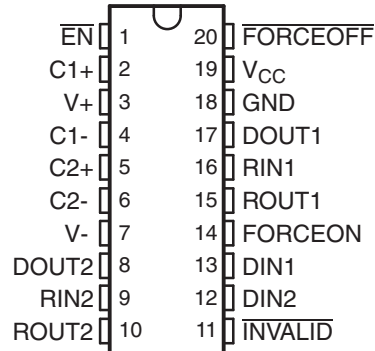


3-V To 5.5-V MULTICHANNEL RS-232 LINE DRIVER/RECEIVER WITH ±15-kV ESD PROTECTION

FEATURES

- Qualified for Automotive Applications
- RS-232 Bus-Pin ESD Protection Exceeds ±15 kV Using Human-Body Model (HBM)
- Meets or Exceeds the Requirements of TIA/EIA-232-F and ITU v.28 Standards
- Operates With 3-V to 5.5-V V_{CC} Supply
- Operates up to 250 kbit/s
- Two Drivers and Two Receivers
- Low Standby Current . . . 1 μ A Typical
- External Capacitors . . . 4 × 0.1 μ F
- Accepts 5-V Logic Input With 3.3-V Supply

**PW PACKAGE
(TOP VIEW)**



DESCRIPTION/ORDERING INFORMATION

The TRS3223 consists of two line drivers, two line receivers, and a dual charge-pump circuit with ±15-kV ESD protection pin to pin (serial-port connection pins, including GND). 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 device operates at data signaling rates up to 250 kbit/s and a maximum of 30-V/ μ s driver output slew rate.

Flexible control options for power management are available when the serial port is inactive. The auto-powerdown feature functions when FORCEON is low and FORCEOFF is high. During this mode of operation, if the device does not sense a valid RS-232 signal, the driver outputs are disabled. If FORCEOFF is set low and $\overline{EN}$ is high, both drivers and receivers are shut off, and the supply current is reduced to 1 μ A. Disconnecting the serial port or turning off the peripheral drivers causes auto-powerdown to occur. Auto-powerdown can be disabled when FORCEON and FORCEOFF are high. With auto-powerdown enabled, the device is activated automatically when a valid signal is applied to any receiver input. The INVALID output is used to notify the user if an RS-232 signal is present at any receiver input. INVALID is high (valid data) if any receiver input voltage is greater than 2.7 V or less than –2.7 V, or has been between –0.3 V and 0.3 V for less than 30 μ s. INVALID is low (invalid data) if the receiver input voltage is between –0.3 V and 0.3 V for more than 30 μ s. See Figure 4 for receiver input levels.

ORDERING INFORMATION⁽¹⁾

T_A	PACKAGE ⁽²⁾		ORDERABLE PART NUMBER	TOP-SIDE MARKING
–40°C to 125°C	TSSOP – PW	Reel of 2000	TRS3223QPWRQ1	T3223

- (1) For the most current package and ordering information, see the Package Option Addendum at the end of this document, or see the TI web site at www.ti.com.
- (2) Package drawings, thermal data, and symbolization are available at www.ti.com/packaging.



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DRIVER FUNCTION TABLE (EACH DRIVER)⁽¹⁾

INPUTS				OUTPUT DOUT	DRIVER STATUS
DIN	FORCEON	FORCEOFF	VALID RIN RS-232 LEVEL		
X	X	L	X	Z	Powered off
L	H	H	X	H	Normal operation with auto-powerdown disabled
H	H	H	X	L	
L	L	H	Yes	H	Normal operation with auto-powerdown enabled
H	L	H	Yes	L	
L	L	H	No	Z	Powered off by auto-powerdown feature
H	L	H	No	Z	

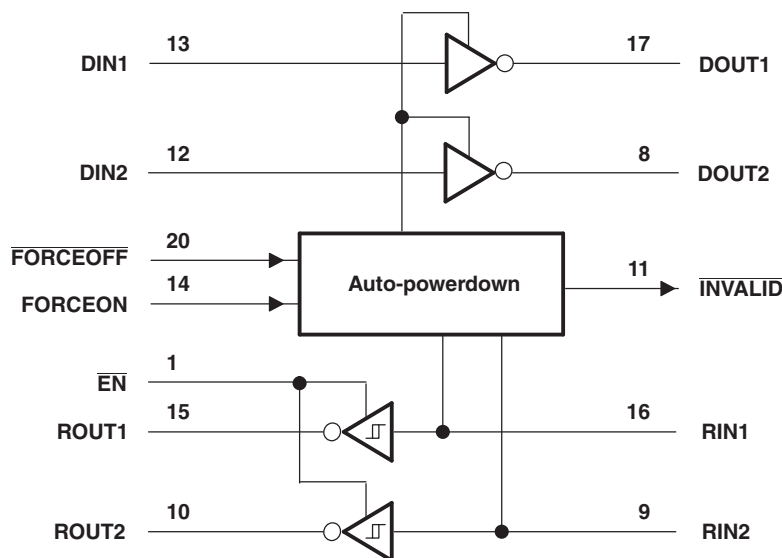
(1) H = high level, L = low level, X = irrelevant, Z = high impedance

