

3.0V to 5.5V, RS-232 Transceivers

Features

- Meets EIA/TIA-232-F standards
- Operates With 3-V to 5.5-V VCC Supply
- Operates up to 250 kbit/s
- Two Drivers and Two Receivers
- Low Supply Current
- External Capacitors: 4x0.1 μ F
- Accepts 5-V Logic Input With 3.3-V Supply
- 1 μ A low power shutdown with receivers active (COSMAX3222)
- Packaging:
COSMAX3232: SOP16/TSSOP16
COSMAX3222: SOP20/TSSOP20

Applications

- Battery-Powered Systems
- Hand-Held Equipment
- Laptops
- Notebooks

General Description

The COSMAX3232 and COSMAX3222 family consists of two-line drivers, two-line receivers, and a dual charge-pump circuit. The device meets the requirements of TIA/EIA-232-F and provides the electrical interface between an asynchronous communication controller and the serial-port connector. The charge pump and four small external capacitors allow operation from a single 3-V to 5.5-V supply. The devices operate at data signaling rates up to 250 kbit/s and a maximum of 30-V/ μ s driver output slew rate.

The COSMAX3222 device has a low-power shutdown mode where the devices' driver outputs and charge pumps are disabled. During shutdown, the supply current falls to less than 1 μ A. When the device is powered down, the receivers remain active while the drivers are placed in the high-impedance state. Receiver outputs also can be placed in the high impedance state by setting \overline{EN} high.

Rev1.1

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1. Pin Configuration and Functions

