



# LTM2881

## Complete Isolated RS485/RS422 $\mu$ Module Transceiver + Power

### FEATURES

- Isolator  $\mu$ Module Technology
- Isolated RS485/RS422 Transceiver: 2500V<sub>RMS</sub>
- Integrated Isolated DC/DC Converter: 1W, 62% Efficiency
- No External Components Required
- 20Mbps or Low EMI 250kbps Data Rate
- High ESD:  $\pm 15$ kV HBM on Transceiver Interface
- High Common Mode Transient Immunity: 30kV/ $\mu$ s
- Integrated Selectable 120 $\Omega$  Termination
- 3.3V (LTM2881-3) or 5.0V (LTM2881-5) Operation
- 1.62V to 5.5V Logic Supply Pin for Flexible Digital Interface
- Common Mode Working Voltage: 560V<sub>PEAK</sub>
- High Input Impedance Failsafe RS485 Receiver
- Current Limited Drivers and Thermal Shutdown
- Compatible with TIA/EIA-485-A Specification
- High Impedance Output During Internal Fault Condition
- Low Current Shutdown Mode (< 5 $\mu$ A)
- General Purpose CMOS Isolated Channel
- Small, Low Profile (15mm  $\times$  11.25mm  $\times$  2.8mm) Surface Mount LGA and BGA Packages

### APPLICATIONS

- Isolated RS485/RS422 Interface
- Industrial Networks
- Breaking RS485 Ground Loops

### DESCRIPTION

The LTM<sup>®</sup>2881 is a complete galvanically isolated full-duplex RS485/RS422  $\mu$ Module<sup>®</sup> transceiver. No external components are required. A single supply powers both sides of the interface through an integrated, isolated, low noise, efficient 5V output DC/DC converter.

Coupled inductors and an isolation power transformer provide 2500V<sub>RMS</sub> of isolation between the line transceiver and the logic interface. This device is ideal for systems where the ground loop is broken allowing for large common mode voltage variation. Uninterrupted communication is guaranteed for common mode transients greater than 30kV/ $\mu$ s.

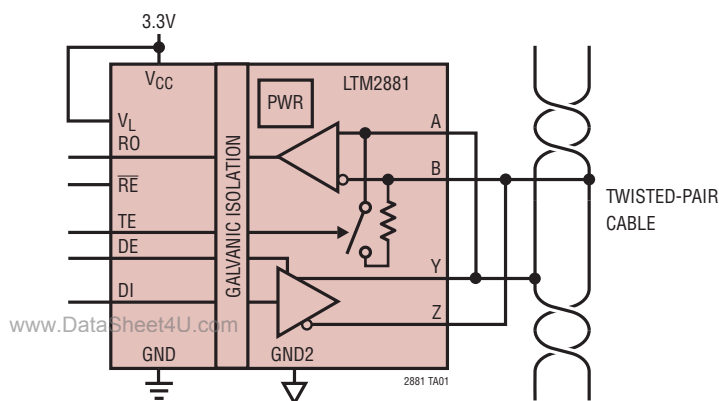
Maximum data rates are 20Mbps or 250kbps in slew limited mode. Transmit data, DI and receive data, RO, implemented with event driven low jitter processing. The receiver has a one-eighth unit load supporting up to 256 nodes per bus. A logic supply pin allows easy interfacing with different logic levels from 1.62V to 5.5V, independent of the main supply.

Enhanced ESD protection allows this part to withstand up to  $\pm 15$ kV (human body model) on the transceiver interface pins to isolated supplies and  $\pm 10$ kV through the isolation barrier to logic supplies without latch-up or damage.

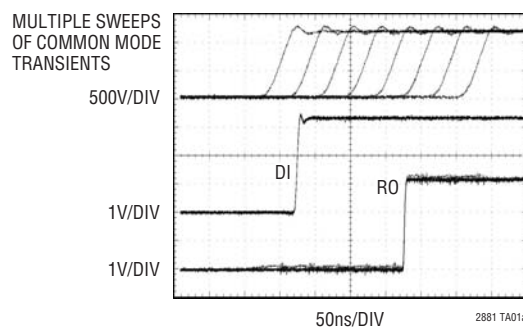
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### TYPICAL APPLICATION

Isolated Half-Duplex RS485  $\mu$ Module Transceiver



LTM2881 Operating Through 35kV/ $\mu$ s CM Transient



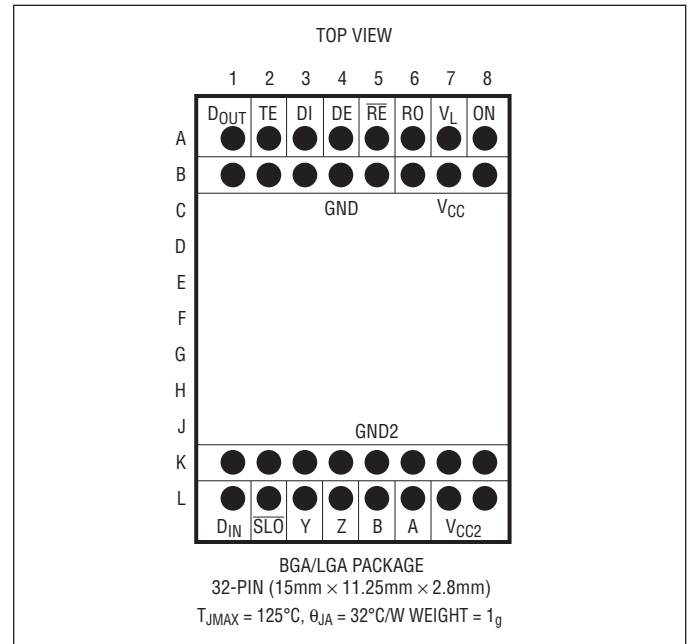
# LTM2881

## ABSOLUTE MAXIMUM RATINGS

(Note 1)

$V_{CC}$ to GND .....	-0.3V to 6V
$V_{CC2}$ to GND2.....	-0.3V to 6V
$V_L$ to GND .....	-0.3V to 6V
Interface Voltages	
(A, B, Y, Z) to GND2 .....	$V_{CC2}$ -15V to 15V
Signal Voltages ON, RO, DI, DE,	
$\overline{RE}$ , TE, $D_{OUT}$ to GND.....	-0.3V to $V_L$ +0.3V
Signal Voltages $\overline{SLO}$ ,	
$D_{IN}$ to GND2.....	-0.3V to $V_{CC2}$ +0.3V
Operating Temperature Range	
LTM2881C.....	0°C to 70°C
LTM2881I.....	-40°C to 85°C
Storage Temperature Range.....	
	-55°C to 125°C
Peak Reflow Temperature (Soldering, 10 sec) .....	
	260°C

## PIN CONFIGURATION



## ORDER INFORMATION

LEAD FREE FINISH	TRAY	PART MARKING*	PACKAGE DESCRIPTION	TEMPERATURE RANGE
LTM2881CV-3#PBF	LTM2881CV-3#PBF	LTM2881V-3	32-Pin (15mm × 11.25mm × 2.8mm) LGA	0°C to 70°C
LTM2881IV-3#PBF	LTM2881IV-3#PBF	LTM2881V-3	32-Pin (15mm × 11.25mm × 2.8mm) LGA	-40°C to 85°C
LTM2881CV-5#PBF	LTM2881CV-5#PBF	LTM2881V-5	32-Pin (15mm × 11.25mm × 2.8mm) LGA	0°C to 70°C
LTM2881IV-5#PBF	LTM2881IV-5#PBF	LTM2881V-5	32-Pin (15mm × 11.25mm × 2.8mm) LGA	-40°C to 85°C
LTM2881CY-3#PBF	LTM2881CY-3#PBF	LTM2881Y-3	32-Pin (15mm × 11.25mm × 2.8mm) BGA	0°C to 70°C
LTM2881IY-3#PBF	LTM2881IY-3#PBF	LTM2881Y-3	32-Pin (15mm × 11.25mm × 2.8mm) BGA	-40°C to 85°C
LTM2881CY-5#PBF	LTM2881CY-5#PBF	LTM2881Y-5	32-Pin (15mm × 11.25mm × 2.8mm) BGA	0°C to 70°C
LTM2881IY-5#PBF	LTM2881IY-5#PBF	LTM2881Y-5	32-Pin (15mm × 11.25mm × 2.8mm) BGA	-40°C to 85°C

Consult LTC Marketing for parts specified with wider operating temperature ranges. \*The temperature grade is identified by a label on the shipping container.

For more information on lead free part marking, go to: <http://www.linear.com/leadfree/>

This product is only offered in trays. For more information go to: <http://www.linear.com/packaging/>

## LTM2881

**ELECTRICAL CHARACTERISTICS** The ● denotes the specifications which apply over the full operating temperature range, otherwise specifications are at  $T_A = 25^\circ\text{C}$ . LTM2881-3  $V_{CC} = 3.3\text{V}$ , LTM2881-5  $V_{CC} = 5.0\text{V}$ ,  $V_L = 3.3\text{V}$ ,  $\text{GND} = \text{GND2} = 0\text{V}$ ,  $\text{ON} = V_L$  unless otherwise noted.