RECEIVER FUNCTION TABLE (EACH RECEIVER)⁽¹⁾

INPUTS			OUTPUT ROUT
RIN	EN	VALID RIN RS-232 LEVEL	
L	L	X	H
H	L	X	L
X	H	X	Z
Open	L	No	H

(1) H = high level, L = low level, X = irrelevant, Z = high impedance (off),
Open = input disconnected or connected driver off

LOGIC DIAGRAM



ABSOLUTE MAXIMUM RATINGS⁽¹⁾⁽²⁾

over operating free-air temperature range (unless otherwise noted)

V _{CC}	Supply voltage range		–0.3 V to 6 V
V ₊	Positive output supply voltage range		–0.3 V to 7 V
V _–	Negative output supply voltage range		0.3 V to –7 V
V ₊ – V _–	Supply voltage difference		13 V
V _I	Input voltage range	Driver, $\overline{\text{FORCEOFF}}$, FORCEON, $\overline{\text{EN}}$	–0.3 V to 6 V
		Receiver	–25 V to 25 V
V _O	Output voltage range	Driver	–13.2 V to 13.2 V
		Receiver, $\overline{\text{INVALID}}$	–0.3 V to V _{CC} + 0.3 V
θ _{JA}	Package thermal impedance ⁽³⁾		83°C/W
T _J	Operating virtual-junction temperature		150°C
T _{stg}	Storage temperature range		–65°C to 150°C

(1) Stresses beyond those listed under *absolute maximum ratings* may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under *recommended operating conditions* is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

(2) All voltages are with respect to network GND.

(3) The package thermal impedance is calculated in accordance with JESD 51-7.

RECOMMENDED OPERATING CONDITIONS⁽¹⁾

see [Figure 6](#)

			MIN	NOM	MAX	UNIT
V _{CC}	Supply voltage	V _{CC} = 3.3 V	3	3.3	3.6	V
		V _{CC} = 5 V	4.5	5	5.5	
V _{IH}	High-level input voltage	Driver and control, DIN, $\overline{\text{EN}}$, $\overline{\text{FORCEOFF}}$, FORCEON	2			V
			2.4			
V _{IL}	Low-level input voltage	Driver and control, DIN, $\overline{\text{EN}}$, $\overline{\text{FORCEOFF}}$, FORCEON			0.8	V
V _I	Input voltage	Driver and control, DIN, $\overline{\text{EN}}$, $\overline{\text{FORCEOFF}}$, FORCEON	0		5.5	V
		Receiver	–25		25	
T _A	Operating free-air temperature		–40		125	°C

(1) Test conditions are C1–C4 = 0.1 μF at V_{CC} = 3.3 V ± 0.3 V; C1 = 0.047 μF, C2–C4 = 0.33 μF at V_{CC} = 5 V ± 0.5 V.

ELECTRICAL CHARACTERISTICS⁽¹⁾

over recommended ranges of supply voltage and operating free-air temperature (unless otherwise noted) (see [Figure 6](#))

PARAMETER		TEST CONDITIONS		MIN	TYP ⁽²⁾	MAX	UNIT
I _I	Input leakage current	$\overline{\text{EN}}$, $\overline{\text{FORCEOFF}}$, FORCEON		±0.01		±1	μA
I _{CC}	Auto-powerdown disabled	V _{CC} = 3.3 V or 5 V, T _A = 25°C	No load, $\overline{\text{FORCEOFF}}$ and FORCEON at V _{CC}		0.3	2	mA
	Powered off		No load, $\overline{\text{FORCEOFF}}$ at GND		1	20	
	Auto-powerdown enabled		No load, $\overline{\text{FORCEOFF}}$ at V _{CC} , FORCEON at GND, All RIN are open or grounded		1	20	μA

(1) Test conditions are C1–C4 = 0.1 μF at V_{CC} = 3.3 V ± 0.3 V; C1 = 0.047 μF, C2–C4 = 0.33 μF at V_{CC} = 5 V ± 0.5 V.

(2) All typical values are at V_{CC} = 3.3 V or V_{CC} = 5 V, and T_A = 25°C.

