HOLT INC.
INTEGRATED CIRCUITS

AN-300

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ARINC 429 Devices Lightning Protection RTCA/DO-160G, Section 22 Level 3

INTRODUCTION

This Application Note provides recommended practices for protection against lightning induced transient susceptibility for Holt's family of ARINC 429 Devices. These recommended circuit diagrams were tested according to RTCA/DO-160G, Section 22 Level 3 Pin Injection Test Waveform Set A (3 & 4), Set B (3 & 5A), Set Z (3 & 5B). Pin surge levels for Level 3 are listed in a matrix of four separate pin injection threats as shown below:

Level	Waveforms			
	3 VOC/ISC	4 VOC/ISC	5A VOC/ISC	5B VOC/ISC
3	600/24	300/60	300/300	300/300

RTCA/DO-160G Table 22-2 Pin Injection Level 3

The circuit diagram provided in Figure 1 with R1 (Table 1), Figure 2 and Figure 4 (Table 2) achieved RTCA/DO-160G category designation A3XXXX, B3XXXX and Z3XXXX

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RECEIVER INPUT PROTECTION

Holt has three categories of lightning protection for ARINC inputs for their products. The first are products which require no external components and have "Built-In" Level 3 protection identified in Table 1. The second are products that have a "Lightning" option and are designed to be used with an external resistor, R1, in series with each ARINC input as shown in Figure 1. All "Lightning" option parts must have the resistor specified in Table 1 in series with each ARINC input for proper ARINC signal level detection.

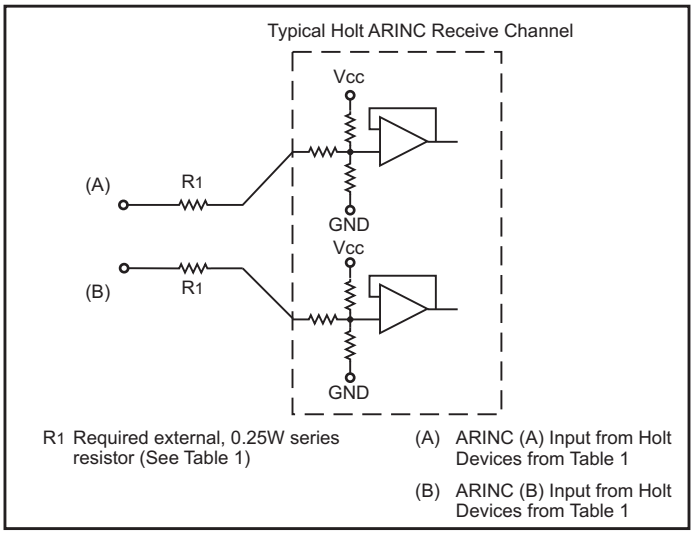

Figure 1 - Line Receiver Input Protection for "Lightning" Option Products

Part Number	Required External Resistor (R1) Ω
HI-3282-10	15K
HI-3582-10	15K
HI-3582A-15	15K
HI-3583-10	15K
HI-3583A-15	15K
HI-3584-10	15K
HI-3584A-15	15K
HI-3585 (RIN-40 only)	40K
HI-3586 (RIN-40 only)	40K
HI-3588 (RIN-40 only)	40K
HI-3593 (RIN-40 only)	40K
HI-3596-40	40K
HI-3597-40	40K
HI-3598 (RIN-40 only)	40K
HI-3599-40	40K
HI-3717 (RIN-40 only)	40K
HI-3718 (RIN-40 only)	40K
HI-8282A-10	15K
HI-8444-10	15K
HI-8445-10	15K
HI-8450	**Built-In**
HI-8451	**Built-In**
HI-8454	**Built-In**
HI-8455	**Built-In**
HI-8448-10	15K
HI-8475	13K
HI-8476	13K
HI-8581-10	15K
HI-8582-10	15K
HI-8583-10	15K
HI-8584-10	15K
HI-8588-10	10K
HI-8589-10	15K
HI-8591-40	40K
HI-8599-10	15K
HI-8684-10	15K
HI-8685-10	15K
HI-8686 (RIN-10 only)	15K

