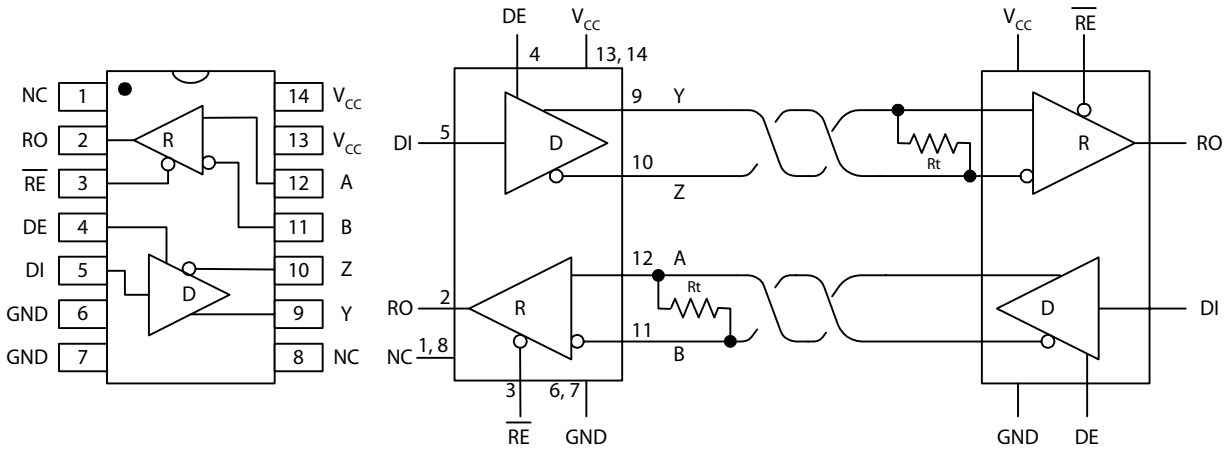
PRELIMINARY

SPACE ELECTRONICS INC.
SPACE PRODUCTS

LOW POWER RS-422 TRANSCEIVERS

422D/Q10RH



PIN CONFIGURATION AND TYPICAL OPERATING CIRCUIT

FEATURES:

- Two or four tranceivers per device
- Single 3.3V Supply without Charge Pump!
- Interoperable with +5V Logic
- 8ns max skew
- 2nA Low-Current Shutdown Mode
- -7V to +12V Common-Mode Input Voltage Range
- Full-Duplex Operation
- Current-Limiting and Thermal Shutdown for Driver Overload Protection
- Total dose hardened to 100 Krads (Si) depending on orbit and duration of mission
- Single Event Latch-up Immune
- Available in RT-10, RT-25, RT-40 and RH versions

APPLICATIONS:

- High level space raiation environments
- Deep space missions

DESCRIPTION:

Space Electronics' 422D10RH and 422Q10RH are dual and quad, low power, full duplex transceivers for RS-422 and RS-485 space communications. Each device contains multiple drivers and receivers. The 422D10RH and 422Q10RH are not slew rate limited, allowing for data rates up to 10 Mbps.

The drivers are short-circuit current limited and are protected against excessive power dissipation by thermal shut-down circuitry that places the driver outputs into a high impedance state. The receiver inputs have a fail-safe feature that guarantees a logic-high output if the input is open circuited.

The 422D10RH and 422Q10RH transceivers feature a typical 100 Krads (Si) total dose tolerance depending upon orbit and duration of mission. The 422D10RH AND 422Q10RH are intended for use in the environments encountered by high reliability spacecraft applications. The patented radiation-hardened RAD-PAK® technology incorporates radiation shielding in the microcircuit package. Capable of surviving in-space environments, the 422D10RH and 422Q10RH are ideal for satellite, spacecraft, and space probe missions.

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TABLE 1. 422D/Q10RH ABSOLUTE MAXIMUM RATINGS

PARAMETER	SYMBOL	MIN	MAX	UNIT
Supply Voltage	V_{CC}		7	V
Control Input Voltage	$\overline{RE}$, DE	-0.3	7	V
Driver Input Voltage	DI	-0.3	7	V
Driver Output Voltage	A, B, Y, Z	-7.5	12.5	V
Receiver Input Voltage	A, B	-7.5	12.5	V
Receiver Output Voltage	RO	-0.3	(V_{CC} + 0.3)	V
Operating Temperature Ranges		-40	+85	ºC
Storage Temperature Range		-65	+160	ºC
Lead Temperature (soldering, 10sec)			+300	ºC

