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TouchXpress™ Family
CPT212B Data Sheet

The CPT212B device, part of the TouchXpress family, is designed to quickly add capacitive touch via an I2C interface by eliminating the firmware complexity and reducing the development time for capacitive sensing applications.

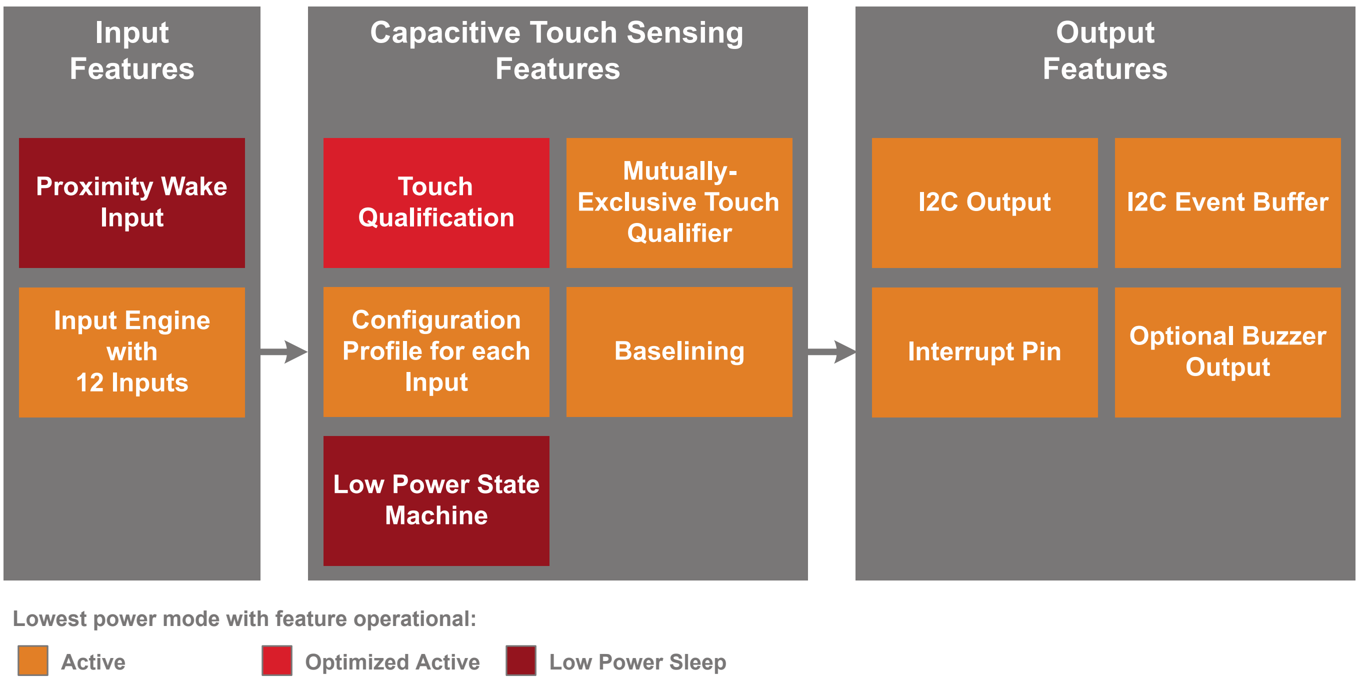
Supporting up to 12 capacitive sensor inputs in packages as small as a 3 mm x 3 mm QFN, the CPT212B is a highly-integrated device that interfaces via I2C to the host processor to provide a simple solution for adding capacitive touch. The device also comes with advanced features like moisture immunity, wake-on proximity, and buzzer feedback for an enhanced user experience. No firmware development is needed, and all the capacitive touch sense parameters can be configured using a simple GUI-based configurator. By eliminating the need for complex firmware development, the CPT212B device enables rapid user interface designs with minimal development effort.

The CPT212B device is ideal for a wide range of capacitive touch applications including the following:

- Home appliances
- Instrument / Control panels
- White goods
- Medical equipment
- Consumer electronics
- Lighting control

KEY FEATURES

- No firmware development required
- Simple GUI-based configurator
- 12 Capacitive Sensor inputs with programmable sensitivity
- I2C interface to communicate to and configure from the host
- Lowest power capacitive sense solution
  - Active — 200 µA
  - Sleep — 1 µA
- Wake on proximity
- Superior noise immunity: SNR up to 270:1
- Moisture immunity
- Mutually-exclusive touch qualifier
- Buzzer output for audible touch feedback



1. Feature List and Ordering Information

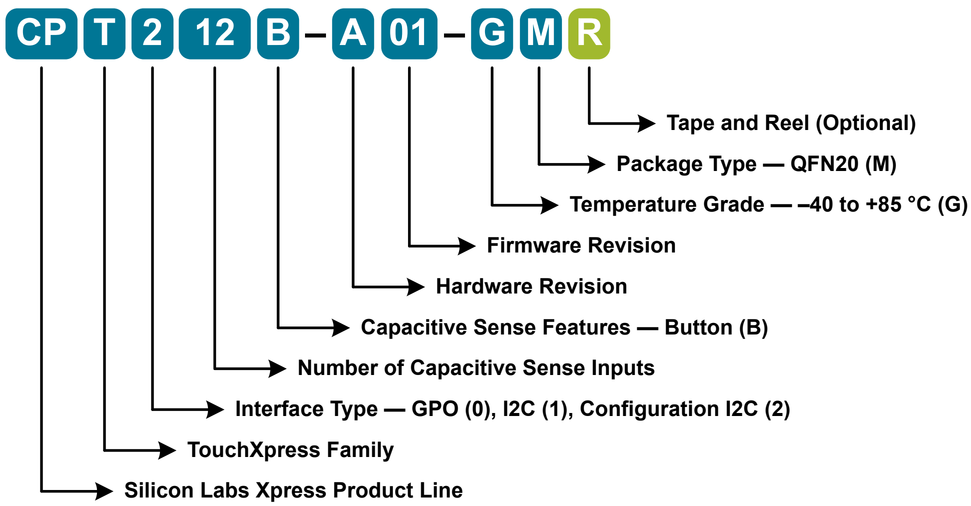


Figure 1.1. CPT212B Part Numbering

The CPT212B has the following features:

- Capacitive sensing input engine with 12 inputs
- Post-sample touch qualification engine
- Configuration profile space in non-volatile memory
- I2C event buffer with interrupt pin to signal when new touch events have been qualified
- Configuration loading with both the dedicated configuration interface and through the I2C interface
- Low power state machine to minimize current draw in all use cases
- Capacitive proximity sensing input
- Buzzer output
- Mutually-exclusive touch qualifier

Table 1.1. Product Selection Guide

Ordering Part Number	Configuration over I2C	Pb-free (RoHS Compliant)	Temperature Range	Package
CPT212B-A01-GM	Yes	Yes	-40 to +85 °C	QFN20

See http://www.silabs.com/products/interface/capacitive-touch-controllers for other devices available in the TouchXpress family.

Table of Contents

2. Typical Connection Diagrams

2.1 Signal, Analog, and Power Connections

Figure 2.1 Connection Diagram on page 5 shows a typical connection diagram for the power pins of CPT212B devices.

