



# mXT1067TD-AT/mXT1067TD-AB 1.0 I<sup>2</sup>C Variant

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## maXTouch 1066-node Touchscreen Controller

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### Automotive Applications

- AEC-Q100 Qualified
- Developed following Automotive SPICE<sup>®</sup> Level 3 certified processes
- CISPR 25 compliant (for both mutual and self capacitance measurements)

### maXTouch<sup>®</sup> Adaptive Sensing Touchscreen Technology

- Up to 41 X (transmit) lines and 26 Y (receive) lines for use by a touchscreen and a key array (see [Section 4.3 "Permitted Configurations"](#))
- Touchscreen size 10.51 inches (16:10 aspect ratio), assuming a sensor electrode pitch of 5.5 mm. Other sizes are possible with different electrode pitches and appropriate sensor material
- A maximum of 1066 X/Y nodes can be allocated to the touch sensor
- Multiple touch support with up to 16 concurrent touches tracked in real time

### Keys

- Up to 16 nodes can be allocated as mutual capacitance sensor keys (subject to other configurations)
- Adjacent Key Suppression (AKS) technology is supported for false key touch prevention

### Touch Sensor Technology

- Discrete/out-cell support including glass and PET film-based sensors
- On-cell/touch-on display support including TFT, IPS and OLED
- Synchronization with display refresh timing capability
- Support for standard (for example, Diamond) and proprietary sensor patterns (review of designs by Microchip or a Microchip-qualified touch sensor module partner is recommended)

### Front Panel Material

- Works with PET or glass, including curved profiles (configuration and stack-up to be approved by Microchip or a Microchip-qualified touch sensor module partner)
- 10 mm glass (or 5 mm PMMA) with bare finger (dependent on screen size, touch size, configuration and stack-up)
- 6 mm glass (or 3 mm PMMA) with multi-finger 5 mm glove (2.7 mm PMMA equivalent) (dependent on screen size, touch size, configuration and stack-up)

### Touch Performance

- Moisture/Water Compensation
  - No false touch with condensation or water drop up to 22 mm diameter
  - One-finger tracking with condensation or water drop up to 22 mm diameter
- Mutual capacitance and self capacitance measurements supported for robust touch detection
- P2P mutual capacitance measurements supported for extra sensitive multi-touch sensing
- Noise suppression technology to combat ambient and power-line noise
  - Up to 240 V<sub>PP</sub> between 1 Hz and 1 kHz sinusoidal waveform
  - Up to 20 V<sub>PP</sub> between 1 kHz and 1 MHz sinusoidal waveform
- Burst Frequency
  - Flexible and dynamic Tx burst frequency selection to reduce EMC disturbance
  - Controlled Tx burst frequency drift over process and temperature range
  - Configurable Tx waveform shaping to reduce emissions
- Scan Speed
  - Up to 112 Hz report rate for one finger (subject to configuration)
  - Typical report rate for 10 touches ≥85 Hz (subject to configuration)
  - Initial touch latency <20 ms for first touch from idle (subject to configuration)
  - Configurable to allow for power and speed optimization

# mXT1067TD-Ax (I<sup>2</sup>C) 1.0

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- Touch panel failure detection
  - Automatic touch sensor diagnostics during run time to support the implementation of safety critical features
  - Diagnostics reported using dedicated output pin or by standard Object Protocol messages
  - Configurable test limits

## On-chip Gestures

- Reports one-touch and two-touch gestures

## Enhanced Algorithms

- Lens bending algorithms to remove display noise
- Touch suppression algorithms to remove unintentional large touches, such as palm
- Palm Recovery Algorithm for quick restoration to normal state

## Power Saving

- Programmable timeout for automatic transition from Active to Idle state
- Pipelined analog sensing detection and digital processing to optimize system power efficiency

## Application Interfaces

- I<sup>2</sup>C slave with support for Standard mode (up to 100 kHz), Fast mode (up to 400 kHz), Fast-mode Plus (up to 1 MHz)
- Interrupt to indicate when a message is available
- Additional SPI Debug Interface to read the raw data for tuning and debugging purposes

## Power Supply

- Digital (V<sub>dd</sub>) 3.3V nominal
- Digital I/O (V<sub>ddIO</sub>) 3.3V nominal
- Analog (AV<sub>dd</sub>) 3.3V nominal
- High voltage internal X line drive (XV<sub>dd</sub>) 6.6 V with internal voltage pump (XV<sub>dd</sub> connected to V<sub>dd</sub> if voltage pump not used)

## Package

- 128-lead TQFP 14 × 14 × 1 mm, 0.4 mm pitch

## Operating Temperature

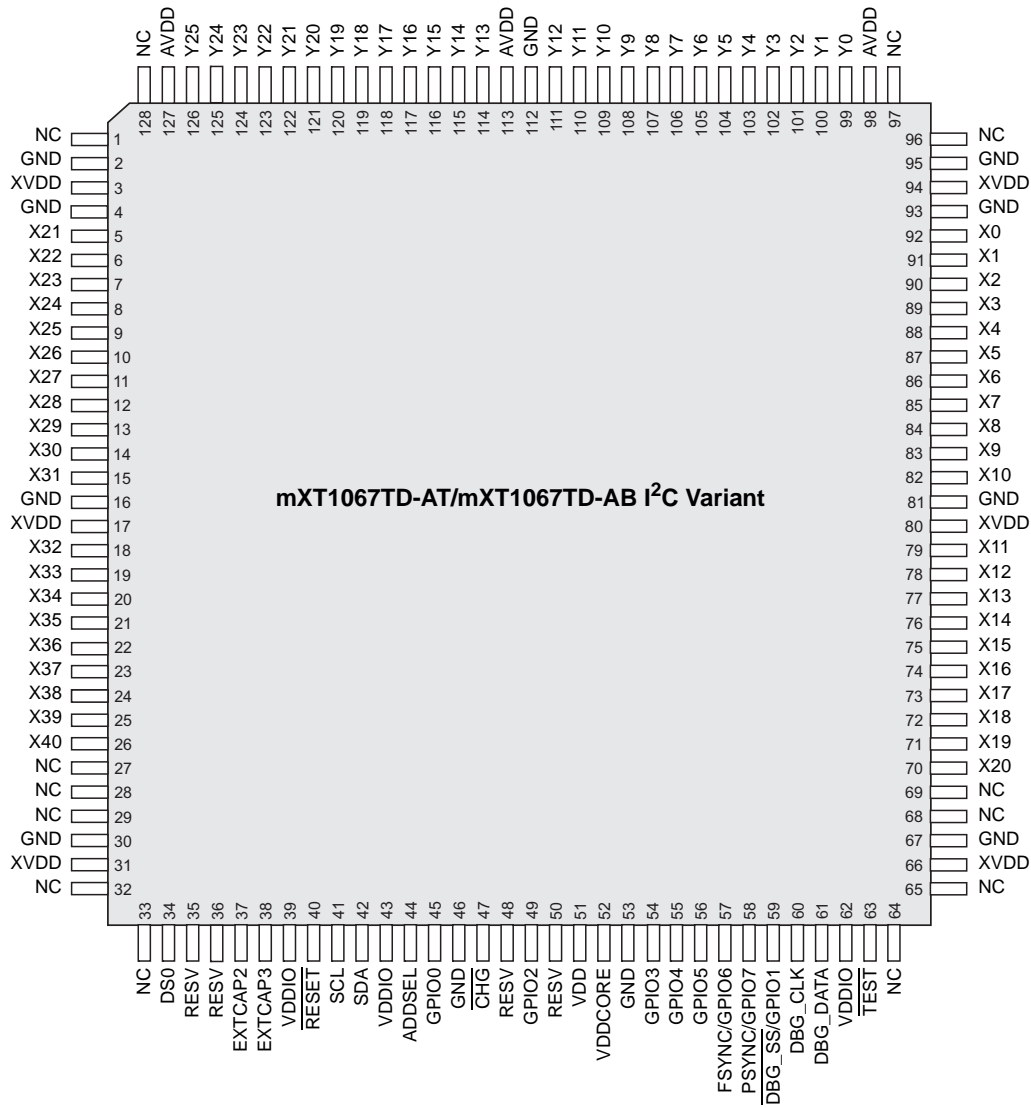
- mXT1067TD-AT I<sup>2</sup>C Variant: -40°C to +85°C (Grade 3)
- mXT1067TD-AB I<sup>2</sup>C Variant: -40°C to +105°C (Grade 2)

## Design Services

- Review of device configuration, stack-up and sensor patterns
- Custom firmware versions can be considered
- Contact your Microchip representative for more information

## PIN CONFIGURATION

### Pin Configuration – 128-lead TQFP



Top view

# mXT1067TD-Ax (I<sup>2</sup>C) 1.0

**TABLE 0-1: PIN LISTING – 128-LEAD TQFP**

Pin	Name	Type	Supply	Description	If Unused...
1	NC	–	–	No connection	–
2	GND	P	–	Ground	–
3	XVDD	P	–	X line drive power	–
4	GND	P	–	Ground	–
5	X21	S	XVdd	X line connection	Leave open
6	X22	S	XVdd	X line connection	Leave open
7	X23	S	XVdd	X line connection	Leave open
8	X24	S	XVdd	X line connection	Leave open
9	X25	S	XVdd	X line connection	Leave open
10	X26	S	XVdd	X line connection	Leave open
11	X27	S	XVdd	X line connection	Leave open
12	X28	S	XVdd	X line connection	Leave open
13	X29	S	XVdd	X line connection	Leave open
14	X30	S	XVdd	X line connection	Leave open
15	X31	S	XVdd	X line connection	Leave open
16	GND	P	–	Ground	–
17	XVDD	P	–	X line drive power	–
18	X32	S	XVdd	X line connection	Leave open
19	X33	S	XVdd	X line connection	Leave open
20	X34	S	XVdd	X line connection	Leave open
21	X35	S	XVdd	X line connection	Leave open
22	X36	S	XVdd	X line connection	Leave open
23	X37	S	XVdd	X line connection	Leave open
24	X38	S	XVdd	X line connection	Leave open
25	X39	S	XVdd	X line connection	Leave open
26	X40	S	XVdd	X line connection	Leave open
27	NC	–	–	No connection	–
28	NC	–	–	No connection	–
29	NC	–	–	No connection	–
30	GND	P	–	Ground	–
31	XVDD	P	–	X line drive power	–
32	NC	–	–	No connection	–
33	NC	–	–	No connection	–
34	DS0	O	AVdd	Driven Shield signal; used as guard track between X/Y signals and ground	Leave open
35	RESV	–	–	Reserved for future use	Leave open
36	RESV	–	–	Reserved for future use	Leave open
37	EXTCAP2	P	–	Connect to EXTCAP3 via capacitor; see <a href="#">Section 2.2.4 "Internal Voltage Pump"</a>	Leave open
38	EXTCAP3	P	–	Connect to EXTCAP2 via capacitor; see <a href="#">Section 2.2.4 "Internal Voltage Pump"</a>	Leave open
39	VDDIO	P	–	Digital power	–

**TABLE 0-1: PIN LISTING – 128-LEAD TQFP (CONTINUED)**

Pin	Name	Type	Supply	Description	If Unused...
40	$\overline{\text{RESET}}$	I	VddIO	Reset low. Connection to host system is recommended	Pull up to VddIO
41	SCL	OD	VddIO	I <sup>2</sup> C clock	–
42	SDA	OD	VddIO	I <sup>2</sup> C data	–
43	VDDIO	P	–	Digital power	–
44	ADDSEL	I	VddIO	I <sup>2</sup> C address select; see <a href="#">Section 7.1 “I<sup>2</sup>C Address Selection – ADDSEL Pin”</a>	–
45	GPIO0	I/O	VddIO	General purpose I/O; see <a href="#">Section 2.2.8 “GPIO Pins”</a>	Input: connect to GND Output: leave open
46	GND	P	–	Ground	–
47	$\overline{\text{CHG}}$	OD	VddIO	State change interrupt Note: Briefly set (~100 ms) as an input after power-up/reset for diagnostic purposes	Pull up to VddIO
48	RESV	–	–	Reserved for future use; pull up to VddIO	–
49	GPIO2	I/O	VddIO	General purpose I/O; see <a href="#">Section 2.2.8 “GPIO Pins”</a>	Input: connect to GND Output: leave open
50	RESV	–	VddIO	Reserved for future use; connect to GND	Connect to GND
51	VDD	P	–	Digital power	–
52	VDDCORE	P	–	Digital core power	–
53	GND	P	–	Ground	–
54	GPIO3	I/O	VddIO	General purpose I/O; see <a href="#">Section 2.2.8 “GPIO Pins”</a>	Input: connect to GND Output: leave open
55	GPIO4	I/O	VddIO	General purpose I/O; see <a href="#">Section 2.2.8 “GPIO Pins”</a>	Input: connect to GND Output: leave open
56	GPIO5	I/O	VddIO	General purpose I/O; see <a href="#">Section 2.2.8 “GPIO Pins”</a>	Input: connect to GND Output: leave open
57	FSYNC	I	VddIO	External frame synchronization (usually VSYNC)	Input: connect to GND Output: leave open
	GPIO6	I/O		General purpose I/O; see <a href="#">Section 2.2.8 “GPIO Pins”</a>	
58	PSYNC	I	VddIO	External pulse synchronization (usually HSYNC)	Input: connect to GND Output: leave open
	GPIO7	I/O		General purpose I/O; see <a href="#">Section 2.2.8 “GPIO Pins”</a>	
59	$\overline{\text{DBG\_SS}}$	O	VddIO	Debug SS line; pull up to VddIO; see <a href="#">Section 2.2.9 “SPI Debug Interface”</a>	Connect to test point leave open
	GPIO1	I/O		General purpose I/O; see <a href="#">Section 2.2.8 “GPIO Pins”</a>	
60	DBG_CLK	O	VddIO	Debug clock; see <a href="#">Section 2.2.9 “SPI Debug Interface”</a>	Connect to test point leave open
61	DBG_DATA	O	VddIO	Debug data; see <a href="#">Section 2.2.9 “SPI Debug Interface”</a>	Connect to test point leave open
62	VDDIO	P	–	Digital power	–
63	$\overline{\text{TEST}}$	–	VddIO	Reserved; must be pulled up to VddIO	–
64	NC	–	–	No connection	–
65	NC	–	–	No connection	–
66	XVDD	P	–	X line drive power	–
67	GND	P	–	Ground	–
68	NC	–	–	No connection	–
69	NC	–	–	No connection	–
70	X20	S	XVdd	X line connection	Leave open

# mXT1067TD-Ax (I<sup>2</sup>C) 1.0

**TABLE 0-1: PIN LISTING – 128-LEAD TQFP (CONTINUED)**

Pin	Name	Type	Supply	Description	If Unused...
71	X19	S	XVdd	X line connection	Leave open
72	X18	S	XVdd	X line connection	Leave open
73	X17	S	XVdd	X line connection	Leave open
74	X16	S	XVdd	X line connection	Leave open
75	X15	S	XVdd	X line connection	Leave open
76	X14	S	XVdd	X line connection	Leave open
77	X13	S	XVdd	X line connection	Leave open
78	X12	S	XVdd	X line connection	Leave open
79	X11	S	XVdd	X line connection	Leave open
80	XVDD	P	–	X line drive power	–
81	GND	P	–	Ground	–
82	X10	S	XVdd	X line connection	Leave open
83	X9	S	XVdd	X line connection	Leave open
84	X8	S	XVdd	X line connection	Leave open
85	X7	S	XVdd	X line connection	Leave open
86	X6	S	XVdd	X line connection	Leave open
87	X5	S	XVdd	X line connection	Leave open
88	X4	S	XVdd	X line connection	Leave open
89	X3	S	XVdd	X line connection	Leave open
90	X2	S	XVdd	X line connection	Leave open
91	X1	S	XVdd	X line connection	Leave open
92	X0	S	XVdd	X line connection	Leave open
93	GND	P	–	Ground	–
94	XVDD	P	–	X line drive power	–
95	GND	P	–	Ground	–
96	NC	–	–	No connection	–
97	NC	–	–	No connection	–
98	AVDD	P	–	Analog power	–
99	Y0	S	AVdd	Y line connection	Leave open
100	Y1	S	AVdd	Y line connection	Leave open
101	Y2	S	AVdd	Y line connection	Leave open
102	Y3	S	AVdd	Y line connection	Leave open
103	Y4	S	AVdd	Y line connection	Leave open
104	Y5	S	AVdd	Y line connection	Leave open
105	Y6	S	AVdd	Y line connection	Leave open
106	Y7	S	AVdd	Y line connection	Leave open
107	Y8	S	AVdd	Y line connection	Leave open
108	Y9	S	AVdd	Y line connection	Leave open
109	Y10	S	AVdd	Y line connection	Leave open
110	Y11	S	AVdd	Y line connection	Leave open
111	Y12	S	AVdd	Y line connection	Leave open
112	GND	P	–	Ground	–

**TABLE 0-1: PIN LISTING – 128-LEAD TQFP (CONTINUED)**

Pin	Name	Type	Supply	Description	If Unused...
113	AVDD	P	–	Analog power	–
114	Y13	S	AVdd	Y line connection	Leave open
115	Y14	S	AVdd	Y line connection	Leave open
116	Y15	S	AVdd	Y line connection	Leave open
117	Y16	S	AVdd	Y line connection	Leave open
118	Y17	S	AVdd	Y line connection	Leave open
119	Y18	S	AVdd	Y line connection	Leave open
120	Y19	S	AVdd	Y line connection	Leave open
121	Y20	S	AVdd	Y line connection	Leave open
122	Y21	S	AVdd	Y line connection	Leave open
123	Y22	S	AVdd	Y line connection	Leave open
124	Y23	S	AVdd	Y line connection	Leave open
125	Y24	S	AVdd	Y line connection	Leave open
126	Y25	S	AVdd	Y line connection	Leave open
127	AVDD	P	–	Analog power	–
128	NC	–	–	No connection	–

**Key:**

I     Input only	O     Output only	I/O    Input or output
OD    Open drain output	P     Ground or power	S     Sense pin

# mXT1067TD-Ax (I<sup>2</sup>C) 1.0

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## TABLE OF CONTENTS

Pin configuration .....	3
Table of Contents .....	8
To Our Valued Customers .....	9
1.0 Overview of mXT1067TD-AT/mXT1067TD-AB I <sup>2</sup> C Variant .....	10
2.0 Schematic .....	11
3.0 Touchscreen Basics .....	14
4.0 Sensor Layout .....	15
5.0 Power-up / Reset Requirements .....	17
6.0 Detailed Operation .....	20
7.0 Host Communications .....	24
8.0 I2C Communications .....	25
9.0 PCB Design Considerations .....	31
10.0 Getting Started with mXT1067TD-AT/mXT1067TD-AB I <sup>2</sup> C Variant .....	35
11.0 Debugging and Tuning .....	39
12.0 Specifications .....	40
13.0 Packaging Information .....	50
Appendix A. Associated Documents .....	54
Appendix B. Revision History .....	55
Product Identification System .....	59
The Microchip Web Site .....	60
Customer Change Notification Service .....	60
Customer Support .....	60

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# mXT1067TD-Ax (I<sup>2</sup>C) 1.0

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## 1.0 OVERVIEW OF MXT1067TD-AT/MXT1067TD-AB I<sup>2</sup>C VARIANT

The Microchip maXTouch family of touch controllers brings industry-leading capacitive touch performance to customer automotive applications. The mXT1067TD-AT/mXT1067TD-AB I<sup>2</sup>C Variant (known as mXT1067TD-Ax I<sup>2</sup>C Variant) features the latest generation of Microchip adaptive sensing technology that utilizes a hybrid mutual and self capacitive sensing system in order to deliver unparalleled touch features and a robust user experience.

