MTCH6301 Projected Capacitive Touch Controller

Description

The MTCH6301 is a turnkey projected capacitive controller that allows easy integration of multi-touch and gestures to create a rich user interface in your design. Through a sophisticated combination of Self and Mutual Capacitive scanning for both XY screens and touch pads, the MTCH6301 allows designers to quickly and easily integrate projected capacitive touch into their application.

Applications:

- Human-machine interfaces with configurable button, keypad or scrolling functions
- Single-finger gesture based interfaces to swipe, scroll, or doubletap controls
- Home automation control panels
- Security control keypads
- Automotive center stack controls
- Gaming devices
- Remote control touch pads

Touch Sensor Support

- Up to 13RX x 18TX channels
- Works with printed circuit board (PCB), film, glass, and flexible circuit board (FPC) sensors
- Supports sensor sizes up to 4.3”
- Individual channel tuning for optimal sensitivity
- Cover layer support:
  - Plastic: up to 3 mm
  - Glass: up to 5 mm

Touch Performance

- >100 reports per second single touch
- >60 reports per second dual touch
- Up to 12-bit resolution coordinate reporting

Touch Features

- Multitouch (up to 10 touches)
- Gesture detection and reporting
- Single and dual touch drawing
- Self and Mutual signal acquisition
- Built-in noise detection and filtering

Power Management

- Configurable Sleep mode
- Integrated Power-on Reset and Brown-out Reset
- 20 µA sleep current (typical)

Communication Interface

- I^2C™ (up to 400 kbps)

Operating Conditions

- 2.4V to 3.6V, -40ºC to +105ºC

Package Types

- 44-Lead TQFP
- 44-Lead QFN

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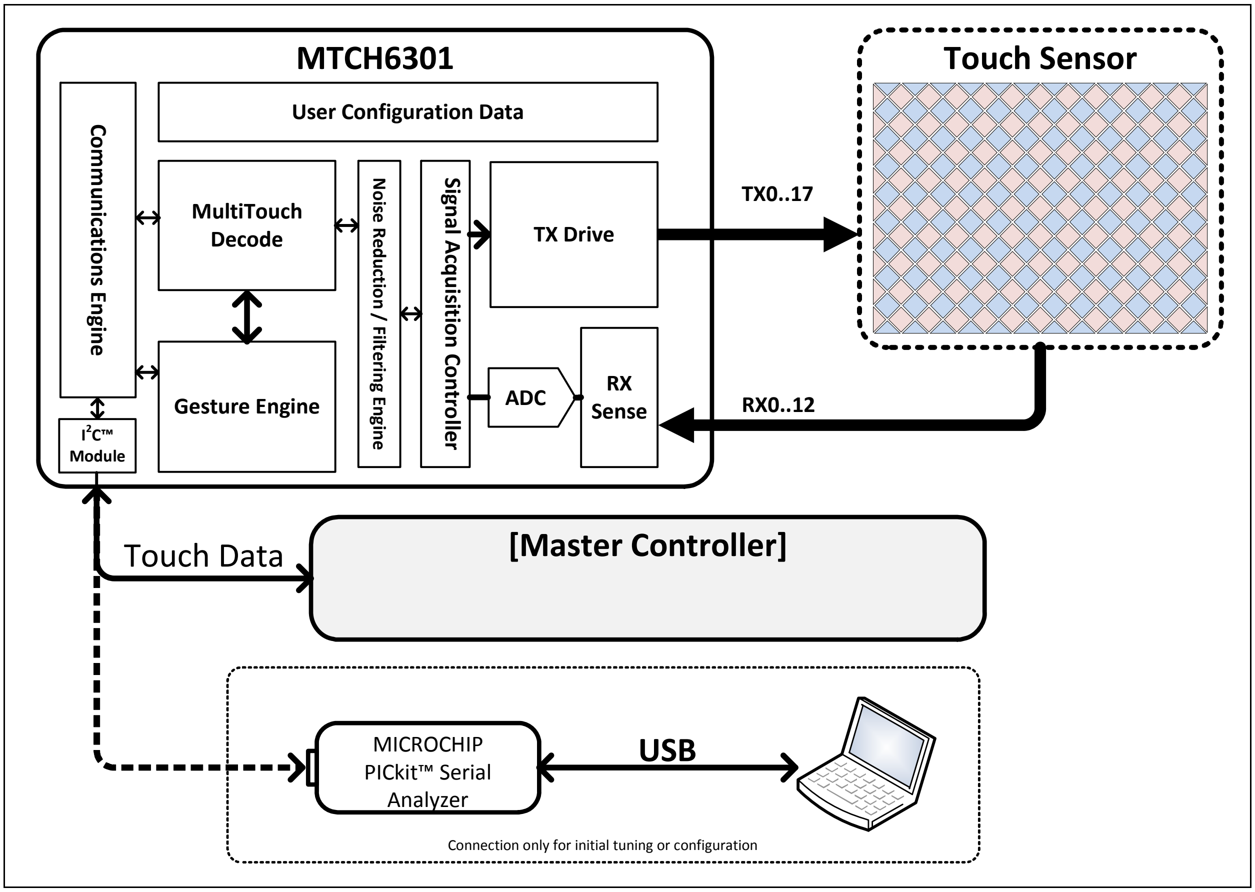
1.0 SYSTEM BLOCK DIAGRAM

The MTCH6301 is a turnkey projected capacitive touch controller that allows easy integration of multitouch and gestures to create a rich user interface in your design. Through a sophisticated combination of Self and Mutual Capacitive scanning for both XY screens and touch pads, the MTCH6301 allows designers to quickly and easily integrate projected capacitive touch into their application.

The Projected Capacitive Configuration Utility with an autotune feature allows fast customization for different sizes and top layer thicknesses.

For further customization, designers can also get access to the firmware library to optimize and improve designs as needed.

FIGURE 1-1: BLOCK DIAGRAM



2.0 CONFIGURATION AND SETUP

The MTCH6301 is pre-configured for a 12 Receiver (RX)/9 Transmitter (TX) touch sensor, mapped as shown in **Section 4.0 "Layout"**. While the device will work out of the box using this specific sensor configuration, most applications will require additional configuration and sensor tuning to determine the correct set of parameters to be used in the final application.

Microchip provides a PC-based configuration tool for this purpose, available in the mTouch™ Sensing Solution Design Center (www.microchip.com/mtouch). Use of this tool requires a PICkit™ Serial Analyzer (updated with MTCH6301 support), as well as access to the I^{2}C communications bus of the MTCH6301.

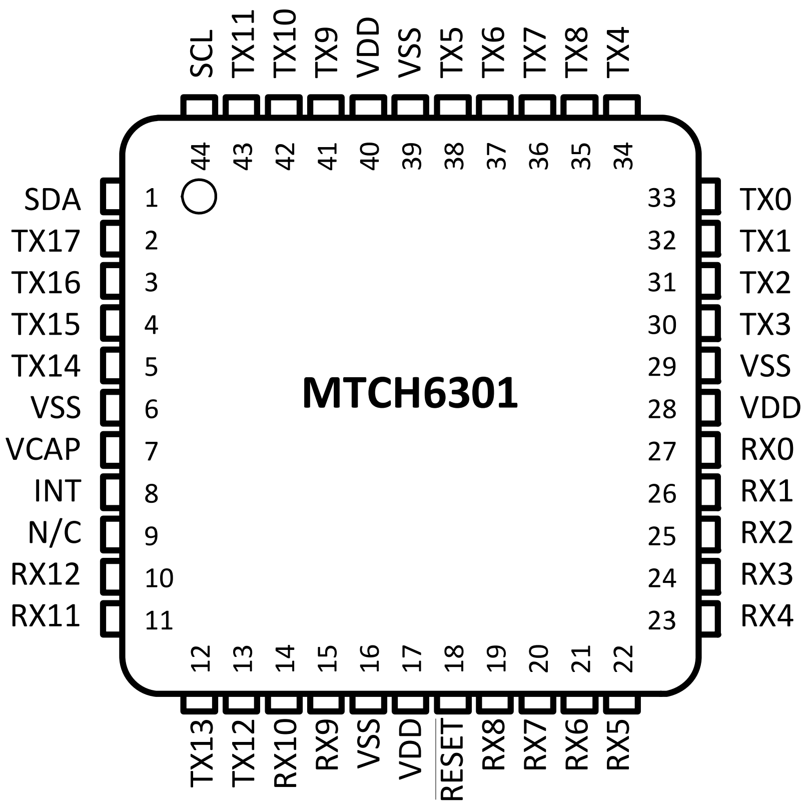
Once the development process is complete, these modified parameters must either be written permanently to the controller (via NVRAM, refer to **Section 7.3 "Non-Volatile RAM (NVRAM)"**), or alternatively can be sent every time the system is powered on. Either the PICkit Serial Analyzer or the Master I^{2}C Controller can be used for this purpose.

3.0 PIN DIAGRAM

FIGURE 3-1: PIN DIAGRAM

44-Pin TQFP(1,2)

44-Pin QFN(1,2)



Note 1: All RX/TX are remappable. Refer to **Section 4.3 "Sensor Layout Configuration"** for further information.

2: The metal plane at the bottom of the device is not connected to any pins and is recommended to be connected to VSS externally.