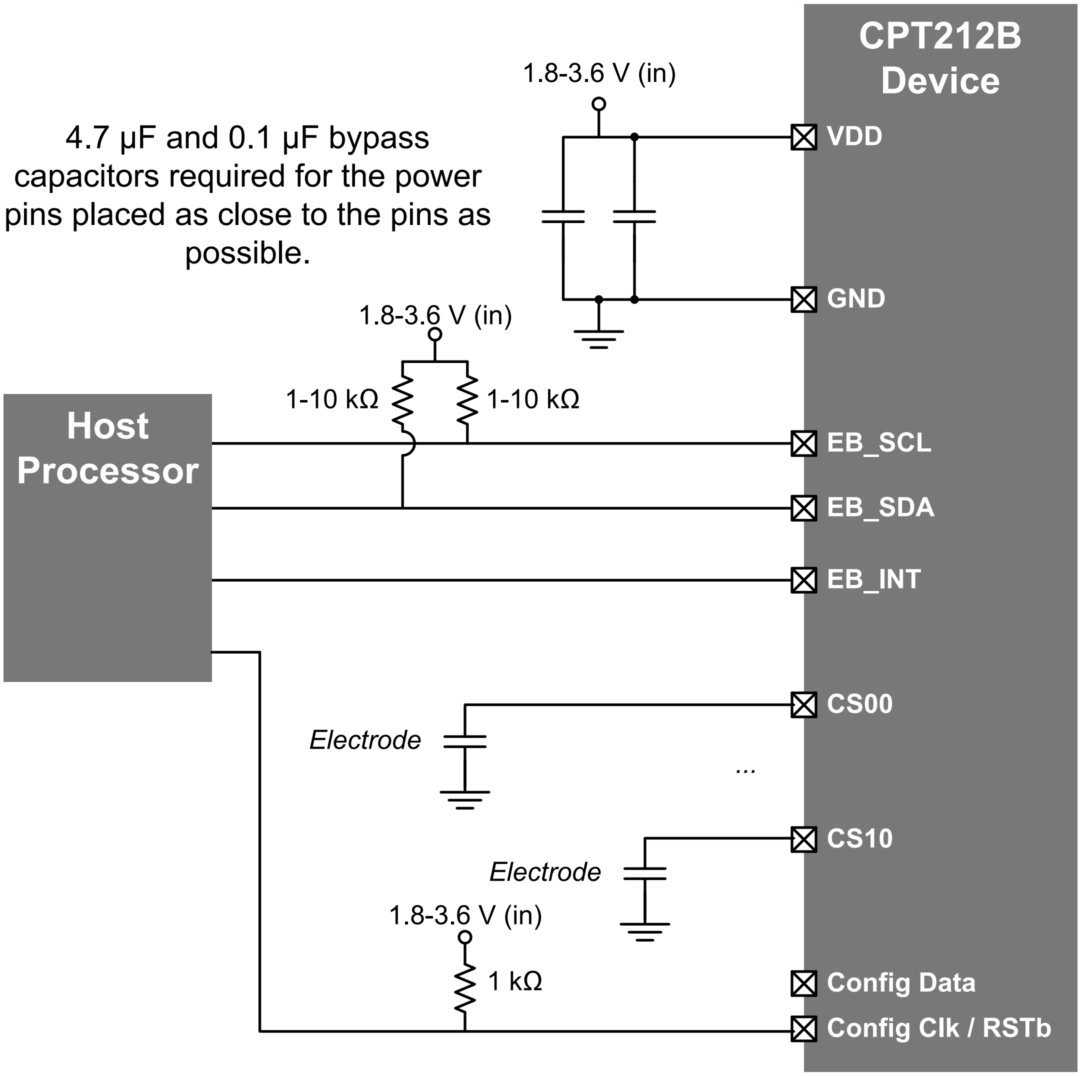


Figure 2.1. Connection Diagram

Note: The I2C pull-up resistor values will vary depending on the speed requirements of the bus and the host processor requirements.

2.2 Configuration

There are two ways to configure the CPT212B: through the I2C interface, and through the dedicated configuration interface. The diagram below shows a typical connection diagram for the dedicated configuration interface pins. The ToolStick Base Adapter is available on the evaluation board.

Note: The USB Debug Adapter does not support configuration for TouchXpress devices. Instead, the ToolStick Base Adapter must be used to configure these devices.

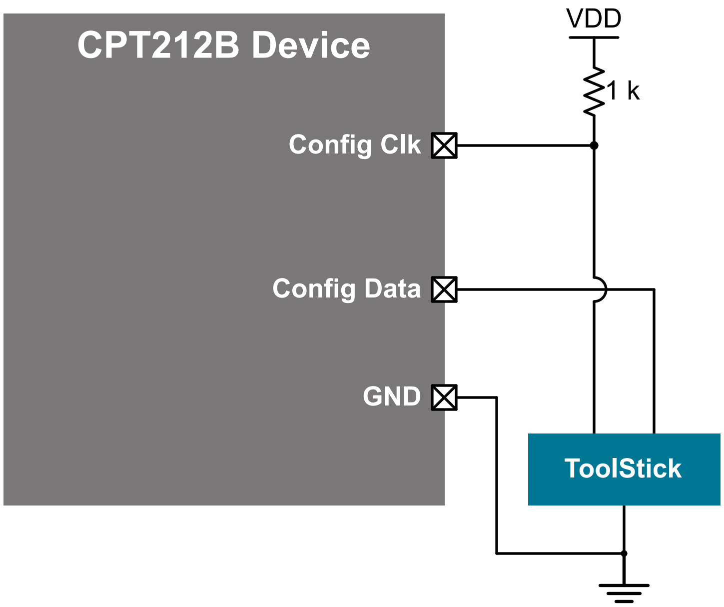


Figure 2.2. Configuration Connection Diagram

3. Electrical Specifications

3.1 Electrical Characteristics

All electrical parameters in all tables are specified under the conditions listed in 3.1.1 Recommended Operating Conditions, unless stated otherwise.

3.1.1 Recommended Operating Conditions

Table 3.1. Recommended Operating Conditions

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
Operating Supply Voltage on VDD	V_{DD}		1.8	2.4	3.6	V
Minimum RAM Data Retention Voltage on VDD[1]	V_{RAM}	Not in Sleep Mode	—	1.4	—	V
		Sleep Mode	—	0.3	0.5	V
Operating Ambient Temperature	T_A		–40	—	85	°C

Note:

1. All voltages with respect to GND.

3.1.2 Power Consumption

See 3.4 Typical Performance Curves for power consumption plots.

Table 3.2. Power Consumption

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
Active Mode Supply Current	I_{DD}	Sensing Mode	—	3.1	—	mA
		Configuration Mode	—	3.1	—	mA
Optimized Active Mode Supply Current	I_{DD}		—	180	—	µA
Sleep Mode Current[1, 2]	I_{DD}	3 sensors or fewer	—	0.78	—	µA
		4 sensors	—	0.79	—	µA
		5 sensors	—	0.81	—	µA
		6 sensors	—	0.82	—	µA
		7 sensors	—	0.84	—	µA
		10 sensors	—	0.88	—	µA
		12 sensors	—	0.95	—	µA
System Current with Varying Scan Time — Base with One Sensor[1]	I_{DD}	Scan period = 10 ms	—	154	—	µA
		Scan period = 20 ms	—	77	—	µA
		Scan period = 50 ms	—	31	—	µA
		Scan period = 75 ms	—	21	—	µA
		Scan period = 100 ms	—	16	—	µA
System Current with Varying Scan Time — Each Additional Sensor[1]	I_{DD}	Scan period = 10 ms	—	47	—	µA
		Scan period = 20 ms	—	23	—	µA
		Scan period = 50 ms	—	9	—	µA
		Scan period = 75 ms	—	6	—	µA
		Scan period = 100 ms	—	5	—	µA

Note:

1. Measured with Free Run Mode disabled and sensors set to 4x accumulation, 8x gain.
2. Measured with scan period set to 250 ms.

