ISL3160E Pin Failure Modes and Effects Analysis

This application note provides a Failure Modes and Effects Analysis (FMEA) for the device pins of the ISL3160E 5V, 40Mbps, full-duplex RS-485 transceiver. The failure conditions covered in this document include failure scenarios such as short-circuits to VCC, GND, and adjacent pins, and if the pin is left open.
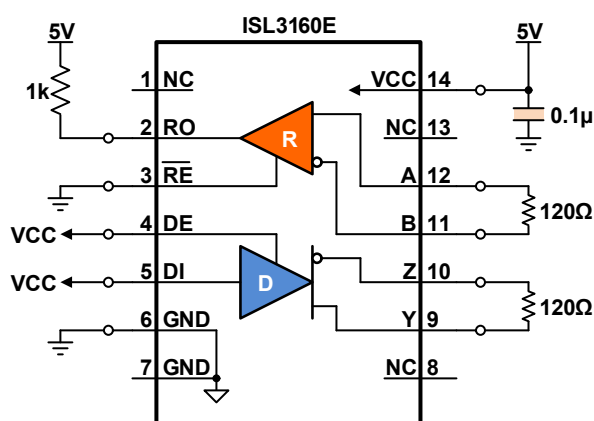

Figure 1. Normal Operating Conditions

Table 2 through Table 5 list how these conditions affect the device. The first effect considered is whether the condition damages the pin under test or the device itself. The second effect considered is whether the device is functional under the condition. The comment section describes how a specific condition affects device operation within an application. Lastly, the failure condition is classified according to the failure mode classifications in Table 1.

Table 1. Classification of Failure Effects

Class	Failure Effects
A	Damage to device affects application functionality
B	No damage to device but thermal damage must be considered
C	No damage to device but can affect application functionality
D	No damage to device and no affect to application functionality

Table 2. Pin FMEA Analysis for Pin Short-Circuit to VCC

Pin		Short-Circuit to VCC			
No.	Name	Damage	Functionality	Comment	Class
1	NC	NO	YES	No damage to device and no effect on application functionality	D
2	RO	NO	NO	When bus drives RO low, large VCC current is about 75mA.	C
3	RE	NO	NO	Receiver is always disabled. Pull up keeps RO high.	C
4	DE	NO	YES	Driver is always enabled.	D
5	DI	NO	NO	Y output is always high, Z output is always low, which does not allow for data transfer.	C

Table 2. Pin FMEA Analysis for Pin Short-Circuit to VCC (Cont.)

Pin				Short-Circuit to VCC	
No.	Name	Damage	Functionality	Comment	Class
6	GND	YES	NO	Transceiver does not operate, 1A current path through any pins to GND. Need to cycle VCC for part to recover.	A
7	GND	YES	NO	Transceiver does not operate, 1A current path through any pins to GND. Need to cycle VCC for part to recover.	A
8	NC	NO	YES	No damage to device and no effect on application functionality	D
9	Y	NO	NO	If Y output is driven low, large output current limited to about 60mA.	C
10	Z	NO	NO	If Y output is driven low, large output current limited to about 60mA.	C
11	B	NO	NO	RO is always high, affecting application functionality.	C
12	A	NO	NO	RO is always high, affecting application functionality.	C
13	NC	NO	YES	No device damage and no effect on application functionality.	D
14	VCC	NO	YES	Normal Operation.	D

Table 3. Pin FMEA Analysis for Pin Short-Circuit to GND

Pin				Short-Circuit to GND	
No.	Name	Damage	Functionality	Comment	Class
1	NC	NO	YES	No damage to device and no effect on application functionality	D
2	RO	NO	NO	When bus drives RO high, large output current 90mA.	C
3	$\overline{RE}$	NO	YES	Receiver is always enabled.	D
4	DE	NO	NO	Driver is always disabled. Y and Z outputs are high impedance.	C
5	DI	NO	NO	Y output is always low, Z output is always high, which does not allow for data transfer.	C
6	GND	NO	YES	Normal Operation	D
7	GND	NO	YES	Normal Operation	D
8	NC	NO	YES	No damage to device and no effect on application functionality	D
9	Y	NO	NO	If Y output is driven high, large output current limited to about 115mA.	C
10	Z	NO	NO	If Y output is driven high, large output current limited to about 115mA.	C
11	B	NO	NO	RO is always high, affecting application functionality.	C
12	A	NO	NO	RO is always high, affecting application functionality.	C
13	NC	NO	YES	No damage to device and no effect on application functionality	D
14	VCC	NO	NO	Transceiver does not operate.	C

Table 4. Pin FMEA Analysis for Pin left Open

Pin				left Open	
No.	Name	Damage	Functionality	Comment	Class
1	NC	NO	YES	No damage to device and no effect on application functionality	D
2	RO	NO	NO	Pull-up keeps RO high for controller I/O.	C

Table 4. Pin FMEA Analysis for Pin left Open (Cont.)

| Pin | | left Open | | | |
No.	Name	Damage	Functionality	Comment	Class
3	$\overline{RE}$	NO	NO	Can cause receiver to turn on and off erratically, therefore not allowing for proper data transmission.	C
4	DE	NO	NO	Can cause driver to turn on and off erratically, therefore not allowing for proper data transmission.	C
5	DI	NO	NO	Can cause driver outputs to switch erratically, therefore not allowing for proper data transmission.	C
6	GND	NO	NO	Transceiver does not operate.	C
7	GND	NO	NO	Transceiver does not operate.	C
8	NC	NO	YES	No damage to device and no effect on application functionality.	D
9	Y	NO	NO	No data goes out on the Y pin.	C
10	Z	NO	NO	No data goes out on the Z pin.	C
11	B	NO	NO	No data goes to RO from B pin.	C
12	A	NO	NO	No data goes to RO from A pin.	C
13	NC	NO	YES	No damage to device and no effect on application functionality.	D
14	VCC	NO	NO	Transceiver does not operate.	C

Table 5. Pin FMEA Analysis for Pin Short-Circuit to Adjacent Pins

| Pin | | Short-Circuit to Adjacent Pins | | | |
No.	Name	Damage	Functionality	Comment	Class
1	RO to NC	NO	YES	No damage to device and no effect on application functionality.	D
2	RO to $\overline{RE}$	NO	NO	$\overline{RE}$ = High from pull up so RO is disabled.	C
3	$\overline{RE}$ to DE	NO	NO	Pins are inputs, so they float and can turn on and off erratically, therefore not allowing for proper data transmission.	C
4	DE to DI	NO	NO	Pins are inputs, so they float and can turn on and off erratically, therefore not allowing for proper data transmission.	C
5	DI to GND	NO	NO	Y output is always low, Z output is always high, which does not allow for data transfer.	C
6	GND to GND	NO	YES	No damage to device and no effect on application functionality.	D
7	Y to NC	NO	YES	No damage to device and no effect on application functionality.	D
8	Z to Y	NO	NO	Large output current triggers internal current limit 60mA.	C
9	B to Z	NO	NO	RO does not switch right.	C
10	A to B	NO	NO	RO does not switch high.	C
11	NC to A	NO	YES	No damage to device and no effect on application functionality	D
12	VCC to NC	NO	YES	No damage to device and no effect on application functionality	D

Revision History

Revision	Date	Description
1.0	Jul 19, 2021	Initial release

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