CYTMA568

Technical Reference Manual (TRM)

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Cypress Semiconductor
198 Champion Court
San Jose, CA 95134-1709

Phone (USA): 800.858.1810
Phone (Intnl): 408.943.2600
http://www.cypress.com

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Contents Overview

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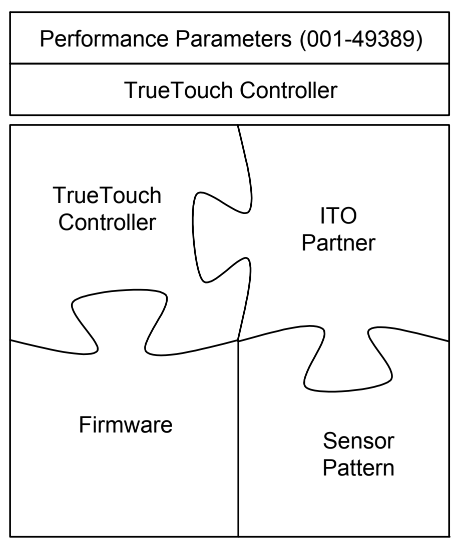
Section A: Overview

The TrueTouch® solution delivers all of the components needed to create a touchscreen solution. The Cypress TrueTouch solution includes the touchscreen device, sensor requirements, pre-qualification of ITO partners, manufacturing test, and business process tools (datasheet and project management). The TrueTouch solution enables development teams to quickly and easily get exciting new systems through development and into production.

TrueTouch is a register-programmable, general-purpose touchscreen system solution, not a low-level sensing development platform. The TrueTouch solution focuses on working at the level of a customer's functional and performance requirements documented in *TrueTouch® Touchscreen Controller Performance Parameters* (Cypress document 001-49389). Figure 1 illustrates the hierarchy of TrueTouch and the component dependencies that the CY8CTMA568 solution addresses. First, the TrueTouch approach establishes a common language for performance between Cypress (field and factory), the customer, and Cypress's ***qualified ITO partners***. Next, it offers customers specific combinations of performance and functionality, as described in the device datasheet.

Figure 1. TrueTouch Hierarchy



The datasheet covers the application solution that focuses on using the language of the *TrueTouch Touchscreen Controller Performance Parameters* (Cypress document 001-49389). The datasheet is the result of the analysis and testing of a combination of the TrueTouch devices, sensor patterns (Diamonds, Manhattan, and SLIM®), and various ITO partners' stackups.

TrueTouch performance specifications are documented in the controller datasheet. TrueTouch performance is defined in terms of the end application performance metrics, such as accuracy and response time. The definition for each of these metrics is documented in the *TrueTouch Touchscreen Controller Performance Parameters* (Cypress document 001-49389).

Document Organization

This manual is organized into sections and chapters according to subject matter. Most chapters within the sections have an introduction, a functional description, and a discussion of applicable ***parameters***. The sections are:

- **Overview** – Presents an overview of the Cypress TrueTouch solution, lists reference documents, chronicles document history, and presents document conventions.
- **TrueTouch® Tools** – Discusses the available Cypress TrueTouch tools and at which phase of product development the tools enable quicker time to market using the CY8CTMA568 device.
- **Host Interface** – Provides information regarding the interface between the TrueTouch device and host including: communication protocol, device startup, bootloading, and hardware connection, touch data acquisition, and command details.
- **Configuration Data** – Describes the three blocks of flash memory that the host can modify.
- **Glossary** – Defines the specialized terminology used in this manual.

This chapter discusses the scope and performance of the TrueTouch CY8CTMA568 device and related documentation.

Related Documents

Cypress' TrueTouch technology is Cypress confidential information and is protected through a Non-Disclosure Agreement (NDA). The documents are not publicly available on the Cypress website. Contact your local Cypress office to request any of these documents pursuant to the aforementioned NDA.

Table 1. Cypress Reference Documents

Document Number	Document Title	Description
Product Specifications		
001-82145	CY8CTMA568 TrueTouch® Multi-Touch All-Points Touchscreen Controller	The datasheet contains features, touchscreen performance and electrical specifications, and package information.
001-87666	CY8CTMA568 TrueTouch® Technical Reference Manual	
001-87774	CYKT55 TrueTouch® Evaluation Kit User Guide	Describes how to setup the kit and use the kit with host emulator software
001-87772	CYKT55 TrueTouch® Evaluation Kit Quick Start Guide	Guide used to quickly get the kit setup and running
001-87715	CY8CTMA568 Touchscreen Controller Tuning Best Practices	Contains tuning guidance during system development
001-85948	Touchscreen Manufacturing Test with CY8CTMA54X and CYTMA568	Contains information on how to create a manufacturing test suite.
Solution Specifications		
001-49389	TrueTouch® Touchscreen Controller Performance Parameters	Contains Cypress touchscreen performance parameter definitions, justification for parameters, and parameter test methodologies.
001-50467	TrueTouch® Touchscreen Controller Module Design Best Practices	A system-level design guide for building a capacitive touchscreen module, covering topics such as touchscreen traces, shielding, mechanical design, FPC/PCB design, and LCD considerations.
001-72845	Design Guidelines for Cypress Quad Flat No Extended Lead (QFN) Packaged Devices - AN72845	Describes the design guidelines to be followed for using QFN packages from Cypress.
001-81514	Using CY8CTMA4/5XX I^2C in Systems With Slow Clock Edges	Discusses how to ensure proper I^2C functionality in extreme bus conditions.
001-83948	TrueTouch® Host Emulator Guide	Describes the TrueTouch® Host Emulator Software
001-63571	CY3295-MTK TrueTouch® Manufacturing Test Kit User Guide	Describes the CY3295-MTK Manufacturing Test Kit
001-60750	CY3295-TTBRIDGE 2.0 TrueTouch® Development Kit Guide	Describes the CY3295-TTBRIDGE 2.0 Development Kit
001-59350	CY8CKIT-002 MiniProg3 User Guide	Describes the MiniProg3 Hardware
001-81891	TrueTouch® Driver for Android (TTDA) User Guide	Contains information on the Android TrueTouch driver
001-85104	TrueTouch® Driver for WinPhone8 (TTDW) User Guide	Contains information on the Windows Phone 8 TrueTouch driver
001-79938	Design Guidelines for Cypress Ball Grid Array (BGA) Packaged Devices - AN79938	Describes the design guidelines to be followed for using BGA packages.

Document History

This section serves as a chronicle of the *CYTMA568 Technical Reference Manual (TRM)*.

Table 2. Technical Reference Manual History

Version	Originator	Description of Change
**	KXK	Initial release

Documentation Conventions

Table 3. Document Conventions

Convention	Usage
Italics	Used for file names and paths, and reference documentation: Read about the *sourcefile.hex* file in the *PSoC Designer User Guide*. Used for parameter names Determine the *Finger Threshold* value.
Bold Italics	Used for terms described in the Glossary of this manual.
Bold	Used for commands, menu paths, and GUI elements in procedures: Click the **File** icon and then click **Open**.
[**Bracketed, Bold]**	Used for keyboard commands in procedures: [**Enter**] or [**Ctrl**] [**C**]
File > **Open**	Represents menu paths: **File** > **Open** > **New Project**
Times New Roman	Used for equations: $2 + 2 = 4$
Courier New	Used for code examples: `-BBootloaderRAM:0` `-BInterruptRAM:0`
Parameter Group > Parameter > Field	Used for TTHE Configurable Parameters and Configurable Registers.

Register Conventions

This table lists the register conventions that are specific to this manual. A more detailed set of register conventions is located in the CYTMA568 Configuration Data Details chapter on page 151.

Table 4. Register Conventions

Convention	Example	Description
'x' in a register name	ACCxxCR1	Multiple instances/address ranges of the same register
R	R : 00	Read register or bit(s)
W	W : 00	Write register or bit(s)
L	RL : 00	Logical register or bit(s)
C	RC : 00	Clearable register or bit(s)
00	RW : 00	Reset value is 0x00 or 00h
XX	RW : XX	Register is not reset
x,	x,F7h	Register exists in multiple register sets
.xxh	Te,xxh	Register address is indeterminate
Empty, grayed-out table cell		Reserved bit or group of bits, unless otherwise stated

Numeric Naming

Hexadecimal numbers are represented with all letters in uppercase with an appended lowercase 'h' (for example, '14h' or '3Ah'); ***hexadecimal*** numbers may also be represented by a '0x' prefix, the ***C*** coding convention. The notation for ***binary*** numbers is an appended lowercase 'b' (for example, '01010100b' or '01000011b'). Numbers not indicated by an 'h' or 'b' are ***decimal***.

Units of Measure

This table lists the units of measure used in this manual.

Table 5. Units of Measure

Symbol	Unit of Measure
°C	degrees Celsius
μA	microamperes
μF	microfarads
μs	microseconds
μV	microvolts
Ω	ohms
b	bits
dB	decibels
fF	femtofarads
Hz	hertz
k	kilo, 1000
K	2^{10}, 1024
KB	1024 bytes
Kbit	1024 bits
Kbps	kilobits (1024 bits) per second
kHz	kilohertz

Table 5. Units of Measure *(continued)*

Symbol	Unit of Measure
kΩ	kilohms
Mbps	megabits per second
MHz	megahertz
MΩ	megaohms
mA	milliamperes
mm	millimeters
ms	milliseconds
mV	millivolts
nA	nanoamperes
ns	nanoseconds
nV	nanovolts
pF	picofarads
pp	peak-to-peak
ppm	parts per million
s	seconds
sps	samples per second
V	volts

Acronyms

This table lists the acronyms that are used in this manual.

Table 6. Acronyms

Acronym	Description
AC	alternating current
ACK	acknowledge
ADC	analog-to-digital converter
API	Application Programming Interface
ASSP	application specific standard product
BCP	bridge control panel
BIST	built in self test
CPU	central processing unit
COMM_INT	communication interrupt
CRC	cyclic redundancy check
DC	direct current
DFT	design for test
ECO	external crystal oscillator
ESD	electrostatic discharge
EVK	evaluation kit
FPC	flexible printed circuit
FW	firmware
GPIO	general purpose I/O
GUI	graphical user interface
HIDI^{2}C	Microsoft HID over I^{2}C
I^{2}C	inter integrated circuit
ID	identifier
IDAC	current digital-to-analog converter (I = current)
ILO	internal low speed oscillator
IMO	internal main oscillator
I/O	input/output

Table 6. Acronyms *(continued)*

Acronym	Description
ISSP	in system serial programming
ITO	indium tin oxide
LCD	liquid crystal display
LSb	least significant bit
LSB	least significant byte
MISO	master-in-slave-out
MOSI	master-out-slave-in
MSb	most significant bit
MSB	most significant byte
MTK	manufacturing test kit
NAK	negative acknowledge
NDA	non-disclosure agreement
PC	personal computer
PCB	printed circuit board
POR	power on reset
PSoC®	Programmable System-on-Chip
RAM	random access memory
RC	resistor-capacitor
RX	receiver/reception
RW	read/write
SCL	I^2C serial clock
SCLK	serial peripheral interface clock
SDA	I^2C serial data
SNR	signal-to-noise ratio
SPI	serial peripheral interface
SRES	software reset
SS	slave select
TBD	to be defined
TMA	TrueTouch multitouch all-points
TRM	technical reference manual
TTHE	TrueTouch host emulator
TX	transceiver/transmission
UART	universal asynchronous receiver/transmitter
USB	universal serial bus
WDR	watchdog reset
WDT	watchdog timer
XRES	external reset

Section B: TrueTouch® Tools

The TrueTouch® Tools section discusses software tools used to explore applications of the CY8CTMA568 parts. For the most up-to-date software and firmware version information refer to the TrueTouch CY8CTMA568 Product Family Release Notes (Cypress document 001-82336). All software, kit contents, and documentation are covered by the non-disclosure agreement (NDA) that your company has executed with Cypress. To obtain this document, contact your Cypress representative. For the most up-to-date software and firmware version information refer to the TrueTouch CY8CTMA568 Product Family Release Notes (Cypress document 001-82336). This section includes the following chapters:

1. TrueTouch® Host Emulator and Evaluation Kit

1.1 CYTK55 Evaluation Kit

The CYTK55 TrueTouch® Evaluation Kit (EVK) is a touchscreen evaluation platform based on the Cypress CY8CTMA568 device. This evaluation kit includes all of the hardware and software you need to configure, optimize, and test touchscreen designs. See the*CYTK55 TrueTouch Evaluation Kit User Guide* (Cypress document 001-87774), for more information about the EVK.

1.2 TrueTouch Host Emulator (TTHE)

With TrueTouch® Host Emulator (TTHE), you can test or emulate touchscreen designs before an end system or host processor is available for evaluation. This tool helps to configure, tune, and debug TrueTouch devices. It drastically reduces design cycle time by making it unnecessary to compile source code, generate the device image, and program the image into the device's nonvolatile memory. The software along with the interface bridge, or TrueTouch Bridge (see "TrueTouch Bridge (TTBridge)" on page 24) helps to emulate and assess touchscreen performance before the end system is available for evaluation.

To test a touchscreen design with TTHE running on a PC, use the Cypress TrueTouch Bridge. The TrueTouch Bridge connects to the touchscreen controller's communication interface and bridges the data between the controller and the host emulation software running on the PC.

TrueTouch Host Emulator includes these features:

- Supports CY8CTMA568 devices
- Supports an I^2C and SPI interface between the TrueTouch Bridge and the controller
- Optimized slot table generation wizard
- Supports bootloading a Cypress CYACD file into the device
- Supports read/write to user-configurable registers
- Supports programming a hex file to the device
- Allows setting (in the Project Configuration window) device family selection, configuration and interface selection, interrupt/wake pin selection, and interrupt/polling mode configuration
- Supports configuration of the hardware parameters of the touchscreen
- Displays touch information and status in text and graphical form
- Displays sensor data (raw counts, difference counts, baseline, and so on) in graphical format in Configuration and Test mode.
- Supports Touch ID and Touch Event data logging (displayed in a field box and can be copied)
- Supports sensor data logging
- Allows saving user settings in a configuration file
- Automatically updates the TrueTouch Bridge firmware
- Supports register access in System Information mode

To explore the features of TrueTouch Host Emulator, see the TrueTouch Host Emulator Guide (Cypress document 001-83948) or the Help section of the GUI. For guidance on configuring a TTHE project with the CYTMA568 device see the *CYTK55 EVK User Guide* (Cypress document 001-87774) or *CYTK55 EVK Quick Start Guide* (Cypress document 001-87772).

1.2.1 Registers and Parameters

This section gives further details on several TTHE Configurable Registers [RAM] and Configurable Parameters [Flash] used with the CYTMA568.

1.2.1.1 Configurable Registers [RAM]

Although the configurable registers can be changed in TTHE, the values are not retained by the device during reset or power off. Each RAM based configurable register has a flash-based register that stores the default value. See "Configurable Registers[RAM]" on page 182 for more information on each configurable register. The initial values after a reset can be configured by TTHE in Configurable Parameters [Flash] under the Device Setup section.

1.2.1.2 Configurable Parameters [Flash]

The configurable parameters can be changed in the TTHE and saved in the device configuration. They may also be changed by the host in the Configuration and Test mode. These values are retained during reset or power off. See "Configurable Parameters[FLASH]" on page 152 for the full list of configurable parameters and the definitions.

1.3 TrueTouch Bridge (TTBridge)

The TrueTouch® Bridge is the interface between the TrueTouch Host Emulator (TTHE) and the CY8CTMA568 controller. This interface facilitates testing and validation using the TTHE GUI. The TrueTouch Bridge allows flexibility with different programming and debugging interfaces for a variety of touchscreen devices. These interfaces include in-system serial programming (ISSP), I^2C, serial peripheral interface (SPI), and universal asynchronous receiver/transmitter (UART).

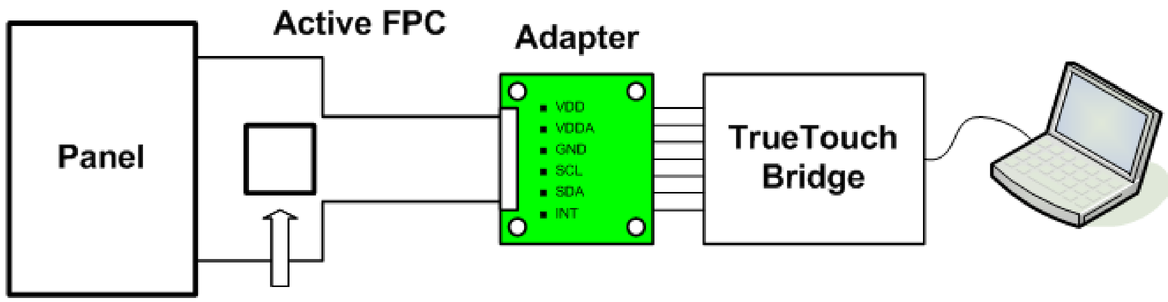
In addition, the TrueTouch Bridge allows communication with target devices using I/O voltage levels from 1.8 V to 5.0 V. The TrueTouch Bridge can also provide two continuous power sources from 1.8 V to 5.0 V to a target board.

The TrueTouch Bridge supports:

- ISSP programming function
- SWD programming and debug function
- USB-I^2C host function
- USB-SPI host function
- USB-UART debug function (receive only)
- TrueTouch mouse demo function
- TrueTouch automated test function
- Device upgrade capability through USB bootloader
- Two power sources
- USB connection

For details about TrueTouch Bridge hardware and software use, see the *TrueTouch Bridge Kit Guide* (Cypress document 001-60750). To use TrueTouch Bridge as an interface between TrueTouch devices and the host, set the VCOM voltage less than or equal to VAUX voltage. If the device is powered through the TrueTouch Bridge, VCOM is used as the power source for the digital core of the device (V_{DDD}) and VAUX for the I/Os and analog core (V_{DDA}). See the kit guide for information about adjusting the VCOM and VAUX supplies. The datasheet has details about setting the analog and digital voltages for the device. The CY8CTMA568 is connected to the TrueTouch Bridge through an adapter board.

Figure 1-1. TrueTouch Bridge Setup



1.4 Bridge Control Panel

Bridge Control Panel software (BCP) is used with the TrueTouch® Drivers to communicate with I^2C/SPI devices, including TrueTouch controllers. This program configures I^2C/SPI devices acquires and processes data received from I^2C/SPI slave devices. The Bridge Control Panel helps to optimize, debug, and calibrate the target applications. Several Bridge Control Panel scripts or commands are referenced throughout this document. These scripts and commands may be copied from this document and pasted into the BCP software to communicate with the device. The BCP software is installed by the TrueTouch Host Emulator (TTHE) installer.

Here are the main features of the application:

- Controls the power supply of connected devices
- Supports two protocols: I^2C and SPI
- Searches and displays a list of devices connected to the bridge
- Works with connected devices in manual and automatic modes
- Supports high-speed data reading from slave devices (ToFile mode of bridge)
- Configures the bridge to work on 50, 100, and 400 kbps CLK speed on an I^2C bus
- For SPI protocol support, selects shift direction type (MSB First, LSB First), mode (00 and 01), and frequency
- Supports simple format for output and input data for communication
- Interprets the input data as variables of varying length
- Supports many possibilities of variables settings such as type, scaling, and offset
- Supports a variety of data presentation and storage options through charts, tables, and other formats
- Saves and loads variable configurations for use with different I^2C slaves
- Saves and loads commands line files
- Supports the I^2C bootloader file format

2. TrueTouch® Manufacturing Test Kit

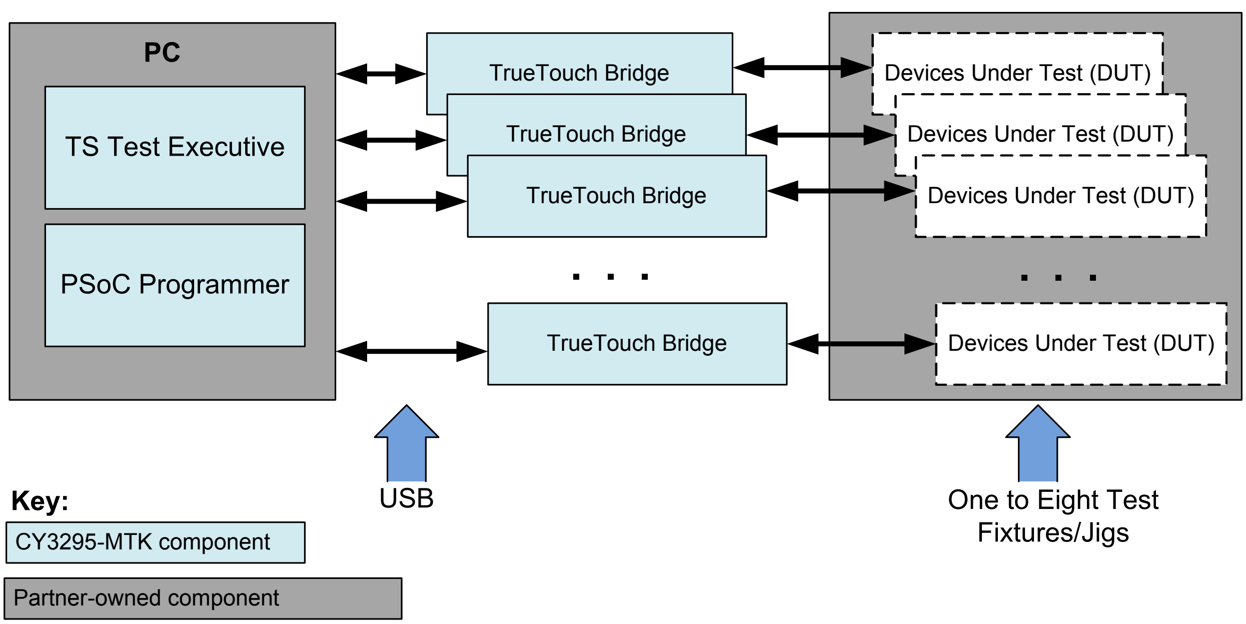
The CY3295-MTK TrueTouch® Manufacturing Test Kit (MTK) increases yield and improves touchscreen quality. MTK provides customers and ITO partners the ability to test touch panels that use Cypress TrueTouch controllers. The kit consists of a Windows® PC application and the TrueTouch Bridge (see "TrueTouch Bridge (TTBridge)" on page 20), a small printed circuit board (PCB) that provides USB-to-I^2C or USB-to-SPI communications along with device programming. MTK enables manufacturing test of touchscreens and the TrueTouch device through several stages of the manufacturing flow including:

- Bare sensor array
- Array with FPC (with or without touchscreen controller on the FPC)
- Array with FPC laminated to cover glass
- Array with integration to LCD

Figure 2-1 shows a high-level block diagram of a test system using this kit. Up to eight TrueTouch Bridge devices can be attached to one PC to test multiple panels simultaneously. The tests done by this kit are production quality and use the built-in test capabilities of the TrueTouch controllers. This kit can be used for early touch panel development and prototype testing, as a final test solution, or as a demonstration of how to implement a custom production test solution.

For device specific test suite information see the CY3295-MTK TrueTouch Manufacturing Test Kit User Guide (Cypress specification 001-63571). See the *Touchscreen Manufacturing Test with CYTMA568* (001-85948) for implementing MTK tests in the host processor software.

Figure 2-1. Manufacturing Test System Block Diagram



3. TrueTouch® Drivers

Cypress's provides a Windows Phone 8 and Android driver to enable developers to quickly integrate Cypress TrueTouch devices into mobile touchscreen applications. Cypress drivers and documents are available under NDA through your local Cypress sales representative or field applications engineer. You can also direct your requests to TrueTouch@cypress.com.

3.1 TrueTouch Driver for Android (TTDA)

Cypress's TrueTouch® Driver for Android (TTDA) enables developers to quickly integrate TrueTouch devices into mobile touchscreen applications that run Android OS. TTDA services TrueTouch device touch reports, parses the touch signals and sends a message to the Android platform layer. The driver components are modular and can be readily integrated into products with either I^2C or SPI host to touchscreen device interfaces.

TTDA services touchscreen device touch reports, parses the touch signals, packs a Linux event with the touch signals as motion signals, and then submits the packed event to the Linux event handling system. This event handling system passes the event information to the Android platform layer which passes the event to requesting applications as a Motion Event.

TTDA is based on Linux bus driver devices and uses Linux module based functions to provide the hardware bus and platform system interfaces. Cypress?s custom User Modules can subscribe for data from the core functions allowing you to quickly create innovative designs. TTDA includes Linux Multi-touch Protocol B platform signaling for coordinate data. This adds slot signaling and associates each track (touch) id with a slot number, making the TTDA suitable for submission to the Linux repository for upstream release into the global Linux community.

TTDA uses Linux modules for interfaces. The following items are supplied:

- TTSP Bus Handler
  - Linux bus type
  - Uses Linux defined bus structure
- Core Module
  - TTSP Bus defined Core Device structure (Core Device)
  - TTSP Bus defined Core Driver structure (Core Driver)
- TTSP Modules
  - TTSP Bus defined Device structure (TTSP Device)
  - TTSP Bus defined Driver structure (TTSP Driver)
- Adapter Modules
  - TTSP Bus defined Adapter structure (Adapter Device)
  - Linux Host Bus defined Driver structure
- Interface Adapters
  - I^2C Adapter Device and Driver
  - SPI Adapter Device and Driver
- CapSense Button Module
- Debug Module
  - Print in human or machine readable format using a standard file system (sysfs) switch

  - TTHE interface support
- Device Access Module
  - Includes TTHE interface
- Manual ADB Loader
  - Uses firmware class with manual concatenate file to loader firmware class sysfs
- Automatic Over the Air (OTA) Loader
  - Occurs at boot-up
  - Uses firmware class with optionally built-in firmware file

3.2 TrueTouch Driver for Windows (TTDW)

TrueTouch® Driver for Windows Phone 8 (TTDW) converts touch and button reports to human interface device (HID) touch pointer reports. The button HID reports are activated along with a method to support virtual keys as they are defined in WinPhone8. The driver also has the firmware loading capability using a file based mechanism. It also provides a file-based touch tuning parameters update mechanism and registry-controlled IDAC calibration initiation.
TTDW uses NT modules for interfaces. The following items are supplied:

- Phase 1 – Startup (Uses registry-based mechanism which informs the driver to perform startup tasks)
  - TrueTouch device firmware load (binary image file stored in Windows Phone 8 file system)
  - TrueTouch configurable parameters update
  - Sensor calibration
  - Button calibration
- Phase 2 – Operational (Converts data to HID records)
  - Touch data
  - Button data
- Interrupt processing
  - CapSense button INT processing
  - Multi-touch sensor INT processing

Section C: Host Interface

The Host Interface section gives you the necessary background information to connect the application processor, known as a host, to the TrueTouch controller. The host physically connects to the device using a physical communication interface and uses a register access communication protocol over that physical interface to retrieve touch reports, perform device firmware updates in the field, manufacturing test, and retrieve touch/button reports. This section contains these chapters:

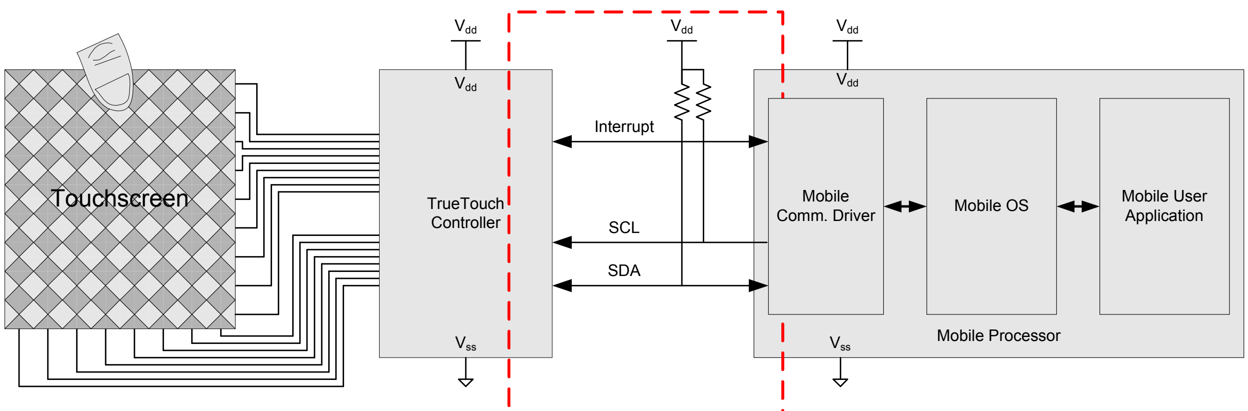
4. Physical Communication Interface

The TrueTouch device exposes an I^{2}C and SPI communication interface with the host. This facilitates run-time configuration, operational data transfer, and field firmware upgrades. Using an interrupt pin to notify the host when new data is available enables low-power operation by eliminating unnecessary polling by the host.

4.1 Functional Description

Two hardware interfaces work together to communicate with the host. The primary communication interface is a packet based protocol operating over an I^{2}C or SPI interface. The secondary communication interface is a unidirectional communication interrupt (COMM_INT) pin used for event notification to the host, and optionally for wake up from deep sleep. The external resistor is an optional pull-up resistor that is needed based on configuration of the COMM_INT pin (see “Communication Interrupt Pin (COMM_INT)” on page 34 for details).

System Diagram



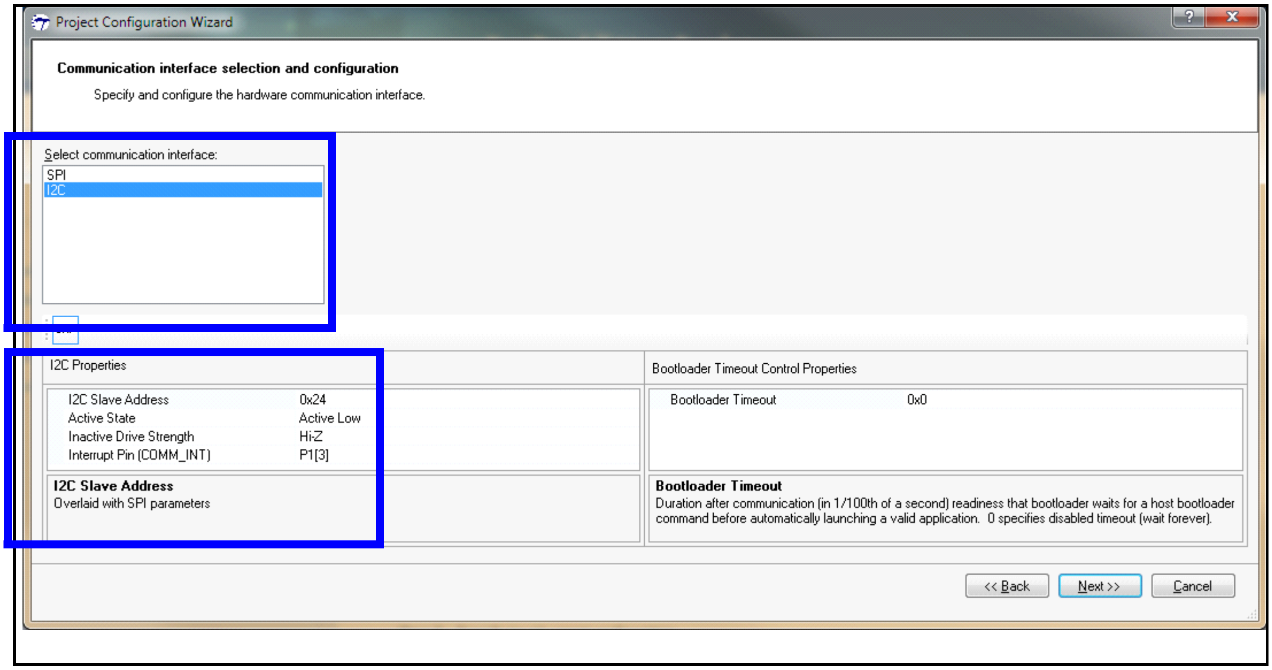
4.2 Configuring the Physical Communication Interface

The communication interface settings are configured in the TTHE Project Configuration Wizard, shown in Figure 4-1, and cannot be changed during run-time. The communication settings are:

- **Physical Communication Interface:**
  - **I^{2}C and SPI:** Selects the physical communication interface.
- **I^{2}C Properties:**
  - **I^{2}C Slave Address:** Sets the I^{2}C slave address (only exposed if the selected Communication Interface is I^{2}C). The following addresses are not valid options: 0h-7h, 78h-7Fh, and odd addresses.
  - **Active State:** Selects between Active Low and Active High COMM_INT configurations
  - **Inactive Drive Strength:** Selects whether the inactive drive strength of the I^{2}C pins are configured to Hi-Z (for use with an external resistor) or resistive (internal pull-up or pull-down).

- Interrupt Pin (COMM_INT): Selects whether P1[3] or P1[0] is used as the communication interrupt (COMM_INT) pin.**SPI Properties:**
  - **Clock Phase:** Selects whether the clock phase is input on leading edge or input on trailing edge.
  - **Clock Polarity:** Selects whether the clock polarity is idle low or idle high.
  - **Active State:** Selects between Active Low and Active High COMM_INT configurations
  - **Inactive Drive Strength:** Selects whether the inactive drive strength of the I^{2}C pins are configured to Hi-Z (for use with an external resistor) or resistive (internal pull-up or pull-down).
  - Interrupt Pin (COMM_INT): Selects whether P1[3] or P1[0] is used as the communication interrupt (COMM_INT) pin.

Figure 4-1. Physical Communication Configuration



4.3 Communication Interrupt Pin (COMM_INT)

The TrueTouch device asserts the communication interrupt pin (COMM_INT) to notify the host that an event requiring interaction over the primary communication bus has occurred. The pin is unidirectional and may be configured active high or active low. The inactive drive strength can also be configured as internally resistive or high-impedance which requires an external resistor to pull the pin state to the deasserted/inactive state. These configurations are active immediately after a device reset and do not require initialization by the device firmware. The configuration of the COMM_INT pin cannot be modified during device operation.

The TTHE Project Configuration Wizard configures the COMM_INT pin, and the configuration is downloaded to the device from TTHE or the host controller. It is recommended that the COMM_INT polarity is selected such that the host device is responding to the leading edge of the COMM_INT assertion. This will provide an improvement in the response time of the host to the TrueTouch device. Using the internal termination (pull-up or pull-down) will reduce the number of parts on the circuit board.

4.4 I^{2}C Communication Interface

The Inter-Integrated Circuit (I^{2}C) bus is a common communication interface for touchscreens and is supported by CYTMA568. When I^{2}C is used in a touchscreen design, the TrueTouch controller is the I^{2}C slave, and the host processor is the I^{2}C master. The CYTMA568 I^{2}C includes these features:

- Fully I^{2}C-compliant
- Bit rate up to 3.4 Mbps

4.4.1 I^{2}C Slave Address

The I^{2}C protocol uses a ***shared bus*** for multiple devices. To uniquely identify each device, an I^{2}C slave address is used. The I^{2}C slave address is a 7-bit value, which allows up to 127 slaves on the bus simultaneously. Because CYTMA568 has a 512 bytes communication register space, it requires two consecutive I^{2}C addresses, one for the lower 256-byte register block and one for the upper-256 byte register block. When the bus master wants to communicate with a slave on the bus, it sends a start condition followed by the I^{2}C address of the relevant slave. The start condition alerts all slaves on the bus that a new transaction is starting. All slaves that do not match the I^{2}C address sent will ignore all further traffic on the bus until the next start condition is detected.

The CYTMA568 is addressed through two I^{2}C addresses. The two addresses are used to expand the available address space, as described in “Communication Protocol” on page 35. The I^{2}C address requirements are as follows:

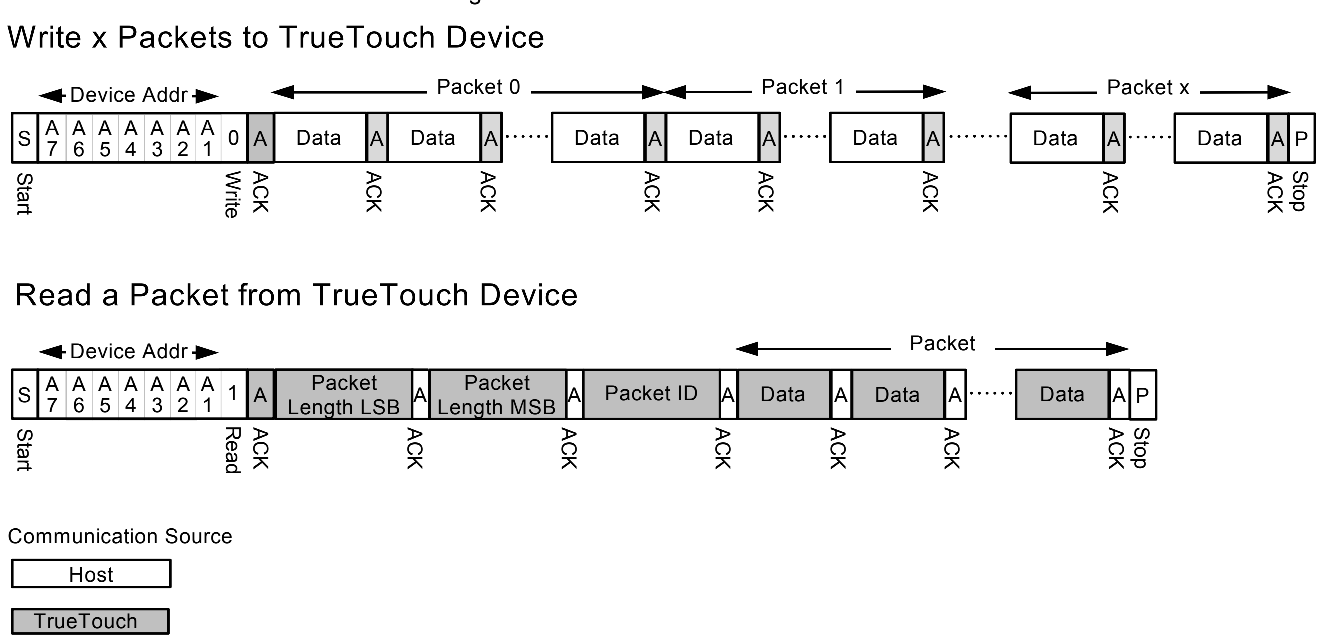
- The base address must be even
- The second address must be the next immediate higher address
- The base address must be within the range 0x08 and 0x118

If the I^{2}C address is changed, the new hex file containing the change must be programmed using SWD mode and not bootloader mode. The reason for this is that bootloader mode uses this address shared with the touch system and therefore prohibits this change as a safeguard.

4.4.2 Communication Protocol

The TrueTouch controller is communicated using a simple protocol illustrated in Figure 4-2. The read and write data is arranged in packets and the length of each packet varies depending on the device commands. In the write operation initiated by the host, multiple packets can be written to the TrueTouch controller. In the read operation, the length of each packet and the packet ID are included in the first three bytes after the first acknowledge.

Figure 4-2. I^{2}C Communication Protocol



4.4.3 Usage

The host can choose to initiate a transaction at any time. The most common use case is that the host responds to assertion of the COMM_INT pin, and immediately retrieves data from the register map (interrupt-driven polling). The less common use case is asynchronous register map access. The typical reason for this use case is to send a command to enter deep sleep or to change mode.

4.4.4 Power Management

For lowest power consumption, I^2C bus traffic must be minimized. Furthermore, the I^2C bus must be idle (SDA and SCL both high) during periods of communication inactivity. An I^2C slave address match can be configured to be a deep sleep wakeup event. I^2C activity that does not match the slave address will increase power consumption in the I^2C block as it determines whether there is an address match, even though the rest of the TrueTouch controller remains in sleep. See Device Setup Configuration Parameters in the Configurable Parameters[FLASH] register on page 152.

4.4.5 Pin Status During Reset

During a reset, the I^2C pins (SCL and SDA) are tri-stated.

4.5 SPI Communication Interface

The Serial Peripheral Interface (***SPI***) bus is a common communication interface for touchscreens and is supported by CYTMA568. The TrueTouch controller is an SPI slave and the host is the SPI master. The TrueTouch controller operates as an SPI slave. Figure 4-3 on page 37 shows a basic system diagram and Figure 4-4 indicates sequencing and protocol details.

SPI features supported by CYTMA568 include:

- SPI Modes 0, 1, 2, 3
- ***Most-significant bit (MSbit)***-first bit order

Figure 4-3. System Diagram

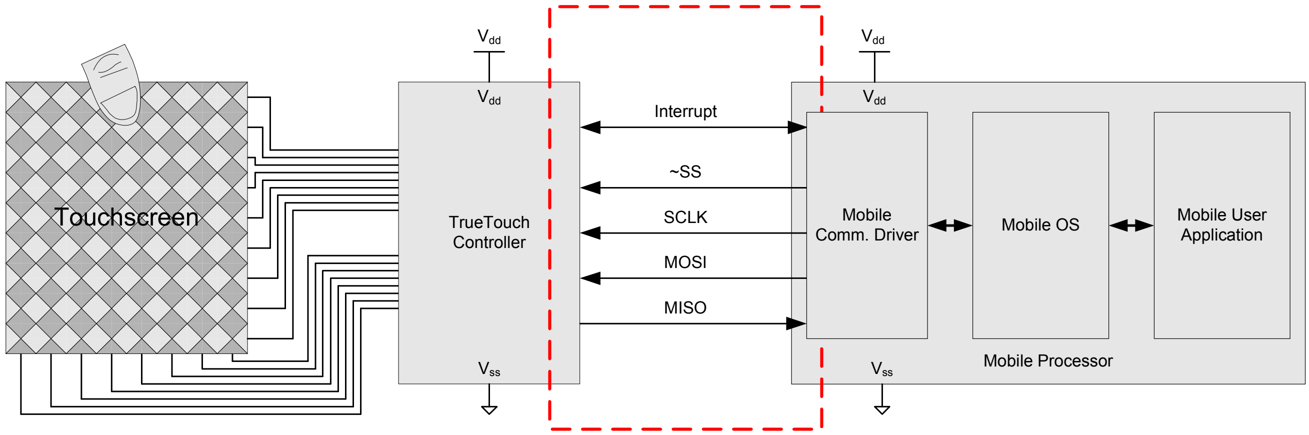
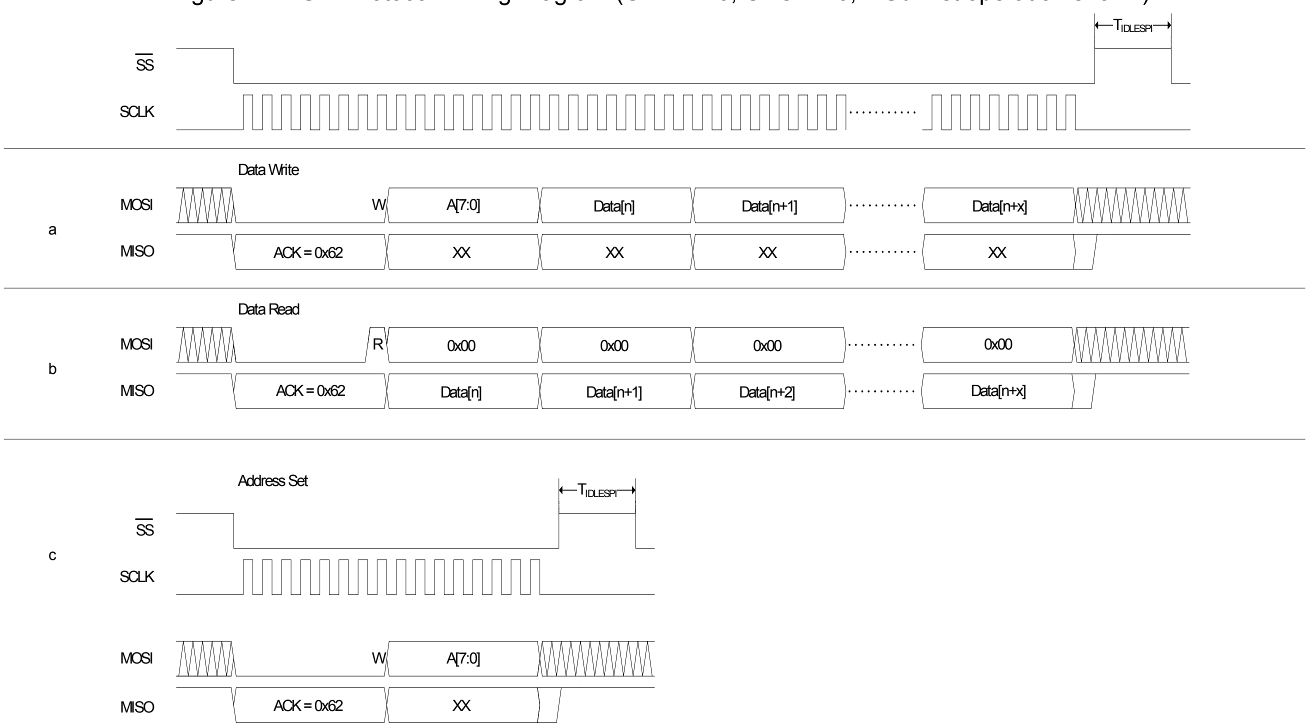


Figure 4-4. SPI Protocol Timing Diagram (CPHA = 0, CPOL = 0, MSb-first operation shown)



Note SPI Mode 0 with MSb-first bit order shown.

4.5.1 Initiating and Terminating SPI Communication

The host must activate Slave Select ($\overline{SS}$) to initiate an SPI transaction. After activating $\overline{SS}$, the host may execute a register map read or write, according to the register access protocol. The host may terminate an SPI transaction at any time by deactivating the $\overline{SS}$ line. After deactivating $\overline{SS}$, the host must wait a minimum of $T_{IDLESPI}$ before activating $\overline{SS}$ again to initiate a new SPI transaction. One register access protocol command (read or write) is executed per SPI transaction.

4.5.2 Register Access Protocol

There are three types of SPI data transactions: Data Write, Address Set, and Data Read.

- A Data Write command consists of a command byte, an address byte, then the data to be written. The command byte will have bit[0] cleared to indicate a data write and bit[1] is the MSB of the register pointer (see Figure 4-4 a).
- A Data Read command consists of a command byte, then dummy bytes sent while the data is read from the device. The command byte will have bit[0] set to indicate a data read. Bit[1] should be set to 0 (see Figure 4-4 b).
- An Address Set command consists of a command byte and an address byte. This is the same as the first two bytes of a Data Write command (see Figure 4-4 c).

Bit 0 (R/W bit, the least significant bit) of the first byte specifies whether the host is writing data to or reading data from the TrueTouch controller. Bits 1 to 7 of the command byte are reserved for future definition by Cypress, and should be cleared.

If the R/W bit is cleared, the host is writing data to the register map. Each byte sent by the host in the data phase is written into consecutive registers starting from the specified starting register address. All data sent from the TrueTouch controller in the data phase of this transaction is undefined. If the host attempts to write past the end of the register map, all incoming data is ignored after all valid registers have been written.

If the R/W bit is set, the host is reading data from the register map. Each byte sent by the TrueTouch controller in the data phase is read from consecutive registers starting from the specified starting register address. The TrueTouch controller ignores all data sent from the host in the data phase. If the host attempts to read past the end of the register map, returned data is undefined after all valid register addresses have been read.

The byte returned by the TrueTouch controller while the host is transferring the command byte is an acknowledgement (ACK) byte indicating whether the TrueTouch controller will service the transaction. An ACK byte value of 0x62 indicates that the TrueTouch controller will service the transaction. Any other value indicates that the TrueTouch controller is not able to service the transaction. It is the responsibility of the master to check the ACK byte and retry a NAKed transaction.

4.5.3 Usage

The host can choose to initiate a transaction at any time. The most common use case is that the host responds to the assertion of the COMM_INT pin, and immediately retrieves data from the register map (interrupt-driven polling). The less common use case is asynchronous register map access. The typical reason for this use case is to send a command to enter deep sleep or to change mode. To ensure data integrity, the host must determine transaction success or failure by examining the ACK byte returned by the TrueTouch controller. The host can execute this examination any time after receiving this byte. Because SPI transactions tend to be fixed-length data streams, the host typically examines the ACK byte after the transaction completes. The host should retry a failed transaction.

4.5.4 Power Management

An $\overline{SS}$ activation can be configured to be a deep-sleep wakeup event.

4.6 Communication Integrity

The communication protocol between the host and the TrueTouch controller is defined to ensure that an unexpected reset of any kind does not confuse the state of the host. For example, a reset is caused by external conditions such as a glitch in the power supply or by an internal firmware issue that forces the ***watchdog timer*** to reset the controller (see “Device Reset” on page 58). An unexpected reset should be extremely rare. If it occurs, normal operation should be resumed as quickly as possible to reduce the impact on the end user.

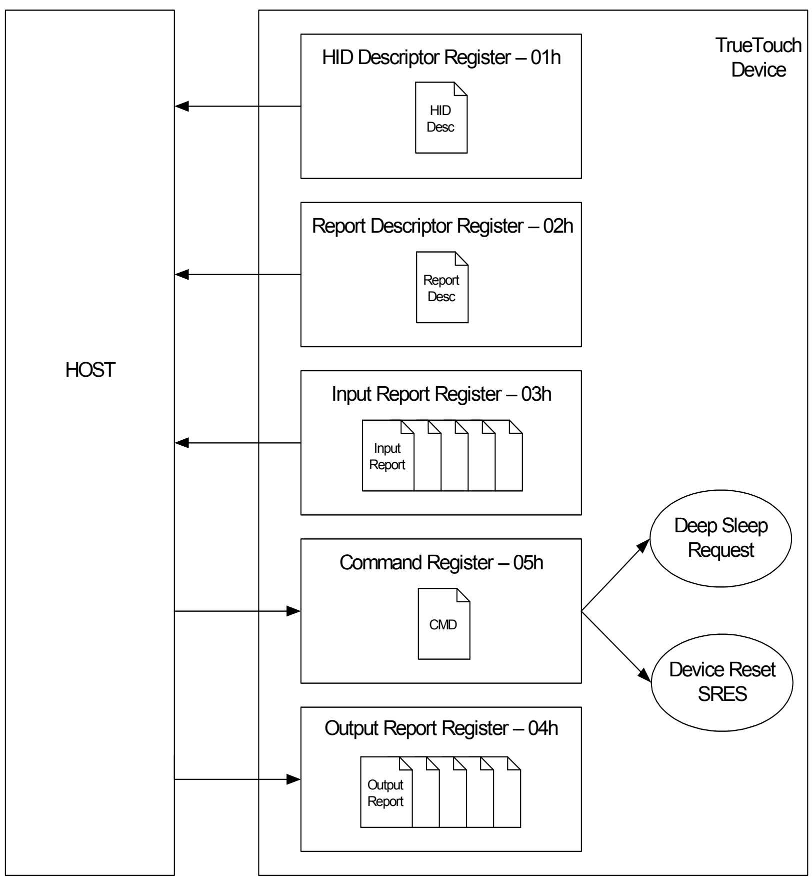
If a reset has occurred, the bootloader will enumerate itself on the communication bus, asserts the COMM_INT pin, and send the reset sentinel to the host (00h 00h). The reset sentinel does not contain a length or packet id header.

5. Packet Interface Protocol (PIP)

Packet Interface Protocol (PIP) is a command and response based communication protocol used to communicate with the TrueTouch device over the physical communication interface. PIP is modeled after Microsoft's HID over I^2C protocol specification, version 1.00. However, PIP extends the functionality of HID over I^2C protocol to support both I^2C and SPI physical communication interfaces, raw data extraction, self-tests, bootloading, and configuration data programming.

Interaction between the TrueTouch device and host processor is performed by reading or writing the PIP registers. Descriptor registers contain meta data describing other registers or what appears in them. PIP has two descriptor registers: HID Descriptor register and Report Descriptor register. HID descriptors summarize data in other registers and top level system info. Report descriptors contain detailed information for each possible report produced by the system. PIP also has an Input register, Output register, Command register, and Data register. Table 5-1 shows a block diagram of the interaction between the host processor and TrueTouch device. A bidirectional arrow represents the capability to write then read with the respective register. The hexadecimal number in the figures denotes the index of each register.

Figure 5-1. Block Diagram of Host and TrueTouch Device Interactions



Each Input Report and Output Report packet has a Report ID to enable the host and device to synchronize what type of request and response is being interpreted. Table 5-1 shows a summary of the Report IDs

Table 5-1. Report IDs

Report ID	Description
FFh	Bootloader HID Descriptor
FEh	Bootloader Report Descriptor
F7h	TrueTouch Application HID Descriptor
F6h	TrueTouch Application Report Descriptor
40h	Bootloader Command (Output Report register)
30h	Bootloader Response (Input Report register)
2Fh	TrueTouch Application Command (Output Report register)
1Fh	TrueTouch Application Command (Input Report register)
0Fh	Start Sensor Data Mode Response (Input Report register)
0Eh	Start Tracking Heat Map Mode (Input Report register)
01h	Touch Report
03h	Button Report
F0h	Deep Sleep Response (Data register)

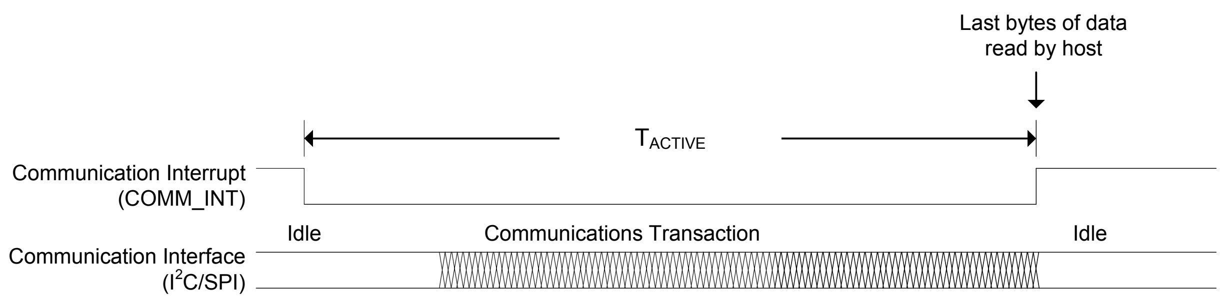
5.1 Communication Handshaking

The TrueTouch device uses a type of communication handshaking called synchronous level. The TrueTouch controller asserts the COMM_INT pin at the end of each scanning/processing cycle. The COMM_INT pin remains asserted until the host reads the entire Input Report register (See Figure 5-2 on page 42).

Scanning and processing are suspended until the last byte of data is read from the Input Report register. This ensures the data returned to the host is up-to-date. A typical sequence is:

1. A scanning/processing cycle completes and the TrueTouch controller asserts the COMM_INT.
2. The host immediately parses the Input Report header to determine the length of the report and reads data.
3. The last byte of data is read by the host and the TrueTouch device de-asserts the COMM_INT interrupt.

Figure 5-2. Synchronous Level Handshaking Timing Diagram



5.2 Register Operations

The TrueTouch device uses a register based read/write protocol over the physical communication interface. For bit-level physical protocol details see Figure 4-2 or Figure 4-4. The device will ignore any register writes to invalid addresses. If the host reads more bytes than the size of the packet, there is no negative impact on the device but data after the last packet byte will be garbage.

The device ignores any attempts by the host to read or write an invalid address. If the host reads more bytes than available in a response packet the data read back are stale values that existed from the last response packet. Reading more data than exists in the buffer will redirect reads to the beginning of the buffer. If the host attempts to write more bytes than allowed by the register buffer, the device will reset.

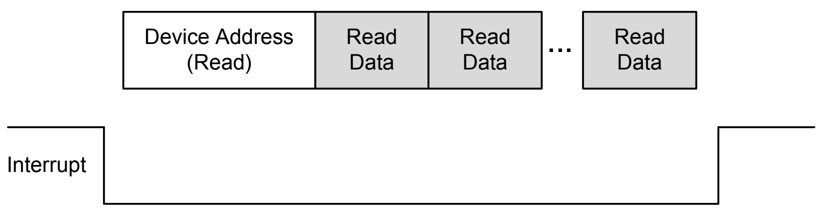
5.2.1 Read/Write Protocol

All data read from the Input Report register, on the TrueTouch device, will have a two byte length header that tells the host how many bytes need to be read. The host may use any of these methods to read the Input Report:

- The host reads the first two bytes to determine the length of the packet and clock-stretches the bus. Then reads the remaining data.
- The host processor reads just the first two bytes to determine the length of the packet, and then reads the entire packet on a second read transaction.
- The host reads the entire Input Report register regardless of how many bytes exist in the packet

When the host writes a command to the Output Report register, the device asserts the COMM_INT pin when the response is available. The device will also assert the COMM_INT pin when a new touch or button report is available. Data is read from the Input Report register by addressing the device for read and then reading the data. There is no need to specify a register address when reading the Input Report (see Figure 5-3).

Figure 5-3. Input Report Register Read



The Output Report and Command register are written to by first addressing the device for a write and specifying the register to write to. The write data follows (see Figure 5-4).

Figure 5-4. Output Report and Command Register Write

Device Address (Write)	Register Address LSB	Register Address MSB	Write Data	Write Data	...	Write Data

The HID Descriptor, Report Descriptor, and Data register are read-only. Data is read from these registers by first addressing the device for a write and specifying the register, then addressing the device for read (see Figure 5-5).

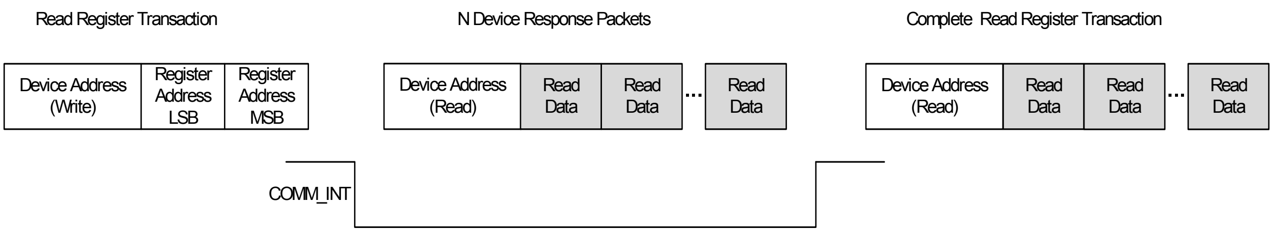
Figure 5-5. HID Descriptor, Report Descriptor, and Data Register Read

Device Address (Write)	Register Address LSB	Register Address MSB	Device Address (Read)	Read Data	Read Data	...	Read Data

Writes may occur asynchronously to the TrueTouch device operations. The device could assert the COMM_INT pin when a new packet is available for the host to read, during a host-initiated a register write. When this occurs the device will allow the host to complete the write, but on the subsequent read the data returned will be the packet response. When all queued response packets are read by the host the device will return the original information requested (see Figure 5-6).

For example, the host may have initiated a read of the HID Descriptor register, when a new touch report becomes available. The host will complete the HID Descriptor register address write, and on will begin reading the touch report packet on the subsequent read transaction. When the entire touch report has been read and the host initiate a new read transaction the device will return the HID Descriptor register.

Figure 5-6. HID Descriptor, Report Descriptor, and Data Register Read Interrupted



5.3 HID Descriptor Register

The HID Descriptor register's address is 0001h. The contents of the HID Descriptor register remain static except when the device transitions from the Bootloader application to the TrueTouch application and visa-versa.

