

## MTCH6303 Projected Capacitive Touch Controller Data Sheet

### Description

Microchip's MTCH6303 is an innovative turnkey projected capacitive touch controller that provides multi-touch coordinates as well as a readymade multi-finger surface gesture suite. MTCH6303 brings modern user interface (UI) elements – such as pinch and zoom, multi-finger scrolling, and swipes – to any embedded design, with minimal host requirements.

The MTCH6303's advanced signal processing provides noise-avoidance techniques and predictive tracking for ten fingers, typically at 100 Hz each for five touches. It also combines with Microchip's MTCH652 High-voltage Line Driver to achieve a superior signal-to-noise ratio (SNR) for outstanding touch performance in noisy environments (refer to [www.microchip.com/MTCH652](http://www.microchip.com/MTCH652)). These capabilities are critical in demanding environments such as industrial controls, home and office automation with security control panels, thermostat, printers and lighting controls, and various consumer applications including exercise equipment and audio systems.

### Features

- Multi-Touch up to Ten Touches
- Five Touches Typically at 100 Hz+ Each
- 27RX x 19TX Channels Support Approximately 8" Touch Screens (larger possible)
- Combines with MTCH652 High-Voltage Driver for Superior Signal-to-Noise Ratio (SNR)
- Integrated Single and Multi-finger Gesture Recognition Suite including Taps, Swipes, Scrolling, Pinching and Zooming
- Advanced Processing Provides Noise Avoidance Techniques
- USB and I<sup>2</sup>C™ Communication
- Supports 3D Gestures up to 20 cm when Combined with the MGC3130 GestIC® Controller

### Power Management

Example:

- 27RX 19TX Sensor
  - 27 mA full-scan rate
  - 1 mA reduced-scan rate

### Applications

- Touch screen designs and touch pads that require cost effective, easy to integrate, fast time to market PCAP touch solutions
- Perfect for touch screens over displays, control panels, keypads and many other input devices
- Targeting the industrial, medical, home and office automation, and consumer markets

**TABLE 1: MTCH6303 SOLUTION PART NUMBERS**

| Device        | Pin Count | Package Types  | Touch Channels | Features                                       |
|---------------|-----------|----------------|----------------|------------------------------------------------|
| MTCH6303-I/PT | 64        | 10 x10 mm TQFP | Up to 27 RX    | Multi-touch, up to 8" sensors                  |
| MTCH6303-I/RG |           | 9 x 9 mm QFN   |                |                                                |
| *MTCH652-I/SO | 28        | 7.5 mm SOIC    | Up to 19 TX    | 1.8 – 5.5V input, 6V – 18V configurable output |
| *MTCH652-I/SS |           | 5.3 mm SSOP    |                |                                                |
| *MTCH652-I/MV |           | 4 x 4 mm UQFN  |                |                                                |

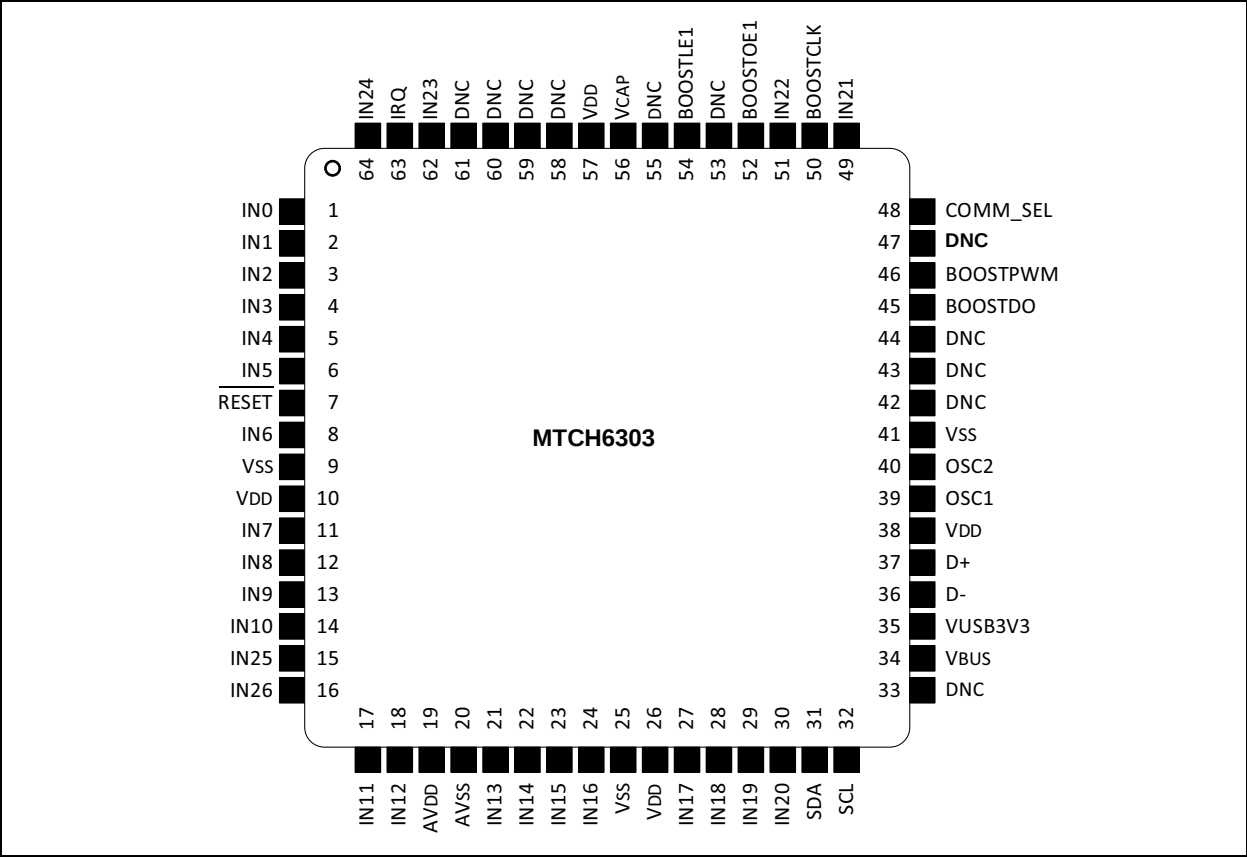
**Note:** \*One MTCH652 high-voltage driver (boost) is required with MTCH6303.

**Note:** The MTCH6303 devices are pre-programmed with a Library Loader (bootloader) only. Refer to [Section 8.0, Firmware update](#) for more details.

# MTCH6303

## PIN DIAGRAM

FIGURE 1: MTCH6303 64-PIN DIAGRAM TQFP/QFN



## PIN ALLOCATION TABLE

**TABLE 2: MTCH6303 PINOUT DESCRIPTION**

| Name  | Pin | Description                                                                  |
|-------|-----|------------------------------------------------------------------------------|
| IN0   | 1   | IN 0 – 5                                                                     |
| IN1   | 2   |                                                                              |
| IN2   | 3   |                                                                              |
| IN3   | 4   |                                                                              |
| IN4   | 5   |                                                                              |
| IN5   | 6   |                                                                              |
| RESET | 7   | Reset                                                                        |
| IN6   | 8   | IN 6                                                                         |
| VSS   | 9   | Ground                                                                       |
| VDD   | 10  | Power Supply Input                                                           |
| IN7   | 11  | IN 7 – 10                                                                    |
| IN8   | 12  |                                                                              |
| IN9   | 13  |                                                                              |
| IN10  | 14  |                                                                              |
| IN25  | 15  | IN 25 – 26                                                                   |
| IN26  | 16  |                                                                              |
| IN11  | 17  | IN 11 – 12                                                                   |
| IN12  | 18  |                                                                              |
| AVDD  | 19  | Positive supply for analog modules. This pin must be connected at all times. |
| AVSS  | 20  | Ground reference for analog modules                                          |
| IN13  | 21  | IN 13 – 16                                                                   |
| IN14  | 22  |                                                                              |
| IN15  | 23  |                                                                              |
| IN16  | 24  |                                                                              |
| VSS   | 25  | Ground                                                                       |
| VDD   | 26  | Power Supply Input                                                           |
| IN17  | 27  | IN 17 – 20                                                                   |
| IN18  | 28  |                                                                              |
| IN19  | 29  |                                                                              |
| IN20  | 30  |                                                                              |
| SDA   | 31  | I <sup>2</sup> C™ Data                                                       |
| SCL   | 32  | I <sup>2</sup> C Clock                                                       |

# MTCH6303

**TABLE 2: MTCH6303 PINOUT DESCRIPTION (CONTINUED)**

| Name            | Pin | Description                                                                                                     |
|-----------------|-----|-----------------------------------------------------------------------------------------------------------------|
| DNC             | 33  | Do not connect any signal to these pins.                                                                        |
|                 | 42  |                                                                                                                 |
|                 | 43  |                                                                                                                 |
|                 | 44  |                                                                                                                 |
|                 | 47  |                                                                                                                 |
|                 | 53  |                                                                                                                 |
|                 | 55  |                                                                                                                 |
|                 | 58  |                                                                                                                 |
|                 | 59  |                                                                                                                 |
|                 | 60  |                                                                                                                 |
|                 | 61  |                                                                                                                 |
| VBUS            | 34  | USB Bus Power Monitor                                                                                           |
| VUSB3V3         | 35  | USB internal transceiver supply. If the USB module is not used, this pin must be connected to V <sub>DD</sub> . |
| D-              | 36  | USB D-                                                                                                          |
| D+              | 37  | USB D+                                                                                                          |
| V <sub>DD</sub> | 38  | Power Supply Input                                                                                              |
| OSC1            | 39  | Oscillator Pin 1                                                                                                |
| OSC2            | 40  | Oscillator Pin 2                                                                                                |
| V <sub>SS</sub> | 41  | Ground                                                                                                          |
| BOOSTDO         | 45  | MTCH652 DO output/DIN Input                                                                                     |
| BOOSTPWM        | 46  | MTCH652 PWM Out/OSCIN input                                                                                     |
| COMM_SEL        | 48  | Communication Select Pin (V <sub>DD</sub> = I <sup>2</sup> C™, V <sub>SS</sub> = USB)                           |
| IN21            | 49  | IN 21                                                                                                           |
| BOOSTCLK        | 50  | MTCH652 CLK Output                                                                                              |
| IN22            | 51  | IN 22                                                                                                           |
| BOOSTOE1        | 52  | MTCH652 OE Output 1                                                                                             |
| BOOSTLE1        | 54  | MTCH652 LE Output 1                                                                                             |
| VCAP            | 56  | Capacitor for Internal Voltage Regulator                                                                        |
| V <sub>DD</sub> | 57  | Power Supply Input                                                                                              |
| IN23            | 62  | IN 23                                                                                                           |
| IRQ             | 63  | I <sup>2</sup> C Interrupt                                                                                      |
| IN24            | 64  | IN 24                                                                                                           |
| MGC_TS          | 42  | Gesture Transfer Status                                                                                         |
| MGC_SDA         | 43  | Gesture I <sup>2</sup> C Data                                                                                   |
| MGC_SCL         | 44  | Gesture I <sup>2</sup> C Clock                                                                                  |
| MGC_MCLR        | 61  | Gesture Reset                                                                                                   |
| MGC_MODE        | 60  | Gesture Mode Control                                                                                            |
| MGC_SYNC        | 47  | Gesture Sync                                                                                                    |

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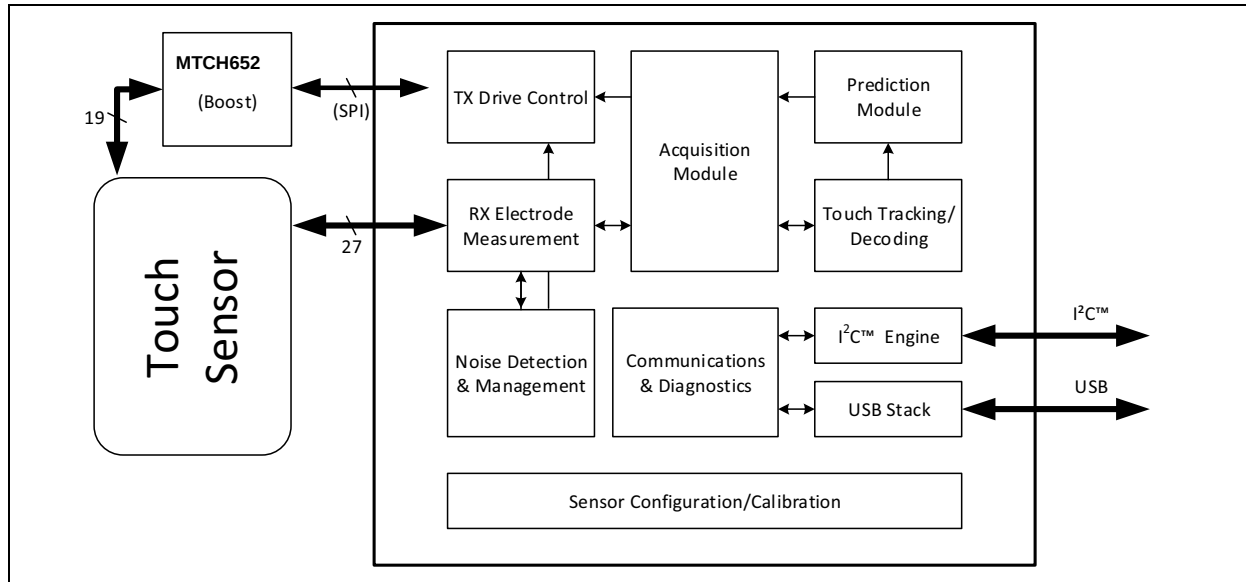
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# MTCH6303

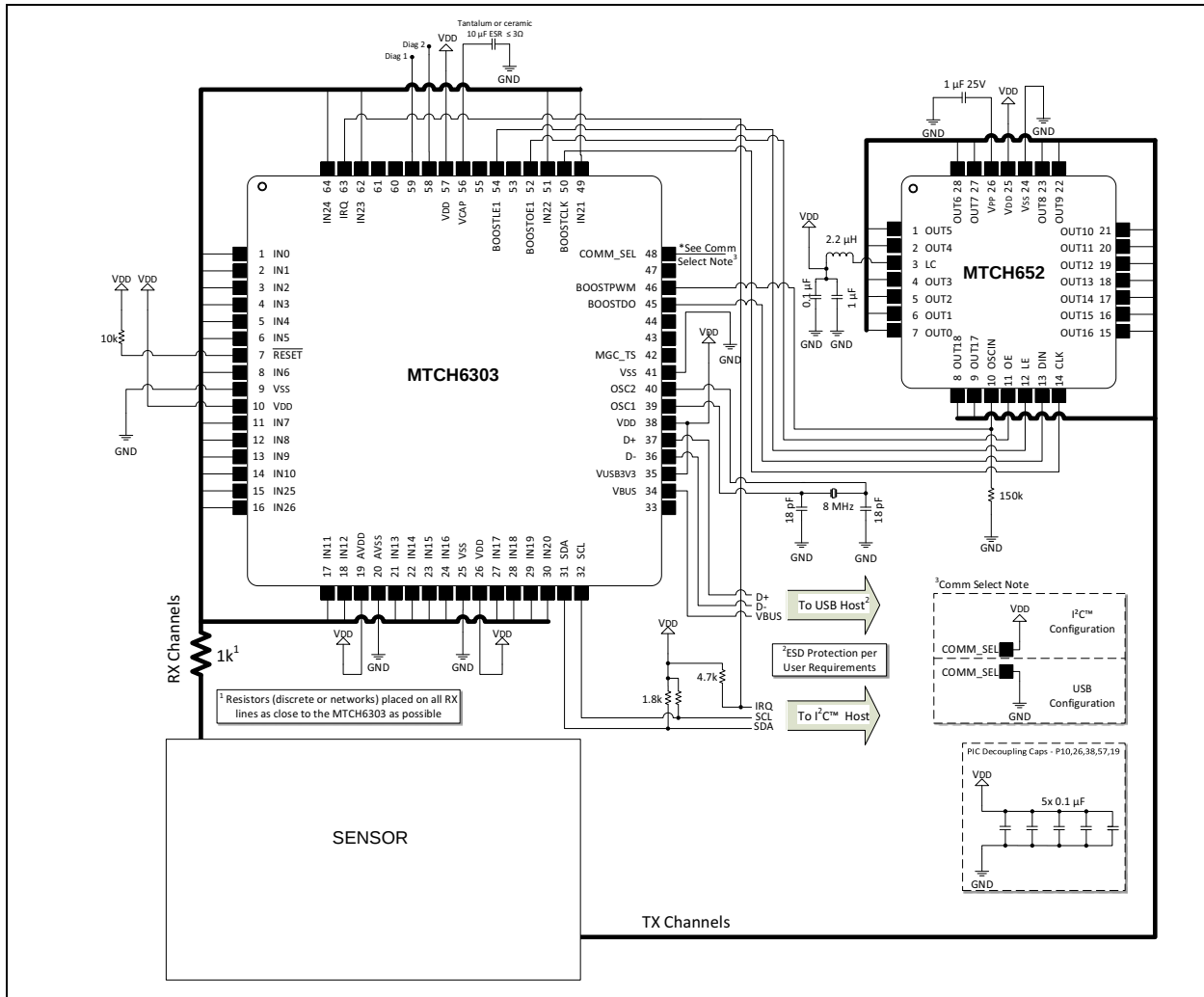
## 1.0 DEVICE OVERVIEW

FIGURE 1-1: MTCH6303 BLOCK DIAGRAM



## 2.0 LAYOUT

FIGURE 2-1: TYPICAL APPLICATION CIRCUIT

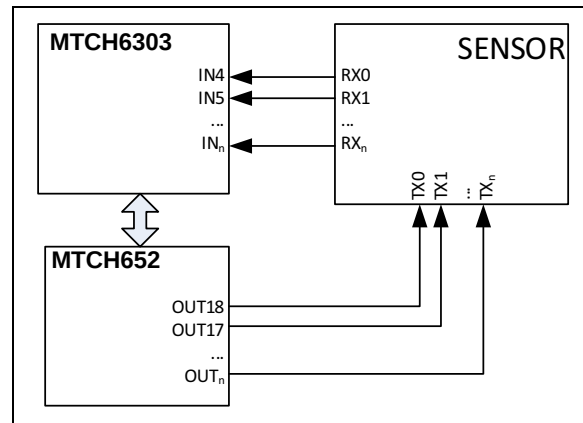


## 2.1 SENSOR CHANNEL NAMING CONVENTION

Throughout this document, there are references to signals such as IN, RX, OUT and TX. This is deliberately done to avoid confusion between sensor channels and physical pins on the controller. Refer to [Figure 2-2](#) for an example of channel numbers chosen randomly.

- When referring to a sensor, the channels are labeled RX0-RXn and TX0-TXn.
- When referring to the MTCH6303 controller, the INn pins connect to any RXn on the sensor.
- When referring to the MTCH652 boost converter, the OUTn pins connect to any TXn on the sensor.

FIGURE 2-2: EXAMPLE OF CHANNEL NUMBERS CHOSEN AT RANDOM



## 2.2 Decoupling Capacitors

The use of decoupling capacitors on power supply pins, such as VDD, VSS, is required. Consider the following criteria when using decoupling capacitors.

### 2.2.1 VALUE AND TYPE OF CAPACITOR

A value of 0.1  $\mu\text{F}$  (100 nF), 10-20V is recommended. The capacitor should be a low Equivalent Series Resistance (low ESR) capacitor and have resonance frequency in the range of 20 MHz and higher. It is further recommended that ceramic capacitors be used.

### 2.2.2 PLACEMENT ON THE PRINTED CIRCUIT BOARD

The decoupling capacitors should be placed as close to the pins as possible. It is recommended that the capacitors be placed on the same side of the board as the device. If space is restricted, the capacitor can be placed on another layer on the PCB; however, ensure that the trace length from the pin to the capacitor is within one-quarter of an inch (6 mm) in length.

### 2.2.3 HANDLING HIGH-FREQUENCY NOISE

If the board is experiencing high-frequency noise, upward of tens of MHz, add a second ceramic-type capacitor in parallel to the above described decoupling capacitor. The value of the second capacitor can be in the range of 0.01  $\mu\text{F}$  to 0.001  $\mu\text{F}$ . Place this second capacitor next to the primary decoupling capacitor. In high-speed circuit designs, consider implementing a decade pair of capacitances as close to the power and ground pins as possible. For example, 0.1  $\mu\text{F}$  in parallel with 0.001  $\mu\text{F}$ .

### 2.2.4 MAXIMIZING PERFORMANCE

On the board layout from the power supply circuit, run the power and return traces to the decoupling capacitors first, and then to the device pins. This ensures that the decoupling capacitors are first in the power chain. Equally important is to keep the trace length between the capacitor and the power pins to a minimum, thereby reducing PCB track inductance.

## 2.3 Bulk Capacitors

The use of a bulk capacitor is recommended to improve power supply stability. Typical values range from 4.7  $\mu\text{F}$  to 47  $\mu\text{F}$ . This capacitor should be located as close to the device as possible.

## 3.0 COMMUNICATION

Both types of data are available over either USB or I<sup>2</sup>C, as shown in the [Table 3-2](#) below.

### 3.1 USB/I<sup>2</sup>C™ Selection

The MTCH6303 can communicate over either USB or I<sup>2</sup>C™. The decision of which protocol is selected is made on start-up and persists until the controller is reset.

Communications are selectable between USB/I<sup>2</sup>C through the use of the COMM\_SEL pin, which must be permanently tied to either VSS or VDD as follows:

**TABLE 3-1: COMM\_SEL SETTINGS**

| Setting | Communications Type |
|---------|---------------------|
| VDD     | I <sup>2</sup> C™   |
| VSS     | USB                 |

**TABLE 3-2: COMMUNICATIONS CATEGORIES**

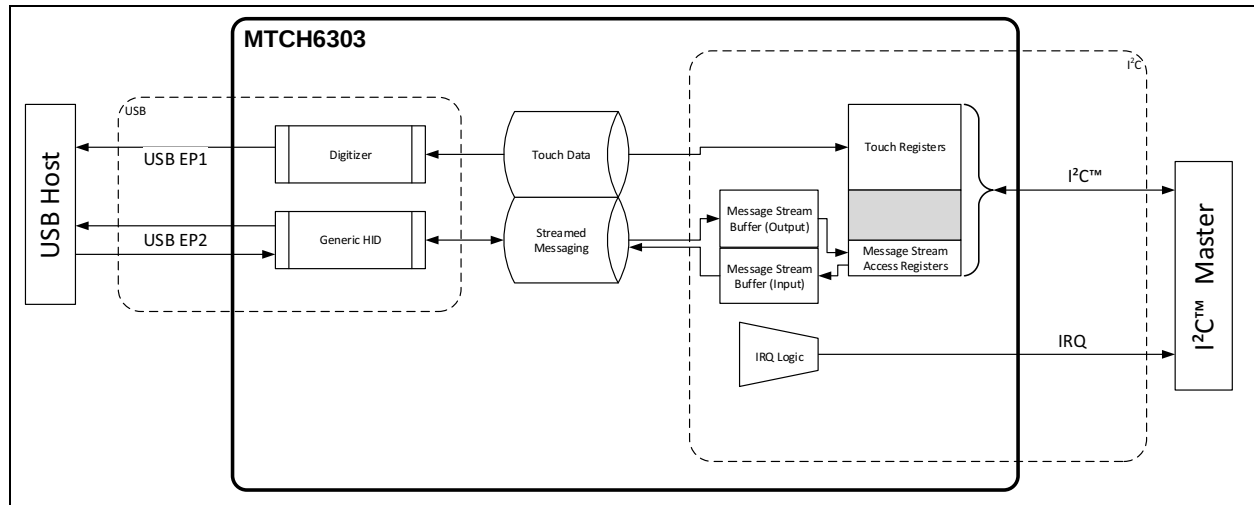
| Data Type          | USB                  | I <sup>2</sup> C™                                       |
|--------------------|----------------------|---------------------------------------------------------|
| Touch Data         | Digitizer endpoint   | Register-based memory map                               |
| Streamed Messaging | Generic HID endpoint | Stream buffers accessed via I <sup>2</sup> C™ registers |

### 3.2 Communications Overview

Communications with the MTCH6303 fall into two main categories:

1. **Touch Data:** Data representing the current state of any contact points; this is the main function of the touch controller.
2. **Streamed Messaging:** Packet-based messaging protocol used to:
  - Send controller commands
  - Read/Write parameters
  - Receive diagnostic reports (when enabled)
  - Read 2D gesture data
  - Read 3D gesture data (requires MGC3130)

**FIGURE 3-1: COMMUNICATIONS OVERVIEW DIAGRAM**



## 3.3 USB Protocol

### 3.3.1 HID DIGITIZER (EP 1, TOUCH DATA)

**TABLE 3-3: HID DIGITIZER**

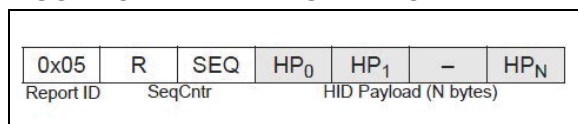
| Byte | 7                 | 6 | 5 | 4 | 3 | 2 | 1  | 0  |             |
|------|-------------------|---|---|---|---|---|----|----|-------------|
| 0    | REPORT ID (0X01)  |   |   |   |   |   |    |    | TOUCH 1     |
| 1    | PADDING           |   |   |   |   |   | IR | TS |             |
| 2    | TOUCH ID 0        |   |   |   |   |   |    |    |             |
| 3    | X1 LSB            |   |   |   |   |   |    |    |             |
| 4    | X1 MSB            |   |   |   |   |   |    |    |             |
| 5    | Y1 LSB            |   |   |   |   |   |    |    |             |
| 6    | Y1 MSB            |   |   |   |   |   |    |    |             |
| 7    | PADDING           |   |   |   |   |   | IR | TS | TOUCH 2     |
| 8    | TOUCH ID 1        |   |   |   |   |   |    |    |             |
| 9    | X2 LSB            |   |   |   |   |   |    |    |             |
| 10   | X2 MSB            |   |   |   |   |   |    |    |             |
| 11   | Y2 LSB            |   |   |   |   |   |    |    |             |
| 12   | Y2 MSB            |   |   |   |   |   |    |    |             |
| ..   | ..                |   |   |   |   |   | .. | .. | TOUCHES 3-9 |
| ..   | ..                |   |   |   |   |   |    |    |             |
| ..   | ..                |   |   |   |   |   |    |    |             |
| ..   | ..                |   |   |   |   |   |    |    |             |
| ..   | ..                |   |   |   |   |   |    |    |             |
| ..   | ..                |   |   |   |   |   |    |    |             |
| 47   | PADDING           |   |   |   |   |   | IR | TS | TOUCH 10    |
| 48   | TOUCH ID 9        |   |   |   |   |   |    |    |             |
| 49   | X4 LSB            |   |   |   |   |   |    |    |             |
| 50   | X4 MSB            |   |   |   |   |   |    |    |             |
| 51   | Y4 LSB            |   |   |   |   |   |    |    |             |
| 52   | Y4 MSB            |   |   |   |   |   |    |    |             |
| 53   | #OF VALID TOUCHES |   |   |   |   |   |    |    |             |

**Legend:** IR = In Range  
TS = Touch State

### 3.3.2 HID GENERIC (EP 2, STREAMED MESSAGES)

This generic endpoint is used to send and receive one or more messages within the payload.

