CYTMA445A, CYTT21X, CYTT31X

Technical Reference Manual (TRM)

Document No. 001-88195 Rev. *D

April 9, 2015

THIS DOCUMENT IS CONFIDENTIAL AND COVERED UNDER NDA

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

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

License

Copyrights

Disclaimer

Flash Code Protection

Cypress products meet the specifications contained in their particular Cypress Datasheets. Cypress believes that its family of PSoC products is one of the most secure families of its kind on the market today, regardless of how they are used. There may be methods that can breach the code protection features. Any of these methods, to our knowledge, would be dishonest and possibly illegal. Neither Cypress nor any other semiconductor manufacturer can guarantee the security of their code. Code protection does not mean that we are guaranteeing the product as "unbreakable."

Cypress is willing to work with the customer who is concerned about the integrity of their code. Code protection is constantly evolving. We at Cypress are committed to continuously improving the code protection features of our products.

Contents Overview

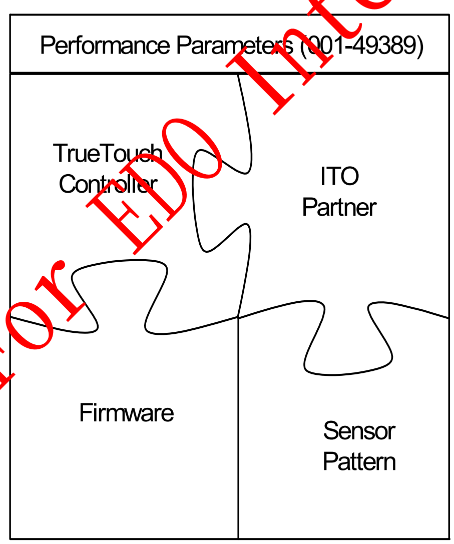
Contents

Section A: Overview

The Cypress TrueTouch® solution delivers all of the components needed to create a touchscreen solution. It includes the touchscreen device, sensor requirements, prequalification 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 1-1 illustrates the hierarchy of TrueTouch and the component dependencies that the TrueTouch 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 1-1. TrueTouch Solution



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 TrueTouch devices, sensor patterns (e.g. 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. Discusses the TrueTouch tools and at which phase of product development the tools enable quicker time-to-market using the TrueTouch device.
- **Host Interface** – Provides information regarding the interface between the TrueTouch device and host including communication protocol, device startup, bootloading, hardware connection, touch data acquisition, and command details.
- **Touchscreen System** – Includes information for power management, reading touch and button reports, and setting pin assignments.
- **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 devices and related documentation.

Related Documents

The 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 A-1. Product Specifications

Document Number	Document Title	Description
Product Specifications		
001-87143	CYTMA445A TrueTouch® Multi-Touch All-Points Touchscreen Controller Datasheet	Contains features, touchscreen performance and electrical specifications, and package information.
001-96228	CYTT21X (28, 33, 35, 36 IOs) TrueTouch® Multi-Touch All-Points Touchscreen Controller Datasheet	Contains features, touchscreen performance and electrical specifications, and package information.
001-88987	TrueTouch® CYTMA445A, CYTT21X (28, 33, 35, 36 IOs) Product Family Release Notes	Contains software requirements and known issues.
001-90992	CYTK-44 TrueTouch® Evaluation Kit User Guide	Describes how to set up and use the kit with host emulator software
001-93125	CYTK-44 TrueTouch® Evaluation Kit Quick Start Guide	Describes steps quickly set up the kit and get it running
001-93969	CYTT21X/31X TrueTouch® Multi-Touch All-Points Touchscreen Controller Datasheet	Contains features, touchscreen performance and electrical specifications, and package information.
001-96087	TrueTouch® CYTT21X/31X (40, 44, 48 IOs) Product Family Release Notes	Contains software requirements and known issues.
001-95533	CYTK-450 TrueTouch® Evaluation Kit User Guide	Describes how to set up and use the kit with host emulator software
001-95515	CYTK-450 TrueTouch® Evaluation Kit Quick Start Guide	Describes steps quickly set up the kit and get it running
001-92531	CYTMA445A and CYTT21XXX/31XXX Touchscreen Controller Tuning Best Practices	Contains tuning guidance during system development
001-85948	TrueTouch Communication Examples - Packet Interface Protocol (PIP) - AN85948	Contains information on how to create a manufacturing test suite.

Table A-2. Solution Specifications

Document Number	Document Title	Description
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

Document History

This section serves as a chronicle of the *CYTMA445A, CYTT21X, CYTT31X Technical Reference Manual*.

Table A-3. Technical Reference Manual History

Version	Originator	Description of Change
**	SWU	Initial release
*A	SWU	Supports FW Version 1.0.699946 Updated Table 6-55. Updated opens output data in Table 6-68 Section 10.1 - Updated all configurable parameters [RAM] Section 10.4 - Updated all configurable parameters [FLASH]
*B	SWU	Supports FW Version 1.0.711596 Section 8.1.1- Fixed a typo Section 9 - Updated pin mapping Section 10.4 - Updated flash map

Table A-3. Technical Reference Manual History

Version	Originator	Description of Change
*C	SWU	Supports CYTMA445A FW Version 1.0.711596 Supports CYTT21X/31X FW Version 1.0.765877 Section A-1 - Added CYTT21X/31X document references. Section 2.2 - Fixed defect that described the Inactive Drive Strength configuration setting as an I^2C or SPI setting. This setting applies to the COMM_INT pin only. Section 2.8 - Updated details for Panel ID to include multiple-pin configurations. Removed pin-specific numbers which are located in the datasheet Section 6.2.8 - Added Read Application Information command Section 6.2.9 - Added Read Application Image command Section 6.2.9 - Added Get Panel ID command Section 6.3.14 - Fixed a defect where CRC byte order was swapped in the output report. Section 6.3.15 - Fixed a defect where CRC byte order was swapped in the input report. Section 6.3.18.1 - Added additional information for a self-test summary result of 0xff. Section 6.3.19.2 - Added additional information for a self-test summary result of 0xff. Section 6.3.19.3 - Added additional information about the results returned from the Opens test and the format of button results. Fixed defect that noted IDAC calibration was returned. Updated description to explain how raw data is compared. Section 6.3.20.1 - Added a parameter to set the reference voltage used for the Shorts test. Added a note which references where to find the shorts test pin mask definitions for each device package. Added additional information for a self-test summary result of 0xff. Section 8.1.1- Added details to note that dynamic calibration checks calibration data after device reset and will perform a recalibration if data is invalid. Section 9 - Add pin assignment details for CYTT21X/31X in Figure 9-2 and Table 9-2 Section - Added manufacturing data section Section 10.2 - Added design data section Section 3.7.2 - Fixed incorrect input and output report values in Deep Sleep command. Section 6.3.20.3 - Added new Sense Mode selection to input report in Calibrate command.
*D		Supports CYTMA445A FW Version 1.0.711596 Supports CYTT21X (28, 33, 35, 36 IOs) FW Version 1.1.797879 Supports CYTT21X/31X (40, 44, 48 IOs) FW Version 1.0.797879 Added support for CYTT21X (28, 33, 35, 36 IOs) Section E - Updated definition of touch id. Table 6-2 and Table 6-3 - Updated incorrect byte range for CRC calculation. Section 4 - Added a short overview of device startup. Section 7.1 - Fixed defect in definition of tip in touch record. Section 10.1 and Section 10.2 - Moved Design data and Manufacturing data section RAM and Flash Configuration Data section. Section 6.2.3 - Updated meta-data parameters for Initiate Bootload command.

Documentation 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**]

Convention	Usage
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 Flash Configuration Data chapter on page 161.

Table 4-4. 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 4-5. 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
kΩ	kilohms
Mbps	megabits per second
MHz	megahertz
MΩ	megaohms
mA	milliamperes

Table 4-5. Units of Measure *(continued)*

Symbol	Unit of Measure
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 4-6. 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
I^2C	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
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

Table 4-6. Acronyms *(continued)*

Acronym	Description
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

1. TrueTouch Tools

The TrueTouch® Tools chapter discusses software tools used to explore applications of the TrueTouch devices. For the most up-to-date software and firmware version information, refer to the TrueTouch Product Family Release Notes (see Table A-1 on page 18). To obtain this document, contact your Cypress representative. All software, kit contents, and documentation are covered by the non-disclosure agreement (NDA) that your company has executed with Cypress.

You will find information on each of these tools in the TrueTouch Tools chapter:

1.1 CYTK-44 Evaluation Kit

The TrueTouch Evaluation Kit (EVK) is a touchscreen evaluation platform based on the Cypress CYTMA445A device. This evaluation kit includes all of the hardware and software you need to configure, optimize, and test touchscreen designs. See the *CYTK-44 EVK User Guide* (Cypress document 001-90992) or *CYTK-44 EVK Quick Start Guide* (Cypress document 001-93125), for more information about the EVK.

1.2 TrueTouch Host Emulator (TTHE)

With the 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 26) 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 CYTMA445A/CYTT21XXX/CYTT31XXX devices
- Supports either an I^2C or SPI interface between the TrueTouch Bridge and the controller
- Supports mobile tuner over USB and Wi-Fi
- 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 modes.
- 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

For guidance on configuring a TTHE project with the TrueTouch device, see the products EVK User Guide, Quick Start Guide, or TrueTouch Host Emulator User Guide (see Table A-1 on page 18 and Table A-2 on page 18).

1.2.1 Mobile Tuner

The Mobile Tuner helps to configure, debug, and tune the TrueTouch device in a fully assembled end product, using either a USB or Wi-Fi interface to communicate with the target device. The ability to debug, assess noise, and tune touchscreens in their final product environment eliminates issues during production and greatly improves product quality.

Mobile Tuner is currently supported on Android platforms and will be supported on Windows platforms in the near future.

1.2.2 Registers and Parameters

1.2.2.1 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 "Manufacturing Data [RAM]" on page 137 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.

1.2.2.2 Configurable Parameters [Flash]

The configurable parameters can be changed in TTHE and saved in the device configuration. They may also be changed by the host in the Configuration and Test modes. These values are retained during reset or power off. See "Configurable Parameters[FLASH]" on page 161 for the full list of configurable parameters and the definitions.

1.3 TrueTouch Bridge (TTBridge)

The TrueTouch Bridge is the interface between TTHE and the TrueTouch 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.

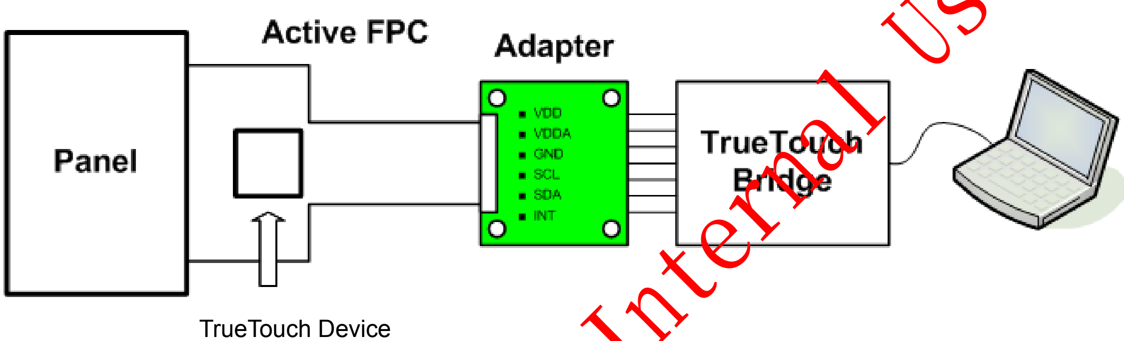
The TrueTouch Bridge supports:

- 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 TrueTouch device is connected to the TrueTouch Bridge through an adapter board.

Figure 1-1. TrueTouch Bridge Setup



1.4 Bridge Control Panel

The 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 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

1.5 TrueTouch Manufacturing Test Kit

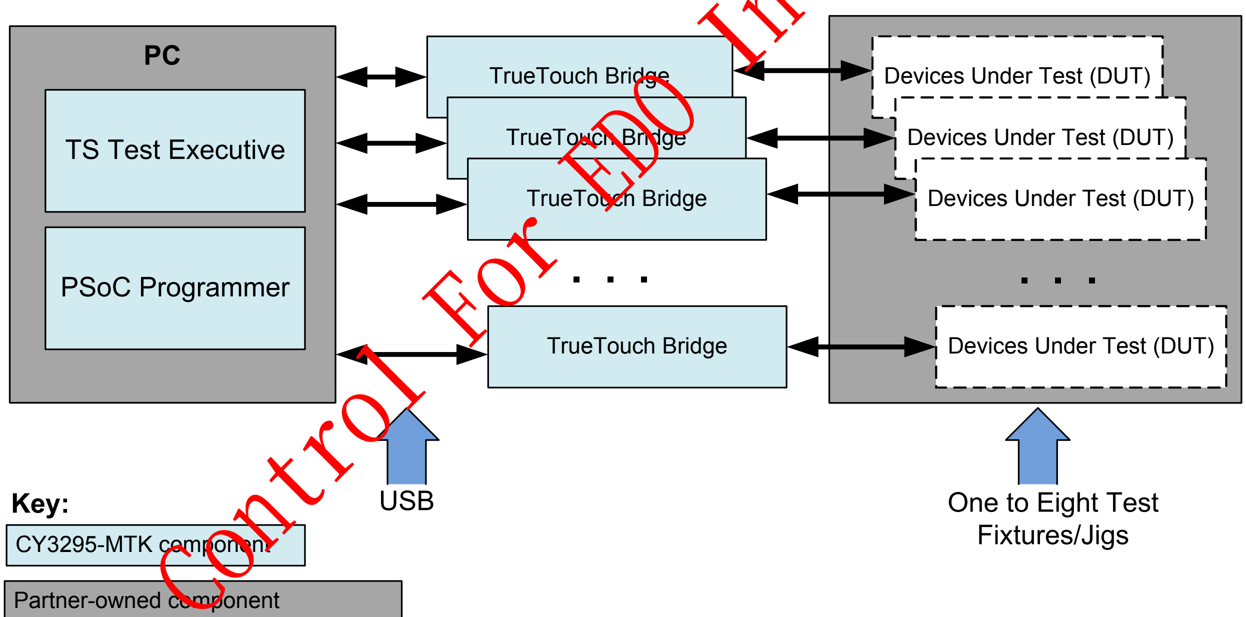
The CY3295-MTK TrueTouch Manufacturing Test Kit (MTK) increases yield and improves touchscreen quality. MTK provides customers and ITO partners the ability to test touch panels that use Cypress TrueTouch controllers. The kit consists of a Windows® PC application and the TrueTouch Bridge (see "TrueTouch Bridge (TTBridge)" on page 26), 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 1-2 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 TrueTouch Communication Examples - Packet Interface Protocol (PIP) - AN85948 (001-85948) for implementing MTK tests in the host processor software.

Figure 1-2. Manufacturing Test System Block Diagram



1.6 TrueTouch Drivers

Cypress 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.

1.6.1 TrueTouch Driver for Android (TTDA)

Cypress's TrueTouch Driver for Android (TTDA) enables developers to quickly integrate TrueTouch devices into mobile touch-screen 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, generates a Linux event with the touch signals as motion signals, and then submits the 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

1.6.2 TrueTouch Driver for Windows (TTDW)

The 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 Windows Phone 8. 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 B: 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:

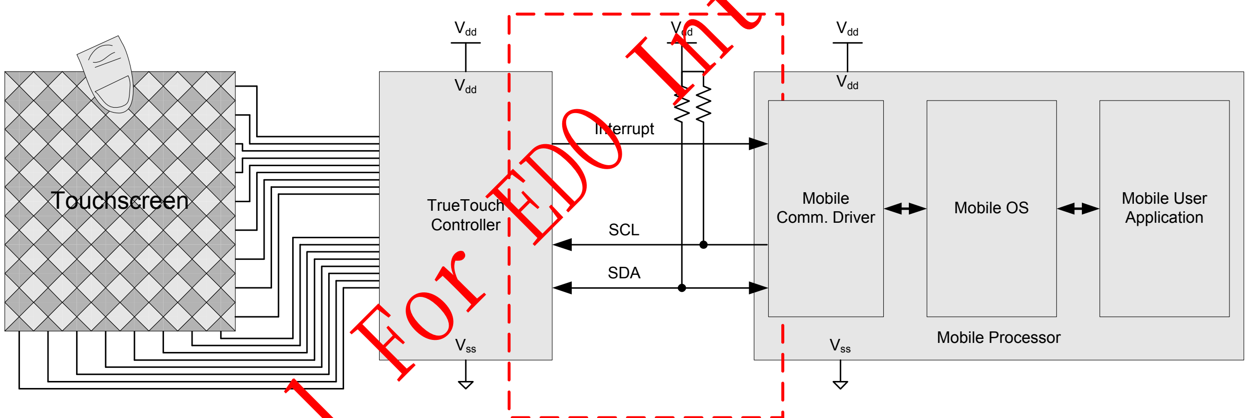
2. Physical Communication Interface

The TrueTouch device exposes an I^2C 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.

2.1 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^2C or SPI interface. The secondary communication interface is a unidirectional communication interrupt (COMM_INT) pin used for event notification to the host. 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 35 for details).

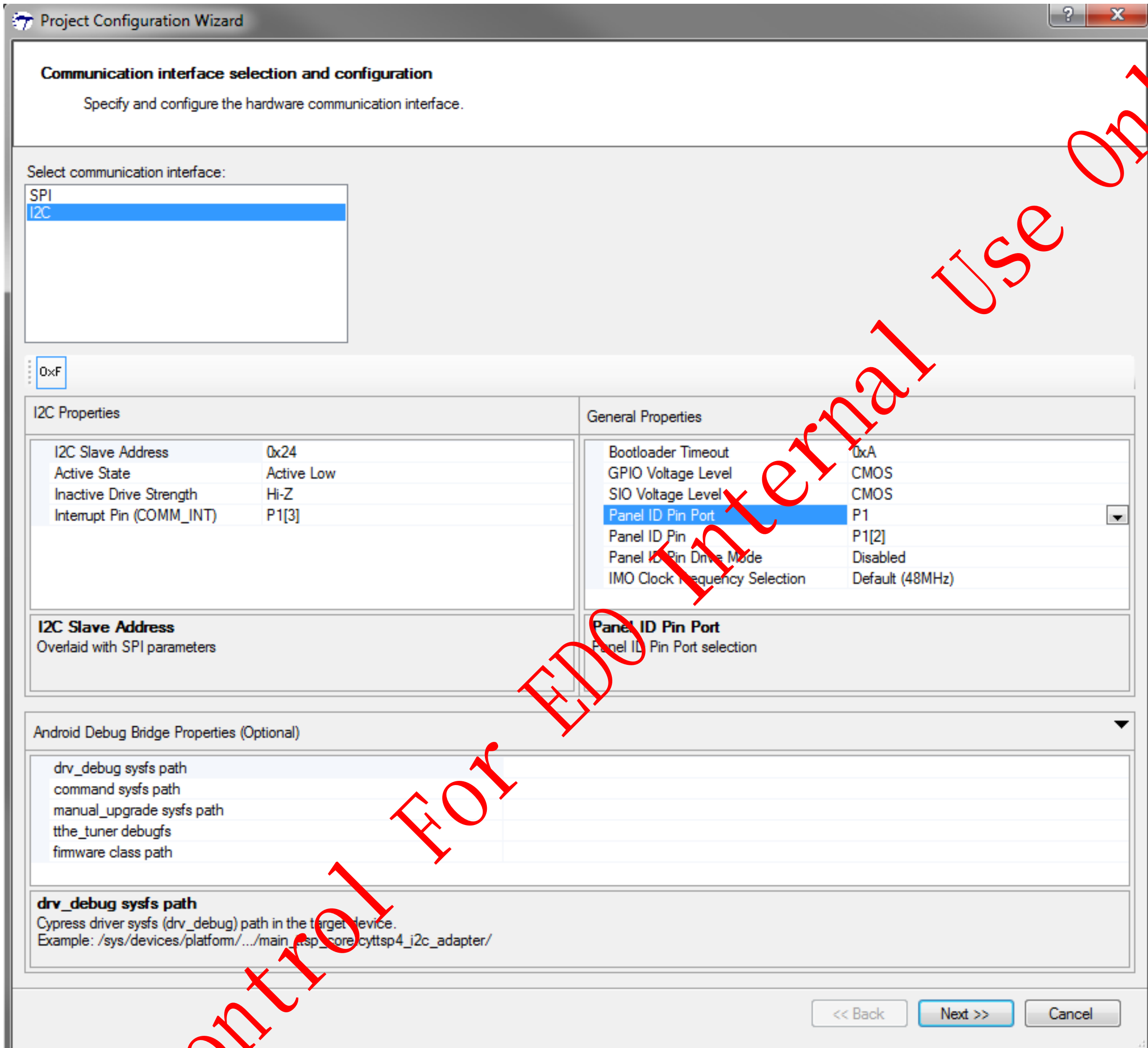
Figure 2-1. System Diagram



2.2 Configuring the Physical Communication Interface

The communication interface settings are configured in the TTHE Project Configuration Wizard, shown in Figure 2-2, and cannot be changed during run-time.

Figure 2-2. Physical Communication Configuration



The communication settings are:

- **Physical Communication Interface:**
  - **I²C and SPI:** Selects the physical communication interface.
- **General Properties:**
  - Bootloader Timeout: Duration after communication (in 1/100th of a second) readiness that bootloader waits for a host bootloader command before automatically launching a valid application. This parameter IS NOT BOOTLOADABLE! It is only updated through SWD programming. 0 specifies disabled timeout (wait forever).
  - GPIO Voltage Level: Option between CMOS or TTL.
  - SIO Voltage Level: Option between CMOS or TTL.
- **I²C Properties:**

- **I^{2}C Slave Address:** Sets the I^{2}C slave address. The following addresses are not valid options: 0h-7h, 78h-7Fh, and odd addresses.
- **Active State (COMM_INT):** Selects between Active Low and Active High COMM_INT configurations.
- **Inactive Drive Strength (COMM_INT):** Selects whether the inactive drive strength of the COMM_INT pins is configured to use an internal termination resistor (Resistive) or to be open-drain (Hi-Z).
- **Interrupt Pin (COMM_INT):** Selects the communication interrupt (COMM_INT) pin.

- **SPI Properties:**
  - **Clock Phase:** Selects whether the clock phase is input on leading edge or trailing edge.
  - **Clock Polarity:** Selects whether the clock polarity is idle low or idle high.
  - **Active State (COMM_INT):** Selects between Active Low and Active High COMM_INT configurations
  - **Inactive Drive Strength (COMM_INT):** Selects whether the inactive drive strength of the COMM_INT pins is configured to use an internal termination resistor (Resistive) or to be open-drain (Hi-Z).
  - **Interrupt Pin (COMM_INT)**: Selects the communication interrupt (COMM_INT) pin.

2.3 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 open drain or internal pull-up. 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 provides 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. See the device datasheet for the recommended value of an external resistor for the COMM_INT pin.

2.4 I^{2}C Communication Interface

The Inter-Integrated Circuit (I^{2}C) bus is a common communication interface for touchscreens. 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. CYTMA445A/CYTT21XXX/CYTT31XXX I^{2}C includes these features:

- I^{2}C-compliant
- Bit rate up to 400 kbps

2.4.1 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. The TrueTouch device has a 512 bytes communication register space. 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 TrueTouch device 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 36. The I^{2}C address requirements are as follows:

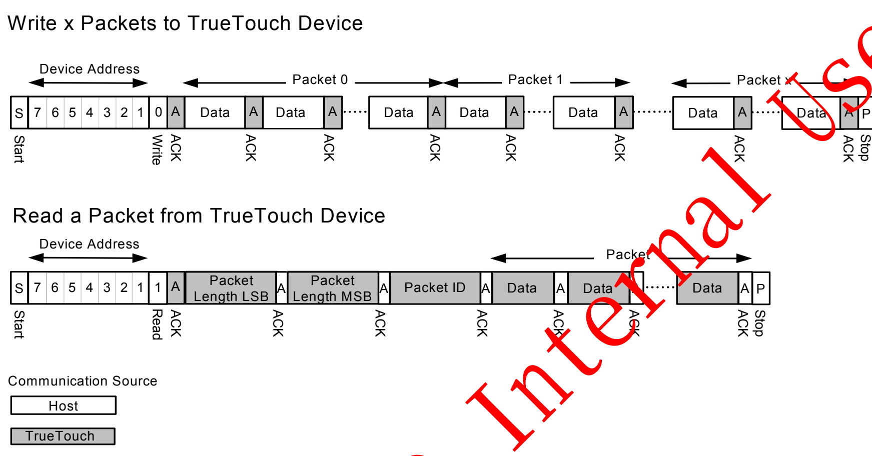
- The base address must be even.
- The base address must be within the range 0x08 and 0x118

If the I^2C 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.

2.4.2 Communication Protocol

The TrueTouch controller communicates using a simple protocol illustrated in Figure 2-3. 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 2-3. I^2C Communication Protocol



2.4.3 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.

2.4.4 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. The I^2C activity that does not match the slave address will increase power consumption in the I^2C block because 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 161.

2.4.5 Pin Status During Reset

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

2.5 SPI Communication Interface

The TrueTouch device supports the Serial Peripheral Interface (***SPI***) bus, which is a common communication interface for touchscreens. The TrueTouch controller is an SPI slave and the host is the SPI master. The TrueTouch controller operates as an SPI slave. Figure 2-4 shows a basic system diagram and Figure 2-5 indicates sequencing and protocol details.

CYTMA445A/CYTT21XXX/CYTT31XXX supports these SPI features:

- SPI Modes 0, 1, 2, 3

- ***Most-significant bit (MSbit)***-first bit order

Figure 2-4. System Diagram

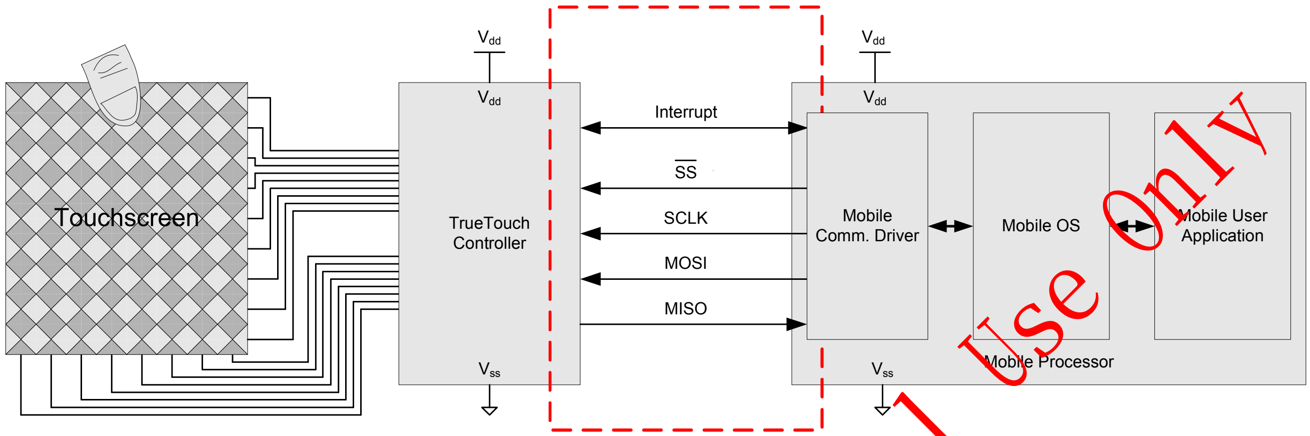
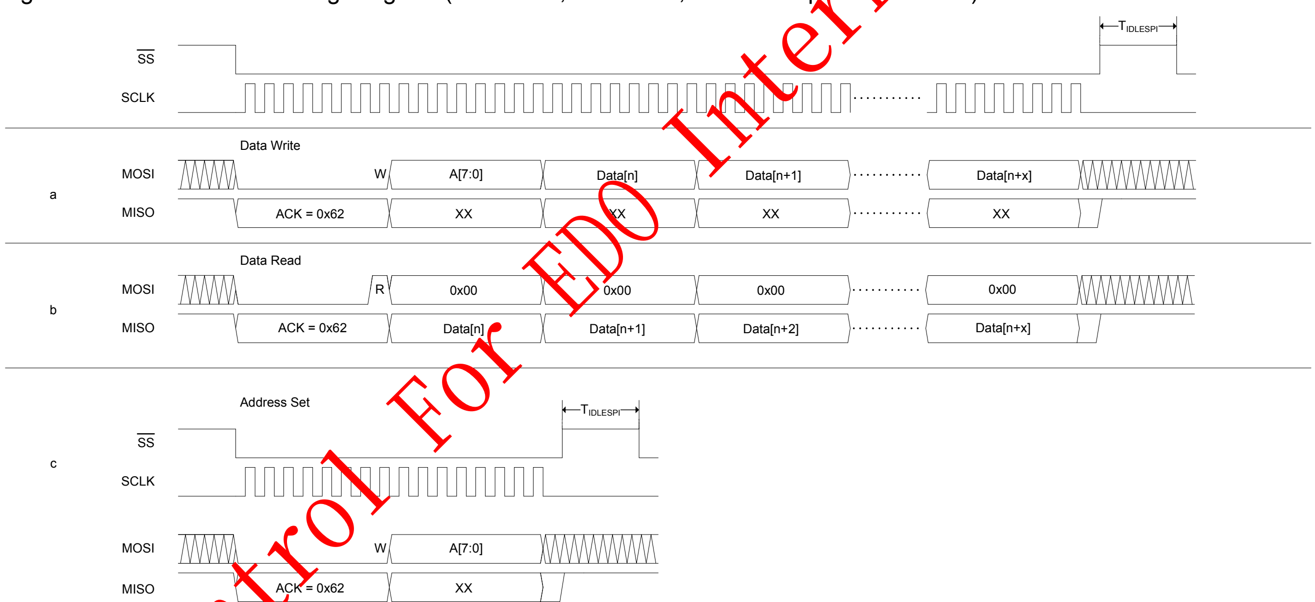


Figure 2-5. SPI Protocol Timing Diagram (CPHA = 0, CPOL = 0, MSb-first operation shown)



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

2.5.1 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.

2.5.2 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, and the data to be written. The command byte will have bit[0] cleared to indicate a data write (see Figure 2-5 a).
- A Data Read command consists of a command byte and the 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 2-5 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 2-5 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 NACK'd transaction.

2.5.3 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.

2.5.4 Power Management

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

2.6 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 “CRC” on page 57). 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.

2.7 Port 0 and Port 1 Input Configuration

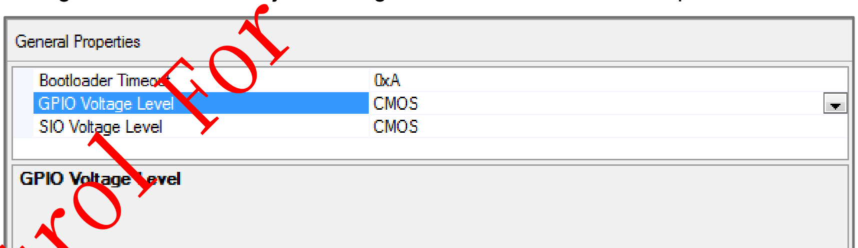
I/O Port 0 (SIO) and Port 1 (GPIO) can be configured as CMOS or TTL input. In TrueTouch Host Emulator, select **View > Project Configuration Wizard**. In the **General Properties** panel, set the **GPIO Voltage Level** selection for all Port 1 inputs. Set the **SIO Voltage Level** selection for all Port 0 inputs. When the VDDA and VDDD are supplied with 2.7 V, 1.8-V communication is possible by using TTL mode for the receiving function of I/O Port 0 and Port 1. See the datasheet for V_{IH}, V_{IL}, and supply specifications.

The default configuration is CMOS input. A new input level selection can only be applied to the device through programming. It cannot be applied to the device through bootloading because these configuration registers are located in the Bootloader Application Code area which can only be accessed through programming via SWD connection (see 4.4 Memory Map on page 58).

Device will not be able to communicate to the host if it is configured to CMOS inputs and the host is communicating at the TTL levels. It is because the CMOS V_{IH} level is higher than the TTL V_{IH} level and the device cannot reliably detect a logic high. The only way to resolve this issue is to re-program the device configuration to CMOS inputs while communicating to the device with CMOS signal levels during programming.

Device will be able to communicate to the host if it is configured to TTL inputs and the host is communicating at the CMOS levels. It is because the TTL V_{IH} level is lower than the CMOS V_{IH} level. However, the device will have lower noise margin potentially more vulnerable to noise event.

Figure 2-6. TTHE Project Configuration Wizard General Properties Panel



2.8 Panel ID Configuration

Custom panel ID can be defined to determine panel manufacturer. A binary value assigned to a panel vendor can be set by connecting pins on the ITO panel to the panel ID pins on the TrueTouch device. For example, one panel ID allows the TrueTouch device to store 2 panel vendors. If 3 panel ID pins are available, up to 8 panel vendors can be stored within the TrueTouch device.

The Panel ID pin is sensed at device startup, if enabled in TTHE (see Figure 2-2), and written to the Panel ID register in the Systems Information command. This status can be used to indicate panel manufacturing information to the host.

There are two options for the panel ID pull-up configuration: Hi-Z or Internal Pull-Up. If Internal Pull-Up is selected, the pin is internally connected to a pull-up resistor (nominal value of 5.6 kΩ) during panel ID check at power-up. Floating panel ID pin is reported as ‘1’. Grounded panel ID pin is reported as ‘0’. It is recommended connecting the panel ID pin directly to ground or to use a pull-down resistor less han 1 kΩ on the pin to ensure proper panel ID reading. Unused panel ID pin should be left unconnected.

During the panel ID check at power-up, the device enables the pull-up resistor and waits for 1 µs for the voltage to settle before checking the value. Make sure that the additional loading on the pin does not affect the panel ID check. See the datasheet for the panel ID pin input capacitance specification.

If Hi-Z is selected, there will be no internal pull-up resistor connected to the pin. The panel ID pin should be driven to either supply or ground level.

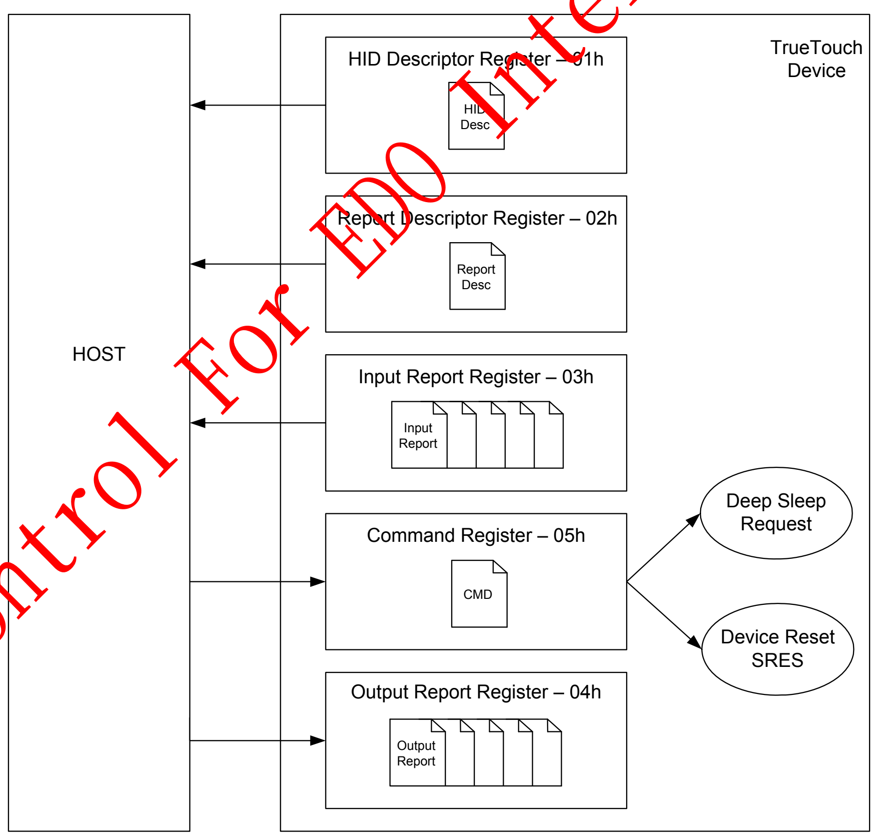
Note that the panel ID pins are shared with other functions. When the panel ID pin is used for other functions, it cannot be used for panel ID and the value should be ignored.

3. 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 metadata 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 information. 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 3-1 shows a block diagram of the interaction between the host processor and TrueTouch device. The hexadecimal number in the figure denotes the index of each register.

Figure 3-1. 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 the type of request and response being interpreted. Table 3-1 shows a summary of the Report IDs.

Table 3-1. PIP 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)
00h	Invalid Report
01h	Touch Report
03h	Button Report
04h	Wakeup Event Report
06h	Push Button Report
F0h	Deep-Sleep Response (Data register)

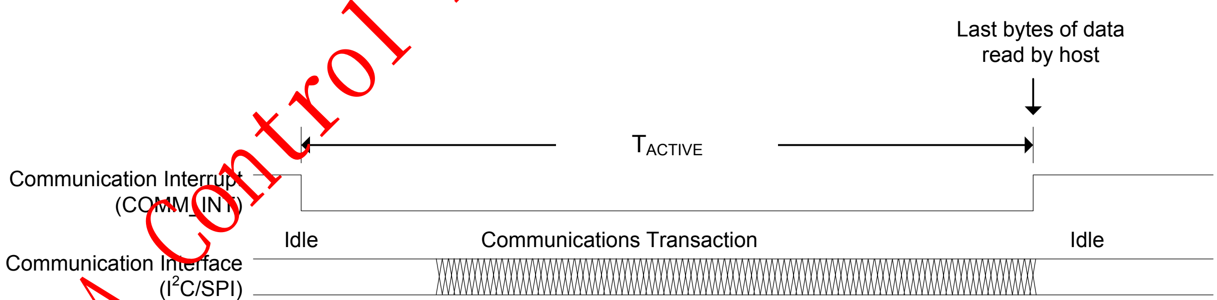
3.1 Communication Handshaking

The TrueTouch device uses the synchronous level communication handshaking. 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 3-2).

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 3-2. Synchronous Level Handshaking Timing Diagram



3.2 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 2-5. 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 invalid.

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.

3.2.1 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 packet length and clock-stretches the bus. Then, it reads the remaining data.
- The host processor reads just the first two bytes to determine the packet length, 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 3-3 and Figure 3-4).

Figure 3-3. Input Report Register Read (Bootloader)

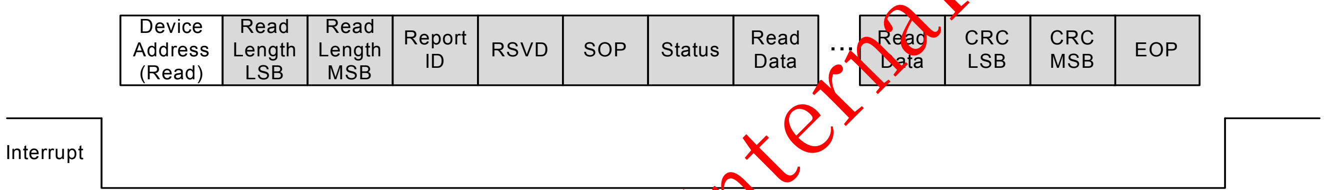
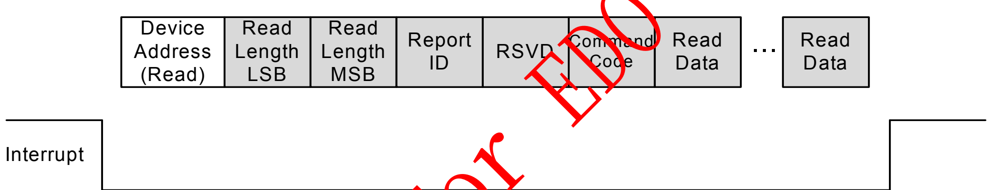


Figure 3-4. Input Report Register Read (TrueTouch Application)



The Output Report and Command registers are written to by first addressing the device for a write and specifying the register to write to. The write data follows (see Figure 3-5).

Figure 3-5. Output Report and Command Register Write (Bootloader)

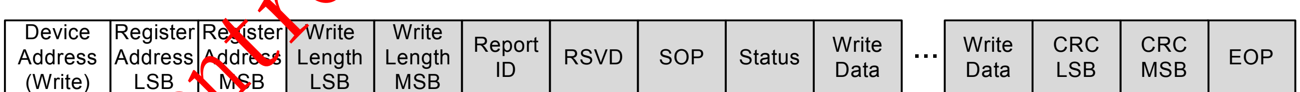
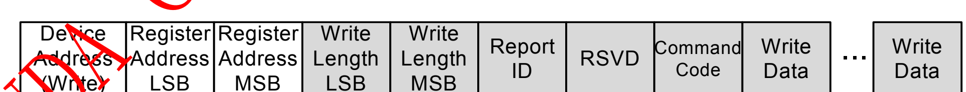
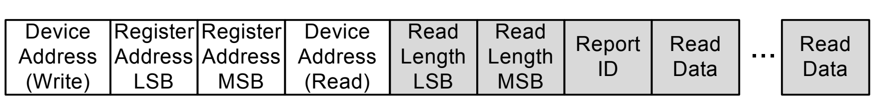


Figure 3-6. Output Report and Command Register Write (TrueTouch Application)



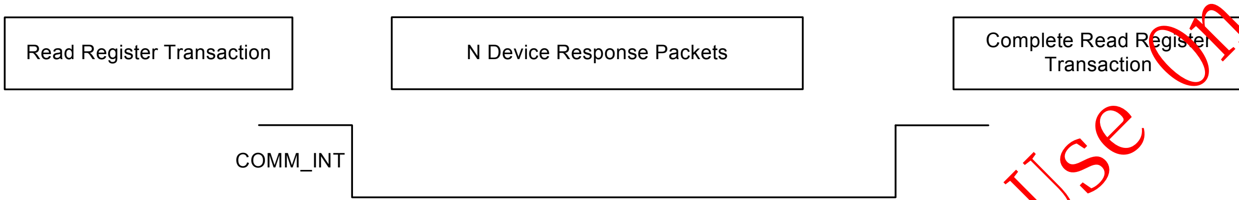
The HID Descriptor, Report Descriptor, and Data registers are read-only. Data is read from these registers by first addressing the device for a write and specifying the register, then addressing the device for read (see Figure 3-7).

Figure 3-7. HID Descriptor, Report Descriptor, and Data Register Read



Writes may occur asynchronously to the TrueTouch device operations. The device can assert the COMM_INT pin when a new packet is available for the host to read, during a host-initiated register write. When this occurs, the device will allow the host to complete the write; however, 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 3-8). 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 begin reading the touch report packet on the subsequent read transaction. When the entire touch report has been read and the host initiates a new read transaction, the device will return the HID Descriptor register.

Figure 3-8. HID Descriptor, Report Descriptor, and Data Register Read Interrupted



3.3 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. In Table 3-2, shaded value cells indicate a difference in value between the TrueTouch and Bootloader HID descriptors.

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 3-2. Bootloader and TrueTouch HID Descriptor

Note: Highlighted values in the Bootloader and Touch App columns indicate that the values differ.

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

Table 3-2. Bootloader and TrueTouch HID Descriptor

Note: Highlighted values in the Bootloader and Touch App columns indicate that the values differ.

Byte	Bootloader Description	TrueTouch App Description	Bootloader Value	Touch App. Value
18	Command Register[7:0]		05h	05h
19	Command Register[15:8]		00h	00h
20	Data Register[7:0]		06h	06h
21	Data Register[15:8]		00h	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	00h
29			00h	00h
30			00h	00h
31			00h	00h

3.4 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 3-3).

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 3-3. 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

3.4.1 Bootloader Report Descriptor

Item	Value
REPORT_DESCRIPTOR_LENGTH	0X1D
REPORT_DESCRIPTOR_PACKET_ID	0xFE
USAGE_PAGE (PIP 0xFF01)	0x06, 0x01, 0xff
USAGE (Bootloader)	0x09, 0x01
COLLECTION (Application)	0xa1, 0x01
REPORT_SIZE (8)	0x75, 0x08
Bootloader Input Report (Report ID 30h) - Up to 16 bytes (packet content after report ID)	
REPORT_ID (48)	0x85, 0x30
USAGE (Generic Item)	0x09, 0x30
REPORT_COUNT (16)	0x95, 0x10
INPUT (Data,Var,Abs)	0x81, 0x02
Bootloader Output Report (Report ID 40h) - Up to 144 bytes (packet content after report ID)	
REPORT_ID (64)	0x85, 0x40
USAGE (Generic Item)	0x09, 0x30
REPORT_COUNT (144)	0x95, 0x90
OUTPUT (Data,Var,Abs)	0x91, 0x02
END_COLLECTION	0xc0

3.4.1.1 Example Report Descriptor Code

```
#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 */
```

3.4.2 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 */
```

3.5 Output Report Register

The Output Report register is located at address 04h. The Output Report register is written by the host to initiate a Bootloader or TrueTouch application command. The command response is available in the Input Report Register and is automatically loaded in the subsequent read transaction. For details on command response structure for Bootloader and TrueTouch application commands, see “Bootloader Commands” on page 65 and “TrueTouch Application Commands” on page 76. 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)

3.6 Input Report Register

The TrueTouch device writes the Input Report register with scan data and responses to the host-initiated commands. After initiating a Bootloader or TrueTouch application command, the command response is automatically loaded in the subsequent read transaction. The structure of touch and button scan is documented in "Touch Reports" on page 120 and "Button Reports" on page 122. 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)

3.7 Command and Data Register

The Command register's address is 05h and the Data register's address is 06h. 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.

3.7.1 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 3-4. SRES Command (Output Report)

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 3-5. SRES Command (Input Report)

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

3.7.2 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 toggle (TGL) bit is 0 in the first deep-sleep response and will be the compliment of the previous value thereafter.

Table 3-6. Deep Sleep Command (Output Report)

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						Power State		01h
3	Reserved				Opcode = 1000b				08h

Table 3-7. Deep Sleep Command 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
1	Length [15:8]								00h
2	Report ID = Request Response								F0h
3	Reserved						Power State		0Xh
4	TGL	Reserved = 000b			Opcode = 1000b				X8h

4. Device Startup

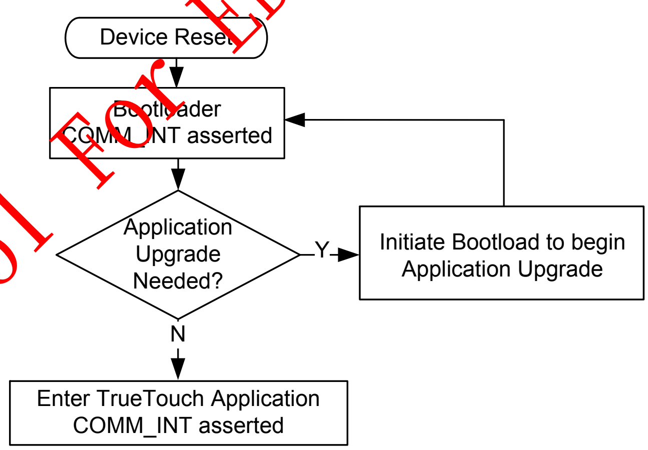
After a device ***reset***, the TrueTouch controller enters the ***bootloader*** application to allow the host to initiate a ***field upgrade***. The TrueTouch device will automatically enter the TrueTouch application if a bootload is not initiated by the host. The TrueTouch device will assert the COMM_INT 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 59.

When 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 "TrueTouch Application Commands" on page 76). An example device startup flow is illustrated in Figure 4-1. For more details on command and response protocol, see Packet Interface Protocol (PIP) chapter on page 41.

Device Startup Flow Overview:

1. Device reset
2. Device enters bootloader
3. Bootloader timeout period expires (if timeout = 0, host must launch application)
4. Device enters TrueTouch application
5. Host reads reset sentinel (00h 00h)

Figure 4-1. Device Startup Flow



4.1 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. 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 57). 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 5-5 on page 63 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 51) except the Launch Application command from the finite wait state (see “Launch Application” on page 73). 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 the TrueTouch application.

The communication interface becomes unresponsive from the time 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 80):

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 POST_L AUTO SH and POST_H AUTO SH bits. 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 POST_L VDDA CHECK bit. This bit is set to ‘1’ when the test passes and ‘0’ if the test fails.

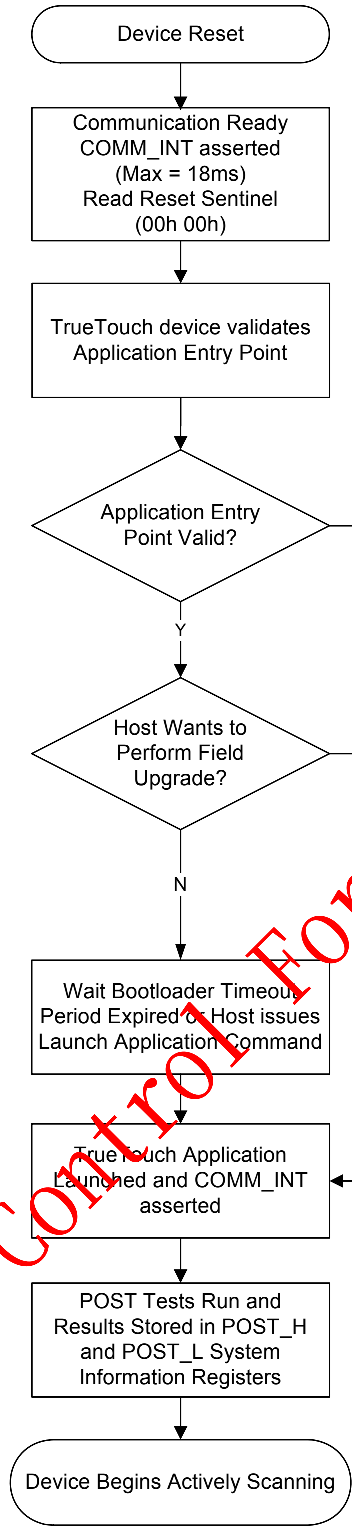
Based on POST results, touch scanning can be disabled if configuration data is not valid, configuration is not supported, or panel test failed. Scanning status is reported in the SCAN EN bit of POST_CODEL. The bit is set to ‘1’ if scanning is enabled and cleared otherwise. The configurable parameter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

4.2 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 125). 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 wake-up. When the device is actively running after wake-up, the active mode timeout periods apply. Before execution of a self-test or 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 80).
- **Software Reset (SRES).** The ***software reset*** occurs when the host performs a Reset HID Request (see “Command and Data Register” on page 51).

Figure 4-2. Device Startup Flow



4.3 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 metadata and application entry point, each have a CRC. The following sections describe the points at which each of the CRCs are validated. See Figure 4-3 for the flash map layout including the CRCs.

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

4.3.1 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 64).

4.3.2 TrueTouch Application CRC

Three TrueTouch application CRCs exist in the TrueTouch application code.

4.3.2.1 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.

4.3.2.2 TrueTouch Application Metadata CRC

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

4.3.2.3 TrueTouch Application Code CRC

Following an Initiate Bootload command, the TrueTouch device will calculate the TrueTouch application CRC, which is stored in the metadata of the TrueTouch application. The CRC of the TrueTouch application is calculated over the TrueTouch application Start and TrueTouch application Length values in the metadata area (see "Metadata Parameter Definitions" on page 69). 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.

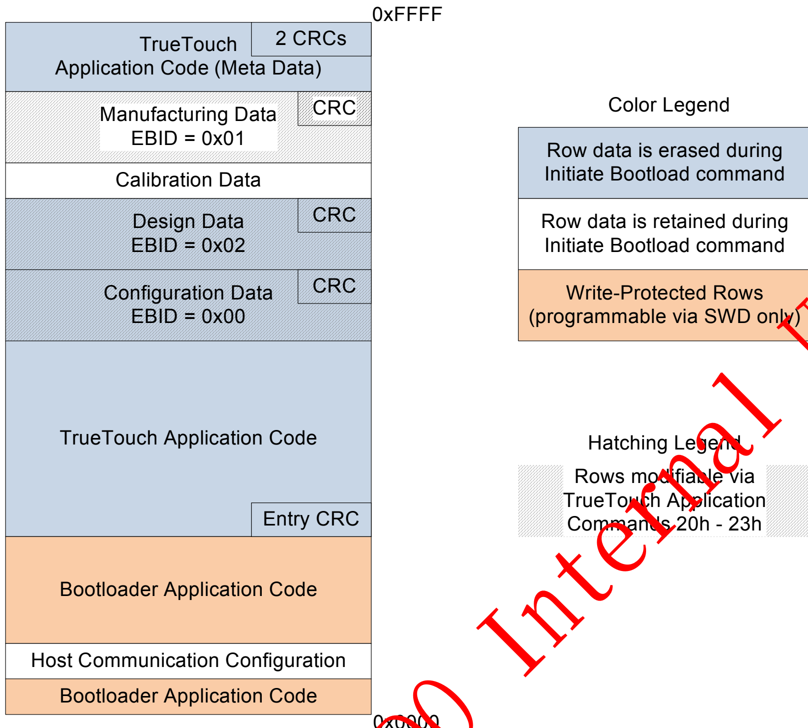
4.3.3 Configuration CRC

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.

4.4 Memory Map

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

Figure 4-3. Flash Memory Map



5. 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 independent 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.

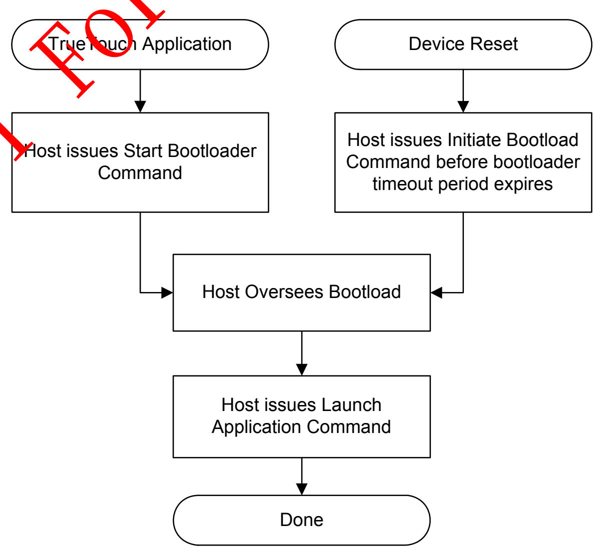
5.1 Functional Description

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 "Bootloader Commands" on page 65). For details regarding the communication protocol used to execute these commands, see Packet Interface Protocol (PIP) chapter on page 41.

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 ("TrueTouch Application Commands" on page 76).

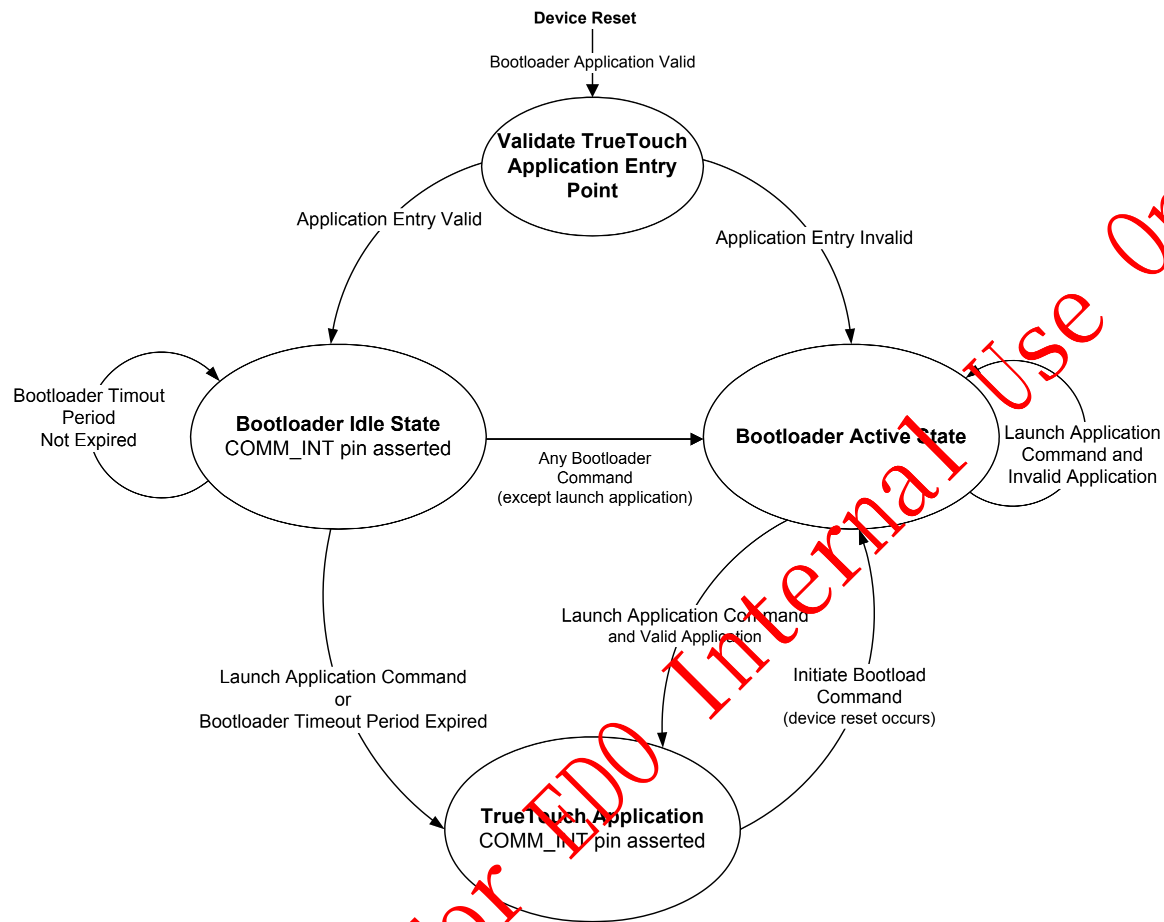
Because the application image is invalidated when the bootload is initiated, aborting a bootload (or an unexpected terminating event such as a power failure) leaves the application image in an invalid state, which prevents launch of the application. Recovery from an aborted bootload requires initiation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

Figure 5-1. Bootloader Field Upgrade Overview



5.2 Bootloader States

Figure 5-2. Bootloader State Diagram



5.2.1 Initialization

Following a device reset, the bootloader application is launched (see “CRC” on page 57). The host can identify whether the controller is in the bootloader application by reading the HID Descriptor register (see “HID Descriptor Register” on page 44). First, the bootloader application performs its 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 requires the device to be acquired via SWD and reprogrammed (see “Programming the Bootloader” on page 64). If the CRC check passes, the physical communication interface and COMM_INT pin are initialized.

5.2.2 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 57). If this check fails, the device will automatically enter the active bootloader state and allow a bootload to proceed and repair the application image. If the integrity check passes, the device 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.

5.2.3 Active State

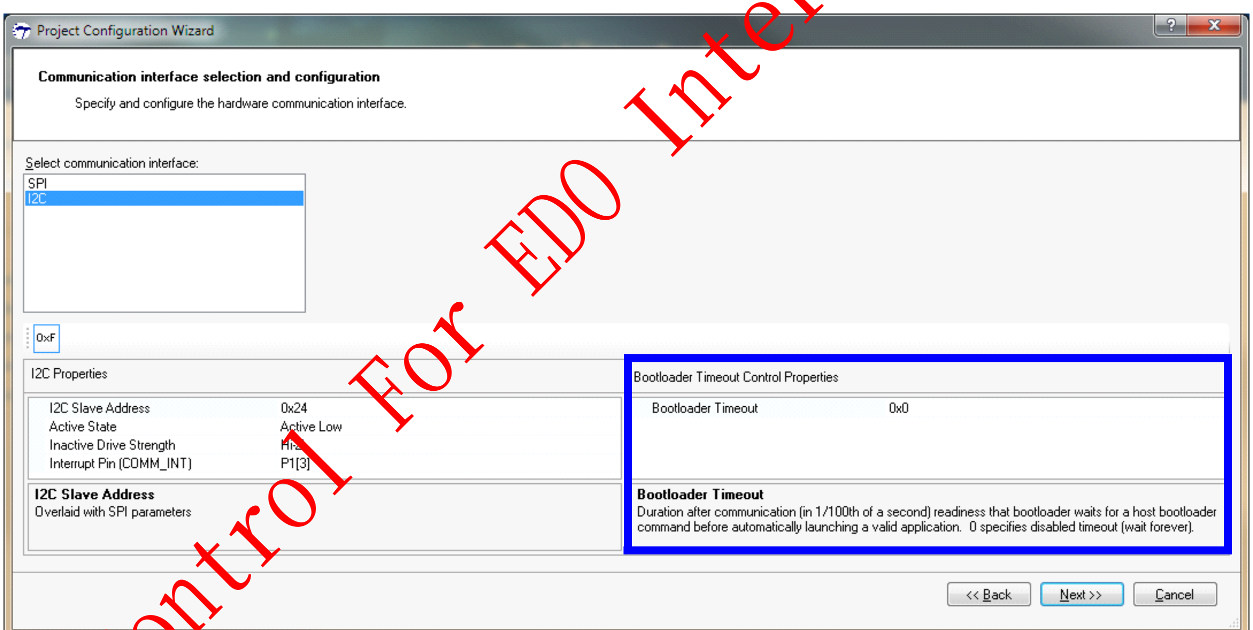
After entering the active state, the host must issue a series of bootloader commands (see “Command and Data Register” on page 51) to initiate and complete a bootload. The flow of a field upgrade is shown in Figure 5-5. When a bootload is complete, the host must execute the Launch Application command 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 “Field Upgrade Flow” on page 62 for details on bootloader states.

5.3 Configuring Bootloader Timeout

The bootloader timeout value is set using the TTHE Project Configuration Wizard shown in Figure 5-3. 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 0x00 - 0xFF.

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 5-3. Bootloader Timeout Configuration



5.4 Field Upgrade Flow

To update the application code, the host reads the CYACD file and then parses it (see “CYACD File Format” on page 64 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 5-4 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 5-4. One Command Execution Flow

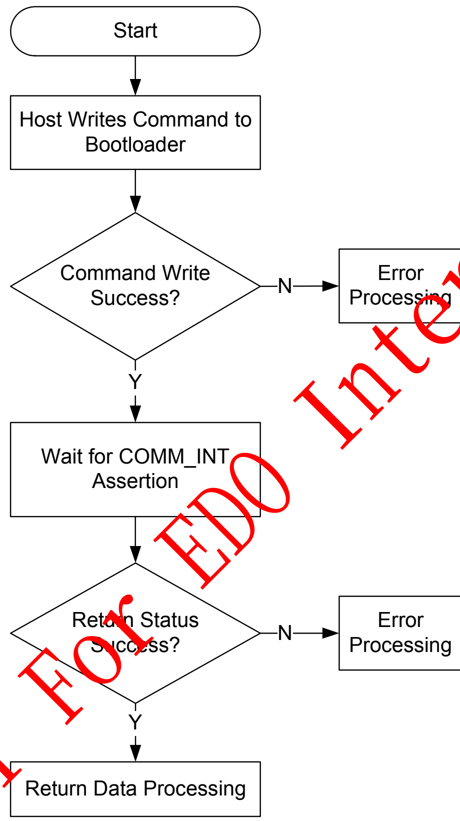
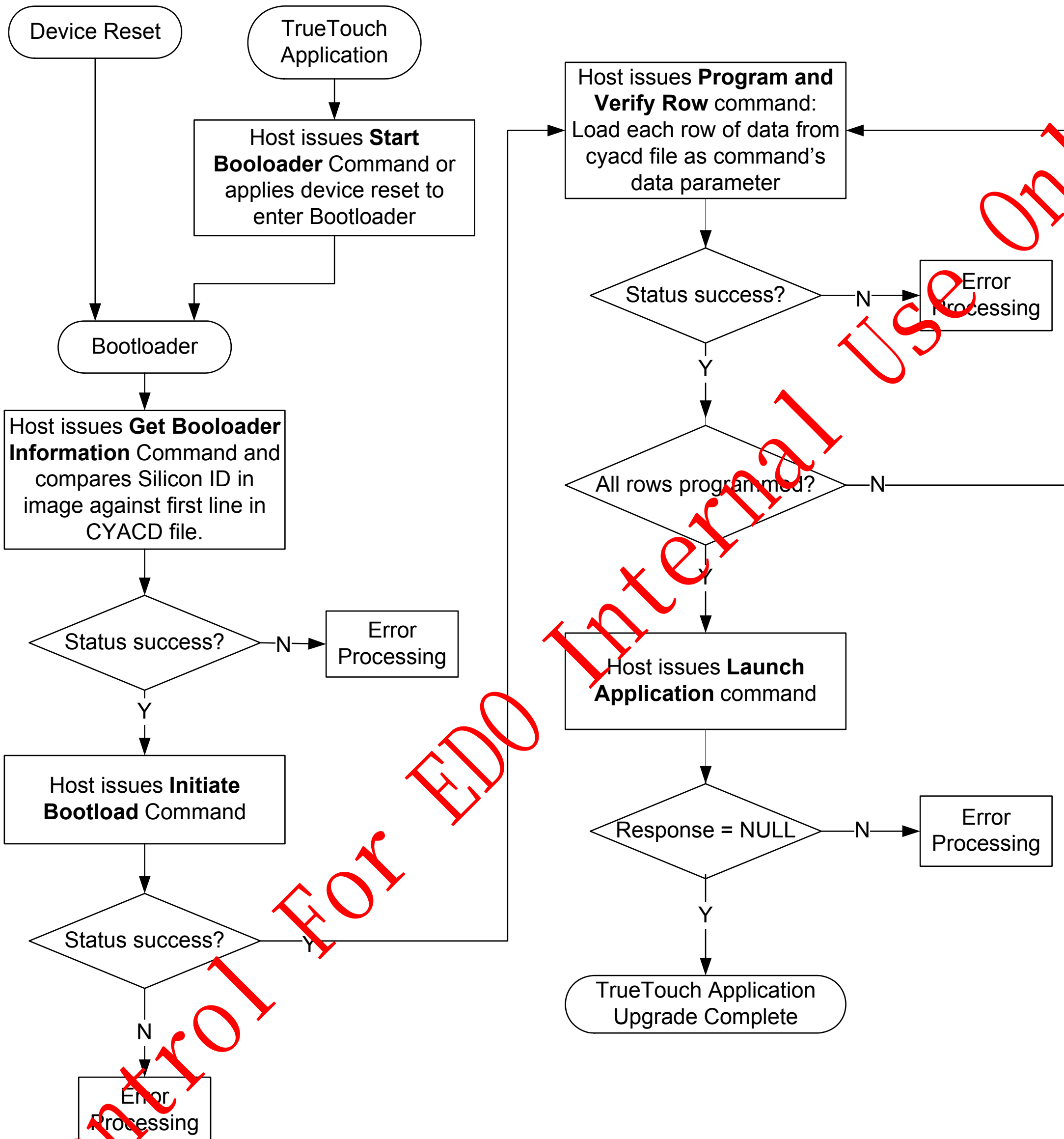


Figure 5-5 shows the recommended command sequence for a field upgrade. The host determines whether a field upgrade is needed by issuing the Get System Information: 02h command from the TrueTouch application. The TrueTouch application Major/Minor, Revision Control Number, and Customer Specified Firmware/Configuration 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 “Run CM Panel Self-test Command" on page 99 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 5-5. Field Upgrade Sequence



5.5 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 57.

Example cyacd file record

