

# LMS202E

*LMS202E 15KV ESD Rated, 5V Single Supply TIA/EIA-232 Dual Transceivers*



Literature Number: SNLS160C

# LMS202E

## 15KV ESD Rated, 5V Single Supply TIA/EIA-232 Dual Transceivers

### General Description

The LMS202E features two transmitters and two receivers for RS-232 communication. It has a DC-to-DC converter that permits the device to operate with only a single +5V power supply. The on-chip DC-to-DC converter which utilizes four external 0.1µF capacitors to generate dual internal power supplies for RS-232 compatible output levels.

The device meet EIA/TIA-232E and CCITT V.28 specifications up to 230kbits/sec. The LMS202E is available in a 16 pin narrow and wide SOIC package.

The transmitter outputs and receiver inputs have ±15kV electrostatic discharge (ESD) protection. The LMS202E survives a ± 15kV ESD event to the RS-232 input and output pins when subjected according to Human Body Model or IEC 1000-4-2 (EN61000-4-2), air-gap specification. It survives a ±8kV discharge when subjected to IEC 1000-4-2 (EN61000-4-2), contact specification. This device is designed for use in harsh environments where ESD is a concern.

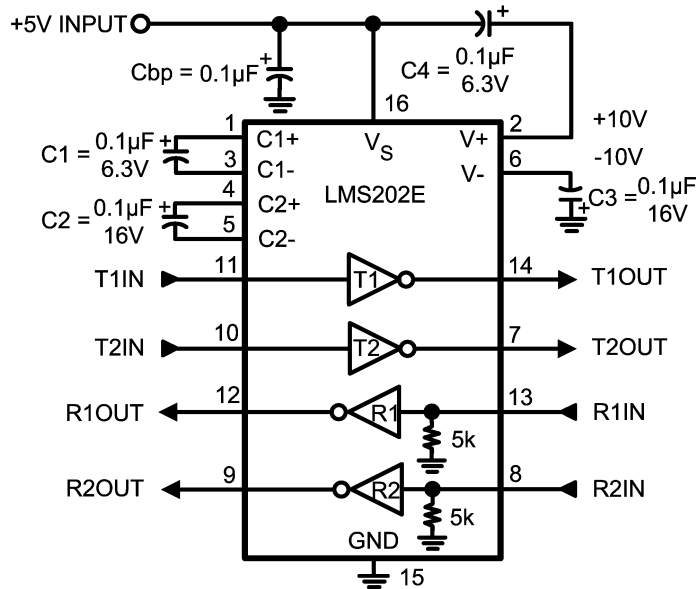
### Features

- ESD protection for RS-232 I/O pins
  - ±15kV-IEC1000 4-2 (EN61000-4-2) Contact Discharge
  - ±8kV-IEC1000 4-2 (EN61000-4-2) Air-Gap Discharge
  - ±15kV Human Body Model
- Single +5V power supply
- 230 kbps data rate
- On-board DC-to-DC converter
- 0.1µF charge pump capacitors
- Drop-in replacement to Maxim's MAX202E

### Applications

- POS equipment (Bar code reader)
- Hand-held equipment
- General purpose RS-232 communication

