

# MX•COM, INC. MiXed Signal ICs

DATA BULLETIN

## MX465

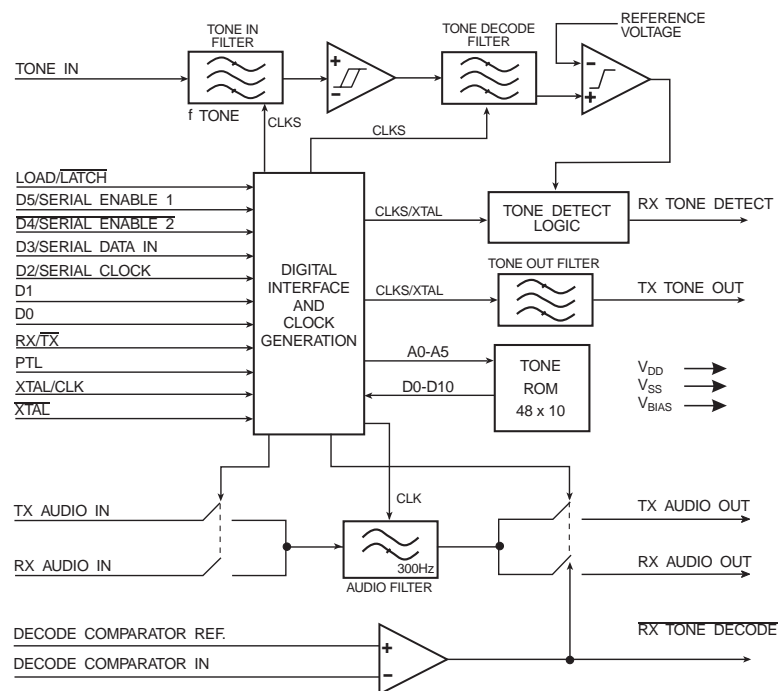
**LOW VOLTAGE  
CTCSS ENCODER/DECODER**  
with Tx and Rx Audio Filters

### Features

- Meets TIA/EIA-603 Standards
- 47 CTCSS Tones + Notone
- TX/RX Speech Filters
- Improved Sinad
- Serial or Parallel Programming
- Easy  $\mu$ P Interface
- Scanning on any Channel
- Standard 4MHz Xtal  
(See MX165C for 1MHz)
- Low Voltage 3.3V to 5.0V

### Applications

- Mobile Radio Channel Sharing
- Scan Trunking
- Wireless Intercom Traffic Control
- Hookswitch Supervision
- Repeater Control



The MX465 CTCSS Encoder/Decoder is a low voltage, CMOS device that meets TIA/EIA-603 Standards. The MX465 will encode and decode the tones 159.8Hz, 183.5Hz, 189.9Hz, 196.6Hz, 199.5Hz, 206.5Hz, 229.1Hz, and 254.1Hz in addition to the 39 standard CTCSS tones, for a total of 47 CTCSS tones + Notone. With the incorporation of the on-chip TX and RX speech filter, the MX465 enhances voice/tone multiplexing by attenuating TX and RX speech 36dB at frequencies below 250Hz while passing signals > 300Hz with only 1dB of ripple. This not only minimizes CTCSS talk-off in the TX mode but also improves Hum and Noise performance in the RX mode.

Available in the following package styles: 24-pin TSSOP (MX465TN), 24-pin SSOP (MX465DS), 24-pin SOIC (MX465DW), 24-pin PLCC (MX465LH), 24-pin PDIP (MX465P), and 24-pin CDIP (MX465J) the MX465 requires a single 3.3V to 5.0V supply and a 4MHz clock or crystal.

# CONTENTS

| Section                                   | Page      |
|---|-----------|
| <b>1. Block Diagram .....</b>             | <b>3</b>  |
| <b>2. Signal List .....</b>               | <b>4</b>  |
| <b>3. External Components .....</b>       | <b>6</b>  |
| <b>4. General Description .....</b>       | <b>7</b>  |
| 4.1 Description .....                     | 7         |
| 4.2 I/O Conditions.....                   | 7         |
| 4.3 Filter Response .....                 | 8         |
| 4.4 Serial and Parallel Mode Timing ..... | 8         |
| 4.5 CTCSS Programming.....                | 10        |
| <b>5. Performance Specification .....</b> | <b>11</b> |
| 5.1 Electrical Performance .....          | 11        |
| 5.1.1 Absolute Maximum Ratings .....      | 11        |
| 5.1.2 Operating Limits.....               | 12        |
| 5.2 Packaging.....                        | 14        |

MX-COM, Inc. Reserves the right to change specifications at any time and without notice

