TC1320

8-Bit Digital-to-Analog Converter with Two-Wire Interface

Features
- 8-bit Digital-to-Analog Converter
- ±2 LSB INL
- ±0.8 LSB DNL
- 2.7-5.5V Single Supply Operation
- Simple SMBus/I²C™ Serial Interface
- Low Power: 350µA Operation, 0.5µA Shutdown
- 8-Pin SOIC and 8-Pin MSOP Packages

Applications
- Programmable Voltage Sources
- Digital Controlled Amplifiers/Attenuators
- Process Monitoring and Control

Device Selection Table

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Package</th>
<th>Temperature Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>TC1320EOA</td>
<td>8-Pin SOIC (Narrow)</td>
<td>-40°C to +85°C</td>
</tr>
<tr>
<td>TC1320EUA</td>
<td>8-Pin MSOP</td>
<td>-40°C to +85°C</td>
</tr>
</tbody>
</table>

General Description

The TC1320 is a serially accessible 8-bit voltage output digital-to-analog converter (DAC). The DAC produces an output voltage that ranges from ground to an externally supplied reference voltage. It operates from a single power supply that can range from 2.7V to 5.5V, making it ideal for a wide range of applications. Built into the part is a Power-on Reset function that ensures that the device starts at a known condition.

Communication with the TC1320 is accomplished via a simple 2-wire SMBus/I²C™ compatible serial port with the TC1320 acting as a slave only device. The host can enable the SHDN bit in the CONFIG register to activate the Low Power Standby mode.

Package Type

8-Pin MSOP and 8-Pin SOIC (Narrow)

Typical Application

[Diagram showing the typical application of the TC1320]
Functional Block Diagram

TC1320

- **V_{DD}**
- **SDA**
- **SCL**
- **Configuration Register**
- **Serial Port Interface**
- **Control**
- **Data Register**
- **DAC**
- **DAC-OUT**
- **V_{OUT}**
- **V_{REF}**
- **GND**
1.0 ELECTRICAL CHARACTERISTICS

Absolute Maximum Ratings*

Supply Voltage (VDD) ............................................. +6V
Voltage on any Pin .. (GND – 0.3V) to (VDD + 0.3V)
Current on any Pin ............................................ ±50mA
Package Thermal Resistance (θJA)............ 330°C C/W
Operating Temperature (TA)........................ See Below
Storage Temperature (TSTG) .............. -65°C to +150°C

*Stresses above those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only and functional operation of the device at these or any other conditions above those indicated in the operation sections of the specifications is not implied. Exposure to Absolute Maximum Rating conditions for extended periods may affect device reliability.

TC1320 ELECTRICAL SPECIFICATIONS

Electrical Characteristics: VDD = 2.7V to 5.5V, -40°C ≤ TA ≤ +85°C, VREF = 1.2V unless otherwise noted.

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Unit</th>
<th>Test Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>VDD</td>
<td>Supply Voltage</td>
<td>2.7</td>
<td>350</td>
<td>500</td>
<td>µA</td>
<td>VDD = 5.5V, VREF = 1.2V</td>
</tr>
<tr>
<td>IDD</td>
<td>Operating Current</td>
<td>—</td>
<td>0.35</td>
<td>0.5</td>
<td>mA</td>
<td>Serial Port Inactive (Note 1)</td>
</tr>
<tr>
<td>IDD-STANDBY</td>
<td>Standby Supply Current</td>
<td>—</td>
<td>0.1</td>
<td>1</td>
<td>µA</td>
<td>VDD = 3.3V</td>
</tr>
</tbody>
</table>

