Motion Engineering, Inc.
33 South La Patera Lane
Santa Barbara, CA 93117-3214
ph (805) 681-3300
fax (805) 681-3311
tech@motioneng.com
www.motioneng.com

Release Note

How to Use the OptoCon Connection Module

Option C002-0007 **Revision 4** **Revised 8/13/98**

1 Introduction

The Optical Isolation Connection Module (OptoCon) is a connection accessory for Motion Engineering's LC/DSP, 104/DSP and SL/DSP motion controllers. The OptoCon converts a 50-pin ribbon cable (from the motion controller) to screw terminal connections. The OptoCon replaces the standard passive Phoenix Contact terminal block (STC-50) with an *active* terminal block that provides optical isolation and fused overvoltage protection for dedicated and user I/O.

The OptoCon and STC-50 have the same physical dimensions. The pinouts are identical except that a ground and +5 volt connection on the screw terminal block have been replaced with an opto-ground and an opto-Vcc (5-24 volts). Two microswitches configure the direction of 3 user I/O ports.

Each OptoCon supports 2 motion control axes, dedicated I/O (2 axes) and 10 lines of user I/O. Connector P1 is a 50-pin IDC connector, and is compatible with the LC/DSP, SL/DSP and 104/DSP controllers. Four-axis applications require using 2 OptoCon modules. The OptoCon requires that you use the CBL-100 cable, with each CBL-100 cable supporting up to 4 axes of control.

2 Switch Settings

Switch S1

The dedicated output circuits (Amp Enable & In Position) of the OptoCon have pull-down resistors on their inputs that prevent unwanted output transitions during a motion controller reset or power-up sequence. Refer to the *Output Circuit* figure on page 7. To disable the pull-down resistors, use switch S1.

Note:	The **Amp Enable pull-down resistors should only be enabled** when the Amp Enables are configured as **Active High** on the motion controller.

If either of the Amp Enable outputs are configured as *Active Low*, the appropriate pull-down resistor should be disabled (as indicated in the table below). To configure the Amp Enables for *Active High* or *Active Low* operation, use the MEI library function **set_boot_amp_enable_level(...)**.

Note:	Because the *In Position* outputs are always *Active High*, **the pull-down resistors for the *In Position* outputs should always be enabled**.

Table 1 Switch S1 Settings (To enable/disable pull-down resistors)

	Position	***Setting***	***Signal***	***Pull-Down Resistor is***
Switch S1	1	On	Amp Enable(0/2)	Enabled
	1	Off	Amp Enable(0/2)	Disabled
	2	On	In Position(0/2)	Enabled
	2	Off	In Position(0/2)	Disabled
	3	On	Amp Enable(1/3)	Enabled
	3	Off	Amp Enable(1/3)	Disabled
	4	On	In Position(1/3)	Enabled
	4	Off	In Position(1/3)	Disabled

Switches S2, S3

To configure the User I/O opto-isolation circuitry as inputs or outputs, use switches S2 and S3. Use the settings in Table 2 to set the input and output directions.

The directions set with the switches should match those set on the controller using the MEI library function **init_boot_io(...)**, so that the OptoCon and the controller are configured the same at power-up. After using **init_boot_io(...)** to configure a port's direction, do not use **init_io(...)** to reconfigure the port's direction.

Warning!	**You can only use the switch settings shown in the table.** Other switch settings may damage the OptoCon circuits.