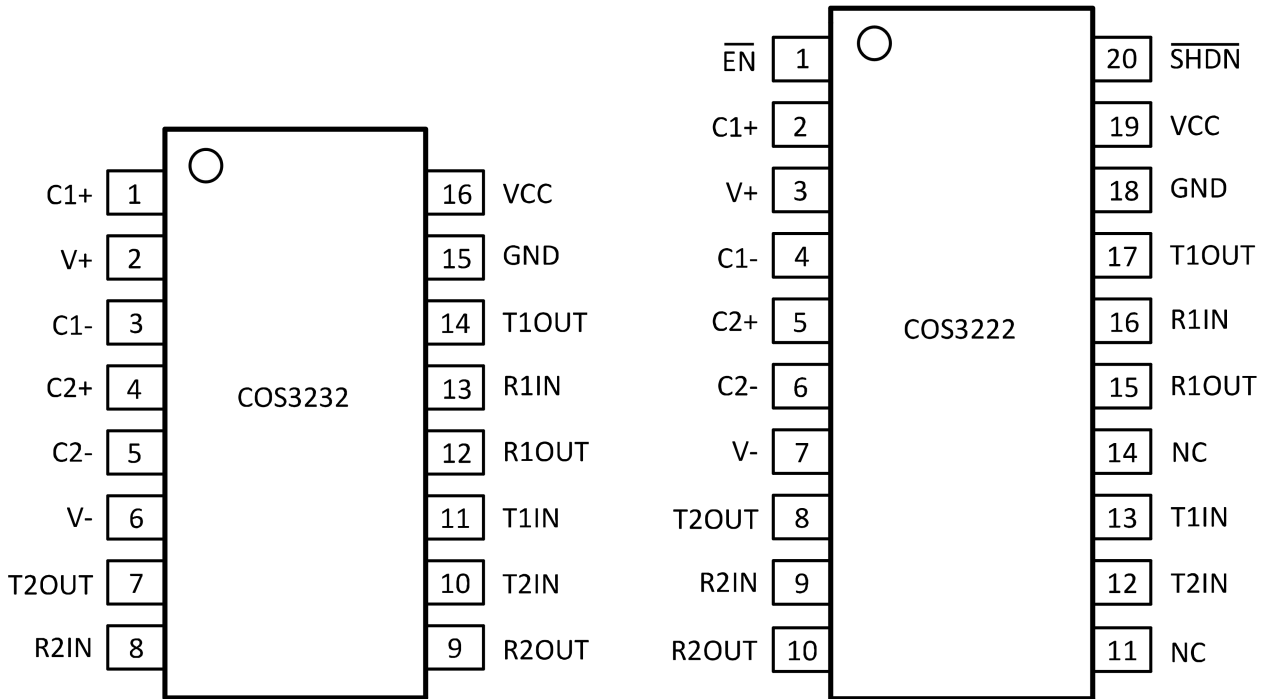


Figure 1 Pin Diagram

Pin Description

| Pin Name | Description | Pin Number | |
|-----------------|---|------------|------------|
| | | COSMAX3232 | COSMAX3222 |
| \overline{EN} | Receiver Enable. Apply logic LOW for normal operation. Apply logic HIGH to disable the receiver outputs (high-Z state). | - | 1 |
| C1 + | Positive terminal of the voltage doubler charge-pump capacitor | 1 | 2 |
| V+ | 5.5V output generated by the charge pump | 2 | 3 |
| C1- | Negative terminal of the voltage doubler charge-pump capacitor | 3 | 4 |
| C2+ | Positive terminal of the inverting charge-pump capacitor | 4 | 5 |
| C2- | Negative terminal of the inverting charge-pump capacitor | 5 | 6 |

| | | | |
|--------------------------|--|----|----|
| V- | -5.5V output generated by the charge pump | 6 | 7 |
| TOUT1 | RS-232 driver output | 14 | 17 |
| TOUT2 | RS-232 driver output | 7 | 8 |
| RIN1 | RS-232 driver input | 13 | 16 |
| RIN2 | RS-232 driver input | 8 | 9 |
| ROUT1 | TTL/CMOS receiver output | 12 | 15 |
| ROUT2 | TTL/CMOS receiver output | 9 | 10 |
| TIN1 | TTL/CMOS driver input, must be valid high or low | 11 | 13 |
| TIN2 | TTL/CMOS driver input, must be valid high or low | 10 | 12 |
| GND | Ground | 15 | 18 |
| VCC | 3.0V to 5.5V supply voltage | 16 | 19 |
| $\overline{\text{SHDN}}$ | Shutdown Control Input. Drive HIGH for normal device operation. Drive LOW to shutdown the drivers (high-Z output) and the on-board power supply. | - | 20 |

2. Product Specification

2.1 Absolute Maximum Ratings ⁽¹⁾

| Parameter | Min | Max | Unit |
|--|------|----------------------|------|
| DC supply voltage, V _{CC} | -0.3 | 6 | V |
| Positive output supply voltage, V ₊ | -0.3 | 8 | V |
| Negative output supply voltage, V ₋ | -0.3 | -8 | V |
| Supply voltage difference, V ₊ - V ₋ | | 16 | V |
| Driver input voltage, V _{TI} | -0.3 | 6 | V |
| Receiver input voltage, V _{RI} | -16 | +16 | V |
| Driver output voltage, V _{TO} | -16 | +16 | V |
| Receiver output voltage, V _{RO} | -0.3 | V _{CC} +0.3 | V |
| Operating junction temperature | | +150 | °C |
| Storage temperature | -65 | +150 | °C |

(1) Stresses exceeding the absolute maximum ratings may damage the device. The device may not function or be operable above the recommended operating conditions and stressing the parts to these levels is not recommended. In addition, extended exposure to stresses above the recommended operating conditions may affect device reliability. The absolute maximum ratings are stress ratings only.

