MTCH101

Single-Channel Proximity Detector

Features:
• Capacitive Proximity Detection System:
  - High Signal to Noise Ratio (SNR)
  - Adjustable sensitivity
  - Noise rejection filters
  - Automatic Environmental Compensation
  - Wide range of sensor shape and size support
  - Stuck Release Mechanism
• No External Components
• Low-Power mode
• Response Time Down to 75 ms
• Wide Operative Voltage:
  - 2.0V to 5.5V
• Operating Temperature:
  - -40°C to +85°C

Applications:
• Light Switch
• Portable Device Enabler
• White Goods and Appliances
• Office Equipment and Toys
• Display and Keypad Backlighting Activation
• SAR Compliant Application

Package Type
The device is available in 6-lead SOT-23 packaging (see Figure 1).

FIGURE 1: 6-PIN DIAGRAM

SOT-23

TABLE 1: 6-PIN SOT-23 PINOUT

<table>
<thead>
<tr>
<th>I/O</th>
<th>6-Pin SOT-23</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>MTI</td>
<td>1</td>
<td>Proximity Sensor Input</td>
</tr>
<tr>
<td>Vss</td>
<td>2</td>
<td>Ground</td>
</tr>
<tr>
<td>MTSA</td>
<td>3</td>
<td>Sensitivity Adjust Input</td>
</tr>
<tr>
<td>MTO</td>
<td>4</td>
<td>Detect Output (Active-Low)</td>
</tr>
<tr>
<td>VDD</td>
<td>5</td>
<td>Power Supply Input</td>
</tr>
<tr>
<td>MTPM</td>
<td>6</td>
<td>Low-Power mode Select (Active-Low)</td>
</tr>
</tbody>
</table>

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DS40001664B-page 1
# Table of Contents

1.0 Device Overview............................................................................................................. ........................................................... 3
2.0 Typical Circuit............................................................................................................. ............................................................... 4
3.0 Sensitivity Adjustment...................................................................................................... .........................................................  5
4.0 Power Mode.................................................................................................................. ............................................................. 6
5.0 Reset....................................................................................................................... ................................................................... 7
6.0 Interface with the Host..................................................................................................... .......................................................... 8
7.0 Detection Distance.......................................................................................................... ........................................................... 9
8.0 Electrical Characteristics.................................................................................................. ........................................................ 10
9.0 Packaging Information ....................................................................................................... ...................................................... 12

Index ........................................................................................................... ............... ......................................................................... 16

The Microchip Web Site......................................................................................................... .............................................................. 17
Customer Change Notification Service ........................................................................................... ..................................................... 17
Customer Support............................................................................................................... ................................................................. 17
Product Identification System ................................................................................................. ............................................................. 18

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### Errata

An errata sheet, describing minor operational differences from the data sheet and recommended workarounds, may exist for current devices. As device/documentation issues become known to us, we will publish an errata sheet. The errata will specify the revision of silicon and revision of document to which it applies.

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1.0 DEVICE OVERVIEW

The MTCH101 provides an easy way to add proximity or touch detection to any human interface application. The device integrates a single-channel capacitive proximity detection, which can work through plastic, glass or wood-front panel. It also supports a wide range of conductive materials as sensor, like copper pad on PCB, silver or carbon printing on plastic, Indium Tin Oxide (ITO) pad, wire/cable, etc. On-board adjustable sensitivity and power mode selection allow the user to configure the device at run time easily. An active-low output will communicate the state of the sensor to a host/master MCU, or drive an indication LED (see Figure 1-1).

FIGURE 1-1: BLOCK DIAGRAM
2.0 TYPICAL CIRCUIT

The MTCH101 can work either as a stand-alone device to control a LED (see Figure 2-1) to indicate touch/proximity, or work with host MCU (see Figure 2-2).

