Very High Speed Counter Module Cat. No. 1771-VHSC

This release note contains information on:

- adherence to European Union Directive Compliance
- changes and additions to Figures 2-3 and 2-4
- revised specifications (Appendix A)
- revised Appendix C

European Union Directive Compliance

If this product is installed within the European Union or EEA regions and has the CE mark, the following regulations apply.

EMC Directive

This apparatus is tested to meet Council Directive 89/336/EEC Electromagnetic Compatibility (EMC) using a technical construction file and the following standards, in whole or in part:

- EN 50081-2 EMC – Generic Emission Standard, Part 2 – Industrial Environment
- EN 50082-2 EMC – Generic Immunity Standard, Part 2 – Industrial Environment

The product described in this manual is intended for use in an industrial environment.

Low Voltage Directive

This apparatus is also designed to meet Council Directive 73/23/EEC Low Voltage, by applying the safety requirements of EN 61131–2 Programmable Controllers, Part 2 – Equipment Requirements and Tests.

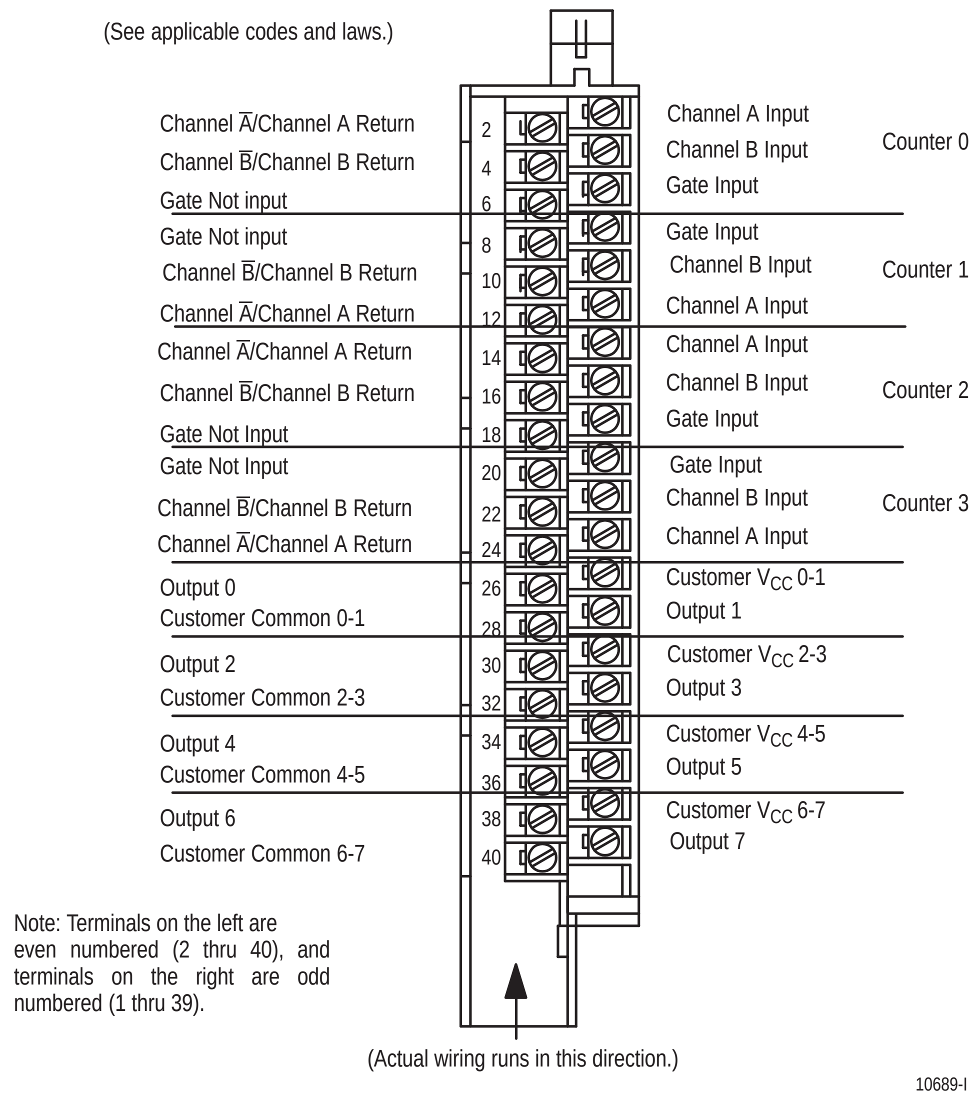
For specific information that the above norm requires, see the appropriate sections in this manual, as well as the following Allen-Bradley publications:

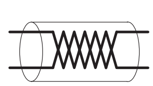
- Industrial Automation Wiring and Grounding Guidelines, publication 1770-4.1
- Guidelines for Handling Lithium Batteries, publication AG-5.4
- Automation Systems Catalog, publication B111

Connecting Wiring

Connect your I/O devices to the 40-terminal field wiring arm (cat. no. 1771-WN) shipped with the module. Attach the field wiring arm to the pivot bar at the bottom of the I/O chassis. The field wiring arm pivots upward and connects with the module so you can install or remove the module without disconnecting the wires.