Table 1- Line Receiver "Built-In" & "Lightning" Options Resistor Values

The third category of ARINC 429 line receivers inputs do not have the “Lightning” option. These rely on a zener type protective diode, D1, with ratings as shown in Figure 2 to provide lightning protection to RTCA/DO-160G, Section 22 Level 3 Pin Injection Test Waveform Set A (3 & 4), Set B (3 & 5A), Set Z (3 & 5B). Some series resistance, R2, may also be desirable, but must be kept to less than 500Ω so as not to effect the ratio of the internal resistor network used to detect valid ARINC levels. Care must also be taken when selecting protection diodes to ensure that the diode capacitance in conjunction with the external series resistance does not cause excessive distortion of the input waveforms, particularly when operating at high speed (100 Kbps).

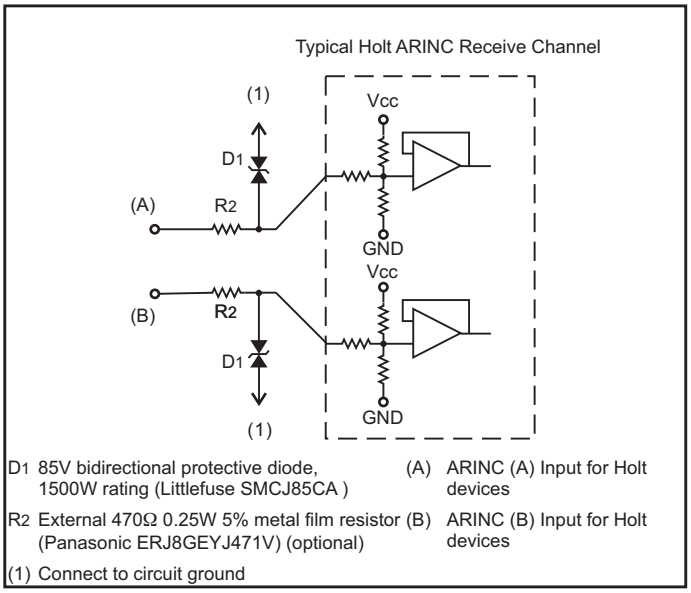

Figure 2 - Line Receiver Input Protection for Non- “Lightning” Option Products

DIFFERENTIAL LINE DRIVER PROTECTION

There are three types of Holt differential line drivers. Table 2 lists the lightning protection configuration suggested for each part number with an internal line driver.

The first type is “Built-In” Level 3 lightning protection and requires no additional components for direct drive of the ARINC 429 bus. These products have a nominal 37.5Ω internal resistor in series with each ARINC output to match the 75Ω characteristic impedance of the ARINC bus achieving full Level 3 protection for waveform set A, B & Z.

The second type is also designed for direct drive of the ARINC 429 bus, but they rely on an external protective type diode, D2, with ratings as shown in Figure 3 and, if required, a 15V zener diode, D4, for lightning protection to RTCA DO-160G, Pin Injection Level 3, waveform Set A only. Refer to Table 2 to determine which part numbers require zener diode, D4. Since any series resistance will cause a mismatch to the ARINC bus, the addition of external resistors is not recommended with this type of line driver.

