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Relays and Recorders
Connecting Multiple ERLPhase Relays & Recorders to an IRIG-B Clock Source

Overview:

This document explains how to connect multiple ERLPhase relays and recorders to a single unmodulated IRIG-B clock source.

The application note addresses ERLPhase IRIG-B input specifications, clock characteristics, cabling and the number of ERLPhase relay and recorder devices that may be used with a single clock source.

For the purposes of this document:

- ERLPhase relays and recorders are referred to as “the device”
- The unmodulated IRIG-B clock source will be referred to as “the clock”

Figure 1 provides an equivalent circuit for the IRIG-B input of ERLPhase relays and recorders.

1. Device IRIG-B Port Input Specifications

Table I gives the specifications of the IRIG-B input port on ERLPhase IED devices:

Table 1: IRIG-B Port Input Specifications

Parameter		Minimum	Typical	Maximum	Units
R_L	Input Impedance		500		Ω
$V_{L\ (mod)}$	Input Voltage, Modulated	1.5		10	Vp-p
$V_{L\ (unmod)}$	Input Voltage, Unmodulated	3.5		10	Vp-p

2. Typical Clock Characteristics

The unmodulated IRIG-B output from the Arbiter Systems 1084 or 1094 series clock can be considered typical. Table II gives the output characteristics of this clock:

Table II: Typical Unmodulated IRIG-B Output Specifications

Parameter		Minimum	Typical	Maximum	Units
I_s	Output Current			75	mA
V_s	Output Voltage		5		Vp-p
R_s	Output Impedance		10		Ω

3. Cable Type and Grounding

For most applications, shielded twisted pair cable (like Belden 8451) is recommended for distribution of the clock signal. The chassis of the clock source must be securely bonded to the chassis of all devices using the signal, to ensure that ground potential rise is not applied to the IRIG-B input port.

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4. Physical Connection Between the Clock and Multiple Devices

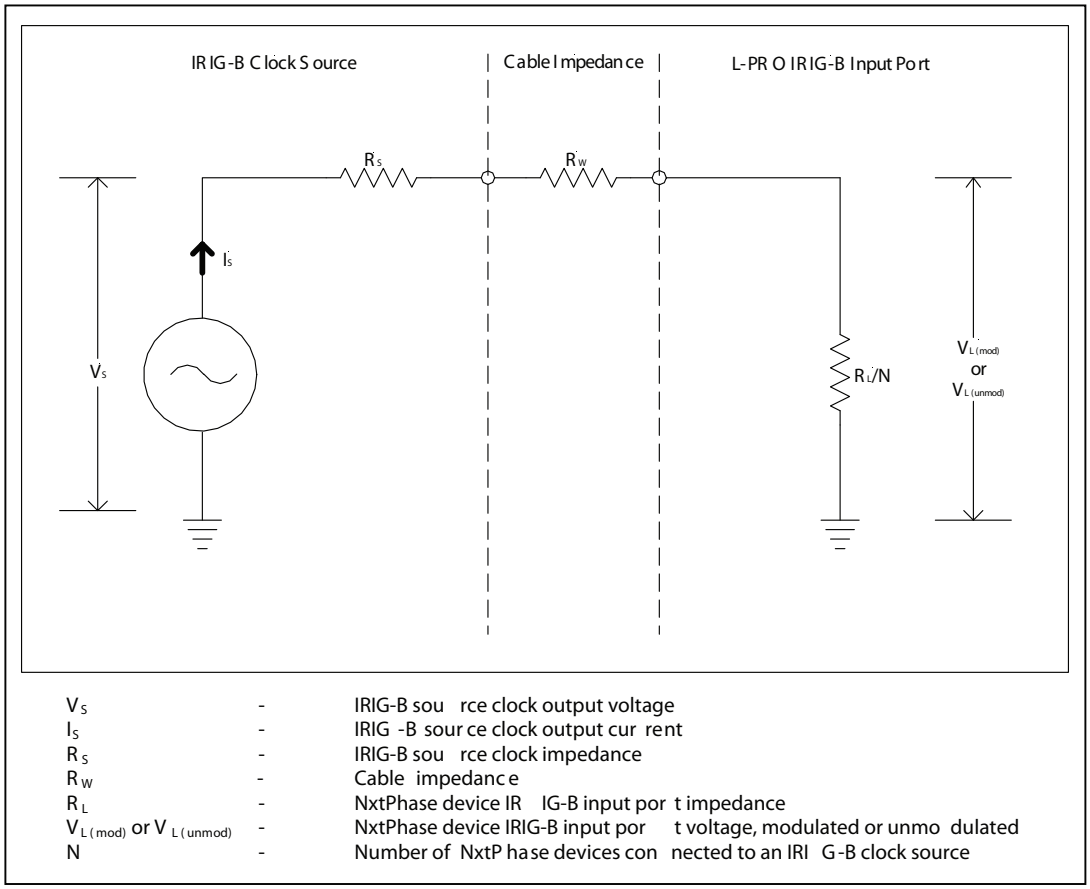
The IRIG-B inputs of all devices are connected in parallel. Groups of devices may be locally connected in parallel. Each parallel-connected group must be independently run back to the clock source. Avoid “daisy-chain” wiring unless over very short distances. For maximum drive capability, the round-trip resistance must be kept below 2 Ω. This represents about 20 m (70 ft) of Belden 8451. If fewer devices are connected to the clock source, then more wiring resistance can be tolerated.