- **Patented capacitive sensing method** – The mXT1067TD-Ax I<sup>2</sup>C Variant uses a unique charge-transfer acquisition engine to implement Microchip's patented capacitive sensing method. Coupled with a state-of-the-art CPU, the entire touchscreen sensing solution can measure, classify and track a number of individual finger touches with a high degree of accuracy in the shortest response time.
- **Capacitive Touch Engine (CTE)** – The mXT1067TD-Ax I<sup>2</sup>C Variant features an acquisition engine that uses an optimal measurement approach to ensure almost complete immunity from parasitic capacitance on the receiver input lines. The engine includes sufficient dynamic range to cope with anticipated touchscreen self and mutual capacitances, which allows great flexibility for use with the Microchip proprietary sensor pattern designs. One- and two-layer ITO sensors are possible using glass or PET substrates.
- **Touch detection** – The mXT1067TD-Ax I<sup>2</sup>C Variant allows for both mutual and self capacitance measurements, with the self capacitance measurements being used to augment the mutual capacitance measurements to produce reliable touch information.

When self capacitance measurements are enabled, touch classification is achieved using both mutual and self capacitance touch data. This has the advantage that both types of measurement systems can work together to detect touches under a wide variety of circumstances.

The system may be configured for different types of default measurements in both idle and active modes. For example, the device may be configured for Mutual Capacitance Touch as the default in active mode and Self Capacitance Touch as the default in idle mode. Note that other types of scans (such as P2P mutual capacitance scans and other types of self capacitance scans) may also be made depending on configuration.

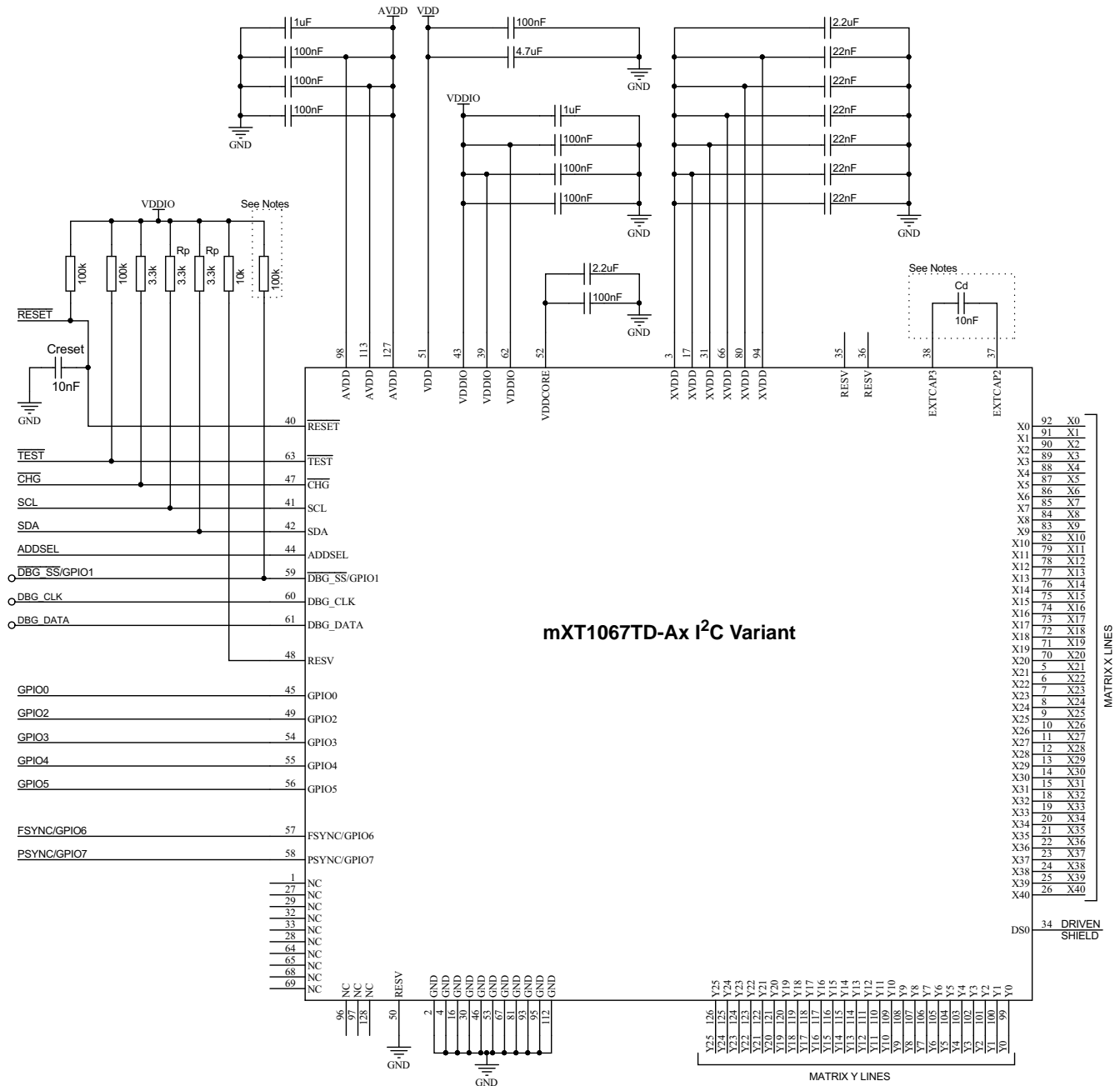
Mutual capacitance touch data is used wherever possible to classify touches as this has greater granularity than self capacitance measurements and provides positional information on touches. For this reason, multiple touches can only be determined by mutual capacitance touch data. In Self Capacitance Touch Default mode, if the self capacitance touch processing detects multiple touches, touchscreen processing is skipped until mutual capacitance touch data is available.

Self capacitance and P2P mutual capacitance measurements allow for the detection of touches in extreme cases, such as thick glove touches, when mutual capacitance touch detection alone may miss touches.

- **Display Noise Cancellation** – A combination of analog circuitry, hardware noise processing, and firmware that combats display noise without requiring additional listening channels or synchronization to display timing. This enables the use of shieldless touch sensor stacks, including touch-on-lens.
- **Noise filtering** – Hardware noise processing in the capacitive touch engine provides enhanced autonomous filtering and allows a broad range of noise profiles to be handled. The result is good performance in the presence of LCD noise.
- **Processing power** – The main CPU has two powerful microsequencer coprocessors under its control consuming low power. This system allows the signal acquisition, preprocessing, postprocessing and housekeeping to be partitioned in an efficient and flexible way.
- **Interpreting user intention** – The Microchip hybrid mutual and self capacitance method provides unambiguous multitouch performance. Algorithms in the mXT1067TD-Ax I<sup>2</sup>C Variant provide optimized touchscreen position filtering for the smooth tracking of touches, responding to a user's intended touches while preventing false touches triggered by ambient noise, conductive material on the sensor surface, such as moisture, or unintentional touches from the user's resting palm or fingers.

## 2.0 SCHEMATIC

### 2.1 128-lead TQFP – I<sup>2</sup>C Variant



See Section 2.2 "Schematic Notes".

# mXT1067TD-Ax (I<sup>2</sup>C) 1.0

## 2.2 Schematic Notes

### 2.2.1 POWER SUPPLY

The sense and I/O pins are supplied by the power rails on the device as listed in [Table 2-1](#). This information is also indicated in “[Pin configuration](#)”.

**TABLE 2-1: POWER SUPPLY FOR SENSE AND I/O PINS**

Power Supply	Pins
XVdd	X sense lines
AVdd	Y sense lines, DS0
VddIO	$\overline{\text{RESET}}$ , $\text{GPIO}_n$ , FSYNC, PSYNC, SDA, SCL, ADDSEL, $\overline{\text{CHG}}$ , DBG_CLK, DBG_DATA, DBG_SS

### 2.2.2 DECOUPLING CAPACITORS

All decoupling capacitors must be X7R or X5R and placed less than 5 mm away from the pins for which they act as bypass capacitors. Pins of the same type can share a capacitor provided no pin is more than 10 mm from the capacitor.

The schematics on the previous pages show the capacitors required. The parallel combination of capacitors is recommended to give high and low frequency filtering, which is beneficial if the voltage regulators are likely to be some distance from the device (for example, if an active tail design is used). Note that this requires that the voltage regulator supplies for AVdd, Vdd and VddIO are clean and noise free. It also assumes that the track length between the capacitors and on-board power supplies is less than 50 mm.

The number of base capacitors can be reduced if the pinout configuration means that sharing a bypass capacitor is possible (subject to the distance between the pins satisfying the conditions above and there being no routing difficulties).

### 2.2.3 PULL-UP RESISTORS

The pull-up resistors shown in the schematic are suggested typical values and may be modified to meet the requirements of an individual customer design.

This applies, in particular, to the pull-up resistors on the I<sup>2</sup>C SDA and SCL lines (shown on the schematic), as the values of these resistors depend on the speed of the I<sup>2</sup>C interface. See [Section 12.9 “I<sup>2</sup>C Specification”](#) for details.

### 2.2.4 INTERNAL VOLTAGE PUMP

XVdd power can be supplied using an internal voltage pump.

The voltage pump requires one external capacitor:

- EXTCAP2 must be connected to EXTCAP3 via a capacitor (Cd). The capacitor must be placed as close as possible to the EXTCAP $n$  pins.
- The capacitor on XVDD should be rated at least 10 V if the voltage doubler is used.

Capacitor Cd should provide a capacitance of 10 nF.

**If XVdd voltage doubler is not required:**

- Capacitor Cd should be omitted and EXTCAP2 and EXTCAP3 left unconnected.
- XVDD must be connected to VDD.

### 2.2.5 VDDCORE

VddCore is internally generated from the Vdd power supply. To guarantee stability of the internal voltage regulator, one or more external decoupling capacitors are required.

### 2.2.6 DRIVEN SHIELD LINE

The driven shield line (DS0) can be used to shield the X/Y sense lines. Specifically, it acts as a driven shield in self capacitance operation. See [Section 9.4 “Driven Shield Line”](#) for more details.

<b>NOTE</b> DS0 is internally multiplexed to X31. X31 must be configured for use if DS0 is to be used (either as a driven shield for self capacitance measurements or as a Ground guard track in a mutual capacitance only design), otherwise DS0 cannot be used in the user's design.
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## 2.2.7 MULTIPLE FUNCTION PINS

Some pins may have multiple functions. In this case, only one function can be chosen and the circuit should be designed accordingly.

## 2.2.8 GPIO PINS

The mXT1067TD-Ax I<sup>2</sup>C Variant has 8 GPIO pins. The pins can be set to be either an input or an output, as required, using the GPIO Configuration T19 object.

If a GPIO pin is unused, it can be left unconnected externally as long as it is given a defined state by the GPIO Configuration T19 object.

By default the GPIO pins are set to be inputs so if a pin is not used, and is left configured as an input, it should be connected to GND through a resistor or else the internal resistor should be pulled up using the GPIO Configuration T19 object. Note that this does not apply if the GPIO pin is shared with a debug line; see [Section 2.2.9 “SPI Debug Interface”](#) for advice on how to treat an unused GPIO pin in this case.

Alternatively, the GPIO pin can be set as an output low using the GPIO Configuration T19 object and left open. This second option avoids any problems should the pin accidentally be configured as output high at a later date.

If the GPIO Configuration T19 object is not enabled for use, the GPIO pins cannot be used for GPIO purposes, although any alternative function can still be used.

Some GPIO pins have alternative functions. If an alternative function is used then this takes precedence over the GPIO function and the pin cannot be used as a GPIO pin. In particular:

- GPIO6 cannot be used if the FSYNC function is in use
- GPIO7 cannot be used if the PSYNC function is in use
- The SPI Debug Interface functionality is shared with some of the GPIO pins. See [Section 2.2.9 “SPI Debug Interface”](#) for more details on the SPI Debug Interface and how to handle these pins if they are totally unused.

## 2.2.9 SPI DEBUG INTERFACE

The  $\overline{\text{DBG\_CLK}}$ ,  $\overline{\text{DBG\_DATA}}$  and  $\overline{\text{DBG\_SS}}$  lines form the SPI Debug Interface. These pins should be routed to test points on all designs, such that they can be connected to external hardware during system development and for debug purposes. See also [Section 11.1 “SPI Debug Interface”](#).

The debug lines may share pins with other functionality. If the circuit is designed to use the SPI Debug Interface, then any alternative functionality cannot be used. Specifically:

- The  $\overline{\text{DBG\_SS}}$  line shares functionality with GPIO1, so GPIO1 cannot be used.
- The pull-up resistor for  $\overline{\text{DBG\_SS}}$  in the schematics is optional and should be present only if the line is used as  $\overline{\text{DBG\_SS}}$ .

The  $\overline{\text{DBG\_CLK}}$ ,  $\overline{\text{DBG\_DATA}}$  and  $\overline{\text{DBG\_SS}}$  lines should not be connected to power or GND. For this reason, where these pins are shared with GPIO pins and they are totally unused (that is, they are not being used as debug or GPIO pins), they should be set as outputs using the GPIO Configuration T19 object.

# mXT1067TD-Ax (I<sup>2</sup>C) 1.0

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## 3.0 TOUCHSCREEN BASICS

### 3.1 Sensor Construction

A touchscreen is usually constructed from a number of transparent electrodes. These are typically on a glass or plastic substrate. They can also be made using non-transparent electrodes, such as copper or carbon. Electrodes are constructed from Indium Tin Oxide (ITO) or metal mesh. Thicker electrodes yield lower levels of resistance (perhaps tens to hundreds of  $\Omega$ /square) at the expense of reduced optical clarity. Lower levels of resistance are generally more compatible with capacitive sensing. Thinner electrodes lead to higher levels of resistance (perhaps hundreds to thousands of  $\Omega$ /square) with some of the best optical characteristics.

Interconnecting tracks can cause problems. The excessive RC time constants formed between the resistance of the track and the capacitance of the electrode to ground can inhibit the capacitive sensing function. In such cases, the tracks should be replaced by screen printed conductive inks (non-transparent) outside the touchscreen viewing area.

### 3.2 Electrode Configuration

The specific electrode designs used in Microchip touchscreens are the subject of various patents and patent applications. Further information is available on request.

The device supports various configurations of electrodes as summarized in [Section 4.0 "Sensor Layout"](#).

### 3.3 Scanning Sequence

All nodes are scanned in sequence by the device. There is a full parallelism in the scanning sequence to improve overall response time. The nodes are scanned by measuring capacitive changes at the intersections formed between the first X line and all the Y lines. Then the intersections between the next X line and all the Y lines are scanned, and so on, until all X and Y combinations have been measured.

The device can be configured in various ways. It is possible to disable some nodes so that they are not scanned at all. This can be used to improve overall scanning time.

### 3.4 Touchscreen Sensitivity

#### 3.4.1 ADJUSTMENT

Sensitivity of touchscreens can vary across the extents of the electrode pattern due to natural differences in the parasitic capacitance of the interconnections, control chip, and so on. An important factor in the uniformity of sensitivity is the electrode design itself. It is a natural consequence of a touchscreen pattern that the edges form a discontinuity and hence tend to have a different sensitivity. The electrodes at the far edges do not have a neighboring electrode on one side and this affects the electric field distribution in that region.

A sensitivity adjustment is available for the whole touchscreen. This adjustment is a basic algorithmic threshold that defines when a node is considered to have enough signal change to qualify as being in detect.

#### 3.4.2 MECHANICAL STACKUP

The mechanical stackup refers to the arrangement of material layers that exist above and below a touchscreen. The arrangement of the touchscreen in relation to other parts of the mechanical stackup has an effect on the overall sensitivity of the screen. QMatrix technology has an excellent ability to operate in the presence of ground planes close to the sensor. QMatrix sensitivity is attributed more to the interaction of the electric fields between the transmitting (X) and receiving (Y) electrodes than to the surface area of these electrodes. For this reason, stray capacitance on the X or Y electrodes does not strongly reduce sensitivity.

Front panel dielectric material has a direct bearing on sensitivity. Plastic front panels are usually suitable up to about 5 mm, and glass up to about 10 mm (dependent upon the screen size and layout). The thicker the front panel, the lower the signal-to-noise ratio of the measured capacitive changes and hence the lower the resolution of the touchscreen. In general, glass front panels are near optimal because they conduct electric fields almost twice as easily as plastic panels.

<b>NOTE</b> Care should be taken using ultra-thin glass panels as retransmission effects can occur, which can significantly degrade performance.
--

## 4.0 SENSOR LAYOUT

**NOTE** The specific electrode designs used in Microchip touchscreens may be the subject of various patents and patent applications. Further information is available on request.

### 4.1 Electrodes

The device supports various configurations of touch electrodes as summarized below:

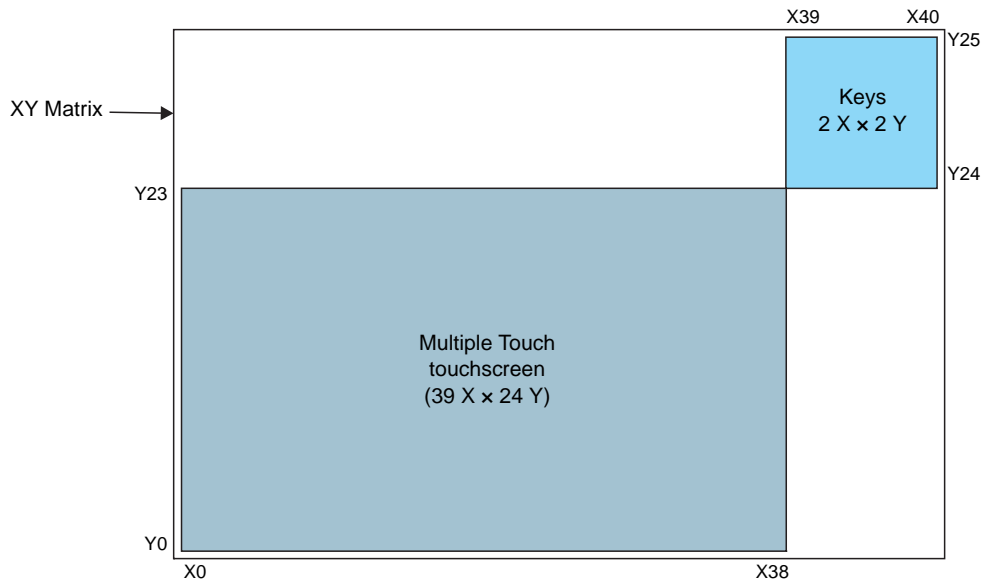
- Touchscreen: 1 touchscreen panel occupies a rectangular matrix of up to 41 X x 26 Y lines maximum (subject to other configurations).
- Keys: Up to 16 keys in an X/Y grid (Key Array), with each node (X/Y intersection) forming a key within the array.