TABLE 3-1: PINOUT I/O DESCRIPTIONS

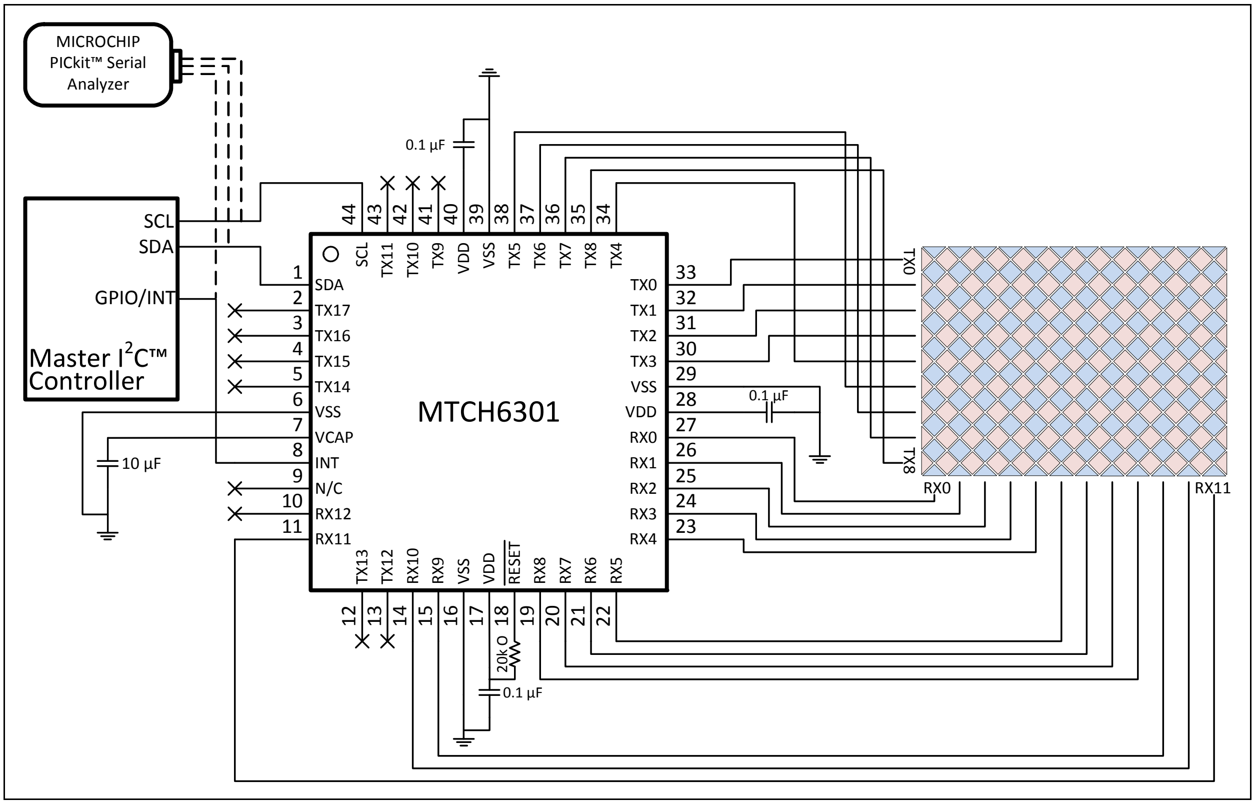
Pin Name	Pin Number	Pin Type	Description
$\overline{\text{RESET}}$	18	I/P	Reset device (active low)
SCL	44	I	Synchronous serial clock input/output for I^2C™
SDA	1	I/O	Synchronous serial data input/output for I^2C
INT	8	O	Interrupt (from MTCH6301 to master) for I^2C
RX0	27	I/O	RX Sense (or TX Drive)
RX1	26	I/O	
RX2	25	I/O	
RX3	24	I/O	
RX4	23	I/O	
RX5	22	I/O	
RX6	21	I/O	
RX7	20	I/O	
RX8	19	I/O	
RX9	15	I/O	
RX10	14	I/O	
RX11	11	I/O	
RX12	10	I/O	
TX0	33	O	TX Drive
TX1	32	O	
TX2	31	O	
TX3	30	O	
TX4	34	O	
TX5	38	O	
TX6	37	O	
TX7	36	O	
TX8	35	O	
TX9	41	O	
TX10	42	O	
TX11	43	O	
TX12	13	O	
TX13	12	O	
TX14	5	O	
TX15	4	O	
TX16	3	O	
TX17	2	O	
N/C	9	N/C	No Connect
V_{CAP}	7	P	CPU logic filter capacitor connection
V_{DD}	17, 28, 40	P	Positive supply for peripheral logic and I/O pins
V_{SS}	6, 16, 29, 39	P	Ground reference for logic and I/O pins. This pin must be connected at all times

4.0 LAYOUT

4.1 Typical Application Circuit

The following schematic portrays a typical application circuit, based on a 12RX/9TX touch sensor.

FIGURE 4-1: TYPICAL APPLICATION CIRCUIT



4.2 Touch Sensor Design

Please refer to the mTouch Sensing Solution design center at www.microchip.com/mtouch for additional information regarding design and layout of touch sensors.

4.3 Sensor Layout Configuration

To properly configure a sensor from a physical layout standpoint, the following registers must be correctly configured:

- RX Pin Map/TX Pin Map
- RX Scaling Coefficient/TX Scaling Coefficient
- Flip State

4.3.1 RX/TX PIN MAP

By default, the RX and TX pins are set as shown in the Typical Application Circuit (Figure 4.1). If you require a different layout or a different amount of sensor channels, the RX and TX pins are configured via pin map arrays. To access these arrays, reference **Section 5.0 "Communication Protocol"** and **Section 6.0 "Memory Map"** of this document.

The RX and TX lines are configurable for the purpose of making trace routing and board layout more convenient. Please note that while RX pins can be used as TX pins instead, a single pin cannot be used as BOTH an RX and a TX channel concurrently. The pin maps are comprised of "Pin Map ID" numbers, which are shown in Table 4-1.

TABLE 4-1: PIN MAP ID CHART

Pin	Map ID (TX)	Map ID (RX)
RX0	27	8
RX1	26	7
RX2	25	6
RX3	12	5
RX4	11	4
RX5	10	3
RX6	9	2
RX7	1	1
RX8	0	0
RX9	24	9
RX10	23	10
RX11	22	11
RX12	21	12
TX0	13	—
TX1	6	—
TX2	3	—
TX3	2	—
TX4	4	—
TX5	7	—
TX6	28	—
TX7	29	—
TX8	30	—
TX9	14	—
TX10	15	—
TX11	16	—
TX12	5	—
TX13	8	—
TX14	34	—
TX15	33	—
TX16	32	—
TX17	31	—

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Note: Trace routing for sensors requires proper design technique. Please refer to the mTouch Sensing Solution design center at www.microchip.com/mtouch for additional information on correctly routing touch sensor traces.

4.3.2 UNUSED RX/TX PINS

Unused RX/TX pins are driven to Vss automatically, and should be left as no connects.

4.3.3 RX/TX SCALING COEFFICIENTS

Scaling coefficient registers exist in RAM for each axis (RX/TX) and must be modified in accordance with the number of channels that are in use. Special attention must be paid to sensor dimensions that have fewer than 5 channels, which will have a smaller maximum touch output value (coordinate).

The relationship between these constant, as well as the maximum coordinates that will be transmitted are displayed in Table 4-2.

TABLE 4-2: RX/TX SCALING COEFFICIENTS

<table>
<tr><th>Number of Channels</th><th>RX/TX Scaling Coefficient</th><th>Controller Output Range</th></tr>
<tr><td>3</td><td rowspan="3">65535</td><td>[0-2047]</td></tr>
<tr><td>4</td><td>[0-3071]</td></tr>
<tr><td>5</td><td rowspan="14">[0-4095]</td></tr>
<tr><td>6</td><td>52429</td></tr>
<tr><td>7</td><td>43691</td></tr>
<tr><td>8</td><td>37449</td></tr>
<tr><td>9</td><td>32768</td></tr>
<tr><td>10</td><td>29127</td></tr>
<tr><td>11</td><td>26214</td></tr>
<tr><td>12</td><td>23831</td></tr>
<tr><td>13</td><td>21845</td></tr>
<tr><td>14</td><td>20165</td></tr>
<tr><td>15</td><td>18725</td></tr>
<tr><td>16</td><td>17476</td></tr>
<tr><td>17</td><td>16384</td></tr>
<tr><td>18</td><td>15420</td></tr>
</table>

4.3.4 SENSOR ORIENTATION

The final output orientation is configured via the FLIPSTATE register. This register can be adjusted during operation for applications where rotation occurs during use.

Figure 4-2 shows the initial upright orientation FLIPSTATE register values for all possible sensor layouts.

REGISTER 4-1: FLIPSTATE REGISTER

U-0	U-0	U-0	U-0	U-0	R/W-0	R/W-0	R/W-1
—	—	—	—	—	SWAP	TXFLIP	RXFLIP
bit 7							bit 0

Legend:			
R = Readable bit	W = Writable bit	U = Unimplemented bit, read as ‘0’	
-n = Value at POR	‘1’ = Bit is set	‘0’ = Bit is cleared	x = Bit is unknown

bit 7-3 **Unimplemented: Read as ‘0’**

bit 2 **SWAP**

`1` = RX axis horizontal; TX axis vertical
`0` = RX axis vertical; TX axis horizontal