Figure 2.3
Connection Diagram for Very High Speed Counter Module (Cat. No. 1771-VHSC)





The sensor cable must be shielded. The shield must:

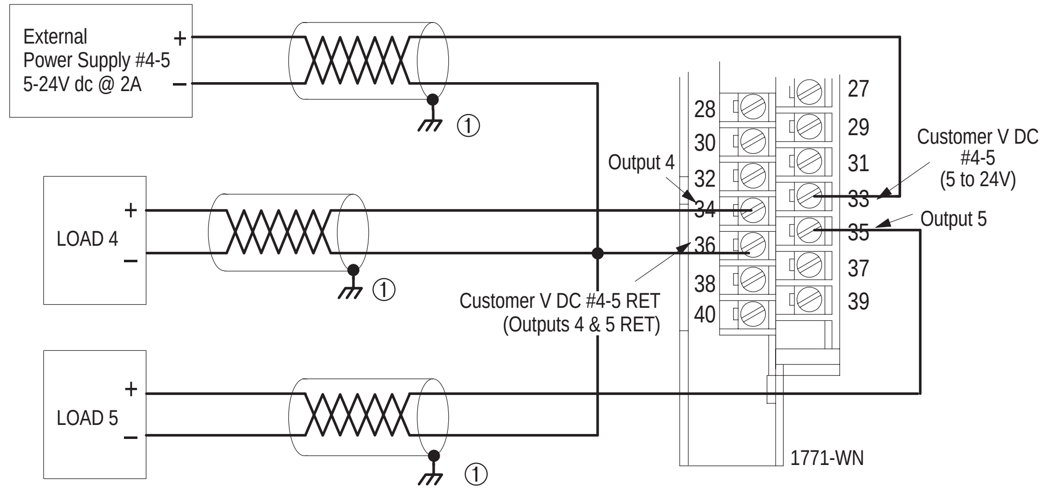
- extend the length of the cable, but be connected only at the 1771 I/O chassis
- extend up to the point of termination

Important: The shield should extend to the termination point, exposing just enough cable to adequately terminate the inner conductors. Use heat shrink or another suitable insulation where the wire exits the cable jacket.

Addition to Figure 2-3, Connection Diagram

Add the following to the connection diagram on page 2-5.

Standard Output



① For new installations, terminate the shields at the chassis. While not recommended, existing installations can continue to terminate the shields at the return (RET) terminal.

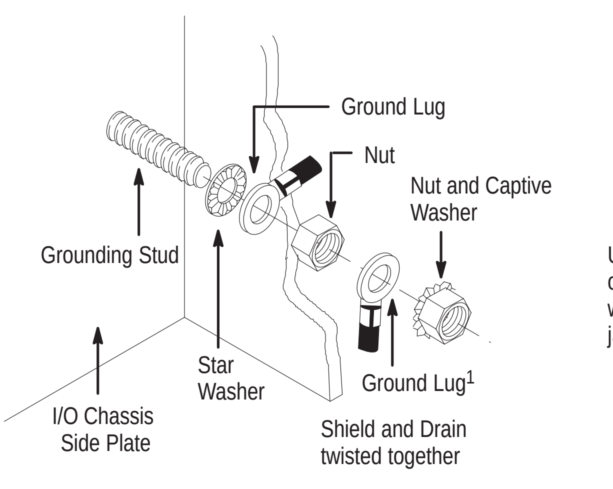
Revised Figure 2-4

The following figure replaces the current cable grounding figure.

Figure 2.4
Cable Grounding

Chassis Ground

When you connect grounding conductors to the I/O chassis grounding stud, place a star washer under the first lug, then place a nut with captive lock washer on top of each ground lug.



1Use the cup washer if crimp-on lugs are not used.