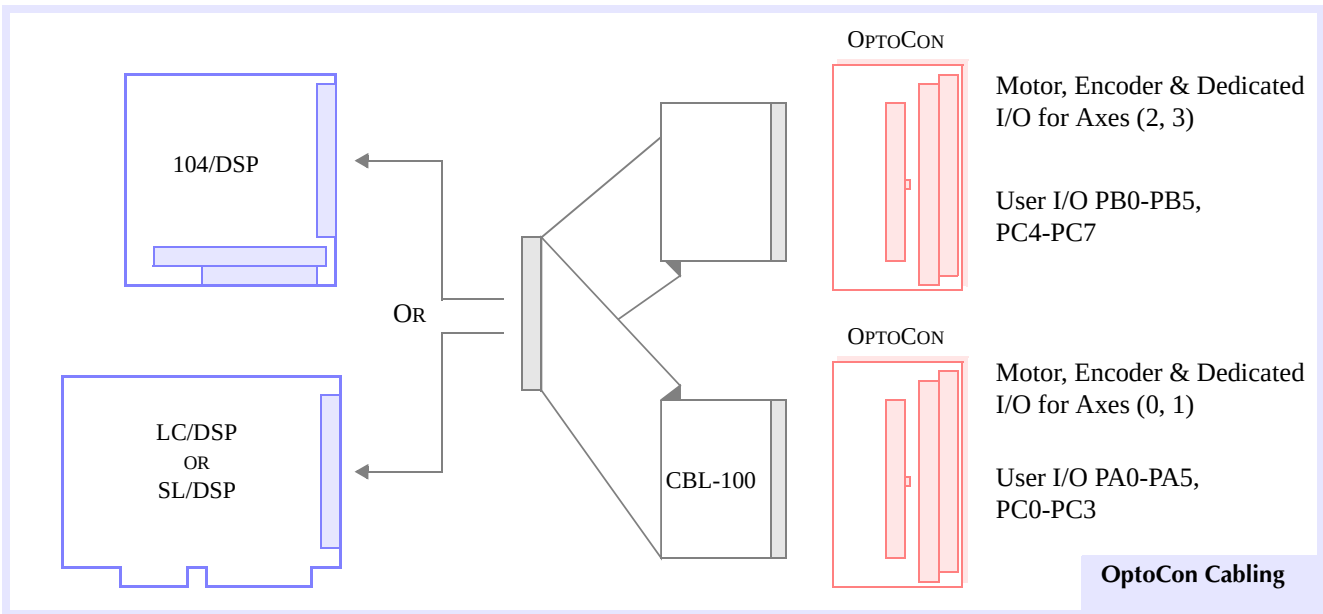
Table 2 Switch S2/S3 Settings (To configure User I/O as inputs or outputs)

	Position	*Port A/B Input Port C Input*	*Port A/B Input Port C Output*	*Port A/B Output Port C Input*	*Port A/B Output Port C Output*
Switch S2	1	Off	Off	On	On
	2	Off	On	Off	On
	3	Off	Off	On	On
	4	Off	Off	On	On
Switch S3	1	Off	Off	On	On
	2	Off	Off	On	On
	3	Off	Off	On	On
	4	Off	Off	On	On
	5	Off	On	Off	On
	6	Off	On	Off	On
	7	Off	On	Off	On
	8	Off	On	Off	On

3 Installation Steps

Before connecting any cables or wires to the OptoCon, you must correctly set the switches as described in the preceding section. **Only the settings shown in the table are allowed!** Other settings may cause damage to the OptoCon module and/or the controller card.

Connect the 100-pin connector on MEI accessory cable CBL-100 to the 100-pin header on the LC/DSP or 104/DSP. Connect either of the two 50-pin connectors on the CBL-100 to the 50-pin header on the OptoCon.



4 Screw Terminal Connectors

4.1 For Axes 0, 1

Table 3 Screw Terminal Connector (Axes 0, 1)

Pin	*Signal*	*Pin*	*Signal*
1	+5V	2	V_USER
3	Encoder A(0) +	4	Encoder A(1) +
5	Encoder A(0) -	6	Encoder A(1) -
7	Encoder B(0) +	8	Encoder B(1) +
9	Encoder B(0) -	10	Encoder B(1) -
11	Encoder Index(0) +	12	Encoder Index(1) +
13	Encoder Index(0) -	14	Encoder Index(1) -
15	+/- 10V Analog Out(0)	16	+/- 10V Analog Out(1)
17	GND	18	USER_GND
19	Step Pulse(0) +	20	Step Pulse(1) +
21	Step Pulse(0) -	22	Step Pulse(1) -
23	Direction(0) +	24	Direction(1) +
25	Direction(0) -	26	Direction(1) -
27	Positive Limit(0)	28	Positive Limit(1)
29	Negative Limit(0)	30	Negative Limit(1)
31	Home Input(0)	32	Home Input(1)
33	Amp Fault(0)	34	Amp Fault(1)
35	Amp Enable(0)	36	Amp Enable(1)
37	In Position(0)	38	In Position(1)
39	User I/O PA0	40	User I/O PA3
41	User I/O PA1	42	User I/O PA4
43	User I/O PA2	44	User I/O PA5
45	User I/O PC0	46	User I/O PC2
47	User I/O PC1	48	User I/O PC3
49	GND	50	USER_GND

Note	Signals in gray are optically-isolated.