The HID Descriptor register contains:

- Identifier of currently running applications (Bootloader/TrueTouch)
- Size of HID Descriptor
- Vendor, Product, and Version Information
- Size of Report Descriptor
- Offsets for all other PIP registers

Table 5-2. HID Descriptor

Byte	Bootloader Description	TrueTouch App Description	Bootloader Value	Touch App. Value
0	HID Descriptor Length[7:0]		20h	
1	HID Descriptor Length[15:8]		00h	
2	Report ID		FFh	F7h
3	RESERVED		00h	
4	BCD Version[7:0]		00h	
5	BCD Version[15:8]		01h	
6	Report Descriptor Length[7:0]		XXh	
7	Report Descriptor Length[15:8]		XXh	
8	Report Descriptor Register[7:0]		02h	
9	Report Descriptor Register[15:8]		00h	
10	Input Register[7:0]		03h	
11	Input Register[15:8]		00h	
12	Max Input Length[7:0]		00h	
13	Max Input Length[15:8]		01h	
14	Output Register[7:0]		04h	
15	Output Register[15:8]		00h	
16	Max Output Length[7:0]		00h	FEh
17	Max Output Length[15:8]		01h	00h

Table 5-2. HID Descriptor

Byte	Bootloader Description	TrueTouch App Description	Bootloader Value	Touch App. Value
18	Command Register[7:0]		05h	
19	Command Register[15:8]		00h	
20	Data Register[7:0]		06h	
21	Data Register[15:8]		00h	
22	Vendor ID[7:0] (Cypress assigned USB Vendor ID)	Vendor ID[7:0] (Customer Configurable - default is B4h)	B4h	B4h
23	Vendor ID[15:8] (Cypress assigned USB Vendor ID)	Vendor ID[15:8] (Customer Configurable - default is 04h)	04h	04h
24	Product ID[7:0] (PIP v1.0 Bootloader PID)	Product ID[7:0] (Customer Configurable - default is 01h)	00h	01h
25	Product ID[15:8] (PIP v1.0 Bootloader PID)	Product ID[15:8] (Customer Configurable - default is C1h)	C1h	C1h
26	PIP Bootloader Firmware Version[7:0], major version number	Customer-configurable.Version [7:0] (Initial value = CY firmware version) major version number	01h	00h
27	PIP Bootloader Firmware Version[15:8], minor version number	Customer-configurable.Version [15:8] (Initial value = CY firmware version) minor version number	00h	01h
28	RESERVED = 0000 0000h		00h	
29			00h	
30			00h	
31			00h	

5.4 Report Descriptor Register

The Report Descriptor register's address is 0002h. Report descriptors contain detailed information for each possible report produced by the system. The contents of the Report Descriptor register remain static except when the device transitions from the Bootloader application to the TrueTouch application and visa-versa. Report descriptors are formally specified using USB HID item codes specified in: USB HID Usage Tables, Windows Pointer Device Delivery Protocol specification, and Vendor-specific usages (see Table 5-3).

The Vendor Specific usage page ID is specified as FF01h. The Generic Item ID 30h represents a generic set of 1 or more bits. The typical usage for this item is to define sets of bytes (set REPORT_SIZE = 8) that are combined into command packets (output reports) or response packets (input reports) for commands in the touch application and the bootloader.

Table 5-3. Vendor Specific Usages

Usage ID	Usage Target	Usage Description
00h	Undefined	Undefined
01h	Application Collection	Bootloader: Identifies the application collection as belonging to the Bootloader
02h	Application Collection	Touch Application: Identifies the application collection as belonging to the Touch Application
20h	Logical Collection	Buttons
30h	Data	Generic Item.
40h	Data	Large Object
41h	Data	Noise Effects
42h	Data	Report Counter
60h	Data	Touch Type
61h	Data	Event ID
62h	Data	Major Axis Length
63h	Data	Minor Axis Length
64h	Data	Orientation
65h	Data	Button Signal

5.4.1 Bootloader Report Descriptor

```
#define REPORT_DESCRIPTOR_LENGTH        0X1D
#define REPORT_DESCRIPTOR_PACKET_ID     0xFE
    (REPORT_DESCRIPTOR_LENGTH & 0xFF), (REPORT_DESCRIPTOR_LENGTH >> 8), /* Report Descriptor Size */
    REPORT_DESCRIPTOR_PACKET_ID,                                        /* Report Descriptor ID */

    0x06, 0x01, 0xff,              /* USAGE_PAGE (PIP 0xFF01) */
    0x09, 0x01,                    /* USAGE (Bootloader) */
    0xa1, 0x01,                    /* COLLECTION (Application) */
    0x75, 0x08,                    /*   REPORT_SIZE (8) */

    /*****************************************************************************
    * Bootloader Input Report (Report ID 30h)
    *    * Up to 16 bytes (packet content after report ID)
    *****************************************************************************/
    0x85, 0x30,                    /*   REPORT_ID (48) */
    0x09, 0x30,                    /*   USAGE (Generic Item) */
    0x95, 0x10,                    /*   REPORT_COUNT (16) */
    0x81, 0x02,                    /*   INPUT (Data,Var,Abs) */

    /*****************************************************************************
    * Bootloader Output Report (Report ID 40h)
    *
    * Up to 144 bytes (packet content after report ID)
    *****************************************************************************/
    0x85, 0x40,                    /*   REPORT_ID (64) */
    0x09, 0x30,                    /*   USAGE (Generic Item) */
    0x95, 0x90,                    /*   REPORT_COUNT (144) */
    0x91, 0x02,                    /*   OUTPUT (Data,Var,Abs) */

    0xc0                           /* END_COLLECTION */
```

5.4.2 TrueTouch Report Descriptor

```
#define REPORT_DESCRIPTOR_LENGTH       0xEE
#define REPORT_DESCRIPTOR_PACKET_ID    0xF6
    (REPORT_DESCRIPTOR_LENGTH & 0xFF), (REPORT_DESCRIPTOR_LENGTH >> 8), /* Report Descriptor Size */
    REPORT_DESCRIPTOR_PACKET_ID,                                      /* Report Descriptor ID */

    /***************************************************************************
    * Touch Report (Report ID 1)
    *
    * Header Structure
    * Timestamp (Scan Time)             : 16 bits
    * Number of Records (Contact Count):  5 bits
    * Large Object                      :  1 bit
    * Reserved                          :  2 bits (24 total)
    * Noise Effects                     :  3 bits
    * Reserved                          :  3 bits
    * Report Counter                    :  2 bits (32 total)
    *
    * Record Structure
    * Touch Type                        :  3 bits
    * Reserved                          :  5 bits (8 total)
    * Touch ID (Contact Identifier)     :  5 bits
    * Event ID                          :  2 bits
    * Tip (Tip Switch)                  :  1 bit  (16 total)
    * X                                 : 16 bits (32 total)
    * Y                                 : 16 bits (48 total)
    * Pressure                          :  8 bits (56 total)
    * Major Axis Length                 :  8 bits (64 total)
    * Minor Axis Length                 :  8 bits (72 total)
    * Orientation                       :  8 bits (80 total)
    ***************************************************************************/
    0x05, 0x0d,                   /* USAGE_PAGE (Digitizers) */
    0x09, 0x04,                   /* USAGE (Touch Screen) */
    0xa1, 0x01,                   /* COLLECTION (Application) */
    0x95, 0x01,                   /*   REPORT_COUNT (1) */
    0x85, 0x01,                   /*   REPORT_ID (1) */

    /* Touch Report Header Collection */
    0x09, 0x22,                   /*   USAGE (Finger) */
    0xa1, 0x02,                   /*   COLLECTION (Logical) */
    0x05, 0x0d,                   /*     USAGE_PAGE (Digitizers) */
    0x09, 0x56,                   /*     USAGE (Scan Time) */
    0x75, 0x10,                   /*     REPORT_SIZE (16) */
    0x81, 0x02,                   /*     INPUT (Data,Var,Abs) */
    0x09, 0x54,                   /*     USAGE (Contact Count) */
    0x75, 0x05,                   /*     REPORT_SIZE (5) */
    0x81, 0x02,                   /*     INPUT (Data,Var,Abs) */
    0x06, 0x01, 0xff,             /*     USAGE_PAGE (PIP 0xFF01) */
    0x09, 0x40,                   /*     USAGE (Large Object) */
    0x75, 0x01,                   /*     REPORT_SIZE (1) */
    0x81, 0x02,                   /*     INPUT (Data,Var,Abs) */
    0x75, 0x02,                   /*     REPORT_SIZE (2) */
    0x81, 0x03,                   /*     INPUT (Cnst,Var,Abs) */
    0x09, 0x41,                   /*     USAGE (Noise Effects) */
    0x75, 0x03,                   /*     REPORT_SIZE (3) */
    0x81, 0x02,                   /*     INPUT (Data,Var,Abs) */
    0x81, 0x03,                   /*     INPUT (Cnst,Var,Abs) */
```

```
0x09, 0x42,                  /*     USAGE (Report Counter) */
0x75, 0x02,                  /*     REPORT_SIZE (2) */
0x81, 0x02,                  /*     INPUT (Data,Var,Abs) */
0xc0,                        /*   END_COLLECTION */

/* Touch Report Record Collection */
0x05, 0x0d,                  /*   USAGE_PAGE (Digitizers) */
0x09, 0x22,                  /*   USAGE (Finger) */
0xa1, 0x02,                  /*   COLLECTION (Logical) */
0x06, 0x01, 0xff,            /*     USAGE_PAGE (PIP 0xFF01) */
0x09, 0x60,                  /*     USAGE (Touch Type) */
0x75, 0x03,                  /*     REPORT_SIZE (3) */
0x81, 0x02,                  /*     INPUT (Data,Var,Abs) */
0x75, 0x05,                  /*     REPORT_SIZE (5) */
0x81, 0x03,                  /*     INPUT (Cnst,Var,Abs) */
0x05, 0x0d,                  /*     USAGE_PAGE (Digitizers) */
0x09, 0x51,                  /*     USAGE (Contact Identifier) */
0x75, 0x05,                  /*     REPORT_SIZE (5) */
0x81, 0x02,                  /*     INPUT (Data,Var,Abs) */
0x06, 0x01, 0xff,            /*     USAGE_PAGE (PIP 0xFF01) */
0x09, 0x61,                  /*     USAGE (Event ID) */
0x75, 0x02,                  /*     REPORT_SIZE (2) */
0x81, 0x02,                  /*     INPUT (Data,Var,Abs) */
0x05, 0x0d,                  /*     USAGE_PAGE (Digitizers) */
0x09, 0x42,                  /*     USAGE (Tip Switch) */
0x75, 0x01,                  /*     REPORT_SIZE (1) */
0x81, 0x02,                  /*     INPUT (Data,Var,Abs) */
0x05, 0x01,                  /*     USAGE_PAGE (Generic Desktop) */
0x09, 0x30,                  /*     USAGE (X) */
0x75, 0x10,                  /*     REPORT_SIZE (16) */
0x81, 0x02,                  /*     INPUT (Data,Var,Abs) */
0x09, 0x31,                  /*     USAGE (Y) */
0x81, 0x02,                  /*     INPUT (Data,Var,Abs) */
0x05, 0x0d,                  /*     USAGE_PAGE (Digitizers) */
0x09, 0x30,                  /*     USAGE (Tip Pressure) */
0x75, 0x08,                  /*     REPORT_SIZE (8) */
0x81, 0x02,                  /*     INPUT (Data,Var,Abs) */
0x06, 0x01, 0xff,            /*     USAGE_PAGE (PIP 0xFF01) */
0x09, 0x62,                  /*     USAGE (Major Axis Length) */
0x81, 0x02,                  /*     INPUT (Data,Var,Abs) */
0x09, 0x63,                  /*     USAGE (Minor Axis Length) */
0x81, 0x02,                  /*     INPUT (Data,Var,Abs) */
0x09, 0x64,                  /*     USAGE (Orientation) */
0x81, 0x02,                  /*     INPUT (Data,Var,Abs) */
0xc0,                        /*   END_COLLECTION */
0xc0,                        /* END_COLLECTION */
```

```
/*************************************************************************
* Button Report (Report ID 3)
*
* Structure
* Timestamp (scan time): 16 bits
* Button 1             :  1 bit
* Button 2             :  1 bit
* Button 3             :  1 bit
* Button 4             :  1 bit
* Reserved             :  4 Bits
* Button 1 Signal      : 16 bits
* Button 2 Signal      : 16 bits
* Button 3 Signal      : 16 bits
* Button 4 Signal      : 16 bits
*************************************************************************/
0x05, 0x0d,                 /* USAGE_PAGE (Digitizers) */
0x09, 0x04,                 /* USAGE (Touch Screen) */
0xa1, 0x01,                 /* COLLECTION (Application) */
0x85, 0x03,                 /*   REPORT_ID (3) */
0x06, 0x01, 0xff,           /*   USAGE_PAGE (Generic Desktop) */
0x09, 0x20,                 /*   USAGE (Buttons) */
0xa1, 0x02,                 /*   COLLECTION (Logical) */
0x05, 0x0d,                 /*     USAGE_PAGE (Digitizers) */
0x09, 0x56,                 /*     USAGE (Scan Time) */
0x75, 0x10,                 /*     REPORT_SIZE (16) */
0x81, 0x02,                 /*     INPUT (Data,Var,Abs) */
0x05, 0x09,                 /*     USAGE_PAGE (Button) */
0x19, 0x01,                 /*     USAGE_MINIMUM (Button 1) */
0x29, 0x04,                 /*     USAGE_MAXIMUM (Button 4) */
0x95, 0x04,                 /*     REPORT_COUNT (4) */
0x75, 0x01,                 /*     REPORT_SIZE (1) */
0x81, 0x02,                 /*     INPUT (Data,Var,Abs) */
0x81, 0x03,                 /*     INPUT (Cnst,Var,Abs) */
0x06, 0x01, 0xff,           /*     USAGE_PAGE (PIP 0xFF01) */
0x75, 0x10,                 /*     REPORT_SIZE (16) */
0x09, 0x65,                 /*     USAGE (Button Signal) */
0x81, 0x02,                 /*     INPUT (Data,Var,Abs) */
0xc0,                       /*   END_COLLECTION */
0xc0,                       /* END_COLLECTION */

/*************************************************************************
* Non-HID Command/Response Reports
*************************************************************************/
0x06, 0x01, 0xff,           /* USAGE_PAGE (PIP 0xFF01) */
0x09, 0x02,                 /* USAGE (Touch Application) */
0xa1, 0x01,                 /* COLLECTION (Application) */
0x75, 0x08,                 /*   REPORT_SIZE (8) */

/*************************************************************************
* Wakeup Event Input Report (Report ID 04h)
*************************************************************************/
0x85, 0x04,                 /*   REPORT_ID (4) */
0x09, 0x30,                 /*   USAGE (Generic Item) */
0x95, 0x01,                 /*   REPORT_COUNT (1) */
0x81, 0x02,                 /*   INPUT (Data,Var,Abs) */
```

```
/***************************************************************************
* Noise Metrics Input Report (Report ID 05h)
***************************************************************************/
0x85, 0x05,                    /*   REPORT_ID (5) */
0x09, 0x30,                    /*   USAGE (Generic Item) */
0x95, 0x07,                    /*   REPORT_COUNT (7) */
0x81, 0x02,                    /*   INPUT (Data,Var,Abs) */

/***************************************************************************
* Sensor Data Mode Input Report (Report ID 0Fh)
*
* Up to 151 bytes (packet content after report ID)
***************************************************************************/
0x85, 0x0f,                    /*   REPORT_ID (15) */
0x09, 0x30,                    /*   USAGE (Generic Item) */
0x95, 0x97,                    /*   REPORT_COUNT (151) */
0x81, 0x02,                    /*   INPUT (Data,Var,Abs) */

/*******************************************************************************
* Non-HID Input Report (Report ID 1Fh)
*
* Up to 253 bytes (packet content after report ID)
*******************************************************************************/
0x85, 0x1f,                    /*   REPORT_ID (31) */
0x09, 0x30,                    /*   USAGE (Generic Item) */
0x95, 0xfd,                    /*   REPORT_COUNT (253) */
0x81, 0x02,                    /*   INPUT (Data,Var,Abs) */

/*******************************************************************************
* Non-HID Output Report (Report ID 2Fh)
*
* Up to 251 bytes (packet content after report ID)
*******************************************************************************/
0x85, 0x2f,                    /*   REPORT_ID (47) */
0x09, 0x30,                    /*   USAGE (Generic Item) */
0x96, 0xfb,                    /*   REPORT_COUNT (251) */
0x91, 0x02,                    /*   OUTPUT (Data,Var,Abs) */

0xc0                           /* END_COLLECTION */
```

5.5 Input Report Register

The Input Report register's address is 0003h. The TrueTouch device writes the Input Report register with scan data and responses to host-initiated commands. For details on command response structure for Bootloader and TrueTouch application commands, see “” on page 54 and “” on page 65. The structure of touch and button scan is documented in “Touch Reports” on page 136 and “Button Reports” on page 138. The Input Report register holds up to 512 bytes.

These reports are written to the Input Report register:

- Touch Reports (Report ID - 01h)
- Button Reports (Report ID - 03h)
- Bootloader Command Responses (Report ID - 40h)
- TrueTouch Application Responses (Report ID - 1Fh)
- Sensor Data Mode (Report ID - 0Fh)

5.6 Output Report Register

The Output Report register is located at address 0004h. The Output Report register is written by the host to initiate a Bootloader or TrueTouch application command For a details on command response structure for Bootloader and TrueTouch application commands, see “” on page 54 and “” on page 65. The response from the TrueTouch device will be set in the Input Report Register. The Output Report register holds up to 510 bytes.

These reports are written to the Output Report register:

- Bootloader Command (Report ID - 40h)
- TrueTouch Application Command (Report ID - 2Fh)

5.7 Command and Data Register

The Command register’s address is 05h and the Data register’s address is 0006h. The Command and Data registers are used to perform a device software reset (SRES) and to command the device in and out of the Deep Sleep power state, using HID requests (specified in the Microsoft HID over I2C Protocol Specification Version 1.00). The host writes commands to the Command register and the device writes responses to the Data register. The device ignores any data written to the Data register by the host. The Command register is read-only by the TrueTouch device.

5.7.1 Device Reset (SRES) Command

The device is reset using the Device Reset command, which complies with Microsoft’s RESET HID. When the host sends the Reset command, the device will reset itself and write the Input Report register with a 2 byte reset sentinel value of 0000h and asserts COMM_INT to indicate the reset has occurred. The first byte of the Data register is also reset to a value of 00h following a device reset.

Table 5-4. Command Register (from host)

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Value
0	Command Register Address [7:0]								05h
1	Command Register Address [15:8]								00h
2	Reserved		Report Type = 00b		Report ID = 0000b				00h
3	Reserved				Opcode = 0001b				01h

Table 5-5. Data Register (from device)

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Value
0	Reset Value								00h

5.7.2 Deep Sleep Command

The device enters and exits the Deep Sleep state using the Deep Sleep command, which is an implementation of the Microsoft SET_POWER HID request. The Power state may be set to On (00h) or Deep Sleep (01h). When the device wakes from Deep Sleep it enters the Active Look-for-touch state. The TGL bit is 0 in the first Deep Sleep response and will be the compliment of the previous value thereafter.

Table 5-6. Command Register (from host)

<table>
<tr><th>Byte</th><th>Bit 7</th><th>Bit 6</th><th>Bit 5</th><th>Bit 4</th><th>Bit 3</th><th>Bit 2</th><th>Bit 1</th><th>Bit 0</th><th>Value</th></tr>
<tr><td>0</td><td colspan="8">Command Register Address [7:0]</td><td>05h</td></tr>
<tr><td>1</td><td colspan="8">Command Register Address [15:8]</td><td>00h</td></tr>
<tr><td>2</td><td colspan="6">Reserved</td><td colspan="2">Power State</td><td>20h</td></tr>
<tr><td>3</td><td colspan="4">Reserved</td><td colspan="4">Opcode = 1000b</td><td>08h</td></tr>
</table>

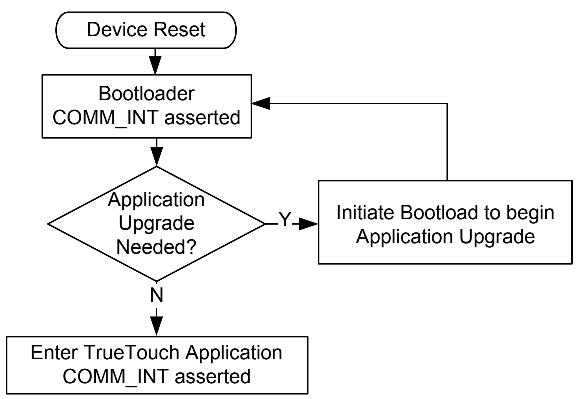
Table 5-7. Data Register (from device)

<table>
<tr><th>Byte</th><th>Bit 7</th><th>Bit 6</th><th>Bit 5</th><th>Bit 4</th><th>Bit 3</th><th>Bit 2</th><th>Bit 1</th><th>Bit 0</th><th>Value</th></tr>
<tr><td>0</td><td colspan="8">Length [7:0]</td><td>05h</td></tr>
<tr><td>1</td><td colspan="8">Length [15:8]</td><td>00h</td></tr>
<tr><td>2</td><td colspan="8">Report ID = Request Response</td><td>F0h</td></tr>
<tr><td>3</td><td colspan="6">Reserved</td><td colspan="2">Power State</td><td>0Xh</td></tr>
<tr><td>4</td><td>TGL</td><td colspan="3">Reserved</td><td colspan="4">Opcode = 1000b</td><td>X8h</td></tr>
</table>

6. Device Startup

After a device ***reset***, the TrueTouch controller enters the ***bootloader*** application to allow the host to initiate a ***field upgrade***. The TrueTouch device will automatically enter the TrueTouch application if a bootload is not initiated by the host. The True-Touch device will assert the COMM_INT pin, while in the bootloader application, when the primary communication interface is ready for communication from the host. For more information on the bootloader, see the Field Upgrade (Bootloader) chapter on page 61. Once the device has successfully entered the TrueTouch application, the COMM_INT pin will be asserted again and the TrueTouch device will begin actively scanning and reported touches to the host. From the TrueTouch application the host may issue any of the TrueTouch application Commands (see “” on page 65). An example device startup flow is illustrated in Figure 6-1 below. For more details on command and response protocol see Packet Interface Protocol (PIP) chapter on page 39.

Figure 6-1. Device Startup Flow



6.1 Functional Description

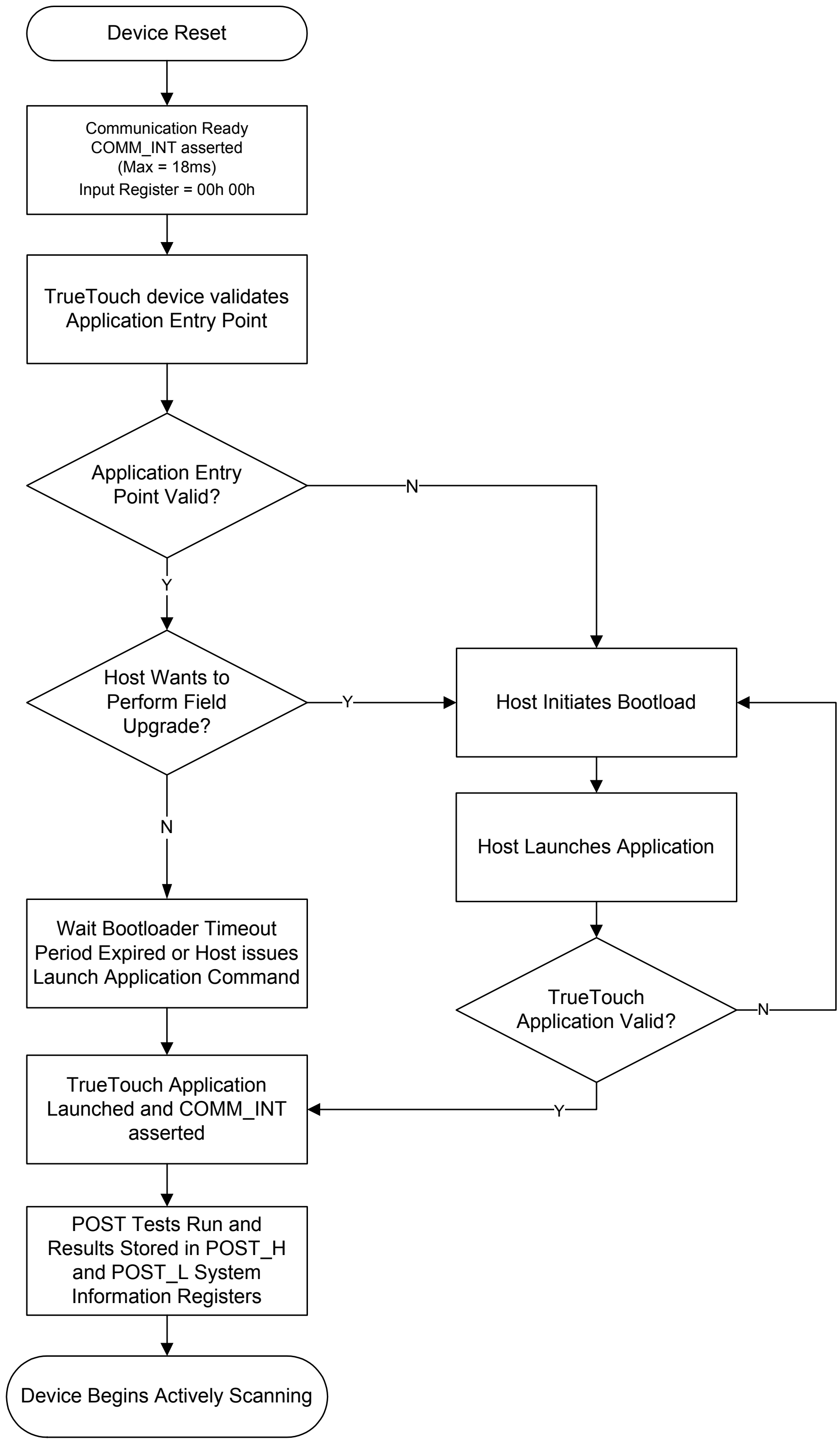
Following a device reset, the TrueTouch bootloader enumerates itself on the communications bus and asserts the COMM_INT pin when the TrueTouch device is ready for communication (see “Packet Interface Protocol (PIP)” on page 39 for command and response details). The bootloader performs a quick application integrity check on the row of flash containing the TrueTouch application entry point (see “Quick Application Integrity Check” on page 58). If the integrity check fails, the bootloader waits for an infinite amount of time for the host to initiate and complete a bootload, before the device can enter the TrueTouch application. Completion of a bootload includes passing a full CRC validation of the programmed TrueTouch application. See Figure 7-5 on page 65 for a step-by-step guide to performing a application upgrade. If the integrity check passes the bootloader enters a finite wait state and waits for a configurable Bootloader Timeout period. The host may command the device to enter the infinite wait state by issuing any Bootloader Command (see “Command and Data Register” on page 50) except the Launch Application command from the finite wait state (see “Launch Application” on page 77). Otherwise, the bootloader launches the TrueTouch application automatically after the expiration of a configurable bootloader timeout period. Additionally, if the bootloader receives a valid Launch Application command while waiting, the bootloader immediately launches TrueTouch application. The communication interface becomes unresponsive from the time that the Launch Application command is issued until the COMM_INT pin is asserted by the TrueTouch device. When the TrueTouch application launches, it enumerates itself on the communication bus and asserts the COMM_INT pin. This assertion indicates that the host can begin communicating with the TrueTouch application.

The TrueTouch Application performs Power-on Self Test (POST) before performing any scanning. If the POST is aborted due to failure, no scanning of the panel will be performed and no touches will be reported until a valid configuration is loaded and the TrueTouch controller is reset.The POST tests are performed in the following order and results are reported in the POST_H and POST_L registers retrieved by executing the Get System Information command (see “Get System Information: 02h” on page 83):

1. The WDT Reset bit is set to a value of 1 in the POST_L register if the most recent reset was due to a watchdog reset.
2. The CRC of the Configuration Data Block is calculated and compared against the stored CRC. If the values do not match, the POST is aborted. The result is reported in the TTCFG CRC bit of the POST_L register. The bit is set to 1 when CRC check passes and to 0 when CRC check fails.
3. The current configuration of the device is checked to ensure that it is supported by the product segmentation. If this check fails, POST is aborted. The result is reported in the SGMT bit in the POST_H register. This bit is set to 1 when the test passes and 0 if the test fails.
4. A Shorts Test is executed to determine if any XY sense pins are shorted to any external supplies or other sense pins. If the Shorts Test fails, POST is aborted. The result will be reported in the BIST bits in the POST_L and POST_H register. These bits are set to 1 if the test passes and 0 if the test fails.
5. The voltage supply is validated to the VDDA pin. If the check fails, POST is aborted. The result is reported in the VDDA bit of the POST_L register. This bit is set to 1 when the test passes and 0 if the test fails.

Based on POST results touch scanning can be disabled if configuration data is not valid, configuration is not supported or panel test failed. Scanning status is reported in the SCAN EN bit of POST_CODEL. The bit is set to 1 if scanning is enabled and cleared otherwise. The configurable parameter POST_CFG controls whether the device disables scanning after a failed POST.

Figure 6-2. Device Startup Flow



6.2 Device Reset

Following any device reset, the bootloader will enumerate on the communications bus, and the reset sentinel (00h 00h) will be sent to the host. The following types of device resets occur in the TrueTouch controller:

- **Power-on-Reset (POR).** This occurs at low supply voltage and is comprised of multiple sources. Cycling power connected to the TrueTouch device, causes a device reset.
- **External Reset (XRES).** This active low reset is driven into the TrueTouch device via the XRES pin. Cycling power connected to the TrueTouch device, causes a device reset.
- **Watchdog Reset (WDR).** This reset occurs when the watchdog timer expires before being cleared by the TrueTouch application. The watchdog timer period is configured to the greater of either 500 ms or three times the configured refresh interval (“Refresh, Response and Report Timing” on page 135). The watchdog timer is cleared at least once per refresh interval if application execution is in a valid state. This applies to the Active, Active Look-for-Touch, and Low Power modes. The watchdog timer is set to 10 seconds after device reset to ensure timeout does not occur during initialization. Operation of the WDT is suspended during deep sleep to prevent resets in this mode, and preset to 3 seconds to prevent timeout during wakeup. Once the device is actively running after wakeup, the active mode timeout periods apply. Prior to execution of a self-test or PWC Calibration the timeout period is set to 10 seconds. Upon completion of the respective function, the watchdog timeout is restored to the active timeout. Watchdog reset is enabled by the application and may not be disabled by the host. If the most recent reset was caused by the watchdog timer, the WDT Reset bit of the POSTL register is set to 1 (see “Get System Information: 02h” on page 83).
- **Software Reset (SRES).** The ***software reset*** occurs when the host performs a Reset HID Request (see “Command and Data Register” on page 50).

6.3 CRC

The TrueTouch performs CRC checks on the application image and rows of memory as an integrity check. Both the bootloader and TrueTouch application have a CRC. Additionally the configuration, manufacturing, and design data blocks each have a CRC. The two rows of flash which contain the TrueTouch application meta data and application entry point each have a CRC. The following sections describe in detail the points at which each of these CRCs are validated. See the Figure 6-3 on page 59 for the flash map layout including the CRCs.

A CRC is calculated using the 16-bit CCITT algorithm with polynomial value $x^{16} + x^{12} + x^5 + 1$.

6.3.1 Bootloader CRC

The TrueTouch device bootloader calculates the CRC of the bootloader image before executing the bootloader application, and compares it to the stored value to prevent running a corrupted bootloader image. If the CRC check fails, the processor waits in an infinite loop and I^2C communication will be unsuccessful. If a CRC mismatch occurs, the TrueTouch device must be acquired via SWD to reprogram the bootloader application using a MiniProg3 hardware (see “Programming the Bootloader” on page 66).

6.3.2 TrueTouch Application CRC

Three TrueTouch application CRCs exist in the TrueTouch application code.

6.3.2.1 Quick Application Integrity Check

A Quick Application Integrity Check is performed on the row of flash memory that the TrueTouch application entry point resides in. The check consists of calculating the CRC of the row and verifying it against the stored CRC of that row. The check additionally verifies that the row does not contain bits that are all equal to 1 or all equal to 0.

6.3.2.2 TrueTouch Application Meta Data CRC

This CRC is only computed when the host issues an Initiate Bootload command. Before the TrueTouch application is erased, the CRC of the Meta Data is computed and checked against the stored value. If the check fails, the TrueTouch device will program only the new Meta Data row.

6.3.2.3 TrueTouch Application Code CRC

Following an Initiate Bootload command, the TrueTouch device will calculate the TrueTouch application CRC which is stored in the Meta Data of the TrueTouch application. The CRC of the TrueTouch application is calculated over the TrueTouch application Start and TrueTouch application Length values in the Meta Data area (see “Meta Data Parameter Definitions” on page 72). If the stored CRC and computed CRC do not match, the bootloader remains in an infinite wait state to allow a new image to be programmed. The application will not launch until a matching CRC is verified.

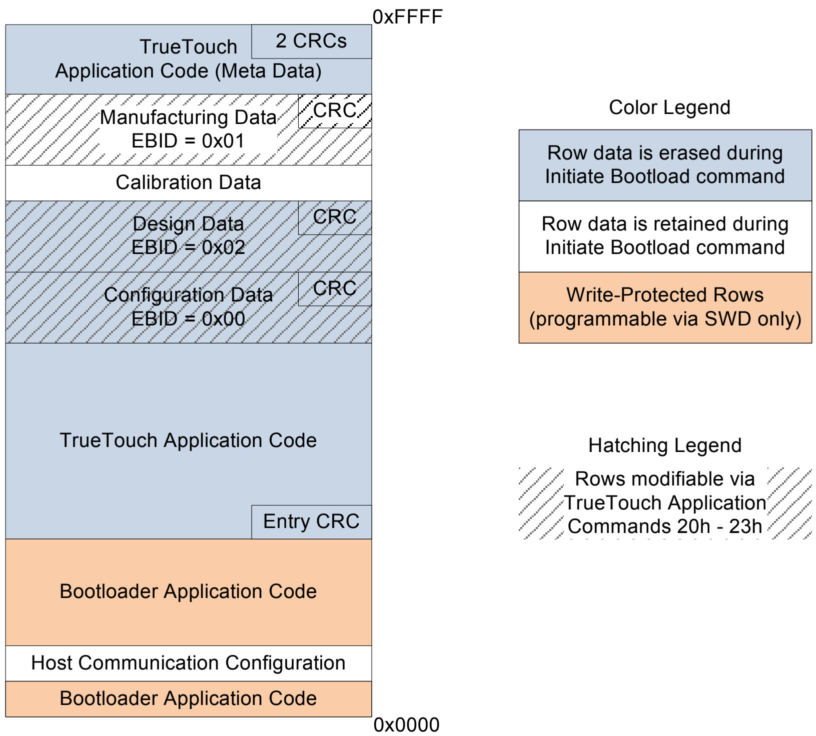
6.3.3 Configuration CRC

When the TrueTouch application launches, it will calculate the CRC over the Configuration Data block and compare the calculated CRC to the stored CRC. The TrueTouch devices use these CRCs tor detect communication errors between the host and the device application. If a CRC check fails the persistent POST return code will be set in the POST_CODEH register and the CRC Check bit will be set to a value of ‘0’ in the POST_CODEL System Information registers.

6.4 Memory Map

The following diagram shows the device's flash memory layout.

Figure 6-3. Flash Memory Map



7. Field Upgrade (Bootloader)

Field upgrades allows the TrueTouch application to be updated in the field. Field upgrades are performed using the True-Touch bootloader application which runs independently of the TrueTouch application. A bootload can be initiated from a driver, host emulation software (TTHE), or BCP software. This chapter provides example procedures to perform a bootload, and includes the following information:

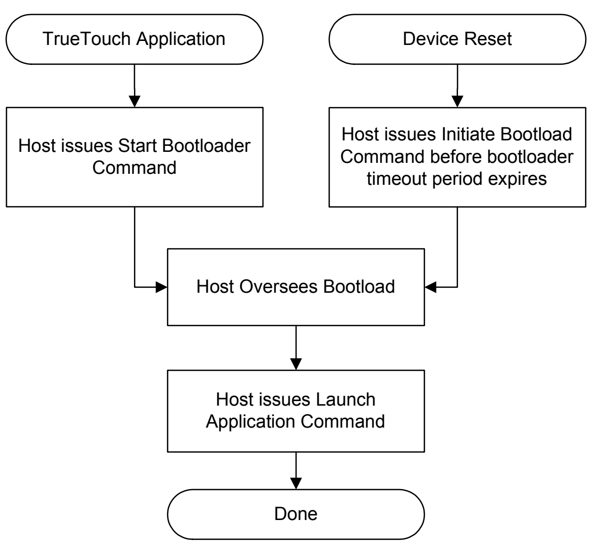
7.1 Functional Description

Field upgrades are accomplished by issuing bootloader commands over the primary communications interface. The boot-loader commands erase the flash area that contains the TrueTouch application, reprograms an updated application and/or configuration, and performs an application integrity check. While initiating a bootload, the TrueTouch application is completely disabled to allow the bootloader to write the new application image into the device flash. The bootloader collects the received data and manages flash updates by exposing a simple command interface (see “” on page 54). For details regarding the com-munication protocol used to execute these commands, see Packet Interface Protocol (PIP) chapter on page 39.

To determine if a field upgrade is necessary the host may read the TrueTouch firmware version (FW_VER_MAJOR, FW_VER_MINOR), TrueTouch application revision control number (REVCTRL), and TrueTouch configuration version (CFG_VERH, CFG_VERL), returned by the Get System Information command (“” on page 65).

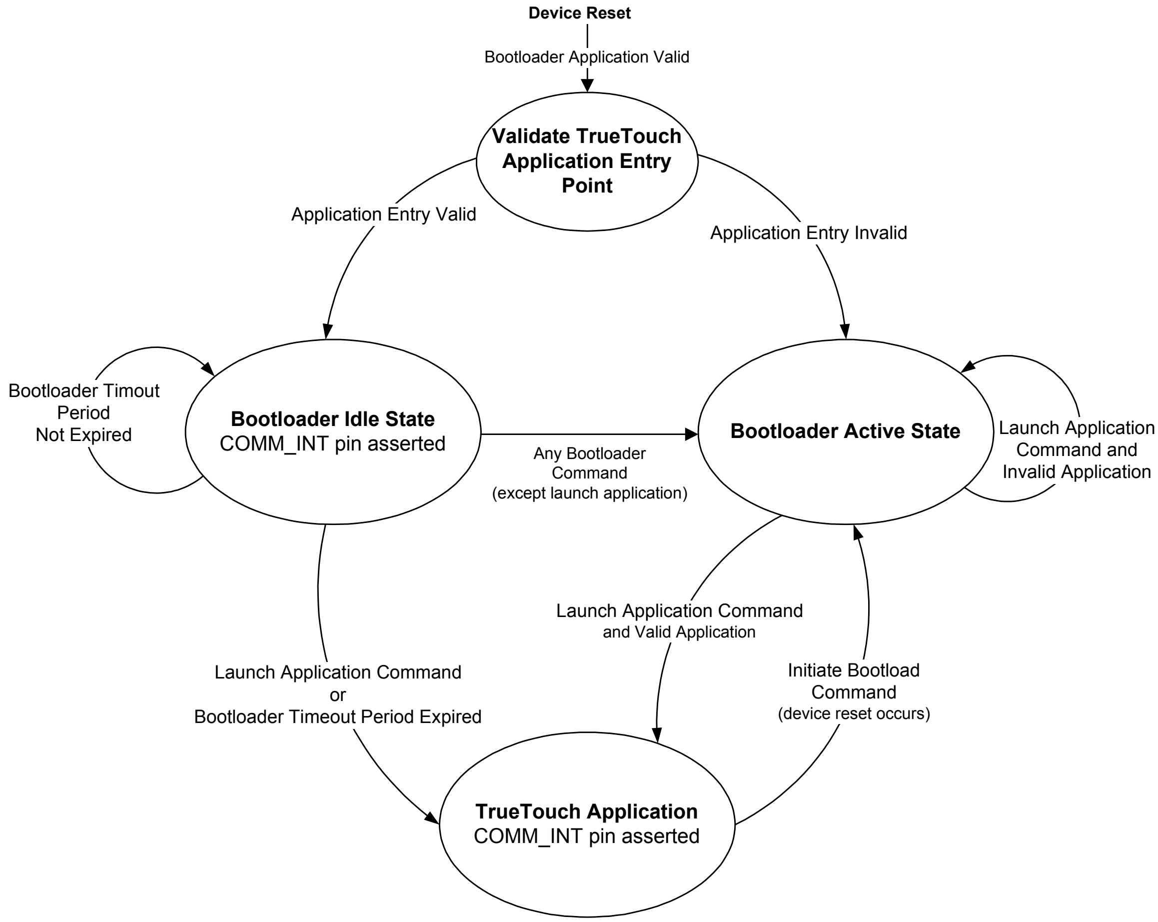
Because the application image is invalidated when the bootload is initiated, aborting a bootload (or an unexpected terminating event such as a power failure) leaves the application image in an invalid state, which prevents launch of the application. Recovery from an aborted bootload requires initiation and completion of a new bootload.

Figure 7-1. Bootloader Field Upgrade Overview



7.2 Bootloader States

Figure 7-2. Bootloader State Diagram



7.2.1 Initialization

Following a device reset, the bootloader application is launched (see “Device Reset” on page 58). The host can identify whether the controller is in the bootloader application by reading the HID Descriptor Register (see “HID Descriptor Register” on page 42). First, the bootloader application performs it’s own integrity check by calculating the CRC of the bootloader image and comparing it against the stored value. If this integrity check fails, the device will enter an infinite loop and the physical communication interface will be unresponsive. An invalid bootloader application will require the device to be acquired via SWD and reprogrammed (see “Programming the Bootloader” on page 66). If the CRC check passes, the physical communication interface and COMM_INT pin are initialized.

7.2.2 Idle State

Following initialization, the COMM_INT pin is asserted to alert the host that the device is ready for communication. The bootloader then performs a quick application integrity check to ensure the entry point of the TrueTouch application is not corrupt (see “Quick Application Integrity Check” on page 58). If this check fails, the device will automatically enter the active bootloader state to allow a bootload to proceed in order to repair the application image. If the integrity check passes, the device then enters the idle state in the bootloader, where the host may still choose to initiate a bootload. If a bootload is not initiated within the bootloader timeout period (configurable in TTHE Project Configuration Wizard) the TrueTouch application will be automatically launched. From the idle state, the device may enter into the active state by issuing any Bootloader command, other than Launch Application, before the bootloader timeout period expires. The active bootloader state will also be entered if the Initiate Bootload command is issued by the host while running the TrueTouch Application. A bootload can only be performed from the active state.

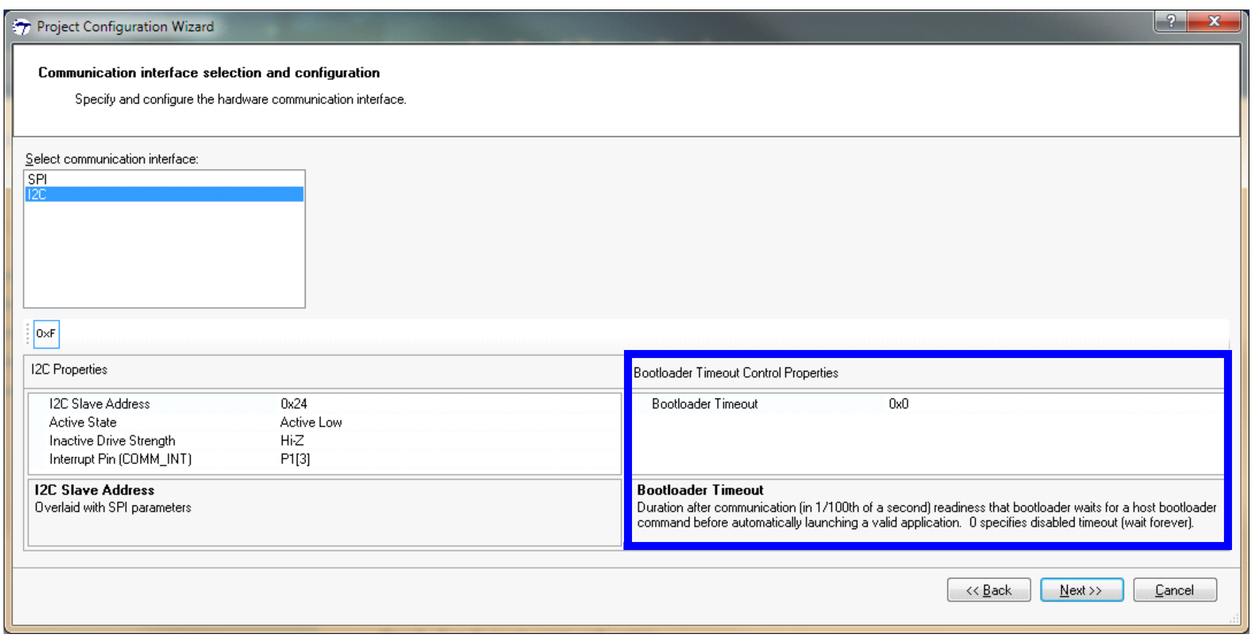
7.2.3 Active State

Once the active state has been entered, the host must issue a series of Bootloader Commands (see "Command and Data Register" on page 50) to initiate and complete a bootload. The flow of a field upgrade is shown in Figure 7-5. Once a bootload is complete, the host must execute the Launch Application command to complete the bootload. This command will perform a full TrueTouch application integrity check by calculating the CRC and comparing it against the stored TrueTouch application CRC. The row of flash containing the entry point is not programmed until the TrueTouch application CRC validation passes. The calculated CRC includes the entry point row, which is stored in a cache, until the integrity check passes. If the CRC validation passes, the device will enter the TrueTouch application and begin scanning and reported touches, otherwise the device will remain in the bootloader until a valid application has been programmed and verified. See Figure 7.4 for details on bootloader states.

7.3 Configuring Bootloader Timeout

The bootloader timeout value is set using the TTHE Project Configuration Wizard, shown in Figure 7-3. This value determines how long the TrueTouch device waits in the Bootloader Idle state for a bootload to be initiated by the host. The Bootloader Timeout resolution is in 1/100th of a second, where the range is 0-255.
Important Note: Setting the Bootloader Timeout period to a value of 0 disables the timeout period, and the TrueTouch device will wait for an infinite period of time. When the Bootloader Timeout period is set to 0, the Launch Application command must be used to transition from the Bootloader Idle state to the TrueTouch Application.

Figure 7-3. Bootloader Timeout Configuration



7.4 Field Upgrade Flow

To update the application code, the host reads the CYACD file and then parses it (see "CYACD File Format" on page 66 for more details about the CYACD file format). It organizes the data along with the command as a packet format, and then sends it to the bootloader.

Figure 7-4 shows the single command execution flow. The host writes the command packet to the bootloader over the communication interface and waits for the COMM_INT interrupt pin to be toggled by the device. This indicates command execution completion. The host then reads the status from the device. If the command status is a success, the host processes the data from the device if required. Otherwise, it performs error processing. The host can resend the command or stop the bootloading process.

Figure 7-4. One Command Execution Flow

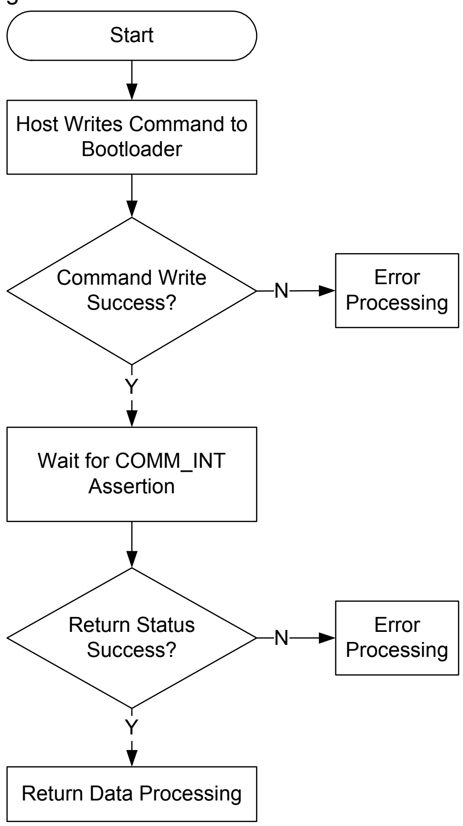
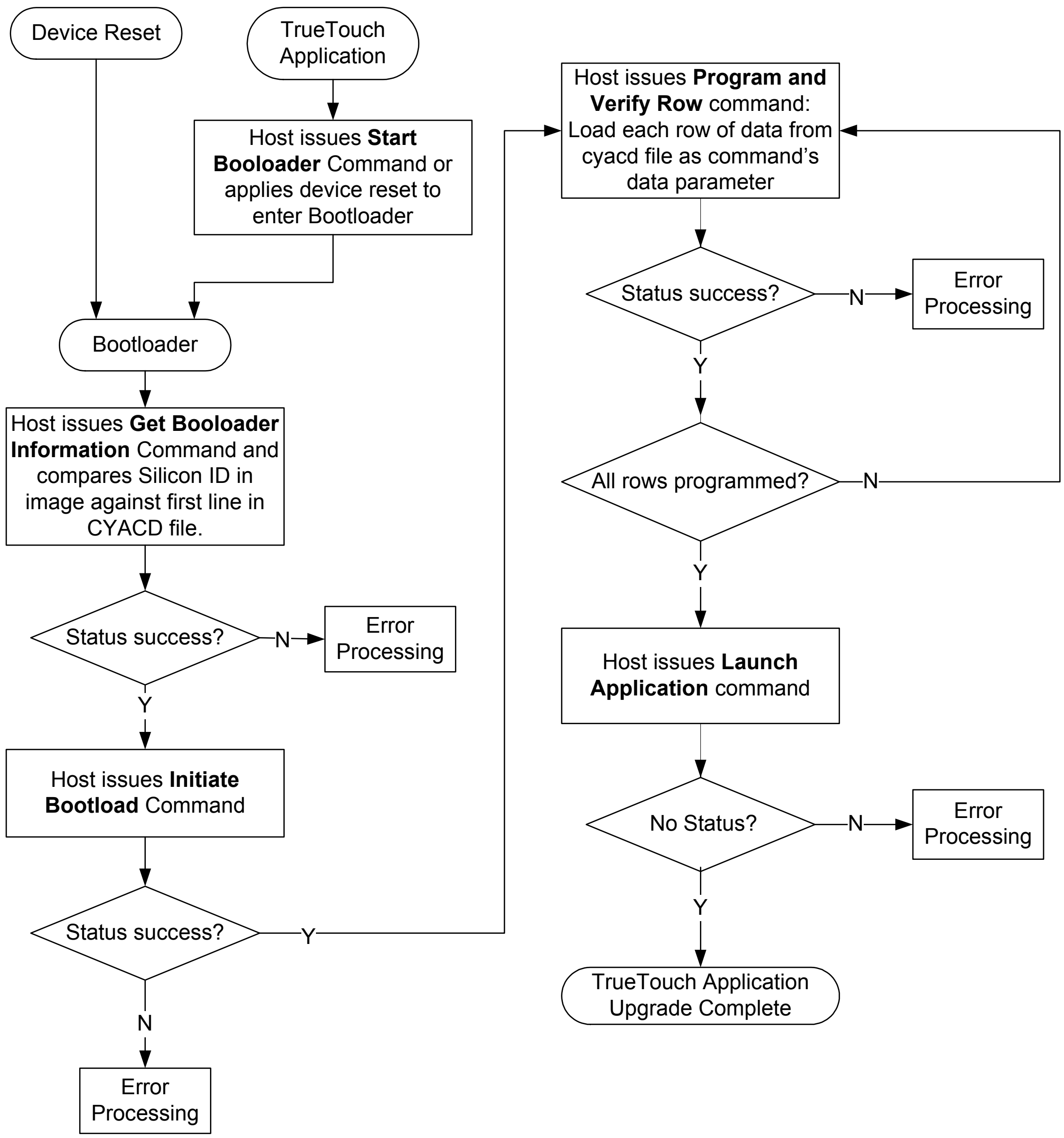


Figure 7-5 shows the recommended command sequence for a field upgrade. The host determines whether a field upgrade is needed by reading issuing the Get System Information: 02h command from the TrueTouch application. The TrueTouch application Major/Minor, Revision Control Number, and Customer Specified Firmware/Configuration Version information is evaluated by the host. To initiate a field upgrade from the TrueTouch application state the host must issue a Start Bootloader: 01h command. Alternatively, a device reset may be performed to enter the Bootloader state. The host issues the Initiate Bootload command to the device followed by the Get Bootloader Information command to get the device Silicon ID. The silicon ID should be compared to the CYACD file silicon ID before proceeding. If the IDs match, the host reads the program data from the next line of the CYACD file. The host then sends the program data and the Program and Verify Row command to perform the flash write operation. The host continues the program and verify loop until all program data of the CYACD file is successfully programmed. Then, the host sends the Launch Application command to the device to start the TrueTouch application. The touch calibration data is not overwritten during a device update. The host should execute the Calibrate PWCs command to update the calibration data after a device update. Updating the entire application program space using the TrueTouch Host Emulator takes approximately 15 seconds.

Figure 7-5. Field Upgrade Sequence



7.5 CYACD File Format

The CYACD file contains the data to be written to the flash. The file consists of a header followed by lines of flash data. Excluding the header, each line in the CYACD file represents an entire row of flash data. The data is stored as ASCII data in big endian format.

The header record has this format:

Byte	0	1	2	3	4	5
Usage	JTAG ID[3]	JTAG ID[2]	JTAG ID[1]	JTAG ID[0]	Chip Revision	Checksum Type

The data records have this format:

Items	1	2	3	4	5	6
Number of Bytes	–	1	2	2	128	1
Endian Format	–	–	Big	Big	–	–
Description	Record Start	Flash Array ID	Row ID	Record Length In Bytes	Flash Record	1 Byte Checksum of Items 2 to 5

Where:

- Record Start: This is a colon (:) to indicate the start of a new row record.
- Flash Array ID
- Row ID
- Record Length in Bytes: The number of bytes of flash program data contained in this record.
- Flash Record: The flash program data
- 1 Byte Checksum: The checksum of items 2 to 5.

The checksum is computed as described in "CRC" on page 58.

Example cyacd file record

```
013D21902101
:000025008000200020A5130000A17D0000A17D0000A17D0000A17D0000A17D0000A17D0000A17D0000A17D0000
A17D0000A17D0000A17D0000A17D0000A17D0000A17D0000A17D0000A17D0000A17D0000A17D0000A17D0000A17
D0000A17D0000A17D0000A17D0000A17D0000A17D0000A17D0000A17D0000A17D0000A17D0000A17D0000DF

:000026008000F002F800F040F80CA030C8083824182D18A246671EAB4654465D46AC4201D100F032F87E460F3E
0FCCB6460126334200D0FB1AA246AB4633431847B4B20000E4B20000103A02D378C878C1FAD8520701D330C830C
101D504680C607047000000230024002500026103A01D378C1FBD8520700D330C100D50B6070471FB5C046CC

:0000270080C0461FBD10B510BD03488546FFF7F6FF00F0A1F900F062F900200020FFF7F2FF00F062F9014B9D46
01480047002000200113000070B505460C46164602E00FCC0FC5103E102EFAD2082E02D303CC03C5083E042E07D
301CC01C5361F03E021782970641C6D1C761EF9D270BD00000000801C800803D000BF401E0046FCD170471F
```

7.6 Programming the Bootloader

The bootloader allows you to update the application firmware. However, the bootloader cannot update itself. To update the bootloader, you will need an external programmer such as the MiniProg3 or 3rd party programmer/debugger. For more information, see Table 4-2, "Solution Specifications," on page 15 for MiniProg3 reference documents.

8. Command Details

Bootloader commands are available only from the bootloader state and TrueTouch application commands are available only from the TrueTouch application state (see Field Upgrade (Bootloader) chapter on page 61 and Device Startup chapter on page 55 for details on state transitions.) The Bootloader and TrueTouch application commands use Packet Interface Protocol (PIP) format. See Packet Interface Protocol (PIP) chapter on page 41 for details.

Command Failure Status Troubleshooting:

- Possible reasons for a failure include, but are not necessarily limited to:
- V_{ccts} variation across PVT results in unreliable data.
- Capacitive coupling to AC noise source causes test output voltage fluctuations.
- Cannot detect short circuits to voltages near $V_{ccts}/2$.
- External voltage source >5 V directly shorted to RX pin.
  - This problem will permanently damage the chip.
- V_{dda} brownout.
  - Expected effect is droops in V_{ccts} which will cause loss of accuracy in the measurement system.

8.1 Bootloader Commands

Bootloader commands are initiated by the host using the Output Report Register while in the Bootloader Active or Bootloader Idle state. The device responds to the host initiated command by writing response data to the Input Report Register. Bootloader commands are non-HIDI^{2}C compliant. Bootloader commands are listed in Table 8-1 The CRC parameter of the Output Report must be calculated by the host over the data from the start of packet (SOP) byte up to the CRC field (Byte 06 - Data Length + 7). The CRC value is calculated by the bootloader and compared to the CRC in the Output Report to validate the packet. The host then performs the same process on the Input Report by calculating the CRC and comparing it to the CRC returned by the bootloader in the Input Report.

Table 8-1. Bootloader Commands

Command Code	Command Description	Command Code	Command Description
31h	Verify Application Integrity	39h	Program And Verify Row
37h	Append Data Buffer	3Bh	Launch Application
38h	Get Bootloader Information	48h	Initiate Bootload

8.1.1 Bootloader Command/Response Packet Format

Table 8-2. Bootloader Command Packet Format

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Value
0	Output Report Register Address[7:0] = 04h								04h
1	Output Report Register Address[15:8] = 00h								00h
2	Length[7:0] (Size of packet not including Output Report Register Address)								XXh
3	Length[15:8] (Size of packet not including Output Report Register Address)								XXh
4	Report ID = 40h (Bootloader Output Report ID)								40h
5	RSVD = 00h (Bytes marked “RSVD” must be set to 0)								00h
6	SOP (Start of Packet) = 01h								01h
7	Command Code								XXh
8	Data Length[7:0] (Size of Data parameter)								XXh
9	Data Length[15:8] (Size of Data parameter)								XXh
…	Data								XXh
Data Length + 8	CRC[7:0] (Calculated over bytes 6 to Data Length + 7)								XXh
Data Length + 9	CRC[15:8] (Calculated over bytes 6 to Data Length + 7)								XXh
Data Length + 10	EOP (End of Packet) = 17h								17h

Table 8-3. Bootloader Response Packet Format

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Value
0	Length[7:0] (Size of packet)								XXh
1	Length[15:8] (Size of packet)								XXh
2	Report ID = 30h (Bootloader Input Report ID)								30h
3	RSVD = 00h (Bytes marked “RSVD” must be set to 0)								00h
4	SOP (Start of Packet) = 01h								01h
5	Status								XXh
6	Data Length[7:0] (Size of Data parameter)								XXh
7	Data Length[15:8] (Size of Data parameter)								XXh
…	Data								XXh
Data Length + 7	CRC[7:0] (Calculated over bytes 4 to Data Length + 6)								XXh
Data Length + 8	CRC[15:8] (Calculated over bytes 4 to Data Length + 6)								XXh
Data Length + 9	EOP (End of Packet) = 17h								17h

Table 8-4. Bootloader Command Status Codes

Value	Name	Description
00h	Success	The command was successfully received and executed.
01h	Key Error	The provided key does not match the expected value
02h	Verification Error	The flash verification failed
03h	Length Error	The amount of data available is outside the expected range. This error is returned in the number of bytes claimed to be part of the packet is less than the actual number of data bytes received.
04h	Data Error	The data is not of the proper form. This is returned if the packet sent from the host is too small, the packet is too big, the SOP field is not 01h, or the EOP field is not 17h.
05h	Command Error	The command is not recognized.