3.1.3 Reset and Supply Monitor

Table 3.3. Reset and Supply Monitor

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
VDD Supply Monitor Threshold	V_{VDDM}	Reset Trigger	1.7	1.75	1.8	V
	V_{WARN}	Early Warning	1.8	1.85	1.9	V
Power-On Reset (POR) Monitor Threshold	V_{POR}	Rising Voltage on V_{DD}	—	1.75	—	V
		Falling Voltage on V_{DD}	0.75	1.0	1.3	V
V_{DD} Ramp Time	t_{RMP}	Time to $V_{DD} \geq 1.8$ V	—	—	3	ms
RST Low Time to Generate Reset	t_{RSTL}		15	—	—	µs
Boot Time[1]	t_{boot}	1 sensor	—	25	—	ms
		2 sensors	—	40	—	ms
		3 sensors	—	55	—	ms
		4 sensors	—	70	—	ms
		5 sensors	—	85	—	ms
		6 sensors	—	100	—	ms
		7 sensors	—	115	—	ms
		8 sensors	—	130	—	ms
		9 sensors	—	145	—	ms
		10 sensors	—	160	—	ms
		11 sensors	—	175	—	ms
		12 sensors	—	200	—	ms

Note:

1. Boot time is defined as the time from when the device enters sensing mode until the first capacitive sensing scan occurs.

3.1.4 Configuration Memory

Table 3.4. Configuration Memory

Parameter	Symbol	Test Condition	Min	Typ	Max	Units
Endurance (Write/Erase Cycles)	N_{WE}		20 k	100 k	—	Cycles

Note:

1. Data Retention Information is published in the Quarterly Quality and Reliability Report.

3.1.5 I2C Configuration Interface

Table 3.5. I2C Configuration Interface

Parameter	Symbol	Test Condition	Min	Typ	Max	Units
I2C Configuration Interface Boot Time	t_{I2C_boot}	Time after any reset until the I2C Configuration Interface is ready to receive commands	—	200	—	µs
I2C Configuration Erase Delay	t_{erase}		—	45	—	ms
I2C Configuration Write Delay	t_{write}		—	1	—	ms
I2C Configuration CRC Delay	t_{CRC}		—	45	—	ms
I2C Configuration Validity Check Delay	t_{valid}		—	200	—	µs
Interrupt Pin Low Time After Entering Sensing Mode	t_{INT_low}		—	—	5	µs

3.1.6 Capacitive Sense

Table 3.6. Capacitive Sense

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
Scan Time Per Sensor[1]	t_{SCAN}	Accumulation = 1x	—	64	—	µs
		Accumulation = 4x	—	256	—	µs
		Accumulation = 8x	—	512	—	µs
		Accumulation = 16x	—	1.024	—	ms
		Accumulation = 32x	—	2.048	—	ms
		Accumulation = 64x	—	4.096	—	ms
Signal to Noise Ratio[1, 2]	SNR	Accumulation = 1x	—	90:1	—	codes
		Accumulation = 4x	—	180:1	—	codes
		Accumulation = 8x	—	182:1	—	codes
		Accumulation = 16x	—	210:1	—	codes
		Accumulation = 32x	—	230:1	—	codes
		Accumulation = 64x	—	270:1	—	codes
Conversion Time	t_{CONV}	Gain = 1x	—	205	—	µs
		Gain = 2x	—	123	—	µs
		Gain = 3x	—	98	—	µs
		Gain = 4x	—	85	—	µs
		Gain = 5x	—	76	—	µs
		Gain = 6x	—	72	—	µs
		Gain = 7x	—	67	—	µs
		Gain = 8x	—	64	—	µs
Total Processing Time[3]	t_{PROC}	1 sensor	—	576	—	µs
		2 sensors	—	796	—	µs
		3 sensors	—	1.0	—	ms
		4 sensors	—	1.2	—	ms
		5 sensors	—	1.4	—	ms
		6 sensors	—	1.7	—	ms
		7 sensors	—	1.9	—	ms
		8 sensors	—	2.1	—	ms
		9 sensors	—	2.3	—	ms
		10 sensors	—	2.6	—	ms
		11 sensors	—	2.8	—	ms
		12 sensors	—	3.0	—	ms
Maximum External Capacitive Load	C_{EXTMAX}	Gain = 8x	—	45	—	pF
		Gain = 1x	—	500	—	pF

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
Maximum External Series Impedance	R_{EXTMAX}	Gain = 8x	—	50	—	kΩ

Note:
1. Measured with gain set to 8x.
2. Measured with an evaluation board with 1/16" overlay using Capacitive Sense Profiler.
3. Sensors configured to 8x gain, 1x accumulation with sensor sampling and system processing time included and mutually-exclusive buttons, buzzer, and touch time-outs disabled.

3.1.7 Buzzer Output

Table 3.7. Buzzer Output

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
Output High Voltage (High Drive)	V_{OH}	I_{OH} = –3 mA	V_{DD} – 0.7	—	—	V
Output Low Voltage (High Drive)	V_{OL}	I_{OL} = 8.5 mA	—	—	0.6	V
Output High Voltage (Low Drive)	V_{OH}	I_{OH} = –1 mA	V_{DD} – 0.7	—	—	V
Output Low Voltage (Low Drive)	V_{OL}	I_{OL} = 1.4 mA	—	—	0.6	V
Weak Pull-Up Current	I_{PU}	V_{DD} = 1.8 V V_{IN} = 0 V	—	–4	—	µA
		V_{DD} = 3.6 V V_{IN} = 0 V	–35	–20	—	µA

3.2 Thermal Conditions

Table 3.8. Thermal Conditions

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
Thermal Resistance*	θ_{JA}	QFN20 Packages	—	60	—	°C/W

Note:
1. Thermal resistance assumes a multi-layer PCB with any exposed pad soldered to a PCB pad.

3.3 Absolute Maximum Ratings

Stresses above those listed in Table 3.9 Absolute Maximum Ratings on page 13 may cause permanent damage to the device. This is a stress rating only and functional operation of the devices at those or any other conditions above those indicated in the operation listings of this specification is not implied. Exposure to maximum rating conditions for extended periods may affect device reliability. For more information on the available quality and reliability data, see the Quality and Reliability Monitor Report at http://www.silabs.com/support/quality/pages/default.aspx.

Table 3.9. Absolute Maximum Ratings

Parameter	Symbol	Test Condition	Min	Max	Unit
Ambient Temperature Under Bias	T_{BIAS}		–55	125	°C
Storage Temperature	T_{STG}		–65	150	°C
Voltage on V_{DD}	V_{DD}		GND–0.3	4.0	V
Voltage on I/O pins or RSTb	V_{IN}		GND–0.3	V_{DD} + 0.3	V
Total Current Sunk into Supply Pin	I_{VDD}		—	400	mA
Total Current Sourced out of Ground Pin	I_{GND}		400	—	mA
Current Sourced or Sunk by Any I/O Pin or RSTb	I_{IO}		–100	100	mA
Maximum Total Current through all Port Pins	I_{IOTOT}		—	200	mA
Operating Junction Temperature	T_J		–40	105	°C
Exposure to maximum rating conditions for extended periods may affect device reliability.					