DRIVER SECTION ELECTRICAL CHARACTERISTICS⁽¹⁾

over recommended ranges of supply voltage and operating free-air temperature (unless otherwise noted) (see [Figure 6](#))

PARAMETER	TEST CONDITIONS	MIN	TYP ⁽²⁾	MAX	UNIT
V _{OH} High-level output voltage	DOUT at R _L = 3 kΩ to GND	5	5.4		V
V _{OL} Low-level output voltage	DOUT at R _L = 3 kΩ to GND	–5	–5.4		V
I _{IH} High-level input current	V _I = V _{CC}		±0.01	±1	μA
I _{IL} Low-level input current	V _I = GND		±0.01	±1	μA
I _{OS} Short-circuit output current ⁽³⁾	V _{CC} = 3.6 V, V _O = 0 V		±35	±60	mA
	V _{CC} = 5.5 V, V _O = 0 V		±35	±60	
r _o Output resistance	V _{CC} , V _I , and V _O = 0 V, V _O = ±2 V	300	10M		Ω
I _{off} Output leakage current	FORCEOFF = GND			±25	μA
	V _O = ±12 V, V _{CC} = 3 V to 3.6 V			±25	
	V _O = ±10 V, V _{CC} = 4.5 V to 5.5 V			±25	

(1) Test conditions are C1–C4 = 0.1 μF at V_{CC} = 3.3 V ± 0.3 V; C1 = 0.047 μF, C2–C4 = 0.33 μF at V_{CC} = 5 V ± 0.5 V.

(2) All typical values are at V_{CC} = 3.3 V or V_{CC} = 5 V, and T_A = 25°C.

(3) Short-circuit durations should be controlled to prevent exceeding the device absolute power-dissipation ratings, and not more than one output should be shorted at a time.

DRIVER SECTION SWITCHING CHARACTERISTICS⁽¹⁾

over recommended ranges of supply voltage and operating free-air temperature (unless otherwise noted) (see [Figure 6](#))

PARAMETER	TEST CONDITIONS	MIN	TYP ⁽²⁾	MAX	UNIT
Maximum data rate	C _L = 1000 pF, One DOUT switching, R _L = 3 kΩ (see Figure 1)	250			kbit/s
t _{sk(p)} Pulse skew ⁽³⁾	C _L = 150 pF to 2500 pF, R _L = 3 kΩ to 7 kΩ (see Figure 2)		100		ns
SR(tr) Slew rate, transition region (see Figure 1)	V _{CC} = 3.3 V, R _L = 3 kΩ to 7 kΩ	C _L = 150 pF to 1000 pF	6	30	V/μs
		C _L = 150 pF to 2500 pF	4	30	

(1) Test conditions are C1–C4 = 0.1 μF at V_{CC} = 3.3 V ± 0.3 V; C1 = 0.047 μF, C2–C4 = 0.33 μF at V_{CC} = 5 V ± 0.5 V.

(2) All typical values are at V_{CC} = 3.3 V or V_{CC} = 5 V, and T_A = 25°C.

(3) Pulse skew is defined as |t_{PLH} – t_{PHL}| of each channel of the same device.

RECEIVER SECTION ELECTRICAL CHARACTERISTICS⁽¹⁾

over recommended ranges of supply voltage and operating free-air temperature (unless otherwise noted) (see [Figure 6](#))

PARAMETER	TEST CONDITIONS	MIN	TYP ⁽²⁾	MAX	UNIT
V _{OH} High-level output voltage	I _{OH} = –1 mA	V _{CC} – 0.6	V _{CC} – 0.1		V
V _{OL} Low-level output voltage	I _{OL} = 1.6 mA			0.4	V
V _{IT+} Positive-going input threshold voltage	V _{CC} = 3.3 V		1.6	2.4	V
	V _{CC} = 5 V		1.9	2.4	
V _{IT–} Negative-going input threshold voltage	V _{CC} = 3.3 V	0.6	1.1		V
	V _{CC} = 5 V	0.8	1.4		
V _{hys} Input hysteresis (V _{IT+} – V _{IT–})			0.5		V
I _{off} Output leakage current	$\overline{\text{EN}} = V_{CC}$		±0.05	±10	μA
r _i Input resistance	V _I = ±3 V to ±25 V	3	5	8.3	kΩ

(1) Test conditions are C1–C4 = 0.1 μF at V_{CC} = 3.3 V ± 0.3 V; C1 = 0.047 μF, C2–C4 = 0.33 μF at V_{CC} = 5 V ± 0.5 V.

(2) All typical values are at V_{CC} = 3.3 V or V_{CC} = 5 V, and T_A = 25°C.

