Sinking vs. Sourcing Inputs/Outputs

1. Sink or Source?

The terms sinking and sourcing are often used to refer to the direction of current flow in an electrical circuit, yet many people really don’t understand the difference between these terms. If you are unfamiliar with these terms, take a minute to read these guidelines.

- Voltage “Sinking” means current flows to the ground (0 Volts).
- Voltage “Sourcing” means current flows from a voltage source.

With those two fundamental facts in mind, let’s take a look at how they apply to inputs and outputs. MACO digital inputs and outputs are sink and source types, respectively.

MACO digital Inputs are sinking type. MACO digital Outputs are sourcing type.

**Sourcing Outputs** switch current from the source voltage. Sourcing outputs typically have a common positive (high voltage) rail that is switched. This type of output easily interfaces with a sinking current input (the input circuit expects a high voltage and sinks the current to ground (0 Volts). Typically, “P Channel” output devices are used in the output circuit design. (See Figure 4)

**Sinking Outputs** switch from the low side voltage. Sinking outputs typically have a common 0 Volt rail that is switched. This type of output easily interfaces with sourcing input types (loads are connected directly to the high voltage rail and the other side is connected to the output connection and the current sinks to common). Typically, “N Channel” output devices are used in the output circuit design. (See Figure 3)

**Sourcing Inputs** have a common high voltage connection to the input sensor circuitry and the switch is connected to DC 0 Volts. Multiple input circuits have one VCC connection terminal. (See Figure 2)

**Sinking Inputs** have a common low voltage (typically 0 Volts) connection to the input circuitry and the switch is connected to the high voltage. Multiple input circuits have one common 0 VDC connection terminal. (See Figure 1)

*If Input circuits have two unique terminals per input then the inputs can typically be used as either sinking or sourcing inputs. It is when multiple input circuits have a common connection to either the high side rail (thus sourcing inputs) or the low side rail 0VDC (thus sinking inputs) that the type is critical.*
2. Sinking Inputs

In an input slice (a slice being one of several inputs), “sinking” describes what the slice does with the current from the load - it “sinks” current to ground. You will need to supply the voltage rail for the load.

Let’s look at a simple diagram of how to wire a switch to a sinking input. Notice that you switch a positive voltage to the slice, which “sinks” current to ground.

![Figure 1. Sinking Input Diagram](image1)

MACO inputs are sinking type (represented by large blue area): Positive Voltage is applied to the input terminal and the current will sink to ground. All DC inputs on the card have a common connection to 0V (DC common, sometimes referred to as ground since DC – 0V is often connected to ground).

3. Sourcing Inputs

In an input slice (a slice being one of several inputs), “sourcing” describes what the slice does with the current from the load - it “sources” current to the voltage rail. You will need to supply the ground for the load.

Let’s look at a simple diagram of how to wire a switch to a sourcing input. Notice that you switch the ground connection to the slice, which “sources” it from the voltage rail.

![Figure 2. Sourcing Input Diagram](image2)

Note that this type of input is not available on the MACO. MACO inputs have a (0 Volt) common, whereas sourcing input circuits typically have a common connection to the high voltage rail.
4. Sinking Outputs

In an output slice (a slice being one of several outputs), “sinking” describes what the slice does with the current from the load - it “sinks” current to ground. You will need to supply the voltage rail for the load.

MACO outputs are not sinking types. Continental input modules have sinking type outputs.

5. Sourcing Outputs

In an output slice (a slice being one of several outputs), “sourcing” describes what the slice does with the current from the load - it “sources” current from the voltage rail. You will need to supply the ground for the load.

The MACO provides sourcing outputs. This type of output is sometimes referred to as a “high side” switching output - this is because the voltage rail (typically 24VDC for MACO) is switched to the load. DC Common/Ground/DC 0VDC is wired directly to the load.
6. Using Continental Mini DIN Rail Mount Input Modules with a MACO

Remember that the MACO has sinking type inputs, which means that a group of inputs will have a single terminal connection for DC Common (0V). When a specified voltage is applied the input will turn ON; and when below a specified voltage the input will turn OFF.