### Connection Diagram and Typical Circuit



20048001

## Pin Descriptions

| Pin Number | Pin Name        | Pin Function   |
|------------|-----------------|--|
| 1, 3       | C1+, C1-        | External capacitor connection pins. Recommended external capacitor C1 = 0.1 $\mu$ F (6.3V)   |
| 2          | V+              | Positive supply for TIA/EIA-232E drivers. Recommended external capacitor C4 = 0.1 $\mu$ F (6.3V)   |
| 4, 5       | C2+, C2-        | External capacitor connection pins. Recommended external capacitor C2 = 0.1 $\mu$ F (16V)  |
| 6          | V-              | Negative supply for TIA/EIA-232E drivers. Recommended external capacitor C3 = 0.1 $\mu$ F (16V)  |
| 7, 14      | T1out, T2out    | Transmitter output pins conform to TIA/EIA-232E levels. The typical transmitter output swing is $\pm$ 8V when loaded 3k $\Omega$ load to ground. The open-circuit output voltage swings from (V+ - 0.6V) to V- |
| 8,13       | R1in, R2in      | Receiver inputs accept TIA/EIA-232   |
| 9, 12      | R1out and R2out | Receiver output pins are TTL/CMOS compatible   |
| 10, 11     | Tin1, Tin2      | Transmitter input pins are TTL/CMOS compatible. Inputs of transmitter do not have pull-up resistors. Connect all unused transmitter inputs to ground   |
| 15         | GND             | Ground pin   |
| 16         | V <sub>S</sub>  | Power supply pin for the device, +5V ( $\pm$ 10%)  |

## Ordering Information

| Package          | Part Number | Package Marking | Transport Media          | NSC Drawing |
|------------------|-------------|-----------------|--------------------------|-------------|
| 16-Pin SOIC      | LMS202ECM   | LMS202ECM       | 48 Units/Rail            | M16A        |
|                  | LMS202ECMX  |                 | 2.5k Units Tape and Reel |             |
|                  | LMS202EIM   | LMS202EIM       | 48 Units/Rail            |             |
|                  | LMS202EIMX  |                 | 2.5k Units Tape and Reel |             |
| 16-Pin Wide SOIC | LMS202ECMW  | LMS202ECMW      | 45 Units/Rail            | M16B        |
|                  | LMS202ECMWX |                 | 1.0k Units Tape and Reel |             |
|                  | LMS202EIMW  | LMS202EIMW      | 45 Units/Rail            |             |
|                  | LMS202EIMWX |                 | 1.0k Units Tape and Reel |             |

**Absolute Maximum Ratings** (Note 1)

If Military/Aerospace specified devices are required, please contact the National Semiconductor Sales Office/Distributors for availability and specifications.

|                                  |                                  |
|----------------------------------|----------------------------------|
| $V_S$                            | -0.3V to 6V                      |
| $V_+$                            | $(V_S - 0.3V)$ to + 14V          |
| $V_-$                            | +0.3V to -14V                    |
| Driver Input Voltage, $T_{IN}$   | -0.3V to $(V_+ + 0.3V)$          |
| Receiver Input Voltage, $R_{IN}$ | $\pm 30V$                        |
| Driver Output Voltage $T_O$      | $(V_- - 0.3V)$ to $(V_+ + 0.3V)$ |
| Receiver Output Voltage $R_O$    | -0.3 to $(V_S + 0.3)$            |
| Short Circuit Duration, $T_O$    | Continuous                       |
| ESD Rating                       |                                  |
| IEC 1000-4-2) (Note 7)           |                                  |
| (Note 8)                         |                                  |
| Air-Gap Discharge                | 15kV                             |
| Contact Discharge                | 8kV                              |
| Human Body Model (Note 2)        |                                  |
| (Note 8)                         | 15kV                             |

(Note 9)

|                           |                        |
|---------------------------|------------------------|
| ESD Rating (MM)           | 200V (Note 6) (Note 9) |
| Soldering Information     |                        |
| Infrared or Convection    | 235°C                  |
| (20sec.)                  |                        |
| Junction Temperature      | 150°C                  |
| Storage Temperature Range | -65°C to +150°C        |

**Operating Ratings**

|                                  |                |
|----------------------------------|----------------|
| Supply Voltage $V_S$             | 4.5V to 5.5V   |
| Ambient Temperature Range, $T_A$ |                |
| Commercial (C)                   | 0°C to +70°C   |
| Industrial (I)                   | -40°C to +85°C |
| Package Thermal Resistance       |                |
| (Note 3)                         |                |
| SO                               | 71°C/W         |
| WSO                              | 55°C/W         |

