

ISL71026M

3.3V CAN Transceiver, 1Mbps, Listen Mode, Loopback

Description

The **ISL71026M** is a radiation tolerant 3.3V CAN transceiver that is compatible with the ISO11898-2 standard for applications calling for Controller Area Network (CAN) serial communication in satellites and aerospace communications and telemetry data processing in harsh industrial environments.

The transceiver can transmit and receive at bus speeds up to 5Mbps. It can drive a 40m cable at 1Mbps per the ISO11898-2 specification. The device is designed to operate across a common-mode range of -7V to +12V with a maximum of 120 nodes. The device has three discrete selectable driver rise/fall time options, a listen mode feature, and loopback test capability.

The ISL71026M is available in a plastic 14 Ld TSSOP package. It operates across the temperature range of -55°C to +125°C. The logic inputs are tolerant with 5V systems.

Applications

- Telemetry data processing in commercial satellites
- Low earth orbits (LEO) applications
- Launch vehicles and high altitude avionics

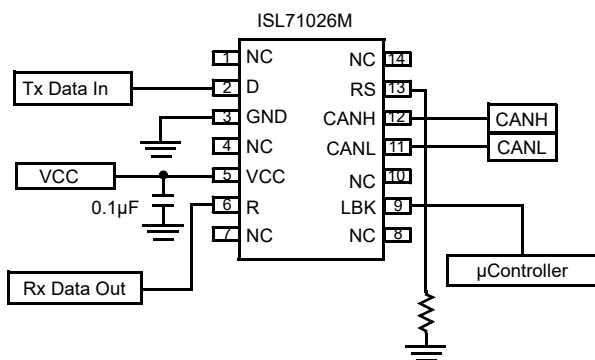


Figure 1. Typical Application

Features

- Qualified to Renesas Rad Tolerant Screening and QCI Flow ([R34TB0004EU](#))
- ESD protection on all pins: 5kV HBM
- Compatible with ISO11898-2
- Operating supply range: 3.0V to 3.6V
- Bus pin fault protection to ±20V
- Three selectable driver rise and fall times
- High data rates up to 5Mbps
- -7V to +12V common mode input voltage range
- Hi Z input allows for 120 nodes on the bus
- Cold spare: powered down devices/nodes will not affect active devices operating in parallel
- Full fail-safe (open, short, terminated/undriven) receiver
- Quiescent supply current: 7mA (max), Listen mode supply current: 2mA (max)
- Tin (Sn) free lead finish with Ni/Pd/Au-Ag lead finish
- Passes NASA Low Outgassing Specifications
- TID Radiation Lot Acceptance Testing (LDR: <0.01rad(Si)/s)
 - ISL71026M30VZ: 30krad(Si)
 - ISL71026M50VZ: 50krad(Si)
- SEE Characterization
 - No DSEE for VCC = 5.5V, CANL = ±20V and CANH = ±20V at 43MeV•cm²/mg
 - SET < 370µm² with fast slew rate at 43MeV•cm²/mg
 - SET < 14,370µm² with medium slew rate at 43MeV•cm²/mg

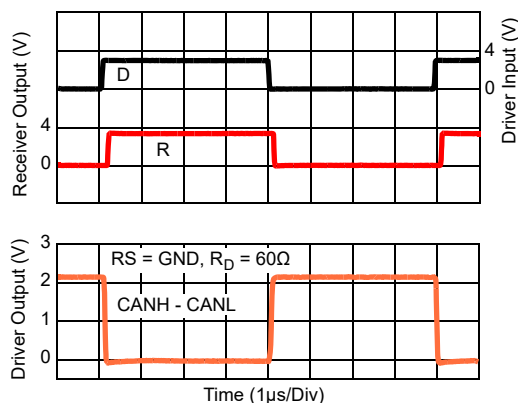


Figure 2. Fast Driver and Receiver Waveforms

Contents

1. Pin Information	3
1.1 Pin Assignments	3
1.2 Pin Descriptions	3
2. Specifications	4
2.1 Absolute Maximum Ratings	4
2.2 Outgas Testing	4
2.3 Thermal Information	4
2.4 Operating Conditions	4
2.5 Electrical Specifications	5
2.6 Equivalent Input and Output Schematic Diagrams	8
2.7 Test Circuits and Waveforms	9
3. Typical Performance Curves	12
4. Functional Description	16
4.1 Overview	16
4.2 Slope Adjustment	16
4.3 Cable Length	16
4.4 Cold Spare	16
4.5 Listen Mode	17
4.6 Loopback Mode	17
4.7 Using 3.3V Devices in 5V Systems	17
5. Radiation Tolerance	17
5.1 Total Ionizing Dose (TID) Testing	17
5.1.1 Introduction	17
5.1.2 Results	18
5.2 Data Plots	19
5.2.1 Conclusion	20
5.3 Single-Event Effects Testing	24
5.3.1 Introduction	24
5.3.2 SEE Test Setup	25
5.3.3 SEL, SEB, and SEGR Testing Results	25
5.3.4 Single-Event Transient Testing	26
5.3.5 Conclusion	26
6. Package Outline Drawing	27
7. Ordering Information	28
8. Revision History	28

1. Pin Information

1.1 Pin Assignments

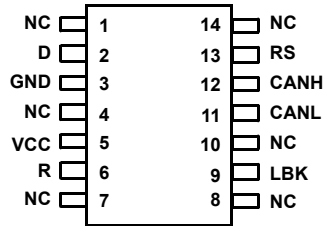


Figure 3. Pin Assignments - Top View

1.2 Pin Descriptions

Pin Number	Pin Name	Function
1, 4, 7, 8, 10, 14	NC	No connect.
2	D	CAN driver digital input. The bus states are LOW = Dominant and HIGH = Recessive. Internally tied HIGH.
3	GND	Ground connection.
5	VCC	System power supply input (3.0V to 3.6V). The typical voltage for the device is 3.3V.
6	R	CAN Data Receiver Output. The bus states are LOW = Dominant and HIGH = Recessive.
9	LBK	A HIGH on this pin places CANH and CANL pins in a high impedance state. The rest of the circuit remains active so that the TX and RX can loopback diagnostic information. Internally tied LOW.
11	CANL	CAN bus line for low level output.
12	CANH	CAN bus line for high level output.
13	RS	A resistor to GND from this pin controls the rise and fall time of the CAN output waveform. Drive RS HIGH to put into Listen Mode.

2. Specifications

2.1 Absolute Maximum Ratings

CAUTION: Do not operate at or near the maximum ratings listed for extended periods of time. Exposure to such conditions may adversely impact product reliability and result in failures not covered by warranty.

Parameter	Minimum	Maximum	Unit
VCC to GND	-0.3V	5.5	V
CANH, CANL, VREF		±20	V
I/O Voltages D, R, RS	-0.5	7	V
Receiver Output Current	-10	10	mA
Output Short-Circuit Duration	-	Continuous	
Maximum Junction Temperature	-	+150	°C
Storage Temperature Range	-65	+150	°C
Human Body Model (Tested per JS-001-2014)	-	5	kV
Charged Device Model (Tested per JS-002-2014)	-	2	kV
Machine Model (Tested per JESD22-A115-C)	-	300	V
Latch-up (Tested per JESD-78E; Class 2, Level A) at +125°C	-	100	mA

2.2 Outgas Testing

Specification (Tested per ASTM E 595, 1.5)	Value	Unit
Total Mass Lost ^[1]	0.06	%
Collected Volatile Condensable Material ^[1]	<0.01	%
Water Vapor Recovered	0.03	%

1. Results meet NASA low outgassing requirements of "Total Mass Lost" of <1% and Collected Volatile Condensable Material of <0.1%.

2.3 Thermal Information

Parameter	Package	Symbol	Conditions	Typical Value	Unit
Thermal Resistance	14 Ld TSSOP Package	θ_{JA} ^[1]	Junction to ambient	92	°C/W
		θ_{JC} ^[2]	Junction to case	30	°C/W

1. θ_{JA} is measured with the component mounted on a high-effective thermal conductivity test board in free air. See [TB379](#).

2. For θ_{JC} , the case temperature location is taken at the package top center.

2.4 Operating Conditions

Parameter	Minimum	Maximum	Unit
Temperature Range	-55	+125	°C
V _{CC} Supply Voltage	3.0	3.6	V
Voltage on CAN I/O	-7	12	V
V _{IH} Logic Pins (D, LBK)	2	5.5	V
V _{IL} Logic Pins (D, LBK)	0	0.8	V
I _{OH} Driver (CANH - CANL = 1.5V, V _{CC} = 3.3V)	-	-40	mA
I _{OH} Receiver (V _{OH} = 2.4V)	-	-4	mA

Parameter	Minimum	Maximum	Unit
I _{OL} Driver (CANH - CANL = 1.5V, V _{CC} = 3.3V)	-	+40	mA
I _{OL} Receiver (V _{OL} = 0.4V)	-	+4	mA

2.5 Electrical Specifications

Test Conditions: V_{CC} = 3.0V to 3.6V; Typicals are at T_A = +25°C; unless otherwise specified^[1]. **Boldface limits apply across the operating temperature range, -55°C to +125°C.**

Parameter	Symbol	Test Conditions	Min ^[2]	Typ ^[3]	Max ^[2]	Unit	
Driver Electrical Characteristics							
Dominant Bus Output Voltage	V _{O(DOM)}	D = 0V, CANH, RS = 0V, Figure 11 and Figure 12	3.0V ≤ V _{CC} ≤ 3.6V	2.25	2.57	V_{CC}	V
		D = 0V, CANL, RS = 0V, Figure 11 and Figure 12		0.1	0.58	1.25	V
Recessive Bus Output Voltage	V _{O(REC)}	D = 3V, CANH, RS = 0V, 60Ω and no load, Figure 11 and Figure 12	3.0V ≤ V _{CC} ≤ 3.6V	1.80	2.1	2.70	V
		D = 3V, CANL, RS = 0V, 60Ω and no load, Figure 11 and Figure 12		1.80	2.1	2.80	V
Dominant Output Differential Voltage	V _{OD(DOM)}	D = 0V, RS = 0V, 3.0V ≤ V _{CC} ≤ 3.6V, Figure 11 and Figure 12	3.0V ≤ V _{CC} ≤ 3.6V	1.5	2.4	3	V
		D = 0V, RS = 0V, 3.0V ≤ V _{CC} ≤ 3.6V, Figure 12 and Figure 13		1.2	2.0	3	V
Recessive Output Differential Voltage	V _{OD(REC)}	D = 3V, RS = 0V, 3.0V ≤ V _{CC} ≤ 3.6V, Figure 11 and Figure 12	3.0V ≤ V _{CC} ≤ 3.6V	-120	0.2	12	mV
		D = 3V, RS = 0V, 3.0V ≤ V _{CC} ≤ 3.6V, no load		-500	-30	50	mV
Logic Input High Voltage (D, LBK)	V _{IH}	3.0V ≤ V _{CC} ≤ 3.6V ^[4]	2.0	-	5.5	V	
Logic Input Low Voltage (D, LBK)	V _{IL}	3.0V ≤ V _{CC} ≤ 3.6V ^[4]	0	-	0.8	V	
Logic High Level Input Current (D, LBK)	I _{IH}	D = 2.0V, 3.0V ≤ V _{CC} ≤ 3.6V	-30	-3	30	μA	
Logic Low Level Input Current (D, LBK)	I _{IL}	D = 0.8V, 3.0V ≤ V _{CC} ≤ 3.6V	-30	-7	30	μA	
RS Input Voltage for Listen Mode	V _{IN(RS)}	3.0V ≤ V _{CC} ≤ 3.6V	0.75 V_{CC}	1.9	5.5	V	
Output Short-Circuit Current	I _{OSC}	V _{CANH} = -7V, CANL = Open, 3.0V ≤ V _{CC} ≤ 3.6V, Figure 25	3.0V ≤ V _{CC} ≤ 3.6V	-250	-108	-	mA
		V _{CANH} = +12V, CANL = Open, 3.0V ≤ V _{CC} ≤ 3.6V, Figure 25		-	0.4	1	mA
		V _{CANL} = -7V, CANH = Open, 3.0V ≤ V _{CC} ≤ 3.6V, Figure 25		-1	-0.4	-	mA
		V _{CANL} = +12V, CANH = Open, 3.0V ≤ V _{CC} ≤ 3.6V, Figure 25		-	90	250	mA
Thermal Shutdown Temperature	T _{SHDN}	3.0V < V _{IN} < 3.6V	-	163	-	°C	
Thermal Shutdown Hysteresis	T _{HYS}	3.0V < V _{IN} < 3.6V	-	12	-	°C	
Receiver Electrical Characteristics							
Input Threshold Voltage (Rising)	V _{THR}	LBK = 0V, RS = 0V, 10k, 50k, (recessive to dominant), Common Mode Voltage Range: -2V to +7V, Figure 17	3.0V ≤ V _{CC} ≤ 3.6V	-	740	900	mV
		LBK = 0V, RS = 0V, 10k, 50k, (recessive to dominant), Common Mode Voltage Range: <-2V to -7V or >+7V to +12V, Figure 17		-	740	950	mV

Test Conditions: $V_{CC} = 3.0V$ to $3.6V$; Typicals are at $T_A = +25^{\circ}C$; unless otherwise specified^[1]. **Boldface limits apply across the operating temperature range, $-55^{\circ}C$ to $+125^{\circ}C$.** (Cont.)