TABLE 2. 422D/Q10RH DC ELECTRICAL CHARACTERISTICS

(V_{CC} = 3.3V ± 0.3V, $T_A = T_{MIN}$ TO T_{MAX}, UNLESS OTHERWISE NOTED. TYPICAL VALUES @ TA = +25ºC)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNIT
Differential Driver Output	V_{OD}	R_L = 100Ω (RS-422), Figure 1	2.0	--	--	V
		R_L = 100Ω (RS-485), Figure 1	1.5	--	--	V
		R_L = 100Ω (RS-485), V_{CC} = 3.3V, Figure 2	1.5	--	--	V
Change in Magnitude of Driver Differential Output Voltage for Complementary Output States	ΔV_{OD} [1]	R_L = 54Ω or 100Ω, Figure 1	--	--	0.2	V
Driver Common-Mode Output Voltage	V_{OC}	R_L = 54Ω or 100Ω, Figure 1	--	--	3	V
Change in Magnitude of Common-Mode Output Voltage	ΔV_{OC} [1]	R_L = 54Ω or 100Ω, Figure 1	--	--	0.2	V
Input High Voltage	V_{IH}	DE, DI, $\overline{RE}$	2.0	--	--	V
Input Low Voltage	V_{IL}	DE, DI, $\overline{RE}$	--	--	0.8	V
Logic Input Current	I_{IN1}	DE, DI, $\overline{RE}$	--	--	±2	µA
Input Current (A,B)	I_{IN2}	DE = 0V, V_{CC} = 0V or 3.6V, V_{IN} = 12V	--	--	1.0	mA
		DE = 0V, V_{CC} = 0V or 3.6V, V_{IN} = -7V	--	--	-0.8	mA
Output Leakage (Y,Z)	I_O	V_{CC} = 0V or 3.6V, V_{IN} = -12V			20	µA
		V_{CC} = 0V or 3.6V, V_{IN} = -7V			-20	µA
Output Leakage (Y,Z) in Shutdown Mode	I_O	V_{CC} = 0V or 3.6V, V_{IN} = -12V			1	µA
		V_{CC} = 0V or 3.6V, V_{IN} = -7V			-1	µA
Receiver Differential Threshold Voltage	V_{TH}	-7V < V_{CM} < 12V	-0.2	--	0.2	V
Receiver Input Hysteresis	ΔV_{TH}	V_{CM} = 0V	--	50	--	mV
Receiver Output High Voltage	V_{OH}	I_{OUT} = -1.5mA, VID = 200mV, Figure 3	V_{CC} - 0.4	--	--	V
Receiver Output Low Voltage	V_{OL}	I_{OUT} = 2.5mA, VID = 200mV, Figure 3	--	--	0.4	V

TABLE 2. 422D/Q10RH DC ELECTRICAL CHARACTERISTICS

($V_{CC} = 3.3V \pm 0.3V$, $T_A = T_{MIN}$ TO T_{MAX}, UNLESS OTHERWISE NOTED. TYPICAL VALUES @ TA = +25°C)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNIT
Three-state (High-Z) Output Current at Receiver	I_{OZR}	$V_{CC} = 3.6, 0V < V_{OUT} < V_{CC}$	--	--	±1	µA
Receiver Input Resistance	R_{IN}	$-7V < V_{CM} < 12V$	12	--	--	kΩ
Supply Current	I_{CC}	No load, DI = 0V or V_{CC}, DE = V_{CC}, $\overline{RE}$ = 0V or V_{CC}	--	1.1	2.2	mA
		No load, DI = 0V or V_{CC}, DE = 0V, $\overline{RE}$ = 0V	--	0.95	1.9	mA
Supply Current in Shutdown Mode	I_{SHDN}	DE = 0V, $\overline{RE}$ = V_{CC}, DI = 0V or V_{CC}	--	0.002	1	µA
Driver Short-circuit Output Current	I_{OSD}	V_{OUT} = -7V	--	--	-250	mA
		V_{OUT} = -12V	--	--	250	mA
Receiver Short-circuit Output Current	I_{OSR}	$0V < V_{RO} < V_{CC}$	±8	--	±60	mA

1. ΔV_{OD} and ΔV_{OC} are the changes in V_{OD} and V_{OC}, respectively, when the DI input changes state.

TABLE 3. DRIVER SWITCHING CHARACTERISTICS

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNIT
Driver Differential Output Delay	t_{DD}	$R_L = 60\Omega$, Figure 4	1	22	35	ns
Driver Differential Output Transition Time	t_{TD}	$R_L = 60\Omega$, Figure 4	3	8	25	ns
Driver Propagation Delay, Low-to-High Level	t_{PLH}	$R_L = 27\Omega$, Figure 5	7	22	35	ns
		$R_L = 27\Omega$, Figure 5	7	22	35	ns
$\lvert t_{PLH} - t_{PHL} \rvert$ Driver Propagation Delay Skew	t_{PDS} [1]	$R_L = 27\Omega$, Figure 5	--	--	8	ns
DRIVER OUTPUT ENABLE/DISABLE TIMES						
Driver Output Enable Time to Low Level	t_{PZL}	$R_L = 110\Omega$, Figure 7	--	45	90	ns
Driver Output Enable Time to High Level	t_{PZH}	$R_L = 110\Omega$, Figure 6	--	45	90	ns
Driver Output Disable Time from High Level	t_{PHZ}	$R_L = 110\Omega$, Figure 6	--	40	80	ns
Driver Output Disable Time from Low Level	t_{PLZ}	$R_L = 110\Omega$, Figure 7	--	40	80	ns
Driver Output Enable Time from Shutdown to Low Level	t_{PSL}	$R_L = 110\Omega$, Figure 7	--	650	900	ns
Driver Output Enable Time from Shutdown to High Level	t_{PSH}	$R_L = 110\Omega$, Figure 6	--	650	900	ns