RECEIVER SECTION SWITCHING CHARACTERISTICS⁽¹⁾

over recommended ranges of supply voltage and operating free-air temperature (unless otherwise noted) (see [Figure 6](#))

PARAMETER	TEST CONDITIONS	TYP ⁽²⁾	UNIT
t _{PLH} Propagation delay time, low-level to high-level output	C _L = 150 pF, See Figure 3	150	ns
t _{PHL} Propagation delay time, high-level to low-level output	C _L = 150 pF, See Figure 3	150	ns
t _{en} Output enable time	C _L = 150 pF, R _L = 3 kΩ, See Figure 4	200	ns
t _{dis} Output disable time	C _L = 150 pF, R _L = 3 kΩ, See Figure 4	200	ns
t _{sk(p)} Pulse skew ⁽³⁾	See Figure 3	50	ns

(1) Test conditions are C1–C4 = 0.1 μF at V_{CC} = 3.3 V ± 0.3 V; C1 = 0.047 μF, C2–C4 = 0.33 μF at V_{CC} = 5 V ± 0.5 V.

(2) All typical values are at V_{CC} = 3.3 V or V_{CC} = 5 V, and T_A = 25°C.

(3) Pulse skew is defined as |t_{PLH} – t_{PHL}| of each channel of the same device.

AUTO-POWERDOWN SECTION ELECTRICAL CHARACTERISTICS

over recommended ranges of supply voltage and operating free-air temperature (unless otherwise noted) (see [Figure 5](#))

PARAMETER		TEST CONDITIONS	MIN	MAX	UNIT
$V_{T+}(\text{valid})$	Receiver input threshold for $\overline{\text{INVALID}}$ high-level output voltage	FORCEON = GND, $\overline{\text{FORCEOFF}} = V_{CC}$		2.7	V
$V_{T-}(\text{valid})$	Receiver input threshold for $\overline{\text{INVALID}}$ high-level output voltage	FORCEON = GND, $\overline{\text{FORCEOFF}} = V_{CC}$	–2.7		V
$V_{T}(\text{invalid})$	Receiver input threshold for $\overline{\text{INVALID}}$ low-level output voltage	FORCEON = GND, $\overline{\text{FORCEOFF}} = V_{CC}$	–0.3	0.3	V
V_{OH}	$\overline{\text{INVALID}}$ high-level output voltage	$I_{OH} = -1 \text{ mA}$, FORCEON = GND, $\overline{\text{FORCEOFF}} = V_{CC}$	$V_{CC} - 0.6$		V
V_{OL}	$\overline{\text{INVALID}}$ low-level output voltage	$I_{OL} = 1.6 \text{ mA}$, FORCEON = GND, $\overline{\text{FORCEOFF}} = V_{CC}$		0.4	V

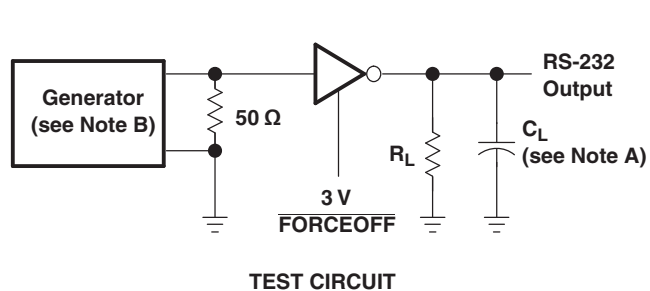
AUTO-POWERDOWN SECTION SWITCHING CHARACTERISTICS

over recommended ranges of supply voltage and operating free-air temperature (unless otherwise noted) (see [Figure 5](#))

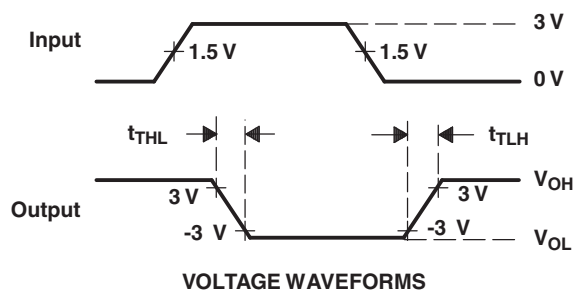
PARAMETER		TYP ⁽¹⁾	UNIT
t_{valid}	Propagation delay time, low- to high-level output	1	μs
t_{invalid}	Propagation delay time, high- to low-level output	30	μs
t_{en}	Supply enable time	100	μs

(1) All typical values are at $V_{CC} = 3.3 \text{ V}$ or $V_{CC} = 5 \text{ V}$, and $T_A = 25^\circ\text{C}$.

