

USER GUIDE

SCC-CTR01 Isolated Counter/Timer I/O Module

The SCC-CTR01 is a two input and one output isolation module for general-purpose counter/timers on DAQ devices. The gate and source inputs are optically isolated to allow an increased voltage range and protect against common-mode voltages. The inputs also have reverse and overvoltage protection. The output channel is isolated and has advanced short-circuit protection, which allows the circuit to recover automatically 250 ms after a short is removed.

Conventions

The following conventions are used in this guide:

»

The » symbol leads you through nested menu items and dialog box options to a final action. The sequence **File»Page Setup»Options** directs you to pull down the **File** menu, select the **Page Setup** item, and select **Options** from the last dialog box.



This icon denotes a caution, which advises you of precautions to take to avoid injury, data loss, or a system crash. When this symbol is marked on the product, refer to the *Read Me First: Safety and Radio-Frequency Interference* document, shipped with the product, for precautions to take.



This icon denotes a note, which alerts you to important information.



When symbol is marked on a product, it denotes a warning advising you to take precautions to avoid electrical shock.



When symbol is marked on a product, it denotes a component that may be hot. Touching this component may result in bodily injury.

bold

Bold text denotes items that you must select in software, such as menu items and dialog box options. Bold text also denotes parameter names.

<i>italic</i>	Italic text denotes variables, emphasis, a cross reference, or an introduction to a key concept. Italic text also denotes text that is a placeholder for a word or value that you must supply.
monospace	Text in this font denotes text or characters that you should enter from the keyboard, sections of code, programming examples, and syntax examples. This font is also used for the proper names of disk drives, paths, directories, programs, subprograms, subroutines, device names, functions, operations, variables, filenames, and extensions.
SC-2345	SC-2345 refers to both the SC-2345 connector block and the SC-2345 with configurable connectors.
SCC	SCC refers to any SCC Series signal-conditioning module.

What You Need to Get Started

To set up and use the SCC-CTR01, you need the following items:

- SC-2345 with one of the following:
 - SCC-PWR01
 - SCC-PWR02 and the PS01 power supply
 - SCC-PWR03 (requires a 7 to 42 VDC power supply, not included)
- One or more SCC-CTR01 modules
- SC-2345/2350 Carrier User Manual*, available at ni.com
- SCC-CTR01 Isolated Counter/Timer I/O Module User Guide*
- SCC Quick Start Guide*, available at ni.com
- Read Me First: Safety and Radio-Frequency Interference*
- SC-2345 Quick Reference Label
- 68-pin E/M Series DAQ device with the following:
 - Documentation
 - 68-pin cable of less than 2 m length
- 1/8 in. flathead screwdriver
- Numbers 1 and 2 Phillips screwdrivers

- Wire insulation strippers
- NI-DAQ (current version) for Windows 2000/NT/XP/Me



Note Mac OS is not supported.

Device-Specific Information



Note For general SCC module installation and signal connection information, and information about the SC-2345 carrier, refer to the *SCC Quick Start Guide*, available for download at ni.com/manuals.

Installing the Module



Caution Refer to the *Read Me First: Safety and Radio-Frequency Interference* document before removing equipment covers or connecting/disconnecting any signal wires.



Note When using the module with a PXI/PCI chassis, E/M Series DAQ device, and an SC-2345 carrier, the SCC-CTR01 should be grounded.

Plug the SCC-CTR01 into either general-purpose counter/timer socket J19 or J20 on the SC-2345. When you configure the SC-2345 according to the procedure in the *SCC Quick Start Guide*, the SC-2345 routes the CTR_SRC, CTR_GATE, and CTR_OUT signals through the module.

Connecting Signals and Loads to the SCC-CTR01

Inputs (Gate and Source)

The inputs on the SCC-CTR01 are referenced to either the ground or the supply of the external device to which they are connected. An optical isolator transfers the externally connected signals to the internal GPCTR SRC or GATE. A current limiter protects the optical isolator. A diode protects against reverse-connected signals.

Figure 1 illustrates a single isolated input.

