

Technical Support

Technical Bulletin

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Product:	MVS-8600	Rev: All
Title:	Selecting An Encoder for the MVS-8600 and Special Consideration for Encoders with >5 Volt Output	

PURPOSE

This document outlines the electrical characteristics of encoders that are best suited to and compatible with the MVS-8600 Camera Link PCI frame grabbers used in Line Scan applications. The MVS-8600 is capable of supporting many types of encoders, but not all meet the electrical voltage and signal requirements. There are many types of rotary and linear encoders available to the user with a wide variety of electrical characteristics. Use this document as a guide when selecting an encoder for your Line Scan application. This document also describes a possible solution when the selected encoder does not meet the MVS-8600's encoder input requirements.

PROBLEM DESCRIPTION

It is very important to select an encoder with the proper electrical characteristics. Using an encoder with incompatible electrical characteristics on the MVS-8600 Camera Link PCI frame grabbers may result in damage to the encoder, the frame grabber, or both. The encoder may overheat and cause intermittent image acquisition problems such as image jitter and encoder overruns that can be very difficult to diagnose.

SOLUTION SUMMARY

The MVS-8600 I/O interface is multi-purpose and encompasses LVDS, RS-422, and TTL standards, but it provides overvoltage protection through the use of a +5V clamp on the signal interface. This means that the effective operating voltage input range is limited from 0V to 5V. **Cognex recommends using an encoder whose voltage output range is 5 volts maximum.**

Most differential RS-422 "compatible" encoders will be compatible as long as all the differential outputs are limited to 0 to +5V absolute range (referenced to ground), which is often the case when using a +5V power supply. For encoders with outputs greater than +5V, the recommended solution is to use series resistors. The value of these resistors is calculated based on the encoder's output voltage range with the goal of providing a balance of circuit current and signal quality.

Interface option	Encoder Output Absolute Voltage Range		
	0V ... +5V	0V ... +12V	0V ... 28V(max)
Series resistors (R ₁ , R ₂)	None needed	2.3kΩ (kOhms)	5.5kΩ (kOhms)

Table 1: Recommended series resistor values, refer to Figure 1 for wiring schematic

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TECHNICAL DETAILS OF SOLUTION

There are several interface standards used for incremental encoders, such as RS-422, RS-485, LVDS (EIA-644), Push-Pull, Open-Collector, Sink/Source, and various TTL type “Line Drivers.” Each of these interfaces has a specification for voltage minimum and maximum, current sourcing or sinking limits, cable type and length maximums, as well as numerous industry association standards. These are summarized in Table 2 below.

Specification	LVDS (EIA-644)	RS-422	TTL & 5V Line Driver	Push-Pull & Sink/Source ‡	Open Collector ‡
Output current (typ)	< 5 mA	< 150 mA	<100 mA	± 150 mA	20mA
Output Impedance (Ohms)	100 Ω	100 Ω	1 kΩ	Hi-Z	10k (typ)
Output Voltage Range Max (-CMV)	± 600 mV	± 12.0 V	0 to 5.5 V	NA	NA
Input common mode voltage	0 to 2.4V	± 7.0 V	NA	NA	NA
Input (differential) threshold minimum	± 100 mV	± 200 mV	.3V <> 1.2V	0 to VCC	0 to VCC
Transmission Distance	<30m	<100m	<10m	<50m	<10m

‡ Not fully tested or verified by Cognex on MVS-8600

Table 2: Specifications and standards

The MVS-8600 I/O interface is multi-purpose and encompasses LVDS, RS-422, and TTL standards, but provides overvoltage protection, without opto-isolation, through the use of a +5V clamp on the signal interface. This means that the effective operating voltage input range is limited from 0V to 5V. The over-voltage feature protects up to + 30V input with high current sinking limits (2 Amps maximum). Thus, when the MVS-8600 is operating in TTL mode, it is compatible with TTL line driver encoders and open collector or push/pull interfaces when they operate within the +5V limit for the encoder signals (such as A, B, Z, etc).