3.4 Typical Performance Curves

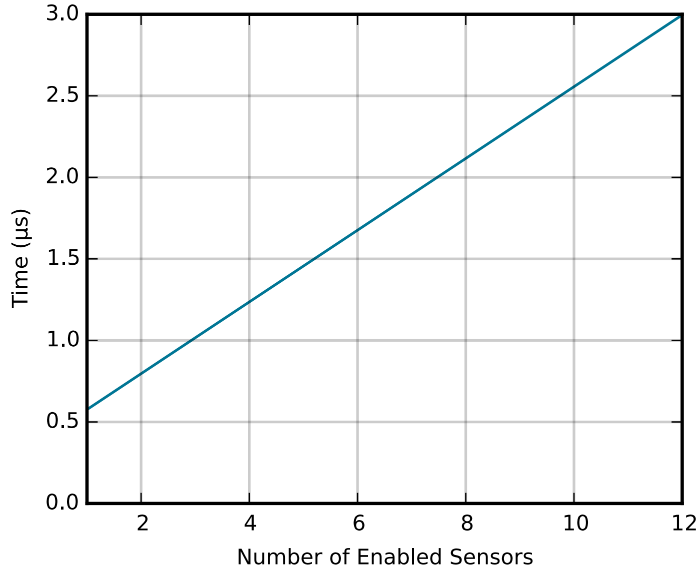


Figure 3.1. Active Mode Processing Time Per Sensor

Note: Active mode processing time per sensor measured with sensors configured to 1x accumulation, 8x gain. Sensor sampling and system processing time is included with mutually-exclusive buttons, the buzzer, and touch time-outs disabled.

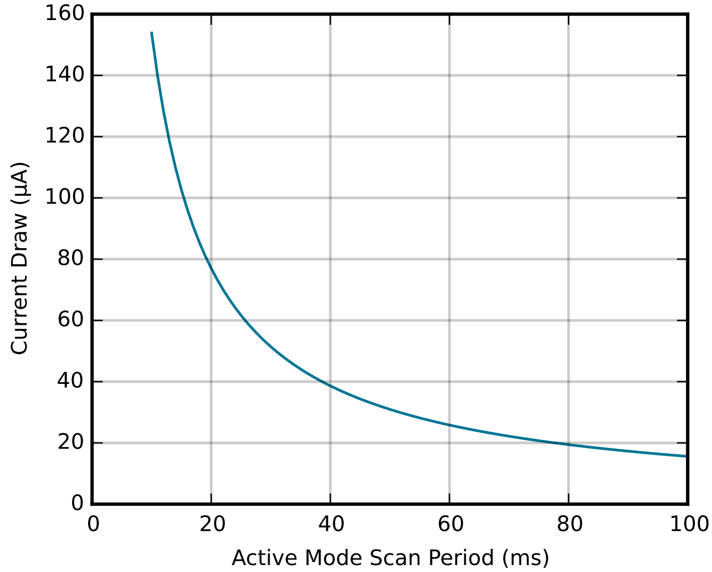


Figure 3.2. Current vs. Active Mode Scan Period — Base Current Consumption

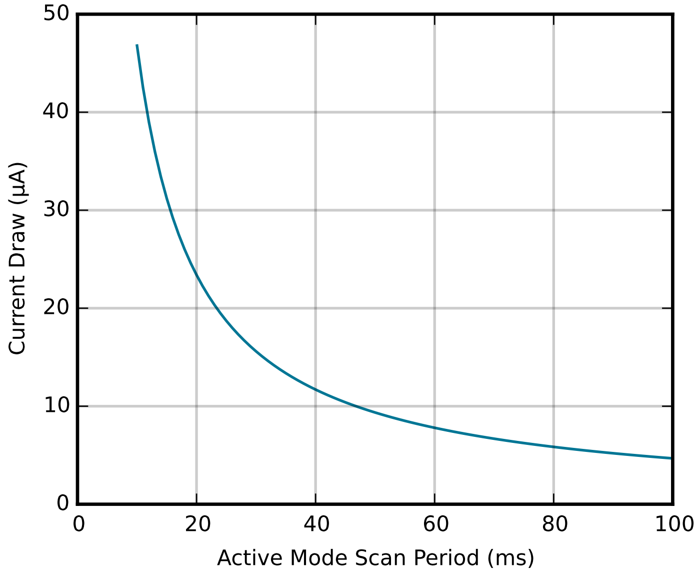


Figure 3.3. Current vs. Active Mode Scan Period — Current Consumption for Each Additional Sensor

Note: Active mode scan period current draw measured with free run mode disabled and all 12 sensors enabled at 4x accumulation, 8x gain. In addition, the buzzer, and mutually-exclusive button groups were disabled.