**Electrical Characteristics**

Over recommended operating supply and temperature ranges unless otherwise specified  $C_1 = C_2 = C_3 = C_4 = C_{bp} = 0.1\mu F$

| Symbol                            | Parameter                        | Conditions   | Min<br>(Note 5) | Typ         | Max<br>(Note 5) | Units      |
|-----------------------------------|----------------------------------|--|-----------------|-------------|-----------------|------------|
| <b>DC Characteristics</b>         |                                  |  |                 |             |                 |            |
| $I_S$                             | Supply Current                   | No Load, $T_A = 25^\circ C$                                |                 | 1           | 7               | mA         |
| <b>Logic</b>                      |                                  |  |                 |             |                 |            |
| $I_{INPUT}$                       | Input Leakage Current            | $T_{IN} = 0V$ to $V_S$                                     |                 |             | $\pm 10$        | $\mu A$    |
| $V_{THL}$                         | Input Logic Theshold Low         | $T_{IN}$   |                 |             | 0.8             | V          |
| $V_{THH}$                         | Input Logic Theshold High        | $T_{IN}$   | 2.0             |             |                 | V          |
| $V_{OL}$                          | TTL/CMOS Output Voltage Low      | $R_{OUT}, I_{OUT} = 3.2mA$                                 |                 |             | 0.4             | V          |
| $V_{OH}$                          | TTL/CMOS Output Voltage High     | $R_{OUT}, I_{OUT} = -1.0mA$                                | 3.5             | $V_S - 0.1$ |                 | V          |
| <b>RS-232 Receiver Inputs</b>     |                                  |  |                 |             |                 |            |
| $V_{RI}$                          | Receiver Input Voltage Range     |  | -30             |             | +30             | V          |
| $V_{RTHL}$                        | Receiver Input Theshold Low      | $V_S = 5V, T_A = 25^\circ C$                               | 0.8             | 1.4         |                 | V          |
| $V_{RTHH}$                        | Receiver Input Theshold High     | $V_S = 5V, T_A = 25^\circ C$                               |                 | 2           | 2.4             | V          |
| $V_{HYST}$                        | Receiver Input Hysteresis        | $V_S = 5V$   | 0.2             | 0.6         | 1.0             | V          |
| $R_I$                             | Receiver Input Resistance        | $V_S = 5V, T_A = 25^\circ C$                               | 3               | 5           | 7               | k $\Omega$ |
| <b>RS-232 Transmitter Outputs</b> |                                  |  |                 |             |                 |            |
| $V_O$                             | Transmitter Output Voltage Swing | All transmitters loaded with 3k $\Omega$ to GND            | $\pm 5$         | $\pm 8$     |                 | V          |
| $R_O$                             | Output Resistance                | $V_S = V_+ = V_- = 0V,$<br>$V_O = \pm 2V$                  | 300             |             |                 | $\Omega$   |
| $I_{OS}$                          | Output Short Circuit Current     |  |                 | $\pm 11$    | $\pm 60$        | mA         |
| <b>Timing Characteristics</b>     |                                  |  |                 |             |                 |            |
| DR                                | Maximum Data Rate                | $C_L = 50pF$ to 1000pF,<br>$R_L = 3k\Omega$ to 7k $\Omega$ | 230             |             |                 | kbps       |

**Electrical Characteristics** (Continued)Over recommended operating supply and temperature ranges unless otherwise specified  $C_1 = C_2 = C_3 = C_4 = C_{bp} = 0.1\mu\text{F}$ 