# 1 Block Diagram

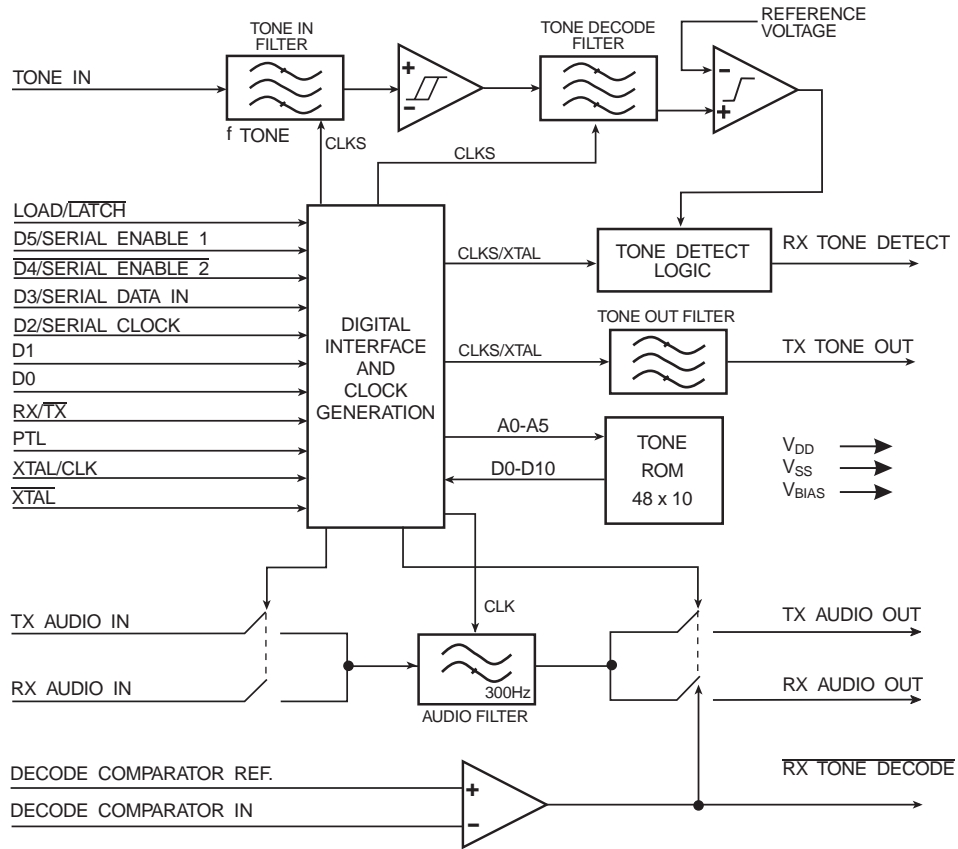


Figure 1 : Block Diagram

## 2 Signal List

| Pin No. | Signal                 | Type   | Description   |
|---------|------------------------|--------|---|
| 1       | V <sub>DD</sub>        | power  | Positive supply. This pin should be bypassed to V <sub>SS</sub> by a capacitor mounted close to the device pins.  |
| 2       | XTAL/CLOCK             | input  | Input to the on-chip inverter used with a 4 MHz Xtal or external clock source.  |
| 3       | XTAL                   | output | Output of the on-chip inverter (clock output).  |
| 4       | LOAD/LATCH             | input  | Controls 8 on-chip latches. It is used to latch RX/TX, PTL, and D0-D5. A logic 1 applied to this input places the 8 latches in the 'transparent' mode. A logic 0 applied to this input places the 8 latches in the 'latched' mode. In Parallel Mode, data is loaded and latched by a logic 1-0 transition (see Figure 4). In Serial Mode, data is loaded and latched by a 0-1-0 strobe pulse on this pin (see Figure 5). Internally pulled to V <sub>DD</sub> . |
| 5       | D5 / SERIAL ENABLE 1   | input  | Data input D5 (Parallel Mode). A logic 1 applied to this input together with a logic 0 applied to D4/SERIAL ENABLE 2 will place the device in Serial Mode (see Figure 5). Internally pulled to V <sub>DD</sub> .  |
| 6       | D4 / SERIAL ENABLE 2   | input  | Data input D4 (Parallel Mode). A logic 0 applied to this input together with a logic 1 applied to D5 / SERIAL ENABLE 1 will place the device in Serial Mode (see Figure 5). Internally pulled to V <sub>DD</sub> .  |
| 7       | D3 / SERIAL DATA IN    | input  | Data input D3 (Parallel Mode). In Serial Mode this pin becomes the serial data input for D5-D0, RX/TX and PTL (see Figure 5). D5 is clocked first and PTL last. Internally pulled to V <sub>DD</sub> .  |
| 8       | D2 / SERIAL CLOCK      | input  | Data input D2 (Parallel Mode). In Serial Mode this pin becomes the SERIAL CLOCK input. Data is clocked on the positive going edge (see Figure 5). Internally pulled to V <sub>DD</sub> .  |
| 9       | D1                     | input  | Data input D1 (Parallel Mode). Internally pulled to V <sub>DD</sub> .   |
| 10      | D0                     | input  | Data input D0 (Parallel Mode). Internally pulled to V <sub>DD</sub> .   |
| 11      | V <sub>SS</sub>        | power  | Negative supply.  |
| 12      | DECODE COMPARATOR REF. | input  | Internally biased to V <sub>DD</sub> /3 or 2 V <sub>DD</sub> /3 via 1M resistors depending on the logic state of the RX TONE DECODE pin. RX TONE DECODE = 1 will bias this input 2 V <sub>DD</sub> /3; a logic 0 will bias this input V <sub>DD</sub> /3. This input provides the DECODE COMPARATOR REFERENCE voltage, and the switching of bias voltages provides hysteresis to reduce 'chatter' under marginal conditions.                                    |
| 13      | RX TONE DECODE         | output | Gated output of the decode comparator. This output is used to gate the RX Audio path. A logic 0 on this pin indicates a successful decode and the DECODE COMPARATOR IN pin is more positive than the DECODE COMPARATOR REF. input (see Table 3).  |
| 14      | DECODE COMPARATOR IN   | input  | Inverting input of the DECODE COMPARATOR. This pin is normally connected to the integrated output of the RX TONE DETECT line.   |
| 15      | RX TONE DETECT         | output | In RX mode this output will go to logic 1 during a successful decode. It must be externally integrated to control response and deresponse times (see Table 3).  |

| Pin No. | Signal       | Type   | Description   |
|---------|--------------|--------|---|
| 16      | TX TONE OUT  | output | The CTCSS sinewave output appears on this pin under control of the RX/TX pin. When not transmitting a tone, TX TONE OUT may be biased to $V_{DD}/2$ . (see Table 3).  |
| 17      | RX/TX        | input  | RX or TX modes selected in Parallel Mode (see Figure 4). In Serial Mode this function is serially loaded. This pin is internally pulled to $V_{DD}$ via a $1M\Omega$ resistor.  |
| 18      | PTL          | input  | In RX mode this pin operates as a 'Push To Listen' function by enabling the RX audio path, thus overriding the tone squelch function (Parallel Mode). In Serial Mode this function is loaded serially. Internal pull-up to $V_{DD}$ |
| 19      | RX AUDIO OUT | output | High pass filtered RX AUDIO OUT. This pin outputs audio when RX TONE DECODE = logic 0, PTL = logic 1, or when Notone is programmed (see Table 4). In TX mode this pin is biased to $V_{DD}/2$ .                                     |
| 20      | TX AUDIO OUT | output | High pass filtered TX AUDIO OUT pin. In TX mode this pin outputs audio present at the TX AUDIO IN pin. In RX mode this pin is biased to $V_{DD}/2$  |
| 21      | $V_{BIAS}$   | output | Output of an internally generated $V_{DD}/2$ bias level that would normally be externally bypassed to $V_{SS}$ via capacitor C6.  |
| 22      | TX AUDIO IN  | input  | In TX mode TX AUDIO IN may be prefiltered, using the TX Audio path, thus helping to avoid talk-off due to intermodulation of speech frequencies with the transmitted CTCSS tone. Internally biased to $V_{DD}/2$ .                  |
| 23      | RX AUDIO IN  | input  | Input to the audio high pass filter in RX mode. Internally biased to $V_{DD}/2$ .   |
| 24      | TONE INPUT   | input  | Input to the CTCSS tone detector. Internally biased to $V_{DD}/2$ .   |