4.2 For Axes 2, 3

Table 4 Screw Terminal Connector (Axes 2, 3)

Pin	*Signal*	*Pin*	*Signal*
1	+5V	2	V_USER
3	Encoder A(2) +	4	Encoder A(3) +
5	Encoder A(2) -	6	Encoder A(3) -
7	Encoder B(2) +	8	Encoder B(3) +
9	Encoder B(2) -	10	Encoder B(3) -
11	Encoder Index(2) +	12	Encoder Index(3) +
13	Encoder Index(2) -	14	Encoder Index(3) -
15	+/- 10V Analog Out(2)	16	+/- 10V Analog Out(3)
17	GND	18	USER_GND
19	Step Pulse(2) +	20	Step Pulse(3) +
21	Step Pulse(2) -	22	Step Pulse(3) -
23	Direction(2) +	24	Direction(3) +
25	Direction(2) -	26	Direction(3) -
27	Positive Limit(2)	28	Positive Limit(3)
29	Negative Limit(2)	30	Negative Limit(3)
31	Home Input(2)	32	Home Input(3)
33	Amp Fault(2)	34	Amp Fault(3)
35	Amp Enable(2)	36	Amp Enable(3)
37	In Position(2)	38	In Position(3)
39	User I/O PB0	40	User I/O PB3
41	User I/O PB1	42	User I/O PB4
43	User I/O PB2	44	User I/O PB5
45	User I/O PC4	46	User I/O PC6 (or DSP Interrupt)
47	User I/O PC5	48	User I/O PC7 (or PC Interrupt)
49	GND	50	USER_GND

Note:	Signals in gray are optically-isolated.

5 Specifications

All optically isolated outputs (Amp Enables, In Position bits and User I/O) and the V_USER input are protected by automatic fuses. When tripped, these fuses automatically reset themselves within a few seconds.

Table 5

Operating temperature range	0 – 50° C
Isolation voltage	2500 V_{RMS}
V_USER voltage range	5 – 24 V_{DC}
V_USER voltage fuse trip current	1 A

Table 6 Inputs

	V_USER = 5 VDC	***V_USER = 24 VDC***
"On" threshold voltage	0.6 V max	19 V max
Propagation delay High-Low, t_{PDHL}	50 µsec max	20 µsec max
Propagation delay Low-High, t_{PDLH}	300 µsec max	400 µsec max

Table 7 Outputs

	V_USER = 5 VDC	***V_USER = 24 VDC***
"On" state output *voltage*	0.25 V @ 250mA	0.25 V @ 250mA
"On" state output *current*	250 mA max	250 mA max
"Off" state output *leakage current*	25 µA max	25 µA max
Propagation delay Low-High, t_{PDLH}	10 µsec max	20 µsec max
Propagation delay High-Low, t_{PDHL}	300 µsec max	100 µsec max
Output *rise time*, t_R	5 µsec max	5 µsec max
Output *fall time*, t_F	75 µsec max	25 µsec max

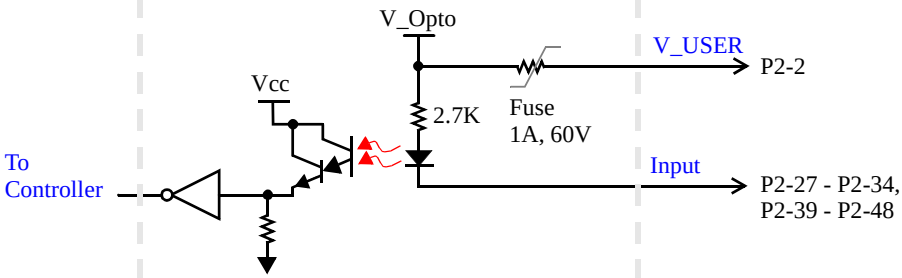
6 Schematics

All OptoCon input circuits are electrically identical, as are the output circuits. To program the User I/O signals (OptoCon 1: PA0-5, PC0-3; OptoCon 2: PB0-5, PC4-7) as inputs or outputs, you use the switches S2 and S3 on the OptoCon and you must also use the MEI library function **init_boot_io(...)** on the motion controller. After using **init_boot_io(...)** to configure a port's direction, do not use **init_io(...)** to reconfigure the port's direction.