Table 8-4. Bootloader Command Status Codes

08h	CRC Error	The provided CRC does not match the calculated value.
09h	Flash Array Error	Invalid flash array specified.
0Ah	Flash Row Error	Invalid flash row specified.
0Bh	Flash Protection Error	Flash row was write protected
0Fh	Unknown error	Unknown error

8.1.2 Get Bootloader Information

Command Code: 38h

This command returns bootloader version and chip identification information.

Table 8-5. Get Bootloader Information Command (Output Report)

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Value
0	Output Report Register Address[7:0] = 04h								04h
1	Output Report Register Address[15:8] = 00h								00h
2	Length[7:0] = 0Bh								0Bh
3	Length[15:8] = 00h								00h
4	Report ID = 40h								40h
5	RSVD = 00h								00h
6	SOP = 01h								01h
7	Command Code = 38h								38h
8	Data Length[7:0] = 00h								00h
9	Data Length[15:8] = 00h								00h
10	CRC[7:0] = A0h								A0h
11	CRC[15:8] = 09h								09h
12	EOP = 17h								17h

Table 8-6. Get Bootloader Information Response (Input Report)

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Value
0	Length[7:0] = 0013h								13h
1	Length[15:8] = 00h								00h
2	Report ID = 30h								30h
3	RSVD = 00h								00h
4	SOP = 01h								01h
5	Status								XXh
6	Data Length[7:0] = 08h								08h
7	Data Length[15:8] = 00h								00h
8	Family ID								XXh
9	Chip Rev ID								XXh
10	Silicon ID[7:0]								XXh
11	Silicon ID[15:8]								XXh
12	Chip Revision								XXh
13	Bootloader Major Version								XXh
14	Bootloader Minor Version								XXh
15	Bootloader Version = 01h								01h
16	CRC[7:0]								XXh
17	CRC[15:8]								XXh
18	EOP = 17h								17h

8.1.3 Initiate Bootload

Command Code: 48h

Initiate Bootload erases the entire TrueTouch application, Configuration Data block, and Design Data block in flash and enables the host to execute the Program and Verify Row command to bootload the application image and data. After the Initiate Bootload command is executed, a new application image must be successfully bootloaded in order to guarantee that the application can launch. See Figure 7-5 on page 65 for an example host initiated bootload sequence.

The TrueTouch application contains a meta data row which includes information that defines the size, start address, and CRC of the TrueTouch application. This row is programmed after the TrueTouch application is erased. The meta data row allows host-defined TrueTouch application boundaries.

Before erasing flash, the bootloader calculates the TrueTouch application meta data block CRC and compares it against the stored CRC in that block (see “TrueTouch Application CRC” on page 58). If this validation fails, the bootloader does not erase any flash, but the bootloader will proceed to program the new metadata into the metadata block and allow a bootload to proceed.

Table 8-7. Initiate Bootload Command (Output Report)

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Value
0	Output Report Register Address[7:0] = 04h								04h
1	Output Report Register Address[15:8] = 00h								00h
2	Length[7:0]								XXh
3	Length[15:8]								XXh
4	Report ID = 40h								40h
5	RSVD = 00h								00h
6	SOP = 01h								01h
7	Command Code = 48h								48h
8	Data Length[7:0]								XXh
9	Data Length[15:8]								XXh
10	Key Byte 0 = A5h								A5h
11	Key Byte 1 = 01h								01h
12	Key Byte 2 = 02h								02h
13	Key Byte 3 = 03h								03h
14	Key Byte 4 = FFh								FFh
15	Key Byte 5 = FEh								FEh
16	Key Byte 6 = FDh								FDh
17	Key Byte 7 = 5Ah								5Ah
18	Meta Data Row Parameter (0)*								XXh
19	Meta Data Row Parameter (1)								XXh
..	..								XXh
17 + Row Size	Meta Data Row Parameter (Row Size – 1)								XXh
18 + Row Size	CRC[7:0]								XXh
19 + Row Size	CRC[15:8]								XXh
20 + Row Size	EOP = 17h								17h

*Table 8-8 describes the Output Report Meta Data Row Parameters in Table 8-9 in detail.

Table 8-8. Meta Data Row Parameters (Output Report)

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Value
0	Size = 0040h								40h
1									00h
2	Maximum Size[7:0] = 40h								40h
3	Maximum Size[15:8] = 00h								00h
4	TrueTouch Application Start[7:0]								XXh
5	TrueTouch Application Start[15:8]								XXh
6	TrueTouch Application Start[23:16]								XXh
7	TrueTouch Application Start[31:24]								XXh
8	TrueTouch Application Length[7:0]								XXh
9	TrueTouch Application Length[15:8]								XXh
10	TrueTouch Application CRC[7:0]								XXh
11	TrueTouch Application CRC[15:8]								XXh
12	TrueTouch Application Entry[7:0]								XXh
13	TrueTouch Application Entry[15:8]								XXh
14	TrueTouch Application Entry[23:16]								XXh
15	TrueTouch Application Entry[31:24]								XXh
16	Upgrade Start[7:0]								XXh
17	Upgrade Start[15:8]								XXh
18	Upgrade Start[23:16]								XXh
19	Upgrade Start[31:24]								XXh
20	Upgrade Length[7:0]								XXh
21	Upgrade Length[15:8]								XXh
22	Entry Row CRC[7:0]								XXh
23	Entry Row CRC[15:8]								XXh
24	Padding = 00h								00h
…	Padding = 00h								00h
61	Padding = 00h								00h
62	Meta Data CRC[7:0]								XXh
63	Meta Data CRC[15:8]								XXh
64	Pad = 00h								00h
…	Pad = 00h								00h
Row Size - 1	Pad = 00h								00h

8.1.3.1 Meta Data Parameter Definitions

The meta data parameters that must be input into this command must be read out of the last line of the CYACD file. The meta data begins in the last line of the CYACD file following the string ":0001FF00" (see 7.5 CYACD File Format for details). The following describes each Meta Data parameter, however the values must be sourced from the CYACD file.

The following defines two contiguous ranges of flash. The TrueTouch application start and TrueTouch application length parameters define the range that the bootloader calculates the CRC over to determine if an upgrade was successful. Upgrade Start and Upgrade Length define the second range which is the area that the bootloader erases and upgrades. For a given meta data record, the TrueTouch application range must be a subset of the Upgrade range.

Size: Number of bytes in the meta data structure, including the Size parameter, over which the CRC checksum is calculated.

Max Size: Maximum value of the Size parameter.

TrueTouch Application Start: Address of the first byte of the TrueTouch application that the bootloader calculates the CRC for application validation. This address must be the first byte in a flash row. TrueTouch application start must be greater than or equal to Upgrade Start.

TrueTouch Application Length: Number of bytes in the range over which the bootloader performs application image validation. The beginning of this range is defined by the TrueTouch application start parameter. The sum of the TrueTouch application start and length parameters must be less than or equal to the sum of the Upgrade Start and Length parameters.

TrueTouch Application CRC: CRC checksum for the range of bytes over which the bootloader performs application image validation.

TrueTouch Application Entry: Entry point the application image.

Upgrade Start: When this value resides in the meta data flash row, it represents the address of the first byte in the range of flash that will be erased on initiation of a new bootload. When this value resides in the meta data passed into the Initiate Bootload command, it represents the address of the first byte in the range of flash that will be upgraded. This value must reference the first byte of a flash row that the bootloader is capable of upgrading without respect to limits imposed by metadata.

Upgrade Length: When this value resides in the meta data flash row, it represents the number of bytes in the range of flash that will be erased on initiation of a new bootload. When this value resides in the meta data passed into the Initiate Bootload command, it represents the number of bytes in the range of flash that will be upgraded. Upgrade Start must be evenly divisible by the flash row size. The sum of Upgrade Start and Upgrade Length must be less than or equal to the sum of 1 and the last byte of flash that the bootloader is capable of upgrading without respect to limits imposed by metadata.

Entry Row CRC: CRC checksum of the contents of the flash row containing the application entry point. This value is used for quick validation.

Table 8-9. Initiate Bootload Response (Input Report)

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Value
0	Length[7:0] = 0Bh								0Bh
1	Length[15:8] = 00h								00h
2	Report ID = 30h								30h
3	RSVD = 00h								00h
4	SOP = 01h								01h
5	Status								XXh
6	Data Length[7:0] = 00h								00h
7	Data Length[15:8] = 00h								00h
8	CRC[7:0]								XXh
9	CRC[15:8]								XXh
10	EOP = 17h								17h

8.1.4 Append Data Buffer

Command Code: 37h

This command enables breakup of large transfers into smaller pieces to prevent bus starvation of other devices on the bus or to facilitate hosts with small maximum data transfer sizes. The Append Data command sends a block of data to the TrueTouch device in anticipation of another command that will tell the bootloader what to do with it. Data is appended to the end of the command data buffer such that consecutive calls can be used to construct a complete command data buffer. If a subsequent command is called and additional data is provided, the respective command's data is appended to the end of the buffer prior to execution of the requested operation. Execution of any command that operates on the data in the data buffer empties the buffer.

Table 8-10. Append Data Buffer Command (Output Report)

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Value
0	Output Report Register Address[7:0] = 04h								04h
1	Output Report Register Address[15:8] = 00h								00h
2	Length[7:0]								XXh
3	Length[15:8]								XXh
4	Report ID = 40h								40h
5	RSVD = 00h								00h
6	SOP = 01h								01h
7	Command Code = 37h								37h
8	Data Length[7:0]								XXh
9	Data Length[15:8]								XXh
10	Data 0								XXh
11	Data 1								XXh
…	…								XXh
Data Length + 9	Data (N – 1 where N = Data Length - 3)								XXh
Data Length + 10	CRC[7:0]								XXh
Data Length + 11	CRC[15:8]								XXh
Data Length + 12	SOP = 17h								17h

Table 8-11. Append Data Buffer Response (Input Report)

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Value
0	Length[7:0] = 0Bh								0Bh
1	Length[15:8] = 00h								00h
2	Report ID = 30h								30h
3	RSVD = 00h								00h
4	SOP = 01h								01h
5	Status								XXh
6	Data Length[7:0] = 00h								00h
7	Data Length[15:8] = 00h								00h
8	CRC[7:0]								XXh
9	CRC[15:8]								XXh
10	EOP = 17h								17h

8.1.5 Program and Verify Row

Command Code: 39h

Uploads and programs a 128-byte row of TrueTouch application code into the flash, and then verifies that the row was successfully written by reading the row and comparing it to the data provided by the host. The row of data can be written is smaller blocks using the Append Data command. The bootloader will not program any rows unless a bootload has been initiated via the Initiate Bootload command.

Table 8-12. Program and Verify Row Command (Output Report)

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Value
0	Output Report Register Address[7:0] = 04h								04h
1	Output Report Register Address[15:8] = 00h								00h
2	Length[7:0]								XXh
3	Length[15:8]								XXh
4	Report ID = 40h								40h
5	RSVD = 00h								00h
6	SOP = 01h								01h
7	Command Code = 39h								39h
8	Data Length[7:0]								XXh
9	Data Length[15:8]								XXh
10	Flash Array ID = 00h								00h
11	Flash Row ID[7:0]								XXh
12	Flash Row ID[15:8]								XXh
13	Data 0								XXh
14	Data 1								XXh
15	…								XXh
Data Length + 12	Data (N – 1 where N = Data Length - 3)								XXh
Data Length + 13	CRC[7:0]								XXh
Data Length + 14	CRC[15:8]								XXh
Data Length + 15	SOP = 17h								17h

Table 8-13. Program and Verify Row Response (Input Report)

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Value
0	Length[7:0] = 0Bh								0Bh
1	Length[15:8] = 00h								00h
2	Report ID = 30h								30h
3	RSVD = 00h								00h
4	SOP = 01h								01h
5	Status								XXh
6	Data Length[7:0] = 00h								00h
7	Data Length[15:8] = 00h								00h
8	CRC[7:0]								XXh
9	CRC[15:8]								XXh
10	EOP = 17h								17h

8.1.6 Verify Application Integrity

Command Code: 31h

Performs a full verification of the application integrity by calculating the CRC of the TrueTouch application image in flash and comparing it to the expected CRC stored in the TrueTouch application CRC value stored in the Meta Data row (see "Initiate Bootload" on page 71 for details on Meta Row parameters). CRC calculation is performed on data bounded by the Application Start and Application Length values programmed in the Meta Data row.

If the application unexpectedly crashes, the host should issue this command to troubleshoot after entering into the bootloader. Verification of application integrity is performed by the Launch Application command before entering the TrueTouch application, so this command is not recommended during a bootload.

Table 8-14. Verify Application Integrity Command (Output Report)

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Value
0	Output Report Register Address[7:0] = 04h								04h
1	Output Report Register Address[15:8] = 00h								00h
2	Length[7:0] = 0Bh								0Bh
3	Length[15:8] = 00h								00h
4	Report ID = 40h								40h
5	RSVD = 00h								00h
6	SOP = 01h								01h
7	Command Code = 31h								31h
8	Data Length[7:0] = 00h								00h
9	Data Length[15:8] = 00h								00h
10	CRC[7:0]								XXh
11	CRC[15:8]								XXh
12	EOP = 17h								17h

Table 8-15. Verify Application Integrity Response (Input Report)

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Value
0	Length[7:0] = 0Ch								0Ch
1	Length[15:8] = 00h								00h
2	Report ID = 30h								30h
3	RSVD = 00h								00h
4	SOP = 01h								01h
5	Status								XXh
6	Data Length[7:0] = 01h								01h
7	Data Length[15:8] = 00h								00h
8	Application Integrity Check Result: 0 = fail; 1 = pass								XXh
9	CRC[7:0]								XXh
10	CRC[15:8]								XXh
11	Packet End = 17h								17h

8.1.7 Launch Application

Command Code: 3Bh

Launch Application will validate the TrueTouch application before entering it. If a bootload is in progress a CRC is calculated on the programmed TrueTouch application rows and the cached application entry point row from volatile memory. If the calculated CRC matches the Application CRC in the meta data row, the bootloader writes the cached contents of the flash row containing the application entry point from volatile memory into flash. If a bootload is not in progress, the bootloader performs a quick validation of the row containing the application entry point.

If the validation passes, the bootloader launches the application without returning any status. If the validation fails, the bootloader returns a failure status.

Table 8-16. Launch Application Command (Output Report)

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Value
0	Output Report Register Address[7:0] = 04h								04h
1	Output Report Register Address[15:8] = 00h								00h
2	Length[7:0] = 0Bh								0Bh
3	Length[15:8] = 00h								00h
4	Report ID = 40h								40h
5	RSVD = 00h								00h
6	SOP = 01h								01h
7	Command Code = 3Bh								3Bh
8	Data Length[7:0] = 00h								00h
9	Data Length[15:8] = 00h								00h
10	CRC[7:0]								XXh
11	CRC[15:8]								XXh
12	EOP = 17h								17h

Successful Response:
On successful, validation, the bootloader does not return a status. After the application launches, COMM_INT will be asserted and a NULL packet will be returned to the host.

Table 8-17. Successful Launch Application Response (Input Report)

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Value
0	Length[7:0] = 00h								00h
1	Length[15:8] = 00h								00h

Failure Response:
On a failed application validation, the bootloader returns the following packet.

Table 8-18. Failed Launch Application Response (Output Report)

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 2	Bit 0	Value
0	Length[7:0] = 0Bh								0Bh
1	Length[15:8] = 00h								00h
2	Report ID = 30h								30h
3	RSVD = 00h								00h
4	SOP = 01h								01h
5	Status = 0Ch								08h
6	Data Length[7:0] = 00h								00h

Table 8-18. Failed Launch Application Response (Output Report)

7	Data Length[15:8] = 00h	00h
8	CRC[7:0]	XXh
9	CRC[15:8]	XXh
10	Packet End = 17h	17h

8.2 TrueTouch Application Commands

Touch Application commands are initiated by the host using the Output Report Register, in the Touch Application state. The device responds to the host initiated command by writing response data to the Input Report Register. Touch Application commands are non-HIDI^{2}C compliant. Touch Application commands are listed in Table 8-19.

Touch Application commands are grouped in functional categories as follows:

Command Code 00h – 07h

These commands execute regardless of the state of scanning and reporting as directed by the Suspend Scanning/Resume Scanning commands.

Command Code 20h –2Dh

These are test/tuning commands that will execute successfully only after scanning and reporting have been suspended via the Suspend Scanning command.

Command Code 40h

These are customer design for test (DFT) commands that will execute successfully only after scanning and reporting have been suspended via the Suspend Scanning command.

See *Touchscreen Manufacturing Testing with CY8CTMA5XX* (Cypress document 001-85948) for example I2C scripts and the recommended manufacturing test flow.

Table 8-19. TrueTouch Application Commands

Command Code	Command Description	Command Code	Command Description
00h	Ping	24h	Retrieve Data Structure
01h	Start Bootloader	25h	Load Self Test Parameters
02h	Get System Information	26h	Run Self Test
03h	Suspend Scanning	27h	Get Self Test Results
04h	Resume Scanning	28h	Calibrate IDAC and PWCs
05h	Get Parameter	29h	Initialize Baselines
06h	Set Parameter	2Ah	Execute Panel Scan
07h	Get Noise Metrics	2Bh	Retrieve Panel Scan
20h	Verify Data Block CRC	2Ch	Start Sensor Data Mode
21h	Get Data Row Size	2Dh	Stop Sensor Data Mode
22h	Read Data Block	2Eh	Heat Map Finger Tracking Mode
23h	Write Data Block	40h	Interrupt Pin Override

8.2.1 TrueTouch Application Command/Response Packet Format

Table 8-20. TrueTouch Application Command Packet Format (Output Report)

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Value
0	Output Report Register Address[7:0] = 04h								04h
1	Output Report Register Address[15:8] = 00h								00h
2	Length[7:0] (Size of Output Report packet not including Output Report Register Address)								XXh
3	Length[15:8] (Size of Output Report packet not including Output Report Register Address)								XXh
4	Report ID = 2Fh (TrueTouch Application Output Report ID)								2Fh
5	RSVD = 00h (Bytes marked “RSVD” must be set to 0)								00h
6	RSVD	Command Code							XXh
7	Parameter Data[7:0]								XXh
8	Parameter Data[15:8]								XXh
…	…								XXh
Length + 1	Parameter Data[x:x]h								XXh

Table 8-21. TrueTouch Application Response Packet Format (Input Report)

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Value
0	Length[7:0] (Size of Input Report packet)								XXh
1	Length[15:8] (Size of Input Report packet)								XXh
2	Report ID = 1Fh (TrueTouch Application Input Report (ID)								1Fh
3	RSVD = 00h (Bytes marked “RSVD” must be set to 0)								00h
4	TGL	Command Code							XXh
5	Return Data/ Status								XXh
6	Return Data								XXh
…	...								XXh
Length - 1	Return Data								XXh

TGL: This bit is for each command processed by the TrueTouch device, toggled to serve as a command counter. Each command will return This the complement of the value that was returned on completion of the previous command.

Status: 00h = success; 01h = fail

8.2.2 Touch Application Unsupported Command Error Response

Only one type of error response to TrueTouch application commands is possible. Command response error checking is performed by the host by validating the expected TGL and Command parameters. If the host issues an unsupported command code, the touch application protocol returns a packet with the command code replacing the usually returned command code and a copy of the unsupported command code.

Table 8-22. Unsupported Command Code Response Packet Format (Input Report)

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Value
0	Length[7:0] = 06h								06h
1	Length[15:8] = 00h								00h
2	Report ID = 1Fh								1Fh
3	RSVD = 00h								00h
4	TGL	Command Code = 00h							X0h
5	Unsupported Command Code = Code Requested in Output Report								XXh

8.2.3 Ping

Command Code: 00h

This command performs no action except returning an input report indicating that it was executed (similar to ping TCP/IP utility). A host can use this command for a watchdog function to verify that the TrueTouch application is operating by inspecting the returned Toggle bit. If the application is in a non-operating state, due to an event such as ESD, the host should issue a device reset.

Table 8-23. Ping Command Packet Format (Output Report)

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Value
0	Output Report Register Address[7:0] = 04h								04h
1	Output Report Register Address[15:8] = 00h								00h
2	Length[7:0] = 05h								05h
3	Length[15:8] = 00h								00h
4	Report ID = 2Fh								2Fh
5	RSVD = 00h								00h
6	RSVD	Command Code = 00h							00h

Table 8-24. Ping Response Packet Format (Input Report)

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Value
0	Length[7:0] = 05h								05h
1	Length[15:8] = 00h								00h
2	Report ID = 1Fh								1Fh
3	RSVD = 00h								00h
4	TGL	Command Code = 00h							X0h

8.2.4 Start Bootloader: 01h

This command stops touch acquisition/reporting and launches the bootloader (field upgrade) application. This action results in a device reset (into the bootloader) which triggers the host to re-enumerate the device using descriptors provided by the bootloader.

Table 8-25. Start Bootloader Command (Output Report)

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Value
0	Output Report Register Address[7:0] = 04h								04h
1	Output Report Register Address[15:8] = 00h								00h
2	Length[7:0] = 05h								05h
3	Length[15:8] = 00h								00h
4	Report ID = 2Fh								2Fh
5	RSVD = 00h								00h
6	RSVD	Command Code = 01h							01h

Successful Response:

On successful reset and launch of the bootloader application, COMM_INT will be asserted and a NULL packet will be returned to the host.

Table 8-26. Successful Start Bootloader Response (Input Report)

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Value
0	Length[7:0] = 00h								00h
1	Length[15:8] = 00h								00h

8.2.5 Get System Information: 02h

This command returns system information.

Table 8-27. Get System Information Command (Output Report)

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Value
0	Output Report Register Address[7:0] = 04h								04h
1	Output Report Register Address[15:8] = 00h								00h
2	Length[7:0] = 05h								05h
3	Length[15:8] = 00h								00h
4	Report ID = 2Fh								2Fh
5	RSVD = 00h								00h
6	RSVD	Command Code = 02h							02h

Table 8-28. Get System Information Response (Input Report)

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Value or Description
0	Length[7:0] = 33h								33h
1	Length[15:8] = 00h								00h
2	Report ID = 1Fh								1Fh
3	RSVD = 00h								00h
4	TGL	Command Code = 02h							X2h
5	PIP Major Version								01h
6	PIP Minor Version								00h
7	TTPIDL [7:0] - TrueTouch Application Product ID								02h
8	TTPIDH [15:8] - TrueTouch Application Product ID								00h
9	FW_VER_MAJOR - TrueTouch Application Major Version								XXh
10	FW_VER_MINOR - TrueTouch Application Minor Version								XXh
11	REVCTRL [7:0] - TrueTouch Application Revision Control Number								XXh
12	REVCTRL [15:8] - TrueTouch Application Revision Control Number								XXh
13	REVCTRL [23:16] - TrueTouch Application Revision Control Number								XXh
14	REVCTRL [31:24] - TrueTouch Application Revision Control Number								XXh
15	CFG_VER [7:0] - Customer-Specified Firmware/Configuration Version								XXh
16	CFG_VER [15:8] - Customer-Specified Firmware/Configuration Version								XXh
17	BL_VER_MAJOR - Bootloader Major Version								XXh
18	BL_VER_MINOR - Bootloader Minor Version								XXh
19	FAMILY_ID								XXh
20	REVISION_ID								XXh
21	SILICON_ID [7:0]								XXh
22	SILICON_ID [15:8]								XXh
23	MFGID0 [7:0] - Cypress Manufacturing ID Lot Number								XXh
24	MFGID1 [15:8] - Cypress Manufacturing ID Lot Number								XXh
25	MFGID2 [7:0] - Cypress Manufacturing ID Wafer Number								XXh
26	MFGID3 [7:0] - Cypress Manufacturing ID Die X Position								XXh
27	MFGID4 [7:0] - Cypress Manufacturing ID Die Y Position								XXh

Table 8-28. Get System Information Response (Input Report)

28	MFGID5 [7:0] - Cypress Manufacturing ID Work Week Produced						XXh
29	MFGID6 [7:0] - Cypress Manufacturing ID Year Produced						XXh
30	MFGID7 [7:0] - Cypress Manufacturing ID Minor Revision Number						XXh
31	RSVD				POSTH SGMT	POSTH BIST	XXh
32	RSVD	POSTL VDDA Check	SCAN EN	POSTL BIST	POSTL TT CFG CRC	POSTL WDT Reset	XXh
33	ELECTRODES_X - Number of Electrodes on the X Axis						XXh
34	ELECTRODES_Y - Number of Electrodes on the Y Axis						XXh
35	LEN_X [7:0] - Panel X Axis Length (in $1/100^{th}$ mm)						XXh
36	LEN_X [15:8] - Panel X Axis Length (in $1/100^{th}$ mm)						XXh
37	LEN_Y [7:0] - Panel Y Axis Length (in $1/100^{th}$ mm)						XXh
38	LEN_Y [15:8] - Panel Y Axis Length (in $1/100^{th}$ mm)						XXh
39	RES_X [7:0] - Panel X Axis Resolution (in pixels)						XXh
40	RES_X [15:8] - Panel X Axis Resolution (in pixels)						XXh
41	RES_Y [7:0] - Panel Y Axis Resolution (in pixels)						XXh
42	RES_YL [15:8] - Panel Y Axis Resolution (in pixels)						XXh
43	MAX_Z [7:0] - Panel Pressure Resolution (in counts)						FFh
44	MAX_Z [15:8] - Panel Pressure Resolution (in counts)						00h
45	RSVD = 0					Panel X	0Xh
46	RSVD = 0					Panel Y	0Xh
47	RSVD = 0		Panel ID				0Xh
48	RSVD = 0		BTN4 Exists	BTN3 Exists	BTN2 Exists	BTN1 Exists	0Xh
49	RSVD = 0				SELF	MC	0Xh
50	MAX_TCHS - Maximum Number of Touch Records per Refresh Cycle						0Ah

POSTH SGMT: CFG supported by product segmentation: 0 = fail; 1 = pass

POSTH BIST and POSTL BIST: Reports the results of the test for short circuits to external voltages and pin-to-pin shorts. Both POSTH BIST and POSTL bits are set when this test passes. If this test fails POST is aborted: 0 = fail; 1 = pass

POSTL VDDA Check: Checks voltage supplied to VDDA: 0 = fail; 1 = pass

POSTL SCAN EN Report: Based on POST results scanning may be disabled or enabled if configuration data is invalid, configuration is not supported or panel test failed. The configurable parameter POST_CFG controls whether the device disables scanning after a failed POST: Scanning Disabled = 0; Scanning Enabled = 1

POSTL TT CFG CRCL: Results of CRC check on Configuration Data (see “Configuration CRC” on page 59):

0 = fail; 1 = pass

POSTL WDT Reset: Checks if most recent reset was caused by the watchdog timer:

0 = Other Device Reset; 1 = WDT Timer Reset

Panel X: X Axis Origin: 0 = left side; 1 = right side

Panel Y: Y Axis Origin: 0 = top; 1 = bottom

Panel ID: Customer defined ID used to determine panel manufacturer. The Panel ID pin is sensed at device startup, if enabled by PANELID_ENABLE (see PANELID_ENABLE register on page 179). This status can be used to indicate panel manufacturing information to the host. Each pin is reported as 0 if it is grounded at device startup. Floating panel ID pins are reported as 1. Reference the *CY8CTMA568 TrueTouch® Multi-Touch All-Points Touchscreen Controller* datasheet (001-82145) for the pins that support the Panel ID feature.

BTN1 Exists: Indicates if button 1 is enabled in configuration: 0 = disabled; 1 = enabled

BTN2 Exists: Indicates if button 2 is enabled in configuration: 0 = disabled; 1 = enabled

BTN3 Exists: Indicates if button 3 is enabled in configuration: 0 = disabled; 1 = enabled

BTN4 Exists: Indicates if button 4 is enabled in configuration: 0 = disabled; 1 = enabled

MC: Indicates if mutual capacitance scanning is enabled in the configuration: 0 = disabled; 1 = enabled

SELF: Indicates if self capacitance scanning is enabled in the configuration: 0 = disabled; 1 = enabled

MAX_TCHS: Maximum number of touch records per refresh cycle.

8.2.6 Suspend Scanning: 03h

This command suspends touch acquisition and asynchronous touch reporting.

Table 8-29. Suspend Scanning Command (Output Report)

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Value
0	Output Report Register Address[7:0] = 04h								04h
1	Output Report Register Address[15:8] = 00h								00h
2	Length[7:0] = 05h								05h
3	Length[15:8] = 00h								00h
4	Report ID = 2Fh								2Fh
5	RSVD = 00h								00h
6	RSVD	Command Code = 03h							03h

Table 8-30. Suspend Scanning Response (Input Report)

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Value
0	Length[7:0] = 05h								05h
1	Length[15:8] = 00h								00h
2	Report ID = 1Fh								1Fh
3	RSVD = 00h								00h
4	TGL	Command Code = 03h							X3h

8.2.7 Resume Scanning: 04h

Resumes touch scanning and asynchronous touch reporting.

Table 8-31. Resume Scanning Command (Output Report)

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Value
0	Output Report Register Address[7:0] = 04h								04h
1	Output Report Register Address[15:8] = 00h								00h
2	Length[7:0] = 05h								05h
3	Length[15:8] = 00h								00h
4	Report ID = 2Fh								2Fh
5	RSVD = 00h								00h
6	RSVD	Command Code = 04h							04h

Table 8-32. Resume Scanning Command (Input Report)

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Value
0	Length[7:0] = 05h								05h
1	Length[15:8] = 00h								00h
2	Report ID = 1Fh								1Fh
3	Reserved = 00h								00h
4	TGL	Command Code = 04h							X4h

8.2.8 Get Parameter

Command Code: 05h

Retrieves the value of a run-time configuration parameter (see "Run-time Configurable Parameters[RAM]" on page 141). If the parameter ID is invalid, the command will return zero bytes. Table 12-2 contains a list of parameter IDs and sizes.

Table 8-33. Get Parameter Command Packet (Output Report)

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Value
0	Length[7:0] (8 for 1-byte parameter, 9 for 2-byte parameter, 11 for 4-byte parameter)								08/09/0Bh
1	Length[15:8] (8 for 1-byte parameter, 9 for 2-byte parameter, 11 for 4-byte parameter)								00h
2	Report ID = 1Fh								1Fh
3	RSVD = 00h								00h
4	TGL	Command Code = 05h							X5h
5	Parameter ID								XXh
6	Parameter Size (in bytes)								XXh
7	Parameter Value [7:0]								XXh
8	Parameter Value [15:8]								XXh
9	Parameter Value [23:16]								XXh
10	Parameter Value [31:24]								XXh

8.2.9 Set Parameter

Command Code: 06h

Sets the value of a run-time configuration parameter (see “Run-time Configurable Parameters[RAM]” on page 141). If the parameter ID is invalid, the command will return zero bytes. Table 12-2 contains a list of parameter IDs and sizes.

Table 8-34. Set Parameter Command Packet (Input Report)

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Value
0	Output Report Register Address[7:0] = 04h								04h
1	Output Report Register Address[15:8] = 00h								00h
2	Length[7:0] (8 for 1-byte parameter, 9 for 2-byte parameter, 11 for 4-byte parameter)								XXh
3	Length[15:8] (8 for 1-byte parameter, 9 for 2-byte parameter, 11 for 4-byte parameter)								00h
4	Report ID = 2Fh								2Fh
5	RSVD = 00h								00h
6	RSVD	Command Code = 06h							06h
7	Parameter ID								XXh
8	Parameter Size (in bytes)								XXh
9	Parameter Value [7:0]								XXh
10	Parameter Value [15:8]								XXh
11	Parameter Value [23:16]								XXh
12	Parameter Value [31:24]								XXh

Table 8-35. Set Parameter Response (Input Report)

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Value
0	Length[7:0] = 07h								07h
1	Length[15:8] = 00h								00h
2	Report ID = 1Fh								1Fh
3	RSVD = 00h								00h
4	TGL	Command Code = 06h							X6h
5	Parameter ID								XXh
6	Parameter Size (in bytes)								XXh

8.2.10 Get Noise Metrics

Command Code: 07h

This command returns a metric associated with the level of noise. See CY8CTMA568 Touchscreen Controller Tuning Best Practices (Cypress specification 001-87715) for details on noise metrics.

Table 8-36. Get Noise Metrics Command (Output Report)

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Value
0	Output Report Register Address[7:0] = 04h								04h
1	Output Report Register Address[15:8] = 00h								00h
2	Length[7:0] = 05h								05h
3	Length[15:8] = 00h								00h
4	Report ID = 2Fh								2Fh
5	RSVD = 00h								00h
6	RSVD	Command Code = 07h							07h

Table 8-37. Get Noise Metrics Response (Input Report)

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Value
0	Length[7:0]								XXh
1	Length[15:8]								XXh
2	Report ID = 1Fh								1Fh
3	RSVD = 00h								00h
4	TGL	Command Code = 07h							X7h
5	Wideband Noise Metric [7:0]								XXh
6	Wideband Noise Metric [15:8]								XXh
7	Injected Touch Noise Metric [7:0]								XXh
8	Injected Touch Noise Metric [15:8]								XXh
9	Frequency Noise Metric [7:0]								XXh
10	Frequency Noise Metric [15:8]								XXh
0	Wideband Noise Metric [7:0]								XXh
1	Wideband Noise Metric [15:8]								XXh
2	Injected Touch Noise Metric [7:0]								XXh
3	Injected Touch Noise Metric [15:8]								XXh
4	Frequency Noise Metric [7:0]								XXh
5	Frequency Noise Metric [15:8]								XXh

8.2.11 Data Block Commands

Command Codes: 20h - 23h

These commands operate on the customer-defined data blocks: Configuration Data, Manufacturing Data, and Design Data.

Data in each block is addressable by it's respective Block ID and Row ID. The Manufacturing Data and Design Data areas are fixed sizes of 64 bytes and 32 bytes respectively. The row size of a Data Block is 128 bytes, which means that the Manufacturing Data and Design Data blocks have a maximum Row ID of 0. The Configuration Data block size is not fixed, and therefore may have a maximum Row ID greater than 0. To determine the maximum Row ID of the Configuration Data Block, the Configuration Data Block size must be read from the first two bytes of Row ID 0. This value divided by 128 bytes will determine the number of rows available in the Configuration Data block.

Each Data Block contains the following information in the first four bytes of the first row of data (Row ID 0):

Byte0	Byte1	Byte2	Byte3
Block Size LSB (bytes)	Block Size MSB (bytes)	Block Max Size LSB (bytes)	Block Max Size MSB (bytes)

Block ID:

0: Configuration Parameters Block - Used to configure the TrueTouch device to operate within system specifications.

1: Manufacturing Data Block (Manufacturing data size Maximum is 64 bytes; Row ID Maximum is 0x00) - The manufacturing data block is fully customer defined and may contain manufacturing test data gathered at each cycle of manufacturing test (see the TrueTouch® Manufacturing Test Kit chapter on page 27 for additional details).

2: Design Data Block (Design data maximum size is 32 bytes; Row ID Maximum is 0x00) - Used to store customer defined data that may be needed by the host.

8.2.12 Verify Data Block CRC

Command Code: 20h

Calculates a data block's CRC and compares it to the block's stored CRC. Returns pass status if both CRCs match, otherwise the status is set to fail. The calculated and stored CRCs are returned in the response packet, to assist in trouble-shooting. For more detail on Data Blocks see "Data Block Commands" on page 91.

A data block may be composed of several rows and a host may choose to only update a subset of rows for a block. This command allows the host to verify the CRC of a data block to validate that the partial update was successful. In the case of a partial block update, the host could choose to use this command to establish the new CRC for the block.

Table 8-38. Verify Data Block CRC Command (Output Report)

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Value
0	Output Report Register Address[7:0] = 04h								04h
1	Output Report Register Address[15:8] = 00h								00h
2	Length[7:0] = 06h								06h
3	Length[15:8] = 00h								00h
4	Report ID = 2Fh								2Fh
5	RSVD = 00h								00h
6	RSVD	Command Code = 20h							20h
7	Block ID: 0 = Configuration Data; 1 = Manufacturing Data; 2 = Design Data								XXh

Table 8-39. Verify Data Block CRC Response (Input Report)

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Value
0	Length[7:0] = 0Ah								0Ah
1	Length[15:8] = 00h								00h
2	Report ID = 1Fh								1Fh
3	RSVD = 00h								00h
4	TGL	Command Code = 20h							X0h
5	Status: 00h = pass; 01h = fail								XXh
6	Calculated CRC[7:0]								XXh
7	Calculated CRC[15:8]								XXh
8	Stored CRC[7:0]								XXh
9	Stored CRC[15:8]								XXh

8.2.13 Get Row Size

Command Code: 21h

This command will always return a row size of 128 bytes and is not recommended for use when operating on a data block. Returns the row size, in bytes, of a data block's. For more detail on Data Blocks see "Data Block Commands" on page 91.

Table 8-40. Get Row Size Command (Output Report)

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Value
0	Output Report Register Address[7:0] = 04h								04h
1	Output Report Register Address[15:8] = 00h								00h
2	Length[7:0] = 06h								05h
3	Length[15:8] = 00h								00h
4	Report ID = 2Fh								2Fh
5	RSVD = 00h								00h
6	RSVD	Command Code = 21h							21h

Table 8-41. Get Row Size Response (Input Report)

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Value
0	Length[7:0] = 07h								07h
1	Length[15:8] = 00h								00h
2	Report ID = 1Fh								1Fh
3	RSVD = 00h								00h
4	TGL	Command Code = 21h							X1h
5	Data Block Row Size (in bytes) LSB = 80h								80h
6	Data Block Row Size (in bytes) MSB = 00h								00h

8.2.14 Read Data Block

Command Code: 22h

Returns up to 128 bytes of the specified data block. The offset is the number of rows from the start of the configuration block identified by the Block ID. A value of 0 in the Requested Read Length Parameter will result in the number of remaining bytes in the addressed Row ID being returned in the Row Data parameter. The Data Block size will be returned if Row ID and Read Length are zero. A read will fail if the Block ID, Row ID, or Read Length are out of range. The read data will contain either the whole configuration block or a portion of it. For more details on Data Blocks see "Data Block Commands" on page 91. See "CRC" on page 37 for details on CRC calculation.

Table 8-42. Read Data Block Command (Output Report)

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Value
0	Output Report Register Address[7:0] = 04h								04h
1	Output Report Register Address[15:8] = 00h								00h
2	Length[7:0] = 0Ah								0Ah
3	Length[15:8] = 00h								00h
4	Report ID = 2Fh								2Fh
5	RSVD = 00h								00h
6	RSVD	Command Code = 22h							22h
7	Row ID[7:0]: Index of a row in a data block starting from 0								XXh
8	Row ID[15:8]: Index of a row in a data block starting from 0								XXh
9	Read Length[7:0] (in bytes): Maximum Read Length is 128 bytes								XXh
10	RSVD = 00h								00h
11	Block ID: 0 = Configuration Data; 1 = Manufacturing Data; 2 = Design Data								XXh

Table 8-43. Read Data Block Response (Input Report)

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Value
0	Length[7:0]								XXh
1	Length[15:8]								XXh
2	Report ID = 1Fh								1Fh
3	RSVD = 00h								00h
4	TGL	Command Code = 22h							X2h
5	Status: 00h = success; 01h = failure								XXh
6	Block ID: 0 = Configuration Data; 1 = Manufacturing Data; 2 = Design Data								XXh
7	Read Length[7:0]: Returns the actual number of bytes read								XXh
8	RSVD = 00h								00h
	RSVD = 00h								00h
10	Row Data (0)								XXh
11	Row Data (1)								XXh
…	…								XXh
Actual Read Length + 9	Row Data (Actual Read Length – 1)								XXh
Actual Read Length + 10	Row Data CRC LSB: Computed on returned Row Data only (byte 10 + Actual Read Length)								XXh
Actual Read Length + 11	Row Data CRC MSB: Computed on returned Row Data only (byte 10 + Actual Read Length)								XXh

8.2.15 Write Data Block

Command Code: 23h

Writes up to 128 bytes into the addressed location of a data block. The address of the area to write is specified by the Block ID, Flash Row ID, and Write Length parameters. To ensure a write is intended by the host, an eight byte key must be provided. A read will fail if the Block ID, Row ID, or Write Length are out of range. A failure status will occur if a power outage or V_{DDA} brownout is detected during the write operation, leaving the data block in a undefined state.

The host is responsible for preserving existing configuration data that is not to be modified. A CRC check for the entire block is performed after every Write Data Block command if scanning is enabled. If the CRC check fails, scanning is disabled and further Write Data Block commands may be executed. To re-enable scanning, a reset is required. This will cause the device to perform a power-on self-test and re-enable scanning if the CRC check passes. For more details on Data Blocks see "Data Block Commands" on page 91. See "CRC" on page 37 for details on CRC calculation.

Table 8-44. Write Data Block Command (Output Report)

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Value
0	Output Report Register Address[7:0] = 04h								04h
1	Output Report Register Address[15:8] = 00h								00h
2	Length[7:0]								XXh
3	Length[15:8]								XXh
4	Report ID = 2Fh								2Fh
5	RSVD = 00h								00h
6	RSVD	Command Code = 23h							23h
7	Row ID[7:0]: Index of row within a block starting from 0								XXh
8	Row ID[15:8]: Index of row within a block starting from 0								XXh
9	Write Length[7:0] (in bytes): Maximum size is 128 bytes								XXh
10	Write Length[15:8] (in bytes): Maximum size is 128 bytes								XXh
11	Block ID: 0 = Configuration Data; 1 = Manufacturing Data; 2 = Design Data								XXh
12	Row Data (0)								XXh
13	Row Data (1)								XXh
…	…								XXh
Write Length+11	Row Data (Write Length – 1)								XXh
Write Length+12	Security Key (0)								5Ah
Write Length+13	Security Key (1)								FDh
Write Length+14	Security Key (2)								FEh
Write Length+15	Security Key (3)								FFh
Write Length+16	Security Key (4)								03h
Write Length+17	Security Key (5)								02h
Write Length+18	Security Key (6)								01h
Write Length+19	Security Key (7)								A5h
Write Length+20	CRC LSB: Computed over Row Data only (byte 12 + Write Length)								XXh
Write Length+21	CRC MSB: Computed over Row Data only (byte 12 + Write Length)								XXh

Table 8-45. Write Data Block Response (Input Report)

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Value
0	Length[7:0] = 09h								09h
1	Length[15:8] = 00h								00h
2	Report ID = 1Fh								1Fh
3	RSVD = 00h								00h
4	TGL	Command Code = 23h							X3h
5	Status: 00h = success; 01h = failure								XXh
6	Block ID: 0 = Configuration Data; 1 = Manufacturing Data; 2 = Design Data								XXh
7	Actual Write Length[7:0]								XXh
8	Actual Write Length[15:8]								XXh

8.2.16 Retrieve Data Structure

Command Code: 24h

This command retrieves a structure of global and local calibration data for the selected scanning type and stores it in a virtual buffer. This command may need to be called multiple times if the structure is too large to be returned by a single command. Data returned in this command is order in the order of the panel for Mutual sensing and by sensor for all other sensing methods. The data is addressed in the virtual buffer using the Read Offset and Read Length parameters. An invalid Read Offset, Read Length, or Data ID will result in a failure status.

For example, for self-capacitance mode, an offset of 2 and a size of 4 will retrieve the first four local values.

Table 8-46. Data IDs

Data ID	Description
00h	Mutual IDAC and PWC Data (center frequency)
01h	Self Cap IDAC and PWC Data
03h	Button IDAC and PWC Data
04h	Mutual IDAC and PWC Data, Alternate Frequency 1 (if AFH enabled)
05h	Mutual IDAC and PWC Data, Alternate Frequency 2 (if AFH enabled)
07h	Mutual IDAC and PWC Data, Alternate Frequency 3 (if AFH enabled)
08h	Mutual IDAC and PWC Data, Alternate Frequency 4 (if AFH enabled)
09h	Mutual IDAC and PWC Data, Alternate Frequency 5 (if AFH enabled)

Table 8-47. Retrieve Data Structure Command (Output Report)

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Value
0	Output Report Register Address[7:0] = 04h								04h
1	Output Report Register Address[15:8] = 00h								00h
2	Length[7:0] = 0Ah								0Ah
3	Length[15:8] = 00h								00h
4	Report ID = 2Fh								2Fh
5	RSVD = 00h								00h
6	RSVD	Command Code = 24h							24h
7	Read Offset[7:0]: Byte offset into Data Structure (see Table 8-46 for more details)								XXh
8	Read Offset[15:8]								XXh
9	Read Length[7:0]: Number of bytes to return starting from Read Offset								XXh
10	Read Length[15:8]								XXh
11	Data ID: Type of scan mode data to retrieve (see Table 8-46 for more details)								XXh

Table 8-48. Retrieve Data Structure Response (Input Report)

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Value
0	Length[7:0] = 0Ah								0Ah
1	Length[15:8] = 00h								00h
2	Report ID = 1Fh								2Fh
3	RSVD = 00h								00h
4	RSVD	Command Code = 24h							24h
5	Status: 00h = success; 01h = failure								XXh
6	Data ID: Data ID Selected in Output Report								XXh

Table 8-48. Retrieve Data Structure Response (Input Report)

7	Actual Read Length[7:0]: Actual number of bytes returned			
8	Actual Read Length[15:8]: Actual number of bytes returned			
9	RSVD = 0h	MTRX	RSVD = 001b	XXh
10	Data (0)			XXh
…	…			
Actual Read Length +11	Data (Actual Read Length - 1)			

MTRX: Matrix mapping if the data is a 2D array: 0 = row major; 1 = column major.]

Table 8-49. Data ID and Read Offset Values for Data Structures

Data ID	Read Offset and Data Structure Returned
00h - Mutual IDAC and PWC Data (center frequency)	0 - Global IDAC Data [0]
	M-1 - Global IDAC Data [TX_Patterns]
	M - Local PWC Data [0] [0]
	M + N - Local PWC Data [TX_Patterns] [Num RX - 1]: N = (Num RX * TX_Patterns) - 1
01h - Self-cap IDAC and PWC Data	0 - Global IDAC Self RX
	1 - Global IDAC Self TX
	2 - Local PWC Data [RX 0]
	2 + (Num RX - 1) - Local PWC Data [Num RX - 1]
	3 + (Num RX - 1) - Local PWC Data [TX 0]
	2 + N - Local PWC Data [Num TX - 1]: N = (Num RX * Num TX) - 1
02h - Reserved	Reserved
03h - Button IDAC and PWC Data * Mutual Scan Configuration	0 - (Mutual) Global Mutual IDAC Data
	1 - (Mutual) Local PWC Mutual Data [BUTTON 0]
	N - (Mutual) Local PWC Mutual Data [BUTTON N]: N = Num of Buttons - 1
03h - Button IDAC and PWC Data * Self Scan Configuration	0 - (Self) Global Self IDAC Data
	1 - (Self) Local PWC Self Data [BUTTON 0]
	N - (Self) Local PWC Self Data [BUTTON N]: N = Num of Buttons - 1
03h - Button IDAC and PWC Data * Self + Mutual Scan Configuration	0 - (Self + Mutual) Global Mutual IDAC Data
	1 - (Self + Mutual) Local PWC Self Data
	2 - (Self + Mutual) Local PWC Mutual and Self Data [Button 0 Mutual]
	3 - (Self + Mutual Mode) Local PWC Mutual and Self Data [Button 0 Self]
	N-1 - (Self + Mutual) Local PWC Mutual and Self Data [Button N Mutual]: N-1 = (2 * Num Button) - 1
	N - (Self + Mutual) Local PWC Mutual and Self Data [Button N Self] N = (2 * Num Button) - 1
04h to 09h - Mutual IDAC and PWC Data (if AFH enabled)	0 - Global IDAC Data [0]
	M-1 - Global IDAC Data [TX_Patterns]
	M - Local PWC Data [0] [0]
	M + N - Local PWC Data [TX_Patterns] [Num RX - 1]: N = (Num RX * TX_Patterns) - 1

TX_Patterns = Round ((Num TX - 1) / N_{PHASE} + 1) * N_{PHASE}

N_{PHASE} is the number TX phases for the Multi-Phase TX feature which is configurable through the configurable parameter **CDC : MTX_ORDER**. Recommend to select between 1, 4, and 8 if the TX Pump is selected. It can be selected up to the number of TX electrodes if external TX voltage (VCCTX) is provided,

8.2.17 Self Test Commands

Command Code: 25h - 27h; Self Test IDs: 00h - 04h

Some Self Tests are run by first loading the self-test parameters using the Load Self-test Parameters command. Once the parameters are loaded for the specified test, the Run Self-test command must be initiated to begin the self-test. Finally, results are retrieved via the Get Self-test Results command. Each self-test documents the input and output parameters required for each command.

Some self-tests have unique parameters that characterize the type of test that will be run. This section describes each of these tests in detail.

Table 8-50. Self-test IDs

Name	Code	Description
NULL test	0x00	Performs no action
BIST	0x01	Comprehensive built-in self-test
Shorts	0x02	Short circuit test suites
Opens	0x03	Open circuit test suites
Automatic Shorts	0x04	Short circuit test suite - external and pin-to-pin

8.2.18 Self-Test Input Parameters

The BIST and Shorts Tests require the Pin Mask as an input parameter. For each XY pin configured on the device, the related bit must be asserted in the pin mask, to enable shorts and opens testing of that pin. Each bit in the pin masks corresponds to an XY sense pin on the device.

Pins are represented in sequential order, from LSB to MSB, from first byte 0 to the last byte in Pin Masks. A bit value of 1, in the pin mask, indicates that the pin should be included in testing. A bit value of 0 indicates that the pin is not configured and should not be included. See the device datasheet (001-82145) for pinout details..

Table 8-51. (44 I/O 56-pin QFN) Shorts Test Pin Masks

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	XY00	-	-	-	-	-	-	-
1	XY08	XY07	XY06	XY05	XY04	XY03	XY02	XY01
2	XY16	XY15	XY14	XY13	XY12	XY11	XY10	XY09
3	XY24	XY23	XY22	XY21	XY20	XY19	XY18	XY17
4	XY32	XY31	XY30	XY29	XY28	XY27	XY26	XY25
5	XY40	XY39	XY38	XY37	XY36	XY35	XY34	XY33
6	-	-	-	-	-	XY43	XY42	XY41

Table 8-52. (48 I/O 70-ball BGA) Shorts Test Pin Masks

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	XY02	XY01	XY00	-	-	-	-	-
1	XY10	XY09	XY08	XY07	XY06	XY05	XY04	XY03
2	XY18	XY17	XY16	XY15	XY14	XY13	XY12	XY11
3	XY26	XY25	XY24	XY23	XY22	XY21	XY20	XY19
4	XY34	XY33	XY32	XY31	XY30	XY29	XY28	XY27
5	XY42	XY41	XY40	XY39	XY38	XY37	XY36	XY35
6	-	-	-	XY47	XY46	XY45	XY44	XY43

Table 8-54. (54 I/O 70-ball BGA) Shorts Test Pin Masks

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	XY05	XY04	XY03	XY02	XY01	XY00	-	-
1	XY13	XY12	XY11	XY10	XY09	XY08	XY07	XY06
2	XY21	XY20	XY19	XY18	XY17	XY16	XY15	XY14
3	XY29	XY28	XY27	XY26	XY25	XY24	XY23	XY22
4	XY37	XY36	XY35	XY34	XY33	XY32	XY31	XY30
5	XY45	XY44	XY43	XY42	XY41	XY40	XY39	XY38
6	XY53	XY52	XY51	XY50	XY49	XY48	XY47	XY46

Table 8-55. (58 I/O 70-ball BGA) Shorts Test Pin Masks

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	XY07	XY06	XY05	XY04	XY03	XY02	XY01	XY00
1	XY15	XY14	XY13	XY12	XY11	XY10	XY09	XY08
2	XY23	XY22	XY21	XY20	XY19	XY18	XY17	XY16
3	XY31	XY30	XY29	XY28	XY27	XY26	XY25	XY24

Table 8-55. (58 I/O 70-ball BGA) Shorts Test Pin Masks

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
4	XY39	XY38	XY37	XY36	XY35	XY34	XY33	XY32
5	XY47	XY46	XY45	XY44	XY43	XY42	XY41	XY40
6	XY55	XY54	XY53	XY52	XY51	XY50	XY49	XY48
7	-	-	-	-	-	-	XY57	XY56

8.2.19 BIST (Built-In Self-Test)

Self-Test ID: 01h

Built-in self-test will execute both the Shorts Test and Opens Test, each described in the following sections (see "Shorts Test" on page 106 and "Opens Test" on page 111). BIST test failures include any of the possible Shorts Test or Opens Test failures. The BIST test provides only a return status for each BIST test. To get detailed return data the pin-to-pin shorts, external shorts, and opens tests must be run individually.

The BIST test requires running three consecutive commands to load test parameters ("Load BIST Self-test Command"), run test ("Run BIST Self-test Command"), and get the test results ("Get BIST Self-test Results Command").

Table 8-57. Threshold Parameters Used for Test Pass/Fail

Parameter	Description
ILEAK_MAX	Shorts test threshold in units of nA
OPENS_TEST_GIDAC	Global IDAC value for Opens Test Calibration
PWCOPEN_LOW	Opens test PWC Threshold Low
PWCOPEN_HIGH	Opens test PWC Threshold High
PWCOPEN_BUTTON_LOW	Opens test PWC Threshold Low - Buttons
PWCOPEN_BUTTON_HIGH	Opens test PWC Threshold High - Buttons

8.2.19.1 Load BIST Self-test Command

Command Code: 25h

Loads self test parameters prior to running the specified self test.

Table 8-58. Load BIST Self-test Command (Output Report register)

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Value
0	Output Report Register Address[7:0] = 04h								04h
1	Output Report Register Address[15:8] = 00h								00h
2	Length[7:0]								XXh
3	Length[15:8]								XXh
4	Report ID = 2Fh								2Fh
5	RSVD = 00h								00h
6	RSVD	Command Code = 25h							25h
7	Load Offset[7:0]								XXh
8	Load Offset[15:8]								XXh
9	Load Length[7:0] (in bytes): Calculated over bytes 12 - (Load Length + 16)								05h
10	Load Length[15:8](in bytes)								00h
11	BIST Self Test ID								01h
12	Pin Mask (0) (see Table 8-51 - Table 8-77)								XXh
13	Pin Mask (1)								XXh
14	Pin Mask (2)								XXh
15	Pin Mask (3)								XXh
16	Pin Mask (4)								XXh

Table 8-59. Load BIST Self-test Response (Input Report register)

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Value
0	Length[7:0] = 09h								09h
1	Length[15:8] = 00h								00h
2	Report ID = 1Fh								1Fh
3	RSVD = 00h								00h
4	TGL	Command Code							X5h
5	Status: 00h = success; 01h = fail; ffh = unsupported self-test ID								XXh
6	BIST Self Test ID								01h
7	Actual Read Length[7:0]								XXh
8	Actual Read Length[15:8]								XXh

8.2.19.2 Run BIST Self-test Command

Command Code: 26h

Executes BIST self test. Results are retrieved from RAM using the "Get BIST Self-test Results Command", if the Results Available parameters indicates results are available. Detailed results may be available regardless of the test's ability to determine a summary result.

Table 8-60. Run BIST Self-test Command (Output Report Register)

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Value
0	Output Report Register Address[7:0] = 04h								04h
1	Output Report Register Address[15:8] = 00h								00h
2	Length[7:0] = 07h								07h
3	Length[15:8] = 00h								00h
4	Report ID = 2Fh								2Fh
5	RSVD = 00h								00h
6	RSVD	Command Code = 26h							26h
7	BIST Self Test ID								01h
8	Write IDACs to Flash								00h

Table 8-61. Run BIST Self-test Response (Input Report register)

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Value
0	Length[7:0] = 08h								08h
1	Length[15:8] = 00h								00h
2	Report ID = 1Fh								1Fh
3	RSVD = 00h								00h
4	TGL	Command Code = 26h							X6h
5	Status: 00h = success; 01h = fail; ffh = unsupported self-test ID								XXh
6	Self Test Summary Result: 00h = pass; 01h = fail; ffh= host must interpret results								XXh
7	Results Available: 00h = none; nonzero = available								XXh

8.2.19.3 Get BIST Self-test Results Command

Command Code: 27h

Returns the BIST self-test results data. The "Run BIST Self-test Command" must have been executed prior to this command. The pass/fail status is reported for each test run in the BIST test suite.

Table 8-62. Get BIST Self-test Command (Output Report register)

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Value
0	Output Report Register Address[7:0] = 04h								04h
1	Output Report Register Address[15:8] = 00h								00h
2	Length[7:0] = 0Ah								0Ah
3	Length[15:8] = 00h								00h
4	Report ID = 2Fh								2Fh
5	RSVD = 00h								00h
6	RSVD	Command Code = 27h							27h
7	Read Offset[7:0]: Byte offset into self test results to start retrieving data								XXh
8	Read Offset[15:8]								XXh
9	Read Length[7:0]: Number of bytes to read from self test results								XXh
10	Read Length[15:8]								XXh
11	BIST Self Test ID: ID assigned to the self test that just completed								01h

Table 8-63. Get BIST Self-test Response (Input Report)

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Value
0	Length[7:0]								XXh
1	Length[15:8]								XXh
2	Report ID = 1Fh								1Fh
3	RSVD = 00h								00h
4	TGL	Command Code = 27h							X7h
5	Status: 00h = success; 01h = fail; ffh = unsupported self-test ID								XXh
6	BIST Self Test ID								01h
7	Actual Read Length[7:0]: Actual number of bytes returned								XXh
8	Actual Read Length[15:8]								XXh
9	RSVD = 00h								00h
10	Status External Short Circuit Test: 00h = pass; 01h = fail								01h
11	Status Pin-to-pin Short Circuit Test: 00h = pass; 01h = fail								XXh
12	Status Open Circuit Test: 00h = pass; 01h = fail								XXh
13	Status BIST Panel Scanning Disabled								XXh

Status BIST Panel Scanning Disabled:

0x0 = Panel scanning enabled, results are valid

0x1 = Panel scanning disabled, tests not run, BIST has failed

8.2.20 Shorts Test

Self-Test ID: 02h

The Shorts Test will test for short circuits between sense pins to supply voltages or ground (external shorts) and shorts to other pins (pin-to-pin shorts). The shorts test requires running three consecutive commands to load test parameters ("Load Shorts Self-test Command"), run test ("Run Shorts Self-test Command"), and get the test results ("Get Shorts Self-test Results Command").

Test parameters used during the Shorts test should be set using the "Set Parameter" before initiating a Shorts test (see Table 8-64)

Table 8-64. Parameters Used for Test

Parameter	Description
ILEAK_MAX	Shorts Test threshold in units of nA

8.2.20.1External Shorts Test Functional Overview

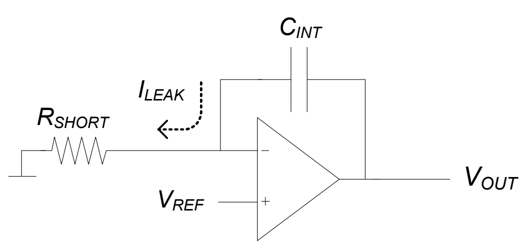
Shorts from XY sense pins to external voltage sources or GND are performed by measuring steady-state current into or out of a sense pin while all other sense pins are driven HI-Z. The sense pin is connected to the integrator input, and the ADC measures the integrator voltage output.

A short circuit causes a current (I_{leak}) into or out of the sense pin. A current path to GND or any other voltage less than the integrator reference voltage causes the integrator output voltage to rise above the integrator reference voltage, and a current path from a voltage greater than the integrator reference voltage causes the integrator output voltage to dip below the integrator reference voltage.