**FIGURE 2-1: TYPICAL CIRCUIT AS STAND-ALONE**

**FIGURE 2-2: TYPICAL CIRCUIT WITH HOST MCU**

Diagram images are not provided in this text format.
3.0 SENSITIVITY ADJUSTMENT

The sensitivity of the system determines how far and fast it can respond to proximity or touch. The MTCH101 provides the MTSA pin to adjust the sensitivity, and the voltage on this pin will determine the sensitivity. Vdd voltage will give the lowest sensitivity, while GND voltage will give the highest sensitivity.

The device will sample the voltage on the MTSA pin after each scan, so it does not only support setting a fixed sensitivity by a resistor ladder, but it also allows adjusting the sensitivity dynamically, while the device is running. A Digital-to-Analog Converter (DAC) controlled by the host, or a hardware potentiometer can be used to adjust the sensitivity. See typical circuit in Figure 3-1 to Figure 3-4.

FIGURE 3-1: FIXED SENSITIVITY USING RESISTOR LADDER

![Fixed Sensitivity Using Resistor Ladder](image1)

**Note:** Both R1 and R2 are recommended to be greater than 100K for lower power consumption.

FIGURE 3-2: HARDWARE SENSITIVITY ADJUST USING POTENTIOMETER

![Hardware Sensitivity Adjust Using Potentiometer](image2)

**Note:** Application Note AN538, “Using PWM to Generate Analog Output” has details about how to choose appropriate R and C values.

FIGURE 3-3: SENSITIVITY CONTROLLED BY HOST USING DAC

![Sensitivity Controlled by Host Using DAC](image3)

FIGURE 3-4: SENSITIVITY CONTROLLED BY HOST USING PWM

![Sensitivity Controlled by Host Using PWM](image4)

**Note 1:** Application Note AN538, “Using PWM to Generate Analog Output” has details about how to choose appropriate R and C values.
4.0 POWER MODE

The MTCH101 has two power mode options: Normal mode and Low-Power mode. The state of the MTPM pin determines the power mode.

4.1 Normal Mode Option

The device will run in Normal mode if the MTPM pin is set high and no proximity or touch is detected. In this mode, after an active scan, sleep time is between 69 and 105 ms, as shown in Figure 4-1. The sleep time depends on the VDD voltage, the lower the voltage, the more time it will be in the Idle state.

![Figure 4-1: Normal Mode](image)

### FIGURE 4-1: NORMAL MODE

4.2 Low-Power Mode Option

The device will run in Low-Power mode if the MTPM pin is set low and no proximity or touch is detected. In this mode, after an active scan, sleep time is between 572 and 845 ms, as shown in Figure 4-2. As in Normal mode, the sleep time depends on the VDD voltage, the lower the voltage, the more time it will be in the Idle state.

![Figure 4-2: Low-Power Mode](image)

### FIGURE 4-2: LOW-POWER MODE

**Note:** If the device makes a proximity or touch detection, it will automatically perform active scans continually. Once the device releases from its proximity-detected state, it will return to the power mode set by the MTPM pin.
5.0 RESET

The MTCH101 can be stuck in a proximity-detected state in some cases, such as sudden temperature change, or higher dielectric materials (metal, wood or glass) present near the sensor. Two methods can be used to release the proximity-detected state without repowering the device.

5.1 Reset by the MTPM pin

Changing the state of the MTPM pin, either from low-to-high or from high-to-low, will reset the proximity detection system and release the detection state. If the device needs to keep the same power mode, then a pulse, which holds at least 4.5 ms, can be used to reset the device (see Figure 5-1). This reset method can be used at anytime during the operation, not only when the state is stuck in a proximity-detected state.

5.2 Reset by Touch and Release

A stuck release mechanism is implemented for this device. When the device is stuck in a proximity-detected state, the user can touch the sensor pad and then release. This action will release the proximity-detected state (see Figure 5-2).

Note: In non-detected state, because the device goes to Sleep for a certain time, the Reset pulse duration should be 4.5 ms plus the Sleep time.
6.0 INTERFACE WITH THE HOST

The MTO pin can be considered as an open drain output. A pull-up resistor (usually 3.3k~10 kΩ) is needed to interface with a host. The pull-up voltage can be any voltage lower than VDD. This allows a simple interface with a lower VDD host device (see Figure 6-1).