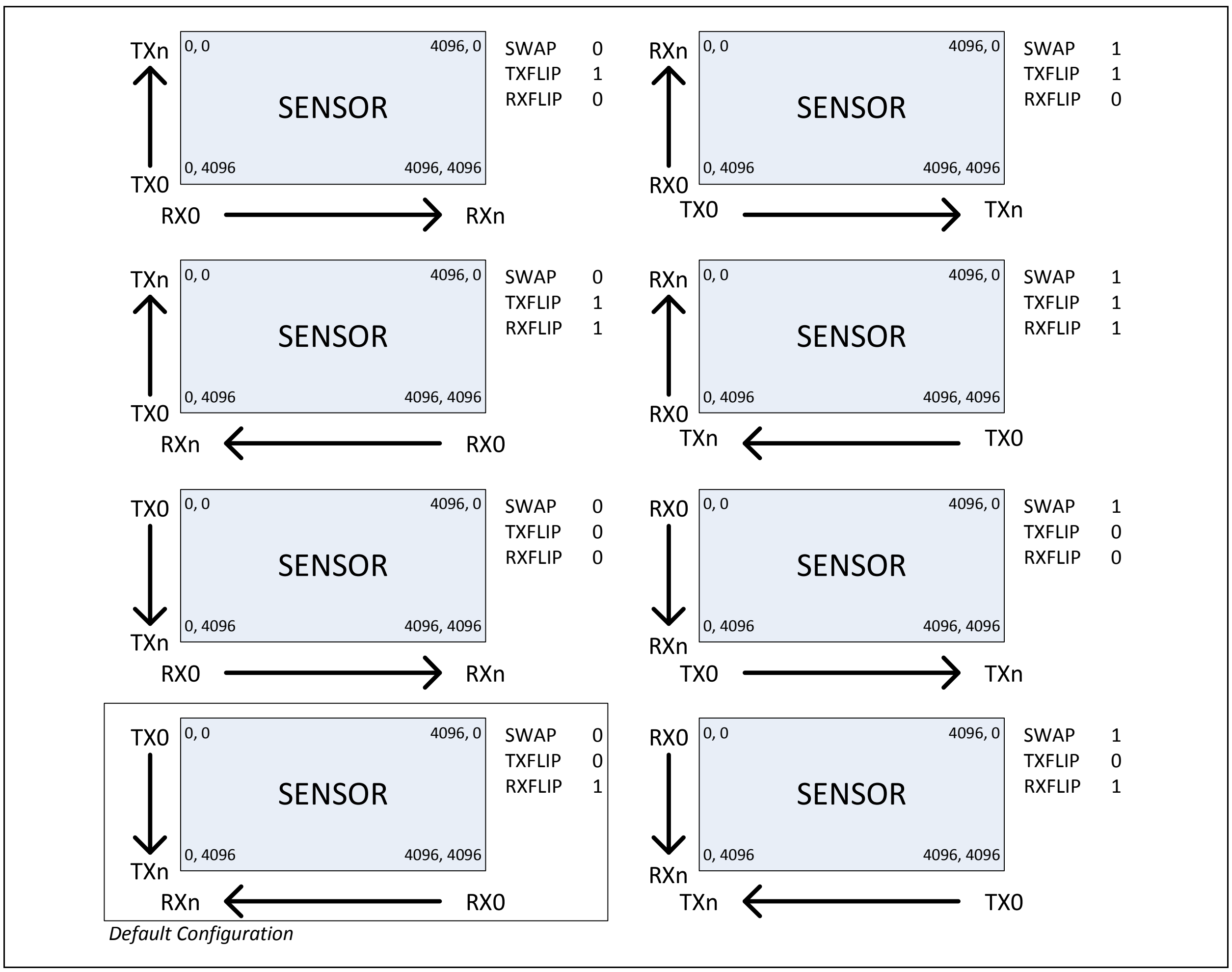
bit 1 **TXFLIP**

`1` = Invert the TX axis
`0` = Do not invert the TX axis

bit 0 **RXFLIP**

`1` = Invert the RX axis
`0` = Do not invert the RX axis

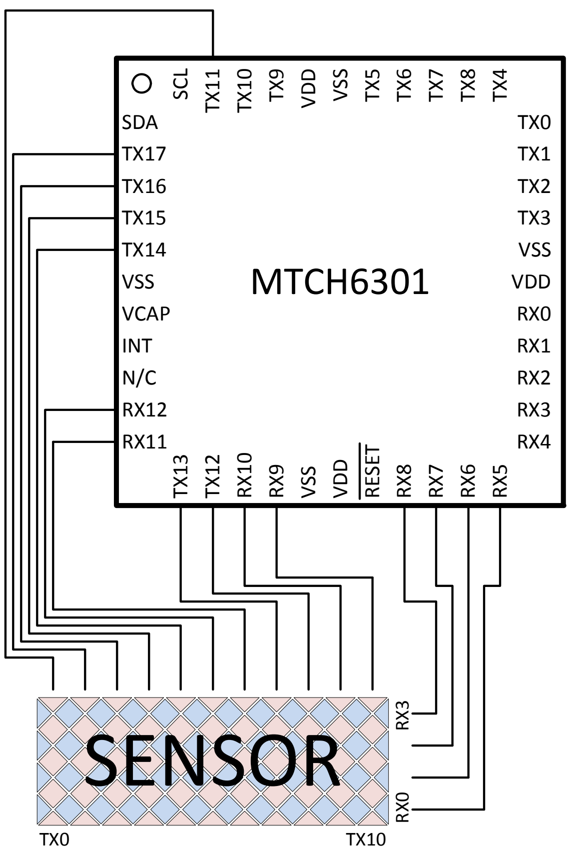
FIGURE 4-2: SENSOR ORIENTATION CHART



4.4 Example Custom Application Layout

An example 4-channel RX/11-channel TX sensor is shown in Figure 4-3. In addition to using a completely modified pin layout, this example differs from the default configuration by also having the TX axis along the bottom (X) and RX axis along the side (Y). Note that some RX pins are used as TX lines in this example.

FIGURE 4-3: NON-STANDARD LAYOUT EXAMPLE



Sensor Line		MTCH63001 Pin	Map ID
TX	0	TX11	16
	1	TX17	31
	2	TX16	32
	3	TX15	33
	4	TX14	34
	5	RX12	21
	6	RX11	22
	7	TX13	8
	8	TX12	5
	9	RX10	23
	10	RX9	24
RX	0	RX5	10
	1	RX6	9
	2	RX7	1
	3	RX8	0

The Pin Map arrays for this particular setup are as follows (arrays are shown as organized in memory):

RXPinMap: {10,9,1,0}

TXPinMap: {16,31,32,33,34,21,22,8,5,23,24}

Using the scaling coefficient table generates the values displayed in Table 4-3.

TABLE 4-3: CUSTOM APPLICATION SCALING COEFFICIENTS

Axis	Channels	Scaling Coefficient	Maximum Output
RX	4	65535	[0-3071]
TX	11	26214	[0-4095]

The FLIPSTATE register, using Figure 4-2, should be set to 0b111, or 0x7, for this particular example.

5.0 COMMUNICATION PROTOCOL

5.1 Overview

The MTCH6301 has two basic communication types: Touch & Gesture Protocol, and Command Protocol.

Touch & Gesture Protocol

Fully processed touch coordinates and gestures will be transmitted immediately as they are processed by the MTCH6301. Since it is a slave device, the INT pin will be asserted whenever one of these packets is ready for transmission. This requires the master controller to initiate a READ command to receive the touch or gesture packet.

Command Protocol

All other commands are invoked by the I^{2}C master controller. Commands are used for configuring and controlling the device.

Master Read Details

Please note that any read from the controller by the master, including both touch & gesture protocol and command protocol, will be prefixed by a single byte. This single byte denotes the number of bytes that are to be transferred. This byte is NOT represented in the tables and figures for the protocol, but is detailed in Figure 5-6 and Figure 5-7.

5.2 Touch Protocol

The packet in Table 5-1 is transmitted for each touch that is present on the sensor.

TABLE 5-1: TOUCH PROTOCOL

Packet	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	1	TOUCHID<3:0>				TCH(0)	0	PEN
1	0	X<6:0>						
2	0	0	0	X<11:7>				
3	0	Y<6:0>						
4	0	0	0	Y<11:7>				

Legend:
TOUCHID: Touch ID (0-9)
PEN: Pen State
0 = Pen Up
1 = Pen Down
X: X Coordinate of Touch
Y: Y Coordinate of Touch
TCH: Always 0, denotes a touch packet

5.3 Gesture Protocol

The packet in Table 5-2 is transmitted whenever a gesture is performed on the sensor. This feature can be enabled via the Gesture Protocol register (Table 5-2). Gestures are NOT enabled by default.

> **Note:** For any “hold” gestures, packets are sent continuously until the gesture (touch) is released.

TABLE 5-2: GESTURE PROTOCOL

Packet	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	1	TOUCHID<3:0>				GEST(1)	0	0
1	0	GESTURE<6:0>						

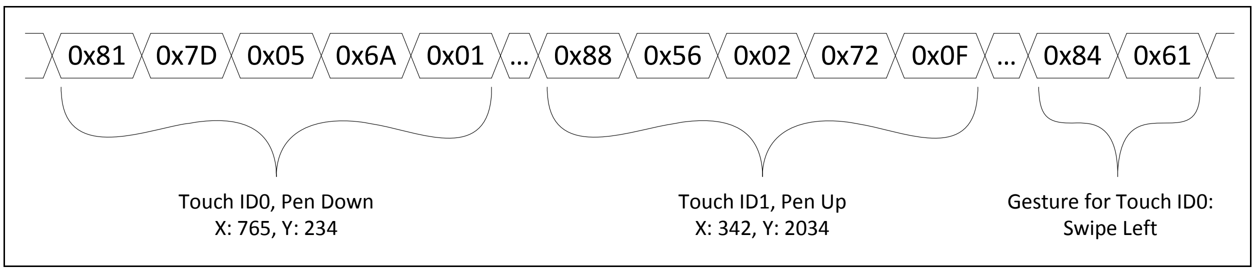
Legend:
TOUCHID: Touch ID (0-7)
GESTURE: Gesture ID
0x10 Single Tap
0x11 Single Tap (hold)
0x20 Double Tap
0x31 Up Swipe
0x32 Up Swipe (hold)
0x41 Right Swipe
0x42 Right Swipe (hold)
0x51 Down Swipe
0x52 Down Swipe (hold)
0x61 Left Swipe
0x62 Left Swipe (hold)
GEST: Always 1, denotes a gesture packet

5.4 Example Touch Data

Figure 5-1 depicts multitouch transmission in one touch activation that is already in progress (ID0), and a second activation (ID1) being removed from the sensor.

The first activation also completes a gesture. The I^2C prefix bytes are not shown in this example.

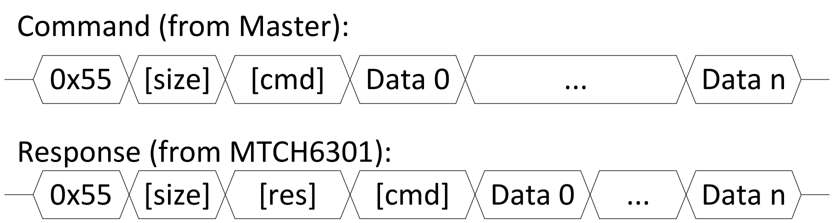
FIGURE 5-1: EXAMPLE TOUCH DATA



5.5 Command Protocol

Figure 5-2 depicts bidirectional communication protocol (for reading/writing configuration data).

FIGURE 5-2: COMMAND PROTOCOL



size: Number of remaining bytes in packet

cmd: Command invoked for being responded to

result: Controller command-specific result
0x00 = Success
0x80 = Parameter out of range
0xFE = Timeout (not enough bytes received)
0xFF = Unrecognized command
0xFD = Invalid parameter
0xFC = Missing or extra parameter

data: Data associated with command

5.6 Full Command Set

A complete listing of MTCH6301 commands is shown in Table 5-3. Any commands which contain data bytes, either sent or received, are shown alongside an example stream of data in the following sections.