Parameter	Symbol	Test Conditions	Min ^[2]	Typ ^[3]	Max ^[2]	Unit
Input Threshold Voltage (Falling)	V_{THF}	LBK = 0V, RS = 0V, 10k, 50k, (dominant to recessive), Common Mode Voltage Range: -2V to +7V, Figure 17	500	650	-	mV
		LBK = 0V, RS = 0V, 10k, 50k, (dominant to recessive), Common Mode Voltage Range: <-2V to -7V or >+7V to +12V, Figure 17	450	650	-	mV
Input Hysteresis	V_{HYS}	$(V_{THR} - V_{THF})$, RS = 0V, 10k, 50k	40	90	-	mV
Listen Mode Input Threshold Voltage (Rising)	V_{THRLM}	RS = V_{CC} , (recessive to dominant), Figure 17	-	990	1150	mV
Listen Mode Input Threshold Voltage (Falling)	V_{THFLM}	RS = V_{CC} , (dominant to recessive), Figure 17	525	890	-	mV
Listen Mode Input Hysteresis	V_{HYSLM}	$(V_{THR} - V_{THF})$, RS = V_{CC}	50	100	-	mV
Receiver Output High Voltage	V_{OH}	$I_O = -4mA$	2.4	$V_{CC} - 0.2$	-	V
Receiver Output Low Voltage	V_{OL}	$I_O = +4mA$	-	0.15	0.4	V
Input Current for CAN Bus	I_{CAN}	CANH or CANL at 12V, D = 3V, other bus pin at 0V, LBK = RS = 0V	-	435	500	μA
		CANH or CANL at 12V, D = 3V, $V_{CC} = 0V$, other bus pin at 0V, LBK = RS = 0V	-	150	250	μA
		CANH or CANL at -7V, D = 3V, other bus pin at 0V, LBK = RS = 0V	-400	-334	-	μA
		CANH or CANL at -7V, D = 3V, $V_{CC} = 0V$, other bus pin at 0V, LBK = RS = 0V	-150	-85	-	μA
Input Capacitance (CANH or CANL)	C_{IN}	Input to GND, D = 3V, LBK = RS = 0V	-	35	-	pF
Differential Input Capacitance	C_{IND}	Input to Input, D = 3V, LBK = RS = 0V	-	15	-	pF
Input Resistance (CANH or CANL)	R_{IN}	Input to GND, D = 3V, LBK = RS = 0V	20	40	50	k Ω
Differential Input Resistance	R_{IND}	Input to Input, D = 3V, LBK = RS = 0V	40	80	100	k Ω
Supply Current						
Supply Current, Listen Mode	$I_{CC(L)}$	RS = D = V_{CC} , LBK = 0V, $3.0V \leq V_{CC} \leq 3.6V$	-	1	2	mA
Supply Current, Dominant	$I_{CC(DOM)}$	D = LBK = RS = 0V, no load, $3.0V \leq V_{CC} \leq 3.6V$	-	5	7	mA
Supply Current, Recessive	$I_{CC(REC)}$	D = V_{CC} , LBK = RS = 0V, no load, $3.0V \leq V_{CC} \leq 3.6V$	-	2.6	5	mA
Cold Sparing Bus Current						
CANH Leakage Current	$I_{L(CANH)}$	$V_{CC} = 0.2V$, CANH = -7V or 12V, CANL = float, D = V_{CC} , RS = 0V	-25	-4	25	μA
CANL Leakage Current	$I_{L(CANL)}$	$V_{CC} = 0.2V$, CANL = -7V or 12V, CANH = float, D = V_{CC} , RS = 0V	-25	-4	25	μA
Driver Switching Characteristics						
Propagation Delay LOW to HIGH	t_{PDLH1}	RS = 0V, Figure 14	-	87	150	ns
Propagation Delay LOW to HIGH	t_{PDLH2}	RS = 10k Ω , Figure 14	-	535	850	ns
Propagation Delay LOW to HIGH	t_{PDLH3}	RS = 50k Ω , Figure 14	-	854	1400	ns
Propagation Delay HIGH to LOW	t_{PDHL1}	RS = 0V, Figure 14	-	90	155	ns
Propagation Delay HIGH to LOW	t_{PDHL2}	RS = 10k Ω , Figure 14	-	456	800	ns

Test Conditions: $V_{CC} = 3.0V$ to $3.6V$; Typicals are at $T_A = +25^\circ C$; unless otherwise specified^[1]. **Boldface limits apply across the operating temperature range, $-55^\circ C$ to $+125^\circ C$.** (Cont.)

Parameter	Symbol	Test Conditions	Min ^[2]	Typ ^[3]	Max ^[2]	Unit
Propagation Delay HIGH to LOW	t_{PDHL3}	RS = 50k Ω , Figure 14	-	719	1300	ns
Output Skew	t_{SKEW1}	RS = 0V, ($t_{PHL} - t_{PLH}$), Figure 14	-	3	50	ns
Output Skew	t_{SKEW2}	RS = 10k Ω , ($t_{PHL} - t_{PLH}$), Figure 14	-	79	510	ns
Output Skew	t_{SKEW3}	RS = 50k Ω , ($t_{PHL} - t_{PLH}$), Figure 14	-	135	800	ns
Output Rise Time	t_{r1}	RS = 0V, (fast speed - 1Mbps)	20	59	100	ns
Output Fall Time	t_{f1}	Figure 14	10	30	75	ns
Output Rise Time	t_{r2}	RS = 10k Ω , (medium speed - 250kbps)	200	386	780	ns
Output Fall Time	t_{f2}	Figure 14	175	318	500	ns
Output Rise Time	t_{r3}	RS = 50k Ω , (slow speed - 125kbps)	400	646	1400	ns
Output Fall Time	t_{f3}	Figure 14	300	627	1000	ns
Total Loop Delay, Driver Input to Receiver Output, Recessive to Dominant	$t_{(LOOP1)}$	RS = 0V, Figure 21	-	126	210	ns
		RS = 10k Ω , Figure 21	-	574	875	ns
		RS = 50k Ω , Figure 21	-	852	1400	ns
Total Loop Delay, Driver Input to Receiver Output, Dominant to Recessive	$t_{(LOOP2)}$	RS = 0V, Figure 21	-	137	270	ns
		RS = 10k Ω , Figure 21	-	494	825	ns
		RS = 50k Ω , Figure 21	-	725	1300	ns
Listen to Valid Dominant Time	t_{L-DOM}	Figure 19	-	4	15	μs
Receiver Switching Characteristics						
Propagation Delay LOW to HIGH	t_{PLH}	Figure 17	-	52	110	ns
Propagation Delay HIGH to LOW	t_{PHL}	Figure 17	-	51	110	ns
Rx Skew	t_{SKEW1}	$ t_{PHL} - t_{PLH} $, Figure 17	-	1	35	ns
Rx Rise Time	t_r	Figure 17	-	2	-	ns
Rx Fall Time	t_f	Figure 17	-	2	-	ns
LBK Delay I/O to Rx Output	t_{LBK}	Figure 23	-	42	75	ns
RS Pin Characteristics						
RS Input Current	$I_{RS(H)}$	RS = $0.75 \times V_{CC}$	-10	-0.2	-	μA
	$I_{RS(L)}$	$V_{RS} = 0V$	-450	-125	0	μA

1. All currents into device pins are positive; all currents out of device pins are negative. All voltages are referenced to device ground unless otherwise specified.
2. Compliance to datasheet limits are assured by one or more methods: production test, characterization, and/or design.
3. Typical values are at 3.3V. Parameters with a single entry in the Typ column apply to 3.3V. Typical values shown are not guaranteed.
4. Parameter included in functional testing.

2.6 Equivalent Input and Output Schematic Diagrams

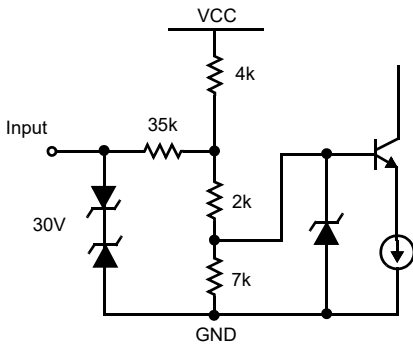


Figure 4. CANH and CANL Inputs

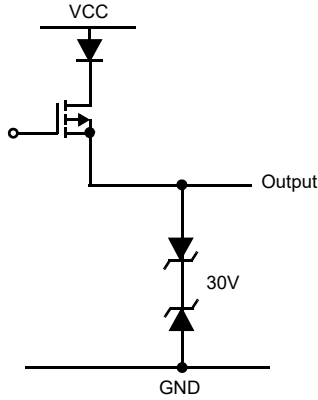


Figure 5. CANH Output

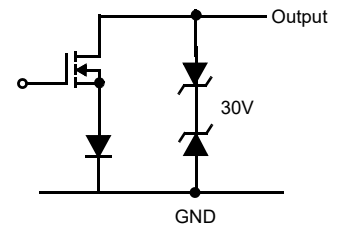


Figure 6. CANL Output

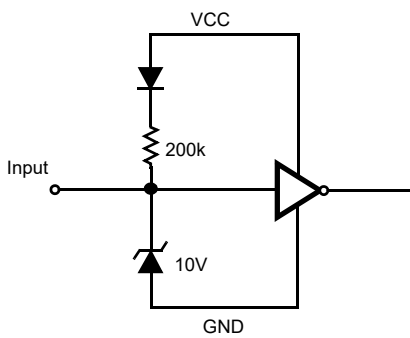


Figure 7. D Input

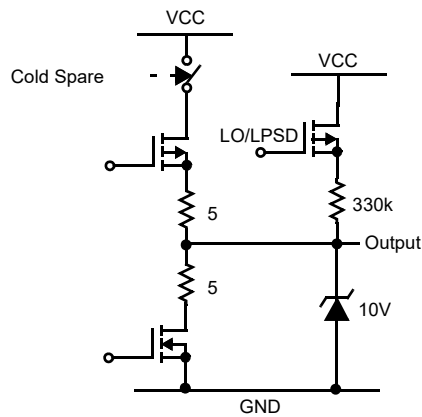


Figure 8. R Output

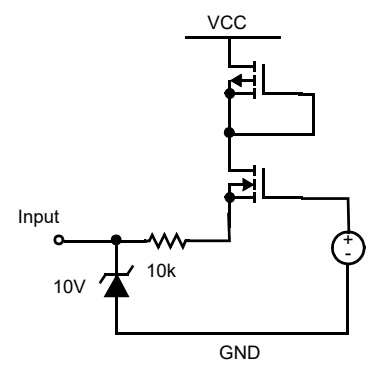


Figure 9. RS Input

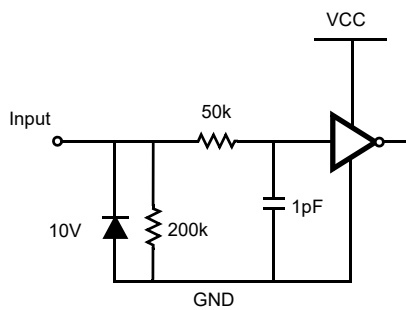


Figure 10. LBK Input

2.7 Test Circuits and Waveforms

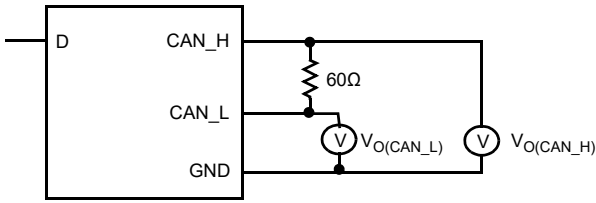


Figure 11. Driver Test Circuit

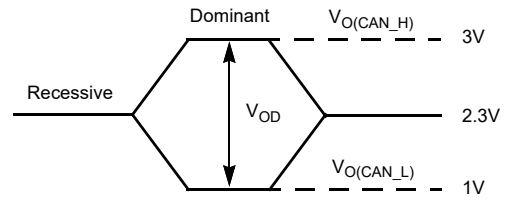


Figure 12. Driver Bus Voltage Definitions

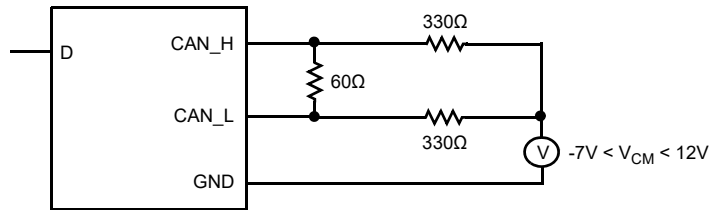
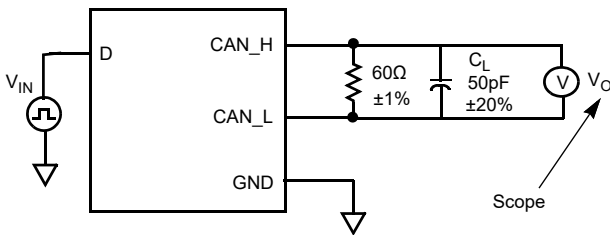


Figure 13. Driver Common-Mode Circuit



$V_{IN} = 125\text{kHz}$, 0V to V_{CC} , Duty Cycle 50%, $t_r = t_f \leq 6\text{ns}$, $Z_O = 50\Omega$
 C_L includes fixture and instrumentation capacitance.