Table 1: Signal List

### 3 External Components

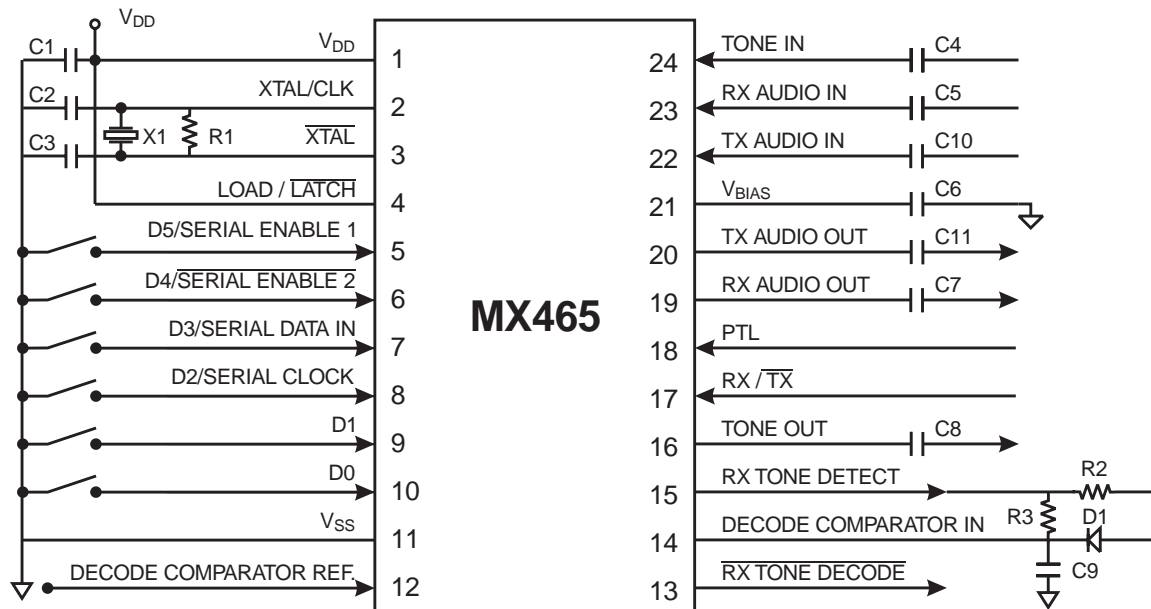


Figure 2 : Recommended External Components for Typical Application

|    |        |               |            |     |        |              |             |
|----|--------|---------------|------------|-----|--------|--------------|-------------|
| R1 | Note 1 | 1.0M $\Omega$ | $\pm 10\%$ | C6  |        | 0.47 $\mu$ F | $\pm 20\%$  |
| R2 |        | 560k $\Omega$ | $\pm 10\%$ | C7  | Note 2 | 0.1 $\mu$ F  | $\pm 20\%$  |
| R3 |        | 820k $\Omega$ | $\pm 10\%$ | C8  | Note 2 | 0.1 $\mu$ F  | $\pm 20\%$  |
| C1 |        | 0.1 $\mu$ F   | $\pm 20\%$ | C9  | Note 2 | 0.1 $\mu$ F  | $\pm 20\%$  |
| C2 | Note 1 | 18pF          | $\pm 20\%$ | C10 | Note 2 | 0.1 $\mu$ F  | $\pm 20\%$  |
| C3 | Note 1 | 33pF          | $\pm 20\%$ | C11 | Note 2 | 0.1 $\mu$ F  | $\pm 20\%$  |
| C4 | Note 2 | 0.1 $\mu$ F   | $\pm 20\%$ | D1  |        | small signal |             |
| C5 | Note 2 | 0.1 $\mu$ F   | $\pm 20\%$ | X1  | Note 1 | 4MHz         | 100ppm max. |

Table 2: External Components

#### External Components Notes:

- The values specified for R1, C2, and C3 have been found to be satisfactory when used with a crystal (X1) whose equivalent series resistance is  $\leq 1000\Omega$ . For best results, a crystal oscillator design should drive the clock inverter input with signal levels of at least 40% of  $V_{DD}$ , peak to peak. Tuning fork crystals generally cannot meet this requirement. To obtain crystal oscillator design assistance, consult your crystal manufacturer.
- The 0.1 $\mu$ F value for the DC Blocking capacitors, C4, C5, C7, C8, C9, C10, and C11 is not a requirement. For the capacitors C4, C5, and C10, the input impedance is internal to the device and specified typical as 550k $\Omega$ . For the remaining capacitors external circuits will be important in determining the input impedance.

## 4 General Description

### 4.1 Description

Voice on shared radio channels are multiplexed with a subaudible CTCSS (Continuous Tone Controlled Subaudible Squelch) tone as a means of directing messages among user groups sharing the same RF frequencies. CTCSS modulates the transmitter with a discrete tone, from 39 standard CTCSS tones in the range (67.0Hz to 250.0Hz) according to TIA/EIA-603. There are an additional eight CTCSS tones not specified in TIA/EIA-603 that the MX465 will encode and decode. They are : 159.8Hz, 183.5Hz, 189.9Hz, 196.6Hz, 199.5Hz, 206.5Hz, 229.1Hz, and 254.1Hz, for a total of 47 CTCSS tones plus Notone.

The MX465 also incorporates TX/RX on chip speech filters. In early CTCSS designs, TX speech was not filtered from the CTCSS tone, rather the filtering was dependent upon the host transmitter's pre-emphasis network. At only 6dB/octave, the attenuation of speech components at higher CTCSS tones was only a few dB which resulted in talk-off (low frequency voice components unquenching the receiver audio).

### 4.2 I/O Conditions

| D0-D5                              | Tone      | No Tone   | Tone      | Tone      | Tone      | No Tone   |
|------------------------------------|-----------|-----------|-----------|-----------|-----------|-----------|
| Input Pins Condition               |           |           |           |           |           |           |
| RX / $\overline{\text{TX}}$        | 0         | 0         | 1         | 1         | 1         | 1         |
| PTL                                | 0         | X         | 0         | 1         | X         | X         |
| Decode Comparator In               | X         | X         | 0         | 0         | 1         | X         |
| Output Pins Condition              |           |           |           |           |           |           |
| RX TONE DETECT                     | 0         | 0         | 0         | 0         | 1         | X         |
| $\overline{\text{RX TONE DECODE}}$ | 1         | 1         | 1         | 1         | 0         | 0         |
| Result / Function                  |           |           |           |           |           |           |
| Tone Transmitter Enabled           | Yes       | No (Bias) | No (Bias) | No (Bias) | No (Bias) | No (Bias) |
| TX Audio Path Enabled              | Yes       | Yes       | No        | No        | No        | No        |
| Tone Decode Enabled                | No        | No        | Yes       | Yes       | Yes       | Yes       |
| RX Audio Path Enabled              | No (Bias) | No (Bias) | No (Bias) | Yes       | Yes       | Yes       |
| Notes                              | 1         | 2         | 3         | 4         | 5         | 6         |

#### Notes:

1. Normal tone transmit condition.
2. Notone programmed in TX mode, tone transmit output set to  $V_{DD}/2$ . TX audio path enabled.
3. Normal decode standby.
4. Normal decode standby with PTL used to enable audio.
5. Normal decode of correct CTCSS tone condition, PTL has no effect.
6. Notone programmed in RX mode, tone transmit output (Bias). RX audio path enabled.
7. X = don't care