TABLE 5-3: COMMAND SET

ID	Name	Description
0x00	Enable Touch	Enable touch functionality
0x01	Disable Touch	Disable touch functionality
0x14	Scan Baseline	Instruct controller to scan for a new sensor baseline
0x15	Write Register	Write data to a specific register
0x16	Read Register	Read data from a specific register
0x17	Write NVRAM	Write all current register values to NVRAM
0x18	Software Sleep	Instructs the controller to enter sleep mode
0x19	Erase NVRAM	Erase the contents of the non-volatile RAM section.
0x1A	Manufacturing Test	Perform manufacturing tests on all sensor I/O channels

5.6.1 WRITE REGISTER/READ REGISTER

Writes or reads a single register. Note that all registers are volatile, and any modified data will be lost on power down. Registers must be saved to NVRAM to store the configuration permanently

FIGURE 5-3: WRITE REGISTER COMMAND

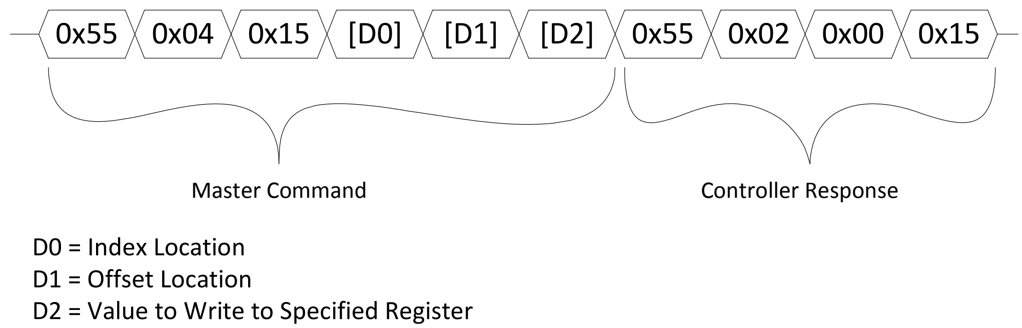
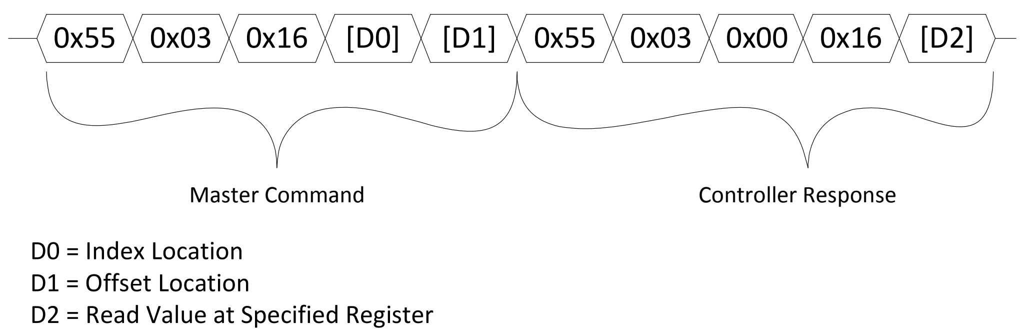


FIGURE 5-4: READ REGISTER COMMAND



5.6.2 MANUFACTURING TEST

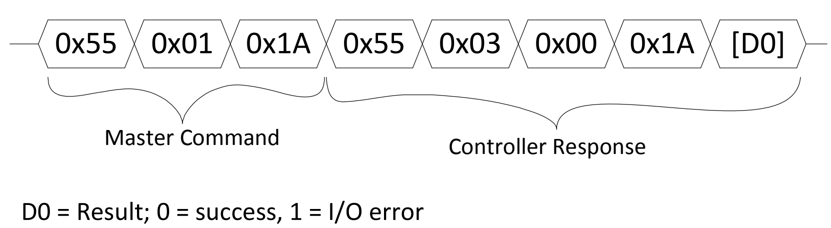
The manufacturing test ensures electrical functionality of the sensor. This test performs the following checks on all mapped sensor pins: short to V_{DD}, Short to G_{ND}, and pin-to-pin short.

If an I/O error is reported, bits for the pins in question will be set in the “TX Short Status” and “RX Short Status” registers.

Please note that:

1. The RX7/RX8 pins will always report an error.
2. If the sensor has more than 16 TX channels, then channels 17 and 18 will never report an error.

FIGURE 5-5: MANUFACTURING TEST



5.7 I²C Specification

The MTCH6301 device supports the I²C serial protocol, with the addition of an interrupt pin for notifying the master that data is ready. The device operates in Slave mode, meaning that the device does not generate the serial clock.

5.7.1 SERIAL DATA (SDA)

The Serial Data (SDA) signal is the data signal of the device. The value on this pin is latched on the rising edge of the SCL signal when the signal is an input. With the exception of the START (RESTART) and STOP conditions, the high or low state of the SDA pin can only change when the clock signal on the SCL pin is low. During the high period of the clock, the SDA pin's value (high or low) must be stable. Changes in the SDA pin's value while the SCL pin is HIGH will be interpreted as a START or a STOP condition.

5.7.2 SERIAL CLOCK (SCL)

The Serial Clock (SCL) signal is the clock signal of the device. The rising edge of the SCL signal latches the value on the SDA pin. The MTCH6301 employs clock stretching, and this should be taken into account by the master controller. The maximum speed at which the MTCH6301 can operate is 400 kbps.

5.7.3 INTERRUPT (INT)

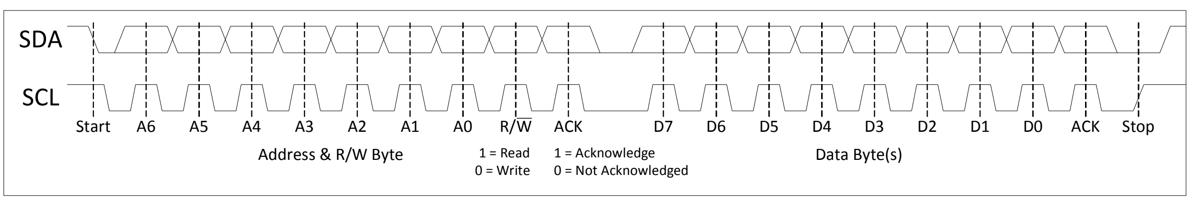
This pin is utilized by the MTCH6301 to signal that data is available, and that the master controller should invoke a MASTER READ. INT is an active high pin, and is held low during all other activities.

Note:	If the device is not read within 25 ms of asserting the INT pin, it will time out and data will no longer be available.

5.7.4 DEVICE ADDRESSING

The MTCH6301 7-bit base address is set to 0x25, and is not configurable by the user. Every transmission must be prefixed with this address, as well as a bit signifying whether the transmission is a MASTER WRITE (‘0’) or MASTER READ (‘1’). After appending this read/write bit to the base address, this first byte becomes either 0x4A (WRITE) or 0x4B (READ).

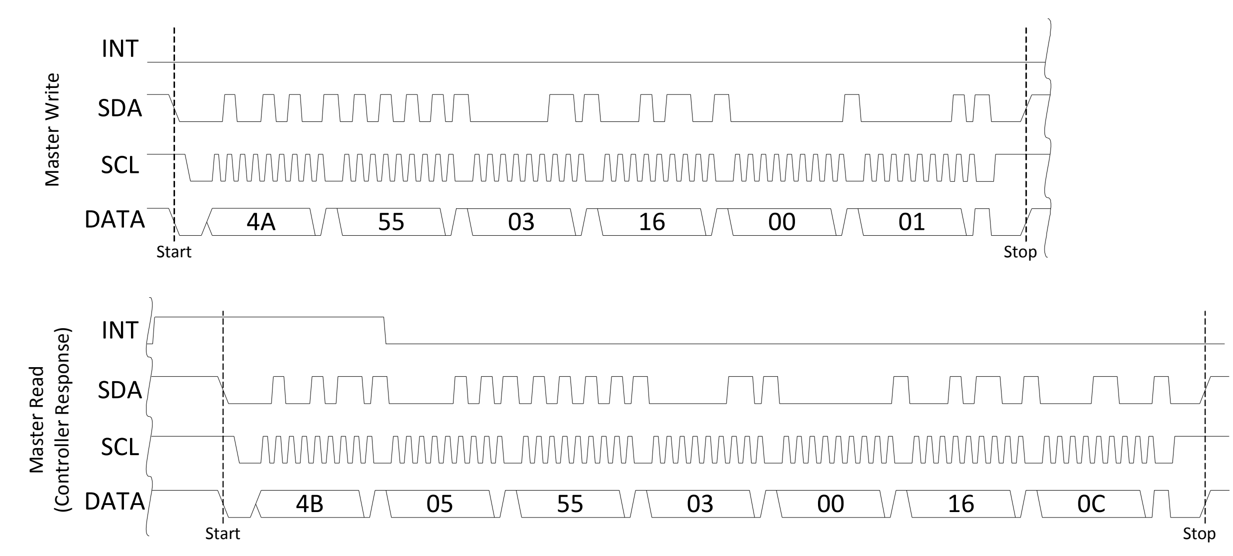
FIGURE 5-6: SINGLE TRANSMISSION I²C™ FORMAT



5.7.5 TYPICAL I²C™ COMMAND READ AND WRITE

Figure 5-7 depicts the master controller reading from RAM location 0x01 (number of RX channels), and the device responding accordingly with 0x0C (Figure 5-6).

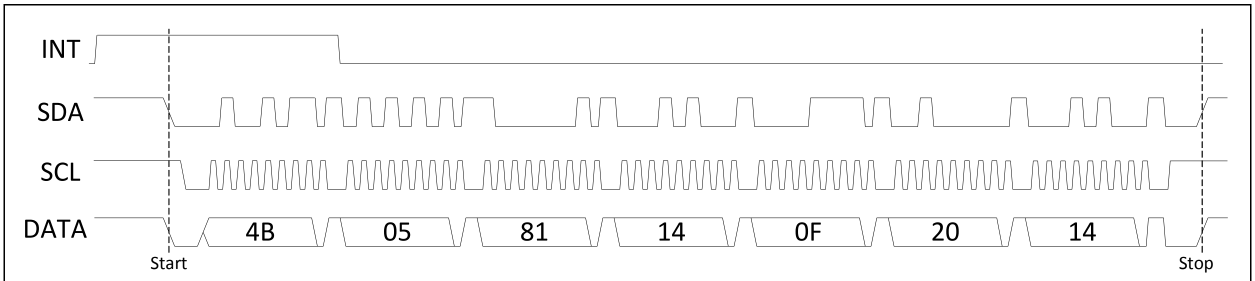
FIGURE 5-7: I²C™ COMMAND READ AND WRITE



5.7.6 TYPICAL I²C TOUCH PACKET READ

Figure 5-8 depicts a single touch packet being streamed from the controller. In this case, touch ID 0 at location (1940,2592).

FIGURE 5-8: I²C™ TOUCH PACKET READ



5.7.7 WAKE ON I²C

The MTCH6301 is capable of waking up upon receiving an I²C command from the host. Note that since wake-up time can take up to 350 µs, the controller must resend any I²C bytes that were not acknowledged (ACK) before continuing the transmission.

Since the controller will wake up upon a correct I²C address match, it does not matter which command is sent. For simplicity, the Enable Touch command is recommended.