PARAMETER MEASUREMENT INFORMATION



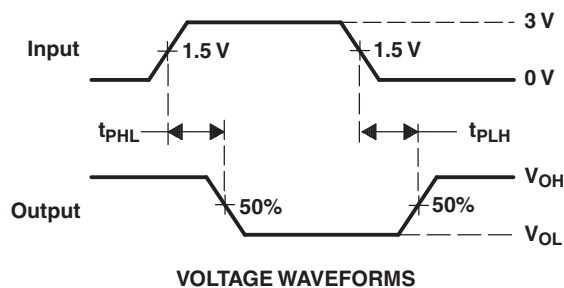
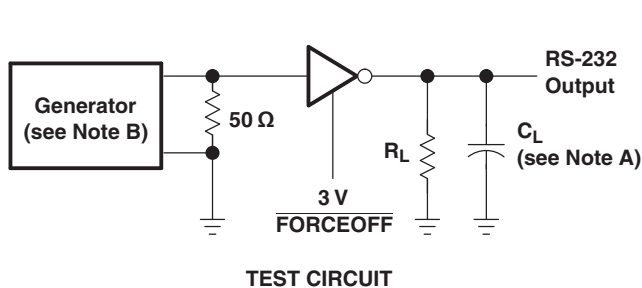
$$SR(tr) = \frac{6\text{ V}}{t_{THL} \text{ or } t_{TLH}}$$



A. C_L includes probe and jig capacitance.

B. The pulse generator has the following characteristics: PRR = 250 kbit/s, $Z_O = 50\ \Omega$, 50% duty cycle, $t_r \leq 10\text{ ns}$, $t_f \leq 10\text{ ns}$.

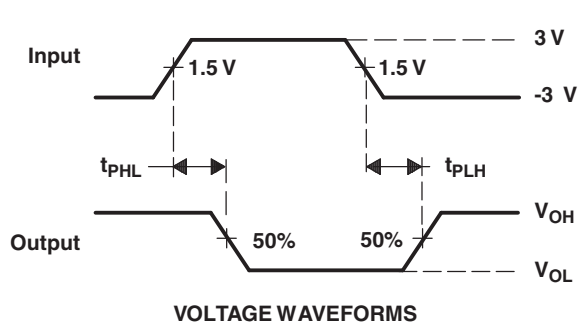
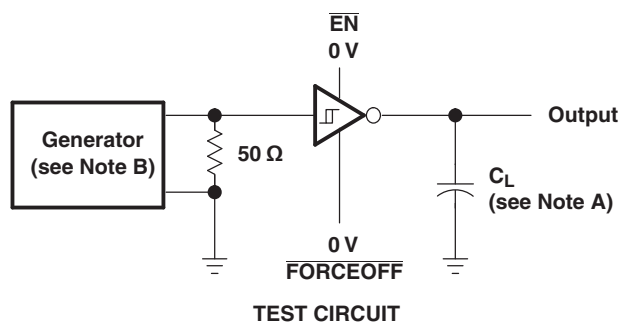
Figure 1. Driver Slew Rate



A. C_L includes probe and jig capacitance.

B. The pulse generator has the following characteristics: PRR = 250 kbit/s, $Z_O = 50\ \Omega$, 50% duty cycle, $t_r \leq 10\text{ ns}$, $t_f \leq 10\text{ ns}$.