For this test, each sense pin is connected to the integrator and assessed for a leakage current. The test algorithm integrates the leakage current over a fixed period of time after connecting the pin to the integrator before performing an ADC conversion.

At the conclusion of the shorts test, the TrueTouch controller asserts the COMM_INT pin to indicate completion. The host then downloads the failure report.

Figure 8-1. External Shorts Test Block Diagram



The shorts test is illustrated in Figure 8-1. The resistor R_{SHORT} is the short circuit resistance to either the ground or an external voltage source. The current I_{LEAK} through the resistor can be calculated using Equation 1.

$$\mathbf{I_{LEAK} = V_{REF} / R_{SHORT}} \quad \textbf{Equation 1}$$

V_{REF} is the reference voltage. It is set to 1.3 V in the shorts test. The voltage across the integrator capacitor C_{INT} is expressed by the following equation.

$$\mathbf{V_{C\_INT} = I_{LEAK} * \Delta t / C_{INT}} \quad \textbf{Equation 2}$$

Δt is the TX period allowed for the integration. It is set to 256 48MHz system clock periods which equals to 5.333µs for the shorts test. The integrator capacitance is set to 31pF for the test. The integrator voltage V_{OUT} equals to the sum of V_{REF} and V_{C_INT}. Equation 3 and Equation 4 show V_{OUT} before and after integration.

$$\mathbf{V_{OUT\_BEFORE} = V_{REF}} \quad \textbf{Equation 3}$$

$$\mathbf{V_{OUT\_AFTER} = V_{REF} + V_{C\_INT}} \quad \textbf{Equation 4}$$

By measuring difference of the integrator output voltage before and after the integration, one can determine the voltage across the integrator capacitor which is proportional to the leakage current due to the short circuits resistance. The equivalent digital value is shown in Equation 6 and Equation 7 show the difference in integrator output voltage before and after integration.

$$\Delta D_{OUT} = V_{C\_INT} / V_{RES} \qquad \textbf{Equation 5}$$

V_{RES} is the ADC conversion resolution. It is set to 2 V for the shorts test. The advantage of implementing the shorts test using the integrator channel is that the converted results can be accumulated over multiple TX pulses effectively multiplying the sampling resolution. The final output result can be expressed by the following equation. The multiplication factor of 2 is used because conversion is performed at each high and low TX phases.

$$\Delta D_{OUT\_FINAL} = 2 * TX\_PULSES\_NUM * \Delta D_{OUT} \qquad \textbf{Equation 6}$$

In the current implementation, the number of TX pulses is selected to be 23. This value is picked such that the number of counts of the resulting digital output is roughly equals to the number of 1nA of leakage current being measured.

$$\Delta D_{OUT\_FINAL} = 2 * 23 * I_{LEAK} * (256 / 48MHz) * (1 / 31pF) * (256 / 2V) \qquad \textbf{Equation 7}$$

$$\Delta D_{OUT\_FINAL} = 1.013e9 * I_{LEAK} \qquad \textbf{Equation 8}$$

The test threshold is configurable by the parameter ILEAK_MAX in nA. Set this parameter based on the specified short resistance threshold using Equation 9.

$$ILEAK\_MAX = 1.3\ V / R_{SHORT\_THRESHOLD} \qquad \textbf{Equation 9}$$

With the current implementation, the highest shorts test leakage current threshold can be set up to about 5.8µA without saturating the integrator. This translates to about 220kΩ of short circuits resistance.

8.2.20.2Pins-to-pin Shorts Test Functional Overview

Shorts from XY sense pins to other sense pins are detected by measuring steady state current into or out of one sense pin while the other sense pin is driven strong to GND, and all other sense pins are driven HI-Z.

For this test, the resistance between each possible set of two sense pins connected to the panel is tested. Each combination of pins is tested only once. For a panel with N electrodes, the first pin is tested against the (N–1) remaining pins, the second pin is tested against (N– 2) pins (because it has already been tested against the first pin), the third pin is tested against (N–3) pins (because it has already been tested against the first and second pins), and so on. The test algorithm waits a minimum of 1 mutual-capacitance TX cycle time after connecting each pin to ground before performing an ADC measurement to allow for charging of the mutual-capacitance between the grounded pin and the pin connected to the integrator.

At the conclusion of the short circuit test, the TrueTouch controller asserts the COMM_INT pin to indicate completion. The host then downloads the failure records.

The test threshold is specified in the Configurable Parameter ILEAK_MAX. Refer to section "External Shorts Test Functional Overview" on page 106 for information on setting the test threshold.

Previous experience indicates the need to address the following conditions in short circuits testing.

- Typical short circuit.
  - Short circuits on Manhattan 3 panels can have resistances on the order of 50 kΩ. The test result must be FAIL.
  - Short circuits on the edges of panels can have resistances on the order of 100 Ω. The test result must be FAIL.
- Resistive current paths due to conductive residues. Flux left on a panel due to the lack of a cleaning process can provide a current path with resistance on the order of 5 MΩ. The test result must be PASS.

8.2.20.3 Load Shorts Self-test Command

Command Code: 25h

Loads Shorts self-test pin masks prior to running the shorts self-test.

Table 8-65. Load Shorts Self-test Command (Output Report register)

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Value
0	Output Report Register Address[7:0] = 04h								04h
1	Output Report Register Address[15:8] = 00h								00h
2	Length[7:0]								XXh
3	Length[15:8]								XXh
4	Report ID = 2Fh								2Fh
5	RSVD = 00h								00h
6	RSVD	Command Code = 25h							25h
7	Load Offset[7:0]								XXh
8	Load Offset[15:8]								XXh
9	Load Length[7:0] (in bytes): Calculated over bytes 12 - 17								06h
10	Load Length[15:8](in bytes)								00h
11	Shorts Self Test ID								02h
12	Shorts Test ID: 0 = External Shorts Test; 1 = Pin-to-pin shorts test								0Xh
13	Pin Mask (0) (see Table)								XXh
14	Pin Mask (1)								XXh
15	Pin Mask (2)								XXh
16	Pin Mask (3)								XXh
17	Pin Mask (4)								XXh

Table 8-66. Load Shorts Self-test Response (Input Report register)

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Value
0	Length[7:0] = 09h								09h
1	Length[15:8] = 00h								00h
2	Report ID = 1Fh								1Fh
3	RSVD = 00h								00h
4	TGL	Command Code = 24h							X4h
5	Status: 00h = success; 01h = fail; ffh = unsupported self-test ID								XXh
6	Shorts Self Test ID								02h
7	Actual Load Length[7:0]								XXh
8	Actual Load Length[15:8]								XXh

8.2.20.4 Run Shorts Self-test Command

Command Code: 26h

Executes shorts self-test. Results are retrieved from RAM using the “Get Shorts Self-test Results Command”, if the Results Available parameters indicates results are available. Detailed results may be available regardless of the test’s ability to determine a summary result.

Table 8-67. Run Shorts Self-test Command (Output Report Register)

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Value
0	Output Report Register Address[7:0] = 04h								04h
1	Output Report Register Address[15:8] = 00h								00h
2	Length[7:0] = 07h								07h
3	Length[15:8] = 00h								00h
4	Report ID = 2Fh								2Fh
5	RSVD = 00h								00h
6	RSVD	Command Code = 26h							26h
7	Shorts Self Test ID								02h
8	Write IDACs to Flash								00h

Table 8-68. Run Shorts Self-test Response (Input Report register)

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Value
0	Length[7:0] = 08h								08h
1	Length[15:8] = 00h								00h
2	Report ID = 1Fh								1Fh
3	RSVD = 00h								00h
4	TGL	Command Code = 26h							X6h
5	Status: 00h = success; 01h = fail; ffh = unsupported self-test ID								XXh
6	Self Test Summary Result: 00h = pass; 01h = fail; ffh= host must interpret results								XXh
7	Results Available: 00h = none; nonzero = available								XXh

8.2.20.5 Get Shorts Self-test Results Command

Command Code: 27h

Returns the shorts self-test results data. The “Run Shorts Self-test Command” must have been executed prior to this command. Results for each pin are reported in the Results Pin Mask field (see Table 8-51 - Table 8-77 for pin mask structure)

Table 8-69. Get Shorts Self-test Command (Output Report register)

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Value
0	Output Report Register Address[7:0] = 04h								04h
1	Output Report Register Address[15:8] = 00h								00h
2	Length[7:0] = 0Ah								0Ah
3	Length[15:8] = 00h								00h
4	Report ID = 2Fh								2Fh
5	RSVD = 00h								00h
6	RSVD	Command Code = 27h							27h
7	Read Offset[7:0]: Byte offset into self test results to start retrieving data								XXh

Table 8-69. Get Shorts Self-test Command (Output Report register)

8	Read Offset[15:8]	XXh
9	Read Length[7:0]: Number of bytes to read from self test results	XXh
10	Read Length[15:8]	XXh
11	Shorts Self Test ID: ID assigned to the self test that just completed	02h

Table 8-70. Get Shorts Self-test Response (Input Report)

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Value
0	Length[7:0]								XXh
1	Length[15:8]								XXh
2	Report ID = 1Fh								1Fh
3	RSVD = 00h								00h
4	TGL	Command Code = 27h							X7h
5	Status: 00h = success; 01h = fail; ffh = unsupported self-test ID								XXh
6	Shorts Self-test ID								02h
7	Actual Read Length[7:0]: Actual number of bytes returned								XXh
8	Actual Read Length[15:8]								XXh
9	RSVD = 00h								00h
10	Results Pin Mask 0: 0 = no short; 1 = short detected								02h
11	Results Pin Mask 1:								XXh
12	Results Pin Mask 2:								XXh
13	Results Pin Mask 3:								XXh
14	Results Pin Mask 4:								XXh

8.2.21 Opens Test

Self-Test ID - 03h

This command executes an open circuits test on a panel. The open circuits test is a PWC-only mutual-cap calibration with Multi-TX order of 1 (**MTX_ORDER** = 1). The calibration uses the Global IDAC value provided in the parameter **OPENS_TEST_GIDAC**. The calibrated test data remains in the RAM by default, but can be stored in the flash memory by setting the Write IDACs to Flash command parameter to 0x01. An open circuit generally reduces the equivalent mutual-capacitance at a given intersection (or set of intersections) by introducing a capacitance in series with the existing panel capacitances. Therefore, the baseline charge compensation IDAC setting required in the TX-RX path of an open circuit is less than the baseline compensation IDAC setting required in an undamaged TX-RX path.

The opens test requires running two consecutive commands to run the test ("Run Opens Self-test Command") and get the test results ("Get Opens Self-test Results Command").

Table 8-71. Threshold Parameters Used for Test Pass/Fail

Parameter	Description
OPENS_TEST_GIDAC	Global IDAC value for Opens Test Calibration
PWCOPEN_LOW	Opens PWC Threshold Low
PWCOPEN_HIGH	Opens PWC Threshold High
PWCOPEN_BUTTON_LOW	Opens PWC Threshold Low - Buttons
PWCOPEN_BUTTON_HIGH	Opens PWC Threshold High - Buttons

8.2.21.1 Run Opens Self-test Command

Command Code: 26h

Executes opens self-test. Results are retrieved from RAM or FLASH (if Write IDACs to Flash is set) using the "Get Opens Self-test Results Command", if the Results Available parameters indicates results are available. Detailed results may be available regardless of the test's ability to determine a summary result.

Table 8-72. Run Opens Self-test Command (Output Report Register)

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Value
0	Output Report Register Address[7:0] = 04h								04h
1	Output Report Register Address[15:8] = 00h								00h
2	Length[7:0] = 07h								07h
3	Length[15:8] = 00h								00h
4	Report ID = 2Fh								2Fh
5	RSVD = 00h								00h
6	RSVD	Command Code = 26h							26h
7	Opens Self Test ID								03h
8	Write IDACs to Flash: 00h = Write PWC values to RAM; 01h = Write PWC values to FLASH								XXh

Table 8-73. Run Opens Self-test Response (Input Report register)

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Value
0	Length[7:0] = 08h								08h
1	Length[15:8] = 00h								00h
2	Report ID = 1Fh								1Fh
3	RSVD = 00h								00h

Table 8-73. Run Opens Self-test Response (Input Report register)

4	TGL	Command Code = 26h	X6h
5	Status: 00h = success; 01h = fail; ffh = unsupported self-test ID		XXh
6	Self Test Summary Result: 00h = pass; 01h = fail; ffh= host must interpret results		XXh
7	Results Available: 00h = none; nonzero = available		XXh

8.2.21.2 Get Opens Self-test Results Command

Command Code: 27h

Returns the opens self-test results data. The “Run Opens Self-test Command” must have been executed prior to this command. The measured PWC values are returned with pass/fail status of the opens test.

Table 8-74. Get Opens Self-test Command (Output Report register)

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Value
0	Output Report Register Address[7:0] = 04h								04h
1	Output Report Register Address[15:8] = 00h								00h
2	Length[7:0] = 0Ah								0Ah
3	Length[15:8] = 00h								00h
4	Report ID = 2Fh								2Fh
5	RSVD = 00h								00h
6	RSVD	Command Code = 27h							27h
7	Read Offset[7:0]: Byte offset into self test results to start retrieving data								XXh
8	Read Offset[15:8]								XXh
9	Read Length[7:0]: Number of bytes to read from self test results								XXh
10	Read Length[15:8]								XXh
11	Opens Self Test ID: ID assigned to the self test that just completed								03h

Table 8-75. Get Opens Self-test Response (Input Report)

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Value
0	Length[7:0]								XXh
1	Length[15:8]								XXh
2	Report ID = 1Fh								1Fh
3	RSVD = 00h								00h
4	TGL	Command Code = 27h							X7h
5	Status: 00h = success; 01h = fail; ffh = unsupported self-test ID								XXh
6	Opens Self-test ID								03h
7	Actual Read Length[7:0]: Actual number of bytes returned								XXh
8	Actual Read Length[15:8]								XXh
9	RSVD = 00h								00h
10	Local PWC Value (see “Retrieve Data Structure” on page 97 for details on format of return data)								03h
11	Local PWC Value								XXh
...	...								XXh
Actual Read Length + 11	Local PWC Value								XXh

8.2.22 Automatic Shorts Test

Self-Test ID - 04h

This command runs both the pin-to-pin and the external shorts tests, using the calculated pins mask based on the configuration in the device. For details on how shorts tests are performed see “Shorts Test” on page 106. The automatic shorts test requires running two consecutive commands to run the test (“Run Automatic Shorts Self-test Command”) and get the test results (“Get Automatic Shorts Self-test Results Command”).

Table 8-76. Threshold Parameters Used for Test Pass/Fail

Parameter	Description
ILEAK_MAX	Shorts test threshold in units of nA

8.2.22.1 Run Automatic Shorts Self-test Command

Command Code: 26h

Executes automatic shorts self-test. Results are retrieved from RAM using the “Get Automatic Shorts Self-test Results Command”, if the Results Available parameters indicates results are available. Detailed results may be available regardless of the test’s ability to determine a summary result.

Table 8-77. Run Automatic Shorts Self-test Command (Output Report Register)

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Value
0	Output Report Register Address[7:0] = 04h								04h
1	Output Report Register Address[15:8] = 00h								00h
2	Length[7:0] = 07h								07h
3	Length[15:8] = 00h								00h
4	Report ID = 2Fh								2Fh
5	RSVD = 00h								00h
6	RSVD	Command Code = 26h							26h
7	Automatic Shorts Self Test ID								04h
8	Write IDACs to Flash								00h

Table 8-78. Run Automatic Shorts Self-test Response (Input Report register)

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Value
0	Length[7:0] = 08h								08h
1	Length[15:8] = 00h								00h
2	Report ID = 1Fh								1Fh
3	RSVD = 00h								00h
4	TGL	Command Code = 26h							X6h
5	Status: 00h = success; 01h = fail; ffh = unsupported self-test ID								XXh
6	Self Test Summary Result: 00h = pass; 01h = fail; ffh= host must interpret results								XXh
7	Results Available: 00h = none; nonzero = available								XXh

8.2.22.2 Get Automatic Shorts Self-test Results Command

Command Code: 27h

Returns the automatic shorts self-test results data. The “Run Automatic Shorts Self-test Command” must have been executed prior to this command. The calculated data field returns the calculated, 5-byte pin mask (indicating which pins on each port are actually in use). See Table 8-51 on page 101 for details on pin masks. The 5-byte external shorts results and 5-byte pin-to-pin shorts results are reported following the calculated pin masks.

Table 8-79. Get Automatic Shorts Self-test Command (Output Report register)

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Value
0	Output Report Register Address[7:0] = 04h								04h
1	Output Report Register Address[15:8] = 00h								00h
2	Length[7:0] = 0Ah								0Ah
3	Length[15:8] = 00h								00h
4	Report ID = 2Fh								2Fh
5	RSVD = 00h								00h
6	RSVD	Command Code = 27h							27h
7	Read Offset[7:0]: Byte offset into self test results to start retrieving data								XXh
8	Read Offset[15:8]								XXh
9	Read Length[7:0]: Number of bytes to read from self test results								XXh
10	Read Length[15:8]								XXh
11	Automatic Shorts Self Test ID: ID assigned to the self test that just completed								04h

Table 8-80. Get Automatic Shorts Self-test Response (Input Report)

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Value
0	Length[7:0]								XXh
1	Length[15:8]								XXh
2	Report ID = 1Fh								1Fh
3	RSVD = 00h								00h
4	TGL	Command Code = 27h							X7h
5	Status: 00h = success; 01h = fail; ffh = unsupported self-test ID								XXh
6	Automatic Shorts Self-test ID								04h
7	Actual Read Length[7:0]: Actual number of bytes returned								XXh
8	Actual Read Length[15:8]								XXh
9	RSVD = 00h								00h
10	Calculated Pin Mask (0): 0 = pin not configured; 1 = pin configured								XXh
11	Calculated Pin Mask (1): 0 = pin not configured; 1 = pin configured								XXh
12	Calculated Pin Mask (20): 0 = pin not configured; 1 = pin configured								XXh
13	Calculated Pin Mask (3): 0 = pin not configured; 1 = pin configured								XXh
14	Calculated Pin Mask (4): 0 = pin not configured; 1 = pin configured								XXh
15	External Shorts Results (0): 0 = no short; 1 = short detected								XXh
16	External Shorts Results (1): 0 = no short; 1 = short detected								XXh
17	External Shorts Results (2): 0 = no short; 1 = short detected								XXh
18	External Shorts Results (3): 0 = no short; 1 = short detected								XXh
19	External Shorts Results (4): 0 = no short; 1 = short detected								XXh
20	Pin-to-pin Shorts Results (0): 0 = no short; 1 = short detected								XXh

Table 8-80. Get Automatic Shorts Self-test Response (Input Report)

21	Pin-to-pin Shorts Results (1): 0 = no short; 1 = short detected	XXh
22	Pin-to-pin Shorts Results (2): 0 = no short; 1 = short detected	XXh
23	Pin-to-pin Shorts Results (3): 0 = no short; 1 = short detected	XXh
24	Pin-to-pin Shorts Results (4): 0 = no short; 1 = short detected	XXh

8.2.23 Calibrate IDAC and PWCs

Command Code: 28h

Performs IDAC and PWC calibration for the whole panel for a given sensing mode. A full calibration can be performed in a controlled environment after open circuit identification as part of the manufacturing process to prepare the TrueTouch device for field operation. The host retrieves the calibration data using "Retrieve Data Structure" on page 97. A failure status will occur if a power outage or V_{DDA} brownout is detected during the write operation, leaving the data block in a undefined state. The expected effect of V_{DDA} brownout is drops in V_{TX} and V_{ccts} which will cause loss of accuracy in the measurement system.

Table 8-81. Calibrate IDAC and PWCs Command (Output Report)

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Value
0	Output Report Register Address[7:0] = 04h								04h
1	Output Report Register Address[15:8] = 00h								00h
2	Length[7:0]								06h
3	Length[15:8]								00h
4	Report ID = 2Fh								2Fh
5	RSVD = 00h								00h
6	RSVD	Command Code = 28h							28h
7	Capacitive Sensing Mode: 00h = Mutual Cap Fine; 01h = Mutual cap Button; 02h = Self Cap								XXh

Table 8-82. Calibrate IDAC and PWCs Response (Input Report)

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Value
0	Length[7:0]								XXh
1	Length[15:8]								XXh
2	Report ID = 1Fh								1Fh
3	RSVD = 00h								00h
4	TGL	Command Code = 28h							X8h
5	Status: 00h = success; 01h = fail								XXh

8.2.24 Initialize Baselines

Command Code: 29h

Initializes the baselines for a given sensing mode to the current raw values. The primary purpose of initialize baselines is to support manufacturing test by ensuring initialization of baselines to realistic values prior to retrieving raw, baseline, and/or signal data. Initializing baseline using unsupported scan modes will result in a failure. A failure status will occur if a power outage or V_{DDA} brownout is detected during the write operation, leaving the data block in a undefined state. The expected effect of V_{DDA} brownout is drops in V_{TX} and V_{ccts} which will cause loss of accuracy in the measurement system.

Table 8-83. Initialize Baselines Command (Output Report)

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Value
0	Output Report Register Address[7:0] = 04h								04h
1	Output Report Register Address[15:8] = 00h								00h
2	Length[7:0] = 06h								06h
3	Length[15:8] = 00h								00h
4	Report ID = 2Fh								2Fh
5	RSVD = 00h								00h
6	RSVD	Command Code = 29h							29h
7	RSVD = 00h					SELF	BTN	MUT	0Xh

MUT: 0 = do not initialize mutual cap baseline; 1 = initialize mutual cap baseline.

BTN: 0 = do not initialize button scan baseline(s); 1 = initialize button scan baseline(s)

SELF: 0 = do not initialize self cap baseline; 1 = initialize self cap baseline

Table 8-84. Initialize Baselines Response (Input Report)

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Value
0	Length[7:0] = 06h								06h
1	Length[15:8] = 00h								00h
2	Report ID = 1Fh								1Fh
3	RSVD = 00h								00h
4	TGL	Command Code = 29h							X9h
5	Status: 00h = success; non-zero = failure								XXh

8.2.25 Execute Panel Scan

Command Code: 2Ah

Executes a single full panel scan for each of the scan types configured for the device. This command must be run before data can be read using the Retrieve Panel Scan command (see “Retrieve Panel Scan” on page 119).

Table 8-85. Execute Panel Scan Command (Output Report)

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Value
0	Output Report Register Address[7:0] = 04h								04h
1	Output Report Register Address[15:8] = 00h								00h
2	Length[7:0] = 05h								05h
3	Length[15:8] = 00h								00h
4	Report ID = 2Fh								2Fh
5	RSVD = 00h								00h
6	RSVD	Command Code = 2Ah							2Ah

Table 8-86. Execute Panel Scan Response (Input Report)

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Value
0	Length[7:0] = 06h								06h
1	Length[15:8] = 00h								00h
2	Report ID = 1Fh								1Fh
3	RSVD = 00h								00h
4	TGL	Command Code = 2Ah							XAh
5	Status: 00h = success; non-zero = failure								XXh

8.2.26 Retrieve Panel Scan

Command Code: 2Bh

Retrieves the specified data type for a the last successful Execute Panel Scan command (see “Execute Panel Scan” on page 118). If a Element Read Length of zero is passed in, the remaining number of bytes from the specified offset is returned but no data will be provided. If an Element Read Length of zero is returned, there are no bytes left to read. All data is returned in a two-byte, 2’s complement signed format. Data returned for buttons includes 1 status byte appended to the data packet, where bit 0 indicates the state of the button (0 = idle; 1 = active).

Table 8-87. Retrieve Panel Scan Command Data ID

Data ID	Data Type
00h	Mutual Cap Raw Data
01h	Mutual Cap Baseline Data
02h	Mutual Cap Difference/Signal Data
03h	Self Cap Raw Data
04h	Self Cap Baseline Data
05h	Self Cap Difference/Signal Data
09h	Buttons Data
0Ah	Data Record

Figure 8-2. Mutual-Cap and Self-Cap Data

Origin	X0	X1	X2	X3	X4
Y0	Element / Byte0/1	Byte8/9	Byte16/17	Byte24/25	Byte32/33
Y1	Byte2/3	Byte10/11	Byte18/19	Byte26/27	Byte34/35
Y2	Byte4/5	Byte12/13	Byte20/21	Byte28/29	Byte36/37
Y3	Byte6/7	Byte8/9 / Byte14/15	Byte15/16 / Byte38/39	Byte10/11 / Byte22/23	Byte12/13 / Byte30/31

Self-Cap
Mut-Cap

Figure 8-3. Button for Mutual-Cap or Self-Cap Modes Data

Self-Cap
Mut-Cap

Element	Data
Button0 (8 bytes)	Raw Data (2 bytes)
	Baseline Data (2 bytes)
	Diff/Signal Data (2 bytes)
	Status (2 bytes)
Button1	Raw Data
	Baseline Data
	Diff/Signal Data
	Status Bit0
Button2	Raw Data
	Baseline Data
	Diff/Signal Data
	Status Bit0
Button3	Raw Data
	Baseline Data
	Diff/Signal Data
	Status Bit0

Figure 8-4. Button Mutual-Cap + Self-Cap Data

Self-Cap
Mut-Cap

Element	Data
Button0 (8 bytes)	Raw Data (2 bytes)
	Baseline Data (2 bytes)
	Diff/Signal Data (2 bytes)
	Status (2 bytes)
Button1	Raw Data
	Baseline Data
	Diff/Signal Data
	Status
Button2	Raw Data
	Baseline Data
	Diff/Signal Data
	Status
Button3	Raw Data
	Baseline Data
	Diff/Signal Data
	Status
Button0 (7 bytes)	Raw Data
	Baseline Data
	Diff/Signal Data
	Status
Button1	Raw Data
	Baseline Data
	Diff/Signal Data
	Status
Button2	Raw Data
	Baseline Data
	Diff/Signal Data
	Status
Button3	Raw Data
	Baseline Data
	Diff/Signal Data
	Status

Table 8-88. Retrieve Panel Scan Command (Output Report)

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Value
0	Output Report Register Address[7:0] = 04h								04h
1	Output Report Register Address[15:8] = 00h								00h
2	Length[7:0] = 0Ah								0Ah
3	Length[15:8] = 00h								00h
4	Report ID = 2Fh								2Fh
5	RSVD = 00h								00h
6	RSVD	Command Code = 2Bh							2Bh
7	Read Offset[7:0]: Offset into requested data array to read data								XXh
8	Read Offset[15:8]								XXh
9	Element Read Length[7:0]: Number of elements in requested data array to read								XXh
10	Element Read Length[15:8]								XXh
11	Data ID (see Table 8-87 on page 119)								XXh

Table 8-89. Retrieve Panel Scan (Input Report)

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Value
0	Length[7:0]								XXh
1	Length[15:8]								XXh
2	Report ID = 1Fh								1Fh
3	RSVD = 00h								00h
4	TGL	Command Code = 2Bh							XBh
5	Status: 00h = success; 01h = failure								XXh
6	Data ID (see Table 8-87 on page 119)								XXh
7	Actual Element Read Length[7:0]: Number of elements read from the device								XXh
8	Actual Element Read Length[15:8]								XXh
9	RSVD = 00110b					Size			XXh
10	Data (0)								XXh
11	Data (1)								XXh
…	…								XXh
Size * Actual Read Length + 9	Data (Size * Actual Read Length – 1)								XXh

Size: Data element size in bytes

Data: Data Bytes = Element Read Length × Size; Size range 1-7

Table 8-90. Single Mode Button Scanning Data Format

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Value
0	Button 0 - Raw Data [7:0]								XXh
1	Button 0 - Raw Data [15:8]								XXh
2	Button 0 - Baseline Data [7:0]								XXh
3	Button 0 - Baseline Data [15:8]								XXh

Table 8-90. Single Mode Button Scanning Data Format

4	Button 0 - Difference/Signal [7:0]	XXh
5	Button 0 - Difference/Signal Data [15:8]	XXh
6	Button 0 - Status (Currently use bit-0, On/Off) [7:0]	XXh
7	Button 0 - Status (Currently use bit-0, On/Off) [15:8]	XXh
...	...	XXh
Actual Element Read Length - 8	Button N - Raw Data [7:0]	XXh
Actual Element Read Length - 7	Button N - Raw Data [15:8]	XXh
Actual Element Read Length - 6	Button N - Baseline Data [7:0]	XXh
Actual Element Read Length - 5	Button N - Baseline Data [15:8]	XXh
Actual Element Read Length - 4	Button N - Difference/Signal Data [7:0]	XXh
Actual Element Read Length - 3	Button N - Difference/Signal Data [15:8]	XXh
Actual Element Read Length - 2	Button N - Status (Currently use bit-0, On/Off) [7:0]	XXh
Actual Element Read Length - 1	Button N - Status (Currently use bit-0, On/Off) [15:8]	XXh

Table 8-91. Self + Mutual Button Scanning Data Format

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Value
0	Button 0 - Raw Data (Mutual) [7:0]								XXh
1	Button 0 - Raw Data (Mutual) [15:8]								XXh
2	Button 0 - Baseline Data (Mutual) [7:0]								XXh
3	Button 0 - Baseline Data (Mutual) [15:8]								XXh
4	Button 0 - Difference/Signal Data (Mutual) [7:0]								XXh
5	Button 0 - Difference/Signal Data (Mutual) [15:8]								XXh
6	Button 0 - Status (Currently use bit-0, On/Off) (Mutual) [7:0]								XXh
7	Button 0 - Status (Currently use bit-0, On/Off) (Mutual) [15:8]								XXh
...	...								XXh
Actual Element Read Length/2 - 8	Button N - Raw Data (Mutual) [7:0]								XXh
Actual Element Read Length/2 - 7	Button N - Raw Data (Mutual) [15:8]								XXh
Actual Element Read Length/2 - 6	Button N - Baseline Data (Mutual) [7:0]								XXh
Actual Element Read Length/2 - 5	Button N - Baseline Data (Mutual) [15:8]								XXh
Actual Element Read Length/2 - 4	Button N - Difference/Signal Data (Mutual) [7:0]								XXh
Actual Element Read Length/2 - 3	Button N - Difference/Signal Data (Mutual) [15:8]								XXh
Actual Element Read Length/2 - 2	Button N - Status (Currently use bit-0, On/Off) (Mutual) [7:0]								XXh

Table 8-91. Self + Mutual Button Scanning Data Format

Actual Element Read Length/2 - 1	Button N - Status (Currently use bit-0, On/Off) (Mutual) [15:8]	XXh
Actual Element Read Length/2	Button 0 - Raw Data (Self) [7:0]	XXh
Actual Element Read Length/2	Button 0 - Raw Data (Self) [15:8]	XXh
Actual Element Read Length/2 + 1	Button 0 - Baseline Data (Self) [7:0]	XXh
Actual Element Read Length/2 + 1	Button 0 - Baseline Data (Self) [15:8]	XXh
Actual Element Read Length/2 + 2	Button 0 - Difference/Signal Data (Self) [7:0]	XXh
Actual Element Read Length/2 + 2	Button 0 - Difference/Signal Data (Self) [15:8]	XXh
Actual Element Read Length/2 + 3	Button 0 - Status (Currently use bit-0, On/Off) (Self) [7:0]	XXh
Actual Element Read Length/2 + 3	Button 0 - Status (Currently use bit-0, On/Off) (Self) [15:8]	XXh
...	...	XXh
Actual Element Read Length - 8	Button N - Raw Data (Self) [7:0]	XXh
Actual Element Read Length - 7	Button N - Raw Data (Self) [15:8]	XXh
Actual Element Read Length - 6	Button N - Baseline Data (Self) [7:0]	XXh
Actual Element Read Length - 5	Button N - Baseline Data (Self) [15:8]	XXh
Actual Element Read Length - 4	Button N - Difference/Signal Data (Self) [7:0]	XXh
Actual Element Read Length - 3	Button N - Difference/Signal Data (Self) [15:8]	XXh
Actual Element Read Length - 2	Button N - Status (Currently use bit-0, On/Off) (Self) [7:0]	XXh
Actual Element Read Length - 1	Button N - Status (Currently use bit-0, On/Off) (Self) [15:8]	XXh

8.2.27 Start Sensor Data Mode

Command Code: 2Ch

Reports data for up to 25 sensors. Sensor data information will continue to be reported until the Stop Sensor Mode Data command is issued by the host or a device reset occurs (see "Stop Sensor Data Mode" on page 125). Sensor data is reported in a Input report that is reported along with the touch and button reports during a scan. The sensor data mode Input report may be up to 256 bytes (including length and report ID). This command may be issued multiple times with different parameters without requiring the Stop Sensor Data Mode command. If fewer than 25 sensors are provided, the list must be terminated as indicated in the Offset description, and the length of the report may be adjusted to reduce the amount of data communicated.

Table 8-92. Start Sensor Data Mode Command (Output Report)

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Value
0	Output Report Register Address[7:0] = 04h								04h
1	Output Report Register Address[15:8] = 00h								00h
2	Length[7:0]								XXh
3	Length[15:8]								XXh
4	Report ID = 2Fh								2Fh
5	RSVD = 00h								00h
6	RSVD	Command Code = 2Ch							2Ch
7	Data Point Description Record (0) [7:0]								XXh
8	Data Point Description Record (0) [15:8]								XXh
9	Data Point Description Record (1) [7:0]								XXh
10	Data Point Description Record (1) [15:8]								XXh
…	…								...
… + 1									...
55	Data Point Description Record (24) [7:0]								XXh
56	Data Point Description Record (24) [15:8]								XXh

Table 8-93. Start Sensor Data Point Description Record

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Value
0	Offset[7:0]								XXh
1	Mode		RSVD = 000b			Offset[10:8]			XXh

Mode: Scanning mode for the selected data point: 00b = mutual capacitance; 01b = button; 10b = self

Offset: Offset into the applicable data array at which to retrieve the data. A value of 07h terminates the sensor list of data point descriptions instead of an requesting additional data point descriptions.

Table 8-94. Start Sensor Data Mode Response (Input Report)

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Value
0	Length[7:0] = 05h								05h
1	Length[15:8] = 00h								00h
2	Report ID = 1Fh								1Fh
3	RSVD = 00h								00h
4	TGL	Command Code = 2Ch							XCh

When sensor data mode is active, the following input report is presented to the host in addition to the usual touch and button reports after scanning and reporting are re-enabled.

8.2.28 Stop Sensor Data Mode

Command Code: 2Dh

Disables the Start Sensor Data Mode Command (see "Start Sensor Data Mode" on page 124).

Table 8-95. Stop Sensor Data Mode Command (Output Report)

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Value
0	Output Report Register Address[7:0] = 04h								04h
1	Output Report Register Address[15:8] = 00h								00h
2	Length[7:0] = 05h								05h
3	Length[15:8] = 00h								00h
4	Report ID = 2Fh								2Fh
5	RSVD = 00h								00h
6	RSVD	Command Code = 2Dh							2Dh

Table 8-96. Stop Sensor Data Mode Response (Input Report)

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Value
0	Length[7:0] = 05h								05h
1	Length[15:8] = 00h								00h
2	Report ID = 1Fh								1Fh
3	RSVD = 00h								00h
4	TGL	Command Code = 2Dh							XDh

8.2.29 Start Tracking Heat Map Mode

Command Code: 2Eh

Enables the Tracking Heat Map Mode. The device reports the 7x7 sensor matrix data around a touch or two touches until device reset or the Stop Sensor Data Mode command is received (see “Stop Sensor Data Mode” on page 125).

Table 8-97. Start Tracking Heat Map Mode Command (Output Report)

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Value
0	Output Report Register Address[7:0] = 04h								04h
1	Output Report Register Address[15:8] = 00h								00h
2	Length[7:0] = 05h								05h
3	Length[15:8] = 00h								00h
4	Report ID = 2Fh								2Fh
5	RSVD = 00h								00h
6	RSVD	Command Code = 2Eh							2Eh

Table 8-98. Start Tracking Heat Map Mode Response (Input Report)

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Value
0	Length[7:0] = 05h								05h
1	Length[15:8] = 00h								00h
2	Report ID = 1Fh								1Fh
3	RSVD = 00h								00h
4	TGL	Command Code = 2Eh							XEh

When Start Tracking Heat Map Mode is active, the firmware exposes the Input Report shown in Table 8-99 on page 128 to the host in addition to the usual touch and button reports after scanning and reporting are re-enabled.

The reported data reports a square region of 7x7 sensors surrounding the first and second finger or stylus reported. The X/Y position of the region is reported as well. If the region extends off of the panel, it is moved back onto the panel. In Figure 8-5, point A reports 5,12 as coordinate of upper left corner, point B reports 4,0 as coordinate of upper left corner, point C reports 9,0 as coordinate of upper left corner. If both point B and C are on the panel at the same time and they are the first two finger touches, the overlapping region will be reported twice, once for each finger.

Figure 8-5. Heat Map Tracking Mode Example Sensor Regions

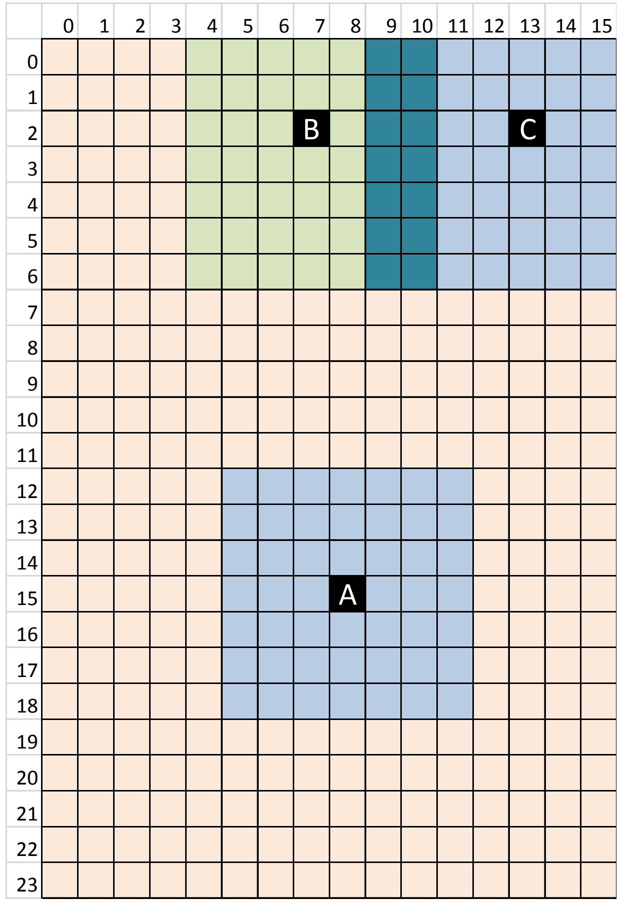


Table 8-99. Start Tracking Heat Map Mode Input Report

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Value
0	Length[7:0] = C9h								C9h
1	Length[15:8] = 00h								00h
2	Report ID = 0Eh								0Eh
3	RSVD = 00h								00h
4	First finger / stylus - Lowest X sensor reported								XXh
5	First finger / stylus - Lowest Y sensor reported								XXh
6	Signal Data for Point (0,0)								XXh
7									XXh
8	Signal Data for Point (0,1)								XXh
9									XXh
....	....								XXh
....									XXh
102	Signal Data for Point (6,6)								XXh
103									XXh
104	Second finger / stylus - Lowest X sensor reported								XXh
105	Second finger / stylus - Lowest Y sensor reported								XXh
106	Signal Data for Point (0,0)								XXh
107									XXh
108	Signal Data for Point (0,1)								XXh
109									XXh
....	....								XXh
....									XXh
202	Signal Data for Point (6,6)								XXh
203									XXh

8.2.30 Interrupt Pin Override

Command Code: 40h

Overrides the behavior of the COMM_INT pin. For each asserted TGL bit, the COMM_INT pin is toggled to indicate that the stage during scan processing has been performed. Run-time debugging and black box verification of operating states and timing can be evaluated or verified using this function.

Table 8-100. Interrupt Pin Override Command (Output Report)

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Value
0	Output Report Register Address[7:0] = 04h								04h
1	Output Report Register Address[15:8] = 00h								00h
2	Length[7:0] = 06h								06h
3	Length[15:8] = 00h								00h
4	Report ID = 2Fh								2Fh
5	RSVD = 00h								00h
6	RSVD	Command Code = 40h							40h
7	TGL7	TGL6	TGL5	TGL4	TGL3	TGL2	TGL1	TGL0	XXh

TGLx: Setting each TGL bit independently enables the COMM_INT pin to be toggled at each of the eight possible stages of scan processing:
00h = Normal COMM_INT pin operation
01h = Start of Refresh
02h = Toggle interrupt pin at completion of scanning and processing but before report generation.
03h - Toggle COMM_INT pin at start of ILO calibration.
04h - 06h = RSVD *Setting these bits will be ignored by the TrueTouch application.
07h = End of scan processing just prior to going into ARM CPU Deep Sleep mode.

Table 8-101. Interrupt Pin Override Response (Input Report)

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 2	Bit 0	Value
0	Length[7:0] = 06h								06h
1	Length[15:8] = 00h								00h
2	Report ID = 1Fh								1Fh
3	RSVD = 00h								00h
4	TGL	Command Code = 40h							X0h
5	Status: 00h - success; 01h = fail								XXh

Section D: Touchscreen System

This section contains specific information related to scanning, pin assignments, and power. For step-by-step tuning guidance, see the Cypress specification 001-87715.

This section includes the following chapter:

- Power System chapter on page 133
- Touch Reports on page 111
- Scanning on page 115
- Pin Assignment on page 117

Sensor Design

The *TrueTouch Touchscreen Controller Module Design Best Practices* (Cypress document 001-50467) outlines some considerations for designing touch panels, flex circuits, and PCBs for a touchscreen system. It also contains information about designing touchscreen buttons.

9. Power System

9.1 Power Domains

The TrueTouch device has two primary external power domains: an analog domain powered from a V_{DDA} supply, and a digital domain powered from a V_{DDD} supply. Optionally, a third external V_{CCTX} supply may also be connected to the device, used to drive the TX pins with up to 10 volts. An external V_{CCTX} supply must be externally regulated and is independent of the V_{DDA} domain, which must also be provided to power the RX channels. Alternately, the device can be configured to internally generate up to 10 volts, using the V_{DDA} supply. In this configuration, an external capacitor connected to the VCCTX pin provides additional charge to serve to serve higher capacitance loads or higher operating frequencies.

V_{DDA} supplies power for the RX channels and TX drivers, as well as other sensing components on the TrueTouch device. V_{DDD} supplies power to the core digital and core analog power domains which provide power during deep sleep. See the device datasheet for detailed power domain specification and typical supply connections.

To communicate with the host, using I^2C, only the V_{DDD} supply must be active and stable. If the I^2C port is isolated to its own bus or if all devices on that bus are power cycled together, then no specific concerns or controls are needed, and the V_{DDD} supply may be enabled or disabled at any time. If the CY8CTMA568 is operated on a shared I^2C bus, the device can be powered up or down independent of the other devices. The signal pins on the CY8CTMA568 are specifically designed to not load the bus when the device is in a powered down state, which allows the other devices to continue using the shared bus. To ensure data integrity during such power cycling of the CY8CTMA568, the host system must pause communications as the supply is being ramped up or down.

9.1.1 Power Supply Sequencing

The power supplies (VDDD, VDDA, and VCCTX) may be sequenced in any order, at any time, and any ramp rate allowed by the specifications. The device is only fully functional when all supplies are stable and within their allowed operational limits. If the device digital and analog domains have been fully powered up (VDDD and VDDA valid and stable) and the TX pins are enabled before VCCTX is asserted (when an external VCCTX supply is use) a current of up to 200 µA can flow through the device from the VDDA supply to the VCCTX supply. To avoid this current, ensure that the VCCTX power supply is asserted before VDDA and VDDD are valid, or have the VCCTX supply in a high-Z state when not valid.

9.1.2 Configuring Power Supplies

The $V_{DDD\ \mathrm{and}}$ V_{DDA} domains do not need to be configured by any parameter. Here are the configurations to enable wither the V_{DDA} pump or externally supplied V_{CCTX}.

Enabling VDDA Charge Pump:

1. Use the default setting for TX_CTRL.**PUMP_EN,** TX_CTRL**. VDDA_EN**, and TX_CTRL.**V5V_BYPASS**
2. Set TX_CTRL2.**PUMP_MODE** to 2x or 4x (Default is 2x)
3. Set TX_CTRL2.**PUMP_STRENGTH_RAMP** to max (Default)
4. Set TX_CTRL2.**PUMP_STRENGTH_KEEP** to max (Default)

Enabling External VCCTX:

1. Set TX_CTRL.**PUMP_EN** to Disabled
2. Set TX_CTRL**. VDDA_EN** to Enabled
3. Set TX_CTRL.**V5V_BYPASS** to Enabled

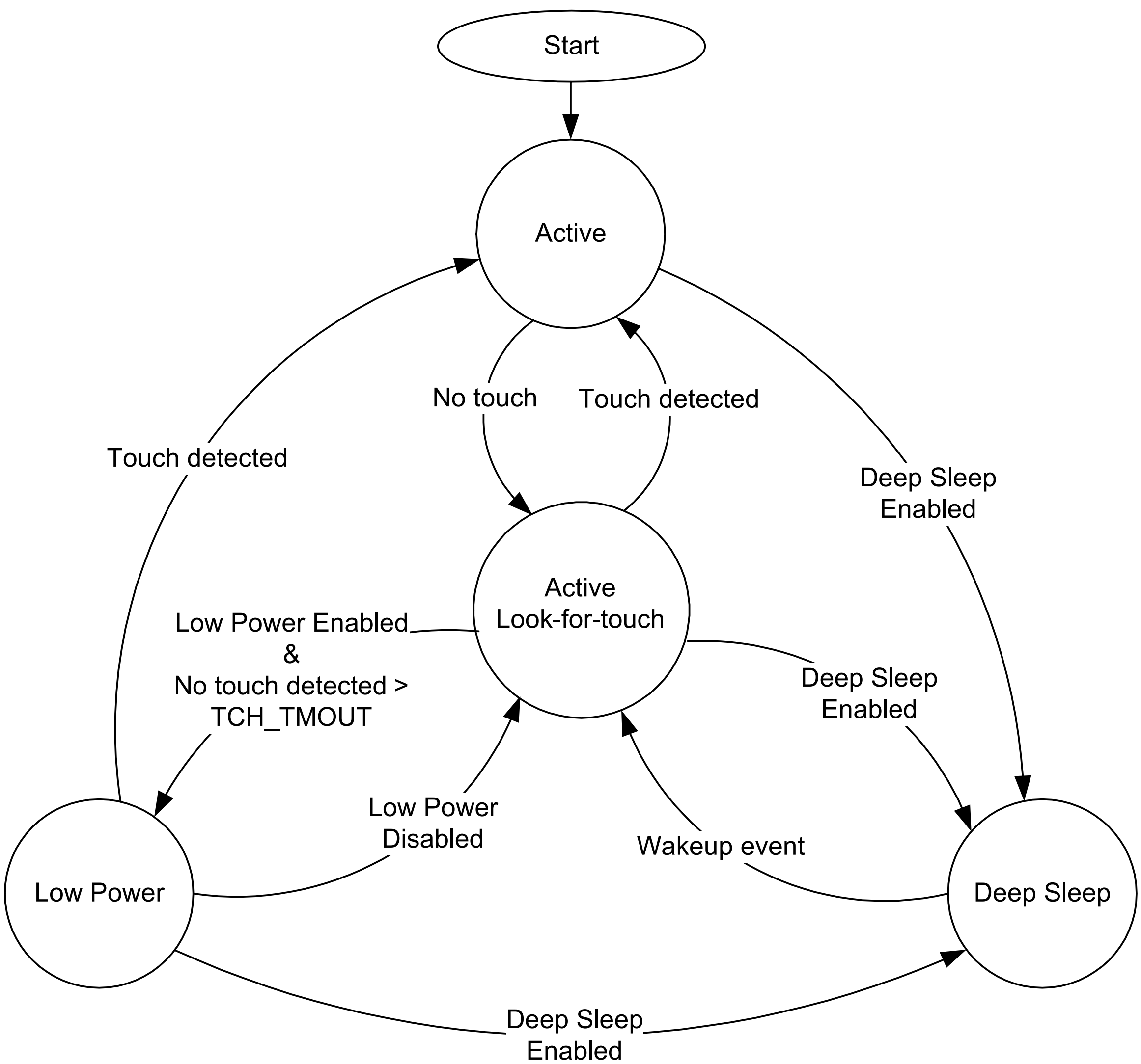
9.2 Power States

Power management is applicable while the device is actively scanning and reporting. Power is managed by the host or configured to be automatically managed by the device, using the following power states:

- Active (entered at device startup; highest power consumption)
- Active Look-for-touch (Active LFT) (device controlled Low Power entry/exit)
- Low-Power (device controlled entry; host controlled exit)
- Deep Sleep (host controlled entry/exit; lowest power consumption)

Enabling automatic power management allows the device to adjust the scan refresh rate as touch activity increases or decreases. After the user temporarily stops interacting with the application (no touches for a period of time), it is acceptable to decrease sampling rate which reduces power consumption at the cost of increasing response time to the next touch. By transitioning to the Low-Power state, the TrueTouch controller can sample the touchscreen panel slower than it does in the Active state to reduce power consumption. When a touch is detected, the TrueTouch controller resumes the Active power state. Automatic power management is enabled by setting the HST_MODE0 parameter.

Power States and Transitions

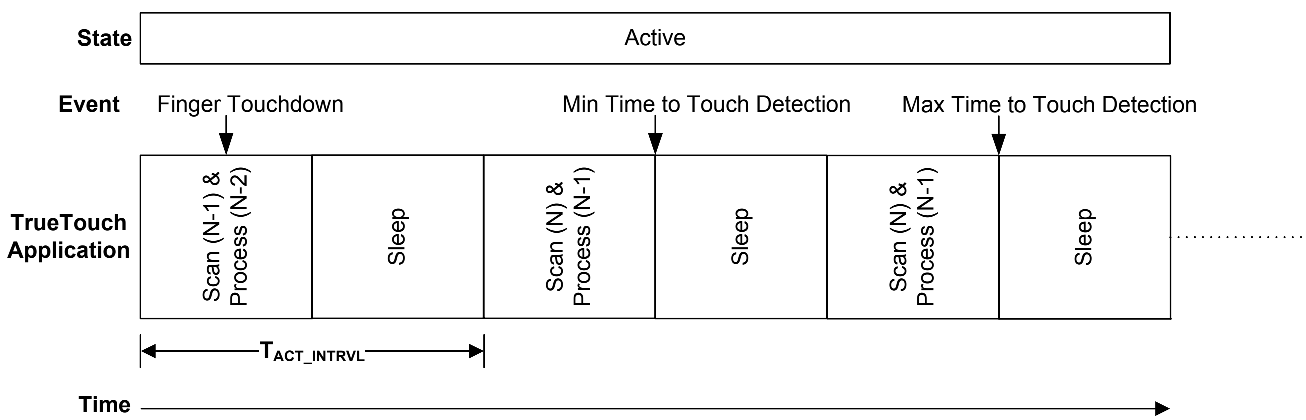


9.2.1 Refresh, Response and Report Timing

The Refresh Interval is the time between scanning and processing cycles. If the Refresh Interval is greater than the scan/process cycle, the TrueTouch device sleeps between scan/process cycles to conserve power. Active, Active LFT, and Low Power states each have a separate refresh interval parameter. Typical active refresh interval values are on the order of 1 s. A slower refresh rate is typically used in the Low Power state, which may be near 10 Hz (or 100 ms intervals). Increasing the ACT_INTRVL0 decreases power consumption in the Active state but increases Refresh Time, Response Time and Report Time. Refresh intervals may be configured during run-time (see the respective refresh interval register description for more details).

Response Time is the time from a touch down event while the TrueTouch controller is in Active, Active LFT or Low Power state to the TrueTouch controller generating the COMM_INT signal. Because the panel scanning and data processing are pipelined in Active state, it takes one refresh cycle to scan for finger position and another refresh cycle to process the scan data. The touch data is ready for the host at the end of the data process refresh cycle. Because the finger touch down may occur when the panel is partially scanned, it may not be detected in the first refresh cycle. Therefore, the Response Time may take longer than two refresh cycles, as shown in Figure on page 136.

Figure 9-1. Active State Pipelined Scan



Report Time is the time from a finger position change or touch lift-off while the TrueTouch controller is in Active state to the TrueTouch controller generating an interrupt signal. Similar to the Response Time, the Report Time may take longer than two refresh cycles.

Low Power state refresh time (and response time) is greater than Active state response time to achieve lower power consumption based on the following power consumption equation.

$$P_{average} = P_{scan/process/communicat} \times \frac{T_{\mathrm{scan/process/communicat}}}{T_{refresh}} + P_{idle} \times \left(1 - \frac{T_{scan/process/communicat}}{T_{refresh}}\right) \quad \textbf{Equation 1}$$

Note The TrueTouch controller does not initiate communication while it is in the Low Power state.

9.2.2 Active State

The Active state uses the shortest refresh interval of all states, and is used during touch activity. The ACT_INTRVL0 parameter specifies the interval between scans in the Active state. If there are no touches detected after processing scan N-1 and still no touches after processing scan N, the device enters the Active LFT state (see Figure 9-2). The device sleeps between scanning/processing cycles to reduce power consumption. Scanning and processing will be performed continuously if the ACT_INTRVL0 is set to less than or equal to the time that it takes to perform one scan/process cycle, and the device will not sleep. Table 9-1 specifies equations for calculating these times.

Figure 9-2. Active LFT Timing Diagram

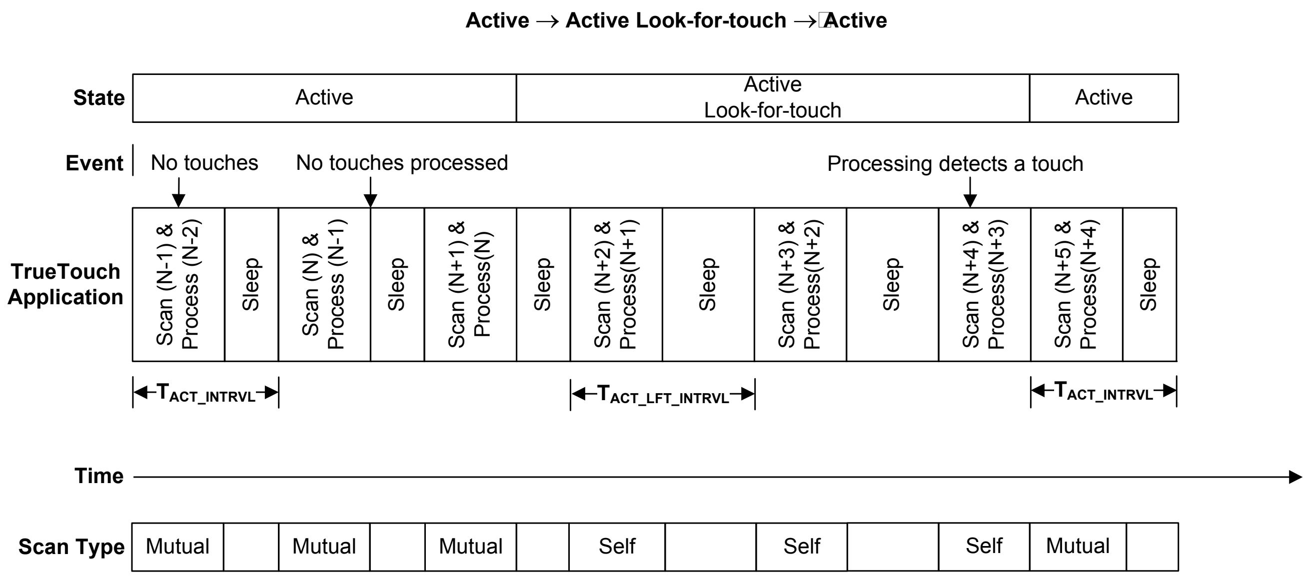


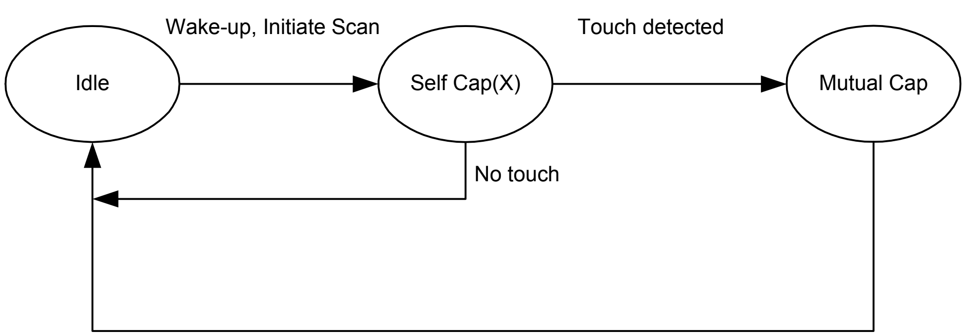
Table 9-1. Active State Timing Equations

Parameters	Conditions	Governing Equation
Refresh Time	$T_{ACT\_INTRVL} < T_{scan/process/communicat}$	$T_{refresh\_ACT} = T_{scan/process/communicat}$
	$T_{ACT\_INTRVL} \geq T_{scan/process/communicat}$	$T_{refresh\_ACT} = T_{ACT\_INTRVL}$
Response Time	In Active state	$3 \times T_{refresh\_ACT} > T_{response\_ACT} \geq 2 \times T_{refresh\_ACT}$
Report Time	In Active state	$3 \times T_{refresh\_ACT} > T_{report} \geq 2 \times T_{refresh\_ACT}$

9.2.3 Active Look-for-Touch State

The Active LFT state is entered automatically when there is no touch activity. While in the Active LFT state only a self capacitive scan is performed to determine if there is any touch on the panel. A mutual capacitive scan is only performed if the self capacitive scan indicates a touch was detected (see Figure 9-3). Self-capacitive scanning in the Active LFT state must be enabled in the ACT_LFT_EN parameter, otherwise mutual scanning will be used to detect a touch. The device sleeps between a scanning/processing cycles to reduce power consumption. See Figure for state transition timing information.

Figure 9-3. Active LFT Scanning Flow



The ACT_LFT_INTRVL0 parameter specifies the Active LFT refresh interval (in 1-ms increments). For most systems, the ACT_LFT_INTRVL0 is greater than ACT_INTRVL0. For systems that require fast first-touch response the two intervals may be set equal at the expense of power consumption. If Low Power is enabled, the device will automatically enter the Low Power state after a configurable time has elapsed, during which no touch activity has occurred (see “Low-Power State” on page 137). The host may request the device to deep sleep from this state. If a touch is detected the device enters the Active state.

Table specifies equations for calculating the timeout based on the values of ACT_LFT_INTRVL0 and TCH_TMOUT0 and the scanning/processing cycle time.

Table 9-2. Active Look for Touch State Timing Equations

Parameters	Conditions	Governing Equation
Refresh Time	In Active LFT state	$T_{refresh\_ACT\_LFT} = T_{ACT\_LFT\_INTRVL}$
Response Time	In Active LFT state	$T_{ACT\_LFT\_INTRVL} + T_{scan} + T_{refresh\_ACT} > T_{response\_ACT\_LFT} \geq T_{scan} + T_{refresh\_ACT}$
Touch Timeout	$T_{ACT\_LFT\_INTRVL} < T_{scan/process}$	$T_{timeout} = T_{scan/process} \times ceiling\left(\frac{TCH\_TMOUT0}{T_{scan/process}}\right)$
	$T_{ACT\_LFT\_INTRVL} \geq T_{scan/process}$	$T_{timeout} = T_{ACT\_LFT\_INTRVL} \times ceiling\left(\frac{TCH\_TMOUT0}{T_{ACT\_LFT\_INTRVL}}\right)$

Note It is assumed that no communication occurs while there are no touches.