Static Performance - Analog Section

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resolution</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>8</td>
<td>Bits</td>
</tr>
<tr>
<td>INL</td>
<td>Integral Non-Linearity at FS, TA = +25°C</td>
<td>—</td>
<td>—</td>
<td>±2</td>
<td>LSB</td>
</tr>
<tr>
<td>FSE</td>
<td>Full Scale Error</td>
<td>—</td>
<td>—</td>
<td>±3</td>
<td>%FS</td>
</tr>
<tr>
<td>DNL</td>
<td>Differential Non-Linearity, TA = +25°C</td>
<td>—</td>
<td>—</td>
<td>±0.8</td>
<td>LSB</td>
</tr>
<tr>
<td>VOUT</td>
<td>Offset Error at VOUT</td>
<td>—</td>
<td>±0.3</td>
<td>±8</td>
<td>mV</td>
</tr>
<tr>
<td>TCVOS</td>
<td>Offset Error Tempco at VOUT</td>
<td>—</td>
<td>10</td>
<td>—</td>
<td>µV/°C</td>
</tr>
<tr>
<td>PSRR</td>
<td>Power Supply Rejection Ratio</td>
<td>—</td>
<td>80</td>
<td>—</td>
<td>dB</td>
</tr>
<tr>
<td>VREF</td>
<td>Voltage Reference Range</td>
<td>0</td>
<td>—</td>
<td>VDD</td>
<td>— 1.2</td>
</tr>
<tr>
<td>IREF</td>
<td>Reference Input Leakage Current</td>
<td>—</td>
<td>—</td>
<td>±1.0</td>
<td>µA</td>
</tr>
<tr>
<td>VSW</td>
<td>Voltage Swing</td>
<td>0</td>
<td>—</td>
<td>VREF</td>
<td>V</td>
</tr>
<tr>
<td>ROUT</td>
<td>Output Resistance @ VOUT</td>
<td>—</td>
<td>5</td>
<td>—</td>
<td>Ω</td>
</tr>
<tr>
<td>IOUT</td>
<td>Output Current (Source or Sink)</td>
<td>—</td>
<td>2</td>
<td>—</td>
<td>mA</td>
</tr>
<tr>
<td>ISC</td>
<td>Output Short-Circuit Current</td>
<td>—</td>
<td>30</td>
<td>50</td>
<td>mA</td>
</tr>
<tr>
<td>ISC</td>
<td>Output Short-Circuit Current</td>
<td>—</td>
<td>20</td>
<td>50</td>
<td>mA</td>
</tr>
</tbody>
</table>

Dynamic Performance

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>SR</td>
<td>Voltage Output Slew Rate</td>
<td>—</td>
<td>0.8</td>
<td>—</td>
<td>V/µs</td>
</tr>
<tr>
<td>ISETTLE</td>
<td>Output Voltage Full Scale Settling Time</td>
<td>—</td>
<td>10</td>
<td>—</td>
<td>µsec</td>
</tr>
<tr>
<td>IWU</td>
<td>Wake-up Time</td>
<td>—</td>
<td>20</td>
<td>—</td>
<td>µs</td>
</tr>
<tr>
<td>Digital Feed Through and Crosstalk</td>
<td>—</td>
<td>5</td>
<td>—</td>
<td>nV-s</td>
<td>SDA = VDD, SCL = 100kHz</td>
</tr>
</tbody>
</table>

Serial Port Interface

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>VIH</td>
<td>Logic Input High</td>
<td>2.4</td>
<td>—</td>
<td>VDD</td>
<td>V</td>
</tr>
<tr>
<td>VIL</td>
<td>Logic Input Low</td>
<td>—</td>
<td>—</td>
<td>0.6</td>
<td>—</td>
</tr>
<tr>
<td>VOL</td>
<td>SDA Output Low</td>
<td>—</td>
<td>—</td>
<td>0.4</td>
<td>V</td>
</tr>
<tr>
<td>CIN</td>
<td>Input Capacitance SDA, SCL</td>
<td>—</td>
<td>—</td>
<td>0.4</td>
<td>pF</td>
</tr>
<tr>
<td>ILEAK</td>
<td>I/O Leakage</td>
<td>—</td>
<td>—</td>
<td>±1.0</td>
<td>µA</td>
</tr>
</tbody>
</table>

Note 1: SDA and SCL must be connected to VDD or GND.
2: Measured at VOUT ≥ 50mV referred to GND to avoid output buffer clipping.
### TC1320 ELECTRICAL SPECIFICATIONS (CONTINUED)