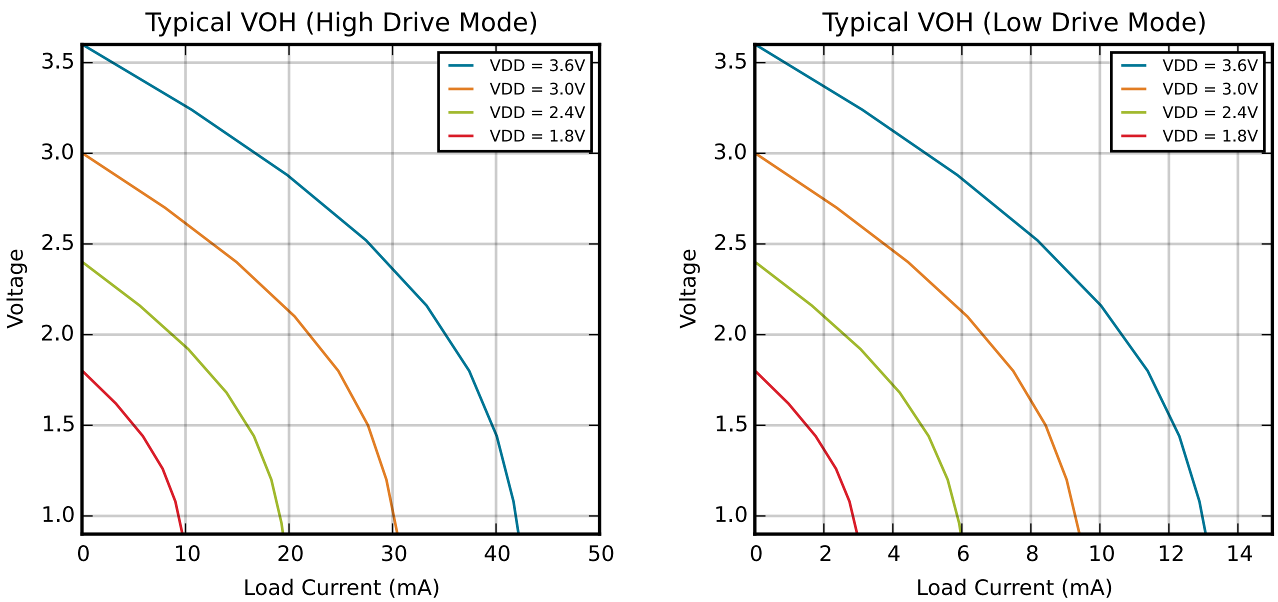


Figure 3.4. Typical V_{OH} Curves

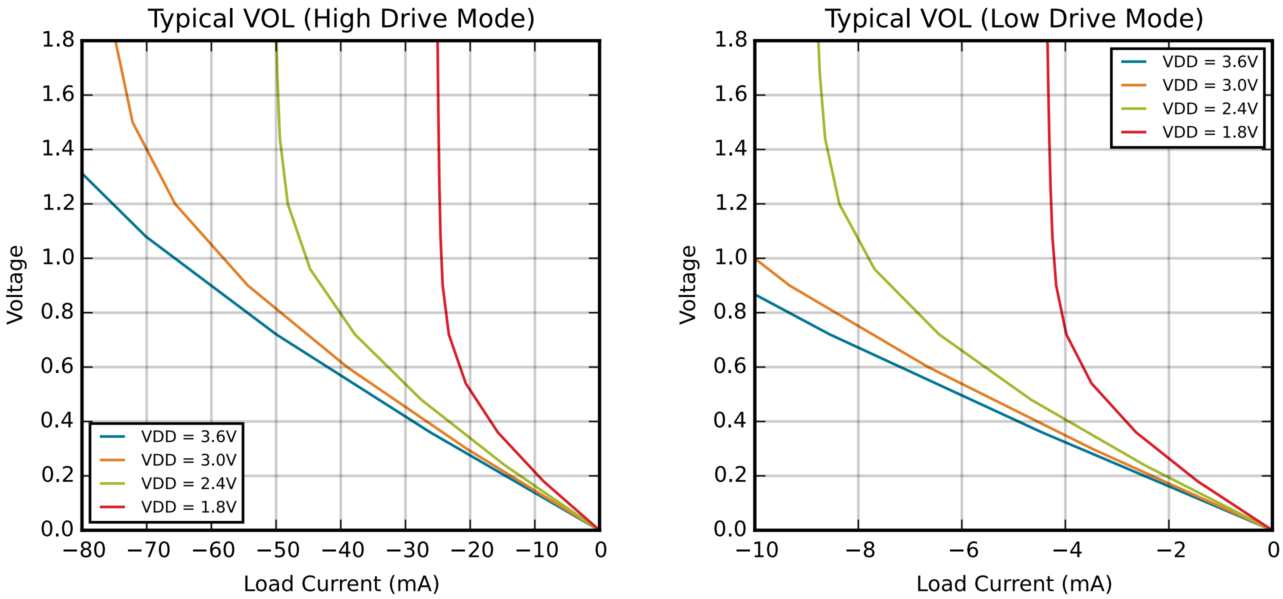


Figure 3.5. Typical V_{OL} Curves

4. Functional Description

4.1 Capacitive Sensing Input

4.1.1 Introduction

The capacitive to digital converter uses an iterative, charge-timing self-capacitance technique to measure capacitance on an input pin. Sampling is configured and controlled by settings in the non-volatile configuration profile, which can be changed through the 2-pin configuration interface.

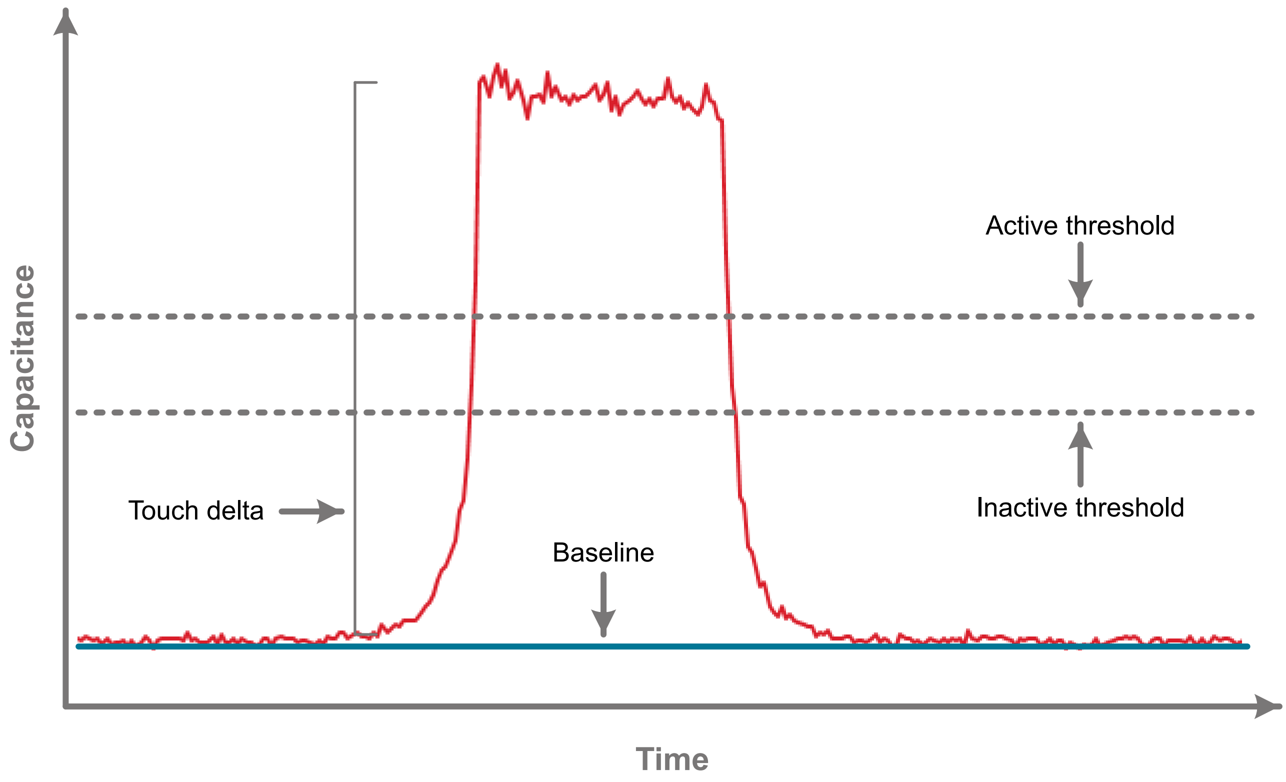


Figure 4.1. Capacitive Sense Data Types

4.1.2 Touch Qualification Criteria

The device detects a touch event when an inactive (untouched) input enabled by the input enable mask detects an sequence of measurements that cross the active threshold.

The device detects a touch release event when an active (touched) input enabled by the input enable mask detects an sequence of measurements that cross the inactive threshold.

The debounce configuration profile parameter defines how many measurements in a row must cross a threshold before a touch or release is qualified. In electrically noisy environments more heavily filtered data is used for qualification.

4.1.3 Thresholds

Capacitive sensing inputs use input-specific thresholds for touch qualification. Each input uses two thresholds, one to detect inactive-to-active transitions on the input, and another to determine active-to-inactive transitions on the input. The inputs use two thresholds to add hysteresis and prevent active/inactive ringing on inputs. Each threshold can be set through Simplicity Studio tools and all thresholds are stored in non-volatile memory in the device's configuration profile.

Thresholds are defined as percentages of a capacitive sensing input's touch delta.

4.1.4 Debounce Counter

Each capacitive sensing input maintains its own debounce counter. For an inactive sensor, this counter tracks the number of successive samples which have crossed that input's active threshold. For an active sensor, this counter tracks the number of successive samples which have crossed the inactive threshold. When the counter reaches a terminal value defined in the the configuration profile, the touch/release event is qualified.

4.1.5 Touch Deltas

Each capacitive sensing input uses a stored touch delta value that describes the expected difference between inactive and active capacitive sensing output codes. This value is stored in the configuration profile for the system and is used by the touch qualification engine, which defines inactive and active thresholds relative to the touch delta.

The touch deltas are stored in the configuration profile in a touch delta/16 format. For this reason, touch deltas must be configured as multiples of 16.

4.1.6 Auto-Accumulation and Averaging

Capacitive sensing inputs have an auto-accumulate and average post-sample filter that can be used to improve signal strength if needed. Settings stored in the configuration profile can configure the engine to accumulate 1, 4, 8, 16, 32, or 64 samples. After the defined number of samples have been accumulated, the result is divided by either 1, 4, 8, 16, 32, or 64, depending on the accumulation setting. This auto-accumulated and averaged value is the sample output used for all touch qualification processing. Note that sample time per sensor increases as the level of accumulation increases. To reduce current consumption, the engine should not be set to auto-accumulate unless it is required to achieve acceptable signal strength due to thick overlays or other system-level factors.