**FIGURE 3-2: HID GENERIC**



**TABLE 3-4: HID GENERIC**

| Byte Name     |      | Value/Description                                                                                                                                                                            |
|---------------|------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Report ID     | 0x05 | 0x05 (Constant)                                                                                                                                                                              |
| SeqCntr [7:6] | R    | [reserved]                                                                                                                                                                                   |
| SeqCntr [5:0] | SEQ  | Sequence counter, increments on every HID packet. <ul style="list-style-type: none"> <li>Values range from 0-63</li> <li>IN and OUT packets utilize independent sequence counters</li> </ul> |

## 3.4 I<sup>2</sup>C™ PROTOCOL

### 3.4.1 OVERVIEW

The MTCH6303 uses a standard register-based read/write I<sup>2</sup>C™ protocol. This protocol is similar to many other devices such as temperature sensors and serial EEPROMs. Although data can be read at any time (polling), a configurable interrupt pin (INT) is provided for flexible integration options.

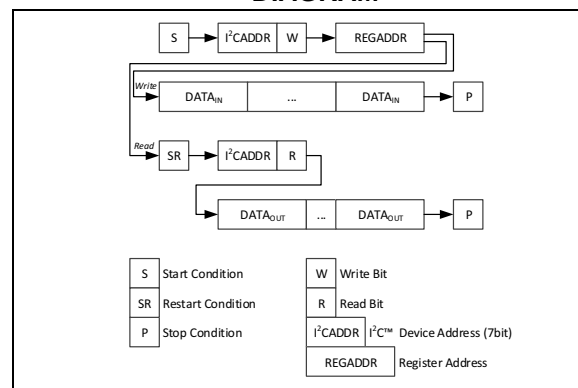
### 3.4.2 READING/WRITING REGISTERS

To access memory (both to read or write), the I<sup>2</sup>C transaction must start by addressing the chip with the WRITE bit set, then writing out a single byte of data representing the memory address to be operated on. After that, the host can choose to do either of the following:

1. To write memory, continue writing “n” data bytes.
2. To read memory, restart the I<sup>2</sup>C transaction (via either a Stop and Start or Restart), then address the chip with the READ bit set. Continue to read “n” data bytes.

During either of these transactions, multiple bytes may be read or written due to the device's address auto-increment feature.

**FIGURE 3-3: I<sup>2</sup>C™ TRANSACTION DIAGRAM**



3.4.3 DEVICE ADDRESSING

The device's 7-bit base address is 0x25. Each 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).

**Note:** If this address conflicts with another in the system, it may be possible to customize the device. Contact Microchip support for more information.

FIGURE 3-4: EXAMPLE I<sup>2</sup>C™ READ TRANSACTION

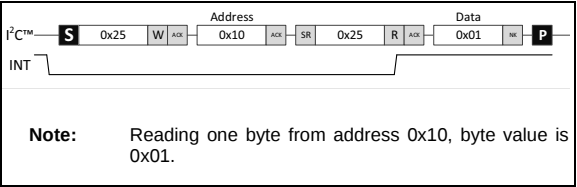
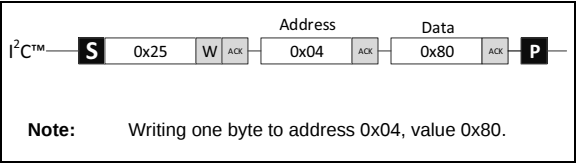


FIGURE 3-5: EXAMPLE I<sup>2</sup>C™ WRITE TRANSACTION



# MTCH6303

**TABLE 3-5: I<sup>2</sup>C™ MEMORY MAP**

| ADDR | NAME           | 7             | 6   | 5   | 4   | 3          | 2 | 1  | 0  | Description                                                  |
|------|----------------|---------------|-----|-----|-----|------------|---|----|----|--------------------------------------------------------------|
|      |                | TOUCH         |     |     |     |            |   |    |    |                                                              |
| 0x00 | TOUCHSTATUS    | R             | MGC | GST | STR | NUMTOUCHES |   |    |    | MGC = GestIC® data, GST = Gestures Ready, STR = Stream Ready |
| 0x01 | TOUCH 0        |               |     |     |     |            |   | IR | TS | IR = In Range, TS = Touch State                              |
| 0x02 |                | TOUCH ID 1    |     |     |     |            |   |    |    | ID = touch ID, 0-16                                          |
| 0x03 |                | X1 LSB        |     |     |     |            |   |    |    |                                                              |
| 0x04 |                | X1 MSB        |     |     |     |            |   |    |    |                                                              |
| 0x05 |                | Y1 LSB        |     |     |     |            |   |    |    |                                                              |
| 0x06 |                | Y1 MSB        |     |     |     |            |   |    |    |                                                              |
| 0x07 | TOUCH 1        |               |     |     |     |            |   | IR | TS |                                                              |
| 0x08 |                | TOUCH ID 1    |     |     |     |            |   |    |    |                                                              |
| 0x09 |                | X1 LSB        |     |     |     |            |   |    |    |                                                              |
| 0x0A |                | X1 MSB        |     |     |     |            |   |    |    |                                                              |
| 0x0B |                | Y1 LSB        |     |     |     |            |   |    |    |                                                              |
| 0x0C |                | Y1 MSB        |     |     |     |            |   |    |    |                                                              |
| 0x0D | (TOUCH 2)      | ...           |     |     |     |            |   |    |    | (format follows from above)                                  |
| 0x13 | (TOUCH 3)      | ...           |     |     |     |            |   |    |    |                                                              |
| 0x19 | (TOUCH 4)      | ...           |     |     |     |            |   |    |    |                                                              |
| 0x1F | (TOUCH 5)      | ...           |     |     |     |            |   |    |    |                                                              |
| 0x25 | (TOUCH 6)      | ...           |     |     |     |            |   |    |    |                                                              |
| 0x2B | (TOUCH 7)      | ...           |     |     |     |            |   |    |    |                                                              |
| 0x31 | (TOUCH 8)      | ...           |     |     |     |            |   |    |    |                                                              |
| 0x37 | (TOUCH 9)      | ...           |     |     |     |            |   |    |    |                                                              |
| 0x42 | —              | [RESERVED]    |     |     |     |            |   |    |    |                                                              |
|      |                |               |     |     |     |            |   |    |    |                                                              |
| 0x7F |                |               |     |     |     |            |   |    |    |                                                              |
|      |                |               |     |     |     |            |   |    |    |                                                              |
|      |                | STREAM BUFFER |     |     |     |            |   |    |    |                                                              |
| 0xF0 |                | [RESERVED]    |     |     |     |            |   |    |    |                                                              |
| —    |                |               |     |     |     |            |   |    |    |                                                              |
| 0xFA |                |               |     |     |     |            |   |    |    |                                                              |
| 0xFB | RX Bytes Ready | RXRDY         |     |     |     |            |   |    |    | Space available (bytes) for writing into RX buffer           |
| 0xFC | RX Buffer      | RXBUFF        |     |     |     |            |   |    |    | Pointer to RX Buffer                                         |
| 0xFD | TX Bytes Left  | TXRDY         |     |     |     |            |   |    |    | Bytes ready to be read from TX buffer                        |
| 0xFE | TX Buffer      | TXBUFF        |     |     |     |            |   |    |    | Pointer to TX Buffer                                         |

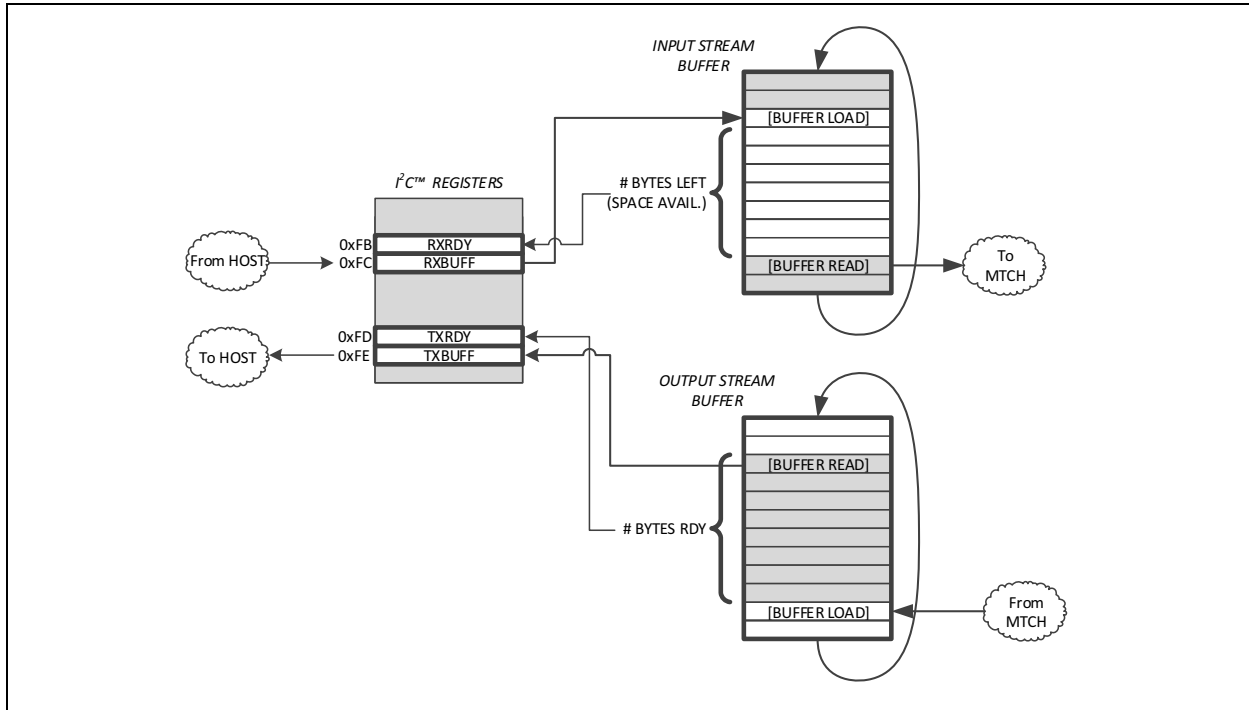
## 3.4.4 TOUCH REGISTERS

Touch data can be read out of the touch registers at any time, and is ensured to represent the latest state of the sensor. Use of the IRQ pin can improve efficiency by letting the host controller only read data when necessary. (See [Section 6.0, Communication Examples](#) for more details.)

## 3.4.5 MESSAGE STREAM ACCESS

For sending and receiving stream messages (described further on in this document), register-based access to the message stream is provided as shown in [Figure 3-6](#).

**FIGURE 3-6: MESSAGE STREAM ACCESS**



### 3.4.5.1 Reading Stream Messages Over I<sup>2</sup>C

The host discovers that data is ready to be read from the stream by reading a non-zero value from the TXRDY register. This register should be queried after one of the following events:

- IRQ activity
- STR bit of TOUCHSTATUS register is set
- Polled at a random interval (of the host's choosing)

To read the data, an I<sup>2</sup>C register read should be started at the address of TXBUFF. The host can choose to read any amount of bytes (up to the value in TXRDY).

### 3.4.5.2 Writing Stream Messages Over I<sup>2</sup>C

The host can write messages directly into the address of RXBUFF. Before writing, the host should check the amount of space available for writing by reading the RXRDY register.

### 3.4.5.3 Interrupt Pin

To alert the host that new data is ready, an interrupt pin (IRQ) is provided. The IRQ is an 'open-drain' output that is pulled to GND when asserted, and high-impedance (tri-state) when not asserted. A suitable pull-up resistor should be used on this output.

The IRQ can be configured using the parameters in [Table 3-6](#) below (refer to [Section 5.0, Parameters](#) for accessing).

**TABLE 3-6:     IRQ CONFIGURATION PARAMETERS**

| Parameter     | Default | Description                                                                                                                               |
|---------------|---------|-------------------------------------------------------------------------------------------------------------------------------------------|
| irqMode       | 1       | Overall IRQ mode<br>0 = IRQ deactivated<br>1 = IRQ level maintained until data read<br>2 = IRQ pulsed for [irqPulseWidth] msec            |
| irqPolarity   | 0       | IRQ Polarity control<br>0 = Active-Low,<br>1 = Active-High                                                                                |
| irqPulseWidth | 5       | Value (msec) to pulse IRQ when irqMode is set to '2'                                                                                      |
| irqTrigger    | 2       | Event control for IRQ activity<br>0 = Off<br>1 = Every touch decoding frame<br>2 = Any touch is present<br>3 = Only when touch is changed |

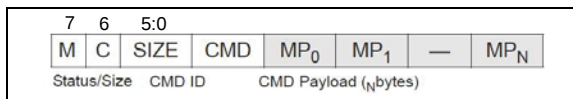
## 4.0 MESSAGE PROTOCOL

### 4.1 Overview

The MTCH6303 messaging protocol is used to send and receive streamed messages. Full or partial (fragment) messages may be exchanged with this protocol.

Messages are transmitted in an overall 'block' size of 64 and must be split up accordingly. Refer to [Section 6.0, Communication Examples](#) for depictions of messages being fragmented.

**FIGURE 4-1: MESSAGE PROTOCOL**



**TABLE 4-1: MTCH6303 MESSAGE FORMAT**

| Name            | Description                                                                                                                               |
|-----------------|-------------------------------------------------------------------------------------------------------------------------------------------|
| Status/<br>Size | <b>B5-0 SZ</b><br>Size of message fragment. If 63 (0x3f), the fragment is incomplete and uses up ALL of the parent transport layer packet |
|                 | <b>B6 C</b><br>1 = Continued (from last fragment)<br>0 = Not continued (start of message)                                                 |
|                 | <b>B7 M</b><br>1 = More messages to follow in this block<br>0 = Last message                                                              |
| CMD ID          | Command ID, <b>only sent on first fragment of message.</b> For fragments after, this is a normal payload byte.                            |
| CMD Payload     | Data bytes of message fragment.                                                                                                           |

### 4.2 Message Definitions

Messages starting with REP are reports sent from the MTCH6303 to the host. Messages starting with CMD are commands sent from the host to the MTCH6303. Messages that require further clarification are expanded upon in the following section.

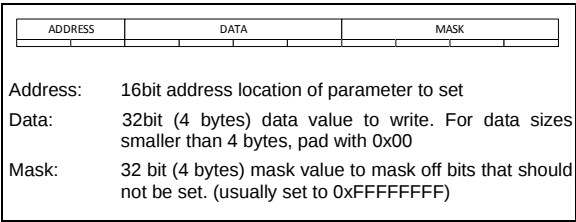
TABLE 4-2: MESSAGE DEFINITIONS

| ID   | Name                | Payload size | Payload Description<br>(assume uint8 unless noted)                 | Gated by NVDM <sup>(1)</sup> | Description                                                                            |
|------|---------------------|--------------|--------------------------------------------------------------------|------------------------------|----------------------------------------------------------------------------------------|
| 0x04 | REP_Echo            | <varies>     | [data]...[datan]                                                   | [NO GATE]                    | It will echo the exact payload of a received 'echo' command                            |
| 0x17 | REP_FlashContents   | <varies>     | [data]...[datan]                                                   | [NO GATE]                    | Flash contents readback (invoked by CMD_ReadFlash)                                     |
| 0x60 | REP_AdcDbg          | 132          | [rx] [tx] [freq] [RSVD] [uint16 D0] [uint16 D1]...[uint16 Dn]      | NVDM_ADC                     | Raw sample output from ADC                                                             |
| 0x90 | REP_Trace           | 2            | [location][event]                                                  | NVDM_DIAG                    | —                                                                                      |
| 0xA0 | REP_Swipe           | 2            | [flags][fingers]                                                   | NVDM_GESTURE                 | Swipe gesture                                                                          |
| 0xA1 | REP_Scroll          | 8            | [fingers][diamHI][uint16 diameter][uint16 centerX][uint16 centery] | NVDM_GESTURE                 | Scroll gesture                                                                         |
| 0xA2 | REP_Tap             | 2            | [flags][fingers]                                                   | NVDM_GESTURE                 | Tap gesture                                                                            |
| 0xB0 | REP_Noise           | <varies>     | [subID][data]...[datan]                                            | NVDM_NOISE                   | Noise messages (see below)                                                             |
| 0xC3 | REP_MutNormSection  | 2+2*nodes    | [rx][tx][uint16 node0][uint16 node1]...[uint16 noden]              | NVDM_MUTCACHE                | Sends out a dynamic amount of nodes (from 1 to full RX electrode)                      |
| 0xCF | REP_ParameterRead   | 2+len        | [uint16 address][data] (up to 'len' bytes)                         | [NO GATE]                    | Parameter read response                                                                |
| 0xF0 | REP_Ack             | 1            | [command ID]                                                       | [NO GATE]                    | Acknowledgment of receipt of command                                                   |
| 0xF2 | REP_TouchFiltered   | 5*i          | [STATE/ID][uint16 X][uint16 Y]                                     | NVDM_FINGERPOS               | Filtered (but not scaled) touch coordinates                                            |
| 0xF3 | REP_TouchPredict    | 9            | [ID][uint16 X0][uint16 Y0][uint16 Xpred][uint16 Ypred]             | NVDM_RAWPOS                  | Prediction value for a touch                                                           |
| 0xF4 | REP_TouchRaw        | 5*i          | [STATE/ID][uint16 X][uint16 Y]                                     | NVDM_RAWPOS                  | Raw touch report (pre-filter)                                                          |
| 0xF5 | REP_TouchPos16      | 5*i          | [PEN/ID][uint16 X][uint16 Y]                                       | NVDM_FINGERPOS               | Final scaled touch report – first byte has touch status as bit 7                       |
| 0xFA | REP_SelfRaw         | 2*numRXch    | [uint16 self0][uint16 self1]...[uint16 selfn]                      | NVDM_SELFRAW                 | Self measurements (raw)                                                                |
| 0xFD | REP_SelfNorm        | 2*numRXch    | [uint16 self0][uint16 self1]...[uint16 selfn]                      | NVDM_SELFNORM                | Self measurements (normalized)                                                         |
| 0xFE | REP_ForwardGestIC   | <varies>     | [data]...[datan]                                                   | NVDM_GESTIC                  | Packet from GestIC® (direct)                                                           |
| 0xFF | REP_FwVersion       | <varies>     | [fwVersionInfo]                                                    | [NO GATE]                    | Large array of bytes denoting all firmware information                                 |
| 0x04 | CMD_Echo            | <varies>     | [data]...[datan]                                                   | n/a                          | Firmware will echo back any payload sent                                               |
| 0x17 | CMD_ReadFlash       | 6            | [uin32 address][uint16 size]                                       | n/a                          | Allows host to read Flash contents of device (fw dump)                                 |
| 0x55 | CMD_EnterBootLoader | 0            | (none)                                                             | n/a                          | Commands firmware to enter the bootloader – ACK will be sent before jumping            |
| 0xE0 | CMD_SetParameter    | 10           | [uint16 address][uint8[4] data][uint8[4] mask]                     | n/a                          | Writes a parameter                                                                     |
| 0xE1 | CMD_GetParameter    | 2            | [uint16 address]                                                   | n/a                          | Reads a parameter                                                                      |
| 0xFB | CMD_ForceBaseline   | 0            | (none)                                                             | n/a                          | Forces a baseline                                                                      |
| 0xFC | CMD_ResetGestIC     | 0            | (none)                                                             | n/a                          | Resets GestIC immediately                                                              |
| 0xFD | CMD_GestIC          | <varies>     | (gestic command)                                                   | n/a                          | Sends packet directly on to GestIC                                                     |
| 0xFF | CMD_QueryVersion    | 0            | (none)                                                             | n/a                          | Requests all firmware version information – bytes 124:127 represent Rev[2].Minor.Major |

**Note:** Refer to parameter documentation for explanation of NVDM bitfields.

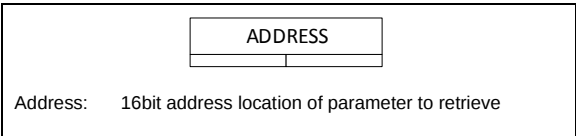
4.2.1 SET PARAMETER COMMAND

FIGURE 4-2: SET PARAMETER COMMAND



4.2.2 GET PARAMETER COMMAND

FIGURE 4-3: GET PARAMETER COMMAND



## 5.0 PARAMETERS

### 5.1 Operation

Default parameters are loaded on start-up, as shown in the parameter table section. These values can be modified during runtime, but will not be restored on Reset. To permanently modify parameters, the MTCH6303 Utility should be used to export and Flash a new configuration. Refer to the MTCH6303 Utility documentation for more information.

### 5.2 Parameter Table

Many parameters are tuned by the MTCH6303 Utility itself, so descriptions are not provided. [Table 5-1](#) is provided for reference only.

**TABLE 5-1: PARAMETER TABLE**

| Module | Name                  | Address      | Format       | Default                          | Description                                                           |
|--------|-----------------------|--------------|--------------|----------------------------------|-----------------------------------------------------------------------|
| pub    | mgc3130               | 0x0102       | uint8_t      | 0                                | 1 = MTC3130 is present                                                |
| pub    | numberOfRXChannels    | 0x0100       | uint8_t      | 27                               | Number of RX channels currently in use                                |
| pub    | numberOfTXChannels    | 0x0101       | uint8_t      | 19                               | Number of TX channels currently in use                                |
| pub    | diagMask              | 0x0080       | uint16_t     | [see NVDM]                       | [see NVDM]                                                            |
| pub    | activeModules         | 0x0081       | uint16_t     | [see NVAM]                       | [see NVAM]                                                            |
| pub    | streamingMode         | 0x0082       | uint8_t      | 0                                | see Operating Modes                                                   |
| pub    | swipeDistance         | 0x0501       | uint16_t     | 4*256                            | See Gesture definition                                                |
| pub    | swipeTimeout          | 0x0500       | uint32_t     | msec2ticks(1500) <sup>(1)</sup>  | See Gesture definition                                                |
| pub    | swipeBorder           | n/a (struct) |              | n/a                              | See Gesture definition                                                |
| pub    | swipeBorder.left      | 0x0502       | uint16_t     | 3*256                            | See Gesture definition                                                |
| pub    | swipeBorder.right     | 0x0503       | uint16_t     | 24*256                           | See Gesture definition                                                |
| pub    | swipeBorder.top       | 0x0504       | uint16_t     | 3*256                            | See Gesture definition                                                |
| pub    | swipeBorder.bottom    | 0x0505       | uint16_t     | 16*256                           | See Gesture definition                                                |
| pub    | swipeExtBorder        | n/a (struct) |              | n/a                              | See Gesture definition                                                |
| pub    | swipeExtBorder.left   | 0x0506       | uint16_t     | 2*256                            | See Gesture definition                                                |
| pub    | swipeExtBorder.right  | 0x0507       | uint16_t     | 25*256                           | See Gesture definition                                                |
| pub    | swipeExtBorder.top    | 0x0508       | uint16_t     | 2*256                            | See Gesture definition                                                |
| pub    | swipeExtBorder.bottom | 0x0509       | uint16_t     | 17*256                           | See Gesture definition                                                |
| pub    | tapBorder             | n/a (struct) |              | n/a                              | See Gesture definition                                                |
| pub    | tapBorder.left        | 0x0540       | uint16_t     | 1*256                            | See Gesture definition                                                |
| pub    | tapBorder.right       | 0x0541       | uint16_t     | 26*256                           | See Gesture definition                                                |
| pub    | tapBorder.top         | 0x0542       | uint16_t     | 1*256                            | See Gesture definition                                                |
| pub    | tapBorder.bottom      | 0x0543       | uint16_t     | 18*256                           | See Gesture definition                                                |
| pub    | tapTimeout            | 0x0544       | uint32_t     | mSec2Ticks(200) <sup>(1)</sup>   | See Gesture definition                                                |
| pub    | dblTapTimeout         | 0x0545       | uint32_t     | mSec2Ticks(500) <sup>(1)</sup>   | See Gesture definition                                                |
| pub    | commSelectMode        | 0x0584       | uint8_t      | 0                                | 0 = use COMMSSEL pin, 1 = force I <sup>2</sup> C™, 2 = force USB      |
| pub    | irqPolarity           | 0x0581       | uint8_t      | 0                                | 0 = Active-Low, 1 = Active-High                                       |
| pub    | irqPulseWidth         | 0x0582       | uint8_t      | 5                                | Value in msec to pulse (when mode 2)                                  |
| pub    | irqTrigger            | 0x0583       | uint8_t      | 2                                | 0 = Off, 1 = Set on frame, 2 = Set on touch, 3 = Set on touch changed |
| pub    | irqMode               | 0x0580       | uint8_t      | 1                                | 0 = Off, 1 = Level-trigger, 2 = Pulse-trigger                         |
| pub    | idleTime2D            | 0x0103       | uint16_t     | 100                              | Scan period while 2D is idle (in msec)                                |
| map    | txSelfTape            | 0x02c0       | uint16_t[66] | [see below]                      |                                                                       |
| map    | rxPinMap              | 0x0200       | uint8_t[27]  | [see below]                      |                                                                       |
| map    | rxPrechargePinMap     | 0x0240       | uint8_t[27]  | [see below]                      |                                                                       |
| map    | txPinMap              | 0x0280       | uint8_t[36]  | [see below]                      |                                                                       |
| acq    | baseUpdateTime        | 0x0802       | uint32_t     | mSec2Ticks(10000) <sup>(1)</sup> | Calibration update rate                                               |
| acq    | selfScanPhase         | 0x0812       | uint16_t[4]  | {52,45,40,40}                    | Self measurement period                                               |
| acq    | selfScanISRPhase      | 0x0816       | uint16_t[4]  | {59,49,46,45}                    | Self measurement phase                                                |
| acq    | mutScanPeriod         | 0x0803       | uint16_t[4]  | {122,105,104,100}                | Mutual measurement period                                             |