2.2 Thermal Data

| Parameter | Rating | Unit |
|--------------------------------------|----------------------------|-----------------------------|
| Package Thermal Resistance, R_{JA} | 80 (SOP16) 90 (TSSOP20) | $^{\circ}\text{C}/\text{W}$ |

2.3 Recommended Operating Conditions

| Parameter | Min. | Typ. | Max. | Unit |
|---------------------------------|------|------|------|--------------------|
| DC Supply voltage, V_{CC} | 3.0 | 3.3 | 5.5 | V |
| Driver high-level input voltage | 2 | | 5.5 | V |
| Driver low-level input voltage | 0 | | 0.8 | V |
| Receiver input voltage | -15 | | +15 | V |
| Data rate | 0 | | 250 | Kbps |
| Operating ambient temperature | -40 | | +85 | $^{\circ}\text{C}$ |
| Operating junction temperature | -40 | | +125 | $^{\circ}\text{C}$ |

2.4 Electrical Characteristics

(Typical values are tested at $T_A=25^{\circ}\text{C}$, $V_{CC}=3.3\text{V}$)

| Parameter | Symbol | Conditions | Min. | Typ. | Max. | Unit |
|-------------------------------|----------|--|------|------|------|---------------|
| DC Characteristics | | | | | | |
| Supply current | I_{CC} | no load, $V_{CC} = 3.3\text{V}$, $T_{XIN} = \text{GND}$ or V_{CC} | | 0.4 | 1.0 | mA |
| Shutdown supply current | I_{SD} | $\overline{\text{SHDN}} = \text{GND}$, $V_{CC} = 3.3\text{V}$, $T_{XIN} = \text{GND}$ or V_{CC} | | 1.0 | 10 | μA |
| Driver Characteristics | | | | | | |
| High-level output voltage | V_{OH} | $\text{DIN} = \text{GND}$ $R_L = 3\text{k}\Omega$ to GND | +5.0 | +5.4 | | V |
| Low-level output voltage | V_{OL} | $\text{DIN} = V_{CC}$ $R_L = 3\text{k}\Omega$ to GND | -5.0 | -5.4 | | V |

| | | | | | | |
|--|-----------|---|--------------|----------|----------|---------------|
| Output resistance | R_O | $V_{CC}, V+, \text{ and } V- = 0 \text{ V},$ $V_{OUT} = \pm 2 \text{ V}$ | 300 | | | Ω |
| Output short-circuit current | I_{OS} | $V_{OUT}=0$ | | ± 35 | ± 60 | mA |
| Output leakage current | I_{OK} | $V_{OUT}=\pm 12\text{V}$, drivers disabled $V_{CC}=0\text{V}$ or 3.0V to 5.5V | | | ± 25 | μA |
| Receiver Characteristics | | | | | | |
| Input voltage range | V_{IN} | | -15 | | +15 | V |
| Input threshold LOW | V_{ITL} | $V_{CC} = 3.3\text{V}$ | 0.6 | 1.2 | | V |
| | | $V_{CC} = 5.0\text{V}$ | 0.8 | 1.5 | | V |
| Input threshold HIGH | V_{ITH} | $V_{CC} = 3.3\text{V}$ | | 1.5 | 2.4 | V |
| | | $V_{CC} = 5.0\text{V}$ | | 1.8 | 2.4 | V |
| Input hysteresis | V_{HYS} | | | 0.3 | | V |
| Input resistance | R_i | $V_{IN} = \pm 3 \text{ V to } \pm 15 \text{ V}$ | 3 | 5 | 7 | k Ω |
| Logic Inputs and Receiver Outputs | | | | | | |
| Input logic threshold LOW | | $\overline{\text{SHDN}}, \overline{\text{EN}}, \text{TxIN}$ | | | 0.8 | V |
| Input logic threshold HIGH | | $V_{CC}=3.3\text{V}$ | 2.0 | | V_{CC} | V |
| Input logic threshold HIGH | | $V_{CC}=5.0\text{V}$ | 2.4 | | V_{CC} | V |
| Input leakage current | | $\overline{\text{SHDN}}, \overline{\text{EN}}, \text{TxIN}$ | | 0.01 | 1 | μA |
| Output leakage current | | Receivers disabled, $V_{out}=0\text{V}$ to V_{CC} | | 0.05 | 10 | μA |
| Logic Input low voltage | | $I_{OUT}=1.6\text{mA}$ | | | 0.4 | V |
| Logic Input current | | $I_{OUT}=-1.0\text{mA}$ | $V_{CC}-0.6$ | | | V |