FIGURE 6-1: INTERFACE WITH THE HOST

```
MTO

<p>| |</p>
<table>
<thead>
<tr>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

10k R

---

Digital Input

Host

---

Digital Input

Host

---

Digital Input

Host
```
7.0 DETECTION DISTANCE

FIGURE 7-1: DISTANCE vs. SENSOR AREA

Note: The tested sensors are round solid pads on FR4 PCB. No ground plane was near the sensor, as this would give the maximum detection distance.
8.0 ELECTRICAL CHARACTERISTICS

8.1 Absolute Maximum Ratings

Ambient temperature under bias .......................................................................................................... -40°C to +125°C
Storage temperature ............................................................................................................................ -65°C to +150°C
Voltage on pins with respect to VSS
on VDD pin .................................................................................................................................... 0 to +6.5V
on all other pins .......................................................................................................... -0.3V to (VDD + 0.3V)
Max. current
out of VSS pin ..................................................................................................................................... 80 mA
into VDD pin ........................................................................................................................................ 80 mA
Input clamp current, IIK (VI < 0 or VI > VDD)................................................................................... ±20 mA
Output clamp current, IOK (VO < 0 or VO > VDD)............................................................................... ±20 mA
Max. output current
sunk by any I/O pin ............................................................................................................................ 25 mA
sourced by any I/O pin ....................................................................................................................... 25 mA

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.

8.2 Standard Operating Conditions

The standard operating conditions for any device are defined as:

Operating Voltage: VDDMIN ≤ VDD ≤ VDDMAX
Operating Temperature: TA_MIN ≤ TA ≤ TA_MAX

VDD — Operating Supply Voltage

VDDMIN ......................................................................................................................................... +2.0V
VDDMAX ........................................................................................................................................ +5.5V

TA — Operating Ambient Temperature Range

Industrial Temperature
TA_MIN .......................................................................................................................................... -40°C
TA_MAX ........................................................................................................................................ +85°C

Note 1: See Parameter D001 in Table 8-1.
8.3 DC Characteristics

TABLE 8-1: MTCH101 (INDUSTRIAL) DC CHARACTERISTICS

<table>
<thead>
<tr>
<th>Param No.</th>
<th>Sym.</th>
<th>Characteristic</th>
<th>Min.</th>
<th>Typ†</th>
<th>Max.</th>
<th>Units</th>
<th>Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>D001</td>
<td>VDD</td>
<td>Supply Voltage</td>
<td>2.0</td>
<td>—</td>
<td>5.5</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>D002</td>
<td>VPOR</td>
<td>VDD Start Voltage to ensure Power-on-Reset</td>
<td>—</td>
<td>Vss</td>
<td>—</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>D003</td>
<td>SVDD</td>
<td>VDD Rise Rate to ensure Power-on Reset</td>
<td>0.05*</td>
<td>—</td>
<td>—</td>
<td>V/ms</td>
<td></td>
</tr>
</tbody>
</table>

* These parameters are characterized but not tested.
† Data in “Typ” column is at 3.0V, 25°C unless otherwise stated. These parameters are for design guidance only and are not tested.

TABLE 8-2: RESPONSE TIME AND CURRENT CONSUMPTION

<table>
<thead>
<tr>
<th>Power Mode</th>
<th>Typical Current (µA)</th>
<th>Highest Sensitivity Response Time (ms)</th>
<th>Lowest Sensitivity Response Time (ms)</th>
<th>Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Typical</td>
<td>Max.</td>
<td>Typical</td>
</tr>
<tr>
<td>Normal mode</td>
<td>120</td>
<td>100</td>
<td>150</td>
<td>210</td>
</tr>
<tr>
<td>Low-Power mode</td>
<td>30</td>
<td>790</td>
<td>890</td>
<td>900</td>
</tr>
<tr>
<td>Normal mode</td>
<td>200</td>
<td>80</td>
<td>130</td>
<td>190</td>
</tr>
<tr>
<td>Low-Power mode</td>
<td>54</td>
<td>640</td>
<td>740</td>
<td>750</td>
</tr>
<tr>
<td>Normal mode</td>
<td>340</td>
<td>76</td>
<td>119</td>
<td>190</td>
</tr>
<tr>
<td>Low-Power mode</td>
<td>97</td>
<td>530</td>
<td>620</td>
<td>640</td>
</tr>
</tbody>
</table>
9.0 PACKAGING INFORMATION