1. Measured on $\lvert t_{PLH}(Y) - t_{PHL}(Y) \rvert$ and $\lvert t_{PLH}(Z) - t_{PHL}(Z) \rvert$.

TABLE 4. RECEIVER SWITCHING CHARACTERISTICS

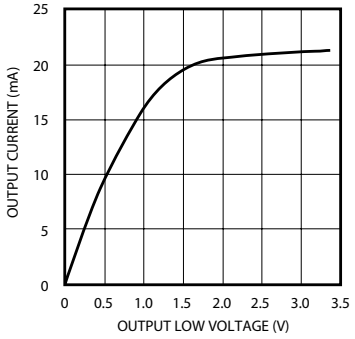
(V_{CC} = 3.3V, T_A = +25°C)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNIT
Time to Shutdown	t_{SHDN}		80	190	300	ns
Receiver Propagation Delay, Low-to-High Level	t_{RPLH}	V_{ID} = 0V to 3.0V, C_L = 15pF, Figure 8	25	65	90	ns
Receiver Propagation Delay, High-to-Low Level	t_{RPHL}	V_{ID} = 0V to 3.0V, C_L = 15pF, Figure 8	25	65	90	ns
$\|t_{PLH} - t_{PHL}\|$ Receiver Propagation Delay Skew	t_{RPDS}	V_{ID} = 0V to 3.0V, C_L = 15pF, Figure 8	--	--	10	ns
Receiver Output Enable Time to Low Level	t_{PRZL}	C_L = 15pF, Figure 13	--	25	50	ns
Receiver Output Enable Time to High Level	t_{PRZH}	C_L = 15pF, Figure 13	--	25	50	ns
Receiver Output Disable Time from High Level	t_{PRHZ}	C_L = 15pF, Figure 13	--	25	45	ns
Receiver Output Disable Time from Low Level	t_{PRLZ}	C_L = 15pF, Figure 13	--	25	45	ns
Receiver Output Enable Time from Shutdown to Low Level	t_{PRSL}	C_L = 15pF, Figure 13	--	720	1400	ns
Receiver Output Enable Time from Shutdown to High Level	t_{PRSH}	C_L = 15pF, Figure 13	--	720	1400	ns

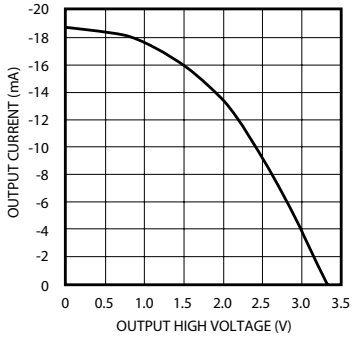
TYPICAL OPERATING CHARACTERISTICS

(V_{CC} = +3.3V, T_A = +25°C UNLESS OTHERWISE SPECIFIED.)

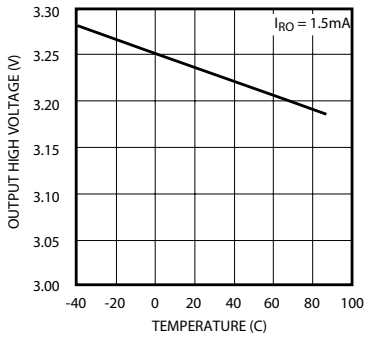
OUTPUT CURRENT vs. RECEIVER OUTPUT LOW VOLTAGE



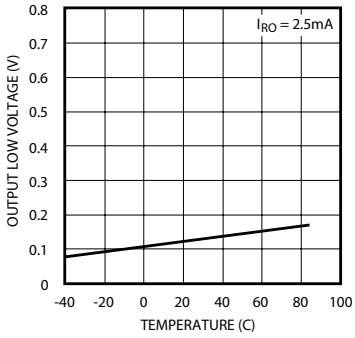
OUTPUT CURRENT vs. RECEIVER OUTPUT HIGH VOLTAGE



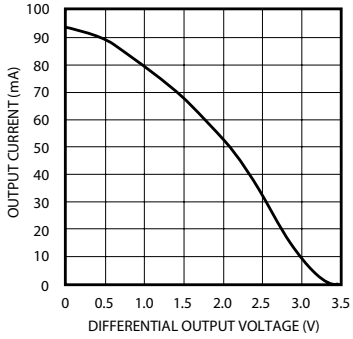
RECEIVER OUTPUT HIGH VOLTAGE vs. TEMPERATURE



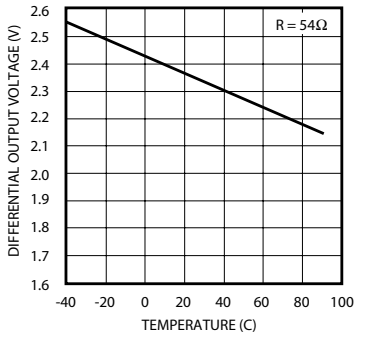
RECEIVER OUTPUT LOW VOLTAGE vs. TEMPERATURE



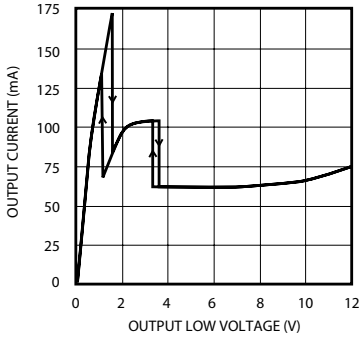
DRIVER OUTPUT CURRENT vs. DIFFERENTIAL OUTPUT VOLTAGE



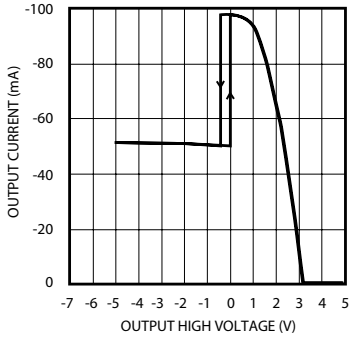
DRIVER DIFFERENTIAL OUTPUT VOLTAGE vs.TEMPERATURE



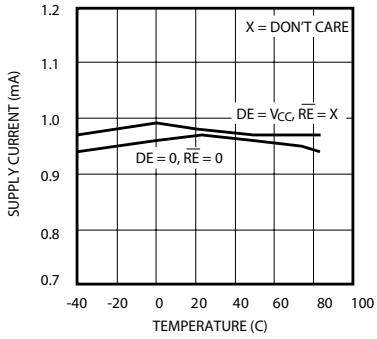
OUTPUT CURRENT vs. DRIVER OUTPUT LOW VOLTAGE