**Electrical Characteristics:** $V_{DD} = 2.7\text{V to } 5.5\text{V, } -40^\circ\text{C} \leq T_A \leq +85^\circ\text{C, } V_{REF} = 1.2\text{V unless otherwise noted.}

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Unit</th>
<th>Test Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>$t_{SMB}$</td>
<td>SMBus Clock Frequency</td>
<td>10</td>
<td></td>
<td>100</td>
<td>kHz</td>
<td></td>
</tr>
<tr>
<td>$t_{IDLE}$</td>
<td>Bus Free Time Prior to New Transition</td>
<td>4.7</td>
<td></td>
<td></td>
<td>µsec</td>
<td></td>
</tr>
<tr>
<td>$t_{H(START)}$</td>
<td>START Condition Hold Time</td>
<td>4.0</td>
<td></td>
<td></td>
<td>µsec</td>
<td></td>
</tr>
<tr>
<td>$t_{SU(START)}$</td>
<td>START Condition Setup Time</td>
<td>4.7</td>
<td></td>
<td></td>
<td>µsec</td>
<td>90% SCL to 10% SDA (for Repeated START Condition)</td>
</tr>
<tr>
<td>$t_{SU(STOP)}$</td>
<td>STOP Condition Setup Time</td>
<td>4.0</td>
<td></td>
<td></td>
<td>µsec</td>
<td></td>
</tr>
<tr>
<td>$t_{H-DATA}$</td>
<td>Data In Hold Time</td>
<td>100</td>
<td></td>
<td></td>
<td>nsec</td>
<td></td>
</tr>
<tr>
<td>$t_{SU-DATA}$</td>
<td>Data In Setup Time</td>
<td>100</td>
<td></td>
<td></td>
<td>nsec</td>
<td></td>
</tr>
<tr>
<td>$t_{LOW}$</td>
<td>Low Clock Period</td>
<td>4.7</td>
<td></td>
<td></td>
<td>µsec</td>
<td>10% to 10%</td>
</tr>
<tr>
<td>$t_{HIGH}$</td>
<td>High Clock Period</td>
<td>4</td>
<td></td>
<td></td>
<td>µsec</td>
<td>90% to 90%</td>
</tr>
<tr>
<td>$t_{F}$</td>
<td>SMBus Fall Time</td>
<td></td>
<td></td>
<td>300</td>
<td>nsec</td>
<td>90% to 10%</td>
</tr>
<tr>
<td>$t_{R}$</td>
<td>SMBus Rise Time</td>
<td></td>
<td></td>
<td>1000</td>
<td>nsec</td>
<td>10% to 90%</td>
</tr>
<tr>
<td>$t_{POR}$</td>
<td>Power-on Reset Delay</td>
<td></td>
<td>500</td>
<td></td>
<td>µsec</td>
<td>$V_{DD} \geq V_{POR}$ (Rising Edge)</td>
</tr>
</tbody>
</table>

**Notes:**
1. SDA and SCL must be connected to $V_{DD}$ or GND.
2. Measured at $V_{OUT}$ ≥ 50mV referred to GND to avoid output buffer clipping.
2.0 PIN DESCRIPTIONS

The descriptions of the pins are listed in Table 2-1.

TABLE 2-1: PIN FUNCTION TABLE

<table>
<thead>
<tr>
<th>Pin Number</th>
<th>Symbol</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>V_REF</td>
<td>Input</td>
<td>Input. Voltage Reference Input can range from 0V to 1.2V below V_DD.</td>
</tr>
<tr>
<td>2</td>
<td>SDA</td>
<td>Bi-Directional</td>
<td>Bi-directional. Serial data is transferred on the SMBus in both directions using this pin.</td>
</tr>
<tr>
<td>3</td>
<td>SCL</td>
<td>Input</td>
<td>Input. SMBus serial clock. Clocks data into and out of the TC1320.</td>
</tr>
<tr>
<td>4</td>
<td>GND</td>
<td>Power</td>
<td>Ground.</td>
</tr>
<tr>
<td>5</td>
<td>V_OUT</td>
<td>Output</td>
<td>Output. Buffered DAC output voltage. This voltage is a function of the reference voltage and the contents of the DATA register.</td>
</tr>
<tr>
<td>6</td>
<td>NC</td>
<td>None</td>
<td>No connection.</td>
</tr>
<tr>
<td>7</td>
<td>DAC-OUT</td>
<td>Output</td>
<td>Output. Unbuffered DAC output voltage. This voltage is a function of the reference voltage and the contents of the DATA register. This output is unbuffered and care must be taken that the pin is connected only to a high-impedance node.</td>
</tr>
<tr>
<td>8</td>
<td>V_DD</td>
<td>Power</td>
<td>Positive power supply input. See electrical specifications.</td>
</tr>
</tbody>
</table>
3.0 DETAILED DESCRIPTION