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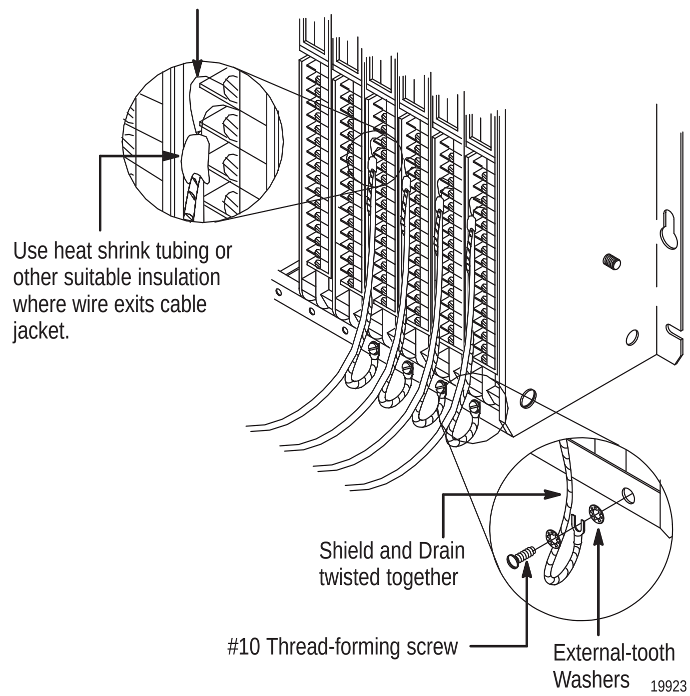
Single-point Grounding

Extend shield to termination point. Expose just enough cable to adequately terminate inner conductors.



Change to Specifications, Appendix A

Replace the existing specification table with the following revised specifications.

Number of Counters	4
Module Location	1771 Series A or B I/O chassis
Maximum Count Value	0–999,999 (programmable)
BTW Processing Time (worst case)	5.5ms - binary } on a configuration change 11ms - BCD } (1.5-2.9ms — typical)
Maximum Input Frequency	100Hz for switch bounce; electromechanical switch (user-selectable) 250kHz in encoder modes (2–channel quadrature) 500kHz in period/rate, rate/measurement and continuous/rate modes 1MHz in counter modes (single channel)
Inputs per Counter	3 – A, B, Gate/reset
Input Voltage	5V or 12–24V (user selectable)
Input Current	Typically 20mA @ 5V; 8.7 to 19.0mA @ 12–24V
Minimum Input Current	5mA
Number of Outputs	8
Maximum Output Off-state Leakage Current	less than 10µA @ 24V dc
Maximum On-state Voltage Drop	0.05Ω x current
Output Control	Any number of outputs are assignable to any of 4 counter channels. One “turn–on” preset value and one “turn–off” preset per output.
Output Voltage	5 to 24V dc, customer supplied
Output Current	2A per channel sourced out of module. All outputs can be on simultaneously without derating.
Output Switching Time	< 10µs turn on; < 100µs turn off Typical: 3µs turn on; 30µs turn off
Filtering	Selectable — high-speed or normal (normal = below 100Hz)
Backplane Current	650mA
Isolation Voltage	1500V between input and backplane 1500V between output and backplane 300V between isolated channels
Power Dissipation	13 Watts (max); 2 Watts (min)
Thermal Dissipation	54.2 BTU/hr (max); 6.8 BTU/hr (min)
Input Conductors — Wire Size Category Length	Belden 9182 Category 2[1] 250 feet (76.2m)
Output Conductors — Wire Size Category	Belden 8761 Category 1[1]
Fuse	2AG 3A fuse — Littelfuse 225003
Environmental Conditions — Operating Temperature Storage Temperature Relative Humidity	0 to 60°C (32 to 140°F) –40 to 85°C (–40 to 185°F) 5 to 95% (without condensation)
Keying	Between 24 and 26 Between 28 and 30
Field Wiring Arm	40-terminal cat. no. 1771–WN
Wiring Arm Screw Torque	7-9 inch-pounds
Agency Certification (when product or packaging is marked)	• CSA certified • CSA Class I, Division 2, Groups A, B, C, D certified • UL listed • CE marked for all applicable directives

[1] Use this conductor-category information for planning conductor routing as described in the system-level installation manual.

Change to Appendix C

Due to certain component changes, the entire appendix has been revised. Use this appendix in place of Appendix C in the May 1993 version of publication 1771-6.5.74.

Application Considerations

Appendix Objectives

This appendix will provide you with background for selecting the appropriate input device for your 1771-VHSC module, explain the output circuit, and provide you with information for selecting the type and length of input cabling.