4.1.7 Drive Strength

The drive strength of the current source used to charge the electrode being measured by the capacitive sensing input can be adjusted in integer increments from 1x to 8x (8x is the default). High drive strength gives the best sensitivity and resolution for small capacitors, such as those typically implemented as touch-sensitive PCB features. To measure larger capacitance values, the drive strength should be lowered accordingly. The highest drive strength setting that yields capacitive sensing output which does not saturate the sensing engine when the electrode is active (touched) should always be used to maximize input sensitivity.

4.1.8 Active Mode Scan Enable

Active mode scanning of capacitive sensing inputs is controlled by an enable setting for each capacitive sensing input. This setting is stored in the configuration profile.

4.1.9 Active Mode Scan Period

The capacitive sensing input engine stays in active mode whenever one or more inputs have qualified as active. During this time, the sensors scan at a periodicity defined by the active mode scan period, which is stored in the configuration profile. Every active mode scan pushes new samples through the processing engine, which checks for new touch and release events on all enabled inputs.

If free run mode is enabled, the engine will repeatedly scan all enabled inputs during the active mode scan period. In this mode of operation, the active mode scan period is used as a timer to determine how much time has passed since the last qualified active sensor has been seen. When a defined amount of time without a qualified touch event has occurred, the engine switches to a low power mode using the sleep mode scan period, and conserves current.

If free run mode is disabled, the engine will enter a low power state after completing one scan of all enabled inputs and processing the resulting samples. The engine will remain in this low power state until it wakes, at a time defined by active mode scan period, to perform another scan.

4.1.10 Active Mode Scan Type

The active mode scan type, which is stored in the configuration profile, controls whether the capacitive sensing engine in active mode will scan only once during the active mode scan period before going to sleep, or whether the engine will continue scanning as quickly as possible during the active mode scan period, never entering a low power state.

For optimal responsiveness, the engine should be configured to run with free run mode enabled. Setting the scan mode to 'free run' causes touch qualification on a new touch to occur as quickly as the scanning engine can convert and process samples on all sensors. In this mode, qualification time is not bounded by active mode scan period, and is only bounded by scanning configuration factors such as the debounce setting, the number of enabled sensors, the accumulation setting on each sensor, and the timing constraints of any enabled component.

For optimal current draw when in active mode, the engine should be configured to use the 'one scan per period' mode setting. In this case, touch qualification is bound by the scan period and the debounce setting of the device.

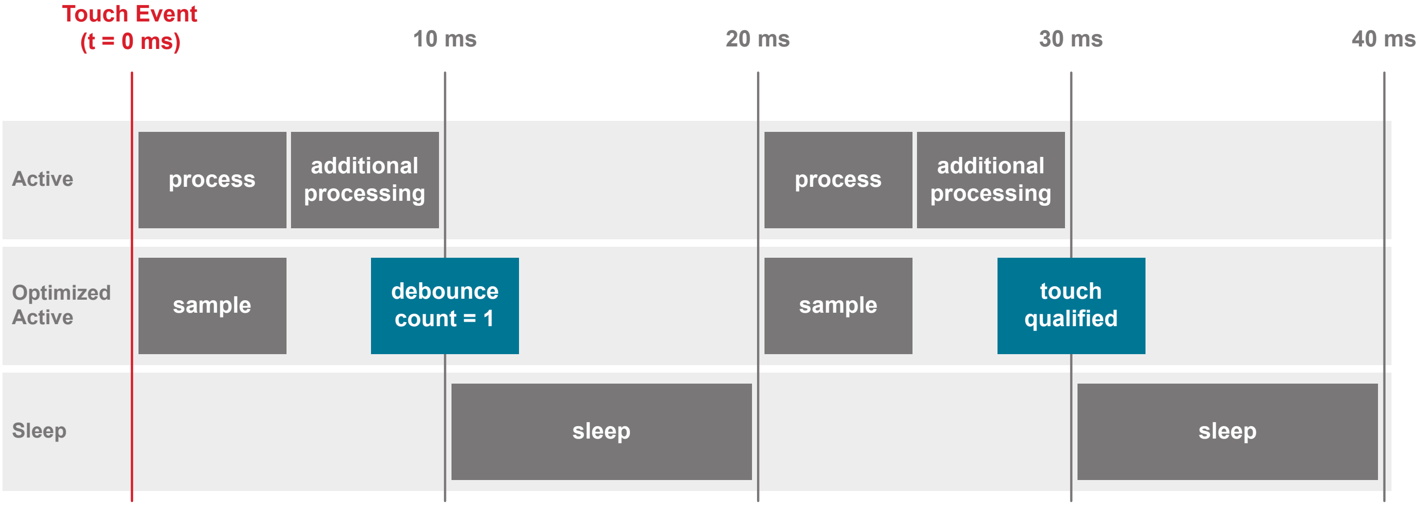


Figure 4.2. Timing and Current — One Sample Per Period Mode

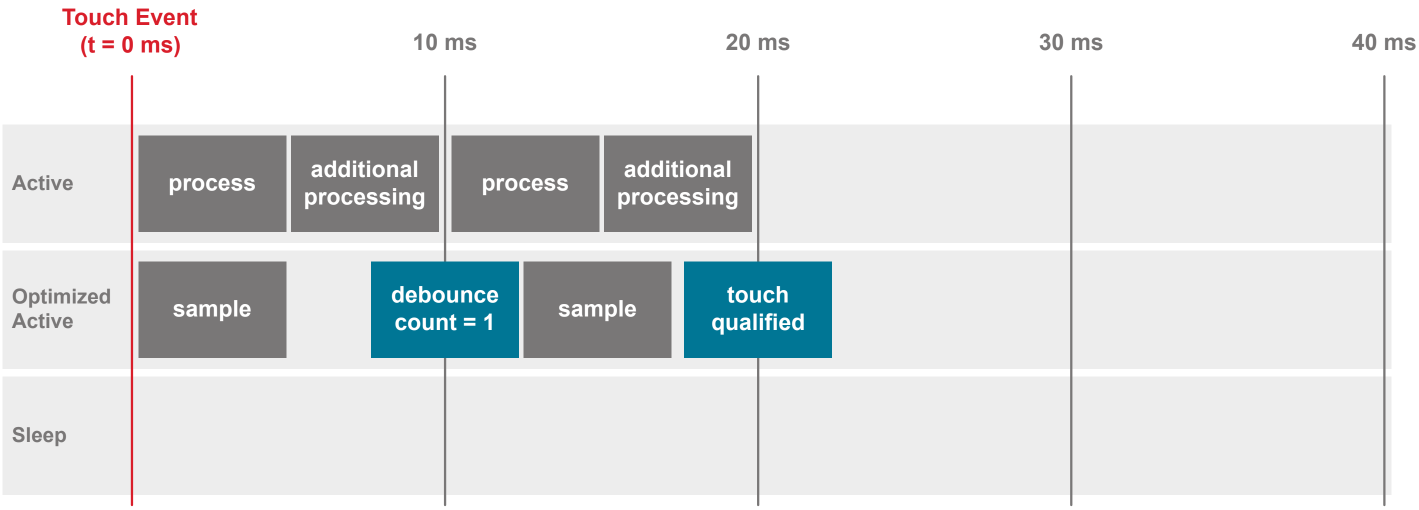


Figure 4.3. Timing and Current — Free Run Mode

4.1.11 Sleep Mode Scan Period

The sleep mode scan period defines the rate at which a scan of the inputs enabled as wake-up sources are sampled. Each enabled sensor can also be enabled as a wake-up source. After the sleep mode scan completes, the scan is processed for a qualified candidate touch. If a candidate touch is qualified, the system wakes form sleep mode and enters active mode scanning.