Figure 14. Driver Timing Test Circuit

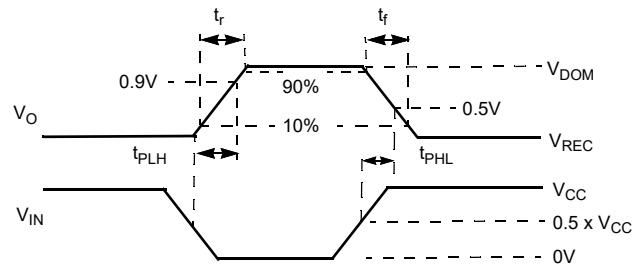


Figure 15. Driver Timing Measurement Points

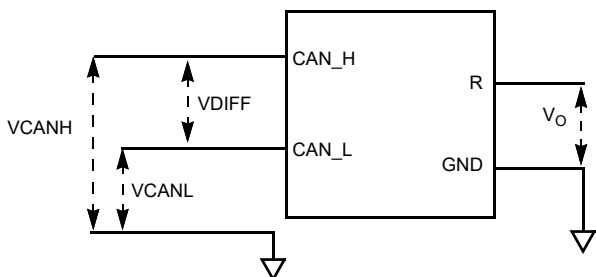
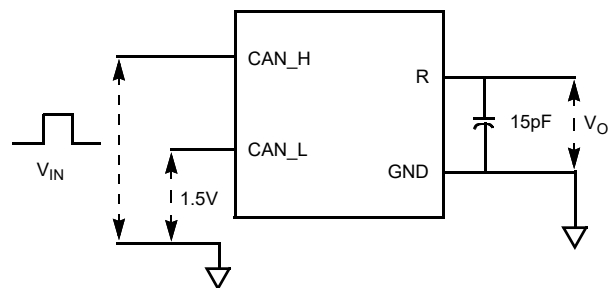


Figure 16. Receiver Voltage Definitions



$V_{IN} = 125\text{kHz}$, Duty Cycle 50%, $t_r = t_f = 6\text{ns}$, $Z_O = 50\Omega$
 C_L includes test setup capacitance

Figure 17. Receiver Test Circuit

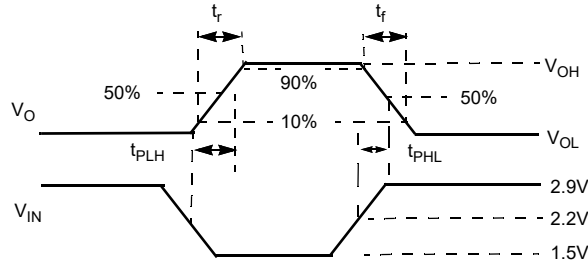
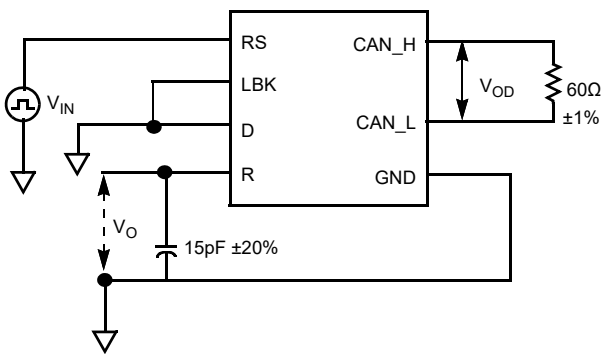


Figure 18. Receiver Test Measurement Points

Table 1. Differential Input Voltage Threshold Test

Input		Output	Measured
VCANH	VCANL	R	VDIFF
-6.1V	-7V	L	900mV
12V	11.1V	L	900mV
-1V	-7V	L	6V
12V	6V	L	6V
-6.5V	-7V	H	500mV
12V	11.5V	H	500mV
-7V	-1V	H	6V
6V	12V	H	6V
Open	Open	H	X



$V_{IN} = 125\text{kHz}$, 0V to V_{CC} , Duty Cycle 50%, $t_r = t_f \leq 6\text{ns}$