Types of Input Devices

To turn on an input circuit in the VHSC module, you must source current through the input resistors sufficient to turn on the opto-isolator in the circuit.

If no connection is made to a pair of input terminals, no current will flow through the photodiode of the opto-isolator and that channel will be off. Its corresponding input status indicator will be off.

All 12 inputs are electrically identical.

There are 2 basic classes of driver devices built-in to encoders and other pulse sources: single-ended and differential. A single-ended driver output consists of a signal and a ground reference. A differential driver consists of a pair of totem-pole outputs driven out of phase. One terminal actively sources current while the other sinks, and there is no direct connection to ground.

Differential line drivers provide reliable, high speed communication over long wires. Most differential line drivers are powered by 5V, and are more immune to noise than single-ended drivers at any operating voltage.

Any installation must follow customary good wiring practices: separate conduit for low voltage dc control wiring and any 50/60Hz ac wiring, use of shielded cable, twisted pair cables, etc. Refer to publication 1770-4.1, “Programmable Controller Wiring and Grounding Guidelines” for more information.

Examples for Selecting Input Devices

The following examples will help you in determining the best input type for your particular application. These examples include:

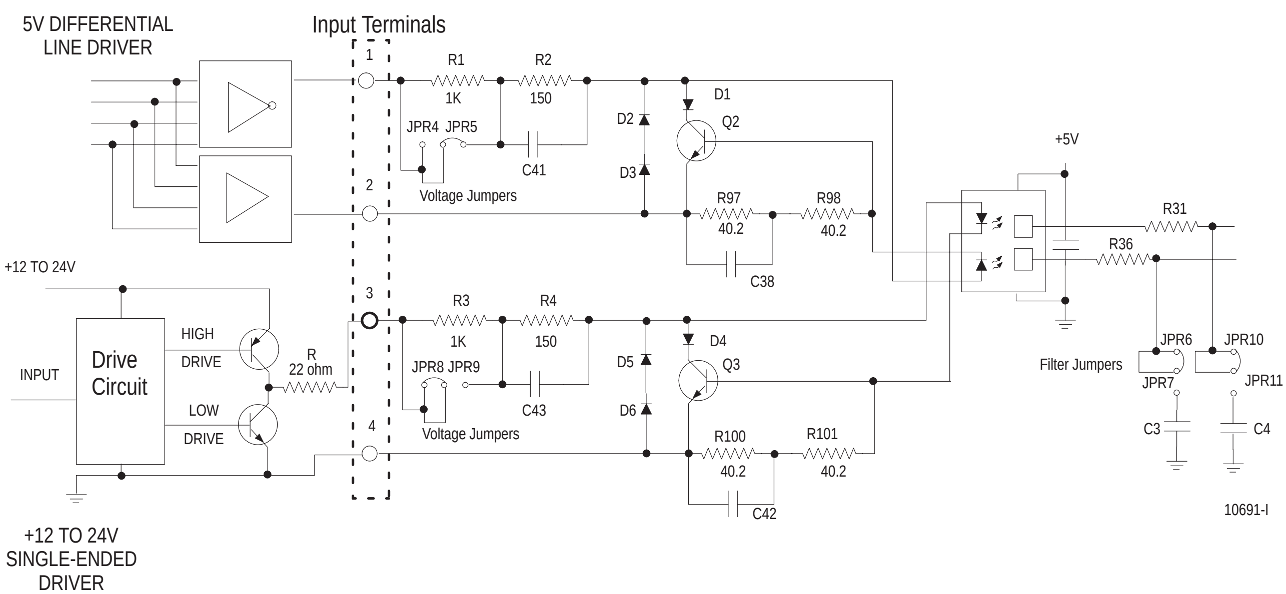
- 5V differential line driver
- single-ended driver
- open collector circuit
- electromechanical limit switch

Circuit Overview

To make sure your signal source and the 1771-VHSC module are compatibility, you need to understand the electrical characteristics of your output driver and its interaction with the 1771-VHSC input circuit.

Refer to Figure C.1. The most basic circuit would consist of R1, R2, JPR4, JPR5, the photodiode and associated circuitry around half of the opto-isolator. The resistors provide first-order current limiting to the photodiodes of the dual high speed opto-isolator. With JPR4 closed, and JPR5 open, the total limiting resistance is R1 + R2 = 1150 ohms. This jumper position is designated "12 to 24 Volt Range." Assuming a 2V drop across the photodiode and R97 and R98, you would have 8.7-19mA demanded from the driving circuit as the applied voltage ranged from 12 to 24V.