5. Maximum Number of ERLPhase Devices Connected to a Clock Source

A single clock can drive a limited number of devices. The following provides a rationale and procedure to determine whether an application meets the requirements of the clock and of the devices.

5.1 Background

There is a limit to the number of devices that can be connected to a single clock source. These methods and examples explain the underlying issues. Figure 1 provides a simplified circuit of the interface between the clock and connected devices. The maximum number of devices (N) that can be connected to the clock source is determined by checking if the source current (IS) required to drive the connected devices is less than the maximum drive current the clock source can provide, and verifying that the load voltage (VL) the connected devices see is greater than the minimum required voltage.



V_S	-	IRIG-B source clock output voltage
I_S	-	IRIG-B source clock output current
R_S	-	IRIG-B source clock impedance
R_W	-	Cable impedance
R_L	-	NxtPhase device IRIG-B input port impedance
$V_{L(mod)}$ or $V_{L(unmod)}$	-	NxtPhase device IRIG-B input port voltage, modulated or unmodulated
N	-	Number of NxtPhase devices connected to an IRIG-B clock source

Figure 1. Simplified model of the IRIG-B clock source and ERLPhase L-PRO relay interface

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5.2 Example 1

Consider 6 devices connected to the clock source. Assume all devices are at the end of a single 20 m length of Belden 8451 cable, so round trip resistance is approximately 2 Ω. Does the installation meet the requirements?

Check output current from source:

5 Vp-p / [(500 Ω/6) + 10 Ω + 2 Ω] = 52 mA Yes

Check voltage level at units:

5 Vp-p x ([500 Ω/6]/[(500 Ω/6) + 10 Ω + 2 Ω]) = 4.4 Vp-p Yes

The required current (IS) is less than the maximum current of the source and the device IRIG-B input port voltage level (VL (unmod)) is greater than the minimum required voltage of 3.5 Volts. Therefore, 6 devices can be connected to the clock.

5.3 Example 2

Consider 7 devices connected to the clock. Assume all devices are very close to the source, so round trip resistance is negligible. Does the installation meet the requirements?

Check output current from source:

5 Vp-p / [(500 Ω/7) + 10 Ω] = 61 mA Yes

Check voltage level at IEDs:

5 Vp-p x ([500 Ω/7]/[(500 Ω/7) + 10 Ω]) = 4.4 Vp-p Yes

The required current (IS) is less than the maximum current of the source and the device IRIG-B input port voltage level (VL (unmod)) is greater than the minimum required voltage. Therefore, 7 devices can be connected to the clock.

5.4 Example 3

Consider 10 ERLPhase devices connected to the clock. Assume all devices are at the end of a single 20 m length of Belden 8451 cable, so round trip resistance is approximately 2 Ω. Does the installation meet the requirements?

Check output current from source:

5 Vp-p / [(500 Ω/10) + 10 Ω + 2 Ω] = 80 mA No

Check voltage level at IEDs:

5 Vp-p x ([500 Ω/10]/[(500 Ω/10) + 10 Ω + 2 Ω]) = 4.0 Vp-p Yes

The required current (IS) is greater than the maximum output current of the clock source. Therefore, 10 devices cannot be connected to the clock source because the current requirement is greater than the clock can supply.

6. Summary

These guidelines should assist in understanding the use of the IRIG-B inputs to ERLPhase relays and recorders. This document has provided information on the number of units that can be connected, the type of wire to use, the specifications for unit IRIG-B port, and the required grounding.

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