Additionally, the interface offers the benefits of operating in differential signaling mode (a positive and negative signal pair) to increase noise immunity and the signal to noise ratio (SNR), while reducing the effects of glitches and ground bounce in noisy electrical environments. However, some differential encoders may not be directly connected to the I/O without additional circuitry in order to meet the interface voltage and current requirements.

Generally, most differential RS-422 “compatible” encoders will be compatible as long as all the differential outputs (usually named A+, A-, B+, B-, etc) are limited to 0 to +5V absolute range referenced to ground, which is often the case when using a +5V power supply. It is also important to note that the common mode voltage is the average of the voltage between the positive and negative encoder signal pair. Unfortunately, most industrial environments have limited DC power supply sources available, and often +12V or +24V is used for encoders, resulting in a much higher voltage for the encoder signal outputs.

For encoders with signal outputs greater than +5V (absolute reference to ground), the signal needs to be made compliant with the input voltage requirements and properly conditioned, given the effect of the circuit’s overvoltage clamp.

A simple solution is to utilize a series resistor in the path between each of the encoder signal outputs. The resistor then functions as a voltage attenuation circuit. Its value is determined through Ohm’s Law - (Voltage)=(Current)·(Resistance) - and depends on the current loop through the 100 Ohm termination resistor. The wiring schematic is shown in Figure 1 with the added series resistors labeled as R₁ and R₂.

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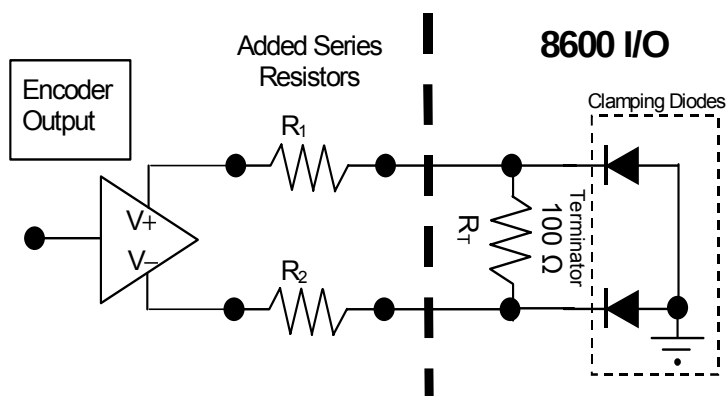


Figure 1: Schematic with series resistors

It is important to realize that the overvoltage protection diode will clamp the input voltage to a maximum of 5V, and as such, there will be a maximum voltage drop across R_1 . (When the polarity is switched, the clamp to ground is -0.3V for R_T). Additionally, in order to maintain balanced impedance for both the encoder positive signal (V_+) and encoder negative signal (V_-), both R_1 and R_2 should be of the same value. In this case, the differential receiver circuit voltage input can be as low as 0.5V (a ± 200 mV range with some small margin). Putting all this information together, it is then possible to calculate the resistor value required to provide the correct signal voltage with minimum current draw.

For the scenario of a 0V to 12V differential voltage signal pair (V_+ minus V_- is 12V), the resistor value is determined as shown.

$$V = I \cdot R$$

$$(R_1) = \frac{12V - 0.5V}{\frac{0.5V}{100\Omega}} = \frac{11.5V}{5mA} = 2300\Omega$$

Refer to Table 1 (reproduced below) for the various recommended resistor values, depending on the encoder's signal. It is important to note that, if necessary, line voltage regulators such as a passive decoupling capacitor can be added to the circuitry to bring the common mode voltage into the acceptable range, as given by the 0 to +5V absolute range (referenced to ground) requirement.

Interface option	Encoder Output Absolute Voltage Range		
	0V ... +5V	0V ... +12V	0V ... 28V(max)
Series resistors (R_1 , R_2)	None needed	2.3k Ω (kOhms)	5.5k Ω (kOhms)

Recommended series resistor values



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MOVING FORWARD

Refer to the MVS-8600 Hardware Manual installed with your software installation for additional information on encoders, electrical wiring, and their operation with the MVS-8600 Camera Link PCI frame grabber.