9.2.4 Low-Power State

The LP_INTRVL0 parameter specifies the refresh interval (in 1-ms increments). If a touch is detected while in the Low Power state the device will scan and process the touch data and then transition into the Active state. While automatic power management is enabled, the TrueTouch controller increases its response time to decrease power consumption after no touches have been detected for a period of time. If the host needs to maintain responsiveness to initial touches during periods of inactivity, the host may prevent the device from entering the Low Power state by setting the HST_MODE0 parameter. If Low Power is disabled the device will stay in the Active LFT state. Scan types in the Low Power state are the same as in the Active LFT state. Deep Sleep may be requested by the host from the Low Power state. See Figure 9-4 for state transition timing information. When a liftoff event occurs a timer begins a countdown, where the time is defined by the TCH_TMOUT0 parameter. If a touch event does not occur before this timer expires, the device will enter the Low Power state if allowed by the host. If a touch is detected the device enters the Active state.

Figure 9-4. Low Power Timing Diagram

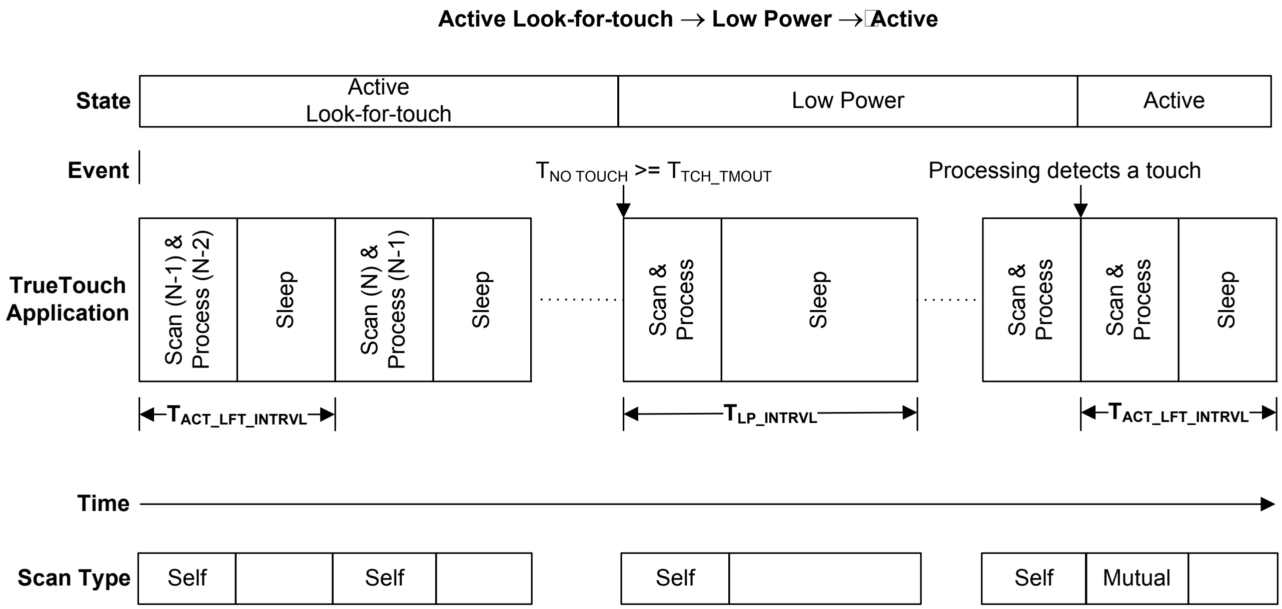


Table 9-3 specifies equations for calculating refresh time and response time.

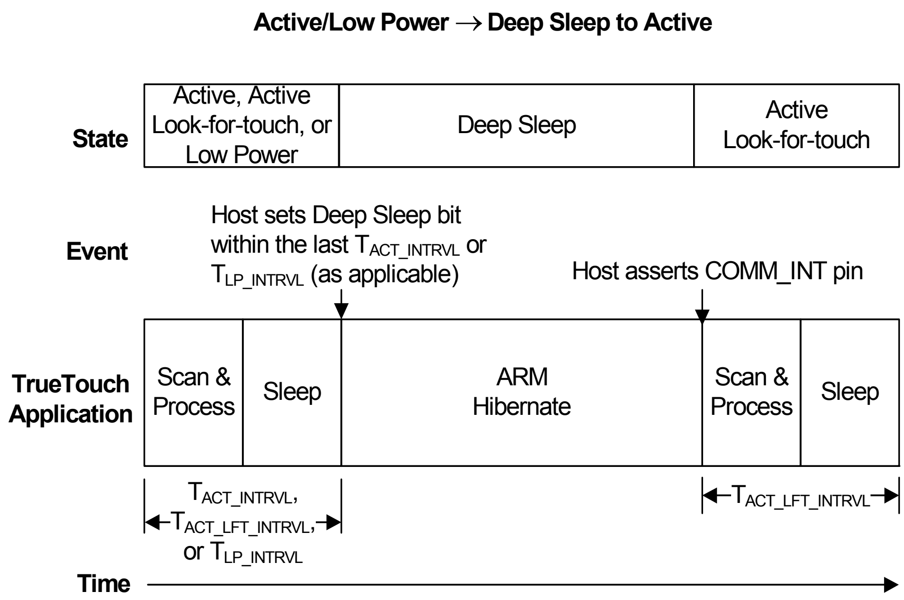
Table 9-3. Low Power State Timing Equations

Parameters	Conditions	Governing Equation
Refresh Time	$T_{LP\_INTRVL} < T_{scan/process}$	$T_{refresh\_LP} = T_{scan/process}$
	$T_{LP\_INTRVL} \geq T_{scan/process}$	$T_{refresh\_LP} = T_{LP\_INTRVL}$
Response Time	In Low Power state	$T_{response\_LP} = 2 \times T_{refresh\_ACT} + T_{LP\_INTRVL}$

Note It is assumed that no communication occurs while there are no touches.

9.2.5 Deep Sleep State

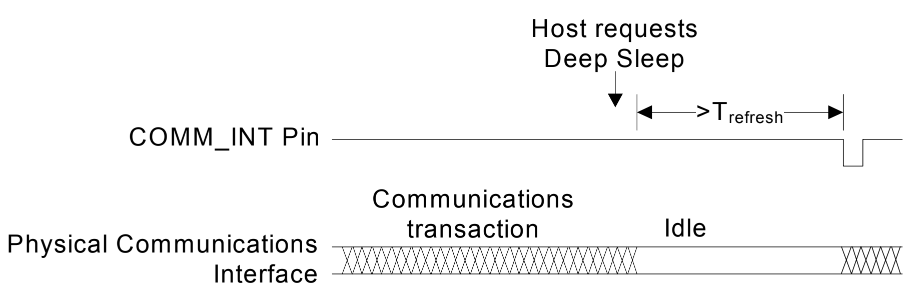
Figure 9-5. Deep Sleep Timing Diagrams



Deep Sleep is the lowest power consumption state for the TrueTouch device. In this state the internal clocks are disabled, but the RAM and register states are maintained. No scanning of the panel is performed, therefore no touch can be detected. Because no sensing is performed during Deep Sleep, neither response time nor refresh rate are considered. A typical application on a portable device is deactivation of the user interface after a period of inactivity. In this case, the host turns off the LCD screen and places the TrueTouch controller in deep sleep. At a later time, the host captures a mechanical button press, turns on the LCD, and wakes the controller.

The host may command the device to enter the Deep Sleep state from any other state. The TrueTouch device enters the Deep Sleep state after the next scheduled touchscreen scan or up to 1 refresh interval. The host may trigger a wakeup only after 1 refresh interval has passed since the last communication with the TrueTouch controller.

Figure 9-6. Deep Sleep Wakeup Communication Timing Diagram



The host must send a SET_POWER command to enter and wake from Deep Sleep (see"Deep Sleep Command" on page 51). Upon exit from Deep Sleep, the TrueTouch device sends a response to indicate a successful wakeup. Upon exit from the Deep Sleep, the TrueTouch controller immediately executes a scanning/processing cycle to provide touch data to the host.

9.3 Power Management Techniques

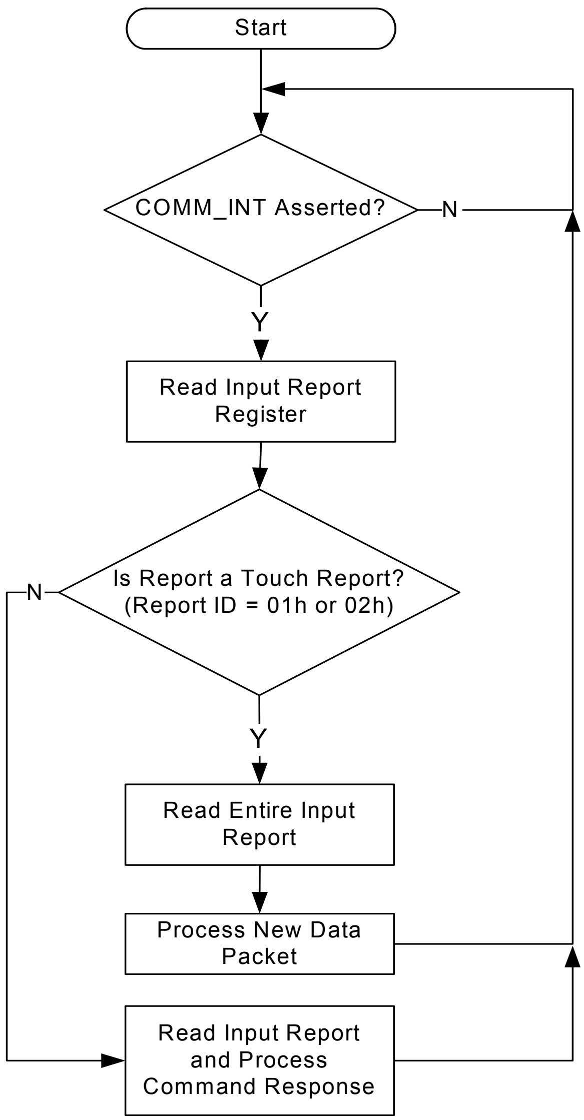
Power in the V_{DDD} domain can be managed in two primary ways: use of the deep sleep state or cycling power to the VDDD pin of the device. Deep sleep is the preferred method of power management. Cycling power is possible, but depending on how the system is implemented may require specific control in system firmware. To enter the Deep Sleep state the host must initiate the HID request Set Power command (see "Deep Sleep Command" on page 51).

Power consumption increases while I^2C communication with the host occurs because this communication causes the True-Touch controller's CPU to wake up. Therefore, to realize low power consumption while Low Power is enabled, the host must not poll the communication interface. Cypress recommends interrupt pin initiated host communication for I^2C touch data acquisition.

10. Touch and Button Reports

The TrueTouch controller updates the Input Report register and asserts the COMM_INT pin at the end of a scanning/processing interval, when touch or button data has changed. Updated touch or button data can arise from a change in the number of touches, movement in one of the touches (greater than the active distance), or a user defined event. Scanning is suspended and the COMM_INT pin remains asserted until the host reads the entire Input Report. The host can identify a touch or button report from the Report ID. For a reference to all available Report IDs see Table on page 40.

Figure 10-1. Data Acquisition Flow in Response to Interrupt Pin



10.1 Touch Reports

Touch reports are located in the Input Report register. See Packet Interface Protocol (PIP) chapter on page 39 for more details

Table 10-1. Touch Report Structure

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Value
0	Length = 7 + Number of Records * Record Length								XXh
1									
2	Report ID								01h
3	Timestamp								XXh
4									XXh
5	Reserved		LO	Number of Records					XXh
6	Report Counter		Reserved			Noise Effects			XXh
7	Touch Record 0 (see record description in table below)								
…									
6 + Record Length									
7 + Record Length	Touch Record 1								
…									
6 + 2 * Record Length									
7 + 2 * Record Length	Touch Record 2								
…									
6 + 3 * Record Length									
7 + 3 * Record Length	Touch Record 3								
…									
6 + 4 * Record Length									
7 + 4 * Record Length	Touch Record 4								
…									
6 + 5 * Record Length									
7 + 5 * Record Length	Touch Record 5								
…									
6 + 6 * Record Length									
7 + 6 * Record Length	Touch Record 6								
…									
6 + 7 * Record Length									
7 + 7 * Record Length	Touch Record 7								
…									
6 + 8 * Record Length									
7 + 8 * Record Length	Touch Record 8								
…									
6 + 9 * Record Length									
7 + 9 * Record Length	Touch Record 9								
…									
6 + 10 * Record Length									

Timestamp: Timestamp is unsigned in units of 0.1 milliseconds.

LO: Large object indicator.

0 = No large object on the panel or large object is rejected when passive stylus is detected.
1 = Large object detected

Number of Records: Number of touches is unsigned, indicating number of reports for a given scan iteration.

Report Counter: Counter that increments on each touch report issue. The host driver can use this for synchronization and error checking.

Noise Effects: Charger Noise Effect levels increment based on the detected noise in the system. Additional noise mitigation techniques are enabled for each level (see Cypress specification 001-87715 for details).

0 = Undetectable (Charger Armor is off)
1 - 4 = Level 1 (Charger Armor is on)
5 = Excessive Noise (Charger Armor is on touches are blocked.

Table 10-2. Touch Record Structure

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Value
0	Reserved					Touch Type			XXh
1	Tip	Event ID		Touch ID					XXh
2	X[7:0]								XXh
3	X[15:8]								XXh
4	Y[7:0]								XXh
5	Y[15:8]								XXh
6	Pressure								XXh
7	Major Axis Length[7:0]								XXh
8	Minor Axis Length[15:8]								XXh
9	Orientation								XXh

Touch Type: The type of touch object for a given record.

0 = Standard finger
2 = Stylus
1, 3-15 = Reserved

Tip: Indicates touch liftoff status.

0 = Touch is currently on the panel.
1 = Touch record indicates a liftoff.

Event ID[1:0]: Indicates an event associated with this touch instance.

0 = No event
1 = Touchdown
2 = Significant displacement (> active distance)
3 = Liftoff (record reports last known coordinates)

Touch ID[4:0]: An arbitrary ID tag associated with a finger to allow tracking of a touch as it moves around the panel.

X[n:0]: The X-axis coordinate of the touch in pixels.

Y[m:0]: The Y-axis coordinate of the touch in pixels.

Pressure[7:0]: The touch intensity in counts.

Major Axis Length: The length of the major axis (in pixels) of the ellipse of contact between the finger and the panel. This is a 8-bit unsigned integer.

Minor Axis Length: The length of the minor axis (in pixels) of the ellipse of contact between the finger and the panel. This is a 8-bit unsigned integer. If the ellipse of contact degenerates to a circle, the minor axis is set equal to the major axis.

Orientation: The angle between the panel vertical axis and the major axis of the contact ellipse. This value is an 8-bit signed integer. The range is -127 to +127 (corresponding to -90° and +90° respectively). The positive direction is clockwise from the vertical axis. If the ellipse of contact degenerates into a circle, orientation is reported as 0.

10.2 Button Reports

Touch reports are located in the Input Report register. See Packet Interface Protocol (PIP) chapter on page 39 for more details

Table 10-3. Button Report Structure

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Value
0	Length = 14								0Eh
1									00h
2	Report ID = 03h								03h
3	Timestamp								XXh
4									XXh
5	Reserved				Button 4	Button 3	Button 2	Button 1	XXh
6	Button 1 Signal								XXh
7									XXh
8	Button 2 Signal								XXh
9									XXh
10	Button 3 Signal								XXh
11									XXh
12	Button 4 Signal								XXh
13									XXh

Timestamp: Timestamp is unsigned in units of 0.1 milliseconds.

Button 1: Indicates button 1 status and events.
0 = Button 1 is idle.
1 = Button 1 is active.

Button 2: Indicates button 2 status and events.
0 = Button 2 is idle.
1 = Button 2 is active.

Button 3: Indicates button 3 status and events.
0 = Button 3 is idle.
1 = Button 3 is active.

Button 4: Indicates button 4 status and events.
0 = Button 4 is idle.
1 = Button 4 is active.

Button 1 Signal: Reports the difference/signal data for button 1.

Button 2 Signal: Reports the difference/signal data for button 2.

Button 3 Signal: Reports the difference/signal data for button 3.

Button 4 Signal: Reports the difference/signal data for button 4.

11. Pin Assignment

Pin assignment is critical to optimal sensing performance. The TrueTouch device has twenty receive (RX) channels and an additional Listen/Receive (LX/RX) channel, which may be connected to any pin, for a total of 21 RX channels. The transmit (TX) pins do not have any routing limitations and can be connected to any XY (RX/TX sense) pins. See the device datasheet for details on pin information.

A slot is a group of RX channels that have been configured for use on the TrueTouch device. If a channel is connected to two different pins, this creates two slots. Single-pass scanning refers to a configuration that only uses one slot. Likewise, dual-pass scanning refers to a configuration which uses two slots. CYTMA568 currently only supports single-pass scan.

Button scans are always performed on a separate slot than touchscreen scans. Pins allocated for buttons may be connected to pins already assigned as RX/TX pins for the touchscreen. Pin assignments are done in TTHE, which will limit pin and slot assignments to only those that are allowable by the device.

Channels 1-10 are and channels 11-20 are physically located on opposite sides of the TrueTouch device. This impacts the routing options that are available when connecting RX/TX pins to the touchscreen. See *TrueTouch® Touchscreen Controller Module Design Best Practices (001-50467)* for additional information on routing and layout. Table 11-1 shows the pin assignment options and specifies the differences between the 70-ball BGA and 56-pin QFN packages.

Table 11-1. RX Pin Assignment Configuration

70-ball BGA				56-pin QFN		RX Channels																			
Pin #	58 I/O	54 I/O	48 I/O	Pin #	44 I/O	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
H3	XY0					LX/RX		RX																		
K2	XY1					LX/RX			RX																	
J2	XY2	XY0				LX/RX				RX																
K1	XY3	XY1				LX/RX					RX															
J1	XY4	XY2				LX/RX						RX														
H2	XY5	XY3	XY0			LX/RX							RX													
H1	XY6	XY4	XY1			LX/RX								RX												
G2	XY7	XY5	XY2	17	XY0	LX/RX									RX											
G1	XY8	XY6	XY3	16	XY1	LX/RX										RX										
G3	XY9	XY7	XY4	15	XY2	LX/RX	RX																			
G4	XY10	XY8	XY5	14	XY3	LX/RX		RX																		
F4	XY11	XY9	XY6	13	XY4	LX/RX			RX																	
E3	XY12	XY10	XY7	12	XY5	LX/RX				RX																
E1	XY13	XY11	XY8	11	XY6	LX/RX					RX															
E2	XY14	XY12	XY9	10	XY7	LX/RX						RX														
D1	XY15	XY13	XY10	9	XY8	LX/RX							RX													
D2	XY16	XY14	XY11	8	XY9	LX/RX								RX												
C1	XY17	XY15	XY12	7	XY10	LX/RX									RX											
C2	XY18	XY16	XY13	6	XY11	LX/RX										RX										
B2	XY19	XY17	XY14	5	XY12	LX/RX	RX																			
A1	XY20	XY18	XY15	4	XY13	LX/RX		RX																		
C3	XY21	XY19	XY16	3	XY14	LX/RX			RX																	
A2	XY22	XY20	XY17	2	XY15	LX/RX				RX																
B3	XY23	XY21	XY18	1	XY16	LX/RX					RX															
A3	XY24	XY22	XY19	56	XY17	LX/RX						RX														
B4	XY25	XY23	XY20	55	XY18	LX/RX							RX													
A4	XY26	XY24	XY21	54	XY19	LX/RX								RX												
B5	XY27	XY25	XY22	53	XY20	LX/RX									RX											
A5	XY28	XY26	XY23	52	XY21	LX/RX										RX										
C5	XY29	XY27	XY24	51	XY22	LX/RX											RX									
D5	XY30	XY28	XY25	50	XY23	LX/RX												RX								
D6	XY31	XY29	XY26	49	XY24	LX/RX													RX							
C7	XY32	XY30	XY27	48	XY25	LX/RX														RX						
A7	XY33	XY31	XY28	47	XY26	LX/RX															RX					
B7	XY34	XY32	XY29	46	XY27	LX/RX																RX				
A8	XY35	XY33	XY30	45	XY28	LX/RX																	RX			
B8	XY36	XY34	XY31	44	XY29	LX/RX																		RX		
A9	XY37	XY35	XY32	43	XY30	LX/RX																			RX	
B9	XY38	XY36	XY33	42	XY31	LX/RX																				RX
A10	XY39	XY37	XY34	41	XY32	LX/RX											RX									
B10	XY40	XY38	XY35	40	XY33	LX/RX												RX								
C9	XY41	XY39	XY36	39	XY34	LX/RX													RX							
C10	XY42	XY40	XY37	38	XY35	LX/RX														RX						
D9	XY43	XY41	XY38	37	XY36	LX/RX															RX					
D10	XY44	XY42	XY39	36	XY37	LX/RX																RX				

Table 11-1. RX Pin Assignment Configuration

70-ball BGA				56-pin QFN		RX Channels																				
Pin #	58 I/O	54 I/O	48 I/O	Pin #	44 I/O	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
D8	XY45	XY43	XY40	35	XY38	LX/RX																	RX			
E7	XY46	XY44	XY41	34	XY39	LX/RX																		RX		
F8	XY47	XY45	XY42	33	XY40	LX/RX																			RX	
F10	XY48	XY46	XY43	32	XY41	LX/RX																				RX
F9	XY49	XY47	XY44	31	XY42	LX/RX											RX									
G10	XY50	XY48	XY45	30	XY43	LX/RX												RX								
G9	XY51	XY49	XY46			LX/RX													RX							
H10	XY52	XY50	XY47			LX/RX														RX						
H9	XY53	XY51				LX/RX															RX					
J10	XY54	XY52				LX/RX																RX				
J9	XY55	XY53				LX/RX																	RX			
K10	XY56					LX/RX																		RX		
K9	XY57					LX/RX																			RX	

Section E: Configuration Data

The host can read and modify Data Blocks of the CY8CTMA568 flash memory, shown in Table 12-1. These blocks can be modified using the commands outlined in “Data Block Commands” on page 72.

Table 12-1. Data Blocks

Block Name	Block ID	Description	Overwritten by Bootload
Configuration Data	0	TrueTouch application configuration data. These parameters control the operation of the TrueTouch device.	Yes
Design Data	2	User/Manufacturer-defined design data	Yes
Manufacturing Data	1	User/Manufacturer-defined unit specific data. Typically contains manufacturing test data	No

Do not modify the reserved blocks; unpredictable operation may result.

The flash memory block containing the TrueTouch application is not accessible to the host from the application. The host must put the device into bootloader mode to modify the application flash block. See Field Upgrade (Bootloader) chapter on page 61 for more details.

Run-time Configurable Parameters [RAM]

Run-time Configurable Parameters are located in RAM. Each parameter in Table 12-2 has a static copy located in Flash. The Flash copy is used as the default value and is copied into RAM at device startup. Configurable parameters in RAM are volatile and are not retained during a device reset or power-down. The configurable parameters stored in Flash are static and are retained during a device reset or power-down. Run-time Configurable Parameters in RAM are read and written using the commands: “Get Parameter” and “Set Parameter” commands. Both of these parameter types can be modified by the host controller or by the TrueTouch Host Emulator (TTHE).

Table 12-2. Run-time Configurable Parameters [RAM]

Name	Description	ID	Size (bytes)
Low Power Enable	Enables or prevents the device from entering the low power state. The default setting for Low Power State is in the HST_MODE0 parameter. Setting this parameter to 0 will prevent the device from entering the low power state. Setting this parameter to 1 will allow the device to enter the low power state.	0x06	1
Smart Scan Enable	Active Look-For-Touch Enable	0x07	4
Scan Type	Selecting scan types of APA-MC (finger) or stylus.	0x4B	1
Low Power Interval	Initial low power interval (in ms)	0x4C	2
Refresh Interval	Initial active state refresh interval (in ms)	0x4D	1
Active Mode Timeout	Initial touch timeout (in ms)	0x4E	2
Active Look for Touch Interval	Initial active for touch state refresh interval (in ms)	0x4F	2
Active Distance 2	Active distance (in pixels) applied to determine whether a given finger's motion should trigger a report. This active distance is applied after the first report update triggered by the finger's motion exceeding Active Distance.	0x50	1

Table 12-2. Run-time Configurable Parameters [RAM]

Name	Description	ID	Size (bytes)
CHARGER_ARMOR_ENABLE	Charger Armor Enable	0x53	1
Velocity Threshold Square	Square of the "speed" (maximum distance change per refresh interval) threshold distinguishing fast finger movement from separate finger touches	0x55	4
GRIP_XEDG_A	Grip Suppression: X edge width (in pixels), side A	0x70	2
GRIP_XEDG_B	Grip Suppression: X edge width (in pixels), side B	0x71	2
GRIP_XEXC_A	Grip Suppression: X exception area width (in pixels), side A	0x72	2
GRIP_XEXC_B	Grip Suppression: X exception area width (in pixels), side B	0x73	2
GRIP_YEDG_A	Grip Suppression: Y edge width (in pixels), side A	0x74	2
GRIP_YEDG_B	Grip Suppression: Y edge width (in pixels), side B	0x75	2
GRIP_YEXC_A	Grip Suppression: Y exception area width (in pixels), side A	0x76	2
GRIP_YEXC_B	Grip Suppression: Y exception area width (in pixels), side B	0x77	2
GRIP_FIRST_EXC	Grip Suppression: Enable/Disable reporting first touch on panel regardless of location.	0x78	1
GRIP_EXC_EDGE_ORIGIN	Grip Suppression: Enable/Disable suppression of touches originating in an edge area	0x79	1
GRIP Suppression ENABLE	Grip suppression enabled or disabled	0x7A	1
Size Orientation Enable	Enables/disables for touch contact ellipse axis length and orientation calculations	0x80	1
IMO_TRIM	IMO frequency trim	0xC0	1

12. CYTMA568 Configuration Data Details

This chapter provides detailed descriptions of configuration registers and fields.

12.1 Maneuvering Around the Registers

For ease of use, this chapter is formatted so that there is one configurable register on each page, although some registers use two pages. On each page, from top to bottom, there are four sections:

1. Register name and address (from lowest to highest)
2. Register table showing the bit organization, with reserved bits grayed out
3. Written description of register specifics or links to additional register information
4. Detailed register bit descriptions

Use the register descriptions to determine which bits are reserved. Reserved bits are grayed table cells and are not described in the bit description section. Reserved bits must always be written with a value of ‘0’ unless otherwise noted. Register which do not specify a range in the register bit description support the full range of the bit field.

12.1.1 Register Conventions

This table lists the register conventions that are specific to this chapter.

Table A-1. Register Conventions

Convention	Example	Description
Empty, grayed-out table cell		Reserved bit or group of bits, unless otherwise stated
‘x’ in a register name	WIDTH_DIAGx	Indicates that there are multiple instances of the same register
R	R : 00	Read register or bit(s)
W	W : 00	Write register or bit(s)
ACCESS : POR	R : 01	Access type is read and the register’s power-on-reset value is 01

12.2 Configurable Parameters[FLASH]

Configurable Parameters located in Flash are static and are retained during a device reset or power-down. Some Flash Configurable parameters have a copy in RAM. If a Configurable parameter exists in RAM, the flash copy serves only as a default value used when the device is reset or powered on. The TrueTouch application uses the Configurable Parameter in RAM during when executing the application. Configurable Parameters in Flash can be modified by the host controller or by the TrueTouch Host Emulator (TTHE) by using "Data Block Commands". For examples of how to update Data Blocks see Touchscreen Manufacturing Testing with CY8CTMA5XX (Cypress specification 001-85948).

12.2.1 [Device Setup] CONFIG_VER

[TTHE Group] Register Name : Address

[Device Setup] CONFIG_VER : 0x0008

Bits	15	14	13	12	11	10	9	8
Access:POR	RW:00h							
Bit Name	Version[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:00h							
Bit Name	Version[7:0]							

Configuration Version (customer-defined)

Bits	Name	Description
15:0	Version[15:0]	A device configuration is defined by the combination of values set in the Configuration Data registers. During development, multiple configurations may be created for test, development, or production. This two-byte register allows a value to be stored in the device to identify the configuration version. Reading the System Information registers CYITO_VERH and CYITO_VERL will return the value stored in this CONFIG_VER parameter. This is useful when the host is determining whether a bootload is necessary. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-65535 Default: 0

12.2.2 [Device Setup] PANELID_ENABLE

[TTHE Group] Register Name : Address

[Device Setup] PANELID_ENABLE : 0x000a

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:00h							
Bit Name	Enable[7:0]							

Enable Panel ID GPIO Capture

Bits	Name	Description
7:0	Enable[7:0]	Panel ID is available on P1[1] when configured for SPI communication or on P1[2] when configured for I2C communication. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-255 Default: 0

12.2.3 [Device Setup] PIP_REPORTING_DISABLE

[TTHE Group] Register Name : Address

[Device Setup] PIP_REPORTING_DISABLE : 0x000b

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:00h							RW:0h
Bit Name	Reserved[7:1]							Disable PIP Reporting

Disable touch, button, noise, and sensor data mode reports

Bits	Name	Description
7:1	Reserved[6:0]	Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0
0	Disable PIP Reporting[0:0]	Disable TrueTouch device reports not requested by the host. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0 **0:** Normal PIP Reporting **1:** Reporting Disabled

12.2.4 [Device Setup] X_LEN_PHY

[TTHE Group] Register Name : Address

[Device Setup] X_LEN_PHY : 0x000c

Bits	15	14	13	12	11	10	9	8
Access:POR	RW:2dh							
Bit Name	Length[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:d5h							
Bit Name	Length[7:0]							

X (Horizontal) Axis Physical Length

Bits	Name	Description
15:0	Length[15:0]	X (horizontal) Axis Physical Length (in 1/100 mm). Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-65535 Default: 11733

12.2.5 [Device Setup] Y_LEN_PHY

[TTHE Group] Register Name : Address

[Device Setup] Y_LEN_PHY : 0x000e

Bits	15	14	13	12	11	10	9	8
Access:POR	RW:19h							
Bit Name	Length[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:c8h							
Bit Name	Length[7:0]							

Y (Vertical) Axis Physical Length

Bits	Name	Description
15:0	Length[15:0]	Y (vertical) Axis Physical Length (in 1/100 mm). Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-65535 Default: 6600

12.2.6 [Device Setup] HST_MODE0

[TTHE Group] Register Name : Address

[Device Setup] HST_MODE0 : 0x0010

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:02h					RW:1h	RW:0h	
Bit Name	Reserved[7:3]					LOW_PWR_STATE	Reserved[1:0]	

Initial HST_MODE0 Value

Bits	Name	Description
7:3	Reserved[4:0]	Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 2
2	LOW_PWR_STATE[0:0]	Determines whether the operating mode power state machine is allowed to enter the low power state. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 1 **0:** Disable **1:** Enable
1:0	Reserved[1:0]	Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0

12.2.7 [Device Setup] ACT_DIST0

[TTHE Group] Register Name : Address

[Device Setup] ACT_DIST0 : 0x0011

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:00h							
Bit Name	Active Distance[7:0]							

Active distance (in pixels) applied on touchdown of a finger to determine whether this finger should trigger a report.

Bits	Name	Description
7:0	Active Distance[7:0]	Active distance (in pixels) applied on touchdown of a finger to determine whether this finger's motion should trigger a new report. After the touch motion exceeds this distance, ACT_DIST2 is applied. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-255 Default: 0

12.2.8 [Device Setup] SCAN_TYP0

[TTHE Group] Register Name : Address

[Device Setup] SCAN_TYP0 : 0x0012

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:0h	RW:0h			RW:0h			
Bit Name	Stylus Enable	Scan Type[6:4]			Reserved[3:0]			

Initial SCAN_TYP0 register value.

Bits	Name	Description
7	Stylus Enable[0:0]	Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0 **0:** Disable **1:** Enable
6:4	Scan Type[2:0]	Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0 **0:** APA-MC **1:** Balanced **2:** Hover
3:0	Reserved[3:0]	Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0

12.2.9 [Device Setup] ACT_INTRVL0

[TTHE Group] Register Name : Address

[Device Setup] ACT_INTRVL0 : 0x0013

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:08h							
Bit Name	Active Interval[7:0]							

Initial active state refresh interval (in ms)

Bits	Name	Description
7:0	Active Interval[7:0]	Initial active state refresh interval (in ms). Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-250 Default: 8

12.2.10 [Device Setup] ACT_LFT_INTRVL0

[TTHE Group] Register Name : Address

[Device Setup] ACT_LFT_INTRVL0 : 0x0014

Bits	15	14	13	12	11	10	9	8
Access:POR	RW:00h							
Bit Name	Active Look for Touch Interval[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:03h							
Bit Name	Active Look for Touch Interval[7:0]							

Initial active for touch state refresh interval (in ms)

Bits	Name	Description
15:0	Active Look for Touch Interval[15:0]	Initial active look for touch state refresh interval (in ms). Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-1000 Default: 3

12.2.11 [Device Setup] LP_INTRVL0

[TTHE Group] Register Name : Address

[Device Setup] LP_INTRVL0 : 0x0018

Bits	15	14	13	12	11	10	9	8
Access:POR	RW:00h							
Bit Name	Low Power Interval[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:64h							
Bit Name	Low Power Interval[7:0]							

Initial low power interval (in ms)

Bits	Name	Description
15:0	Low Power Interval[15:0]	Initial low power state refresh interval (in ms). Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-1000 Default: 100

12.2.12 [Device Setup] TCH_TMOUT0

[TTHE Group] Register Name : Address

[Device Setup] TCH_TMOUT0 : 0x001a

Bits	15	14	13	12	11	10	9	8
Access:POR	RW:03h							
Bit Name	Touch Timeout[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:e8h							
Bit Name	Touch Timeout[7:0]							

Initial touch timeout (in ms)

Bits	Name	Description
15:0	Touch Timeout[15:0]	Initial touch timeout (in ms). Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-60000 Default: 1000

12.2.13 [Device Setup] PWR_CFG

[TTHE Group] Register Name : Address

[Device Setup] PWR_CFG : 0x001c

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:0h				RW:0h			RW:1h
Bit Name	Reserved[7:4]				Reserved[3:1]			Vddd/Vccd Configuration

Power supply configuration

Bits	Name	Description
7:4	Reserved[3:0]	Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0
3:1	Reserved[2:0]	Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0
0	Vddd/Vccd Configuration[0:0]	Determines nominal power supply voltages for Vccd and Vddd. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 1 **0:** Vddd = 1.8V; Vccd Externally Supplied **1:** Vddd > 1.8V; Vccd Internally Supplied

12.2.14 [Device Setup] INT_PULSE_DATA

[TTHE Group] Register Name : Address

[Device Setup] INT_PULSE_DATA : 0x001e

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:64h							
Bit Name	Pulse Length[7:0]							

New touch data Interrupt pin pulse length

Bits	Name	Description
7:0	Pulse Length[7:0]	Minimum interrupt pin pulse length (in ms) to notify the host of new touch data. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 3-255 Default: 100

12.2.15 [Device Setup] OPMODE_CFG

[TTHE Group] Register Name : Address

[Device Setup] OPMODE_CFG : 0x001f

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:0h			RW:1h		RW:0h	RW:0h	
Bit Name	Reserved[7:5]			Large Object Interrupt[4:3]		Noise metrics output enable	Handshake Configuration[1:0]	

Operating mode configuration

Bits	Name	Description
7:5	Reserved[2:0]	Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0
4:3	Large Object Interrupt[1:0]	Configures interrupt. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 1 **0:** Disabled **1:** Change **3:** Detection and Removal
2	Noise metrics output enable[0:0]	Noise metrics output enable. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0 **0:** Disabled **1:** Enabled
1:0	Handshake Configuration[1:0]	Sets the host notification and handshaking mechanism for operating mode touch data transfer. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0 **0:** Asynchronous Pulse **1:** Synchronous Pulse **2:** Synchronous Level

12.2.16 [Device Setup] TIMER_CAL_INTERVAL

[TTHE Group] Register Name : Address

[Device Setup] TIMER_CAL_INTERVAL : 0x0022

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:1eh							
Bit Name	Calibration interval[7:0]							

Refresh timer recalibration interval

Bits	Name	Description
7:0	Calibration interval[7:0]	Refresh timer recalibration interval (in s). Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-255 Default: 30

12.2.17 [MFG] ILEAK_MAX

[TTHE Group] Register Name : Address

[MFG] ILEAK_MAX : 0x0024

Bits	15	14	13	12	11	10	9	8
Access:POR	RW:13h							
Bit Name	Current[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:88h							
Bit Name	Current[7:0]							

Maximum Allowable Sense Pin Peak Leakage Current

Bits	Name	Description
15:0	Current[15:0]	Maximum allowable (non short circuit) sense pin leakage current to/from external sinks/sources (in nA). Possible values are from 0 to 5500 nA. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-5500 Default: 5000

12.2.18 [MFG] PWCOPEN_LOW

[TTHE Group] Register Name : Address

[MFG] PWCOPEN_LOW : 0x0026

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:14h							
Bit Name	IDAC[7:0]							

Minimum Allowable Open Circuits Test Local IDAC Value for Panel

Bits	Name	Description
7:0	IDAC[7:0]	Minimum allowable PWC value to pass a panel open circuit test (in system clock periods). Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-255 Default: 20

12.2.19 [MFG] PWCOPEN_HIGH

[TTHE Group] Register Name : Address

[MFG] PWCOPEN_HIGH : 0x0027

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:3ch							
Bit Name	IDAC[7:0]							

Maximum Allowable Open Circuits Test Local IDAC Value for Panel

Bits	Name	Description
7:0	IDAC[7:0]	Maximum allowable PWC value to pass a panel open circuit test (in system clock periods). Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-255 Default: 60

12.2.20 [MFG] PWCOPEN_BUTTON_LOW

[TTHE Group] Register Name : Address

[MFG] PWCOPEN_BUTTON_LOW : 0x0028

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:14h							
Bit Name	IDAC[7:0]							

Minimum Allowable Open Circuits Test Local IDAC Value for Buttons

Bits	Name	Description
7:0	IDAC[7:0]	Minimum allowable PWC value to pass a CapSense Buttons open circuit test (in system clock periods). Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-255 Default: 20

12.2.21 [MFG] PWCOPEN_BUTTON_HIGH

[TTHE Group] Register Name : Address

[MFG] PWCOPEN_BUTTON_HIGH : 0x0029

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:3ch							
Bit Name	IDAC[7:0]							

Maximum Allowable Open Circuits Test Local IDAC Value for Buttons

Bits	Name	Description
7:0	IDAC[7:0]	Maximum allowable PWC value to pass a CapSense Buttons open circuit test (in system clock periods). Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-255 Default: 60

12.2.22 [MFG] POST_CFG

[TTHE Group] Register Name : Address

[MFG] POST_CFG : 0x002a

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:00h							RW:0h
Bit Name	Reserved[7:1]							Failure Response

Power-On Self Test Configuration

Bits	Name	Description
7:1	Reserved[6:0]	Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0
0	Failure Response[0:0]	Specifies actions the firmware shall take in response to a power-on self test (POST) failure. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0 **0:** No Response **1:** Disable Touch Sensing

12.2.23 [Device Setup] ACT_DIST2

[TTHE Group] Register Name : Address

[Device Setup] ACT_DIST2 : 0x002b

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:00h							
Bit Name	Distance[7:0]							

Active distance (in pixels) applied to determine whether a given finger's motion should trigger a report. This active distance is applied after the first report update triggered by the finger's motion exceeding ACT_DIST0.

Bits	Name	Description
7:0	Distance[7:0]	Active distance (in pixels) applied to determine whether a given finger's motion should trigger a report. This active distance is applied after the first report update triggered by the finger's motion exceeding ACT_DIST0. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-255 Default: 0

12.2.24 [Device Setup] EXT_SYNC

[TTHE Group] Register Name : Address

[Device Setup] EXT_SYNC : 0x002c

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:00h							
Bit Name	External syncronization[7:0]							

Allow external syncronization and select dedicated pin.

Bits	Name	Description
7:0	External syncronization[7:0]	External synchronization enable and selection for external sync signal I/O pin. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0 **0:** Disabled **1:** P1[0] **2:** P1[2]

12.2.25 [MFG] OPENS_TEST_GIDAC

[TTHE Group] Register Name : Address

[MFG] OPENS_TEST_GIDAC : 0x002d

Bits	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
Access:POR	RW:0ah							
Bit Name	GIDAC[7:0]							

Global IDAC value for opens test calibration

Bits	**Name**	**Description**
7:0	GIDAC[7:0]	Global IDAC value for opens test calibration. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-127 Default: 10

12.2.26 [Device Setup] INTERRUPT_PIN_OVERRIDE

[TTHE Group] Register Name : Address

[Device Setup] INTERRUPT_PIN_OVERRIDE : 0x002e

Bits	15	14	13	12	11	10	9	8
Access:POR	RW:0h	RW:0h	RW:0h	RW:0h	RW:0h	RW:0h	RW:0h	RW:0h
Bit Name	Station 15	Station 14	Station 13	Station 12	Station 11	Deconvolution	Report Generated	End of Touch Processing

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:0h	RW:0h	RW:0h	RW:0h	RW:0h	RW:0h	RW:0h	RW:0h
Bit Name	End of all Scanning/ Processing	Start of Touch Processing	Start of Raw Processing	Self Cap Processing	Interrupt Event Assertion	IMO Calibration Interval	Scan Complete	Beginning of Refresh Interval

Interrupt pin override value used for firmware timing measurements

Bits	Name	Description
15	Station 15[0:0]	Station 15. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0 **0:** Disabled **1:** Enabled
14	Station 14[0:0]	Station 14. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0 **0:** Disabled **1:** Enabled
13	Station 13[0:0]	Station 13. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0 **0:** Disabled **1:** Enabled
12	Station 12[0:0]	Station 12. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0 **0:** Disabled **1:** Enabled
11	Station 11[0:0]	Station 11. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0 **0:** Disabled **1:** Enabled
10	Deconvolution[0:0]	Deconvolution. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0 **0:** Disabled **1:** Enabled

12.2.26 [Device Setup] INTERRUPT_PIN_OVERRIDE (continued)

9	Report Generated[0:0]	Report Generated. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0 **0:** Disabled **1:** Enabled
8	End of Touch Processing[0:0]	End of Touch Processing. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0 **0:** Disabled **1:** Enabled
7	End of all Scanning/Processing[0:0]	End of all Scanning/Processing. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0 **0:** Disabled **1:** Enabled
6	Start of Touch Processing[0:0]	Start of Touch Processing. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0 **0:** Disabled **1:** Enabled
5	Start of Raw Processing[0:0]	Start of Raw Processing. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0 **0:** Disabled **1:** Enabled
4	Self Cap Processing[0:0]	Self Cap Processing. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0 **0:** Disabled **1:** Enabled
3	Interrupt Event Assertion[0:0]	Interrupt Event Assertion. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0 **0:** Disabled **1:** Enabled
2	IMO Calibration Interval[0:0]	IMO Calibration Interval. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0 **0:** Disabled **1:** Enabled
1	Scan Complete[0:0]	Scan Complete. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0 **0:** Disabled **1:** Enabled
0	Beginning of Refresh Interval[0:0]	Beginning of Refresh Interval. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0 **0:** Disabled **1:** Enabled

12.2.27 [Device Setup] ACT_DIST_TOUCHDOWN

[TTHE Group] Register Name : Address

[Device Setup] ACT_DIST_TOUCHDOWN : 0x0034

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:00h							
Bit Name	Distance[7:0]							

Active distance (in pixels) applied to determine whether a given finger's motion should trigger a report. This active distance is applied after the first report update triggered by the finger's motion exceeding ACT_DIST0.

Bits	Name	Description
7:0	Distance[7:0]	Active distance (in pixels) applied to determine whether a given finger's motion should trigger a report. This active distance is applied after the first report update triggered by the finger's motion exceeding ACT_DIST0. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-255 Default: 0

12.2.28 [Device Setup] ACT_DIST_LIFTOFF

[TTHE Group] Register Name : Address

[Device Setup] ACT_DIST_LIFTOFF : 0x0035

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:00h							
Bit Name	Distance[7:0]							

Active distance (in pixels) applied to determine whether a given finger's motion should trigger a report on the liftoff condition that is defined by ACT_DIST_Z_THRESHOLD.

Bits	Name	Description
7:0	Distance[7:0]	Active distance (in pixels) applied to determine whether a given finger's motion should trigger a report on the liftoff condition that is defined by ACT_DIST_Z_THRESHOLD. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-255 Default: 0

12.2.29 [Device Setup] ACT_DIST_COUNTER

[TTHE Group] Register Name : Address

[Device Setup] ACT_DIST_COUNTER : 0x0036

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:00h							
Bit Name	Counter[7:0]							

This counter indicates how many cycles after touchdown should be applied

Bits	Name	Description
7:0	Counter[7:0]	This counter indicates how many cycles after touchdown should be applied. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-255 Default: 0

12.2.30 [Device Setup] ACT_DIST_Z_THRESHOLD

[TTHE Group] Register Name : Address

[Device Setup] ACT_DIST_Z_THRESHOLD : 0x0037

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:ffh							
Bit Name	Distance[7:0]							

This threshold is applied to a delta in Z magnitude, if the Z value was greater than the threshold and last movement was less than ACT_DIST0 then ACT_DIST_LIFTOFF is applied.

Bits	Name	Description
7:0	Distance[7:0]	This threshold is applied to a delta in Z magnitude, if the Z value was greater than the threshold and last movement was less than ACT_DIST0 then ACT_DIST_LIFTOFF is applied. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-255 Default: 255

12.2.31 [Device Setup] FIRST_TOUCH_SUPPRESSION

[TTHE Group] Register Name : Address

[Device Setup] FIRST_TOUCH_SUPPRESSION : 0x0038

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:00h							
Bit Name	Enable[7:0]							

Enables First Touch Suppression feature. The parameters used are ACT_DIST_Z_THRESHOLD and ACT_DIST_LIFTOFF

Bits	Name	Description
7:0	Enable[7:0]	Enables First Touch Suppression feature. The parameters used are ACT_DIST_Z_THRESHOLD and ACT_DIST_LIFTOFF. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0 **0:** Disabled **1:** Enabled

12.2.32 [Finger Tracking] GRIP_XEDG_A

[TTHE Group] Register Name : Address

[Finger Tracking] GRIP_XEDG_A : 0x0040

Bits	15	14	13	12	11	10	9	8
Access:POR	RW:0h		RW:00h					
Bit Name	Reserved[15:14]		Width[13:8]					

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:00h							
Bit Name	Width[7:0]							

Grip Suppression: X edge width (in pixels), side A

Bits	Name	Description
15:14	Reserved[1:0]	Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0
13:0	Width[13:0]	Grip Suppression: X edge width (in pixels), side A. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-16383 Default: 0

12.2.33 [Finger Tracking] GRIP_XEDG_B

[TTHE Group] Register Name : Address

[Finger Tracking] GRIP_XEDG_B : 0x0042

Bits	15	14	13	12	11	10	9	8
Access:POR	RW:0h		RW:00h					
Bit Name	Reserved[15:14]		Width[13:8]					

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:00h							
Bit Name	Width[7:0]							

Grip Suppression: X edge width (in pixels), side B

Bits	Name	Description
15:14	Reserved[1:0]	Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0
13:0	Width[13:0]	Grip Suppression: X edge width (in pixels), side B. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-16383 Default: 0

12.2.34 [Finger Tracking] GRIP_XEXC_A

[TTHE Group] Register Name : Address

[Finger Tracking] GRIP_XEXC_A : 0x0044

Bits	15	14	13	12	11	10	9	8
Access:POR	RW:0h		RW:00h					
Bit Name	Reserved[15:14]		Width[13:8]					

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:00h							
Bit Name	Width[7:0]							

Grip Suppression: X exception area width (in pixels), side A

Bits	Name	Description
15:14	Reserved[1:0]	Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0
13:0	Width[13:0]	Grip Suppression: X exception area width (in pixels), side A. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-16383 Default: 0

12.2.35 [Finger Tracking] GRIP_XEXC_B

[TTHE Group] Register Name : Address

[Finger Tracking] GRIP_XEXC_B : 0x0046

Bits	15	14	13	12	11	10	9	8
Access:POR	RW:0h		RW:00h					
Bit Name	Reserved[15:14]		Width[13:8]					

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:00h							
Bit Name	Width[7:0]							

Grip Suppression: X exception area width (in pixels), side B

Bits	Name	Description
15:14	Reserved[1:0]	Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0
13:0	Width[13:0]	Grip Suppression: X exception area width (in pixels), side B. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-16383 Default: 0

12.2.36 [Finger Tracking] GRIP_YEDG_A

[TTHE Group] Register Name : Address

[Finger Tracking] GRIP_YEDG_A : 0x0048

Bits	15	14	13	12	11	10	9	8
Access:POR	RW:0h		RW:00h					
Bit Name	Reserved[15:14]		Width[13:8]					

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:00h							
Bit Name	Width[7:0]							

Grip Suppression: Y edge width (in pixels), side A

Bits	Name	Description
15:14	Reserved[1:0]	Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0
13:0	Width[13:0]	Grip Suppression: Y edge width (in pixels), side A. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-16383 Default: 0

12.2.37 [Finger Tracking] GRIP_YEDG_B

[TTHE Group] Register Name : Address

[Finger Tracking] GRIP_YEDG_B : 0x004a

Bits	15	14	13	12	11	10	9	8
Access:POR	RW:0h		RW:00h					
Bit Name	Reserved[15:14]		Width[13:8]					

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:00h							
Bit Name	Width[7:0]							

Grip Suppression: Y edge width (in pixels), side B

Bits	Name	Description
15:14	Reserved[1:0]	Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0
13:0	Width[13:0]	Grip Suppression: Y edge width (in pixels), side B. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-16383 Default: 0

12.2.38 [Finger Tracking] GRIP_YEXC_A

[TTHE Group] Register Name : Address

[Finger Tracking] GRIP_YEXC_A : 0x004c

Bits	15	14	13	12	11	10	9	8
Access:POR	RW:0h		RW:00h					
Bit Name	Reserved[15:14]		Width[13:8]					

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:00h							
Bit Name	Width[7:0]							

Grip Suppression: Y exception area width (in pixels), side A

Bits	Name	Description
15:14	Reserved[1:0]	Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0
13:0	Width[13:0]	Grip Suppression: Y exception area width (in pixels), side A. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-16383 Default: 0

12.2.39 [Finger Tracking] GRIP_YEXC_B

[TTHE Group] Register Name : Address

[Finger Tracking] GRIP_YEXC_B : 0x004e

Bits	15	14	13	12	11	10	9	8
Access:POR	RW:0h		RW:00h					
Bit Name	Reserved[15:14]		Width[13:8]					

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:00h							
Bit Name	Width[7:0]							

Grip Suppression: Y exception area width (in pixels), side B

Bits	Name	Description
15:14	Reserved[1:0]	Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0
13:0	Width[13:0]	Grip Suppression: Y exception area width (in pixels), side B. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-16383 Default: 0

12.2.40 [Finger Tracking] GRIP_FIRST_EXC

[TTHE Group] Register Name : Address

[Finger Tracking] GRIP_FIRST_EXC : 0x0050

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:01h							
Bit Name	First Touch Reporting[7:0]							

Grip Suppression: Enable/Disable reporting first touch on panel regardless of location.

Bits	Name	Description
7:0	First Touch Reporting[7:0]	GRIP_FIRST_EXC enables or disables the first touch being excluded from grip suppression. When GRIP_FIRST_EXC is enabled, the first touch is always reported even if the point of first touch is in a suppressed region. Grip suppression is disabled for the first touch and is applied to all subsequent touches. If both GRIP_EXC_EDGE_ORIGIN and this parameter are enabled, the first touch is always reported to the host regardless the origin area. All subsequent touches are ignored if originate from the suppressed regions. All subsequent touches are reported to the host if they originate from the core area or exception areas. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 1 **0:** Disabled **1:** Enabled

12.2.41 [Finger Tracking] GRIP_EXC_EDGE_ORIGIN

[TTHE Group] Register Name : Address

[Finger Tracking] GRIP_EXC_EDGE_ORIGIN : 0x0051

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:00h							
Bit Name	Edge Origin Full Suppression[7:0]							

Grip Suppression: Enable/Disable suppression of touches originating in an edge area

Bits	Name	Description
7:0	Edge Origin Full Suppression[7:0]	GRIP_EXC_EDGE_ORIGN enables or disables edge touches from being reported. Edge touches are touches that originate in a grip suppression region. When GRIP_EXC_EDGE_ORIGIN is enabled, touches that originate from the suppressed region are never reported even if they move out of the suppressed region. Touches that originate from one of the four suppressed regions are never reported to the host. If both GRIP_FIRST_EXC and this parameter are enabled, the first touch is always reported to the host regardless the origin area. All subsequent touches are ignored if originate from the suppressed regions. All subsequent touches are reported to the host if they originate from the core area or exception areas. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0 **0:** Disabled **1:** Enabled

12.2.42 [Finger Tracking] GRIP_ENABLE

[TTHE Group] Register Name : Address

[Finger Tracking] GRIP_ENABLE : 0x0052

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:00h							RW:0h
Bit Name	Reserved[7:1]							Grip Enable

Grip suppression enabled or disabled

Bits	Name	Description
7:1	Reserved[6:0]	Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0
0	Grip Enable[0:0]	Enables or disables grip suppression. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0 **0:** Disabled **1:** Enabled

12.2.43 [Device Setup] MAX_MUTUAL_SCAN_INTERVAL

[TTHE Group] Register Name : Address

[Device Setup] MAX_MUTUAL_SCAN_INTERVAL : 0x0060

Bits	15	14	13	12	11	10	9	8
Access:POR	RW:00h							
Bit Name	Interval[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:64h							
Bit Name	Interval[7:0]							

Maximum interval between mutual capacitance scans

Bits	Name	Description
15:0	Interval[15:0]	Maximum interval between Mutual Cap scans (in ms). Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-65535 Default: 100

12.2.44 [Finger Tracking] SELF_Z_THRSH

[TTHE Group] Register Name : Address

[Finger Tracking] SELF_Z_THRSH : 0x0062

Bits	15	14	13	12	11	10	9	8
Access:POR	RW:00h							
Bit Name	Z Threshold[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:32h							
Bit Name	Z Threshold[7:0]							

Self capacitance Z threshold to validate balanced scan action

Bits	Name	Description
15:0	Z Threshold[15:0]	Self capacitance Z threshold to validate balanced scan action (in counts). Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-65535 Default: 50

12.2.45 [Finger Tracking] SELF_Z_MODE

[TTHE Group] Register Name : Address

[Finger Tracking] SELF_Z_MODE : 0x0064

Bits	7	6	5	4	3	2	1	0	
Access:POR	RW:00h							RW:1h	
Bit Name	Reserved[7:1]							Z Mode[1:0]	

Mode for calculating self capacitance Z value

Bits	Name	Description
7:1	Reserved[6:0]	Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0
1:0	Z Mode[1:0]	Select Self Cap scan mode. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 1 **1:** Self Cap RX **2:** Self Cap TX **3:** Self Cap TX & RX

12.2.46 [Finger Tracking] ACT_LFT_EN

[TTHE Group] Register Name : Address

[Finger Tracking] ACT_LFT_EN : 0x0065

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:00h							RW:1h
Bit Name	Reserved[7:1]							Active Look-For-Touch Enable

Active Look-For-Touch Enable

Bits	Name	Description
7:1	Reserved[6:0]	Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0
0	Active Look-For-Touch Enable[0:0]	Active Look-for-Touch enable for touch detection in Low-Power Mode. If disable, Mutual cap scan is used to detect the presence of touch. If enable, Self Cap scan is used to detect the presence of touch reducing the power consumption in Low-Power Mode. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 1 **0:** Disabled **1:** Enabled

12.2.47 [Charger Armor] CA_HOST_CONTROLLED_CHARGER

[TTHE Group] Register Name : Address

[Charger Armor] CA_HOST_CONTROLLED_CHARGER : 0x0066

Bits	15	14	13	12	11	10	9	8
Access:POR	RW:00h							
Bit Name	Reserved[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:00h						RW:0h	RW:0h
Bit Name	Reserved[7:2]						Default Val-ue	Enable

Adds ability for host to explicitly control activation of charger armor noise mitigation behavior

Bits	Name	Description
15:2	Reserved[13:0]	Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0
1	Default Value[0:0]	Initialize the Charger Status value at device power-up. If charger noise is expected to be present after device power-up, set it to Enable. Otherwise, leave it as Disable. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0 **1:** Enable **0:** Disable
0	Enable[0:0]	Enable/Disable Host Controlled Charger Armor. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0 **1:** Enable **0:** Disable

12.2.48 [Charger Armor] CHARGER_ARMOR_ENABLE

[TTHE Group] Register Name : Address

[Charger Armor] CHARGER_ARMOR_ENABLE : 0x0070

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:00h							RW:1h
Bit Name	Reserved[7:1]							Value

Charger Armor Enable

Bits	Name	Description
7:1	Reserved[6:0]	Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0
0	Value[0:0]	Charger Armor Enable. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 1 **0:** Disabled **1:** Enabled

12.2.49 [Charger Armor] AFH_ENABLE

[TTHE Group] Register Name : Address

[Charger Armor] AFH_ENABLE : 0x0071

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:00h							RW:1h
Bit Name	Reserved[7:1]							Value

Adaptive Frequency Hopping Enable

Bits	Name	Description
7:1	Reserved[6:0]	Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0
0	Value[0:0]	Adaptive Frequency Hopping Enable. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 1 **0:** Disabled **1:** Enabled

12.2.50 [Charger Armor] AFH_LISTENING_SCAN_COUNT

[TTHE Group] Register Name : Address

[Charger Armor] AFH_LISTENING_SCAN_COUNT : 0x0072

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:06h							
Bit Name	Value[7:0]							

Bits	Name	Description
7:0	Value[7:0]	Number of scans used when listening for channel noise. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 2-12 Default: 6

12.2.51 [Charger Armor] AFH_LISTEN_SCAN_CYCLE_REPEATS

[TTHE Group] Register Name : Address

[Charger Armor] AFH_LISTEN_SCAN_CYCLE_REPEATS : 0x0073

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:06h							
Bit Name	Value[7:0]							

Bits	Name	Description
7:0	Value[7:0]	Number of times the adaptive frequency hopping logic looping through the available TX frequencies prior to blocking touch reports. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-255 Default: 6

12.2.52 [Charger Armor] CA_INJTCH_MAGNITUDE

[TTHE Group] Register Name : Address

[Charger Armor] CA_INJTCH_MAGNITUDE : 0x0074

Bits	15	14	13	12	11	10	9	8
Access:POR	RW:00h							
Bit Name	Magnitude[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:b4h							
Bit Name	Magnitude[7:0]							

Injected Touch Target Magnitude

Bits	Name	Description
15:0	Magnitude[15:0]	Injected Touch Target Magnitude. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-65535 Default: 180

12.2.53 [Charger Armor] CA_INJTCH_FINGER_THOLD

[TTHE Group] Register Name : Address

[Charger Armor] CA_INJTCH_FINGER_THOLD : 0x0076

Bits	15	14	13	12	11	10	9	8
Access:POR	RW:00h							
Bit Name	Threshold[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:5ah							
Bit Name	Threshold[7:0]							

Injected Touch Finger Threshold

Bits	Name	Description
15:0	Threshold[15:0]	Injected Touch Finger Threshold. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-65535 Default: 90

12.2.54 [Charger Armor] CA_DEFAULT_REVERT_TIME

[TTHE Group] Register Name : Address

[Charger Armor] CA_DEFAULT_REVERT_TIME : 0x0078

Bits	31	30	29	28	27	26	25	24
Access:POR	RW:00h							
Bit Name	Value[31:24]							

Bits	23	22	21	20	19	18	17	16
Access:POR	RW:00h							
Bit Name	Value[23:16]							

Bits	15	14	13	12	11	10	9	8
Access:POR	RW:03h							
Bit Name	Value[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:e8h							
Bit Name	Value[7:0]							

Bits	Name	Description
31:0	Value[31:0]	Delay in ms following a final touch liftoff before the Charger Armor logic resets the charger noise level. Modifying this parameter affects the baseline data and requires the host to perform a re-calibration (see Calibrate PWC Command). Range: 0-4294967295 Default: 1000

12.2.55 [Charger Armor] CA_BASE_TX_PULSES_NUM_MUTUAL

[TTHE Group] Register Name : Address

[Charger Armor] CA_BASE_TX_PULSES_NUM_MUTUAL : 0x007e

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:7fh							
Bit Name	TX Pulses[7:0]							

Number of TX Pulses per conversion for extended Mutual Cap integration time used in Charger Armor

Bits	Name	Description
7:0	TX Pulses[7:0]	Number of TX Pulses per conversion for extended Mutual Cap integration time used in Charger Armor. Modifying this parameter affects the baseline data and requires the host to perform a re-calibration (see Calibrate PWC Command). Range: 0-255 Default: 127

12.2.56 [Charger Armor] CA_WIDEBAND_TX_PERIOD

[TTHE Group] Register Name : Address

[Charger Armor] CA_WIDEBAND_TX_PERIOD : 0x0080

Bits	15	14	13	12	11	10	9	8
Access:POR	RW:00h							
Bit Name	TX Period[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:2dh							
Bit Name	TX Period[7:0]							

TX period used for wideband listen scans (specify in 1/2 period)

Bits	Name	Description
15:0	TX Period[15:0]	TX period used for wideband listen scans (specify in 1/2 period). Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-65535 Default: 45

12.2.57 [Charger Armor] CA_WIDEBAND_TX_PERIOD_DITHER

[TTHE Group] Register Name : Address

[Charger Armor] CA_WIDEBAND_TX_PERIOD_DITHER : 0x0082

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:01h							
Bit Name	Value[7:0]							

TX period dither used for wide band listen scans

Bits	Name	Description
7:0	Value[7:0]	TX period dither used for wide band listen scans. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-255 Default: 1

12.2.58 [Charger Armor] CA_WB_NMX_THOLD

[TTHE Group] Register Name : Address

[Charger Armor] CA_WB_NMX_THOLD : 0x0083

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:60h							
Bit Name	Value[7:0]							

The wide band is checked against this threshold before checking frequency metrics against it's threshold.