Figure 19. Listen to Valid Dominant Time Test Circuit

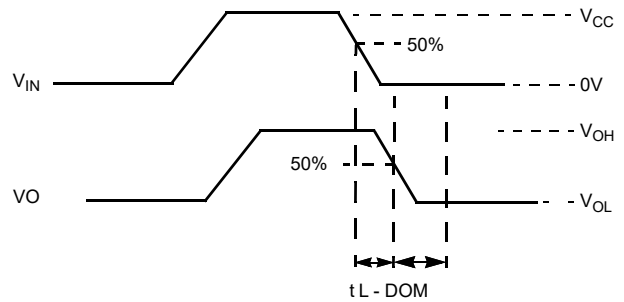


Figure 20. Listen to Valid Dominant Time Measurement Points

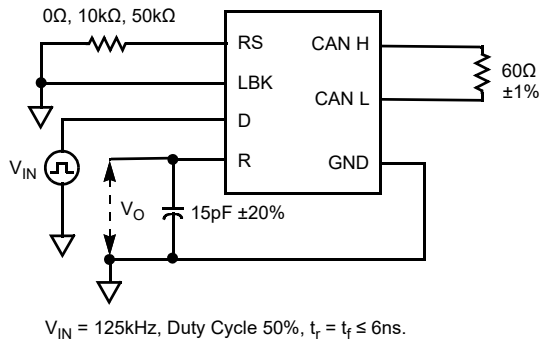


Figure 21. Total Loop Delay Test Circuit

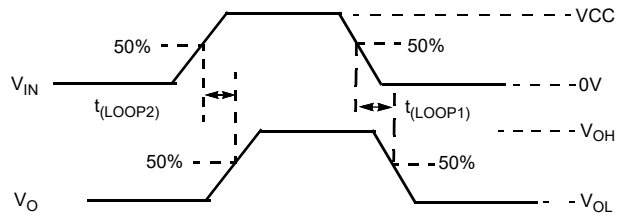


Figure 22. Total Loop Delay Measurement Points

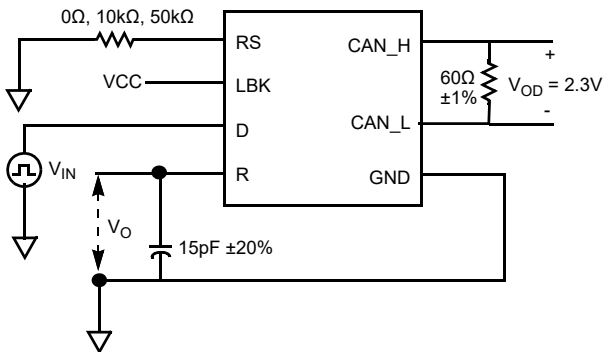


Figure 23. Loop Back Delay to Dominant Time Test Circuit

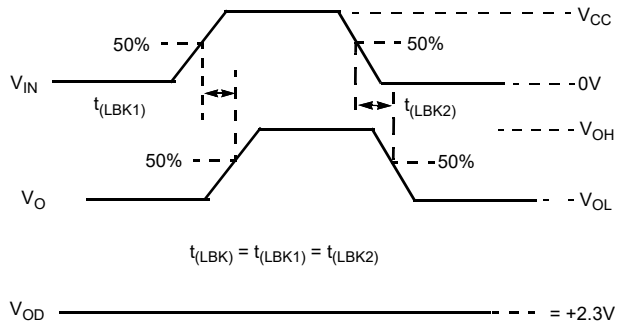


Figure 24. Loop Back Delay to Dominant Measurement Points

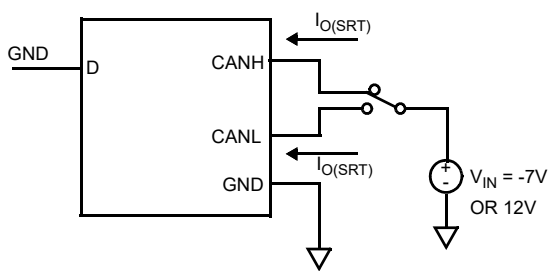


Figure 25. Output Short-Circuit Current Test Circuit

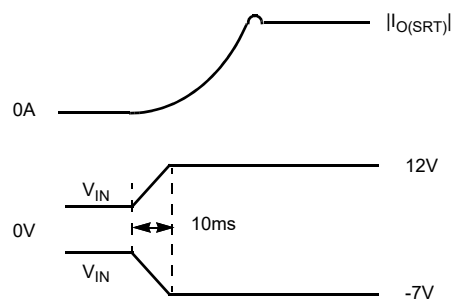


Figure 26. Output Short-Circuit Current Waveforms

3. Typical Performance Curves

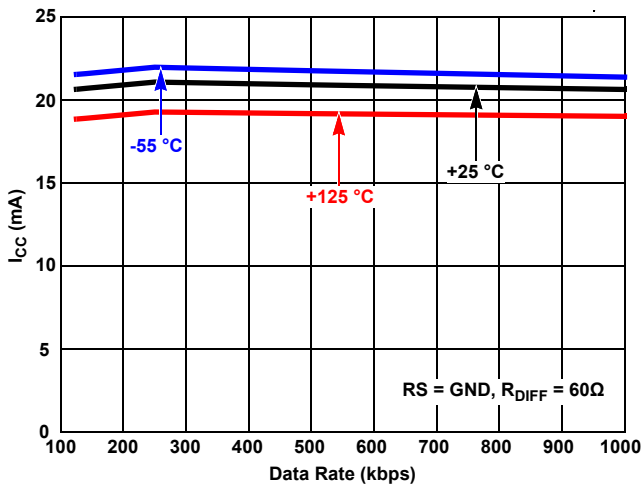


Figure 27. Supply Current vs Fast Data Rate vs Temperature

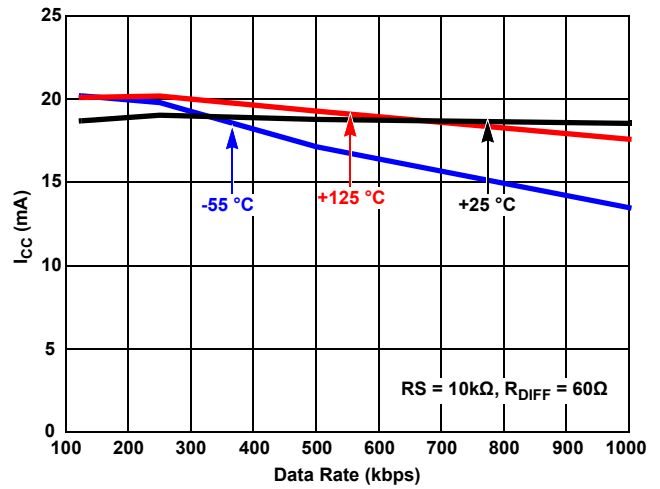


Figure 28. Supply Current vs Medium Data Rate vs Temperature

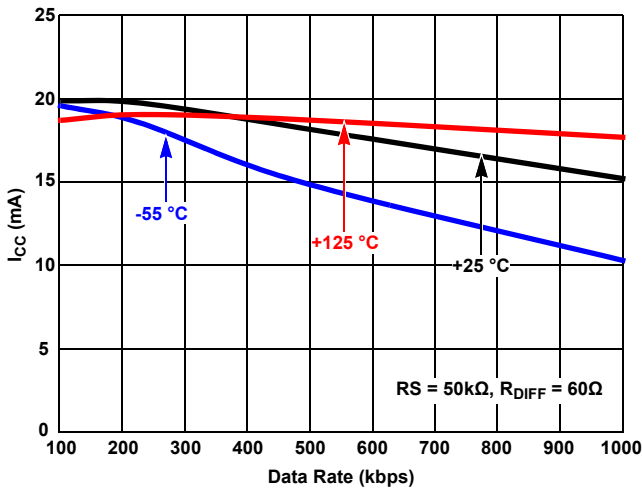


Figure 29. Supply Current vs Slow Data Rate vs Temperature

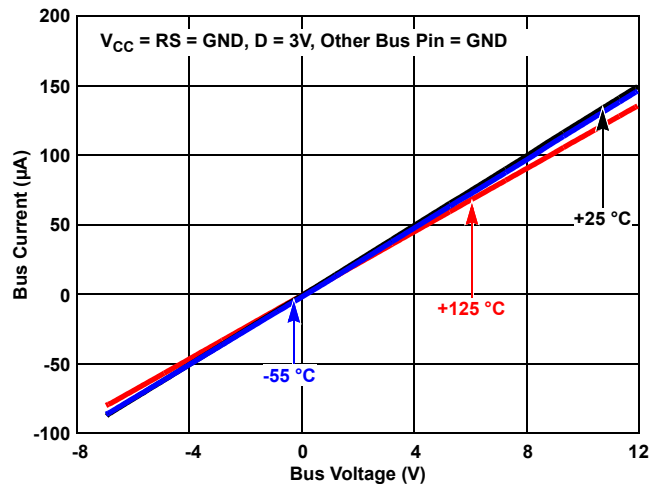


Figure 30. Bus Pin Leakage vs VCM at $V_{CC} = 0V$

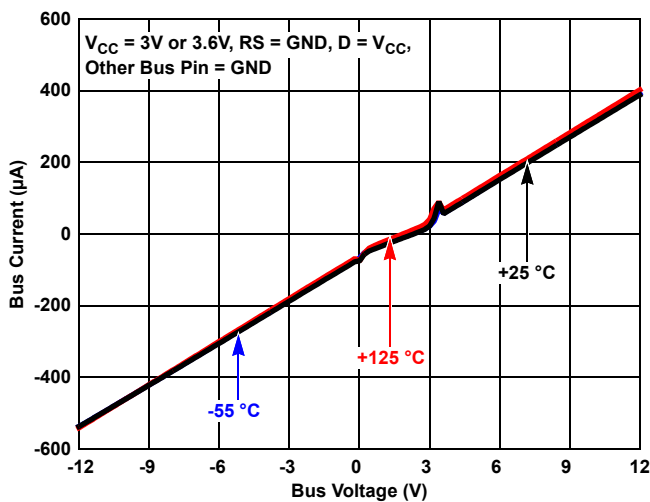


Figure 31. Bus Pin Leakage vs $\pm 12V$ VCM

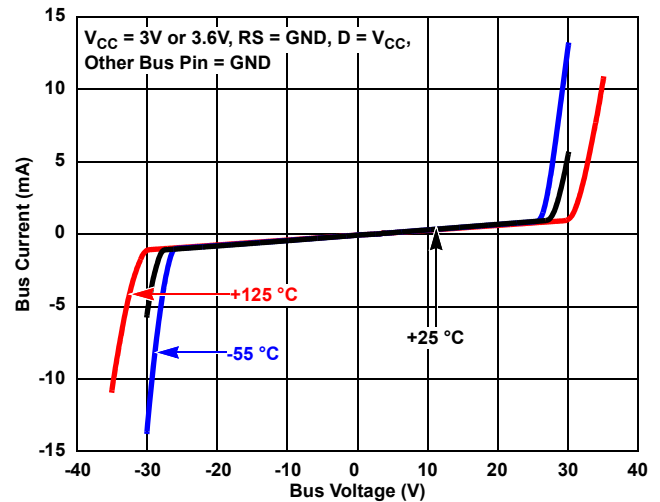


Figure 32. Bus Pin Leakage vs $\pm 35V$ VCM

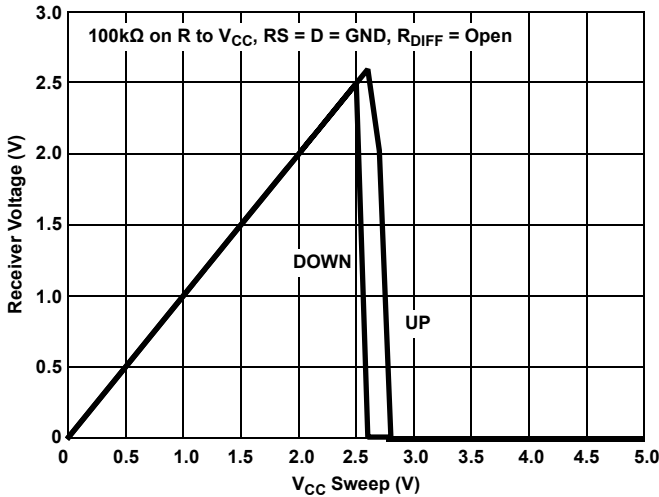


Figure 33. V_{CC} Undervoltage Lockout

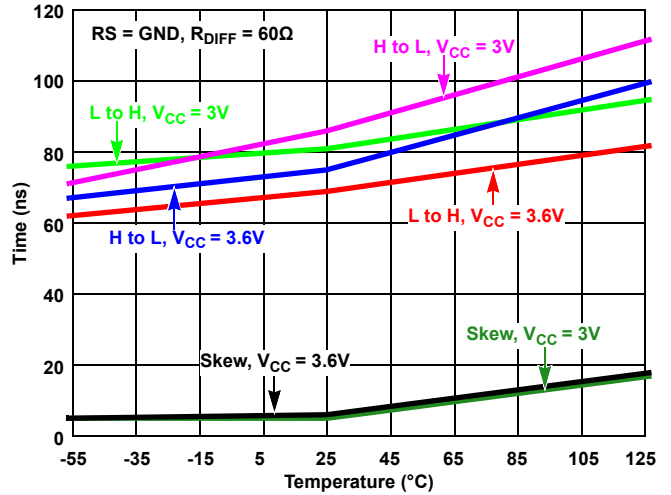


Figure 34. Transmitter Propagation Delay and Skew vs Temperature at Fast Speed

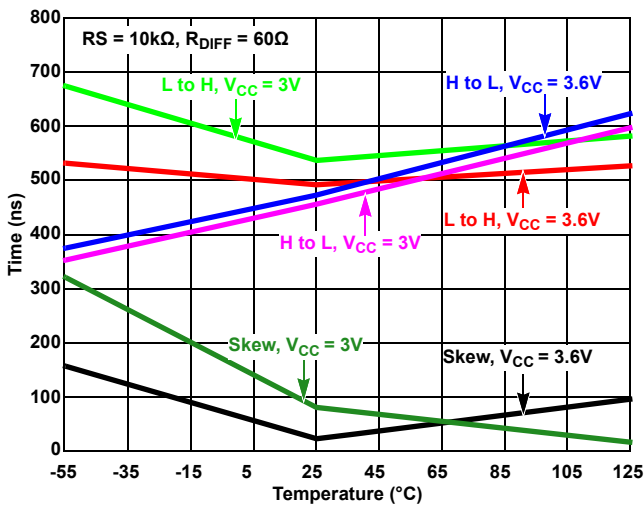


Figure 35. Transmitter Propagation Delay and Skew vs Temperature at Medium Speed

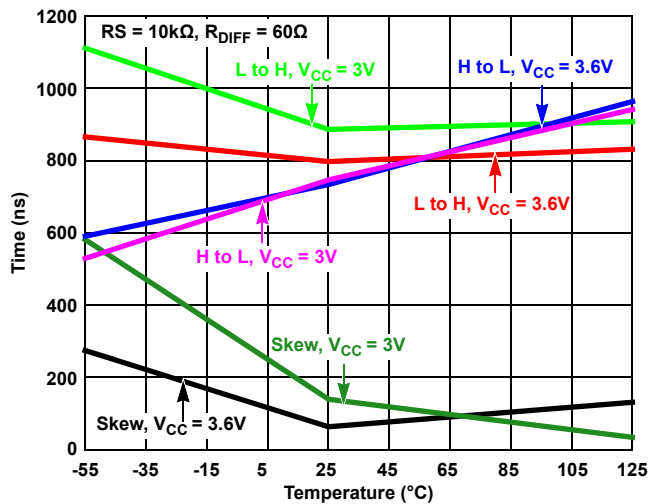


Figure 36. Transmitter Propagation Delay and Skew vs Temperature at Slow Speed

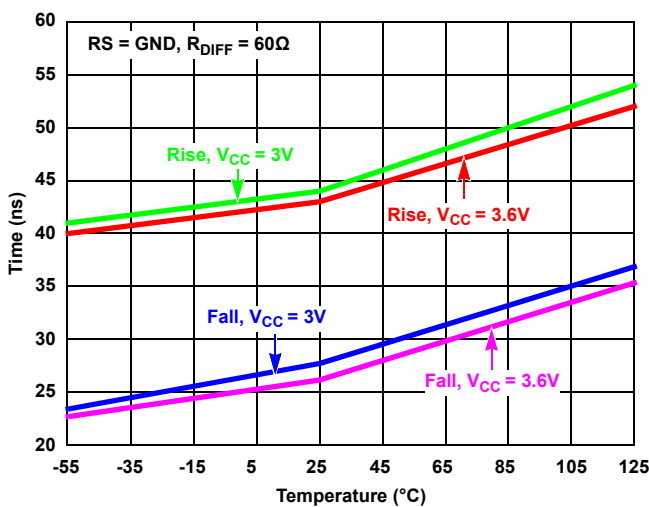


Figure 37. Transmitter Rise and Fall Times vs Temperature at Fast Speed

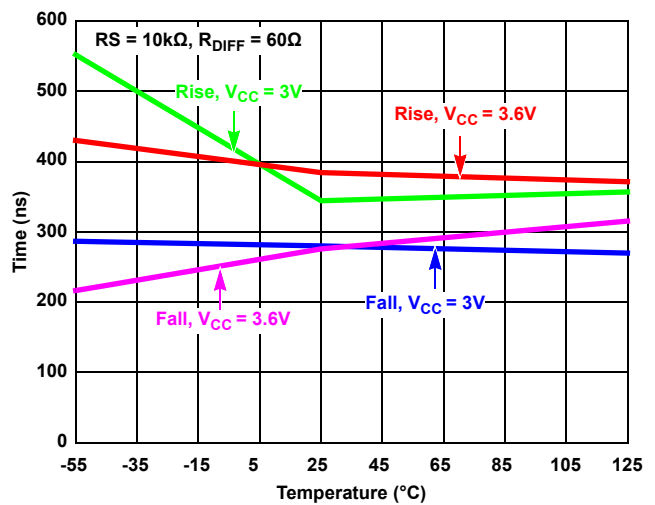


Figure 38. Transmitter Rise and Fall Times vs Temperature at Medium Speed

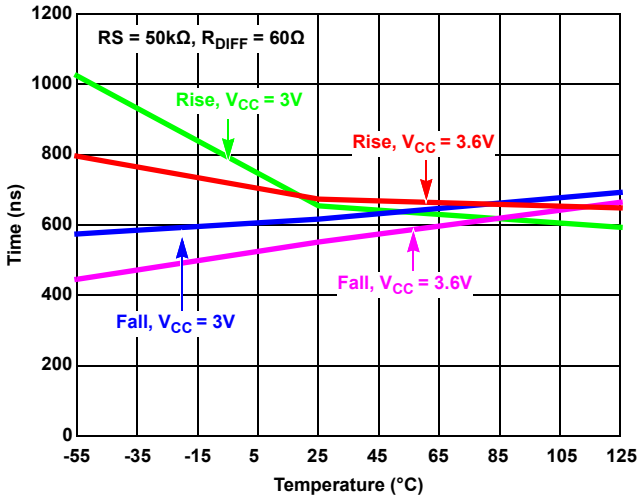


Figure 39. Transmitter Rise and Fall Times vs Temperature at Slow Speed

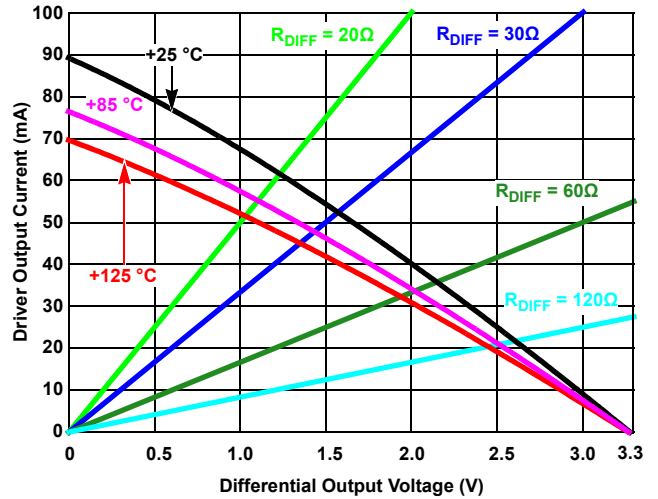


Figure 40. Driver Output Current vs Differential Output Voltage

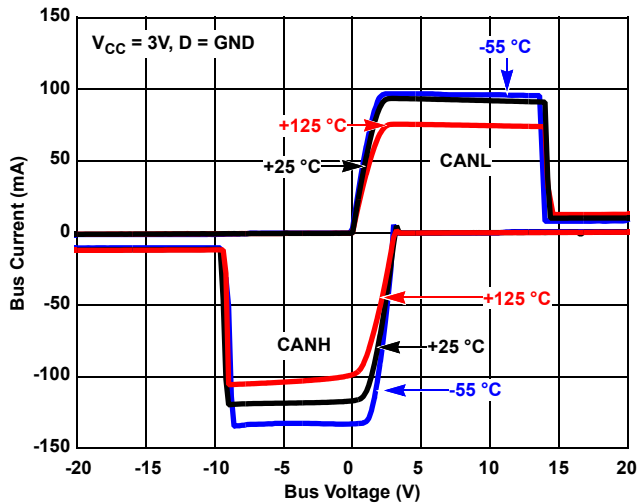


Figure 41. Driver Output Current vs Short-Circuit Voltage vs Temperature

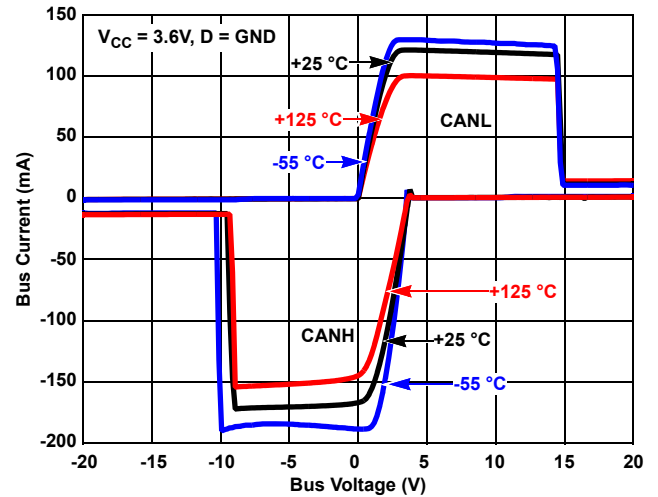


Figure 42. Driver Output Current vs Short-Circuit Voltage vs Temperature

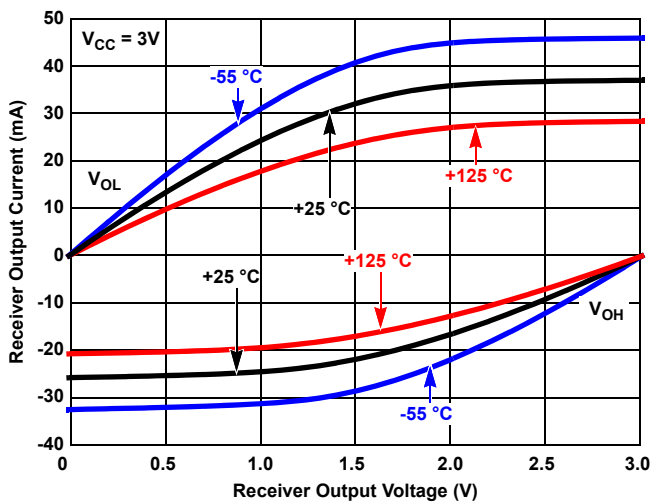


Figure 43. Receiver Output Current vs Receiver Output Voltage at $V_{CC} = 3V$

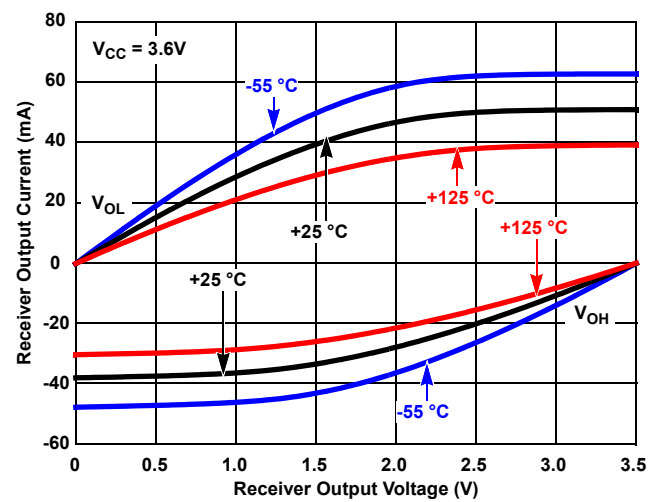


Figure 44. Receiver Output Current vs Receiver Output Voltage at $V_{CC} = 3.6V$

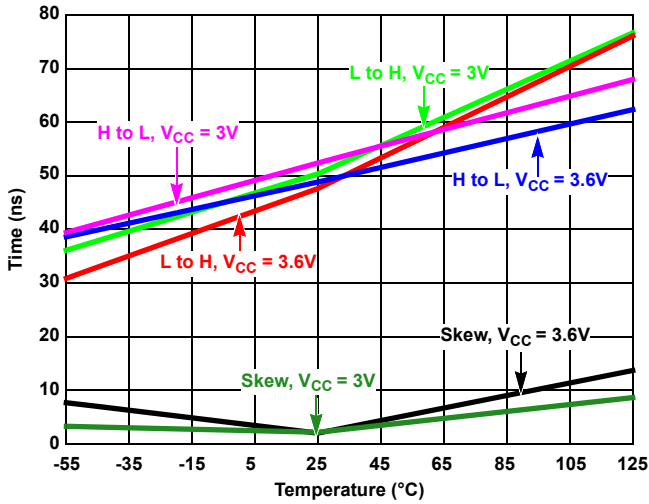


Figure 45. Receiver Propagation Delay and Skew vs Temperature

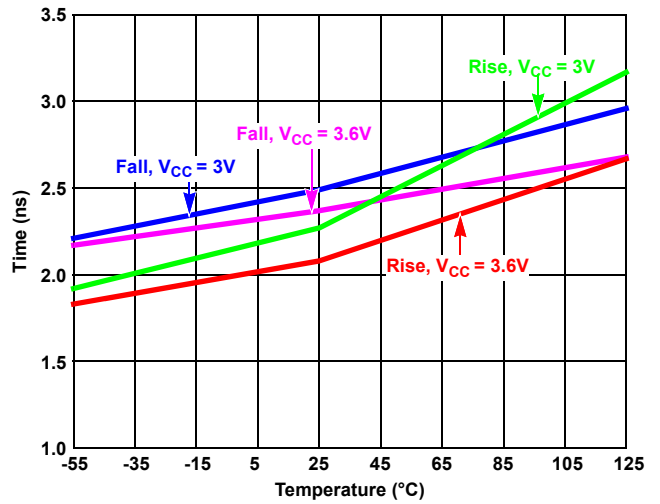


Figure 46. Receiver Rise and Fall Times vs Temperature

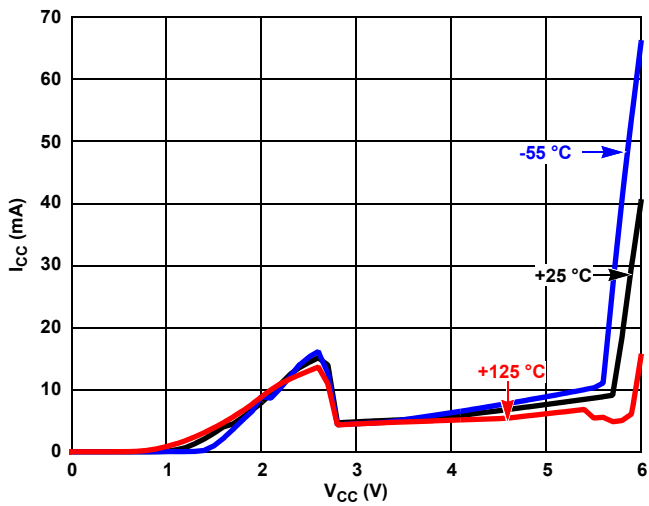


Figure 47. Supply Current vs Supply Voltage vs Temperature

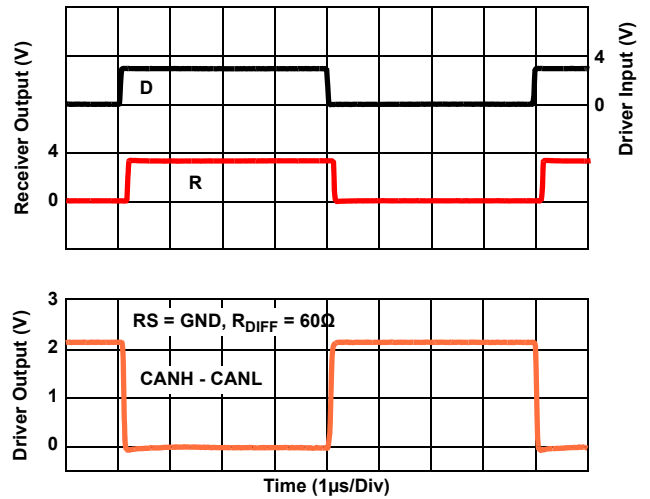


Figure 48. Fast Driver and Receiver Waveforms

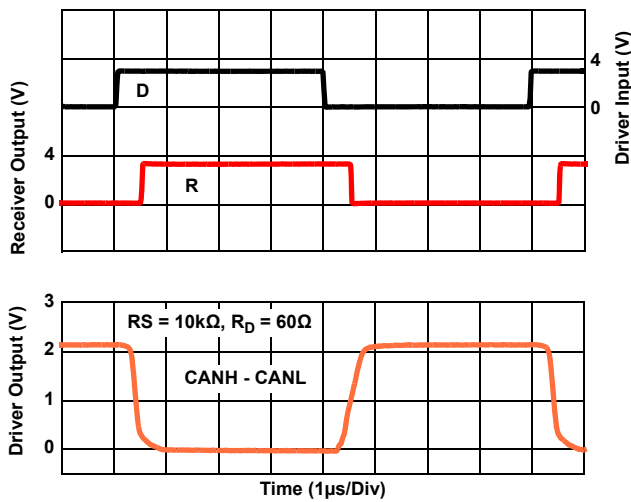


Figure 49. Medium Driver and Receiver Waveforms

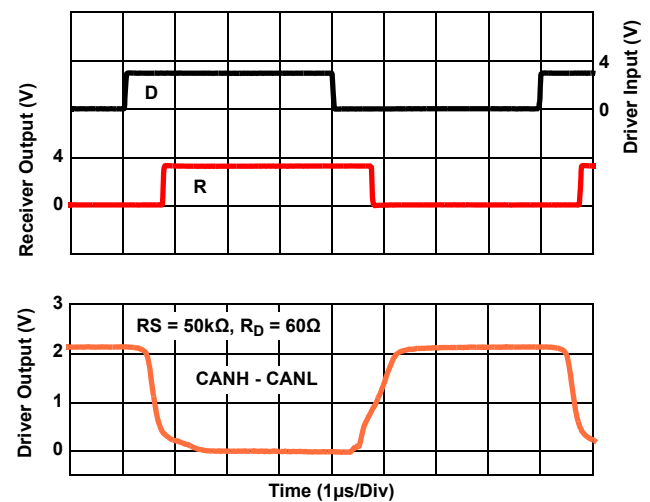


Figure 50. Slow Driver and Receiver Waveforms

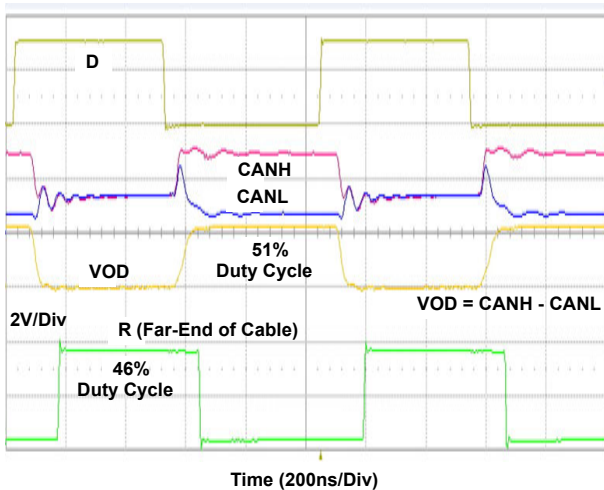


Figure 51. 2Mbps CAN Transceiver Waveforms Over 10ft Cable

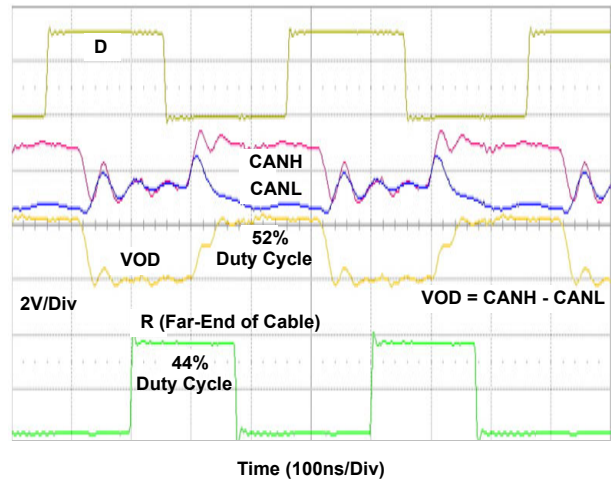


Figure 52. 5Mbps CAN Transceiver Waveforms Over 10ft Cable

4. Functional Description

4.1 Overview

The ISL71026M is a 3.3V radiation tolerant CAN transceiver that is compatible with the ISO11898-2 standard for use in Controller Area Network (CAN) serial communication systems.

The device performs transmit and receive functions between the CAN controller and the CAN differential bus. It can transmit and receive at bus speeds of up to 5Mbps. It is designed to operate over a common-mode range of -7V to +12V with a maximum of 120 nodes. The device is capable of withstanding $\pm 20V$ on the CANH and CANL bus pins.

4.2 Slope Adjustment

The output driver rise and fall time has three distinct selections that can be chosen by using a resistor from the RS pin to GND. Connecting the RS pin directly to GND results in output switching times that are the fastest, limited only by the drive capability of the output stage. $RS = 10k\Omega$ provides for a typical slew rate of $8V/\mu s$ and $RS = 50k\Omega$ provides for a typical slew rate of $4V/\mu s$.