**TABLE 5-1: PARAMETER TABLE (CONTINUED)**

| Module | Name                                | Address      | Format      | Default       | Description                                                  |
|--------|-------------------------------------|--------------|-------------|---------------|--------------------------------------------------------------|
| acq    | mutScanPhase                        | 0x0807       | uint16_t[4] | {68,60,59,55} | Mutual measurement phase                                     |
| acq    | mutFreqHopping                      | 0x080B       | uint8_t     | 0             | Frequency hopping control (0 = enabled, 1-4 = lock to F0-F3) |
| acq    | mutFreqHoppingLevel                 | 0x080C       | int8_t[4]   | {0,0,0,0}     | Linear gain to apply to results from each frequency          |
| acq    | diagRxChannel                       | 0x0800       | uint8_t     | 0xff          |                                                              |
| acq    | diagTxChannel                       | 0x0801       | uint8_t     | 0xff          |                                                              |
| acq    | syncRxChannel                       | 0x081A       | uint8_t     | 0xff          |                                                              |
| acq    | syncTxChannel                       | 0x081B       | uint8_t     | 0xff          |                                                              |
| acq    | fullScanRxStart                     | 0x081C       | uint8_t     | 0             |                                                              |
| acq    | fullScanRxStop                      | 0x081D       | uint8_t     | 27            |                                                              |
| acq    | fullScanTxStart                     | 0x081E       | uint8_t     | 0             |                                                              |
| acq    | fullScanTxStop                      | 0x081F       | uint8_t     | 19            |                                                              |
| dec    | penDownTimer                        | 0x0403       | uint16_t    | 781           |                                                              |
| dec    | penUpTimer                          | 0x0404       | uint16_t    | 781           |                                                              |
| dec    | selfTouchThres                      | 0x0400       | uint8_t     | 60            |                                                              |
| dec    | mutTouchThres                       | 0x0401       | uint8_t     | 60            |                                                              |
| dec    | minCuspDelta                        | 0x040b       | uint8_t     | 25            |                                                              |
| dec    | weightThreshold                     | 0x0402       | uint8_t     | 20            |                                                              |
| dec    | minTouchDistance                    | 0x040c       | uint8_t     | 5*8           |                                                              |
| dec    | fatThreshold                        | 0x040d       | uint8_t     | 95            |                                                              |
| dec    | nbSampleSelf                        | 0x0407       | uint8_t     | 64            |                                                              |
| dec    | touchActiveHysteresis2D             | 0x0409       | uint16_t    | 1000          |                                                              |
| dec    | touchActiveHysteresis2D3D           | 0x0401       | uint16_t    | 50            |                                                              |
| rep    | flipState                           | 0x0041       | uint8_t     | 0b010         |                                                              |
| rep    | rxScale                             | n/a (struct) |             | n/a           |                                                              |
| rep    | rxScale.shift                       | 0x0042       | uint8_t     | 7             |                                                              |
| rep    | rxScale.divide                      | 0x0043       | uint8_t     | 27            |                                                              |
| rep    | rxScale.offset                      | 0x0044       | uint16_t    | 0             |                                                              |
| rep    | txScale                             | n/a (struct) |             | n/a           |                                                              |
| rep    | txScale.shift                       | 0x0045       | uint8_t     | 7             |                                                              |
| rep    | txScale.divide                      | 0x0046       | uint8_t     | 19            |                                                              |
| rep    | txScale.offset                      | 0x0047       | uint16_t    | 0             |                                                              |
| mtc    | mtch65x_active_config               | none         | uint32_t    | 0x27          |                                                              |
| mtc    | mtch65x_periode_fast_rise           | 0x0900       | uint16_t    | 10            |                                                              |
| mtc    | mtch65x_periode_fast_rise_oc        | 0x0901       | uint16_t    | 7             |                                                              |
| mtc    | mtch65x_fast_rise_delay             | 0x0902       | uint16_t    | 300           |                                                              |
| mtc    | mtch65x_periode_self_measurement    | 0x090D       | uint16_t[4] | {20,20,20,20} |                                                              |
| mtc    | mtch65x_periode_self_measurement_oc | 0x0911       | uint16_t[4] | {10,10,10,10} |                                                              |
| mtc    | mtch65x_periode_mutu_measurement    | 0x0905       | uint16_t[4] | {66,60,59,58} |                                                              |
| mtc    | mtch65x_periode_mutu_measurement_oc | 0x0909       | uint16_t[4] | {16,15,14,14} |                                                              |

**Note 1:** mSec2Ticks(ms) = (((ms) \* 625 + 2) / 4)

## EXAMPLE 5-1: COMPLICATED INITIALIZATIONS

```
rxPinMap = {(15), (14), (13), (12), (11), (10), (9), (8), (7), (6), (0), (1), (2), (3), (4), (5),
(19), (18), (17), (16), (27), (23), (22), (21), (20), (26), (24)}
rxPrechargePinMap = {(24), (24), (24), (24), (24), (24), (24), (24), (24), (24), (24), (24), (24), (24),
(15), (15), (15), (15), (15), (15), (15), (15), (15), (15), (15), (15), (15), (15), (15), (15)}
txPinMap = {(0+ 17), (0+ 18), (0+ 0), (0+ 1), (0+ 2), (0+ 3), (0+ 4), (0+ 5), (0+ 6), (0+ 7), (0+
8), (0+ 9), (0+ 10), (0+ 11), (0+ 12), (0+ 13), (0+ 14), (0+ 15), (0+ 16)}
txSelfTape = {0x0000,
0x0F,0x0010,0x0010,0x7110,0x00,0x00,0x00,0x00,0x00,0x00,0x0F,0x0010,0x0310,0x8110,0x00,0x00,0x00
,0x00,0x00,0x00,0x0F,0x0010,0x1C10,0x0110,0x00,0x00,0x00,0x00,0x00,0x0F,0x0010,0xE010,0x011
0,0x00,0x00,0x00,0x00,0x00,0x00,0x0F,0x0F10,0x0010,0x0110,0x00,0x00,0x00,0x00,0x00,0x0C,0x0
000,0x0000,0,0,0,0,0,0,0,0,0,0,0,0}
```

## 5.3 Special Parameters

### 5.3.1 ACTIVE MODULES REGISTER (NVAM)

#### REGISTER 5-1: ACTIVE MODULES REGISTER (NVAM)

| U-x    | U-x | U-x | U-x | R/W-1  | R/W-1     | R/W-1    | R/W-1    |
|--------|-----|-----|-----|--------|-----------|----------|----------|
| —      | —   | —   | —   | DECODE | DIGITIZER | AUTOBASE | BESTFREQ |
| bit 15 |     |     |     | bit 8  |           |          |          |

| R/W-0    | R/W-0    | R/W-0    | U-x | U-x   | R/W-0    | U-x | R/W-1   |
|----------|----------|----------|-----|-------|----------|-----|---------|
| AW_EVENT | SW_EVENT | FL_EVENT | —   | —     | FULLSCAN | —   | GESTURE |
| bit 7    |          |          |     | bit 0 |          |     |         |

#### Legend:

R = Readable bit                      x = Bit is unknown                      -n = Value after initialization (default)  
W = Writable bit                      U = Unimplemented bit                      q = Conditional  
'1' = Bit is set                      '0' = Bit is cleared

bit 15-12      **Unused**

bit 11      **DECODE:**      Turns touch decoding logic on or off

bit 10      **DIGITIZER:**      Turns digitizer/I<sup>2</sup>C™ register output on or off

bit 9      **AUTOBASE:**      Turns on or off automatic baseline functionality

bit 8      **BESTFREQ:**      Turns on or off bestfrequency selection algorithms

bit 7      **AW\_EVENT:**      Events related to GestIC airwheel

bit 6      **SW\_EVENT:**      Events related to GestIC swipes

bit 5      **FL\_EVENT:**      Events related to GestIC flicks

bit 4-3      **Unused**

bit 2      **FULLSCAN:**      Turns on full mutual scanning

bit 1      **Unused**

bit 0      **GESTURE:**      Turns on 2d gesture recognition

## 5.3.2 DIAGNOSTIC MODULES REGISTER (NVDM)

### REGISTER 5-2: ACTIVE DIAGNOSTICS MODULES REGISTER (NVDM)

|        |       |        |         |           |        |       |       |
|--------|-------|--------|---------|-----------|--------|-------|-------|
| R/W-1  | R/W-1 | R/W-1  | R/W-1   | R/W-1     | R/W-1  | R/W-1 | R/W-1 |
| GESTIC | DIAG  | CUSTOM | GESTURE | FINGERPOS | RAWPOS | NOISE | TRACE |
| bit 15 |       |        |         |           |        |       | bit 8 |

|       |     |         |       |        |         |          |          |
|-------|-----|---------|-------|--------|---------|----------|----------|
| U-x   | U-x | R/W-1   | R/W-1 | R/W-1  | R/W-1   | R/W-1    | R/W-1    |
| —     | —   | ADC_COR | ADC   | MUTRAW | SELFRAW | MUTCACHE | SELFNORM |
| bit 7 |     |         |       |        |         |          | bit 0    |

#### Legend:

R = Readable bit

x = Bit is unknown

-n = Value after initialization (default)

W = Writable bit

U = Unimplemented bit

q = Conditional

'1' = Bit is set

'0' = Bit is cleared

|         |                   |                                                                               |
|---------|-------------------|-------------------------------------------------------------------------------|
| bit 15  | <b>GESTIC:</b>    | Forward GestIC <sup>®</sup> packets to host, also packets from host to GestIC |
| bit 14  | <b>DIAG:</b>      | Diagnostic Messages                                                           |
| bit 13  | <b>CUSTOM:</b>    | Custom Messages                                                               |
| bit 12  | <b>GESTURE:</b>   | Gesture Messages                                                              |
| bit 11  | <b>FINGERPOS:</b> | Filtered Touch Data                                                           |
| bit 10  | <b>RAWPOS:</b>    | Unfiltered Touch Data                                                         |
| bit 9   | <b>NOISE:</b>     | Noise Messages                                                                |
| bit 8   | <b>TRACE:</b>     | Trace Messages                                                                |
| bit 7-6 | <b>Unused</b>     |                                                                               |
| bit 5   | <b>ADC_COR:</b>   | Use ADC Offsets                                                               |
| bit 4   | <b>ADC:</b>       | ADC Messages                                                                  |
| bit 3   | <b>MUTRAW:</b>    | Mutual Raw Data                                                               |
| bit 2   | <b>SELFRAW:</b>   | Self Raw Data                                                                 |
| bit 1   | <b>MUTCACHE:</b>  | Mutual Normalized Data                                                        |
| bit 0   | <b>SELFNORM:</b>  | Self Normalized Data                                                          |

## 6.0 COMMUNICATION EXAMPLES

### 6.1 Reading Touch Data

The following examples show a frame of data communicating three Touch ID contact points:

#### 6.1.1 READING TOUCH DATA (USB)

Touch data is populated in the HID report (refer to [Section 3.3.2, HID Generic \(EP 2, Streamed Messages\)](#)).

**TABLE 6-1: READING TOUCH DATA**

| Touch ID | ID5                                    |
|----------|----------------------------------------|
| 5        | Contact at (2345,4657)                 |
| 8        | Contact at (9823,0023)                 |
| 13       | Touch Removed (last contact 7264,1893) |

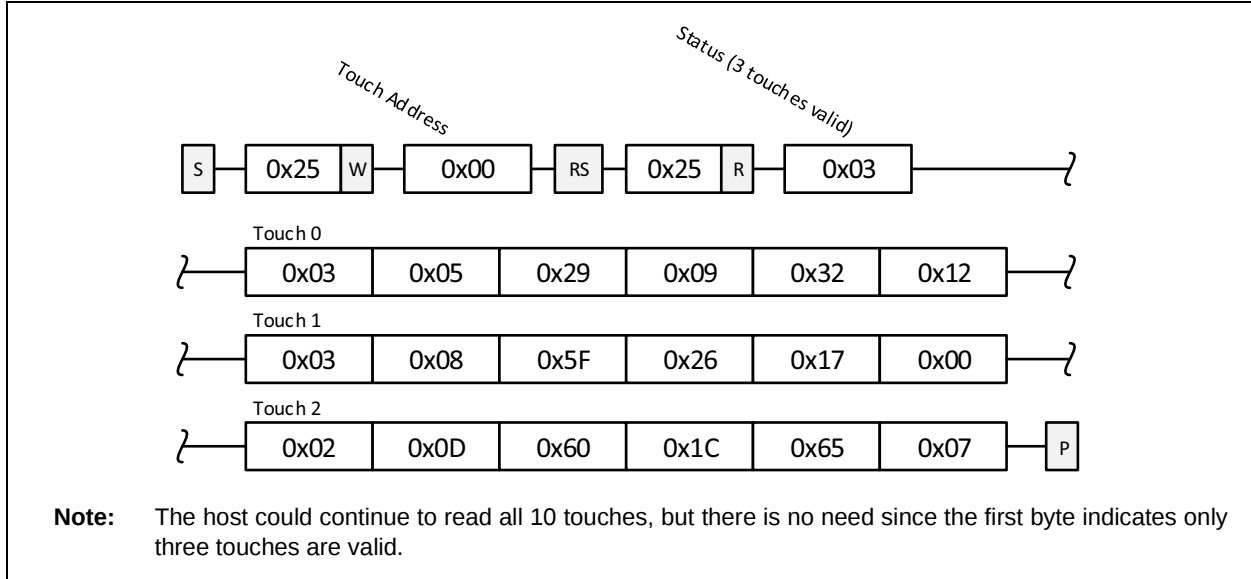
**TABLE 6-2: READING TOUCH DATA HID REPORT**

|    |               |                 |               |                 |               |                 |               |                 |    |
|----|---------------|-----------------|---------------|-----------------|---------------|-----------------|---------------|-----------------|----|
| 0  | 0x01<br>REPID | 0x03<br>STATUS0 | 0x05<br>ID0   | 0x29<br>XLSB0   | 0x09<br>XMSB0 | 0x31<br>YLSB0   | 0x12<br>YLSB0 | 0x03<br>STATUS1 | 7  |
| 8  | 0x08<br>ID1   | 0x5F<br>XLSB1   | 0x26<br>XMSB1 | 0x17<br>YLSB1   | 0x00<br>YMSB1 | 0x02<br>STATUS2 | 0x0D<br>ID2   | 0x60<br>XLSB2   | 15 |
| 16 | 0x1C<br>XMSB2 | 0x65<br>YLSB2   | 0x07<br>YMSB2 | 0x00<br>STATUS3 | —<br>ID3      | —<br>XLSB3      | —<br>XMSB3    | —<br>YLSB3      | 23 |
| 24 | —<br>YMSB3    | —<br>STATUS4    | —<br>ID4      | —<br>XLSB4      | —<br>XMSB4    | —<br>YLSB4      | —<br>YMSB4    | —<br>STATUS5    | 31 |
| 32 | —<br>ID5      | —<br>XLSB5      | —<br>XMSB5    | —<br>YLSB5      | —<br>YMSB5    | —<br>STATUS6    | —<br>ID6      | —<br>XLSB6      | 39 |
| 40 | —<br>XMSB6    | —<br>YLSB6      | —<br>YMSB6    | —<br>STATUS7    | —<br>ID7      | —<br>XLSB7      | —<br>XMSB7    | —<br>YLSB7      | 47 |
| 48 | —<br>YMSB7    | —<br>STATUS8    | —<br>ID8      | —<br>XLSB8      | —<br>XMSB8    | —<br>YLSB8      | —<br>YMSB8    | —<br>STATUS9    | 55 |
| 56 | —<br>ID9      | —<br>XLSB9      | —<br>XMSB9    | —<br>YLSB9      | —<br>YMSB9    | 0x03<br>#VALID  | —<br>—        | —<br>—          |    |

## 6.1.2 READING TOUCH DATA (I<sup>2</sup>C)

Reading touch data over I<sup>2</sup>C must be performed in one single transaction to ensure the data is all from the same frame.

**FIGURE 6-1: READING TOUCH DATA (I<sup>2</sup>C™)**



## 6.2 Message Send/Receive

In these examples, a message setting the current number of RX channels is sent, and the response received is shown. (including acknowledgment).

### 6.2.1 MESSAGE TO SEND

#### Message ID

0xE0 (CMD\_SetParameter)

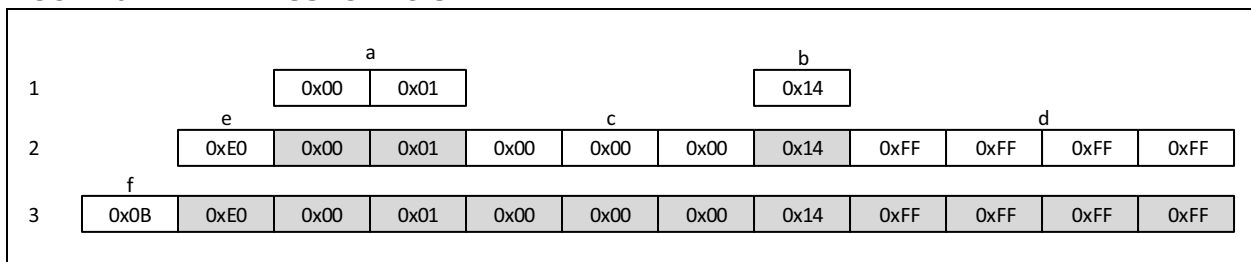
#### Payload (message specific)

Address: 0x0100

Data: 0x14

First, the message must be created according to the message format in [Figure 6-2](#).

**FIGURE 6-2: MESSAGE TO SEND**



## 6.2.1.1 Steps

1. Parameter address (a) and value to write (b)
2. Message ID is added (e).

Fill bytes are added to value to make it 32 bits (c).

Data mask is added (d) – note that since the parameter is only one byte, only the last byte of the mask actually affects the behavior.

3. Status byte is added:

- size is 11 (0x0B)
- “more messages” is set to 0
- “is continued” ID set to 0 (this is the start of message)

## 6.2.2 EXPECTED RESPONSE

Every message sent to the controller also contains an acknowledgment message back (ACK), which follows this format:

### Message ID

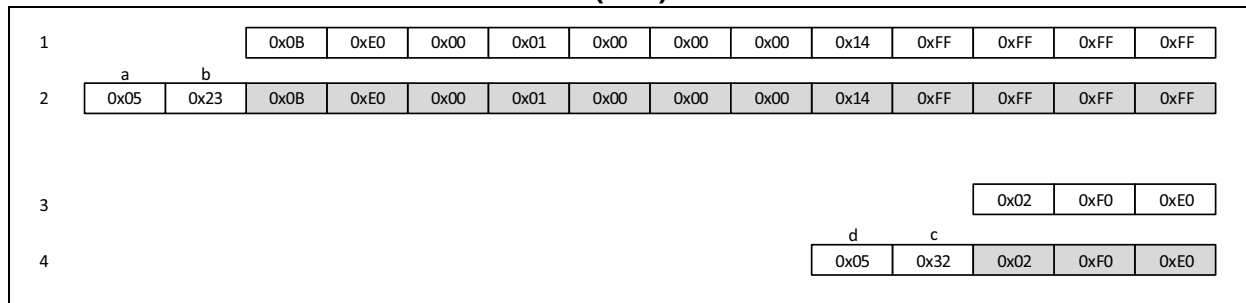
0xF0 (REP\_Ack)

### Payload

0xE0 (command received was CMD\_SetParameter)

## 6.2.3 MESSAGE SEND/RECEIVE (USB)

**FIGURE 6-4: MESSAGE SEND/RECEIVE (USB)**



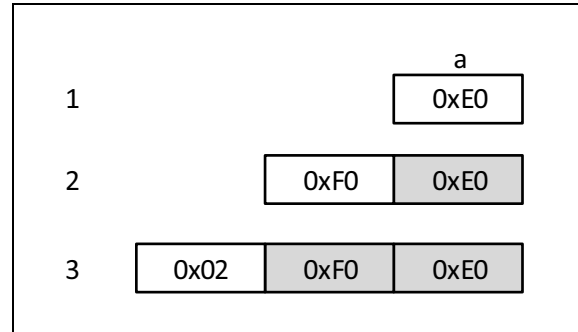
## 6.2.3.1 Steps

1. Message to send (from previous section)
2. Adding sequence ID (b), which was chosen at random for this example. Adding reportID (always 0x05)
3. Response expected (from previous section)
4. Adding sequence ID (c), which was chosen at random for this example. Adding reportID (always 0x05).

## 6.2.4 MESSAGE SEND/RECEIVE (I<sup>2</sup>C)

First, the host must query the RXRDY buffer to ensure there is enough space to write the command. In this case, the controller is reporting that 255 bytes are available for writing:

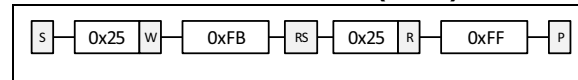
**FIGURE 6-3: EXPECTED RESPONSE**



## 6.2.2.1 Steps

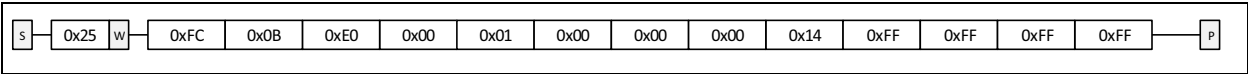
1. Expected payload for an ACK message is an echo of the command being ACK'd – in this case, 0xE0
2. Message ID is added
3. Status byte is added:
  - Size = 2
  - More messages = 0
  - Continued = 0

**FIGURE 6-5: MESSAGE SEND/RECEIVE (I<sup>2</sup>C™)**



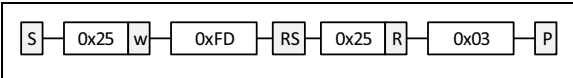
Next, the host writes the command into the controller's RXBUFF register (Figure 6-6).

FIGURE 6-6: HOST WRITE TO RXBUFF REGISTER



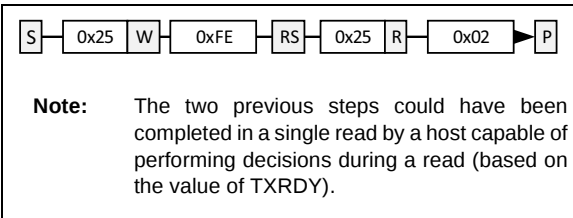
The host may now query the TXRDY buffer to see if the response is ready, either after a set amount of time or by observing IRQ (Figure 6-7).

FIGURE 6-7: HOST READ FROM TXRDY REGISTER



Since there are three bytes ready to be read, the host should now read those three bytes out of the TXBUFF register (Figure 6-8).

FIGURE 6-8: HOST READ FROM TXBUFF REGISTER



Reading address 0xFD auto-increments the address pointer to 0xFE, the stream buffer. Further bytes read will all be from within the stream buffer, maintaining the 0xFE address. The first byte read, 0x03, would indicate that three more bytes are within the stream buffer and may be read immediately.

## 7.0 SENSOR DESIGN CONSIDERATIONS

### 7.1 Sensor Patterns and PCB Layout

With regard to touch sensor patterns, refer to the mTouch® Design Center ([www.microchip.com/mtouch](http://www.microchip.com/mtouch)) for additional information on designing and laying out a touch sensor pattern, as well as using the correct techniques for PCB trace routing.

#### 7.1.1 PROTOTYPING DESIGNS

Touch sensor designs typically require a thorough debugging phase to ensure a reliable product. If possible, it is recommended that flexible prototyping hardware be created with this in mind. A common example is providing external access to the communication lines for quick test and tuning while in circuit.

#### 7.1.2 SENSOR OVERLAY MATERIAL

To prevent saturation of sensor levels, a minimum overlay of 0.5 mm plastic or glass is required for proper operation of the device, even during a prototyping phase. (Even if this value is different than the final design.)

**Note:** At no time should the device be expected to respond correctly to a user touching a bare PCB sensor.

#### 7.1.3 OPERATION WITH AN LCD

The MTCH6303 has integrated algorithms to detect and minimize the effects of noise, but proper care should always be taken in selecting an LCD and support components with a focus on reducing noise as much as possible. Since the interaction between the touch sensor and display is highly dependent upon the physical arrangement of the components, proper testing should always be executed with a fully integrated device. Please reference your projected capacitive touch screen manufacturer's integration guide for additional design considerations.

## 7.2 Sensor Layout Configuration

**TABLE 7-1: REGISTERS ASSOCIATED WITH SENSORS LAYOUT CONFIGURATION**

| Address | Name               | Description                        |
|---------|--------------------|------------------------------------|
| 0x0200  | NUMBEROFX-CHANNELS | Number of channels used for X axis |
| 0x0280  | NUMBEROFY-CHANNELS | Number of channels used for Y axis |

The MTCH6303 is designed to work with sensors with a minimum of 3 RX and 3 TX sensor channels, and a maximum of 27 RX and 19 TX channels using a single MTCH652.

### 7.3 Sensor Output Resolution

The MTCH6303 interpolates 256 discrete points between each sensor channel and 128 points past the centerline of each edge. These internal values are then scaled over a default range of 0-32767 (0-0x7FFF) for the default sensor configuration. If the number of TX or RX channels is modified, then the related output resolution values must also be updated.

#### 7.3.1 MODIFYING OUTPUT RESOLUTION

**TABLE 7-2: OUTPUT RESOLUTION REGISTERS**

| Address | Name      |
|---------|-----------|
| 0x0042  | RX Shift  |
| 0x0043  | RX Divide |
| 0x0044  | RX Offset |
| 0x0045  | TX Shift  |
| 0x0046  | TX Divide |
| 0x0047  | TX Offset |

The X and Y resolution may be modified by changing addresses 0x0042 through 0x0047. The firmware uses the values in equation [Equation 7-1](#).

**EQUATION 7-1: RESOLUTION CHANGE**

$$Final\ Value = \frac{Value \cdot 2^{Shift}}{Divide} + Offset$$

These values must be updated when changing the number of TX or RX channels on the sensor if the 0-0x7FFF resolution is to be maintained.