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
<b>Power Supply</b>						
$V_{CC}$	$V_{CC}$ Supply Voltage	LTM2881-3 LTM2881-5	● ●	3.0 4.5	3.3 5.0	3.6 5.5 V V
$V_L$	$V_L$ Supply Voltage		●	1.62		5.5 V
$I_{CCPOFF}$	$V_{CC}$ Supply Current in Off Mode	$\text{ON} = 0\text{V}$	●		0	5 $\mu\text{A}$
$I_{CCS}$	$V_{CC}$ Supply Current in On Mode	LTM2881-3 $\text{DE} = 0\text{V}$ , $\overline{\text{RE}} = V_L$ , No Load LTM2881-5 $\text{DE} = 0\text{V}$ , $\overline{\text{RE}} = V_L$ , No Load	● ●		20 15	25 19 mA mA
$V_{CC2}$	Regulated $V_{CC2}$ Output Voltage, Loaded	LTM2881-3 $\text{DE} = 0\text{V}$ , $\overline{\text{RE}} = V_L$ , $I_{\text{LOAD}} = 100\text{mA}$ LTM2881-5 $\text{DE} = 0\text{V}$ , $\overline{\text{RE}} = V_L$ , $I_{\text{LOAD}} = 180\text{mA}$		4.5 4.5	5.0 5.0	V V
$V_{CC2\text{NOLOAD}}$	Regulated $V_{CC2}$ Output Voltage, No Load	$\text{DE} = 0\text{V}$ , $\overline{\text{RE}} = V_L$ , No Load	●	4.8	5.0	5.2 V
	Efficiency	$I_{CC2} = 100\text{mA}$ (Note 2)			50	%
$I_{CC2S}$	$V_{CC2}$ Short-Circuit Current	$\text{DE} = 0\text{V}$ , $\overline{\text{RE}} = V_L$ , $V_{CC2} = 0\text{V}$	●			250 mA
<b>Driver</b>						
$ V_{OD} $	Differential Driver Output Voltage	$R = \infty$ (Figure 1) $R = 27\Omega$ (RS485) (Figure 1) $R = 50\Omega$ (RS422) (Figure 1)	● ● ●	1.5 2		$V_{CC2}$ $V_{CC2}$ $V_{CC2}$ V V V
$\Delta V_{OD} $	Difference in Magnitude of Driver Differential Output Voltage for Complementary Output States	$R = 27\Omega$ or $R = 50\Omega$ (Figure 1)	●			0.2 V
$V_{OC}$	Driver Common Mode Output Voltage	$R = 27\Omega$ or $R = 50\Omega$ (Figure 1)	●			3 V
$\Delta V_{OC} $	Difference in Magnitude of Driver Common Mode Output Voltage for Complementary Output States	$R = 27\Omega$ or $R = 50\Omega$ (Figure 1)	●			0.2 V
$I_{OZD}$	Driver Three-State (High Impedance) Output Current on Y and Z	$\text{DE} = 0\text{V}$ , (Y or Z) = $-7\text{V}$ , $+12\text{V}$	●			$\pm 10$ $\mu\text{A}$
$I_{OSD}$	Maximum Driver Short-Circuit Current	$-7\text{V} \leq (\text{Y or Z}) \leq 12\text{V}$ (Figure 2)	●	-250		250 mA
<b>Receiver</b>						
$R_{IN}$	Receiver Input Resistance	$\overline{\text{RE}} = 0\text{V}$ or $V_L$ , $V_{IN} = -7\text{V}$ , $-3\text{V}$ , $3\text{V}$ , $7\text{V}$ , $12\text{V}$ (Figure 3)	●	96	125	k $\Omega$
$R_{TE}$	Receiver Termination Resistance Enabled	$\text{TE} = V_L$ , $V_{AB} = 2\text{V}$ , $V_B = -7\text{V}$ , $0\text{V}$ , $10\text{V}$ (Figure 8)	●	108	120	156 $\Omega$
$I_{IN}$	Receiver Input Current (A, B)	$\text{ON} = 0\text{V}$ $V_{CC2} = 0\text{V}$ or $5\text{V}$ , $V_{IN} = 12\text{V}$ (Figure 3)	●			125 $\mu\text{A}$
		$\text{ON} = 0\text{V}$ $V_{CC2} = 0\text{V}$ or $5\text{V}$ , $V_{IN} = -7\text{V}$ (Figure 3)	●	-100		$\mu\text{A}$
$V_{TH}$	Receiver Differential Input Threshold Voltage (A-B)	$-7\text{V} \leq B \leq 12\text{V}$	●	-0.2		0.2 V
$\Delta V_{TH}$	Receiver Input Failsafe Hysteresis	$B = 0\text{V}$	●		25	mV
	Receiver Input Failsafe Threshold	$B = 0\text{V}$	●	-0.2		-0.01 V
<b>Logic</b>						
$V_{IL}$	Logic Input Low Voltage	$1.62\text{V} \leq V_L \leq 5.5\text{V}$	●			0.4 V
$V_{IH}$	Logic Input High Voltage	$D_{IN}$ $S_{LO}$ $D_I$ , $\text{TE}$ , $\text{DE}$ , $\text{ON}$ , $\overline{\text{RE}}$ : $V_L \geq 2.35\text{V}$ $1.62\text{V} \leq V_L < 2.35\text{V}$	● ● ● ●	$0.67 \cdot V_{CC2}$ 2		V V V V

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SYMBOL	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
$I_{INL}$	Logic Input Current		●	0	$\pm 1$	$\mu\text{A}$
$V_{HYS}$	Logic Input Hysteresis	(Note 2)		150		mV
$V_{OH}$	Output High Voltage	Output High, $I_{LOAD} = -4\text{mA}$ (Sourcing), $5.5\text{V} \geq V_L \geq 3\text{V}$ Output High, $I_{LOAD} = -1\text{mA}$ (Sourcing), $1.62\text{V} \leq V_L < 3\text{V}$	●	$V_L - 0.4$		V
			●	$V_L - 0.4$		V
$V_{OL}$	Output Low Voltage	Output Low, $I_{LOAD} = 4\text{mA}$ (Sinking), $5.5\text{V} \geq V_L \geq 3\text{V}$ Output High, $I_{LOAD} = 1\text{mA}$ (Sinking), $1.62\text{V} \leq V_L < 3\text{V}$	●		0.4	V
			●		0.4	V
$I_{OZR}$	Three-State (High Impedance) Output Current on RO	$\overline{RE} = V_L$ , $0\text{V} \leq R_O \leq V_L$	●		$\pm 1$	$\mu\text{A}$
$I_{OSR}$	Short-Circuit Current	$0\text{V} \leq (R_O \text{ or } D_{OUT}) \leq V_L$	●		$\pm 85$	mA

**SWITCHING CHARACTERISTICS** The ● denotes the specifications which apply over the full operating temperature range, otherwise specifications are at  $T_A = 25^\circ\text{C}$ . LTM2881-3  $V_{CC} = 3.3\text{V}$ , LTM2881-5  $V_{CC} = 5.0\text{V}$ ,  $V_L = 3.3\text{V}$ ,  $\text{GND} = \text{GND2} = 0\text{V}$ ,  $\text{ON} = V_L$  unless otherwise noted.

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
<b>Driver SLO = V<sub>CC2</sub></b>						
$f_{MAX}$	Maximum Data Rate	(Note 3)		20		Mbps
$t_{PLHD}$ $t_{PHLD}$	Driver Input to Output	$R_{DIFF} = 54\Omega$ , $C_L = 100\text{pF}$ (Figure 4)	●	60	85	ns
$\Delta t_{PD}$	Driver Input to Output Difference $ t_{PLHD} - t_{PHLD} $	$R_{DIFF} = 54\Omega$ , $C_L = 100\text{pF}$ (Figure 4)	●	1	8	ns
$t_{SKEWD}$	Driver Output Y to Output Z	$R_{DIFF} = 54\Omega$ , $C_L = 100\text{pF}$ (Figure 4)	●	1	$\pm 8$	ns
$t_{RD}$ $t_{FD}$	Driver Rise or Fall Time	$R_{DIFF} = 54\Omega$ , $C_L = 100\text{pF}$ (Figure 4)	●	4	12.5	ns
$t_{ZLD}$ , $t_{ZHD}$ , $t_{LZD}$ , $t_{HZD}$	Driver Output Enable or Disable Time	$R_L = 500\Omega$ , $C_L = 50\text{pF}$ (Figure 5)	●		170	ns
<b>Driver SLO = GND2</b>						
$f_{MAX}$	Maximum Data Rate	(Note 3)		250		kbps
$t_{PLHD}$ $t_{PHLD}$	Driver Input to Output	$R_{DIFF} = 54\Omega$ , $C_L = 100\text{pF}$ (Figure 4)	●	1	1.55	$\mu\text{s}$
$\Delta t_{PD}$	Driver Input to Output Difference $ t_{PLHD} - t_{PHLD} $	$R_{DIFF} = 54\Omega$ , $C_L = 100\text{pF}$ (Figure 4)	●	50	500	ns
$t_{SKEWD}$	Driver Output Y to Output Z	$R_{DIFF} = 54\Omega$ , $C_L = 100\text{pF}$ (Figure 4)	●	$\pm 200$	$\pm 500$	ns
$t_{RD}$ $t_{FD}$	Driver Rise or Fall Time	$R_{DIFF} = 54\Omega$ , $C_L = 100\text{pF}$ (Figure 4)	●	0.9	1.5	$\mu\text{s}$
$t_{ZLD}$ , $t_{ZHD}$ , $t_{LZD}$ , $t_{HZD}$	Driver Output Enable or Disable Time	$R_L = 500\Omega$ , $C_L = 50\text{pF}$ (Figure 5)	●		400	ns

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SYMBOL	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
<b>Receiver</b>						
$t_{PLHR}$ $t_{PHLR}$	Receiver Input to Output	$C_L = 15\text{pF}$ , $V_{CM} = 2.5\text{V}$ , $ V_{AB}  = 1.4\text{V}$ , $t_R$ and $t_F < 4\text{ns}$ , (Figure 6)	●	100	140	ns
$t_{SKEWR}$	Differential Receiver Skew $ t_{PLHR} - t_{PHLR} $	$C_L = 15\text{pF}$ (Figure 6)	●	1	8	ns
$t_{RR}$ $t_{FR}$	Receiver Output Rise or Fall Time	$C_L = 15\text{pF}$ (Figure 6)	●	3	12.5	ns
$t_{ZLR}$ , $t_{ZHR}$ , $t_{LZR}$ , $t_{HZR}$	Receiver Output Enable Time	$R_L = 1\text{k}\Omega$ , $C_L = 15\text{pF}$ (Figure 7)	●		50	ns
$t_{RTEN}$ , $t_{RTZ}$	Termination Enable or Disable Time	$\overline{RE} = 0\text{V}$ , $DE = 0\text{V}$ , $V_{AB} = 2\text{V}$ , $V_B = 0\text{V}$ (Figure 8)	●		100	$\mu\text{s}$
<b>Generic Logic Input</b>						
$t_{PLHL1}$ $t_{PHLL1}$	$D_{IN}$ to $D_{OUT}$ Input to Output	$C_L = 15\text{pF}$ , $t_R$ and $t_F < 4\text{ns}$	●	60	100	ns
<b>Power Supply Generator</b>						
	$V_{CC2} - \text{GND2}$ Supply Start-Up Time (0V to 4.5V)	$\text{ON} \rightarrow V_L$ , No Load	●	250	500	$\mu\text{s}$

**ISOLATION CHARACTERISTICS**  $T_A = 25^\circ\text{C}$ , LTM2881-3  $V_{CC} = 3.3\text{V}$ , LTM2881-5  $V_{CC} = 5.0\text{V}$ ,  $V_L = 3.3\text{V}$  unless otherwise noted.