6.0 MEMORY MAP

TABLE 6-1: MTCH6301 MEMORY MAP

<table>
<tr><th></th><th>Index Byte</th><th>Offset Byte</th><th>Register Name</th><th>Size Bytes</th><th>Description</th><th>Data Range</th><th>Default Value</th></tr>
<tr><td rowspan="6">General</td><td rowspan="6">0x00</td><td>0x01</td><td>RX Channels</td><td>1</td><td>Number of RX Sensor Channels</td><td>3-13</td><td>12</td></tr>
<tr><td>0x02</td><td>TX Channels</td><td>1</td><td>Number of TX Sensor Channels</td><td>3-18</td><td>9</td></tr>
<tr><td>0x04</td><td>RX Scaling [7:0]</td><td rowspan="2">2</td><td rowspan="2">RX Scaling Coefficient</td><td rowspan="2">15420-65535</td><td rowspan="2">23831</td></tr>
<tr><td>0x05</td><td>RX Scaling [15:8]</td></tr>
<tr><td>0x06</td><td>TX Scaling [7:0]</td><td rowspan="2">2</td><td rowspan="2">TX Scaling Coefficient</td><td rowspan="2">15420-65535</td><td rowspan="2">32768</td></tr>
<tr><td>0x07</td><td>TX Scaling [15:8]</td></tr>
<tr><td rowspan="2">Sensor Map</td><td>0x01</td><td>0x00-0x0C</td><td>RX Pin map</td><td>13</td><td>RX Pin Map Array</td><td>0-12</td><td>Note 1</td></tr>
<tr><td>0x02</td><td>0x00-0x12</td><td>TX Pin map</td><td>18</td><td>TX Pin Map Array</td><td>0-34</td><td>Note 1</td></tr>
<tr><td rowspan="2">Self</td><td rowspan="2">0x10</td><td>0x00</td><td>Self Scan Time</td><td>1</td><td>Number of self readings to sum per electrode</td><td>1-30</td><td>5</td></tr>
<tr><td>0x01</td><td>Self Threshold</td><td>1</td><td>Threshold for detecting a touch</td><td>10-150</td><td>50</td></tr>
<tr><td rowspan="2">Mutual</td><td rowspan="2">0x20</td><td>0x00</td><td>Mutual Scan Time</td><td>1</td><td>Number of mutual readings to sum per node</td><td>1-30</td><td>9</td></tr>
<tr><td>0x01</td><td>Mutual Threshold</td><td>1</td><td>Threshold for detecting a touch</td><td>10-150</td><td>55</td></tr>
<tr><td rowspan="6">Decoding</td><td rowspan="6">0x30</td><td>0x00</td><td>FlipState</td><td>1</td><td>Determines orientation of sensor with respect to coordinate output</td><td>0b000-0b111</td><td>0b001</td></tr>
<tr><td>0x01</td><td>Number of Averages</td><td>1</td><td>Smoothing Filter (number of previous coordinates to be averaged with current touch position)</td><td>1-16</td><td>8</td></tr>
<tr><td>0x04</td><td>Minimum Touch Distance</td><td>1</td><td>Minimum distance allowed between touch locations – used for suppressing weak touches</td><td>0-255</td><td>150</td></tr>
<tr><td>0x05</td><td>Pen Down Timer</td><td>1</td><td>Number of successive sensor scans needed to identify a touch prior to transmitting data</td><td>0-10</td><td>3</td></tr>
<tr><td>0x06</td><td>Pen Up Timer</td><td>1</td><td>Number of successive sensor scans needed to identify released touch prior to transmitting data</td><td>0-10</td><td>3</td></tr>
<tr><td>0x07</td><td>Touch Suppression Value</td><td>1</td><td>The maximum number of activations reported. 10 activations are tracked, but may not be reported. 0 = disable suppression feature</td><td>0-10</td><td>0</td></tr>
</table>

Note 1: RX Pin Map: {0x08 0x07 0x06 0x05 0x04 0x03 0x02 0x01 0x00 0x09 0x0A 0x0B 0x00}
TX Pin Map: {0x0D 0x06 0x03 0x02 0x04 0x07 0x1C 0x1D 0x1E 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00}
Pin map array order reflects the physical sensor pin order, not the MTCH6301 pin sequence.

TABLE 6-1: MTCH6301 MEMORY MAP

	Index Byte	Offset Byte	Register Name	Size Bytes	Description	Data Range	Default Value
Gestures	0x50	0x00	RX Swipe Length	1	Minimum interpolated X-distance for 'swipe' gesture	10-255	160
		0x01	TX Swipe Length	1	Minimum interpolated Y-distance for 'swipe' gesture	10-255	150
		0x02	Swipe Boundary	1	Maximum interpolated distance in opposing direction to cancel 'swipe' gesture	0-255	150
		0x03	Swipe Hold Threshold	1	Maximum interpolated distance deviation allowed to determine 'held' swipe gesture	0-255	70
		0x04	Swipe Time [7:0]	2	Maximum time (ms) for 'swipe' gesture to be completed, beginning at initial touch-down	0-65535	200
		0x05	Swipe Time [15:8]				
		0x06	Tap Time [7:0]	2	Maximum time (ms) for 'tap' gesture, beginning at initial touch-down	0-65535	500
		0x07	Tap Time [15:8]				
		0x08	Tap Threshold	1	Maximum interpolated distance deviation allowed to determine 'tap' gesture	1-255	120
		0x09	Minimum Swipe Velocity	1	Minimum velocity to register the 'swipe' gesture. Events below this threshold will cancel the gesture (touch removed) or be re-evaluated for 'swipe-and-hold' (touch is held)	1-50	3
		0x0A	Double Tap Time [7:0]	2	Maximum time allowed between two taps to determine 'double tap' gesture	50-1000	350
		0x0B	Double Tap Time [15:8]				
		0x0C	Gesture Edge Keepout	1	Determines the width of 'keepout barrier' (inactive edge) of the perimeter of the sensor to reduce or eliminate issues due to edge effects	0-255	128
Configure	0xF0	0x00	SLP2 [7:0]	4	Time-out duration (ms) with no activations before controller enters Sleep mode	0-4,000,000,000	8000
		0x01	SLP2 [15:8]				
		0x02	SLP2 [23:16]				
		0x03	SLP2 [31:24]				
		0x05	SLP1	1	Interval to poll for touch while in Sleep mode	0-11	7
		0x07	Touch Packet CFG	1	Touch Packet Configuration	0x81 = Enabled 0x01 = Disabled	0x81
		0x09	Gesture Packet CFG	1	Gesture Packet Configuration	0x81 = Enabled 0x01 = Disabled	0x01
		0x0A	Status Packet CFG	1	Status Packet Configuration	0x81 = Enabled 0x01 = Disabled	0x01
I/O Status	0xF1	0x02	TX Short Status [7:0]	2	Identifies which TX pins are shorted after executing Manufacturing Test command – Read Only	0x00-0xFF	0x00
		0x03	TX Short Status [15:8]				
		0x06	RX Short Status [7:0]	2	Identifies which RX pins are shorted after executing Manufacturing Test command – Read Only	0x00-0xFF	0x00
		0x07	RX Short Status [15:8]				

Note 1: RX Pin Map: {0x08 0x07 0x06 0x05 0x04 0x03 0x02 0x01 0x00 0x09 0x0A 0x0B 0x00}
TX Pin Map: {0x0D 0x06 0x03 0x02 0x04 0x07 0x1C 0x1D 0x1E 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00}
Pin map array order reflects the physical sensor pin order, not the MTCH6301 pin sequence.

7.0 SPECIAL FEATURES

7.1 Gestures

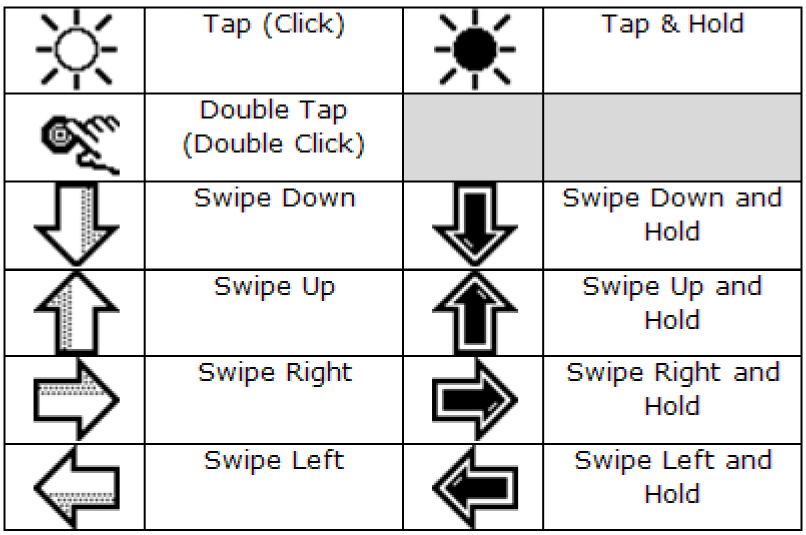
Single finger gestures are a fast and intuitive way to navigate a feature rich human-machine interface. The MTCH6301 supports 11 single finger gestures natively, without requiring interaction from the master processor.

Tuning may be required depending on the layout of the sensor, the time duration, and length of activation required for your gesture supported application. The most common defaults are already preloaded and should serve most applications. These parameters and their descriptions are available in the "Gestures" section of the memory map (**Section 6.0 "Memory Map"**).

Note:	Gestures are NOT enabled by default, and must be enabled via the gesture packet configuration byte in RAM (refer to **Section 6.0 "Memory Map"**).

If your application requires ONLY gesture functionality, and does not require touch coordinates, the touch packet configuration byte (refer to **Section 6.0 "Memory Map"**) can be used to turn off all touch coordinate data.

FIGURE 7-1: GESTURE TYPES



7.2 Sleep

Sleep functionality is enabled by default, and follows the behavior detailed in Figure 7-2. This functionality can be modified via the registers related to sleep.

SLP1: This delay controls how often the sensor is scanned for a touch while in Sleep mode. Table 7-1 correlates the value of SLP1 to time (ms).

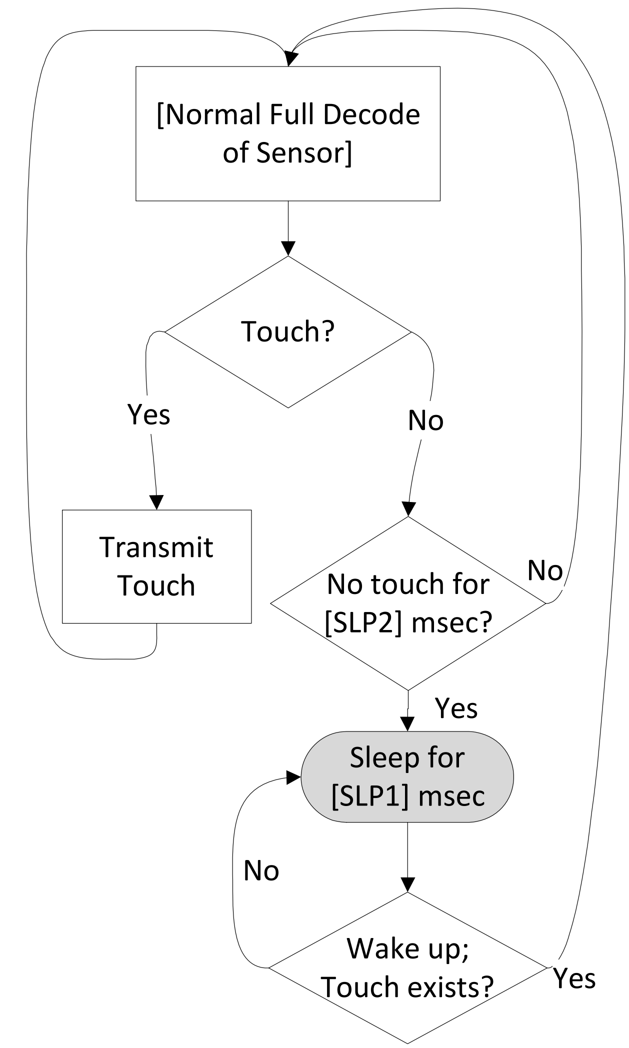
TABLE 7-1: SLP1 DELAY CHART

SLP1	Delay (ms)	SLP1	Delay (ms)
0	1	6	64
1	2	7(1)	128(1)
2	4	8	256
3	8	9	512
4	16	10	1024
5	32	11	2048

Note 1: Default setting.