## 7.4 Sensor Orientation

**TABLE 7-3: SENSOR ORIENTATION**

| Address | Name      | Description                                |
|---------|-----------|--------------------------------------------|
| 0x0041  | FLIPSTATE | Determines X and Y flips, as well as swaps |

**REGISTER 7-1: SENSOR ORIENTATION REGISTER**

|       |     |     |     |     |        |        |        |
|-------|-----|-----|-----|-----|--------|--------|--------|
| U-x   | U-x | U-x | U-x | U-x | R/W-0  | R/W-0  | R/W-0  |
| —     | —   | —   | —   | —   | XYSWAP | TXFLIP | RXFLIP |
| bit 7 |     |     |     |     |        | bit 0  |        |

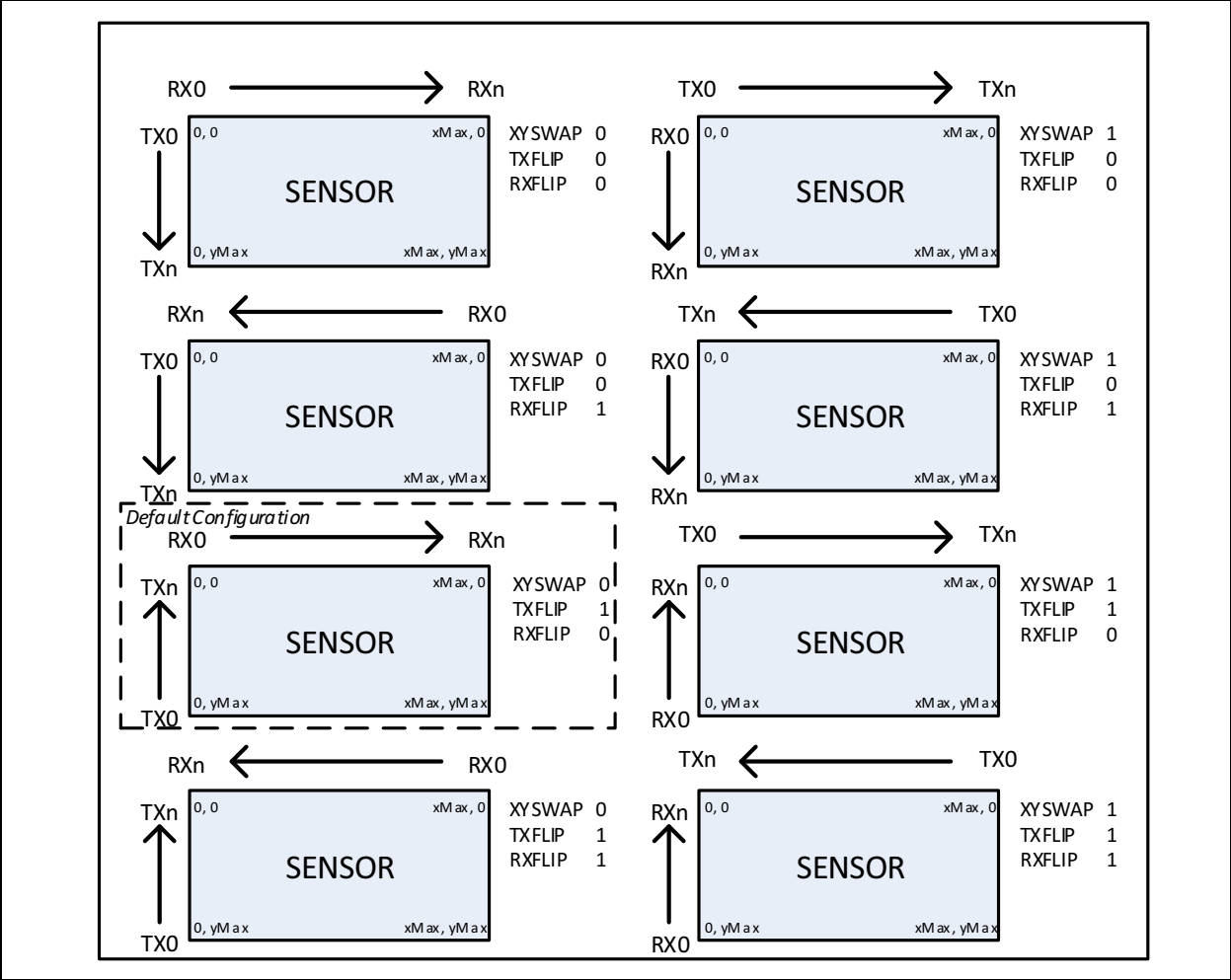
**Legend:**

|                  |                       |                                           |
|------------------|-----------------------|-------------------------------------------|
| R = Readable bit | x = Bit is unknown    | -n = Value after initialization (default) |
| W = Writable bit | U = Unimplemented bit | q = Conditional                           |
| '1' = Bit is set | '0' = Bit is cleared  |                                           |

- bit 7-3      **Unused**
- bit 2      **XYSWAP:** Swap the TX and RX coordinates
- bit 1      **TXFLIP:** Swap the coordinates along the TX axis
- bit 0      **RXFLIP:** Swap the coordinates along the RX axis

To aid in PCB layout, the sensor can be oriented in any direction, have either axis reversed or have the axis swapped.

FIGURE 7-1: SENSOR ORIENTATION EXAMPLES



## 8.0 FIRMWARE UPDATE

### 8.1 Library Loader

The MTCH6303 devices are manufactured with a built-in Library Loader (bootloader) only. There will not be any PCAP touch decoding library preloaded. The library loader has interfaces for USB HID and I<sup>2</sup>C, so that an MTCH6303 library can be uploaded to the MTCH6303 Flash memory.

The latest MTCH6303 PCAP touch decoding library can be found in the MTCH6303 Utility download which can be accessed from the MTCH6303 device page.

There are three ways to upload the MTCH6303 library to the MTCH6303 device, as listed in Sections 8.1.1. to 8.1.3 below.

#### 8.1.1 UPLOAD VIA THE MTCH6303 UTILITY

The MTCH6303 Utility can be used to perform the update. For this option, USB connectivity to a PC with the MTCH6303 Utility installed will be needed.

#### 8.1.2 UPLOAD VIA EMBEDDED HOST CONTROLLER

This option requires an embedded host controller which performs the upload using the MTCH6303 Bootloader commands (refer to Table 8-1).

Microchip pre-programmed MTCH6303 parts can be ordered through the Microchip Programming Center. Please reference [www.microchipdirect.com/programming](http://www.microchipdirect.com/programming) for further information.

#### 8.1.3 QUICK TIME PROGRAMMING (QTP)

For larger quantities of pre-programmed parts with unique part numbers, contact your local Microchip sales office.

### 8.2 Overview

The firmware update process involves a host device transmitting a hex file to the MTCH6303 while in Bootloader mode. The hex file should be parsed and all data bytes extracted before being sent to the MTCH6303. This can either be done by the host or by software that utilizes the host as a bridge to send the bytes to the MTCH6303.

When the MTCH6303 is in Bootloader mode, the host has access to commands to read, erase and write ROM pages that contain the touch application. An outline of the update procedure is detailed in this section.

### 8.3 Bootloader Command Overview

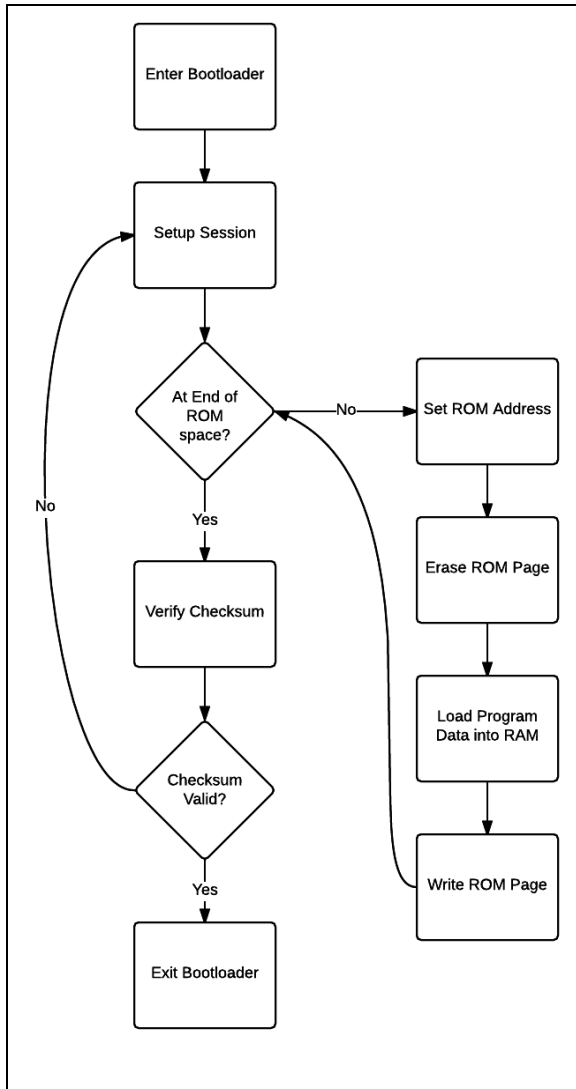
The command interpreter within the bootloader operates in a similar manner as the standard MTCH6303 command interpreter. The bootloader supports the following commands:

**TABLE 8-1: BOOTLOADER COMMANDS**

| ID   | Name            | Description                              |
|------|-----------------|------------------------------------------|
| 0x10 | EXIT_BOOTLOADER | Exit Bootloader mode                     |
| 0x11 | SETUP_SESSION   | Setup and initiate a bootloading session |
| 0x12 | ERASE_PAGE      | Erase a ROM page                         |
| 0x13 | SET_ADDRESS     | Write the Flash address to operate on    |
| 0x14 | LOAD_DATA       | Load program data into RAM               |
| 0x15 | WRITE_PAGE      | Latch program data from RAM into ROM     |
| 0x16 | VALIDATE_FW     | Read from a section in Flash             |
| 0x17 | READ_FLASH      | Read a section in ROM                    |
| 0xff | QUERY_VERSION   | Read the bootloader firmware revision    |

## 8.4 Update Procedure

**FIGURE 8-1: BOOTLOADER FLOWCHART**



### 8.4.1 ENTER THE BOOTLOADER

The MTCH6303 normally runs in Application mode, so the host must communicate to the MTCH6303 to enter its Bootloader mode. To do this, issue the 'Enter bootloader' command as seen in [Section 10.5, Command: ENTER\\_BOOTLOADER](#). If using USB, the device will disconnect from the USB bus, then re-attach as the bootloader. (VID 0x04D8, PID 0x09D5)

### 8.4.2 SETUP A FIRMWARE UPDATE SESSION

Once the MTCH6303 is in Bootloader mode establish an update session with the MTCH6303. The purpose of this is to setup the ROM boundaries and other various parameters for the update. Use the SETUP\_SESSION command to configure the session. Prior to receiving a

valid SETUP\_SESSION command the bootloader will not allow modifications to the ROM. Once a SETUP\_SESSION command is received, the application firmware is identified as unstable and it is no longer possible to exit the bootloader until a firmware update sequence has been completed.

### 8.4.3 PERFORM A SETADDRESS/ERASE/ WRITE CYCLE ON EACH ROM PAGE

With a valid session in place the host can now begin accessing the MTCH6303 device's ROM to update the firmware. The typical procedure is to update the device one Flash page at a time, erasing and writing one page before moving onto the next.

First, use SET\_ADDRESS to configure the address of the start of the ROM page to perform further operations on. The address should be the start of a 4 Kb ROM page.

Next, use ERASE\_PAGE to erase the page starting at the address selected using the SET\_ADDRESS command.

Once the page is erased, the host should send parsed hex data to update the selected page. This process will take several iterations of the LOAD\_DATA command to write all 4Kb of data. The LOAD\_DATA command has size and offset parameters that denote respectively the size of the current LOAD\_DATA packet and the offset from the address defined by the SET\_ADDRESS command.

After all 4 Kb of data has been provided to the controller, use the WRITE\_PAGE command to write the data into the selected page.

Continue this process of SET\_ADDRESS, ERASE\_PAGE, LOAD\_DATA(s), and WRITE\_PAGE for each 4Kb block of ROM until the entire update is completed.

## 8.5 Bootloader Commands

This section describes the bootloader commands. The format for each command and its response are detailed below.

### 8.5.1 COMMANDS

#### 8.5.1.1 0X10 EXIT\_BOOTLOADER

When called, this command will cause the bootloader to exit, returning to the touch application if a valid application is present. If not, the controller will remain in Bootloader mode.

**TABLE 8-2: EXIT BOOTLOADER**

| Cmd Size | Cmd ID | Data   |
|----------|--------|--------|
| 0x01     | 0x10   | <none> |

## 8.5.1.2 0x11 SETUP\_SESSION

This will initiate a bootloading session, defining session type, start address and end address.

**TABLE 8-3: SETUP SESSION**

| Cmd Size | Cmd ID | Data                  |                         |                       |
|----------|--------|-----------------------|-------------------------|-----------------------|
| 0x0A     | 0x11   | Session Type [8 bits] | Start Address [32 bits] | End Address [32 bits] |

## 8.5.1.3 0x12 ERASE\_PAGE

This command will cause the currently set page to be erased. The SET\_ADDRESS command must be used to define the address of the page to be erased prior to calling ERASE\_PAGE.

**TABLE 8-4: ERASE PAGE**

| Cmd Size | Cmd ID | Data   |
|----------|--------|--------|
| 0x01     | 0x12   | <none> |

## 8.5.1.4 0x13 SET\_ADDRESS

This command defines the start address of the page of ROM to perform further operations upon. This address MUST be the start of one of the 4 Kb ROM pages.

**TABLE 8-5: SET ADDRESS**

| Cmd Size | Cmd ID | Data      |            |             |             |
|----------|--------|-----------|------------|-------------|-------------|
| 0x05     | 0x13   | Addr[7:0] | Addr[15:8] | Addr[23:16] | Addr[31:24] |

## 8.5.1.5 0x14 LOAD\_DATA

Load application data from the host into RAM.

**TABLE 8-6: LOAD DATA**

| Cmd Size | Cmd ID | Data  |        |        |        |                           |       |
|----------|--------|-------|--------|--------|--------|---------------------------|-------|
|          |        | Size  |        | Offset |        | progData[0]-progData[n]** |       |
| varies   | 0x14   | [7:0] | [15:8] | [7:0]  | [15:8] | [0]                       | [n]** |

**Note:** Max length of progData is 54 bytes.

## 8.5.1.6 0x15 WRITE\_PAGE

Write loaded RAM data into ROM at the defined address.

**TABLE 8-7: WRITE PAGE**

| Cmd Size | Cmd ID | Data   |
|----------|--------|--------|
| 0x01     | 0x15   | <none> |

## 8.5.1.7 0x16 VALIDATE\_FW

Read from a section in Flash.

**TABLE 8-8: VALIDATE FW**

| Cmd Size | Cmd ID | Data   |
|----------|--------|--------|
| 0x01     | 0x16   | <none> |

## 8.5.1.8 0x17 READ\_FLASH

Read a section in ROM.

**TABLE 8-9: READ FLASH**

| Cmd Size | Cmd ID | Data       |            |
|----------|--------|------------|------------|
| 0x03     | 0x17   | Size [7:0] | Size[15:8] |

## 8.5.1.9 0xff QUERY\_VERSION

Read the bootloader firmware version.

**TABLE 8-10: QUERY VERSION**

| Cmd Size | Cmd ID | Data   |
|----------|--------|--------|
| 0x01     | 0xff   | <none> |

## 8.5.2 RESPONSES

**TABLE 8-11: BOOTLOAD COMMAND RESPONSE ID**

| Value | Description                              |
|-------|------------------------------------------|
| 0x00  | Successful operation                     |
| 0x07  | Checksum mismatch                        |
| 0x08  | Flash read/erase/write failure           |
| 0x0a  | Out-of-Range address                     |
| 0x0b  | No session data                          |
| 0x0c  | Unrecognized command ID                  |
| 0x0d  | Invalid number of bytes for this command |
| 0x0e  | Error exiting Bootloader mode            |

**TABLE 8-12: BOOTLOADER COMMAND RESPONSE**

| Byte | Value                                     | Description                       |
|------|-------------------------------------------|-----------------------------------|
| 1    | 0x02                                      | Length, number of bytes to follow |
| 2    | varies                                    | Echo Command ID                   |
| 3    | See <a href="#">Table 8-11</a> for values | Response Status                   |

## 9.0 OPERATING MODES

The MTCH6303 allows enabling and disabling individual modules within the controller by modifying the active Modules (NVAM) register. Node control is from the NVAM in conjunction with the Streaming Modes register.

### REGISTER 9-1: STREAMING MODE REGISTER (STREAMINGMODE)

|           |     |     |     |       |     |     |     |
|-----------|-----|-----|-----|-------|-----|-----|-----|
| U-x       | U-x | U-x | U-x | U-x   | U-x | U-x | U-x |
| MODE<7:0> |     |     |     |       |     |     |     |
| bit 7     |     |     |     | bit 0 |     |     |     |

#### Legend:

|                  |                       |                                           |
|------------------|-----------------------|-------------------------------------------|
| R = Readable bit | x = Bit is unknown    | -n = Value after initialization (default) |
| W = Writable bit | U = Unimplemented bit | q = Conditional                           |
| '1' = Bit is set | '0' = Bit is cleared  |                                           |

bit 7-0      **MODE:** Mode Selection – See [Section 9.2, Controller State Machine](#) for more information.

- 0: 2D3D
- 1: PCAP\_ONLY
- 2: GESTIC\_BRIDGE
- 4: ACTIVE\_STANDBY
- 5: 2D\_SLEEP\_MODE
- 0xFF: INVALID

# MTCH6303

## 9.1 Active Modules Register (NVAM)

REGISTER 9-2: ACTIVE MODULES REGISTER (NVAM)

| U-x    | U-x | U-x | U-x | R/W-1  | R/W-1     | R/W-1    | R/W-1    |
|--------|-----|-----|-----|--------|-----------|----------|----------|
| —      | —   | —   | —   | DECODE | DIGITIZER | AUTOBASE | BESTFREQ |
| bit 15 |     |     |     | bit 8  |           |          |          |

| R/W-0    | R/W-0    | R/W-0    | U-x | U-x   | R/W-0    | U-x | R/W-1   |
|----------|----------|----------|-----|-------|----------|-----|---------|
| AW_EVENT | SW_EVENT | FL_EVENT | —   | —     | FULLSCAN | —   | GESTURE |
| bit 7    |          |          |     | bit 0 |          |     |         |

**Legend:**

R = Readable bit

x = Bit is unknown

-n = Value after initialization (default)

W = Writable bit

U = Unimplemented bit

q = Conditional

'1' = Bit is set

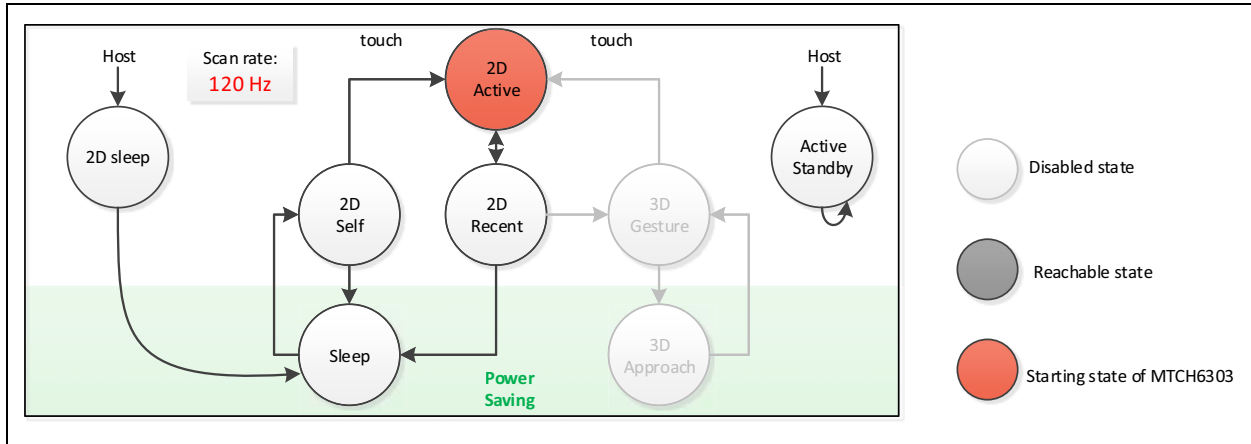
'0' = Bit is cleared

- bit 15-12     **Unused**
- bit 11        **DECODE:** Turns touch decoding logic on or off
- bit 10        **DIGITIZER:** Turns digitizer/I<sup>2</sup>C register output on or off
- bit 9          **AUTOBASE:** Turns on or off automatic baseline functionality
- bit 8          **BESTFREQ:** Turns on or off bestfrequency selection algorithms
- bit 7          **AW\_EVENT:** Events related to GestIC<sup>®</sup> airwheel
- bit 6          **SW\_EVENT:** Events related to GestIC<sup>®</sup> swipes
- bit 5          **FL\_EVENT:** Events related to GestIC<sup>®</sup> flicks
- bit 4-3        **Unused**
- bit 2          **FULLSCAN:** Turns on full mutual scanning
- bit 1          **Unused**
- bit 0          **GESTURE:** Turns on 2D gesture recognition

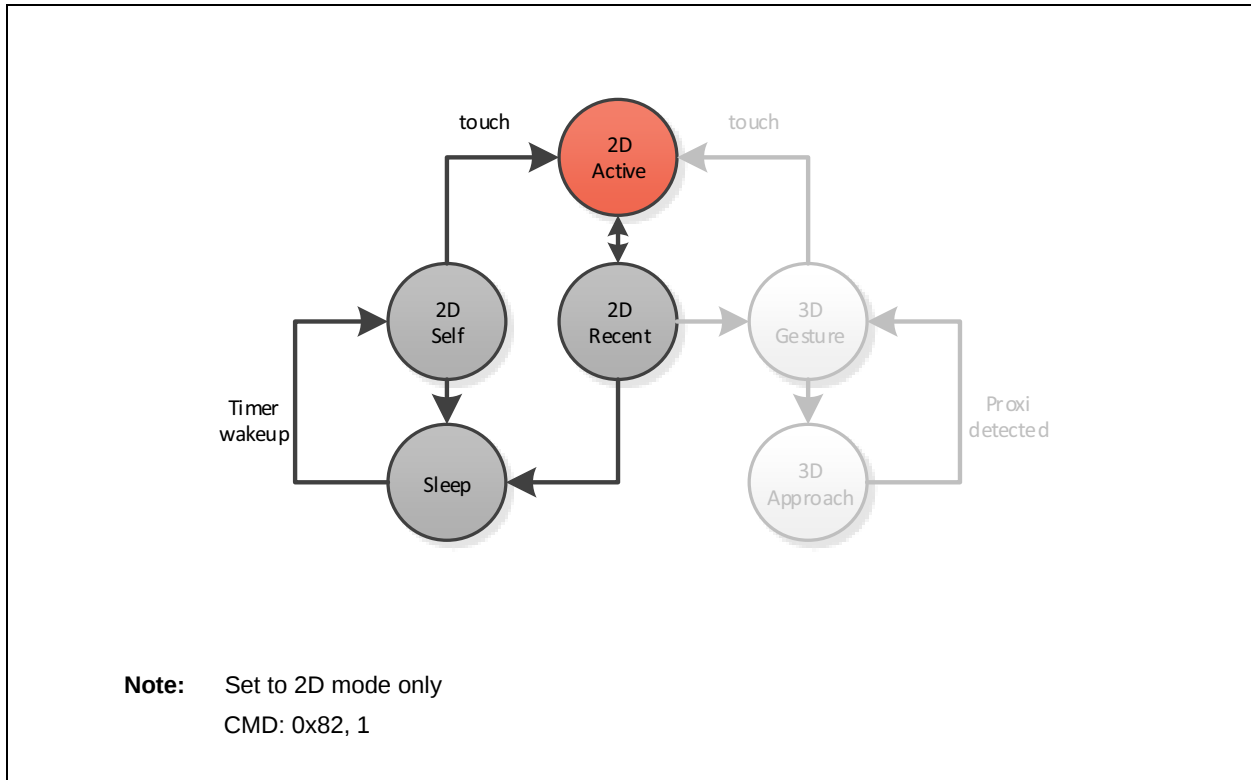
## 9.2 Controller State Machine

Using the Active Modules Register there are numerous different operating modes for the MTCH6303. The streaming Mode register (address 0x0082) can be used to configure the overall operational mode of the controller. Please contact Microchip for further information on using the MTCH6303 in combination with an MGC3130 GestIC<sup>®</sup> controller for 3D gestures.