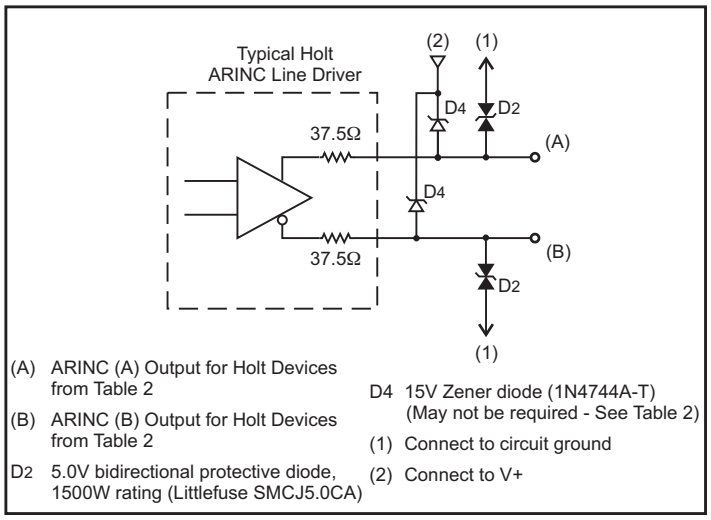

Figure 3 - Line Driver Protection with Built-in 37.5Ω Series Resistors (Non-“Lightning” Option)

The third type of Holt ARINC 429 line driver has some or all of the internal series resistance removed as shown in Figure 4. This allows the user to add external series resistors, R4 & R5, between the device and the ARINC bus to provide lightning protection to RTCA DO-160G, Pin Injection Level 3, waveform Set A, B & Z. The external resistor R5 limits the current in the bidirectional protective diode, D3. A 15V zener diode, D4, may also be required for full protection. Refer to Table 2 for the correct external resistor values to correctly match the impedance of the ARINC bus and if zener diode, D4, is required.

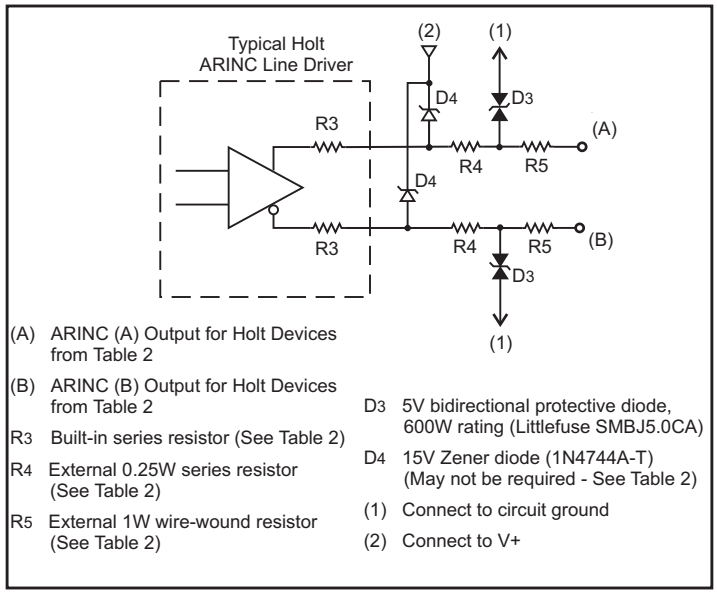

Figure 4 - Line Driver Protection Using External Series Resistors (“Lightning” Option)