OUTPUT CURRENT vs. DRIVER OUTPUT HIGH VOLTAGE



SUPPLY CURRENT vs. TEMPERATURE



SHUTDOWN CURRENT vs. TEMPERATURE

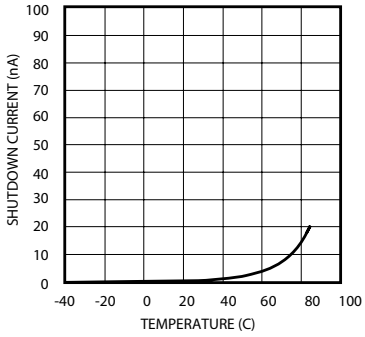


TABLE 5. PIN DESCRIPTION

PIN	NAME	FUNCTION
1, 8	NC	No Connect-not internally connected
2	RO	Receiver Output. If A > B by 200mV, RO will be high; if A < B by 200mV, RO will be low.
3	RE	Receiver Output Enable. RO is enabled when RE is low; RO is high impedance when RE is high. If RE is high and DE is low, the device will enter a low-power shutdown mode.
4	DE	Driver Output Enable. The driver outputs are enabled by bringing DE high. They are high impedance when DE is low. If RE is high and DE is low, the device will enter a low-power shutdown mode. If the driver outputs are enabled, the parts function as line drivers. While they are high impedance, they function as line receivers if RE is low.
5	DI	Driver Input. A low on DI forces output Y low and output Z high. Similarly, a high on DI forces output Y high and output Z low.
6, 7	GND	Ground
9	Y	Non-inverting Driver Output
10	Z	Inverting Driver Output
--	A	Non-inverting Receiver Input and Non-inverting Driver Output
12	A	Non-inverting Receiver Input
--	B	Inverting Receiver Input and Inverting Driver Output
11	B	Inverting Receiver Input
13, 14	V_{CC}	Positive Supply: $3.0V \leq V_{CC} \leq 3.6V$