**Table 3: Combinations of Input / Output conditions**

### 4.3 Filter Response

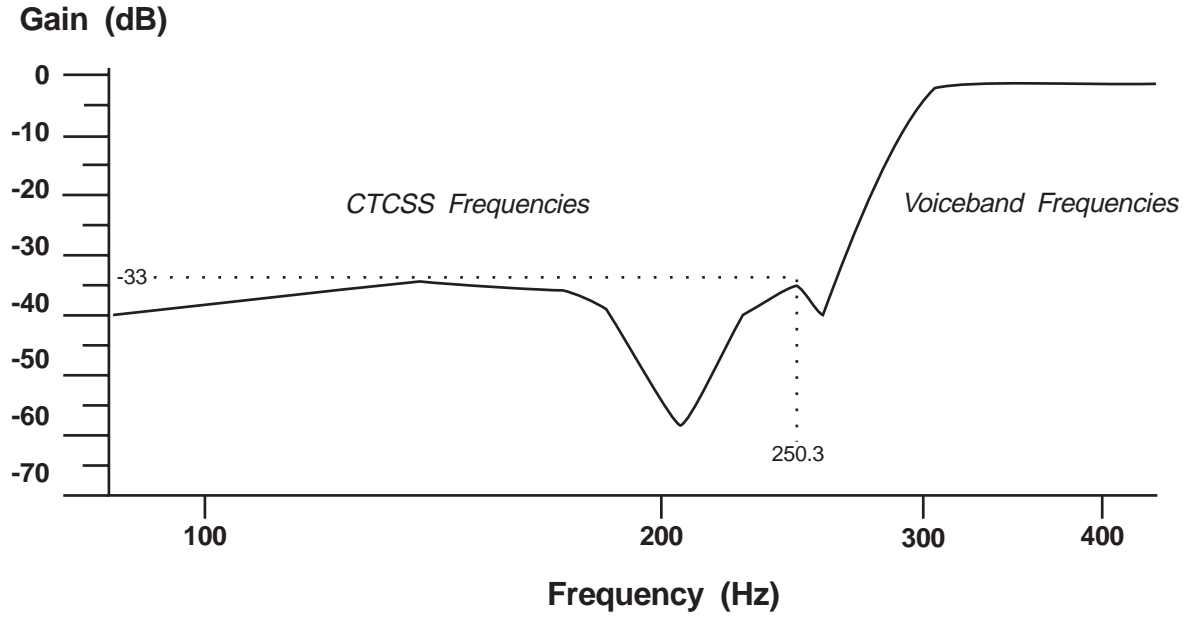


Figure 3 : Voiceband Filter Response

### 4.4 Serial and Parallel Mode Timing

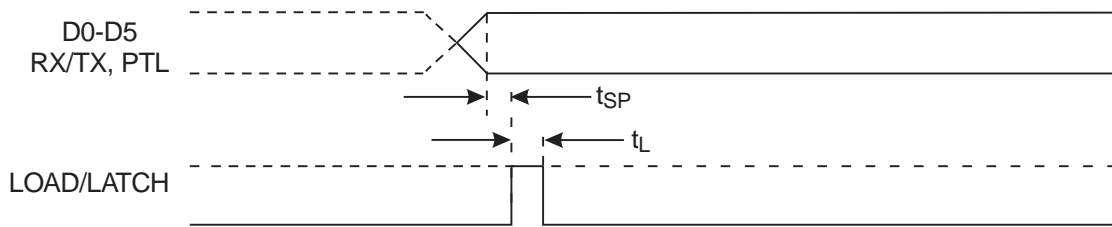
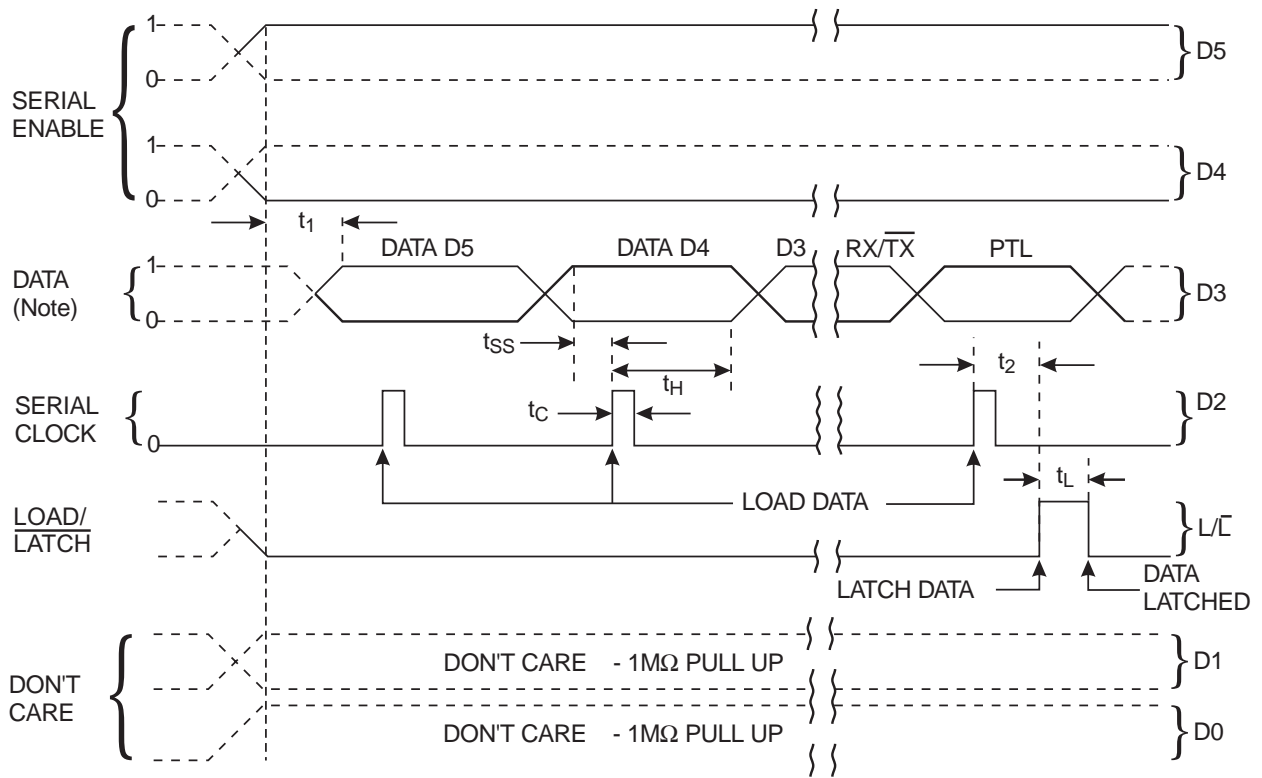


Figure 4 : Parallel Mode





Note : Serial bit 1 through bit 8 = D5, D4, D3, D2, D1, D0, RX/TX and PTL respectively. Load bit 1 first, bit 8 last