```
013D21902101
:000025008000200020A5130000A17D0000A17D0000A17D0000A17D0000A17D0000A17D0000A17D0000A17D0000
A17D0000A17D0000A17D0000A17D0000A17D0000A17D0000A17D0000A17D0000A17D0000A17D0000A17D0000A17
D0000A17D0000A17D0000A17D0000A17D0000A17D0000A17D0000A17D0000A17D0000A17D0000A17D0000DF

:000026008000F002F800F040F80CA030C8083824182D18A246671EAB4654465D46AC4201D100F032F87E460F3E
0FCCB6460126334200D0FB1AA246AB4633431847B4B20000E4B20000103A02D378C878C1FAD8520701D330C830C
101D504680C60704700000002300240025002610 3A01D378C1FBD8520700D330C100D50B6070471FB5C046CC

:0000270080C0461FBD10B510BD03488546FFF7F6FF00F0A1F900F062F900200020FFF7F2FF00F062F9014B9D46
01480047002000200113000070B505460C46164602E00FCC0FC5103E102EFAD2082E02D303CC03C5083E042E07D
301CC01C5361F03E021782970641C6D1C761EF9D270BD00000000801C800803D000BF401E0046FCD170471F
```

5.6 Programming the Bootloader

The bootloader allows you to update the application firmware. However, it cannot update itself. To update the bootloader, you will need a TrueTouch Bridge (TTBridge), a MiniProg3, or third-party programmer/debugger. For more information, see Table A-2 on page 18 for TTBridge and MiniProg3 reference documents.

6. Command Details

Bootloader commands are available only from the bootloader state and TrueTouch application commands are available only from the TrueTouch application state (see the Field Upgrade (Bootloader) chapter on page 59 and the Device Startup chapter on page 53 for details on state transitions). The Bootloader and TrueTouch application commands use Packet Interface Protocol (PIP) format. See the Packet Interface Protocol (PIP) chapter on page 41 for details.

6.1 Command Failure Status Troubleshooting

Possible reasons for a failure include, but are not necessarily limited to:

- Direct coupling from a noisy V_{DDA} or V_{DDD} supply
- Capacitive coupling to AC noise source causes test output voltage fluctuations
- External voltage source greater than 5 V directly shorted to RX pin
  - This problem will permanently damage the chip

6.2 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 not HID-over-I^2C compliant. Bootloader commands are listed in Table 6-1. 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. 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 6-1. Bootloader Commands

Command Code	Command Description	Command Code	Command Description
31h	Verify Application Integrity	3Ch	Read Application Information
37h	Append Data Buffer	3Dh	Read Application Image
38h	Get Bootloader Information	3Eh	Get Panel ID
39h	Program And Verify Row	48h	Initiate Bootload
3Bh	Launch Application		

6.2.1 Bootloader Command/Response Packet Format

Table 6-2. Bootloader Command Packet (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 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 + 10	CRC[7:0] Calculated over bytes 6 to (Data Length + 9)								XXh
Data Length + 11	CRC[15:8] Calculated over bytes 6 to (Data Length + 9)								XXh
Data Length + 12	EOP (End of Packet) = 17h								17h

Table 6-3. Bootloader Command Response Packet (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 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 + 8	CRC[7:0] Calculated over bytes 4 to (Data Length + 7)								XXh
Data Length + 9	CRC[15:8] Calculated over bytes 4 to (Data Length + 7)								XXh
Data Length + 10	EOP (End of Packet) = 17h								17h

Table 6-4. Status/Error 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.
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

6.2.2 Get Bootloader Information

Command Code: 38h

This command returns bootloader version and chip identification information.

Table 6-5. Get Bootloader Information Command Packet (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
1	Output Report Register Address[15:8]								00h
2	Length[7:0]								0Bh
3	Length[15:8]								00h
4	Report ID								40h
5	RSVD								00h
6	SOP								01h
7	Command Code								38h
8	Data Length[7:0]								00h
9	Data Length[15:8]								00h
10	CRC[7:0]								9Eh
11	CRC[15:8]								70h
12	EOP = 17h								17h

Table 6-6. 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

6.2.3 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 to guarantee that the application can launch. See Figure 5-5 on page 63 for an example host initiated bootload sequence.

The TrueTouch application contains a metadata 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 metadata row allows host-defined TrueTouch application boundaries.

Before erasing flash, the bootloader calculates the TrueTouch application metadata block CRC and compares it against the stored CRC in that block (see "TrueTouch Application CRC" on page 57). 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 6-7. Initiate Bootloader Command Packet (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	Metadata Row Parameter (0)*								XXh
19	Metadata Row Parameter (1)								XXh
..	..								XXh
17 + Row Size	Metadata 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 6-8 describes the Output Report Metadata Row Parameters in Table 6-7 in detail.

Table 6-8. Initiate Bootloader Metadata Parameters

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

Table 6-8. Initiate Bootloader Metadata Parameters

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Value
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	Application info size								02h
25	Firmware version major								XXh
26	Firmware version minor								XXh
27	Padding = 00h								00h
…	Padding = 00h								00h
59	Padding = 00h								00h
60	Metadata CRC[7:0]								XXh
61	Metadata CRC[15:8]								XXh
62	Pad = 00h								00h
…	Pad = 00h								00h
Row Size - 1	Pad = 00h								00h

6.2.3.1 *Metadata Parameter Definitions*

The metadata parameters that must be input into this command must be read out of the last line of the CYACD file. The metadata begins in the last line of the CYACD file following the string ":0001FF00" (see 5.5 CYACD File Format for details). The following describes each Metadata 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 metadata record, the TrueTouch application range must be a subset of the Upgrade range.

Size: Number of bytes in the metadata 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.

Command Details

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 metadata 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 metadata 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 metadata 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 metadata 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 6-9. Initiate 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] = 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

6.2.4 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 before execution of the requested operation. Execution of any command that operates on the data in the data buffer empties the buffer.

Table 6-10. Append Data Buffer Command Packet (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

Table 6-10. Append Data Buffer Command Packet (Output Report)

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Value
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	EOP = 17h								17h

Table 6-11. Append Data Buffer Response Packet (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

6.2.5 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 6-12. Program and Verify Row Command Packet (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

Command Details

Table 6-12. Program and Verify Row Command Packet (Output Report)

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	EOP = 17h	17h

Table 6-13. 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

6.2.6 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 Metadata row (see "Initiate Bootload" on page 68 for details on Meta Row parameters). CRC calculation is performed on data bounded by the Application Start and Application Length values programmed in the Metadata 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 6-14. Verify Application Integrity Command Packet (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 6-15. Verify Application Integrity Response Packet (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	EOP = 17h								17h

6.2.7 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 metadata 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 6-16. Launch Application Command Packet (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 6-17. Launch Application Success Response Packet (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 6-18. Launch Application Failure Response Packet (Input Report)

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

6.2.8 Read Application Information

Command Code: 3Ch

This command reads the product specific system information. Its structure and data length may vary for different product types. Look at the System Information response for more information related to Product Family.

Table 6-19. Read Application Information Command Packet (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 = 3Ch								3Ch
8	Data Length[7:0] = 00h								00h
9	Data Length[15:8] = 00h								00h
10	CRC[7:0]								B0h
11	CRC[15:8]								42h
12	EOP = 17h								17h

Table 6-20. Read Application Information Response Packet (Input 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								XXh
6	Data Length[7:0] = 00h								02h
7	Data Length[15:8] = 00h								00h

Table 6-20. Read Application Information Response Packet (Input Report)

8	FW Version Major	XXh
9	FW Version Minor	XXh
10	CRC[7:0]	XXh
11	CRC[15:8]	XXh
12	EOP = 17h	17h

6.2.9 Read Application Image

Command Code: 3Dh

This command reads the application firmware image and returns the image as an array of bytes. This command begins reading from the first byte of the application image plus any specified Offset. The returned array size is specified in the Input Report's Data Length parameter.

Table 6-21. Read Application Image Command Packet (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] = 0Eh								0Eh
3	Length[15:8] = 00h								00h
4	Report ID = 40h								40h
5	RSVD = 00h								00h
6	SOP = 01h								01h
7	Command Code = 3Dh								3Dh
8	Data Length[7:0] = 03h								03h
9	Data Length[15:8] = 00h								00h
10	Offset[7:0]								XXh
11	Offset[15:8]								XXh
12	Length								XXh
13	CRC[7:0]								XXh
14	CRC[15:8]								XXh
15	EOP = 17h								17h

Table 6-22. Read Application Image Response Packet (Input Report)

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 2	Bit 0	Value
0	Length[7:0]								XXh
1	Length[15:8]								XXh
2	Report ID = 30h								30h
3	RSVD = 00h								00h
4	SOP = 01h								01h
5	Status								XXh
6	Data Length[7:0]								XXh
7	Data Length[15:8]								XXh
8	flash[START_OF_APPLICATION+Offset +0]								00h
9	flash[START_OF_APPLICATION+Offset +1]								00h
...	flash[START_OF_APPLICATION+Offset +xx]								00h
...	flash[START_OF_APPLICATION+Offset +Data Length-1]								00h
...	CRC[7:0]								XXh
...	CRC[15:8]								XXh
Length - 1	EOP = 17h								17h

6.2.10 Get Panel ID

Command Code: 3Eh

Returns the Panel ID value store in the System Information. Panel ID is sensed at system startup if enabled. The Panel ID is also returned in the "Get System Information: 02h" command.

Table 6-23. Get Panel ID Command Packet (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 = 3Eh								3Eh
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 6-24. Get Panel ID Response Packet (Input Report)

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 2	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	Panel ID: FFh - Panel ID is unknown, otherwise the Panel ID is returned								XXh
9	CRC[7:0]								XXh
10	CRC[15:8]								XXh
11	EOP = 17h								17h

6.3 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 not HID-over-I^{2}C compliant. Touch application commands are listed in Table 6-25.

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 TrueTouch Communication Examples - Packet Interface Protocol (PIP) - AN85948 (Cypress document 001-85948) for example I2C scripts and the recommended manufacturing test flow.

Table 6-25. 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
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

6.3.1 TrueTouch Application Command/Response Packet Format

Table 6-26. TrueTouch Application Command Packet (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 6-27. TrueTouch Application Response Packet (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 the complement of the value that was returned on completion of the previous command.

Status: 00h = success; 01h = fail

6.3.2 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 toggle (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 6-28. Unsupported Command Response Packet

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

6.3.3 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 TGL 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 6-29. Ping Command Packet (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 6-30. Ping Response Packet (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

6.3.4 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 6-31. Start Bootloader Command Packet (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 6-32. Start Bootloader Success Response Packet (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

6.3.5 Get System Information: 02h

This command returns system information.

Table 6-33. Get System Information Command Packet (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 6-34. Get System Information Response Packet (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
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 AUTO SHORT	XXh

Table 6-34. Get System Information Response Packet (Input Report)

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Value or Description
32	RSVD			POSTL VDDA Check	SCAN EN	POSTL AUTO SHORT	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 1/100th mm)								XXh
36	LEN_X [15:8] - Panel X Axis Length (in 1/100th mm)								XXh
37	LEN_Y [7:0] - Panel Y Axis Length (in 1/100th mm)								XXh
38	LEN_Y [15:8] - Panel Y Axis Length (in 1/100th 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							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 AUTO SH and POSTL AUTO SH: Reports the results of the automatic short circuits test. Both POSTH 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 [Device Setup] 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 57):

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 (see “Panel ID Configuration” on page 40). The Panel ID pin is sensed at device startup, if enabled. 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 device datasheet 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

Command Details

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.

6.3.6 Suspend Scanning: 03h

This command suspends touch acquisition and asynchronous touch reporting.

Table 6-35. Suspend Scanning Command Packet (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 6-36. Suspend Scanning Response Packet (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

6.3.7 Resume Scanning: 04h

Resumes touch scanning and asynchronous touch reporting.

Table 6-37. Resume Scanning Command Packet (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 6-38. Resume Scanning Response Packet (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

6.3.8 Get Parameter

Command Code: 05h

Retrieves the value of a run-time configuration parameter (See the RAM and FLASH Configuration Data chapter on page 137). If the parameter ID is invalid, the command will return zero bytes. “Manufacturing Data [RAM]” on page 137 contains a list of parameter IDs and sizes.

Table 6-39. 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	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 = 05h							05h
7	Parameter ID								XXh

Table 6-40. Get Parameter Response Packet (Input 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

6.3.9 Set Parameter

Command Code: 06h

Sets the value of a run-time configuration parameter in RAM. If the parameter ID is invalid, the command will return zero bytes. “Manufacturing Data [RAM]” on page 137 contains a list of parameter IDs and sizes.

Table 6-41. Set Parameter Command Packet (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] (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

Command Details

Table 6-41. Set Parameter Command Packet (Output Report)

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 6-42. Set Parameter Response Packet (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

6.3.10 Get Noise Metrics

Command Code: 07h

This command returns a metric associated with the level of noise. See CYTMA445A and CYTT21XXX/31XXX Touchscreen Controller Tuning Best Practices Touchscreen Controller Tuning Best Practices (Cypress specification 001-92531) for details on noise metrics.

Table 6-43. Get Noise Metrics Command Packet (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 6-44. Get Noise Metrics Response Packet (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] - Bits [7:0] of the measured noise frequency								XXh
10	Frequency Noise Metric [15:8] - Bits [7:0] of the TouchType								XXh

6.3.11 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 its 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):

Table 6-45. Data Block Format

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 28 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.

6.3.12 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 84.

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 6-46. Verify Data Block CRC Command Packet (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 6-47. Verify Data Block CRC Response Packet (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

Command Details

Table 6-47. Verify Data Block CRC Response Packet (Input Report)

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Value
6	Calculated CRC[7:0]								XXh
7	Calculated CRC[15:8]								XXh
8	Stored CRC[7:0]								XXh
9	Stored CRC[15:8]								XXh

6.3.13 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 84.

Table 6-48. Get Row Size Command Packet (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 6-49. Get Row Size Response Packet (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

6.3.14 Read Data Block

Command Code: 22h

Returns up to 128 bytes of the specified data block. The Row ID is the number of rows from the start of the configuration block identified by the Block ID. Requested Read Length specifies the size of the return data in bytes. If both the Requested Read Length value and the Row ID value are 0, command will return the total number of bytes of the specified data block. If the Requested Read Length is 0 and the Row ID value is non-zero, it will return the total number of remaining bytes beginning from the specified Row ID to the end of the specified data block. A read will fail if the Block ID, Row ID, or Requested Read Length are out of range. Command will fail if a non-zero value is written to byte 10 of the command packet. For more details on data blocks, see "Data Block Commands" on page 84. See "CRC" on page 57 for details on CRC calculation.

Table 6-50. Read Data Block Command Packet (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	Requested 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 6-51. Read Data Block Response Packet with Non-Zero Requested Read Length (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
9	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 MSB: Computed on returned Row Data only (byte 10 + Actual Read Length)								XXh
Actual Read Length + 11	Row Data CRC LSB: Computed on returned Row Data only (byte 10 + Actual Read Length)								XXh

Table 6-52. Read Data Block Response Packet with Zero Requested Read Length (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	Size LSB in bytes (from offset to end of the block minus 2 bytes of CRC)								XXh
8	Size MSB in bytes (from offset to end of the block minus 2 bytes of CRC)								XXh
9	RSVD = 00h								00h
10	Row Data CRC MSB = 0xFF								FFh
11	Row Data CRC LSB = 0xFF								FFh

6.3.15 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 84. See “CRC” on page 57 for details on CRC calculation.

Table 6-53. Write Data Block Command Packet (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)								A5h
Write Length+13	Security Key (1)								01h
Write Length+14	Security Key (2)								02h
Write Length+15	Security Key (3)								03h
Write Length+16	Security Key (4)								FFh
Write Length+17	Security Key (5)								FEh
Write Length+18	Security Key (6)								FDh
Write Length+19	Security Key (7)								5Ah
Write Length+20	CRC MSB: Computed over Row Data only (byte 12 + Write Length)								XXh
Write Length+21	CRC LSB: Computed over Row Data only (byte 12 + Write Length)								XXh

Table 6-54. Write Data Block Response Packet (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

Table 6-54. Write Data Block Response Packet (Input Report)

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

6.3.16 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. The order of data returned in this command is 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.

Note: The returned Attenuator Trim values are actually indexes to the attenuator ratios. This means that to obtain the attenuator ratio, use the index in the following table.

Table 6-55. RX Attenuator Ratio Decoding

RX Attenuator Index	RX Attenuator Ratio
1	24
2	12
3	8
4	6
5	4.8
6	4
8	3
11	2
12	1

Table 6-56. Data IDs

Data ID	Description
00h	IDAC and RX Attenuator Calibration Data (Center Frequency)
04h	IDAC and RX Attenuator Calibration Data, Alternate Frequency 1 (if AFH enabled)
05h	IDAC and RX Attenuator Calibration Data, Alternate Frequency 2 (if AFH enabled)
07h	IDAC and RX Attenuator Calibration Data, Alternate Frequency 3 (if AFH enabled)
08h	IDAC and RX Attenuator Calibration Data, Alternate Frequency 4 (if AFH enabled)
09h	IDAC and RX Attenuator Calibration Data, Alternate Frequency 5 (if AFH enabled)
10h	Mutual Gain Correction
11h	Self Gain Correction
12h	Attenuator Trim

Table 6-57. 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

Table 6-57. Retrieve Data Structure Command (Output Report)

5	RSVD = 00h		00h
6	RSVD	Command Code = 24h	24h
7	Read Offset[7:0]: Byte offset into Data Structure (see Table 6-56 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 6-56 for more details)		XXh

Table 6-58. 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								1Fh
3	RSVD = 00h								00h
4	TGL	Command Code = 24h							24h
5	Status: 00h = success; 01h = failure								XXh
6	Data ID: Data ID Selected in Output Report								XXh
7	Actual Read Length[7:0]: Actual number of bytes returned								
8	Actual Read Length[15:8]: Actual number of bytes returned								
9	RSVD								09h
10	Data (0)								XXh
…	…								
Actual Read Length +9	Data (Actual Read Length - 1)								

.

Table 6-59. Data ID and Read Offset Values for Data Structures

Data ID	Read Offset and Data Structure Returned
00h - IDAC and RX Attenuator Calibration Data (center frequency, and alternative frequencies if AFH is enabled)	0 - RX Attenuator Mutual
	1 - IDAC Mutual
	2 - RX Attenuator Self RX
	3 - IDAC Self RX
	4 - RX Attenuator Self TX
	5 - IDAC Self TX
	6 - RX Attenuator Button Mutual
	7 - IDAC Button Mutual
	8 - RX Attenuator Button Self
	9 - IDAC Button Self

Table 6-59. Data ID and Read Offset Values for Data Structures

10h - Mutual Gain Correction 11h - Self Gain Correction	0 - RX0 Gain Correction (+ve phase) [7:0]
	1 - RX0 Gain Correction (+ve phase) [15:8]
	2 - RX0 Gain Correction (-ve phase) [7:0]
	3 - RX0 Gain Correction (-ve phase) [15:8]
	4 - RX1 Gain Correction (+ve phase) [7:0]
	5 - RX1 Gain Correction (+ve phase)) [15:8]
	6 - RX1 Gain Correction (-ve phase) [7:0]
	7 - RX1 Gain Correction (-ve phase)) [15:8]
	...
	(4 * RX_NUM - 4) - RX[RX_NUM - 1] (+ve phase) [7:0]
	(4 * RX_NUM - 3) - RX[RX_NUM - 1] (+ve phase) [15:8]
	(4 * RX_NUM - 2) - RX[RX_NUM - 1] (-ve phase) [7:0]
	(4 * RX_NUM - 1) - RX[RX_NUM - 1] (-ve phase) [15:8]
12h - Attenuator Trim	0 - RX0 Attenuator Trim
	1 - RX1 Attenuator Trim
	...
	[RX_NUM - 1] - RX[RX_NUM - 1] Attenuator Trim

6.3.17 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. After 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 6-60. Self Test Commands

Name	Code	Description
NULL test	0x00	Performs no action
BIST	0x01	Comprehensive built-in self-test
Opens	0x03	Open circuit test suites
Automatic Shorts	0x04	Short circuit test suite - external and pin-to-pin
CM Panel Test	0x05	Mutual-capacitance panel test
CM Buttons Test	0x06	Mutual-capacitance buttons test
CP Panel Test	0x07	Self-capacitance panel test
CP Buttons Test	0x08	Self-capacitance buttons test

6.3.18 BIST (Built-In Self-Test)

Self-Test ID: 01h

Built-in self-test will execute both the Automatic Shorts test and Opens test, each described in the following sections (see “Automatic Shorts Test” on page 97 and “Opens Test” on page 94). The test returns a single pass/fail status. To get detailed return data the automatic shorts test must be run.

Table 6-61. BIST Test Parameters

Parameter	Type	Description
[MFG] ILEAK_MAX	Flash	Shorts test threshold in units of nA
[MFG] OPENS_TEST_RAW_THRESHOLD_MUTUAL	Flash	Maximum Allowable Open Circuits Test RawCount Value for Panel
[MFG] OPENS_TEST_RAW_THRESHOLD_BUTTON	Flash	Maximum Allowable Open Circuits Test RawCount Value for Buttons
[MFG] OPENS_TEST_IDAC_MUTUAL	Flash	Open test IDAC value for mutual
[MFG] OPENS_TEST_ATTEN_MUTUAL	Flash	Open test RX Attenuator value for mutual
[MFG] OPENS_TEST_IDAC_BUTTON	Flash	Open test IDAC value for button
[MFG] OPENS_TEST_ATTEN_BUTTON	Flash	Open test RX attenuator value for button

6.3.18.1 *Run BIST Self-test Command*

Command Code: 26h

Table 6-62. Run BIST self test (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] = 07h								07h
3	Length[15:8] = 00h								00h

Command Details

Table 6-62. Run BIST self test (Output Report)

4	Report ID = 2Fh		2Fh
5	RSVD = 00h		00h
6	RSVD	Command Code = 26h	26h
7	BIST Self test ID		01h

Table 6-63. Run Self-test (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 = 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 retrieve the detail test results and evaluate if the self-test is pass or fail								XXh

6.3.19 Opens Test

Self-Test ID - 03h

This command executes an open circuits test on a panel. The open circuits test provides thresholds for panel-wide mutual-cap and button RawCount values. Additionally test limits can be set for IDAC and RX Attenuator values for both mutual and button scan types.The opens test requires running two consecutive commands to run the test ("Run Opens Self-test Command" on page 96) and get the test results ("Get Opens Self-test Results Command" on page 96).

The parameters used to run this test are shown in Table 6-64.

Table 6-64. Threshold Parameters Used for Test Pass/Fail

Parameter	Type	Description
OPENS_TEST_RAW_THRESHOLD_MUTUAL	Flash	Maximum Allowable Open Circuits Test RawCount Value for Panel
OPENS_TEST_RAW_THRESHOLD_BUTTON	Flash	Maximum Allowable Open Circuits Test RawCount Value for Buttons
OPENS_TEST_IDAC_MUTUAL	Flash	Open test IDAC value for mutual
OPENS_TEST_ATTEN_MUTUAL	Flash	Open test RX Attenuator value for mutual
OPENS_TEST_IDAC_BUTTON	Flash	Open test IDAC value for button
OPENS_TEST_ATTEN_BUTTON	Flash	Open test RX attenuator value for button

6.3.19.1 Opens Test Theory

The purpose of the opens circuits test is to detect open circuit ITO traces on the panel. With a known IDAC value, Attenuator value and CDC configuration the raw data will never reach predefined threshold. If this threshold is reached an open circuit exists at the TX/RX intersection. The Opens test uses the current CDC configuration for the base Tx frequency but will override the setting for MTX_ORDER with a value of 1 during the test.

In the following figures one ITO trace was cut between the touchscreen and controller to demonstrate the differences between a panel with and without open-circuit ITO traces. The raw-count heat maps from TTHE are shown in Table 6-1 for a touchscreen without open-circuits and Table 6-2 for a touchscreen with open-circuit ITO traces.

A difference between a TX-RX intersection without an open-circuit and one with an open-circuit is about 3000 counts, where a finger touch is about 400.

Figure 6-1. TTHE Heat Map of Touchscreen With No Open Circuits

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
12	-931	-758	-564	-470	-403	-327	-247	-175	-103	-64	-17	428	467	521	473	469	310	112	-2905	742	769	791	853
11	-1013	-964	-691	-592	-522	-442	-364	-286	-212	-165	-110	275	318	375	357	368	356	283	-2181	603	630	650	715
10	-926	-987	-611	-519	-443	-372	-293	-221	-149	-100	-38	260	304	360	354	381	381	395	166	582	606	627	684
9	-935	-1151	-640	-546	-467	-387	-305	-229	-156	-102	-36	209	254	310	314	347	377	393	17	537	564	585	647
8	-858	-1125	-558	-469	-384	-309	-232	-159	-87	-31	37	211	255	310	315	352	380	414	380	529	554	575	635
7	-833	-1362	-574	-485	-397	-316	-240	-164	-88	-27	42	157	205	261	267	305	343	376	295	481	504	524	588
6	-800	-1365	-527	-443	-348	-270	-187	-114	-41	18	91	146	193	247	258	295	331	369	382	463	488	[illegible]	570
5	-813	-1133	-538	-453	-351	-269	-190	-112	-37	20	94	87	139	192	205	247	287	321	323	410	432	450	511
4	-871	-1109	-572	-494	-366	-280	-200	-121	-45	16	93	20	76	132	150	186	223	263	289	352	377	393	455
3	-773	-920	-501	-435	-288	-205	-124	-44	31	89	166	27	89	145	162	203	244	277	295	[illegible]	380	399	457
2	-771	-772	-490	-478	-247	-164	-80	1	78	124	219	7	76	134	156	192	[illegible]	[illegible]	[illegible]	352	373	392	448
1	-807	-758	-552	-594	-264	-180	-95	-14	62	124	212	-91	-2	59	85	125	166	203	227	283	303	322	378
0	-632	-533	-427	-913	-52	30	111	189	263	320	410	-29	104	177	209	[illegible]	286	322	358	405	425	445	499

Figure 6-2. Heat map for damaged panel

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
12	2262	-1022	-611	-472	-404	-328	-248	-176	-102	-65	-18	426	[illegible]	521	471	467	309	111	-2906	742	768	790	851
11	2262	-1234	-740	-594	-524	-442	-365	-287	-214	-165	-111	274	316	374	356	367	355	280	-2183	601	628	650	714
10	2257	-1250	-657	-520	-447	-373	-296	-221	-149	[illegible]	-38	260	303	359	353	381	382	394	166	581	605	626	685
9	2273	-1416	-689	-547	-468	-387	-307	-229	-158	-103	-36	207	251	309	314	346	374	392	16	536	562	585	644
8	2261	-1386	-605	-469	-385	-310	[illegible]	[illegible]	-90	-32	36	210	254	309	315	351	379	412	381	529	553	574	634
7	2262	-1621	-620	-487	-399	[illegible]	-241	[illegible]	-90	-29	41	155	204	260	266	304	343	374	294	480	502	524	587
6	2259	-1622	-573	-443	-350	-270	[illegible]	-115	-42	17	90	145	191	246	255	293	330	367	381	462	487	506	570
5	2259	-1390	-585	-453	[illegible]	-270	-191	-113	-39	18	92	84	137	192	204	246	286	319	321	408	430	451	511
4	2252	-1369	-618	[illegible]	-367	-282	-202	-123	-45	14	91	19	75	131	148	185	222	261	288	351	374	394	453
3	2251	-1173	-547	[illegible]	-289	-207	-126	-47	30	88	166	26	87	142	161	201	242	275	294	358	378	399	455
2	2236	[illegible]	-534	-479	-248	-165	-82	-2	75	122	219	5	74	133	154	192	232	269	300	351	371	391	447
1	[illegible]	[illegible]	-597	-595	-266	-182	-98	-16	61	122	211	-92	-3	58	84	124	166	201	226	283	302	321	377
0	2199	-772	-472	-913	-53	30	109	187	262	319	410	-30	103	177	208	246	285	322	357	405	424	444	498

6.3.19.2 Run Opens Self-test Command

Command Code: 26h

Executes opens self-test. Results are retrieved from RAM using the “Get Opens Self-test Results Command” on page 96.

Table 6-65. Run Opens Self-test Command Packet (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 = 26h							26h
7	Opens Self test ID								03h

Table 6-66. Run Opens Self-test Response Packet (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 = 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 retrieve the detail test results and evaluate if the self-test is pass or fail								XXh

6.3.19.3 Get Opens Self-test Results Command

Command Code: 27h

Returns the opens self-test results data. The “Run Opens Self-test Command” on page 96 must have been executed before this command. The raw count of each mutual-cap intersection is compared against the test threshold. If the sensor charge is dropped due to an open circuit, the raw count is expected to increase. The test passes if all the mutual-capacitance raw counts are below the test threshold. The test fails if any of the raw count values are above the test threshold. The individual binary test results for each intersection are returned. The individual raw count comparison binary test results are saved in the RAM and can be retrieved using the Get Self-Test Result command. But the individual raw count values are not saved.

Button data is appended to the end of the TX/RX intersection data. The first half of the button data is the mutual-cap button data. The remaining data is the self-cap button data. For example, if 4 buttons are configured a total of 8 bytes of opens button data will be returned. The first 4 bytes are mutual-cap data and the last 4 bytes are self-cap data. Though the device will always return mutual-cap and self-cap data for the buttons, the configuration parameter [CDC] SCANNING_MODE_BUTTON determines the validity of the returned button data. If the button scanning mode is set to Hybrid, all of the button data is valid. If the mode is set to Mutual Capacitance, the mutual-capacitance data is valid. Likewise, if the mode is set to Self Capacitance, only the self-capacitance data is valid.

The measured raw data values are returned with pass/fail status of the opens test.

Table 6-67. Get Opens Self-test Results Command Packet (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

Table 6-67. Get Opens Self-test Results Command Packet (Output Report)

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Value
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 6-68. Get Opens Self-test Results Response Packet (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	For each intersection - 1 byte of data will be returned indicating a pass / fail, where 00h = success; 01h = fail; The first byte will be the TX0 / RX0 intersection, followed by TX0 / RX1 - TX0 / RX(N-1). The data returned will increment through for the number of TX configured. If button data is configured, the button data will be appended to the touchscreen sensor results starting with button number 0.								XXh
...									XXh
Actual Read Length + 9									XXh

6.3.20 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. The automatic shorts test requires running two consecutive commands to run the test (“Run Automatic Shorts Self-test Command” on page 97) and get the test results (“Get Automatic Shorts Self-test Results Command” on page 98).

Table 6-69. Automatic Shorts Test Parameters

Parameter	Description
[MFG] ILEAK_MAX	Shorts test threshold in units of nA
[CDC] REFGEN_CTL.REF_SCALE	Sets the Shorts test reference (V_{REF}) voltage.

6.3.20.1 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” on page 98, 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 6-70. Run Automatic Shorts Self-test Command Packet (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

Command Details

Table 6-70. Run Automatic Shorts Self-test Command Packet (Output Report)

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

Table 6-71. Run Automatic Shorts Self-test Response Packet (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 = 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 retrieve the detail test results and evaluate if the self-test is pass or fail								XXh

6.3.20.2 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” on page 97 must have been executed before this command. The calculated data field returns the calculated Pin Masks (indicating which pins on each port are actually in use). See *TrueTouch Communication Examples - Packet Interface Protocol (PIP)* - AN85948 for a full listing of pins masks for each device package. The external shorts test results and pin-to-pin shorts test results are reported following the calculated Pin Masks. The length of the external shorts test results and the pin-pin shorts test results are always the same as the calculated Pin Masks. The Active Read Length[15:0] is the number of bytes of the sum of the calculated Pin Masks, the external shorts test results, and the pin-pin shorts test results.

Table 6-72. Get Automatic Shorts Self-test Results Command Packet (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 = 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 6-73. Get Automatic Shorts Self-test Results Response Packet (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

Table 6-73. Get Automatic Shorts Self-test Results Response Packet (Input Report)

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 **Note:** See *TrueTouch Communication Examples - Packet Interface Protocol (PIP)* - AN85948 for a full listing of pins masks for each device package.	XXh
11	Calculated Pin Mask (1): 0 = pin not configured; 1 = pin configured	XXh
...	...	XXh
9 + N	Calculated Pin Mask (N-1): 0 = pin not configured; 1 = pin configured	XXh
9 + N + 1	External Shorts Results (0): 0 = no short; 1 = short detected	XXh
9 + N + 2	External Shorts Results (1): 0 = no short; 1 = short detected	XXh
...	...	XXh
9 + 2*N	External Shorts Results (N-1): 0 = no short; 1 = short detected	XXh
9 + 2*N + 1	Pin-to-pin Shorts Results (0): 0 = no short; 1 = short detected	XXh
9 + 2*N + 2	Pin-to-pin Shorts Results (1): 0 = no short; 1 = short detected	XXh
...	...	XXh
9 + 3*N	Pin-to-pin Shorts Results (N-1): 0 = no short; 1 = short detected	XXh

6.3.20.3 Run C_M Panel Self-test Command

Command Code: 26h

Executes C_M Panel self-test. Results are retrieved from RAM using the “Get CM Panel Self-test Results Command” on page 100, 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.

The C_M Panel test is a general-purpose manufacturing test that can be used to screen touch panels for:

- Defects (open-circuits, hairline cracks, and scratches)
- Panel uniformity
- Validation of Calibration Data

This test uses the sensor charge received by the TrueTouch controller to calculate the effective mutual-capacitance (C_M) of each TX/RX intersection. The integrity of the touch panel can be evaluated by comparing the calculated C_M of each intersection against a whole-panel target value or per-element limit.

Table 6-74. C_M Panel Self-test Command Packet (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 = 26h							26h
7	CM Panel Self-test ID								05h

Command Details

Table 6-75. CM Panel Self-test Response Packet (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 = 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 retrieve the detail test results and evaluate if the self-test is pass or fail								XXh

6.3.20.4 Get C_M Panel Self-test Results Command

Command Code: 27h

Returns the C_M Panel self-test results data. The "Run CM Panel Self-test Command" on page 99 must have been executed before this command. A two-byte mutual-capacitance value for each TX/RX intersection in the format. This mutual-capacitance value must be multiplied by decimal 10 to get a value in femto-farads. The last two bytes returned contains the mutual-capacitance calibration value.

Table 6-76. Get C_M Panel Self-test Results Command Packet (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 = 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	CM Panel Self Test ID: ID assigned to the self test that just completed								05h

Table 6-77. Get C_M Panel Self-test Results Response Packet (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	CM Panel Self-test ID								05h
7	Actual Read Length[7:0]: Actual number of bytes returned								XXh
8	Actual Read Length[15:8]								XXh
9	RSVD = 00h								00h
...	A two-byte mutual-capacitance value for each TX/RX intersection in the format: TX0RX0, TX0RX1, TX0RX2, ..., TX[N-1]RX[N-1]. This mutual-capacitance value must be multiplied by decimal 10 to get a value in femto-farads. The size of this structure will be TX * RX * 2								XXh
Length-2	Mutual-cap calibration LSB								XXh
Length-1	Mutual-cap calibration MSB								XXh

6.3.20.5 Run C_P Panel Self-test Command

Command Code: 26h

Executes C_P Panel self-test. Results are retrieved from RAM using the “Get CP Panel Self-test Results Command” on page 101, 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.

The C_P Panel test can be used to validate the self-capacitance calibration for the touch panel. The C_P test uses the sensor charge received by the TrueTouch controller to calculate the effective self-capacitance (C_P) of each self-cap electrodes.

Table 6-78. C_P Panel Self-test Command Packet (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 = 26h							26h
7	CP Panel Self-test ID								06h

Table 6-79. C_P Panel Self-test Response Packet (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 = 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 retrieve the detail test results and evaluate if the self-test is pass or fail								XXh

6.3.20.6 Get C_P Panel Self-test Results Command

Command Code: 27h

Returns the C_P Panel self-test results data. The “Run CP Panel Self-test Command” on page 101 must have been executed before this command. This command returns a two-byte self-capacitance value for each TX, followed by a two-byte TX self-cap calibration value for each TX. A two-byte self-capacitance value for each RX follows the TX data. The two-byte self-cap calibration data is the final data structure returned in this command. The self-capacitance value returned must be multiplied by decimal 10 to get a value in femto-farads.

Table 6-80. Get C_P Panel Self-test Results Command Packet (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 = 27h							27h
7	Read Offset[7:0]: Byte offset into self test results to start retrieving data								XXh

Command Details

Table 6-80. Get C_P Panel Self-test Results Command Packet (Output Report)

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	CP Panel Self Test ID: ID assigned to the self test that just completed	06h

Table 6-81. Get C_P Panel Self-test Results Response Packet (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	CP Panel Self-test ID								06h
7	Actual Read Length[7:0]: Actual number of bytes returned								XXh
8	Actual Read Length[15:8]								XXh
9	RSVD = 00h								00h
...	A two-byte self-capacitance value for each TX. This self-capacitance value must be multiplied by decimal 10 to get a value in femto-farads. The size of this structure will be TX * 2								XXh
...	A two-byte self-capacitance calibration value for each TX. This self-capacitance value must be multiplied by decimal 10 to get a value in femto-farads. The size of this structure will be TX * 2								XXh
...	A two-byte self-capacitance value for each RX. This self-capacitance value must be multiplied by decimal 10 to get a value in femto-farads. The size of this structure will be RX * 2								XXh
...	A two-byte self-capacitance calibration value for each RX. This self-capacitance value must be multiplied by decimal 10 to get a value in femto-farads. The size of this structure will be RX * 2								XXh

6.3.20.7 Run C_M Button Self-test Command

Command Code: 26h

Executes C_M Button self-test. Results are retrieved from RAM using the "Get CM Button Self-test Results Command" on page 103, 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.

The C_M Button test is a general-purpose manufacturing test that can be used to screen CapSense buttons for:

- Defects (open-circuits, hairline cracks, and scratches)
- Panel uniformity
- Validation of Calibration Data

This test uses the sensor charge received by the TrueTouch controller to calculate the effective mutual-capacitance (C_M) of each button. The integrity of the touch panel can be evaluated by comparing the calculated C_M of each button against a whole-panel target value or per-element limit.

Table 6-82. C_M Button Self-test Command Packet (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 = 26h							26h
7	CM Panel Self-test ID								07h

Table 6-83. C_M Button Self-test Response Packet (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 = 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 retrieve the detail test results and evaluate if the self-test is pass or fail								XXh

6.3.20.8 Get C_M Button Self-test Results Command

Command Code: 27h

Returns the C_M Button self-test results data. The "Run CM Button Self-test Command" on page 102 must have been executed before this command. A two-byte mutual-capacitance value for each button in the format. This mutual-capacitance value must be multiplied by decimal 10 to get a value in femto-farads. The last two bytes returned contains the mutual-capacitance calibration value.

Table 6-84. Get C_M Button Self-test Results Command Packet (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 = 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	CM Button Self Test ID: ID assigned to the self test that just completed								07h

Table 6-85. Get C_M Button Self-test Results Response Packet (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	CM Panel Self-test ID								07h
7	Actual Read Length[7:0]: Actual number of bytes returned								XXh
8	Actual Read Length[15:8]								XXh
9	RSVD = 00h								00h
...	A two-byte mutual-capacitance value for each button (size = 2 * NUM_BTN). This mutual-capacitance value must be multiplied by decimal 10 to get a value in femto-farads.								XXh
Length-2	Mutual-cap calibration LSB								XXh
Length-1	Mutual-cap calibration MSB								XXh

6.3.20.9 Run C_P Button Self-test Command

Command Code: 26h

Executes C_P Button self-test. Results are retrieved from RAM using the "Get CP Button Self-test Results Command" on page 104, 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.

The C_P Button test can be used to validate the self-capacitance calibration for the touch panel. The C_P Button test uses the sensor charge received by the TrueTouch controller to calculate the effective self-capacitance (C_P) of each self-cap electrodes.

The C_P Button test is a set of calculations that use the calibration and RawCount values to find the sensor C_P. These calculations are performed either in the host processor or by using the attached spreadsheet calculator tool. Prior to performing the C_P test, a valid calibration must exist in the device.

Table 6-86. C_P Button Self-test Command Packet (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 = 26h							26h
7	CP Panel Self-test ID								08h

Table 6-87. C_P Button Self-test Response Packet (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 = 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 retrieve the detail test results and evaluate if the self-test is pass or fail								XXh

6.3.20.10 Get C_P Button Self-test Results Command

Command Code: 27h

Returns the C_P Button self-test results data. The "Run CM Panel Self-test Command" on page 99 must have been executed before this command. A two-byte mutual-capacitance value for each button in the format. This mutual-capacitance value must be multiplied by decimal 10 to get a value in femto-farads. The last two bytes returned contains the mutual-capacitance calibration value.

Table 6-88. Get C_P Button Self-test Results Command Packet (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

Table 6-88. Get C_P Button Self-test Results Command Packet (Output Report)

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	CP Button Self Test ID: ID assigned to the self test that just completed								08h

Table 6-89. Get C_P Button Self-test Results Response Packet (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	CP Button Self-test ID								08h
7	Actual Read Length[7:0]: Actual number of bytes returned								XXh
8	Actual Read Length[15:8]								XXh
9	RSVD = 00h								00h
...	A two-byte slf-capacitance value for each button (size = NUM_BTN * 2). This mutual-capacitance value must be multiplied by decimal 10 to get a value in femto-farads.								XXh
Length-2	Self-cap calibration LSB								XXh
Length-1	Self-cap calibration MSB								XXh

6.3.21 Calibrate

Command Code: 28h

Performs calibration for the whole panel for all sensing modes. Mutual, Self-cap Rx, Self-cap Tx, Button Mutual, and Button Self each have individual IDAC and RX Attenuator calibration values. In addition, calibration will perform a gain correction and attenuator trim for all enabled RX channels to minimize channel-to-channel mismatch and attenuator offset. The 8-bit gain correction is minimizes the IDAC balance current mismatch between RX channels. Each attenuator supports an 8-bit trim value to improve attenuation ratio precision. A full calibration can be performed in a controlled environment 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 90. 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 6-90. Calibrate Command Packet (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	Sense Mode: 0: Calibrate IDAC for mutual-cap 1: Calibrate IDAC for buttons 2: Calibrate IDAC for self-cap								00h

Table 6-91. Calibrate Response Packet (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

6.3.22 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 before 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 6-92. Initialize Baselines Command Packet (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 6-93. Initialize Baselines Response Packet (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

6.3.23 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 108).

Table 6-94. Execute Panel Scan Command Packet (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 6-95. Execute Panel Scan Response Packet (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

6.3.24 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 106). 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 one status byte appended to the data packet, where bit 0 indicates the state of the button (0 = idle; 1 = active).

Table 6-96. Retrieve Panel Scan Data Types and IDs

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

Figure 6-3. Button for Mutual-Cap or Self-Cap Modes Data

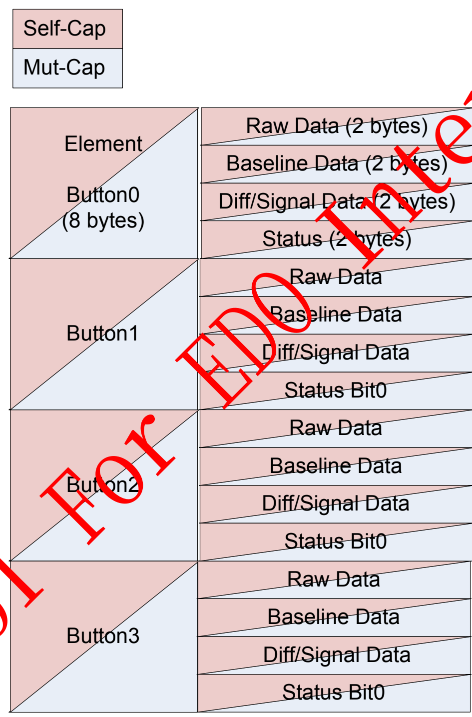


Figure 6-4. Button Mutual-Cap + Self-Cap Data

Self-Cap
Mut-Cap

Element	
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 6-97. Retrieve Panel Scan Command Packet (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

Command Details

Table 6-97. Retrieve Panel Scan Command Packet (Output Report)

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 6-96 on page 108)		XXh

Table 6-98. Retrieve Panel Scan Response Packet (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 6-96 on page 108)								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 = 0011b				MTRX	Size			XXh
10	Data (0)								XXh
11	Data (1)								XXh
…	…								XXh
Size * Actual Read Length + 9	Data (Size * Actual Read Length – 1)								XXh

MTRX: See [Device Setup] SENSOR_ASSIGNMENT register on page 131

Size: Data element size in bytes

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

Table 6-99. 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
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 6-100. 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
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

6.3.25 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 114). 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 6-101. Start Sensor Mode Data Command Packet (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 6-102. Touchscreen Sensor Type 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 00 - Mutual 10 - Self		RSVD = 000b			Offset[10:8]			XXh

Table 6-103. Button Sensor Type Data Point Description

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Value
0	RSVD = 0h				ID				XXh
1	01 - Button		RSVD = 000b			00 - Self 01 - Mutual		RSVD = 0b	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 07FFh terminates the sensor list of data point descriptions instead of an requesting additional data point descriptions.

Table 6-104. Start Sensor Mode Data Point Response Packet (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.

6.3.26 Stop Sensor Data Mode

Command Code: 2Dh

Disables the Start Sensor Data Mode Command (see “Start Sensor Data Mode” on page 112).

Table 6-105. Stop Sensor Data Mode Command Packet (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 6-106. Start Sensor Data Mode Response Packet (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

6.3.27 Start Tracking Heat Map Mode

Command Code: 2Eh

Enables the Tracking Heat Map Mode. The device reports the 7x7 sensor matrix data for up to two touches until device reset or the Stop Sensor Data Mode command is received (see “Stop Sensor Data Mode” on page 114).

Table 6-107. 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 6-108. 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 6-109 to the host in addition to the usual touch and button reports after scanning and reporting are re-enabled.

The data reports a square region of 7x7 sensors surrounding the first and second valid touch object reported. The X/Y position of the region is reported. If the region extends off of the panel, it is moved back onto the panel. In Figure 6-5, 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 6-5. Heat Map Tracking Mode Example Sensor Regions

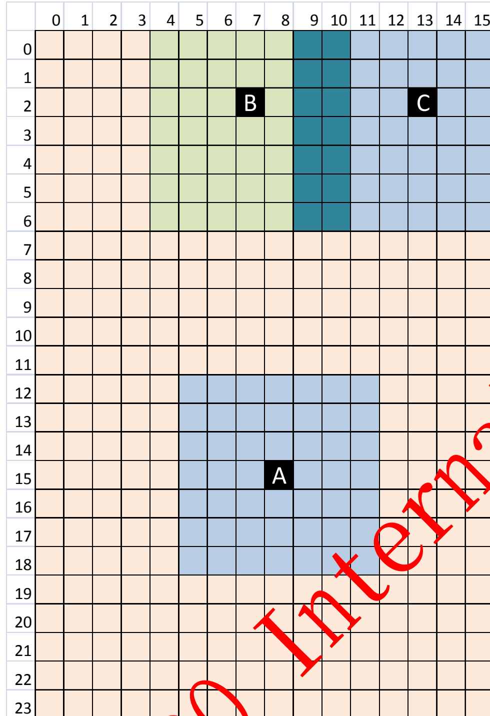


Table 6-109. Start Tracking Heat Map Mode Input Report

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 touch - Lowest X sensor reported								XXh
5	First touch - 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 touch - Lowest X sensor reported								XXh
105	Second touch - 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

Command Details

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Value
....	....								XXh
....									XXh
202	Signal Data for Point (6,6)								XXh
203									XXh