The physical sensor matrix is configured using one or more touch objects. It is not mandatory to have all the allowable touch objects on the device enabled, so objects that are not required can be left disabled (default).

### 4.2 Sensor Matrix Layout

An example layout is shown in [Figure 4-1](#).

**FIGURE 4-1: EXAMPLE LAYOUT**



When designing the physical layout of the touch panel, the following rules must be obeyed:

• **General layout rules:**

- Each touch object should be a regular rectangular shape in terms of the lines it uses.
- X31 is connected internally to the driven shield line (DS0). The driven shield does not function if X31 is not used for self capacitance measurements. X31 must therefore be included within the sensor matrix if the driven shield is used.
- Although each touch object must use a contiguous block of X or Y lines, there can be gaps between the blocks of X and Y lines used for the different touch objects

• **Additional layout rules for Multiple Touch Touchscreen T100:**

- The Multiple Touch Touchscreen T100 object **must** start at (X0, Y0)
- The Multiple Touch Touchscreen T100 object cannot share an X or Y line with another touch object (for example, a Key Array T15).
- The touchscreen must contain a minimum of 3 X lines for mutual capacitance measurements. If Dual X Drive is enabled for use in the Noise Suppression T72 object, the minimum is 4 X lines. If self capacitance measurements are enabled in the Acquisition Configuration T8 object, the minimum is 6 X lines.
- The touchscreen must contain a minimum of 3 Y lines.

# mXT1067TD-Ax (I<sup>2</sup>C) 1.0

• **Additional layout rules for Key Array T15:**

- The Key Array must occupy higher X and Y lines than those used by the Multiple Touch Touchscreen T100 object.

## 4.3 Permitted Configurations

The permitted X/Y configurations are shown in [Table 4-1](#).

**TABLE 4-1: PERMITTED TOUCHSCREEN CONFIGURATIONS**

		Number of X Lines																																																						
		41	40	39	38	37	36	35	34	33	32	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1														
26	Number of Y Lines	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y																																												
25	Number of Y Lines	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y																																												
24	Number of Y Lines	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y																																												
23	Number of Y Lines	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y																																												
22	Number of Y Lines	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y																																												
21	Number of Y Lines	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y																																												
20	Number of Y Lines	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y																																												
19	Number of Y Lines	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y																																												
18	Number of Y Lines	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y																																												
17	Number of Y Lines	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y																																												
16	Number of Y Lines	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y																																												
15	Number of Y Lines	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y																																												
14	Number of Y Lines	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y																																												
13	Number of Y Lines	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y																																												
12	Number of Y Lines	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y																																												
11	Number of Y Lines	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y																																												
10	Number of Y Lines	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y																																												
9	Number of Y Lines	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y																																												
8	Number of Y Lines	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y																																												
7	Number of Y Lines	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y																																												
6	Number of Y Lines	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y																																												
5	Number of Y Lines	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y																																												
4	Number of Y Lines	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y																																												
3	Number of Y Lines	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y																																												
2	Number of Y Lines																																																							
1	Number of Y Lines																																																							

Key: Y Configuration supported  
  Configuration not supported

## 4.4 Screen Size

[Table 4-2](#) lists some typical screen size and electrode pitch combinations to achieve various aspect ratios.

**TABLE 4-2: TYPICAL SCREEN SIZES**

Aspect Ratio	Matrix Size	Node Count	Screen Diagonal (Inches)			
			4.5 mm Pitch	5 mm Pitch	5.5 mm Pitch	6 mm Pitch
<b>Single Touchscreen <sup>(1)</sup></b>						
16:10	X = 41, Y = 26	1066	8.6	9.56	10.51	11.47
16:9	X = 41, Y = 23	943	8.33	9.25	10.18	11.1
8:3	X = 41, Y = 15	615	7.73	8.59	9.45	10.31
4:3	X = 35, Y = 26	910	7.72	8.58	9.44	10.3

**Note 1:** The figures given in the table are for a Touchscreen and show the largest node count possible to achieve the desired aspect ratio. No provision has been made for a Key Array.

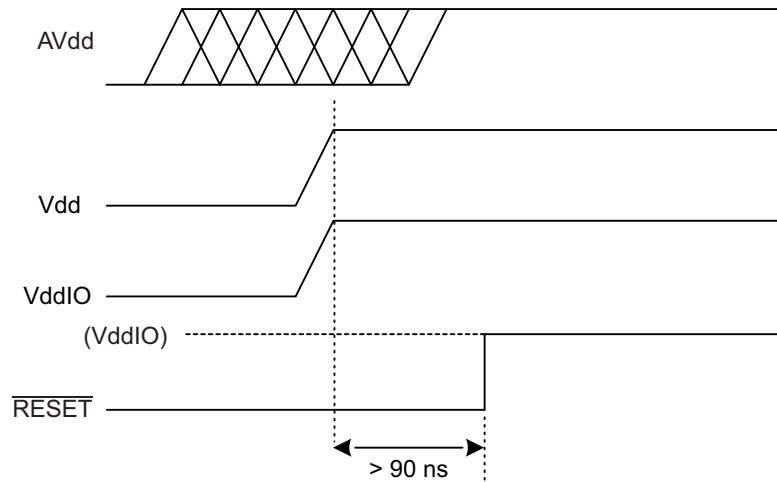
## 5.0 POWER-UP / RESET REQUIREMENTS

### 5.1 Power-on Reset

There is an internal Power-on Reset (POR) in the device.

If an external reset is to be used the device must be held in  $\overline{\text{RESET}}$  (active low) while the digital (Vdd), analog (AVdd) and digital I/O (VddIO) power supplies are powering up. The supplies must have reached their nominal values before the  $\overline{\text{RESET}}$  signal is deasserted (that is, goes high). This is shown in Figure 5-1. See Section 12.2 “Recommended Operating Conditions” for nominal values for the power supplies to the device.

**FIGURE 5-1: POWER SEQUENCING ON THE MXT1067TD-Ax I<sup>2</sup>C VARIANT**



Note: When using external  $\overline{\text{RESET}}$  at power-up, VddIO must not be enabled after Vdd

It is recommended that customer designs include the capability for the host to control all the maXTouch power supplies and pull the  $\overline{\text{RESET}}$  line low.

After power-up, the device typically takes 93 ms before it is ready to start communications.

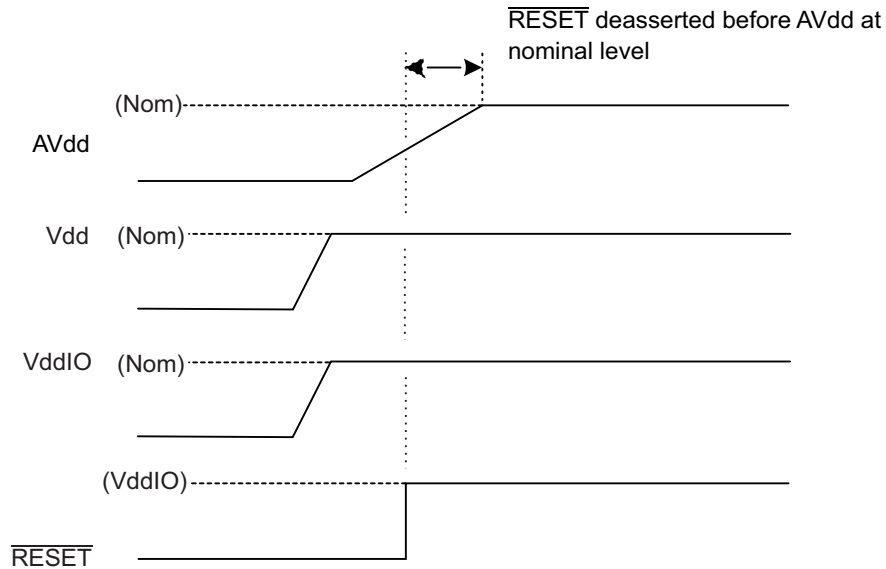
**NOTE** Device initialization will not complete until after all the power supplies are present. If any power supply is not present, internal initialization stalls and the device will not communicate with the host.

If the  $\overline{\text{RESET}}$  line is released before the AVdd supply has reached its nominal voltage (see Figure 5-2), then some additional operations need to be carried out by the host. There are two options open to the host controller:

- Start the part in Deep Sleep mode and then send the command sequence to set the cycle time to wake the part and allow it to run normally. Note that in this case a calibration command is also needed.
- Send a RESET command.

# mXT1067TD-Ax (I<sup>2</sup>C) 1.0

**FIGURE 5-2: POWER SEQUENCING ON THE MXT1067TD-Ax I<sup>2</sup>C VARIANT – LATE RISE ON AVDD**



The  $\overline{\text{RESET}}$  pin can be used to reset the device whenever necessary. The  $\overline{\text{RESET}}$  pin must be asserted low for at least 90 ns to cause a reset. After the host has released the  $\overline{\text{RESET}}$  pin, the device typically takes 93 ms before it is ready to start communications. It is recommended to connect the  $\overline{\text{RESET}}$  pin to a host controller to allow the host to initiate a full hardware reset without requiring the mXT1067TD-Ax I<sup>2</sup>C Variant to be powered down.

**WARNING** The device should be reset only by using the  $\overline{\text{RESET}}$  line. If an attempt is made to reset by removing the power from the device without also sending the signal lines low, power will be drawn from the communication and I/O lines and the device will not reset correctly.

Make sure that any lines connected to the device are below or equal to Vdd during power-up. For example, if  $\overline{\text{RESET}}$  is supplied from a different power domain to the VDDIO pin, make sure that it is held low when Vdd is off. If this is not done, the  $\overline{\text{RESET}}$  signal could parasitically couple power via the  $\overline{\text{RESET}}$  pin into the Vdd supply.

**NOTE** The voltage level on the  $\overline{\text{RESET}}$  pin of the device must never exceed VddIO (digital supply voltage).

A software RESET command (using the Command Processor T6 object) can be used to reset the chip. A software reset typically takes 115 ms. After the chip has finished it asserts the CHG line to signal to the host that a message is available. The reset flag is set in the Command Processor T6 object message data to indicate to the host that it has just completed a reset cycle. This bit can be used by the host to detect any unexpected brownout events. This allows the host to take any necessary corrective actions, such as reconfiguration.

**NOTE** The CHG line is briefly set (~100 ms) as an input during power-up or reset. It is therefore particularly important that the line should be allowed to float high via the CHG line pull-up resistor during this period. It should never be driven by the host (see Section 12.5.4 "Reset Timings").

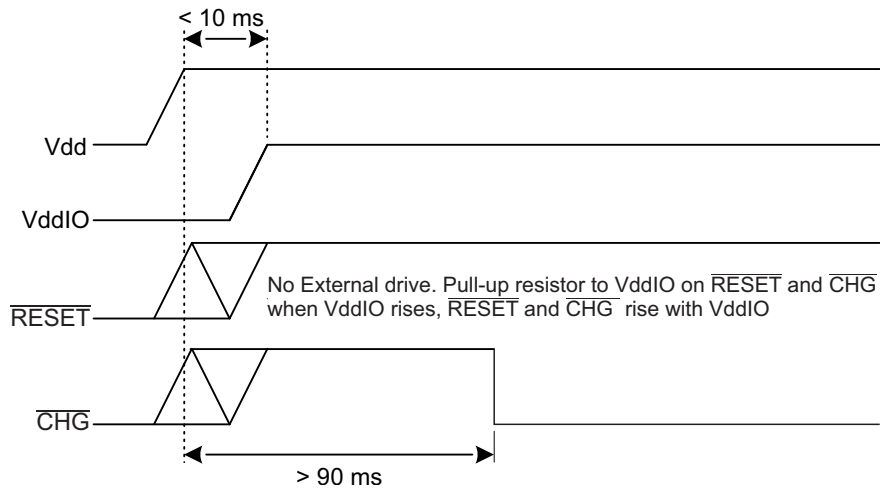
At power-on, the device performs a self-test routine (using the Self Test T25 object) to check for shorts that might cause damage to the device.

## 5.2 Power-up and Reset Sequence – VddIO Enabled after Vdd

The power-up sequence that can be used in applications where VddIO must be powered up after Vdd, is shown in Figure 5-3.

In this case the communication interface to the maXTouch device is not driven by the host system. The  $\overline{\text{RESET}}$  and CHG pins are connected to VddIO using suitable pull-up resistors. Vdd is powered up, followed by VddIO, no more than 10 ms after Vdd. Due to the pull-up resistors,  $\overline{\text{RESET}}$  and CHG will rise with VddIO. The internal POR system ensures reliable boot up of the device and the CHG line will go low approximately 93 ms after Vdd to notify the host that the device is ready to start communication.

**FIGURE 5-3: POWER-UP SEQUENCE**



### 5.3 Power-up and Initialization

The device uses a number of different power domains for optimum performance and contains circuitry to interface internal signals crossing between the different domains. There is also circuitry to ensure that the device interface logic will be initialized correctly as the device powers on. Note, however, that this does not negate specific instructions elsewhere in this section about the order that the different supplies should power up. Also, as previously mentioned,  $\overline{\text{RESET}}$  should be held low until after all power rails are stable. In addition, the device will not initialize until all the voltage rails have powered up and are present.

If one domain loses power, however (for example, due to a fault or an ESD event), the device should be power-cycled to ensure that the interface logic is once again initialized. It is therefore recommended that customer designs include the capability for the host to control all the maXTouch power supplies and pull the  $\overline{\text{RESET}}$  line low.

### 5.4 Summary

The power-up and reset requirements for the maXTouch devices are summarized in [Table 5-1](#).

**TABLE 5-1: POWER-UP AND RESET REQUIREMENTS**

Condition	External $\overline{\text{RESET}}$	VddIO Delay (After Vdd)	AVdd Power-Up	Comments
1	Low at Power-up	0 ms	Before $\overline{\text{RESET}}$ is released	If AVdd bring-up is delayed, then additional actions will be required by the host (see <a href="#">Section 5.1 "Power-on Reset"</a> )
2	Not driven	<10 ms	Before VddIO	

# mXT1067TD-Ax (I<sup>2</sup>C) 1.0

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## 6.0 DETAILED OPERATION

### 6.1 Touch Detection

The mXT1067TD-Ax I<sup>2</sup>C Variant allows for both mutual and self capacitance measurements, with the self capacitance measurements being used to augment the mutual capacitance measurements to produce reliable touch information.

When self capacitance measurements are enabled, touch classification is achieved using both mutual and self capacitance touch data. This has the advantage that both types of measurement systems can work together to detect touches under a wide variety of circumstances.

Mutual capacitance touch data is used wherever possible to classify touches as this has greater granularity than self capacitance measurements and provides positional information on touches.

Self capacitance measurements, on the other hand, allow for the detection of single touches in extreme cases, such as single thick glove touches, when touches can only be detected by self capacitance data and may be missed by mutual capacitance touch detection.

### 6.2 Operational Modes

The device operates in two modes: **Active** (touch detected) and **Idle** (no touches detected). Both modes operate as a series of burst cycles. Each cycle consists of a short burst (during which measurements are taken) followed by an inactive sleep period. The difference between these modes is the length of the cycles. Those in idle mode typically have longer sleep periods. The cycle length is configured using the IDLEACQINT and ACTVACQINT settings in the Power Configuration T7. In addition, an *Active to Idle Timeout* setting is provided.

### 6.3 Detection Integrator

The device features a touch detection integration mechanism. This acts to confirm a detection in a robust fashion. A counter is incremented each time a touch has exceeded its threshold and has remained above the threshold for the current acquisition. When this counter reaches a preset limit the sensor is finally declared to be touched. If, on any acquisition, the signal is not seen to exceed the threshold level, the counter is cleared and the process has to start from the beginning.

The detection integrator is configured using the appropriate touch objects (Multiple Touch Touchscreen T100, Key Array T15).

### 6.4 Sensor Acquisition

The charge time for mutual capacitance measurements is set using the Acquisition Configuration T8 object.

The device combines a number of factors together to arrive at the total acquisition time for one drive line (that is, one X line for mutual capacitance acquisitions or one axis for self capacitance acquisitions), but the maximum time to complete the acquisition must not exceed 2 ms. Furthermore, the total acquisition time for the sensor as a whole must not exceed 250 ms. If either of these conditions are not met, a SIGERR will be reported.

In addition, the following constraints apply on the mXT1067TD-Ax I<sup>2</sup>C Variant:

- The per X line mutual capacitance touch measurement and the per axis self capacitance measurement must not exceed 2 ms
- The high and low pulse periods must not exceed 38.65  $\mu$ s each. This means that the maximum possible burst period is 77.34  $\mu$ s (that is, a minimum frequency of 12.93 kHz). In addition, the burst period must not be less than 4  $\mu$ s (that is, a maximum frequency of 250 kHz).

Unpredictable system behavior might occur if any of the above constraints are not met.

Care should be taken to configure all the objects that can affect the measurement timing so that these limits are not exceeded.

## 6.5 Calibration

Calibration is the process by which a sensor chip assesses the background capacitance on each node. Calibration occurs in a variety of circumstances, for example:

- When determined by the mutual capacitance recalibration process, as controlled by the Acquisition Configuration T8 object
- When determined by the self capacitance recalibration process, as controlled by the Self Capacitance Configuration T111 object
- When the Retransmission Compensation T80 object detects calibrated-in moisture has been removed
- Following a Self Capacitance Global Configuration T109 Tune command
- When the host issues a recalibrate command
- When certain configuration settings are changed

## 6.6 Digital Filtering and Noise Suppression

The mXT1067TD-Ax I<sup>2</sup>C Variant supports on-chip filtering of the acquisition data received from the sensor. Specifically, the Noise Suppression T72 object provides an algorithm to suppress the effects of noise (for example, from a noisy charger plugged into the user's product). This algorithm can automatically adjust some of the acquisition parameters on-the-fly to filter the Analog-to-Digital Conversions (ADCs) received from the sensor.

Additional noise suppression is provided by the Self Capacitance Noise Suppression T108 object. Similar in both design and configuration to the Noise Suppression T72 object, the Self Capacitance Noise Suppression T108 object is the noise suppression interface for self capacitance touch measurements.

Noise suppression is triggered when a noise source is detected.

- The host driver code can indicate when a noise source is present.
- The noise suppression is also triggered based on the noise levels detected using internal line measurements. The Noise Suppression T72 and Self Capacitance Noise Suppression T108 object selects the appropriate controls to suppress the noise present in the system.

## 6.7 EMC Reduction

The mXT1067TD-Ax I<sup>2</sup>C Variant has various mechanisms that help reduce EMC emissions and ensure that the user's product operates within the desired EMC limits:

- **Spread spectrum** – Varies the burst frequency on each measurement pulse to spread the EMC energy over the frequency domain.
- **Configurable voltage reference mode** – Allows for the selection of voltage swing of the self capacitance measurements.
- **Configurable wave shaping** – Control of the voltage modulation on self capacitance scans allows wave shaping of the edge for EMC harmonic control.

These features are configured using the CTE Configuration T46, Self Capacitance Voltage Modulation T133 and Self Capacitance Global Configuration T109 objects.

## 6.8 Shieldless Support and Display Noise Suppression

The mXT1067TD-Ax I<sup>2</sup>C Variant can support shieldless sensor design even with a noisy LCD.

The Optimal Integration feature is not filtering as such, but enables the user to use a shorter integration window. The integration window optimizes the amount of charge collected against the amount of noise collected, to ensure an optimal SNR. This feature also benefits the system in the presence of an external noise source. This feature is configured using the Shieldless T56 object.