The TC1320 is a monolithic 8-bit digital-to-analog converter, that is designed to operate from a single supply that can range from 2.7V to 5.5V. The DAC consists of a data register (DATA), a configuration register (CONF), and a current output amplifier. The TC1320 uses an external reference, which also determines the maximum output voltage.

The TC1320 uses a current steering DAC, based on an array of matched current sources. This current, along a precision resistor, converts the contents of the Data Register and VREF into an output voltage, \( V_{\text{OUT}} \) given by:

\[
V_{\text{OUT}} = V_{\text{REF}} \left( \frac{\text{DATA}}{256} \right)
\]

3.1 Reference Input

The reference pin, \( V_{\text{REF}} \), is a buffered high-impedance input and because of this, the load regulation of the reference source needs only to be able to tolerate leakage levels of current (less than 1\( \mu \)A). \( V_{\text{REF}} \) accepts a voltage range from 0 to \((V_{\text{DD}} - 1.2V)\). Input capacitance is typically 10pF.

3.2 Output Amplifier

The TC1320 DAC output is buffered with an internal unity gain rail-to-rail input/output amplifier, with a typical slew rate of 0.8V/\( \mu \)sec. Maximum full scale transition settling time is 10\( \mu \)sec to within \( \pm 1/2 \)LSB when loaded with 1k\( \Omega \) in parallel with 100pF.

3.3 Standby Mode

The TC1320 allows the host to put it into a Low Power (\( I_{\text{DD}} = 0.5 \mu \)A, typical) Standby mode. In this mode, the D/A conversion is halted. The SMBus port operates normally. Standby mode is enabled by setting the SHDN bit in the CONFIG register. The table below summarizes this operation.

<table>
<thead>
<tr>
<th>SHDN Bit</th>
<th>Operating Mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Normal</td>
</tr>
<tr>
<td>1</td>
<td>Standby</td>
</tr>
</tbody>
</table>

3.4 SMBus Slave Address

The TC1320 is internally programmed to have a default SMBus address value of 1001000b. Seven other addresses are available by custom order (contact factory). See Figure 3-1 for locating address bits in SMBus protocol.

---

### FIGURE 3-1: SMBus PROTOCOLS

#### Write 1-Byte Format

<table>
<thead>
<tr>
<th>S</th>
<th>Address</th>
<th>R/W</th>
<th>ACK</th>
<th>Command</th>
<th>ACK</th>
<th>Data</th>
<th>ACK</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>7-Bits</td>
<td></td>
<td>0</td>
<td></td>
<td>8-Bits</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Slave Address

Command Byte: selects which register you are writing to.

Data Byte: data goes into the register set by the command byte.

#### Read 1-Byte Format

<table>
<thead>
<tr>
<th>S</th>
<th>Address</th>
<th>R/W</th>
<th>ACK</th>
<th>Command</th>
<th>ACK</th>
<th>S</th>
<th>Address</th>
<th>R/W</th>
<th>ACK</th>
<th>Data</th>
<th>NACK</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>7-Bits</td>
<td></td>
<td>0</td>
<td></td>
<td>8-Bits</td>
<td></td>
<td></td>
<td>7-Bits</td>
<td>1</td>
<td></td>
<td>8-Bits</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Slave Address

Command Byte: selects which register you are reading from.