Putting a high logic level to the RS pin places the device in a low current listen mode. The protocol controller uses this mode to switch between low power listen mode and normal transmit mode.

4.3 Cable Length

The device can work per ISO11898 specification with a 40m cable and stub length of 0.3m and 60 nodes at 1Mbps. This is greater than the ISO requirement of 30 nodes. The cable type specified is twisted pair (shielded or unshielded) with a characteristic impedance of 120Ω . Resistors equal to this are to be terminated at both ends of the cable. Stubs should be kept as short as possible to prevent reflections.

4.4 Cold Spare

High reliability system designers implementing data communications must be sensitive to the potential for single point failures. To mitigate the risk of a failure they use redundant bus transceivers in parallel. In this arrangement both active and quiescent devices can be present simultaneously on the bus. The quiescent devices are powered down for cold spare and do not affect the communication of the other active nodes.

The powered down transceiver ($V_{CC} < 200\text{mV}$) has a resistance between the CANH or CANL bus pin and the V_{CC} supply rail of at least $480\text{k}\Omega$ with a typical resistance of $2\text{M}\Omega$. The resistance between CANH and CANL of a powered-down transceiver has a typical resistance of $80\text{k}\Omega$.

The receiver output (R pin) of a powered-down transceiver ($V_{CC} < 200\text{mV}$) is internally connected to ground. Therefore, the receiver outputs of an active transceiver and a cold spare transceiver cannot be connected together in the redundant application.

4.5 Listen Mode

When a high level is applied to the RS pin, the device enters a low power listen mode. The driver of the transceiver is switched off to conserve power while the receiver remains active. In listen mode the transceiver draws 2mA (max) of current. A low level on the RS pin brings the device back to normal operation.

4.6 Loopback Mode

When a high level is applied to the LBK pin, the device enters the loopback state. The transceiver CANH and CANL pins are disconnected from the bus. The driver and receiver circuitry of the transceiver remain active to allow for diagnostic testing of the node.

4.7 Using 3.3V Devices in 5V Systems

The differential voltage of the 3.3V and 5V devices, is the same and the recessive common-mode output is the same. The dominant common-mode output voltage is slightly lower than the 5V counterparts. The receiver specifications are also the same. Though the electrical parameters appear compatible it is advised that necessary system testing be performed to verify interchangeable operation.

5. Radiation Tolerance

The ISL71026M is a radiation tolerant device for commercial space applications, Low Earth Orbit (LEO) applications, high altitude avionics, launch vehicles, and other harsh environments. This device's response to Total Ionizing Dose (TID) radiation effects and Single-Event Effects (SEE) has been measured, characterized, and reported in the following sections. The TID performance of the ISL71026MNZ is not guaranteed through radiation acceptance testing. The ISL71026M30NZ is radiation lot acceptance tested (RLAT) to $30\text{krad}(\text{Si})$, and the ISL71026M50NZ is RLAT to $50\text{krad}(\text{Si})$. The SEE characterized performance is not guaranteed.

5.1 Total Ionizing Dose (TID) Testing

5.1.1 Introduction

This test was conducted to determine the sensitivity of the part to the total dose environment. Down points were $0\text{krad}(\text{Si})$, $10\text{krad}(\text{Si})$, $30\text{krad}(\text{Si})$, and $50\text{krad}(\text{Si})$. The irradiations were followed by a biased anneal for 168 hours at $+100^\circ\text{C}$.

Total dose testing was performed using a Hopewell Designs N40 panoramic ^{60}Co irradiator. The irradiations were performed at $0.00875\text{rad}(\text{Si})/\text{s}$. A PbAl box was used to shield the test fixture and devices under test against low energy secondary gamma radiation.

The characterization matrix consisted of 24 samples irradiated under bias and 24 samples irradiated with all pins grounded. Six control units were used to ensure repeatable data. Three different wafers were used. The bias configuration is shown in [Figure 53](#).