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
$V_{ISO}$	Rated Dielectric Insulation Voltage	1 Minute (Derived from 1 Second Test)	2500			$V_{RMS}$
		1 Second	$\pm 4400$			$V_{DC}$
	Common Mode Transient Immunity	(Note 2)	30			$\text{kV}/\mu\text{s}$
$V_{IORM}$	Maximum Working Insulation Voltage	(Note 2)	560			$V_{PEAK}$
	Partial Discharge	$V_{PR} = 1050 V_{PEAK}$ (Note 2)			<5	pC
	Input to Output Resistance	(Note 2)	$>10^9$			$\Omega$
	Input to Output Capacitance	(Note 2)		6		pF
	Creepage Distance	(Note 2)		9.48		mm

**Note 1:** Stresses beyond those listed under Absolute Maximum Ratings may cause permanent damage to the device. Exposure to any Absolute Maximum Rating condition for extended periods may affect device reliability and lifetime.

**Note 2:** Guaranteed by design and not subject to production test.

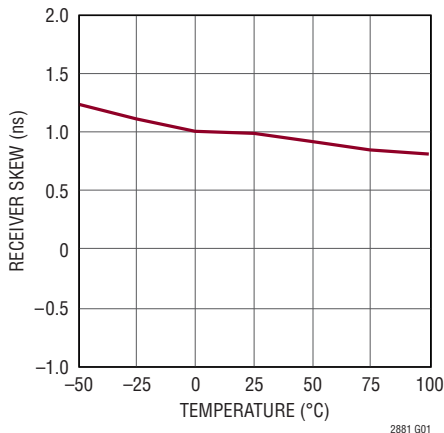
**Note 3:** Maximum Data rate is guaranteed by other measured parameters and is not tested directly.

**Note 4:** This  $\mu\text{Module}$  transceiver includes over temperature protection that is intended to protect the device during momentary overload conditions. Junction temperature will exceed  $125^\circ\text{C}$  when over temperature protection is active. Continuous operation above specified maximum operating junction temperature may result in device degradation or failure.

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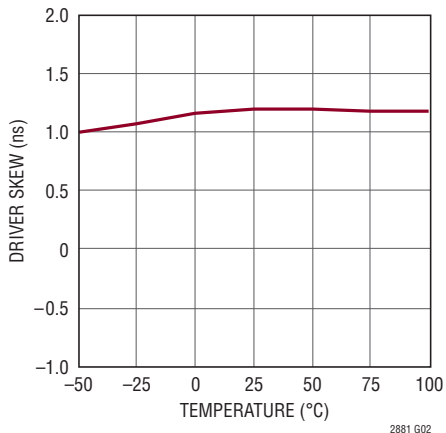
## TYPICAL PERFORMANCE CHARACTERISTICS $T_A = 25^\circ\text{C}$ , LTM2881-3 $V_{CC} = 3.3\text{V}$ , LTM2881-5 $V_{CC} = 5.0\text{V}$ , $V_L = 3.3\text{V}$ unless otherwise noted.

Receiver Skew vs Temperature



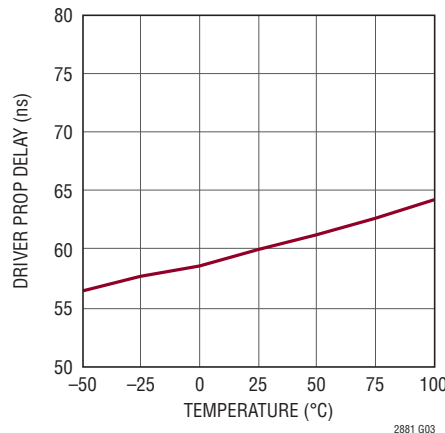
2881 G01

Driver Skew vs Temperature



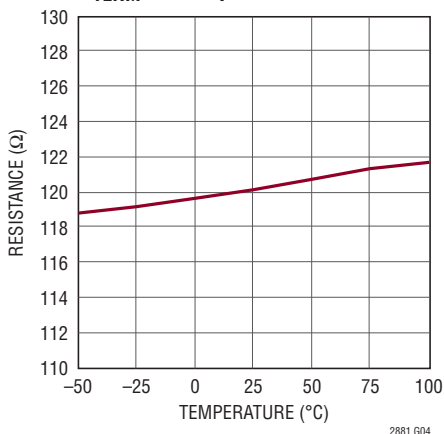
2881 G02

Driver Propagation Delay vs Temperature



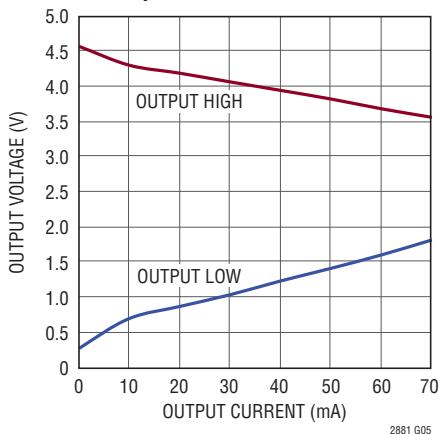
2881 G03

$R_{TERM}$  vs Temperature



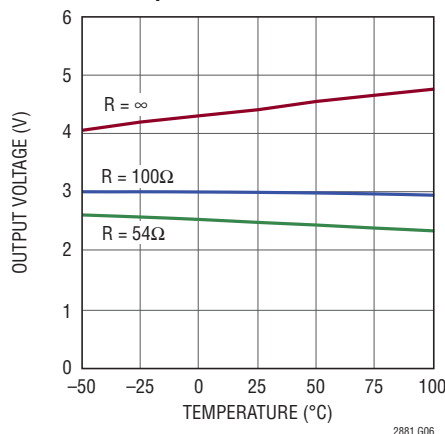
2881 G04

Driver Output Low/High Voltage vs Output Current



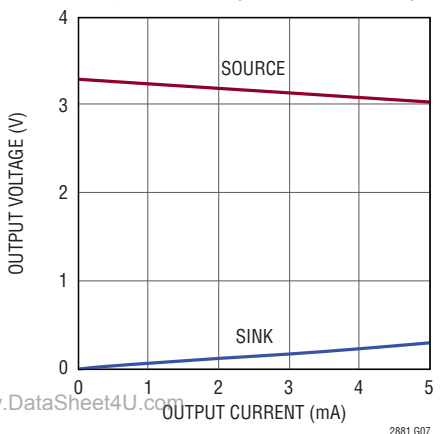
2881 G05

Driver Differential Output Voltage vs Temperature



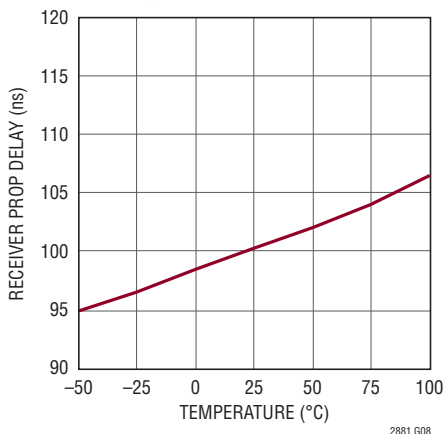
2881 G06

Receiver Output Voltage vs Output Current (Source and Sink)



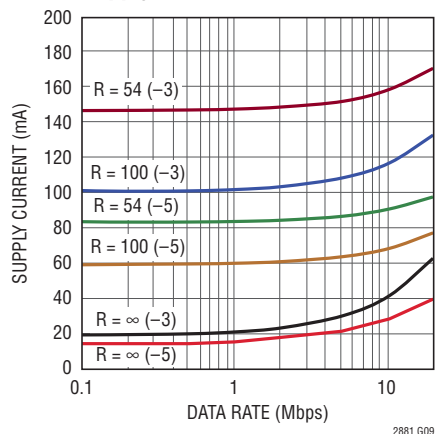
2881 G07

Receiver Propagation Delay vs Temperature



2881 G08

Supply Current vs Data Rate

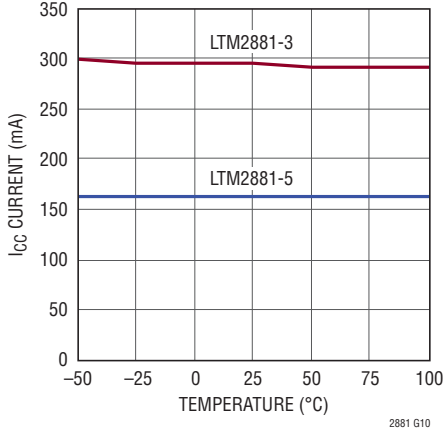


2881 G09

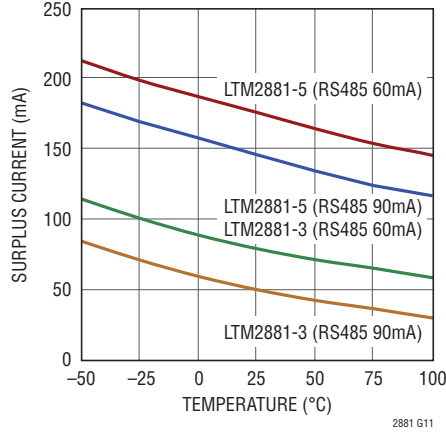
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## TYPICAL PERFORMANCE CHARACTERISTICS $T_A = 25^\circ\text{C}$ , LTM2881-3 $V_{CC} = 3.3\text{V}$ , LTM2881-5 $V_{CC} = 5.0\text{V}$ , $V_L = 3.3\text{V}$ unless otherwise noted.