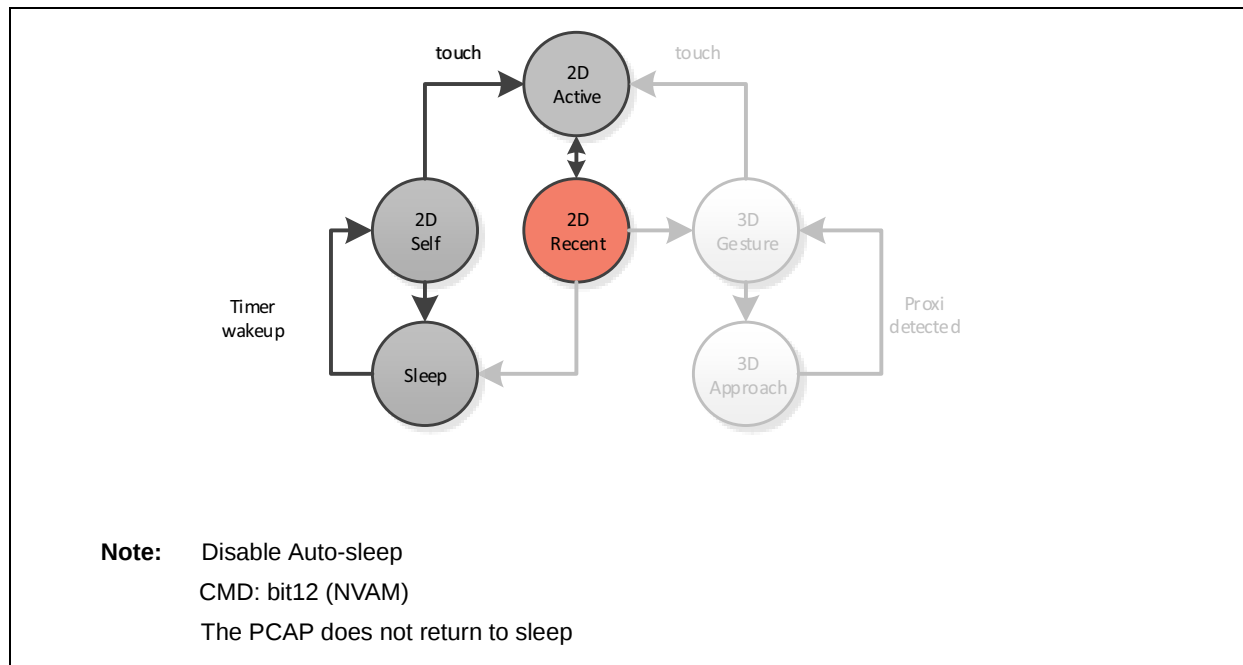
**FIGURE 9-1: STANDARD CONTROLLER OPERATION STATE MACHINE**



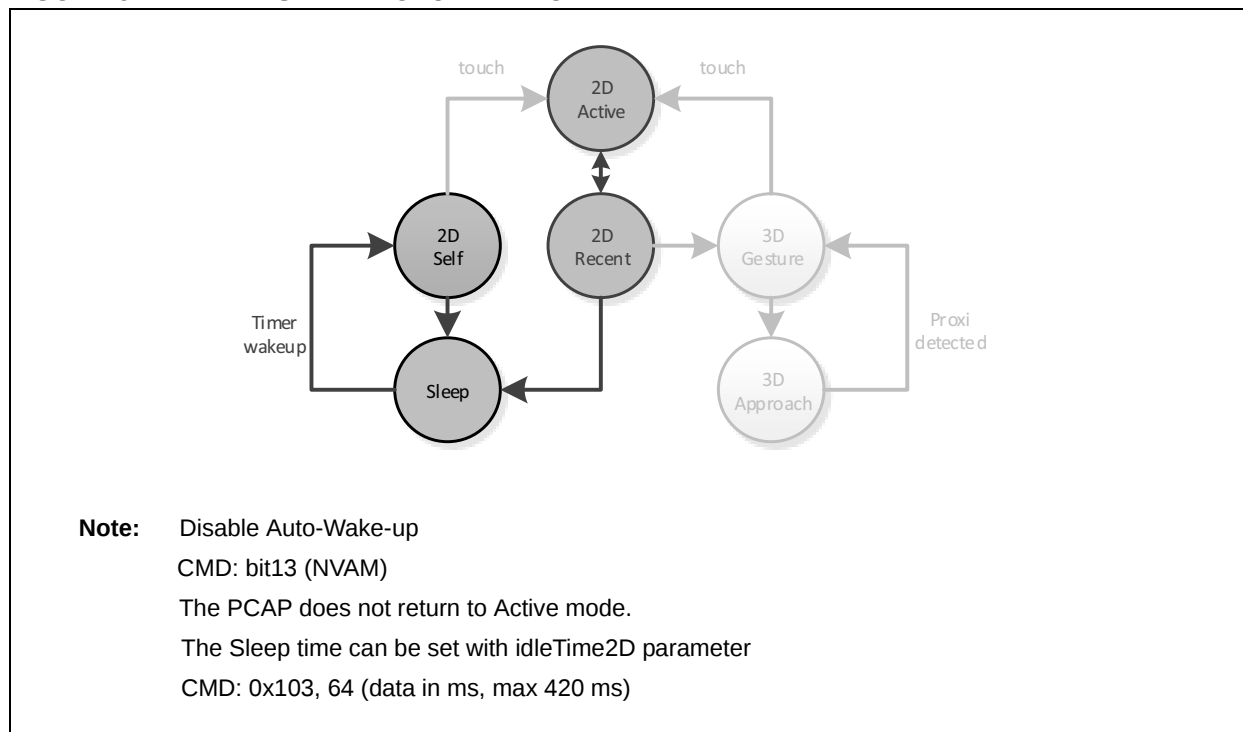
**FIGURE 9-2: 2D ONLY MODE**



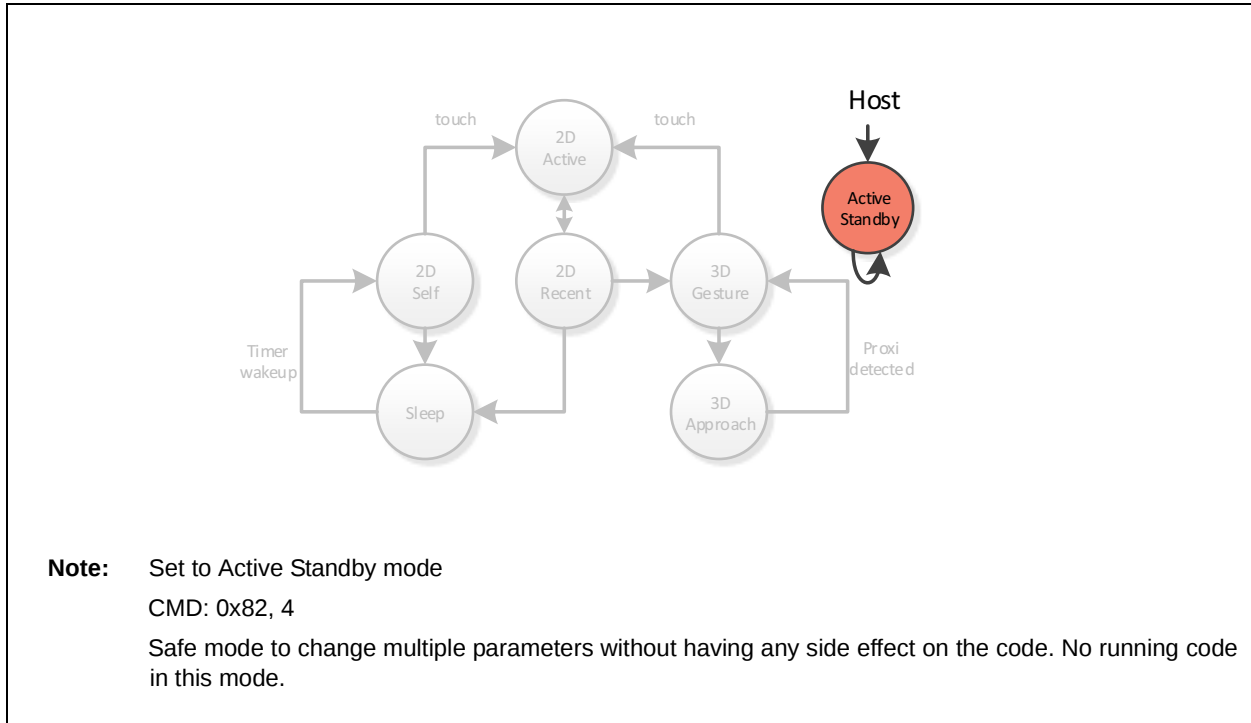
**FIGURE 9-3: DISABLE AUTO-SLEEP**



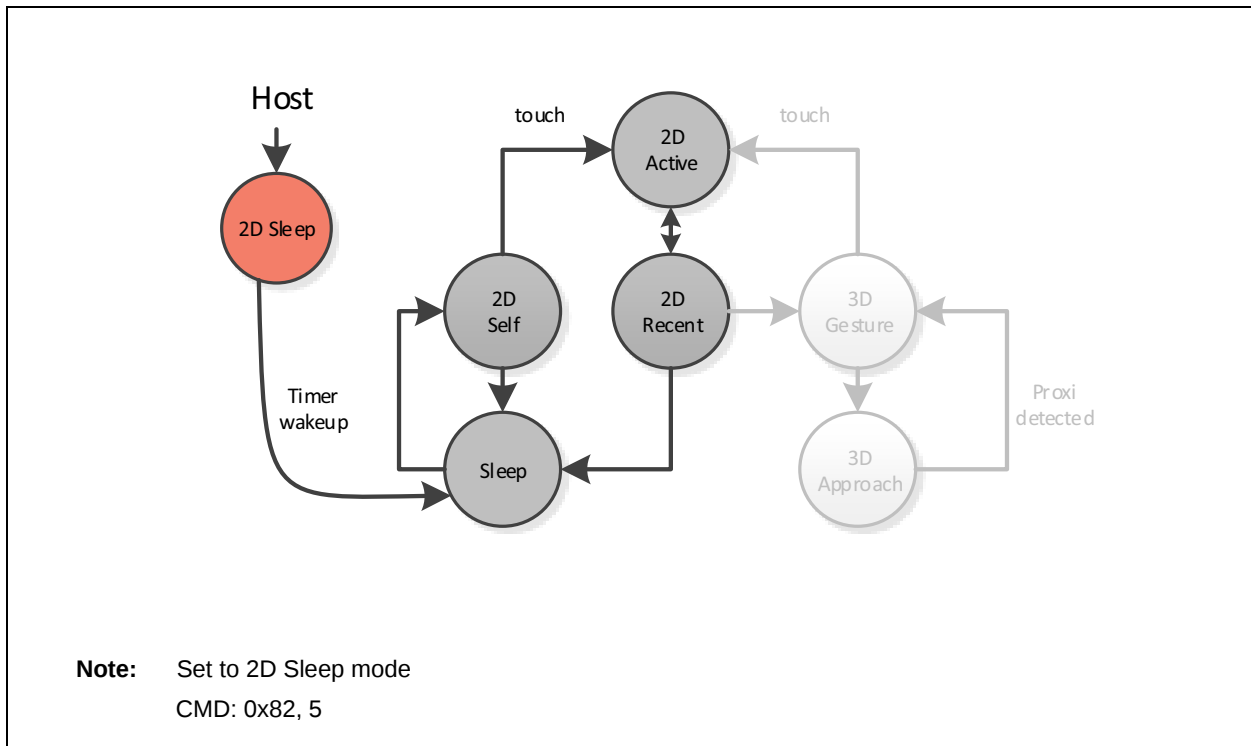
**FIGURE 9-4: DISABLE AUTO-WAKE-UP**



**FIGURE 9-5: ACTIVE STANDBY MODE**



**FIGURE 9-6: 2D SLEEP MODE**



## 10.0 APPLICATION COMMANDS

**TABLE 10-1: APPLICATION COMMANDS**

| CMD ID | Name             | Description                                                |
|--------|------------------|------------------------------------------------------------|
| 0x04   | ECHO             | Echo back the received packet                              |
| 0xfb   | FORCE_BASELINE   | Force the touch sensor to update its baseline measurements |
| 0xff   | QUERY_VERSION    | Read the MTCH6303 firmware and application revisions       |
| 0x17   | READ_FLASH       | Read from a section in ROM                                 |
| 0x55   | ENTER_BOOTLOADER | Enter Bootloader mode                                      |
| 0xfc   | GESTIC_BRIDGE    | Pass information through to an MGC3130                     |
| 0xe0   | SET_PARAMETER    | Write a value to a register                                |
| 0xe1   | GET_PARAMETER    | Read a value from a register                               |

### 10.1 Command: ECHO

Host command to test communication. Host sends <04><01><02><03>, and the controller will respond with the exact same packet <04><01><02><03>. Any bytes following the 0x04 ID byte will not be processed by the controller, and should only be used to verify communication is working properly.

**TABLE 10-2: COMMAND: ECHO**

| Byte | Value               | Description                              |
|------|---------------------|------------------------------------------|
| 1    | n+1                 | Length, # of bytes to follow             |
| 2    | 0X04                | Command ID                               |
| 3-n  | Packet[0]:Packet[n] | Test packet information for confirmation |

**TABLE 10-3: COMMAND RESPONSE: ECHO**

| Byte | Value               | Description                            |
|------|---------------------|----------------------------------------|
| 1    | n+1                 | Length, # of bytes to follow           |
| 2    | 0X04                | Command ID                             |
| 3-n  | Packet[0]:Packet[n] | Identical test packet for confirmation |

### 10.2 Command: FORCE\_BASELINE

Forces the controller to update touch sensor baseline measurements.

**TABLE 10-4: COMMAND: FORCE\_BASELINE**

| Byte | Value | Description                  |
|------|-------|------------------------------|
| 1    | 0x01  | Length, # of bytes to follow |
| 2    | 0Xfb  | Command ID                   |

**TABLE 10-5: COMMAND RESPONSE: FORCE\_BASELINE**

| Byte | Value | Description                      |
|------|-------|----------------------------------|
| 1    | 0x02  | Length, # of bytes to follow     |
| 2    | 0Xf0  | Acknowledge CMD ID               |
| 3    | 0xfb  | Repeat FORCE_BASELINE Command ID |

**TABLE 10-6: FORCE\_BASELINE EXAMPLE**

|        |        |
|--------|--------|
| SEND   |        |
| 0x01   | 0xfb   |
| Length | CMD ID |

|         |            |                          |
|---------|------------|--------------------------|
| RECEIVE |            |                          |
| 0x02    | 0xf0       | 0xfb                     |
| Length  | ACK CMD ID | Repeat FORCE_BASELINE ID |

## 10.3 Command: QUERY\_VERSION

The QUERY\_VERSION command will read the MTCH6303 firmware and application revisions. Sending a QUERY\_VERSION command while in Application mode will prompt two packets to be returned from the MTCH6303. The first packet will contain the 128 bytes of version data, and the second packet is the acknowledgment of the QUERY\_VERSION command.

**TABLE 10-7: COMMAND: QUERY\_VERSION**

| Byte | Value | Description                  |
|------|-------|------------------------------|
| 1    | 0x01  | Length, # of bytes to follow |
| 2    | 0xff  | Command ID                   |

**TABLE 10-8: COMMAND RESPONSE: QUERY\_VERSION**

| Byte | Value | Description                      |
|------|-------|----------------------------------|
| 1    | 0x80  | Length, # of bytes to follow     |
| 2    |       | 128 bytes of version information |
| 130  |       |                                  |
| 1    | 0x02  | Length, # of bytes to follow     |
| 2    | 0xf0  | Acknowledge CMD ID               |
| 3    | 0xff  | Repeat QUERY_VERSION Command ID  |

## 10.4 Command: READ\_FLASH

Read from a section in ROM. When used as an application command, the controller will respond with two packets: one containing the read data, and a second acknowledgment packet.

**TABLE 10-9: COMMAND: READ\_FLASH**

| Byte | Value       | Description                             |
|------|-------------|-----------------------------------------|
| 1    | 0x07        | Length, # of bytes to follow            |
| 2    | 0x17        | Command ID                              |
| 3    | addr[7:0]   | 4-byte (32-bit) Start address           |
| 4    | addr[15:8]  |                                         |
| 5    | addr[23:16] |                                         |
| 6    | addr[31:24] |                                         |
| 7    | size[7:0]   | Length of Flash block to read, in Bytes |
| 8    | size[15:8]  |                                         |

**TABLE 10-10: COMMAND RESPONSE: READ\_FLASH**

| Byte     | Value | Description                                                                        |
|----------|-------|------------------------------------------------------------------------------------|
| 1        | 0x05  | Length, # of bytes to follow                                                       |
| 2        | 0x17  | Command ID                                                                         |
| 3-[size] | Data  | [size] number of bytes of data, as requested in command, starting at Start address |
|          |       |                                                                                    |
| 1        | 0x02  | Length, # of bytes to follow                                                       |
| 2        | 0xf0  | Acknowledge CMD ID                                                                 |
| 3        | 0x17  | Repeat GET_REGISTER CMD ID                                                         |

## 10.5 Command: ENTER\_BOOTLOADER

**TABLE 10-11: COMMAND: ENTER\_BOOTLOADER**

| Byte | Value | Description                  |
|------|-------|------------------------------|
| 1    | 0x01  | Length, # of bytes to follow |
| 2    | 0x55  | Command ID                   |

**TABLE 10-12: COMMAND RESPONSE: ENTER\_BOOTLOADER**

| Byte | Value | Description                        |
|------|-------|------------------------------------|
| 1    | 0x02  | Length, # of bytes to follow       |
| 2    | 0xf0  | Acknowledge CMD ID                 |
| 3    | 0x55  | Repeat ENTER_BOOTLOADER command ID |

## 10.6 Command: GESTIC\_BRIDGE

Use GESTIC\_BRIDGE to pass information through the MTCH6303 to the MGC3130 controller.

**TABLE 10-13: COMMAND: GESTIC\_BRIDGE**

| Byte | Value               | Description                  |
|------|---------------------|------------------------------|
| 1    | n+1                 | Length, # of bytes to follow |
| 2    | 0xfc                | Command ID                   |
| 3-n  | Packet[0]:Packet[n] | Packets to send to MGC3130   |

**TABLE 10-14: COMMAND RESPONSE: GESTIC\_BRIDGE**

| Byte | Value                   | Description                  |
|------|-------------------------|------------------------------|
| 1    | n+1                     | Length, # of bytes to follow |
| 2    | 0xf0                    | Acknowledge CMD ID           |
| 3-n  | Packet[0]:<br>Packet[n] | Packets to send to MGC3130   |

**TABLE 10-16: COMMAND: SET\_REGISTER RESPONSE**

| Byte | Value | Description                    |
|------|-------|--------------------------------|
| 1    | 0x02  | Length, # of bytes to follow   |
| 2    | 0xf0  | Acknowledge CMD ID             |
| 3    | 0xe0  | Repeat SET_REGISTER Command ID |

## 10.7 Register Commands

There are a number of parameter registers that can be configured to modify the performance of the MTCH6303. Table details a list of all modifiable registers.

**TABLE 10-15: COMMAND: SET\_REGISTER**

| Byte | Value        | Description                                                |
|------|--------------|------------------------------------------------------------|
| 1    | 0x0b         | Length, # of bytes to follow                               |
| 2    | 0xe0         | Command ID                                                 |
| 3    | addr[7:0]    | 2-byte (16-bit) Register Address                           |
| 4    | addr[15:8]   |                                                            |
| 5    | value[7:0]   | 4-byte (32-bit) register value to be written               |
| 6    | value[15:8]  |                                                            |
| 7    | value[23:16] |                                                            |
| 8    | value[31:24] |                                                            |
| 9    | mask[7:0]    | 4-byte (32-bit) value to mask register value to be written |
| 10   | mask[15:8]   |                                                            |
| 11   | mask[23:16]  |                                                            |
| 12   | mask[31:24]  |                                                            |

**TABLE 10-17: SET\_REGISTER 0X0004 TO VALUE 0XAABBCCDD EXAMPLE**

|        |        |                 |      |                               |      |      |      |                   |      |      |      |
|--------|--------|-----------------|------|-------------------------------|------|------|------|-------------------|------|------|------|
| SEND   |        |                 |      |                               |      |      |      |                   |      |      |      |
| 0x0b   | 0xe0   | 0x04            | 0x00 | 0xdd                          | 0xcc | 0xbb | 0xaa | 0xff              | 0xff | 0xff | 0xff |
| Length | CMD ID | Register 0x0004 |      | New Register Value 0xaabbccdd |      |      |      | Register Bit Mask |      |      |      |

|         |            |                        |
|---------|------------|------------------------|
| RECEIVE |            |                        |
| 0x02    | 0xf0       | 0xe0                   |
| Length  | ACK CMD ID | Repeat SET_REGISTER ID |

## 10.8 Command: GET\_REGISTER

The MTCH6303 will respond with two packets when issued the GET\_REGISTER command. The first packet will contain the data, and the second packet is the acknowledgment of the GET\_REGISTER command.

**TABLE 10-18: COMMAND: GET\_REGISTER**

| Byte | Value     | Description                      |
|------|-----------|----------------------------------|
| 1    | 0x03      | Length, # of bytes to follow     |
| 2    | 0xe1      | Command ID                       |
| 3    | addr[7:0] | 2-byte (16-bit) Register Address |

**TABLE 10-19: COMMAND: GET\_REGISTER RESPONSE**

| Byte | Value               | Description                                                |
|------|---------------------|------------------------------------------------------------|
| 1    | 0x05, 0x06, or 0x07 | Length, # of bytes to follow                               |
| 2    | 0xe1                | Command ID                                                 |
| 3    | addr[7:0]           | 2-byte (16-bit) Register Address                           |
| 4    | addr[15:8]          |                                                            |
| 5    | value[7:0]          | Up to 4 bytes (32bit) of value data, depending on register |
| 6    | value[15:8]         |                                                            |
| 7    | value[23:16]        |                                                            |
| 8    | value[31:24]        |                                                            |

|   |      |                              |
|---|------|------------------------------|
| 1 | 0x02 | Length, # of bytes to follow |
| 2 | 0xf0 | Acknowledge CMD ID           |
| 3 | 0xe1 | Repeat GET_REGISTER CMD ID   |

**TABLE 10-20: GET\_REGISTER VALUE 0X00CC AT 0X0004 EXAMPLE**

|        |        |                 |      |
|--------|--------|-----------------|------|
| SEND   |        |                 |      |
| 0x03   | 0xe1   | 0x04            | 0x00 |
| Length | CMD ID | Register 0x0004 |      |

|         |        |                 |      |      |      |
|---------|--------|-----------------|------|------|------|
| RECEIVE |        |                 |      |      |      |
| 0x05    | 0xe1   | 0x04            | 0x00 | 0xcc | 0x00 |
| Length  | CMD ID | Register 0x0004 |      | Data |      |

|        |            |                            |
|--------|------------|----------------------------|
| 0x02   | 0xf0       | 0xe1                       |
| Length | ACK CMD ID | Repeat GET_REGISTER CMD ID |

# MTCH6303

**TABLE 10-21: MTCH6303 PARAMETER REGISTERS**

| Register #      | Name                                  | Description                                                                                                 | Default Value |
|-----------------|---------------------------------------|-------------------------------------------------------------------------------------------------------------|---------------|
| 0x0040          | numOfAvg                              |                                                                                                             |               |
| 0x0041          | flipState                             | bit 0 = X flip, bit 1 = Y flip, bit 2 = X/Y swap                                                            |               |
| 0x0080          | diagMask                              |                                                                                                             |               |
| 0x0081          | activeModules                         |                                                                                                             |               |
| 0x0082          | streamingMode                         |                                                                                                             |               |
| 0x0100          | numberOfXChannels                     | Number of RX Channels along long/wide axis of touch screen                                                  |               |
| 0x0101          | numberOfYChannels                     | Number of TX Channels along short/narrow axis of touch screen                                               |               |
| 0x0200 - 0x021a | rxPinMap[0] - rxPinMap[26]            |                                                                                                             |               |
| 0x0280 - 0x02a3 | txPinMap[0] - txPinMap[35]            |                                                                                                             |               |
| 0x0400          | selfTouchThres                        |                                                                                                             |               |
| 0x0401          | mutTouchThres                         |                                                                                                             |               |
| 0x0402          | weightThreshold                       | Limits the max distance a touch can travel between frames before assigning a new ID (native position units) |               |
| 0x0403          | penDownTimer                          |                                                                                                             |               |
| 0x0404          | penUpTimer                            |                                                                                                             |               |
| 0x0405          | largeActThres                         |                                                                                                             |               |
| 0x0480          | minCuspDelta                          | Slope value must be above this to determine that a 'peak' has been found                                    |               |
| 0x0500          | swipeTimeout                          |                                                                                                             |               |
| 0x0501          | swipeDistance                         |                                                                                                             |               |
| 0x0502          | swipeBorder.left                      |                                                                                                             |               |
| 0x0503          | swipeBorder.right                     |                                                                                                             |               |
| 0x0504          | swipeBorder.top                       |                                                                                                             |               |
| 0x0505          | swipeBorder.bottom                    |                                                                                                             |               |
| 0x0540          | tapBorder.left                        |                                                                                                             |               |
| 0x0541          | tapBorder.right                       |                                                                                                             |               |
| 0x0542          | tapBorder.top                         |                                                                                                             |               |
| 0x0543          | tapBorder.bottom                      |                                                                                                             |               |
| 0x0800          | diagRxChannel                         |                                                                                                             |               |
| 0x0801          | diagTxChannel                         |                                                                                                             |               |
| 0x0802          | baseUpdateTime                        | Stopwatch time for baseline counter, no touch for this duration will engage a recalibration                 |               |
| 0x0803 - 0x0806 | mutScanPeriode[0] - mutScanPeriode[3] |                                                                                                             |               |

**TABLE 10-21: MTCH6303 PARAMETER REGISTERS (CONTINUED)**

| Register #      | Name                                                                            | Description                                                                                     | Default Value |
|-----------------|---------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------|---------------|
| 0x0807 - 0x080a | mutScanPhase[0] - mutScanPhase[3]                                               |                                                                                                 |               |
| 0x080b          | mutFreqHopping                                                                  | If >0, selects Fixed Frequency mode (indexed by this value). If 0, all frequencies are in use   |               |
| 0x080c - 0x080f | mutFreqHoppingLevel[0] - mutFreqHoppingLevel[3]                                 | Provides a software gain for frequencies that provide smaller amplitude than normal. (0 = none) |               |
| 0x0810          | selfSampleTime                                                                  |                                                                                                 |               |
| 0x0811          | mutSampleTime                                                                   |                                                                                                 |               |
| 0x0812 - 0x0815 | selfScanPhase[0] - selfScanPhase[3]                                             |                                                                                                 |               |
| 0x0816 - 0x0819 | selfScanISRPhase[0] - selfScanISRPhase[3]                                       |                                                                                                 |               |
| 0x081a          | syncRxChannel                                                                   |                                                                                                 |               |
| 0x081b          | syncTxChannel                                                                   |                                                                                                 |               |
| 0x081c          | fullScanRxStart                                                                 |                                                                                                 |               |
| 0x081d          | fullScanRxStop                                                                  |                                                                                                 |               |
| 0x081e          | fullScanTxStart                                                                 |                                                                                                 |               |
| 0x081f          | fullScanTxStop                                                                  |                                                                                                 |               |
| 0x0900          | mtch65x_periode_fast_rise                                                       | Period for TMR2 (pwm for 652)                                                                   |               |
| 0x0901          | mtch65x_periode_fast_rise_oc                                                    | Sets OC1 for TMR2 duty cycle - divide "fast_rise" by this number to calculate DC                |               |
| 0x0902          | mtch65x_fast_rise_delay                                                         | TMR1 counts to wait until full boost is established                                             |               |
| 0x0905 - 0x0908 | mtch65x_periode_mutu_measurement[0] - mtch65x_periode_mutu_measurement[3]       |                                                                                                 |               |
| 0x0909 - 0x090c | mtch65x_periode_mutu_measurement_oc[0] - mtch65x_periode_mutu_measurement_oc[3] |                                                                                                 |               |
| 0x090d - 0x0910 | mtch65x_periode_self_measurement[0] - mtch65x_periode_self_measurement[3]       |                                                                                                 |               |
| 0x0911 - 0x0914 | mtch65x_periode_self_measurement_oc[0] - mtch65x_periode_self_measurement_oc[3] |                                                                                                 |               |

## 11.0 GESTURE FEATURES AND PARAMETERS

To simplify touch-based application development the controller already includes the capability to recognize a fixed set of touch gestures. The gesture recognizer supports the following kinds of gestures:

- Swipe-Gestures
- Scroll-Gestures
- Tap-Gestures

The gesture recognizer in the MTCH6303 is generic in that it supports those gestures for any number of fingers greater or equal to one. In practice, the maximum number of fingers is still limited because of the following two other factors:

1. The number of concurrent finger contacts the touch digitizer stages of the MTCH6303 is able to trace. This is currently internally limited to 10 although HID only reports a maximum of 5.