MACO inputs represent approximately a 2 to 3mA load at 24VDC (12K ohms effective impedance). In order for a MACO input to function with a Continental input module, the MACO input would be connected between the logic terminal (Terminal 4) and the ground terminal (Terminal 5). On the Continental device, an internal resistor pulls Terminal 4 to VCC (Terminal 3 on the Continental device). This internal resistor is typically 3.3K ohms. If the combined impedance of the MACO input and the 3.3K ohm pull-up resistor permitted 3mA current from VCC to Common, then Terminal 4 of the Continental device would measure 9.9V less than VDC (typically 24VDC) and 24V - 9.9V is 14.1V with respect to common (0V), which is below the guaranteed turn ON voltage of the MACO input!

**Figure 5.** Mini DIN to MACO Input without Pullup Resistor

6.1 How to Make the Mini DIN Module work Properly

Add an external 1800 ohm, 2 Watt pullup resistor.

**Figure 6.** Mini DIN to MACO Input with Pullup Resistor
6.2 Doing the Calculations

**Turn ON Voltage**
MACO Combo I/O cards have a guaranteed turn ON voltage of 16VDC. If the supply has a +/- 10% rating then possibly only 21.4VDC would be available. Using 8K ohms as the nominal input impedance and an 1800 ohm, 2 watt resistor in parallel with the 3.3K ohm typical internal pullup resistor (1164 ohms equivalent):

\[
\frac{21.4\text{V} \times 8000\text{ ohms}}{8000\text{ ohms} + 1164\text{ ohms}} = 18.7\text{V}
\]

(Which is greater than the guaranteed turn on voltage of 16VDC.)

**Turn OFF Voltage**
MACO Combo I/O cards have a guaranteed turn OFF voltage of 5VDC. The Continental input module can sink 100mA with a 0.5V drop. This means that the minimum combined impedance at 24VDC is 240 ohms. The 3.3K ohms in parallel with 1800 ohms is effectively 1164 ohms:

\[
\frac{26.2\text{VDC}}{1164\text{ ohms}} = 22\text{mA}
\]

(Which is well less than the 100 mA sinking capability of the Continental module, and the 0.5VDC spec is well below the guaranteed turn off voltage.)

**Power Rating of the Resistor**
Resistor power rating calculation:

\[
26.4\text{V} \times \frac{26.4\text{V}}{1800\text{ ohms}} = 0.38\text{ Watts (dissipated when input is OFF)}
\]

This is the minimum wattage resistor required - use a 2 Watt resistor to minimize resistor temperature rise.

**Note:** Continental does not publish the internal pullup resistor value, but the schematic specifies a 3.3K ohm resistor. The published documentation specifies that with a 100 mA load the drop will be no more than 0.5 VDC. It does not state that the circuit is “sinking type.” It does show an NPN transistor with a pullup resistor. This specification can only be met by the module if the load is connected between Terminals 3 and 4. The MACO input must be wired between Terminals 4 and 5. A voltage greater than 20VDC is a conservative minimum turn on voltage for all MACO DC input circuits (individual assemblies may permit a turn on voltage less than 18VDC - check specific assemblies).
7. Using Continental Mini DIN Rail Mount Output Modules with MACO DC Outputs

MACO DC outputs can be wired directly to Continental Mini DIN output modules with no further preparation.

Figure 6. MACO Output to Mini DIN Input
8. Positive vs Negative Logic

Positive vs Negative logic has nothing to do with sinking or sourcing types.

<table>
<thead>
<tr>
<th>Module Logic</th>
<th>Field Voltage applied</th>
<th>Logic Voltage Signal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Negative</td>
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<td>No</td>
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<tr>
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<td>Yes</td>
</tr>
<tr>
<td>Positive</td>
<td>No</td>
<td>No</td>
</tr>
</tbody>
</table>

(Both positive and negative logic Continental input modules have “Sinking Outputs” using “N Channel” devices.)

Note that MACO inputs and outputs are always positive logic in our usage. If an input is turned on (voltage applied) it is considered “ON” or “True.” When an input is turned off (no voltage applied) it is considered “OFF” or “False.” The logic may test for an input to be on or off, and depending on the type of test, the results can be inverted.

Test Switch Closed TSC (Test Coil energized TCE)
- Input On = True
- Input Off = False

Test Switch Open TSO (Test Coil De-energized TCD)
- Input On = False
- Input Off = True