The Dedicated I/O signals (Amp Enable, In Position, Positive Limit, Negative Limit, Home and Fault) cannot be reconfigured. All of the I/O signals share a common supply voltage, V_USER/USER_GND, which is fused at 1 amp. Additionally, each individual output is fused at 1 amp.

The next 2 figures show typical circuits used on the Inputs and Outputs of the OptoCon.

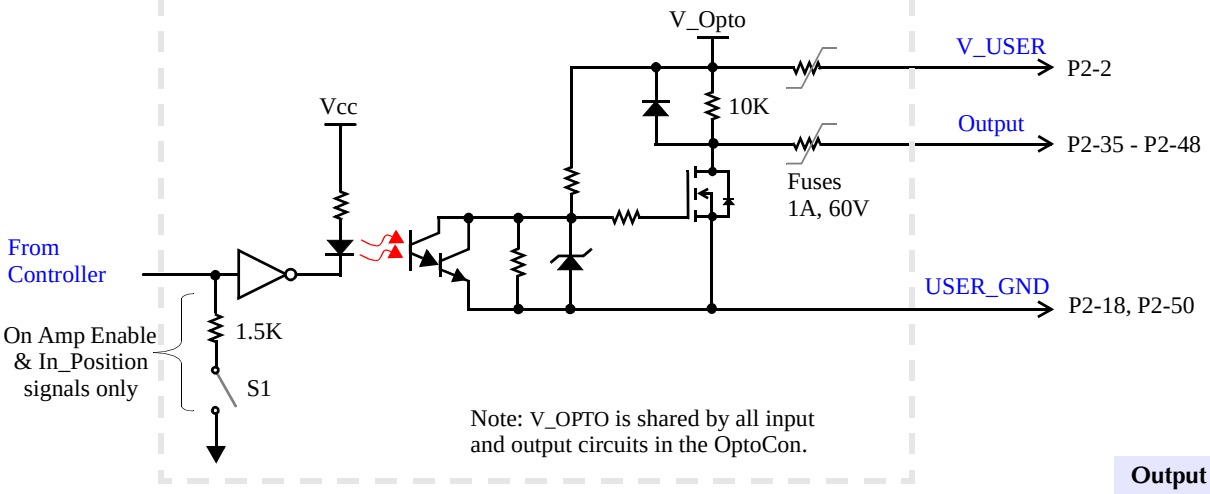
TYPICAL INPUT CIRCUIT



Note: V_OPTO is shared by all input and output circuits in the OptoCon.

Input Circuit

TYPICAL OUTPUT CIRCUIT



Note: V_OPTO is shared by all input and output circuits in the OptoCon.

Output Circuit

7 Circuit Examples

7.1 Connect an OptoCon Input to a Switch

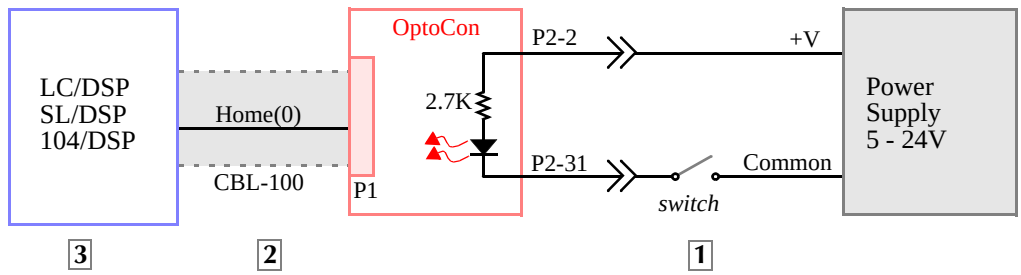
The next figure shows how to connect an OptoCon input to detect the state of a Home switch. This circuit will also work for *any* of the OptoCon inputs.

Your system must supply the voltage that is connected to V_USER on connector P2 on the OptoCon (P2-2). The switch is connected between your power supply *Common* and P2-31.