| Switching Characteristics | | | | | | |
|----------------------------------|-----------|--|-----|-----|------|-----------|
| Maximum data rate | t_{PZH} | $R_L = 3k\Omega, C_L = 1000pF,$ one driver switching | 150 | 250 | | kbps |
| Driver propagation delay | t_{PHL} | $R_L = 3k\Omega, C_L = 1000pF$ | | 1.0 | | μs |
| | t_{PLH} | $R_L = 3k\Omega, C_L = 1000pF$ | | 1.0 | | μs |
| Receiver propagation delay | t_{PHL} | Receiver input to receiver output, $C_L = 150pF$ | | 0.3 | | μs |
| | t_{PLH} | Receiver input to receiver output, $C_L = 150pF$ | | 0.3 | | μs |
| Receiver output enable time | | | | 200 | | ns |
| Receiver output disable time | | | | 200 | | ns |
| Driver skew | | $ t_{PHL} - t_{PLH} $ | | 100 | 500 | ns |
| Receiver skew | | $ t_{PHL} - t_{PLH} $ | | 200 | 1000 | ns |
| Slew Rate | SR | $R_L = 3k\Omega$ to $7k\Omega,$ $C_L = 150pF$ to $1000pF$ | 6 | | 30 | $V/\mu s$ |

3. Application Information

3.1 Overview

The COSMAX3232 (Figure 2) and COSMAX3222 (Figure 3) are 2-driver / 2-receiver devices ideal for portable or hand-held applications. The COSMAX3222 features a $1\mu A$ shutdown mode that reduces power consumption and extends battery life in portable systems. Its receivers remain active in shutdown mode, allowing external devices such as modems to be monitored using only $1\mu A$ supply current. The charge pump and four small external capacitors allow operation from a single 3-V to 5.5-V supply. The device operates at data signaling rates up to 250 kbit/s and a maximum of $30-V/\mu s$ driver output slew rate. Outputs are protected against shorts to ground. Table 1 and Table 2 list the functional modes of the COSMAX3232 drivers and receivers.