Display noise suppression allows the device to overcome display noise simultaneously with external noise. This feature is based on filtering provided by the Lens Bending T65 object (see [Section 6.11 "Lens Bending"](#)).

## 6.9 Retransmission Compensation

The device can limit the undesirable effects on the mutual capacitance touch signals caused by poor device coupling to ground, such as poor sensitivity and touch break-up. This is achieved using the Retransmission Compensation T80 object. This object can be configured to allow the touchscreen to compensate for signal degradation due to these undesirable effects. If self capacitance measurements are also scheduled, the Retransmission Compensation T80 object will use the resultant data to enhance the compensation process.

The Retransmission Compensation T80 object is also capable of compensating for water presence on the sensor if self capacitance measurements are scheduled. In this case, both mutual capacitance and self capacitance measurements are used to detect moisture and then, once moisture is detected, self capacitance measurements are used to detect single touches in the presence of moisture.

## 6.10 Grip Suppression

The device has grip suppression functionality to suppress false detections from a user's grip.

Self Capacitance grip suppression works by looking for characteristic shapes in the self capacitance measurement along the touchscreen boundary, and thereby distinguishing between a grip and a touch further into the sensor. Self capacitance grip suppression is configured using the Self Capacitance Grip Suppression T112 object.

## 6.11 Lens Bending

The device supports algorithms to eliminate disturbances from the measured signal.

When the sensor suffers from the screen deformation (lens bending) the signal values acquired by normal procedure are corrupted by the disturbance component (bend). The amount of bend depends on:

- The mechanical and electrical characteristics of the sensor
- The amount and location of the force applied by the user touch to the sensor

The Lens Bending T65 object measures the bend component and compensates for any distortion caused by the bend. As the bend component is primarily influenced by the user touch force, it can be used as a secondary source to identify the presence of a touch. The additional benefit of the Lens Bending T65 object is that it will eliminate LCD noise as well.

## 6.12 Glove Detection

The device has glove detection algorithms that process the measurement data received from the touchscreen classifying touches as potential gloved touches.

The Glove Detection T78 object is used to detect glove touches. In Normal Mode the Glove Detection T78 object applies vigorous glove classification to small signal touches to minimize the effect of unintentional hovering finger reporting. Once a gloved touch is found, the Glove Detection T78 object enters Glove Confidence Mode. In this mode the device expects the user to be wearing gloves so the classification process is much less stringent.

## 6.13 Unintentional Touch Suppression

The Touch Suppression T42 object provides a mechanism to suppress false detections from unintentional touches from a large body area, such as from a face, ear or palm. The Touch Suppression T42 object also provides Maximum Touch Suppression to suppress all touches if more than a specified number of touches has been detected. There is one instance of the Touch Suppression T42 object for each Multiple Touch Touchscreen T100 object present on the device.

## 6.14 Adjacent Key Suppression Technology

Adjacent Key Suppression (AKS) technology is a patented method used to detect which touch object (Multiple Touch Touchscreen T100 or Key Array T15) is touched, and to suppress touches on the other touch objects, when touch objects are located close together.

The device has two levels of AKS:

- The first level works between the touch objects (Multiple Touch Touchscreen T100 and Key Array T15). The touch objects are assigned to AKS groups. If a touch occurs within one of the touch objects in a group, then touches within other objects inside that group are suppressed. For example, if a touchscreen and a Key Array are placed in the same AKS group, then a touch in the touchscreen will suppress touches in the Key Array, and vice versa. Objects can be in more than one AKS group.

- The second level of AKS is internal AKS within an individual Key Array object. If internal AKS is enabled, then when one key is touched, touches on all the other keys within the Key Array are suppressed. Note that internal AKS is not present on other types of touch objects.

# mXT1067TD-Ax (I<sup>2</sup>C) 1.0

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## 7.0 HOST COMMUNICATIONS

Communication between the mXT1067TD-Ax I<sup>2</sup>C Variant and the host is achieved using the I<sup>2</sup>C interface.

### 7.1 I<sup>2</sup>C Address Selection – ADDSEL Pin

The I<sup>2</sup>C address is selected by connecting the ADDSEL pin according to [Table 7-1](#).

**TABLE 7-1: I<sup>2</sup>C ADDRESS SELECTION**

ADDSEL	I <sup>2</sup> C Address
Connected to GND	0x4A
Pulled up to VddIO <sup>(1)</sup>	0x4B

**Note 1:** Requires a pull-up resistor

## 8.0 I<sup>2</sup>C COMMUNICATIONS

Communication with the device is carried out over the I<sup>2</sup>C interface.

The I<sup>2</sup>C interface is used in conjunction with the  $\overline{\text{CHG}}$  line. The  $\overline{\text{CHG}}$  line going active signifies that a new data packet is available. This provides an interrupt-style interface and allows the device to present data packets when internal changes have occurred. See [Section 8.6 “CHG Line”](#) for more information.

### 8.1 I<sup>2</sup>C Addresses

The device supports two I<sup>2</sup>C device addresses that are selected using the ADDSEL line at startup. The two internal I<sup>2</sup>C device addresses are 0x4A and 0x4B. The selection of the address (and the communication mode) is described in [Section 7.1 “I<sup>2</sup>C Address Selection – ADDSEL Pin”](#).

The I<sup>2</sup>C address is shifted left to form the SLA+W or SLA+R address when transmitted over the I<sup>2</sup>C interface, as shown in [Table 8-1](#).

**TABLE 8-1: FORMAT OF AN I<sup>2</sup>C ADDRESS**

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Address: 0x4A or 0x4B							Read/write

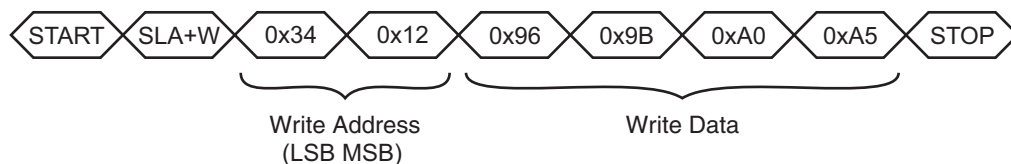
### 8.2 Writing To the Device

A WRITE cycle to the device consists of a START condition followed by the I<sup>2</sup>C address of the device (SLA+W). The next two bytes are the address of the location into which the writing starts. The first byte is the Least Significant Byte (LSByte) of the address, and the second byte is the Most Significant Byte (MSByte). This address is then stored as the address pointer.

Subsequent bytes in a multi-byte transfer form the actual data. These are written to the location of the address pointer, location of the address pointer + 1, location of the address pointer + 2, and so on. The address pointer returns to its starting value when the WRITE cycle STOP condition is detected.

[Figure 8-1](#) shows an example of writing four bytes of data to contiguous addresses starting at 0x1234.

**FIGURE 8-1: EXAMPLE OF A FOUR-BYTE WRITE STARTING AT ADDRESS 0x1234**

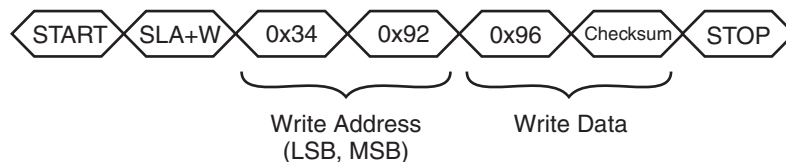


### 8.3 I<sup>2</sup>C Writes in Checksum Mode

In I<sup>2</sup>C checksum mode an 8-bit CRC is added to all I<sup>2</sup>C writes. The CRC is sent at the end of the data write as the last byte before the STOP condition. All the bytes sent are included in the CRC, including the two address bytes. Any command or data sent to the device is processed even if the CRC fails.

To indicate that a checksum is to be sent in the write, the most significant bit of the MSByte of the address is set to 1. For example, the I<sup>2</sup>C command shown in [Figure 8-2](#) writes a value of 150 (0x96) to address 0x1234 with a checksum. The address is changed to 0x9234 to indicate checksum mode.

**FIGURE 8-2: EXAMPLE OF A WRITE TO ADDRESS 0x1234 WITH A CHECKSUM**



# mXT1067TD-Ax (I<sup>2</sup>C) 1.0

## 8.4 Reading From the Device

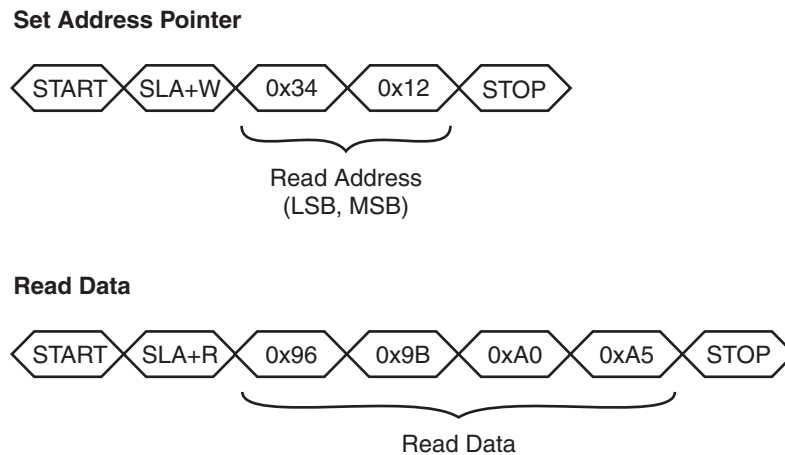
Two I<sup>2</sup>C bus activities must take place to read from the device. The first activity is an I<sup>2</sup>C write to set the address pointer (LSByte then MSByte). The second activity is the actual I<sup>2</sup>C read to receive the data. The address pointer returns to its starting value when the read cycle NACK is detected.

It is not necessary to set the address pointer before every read. The address pointer is updated automatically after every read operation. The address pointer will be correct if the reads occur in order. In particular, when reading multiple messages from the Message Processor T5 object, the address pointer is automatically reset to allow continuous reads (see Section 8.5 “Reading Status Messages with DMA”).

The WRITE and READ cycles consist of a START condition followed by the I<sup>2</sup>C address of the device (SLA+W or SLA+R respectively). Note that in this mode, calculating a checksum of the data packets is not supported.

Figure 8-3 shows the I<sup>2</sup>C commands to read four bytes starting at address 0x1234.

**FIGURE 8-3: EXAMPLE OF A FOUR-BYTE READ STARTING AT ADDRESS 0x1234**



## 8.5 Reading Status Messages with DMA

The device facilitates the easy reading of multiple messages using a single continuous read operation. This allows the host hardware to use a Direct Memory Access (DMA) controller for the fast reading of messages, as follows:

1. The host uses a write operation to set the address pointer to the start of the Message Count T44 object, if necessary. Note that the STOP condition at the end of the read resets the address pointer to its initial location, so it may already be pointing at the Message Count T44 object following a previous message read. If a checksum is required on each message, the most significant bit of the MSByte of the read address must be set to 1.
2. The host starts the read operation of the message by sending a START condition.
3. The host reads the Message Count T44 object (one byte) to retrieve a count of the pending messages.
4. The host calculates the number of bytes to read by multiplying the message count by the size of the Message Processor T5 object. Note that the host should have already read the size of the Message Processor T5 object in its initialization code.

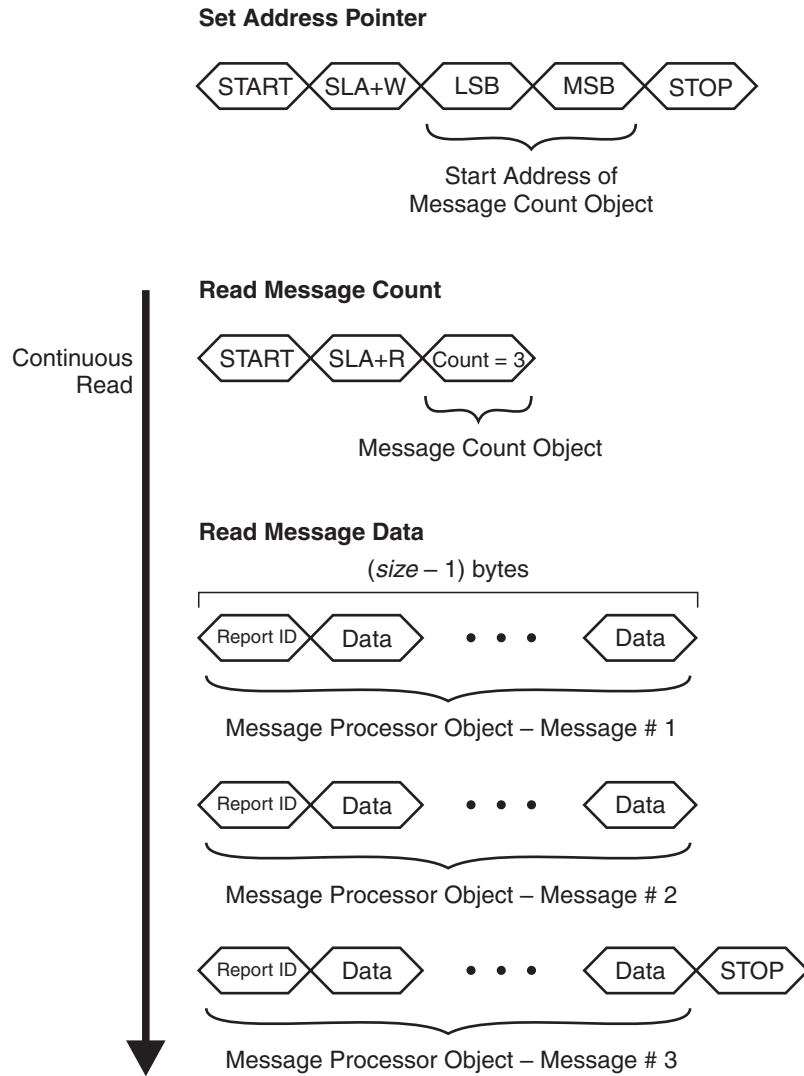
Note that the size of the Message Processor T5 object as recorded in the Object Table includes a checksum byte. If a checksum has not been requested, one byte should be deducted from the size of the object.

That is: number of bytes = count × (size – 1).

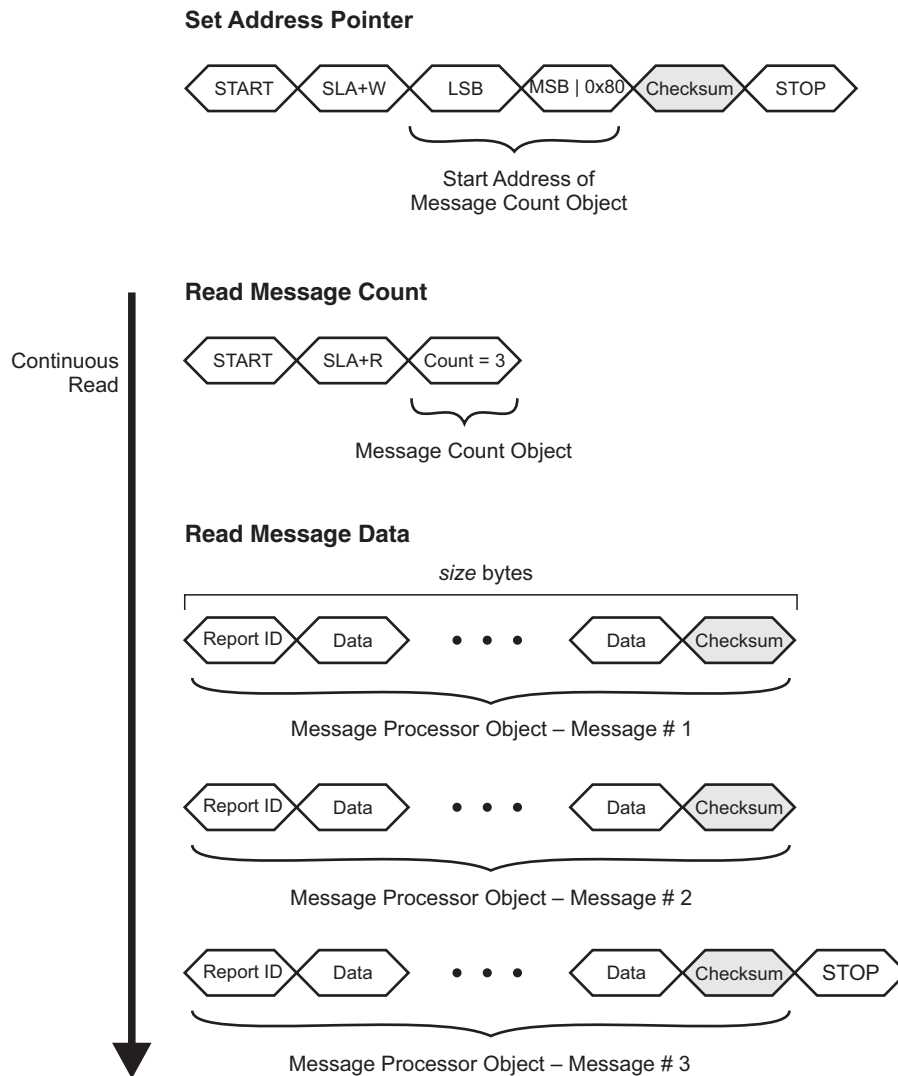
5. The host reads the calculated number of message bytes. It is important that the host does *not* send a STOP condition during the message reads, as this will terminate the continuous read operation and reset the address pointer. No START and STOP conditions must be sent between the messages.
6. The host sends a STOP condition at the end of the read operation after the last message has been read. The NACK condition immediately before the STOP condition resets the address pointer to the start of the Message Count T44 object.

Figure 8-4 shows an example of using a continuous read operation to read three messages from the device without a checksum. Figure 8-5 shows the same example with a checksum.

**FIGURE 8-4: CONTINUOUS MESSAGE READ EXAMPLE – NO CHECKSUM**



**FIGURE 8-5: CONTINUOUS MESSAGE READ EXAMPLE – I<sup>2</sup>C CHECKSUM MODE**



There are no checksums added on any other I<sup>2</sup>C reads. An 8-bit CRC can be added, however, to all I<sup>2</sup>C writes, as described in [Section 8.3 “I<sup>2</sup>C Writes in Checksum Mode”](#).

An alternative method of reading messages using the  $\overline{\text{CHG}}$  line is given in [Section 8.6 “CHG Line”](#).