The sleep mode scan period is stored in the configuration profile and is defined in units of ms.

4.1.12 Active Mode and Sleep Mode Transitions

Capacitive sensing inputs will stay in active mode until no inputs detect qualified touches for a span of time defined by the counts until sleep parameter stored in the configuration profile. The scan period of enabled inputs is defined by the active mode scan period, also found in the configuration profile. If free run mode is enabled, the active mode sensing engine will remain awake and scanning the sensors as fast as possible. If free run mode is disabled, the engine will put itself into a low power state for the remainder of the active mode scan period, after a scan has completed.

When in sleep mode, the sensing engine will wake at a period defined by sleep mode scan period to do a scan on sensors that have been enabled as wakeup sources. If the engine finds a candidate touch in this state, the system reverts to active mode to continue scanning.

Note that in systems where a proximity input is selected, the sleep mode scan engine uses conversions on the proximity input instead of sensors enabled as wakeup sources.

Devices configured to wake on a touch will attempt to qualify the candidate touch that initiated the sleep-to-active transition. If qualification completes successfully, the device will signal this qualification to the external system. Touch qualification of this candidate touch uses the same active mode thresholds, debounce setting, and active mode scan period settings as any touch that occurs during active mode scanning.

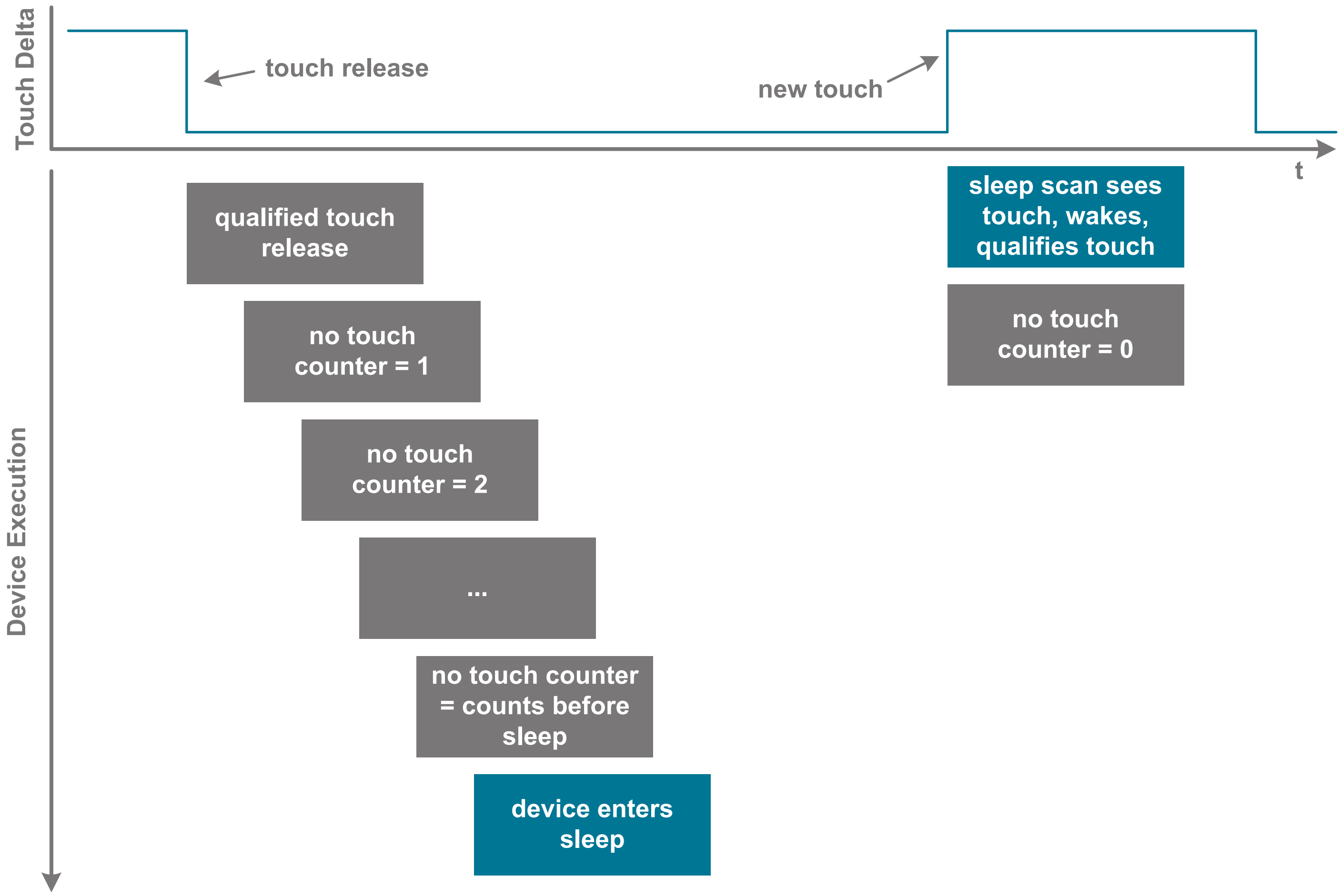


Figure 4.4. Active and Sleep Transitions

4.2 I2C Event Buffer Interface

4.2.1 Introduction

The event buffer I2C interface provides an event-driven, packetized communication system describing newly qualified events generated by the capacitive sensing input engine. The interface runs in one of two mutually exclusive modes: sensing mode and configuration loading mode, where a new configuration profile can be downloaded to the device and stored in non-volatile memory.

In sensing mode, the interface provides access to a first-in-first-out buffer of data packets. When the sensing engine generates these packets and pushes them onto the buffer, the interface then signals the host to indicate that one or more packets are available in the buffer by activating the event buffer interrupt pin.

In sensing mode, the interrupt pin is defined as active-low and operates as a push-pull digital output. In configuration loading mode, the interrupt pin is configured as a digital input and functions as a chip select. I2C transactions will be ignored by the device unless the host has pulled the interrupt pin low before sending the start condition.

The host reads the packets through an I2C interface, with the host acting as an I2C master. Once all packets have been fully transmitted across the I2C interface, the event buffer interrupt pin is de-activated. The device will remain in active mode until no packets remain in the buffer, even if no sensors have been qualified as active for the period of time defined by the active mode scan period.

In configuration loading mode, the interface enables an in-system programming initiated by the host. In this mode, the host can update the performance configuration space.

4.2.2 Startup Behavior

When the device exits a POR or hardware reset, it first enters configuration loading mode, discussed in detail 4.2.10 Configuration Loading Procedure. A host can command the device to enter sensing mode using the mode selection command discussed in 4.2.8 Entering Sensing Mode from Configuration Loading Mode. If the device has a valid configuration profile stored in non-volatile memory, the device will then enter sensing mode and remain in this mode until the next power cycle or reset.

4.2.3 Sensing Mode Event Packet Structure

Every qualified event detected by the capacitive sensing input engine generates a single packet that can be retrieved by the host processor through the event buffer I2C interface. The packet is an atomic data unit that fully describes the generated event.

Note: The bytes in the packet are transmitted MSB first.

Each packet has a standard structure that can be parsed by the host.

Table 4.1. Standard Packet Structure

Byte #	Designator
0	I2C Slave Address + read bit
1	Packet counter and event type
2	Event description (byte 1)
3	Event description (byte 2)

The packet counter is a 4-bit number stored in the upper bits of byte 1. Each new event will be assigned a counter value that is +1 from the last qualified event. After event 15, the counter wraps back to 0 for the next event. The counter captures the temporal nature of touch events so that a host can reconstruct a sequence of events over time. Also, the host can use the counter value to determine if a packet has been lost due to a buffer overflow. The event buffer counter is reset to 0 upon entrance to sensing mode.