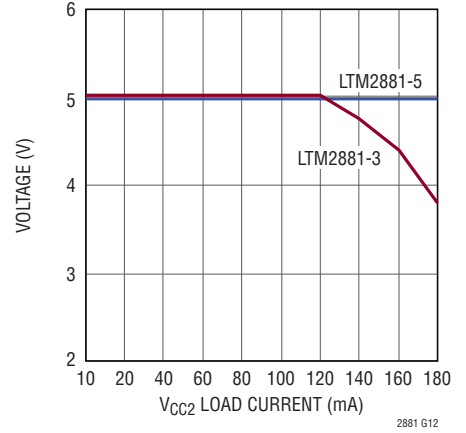
**$V_{CC}$  Supply Current vs Temperature at  $I_{LOAD} = 100\text{mA}$  on  $V_{CC2}$**



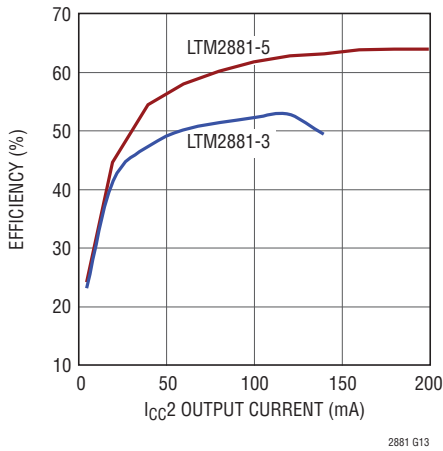
**$V_{CC2}$  Surplus Current vs Temperature**



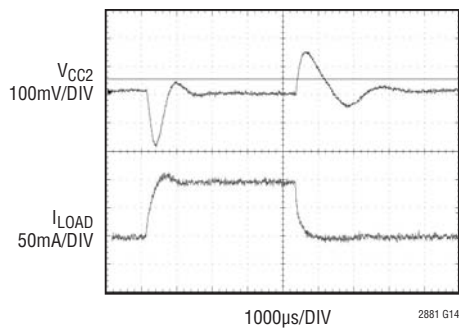
**$V_{CC2}$  vs Load Current**



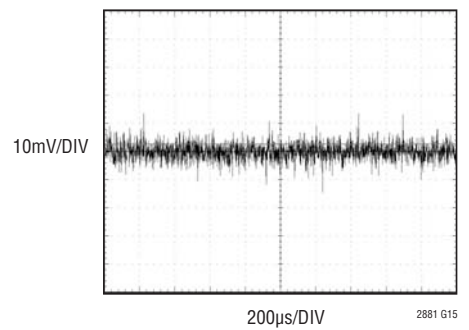
**$V_{CC2}$  Power Efficiency**



**$V_{CC2}$  Load Step (100mA)**



**$V_{CC2}$  Noise**



# LTM2881

## PIN FUNCTIONS

### LOGIC SIDE ( $V_{CC}$ , $V_L$ , GND)

**D<sub>OUT</sub> (Pin A1):** General Purpose Logic Output. Logic output connected through isolation path to D<sub>IN</sub>. Under the condition of an isolation communication failure D<sub>OUT</sub> is in a high impedance state.

**TE (Pin A2):** Terminator Enable. A logic high enables a termination resistor (typically 120Ω) between pins A and B.

**DI (Pin A3):** Driver Input. If the driver outputs are enabled (DE high), then a low on DI forces the driver noninverting output (Y) low and the inverting output (Z) high. A high on DI, with the driver outputs enabled, forces the driver noninverting output (Y) high and inverting output (Z) low.

**DE (Pin A4):** Driver Enable. A logic low disables the driver leaving the outputs Y and Z in a high impedance state. A logic high enables the driver.

**$\overline{RE}$  (Pin A5):** Receiver Enable. A logic low enables the receiver output. A logic high disables RO to a high impedance state.

**RO (Pin A6):** Receiver Output. If the receiver output is enabled ( $\overline{RE}$  low) and if  $A - B$  is  $> 200\text{mV}$ , RO is a logic high, if  $A - B$  is  $< 200\text{mV}$  RO is a logic low. If the receiver inputs are open, shorted, or terminated without a valid signal, RO will be high. Under the condition of an isolation communication failure RO is in a high impedance state.

**V<sub>L</sub> (Pin A7):** Logic Supply. Interface supply voltage for pins RO,  $\overline{RE}$ , TE, DI, DE, D<sub>OUT</sub>, and ON. Recommended operating voltage is 1.62V to 5.5V.

**ON (Pin A8):** Enable. Enables power and data communication through the isolation barrier. If ON is high the part is enabled and power and communications are functional to the isolated side. If ON is low the logic side is held in reset and the isolated side is unpowered.

**GND (Pins B1-B5):** Circuit Ground.

**V<sub>CC</sub> (Pins B6-B8):** Supply Voltage. Recommended operating voltage is 3V to 3.6V for LTM2881-3 and 4.5V to 5.5V for LTM2881-5.

### ISOLATED SIDE ( $V_{CC2}$ , GND2)

**D<sub>IN</sub> (Pin L1):** General Purpose Isolated Logic Input. Logic input on the isolated side relative to V<sub>CC2</sub> and GND2. A logic high on D<sub>IN</sub> will generate a logic high on D<sub>OUT</sub>. A logic low on D<sub>IN</sub> will generate a logic low on D<sub>OUT</sub>.

**$\overline{SLO}$  (Pin L2):** Driver Slew Rate Control. A low input, relative to GND2, will force the driver into a reduced slew rate mode for reduced EMI. A high input, relative to GND2, puts the driver into full speed mode to support maximum data rates.

**Y (Pin L3):** Non Inverting Driver Output. High impedance when the driver is disabled.

**Z (Pin L4):** Inverting Driver Output. High impedance when the driver is disabled.

**B (Pin L5):** Inverting Receiver Input. Impedance is  $> 96\text{k}\Omega$  in receive mode with TE low or unpowered.

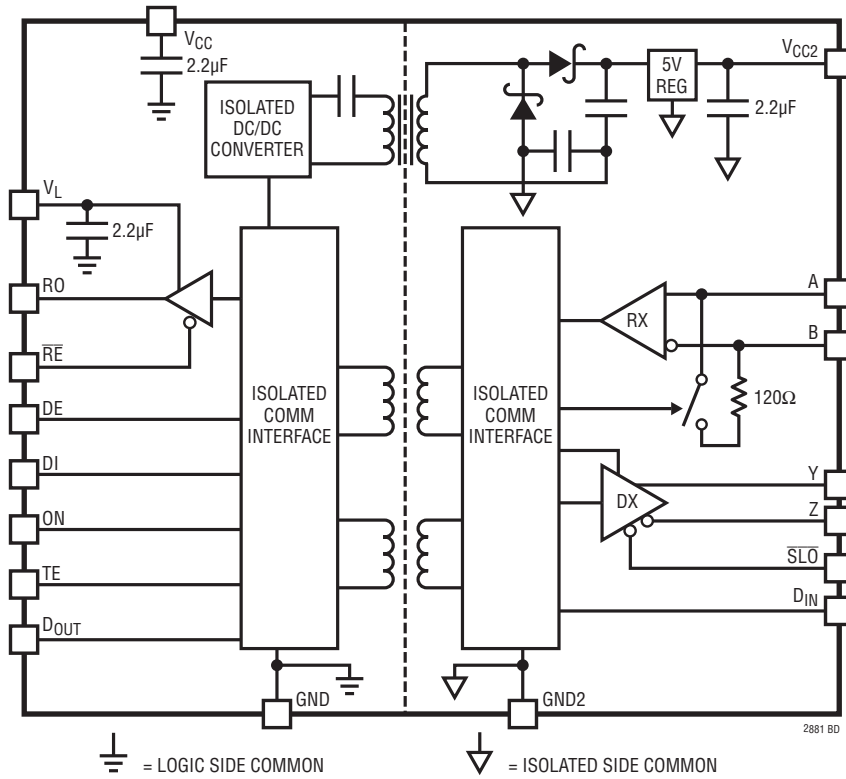
**A (Pin L6):** Non Inverting Receiver Input. Impedance is  $> 96\text{k}\Omega$  in receive mode with TE low or unpowered.

**V<sub>CC2</sub> (Pins L7-L8):** Isolated Supply Voltage. Internally generated from V<sub>CC</sub> by an isolated DC/DC converter and regulated to 5V.

**GND2 (Pins K1-K8):** Isolated Side Circuit Ground. The pads should be connected to the isolated ground and/or cable shield.