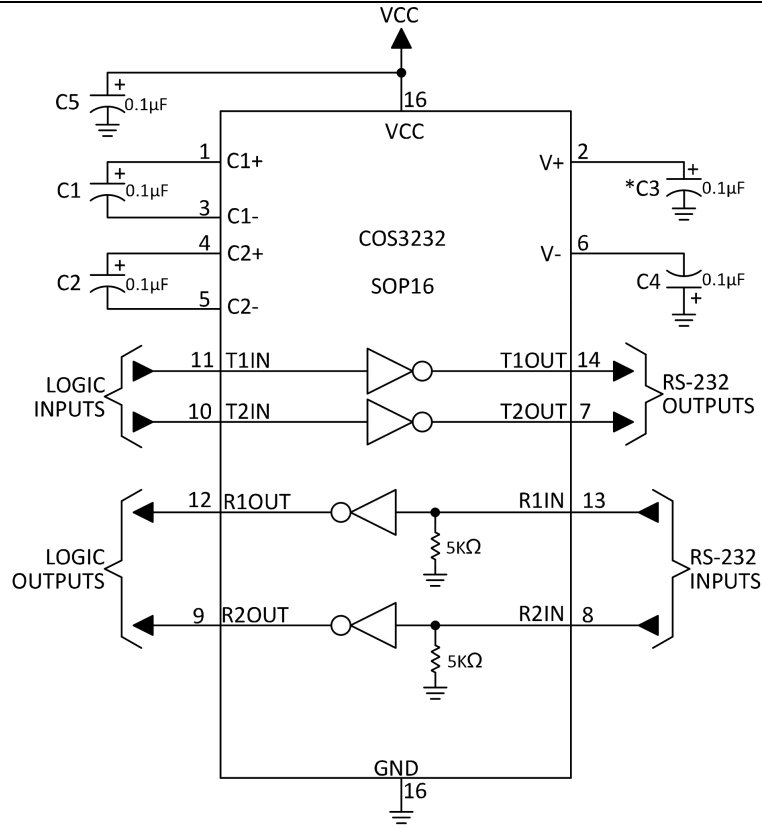


Figure 2 COSMAX3232 Typical Operation Circuit

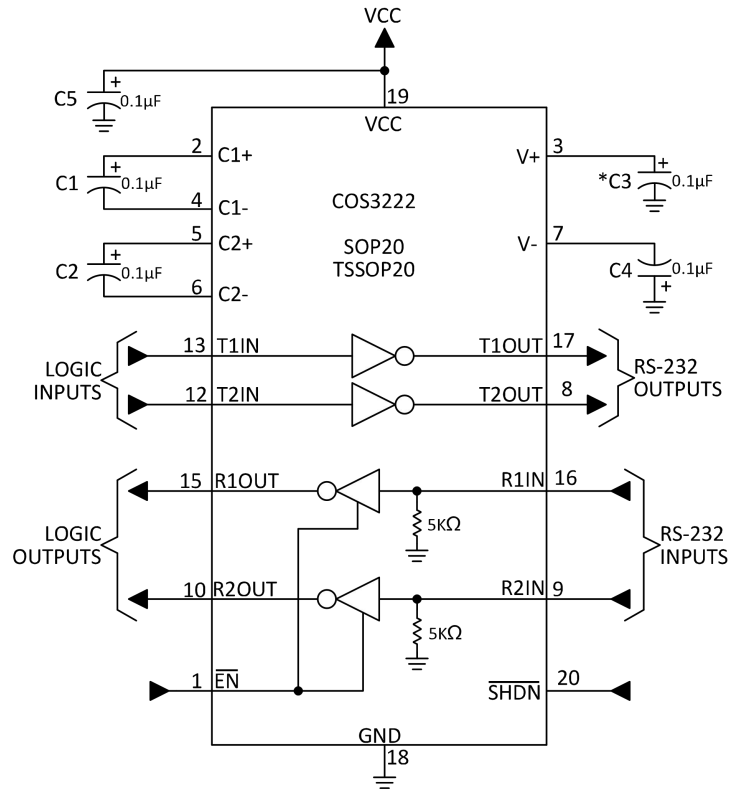


Figure 3 COSMAX3222 Typical Operation Circuit

Table 1. COSMAX3232 Driver Function Modes

| INPUT TIN | OUTPUT TOUT |
|--------------|----------------|
| L | H |
| H | L |

Table 2. COSMAX3232 Receiver Function Modes

| INPUT RIN | OUTPUT ROUT |
|--------------|----------------|
| L | H |
| H | L |
| Open | H |

3.2 Drivers

The COSMAX3232/COSMAX3222 drivers are inverting level transmitters that convert TTL or CMOS logic levels to 5.0V EIA/TIA-232 levels with an inverted sense relative to the input logic levels. Typically, the RS-232 output voltage swing is 5.4V with no load and 5V minimum fully loaded. The driver outputs are protected against infinite short-circuits to ground without degradation in reliability. Driver outputs will meet EIA/TIA-562 levels of $\pm 3.7V$ with supply voltages as low as 2.7V. The drivers can guarantee a data rate of 120kbps fully loaded with $3k\Omega$ in parallel with 1000pF, ensuring compatibility with PC-to-PC communication software. The slew rate of the driver is internally limited to a maximum of $30V/\mu s$ in order to meet the EIA standards (EIA RS-232D 2.1.7, Paragraph 5). The transition of the loaded output from HIGH to LOW also meet the monotonicity requirements of the standard.