Slave Address: repeated due to change in data flow direction.

Data Byte: reads from the register set by the command byte.

#### Receive 1-Byte Format

<table>
<thead>
<tr>
<th>S</th>
<th>Address</th>
<th>R/W</th>
<th>ACK</th>
<th>Data</th>
<th>NACK</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>7-Bits</td>
<td></td>
<td>1</td>
<td></td>
<td>8-Bits</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

S = START Condition

P = STOP Condition

Shaded = Slave Transmission

Data Byte: reads data from the register commanded by the last Read Byte or Write Byte transmission.
4.0 SERIAL PORT OPERATION

The Serial Clock input (SCL) and bi-directional data port (SDA) form a 2-wire bi-directional serial port for programming and interrogating the TC1320. The following conventions are used in this bus architecture:

**TABLE 4-1: TC1320 SERIAL BUS CONVENTIONS**

<table>
<thead>
<tr>
<th>Term</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transmitter</td>
<td>The device sending data to the bus.</td>
</tr>
<tr>
<td>Receiver</td>
<td>The device receiving data from the bus.</td>
</tr>
<tr>
<td>Master</td>
<td>The device which controls the bus: initiating transfers (START), generating the clock, and terminating transfers (STOP).</td>
</tr>
<tr>
<td>Slave</td>
<td>The device addressed by the master.</td>
</tr>
<tr>
<td>START</td>
<td>A unique condition signaling the beginning of a transfer indicated by SDA falling (High - Low) while SCL is high.</td>
</tr>
<tr>
<td>STOP</td>
<td>A unique condition signaling the end of a transfer indicated by SDA rising (Low - High) while SCL is high.</td>
</tr>
<tr>
<td>ACK</td>
<td>A Receiver Acknowledges the receipt of each byte with this unique condition. The Receiver drives SDA low during SCL high of the ACK clock pulse. The Master provides the clock pulse for the ACK cycle.</td>
</tr>
<tr>
<td>Busy</td>
<td>Communication is not possible because the bus is in use.</td>
</tr>
<tr>
<td>Not Busy</td>
<td>When the bus is IDLE, both SDA and SCL will remain high.</td>
</tr>
<tr>
<td>Data Valid</td>
<td>The state of SDA must remain stable during the High period of SCL in order for a data bit to be considered valid. SDA only changes state while SCL is low during normal data transfers. (See START and STOP conditions.)</td>
</tr>
</tbody>
</table>

All transfers take place under control of a host, usually a CPU or microcontroller, acting as the Master, which provides the clock signal for all transfers. The TC1320 always operates as a Slave. The serial protocol is illustrated in Figure 3-1. All data transfers have two phases; all bytes are transferred MSB first. Accesses are initiated by a START condition (START), followed by a device address byte and one or more data bytes. The device address byte includes a Read/Write selection bit. Each access must be terminated by a STOP Condition (STOP). A convention called Acknowledge (ACK) confirms receipt of each byte. Note that SDA can change only during periods when SCL is LOW (SDA changes while SCL is HIGH is reserved for START and STOP Conditions).

4.1 START Condition (START)

The TC1320 continuously monitors the SDA and SCL lines for a START condition (a HIGH to LOW transition of SDA while SCL is HIGH), and will not respond until this condition is met.

4.2 Address Byte

Immediately following the START Condition, the host must transmit the address byte to the TC1320. The 7-bit SMBus address for the TC1320 is 1001000. The 7-bit address transmitted in the serial bit stream must match for the TC1320 to respond with an Acknowledge (indicating the TC1320 is on the bus and ready to accept data). The eighth bit in the Address Byte is a Read/Write bit. This bit is a 1 for a read operation, or 0 for a write operation. During the first phase of any transfer, this bit will be set = 0 to indicate that the command byte is being written.

4.3 Acknowledge (ACK)

Acknowledge (ACK) provides a positive handshake between the host and the TC1320. The host releases SDA after transmitting eight bits, then generates a ninth clock cycle to allow the TC1320 to pull the SDA line LOW to Acknowledge that it successfully received the previous eight bits of data or address.