Figure 5 : Serial Mode

## 4.5 CTCSS Programming

|   | Tone                   |                      |                  | Programming Inputs |    |    |    |    |    |     |
|---|------------------------|----------------------|------------------|--------------------|----|----|----|----|----|-----|
|   | Nominal Frequency (Hz) | MX465 Frequency (Hz) | $\Delta f_0$ (%) | D5                 | D4 | D3 | D2 | D1 | D0 | Hex |
|   | 67.0                   | 66.98                | -0.029           | 1                  | 1  | 1  | 1  | 1  | 1  | 3F  |
|   | 69.3                   | 69.32                | 0.024            | 1                  | 1  | 1  | 0  | 0  | 1  | 39  |
|   | 71.9                   | 71.901               | 0.001            | 0                  | 1  | 1  | 1  | 1  | 1  | 1F  |
|   | 74.4                   | 74.431               | 0.042            | 1                  | 1  | 1  | 1  | 1  | 0  | 3E  |
|   | 77.0                   | 76.965               | -0.046           | 0                  | 0  | 1  | 1  | 1  | 1  | 0F  |
|   | 79.7                   | 79.677               | -0.029           | 1                  | 1  | 1  | 1  | 0  | 1  | 3D  |
|   | 82.5                   | 82.483               | -0.021           | 0                  | 1  | 1  | 1  | 1  | 0  | 1E  |
|   | 85.4                   | 85.383               | -0.020           | 1                  | 1  | 1  | 1  | 0  | 0  | 3C  |
|   | 88.5                   | 88.494               | -0.007           | 0                  | 0  | 1  | 1  | 1  | 0  | 0E  |
|   | 91.5                   | 91.456               | -0.048           | 1                  | 1  | 1  | 0  | 1  | 1  | 3B  |
|   | 94.8                   | 94.76                | -0.042           | 0                  | 1  | 1  | 1  | 0  | 1  | 1D  |
|   | 97.4                   | 97.435               | -0.036           | 1                  | 1  | 1  | 0  | 1  | 0  | 3A  |
|   | 100.0                  | 99.96                | -0.040           | 0                  | 0  | 1  | 1  | 0  | 1  | 0D  |
|   | 103.5                  | 103.429              | -0.069           | 0                  | 1  | 1  | 1  | 0  | 0  | 1C  |
|   | 107.2                  | 107.147              | -0.05            | 0                  | 0  | 1  | 1  | 0  | 0  | 0C  |
|   | 110.9                  | 110.954              | 0.049            | 0                  | 1  | 1  | 0  | 1  | 1  | 1B  |
|   | 114.8                  | 114.84               | 0.035            | 0                  | 0  | 1  | 0  | 1  | 1  | 0B  |
|   | 118.8                  | 118.793              | -0.006           | 0                  | 1  | 1  | 0  | 1  | 0  | 1A  |
|   | 123.0                  | 123.028              | 0.023            | 0                  | 0  | 1  | 0  | 1  | 0  | 0A  |
|   | 127.3                  | 127.328              | 0.022            | 0                  | 1  | 1  | 0  | 0  | 1  | 19  |
|   | 131.8                  | 131.674              | -0.095           | 0                  | 0  | 1  | 0  | 0  | 1  | 09  |
|   | 136.5                  | 136.612              | 0.082            | 0                  | 1  | 1  | 0  | 0  | 0  | 18  |
|   | 141.3                  | 141.323              | 0.016            | 0                  | 0  | 1  | 0  | 0  | 0  | 08  |
|   | 146.2                  | 146.044              | -0.107           | 0                  | 1  | 0  | 1  | 1  | 1  | 17  |
|   | 151.4                  | 151.441              | 0.027            | 0                  | 0  | 0  | 1  | 1  | 1  | 07  |
|   | 156.7                  | 156.875              | 0.112            | 0                  | 1  | 0  | 1  | 1  | 0  | 16  |
| • | 159.8                  | 159.936              | 0.085            | 1                  | 1  | 0  | 0  | 0  | 1  | 31  |
|   | 162.2                  | 162.311              | 0.069            | 0                  | 0  | 0  | 1  | 1  | 0  | 06  |
|   | 167.9                  | 167.708              | -0.114           | 0                  | 1  | 0  | 1  | 0  | 1  | 15  |
|   | 173.8                  | 173.936              | 0.078            | 0                  | 0  | 0  | 1  | 0  | 1  | 05  |
|   | 179.9                  | 179.654              | -0.137           | 0                  | 1  | 0  | 1  | 0  | 0  | 14  |
| • | 183.5                  | 183.680              | 0.098            | 1                  | 1  | 0  | 0  | 1  | 0  | 32  |
|   | 186.2                  | 186.289              | 0.048            | 0                  | 0  | 0  | 1  | 0  | 0  | 04  |
| • | 189.9                  | 190.069              | 0.089            | 1                  | 1  | 0  | 0  | 1  | 1  | 33  |
|   | 192.8                  | 192.864              | 0.033            | 0                  | 1  | 0  | 0  | 1  | 1  | 13  |
| • | 196.6                  | 196.329              | -0.138           | 1                  | 1  | 0  | 1  | 0  | 0  | 34  |
| • | 199.5                  | 199.312              | -0.094           | 1                  | 1  | 0  | 1  | 0  | 1  | 35  |
|   | 203.5                  | 203.645              | 0.071            | 0                  | 0  | 0  | 0  | 1  | 1  | 03  |
| • | 206.5                  | 206.207              | -0.142           | 1                  | 1  | 0  | 1  | 1  | 0  | 36  |
|   | 210.7                  | 210.848              | 0.070            | 0                  | 1  | 0  | 0  | 1  | 0  | 12  |
|   | 218.1                  | 217.853              | -0.113           | 0                  | 0  | 0  | 0  | 1  | 0  | 02  |

|   | Tone                                  |                      |                  | Programming Inputs |    |      |       |    |    |     |
|---|---------------------------------------|----------------------|------------------|--------------------|----|------|-------|----|----|-----|
|   | Nominal Frequency (Hz)                | MX465 Frequency (Hz) | $\Delta f_0$ (%) | D5                 | D4 | D3   | D2    | D1 | D0 | Hex |
|   | 225.7                                 | 225.339              | -0.160           | 0                  | 1  | 0    | 0     | 0  | 1  | 11  |
| • | 229.1                                 | 229.279              | 0.078            | 1                  | 1  | 0    | 1     | 1  | 1  | 37  |
|   | 233.6                                 | 233.359              | -0.103           | 0                  | 0  | 0    | 0     | 0  | 1  | 01  |
|   | 241.8                                 | 241.970              | 0.070            | 0                  | 1  | 0    | 0     | 0  | 0  | 10  |
|   | 250.3                                 | 250.282              | -0.007           | 0                  | 0  | 0    | 0     | 0  | 0  | 00  |
| • | 254.1                                 | 254.162              | 0.024            | 1                  | 1  | 1    | 0     | 0  | 0  | 38  |
|   | Notone                                |                      | N/A              | 1                  | 1  | 0    | 0     | 0  | 0  | 30  |
|   | Serial input mode                     |                      | N/A              | 1                  | 0  | Data | Clock | X  | X  | 2X  |
| • | Not specified in the TIA/EIA tone set |                      |                  |                    |    |      |       |    |    |     |

Table 4: CTCSS Tones

## 5 Performance Specification

### 5.1 Electrical Performance

#### 5.1.1 Absolute Maximum Ratings

Exceeding these maximum ratings can result in damage to the device. Operation of the device outside the operating limits is not implied.

| General   | Min. | Max.           | Units   |
|---|------|----------------|---|
| Supply ( $V_{DD} - V_{SS}$ )                                      | -0.3 | 7.0            | V   |
| Voltage on any pin to $V_{SS}$                                    | -0.3 | $V_{DD} + 0.3$ | V   |
| Current   |      |                |   |
| $V_{DD}$  | -30  | 30             | mA  |
| $V_{SS}$  | -30  | 30             | mA  |
| any other pins  | -20  | 20             | mA  |
| <b>TN / DW / LH / DIP Package</b>                                 |      |                |   |
| Total Allowable Power Dissipation at $T_{AMB} = 25^\circ\text{C}$ |      | 800            | mW  |
| Derating above $25^\circ\text{C}$                                 |      | 10             | mW/ $^\circ\text{C}$ above $25^\circ\text{C}$ |
| Storage Temperature   | -55  | 125            | $^\circ\text{C}$                              |
| Operating temperature   | - 40 | 85             | $^\circ\text{C}$                              |
| <b>DS Package</b>   |      |                |   |
| Total Allowable Power Dissipation at $T_{AMB} = 25^\circ\text{C}$ |      | 550            | mW  |
| Derating above $25^\circ\text{C}$                                 |      | 9              | mW/ $^\circ\text{C}$ above $25^\circ\text{C}$ |
| Storage Temperature   | -55  | 125            | $^\circ\text{C}$                              |
| Operating temperature   | - 40 | 85             | $^\circ\text{C}$                              |

### 5.1.2 Operating Limits

Correct operation of the device outside these limits is not implied.

|                            | Min. | Max. | Units |
|----------------------------|------|------|-------|
| Supply ( $V_{DD}-V_{SS}$ ) | 2.7  | 5.5  | V     |
| Xtal Frequency             | 4.0  | 4.0  | MHz   |
| Operating Temperature      | -40  | 85   | °C    |

### 5.1.3 Operating Characteristics

For the following conditions unless otherwise specified:

$V_{DD} = 3.3V / 5.0V$  at  $T_{AMB} = 25^{\circ}C$ ,  $V_{SS} = 0V$ ,  
Xtal Frequency = 4.0 MHz, 100ppm max.