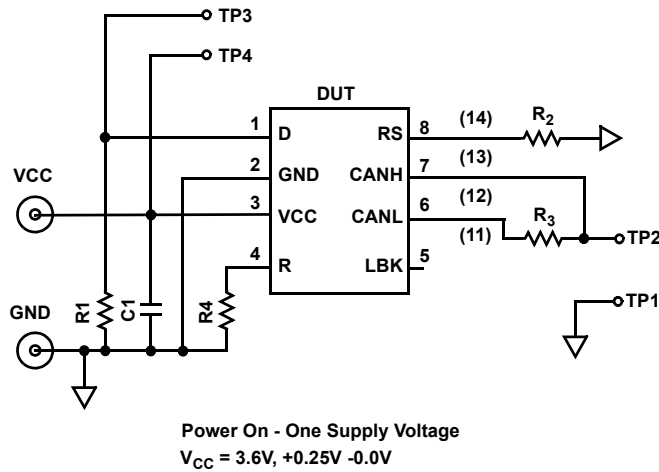


Figure 53. Irradiation Bias Configuration and Power Supply Sequencing for the ISL71026M

All electrical testing was performed outside the irradiator using the production Automated Test Equipment (ATE), with data logging at each down point (including anneal). Downpoint electrical testing was performed at room temperature.

5.1.2 Results

Table 2 summarizes the attributes data. “Bin 1” indicates a device that passes all datasheet specification limits.

Table 2. ISL71026M Total Dose Test Attributes Data

Dose Rate (mrad(Si)/s)	Bias	Sample Size	Down Point	Bin 1	Rejects
8.75	Figure 53	24	Pre-rad	24	
			10krad(Si)	24	0
			30krad(Si)	24	0
			50krad(Si)	24	0
			Anneal	24	0
8.75	Grounded	24	Pre-rad	24	
			10krad(Si)	24	0
			30krad(Si)	24	0
			50krad(Si)	24	0
			Anneal	24	0

The plots in Figure 54 through Figure 59 show data for key parameters at all down points. The plots show the average as a function of total dose for each of the irradiation conditions; we chose to use the average because of the relatively large sample sizes. All parts showed excellent stability over irradiation.

Table 3 shows the average of other key parameters with respect to total dose in table form.

5.2 Data Plots

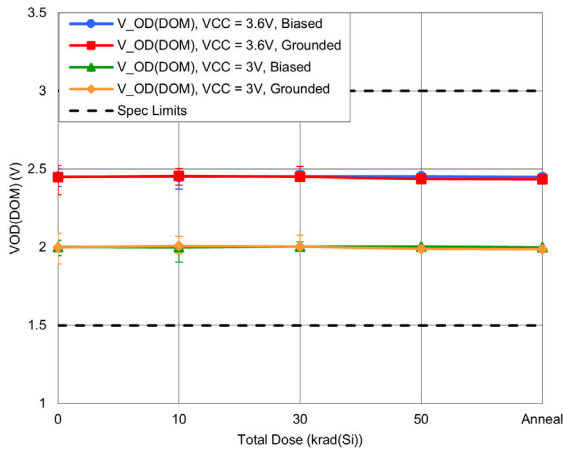


Figure 54. Dominant Output Differential Voltage - VOD(DOM) vs TID

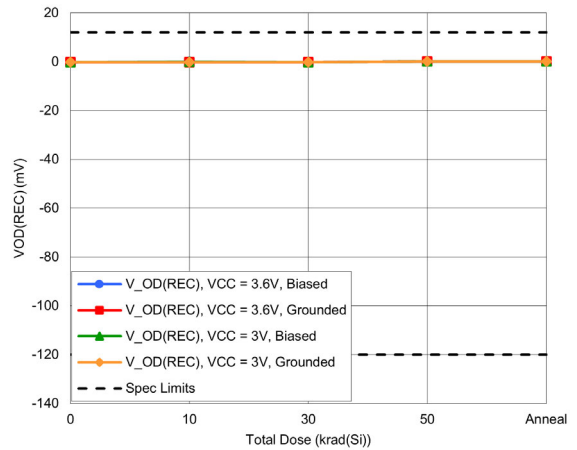


Figure 55. Recessive Output Differential Voltage - VOD(REC) vs TID

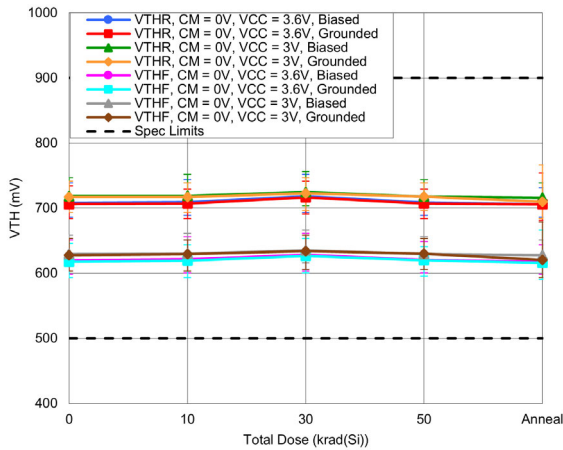


Figure 56. Receiver Input Threshold Voltage Rising/Falling vs TID

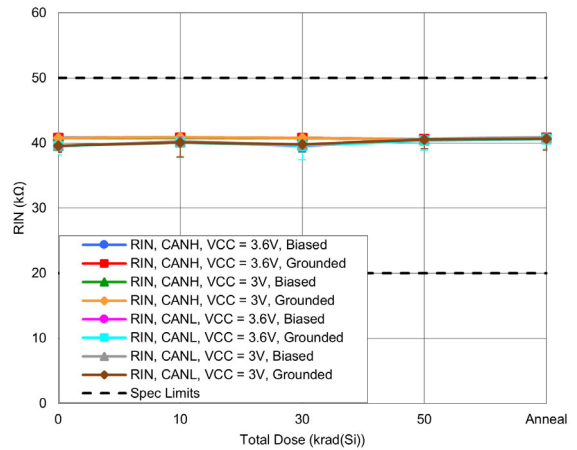


Figure 57. Receiver Input Resistance vs TID

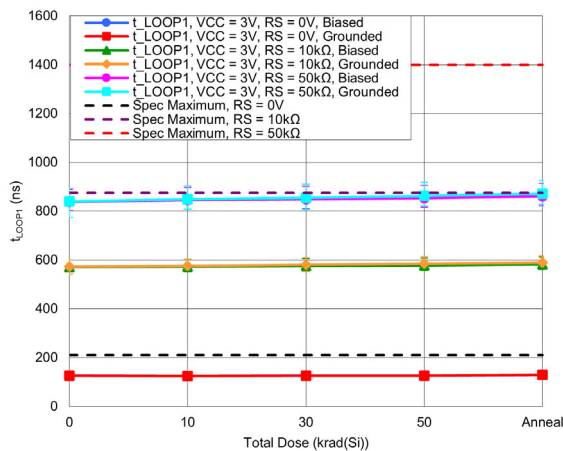


Figure 58. Total Loop Delay (Recessive to Dominant) vs TID

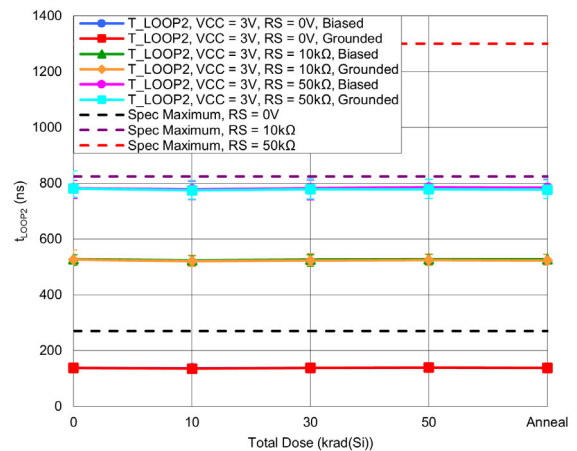


Figure 59. Total Loop Delay (Dominant to Recessive) vs TID

5.2.1 Conclusion

ATE characterization testing showed no rejects to the datasheet limits at all down points. Variables data for selected parameters is presented in [Figure 54](#) through [Figure 59](#). No differences between biased and unbiased irradiation were noted, and the part is not considered bias sensitive.

Table 3. ISL71026M Response of Key Parameters vs TID

Parameter	Symbol	Condition	Bias	Pre-Rad Value	10krad (Si)	30krad (Si)	50krad (Si)	Anneal	Unit
Dominant Output Differential Voltage D = 0V, RS = 0V	V _{OD(DOM)}	VCC = 3.0V	Biased	2.00	2.00	2.00	2.00	2.00	V
			Grounded	2.00	2.01	2.00	1.99	1.99	
		VCC = 3.6V	Biased	2.45	2.45	2.45	2.45	2.45	
			Grounded	2.45	2.46	2.45	2.44	2.43	
		Limit -	-	1.5	1.5	1.5	1.5	1.5	
Limit +	-	3	3	3	3	3			
Recessive Output Differential Voltage D = 3V, RS = 0V	V _{OD(REC)}	VCC = 3.0V	Biased	-0.14	-0.08	-0.17	0.09	0.08	mV
			Grounded	-0.14	-0.12	-0.17	0.11	0.08	
		VCC = 3.6V	Biased	-0.15	-0.07	-0.15	0.09	0.06	
			Grounded	-0.14	-0.12	-0.17	0.08	0.09	
		Limit -	-	-120	-120	-120	-120	-120	
Limit +	-	12	12	12	12	12			
Recessive Output Differential Voltage D = 3V, RS = 0V, No Load	V _{OD(REC)}	VCC = 3.0V	Biased	-45.79	-36.55	-40.40	-27.87	-24.89	mV
			Grounded	-46.09	-39.61	-40.47	-28.54	-24.25	
		VCC = 3.6V	Biased	-42.92	-35.08	-38.61	-25.42	-22.07	
			Grounded	-43.53	-37.31	-38.82	-26.57	-21.96	
		Limit -	-	-500	-500	-500	-500	-500	
Limit +	-	50	50	50	50	50			
Input Threshold Voltage (Rising) LBK = 0V, RS = 0V, 10k, 50k, (recessive to dominant) CM Voltage Range: (-2V to +7V)	V _{THR}	VCC = 3.0V	Biased	718.63	718.84	724.50	717.69	715.81	mV
			Grounded	716.96	717.06	723.03	717.59	709.74	
		VCC = 3.6V	Biased	708.17	709.42	718.22	708.48	705.97	
			Grounded	706.18	706.80	716.65	707.22	705.76	
		Limit -	-	-	-	-	-	-	
Limit +	-	900	900	900	900	900			
Input Threshold Voltage (Falling) LBK = 0V, RS = 0V, 10k, 50k, (dominant to recessive) CM Voltage Range: (-2V to +7V)	V _{THF}	VCC = 3.0V	Biased	629.65	630.17	634.99	629.33	627.97	mV
			Grounded	627.97	629.23	634.15	630.17	620.44	
		VCC = 3.6V	Biased	619.81	621.38	628.39	620.23	617.82	
			Grounded	617.40	619.07	626.61	620.12	615.83	
		Limit -	-	500	500	500	500	500	
Limit +	-	-	-	-	-	-			
Input Hysteresis (V _{THR} - V _{THF}), RS = 0V, 10k, 50k	V _{HYS}	VCC = 3.0V	Biased	88.99	88.67	89.51	88.36	87.83	mV
			Grounded	88.99	87.84	88.88	87.42	89.30	
		VCC = 3.6V	Biased	88.36	88.04	89.82	88.25	88.15	
			Grounded	88.78	87.73	90.03	87.10	89.93	
		Limit -	-	40	40	40	40	40	
Limit +	-	-	-	-	-	-			

Table 3. ISL71026M Response of Key Parameters vs TID (Cont.)

Parameter	Symbol	Condition	Bias	Pre-Rad Value	10krad (Si)	30krad (Si)	50krad (Si)	Anneal	Unit
Differential Input Resistance Input to Input, D = 3V, LBK = RS = 0V	R _{IND}	VCC = 3.0V	Biased	78.67	79.35	78.72	79.53	79.77	kΩ
			Grounded	78.48	79.20	78.63	79.47	79.73	
		VCC = 3.6V	Biased	78.56	79.30	78.58	79.50	79.83	
			Grounded	78.51	79.20	78.69	79.44	79.71	
		Limit -	-	40	40	40	40	40	
Limit +	-	100	100	100	100	100			
Supply Current Dominant D = LBK = RS = 0V, No Load	I _{CC(DOM)}	VCC = 3.0V	Biased	4.53	4.52	4.51	4.57	4.47	mA
			Grounded	4.50	4.48	4.51	4.57	4.64	
		VCC = 3.6V	Biased	4.81	4.77	4.78	4.84	4.73	
			Grounded	4.78	4.76	4.78	4.84	4.92	
		Limit -	-	-	-	-	-	-	
Limit +	-	7	7	7	7	7			
Supply Current Recessive D = V _{CC} , LBK = RS = 0V, No Load	I _{CC(REC)}	VCC = 3.0V	Biased	2.36	2.42	2.34	2.37	2.29	mA
			Grounded	2.35	2.45	2.34	2.37	2.13	
		VCC = 3.6V	Biased	2.62	2.71	2.60	2.64	2.54	
			Grounded	2.62	2.71	2.59	2.64	2.40	
		Limit -	-	-	-	-	-	-	
Limit +	-	5	5	5	5	5			
Propagation Delay LOW to HIGH RS = 0V	t _{PDLH1}	VCC = 3.0V	Biased	87.71	87.81	88.00	87.89	89.68	ns
			Grounded	87.82	87.75	88.14	88.04	90.47	
		VCC = 3.6V	Biased	69.57	69.42	69.62	69.83	70.96	
			Grounded	69.83	69.57	69.82	70.07	71.46	
		Limit -	-	-	-	-	-	-	
Limit +	-	150	150	150	150	150			
Propagation Delay LOW to HIGH RS = 10kΩ	t _{PDLH2}	VCC = 3.0V	Biased	543.40	544.89	548.12	547.77	552.52	ns
			Grounded	549.16	551.29	553.97	554.96	560.48	
		VCC = 3.6V	Biased	488.29	489.81	492.22	492.49	496.53	
			Grounded	492.76	494.73	497.01	498.83	503.91	
		Limit -	-	-	-	-	-	-	
Limit +	-	850	850	850	850	850			
Propagation Delay LOW to HIGH RS = 50kΩ	t _{PDLH3}	VCC = 3.0V	Biased	865.93	871.79	876.84	878.36	886.19	ns
			Grounded	874.14	879.34	884.51	889.21	898.50	
		VCC = 3.6V	Biased	776.39	781.80	786.88	786.08	793.68	
			Grounded	786.57	789.70	794.50	795.89	805.88	
		Limit -	-	-	-	-	-	-	
Limit +	-	1400	1400	1400	1400	1400			
Propagation Delay HIGH to LOW RS = 0V	t _{PDLH1}	VCC = 3.0V	Biased	89.39	88.73	89.06	88.96	88.29	ns
			Grounded	90.14	89.46	89.36	80.26	88.57	
		VCC = 3.6V	Biased	75.19	74.63	74.71	74.54	73.86	
			Grounded	76.14	75.23	74.89	74.70	73.90	
		Limit -	-	-	-	-	-	-	
Limit +	-	155	155	155	155	155			

Table 3. ISL71026M Response of Key Parameters vs TID (Cont.)