6.3.28 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 6-110. Interrupt Pin Override Command Packet (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 before going into ARM CPU Deep-Sleep mode.

Table 6-111. Interrupt Pin Override Response Packet (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 C: Touchscreen System

This section contains specific information related to scanning, pin assignments, and power. For step-by-step tuning guidance, see the Cypress specification 001-92531.

This section includes the following chapters:

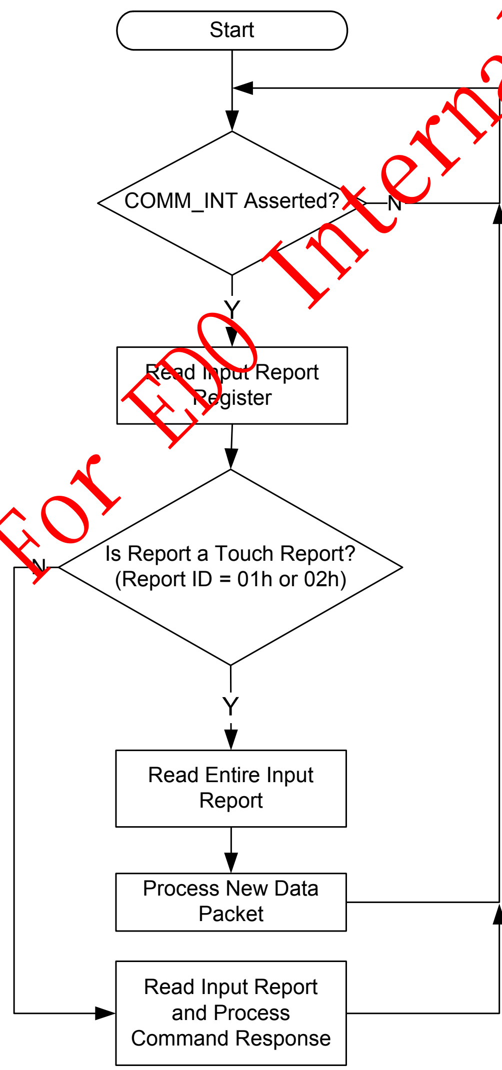
Sensor Design

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.

7. 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 3-1 on page 42.

Figure 7-1. Data Acquisition Flow in Response to Interrupt Pin



7.1 Touch Reports

Touch reports are located in the Input Report register. See Packet Interface Protocol (PIP) chapter on page 41 for more details For a part designed to track 10 fingers and the number of touches on the panel is exceeded by one, the device continues to operate normally, tracking and reporting maximum touches, while ignoring the additional touch. If the number of touches is exceeded by 2 or more, the device may not properly report existing touches.

Table 7-1. 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 7-2)								
…									
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 001-84609 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 7-2. 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 and glove
1 = Proximity
4-15 = Reserved

Tip: Indicates touch liftoff status.
1 = Touch is currently on the panel.
0 = 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 mm) 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 mm) 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.

7.2 Button Reports

Touch reports are located in the Input Report register. See Packet Interface Protocol (PIP) chapter on page 41 for more details

Table 7-3. 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.

8. Power System

8.1 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.

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. The Deep Sleep power domain is powered by the V_{DDD} supply. See the device datasheet for detailed power domain specification and typical supply connections.

To communicate with the host using I^2C 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 TrueTouch device 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 device 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 TrueTouch device, the host system must pause communications as the supply is being ramped up or down.

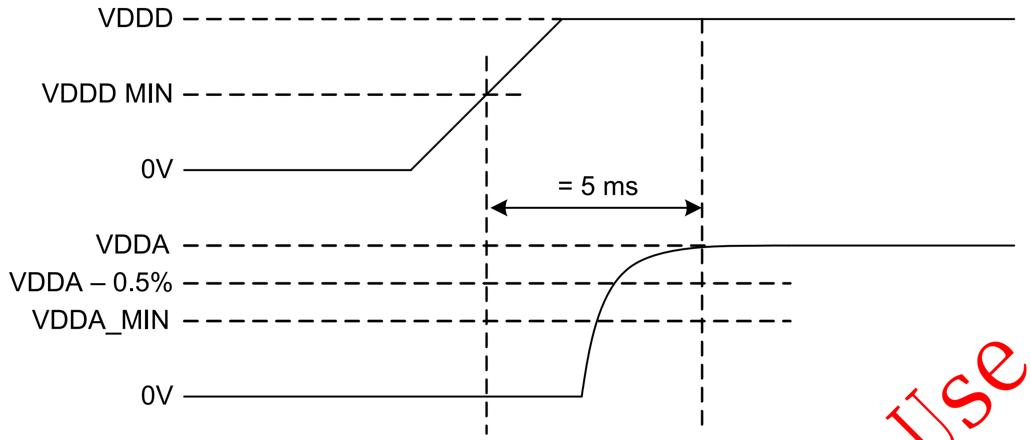
8.1.1 Power Supply Sequencing

The power supplies (V_{DDD} and V_{DDA}) may be sequenced in any order, at any time, and any ramp rate allowed by the specifications in the device datasheet. The device is only fully functional when all supplies are stable and within their allowed operational limits.

The device begins communication and firmware execution when the minimum V_{DDD} supply is met. Scanning begins when the minimum V_{DDA} supply is met. To ensure touch report accuracy, the V_{DDA} supply must be fully ramped within 5 ms of V_{DDD} reaching the minimum voltage. V_{DDA} can be supplied before V_{DDD} to ensure this condition is met. If this ramp rate requirement can't be met the following are guidelines to prevent inaccuracy in touch reports:

- **Device Reset with Calibration -** Ramp rate is especially critical during the first power-up following a device program, because the IDACs are calibrated during this power-up sequence. If the V_{DDA} ramp rate is very slow, the IDACs may be calibrated using an invalid V_{DDA} supply reference. This may occur if V_{DDA} is still rising 5 ms after the V_{DDD} supply minimum has been met. If this occurs, the device must be recalibrated manually after both supplies are stable (see "Run CM Panel Self-test Command" on page 99).
- **Device Reset no Calibration -** Ramp rate of the V_{DDA} supply that does not meet the 5 ms requirement may cause false touches, due to an invalid baseline. If this occurs, the device may be reset after supplies are stabilized using a software reset (SRES) or external reset (XRES). If a reset is not possible, touch reports should be ignored until the baselines have recovered or have been initialized manually (see "Initialize Baselines" on page 106). Although a calibration does not need to be performed using this method, a calibration may occur automatically. Dynamic calibration, which is enabled in this TrueTouch device, ensures that the device is properly calibrated with the connected touch panel. It evaluates the calibration data of each scanning mode and compares against a target threshold at each device power-up or reset. If the calibration data fails to meet the specified target, it will automatically execute a device calibration once. The existing calibration data in the flash memory will be replaced.

Figure 8-1. Power Supply Sequencing Timing Diagram



8.1.2 Configuring Power Supplies

The V_{DDD} and V_{DDA} domains do not need to be configured by any parameter. Here are the configurations to enable the V_{DDA} pump.

Enabling V_{DDA} charge pump (see [CDC] VDDA_MODE):

1. Use the default setting for **VDDA_MODE**.**PUMP_MODE**

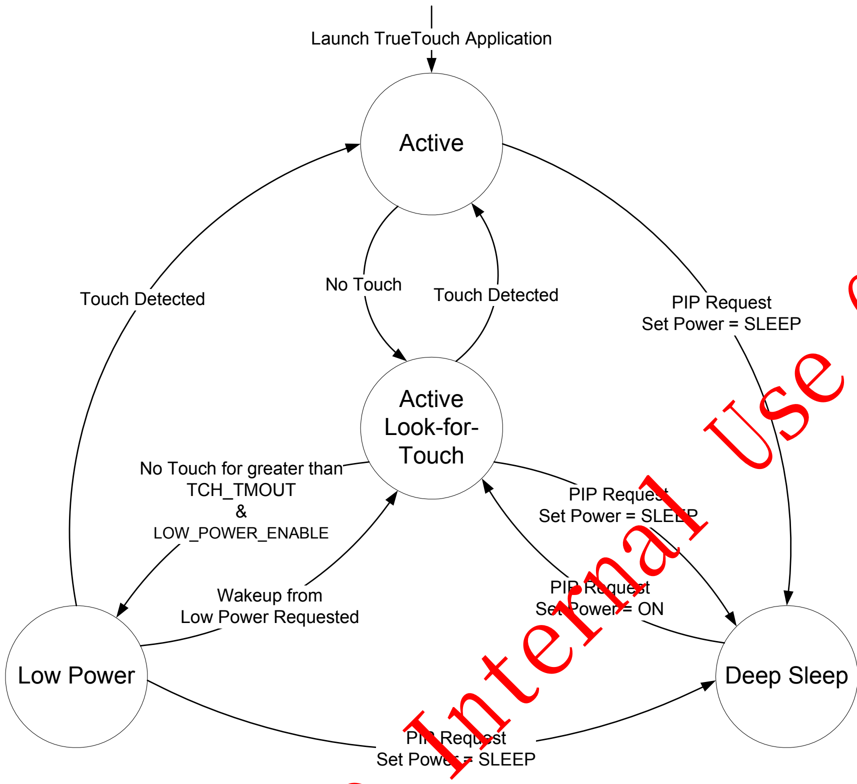
8.2 Power States

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 LOW_POWER_STATE bit in the RAM LOW_POWER_ENABLE parameter.

Figure 8-2. Power States and Transitions

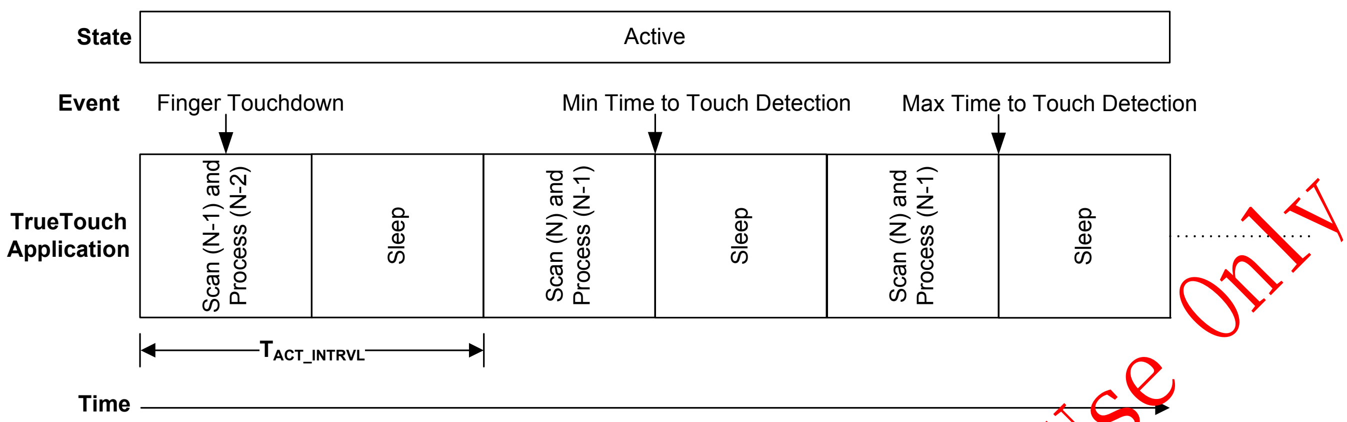


8.2.1 Refresh, Response, and Report Timing

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. The Active, Active LFT, and Low-Power states each have a separate refresh interval parameter. Typical active refresh interval values are in the order of 8-10 ms. A slower refresh rate is typically used in the Low-Power state, which may be near 10 Hz (or 100 ms intervals). Increasing the [Device Setup] 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 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 8-3.

Figure 8-3. 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.

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

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

8.2.2 Active State

The Active state uses the shortest refresh interval of all states, and is used during touch activity. The [Device Setup] 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 8-4). The device sleeps between scanning/processing cycles to reduce power consumption. Scanning and processing will be performed continuously if the [Device Setup] 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 8-1 specifies equations for calculating these times.

Figure 8-4. Active LFT Timing Diagram

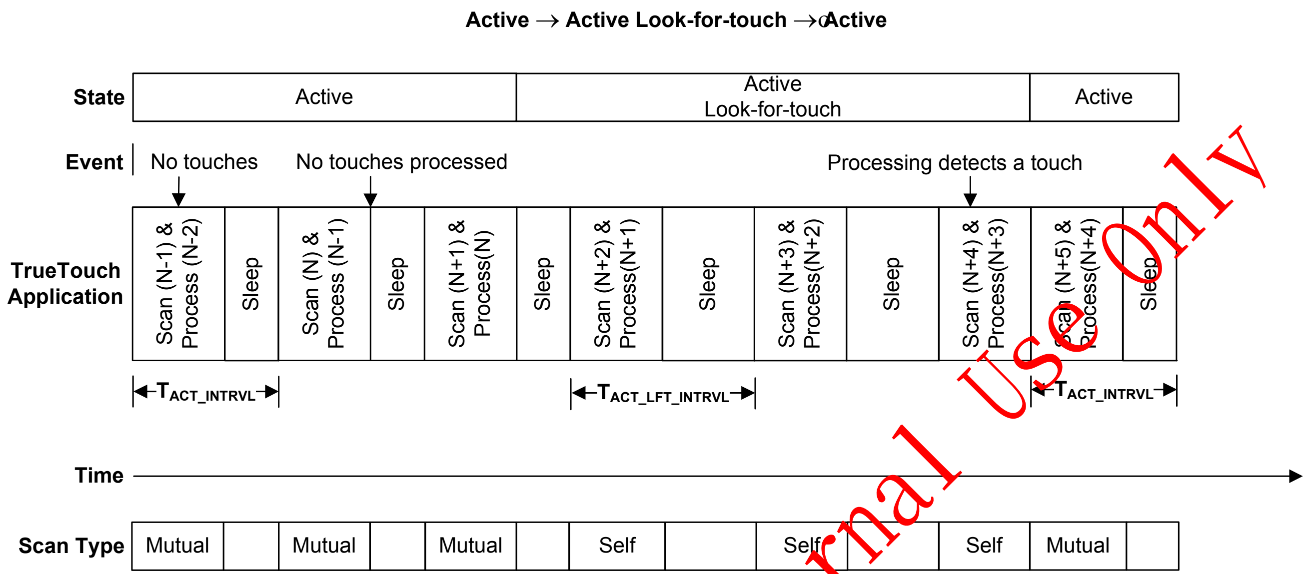


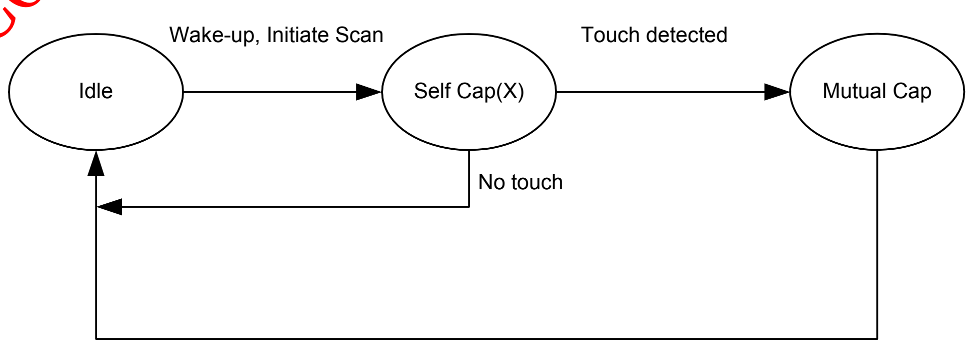
Table 8-1. Active State Timing Equations

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	$3 \times T_{refresh\_ACT} > T_{report} \geq 2 \times T_{refresh\_ACT}$

8.2.3 Active Look-for-Touch State

The Active LFT state is entered automatically when there is no touch activity. In the Active LFT state, only a self-capacitive scan is performed to determine if there is a touch on the panel. A mutual-capacitive scan is only performed if the self-capacitive scan indicates that a touch was detected (see Figure 8-5). Self-capacitive scanning in the Active LFT state must be enabled in the [Finger Tracking] 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 8-4 for state transition timing information.

Figure 8-5. Active LFT Scanning Flow



The [Device Setup] ACT_INTRVL0 parameter specifies the Active LFT refresh interval (in 1-ms increments). For most systems, the [Device Setup] ACT_INTRVL0 is greater than [Device Setup] 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 128). The host may request the device to deep sleep from this state. If a touch is detected, the device enters the Active state.

Table 8-2 specifies equations for calculating the timeout based on the values of [Device Setup] ACT_INTRVL0 and [Device Setup] TCH_TMOUT0 and the scanning/processing cycle time.

Table 8-2. 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	$_{INTRVL} + T_{PROCESS\_MC} + T_{SCAN\_SC} + T_{SCAN\_MC} > T_{response\_ACT\_LFT} \geq T_{scan} + T_{r\ldots}$
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.

8.2.4 Low-Power State

The [Device Setup] ACT_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 RAM parameter LOW_POWER_MODE to disabled. 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 8-6 for state transition timing information. When a liftoff event occurs, a timer begins a countdown, where the time is defined by the [Device Setup] 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 8-6. Low-Power Timing Diagram

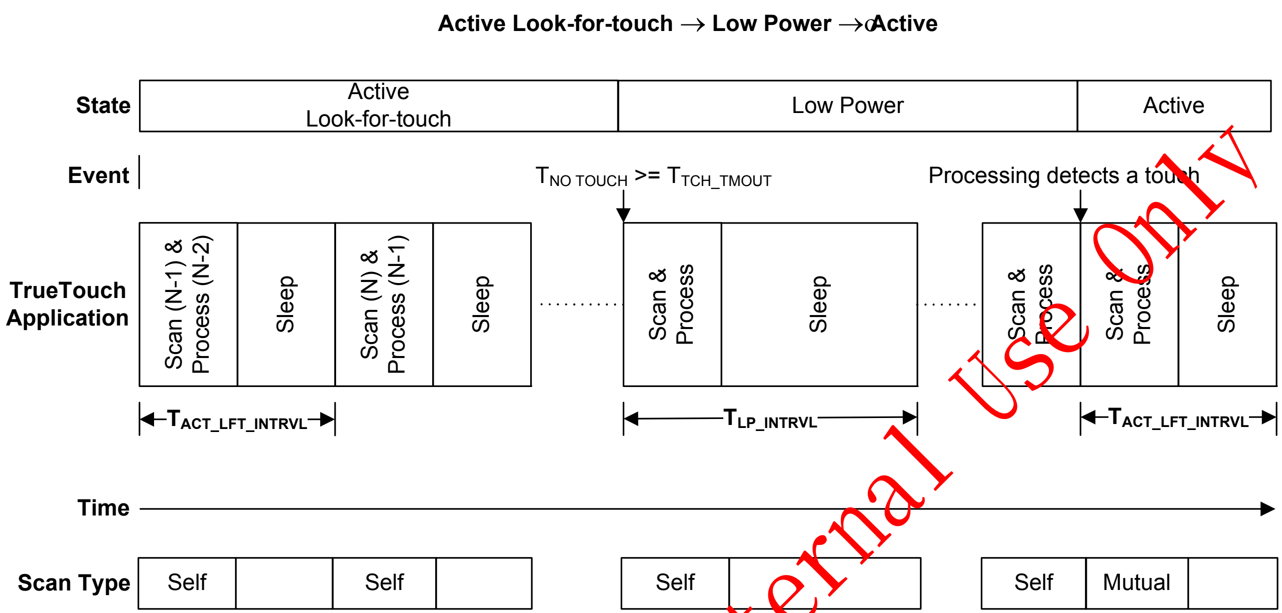


Table 8-3 specifies equations for calculating refresh time and response time.

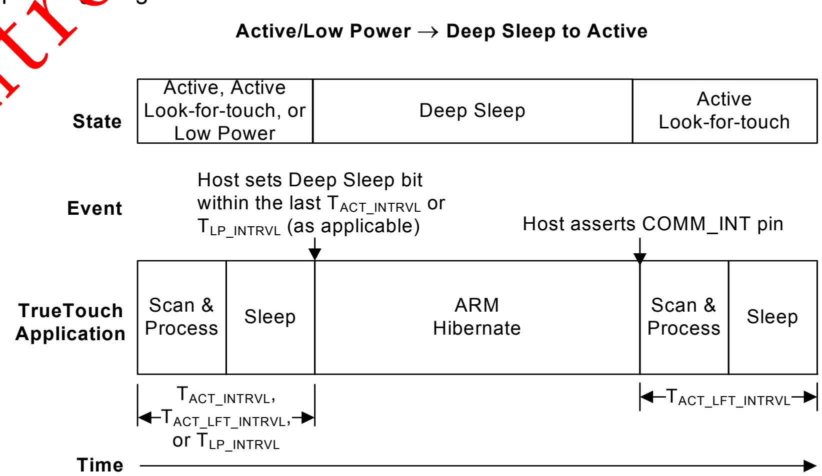
Table 8-3. Low-Power State Timing Equations

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.

8.2.5 Deep-Sleep State

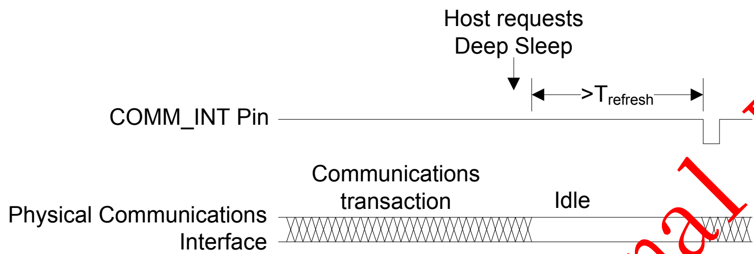
Figure 8-7. Deep-Sleep Timing Diagrams



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. The panel is not scanned; therefore, no touch can be detected. Because no sensing is performed during the Deep-Sleep state, 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 8-8. Deep-Sleep Wakeup Communication Timing Diagram



The host must send a Deep Sleep command to enter and wake from Deep Sleep (see "Deep-Sleep Command" on page 52). 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.

8.3 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 V_{DDD} 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 Deep Sleep command (see "Deep-Sleep Command" on page 52).

Power consumption increases while I^2C communication with the host occurs because this communication causes the TrueTouch 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.

9. Pin Assignment

This chapter shows the available pin assignments for the CYTMA445A and CYTT21X/31X devices.

Pin assignment is critical to optimal sensing performance. CYTMA445A has 14 receive (RX) channels and CYTT21X/31X has 17 receive (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 that uses two slots. Dual-pass scanning lowers refresh rate due to scanning an additional slot. 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.

Figure 9-1. CYTMA445A and CYTT21X (28, 33, 35, 36 IOs) TX and RX Pin Assignment Options

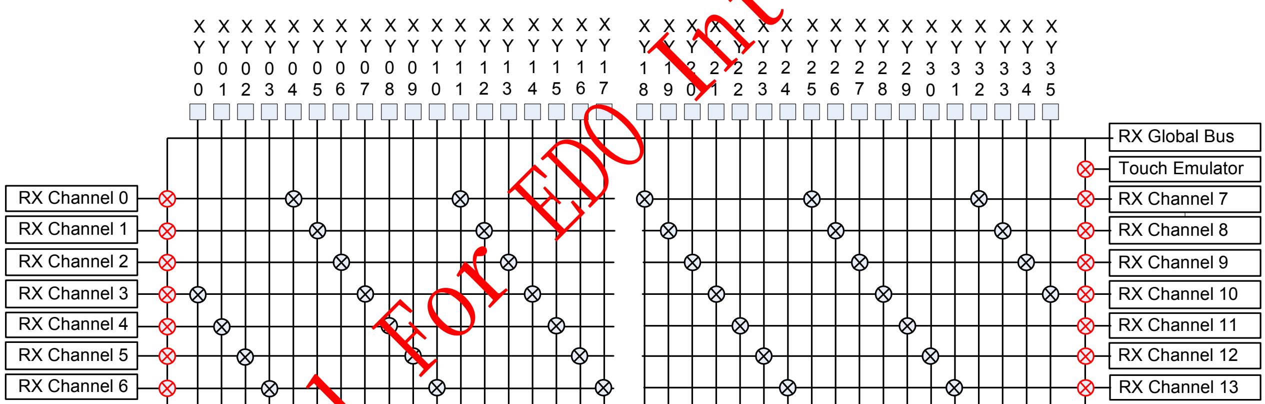
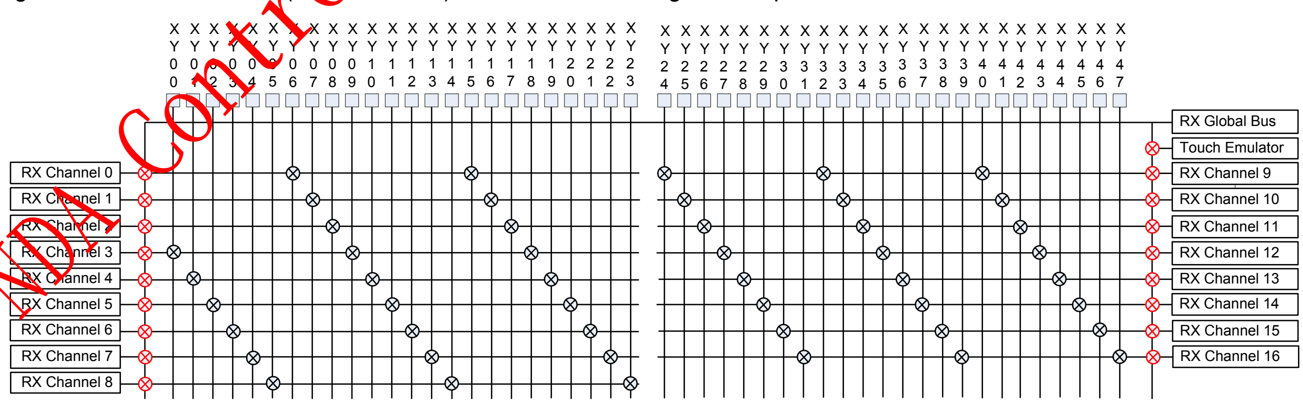


Figure 9-2. CYTT21X/31X (40, 44, 48 IOs) TX and RX Pin Assignment Options



Pin Assignment

Table 9-1. CYTMA445A and CYTT21X (28, 33, 35, 36 IOS) TX/RX Pin Configuration

XY Pin	Ch0	Ch1	Ch2	Ch3	Ch4	Ch5	Ch6	Ch7	Ch8	Ch9	Ch10	Ch11	Ch12	Ch13
0				RX										
1					RX									
2						RX								
3							RX							
4	RX													
5		RX												
6			RX											
7				RX										
8					RX									
9						RX								
10							RX							
11	RX													
12		RX												
13			RX											
14				RX										
15					RX									
16						RX								
17							RX							
18								RX						
19									RX					
20										RX				
21											RX			
22												RX		
23													RX	
24														RX
25								RX						
26									RX					
27										RX				
28											RX			
29												RX		
30													RX	
31														RX
32								RX						
33									RX					
34										RX				
35											RX			

Table 9-2. CYTT21X/31X (40, 44, 48 IOs) TX/RX Pin Configuration

XY Pin	Ch0	Ch1	Ch2	Ch3	Ch4	Ch5	Ch6	Ch7	Ch8	Ch9	Ch10	Ch11	Ch12	Ch13	Ch14	Ch15	Ch16
0				RX													
1					RX												
2						RX											
3							RX										
4								RX									
5									RX								
6	RX																
7		RX															
8			RX														
9				RX													
10					RX												
11						RX											
12							RX										
13								RX									
14									RX								
15	RX																
16		RX															
17			RX														
18				RX													
19					RX												
20						RX											
21							RX										
22								RX									
23									RX								
24										RX							
25											RX						
26												RX					
27													RX				
28														RX			
29															RX		
30																RX	
31																	RX
32										RX							
33											RX						
34												RX					
35													RX				
36														RX			
37															RX		
38																RX	

Pin Assignment

XY Pin	Ch0	Ch1	Ch2	Ch3	Ch4	Ch5	Ch6	Ch7	Ch8	Ch9	Ch10	Ch11	Ch12	Ch13	Ch14	Ch15	Ch16
39																	RX
40										RX							
41											RX						
42												RX					
43													RX				
44														RX			
45															RX		
46																RX	
47																	RX

Section D: Configuration Data

The host can read and modify blocks of the TrueTouch device flash memory using the Get Parameter and Set Parameter. Table D-1 defines the blocks that can be modified and the enumerated block ID (EBID or block ID) used to access each block. Do not modify blocks with a block ID other than those listed in Table D-1.

TableD-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
Manufacturing data	1	User/Manufacturer-defined unit specific data. Typically contains manufacturing test data	No
Design data	2	User/Manufacturer-defined design data	Yes

The flash memory block containing the application firmware 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 See Chapter "Field Upgrade (Bootloader)" on page 59 for more details.

This section includes the following chapters:

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.

Register Conventions

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

Table D-2. 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)
00	RW : 00	Reset value is 0x00 or 00h
XX	RW : XX	Register is not reset
ACCESS : POR	R : 01	Access type is read and the register's power-on-reset value is 01

10. RAM and FLASH Configuration Data

Device configuration data consists of two types of parameters: volatile Configurable Registers[RAM] and non-volatile Configurable Parameters[Flash]. The values stored in the Configurable Registers[RAM] are volatile and are not retained during a reset or a power-down. The values stored in the Configurable Parameters[Flash] are static and are retained during a reset or a power-down. The Configurable Parameters[Flash] have a limit on the number of times they can be changed (see the device datasheet for detail). Both of these parameter types can be modified by the host controller or by the TrueTouch Host Emulator (TTHE).

Using TTHE, one can set parameters in the Configurable Registers[RAM] or Configurable Parameters [Flash] Tools window. Download parameters to the part or to a configuration file for export and then download them using the host controller.

10.1 Manufacturing Data [RAM]

The manufacturing data block is reserved for host accessible unit-specific data written at runtime. The firmware does not use manufacturing data in any way. This block is not updated during firmware upgrade.

At device startup, the TrueTouch application checks whether the manufacturing data block is valid. If it is not valid, the firmware initializes it with the block size and max size values. This section maybe invalid for these reasons:

- A previous write, by the host, failed (e.g. due to a brownout).
- The manufacturing data has never been written (formatted).
  - This case occurs when only the bootloader image is programmed to device, and the TrueTouch application is not. The bootloader image does not include the manufacturing data.
  - If the TrueTouch application the full image (bootloader + application) is written through SWD, then this case does not occur.
- The location or size of the previously written block is different. In this case the previous data is lost.

10.2 Design Data [RAM]

The design data block is reserved for host accessible unit-specific data written at runtime. The firmware does not use design data in any way. This block is updated during firmware upgrade.

10.3 Run-time Configurable Parameters [RAM]

Run-time configurable parameters are located in RAM. Each parameter in the following table 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 Row Size” on page 86 and “Set Parameter” on page 83 commands. Both of these parameter types can be modified by the host controller or by the TrueTouch Host Emulator (TTHE).

Table 10-1. CYTMA445A Run-time Configurable Parameters [RAM]

Name	Description	ID (hex)	Size (bytes)
Parameters In RAM Only			
CHARGER_STATUS	Allows host to control CA actions by notifying firmware when charger is connected. Only valid when CA_HOST_CONTROLLED_CHARGER is enabled. Reserved for RAM parameter.	09	1
FORCE_SINGLE_TX	Forces CDC to scan in single-Tx mode	15	1
Parameters In RAM with Default Value in FLASH			
BL_H20_RJCT	Enable/Disable Water Rejection Feature	05	1
CHARGER_ARMOR_ENABLE	Enable/Disable Charger Armor Feature	04	1
TOUCHMODE_ENABLED	Selection of used touch mode	02	1
OPENS_TEST_RAW_THRESHOLD_MUTUAL	Maximum allowable Open Circuits Test RawCount value for panel	20	2
OPENS_TEST_IDAC_MUTUAL	Open Test IDAC value for mutual.	21	1
OPENS_TEST_ATTEN_MUTUAL	Open Test attenuator value for mutual.	22	1
DETECT_CHARGER_THRESHOLD	WB level exceeding of which starts InjTch NM.	07	2
NM_INJ_TCH_THRESHOLD	InjTch level exceeding of which triggers Charger Armor.	08	2
ACT_LFT_EN	Enables the Active Look-for-touch feature which automatically manages power consumption. When enabled, a self-cap scan is used to detect the presence of a touch. If disabled, a mutual scan is used to detect the presence of a touch.	1A	1
ACT_INTRVL0	Initial active state refresh interval (in ms)	1B	1

Table 10-1. CYTMA445A Run-time Configurable Parameters [RAM]

Name	Description	ID (hex)	Size (bytes)
ACT_LFT_INTRVL0	Initial active look-for-touch state refresh interval (in ms)	1D	2
LP_INTRVL0	Initial low power interval (in ms)	19	2
TCH_TMOUT0	Initial touch timeout (in ms). TCH_TMOUT0 is the period of time that the device waits after the last touch liftoff event, before transistioning from the Active look-for-touch state to the Low Power state.	1C	2
LOW_POWER_ENABLE	Enable low power mode	06	1
ACT_DIST0	Active distance (in pixels) applied on touchdown of a finger to determine whether this finger should trigger a report.	0A	1
ACT_DIST2	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.	0B	1
ACTIVE_DELTA_Z	One-dimensional active distance (estimated distance in mm from object to the panel) applied on touchdown of a Proximity to determine whether this proximity's approaching/moving away to/from the panel should trigger a new report.	03	1
FINGER_ID_MAX_FINGER_VELOCITY2	Square of the "speed" (maximum distance change per refresh interval) threshold distinguishing fast finger movement from separate finger touches	0D	4
GRIP_XEDG_A	Grip Suppression: X edge width (in pixels), side A	0E	2
GRIP_XEDG_B	Grip Suppression: X edge width (in pixels), side B	0F	2
GRIP_XEXC_A	Grip Suppression: X exception area width (in pixels), side A	10	2
GRIP_XEXC_B	Grip Suppression: X exception area width (in pixels), side B	11	2
GRIP_YEDG_A	Grip Suppression: Y edge width (in pixels), side A	12	2
GRIP_YEDG_B	Grip Suppression: Y edge width (in pixels), side B	13	2

Table 10-1. CYTMA445A Run-time Configurable Parameters [RAM]

Name	**Description**	**ID (hex)**	**Size (bytes)**
GRIP_YEXC_A	Grip Suppression: Y exception area width (in pixels), side A	14	2
GRIP_YEXC_B	Grip Suppression: Y exception area width (in pixels), side B	15	2
GRIP_FIRST_EXC	Grip Suppression: Enable/Disable reporting first touch on panel regardless of location.	16	1
GRIP_EXC_EDGE_ORIGIN	Grip Suppression: Enable/Disable suppression of touches originating in an edge area	17	1
GRIP_ENABLE	Grip suppression enabled or disabled	18	1
SIZE_ORIENTATION_ENABLE	Enables/disables for touch contact ellipse axis length and orientation calculations	0C	1
PIP_REPORTING_DISABLE	Disable touch, button, noise, and sensor data mode reports so that the 'interrupt pin override' feature may be used to test scan and processing time.	1E	1

Table 11: CTTT21X (28, 33, 35, 36 IOs)

Name	**Description**	**ID (hex)**	**Size (bytes)**
Parameters In RAM Only			
CHARGER_STATUS	Allows host to control CA actions by notifying firmware when charger is connected. Only valid when CA_HOST_CONTROLLED_CHARGER is enabled. Reserved for RAM parameter.	09	1
FORCE_SINGLE_TX	Forces CDC to scan in single-Tx mode	1F	1
Parameters In RAM with Default Value in FLASH			
BL_H20_RJCT	Enable/Disable Water Rejection Feature	05	1
CHARGER_ARMOR_ENABLE	Enable/Disable Charger Armor Feature	04	1

Table 11: CTTT21X (28, 33, 35, 36 IOs)

Name	Description	ID (hex)	Size (bytes)
TOUCHMODE_ENABLED	Selection of used touch mode	02	1
DETECT_CHARGER_THRESHOLD	WB level exceeding of which starts InjTch NM.	07	2
NM_INJ_TCH_THRESHOLD	InjTch level exceeding of which triggers Charger Armor.	08	2
ACT_LFT_EN	Enables the Active Look-for-touch feature which automatically manages power consumption. When enabled, a self-cap scan is used to detect the presence of a touch. If disabled, a mutual scan is used to detect the presence of a touch.	1A	1
ACT_INTRVL0	Initial active state refresh interval (in ms)	1B	1
ACT_LFT_INTRVL0	Initial active look-for-touch state refresh interval (in ms)	1D	2
LP_INTRVL0	Initial low power interval (in ms)	19	2
TCH_TMOUT0	Initial touch timeout (in ms). TCH_TMOUT0 is the period of time that the device waits after the last touch liftoff event, before transitioning from the Active look-for-touch state to the Low Power state.	1C	2
LOW_POWER_ENABLE	Enable low power mode	06	1
ACT_DIST0	Active distance (in pixels) applied on touchdown of a finger to determine whether this finger should trigger a report.	0A	1
ACT_DIST2	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.	0B	1
ACTIVE_DELTA_Z	One-dimensional active distance (estimated distance in mm from object to the panel) applied on touchdown of a Proximity to determine whether this proximity's approaching/moving away to/from the panel should trigger a new report.	03	1
FINGER_ID_MAX_FINGER_VELOCITY2	Square of the "speed" (maximum distance change per refresh interval) threshold distinguishing fast finger movement from separate finger touches	0D	4

Table 11: CTTT21X (28, 33, 35, 36 IOs)

Name	Description	ID (hex)	Size (bytes)
FINGER_ID_MAX_FINGER_ACCELERATION2	Square of the acceleration (maximum velocity change per refresh interval) threshold distinguishing fast finger movement from separate finger touches	24	4
GRIP_XEDG_A	Grip Suppression: X edge width (in pixels), side A	0E	2
GRIP_XEDG_B	Grip Suppression: X edge width (in pixels), side B	0F	2
GRIP_XEXC_A	Grip Suppression: X exception area width (in pixels), side A	10	2
GRIP_XEXC_B	Grip Suppression: X exception area width (in pixels), side B	11	2
GRIP_YEDG_A	Grip Suppression: Y edge width (in pixels), side A	12	2
GRIP_YEDG_B	Grip Suppression: Y edge width (in pixels), side B	13	2
GRIP_YEXC_A	Grip Suppression: Y exception area width (in pixels), side A	14	2
GRIP_YEXC_B	Grip Suppression: Y exception area width (in pixels), side B	15	2
GRIP_FIRST_EXC	Grip Suppression: Enable/Disable reporting first touch on panel regardless of location.	16	1
GRIP_EXC_EDGE_ORIGIN	Grip Suppression: Enable/Disable suppression of touches originating in an edge area	17	1
GRIP_ENABLE	Grip suppression enabled or disabled	18	1
SIZE_ORIENTATION_ENABLE	Enables/disables for touch contact ellipse axis length and orientation calculations	0C	1
PIP_REPORTING_DISABLE	Disable touch, button, noise, and sensor data mode reports so that the 'interrupt pin override' feature may be used to test scan and processing time.	1E	1

Table 10-1. CYTT21X/31X Run-time Configurable Parameters [RAM]

Name	Description	ID (hex)	Size (bytes)
Parameters In RAM Only			
FORCE_SINGLE_TX	Forces CDC to scan in single-Tx mode	1F	1
CHARGER_STATUS	Allows 2 to control CA actions by notifying firmware when charger is connected. Only valid when CA_HOST_CONTROLLED_CHARGER is enabled. Reserved for RAM parameter.	09	1
Parameters In RAM with Default Value in FLASH			
BL_H20_RJCT	Enable/Disable Water Rejection Feature	05	1
CHARGER_ARMOR_ENABLE	Enable/Disable Charger Armor Feature	04	1
TOUCHMODE_ENABLED	Selection of used touch mode	02	1
STYLUS_HIGH_PRIORITY	Enable/Disable Stylus High Priority.	21	1
DETECT_CHARGER_THRESHOLD	WB level exceeding of which starts InjTch NM.	07	2
NM_INJ_TCH_THRESHOLD	InjTch level exceeding of which triggers Charger Armor.	08	2
ACT_LFT_EN	Enables the Active Look-for-touch feature which automatically manages power consumption. When enabled, a self-cap scan is used to detect the presence of a touch. If disabled, a mutual scan is used to detect the presence of a touch.	1A	1
ACT_INTRVL0	Initial active state refresh interval (in ms)	1B	1
ACT_LFT_INTRVL0	Initial active look-for-touch state refresh interval (in ms)	1D	2
LP_INTRVL0	Initial low power interval (in ms)	19	2

Table 10-1. CYTT21X/31X Run-time Configurable Parameters [RAM]

TCH_TMOUT0	Initial touch timeout (in ms). TCH_TMOUT0 is the period of time that the device waits after the last touch liftoff event, before transitioning from the Active look-for-touch state to the Low Power state.	1C	2
LOW_POWER_ENABLE	Enable low power mode	06	1
ACT_DIST0	Active distance (in pixels) applied on touchdown of a finger to determine whether this finger should trigger a report.	0A	1
ACT_DIST2	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.	0B	1
FINGER_ID_MAX_FINGER_VELOCITY 2	Square of the "speed" (maximum distance change per refresh interval) threshold distinguishing fast finger movement from separate finger touches	0D	4
FINGER_ID_MAX_FINGER_ACCELER ATION2	Square of the acceleration (maximum velocity change per refresh interval) threshold distinguishing fast finger movement from separate finger touches	24	4
GRIP_XEDG_A	Grip Suppression: X edge width (in pixels), side A	0E	2
GRIP_XEDG_B	Grip Suppression: X edge width (in pixels), side B	0F	2
GRIP_XEXC_A	Grip Suppression: X exception area width (in pixels), side A	10	2
GRIP_XEXC_B	Grip Suppression: X exception area width (in pixels), side B	11	2
GRIP_YEDG_A	Grip Suppression: Y edge width (in pixels), side A	12	2
GRIP_YEDG_B	Grip Suppression: Y edge width (in pixels), side B	13	2
GRIP_YEXC_A	Grip Suppression: Y exception area width (in pixels), side A	14	2
GRIP_YEXC_B	Grip Suppression: Y exception area width (in pixels), side B	15	2

Table 10-1. CYTT21X/31X Run-time Configurable Parameters [RAM]

GRIP_FIRST_EXC	Grip Suppression: Enable/Disable reporting first touch on panel regardless of location.	16	1
GRIP_EXC_EDGE_ORIGIN	Grip Suppression: Enable/Disable suppression of touches originating in an edge area	17	1
GRIP_ENABLE	Grip suppression enabled or disabled	18	1
SIZE_ORIENTATION_ENABLE	Enables/disables for touch contact ellipse axis length and orientation calculations	0C	1
PIP_REPORTING_DISABLE	Disable touch, button, noise, and sensor data mode reports so that the 'interrupt pin override' feature may be used to test scan and processing time.	1E	1

10.4 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” on page 84. For examples of how to update Data Blocks see TrueTouch Communication Examples - Packet Interface Protocol (PIP) - AN85948 (Cypress specification 001-85948).

Each flash parameter listed will have a device name and associated address where the flash parameter is located on that device. Some parameters may not be available on all devices.

11.0.1 LOW_PIVOT

[TTHE Group] Register Name : Address

[Device Setup] LOW_PIVOT : CYTT21X/31X (40, 44, 48 IOs) - 0x0398, CYTMA445A - 0x0320, CYTT21X (28, 33, 35, 36 IOs) - 0x03AC

Bits	31	30	29	28	27	26	25	24
Access:POR	RW: 0x00							
Bit Name	LowPivot[31:24]							

Bits	23	22	21	20	19	18	17	16
Access:POR	RW: 0x00							
Bit Name	LowPivot[23:16]							

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x00							
Bit Name	LowPivot[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x78							
Bit Name	LowPivot[7:0]							

When zMagnitude = LowPivot than Scalar = 1x. This is used for 4~8 mm finger.

Bits	Name	Description
[31:0]	LowPivot [31:0]	When zMagnitude = LowPivot than Scalar = 1x Default: 0x78 Range: -2147483648:2147483647

11.0.2 TOUCHMODE_GLOVE_NOISE_DEBOUNCE

[TTHE Group] Register Name : Address

[Touch Mode] TOUCHMODE_GLOVE_NOISE_DEBOUNCE : CYTT21X/31X (40, 44, 48 IOs) - 0x0368, CYTT21X (28, 33, 35, 36 IOs) - 0x0384

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x0							
Bit Name	gloveNoiseDebounce[7:0]							

The debounce in mS for switching from glove to other modes in case of noise (LCD/Charger/ESD). The mode switch will be cancelled if the signal pattern is changed in the debounce period.

Bits	Name	Description
[7:0]	gloveNoiseDebounce [7:0]	The debounce in mS for switching from glove to other modes in case of noise (LCD/Charger/ESD). The mode switch will be cancelled if the signal pattern is changed in the debounce period. Default: 0x0 Range: 0:255

11.0.3 MAX_FAT_FINGER_SIZE_ON

[TTHE Group] Register Name : Address

[Finger Tracking] MAX_FAT_FINGER_SIZE_ON : CYTT21X/31X (40, 44, 48 IOs) - 0x03D8, CYTMA445A - 0x0377, CYTT21X (28, 33, 35, 36 IOs) - 0x0400

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x18							
Bit Name	Max Fat Finger Size On[7:0]							

Minimum number of contiguous activated panel intersections that define a large object. It is used when a large object was not detected yet. Fat finger detection takes priority in determining whether to increase or reduce the threshold. Make sure the condition (0 <= MAX_FAT_FINGER_SIZE_HYST <= 1/2 of MAX_FAT_FINGER_SIZE_ON) is true when tuning.

Bits	Name	Description
[15:0]	Max Fat Finger Size On [15:0]	Minimum number of contiguous activated panel intersections that define a large object. It is used when a large object was not detected yet. Fat finger detection takes priority in determining whether to increase or reduce the threshold. Make sure the condition (0 <= MAX_FAT_FINGER_SIZE_HYST <= 1/2 of MAX_FAT_FINGER_SIZE_ON) is true when tuning. Default: 0x18 Range: 0:65535

11.0.4 TOUCHMODE_STYLUS_SWITCH_DEBOUNCE

[TTHE Group] Register Name : Address

[Touch Mode] TOUCHMODE_STYLUS_SWITCH_DEBOUNCE : CYTT21X/31X (40, 44, 48 IOs) - 0x036C

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x00							
Bit Name	stylusSwitchDebounce[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x0a							
Bit Name	stylusSwitchDebounce[7:0]							

The debounce in mS for switching to Stylus mode (LFT->Stylus). The mode switch will be cancelled if the signal pattern is changed in the debounce period.

Bits	Name	Description
[15:0]	stylusSwitchDebounce [15:0]	The debounce in mS for switching to Stylus mode (LFT->Stylus). The mode switch will be cancelled if the signal pattern is changed in the debounce period. Default: 0xa Range: 0:1000

11.0.5 TX_PULSES_NUM_MUTUAL

[TTHE Group] Register Name : Address

[CDC] TX_PULSES_NUM_MUTUAL : CYTT21X/31X (40, 44, 48 IOs) - 0x008A, CYTMA445A - 0x007A, CYTT21X (28, 33, 35, 36 IOs) - 0x0086

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x00							
Bit Name	TX Pulses[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x40							
Bit Name	TX Pulses[7:0]							

Mutual Scanning Number of TX Pulses

Bits	Name	Description
[15:0]	TX Pulses [15:0]	Number of TX Pulses per conversion for Mutual Cap scan Default: 0x40 Range: 1:255

11.0.6 INTEGRATOR_VOLTAGE_MUTUAL

[TTHE Group] Register Name : Address

[Calibration] INTEGRATOR_VOLTAGE_MUTUAL : CYTT21X/31X (40, 44, 48 IOs) - 0x0062, CYTMA445A - 0x005E, CYTT21X (28, 33, 35, 36 IOs) - 0x0062

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x00							
Bit Name	Integrator Voltage Mut[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x7a							
Bit Name	Integrator Voltage Mut[7:0]							

Target Integrator voltage in Mutual Mode

Bits	Name	Description
[15:0]	Integrator Voltage Mut [15:0]	Target Integrator voltage in Mutual Mode Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0xfa Range: 10:650

11.0.7 DETECT_CHARGER_THRESHOLD

[TTHE Group] Register Name : Address

[Charger Armor] DETECT_CHARGER_THRESHOLD : CYTT21X/31X (40, 44, 48 IOs) - 0x030C, CYTMA445A - 0x02B0, CYTT21X (28, 33, 35, 36 IOs) - 0x0324

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x00							
Bit Name	Value[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x0f							
Bit Name	Value[7:0]							

WB level exceeding of which starts InjTch NM.

Bits	Name	Description
[15:0]	Value [15:0]	WB level exceeding of which starts InjTch NM. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0xf Range: 0:65535

11.0.8 GLOVE_Z8_FILTER_SCALE

[TTHE Group] Register Name : Address

[Glove] GLOVE_Z8_FILTER_SCALE : CYTT21X/31X (40, 44, 48 IOs) - 0x042D, CYTMA445A - 0x03C9, CYTT21X (28, 33, 35, 36 IOs) - 0x0455

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x1							
Bit Name	Scale[7:0]							

Z8 filter scale for glove detection. A valid touch must satisfy this requirement: Z8 Sum > Glove Peak Diff Count * GLOVE_Z8_FILTER_SCALE

Bits	Name	Description
[7:0]	Scale [7:0]	Z8 filter scale for glove detection. A valid touch must satisfy this requirement: Z8 Sum > Glove Peak Diff Count * GLOVE_Z8_FILTER_SCALE Default: 0x1 Range: 0:255

11.0.9 STYL_HOVER_COEF

[TTHE Group] Register Name : Address

[Stylus Tracking] STYL_HOVER_COEF : CYTT21X/31X (40, 44, 48 IOs) - 0x0446

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x01							
Bit Name	Threshold[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x10							
Bit Name	Threshold[7:0]							

Coefficient for Stylus/Hover criterion.

Bits	Name	Description
[15:0]	Threshold [15:0]	Coefficient for rejecting hovering finger from triggering false stylus. Stylus signal not meeting the following criterion is considered a hover finger and is rejected. STYL_HOVER_COEF > Function(5x5_Signal_Sum / Local_Max_Value). Increasing this parameter relaxes the hover finger rejection. Overly reducing this parameter could compromise reliable stylus detection. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0x190 Range: 0:1000

11.0.10 CA_HOP1_TX_PERIOD_MUTUAL

[TTHE Group] Register Name : Address

[Charger Armor] CA_HOP1_TX_PERIOD_MUTUAL : CYTT21X/31X (40, 44, 48 IOs) - 0x007C, CYTMA445A - 0x0084, CYTT21X (28, 33, 35, 36 IOs) - 0x0078

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x00							
Bit Name	TX Period[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x38							
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). Default: 0x38 Range: 48:510

11.0.11 VIRTUAL_PEAK_DELTA_THRESHOLD

[TTHE Group] Register Name : Address

[Finger Tracking] VIRTUAL_PEAK_DELTA_THRESHOLD : CYTT21X/31X (40, 44, 48 IOs) - 0x03C8, CYTMA445A - 0x0350, CYTT21X (28, 33, 35, 36 IOs) - 0x03DC

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x75							
Bit Name	Threshold[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x30							
Bit Name	Threshold[7:0]							

Delta Signal Sum Threshold to determine whether to insert virtual peak or not; when peak number decreased: if the accumulated delta signal sum is less than this threshold then insert virtual peak; orelse do not insert virtual peak; default value: twice HTI of 12mm finger.

Bits	Name	Description
[15:0]	Threshold [15:0]	Delta Signal Sum Threshold to determine whether to insert virtual peak or not; when peak number decreased: if the accumulated delta signal sum is less than this threshold then insert virtual peak; orelse do not insert virtual peak; default value: twice HTI of 12mm finger. Default: 0x7530 Range: 0:65535

11.0.12 SD_EXIT_SIGNAL_THRESHOLD

[TTHE Group] Register Name : Address

[Finger Tracking] SD_EXIT_SIGNAL_THRESHOLD : CYTT21X/31X (40, 44, 48 IOs) - 0x03C4, CYTMA445A - 0x034C, CYTT21X (28, 33, 35, 36 IOs) - 0x03D8

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x33							
Bit Name	Threshold[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x45							
Bit Name	Threshold[7:0]							

Threshold for max peak value of the whole panel to exit SD event; SD event should exit if max peak value of the whole panel is larger than sdExitSigThold; default value: 7/8 of HTI of 12mm finger.

Bits	Name	Description
[15:0]	Threshold [15:0]	Threshold for max peak value of the whole panel to exit SD event; SD event should exit if max peak value of the whole panel is larger than sdExitSigThold; default value: 7/8 of HTI of 12mm finger. Default: 0x3345 Range: 0:65535

11.0.13 MAX_NUM_SHORT_SCAN

[TTHE Group] Register Name : Address

[Proximity] MAX_NUM_SHORT_SCAN : CYTMA445A - 0x0362, CYTT21X (28, 33, 35, 36 IOs) - 0x03EE

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x1e							
Bit Name	maxNumOfShortScans[7:0]							

Maximum number of repeated short scans

Bits	Name	Description
[7:0]	maxNumOfShortScans [7:0]	Maximum number of repeated short scans Default: 0x1e Range: 0:255

11.0.14 Z2_SUM_4MM

[TTHE Group] Register Name : Address

[Device Setup] Z2_SUM_4MM : CYTT21X/31X (40, 44, 48 IOs) - 0x038C, CYTMA445A - 0x0314, CYTT21X (28, 33, 35, 36 IOs) - 0x03A0

Bits	31	30	29	28	27	26	25	24
Access:POR	RW: 0x00							
Bit Name	z2[31:24]							

Bits	23	22	21	20	19	18	17	16
Access:POR	RW: 0x00							
Bit Name	z2[23:16]							

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x00							
Bit Name	z2[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x82							
Bit Name	z2[7:0]							

Sum of the 3x3 sensor diff count of a 4 mm finger touch

Bits	Name	Description
[31:0]	z2 [31:0]	Sum of the 3x3 sensor diff count of a 4 mm finger touch Default: 0x82 Range: -2147483648:2147483647

11.0.15 GLOVE_SIGNAL_THRESHOLD_MULTIPLIER

[TTHE Group] Register Name : Address

[Glove] GLOVE_SIGNAL_THRESHOLD_MULTIPLIER : CYTT21X/31X (40, 44, 48 IOs) - 0x0438, CYTMA445A - 0x03D2, CYTT21X (28, 33, 35, 36 IOs) - 0x0460

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x40							
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 touch zone.

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 touch zone. Default: 0x40 Range: 0:255

11.0.16 WATER_TIMEOUT

[TTHE Group] Register Name : Address

[Proximity] WATER_TIMEOUT : CYTMA445A - 0x0230, CYTT21X (28, 33, 35, 36 IOs) - 0x0290

Bits	31	30	29	28	27	26	25	24
Access:POR	RW: 0x00							
Bit Name	Value[31:24]							

Bits	23	22	21	20	19	18	17	16
Access:POR	RW: 0x09							
Bit Name	Value[23:16]							

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x27							
Bit Name	Value[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0xc0							
Bit Name	Value[7:0]							

Baseline reset timer after water drop is detected (in ms)

Bits	Name	Description
[31:0]	Value [31:0]	Baseline reset timer after water drop is detected (in ms) Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0x927c0 Range: 0:4294967295

11.0.17 MAX_NUM_OF_REPORTED_TOUCHES

[TTHE Group] Register Name : Address

[Device Setup] MAX_NUM_OF_REPORTED_TOUCHES : CYTT21X/31X (40, 44, 48 IOs) - 0x001B, CYTMA445A - 0x0019, CYTT21X (28, 33, 35, 36 IOs) - 0x001B

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0xa							
Bit Name	Maximum number of reported touches[7:0]							

Maximum number of reported touches.

Bits	Name	Description
[7:0]	Maximum number of reported touches [7:0]	Maximum number of reported touches. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0xa Range: 1:10

11.0.18 DECREASE_BY_WATER

[TTHE Group] Register Name : Address

[Proximity] DECREASE_BY_WATER : CYTMA445A - 0x0228, CYTT21X (28, 33, 35, 36 IOs) - 0x0288

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x01							
Bit Name	Value[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x74							
Bit Name	Value[7:0]							

Decrease in rawdata because of water drops

Bits	Name	Description
[15:0]	Value [15:0]	Decrease in rawdata because of water drops Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0x1f4 Range: 0:65535

11.0.19 FILT_CMF_THRESHOLD_MUT

[TTHE Group] Register Name : Address

[Raw Processing] FILT_CMF_THRESHOLD_MUT : CYTT21X/31X (40, 44, 48 IOs) - 0x02B0, CYTMA445A - 0x0260, CYTT21X (28, 33, 35, 36 IOs) - 0x02C8

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x00							
Bit Name	Value[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x3c							
Bit Name	Value[7:0]							

CMF Threshold for Base Mutual

Bits	Name	Description
[15:0]	Value [15:0]	CMF Threshold Base for Mutual Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0x3c Range: 0:32767

11.0.20 TRIGGER_CA

[TTHE Group] Register Name : Address

[Charger Armor] TRIGGER_CA : CYTT21X/31X (40, 44, 48 IOs) - 0x0312, CYTMA445A - 0x02B6, CYTT21X (28, 33, 35, 36 IOs) - 0x032A

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x0						RW: 0x0	
Bit Name	Reserved[7:2]						Value[1:0]	

Defines which noise metric can trigger CA.

Bits	Name	Description
[7:2]	Reserved [5:0]	Default: 0x0 Range:
[1:0]	Value [1:0]	Defines which noise metric can trigger CA. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0x0 **0:** WbAndInjTch - Enter Charger Armor if both WB and InjTch are larger than threshold. **1:** Wb - Enter Charger Armor if WB is larger than threshold. **2:** InjTch - Enter Charger Armor if InjTch is larger than threshold.

11.0.21 Z1_SUM_8MM

[TTHE Group] Register Name : Address

[Device Setup] Z1_SUM_8MM : CYTT21X/31X (40, 44, 48 IOs) - 0x0388, CYTMA445A - 0x0310, CYTT21X (28, 33, 35, 36 IOs) - 0x039C

Bits	31	30	29	28	27	26	25	24
Access:POR	RW: 0x00							
Bit Name	z1[31:24]							

Bits	23	22	21	20	19	18	17	16
Access:POR	RW: 0x00							
Bit Name	z1[23:16]							

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x01							
Bit Name	z1[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x4a							
Bit Name	z1[7:0]							

Sum of the 3x3 sensor diff count of a 8 mm finger touch

Bits	Name	Description
[31:0]	z1 [31:0]	Sum of the 3x3 sensor diff count of a 8 mm finger touch Default: 0x14a Range: -2147483648:2147483647

11.0.22 TOUCHMODE_FRAME_NUM_TO_CONFIRM_FINGER_MODE

[TTHE Group] Register Name : Address

[Touch Mode] TOUCHMODE_FRAME_NUM_TO_CONFIRM_FINGER_MODE : CYTT21X/31X (40, 44, 48 IOs) - 0x03E6, CYTT21X (28, 33, 35, 36 IOs) - 0x040E

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

Threshold of number of frame which continously satisfy absolute finger criteria; absolute finger criteria means max diff signal is over HTI of stylus/glove.

Bits	Name	Description
[7:0]	Threshold [7:0]	Threshold of number of frame which continosly satisfy absolute finger criteria; absolute finger criteria means max diff signal is over HTI of stylus/glove. Default: 0xa Range: 0:255

11.0.23 CA_WIDEBAND_SCAN_COUNT

[TTHE Group] Register Name : Address

[Charger Armor] CA_WIDEBAND_SCAN_COUNT : CYTT21X/31X (40, 44, 48 IOs) - 0x005A

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x2							
Bit Name	Value[7:0]							

Number of WB+NMF scan frames in the single noise listening scan.

Bits	Name	Description
[7:0]	Value [7:0]	Number of WB+NMF scan frames in the single noise listening scan. Default: 0x2 Range: 1:2

11.0.24 EXT_SYNC

[TTHE Group] Register Name : Address

[Device Setup] EXT_SYNC : CYTT21X/31X (40, 44, 48 IOs) - 0x0055, CYTMA445A - 0x0404, CYTT21X (28, 33, 35, 36 IOs) - 0x0055

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x0							
Bit Name	External syncronization[7:0]							

External sync. pin.

Bits	Name	Description
[7:0]	External syncronization [7:0]	External synchronization enable Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0x0 **0:** Disabled **1:** P1[0] **2:** P1[1] **3:** P1[2] **4:** P1[3]

11.0.25 MAX_MULTI_FINGER_Z9

[TTHE Group] Register Name : Address

[Finger Tracking] MAX_MULTI_FINGER_Z9 : CYTT21X/31X (40, 44, 48 IOs) - 0x03B8, CYTMA445A - 0x0340, CYTT21X (28, 33, 35, 36 IOs) - 0x03CC

Bits	31	30	29	28	27	26	25	24
Access:POR	RW: 0x00							
Bit Name	Threshold[31:24]							

Bits	23	22	21	20	19	18	17	16
Access:POR	RW: 0x01							
Bit Name	Threshold[23:16]							

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x5f							
Bit Name	Threshold[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x10							
Bit Name	Threshold[7:0]							

Multi-Finger max Z9 value; for touch zone with 2 or more peaks: if its Z9 signal sum is larger than this parameter will be identified as fat-finger; default value: 6 times of HTI of 12mm finger.

Bits	Name	Description
[31:0]	Threshold [31:0]	Multi-Finger max Z9 value; for touch zone with 2 or more peaks: if its Z9 signal sum is larger than this parameter will be identified as fat-finger; default value: 6 times of HTI of 12mm finger. Default: 0x15f90 Range: 0:500000

11.0.26 FINGER_THRESH_MUTUAL_OFF

[TTHE Group] Register Name : Address

[Finger Tracking] FINGER_THRESH_MUTUAL_OFF : CYTT21X/31X (40, 44, 48 IOs) - 0x03CE, CYTMA445A - 0x036A, CYTT21X (28, 33, 35, 36 IOs) - 0x03F6

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x00							
Bit Name	Threshold Off[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x48							
Bit Name	Threshold Off[7:0]							

Mutual Capacitance Finger Threshold OFF. It is used when finger was previously detected.

Bits	Name	Description
[15:0]	Threshold Off [15:0]	Mutual Capacitance Finger Threshold OFF. It is used when finger was previously detected. Default: 0xc8 Range: 0:32767

11.0.27 PIP_REPORTING_DISABLE

[TTHE Group] Register Name : Address

[Device Setup] PIP_REPORTING_DISABLE : CYTT21X/31X (40, 44, 48 IOs) - 0x0495, CYTMA445A - 0x0409, CYTT21X (28, 33, 35, 36 IOs) - 0x0495

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x0							RW: 0x0
Bit Name	Reserved[7:1]							Disable PIP Reporting[0:0]

Disable touch, button, noise, and sensor data mode reports so that the 'interrupt pin override' feature may be used to test scan and processing time.

Bits	Name	Description
[7:1]	Reserved [6:0]	Default: 0x0 Range:
[0:0]	Disable PIP Reporting [0:0]	Disable TrueTouch device reports not requested by the 2. Default: 0x0 **0:** Normal PIP Reporting - Normal PIP reporting **1:** Reporting Disabled - Touch reports are disabled.

11.0.28 ACT_DIST_TOUCHDOWN

[TTHE Group] Register Name : Address

[Finger Tracking] ACT_DIST_TOUCHDOWN : CYTT21X/31X (40, 44, 48 IOs) - 0x0332, CYTMA445A - 0x02CE, CYTT21X (28, 33, 35, 36 IOs) - 0x034A

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x0							
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]	Two-dimensional active distance threshold (in pixels) for the Adaptive Touchdown Active Distance algorithm. After the initial finger touchdown report and before the ACT_DIST_COUNTER expires, the touch report is continuously generated if the 2-dimensional finger displacement since the last reported location is less than this parameter. Set this parameter to 0 to disable the Adaptive Touchdown Active Distance algorithm. Default: 0x0 Range: 0:255

11.0.29 INTEGRATOR_VOLTAGE_BUTTON_SELF

[TTHE Group] Register Name : Address

[Calibration] INTEGRATOR_VOLTAGE_BUTTON_SELF : CYTT21X/31X (40, 44, 48 IOs) - 0x0068, CYTMA445A - 0x0064, CYTT21X (28, 33, 35, 36 IOs) - 0x0068

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x00							
Bit Name	Integrator Voltage Btn Self[15:8]							
Bits	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
Access:POR	RW: 0x7a							
Bit Name	Integrator Voltage Btn Self[7:0]							

Target Integrator voltage for Buttons in SelfCap Mode

Bits	Name	Description
[15:0]	Integrator Voltage Btn Self [15:0]	Target Integrator voltage for Buttons in SelfCap Mode Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0xfa Range: 10:650

11.0.30 PWR_CFG

[TTHE Group] Register Name : Address

[Device Setup] PWR_CFG : CYTMA445A - 0x0405

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x0							RW: 0x1
Bit Name	Reserved[7:1]							Vddd/Vccd Configura-tion[0:0]

Configures Vccd to be supplied internally or externally.

Bits	Name	Description
[7:1]	Reserved [6:0]	Default: 0x0 Range:
[0:0]	Vddd/Vccd Configuration [0:0]	Determines nominal power supply voltages for Vccd and Vddd Default: 0x1 **0:** Vccd Externally Supplied - Vccd Externally Vccd = Vddd = 1.8V externally supplied **1:** Vccd Internally Supplied - Internal LDO supplies 1.8V to Vccd

11.0.31 FILT_FILTER_MASK_BUT_GLOVE_MUT

[TTHE Group] Register Name : Address

[Raw Processing] FILT_FILTER_MASK_BUT_GLOVE_MUT : CYTT21X/31X (40, 44, 48 IOs) - 0x02E2, CYTMA445A - 0x0292, CYTT21X (28, 33, 35, 36 IOs) - 0x02FA

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x0						RW: 0x1	RW: 0x1
Bit Name	Reserved[7:2]						IIR Filter[1:1]	CMF Filter[0:0]

Indicates what filters are enabled/disabled for Glove Button Mutual

Bits	Name	Description
[7:2]	Reserved [5:0]	Default: 0x0 Range:
[1:1]	IIR Filter [0:0]	Enable/Disable IIR Filter Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0x1 **0:** Disabled - Filter is Disabled **1:** Enabled - Filter is Enabled
[0:0]	CMF Filter [0:0]	Enable/Disable CMF Filter Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0x1 **0:** Disabled - Filter is Disabled **1:** Enabled - Filter is Enabled

11.0.32 FILT_IIR_COEFF_BUT_GLOVE_SELF

[TTHE Group] Register Name : Address

[Raw Processing] FILT_IIR_COEFF_BUT_GLOVE_SELF : CYTT21X/31X (40, 44, 48 IOs) - 0x02E9, CYTMA445A - 0x0299, CYTT21X (28, 33, 35, 36 IOs) - 0x0301

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x0					RW: 0x1		
Bit Name	Reserved[7:3]					IIR Filter Input Weight[2:0]		

IIR Coefficient for Glove Button Self

Bits	Name	Description
[7:3]	Reserved [4:0]	Default: 0x0 Range:
[2:0]	IIR Filter Input Weight [2:0]	Raw IIR filter coefficient for Glove Button Self Default: 0x1 **0:** One Half - Filter output = 0.5 * Filter Input + 0.5 * Previous Filter Output **1:** One Quarter - Filter output = 0.25 * Filter Input + 0.75 * Previous Filter Output **2:** One Eighth - Filter output = 0.125 * Filter Input + 0.875 * Previous Filter Output **3:** One Sixteenth - Filter output = 0.0625 * Filter Input + 0.9375 * Previous Filter Output **4:** One Thirty-second - Filter output = 0.03125 * Filter Input + 0.96875 * Previous Filter Output

11.0.33 ACT_DIST_LIFTOFF

[TTHE Group] Register Name : Address

[Finger Tracking] ACT_DIST_LIFTOFF : CYTT21X/31X (40, 44, 48 IOs) - 0x0333, CYTMA445A - 0x02CF, CYTT21X (28, 33, 35, 36 IOs) - 0x034B

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x0							
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]	One-dimensional active distance threshold. This parameter is used for both the Adaptive Liftoff Active Distance algorithm and the First Touch Suppression. For Active Liftoff Active Distance algorithm, this threshold is applied if the following criteria are satisfied: 1. The 2-dimensional finger displacement is less than the threshold ACT_DIST0. 2. The change in touch size (Z) is more than threshold ACT_DIST_Z_THRESHOLD since the last touch report. For First Touch Suppression, a new touch is reported if the following criteria are satisfied: 1. Touch size Z value change between consecutive refresh cycles is less than threshold ACT_DIST_Z_THRESHOLD. 2. The x-direction or y-direction finger displacement is larger than this threshold. Default: 0x0 Range: 0:255

11.0.34 INFRA_CTRL

[TTHE Group] Register Name : Address

[CDC] INFRA_CTRL : CYTT21X/31X (40, 44, 48 IOs) - 0x003C, CYTMA445A - 0x0038, CYTT21X (28, 33, 35, 36 IOs) - 0x003C

Bits	31	30	29	28	27	26	25	24
Access:POR	RW: 0x0	RW: 0x1	RW: 0x0					
Bit Name	Reserved[31:31]	Reserved[30:30]	Reserved[29:24]					

Bits	23	22	21	20	19	18	17	16
Access:POR	RW: 0x0	RW: 0x40						
Bit Name	Reserved[23:23]	Reserved[22:16]						

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x0		RW: 0x1		RW: 0x00			
Bit Name	Reserved[15:14]		GIDAC_MULT[13:12]		Reserved[11:8]			

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x00							
Bit Name	Reserved[7:0]							

GIDAC Multiplier

Bits	Name	Description
[31:31]	Reserved [0:0]	Reserved Default: 0x0 Range:
[30:30]	Reserved [0:0]	GIDAC Enable Default: 0x1 Range:
[29:24]	Reserved [5:0]	Reserved Default: 0x0 Range:
[23:23]	Reserved [0:0]	GIDAC LPF Default: 0x0 Range:
[22:16]	Reserved [6:0]	GIDAC value Default: 0x40 Range:
[15:14]	Reserved [1:0]	Reserved Default: 0x0 Range:
[13:12]	GIDAC_MULT [1:0]	Specifies the output current range for the Global IDAC Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0x1 **1:** 1x - Output current between 2 uA and 10 uA. **2:** 2x - Output current between 2 uA and 20 uA.
[11:0]	Reserved [11:0]	Reserved Default: 0x0 Range:

11.0.35 FILT_CMF_THRESHOLD_GLOVE_MUT

[TTHE Group] Register Name : Address

[Raw Processing] FILT_CMF_THRESHOLD_GLOVE_MUT : CYTT21X/31X (40, 44, 48 IOs) - 0x02DA, CYTMA445A - 0x028A, CYTT21X (28, 33, 35, 36 IOs) - 0x02F2

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x00							
Bit Name	Value[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x3c							
Bit Name	Value[7:0]							

CMF Threshold for Glove Mutual

Bits	Name	Description
[15:0]	Value [15:0]	CMF Threshold Glove for Mutual Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0x3c Range: 0:32767

11.0.36 FILT_IIR_THRESHOLD_BUT_GLOVE_SELF

[TTHE Group] Register Name : Address

[Raw Processing] FILT_IIR_THRESHOLD_BUT_GLOVE_SELF : CYTT21X/31X (40, 44, 48 IOs) - 0x02EA, CYTMA445A - 0x029A, CYTT21X (28, 33, 35, 36 IOs) - 0x0302

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x00							
Bit Name	Value[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x14							
Bit Name	Value[7:0]							

IIR Threshold for Glove Button Self

Bits	Name	Description
[15:0]	Value [15:0]	IIR Threshold for Glove Button Self Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0x14 Range: 0:32767

11.0.37 TX_PULSES_NUM_GLOVE_BUTTON_MUTUAL

[TTHE Group] Register Name : Address

[CDC] TX_PULSES_NUM_GLOVE_BUTTON_MUTUAL : CYTT21X/31X (40, 44, 48 IOs) - 0x00A4, CYTMA445A - 0x00AE, CYTT21X (28, 33, 35, 36 IOs) - 0x00A0

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x00							
Bit Name	TX Pulses[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x40							
Bit Name	TX Pulses[7:0]							

Number of TX Pulses for Glove Button Mutual Scanning

Bits	Name	Description
[15:0]	TX Pulses [15:0]	Number of TX Pulses per conversion for Glove Button Mutual Scan Default: 0x40 Range: 0:255

11.0.38 CA_HOP1_TX_PULSES_NUM_MUTUAL

[TTHE Group] Register Name : Address

[Charger Armor] CA_HOP1_TX_PULSES_NUM_MUTUAL : CYTT21X/31X (40, 44, 48 IOs) - 0x0090, CYTMA445A - 0x0086, CYTT21X (28, 33, 35, 36 IOs) - 0x008C

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x00							