Use the MEI library functions **set_home_level(...)** or **set_boot_home_level(...)** to configure the Home(0) input on the MEI motion controller for either *Active High* or *Active Low* event generation logic.

The truth table below shows the values that the motion controller will read, depending upon the state of the switch and the configuration of the Home event logic. For example, if the switch is open, the Home input will he high (1), and if the Home event logic is configured for *Active High*, the controller will generate an event.

For input circuitry, see schematics on page 7.



1	2	3	
Switch State	Home Input (State)	Active High (Event?)	Active Low (Event?)
Open	1	Yes	No
Closed	0	No	Yes

*Use **home_switch(...)** to read the Home input state.*

*Use **axis_state(...)** to read the event generation.*

Switch to OptoCon Input

7.2 Connect an OptoCon Input to an Open Collector Driver

The next figure shows how to connect an OptoCon input to detect the state of an open collector driver. This circuit will also work for *any* of the OptoCon inputs.

Your system must supply the voltage that is connected to V_USER on connector P2 on the OptoCon (P2-2). The collector of the driver transistor is connected to the Home(0) input, P2-31.

Use the MEI library functions **set_home_level(...)** or **set_boot_home_level(...)** to configure the Home(0) input on the MEI motion controller for either *Active High* or *Active Low* event generation logic.

The truth table below shows the values that the motion controller will read, depending upon the state of the driver transistor and the configuration of the Home event logic. For example, if the *In* = 1 (turning the transistor *On*), the Home input will be low (0), and if the Home event logic is configured for *Active High*, the controller will *not* generate an event.

When *In* is high, the driver transistor is required to sink the current flowing through the opto-isolator diode. The driver transistor must be capable of sinking this current. To calculate I_C:

$$I_C \cong (V - V_D - V_{CE}) / 2700$$

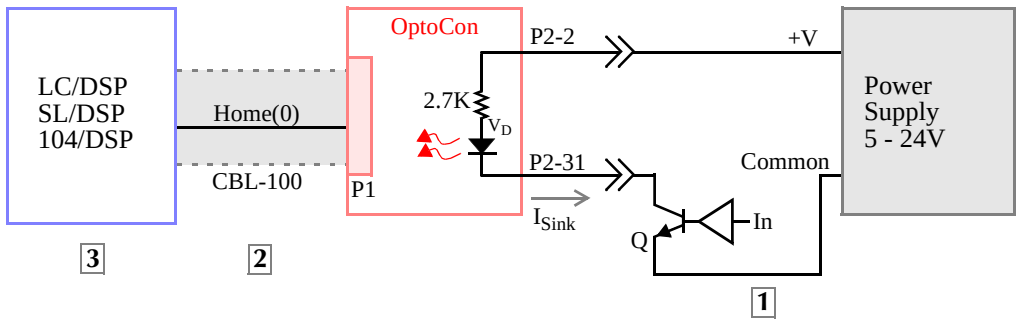
V = Your system's power supply voltage

V_D = Voltage across diode, $V_D \cong 1V$

V_{CE} = Collector-emitter *"On" voltage* for Q

For V = 24V, V_{CE} = 0.2V and $I_C \cong 8.4$ mA.
For V = 5V, V_{CE} = 0.2V and $I_C \cong 1.4$ mA.

For input circuitry, see schematics on page 7.



1		2	3	
In	Transistor "Q"	Home Input (State)	Active High (Event?)	Active Low (Event?)
1	On	0	No	Yes
0	Off	1	Yes	No

*Use **home_switch(...)** to read the Home input state.*

*Use **axis_state(...)** to read the event generation.*

Open Collector Driver to OptoCon Input

7.3 Connect an OptoCon Output to an Amplifier Enable Input

The amplifier's logic *power supply output* is connected to V_USER (P2-2) on the OptoCon, while the amplifier's logic *Common* is connected to USER_GND (P2-18,50). The Amp Enable(0) output from the OptoCon (P2-35) is connected to the Enable input on the amplifier. This circuit will also work for *any* of the OptoCon outputs.

7.3.1 Using an Internal Pull-Up Resistor

In the next figure, the Enable input on the amplifier has an internal pull-up resistor (R_{in}). You can use this configuration for either *Active High* or *Active Low* Amp Enable inputs.