When the COSMAX3222 device is shut down (\overline{SHDN} = LOW), the device's driver outputs are disabled (tri-stated) and the charge pumps are turned off with $V+$ pulled down to VCC and $V-$ pulled to GND. In the shutdown mode, the supply current falls to less than $1\mu A$. The time required to exit shutdown is typically $100\mu s$. Connect \overline{SHDN} to VCC if the shutdown mode is not used. The driver's inputs do not have pullup resistors. Designers should connect unused inputs to VCC or GND.

3.3 Receivers

The Receivers convert EIA/TIA-232 levels to TTL or CMOS logic output levels. The COSMAX3222 receivers have an inverting tri-state output. These receiver outputs (RxOUT) are tri-stated when the enable control $\overline{EN} = \text{HIGH}$. In the shutdown mode, the receivers can be active or inactive. \overline{EN} has no effect on TxOUT. The truth table logic of the COSMAX3222 driver and receiver outputs can be found in Table 3.

Table 3 COSMAX3222 Truth Table Logic for Shutdown and Enable Control

| \overline{SHDN} | \overline{EN} | TOUT1,2 | ROUT1,2 |
|-------------------|-----------------|-----------|-----------|
| 0 | 0 | Tri-state | Active |
| 0 | 1 | Tri-state | Tri-state |
| 1 | 0 | Active | Active |
| 1 | 1 | Active | Tri-state |

Since receiver input is usually from a transmission line where long cable lengths and system interference can degrade the signal, the inputs have a typical hysteresis margin of 300mV. This ensures that the receiver is virtually immune to noisy transmission lines. Should an input be left unconnected, an internal 5kΩ pulldown resistor to ground will commit the output of the receiver to a HIGH state.

3.4 Charge Pump

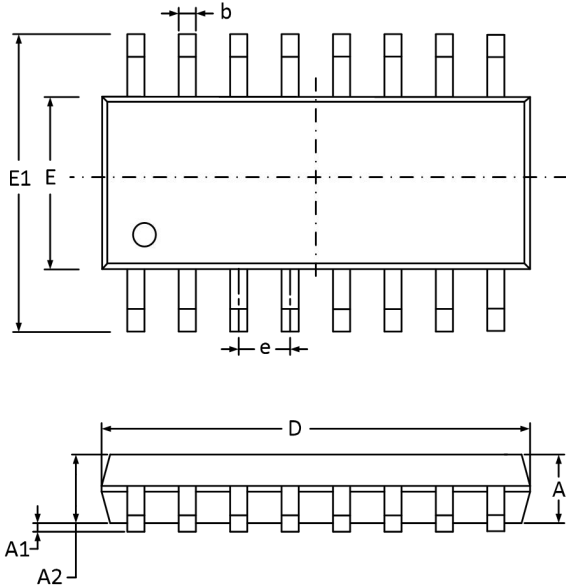
The internal charge pump and four small external capacitors allow operation from a single 3-V to 5.5-V supply. Select capacitor values (Table 4) based on Vcc level for best performance.

Table 4. VCC vs Capacitor Values

| VCC | C1 | C2, C3, C4 |
|----------------|----------|------------|
| 3.3 V ± 0.5 V | 0.1 μF | 0.1 μF |
| 5 V ± 0.5 V | 0.047 μF | 0.33 μF |
| 3.0 V to 5.5 V | 0.1 μF | 0.47 μF |