# BLOCK DIAGRAM



# TEST CIRCUITS

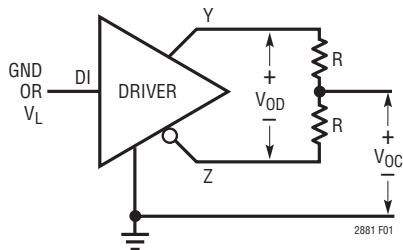


Figure 1. Driver DC Characteristics

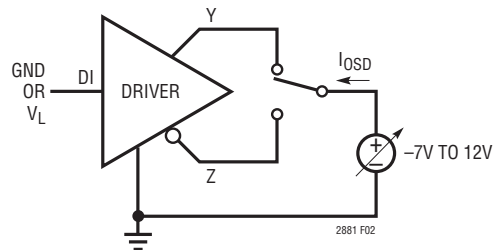


Figure 2. Driver Output Short-Circuit Current

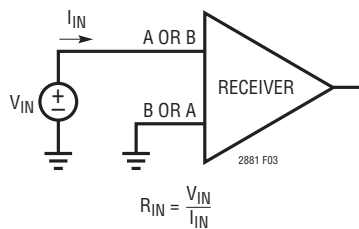


Figure 3. Receiver Input Current and Input Resistance

# LTM2881

## TEST CIRCUITS

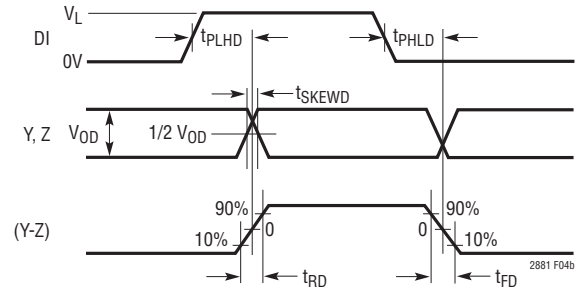
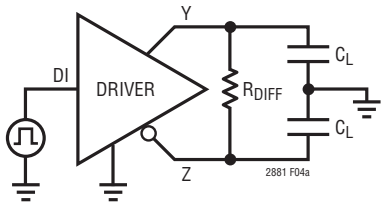


Figure 4. Driver Timing Measurement

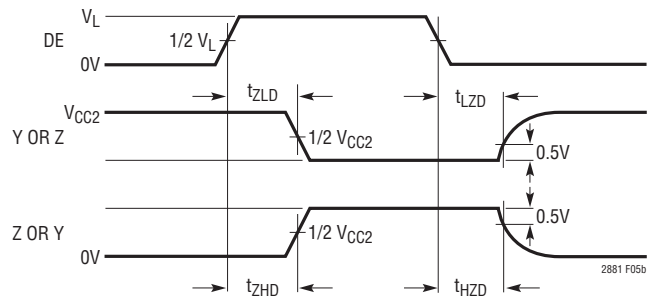
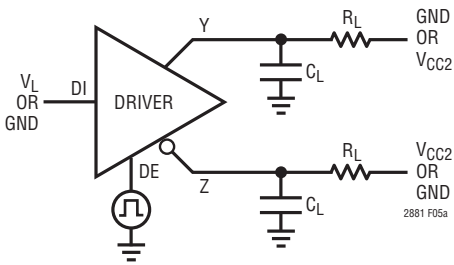


Figure 5. Driver Enable and Disable Timing Measurements

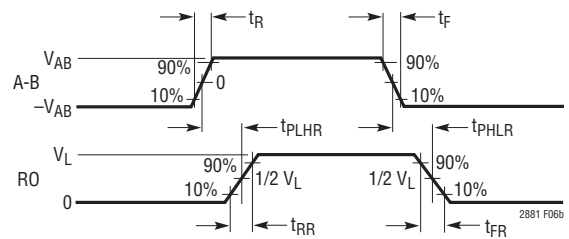
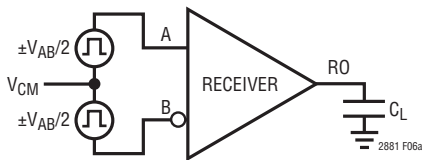


Figure 6. Receiver Propagation Delay Measurements

## TEST CIRCUITS

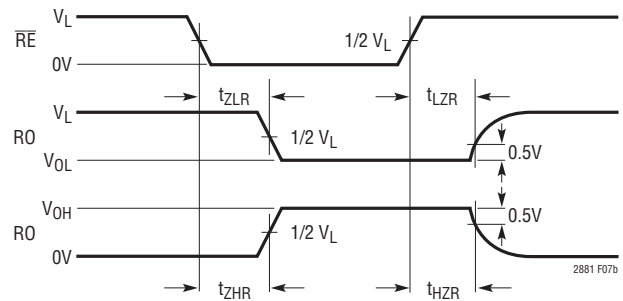
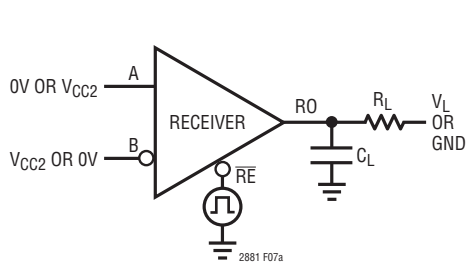


Figure 7. Receiver Enable/Disable Time Measurements

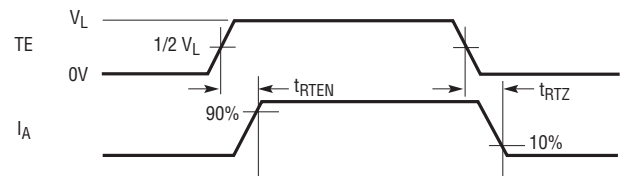
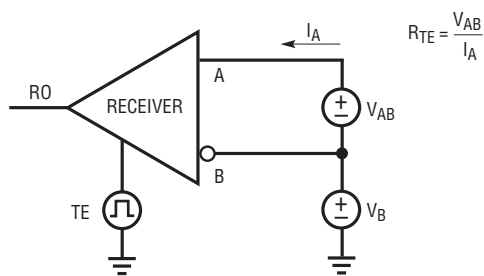


Figure 8. Termination Resistance and Timing Measurements

## FUNCTIONAL TABLE

LOGIC INPUTS				MODE	A, B	Y, Z	RO	DC/DC CONVERTER	TERMINATOR
ON	RE	TE	DE						
1	0	0	0	Receive	$R_{IN}$	Hi-Z	Enabled	On	Off
1	0	0	1	Transceiver	$R_{IN}$	Driven	Enabled	On	Off
1	1	0	1	Transmit	$R_{IN}$	Driven	Hi-Z	On	Off
1	0	1	0	Receive + Term On	$R_{TE}$	Hi-Z	Enabled	On	On
0	X	X	X	Off	$R_{IN}$	Hi-Z	Hi-Z	Off	Off

# LTM2881

## APPLICATIONS INFORMATION

### Overview

The LTM2881  $\mu$ Module transceiver provides a galvanically-isolated robust RS485/RS422 interface, powered by an integrated, regulated DC/DC converter, complete with decoupling capacitors. A switchable termination resistor is integrated at the receiver input to provide proper termination to the RS485 bus. The LTM2881 is ideal for use in networks where grounds can take on different voltages. Isolation in the LTM2881 blocks high voltage differences and eliminates ground loops and is extremely tolerant of common mode transients between ground potentials. Error free operation is maintained through common mode events greater than 30kV/ $\mu$ s providing excellent noise isolation.

### DC/DC Converter

The LTM2881 contains a fully integrated isolated DC/DC converter, including the transformer, so that no external components are necessary. The logic side contains a full-bridge driver, running at 1.6MHz, and is AC-coupled to a single transformer primary. A series DC blocking capacitor prevents transformer saturation due to driver duty cycle imbalance. The transformer scales the primary voltage, and is rectified by a full-wave voltage doubler. This topology eliminates transformer saturation caused by secondary imbalances.

The DC/DC converter is connected to a low dropout regulator (LDO) to provide a regulated low noise 5V output.

The internal power solution is sufficient to support the transceiver interface at its maximum specified load and data rate, and external pins are supplied for extra decoupling (optional) and heat dissipation. The logic supplies,  $V_{CC}$  and  $V_L$  have a 2.2 $\mu$ F decoupling capacitance to GND and the isolated supply  $V_{CC2}$  has a 2.2 $\mu$ F decoupling capacitance to GND2 within the  $\mu$ Module package. Surplus current is available to external applications. The amount of surplus current is dependent upon the implementation and current delivered to the RS485 driver and line load. An example of available surplus current is shown in the Typical Performance Characteristics graph,  $V_{CC2}$  Surplus Current vs Temperature.

### Driver

The driver provides full RS485 and RS422 compatibility. When enabled, if DI is high, Y-Z is positive. When the driver is disabled, both outputs are high impedance with less than 10 $\mu$ A of leakage current over the entire common mode range of -7V to 12V, with respect to GND2.

## APPLICATIONS INFORMATION

### Driver Overvoltage and Overcurrent Protection

The driver outputs are protected from short circuits to any voltage within the absolute maximum range of ( $V_{CC2} - 15V$ ) to ( $GND2 + 15V$ ) levels. The maximum  $V_{CC2}$  current in this condition is 250mA. If the pin voltage exceeds about  $\pm 10V$ , current limit folds back to about half of the peak value to reduce overall power dissipation and avoid damaging the part.

The device also features thermal shutdown protection that disables the driver and receiver output in case of excessive power dissipation (See Note 4 in the Electrical Characteristics section).

### $\overline{SLO}$ Mode

The LTM2881 features a logic-selectable reduced slew rate mode ( $\overline{SLO}$  mode) that softens the driver output edges to reduce EMI emissions from equipment and data cables. The reduced slew rate mode is entered by taking the  $\overline{SLO}$  pin low to  $GND2$ , where the data rate is limited to about 250kbps. Slew limiting also mitigates the adverse effects of imperfect transmission line termination caused by stubs or mismatched cables.

Figures 9a and 9b show the frequency spectrums of the LTM2881 driver outputs in normal and  $\overline{SLO}$  mode operating at 250kbps.  $\overline{SLO}$  mode significantly reduces the high frequency harmonics.