| Symbol                   | Parameter                     | Conditions  | Min<br>(Note 5) | Typ  | Max<br>(Note 5) | Units                  |
|--------------------------|-------------------------------|---|-----------------|------|-----------------|------------------------|
| $T_{RPLH}$<br>$T_{RPHL}$ | Receiver Propagation Delay    | $C_L = 150\text{pF}$  |                 | 0.08 | 1               | $\mu\text{s}$          |
| $T_{DPLH}$<br>$T_{DPHL}$ | Transmitter Propagation Delay | $R_L = 3\text{k}\Omega$ , $C_L = 2500\text{pF}$<br>All transmitters loaded  |                 | 2.4  |                 | $\mu\text{s}$          |
| $V_{SLEW}$               | Transition Region Slew Rate   | $T_A = 25^\circ\text{C}$ , $V_S = 5\text{V}$<br>$C_L = 50\text{pF}$ to $1000\text{pF}$ , $R_L = 3\text{k}\Omega$ to $7\text{k}\Omega$<br>Measured from $+3\text{V}$ to $-3\text{V}$ or vice versa | 3               | 6    | 30              | $\text{V}/\mu\text{s}$ |

**ESD Performance: Transmitter Outputs and Receiver Inputs**

| ESD Rating | Model                 | Min | Typ      | Max | Units |
|------------|-----------------------|-----|----------|-----|-------|
|            | Human Body Model      |     | $\pm 15$ |     | kV    |
|            | IEC 1000-4-2, Contact |     | $\pm 8$  |     |       |
|            | IEC 1000-4-2, Air-gap |     | $\pm 15$ |     |       |

**Note 1:** Absolute Maximum Ratings indicate limits beyond which damage to the device may occur. Operating Ratings indicate conditions for which the device is intended to be functional, but specific performance is not guaranteed. For guaranteed specifications and the test conditions, see the Electrical Characteristics.

**Note 2:** Human Body Model,  $1.5\text{k}\Omega$  in series with  $100\text{pF}$

**Note 3:** The maximum power dissipation is a function of  $T_{J(\text{MAX})}$ ,  $\theta_{JA}$ , and  $T_A$ . The maximum allowable power dissipation at any ambient temperature is  $P_D = (T_{J(\text{MAX})} - T_A) / \theta_{JA}$ . All numbers apply for packages soldered directly onto a PC board.

**Note 4:** Typical Values represent the most likely parametric norm.

**Note 5:** All limits are guaranteed by testing or statistical analysis

**Note 6:** Machine model,  $0\Omega$  in series with  $200\text{pF}$

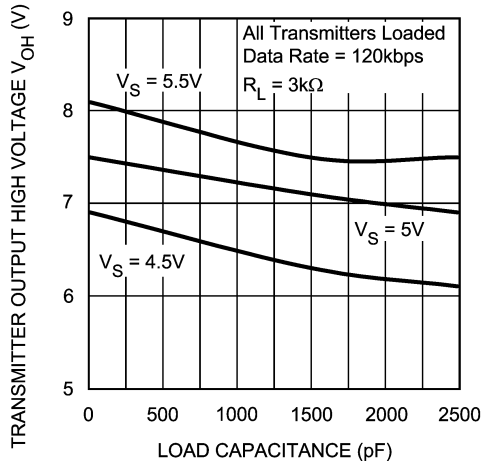
**Note 7:** IEC 1000-4-2,  $330\Omega$  in series with  $150\text{pF}$

**Note 8:** ESD rating applies to pins 7, 8, 13 and 14

**Note 9:** ESD rating applies to pins 1, 2, 3, 4, 5, 6, 9, 10, 11, 12, 15 and 16

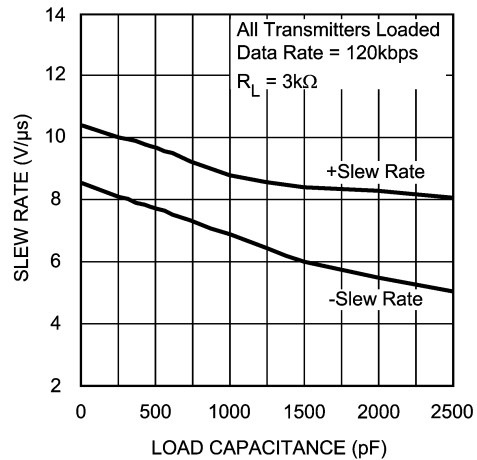
## Typical Characteristics

Transmitter Output High Voltage vs. Load Capacitance



20048002

Transmitter Slew Rate vs. Load Capacitance



20048003

## Application Information

### CAPACITOR SELECTION

The recommended capacitors are 0.1μF. However, larger capacitors for the charge pump may be used to minimize ripples on V+ and V- pins.