## 8.6 $\overline{\text{CHG}}$ Line

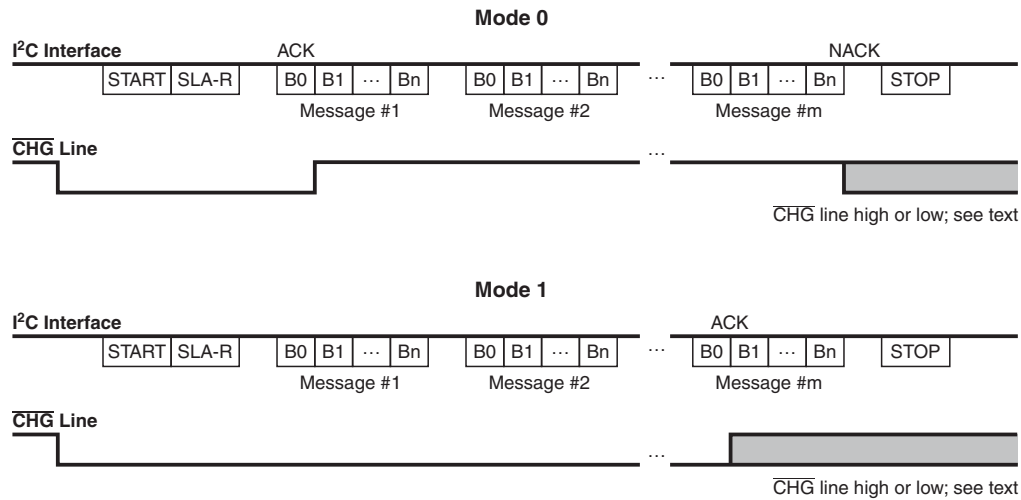
The  $\overline{\text{CHG}}$  line is an active-low, open-drain output that is used to alert the host that a new message is available in the Message Processor T5 object. This provides the host with an interrupt-style interface with the potential for fast response times. It reduces the need for wasteful I<sup>2</sup>C communications.

The  $\overline{\text{CHG}}$  line should always be configured as an input on the host during normal usage. This is particularly important after power-up or reset (see [Section 5.0 “Power-up / Reset Requirements”](#)).

A pull-up resistor is required to VddIO (see [Section 2.0 “Schematic”](#)).

The  $\overline{\text{CHG}}$  line operates in two modes when it is used with I<sup>2</sup>C communications, as defined by the Communications Configuration T18 object.

**FIGURE 8-6: CHG LINE MODES FOR I<sup>2</sup>C-COMPATIBLE TRANSFERS**



In Mode 0 (edge-triggered operation):

1. The  $\overline{\text{CHG}}$  line goes low to indicate that a message is present.
2. The  $\overline{\text{CHG}}$  line goes high when the first byte of the first message (that is, its report ID) has been sent and acknowledged (ACK sent) and the next byte has been prepared in the buffer.
3. The STOP condition at the end of an I<sup>2</sup>C transfer causes the  $\overline{\text{CHG}}$  line to stay high if there are no more messages. Otherwise the CHG line goes low to indicate a further message.

Note that Mode 0 also allows the host to continually read messages by simply continuing to read bytes back without issuing a STOP condition. Message reading should end when a report ID of 255 (“invalid message”) is received. Alternatively the host ends the transfer by sending a NACK after receiving the last byte of a message, followed by a STOP condition. If there is another message present, the  $\overline{\text{CHG}}$  line goes low again, as in step 1. In this mode the state of the  $\overline{\text{CHG}}$  line does not need to be checked during the I<sup>2</sup>C read.

In Mode 1 (level-triggered operation):

1. The  $\overline{\text{CHG}}$  line goes low to indicate that a message is present.
2. The  $\overline{\text{CHG}}$  line remains low while there are further messages to be sent after the current message.
3. The CHG line goes high again only once the first byte of the last message (that is, its report ID) has been sent and acknowledged (ACK sent) and the next byte has been prepared in the output buffer.

Mode 1 allows the host to continually read the messages until the  $\overline{\text{CHG}}$  line goes high, and the state of the  $\overline{\text{CHG}}$  line determines whether or not the host should continue receiving messages from the device.

**NOTE** The state of the  $\overline{\text{CHG}}$  line should be checked only between messages and not between the bytes of a message. The precise point at which the  $\overline{\text{CHG}}$  line changes state cannot be predicted and so the state of the  $\overline{\text{CHG}}$  line cannot be guaranteed between bytes.

The Communications Configuration T18 object can be used to configure the behavior of the  $\overline{\text{CHG}}$  line. In addition to the  $\overline{\text{CHG}}$  line operation modes described above, this object allows direct control over the state of the  $\overline{\text{CHG}}$  line.

## 8.7 SDA and SCL

The I<sup>2</sup>C bus transmits data and clock with SDA and SCL, respectively. These are open-drain. The device can only drive these lines low or leave them open. The termination resistors (R<sub>p</sub>) pull the line up to V<sub>ddIO</sub> if no I<sup>2</sup>C device is pulling it down.

The termination resistors should be chosen so that the rise times on SDA and SCL meet the I<sup>2</sup>C specifications for the interface speed being used, bearing in mind other loads on the bus. For best latency performance, it is recommended that no other devices share the I<sup>2</sup>C bus with the maXTouch controller.

## 8.8 Clock Stretching

The device supports clock stretching in accordance with the I<sup>2</sup>C specification. It may also instigate a clock stretch if a communications event happens during a period when the device is busy internally. The maximum clock stretch is 2 ms and typically less than 350  $\mu$ s.

The device has an internal bus monitor that can reset the internal I<sup>2</sup>C hardware if either SDA or SCL is stuck low for more than 200 ms. This means that if a prolonged clock stretch of more than 200 ms is seen by the device, then any ongoing transfers with the device may be corrupted.

The bus monitor is enabled or disabled using the Communications Configuration T18 object.

## 9.0 PCB DESIGN CONSIDERATIONS

### 9.1 Introduction

The following sections give the design considerations that should be adhered to when designing a PCB layout for use with the mXT1067TD-Ax I<sup>2</sup>C Variant. Of these, power supply and ground tracking considerations are the most critical.

By observing the following design rules, and with careful preparation for the PCB layout exercise, designers will be assured of a far better chance of success and a correctly functioning product.

### 9.2 Printed Circuit Board

Microchip recommends the use of a four-layer printed circuit board for mXT1067TD-Ax I<sup>2</sup>C Variant applications. This, together with careful layout, will ensure that the board meets relevant EMC requirements for both noise radiation and susceptibility, as laid down by the various national and international standards agencies.

#### 9.2.1 PCB CLEANLINESS

Modern no-clean-flux is generally compatible with capacitive sensing circuits.

**CAUTION!** If a PCB is reworked to correct soldering faults relating to any device, or to any associated traces or components, be sure that you fully understand the nature of the flux used during the rework process. Leakage currents from hygroscopic ionic residues can stop capacitive sensors from functioning. If you have any doubts, a thorough cleaning after rework may be the only safe option.

### 9.3 Power Supply

#### 9.3.1 SUPPLY QUALITY

While the device has good Power Supply Rejection Ratio properties, poorly regulated and/or noisy power supplies can significantly reduce performance.

Particular care should be taken of the AVdd supply, as it supplies the sensitive analog stages in the device.

#### 9.3.2 SUPPLY RAILS AND GROUND TRACKING

Power supply and clock distribution are the most critical parts of any board layout. Because of this, it is advisable that these be completed before any other tracking is undertaken. After these, supply decoupling, and analog and high speed digital signals should be addressed. Track widths for all signals, especially power rails should be kept as wide as possible in order to reduce inductance.

The Power and Ground planes themselves can form a useful capacitor. Flood filling for either or both of these supply rails, therefore, should be used where possible. It is important to ensure that there are no floating copper areas remaining on the board: all such areas should be connected to the ground plane. The flood filling should be done on the outside layers of the board.

#### 9.3.3 POWER SUPPLY DECOUPLING

Decoupling capacitors should be fitted as specified in [Section 2.2 “Schematic Notes”](#).

The decoupling capacitors must be placed as close as possible to the pin being decoupled. The traces from these capacitors to the respective device pins should be wide and take a straight route. They should be routed over a ground plane as much as possible. The capacitor ground pins should also be connected directly to a ground plane.

Surface mounting capacitors are preferred over wire-leaded types due to their lower ESR and ESL. It is often possible to fit these decoupling capacitors underneath and on the opposite side of the PCB to the digital ICs. This will provide the shortest tracking, and most effective decoupling possible.

#### 9.3.4 VOLTAGE PUMP

The traces for the voltage pump capacitor between EXTCAP2 and EXTCAP3 (Cd on the schematic in [Section 2.0 “Schematic”](#)) should be kept as short and as wide as possible for best pump performance. They should also be routed as parallel and as close as possible to each other in order to reduce emissions, and ideally the traces should be the same length.

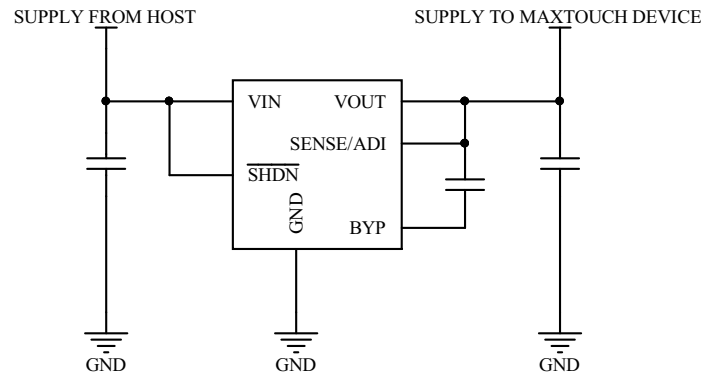
# mXT1067TD-Ax (I<sup>2</sup>C) 1.0

## 9.3.5 VOLTAGE REGULATORS

Each supply rail requires a Low Drop-Out (LDO) voltage regulator, although an LDO can be shared where supply rails share the same voltage level.

Figure 9-1 shows an example circuit for an LDO.

**FIGURE 9-1: EXAMPLE LDO CIRCUIT**



An LDO regulator should be chosen that provides adequate output capability, low noise, good load regulation and step response. The voltage regulators listed in Table 9-1 have been tested and found to work well with maXTouch devices. If it is desired to use an alternative LDO, however, certain performance criteria should be verified before using the device. These are:

- Stable with high value multi-layer ceramic capacitors on the output
- Low output noise – ideally less than 100  $\mu\text{V}_{\text{RMS}}$  over the range 10 Hz to 1 MHz
- Good load transient response – this should be less than 35 mV peak when a load step change of 100 mA is applied at the device output terminal
- No-load stable – Some LDOs become unstable if the output current falls below a certain minimum. If this is the case, then this minimum must be lower than the minimum current consumed by the mXT1067TD-Ax I<sup>2</sup>C Variant (for example, in deep sleep).

**TABLE 9-1: SUITABLE LDO REGULATORS**

Manufacturer	Device	Current Rating (mA)
Microchip Technology Inc.	MCP1824	300
Microchip Technology Inc.	MCP1824S	300
Microchip Technology Inc.	MAQ5300	300
Microchip Technology Inc.	MCP1725	500
Analog Devices	ADP122/ADP123	300
Diodes Inc.	AP2125	300
Diodes Inc.	AP7335	300
Linear Technology	LT1763CS8-3.3	500
NXP	LD6836	300
Texas Instruments	LP3981	300

**Note:** Some manufacturers claim that minimal or no capacitance is required for correct regulator operation. However, in all cases, a minimum of a 1.0  $\mu\text{F}$  ceramic, low ESR capacitor at the input and output of these devices should be used. The manufacturer's datasheets should always be referred to when selecting capacitors for these devices and the typical recommended values, types and dielectrics adhered to.

## 9.3.6 SINGLE SUPPLY OPERATION

When designing a PCB for an application using a single LDO, extra care should be taken to ensure short, low inductance traces between the supply and the touch controller supply input pins. Ideally, tracking for the individual supplies should be arranged in a star configuration, with the LDO at the junction of the star. This will ensure that supply current variations or noise in one supply rail will have minimum effect on the other supplies. In applications where a ground plane is not practical, this same star layout should also apply to the power supply ground returns.

Only regulators with a 300 mA or greater rating can be used in a single-supply design.

Refer to the following application note for more information:

- Application Note: MXTAN0208 – *Design Guide for PCB Layouts for maXTouch Touch Controllers*

## 9.3.7 MULTIPLE VOLTAGE REGULATOR SUPPLY

The AVdd supply stability is critical for the device because this supply interacts directly with the analog front end. If noise problems exist when using a single LDO regulator, Microchip recommends that AVdd is supplied by a regulator that is separate from the digital supply. This reduces the amount of noise injected into the sensitive, low signal level parts of the design.

## 9.4 Driven Shield Line

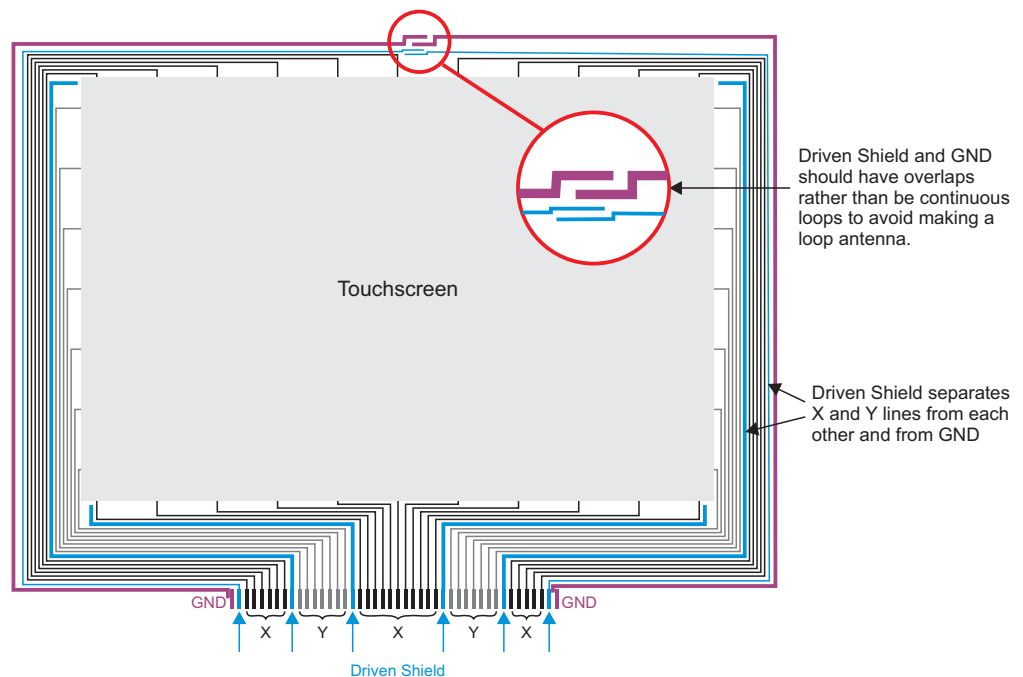
The driven shield line can be used to provide a guard track that serves as Ground in mutual capacitance operation and as a driven shield in self capacitance operation.

The guard track must be routed between the X and Y tracks, as well as between the X/Y tracks and Ground. It should be fairly wide to avoid X-to-Y coupling in mutual capacitance operation, as the guard track will act as Ground in this circumstance.

A guard track is also needed between any self capacitance X/Y lines and mutual capacitance only X/Y lines (for example, between Multiple Touch Touchscreen T100 and Key Array T15 lines).

**NOTE** DS0 is internally multiplexed to X31. X31 must be configured for use if DS0 is to be used (either as a driven shield for self capacitance measurements or as a Ground guard track in a mutual capacitance only design), otherwise DS0 cannot be used in the user's design.

**FIGURE 9-2: EXAMPLE DRIVEN SHIELD ROUTING**



NOTE: Sample touchscreen for illustrative purposes only. The number of X/Y lines available on any given device might differ from that shown here. Similarly, the routing of the X/Y lines shown should not be taken as indicative of any preferred layout and the user's layout may vary.

## 9.5 ESD Ground Routing

To avoid damage due to ESD strikes, the outermost track on the sensor should be an ESD ground (see [Figure 9-2](#)). Like the driven shield, this should completely surround the sensor but with an overlap at the top rather than forming a complete loop.

To avoid electromagnetic induction of currents into the driven shield trace, a minimum separation of 0.3 mm should be maintained between the ESD GND trace and the Driven Shield.

The ESD ground traces should be connected to a dedicated ground trace in the PCB, and routed such that ESD strike currents do not flow under or close to the touch controller or the connecting wiring between it and the touchscreen array. The ESD ground should be connected in to the main system ground at a star point at the main GND connection to the PCB.

See also:

- MXTAN0208 – *Design guide for PCB Layouts for maXTouch Touch Controllers*

## 9.6 Analog I/O

In general, tracking for the analog I/O signals from the device should be kept as short as possible. These normally go to a connector which interfaces directly to the touchscreen.

Ensure that adequate ground-planes are used. An analog ground plane should be used in addition to a digital one. Care should be taken to ensure that both ground planes are kept separate and are connected together only at the point of entry for the power to the PCB. This is usually at the input connector.

## 9.7 Component Placement and Tracking

It is important to orient all devices so that the tracking for important signals (such as power and clocks) are kept as short as possible.

### 9.7.1 DIGITAL SIGNALS

In general, when tracking digital signals, it is advisable to avoid sharp directional changes on sensitive signal tracks (such as analog I/O) and any clock or crystal tracking.

A good ground return path for all signals should be provided, where possible, to ensure that there are no discontinuities.

## 9.8 EMC and Other Observations

The following recommendations are not mandatory, but may help in situations where particularly difficult EMC or other problems are present:

- Try to keep as many signals as possible on the inside layers of the board. If suitable ground flood fills are used on the top and bottom layers, these will provide a good level of screening for noisy signals, both into and out of the PCB.
- Ensure that the on-board regulators have sufficient tracking around and underneath the devices to act as a heatsink. This heatsink will normally be connected to the 0 V or ground supply pin. Increasing the width of the copper tracking to any of the device pins will aid in removing heat. There should be no solder mask over the copper track underneath the body of the regulators.
- Ensure that the decoupling capacitors, especially high capacity ceramic type, have the requisite low ESR, ESL and good stability/temperature properties. Refer to the regulator manufacturer's datasheet for more information.

## 10.0 GETTING STARTED WITH MXT1067TD-AT/MXT1067TD-AB I<sup>2</sup>C VARIANT

### 10.1 Establishing Contact

#### 10.1.1 COMMUNICATION WITH THE HOST

The host can use the following interface to communicate with the device:

- I<sup>2</sup>C interface (see [Section 8.0 "I<sup>2</sup>C Communications"](#))

#### 10.1.2 POWER-UP SEQUENCE

On power-up, the  $\overline{\text{CHG}}$  line goes low to indicate that there is new data to be read from the device. If the  $\overline{\text{CHG}}$  line does not go low, there is a problem with the device.

Once the  $\overline{\text{CHG}}$  line goes low, the host should attempt to read the first 7 bytes of memory from location 0x00 to establish that the device is present and running following power-up.

A checksum check is performed on the configuration settings held in the non-volatile memory. If the checksum does not match a stored copy of the last checksum, then this indicates that the settings have become corrupted. The host should write a correct configuration to the device if the read checksum does not match the expected checksum, or if the configuration error bit in the message data from the Command Processor T6 object is set.

### 10.2 Using the Object Protocol

The device has an object-based protocol that is used to communicate with the device. Typical communication includes configuring the device, sending commands to the device, and receiving messages from the device.

The host must perform the following initialization so that it can communicate with the device:

1. Read the start positions of all the objects in the device from the Object Table and build up a list of these addresses.
2. Use the Object Table to calculate the report IDs so that messages from the device can be correctly interpreted.

#### 10.2.1 CLASSES OF OBJECTS

The mXT1067TD-Ax I<sup>2</sup>C Variant contains the following classes of objects:

- **Debug objects** – provide a raw data output method for development and testing.
- **General objects** – required for global configuration, transmitting messages and receiving commands.
- **Touch objects** – operate on measured signals from the touch sensor and report touch data.
- **Signal processing objects** – process data from other objects (typically signal filtering operations).
- **Support objects** – provide additional functionality on the device.

