Application Brief

Space-Grade, 30-krad, Isolated RS-422 Serial Transceiver Circuit

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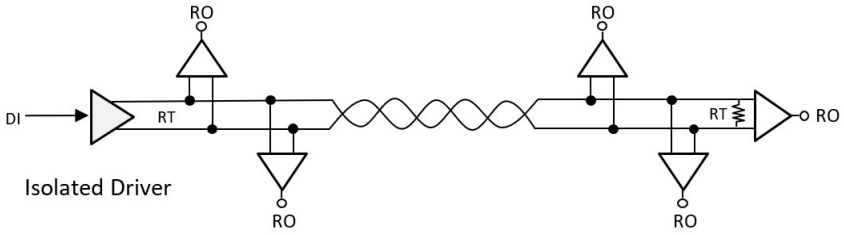
Design Goals

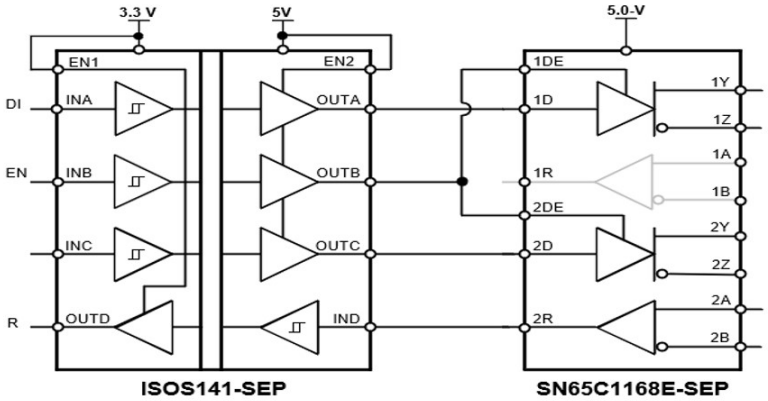
Parameter	Design Requirement
Bit rate	100kbps to 10Mbps
Bus length	12M to 1500M
Maximum Total Ionizing Dose	30krad(Si)
Maximum SEL to LET	43MeV × cm^2/mg
Isolation voltage	3000V_{RMS} per UL1577

Design Description

In spacecraft applications RS-422 might be used as a bus and payload *telecommand and control* interfaces. RS-422 was designed as serial communication methods to convey information between equipment by using balanced and differential twisted-pair cable. RS-422 is specified for multi-drop applications where only one driver connects up to 10 receivers through a single differential twisted bus. The following figure shows a typical half-duplex isolated RS-422 interface circuit.



The following circuit uses the ISOS141-SEP digital isolator and SN65C1168E-SEP transceiver devices to achieve a space-grade isolated RS-422 driver.