Figure C.1
Example Circuits for 5V Differential and +12 to +24V Single-Ended Drivers



In the "5 Volt" position (JPR4 open; JPR5 closed), R1 is shorted and the limiting resistance is 250 ohms. If 5.0V was applied at the input, the current demanded would be (5.0 - 2.0)/150 = 20mA.

The above type of calculation is necessary to the user since the driving device must cause a minimum of 5mA to flow through the photodiode regardless of which jumper position is selected.

The optical isolator manufacturer recommends a maximum of 8mA to flow through the photodiode. This current could be exceeded in the 24V position. To obtain this limit, a dc shunt circuit is included, consisting of D1, Q2, R97 and R98. If the photodiode current exceeds about 8mA, the drop across R97-R98 will be sufficient to turn Q2 on, and any excess current will be shunted through D1 and Q2 instead of through the photodiode.

If the driving device is a standard 5V differential line driver, D2 and D3 provide a path for reverse current when the field wiring arm terminal 1 is logic low and terminal 2 is logic high. The combined drop is about the same at the photodiode (about 1.4V). The circuit appears more symmetrical, or balanced, to the driver as opposed to just one diode.

Detailed Circuit Analysis

In the example above, we used a constant 2.0V drop across the photodiode and R97-R98. To calculate the true photodiode current, consider the photodiode, D1, Q2, R97 and R98 as one circuit. The voltage drop across D1 and Q2 will always be equal to the drop across the photodiode and R97-R98. We will call this V_{drop}.

First, consider the minimum requirement of I_f = 5mA.The V_f curves for this photodiode will typically have a 1.5V drop With 5mA current, R97 and R98 will drop (80.4 ohms x 5mA) = 0.40V. Thus, at 5mA,

$$V_{drop} = (1.5V + 0.40V) = 1.90V.$$

Now let's see what happens when I_f goes to 8mA or above. With the temperature about half way between 25 and 70ºC, V_f becomes about 1.5V. R97-R98 will now drop 0.64V (80.4 ohms x 8mA). That means:

$$V_{drop} = 1.5V + 0.64V = 2.14V.$$

The V_{be} of Q2 is now sufficient to start to turn Q2 on. If the current through the photodiode increases to 9mA, V_{be} becomes 0.72V and Q2 is fully on. Any additional current (supplied by a 24V applied input) will be shunted away from the photodiode and dissipated in Q2 and D1.

Thus, Vdrop will never exceed about 2.52V regardless of the applied voltage. In addition, it will never be less than 1.7V if the minimum of 5mA is flowing. Although there are some minor temperature effects on the photodiode drop, you can expect the value Vdrop to be relatively linear from about 1.9V to 2.14V as the current increases from 5mA to 8mA.

Why is this important? Let's look at the 5V differential line driver example below.

5V Differential Line Driver Example

You want to use a 5V differential line driver in your encoder when you have a long cable run and/or high input frequency or narrow input pulses (input duty cycle < 50%). The top circuit (NO TAG) shows a typical 5V differential line driver. The output is connected to the field wiring arm terminal 1 and is sourcing current and the output to terminal 2 is sinking current. JPR5 is connected to short out resistor R1.

Important: Neither output of the differential line driver can be connected to ground. Damage could occur to your driving device.

To be sure that your device will drive the 1771-VHSC, you must know the electrical characteristics of the output driver component used in your signal source device. The output voltage differential $V_{diff} = (V_{oh} - V_{ol})$ is critical, because this is the drive voltage across the 1771-VHSC input terminals 1 and 2, and the photodiode current is a function of $V_{diff} - V_{drop}$.

The manufacturer of your shaft encoder or other pulse-producing device can provide information on the specific output device used.

Note: Any signal source which uses a standard TTL output device driver rated to source 400μA or less in the high logic state is not compatible with the 1771-VHSC module.

Many popular differential line drivers, such as the 75114, 75ALS192, and the DM8830 have similar characteristics and can source or sink up to 40mA.