Part Number	Schematic Figure No.	Diode 15V Zener (D_4)	Resistors				
			Built-in (R_3)	External (R_4)	External (R_5)	Total	Units
HI-3182	3	Not Required	37.5	0	0	37.5	Ω
HI-3183	4	Not Required	13	20.5	4	37.5	Ω
HI-3184	3	Not Required	37.5	0	0	37.5	Ω
HI-3185	3	Not Required	37.5	0	0	37.5	Ω
HI-3186	4	Not Required	0	33.5	4	37.5	Ω
HI-3188	4	Not Required	0	33.5	4	37.5	Ω
HI-3189	4	Not Required	0	33.5	4	37.5	Ω
HI-3582	3	Required	37.5	0	0	37.5	Ω
HI-3582A	3	Not Required	37.5	0	0	37.5	Ω
HI-3583	4	Required	10	23.5	4	37.5	Ω
HI-3583A	4	Not Required	10	23.5	4	37.5	Ω
HI-3585 (A/BOUT27)	4	Not Required	27.5	2	8	37.5	Ω
IH-3585 (A/BOUT37)	3	Not Required	37.5	0	0	37.5	Ω
HI-3587 (A/BOUT27)	4	Not Required	27.5	2	8	37.5	Ω
HI-3587 (A/BOUT37)	3	Not Required	37.5	0	0	37.5	Ω
HI-3593 (TXA/BOUT)	3	Not Required	37.5	0	0	37.5	Ω
HI-3593 (AMPA/B)	4	Not Required	5	28.5	4	37.5	Ω
$HI\text{-}3717_{TXOUTBA/BB(HA/HB)}$	3	Not Required	37.5	0	0	37.5	Ω
$HI\text{-}3717_{OUTBA/BB(HA/HB)}$	4	Not Required	5	28.5	4	37.5	Ω
$HI\text{-}3718_{TXOUTBA/BB(HA/HB)}$	3	Not Required	37.5	0	0	37.5	Ω
$HI\text{-}3718_{OUTBA/BB(HA/HB)}$	4	Not Required	5	28.5	4	37.5	Ω
HI-8470	**Built-In**	Not Required	37.5	0	0	37.5	Ω
HI-8570	3	Not Required	37.5	0	0	37.5	Ω
HI-8571	4	Not Required	27.5	6	4	37.5	Ω
HI-8281	3	Not Required	37.5	0	0	37.5	Ω
HI-8382	3	Not Required	37.5	0	0	37.5	Ω
HI-8383	4	Not Required	13.0	20.5	4	37.5	Ω
HI-8581	3	Required	37.5	0	0	37.5	Ω
HI-8582	3	Required	37.5	0	0	37.5	Ω
HI-8583	4	Required	10	23.5	4	37.5	Ω
HI-8585	3	Not Required	37.5	0	0	37.5	Ω
HI-8586	4	Not Required	2	31.5	4	37.5	Ω
HI-8592 (TXA/BOUT)	3	Not Required	37.5	0	0	37.5	Ω
HI-8592 (AMPA/B)	4	Not Required	5	28.5	4	37.5	Ω
HI-8593	3	Not Required	37.5	0	0	37.5	Ω
HI-8594	4	Not Required	5	28.5	4	37.5	Ω
HI-8596 (TXA/BOUT)	3	Not Required	37.5	0	0	37.5	Ω
HI-8596 (AMPA/B)	4	Not Required	5	28.5	4	37.5	Ω
HI-8597	**Built-In**	Not Required	37.5	0	0	37.5	Ω
HI-8589	4	Required	10	23.5	4	37.5	Ω
HI-8599	4	Required	10	23.5	4	37.5	Ω
HI-8784	3	Required	37.5	0	0	37.5	Ω
HI-8785	4	Required	10	23.5	4	37.5	Ω
HI-8787	3	Required	37.5	0	0	37.5	Ω
HI-8788	4	Required	10	23.5	4	37.5	Ω

Table 2 - Line Driver Lightning Protection Component Values

REVISION HISTORY

Document	Rev.	Date	Description of Change
AN-300	D	08/07/09	Major update to add new part numbers and update protection requirements.
	E	12/14/10	Added HI-8592, HI-8593, HI-8594 & HI-8596 to Table 2.
	F	02/07/11	Added HI-3586, HI-3593, HI-3596 & HI-3597 to Table 1 & HI-3593 to Table 2.
	G	11/05/14	Added HI-371x, HI-845x, HI-847x, HI-8597, to Table 1 & 2 and text. Removed ARINC Data Bus reference in Figure 1-4. Removed Protection Background, Wiring Consideration, Protective Devices, Verification Damage vs. Functional Upset Text and Figure 5.
	H	11/20/14	Changed Table 1 HI-8475/76 from not required to 13K.