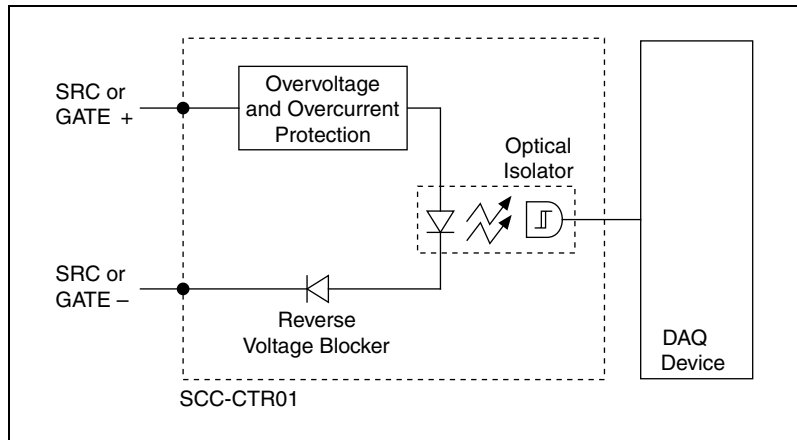


Figure 1. Single Isolated Input

Inputs are referenced to either the ground or supply of the external device, depending on whether or not the external device can source the amount of current required by the SCC-CTR01 input circuitry. To guarantee a digital HIGH, the minimum amount of current required by the SCC-CTR01 inputs is 2.2 mA. The overvoltage and overcurrent protector does not allow the amount of current flowing through the input circuitry to exceed 10 mA.

Connecting the SCC-CTR01

The following sections describe how to connect the SCC-CTR01 as referenced to ground and as referenced to the supply.

Connecting the SCC-CTR01 as Referenced to Ground

Connect the external device to the SRC or GATE + pin, and connect the device ground to the SRC or GATE - pin, as shown in Figure 2.

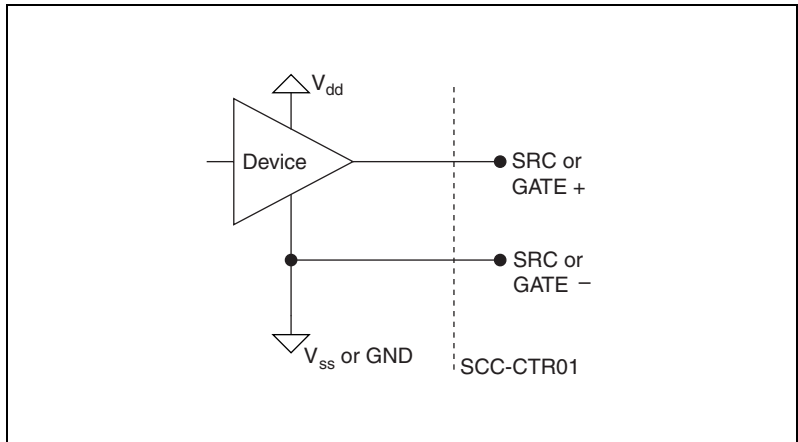


Figure 2. Referenced to Ground

Connecting the SCC-CTR01 as Referenced to the Supply

Connect the V_{dd} on the external device to the SCC-CTR01 SRC or GATE + pin, and connect the output of the external device to the SRC or GATE - pin, as shown in Figure 3.

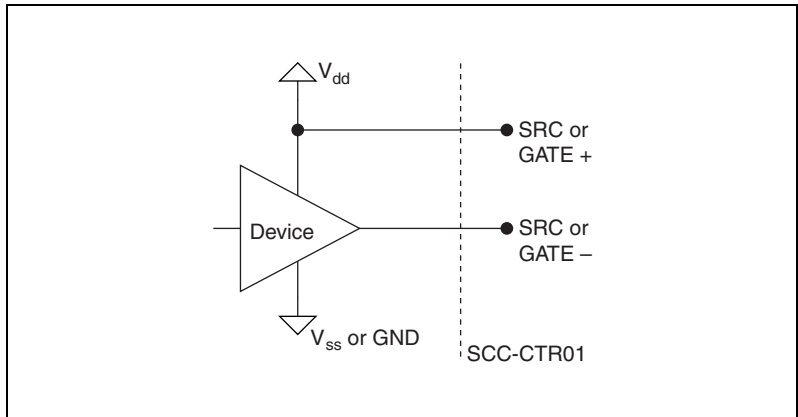


Figure 3. Referenced to Supply



Note Connecting the SCC-CTR01 as referenced to the supply reverses the digital logic. To operate the SCC-CTR01 with TTL devices, reference the SCC-CTR01 to the supply, as shown in Figure 3.