#### 10.2.2 OBJECT INSTANCES

**TABLE 10-1: OBJECTS ON THE MXT1067TD-Ax I<sup>2</sup>C VARIANT**

Object	Description	Number of Instances	Usage
<b>Debug Objects</b>			
Diagnostic Debug T37	Allows access to diagnostic debug data to aid development.	1	Debug commands only. No configuration/tuning necessary. Not for use in production.
<b>General Objects</b>			
Message Processor T5	Handles the transmission of messages. This object holds a message in its memory space for the host to read.	1	No configuration necessary.
Command Processor T6	Performs a command when written to. Commands include reset, calibrate and backup settings.	1	No configuration necessary.

# mXT1067TD-Ax (I<sup>2</sup>C) 1.0

**TABLE 10-1: OBJECTS ON THE MXT1067TD-Ax I<sup>2</sup>C VARIANT (CONTINUED)**

Object	Description	Number of Instances	Usage
Power Configuration T7	Controls the sleep mode of the device. Power consumption can be lowered by controlling the acquisition frequency and the sleep time between acquisitions.	1	Must be configured before use.
Acquisition Configuration T8	Controls how the device takes each capacitive measurement.	1	Must be configured before use.
<b>Touch Objects</b>			
Key Array T15	Defines a rectangular array of keys. A Key Array T15 object reports simple on/off touch information.	1	Enable and configure as required.
Multiple Touch Touchscreen T100	Creates a Touchscreen that supports the tracking of more than one touch.	1	Enable and configure as required.
<b>Signal Processing Objects</b>			
Key Thresholds T14	Allows different thresholds to be specified for each key in a Key Array.	1	Configure as required.
One-touch Gesture Processor T24	Operates on the data from a Touchscreen object. A One-touch Gesture Processor T24 converts touches into one-touch finger gestures (for example, taps, double taps and drags).	1	Enable and configure as required.
Two-touch Gesture Processor T27	Operates on the data from a One-touch Gesture Processor T24 object. A Two-touch Gesture Processor T27 converts touches into two-touch finger gestures (for example, pinches, stretches and rotates).	1	Enable and configure as required.
Touch Suppression T42	Suppresses false detections caused by unintentional large touches by the user.	1	Enable and configure as required.
Shieldless T56	Allows a sensor to use true single-layer coplanar construction.	1	Enable and configure as required.
Lens Bending T65	Compensates for lens deformation (lens bending) by attempting to eliminate the disturbance signal from the reported deltas.	3	Enable and configure as required.
Noise Suppression T72	Performs various noise reduction techniques during sensor signal acquisition.	1	Enable and configure as required.
Glove Detection T78	Allows for the reporting of glove touches.	1	Enable and configure as required.
Retransmission Compensation T80	Limits the negative effects on touch signals caused by poor device coupling to ground or moisture on the sensor.	1	Enable and configure as required.
Self Capacitance Noise Suppression T108	Suppresses the effects of external noise within the context of self capacitance touch measurements.	1	Enable and configure as required.
Self Capacitance Grip Suppression T112	Allows touches to be reported from the self capacitance measurements while the device is being gripped.	1	Enable and configure as required.
<b>Support Objects</b>			
Communications Configuration T18	Configures additional communications behavior for the device.	1	Check and configure as necessary.
GPIO Configuration T19	Allows the host controller to configure and use the general purpose I/O pins on the device.	1	Enable and configure as required.

**TABLE 10-1: OBJECTS ON THE MXT1067TD-Ax I<sup>2</sup>C VARIANT (CONTINUED)**

Object	Description	Number of Instances	Usage
Self Test T25	Configures and performs self-test routines to find faults on a touch sensor.	1	Configure as required for pin test commands.
User Data T38	Provides a data storage area for user data.	1	Configure as required.
Message Count T44	Provides a count of pending messages.	1	Read-only object.
CTE Configuration T46	Controls the capacitive touch engine for the device.	1	Must be configured.
Timer T61	Provides control of a timer.	6	Enable and configure as required.
Dynamic Configuration Controller T70	Allows rules to be defined that respond to system events.	20	Enable and configure as required.
Dynamic Configuration Container T71	Allows the storage of user configuration on the device that can be selected at runtime based on rules defined in the Dynamic Configuration Controller T70 object.	1	Configure if Dynamic Configuration Controller T70 is in use.
Touch Event Trigger T79	Configures touch triggers for use with the event handler.	3	Enable and configure as required.
Auxiliary Touch Configuration T104	Allows the setting of self capacitance gain and thresholds for a particular measurement to generate auxiliary touch data for use by other objects.	1	Enable and configure if using self capacitance measurements
Self Capacitance Global Configuration T109	Provides configuration for self capacitance measurements employed on the device.	1	Check and configure as required (if using self capacitance measurements).
Self Capacitance Tuning Parameters T110	Provides configuration space for a generic set of settings for self capacitance measurements.	6	Use under the guidance of Microchip field engineers only.
Self Capacitance Configuration T111	Provides configuration for self capacitance measurements employed on the device.	2	Check and configure as required (if using self capacitance measurements).
Self Capacitance Measurement Configuration T113	Configures self capacitance measurements to generate data for use by other objects.	1	Enable and configure as required.
Self Capacitance Voltage Modulation T133	Controls the voltage modulation on self capacitance scans.	2	Enable and configure as required.

### 10.2.3 CONFIGURING AND TUNING THE DEVICE

The objects are designed such that a default value of zero in their fields is a “safe” value that typically disables functionality. The objects must be configured before use and the settings written to the non-volatile memory using the Command Processor T6 object.

Perform the following actions for each object:

1. Enable the object, if the object requires it.
2. Configure the fields in the object, as required.
3. Enable reporting, if the object supports messages, to receive messages from the object.

### 10.3 Writing to the Device

The following mechanism can be used to write to the device:

- Using an I<sup>2</sup>C write operation (see [Section 8.2 “Writing To the Device”](#)).

Communication with the device is achieved by writing to the appropriate object:

- To send a command to the device, an appropriate command is written to the Command Processor T6 object.

# mXT1067TD-Ax (I<sup>2</sup>C) 1.0

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- To configure the device, a configuration parameter is written to the appropriate object. For example, writing to the Power Configuration T7 configures the power consumption for the device and writing to the touchscreen Multiple Touch Touchscreen T100 object sets up the touchscreen. Some objects are optional and need to be enabled before use.

<p><b>IMPORTANT!</b> When the host issues any command within an object that results in a flash write to the device Non-Volatile Memory (NVM), that object should have its CTRL RPTEN bit set to 1, if it has one. This ensures that a message from the <u>object</u> writing to the NVM is generated at the completion of the process and an assertion of the <math>\overline{\text{CHG}}</math> line is executed.</p> <p>The host must also ensure that the assertion of the <math>\overline{\text{CHG}}</math> line refers to the expected object report ID before asserting the <math>\overline{\text{RESET}}</math> line to perform a reset. Failure to follow this guidance may result in a corruption of device configuration area and the generation of a CFGERR.</p>
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## 10.4 Reading from the Device

Status information is stored in the Message Processor T5 object. This object can be read to receive any status information from the device. The following mechanism provides an interrupt-style interface for reading messages in the Message Processor T5 object:

- The  $\overline{\text{CHG}}$  line is asserted whenever a new message is available in the Message Processor T5 object (see [Section 8.6 “CHG Line”](#)). See [Section 8.4 “Reading From the Device”](#) for information on the format of the I<sup>2</sup>C read operation.

Note that the host should always wait to be notified of messages; the host should not poll the device for messages.

## 11.0 DEBUGGING AND TUNING

### 11.1 SPI Debug Interface

The SPI Debug Interface is used for tuning and debugging when running the system and allows the development engineer to use Microchip maXTouch Studio to read the real-time raw data. This uses the low-level debug port.

The SPI Debug Interface consists of the  $\overline{\text{DBG\_SS}}$ ,  $\text{DBG\_CLK}$ , and  $\text{DBG\_DATA}$  lines. It is recommended that these pins are routed to test points on all designs such that they can be connected to external hardware during system development. These lines should not be connected to power or GND. See [Section 2.2.9 "SPI Debug Interface"](#) for more details.

The SPI Debug Interface is enabled by the Command Processor T6 object and by default will be off.

<b>NOTE</b>	The touch controller will take care of the pin configuration. When the $\overline{\text{DBG\_SS}}$ , $\text{DBG\_CLK}$ , and $\text{DBG\_DATA}$ lines are in use for debugging, any alternative function for the pins cannot be used.
-------------	---

### 11.2 Object-based Protocol

The device provides a mechanism for obtaining debug data for development and testing purposes by reading data from the Diagnostic Debug T37 object.

<b>NOTE</b>	The Diagnostic Debug T37 object is of most use for simple tuning purposes. When debugging a design, it is preferable to use the SPI Debug Interface, as this will have a much higher bandwidth and can provide real-time data.
-------------	--

### 11.3 Self Test

There is a Self Test T25 object that runs self-test routines in the device to find hardware faults on the sense lines and the electrodes. This object also performs an initial pin fault test on power-up to ensure that there is no pin short (X-to-Y, or sense pin to power or GND) before the high-voltage supply is enabled inside the chip. A high-voltage short on the sense lines could damage the device.

In addition to one-off hardware tests, the Self Test T25 object can also provide continuous monitoring of the health of the device while it is in operation. A periodic test can be run at a user-specified interval and reports pass and/or fail messages (as determined by the device configuration). Reporting is achieved either by standard Self Test T25 object protocol messages or by a dedicated hardware GPIO pin, configured using the GPIO Configuration T19 object.

# mXT1067TD-Ax (I<sup>2</sup>C) 1.0

## 12.0 SPECIFICATIONS

### 12.1 Absolute Maximum Specifications

Vdd	3.6V
VddIO	3.6V
AVdd	3.6V
Maximum continuous combined pin current, all GPIO $n$ pins	60 mA
Voltage forced onto any pin	-0.3 V to Vdd/VddIO/AVdd + 0.3 V
Configuration parameters maximum writes	10,000
Maximum junction temperature	125°C

**CAUTION!** Stresses beyond those listed under *Absolute Maximum Specifications* may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or other conditions beyond those indicated in the operational sections of this specification is not implied. Exposure to absolute maximum specification conditions for extended periods may affect device reliability.

### 12.2 Recommended Operating Conditions

Operating temperature	mXT1067TD-AT: -40°C to +85°C (Grade 3)
	mXT1067TD-AB: -40°C to +105°C (Grade 2)
Storage temperature	-60°C to +150°C
Vdd	3.3 V $\pm$ 5%
VddIO	3.3 V $\pm$ 5%
AVdd	3.3 V $\pm$ 5%
XVdd with internal voltage doubler enabled	2 $\times$ Vdd
XVdd with internal voltage doubler disabled	Connected to Vdd (3.3 V $\pm$ 5%)
Temperature slew rate	10°C/min

## 12.2.1 DC CHARACTERISTICS

### 12.2.1.1 Analog Voltage Supply – AVdd

Parameter	Min	Typ	Max	Units	Notes
<b>AVdd</b>					
Operating limits	3.14	3.3	3.47	V	
Supply Rise Rate	–	–	0.036	V/μs	For example, for a 3.3 V rail, the voltage should take a minimum of 92 μs to rise

### 12.2.1.2 Digital Voltage Supply – VddIO, Vdd

Parameter	Min	Typ	Max	Units	Notes
<b>VddIO</b>					
Operating limits	3.14	3.3	3.47	V	
Supply Rise Rate	–	–	0.036	V/μs	For example, for a 3.3 V rail, the voltage should take a minimum of 92 μs to rise
<b>Vdd</b>					
Operating limits	3.14	3.3	3.47	V	
Supply Rise Rate	–	–	0.036	V/μs	For example, for a 3.3 V rail, the voltage should take a minimum of 92 μs to rise
Supply Fall Rate	–	–	0.05	V/μs	For example, for a 3.3 V rail, the voltage should take a minimum of 66 μs to fall

### 12.2.1.3 XVdd Voltage Supply – XVdd

Parameter	Min	Typ	Max	Units	Notes
<b>XVdd</b>					
Operating limits – voltage doubler enabled	–	2 × Vdd	–	V	
Operating limits – voltage doubler disabled	–	Vdd	–	V	

## 12.2.2 POWER SUPPLY RIPPLE AND NOISE

Parameter	Min	Typ	Max	Units	Notes
Vdd	–	–	±50	mV	Across frequency range 1 Hz to 1 MHz
AVdd	–	–	±40	mV	Across frequency range 1 Hz to 1 MHz, with Noise Suppression enabled

# mXT1067TD-Ax (I<sup>2</sup>C) 1.0

## 12.3 Test Configuration

The configuration values listed below were used in the reference unit to validate the interfaces and derive the characterization data provided in the following sections.

**TABLE 12-1: TEST CONFIGURATION**

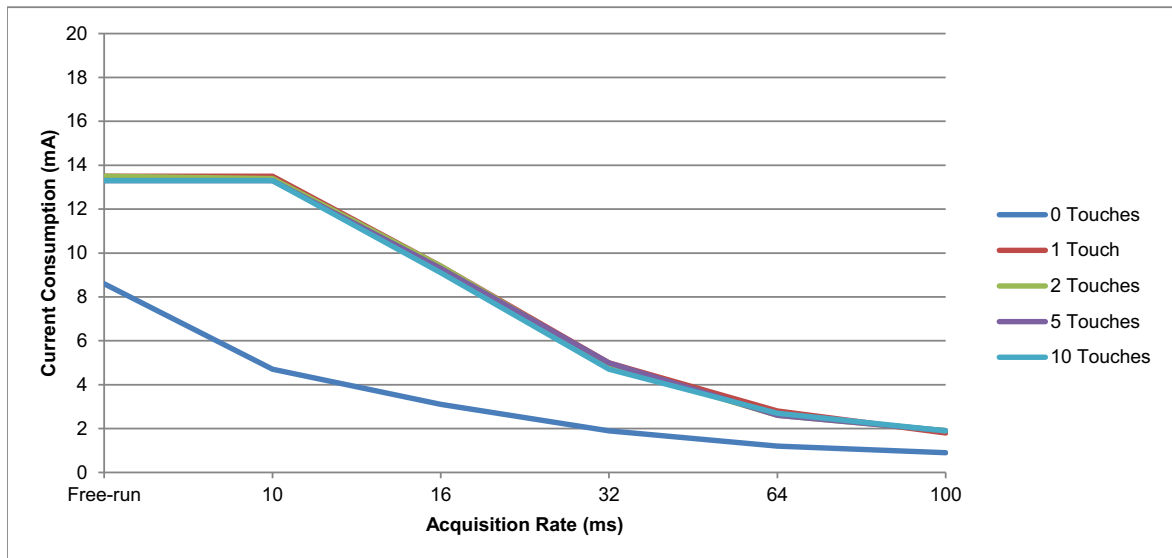
Object/Parameter	Description/Setting (Numbers in Decimal)
Acquisition Configuration T8	
CHRGTIME	39
MEASALLOW	3
Self Test T25	Object Enabled
CTRL PERTSTMODE	3 = Periodic testing, report on failure and success
Touch Suppression T42	Object Enabled
CTE Configuration T46	
IDLESYNCSPERX	16
ACTVSYNCSPERX	16
Shieldless T56	Object Enabled
INTTIME	21
Lens Bending T65 Instance 0	Object Instance Enabled
Lens Bending T65 Instance 1	Object Instance Enabled
Lens Bending T65 Instance 2	Object Instance Enabled
Noise Suppression T72	Object Enabled
Glove Detection T78	Object Enabled
Retransmission Compensation T80	Object Enabled
Multiple Touch Touchscreen T100	Object Enabled
XSIZE	41
YSIZE	26
Default measurement in Idle mode	Deselected
Default measurement in Active mode	Selected
Auxiliary Touch Configuration T104	Object Enabled
Default measurement in Idle mode	Selected
Self Capacitance Noise Suppression T108	Object Enabled
Self Capacitance Configuration T111 Instance 0	
INTTIME	65
IDLESYNCSPERL	24
ACTVSYNCSPERL	24
Self Capacitance Configuration T111 Instance 1	
INTTIME	65
IDLESYNCSPERL	32
ACTVSYNCSPERL	32
Self Capacitance Voltage Modulation T133 Instance 0	Object Instance Enabled
Self Capacitance Voltage Modulation T133 Instance 1	Object Instance Enabled

## 12.4 Current Consumption

**NOTE** The characterization charts show typical values based on the configuration in [Table 12-1](#). Actual power consumption in the user's application will depend on the circumstances of that particular project and will vary from that shown here. Further tuning will be required to achieve an optimal performance.