(Over the life of the XTAL the operating range may vary from 100ppm up to 1000ppm)  
0dB ref. = 750mV<sub>RMS</sub> (proportional to  $V_{DD}$ ; see note 17)

**Composite Signal:**

1kHz test tone = 300mV<sub>RMS</sub>, f<sub>0</sub> CTCSS tone = 30 mV<sub>RMS</sub>, 75mV<sub>RMS</sub> Noise (band limited to 6kHz Gaussian)

|   | Notes  | Min.         | Typ.    | Max.         | Units             |
|---|--------|--------------|---------|--------------|-------------------|
| <b>Static Values</b>  |        |              |         |              |                   |
| Supply voltage  |        | 2.7          | 3.3/5.0 | 5.5          | V                 |
| Supply current  |        |              |         |              |                   |
| $V_{DD} = 5.0V$   |        |              | 3.7     | 4.2          | mA                |
| $V_{DD} = 3.3V$   |        |              | 1.3     | 1.6          | mA                |
| Analog input impedance  | 18     | 480          | 550     |              | k $\Omega$        |
| Analog output impedance   | 18     |              | 400     | 1000         | $\Omega$          |
| Digital Input impedance   | 1,18   | 25           | 40      |              | k $\Omega$        |
| Input logic 1   | 1      | 70% $V_{DD}$ |         |              | V                 |
| Input logic 0   | 1      |              |         | 30% $V_{DD}$ | V                 |
| Output Logic 1 source = 0.1mA                                     | 2      | 80% $V_{DD}$ |         |              | V                 |
| Output Logic 0 sink = 0.1mA                                       | 2      |              |         | 20% $V_{DD}$ | V                 |
| <b>Dynamic Values</b>   |        |              |         |              |                   |
| <b>Speech filter</b>  |        |              |         |              |                   |
| Total harmonic distortion   | 5,8,19 |              | 1.0     | 1.5          | %                 |
| Output noise level (input AC short circuit, audio switch enabled) | 8,18   |              | 0.5     | 1.0          | mV <sub>RMS</sub> |
| Sinad   | 8,9    | 40           | 50      |              | dB                |
| Spurious emissions  | 18     |              |         | - 48         | dB                |
| Cutoff frequency  |        |              | 300     |              | Hz                |
| Bandpass ripple   | 8      |              | 1       | 1.8          | dB                |
| Stopband attenuation <250Hz                                       | 7,8,19 | 33           | 36      |              | dB                |
| Passband gain 1kHz  |        | - 0.5        | 0       | 0.5          | dB                |
| TX/RX isolation   | 5      |              | 60      |              | dB                |

|   | Notes      | Min.                  | Typ.                | Max.                  | Units             |
|---|------------|-----------------------|---------------------|-----------------------|-------------------|
| <b>Encoder</b>                                    |            |                       |                     |                       |                   |
| Tone output level                                 | 12         | - 1.0                 | 0                   | 1.0                   | dB                |
| Tone Frequency Accuracy (f error)                 |            | - 0.3                 |                     | 0.3                   | %f <sub>0</sub>   |
| Risetime to 90% nominal output                    |            |                       |                     |                       |                   |
| f <sub>0</sub> >100Hz                             | 4,10       |                       | 15                  | 75                    | ms                |
| f <sub>0</sub> <100Hz                             | 4,10       |                       | 45                  | 120                   | ms                |
| Total Harmonic Distortion                         | 19         |                       | 1.5                 | 2                     | %                 |
| <b>Decoder</b>                                    |            |                       |                     |                       |                   |
| Pure tone decode threshold                        | 19         |                       | 7                   | 15                    | mV <sub>RMS</sub> |
| Composite signal decode threshold                 | 3          |                       |                     | 30                    | mV <sub>RMS</sub> |
| Decode input signal level                         | 16         | -20                   |                     | 3.5                   | dB                |
| Pure tone decode response time                    | 13,14      | 95                    | 115                 | 140                   | ms                |
| Pure tone decode deresponse time                  | 13,15      | 95                    | 130                 | 170                   | ms                |
| Decode response time                              | 3,6,10     |                       |                     | 250                   | ms                |
| Deresponse time                                   | 3,10       |                       | 180                 | 250                   | ms                |
| <b>Decode selectivity:</b>                        |            |                       |                     |                       |                   |
| Upper decode band edge                            | 3,11,19,20 | 1.005f <sub>0</sub>   | 1.015f <sub>0</sub> | 0.995f <sub>0+1</sub> | Hz                |
| Lower decode band edge                            | 3,11,19,20 | 1.005f <sub>0-1</sub> | 0.985f <sub>0</sub> | 0.995f <sub>0</sub>   | Hz                |
| <b>Serial / Parallel Inputs</b>                   |            |                       |                     |                       |                   |
| Parallel Set Up Time (t <sub>SP</sub> )           |            | 400                   |                     |                       | ns                |
| Load / Latch Pulse Width (t <sub>L</sub> )        |            | 400                   |                     |                       | ns                |
| Serial Clock Pulse Width (t <sub>C</sub> )        |            | 400                   |                     |                       | ns                |
| Serial Data Set-Up Time (t <sub>SS</sub> )        |            | 400                   |                     |                       | ns                |
| Serial Data Hold Time (t <sub>H</sub> )           |            | 400                   |                     |                       | ns                |
| Serial Enable Time (t <sub>1</sub> )              |            | 400                   |                     |                       | ns                |
| Serial Load / Latch Set-Up Time (t <sub>2</sub> ) |            | 400                   |                     |                       | ns                |
| Serial Clock Frequency                            |            |                       | 1                   |                       | MHz               |

**Operating Characteristics Notes:**

1. Refers to RX/TX, PTL, Decode Comparator Input, D0-D5.
2. All logic outputs.
3. Composite signal test condition.
4. Any programming tone and R<sub>L</sub> = 10kΩ, C<sub>L</sub> = 15pF.
5. With an input level of 0dB @ 1kHz
6. f<sub>0</sub>>100Hz (for 100 Hz> f<sub>0</sub>>67Hz: t=100/ f<sub>0</sub>Hz x 250ms)
7. See Figure 3.
8. Measured in a 30kHz bandwidth.
9. With an input level of -3.5dB @ 1kHz
10. Per TIA/EIA-603.
11. Per TIA/EIA-603, device will not decode adjacent TIA/EIA-603 Tones.
12. Tone output level is proportional to V<sub>DD</sub>.
13. f<sub>0</sub>=156.7Hz @ -20dB.
14. Typically 12.5 Tone Cycles + 40ms.
15. Typically 7 Tone Cycles + 90ms.