FIGURE 1. DRIVER V_{OD} AND V_{OC}

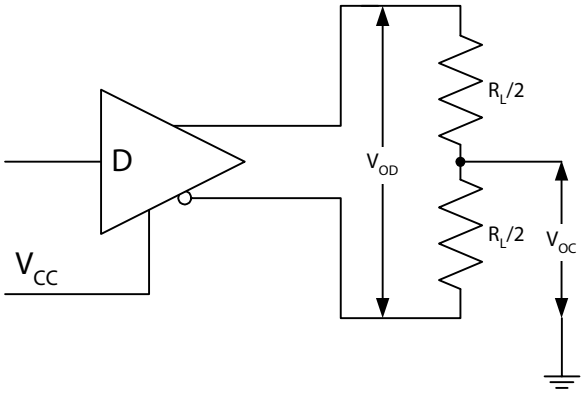


FIGURE 2. DRIVER V_{OD} WITH VARYING COMMON-MODE VOLTAGE

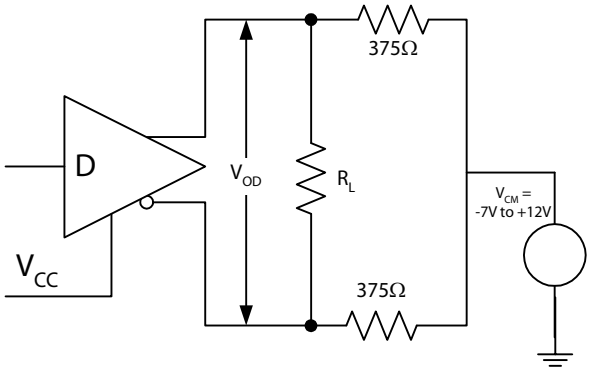


FIGURE 3. RECEIVER V_{OH} AND V_{OL}

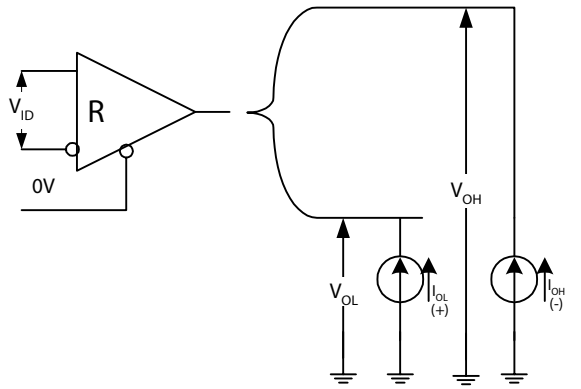


FIGURE 4. DRIVER DIFFERENTIAL OUTPUT DELAY AND TRANSITION TIMES

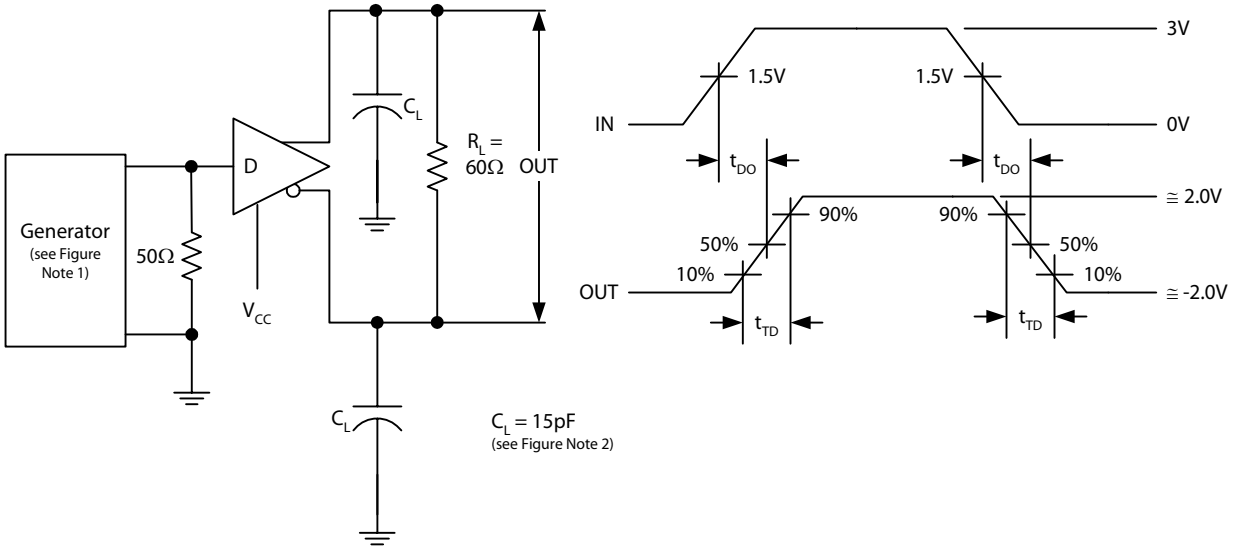


FIGURE 5. DRIVER PROPAGATION TIMES

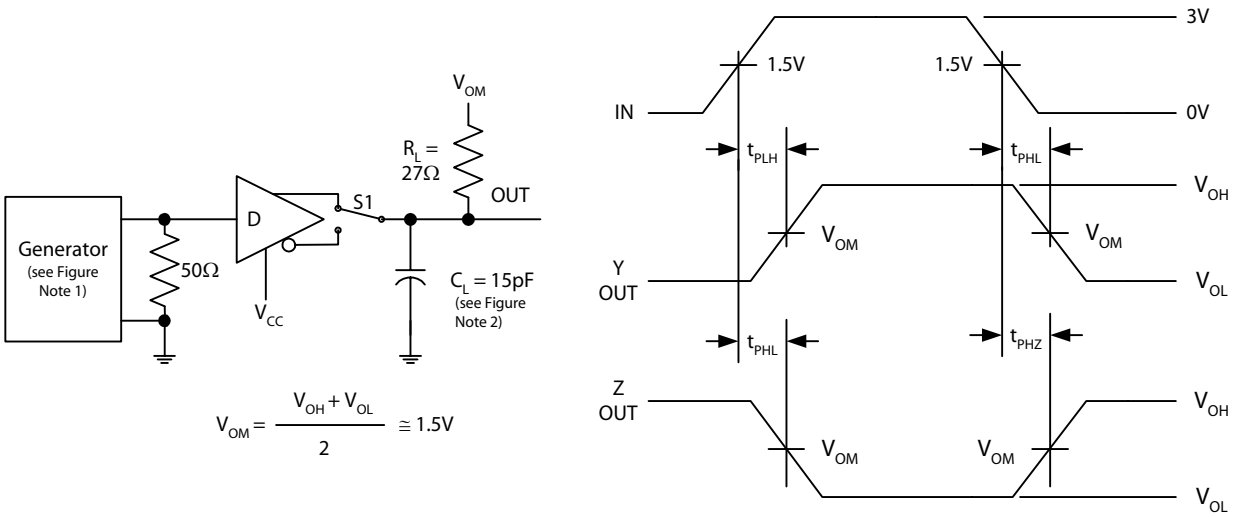


FIGURE 6. DRIVER ENABLE AND DISABLE TIMES (t_{PZH}, t_{PSH}, t_{PHZ})

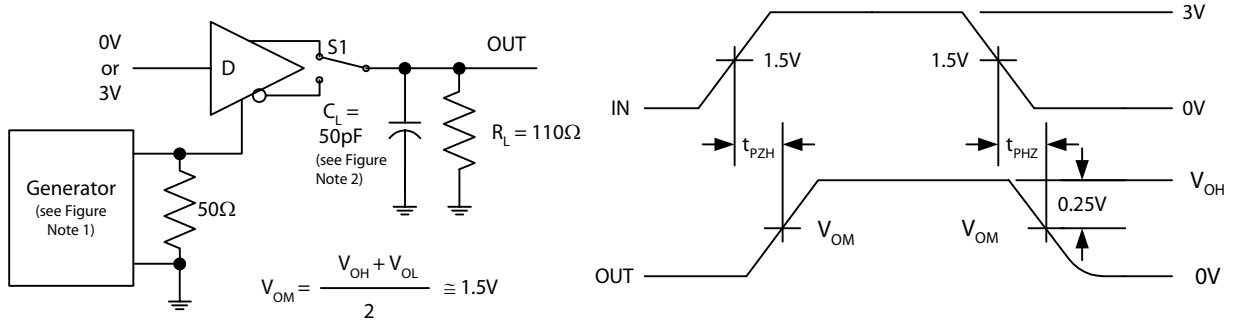


FIGURE 7. DRIVER ENABLE AND DISABLE TIMES (t_{PZL}, t_{PSL}, t_{PLZ})