Bits	Name	Description
7:0	Value[7:0]	The wide band is checked against this threshold before checking frequency metrics against it's threshold. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-255 Default: 96

12.2.59 [Charger Armor] CA_HOP0_TX_PERIOD_MUTUAL

[TTHE Group] Register Name : Address

[Charger Armor] CA_HOP0_TX_PERIOD_MUTUAL : 0x0084

Bits	15	14	13	12	11	10	9	8
Access:POR	RW:00h							
Bit Name	TX Period[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:30h							
Bit Name	TX Period[7:0]							

TX period while operating at Charger Armor noise levels 3-7 at alternate frequency 1

Bits	Name	Description
15:0	TX Period[15:0]	First AFH alternative frequency Mutual Cap scan TX period configuration. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 48-510 Default: 48

12.2.60 [Charger Armor] CA_HOP0_SCALING_MUTUAL

[TTHE Group] Register Name : Address

[Charger Armor] CA_HOP0_SCALING_MUTUAL : 0x0086

Bits	15	14	13	12	11	10	9	8
Access:POR	RW:01h							
Bit Name	Scale Factor[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:90h							
Bit Name	Scale Factor[7:0]							

First AFH alternative frequency Mutual Cap scan scaling factor

Bits	Name	Description
15:0	Scale Factor[15:0]	First AFH alternative frequency Mutual Cap scan scaling factor. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 1-1000 Default: 400

12.2.61 [Charger Armor] CA_HOP0_RX_ATTENUATOR

[TTHE Group] Register Name : Address

[Charger Armor] CA_HOP0_RX_ATTENUATOR : 0x0088

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:00h					RW:0h		
Bit Name	Reserved[7:3]					Ratio[2:0]		

Input Attenuator ratio for CA HOP 0 configuration

Bits	Name	Description
7:3	Reserved[4:0]	Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0
2:0	Ratio[2:0]	First AFH alternative frequency input attenuation ratio. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0 **0:** 1.0 (Bypass Attenuator) **1:** 1.5 **2:** 2.0 **3:** 3.0 **4:** 4.0 **5:** 6.0 **6:** 8.0

12.2.62 [Charger Armor] CA_HOP0_TX_PULSES_NUM_MUTUAL

[TTHE Group] Register Name : Address

[Charger Armor] CA_HOP0_TX_PULSES_NUM_MUTUAL : 0x0089

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:7fh							
Bit Name	TX Pulses[7:0]							

First AFH alternative frequency Mutual Cap scan Number of TX Pulses per conversion

Bits	Name	Description
7:0	TX Pulses[7:0]	First AFH alternative frequency Mutual Cap scan Number of TX Pulses per conversion. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-255 Default: 127

12.2.63 [Charger Armor] CA_HOP0_TX_VOLTAGE_MUTUAL

[TTHE Group] Register Name : Address

[Charger Armor] CA_HOP0_TX_VOLTAGE_MUTUAL : 0x008a

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:4h							
Bit Name	Voltage[3:0]							

First AFH alternative frequency Mutual Cap TX voltage configuration

Bits	Name	Description
3:0	Voltage[3:0]	First AFH alternative frequency Mutual Cap TX voltage configuration. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 4 **0:** 5.0V **1:** 5.5V **2:** 6.0V **3:** 6.5V **4:** 7.0V **5:** 7.5V **6:** 8.0V **7:** 8.5V **8:** 9.0V **9:** 9.5V **10:** 10V

12.2.64 [Charger Armor] CA_HOP0_TX_VOLTAGE_PUMPMODE

[TTHE Group] Register Name : Address

[Charger Armor] CA_HOP0_TX_VOLTAGE_PUMPMODE : 0x008b

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:00h							RW:0h
Bit Name	Reserved[7:1]							PUMP_MODE

First AFH alternative frequency Mutual Cap scan TX pump mode configuration: 2x pump: supply up to 7V when Vdda is 2.65V (The TX pump output (Vcctx) in 2x mode can be approximated by Vcctx = Vdda + 2*Vdda*losses. The loss factor is approximately 0.8 to 0.9 depending on the corner of the silicon). 4x pump: supply up to 10V.

Bits	Name	Description
7:1	Reserved[6:0]	Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0
0	PUMP_MODE[0:0]	First AFH alternative frequency Mutual Cap scan TX pump mode configuration: 2x pump: supply up to 7V when Vdda is 2.65V (The TX pump output (Vcctx) in 2x mode can be approximated by Vcctx = Vdda + 2*Vdda*losses. The loss factor is approximately 0.8 to 0.9 depending on the corner of the silicon). 4x pump: supply up to 10V. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0 **0:** 2x **1:** 4x

12.2.65 [Charger Armor] CA_HOP0_INT_CAP

[TTHE Group] Register Name : Address

[Charger Armor] CA_HOP0_INT_CAP : 0x008c

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:1fh							
Bit Name	INT_CAP[7:0]							

First AFH alternative frequency Integrator capacitance (in pF)

Bits	Name	Description
7:0	INT_CAP[7:0]	First AFH alternative frequency Integrator capacitance (in pF). Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-31 Default: 31

12.2.66 [Charger Armor] CA_HOP0_TX_PULSES_NUM_WINDOWING

[TTHE Group] Register Name : Address

[Charger Armor] CA_HOP0_TX_PULSES_NUM_WINDOWING : 0x008d

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:02h							
Bit Name	Value[7:0]							

First AFH alternative frequency number of Tx Pulses per Subconverison in Windowed Scanning

Bits	Name	Description
7:0	Value[7:0]	First AFH alternative frequency number of Tx Pulses per Subconverison in Windowed Scanning. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 1-4 Default: 2

12.2.67 [Charger Armor] CA_HOP1_TX_PERIOD_MUTUAL

[TTHE Group] Register Name : Address

[Charger Armor] CA_HOP1_TX_PERIOD_MUTUAL : 0x0090

Bits	**15**	**14**	**13**	**12**	**11**	**10**	**9**	**8**
Access:POR	RW:00h							
Bit Name	TX Period[15:8]							

Bits	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
Access:POR	RW:38h							
Bit Name	TX Period[7:0]							

Second AFH alternative frequency Mutual Cap scan TX period configuration

Bits	**Name**	**Description**
15:0	TX Period[15:0]	Second AFH alternative frequency Mutual Cap scan TX period configuration. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 48-510 Default: 56

12.2.68 [Charger Armor] CA_HOP1_SCALING_MUTUAL

[TTHE Group] Register Name : Address

[Charger Armor] CA_HOP1_SCALING_MUTUAL : 0x0092

Bits	15	14	13	12	11	10	9	8
Access:POR	RW:01h							
Bit Name	Scale Factor[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:90h							
Bit Name	Scale Factor[7:0]							

Second AFH alternative frequency Mutual Cap scan scaling factor

Bits	Name	Description
15:0	Scale Factor[15:0]	Second AFH alternative frequency Mutual Cap scan scaling factor. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 1-1000 Default: 400

12.2.69 [Charger Armor] CA_HOP1_RX_ATTENUATOR

[TTHE Group] Register Name : Address

[Charger Armor] CA_HOP1_RX_ATTENUATOR : 0x0094

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:00h					RW:0h		
Bit Name	Reserved[7:3]					Ratio[2:0]		

Input Attenuator ratio for CA HOP 1 configuration

Bits	Name	Description
7:3	Reserved[4:0]	Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0
2:0	Ratio[2:0]	Second AFH alternative frequency input attenuation ratio. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0 **0:** 1.0 (Bypass Attenuator) **1:** 1.5 **2:** 2.0 **3:** 3.0 **4:** 4.0 **5:** 6.0 **6:** 8.0

12.2.70 [Charger Armor] CA_HOP1_TX_PULSES_NUM_MUTUAL

[TTHE Group] Register Name : Address

[Charger Armor] CA_HOP1_TX_PULSES_NUM_MUTUAL : 0x0095

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:7fh							
Bit Name	TX Pulses[7:0]							

Second AFH alternative frequency Mutual Cap scan Number of TX Pulses per conversion

Bits	Name	Description
7:0	TX Pulses[7:0]	Second AFH alternative frequency Mutual Cap scan Number of TX Pulses per conversion. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-255 Default: 127

12.2.71 [Charger Armor] CA_HOP1_TX_VOLTAGE_MUTUAL

[TTHE Group] Register Name : Address

[Charger Armor] CA_HOP1_TX_VOLTAGE_MUTUAL : 0x0096

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:4h							
Bit Name	Voltage[3:0]							

Second AFH alternative frequency Mutual Cap TX voltage configuration

Bits	Name	Description
3:0	Voltage[3:0]	Second AFH alternative frequency Mutual Cap TX voltage configuration. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 4 **0:** 5.0V **1:** 5.5V **2:** 6.0V **3:** 6.5V **4:** 7.0V **5:** 7.5V **6:** 8.0V **7:** 8.5V **8:** 9.0V **9:** 9.5V **10:** 10V

12.2.72 [Charger Armor] CA_HOP1_TX_VOLTAGE_PUMPMODE

[TTHE Group] Register Name : Address

[Charger Armor] CA_HOP1_TX_VOLTAGE_PUMPMODE : 0x0097

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:00h							RW:0h
Bit Name	Reserved[7:1]							PUMP_MODE

Second AFH alternative frequency Mutual Cap scan TX pump mode configuration: 2x pump: supply up to 7V when Vdda is 2.65V (The TX pump output (Vcctx) in 2x mode can be approximated by Vcctx = Vdda + 2*Vdda*losses. The loss factor is approximately 0.8 to 0.9 depending on the corner of the silicon). 4x pump: supply up to 10V.

Bits	Name	Description
7:1	Reserved[6:0]	Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0
0	PUMP_MODE[0:0]	Second AFH alternative frequency Mutual Cap scan TX pump mode configuration: 2x pump: supply up to 7V when Vdda is 2.65V (The TX pump output (Vcctx) in 2x mode can be approximated by Vcctx = Vdda + 2*Vdda*losses. The loss factor is approximately 0.8 to 0.9 depending on the corner of the silicon). 4x pump: supply up to 10V. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0 **0:** 2x **1:** 4x

12.2.73 [Charger Armor] CA_HOP1_INT_CAP

[TTHE Group] Register Name : Address

[Charger Armor] CA_HOP1_INT_CAP : 0x0098

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:1fh							
Bit Name	INT_CAP[7:0]							

Second AFH alternative frequency Integrator capacitance (in pF)

Bits	Name	Description
7:0	INT_CAP[7:0]	Second AFH alternative frequency Integrator capacitance (in pF). Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-31 Default: 31

12.2.74 [Charger Armor] CA_HOP1_TX_PULSES_NUM_WINDOWING

[TTHE Group] Register Name : Address

[Charger Armor] CA_HOP1_TX_PULSES_NUM_WINDOWING : 0x0099

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:02h							
Bit Name	Value[7:0]							

Second AFH alternative frequency number of Tx Pulses per Subconverison in Windowed Scanning

Bits	Name	Description
7:0	Value[7:0]	Second AFH alternative frequency number of Tx Pulses per Subconverison in Windowed Scanning. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 1-4 Default: 2

12.2.75 [Charger Armor] CA_HOP2_TX_PERIOD_MUTUAL

[TTHE Group] Register Name : Address

[Charger Armor] CA_HOP2_TX_PERIOD_MUTUAL : 0x009c

Bits	15	14	13	12	11	10	9	8
Access:POR	RW:00h							
Bit Name	TX Period[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:3ch							
Bit Name	TX Period[7:0]							

the Mutual TX Period used in CA HOP2 configuration

Bits	Name	Description
15:0	TX Period[15:0]	Third AFH alternative frequency Mutual Cap scan TX period configuration. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 48-510 Default: 60

12.2.76 [Charger Armor] CA_HOP2_SCALING_MUTUAL

[TTHE Group] Register Name : Address

[Charger Armor] CA_HOP2_SCALING_MUTUAL : 0x009e

Bits	15	14	13	12	11	10	9	8
Access:POR	RW:01h							
Bit Name	Scale Factor[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:90h							
Bit Name	Scale Factor[7:0]							

Third AFH alternative frequency Mutual Cap scan scaling factor

Bits	Name	Description
15:0	Scale Factor[15:0]	Third AFH alternative frequency Mutual Cap scan scaling factor. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 1-1000 Default: 400

12.2.77 [Charger Armor] CA_HOP2_RX_ATTENUATOR

[TTHE Group] Register Name : Address

[Charger Armor] CA_HOP2_RX_ATTENUATOR : 0x00a0

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:00h					RW:0h		
Bit Name	Reserved[7:3]					Ratio[2:0]		

Third AFH alternative frequency input attenuation ratio

Bits	Name	Description
7:3	Reserved[4:0]	Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0
2:0	Ratio[2:0]	Third AFH alternative frequency input attenuation ratio. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0 **0:** 1.0 (Bypass Attenuator) **1:** 1.5 **2:** 2.0 **3:** 3.0 **4:** 4.0 **5:** 6.0 **6:** 8.0

12.2.78 [Charger Armor] CA_HOP2_TX_PULSES_NUM_MUTUAL

[TTHE Group] Register Name : Address

[Charger Armor] CA_HOP2_TX_PULSES_NUM_MUTUAL : 0x00a1

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:7fh							
Bit Name	TX Pulses[7:0]							

Third AFH alternative frequency Mutual Cap scan Number of TX Pulses per conversion

Bits	Name	Description
7:0	TX Pulses[7:0]	Third AFH alternative frequency Mutual Cap scan Number of TX Pulses per conversion. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-255 Default: 127

12.2.79 [Charger Armor] CA_HOP2_TX_VOLTAGE_MUTUAL

[TTHE Group] Register Name : Address

[Charger Armor] CA_HOP2_TX_VOLTAGE_MUTUAL : 0x00a2

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:4h							
Bit Name	Voltage[3:0]							

Third AFH alternative frequency Mutual Cap TX voltage configuration

Bits	Name	Description
3:0	Voltage[3:0]	Third AFH alternative frequency Mutual Cap TX voltage configuration. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 4 **0:** 5.0V **1:** 5.5V **2:** 6.0V **3:** 6.5V **4:** 7.0V **5:** 7.5V **6:** 8.0V **7:** 8.5V **8:** 9.0V **9:** 9.5V **10:** 10V

12.2.80 [Charger Armor] CA_HOP2_TX_VOLTAGE_PUMPMODE

[TTHE Group] Register Name : Address

[Charger Armor] CA_HOP2_TX_VOLTAGE_PUMPMODE : 0x00a3

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:00h							RW:0h
Bit Name	Reserved[7:1]							PUMP_MODE

Third AFH alternative frequency Mutual Cap scan TX pump mode configuration: 2x pump: supply up to 7V when Vdda is 2.65V (The TX pump output (Vcctx) in 2x mode can be approximated by Vcctx = Vdda + 2*Vdda*losses. The loss factor is approximately 0.8 to 0.9 depending on the corner of the silicon). 4x pump: supply up to 10V.

Bits	Name	Description
7:1	Reserved[6:0]	Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0
0	PUMP_MODE[0:0]	Third AFH alternative frequency Mutual Cap scan TX pump mode configuration: 2x pump: supply up to 7V when Vdda is 2.65V (The TX pump output (Vcctx) in 2x mode can be approximated by Vcctx = Vdda + 2*Vdda*losses. The loss factor is approximately 0.8 to 0.9 depending on the corner of the silicon). 4x pump: supply up to 10V. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0 **0:** 2x **1:** 4x

12.2.81 [Charger Armor] CA_HOP2_INT_CAP

[TTHE Group] Register Name : Address

[Charger Armor] CA_HOP2_INT_CAP : 0x00a4

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:1fh							
Bit Name	INT_CAP[7:0]							

Third AFH alternative frequency Integrator capacitance (in pF)

Bits	Name	Description
7:0	INT_CAP[7:0]	Third AFH alternative frequency Integrator capacitance (in pF). Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-31 Default: 31

12.2.82 [Charger Armor] CA_HOP2_TX_PULSES_NUM_WINDOWING

[TTHE Group] Register Name : Address

[Charger Armor] CA_HOP2_TX_PULSES_NUM_WINDOWING : 0x00a5

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:02h							
Bit Name	Value[7:0]							

Third AFH alternative frequency number of Tx Pulses per Subconverison in Windowed Scanning

Bits	Name	Description
7:0	Value[7:0]	Third AFH alternative frequency number of Tx Pulses per Subconverison in Windowed Scanning. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 1-4 Default: 2

12.2.83 [Charger Armor] CA_HOP3_TX_PERIOD_MUTUAL

[TTHE Group] Register Name : Address

[Charger Armor] CA_HOP3_TX_PERIOD_MUTUAL : 0x00a8

Bits	15	14	13	12	11	10	9	8
Access:POR	RW:00h							
Bit Name	TX Period[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:3fh							
Bit Name	TX Period[7:0]							

Fourth AFH alternative frequency Mutual Cap scan TX period configuration

Bits	Name	Description
15:0	TX Period[15:0]	Fourth AFH alternative frequency Mutual Cap scan TX period configuration. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 48-510 Default: 63

12.2.84 [Charger Armor] CA_HOP3_SCALING_MUTUAL

[TTHE Group] Register Name : Address

[Charger Armor] CA_HOP3_SCALING_MUTUAL : 0x00aa

Bits	15	14	13	12	11	10	9	8
Access:POR	RW:01h							
Bit Name	Scale Factor[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:90h							
Bit Name	Scale Factor[7:0]							

Fourth AFH alternative frequency Mutual Cap scan scaling factor

Bits	Name	Description
15:0	Scale Factor[15:0]	Fourth AFH alternative frequency Mutual Cap scan scaling factor. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 1-1000 Default: 400

12.2.85 [Charger Armor] CA_HOP3_RX_ATTENUATOR

[TTHE Group] Register Name : Address

[Charger Armor] CA_HOP3_RX_ATTENUATOR : 0x00ac

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:00h					RW:0h		
Bit Name	Reserved[7:3]					Ratio[2:0]		

Fourth AFH alternative frequency input attenuation ratio

Bits	Name	Description
7:3	Reserved[4:0]	Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0
2:0	Ratio[2:0]	Fourth AFH alternative frequency input attenuation ratio. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0 **0:** 1.0 (Bypass Attenuator) **1:** 1.5 **2:** 2.0 **3:** 3.0 **4:** 4.0 **5:** 6.0 **6:** 8.0

12.2.86 [Charger Armor] CA_HOP3_TX_PULSES_NUM_MUTUAL

[TTHE Group] Register Name : Address

[Charger Armor] CA_HOP3_TX_PULSES_NUM_MUTUAL : 0x00ad

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:7fh							
Bit Name	TX Pulses[7:0]							

Fourth AFH alternative frequency Mutual Cap scan Number of TX Pulses per conversion

Bits	Name	Description
7:0	TX Pulses[7:0]	Fourth AFH alternative frequency Mutual Cap scan Number of TX Pulses per conversion. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-255 Default: 127

12.2.87 [Charger Armor] CA_HOP3_TX_VOLTAGE_MUTUAL

[TTHE Group] Register Name : Address

[Charger Armor] CA_HOP3_TX_VOLTAGE_MUTUAL : 0x00ae

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:4h							
Bit Name	Voltage[3:0]							

Fourth AFH alternative frequency Mutual Cap TX voltage configuration

Bits	Name	Description
3:0	Voltage[3:0]	Fourth AFH alternative frequency Mutual Cap TX voltage configuration. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 4 **0:** 5.0V **1:** 5.5V **2:** 6.0V **3:** 6.5V **4:** 7.0V **5:** 7.5V **6:** 8.0V **7:** 8.5V **8:** 9.0V **9:** 9.5V **10:** 10V

12.2.88 [Charger Armor] CA_HOP3_TX_VOLTAGE_PUMPMODE

[TTHE Group] Register Name : Address

[Charger Armor] CA_HOP3_TX_VOLTAGE_PUMPMODE : 0x00af

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:00h							RW:0h
Bit Name	Reserved[7:1]							PUMP_MODE

Fourth AFH alternative frequency Mutual Cap scan TX pump mode configuration: 2x pump: supply up to 7V when Vdda is 2.65V (The TX pump output (Vcctx) in 2x mode can be approximated by Vcctx = Vdda + 2*Vdda*losses. The loss factor is approximately 0.8 to 0.9 depending on the corner of the silicon). 4x pump: supply up to 10V.

Bits	Name	Description
7:1	Reserved[6:0]	Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0
0	PUMP_MODE[0:0]	Fourth AFH alternative frequency Mutual Cap scan TX pump mode configuration: 2x pump: supply up to 7V when Vdda is 2.65V (The TX pump output (Vcctx) in 2x mode can be approximated by Vcctx = Vdda + 2*Vdda*losses. The loss factor is approximately 0.8 to 0.9 depending on the corner of the silicon). 4x pump: supply up to 10V. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0 **0:** 2x **1:** 4x

12.2.89 [Charger Armor] CA_HOP3_INT_CAP

[TTHE Group] Register Name : Address

[Charger Armor] CA_HOP3_INT_CAP : 0x00b0

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:1fh							
Bit Name	INT_CAP[7:0]							

Fourth AFH alternative frequency Integrator capacitance (in pF)

Bits	Name	Description
7:0	INT_CAP[7:0]	Fourth AFH alternative frequency Integrator capacitance (in pF). Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-31 Default: 31

12.2.90 [Charger Armor] CA_HOP3_TX_PULSES_NUM_WINDOWING

[TTHE Group] Register Name : Address

[Charger Armor] CA_HOP3_TX_PULSES_NUM_WINDOWING : 0x00b1

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:02h							
Bit Name	Value[7:0]							

Fourth AFH alternative frequency number of Tx Pulses per Subconverison in Windowed Scanning

Bits	Name	Description
7:0	Value[7:0]	Fourth AFH alternative frequency number of Tx Pulses per Subconverison in Windowed Scanning. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 1-4 Default: 2

12.2.91 [Charger Armor] CA_HOP4_TX_PERIOD_MUTUAL

[TTHE Group] Register Name : Address

[Charger Armor] CA_HOP4_TX_PERIOD_MUTUAL : 0x00b4

Bits	15	14	13	12	11	10	9	8
Access:POR	RW:00h							
Bit Name	TX Period[15:8]							
Bits	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
Access:POR	RW:4bh							
Bit Name	TX Period[7:0]							

Fifth AFH alternative frequency Mutual Cap scan TX period configuration

Bits	Name	Description
15:0	TX Period[15:0]	Fifth AFH alternative frequency Mutual Cap scan TX period configuration. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 48-510 Default: 75

12.2.92 [Charger Armor] CA_HOP4_SCALING_MUTUAL

[TTHE Group] Register Name : Address

[Charger Armor] CA_HOP4_SCALING_MUTUAL : 0x00b6

Bits	15	14	13	12	11	10	9	8
Access:POR	RW:01h							
Bit Name	Scale Factor[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:90h							
Bit Name	Scale Factor[7:0]							

Fifth AFH alternative frequency Mutual Cap scan scaling factor

Bits	Name	Description
15:0	Scale Factor[15:0]	Fifth AFH alternative frequency Mutual Cap scan scaling factor. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 1-1000 Default: 400

12.2.93 [Charger Armor] CA_HOP4_RX_ATTENUATOR

[TTHE Group] Register Name : Address

[Charger Armor] CA_HOP4_RX_ATTENUATOR : 0x00b8

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:00h					RW:0h		
Bit Name	Reserved[7:3]					Ratio[2:0]		

Fifth AFH alternative frequency input attenuation ratio

Bits	Name	Description
7:3	Reserved[4:0]	Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0
2:0	Ratio[2:0]	Fifth AFH alternative frequency input attenuation ratio. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0 **0:** 1.0 (Bypass Attenuator) **1:** 1.5 **2:** 2.0 **3:** 3.0 **4:** 4.0 **5:** 6.0 **6:** 8.0

12.2.94 [Charger Armor] CA_HOP4_TX_PULSES_NUM_MUTUAL

[TTHE Group] Register Name : Address

[Charger Armor] CA_HOP4_TX_PULSES_NUM_MUTUAL : 0x00b9

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:7fh							
Bit Name	TX Pulses[7:0]							

Fifth AFH alternative frequency Mutual Cap scan Number of TX Pulses per conversion

Bits	Name	Description
7:0	TX Pulses[7:0]	Fifth AFH alternative frequency Mutual Cap scan Number of TX Pulses per conversion. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-255 Default: 127

12.2.95 [Charger Armor] CA_HOP4_TX_VOLTAGE_MUTUAL

[TTHE Group] Register Name : Address

[Charger Armor] CA_HOP4_TX_VOLTAGE_MUTUAL : 0x00ba

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:4h							
Bit Name	Voltage[3:0]							

Fifth AFH alternative frequency Mutual Cap TX voltage configuration

Bits	Name	Description
3:0	Voltage[3:0]	Fifth AFH alternative frequency Mutual Cap TX voltage configuration. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 4 **0:** 5.0V **1:** 5.5V **2:** 6.0V **3:** 6.5V **4:** 7.0V **5:** 7.5V **6:** 8.0V **7:** 8.5V **8:** 9.0V **9:** 9.5V **10:** 10V

12.2.96 [Charger Armor] CA_HOP4_TX_VOLTAGE_PUMPMODE

[TTHE Group] Register Name : Address

[Charger Armor] CA_HOP4_TX_VOLTAGE_PUMPMODE : 0x00bb

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:00h							RW:0h
Bit Name	Reserved[7:1]							PUMP_MODE

Fifth AFH alternative frequency Mutual Cap scan TX pump mode configuration: 2x pump: supply up to 7V when Vdda is 2.65V (The TX pump output (Vcctx) in 2x mode can be approximated by Vcctx = Vdda + 2*Vdda*losses. The loss factor is approximately 0.8 to 0.9 depending on the corner of the silicon). 4x pump: supply up to 10V.

Bits	Name	Description
7:1	Reserved[6:0]	Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0
0	PUMP_MODE[0:0]	Fifth AFH alternative frequency Mutual Cap scan TX pump mode configuration: 2x pump: supply up to 7V when Vdda is 2.65V (The TX pump output (Vcctx) in 2x mode can be approximated by Vcctx = Vdda + 2*Vdda*losses. The loss factor is approximately 0.8 to 0.9 depending on the corner of the silicon). 4x pump: supply up to 10V. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0 **0:** 2x **1:** 4x

12.2.97 [Charger Armor] CA_HOP4_INT_CAP

[TTHE Group] Register Name : Address

[Charger Armor] CA_HOP4_INT_CAP : 0x00bc

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:1fh							
Bit Name	INT_CAP[7:0]							

Fifth AFH alternative frequency Integrator capacitance (in pF)

Bits	Name	Description
7:0	INT_CAP[7:0]	Fifth AFH alternative frequency Integrator capacitance (in pF). Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-31 Default: 31

12.2.98 [Charger Armor] CA_HOP4_TX_PULSES_NUM_WINDOWING

[TTHE Group] Register Name : Address

[Charger Armor] CA_HOP4_TX_PULSES_NUM_WINDOWING : 0x00bd

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:02h							
Bit Name	Value[7:0]							

Fifth AFH alternative frequency number of Tx Pulses per Subconverison in Windowed Scanning

Bits	Name	Description
7:0	Value[7:0]	Fifth AFH alternative frequency number of Tx Pulses per Subconverison in Windowed Scanning. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 1-4 Default: 2

12.2.99 [Scan Filtering] XY_FILTER_MASK

[TTHE Group] Register Name : Address

[Scan Filtering] XY_FILTER_MASK : 0x00c4

Bits	31	30	29	28	27	26	25	24
Access:POR	RW:00h							
Bit Name	Reserved[31:24]							

Bits	23	22	21	20	19	18	17	16
Access:POR	RW:00h							
Bit Name	Reserved[23:16]							

Bits	15	14	13	12	11	10	9	8
Access:POR	RW:00h							
Bit Name	Reserved[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:1h	RW:1h	RW:1h	RW:1h	RW:0h			
Bit Name	XY IIR Filter Enable	XY Jitter Filter Enable	Z IIR Filter Enable	Z Jitter Filter Enable	Reserved[3:0]			

XY filter mask when Charger Armor is not active

Bits	Name	Description
31:8	Reserved[23:0]	Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0
7	XY IIR Filter Enable[0:0]	Enables or disables the XY IIR filter. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 1 **0:** Disabled **1:** Enabled
6	XY Jitter Filter Enable[0:0]	Enables or disables the XY jitter filter. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 1 **0:** Disabled **1:** Enabled
5	Z IIR Filter Enable[0:0]	Enables or disables the Z IIR filter. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 1 **0:** Disabled **1:** Enabled
4	Z Jitter Filter Enable[0:0]	Enables or disables the Z jitter filter. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 1 **0:** Disabled **1:** Enabled
3:0	Reserved[3:0]	Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0

12.2.100 [Scan Filtering] XY_FILT_IIR_COEFF

[TTHE Group] Register Name : Address

[Scan Filtering] XY_FILT_IIR_COEFF : 0x00c8

Bits	31	30	29	28	27	26	25	24
Access:POR	RW:00h							
Bit Name	Reserved[31:24]							

Bits	23	22	21	20	19	18	17	16
Access:POR	RW:00h							
Bit Name	Reserved[23:16]							

Bits	15	14	13	12	11	10	9	8
Access:POR	RW:00h							
Bit Name	Reserved[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:00h						RW:2h	
Bit Name	Reserved[7:2]						IIR Filter Input Weight[1:0]	

Weighting of the input X and Y values in the IIR filter for displacements less than XY_FILT_SLOW_THR when Charger Armor is NOT active.

Bits	Name	Description
31:2	Reserved[29:0]	Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0
1:0	IIR Filter Input Weight[1:0]	Weighting of the input X and Y values in the IIR filter for displacements less than XY_FILT_SLOW_THR when Charger Armor is NOT active. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 2 **1:** One Half **2:** One Quarter

12.2.101 [Scan Filtering] XY_FILT_Z_IIR_COEFF

[TTHE Group] Register Name : Address

[Scan Filtering] XY_FILT_Z_IIR_COEFF : 0x00cc

Bits	31	30	29	28	27	26	25	24
Access:POR	RW:00h							
Bit Name	Reserved[31:24]							

Bits	23	22	21	20	19	18	17	16
Access:POR	RW:00h							
Bit Name	Reserved[23:16]							

Bits	15	14	13	12	11	10	9	8
Access:POR	RW:00h							
Bit Name	Reserved[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:00h						RW:1h	
Bit Name	Reserved[7:2]						IIR Filter Input Weight[1:0]	

Weighting of the input Z value in the IIR filter when Charger Armor is not active.

Bits	Name	Description
31:2	Reserved[29:0]	Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0
1:0	IIR Filter Input Weight[1:0]	Weighting of the input Z value in the IIR filter when Charger Armor is not active. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 1 **1:** One Half **2:** One Quarter

12.2.102 [Scan Filtering] XY_FILT_XY_FAST_THR

[TTHE Group] Register Name : Address

[Scan Filtering] XY_FILT_XY_FAST_THR : 0x00d0

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:ffh							
Bit Name	Threshold[7:0]							

Displacement (in pixels) along X or Y axis above which the IIR filter input weight is set to XY_FILT_IIR_FAST_COEFF for filtering along the corresponding axis when Charger Armor is not active

Bits	Name	Description
7:0	Threshold[7:0]	Displacement (in pixels) along X or Y axis above which the IIR filter input weight is set to XY_FILT_IIR_FAST_COEFF for filtering along the corresponding axis when Charger Armor is not active. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-255 Default: 255

12.2.103 [Scan Filtering] XY_FILT_XY_SLOW_THR

[TTHE Group] Register Name : Address

[Scan Filtering] XY_FILT_XY_SLOW_THR : 0x00d1

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:ffh							
Bit Name	Threshold[7:0]							

Displacement (in pixels) along X or Y axis below which the IIR filter input weight is set to XY_FILT_IIR_COEFF for filtering along the corresponding axis wwhen Charger Armor is not active

Bits	Name	Description
7:0	Threshold[7:0]	Displacement (in pixels) along X or Y axis below which the IIR filter input weight is set to XY_FILT_IIR_COEFF for filtering along the corresponding axis wwhen Charger Armor is not active. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-255 Default: 255

12.2.104 [Scan Filtering] XY_FILT_IIR_FAST_COEFF

[TTHE Group] Register Name : Address

[Scan Filtering] XY_FILT_IIR_FAST_COEFF : 0x00d2

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:00h						RW:1h	
Bit Name	Reserved[7:2]						IIR Filter Input Weight[1:0]	

Weighting of the input X and Y values in the IIR filter for displacements greater than XY_FILT_FAST_THR when Charger Armor is not active.

Bits	Name	Description
7:2	Reserved[5:0]	Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0
1:0	IIR Filter Input Weight[1:0]	Weighting of the input X and Y values in the IIR filter for displacements greater than XY_FILT_FAST_THR when Charger Armor is not active. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 1 **0:** One **1:** One Half **2:** One Quarter

12.2.105 [Charger Armor] XY_FILTER_MASK_CA

[TTHE Group] Register Name : Address

[Charger Armor] XY_FILTER_MASK_CA : 0x00d4

Bits	31	30	29	28	27	26	25	24
Access:POR	RW:00h							
Bit Name	Reserved[31:24]							

Bits	23	22	21	20	19	18	17	16
Access:POR	RW:00h							
Bit Name	Reserved[23:16]							

Bits	15	14	13	12	11	10	9	8
Access:POR	RW:00h							
Bit Name	Reserved[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:1h	RW:1h	RW:1h	RW:1h	RW:0h			
Bit Name	XY IIR Filter Enable	XY Jitter Filter Enable	Z IIR Filter Enable	Z Jitter Filter Enable	Reserved[3:0]			

XY filter mask when Charger Armor is active

Bits	Name	Description
31:8	Reserved[23:0]	Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0
7	XY IIR Filter Enable[0:0]	Enables or disables the XY IIR filter when Charger Armor is active. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 1 **0:** Disabled **1:** Enabled
6	XY Jitter Filter Enable[0:0]	Enables or disables the XY jitter filter when Charger Armor is active. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 1 **0:** Disabled **1:** Enabled
5	Z IIR Filter Enable[0:0]	Enables or disables the Z IIR filter when Charger Armor is active. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 1 **0:** Disabled **1:** Enabled
4	Z Jitter Filter Enable[0:0]	Enables or disables the Z jitter filter when Charger Armor is active. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 1 **0:** Disabled

12.2.105 [Charger Armor] XY_FILTER_MASK_CA (continued)

		1: Enabled
3:0	Reserved[3:0]	Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0

12.2.106 [Charger Armor] XY_FILT_IIR_COEFF_CA

[TTHE Group] Register Name : Address

[Charger Armor] XY_FILT_IIR_COEFF_CA : 0x00d8

Bits	31	30	29	28	27	26	25	24
Access:POR	RW:00h							
Bit Name	Reserved[31:24]							

Bits	23	22	21	20	19	18	17	16
Access:POR	RW:00h							
Bit Name	Reserved[23:16]							

Bits	15	14	13	12	11	10	9	8
Access:POR	RW:00h							
Bit Name	Reserved[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:00h						RW:2h	
Bit Name	Reserved[7:2]						IIR Filter Input Weight[1:0]	

Weighting of the input X and Y values in the IIR filter for displacements less than XY_FILT_SLOW_THR_CA when Charger Armor is active.

Bits	Name	Description
31:2	Reserved[29:0]	Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0
1:0	IIR Filter Input Weight[1:0]	Weighting of the input X and Y values in the IIR filter for displacements less than XY_FILT_SLOW_THR_CA when Charger Armor is active. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 2 **1:** One Half **2:** One Quarter

12.2.107 [Charger Armor] XY_FILT_Z_IIR_COEFF_CA

[TTHE Group] Register Name : Address

[Charger Armor] XY_FILT_Z_IIR_COEFF_CA : 0x00dc

Bits	31	30	29	28	27	26	25	24
Access:POR	RW:00h							
Bit Name	Reserved[31:24]							

Bits	23	22	21	20	19	18	17	16
Access:POR	RW:00h							
Bit Name	Reserved[23:16]							

Bits	15	14	13	12	11	10	9	8
Access:POR	RW:00h							
Bit Name	Reserved[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:00h						RW:2h	
Bit Name	Reserved[7:2]						IIR Filter Input Weight[1:0]	

Weighting of the input Z value in the IIR filter when Charger Armor is active.

Bits	Name	Description
31:2	Reserved[29:0]	Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0
1:0	IIR Filter Input Weight[1:0]	Weighting of the input Z value in the IIR filter when Charger Armor is active. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 2 **1:** One Half **2:** One Quarter

12.2.108 [Charger Armor] XY_FILT_XY_FAST_THR_CA

[TTHE Group] Register Name : Address

[Charger Armor] XY_FILT_XY_FAST_THR_CA : 0x00e0

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:ffh							
Bit Name	Threshold[7:0]							

Displacement (in pixels) along X or Y axis above which the IIR filter input weight is set to XY_FILT_IIR_FAST_COEFF_CA for filtering along the corresponding axis when Charger Armor is active

Bits	Name	Description
7:0	Threshold[7:0]	Displacement (in pixels) along X or Y axis above which the IIR filter input weight is set to XY_FILT_IIR_FAST_COEFF_CA for filtering along the corresponding axis when Charger Armor is active. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-255 Default: 255

12.2.109 [Charger Armor] XY_FILT_XY_SLOW_THR_CA

[TTHE Group] Register Name : Address

[Charger Armor] XY_FILT_XY_SLOW_THR_CA : 0x00e1

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:ffh							
Bit Name	Threshold[7:0]							

Displacement (in pixels) along X or Y axis below which the IIR filter input weight is set to XY_FILT_IIR_COEFF_CA for filtering along the corresponding axis wwhen Charger Armor is active

Bits	Name	Description
7:0	Threshold[7:0]	Displacement (in pixels) along X or Y axis below which the IIR filter input weight is set to XY_FILT_IIR_COEFF_CA for filtering along the corresponding axis wwhen Charger Armor is active. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-255 Default: 255

12.2.110 [Charger Armor] XY_FILT_IIR_FAST_COEFF_CA

[TTHE Group] Register Name : Address

[Charger Armor] XY_FILT_IIR_FAST_COEFF_CA : 0x00e2

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:00h						RW:1h	
Bit Name	Reserved[7:2]						IIR Filter Input Weight[1:0]	

Weighting of the input X and Y values in the IIR filter for displacements greater than XY_FILT_FAST_THR_CA when Charger Armor is active.

Bits	Name	Description
31:2	Reserved[29:0]	Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0
1:0	IIR Filter Input Weight[1:0]	Weighting of the input X and Y values in the IIR filter for displacements greater than XY_FILT_FAST_THR_CA when Charger Armor is active. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 1 **0:** One **1:** One Half **2:** One Quarter

12.2.111 [Charger Armor] XY_FILT_ADAPTIVE_IIR_FILTER

[TTHE Group] Register Name : Address

[Charger Armor] XY_FILT_ADAPTIVE_IIR_FILTER : 0x00e4

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:00h							
Bit Name	Adaptive IIR Filter[7:0]							

Charger Armor Adaptive XY IIR Filter enable

Bits	Name	Description
7:0	Adaptive IIR Filter[7:0]	Charger Armor Adaptive XY IIR Filter enable. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0 **0:** Disabled **1:** Enabled

12.2.112 [Charger Armor] XY_FILT_ADAPTIVE_IIR_FILTER_DISTANCE

[TTHE Group] Register Name : Address

[Charger Armor] XY_FILT_ADAPTIVE_IIR_FILTER_DISTANCE : 0x00e5

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:0ch							
Bit Name	Distance[7:0]							

Charger Armor Adaptive XY IIR Filter Reset Scaling Factor

Bits	Name	Description
7:0	Distance[7:0]	Charger Armor XY adaptive IIR filter output (X or Y coordinate) is set equal to filter input (i.e. not filtered) when the distance between the input and the previous output multiplied by this value exceeds the corresponding axis resolution. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-255 Default: 12

12.2.113 [Scan Filtering] XY_FILT_TOUCH_SIZE_IIR_COEFF

[TTHE Group] Register Name : Address

[Scan Filtering] XY_FILT_TOUCH_SIZE_IIR_COEFF : 0x00e6

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:00h							
Bit Name	Input Weight[7:0]							

Weight applied to the input of the IIR filter for touch contact ellipse major and minor axis lengths.

Bits	Name	Description
7:0	Input Weight[7:0]	Weight applied to the input of the IIR filter for touch contact ellipse major and minor axis lengths. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0 **0:** One **1:** One Half **2:** One Quarter **3:** One Eighth **4:** One Sixteenth

12.2.114 [Scan Filtering] XY_FILT_TOUCH_SIZE_HYST

[TTHE Group] Register Name : Address

[Scan Filtering] XY_FILT_TOUCH_SIZE_HYST : 0x00e7

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:00h							
Bit Name	Hysteresis[7:0]							

Change in touch contact ellipse major or minor axis length (output from the IIR filter; in counts) required to change the corresponding filter output value.

Bits	Name	Description
7:0	Hysteresis[7:0]	Change in touch contact ellipse major or minor axis length (output from the IIR filter; in counts) required to change the corresponding filter output value. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-255 Default: 0

12.2.115 [Scan Filtering] XY_FILT_TOUCH_ORIENTATION_IIR_COEFF

[TTHE Group] Register Name : Address

[Scan Filtering] XY_FILT_TOUCH_ORIENTATION_IIR_COEFF : 0x00e8

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:00h							
Bit Name	Input Weight[7:0]							

Weight applied to the input of the IIR filter for touch contact ellipse major axis angle with respect to the Y axis.

Bits	Name	Description
7:0	Input Weight[7:0]	Weight applied to the input of the IIR filter for touch contact ellipse major axis angle with respect to the Y axis. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0 **0:** One **1:** One Half **2:** One Quarter **3:** One Eighth **4:** One Sixteenth

12.2.116 [Scan Filtering] XY_FILT_TOUCH_ORIENTATION_HYST

[TTHE Group] Register Name : Address

[Scan Filtering] XY_FILT_TOUCH_ORIENTATION_HYST : 0x00e9

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:00h							
Bit Name	Hysteresis[7:0]							

Change in touch contact ellipse major axis angle with respect to the Y axis (output from the IIR filter; in counts) required to change the filter output value.

Bits	Name	Description
7:0	Hysteresis[7:0]	Change in touch contact ellipse major axis angle with respect to the Y axis (output from the IIR filter; in counts) required to change the filter output value. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-255 Default: 0

12.2.117 [Finger Tracking] FINGER_ID_MAX_FINGER_VELOCITY2

[TTHE Group] Register Name : Address

[Finger Tracking] FINGER_ID_MAX_FINGER_VELOCITY2 : 0x00f8

Bits	31	30	29	28	27	26	25	24
Access:POR	RW:00h							
Bit Name	Velocity Threshold Square[31:24]							

Bits	23	22	21	20	19	18	17	16
Access:POR	RW:03h							
Bit Name	Velocity Threshold Square[23:16]							

Bits	15	14	13	12	11	10	9	8
Access:POR	RW:17h							
Bit Name	Velocity Threshold Square[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:04h							
Bit Name	Velocity Threshold Square[7:0]							

Square of the "speed" (maximum distance change per refresh interval) threshold distinguishing fast finger movement from separate finger touches

Bits	Name	Description
31:0	Velocity Threshold Square[31:0]	Square of the "speed" (maximum distance change per refresh interval) threshold distinguishing fast finger movement from separate finger touches (in [pixels/refresh interval]2). Squared speeds exceeding this value indicate separate finger touches. Squared speeds below this value indicate fast single finger movement. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-4294836225 Default: 202500

12.2.118 [Finger Tracking] LIFTOFF_DEBOUNCE

[TTHE Group] Register Name : Address

[Finger Tracking] LIFTOFF_DEBOUNCE : 0x00fc

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:00h							
Bit Name	Debounce period[7:0]							

Number of consecutive refresh cycles for which a touch must not be detected before the lack of touch is identified as a liftoff

Bits	Name	Description
7:0	Debounce period[7:0]	Number of consecutive refresh cycles for which a touch must not be detected before the lack of touch is identified as a liftoff. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-63 Default: 0

12.2.119 [Device Setup] X_RESOLUTION

[TTHE Group] Register Name : Address

[Device Setup] X_RESOLUTION : 0x0100

Bits	31	30	29	28	27	26	25	24
Access:POR	RW:00h							
Bit Name	Length[31:24]							

Bits	23	22	21	20	19	18	17	16
Access:POR	RW:00h							
Bit Name	Length[23:16]							

Bits	15	14	13	12	11	10	9	8
Access:POR	RW:0eh							
Bit Name	Length[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:74h							
Bit Name	Length[7:0]							

X (horizontal) Axis Length (in pixels)

Bits	Name	Description
31:0	Length[31:0]	X (horizontal) axis length (in pixels). Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-65535 Default: 3700

12.2.120 [Device Setup] Y_RESOLUTION

[TTHE Group] Register Name : Address

[Device Setup] Y_RESOLUTION : 0x0104

Bits	31	30	29	28	27	26	25	24
Access:POR	RW:00h							
Bit Name	Length[31:24]							

Bits	23	22	21	20	19	18	17	16
Access:POR	RW:00h							
Bit Name	Length[23:16]							

Bits	15	14	13	12	11	10	9	8
Access:POR	RW:08h							
Bit Name	Length[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:34h							
Bit Name	Length[7:0]							

Y (vertical) Axis Length (in pixels)

Bits	Name	Description
31:0	Length[31:0]	Y (vertical) axis length (in pixels). Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-65535 Default: 2100

12.2.121 [Device Setup] SENSOR_ASSIGNMENT

[TTHE Group] Register Name : Address

[Device Setup] SENSOR_ASSIGNMENT : 0x0108

Bits	31	30	29	28	27	26	25	24
Access:POR	RW:00h							
Bit Name	Reserved[31:24]							

Bits	23	22	21	20	19	18	17	16
Access:POR	RW:00h							
Bit Name	Reserved[23:16]							

Bits	15	14	13	12	11	10	9	8
Access:POR	RW:00h							
Bit Name	Reserved[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:00h							RW:1h
Bit Name	Reserved[7:1]							Axis Assign-ment

Assignment of X/Y axes to TX/RX axes

Bits	Name	Description
31:1	Reserved[30:0]	Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0
0	Axis Assignment[0:0]	Assignment of TX/RX axes to X/Y axes. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 1 **0:** RX = X; TX = Y **1:** RX = Y; TX = X

12.2.122 [Finger Tracking] Z_SCALING

[TTHE Group] Register Name : Address

[Finger Tracking] Z_SCALING : 0x010c

Bits	31	30	29	28	27	26	25	24
Access:POR	RW:00h							
Bit Name	Scale Factor[31:24]							

Bits	23	22	21	20	19	18	17	16
Access:POR	RW:00h							
Bit Name	Scale Factor[23:16]							

Bits	15	14	13	12	11	10	9	8
Access:POR	RW:00h							
Bit Name	Scale Factor[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:80h							
Bit Name	Scale Factor[7:0]							

Z Scaling Factor

Bits	Name	Description
31:0	Scale Factor[31:0]	Factor to scale the Z value. Adjust this value to achieve 255 Z counts for the maximum finger size. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-255 Default: 128

12.2.123 [Finger Tracking] FINGER_THRESH_SELF

[TTHE Group] Register Name : Address

[Finger Tracking] FINGER_THRESH_SELF : 0x0110

Bits	15	14	13	12	11	10	9	8
Access:POR	RW : 00h							
Bit Name	Reserved[7:0]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:1eh							
Bit Name	Threshold[7:0]							

Self Capacitance Finger Threshold

Bits	Name	Description
15:8	Reserved[7:0]	
7:0	Threshold[7:0]	Sensor data threshold for Self Cap scan to identify a finger touch. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-255 Default: 30

12.2.124 [Finger Tracking] FINGER_THRESH_MUTUAL

[TTHE Group] Register Name : Address

[Finger Tracking] FINGER_THRESH_MUTUAL : 0x0112

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:1ah							
Bit Name	Threshold[7:0]							

Mutual Capacitance Finger Threshold

Bits	Name	Description
7:0	Threshold[7:0]	Sensor data threshold for Mutual Cap scan to identify a finger touch. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-255 Default: 26

12.2.125 [Charger Armor] RX_LINE_FILTER

[TTHE Group] Register Name : Address

[Charger Armor] RX_LINE_FILTER : 0x0113

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:01h							
Bit Name	RX Line Filter[7:0]							

Rx Line Filter Enable/Disable

Bits	Name	Description
7:0	RX Line Filter[7:0]	Charger Armor RX Line Filter enable. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 1 **0:** Disabled **1:** Enabled

12.2.126 [Finger Tracking] FINGER_THR_MUT_HYST

[TTHE Group] Register Name : Address

[Finger Tracking] FINGER_THR_MUT_HYST : 0x0114

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:04h							
Bit Name	Hysteresis[7:0]							

Hysteresis applied to the mutual capacitance finger threshold to identify touches and liftoffs

Bits	Name	Description
7:0	Hysteresis[7:0]	Mutual capacitance threshold hysteresis, applied to the Mutual Capacitance Finger Threshold to identify touches and liftoffs. Finger Detected: No Charger Armor: Finger Threshold Mutual = FINGER_THRESH_MUTUAL + FINGER_THR_MUT_HYST Charger Armor: Finger Threshold Mutual Charger Armor = CA_FINGER_THRESHOLD_MUTUAL + FINGER_THR_MUT_HYST Liftoff Detected: No Charger Armor: Finger Threshold Mutual = FINGER_THRESH_MUTUAL - FINGER_THR_MUT_HYST Charger Armor: Finger Threshold Mutual Charger Armor = CA_FINGER_THRESHOLD_MUTUAL - FINGER_THR_MUT_HYST. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-255 Default: 4

12.2.127 [Finger Tracking] MULTI_TOUCH_DEBOUNCE

[TTHE Group] Register Name : Address

[Finger Tracking] MULTI_TOUCH_DEBOUNCE : 0x0115

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:00h							
Bit Name	Debounce period[7:0]							

Number of consecutive refresh cycles for which a touch must be detected prior to being reported.

Bits	Name	Description
7:0	Debounce period[7:0]	Number of consecutive refresh cycles for which a touch must be detected prior to being reported. Applies to 2nd and successive touches, but not to 1st touch.. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-255 Default: 0

12.2.128 [Charger Armor] CA_FINGER_THRESHOLD_MUTUAL

[TTHE Group] Register Name : Address

[Charger Armor] CA_FINGER_THRESHOLD_MUTUAL : 0x0116

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:38h							
Bit Name	Threshold[7:0]							

Mutual capacitance finger threshold applied in the presence of charger noise (level 2 or higher)

Bits	Name	Description
7:0	Threshold[7:0]	Mutual Cap finger threshold applied in the presence of charger noise (level 2 or higher). Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-255 Default: 56

12.2.129 [Finger Tracking] SIZE_ORIENTATION_ENABLE

[TTHE Group] Register Name : Address

[Finger Tracking] SIZE_ORIENTATION_ENABLE : 0x0117

Bits	7	6	5	4	3	2	1	0
Access:POR	RW : 00h						RW:1h	RW:1h
Bit Name	Reserved[7:2]						Orientation Enable	Axis Length Enable

Enables/disables for touch contact ellipse axis length and orientation calculations

Bits	Name	Description
7:2	Reserved[5:0]	
1	Orientation Enable[0:0]	Enable/Disable major axis orientation calculation. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 1 **0:** Disabled **1:** Enabled
0	Axis Length Enable[0:0]	Enable/Disable major and minor axis length calculation. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 1 **0:** Disabled **1:** Enabled

12.2.130 [Charger Armor] RX_LINE_FILTER_DEBOUNCE

[TTHE Group] Register Name : Address

[Charger Armor] RX_LINE_FILTER_DEBOUNCE : 0x0118

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:02h							
Bit Name	Debounce Period[7:0]							

The RX line filter applies this debounce period for touchdown to signal local maximums whose combined signal from their surrounding 8 intersections is greater than RX_LINE_FILTER_THRESHOLD/100 of the combined signal from the 8 intersections surrounding the largest local maximum in proximity (within 3 RX electrodes) to the local maximum of interest.

Bits	Name	Description
7:0	Debounce Period[7:0]	The Charger Armor RX line filter applies this debounce period for touchdown to signal local maximums whose combined signal from their surrounding 8 intersections is greater than RX_LINE_FILTER_THRESHOLD/100 of the combined signal from the 8 interesections surrounding the largest local maximum in proximity (within 3 RX electrodes) to the local maximum of interest. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-255 Default: 2

12.2.131 [Device Setup] CLIPPING_X_LOW

[TTHE Group] Register Name : Address

[Device Setup] CLIPPING_X_LOW : 0x0119

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:00h							
Bit Name	Clipping at low X[7:0]							

Parameter defines the clipping region boundary at the low X side in pixel. The X coordinate is reported as 0 when a touch is at this boundary. The reported X coordinate is linearly scaled when a touch within the high X and low X boundary. A touch between this boundary and the neighboring panel edge is not reported.

Bits	Name	Description
7:0	Clipping at low X[7:0]	Parameter defines the clipping region boundary at the low X side in pixel. The X coordinate is reported as 0 when a touch is at this boundary. The reported X coordinate is linearly scaled when a touch within the high X and low X boundary. A touch between this boundary and the neighboring panel edge is not reported. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: -128-127 Default: 0

12.2.132 [Device Setup] CLIPPING_X_HIGH

[TTHE Group] Register Name : Address

[Device Setup] CLIPPING_X_HIGH : 0x011a

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:00h							
Bit Name	Clipping at high X[7:0]							

Parameter defines the clipping region boundary at the high X side in pixel. The reported X coordinate is the maximum panel X resolution when a touch isat this boundary. The reported X coordinate is linearly scaled when a touch within the high X and low X boundary. A touch between this boundary and the neighboring panel edge is not reported.

Bits	Name	Description
7:0	Clipping at high X[7:0]	Parameter defines the clipping region boundary at the high X side in pixel. The reported X coordinate is the maximum panel X resolution when a touch isat this boundary. The reported X coordinate is linearly scaled when a touch within the high X and low X boundary. A touch between this boundary and the neighboring panel edge is not reported. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: -128-127 Default: 0

12.2.133 [Device Setup] CLIPPING_Y_LOW

[TTHE Group] Register Name : Address

[Device Setup] CLIPPING_Y_LOW : 0x011b

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:00h							
Bit Name	Clipping at low Y[7:0]							

Parameter defines the clipping region boundary at the low Y side in pixel. The Y coordinate is reported as 0 when a touch is at this boundary. The reported Y coordinate is linearly scaled when a touch within the high Y and low Y boundary. A touch between this boundary and the neighboring panel edge is not reported.

Bits	Name	Description
7:0	Clipping at low Y[7:0]	Parameter defines the clipping region boundary at the low Y side in pixel. The Y coordinate is reported as 0 when a touch is at this boundary. The reported Y coordinate is linearly scaled when a touch within the high Y and low Y boundary. A touch between this boundary and the neighboring panel edge is not reported. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: -128-127 Default: 0

12.2.134 [Device Setup] CLIPPING_Y_HIGH

[TTHE Group] Register Name : Address

[Device Setup] CLIPPING_Y_HIGH : 0x011c

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:00h							
Bit Name	Clipping at high Y[7:0]							

Parameter defines the clipping region boundary at the high Y side in pixel. The reported Y coordinate is the maximum panel Y resolution when a touch isat this boundary. The reported Y coordinate is linearly scaled when a touch within the high Y and low Y boundary. A touch between this boundary and the neighboring panel edge is not reported.