Bit Name	TX Pulses[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x7f							
Bit Name	TX Pulses[7:0]							

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

Bits	Name	Description
[15:0]	TX Pulses [15:0]	Second AFH alternative frequency Mutual Cap scan Number of TX Pulses per conversion Default: 0x7f Range: 0:255

11.0.39 WF_ENABLE

[TTHE Group] Register Name : Address

[Wet Finger] WF_ENABLE : CYTT21X/31X (40, 44, 48 IOs) - 0x0020, CYTMA445A - 0x001E, CYTT21X (28, 33, 35, 36 IOs) - 0x0020

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x0							RW: 0x1
Bit Name	Reserved[7:1]							Value[0:0]

Enable/Disable WetFinger Feature

Bits	Name	Description
[7:1]	Reserved [6:0]	Default: 0x0 Range:
[0:0]	Value [0:0]	Enable/Disable Wet Finger Tracking Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0x1 **0:** Disabled - Wet Finger is Disabled **1:** Enabled - Wet Finger is Enabled

11.0.40 HIGH_PIVOT

[TTHE Group] Register Name : Address

[Device Setup] HIGH_PIVOT : CYTT21X/31X (40, 44, 48 IOs) - 0x039C, CYTMA445A - 0x0324, CYTT21X (28, 33, 35, 36 IOs) - 0x03B0

Bits	31	30	29	28	27	26	25	24
Access:POR	RW: 0x00							
Bit Name	HighPivot[31:24]							

Bits	23	22	21	20	19	18	17	16
Access:POR	RW: 0x00							
Bit Name	HighPivot[23:16]							

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x00							
Bit Name	HighPivot[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0xb4							
Bit Name	HighPivot[7:0]							

When zMagnitude = HighPivot than Scalar = MinGain(based on FS) This is used for 4~8 mm finger.

Bits	Name	Description
[31:0]	HighPivot [31:0]	When zMagnitude = HighPivot than Scalar = MinGain(based on FS) Default: 0xb4 Range: -2147483648:2147483647

11.0.41 DELAY_TIME_FOR_PUMP

[TTHE Group] Register Name : Address

[CDC] DELAY_TIME_FOR_PUMP : CYTT21X/31X (40, 44, 48 IOs) - 0x0072, CYTT21X (28, 33, 35, 36 IOs) - 0x0072

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x03							
Bit Name	time[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x68							
Bit Name	time[7:0]							

Delay time for Pumping VCCTX to target voltage, in us

Bits	Name	Description
[15:0]	time [15:0]	Delay time for Pumping VCCTX to target voltage, in us Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0x3e8 Range: 0:10000

11.0.42 GLOVE_FIRST_TOUCH_DEBOUNCE

[TTHE Group] Register Name : Address

[Glove] GLOVE_FIRST_TOUCH_DEBOUNCE : CYTT21X/31X (40, 44, 48 IOs) - 0x042A, CYTMA445A - 0x03C6, CYTT21X (28, 33, 35, 36 IOs) - 0x0452

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x2							
Bit Name	Debounce[7:0]							

Number of consecutive refresh cycles for which a glove touch must be detected prior to being reported. Applies to the first glove touch.

Bits	Name	Description
[7:0]	Debounce [7:0]	Number of consecutive refresh cycles for which a glove touch must be detected prior to being reported. Applies to the first glove touch. Default: 0x2 Range: 0-63

11.0.43 BTN_PROCESS_IF_TOUCH_DETECTED

[TTHE Group] Register Name : Address

[CapSense Buttons] BTN_PROCESS_IF_TOUCH_DETECTED : CYTT21X/31X (40, 44, 48 IOs) - 0x0420, CYTMA445A - 0x03BC, CYTT21X (28, 33, 35, 36 IOs) - 0x0448

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x0							RW: 0x0
Bit Name	Reserved[7:1]							processButtonIfTouchDetected[0:0]

Allow buttons processing when touch detected on the panel.

Bits	Name	Description
[7:1]	Reserved [6:0]	Default: 0x0 Range:
[0:0]	processButtonIfTouchDetected [0:0]	Allow buttons processing when touch detected on the panel. Default: 0x0 **0:** Disabled **1:** Enabled

11.0.44 IIR_COEF

[TTHE Group] Register Name : Address

[Proximity] IIR_COEF : CYTMA445A - 0x0275, CYTT21X (28, 33, 35, 36 IOs) - 0x02DD

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x1							
Bit Name	IIR Filter Input Weight[7:0]							

IIR Coefficient for Base Proximity

Bits	Name	Description
[7:0]	IIR Filter Input Weight [7:0]	Raw IIR filter coefficient for Base Button Self Default: 0x1 **0:** OFF - Filter output = Filter Input **1:** 1/2 - Filter output = 1/2 * Filter Input + 1/2 * Previous Filter Output **2:** 1/4 - Filter output = 1/4 * Filter Input + 3/4 * Previous Filter Output **3:** 1/8 - Filter output = 1/8 * Filter Input + 7/8 * Previous Filter Output **4:** 1/16 - Filter output = 1/16 * Filter Input + 15/16 * Previous Filter Output **5:** 1/32 - Filter output = 1/32 * Filter Input + 31/32 * Previous Filter Output **6:** 1/64 - Filter output = 1/64 * Filter Input + 63/64 * Previous Filter Output **7:** 1/128 - Filter output = 1/128 * Filter Input + 127/128 * Previous Filter Output **8:** 1/256 - Filter output = 1/256 * Filter Input + 255/256 * Previous Filter Output

11.0.45 BL_FILT_BTN_SELF

[TTHE Group] Register Name : Address

[Raw Processing] BL_FILT_BTN_SELF : CYTT21X/31X (40, 44, 48 IOs) - 0x027B, CYTMA445A - 0x021D, CYTT21X (28, 33, 35, 36 IOs) - 0x0277

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0xa					RW: 0x0		
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. Default: 0xa Range: 0:31
[2:0]	Additional Samples [2:0]	Number of additional samples to average for baseline. 0 = no baseline filter. Default: 0x0 Range: 0:7

11.0.46 BTN_LS_ON_THRSH_MUT_1

[TTHE Group] Register Name : Address

[CapSense Buttons] BTN_LS_ON_THRSH_MUT_1 : CYTT21X/31X (40, 44, 48 IOs) - 0x03ED, CYTMA445A - 0x0389, CYTT21X (28, 33, 35, 36 IOs) - 0x0415

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x50							
Bit Name	On Threshold[7:0]							

CapSense Button Mutual Cap LowSensitive scan On threshold for button 1

Bits	Name	Description
[7:0]	On Threshold [7:0]	CapSense Button Mutual Cap LowSensitive scan On threshold for button 1 Default: 0x50 Range: 5:255

11.0.47 BTN_LS_ON_THRSH_MUT_0

[TTHE Group] Register Name : Address

[CapSense Buttons] BTN_LS_ON_THRSH_MUT_0 : CYTT21X/31X (40, 44, 48 IOs) - 0x03EC, CYTMA445A - 0x0388, CYTT21X (28, 33, 35, 36 IOs) - 0x0414

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x50							
Bit Name	On Threshold[7:0]							

CapSense Button Mutual Cap LowSensitive scan On threshold for button 0

Bits	Name	Description
[7:0]	On Threshold [7:0]	CapSense Button Mutual Cap LowSensitive scan On threshold for button 0 Default: 0x50 Range: 5:255

11.0.48 BTN_LS_ON_THRSH_MUT_3

[TTHE Group] Register Name : Address

[CapSense Buttons] BTN_LS_ON_THRSH_MUT_3 : CYTT21X/31X (40, 44, 48 IOs) - 0x03EF, CYTMA445A - 0x038B, CYTT21X (28, 33, 35, 36 IOs) - 0x0417

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x50							
Bit Name	On Threshold[7:0]							

CapSense Button Mutual Cap LowSensitive scan On threshold for button 3

Bits	Name	Description
[7:0]	On Threshold [7:0]	CapSense Button Mutual Cap LowSensitive scan On threshold for button 3 Default: 0x50 Range: 5:255

11.0.49 BTN_LS_ON_THRSH_MUT_2

[TTHE Group] Register Name : Address

[CapSense Buttons] BTN_LS_ON_THRSH_MUT_2 : CYTT21X/31X (40, 44, 48 IOs) - 0x03EE, CYTMA445A - 0x038A, CYTT21X (28, 33, 35, 36 IOs) - 0x0416

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x50							
Bit Name	On Threshold[7:0]							

CapSense Button Mutual Cap LowSensitive scan On threshold for button 2

Bits	Name	Description
[7:0]	On Threshold [7:0]	CapSense Button Mutual Cap LowSensitive scan On threshold for button 2 Default: 0x50 Range: 5:255

11.0.50 FILT_IIR_COEFF_MUT

[TTHE Group] Register Name : Address

[Raw Processing] FILT_IIR_COEFF_MUT : CYTT21X/31X (40, 44, 48 IOs) - 0x02AD, CYTMA445A - 0x025D, CYTT21X (28, 33, 35, 36 IOs) - 0x02C5

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x0					RW: 0x1		
Bit Name	Reserved[7:3]					IIR Filter Input Weight[2:0]		

IIR Coefficient for Base Mutual

Bits	Name	Description
[7:3]	Reserved [4:0]	Default: 0x0 Range:
[2:0]	IIR Filter Input Weight [2:0]	Raw IIR filter coefficient for Mutual Cap scan Default: 0x1
		0: One Half - Filter output = 0.5 * Filter Input + 0.5 * Previous Filter Output
		1: One Quarter - Filter output = 0.25 * Filter Input + 0.75 * Previous Filter Output
		2: One Eighth - Filter output = 0.125 * Filter Input + 0.875 * Previous Filter Output
		3: One Sixteenth - Filter output = 0.0625 * Filter Input + 0.9375 * Previous Filter Output
		4: One Thirty-second - Filter output = 0.03125 * Filter Input + 0.96875 * Previous Filter Output

11.0.51 BEZEL_FILTER_FOR_STYLUS

[TTHE Group] Register Name : Address

[Stylus Tracking] BEZEL_FILTER_FOR_STYLUS : CYTT21X/31X (40, 44, 48 IOs) - 0x0453

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x0							RW: 0x0
Bit Name	Reserved[7:1]							enable-Work-Around[0:0]

Enable bezel filter to subtract ghost signal appearing on RX15 when there is a palm on the bezel. This fix works only for panel 1546. Details in CDT201382.

Bits	Name	Description
[7:1]	Reserved [6:0]	Default: 0x0 Range:
[0:0]	enableWorkAround [0:0]	Workaround for preventing false touch when touch at Panel 1546 sensor bezel. Only applicable for Panel 1546. Please keep disabled for other panels. Details in CDT201382. Default: 0x0 **1:** Enabled **0:** Disabled

11.0.52 GLOVE_INNER_EDGE_GAIN

[TTHE Group] Register Name : Address

[Glove] GLOVE_INNER_EDGE_GAIN : CYTT21X/31X (40, 44, 48 IOs) - 0x0439, CYTMA445A - 0x03D3, CYTT21X (28, 33, 35, 36 IOs) - 0x0461

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x8							
Bit Name	Gain[7:0]							

Inner edge gain in Glove Mode

Bits	Name	Description
[7:0]	Gain [7:0]	Inner edge gain in Glove Mode Default: 0x8 Range: 0:255

11.0.53 TX_PULSES_NUM_GLOVE_SELF

[TTHE Group] Register Name : Address

[CDC] TX_PULSES_NUM_GLOVE_SELF : CYTT21X/31X (40, 44, 48 IOs) - 0x00A2, CYTMA445A - 0x00AA, CYTT21X (28, 33, 35, 36 IOs) - 0x009E

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x00							
Bit Name	TX Pulses[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x40							
Bit Name	TX Pulses[7:0]							

Number of TX Pulses for Glove Self Scanning

Bits	Name	Description
[15:0]	TX Pulses [15:0]	Number of TX Pulses per conversion for Glove Self Scan Default: 0x40 Range: 0:255

11.0.54 CA_DYN_CAL_NUM_SENSOR_THLD_PERCENT

[TTHE Group] Register Name : Address

[Charger Armor] CA_DYN_CAL_NUM_SENSOR_THLD_PERCENT : CYTT21X/31X (40, 44, 48 IOs) - 0x0313, CYTMA445A - 0x02B7, CYTT21X (28, 33, 35, 36 IOs) - 0x032B

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x4b							
Bit Name	Value[7:0]							

Dynamic Recalibration will be triggered when amount of properly compensated crossings is lower than this value.

Bits	Name	Description
[7:0]	Value [7:0]	Dynamic Recalibration will be triggered when amount of properly compensated crossings is lower than this value. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0x4b Range: 0:255

11.0.55 ACT_DIST2

[TTHE Group] Register Name : Address

[Finger Tracking] ACT_DIST2 : CYTT21X/31X (40, 44, 48 IOs) - 0x0331, CYTMA445A - 0x02CD, CYTT21X (28, 33, 35, 36 IOs) - 0x0349

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x0							
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]	One-dimensional active distance threshold (in pixels) applied to determine whether a given finger's motion should trigger a report. When the displacement of a new finger touch exceeds threshold ACT_DIST0, a new report is generated to the host. After that, the displacement of this finger in either x-direction or y-direction must exceed threshold ACT_DIST2 to generate additional report to the host. Default: 0x0 Range: 0,255

11.0.56 CLIPPING_X_HIGH

[TTHE Group] Register Name : Address

[Device Setup] CLIPPING_X_HIGH : CYTT21X/31X (40, 44, 48 IOs) - 0x0375, CYTMA445A - 0x0301, CYTT21X (28, 33, 35, 36 IOs) - 0x0389

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x0							
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. Default: 0x0 Range: -128:127

11.0.57 CAFILT_IIR_COEFF_BUT

[TTHE Group] Register Name : Address

[Charger Armor] CAFILT_IIR_COEFF_BUT : CYTT21X/31X (40, 44, 48 IOs) - 0x02D1, CYTMA445A - 0x0281, CYTT21X (28, 33, 35, 36 IOs) - 0x02E9

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x0					RW: 0x1		
Bit Name	Reserved[7:3]					IIR Filter Input Weight[2:0]		

IIR Coefficient for Mutual Button scan when Charger Armor is active

Bits	Name	Description
[7:3]	Reserved [4:0]	Default: 0x0 Range:
[2:0]	IIR Filter Input Weight [2:0]	IIR Coefficient for Mutual Button scan when Charger Armor is active Default: 0x1 **0:** One Half - Filter output = 0.5 * Filter Input + 0.5 * Previous Filter Output **1:** One Quarter - Filter output = 0.25 * Filter Input + 0.75 * Previous Filter Output **2:** One Eighth - Filter output = 0.125 * Filter Input + 0.875 * Previous Filter Output **3:** One Sixteenth - Filter output = 0.0625 * Filter Input + 0.9375 * Previous Filter Output **4:** One Thirty-second - Filter output = 0.03125 * Filter Input + 0.96875 * Previous Filter Output

11.0.58 RX_LINE_FILTER_DEBOUNCE

[TTHE Group] Register Name : Address

[Charger Armor] RX_LINE_FILTER_DEBOUNCE : CYTT21X/31X (40, 44, 48 IOs) - 0x03E4, CYTMA445A - 0x037F, CYTT21X (28, 33, 35, 36 IOs) - 0x040C

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x2							
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 intersections surrounding the largest local maximum in proximity (within 3 RX electrodes) to the local maximum of interest. Default: 0x2 Range: 0:255

11.0.59 FILT_FILTER_MASK_BTN_SELF

[TTHE Group] Register Name : Address

[Raw Processing] FILT_FILTER_MASK_BTN_SELF : CYTT21X/31X (40, 44, 48 IOs) - 0x02BE, CYTMA445A - 0x026E, CYTT21X (28, 33, 35, 36 IOs) - 0x02D6

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x0						RW: 0x1	RW: 0x1
Bit Name	Reserved[7:2]						IIR Fil-ter[1:1]	CMF Fil-ter[0:0]

Indicates what filters are enabled/disabled for Base Button Self

Bits	Name	Description
[7:2]	Reserved [5:0]	Default: 0x0 Range:
[1:1]	IIR Filter [0:0]	Enable/Disable IIR Filter Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0x1 **0:** Disabled - Filter is Disabled **1:** Enabled - Filter is Enabled
[0:0]	CMF Filter [0:0]	Enable/Disable CMF Filter Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0x1 **0:** Disabled - Filter is Disabled **1:** Enabled - Filter is Enabled

11.0.60 FILT_FILTER_MASK

[TTHE Group] Register Name : Address

[Raw Processing] FILT_FILTER_MASK : CYTT21X/31X (40, 44, 48 IOs) - 0x02AC, CYTMA445A - 0x025C, CYTT21X (28, 33, 35, 36 IOs) - 0x02C4

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x0						RW: 0x1	RW: 0x1
Bit Name	Reserved[7:2]						IIR Filter[1:1]	CMF Filter[0:0]

Indicates what filters are enabled/disabled for Base Mutual

Bits	Name	Description
[7:2]	Reserved [5:0]	Default: 0x0 Range:
[1:1]	IIR Filter [0:0]	Enable/Disable IIR Filter Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0x1 **0:** Disabled - Filter is Disabled **1:** Enabled - Filter is Enabled
[0:0]	CMF Filter [0:0]	Enable/Disable CMF Filter Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0x1 **0:** Disabled - Filter is Disabled **1:** Enabled - Filter is Enabled

11.0.61 FILT_FILTER_MASK_STYLUS_SELF

[TTHE Group] Register Name : Address

[Raw Processing] FILT_FILTER_MASK_STYLUS_SELF : CYTT21X/31X (40, 44, 48 IOs) - 0x02F4

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x0						RW: 0x1	RW: 0x1
Bit Name	Reserved[7:2]						IIR Filter[1:1]	CMF Filter[0:0]

Indicates what filters are enabled/disabled for Stylus Self

Bits	Name	Description
[7:2]	Reserved [5:0]	Default: 0x0 Range:
[1:1]	IIR Filter [0:0]	Enable/Disable IIR Filter Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0x1 **0:** Disabled - Filter is Disabled **1:** Enabled - Filter is Enabled
[0:0]	CMF Filter [0:0]	Enable/Disable CMF Filter Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0x1 **0:** Disabled - Filter is Disabled **1:** Enabled - Filter is Enabled

11.0.62 TOUCH_IGNORE_COEFF

[TTHE Group] Register Name : Address

[Finger Tracking] TOUCH_IGNORE_COEFF : CYTT21X/31X (40, 44, 48 IOs) - 0x03CB, CYTMA445A - 0x0353, CYTT21X (28, 33, 35, 36 IOs) - 0x03DF

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x0							
Bit Name	Threshold[7:0]							

Coefficient defining the fraction (in 1/32 increments) of the LocalMax to the biggest signal on the panel. Touch ignored if LocalMax/MaxSig < TOUCH_IGNORE_COEFF/32 (0 = Disabled)

Bits	Name	Description
[7:0]	Threshold [7:0]	Coefficient defining the fraction (in 1/32 increments) of the LocalMax to the biggest signal on the panel. Touch ignored if LocalMax/MaxSig < TOUCH_IGNORE_COEFF/32 (0 = Disabled) Default: 0x0 Range: 0:32

11.0.63 PROXIMITY_ENABLE

[TTHE Group] Register Name : Address

[Touch Mode] PROXIMITY_ENABLE : CYTT21X (28, 33, 35, 36 IOs) - 0x0016

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x0							RW: 0x0
Bit Name	Reserved[7:1]							Enable[0:0]

Enable/Disable Proximity

Bits	Name	Description
[7:1]	Reserved [6:0]	Default: 0x0 Range:
[0:0]	Enable [0:0]	Enable/Disable Proximity Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0x0 **0:** Disabled - Proximity is disabled **1:** Enabled - Proximity is enabled

11.0.64 STYL_HIGH_SUM_THRESH_MUTUAL

[TTHE Group] Register Name : Address

[Stylus Tracking] STYL_HIGH_SUM_THRESH_MUTUAL : CYTT21X/31X (40, 44, 48 IOs) - 0x0440

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x02							
Bit Name	Threshold On[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x58							
Bit Name	Threshold On[7:0]							

Mutual Cap diff count sum of the 5x5 sensors around the peak sensor in the panel core area. Value must be below this threshold for valid stylus detection.

Bits	Name	Description
[15:0]	Threshold On [15:0]	Mutual Cap diff count sum of the 5x5 sensors around the peak sensor in the panel core area. Value must be below this threshold for valid stylus detection. Default: 0x258 Range: 0:65535

11.0.65 TX_PERIOD_BTN_MUTUAL

[TTHE Group] Register Name : Address

[CDC] TX_PERIOD_BTN_MUTUAL : CYTT21X/31X (40, 44, 48 IOs) - 0x0086, CYTMA445A - 0x0098, CYTT21X (28, 33, 35, 36 IOs) - 0x0082

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x00							
Bit Name	txPeriodButtonMutual[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x3d							
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]	txPeriodButtonMutual [15:0]	Number of system clocks in each TX half period for CapSense Buttons Mutual Cap scan, Button Mutual Cap Glove scan Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0x3d Range: 48:510

11.0.66 CAFILT_IIR_THRESHOLD_MUT

[TTHE Group] Register Name : Address

[Charger Armor] CAFILT_IIR_THRESHOLD_MUT : CYTT21X/31X (40, 44, 48 IOs) - 0x02CC, CYTMA445A - 0x027C, CYTT21X (28, 33, 35, 36 IOs) - 0x02E4

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x00							
Bit Name	Value[15:8]							
Bits	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
Access:POR	RW: 0x14							
Bit Name	Value[7:0]							

IIR Threshold for Mutual scan when Charger Armor is active

Bits	Name	Description
[15:0]	Value [15:0]	IIR Threshold Base for Mutual scan 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: 0x14 Range: 0:32767

11.0.67 FILT_IIR_COEFF_SELF

[TTHE Group] Register Name : Address

[Raw Processing] FILT_IIR_COEFF_SELF : CYTT21X/31X (40, 44, 48 IOs) - 0x02B3, CYTMA445A - 0x0263, CYTT21X (28, 33, 35, 36 IOs) - 0x02CB

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x0					RW: 0x1		
Bit Name	Reserved[7:3]					IIR Filter Input Weight[2:0]		

IIR Coefficient for Base Self

Bits	Name	Description
[7:3]	Reserved [4:0]	Default: 0x0 Range:
[2:0]	IIR Filter Input Weight [2:0]	Raw IIR filter coefficient for Base Self Cap scan Default: 0x1 **0:** One Half - Filter output = 0.5 * Filter Input + 0.5 * Previous Filter Output **1:** One Quarter - Filter output = 0.25 * Filter Input + 0.75 * Previous Filter Output **2:** One Eighth - Filter output = 0.125 * Filter Input + 0.875 * Previous Filter Output **3:** One Sixteenth - Filter output = 0.0625 * Filter Input + 0.9375 * Previous Filter Output **4:** One Thirty-second - Filter output = 0.03125 * Filter Input + 0.96875 * Previous Filter Output

11.0.68 GLOVE_FIRST_TOUCH_DEBOUNCE_EDGE_MASK

[TTHE Group] Register Name : Address

[Glove] GLOVE_FIRST_TOUCH_DEBOUNCE_EDGE_MASK : CYTT21X/31X (40, 44, 48 IOs) - 0x042B, CYTMA445A - 0x03C7, CYTT21X (28, 33, 35, 36 IOs) - 0x0453

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x0				RW: 0x0	RW: 0x0	RW: 0x0	RW: 0x0
Bit Name	Reserved[7:4]				RXMax First Touch De-bounce[3:3]	RX0 First Touch De-bounce[2:2]	TXMax First Touch De-bounce[1:1]	TX0 First Touch De-bounce[0:0]

Individual first glove touch debounce enable for each of the 4 edges

Bits	Name	Description
[7:4]	Reserved [3:0]	Reserved Default: 0x0 Range:
[3:3]	RXMax First Touch De-bounce [0:0]	Default: 0x0 **0:** Enabled **1:** Disabled
[2:2]	RX0 First Touch Debounce [0:0]	Default: 0x0 **0:** Enabled **1:** Disabled
[1:1]	TXMax First Touch De-bounce [0:0]	Default: 0x0 **0:** Enabled **1:** Disabled
[0:0]	TX0 First Touch Debounce [0:0]	Default: 0x0 **0:** Enabled **1:** Disabled

11.0.69 BTN_HS_OFF_THRSH_SELF_1

[TTHE Group] Register Name : Address

[CapSense Buttons] BTN_HS_OFF_THRSH_SELF_1 : CYTT21X/31X (40, 44, 48 IOs) - 0x040D, CYTMA445A - 0x03A9, CYTT21X (28, 33, 35, 36 IOs) - 0x0435

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

CapSense Button Self Cap HighSensitive scan Off threshold for button 1

Bits	Name	Description
[7:0]	On Threshold [7:0]	CapSense Button Self Cap HighSensitive scan Off threshold for button 1 Default: 0xa Range: 5:255

11.0.70 FILT_CMF_THRESHOLD_GLOVE_SELF

[TTHE Group] Register Name : Address

[Raw Processing] FILT_CMF_THRESHOLD_GLOVE_SELF : CYTT21X/31X (40, 44, 48 IOs) - 0x02E0, CYTMA445A - 0x0290, CYTT21X (28, 33, 35, 36 IOs) - 0x02F8

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x00							
Bit Name	Value[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x3c							
Bit Name	Value[7:0]							

CMF Threshold for Glove Self

Bits	Name	Description
[15:0]	Value [15:0]	CMF Threshold Glove for Self TX Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0x3c Range: 0:32767

11.0.71 STYL_LIFTOFF_DEBOUNCE

[TTHE Group] Register Name : Address

[Stylus Tracking] STYL_LIFTOFF_DEBOUNCE : CYTT21X/31X (40, 44, 48 IOs) - 0x0355

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x0							
Bit Name	Debounce period[7:0]							

Number of consecutive refresh cycles for which a Stylus 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 Stylus touch must not be detected before the lack of touch is identified as a liftoff Default: 0x0 Range: 0:63

11.0.72 CONFIG_CRC

[TTHE Group] Register Name : Address

[Other] CONFIG_CRC : CYTT21X/31X (40, 44, 48 IOs) - 0x0498, CYTMA445A - 0x0410, CYTT21X (28, 33, 35, 36 IOs) - 0x0498

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x00							
Bit Name	CRC Check Value[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x00							
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. Default: 0x0 Range: 0:65535

11.0.73 CAFILT_FILT_BTN_MUT

[TTHE Group] Register Name : Address

[Charger Armor] CAFILT_FILT_BTN_MUT : CYTT21X/31X (40, 44, 48 IOs) - 0x02D0, CYTMA445A - 0x0280, CYTT21X (28, 33, 35, 36 IOs) - 0x02E8

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x0						RW: 0x1	RW: 0x1
Bit Name	Reserved[7:2]						IIR Filter[1:1]	CMF Filter[0:0]

Indicates what filters are enabled/disabled for Mutual Button scan when Charger Armor is active

Bits	Name	Description
[7:2]	Reserved [5:0]	Default: 0x0 Range:
[1:1]	IIR Filter [0:0]	Enable/Disable IIR Filter Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0x1 **0:** Disabled - Filter is Disabled **1:** Enabled - Filter is Enabled
[0:0]	CMF Filter [0:0]	Enable/Disable CMF Filter Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0x1 **0:** Disabled - Filter is Disabled **1:** Enabled - Filter is Enabled

11.0.74 BL_DELAY_BTN

[TTHE Group] Register Name : Address

[Raw Processing] BL_DELAY_BTN : CYTT21X/31X (40, 44, 48 IOs) - 0x0279, CYTMA445A - 0x0214, CYTT21X (28, 33, 35, 36 IOs) - 0x0275

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x3							
Bit Name	Value[7:0]							

Button Baseline Update Delay

Bits	Name	Description
[7:0]	Value [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). Default: 0x3 Range: 0:255

11.0.75 SENSOR_NUM_THRSH_FINGER

[TTHE Group] Register Name : Address

[Proximity] SENSOR_NUM_THRSH_FINGER : CYTMA445A - 0x0364, CYTT21X (28, 33, 35, 36 IOs) - 0x03F0

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x4							
Bit Name	sensorNumThresholdFinger[7:0]							

Number of active sensors threshold to discriminate between finger and proximity cases, if there are less sensors than this value that have higher values than ACTIVE_SENSOR_THRESHOLD_FINGER, the object is decided as finger, otherwise proximity.

Bits	Name	Description
[7:0]	sensorNumThresholdFinger [7:0]	Number of active sensors threshold to discriminate between finger and proximity cases, if there are less sensors than this value that have higher values than ACTIVE_SENSOR_THRESHOLD_FINGER, the object is decided as finger, otherwise proximity. Default: 0x4 Range: 0:255

11.0.76 MIN_FAT_FINGER_SIZE_HYST

[TTHE Group] Register Name : Address

[Finger Tracking] MIN_FAT_FINGER_SIZE_HYST : CYTT21X/31X (40, 44, 48 IOs) - 0x03DC, CYTMA445A - 0x0374, CYTT21X (28, 33, 35, 36 IOs) - 0x0404

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x1							
Bit Name	Min Fat Finger Size 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]	Min Fat Finger Size 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. Default: 0x1 Range: 0:255

11.0.77 DROP_RESET_COUNTER

[TTHE Group] Register Name : Address

[Proximity] DROP_RESET_COUNTER : CYTMA445A - 0x022E, CYTT21X (28, 33, 35, 36 IOs) - 0x028E

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x00							
Bit Name	Value[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x64							
Bit Name	Value[7:0]							

Proximity Drop Reset Counter

Bits	Name	Description
[15:0]	Value [15:0]	Proximity Drop reset Counter Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0x64 Range: 0:65535

11.0.78 COUNTS_TO_BL_RESET_SELF

[TTHE Group] Register Name : Address

[Raw Processing] COUNTS_TO_BL_RESET_SELF : CYTT21X/31X (40, 44, 48 IOs) - 0x0278, CYTMA445A - 0x021B, CYTT21X (28, 33, 35, 36 IOs) - 0x0274

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x1							
Bit Name	Value[7:0]							

The number of consecutive refresh cycles when one of the conditions to baseline signals is met to reset self/mutual signals for H2O rejection enabled/disabled. In the low power mode: with H2O rejection enabled, (LP_INTRLV0 * COUNTS_TO_BL_RESET_SELF) defines the baseline update interval for MUTUAL. With H2O rejection disabled, this value defines the baseline update rate for SELF. In the active power mode: with H2O rejection enabled, (ACT_INTRVL0 * COUNTS_TO_BL_RESET_SELF) defines the baseline update interval for MUTUAL. With H2O rejection disabled, this value defines the baseline update rate for SELF.

Bits	Name	Description
[7:0]	Value [7:0]	The number of consecutive refresh cycles when one of the conditions to baseline signals is met to reset self/mutual signals for H2O rejection enabled/disabled. In the low power mode: with H2O rejection enabled, (LP_INTRLV0 * COUNTS_TO_BL_RESET_SELF) defines the baseline update interval for MUTUAL. With H2O rejection disabled, this value defines the baseline update rate for SELF. In the active power mode: with H2O rejection enabled, (ACT_INTRVL0 * COUNTS_TO_BL_RESET_SELF) defines the baseline update interval for MUTUAL. With H2O rejection disabled, this value defines the baseline update rate for SELF. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0x1 Range: 0:255

11.0.79 PQ_CTRL

[TTHE Group] Register Name : Address

[CDC] PQ_CTRL : CYTT21X/31X (40, 44, 48 IOs) - 0x0024, CYTMA445A - 0x0020, CYTT21X (28, 33, 35, 36 IOs) - 0x0024

Bits	31	30	29	28	27	26	25	24
Access:POR	RW: 0x0	RW: 0x0	RW: 0x00					
Bit Name	PQ_ENABLED[31:31]	START_ENABLED[30:30]	Reserved[29:24]					

Bits	23	22	21	20	19	18	17	16
Access:POR	RW: 0x00							
Bit Name	Reserved[23:16]							

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x00					RW: 0x0		
Bit Name	Reserved[15:11]					SRC_SEL[10:8]		

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x0							RW: 0x0
Bit Name	Reserved[7:1]							POLARITY[0:0]

External events control

Bits	Name	Description
[31:31]	PQ_ENABLED [0:0]	Pulse qualifier enable. Default: 0x0 **0:** DISABLED - PQ Disabled **1:** ENABLED - PQ Enabled
[30:30]	START_ENABLED [0:0]	Start enable: '0': Disabled: "pq_start" is not generated, "pq_start_prel" is generated (when ENABLED is '1'). '1': Enabled: "pq_start" is generated (when ENABLED is '1'). Note: "pq_start_prel" is used as interrupt cause INTR.PQ_START_PREL. Both "pq_start_prel" and "pq_start" can be brough out as observe signals 0, 1, 2, and 3. Default: 0x0 **0:** DISABLED - Start Disabled **1:** ENABLED - Start Enabled
[29:11]	Reserved [18:0]	Reserved Default: 0x0 Range:
[10:8]	SRC_SEL [2:0]	Specifies which signal is used as input for the pulse qualifier logic: "0": "ext_start_in" "1": MUX_DATA.DATA_IN[0] "2": MUX_DATA.DATA_IN[1] "3": MUX_DATA.DATA_IN[2] "4": MUX_DATA.DATA_IN[3] "5": MUX_DATA.DATA_IN[4] "6": MUX_DATA.DATA_IN[5] "7": MUX_DATA.DATA_IN[6] Default: 0x0 **0:** Ext_Start_In

		1: MUX_DATA.DATA_IN[0] **2:** MUX_DATA.DATA_IN[1] **3:** MUX_DATA.DATA_IN[2] **4:** MUX_DATA.DATA_IN[3] **5:** MUX_DATA.DATA_IN[4] **6:** MUX_DATA.DATA_IN[5] **7:** MUX_DATA.DATA_IN[6]
[7:1]	Reserved [6:0]	Reserved Default: 0x0 Range:
[0:0]	POLARITY [0:0]	Polarity of the pulse qualifier input signal as specified by SRC_SEL: '0': High/'1 active. '1': Low/'0' active. Default: 0x0 **0:** NORMAL - Normal (active high) polarity **1:** INVERTED - Inverted (active low) polarity

11.0.80 CA_Z9_FILTER_SCALE

[TTHE Group] Register Name : Address

[Charger Armor] CA_Z9_FILTER_SCALE : CYTT21X/31X (40, 44, 48 IOs) - 0x03D5, CYTMA445A - 0x0373, CYTT21X (28, 33, 35, 36 IOs) - 0x03FD

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x4							
Bit Name	Z9 Filter Scale[7:0]							

Z9 filter scale for normal finger when Charger Armor is active. Peak with Z9<(scale*CA_FINGER_THRESHOLD_MUTUAL) will be removed.

Bits	Name	Description
[7:0]	Z9 Filter Scale [7:0]	Z9 filter scale for normal finger when Charger Armor is active. Peak with Z9<(scale*CA_FINGER_THRESHOLD_MUTUAL) will be removed. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0x4 Range: 0:4

11.0.81 TOUCHMODE_FRAME_NUM_TO_CONFIRM_STYLUS_MODE

[TTHE Group] Register Name : Address

[Touch Mode] TOUCHMODE_FRAME_NUM_TO_CONFIRM_STYLUS_MODE : CYTT21X/31X (40, 44, 48 IOs) - 0x0452

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x14							
Bit Name	Threshold[7:0]							

Threshold of number of frame which continously satisfy stylus criteria in core panel.

Bits	Name	Description
[7:0]	Threshold [7:0]	Threshold of number of frame which continously satisfy stylus criteria in core panel. Default: 0x14 Range: 0:255

11.0.82 BL_BTN_THRSH_MUT_CA

[TTHE Group] Register Name : Address

[Charger Armor] BL_BTN_THRSH_MUT_CA : CYTT21X/31X (40, 44, 48 IOs) - 0x028C, CYTMA445A - 0x0244, CYTT21X (28, 33, 35, 36 IOs) - 0x02A4

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x00							
Bit Name	Value[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x0a							
Bit Name	Value[7:0]							

Button Threshold Mutual for baseline updating for Button Button Mutual Configuration. The buttons baselines are not updating in case of the button touch signals are above this threshold

Bits	Name	Description
[15:0]	Value [15:0]	Button Threshold Mutual for baseline updating for Button Button Mutual Configuration. The buttons baselines are not updating in case of the button touch signals are above this threshold Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0xa Range: 0:65535

11.0.83 CA_NMF_THRESHOD

[TTHE Group] Register Name : Address

[Charger Armor] CA_NMF_THRESHOD : CYTT21X/31X (40, 44, 48 IOs) - 0x0319

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x19							
Bit Name	Value[7:0]							

NMF level exceeding of which triggers Charger Armor. Set it to 255 to disable Charger Armor triggering by NMF.

Bits	Name	Description
[7:0]	Value [7:0]	NMF level exceeding of which triggers Charger Armor. Set it to 255 to disable Charger Armor triggering by NMF. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0x19 Range: 0:255

11.0.84 X_RESOLUTION

[TTHE Group] Register Name : Address

[Device Setup] X_RESOLUTION : CYTT21X/31X (40, 44, 48 IOs) - 0x0004, CYTMA445A - 0x0004, CYTT21X (28, 33, 35, 36 IOs) - 0x0004

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x0e							
Bit Name	Length[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x74							
Bit Name	Length[7:0]							

X (horizontal) Axis Length (in pixels)

Bits	Name	Description
[15:0]	Length [15:0]	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). Default: 0xe74 Range: 0:32767

11.0.85 GLOVE_Z9_FILTER_SCALE

[TTHE Group] Register Name : Address

[Glove] GLOVE_Z9_FILTER_SCALE : CYTT21X/31X (40, 44, 48 IOs) - 0x042E, CYTMA445A - 0x03CA, CYTT21X (28, 33, 35, 36 IOs) - 0x0456

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x4							
Bit Name	Scale[7:0]							

Z8 filter scale for glove detection. A valid touch must satisfy this requirement: Z8 Sum > Glove Peak Diff Count * GLOVE_Z8_FILTER_SCALE

Bits	Name	Description
[7:0]	Scale [7:0]	Z9 filter scale for glove detection. A valid touch must satisfy this requirement: Z9 Sum > (GLOVE_OFF_THRSH_MUTUAL * GLOVE_Z9_FILTER_SCALE)>>shifter. where shifter = 0/1/2 for middle/edge/corner of the panel Default: 0x4 Range: 0:4

11.0.86 EDGE_DEBOUNCE_COUNT_THRESHOLD

[TTHE Group] Register Name : Address

[Device Setup] EDGE_DEBOUNCE_COUNT_THRESHOLD : CYTT21X/31X (40, 44, 48 IOs) - 0x03A8, CYTMA445A - 0x0330, CYTT21X (28, 33, 35, 36 IOs) - 0x03BC

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x00							
Bit Name	Edge Debounce Threshold[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x64							
Bit Name	Edge Debounce Threshold[7:0]							

Apply EDGE_DEBOUNCE_COUNT for new touch on edge when sum3x3 of this single touch is below this threshold

Bits	Name	Description
[15:0]	Edge Debounce Threshold [15:0]	Apply EDGE_DEBOUNCE_COUNT for new touch on edge when sum3x3 of this single touch is below this threshold Default: 0x64 Range: -32768:32767

11.0.87 CA_DEFAULT_REVERT_TIME

[TTHE Group] Register Name : Address

[Charger Armor] CA_DEFAULT_REVERT_TIME : CYTT21X/31X (40, 44, 48 IOs) - 0x0308, CYTMA445A - 0x02AC, CYTT21X (28, 33, 35, 36 IOs) - 0x0320

Bits	31	30	29	28	27	26	25	24
Access:POR	RW: 0x00							
Bit Name	Value[31:24]							

Bits	23	22	21	20	19	18	17	16
Access:POR	RW: 0x00							
Bit Name	Value[23:16]							

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x03							
Bit Name	Value[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x68							
Bit Name	Value[7:0]							

Delay in ms after charger noise is removed, before going back to normal scanning (no charger noise detected).

Bits	Name	Description
[31:0]	Value [31:0]	Delay in ms after charger noise is removed, before going back to normal scanning (no charger noise detected). Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0x3e8 Range: 50:4294967295

11.0.88 CENTROID_FINGER_MAX_JUMP

[TTHE Group] Register Name : Address

[Device Setup] CENTROID_FINGER_MAX_JUMP : CYTT21X/31X (40, 44, 48 IOs) - 0x03AE, CYTMA445A - 0x0336, CYTT21X (28, 33, 35, 36 IOs) - 0x03C2

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x3							
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 Default: 0x3 Range: 0:8

11.0.89 GLOVE_MAX_FAT_FINGER_SIZE

[TTHE Group] Register Name : Address

[Glove] GLOVE_MAX_FAT_FINGER_SIZE : CYTT21X/31X (40, 44, 48 IOs) - 0x0432, CYTMA445A - 0x03CE, CYTT21X (28, 33, 35, 36 IOs) - 0x045A

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x28							
Bit Name	Max Fat Finger Size[7:0]							

Maximum number of contiguous activated panel intersections that define a large object in glove mode. Make sure the condition (0 <= GLOVE_MAX_FAT_FINGER_HYST <= 1/2 of GLOVE_MAX_FAT_FINGER_SIZE) is true when tuning.

Bits	Name	Description
[15:0]	Max Fat Finger Size [15:0]	Maximum number of contiguous activated panel intersections that define a large object in glove mode. Make sure the condition (0 <= GLOVE_MAX_FAT_FINGER_HYST <= 1/2 of GLOVE_MAX_FAT_FINGER_SIZE) is true when tuning. Default: 0x28 Range: 0:65535

11.0.90 XY_FILT_PREDICTION_COEF_CA

[TTHE Group] Register Name : Address

[Charger Armor] XY_FILT_PREDICTION_COEF_CA : CYTT21X/31X (40, 44, 48 IOs) - 0x0473, CYTT21X (28, 33, 35, 36 IOs) - 0x0483

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x0							
Bit Name	Coefficient[7:0]							

Weight of the predicted position that is based on the velocity when Charger Armor is active.

Bits	Name	Description
[7:0]	Coefficient [7:0]	Weight of the predicted position that is based on the velocity when Charger Armor is active. Default: 0x0 Range: 0:128

11.0.91 GLOVE_BTN_TO_LOWSEN_MODE_SWITCH_THRSH_SELF

[TTHE Group] Register Name : Address

[Glove] GLOVE_BTN_TO_LOWSEN_MODE_SWITCH_THRSH_SELF : CYTT21X/31X (40, 44, 48 IOs) - 0x041C, CYTMA445A - 0x03B8, CYTT21X (28, 33, 35, 36 IOs) - 0x0444

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x01							
Bit Name	Threshold[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x5e							
Bit Name	Threshold[7:0]							

Self threshold to Enter Low Sensitive Mode.

Bits	Name	Description
[15:0]	Threshold [15:0]	Self threshold to Enter Low Sensitive Mode. Default: 0x15e Range: 0:32767

11.0.92 CENTER_MAGNITUDE_SCALE

[TTHE Group] Register Name : Address

[Device Setup] CENTER_MAGNITUDE_SCALE : CYTT21X/31X (40, 44, 48 IOs) - 0x03AA, CYTMA445A - 0x0332, CYTT21X (28, 33, 35, 36 IOs) - 0x03BE

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x00							
Bit Name	Center Magnitude Scale[15:8]							
Bits	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
Access:POR	RW: 0x78							
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 Default: 0x78 Range: -32768:32767

11.0.93 TX_PERIOD_MUTUAL

[TTHE Group] Register Name : Address

[CDC] TX_PERIOD_MUTUAL : CYTT21X/31X (40, 44, 48 IOs) - 0x0078, CYTMA445A - 0x0078, CYTT21X (28, 33, 35, 36 IOs) - 0x0074

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x00							
Bit Name	txPeriodMutual[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x3d							
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, Mutual Cap Glove scan, Stylus Mutual scan, Charger Armor noise levels 1-2. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0x3d Range: 48:510

11.0.94 PROXIMITY_GRIP_SUPPRESSION_SIZE

[TTHE Group] Register Name : Address

[Proximity] PROXIMITY_GRIP_SUPPRESSION_SIZE : CYTMA445A - 0x0018, CYTT21X (28, 33, 35, 36 IOs) - 0x001A

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x2							
Bit Name	gripSuppressionSize[7:0]							

Number of channels to disable along the edges for Gorilla Grip case.

Bits	Name	Description
[7:0]	gripSuppressionSize [7:0]	Number of channels to disable along the edges for Gorilla Grip case. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0x2 Range: 0:255

11.0.95 LOW_PIVOT2

[TTHE Group] Register Name : Address

[Device Setup] LOW_PIVOT2 : CYTT21X/31X (40, 44, 48 IOs) - 0x03A0, CYTMA445A - 0x0328, CYTT21X (28, 33, 35, 36 IOs) - 0x03B4

Bits	31	30	29	28	27	26	25	24
Access:POR	RW: 0x00							
Bit Name	LowPivot2[31:24]							

Bits	23	22	21	20	19	18	17	16
Access:POR	RW: 0x00							
Bit Name	LowPivot2[23:16]							

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x00							
Bit Name	LowPivot2[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x78							
Bit Name	LowPivot2[7:0]							

When zMagnitude = LowPivot than Scalar = 1x.This is used for 1~3 mm finger.

Bits	Name	Description
[31:0]	LowPivot2 [31:0]	When zMagnitude = LowPivot than Scalar = 1x.This is used for 1~3 mm finger. Default: 0x78 Range: -2147483648:2147483647

11.0.96 BL_THRESHOLD_MUT

[TTHE Group] Register Name : Address

[Raw Processing] BL_THRESHOLD_MUT : CYTT21X/31X (40, 44, 48 IOs) - 0x0272, CYTMA445A - 0x0215, CYTT21X (28, 33, 35, 36 IOs) - 0x026E

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x3							
Bit Name	Value[7:0]							

Threshold to reset self/mutual signals for H2O rejection enabled/disabled. Condition to reset is (averageValueOfMutualSignals < baselineThresholdMut/4).

Bits	Name	Description
[7:0]	Value [7:0]	Threshold to reset self/mutual signals for H2O rejection enabled/disabled. Condition to reset is (averageValueOfMutualSignals < baselineThresholdMut/4). Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0x3 Range: -128:127

11.0.97 WF_MT_DEBOUNCE

[TTHE Group] Register Name : Address

[Wet Finger] WF_MT_DEBOUNCE : CYTT21X/31X (40, 44, 48 IOs) - 0x03E2, CYTMA445A - 0x037D, CYTT21X (28, 33, 35, 36 IOs) - 0x040A

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x5							
Bit Name	Value[7:0]							

Multi-Touch debounce when wet finger tracking detected.

Bits	Name	Description
[7:0]	Value [7:0]	Multi-Touch debounce when wet finger tracking detected. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0x5 Range: 0:15

11.0.98 OBJ_WITHHOLD_CFG

[TTHE Group] Register Name : Address

[Finger Tracking] OBJ_WITHHOLD_CFG : CYTT21X/31X (40, 44, 48 IOs) - 0x0337, CYTMA445A - 0x02D3, CYTT21X (28, 33, 35, 36 IOs) - 0x034F

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x0							
Bit Name	Withhold Config[7:0]							

Enables LO and Finger withholding configuration at reporting to a host. DISABLED: Finger and Large Object can be reported to a host in the same time. FINGER: Large object withholds Finger. LARGE OBJECT: Finger withholds Large Object.

Bits	Name	Description
[7:0]	Withhold Config [7:0]	Enables LO and Finger withholding configuration at reporting to a 2. DISABLED: Finger and Large Object can be reported to a 2 in the same time. FINGER: Large object withholds Finger. LARGE OBJECT: Finger withholds Large Object. Default: 0x0 **0:** Disabled - Finger and Large Object can be reported to a 2 in the same time **1:** Finger - Large object withholds Finger **2:** Large Object - Finger withholds Large Object

11.0.99 CA_DYN_CAL_SAFE_RAW_RANGE

[TTHE Group] Register Name : Address

[Charger Armor] CA_DYN_CAL_SAFE_RAW_RANGE : CYTT21X/31X (40, 44, 48 IOs) - 0x0314, CYTMA445A - 0x02B8, CYTT21X (28, 33, 35, 36 IOs) - 0x032C

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x00							
Bit Name	Value[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x1a							
Bit Name	Value[7:0]							

Safe range of Baseline HOP Compensation Data (in absolute RAW counts).

Bits	Name	Description
[15:0]	Value [15:0]	Safe range of Baseline HOP Compensation Data (in absolute RAW counts). Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0x1a Range: 0:65535

11.0.100 FILT_IIR_THRESHOLD_SELF

[TTHE Group] Register Name : Address

[Raw Processing] FILT_IIR_THRESHOLD_SELF : CYTT21X/31X (40, 44, 48 IOs) - 0x02B4, CYTMA445A - 0x0264, CYTT21X (28, 33, 35, 36 IOs) - 0x02CC

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x00							
Bit Name	Value[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x14							
Bit Name	Value[7:0]							

IIR Threshold for Base Self

Bits	Name	Description
[15:0]	Value [15:0]	IIR Threshold Base for Self TX Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0x14 Range: 0:32767

11.0.101 SELF_LIFTOFF_SENSOR_NUM

[TTHE Group] Register Name : Address

[Raw Processing] SELF_LIFTOFF_SENSOR_NUM : CYTT21X/31X (40, 44, 48 IOs) - 0x0280, CYTT21X (28, 33, 35, 36 IOs) - 0x027C

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x00							
Bit Name	Value[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x03							
Bit Name	Value[7:0]							

Self negative sensor number after baseline init with finger. If the number of self cap signal drops by more than SELF_LIFTOFF_THRESHOLD after device reset, the mutual baseline will be reset

Bits	Name	Description
[15:0]	Value [15:0]	Self negative sensor number after baseline init with finger. If the number of self cap signal drops by more than SELF_LIFTOFF_THRESHOLD after device reset, the mutual baseline will be reset Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0x3 Range: 1:65535

11.0.102 CA_HOP2_TX_PERIOD_MUTUAL

[TTHE Group] Register Name : Address

[Charger Armor] CA_HOP2_TX_PERIOD_MUTUAL : CYTT21X/31X (40, 44, 48 IOs) - 0x007E, CYTMA445A - 0x0088, CYTT21X (28, 33, 35, 36 IOs) - 0x007A

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x00							
Bit Name	TX Period[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x3c							
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). Default: 0x3c Range: 48:510

11.0.103 WIPE_DELAY

[TTHE Group] Register Name : Address

[Proximity] WIPE_DELAY : CYTMA445A - 0x022C, CYTT21X (28, 33, 35, 36 IOs) - 0x028C

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x00							
Bit Name	Value[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x02							
Bit Name	Value[7:0]							

Number of raw-data wiggling around the baseline to decide wipe is happening

Bits	Name	Description
[15:0]	Value [15:0]	Number of raw-data wiggling around the baseline to decide wipe is happening Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0x2 Range: 0:65535

11.0.104 BTN_LS_OFF_THRSH_SELF_3

[TTHE Group] Register Name : Address

[CapSense Buttons] BTN_LS_OFF_THRSH_SELF_3 : CYTT21X/31X (40, 44, 48 IOs) - 0x03FB, CYTMA445A - 0x0397, CYTT21X (28, 33, 35, 36 IOs) - 0x0423

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x28							
Bit Name	On Threshold[7:0]							

CapSense Button Self Cap LowSensitive scan Off threshold for button 3

Bits	Name	Description
[7:0]	On Threshold [7:0]	CapSense Button Self Cap LowSensitive scan Off threshold for button 3 Default: 0x28 Range: 5:255

11.0.105 BTN_LS_OFF_THRSH_SELF_2

[TTHE Group] Register Name : Address

[CapSense Buttons] BTN_LS_OFF_THRSH_SELF_2 : CYTT21X/31X (40, 44, 48 IOs) - 0x03FA, CYTMA445A - 0x0396, CYTT21X (28, 33, 35, 36 IOs) - 0x0422

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x28							
Bit Name	On Threshold[7:0]							

CapSense Button Self Cap LowSensitive scan Off threshold for button 2

Bits	Name	Description
[7:0]	On Threshold [7:0]	CapSense Button Self Cap LowSensitive scan Off threshold for button 2 Default: 0x28 Range: 5:255

11.0.106 BTN_LS_OFF_THRSH_SELF_1

[TTHE Group] Register Name : Address

[CapSense Buttons] BTN_LS_OFF_THRSH_SELF_1 : CYTT21X/31X (40, 44, 48 IOs) - 0x03F9, CYTMA445A - 0x0395, CYTT21X (28, 33, 35, 36 IOs) - 0x0421

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x28							
Bit Name	On Threshold[7:0]							

CapSense Button Self Cap LowSensitive scan Off threshold for button 1

Bits	Name	Description
[7:0]	On Threshold [7:0]	CapSense Button Self Cap LowSensitive scan Off threshold for button 1 Default: 0x28 Range: 5:255

11.0.107 BTN_LS_OFF_THRSH_SELF_0

[TTHE Group] Register Name : Address

[CapSense Buttons] BTN_LS_OFF_THRSH_SELF_0 : CYTT21X/31X (40, 44, 48 IOs) - 0x03F8, CYTMA445A - 0x0394, CYTT21X (28, 33, 35, 36 IOs) - 0x0420

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x28							
Bit Name	On Threshold[7:0]							

CapSense Button Self Cap LowSensitive scan Off threshold for button 0

Bits	Name	Description
[7:0]	On Threshold [7:0]	CapSense Button Self Cap LowSensitive scan Off threshold for button 0 Default: 0x28 Range: 5:255

11.0.108 CENTROID_CORNER_NUMER

[TTHE Group] Register Name : Address

[Device Setup] CENTROID_CORNER_NUMER : CYTT21X/31X (40, 44, 48 IOs) - 0x03AC, CYTMA445A - 0x0334, CYTT21X (28, 33, 35, 36 IOs) - 0x03C0

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x3							
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 Default: 0x3 Range: 0:255

11.0.109 CMF_DELTA_TEMPCO_INCREMENT

[TTHE Group] Register Name : Address

[Raw Processing] CMF_DELTA_TEMPCO_INCREMENT : CYTT21X/31X (40, 44, 48 IOs) - 0x0294, CYTMA445A - 0x024C, CYTT21X (28, 33, 35, 36 IOs) - 0x02AC

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x3							
Bit Name	cmfDeltaTempCoIncrement[7:0]							

CMF Temperature compensation speed. Higher values cause fast temperature compensation, lower values slow down temperature compensation. Zero value OFF temperature compensation.

Bits	Name	Description
[7:0]	cmfDeltaTempCoIncrement [7:0]	CMF Temperature compensation speed. Higher values cause fast temperature compensation, lower values slow down temperature compensation. Zero value OFF temperature compensation.CMF average larger than 4x of the value will not considered as temperature change. Default: 0x3 Range: 0:127

11.0.110 XY_FILT_EXTRA_IIR_FILTER

[TTHE Group] Register Name : Address

[Charger Armor] XY_FILT_EXTRA_IIR_FILTER : CYTT21X/31X (40, 44, 48 IOs) - 0x0484, CYTMA445A - 0x03F8, CYTT21X (28, 33, 35, 36 IOs) - 0x0484

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x0							
Bit Name	EXTRA IIR Filter[7:0]							

Charger Armor EXTRA XY IIR Filter enable

Bits	Name	Description
[7:0]	EXTRA IIR Filter [7:0]	Charger Armor EXTRA XY IIR Filter enable Default: 0x0 **0:** Disabled **1:** Enabled

11.0.111 SIZE_ORIENTATION_ENABLE

[TTHE Group] Register Name : Address

[Finger Tracking] SIZE_ORIENTATION_ENABLE : CYTT21X/31X (40, 44, 48 IOs) - 0x048C, CYTMA445A - 0x0400, CYTT21X (28, 33, 35, 36 IOs) - 0x048C

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x0						RW: 0x1	RW: 0x1
Bit Name	Reserved[7:2]						Orientation Enable[1:1]	Axis Length Enable[0:0]

Enables/disables for touch contact ellipse axis length and orientation calculations

Bits	Name	Description
[7:2]	Reserved [5:0]	Default: 0x0 Range:
[1:1]	Orientation Enable [0:0]	Enable/Disable major axis orientation calculation Default: 0x1 **0:** Disabled **1:** Enabled
[0:0]	Axis Length Enable [0:0]	Enable/Disable major and minor axis length calculation Default: 0x1 **0:** Disabled **1:** Enabled

11.0.112 WIPE_RESET_COUNTER

[TTHE Group] Register Name : Address

[Proximity] WIPE_RESET_COUNTER : CYTMA445A - 0x0226, CYTT21X (28, 33, 35, 36 IOs) - 0x0286

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x01							
Bit Name	Value[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x74							
Bit Name	Value[7:0]							

Baseline reset counter after wipe is detected (in refresh cycles)

Bits	Name	Description
[15:0]	Value [15:0]	Baseline reset counter after wipe is detected (in refresh cycles) Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0x1f4 Range: 0:65535

11.0.113 FILT_IIR_COEFF_BUT_BASE_SELF

[TTHE Group] Register Name : Address

[Raw Processing] FILT_IIR_COEFF_BUT_BASE_SELF : CYTT21X/31X (40, 44, 48 IOs) - 0x02BF, CYTMA445A - 0x026F, CYTT21X (28, 33, 35, 36 IOs) - 0x02D7

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x0					RW: 0x1		
Bit Name	Reserved[7:3]					IIR Filter Input Weight[2:0]		

IIR Coefficient for Base Button Self

Bits	Name	Description
[7:3]	Reserved [4:0]	Default: 0x0 Range:
[2:0]	IIR Filter Input Weight [2:0]	Raw IIR filter coefficient for Base Button Self Default: 0x1 **0:** One Half - Filter output = 0.5 * Filter Input + 0.5 * Previous Filter Output **1:** One Quarter - Filter output = 0.25 * Filter Input + 0.75 * Previous Filter Output **2:** One Eighth - Filter output = 0.125 * Filter Input + 0.875 * Previous Filter Output **3:** One Sixteenth - Filter output = 0.0625 * Filter Input + 0.9375 * Previous Filter Output **4:** One Thirty-second - Filter output = 0.03125 * Filter Input + 0.96875 * Previous Filter Output

11.0.114 SLOW_BL_THRSH

[TTHE Group] Register Name : Address

[Proximity] SLOW_BL_THRSH : CYTMA445A - 0x0222, CYTT21X (28, 33, 35, 36 IOs) - 0x0282

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x14							
Bit Name	Value[7:0]							

Threshold above which the difference in current and previous raw values is not filtered

Bits	Name	Description
[7:0]	Value [7:0]	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). Default: 0x14 Range: 0:255

11.0.115 TX_PUMP_VOLTAGE

[TTHE Group] Register Name : Address

[CDC] TX_PUMP_VOLTAGE : CYTT21X/31X (40, 44, 48 IOs) - 0x0050, CYTMA445A - 0x004C, CYTT21X (28, 33, 35, 36 IOs) - 0x0050

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x0						RW: 0x2	
Bit Name	Reserved[7:2]						tx Pump Voltage[1:0]	

Tx Pump Voltage Selection

Bits	Name	Description
[7:2]	Reserved [5:0]	Reserved Default: 0x0 Range:
[1:0]	tx Pump Voltage [1:0]	Tx Pump Voltage Selection Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0x2 **0:** 4.3V - 4.3V **1:** 4.6V - 4.3V **2:** 5.0V - 5.0V **3:** 5.5V - 5.5V

11.0.116 INTERRUPT_PIN_OVERRIDE

[TTHE Group] Register Name : Address

[Device Setup] INTERRUPT_PIN_OVERRIDE : CYTT21X/31X (40, 44, 48 IOs) - 0x0496, CYTMA445A - 0x040A, CYTT21X (28, 33, 35, 36 IOs) - 0x0496

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x0	RW: 0x0	RW: 0x0	RW: 0x0	RW: 0x0	RW: 0x0	RW: 0x0	RW: 0x0
Bit Name	Station 15[15:15]	Station 14[14:14]	Station 13[13:13]	Station 12[12:12]	Station 11[11:11]	Deconvolution[10:10]	Report Generated[9:9]	End of Touch Processing[8:8]

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x0	RW: 0x0	RW: 0x0	RW: 0x0	RW: 0x0	RW: 0x0	RW: 0x0	RW: 0x0
Bit Name	End of all Scanning/ Processing[7:7]	Start of Touch Processing[6:6]	Start of Raw Processing[5:5]	Self Cap Processing[4:4]	Interrupt Event Assertion[3:3]	Station 2[2:2]	Scan Complete[1:1]	Beginning of Refresh Interval[0:0]

Interrupt pin override value used for firmware timing measurements

Bits	Name	Description
[15:15]	Station 15 [0:0]	Station 15 Default: 0x0 **0:** Disabled **1:** Enabled
[14:14]	Station 14 [0:0]	Station 14 Default: 0x0 **0:** Disabled **1:** Enabled
[13:13]	Station 13 [0:0]	Station 13 Default: 0x0 **0:** Disabled **1:** Enabled
[12:12]	Station 12 [0:0]	Station 12 Default: 0x0 **0:** Disabled **1:** Enabled
[11:11]	Station 11 [0:0]	Station 11 Default: 0x0 **0:** Disabled **1:** Enabled
[10:10]	Deconvolution [0:0]	Deconvolution Default: 0x0 **0:** Disabled **1:** Enabled
[9:9]	Report Generated [0:0]	Report Generated Default: 0x0 **0:** Disabled **1:** Enabled

[8:8]	End of Touch Processing [0:0]	End of Touch Processing Default: 0x0 **0:** Disabled **1:** Enabled
[7:7]	End of all Scanning/Processing [0:0]	End of all Scanning/Processing Default: 0x0 **0:** Disabled **1:** Enabled
[6:6]	Start of Touch Processing [0:0]	Start of Touch Processing Default: 0x0 **0:** Disabled **1:** Enabled
[5:5]	Start of Raw Processing [0:0]	Start of Raw Processing Default: 0x0 **0:** Disabled **1:** Enabled
[4:4]	Self Cap Processing [0:0]	Self Cap Processing Default: 0x0 **0:** Disabled **1:** Enabled