Note When placing a relatively slow rise time signal—such as a 5V peak sine or triangle wave—on one of the inputs, and a fast rise time, high voltage signal—such as a 400 kHz, 48 V square wave—on the other input, crosstalk between input lines can cause false

triggering. You should separate the input wires as much as possible. If you are using an M Series DAQ device, consult the device documentation for information about applying the appropriate digital filter to prevent incorrect measurements.

Outputs

The outputs on the SCC-CTR01 consist of N-channel MOSFETs that are connected as low-side switches. A Schottky diode blocks reverse current flow.

Figure 4 illustrates an SCC-CTR01 isolated output.

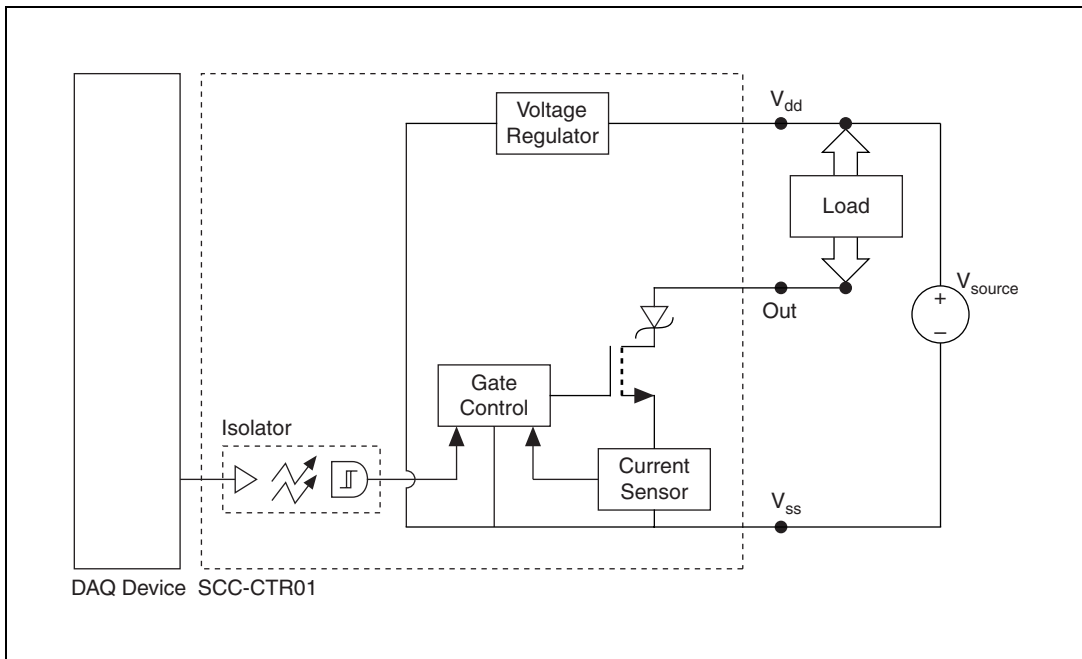


Figure 4. Connecting an SCC-CTR01 Isolated Output

For the output circuit to function, you must provide 5 to 48 V between V_{dd} and V_{ss} . Reverse connections of V_{dd} and V_{ss} do not damage the circuit as long as these connections do not exceed 60 VDC, as listed in the [Specifications](#) section.

If the amount of current the MOSFET conducts exceeds a certain level (800 mA, typical)—such as when a short occurs in the load—the MOSFET turns off for 250 ms to protect itself and the load. After this period of time, the output tries to switch on. If the short still exists, it turns off for another 250 ms. This process continues until the overcurrent or short condition is removed, after which switching automatically resumes.



Note Add bypass capacitor(s) between V_{dd} and V_{ss} at the load to reduce the chances of ringing when the output switches on and off, especially when the connecting wires are longer than 2 m.