Figure 2. Driver Pulse Skew

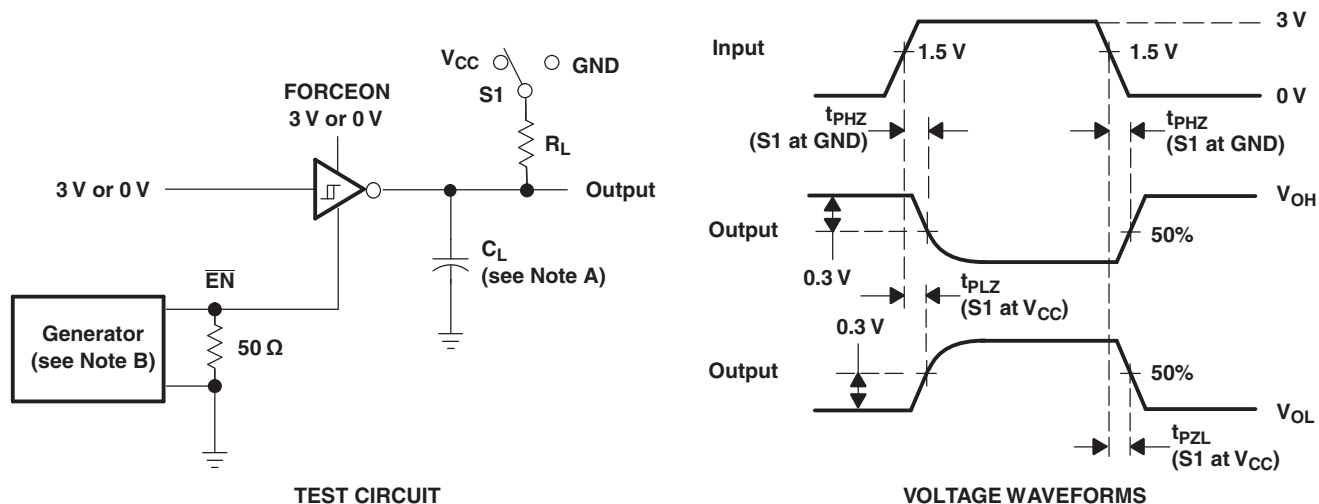


A. C_L includes probe and jig capacitance.

B. The pulse generator has the following characteristics: $Z_O = 50\ \Omega$, 50% duty cycle, $t_r \leq 10\text{ ns}$, $t_f \leq 10\text{ ns}$.

Figure 3. Receiver Propagation Delay Times

PARAMETER MEASUREMENT INFORMATION (continued)

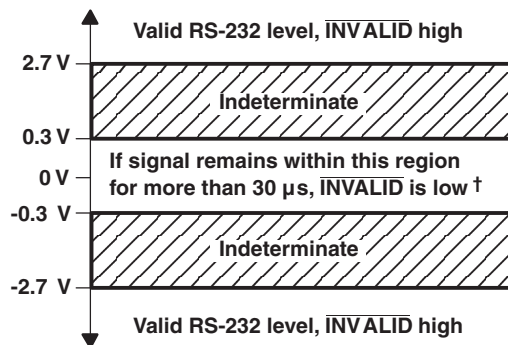
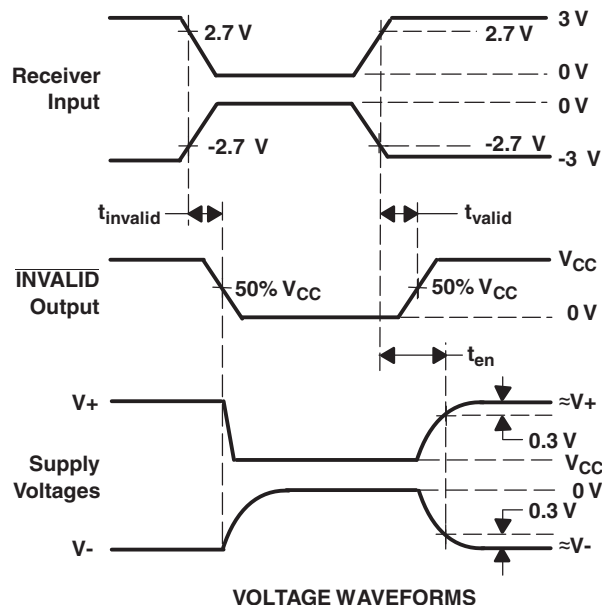
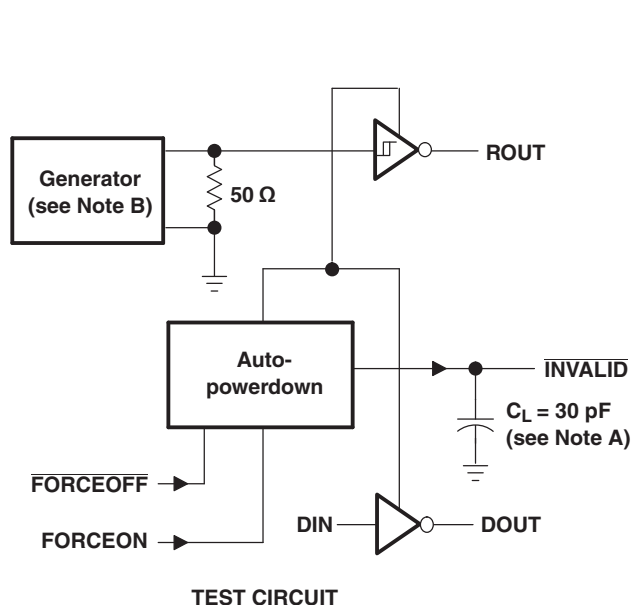


A. C_L includes probe and jig capacitance.

B. The pulse generator has the following characteristics: $Z_O = 50\ \Omega$, 50% duty cycle, $t_r \leq 10\text{ ns}$, $t_f \leq 10\text{ ns}$.