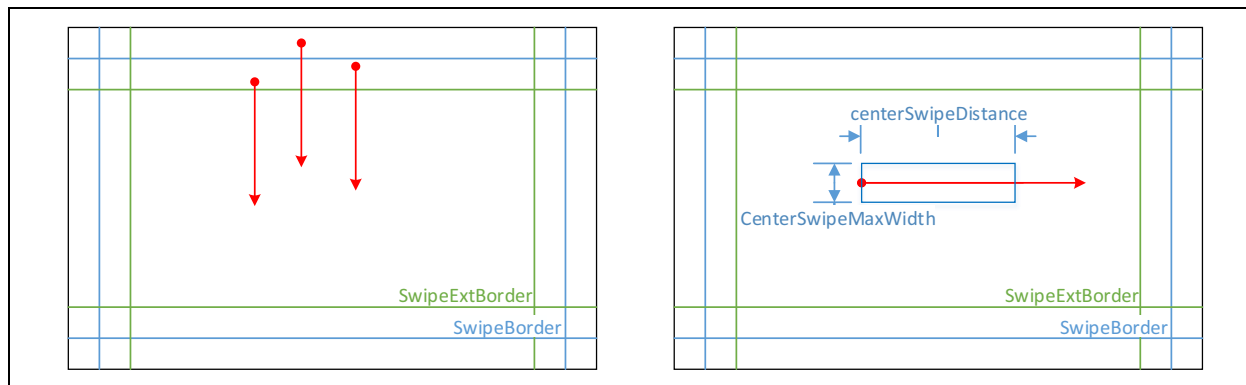
2. Ergonomic considerations also play a role: e.g., on a 3.7-inch touch surface the user would be hard pressed to correctly perform a five finger gesture.

In order for gestures to be recognized, the gesture recognition module has to be enabled and in order to output results the gesture bit has to be set in the diagnostic mask (see [Section 7.0, Sensor Design Considerations](#)).

### 11.1 Swipe Gestures

The MTCH6303 can detect two different types of swipes: swipes starting from the edge and then going towards the center of the touch surface and swipes within the central area of the sensor. The criteria used to decide when a user's movement should be considered an edge swipe are illustrated in [Figure 11-1](#) below.

**FIGURE 11-1: SWIPE GESTURES**



1. The user starts touching the surface with “n” fingers, where n is any number greater than zero. In the illustration above the user touches the surface with three fingers on the northern edge of the device.
2. The gesture recognizer checks if all fingers started on the same edge of the device. It does so in a tolerant way: i.e., if two fingers were on the northern edge, but a third finger was in the north-east corner, it would consider it to be on the northern edge. If all fingers did not start on the same edge, the gesture recognizer will abort the swipe detection at this stage.
3. To distinguish between the edge and the inner area of the surface the gesture recognizer uses two parameters: `SwipeBorder` and `SwipeExtBorder`. The two parameters are necessary for the following reasons:
  - In order to avoid the user accidentally starting a swipe gesture it is desirable to make the border area as narrow as possible.
  - However when touching with multiple fingers it is hard for the user to align all of them sufficiently

within a narrow band. Typically the contact points, when touching with multiple fingers, would be on a slight curve, not a straight line.

- To resolve this dilemma, between having narrow border area to avoid accidental swipes and having a wider one to allow for easier use with multiple fingers, the recognizer utilizes two border areas. One, `SwipeBorder`, having smaller borders and another one, `SwipeExtBorder`, with bigger borders, which is inside of it. The recognizer then only requires one finger to start within the narrower borders described by `SwipeBorder`, all the other fingers are allowed to start within the wider borders from `SwipeExtBorder` to be considered on an edge.
4. If the controller determines that the start position is not within the edge, the recognizer checks for a center swipe to have occurred. If all fingers have moved beyond a certain distance (parameter `centerSwipeDistance`) and stayed within a certain range of horizontal or vertical (parameter `centerSwipeMaxWidth`), then a center swipe message is generated.

5. If the edge criteria have been fulfilled, the user has to move all fingers towards the center. The recognizer checks if all fingers have moved beyond a certain distance (parameter `SwipeDistance`) within a specific timeout (parameter `SwipeTimeout`). For swipes starting from the northern or the southern edge, only the vertical distance is considered, while for swipes starting from the western or eastern edge only the horizontal distance is considered. Once the user has moved all touching fingers beyond the distance threshold, a swipe is reported, unless the timeout has expired. The gesture recognizer then stops the swipe detection until the user has removed all fingers from the surface and starts touching again.

**TABLE 11-1: PARAMETERS ASSOCIATED WITH SWIPE GESTURES**

| ID     | Name                  | Type   | Default (Sensor: 10137_100h) |
|--------|-----------------------|--------|------------------------------|
| 0x0500 | SwipeTimeout          | uint32 | 234375 (1.5s)                |
| 0x0501 | SwipeDistance         | uint16 | 1024                         |
| 0x0502 | SwipeBorder.Left      | uint16 | 768                          |
| 0x0503 | SwipeBorder.Right     | uint16 | 4352                         |
| 0x0504 | SwipeBorder.Top       | uint16 | 768                          |
| 0x0505 | SwipeBorder.Bottom    | uint16 | 8448                         |
| 0x0506 | SwipeExtBorder.Left   | uint16 | 1536                         |
| 0x0507 | SwipeExtBorder.Right  | uint16 | 3484                         |
| 0x0508 | SwipeExtBorder.Top    | uint16 | 1536                         |
| 0x0509 | SwipeExtBorder.Bottom | uint16 | 7680                         |
| 0x050A | centerSwipeDistance   | uint16 | 1024                         |
| 0x050B | centerSwipeMaxWidth   | uint16 | 512                          |

The unit for the timeout is in 1s/156250, so a value of 234375 corresponds to 1.5 seconds.

Distance and border are in units of internal digitizer resolution, without any coordinate transformation such as scaling or flipping applied.

**TABLE 11-2: MESSAGE OUTPUT FOR SWIPE GESTURES**

| ID   | Payload |         |
|------|---------|---------|
| 0xA0 | Flags   | Fingers |
| byte | UInt8   | UInt8   |

ID: A0

Payload:

uint8 flags; // flags describing the swipe

uint8 fingers; // number of fingers which

participated in the swipe.

Flags is a bitmask. It contains currently only one of the following values (in theory they are logically or-ed together, but practically a swipe is only from one edge, so they are mutually exclusive).

EDGE\_N 0x01 // swipe started at northern

edge

EDGE\_E 0x02 // ... eastern...

EDGE\_S 0x04 // ... southern...

EDGE\_W 0x08 // ... western...

SWIPE\_SOUTH 0x10 // center swipe moving south

SWIPE\_WEST 0x20 // center swipe moving west

SWIPE\_NORTH 0x40 // center swipe moving north

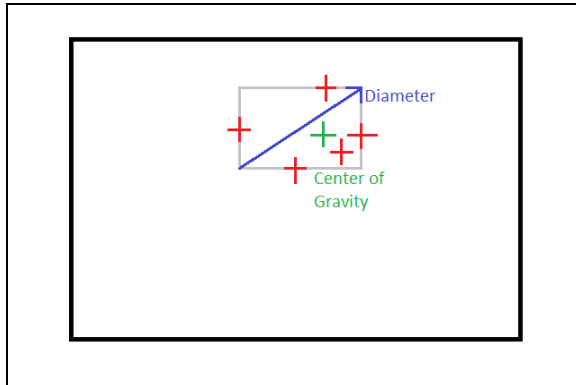
SWIPE\_EAST 0x80 // center swipe moving east

**Note:** Edge swipes are named by the edge the swipe starts from. Center swipes are named by the direction of travel.

## 11.2 Scroll Gestures

The gesture recognizer takes the incoming data of the moving fingers and derives additional data from them which can be used in an application to generate responses such as scroll, zoom and other gestures which depend on sliding fingers. As soon as the user touches the surface with *n* fingers, with *n* being any number greater than zero, the gesture recognizer continuously calculates the center of the touching points as well as the length of the diagonal of the bounding box around those points, as illustrated by the following drawing.

**FIGURE 11-2: SCROLL GESTURES**



As can be seen, the bounding box is orthogonal to the coordinate system of the surface, the edges being horizontal and vertical. There is no attempt to find a smaller bounding box for the surface contact points, which would be rotated against the surface. For two fingers the length of the diagonal of the bounding box is incidentally equal to the distance between those two fingers and the center of gravity would equal the midpoint between the two. For three or more fingers no such obvious interpretation is available, but since the bounding box circumscribes all touching fingers the behavior of the diagonal measure when spreading out those fingers on the surface or contracting them is often quite usable, depending on the application. The computation also runs when the user touches with only a single finger.

There are no parameters associated with scroll gestures.

**TABLE 11-3: MESSAGE OUTPUT FOR SCROLL GESTURES**

| ID   | Payload |        |        |         |        |
|------|---------|--------|--------|---------|--------|
| 0xA1 | Fingers | diamHi | Diam   | centerX | center |
| byte | UInt8   | UInt8  | UInt16 | UInt16  | UInt16 |

ID: 0xA1

Payload:

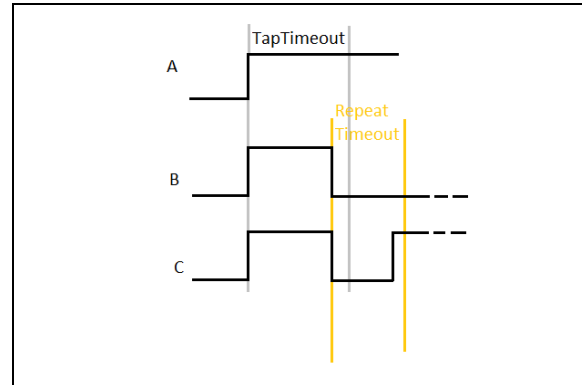
uint8 fingers; // number of fingers touching  
 uint8 diamHi; // bits 16 to 23 of diameter  
 uint16 diam; // bits 0 to 15 of diameter  
 uint16 centerX; // x of center of gravity  
 uint16 centerY; // y of center of gravity

Currently diamHi can be ignored. It is here for future compatibility.

## 11.3 Tap Gestures

There is also support in the gesture recognizer to detect short taps on the surface. The implemented algorithm also supports detection of repeated taps as well as taps with multiple fingers.

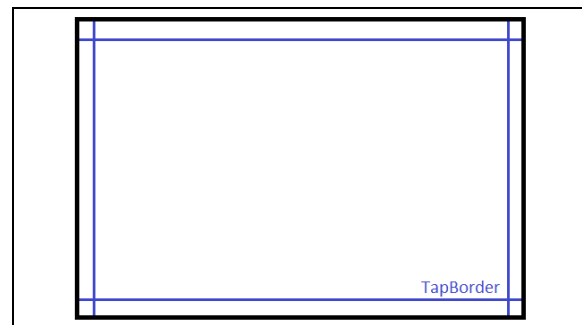
**FIGURE 11-3: TAP RECOGNIZER**



Once the user contacts the surface a timer starts running. If the user does not lift their finger(s) from the surface before TapTimeout has expired (as in part A of the drawing), the tap is considered aborted and the recognizer stops further processing. If the user lifts the finger without exceeding the timeout (as in part B and C), the recognizer considers it a tap.

If the gesture recognizer has recognized a tap a second timeout, which is used to distinguish repeated taps from single taps and is called RepeatTimeout, starts running. If the user does not touch the surface before the timer has expired (part B), the next tap will not be considered a repeated tap. Otherwise, if he does touch the surface while the timeout has not expired, the following touch will be indicated as a repeated tap.

**FIGURE 11-4: TAPBOARDER PARAMETER**



At least one finger has to be inside the area enclosed by TapBorder to start tap recognition, while the other fingers may be either outside or inside. So for a one finger tap the finger has to be inside, while for a two finger tap, one finger must be inside, while the second can be either inside or outside.

This is done because a user moving around at the edges of the surface might enter and leave the actual area where touch is detected for very short moments and thereby trigger accidental tap events. By requiring at least one finger to be inside a smaller area, this can be prevented.

**TABLE 11-4: PARAMETERS ASSOCIATED WITH THE TAP RECOGNIZER**

| ID     | Name             | Type   | Default (Sensor: 10137_100h) |
|--------|------------------|--------|------------------------------|
| 0x0540 | TapBorder.Left   | uint16 | 256                          |
| 0x0541 | TapBorder.Right  | uint16 | 4864                         |
| 0x0542 | TapBorder.Top    | uint16 | 256                          |
| 0x0543 | TapBorder.Bottom | uint16 | 8960                         |
| 0x0544 | TapTimeout       | uint32 | 31250 (200ms)                |
| 0x0545 | RepeatTimeout    | uint32 | 78125 (500ms)                |

The unit for the timeouts is 1s/156250, so a value of 31250 corresponds to 200 milliseconds and a value of 78125 to 500 milliseconds.

The border is in units of internal digitizer resolution, without any coordinate transformation such as scaling or flipping applied.

**TABLE 11-5: MESSAGE OUTPUT FOR SWIPE GESTURES**

| ID   | Payload |         |
|------|---------|---------|
| 0xA2 | Flags   | Fingers |
| byte | Uint8   | Uint8   |

ID: A2

Payload:

uint8 flags; // flags with details about the tap  
uint8 fingers; // number of fingers for this tap.

The flags field is a bitmask where the following values could be logically or-ed together:

TAPPED 0x01  
ABORTED 0x02  
NOREPEAT 0x04  
REPEAT 0x08  
EQFINGERS 0x10

If TAPPED is set it means that a tap has occurred, in that case the "fingers" field contains the number of fingers used for this tap.

The ABORTED flag is set if tap recognition has been aborted because TapTimeout has expired (part A of previous drawing). In this case the "fingers" field is not valid.

The REPEAT/NOREPEAT flags can be used to distinguish between taps which happened within a timespan of RepeatTimeout from the previous tap, or from which the previous tap has been a longer while back.

The EQFINGERS flag indicates that the previous tap was performed with the same number of fingers touching the surface than the current one.

Having all those flags allows the user to decide whether to distinguish between repeated taps and single isolated taps or not to do so by either looking at the REPEAT/NOREPEAT flags or by ignoring them. Likewise, the user may decide if a repeated tap should only be considered a repeated tap if it was performed with the same number of fingers as the previous tap by simply looking at the EQFINGERS field in addition to the REPEAT field. If the user instead does not care if a repeated tap has been performed with a different number of fingers, he can ignore the EQFINGERS flag. That way the user can chose the behavior which fits the application best.

## 12.0 ELECTRICAL SPECIFICATIONS

Absolute Maximum Ratings for the MTCH6303 devices are listed below. Stresses above those listed under the 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.

### Absolute Maximum Ratings<sup>(†)</sup>

|                                                             |                           |
|-------------------------------------------------------------|---------------------------|
| Ambient temperature under bias .....                        | -40°C to +85°C            |
| Storage temperature .....                                   | -65°C to +150°C           |
| Voltage on pins with respect to Vss                         |                           |
| on VDD pin.....                                             | -0.3V to +4.0V            |
| on any pin that is not 5V tolerant <sup>(2)</sup> .....     | -0.3V to (VDD + 0.3V)     |
| on any 5V tolerant pin when VDD ≥ 2.3V <sup>(2)</sup> ..... | -0.3V to +6.0V            |
| on any 5V tolerant pin when VDD < 2.3V <sup>(2)</sup> ..... | -0.3V to +3.6V            |
| Voltage on D+ or D- pin with respect to VUSB3V3 .....       | -0.3V to (VUSB3V3 + 0.3V) |
| Voltage on VBUS with respect to Vss .....                   | -0.3V to + 5.5V           |
| Maximum current                                             |                           |
| out of Vss pin(s).....                                      | 200 mA                    |
| into VDD pin(s) <sup>(1)</sup> .....                        | 200 mA                    |
| Maximum output current                                      |                           |
| sourced/sunk by any 4x I/O pin .....                        | 15 mA                     |
| sourced/sunk by any 8x I/O pin .....                        | 25 mA                     |
| Maximum current sunk by all ports .....                     | 150 mA                    |
| Maximum current sourced by all ports <sup>(1)</sup> .....   | 150 mA                    |

**Note 1:** Maximum allowable current is a function of device maximum power dissipation (see [Table 12-2](#))

**2:** See the [Pin Diagram](#) section for the 5V tolerant pins.

† **NOTICE:** 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.

This device is sensitive to ESD damage and must be handled appropriately. Failure to properly handle and protect the device in an application may cause partial to complete failure of the device.

### 12.1 DC Characteristics: MTCH6303

| Rating         | Min. | Typ.† | Max. | Units | Conditions |
|----------------|------|-------|------|-------|------------|
| Supply Voltage | 2.3  | —     | 3.6  | V     |            |

**TABLE 12-1: THERMAL OPERATING CONDITIONS**

| Rating                                                                                                                                                                                                                      | Symbol            | Min.                        | Typical | Max. | Unit |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|-----------------------------|---------|------|------|
| <b>Industrial Temperature Devices</b>                                                                                                                                                                                       |                   |                             |         |      |      |
| Operating Junction Temperature Range                                                                                                                                                                                        | T <sub>J</sub>    | -40                         | —       | +125 | °C   |
| Operating Ambient Temperature Range                                                                                                                                                                                         | T <sub>A</sub>    | -40                         | —       | +85  | °C   |
| <b>Power Dissipation:</b><br>Internal Chip Power Dissipation:<br>$P_{INT} = V_{DD} \times (I_{DD} - S_{IOH})$<br>I/O Pin Power Dissipation:<br>$I/O = S \{ ([V_{DD} - V_{OH}] \times I_{OH}) + S (V_{OL} \times I_{OL}) \}$ |                   |                             |         |      |      |
|                                                                                                                                                                                                                             | P <sub>D</sub>    | $P_{INT} + P_{I/O}$         |         |      |      |
| Maximum Allowed Power Dissipation                                                                                                                                                                                           | P <sub>DMAX</sub> | $(T_J - T_A) / \theta_{JA}$ |         |      |      |
|                                                                                                                                                                                                                             |                   |                             |         |      | W    |

**TABLE 12-2: THERMAL PACKAGING CHARACTERISTICS**

| Characteristics                                                     | Symbol          | Typical | Max. | Unit |
|---------------------------------------------------------------------|-----------------|---------|------|------|
| Package Thermal Resistance, 64-pin QFN (9x9x0.9 mm) <sup>(1)</sup>  | θ <sub>JA</sub> | 28      | —    | °C/W |
| Package Thermal Resistance, 64-pin TQFP (10x10x1 mm) <sup>(1)</sup> | θ <sub>JA</sub> | 47      | —    | °C/W |

**Note 1:** Junction to ambient thermal resistance, Theta-JA (θ<sub>JA</sub>) numbers are achieved by package simulations.

**TABLE 12-3: DC TEMPERATURE AND VOLTAGE SPECIFICATIONS**

| DC CHARACTERISTICS       |                  |                                                                        |         | Standard Operating Conditions:<br>(unless otherwise stated)<br>2.3V to 3.6V<br>Operating temperature -40°C ≤ T <sub>A</sub> ≤ +85°C for Industrial |       |       |            |
|--------------------------|------------------|------------------------------------------------------------------------|---------|----------------------------------------------------------------------------------------------------------------------------------------------------|-------|-------|------------|
| Param. No.               | Symbol           | Characteristics                                                        | Min.    | Typical                                                                                                                                            | Max.  | Units | Conditions |
| <b>Operating Voltage</b> |                  |                                                                        |         |                                                                                                                                                    |       |       |            |
| DC10                     | V <sub>DD</sub>  | Supply Voltage                                                         | 2.3     | —                                                                                                                                                  | 3.6   | V     | —          |
| DC12                     | V <sub>DR</sub>  | RAM Data Retention Voltage (Note 1)                                    | 1.75    | —                                                                                                                                                  | —     | V     | —          |
| DC16                     | V <sub>POR</sub> | V <sub>DD</sub> Start Voltage to Ensure Internal Power-on Reset Signal | 1.75    | —                                                                                                                                                  | 2.1   | V     | —          |
| DC17                     | SV <sub>DD</sub> | V <sub>DD</sub> Rise Rate to Ensure Internal Power-on Reset Signal     | 0.00005 | —                                                                                                                                                  | 0.115 | V/μs  | —          |

**Note 1:** This is the limit to which V<sub>DD</sub> can be lowered without losing RAM data.

**TABLE 12-4: DC CHARACTERISTICS: I/O PIN INPUT SPECIFICATIONS**

| DC CHARACTERISTICS |                 |                                              | Standard Operating Conditions:<br>(unless otherwise stated)<br>2.3V to 3.6V<br>Operating temperature -40°C ≤ TA ≤ +85°C for Industrial |                     |                     |       |                                                                                 |
|--------------------|-----------------|----------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------|---------------------|---------------------|-------|---------------------------------------------------------------------------------|
| Param. No.         | Symb.           | Characteristics                              | Min.                                                                                                                                   | Typ. <sup>(1)</sup> | Max.                | Units | Conditions                                                                      |
| DI18               | V <sub>IL</sub> | <b>Input Low Voltage</b>                     |                                                                                                                                        |                     |                     |       |                                                                                 |
|                    |                 | I/O Pins                                     | V <sub>SS</sub>                                                                                                                        | —                   | 0.2 V <sub>DD</sub> | V     |                                                                                 |
|                    |                 | SDAx, SCLx                                   | V <sub>SS</sub>                                                                                                                        | —                   | 0.3 V <sub>DD</sub> | V     |                                                                                 |
| DI19               |                 | SDAx, SCLx                                   | V <sub>SS</sub>                                                                                                                        | —                   | 0.8                 | V     |                                                                                 |
|                    | V <sub>IH</sub> | <b>Input High Voltage</b>                    |                                                                                                                                        |                     |                     |       |                                                                                 |
|                    |                 | I/O Pins 5V-tolerant with PMP <sup>(4)</sup> | 0.25 V <sub>DD</sub> + 0.8V                                                                                                            | —                   | 5.5                 | V     | (Note 5)                                                                        |
|                    |                 | I/O Pins 5V-tolerant <sup>(4)</sup>          | 0.65 V <sub>DD</sub>                                                                                                                   | —                   | 5.5                 | V     |                                                                                 |
| DI28               |                 | SDAx, SCLx                                   | 0.65 V <sub>DD</sub>                                                                                                                   | —                   | 5.5                 | V     |                                                                                 |
| DI29               |                 | SDAx, SCLx                                   | 2.1                                                                                                                                    | —                   | 5.5                 | V     |                                                                                 |
| DI50               | I <sub>IL</sub> | <b>Input Leakage Current<sup>(3)</sup></b>   |                                                                                                                                        |                     |                     |       |                                                                                 |
|                    |                 | I/O Ports                                    | —                                                                                                                                      | —                   | ±1                  | μA    | V <sub>SS</sub> ≤ V <sub>PIN</sub> ≤ V <sub>DD</sub> ,<br>Pin at high-impedance |
| DI51               |                 | Analog Input Pins                            | —                                                                                                                                      | —                   | ±1                  | μA    | V <sub>SS</sub> ≤ V <sub>PIN</sub> ≤ V <sub>DD</sub> ,<br>Pin at high-impedance |
| DI55               |                 | MCLR <sup>(2)</sup>                          | —                                                                                                                                      | —                   | ±1                  | μA    | V <sub>SS</sub> ≤ V <sub>PIN</sub> ≤ V <sub>DD</sub>                            |

- Note 1:** Data in "Typical" column is at 3.3V, 25°C unless otherwise stated. Parameters are for design guidance only and are not tested.
- Note 2:** The leakage current on the MCLR pin is strongly dependent on the applied voltage level. The specified levels represent normal operating conditions. Higher leakage current may be measured at different input voltages.
- Note 3:** Negative current is defined as current sourced by the pin.
- Note 4:** See the [Pin Diagram](#) section for the 5V tolerant pins.
- Note 5:** The V<sub>IH</sub> specifications are only in relation to externally applied inputs, and not with respect to the user-selectable internal pull-ups. External open-drain input signals utilizing the internal pull-ups of the PIC32 device are ensured to be recognized only as a logic "high" internally to the PIC32 device, provided that the external load does not exceed the minimum value of I<sub>CNPU</sub>. For External "input" logic inputs that require a pull-up source, to ensure the minimum V<sub>IH</sub> of those components, it is recommended to use an external pull-up resistor rather than the internal pull-ups of the PIC32 device.
- Note 6:** V<sub>IH</sub> source > (V<sub>DD</sub> + 0.3) for non-5V tolerant pins only.
- Note 7:** Digital 5V tolerant pins do not have an internal high side diode to V<sub>DD</sub>, and therefore, cannot tolerate any "positive" input injection current.
- Note 8:** Injection currents > |I<sub>O</sub>| can affect the ADC results by approximately 4 to 6 counts (i.e., V<sub>IH</sub> Source > (V<sub>DD</sub> + 0.3) or V<sub>IL</sub> source < (V<sub>SS</sub> - 0.3)).
- Note 9:** Any number and/or combination of I/O pins not excluded under I<sub>ICL</sub> or I<sub>ICH</sub> conditions are permitted provided the "absolute instantaneous" sum of the input injection currents from all pins do not exceed the specified limit. If **Note 7**, I<sub>ICL</sub> = (((V<sub>SS</sub> - 0.3) - V<sub>IL</sub> source) / R<sub>S</sub>). If **Note 8**, I<sub>ICH</sub> = ((I<sub>ICH</sub> source - (V<sub>DD</sub> + 0.3)) / R<sub>S</sub>). R<sub>S</sub> = Resistance between input source voltage and device pin. If (V<sub>SS</sub> - 0.3) ≤ V<sub>SOURCE</sub> ≤ (V<sub>DD</sub> + 0.3), injection current = 0.