16. Max composite signal is 3.5dB with:  
 Noise (band limited 6kHz Gaussian) = -12dB ref to 1kHz test tone  
 $f_0$  CTCSS tone = -20dB ref to 1kHz test tone
17. For maximum dynamic range, set audio level to 0dB,  $V_{DD} \times 150mV_{RMS}$ , using minimum  $V_{DD}$  under which system is intended to work. (e.g. for a 2.7V system, use 0dB equal to 405mV<sub>RMS</sub>).
18. By characterization only.
19. Batch sampled only
20. For example, if:  $f_0 = 100.0\text{Hz}$  ( $f_{0-1} = 97.4\text{Hz}$   $f_{0+1} = 103.5\text{Hz}$ )

| Decode Selectivity     | Min   | Typ   | Max    | Unit |
|------------------------|-------|-------|--------|------|
| Upper Decode Band Edge | 100.5 | 101.5 | 102.98 | Hz   |
| Lower Decode Band Edge | 97.89 | 98.5  | 99.5   | Hz   |

## 5.2 Packaging

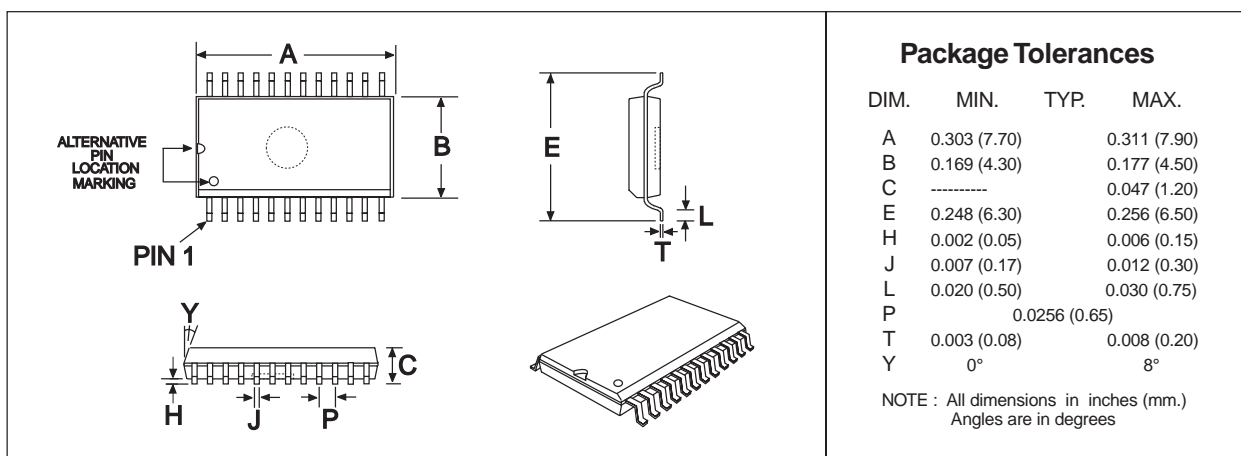