9.1 Package Marking Information

6-Lead SOT-23

Example

**Legend:**
- **XX...X** Customer-specific information
- **Y** Year code (last digit of calendar year)
- **YY** Year code (last 2 digits of calendar year)
- **WW** Week code (week of January 1 is week '01')
- **NNN** Alphanumeric traceability code
- **3e** Pb-free JEDEC designator for Matte Tin (Sn)
- ***** This package is Pb-free. The Pb-free JEDEC designator (3e)
  can be found on the outer packaging for this package.

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

* Standard PIC® device marking consists of Microchip part number, year code, week code, and traceability
code. For PIC device marking beyond this, certain price adders apply. Please check with your Microchip
Sales Office. For QTP devices, any special marking adders are included in QTP price.
9.2 Package Details

The following sections give the technical details of the packages.

6-Lead Plastic Small Outline Transistor (OT) [SOT-23]

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

### UNITS MILLIMETERS

<table>
<thead>
<tr>
<th>Dimension Limits</th>
<th>MIN</th>
<th>NOM</th>
<th>MAX</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Pins</td>
<td>N</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Pitch</td>
<td>e</td>
<td>0.95 BSC</td>
<td></td>
</tr>
<tr>
<td>Outside Lead Pitch</td>
<td>e1</td>
<td>1.90 BSC</td>
<td></td>
</tr>
<tr>
<td>Overall Height</td>
<td>A</td>
<td>0.90</td>
<td>1.45</td>
</tr>
<tr>
<td>Molded Package Thickness</td>
<td>A2</td>
<td>0.89</td>
<td>1.30</td>
</tr>
<tr>
<td>Standoff</td>
<td>A1</td>
<td>0.00</td>
<td>0.15</td>
</tr>
<tr>
<td>Overall Width</td>
<td>E</td>
<td>2.20</td>
<td>3.20</td>
</tr>
<tr>
<td>Molded Package Width</td>
<td>E1</td>
<td>1.30</td>
<td>1.80</td>
</tr>
<tr>
<td>Overall Length</td>
<td>D</td>
<td>2.70</td>
<td>3.10</td>
</tr>
<tr>
<td>Foot Length</td>
<td>L</td>
<td>0.10</td>
<td>0.60</td>
</tr>
<tr>
<td>Footprint</td>
<td>L1</td>
<td>0.35</td>
<td>0.80</td>
</tr>
<tr>
<td>Foot Angle</td>
<td>φ</td>
<td>0°</td>
<td>30°</td>
</tr>
<tr>
<td>Lead Thickness</td>
<td>c</td>
<td>0.08</td>
<td>0.26</td>
</tr>
<tr>
<td>Lead Width</td>
<td>b</td>
<td>0.20</td>
<td>0.51</td>
</tr>
</tbody>
</table>

**Notes:**
1. Dimensions D and E1 do not include mold flash or protrusions. Mold flash or protrusions shall not exceed 0.127 mm per side.
2. Dimensioning and tolerancing per ASME Y14.5M.
   BSC: Basic Dimension. Theoretically exact value shown without tolerances.