Bits	Name	Description
7:0	Clipping at high Y[7:0]	Parameter defines the clipping region boundary at the high Y side in pixel. The reported Y coordinate is the maximum panel Y resolution when a touch isat this boundary. The reported Y coordinate is linearly scaled when a touch within the high Y and low Y boundary. A touch between this boundary and the neighboring panel edge is not reported. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: -128-127 Default: 0

12.2.135 [Charger Armor] RX_LINE_FILTER_THRESHOLD

[TTHE Group] Register Name : Address

[Charger Armor] RX_LINE_FILTER_THRESHOLD : 0x011d

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:58h							
Bit Name	Threshold Percentage[7:0]							

Threshold (percentage of maximum proximal 3x3 surrounding signal) at which the RX line filter rejects a local maximum

Bits	Name	Description
7:0	Threshold Percentage[7:0]	Threshold (percentage of maximum proximal 3x3 surrounding signal) at which the Charger Armor RX line filter rejects a local maximum. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-100 Default: 88

12.2.136 [Finger Tracking] NOISE_REJECTION_3x3_FILTER_SCALE

[TTHE Group] Register Name : Address

[Finger Tracking] NOISE_REJECTION_3x3_FILTER_SCALE : 0x011e

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:02h							
Bit Name	Noise Rejection 3x3 Filter Scale - No CA[7:0]							

Noise rejection filter scale when Charger Armor is not active

Bits	Name	Description
7:0	Noise Rejection 3x3 Filter Scale - No CA[7:0]	Noise rejection filter scale when Charger Armor is not active. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 2 **0:** 0x **1:** 2x **2:** 4x

12.2.137 [Charger Armor] NOISE_REJECTION_3x3_FILTER_SCALE_CA

[TTHE Group] Register Name : Address

[Charger Armor] NOISE_REJECTION_3x3_FILTER_SCALE_CA : 0x011f

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:02h							
Bit Name	Noise Rejection 3x3 Filter Scale - CA[7:0]							

Noise rejection filter scale when Charger Armor is active

Bits	Name	Description
7:0	Noise Rejection 3x3 Filter Scale - CA[7:0]	Noise rejection filter scale when Charger Armor is active. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 2 **0:** 0x **1:** 2x **2:** 4x

12.2.138 [Finger Tracking] INNER_EDGE_GAIN

[TTHE Group] Register Name : Address

[Finger Tracking] INNER_EDGE_GAIN : 0x0120

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:08h							
Bit Name	Gain[7:0]							

Gain for Edge Correction (Inner Virtual Sensor)

Bits	Name	Description
7:0	Gain[7:0]	Inner Virtual Sensor Gain (in 1/128 increments) for panel edge finger touch correction. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-255 Default: 8

12.2.139 [Finger Tracking] OUTER_EDGE_GAIN

[TTHE Group] Register Name : Address

[Finger Tracking] OUTER_EDGE_GAIN : 0x0121

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:78h							
Bit Name	Gain[7:0]							

Gain for Edge Correction (Outer Virtual Sensor)

Bits	Name	Description
7:0	Gain[7:0]	Outer Virtual Sensor Gain (in 1/128 increments) for panel edge finger touch correction. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-255 Default: 120

12.2.140 [Device Setup] CALC_THRESHOLD

[TTHE Group] Register Name : Address

[Device Setup] CALC_THRESHOLD : 0x0122

Bits	15	14	13	12	11	10	9	8
Access:POR	RW:00h							
Bit Name	Calc_Threshold[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:02h							
Bit Name	Calc_Threshold[7:0]							

Value is subtracted from every element

Bits	Name	Description
15:0	Calc_Threshold[15:0]	Value is subtracted from every element. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: -32768-32767 Default: 2

12.2.141 [Device Setup] OFFSET_S1

[TTHE Group] Register Name : Address

[Device Setup] OFFSET_S1 : 0x0124

Bits	15	14	13	12	11	10	9	8
Access:POR	RW:00h							
Bit Name	S1_Threshold[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:05h							
Bit Name	S1_Threshold[7:0]							

Offset 1 Value is subtracted from Sensor next to edge.

Bits	Name	Description
15:0	S1_Threshold[15:0]	Offset 1 Value is subtracted from Sensor next to edge. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: -32768-32767 Default: 5

12.2.142 [Device Setup] OFFSET_S2

[TTHE Group] Register Name : Address

[Device Setup] OFFSET_S2 : 0x0126

Bits	15	14	13	12	11	10	9	8
Access:POR	RW:00h							
Bit Name	S2_Threshold[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:02h							
Bit Name	S2_Threshold[7:0]							

Offset 2 Value is subtracted from Sensor next to edge.

Bits	Name	Description
15:0	S2_Threshold[15:0]	Offset 2 Value is subtracted from Sensor next to edge. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: -32768-32767 Default: 2

12.2.143 [Device Setup] Z1_SUM_8MM

[TTHE Group] Register Name : Address

[Device Setup] Z1_SUM_8MM : 0x0128

Bits	15	14	13	12	11	10	9	8
Access:POR	RW:01h							
Bit Name	z1[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:4ah							
Bit Name	z1[7:0]							

Sum of the 3x3 sensor diff count of a 8 mm finger touch

Bits	Name	Description
15:0	z1[15:0]	Sum of the 3x3 sensor diff count of a 8 mm finger touch. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: -32768-32767 Default: 330

12.2.144 [Device Setup] Z2_SUM_4MM

[TTHE Group] Register Name : Address

[Device Setup] Z2_SUM_4MM : 0x012a

Bits	15	14	13	12	11	10	9	8
Access:POR	RW:00h							
Bit Name	z2[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:82h							
Bit Name	z2[7:0]							

Sum of the 3x3 sensor diff count of a 4 mm finger touch

Bits	Name	Description
15:0	z2[15:0]	Sum of the 3x3 sensor diff count of a 4 mm finger touch. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: -32768-32767 Default: 130

12.2.145 [Device Setup] LOW_PIVOT

[TTHE Group] Register Name : Address

[Device Setup] LOW_PIVOT : 0x012c

Bits	15	14	13	12	11	10	9	8
Access:POR	RW:00h							
Bit Name	LowPivot[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:78h							
Bit Name	LowPivot[7:0]							

When zMagnitude = LowPivot than Scalar = 1x

Bits	Name	Description
15:0	LowPivot[15:0]	When zMagnitude = LowPivot than Scalar = 1x. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: -32768-32767 Default: 120

12.2.146 [Device Setup] HIGH_PIVOT

[TTHE Group] Register Name : Address

[Device Setup] HIGH_PIVOT : 0x012e

Bits	15	14	13	12	11	10	9	8
Access:POR	RW:00h							
Bit Name	HighPivot[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:b4h							
Bit Name	HighPivot[7:0]							

When zMagnitude = HighPivot than Scalar = MinGain(based on FS)

Bits	Name	Description
15:0	HighPivot[15:0]	When zMagnitude = HighPivot than Scalar = MinGain(based on FS). Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: -32768-32767 Default: 180

12.2.147 [Device Setup] BR2_ALWAYS_ON_FLAG

[TTHE Group] Register Name : Address

[Device Setup] BR2_ALWAYS_ON_FLAG : 0x0130

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:00h							
Bit Name	Enable BR2 always usage[7:0]							

Enables the BR2 algorithm to be used all the time

Bits	Name	Description
7:0	Enable BR2 always usage[7:0]	Enables the BR2 algorithm to be used all the time. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-255 Default: 0

12.2.148 [Device Setup] EDGE_DEBOUNCE_COUNT

[TTHE Group] Register Name : Address

[Device Setup] EDGE_DEBOUNCE_COUNT : 0x0131

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:03h							
Bit Name	Edge Debounce Count[7:0]							

Dismisses new touches on edge for 3 cycles times before accepting

Bits	Name	Description
7:0	Edge Debounce Count[7:0]	Dismisses new touches on edge for 3 cycles times before accepting. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-255 Default: 3

12.2.149 [Device Setup] EDGE_DEBOUNCE_COUNT_THRESHOLD

[TTHE Group] Register Name : Address

[Device Setup] EDGE_DEBOUNCE_COUNT_THRESHOLD : 0x0132

Bits	15	14	13	12	11	10	9	8
Access:POR	RW:00h							
Bit Name	Edge Debounce Threshold[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:64h							
Bit Name	Edge Debounce Threshold[7:0]							

Dismisses new touches on edge when below threshold

Bits	Name	Description
15:0	Edge Debounce Thresh-old[15:0]	Dismisses new touches on edge when below threshold. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: -32768-32767 Default: 100

12.2.150 [Device Setup] CENTER_MAGNITUDE_SCALE

[TTHE Group] Register Name : Address

[Device Setup] CENTER_MAGNITUDE_SCALE : 0x0134

Bits	15	14	13	12	11	10	9	8
Access:POR	RW:00h							
Bit Name	Center Magnitude Scale[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:78h							
Bit Name	Center Magnitude Scale[7:0]							

Scale for center Magnitude (CENTER_MAGNITUDE_SCALE) used in EstimateCurve API

Bits	Name	Description
15:0	Center Magnitude Scale[15:0]	Scale for center Magnitude (CENTER_MAGNITUDE_SCALE) used in EstimateCurve API. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: -32768-32767 Default: 120

12.2.151 [Device Setup] CENTROID_CORNER_NUMER

[TTHE Group] Register Name : Address

[Device Setup] CENTROID_CORNER_NUMER : 0x0136

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:03h							
Bit Name	Centroid Corner Numerator[7:0]							

Used in pair with CENTROID_CORNER_DENOM as gain factor which will pull a touch into the corner of the panel

Bits	Name	Description
7:0	Centroid Corner Numerator[7:0]	Used in pair with CENTROID_CORNER_DENOM as gain factor which will pull a touch into the corner of the panel. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-255 Default: 3

12.2.152 [Device Setup] CENTROID_CORNER_DENOM

[TTHE Group] Register Name : Address

[Device Setup] CENTROID_CORNER_DENOM : 0x0137

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:04h							
Bit Name	Centroid Corner Denominator[7:0]							

Used in pair with CENTROID_CORNER_NUMER as gain factor which will pull a touch into the corner of the panel

Bits	Name	Description
7:0	Centroid Corner Denominator[7:0]	Used in pair with CENTROID_CORNER_NUMER as gain factor which will pull a touch into the corner of the panel. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 1-255 Default: 4

12.2.153 [Device Setup] CENTROID_FINGER_MAX_JUMP

[TTHE Group] Register Name : Address

[Device Setup] CENTROID_FINGER_MAX_JUMP : 0x0138

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:03h							
Bit Name	Centroid Finger Maximum Jump[7:0]							

Specifies in mm how more should be finger size detected in the edge than previous finger size detected in the core to use finger size in the edge instead of previously detected core value

Bits	Name	Description
7:0	Centroid Finger Maximum Jump[7:0]	If the finger size detected in the edge is more than CENTROID_FINGER_MAX_JUMP millimeters different in size than the previous finger size detected in the core, use the finger size detected in the edge instead of the previously detected core value. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-8 Default: 3

12.2.154 [Finger Tracking] GRADIENT_OUTER_EDGE_CONST_GAIN

[TTHE Group] Register Name : Address

[Finger Tracking] GRADIENT_OUTER_EDGE_CONST_GAIN : 0x0139

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:68h							
Bit Name	Gradient Outer Constant Gain[7:0]							

Outer Constant Gain for Edge Correction by Gradients Method for tighter sensor pitch panel (Outer Virtual Sensor)

Bits	Name	Description
7:0	Gradient Outer Constant Gain[7:0]	Gradient Outer Virtual Sensor Constant Gain (in 1/128 increments) for edge finger touch correction of tighter sensor pitch panel. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-255 Default: 104

12.2.155 [Finger Tracking] GRADIENT_OUTER_EDGE_CONST_RESPONSE

[TTHE Group] Register Name : Address

[Finger Tracking] GRADIENT_OUTER_EDGE_CONST_RESPONSE : 0x013a

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:80h							
Bit Name	Gradient Outer Constant Response[7:0]							

Outer Constant Response for Edge Correction by Gradients Method for tighter sensor pitch panel (Outer Virtual Sensor)

Bits	Name	Description
7:0	Gradient Outer Constant Response[7:0]	Gradient Outer Virtual Sensor Constant Response (in 1/128 increments) for edge finger touch correction of tighter sensor pitch panel. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-255 Default: 128

12.2.156 [Finger Tracking] GRADIENT_EDGE_COEF

[TTHE Group] Register Name : Address

[Finger Tracking] GRADIENT_EDGE_COEF : 0x013b

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:40h							
Bit Name	Gradient Edge Coef[7:0]							

Edge coefficient for Edge Correction by Gradients Method for tighter sensor pitch panel

Bits	Name	Description
7:0	Gradient Edge Coef[7:0]	Gradient Edge Coefficient for edge finger touch correction of tighter sensor pitch panel. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-255 Default: 64

12.2.157 [Finger Tracking] GRADIENT_COEF

[TTHE Group] Register Name : Address

[Finger Tracking] GRADIENT_COEF : 0x013c

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:04h							
Bit Name	Gradient Coef[7:0]							

Gradient Coefficient for Edge Correction by Gradients Method for tighter sensor pitch panel

Bits	Name	Description
7:0	Gradient Coef[7:0]	Gradient Coefficient for edge finger touch correction of tighter sensor pitch panel. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-255 Default: 4

12.2.158 [Finger Tracking] GRADIENT_THRESHOLD

[TTHE Group] Register Name : Address

[Finger Tracking] GRADIENT_THRESHOLD : 0x013d

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:19h							
Bit Name	Gradient Threshold[7:0]							

Gradient Threshold for Edge Correction by Gradients Method for tighter sensor pitch panel

Bits	Name	Description
7:0	Gradient Threshold[7:0]	Gradient Threshold for edge finger touch correction of tighter sensor pitch panel. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-255 Default: 25

12.2.159 [Finger Tracking] LRG_OBJ_CFG

[TTHE Group] Register Name : Address

[Finger Tracking] LRG_OBJ_CFG : 0x0140

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:00h						RW:2h	
Bit Name	Reserved[7:2]						Large Object and Fat Finger[1:0]	

Large object and fat finger detection configuration

Bits	Name	Description
7:2	Reserved[5:0]	Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0
1:0	Large Object and Fat Finger[1:0]	Determines whether large objects and fat fingers are distinguished from regular finger touches. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 2 **0:** Regular Fingers Detected Only **1:** Fat Fingers Detected **2:** Fat Fingers & Large Objects Detected

12.2.160 [Finger Tracking] MAX_FAT_FINGER_SIZE

[TTHE Group] Register Name : Address

[Finger Tracking] MAX_FAT_FINGER_SIZE : 0x0141

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:37h							
Bit Name	Max Fat Finger Size[7:0]							

Maximum fat finger size

Bits	Name	Description
7:0	Max Fat Finger Size[7:0]	Maximum number of contiguous activated panel intersections that define a fat finger. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-255 Default: 55

12.2.161 [Finger Tracking] MIN_FAT_FINGER_SIZE

[TTHE Group] Register Name : Address

[Finger Tracking] MIN_FAT_FINGER_SIZE : 0x0142

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:09h							
Bit Name	Min Fat Finger Size[7:0]							

Minimum fat finger size

Bits	Name	Description
7:0	Min Fat Finger Size[7:0]	Minimum number of contiguous activated panel intersections that define a fat finger. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-255 Default: 9

12.2.162 [Finger Tracking] MAX_FAT_FINGER_SIZE_HYST

[TTHE Group] Register Name : Address

[Finger Tracking] MAX_FAT_FINGER_SIZE_HYST : 0x0143

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:00h							
Bit Name	Hysteresis[7:0]							

Hysteresis applied to maximum number of intersections defining a fat finger on detection of a large object (reducing this threshold) or detection of a fat finger (increasing this threshold). Fat finger detection takes priority in determining whether to increase or reduce the threshold.

Bits	Name	Description
7:0	Hysteresis[7:0]	Hysteresis applied to reduce the MAX_FAT_FINGER_SIZE on detection of a large object. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-255 Default: 0

12.2.163 [Finger Tracking] MIN_FAT_FINGER_SIZE_HYST

[TTHE Group] Register Name : Address

[Finger Tracking] MIN_FAT_FINGER_SIZE_HYST : 0x0144

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:00h							
Bit Name	Hysteresis[7:0]							

Hysteresis applied to the minimum number of intersections defining a fat finger on detection of a fat finger (reducing the minimum fat finger threshold).

Bits	Name	Description
7:0	Hysteresis[7:0]	Hysteresis applied to reduce the MIN_FAT_FINGER_SIZE on detection of a fat finger. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-255 Default: 0

12.2.164 [Finger Tracking] BYPASS_THRESHOLD_GAIN

[TTHE Group] Register Name : Address

[Finger Tracking] BYPASS_THRESHOLD_GAIN : 0x0145

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:10h							
Bit Name	Gain[7:0]							

Fat finger centroid bypass threshold gain for panel interior intersections

Bits	Name	Description
7:0	Gain[7:0]	Fat finger centroid bypass threshold gain for panel interior intersections. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-255 Default: 16

12.2.165 [Finger Tracking] BYPASS_THRESHOLD_EDGE_GAIN

[TTHE Group] Register Name : Address

[Finger Tracking] BYPASS_THRESHOLD_EDGE_GAIN : 0x0146

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:09h							
Bit Name	Gain[7:0]							

Fat finger centroid bypass threshold gain for panel edge intersections

Bits	Name	Description
7:0	Gain[7:0]	Fat finger centroid bypass threshold gain for panel edge intersections. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-255 Default: 9

12.2.166 [Finger Tracking] FAT_FINGER_THRESHOLD_COEFF

[TTHE Group] Register Name : Address

[Finger Tracking] FAT_FINGER_THRESHOLD_COEFF : 0x0147

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:20h							
Bit Name	Threshold[7:0]							

Signal threshold defining the fraction of the local maximum signal (in 1/128 increments) above which a given intersection is included in a contiguous set of sensors that defines a fat finger.

Bits	Name	Description
7:0	Threshold[7:0]	Signal threshold defining the fraction of the local maximum signal (in 1/128 increments) above which a given intersection is included in a contiguous set of sensors that defines a fat finger. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-128 Default: 32

12.2.167 [Charger Armor] CA_MIN_FAT_FINGER_SIZE

[TTHE Group] Register Name : Address

[Charger Armor] CA_MIN_FAT_FINGER_SIZE : 0x0148

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:09h							
Bit Name	CA Min Fat Finger Size[7:0]							

Minimum fat finger size for Charger Armor

Bits	Name	Description
7:0	CA Min Fat Finger Size[7:0]	Minimum number of contiguous activated panel intersections that define a fat fingerwhen CA is active. Modifying this parameter affects the baseline data and requires the host to perform a re-calibration (see Calibrate PWC Command). Range: 0-255 Default: 9

12.2.168 [Finger Tracking] FINGER_SIZE_SCALE

[TTHE Group] Register Name : Address

[Finger Tracking] FINGER_SIZE_SCALE : 0x0149

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:2fh							
Bit Name	Finger Size Scale[7:0]							

Finger Size Scale to adjust major and minor axis length calculation

Bits	Name	Description
7:0	Finger Size Scale[7:0]	Finger Size Scale to adjust major and minor axis length calculation optimally should be set about to pitch size of supported panel (in 1/10 mm). Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-255 Default: 47

12.2.169 [CapSense Buttons] BTN_THRSH_MUT

[TTHE Group] Register Name : Address

[CapSense Buttons] BTN_THRSH_MUT : 0x0150

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:50h							
Bit Name	Threshold[7:0]							

Mutual Capacitance Button 0 Threshold

Bits	Name	Description
7:0	Threshold[7:0]	CapSense Button Mutual Cap scan threshold for button 0. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-255 Default: 80

12.2.170 [CapSense Buttons] BTN_THRSH_MUT_1

[TTHE Group] Register Name : Address

[CapSense Buttons] BTN_THRSH_MUT_1 : 0x0151

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:50h							
Bit Name	Threshold[7:0]							

Mutual Capacitance Button 1 Threshold

Bits	Name	Description
7:0	Threshold[7:0]	CapSense Button Mutual Cap scan threshold for button 1. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-255 Default: 80

12.2.171 [CapSense Buttons] BTN_THRSH_MUT_2

[TTHE Group] Register Name : Address

[CapSense Buttons] BTN_THRSH_MUT_2 : 0x0152

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:50h							
Bit Name	Threshold[7:0]							

Mutual Capacitance Button 2 Threshold

Bits	Name	Description
7:0	Threshold[7:0]	CapSense Button Mutual Cap scan threshold for button 2. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-255 Default: 80

12.2.172 [CapSense Buttons] BTN_THRSH_MUT_3

[TTHE Group] Register Name : Address

[CapSense Buttons] BTN_THRSH_MUT_3 : 0x0153

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:50h							
Bit Name	Threshold[7:0]							

Mutual Capacitance Button 3 Threshold

Bits	Name	Description
7:0	Threshold[7:0]	CapSense Button Mutual Cap scan threshold for button 3. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-255 Default: 80

12.2.173 [CapSense Buttons] BTN_THRSH_SELF

[TTHE Group] Register Name : Address

[CapSense Buttons] BTN_THRSH_SELF : 0x0154

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:41h							
Bit Name	Threshold[7:0]							

Self Capacitance Button 0 Threshold

Bits	Name	Description
7:0	Threshold[7:0]	CapSense Button Self Cap threshold for button 0. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-255 Default: 65

12.2.174 [CapSense Buttons] BTN_THRSH_SELF_1

[TTHE Group] Register Name : Address

[CapSense Buttons] BTN_THRSH_SELF_1 : 0x0155

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:41h							
Bit Name	Threshold[7:0]							

Self Capacitance Button 1 Threshold

Bits	Name	Description
7:0	Threshold[7:0]	CapSense Button Self Cap threshold for button 1. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-255 Default: 65

12.2.175 [CapSense Buttons] BTN_THRSH_SELF_2

[TTHE Group] Register Name : Address

[CapSense Buttons] BTN_THRSH_SELF_2 : 0x0156

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:41h							
Bit Name	Threshold[7:0]							

Self Capacitance Button 2 Threshold

Bits	Name	Description
7:0	Threshold[7:0]	CapSense Button Self Cap threshold for button 2. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-255 Default: 65

12.2.176 [CapSense Buttons] BTN_THRSH_SELF_3

[TTHE Group] Register Name : Address

[CapSense Buttons] BTN_THRSH_SELF_3 : 0x0157

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:41h							
Bit Name	Threshold[7:0]							

Self Capacitance Button 3 Threshold

Bits	Name	Description
7:0	Threshold[7:0]	CapSense Button Self Cap threshold for button 3. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-255 Default: 65

12.2.177 [CapSense Buttons] BTN_HYST_SELF

[TTHE Group] Register Name : Address

[CapSense Buttons] BTN_HYST_SELF : 0x0158

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:0ah							
Bit Name	Hysteresis[7:0]							

Self Capacitance Button Hysteresis

Bits	Name	Description
7:0	Hysteresis[7:0]	CapSense Button Self Cap threshold hysteresis, applied to the Self Capacitance Button Threshold to identify touches and liftoffs. Finger Detected: BTN_THRSH_SELF = BTN_THRSH_SELF + BTN_HYST_SELF Liftoff Detected: BTN_THRSH_SELF = BTN_THRSH_SELF - BTN_HYST_SELF. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-255 Default: 10

12.2.178 [CapSense Buttons] BTN_HYST_MUT

[TTHE Group] Register Name : Address

[CapSense Buttons] BTN_HYST_MUT : 0x0159

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:14h							
Bit Name	Hysteresis[7:0]							

Mutual Capacitance Button Hysteresis

Bits	Name	Description
7:0	Hysteresis[7:0]	CapSense Button Mutual Cap threshold hysteresis, applied to the Mutual Capacitance Button Threshold to identify touches and liftoffs. Finger Detected: BTN_THRSH_MUT = BTN_THRSH_MUT + BTN_HYST_MUT Liftoff Detected: BTN_THRSH_MUT = BTN_THRSH_MUT - BTN_HYST_MUT. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-255 Default: 20

12.2.179 [Raw Processing] FILT_FILTER_MASK

[TTHE Group] Register Name : Address

[Raw Processing] FILT_FILTER_MASK : 0x0164

Bits	15	14	13	12	11	10	9	8
Access:POR	RW:0h	RW:1h	RW:1h	RW:1h	RW:0h	RW:1h	RW:1h	RW:1h
Bit Name	Reserved	IIR Filter Enable for Buttons	Jitter Filter Enable for Buttons	Common Mode Filter Enable for Buttons	Reserved	IIR Filter Enable for Balanced	Jitter Filter Enable for Balanced	Common Mode Filter Enable for Balanced

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:0h	RW:1h	RW:1h	RW:1h	RW:0h	RW:1h	RW:1h	RW:1h
Bit Name	Reserved	IIR Filter Enable for Self-Cap	Jitter Filter Enable for Self-Cap	Common Mode Filter Enable for Self-Cap	Reserved	IIR Filter Enable for Mutual	Jitter Filter Enable for Mutual	Common Mode Filter Enable for Mutual

Raw Filter Mask

Bits	Name	Description
15	Reserved[0:0]	Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0
14	IIR Filter Enable for Buttons[0:0]	Raw IIR filter enable for CapSense Buttons. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 1 **0:** Disabled **1:** Enabled
13	Jitter Filter Enable for Buttons[0:0]	Raw jitter filter enable for CapSense Buttons. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 1 **0:** Disabled **1:** Enabled
12	Common Mode Filter Enable for Buttons[0:0]	Raw common mode filter enable for CapSense Buttons. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 1 **0:** Disabled **1:** Enabled
11	Reserved[0:0]	Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0
10	IIR Filter Enable for Balanced[0:0]	Raw IIR filter enable for Balanced scan. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 1 **0:** Disabled **1:** Enabled
9	Jitter Filter Enable for Balanced[0:0]	Raw jitter filter enable for Balanced scan. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 1 **0:** Disabled

12.2.179 [Raw Processing] FILT_FILTER_MASK (continued)

		1: Enabled
8	Common Mode Filter Enable for Balanced[0:0]	Raw common mode filter enable for Balanced scan. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 1 **0:** Disabled **1:** Enabled
7	Reserved[0:0]	Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0
6	IIR Filter Enable for Self-Cap[0:0]	Raw IIR filter enable for Self Cap scan. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 1 **0:** Disabled **1:** Enabled
5	Jitter Filter Enable for Self-Cap[0:0]	Raw jitter filter enable for Self Cap scan. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 1 **0:** Disabled **1:** Enabled
4	Common Mode Filter Enable for Self-Cap[0:0]	Raw common mode filter enable for Self Cap scan. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 1 **0:** Disabled **1:** Enabled
3	Reserved[0:0]	Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0
2	IIR Filter Enable for Mutual[0:0]	Raw IIR filter enable for Mutual Cap scan. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 1 **0:** Disabled **1:** Enabled
1	Jitter Filter Enable for Mutual[0:0]	Raw jitter filter enable for Mutual Cap scan. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 1 **0:** Disabled **1:** Enabled
0	Common Mode Filter Enable for Mutual[0:0]	Raw common mode filter enable for Mutual Cap scan. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 1 **0:** Disabled **1:** Enabled

12.2.180 [Raw Processing] FILT_IIR_COEFF_MUT

[TTHE Group] Register Name : Address

[Raw Processing] FILT_IIR_COEFF_MUT : 0x0166

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:00h							RW:0h
Bit Name	Reserved[7:1]							IIR Filter Input Weight

Raw IIR Filter Coefficient for Mutual-Cap Mode

Bits	Name	Description
7:1	Reserved[6:0]	Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0
0	IIR Filter Input Weight[0:0]	Raw IIR filter coefficient for Mutual Cap scan. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0 **0:** One Half **1:** One Quarter

12.2.181 [Raw Processing] FILT_IIR_THRESHOLD_MUT

[TTHE Group] Register Name : Address

[Raw Processing] FILT_IIR_THRESHOLD_MUT : 0x0167

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:0ah							
Bit Name	Threshold[7:0]							

Raw Adaptive IIR Filter Threshold for Mutual-Cap Mode

Bits	Name	Description
7:0	Threshold[7:0]	Mutual Cap scan raw IIR filter threshold above which the difference in current and previous raw values is not filtered. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-127 Default: 10

12.2.182 [Raw Processing] FILT_IIR_COEFF_SELF

[TTHE Group] Register Name : Address

[Raw Processing] FILT_IIR_COEFF_SELF : 0x0168

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:00h							RW:1h
Bit Name	Reserved[7:1]							IIR Filter Input Weight

Raw IIR Filter Coefficient for Self-Cap Mode

Bits	Name	Description
7:1	Reserved[6:0]	Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0
0	IIR Filter Input Weight[0:0]	Raw IIR filter coefficient for Self Cap scan. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 1 **0:** One Half **1:** One Quarter

12.2.183 [Raw Processing] FILT_IIR_THRESHOLD_SELF

[TTHE Group] Register Name : Address

[Raw Processing] FILT_IIR_THRESHOLD_SELF : 0x0169

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:0ah							
Bit Name	Threshold[7:0]							

Raw Adaptive IIR Filter Threshold for Self-Cap Mode

Bits	Name	Description
7:0	Threshold[7:0]	Self Cap scan raw IIR filter threshold above which the difference in current and previous raw values is not filtered. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-127 Default: 10

12.2.184 [Raw Processing] FILT_IIR_COEFF_BAL

[TTHE Group] Register Name : Address

[Raw Processing] FILT_IIR_COEFF_BAL : 0x016a

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:00h							RW:1h
Bit Name	Reserved[7:1]							IIR Filter Input Weight

Raw IIR Filter Coefficient for Balanced Mode

Bits	Name	Description
7:1	Reserved[6:0]	Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0
0	IIR Filter Input Weight[0:0]	Raw IIR filter coefficient for Balanced scan. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 1 **0:** One Half **1:** One Quarter

12.2.185 [Raw Processing] FILT_IIR_THRESHOLD_BAL

[TTHE Group] Register Name : Address

[Raw Processing] FILT_IIR_THRESHOLD_BAL : 0x016b

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:14h							
Bit Name	Threshold[7:0]							

Raw Adaptive IIR Filter Threshold for Balanced Mode

Bits	Name	Description
7:0	Threshold[7:0]	Balanced scan raw IIR filter threshold above which the difference in current and previous raw values is not filtered. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-127 Default: 20

12.2.186 [Raw Processing] FILT_IIR_COEFF_BUT

[TTHE Group] Register Name : Address

[Raw Processing] FILT_IIR_COEFF_BUT : 0x016c

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:00h							RW:1h
Bit Name	Reserved[7:1]							IIR Filter Input Weight

Raw IIR Filter Coefficient for Buttons Mode

Bits	Name	Description
7:1	Reserved[6:0]	Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0
0	IIR Filter Input Weight[0:0]	Raw IIR filter coefficient for CapSense Buttons. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 1 **0:** One Half **1:** One Quarter

12.2.187 [Raw Processing] FILT_IIR_THRESHOLD_BUT

[TTHE Group] Register Name : Address

[Raw Processing] FILT_IIR_THRESHOLD_BUT : 0x016d

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:14h							
Bit Name	Threshold[7:0]							

Raw Adaptive IIR Filter Threshold for Buttons Mode

Bits	Name	Description
7:0	Threshold[7:0]	CapSense Buttons raw IIR filter threshold above which the difference in current and previous raw values is not filtered. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-127 Default: 20

12.2.188 [Raw Processing] FILT_CMF_THRESHOLD_MUT

[TTHE Group] Register Name : Address

[Raw Processing] FILT_CMF_THRESHOLD_MUT : 0x016e

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:28h							
Bit Name	Threshold[7:0]							

Raw Adaptive CMF Filter Threshold for Mutual Mode

Bits	Name	Description
7:0	Threshold[7:0]	Common-mode filter threshold for Mutual Cap scan (0 = Disable). Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-255 Default: 40

12.2.189 [Charger Armor] CAFILT_FILTER_MASK

[TTHE Group] Register Name : Address

[Charger Armor] CAFILT_FILTER_MASK : 0x0170

Bits	15	14	13	12	11	10	9	8
Access:POR	RW:0h	RW:1h	RW:1h	RW:1h	RW:0h			
Bit Name	Reserved	IIR Filter Enable for Buttons	Jitter Filter Enable for Buttons	Common Mode Filter Enable for Buttons	Reserved[11:8]			

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:00h					RW:1h	RW:1h	RW:1h
Bit Name	Reserved[7:3]					IIR Filter Enable for Mutual	Jitter Filter Enable for Mutual	Common Mode Filter Enable for Mutual

Charger Armor Raw Filter Mask

Bits	Name	Description
15	Reserved[0:0]	Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0
14	IIR Filter Enable for Buttons[0:0]	Charger Armor raw IIR filter enable for CapSense Buttons. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 1 **0:** Disabled **1:** Enabled
13	Jitter Filter Enable for Buttons[0:0]	Charger Armor raw jitter filter enable for CapSense Buttons. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 1 **0:** Disabled **1:** Enabled
12	Common Mode Filter Enable for Buttons[0:0]	Charger Armor raw common mode filter enable for CapSense Buttons. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 1 **0:** Disabled **1:** Enabled
11:3	Reserved[8:0]	Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0
2	IIR Filter Enable for Mutual[0:0]	Charger Armor raw IIR filter enable for Mutual Cap scan. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 1 **0:** Disabled **1:** Enabled

12.2.189 [Charger Armor] CAFILT_FILTER_MASK (continued)

1	Jitter Filter Enable for Mutual[0:0]	Charger Armor raw jitter filter enable for Mutual Cap scan. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 1 **0:** Disabled **1:** Enabled
0	Common Mode Filter Enable for Mutual[0:0]	Charger Armor raw common mode filter enable for Mutual Cap scan. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 1 **0:** Disabled **1:** Enabled

12.2.190 [Charger Armor] CAFILT_IIR_COEFF_MUT

[TTHE Group] Register Name : Address

[Charger Armor] CAFILT_IIR_COEFF_MUT : 0x0172

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:00h							RW:1h
Bit Name	Reserved[7:1]							IIR Filter Input Weight

Charger Armor Raw IIR Filter Coefficient for Mutual-Cap Mode

Bits	Name	Description
7:1	Reserved[6:0]	Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0
0	IIR Filter Input Weight[0:0]	Charger Armor raw IIR filter coefficient for Mutual Cap scan. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 1 **0:** One Half **1:** One Quarter

12.2.191 [Charger Armor] CAFILT_IIR_THRESHOLD_MUT

[TTHE Group] Register Name : Address

[Charger Armor] CAFILT_IIR_THRESHOLD_MUT : 0x0173

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:14h							
Bit Name	Threshold[7:0]							

Charger Armor Raw Adaptive IIR Filter Threshold for Mutual-Cap Mode

Bits	Name	Description
7:0	Threshold[7:0]	Charger Armor Mutual Cap scan raw IIR filter threshold above which the difference in current and previous raw values is not filtered. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-127 Default: 20

12.2.192 [Charger Armor] CAFILT_IIR_COEFF_BUT

[TTHE Group] Register Name : Address

[Charger Armor] CAFILT_IIR_COEFF_BUT : 0x0178

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:00h							RW:1h
Bit Name	Reserved[7:1]							IIR Filter Input Weight

Charger Armor Raw IIR Filter Coefficient for Buttons Mode

Bits	Name	Description
7:1	Reserved[6:0]	Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0
0	IIR Filter Input Weight[0:0]	Charger Armor raw IIR filter coefficient for CapSense Buttons. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 1 **0:** One Half **1:** One Quarter

12.2.193 [Charger Armor] CAFILT_IIR_THRESHOLD_BUT

[TTHE Group] Register Name : Address

[Charger Armor] CAFILT_IIR_THRESHOLD_BUT : 0x0179

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:14h							
Bit Name	Threshold[7:0]							

Charger Armor Raw Adaptive IIR Filter Threshold for Buttons Mode

Bits	Name	Description
7:0	Threshold[7:0]	Charger Armor CapSense Buttons raw IIR filter threshold above which the difference in current and previous raw values is not filtered. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-127 Default: 20

12.2.194 [Charger Armor] CAFILT_CMF_THRESHOLD_MUT

[TTHE Group] Register Name : Address

[Charger Armor] CAFILT_CMF_THRESHOLD_MUT : 0x017a

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:3ch							
Bit Name	Threshold[7:0]							

Raw Adaptive CMF Filter Threshold for Mutual Mode

Bits	Name	Description
7:0	Threshold[7:0]	Charger Armor Common-mode filter threshold for Mutual Cap scan (0 = Disable). Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-255 Default: 60

12.2.195 [Raw Processing] BL_DELAY_MUT

[TTHE Group] Register Name : Address

[Raw Processing] BL_DELAY_MUT : 0x0188

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:05h							
Bit Name	Reset Delay[7:0]							

Mutual Capacitance Baseline Reset Delay

Bits	Name	Description
7:0	Reset Delay[7:0]	Mutual Cap scan baseline reset delay (in refresh cycles). Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-255 Default: 5

12.2.196 [Raw Processing] BL_DELAY_SELF

[TTHE Group] Register Name : Address

[Raw Processing] BL_DELAY_SELF : 0x0189

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:05h							
Bit Name	Reset Delay[7:0]							

Self Capacitance Baseline Reset Delay

Bits	Name	Description
7:0	Reset Delay[7:0]	Self Cap scan baseline reset delay (in refresh cycles). Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-255 Default: 5

12.2.197 [Raw Processing] BL_DELAY_BAL

[TTHE Group] Register Name : Address

[Raw Processing] BL_DELAY_BAL : 0x018a

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:14h							
Bit Name	Reset Delay[7:0]							

Balanced Baseline Reset Delay

Bits	Name	Description
7:0	Reset Delay[7:0]	Balanced capacitance baseline reset delay (in refresh cycles). Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-255 Default: 20

12.2.198 [Raw Processing] BL_DELAY_BTN

[TTHE Group] Register Name : Address

[Raw Processing] BL_DELAY_BTN : 0x018b

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:03h							
Bit Name	Reset Delay[7:0]							

Button Baseline Update Delay

Bits	Name	Description
7:0	Reset Delay[7:0]	CapSense Buttons baseline reset delay (in refresh cycles). Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-255 Default: 3

12.2.199 [Raw Processing] MUT_SIG_THRESH

[TTHE Group] Register Name : Address

[Raw Processing] MUT_SIG_THRESH : 0x018c

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:0fh							
Bit Name	Threshold[7:0]							

Mutual Capacitance Signal Threshold to Reset a Mutual Capacitance Delay Timer

Bits	Name	Description
7:0	Threshold[7:0]	Mutual Cap signal threshold to reset the Mutual Cap baseline when Charger Armor is not active. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-255 Default: 15

12.2.200 [Raw Processing] SELF_SIG_THRESH

[TTHE Group] Register Name : Address

[Raw Processing] SELF_SIG_THRESH : 0x018d

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:0ah							
Bit Name	Threshold[7:0]							

Self Capacitance Signal Threshold to Reset a Self Capacitance Delay Timer

Bits	Name	Description
7:0	Threshold[7:0]	Self Cap signal threshold to reset the Self Cap baseline. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-255 Default: 10

12.2.201 [Raw Processing] BAL_SIG_THRESH

[TTHE Group] Register Name : Address

[Raw Processing] BAL_SIG_THRESH : 0x018e

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:0ah							
Bit Name	Threshold[7:0]							

Balanced Capacitance Signal Threshold to Reset a Balanced Capacitance Delay Timer

Bits	Name	Description
7:0	Threshold[7:0]	Balanced Capacitance Signal Threshold. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-255 Default: 10

12.2.202 [Raw Processing] BUTTON_SIG_THRESH_MUT

[TTHE Group] Register Name : Address

[Raw Processing] BUTTON_SIG_THRESH_MUT : 0x018f

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:0ah							
Bit Name	Threshold[7:0]							

Button Mutual Capacitance Signal Threshold to Reset a Button Capacitance Delay Timer

Bits	Name	Description
7:0	Threshold[7:0]	CapSense Button Mutual Cap signal threshold to reset the Mutual Cap baseline when Charger Armor is not active. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-255 Default: 10

12.2.203 [Raw Processing] BUTTON_SIG_THRESH_SELF

[TTHE Group] Register Name : Address

[Raw Processing] BUTTON_SIG_THRESH_SELF : 0x0190

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:0ah							
Bit Name	Threshold[7:0]							

Button Self Capacitance Signal Threshold to Reset a Button Capacitance Delay Timer

Bits	Name	Description
7:0	Threshold[7:0]	CapSense Button Self Cap signal threshold to reset the Self Cap baseline when Charger Armor is not active. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-255 Default: 10

12.2.204 [Charger Armor] CA_MUT_SIG_THRESHOLD

[TTHE Group] Register Name : Address

[Charger Armor] CA_MUT_SIG_THRESHOLD : 0x0191

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:05h							
Bit Name	Threshold[7:0]							

Mutual Capacitance Signal Threshold to Reset a Mutual Capacitance Delay Timer in the presence of charger noise (Charger Armor noise level 2)

Bits	Name	Description
7:0	Threshold[7:0]	Mutual Capacitance Signal Threshold to Reset the Mutual Cap baseline when Charger Armor is active (noise level 2 or above). Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-255 Default: 5

12.2.205 [Raw Processing] BL_FILT_MUT

[TTHE Group] Register Name : Address

[Raw Processing] BL_FILT_MUT : 0x0192

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:0ah					RW:0h		
Bit Name	Spike Rejection Threshold[7:3]					Additional Samples[2:0]		

Baseline filter settings for Mutual Cap scan

Bits	Name	Description
7:3	Spike Rejection Threshold[4:0]	Sample collection for baseline reset is restarted if any sample deviates from the average by more than this threshold. 31 - indicates no spike rejection. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-31 Default: 10
2:0	Additional Samples[2:0]	Number of additional samples to average for baseline. 0 = no baseline filter. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-7 Default: 0

12.2.206 [Raw Processing] BL_FILT_SELF

[TTHE Group] Register Name : Address

[Raw Processing] BL_FILT_SELF : 0x0193

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:0ah					RW:0h		
Bit Name	Spike Rejection Threshold[7:3]					Additional Samples[2:0]		

Baseline filter settings for Self Cap scan

Bits	Name	Description
7:3	Spike Rejection Threshold[4:0]	Sample collection for baseline reset is restarted if any sample deviates from the average by more than this threshold. 31 - indicates no spike rejection. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-31 Default: 10
2:0	Additional Samples[2:0]	Number of additional samples to average for baseline. 0 = no baseline filter. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-7 Default: 0

12.2.207 [Raw Processing] BL_FILT_BAL

[TTHE Group] Register Name : Address

[Raw Processing] BL_FILT_BAL : 0x0194

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:0ah					RW:0h		
Bit Name	Spike Rejection Threshold[7:3]					Additional Samples[2:0]		

Baseline filter settings for Balanced Capacitance

Bits	Name	Description
7:3	Spike Rejection Threshold[4:0]	Sample collection for baseline reset is restarted if any sample deviates from the average by more than this threshold. 31 - indicates no spike rejection. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-31 Default: 10
2:0	Additional Samples[2:0]	Number of additional samples to average for baseline. 0 = no baseline filter. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-7 Default: 0

12.2.208 [Raw Processing] BL_FILT_BTN_MUT

[TTHE Group] Register Name : Address

[Raw Processing] BL_FILT_BTN_MUT : 0x0195

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:0ah					RW:0h		
Bit Name	Spike Rejection Threshold[7:3]					Additional Samples[2:0]		

Baseline filter settings for CapSense Button Mutual Cap scan

Bits	Name	Description
7:3	Spike Rejection Threshold[4:0]	Sample collection for baseline reset is restarted if any sample deviates from the average by more than this threshold. 31 - indicates no spike rejection. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-31 Default: 10
2:0	Additional Samples[2:0]	Number of additional samples to average for baseline. 0 = no baseline filter. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-7 Default: 0

12.2.209 [Raw Processing] BL_FILT_BTN_SELF

[TTHE Group] Register Name : Address

[Raw Processing] BL_FILT_BTN_SELF : 0x0196

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:0ah					RW:0h		
Bit Name	Spike Rejection Threshold[7:3]					Additional Samples[2:0]		

Baseline filter settings for CapSense Button Self Cap scan

Bits	Name	Description
7:3	Spike Rejection Threshold[4:0]	Sample collection for baseline reset is restarted if any sample deviates from the average by more than this threshold. 31 - indicates no spike rejection. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-31 Default: 10
2:0	Additional Samples[2:0]	Number of additional samples to average for baseline. 0 = no baseline filter. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-7 Default: 0

12.2.210 [Raw Processing] CMF_THR_SELF

[TTHE Group] Register Name : Address

[Raw Processing] CMF_THR_SELF : 0x0197

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:78h							
Bit Name	Threshold[7:0]							

Common Mode Filter Threshold for Self Capacitance (0 = Disable, 255=Unlimited)

Bits	Name	Description
7:0	Threshold[7:0]	Common-mode filter threshold for Self Cap scan (0 = Disable, 255=Unlimited). Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-255 Default: 120

12.2.211 [Raw Processing] CMF_THR_BAL

[TTHE Group] Register Name : Address

[Raw Processing] CMF_THR_BAL : 0x0198

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:0ch							
Bit Name	Threshold[7:0]							

Common Mode Filter Threshold for Balanced Capacitance (0 = Disable, 255=Unlimited)

Bits	Name	Description
7:0	Threshold[7:0]	Common Mode Filter Threshold for Balanced Capacitance (0 = Disable, 255=Unlimited). Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-255 Default: 12

12.2.212 [Raw Processing] CMF_THR_BTN_MUT

[TTHE Group] Register Name : Address

[Raw Processing] CMF_THR_BTN_MUT : 0x0199

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:0ch							
Bit Name	Threshold[7:0]							

Common Mode Filter Threshold for Button Mutual Capacitance (0 = Disable, 255=Unlimited)

Bits	Name	Description
7:0	Threshold[7:0]	Common-mode filter threshold for CapSense Button Mutual Cap scan (0 = Disable, 255=Unlimited). Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-255 Default: 12

12.2.213 [Raw Processing] CMF_THR_BTN_SELF

[TTHE Group] Register Name : Address

[Raw Processing] CMF_THR_BTN_SELF : 0x019a

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:0ch							
Bit Name	Threshold[7:0]							

Common Mode Filter Threshold for Button Self Capacitance (0 = Disable, 255=Unlimited)

Bits	Name	Description
7:0	Threshold[7:0]	Common-mode filter threshold for CapSense Button Self Cap scan (0 = Disable, 255=Unlimited). Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-255 Default: 12

12.2.214 [Scan Filtering] BL_H20_RJCT

[TTHE Group] Register Name : Address

[Scan Filtering] BL_H20_RJCT : 0x01a4

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:00h							RW:1h
Bit Name	Reserved[7:1]							H2O Reject

Water Rejection Enable

Bits	Name	Description
7:1	Reserved[6:0]	Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0
0	H2O Reject[0:0]	Water Rejection enable. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 1 **0:** Disabled **1:** Enabled

12.2.215 [Scan Filtering] H2O_REJECTION_SNS_WIDTH

[TTHE Group] Register Name : Address

[Scan Filtering] H2O_REJECTION_SNS_WIDTH : 0x01a5

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:00h							
Bit Name	Threshold[7:0]							

Sensor Width for Water Rejection (Maximum value is 7)

Bits	Name	Description
7:0	Threshold[7:0]	Sensor width for Water Rejection (Maximum value is 7). Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-7 Default: 0

12.2.216 [CDC] EXT_CTRL

[TTHE Group] Register Name : Address

[CDC] EXT_CTRL : 0x01b0

Bits	31	30	29	28	27	26	25	24
Access:POR	RW:00h							
Bit Name	Reserved[31:24]							

Bits	23	22	21	20	19	18	17	16
Access:POR	RW:0h				RW:0h			
Bit Name	PHASE_ADJ[23:20]				FREQ_ADJ[19:16]			

Bits	15	14	13	12	11	10	9	8
Access:POR	RW:00h						RW:0h	RW:0h
Bit Name	Reserved[15:10]						RS_EN	Re-served[8:8]

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:00h					RW:0h	RW:0h	RW:0h
Bit Name	Reserved[7:3]					POLARITY	START_ENABLED	REJ_ENABLED

External events control

Bits	Name	Description
31:24	Reserved[7:0]	Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0
23:20	PHASE_ADJ[3:0]	Phase based adjustment is expressed as a fraction selection. When 0, the deviation has no effect; i.e. no adjustment is performed. When 1, the deviation has a complete and immediate effect; i.e. the complete deviation. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0 **0:** 0x **1:** 0.125x **2:** 0.250x **3:** 0.325x **4:** 0.500x **5:** 0.625x **6:** 0.750x **7:** 0.875x **8:** 1.000x
19:16	FREQ_ADJ[3:0]	Frequency based adjustment is expressed as a fraction selection. When 0, the deviation has no effect; i.e. no adjustment is performed. When 1, the deviation has a complete and immediate effect; i.e. the complete deviation. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0

12.2.216 [CDC] EXT_CTRL (continued)

		0: 0x **1:** 0.125x **2:** 0.250x **3:** 0.325x **4:** 0.500x **5:** 0.625x **6:** 0.750x **7:** 0.875x **8:** 1.000x
15:10	Reserved[5:0]	Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0
9	RS_EN[0:0]	Locking/"repeated start" enable field. When 1, locking is enabled. When 0, locking is disabled, and "ext_start" equals the preliminary "ext_start". This field allows the design to bypass the locking/"repeated start" step for debug purposes. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0 **0:** Disabled **1:** Enabled
8:3	Reserved[5:0]	Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0
2	POLARITY[0:0]	Input signal (see SRC_SEL) polarity (used for both the rejection and start events). When POLARITY is 0, "ext_start_rej" is considered active when 1. When POLARITY is 1, "ext_start_rej" is considered active when 0. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0 **0:** NORMAL **1:** INVERTED
1	START_ENABLED[0:0]	Start Event Enable. The start event is derived from the SRC_SEL specified chip input signal. Note REJ_ENABLED and START_ENABLED are mutually exclusive. If this field is 0, no final start signal is derived, however, the preliminary external start signal (result of the first pulse qualification step) is still derived and used as interrupt cause INTR.EXT_START. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0 **0:** Disabled **1:** Enabled
0	REJ_ENABLED[0:0]	Reject Event Enable. REJ_ENABLED and START_ENABLED are mutually exclusive. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0 **0:** Disabled **1:** Enabled

12.2.217 [CDC] EXT_CTRL2

[TTHE Group] Register Name : Address

[CDC] EXT_CTRL2 : 0x01b4

Bits	31	30	29	28	27	26	25	24
Access:POR	RW:00h							
Bit Name	DEACT_RANGE[31:24]							

Bits	23	22	21	20	19	18	17	16
Access:POR	RW:00h							
Bit Name	DEACT_RANGE[23:16]							

Bits	15	14	13	12	11	10	9	8
Access:POR	RW:00h							
Bit Name	ACT_RANGE[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:00h							
Bit Name	ACT_RANGE[7:0]							

External events control 2

Bits	Name	Description
31:16	DEACT_RANGE[15:0]	De-activation range in cycles (minus 1): amount of consecutive cycles the "ext_start"rej" signal should be inactive before the signal is considered de-activated. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-65535 Default: 0
15:0	ACT_RANGE[15:0]	Activation range in cycles (minus 1): amount of consecutive cycles the "ext_start_rej" signal should be active, before the signal is considered activated and a preliminary event is generated. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-65535 Default: 0

12.2.218 [CDC] EXT_CTRL3

[TTHE Group] Register Name : Address

[CDC] EXT_CTRL3 : 0x01b8

Bits	31	30	29	28	27	26	25	24
Access:POR	RW:00h							
Bit Name	Reserved[31:24]							

Bits	23	22	21	20	19	18	17	16
Access:POR	RW:0h				RW:0h			
Bit Name	Reserved[23:20]				PERIOD[19:16]			

Bits	15	14	13	12	11	10	9	8
Access:POR	RW:00h							
Bit Name	PERIOD[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:01h							
Bit Name	PERIOD[7:0]							

CDC External Control 3

Bits	Name	Description
31:20	Reserved[11:0]	Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0
19:0	PERIOD[19:0]	Only applicable to start event. Expected delay between preliminary start events in IP clock cycles. The following constraint applies: PERIOD > 4*EXT_CTL4.DET_DELTA. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 1-1048575 Default: 1

12.2.219 [CDC] EXT_CTRL4

[TTHE Group] Register Name : Address

[CDC] EXT_CTRL4 : 0x01bc

Bits	31	30	29	28	27	26	25	24
Access:POR	RW:00h							
Bit Name	DET_MISS_MIN[31:24]							

Bits	23	22	21	20	19	18	17	16
Access:POR	RW:00h							
Bit Name	DET_HIT_MIN[23:16]							

Bits	15	14	13	12	11	10	9	8
Access:POR	RW:00h							
Bit Name	DET_DELTA[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:01h							
Bit Name	DET_DELTA[7:0]							

CDC External Control 4

Bits	Name	Description
31:24	DET_MISS_MIN[7:0]	Minimum amount of successively miss-detected preliminary start events (minus 1) for the "repeated start" logic to unlock. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-254 Default: 0
23:16	DET_HIT_MIN[7:0]	Minimum amount of successively detected preliminary start events (minus 1) for the "repeated start" logic to lock. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-254 Default: 0
15:0	DET_DELTA[15:0]	Defines an interval +/-DET_DELTA in IP clock cycles. This interval restricts the time frame in which preliminary start events are detected. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 1-65535 Default: 1

12.2.220 [CDC] EXT_CTRL5

[TTHE Group] Register Name : Address

[CDC] EXT_CTRL5 : 0x01c0

Bits	31	30	29	28	27	26	25	24
Access:POR	RW:00h							
Bit Name	Reserved[31:24]							
Bits	**23**	**22**	**21**	**20**	**19**	**18**	**17**	**16**
Access:POR	RW:0h				RW:0h			
Bit Name	Reserved[23:20]				DELAY[19:16]			
Bits	**15**	**14**	**13**	**12**	**11**	**10**	**9**	**8**
Access:POR	RW:00h							
Bit Name	DELAY[15:8]							
Bits	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
Access:POR	RW:00h							
Bit Name	DELAY[7:0]							

CDC External Control 5

Bits	Name	Description
31:20	Reserved[11:0]	Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0
19:0	DELAY[19:0]	Delay between start event and final start event in clock cycles. Applicable to start event only. Note: must be less then EXT_CTL3.PERIOD-EXT_CTL4.DET_DELTA. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-1048575 Default: 0

12.2.221 [CDC] TX_CTRL

[TTHE Group] Register Name : Address

[CDC] TX_CTRL : 0x01d4

Bits	31	30	29	28	27	26	25	24
Access:POR	RW:1h		RW:1h	RW:1h	RW:0h	RW:0h	RW:0h	
Bit Name	Reserved[31:30]		PUMP_EN	Reserved	VDDA_EN	V5V_BYPASS	Reserved[25:24]	

Bits	23	22	21	20	19	18	17	16
Access:POR	RW:1h				RW:5h			
Bit Name	TX_DISCHARGE_TIME[23:20]				TX_RST_LVL_LO_TIME[19:16]			

Bits	15	14	13	12	11	10	9	8
Access:POR	RW:ch				RW:3h			
Bit Name	TX_RST_LVL_HI_TIME[15:12]				TX_RST_LVL_DELAY[11:8]			

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:00h							
Bit Name	Reserved[7:0]							

Sets internal TX block signal timings at 48 MHz clock. For different clock frequencies, the value scales proportionally (in brackets the amount of clock cycles on a 48 MHz clock)

Bits	Name	Description
31:30	Reserved[1:0]	Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 1
29	PUMP_EN[0:0]	Enable the TX Pump. The TX Pump must be disabled when external VCCTX supply is used. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 1 **0:** Disabled **1:** Enabled
28	Reserved[0:0]	Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 1
27	VDDA_EN[0:0]	Enable Vdda driver mode. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0 **0:** Disabled **1:** Enabled
26	V5V_BYPASS[0:0]	Connects Vswitch output to VDDA supply. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0 **0:** Disabled **1:** Enabled
25:24	Reserved[1:0]	Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0

12.2.221 [CDC] TX_CTRL (continued)

23:20	TX_DISCHARGE_TIME[3:0]	Specifies the time for the seq_tx_vcctx_m5v_dischg signal assertion (1) after TX_CTL.EN has been set to 0 in 0.5us increments. Used when TX_CTL.SEQ_SW_INIT is '0' (sequencer HW controlled TX block initialization/de-initialization). Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 1 **0:** 0.5 us (24 cycles) **1:** 1.0 us (48 cycles) **2:** 1.5 us (72 cycles) **3:** 2.0 us (96 cycles) **4:** 2.5 us (120 cycles) **5:** 3.0 us (144 cycles) **6:** 3.5 us (168 cycles) **7:** 4.0 us (192 cycles) **8:** 4.5 us (216 cycles) **9:** 5.0 us (240 cycles) **10:** 5.5 us (264 cycles) **11:** 6.0 us (288 cycles) **12:** 6.5 us (312 cycles) **13:** 7.0 us (336 cycles) **14:** 7.5 us (360 cycles) **15:** 8.0 us (384 cycles)
19:16	TX_RST_LVL_LO_TIME[3:0]	Specifies the assertion (1->0) time of the seq_rst_lvl_n pulse in us. Used when TX_CTL.SEQ_SW_INIT is 0 (sequencer HW controlled TX block initialization/de-initialization). Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 5 **0:** 0.5 us (24 cycles) **1:** 1.0 us (48 cycles) **2:** 1.5 us (72 cycles) **3:** 2.0 us (96 cycles) **4:** 2.5 us (120 cycles) **5:** 3.0 us (144 cycles) **6:** 4.0 us (192 cycles) **7:** 5.0 us (240 cycles) **8:** 6.0 us (288 cycles) **9:** 7.0 us (336 cycles) **10:** 8.0 us (384 cycles) **11:** 10.0 us (480 cycles) **12:** 15.0 us (720 cycles) **13:** 20.0 us (960 cycles) **14:** 25.0 us (1200 cycles)

12.2.221 [CDC] TX_CTRL (continued)

		15: 30.0 us (1440 cycles)
15:12	TX_RST_LVL_HI_TIME[3:0]	Specifies the time of the initial seq_rst_lvl_n deassertion (0->1) pulse in us. Used when TX_CTL.SEQ_SW_INIT is 0 (sequencer HW controlled TX block initialization/de-initialization). Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 12
		0: 1.0 us (48 cycles)
		1: 2.0 us (96 cycles)
		2: 4.0 us (192 cycles)
		3: 6.0 us (288 cycles)
		4: 8.0 us (384 cycles)
		5: 10.0 us (4800 cycles)
		6: 15.0 us (7200 cycles)
		7: 20.0 us (960 cycles)
		8: 40.0 us (1920 cycles)
		9: 60.0 us (2880 cycles)
		10: 80.0 us (3840 cycles)
		11: 100.0 us (4800 cycles)
		12: 150.0 us (7200 cycles)
		13: 250.0 us (12000 cycles)
		14: 500.0 us (24000 cycles)
		15: 1000.0 us (48000 cycles)
11:8	TX_RST_LVL_DELAY[3:0]	Specifies the time between seq_tx_rst_lvl_n deasserting (0->1) and seq_tx_rst_lvl_del_n deasserting (0->1) in us (on a 48 MHz clock reference clk_tss). It represents the time it takes for the MUXs to come out of reset. Used when TX_CTL.SEQ_SW_INIT is 0 (sequencer HW controlled TX block initialization/de-initialization). Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 3
		0: 0.5 us (24 cycles)
		1: 1.0 us (48 cycles)
		2: 1.5 us (72 cycles)
		3: 2.0 us (96 cycles)
		4: 2.5 us (120 cycles)
		5: 3.0 us (144 cycles)
		6: 4.0 us (192 cycles)
		7: 5.0 us (240 cycles)
		8: 6.0 us (288 cycles)
		9: 7.0 us (336 cycles)
		10: 8.0 us (384 cycles)
		11: 10.0 us (480 cycles)
		12: 15.0 us (720 cycles)

12.2.221 [CDC] TX_CTRL (continued)

		13: 20.0 us (960 cycles)
		14: 25.0 us (1200 cycles)
		15: 30.0 us (1440 cycles)
7:0	Reserved[7:0]	Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0

12.2.222 [CDC] TX_CTRL2

[TTHE Group] Register Name : Address

[CDC] TX_CTRL2 : 0x01d8

Bits	31	30	29	28	27	26	25	24
Access:POR	RW:00h							
Bit Name	Reserved[31:24]							

Bits	23	22	21	20	19	18	17	16
Access:POR	RW:0h		RW:0h	RW:1h	RW:0h			
Bit Name	Reserved[23:22]		PUMP_REG	PUMP_MODE	Reserved[19:16]			

Bits	15	14	13	12	11	10	9	8
Access:POR	RW:ah				RW:ah			
Bit Name	PUMP_STRENGTH_KEEP[15:12]				PUMP_STRENGTH_RAMP[11:8]			

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:fh				RW:fh			
Bit Name	DRV_STRONG[7:4]				DRV_WEAK[3:0]			

TX driver control 2

Bits	Name	Description
31:22	Reserved[9:0]	Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0
21	PUMP_REG[0:0]	Selects pump regulation Continuous/Discontinuous. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0 **0:** Continuous **1:** Discontinuous
20	PUMP_MODE[0:0]	Selects pump mode: 2x pump: supply up to 7V when Vdda is 2.65V (The TX pump output (Vcctx) in 2x mode can be approximated by Vcctx = Vdda + 2*Vdda*losses. The loss factor is approximately 0.8 to 0.9 depending on the corner of the silicon). 4x pump: supply up to 10V. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 1 **0:** 2x **1:** 4x
19:16	Reserved[3:0]	Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0
15:12	PUMP_STRENGTH_KEEP[3:0]	Pump strength after the Vcctx threshold is reached. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-10 Default: 10

12.2.222 [CDC] TX_CTRL2 (continued)

11:8	PUMP_STRENGTH_RAMP[3:0]	Pump strength before the Vcctx threshold is reached. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-10 Default: 10
7:4	DRV_STRONG[3:0]	Strong drive strength control for TX block. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-15 Default: 15
3:0	DRV_WEAK[3:0]	Weak drive strength control for TX block. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-15 Default: 15

12.2.223 [CDC] PROC_CTRL

[TTHE Group] Register Name : Address

[CDC] PROC_CTRL : 0x01dc

Bits	31	30	29	28	27	26	25	24
Access:POR	RW:0h				RW:0h		RW:0h	
Bit Name	Reserved[31:28]				SAMPLE_COMBINE[27:26]		Reserved[25:24]	

Bits	23	22	21	20	19	18	17	16
Access:POR	RW:2h				RW:0h	RW:0h	RW:0h	
Bit Name	Reserved[23:20]				SEPARATE_PHASES	BOUNDARY_IGNORE	OPCODE[17:16]	

Bits	15	14	13	12	11	10	9	8
Access:POR	RW:05h							
Bit Name	THRESHOLD[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:00h						RW:0h	
Bit Name	Reserved[7:2]						WDW_SIZE[1:0]	

ADC samples processing control

Bits	Name	Description
31:28	Reserved[3:0]	Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0
27:26	SAMPLE_COMBINE[1:0]	Datapath samples combining options. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0 **0:** Combine None **1:** Combine Odd **2:** Combine Even **3:** Pass Even
25:20	Reserved[5:0]	Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 2
19	SEPARATE_PHASES[0:0]	Enable for separate even and odd samples filtering. Enable this feature ONLY when SAMPLE_COMBINE = "Combine None". Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0 **0:** Disabled **1:** Enabled
18	BOUNDARY_IGNORE[0:0]	Boundary condition for noise filter window. Mirror to include boundary items. Drop to ignore boundary items. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0 **0:** Mirror

12.2.223 [CDC] PROC_CTRL (continued)

		1: Drop
17:16	OPCODE[1:0]	Selects Channel Engine noise filter. Noise filter is used when Charger Armor is not active. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0 **0:** Cond. Median **1:** Alternate Cond. Median **2:** Sorted FIR
15:8	THRESHOLD[7:0]	Threshold value for Channel Engine Conditional Median filter. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-255 Default: 5
7:2	Reserved[5:0]	Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0
1:0	WDW_SIZE[1:0]	Channel Engine noise filter window size. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0 **0:** 1 sample **1:** 3 samples **2:** 5 samples **3:** 7 samples

12.2.224 [CDC] PROC_WEIGHTS

[TTHE Group] Register Name : Address

[CDC] PROC_WEIGHTS : 0x01e0

Bits	31	30	29	28	27	26	25	24
Access:POR	RW:00h						RW:0h	
Bit Name	Reserved[31:26]						W6[25:24]	

Bits	23	22	21	20	19	18	17	16
Access:POR	RW:0h		RW:0h		RW:0h		RW:0h	
Bit Name	Reserved[23:22]		W5[21:20]		Reserved[19:18]		W4[17:16]	

Bits	15	14	13	12	11	10	9	8
Access:POR	RW:0h		RW:0h		RW:0h		RW:0h	
Bit Name	Reserved[15:14]		W3[13:12]		Reserved[11:10]		W2[9:8]	

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:0h		RW:0h		RW:0h		RW:0h	
Bit Name	Reserved[7:6]		W1[5:4]		Reserved[3:2]		W0[1:0]	

Sorted FIR weights

Bits	Name	Description
31:26	Reserved[5:0]	Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0
25:24	W6[1:0]	Weight for Sorted FIR sample SS6. When WDW_SIZE is less than 7, this weight should be "0". Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-3 Default: 0
23:22	Reserved[1:0]	Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0
21:20	W5[1:0]	Weight for Sorted FIR sample SS5. When WDW_SIZE is less than 5, this weight should be "0". Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-3 Default: 0
19:18	Reserved[1:0]	Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0
17:16	W4[1:0]	Weight for Sorted FIR sample SS4. When WDW_SIZE is less than 3, this weight should be "0". Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-3 Default: 0
15:14	Reserved[1:0]	Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0
13:12	W3[1:0]	Weight for Sorted FIR sample SS3. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-3 Default: 0
11:10	Reserved[1:0]	Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0

12.2.224 [CDC] PROC_WEIGHTS (continued)

9:8	W2[1:0]	Weight for Sorted FIR sample SS2. When WDW_SIZE is less than 3, this weight should be "0". Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-3 Default: 0
7:6	Reserved[1:0]	Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0
5:4	W1[1:0]	Weight for Sorted FIR sample SS1. When WDW_SIZE is less than 5, this weight should be "0". Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-3 Default: 0
3:2	Reserved[1:0]	Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0
1:0	W0[1:0]	Weight for Sorted FIR sample SS0. A weight value of 0 effectively discards the contribution of the associated sample. When WDW_SIZE is less than 7, this weight should be "0". Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-3 Default: 0

12.2.225 [CDC] REJ_CTRL

[TTHE Group] Register Name : Address

[CDC] REJ_CTRL : 0x01e4

Bits	31	30	29	28	27	26	25	24
Access:POR	RW:00h							
Bit Name	Reserved[31:24]							

Bits	23	22	21	20	19	18	17	16
Access:POR	RW:00h							
Bit Name	Reserved[23:16]							

Bits	15	14	13	12	11	10	9	8
Access:POR	RW:04h							
Bit Name	SAMPLE_COUNT[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:0h		RW:00h					
Bit Name	Reserved[7:6]		CH_COUNT[5:0]					

Amplitude limiting filter rejection control.