4.4 Data Byte

After a successful ACK of the address byte, the host must transmit the data byte to be written, or clock out the data to be read. (See the appropriate timing diagrams.) ACK will be generated after a successful write of a data byte into the TC1320.

4.5 STOP Condition (STOP)

Communications must be terminated by a STOP condition (a LOW to HIGH transition of SDA while SCL is HIGH). The STOP Condition must be communicated by the transmitter to the TC1320. Refer to Figure 4-1, Timing Diagrams for serial bus timing.
4.6 Register Set and Programmer’s Model

TABLE 4-2: TC1320 COMMAND SET
(SMBus READ_BYTE AND WRITE_BYTE)

<table>
<thead>
<tr>
<th>Command</th>
<th>Code</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>RWD</td>
<td>00h</td>
<td>Read/Write Data (DATA)</td>
</tr>
<tr>
<td>RWCR</td>
<td>01h</td>
<td>Read/Write Configuration (CONFIG)</td>
</tr>
</tbody>
</table>

TABLE 4-3: CONFIGURATION REGISTER (CONFIG), 8-BIT, READ/WRITE

<table>
<thead>
<tr>
<th>Bit</th>
<th>POR Function</th>
<th>Type</th>
<th>Operation</th>
</tr>
</thead>
<tbody>
<tr>
<td>D[0]</td>
<td>0</td>
<td>Standby Switch</td>
<td>Read/Write</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D[7]</td>
<td>0 Reserved</td>
<td>Always returns Zero when Read</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The DAC output voltage is a function of reference voltage and the binary value of the contents of the Data register. The transfer function is given by the expression:

\[
V_{OUT} = V_{REF} \times \left( \frac{\text{DATA}}{256} \right)
\]

### 4.7 Register Set Summary

The TC1320’s register set is summarized in Table 4-5 below. All registers are 8-bits wide.

**TABLE 4-5: TC1320 REGISTER SET SUMMARY**

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
<th>POR State</th>
<th>Read</th>
<th>Write</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data</td>
<td>Data Register</td>
<td>0000 0000b</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Config</td>
<td>CONFIG Register</td>
<td>0000 0000b</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>
5.0 PACKAGING INFORMATION

5.1 Package Marking Information

Package marking data not available at this time.

5.2 Taping Forms

### Component Taping Orientation for 8-Pin MSOP Devices

- **User Direction of Feed**
- **PIN 1**
- **W**
- **P**

**Carrier Tape, Number of Components Per Reel and Reel Size**

<table>
<thead>
<tr>
<th>Package</th>
<th>Carrier Width (W)</th>
<th>Pitch (P)</th>
<th>Part Per Full Reel</th>
<th>Reel Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>8-Pin MSOP</td>
<td>12 mm</td>
<td>8 mm</td>
<td>2500</td>
<td>13 in</td>
</tr>
</tbody>
</table>

### Component Taping Orientation for 8-Pin SOIC (Narrow) Devices

- **User Direction of Feed**
- **PIN 1**
- **W**
- **P**

**Carrier Tape, Number of Components Per Reel and Reel Size**

<table>
<thead>
<tr>
<th>Package</th>
<th>Carrier Width (W)</th>
<th>Pitch (P)</th>
<th>Part Per Full Reel</th>
<th>Reel Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>8-Pin SOIC (N)</td>
<td>12 mm</td>
<td>8 mm</td>
<td>2500</td>
<td>13 in</td>
</tr>
</tbody>
</table>
5.3 Package Dimensions

8-Pin MSOP

Dimensions: inches (mm)

8-Pin SOIC

Dimensions: inches (mm)
SALES AND SUPPORT

**Data Sheets**
Products supported by a preliminary Data Sheet may have an errata sheet describing minor operational differences and recommended workarounds. To determine if an errata sheet exists for a particular device, please contact one of the following:

1. Your local Microchip sales office
2. The Microchip Corporate Literature Center U.S. FAX: (480) 792-7277
3. The Microchip Worldwide Site (www.microchip.com)

Please specify which device, revision of silicon and Data Sheet (include Literature #) you are using.