### Receiver and Failsafe

With the receiver enabled, when the absolute value of the differential voltage between the A and B pins is greater than 200mV, the state of RO will reflect the polarity of (A-B). During data communication the receiver detects the state of the input with symmetric thresholds around 0V. The symmetric thresholds preserve duty cycle for attenuated signals with slow transition rates on high capacitive busses, or long cable lengths. The receiver incorporates a failsafe feature that guarantees the receiver output to be a logic-high during an idle bus, when the inputs are shorted, left open or terminated, but not driven. The failsafe feature eliminates the need for system level integration of network pre-biasing by guaranteeing a logic-high on RO under

the conditions of an idle bus. Further network biasing constructed to condition transient noise during an idle state is unnecessary due to the common mode transient rejection of the LTM2881. The failsafe detector monitors A and B in parallel with the receiver and detects the state of the bus when A-B is above the input failsafe threshold for longer than about  $3\mu s$  with a hysteresis of 25mV. This failsafe feature is guaranteed to work for inputs spanning the entire common mode range of  $-7V$  to 12V.

The receiver output is internally driven high (to  $V_L$ ) or low (to  $GND$ ) with no external pull-up needed. When the receiver is disabled the RO pin becomes Hi-Z with leakage of less than  $\pm 1\mu A$  for voltages within the supply range.

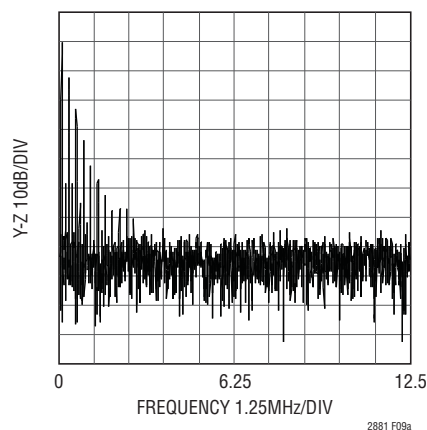


Figure 9a. Frequency Spectrum  $\overline{SLO}$  Mode 125kHz Input

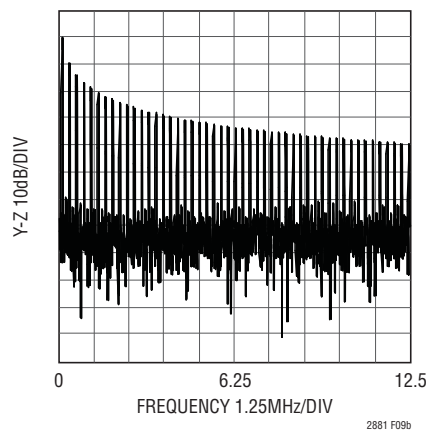


Figure 9b. Normal Mode Frequency Spectrum 125kHz Input

# LTM2881

## APPLICATIONS INFORMATION

### Receiver Input Resistance

The receiver input resistance from A or B to GND2 is greater than 96k permitting up to a total of 256 receivers per system without exceeding the RS485 receiver loading specification. The input resistance of the receiver is unaffected by enabling/disabling the receiver or by powering/unpowering the part. The equivalent input resistance looking into A and B is shown in Figure 10.

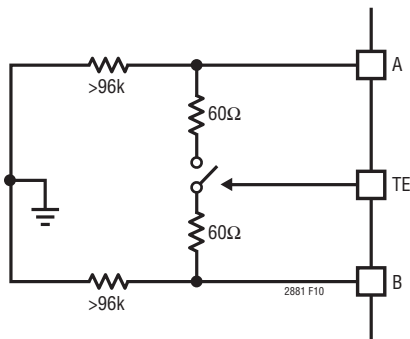


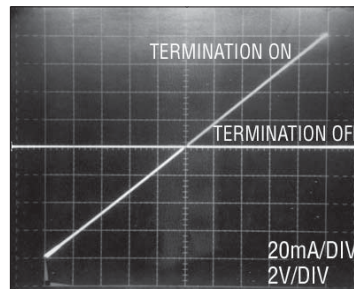
Figure 10. Equivalent Input Resistance into A and B

### Switchable Termination

Proper cable termination is very important for signal fidelity. If the cable is not terminated with its characteristic impedance, reflections will distort the signal waveforms.

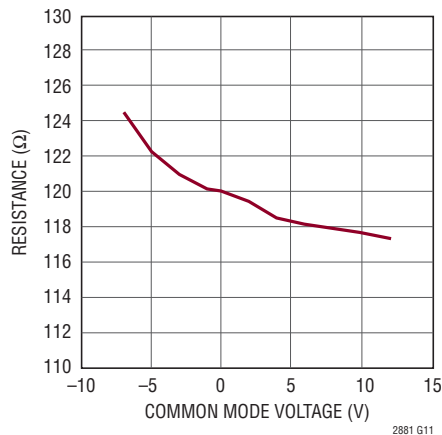
The integrated switchable termination resistor provides logic control of the line termination for optimal performance when configuring transceiver networks.

When the TE pin is high, the termination resistor is enabled and the differential resistance from A to B is 120Ω. Figure 11 shows the I/V characteristics between pins A and B with the termination resistor enabled and disabled. The resistance is maintained over the entire RS485 common mode range of -7V to 12V as shown in Figure 12. The integrated termination resistor has a high frequency response which does not limit performance at the maximum specified data rate. Figure 13 shows the magnitude and phase of the termination impedance versus frequency. The termination resistor cannot be enabled by TE if the device is unpowered, ON is low or the LTM2881 is in thermal shutdown.



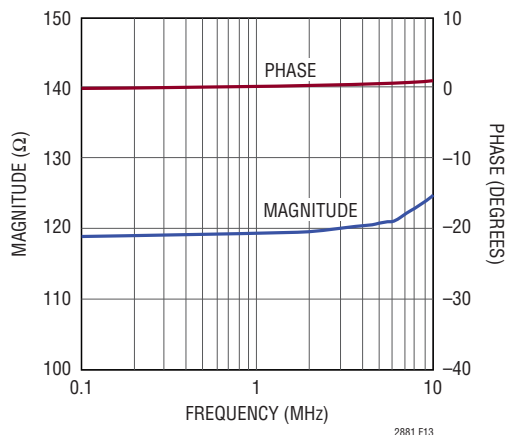
2881 F11

Figure 11. Curve Trace Between A and B with Termination Enabled and Disabled



2881 G11

Figure 12. Termination Resistance vs Common Mode Voltage



2881 F13

Figure 13. Termination Magnitude and Phase vs Frequency

## APPLICATIONS INFORMATION

### Supply Current

The static supply current is dominated by power delivered to the termination resistance. Power supply current increases with data rate due to capacitive loading. Figure 14 shows supply current versus data rate for three different loads for the circuit configuration of Figure 4.

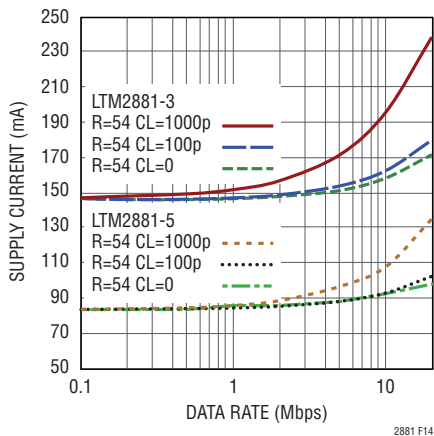


Figure 14. Supply Current vs Data Rate

### PCB Layout Isolation Considerations

The high integration of the LTM2881 makes the PCB board layout very simple. However, to optimize its electrical isolation characteristics and thermal performance, some layout considerations are still necessary. Figure 15 is a suggested layout for good thermal performance and to optimize isolation characteristics.

- Use large PCB copper areas for high current paths, including  $V_{CC}$ , GND,  $V_{CC2}$ , and GND2. It helps to minimize the PCB conduction loss and thermal stress.
- The LTM2881 includes 2.2 $\mu$ F ceramic decoupling capacitors on  $V_{CC}$  to GND,  $V_L$  to GND, and  $V_{CC2}$  to GND2 supply pins. Further decoupling capacitance (10 $\mu$ F) can be added within one-quarter inch away from the  $V_{CC}$ ,  $V_L$ , and/or  $V_{CC2}$  pin.

- If the LTM2881 voltage supply is hot plugged without additional protection, damage may occur. Refer to Linear Technology Application Note 88, entitled “Ceramic Capacitors Can Cause Overvoltage Transients” for a detailed discussion of this problem. To protect against hot plug transients use tantalum for aforementioned additional capacitor.
- Do not place copper on the PCB between the inner rows of pads. This area must remain open to withstand the rated isolation voltage. The PCB may also be slotted in this area to insure contamination does not compromise the isolation voltage.

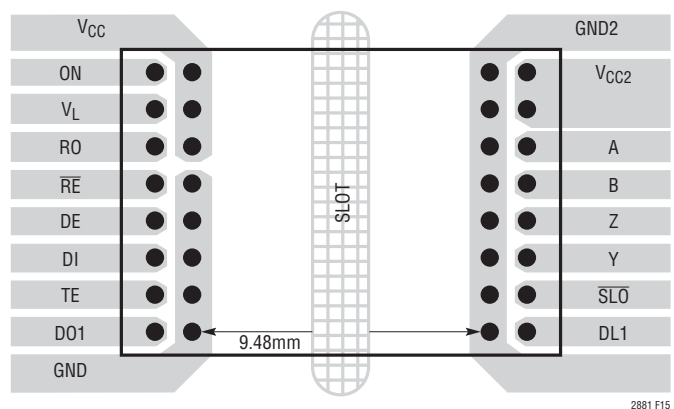


Figure 15. PCB Recommended Layout

# LTM2881

## APPLICATIONS INFORMATION

### Cable Length versus Data Rate

For a given data rate, the maximum transmission distance is bounded by the cable properties. A typical curve of cable length versus data rate compliant with the RS485 standard is shown in Figure 16. Three regions of this curve reflect different performance limiting factors in data transmission. In the flat region of the curve, maximum distance is determined by resistive loss in the cable. The downward sloping region represents limits in distance and rate due to the AC losses in the cable. The solid vertical line represents the specified maximum data rate in the RS485 standard. The dashed line at 250kbps shows the maximum data rate when  $\overline{SLO}$  is low. The dashed line at 20Mbps shows the maximum data rate when  $\overline{SLO}$  is high.