Microchip Technology Drawing C04-028B
6-Lead Plastic Small Outline Transistor (OT) [SOT-23]

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

RECOMMENDED LAND PATTERN

<table>
<thead>
<tr>
<th>Units</th>
<th>MILLIMETERS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dimension Limits</td>
<td>MIN</td>
</tr>
<tr>
<td>Contact Pitch E</td>
<td>0.95</td>
</tr>
<tr>
<td>Contact Pad Spacing C</td>
<td>2.80</td>
</tr>
<tr>
<td>Contact Pad Width (X6) X</td>
<td>0.60</td>
</tr>
<tr>
<td>Contact Pad Length (X6) Y</td>
<td>1.10</td>
</tr>
<tr>
<td>Distance Between Pads G</td>
<td>1.70</td>
</tr>
<tr>
<td>Distance Between Pads GX</td>
<td>0.35</td>
</tr>
<tr>
<td>Overall Width Z</td>
<td>3.90</td>
</tr>
</tbody>
</table>

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

REVISION HISTORY

Revision A (10/2012)
Initial release of this data sheet.

Revision B (7/2013)
Updated Figures 2-1 and 2-2; Updated the Electrical Characteristics section to new format; Other minor corrections.
INDEX

| A | Absolute Maximum Ratings ................................................ 10 |
| A | Applications........................................................................... 1 |

| B | Block Diagram....................................................................... 3 |

| C | Customer Change Notification Service ......................... 17 |
| C | Customer Notification Service........................................... 17 |
| C | Customer Support............................................................. 17 |

| D | DC Characteristics |
| D | MTCH101 (Industrial) .................................................. 11 |
| D | Detection Distance ..................................................... 9 |
| D | Device Overview .......................................................... 3 |
| D | Distance vs. Sensor Area .............................................. 9 |

| E | Electrical Characteristics................................................ 10 |
| E | Errata ................................................................................... 2 |

| F | Features................................................................................ 1 |
| F | Fixed Sensitivity using Resistor Ladder ............................. 5 |

| H | Hardware Sensitivity Adjus using Potentiometer ............... 5 |

| I | Interface with the Host ..................................................... 8 |
| I | Internet Address.................................................................. 17 |

| L | Low-Power Mode ............................................................... 6 |
| L | Low-Power Mode Option..................................................... 6 |

| M | Microchip Internet Web Site ............................................. 17 |

| N | Normal Mode......................................................................... 6 |
| N | Normal Mode Option........................................................... 6 |

| P | Package Type ....................................................................... 1 |
| P | Packaging |
| P | SOT-23 .......................................................... 13 |
| P | Packaging Information ..................................................... 12 |
| P | Power Mode......................................................................... 6 |

| R | Reset................................................................. 7 |
| R | Reset by the MTPM pin.................................................... 7 |
| R | Reset by Touch and Release .......................................... 7 |
| R | Reset Pulse Duration Requirement.................................. 7 |
| R | Revision History ................................................................ 15 |

| S | Sensitivity Adjustment....................................................... 5 |
| S | Sensitivity Controlled by Host using DAC ......................... 5 |
| S | Sensitivity Controlled by Host using PWM ......................... 5 |

| T | Typical Circuit ............................................................... 4 |
| T | Typical Circuit as Standalone ............................................ 4 |
| T | Typical Circuit with Host MCU ......................................... 4 |

| W | WWW Address ..................................................................... 17 |
| W | WWW, On-Line Support .................................................... 2 |
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<table>
<thead>
<tr>
<th>PART NO.</th>
<th>Device</th>
<th>Tape and Reel Option</th>
<th>Temperature Range</th>
<th>Package</th>
<th>Pattern</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>MTCH101</td>
<td>Blank = Standard packaging (tube or tray)</td>
<td>T = Tape and Reel(1)</td>
<td>OT = 6-pin SOT-23</td>
<td>QTP, SQTP, Code or Special Requirements (blank otherwise)</td>
</tr>
</tbody>
</table>

### Examples:

1. MTCH101 - I/OT
   Industrial temperature
   SOT-23 package

### Note:
1. Tape and Reel identifier only appears in the catalog part number description. This identifier is used for ordering purposes and is not printed on the device package. Check with your Microchip Sales Office for package availability with the Tape and Reel option.
2. For other small form-factor package availability and marking information, please visit www.microchip.com/packaging or contact your local sales office.
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- Microchip believes that its family of products is one of the most secure families of its kind on the market today, when used in the intended manner and under normal conditions.
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