### POWER SUPPLY DECOUPLING

In some applications that are sensitive to power supply noise from the charge pump, place a decoupling capacitor, C<sub>bp</sub>, from V<sub>S</sub> to GND. Use at least a 0.1μF capacitor or the same size as the charge pump capacitors (C1 – C4).

### CHARGED PUMP

The dual internal charged-pump provides the ±10V to the transmitters. Using capacitor C1, the charge pump converts +5V to +10V then stores the +10V in capacitor C3. The charge pump uses capacitor C2 to invert the +10V to -10V. The -10V is then stored in capacitor C4.

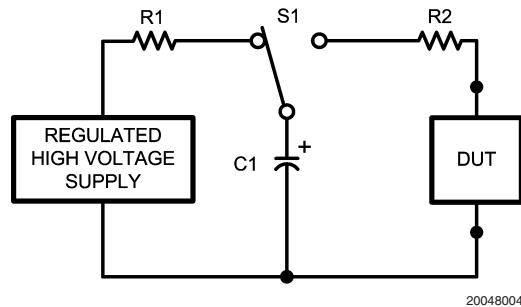
### ELECTROSTATIC DISCHARGE PROTECTION

ESD protection has been placed at all pins to protect the device from ESD. All pins except for the transmitter output pins (pins 7 and 14) and receiver input pins (pins 8 and 13) have a 2kV Human Body Model (HBM) and 200V Machine Model (MM). The RS-232 bus pins (pins 7, 8, 13 and 14) have a more robust ESD protection. The RS-232 bus pins have a 15kV HBM and IEC 1000-4-2, air-gap. In addition, the bus pins meet an ESD rating of 8kV with IEC 1000-4-2, contact. The ESD structures can withstand a high ESD event under the following conditions: powered-on, powered-off, and Input connected to high and low with outputs unloaded.

### HUMAN BODY MODEL

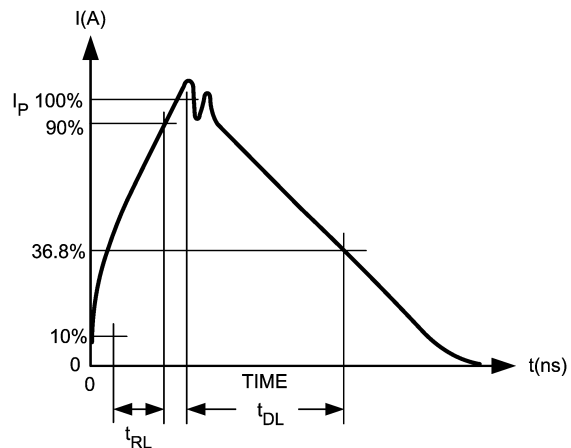
The Human Body Model is an ESD testing standard, defined in Mil-STD-883C method 3015.7. It simulates a human discharging an ESD charge to the IC device. The rise time is approximately 10 ns and decay time is approximately 150 ns. The waveform is obtained by discharging 2kV volts ca-

pacitor through a resistor, R<sub>2</sub> = 1.5 kΩ. The peak current is approximately 1.33A.



20048004

FIGURE 1. HBM ESD Test Model



20048005

FIGURE 2. HBM Waveform

# Application Information (Continued)

## MACHINE MODEL

The Machine Model is the standard ESD test method in Japan and the automotive industry. It simulates a charge on large object discharging through the IC device. This takes place in automated test and handling systems. The equipment can accumulate static charge due to improper grounding, which is transmitted through the IC when it is picked and placed.