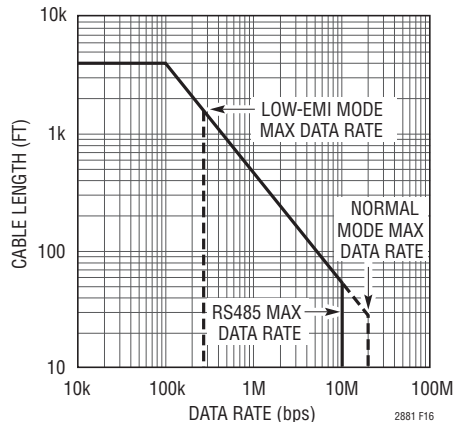
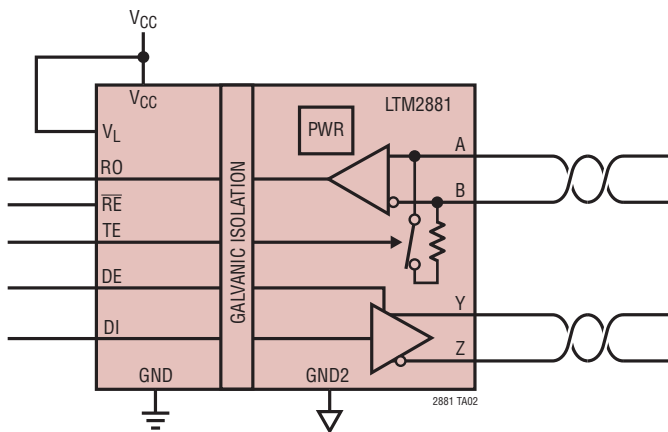


Figure 16. Cable Length vs Data Rate

## TYPICAL APPLICATIONS

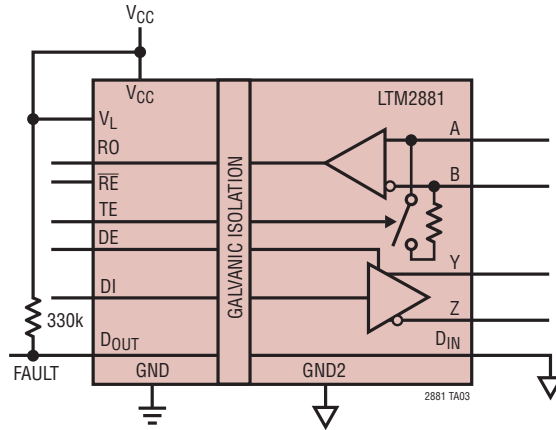
### Full-Duplex RS485 Connection



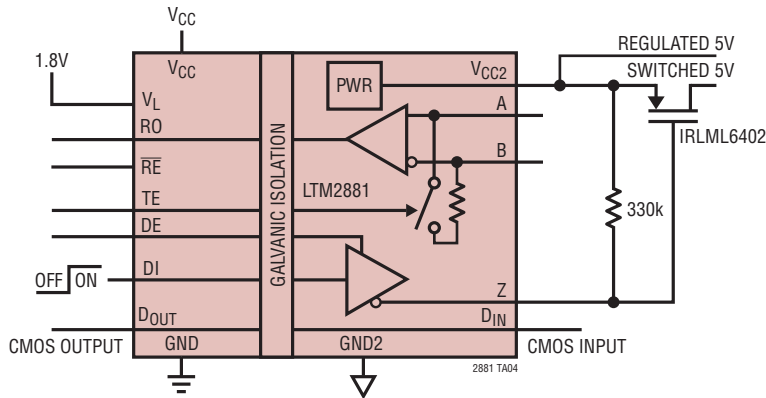


# TYPICAL APPLICATIONS

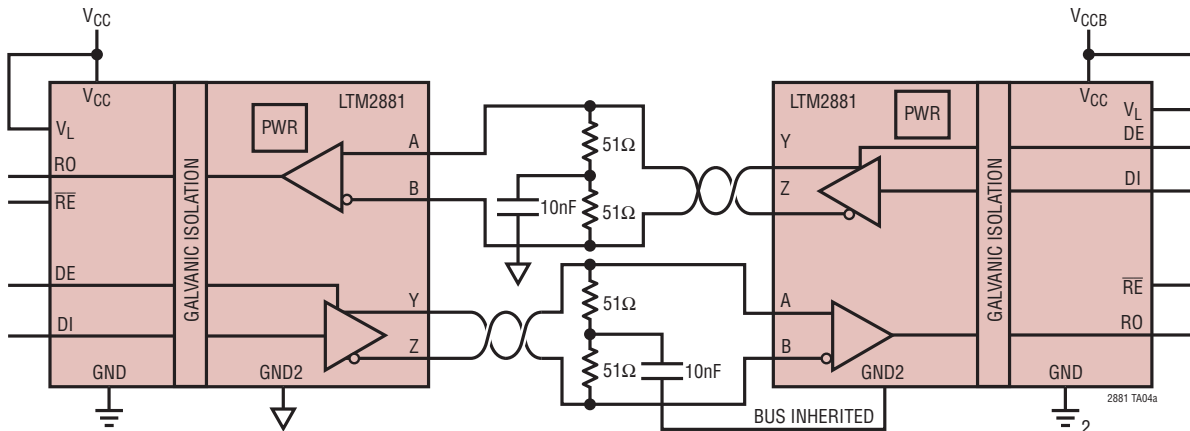
Isolated System Fault Detection



Switched 5V Power with Isolated CMOS Logic Connection with Low Voltage Interface



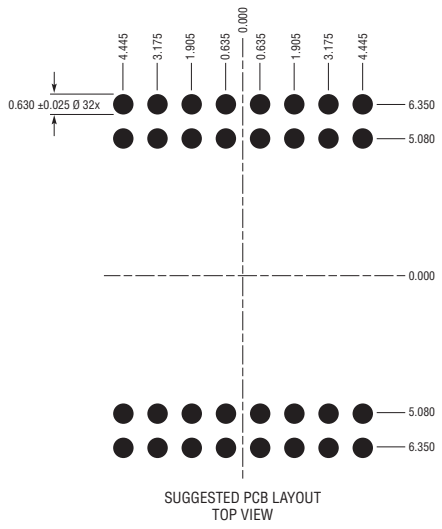
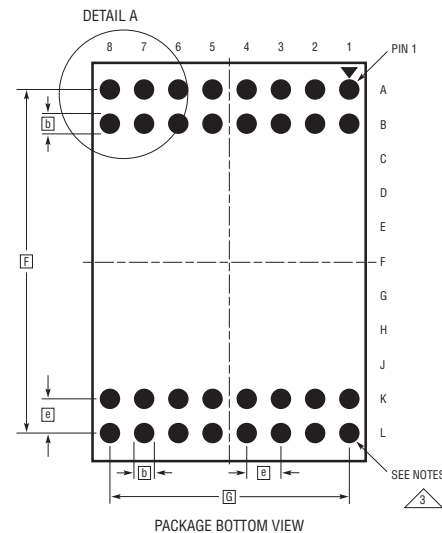
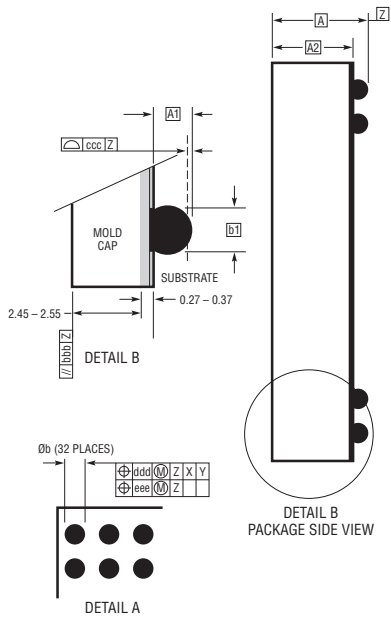
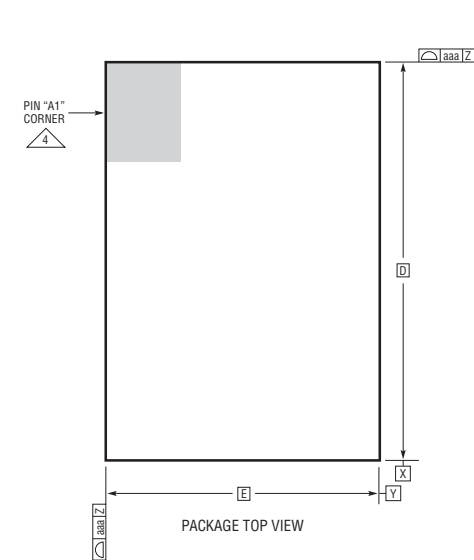
4-Wire Full Duplex Self Biasing for Unshielded CAT5 Connection



# LTM2881

## PACKAGE DESCRIPTION

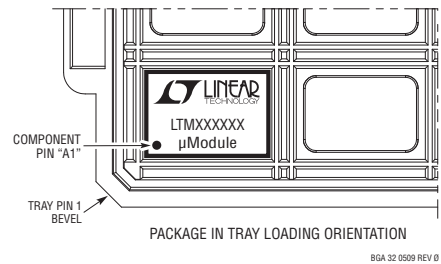
**BGA Package**  
**32-Lead (15mm × 11.25mm × 2.82mm)**  
 (Reference LTC DWG # 05-08-1851 Rev 0)