SLP2: Time (ms) without touch activity before controller enters sleep mode.

FIGURE 7-2: SLEEP FUNCTIONALITY



7.3 Non-Volatile RAM (NVRAM)

Permanent storage of parameters that have been modified can be achieved using the internal NVRAM. This NVRAM is not meant for continuous writing, as it has a low write cycle limit of 20,000.

Upon startup, the NVRAM's data (if present) is loaded into the controller. If no data is available in the NVRAM, the device defaults are loaded instead.

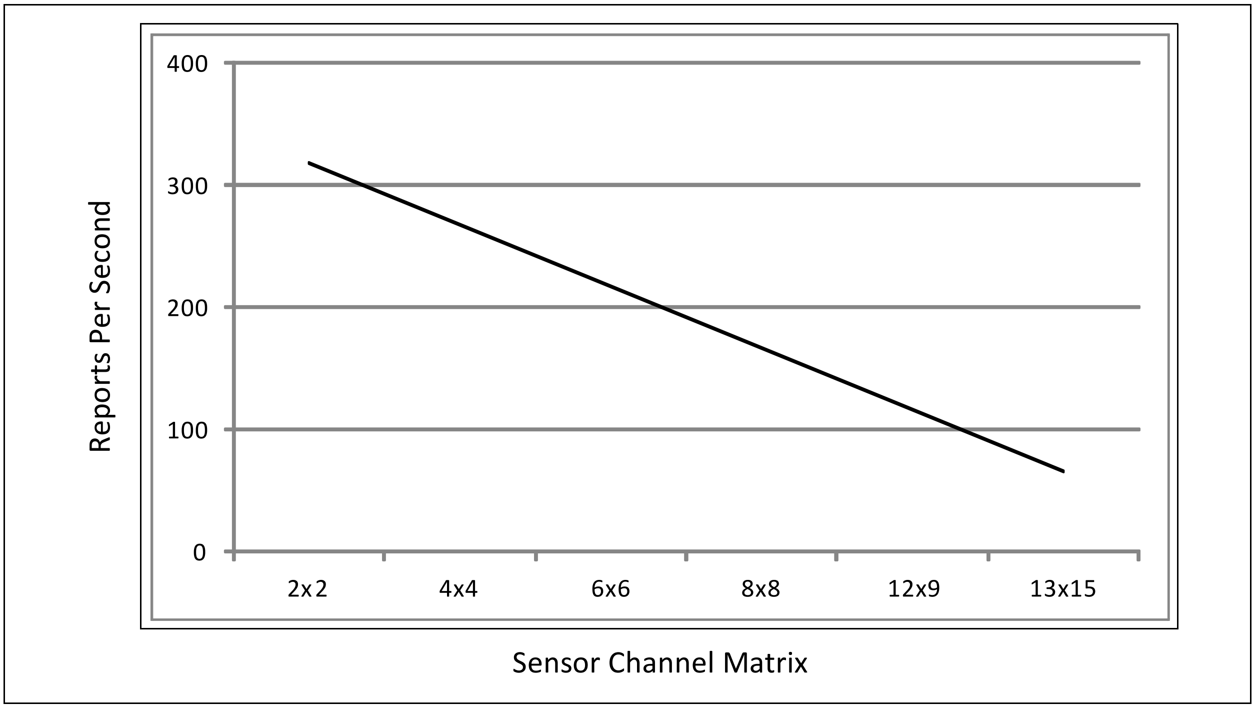
Please note that parameters cannot be written individually to the NVRAM. All registers will be written with one command. See the applicable command within the command set for more details. (**Section 5.6 "Full Command Set"**)

7.4 Touch Performance

Using default acquisition parameters, Figure 7-3 shows the relationship of single touch report rate with regard to sensor size.

Larger sensors will have a reduced report rate, due to the additional time needed to scan the sensor.

FIGURE 7-3: SINGLE-TOUCH REPORT RATE VS SENSOR SIZE



8.0 ELECTRICAL CHARACTERISTICS

This section provides an overview of the MTCH6301 electrical characteristics.

8.1 Absolute Maximum Ratings

Absolute maximum ratings for the MTCH6301 device are listed below. Exposure to these maximum rating conditions for extended periods may affect device reliability. Functional operation of the device at these or any other conditions, above the parameters indicated in the operation listings of this specification, is not implied.

Ambient temperature under bias ....-40 to +85°C
Storage temperature..-65 to 150°C
Voltage on V_{DD} with respect to V_{SS}..-0.3V to 4.0V
Voltage on all other pins with respect to V_{SS}..-0.3V to (VDD + 0.3V)
Maximum current out of V_{SS} pin ....300 mA
Maximum current into V_{DD} pin(s) ....300 mA
Maximum output current sunk by any I/O pin..15 mA
Maximum output current sourced by any I/O pin ....15 mA
Maximum current sunk by all ports. .... 200 mA
Maximum current sourced by all ports. .... 200 mA

Stresses above those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress rating only and functional operation of the device at those or any other conditions, above those indicated in the operation listings of this specification, is not implied. Exposure to maximum rating conditions for extended periods may affect device reliability.

8.2 DC Characteristics

TABLE 8-1: THERMAL OPERATING CONDITIONS

Rating	Symbol	Min.	Typ.	Max.	Units
Operating Junction Temperature Range	TJ	-40	—	+125	ºC
Operating Ambient Temperature Range	TA	-40	—	+85	ºC
Power Dissipation: Internal Chip Power Dissipation: PINT = VDD x (IDD-Σ IOH) I/O Pin Power Dissipation: PI/O = Σ (({VDD - VOH} x IOH) + Σ (VOL x IOL))	PD	PINT + PI/O			W
Maximum Allows Power Dissipation	PDMAX	(TJ - TA) / θJA			W

TABLE 8-2: THERMAL PACKAGING CHARACTERISTICS

Characteristics	Symbol	Typ.	Max.	Units
Package Thermal Resistance, 44-pin QFN	θJA	32	—	ºC/W
Package Thermal Resistance, 44-pin TQFP	θJA	45	—	ºC/W

TABLE 8-3: OPERATING VOLTAGE AND CURRENT

Symbol	Characteristics	Min	Typ	Max	Units
VDD	Supply Voltage	2.4	—	3.6	V
IDD	Operating Current	—	20	30	mA
ISLP	Sleep Current	—	20	—	µA

TABLE 8-4: PIN INPUT AND OUTPUT SPECIFICATIONS

Symbol	Characteristic / Pins	Min.	Max.	Units	Conditions
VIL	**Input Low Voltage**				
	RX, TX	VSS	0.15 VDD	V	—
	SDA, SCL	VSS	0.3 VDD	V	**Note 1**
VIH	**Input High Voltage**				
	RX, TX	0.65 VDD	VDD	V	**Note 1**
	SDA, SCL	0.65 VDD	VDD	V	**Note 1**
VOL	**Output Low Voltage**				
	INT, RX, TX	VSS	0.4	V	IOL < 10 mA, VDD = 3.3V
	SDA, SCL	VSS	0.4	V	IOL < 10 mA, VDD = 3.3V(1,2)
VOH	**Output High Voltage**				
	INT, RX, TX	2.4	VDD	V	IOH < 10mA, VDD = 3.3V
	SDA, SCL	—	—	V	**Note 2**
VBOR	Brown-out event on VDD Transition high-to-low	2.0	2.3	V	Min. not tested

Note 1: Parameter is characterized, but not tested.
2: Open drain structure.

8.3 AC Characteristics and Timing Parameters

TABLE 8-5: AC CHARACTERISTICS AND TIMING PARAMETERS

Symbol	Characteristic	Min.	Typ.	Max	Units	Conditions
TPU	Power-up Period	—	400	—	μs	**Notes 1, 2**
TBOR	Brown-out Pulse Width (Low)	—	1	—	μs	**Note 1**

Note 1: Parameter is characterized, but not tested.
2: Power-up period is for core operation to begin, and does not reflect response time to a touch.