Figure 6: 24-pin TSSOP Mechanical Outline: Order as part no. MX465TN

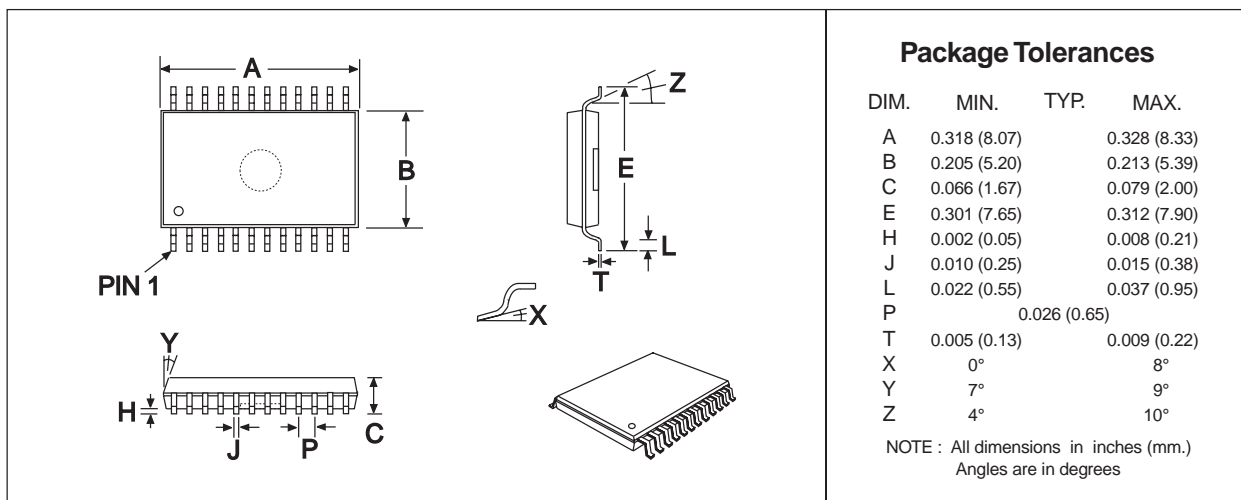


Figure 7: 24-pin-SSOP Mechanical Outline: Order as part no. MX465DS

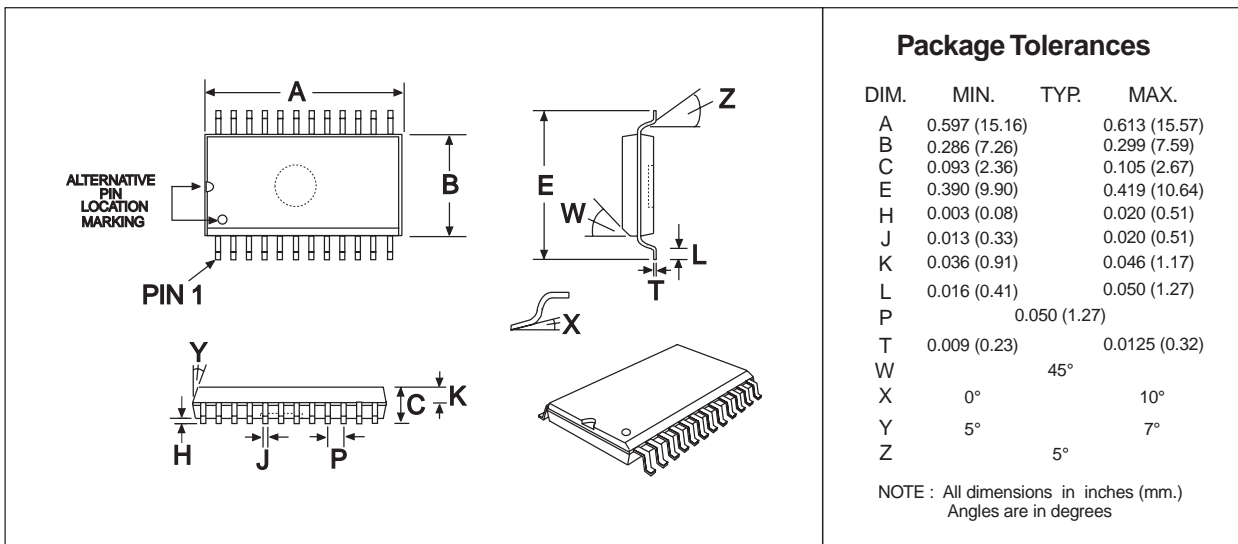


Figure 8: 24-pin SOIC Mechanical Outline: Order as part no. MX465DW

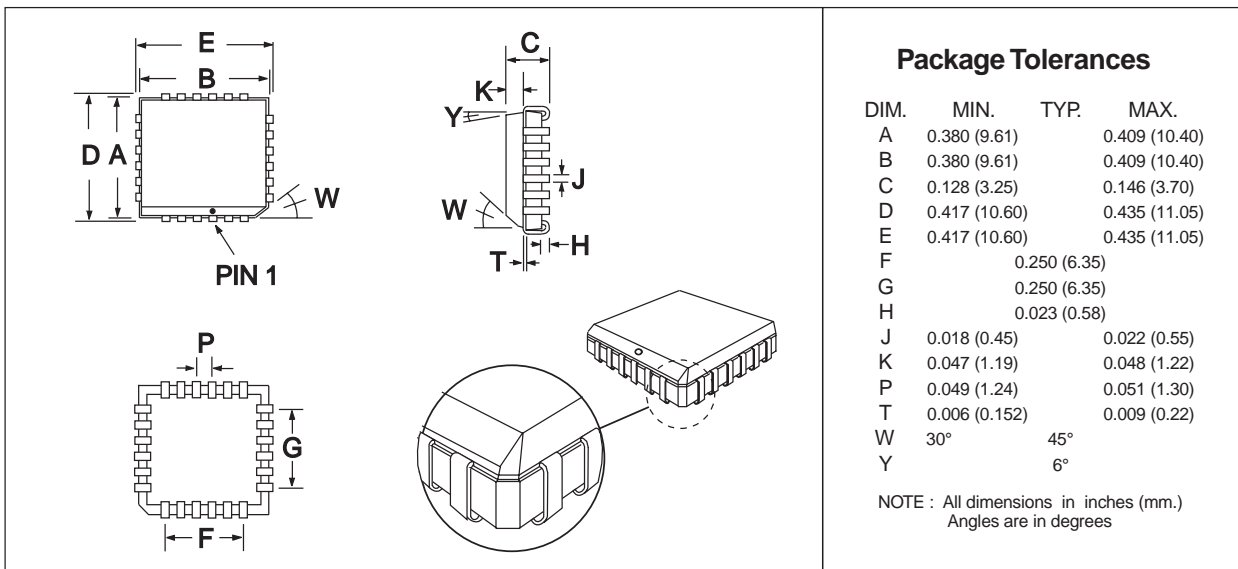


Figure 9: 24-pin PLCC Mechanical Outline: Order as part no. MX465LH

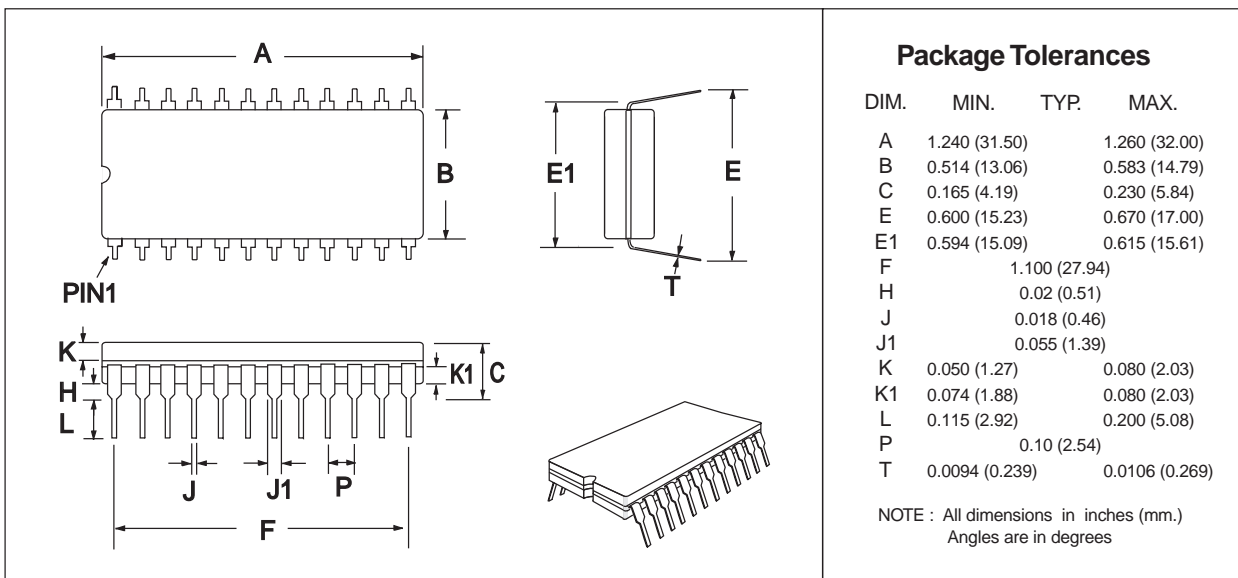


Figure 10: 24-pin CDIP Mechanical Outline: Order as part no. MX465J

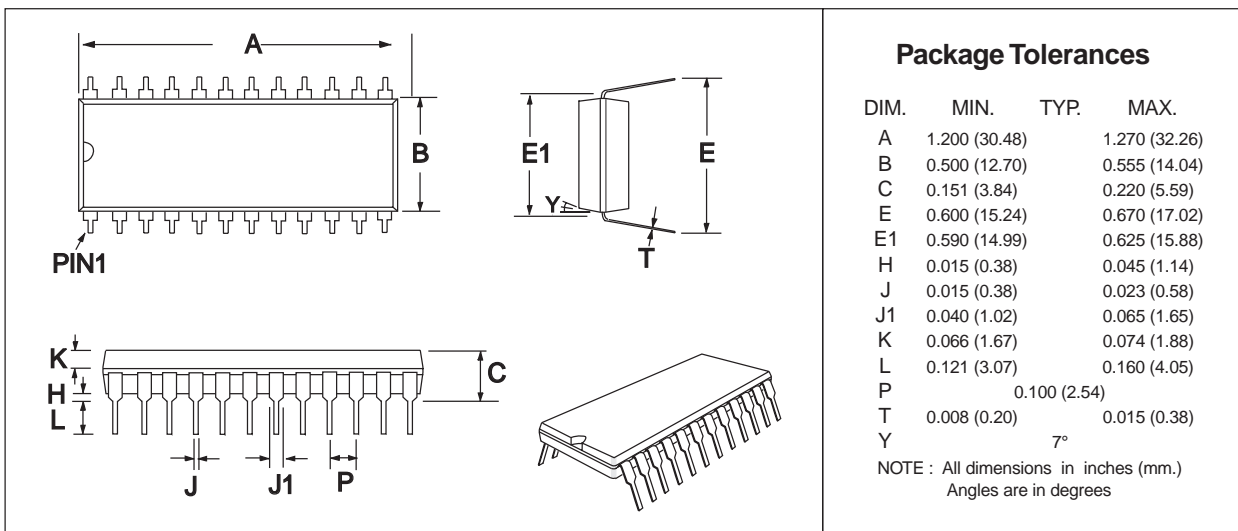


Figure 11: 24-pin PDIP Mechanical Outline: Order as part no. MX465P



This datasheet has been download from:

[www.datasheetcatalog.com](http://www.datasheetcatalog.com)

Datasheets for electronics components.