Use the MEI library function **set_amp_enable_level(...)** or **set_boot_amp_enable_level(...)** to configure the Amp Enable output on the MEI motion controller for either *Active High* or *Active Low* detection.

Note	The Amp Enable output's **polarity must match** the polarity of the amplifier's Enable input. The Amp Enable output and the amplifier's Enable input must be either both *Active High* or both Active Low.

In order for the OptoCon to work correctly in this configuration, I_{sink} must be less than the maximum *"On" state* output current for the OptoCon (250 mA), otherwise the OptoCon may not be able to disable the amplifier by pulling the Enable input low. To calculate I_{sink}:

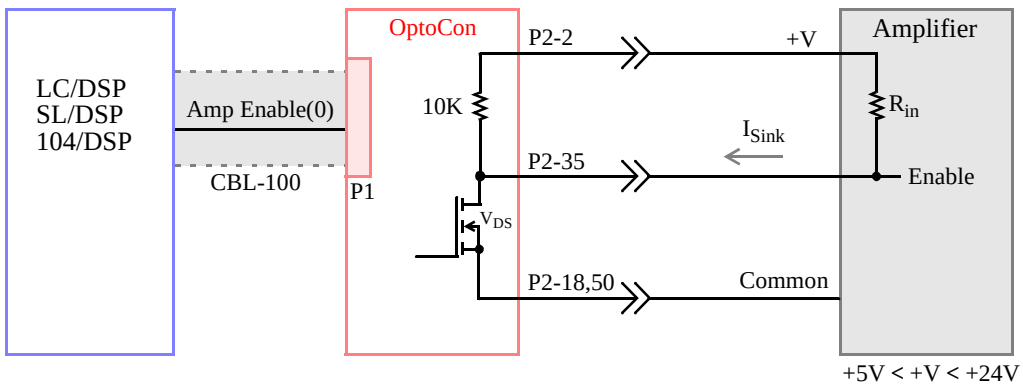
$$I_{sink} \cong (V - V_{DS}) / R_P$$

R_P = Equivalent parallel resistance of R_{in} & 10K, $R_P = R_{in} * 10K / (R_{in} + 10K)$

V = Amplifier logic *power supply voltage*

V_{DS} = OptoCon "On" state *output voltage*, $V_{DS} < 0.25V$

R_{in} = Amplifier Enable internal pull-up resistance



For output circuitry, see schematics on page 7.

OptoCon Output to Amp Enable (Pull-Up Resistor)

Warning!	**You must set S1 correctly for "Active High" or "Active Low" Amp Enable Operation.** (see *Switch Settings* on page 2)

7.3.2 Using an Internal Pull-Down Resistor

The next figure shows how to connect the OptoCon to an amplifier's Enable input that has a pull-down resistor (that is inside the amplifier). This configuration can be used for either *Active High* or *Active Low* amplifier Enable inputs.

Use the MEI library function **set_amp_enable_level(...)** or **set_boot_amp_enable_level(...)** to configure the Amp Enable output on the MEI motion controller for either *Active High* or *Active Low* detection.

Note	The Amp Enable output's **polarity must match** the polarity of the amplifier's Enable input. The Amp Enable output and the amplifier's Enable input must be either both *Active High* or both Active Low.

In order for the OptoCon to work correctly in this configuration, V_{in} must exceed the amplifier manufacturer's minimum "high" input *threshold voltage*. The "high" level at V_{in} is determined by the voltage divider between the OptoCon pull-up resistor (10K) and R_{in}. To calculate V_{in}:

$$V_{in} \cong V * (R_{in} / (R_{in} + 10K))$$

V = Amplifier logic *power supply voltage*

R_{in} = Amplifier Enable internal pull-up resistance

If the value for V_{in} **is lower than** the amplifier manufacturer's minimum "high" input *threshold voltage*, you must add the resistor R_{ext} (see the next figure). To calculate the required value of R_{ext}, first calculate the parallel resistance (R_P) required to achieve the desired V_{in} 'high' level.