**TABLE 12-4: DC CHARACTERISTICS: I/O PIN INPUT SPECIFICATIONS (CONTINUED)**

| DC CHARACTERISTICS |                  |                             | Standard Operating Conditions:<br>(unless otherwise stated)<br>2.3V to 3.6V<br>Operating temperature $-40^{\circ}\text{C} \leq T_A \leq +85^{\circ}\text{C}$ for Industrial |                     |                     |       |                                                                                                                                                                                                                                                  |
|--------------------|------------------|-----------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|---------------------|-------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Param. No.         | Symb.            | Characteristics             | Min.                                                                                                                                                                        | Typ. <sup>(1)</sup> | Max.                | Units | Conditions                                                                                                                                                                                                                                       |
| DI60a              | I <sub>ICL</sub> | Input Low Injection Current | 0                                                                                                                                                                           | —                   | -5 <sup>(6,9)</sup> | mA    | Pins with Analog functions. Exceptions:<br>$[N/A] = 0 \text{ mA max}$<br>Digital 5V tolerant designated pins. Exceptions:<br>$[N/A] = 0 \text{ mA max}$<br>Digital non-5V tolerant designated pins.<br>Exceptions:<br>$[N/A] = 0 \text{ mA max}$ |

**Note 1:** Data in "Typical" column is at 3.3V, 25°C unless otherwise stated. Parameters are for design guidance only and are not tested.

- 2:** The leakage current on the MCLR pin is strongly dependent on the applied voltage level. The specified levels represent normal operating conditions. Higher leakage current may be measured at different input voltages.
- 3:** Negative current is defined as current sourced by the pin.
- 4:** See the [Pin Diagram](#) section for the 5V tolerant pins.
- 5:** The V<sub>IH</sub> specifications are only in relation to externally applied inputs, and not with respect to the user-selectable internal pull-ups. External open-drain input signals utilizing the internal pull-ups of the PIC32 device are ensured to be recognized only as a logic "high" internally to the PIC32 device, provided that the external load does not exceed the minimum value of I<sub>CNPU</sub>. For External "input" logic inputs that require a pull-up source, to ensure the minimum V<sub>IH</sub> of those components, it is recommended to use an external pull-up resistor rather than the internal pull-ups of the PIC32 device.
- 6:** V<sub>IH</sub> source > (V<sub>DD</sub> + 0.3) for non-5V tolerant pins only.
- 7:** Digital 5V tolerant pins do not have an internal high side diode to V<sub>DD</sub>, and therefore, cannot tolerate any "positive" input injection current.
- 8:** Injection currents > 10 μA can affect the ADC results by approximately 4 to 6 counts (i.e., V<sub>IH</sub> Source > (V<sub>DD</sub> + 0.3) or V<sub>IL</sub> source < (V<sub>SS</sub> - 0.3)).
- 9:** Any number and/or combination of I/O pins not excluded under I<sub>ICL</sub> or I<sub>ICH</sub> conditions are permitted provided the "absolute instantaneous" sum of the input injection currents from all pins do not exceed the specified limit. If **Note 7**,  $I_{ICL} = (((V_{SS} - 0.3) - V_{IL} \text{ source}) / R_s)$ . If **Note 8**,  $I_{ICH} = ((I_{ICH} \text{ source} - (V_{DD} + 0.3)) / R_s)$ . R<sub>S</sub> = Resistance between input source voltage and device pin. If  $(V_{SS} - 0.3) \leq V_{SOURCE} \leq (V_{DD} + 0.3)$ , injection current = 0.

**TABLE 12-4: DC CHARACTERISTICS: I/O PIN INPUT SPECIFICATIONS (CONTINUED)**

| DC CHARACTERISTICS |                  |                                                                 | Standard Operating Conditions:<br>(unless otherwise stated)<br>2.3V to 3.6V<br>Operating temperature $-40^{\circ}\text{C} \leq T_A \leq +85^{\circ}\text{C}$ for Industrial |                     |                       |       |                                                                                                                                    |
|--------------------|------------------|-----------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|-----------------------|-------|------------------------------------------------------------------------------------------------------------------------------------|
| Param. No.         | Symb.            | Characteristics                                                 | Min.                                                                                                                                                                        | Typ. <sup>(1)</sup> | Max.                  | Units | Conditions                                                                                                                         |
| DI60b              | I <sub>ICH</sub> | Input High Injection Current                                    | 0                                                                                                                                                                           | —                   | +5 <sup>(7,8,9)</sup> | mA    | Pins with Analog functions. Exceptions: [SOSC] = 0 mA max.                                                                         |
|                    |                  |                                                                 |                                                                                                                                                                             |                     |                       |       | Digital 5V tolerant designated pins ( $V_{IH} < 5.5\text{V}$ ) <sup>(8)</sup> . Exceptions: [All] = 0 mA max.                      |
|                    |                  |                                                                 |                                                                                                                                                                             |                     |                       |       | Digital non-5V tolerant designated pins. Exceptions: [N/A] = 0 mA max.                                                             |
| DI60c              | $\Sigma I_{ICT}$ | Total Input Injection Current (sum of all I/O and control pins) | -20 <sup>(11)</sup>                                                                                                                                                         | —                   | +20 <sup>(9)</sup>    | mA    | Absolute instantaneous sum of all $\pm$ input injection currents from all I/O pins ( $ I_{ICL}  +  I_{ICH}  \leq \Sigma I_{ICT}$ ) |

- Note 1:** Data in "Typical" column is at 3.3V, 25°C unless otherwise stated. Parameters are for design guidance only and are not tested.
- 2:** The leakage current on the MCLR pin is strongly dependent on the applied voltage level. The specified levels represent normal operating conditions. Higher leakage current may be measured at different input voltages.
- 3:** Negative current is defined as current sourced by the pin.
- 4:** See the [Pin Diagram](#) section for the 5V tolerant pins.
- 5:** The  $V_{IH}$  specifications are only in relation to externally applied inputs, and not with respect to the user-selectable internal pull-ups. External open-drain input signals utilizing the internal pull-ups of the PIC32 device are ensured to be recognized only as a logic "high" internally to the PIC32 device, provided that the external load does not exceed the minimum value of  $I_{CNP}$ . For External "input" logic inputs that require a pull-up source, to ensure the minimum  $V_{IH}$  of those components, it is recommended to use an external pull-up resistor rather than the internal pull-ups of the PIC32 device.
- 6:**  $V_{IH}$  source  $> (V_{DD} + 0.3)$  for non-5V tolerant pins only.
- 7:** Digital 5V tolerant pins do not have an internal high side diode to  $V_{DD}$ , and therefore, cannot tolerate any "positive" input injection current.
- 8:** Injection currents  $> 10\mu\text{A}$  can affect the ADC results by approximately 4 to 6 counts (i.e.,  $V_{IH}$  Source  $> (V_{DD} + 0.3)$  or  $V_{IL}$  source  $< (V_{SS} - 0.3)$ ).
- 9:** Any number and/or combination of I/O pins not excluded under  $I_{ICL}$  or  $I_{ICH}$  conditions are permitted provided the "absolute instantaneous" sum of the input injection currents from all pins do not exceed the specified limit. If **Note 7**,  $I_{ICL} = (((V_{SS} - 0.3) - V_{IL} \text{ source}) / R_S)$ . If **Note 8**,  $I_{ICH} = ((I_{CH} \text{ source} - (V_{DD} + 0.3)) / R_S)$ .  $R_S$  = Resistance between input source voltage and device pin. If  $(V_{SS} - 0.3) \leq V_{SOURCE} \leq (V_{DD} + 0.3)$ , injection current = 0.

**TABLE 12-5: DC CHARACTERISTICS: I/O PIN OUTPUT SPECIFICATIONS**

| DC CHARACTERISTICS |        |                                                                                                                             | Standard Operating Conditions:<br>(unless otherwise stated)<br>2.3V to 3.6V<br>Operating temperature $-40^{\circ}\text{C} \leq T_A \leq +85^{\circ}\text{C}$ for Industrial |      |      |       |                                                      |
|--------------------|--------|-----------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|------|-------|------------------------------------------------------|
| Param.             | Symbol | Characteristic                                                                                                              | Min.                                                                                                                                                                        | Typ. | Max. | Units | Conditions                                           |
| DO10               | VOL    | <b>Output Low Voltage</b><br>I/O Pins:<br>4x Sink Driver Pins – All I/O output pins not defined as 8x Sink Driver pins      | —                                                                                                                                                                           | —    | 0.4  | V     | $I_{OL} \leq 9\text{ mA}$ , $V_{DD} = 3.3\text{V}$   |
|                    |        | <b>Output Low Voltage</b><br>I/O Pins:<br>8x Sink Driver Pins – RC15, RD2, RD10, RF6, RG6                                   | —                                                                                                                                                                           | —    | 0.4  | V     | $I_{OL} \leq 15\text{ mA}$ , $V_{DD} = 3.3\text{V}$  |
| DO20               | VOH    | <b>Output High Voltage</b><br>I/O Pins:<br>4x Source Driver Pins – All I/O output pins not defined as 8x Source Driver pins | 2.4                                                                                                                                                                         | —    | —    | V     | $I_{OH} \geq -10\text{ mA}$ , $V_{DD} = 3.3\text{V}$ |
|                    |        | <b>Output High Voltage</b><br>I/O Pins:<br>8x Source Driver Pins – RC15, RD2, RD10, RF6, RG6                                | 2.4                                                                                                                                                                         | —    | —    | V     | $I_{OH} \geq -15\text{ mA}$ , $V_{DD} = 3.3\text{V}$ |
| DO20A              | VOH1   | <b>Output High Voltage</b><br>I/O Pins:<br>4x Source Driver Pins – All I/O output pins not defined as 8x Sink Driver pins   | 1.5 <sup>(1)</sup>                                                                                                                                                          | —    | —    | V     | $I_{OH} \geq -14\text{ mA}$ , $V_{DD} = 3.3\text{V}$ |
|                    |        |                                                                                                                             | 2.0 <sup>(1)</sup>                                                                                                                                                          | —    | —    |       | $I_{OH} \geq -12\text{ mA}$ , $V_{DD} = 3.3\text{V}$ |
|                    |        |                                                                                                                             | 3.0 <sup>(1)</sup>                                                                                                                                                          | —    | —    |       | $I_{OH} \geq -7\text{ mA}$ , $V_{DD} = 3.3\text{V}$  |
|                    |        | <b>Output High Voltage</b><br>I/O Pins:<br>8x Source Driver Pins – RC15, RD2, RD10, RF6, RG6                                | 1.5 <sup>(1)</sup>                                                                                                                                                          | —    | —    | V     | $I_{OH} \geq -22\text{ mA}$ , $V_{DD} = 3.3\text{V}$ |
|                    |        |                                                                                                                             | 2.0 <sup>(1)</sup>                                                                                                                                                          | —    | —    |       | $I_{OH} \geq -18\text{ mA}$ , $V_{DD} = 3.3\text{V}$ |
|                    |        |                                                                                                                             | 3.0 <sup>(1)</sup>                                                                                                                                                          | —    | —    |       | $I_{OH} \geq -10\text{ mA}$ , $V_{DD} = 3.3\text{V}$ |

**Note 1:** Parameters are characterized, but not tested.

**TABLE 12-6: ELECTRICAL CHARACTERISTICS: BOR**

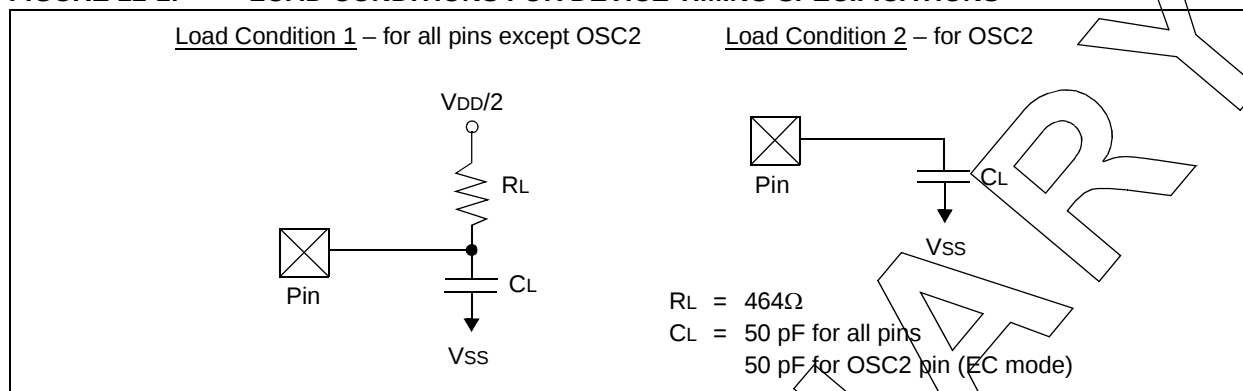
| DC CHARACTERISTICS |        |                                              | Standard Operating Conditions:<br>(unless otherwise stated)<br>2.3V to 3.6V<br>Operating temperature $-40^{\circ}\text{C} \leq T_A \leq +85^{\circ}\text{C}$ for Industrial |         |      |       |            |
|--------------------|--------|----------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------|------|-------|------------|
| Param. No.         | Symbol | Characteristics                              | Min. <sup>(1)</sup>                                                                                                                                                         | Typical | Max. | Units | Conditions |
| BO10               | VBOR   | BOR Event on $V_{DD}$ transition high-to-low | 2.0                                                                                                                                                                         | —       | 2.3  | V     | —          |

**Note 1:** Parameters are for design guidance only and are not tested in manufacturing.

## 12.2 AC Characteristics and Timing Parameters

The information contained in this section defines MTCH6303 AC characteristics and timing parameters.

**FIGURE 12-1: LOAD CONDITIONS FOR DEVICE TIMING SPECIFICATIONS**

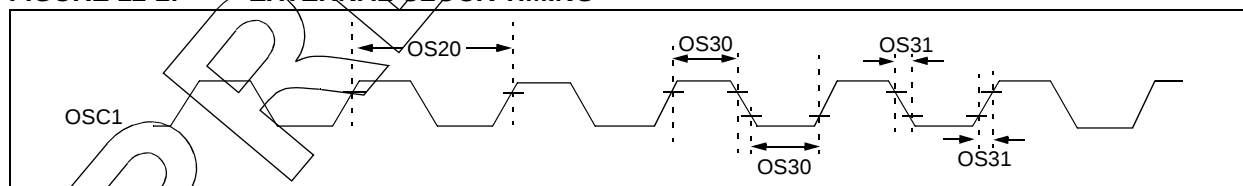


**TABLE 12-7: CAPACITIVE LOADING REQUIREMENTS ON OUTPUT PINS**

| AC CHARACTERISTICS |        |                       | Standard Operating Conditions:<br>(unless otherwise stated)<br>2.3V to 3.6V<br>Operating temperature $-40^\circ\text{C} \leq T_A \leq +85^\circ\text{C}$ for Industrial |                        |      |       |                                                                   |
|--------------------|--------|-----------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------|------|-------|-------------------------------------------------------------------|
| Param. No.         | Symbol | Characteristics       | Min.                                                                                                                                                                    | Typical <sup>(1)</sup> | Max. | Units | Conditions                                                        |
| DO50               | Cosco  | OSC2 pin              | —                                                                                                                                                                       | —                      | 15   | pF    | In XT and HS modes when an external crystal is used to drive OSC1 |
| DO50a              | Csosc  | SOSCI/SOSCO pins      | —                                                                                                                                                                       | 33                     | —    | pF    | Epson P/N: MC-306<br>32.7680K-A0:ROHS                             |
| DO56               | Cio    | All I/O pins and OSC2 | —                                                                                                                                                                       | —                      | 50   | pF    | EC mode                                                           |
| DO58               | CB     | SCLx, SDAx            | —                                                                                                                                                                       | —                      | 400  | pF    | In I <sup>2</sup> C™ mode                                         |

**Note 1:** Data in "Typical" column is at 3.3V, 25°C unless otherwise stated. Parameters are for design guidance only and are not tested.

**FIGURE 12-2: EXTERNAL CLOCK TIMING**

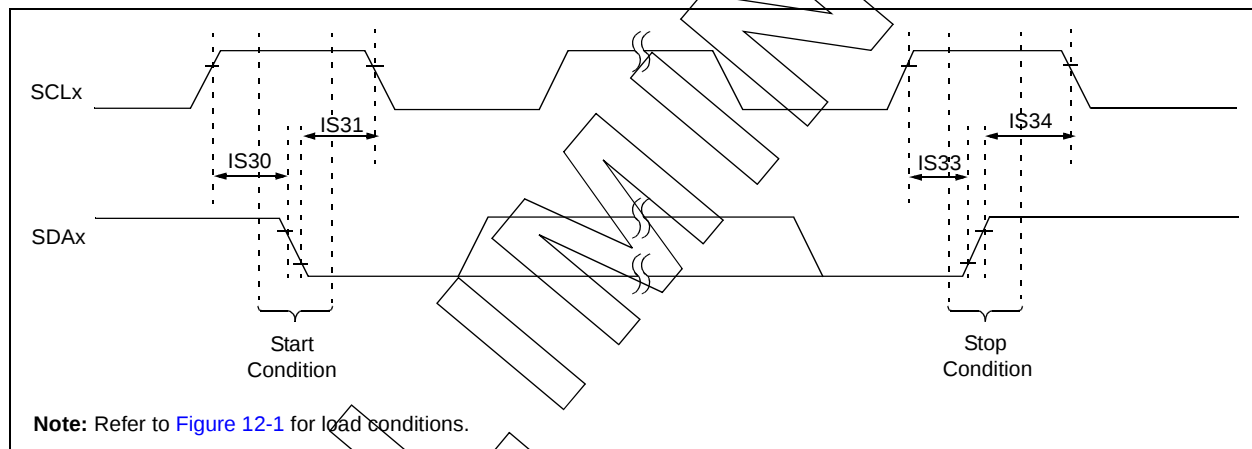


**TABLE 12-8: EXTERNAL CLOCK TIMING REQUIREMENTS**

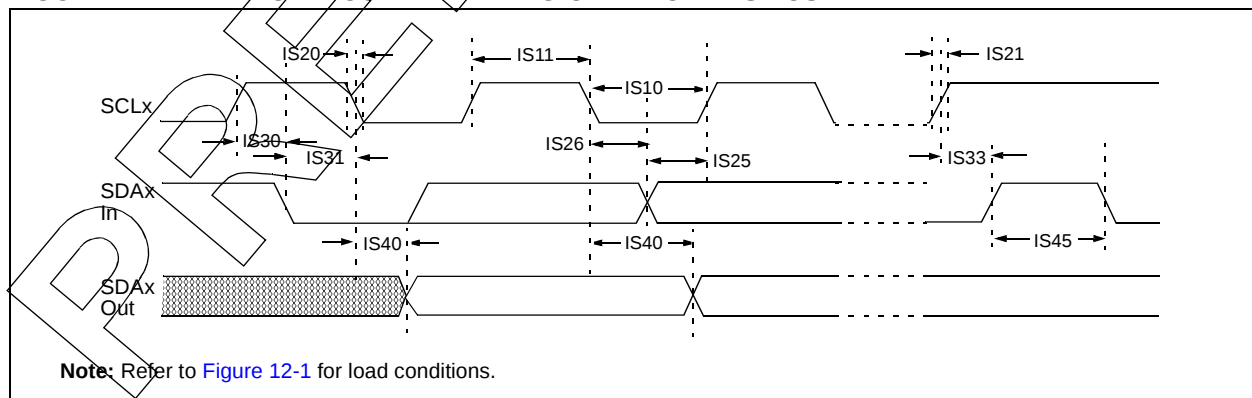
| AC CHARACTERISTICS |        |                                                                | Standard Operating Conditions:<br>(unless otherwise stated)<br>2.3V to 3.6V<br>Operating temperature $-40^{\circ}\text{C} \leq T_A \leq +85^{\circ}\text{C}$ for Industrial |                        |      |       |                                                            |
|--------------------|--------|----------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------|------|-------|------------------------------------------------------------|
| Param. No.         | Symbol | Characteristics                                                | Min.                                                                                                                                                                        | Typical <sup>(1)</sup> | Max. | Units | Conditions                                                 |
| OS11               | Fosc   | Oscillator Crystal Frequency                                   | —                                                                                                                                                                           | 8                      | —    | MHz   | XT (Note)                                                  |
| OS20               | Tosc   | $Tosc = 1/Fosc = Tcy$ <sup>(1)</sup>                           | —                                                                                                                                                                           | —                      | —    | —     | See parameter OS10 for Fosc value                          |
| OS41               | TFSCM  | Primary Clock Fail Safe Time-out Period                        | —                                                                                                                                                                           | 2                      | —    | ms    | (Note)                                                     |
| OS42               | GM     | External Oscillator Transconductance (Primary Oscillator only) | —                                                                                                                                                                           | 12                     | —    | mA/V  | $V_{DD} = 3.3V$ ,<br>$T_A = +25^{\circ}\text{C}$<br>(Note) |

**Note 1:** The external clock is required for USB operation and not needed for I<sup>2</sup>C™ operation.

**FIGURE 12-3: I<sup>2</sup>C™ BUS START/STOP BITS TIMING CHARACTERISTICS**



**FIGURE 12-4: I<sup>2</sup>C™ BUS DATA TIMING CHARACTERISTICS**



**TABLE 12-9: I<sup>2</sup>C™ BUS DATA TIMING REQUIREMENTS**

| AC CHARACTERISTICS |         |                            |              | Standard Operating Conditions:<br>(unless otherwise stated)<br>2.3V to 3.6V<br>Operating temperature -40°C ≤ Ta ≤ +85°C for Industrial |      |       |                                                                             |
|--------------------|---------|----------------------------|--------------|----------------------------------------------------------------------------------------------------------------------------------------|------|-------|-----------------------------------------------------------------------------|
| Param. No.         | Symbol  | Characteristics            |              | Min.                                                                                                                                   | Max. | Units | Conditions                                                                  |
| IS10               | TLO:SCL | Clock Low Time             | 100 kHz mode | 4.7                                                                                                                                    | —    | μs    | PBCLK must operate at a minimum of 800 kHz                                  |
|                    |         |                            | 400 kHz mode | 1.3                                                                                                                                    | —    | μs    | PBCLK must operate at a minimum of 3.2 MHz                                  |
| IS11               | THI:SCL | Clock High Time            | 100 kHz mode | 4.0                                                                                                                                    | —    | μs    | PBCLK must operate at a minimum of 800 kHz                                  |
|                    |         |                            | 400 kHz mode | 0.6                                                                                                                                    | —    | μs    | PBCLK must operate at a minimum of 3.2 MHz                                  |
| IS20               | TF:SCL  | SDAx and SCLx Fall Time    | 100 kHz mode | —                                                                                                                                      | 300  | ns    | Cb is specified to be from 10 to 400 pF                                     |
|                    |         |                            | 400 kHz mode | 20 + 0.1 Cb                                                                                                                            | 300  | ns    |                                                                             |
| IS21               | TR:SCL  | SDAx and SCLx Rise Time    | 100 kHz mode | —                                                                                                                                      | 1000 | ns    | Cb is specified to be from 10 to 400 pF                                     |
|                    |         |                            | 400 kHz mode | 20 + 0.1 Cb                                                                                                                            | 300  | ns    |                                                                             |
| IS25               | TSU:DAT | Data Input Setup Time      | 100 kHz mode | 250                                                                                                                                    | —    | ns    | —                                                                           |
|                    |         |                            | 400 kHz mode | 100                                                                                                                                    | —    | ns    |                                                                             |
| IS26               | THD:DAT | Data Input Hold Time       | 100 kHz mode | 0                                                                                                                                      | —    | ns    | —                                                                           |
|                    |         |                            | 400 kHz mode | 0                                                                                                                                      | 0.9  | μs    |                                                                             |
| IS30               | TSU:STA | Start Condition Setup Time | 100 kHz mode | 4700                                                                                                                                   | —    | ns    | Only relevant for Repeated Start condition                                  |
|                    |         |                            | 400 kHz mode | 600                                                                                                                                    | —    | ns    |                                                                             |
| IS31               | 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    |                                                                             |
| IS33               | TSU:STO | Stop Condition Setup Time  | 100 kHz mode | 4000                                                                                                                                   | —    | ns    | —                                                                           |
|                    |         |                            | 400 kHz mode | 600                                                                                                                                    | —    | ns    |                                                                             |
| IS34               | THD:STO | Stop Condition Hold Time   | 100 kHz mode | 4000                                                                                                                                   | —    | ns    | —                                                                           |
|                    |         |                            | 400 kHz mode | 600                                                                                                                                    | —    | ns    |                                                                             |
| IS40               | TAA:SCL | Output Valid from Clock    | 100 kHz mode | 0                                                                                                                                      | 3500 | ns    | —                                                                           |
|                    |         |                            | 400 kHz mode | 0                                                                                                                                      | 1000 | ns    |                                                                             |
| IS45               | TBF:SDA | Bus Free Time              | 100 kHz mode | 4.7                                                                                                                                    | —    | μs    | The amount of time the bus must be free before a new transmission can start |
|                    |         |                            | 400 kHz mode | 1.3                                                                                                                                    | —    | μs    |                                                                             |
| IS50               | Cb      | Bus Capacitive Loading     |              | —                                                                                                                                      | 400  | pF    | —                                                                           |

## 13.0 ORDERING INFORMATION

**TABLE 13-1: ORDERING INFORMATION**

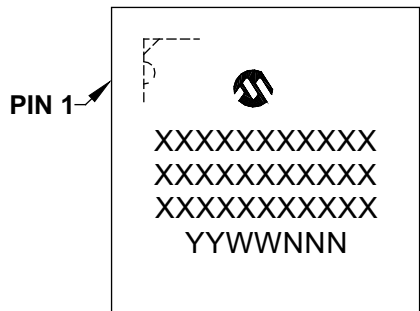
| Part Number    | Pin Package            | Packing |
|----------------|------------------------|---------|
| MTCH6303-I/PT  | 64-Lead TQFP (10x10mm) | Tray    |
| MTCH6303-I/RG  | 64-Lead QFN (9x9mm)    | Tube    |
| MTCH6303T-I/PT | 64-Lead TQFP (10x10mm) | T/R     |
| MTCH6303T-I/RG | 64-Lead QFN (9x9mm)    | T/R     |