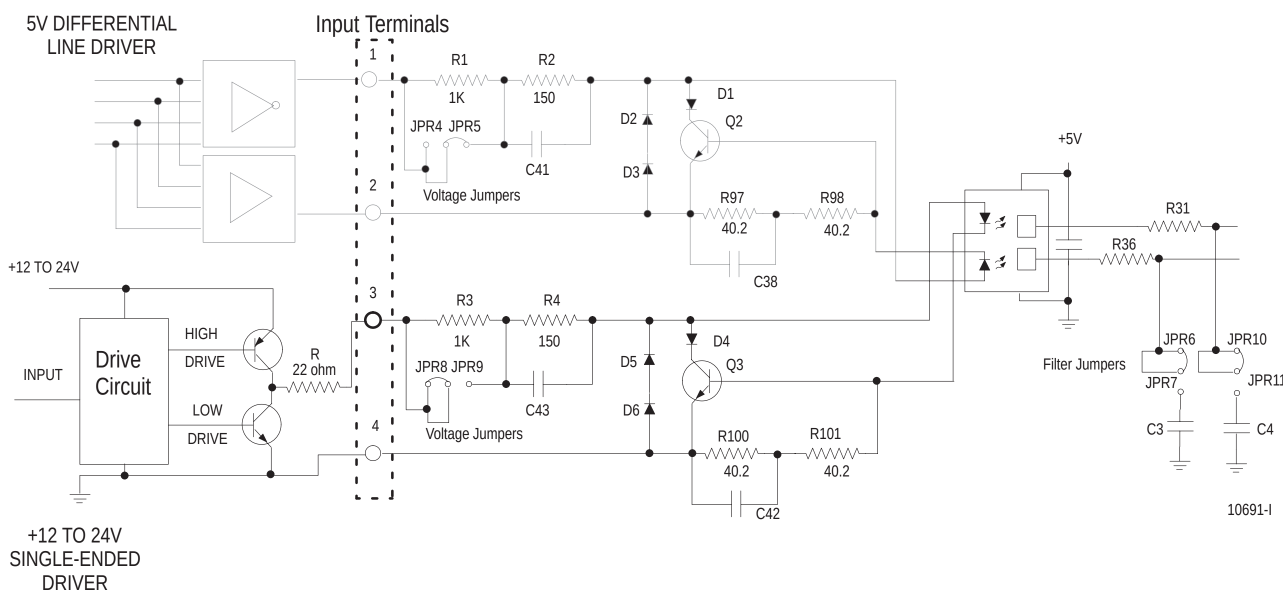
In general, the output voltage V_{oh} will be higher both as the supply voltage and the ambient temperature increase. For example, vendor data for the 75114 shows V_{oh} will be about 3.35V at V_{cc} = 5 V, I_{oh} = 10mA and 25ºC. Vol will be about 0.075V under the same conditions. This means $V_{differential} = V_{oh} - V_{ol}$ = 3.27V if the part is sourcing 10mA. Looking at the curves, if the part were sourcing 5mA you would see V_{diff} = 3.425 - 0.05 = 3.37V.

Assuming that you could supply 5mA to the 1771-VHSC input terminals, how much voltage across the field wiring arm terminals would be required? V_{drop} would be about 1.9V as previously noted. And 5mA through 150 ohms gives an additional 0.75V drop. Thus, you would have to apply about (1.9V + 0.75V) = 2.65V across the terminals to cause a current of 4mA to flow through the photodiode. The 75114 will give about 3.3V at V_{cc} = 5V and 25ºC. Thus you know that this driver will cause more current to flow than the minimum required at 5mA.

+12 to +24V Single-Ended Driver

Some European-made encoders use a circuit similar to the lower circuit in Figure C.2. The current capable of being sourced is limited only by the 22 ohm resistor in the driver output circuit (R). If a 24 volt supply is used, and this driver supplies 15mA, the output voltage would still be about 23V (15mA x 22 ohms = 0.33V, and Vce = .7V).

Figure C.2
Example Circuits for 5V Differential and +12 to +24V Single-Ended Drivers



If the input jumper is in position JPR8, the current to the photodiode is limited by the series resistance of R3 and R4 (about 1.15Kohms). A protection circuit consisting of Q3, R100 and R101 is included. If the current through the photodiode exceeds about 8mA, the voltage across R100 and R101 is sufficient to turn Q3 on, shunting any additional current away from the photodiode. The voltage drop across Q3 will be equal to about 2V (Vphotodiode + Vbe = 2V). The current demanded by the 1771-VHSC input circuit would be about 18mA (23V - 2V/1.15K = 18mA) which is well within the capability of this driver.