[3:3]	Interrupt Event Assertion [0:0]	Interrupt Event Assertion Default: 0x0 **0:** Disabled **1:** Enabled
[2:2]	Station 2 [0:0]	Station 2 Default: 0x0 **0:** Disabled **1:** Enabled
[1:1]	Scan Complete [0:0]	Scan Complete Default: 0x0 **0:** Disabled **1:** Enabled
[0:0]	Beginning of Refresh Interval [0:0]	Beginning of Refresh Interval Default: 0x0 **0:** Disabled **1:** Enabled

11.0.117 BL_FRAME_NUM_AFTER_LIFTOFF

[TTHE Group] Register Name : Address

[Proximity] BL_FRAME_NUM_AFTER_LIFTOFF : CYTMA445A - 0x0238, CYTT21X (28, 33, 35, 36 IOs) - 0x0298

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x00							
Bit Name	Value[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x64							
Bit Name	Value[7:0]							

Number of frames to run fast baseline update after dirty touch removes

Bits	Name	Description
[15:0]	Value [15:0]	Number of frames to run fast baseline update after dirty touch removes Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0x64 Range: 0:65535

11.0.118 CHARGER_ARMOR_ENABLE

[TTHE Group] Register Name : Address

[Charger Armor] CHARGER_ARMOR_ENABLE : CYTT21X/31X (40, 44, 48 IOs) - 0x0014, CYTMA445A - 0x0014, CYTT21X (28, 33, 35, 36 IOs) - 0x0014

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x0							RW: 0x1
Bit Name	Reserved[7:1]							Value[0:0]

Enable/Disable Charger Armor Feature

Bits	Name	Description
[7:1]	Reserved [6:0]	Default: 0x0 Range:
[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: 0x1 **0:** Disabled - Charger Armor is disabled **1:** Enabled - Charger Armor is enabled

11.0.119 MIN_FAT_FINGER_Z9

[TTHE Group] Register Name : Address

[Finger Tracking] MIN_FAT_FINGER_Z9 : CYTT21X/31X (40, 44, 48 IOs) - 0x03B4, CYTMA445A - 0x033C, CYTT21X (28, 33, 35, 36 IOs) - 0x03C8

Bits	31	30	29	28	27	26	25	24
Access:POR	RW: 0x00							
Bit Name	Threshold[31:24]							

Bits	23	22	21	20	19	18	17	16
Access:POR	RW: 0x00							
Bit Name	Threshold[23:16]							

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x6a							
Bit Name	Threshold[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x60							
Bit Name	Threshold[7:0]							

Fat-Finger min Z9 value; for touch zone with 2 or more peaks: if its Z9 signal sum is less than this parameter will be identified as multi-finger; default value: 4 times of HTI of 12mm finger.

Bits	Name	Description
[31:0]	Threshold [31:0]	Fat-Finger min Z9 value; for touch zone with 2 or more peaks: if its Z9 signal sum is less than this parameter will be identified as multi-finger; default value: 4 times of HTI of 12mm finger. Default: 0xea60 Range: 0:500000

11.0.120 BL_FILT_BTN_MUT

[TTHE Group] Register Name : Address

[Raw Processing] BL_FILT_BTN_MUT : CYTT21X/31X (40, 44, 48 IOs) - 0x027A, CYTMA445A - 0x021C, CYTT21X (28, 33, 35, 36 IOs) - 0x0276

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0xa					RW: 0x0		
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. Default: 0xa Range: 0:31
[2:0]	Additional Samples [2:0]	Number of additional samples to average for baseline. 0 = no baseline filter. Default: 0x0 Range: 0:7

11.0.121 SEND_REPORT_AFTER_ACTIVE_INTERVAL_CFG

[TTHE Group] Register Name : Address

[Device Setup] SEND_REPORT_AFTER_ACTIVE_INTERVAL_CFG : CYTT21X/31X (40, 44, 48 IOs) - 0x0494, CYTMA445A - 0x0408, CYTT21X (28, 33, 35, 36 IOs) - 0x0494

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x0							RW: 0x0
Bit Name	Reserved[7:1]							Send report before or after active interval configuration[0:0]

This parameter configures when touch report is sent to the host. Touch report can be sent right after touch processing is completed (default) or at the end of each active interval. The second option is recommended for more consistent touch report interval.

Bits	Name	Description
[7:1]	Reserved [6:0]	Default: 0x0 Range:
[0:0]	Send report before or after active interval configuration [0:0]	This parameter configures when touch report is sent to the 2. Touch report can be sent right after touch processing is completed (default) or at the end of each active interval. The second option is recommended for more consistent touch report interval. Default: 0x0 **0:** Send touch report before active interval - In this option touch reports are sent to the 2 right after they are processed. This may cause a jitter between report intervals. **1:** Send touch report after active interval - In this option touch reports are sent right after active interval. This may cause a slight latency but helps touch report interval to be consistent.

11.0.122 BTN_HS_OFF_THRSH_MUT_0

[TTHE Group] Register Name : Address

[CapSense Buttons] BTN_HS_OFF_THRSH_MUT_0 : CYTT21X/31X (40, 44, 48 IOs) - 0x0404, CYTMA445A - 0x03A0, CYTT21X (28, 33, 35, 36 IOs) - 0x042C

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

CapSense Button Mutual Cap HighSensitive scan Off threshold for button 0

Bits	Name	Description
[7:0]	On Threshold [7:0]	CapSense Button Mutual Cap HighSensitive scan Off threshold for button 0 Default: 0xa Range: 5:255

11.0.123 DEBOUNCE_ON_DETECT

[TTHE Group] Register Name : Address

[Proximity] DEBOUNCE_ON_DETECT : CYTMA445A - 0x0360, CYTT21X (28, 33, 35, 36 IOs) - 0x03EC

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x3							
Bit Name	debounceOnDetect[7:0]							

Number of frames to debounce before detecting face object proximity

Bits	Name	Description
[7:0]	debounceOnDetect [7:0]	Number of frames to debounce before detecting face object proximity Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0x3 Range: 0:255

11.0.124 BTN_HS_OFF_THRSH_MUT_2

[TTHE Group] Register Name : Address

[CapSense Buttons] BTN_HS_OFF_THRSH_MUT_2 : CYTT21X/31X (40, 44, 48 IOs) - 0x0406, CYTMA445A - 0x03A2, CYTT21X (28, 33, 35, 36 IOs) - 0x042E

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

CapSense Button Mutual Cap HighSensitive scan Off threshold for button 2

Bits	Name	Description
[7:0]	On Threshold [7:0]	CapSense Button Mutual Cap HighSensitive scan Off threshold for button 2 Default: 0xa Range: 5:255

11.0.125 BTN_HS_OFF_THRSH_MUT_3

[TTHE Group] Register Name : Address

[CapSense Buttons] BTN_HS_OFF_THRSH_MUT_3 : CYTT21X/31X (40, 44, 48 IOs) - 0x0407, CYTMA445A - 0x03A3, CYTT21X (28, 33, 35, 36 IOs) - 0x042F

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

CapSense Button Mutual Cap HighSensitive scan Off threshold for button 3

Bits	Name	Description
[7:0]	On Threshold [7:0]	CapSense Button Mutual Cap HighSensitive scan Off threshold for button 3 Default: 0xa Range: 5:255

11.0.126 INTEGRATOR_VOLTAGE_BUTTON_MUTUAL

[TTHE Group] Register Name : Address

[Calibration] INTEGRATOR_VOLTAGE_BUTTON_MUTUAL : CYTT21X/31X (40, 44, 48 IOs) - 0x0066, CYTMA445A - 0x0062, CYTT21X (28, 33, 35, 36 IOs) - 0x0066

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x00							
Bit Name	Integrator Voltage Btn Mut[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x7a							
Bit Name	Integrator Voltage Btn Mut[7:0]							

Target Integrator voltage for Buttons in Mutual Mode

Bits	Name	Description
[15:0]	Integrator Voltage Btn Mut [15:0]	Target Integrator voltage for Buttons in Mutual Mode Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0xfa Range: 10:650

11.0.127 FILT_FILTER_MASK_GLOVE_SELF

[TTHE Group] Register Name : Address

[Raw Processing] FILT_FILTER_MASK_GLOVE_SELF : CYTT21X/31X (40, 44, 48 IOs) - 0x02DC, CYTMA445A - 0x028C, CYTT21X (28, 33, 35, 36 IOs) - 0x02F4

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x0						RW: 0x1	RW: 0x1
Bit Name	Reserved[7:2]						IIR Filter[1:1]	CMF Filter[0:0]

Indicates what filters are enabled/disabled for Glove Self

Bits	Name	Description
[7:2]	Reserved [5:0]	Default: 0x0 Range:
[1:1]	IIR Filter [0:0]	Enable/Disable IIR Filter Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0x1 **0:** Disabled - Filter is Disabled **1:** Enabled - Filter is Enabled
[0:0]	CMF Filter [0:0]	Enable/Disable CMF Filter Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0x1 **0:** Disabled - Filter is Disabled **1:** Enabled - Filter is Enabled

11.0.128 TOUCHMODE_GLOVE_FINGER_SWITCH_DEBOUNCE

[TTHE Group] Register Name : Address

[Touch Mode] TOUCHMODE_GLOVE_FINGER_SWITCH_DEBOUNCE : CYTT21X/31X (40, 44, 48 IOs) - 0x0364, CYTMA445A - 0x02F8, CYTT21X (28, 33, 35, 36 IOs) - 0x0380

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x00							
Bit Name	gloveFingerSwitchDebounce[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x00							
Bit Name	gloveFingerSwitchDebounce[7:0]							

The debounce in mS for switching to Finger mode (Glove->Finger). The mode switch will be cancelled if the signal pattern is changed in the debounce period.

Bits	Name	Description
[15:0]	gloveFingerSwitchDebounce [15:0]	The debounce in mS for switching to Finger mode (Glove->Finger). The mode switch will be cancelled if the signal pattern is changed in the debounce period. Default: 0x0 Range: 0:65535

11.0.129 FILT_IIR_THRESHOLD_GLOVE_SELF

[TTHE Group] Register Name : Address

[Raw Processing] FILT_IIR_THRESHOLD_GLOVE_SELF : CYTT21X/31X (40, 44, 48 IOs) - 0x02DE, CYTMA445A - 0x028E, CYTT21X (28, 33, 35, 36 IOs) - 0x02F6

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x00							
Bit Name	Value[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x14							
Bit Name	Value[7:0]							

IIR Threshold for Glove Self

Bits	Name	Description
[15:0]	Value [15:0]	IIR Threshold Glove for Self TX Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0x14 Range: 0:32767

11.0.130 BTN_HS_ON_THRSH_SELF_0

[TTHE Group] Register Name : Address

[CapSense Buttons] BTN_HS_ON_THRSH_SELF_0 : CYTT21X/31X (40, 44, 48 IOs) - 0x0408, CYTMA445A - 0x03A4, CYTT21X (28, 33, 35, 36 IOs) - 0x0430

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x1e							
Bit Name	On Threshold[7:0]							

CapSense Button Self Cap HighSensitive scan On threshold for button 0

Bits	Name	Description
[7:0]	On Threshold [7:0]	CapSense Button Self Cap HighSensitive scan On threshold for button 0 Default: 0x1e Range: 5:255

11.0.131 BTN_HS_ON_THRSH_SELF_1

[TTHE Group] Register Name : Address

[CapSense Buttons] BTN_HS_ON_THRSH_SELF_1 : CYTT21X/31X (40, 44, 48 IOs) - 0x0409, CYTMA445A - 0x03A5, CYTT21X (28, 33, 35, 36 IOs) - 0x0431

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x1e							
Bit Name	On Threshold[7:0]							

CapSense Button Self Cap HighSensitive scan On threshold for button 1

Bits	Name	Description
[7:0]	On Threshold [7:0]	CapSense Button Self Cap HighSensitive scan On threshold for button 1 Default: 0x1e Range: 5:255

11.0.132 BTN_HS_ON_THRSH_SELF_2

[TTHE Group] Register Name : Address

[CapSense Buttons] BTN_HS_ON_THRSH_SELF_2 : CYTT21X/31X (40, 44, 48 IOs) - 0x040A, CYTMA445A - 0x03A6, CYTT21X (28, 33, 35, 36 IOs) - 0x0432

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x1e							
Bit Name	On Threshold[7:0]							

CapSense Button Self Cap HighSensitive scan On threshold for button 2

Bits	Name	Description
[7:0]	On Threshold [7:0]	CapSense Button Self Cap HighSensitive scan On threshold for button 2 Default: 0x1e Range: 5:255

11.0.133 BTN_HS_ON_THRSH_SELF_3

[TTHE Group] Register Name : Address

[CapSense Buttons] BTN_HS_ON_THRSH_SELF_3 : CYTT21X/31X (40, 44, 48 IOs) - 0x040B, CYTMA445A - 0x03A7, CYTT21X (28, 33, 35, 36 IOs) - 0x0433

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x1e							
Bit Name	On Threshold[7:0]							

CapSense Button Self Cap HighSensitive scan On threshold for button 3

Bits	Name	Description
[7:0]	On Threshold [7:0]	CapSense Button Self Cap HighSensitive scan On threshold for button 3 Default: 0x1e Range: 5:255

11.0.134 SLIM_POSITION_OFFSET_ALONG_RX

[TTHE Group] Register Name : Address

[Finger Tracking] SLIM_POSITION_OFFSET_ALONG_RX : CYTT21X/31X (40, 44, 48 IOs) - 0x037A, CYTMA445A - 0x0306, CYTT21X (28, 33, 35, 36 IOs) - 0x038E

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x0							
Bit Name	Slim Position Offset[7:0]							

Reported position offset along Rx axis (in 1/256 increments) due to the routing for SLIM-E patterns

Bits	Name	Description
[7:0]	Slim Position Offset [7:0]	Reported position offset along Rx axis (in 1/256 increments) due to the routing for SLIM-E patterns Default: 0x0 Range: -128:127

11.0.135 LP_INTRVL0

[TTHE Group] Register Name : Address

[Device Setup] LP_INTRVL0 : CYTT21X/31X (40, 44, 48 IOs) - 0x0322, CYTMA445A - 0x02C2, CYTT21X (28, 33, 35, 36 IOs) - 0x033A

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x00							
Bit Name	Low Power Interval[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x64							
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). Default: 0x64 Range: 0:1000

11.0.136 PWC_LIMIT_PERCENT_MUTUAL

[TTHE Group] Register Name : Address

[Calibration] PWC_LIMIT_PERCENT_MUTUAL : CYTT21X/31X (40, 44, 48 IOs) - 0x0074

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x5a							
Bit Name	pwcLimitPercentMutual[7:0]							

PWC limit in percents of period for MutualCap mode

Bits	Name	Description
[7:0]	pwcLimitPercentMutual [7:0]	PWC limit in percents of period for MutualCap mode Modifying this parameter affects the base-line data and requires the host to perform a recalibration (see Calibrate PWC Command). De-fault: 0x5a Range: 5:100

11.0.137 HW_BL_GIDAC_LSB_CONFIG

[TTHE Group] Register Name : Address

[CDC] HW_BL_GIDAC_LSB_CONFIG : CYTT21X/31X (40, 44, 48 IOs) - 0x0076

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x0							RW: 0x1
Bit Name	Reserved[7:1]							HW_BL_GIDAC_LSB_CON-FIG[0:0]

HW Baseline Global IDAC LSB value

Bits	Name	Description
[7:1]	Reserved [6:0]	Reserved Default: 0x0 Range:
[0:0]	HW_BL_GIDAC_LSB_CONFIG [0:0]	HW Baseline Global IDAC LSB value Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0x1 **0:** 160 nA **1:** 320 nA

11.0.138 FIRST_TOUCH_SUPPRESSION

[TTHE Group] Register Name : Address

[Finger Tracking] FIRST_TOUCH_SUPPRESSION : CYTT21X/31X (40, 44, 48 IOs) - 0x0336, CYTMA445A - 0x02D2, CYTT21X (28, 33, 35, 36 IOs) - 0x034E

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x0							
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]	Enable or disable the First Touch Suppression feature. Default: 0x0 **0:** Disabled - First Touch Suppression disabled **1:** Enabled - First Touch Suppression enabled

11.0.139 BTN_LS_ON_THRSH_SELF_1

[TTHE Group] Register Name : Address

[CapSense Buttons] BTN_LS_ON_THRSH_SELF_1 : CYTT21X/31X (40, 44, 48 IOs) - 0x03F5, CYTMA445A - 0x0391, CYTT21X (28, 33, 35, 36 IOs) - 0x041D

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x41							
Bit Name	On Threshold[7:0]							

CapSense Button Self Cap LowSensitive scan On threshold for button 1

Bits	Name	Description
[7:0]	On Threshold [7:0]	CapSense Button Self Cap LowSensitive scan On threshold for button 1 Default: 0x41 Range: 5:255

11.0.140 AFH_LISTENING_SCAN_COUNT

[TTHE Group] Register Name : Address

[Charger Armor] AFH_LISTENING_SCAN_COUNT : CYTT21X/31X (40, 44, 48 IOs) - 0x0303, CYTMA445A - 0x02A7, CYTT21X (28, 33, 35, 36 IOs) - 0x031B

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x6							
Bit Name	Value[7:0]							

Number of InjTch scan frames in the single noise listen scan.

Bits	Name	Description
[7:0]	Value [7:0]	Number of InjTch scan frames in the single noise listen scan. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0x6 Range: 2:12

11.0.141 WF_DIFF_VAR_THOLD

[TTHE Group] Register Name : Address

[Wet Finger] WF_DIFF_VAR_THOLD : CYTT21X/31X (40, 44, 48 IOs) - 0x029E, CYTMA445A - 0x0256, CYTT21X (28, 33, 35, 36 IOs) - 0x02B6

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x01							
Bit Name	Value[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x74							
Bit Name	Value[7:0]							

The threshold for detection water by calculating the variation of diff counts when water drop on panel.

Bits	Name	Description
[15:0]	Value [15:0]	The threshold for detection water by calculating the variation of diff counts when water drop on panel. Default: 0x1f4 Range: 0:65535

11.0.142 CA_NMF_DETECT_THRESHOD

[TTHE Group] Register Name : Address

[Charger Armor] CA_NMF_DETECT_THRESHOD : CYTT21X/31X (40, 44, 48 IOs) - 0x0318

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

NMF level exceeding of which starts InjTch NM. Set it to 255 to disable noise detection by NMF.

Bits	Name	Description
[7:0]	Value [7:0]	NMF level exceeding of which starts InjTch NM. Set it to 255 to disable noise detection by NMF. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0xa Range: 0:255

11.0.143 SELF_Z_THRSH

[TTHE Group] Register Name : Address

[Touch Mode] SELF_Z_THRSH : CYTT21X/31X (40, 44, 48 IOs) - 0x0360, CYTMA445A - 0x02FE, CYTT21X (28, 33, 35, 36 IOs) - 0x037C

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x00							
Bit Name	Threshold[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x50							
Bit Name	Threshold[7:0]							

Self capacitance Z threshold to validate scan action.

Bits	Name	Description
[15:0]	Threshold [15:0]	Self capacitance LFT threshold (in counts). When self signals are above this level in Look-for-Touch mode it means there is touch on the panel and application should proceed to an active mode. Default: 0x50 Range: 0:32767

11.0.144 GLOVE_MAX_FAT_FINGER_HYST

[TTHE Group] Register Name : Address

[Glove] GLOVE_MAX_FAT_FINGER_HYST : CYTT21X/31X (40, 44, 48 IOs) - 0x0434, CYTMA445A - 0x03CF, CYTT21X (28, 33, 35, 36 IOs) - 0x045C

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x00							
Bit Name	Hysteresis[7:0]							

Hysteresis applied to maximum fat-finger size when a large object is detected in glove mode. Make sure the condition (0 <= GLOVE_MAX_FAT_FINGER_HYST <= 1/2 of GLOVE_MAX_FAT_FINGER_SIZE) is true when tuning.

Bits	Name	Description
[15:0]	Hysteresis [15:0]	Hysteresis applied to maximum fat-finger size when a large object is detected in glove mode. Make sure the condition (0 <= GLOVE_MAX_FAT_FINGER_HYST <= 1/2 of GLOVE_MAX_FAT_FINGER_SIZE) is true when tuning. Default: 0x0 Range: 0:65535

11.0.145 MULTI_TOUCH_DEBOUNCE

[TTHE Group] Register Name : Address

[Finger Tracking] MULTI_TOUCH_DEBOUNCE : CYTT21X/31X (40, 44, 48 IOs) - 0x03D2, CYTMA445A - 0x0370, CYTT21X (28, 33, 35, 36 IOs) - 0x03FA

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x0							
Bit Name	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.

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. Default: 0x0 Range: 0:63

11.0.146 CAFILT_CMF_THRESHOLD_MUT

[TTHE Group] Register Name : Address

[Charger Armor] CAFILT_CMF_THRESHOLD_MUT : CYTT21X/31X (40, 44, 48 IOs) - 0x02CE, CYTMA445A - 0x027E, CYTT21X (28, 33, 35, 36 IOs) - 0x02E6

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x00							
Bit Name	Value[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x3c							
Bit Name	Value[7:0]							

CMF Threshold for Mutual scan when Charger Armor is active

Bits	Name	Description
[15:0]	Value [15:0]	CMF Threshold Base for Mutual scan 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: 0x3c Range: 0:32767

11.0.147 CLIPPING_X_LOW

[TTHE Group] Register Name : Address

[Device Setup] CLIPPING_X_LOW : CYTT21X/31X (40, 44, 48 IOs) - 0x0374, CYTMA445A - 0x0300, CYTT21X (28, 33, 35, 36 IOs) - 0x0388

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x0							
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. Default: 0x0 Range: -128:127

11.0.148 CA_WIDEBAND_TX_PERIOD_DITHER

[TTHE Group] Register Name : Address

[Charger Armor] CA_WIDEBAND_TX_PERIOD_DITHER : CYTMA445A - 0x0056, CYTT21X (28, 33, 35, 36 IOs) - 0x005A

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x1							
Bit Name	Value[7:0]							

Dither added to CA_WIDEBAND_TX_PERIOD to get more accurate readings of the Wideband Metric. Set to 1 for most designs.

Bits	Name	Description
[7:0]	Value [7:0]	Dither added to CA_WIDEBAND_TX_PERIOD to get more accurate readings of the Wideband Metric. Set to 1 for most designs. Default: 0x1 Range: 0:255

11.0.149 SLOW_BL_SS

[TTHE Group] Register Name : Address

[Proximity] SLOW_BL_SS : CYTMA445A - 0x0223, CYTT21X (28, 33, 35, 36 IOs) - 0x0283

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x2							
Bit Name	slowBaseliningSpeedShifter[7:0]							

IIR filter coefficient for inner Rx sensor baseline

Bits	Name	Description
[7:0]	slowBaseliningSpeedShift-er [7:0]	IIR filter coefficient for inner Rx sensor baseline. Default: 0x2 **0:** OFF - Filter output = Filter Input **1:** 1/2 - Filter output = 1/2 * Filter Input + 1/2 * Previous Filter Output **2:** 1/4 - Filter output = 1/4 * Filter Input + 3/4 * Previous Filter Output **3:** 1/8 - Filter output = 1/8 * Filter Input + 7/8 * Previous Filter Output **4:** 1/16 - Filter output = 1/16 * Filter Input + 15/16 * Previous Filter Output **5:** 1/32 - Filter output = 1/32 * Filter Input + 31/32 * Previous Filter Output **6:** 1/64 - Filter output = 1/64 * Filter Input + 63/64 * Previous Filter Output **7:** 1/128 - Filter output = 1/128 * Filter Input + 127/128 * Previous Filter Output **8:** 1/256 - Filter output = 1/256 * Filter Input + 255/256 * Previous Filter Output

11.0.150 XY_FILT_Z_IIR_COEFF_CA

[TTHE Group] Register Name : Address

[Charger Armor] XY_FILT_Z_IIR_COEFF_CA : CYTT21X/31X (40, 44, 48 IOs) - 0x046C, CYTMA445A - 0x03F0, CYTT21X (28, 33, 35, 36 IOs) - 0x047C

Bits	31	30	29	28	27	26	25	24
Access:POR	RW: 0x00							
Bit Name	Reserved[31:24]							

Bits	23	22	21	20	19	18	17	16
Access:POR	RW: 0x00							
Bit Name	Reserved[23:16]							

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x00							
Bit Name	Reserved[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x00						RW: 0x2	
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]	Default: 0x0 Range:
[1:0]	IIR Filter Input Weight [1:0]	Weighting of the input Z value in the IIR filter when Charger Armor is active. Default: 0x2 **1:** One Half - Filter output = 0.5 * Filter Input + 0.5 * Previous Filter Output **2:** One Quarter - Filter output = 0.25 * Filter Input + 0.75 * Previous Filter Output

11.0.151 XY_FILTER_MASK

[TTHE Group] Register Name : Address

[Scan Filtering] XY_FILTER_MASK : CYTT21X/31X (40, 44, 48 IOs) - 0x0454, CYTMA445A - 0x03D8, CYTT21X (28, 33, 35, 36 IOs) - 0x0464

Bits	31	30	29	28	27	26	25	24
Access:POR	RW: 0x00							
Bit Name	Reserved[31:24]							

Bits	23	22	21	20	19	18	17	16
Access:POR	RW: 0x00							
Bit Name	Reserved[23:16]							

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x00							
Bit Name	Reserved[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x1	RW: 0x1	RW: 0x1	RW: 0x1	RW: 0x0			
Bit Name	XY IIR Filter Enable[7:7]	XY Jitter Filter Enable[6:6]	Z IIR Filter Enable[5:5]	Z Jitter Filter Enable[4:4]	Reserved[3:0]			

XY filter mask when Charger Armor is not active

Bits	Name	Description
[31:8]	Reserved [23:0]	Default: 0x0 Range:
[7:7]	XY IIR Filter Enable [0:0]	Enables or disables the XY IIR filter Default: 0x1 **0:** Disabled **1:** Enabled
[6:6]	XY Jitter Filter Enable [0:0]	Enables or disables the XY jitter filter Default: 0x1 **0:** Disabled **1:** Enabled
[5:5]	Z IIR Filter Enable [0:0]	Enables or disables the Z IIR filter Default: 0x1 **0:** Disabled **1:** Enabled
[4:4]	Z Jitter Filter Enable [0:0]	Enables or disables the Z jitter filter Default: 0x1 **0:** Disabled **1:** Enabled
[3:0]	Reserved [3:0]	Default: 0x0 Range:

11.0.152 FILT_CMF_THRESHOLD_STYLUS_SELF

[TTHE Group] Register Name : Address

[Raw Processing] FILT_CMF_THRESHOLD_STYLUS_SELF : CYTT21X/31X (40, 44, 48 IOs) - 0x02F8

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x00							
Bit Name	Value[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x32							
Bit Name	Value[7:0]							

CMF Threshold for Stylus Self

Bits	Name	Description
[15:0]	Value [15:0]	CMF Threshold Stylus for Self TX Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0x32 Range: 0:32767

11.0.153 BALANCING_TARGET_BUTTON_MUTUAL

[TTHE Group] Register Name : Address

[Calibration] BALANCING_TARGET_BUTTON_MUTUAL : CYTT21X/31X (40, 44, 48 IOs) - 0x006C, CYTMA445A - 0x0068, CYTT21X (28, 33, 35, 36 IOs) - 0x006C

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x1e							
Bit Name	Balancing Target Btn Mut[7:0]							

Integrator Balancing target for Buttons in Mutual Mode

Bits	Name	Description
[7:0]	Balancing Target Btn Mut [7:0]	Balancing target for Buttons in Mutual Mode Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0x1e Range: 5:95

11.0.154 MAX_FAT_FINGER_SIZE_HYST

[TTHE Group] Register Name : Address

[Finger Tracking] MAX_FAT_FINGER_SIZE_HYST : CYTT21X/31X (40, 44, 48 IOs) - 0x03D6, CYTMA445A - 0x0376, CYTT21X (28, 33, 35, 36 IOs) - 0x03FE

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x08							
Bit Name	Max Fat Finger Size Hysteresis[7:0]							

Hysteresis applied to minimum number of intersections defining a large object; on detection of a large object reducing the maximum fat finger threshold. Fat finger detection takes priority in determining whether to increase or reduce the threshold. Make sure the condition (0 <= MAX_FAT_FINGER_SIZE_HYST <= 1/2 of MAX_FAT_FINGER_SIZE_ON) is true when tuning.

Bits	Name	Description
[15:0]	Max Fat Finger Size Hysteresis [15:0]	Hysteresis applied to minimum number of intersections defining a large object; on detection of a large object reducing the maximum fat finger threshold. Fat finger detection takes priority in determining whether to increase or reduce the threshold. Make sure the condition (0 <= MAX_FAT_FINGER_SIZE_HYST <= 1/2 of MAX_FAT_FINGER_SIZE_ON) is true when tuning. Default: 0x8 Range: 0:65535

11.0.155 STYL_PERIODIC_ERROR_AMPLITUDE

[TTHE Group] Register Name : Address

[Stylus Tracking] STYL_PERIODIC_ERROR_AMPLITUDE : CYTT21X/31X (40, 44, 48 IOs) - 0x0451

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x8							
Bit Name	Amplitude[7:0]							

Amplitude of Periodic Error Correction.

Bits	Name	Description
[7:0]	Amplitude [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). Default: 0x8 Range: 0:255

11.0.156 CA_MIN_SELF_ALLOWED

[TTHE Group] Register Name : Address

[Charger Armor] CA_MIN_SELF_ALLOWED : CYTT21X/31X (40, 44, 48 IOs) - 0x0316, CYTMA445A - 0x02BA, CYTT21X (28, 33, 35, 36 IOs) - 0x032E

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x00							
Bit Name	Value[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x00							
Bit Name	Value[7:0]							

Charger Armor is activated if minimal self cap signal is below this threshold. As self signal is in range[-32768, 32767], setting this value to -32768 disables this feature.

Bits	Name	Description
[15:0]	Value [15:0]	Charger Armor is activated if minimal self cap signal is below this threshold. As self signal is in range[-32768, 32767], setting this value to -32768 disables this feature. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: -0x8000 Range: -32768:0

11.0.157 ACT_LFT_EN

[TTHE Group] Register Name : Address

[Finger Tracking] ACT_LFT_EN : CYTT21X/31X (40, 44, 48 IOs) - 0x031C, CYTMA445A - 0x02BC, CYTT21X (28, 33, 35, 36 IOs) - 0x0334

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x0							RW: 0x0
Bit Name	Reserved[7:1]							Active Look-For-Touch Enable[0:0]

Enables the Active Look-for-touch feature which automatically manages power consumption. When enabled, a self-cap scan is used to detect the presence of a touch. If disabled, a mutual scan is used to detect the presence of a touch.

Bits	Name	Description
[7:1]	Reserved [6:0]	Default: 0x0 Range:
[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. Default: 0x0 **0:** Disabled **1:** Enabled

11.0.158 CA_WIDEBAND_TX_PERIOD

[TTHE Group] Register Name : Address

[Charger Armor] CA_WIDEBAND_TX_PERIOD : CYTMA445A - 0x0054, CYTT21X (28, 33, 35, 36 IOs) - 0x0058

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x00							
Bit Name	TX Period[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x2d							
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) Default: 0x2d Range: 0:65535

11.0.159 GLOVE_BTN_TO_HIGHSEN_MODE_SWITCH_THRSH_MUT

[TTHE Group] Register Name : Address

[Glove] GLOVE_BTN_TO_HIGHSEN_MODE_SWITCH_THRSH_MUT : CYTT21X/31X (40, 44, 48 IOs) - 0x0416, CYTMA445A - 0x03B2, CYTT21X (28, 33, 35, 36 IOs) - 0x043E

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x00							
Bit Name	Threshold[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x28							
Bit Name	Threshold[7:0]							

Mutual threshold to Enter High Sensitive Mode.

Bits	Name	Description
[15:0]	Threshold [15:0]	Mutual threshold to Enter High Sensitive Mode. Default: 0x28 Range: 0:32767

11.0.160 XY_FILT_IIR_COEFF

[TTHE Group] Register Name : Address

[Scan Filtering] XY_FILT_IIR_COEFF : CYTT21X/31X (40, 44, 48 IOs) - 0x0458, CYTMA445A - 0x03DC, CYTT21X (28, 33, 35, 36 IOs) - 0x0468

Bits	31	30	29	28	27	26	25	24
Access:POR	RW: 0x00							
Bit Name	Reserved[31:24]							

Bits	23	22	21	20	19	18	17	16
Access:POR	RW: 0x00							
Bit Name	Reserved[23:16]							

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x00							
Bit Name	Reserved[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x00						RW: 0x2	
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]	Default: 0x0 Range:
[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. Default: 0x2 **1:** One Half - Filter output = 0.5 * Filter Input + 0.5 * Previous Filter Output **2:** One Quarter - Filter output = 0.25 * Filter Input + 0.75 * Previous Filter Output

11.0.161 OPENS_TEST_RAW_THRESHOLD_MUTUAL

[TTHE Group] Register Name : Address

[MFG] OPENS_TEST_RAW_THRESHOLD_MUTUAL : CYTMA445A - 0x006C

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x0b							
Bit Name	Maximum Allowable Open Circuits Test RawCount Value for Panel[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x38							
Bit Name	Maximum Allowable Open Circuits Test RawCount Value for Panel[7:0]							

Maximum Allowable Open Circuits Test RawCount Value for Panel

Bits	Name	Description
[15:0]	Maximum Allowable Open Circuits Test RawCount Value for Panel [15:0]	Maximum Allowable Open Circuits Test RawCount Value for Panel Default: 0xbb8 Range: 0:32767

11.0.162 CA_HOP3_TX_PERIOD_MUTUAL

[TTHE Group] Register Name : Address

[Charger Armor] CA_HOP3_TX_PERIOD_MUTUAL : CYTT21X/31X (40, 44, 48 IOs) - 0x0080, CYTMA445A - 0x008C, CYTT21X (28, 33, 35, 36 IOs) - 0x007C

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x00							
Bit Name	TX Period[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x3f							
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). Default: 0x3f Range: 48:510

11.0.163 BR2_ALWAYS_ON_FLAG

[TTHE Group] Register Name : Address

[Device Setup] BR2_ALWAYS_ON_FLAG : CYTT21X/31X (40, 44, 48 IOs) - 0x0380, CYTMA445A - 0x0308, CYTT21X (28, 33, 35, 36 IOs) - 0x0394

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x0							
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 Default: 0x0 Range: 0:255

11.0.164 CAFILT_CMF_THRESHOLD_BUT_MUT

[TTHE Group] Register Name : Address

[Charger Armor] CAFILT_CMF_THRESHOLD_BUT_MUT : CYTT21X/31X (40, 44, 48 IOs) - 0x02D4, CYTMA445A - 0x0284, CYTT21X (28, 33, 35, 36 IOs) - 0x02EC

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x00							
Bit Name	Value[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x3c							
Bit Name	Value[7:0]							

CMF Threshold for Mutual Button scan when Charger Armor is active

Bits	Name	Description
[15:0]	Value [15:0]	CMF Threshold Base for Mutual Button scan 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: 0x3c Range: 0:32767

11.0.165 SAFE_RAW_RANGE_PERCENT_BTN_MUTUAL

[TTHE Group] Register Name : Address

[Calibration] SAFE_RAW_RANGE_PERCENT_BTN_MUTUAL : CYTT21X/31X (40, 44, 48 IOs) - 0x005F, CYTMA445A - 0x005B, CYTT21X (28, 33, 35, 36 IOs) - 0x005F

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x32							
Bit Name	Safe Range[7:0]							

Safe range of average Raw Valuefor Buttons in MutualCap mode

Bits	Name	Description
[7:0]	Safe Range [7:0]	Safe range of average Raw Value Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate RWC Command). Default: 0x32 Range: 5:95

11.0.166 TOUCHMODE_STYLUS_EXIT_DELAY

[TTHE Group] Register Name : Address

[Touch Mode] TOUCHMODE_STYLUS_EXIT_DELAY : CYTT21X/31X (40, 44, 48 IOs) - 0x0370

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x0b							
Bit Name	stylusExitDelay[15:8]							
Bits	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
Access:POR	RW: 0x38							
Bit Name	stylusExitDelay[7:0]							

Time in mS after Stylus lift-off during which no other object will be reported.

Bits	Name	Description
[15:0]	stylusExitDelay [15:0]	Parameter for transition from stylus mode to default mode. It specifies the duration (in ms) in which both stylus and finger touches are not reported to the 2 upon stylus liftoff from the panel. This restriction will not be applied to the next stylus detection if the previous stylus has been detected on the panel longer than the duration specified in TOUCHMODE_STYLUS_ACTIVE_PERIOD. Default: 0xbb8 Range: 0:5000

11.0.167 FINGER_ID_MAX_FINGER_VELOCITY2

[TTHE Group] Register Name : Address

[Finger Tracking] FINGER_ID_MAX_FINGER_VELOCITY2 : CYTT21X/31X (40, 44, 48 IOs) - 0x0338, CYTMA445A - 0x02D8, CYTT21X (28, 33, 35, 36 IOs) - 0x0354

Bits	31	30	29	28	27	26	25	24
Access:POR	RW: 0x00							
Bit Name	Velocity Threshold Square[31:24]							

Bits	23	22	21	20	19	18	17	16
Access:POR	RW: 0x03							
Bit Name	Velocity Threshold Square[23:16]							

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x17							
Bit Name	Velocity Threshold Square[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x04							
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. Default: 0x31704 Range: 0:4294836225

11.0.168 BL_THRESHOLD_SELF

[TTHE Group] Register Name : Address

[Raw Processing] BL_THRESHOLD_SELF : CYTT21X/31X (40, 44, 48 IOs) - 0x0273, CYTMA445A - 0x0216, CYTT21X (28, 33, 35, 36 IOs) - 0x026F

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x3							
Bit Name	Value[7:0]							

Threshold to reset mutual/self signals for H2O rejection enabled/disabled. Condition to reset is (averageValueOfSelfSignals < baselineThresholdSelf/4).

Bits	Name	Description
[7:0]	Value [7:0]	Threshold to reset mutual/self signals for H2O rejection enabled/disabled. Condition to reset is (averageValueOfSelfSignals < baselineThresholdSelf/4). Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0x3 Range: -128:127

11.0.169 XY_FILT_XY_SLOW_THR_CA

[TTHE Group] Register Name : Address

[Charger Armor] XY_FILT_XY_SLOW_THR_CA : CYTT21X/31X (40, 44, 48 IOs) - 0x0471, CYTMA445A - 0x03F5, CYTT21X (28, 33, 35, 36 IOs) - 0x0481

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0xff							
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 Default: 0xff Range: 0:255

11.0.170 MAX_SELF_SCAN_INTERVAL

[TTHE Group] Register Name : Address

[Device Setup] MAX_SELF_SCAN_INTERVAL : CYTT21X/31X (40, 44, 48 IOs) - 0x0286, CYTMA445A - 0x023E, CYTT21X (28, 33, 35, 36 IOs) - 0x029E

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x00							
Bit Name	Value[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x64							
Bit Name	Value[7:0]							

Maximum interval between self capacitance scans (in ms)

Bits	Name	Description
[15:0]	Value [15:0]	Maximum interval between Self Cap scans (in ms). Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0x64 Range: 0:65535

11.0.171 TX_PERIOD_SELF

[TTHE Group] Register Name : Address

[CDC] TX_PERIOD_SELF : CYTT21X/31X (40, 44, 48 IOs) - 0x0084, CYTMA445A - 0x0094, CYTT21X (28, 33, 35, 36 IOs) - 0x0080

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x00							
Bit Name	txPeriodSelf[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x20							
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, Self Cap Proximity scan, Self Cap Glove scan, Stylus Self scan Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0xa0 Range: 48:510

11.0.172 SD_SIZE_THRESHOLD

[TTHE Group] Register Name : Address

[Finger Tracking] SD_SIZE_THRESHOLD : CYTT21X/31X (40, 44, 48 IOs) - 0x03C1, CYTMA445A - 0x0349, CYTT21X (28, 33, 35, 36 IOs) - 0x03D5

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x9							
Bit Name	Threshold[7:0]							

Threshold for size of touch zone to detect SD event; default value: 9.

Bits	Name	Description
[7:0]	Threshold [7:0]	Threshold for size of touch zone to detect SD event; default value: 9. Default: 0x9 Range: 0:128

11.0.173 OBJECT_INDEX_MAX_VELOCITY

[TTHE Group] Register Name : Address

[Device Setup] OBJECT_INDEX_MAX_VELOCITY : CYTT21X/31X (40, 44, 48 IOs) - 0x037B, CYTT21X (28, 33, 35, 36 IOs) - 0x038F

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x1							
Bit Name	Velocity Threshold[7:0]							

"Speed" (maximum distance change per refresh interval in sensors) threshold distinguishing fast object movement from separate object touches. Applicable to ALL object types (Finger/Glove/Stylus).

Bits	Name	Description
[7:0]	Velocity Threshold [7:0]	"Speed" (maximum distance change per refresh interval in sensors) threshold distinguishing fast object movement from separate object touches (in sensors). Speeds exceeding this value indicate separate object touches. Speeds below this value indicate fast single object movement. Applicable to ALL Object types (Finger/Glove/Stylus). Default: 0x1 Range: 1:6

11.0.174 OPENS_TEST_ATTEN_BUTTON

[TTHE Group] Register Name : Address

[MFG] OPENS_TEST_ATTEN_BUTTON : CYTMA445A - 0x0073

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x8							
Bit Name	Open test attenuator value for button[7:0]							

open test attenuator value for button.

Bits	Name	Description
[7:0]	Open test attenuator value for button [7:0]	open test attenuator value for button. Default: 0x8 **1:** 24x attenuation factor **2:** 12x attenuation factor **3:** 8x attenuation factor **4:** 6x attenuation factor **5:** 4.8x attenuation factor **6:** 4x attenuation factor **8:** 3x attenuation factor

11.0.175 STYL_XY_FILT_XY_FAST_THR

[TTHE Group] Register Name : Address

[Stylus Tracking] STYL_XY_FILT_XY_FAST_THR : CYTT21X/31X (40, 44, 48 IOs) - 0x0480

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0xc8							
Bit Name	Threshold[7:0]							

Displacement (in pixels) along X or Y axis above which the IIR filter input weight is set to STYL_XY_FILT_IIR_FAST_COEF for filtering along the corresponding axis when Stylus 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 STYL_XY_FILT_IIR_FAST_COEF for filtering along the corresponding axis when Stylus is active Default: 0xc8 Range: 0:255

11.0.176 TCH_TMOUT0

[TTHE Group] Register Name : Address

[Device Setup] TCH_TMOUT0 : CYTT21X/31X (40, 44, 48 IOs) - 0x0324, CYTMA445A - 0x02C4, CYTT21X (28, 33, 35, 36 IOs) - 0x033C

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x03							
Bit Name	Touch Timeout[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x68							
Bit Name	Touch Timeout[7:0]							

Initial touch timeout (in ms). TCH_TMOUT0 is the period of time that the device waits after the last touch liftoff event, before transistioning from the Active look-for-touch state to the Low Power state.

Bits	Name	Description
[15:0]	Touch Timeout [15:0]	Initial touch timeout (in ms). Default: 0x3e8 Range: 0:60000

11.0.177 DEBOUNCE_BASELINE_AFTER_REMOVE

[TTHE Group] Register Name : Address

[Proximity] DEBOUNCE_BASELINE_AFTER_REMOVE : CYTMA445A - 0x0221, CYTT21X (28, 33, 35, 36 IOs) - 0x0281

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

Number of frames to debounce after proximity removed

Bits	Name	Description
[7:0]	Value [7:0]	Number of frames to debounce after proximity removed Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0xa Range: 0:255

11.0.178 STYL_THRESH_SELF

[TTHE Group] Register Name : Address

[Stylus Tracking] STYL_THRESH_SELF : CYTT21X/31X (40, 44, 48 IOs) - 0x0442

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x00							
Bit Name	Threshold[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x3c							
Bit Name	Threshold[7:0]							

Self Capacitance Stylus Threshold.

Bits	Name	Description
[15:0]	Threshold [15:0]	Sensor data threshold for Self Cap scan to identify a Stylus touch. Note that this signal threshold is compared with signal sum H2O_REJECTION_SNS_WIDTH sensors. Default: 0x3c Range: 0:5000

11.0.179 XY_FILT_IIR_FAST_COEFF

[TTHE Group] Register Name : Address

[Scan Filtering] XY_FILT_IIR_FAST_COEFF : CYTT21X/31X (40, 44, 48 IOs) - 0x0462, CYTMA445A - 0x03E6, CYTT21X (28, 33, 35, 36 IOs) - 0x0472

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x0						RW: 0x1	
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]	Default: 0x0 Range:
[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. Default: 0x1 **0:** One - Filter output = 1 * Filter Input + 0 * Previous Filter Output **1:** One Half - Filter output = 0.5 * Filter Input + 0.5 * Previous Filter Output **2:** One Quarter - Filter output = 0.25 * Filter Input + 0.75 * Previous Filter Output

11.0.180 FILT_IIR_COEFF_STYLUS_SELF

[TTHE Group] Register Name : Address

[Raw Processing] FILT_IIR_COEFF_STYLUS_SELF : CYTT21X/31X (40, 44, 48 IOs) - 0x02F5

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x0					RW: 0x0		
Bit Name	Reserved[7:3]					IIR Filter Input Weight[2:0]		

IIR Coefficient for Stylus Self TX

Bits	Name	Description
[7:3]	Reserved [4:0]	Default: 0x0 Range:
[2:0]	IIR Filter Input Weight [2:0]	Raw IIR filter coefficient for Stylus Self Cap scan Default: 0x0 **0:** One Half - Filter output = 0.5 * Filter Input + 0.5 * Previous Filter Output **1:** One Quarter - Filter output = 0.25 * Filter Input + 0.75 * Previous Filter Output **2:** One Eighth - Filter output = 0.125 * Filter Input + 0.875 * Previous Filter Output **3:** One Sixteenth - Filter output = 0.0625 * Filter Input + 0.9375 * Previous Filter Output **4:** One Thirty-second - Filter output = 0.03125 * Filter Input + 0.96875 * Previous Filter Output

11.0.181 IIR_THRESHOLD

[TTHE Group] Register Name : Address

[Proximity] IIR_THRESHOLD : CYTMA445A - 0x0276, CYTT21X (28, 33, 35, 36 IOs) - 0x02DE

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x00							
Bit Name	Value[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x14							
Bit Name	Value[7:0]							

IIR Threshold for Base Proximity

Bits	Name	Description
[15:0]	Value [15:0]	IIR Threshold for Base Proximity Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0x14 Range: 0:32767

11.0.182 GRIP_YEXC_A

[TTHE Group] Register Name : Address

[Finger Tracking] GRIP_YEXC_A : CYTT21X/31X (40, 44, 48 IOs) - 0x034C, CYTMA445A - 0x02E8, CYTT21X (28, 33, 35, 36 IOs) - 0x0368

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x0		RW: 0x00					
Bit Name	Reserved[15:14]		Width[13:8]					

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x00							
Bit Name	Width[7:0]							

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

Bits	Name	Description
[15:14]	Reserved [1:0]	Default: 0x0 Range:
[13:0]	Width [13:0]	Grip Suppression: Y exception area width (in pixels), side A Default: 0x0 Range: 0:16383

11.0.183 GRIP_YEXC_B

[TTHE Group] Register Name : Address

[Finger Tracking] GRIP_YEXC_B : CYTT21X/31X (40, 44, 48 IOs) - 0x034E, CYTMA445A - 0x02EA, CYTT21X (28, 33, 35, 36 IOs) - 0x036A

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x0		RW: 0x00					
Bit Name	Reserved[15:14]		Width[13:8]					

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x00							
Bit Name	Width[7:0]							

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

Bits	Name	Description
[15:14]	Reserved [1:0]	Default: 0x0 Range:
[13:0]	Width [13:0]	Grip Suppression: Y exception area width (in pixels), side B Default: 0x0 Range: 0:16383

11.0.184 STYL_CM_GAIN

[TTHE Group] Register Name : Address

[Stylus Tracking] STYL_CM_GAIN : CYTT21X/31X (40, 44, 48 IOs) - 0x044F

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x40							
Bit Name	Threshold[7:0]							

Constant mass gain tuning parameter.

Bits	Name	Description
[7:0]	Threshold [7:0]	Constant mass gain tuning parameter. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0x40 Range: 0:255

11.0.185 TOUCHMODE_KEEP_FIRST_REPORT_TYPE

[TTHE Group] Register Name : Address

[Touch Mode] TOUCHMODE_KEEP_FIRST_REPORT_TYPE : CYTT21X/31X (40, 44, 48 IOs) - 0x0358, CYTT21X (28, 33, 35, 36 IOs) - 0x0374

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x0							RW: 0x1
Bit Name	Reserved[7:1]							TOUCHMODE_KEEP_FIRST_REPORT_TYPE[0:0]

Enabled/Disable feature to keep reporting touch type as firstly reported type;

Bits	Name	Description
[7:1]	Reserved [6:0]	Default: 0x0 Range:
[0:0]	TOUCHMODE_KEEP_FIRST_REPORT_TYPE [0:0]	Enabled/Disable feature to keep reporting touch type as firstly reported type; Default: 0x1 **0:** Disabled - Disable TOUCHMODE_KEEP_FIRST_REPORT_TYPE **1:** Enabled - Enable TOUCHMODE_KEEP_FIRST_REPORT_TYPE

11.0.186 WF_RAW_CALC_THOLD

[TTHE Group] Register Name : Address

[Wet Finger] WF_RAW_CALC_THOLD : CYTT21X/31X (40, 44, 48 IOs) - 0x02A0, CYTMA445A - 0x0258, CYTT21X (28, 33, 35, 36 IOs) - 0x02B8

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x00							
Bit Name	Value[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x7a							
Bit Name	Value[7:0]							

The threshold for calculating the variation of raw counts when water drop on panel. Raw count variation that above this threshold will be included.

Bits	Name	Description
[15:0]	Value [15:0]	The threshold for calculating the variation of raw counts when water drop on panel. Raw count variation that above this threshold will be included. Default: 0xfa Range: 0:65535

11.0.187 ACTIVE_SENSOR_THRESHOLD

[TTHE Group] Register Name : Address

[Proximity] ACTIVE_SENSOR_THRESHOLD : CYTMA445A - 0x035A, CYTT21X (28, 33, 35, 36 IOs) - 0x03E6

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x00							
Bit Name	activeSensorThreshold[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x64							
Bit Name	activeSensorThreshold[7:0]							

Threshold for sensors having high diff-counts due to proximity to count the active sensor number that will be compared with SENSOR_NUM_THRSH

Bits	Name	Description
[15:0]	activeSensorThreshold [15:0]	Threshold for sensors having high diff-counts due to proximity to count the active sensor number that will be compared with SENSOR_NUM_THRSH Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0x64 Range: 0:32767

11.0.188 CENTROID_CORNER_DENOM

[TTHE Group] Register Name : Address

[Device Setup] CENTROID_CORNER_DENOM : CYTT21X/31X (40, 44, 48 IOs) - 0x03AD, CYTMA445A - 0x0335, CYTT21X (28, 33, 35, 36 IOs) - 0x03C1

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x4							
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 Default: 0x4 Range: 1:255

11.0.189 CA_HOP4_TX_PULSES_NUM_MUTUAL

[TTHE Group] Register Name : Address

[Charger Armor] CA_HOP4_TX_PULSES_NUM_MUTUAL : CYTT21X/31X (40, 44, 48 IOs) - 0x0096, CYTMA445A - 0x0092, CYTT21X (28, 33, 35, 36 IOs) - 0x0092

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x00							
Bit Name	TX Pulses[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x7f							
Bit Name	TX Pulses[7:0]							

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

Bits	Name	Description
[15:0]	TX Pulses [15:0]	Fifth AFH alternative frequency Mutual Cap scan Number of TX Pulses per conversion Default: 0x7f Range: 0:255

11.0.190 UPPER_THRSH

[TTHE Group] Register Name : Address

[Proximity] UPPER_THRSH : CYTMA445A - 0x0354, CYTT21X (28, 33, 35, 36 IOs) - 0x03E0

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x27							
Bit Name	onUpperThreshold[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x10							
Bit Name	onUpperThreshold[7:0]							

Upper threshold for proximity signal used for Z value scaling

Bits	Name	Description
[15:0]	onUpperThreshold [15:0]	Upper threshold for proximity signal used for Z value scaling Default: 0x2710 Range: 0:32767

11.0.191 MIN_POSITIVE_THRESHOLD

[TTHE Group] Register Name : Address

[Raw Processing] MIN_POSITIVE_THRESHOLD : CYTT21X/31X (40, 44, 48 IOs) - 0x0275, CYTMA445A - 0x0218, CYTT21X (28, 33, 35, 36 IOs) - 0x0271

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x1e							
Bit Name	Value[7:0]							

Threshold to reset self/mutual signals for H2O rejection enabled/disabled to baseline signals from large amount of water, large ungrounded object on the panel or signals after wiping water. Condition to reset is (sumMutSigPositive > minPositive-Threshold*256).

Bits	Name	Description
[7:0]	Value [7:0]	Threshold to reset self/mutual signals for H2O rejection enabled/disabled to baseline signals from large amount of water, large ungrounded object on the panel or signals after wiping water. Condition to reset is (sumMutSigPositive > minPositiveThreshold*256). Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0x1e Range: 0:255

11.0.192 RATIO_MAXMUT_TO_MAXSELF

[TTHE Group] Register Name : Address

[Raw Processing] RATIO_MAXMUT_TO_MAXSELF : CYTT21X/31X (40, 44, 48 IOs) - 0x0274, CYTMA445A - 0x0217, CYTT21X (28, 33, 35, 36 IOs) - 0x0270

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x7							
Bit Name	Value[7:0]							

Threshold to reset self signals for H2O rejection enabled to baseline signals from small ungrounded object on the panel. Condition to reset is (maxMutSig/maxSelfSig > ratioMaxMutToMaxSelf).

Bits	Name	Description
[7:0]	Value [7:0]	Threshold to reset self signals for H2O rejection enabled to baseline signals from small ungrounded object on the panel. Condition to reset is (maxMutSig/maxSelfSig > ratioMaxMutToMaxSelf). Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0x7 Range: 0:255

11.0.193 TX_FREQ_METHOD_MUTUAL

[TTHE Group] Register Name : Address

[CDC] TX_FREQ_METHOD_MUTUAL : CYTT21X/31X (40, 44, 48 IOs) - 0x0056, CYTMA445A - 0x0052, CYTT21X (28, 33, 35, 36 IOs) - 0x0056

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x0						RW: 0x2	
Bit Name	Reserved[7:2]						Tx Frequency Change Method for Mutual Scan[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: 0x0 Range:
[1:0]	Tx Frequency Change Method for Mutual Scan [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: 0x2 **0:** Maximizing Integration Time - Maximize integration time for the current TX period. Integration time equals to the current TX period minus the reset time as defined in parameter INTEGRATOR_RESET_x **1:** Fixed Integration Time - Limit the integration time based on the highest TX frequency. This option only applies to Mutual Cap scanning since there are 5 Mutual Cap hop frequencies for the Charger Armor. The integration time equals to the minimum Mutual Cap TX period minus the reset time as defined in parameter INTEGRATOR_RESET_MUTUAL. Integration time is fixed for any selected TX frequency. **2:** Limited Integration Time - Integration time is limited to two-third of the current TX period. The reset time defined in INTEGRATOR_RESET_x is ignored.

11.0.194 BL_BTN_THRSH_MUT

[TTHE Group] Register Name : Address

[Raw Processing] BL_BTN_THRSH_MUT : CYTT21X/31X (40, 44, 48 IOs) - 0x0288, CYTMA445A - 0x0240, CYTT21X (28, 33, 35, 36 IOs) - 0x02A0

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x00							
Bit Name	Value[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x0a							
Bit Name	Value[7:0]							

Button Threshold Mutual for baseline updating for Base Button Mutual Configuration. The buttons baselines are not updating in case of the button touch signals are above this threshold

Bits	Name	Description
[15:0]	Value [15:0]	Button Threshold Mutual for Base Button Mutual Configuration. The buttons baselines are not updating in case of the button touch signals are above this threshold Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0xa Range: 0:65535

11.0.195 GLOVE_LIFTOFF_DEBOUNCE

[TTHE Group] Register Name : Address

[Glove] GLOVE_LIFTOFF_DEBOUNCE : CYTT21X/31X (40, 44, 48 IOs) - 0x0357, CYTT21X (28, 33, 35, 36 IOs) - 0x0373

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x0							
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 Default: 0x0 Range: 0:63

11.0.196 FILT_IIR_THRESHOLD_MUT

[TTHE Group] Register Name : Address

[Raw Processing] FILT_IIR_THRESHOLD_MUT : CYTT21X/31X (40, 44, 48 IOs) - 0x02AE, CYTMA445A - 0x025E, CYTT21X (28, 33, 35, 36 IOs) - 0x02C6

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x00							
Bit Name	Value[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x14							
Bit Name	Value[7:0]							

IIR Threshold for Base Mutual

Bits	Name	Description
[15:0]	Value [15:0]	IIR Threshold Base for Mutual Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0x14 Range: 0:32767

11.0.197 FILT_FILTER_MASK_GLOVE_MUT

[TTHE Group] Register Name : Address

[Raw Processing] FILT_FILTER_MASK_GLOVE_MUT : CYTT21X/31X (40, 44, 48 IOs) - 0x02D6, CYTMA445A - 0x0286, CYTT21X (28, 33, 35, 36 IOs) - 0x02EE

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x0						RW: 0x1	RW: 0x1
Bit Name	Reserved[7:2]						IIR Filter[1:1]	CMF Filter[0:0]

Indicates what filters are enabled/disabled for Glove Mutual

Bits	Name	Description
[7:2]	Reserved [5:0]	Default: 0x0 Range:
[1:1]	IIR Filter [0:0]	Enable/Disable IIR Filter Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0x1 **0:** Disabled - Filter is Disabled **1:** Enabled - Filter is Enabled
[0:0]	CMF Filter [0:0]	Enable/Disable CMF Filter Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0x1 **0:** Disabled - Filter is Disabled **1:** Enabled - Filter is Enabled

11.0.198 GLOVE_ON_THRSH_MUTUAL

[TTHE Group] Register Name : Address

[Glove] GLOVE_ON_THRSH_MUTUAL : CYTT21X/31X (40, 44, 48 IOs) - 0x0426, CYTMA445A - 0x03C2, CYTT21X (28, 33, 35, 36 IOs) - 0x044E

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x00							
Bit Name	Threshold[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x3c							
Bit Name	Threshold[7:0]							

Mutual Cap sensor data On threshold to identify an existing glove touch

Bits	Name	Description
[15:0]	Threshold [15:0]	Mutual Cap sensor data On threshold to identify an existing glove touch Default: 0x3c Range: 0:32767

11.0.199 XY_FILT_IIR_FAST_COEFF_CA

[TTHE Group] Register Name : Address

[Charger Armor] XY_FILT_IIR_FAST_COEFF_CA : CYTT21X/31X (40, 44, 48 IOs) - 0x0472, CYTMA445A - 0x03F6, CYTT21X (28, 33, 35, 36 IOs) - 0x0482

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x0						RW: 0x1	
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
[7:2]	Reserved [5:0]	Default: 0x0 Range:
[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. Default: 0x1 **0:** One - Filter output = 1 * Filter Input + 0 * Previous Filter Output **1:** One Half - Filter output = 0.5 * Filter Input + 0.5 * Previous Filter Output **2:** One Quarter - Filter output = 0.25 * Filter Input + 0.75 * Previous Filter Output

11.0.200 IDAC_WB

[TTHE Group] Register Name : Address

[CDC] IDAC_WB : CYTT21X/31X (40, 44, 48 IOs) - 0x005B, CYTMA445A - 0x0057, CYTT21X (28, 33, 35, 36 IOs) - 0x005B

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x18							
Bit Name	idacWb[7:0]							

IDAC value for WB noise metric scan

Bits	Name	Description
[7:0]	idacWb [7:0]	IDAC value for WB noise metric scan Default: 0x18 Range: 12:127

11.0.201 BL_BTN_THRSH_SELF

[TTHE Group] Register Name : Address

[Raw Processing] BL_BTN_THRSH_SELF : CYTT21X/31X (40, 44, 48 IOs) - 0x028A, CYTMA445A - 0x0242, CYTT21X (28, 33, 35, 36 IOs) - 0x02A2

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x00							
Bit Name	Value[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x0a							
Bit Name	Value[7:0]							

Button Threshold Self for Base Button Self Configuration. The buttons baselines are not updating in case of the button touch signals are above this threshold

Bits	Name	Description
[15:0]	Value [15:0]	Button Threshold Self for Base Button Self Configuration. The buttons baselines are not updating in case of the button touch signals are above this threshold Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0xa Range: 0:65535

11.0.202 CA_TX_PERIOD_MUTUAL

[TTHE Group] Register Name : Address

[Charger Armor] CA_TX_PERIOD_MUTUAL : CYTMA445A - 0x007C

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x00							
Bit Name	txPeriodMutual[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x3d							
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 at Charger Armor noise levels 1-2. This value has to be set equal to TX_PERIOD_MUTUAL for correct operation. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0x3d Range: 48:510

11.0.203 WF_BASE_UPDATE_RATE

[TTHE Group] Register Name : Address

[Wet Finger] WF_BASE_UPDATE_RATE : CYTT21X/31X (40, 44, 48 IOs) - 0x02A4, CYTT21X (28, 33, 35, 36 IOs) - 0x02BC

Bits	7	6	5	4	3	2	1	0
Access:PORRW: 0x6RW: 0x5RW: 0x4RW: 0x3RW: 0x2RW: 0x5	RW: 0x7							
Bit Name1/ 64[7:0]1/32[7:0]1/ 16[7:0]1/8[7:0]1/ 4[7:0]Value[7:0]	1/128[7:0]							

The raw variation baseline update rate (IIR coefficient). If the raw variation is smaller than base + rawvariation threshold then it will update with this rate.

Bits	Name	Description
[7:0]	1/128 [7:0]	Default: 0x7 Range:
[7:0]	1/64 [7:0]	Default: 0x6 Range:
[7:0]	1/32 [7:0]	Default: 0x5 Range:
[7:0]	1/16 [7:0]	Default: 0x4 Range:
[7:0]	1/8 [7:0]	Default: 0x3 Range:
[7:0]	1/4 [7:0]	Default: 0x2 Range:
[7:0]	Value [7:0]	The raw variation baseline update rate (IIR coefficient). If the raw variation is smaller than base + rawvariation threshold then it will update with this rate Default: 0x5 Range: 2:7

11.0.204 BL_H20_RJCT

[TTHE Group] Register Name : Address

[Scan Filtering] BL_H20_RJCT : CYTT21X/31X (40, 44, 48 IOs) - 0x0013, CYTMA445A - 0x0013, CYTT21X (28, 33, 35, 36 IOs) - 0x0013

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x0							RW: 0x1
Bit Name	Reserved[7:1]							Value[0:0]

Enable/Disable Water Rejection Feature

Bits	Name	Description
[7:1]	Reserved [6:0]	Default: 0x0 Range:
[0:0]	Value [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: 0x1 **0:** Disabled - Water Rejection is disabled **1:** Enabled - Water Rejection is enabled

11.0.205 OUTER_EDGE_GAIN

[TTHE Group] Register Name : Address

[Device Setup] OUTER_EDGE_GAIN : CYTT21X/31X (40, 44, 48 IOs) - 0x031E, CYTMA445A - 0x02BE, CYTT21X (28, 33, 35, 36 IOs) - 0x0336

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x78							
Bit Name	outerEdgeGain[7:0]							

Gain for Edge Correction (Outer Virtual Sensor)

Bits	Name	Description
[7:0]	outerEdgeGain [7:0]	Outer Virtual Sensor Gain (in 1/128 increments) for panel edge finger touch correction Default: 0x78 Range: 0:255

11.0.206 CAFILT_IIR_COEFF_MUT

[TTHE Group] Register Name : Address

[Charger Armor] CAFILT_IIR_COEFF_MUT : CYTT21X/31X (40, 44, 48 IOs) - 0x02CB, CYTMA445A - 0x027B, CYTT21X (28, 33, 35, 36 IOs) - 0x02E3

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x0					RW: 0x1		
Bit Name	Reserved[7:3]					IIR Filter Input Weight[2:0]		

IIR Coefficient for Mutual scan when Charger Armor is active

Bits	Name	Description
[7:3]	Reserved [4:0]	Default: 0x0 Range:
[2:0]	IIR Filter Input Weight [2:0]	IIR Coefficient for Mutual scan when Charger Armor is active. Default: 0x1 **0:** One Half - Filter output = 0.5 * Filter Input + 0.5 * Previous Filter Output **1:** One Quarter - Filter output = 0.25 * Filter Input + 0.75 * Previous Filter Output **2:** One Eighth - Filter output = 0.125 * Filter Input + 0.875 * Previous Filter Output **3:** One Sixteenth - Filter output = 0.0625 * Filter Input + 0.9375 * Previous Filter Output **4:** One Thirty-second - Filter output = 0.03125 * Filter Input + 0.96875 * Previous Filter Output

11.0.207 TX_PULSES_NUM_PROXIMITY

[TTHE Group] Register Name : Address

[CDC] TX_PULSES_NUM_PROXIMITY : CYTMA445A - 0x00A2, CYTT21X (28, 33, 35, 36 IOs) - 0x009A

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x00							
Bit Name	TX Pulses[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x40							
Bit Name	TX Pulses[7:0]							

Self Proximity Scanning Number of TX Pulses

Bits	Name	Description
[15:0]	TX Pulses [15:0]	Number of TX Pulses per conversion for Proximity Self Cap scan Default: 0x40 Range: 1:255

11.0.208 WF_DIFF_CALC_THOLD

[TTHE Group] Register Name : Address

[Wet Finger] WF_DIFF_CALC_THOLD : CYTT21X/31X (40, 44, 48 IOs) - 0x02A2, CYTMA445A - 0x025A, CYTT21X (28, 33, 35, 36 IOs) - 0x02BA

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x00							
Bit Name	Value[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x48							
Bit Name	Value[7:0]							

The threshold for calculating the variation of diff counts when water drop on panel. Diff count variation that above this threshold will be included.

Bits	Name	Description
[15:0]	Value [15:0]	The threshold for calculating the variation of diff counts when water drop on panel. Diff count variation that above this threshold will be included. Default: 0xc8 Range: 0:65535

11.0.209 FILT_IIR_THRESHOLD_STYLUS_MUT

[TTHE Group] Register Name : Address

[Raw Processing] FILT_IIR_THRESHOLD_STYLUS_MUT : CYTT21X/31X (40, 44, 48 IOs) - 0x02F0

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x00							
Bit Name	Value[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x14							
Bit Name	Value[7:0]							

IIR Threshold for Stylus Mutual

Bits	Name	Description
[15:0]	Value [15:0]	IIR Threshold Stylus for Mutual Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0x14 Range: 0:32767

11.0.210 TX_PULSES_NUM_STYLUS_MUTUAL

[TTHE Group] Register Name : Address

[CDC] TX_PULSES_NUM_STYLUS_MUTUAL : CYTT21X/31X (40, 44, 48 IOs) - 0x00A8

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x00							
Bit Name	TX Pulses[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x40							
Bit Name	TX Pulses[7:0]							

Number of TX Pulses for Stylus Mutual Scanning

Bits	Name	Description
[15:0]	TX Pulses [15:0]	Number of TX Pulses per conversion for Stylus Mutual Scan Default: 0x40 Range: 0:255

11.0.211 EDGE_DEBOUNCE_COUNT

[TTHE Group] Register Name : Address

[Device Setup] EDGE_DEBOUNCE_COUNT : CYTT21X/31X (40, 44, 48 IOs) - 0x0381, CYTMA445A - 0x0309, CYTT21X (28, 33, 35, 36 IOs) - 0x0395

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x3							
Bit Name	Edge Debounce Count[7:0]							

Dismisses new touch on the edge for current number of cycles times before accepting just in case this is single touch on the panel with sum3x3 below EDGE_DEBOUNCE_COUNT_THRESHOLD

Bits	Name	Description
[7:0]	Edge Debounce Count [7:0]	Dismisses new touch on the edge for current number of cycles times before accepting just in case this is single touch on the panel with sum3x3 below EDGE_DEBOUNCE_COUNT_THRESHOLD Default: 0x3 Range: 0:255

11.0.212 BASELINE_DELAY

[TTHE Group] Register Name : Address

[Proximity] BASELINE_DELAY : CYTMA445A - 0x0220, CYTT21X (28, 33, 35, 36 IOs) - 0x0280

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

Proximity scan baseline delay (in refresh cycles)

Bits	Name	Description
[7:0]	baselineDelay [7:0]	Proximity scan baseline delay (in refresh cycles) Default: 0xa Range: 0:255

11.0.213 LOWER_THRSH

[TTHE Group] Register Name : Address

[Proximity] LOWER_THRSH : CYTMA445A - 0x0356, CYTT21X (28, 33, 35, 36 IOs) - 0x03E2

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x03							
Bit Name	onLowerThreshold[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x20							
Bit Name	onLowerThreshold[7:0]							

Lower threshold level of Proximity, signal levels between this and onUpperThreshold will trigger proximity detection

Bits	Name	Description
[15:0]	onLowerThreshold [15:0]	Lower threshold level of Proximity, signal levels between this and onUpperThreshold will trigger proximity detection Default: 0x320 Range: 0:32767

11.0.214 GRIP_EXC_EDGE_ORIGIN

[TTHE Group] Register Name : Address

[Finger Tracking] GRIP_EXC_EDGE_ORIGIN : CYTT21X/31X (40, 44, 48 IOs) - 0x0351, CYTMA445A - 0x02ED, CYTT21X (28, 33, 35, 36 IOs) - 0x036D

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x0							RW: 0x0
Bit Name	Reserved[7:1]							Edge Origin Full Suppression[0:0]

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

Bits	Name	Description
[7:1]	Reserved [6:0]	Default: 0x0 Range:
[0:0]	Edge Origin Full Suppression [0:0]	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 2. If both GRIP_FIRST_EXC and this parameter are enabled, the first touch is always reported to the 2 regardless the origin area. All subsequent touches are ignored if originate from the suppressed regions. All subsequent touches are reported to the 2 if they originate from the core area or exception areas. Default: 0x0 **0:** Disabled - Disable GRIP_EXC_EDGE_ORIGIN **1:** Enabled - Enable GRIP_EXC_EDGE_ORIGIN

11.0.215 BTN_LS_OFF_THRSH_MUT_0

[TTHE Group] Register Name : Address

[CapSense Buttons] BTN_LS_OFF_THRSH_MUT_0 : CYTT21X/31X (40, 44, 48 IOs) - 0x03F0, CYTMA445A - 0x038C, CYTT21X (28, 33, 35, 36 IOs) - 0x0418

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x46							
Bit Name	On Threshold[7:0]							

CapSense Button Mutual Cap LowSensitive scan Off threshold for button 0

Bits	Name	Description
[7:0]	On Threshold [7:0]	CapSense Button Mutual Cap LowSensitive scan Off threshold for button 0 Default: 0x46 Range: 5:255

11.0.216 BTN_LS_OFF_THRSH_MUT_1

[TTHE Group] Register Name : Address

[CapSense Buttons] BTN_LS_OFF_THRSH_MUT_1 : CYTT21X/31X (40, 44, 48 IOs) - 0x03F1, CYTMA445A - 0x038D, CYTT21X (28, 33, 35, 36 IOs) - 0x0419

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x46							
Bit Name	On Threshold[7:0]							

CapSense Button Mutual Cap LowSensitive scan Off threshold for button 1

Bits	Name	Description
[7:0]	On Threshold [7:0]	CapSense Button Mutual Cap LowSensitive scan Off threshold for button 1 Default: 0x46 Range: 5:255

11.0.217 BTN_LS_OFF_THRSH_MUT_2

[TTHE Group] Register Name : Address

[CapSense Buttons] BTN_LS_OFF_THRSH_MUT_2 : CYTT21X/31X (40, 44, 48 IOs) - 0x03F2, CYTMA445A - 0x038E, CYTT21X (28, 33, 35, 36 IOs) - 0x041A

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x46							
Bit Name	On Threshold[7:0]							

CapSense Button Mutual Cap LowSensitive scan Off threshold for button 2

Bits	Name	Description
[7:0]	On Threshold [7:0]	CapSense Button Mutual Cap LowSensitive scan Off threshold for button 2 Default: 0x46 Range: 5:255

11.0.218 BTN_LS_OFF_THRSH_MUT_3

[TTHE Group] Register Name : Address

[CapSense Buttons] BTN_LS_OFF_THRSH_MUT_3 : CYTT21X/31X (40, 44, 48 IOs) - 0x03F3, CYTMA445A - 0x038F, CYTT21X (28, 33, 35, 36 IOs) - 0x041B

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x46							
Bit Name	On Threshold[7:0]							

CapSense Button Mutual Cap LowSensitive scan Off threshold for button 3

Bits	Name	Description
[7:0]	On Threshold [7:0]	CapSense Button Mutual Cap LowSensitive scan Off threshold for button 3 Default: 0x46 Range: 5:255

11.0.219 TX_PERIOD_GLOVE_BUTTON_MUTUAL

[TTHE Group] Register Name : Address

[CDC] TX_PERIOD_GLOVE_BUTTON_MUTUAL : CYTMA445A - 0x00AC

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x00							
Bit Name	txPeriodGlove[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x3d							
Bit Name	txPeriodGlove[7:0]							

Integration Time

Bits	Name	Description
[15:0]	txPeriodGlove [15:0]	Number of system clocks in each TX half period for Button Mutual Cap Glove scan Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0x3d Range: 48:510

11.0.220 WF_RAW_HIGH_THOLD

[TTHE Group] Register Name : Address

[Wet Finger] WF_RAW_HIGH_THOLD : CYTT21X/31X (40, 44, 48 IOs) - 0x029C, CYTMA445A - 0x0254, CYTT21X (28, 33, 35, 36 IOs) - 0x02B4

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x0d							
Bit Name	Value[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x2c							
Bit Name	Value[7:0]							

The threshold for detection high water by calculating the variation of raw counts when water drop on panel

Bits	Name	Description
[15:0]	Value [15:0]	The threshold for detection high water by calculating the variation of raw counts when water drop on panel Default: 0xdac Range: 0:65535

11.0.221 CMF_THR_BTN_MUT

[TTHE Group] Register Name : Address

[Raw Processing] CMF_THR_BTN_MUT : CYTT21X/31X (40, 44, 48 IOs) - 0x02BC, CYTMA445A - 0x026C, CYTT21X (28, 33, 35, 36 IOs) - 0x02D4

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x00							
Bit Name	Value[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x3c							
Bit Name	Value[7:0]							

CMF Threshold for Base Button Mutual

Bits	Name	Description
[15:0]	Value [15:0]	CMF Threshold for Base Button Mutual Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0x3c Range: 0:32767

11.0.222 SCALING_FACTOR_BUTTON_SELF

[TTHE Group] Register Name : Address

[CDC] SCALING_FACTOR_BUTTON_SELF : CYTT21X/31X (40, 44, 48 IOs) - 0x004C, CYTMA445A - 0x0048, CYTT21X (28, 33, 35, 36 IOs) - 0x004C

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x00							
Bit Name	Scale Factor[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x48							
Bit Name	Scale Factor[7:0]							

CapSense Button Self Raw Data Scaling Factor

Bits	Name	Description
[15:0]	Scale Factor [15:0]	Percentage scaling factor for CapSense Buttons Self Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0xc8 Range: 0:1000

11.0.223 WF_STATE_TIMEOUT

[TTHE Group] Register Name : Address

[Wet Finger] WF_STATE_TIMEOUT : CYTT21X/31X (40, 44, 48 IOs) - 0x02A8, CYTT21X (28, 33, 35, 36 IOs) - 0x02C0

Bits	31	30	29	28	27	26	25	24
Access:POR	RW: 0x00							
Bit Name	Value[31:24]							

Bits	23	22	21	20	19	18	17	16
Access:POR	RW: 0x00							
Bit Name	Value[23:16]							

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x75							
Bit Name	Value[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x30							
Bit Name	Value[7:0]							

If there is no activities found for a long time(specified by this value in ms) , force exit water mode. This is useful to avoid stucked in water mode

Bits	Name	Description
[31:0]	Value [31:0]	If there is no activities found for a long time(specified by this value in ms) , force exit water mode. This is useful to avoid stucked in water mode Default: 0x7530 Range: 0:4294967295

11.0.224 GLOVE_BTN_TO_LOWSEN_MODE_SWITCH_THRSH_MUT

[TTHE Group] Register Name : Address

[Glove] GLOVE_BTN_TO_LOWSEN_MODE_SWITCH_THRSH_MUT : CYTT21X/31X (40, 44, 48 IOs) - 0x041A, CYTMA445A - 0x03B6, CYTT21X (28, 33, 35, 36 IOs) - 0x0442

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x00							
Bit Name	Threshold[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x48							
Bit Name	Threshold[7:0]							

Mutual threshold to Enter Low Sensitive Mode.

Bits	Name	Description
[15:0]	Threshold [15:0]	Mutual threshold to Enter Low Sensitive Mode. Default: 0xc8 Range: 0:32767

11.0.225 FILT_IIR_COEFF_BUT

[TTHE Group] Register Name : Address

[Raw Processing] FILT_IIR_COEFF_BUT : CYTT21X/31X (40, 44, 48 IOs) - 0x02B9, CYTMA445A - 0x0269, CYTT21X (28, 33, 35, 36 IOs) - 0x02D1

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x0					RW: 0x1		
Bit Name	Reserved[7:3]					IIR Filter Input Weight[2:0]		

IIR Coefficient for Base Button Mutual

Bits	Name	Description
[7:3]	Reserved [4:0]	Default: 0x0 Range:
[2:0]	IIR Filter Input Weight [2:0]	Raw IIR filter coefficient for Base Button Mutual Default: 0x1 **0:** One Half - Filter output = 0.5 * Filter Input + 0.5 * Previous Filter Output **1:** One Quarter - Filter output = 0.25 * Filter Input + 0.75 * Previous Filter Output **2:** One Eighth - Filter output = 0.125 * Filter Input + 0.875 * Previous Filter Output **3:** One Sixteenth - Filter output = 0.0625 * Filter Input + 0.9375 * Previous Filter Output **4:** One Thirty-second - Filter output = 0.03125 * Filter Input + 0.96875 * Previous Filter Output

11.0.226 FILT_IIR_COEFF_STYLUS_MUT

[TTHE Group] Register Name : Address

[Raw Processing] FILT_IIR_COEFF_STYLUS_MUT : CYTT21X/31X (40, 44, 48 IOs) - 0x02EF

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x0					RW: 0x0		
Bit Name	Reserved[7:3]					IIR Filter Input Weight[2:0]		

IIR Coefficient for Stylus Mutual

Bits	Name	Description
[7:3]	Reserved [4:0]	Default: 0x0 Range:
[2:0]	IIR Filter Input Weight [2:0]	Raw IIR filter coefficient for Mutual Cap scan Default: 0x0 **0:** One Half - Filter output = 0.5 * Filter Input + 0.5 * Previous Filter Output **1:** One Quarter - Filter output = 0.25 * Filter Input + 0.75 * Previous Filter Output **2:** One Eighth - Filter output = 0.125 * Filter Input + 0.875 * Previous Filter Output **3:** One Sixteenth - Filter output = 0.0625 * Filter Input + 0.9375 * Previous Filter Output **4:** One Thirty-second - Filter output = 0.03125 * Filter Input + 0.96875 * Previous Filter Output

11.0.227 BTN_HS_OFF_THRSH_SELF_3

[TTHE Group] Register Name : Address

[CapSense Buttons] BTN_HS_OFF_THRSH_SELF_3 : CYTT21X/31X (40, 44, 48 IOs) - 0x040F, CYTMA445A - 0x03AB, CYTT21X (28, 33, 35, 36 IOs) - 0x0437

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

CapSense Button Self Cap HighSensitive scan Off threshold for button 3

Bits	Name	Description
[7:0]	On Threshold [7:0]	CapSense Button Self Cap HighSensitive scan Off threshold for button 3 Default: 0xa Range: 5:255

11.0.228 BTN_HS_OFF_THRSH_SELF_2

[TTHE Group] Register Name : Address

[CapSense Buttons] BTN_HS_OFF_THRSH_SELF_2 : CYTT21X/31X (40, 44, 48 IOs) - 0x040E, CYTMA445A - 0x03AA, CYTT21X (28, 33, 35, 36 IOs) - 0x0436

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

CapSense Button Self Cap HighSensitive scan Off threshold for button 2

Bits	Name	Description
[7:0]	On Threshold [7:0]	CapSense Button Self Cap HighSensitive scan Off threshold for button 2 Default: 0xa Range: 5:255

11.0.229 TOUCHMODE_GLOVE_SWITCH_DEBOUNCE

[TTHE Group] Register Name : Address

[Touch Mode] TOUCHMODE_GLOVE_SWITCH_DEBOUNCE : CYTT21X/31X (40, 44, 48 IOs) - 0x0362, CYTMA445A - 0x02F4, CYTT21X (28, 33, 35, 36 IOs) - 0x037E

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x00							
Bit Name	gloveSwitchDebounce[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x00							
Bit Name	gloveSwitchDebounce[7:0]							

The debounce in mS for switching to Glove mode (LFT->Glove). The mode switch will be cancelled if the signal pattern is changed in the debounce period.

Bits	Name	Description
[15:0]	gloveSwitchDebounce [15:0]	The debounce in mS for switching to Glove mode (LFT->Glove). The mode switch will be cancelled if the signal pattern is changed in the debounce period. Default: 0x0 Range: 0:65535

11.0.230 BTN_HS_OFF_THRSH_SELF_0

[TTHE Group] Register Name : Address

[CapSense Buttons] BTN_HS_OFF_THRSH_SELF_0 : CYTT21X/31X (40, 44, 48 IOs) - 0x040C, CYTMA445A - 0x03A8, CYTT21X (28, 33, 35, 36 IOs) - 0x0434

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

CapSense Button Self Cap HighSensitive scan Off threshold for button 0

Bits	Name	Description
[7:0]	On Threshold [7:0]	CapSense Button Self Cap HighSensitive scan Off threshold for button 0 Default: 0xa Range: 5:255

11.0.231 CA_MULTI_TOUCH_DEBOUNCE

[TTHE Group] Register Name : Address

[Charger Armor] CA_MULTI_TOUCH_DEBOUNCE : CYTT21X/31X (40, 44, 48 IOs) - 0x03D4, CYTMA445A - 0x0372, CYTT21X (28, 33, 35, 36 IOs) - 0x03FC

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x5							
Bit Name	Debounce period[7:0]							

Number of consecutive refresh cycles for which a touch must be detected prior to being reported when Charger Armor is not active. Applies to 2nd and successive touches but not to 1st touch.

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 when Charger Armor is not active. Applies to 2nd and successive touches but not to 1st touch. Default: 0x5 Range: 0:255

11.0.232 MAX_POSITIVE_THRESHOLD

[TTHE Group] Register Name : Address

[Raw Processing] MAX_POSITIVE_THRESHOLD : CYTT21X/31X (40, 44, 48 IOs) - 0x026E, CYTMA445A - 0x0212, CYTT21X (28, 33, 35, 36 IOs) - 0x026A

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x07							
Bit Name	Value[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x08							
Bit Name	Value[7:0]							

Threshold to reset mutual signals for H2O rejection disabled to baseline signals from large amount of water, large ungrounded object on the panel or signals after wiping water. Condition to reset is (sumMutSigPositive < maxPositiveThreshold).

Bits	Name	Description
[15:0]	Value [15:0]	Threshold to reset mutual signals for H2O rejection disabled to baseline signals from large amount of water, large ungrounded object on the panel or signals after wiping water. Condition to reset is (sumMutSigPositive < maxPositiveThreshold). Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0x708 Range: 0-65535

11.0.233 RX_ATTEN_RES_BYPASS

[TTHE Group] Register Name : Address

[CDC] RX_ATTEN_RES_BYPASS : CYTT21X/31X (40, 44, 48 IOs) - 0x005C, CYTMA445A - 0x0058, CYTT21X (28, 33, 35, 36 IOs) - 0x005C

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x0		RW: 0x0	RW: 0x00				
Bit Name	Reserved[7:6]		RX_ATTEN_RES_BYPASS[5:5]	Reserved[0:4]				

Damping resistor bypass

Bits	Name	Description
[7:6]	Reserved [1:0]	Reserved Default: 0x0 Range:
[5:5]	RX_ATTEN_RES_BYPASS [0:0]	Damping resistor bypass when Enable Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0x0 **0:** No Bypass **1:** Bypass
[4:0]	Reserved [4:0]	Reserved Default: 0x0 Range:

11.0.234 VIRTUAL_PEAK_DELTA_RESET_THRESHOLD

[TTHE Group] Register Name : Address

[Finger Tracking] VIRTUAL_PEAK_DELTA_RESET_THRESHOLD : CYTT21X/31X (40, 44, 48 IOs) - 0x03C6, CYTMA445A - 0x034E, CYTT21X (28, 33, 35, 36 IOs) - 0x03DA

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x05							
Bit Name	Threshold[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x5c							
Bit Name	Threshold[7:0]							

Threshold to reset accumulated delta signal sum for virtual peak algorithm; default value: 1/10 of HTI of 12mm finger.

Bits	Name	Description
[15:0]	Threshold [15:0]	Threshold to reset accumulated delta signal sum for virtual peak algorithm; default value: 1/10 of HTI of 12mm finger. Default: 0x5dc Range: 0..65535

11.0.235 XY_FILT_XY_FAST_THR

[TTHE Group] Register Name : Address

[Scan Filtering] XY_FILT_XY_FAST_THR : CYTT21X/31X (40, 44, 48 IOs) - 0x0460, CYTMA445A - 0x03E4, CYTT21X (28, 33, 35, 36 IOs) - 0x0470

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0xff							
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 Default: 0xff Range: 0:255

11.0.236 WF_EXIT_DEBOUNCE

[TTHE Group] Register Name : Address

[Wet Finger] WF_EXIT_DEBOUNCE : CYTT21X/31X (40, 44, 48 IOs) - 0x02A7, CYTT21X (28, 33, 35, 36 IOs) - 0x02BF

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

This is the debounce to exit from water mode to none-water mode. Water mode exits after water is detected for a number of frames (specified by this value)

Bits	Name	Description
[7:0]	Value [7:0]	This is the debounce to exit from water mode to none-water mode. Water mode exits after water is detected for a number of frames (specified by this value) Default: 0xa Range: 0:255

11.0.237 TOUCH_TRACKING_FEATURES

[TTHE Group] Register Name : Address

[Finger Tracking] TOUCH_TRACKING_FEATURES : CYTT21X/31X (40, 44, 48 IOs) - 0x03DF, CYTMA445A - 0x037A, CYTT21X (28, 33, 35, 36 IOs) - 0x0407

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x0						RW: 0x1	RW: 0x1
Bit Name	Reserved[7:2]						fat-finger feature switch[1:1]	multi-finger feature switch[0:0]

Switches to enable or disable touch zone features.

Bits	Name	Description
[7:2]	Reserved [5:0]	Default: 0x0 Range:
[1:1]	fat-finger feature switch [0:0]	Default: 0x1 **1:** Enabled **0:** Disabled
[0:0]	multi-finger feature switch [0:0]	Default: 0x1 **1:** Enabled **0:** Disabled

11.0.238 TOUCHMODE_GLOVE_EXIT_DELAY

[TTHE Group] Register Name : Address

[Touch Mode] TOUCHMODE_GLOVE_EXIT_DELAY : CYTT21X/31X (40, 44, 48 IOs) - 0x0366, CYTMA445A - 0x02FA, CYTT21X (28, 33, 35, 36 IOs) - 0x0382

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x00							
Bit Name	gloveExitDelay[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x00							
Bit Name	gloveExitDelay[7:0]							

Parameter for transition Glove->LFT. Time in mS after Glove lift-off during which Glove scan mode will performed.

Bits	Name	Description
[15:0]	gloveExitDelay [15:0]	Parameter for transition Glove->LFT. Time in mS after Glove lift-off during which Glove scan mode will performed. Default: 0x0 Range: 0-65535

11.0.239 GLOVE_OFF_THRSH_MUTUAL

[TTHE Group] Register Name : Address

[Glove] GLOVE_OFF_THRSH_MUTUAL : CYTT21X/31X (40, 44, 48 IOs) - 0x0428, CYTMA445A - 0x03C4, CYTT21X (28, 33, 35, 36 IOs) - 0x0450

Bits	**15**	**14**	**13**	**12**	**11**	**10**	**9**	**8**
Access:POR	RW: 0x00							
Bit Name	Threshold[15:8]							

Bits	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
Access:POR	RW: 0x32							
Bit Name	Threshold[7:0]							

Mutual Cap sensor data Off threshold to identify an existing glove touch

Bits	**Name**	**Description**
[15:0]	Threshold [15:0]	Mutual Cap sensor data Off threshold to identify an existing glove touch Default: 0x32 Range: 0:32767

11.0.240 SCANNING_MODE_BUTTON

[TTHE Group] Register Name : Address

[CDC] SCANNING_MODE_BUTTON : CYTT21X/31X (40, 44, 48 IOs) - 0x001D, CYTMA445A - 0x001B, CYTT21X (28, 33, 35, 36 IOs) - 0x001D

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x0						RW: 0x3	
Bit Name	Reserved[7:2]						Scan Mode[1:0]	

Scanning Mode Button

Bits	Name	Description
[7:2]	Reserved [5:0]	Default: 0x0 Range:
[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: 0x3 **1:** Self Capacitance - Self capacitance button scan **2:** Mutual Capacitance - Mutual capacitance button scan **3:** Hybrid - Combination scan: self + mutual

11.0.241 BTN_LS_ON_THRSH_SELF_0

[TTHE Group] Register Name : Address

[CapSense Buttons] BTN_LS_ON_THRSH_SELF_0 : CYTT21X/31X (40, 44, 48 IOs) - 0x03F4, CYTMA445A - 0x0390, CYTT21X (28, 33, 35, 36 IOs) - 0x041C

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x41							
Bit Name	On Threshold[7:0]							

CapSense Button Self Cap LowSensitive scan On threshold for button 0

Bits	Name	Description
[7:0]	On Threshold [7:0]	CapSense Button Self Cap LowSensitive scan On threshold for button 0 Default: 0x41 Range: 5:255

11.0.242 TX_PULSES_NUM_BUTTON_MUTUAL

[TTHE Group] Register Name : Address

[CDC] TX_PULSES_NUM_BUTTON_MUTUAL : CYTT21X/31X (40, 44, 48 IOs) - 0x009A, CYTMA445A - 0x009A, CYTT21X (28, 33, 35, 36 IOs) - 0x0096

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x00							
Bit Name	TX Pulses[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x40							
Bit Name	TX Pulses[7:0]							

Mutual Button Scanning Number of TX Pulses

Bits	Name	Description
[15:0]	TX Pulses [15:0]	Number of TX Pulses per conversion for CapSense Button Mutual Cap scan Default: 0x40 Range: 1:255

11.0.243 BTN_LS_ON_THRSH_SELF_2

[TTHE Group] Register Name : Address

[CapSense Buttons] BTN_LS_ON_THRSH_SELF_2 : CYTT21X/31X (40, 44, 48 IOs) - 0x03F6, CYTMA445A - 0x0392, CYTT21X (28, 33, 35, 36 IOs) - 0x041E

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x41							
Bit Name	On Threshold[7:0]							

CapSense Button Self Cap LowSensitive scan On threshold for button 2

Bits	Name	Description
[7:0]	On Threshold [7:0]	CapSense Button Self Cap LowSensitive scan On threshold for button 2 Default: 0x41 Range: 5:255

11.0.244 BTN_LS_ON_THRSH_SELF_3

[TTHE Group] Register Name : Address

[CapSense Buttons] BTN_LS_ON_THRSH_SELF_3 : CYTT21X/31X (40, 44, 48 IOs) - 0x03F7, CYTMA445A - 0x0393, CYTT21X (28, 33, 35, 36 IOs) - 0x041F

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x41							
Bit Name	On Threshold[7:0]							

CapSense Button Self Cap LowSensitive scan On threshold for button 3

Bits	Name	Description
[7:0]	On Threshold [7:0]	CapSense Button Self Cap LowSensitive scan On threshold for button 3 Default: 0x41 Range: 5:255

11.0.245 TOUCHMODE_STYLUS_NOISE_DEBOUNCE

[TTHE Group] Register Name : Address

[Touch Mode] TOUCHMODE_STYLUS_NOISE_DEBOUNCE : CYTT21X/31X (40, 44, 48 IOs) - 0x0372

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x0							
Bit Name	stylusNoiseDebounce[7:0]							

The debounce in mS for switching from stylus to other modes in case of noise (LCD/Charger/ESD). The mode switch will be cancelled if the signal pattern is changed in the debounce period.

Bits	Name	Description
[7:0]	stylusNoiseDebounce [7:0]	The debounce in mS for switching from stylus to other modes in case of noise (LCD/Charger/ESD). The mode switch will be cancelled if the signal pattern is changed in the debounce period. Default: 0x0 Range: 0:255

11.0.246 TOUCHMODE_FINGER_STYLUS_SWITCH_DEBOUNCE

[TTHE Group] Register Name : Address

[Touch Mode] TOUCHMODE_FINGER_STYLUS_SWITCH_DEBOUNCE : CYTT21X/31X (40, 44, 48 IOs) - 0x036A

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x00							
Bit Name	fingerStylusSwitchDebounce[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x64							
Bit Name	fingerStylusSwitchDebounce[7:0]							

The debounce in mS for switching to Stylus mode (Finger->Stylus). The mode switch will be cancelled if the signal pattern is changed in the debounce period.

Bits	Name	Description
[15:0]	fingerStylusSwitchDebounce [15:0]	The debounce in mS for switching to Stylus mode (Finger->Stylus). The mode switch will be cancelled if the signal pattern is changed in the debounce period. Default: 0x64 Range: 0:1000

11.0.247 COUNTS_TO_BL_RESET_MUT

[TTHE Group] Register Name : Address

[Raw Processing] COUNTS_TO_BL_RESET_MUT : CYTT21X/31X (40, 44, 48 IOs) - 0x0277, CYTMA445A - 0x021A, CYTT21X (28, 33, 35, 36 IOs) - 0x0273

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x1							
Bit Name	Value[7:0]							

The number of consecutive refresh cycles when one of the conditions to baseline signals is met to reset self/mutual signals for H2O rejection enabled/disabled. In the low power mode: with H2O rejection enabled, (MAX_MUTUAL_SCAN_INTERVAL * COUNTS_TO_BL_RESET_MUT) defines the baseline update interval for SELF. With H2O rejection disabled, this value defines the baseline update rate for MUTUAL. In the active power mode: with H2O rejection enabled, (ACT_INTRVL0 * COUNTS_TO_BL_RESET_MUT) defines the baseline update interval for SELF. With H2O rejection disabled, this value defines the baseline update rate for MUTUAL.

Bits	Name	Description
[7:0]	Value [7:0]	The number of consecutive refresh cycles when one of the conditions to baseline signals is met to reset self/mutual signals for H2O rejection enabled/disabled. In the low power mode: with H2O rejection enabled, (MAX_MUTUAL_SCAN_INTERVAL * COUNTS_TO_BL_RESET_MUT) defines the baseline update interval for SELF. With H2O rejection disabled, this value defines the baseline update rate for MUTUAL. In the active power mode: with H2O rejection enabled, (ACT_INTRVL0 * COUNTS_TO_BL_RESET_MUT) defines the baseline update interval for SELF. With H2O rejection disabled, this value defines the baseline update rate for MUTUAL. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0x1 Range: 0:255

11.0.248 X_LEN_PHY

[TTHE Group] Register Name : Address

[Device Setup] X_LEN_PHY : CYTT21X/31X (40, 44, 48 IOs) - 0x0008, CYTMA445A - 0x0008, CYTT21X (28, 33, 35, 36 IOs) - 0x0008

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x2d							
Bit Name	Length[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x55							
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) Default: 0x2dd5 Range: 0:65535

11.0.249 CA_INJTCH_FINGER_THOLD

[TTHE Group] Register Name : Address

[Charger Armor] CA_INJTCH_FINGER_THOLD : CYTT21X/31X (40, 44, 48 IOs) - 0x0306, CYTMA445A - 0x02AA, CYTT21X (28, 33, 35, 36 IOs) - 0x031E

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x00							
Bit Name	Value[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x5a							
Bit Name	Value[7:0]							

Injected Touch Finger Threshold. Set this parameter equal (CA_FINGER THRESHOLD).

Bits	Name	Description
[15:0]	Value [15:0]	Injected Touch Finger Threshold. Refer to tuning guide for this parameter setting. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0x5a Range: 0:65535

11.0.250 TOUCH_THRESHOLD

[TTHE Group] Register Name : Address

[Proximity] TOUCH_THRESHOLD : CYTMA445A - 0x0236, CYTT21X (28, 33, 35, 36 IOs) - 0x0296

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x03							
Bit Name	Value[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x68							
Bit Name	Value[7:0]							

Touch threshold level of Proximity used for filtering out finger touches, signal levels above this threshold will not trigger proximity

Bits	Name	Description
[15:0]	Value [15:0]	Touch threshold level of Proximity used for filtering out finger touches, signal levels above this threshold will not trigger proximity Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0x3e8 Range: 0:65535

11.0.251 WF_BASE_RESET_COUNTER

[TTHE Group] Register Name : Address

[Wet Finger] WF_BASE_RESET_COUNTER : CYTT21X/31X (40, 44, 48 IOs) - 0x02A5, CYTT21X (28, 33, 35, 36 IOs) - 0x02BD

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

If the raw variation is smaller than the base for a number of frames (specified by this value) then the variation base reset to current variation value

Bits	Name	Description
[7:0]	Value [7:0]	This is the debounce to enter water mode from none-water mode. Water mode enters after water is detected for several frames (specified by this value) Default: 0xa Range: 0:255

11.0.252 NM_INJ_TCH_THRESHOLD

[TTHE Group] Register Name : Address

[Charger Armor] NM_INJ_TCH_THRESHOLD : CYTT21X/31X (40, 44, 48 IOs) - 0x030E, CYTMA445A - 0x02B2, CYTT21X (28, 33, 35, 36 IOs) - 0x0326

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x00							
Bit Name	Value[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x0f							
Bit Name	Value[7:0]							

InjTch level exceeding of which triggers Charger Armor.

Bits	Name	Description
[15:0]	Value [15:0]	InjTch level exceeding of which triggers Charger Armor. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0xf Range: 0:65535

11.0.253 ACTIVE_DELTA_Z

[TTHE Group] Register Name : Address

[Proximity] ACTIVE_DELTA_Z : CYTMA445A - 0x02D4, CYTT21X (28, 33, 35, 36 IOs) - 0x0350

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x1							
Bit Name	activeDeltaZ[7:0]							

One-dimensional active distance (estimated distance in mm from object to the panel) applied on touchdown of a Proximity to determine whether this proximity's approaching/moving away to/from the panel should trigger a new report.

Bits	Name	Description
[7:0]	activeDeltaZ [7:0]	One-dimensional active distance (estimated distance in mm from object to the panel) applied on touchdown of a Proximity to determine whether this proximity's approaching/moving away to/from the panel should trigger a new report. Default: 0x1 Range: 0:255

11.0.254 DISCARD_SCAN

[TTHE Group] Register Name : Address

[Proximity] DISCARD_SCAN : CYTMA445A - 0x0365, CYTT21X (28, 33, 35, 36 IOs) - 0x03F1

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x1							
Bit Name	discardScan[7:0]							

Discards the first DISCARD_SCAN number of scan results

Bits	Name	Description
[7:0]	discardScan [7:0]	Disgards the first DISGARD_SCAN number of scan results Default: 0x1 Range: 0:255

11.0.255 BTN_HS_TOUCHDOWN_DEBOUNCE

[TTHE Group] Register Name : Address

[CapSense Buttons] BTN_HS_TOUCHDOWN_DEBOUNCE : CYTT21X/31X (40, 44, 48 IOs) - 0x0410, CYTMA445A - 0x03AC, CYTT21X (28, 33, 35, 36 IOs) - 0x0438

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x00							
Bit Name	Debounce[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x01							
Bit Name	Debounce[7:0]							

Number of consecutive refresh cycles for which button event must be detected prior to being reported.

Bits	Name	Description
[15:0]	Debounce [15:0]	Number of consecutive refresh cycles for which button event must be detected prior to being reported. Default: 0x1 Range: 0:255

11.0.256 XY_FILT_TOUCH_ORIENTATION_IIR_COEFF

[TTHE Group] Register Name : Address

[Scan Filtering] XY_FILT_TOUCH_ORIENTATION_IIR_COEFF : CYTT21X/31X (40, 44, 48 IOs) - 0x0487, CYTMA445A - 0x03FB, CYTT21X (28, 33, 35, 36 IOs) - 0x0487

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x0							
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. Default: 0x0 **0:** One - Filter output = 1 * Filter Input + 0 * Previous Filter Output (ie. no filter) **1:** One Half - Filter output = 0.5 * Filter Input + 0.5 * Previous Filter Output **2:** One Quarter - Filter output = 0.25 * Filter Input + 0.75 * Previous Filter Output **3:** One Eighth - Filter output = 0.125 * Filter Input + 0.875 * Previous Filter Output **4:** One Sixteenth - Filter output = 0.0625 * Filter Input + 0.9375 * Previous Filter Output

11.0.257 ACTIVE_SENSOR_THRESHOLD_FINGER

[TTHE Group] Register Name : Address

[Proximity] ACTIVE_SENSOR_THRESHOLD_FINGER : CYTMA445A - 0x035C, CYTT21X (28, 33, 35, 36 IOs) - 0x03E8

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x03							
Bit Name	activeSensorThresholdFinger[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x68							
Bit Name	activeSensorThresholdFinger[7:0]							

Threshold for sensors having high diff-counts due to finger to count the active sensor number that will be compared with SENSOR_NUM_THRSH_FINGER

Bits	Name	Description
[15:0]	activeSensorThreshold-Finger [15:0]	Threshold for sensors having high diff-counts due to finger to count the active sensor number that will be compared with SENSOR_NUM_THRSH_FINGER Default: 0x3e8 Range: 0:32767

11.0.258 CA_BASE_TX_PULSES_NUM_MUTUAL

[TTHE Group] Register Name : Address

[Charger Armor] CA_BASE_TX_PULSES_NUM_MUTUAL : CYTT21X/31X (40, 44, 48 IOs) - 0x008C, CYTMA445A - 0x007E, CYTT21X (28, 33, 35, 36 IOs) - 0x0088

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x00							
Bit Name	TX Pulses[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x7f							
Bit Name	TX Pulses[7:0]							

Number of TX Pulses per conversion while operating at Charger Armor noise levels 1-2 at base TX frequency

Bits	Name	Description
[15:0]	TX Pulses [15:0]	Number of TX Pulses per conversion while operating at Charger Armor noise levels 1-2 at base TX frequency Default: 0x7f Range: 1:255

11.0.259 PREV_RAW_FRAME_NUM

[TTHE Group] Register Name : Address

[Proximity] PREV_RAW_FRAME_NUM : CYTMA445A - 0x022A, CYTT21X (28, 33, 35, 36 IOs) - 0x028A

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x01							
Bit Name	Value[15:8]							
Bits	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
Access:POR	RW: 0x10							
Bit Name	Value[7:0]							

Interval to hold previous rawdata (in refresh cycles)

Bits	Name	Description
[15:0]	Value [15:0]	Interval to hold previous rawdata (in refresh cycles) Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0x190 Range: 0:65535

11.0.260 SELF_Z_MODE

[TTHE Group] Register Name : Address

[Finger Tracking] SELF_Z_MODE : CYTT21X/31X (40, 44, 48 IOs) - 0x001F, CYTMA445A - 0x001D, CYTT21X (28, 33, 35, 36 IOs) - 0x001F

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x0						RW: 0x1	
Bit Name	Reserved[7:2]						Z Mode[1:0]	

Selects which axis self-cap scanning is performed on.

Bits	Name	Description
[7:2]	Reserved [5:0]	Default: 0x0 Range:
[1:0]	Z Mode [1:0]	Select Self Cap scan mode Default: 0x1 **1:** Self Cap RX - Self cap scan is executed on the mutual cap RX electrodes **2:** Self Cap TX - Self cap scan is executed on the mutual cap TX electrodes **3:** Self Cap TX & RX - Self cap scan is executed on the mutual cap TX & RX electrodes

11.0.261 CA_FINGER_THRESHOLD_MUTUAL

[TTHE Group] Register Name : Address

[Charger Armor] CA_FINGER_THRESHOLD_MUTUAL : CYTT21X/31X (40, 44, 48 IOs) - 0x03D0, CYTMA445A - 0x036E, CYTT21X (28, 33, 35, 36 IOs) - 0x03F8

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x00							
Bit Name	Threshold[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x38							
Bit Name	Threshold[7:0]							

Mutual capacitance finger threshold applied in the presence of charger noise (level 1 or higher).

Bits	Name	Description
[15:0]	Threshold [15:0]	Mutual Cap finger threshold applied in the presence of charger noise (level 1 or higher). Default: 0x38 Range: 0:32767

11.0.262 STYL_XY_FILT_IIR_FAST_COEF

[TTHE Group] Register Name : Address

[Stylus Tracking] STYL_XY_FILT_IIR_FAST_COEF : CYTT21X/31X (40, 44, 48 IOs) - 0x0482

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x0						RW: 0x1	
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 STYL_XY_FILT_XY_FAST_THR when Stylus is active.

Bits	Name	Description
[7:2]	Reserved [5:0]	Default: 0x0 Range:
[1:0]	IIR Filter Input Weight [1:0]	Weighting of the input X and Y values in the IIR filter for displacements greater than STYL_XY_FILT_XY_FAST_THR when Stylus is active. Default: 0x1 **0:** One - Filter output = 1 * Filter Input + 0 * Previous Filter Output **1:** One Half - Filter output = 0.5 * Filter Input + 0.5 * Previous Filter Output **2:** One Quarter - Filter output = 0.25 * Filter Input + 0.75 * Previous Filter Output

11.0.263 BALANCING_TARGET_SELF

[TTHE Group] Register Name : Address

[Calibration] BALANCING_TARGET_SELF : CYTT21X/31X (40, 44, 48 IOs) - 0x006B, CYTMA445A - 0x0067, CYTT21X (28, 33, 35, 36 IOs) - 0x006B

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x32							
Bit Name	Balancing Target Self[7:0]							

Integrator Balancing target in Self Mode

Bits	Name	Description
[7:0]	Balancing Target Self [7:0]	Balancing target in Self Mode Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0x32 Range: 5:95

11.0.264 TX_PERIOD_PROX

[TTHE Group] Register Name : Address

[CDC] TX_PERIOD_PROX : CYTMA445A - 0x00A0

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x00							
Bit Name	txPeriodProximity[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x20							
Bit Name	txPeriodProximity[7:0]							

Integration Time

Bits	Name	Description
[15:0]	txPeriodProximity [15:0]	Number of system clocks in each TX half period for Self Cap Proximity scan Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0xa0 Range: 48-510

11.0.265 RX_LINE_FILTER_THRESHOLD

[TTHE Group] Register Name : Address

[Charger Armor] RX_LINE_FILTER_THRESHOLD : CYTT21X/31X (40, 44, 48 IOs) - 0x03E5, CYTMA445A - 0x0380, CYTT21X (28, 33, 35, 36 IOs) - 0x040D

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x58							
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). Default: 0x58 Range: 0:100

11.0.266 TX_PULSES_NUM_GLOVE_BUTTON_SELF

[TTHE Group] Register Name : Address

[CDC] TX_PULSES_NUM_GLOVE_BUTTON_SELF : CYTT21X/31X (40, 44, 48 IOs) - 0x00A6, CYTMA445A - 0x00B2, CYTT21X (28, 33, 35, 36 IOs) - 0x00A2

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x00							
Bit Name	TX Pulses[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x20							
Bit Name	TX Pulses[7:0]							

Number of TX Pulses for Glove Button Self Scanning

Bits	Name	Description
[15:0]	TX Pulses [15:0]	Number of TX Pulses per conversion for Glove Button Self Scan Default: 0x20 Range: 0:255

11.0.267 FILT_FILTER_MASK_BASE_SELF

[TTHE Group] Register Name : Address

[Raw Processing] FILT_FILTER_MASK_BASE_SELF : CYTT21X/31X (40, 44, 48 IOs) - 0x02B2, CYTMA445A - 0x0262, CYTT21X (28, 33, 35, 36 IOs) - 0x02CA

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x0						RW: 0x1	RW: 0x1
Bit Name	Reserved[7:2]						IIR Filter[1:1]	CMF Filter[0:0]

Indicates what filters are enabled/disabled for Base Self

Bits	Name	Description
[7:2]	Reserved [5:0]	Default: 0x0 Range:
[1:1]	IIR Filter [0:0]	Enable/Disable IIR Filter Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0x1 **0:** Disabled - Filter is Disabled **1:** Enabled - Filter is Enabled
[0:0]	CMF Filter [0:0]	Enable/Disable CMF Filter Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0x1 **0:** Disabled - Filter is Disabled **1:** Enabled - Filter is Enabled

11.0.268 CLIPPING_Y_HIGH

[TTHE Group] Register Name : Address

[Device Setup] CLIPPING_Y_HIGH : CYTT21X/31X (40, 44, 48 IOs) - 0x0377, CYTMA445A - 0x0303, CYTT21X (28, 33, 35, 36 IOs) - 0x038B

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x0							
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. Default: 0x0 Range: -128:127

11.0.269 STYL_XY_FILTER_MASK

[TTHE Group] Register Name : Address

[Stylus Tracking] STYL_XY_FILTER_MASK : CYTT21X/31X (40, 44, 48 IOs) - 0x0474

Bits	**31**	**30**	**29**	**28**	**27**	**26**	**25**	**24**
Access:POR	RW: 0x00							
Bit Name	Reserved[31:24]							

Bits	**23**	**22**	**21**	**20**	**19**	**18**	**17**	**16**
Access:POR	RW: 0x00							
Bit Name	Reserved[23:16]							

Bits	**15**	**14**	**13**	**12**	**11**	**10**	**9**	**8**
Access:POR	RW: 0x00							
Bit Name	Reserved[15:8]							

Bits	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
Access:POR	RW: 0x1	RW: 0x1	RW: 0x1	RW: 0x1	RW: 0x0			
Bit Name	XY IIR Filter Enable[7:7]	XY Jitter Filter Enable[6:6]	Z IIR Filter Enable[5:5]	Z Jitter Filter Enable[4:4]	Reserved[3:0]			

XY filter mask when Stylus is active

Bits	**Name**	**Description**
[31:8]	Reserved [23:0]	Default: 0x0 Range:
[7:7]	XY IIR Filter Enable [0:0]	Enables or disables the XY IIR filter when Stylus is active Default: 0x1 **0:** Disabled **1:** Enabled
[6:6]	XY Jitter Filter Enable [0:0]	Enables or disables the XY jitter filter when Stylus is active Default: 0x1 **0:** Disabled **1:** Enabled
[5:5]	Z IIR Filter Enable [0:0]	Enables or disables the Z IIR filter when Stylus is active Default: 0x1 **0:** Disabled **1:** Enabled
[4:4]	Z Jitter Filter Enable [0:0]	Enables or disables the Z jitter filter when Stylus is active Default: 0x1 **0:** Disabled **1:** Enabled
[3:0]	Reserved [3:0]	Default: 0x0 Range:

11.0.270 OPENS_TEST_RAW_THRESHOLD_BUTTON

[TTHE Group] Register Name : Address

[MFG] OPENS_TEST_RAW_THRESHOLD_BUTTON : CYTMA445A - 0x006E

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x04							
Bit Name	Maximum Allowable Open Circuits Test RawCount Value for Buttons[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x4c							
Bit Name	Maximum Allowable Open Circuits Test RawCount Value for Buttons[7:0]							

Maximum Allowable Open Circuits Test RawCount Value for Buttons

Bits	Name	Description
[15:0]	Maximum Allowable Open Circuits Test RawCount Value for Buttons [15:0]	Maximum Allowable Open Circuits Test RawCount Value for Buttons Default: 0x44c Range: -32768:32767

11.0.271 SLIM_POSITION_OFFSET_ALONG_TX

[TTHE Group] Register Name : Address

[Finger Tracking] SLIM_POSITION_OFFSET_ALONG_TX : CYTT21X/31X (40, 44, 48 IOs) - 0x0379, CYTMA445A - 0x0305, CYTT21X (28, 33, 35, 36 IOs) - 0x038D

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x0							
Bit Name	Slim Position Offset[7:0]							

Reported position offset along Tx axis (in 1/256 increments) due to the routing for SLIM-E patterns

Bits	Name	Description
[7:0]	Slim Position Offset [7:0]	Reported position offset along Tx axis (in 1/256 increments) due to the routing for SLIM-E patterns Default: 0x0 Range: -128:127

11.0.272 WF_Z8_MULTIPLIER

[TTHE Group] Register Name : Address

[Wet Finger] WF_Z8_MULTIPLIER : CYTT21X/31X (40, 44, 48 IOs) - 0x03E8, CYTMA445A - 0x0384, CYTT21X (28, 33, 35, 36 IOs) - 0x0410

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x5							
Bit Name	Axis Length Enable[7:0]							

This parameter is used as multiplier for z8 sum in case of comparing with peak signal

Bits	Name	Description
[7:0]	Axis Length Enable [7:0]	This parameter is used as multiplier for z8 sum in case of comparing with peak signal Default: 0x5 Range: 1:100

11.0.273 FILT_IIR_COEFF_BUT_GLOVE_MUT

[TTHE Group] Register Name : Address

[Raw Processing] FILT_IIR_COEFF_BUT_GLOVE_MUT : CYTT21X/31X (40, 44, 48 IOs) - 0x02E3, CYTMA445A - 0x0293, CYTT21X (28, 33, 35, 36 IOs) - 0x02FB

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x0					RW: 0x1		
Bit Name	Reserved[7:3]					IIR Filter Input Weight[2:0]		

IIR Coeficient for Glove Button Mutual

Bits	Name	Description
[7:3]	Reserved [4:0]	Default: 0x0 Range:
[2:0]	IIR Filter Input Weight [2:0]	Raw IIR filter coefficient for Glove Button Mutual Default: 0x1 **0:** One Half - Filter output = 0.5 * Filter Input + 0.5 * Previous Filter Output **1:** One Quarter - Filter output = 0.25 * Filter Input + 0.75 * Previous Filter Output **2:** One Eighth - Filter output = 0.125 * Filter Input + 0.875 * Previous Filter Output **3:** One Sixteenth - Filter output = 0.0625 * Filter Input + 0.9375 * Previous Filter Output **4:** One Thirty-second - Filter output = 0.03125 * Filter Input + 0.96875 * Previous Filter Output

11.0.274 STYL_CM_EDGE

[TTHE Group] Register Name : Address

[Stylus Tracking] STYL_CM_EDGE : CYTT21X/31X (40, 44, 48 IOs) - 0x044A

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x00							
Bit Name	Threshold[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x16							
Bit Name	Threshold[7:0]							

Lowest possible stylus sum of the 3x3 sensors on edge.

Bits	Name	Description
[15:0]	Threshold [15:0]	Lowest possible stylus sum of the 3x3 sensors on edge. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0x96 Range: 0:65535

11.0.275 INTEGRATOR_VOLTAGE_SELF

[TTHE Group] Register Name : Address

[Calibration] INTEGRATOR_VOLTAGE_SELF : CYTT21X/31X (40, 44, 48 IOs) - 0x0064, CYTMA445A - 0x0060, CYTT21X (28, 33, 35, 36 IOs) - 0x0064

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x00							
Bit Name	Integrator Voltage Self[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x7a							
Bit Name	Integrator Voltage Self[7:0]							

Target Integrator voltage in SelfCap Mode

Bits	Name	Description
[15:0]	Integrator Voltage Self [15:0]	Target Integrator voltage in SelfCap Mode Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0xfa Range: 10:650

11.0.276 MAX_ACCEPTED_FINGER

[TTHE Group] Register Name : Address

[Proximity] MAX_ACCEPTED_FINGER : CYTMA445A - 0x02D5, CYTT21X (28, 33, 35, 36 IOs) - 0x0351

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x2							
Bit Name	maxAcceptedTouchNumber[7:0]							

Maximum number of touches accepted when Proximity mode is enabled. All extra touches are not reported. The oldest "max-AcceptedTouchNumber" touches are reported.

Bits	Name	Description
[7:0]	maxAcceptedTouchNum-ber [7:0]	Maximum number of touches accepted when Proximity mode is enabled. All extra touches are not reported. The oldest "maxAcceptedTouchNumber" touches are reported. Default: 0x2 Range: 0:255

11.0.277 FAST_BL_THRSH

[TTHE Group] Register Name : Address

[Proximity] FAST_BL_THRSH : CYTMA445A - 0x0224, CYTT21X (28, 33, 35, 36 IOs) - 0x0284

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0xc8							
Bit Name	Value[7:0]							

Baseline update threshold after dirty touch

Bits	Name	Description
[7:0]	Value [7:0]	Baseline update threshold after dirty touch Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0xc8 Range: 0:255

11.0.278 WF_FT_COEF

[TTHE Group] Register Name : Address

[Wet Finger] WF_FT_COEF : CYTT21X/31X (40, 44, 48 IOs) - 0x03E1, CYTMA445A - 0x037C, CYTT21X (28, 33, 35, 36 IOs) - 0x0409

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x40							
Bit Name	Value[7:0]							

Finger threshold will increased by the coefficient of max peak (1/128 increment) when wet finger is existed.

Bits	Name	Description
[7:0]	Value [7:0]	Finger threshold will increased by the coefficient of max peak (1/128 increment) when wet finger is existed. Default: 0x40 Range: 1:128

11.0.279 TOUCHMODE_FINGER_SWITCH_DEBOUNCE

[TTHE Group] Register Name : Address

[Touch Mode] TOUCHMODE_FINGER_SWITCH_DEBOUNCE : CYTT21X/31X (40, 44, 48 IOs) - 0x035C, CYTMA445A - 0x02F6, CYTT21X (28, 33, 35, 36 IOs) - 0x0378

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x00							
Bit Name	fingerSwitchDebounce[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x00							
Bit Name	fingerSwitchDebounce[7:0]							

The debounce in mS for switching to Finger mode (LFT->Finger). The mode switch will be cancelled if the signal pattern is changed in the debounce period.

Bits	Name	Description
[15:0]	fingerSwitchDebounce [15:0]	The debounce in mS for switching to Finger mode (LFT->Finger). The mode switch will be cancelled if the signal pattern is changed in the debounce period. Default: 0x0 Range: 0:65535

11.0.280 FILT_IIR_THRESHOLD_BUT

[TTHE Group] Register Name : Address

[Raw Processing] FILT_IIR_THRESHOLD_BUT : CYTT21X/31X (40, 44, 48 IOs) - 0x02BA, CYTMA445A - 0x026A, CYTT21X (28, 33, 35, 36 IOs) - 0x02D2

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x00							
Bit Name	Value[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x14							
Bit Name	Value[7:0]							

IIR Threshold for Base Button Mutual

Bits	Name	Description
[15:0]	Value [15:0]	IIR Threshold for Base Button Mutual Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0x14 Range: 0:32767

11.0.281 XY_FILTER_MASK_CA

[TTHE Group] Register Name : Address

[Charger Armor] XY_FILTER_MASK_CA : CYTT21X/31X (40, 44, 48 IOs) - 0x0464, CYTMA445A - 0x03E8, CYTT21X (28, 33, 35, 36 IOs) - 0x0474

Bits	31	30	29	28	27	26	25	24
Access:POR	RW: 0x00							
Bit Name	Reserved[31:24]							

Bits	23	22	21	20	19	18	17	16
Access:POR	RW: 0x00							
Bit Name	Reserved[23:16]							