# MTCH6303

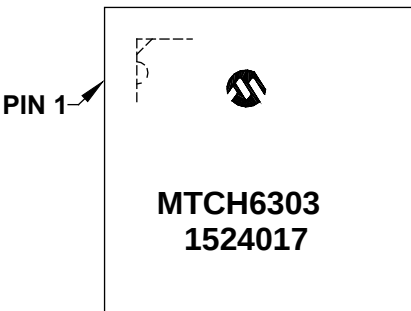
## 14.0 PACKAGING INFORMATION

### 14.1 Package Marking Information

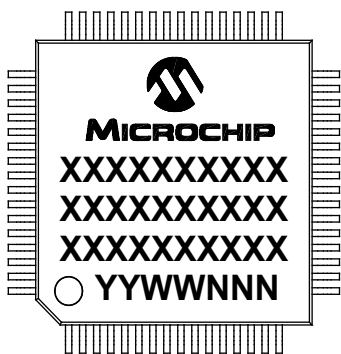
64-Lead QFN (9x9x0.9 mm)



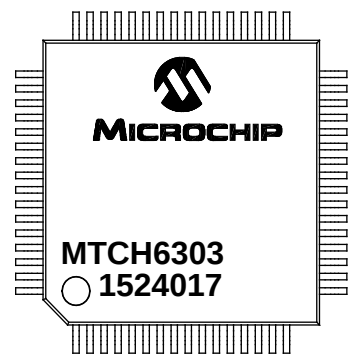
Example



64-Lead TQFP (10x10x1 mm)



Example



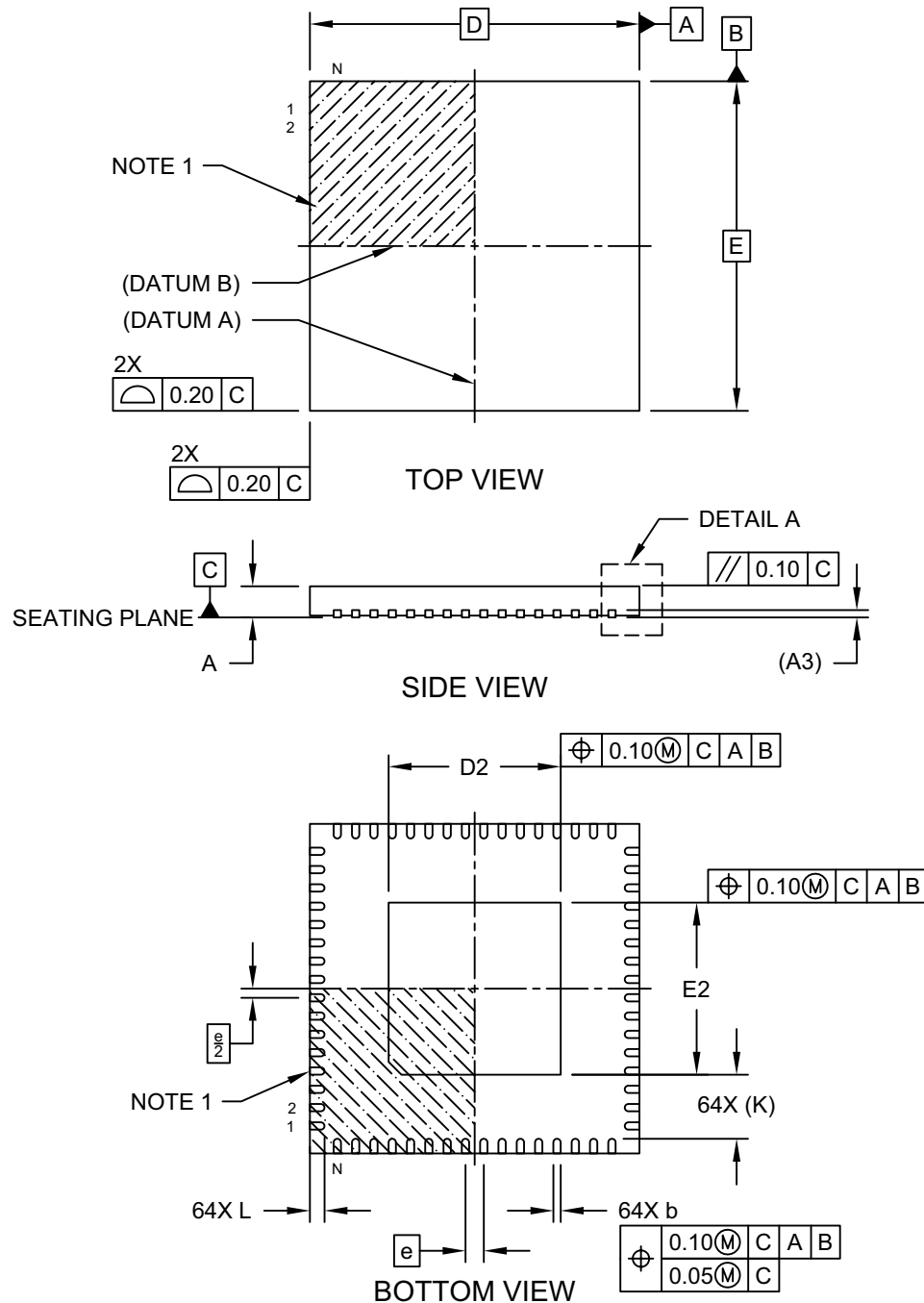
|                |                                                                                                                                                                                                         |                                                                                                                     |
|----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------|
| <b>Legend:</b> | 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. |
| <b>Note:</b>   | 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. |                                                                                                                     |

## 14.2 Package Details

The following sections give the technical details of the packages.

**64-Terminal Plastic Quad Flat Pack, No Lead (RG) 9x9x0.9 mm Body [QFN]  
Saw Singulated**

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

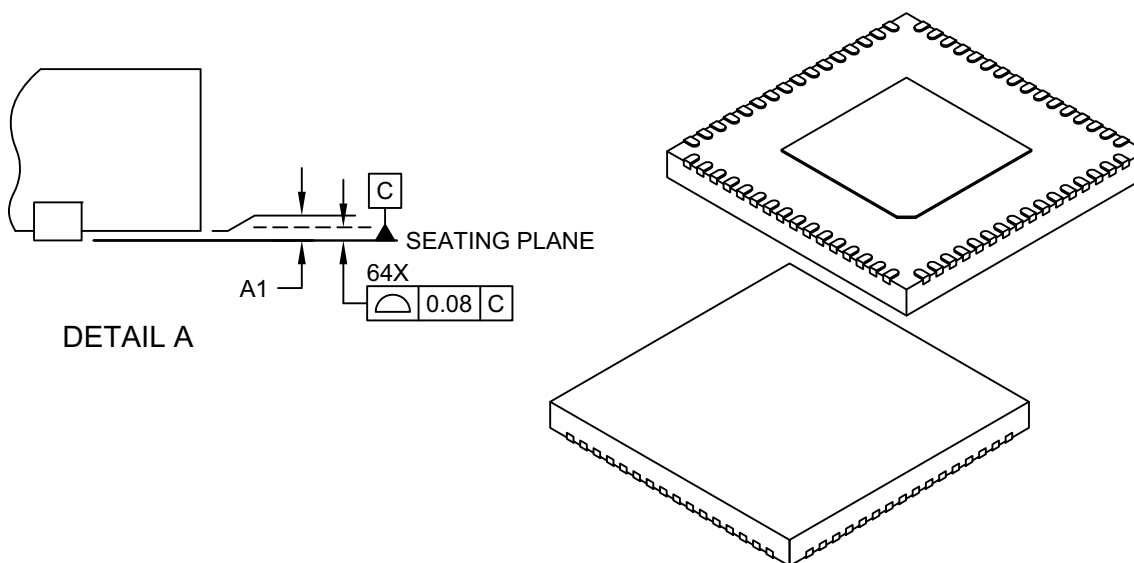


Microchip Technology Drawing C04-260A Sheet 1 of 2

# MTCH6303

## 64-Terminal Plastic Quad Flat Pack, No Lead (RG) 9x9x0.9 mm Body [QFN] Saw Singulated

**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 Terminals     | N  | 64          |      |      |
| Pitch                   | e  | 0.50 BSC    |      |      |
| Overall Height          | A  | 0.80        | 0.85 | 0.90 |
| Standoff                | A1 | 0.00        | 0.02 | 0.05 |
| Standoff                | A3 | 0.20 REF    |      |      |
| Overall Width           | E  | 9.00 BSC    |      |      |
| Exposed Pad Width       | E2 | 4.60        | 4.70 | 4.80 |
| Overall Length          | D  | 9.00 BSC    |      |      |
| Exposed Pad Length      | D2 | 4.60        | 4.70 | 4.80 |
| Terminal Width          | b  | 0.15        | 0.20 | 0.25 |
| Terminal Length         | L  | 0.30        | 0.40 | 0.50 |
| Terminal-to-Exposed-Pad | K  | 1.755 REF   |      |      |

### Notes:

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

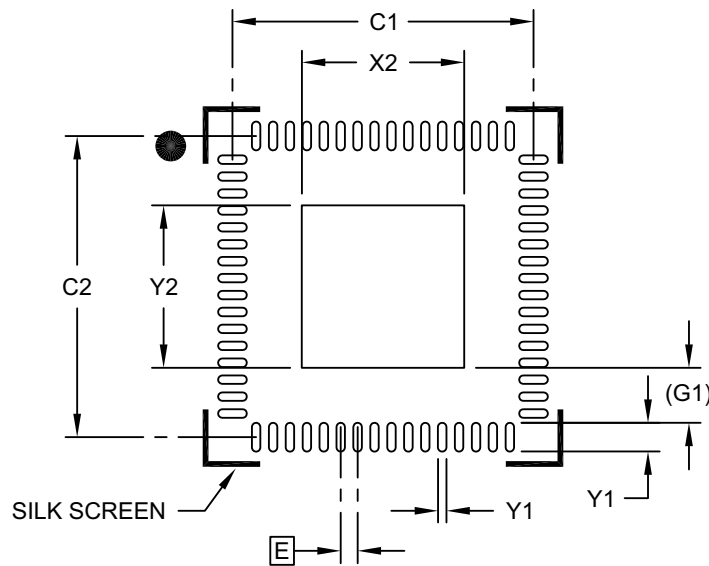
BSC: Basic Dimension. Theoretically exact value shown without tolerances.

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

Microchip Technology Drawing C04-260A Sheet 2 of 2

## 64-Lead Very Thin Plastic Quad Flat, No Lead Package (RG) - 9x9x1.0 mm Body [QFN] 4.7x4.7 mm Exposed Pad

**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  | 0.50 BSC    |      |      |
| Optional Center Pad Width       | X2 |             |      | 4.80 |
| Optional Center Pad Length      | Y2 |             |      | 4.80 |
| Contact Pad Spacing             | C1 |             | 8.90 |      |
| Contact Pad Spacing             | C2 |             | 8.90 |      |
| Contact Pad Width (X64)         | X1 |             |      | 0.25 |
| Contact Pad Length (X64)        | Y1 |             |      | 0.85 |
| Contact Pad to Center Pad (X64) | G1 | 1.625 REF   |      |      |

**Notes:**

1. Dimensioning and tolerancing per ASME Y14.5M

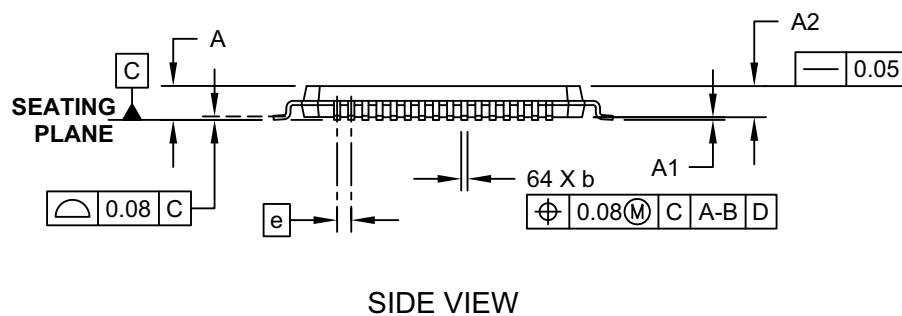
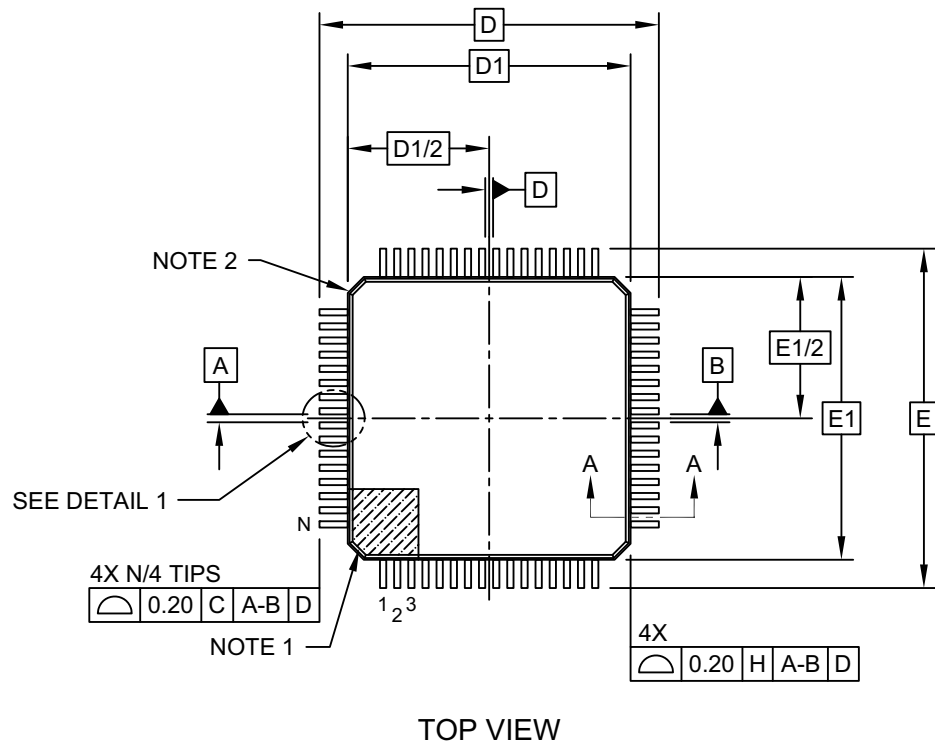
BSC: Basic Dimension. Theoretically exact value shown without tolerances.

Microchip Technology Drawing C04-2260A

# MTCH6303

## 64-Lead Plastic Thin Quad Flatpack (PT)-10x10x1 mm Body, 2.00 mm Footprint [TQFP]

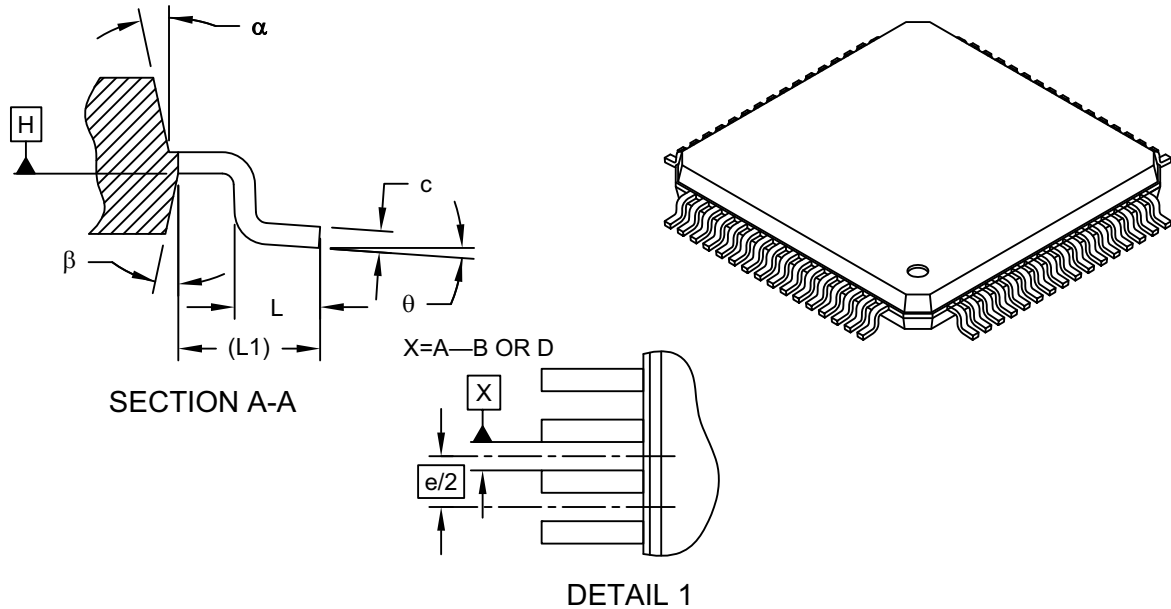
**Note:** For the most current package drawings, please see the Microchip Packaging Specification located at <http://www.microchip.com/packaging>



Microchip Technology Drawing C04-085C Sheet 1 of 2

## 64-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>



| Units                    |       | MILLIMETERS |      |      |
|--------------------------|-------|-------------|------|------|
| Dimension Limits         |       | MIN         | NOM  | MAX  |
| Number of Leads          | N     | 64          |      |      |
| Lead Pitch               | e     | 0.50 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               | phi   | 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     | 0.17        | 0.22 | 0.27 |
| Mold Draft Angle Top     | alpha | 11°         | 12°  | 13°  |
| Mold Draft Angle Bottom  | beta  | 11°         | 12°  | 13°  |

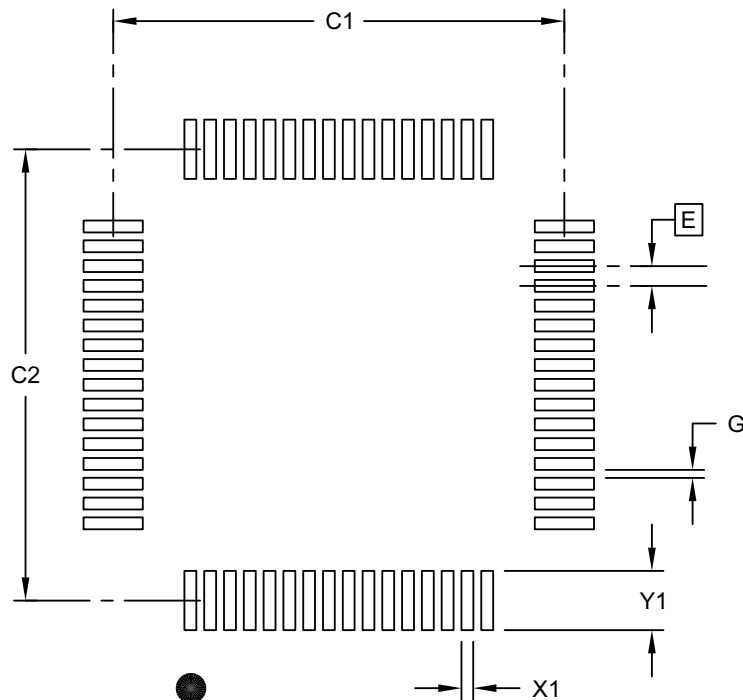
**Notes:**

- Pin 1 visual index feature may vary, but must be located within the hatched area.
- Chamfers at corners are optional; size may vary.
- Dimensions D1 and E1 do not include mold flash or protrusions. Mold flash or protrusions shall not exceed 0.25mm per side.
- 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 C04-085C Sheet 2 of 2

## 64-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  | 0.50 BSC    |       |      |
| Contact Pad Spacing      | C1 |             | 11.40 |      |
| Contact Pad Spacing      | C2 |             | 11.40 |      |
| Contact Pad Width (X28)  | X1 |             |       | 0.30 |
| Contact Pad Length (X28) | Y1 |             |       | 1.50 |
| Distance Between Pads    | G  | 0.20        |       |      |

**Notes:**

1. Dimensioning and tolerancing per ASME Y14.5M

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

Microchip Technology Drawing C04-2085B Sheet 1 of 1

## APPENDIX A: REVISION HISTORY

### Revision A (06/2015)

Initial release of this document.

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| <u>PART NO.</u>                                                                                                                                                                                                                                                                                                                                                                                                            | <u>[X]<sup>(1)</sup></u> | <u>X</u>          | <u>/XX</u> | <u>XXX</u> |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------|-------------------|------------|------------|
| Device                                                                                                                                                                                                                                                                                                                                                                                                                     | Tape and Reel Option     | Temperature Range | Package    | Pattern    |
| <div> <div> <b>Device:</b> MTCH6303 </div> <div> <b>Tape and Reel Option:</b> <div> Blank = Standard packaging (tube or tray) T = Tape and Reel<sup>(1)</sup> </div> </div> <div> <b>Temperature Range:</b> <div> I = -40°C to +85°C (Industrial) </div> </div> <div> <b>Package:</b> <div> RG = QFN PT = TQFP </div> </div> <div> <b>Pattern:</b> QTP, SQTP, Code or Special Requirements (blank otherwise) </div> </div> |                          |                   |            |            |
| <b>Examples:</b><br>a) MTCH6303-I/PT = Industrial Temp TQFP package.                                                                                                                                                                                                                                                                                                                                                       |                          |                   |            |            |
| <b>Note 1:</b> 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. Check with your Microchip Sales Office for package availability with the Tape and Reel option.                                                                                                                                        |                          |                   |            |            |

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Fax: 86-10-8528-2104

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Tel: 86-28-8665-5511  
Fax: 86-28-8665-7889

**China - Chongqing**  
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**China - Hong Kong SAR**  
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**China - Nanjing**  
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**China - Qingdao**  
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Fax: 86-532-8502-7205

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**China - Shenyang**  
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Fax: 86-24-2334-2393

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Fax: 86-755-8203-1760

**China - Wuhan**  
Tel: 86-27-5980-5300  
Fax: 86-27-5980-5118

**China - Xian**  
Tel: 86-29-8833-7252  
Fax: 86-29-8833-7256

### ASIA/PACIFIC

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Fax: 86-592-2388130

**China - Zhuhai**  
Tel: 86-756-3210040  
Fax: 86-756-3210049

**India - Bangalore**  
Tel: 91-80-3090-4444  
Fax: 91-80-3090-4123

**India - New Delhi**  
Tel: 91-11-4160-8631  
Fax: 91-11-4160-8632

**India - Pune**  
Tel: 91-20-3019-1500

**Japan - Osaka**  
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Fax: 81-6-6152-9310

**Japan - Tokyo**  
Tel: 81-3-6880-3770  
Fax: 81-3-6880-3771

**Korea - Daegu**  
Tel: 82-53-744-4301  
Fax: 82-53-744-4302

**Korea - Seoul**  
Tel: 82-2-554-7200  
Fax: 82-2-558-5932 or  
82-2-558-5934

**Malaysia - Kuala Lumpur**  
Tel: 60-3-6201-9857  
Fax: 60-3-6201-9859

**Malaysia - Penang**  
Tel: 60-4-227-8870  
Fax: 60-4-227-4068

**Philippines - Manila**  
Tel: 63-2-634-9065  
Fax: 63-2-634-9069

**Singapore**  
Tel: 65-6334-8870  
Fax: 65-6334-8850

**Taiwan - Hsin Chu**  
Tel: 886-3-5778-366  
Fax: 886-3-5770-955

**Taiwan - Kaohsiung**  
Tel: 886-7-213-7828

**Taiwan - Taipei**  
Tel: 886-2-2508-8600  
Fax: 886-2-2508-0102

**Thailand - Bangkok**  
Tel: 66-2-694-1351  
Fax: 66-2-694-1350

### EUROPE

**Austria - Wels**  
Tel: 43-7242-2244-39  
Fax: 43-7242-2244-393

**Denmark - Copenhagen**  
Tel: 45-4450-2828  
Fax: 45-4485-2829

**France - Paris**  
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Fax: 33-1-69-30-90-79

**Germany - Dusseldorf**  
Tel: 49-2129-3766400

**Germany - Munich**  
Tel: 49-89-627-144-0  
Fax: 49-89-627-144-44

**Germany - Pforzheim**  
Tel: 49-7231-424750

**Italy - Milan**  
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Fax: 39-0331-466781

**Italy - Venice**  
Tel: 39-049-7625286

**Netherlands - Drunen**  
Tel: 31-416-690399  
Fax: 31-416-690340

**Poland - Warsaw**  
Tel: 48-22-3325737

**Spain - Madrid**  
Tel: 34-91-708-08-90  
Fax: 34-91-708-08-91

**Sweden - Stockholm**  
Tel: 46-8-5090-4654

**UK - Wokingham**  
Tel: 44-118-921-5800  
Fax: 44-118-921-5820

01/27/15



Компания «ЭлектроПласт» предлагает заключение долгосрочных отношений при поставках импортных электронных компонентов на взаимовыгодных условиях!

Наши преимущества:

- Оперативные поставки широкого спектра электронных компонентов отечественного и импортного производства напрямую от производителей и с крупнейших мировых складов;
- Поставка более 17-ти миллионов наименований электронных компонентов;
- Поставка сложных, дефицитных, либо снятых с производства позиций;
- Оперативные сроки поставки под заказ (от 5 рабочих дней);
- Экспресс доставка в любую точку России;
- Техническая поддержка проекта, помощь в подборе аналогов, поставка прототипов;
- Система менеджмента качества сертифицирована по Международному стандарту ISO 9001;
- Лицензия ФСБ на осуществление работ с использованием сведений, составляющих государственную тайну;
- Поставка специализированных компонентов (Xilinx, Altera, Analog Devices, Intersil, Interpoint, Microsemi, Aeroflex, Peregrine, Syfer, Eurofarad, Texas Instrument, Miteq, Cobham, E2V, MA-COM, Hittite, Mini-Circuits, General Dynamics и др.);

Помимо этого, одним из направлений компании «ЭлектроПласт» является направление «Источники питания». Мы предлагаем Вам помощь Конструкторского отдела:

- Подбор оптимального решения, техническое обоснование при выборе компонента;
- Подбор аналогов;
- Консультации по применению компонента;
- Поставка образцов и прототипов;
- Техническая поддержка проекта;
- Защита от снятия компонента с производства.



#### Как с нами связаться

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