**New Customer Notification System**
Register on our web site (www.microchip.com/cn) to receive the most current information on our products.
Information contained in this publication regarding device applications and the like is intended through suggestion only and may be superseded by updates. It is your responsibility to ensure that your application meets with your specifications. No representation or warranty is given and no liability is assumed by Microchip Technology Incorporated with respect to the accuracy or use of such information, or infringement of patents or other intellectual property rights arising from such use or otherwise. Use of Microchip’s products as critical components in life support systems is not authorized except with express written approval by Microchip. No licenses are conveyed, implicitly or otherwise, under any intellectual property rights.

Trademarks

The Microchip name and logo, the Microchip logo, FilterLab, Keeloo, microID, MPLAB, PIC, PICmicro, PICMASTER, PICSTART, PRO MATE, SEEVAL and The Embedded Control Solutions Company are registered trademarks of Microchip Technology Incorporated in the U.S.A. and other countries.

dsPIC, ECONOMONITOR, FanSense, FlexROM, fuzzyLAB, In-Circuit Serial Programming, ICSP, ICEPIC, microPort, Migratable Memory, MPASM, MPLIB, MPLINK, MPSIM, MXDEV, PICC, PICDEM, PICDEM.net, rPIC, Select Mode and Total Endurance are trademarks of Microchip Technology Incorporated in the U.S.A.

Serialized Quick Turn Programming (SQTP) is a service mark of Microchip Technology Incorporated in the U.S.A.

All other trademarks mentioned herein are property of their respective companies.

© 2002, Microchip Technology Incorporated, Printed in the U.S.A., All Rights Reserved.

Printed on recycled paper.

Microchip received QS-9000 quality system certification for its worldwide headquarters, design and wafer fabrication facilities in Chandler and Tempe, Arizona in July 1999 and Mountain View, California in March 2002. The Company’s quality system processes and procedures are QS-9000 compliant for its PICmicro® 8-bit MCUs, Keeloo® code hopping devices, Serial EEPROMs, microperipherals, non-volatile memory and analog products. In addition, Microchip’s quality system for the design and manufacture of development systems is ISO 9001 certified.
WORLDWIDE SALES AND SERVICE

AMERICAS
Corporate Office
2335 West Chandler Blvd,
Chandler, AZ 85224-6199
Tel: 480-792-7200 Fax: 480-792-7277
Technical Support: 480-792-7627
Web Address: http://www.microchip.com

Rocky Mountain
2335 West Chandler Blvd,
Chandler, AZ 85224-6199
Tel: 480-792-7966 Fax: 480-792-7456

Atlanta
500 Sugar Mill Road, Suite 200B
Atlanta, GA 30350
Tel: 770-640-0034 Fax: 770-640-0307

Boston
6 Lan Drive, Suite 120
Westford, MA 01886
Tel: 978-692-3848 Fax: 978-692-3821

Chicago
333 Pierce Road, Suite 180
Itasca, IL 60143
Tel: 630-285-0071 Fax: 630-285-0075

Dallas
4570 Westgrove Drive, Suite 160
Addison, TX 75001
Tel: 972-818-7923 Fax: 972-818-2294

Detroit
Tri-Atria Office Building
32255 Northwestern Highway, Suite 190
Farmington Hills, MI 48334
Tel: 248-538-2250 Fax: 248-538-2260

Kokomo
2767 S Albright Road
Kokomo, Indiana 46902
Tel: 765-864-8360 Fax: 765-864-8387

Los Angeles
18201 Von Karman, Suite 1090
Irvine, CA 92612
Tel: 949-263-1888 Fax: 949-263-1338

New York
150 Motor Parkway, Suite 202
Hauppauge, NY 11788
Tel: 631-273-5305 Fax: 631-273-5335

San Jose
Microchip Technology Inc.
2107 North First Street, Suite 590
San Jose, CA 95131
Tel: 408-436-7950 Fax: 408-436-7955

Toronto
6285 Northam Drive, Suite 108
Mississauga, Ontario L4V 1X5, Canada
Tel: 905-673-0699 Fax: 905-673-6509