DIMENSIONS				
SYMBOL	MIN	NOM	MAX	NOTES
A	3.14	3.27	3.40	
A1	0.42	0.45	0.48	
A2	2.72	2.82	2.92	
b	0.70	0.75	0.80	
b1	0.60	0.63	0.66	
D		15.0		
E		11.25		
e		1.27		
F		12.70		
G		8.89		
aaa			0.15	
bbb			0.10	
ccc			0.20	
ddd			0.30	
eee			0.15	

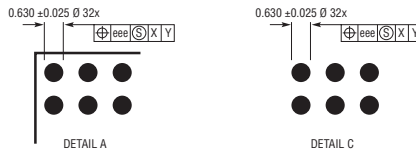
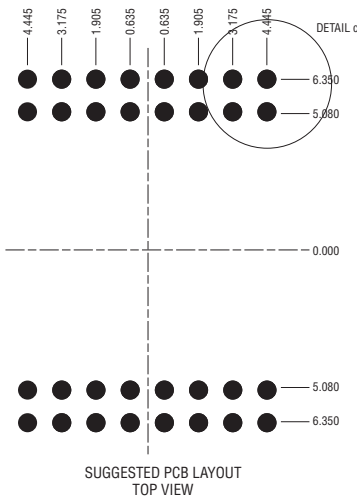
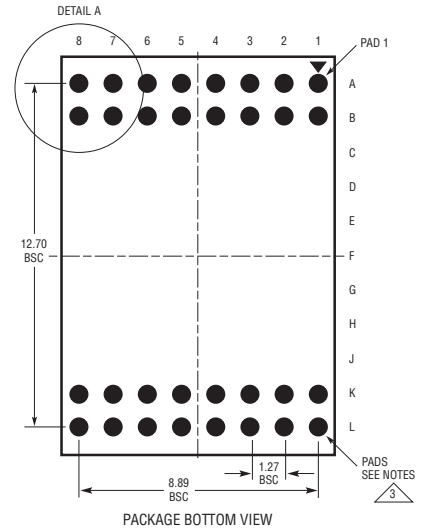
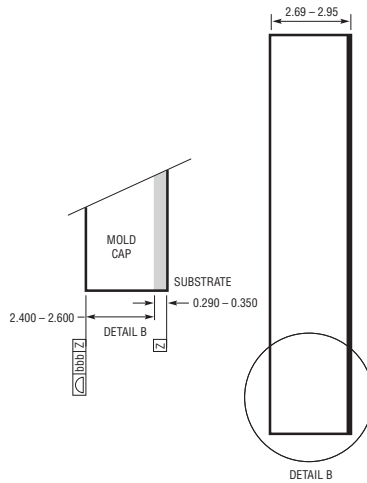
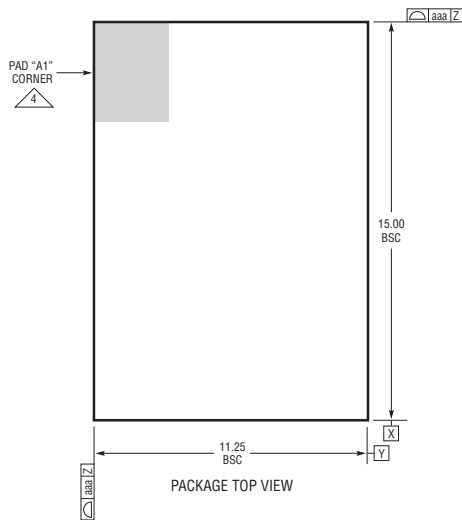
TOTAL NUMBER OF BALLS: 32

- NOTES:
1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M-1994
  2. ALL DIMENSIONS ARE IN MILLIMETERS
  - 3 BALL DESIGNATION PER JESD MS-028 AND JEP95
  - 4 DETAILS OF PIN #1 IDENTIFIER ARE OPTIONAL, BUT MUST BE LOCATED WITHIN THE ZONE INDICATED. THE PIN #1 IDENTIFIER MAY BE EITHER A MOLD OR MARKED FEATURE
  5. PRIMARY DATUM -Z- IS SEATING PLANE



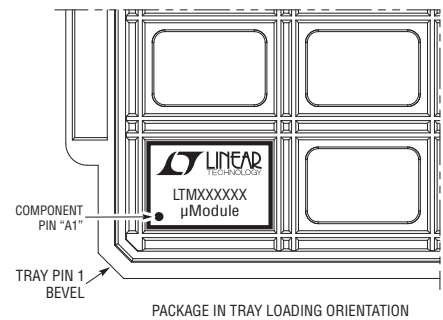
# PACKAGE DESCRIPTION

**LGA Package**  
**32-Lead (15mm × 11.25mm × 2.8mm)**  
 (Reference LTC DWG # 05-08-1773 Rev 0)



- NOTES:
1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M-1994
  2. ALL DIMENSIONS ARE IN MILLIMETERS
  3. LAND DESIGNATION PER JESD MO-222
  4. DETAILS OF PAD #1 IDENTIFIER ARE OPTIONAL, BUT MUST BE LOCATED WITHIN THE ZONE INDICATED. THE PAD #1 IDENTIFIER MAY BE EITHER A MOLD OR MARKED FEATURE
  5. PRIMARY DATUM -Z- IS SEATING PLANE
  6. THE TOTAL NUMBER OF PADS: 32

SYMBOL	TOLERANCE
aaa	0.10
bbb	0.10
eee	0.05

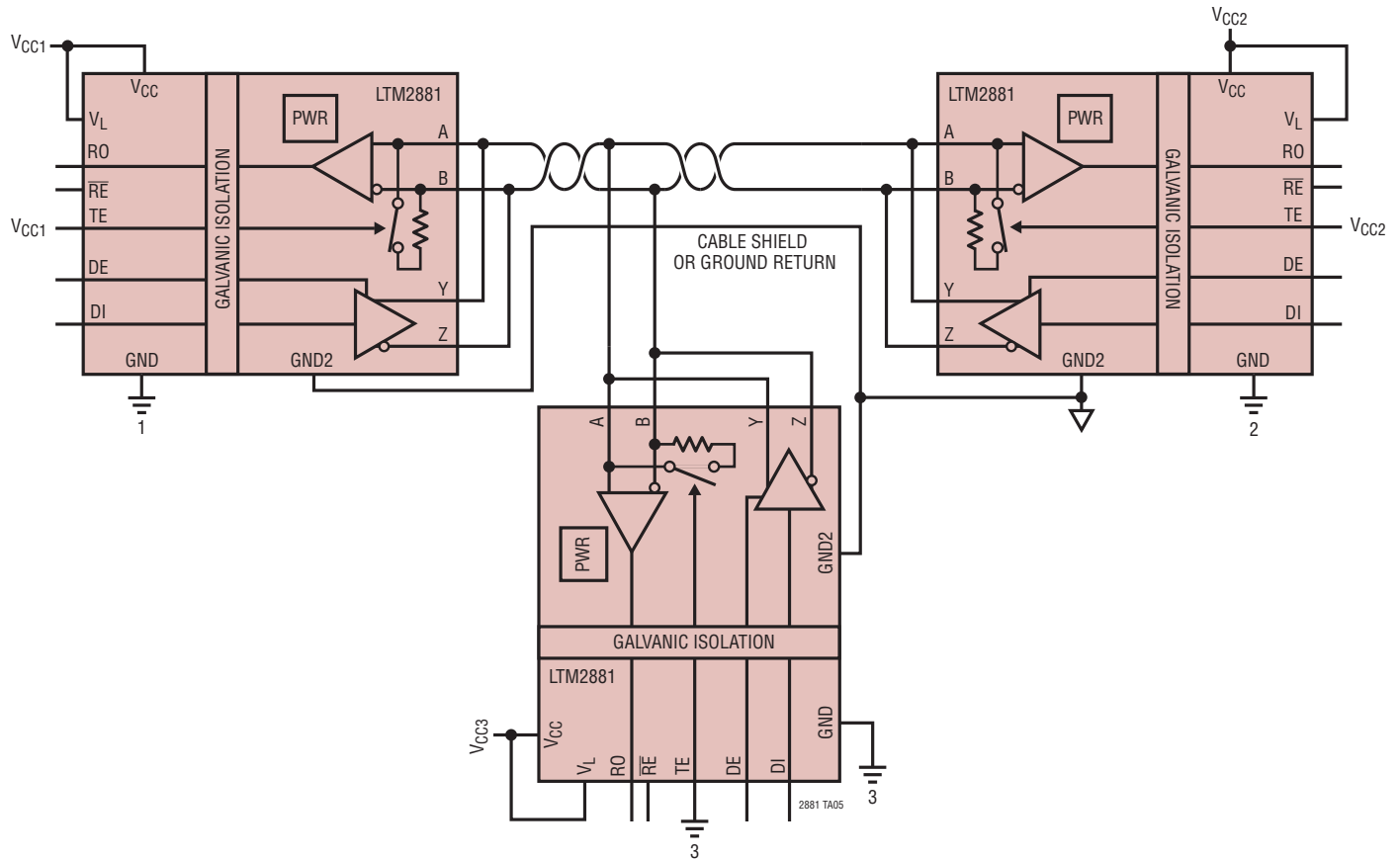


Information furnished by Linear Technology Corporation is believed to be accurate and reliable. However, no responsibility is assumed for its use. Linear Technology Corporation makes no representation that the interconnection of its circuits as described herein will not infringe on existing patent rights.

## LTM2881

## TYPICAL APPLICATION

Multi-Node Network with End Termination and Single Ground Connection on Isolation Bus



## RELATED PARTS

PART NUMBER	DESCRIPTION	COMMENTS
LTC1535	Isolated RS485 Transceiver	2500V <sub>RMS</sub> Isolation in Surface Mount Package
LT1785	±60V Fault-Protected Transceiver	Half Duplex
LT1791	±60V Fault-Protected Transceiver	Full Duplex
LTC2861	20Mbps RS485 Transceivers with Integrated Switchable Termination	Full Duplex 15kV ESD