Figure 4. Receiver Enable and Disable Times

PARAMETER MEASUREMENT INFORMATION (continued)



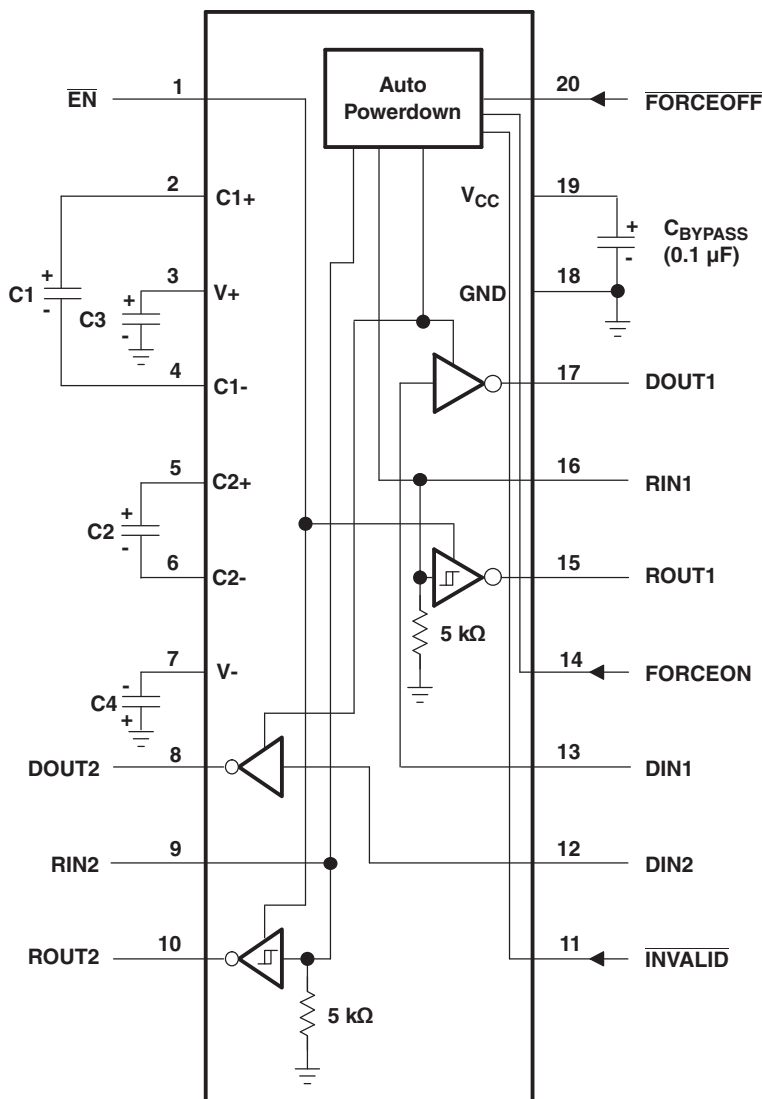
† Auto-powerdown disables drivers and reduces supply current to 1 μ A.

A. C_L includes probe and jig capacitance.

B. The pulse generator has the following characteristics: PRR = 5 kbit/s, Z_O = 50 Ω , 50% duty cycle, $t_r \leq 10$ ns, $t_f \leq 10$ ns.

Figure 5. $\overline{\text{INVALID}}$ Propagation Delay Times and Supply Enabling Time

APPLICATION INFORMATION



A.C3 can be connected to V_{CC} or GND.

B.Resistor values shown are nominal.

C.Nonpolarized ceramic capacitors are acceptable. If polarized tantalum or electrolytic capacitors are used, they should be connected as shown.

V_{CC} vs CAPACITOR VALUES

V_{CC}	C1	C2, C3, C4
3.3 V $\pm$ 0.3 V	0.1 μ F	0.1 μ F
5 V $\pm$ 0.5 V	0.047 μ F	0.33 μ F
3 V to 5.5 V	0.1 μ F	0.47 μ F

Figure 6. Typical Operating Circuit and Capacitor Values

TAPE AND REEL INFORMATION


*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
TRS3223QPWRQ1	TSSOP	PW	20	2000	330.0	16.4	6.95	7.1	1.6	8.0	16.0	Q1

TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
TRS3223QPWRQ1	TSSOP	PW	20	2000	367.0	367.0	38.0

PW (R-PDSO-G20)