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x00							
Bit Name	Reserved[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x1	RW: 0x1	RW: 0x1	RW: 0x1	RW: 0x0			
Bit Name	XY IIR Filter Enable[7:7]	XY Jitter Filter Enable[6:6]	Z IIR Filter Enable[5:5]	Z Jitter Filter Enable[4:4]	Reserved[3:0]			

XY filter mask when Charger Armor is active

Bits	Name	Description
[31:8]	Reserved [23:0]	Default: 0x0 Range:
[7:7]	XY IIR Filter Enable [0:0]	Enables or disables the XY IIR filter when Charger Armor is active Default: 0x1 **0:** Disabled **1:** Enabled
[6:6]	XY Jitter Filter Enable [0:0]	Enables or disables the XY jitter filter when Charger Armor is active Default: 0x1 **0:** Disabled **1:** Enabled
[5:5]	Z IIR Filter Enable [0:0]	Enables or disables the Z IIR filter when Charger Armor is active Default: 0x1 **0:** Disabled **1:** Enabled
[4:4]	Z Jitter Filter Enable [0:0]	Enables or disables the Z jitter filter when Charger Armor is active Default: 0x1 **0:** Disabled **1:** Enabled
[3:0]	Reserved [3:0]	Default: 0x0 Range:

11.0.282 ILEAK_MAX

[TTHE Group] Register Name : Address

[MFG] ILEAK_MAX : CYTT21X/31X (40, 44, 48 IOs) - 0x006E, CYTMA445A - 0x006A, CYTT21X (28, 33, 35, 36 IOs) - 0x006E

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x05							
Bit Name	Current[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x14							
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 24000 nA. Default: 0x514 Range: 0:24000

11.0.283 STYL_THRESH_MUTUAL_ON

[TTHE Group] Register Name : Address

[Stylus Tracking] STYL_THRESH_MUTUAL_ON : CYTT21X/31X (40, 44, 48 IOs) - 0x043C

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x00							
Bit Name	Threshold On[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x37							
Bit Name	Threshold On[7:0]							

Mutual Cap sensor data On threshold to identify an new Stylus touch.

Bits	Name	Description
[15:0]	Threshold On [15:0]	Mutual Cap sensor data On threshold to identify an new Stylus touch. Default: 0x37 Range: 0:32767

11.0.284 CA_HOP0_TX_PERIOD_MUTUAL

[TTHE Group] Register Name : Address

[Charger Armor] CA_HOP0_TX_PERIOD_MUTUAL : CYTT21X/31X (40, 44, 48 IOs) - 0x007A, CYTMA445A - 0x0080, CYTT21X (28, 33, 35, 36 IOs) - 0x0076

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x00							
Bit Name	TX Period[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x30							
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). Default: 0x30 Range: 48:510

11.0.285 XY_FILT_IIR_COEFF_CA

[TTHE Group] Register Name : Address

[Charger Armor] XY_FILT_IIR_COEFF_CA : CYTT21X/31X (40, 44, 48 IOs) - 0x0468, CYTMA445A - 0x03EC, CYTT21X (28, 33, 35, 36 IOs) - 0x0478

Bits	31	30	29	28	27	26	25	24
Access:POR	RW: 0x00							
Bit Name	Reserved[31:24]							

Bits	23	22	21	20	19	18	17	16
Access:POR	RW: 0x00							
Bit Name	Reserved[23:16]							

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x00							
Bit Name	Reserved[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x00					RW: 0x2		
Bit Name	Reserved[7:3]					IIR Filter Input Weight[2:0]		

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
[31:3]	Reserved [28:0]	Default: 0x0 Range:
[2:0]	IIR Filter Input Weight [2:0]	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. Default: 0x2 **1:** One Half - Filter output = 0.5 * Filter Input + 0.5 * Previous Filter Output **2:** One Quarter - Filter output = 0.25 * Filter Input + 0.75 * Previous Filter Output **3:** One Eighth - Filter output = 0.125 * Filter Input + 0.875 * Previous Filter Output **4:** One Sixteenth - Filter output = 0.0625 * Filter Input + 0.9375 * Previous Filter Output

11.0.286 CENTER_SIGNAL_TO_MIN_PEAK_RATIO

[TTHE Group] Register Name : Address

[Finger Tracking] CENTER_SIGNAL_TO_MIN_PEAK_RATIO : CYTT21X/31X (40, 44, 48 IOs) - 0x03C0, CYTMA445A - 0x0348, CYTT21X (28, 33, 35, 36 IOs) - 0x03D4

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x30							
Bit Name	Threshold[7:0]							

Ratio of central signal to min peak signal in the touch zone (centSig/minPkSig*64). Touch zones with 2 or more peaks but whose ratio is less than this parameter will be identified as multi-finger; default value: 48.

Bits	Name	Description
[7:0]	Threshold [7:0]	Ratio of central signal to min peak signal in the touch zone (centSig/minPkSig*64). Touch zones with 2 or more peaks but whose ratio is less than this parameter will be identified as multi-finger; default value: 48. Default: 0x30 Range: 0:63

11.0.287 GLOVE_BTN_MODE_SWITCH_DEBOUNCE

[TTHE Group] Register Name : Address

[Glove] GLOVE_BTN_MODE_SWITCH_DEBOUNCE : CYTT21X/31X (40, 44, 48 IOs) - 0x041E, CYTMA445A - 0x03BA, CYTT21X (28, 33, 35, 36 IOs) - 0x0446

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x00							
Bit Name	Debounce[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x01							
Bit Name	Debounce[7:0]							

Number of consecutive refresh cycles for mode switch from finger mode to glove mode.

Bits	Name	Description
[15:0]	Debounce [15:0]	Number of consecutive refresh cycles for mode switch from finger mode to glove mode Default: 0x1 Range: 0:255

11.0.288 XY_FILT_TOUCH_SIZE_HYST

[TTHE Group] Register Name : Address

[Scan Filtering] XY_FILT_TOUCH_SIZE_HYST : CYTT21X/31X (40, 44, 48 IOs) - 0x0486, CYTMA445A - 0x03FA, CYTT21X (28, 33, 35, 36 IOs) - 0x0486

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x0							
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. Default: 0x0 Range: 0:255

11.0.289 TX_PERIOD_GLOVE_MUTUAL

[TTHE Group] Register Name : Address

[CDC] TX_PERIOD_GLOVE_MUTUAL : CYTMA445A - 0x00A4

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x00							
Bit Name	txPeriodGlove[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x3d							
Bit Name	txPeriodGlove[7:0]							

Integration Time

Bits	Name	Description
[15:0]	txPeriodGlove [15:0]	Number of system clocks in each TX half period for Mutual Cap Glove scan Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0x3d Range: 18:510

11.0.290 FILT_CMF_THRESHOLD_GLOVE_BUT_SELF

[TTHE Group] Register Name : Address

[Raw Processing] FILT_CMF_THRESHOLD_GLOVE_BUT_SELF : CYTT21X/31X (40, 44, 48 IOs) - 0x02EC, CYTMA445A - 0x029C, CYTT21X (28, 33, 35, 36 IOs) - 0x0304

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x00							
Bit Name	Value[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x3c							
Bit Name	Value[7:0]							

CMF Threshold for Glove Button Self

Bits	Name	Description
[15:0]	Value [15:0]	CMF Threshold for Glove Button Self Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0x3c Range: 0:32767

11.0.291 GRIP_YEDG_A

[TTHE Group] Register Name : Address

[Finger Tracking] GRIP_YEDG_A : CYTT21X/31X (40, 44, 48 IOs) - 0x0348, CYTMA445A - 0x02E4, CYTT21X (28, 33, 35, 36 IOs) - 0x0364

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x0		RW: 0x00					
Bit Name	Reserved[15:14]		Width[13:8]					

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x00							
Bit Name	Width[7:0]							

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

Bits	Name	Description
[15:14]	Reserved [1:0]	Default: 0x0 Range:
[13:0]	Width [13:0]	Grip Suppression: Y edge width (in pixels), side A Default: 0x0 Range: 0:16383

11.0.292 GRIP_YEDG_B

[TTHE Group] Register Name : Address

[Finger Tracking] GRIP_YEDG_B : CYTT21X/31X (40, 44, 48 IOs) - 0x034A, CYTMA445A - 0x02E6, CYTT21X (28, 33, 35, 36 IOs) - 0x0366

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x0		RW: 0x00					
Bit Name	Reserved[15:14]		Width[13:8]					

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x00							
Bit Name	Width[7:0]							

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

Bits	Name	Description
[15:14]	Reserved [1:0]	Default: 0x0 Range:
[13:0]	Width [13:0]	Grip Suppression: Y edge width (in pixels), side B Default: 0x0 Range: 0:16383

11.0.293 FINGER_THRESH_SELF

[TTHE Group] Register Name : Address

[Finger Tracking] FINGER_THRESH_SELF : CYTT21X/31X (40, 44, 48 IOs) - 0x0326, CYTMA445A - 0x02C6, CYTT21X (28, 33, 35, 36 IOs) - 0x033E

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x00							
Bit Name	Threshold[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x1e							
Bit Name	Threshold[7:0]							

Self Capacitance Finger Threshold

Bits	Name	Description
[15:0]	Threshold [15:0]	Sensor data threshold for Self Cap scan to identify a finger touch. Note that this signal threshold is compared with signal sum H2O_REJECTION_SNS_WIDTH sensors. Default: 0x1e Range: 0:32767

11.0.294 FILT_IIR_COEFF_GLOVE_MUT

[TTHE Group] Register Name : Address

[Raw Processing] FILT_IIR_COEFF_GLOVE_MUT : CYTT21X/31X (40, 44, 48 IOs) - 0x02D7, CYTMA445A - 0x0287, CYTT21X (28, 33, 35, 36 IOs) - 0x02EF

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x0					RW: 0x1		
Bit Name	Reserved[7:3]					IIR Filter Input Weight[2:0]		

IIR Coefficient for Glove Mutual

Bits	Name	Description
[7:3]	Reserved [4:0]	Default: 0x0 Range:
[2:0]	IIR Filter Input Weight [2:0]	Raw IIR filter coefficient for Mutual Cap scan Default: 0x1 **0:** One Half - Filter output = 0.5 * Filter Input + 0.5 * Previous Filter Output **1:** One Quarter - Filter output = 0.25 * Filter Input + 0.75 * Previous Filter Output **2:** One Eighth - Filter output = 0.125 * Filter Input + 0.875 * Previous Filter Output **3:** One Sixteenth - Filter output = 0.0625 * Filter Input + 0.9375 * Previous Filter Output **4:** One Thirty-second - Filter output = 0.03125 * Filter Input + 0.96875 * Previous Filter Output

11.0.295 CA_HOP4_TX_PERIOD_MUTUAL

[TTHE Group] Register Name : Address

[Charger Armor] CA_HOP4_TX_PERIOD_MUTUAL : CYTT21X/31X (40, 44, 48 IOs) - 0x0082, CYTMA445A - 0x0090, CYTT21X (28, 33, 35, 36 IOs) - 0x007E

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x00							
Bit Name	TX Period[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x4b							
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). Default: 0x4b Range: 48:510

11.0.296 MTX_ORDER

[TTHE Group] Register Name : Address

[CDC] MTX_ORDER : CYTT21X/31X (40, 44, 48 IOs) - 0x0054, CYTMA445A - 0x0050, CYTT21X (28, 33, 35, 36 IOs) - 0x0054

Bits	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
Access:POR	RW: 0x1							
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). Default: 0x1 Range: 1:8

11.0.297 OPENS_TEST_IDAC_BUTTON

[TTHE Group] Register Name : Address

[MFG] OPENS_TEST_IDAC_BUTTON : CYTMA445A - 0x0072

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x7f							
Bit Name	Open test idac value for button[7:0]							

open test idac value for button.

Bits	Name	Description
[7:0]	Open test idac value for button [7:0]	open test idac value for button. Default: 0x7f Range: 0:255

11.0.298 TX_FREQ_METHOD_SELF

[TTHE Group] Register Name : Address

[CDC] TX_FREQ_METHOD_SELF : CYTT21X/31X (40, 44, 48 IOs) - 0x0057, CYTMA445A - 0x0053, CYTT21X (28, 33, 35, 36 IOs) - 0x0057

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x0						RW: 0x2	
Bit Name	Reserved[7:2]						Tx Frequency Change Method for Self Scan[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: 0x0 Range:
[1:0]	Tx Frequency Change Method for Self Scan [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: 0x2 **0:** Maximizing Integration Time - Maximize integration time for the current TX period. Integration time equals to the current TX period minus the reset time as defined in parameter INTEGRATOR_RESET_x **2:** Limited Integration Time - Integration time is limited to two-third of the current TX period. The reset time defined in INTEGRATOR_RESET_x is ignored.

11.0.299 GLOVE_THRSH_SELF

[TTHE Group] Register Name : Address

[Glove] GLOVE_THRSH_SELF : CYTT21X/31X (40, 44, 48 IOs) - 0x0328, CYTMA445A - 0x02C8, CYTT21X (28, 33, 35, 36 IOs) - 0x0340

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x00							
Bit Name	Threshold[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x28							
Bit Name	Threshold[7:0]							

SSelf Capacitance Glove Threshold

Bits	Name	Description
[15:0]	Threshold [15:0]	Self Cap sensor data On threshold to identify an existing glove touch. Note that this signal threshold is compared with signal sum H2O_REJECTION_SNS_WIDTH sensors. Default: 0x28 Range: 0:32767

11.0.300 MAX_NUM_OF_SUPPORTED_TOUCHES

[TTHE Group] Register Name : Address

[Device Setup] MAX_NUM_OF_SUPPORTED_TOUCHES : CYTT21X/31X (40, 44, 48 IOs) - 0x001C, CYTMA445A - 0x001A, CYTT21X (28, 33, 35, 36 IOs) - 0x001C

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0xa							
Bit Name	Maximum number of supported touches[7:0]							

Maximum number of supported touches.

Bits	Name	Description
[7:0]	Maximum number of supported touches [7:0]	Maximum number of supported touches. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0xa Range: 0:10

11.0.301 BTN_HS_OFF_THRSH_MUT_1

[TTHE Group] Register Name : Address

[CapSense Buttons] BTN_HS_OFF_THRSH_MUT_1 : CYTT21X/31X (40, 44, 48 IOs) - 0x0405, CYTMA445A - 0x03A1, CYTT21X (28, 33, 35, 36 IOs) - 0x042D

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

CapSense Button Mutual Cap HighSensitive scan Off threshold for button 1

Bits	Name	Description
[7:0]	On Threshold [7:0]	CapSense Button Mutual Cap HighSensitive scan Off threshold for button 1 Default: 0xa Range: 5:255

11.0.302 XY_FILT_Z_IIR_COEFF

[TTHE Group] Register Name : Address

[Scan Filtering] XY_FILT_Z_IIR_COEFF : CYTT21X/31X (40, 44, 48 IOs) - 0x045C, CYTMA445A - 0x03E0, CYTT21X (28, 33, 35, 36 IOs) - 0x046C

Bits	31	30	29	28	27	26	25	24
Access:POR	RW: 0x00							
Bit Name	Reserved[31:24]							

Bits	23	22	21	20	19	18	17	16
Access:POR	RW: 0x00							
Bit Name	Reserved[23:16]							

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x00							
Bit Name	Reserved[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x00						RW: 0x1	
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]	Default: 0x0 Range:
[1:0]	IIR Filter Input Weight [1:0]	Weighting of the input Z value in the IIR filter when Charger Armor is not active. Default: 0x1 **1:** One Half - Filter output = 0.5 * Filter Input + 0.5 * Previous Filter Output **2:** One Quarter - Filter output = 0.25 * Filter Input + 0.75 * Previous Filter Output

11.0.303 GLOVE_BTN_FORBID_DEBOUNCE

[TTHE Group] Register Name : Address

[Glove] GLOVE_BTN_FORBID_DEBOUNCE : CYTT21X/31X (40, 44, 48 IOs) - 0x0414, CYTMA445A - 0x03B0, CYTT21X (28, 33, 35, 36 IOs) - 0x043C

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x00							
Bit Name	Debounce[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x0a							
Bit Name	Debounce[7:0]							

Number of consecutive refresh cycles after all regular touch liftoff for which a glove touch is not detectable

Bits	Name	Description
[15:0]	Debounce [15:0]	Number of consecutive refresh cycles after all regular touch liftoff for which a glove touch is not detectable Default: 0xa Range: 0:255

11.0.304 CA_MIN_FAT_FINGER_SIZE

[TTHE Group] Register Name : Address

[Charger Armor] CA_MIN_FAT_FINGER_SIZE : CYTT21X/31X (40, 44, 48 IOs) - 0x03DE, CYTMA445A - 0x0378, CYTT21X (28, 33, 35, 36 IOs) - 0x0406

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0xf							
Bit Name	Min Fat Finger Size On when Charger Armor is active[7:0]							

Minimum number of contiguous activated panel intersections that define a fat finger when Charger Armor is active. It is used when a fat finger was not detected yet.

Bits	Name	Description
[7:0]	Min Fat Finger Size On when Charger Armor is active [7:0]	Minimum number of contiguous activated panel intersections that define a fat finger when Charger Armor is active. It is used when a fat finger was not detected yet. Default: 0xf Range: 0:255

11.0.305 Y_LEN_PHY

[TTHE Group] Register Name : Address

[Device Setup] Y_LEN_PHY : CYTT21X/31X (40, 44, 48 IOs) - 0x000A, CYTMA445A - 0x000A, CYTT21X (28, 33, 35, 36 IOs) - 0x000A

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x19							
Bit Name	Length[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x48							
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) Default: 0x19c8 Range: 0:65535

11.0.306 Y_RESOLUTION

[TTHE Group] Register Name : Address

[Device Setup] Y_RESOLUTION : CYTT21X/31X (40, 44, 48 IOs) - 0x0006, CYTMA445A - 0x0006, CYTT21X (28, 33, 35, 36 IOs) - 0x0006

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x08							
Bit Name	Length[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x34							
Bit Name	Length[7:0]							

Y (vertical) Axis Length (in pixels)

Bits	Name	Description
[15:0]	Length [15:0]	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). Default: 0x834 Range: 0:32767

11.0.307 VDDA_LEVEL

[TTHE Group] Register Name : Address

[MFG] VDDA_LEVEL : CYTT21X/31X (40, 44, 48 IOs) - 0x0070, CYTT21X (28, 33, 35, 36 IOs) - 0x0070

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x0a							
Bit Name	Voltage[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x70							
Bit Name	Voltage[7:0]							

VDDA level in unit of mV.

Bits	Name	Description
[15:0]	Voltage [15:0]	VDDA power supply voltage in unit of mV.This value will be used in CM test if power mode is configured as bypass mode. Default: 0xaf0 Range: 2000:5500

11.0.308 GRIP_ENABLE

[TTHE Group] Register Name : Address

[Finger Tracking] GRIP_ENABLE : CYTT21X/31X (40, 44, 48 IOs) - 0x0352, CYTMA445A - 0x02EE, CYTT21X (28, 33, 35, 36 IOs) - 0x036E

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x0							RW: 0x0
Bit Name	Reserved[7:1]							Grip Enable[0:0]

Grip suppression enabled or disabled

Bits	Name	Description
[7:1]	Reserved [6:0]	Default: 0x0 Range:
[0:0]	Grip Enable [0:0]	Enables or disables grip suppression Default: 0x0 **0:** Disabled **1:** Enabled

11.0.309 INNER_EDGE_GAIN

[TTHE Group] Register Name : Address

[Device Setup] INNER_EDGE_GAIN : CYTT21X/31X (40, 44, 48 IOs) - 0x031D, CYTMA445A - 0x02BD, CYTT21X (28, 33, 35, 36 IOs) - 0x0335

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x8							
Bit Name	innerEdgeGain[7:0]							

Gain for Edge Correction (Inner Virtual Sensor)

Bits	Name	Description
[7:0]	innerEdgeGain [7:0]	Inner Virtual Sensor Gain (in 1/128 increments) for panel edge finger touch correction Default: 0x8 Range: 0:255

11.0.310 AFH_LISTEN_SCAN_CYCLE_REPEATS

[TTHE Group] Register Name : Address

[Charger Armor] AFH_LISTEN_SCAN_CYCLE_REPEATS : CYTT21X/31X (40, 44, 48 IOs) - 0x0302, CYTMA445A - 0x02A6, CYTT21X (28, 33, 35, 36 IOs) - 0x031A

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x6							
Bit Name	Value[7:0]							

Number of times the adaptive frequency hopping logic loops through the available TX frequencies before blocking all touch reports (excessive noise).

Bits	Name	Description
[7:0]	Value [7:0]	Number of times the adaptive frequency hopping logic loops through the available TX frequencies before blocking all touch reports (excessive noise). Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0x6 Range: 0:12

11.0.311 GRIP_XEDG_B

[TTHE Group] Register Name : Address

[Finger Tracking] GRIP_XEDG_B : CYTT21X/31X (40, 44, 48 IOs) - 0x0342, CYTMA445A - 0x02DE, CYTT21X (28, 33, 35, 36 IOs) - 0x035E

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x0		RW: 0x00					
Bit Name	Reserved[15:14]		Width[13:8]					

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x00							
Bit Name	Width[7:0]							

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

Bits	Name	Description
[15:14]	Reserved [1:0]	Default: 0x0 Range:
[13:0]	Width [13:0]	Grip Suppression: X edge width (in pixels), side B Default: 0x0 Range: 0:16383

11.0.312 GRIP_XEDG_A

[TTHE Group] Register Name : Address

[Finger Tracking] GRIP_XEDG_A : CYTT21X/31X (40, 44, 48 IOs) - 0x0340, CYTMA445A - 0x02DC, CYTT21X (28, 33, 35, 36 IOs) - 0x035C

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x0		RW: 0x00					
Bit Name	Reserved[15:14]		Width[13:8]					

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x00							
Bit Name	Width[7:0]							

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

Bits	Name	Description
[15:14]	Reserved [1:0]	Default: 0x0 Range:
[13:0]	Width [13:0]	Grip Suppression: X edge width (in pixels), side A Default: 0x0 Range: 0:16383

11.0.313 TX_CTRL

[TTHE Group] Register Name : Address

[CDC] TX_CTRL : CYTT21X/31X (40, 44, 48 IOs) - 0x0034, CYTMA445A - 0x0030, CYTT21X (28, 33, 35, 36 IOs) - 0x0034

Bits	31	30	29	28	27	26	25	24
Access:PORRW: 0x0	RW: 0x0		RW: 0x0	RW: 0x0				
Bit NameRe-served[27:27]	Reserved[31:30]		Re-served[29:29]	Reserved[28:24]				

Bits	23	22	21	20	19	18	17	16
Access:POR	RW: 0xf				RW: 0xf			
Bit Name	DRV_STRONG[23:20]				DRV_WEAK[19:16]			

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x0	RW: 0x0		RW: 0x00				
Bit Name	Re-served[10:10]	SHIELD_RES_SEL[9:8]		Reserved[15:10]				

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x0							
Bit Name	Reserved[7:0]							

Selects the resistor size in the TX Shield Driver for stability (applicable when SHIELD_EN is '1')

Bits	Name	Description
[31:30]	Reserved [1:0]	Reserved Default: 0x0 Range:
[29:29]	Reserved [0:0]	Reserved Default: 0x0 Range:
[28:24]	Reserved [4:0]	Reserved Default: 0x0 Range:
[27:27]	Reserved [0:0]	Reserved Default: 0x0 Range:
[23:20]	DRV_STRONG [3:0]	Strong drive strength control for TX block. Default: 0xf Range: 0:15
[19:16]	DRV_WEAK [3:0]	Weak drive strength control for TX block. Default: 0xf Range: 0:15
[10:10]	Reserved [0:0]	Reserved Default: 0x0 Range:
[9:8]	SHIELD_RES_SEL [1:0]	Selects the resistor size in the TX Shield Driver for stability (applicable when SHIELD_EN is '1'): "0": 4k Ohms "1": 8k Ohms "2": 16k Ohms "3": 2k Ohms Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0x0 **0:** 4 kOhm **1:** 8 kOhm **2:** 16 kOhm **3:** 2 kOhm

[7:0]	Reserved [7:0]	Reserved Default: 0x0 Range:

11.0.314 BTN_LS_TOUCHDOWN_DEBOUNCE

[TTHE Group] Register Name : Address

[CapSense Buttons] BTN_LS_TOUCHDOWN_DEBOUNCE : CYTT21X/31X (40, 44, 48 IOs) - 0x03FC, CYTMA445A - 0x0398, CYTT21X (28, 33, 35, 36 IOs) - 0x0424

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x00							
Bit Name	Debounce[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x00							
Bit Name	Debounce[7:0]							

Number of consecutive refresh cycles for which button event must be detected prior to being reported.

Bits	Name	Description
[15:0]	Debounce [15:0]	Number of consecutive refresh cycles for which button event must be detected prior to being reported. Default: 0x0 Range: 0:255

11.0.315 VDDA_MODE

[TTHE Group] Register Name : Address

[CDC] VDDA_MODE : CYTT21X/31X (40, 44, 48 IOs) - 0x0052, CYTMA445A - 0x004E, CYTT21X (28, 33, 35, 36 IOs) - 0x0052

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x0							RW: 0x0
Bit Name	Reserved[7:1]							Vdda Mode[0:0]

Pump Mode for use TX pump signal, Bypass Mode for VDDA Enabled)

Bits	Name	Description
[7:1]	Reserved [6:0]	Reserved Default: 0x0 Range:
[0:0]	Vdda Mode [0:0]	Pump Mode for use TX pump signal, Bypass Mode for VDDA Enabled) Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0x0 **0:** Pump Mode - disabled (use TX pump signal) **1:** Bypass Mode - enabled (use Vdda. Bypass mode)

11.0.316 WF_ENTER_DEBOUNCE

[TTHE Group] Register Name : Address

[Wet Finger] WF_ENTER_DEBOUNCE : CYTT21X/31X (40, 44, 48 IOs) - 0x02A6, CYTT21X (28, 33, 35, 36 IOs) - 0x02BE

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

This is the debounce to enter water mode from none-water mode. Water mode enters after water is detected for a number of frames (specified by this value)

Bits	Name	Description
[7:0]	Value [7:0]	This is the debounce to enter water mode from none-water mode. Water mode enters after water is detected for a number of frames (specified by this value) Default: 0xa Range: 0:255

11.0.317 FAST_BL_SS

[TTHE Group] Register Name : Address

[Proximity] FAST_BL_SS : CYTMA445A - 0x0225, CYTT21X (28, 33, 35, 36 IOs) - 0x0285

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x2							
Bit Name	fastBaseliningSpeedShifter[7:0]							

IIR filter coefficient for Tx sensor and outer Rx sensor baseline

Bits	Name	Description
[7:0]	fastBaseliningSpeedShift-er [7:0]	IIR filter coefficient for Tx sensor and outer Rx sensor baseline. Default: 0x2 **0:** OFF - Filter output = Filter Input **1:** 1/2 - Filter output = 1/2 * Filter Input + 1/2 * Previous Filter Output **2:** 1/4 - Filter output = 1/4 * Filter Input + 3/4 * Previous Filter Output **3:** 1/8 - Filter output = 1/8 * Filter Input + 7/8 * Previous Filter Output **4:** 1/16 - Filter output = 1/16 * Filter Input + 15/16 * Previous Filter Output **5:** 1/32 - Filter output = 1/32 * Filter Input + 31/32 * Previous Filter Output **6:** 1/64 - Filter output = 1/64 * Filter Input + 63/64 * Previous Filter Output **7:** 1/128 - Filter output = 1/128 * Filter Input + 127/128 * Previous Filter Output **8:** 1/256 - Filter output = 1/256 * Filter Input + 255/256 * Previous Filter Output

11.0.318 CMF_THR_BTN_SELF

[TTHE Group] Register Name : Address

[Raw Processing] CMF_THR_BTN_SELF : CYTT21X/31X (40, 44, 48 IOs) - 0x02C2, CYTMA445A - 0x0272, CYTT21X (28, 33, 35, 36 IOs) - 0x02DA

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x00							
Bit Name	Value[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x3c							
Bit Name	Value[7:0]							

CMF Threshold for Base Button Self

Bits	Name	Description
[15:0]	Value [15:0]	CMF Threshold for Base Button Self Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0x3c Range: 0:32767

11.0.319 SELF_LIFTOFF_TIMEOUT

[TTHE Group] Register Name : Address

[Raw Processing] SELF_LIFTOFF_TIMEOUT : CYTT21X/31X (40, 44, 48 IOs) - 0x0282, CYTT21X (28, 33, 35, 36 IOs) - 0x027E

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x13							
Bit Name	Value[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x08							
Bit Name	Value[7:0]							

The timer in ms that detect finger lift-off after device reset. If this timer timeout, the mutual baseline will NOT be reset even lift-off detected

Bits	Name	Description
[15:0]	Value [15:0]	The timer in ms that detect finger lift-off after device reset. If this timer timeout, the mutual baseline will NOT be reset even lift-off detected. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0x1388 Range: 0:65535

11.0.320 XY_FILT_PREDICTION_COEF

[TTHE Group] Register Name : Address

[Scan Filtering] XY_FILT_PREDICTION_COEF : CYTT21X/31X (40, 44, 48 IOs) - 0x0463, CYTT21X (28, 33, 35, 36 IOs) - 0x0473

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x0							
Bit Name	Coefficient[7:0]							

Weight of the predicted position that is based on the velocity when Charger Armor is NOT active.

Bits	Name	Description
[7:0]	Coefficient [7:0]	Weight of the predicted position that is based on the velocity when Charger Armor is NOT active. Default: 0x0 Range: 0:128

11.0.321 STYL_THRESH_MUTUAL_OFF

[TTHE Group] Register Name : Address

[Stylus Tracking] STYL_THRESH_MUTUAL_OFF : CYTT21X/31X (40, 44, 48 IOs) - 0x043E

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x00							
Bit Name	Threshold Off[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x2d							
Bit Name	Threshold Off[7:0]							

Mutual Cap sensor data On threshold to identify an existing Stylus touch.

Bits	Name	Description
[15:0]	Threshold Off [15:0]	Mutual Cap sensor data On threshold to identify an existing Stylus touch. Default: 0x2d Range: 0:32767

11.0.322 RATIO_SUMALL_TO_POSITIVE

[TTHE Group] Register Name : Address

[Raw Processing] RATIO_SUMALL_TO_POSITIVE : CYTT21X/31X (40, 44, 48 IOs) - 0x0276, CYTMA445A - 0x0219, CYTT21X (28, 33, 35, 36 IOs) - 0x0272

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x7							
Bit Name	Value[7:0]							

Threshold to reset self/mutual signals for H2O rejection enabled/disabled to baseline signals from large amount of water, large ungrounded object on the panel or signals after wiping water. Condition to reset is (sumMutSig/sumMutSigPositive < ratioSumAllToSumPositive/8).

Bits	Name	Description
[7:0]	Value [7:0]	Threshold to reset self/mutual signals for H2O rejection enabled/disabled to baseline signals from large amount of water, large ungrounded object on the panel or signals after wiping water. Condition to reset is (sumMutSig/sumMutSigPositive < ratioSumAllToSumPositive/8). Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0x7 Range: 0:255

11.0.323 SENSOR_NUM_THRSH

[TTHE Group] Register Name : Address

[Proximity] SENSOR_NUM_THRSH : CYTMA445A - 0x0363, CYTT21X (28, 33, 35, 36 IOs) - 0x03EF

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x8							
Bit Name	sensorNumThreshold[7:0]							

Number of active sensors threshold to discriminate between finger and proximity cases, if there are more sensors than this value that have higher values than ACTIVE_SENSOR_THRESHOLD, the object is decided as proximity, otherwise finger.

Bits	Name	Description
[7:0]	sensorNumThreshold [7:0]	Number of active sensors threshold to discriminate between finger and proximity cases, if there are more sensors than this value that have higher values than ACTIVE_SENSOR_THRESHOLD, the object is decided as proximity, otherwise finger. Default: 0x8 Range: 0:255

11.0.324 GLOVE_MIN_FAT_FINGER_HYST

[TTHE Group] Register Name : Address

[Glove] GLOVE_MIN_FAT_FINGER_HYST : CYTT21X/31X (40, 44, 48 IOs) - 0x0437, CYTMA445A - 0x03D1, CYTT21X (28, 33, 35, 36 IOs) - 0x045F

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x0							
Bit Name	Hysteresis[7:0]							

Hysteresis applied to minimum fat-finger size when a fat finger is detected in glove mode.

Bits	Name	Description
[7:0]	Hysteresis [7:0]	Hysteresis applied to minimum fat-finger size when a fat finger is detected in glove mode. Default: 0x0 Range: 0:255

11.0.325 STYL_XY_FILT_PREDICTION_COEF

[TTHE Group] Register Name : Address

[Stylus Tracking] STYL_XY_FILT_PREDICTION_COEF : CYTT21X/31X (40, 44, 48 IOs) - 0x0483

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x0							
Bit Name	Coefficient[7:0]							

Weight of the predicted position that is based on the velocity when Stylus Tracking is active.

Bits	Name	Description
[7:0]	Coefficient [7:0]	Weight of the predicted position that is based on the velocity when Stylus Tracking is active. Default: 0x0 Range: 0:128

11.0.326 OPMODE_CFG

[TTHE Group] Register Name : Address

[Device Setup] OPMODE_CFG : CYTT21X/31X (40, 44, 48 IOs) - 0x001E, CYTMA445A - 0x001C, CYTT21X (28, 33, 35, 36 IOs) - 0x001E

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x0		RW: 0x0	RW: 0x1		RW: 0x0	RW: 0x0	
Bit Name	Reserved[7:6]		Deep Sleep Wakeup Trigger[5:5]	Large Object Interrupt[4:3]		Noise metrics output enable[2:2]	Reserved[1:0]	

Operating mode configuration

Bits	Name	Description
[7:6]	Reserved [1:0]	Default: 0x0 Range:
[5:5]	Deep Sleep Wakeup Trigger [0:0]	Specifies the trigger source for a wakeup from deep sleep. Note: this parameter is only applicable to TMA44x devices. Default: 0x0 **0:** Interrupt Pin Only - Host assertion of the interrupt pin triggers a wakeup **1:** Interrupt Pin or Communication - Host assertion of the interrupt pin or initiation of a communication transaction (I2C: slave address match; SPI: assertion of nSS) triggers a wakeup
[4:3]	Large Object Interrupt [1:0]	Configures large object interrupt. Disabled: Large object presence/non-presence do not generate interrupt events; Change: Generate interrupt events on initial detection of a large object and on removal of the large object; Detection and Removal: Generate interrupt events on every refresh interval in which a large object is detected; and also generate an interrupt event on the removal of the large object. Default: 0x1 **0:** Disabled - Do not use large object presence/non-presence to generate interrupt events **1:** Change - Generate interrupt events on initial detection of a large object and on removal of the large object. **3:** Detection and Removal - Generate interrupt events on every refresh interval in which a large object is detected. Generate an interrupt event on the removal of the large object.
[2:2]	Noise metrics output enable [0:0]	Noise metrics output enable Default: 0x0 **0:** Disabled **1:** Enabled
[1:0]	Reserved [1:0]	Default: 0x0 Range:

11.0.327 GRIP_XEXC_B

[TTHE Group] Register Name : Address

[Finger Tracking] GRIP_XEXC_B : CYTT21X/31X (40, 44, 48 IOs) - 0x0346, CYTMA445A - 0x02E2, CYTT21X (28, 33, 35, 36 IOs) - 0x0362

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x0		RW: 0x00					
Bit Name	Reserved[15:14]		Width[13:8]					

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x00							
Bit Name	Width[7:0]							

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

Bits	Name	Description
[15:14]	Reserved [1:0]	Default: 0x0 Range:
[13:0]	Width [13:0]	Grip Suppression: X exception area width (in pixels), side B Default: 0x0 Range: 0:16383

11.0.328 GRIP_XEXC_A

[TTHE Group] Register Name : Address

[Finger Tracking] GRIP_XEXC_A : CYTT21X/31X (40, 44, 48 IOs) - 0x0344, CYTMA445A - 0x02E0, CYTT21X (28, 33, 35, 36 IOs) - 0x0360

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x0		RW: 0x00					
Bit Name	Reserved[15:14]		Width[13:8]					

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x00							
Bit Name	Width[7:0]							

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

Bits	Name	Description
[15:14]	Reserved [1:0]	Default: 0x0 Range:
[13:0]	Width [13:0]	Grip Suppression: X exception area width (in pixels), side A Default: 0x0 Range: 0:16383

11.0.329 PWC_LIMIT_PERCENT_SELF

[TTHE Group] Register Name : Address

[Calibration] PWC_LIMIT_PERCENT_SELF : CYTT21X/31X (40, 44, 48 IOs) - 0x0075

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x32							
Bit Name	pwcLimitPercentSelf[7:0]							

PWC limit in percents of period for SelfCap mode

Bits	Name	Description
[7:0]	pwcLimitPercentSelf [7:0]	PWC limit in percents of period for SelfCap mode Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0x32 Range: 5:100

11.0.330 STYL_XY_FILT_IIR_COEF

[TTHE Group] Register Name : Address

[Stylus Tracking] STYL_XY_FILT_IIR_COEF : CYTT21X/31X (40, 44, 48 IOs) - 0x0478

Bits	31	30	29	28	27	26	25	24
Access:POR	RW: 0x00							
Bit Name	Reserved[31:24]							

Bits	23	22	21	20	19	18	17	16
Access:POR	RW: 0x00							
Bit Name	Reserved[23:16]							

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x00							
Bit Name	Reserved[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x00					RW: 0x2		
Bit Name	Reserved[7:3]					IIR Filter Input Weight[2:0]		

Weighting of the input X and Y values in the IIR filter for displacements less than STYL_XY_FILT_XY_SLOW_THR when Stylus is active.

Bits	Name	Description
[31:3]	Reserved [28:0]	Default: 0x0 Range:
[2:0]	IIR Filter Input Weight [2:0]	Weighting of the input X and Y values in the IIR filter for displacements less than STYL_XY_FILT_XY_SLOW_THR when Stylus is active. Default: 0x2 **1:** One Half - Filter output = 0.5 * Filter Input + 0.5 * Previous Filter Output **2:** One Quarter - Filter output = 0.25 * Filter Input + 0.75 * Previous Filter Output **3:** One Eighth - Filter output = 0.125 * Filter Input + 0.875 * Previous Filter Output **4:** One Sixteenth - Filter output = 0.0625 * Filter Input + 0.9375 * Previous Filter Output

11.0.331 FILT_IIR_THRESHOLD_BUT_BASE_SELF

[TTHE Group] Register Name : Address

[Raw Processing] FILT_IIR_THRESHOLD_BUT_BASE_SELF : CYTT21X/31X (40, 44, 48 IOs) - 0x02C0, CYTMA445A - 0x0270, CYTT21X (28, 33, 35, 36 IOs) - 0x02D8

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x00							
Bit Name	Value[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x14							
Bit Name	Value[7:0]							

IIR Threshold for Base Button Self

Bits	Name	Description
[15:0]	Value [15:0]	IIR Threshold for Base Button Self Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0x14 Range: 0:32767

11.0.332 SCALING_FACTOR_BUTTON_MUTUAL

[TTHE Group] Register Name : Address

[CDC] SCALING_FACTOR_BUTTON_MUTUAL : CYTT21X/31X (40, 44, 48 IOs) - 0x004A, CYTMA445A - 0x0046, CYTT21X (28, 33, 35, 36 IOs) - 0x004A

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x00							
Bit Name	Scale Factor[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x48							
Bit Name	Scale Factor[7:0]							

CapSense Button Mutual Raw Data Scaling Factor

Bits	Name	Description
[15:0]	Scale Factor [15:0]	Percentage scaling factor for CapSense Buttons Mutual Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0xc8 Range: 0:1000

11.0.333 STYL_PALM_THRESH_MUTUAL

[TTHE Group] Register Name : Address

[Stylus Tracking] STYL_PALM_THRESH_MUTUAL : CYTT21X/31X (40, 44, 48 IOs) - 0x0444

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x01							
Bit Name	Threshold[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x2c							
Bit Name	Threshold[7:0]							

Palm threshold for Mutual Scan.

Bits	Name	Description
[15:0]	Threshold [15:0]	Mutual Cap palm rejection threshold. All sensors with diff count above this threshold are rejected. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0x12c Range: 0:5000

11.0.334 CA_HOST_CONTROLLED_CHARGER

[TTHE Group] Register Name : Address

[Charger Armor] CA_HOST_CONTROLLED_CHARGER : CYTT21X/31X (40, 44, 48 IOs) - 0x0300, CYTMA445A - 0x02A4, CYTT21X (28, 33, 35, 36 IOs) - 0x0318

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x0						RW: 0x0	RW: 0x0
Bit Name	Reserved[7:2]						Default Value[1:1]	Enable[0:0]

Enable/Disable host controlled CA. Initializes the CHARGER_STATUS RAM value at device power-up.

Bits	Name	Description
[7:2]	Reserved [5:0]	Default: 0x0 Range:
[1:1]	Default Value [0:0]	Initializes the CHARGER_STATUS RAM value at device power-up. If charger noise is expected to be present after device power-up, set this bit to Enable. Otherwise, leave it set to Disable. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0x0 **1:** Enable **0:** Disable
[0:0]	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: 0x0 **1:** Enable **0:** Disable

11.0.335 ACT_DIST_COUNTER

[TTHE Group] Register Name : Address

[Finger Tracking] ACT_DIST_COUNTER : CYTT21X/31X (40, 44, 48 IOs) - 0x0334, CYTMA445A - 0x02D0, CYTT21X (28, 33, 35, 36 IOs) - 0x034C

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x0							
Bit Name	Counter[7:0]							

This counter indicates how many cycles after touchdown should be applied.

Bits	Name	Description
[7:0]	Counter [7:0]	Adaptive Touchdown Active Distance timeout parameter. It specifies the timeout period (in number of refresh cycles) for the Adaptive Touchdown Active Distance algorithm. The device exits the Adaptive Touchdown Active Distance algorithm and applies threshold ACT_DIST0 when this timeout period expires. Set this parameter to 0 to disable the Adaptive Touchdown Active Distance algorithm. Default: 0x0 Range: 0:255

11.0.336 GLOVE_GRIP_FILTER_SCALE

[TTHE Group] Register Name : Address

[Glove] GLOVE_GRIP_FILTER_SCALE : CYTT21X/31X (40, 44, 48 IOs) - 0x042F, CYTMA445A - 0x03CB, CYTT21X (28, 33, 35, 36 IOs) - 0x0457

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x4							
Bit Name	Scale[7:0]							

Gripfilter scale the scale is divided by 8 internally GripRatio = maxSignalOnOuterEdge/maxSignalOnInnerEdge if the GripRatio is larger than Gripfilter scale: the glove touch will be rejected.

Bits	Name	Description
[7:0]	Scale [7:0]	Gripfilter scale the scale is divided by 8 internally GripRatio = maxSignalOnOuterEdge/maxSignalOnInnerEdge if the GripRatio is larger than Gripfilter scale: the glove touch will be rejected. Default: 0x4 Range: 0:255

11.0.337 SELF_LIFTOFF_THRESHOLD

[TTHE Group] Register Name : Address

[Raw Processing] SELF_LIFTOFF_THRESHOLD : CYTT21X/31X (40, 44, 48 IOs) - 0x027E, CYTMA445A - 0x021E, CYTT21X (28, 33, 35, 36 IOs) - 0x027A

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x00							
Bit Name	Value[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x48							
Bit Name	Value[7:0]							

Threshold to detect finger lift-off after device reset. If self cap signal drops by more that this threshold after device reset, the mutual baseline will be reset

Bits	Name	Description
[15:0]	Value [15:0]	Threshold to detect finger lift-off after device reset. If self cap signal drops by more that this threshold after device reset, the mutual baseline will be reset Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0xc8 Range: 0:65535

11.0.338 CA_HOP3_TX_PULSES_NUM_MUTUAL

[TTHE Group] Register Name : Address

[Charger Armor] CA_HOP3_TX_PULSES_NUM_MUTUAL : CYTT21X/31X (40, 44, 48 IOs) - 0x0094, CYTMA445A - 0x008E, CYTT21X (28, 33, 35, 36 IOs) - 0x0090

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x00							
Bit Name	TX Pulses[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x7f							
Bit Name	TX Pulses[7:0]							

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

Bits	Name	Description
[15:0]	TX Pulses [15:0]	Fourth AFH alternative frequency Mutual Cap scan Number of TX Pulses per conversion Default: 0x7f Range: 0:255

11.0.339 CAFILT_FILTER_MASK

[TTHE Group] Register Name : Address

[Charger Armor] CAFILT_FILTER_MASK : CYTT21X/31X (40, 44, 48 IOs) - 0x02CA, CYTMA445A - 0x027A, CYTT21X (28, 33, 35, 36 IOs) - 0x02E2

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x0						RW: 0x1	RW: 0x1
Bit Name	Reserved[7:2]						IIR Fil-ter[1:1]	CMF Fil-ter[0:0]

Indicates what filters are enabled/disabled for Mutual scan when Charger Armor is active

Bits	Name	Description
[7:2]	Reserved [5:0]	Default: 0x0 Range:
[1:1]	IIR Filter [0:0]	Enable/Disable IIR Filter Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0x1 **0:** Disabled - Filter is Disabled **1:** Enabled - Filter is Enabled
[0:0]	CMF Filter [0:0]	Enable/Disable CMF Filter Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0x1 **0:** Disabled - Filter is Disabled **1:** Enabled - Filter is Enabled

11.0.340 REFGEN_CTL

[TTHE Group] Register Name : Address

[CDC] REFGEN_CTL : CYTT21X/31X (40, 44, 48 IOs) - 0x0030, CYTMA445A - 0x002C, CYTT21X (28, 33, 35, 36 IOs) - 0x0030

Bits	31	30	29	28	27	26	25	24
Access:POR	RW: 0x00							
Bit Name	Reserved[31:24]							

Bits	23	22	21	20	19	18	17	16
Access:POR	RW: 0x00	RW: 0x0			RW: 0x5			
Bit Name	Reserved[23:23]	REF_SCALE[22:20]			RXDAC[19:16]			

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x5				RW: 0x00			
Bit Name	TX SHIELD[15:12]				Reserved[11:8]			

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x00							
Bit Name	Reserved[7:0]							

TX Shield and RX DAC Output Voltages

Bits	Name	Description
[31:23]	Reserved [8:0]	Reserved Default: 0x140 Range:
[22:20]	REF_SCALE [2:0]	Controls Scaling for the reference voltage. Refer to Tuning Guide for the voltage levels. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0x0 **0:** 0 **1:** 1 **2:** 2 **3:** 3 **4:** 4 **5:** 5 **6:** 6 **7:** 7
[19:16]	RXDAC [3:0]	Controls RX DAC output voltage for self capacitance measuring mode. Refer to Tuning Guide for the voltage levels. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0x5 **0:** 0 **1:** 1 **2:** 2

		3: 3 **4:** 4 **5:** 5 **6:** 6 **7:** 7 **8:** 8 **9:** 9 **10:** 10 **11:** 11 **12:** 12 **13:** 13 **14:** 14 **15:** 15
[15:12]	TX SHIELD [3:0]	Controls TX shield output voltage. Refer to Tuning Guide for the voltage levels. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0x5 **0:** 0 **1:** 1 **2:** 2 **3:** 3 **4:** 4 **5:** 5 **6:** 6 **7:** 7 **8:** 8 **9:** 9 **10:** 10 **11:** 11 **12:** 12 **13:** 13 **14:** 14 **15:** 15
[11:0]	Reserved [11:0]	Reserved Default: 0x0 Range:

11.0.341 DEBOUNCE_ON_DETECT_FINGER

[TTHE Group] Register Name : Address

[Proximity] DEBOUNCE_ON_DETECT_FINGER : CYTMA445A - 0x035E, CYTT21X (28, 33, 35, 36 IOs) - 0x03EA

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x00							
Bit Name	debounceOnDetectFinger[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x0a							
Bit Name	debounceOnDetectFinger[7:0]							

Number of frames to debounce before detecting finger

Bits	Name	Description
[15:0]	debounceOnDetectFinger [15:0]	Number of frames to debounce before detecting finger Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0xa Range: 0:32767

11.0.342 FINGER_THRESH_MUTUAL_ON

[TTHE Group] Register Name : Address

[Finger Tracking] FINGER_THRESH_MUTUAL_ON : CYTT21X/31X (40, 44, 48 IOs) - 0x03CC, CYTMA445A - 0x0368, CYTT21X (28, 33, 35, 36 IOs) - 0x03F4

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x00							
Bit Name	Threshold On[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x52							
Bit Name	Threshold On[7:0]							

Mutual Capacitance Finger Threshold ON. It is used when finger was not detected yet.

Bits	Name	Description
[15:0]	Threshold On [15:0]	Mutual Capacitance Finger Threshold ON. It is used when finger was not detected yet. Default: 0xd2 Range: 0:32767

11.0.343 BALANCING_TARGET_BUTTON_SELF

[TTHE Group] Register Name : Address

[Calibration] BALANCING_TARGET_BUTTON_SELF : CYTT21X/31X (40, 44, 48 IOs) - 0x006D, CYTMA445A - 0x0069, CYTT21X (28, 33, 35, 36 IOs) - 0x006D

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x1e							
Bit Name	Balancing Target Btn Self[7:0]							

Integrator Balancing target for Buttons in Self Mode

Bits	Name	Description
[7:0]	Balancing Target Btn Self [7:0]	Balancing target for Buttons in Self Mode Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0x1e Range: 5:95

11.0.344 TX_PULSES_NUM_BUTTON_SELF

[TTHE Group] Register Name : Address

[CDC] TX_PULSES_NUM_BUTTON_SELF : CYTT21X/31X (40, 44, 48 IOs) - 0x009C, CYTMA445A - 0x009E, CYTT21X (28, 33, 35, 36 IOs) - 0x0098

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x00							
Bit Name	TX Pulses[15:8]							
Bits	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
Access:POR	RW: 0x20							
Bit Name	TX Pulses[7:0]							

Self Button Scanning Number of TX Pulses

Bits	Name	Description
[15:0]	TX Pulses [15:0]	Number of TX Pulses per conversion for CapSense Button Self Cap scan Default: 0x20 Range: 1:255

11.0.345 CA_HOP0_TX_PULSES_NUM_MUTUAL

[TTHE Group] Register Name : Address

[Charger Armor] CA_HOP0_TX_PULSES_NUM_MUTUAL : CYTT21X/31X (40, 44, 48 IOs) - 0x008E, CYTMA445A - 0x0082, CYTT21X (28, 33, 35, 36 IOs) - 0x008A

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x00							
Bit Name	TX Pulses[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x7f							
Bit Name	TX Pulses[7:0]							

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

Bits	Name	Description
[15:0]	TX Pulses [15:0]	First AFH alternative frequency Mutual Cap scan Number of TX Pulses per conversion Default: 0x7f Range: 0:255

11.0.346 FILT_IIR_THRESHOLD_STYLUS_SELF

[TTHE Group] Register Name : Address

[Raw Processing] FILT_IIR_THRESHOLD_STYLUS_SELF : CYTT21X/31X (40, 44, 48 IOs) - 0x02F6

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x00							
Bit Name	Value[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x14							
Bit Name	Value[7:0]							

IIR Threshold for Stylus Self

Bits	Name	Description
[15:0]	Value [15:0]	IIR Threshold Stylus for Self TX Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0x14 Range: 0:32767

11.0.347 STYL_XY_FILT_XY_SLOW_THR

[TTHE Group] Register Name : Address

[Stylus Tracking] STYL_XY_FILT_XY_SLOW_THR : CYTT21X/31X (40, 44, 48 IOs) - 0x0481

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x64							
Bit Name	Threshold[7:0]							

Displacement (in pixels) along X or Y axis below which the IIR filter input weight is set to STYL_XY_FILT_IIR_COEF for filtering along the corresponding axis wwhen Stylus 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 STYL_XY_FILT_IIR_COEF for filtering along the corresponding axis wwhen Stylus is active Default: 0x64 Range: 0:255

11.0.348 STARTUP_DELAY

[TTHE Group] Register Name : Address

[CDC] STARTUP_DELAY : CYTT21X/31X (40, 44, 48 IOs) - 0x0040, CYTMA445A - 0x003C, CYTT21X (28, 33, 35, 36 IOs) - 0x0040

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x64							
Bit Name	STARTUP_DELAY[7:0]							

VDDA settling delay in ms.

Bits	Name	Description
[7:0]	STARTUP_DELAY [7:0]	VDDA settling delay in ms Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0x64 Range: 0:255

11.0.349 DISCARD_TIME

[TTHE Group] Register Name : Address

[CDC] DISCARD_TIME : CYTT21X/31X (40, 44, 48 IOs) - 0x0051, CYTMA445A - 0x004D, CYTT21X (28, 33, 35, 36 IOs) - 0x0051

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x1e							
Bit Name	DISCARD_TIME[7:0]							

Discarded time in us. Number of discarded TX periods equals DISCARD_TIME*24/TX_PERIOD. The first TX periods of each TX pattern can be discarded by setting this field to a value different from "0". Should be in the range [0, 255]. Discarding of the first TX periods of a TX pattern addresses panel settling time.

Bits	Name	Description
[7:0]	DISCARD_TIME [7:0]	Discarded time in us. Number of discarded TX periods equals DISCARD_TIME*24/TX_PERIOD. The first TX periods of each TX pattern can be discarded by setting this field to a value different from "0". Should be in the range [0, 255]. Discarding of the first TX periods of a TX pattern addresses panel settling time. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0x1e Range: 0:255

11.0.350 TOUCHMODE_GLOVE_MAX_PEAK

[TTHE Group] Register Name : Address

[Touch Mode] TOUCHMODE_GLOVE_MAX_PEAK : CYTT21X/31X (40, 44, 48 IOs) - 0x0424, CYTMA445A - 0x03C0, CYTT21X (28, 33, 35, 36 IOs) - 0x044C

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x00							
Bit Name	Maximum Signal[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x16							
Bit Name	Maximum Signal[7:0]							

If maximum signal on the panel are higher than this threshold then glove should be ignored.

Bits	Name	Description
[15:0]	Maximum Signal [15:0]	If maximum signal on the panel are higher than this threshold then glove should be ignored. Default: 0x96 Range: 0:65535

11.0.351 CLIPPING_Y_LOW

[TTHE Group] Register Name : Address

[Device Setup] CLIPPING_Y_LOW : CYTT21X/31X (40, 44, 48 IOs) - 0x0376, CYTMA445A - 0x0302, CYTT21X (28, 33, 35, 36 IOs) - 0x038A

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x0							
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. Default: 0x0 Range: -128:127

11.0.352 PROXIMITY_SCAN_AXIS

[TTHE Group] Register Name : Address

[CDC] PROXIMITY_SCAN_AXIS : CYTMA445A - 0x0012, CYTT21X (28, 33, 35, 36 IOs) - 0x0012

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x0						RW: 0x0	
Bit Name	Reserved[7:2]						Proxomity Axis[1:0]	

Proximity scan axis selection

Bits	Name	Description
[7:2]	Reserved [5:0]	Default: 0x0 Range:
[1:0]	Proxomity Axis [1:0]	Selects Tx or Rx axis to scan for proximity Default: 0x0 **0:** RX **1:** TX

11.0.353 XY_FILT_XY_SLOW_THR

[TTHE Group] Register Name : Address

[Scan Filtering] XY_FILT_XY_SLOW_THR : CYTT21X/31X (40, 44, 48 IOs) - 0x0461, CYTMA445A - 0x03E5, CYTT21X (28, 33, 35, 36 IOs) - 0x0471

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0xff							
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 Default: 0xff Range: 0:255

11.0.354 PQ_CTRL3

[TTHE Group] Register Name : Address

[CDC] PQ_CTRL3 : CYTT21X/31X (40, 44, 48 IOs) - 0x002C, CYTMA445A - 0x0028, CYTT21X (28, 33, 35, 36 IOs) - 0x002C

Bits	31	30	29	28	27	26	25	24
Access:POR	RW: 0x0							
Bit Name	Reserved[31:24]							

Bits	23	22	21	20	19	18	17	16
Access:POR	RW: 0x00							
Bit Name	DELAY[23:16]							

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x00							
Bit Name	DELAY[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x00							
Bit Name	DELAY[7:0]							

External events control 3

Bits	Name	Description
[31:24]	Reserved [7:0]	Reserved Default: 0x0 Range:
[23:0]	DELAY [23:0]	Specifies the delay of the pulse qualifier start signal ("pq_start") wrt. the preliminary start signal ("pq_start_prel"). DELAY specifies the number of delay cycles minus 1. During the delay of the preliminary start signal, no new preliminary start signals are considered. Default: 0x0 Range: 0:16777216

11.0.355 PQ_CTRL2

[TTHE Group] Register Name : Address

[CDC] PQ_CTRL2 : CYTT21X/31X (40, 44, 48 IOs) - 0x0028, CYTMA445A - 0x0024, CYTT21X (28, 33, 35, 36 IOs) - 0x0028

Bits	31	30	29	28	27	26	25	24
Access:POR	RW: 0x0							
Bit Name	Reserved[31:24]							

Bits	23	22	21	20	19	18	17	16
Access:POR	RW: 0x0							
Bit Name	DEACT_RANGE[23:16]							

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x00							
Bit Name	ACT_RANGE[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x00							
Bit Name	ACT_RANGE[7:0]							

External events control 2

Bits	Name	Description
[31:24]	Reserved [7:0]	Reserved Default: 0x0 Range:
[23:16]	DEACT_RANGE [7:0]	Specifies the numer of cycles minus 1, for which the input signal needs to be de-activated. Default: 0x0 Range: 0:255
[15:0]	ACT_RANGE [15:0]	Specifies the numer of cycles minus 1, for which the input signal needs to be activated before it is considered reliable and a preliminary start ("pq_start_prel") signal is generated. Default: 0x0 Range: 0:65535

11.0.356 Z_SCALING

[TTHE Group] Register Name : Address

[Finger Tracking] Z_SCALING : CYTT21X/31X (40, 44, 48 IOs) - 0x032A, CYTMA445A - 0x036C, CYTT21X (28, 33, 35, 36 IOs) - 0x0342

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x00							
Bit Name	Scale Factor[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x00							
Bit Name	Scale Factor[7:0]							

Factor to scale the Z value for normal finger. Adjust this value to achieve 255 Z counts for the maximum finger size.

Bits	Name	Description
[15:0]	Scale Factor [15:0]	Factor to scale the Z value for normal finger. Adjust this value to achieve 255 Z counts for the maximum finger size. Default: 0x80 Range: 0:65535

11.0.357 FILT_CMF_THRESHOLD_GLOVE_BUT_MUT

[TTHE Group] Register Name : Address

[Raw Processing] FILT_CMF_THRESHOLD_GLOVE_BUT_MUT : CYTT21X/31X (40, 44, 48 IOs) - 0x02E6, CYTMA445A - 0x0296, CYTT21X (28, 33, 35, 36 IOs) - 0x02FE

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x00							
Bit Name	Value[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x3c							
Bit Name	Value[7:0]							

CMF Threshold for Glove Button Mutual

Bits	Name	Description
[15:0]	Value [15:0]	CMF Threshold for Glove Button Mutual Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0x3c Range: 0:32767

11.0.358 CMF_THR_SELF

[TTHE Group] Register Name : Address

[Raw Processing] CMF_THR_SELF : CYTT21X/31X (40, 44, 48 IOs) - 0x02B6, CYTMA445A - 0x0266, CYTT21X (28, 33, 35, 36 IOs) - 0x02CE

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x00							
Bit Name	Value[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x3c							
Bit Name	Value[7:0]							

CMF Threshold for Base Self