FIGURE 8-1: I2C™ BUS START/STOP BIT TIMING CHARACTERISTICS

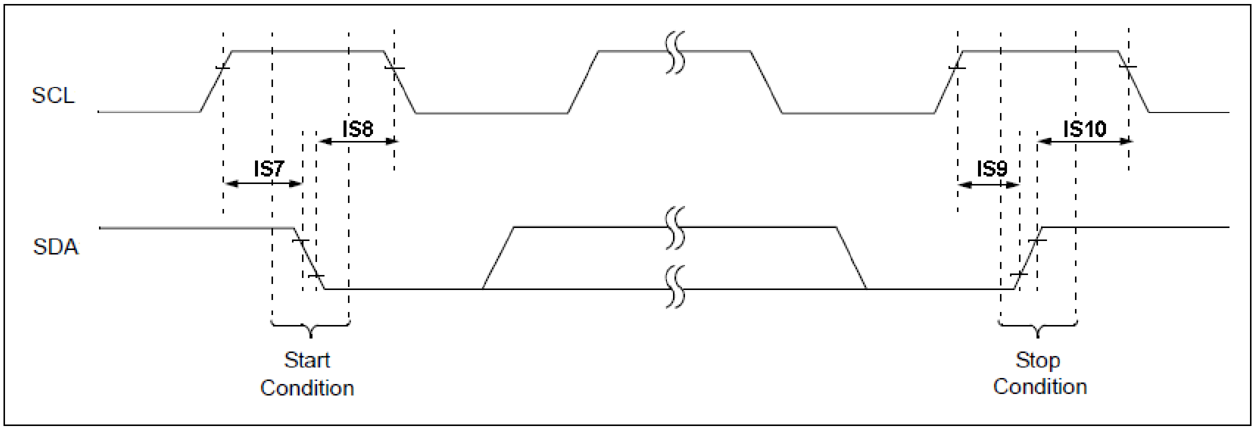


FIGURE 8-2: I²C™ BUS DATA TIMING CHARACTERISTICS

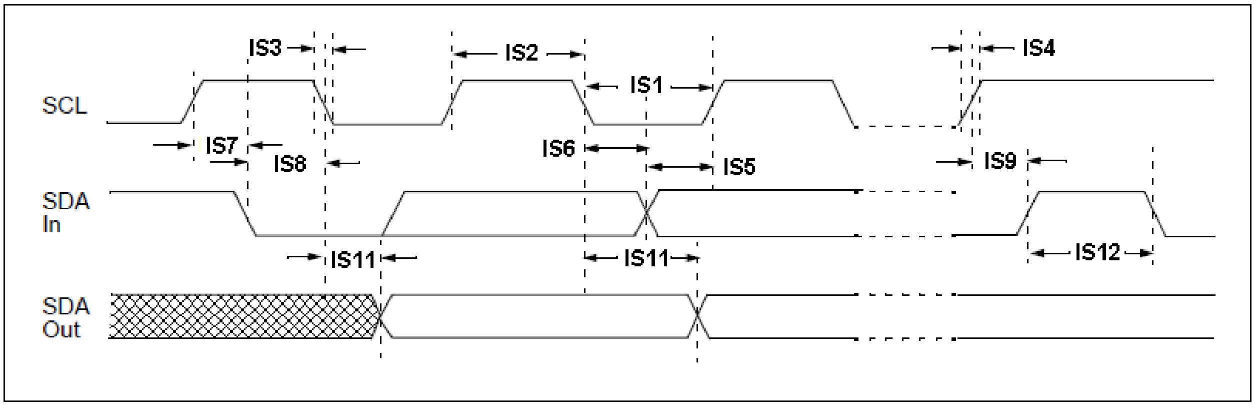


TABLE 8-6: I²C™ BUS DATA TIMING REQUIREMENTS

Parameter Number	Symbol	Characteristic		Min.	Max.	Units	Conditions
IS1	TLO:SCL	Clock Low Time	100 kHz Mode	4.7	—	µs	—
			400 kHz Mode	1.3	—	µs	
IS2	THI:SCL	Clock High Time	100 kHz Mode	4.0	—	µs	—
			400 kHz Mode	.6	—	µs	
IS3	TF:SCL	SDA and SCL Fall Time	100 kHz Mode	—	300	ns	—
			400 kHz Mode	20+0.1 CB	300	ns	
IS4	TR:SCL	SDA and SCL Rise Time	100 kHz Mode	—	1000	ns	—
			400 kHz Mode	20+0.1 CB	300	ns	
IS5	TSU:DAT	Data Input Setup Time	100 kHz Mode	250	—	ns	—
			400 kHz Mode	100	—	ns	
IS6	THD:DAT	Data Input Hold Time	100 kHz Mode	0	—	ns	—
			400 kHz Mode	0	0.9	µs	
IS7	THD:STA	Start Condition Setup Time	100 kHz Mode	4700	—	ns	Only relevant for repeated start condition
			400 kHz Mode	600	—	ns	
IS8	THD:STA	Start Condition Hold Time	100 kHz Mode	4000	—	ns	After this period, the first clock pulse is generated
			400 kHz Mode	600	—	ns	
IS9	TSU:STO	Stop Condition Setup Time	100 kHz Mode	4000	—	ns	—
			400 kHz Mode	600	—	ns	
IS10	THD:STO	Stop Condition Hold Time	100 kHz Mode	4000	—	ns	—
			400 kHz Mode	600	—	ns	
IS11	TAA:SCL	Output Valid from Clock	100 kHz Mode	0	3500	ns	—
			400 kHz Mode	0	1000	ns	
IS12	TDF:SDA	Bus Free Time	100 kHz Mode	4.7	—	µs	Time bus must be free before new transmission can start
			400 kHz Mode	1.3	—	µs	
	CB	SCL, SDC Capacitive Loading		—	400	pF	Parameter is characterized, but not tested

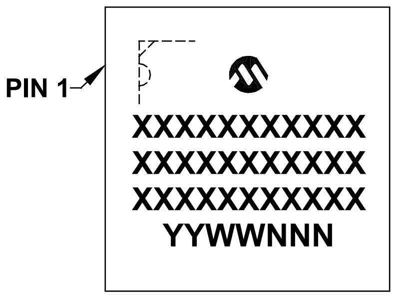
9.0 ORDERING INFORMATION

TABLE 9-1: ORDERING INFORMATION

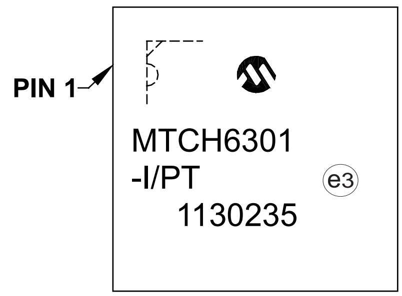
Part Number	Pin Package	Packing
MTCH6301-I/PT	44 TQFP 10x10x1mm	Tray
MTCH6301-I/ML	44 QFN 8x8x0.9mm	Tube
MTCH6301T-I/PT	44 TQFP 10x10x1mm	T/R
MTCH6301T-I/ML	44 QFN 8x8x0.9mm	T/R

10.0 PACKAGING INFORMATION

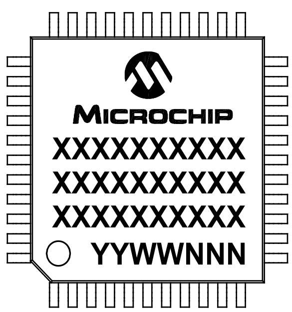
44-Lead QFN (8x8x0.9 mm)



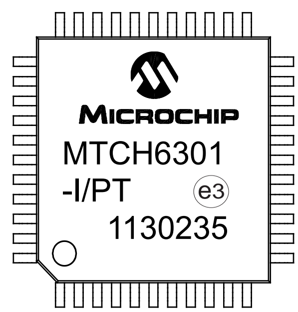
Example



44-Lead TQFP (10x10x1 mm)



Example

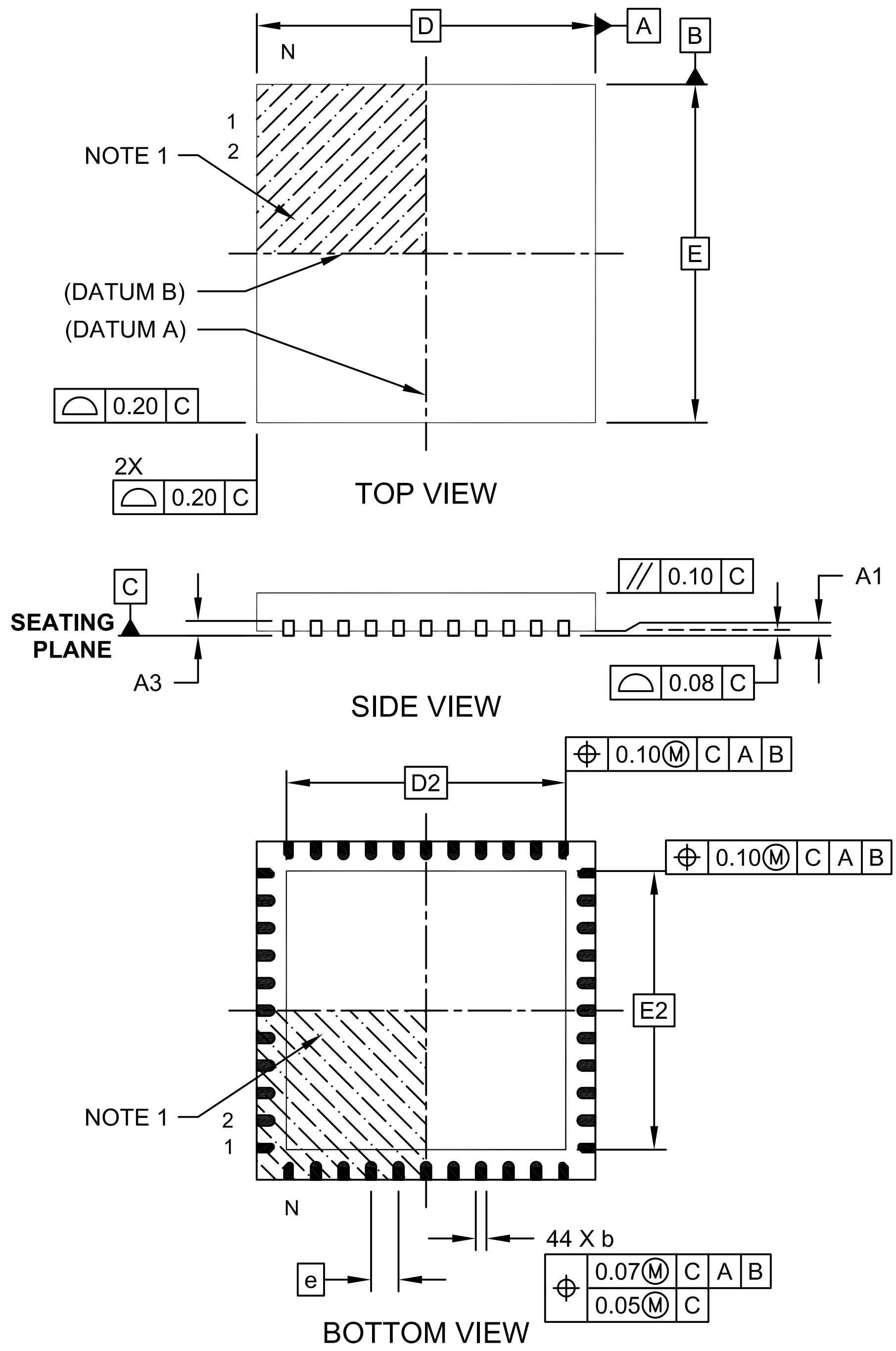


Legend:	XX...X	Customer-specific information
	Y	Year code (last digit of calendar year)
	YY	Year code (last 2 digits of calendar year)
	WW	Week code (week of January 1 is week '01')
	NNN	Alphanumeric traceability code
	(e3)	Pb-free JEDEC designator for Matte Tin (Sn)
	*	This package is Pb-free. The Pb-free JEDEC designator ((e3)) can be found on the outer packaging for this package.

Note: In the event the full Microchip part number cannot be marked on one line, it will be carried over to the next line, thus limiting the number of available characters for customer-specific information.