Note For most DAQ device counters, the default state is LOW, which results in the output MOSFET being switched to ON. If you want to change the default state—for example, to eliminate continuous power dissipation in the load during the idle state—you should consult your DAQ documentation for information about how to change the default to HIGH and switch the MOSFET to OFF.

Driving Inductive Loads



Caution When the output of the SCC-CTR01 is used to drive an inductive load, high voltages will appear suddenly because of the current switching through the inductor. To prevent these high voltages from causing damage to the output circuit or the load, add flyback diodes across your inductive load, as shown in Figure 5.

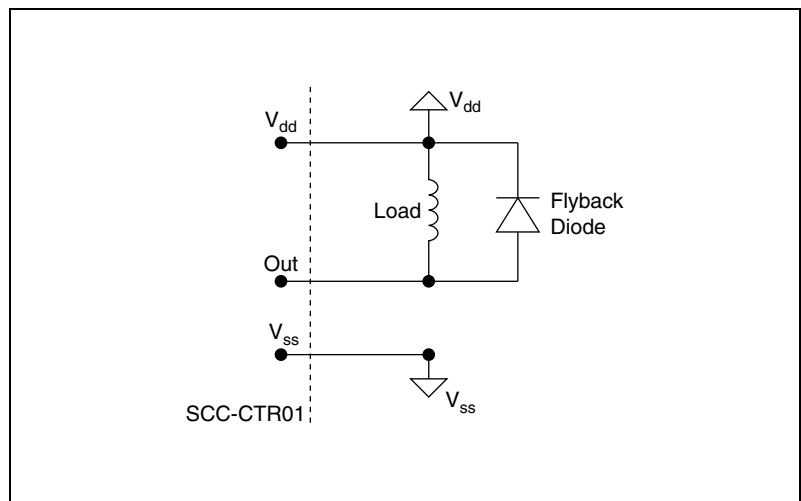


Figure 5. Flyback Diodes on Inductive Load



Caution Ensure the diode you choose is capable of handling the amount of current the load is holding when the output is ON.

Theory of Operation

Input (Source and Gate)

Optical Isolation

The gate and source inputs are isolated from each other and from the SCC-CTR01 internal power and ground signals. The isolation barrier protects the SCC-CTR01 and other equipment from voltages up to 60 VDC. Common-mode voltages higher than 60 VDC can damage the SCC-CTR01 and other equipment. The isolation allows for increased input ranges. The input signal can be varied between 0 VDC and 48 VDC between the + and – terminals. The isolation also protects against ground loops.

Reverse and Over-voltage Protection

A diode placed between the + and – input terminals provides reverse voltage protection to the SCC-CTR01 and other equipment. In addition, the SCC-CTR01 is equipped with overvoltage protection and can handle continuous voltages, between the + and – input terminals, up to ± 60 VDC.

Frequencies of Operation

Based on the application, the SCC-CTR01 may operate at higher than the maximum frequency specified in the *Specifications* section. Table 1 lists the typical SCC-CTR01 input channel operating rates.

Table 1. SCC-CTR01 Typical Input Tasks Maximum Rates

Operating Voltage	Counting Edges	Pulse Width Measurement, Semi-Period Measurement	Period Measurement, Frequency Measurement	Position Measurement
5 V	1 MHz	0.6 μ s	1 MHz	1 MHz
24 V	800 kHz	1 μ s	800 kHz	800 kHz
48 V	400 kHz	1 μ s	400 kHz	400 kHz

Notes: Typical at 25 °C, 1 meter cable connected to DAQ device.

Measurement accuracy can be improved by adjusting the LOW to HIGH and HIGH to LOW switching times in the software. Refer to the *Theory of Operation* section for more information.

Output (Out)

Signal Isolation

The output is isolated from the inputs, and the SCC-CTR01 internal power and ground signals. The isolation barrier protects the SCC-CTR01 and other equipment from voltages up to 60 VDC. Common-mode voltages higher than 60 VDC can damage the SCC-CTR01 and other equipment.

Increased Range

The voltage range of the output is increased by providing the user access to the power terminals V_{dd} and V_{ss} . The user can safely provide 5 to 48 VDC allowing equal scaling of the output.