ASIA/PACIFIC
Australia
Microchip Technology Australia Pty Ltd
Suite 22, 41 Rasown Street
Epping 2121, NSW
Australia
Tel: 61-2-9868-6733 Fax: 61-2-9868-6755

China - Beijing
Microchip Technology Consulting (Shanghai) Co., Ltd., Beijing Liaison Office
Unit 915
Bei Hai Wan Tai Bldg.
No. 6 Chaoyangmen Beidajie
Beijing, 100027, No. China
Tel: 86-10-85282100 Fax: 86-10-85282104

China - Chengdu
Microchip Technology Consulting (Shanghai) Co., Ltd., Chengdu Liaison Office
Rm. 3401, 24th Floor,
Ming Xing Financial Tower
No. 8 TIDU Street
Chengdu 610016, China
Tel: 86-28-6766200 Fax: 86-28-6766599

China - Fuzhou
Microchip Technology Consulting (Shanghai) Co., Ltd., Fuzhou Liaison Office
Unit 71 Wusi Road
Fuzhou 350001, China
Tel: 86-591-7503506 Fax: 86-591-7503521

China - Shenzhen
Microchip Technology Consulting (Shanghai) Co., Ltd., Shenzhen Liaison Office
Rm. 1315, 13/F, Shenzhen Kerry Centre,
Renminnan Lu
Shenzhen 518001, China
Tel: 86-755-2350361 Fax: 86-755-2366086

Hong Kong
Microchip Technology Hong Kong Ltd.
Unit 901-6, Tower 2, Metroplaza
223 Hing Fong Road
Kwai Fong, N.T., Hong Kong
Tel: 852-2401-1200 Fax: 852-2401-3431

India
Microchip Technology Inc.
India Liaison Office
Divyasree Chambers
1 Floor, Wing A (A3/A4)
No. 11, O'Shaugnessy Road
Bangalore, 560 025, India
Tel: 91-80-2290061 Fax: 91-80-2290062

Japan
Microchip Technology Japan K.K.
Benex S-1 6F
3-18-20, Shin-yokohama
Kohoku-Ku, Yokohama-shi
Kanagawa, 222-0033, Japan
Tel: 81-45-471-6166 Fax: 81-45-471-6122

Korea
Microchip Technology Korea
168-1, Youngbo Bldg., 3 Floor
Samsung-Dong, Kangnam-Ku
Seoul, Korea 135-882
Tel: 82-2-554-7200 Fax: 82-2-558-5934

Singapore
Microchip Technology Singapore Pte Ltd.
200 Middle Road
#07-02 Prime Centre
Singapore, 188980
Tel: 65-6334-8870 Fax: 65-6334-8850

Taiwan
Microchip Technology Taiwan
11F-3, No. 207
Tung Hua North Road
Taipei, 105, Taiwan
Tel: 886-2-2717-7175 Fax: 886-2-2545-0139

EUROPE

Denmark
Microchip Technology Nordic ApS
Regus Business Centre
Laturup høj 1-3
Ballentopp DK-2750 Denmark
Tel: 45 4420 9895 Fax: 45 4420 9910

France
Microchip Technology SARL
Parc d’Activite du Moulin de Massy
43 Rue du Saule Trapu
Batiment A - Ire Etage
91300 Massy, France
Tel: 33-1-69-53-63-20 Fax: 33-1-69-30-90-79

Germany
Microchip Technology GmbH
Gustav-Heinemann Ring 125
D-81739 Munich, Germany
Tel: 49-89-6275-5060 Fax: 49-89-6275-5060

Italy
Microchip Technology SRL
Centro Direzionale Colleoni
Palazzo Taurus 1 V. Le Colleoni 1
20041 Agrate Brianza
Milan, Italy
Tel: 39-039-65791-1 Fax: 39-039-6899883

United Kingdom
Arizona Microchip Technology Ltd.
505 Eskdale Road
Winnersh Triangle
Wokingham
Berkshire, England RG41 5TU
Tel: 44 118 921 5869 Fax: 44-118 921-5820

03/01/02