$$R_P = R_{in} * (-1 + V/ V_{in})$$

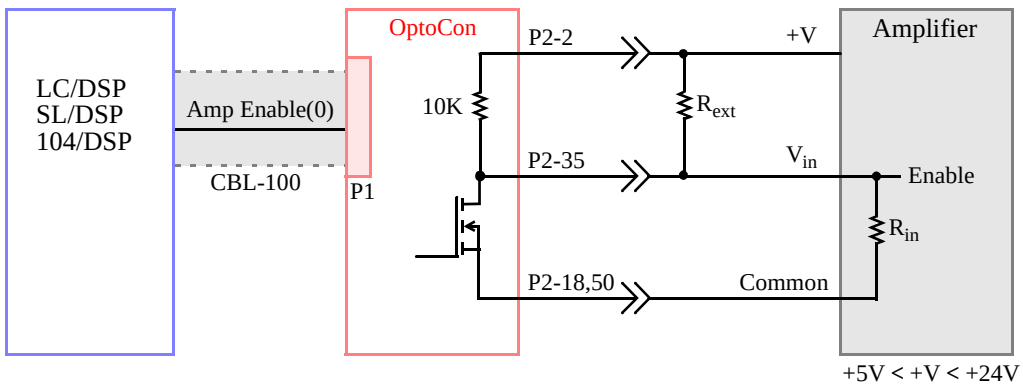
V = Amplifier's logic *power supply voltage*

V_{in} = Required amplifier Enable "high" *input voltage*

R_{in} = Amplifier Enable internal pull-up resistance

Next calculate R_{ext}, so that R_{ext} in parallel with 10K *is equal to* R_P.

$$R_{ext} = R_P / (1 - R_P /10K)$$



For output circuitry, see schematics on page 7.

OptoCon Output to Amp Enable (Pull-Down Resistor)

Warning!	**You must set S1 correctly for "Active High" or "Active Low" Amp Enable Operation.** (see *Switch Settings* on page 2)

7.3.3 Connect an OptoCon Output to a Relay

The next figure shows how to drive a relay using one of the User I/O (PA0) signals from the motion controller via the OptoCon. This circuit can be used with *any* of the OptoCon outputs.

Your system's power supply output is connected to V_USER (P2-2) on the OptoCon, while the *Common* from your power supply is connected to USER_GND (P2-18, 50). The PA0 output from the OptoCon (P2-39) is connected to one side of the relay coil. The other side of the relay coil is connected to the positive terminal (+V) of your power supply.

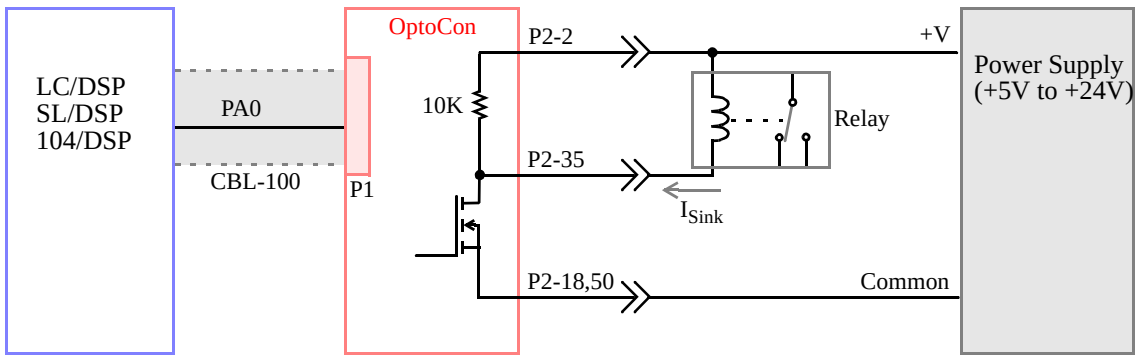
When PA0 is set 'low', the relay is energized. For the OptoCon to work correctly in this configuration, I_{sink} must be smaller than the maximum "On" state *output current* for the OptoCon (250 mA). If this condition is not met, the relay may not switch. To calculate I_{sink}:

$$I_{sink} \cong (V - V_{DS}) / R_C$$

V = Amplifier logic *power supply voltage*

V_{DS} = OptoCon "On" state *output voltage*, $V_{DS} < 0.25V$

R_C = Relay coil resistance



For output circuitry, see schematics on page 7.

OptoCon Output to A Relay