Open Collector

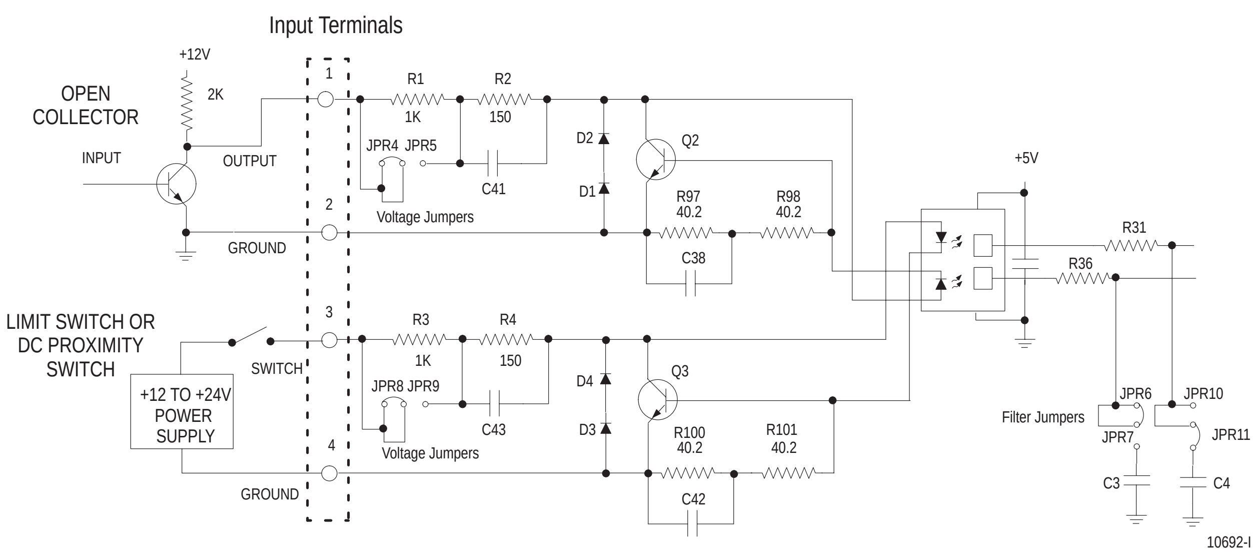
Open collector circuits (the upper circuit in Figure C.3) require close attention so that the input voltage is sufficient to produce the necessary source current, since it is limited not only by the 1771-VHSC input resistors but also the open collector pull-up. Jumper position provides some options as shown in the table below.

Supply Voltage verses Jumper Settings

Supply Voltage	Jumper Setting	Total Impedance	Available Current
+12	JPR4	3.15K	3.2mA (insufficient)
+12	JPR5	2.15K	4.65mA (insufficient)
+24	JPR4	3.15K	7mA (optimal)
+24	JPR5	2.15K	10.2mA (okay)

In this example, you must increase the supply voltage above +12V to make sure there is sufficient input current to overcome the additional 2K source impedance. Note that there is insufficient current with the jumper in the 12-24V position and a +12V supply.

Figure C.3
Example Circuits for Open Collector and Electromechanical Limit Switch



Electromechanical Limit Switch

When using an electromechanical limit switch (the lower circuit in Figure C.3), you must connect the low speed limit capacitor (C4) using jumper JPR11. The RC time constant of R31 and C4 will filter out switch contact bounce. However, this limits the frequency response to around 100Hz. This circuit would be similar when using dc proximity switches, but bounce should not occur unless severe mechanical vibration is present. In either case, source impedance is very low. If you are using a +12 to +24V power supply keep jumper JPR8 in the circuit to add the additional 1K impedance.

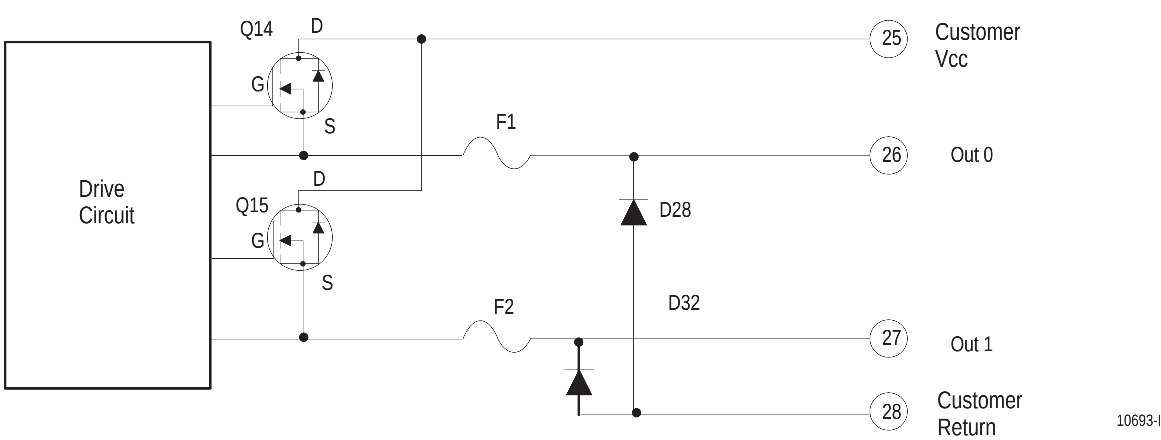
ATTENTION: While the transistor protection circuit limits the optoisolator current to a safe value, make certain that the voltage range jumper JPR9 is not in the circuit. With JPR9 in, you can exceed the 1 Watt dissipation rating on the 150 ohm resistor (R4) and cause permanent damage to the circuit.