Parameter	Symbol	Condition	Bias	Pre-Rad Value	10krad (Si)	30krad (Si)	50krad (Si)	Anneal	Unit
Propagation Delay HIGH to LOW RS = 10kΩ	t _{PDHL2}	VCC = 3.0V	Biased	483.56	480.97	482.66	483.33	482.48	ns
			Grounded	481.84	479.45	479.76	480.75	479.69	
		VCC = 3.6V	Biased	499.21	495.94	497.86	498.45	497.09	
			Grounded	497.97	494.49	494.38	495.41	493.63	
		Limit -	-	-	-	-	-	-	
Limit +	-	800	800	800	800	800	800		
Propagation Delay HIGH to LOW RS = 50kΩ	t _{PDHL3}	VCC = 3.0V	Biased	767.50	763.91	767.35	770.38	769.30	ns
			Grounded	764.21	761.03	763.26	766.01	763.67	
		VCC = 3.6V	Biased	799.17	795.15	798.96	802.63	801.08	
			Grounded	796.40	792.55	794.86	798.42	794.56	
		Limit -	-	-	-	-	-	-	
Limit +	-	1300	1300	1300	1300	1300	1300		
Output Skew RS = 0V (t _{PHL} - t _{PLH})	t _{SKEW1}	VCC = 3.0V	Biased	2.25	1.79	1.88	1.84	1.95	ns
			Grounded	2.69	2.18	1.87	1.86	2.16	
		VCC = 3.6V	Biased	5.62	5.21	5.08	4.71	3.00	
			Grounded	6.31	5.66	5.07	4.64	2.52	
		Limit -	-	-	-	-	-	-	
Limit +	-	50	50	50	50	50	50		
Output Skew RS = 10kΩ (t _{PHL} - t _{PLH})	t _{SKEW2}	VCC = 3.0V	Biased	59.84	63.91	65.46	64.44	70.04	ns
			Grounded	67.32	71.84	74.21	74.21	80.79	
		VCC = 3.6V	Biased	21.74	19.92	20.94	20.92	20.49	
			Grounded	17.77	18.43	19.09	18.86	19.87	
		Limit -	-	-	-	-	-	-	
Limit +	-	510	510	510	510	510	510		
Output Skew RS = 50kΩ (t _{PHL} - t _{PLH})	t _{SKEW3}	VCC = 3.0V	Biased	98.43	107.89	109.49	107.98	116.89	ns
			Grounded	109.93	118.31	121.25	123.20	134.82	
		VCC = 3.6V	Biased	42.22	37.64	39.29	40.31	38.16	
			Grounded	32.29	32.63	33.35	33.86	33.76	
		Limit -	-	-	-	-	-	-	
Limit +	-	800	800	800	800	800	800		
Output Rise Time RS = 0V (fast speed - 1Mbps)	t _{r1}	VCC = 3.0V	Biased	60.25	61.06	61.44	60.58	61.23	ns
			Grounded	60.60	61.93	60.72	59.99	61.65	
		VCC = 3.6V	Biased	56.89	57.67	57.92	57.39	58.07	
			Grounded	57.50	58.43	57.24	56.73	58.28	
		Limit -	-	20	20	20	20	20	
Limit +	-	100	100	100	100	100	100		
Output Fall Time RS = 0V (fast speed - 1Mbps)	t _{f1}	VCC = 3.0V	Biased	30.43	30.01	30.39	29.55	29.83	ns
			Grounded	30.66	30.47	30.63	29.85	29.98	
		VCC = 3.6V	Biased	21.72	21.62	21.74	21.29	21.48	
			Grounded	22.27	22.03	21.84	21.41	21.49	
		Limit -	-	10	10	10	10	10	
Limit +	-	75	75	75	75	75	75		

Table 3. ISL71026M Response of Key Parameters vs TID (Cont.)

Parameter	Symbol	Condition	Bias	Pre-Rad Value	10krad (Si)	30krad (Si)	50krad (Si)	Anneal	Unit
Output Rise Time RS = 10kΩ (medium speed - 250kbps)	t _{r2}	VCC = 3.0V	Biased	386.08	390.67	393.22	389.08	392.61	ns
			Grounded	393.91	403.52	397.81	394.82	397.64	
		VCC = 3.6V	Biased	381.17	386.91	389.10	386.25	390.60	
			Grounded	389.52	400.11	395.28	396.56	399.20	
		Limit -	-	200	200	200	200	200	
Limit +	-	780	780	780	780	780			
Output Fall Time RS = 10kΩ (medium speed - 250kbps)	t _{r2}	VCC = 3.0V	Biased	337.18	334.77	338.63	337.28	339.18	ns
			Grounded	342.34	341.87	341.71	341.02	342.71	
		VCC = 3.6V	Biased	329.26	325.31	329.77	328.49	329.85	
			Grounded	334.16	332.57	332.46	332.58	333.25	
		Limit -	-	175	175	175	175	175	
Limit +	-	500	500	500	500	500			
Output Rise Time RS = 50kΩ (medium speed - 125kbps)	t _{r3}	VCC = 3.0V	Biased	638.00	650.62	653.72	653.28	659.31	ns
			Grounded	644.16	663.74	658.73	662.81	667.09	
		VCC = 3.6V	Biased	661.00	671.23	673.38	672.02	679.24	
			Grounded	671.17	688.78	679.73	681.29	683.95	
		Limit -	-	400	400	400	400	400	
Limit +	-	1400	1400	1400	1400	1400			
Output Fall Time RS = 50kΩ (medium speed - 125kbps)	t _{r3}	VCC = 3.0V	Biased	665.80	662.78	668.87	668.74	674.34	ns
			Grounded	673.86	673.54	673.97	674.98	679.05	
		VCC = 3.6V	Biased	647.27	641.70	648.63	650.01	655.24	
			Grounded	654.13	652.03	654.43	654.15	659.28	
		Limit -	-	300	300	300	300	300	
Limit +	-	1000	1000	1000	1000	1000			
Total Loop Delay, Driver Input to Receiver Output, Recessive to Dominant RS = 0V	t _(LOOP1)	VCC = 3.0V	Biased	125.65	124.89	126.25	125.79	128.42	ns
			Grounded	125.88	125.09	126.59	126.35	129.56	
		VCC = 3.6V	Biased	105.74	105.66	106.24	106.35	108.01	
			Grounded	105.98	106.03	106.41	106.80	108.77	
		Limit -	-	-	-	-	-	-	
Limit +	-	210	210	210	210	210			
Total Loop Delay, Driver Input to Receiver Output, Recessive to Dominant RS = 10kΩ	t _(LOOP1)	VCC = 3.0V	Biased	570.71	573.33	575.84	577.90	581.75	ns
			Grounded	572.70	575.65	580.15	584.94	589.65	
		VCC = 3.6V	Biased	520.33	522.21	524.40	526.39	529.15	
			Grounded	521.44	523.65	527.54	532.06	535.97	
		Limit -	-	-	-	-	-	-	
Limit +	-	875	875	875	875	875			
Total Loop Delay, Driver Input to Receiver Output, Recessive to Dominant RS = 50kΩ	t _(LOOP1)	VCC = 3.0V	Biased	838.52	846.35	849.28	853.59	860.34	ns
			Grounded	839.81	848.83	854.58	862.59	871.26	
		VCC = 3.6V	Biased	766.14	772.75	774.56	778.21	783.03	
			Grounded	766.26	773.47	777.16	783.00	790.09	
		Limit -	-	-	-	-	-	-	
Limit +	-	1400	1400	1400	1400	1400			

Table 3. ISL71026M Response of Key Parameters vs TID (Cont.)

Parameter	Symbol	Condition	Bias	Pre-Rad Value	10krad (Si)	30krad (Si)	50krad (Si)	Anneal	Unit
Total Loop Delay, Driver Input to Receiver Output, Dominant to Recessive RS = 0V	$t_{(LOOP2)}$	VCC = 3.0V	Biased	137.65	137.15	137.74	139.00	138.52	ns
			Grounded	137.46	135.97	138.16	138.82	138.17	
		VCC = 3.6V	Biased	126.81	126.47	127.08	128.63	127.90	
			Grounded	126.41	124.98	127.38	128.28	127.39	
		Limit -	-	-	-	-	-	-	
Limit +	-	270	270	270	270	270			
Total Loop Delay, Driver Input to Receiver Output, Dominant to Recessive RS = 10k Ω	$t_{(LOOP2)}$	VCC = 3.0V	Biased	526.99	523.91	526.19	528.14	527.23	ns
			Grounded	525.65	521.23	524.02	524.55	523.81	
		VCC = 3.6V	Biased	549.05	545.42	547.99	549.64	548.46	
			Grounded	548.21	543.45	545.62	546.02	544.63	
		Limit -	-	-	-	-	-	-	
Limit +	-	825	825	825	825	825			
Total Loop Delay, Driver Input to Receiver Output, Dominant to Recessive RS = 50k Ω	$t_{(LOOP2)}$	VCC = 3.0V	Biased	782.96	778.80	782.41	785.17	784.34	ns
			Grounded	780.79	775.15	777.89	777.83	776.54	
		VCC = 3.6V	Biased	819.43	814.79	818.95	821.59	820.53	
			Grounded	817.46	811.79	814.41	814.18	812.39	
		Limit -	-	-	-	-	-	-	
Limit +	-	1300	1300	1300	1300	1300			
Receiver Propagation Delay LOW to HIGH	t_{PLH}	VCC = 3.0V	Biased	52.08	52.48	52.85	53.35	53.24	ns
			Grounded	51.87	51.97	52.42	52.70	52.71	
		VCC = 3.6V	Biased	49.37	49.85	50.22	50.73	50.58	
			Grounded	49.13	49.38	49.79	50.05	50.03	
		Limit -	-	-	-	-	-	-	
Limit +	-	110	110	110	110	110			
Receiver Propagation Delay HIGH to LOW	t_{PHL}	VCC = 3.0V	Biased	49.13	49.40	49.54	49.43	49.87	ns
			Grounded	49.40	49.59	49.76	49.75	50.20	
		VCC = 3.6V	Biased	46.03	46.26	46.46	46.38	46.64	
			Grounded	46.20	46.36	46.59	46.55	46.86	
		Limit -	-	-	-	-	-	-	
Limit +	-	110	110	110	110	110			
Rx Skew $ t_{PHL} - t_{PLH} $	t_{RxsKEW}	VCC = 3.0V	Biased	2.96	3.08	3.31	3.92	3.37	ns
			Grounded	2.47	2.38	2.66	2.96	2.51	
		VCC = 3.6V	Biased	3.34	3.59	3.75	4.35	3.94	
			Grounded	2.93	3.02	3.19	3.49	3.16	
		Limit -	-	-	-	-	-	-	
Limit +	-	35	35	35	35	35			

5.3 Single-Event Effects Testing

5.3.1 Introduction

The intense heavy ion environment encountered in space applications can cause a variety of Single-Event Effects (SEE). SEE can lead to system-level performance issues including disruption, degradation, and destruction. For predictable and reliable space system operation, individual electronic components should be characterized to determine their SEE response. The following is a summary of the SEE testing of the ISL71026M.

5.3.2 SEE Test Setup

Testing was performed at the Texas A&M University (TAMU) Cyclotron Institute heavy ion facility. This facility is coupled to a K500 super-conducting cyclotron, which is capable of generating a wide range of test particles with the various energy, flux, and fluence levels needed for advanced radiation testing.

A schematic of the SEE test circuit is shown in Figure 60. The cabling connected to the CANH/CANL pins presents 700pF to GND due to the 20 foot cable connecting the DUT to the oscilloscopes in the control room for SET testing. Other supplies and signals indicated by arrows were also cabled to the control room. Two instantiations of the schematic on a single board allowed two devices to be simultaneously irradiated for SEE testing. The two parts were monitored separately. Digital multimeters and oscilloscopes were used to monitor voltages and currents and to capture SET events.