The waveform is obtained by discharging 400V volts capacitor to the device. Resistor,  $R2 = 0\Omega$ .

The parasitic inductance,  $L$ , from the PCB affects the peak current and period of the waveform. For  $L = 0.5\mu\text{H}$ , the peak current is approximately 7A with a period of 60 ns. For  $L = 2.5\mu\text{H}$ , the peak current is reduced to 4A with a period of 140 ns.

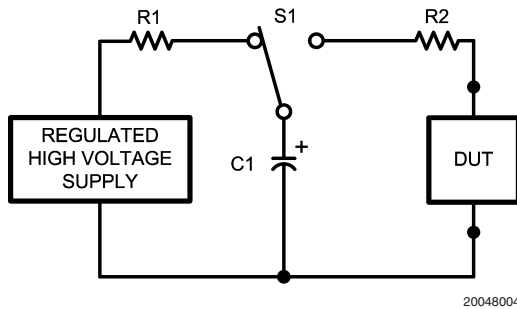


FIGURE 3. MM ESD Model

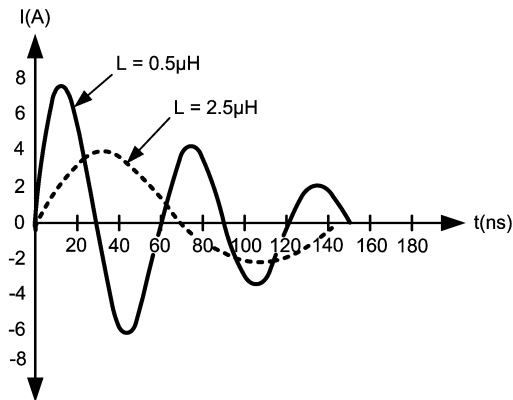


FIGURE 4. MM Waveform

## IEC 1000-4-2 (EN61000-4-2)

The European Union requires ESD immunity testing for all electronic products as a condition for EMC Mark before shipping to any member countries. This is not a IC requirement but an overall system requirement. IEC 1000-4-2 specifies ESD testing both by contact and air-gap discharge. ESD testing by contact are generally more repeatable than air-gap but is less realistic to actual ESD event. However, air-gap discharge is more realistic but ESD results may vary widely dependent on environmental conditions (temperature, humidity,...) The waveform is obtained by discharging 150pF capacitor through a resistor,  $R2 = 330\Omega$ . A typical peak current may be high as 37A with 10kV.

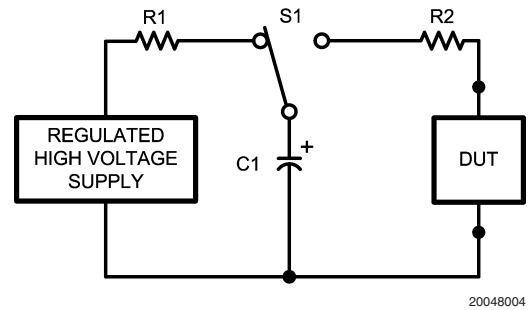


FIGURE 5. IEC ESD Model

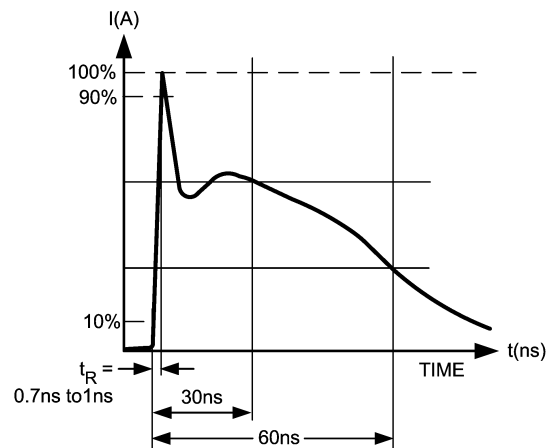


FIGURE 6. IEC Waveform





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