Output Circuits

The 1771-VHSC module contains 4 isolated pairs of output circuits. Customer supplied power, ranging from +5V to +24V dc, is connected internally (through terminal Vcc) to the power output transistors. Refer to Figure C.4.When an output is turned on, current flows into the drain, out of the source, through the fuse and into the load connected to the ground of the customer supply (customer return). Diodes D28 and D32 protect the power output transistors from damage due to inductive loads.

If local electrical codes permit, outputs can be connected to sink current. This is done by connecting the load between the power supply + terminal and the customer Vcc terminal on the field wiring arm. The output terminal is then connected directly to ground (customer return). Note that this wiring method **does not** provide inductive load protection for the power output transistors.

Figure C.4
Output Circuit Diagram



Application Considerations

A successful installation depends on the type of input driver, input cable length, input cable impedance, input cable capacitance, frequency of the input.

The following provides information on these installation factors for the 1771-VHSC module.

Input Cable Length

Maximum input cable length depends on the type of output driver in your encoder, the kind of cable used, and maximum frequency at which you will be running. With a differential line driver, 250 feet or less of high quality, low capacitance cable with an effective shield, and an operating frequency of 250KHz or less will likely result in a successfully installation.

If you use an open collector, or other single-ended driver, at distances of 250 feet and frequencies of 250KHz, your chances of success are low. Refer to the table below for suggested desirable driver types.

Desirable	Adequate	Undesirable
5V Line Drivers: such as DM8830, DM88C30, 75ALS192 or equivalent	Balanced Single-Ended: any AC or ACT family part or Discrete, balanced circuit or Open-Collector: suitable for frequencies of < 50KHz	Standard TTL or LSTTL Gates

Totem-pole Output Devices

Standard TTL totem-pole output devices, such as 7404 and 74LS04, are usually rated to source 400 microamps at 2.4V in the high logic state. This is not enough current to turn on a 1771-VHSC input circuit. If your present encoder has this kind of electrical output rating, you cannot use it with the VHSC module.

Most encoder manufacturers, including Allen-Bradley, offer several output options for a given encoder model. When available, choose the high current 5V differential line driver.

Cable Impedance

Generally, you want the cable imedance to match the source and/or load as closely as possible. Using 150 ohm Belden 9182 (or equivalent) cable more closely matches the impedance of both encoder and module input circuits than 78 ohm cable, such as Belden 9463. A closer impedance match minimizes reflections at high frequencies.

Termination of one, or both ends, of the cable with a fixed resistor whose value is equal to the cable impedance will not necessarily improve “reception” at the end of the cable. It will, however, increase the dc load seen by the cable driver.

Cable Capacitance

Use cable with a low capacitance as measured per unit length. High capacitance rounds off incoming square wave edges and takes driver current to charge and discharge. Increasing cable length causes a linear increase in capacitance, which reduces the maximum usable frequency. This is especially true for open collector drivers with resistive pull-ups. For example, Belden 9182 is rated at a very low 9pF/foot.

Cable Length and Frequency

When cable length or frequency goes up, your selection of cable becomes even more critical. Long cables can result in changes in duty cycle, rise and fall times, and phase relationships. The phase relationship between channels A and B in encoder X1 and X4 mode is critical.

The maximum encoder input of 250KHz is designed to work with Allen-Bradley Bulletin 845H or similar incremental encoders with a quadrature specification of 90º (±22º) and a duty cycle specification of 50% (±10%). Any additional phase or duty cycle changes caused by the cable will reduce the specified 250KHz specification.

For any application over 100 feet, and/or over 100KHz, use Belden 9182, a high performance twisted-pair cable with 100% foil shield, a drain wire, moderate 150 ohm inpedance and low capacitance per unit length.

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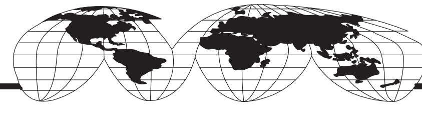

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Publication 1771-6.5.74-RN1 – December 1995 PN955124–26