PLASTIC SMALL OUTLINE



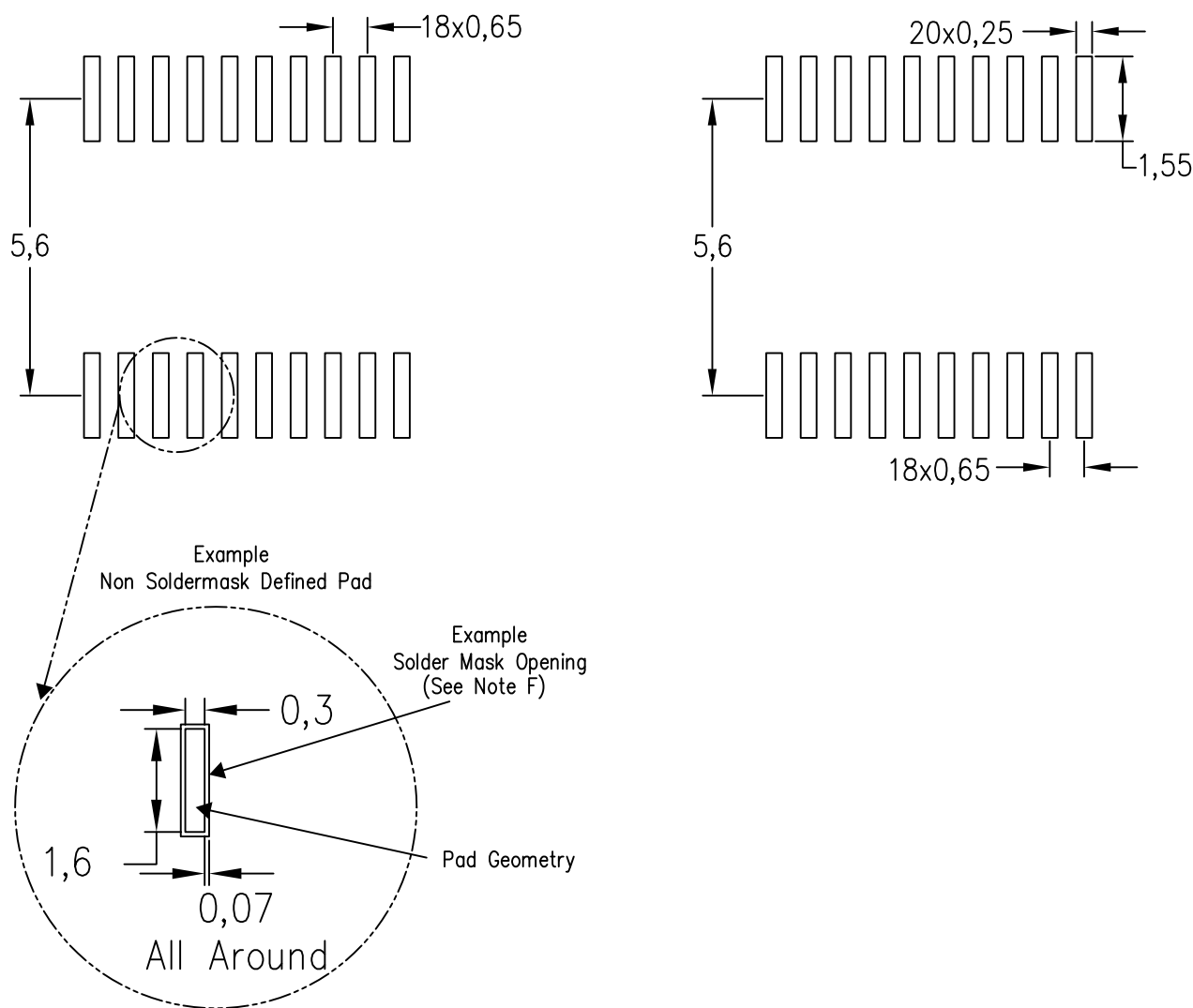
- NOTES:
- A. All linear dimensions are in millimeters. Dimensioning and tolerancing per ASME Y14.5M-1994.
 - B. This drawing is subject to change without notice.
 - C. Body length does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0,15 each side.
 - D. Body width does not include interlead flash. Interlead flash shall not exceed 0,25 each side.
 - E. Falls within JEDEC MO-153

PW (R-PDSO-G20)

PLASTIC SMALL OUTLINE

Example Board Layout

Based on a stencil thickness
of .127mm (.005inch).



4211284-5/F 12/12

- NOTES:
- A. All linear dimensions are in millimeters.
 - B. This drawing is subject to change without notice.
 - C. Publication IPC-7351 is recommended for alternate design.
 - D. Laser cutting apertures with trapezoidal walls and also rounding corners will offer better paste release. Customers should contact their board assembly site for stencil design recommendations. Refer to IPC-7525 for other stencil recommendations.
 - E. Customers should contact their board fabrication site for solder mask tolerances between and around signal pads.

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