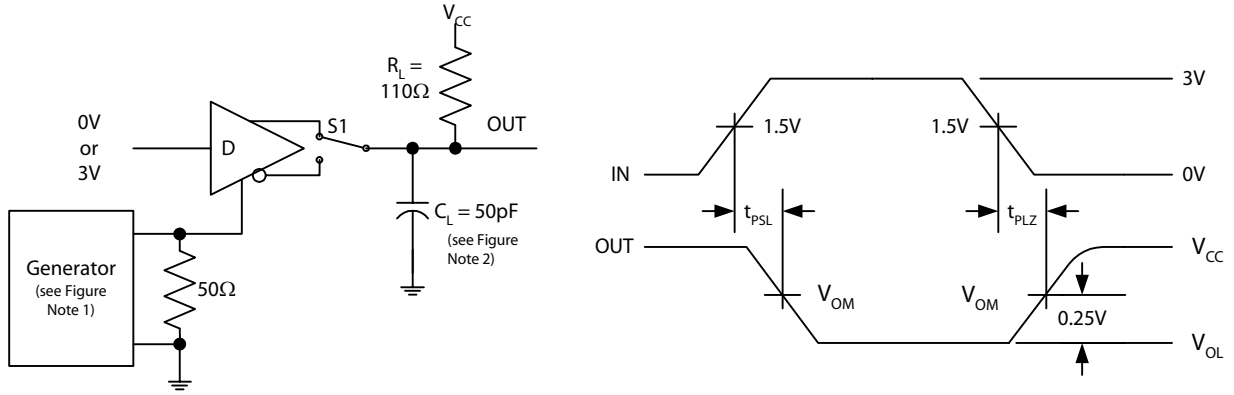


FIGURE 8. RECEIVER PROPAGATION DELAY

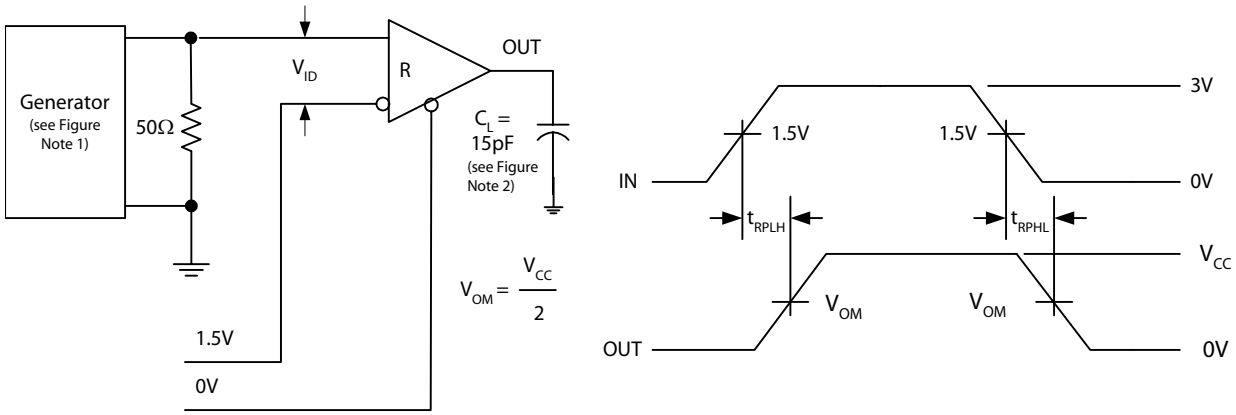


FIGURE 9. RECEIVER ENABLE AND DISABLE TIMES

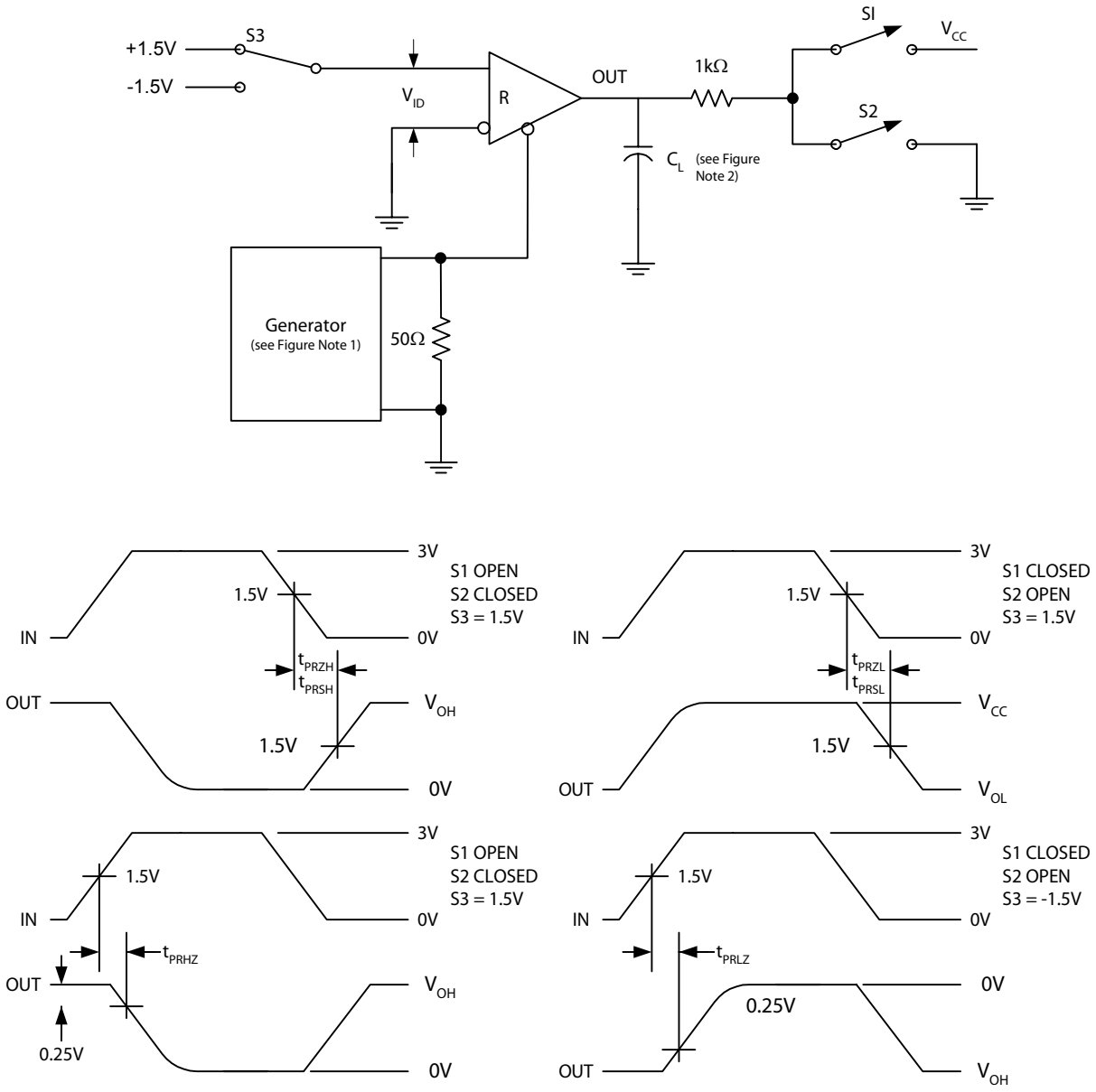


Figure Notes:

1. The input pulse is supplied by a generator with the following characteristices: PRR = 250kHZ, 50% duty cycle, $t_r \leq 6.0$ns, ZO = 50Ω
2. C_L includes probe and stray capacitance.

LOW-POWER SHUTDOWN MODE

A low-power shutdown mode is initiated by bringing both RE high and DE low. The devices will not shut down unless both the driver and receiver are disabled (high impedance). In shutdown, the devices typically draw only 2nA of supply current.

For these devices, the t_{PSH} and t_{PSL} enable times assume the part was in the low-power shutdown mode; the t_{PZH} and t_{PZL} enable times assume the receiver or driver was disabled, but the part was not shut down.

DRIVER OUTPUT PROTECTION

Excessive output current and power dissipation caused by faults or by bus contention are prevented by two mechanisms. A foldback current limit on the output stage provides immediate protection against short circuits over the whole common-mode voltage range (see Typical Operating Characteristics). In addition, a thermal shutdown circuit forces the driver outputs into a high-impedance state if the die temperature rises excessively.

LINE LENGTH VS. DATA RATE

The RS-485/RS-422 standard covers line lengths up to 4000 feet. For line lengths greater than 4000 feet, see Figure 14.

Figure 12 shows the system differential voltage for parts driving 4000 feet of 26AWG twisted-pair wire at 125kHz into 120½ loads.