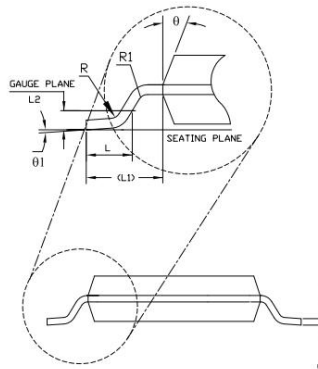
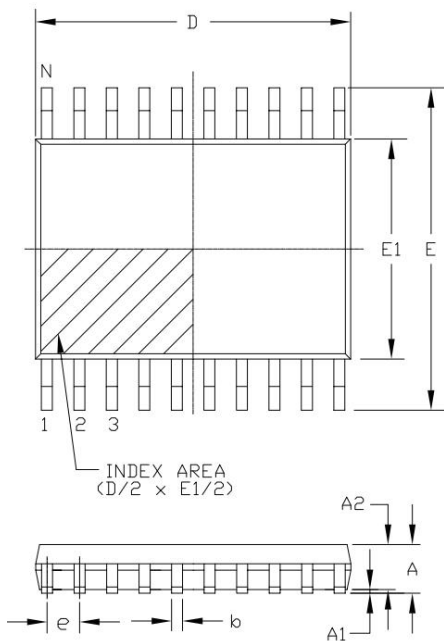
4. Package Information

4.1 SOP16 (Package Outline Dimensions)



| Symbol | Dimensions In Millimeters | | Dimensions In Inches | |
|--------|---------------------------|-------|----------------------|-------|
| | MIN | MAX | MIN | MAX |
| A | 1.350 | 1.750 | 0.053 | 0.069 |
| A1 | 0.100 | 0.250 | 0.004 | 0.010 |
| A2 | 1.350 | 1.550 | 0.053 | 0.061 |
| b | 0.330 | 0.510 | 0.013 | 0.020 |
| c | 0.170 | 0.250 | 0.006 | 0.010 |
| D | 9.800 | 10.20 | 0.386 | 0.402 |
| E | 3.800 | 4.000 | 0.150 | 0.157 |
| E1 | 5.800 | 6.200 | 0.228 | 0.244 |
| e | 1.27 BSC | | 0.050 BSC | |
| L | 0.400 | 1.270 | 0.016 | 0.050 |
| θ | 0° | 8° | 0° | 8° |

4.2 TSSOP20 (Package Outline Dimensions)



| SYMBOLS | DIMENSIONS IN MM (Control Unit) | | | DIMENSIONS IN INCH (Reference Unit) | | |
|---------|---------------------------------|------|------|-------------------------------------|-------|-------|
| | MIN | NOM | MAX | MIN | NOM | MAX |
| A | — | — | 1.20 | — | — | 0.047 |
| A1 | 0.05 | — | 0.15 | 0.002 | — | 0.006 |
| A2 | 0.80 | 1.00 | 1.05 | 0.031 | 0.039 | 0.041 |
| b | 0.19 | — | 0.30 | 0.007 | — | 0.012 |
| c | 0.09 | — | 0.20 | 0.004 | — | 0.008 |
| E | 6.40 BSC | | | 0.252 BSC | | |
| E1 | 4.30 | 4.40 | 4.50 | 0.169 | 0.173 | 0.177 |
| e | 0.65 BSC | | | 0.026 BSC | | |
| L | 0.45 | 0.60 | 0.75 | 0.018 | 0.024 | 0.030 |
| L1 | 1.00 REF | | | 0.039 REF | | |
| L2 | 0.25 BSC | | | 0.010 BSC | | |
| R | 0.09 | — | — | 0.035 | — | — |
| R1 | 0.09 | — | — | 0.035 | — | — |
| θ | 12° REF | | | 12° REF | | |
| θ1 | 0° | — | 8° | 0° | — | 8° |
| D | 6.40 | 6.50 | 6.60 | 0.252 | 0.256 | 0.260 |
| N | 20 | | | 20 | | |

5. Order Information

| Model | Order Number | Package | Package Option | Marking Information |
|--------------|---------------------|----------------|-----------------------|----------------------------|
| COSMAX3232 | COSMAX3232ID | SOP-16 | Tape and Reel, 2000 | COS3232 |
| | COSMAX3232IDB | TSSOP16 | Tape and Reel, 2000 | COS3232 |
| COSMAX3222 | COSMAX3222SR | SOP-20 | Tape and Reel, 2000 | COS3222 |
| | COSMAX3222 | TSSOP20 | Tape and Reel, 2000 | COS3222 |