### 12.4.1 AVDD 3.3V

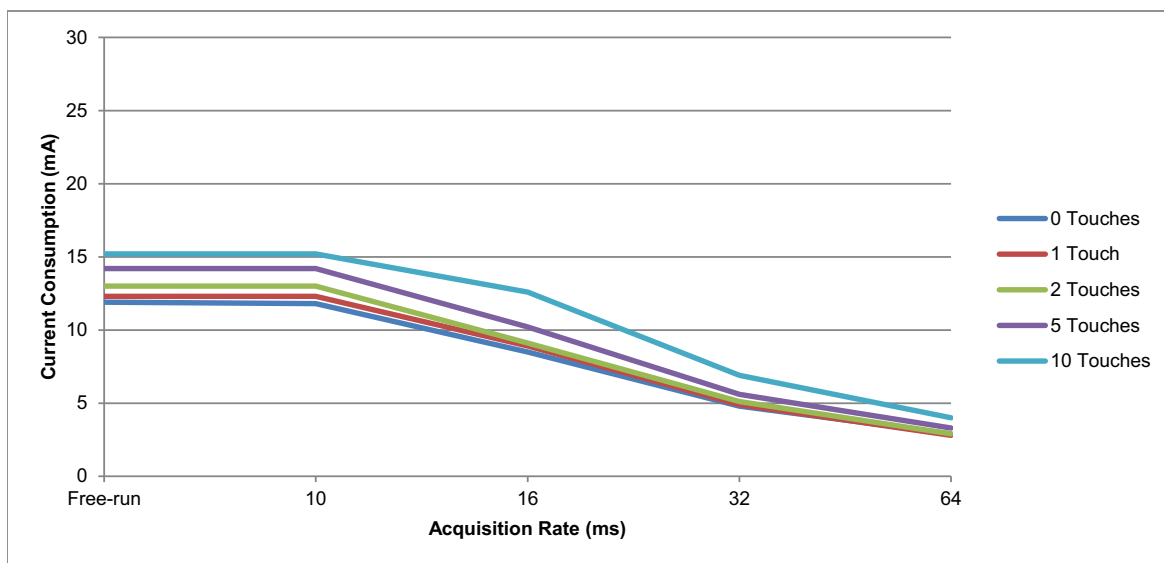
Acquisition Rate (ms)	Current Consumption (mA)				
	0 Touches	1 Touch	2 Touches	5 Touches	10 Touches
Free-run	8.6	13.5	13.5	13.3	13.3
10	4.7	13.5	13.4	13.3	13.3
16	3.1	9.4	9.4	9.3	9.1
32	1.9	5	4.9	5	4.7
64	1.2	2.8	2.6	2.6	2.7
100	0.9	1.8	1.9	1.9	1.9



# mXT1067TD-Ax (I<sup>2</sup>C) 1.0

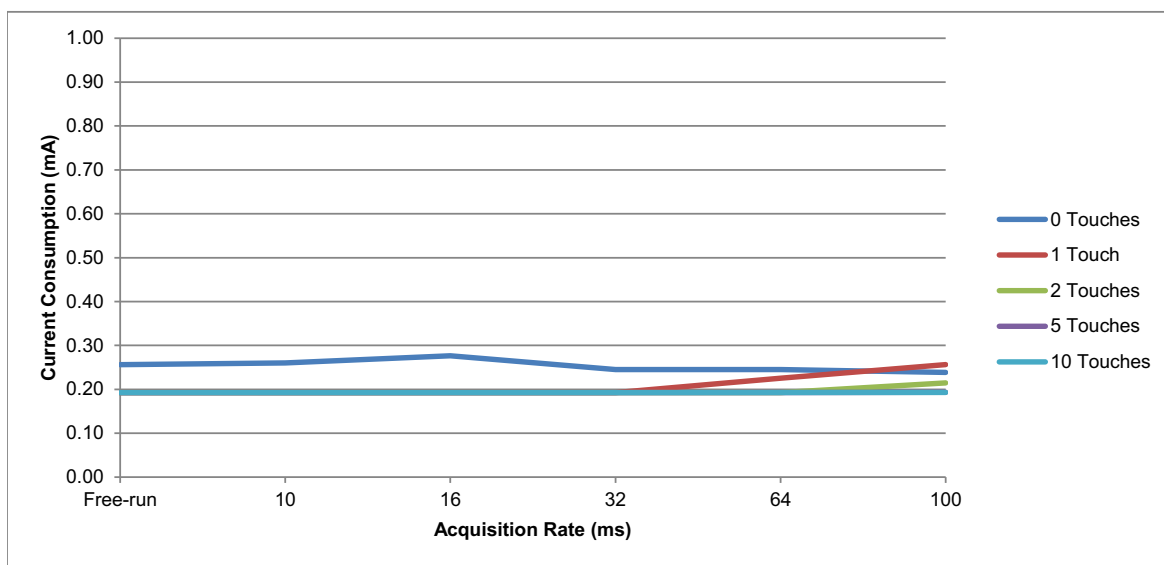
12.4.2 VDD 3.3V

Acquisition Rate (ms)	Current Consumption (mA)				
	0 Touches	1 Touch	2 Touches	5 Touches	10 Touches
Free-run	11.9	12.3	13	14.2	15.2
10	11.8	12.3	13	14.2	15.2
16	8.5	8.9	9.1	10.2	12.6
32	4.8	4.9	5.1	5.6	6.9
64	2.9	2.8	2.9	3.3	4



## 12.4.3 VDDIO 3.3V

Acquisition Rate (ms)	Current Consumption (mA)				
	0 Touches	1 Touch	2 Touches	5 Touches	10 Touches
Free-run	0.26	0.19	0.19	0.19	0.19
10	0.26	0.19	0.19	0.19	0.19
16	0.28	0.19	0.19	0.19	0.19
32	0.25	0.19	0.19	0.19	0.19
64	0.25	0.23	0.19	0.19	0.19
100	0.24	0.26	0.21	0.19	0.19



## 12.4.4 DEEP SLEEP

T<sub>A</sub> = 25°C

Parameter	Min	Typ	Max	Units	Notes
Deep Sleep Current	–	1.16	–	mA	V <sub>dd</sub> = 3.3 V, AV <sub>dd</sub> = 3.3 V, V <sub>ddIO</sub> = 3.3V
Deep Sleep Power	–	3.8	–	mW	V <sub>dd</sub> = 3.3 V, AV <sub>dd</sub> = 3.3 V

# mXT1067TD-Ax (I<sup>2</sup>C) 1.0

## 12.5 Timing Specifications

**NOTE** The figures below show typical values based on the test configuration. Actual timings in the user's application will depend on the circumstances of that particular project and will vary from those shown below. Further tuning will be required to achieve an optimal performance.

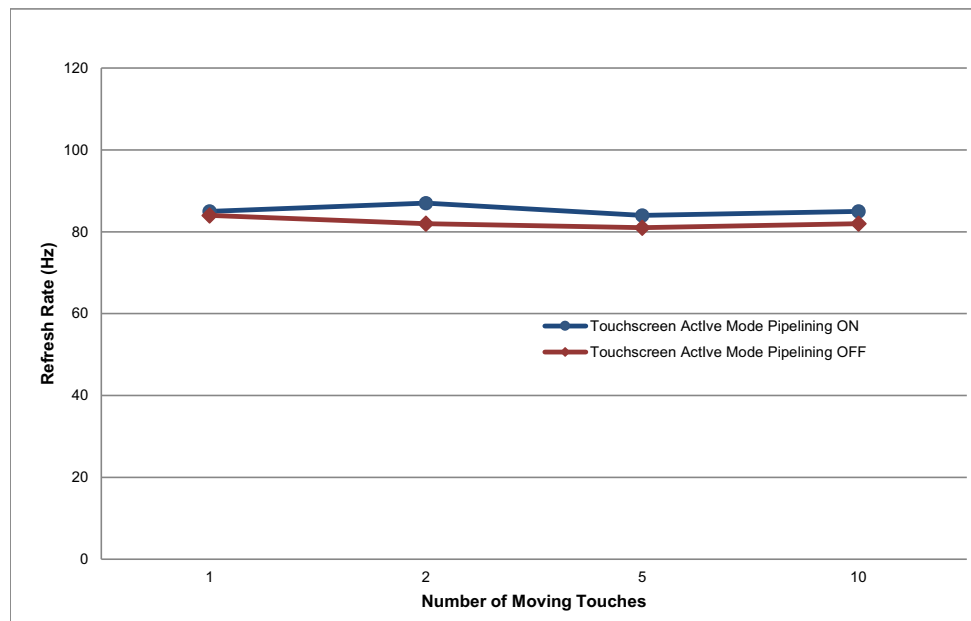
### 12.5.1 TOUCH LATENCY

Conditions: XSIZE = 41; YSIZE = 26; CHRGTIME = 39; IDLESYNCSPERX = 16; ACTVSYNCSPERX = 16;  
 Idle Primary = Self Capacitance; Active Primary = Mutual Capacitance; IDLEACQINT = ACTVACQINT = Free Run  
 T = ambient temperature; Finger center of screen; Reporting off (except T100); C<sub>pk</sub> Process Capability Index calculation not applied

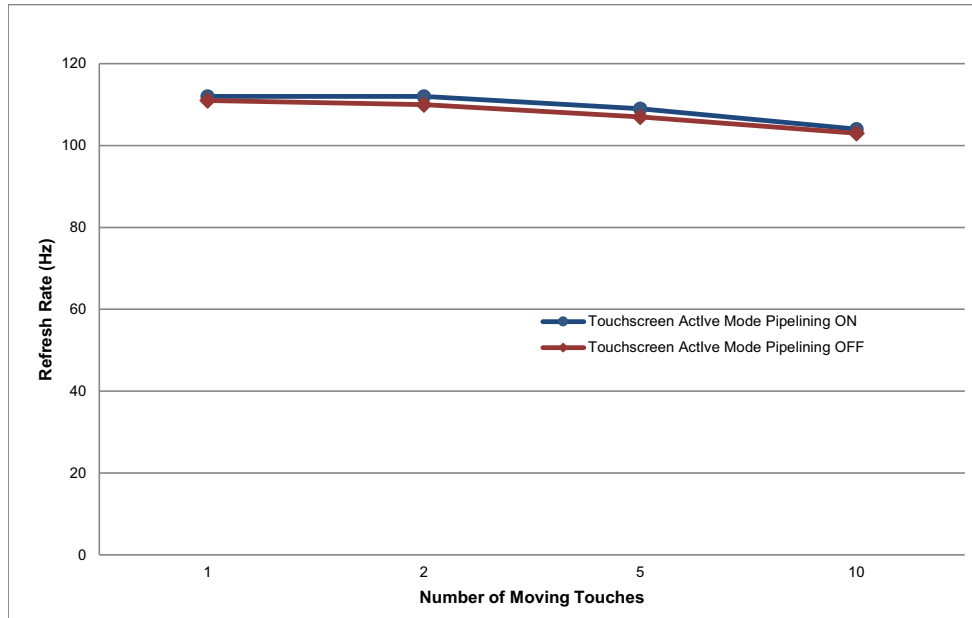
T100 TCHDIDOWN	Pipelining Off			Pipelining On			Units
	Min	Typ	Max	Min	Typ	Max	
2	22.1	27.3	36.4	19.7	21.9	34.8	ms
1	8.0	14.7	22.4	5.4	10.8	18.0	ms
0	8.4	14.7	22.3	5.7	11.9	17.7	ms
Disabled (DISTCHDIDOWN = 1)	7.8	10.7	20.1	5.5	10.6	18.2	ms

### 12.5.2 REPORT RATE

Conditions: Touchscreen: XSIZE = 41; YSIZE = 26; CHRGTIME = 39; IDLESYNCSPERX = 16; ACTVSYNCSPERX = 16;  
 T = ambient temperature



Conditions: Touchscreen: XSIZE = 41; YSIZE = 26; CHRGTIME = 39; IDLESYNCSPERX = 8; ACTVSYNCSPERX = 8;  
T = ambient temperature



## 12.5.3 BURST FREQUENCY TOLERANCE

The burst frequency is directly correlated to the system clock. The burst frequency tolerance depends on the tolerance of the system's oscillator (see [Table 12-2](#)).

**TABLE 12-2: OSCILLATOR TOLERANCE**

Conditions: T = -40°C, 25°C, 85°C, 105°C

Min Drift	Nominal	Max Drift	Notes
-5%	53 MHz (calibrated)	+5%	Minimum/Maximum drift over temperature is specified as percentage below/above nominal frequency

## 12.5.4 RESET TIMINGS

Parameter	Min	Typ	Max	Units	Notes
Power on to CHG line low	-	93	-	ms	Vdd supply for POR VddIO supply for external reset
Hardware reset to $\overline{\text{CHG}}$ line low	-	93	-	ms	
Software reset to $\overline{\text{CHG}}$ line low	-	115	-	ms	

**Note 1:** Any  $\overline{\text{CHG}}$  line activity before the power-on or reset period has expired should be ignored by the host. Operation of this signal cannot be guaranteed before the power-on/reset periods have expired.

## 12.6 Touch Accuracy and Repeatability

Parameter	Min	Typ	Max	Units	Notes
Linearity	-	±0.5	-	mm	Finger diameter 8 mm
Accuracy (across all areas of screen)	-	0.5	-	mm	Finger diameter 8 mm
Repeatability	-	±0.25	-	%	X axis with 12-bit resolution

# mXT1067TD-Ax (I<sup>2</sup>C) 1.0

## 12.7 Touchscreen Sensor Characteristics

Parameter	Description	Value
Cm	Mutual capacitance	Typical value is between 0.15 pF and 10 pF on a single node.
Cpx	Mutual capacitance load to X	Microchip recommends a maximum load of 300 pF on each X or Y line. <sup>(1)</sup>
	With Internal Voltage Pump	Maximum recommended load on each X line: <sup>(2)</sup> Cpx + (num_Y × Cm) < 125 pF
	With Internal Voltage Pump and Dual X	Maximum recommended load on each X line: <sup>(2)</sup> Cpx + (2 × num_Y × Cm) < 125 pF
Cpy	Mutual capacitance load to Y	Microchip recommends a maximum load of 300 pF on each X or Y line. <sup>(1)</sup>
Cpx	Self capacitance load to X	Microchip recommends a maximum load of 100 pF on each X or Y line. <sup>(1)</sup>
Cpy	Self capacitance load to Y	
ΔCpx	Self capacitance imbalance on X	Nominal value is 20.9 pF. Value increases by 1 pF for every 45 pF reduction in Cpx/Cpy (based on 100 pF load)
ΔCpy	Self capacitance imbalance on Y	
Cpds0	Self capacitance load to Driven Shield	Microchip recommends a maximum load of 100 pF on the Driven Shield line. <sup>(1)</sup>

- Note 1:** Please contact your Microchip representative for advice if you intend to use higher values.  
**Note 2:** num\_Y = Number of active Y lines defined by Multiple Touch Touchscreen T100.

## 12.8 Input/Output Characteristics

Parameter	Description	Min	Typ	Max	Units	Notes
<b>Input (GPIO<sub>n</sub>, FSYNC, PSYNC, SDA, SCL, ADDSEL, CHG)</b>						
Vil	Low input logic level	-0.3	-	0.3 × VddIO	V	
Vih	High input logic level	0.7 × VddIO	-	VddIO	V	
Iil	Input leakage current	-	-	1	μA	Pull-up resistors disabled
RESET	Internal pull-up resistor	20	40	60	kΩ	
GPIOs	Internal pull-up/pull-down resistor					
<b>Output (GPIO<sub>n</sub>, SDA, SCL, CHG, DBG_CLK, DBG_DATA, DBG_SS)</b>						
Vol	Low output voltage	0	-	0.2 × VddIO	V	Iol = -4 mA
Voh	High output voltage	0.8 × VddIO	-	VddIO	V	Ioh = 4 mA

## 12.9 I<sup>2</sup>C Specification

Parameter	Value
Addresses	0x4A or 0x4B
I <sup>2</sup> C specification <sup>(1)</sup>	Revision 6.0
Maximum bus speed (SCL) <sup>(2)</sup>	1 MHz
Standard Mode <sup>(3)</sup>	100 kHz
Fast Mode <sup>(3)</sup>	400 kHz
Fast Mode Plus <sup>(3)</sup>	1 MHz

- Note 1:** More detailed information on I<sup>2</sup>C operation is available from [www.nxp.com/documents/user\\_manual/UM10204.pdf](http://www.nxp.com/documents/user_manual/UM10204.pdf).  
**Note 2:** In systems with heavily laden I<sup>2</sup>C lines, even with minimum pull-up resistor values, bus speed may be limited by capacitive loading to less than the theoretical maximum.  
**Note 3:** The values of pull-up resistors should be chosen to ensure SCL and SDA rise and fall times meet the I<sup>2</sup>C specification. The value required will depend on the amount of capacitance loading on the lines.

## 12.10 Thermal Packaging

### 12.10.1 THERMAL DATA

Parameter	Description	Typ	Unit	Condition	Package
$\theta_{JA}$	Junction to ambient thermal resistance	45.4	°C/W	Still air	128-lead TQFP 14 x 14 x 1 mm
$\theta_{JC}$	Junction to case thermal resistance	7.9	°C/W		128-lead TQFP 14 x 14 x 1 mm

### 12.10.2 JUNCTION TEMPERATURE

The maximum junction temperature allowed on this device is 125°C.

The average junction temperature in °C ( $T_J$ ) for this device can be obtained from the following:

$$T_J = T_A + (P_D \times \theta_{JA})$$

If a cooling device is required, use this equation:

$$T_J = T_A + (P_D \times (\theta_{HEATSINK} + \theta_{JC}))$$

where:

- $\theta_{JA}$  = package thermal resistance, Junction to ambient (°C/W) (see [Section 12.10.1 "Thermal Data"](#))
- $\theta_{JC}$  = package thermal resistance, Junction to case thermal resistance (°C/W) (see [Section 12.10.1 "Thermal Data"](#))
- $\theta_{HEATSINK}$  = cooling device thermal resistance (°C/W), provided in the cooling device datasheet
- $P_D$  = device power consumption (W)
- $T_A$  is the ambient temperature (°C)

## 12.11 ESD Information

Parameter	Value	Reference standard	Notes
Human Body Model (HBM)	±2000 V	AEC-Q100	
Charge Device Model (CDM)	±500 V	AEC-Q100	Except corner pins
	±750 V	AEC-Q100	Corner pins only

## 12.12 Soldering Profile

Profile Feature	Green Package
Average Ramp-up Rate (217°C to Peak)	3°C/s max
Preheat Temperature 175°C ±25°C	150 – 200°C
Time Maintained Above 217°C	60 – 150 s
Time within 5°C of Actual Peak Temperature	30 s
Peak Temperature Range	260°C
Ramp down Rate	6°C/s max
Time 25°C to Peak Temperature	8 minutes max

## 12.13 Moisture Sensitivity Level (MSL)

MSL Rating	Package Type(s)	Peak Body Temperature	Specifications
MSL3	QFP	260°C	AEC-Q100

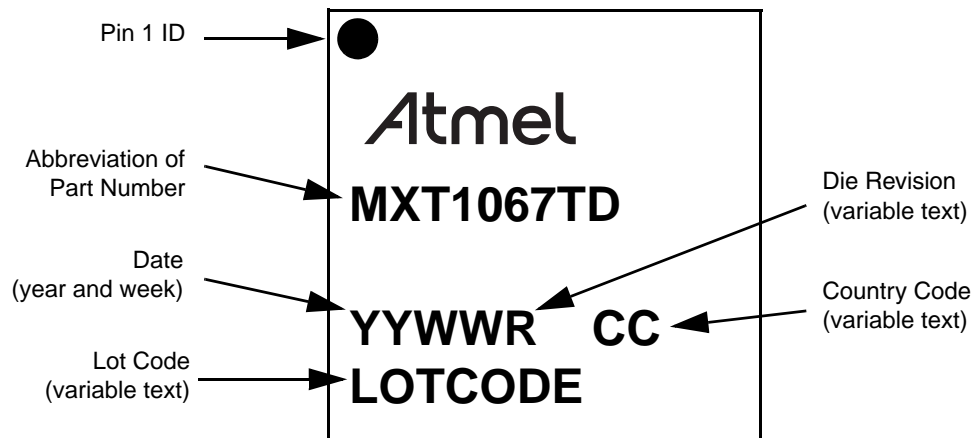
# mXT1067TD-Ax (I<sup>2</sup>C) 1.0

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## 13.0 PACKAGING INFORMATION

### 13.1 Package Marking Information

#### 13.1.1 128-LEAD TQFP



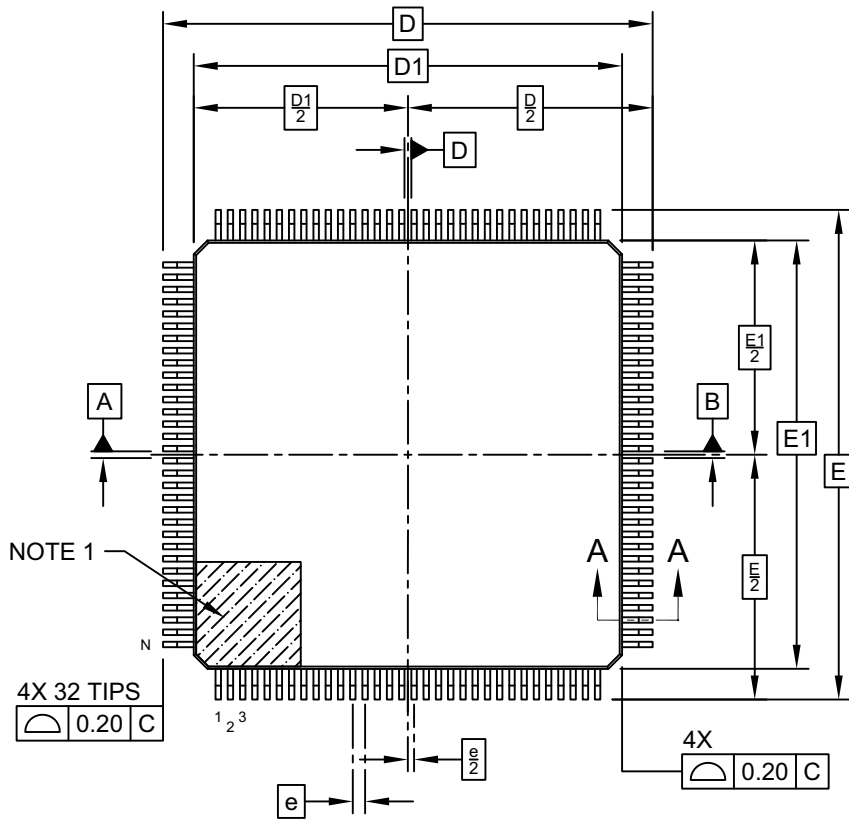
#### 13.1.2 ORDERABLE PART NUMBERS

The product identification system for maXTouch devices is described in "[Product Identification System](#)". That section also lists example part numbers for the device.