Bits	Name	Description
31:16	Reserved[15:0]	Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0
15:8	SAMPLE_COUNT[7:0]	Maximum number of samples that can be rejected. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-255 Default: 4
7:6	Reserved[1:0]	Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0
5:0	CH_COUNT[5:0]	Number of RX channels (minus 1) that must have their signal range exceeding the limit for a rejection to occur. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-63 Default: 0

12.2.226 [CDC] AL_CTRL

[TTHE Group] Register Name : Address

[CDC] AL_CTRL : 0x01e8

Bits	31	30	29	28	27	26	25	24
Access:POR	RW:00h							
Bit Name	Reserved[31:24]							

Bits	23	22	21	20	19	18	17	16
Access:POR	RW:00h							
Bit Name	Reserved[23:16]							

Bits	15	14	13	12	11	10	9	8
Access:POR	RW:ffh							
Bit Name	HIGHER_LIMIT[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:00h							
Bit Name	LOWER_LIMIT[7:0]							

Amplitude limiting filter level control.

Bits	Name	Description
31:16	Reserved[15:0]	Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0
15:8	HIGHER_LIMIT[7:0]	Higher limit for amplitude limiting filtering. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-255 Default: 255
7:0	LOWER_LIMIT[7:0]	Lower limit for amplitude limiting filtering. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-255 Default: 0

12.2.227 [CDC] NOISE_CTRL

[TTHE Group] Register Name : Address

[CDC] NOISE_CTRL : 0x01ec

Bits	31	30	29	28	27	26	25	24
Access:POR	RW:00h							
Bit Name	Reserved[31:24]							

Bits	23	22	21	20	19	18	17	16
Access:POR	RW:00h							
Bit Name	Reserved[23:16]							

Bits	15	14	13	12	11	10	9	8
Access:POR	RW:ffh							
Bit Name	HIGHER_LIMIT[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:00h							
Bit Name	LOWER_LIMIT[7:0]							

Noise metrics level control

Bits	Name	Description
31:16	Reserved[15:0]	Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0
15:8	HIGHER_LIMIT[7:0]	Higher limit for noise limit comparison. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-255 Default: 255
7:0	LOWER_LIMIT[7:0]	Lower limit for noise limit comparison. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-255 Default: 0

12.2.228 [CDC] INFRA_CTRL

[TTHE Group] Register Name : Address

[CDC] INFRA_CTRL : 0x01f0

Bits	31	30	29	28	27	26	25	24
Access:POR	RW:c0h							
Bit Name	Reserved[31:24]							

Bits	23	22	21	20	19	18	17	16
Access:POR	RW:0h	RW:0h			RW:0h		RW:1h	RW:1h
Bit Name	Reserved	REF_SCALE[22:20]			Reserved[19:18]		REF_AUTO_TUNE	GIDAC_LSB_CONFIG

Bits	15	14	13	12	11	10	9	8
Access:POR	RW:0h				RW:fh			
Bit Name	Reserved[15:12]				RXDAC[11:8]			

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:00h							
Bit Name	Reserved[7:0]							

INFRA control

Bits	Name	Description
31:23	Reserved[8:0]	Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 384
22:20	REF_SCALE[2:0]	ADC reference voltage option. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0 **0:** refhi: 2.3V; refmid: 1.3V; reflo:0.3V **1:** refhi: 2.62V; refmid: 1.48V; reflo:0.34V **2:** refhi: 2.94V; refmid: 1.66V; reflo:0.38V **3:** refhi: 3.14V; refmid: 1.77V; reflo:0.41V **4:** refhi: 3.36V; refmid: 1.9V; reflo:0.44V **5:** refhi: 3.92V; refmid: 2.22V; reflo:0.51V **6:** refhi: 4.28V; refmid: 2.42V; reflo:0.56V **7:** refhi: 4.71V; refmid: 2.66V; reflo:0.61V
19:18	Reserved[1:0]	Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0
17	REF_AUTO_TUNE[0:0]	Enable Reference auto tune. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 1 **0:** Disabled **1:** Enabled

12.2.228 [CDC] INFRA_CTRL (continued)

16	GIDAC_LSB_CONFIG[0:0]	Global IDAC LSB value. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 1 **0:** 160 nA **1:** 320 nA
15:12	Reserved[3:0]	Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0
11:8	RXDAC[3:0]	Self Cap scan TX voltage. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 15 **0:** 0.5V **1:** 0.6V **2:** 0.7V **3:** 0.8V **4:** 0.9V **5:** 1.0V **6:** 1.1V **7:** 1.2V **8:** 1.3V **9:** 1.4V **10:** 1.5V **11:** 1.6V **12:** 1.7V **13:** 1.8V **14:** 1.9V **15:** 2.0V
7:0	Reserved[7:0]	Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0

12.2.229 [CDC] INT_CAP_MUTUAL

[TTHE Group] Register Name : Address

[CDC] INT_CAP_MUTUAL : 0x01f4

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:1fh							
Bit Name	Integrator capacitor[7:0]							

Integrator capacitor value (in pF)

Bits	Name	Description
7:0	Integrator capacitor[7:0]	Integrator capacitor value (in pF) for Mutual Cap scan. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-31 Default: 31

12.2.230 [CDC] INT_CAP_SELF

[TTHE Group] Register Name : Address

[CDC] INT_CAP_SELF : 0x01f5

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:1fh							
Bit Name	Integrator capacitor[7:0]							

Integrator capacitor value (in pF)

Bits	Name	Description
7:0	Integrator capacitor[7:0]	Integrator capacitor value (in pF) for Self Cap scan. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-31 Default: 31

12.2.231 [CDC] INT_CAP_BUTTON_MUTUAL

[TTHE Group] Register Name : Address

[CDC] INT_CAP_BUTTON_MUTUAL : 0x01f6

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:1fh							
Bit Name	Integrator capacitor[7:0]							

Integrator capacitor value (in pF)

Bits	Name	Description
7:0	Integrator capacitor[7:0]	Integrator capacitor value (in pF) for Button Mutual Cap scan. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-31 Default: 31

12.2.232 [CDC] INT_CAP_BUTTON_SELF

[TTHE Group] Register Name : Address

[CDC] INT_CAP_BUTTON_SELF : 0x01f7

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:1fh							
Bit Name	Integrator capacitor[7:0]							

Integrator capacitor value (in pF)

Bits	Name	Description
7:0	Integrator capacitor[7:0]	Integrator capacitor value (in pF) for Button Self Cap scan. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-31 Default: 31

12.2.233 [CDC] SCALING_FACTOR_MUTUAL

[TTHE Group] Register Name : Address

[CDC] SCALING_FACTOR_MUTUAL : 0x01f8

Bits	15	14	13	12	11	10	9	8
Access:POR	RW:01h							
Bit Name	Scale Factor[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:90h							
Bit Name	Scale Factor[7:0]							

Mutual Capacitance Raw Data Scaling Factor

Bits	Name	Description
15:0	Scale Factor[15:0]	Percentage scaling factor for Mutual Cap scan. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-1000 Default: 400

12.2.234 [CDC] SCALING_FACTOR_SELF

[TTHE Group] Register Name : Address

[CDC] SCALING_FACTOR_SELF : 0x01fa

Bits	15	14	13	12	11	10	9	8
Access:POR	RW:01h							
Bit Name	Scale Factor[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:f4h							
Bit Name	Scale Factor[7:0]							

Self Capacitance Raw Data Scaling Factor

Bits	Name	Description
15:0	Scale Factor[15:0]	Percentage scaling factor for Self Cap scan. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-1000 Default: 500

12.2.235 [CDC] SCALING_FACTOR_BALANCED

[TTHE Group] Register Name : Address

[CDC] SCALING_FACTOR_BALANCED : 0x01fc

Bits	15	14	13	12	11	10	9	8
Access:POR	RW:00h							
Bit Name	Scale Factor[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:64h							
Bit Name	Scale Factor[7:0]							

Balanced Raw Data Scaling Factor

Bits	Name	Description
15:0	Scale Factor[15:0]	Percentage scaling factor for Balanced scan. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-1000 Default: 100

12.2.236 [CDC] SCALING_FACTOR_BUTTON

[TTHE Group] Register Name : Address

[CDC] SCALING_FACTOR_BUTTON : 0x01fe

Bits	15	14	13	12	11	10	9	8
Access:POR	RW:01h							
Bit Name	Scale Factor[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:2ch							
Bit Name	Scale Factor[7:0]							

CapSense Button Raw Data Scaling Factor

Bits	Name	Description
15:0	Scale Factor[15:0]	Percentage scaling factor for CapSense Buttons. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-1000 Default: 300

12.2.237 [CDC] TX_NUM

[TTHE Group] Register Name : Address

[CDC] TX_NUM : 0x0200

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:15h							
Bit Name	Number of Electrodes[7:0]							

Number of TX Electrodes

Bits	Name	Description
7:0	Number of Electrodes[7:0]	Number of TX Electrodes. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-255 Default: 21

12.2.238 [CDC] RX_NUM

[TTHE Group] Register Name : Address

[CDC] RX_NUM : 0x0201

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:0bh							
Bit Name	Number of Electrodes[7:0]							

Number of RX Electrodes

Bits	Name	Description
7:0	Number of Electrodes[7:0]	Number of RX Electrodes. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-255 Default: 11

12.2.239 [CDC] SENS_NUM

[TTHE Group] Register Name : Address

[CDC] SENS_NUM : 0x0202

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:20h							
Bit Name	Number of Electrodes[7:0]							

Total Number of Electrodes

Bits	Name	Description
7:0	Number of Electrodes[7:0]	Total Number of TX and RX Electrodes. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-255 Default: 32

12.2.240 [CDC] BUTTON_NUM

[TTHE Group] Register Name : Address

[CDC] BUTTON_NUM : 0x0203

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:04h							
Bit Name	Number of Buttons[7:0]							

Number of CapSense Buttons

Bits	Name	Description
7:0	Number of Buttons[7:0]	Total Number of CapSense Buttons. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-255 Default: 4

12.2.241 [CDC] CROSS_NUM

[TTHE Group] Register Name : Address

[CDC] CROSS_NUM : 0x0204

Bits	15	14	13	12	11	10	9	8
Access:POR	RW:00h							
Bit Name	Number of Intersections[15:8]							
Bits	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
Access:POR	RW:e7h							
Bit Name	Number of Intersections[7:0]							

Number of Sensor Crossings

Bits	Name	Description
15:0	Number of Intersections[15:0]	Number of Mutual Cap sensors. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-65535 Default: 231

12.2.242 [CDC] SLOTS_MUT

[TTHE Group] Register Name : Address

[CDC] SLOTS_MUT : 0x0206

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:01h							
Bit Name	Number of Slots[7:0]							

Number of Mutual Capacitance Slots

Bits	Name	Description
7:0	Number of Slots[7:0]	Number of Mutual Cap RX channel slots. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 1-255 Default: 1

12.2.243 [CDC] SLOTS_SELF_RX

[TTHE Group] Register Name : Address

[CDC] SLOTS_SELF_RX : 0x0207

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:01h							
Bit Name	Number of Slots[7:0]							

Number of Self Capacitance Slots (RX)

Bits	Name	Description
7:0	Number of Slots[7:0]	Number of Self Cap slots used along the RX axis. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-66 Default: 1

12.2.244 [CDC] SLOTS_SELF_TX

[TTHE Group] Register Name : Address

[CDC] SLOTS_SELF_TX : 0x0208

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:02h							
Bit Name	Number of Slots[7:0]							

Number of Self Capacitance Slots (TX)

Bits	Name	Description
7:0	Number of Slots[7:0]	Number of Self Cap slots used along the TX Axis. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-255 Default: 2

12.2.245 [CDC] SLOTS_SELF

[TTHE Group] Register Name : Address

[CDC] SLOTS_SELF : 0x0209

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:03h							
Bit Name	Number of Slots[7:0]							

Total Number of Self Capacitance Slots

Bits	Name	Description
7:0	Number of Slots[7:0]	Total Number of Self Cap slots. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-255 Default: 3

12.2.246 [CDC] TX_VOLTAGE_MUTUAL

[TTHE Group] Register Name : Address

[CDC] TX_VOLTAGE_MUTUAL : 0x020a

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:4h							
Bit Name	Voltage[3:0]							

Mutual Scanning TX Voltage

Bits	Name	Description
3:0	Voltage[3:0]	Mutual Cap scan TX Voltage. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 4 **0:** 5.0V **1:** 5.5V **2:** 6.0V **3:** 6.5V **4:** 7.0V **5:** 7.5V **6:** 8.0V **7:** 8.5V **8:** 9.0V **9:** 9.5V **10:** 10V

12.2.247 [CDC] TX_VOLTAGE_BUTTON

[TTHE Group] Register Name : Address

[CDC] TX_VOLTAGE_BUTTON : 0x020b

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:4h							
Bit Name	Voltage[3:0]							

Button Scanning TX Voltage

Bits	Name	Description
3:0	Voltage[3:0]	CapSense Button Mutual Cap scan TX Voltage. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 4 **0:** 5.0V **1:** 5.5V **2:** 6.0V **3:** 6.5V **4:** 7.0V **5:** 7.5V **6:** 8.0V **7:** 8.5V **8:** 9.0V **9:** 9.5V **10:** 10V

12.2.248 [CDC] TX_PULSES_NUM_MUTUAL

[TTHE Group] Register Name : Address

[CDC] TX_PULSES_NUM_MUTUAL : 0x020c

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:32h							
Bit Name	TX Pulses[7:0]							

Mutual Scanning Number of TX Pulses

Bits	Name	Description
7:0	TX Pulses[7:0]	Number of TX Pulses per conversion for Mutual Cap scan. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 1-255 Default: 50

12.2.249 [CDC] TX_PULSES_NUM_SELF

[TTHE Group] Register Name : Address

[CDC] TX_PULSES_NUM_SELF : 0x020d

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:64h							
Bit Name	TX Pulses[7:0]							

Self Scanning Number of TX Pulses

Bits	Name	Description
7:0	TX Pulses[7:0]	Number of TX Pulses per conversion for Self Cap scan. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 1-255 Default: 100

12.2.250 [CDC] TX_PULSES_NUM_BALANCED

[TTHE Group] Register Name : Address

[CDC] TX_PULSES_NUM_BALANCED : 0x020e

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:08h							
Bit Name	TX Pulses[7:0]							

Balanced Scanning Number of TX Pulses

Bits	Name	Description
7:0	TX Pulses[7:0]	Balanced Scanning Number of TX Pulses. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 1-255 Default: 8

12.2.251 [CDC] TX_PULSES_NUM_BUTTON_MUTUAL

[TTHE Group] Register Name : Address

[CDC] TX_PULSES_NUM_BUTTON_MUTUAL : 0x020f

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:32h							
Bit Name	TX Pulses[7:0]							

Mutual Button Scanning Number of TX Pulses

Bits	Name	Description
7:0	TX Pulses[7:0]	Number of TX Pulses per conversion for CapSense Button Mutual Cap scan. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 1-255 Default: 50

12.2.252 [CDC] TX_PULSES_NUM_BUTTON_SELF

[TTHE Group] Register Name : Address

[CDC] TX_PULSES_NUM_BUTTON_SELF : 0x0210

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:20h							
Bit Name	TX Pulses[7:0]							

Self Button Scanning Number of TX Pulses

Bits	Name	Description
7:0	TX Pulses[7:0]	Number of TX Pulses per conversion for CapSense Button Self Cap scan. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 1-255 Default: 32

12.2.253 [CDC] TX_FREQ_METHOD

[TTHE Group] Register Name : Address

[CDC] TX_FREQ_METHOD : 0x0211

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:00h						RW:0h	
Bit Name	Reserved[7:2]						Tx Frequency Change Method[1:0]	

Tx Frequency Change Method

Bits	Name	Description
7:2	Reserved[5:0]	Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0
1:0	Tx Frequency Change Method[1:0]	Integration time setting option. This option sets the RX channel integration time for each high and low TX phase. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0 **0:** Maximizing Integration Time **1:** Fixed Integration Time **2:** Limited Integration Time

12.2.254 [CDC] TX_PERIOD_MUTUAL

[TTHE Group] Register Name : Address

[CDC] TX_PERIOD_MUTUAL : 0x0212

Bits	15	14	13	12	11	10	9	8
Access:POR	RW:00h							
Bit Name	txPeriodMutual[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:3dh							
Bit Name	txPeriodMutual[7:0]							

Integration Time

Bits	Name	Description
15:0	txPeriodMutual[15:0]	Number of system clocks in each TX half period for Mutual Cap scan. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 48-510 Default: 61

12.2.255 [CDC] TX_PERIOD_SELF

[TTHE Group] Register Name : Address

[CDC] TX_PERIOD_SELF : 0x0214

Bits	15	14	13	12	11	10	9	8
Access:POR	RW:00h							
Bit Name	txPeriodSelf[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:a0h							
Bit Name	txPeriodSelf[7:0]							

Integration Time

Bits	Name	Description
15:0	txPeriodSelf[15:0]	Number of system clocks in each TX half period for Self Cap scan. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 48-510 Default: 160

12.2.256 [CDC] TX_PERIOD_BTN_MUTUAL

[TTHE Group] Register Name : Address

[CDC] TX_PERIOD_BTN_MUTUAL : 0x0216

Bits	**15**	**14**	**13**	**12**	**11**	**10**	**9**	**8**
Access:POR	RW:00h							
Bit Name	txPeriodButtonMutual[15:8]							
Bits	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
Access:POR	RW:3dh							
Bit Name	txPeriodButtonMutual[7:0]							

Number of system clocks in each TX half period for CapSense Buttons Mutual Cap scan

Bits	**Name**	**Description**
15:0	txPeriodButtonMutu-al[15:0]	Number of system clocks in each TX half period for CapSense Buttons Mutual Cap scan. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 48-510 Default: 61

12.2.257 [CDC] TX_PERIOD_BTN_SELF

[TTHE Group] Register Name : Address

[CDC] TX_PERIOD_BTN_SELF : 0x0218

Bits	15	14	13	12	11	10	9	8
Access:POR	RW:00h							
Bit Name	txPeriodButtonSelf[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:a0h							
Bit Name	txPeriodButtonSelf[7:0]							

Number of system clocks in each TX half period for CapSense Buttons Self Cap scan

Bits	Name	Description
15:0	txPeriodButtonSelf[15:0]	Number of system clocks in each TX half period for CapSense Buttons Self Cap scan. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 48-510 Default: 160

12.2.258 [CDC] TX_PERIOD_BALANCED

[TTHE Group] Register Name : Address

[CDC] TX_PERIOD_BALANCED : 0x021a

Bits	15	14	13	12	11	10	9	8
Access:POR	RW:00h							
Bit Name	txPeriodBalanced[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:a0h							
Bit Name	txPeriodBalanced[7:0]							

Number of system clocks in each TX half period for Balanced scan

Bits	Name	Description
15:0	txPeriodBalanced[15:0]	Number of system clocks in each TX half period for Balanced scan. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 48-510 Default: 160

12.2.259 [CDC] INTEGRATOR_RESET_MUTUAL

[TTHE Group] Register Name : Address

[CDC] INTEGRATOR_RESET_MUTUAL : 0x021c

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:0bh							
Bit Name	Clocks[7:0]							

Integrator Reset Time for Mutual Scan

Bits	Name	Description
7:0	Clocks[7:0]	Integrator capacitor reset time for Mutual Cap scan (in number of system clocks). Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 7-255 Default: 11

12.2.260 [CDC] INTEGRATOR_RESET_SELF

[TTHE Group] Register Name : Address

[CDC] INTEGRATOR_RESET_SELF : 0x021d

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:1fh							
Bit Name	Clocks[7:0]							

Integrator Reset Time for Self Scan

Bits	Name	Description
7:0	Clocks[7:0]	Integrator capacitor reset time for Self Cap scan (in number of system clocks). Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 7-255 Default: 31

12.2.261 [CDC] INTEGRATOR_RESET_BALANCED

[TTHE Group] Register Name : Address

[CDC] INTEGRATOR_RESET_BALANCED : 0x021e

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:1fh							
Bit Name	Clocks[7:0]							

Integrator Reset Time for Balanced Scan

Bits	Name	Description
7:0	Clocks[7:0]	Integrator capacitor reset time for Balanced scan (in number of system clocks). Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 7-255 Default: 31

12.2.262 [Charger Armor] CA_PROC_CTL_THRESHOLD

[TTHE Group] Register Name : Address

[Charger Armor] CA_PROC_CTL_THRESHOLD : 0x021f

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:00h							
Bit Name	Value[7:0]							

Threshold value for Channel Engine Conditional Median filter in Charger Armor mode

Bits	Name	Description
7:0	Value[7:0]	Threshold value for Channel Engine Conditional Median filter for Charger Armor mode. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-255 Default: 0

12.2.263 [CDC] SCANNING_MODE_BUTTON

[TTHE Group] Register Name : Address

[CDC] SCANNING_MODE_BUTTON : 0x0220

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:00h						RW:3h	
Bit Name	Reserved[7:2]						Scan Mode[1:0]	

Scanning Mode Button

Bits	Name	Description
7:2	Reserved[5:0]	Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0
1:0	Scan Mode[1:0]	Select CapSense Buttons scan type: Self, Mutual or Hybrid = Self+Mutual (Note: Hybrid = Mutual only if Water rejection is Disabled). Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 3 **1:** Self Capacitance **2:** Mutual Capacitance **3:** Hybrid

12.2.264 [CDC] RX_ATTENUATOR

[TTHE Group] Register Name : Address

[CDC] RX_ATTENUATOR : 0x0221

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:00h					RW:0h		
Bit Name	Reserved[7:3]					Ratio[2:0]		

Input Attenuator ratio

Bits	Name	Description
7:3	Reserved[4:0]	Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0
2:0	Ratio[2:0]	Input attenuation ratio. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0 **0:** 1.0 (Bypass Attenuator) **1:** 1.5 **2:** 2.0 **3:** 3.0 **4:** 4.0 **5:** 6.0 **6:** 8.0

12.2.265 [Charger Armor] DETECT_CHARGER_THRESHOLD

[TTHE Group] Register Name : Address

[Charger Armor] DETECT_CHARGER_THRESHOLD : 0x0222

Bits	15	14	13	12	11	10	9	8
Access:POR	RW:00h							
Bit Name	Value[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:3ch							
Bit Name	Value[7:0]							

Detect Charger Threshold

Bits	Name	Description
15:0	Value[15:0]	The initial noise detection threshold for Charger Armor. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-255 Default: 60

12.2.266 [Charger Armor] NM_INJ_TCH_THRESHOLD

[TTHE Group] Register Name : Address

[Charger Armor] NM_INJ_TCH_THRESHOLD : 0x0224

Bits	15	14	13	12	11	10	9	8
Access:POR	RW:00h							
Bit Name	Value[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:0fh							
Bit Name	Value[7:0]							

Frequency hopping threshold 0

Bits	Name	Description
15:0	Value[15:0]	Threshold for Noise Metric Injected Touch to indicate a frequency hop is required. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-255 Default: 15

12.2.267 [Charger Armor] WB_SATURATION_THRESHOLD

[TTHE Group] Register Name : Address

[Charger Armor] WB_SATURATION_THRESHOLD : 0x0226

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:7fh							
Bit Name	Value[7:0]							

Frequency hopping threshold (Wideband noise metric threshold)

Bits	Name	Description
7:0	Value[7:0]	Wideband Noise Metric Threshold. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-255 Default: 127

12.2.268 [Charger Armor] NMX_THOLD_PERCENT

[TTHE Group] Register Name : Address

[Charger Armor] NMX_THOLD_PERCENT : 0x0227

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:14h							
Bit Name	Value[7:0]							

NMx threshold as a percentage of the ratio between the NMx TX period and the NMi TX Period

Bits	Name	Description
7:0	Value[7:0]	NMx threshold as a percentage of the ratio between the NMx TX period and the NMi TX Period. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-100 Default: 20

12.2.269 [CDC] ATT_RESISTOR_ENABLE

[TTHE Group] Register Name : Address

[CDC] ATT_RESISTOR_ENABLE : 0x0228

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:0h		RW:0h					
Bit Name	Reserved[7:6]		Attenuator Resistor					

Enable Rx Attenuator Resistor

Bits	Name	Description
7:6	Reserved[1:0]	Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0
5	Attenuator Resistor[0:0]	Enable RX Attenuator resistor. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0 **0:** Disabled **1:** Enabled

12.2.270 [CDC] TX_PULSES_NUM_WINDOWING

[TTHE Group] Register Name : Address

[CDC] TX_PULSES_NUM_WINDOWING : 0x0229

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:00h							
Bit Name	Value[7:0]							

Number of TX Pulses per Subconverison in Windowed Scanning

Bits	Name	Description
7:0	Value[7:0]	Number of TX Pulses per Subconverison in Windowed Scanning. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0 **0:** Disabled **1:** 1 **2:** 2 **3:** 3 **4:** 4

12.2.271 [CDC] MTX_ORDER

[TTHE Group] Register Name : Address

[CDC] MTX_ORDER : 0x022a

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:04h							
Bit Name	Size[7:0]							

Multi-TX order

Bits	Name	Description
7:0	Size[7:0]	Multi-TX order. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 1-37 Default: 4

12.2.272 [Calibration] PWC_LIMIT_PERCENT_SELF

[TTHE Group] Register Name : Address

[Calibration] PWC_LIMIT_PERCENT_SELF : 0x0400

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:32h							
Bit Name	Size[7:0]							

PWC limit in percent for SelfCap mode

Bits	Name	Description
7:0	Size[7:0]	PWC limit in SelfCap mode. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 5-100 Default: 50

12.2.273 [Calibration] PWC_LIMIT_PERCENT_BUTTON_SELF

[TTHE Group] Register Name : Address

[Calibration] PWC_LIMIT_PERCENT_BUTTON_SELF : 0x0401

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:4bh							
Bit Name	Size[7:0]							

PWC limit in percent for Buttons in SelfCap mode

Bits	Name	Description
7:0	Size[7:0]	PWC limit for Buttons in SelfCap mode. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 5-100 Default: 75

12.2.274 [Stylus Tracking] STYL_SIGNAL_PROCESSINGS

[TTHE Group] Register Name : Address

[Stylus Tracking] STYL_SIGNAL_PROCESSINGS : 0x0410

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:00h					RW:1h	RW:1h	RW:1h
Bit Name	Reserved[7:3]					dynamic-SumCalc	growingFil-ter	removing-Stylu-sOnEdges

Stylus Signal Processings

Bits	Name	Description
7:3	Reserved[4:0]	Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0
2	dynamicSumCalc[0:0]	Calculation of Dynamic sum of 3x3 centroid. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 1 **0:** Disabled **1:** Enabled
1	growingFilter[0:0]	Removes Stylus if value grows too fast. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 1 **0:** Disabled **1:** Enabled
0	removingStylusOnEdg-es[0:0]	Removes Stylus when appears on the edge. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 1 **0:** Disabled **1:** Enabled

12.2.275 [Stylus Tracking] STYL_GROWING_FILTER_COEF

[TTHE Group] Register Name : Address

[Stylus Tracking] STYL_GROWING_FILTER_COEF : 0x0411

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:40h							
Bit Name	growingFiltCoef[7:0]							

Coefficient for growing filter

Bits	Name	Description
7:0	growingFiltCoef[7:0]	Coefficient for growing filter. If growing of LocMaxValue is less then (GROWING_FILTER_COEF*LocMaxValue) than su-press Stylus. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-255 Default: 64

12.2.276 [Stylus Tracking] STYL_PERIODIC_ERROR_AMPLITUDE

[TTHE Group] Register Name : Address

[Stylus Tracking] STYL_PERIODIC_ERROR_AMPLITUDE : 0x0412

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:08h							
Bit Name	periodicErrAmplitude[7:0]							

Amplitude of Periodic Error Correction

Bits	Name	Description
7:0	periodicErrAmplitude[7:0]	Amplitude of Periodic Error Correction. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-255 Default: 8

12.2.277 [Stylus Tracking] STYL_PALM_CLEARANCE

[TTHE Group] Register Name : Address

[Stylus Tracking] STYL_PALM_CLEARANCE : 0x0413

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:05h							
Bit Name	PalmClearance[7:0]							

Palm Clearance used for palm rejection

Bits	Name	Description
7:0	PalmClearance[7:0]	Palm Clearance used for palm rejection. Specifies the area around the Palm/LO where the stylus is ignored. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-255 Default: 5

12.2.278 [Stylus Tracking] STYL_MUT_LOCMAX_COEF

[TTHE Group] Register Name : Address

[Stylus Tracking] STYL_MUT_LOCMAX_COEF : 0x0414

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:41h							
Bit Name	mutLocMaxCoef[7:0]							

Coefficient for local maximum

Bits	Name	Description
7:0	mutLocMaxCoef[7:0]	Signals which are less than (localMax*mutLocMaxCoef) will be included to suma of 3x3 centroid elements to be compared with STYL_MUT_FINGER_THRESH threshold. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-255 Default: 65

12.2.279 [Stylus Tracking] STYL_MUT_Z_SCALING

[TTHE Group] Register Name : Address

[Stylus Tracking] STYL_MUT_Z_SCALING : 0x0415

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:80h							
Bit Name	mutZscaling[7:0]							

Coefficient for scaling Z value

Bits	Name	Description
7:0	mutZscaling[7:0]	Coefficient for scaling Z value. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-255 Default: 128

12.2.280 [Stylus Tracking] STYL_MUT_STYLUS_THRESH

[TTHE Group] Register Name : Address

[Stylus Tracking] STYL_MUT_STYLUS_THRESH : 0x0416

Bits	15	14	13	12	11	10	9	8
Access:POR	RW:00h							
Bit Name	mutStylusTh[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:50h							
Bit Name	mutStylusTh[7:0]							

Stylus threshold for Mutual Scan

Bits	Name	Description
15:0	mutStylusTh[15:0]	Stylus threshold for Mutual Scan. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-1000 Default: 80

12.2.281 [Stylus Tracking] STYL_MUT_FINGER_THRESH

[TTHE Group] Register Name : Address

[Stylus Tracking] STYL_MUT_FINGER_THRESH : 0x0418

Bits	15	14	13	12	11	10	9	8
Access:POR	RW:01h							
Bit Name	mutFingerTh[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:90h							
Bit Name	mutFingerTh[7:0]							

Finger threshold for Mutual Scan

Bits	Name	Description
15:0	mutFingerTh[15:0]	Finger threshold for Mutual Scan. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-1000 Default: 400

12.2.282 [Stylus Tracking] STYL_MUT_PALM_THRESH

[TTHE Group] Register Name : Address

[Stylus Tracking] STYL_MUT_PALM_THRESH : 0x041a

Bits	15	14	13	12	11	10	9	8
Access:POR	RW:01h							
Bit Name	mutPalmTh[15:8]							
Bits	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
Access:POR	RW:90h							
Bit Name	mutPalmTh[7:0]							

Palm threshold for Mutual Scan

Bits	Name	Description
15:0	mutPalmTh[15:0]	Palm threshold for Mutual Scan. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-1000 Default: 400

12.2.283 [Stylus Tracking] STYL_SUM_SIG_ON_EDGE

[TTHE Group] Register Name : Address

[Stylus Tracking] STYL_SUM_SIG_ON_EDGE : 0x041c

Bits	15	14	13	12	11	10	9	8
Access:POR	RW:00h							
Bit Name	sumDiffSignalsEdge[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:b3h							
Bit Name	sumDiffSignalsEdge[7:0]							

Parameter for virtual sensor calculation for Edges

Bits	Name	Description
15:0	sumDiffSignalsEdge[15:0]	Used for virtual sensor calculation for Edges. Means average value of sum of Signals from stylus calculated on 3x3 centroid. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-1000 Default: 179

12.2.284 [Stylus Tracking] STYL_SUM_SIG_ON_CORNER

[TTHE Group] Register Name : Address

[Stylus Tracking] STYL_SUM_SIG_ON_CORNER : 0x041e

Bits	15	14	13	12	11	10	9	8
Access:POR	RW:00h							
Bit Name	sumDiffSignalsCorner[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:b3h							
Bit Name	sumDiffSignalsCorner[7:0]							

Parameter for virtual sensor calculation for Corners

Bits	Name	Description
15:0	sumDiffSignalsCorn-er[15:0]	Used for virtual sensor calculation for Corners. Means average value of sum of Signals from stylus calculated on 3x3 centroid. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-1000 Default: 179

12.2.285 [Stylus Tracking] STYL_TOUCH_DOWN_DEBOUNCE

[TTHE Group] Register Name : Address

[Stylus Tracking] STYL_TOUCH_DOWN_DEBOUNCE : 0x0420

Bits	15	14	13	12	11	10	9	8
Access:POR	RW:00h							
Bit Name	touchDownDebounce[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:01h							
Bit Name	touchDownDebounce[7:0]							

Number of consecutive scans before Stylus is reported in TTHE after touch down

Bits	Name	Description
15:0	touchDownDebounce[15:0]	Number of consecutive scans before Stylus is reported in TTHE after touch down. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-1000 Default: 1

12.2.286 [Stylus Tracking] STYL_LIFT_OFF_DEBOUNCE

[TTHE Group] Register Name : Address

[Stylus Tracking] STYL_LIFT_OFF_DEBOUNCE : 0x0422

Bits	15	14	13	12	11	10	9	8
Access:POR	RW:00h							
Bit Name	liftOffDebounce[15:8]							
Bits	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
Access:POR	RW:1eh							
Bit Name	liftOffDebounce[7:0]							

Number of Low Power scans after Stylus lift-off during which no object will be reported

Bits	Name	Description
15:0	liftOffDebounce[15:0]	Number of Low Power scans after Stylus lift-off during which no object will be reported. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-1000 Default: 30

12.2.287 [Stylus Tracking] STYL_ACTIVE_STYLUS_PERIOD

[TTHE Group] Register Name : Address

[Stylus Tracking] STYL_ACTIVE_STYLUS_PERIOD : 0x0424

Bits	15	14	13	12	11	10	9	8
Access:POR	RW:00h							
Bit Name	activeStylusPeriod[15:8]							
Bits	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
Access:POR	RW:32h							
Bit Name	activeStylusPeriod[7:0]							

Number of Stylus scans after which STYLUS_LIFT_OFF debounce can be applied

Bits	Name	Description
15:0	activeStylusPeriod[15:0]	Number of Stylus scans after which STYLUS_LIFT_OFF debounce can be applied. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-1000 Default: 50

12.2.288 [Stylus Tracking] STYL_ACTIVE_FINGER_PERIOD

[TTHE Group] Register Name : Address

[Stylus Tracking] STYL_ACTIVE_FINGER_PERIOD : 0x0426

Bits	15	14	13	12	11	10	9	8
Access:POR	RW:00h							
Bit Name	activeFingerPeriod[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:03h							
Bit Name	activeFingerPeriod[7:0]							

Number of scans after any but not Stylus scan during which Stylus will not be reported

Bits	Name	Description
15:0	activeFingerPeriod[15:0]	Number of scans after any but not Stylus scan during which Stylus will not be reported. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-1000 Default: 3

12.2.289 [Stylus Tracking] STYL_ACTIVE_PALM_PERIOD

[TTHE Group] Register Name : Address

[Stylus Tracking] STYL_ACTIVE_PALM_PERIOD : 0x0428

Bits	15	14	13	12	11	10	9	8
Access:POR	RW:01h							
Bit Name	activePalmPeriod[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:f4h							
Bit Name	activePalmPeriod[7:0]							

Number of scans during which Fingers will be rejected if Palm is on panel

Bits	Name	Description
15:0	activePalmPeriod[15:0]	Number of scans during which Fingers will be rejected if Palm is on panel. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-1000 Default: 500

12.2.290 [Stylus Tracking] STYL_PALM_INTERSEC_CORE_NUM

[TTHE Group] Register Name : Address

[Stylus Tracking] STYL_PALM_INTERSEC_CORE_NUM : 0x042a

Bits	15	14	13	12	11	10	9	8
Access:POR	RW:00h							
Bit Name	palmIntersecCoreNum[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:64h							
Bit Name	palmIntersecCoreNum[7:0]							

Number of activated intersections in the core region that define a Palm

Bits	Name	Description
15:0	palmIntersecCore-Num[15:0]	Number of activated intersections in the core region that define a Palm. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-1000 Default: 100

12.2.291 [Stylus Tracking] STYL_PALM_INTERSEC_EDGE_NUM

[TTHE Group] Register Name : Address

[Stylus Tracking] STYL_PALM_INTERSEC_EDGE_NUM : 0x042c

Bits	15	14	13	12	11	10	9	8
Access:POR	RW:00h							
Bit Name	palmIntersecEdgeNum[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW:0ch							
Bit Name	palmIntersecEdgeNum[7:0]							

Number of activated intersections on the all edges that define a Palm

Bits	Name	Description
15:0	palmIntersecEdge-Num[15:0]	Number of activated intersections on the all edges that define a Palm. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-1000 Default: 12

12.2.292 [Other] CONFIG_CRC

[TTHE Group] Register Name : Address

[Other] CONFIG_CRC : 0x0430

Bits	**15**	**14**	**13**	**12**	**11**	**10**	**9**	**8**
Access:POR	RW:00h							
Bit Name	CRC Check Value[15:8]							

Bits	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
Access:POR	RW:00h							
Bit Name	CRC Check Value[7:0]							

Non-volatile configuration CRC check value

Bits	**Name**	**Description**
15:0	CRC Check Value[15:0]	16-bit CRC check value corresponding to the entire configuration data set per 001-67313. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Range: 0-65535 Default: 0

Section F: Glossary

The Glossary section explains the terminology used in this technical reference manual. Glossary terms are characterized in ***bold, italic font*** throughout the text of this manual.

A

active distance	The initial pixel displacement that must be exceeded for a movement to be recognized by the TrueTouch controller.
active high	1. A logic signal having its asserted state as the logic 1 state. 2. A logic signal having the logic 1 state as the higher voltage of the two states.
active low	1. A logic signal having its asserted state as the logic 0 state. 2. A logic signal having its logic 1 state as the lower voltage of the two states: inverted logic.
address	The label or number identifying the memory location (***RAM***, ROM, or register) where a unit of information is stored.
AFH	Adaptive Frequency Hopping - a method of avoiding noise by changing the scanning frequency.
algorithm	A procedure for solving a mathematical problem in a finite number of steps that frequently involve repetition of an operation.
analog	As opposed to digital, which are signals that are on or off or ‘1’ or ‘0’. Analog signals vary in a continuous form with respect to continuous times.
asynchronous	A signal whose data is acknowledged or acted upon immediately, irrespective of any clock signal.

B

baseline	A filtered version of the raw count for a particular sensor when it is not being touched. The baseline tracks slow movements in the raw count due to temperature, supply voltage, and mechanical variations over time. It effectively subtracts slow-moving changes that are not assumed to be finger activity.
binary	The name for the base 2 numbering system. The most common numbering system is the base 10 numbering system. The base of a numbering system indicates the number of values that may exist for a particular positioning within a number for that system. For example, in base 2, binary, each position may have one of two values (0 or 1). In the base 10, decimal, each position may have one of ten values (0, 1, 2, 3, 4, 5, 6, 7, 8, and 9).
BIST	Built-In Self-Test. A mechanism that permits a machine to test itself. BIST reduces test complexity, and thereby decreases the cost and reduces reliance upon external test equipment.
bit rate (BR)	The number of bits occurring per unit of time in a bit stream, usually expressed in bits per second (bps).

bootloader A separate application that loads new firmware when instructed. This allows the firmware to be upgraded in the field by a software process.

buffer
1. A storage area for data that is used to compensate for a speed difference, when transferring data from one device to another. Usually refers to an area reserved for I/O operations into which data is read or from which data is written.
2. A portion of memory set aside to store data, often before it is sent to an external device or as it is received from an external device.
3. An amplifier used to lower the output ***impedance*** of a system.

C

capacitance A measure of the ability of two adjacent conductors, separated by an insulator, to hold a charge when a voltage differential is applied between them. Capacitance is measured in units of Farads.

capture To extract information automatically through the use of software or hardware, as opposed to hand-entering data into a computer file.

centroid A method of converting raw data counts into coordinate locations.

clear To force a bit or register to a value of logic 0.

clock The device that generates a periodic signal with a fixed frequency and duty cycle. A clock is sometimes used to synchronize different logic blocks.

communication registers The set of data exposed to the host through a communication interface. Each byte in the data set is assigned a “register address” (starting with 0) by which the host can identify the data that it needs to read or write.

configuration In a computer system, an arrangement of functional units according to their nature, number, and chief characteristics. Configuration pertains to hardware, software, firmware, and documentation. The configuration affects system performance.

D

data block A group of bytes referred to as a single entity. For example, when transmitting a number of bytes over a communication medium, the bytes transmitted may be referred to as a data block.

debounce A real-world signal is never a perfect waveform, especially on a transition. A debounce states that a signal must be in a new state for a given number of samples before the new state is recognized, similar to hysteresis.

decimal A base-10 numbering system, which uses the symbols 0, 1, 2, 3, 4, 5, 6, 7, 8 and 9 (called digits) together with the decimal point and the sign symbols + (plus) and – (minus) to represent numbers.

default value Pertaining to the predefined initial, original, or specific setting, condition, value, or action a system assumes, uses, or takes in the absence of instructions from the user.

diffcount differencecount or diffcount is the difference of raw count – baseline – CALC_THRESHOLD (default value is 5). The difference count is used to determine whether a finger is present. Difference counts are also used to resolve the precise location of the finger when it is present.

digital A signal or function, the amplitude of which is characterized by one of two discrete values: ‘0’ or ‘1’.

E

External Reset (XRES) An active low signal that is driven into the PSoC device. It causes all operation of the CPU and blocks to stop and return to a predefined state.

F

falling edge A transition from a logic 1 to a logic 0. Also known as a ***negative edge***.

field upgrade A method of updating the software after a product has been released. A field upgrade involves the application being erased and then updated while the device is located in the product potentially in the hands of the consumer.

filter Method of removing ***noise*** or other undesirable effects (ESD, EMI) from a data stream.

finger threshold A tuning parameter that controls when a finger is detected. A difference count greater than the finger threshold is recognized as a touch.

firmware The software that is embedded in a hardware device and executed by the CPU. The software may be executed by the end user but it may not be modified.

flags Any of various types of indicators used for identification of a condition or event (for example, a character that signals the termination of a transmission).

flash An electrically programmable and erasable, nonvolatile technology that provides users with the programmability and data storage of EPROMs, plus in-system erasability. Nonvolatile means that the data is retained when power is off.

frequency The number of cycles or events per unit of time, for a periodic function.

G

gain The ratio of output current, voltage, or power to input current, voltage, or power, respectively. Gain is usually expressed in dB.

generate The process of referencing all the user module parameters and producing library source files.

ground

1. The electrical neutral line having the same potential as the surrounding earth.
2. The negative side of DC power supply.
3. The reference point for an electrical system.
4. The conducting paths between an electric circuit or equipment and the earth, or some conducting body serving in place of the earth.

H

hardware A comprehensive term for all of the physical parts of a computer or embedded system, as distinguished from the data it contains or operates on, and the software that provides instructions for the hardware to accomplish tasks.

hexadecimal A base 16 numeral system (often abbreviated and called hex), usually written using the symbols 0 to 9 and A to F. It is a useful system in computers because there is an easy mapping from four bits to a single hex digit. Thus, one can represent every byte as two consecutive hexadecimal digits. Compare the binary, hex, and decimal representations:

bin	**=**	**hex**	**=**	**dec**
0000b	=	0x0	=	0
0001b	=	0x1	=	1
0010b	=	0x2	=	2
...				
1001b	=	0x9	=	9
1010b	=	0xA	=	10
1011b	=	0xB	=	11
...				
1111b	=	0xF	=	15

So the decimal numeral 79 whose binary representation is 0100 1111b can be written as 4Fh in hexadecimal (0x4F).

Host Emulator Tool for emulating functionality of a host processor, enabling validation of a TrueTouch application without having to use the actual host processor. It can also be used to determine the desired configuration parameters for a touch panel and to generate a final configuration HEX file. This enables development and debugging of the TrueTouch application in parallel with the development and debugging of the host application or host hardware.

host or host processor Processor interfacing with the TrueTouch controller that uses the TrueTouch controller's touch data to enable high-level product functionality. Typically, the host processor has more data processing capability than the TrueTouch controller. An example of a host processor is a baseband processor within a touchscreen-enabled cell phone. The host also provides power to the TrueTouch controller.

I

I^2C Inter-integrated circuit serial communications bus. I^2C is an industry standard, 2-wire (excluding GND) hardware interface developed by Philips® (now NXP). For more information on *The I^2C-Bus Specification*, see the NXP web site at www.nxp.com

IDAC Current (I) digital-to-analog converter

idle state A condition that exists whenever user messages are not being transmitted, but the service is immediately available for use.

IIR Infinite Input Response. A digital signal processing filter type.

impedance
1. The resistance to the flow of current caused by resistive, capacitive, or inductive devices in a circuit.
2. The total passive opposition offered to the flow of electric current. Note the impedance is determined by the particular combination of resistance, inductive reactance, and capacitive reactance in a given circuit.

input A point that accepts data in a device, process, or channel.

input/output (I/O) A device that introduces data into or extracts data from a system.

instruction An expression that specifies one operation and identifies its operands, if any, in a programming language such as C or assembly.

interface The means by which two systems or devices are connected and interact with each other.

interrupt — A suspension of a process, such as the execution of a computer program, caused by an event external to that process and performed in such a way that the process can be resumed.

ITO — Indium Tin Oxide. ITO is a conductive material coated on nonconductive substrates in touch-screen construction.

J

jitter

1. A misplacement of the timing of a transition from its ideal position. A typical form of corruption that occurs on serial data streams.
2. The abrupt and unwanted variations of one or more signal characteristics, such as the interval between successive pulses, the amplitude of successive cycles, or the frequency or phase of successive cycles.

L

latency — The time or delay that it takes for a signal to pass through a given circuit or network.

least-significant bit (LSbit) — The binary digit, or bit, in a binary number that represents the least-significant value (typically the right-hand bit).

least-significant byte (LSB) — The byte in a multibyte word that represents the least-significant value (typically the right-hand byte). The byte versus bit distinction is made by using an upper case "B" for byte in LSB.

lift off — An event where the number of touches detected on the touchscreen is greater on the previous scan than on the current scan.

low time — The amount of time the signal has a value of '0' in one period, for a periodic digital signal.

M

mask

1. To obscure, hide, or otherwise prevent information from being derived from a signal. It is usually the result of interaction with another signal, such as noise, static, jamming, or other forms of interference.
2. A pattern of bits that can be used to retain or suppress segments of another pattern of bits in computing and data processing systems.

master or master device — A device that controls the timing for data exchanges between two devices. Or, when devices are cascaded in width, the master device is the one that controls the timing for data exchanges between the cascaded devices and an external interface. The controlled device is called the ***slave***.

microcontroller — An integrated circuit chip that is designed primarily for control systems and products. In addition to a CPU, a microcontroller typically includes memory, timing circuits, and I/O circuitry. The reason for this is to permit the realization of a controller with a minimal quantity of chips, thus achieving maximal possible miniaturization. This, in turn, reduces the volume and the cost of the controller. The microcontroller is normally not used for general-purpose computation as is a microprocessor.

mode

1. A distinct method of operation for software or hardware. For example, the Digital PSoC block may be in either counter mode or timer mode.
2. A TrueTouch controller functionality set selection with a unique register set exposed to the host via the communications interface. TrueTouch modes include Operating and Test.

most-significant bit (MSbit) — The binary digit, or bit, in a binary number that represents the most-significant value (typically the left-hand bit).

most-significant byte (MSB) — The byte in a multi-byte word that represents the most-significant value (typically the left-hand byte).

mutual-capacitance — Capacitance between two electrodes (TX/RX). See also ***capacitance***.

N

negative edge A transition from a logic 1 to a logic 0. Also known as a ***falling edge***.

nibble A group of four bits, which is one-half of a byte.

noise
1. A disturbance that affects a signal and that may distort the information carried by the signal.
2. The random variations of one or more characteristics of any entity such as voltage, current, or data.

noise threshold A tuning parameter that controls the baseline updates. A difference count below this threshold contributes to the baseline update algorithm.

O

oscillator A circuit that may be crystal controlled and is used to generate a clock frequency.

output The electrical signal or signals which are produced by an analog or digital block.

P

parameter Characteristics for a given block that have either been characterized or may be defined by the designer.

path
1. The logical sequence of instructions executed by a computer.
2. The flow of an electrical signal through a circuit.

pin A terminal on a hardware component. Also called lead.

pinout The pin number assignment: the relation between the logical inputs and outputs of the PSoC device and their physical counterparts in the printed circuit board (PCB) package. Pinouts involves pin numbers as a link between schematic and PCB design (both being computer-generated files) and may also involve pin names.

port A port is a place where one device allows another device to interface to it over a predefined protocol; for example, USB ports or laptop docking ports. For a PSoC device, the term means a set of pins, up to eight depending on the chip pin count, which the device uses to communicate to the outside world.

positive edge A transition from a logic 0 to a logic 1. Also known as a ***rising edge***.

power management (automatic) The TrueTouch controller has three power states: active, low power, and sleep. The controller can only enter or exit sleep at the command of the host. For the other two states, there are compile-time parameters that affect the behavior. However, at run time, the TrueTouch controller manages the function of, and the transitions between, these states.

power-on reset (POR) A circuit that forces the PSoC device to reset when the voltage is below a preset level.

power state See ***power management***.

protocol A set of rules. Particularly the rules that govern networked communications.

pulse A rapid change in some characteristic of a signal (for example, phase or frequency) from a baseline value to a higher or lower value, followed by a rapid return to the baseline value.

Q

qualified ITO partner A touchscreen manufacturer qualified by Cypress to supply touchscreens that meet Cypress requirements for operation with TrueTouch controllers.

R

RAM An acronym for random-access memory. A data-storage device from which data can be read out and new data can be written in.

raw count The data conversion result for a particular sensor. Various filters are available as user module parameters to filter this signal before processing if the SNR needs improvement.

refresh interval This may also be termed the report rate. TrueTouch controllers do not wait for communication; therefore, it is up to the host to set how fast the buffer is read. Refresh interval determines how fast the TrueTouch controller can write new data to the communication buffer. This is the time taken for the TrueTouch controller to scan the panel, process the data, and update the communication buffer.

register A storage device with a specific capacity, such as a bit or byte.

refresh interval This may also be termed the report rate. Refresh interval determines how fast the TrueTouch controller can write new data to the communication buffer. This is the time taken for the TrueTouch controller to scan the panel, process the data, update the communication buffer, wait for the host communication or wait for specified interval parameter expiring, whichever is the longest.

reset A means of bringing a system back to a know state.

resistance The resistance to the flow of electric current measured in ohms for a conductor.

rising edge *See* ***positive edge***.

run time The period after a program has been loaded into the device. For example, a run-time configuration is an option that is exercised after the device is powered up.

RX A receiving electrode that receives charge through ***mutual-capacitance*** from a transmitting electrode (***TX***).

S

sampling The process of converting an analog signal into a series of digital values or reversed.

self-capacitance Capacitance between one electrode and ground. See also ***capacitance***.

serial
1. Pertaining to a process in which all events occur one after the other.
2. Pertaining to the sequential or consecutive occurrence of two or more related activities in a single device or channel.

set To force a bit or register to a value of logic 1.

shared bus A bus is a communication medium. The bus may be dedicated between just two nodes, but most buses are designed to be shared between multiple nodes. The maximum number of nodes and the method of communication is bus-protocol specific. For example, SPI has one bus master, and a number of slaves only limited by the added parasitics on the bus and the master's ability to address (enable) the slaves.

shift register A memory storage device that sequentially shifts a word either left or right to output a stream of serial data.

signal A detectable transmitted energy that can be used to carry information. As applied to electronics, any transmitted electrical impulse.

slave or slave device A device that allows another device to control the timing for data exchanges between two devices. Or when devices are cascaded in width, the slave device is the one that allows another device to control the timing of data exchanges between the cascaded devices and an external interface. The controlling device is called the master device.

software A set of computer programs, procedures, and associated documentation concerned with the operation of a data processing system (for example, compilers, library routines, manuals, and circuit diagrams). Software is often written first as source code and then converted to a binary format that is specific to the device on which the code is executed.

software reset A partial reset executed by software to bring part of the system back to a known state. A software reset restores the device to a known state. After a software reset, code execution begins at flash address 0x0000.

SPI Serial Peripheral Interface serial communications bus. SPI is an industry-standard 4-wire hardware interface (excluding GND).

stackup Layers of materials of different thicknesses in defined order that make up a touchscreen panel.

state machine The actual implementation (in hardware or software) of a function that can be considered to consist of a set of states through which it sequences.

subconversion Part of the capacitive scanning process in third-generation devices. Data is collected for each TX/RX cross-point; which is termed a "conversion." Each conversion is split into one or more subconversions, which are integrated for improved noise rejection.

synchronous

1. A signal whose data is not acknowledged or acted upon until the next active edge of a clock signal.
2. A system whose operation is synchronized by a clock signal.

T

threshold The minimum value of a signal that can be detected by the system or sensor under consideration.

TMA Designation for multi-touch all point. Cypress device part numbers containing the TMA specifier can detected up to ten fingers on a touchscreen.

touch ID Applicable to third-generation devices only. A unique ID assigned to each touch. The position of a touch in the reported array may change. However, the associated ID of the touch remains constant. The value ranges from 1 to 15. Zero is not a valid touch ID.

touch down An event where the number of touches detected on the touchscreen is less on the previous scan than on the current scan.

tuning The process of setting parameters for optimal touchscreen performance. This process differs between the various capacitive detection methods.

TX A transmitting electrode that transmits charge through ***mutual-capacitance*** to a receiving electrode (***RX***).

U

UART Acronym for Universal Asynchronous Receiver/Transmitter. UART is an industry standard serial hardware interface with a variable number of wires depending on hardware flow control implementation. The simplest implementation, which has no hardware flow control, uses two wires (excluding GND).

W

watchdog timer A timer that must be serviced periodically. If it is not serviced, the CPU resets after a specified period of time.

waveform The representation of a signal as a plot of amplitude versus time.