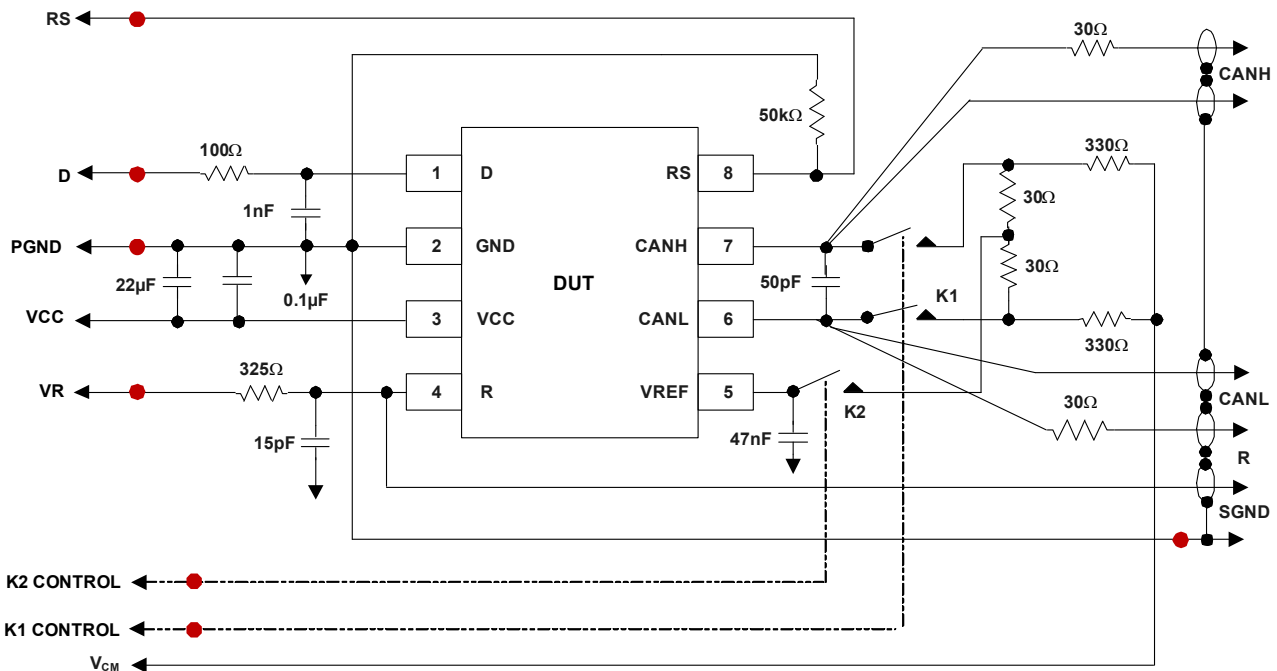


Figure 60. SEE Testing Schematic

5.3.3 SEL, SEB, and SEGR Testing Results

Testing for Single Event Latch-Up (SEL), Single Event Burnout (SEB), and Single Event Gate Rupture (SEGR) proceeded with biasing V_{CC} at both 0V and 5.5V (the supply absolute maximum), and the bus pins (CANL and CANH) alternately set to -20V and +20V (the absolute maximum for the bus terminals). This yielded four conditions for irradiations testing for damaging SEE. For the two powered cases the data input was a 50kHz square wave to exercise both the transmitter and receiver at approximately +25°C (ambient) case temperature. DUTs were irradiated with Ag ions at a 0° incident angle, resulting in an LET of 43MeV·cm²/mg. Each irradiation was done to a fluence of 1×10^7 ion/cm² so that each DUT saw a net of 4×10^7 ion/cm².

Operating supply current (I_{CC}) and common-mode current (I_{CM}) were measured pre-radiation and post-radiation for each irradiation. The changes in current for the powered cases ($V_{CC} = 5.5V$) were less than 0.5% and so were considered to indicate no damaging SEE. For the unpowered cases ($V_{CC} = 0V$) the I_{CM} currents were in the low μA and registered changes only up to 7%. These changes in I_{CM} were interpreted as within the noise on the measurements and again did not indicate damaging SEE.

Before and after each sequence of four irradiations on a DUT a set of four operating currents were measured to characterize the part. These monitor currents were: static recessive I_{CM} for $V_{CM} = -7V$, static recessive I_{CM} for $V_{CM} = +12V$, dynamic unloaded I_{CC} for data at 250kHz, and dynamic loaded I_{CC} for data at 250kHz. All of these

operating currents registered less than 1% change as a result of the four irradiations. This was again interpreted as an indication of no damaging SEE.

5.3.4 Single-Event Transient Testing

Single Event Transient (SET) testing was conducted with a supply of 3.0V, data input of a 500kHz square wave, and +25°C (ambient) case temperature. Irradiation was done with various ions (Ag, Kr, Cu, Ar, Ne) at normal incidence to 1×10^7 ion/cm² for each test. SET were counted for every received pulse deviating by 50ns from the nominal 1000ns. The SET were captured and counted by an oscilloscope. SET testing was done for both the high slew rate (RS = 0Ω) and the medium slew rate (RS = 10kΩ). The results are summarized in [Table 4](#).

Table 4. SET Results¹

LET (MeV•cm ² /mg) (Species)	Fast Slew, RS = 0Ω				Medium Slew, RS = 10kΩ			
	DUT1	DUT2	DUT3	DUT4	DUT1	DUT2	DUT3	DUT4
43 (Ag)	31	8	30	6	1378	990	912	1437
28 (Kr)	3	0	8	0	415	928	867	525
20 (Cu)	0	0	0	0	535	275	226	598
8.5 (Ar)	-	-	-	-	6	34	39	14
2.7 (Ne)	-	-	-	-	0	0	0	0

1. SET counts of ±50ns events on a 500kHz square wave signal taken to a fluence of 1×10^7 ion/cm² at each test.

The data in [Table 4](#) can be reduced to generate Weibull parameters to run CRÈME96 simulations to get approximate times between events in a solar minimum geosynchronous orbit with 100 mils of aluminum shielding. Carrying out these simulations predicts about 10.7 years between ±50ns events when running at medium slew rate, and 2000 years between events when running at the high slew rate.

5.3.5 Conclusion

The SEE test results clearly demonstrate that the ISL71026M is robust against SEL, SEB, and SEGR to a LET of 43MeV•cm²/mg at a supply voltage up to 5.5V, bus voltages to ±20V, and a case temperature up to +125°C.

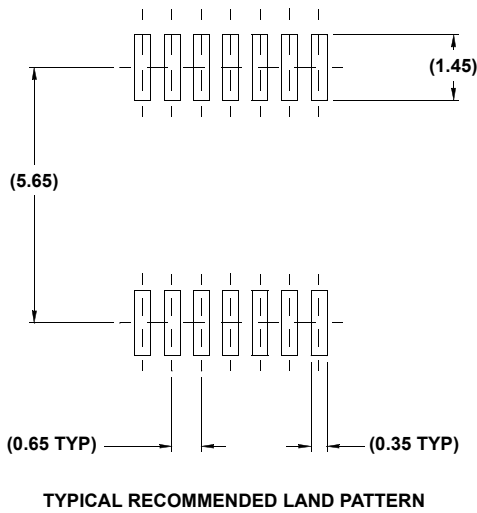
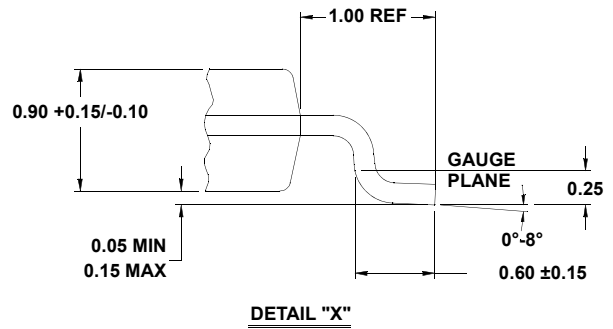
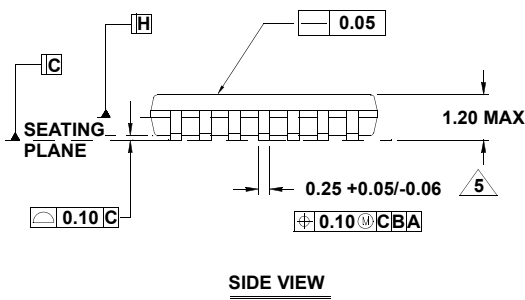
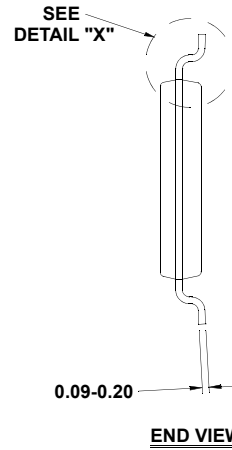
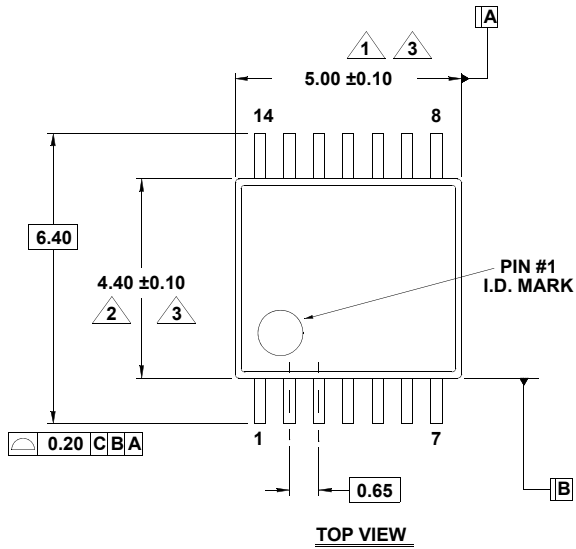
SET characterization showed that relatively benign events of ±50ns timing disruption on a 500kHz signal were rare events when ion abundance is considered. Using a solar minimum geosynchronous orbit with 100 mils of aluminum shielding as a benchmark, events when running at the medium slew rate are roughly once every 10.7 years, and events when running at the fast slew rate occur roughly once every 2000 years.

6. Package Outline Drawing

M14.173

14 LEAD THIN SHRINK SMALL OUTLINE PACKAGE (TSSOP)

Rev 3, 10/09



NOTES:

1. Dimension does not include mold flash, protrusions or gate burrs. Mold flash, protrusions or gate burrs shall not exceed 0.15 per side.
2. Dimension does not include interlead flash or protrusion. Interlead flash or protrusion shall not exceed 0.25 per side.
3. Dimensions are measured at datum plane H.
4. Dimensioning and tolerancing per ASME Y14.5M-1994.
5. Dimension does not include dambar protrusion. Allowable protrusion shall be 0.80mm total in excess of dimension at maximum material condition. Minimum space between protrusion and adjacent lead is 0.07mm.
6. Dimension in () are for reference only.
7. Conforms to JEDEC MO-153, variation AB-1.

7. Ordering Information

Part Number ^{[1][2]}	Part Marking	Radiation Lot Acceptance Testing	Package Description ^[3] (RoHS Compliant)	Pkg. Dwg. #	Carrier Type ^[4]	Temp Range	
ISL71026MVZ	71026 MVZ	N/A	14 Ld TSSOP	M14.173	Tube	-55 to +125°C	
ISL71026MVZ-T					Reel 2.5k		
ISL71026MVZ-T7A					Reel, 250		
ISL71026M30VZ		30krad(Si)			Tube		
ISL71026M30VZ-T					Reel 2.5k		
ISL71026M30VZ-T7A					Reel, 250		
ISL71026M50VZ		50krad(Si)					Tube
ISL71026M50VZ-T							Reel 2.5k
ISL71026M50VZ-T7A							Reel, 250
ISL71026MEVAL1Z							Evaluation Board

1. These Pb-free plastic packaged products employ special Pb-free material sets, molding compounds/die attach materials, and NiPdAu-Ag plate -e4 termination finish, which is RoHS compliant and compatible with both SnPb and Pb-free soldering operations. Pb-free products are MSL classified at Pb-free peak reflow temperatures that meet or exceed the Pb-free requirements of IPC/JEDEC J STD-020.
2. For Moisture Sensitivity Level (MSL), see the [ISL71026M](#) product information page. For more information about MSL, see [TB363](#).
3. For the Pb-Free Reflow Profile, see [TB493](#).
4. Refer to [TB347](#) for details about reel specifications.

8. Revision History

Rev.	Date	Description
2.01	Feb 6, 2025	Updated to the latest template. Updated Features bullets. Added ISL71026M30VZ and ISL71026M50VZ part information throughout document.
2.00	Aug 14, 2020	Changed maximum data rate from 1Mbps to 5Mbps on the following pages: Page 1: Second paragraph and Features section. Page 20: In Overview section. Added curves Figures 50 and 51 in Typical Performance Curves, section 4.
1.00	Mar 26, 2018	Updated to latest layout. Added Outgassing Feature bullet. Updated Ordering information by adding -T and -T7 parts to table and updated Note 1. Added Outgassing specification information. Removed About Intersil section and updated disclaimer.
0.00	May 3, 2017	Initial release

IMPORTANT NOTICE AND DISCLAIMER

RENESAS ELECTRONICS CORPORATION AND ITS SUBSIDIARIES (“RENESAS”) PROVIDES TECHNICAL SPECIFICATIONS AND RELIABILITY DATA (INCLUDING DATASHEETS), DESIGN RESOURCES (INCLUDING REFERENCE DESIGNS), APPLICATION OR OTHER DESIGN ADVICE, WEB TOOLS, SAFETY INFORMATION, AND OTHER RESOURCES “AS IS” AND WITH ALL FAULTS, AND DISCLAIMS ALL WARRANTIES, EXPRESS OR IMPLIED, INCLUDING, WITHOUT LIMITATION, ANY IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE, OR NON-INFRINGEMENT OF THIRD-PARTY INTELLECTUAL PROPERTY RIGHTS.

These resources are intended for developers who are designing with Renesas products. You are solely responsible for (1) selecting the appropriate products for your application, (2) designing, validating, and testing your application, and (3) ensuring your application meets applicable standards, and any other safety, security, or other requirements. These resources are subject to change without notice. Renesas grants you permission to use these resources only to develop an application that uses Renesas products. Other reproduction or use of these resources is strictly prohibited. No license is granted to any other Renesas intellectual property or to any third-party intellectual property. Renesas disclaims responsibility for, and you will fully indemnify Renesas and its representatives against, any claims, damages, costs, losses, or liabilities arising from your use of these resources. Renesas' products are provided only subject to Renesas' Terms and Conditions of Sale or other applicable terms agreed to in writing. No use of any Renesas resources expands or otherwise alters any applicable warranties or warranty disclaimers for these products.

(Disclaimer Rev.1.01)

Corporate Headquarters

TOYOSU FORESIA, 3-2-24 Toyosu,
Koto-ku, Tokyo 135-0061, Japan
www.renesas.com

Trademarks

Renesas and the Renesas logo are trademarks of Renesas Electronics Corporation. All trademarks and registered trademarks are the property of their respective owners.

Contact Information

For further information on a product, technology, the most up-to-date version of a document, or your nearest sales office, please visit www.renesas.com/contact-us/.