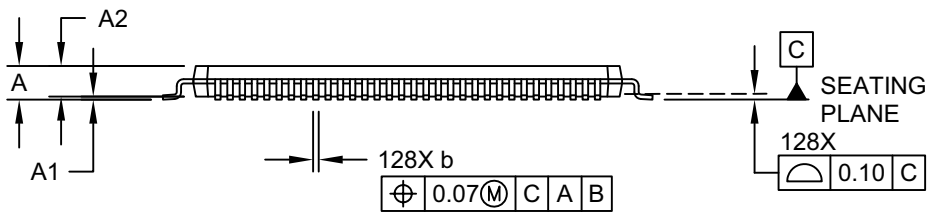
## 13.2 Package Details

### 128-Lead Thin Plastic Quad Flatpack (ZA) - 14x14 mm Body [TQFP] SMSC Legacy VTQE3; Atmel Legacy Global Package Code APL

**Note:** For the most current package drawings, please see the Microchip Packaging Specification located at <http://www.microchip.com/packaging>



TOP VIEW



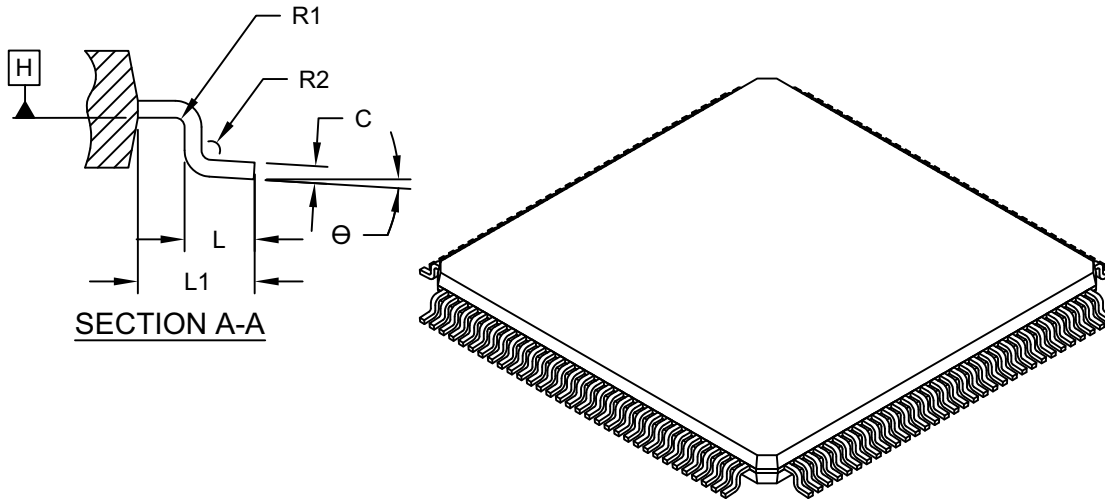
SIDE VIEW

Microchip Technology Drawing C04-181 Rev C Sheet 1 of 2

# mXT1067TD-Ax (I<sup>2</sup>C) 1.0

## 128-Lead Thin Plastic Quad Flatpack (ZA) - 14x14 mm Body [TQFP] SMSC Legacy VTQE3; Atmel Legacy Global Package Code APL

**Note:** For the most current package drawings, please see the Microchip Packaging Specification located at <http://www.microchip.com/packaging>



Dimension Limits	Units	MILLIMETERS		
		MIN	NOM	MAX
Number of Leads	N	128		
Lead Pitch	e	0.40 BSC		
Overall Height	A	-	-	1.20
Standoff	A1	0.05	0.10	0.15
Molded Package Thickness	A2	0.95	1.00	1.05
Foot Length	L	0.45	0.60	0.75
Footprint	L1	1.00 REF		
Foot Angle	$\theta$	0°	-	7°
Overall Width	E	16.00 BSC		
Overall Length	D	16.00 BSC		
Molded Package Width	E1	14.00 BSC		
Molded Package Length	D1	14.00 BSC		
Lead Width	b	0.13	0.16	0.23
Mold Draft Angle Top	C	0.09	-	0.20
Lead Bend Radius	R1	0.08	-	-
Lead Bend Radius	R2	0.08	-	0.20

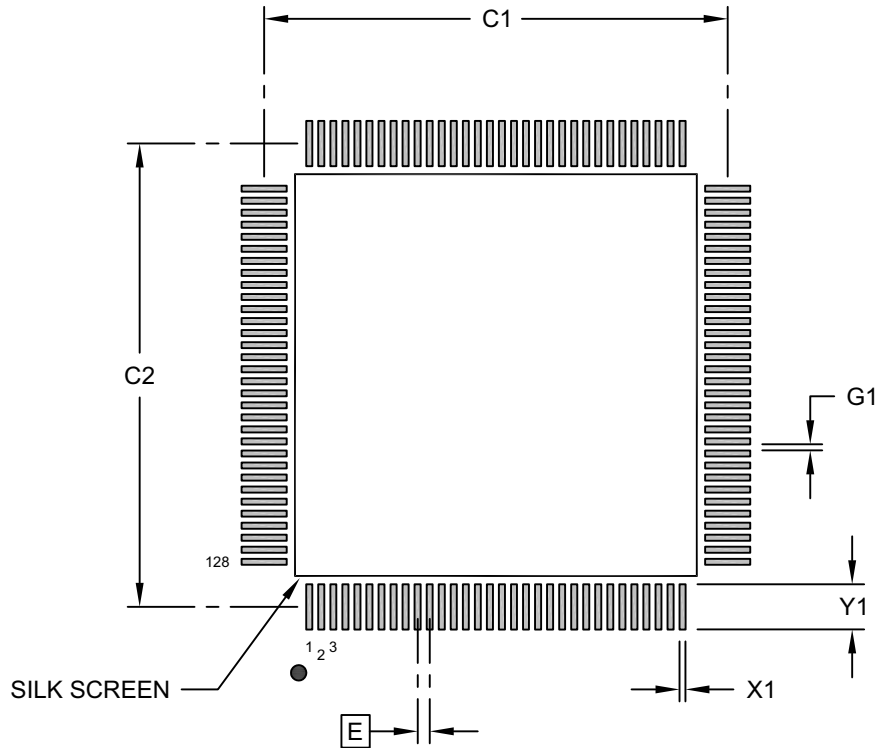
**Notes:**

- Pin 1 visual index feature may vary, but must be located within the hatched area.
- Dimensioning and tolerancing per ASME Y14.5M  
BSC: Basic Dimension. Theoretically exact value shown without tolerances.  
REF: Reference Dimension, usually without tolerance, for information purposes only.

Microchip Technology Drawing C04-181 Rev C Sheet 2 of 2

## 128-Lead Thin Plastic Quad Flatpack (ZA) - 14x14 mm Body [TQFP] SMSC Legacy VTQE3; Atmel Legacy Global Package Code APL

**Note:** For the most current package drawings, please see the Microchip Packaging Specification located at <http://www.microchip.com/packaging>



### RECOMMENDED LAND PATTERN

Dimension Limits	Units	MILLIMETERS		
		MIN	NOM	MAX
Contact Pitch	E	0.40 BSC		
Contact Pad Spacing	C1		15.40	
Contact Pad Spacing	C2		15.40	
Contact Pad Width (X20)	X1			0.20
Contact Pad Length (X20)	Y1			1.50
Contact Pad to Contact Pad (X124)	G1	0.20		

**Notes:**

1. Dimensioning and tolerancing per ASME Y14.5M

BSC: Basic Dimension. Theoretically exact value shown without tolerances.

## APPENDIX A: ASSOCIATED DOCUMENTS

**NOTE** Some of the documents listed below are available under NDA only.

The following documents are available by contacting your Microchip representative:

### Product Documentation

- Application Note: MXTAN0213 – *Interfacing with maXTouch Touchscreen Controllers*

### Touchscreen Design and PCB/FPCB Layout Guidelines

- Application Note: QTAN0054 – *Getting Started with maXTouch Touchscreen Designs*
- Application Note: MXTAN0208 – *Design Guide for PCB Layouts for maXTouch Touch Controllers*
- Application Note: QTAN0080 – *Touchscreens Sensor Design Guide*
- Application Note: AN2683 – *Edge Wiring for Self Capacitance maXTouch Touchscreens*

### Tools

- *maXTouch Studio User Guide* (distributed as on-line help with maXTouch Studio)

## APPENDIX B: REVISION HISTORY

### Revision A (March 2017)

Initial edition – Advance Information

### Revision B (June 2017)

Updated for firmware revision 0.5 – Pre-Alpha

### Revision C (December 2017)

Updated for firmware revision 1.0 – Pre-Alpha

### Revision D (June 2018)

Updated with minor updates

### Revision E (August 2018)

Updated with minor updates

### Revision F (November 2018)

This revision incorporates the following updates:

- [Section 4.0 “Sensor Layout”](#): General layout rule concerning DS0 and X31 added (missing in error)
- [“Product Identification System”](#):
  - [“Orderable Part Numbers”](#): Part numbers updated
- Number of instances of the Key Array T15 object reduced from 2 to 1

### Revision G (December 2018)

Updated to full datasheet for firmware revision 1.0.AA – Release

This revision incorporates the following updates:

- Additional sections added:
  - [Section 3.0 “Touchscreen Basics”](#)
  - [Section 6.0 “Detailed Operation”](#)
  - [Section 8.0 “I2C Communications”](#)
  - [Section 10.0 “Getting Started with mXT1067TD-AT/mXT1067TD-AB I<sup>2</sup>C Variant”](#)
  - [Section 11.0 “Debugging and Tuning”](#)
- [Section 12.0 “Specifications”](#) updated:
  - [Section 12.3 “Test Configuration”](#) added
  - Power consumption charts added
  - [Section 12.5.1 “Touch Latency”](#) added
  - [Section 12.5.2 “Report Rate”](#) added
  - [Section 12.5.4 “Reset Timings”](#) added
  - [Section 12.7 “Touchscreen Sensor Characteristics”](#) updated
- Other minor changes to text for clarity

### Revision H (May 2019)

This revision incorporates the following updates:

- [Section 13.2 “Package Details”](#): Drawings updated to show correct pin numbering
- Part number updated for consistency with other devices

# mXT1067TD-Ax (I<sup>2</sup>C) 1.0

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## Revision J (August 2019)

This revision incorporates the following updates:

- Features: Front Panel Material figures updated and combined with Glove Support
- [Section 3.4.2 “Mechanical Stackup”](#): Front panel figures updated
- [Section 4.3 “Permitted Configurations”](#) added
- [Section 6.5 “Calibration”](#) updated and rewritten
- [Section 9.4 “Driven Shield Line”](#): Note concerning the internal multiplexing of DS0 to X31 updated
- [Section 12.0 “Specifications”](#):
  - [Section 12.5.1 “Touch Latency”](#): Table updated. T100 TCDIDOWN 2 and 0 figures corrected (swapped in error)
  - [Section 12.6 “Touch Accuracy and Repeatability”](#) moved and updated
  - [Section 12.7 “Touchscreen Sensor Characteristics”](#): Cpx specification updated with charge pump specification

## INDEX

### A

Absolute maximum specifications .....	40
ADDSEL pin .....	24, 25
Adjacent key suppression technology .....	22
AKS. See <i>Adjacent key suppression</i>	
Analog I/O .....	34
Analog voltage supply .....	41
AVdd voltage supply .....	41

### C

Calibration .....	21
Capacitive Touch Engine (CTE) .....	10
Charge time .....	20
Checksum in I <sup>2</sup> C writes .....	25
CHG line	
I <sup>2</sup> C .....	28
mode 0 operation .....	29
mode 1 operation .....	29
Clock stretching .....	30
Communications .....	24
Component placement and tracking .....	34
Connection Information see <i>Pinouts</i> .....	3
Current consumption .....	43
Customer Change Notification Service .....	60
Customer Notification Service .....	60
Customer Support .....	60

### D

DC characteristics .....	41
Debugging .....	39
object-based protocol .....	39
self test .....	39
SPI Debug Interface .....	13, 39
Decoupling capacitors .....	12, 31
Detailed operation .....	20
Detection integrator .....	20
Device	
overview .....	10
Digital filtering .....	21
Digital signals .....	34
Digital voltage supply .....	41
Direct Memory Access .....	26
Driven shield lines .....	12, 33

### E

EMC problems .....	34
EMC Reduction .....	21
ESD information .....	49

### G

Glove detection .....	22
GPIO pins .....	13
Grip suppression .....	22
Ground tracking .....	31

### I

I/O pins .....	12
I <sup>2</sup> C communications .....	25–30
address selection .....	24, 25
ADDSEL pin .....	24, 25
CHG line .....	28
clock stretching .....	30
reading from the device .....	26
reading messages with DMA .....	26

SCL line .....	29
SDA line .....	29
specification .....	48
writes in checksum mode .....	25
writing to the device .....	25

### I<sup>2</sup>C interface

SCL line .....	12, 29
SDA line .....	12, 29

Input/Output characteristics .....	48
Internet Address .....	60

### J

Junction temperature .....	49
----------------------------	----

### L

Lens bending .....	22
--------------------	----

### M

Microchip Internet Web Site .....	60
Moisture sensitivity level (msl) .....	49
Multiple function pins .....	13
Mutual capacitance measurements .....	10

### N

Noise suppression .....	21
display .....	21

### O

Object-based protocol .....	39
Operational modes .....	20
Oscillator tolerance specification .....	47
Overview of the mXT1067TD-Ax I2C Variant .....	10

### P

PCB cleanliness .....	31
PCB design .....	31
analog I/O .....	34
component placement and tracking .....	34
decoupling capacitors .....	31
digital signals .....	34
EMC problems .....	34
ground tracking .....	31
PCB cleanliness .....	31
power supply .....	31
supply rails .....	31
voltage pump .....	31
voltage regulator .....	32
Pinouts .....	3
Power supply	
I/O pins .....	12
PCB design .....	31
Power supply ripple and noise .....	41
Power-up/reset .....	17
Initialization .....	19
power-on reset (POR) .....	17
VddIO enabled after Vdd .....	18
Pull-up resistors .....	12

### R

RC130M oscillator tolerance specification .....	47
Recommended operating conditions .....	40
Repeatability .....	47
Reset timings .....	47
Retransmission compensation .....	22

# mXT1067TD-Ax (I<sup>2</sup>C) 1.0

## S

Schematic .....	11
decoupling capacitors .....	12
GPIO pins.....	13
I <sup>2</sup> C interface .....	12
pull-up resistors.....	12
voltage pump.....	12
SCL line.....	29
SCLLine.....	12, 29
Screen size .....	16
SDA line .....	12, 29
Self capacitance measurements .....	10
Self test .....	39
Sensor acquisition.....	20
Sensor layout .....	15-16
electrodes.....	15
sensors.....	15
touch panel.....	15
Shieldless support.....	21
Soldering profile .....	49
Specifications .....	40-49
absolute maximum specifications .....	40
analog voltage supply .....	41
current consumption.....	43
DC characteristics .....	41
digital voltage supply.....	41
ESD information .....	49
I <sup>2</sup> C specification .....	48
input/output characteristics .....	48
junction temperature .....	49
moisture sensitivity level (msl) .....	49
power supply ripple and noise.....	41
RC130M oscillator tolerance .....	47
recommended operating conditions .....	40
repeatability.....	47
reset timings .....	47
soldering profile.....	49
test configuration.....	42
thermal data .....	49
timing specifications .....	46
touch accuracy .....	47
touchscreen sensor characteristics.....	48
XVdd voltage supply .....	41
SPI Debug Interface.....	13, 39
Supply rails.....	31

## T

Test configuration specification .....	42
Thermal data .....	49
Timing specifications .....	46
Touch accuracy .....	47
Touch detection.....	10, 20
Touchscreen sensor characteristics.....	48
Tuning .....	39

## U

Unintentional touch suppression .....	22
---------------------------------------	----

## V

Vdd voltage supply .....	41
VddCore supply.....	12
VddIO voltage supply .....	41
Voltage pump .....	12, 31
Voltage regulator.....	32
multiple supply operation .....	33
single supply operation .....	33

## W

WWW Address .....	60
-------------------	----

## X

XVdd voltage supply .....	41
---------------------------	----

## PRODUCT IDENTIFICATION SYSTEM

The table below gives details on the product identification system for maXTouch devices. See “[Orderable Part Numbers](#)” below for example part numbers for the mXT1067TD-AT/mXT1067TD-AB I<sup>2</sup>C Variant.

To order or obtain information, for example on pricing or delivery, refer to the factory or the listed sales office.

PART NO.	-XXX	[X]	[X]	[XXX]
Device	Package	Temperature Range	Tape and Reel Option	Pattern
Device:	Base device name			
Package:	A	=	QFP (Plastic Quad Flatpack)	
	AM	=	VQFN (Plastic Very Thin Quad Flat No Lead)	
Temperature Range:	T	=	-40°C to +85°C (Grade 3)	
	B	=	-40°C to +105°C (Grade 2)	
Tape and Reel Option:	<i>Blank</i>	=	Standard Packaging (Tube or Tray)	
	R	=	Tape and Reel <sup>(1)</sup>	
Pattern:	Extension, QTP, SQTP, Code or Special Requirements (Blank Otherwise)			

**Note 1:** Tape and Reel identifier only appears in the catalog part number description. This identifier is used for ordering purposes and is not printed on the device package. See “[Orderable Part Numbers](#)” below or check with your Microchip Sales Office for package availability with the Tape and Reel option.

## Orderable Part Numbers

Orderable Part Number	Firmware Revision	Description
ATMXT1067TD-ATI2CVAO (Supplied in trays)	1.0.AA	128-lead TQFP 14 x 14 x 1 mm, RoHS compliant Operating temperature range -40°C to +85°C (Grade 3)
ATMXT1067TD-ATRI2CVAO (Supplied in tape and reel)		
ATMXT1067TD-ABI2CVAO (Supplied in trays)	1.0.AA	128-lead TQFP 14 x 14 x 1 mm, RoHS compliant Operating temperature range -40°C to +105°C (Grade 2)
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