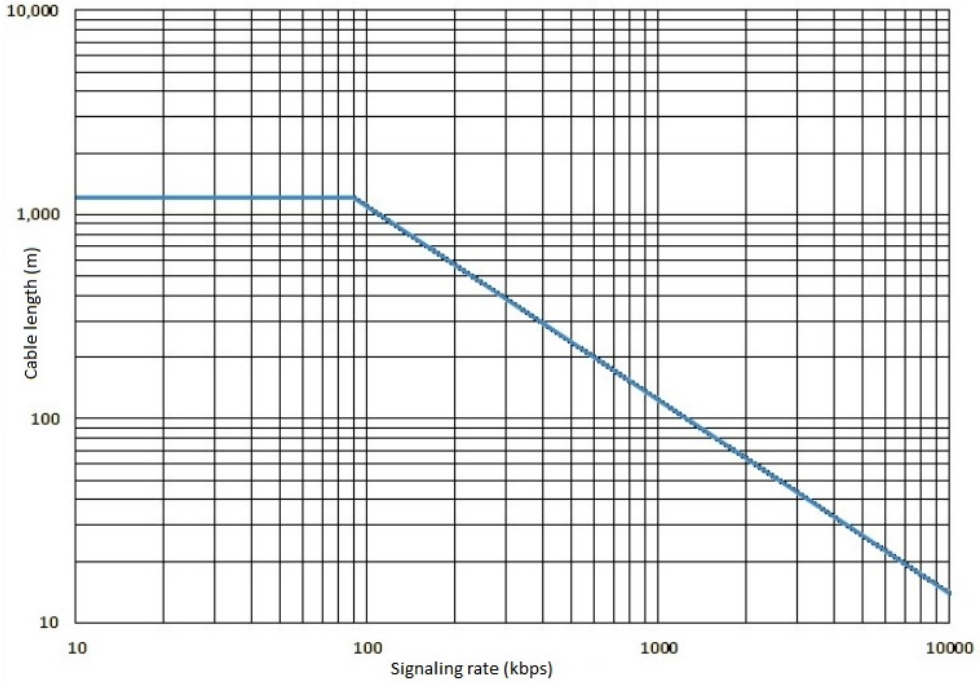
Design Notes

The previous circuit uses the SN65C1168E-SEP driver to create an isolated RS-422 driver to isolate the primary device from the secondary devices. SN65C1168E-SEP consists of two receivers and can be used as secondary devices.

Design Steps

- Determine signaling rate versus cable length

RS-422 system can transmit up to 10Mbps, or over a 1500-m cable at a lower signaling rate. The signal rate is reciprocal to the cable length. Hence, it is important to figure out the maximum signal rate for a given cable length or vice versa. The following figure shows the RS-422 recommended signal rate over the cable length in its annex.



This system design uses a 1500-m cable. From the previous figure, the maximum recommended signal rate is 90kbps.

- Calculate the path delay
  Path delay = Propagation delay of digital isolator + Propagation of RS-422 TX to bus + Propagation delay of wire
  + Propagation delay of bus to RS-422 RX Calculate bit time

Parameter	Conditions	Typ (ns)	MAX (ns)
Propagation delay of ISOS-141-SEP	With R_L = 50Ω, C_L = 15pF	10.7	16
Propagation delay of TX to bus	With R_L = 50Ω, C_L = 40pF	8	16
Propagation delay of 1500-m wire	Approximate delay is 5ns/m (Typ), 5.3ns/m (Max)	7500	7950
Propagation delay of bus to RX	With R_L = 50Ω, C_L = 50pF	15	27

Path delay (Typ) = 10.7+8+7500+15 = 7534ns

Path delay (Max) = 16+16+7950+127 = 8109ns

- Calculate bit time
  $\text{Bit time} = \frac{1}{Bit\ rate} = \frac{1}{90kbps} = 11100ns$
- Check path delay < bit time
- This design meets the timing requirement as the approximate worst-case round-trip delay is 8109ns which is less than 11100ns.

  Note: If the path delay is greater than the bit time, the following options apply:

  1. Pick components with shorter propagation delays
  2. Shorten the cable length
  3. Lower the maximum signaling rate
- It is recommended to place a 120-Ω termination resistor at the other end from the driver.

Reference

Design Featured ISOS141_SEP Digital Isolator

ISOS141-SEP	
VCC1, VCC2	2.25 V to 5.5 V
Data-rate	10Mbps
Propagation delay	10.7ns to 16ns
TID Characterized (ELDRS-Free)	30krad(Si)
TID RLAT, RHA	30krad(Si)
CMTI	±100kV/µs
VISO	3000 V_{RMS}
http://www.ti.com/product/ISOS141-SEP	

Design Featured SN65C1168E-SEP RS-422 Transceiver

SN65C1168E-SEP	
VCC1	4.5 V to 5.5 V
Data-rate	1MHz
TID Characterized (ELDRS-Free)	30krad(Si)
TID RLAT, RHA	20krad(Si)
Common Mode Range	–7 V to 7 V
http://www.ti.com/product/SN65C1168E-SEP	

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