Bits	Name	Description
[15:0]	Value [15:0]	CMF Threshold Base for Self TX Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0x3c Range: 0:32767

11.0.359 BTN_HS_ON_THRSH_MUT_1

[TTHE Group] Register Name : Address

[CapSense Buttons] BTN_HS_ON_THRSH_MUT_1 : CYTT21X/31X (40, 44, 48 IOs) - 0x0401, CYTMA445A - 0x039D, CYTT21X (28, 33, 35, 36 IOs) - 0x0429

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x14							
Bit Name	On Threshold[7:0]							

CapSense Button Mutual Cap HighSensitive scan On threshold for button 1

Bits	Name	Description
[7:0]	On Threshold [7:0]	CapSense Button Mutual Cap HighSensitive scan On threshold for button 1 Default: 0x14 Range: 5:255

11.0.360 BTN_HS_ON_THRSH_MUT_0

[TTHE Group] Register Name : Address

[CapSense Buttons] BTN_HS_ON_THRSH_MUT_0 : CYTT21X/31X (40, 44, 48 IOs) - 0x0400, CYTMA445A - 0x039C, CYTT21X (28, 33, 35, 36 IOs) - 0x0428

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x14							
Bit Name	On Threshold[7:0]							

CapSense Button Mutual Cap HighSensitive scan On threshold for button 0

Bits	Name	Description
[7:0]	On Threshold [7:0]	CapSense Button Mutual Cap HighSensitive scan On threshold for button 0 Default: 0x14 Range: 5:255

11.0.361 BTN_HS_ON_THRSH_MUT_3

[TTHE Group] Register Name : Address

[CapSense Buttons] BTN_HS_ON_THRSH_MUT_3 : CYTT21X/31X (40, 44, 48 IOs) - 0x0403, CYTMA445A - 0x039F, CYTT21X (28, 33, 35, 36 IOs) - 0x042B

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x14							
Bit Name	On Threshold[7:0]							

CapSense Button Mutual Cap HighSensitive scan On threshold for button 3

Bits	Name	Description
[7:0]	On Threshold [7:0]	CapSense Button Mutual Cap HighSensitive scan On threshold for button 3 Default: 0x14 Range: 5:255

11.0.362 FILT_IIR_THRESHOLD_BUT_GLOVE_MUT

[TTHE Group] Register Name : Address

[Raw Processing] FILT_IIR_THRESHOLD_BUT_GLOVE_MUT : CYTT21X/31X (40, 44, 48 IOs) - 0x02E4, CYTMA445A - 0x0294, CYTT21X (28, 33, 35, 36 IOs) - 0x02FC

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x00							
Bit Name	Value[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x14							
Bit Name	Value[7:0]							

IIR Threshold for Glove Button Mutual

Bits	Name	Description
[15:0]	Value [15:0]	IIR Threshold for Glove Button Mutual Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0x14 Range: 0:32767

11.0.363 MAX_MUTUAL_SCAN_INTERVAL

[TTHE Group] Register Name : Address

[Device Setup] MAX_MUTUAL_SCAN_INTERVAL : CYTT21X/31X (40, 44, 48 IOs) - 0x0284, CYTMA445A - 0x023C, CYTT21X (28, 33, 35, 36 IOs) - 0x029C

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x00							
Bit Name	Value[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x64							
Bit Name	Value[7:0]							

Maximum interval between mutual capacitance scans (in ms)

Bits	Name	Description
[15:0]	Value [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). Default: 0x64 Range: 0:65535

11.0.364 SCALING_FACTOR_MUTUAL

[TTHE Group] Register Name : Address

[CDC] SCALING_FACTOR_MUTUAL : CYTT21X/31X (40, 44, 48 IOs) - 0x0046, CYTMA445A - 0x0042, CYTT21X (28, 33, 35, 36 IOs) - 0x0046

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x01							
Bit Name	Scale Factor[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x2c							
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). Default: 0x12c Range: 0:1000

11.0.365 FINGER_ID_MAX_FINGER_ACCELERATION2

[TTHE Group] Register Name : Address

[Finger Tracking] FINGER_ID_MAX_FINGER_ACCELERATION2 : CYTT21X/31X (40, 44, 48 IOs) - 0x033C, CYTT21X (28, 33, 35, 36 IOs) - 0x0358

Bits	31	30	29	28	27	26	25	24
Access:POR	RW: 0x00							
Bit Name	Acceleration Threshold Square[31:24]							

Bits	23	22	21	20	19	18	17	16
Access:POR	RW: 0x00							
Bit Name	Acceleration Threshold Square[23:16]							

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x27							
Bit Name	Acceleration Threshold Square[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x10							
Bit Name	Acceleration Threshold Square[7:0]							

Square of the acceleration (maximum velocity change per refresh interval) threshold distinguishing fast finger movement from separate finger touches

Bits	Name	Description
[31:0]	Acceleration Threshold Square [31:0]	Square of the acceleration (maximum velocity change per refresh interval) threshold distinguishing fast finger movement from separate finger touches (in [pixels/refresh interval]2). Squared acceleration exceeding this value indicate separate finger touches. Squared acceleration below this value indicate fast single finger movement. Default: 0x2710 Range: 0:4294836225

11.0.366 XY_FILT_TOUCH_SIZE_IIR_COEFF

[TTHE Group] Register Name : Address

[Scan Filtering] XY_FILT_TOUCH_SIZE_IIR_COEFF : CYTT21X/31X (40, 44, 48 IOs) - 0x0485, CYTMA445A - 0x03F9, CYTT21X (28, 33, 35, 36 IOs) - 0x0485

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x0							
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. Default: 0x0 **0:** One - Filter output = 1 * Filter Input + 0 * Previous Filter Output (ie. no filter) **1:** One Half - Filter output = 0.5 * Filter Input + 0.5 * Previous Filter Output **2:** One Quarter - Filter output = 0.25 * Filter Input + 0.75 * Previous Filter Output **3:** One Eighth - Filter output = 0.125 * Filter Input + 0.875 * Previous Filter Output **4:** One Sixteenth - Filter output = 0.0625 * Filter Input + 0.9375 * Previous Filter Output

11.0.367 BTN_HS_ON_THRSH_MUT_2

[TTHE Group] Register Name : Address

[CapSense Buttons] BTN_HS_ON_THRSH_MUT_2 : CYTT21X/31X (40, 44, 48 IOs) - 0x0402, CYTMA445A - 0x039E, CYTT21X (28, 33, 35, 36 IOs) - 0x042A

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x14							
Bit Name	On Threshold[7:0]							

CapSense Button Mutual Cap HighSensitive scan On threshold for button 2

Bits	Name	Description
[7:0]	On Threshold [7:0]	CapSense Button Mutual Cap HighSensitive scan On threshold for button 2 Default: 0x14 Range: 5:255

11.0.368 ACT_INTRVL0

[TTHE Group] Register Name : Address

[Device Setup] ACT_INTRVL0 : CYTT21X/31X (40, 44, 48 IOs) - 0x031F, CYTMA445A - 0x02BF, CYTT21X (28, 33, 35, 36 IOs) - 0x0337

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x8							
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). Default: 0x8 Range: 0:250

11.0.369 WF_RAW_VAR_THOLD

[TTHE Group] Register Name : Address

[Wet Finger] WF_RAW_VAR_THOLD : CYTT21X/31X (40, 44, 48 IOs) - 0x029A, CYTMA445A - 0x0252, CYTT21X (28, 33, 35, 36 IOs) - 0x02B2

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x05							
Bit Name	Value[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x5c							
Bit Name	Value[7:0]							

The threshold for detection water by calculating the variation of raw counts when water drop on panel.

Bits	Name	Description
[15:0]	Value [15:0]	The threshold for detection water by calculating the variation of raw counts when water drop on panel. Default: 0x5dc Range: 0:65535

11.0.370 CA_INJTCH_MAGNITUDE

[TTHE Group] Register Name : Address

[Charger Armor] CA_INJTCH_MAGNITUDE : CYTT21X/31X (40, 44, 48 IOs) - 0x0304, CYTMA445A - 0x02A8, CYTT21X (28, 33, 35, 36 IOs) - 0x031C

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x00							
Bit Name	Value[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x34							
Bit Name	Value[7:0]							

Magnitude of the injected touch during the charger armor listen scan. This value should be set to the diffcount value of a typical finger touch.

Bits	Name	Description
[15:0]	Value [15:0]	Magnitude of the injected touch during the charger armor listen scan. This value should be set to the diffcount value of a typical finger touch. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0xb4 Range: 0:65535

11.0.371 SCALING_FACTOR_SELF

[TTHE Group] Register Name : Address

[CDC] SCALING_FACTOR_SELF : CYTT21X/31X (40, 44, 48 IOs) - 0x0048, CYTMA445A - 0x0044, CYTT21X (28, 33, 35, 36 IOs) - 0x0048

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x00							
Bit Name	Scale Factor[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x48							
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). Default: 0xc8 Range: 0:1000

11.0.372 TX_PULSES_NUM_GLOVE_MUTUAL

[TTHE Group] Register Name : Address

[CDC] TX_PULSES_NUM_GLOVE_MUTUAL : CYTT21X/31X (40, 44, 48 IOs) - 0x00A0, CYTMA445A - 0x00A6, CYTT21X (28, 33, 35, 36 IOs) - 0x009C

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x00							
Bit Name	TX Pulses[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x40							
Bit Name	TX Pulses[7:0]							

Number of TX Pulses for Glove Mutual Scanning

Bits	Name	Description
[15:0]	TX Pulses [15:0]	Number of TX Pulses per conversion for Glove Mutual Scan Default: 0x40 Range: 0:255

11.0.373 Z2_SUM_1MM

[TTHE Group] Register Name : Address

[Device Setup] Z2_SUM_1MM : CYTT21X/31X (40, 44, 48 IOs) - 0x0394, CYTMA445A - 0x031C, CYTT21X (28, 33, 35, 36 IOs) - 0x03A8

Bits	31	30	29	28	27	26	25	24
Access:POR	RW: 0x00							
Bit Name	z4[31:24]							

Bits	23	22	21	20	19	18	17	16
Access:POR	RW: 0x00							
Bit Name	z4[23:16]							

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x00							
Bit Name	z4[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x02							
Bit Name	z4[7:0]							

Sum of the 3x3 sensor diff count of a 1mm finger touch

Bits	Name	Description
[31:0]	z4 [31:0]	Sum of the 3x3 sensor diff count of a 1mm finger touch Default: 0x82 Range: -2147483648:2147483647

11.0.374 BL_BTN_THRSH_MUT_GLOVE

[TTHE Group] Register Name : Address

[Glove] BL_BTN_THRSH_MUT_GLOVE : CYTT21X/31X (40, 44, 48 IOs) - 0x028E, CYTMA445A - 0x0246, CYTT21X (28, 33, 35, 36 IOs) - 0x02A6

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x00							
Bit Name	Value[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x0a							
Bit Name	Value[7:0]							

Button Threshold Mutual for baseline updating for Glove Button Mutual Configuration. The buttons baselines are not updating in case of the button touch signals are above this threshold

Bits	Name	Description
[15:0]	Value [15:0]	Button Threshold Mutual for Glove Button Mutual Configuration. The buttons baselines are not updating in case of the button touch signals are above this threshold Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0xa Range: 0:65535

11.0.375 LRG_OBJ_CFG

[TTHE Group] Register Name : Address

[Device Setup] LRG_OBJ_CFG : CYTT21X/31X (40, 44, 48 IOs) - 0x0018, CYTMA445A - 0x0016, CYTT21X (28, 33, 35, 36 IOs) - 0x0018

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x0						RW: 0x2	
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]	Default: 0x0 Range:
[1:0]	Large Object and Fat Finger [1:0]	Determines whether large objects and fat fingers are distinguished from regular finger touches Default: 0x2 **0:** Regular Fingers Detected Only - All touches are interpreted as regular finger touches. Mulitple touches may be reported for Fat Finger and Large Object. **1:** Fat Fingers Detected - Fat fingers are distinguished from regular finger touches for better fat finger accuracy. Large Object not reported, other fingers still detected. **2:** Fat Fingers & Large Objects Detected - Fat fingers and large objects are distinguished from regular finger touches. Presence of Large Object reported, finger tracking is still good.

11.0.376 CA_WB_REVERT_THOLD

[TTHE Group] Register Name : Address

[Charger Armor] CA_WB_REVERT_THOLD : CYTT21X/31X (40, 44, 48 IOs) - 0x0311, CYTMA445A - 0x02B5, CYTT21X (28, 33, 35, 36 IOs) - 0x0329

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

When WB noise is larger than this threshold, it will not revert from charger mode.

Bits	Name	Description
[7:0]	Value [7:0]	When WB noise is larger than this threshold, it will not revert from charger mode. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0xf Range: 0:255

11.0.377 HIGH_PIVOT2

[TTHE Group] Register Name : Address

[Device Setup] HIGH_PIVOT2 : CYTT21X/31X (40, 44, 48 IOs) - 0x03A4, CYTMA445A - 0x032C, CYTT21X (28, 33, 35, 36 IOs) - 0x03B8

Bits	31	30	29	28	27	26	25	24
Access:POR	RW: 0x00							
Bit Name	HighPivot2[31:24]							

Bits	23	22	21	20	19	18	17	16
Access:POR	RW: 0x00							
Bit Name	HighPivot2[23:16]							

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x00							
Bit Name	HighPivot2[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x34							
Bit Name	HighPivot2[7:0]							

When zMagnitude = HighPivot than Scalar = MinGain(based on FS).This is used for 1~3 mm finger.

Bits	Name	Description
[31:0]	HighPivot2 [31:0]	When zMagnitude = HighPivot than Scalar = MinGain(based on FS).This is used for 1~3 mm finger. Default: 0xb4 Range: -2147483648:2147483647

11.0.378 GLOVE_BTN_TO_HIGHSEN_MODE_SWITCH_THRSH_SELF

[TTHE Group] Register Name : Address

[Glove] GLOVE_BTN_TO_HIGHSEN_MODE_SWITCH_THRSH_SELF : CYTT21X/31X (40, 44, 48 IOs) - 0x0418, CYTMA445A - 0x03B4, CYTT21X (28, 33, 35, 36 IOs) - 0x0440

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x00							
Bit Name	Threshold[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x28							
Bit Name	Threshold[7:0]							

Self threshold to Enter High Sensitive Mode.

Bits	Name	Description
[15:0]	Threshold [15:0]	Self threshold to Enter High Sensitive Mode. Default: 0x28 Range: 0:32767

11.0.379 FAT_AXIS_LENGTH_THRESHOLD

[TTHE Group] Register Name : Address

[Finger Tracking] FAT_AXIS_LENGTH_THRESHOLD : CYTT21X/31X (40, 44, 48 IOs) - 0x03CA, CYTMA445A - 0x0352, CYTT21X (28, 33, 35, 36 IOs) - 0x03DE

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x5							
Bit Name	Threshold[7:0]							

Touch Zone width threshold (unit: intersection cell) to determine whether a touch zone is fat or not; therefore determine proper centroid algorithm to be used; default value: 5 (if 5x5 centroid is applied)

Bits	Name	Description
[7:0]	Threshold [7:0]	Touch Zone width threshold (unit: intersection cell) to determine whether a touch zone is fat or not; therefore determine proper centroid algorithm to be used; default value: 5 (if 5x5 centroid is applied) Default: 0x5 Range: 0:128

11.0.380 FILT_CMF_THRESHOLD_STYLUS_MUT

[TTHE Group] Register Name : Address

[Raw Processing] FILT_CMF_THRESHOLD_STYLUS_MUT : CYTT21X/31X (40, 44, 48 IOs) - 0x02F2

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x00							
Bit Name	Value[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x28							
Bit Name	Value[7:0]							

CMF Threshold for Stylus Mutual

Bits	Name	Description
[15:0]	Value [15:0]	CMF Threshold Stylus for Mutual Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0x28 Range: 0:32767

11.0.381 OFFSET_S1

[TTHE Group] Register Name : Address

[Device Setup] OFFSET_S1 : CYTT21X/31X (40, 44, 48 IOs) - 0x0384, CYTMA445A - 0x030C, CYTT21X (28, 33, 35, 36 IOs) - 0x0398

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x00							
Bit Name	S1_Threshold[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x05							
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. Default: 0x5 Range: -32768:32767

11.0.382 OFFSET_S2

[TTHE Group] Register Name : Address

[Device Setup] OFFSET_S2 : CYTT21X/31X (40, 44, 48 IOs) - 0x0386, CYTMA445A - 0x030E, CYTT21X (28, 33, 35, 36 IOs) - 0x039A

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x00							
Bit Name	S2_Threshold[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x02							
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. Default: 0x2 Range: -32768:32767

11.0.383 SD_ENTER_SIGNAL_THRESHOLD

[TTHE Group] Register Name : Address

[Finger Tracking] SD_ENTER_SIGNAL_THRESHOLD : CYTT21X/31X (40, 44, 48 IOs) - 0x03C2, CYTMA445A - 0x034A, CYTT21X (28, 33, 35, 36 IOs) - 0x03D6

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x24							
Bit Name	Threshold[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x1f							
Bit Name	Threshold[7:0]							

Threshold for max peak value of touch zone to enter SD event; SD event should only be triggered by touch zone whose max peak value is less than sdEnterSigThold and whose size is larger or equal to sdSizeTHold; default value: 5/8 of HTI of 12mm finger.

Bits	Name	Description
[15:0]	Threshold [15:0]	Threshold for max peak value of touch zone to enter SD event; SD event should only be triggered by touch zone whose max peak value is less than sdEnterSigThold and whose size is larger or equal to sdSizeTHold; default value: 5/8 of HTI of 12mm finger. Default: 0x249f Range: 0:65535

11.0.384 CAFILT_IIR_THRESHOLD_BUT

[TTHE Group] Register Name : Address

[Charger Armor] CAFILT_IIR_THRESHOLD_BUT : CYTT21X/31X (40, 44, 48 IOs) - 0x02D2, CYTMA445A - 0x0282, CYTT21X (28, 33, 35, 36 IOs) - 0x02EA

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x00							
Bit Name	Value[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x14							
Bit Name	Value[7:0]							

IIR Threshold for Mutual Button scan when Charger Armor is active

Bits	Name	Description
[15:0]	Value [15:0]	IIR Threshold Base for Mutual Button scan 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: 0x14 Range: 0:32767

11.0.385 FILT_FILTER_MASK_BUT_GLOVE_SELF

[TTHE Group] Register Name : Address

[Raw Processing] FILT_FILTER_MASK_BUT_GLOVE_SELF : CYTT21X/31X (40, 44, 48 IOs) - 0x02E8, CYTMA445A - 0x0298, CYTT21X (28, 33, 35, 36 IOs) - 0x0300

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x0						RW: 0x1	RW: 0x1
Bit Name	Reserved[7:2]						IIR Filter[1:1]	CMF Filter[0:0]

Indicates what filters are enabled/disabled for Glove Button Self

Bits	Name	Description
[7:2]	Reserved [5:0]	Default: 0x0 Range:
[1:1]	IIR Filter [0:0]	Enable/Disable IIR Filter Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0x1 **0:** Disabled - Filter is Disabled **1:** Enabled - Filter is Enabled
[0:0]	CMF Filter [0:0]	Enable/Disable CMF Filter Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0x1 **0:** Disabled - Filter is Disabled **1:** Enabled - Filter is Enabled

11.0.386 GLOVE_Z_SCALING

[TTHE Group] Register Name : Address

[Glove] GLOVE_Z_SCALING : CYTT21X/31X (40, 44, 48 IOs) - 0x0430, CYTMA445A - 0x03CC, CYTT21X (28, 33, 35, 36 IOs) - 0x0458

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x00							
Bit Name	Scale[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x0a							
Bit Name	Scale[7:0]							

Z scale parameter for Glove finger

Bits	Name	Description
[15:0]	Scale [15:0]	Z scale parameter for Glove finger Default: 0xa Range: 0:65535

11.0.387 FILT_IIR_COEFF_GLOVE_SELF

[TTHE Group] Register Name : Address

[Raw Processing] FILT_IIR_COEFF_GLOVE_SELF : CYTT21X/31X (40, 44, 48 IOs) - 0x02DD, CYTMA445A - 0x028D, CYTT21X (28, 33, 35, 36 IOs) - 0x02F5

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x0					RW: 0x1		
Bit Name	Reserved[7:3]					IIR Filter Input Weight[2:0]		

IIR Coefficient for Glove Self TX

Bits	Name	Description
[7:3]	Reserved [4:0]	Default: 0x0 Range:
[2:0]	IIR Filter Input Weight [2:0]	Raw IIR filter coefficient for Glove Self Cap scan Default: 0x1 **0:** One Half - Filter output = 0.5 * Filter Input + 0.5 * Previous Filter Output **1:** One Quarter - Filter output = 0.25 * Filter Input + 0.75 * Previous Filter Output **2:** One Eighth - Filter output = 0.125 * Filter Input + 0.875 * Previous Filter Output **3:** One Sixteenth - Filter output = 0.0625 * Filter Input + 0.9375 * Previous Filter Output **4:** One Thirty-second - Filter output = 0.03125 * Filter Input + 0.96875 * Previous Filter Output

11.0.388 STYLUS_HIGH_PRIORITY

[TTHE Group] Register Name : Address

[Touch Mode] STYLUS_HIGH_PRIORITY : CYTT21X/31X (40, 44, 48 IOs) - 0x0017

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x0							RW: 0x0
Bit Name	Reserved[7:1]							Enable[0:0]

Enable/Disable Stylus High Priority.

Bits	Name	Description
[7:1]	Reserved [6:0]	Default: 0x0 Range:
[0:0]	Enable [0:0]	Enable/Disable Stylus High Priority. When stylus priority is set, stylus will be reported even if a finger/palm is already on the panel. If this is not set, a finger on the panel will block initial stylus detection. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0x0 **0:** Disabled - Stylus high priority is disabled **1:** Enabled - Stylus high priority is enabled

11.0.389 INIT_BL_DELAY

[TTHE Group] Register Name : Address

[Proximity] INIT_BL_DELAY : CYTMA445A - 0x0234, CYTT21X (28, 33, 35, 36 IOs) - 0x0294

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x00							
Bit Name	Value[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x05							
Bit Name	Value[7:0]							

Delay for Proximity Baseline Init in scan cycles. In other words - how many times to perform Reset Baseline after Init Baseline.

Bits	Name	Description
[15:0]	Value [15:0]	Delay for Proximity Baseline Init in scan cycles. In other words - how many times to perform Reset Baseline after Init Baseline. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0x5 Range: 0:65535

11.0.390 Z1_SUM_3MM

[TTHE Group] Register Name : Address

[Device Setup] Z1_SUM_3MM : CYTT21X/31X (40, 44, 48 IOs) - 0x0390, CYTMA445A - 0x0318, CYTT21X (28, 33, 35, 36 IOs) - 0x03A4

Bits	31	30	29	28	27	26	25	24
Access:POR	RW: 0x00							
Bit Name	z3[31:24]							

Bits	23	22	21	20	19	18	17	16
Access:POR	RW: 0x00							
Bit Name	z3[23:16]							

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x01							
Bit Name	z3[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x4a							
Bit Name	z3[7:0]							

Sum of the 3x3 sensor diff count of a 3 mm finger touch

Bits	Name	Description
[31:0]	z3 [31:0]	Sum of the 3x3 sensor diff count of a 3 mm finger touch Default: 0x14a Range: -2147483648:2147483647

11.0.391 ACT_LFT_INTRVL0

[TTHE Group] Register Name : Address

[Device Setup] ACT_LFT_INTRVL0 : CYTT21X/31X (40, 44, 48 IOs) - 0x0320, CYTMA445A - 0x02C0, CYTT21X (28, 33, 35, 36 IOs) - 0x0338

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x00							
Bit Name	Active Look for Touch Interval[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x03							
Bit Name	Active Look for Touch Interval[7:0]							

Initial active look-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). Default: 0x3 Range: 0:1000

11.0.392 OPENS_TEST_IDAC_MUTUAL

[TTHE Group] Register Name : Address

[MFG] OPENS_TEST_IDAC_MUTUAL : CYTMA445A - 0x0070

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x67							
Bit Name	Open test idac value for mutual[7:0]							

open test idac value for mutual.

Bits	Name	Description
[7:0]	Open test idac value for mutual [7:0]	open test idac value for mutual. Default: 0x67 Range: 0:255

11.0.393 SIGNAL_THRESHOLD_MULTIPLIER

[TTHE Group] Register Name : Address

[Finger Tracking] SIGNAL_THRESHOLD_MULTIPLIER : CYTT21X/31X (40, 44, 48 IOs) - 0x03E0, CYTMA445A - 0x037B, CYTT21X (28, 33, 35, 36 IOs) - 0x0408

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x40							
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 touch zone.

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 touch zone. Default: 0x40 Range: 0:128

11.0.394 STYL_XY_FILT_Z_IIR_COEF

[TTHE Group] Register Name : Address

[Stylus Tracking] STYL_XY_FILT_Z_IIR_COEF : CYTT21X/31X (40, 44, 48 IOs) - 0x047C

Bits	31	30	29	28	27	26	25	24
Access:POR	RW: 0x00							
Bit Name	Reserved[31:24]							

Bits	23	22	21	20	19	18	17	16
Access:POR	RW: 0x00							
Bit Name	Reserved[23:16]							

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x00							
Bit Name	Reserved[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x00						RW: 0x2	
Bit Name	Reserved[7:2]						IIR Filter Input Weight[1:0]	

Weighting of the input Z value in the IIR filter when Stylus is active.

Bits	Name	Description
[31:2]	Reserved [29:0]	Default: 0x0 Range:
[1:0]	IIR Filter Input Weight [1:0]	Weighting of the input Z value in the IIR filter when Stylus is active. Default: 0x2 **1:** One Half - Filter output = 0.5 * Filter Input + 0.5 * Previous Filter Output **2:** One Quarter - Filter output = 0.25 * Filter Input + 0.75 * Previous Filter Output

11.0.395 CALC_THRESHOLD

[TTHE Group] Register Name : Address

[Device Setup] CALC_THRESHOLD : CYTT21X/31X (40, 44, 48 IOs) - 0x0382, CYTMA445A - 0x030A, CYTT21X (28, 33, 35, 36 IOs) - 0x0396

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x00							
Bit Name	Calc_Threshold[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x02							
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 Default: 0x2 Range: -32768:32767

11.0.396 ACT_DIST0

[TTHE Group] Register Name : Address

[Finger Tracking] ACT_DIST0 : CYTT21X/31X (40, 44, 48 IOs) - 0x0330, CYTMA445A - 0x02CC, CYTT21X (28, 33, 35, 36 IOs) - 0x0348

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x0							
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]	One-dimensional 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 displacement distance, ACT_DIST2 is applied. Default: 0x0 Range: 0:255

11.0.397 STYL_CM_COEF

[TTHE Group] Register Name : Address

[Stylus Tracking] STYL_CM_COEF : CYTT21X/31X (40, 44, 48 IOs) - 0x0450

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x1							
Bit Name	Threshold[7:0]							

Constant mass coefficient to enable Constant mass algorithm.

Bits	Name	Description
[7:0]	Threshold [7:0]	Constant mass coefficient to enable Constant mass algorithm. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0x1 Range: 0:255

11.0.398 CA_HOP2_TX_PULSES_NUM_MUTUAL

[TTHE Group] Register Name : Address

[Charger Armor] CA_HOP2_TX_PULSES_NUM_MUTUAL : CYTT21X/31X (40, 44, 48 IOs) - 0x0092, CYTMA445A - 0x008A, CYTT21X (28, 33, 35, 36 IOs) - 0x008E

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x00							
Bit Name	TX Pulses[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x7f							
Bit Name	TX Pulses[7:0]							

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

Bits	Name	Description
[15:0]	TX Pulses [15:0]	Third AFH alternative frequency Mutual Cap scan Number of TX Pulses per conversion Default: 0x7f Range: 0:255

11.0.399 XY_FILT_TOUCH_ORIENTATION_HYST

[TTHE Group] Register Name : Address

[Scan Filtering] XY_FILT_TOUCH_ORIENTATION_HYST : CYTT21X/31X (40, 44, 48 IOs) - 0x0488, CYTMA445A - 0x03FC, CYTT21X (28, 33, 35, 36 IOs) - 0x0488

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x0							
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. Default: 0x0 Range: 0:255

11.0.400 CA_MAX_FAT_FINGER_SIZE

[TTHE Group] Register Name : Address

[Charger Armor] CA_MAX_FAT_FINGER_SIZE : CYTT21X/31X (40, 44, 48 IOs) - 0x03DA, CYTMA445A - 0x0379, CYTT21X (28, 33, 35, 36 IOs) - 0x0402

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x28							
Bit Name	Max Fat Finger Size On when Charger Armor is active[7:0]							

Maximum number of contiguous activated panel intersections that define a fat finger when Charger Armor is active. It is used when a fat finger was not detected yet.

Bits	Name	Description
[15:0]	Max Fat Finger Size On when Charger Armor is active [15:0]	Maximum number of contiguous activated panel intersections that define a fat finger when Charger Armor is active. It is used when a fat finger was not detected yet. Default: 0x28 Range: 0:65535

11.0.401 TX_PERIOD_GLOVE_BUTTON_SELF

[TTHE Group] Register Name : Address

[CDC] TX_PERIOD_GLOVE_BUTTON_SELF : CYTMA445A - 0x00B0

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x00							
Bit Name	txPeriodGlove[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x20							
Bit Name	txPeriodGlove[7:0]							

Integration Time

Bits	Name	Description
[15:0]	txPeriodGlove [15:0]	Number of system clocks in each TX half period for Button Self Cap Glove scan Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0x20 Range: 48:510

11.0.402 OPENS_TEST_ATTEN_MUTUAL

[TTHE Group] Register Name : Address

[MFG] OPENS_TEST_ATTEN_MUTUAL : CYTMA445A - 0x0071

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x8							
Bit Name	Open test attenuator value for mutual[7:0]							

open test attenuator value for mutual.

Bits	Name	Description
[7:0]	Open test attenuator value for mutual [7:0]	open test attenuator value for mutual. Default: 0x8 **1:** 24x attenuation factor - 24x attenuation factor **2:** 12x attenuation factor - 12x attenuation factor **3:** 8x attenuation factor - 8x attenuation factor **4:** 6x attenuation factor - 6x attenuation factor **5:** 4.8x attenuation factor - 4.8x attenuation factor **6:** 4x attenuation factor - 4x attenuation factor **8:** 3x attenuation factor - 3x attenuation factor

11.0.403 RX_LINE_FILTER

[TTHE Group] Register Name : Address

[Charger Armor] RX_LINE_FILTER : CYTT21X/31X (40, 44, 48 IOs) - 0x03E3, CYTMA445A - 0x037E, CYTT21X (28, 33, 35, 36 IOs) - 0x040B

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x1							
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 Default: 0x1 **0:** Disabled **1:** Enabled

11.0.404 POST_CFG

[TTHE Group] Register Name : Address

[Device Setup] POST_CFG : CYTT21X/31X (40, 44, 48 IOs) - 0x0490, CYTMA445A - 0x040C, CYTT21X (28, 33, 35, 36 IOs) - 0x0490

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x0							RW: 0x0
Bit Name	Reserved[7:1]							Failure Response[0:0]

Power-On Self Test Configuration

Bits	Name	Description
[7:1]	Reserved [6:0]	Default: 0x0 Range:
[0:0]	Failure Response [0:0]	Specifies actions the firmware shall take in response to a power-on self test (POST) failure. Default: 0x0 **0:** No Response - Firmware execution proceeds as normal after a POST failure **1:** Disable Touch Sensing - Firmware disables touch sensing on POST failure (to prevent damage of the TrueTouch controller)

11.0.405 GLOVE_MIN_FAT_FINGER_SIZE

[TTHE Group] Register Name : Address

[Glove] GLOVE_MIN_FAT_FINGER_SIZE : CYTT21X/31X (40, 44, 48 IOs) - 0x0436, CYTMA445A - 0x03D0, CYTT21X (28, 33, 35, 36 IOs) - 0x045E

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0xa							
Bit Name	Min Fat Finger Size[7:0]							

Minimum number of contiguous activated panel intersections that define a fat finger in glove mode

Bits	Name	Description
[7:0]	Min Fat Finger Size [7:0]	Minimum number of contiguous activated panel intersections that define a fat finger in glove mode Default: 0xa Range: 0:255

11.0.406 TOUCHMODE_ENABLED

[TTHE Group] Register Name : Address

[Touch Mode] TOUCHMODE_ENABLED : CYTT21X/31X (40, 44, 48 IOs) - 0x0015, CYTMA445A - 0x0015, CYTT21X (28, 33, 35, 36 IOs) - 0x0015

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x3							
Bit Name	Mode[7:0]							

Selection of used touch mode

Bits	Name	Description
[7:0]	Mode [7:0]	Select Touch Mode (Finger/Glove/Stylus) Default: 0x3 **1:** FingerOnly - Finger only. **3:** FingerAndGlove - Switch between glove and finger. Finger has higher priority. **4:** StylusOnly - Stylus only.

11.0.407 ACT_DIST_Z_THRESHOLD

[TTHE Group] Register Name : Address

[Finger Tracking] ACT_DIST_Z_THRESHOLD : CYTT21X/31X (40, 44, 48 IOs) - 0x0335, CYTMA445A - 0x02D1, CYTT21X (28, 33, 35, 36 IOs) - 0x034D

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0xff							
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]	Finger size Z value change threshold. This parameter is used for both the Adaptive Liftoff Active Distance algorithm and the First Touch Suppression. For Active Liftoff Active Distance algorithm, threshold ACT_DIST_LIFTOFF is applied if the following criteria are satisfied: 1. The 2-dimensional finger displacement is less than the threshold ACT_DIST0. 2. The change in touch size (Z) is more than this parameter since the last touch report. Set this parameter to 255 to disable the Active Liftoff Active Distance algorithm. For First Touch Suppression, a new touch is reported if the following criteria are satisfied: 1. Touch size Z value change between consecutive refresh cycles is less than this parameter. 2. The x-direction or y-direction finger displacement is larger than threshold ACT_DIST_LIFTOFF. Default: 0xff Range: 0:255

11.0.408 STYL_PALM_CLEARANCE

[TTHE Group] Register Name : Address

[Stylus Tracking] STYL_PALM_CLEARANCE : CYTT21X/31X (40, 44, 48 IOs) - 0x044E

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x5							
Bit Name	palmClearance[7:0]							

Palm Clearance used for palm rejection.

Bits	Name	Description
[7:0]	palmClearance [7:0]	This parameter specifies the Palm Rejection clearance area (in number of sensors) around the palm. The palm is rejected and is not reported to the 2. The stylus is also not reported if it is located within the clearance area. 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). Default: 0x5 Range: 0:255

11.0.409 BL_BTN_THRSH_SELF_GLOVE

[TTHE Group] Register Name : Address

[Glove] BL_BTN_THRSH_SELF_GLOVE : CYTT21X/31X (40, 44, 48 IOs) - 0x0290, CYTMA445A - 0x0248, CYTT21X (28, 33, 35, 36 IOs) - 0x02A8

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x00							
Bit Name	Value[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x0a							
Bit Name	Value[7:0]							

Button Threshold Self for baseline updating for Glove Button SelfConfiguration. The buttons baselines are not updating in case of the button touch signals are above this threshold

Bits	Name	Description
[15:0]	Value [15:0]	Button Threshold Self for Glove Button Self Configuration. The buttons baselines are not updating in case of the button touch signals are above this threshold Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0xa Range: 0:65535

11.0.410 Z9_FILTER_SCALE

[TTHE Group] Register Name : Address

[Finger Tracking] Z9_FILTER_SCALE : CYTT21X/31X (40, 44, 48 IOs) - 0x03D3, CYTMA445A - 0x0371, CYTT21X (28, 33, 35, 36 IOs) - 0x03FB

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x2							
Bit Name	Z9 Filter Scale[7:0]							

Z9 filter scale for normal finger when Charger Armor is not active. Peak with Z9<(scale*FINGER_THRESH_MUTUAL_OFF) will be removed.

Bits	Name	Description
[7:0]	Z9 Filter Scale [7:0]	Z9 filter scale for normal finger when Charger Armor is not active. Peak with Z9<(scale*FINGER_THRESH_MUTUAL_OFF) will be removed. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0x2 Range: 0:4

11.0.411 CONFIG_VER

[TTHE Group] Register Name : Address

[Device Setup] CONFIG_VER : CYTT21X/31X (40, 44, 48 IOs) - 0x0492, CYTMA445A - 0x0406, CYTT21X (28, 33, 35, 36 IOs) - 0x0492

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x00							
Bit Name	Version[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x00							
Bit Name	Version[7:0]							

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 CFG_VER will return the value stored in this CONFIG_VER parameter. This is useful when the host is determining whether a bootload is necessary.

Bits	Name	Description
[15:0]	Version [15:0]	Configuration Version (customer defined) Default: 0x0 Range: 0:65535

11.0.412 GLOVE_MULTI_TOUCH_DEBOUNCE

[TTHE Group] Register Name : Address

[Glove] GLOVE_MULTI_TOUCH_DEBOUNCE : CYTT21X/31X (40, 44, 48 IOs) - 0x042C, CYTMA445A - 0x03C8, CYTT21X (28, 33, 35, 36 IOs) - 0x0454

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x0							
Bit Name	Debounce[7:0]							

Number of consecutive refresh cycles for which a glove touch must be detected prior to being reported. Applies to the second and successive glove touches

Bits	Name	Description
[7:0]	Debounce [7:0]	Number of consecutive refresh cycles for which a glove touch must be detected prior to being reported. Applies to the second and successive glove touches, but not the first glove touch. Default: 0x0 Range: 0:63

11.0.413 RX_CTRL

[TTHE Group] Register Name : Address

[CDC] RX_CTRL : CYTT21X/31X (40, 44, 48 IOs) - 0x0038, CYTMA445A - 0x0034, CYTT21X (28, 33, 35, 36 IOs) - 0x0038

Bits	31	30	29	28	27	26	25	24
Access:POR	RW: 0x00							
Bit Name	Reserved[31:24]							

Bits	23	22	21	20	19	18	17	16
Access:POR	RW: 0x00					RW: 0x7		
Bit Name	Reserved[23:19]					RX_CAP_SEL[18:16]		

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x00							
Bit Name	Reserved[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x00							
Bit Name	Reserved[7:0]							

RX channels integration capacitor size selection

Bits	Name	Description
[31:19]	Reserved [12:0]	Reserved Default: 0x0 Range:
[18:16]	RX_CAP_SEL [2:0]	Integrator capacitor value Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0x7 **0:** 2.5 pF **1:** 5 pF **2:** 7.5 pF **3:** 10 pF **4:** 12.5 pF **5:** 15 pF **6:** 17.5 pF **7:** 20 pF
[15:0]	Reserved [15:0]	Reserved Default: 0x0 Range:

11.0.414 MIN_FAT_FINGER_SIZE_ON

[TTHE Group] Register Name : Address

[Finger Tracking] MIN_FAT_FINGER_SIZE_ON : CYTT21X/31X (40, 44, 48 IOs) - 0x03DD, CYTMA445A - 0x0375, CYTT21X (28, 33, 35, 36 IOs) - 0x0405

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0xa							
Bit Name	Min Fat Finger Size On[7:0]							

Minimum number of contiguous activated panel intersections that define a fat finger. It is used when a fat finger was not detected yet.

Bits	Name	Description
[7:0]	Min Fat Finger Size On [7:0]	Minimum number of contiguous activated panel intersections that define a fat finger. It is used when a fat finger was not detected yet. Default: 0xa Range: 0-255

11.0.415 SAFE_RAW_RANGE_PERCENT_MUTUAL

[TTHE Group] Register Name : Address

[Calibration] SAFE_RAW_RANGE_PERCENT_MUTUAL : CYTT21X/31X (40, 44, 48 IOs) - 0x005D, CYTMA445A - 0x0059, CYTT21X (28, 33, 35, 36 IOs) - 0x005D

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x19							
Bit Name	Safe Range[7:0]							

Safe range of average Raw Value in MutualCap mode

Bits	Name	Description
[7:0]	Safe Range [7:0]	Safe range of average Raw Value Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0x19 Range: 5:95

11.0.416 OFF_THRSH

[TTHE Group] Register Name : Address

[Proximity] OFF_THRSH : CYTMA445A - 0x0358, CYTT21X (28, 33, 35, 36 IOs) - 0x03E4

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x00							
Bit Name	offThreshold[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x48							
Bit Name	offThreshold[7:0]							

Threshold for proximity removal

Bits	Name	Description
[15:0]	offThreshold [15:0]	Threshold for proximity removal Default: 0xc8 Range: 0:32767

11.0.417 TX_PULSES_NUM_SELF

[TTHE Group] Register Name : Address

[CDC] TX_PULSES_NUM_SELF : CYTT21X/31X (40, 44, 48 IOs) - 0x0098, CYTMA445A - 0x0096, CYTT21X (28, 33, 35, 36 IOs) - 0x0094

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x00							
Bit Name	TX Pulses[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x40							
Bit Name	TX Pulses[7:0]							

Self Scanning Number of TX Pulses

Bits	Name	Description
[15:0]	TX Pulses [15:0]	Number of TX Pulses per conversion for Self Cap scan Default: 0x40 Range: 1:255

11.0.418 MAX_SELF_SIG_THRESHOLD

[TTHE Group] Register Name : Address

[Raw Processing] MAX_SELF_SIG_THRESHOLD : CYTT21X/31X (40, 44, 48 IOs) - 0x026C, CYTMA445A - 0x0210, CYTT21X (28, 33, 35, 36 IOs) - 0x0268

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x0c							
Bit Name	Value[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x00							
Bit Name	Value[7:0]							

Threshold to reset self signals for H2O rejection enabled to baseline signals from large amount of water, large ungrounded object on the panel or signals after wiping water. Condition to reset is (maxSelfSig < maxSelfSigThreshold).

Bits	Name	Description
[15:0]	Value [15:0]	Threshold to reset self signals for H2O rejection enabled to baseline signals from large amount of water, large ungrounded object on the panel or signals after wiping water. Condition to reset is (maxSelfSig < maxSelfSigThreshold). Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0xc80 Range: 0:65535

11.0.419 FILT_FILTER_MASK_STYLUS_MUT

[TTHE Group] Register Name : Address

[Raw Processing] FILT_FILTER_MASK_STYLUS_MUT : CYTT21X/31X (40, 44, 48 IOs) - 0x02EE

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x0						RW: 0x1	RW: 0x1
Bit Name	Reserved[7:2]						IIR Fil-ter[1:1]	CMF Fil-ter[0:0]

Indicates what filters are enabled/disabled for Stylus Mutual

Bits	Name	Description
[7:2]	Reserved [5:0]	Default: 0x0 Range:
[1:1]	IIR Filter [0:0]	Enable/Disable IIR Filter Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0x1 **0:** Disabled - Filter is Disabled **1:** Enabled - Filter is Enabled
[0:0]	CMF Filter [0:0]	Enable/Disable CMF Filter Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0x1 **0:** Disabled - Filter is Disabled **1:** Enabled - Filter is Enabled

11.0.420 FILT_FILTER_MASK_BTN_MUT

[TTHE Group] Register Name : Address

[Raw Processing] FILT_FILTER_MASK_BTN_MUT : CYTT21X/31X (40, 44, 48 IOs) - 0x02B8, CYTMA445A - 0x0268, CYTT21X (28, 33, 35, 36 IOs) - 0x02D0

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x0						RW: 0x1	RW: 0x1
Bit Name	Reserved[7:2]						IIR Filter[1:1]	CMF Filter[0:0]

Indicates what filters are enabled/disabled for Base Button Mutual

Bits	Name	Description
[7:2]	Reserved [5:0]	Default: 0x0 Range:
[1:1]	IIR Filter [0:0]	Enable/Disable IIR Filter Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0x1 **0:** Disabled - Filter is Disabled **1:** Enabled - Filter is Enabled
[0:0]	CMF Filter [0:0]	Enable/Disable CMF Filter Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0x1 **0:** Disabled - Filter is Disabled **1:** Enabled - Filter is Enabled

11.0.421 TX_PERIOD_BTN_SELF

[TTHE Group] Register Name : Address

[CDC] TX_PERIOD_BTN_SELF : CYTT21X/31X (40, 44, 48 IOs) - 0x0088, CYTMA445A - 0x009C, CYTT21X (28, 33, 35, 36 IOs) - 0x0084

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x00							
Bit Name	txPeriodButtonSelf[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x20							
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, Button Self Cap Glove scan Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0xa0 Range: 48:510

11.0.422 SCALING_FACTOR_PROXIMITY

[TTHE Group] Register Name : Address

[CDC] SCALING_FACTOR_PROXIMITY : CYTMA445A - 0x004A, CYTT21X (28, 33, 35, 36 IOs) - 0x004E

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x00							
Bit Name	Scale Factor[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x48							
Bit Name	Scale Factor[7:0]							

Proximity Self Capacitance Raw Data Scaling Factor

Bits	Name	Description
[15:0]	Scale Factor [15:0]	Percentage scaling factor for Proximity Self Cap scan Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0xc8 Range: 0:1000

11.0.423 GLOVE_OUTER_EDGE_GAIN

[TTHE Group] Register Name : Address

[Glove] GLOVE_OUTER_EDGE_GAIN : CYTT21X/31X (40, 44, 48 IOs) - 0x043A, CYTMA445A - 0x03D4, CYTT21X (28, 33, 35, 36 IOs) - 0x0462

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x78							
Bit Name	Gain[7:0]							

Outer edge gain in Glove Mode

Bits	Name	Description
[7:0]	Gain [7:0]	Outer edge gain in Glove Mode Default: 0x78 Range: 0:255

11.0.424 STYL_STYLUS_MASS

[TTHE Group] Register Name : Address

[Stylus Tracking] STYL_STYLUS_MASS : CYTT21X/31X (40, 44, 48 IOs) - 0x0448

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x01							
Bit Name	Threshold[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x6d							
Bit Name	Threshold[7:0]							

Mutual Cap diff count sum of the 3x3 sensors around the peak sensor in the panel core.

Bits	Name	Description
[15:0]	Threshold [15:0]	Mutual Cap diff count sum of the 3x3 sensors around the peak sensor in the panel core. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0x16d Range: 0:5000

11.0.425 TX_PERIOD_GLOVE_SELF

[TTHE Group] Register Name : Address

[CDC] TX_PERIOD_GLOVE_SELF : CYTMA445A - 0x00A8

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x00							
Bit Name	txPeriodGlove[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x20							
Bit Name	txPeriodGlove[7:0]							

Integration Time

Bits	Name	Description
[15:0]	txPeriodGlove [15:0]	Number of system clocks in each TX half period for Self Cap Glove scan Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0xa0 Range: 48:510

11.0.426 CA_WB_CMF_ENABLE

[TTHE Group] Register Name : Address

[Charger Armor] CA_WB_CMF_ENABLE : CYTT21X/31X (40, 44, 48 IOs) - 0x0310, CYTMA445A - 0x02B4, CYTT21X (28, 33, 35, 36 IOs) - 0x0328

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x0							RW: 0x1
Bit Name	Reserved[7:1]							Value[0:0]

Enable/Disable common mode noise filter during wide band noise detection.

Bits	Name	Description
[7:1]	Reserved [6:0]	Default: 0x0 Range:
[0:0]	Value [0:0]	Enable/Disable common mode noise filter during wide band noise detection. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0x1 **0:** Disabled - Disable common mode noise filter during wide band noise detection. **1:** Enabled - Enable common mode noise filter during wide band noise detection.

11.0.427 TX_PULSES_NUM_STYLUS_SELF

[TTHE Group] Register Name : Address

[CDC] TX_PULSES_NUM_STYLUS_SELF : CYTT21X/31X (40, 44, 48 IOs) - 0x00AA

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x00							
Bit Name	TX Pulses[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x40							
Bit Name	TX Pulses[7:0]							

Number of TX Pulses for Stylus Self Scanning

Bits	Name	Description
[15:0]	TX Pulses [15:0]	Number of TX Pulses per conversion for Stylus Self Scan Default: 0x40 Range: 0:255

11.0.428 MIN_FAT_FINGER_SIG_SUM_ON_EDGE

[TTHE Group] Register Name : Address

[Finger Tracking] MIN_FAT_FINGER_SIG_SUM_ON_EDGE : CYTT21X/31X (40, 44, 48 IOs) - 0x03BC, CYTMA445A - 0x0344, CYTT21X (28, 33, 35, 36 IOs) - 0x03D0

Bits	31	30	29	28	27	26	25	24
Access:POR	RW: 0x00							
Bit Name	Threshold[31:24]							
Bits	**23**	**22**	**21**	**20**	**19**	**18**	**17**	**16**
Access:POR	RW: 0x00							
Bit Name	Threshold[23:16]							
Bits	**15**	**14**	**13**	**12**	**11**	**10**	**9**	**8**
Access:POR	RW: 0x6a							
Bit Name	Threshold[15:8]							
Bits	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
Access:POR	RW: 0x60							
Bit Name	Threshold[7:0]							

The minimum signal sum of fat-finger when 2 or more peaks detected on the panel edge; default value: 4 times of HTI of 12mm finger.

Bits	Name	Description
[31:0]	Threshold [31:0]	The minimum signal sum of fat-finger when 2 or more peaks detected on the panel edge; default value: 4 times of HTI of 12mm finger. Default: 0xea60 Range: 0:500000

11.0.429 SENSOR_ASSIGNMENT

[TTHE Group] Register Name : Address

[Device Setup] SENSOR_ASSIGNMENT : CYTT21X/31X (40, 44, 48 IOs) - 0x0011, CYTMA445A - 0x0011, CYTT21X (28, 33, 35, 36 IOs) - 0x0011

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x0							RW: 0x1
Bit Name	Reserved[7:1]							Axis Assignment[0:0]

Assignment of X/Y axes to TX/RX axes

Bits	Name	Description
[7:1]	Reserved [6:0]	Reserved Default: 0x0 Range:
[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: 0x1 **0:** RX = X; TX = Y **1:** RX = Y; TX = X

11.0.430 SAFE_RAW_RANGE_PERCENT_SELF

[TTHE Group] Register Name : Address

[Calibration] SAFE_RAW_RANGE_PERCENT_SELF : CYTT21X/31X (40, 44, 48 IOs) - 0x005E, CYTMA445A - 0x005A, CYTT21X (28, 33, 35, 36 IOs) - 0x005E

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x32							
Bit Name	Safe Range[7:0]							

Safe range of average Raw Value in SelfCap mode

Bits	Name	Description
[7:0]	Safe Range [7:0]	Safe range of average Raw Value Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0x32 Range: 5:95

11.0.431 SAFE_RAW_RANGE_PERCENT_BTN_SELF

[TTHE Group] Register Name : Address

[Calibration] SAFE_RAW_RANGE_PERCENT_BTN_SELF : CYTT21X/31X (40, 44, 48 IOs) - 0x0060, CYTMA445A - 0x005C, CYTT21X (28, 33, 35, 36 IOs) - 0x0060

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x32							
Bit Name	Safe Range[7:0]							

Safe range of average Raw Value for Buttons in SelfCap mode

Bits	Name	Description
[7:0]	Safe Range [7:0]	Safe range of average Raw Value Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate RWC Command). Default: 0x32 Range: 5:95

11.0.432 RANGE_DATA_RESET

[TTHE Group] Register Name : Address

[Raw Processing] RANGE_DATA_RESET : CYTT21X/31X (40, 44, 48 IOs) - 0x0270, CYTT21X (28, 33, 35, 36 IOs) - 0x026C

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x00							
Bit Name	Value[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x03							
Bit Name	Value[7:0]							

This parameter set the range [-rangeDataReset, +rangeDataReset] that signal within this range will not been counted to calculation of averageValueOfMutualSignals.

Bits	Name	Description
[15:0]	Value [15:0]	This parameter set the range [-rangeDataReset, +rangeDataReset] that signal within this range will not been counted to calculation of averageValueOfMutualSignals. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0x3 Range: 0:65535

11.0.433 XY_FILT_XY_FAST_THR_CA

[TTHE Group] Register Name : Address

[Charger Armor] XY_FILT_XY_FAST_THR_CA : CYTT21X/31X (40, 44, 48 IOs) - 0x0470, CYTMA445A - 0x03F4, CYTT21X (28, 33, 35, 36 IOs) - 0x0480

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0xff							
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 Default: 0xff Range: 0:255

11.0.434 FILT_IIR_THRESHOLD_GLOVE_MUT

[TTHE Group] Register Name : Address

[Raw Processing] FILT_IIR_THRESHOLD_GLOVE_MUT : CYTT21X/31X (40, 44, 48 IOs) - 0x02D8, CYTMA445A - 0x0288, CYTT21X (28, 33, 35, 36 IOs) - 0x02F0

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x00							
Bit Name	Value[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x14							
Bit Name	Value[7:0]							

IIR Threshold for Glove Mutual

Bits	Name	Description
[15:0]	Value [15:0]	IIR Threshold Glove for Mutual Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0x14 Range: 0:32767

11.0.435 BALANCING_TARGET_MUTUAL

[TTHE Group] Register Name : Address

[Calibration] BALANCING_TARGET_MUTUAL : CYTT21X/31X (40, 44, 48 IOs) - 0x006A, CYTMA445A - 0x0066, CYTT21X (28, 33, 35, 36 IOs) - 0x006A

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x1e							
Bit Name	Balancing Target Mut[7:0]							

Integrator Balancing target in Mutual Mode

Bits	Name	Description
[7:0]	Balancing Target Mut [7:0]	Balancing target in Mutual Mode Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0x1e Range: 5:95

11.0.436 LARGE_OBJECT_DEBOUNCE

[TTHE Group] Register Name : Address

[Finger Tracking] LARGE_OBJECT_DEBOUNCE : CYTT21X/31X (40, 44, 48 IOs) - 0x037C, CYTT21X (28, 33, 35, 36 IOs) - 0x0390

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x5							
Bit Name	Large Object Debounce[7:0]							

Debounce specifies number of scans to remove new touches can be detected during Large Object LiftOff transient process

Bits	Name	Description
[7:0]	Large Object Debounce [7:0]	Debounce specifies number of scans to remove new touches can be detected during Large Object LiftOff transient process Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0x5 Range: 0:255

11.0.437 DEBOUNCE_AFTER_REMOVE

[TTHE Group] Register Name : Address

[Proximity] DEBOUNCE_AFTER_REMOVE : CYTMA445A - 0x0361, CYTT21X (28, 33, 35, 36 IOs) - 0x03ED

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x1							
Bit Name	debounceAfterRemove[7:0]							

Number of frames to debounce before reporting proximity object removal.

Bits	Name	Description
[7:0]	debounceAfterRemove [7:0]	Number of frames to debounce before reporting proximity object removal. Modifying this parameter affects the baseline data and requires the host to perform a recalibration (see Calibrate PWC Command). Default: 0x1 Range: 0:255

11.0.438 LIFTOFF_DEBOUNCE

[TTHE Group] Register Name : Address

[Finger Tracking] LIFTOFF_DEBOUNCE : CYTT21X/31X (40, 44, 48 IOs) - 0x0353, CYTMA445A - 0x02EF, CYTT21X (28, 33, 35, 36 IOs) - 0x036F

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x0							
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 Default: 0x0 Range: 0:63

11.0.439 GRIP_FIRST_EXC

[TTHE Group] Register Name : Address

[Finger Tracking] GRIP_FIRST_EXC : CYTT21X/31X (40, 44, 48 IOs) - 0x0350, CYTMA445A - 0x02EC, CYTT21X (28, 33, 35, 36 IOs) - 0x036C

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x0							RW: 0x1
Bit Name	Reserved[7:1]							First Touch Reporting[0:0]

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

Bits	Name	Description
[7:1]	Reserved [6:0]	Default: 0x0 Range:
[0:0]	First Touch Reporting [0:0]	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 2 regardless the origin area. All subsequent touches are ignored if originate from the suppressed regions. All subsequent touches are reported to the 2 if they originate from the core area or exception areas. Default: 0x1 **0:** Disabled - Disable GRIP_FIRST_EXC **1:** Enabled - Enable GRIP_FIRST_EXC

11.0.440 TOUCHMODE_FINGER_EXIT_DELAY

[TTHE Group] Register Name : Address

[Touch Mode] TOUCHMODE_FINGER_EXIT_DELAY : CYTT21X/31X (40, 44, 48 IOs) - 0x035E, CYTMA445A - 0x02FC, CYTT21X (28, 33, 35, 36 IOs) - 0x037A

Bits	15	14	13	12	11	10	9	8
Access:POR	RW: 0x00							
Bit Name	fingerExitDelay[15:8]							

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x00							
Bit Name	fingerExitDelay[7:0]							

Parameter for transition Finger->LFT. Time in mS after Finger lift-off during which Finger scan mode will performed.

Bits	Name	Description
[15:0]	fingerExitDelay [15:0]	Parameter for transition Finger->LFT. Time in mS after Finger lift-off during which Finger scan mode will performed, Glove will not be detected during this period. Default: 0x0 Range: 0:65535

11.0.441 H2O_REJECTION_SNS_WIDTH

[TTHE Group] Register Name : Address

[Scan Filtering] H2O_REJECTION_SNS_WIDTH : CYTT21X/31X (40, 44, 48 IOs) - 0x0378, CYTMA445A - 0x0304, CYTT21X (28, 33, 35, 36 IOs) - 0x038C

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x0							
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) Default: 0x0 Range: 0:7

11.0.442 LOW_POWER_ENABLE

[TTHE Group] Register Name : Address

[Device Setup] LOW_POWER_ENABLE : CYTT21X/31X (40, 44, 48 IOs) - 0x032C, CYTMA445A - 0x02CA, CYTT21X (28, 33, 35, 36 IOs) - 0x0344

Bits	7	6	5	4	3	2	1	0
Access:POR	RW: 0x0							RW: 0x0
Bit Name	Reserved[7:1]							LOW_POWER_ENABLE[0:0]

Enable low power mode

Bits	Name	Description
[7:1]	Reserved [6:0]	Default: 0x0 Range:
[0:0]	LOW_POWER_ENABLE [0:0]	Enable low power mode Default: 0x0 **0:** Disabled - Disable low power mode **1:** Enabled - Enable low power mode

Section E: 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	Analog signals vary in a continuous form with respect to continuous times. As opposed to digital, which are signals that are on or off or '1' or '0'.
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 difference count 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 touchscreen 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 involve 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 0 to 14.

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.