The event type is a 4-bit value describes the originator of the event. For instance, the source could be a capacitive sensing button. The event type is stored in the lower 4 bits of byte 1.

The event description bytes define characteristics of the event that have been qualified. Event descriptions are defined relative to the event source. An event source that is a capacitive sensing input will have a defined set of valid event description values. Those same values will mean something different for a different type of event source. Event description values are defined relative to the event type field of byte 1.

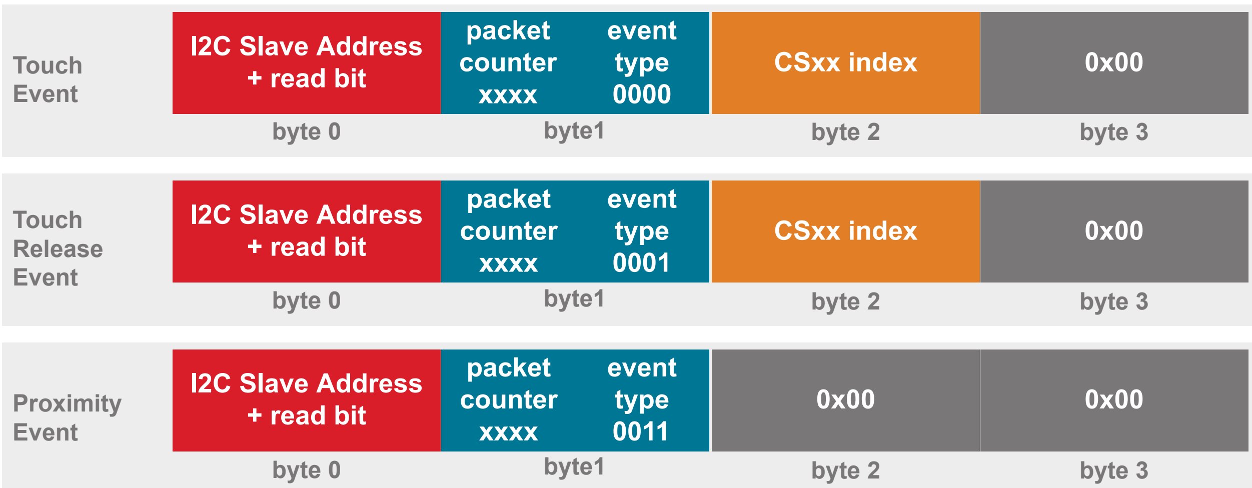


Figure 4.5. I2C Event Buffer Packet Structure

The CSxx index transmitted in byte 2 for Touch and Touch Release events enables the host processor to determine the sensor that caused the event.

4.2.4 Packet Retrieval in Sensing Mode

When the least significant byte of an event packet has been transferred during a master read transaction, that event is popped from the device's buffer. If only a part of the event is read, the event will stay in the buffer and will be transmitted again by the device during the next read.

If the host initiates a master read when the device is in sensing mode but the interrupt pin is not active, signifying that the device has no events in its buffer to transmit, the device will NACK its slave address on the bus.

If the I2C master sends a stop condition on the bus before the entire packet has been read, the device will not pop the packet from its internal buffer. Instead, the I2C state machine will reset, and the next transaction will begin with the first byte of the same event that was being read in the previous, prematurely-terminated transaction.

The I2C event buffer has a depth of 22 events. If the host does not read events promptly after seeing the interrupt pin go active, there is the possibility of a buffer overflow. In the event of an overflow, the I2C engine will discard the oldest events first.

New I2C packets will only be generated at the active mode sample rate, and so the buffer will fill a maximum of 12 packets (in the case simultaneous touch/releases) per sample period. If the host runs the I2C bus at 400 kHz and reads packets as soon as the interrupt pin activates, all packets can be read from the buffer in 1 to 2 ms, which is faster than the rate at which a new active mode scan sequence can complete.

4.2.5 Defined Event Types

The device assigns the following event types:

Table 4.2. Event Type Mapping

Event Type Value	Mapping
Sensing Mode	
0 (0x0)	Sensor activity - touch event
1 (0x1)	Sensor activity - release event
3 (0x3)	Proximity activity
Configuration Loading Mode	
8 (0x8)	Mode selection
9 (0x9)	Configuration unlock
10 (0xA)	Configuration erase
11 (0xB)	Write configuration
12 (0xC)	Write CRC

Note that this event type value is stored in the lower 4 bits of the first non-address byte of a packet. The upper 4 bits are a packet counter value.

4.2.6 Description Bytes for Touch Events

A touch or release event uses only one byte of the description field. That field identifies which sensor caused the touch or release event as shown below.

Table 4.3. Touch or Release Event Sensor Mapping

Value	Mapping
0	Capacitive sensing input 0
1	Capacitive sensing input 1
2	Capacitive sensing input 2
3	Capacitive sensing input 3
4	Capacitive sensing input 4
5	Capacitive sensing input 5
6	Capacitive sensing input 6
7	Capacitive sensing input 7
8	Capacitive sensing input 8
9	Capacitive sensing input 9
10	Capacitive sensing input 10
11	Capacitive sensing input 11

4.2.7 Slave Address

When the device comes out of reset and has not been commanded to enter sensing mode, the device responds to the slave address 0xC0. Additionally, the device will only respond to commands with address 0xC0 if the host drives the interrupt pin low, using the pin as a chip select.

In sensing mode, the device responds to I2C transactions addressed to the slave address stored in the configuration profile.

4.2.8 Entering Sensing Mode from Configuration Loading Mode

Upon exiting reset, the device enters configuration loading mode. During this time, a host can re-write the configuration profile through a sequence of master write commands. The host can also command the device to enter sensing mode using the mode selection command. The mode switch command is structured as shown in the following figure.

Note: The INT pin must be driven low prior to the I2C start and high after the I2C stop.

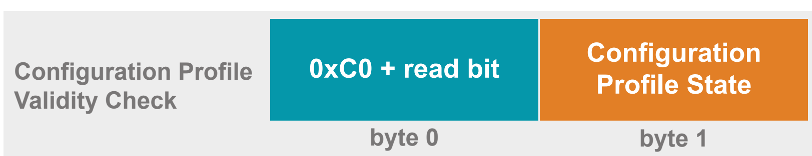
Figure 4.6. Mode Selection Command

The device will only enter sensing mode if the configuration profile stored in non-volatile memory is valid. The validity of the configuration profile can be checked using the Configuration Profile Validity Check command.

Note that this mode setting feature must be executed once per device, per reset. Until this command has been received by a device, the device will remain in its startup state and not performing any touch qualification.

4.2.9 Determining Configuration Validity

At any point when the device is in configuration loading mode, the host can issue a Configuration Profile Validity Check command. This command is issued when the host starts a master read command. This command is unique in that it does not include a byte containing the packet counter or event type.



Note: The INT pin must be driven low prior to the I2C start and high after the I2C stop.

Note: This is a read transaction where data is provided from the CPT device.

Figure 4.7. Configuration Profile Validity Check Command

Table 4.4. Decoding the Configuration Profile State

Value	Description
0x80	Configuration profile valid
0x01	Configuration profile invalid

The validity of the configuration profile is determined by comparing a CRC stored in non-volatile memory to a CRC generated at runtime by the device. The CRC is calculated using the algorithm described in 4.2.11 CRC Algorithm.

Note: The CRC for the configuration profile spans 510 bytes, with 0xFF padding in addresses above any non-0xFF configuration profile bytes.