FIGURE 10. DRIVER PROPAGATION

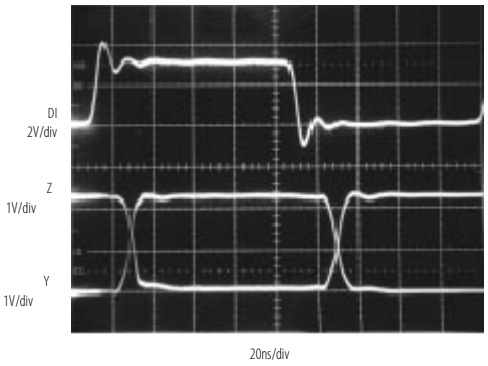


FIGURE 11. RECEIVER PROPAGATION DELAY DRIVEN BY EXTERNAL RS-485 DEVICE

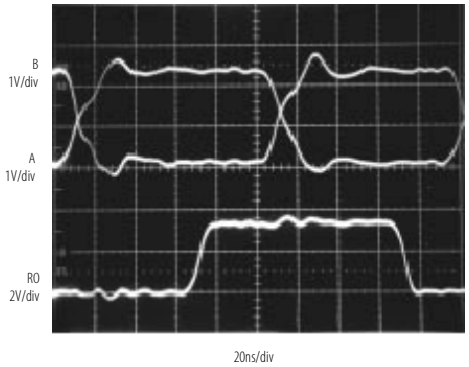


FIGURE 12. SYSTEM DIFFERENTIAL VOLTAGE AT 125KHZ DRIVING 4000 FEET OF CABLE

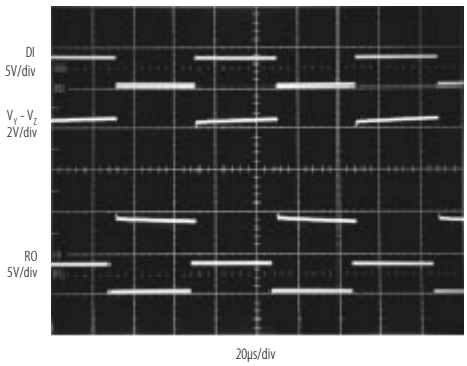


FIGURE 13. FULL-DUPLEX RS-485 NETWORK

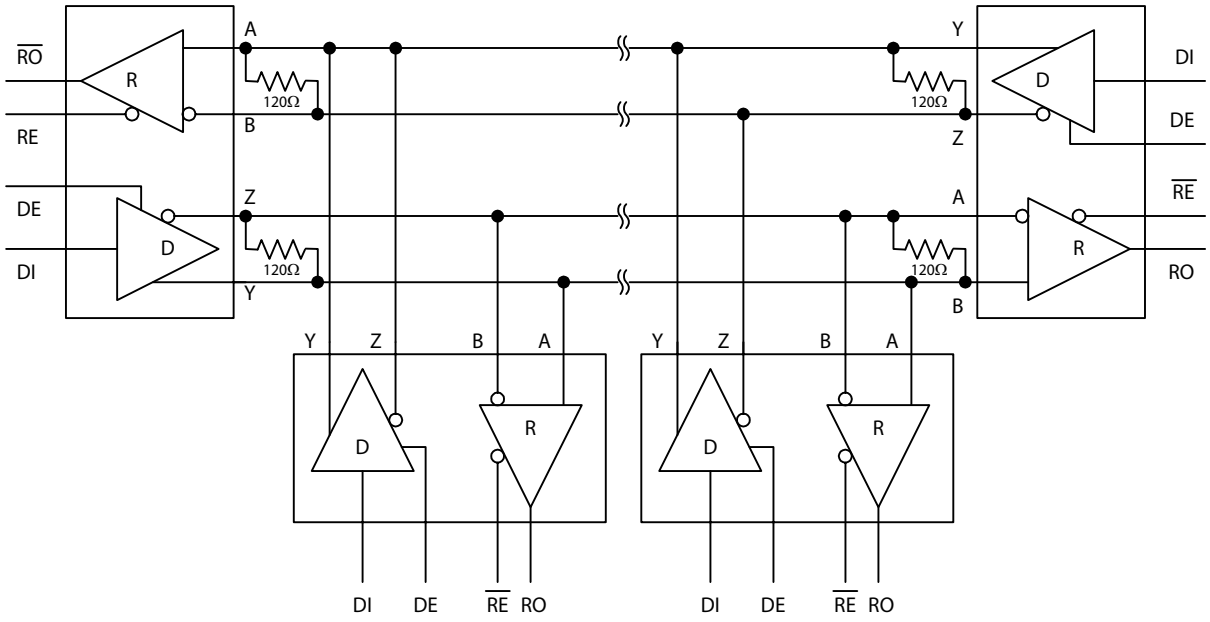
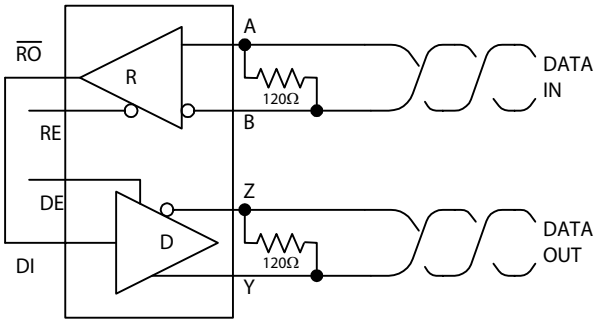


FIGURE 14. LINE REPEATER



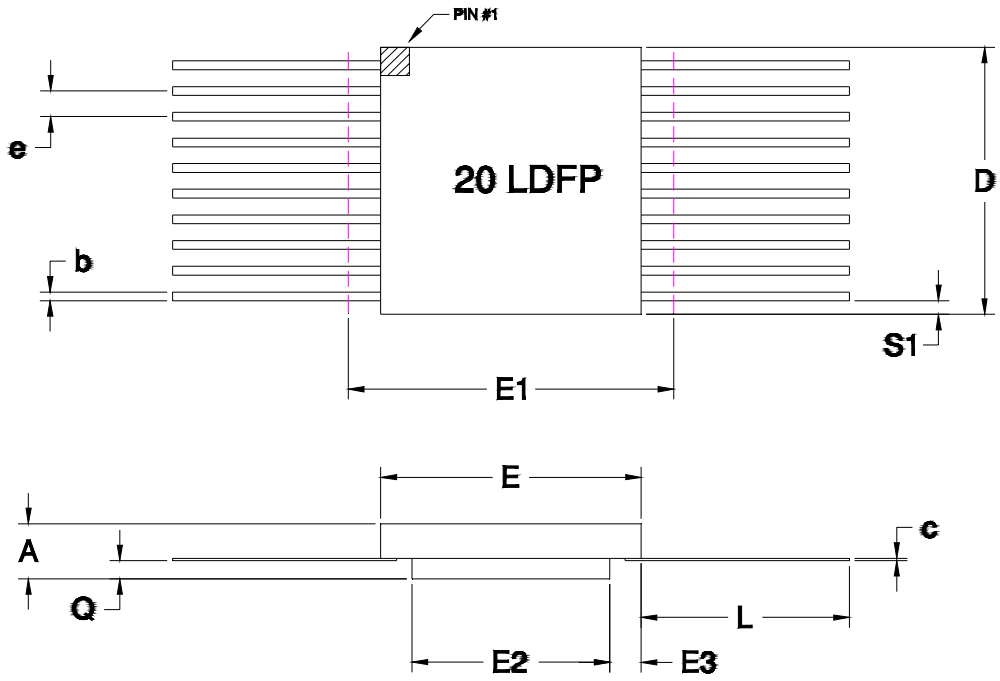


TABLE 15.

SYMBOL	DIMENSION		
	MIN	NOM	MAX
A	0.128	0.141	0.154
b	0.015	0.017	0.022
c	0.004	0.005	0.009
D	0.472	0.480	0.488
E	0.287	0.295	0.303
E1	--	--	0.333
E2	0.155	0.160	--
E3	0.030	0.068	--
e	0.050 BSC		
L	0.370	0.380	0.390
Q	0.035	0.039	0.042
S1	0.005	0.007	--
N	20		

F20-01
Note: All dimensions in inches.

Important Notice:

These data sheets are created using the chip manufacturers published specifications. Space Electronics verifies functionality by testing key parameters either by 100% testing, sample testing or characterization.

The specifications presented within these data sheets represent the latest and most accurate information available to date. However, these specifications are subject to change without notice and Space Electronics assumes no responsibility for the use of this information.

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