44-Lead Plastic Quad Flat, No Lead Package (ML) - 8x8 mm Body [QFN]

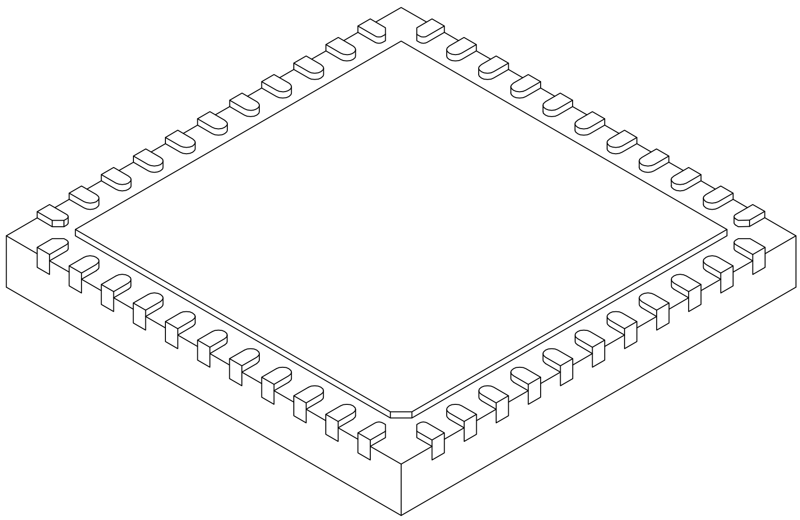
Note:	For the most current package drawings, please see the Microchip Packaging Specification located at http://www.microchip.com/packaging



Microchip Technology Drawing C04-103C Sheet 1 of 2

44-Lead Plastic Quad Flat, No Lead Package (ML) - 8x8 mm Body [QFN]

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



Units		MILLIMETERS		
Dimension Limits		MIN	NOM	MAX
Number of Pins	N		44	
Pitch	e		0.65 BSC	
Overall Height	A	0.80	0.90	1.00
Standoff	A1	0.00	0.02	0.05
Terminal Thickness	A3		0.20 REF	
Overall Width	E		8.00 BSC	
Exposed Pad Width	E2	6.25	6.45	6.60
Overall Length	D		8.00 BSC	
Exposed Pad Length	D2	6.25	6.45	6.60
Terminal Width	b	0.20	0.30	0.35
Terminal Length	L	0.30	0.40	0.50
Terminal-to-Exposed-Pad	K	0.20	-	-

Notes:

1. Pin 1 visual index feature may vary, but must be located within the hatched area.
2. Package is saw singulated
3. Dimensioning and tolerancing per ASME Y14.5M

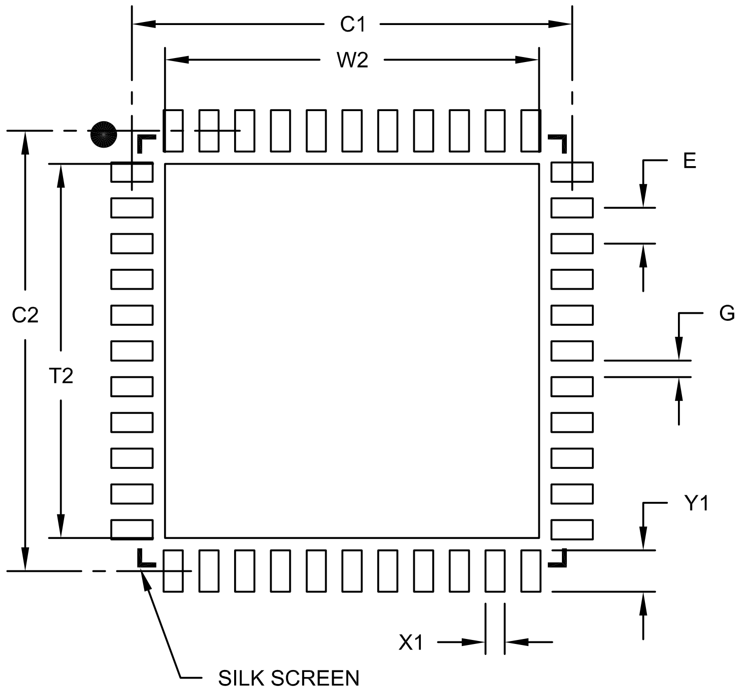
   BSC: Basic Dimension. Theoretically exact value shown without tolerances.

   REF: Reference Dimension, usually without tolerance, for information purposes only.

Microchip Technology Drawing C04-103C Sheet 2 of 2

44-Lead Plastic Quad Flat, No Lead Package (ML) - 8x8 mm Body [QFN]

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



RECOMMENDED LAND PATTERN

		Units	MILLIMETERS		
		Dimension Limits	MIN	NOM	MAX
Contact Pitch	E			0.65 BSC	
Optional Center Pad Width	W2				6.60
Optional Center Pad Length	T2				6.60
Contact Pad Spacing	C1			8.00	
Contact Pad Spacing	C2			8.00	
Contact Pad Width (X44)	X1				0.35
Contact Pad Length (X44)	Y1				0.85
Distance Between Pads	G		0.25		

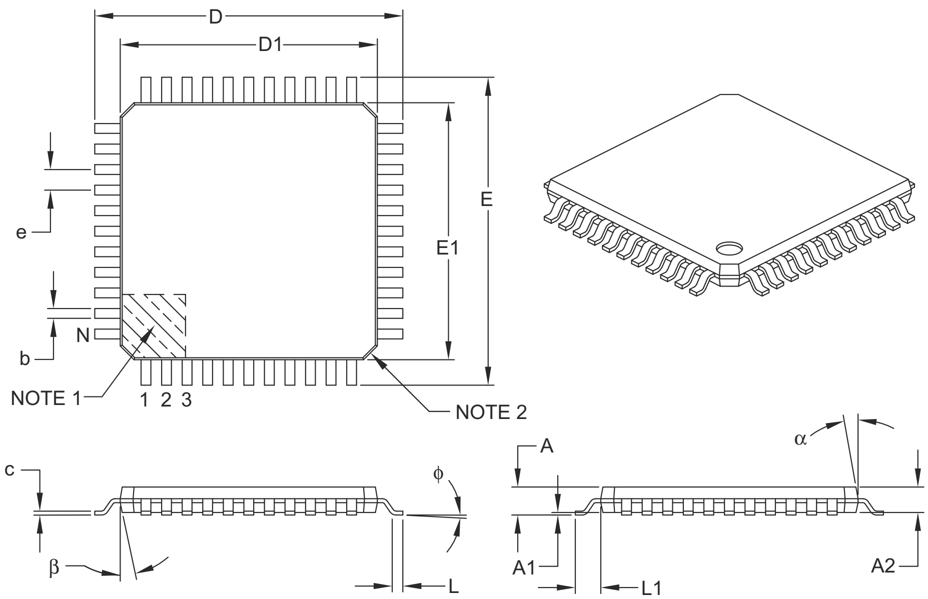
Notes:

1. Dimensioning and tolerancing per ASME Y14.5M
   BSC: Basic Dimension. Theoretically exact value shown without tolerances.

Microchip Technology Drawing No. C04-2103B

44-Lead Plastic Thin Quad Flatpack (PT) – 10x10x1 mm Body, 2.00 mm [TQFP]

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



		Units	MILLIMETERS	
Dimension Limits		MIN	NOM	MAX
Number of Leads	N		44	
Lead Pitch	e		0.80 BSC	
Overall Height	A	–	–	1.20
Molded Package Thickness	A2	0.95	1.00	1.05
Standoff	A1	0.05	–	0.15
Foot Length	L	0.45	0.60	0.75
Footprint	L1		1.00 REF	
Foot Angle	φ	0°	3.5°	7°
Overall Width	E		12.00 BSC	
Overall Length	D		12.00 BSC	
Molded Package Width	E1		10.00 BSC	
Molded Package Length	D1		10.00 BSC	
Lead Thickness	c	0.09	–	0.20
Lead Width	b	0.30	0.37	0.45
Mold Draft Angle Top	α	11°	12°	13°
Mold Draft Angle Bottom	β	11°	12°	13°

Notes:

1. Pin 1 visual index feature may vary, but must be located within the hatched area.
2. Chamfers at corners are optional; size may vary.
3. Dimensions D1 and E1 do not include mold flash or protrusions. Mold flash or protrusions shall not exceed 0.25 mm per side.
4. Dimensioning and tolerancing per ASME Y14.5M.

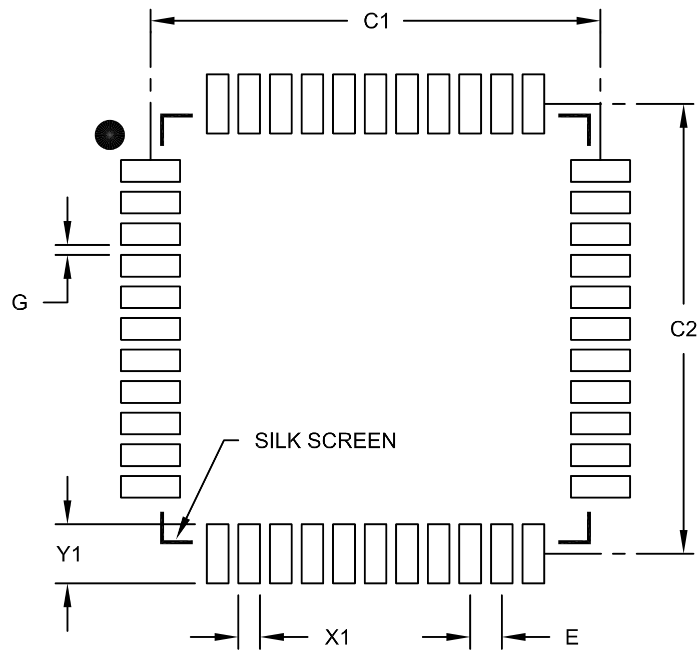
   BSC: Basic Dimension. Theoretically exact value shown without tolerances.

   REF: Reference Dimension, usually without tolerance, for information purposes only.

Microchip Technology Drawing C04-076B

44-Lead Plastic Thin Quad Flatpack (PT) 10X10X1 mm Body, 2.00 mm Footprint [TQFP]

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



RECOMMENDED LAND PATTERN

Units		MILLIMETERS		
Dimension Limits		MIN	NOM	MAX
Contact Pitch	E	0.80 BSC		
Contact Pad Spacing	C1		11.40	
Contact Pad Spacing	C2		11.40	
Contact Pad Width (X44)	X1			0.55
Contact Pad Length (X44)	Y1			1.50
Distance Between Pads	G	0.25		

Notes:

1. Dimensioning and tolerancing per ASME Y14.5M

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

Microchip Technology Drawing No. C04-2076B

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