Current Limited (Short Circuit Protection)

The SCC-CTR01 has advanced short circuit protection. The output is automatically turned off if the output current exceeds a certain limit (800 mA typical, 1.1 A max). The SCC-CTR01 tries to reoperate every 250 ms and automatically recovers after the short is removed.

Reverse and Overvoltage Protection

The SCC-CTR01 provides protection for voltages up to ± 60 VDC between V_{dd} and V_{ss} and the output and V_{ss} .

Frequencies of Operation

Based on the application, the SCC-CTR01 may operate at higher than the maximum frequency specified in the [Specifications](#) section. Table 2 lists typical SCC-CTR01 output channel rates.

Table 2. SCC-CTR01 Output Tasks

Operating Voltage	Frequency Generation	Pulse Generation
5 V	600 kHz	1 μ s
24 V	500 kHz	1 μ s
48 V	400 kHz	1 μ s

Notes: Typical at 25 °C, 250 Ω load, 1 meter cable connected to DAQ device.

Measurement accuracy can be improved by adjusting the ON and OFF switching times in the software. Refer to the [Theory of Operation](#) section for more information.

Using the SCC-CTR01

The SCC-CTR01 is functional in a variety of applications including counting events; pulse width, period, semi-period, position, and frequency measurements; and frequency, pulse, and pulse train generation.

The variation between the LOW to HIGH and the HIGH to LOW propagation delays on the input channels may affect semi-period or pulse-width measurements. Adjusting the measurement by the difference between the LOW to HIGH and the HIGH to LOW propagation delays (typically 30 ns at 5 V operation) minimizes this effect, as illustrated by the following equation for a positive pulse in positive logic:

$$\text{Adjusted Pulse Width} = \text{Actual Measurement} + (\text{LOW to HIGH Delay} - \text{HIGH to LOW Delay}).$$

Example:

If using typical LOW to HIGH and HIGH to LOW propagation delays/relays (180 ns and 150 ns), and the actual measured pulse width is 820 ns, then

$$\text{Adjusted Pulse Width} = 820 \text{ ns} + (180 \text{ ns} - 150 \text{ ns}) = 820 \text{ ns}.$$

The variation between the switching times on the output channel can affect duty cycle generation. Adjusting the output by the difference between the LOW to HIGH (220 ns) time and the HIGH to LOW time (120 ns) minimizes this effect.

$$\text{Adjusted Duty Cycle} = \text{Desired Duty Cycle} + (\text{Low to High} - \text{High to Low Time}) \times \text{Frequency of Generation}.$$

Example:

While using the typical LOW to HIGH and HIGH to LOW times, if the actual desired duty cycle is 0.50 at 400 kHz then:

$$\text{Adjusted Duty Cycle} = 0.50 + (150 \text{ ns} - 500 \text{ ns}) \times 400 \text{ kHz} = 0.36.$$

Specifications

These specifications are typical at 25 °C unless otherwise stated.

Power

Power requirement 140 mW max from +5 V rail
(digital power)

Isolated Inputs

Number of input channels 2 (CTR_SRC, CTR_GATE)

Input type Driven reference to either supply
or ground (two terminals per
input)

Maximum input frequency 400 kHz

Minimum input pulse width 1 μ s

Input-to-input, input-to-output,
and input-to-PC ground isolation 60 VDC, continuous, verified by a
620 Vrms dielectric withstand
test, 5 sec

Input waveform types Any

Voltage

Voltage range Up to 48 VDC

Typical ON voltage 2.5 V

Guaranteed ON voltage 4 V

Guaranteed OFF voltage 0.8 V

Current

ON state current 2.2 mA min, 6 mA typ,
10 mA max

OFF state current 0.1 mA max

Protection

Current limit	10 mA max (over operating temperature range)
Reverse and overvoltage.....	±60 VDC max, continuous

Propagation Delays (for a 5 V Input Signal)

LOW to HIGH	180 ns typ
HIGH to LOW	150 ns typ

Isolated Output

Number of output channels.....	1 (CTR_OUT)
Output type	Sinking (low-side switch)
Output power requirement.....	5 to 48 VDC (10 mA per channel, typical at 400 kHz)
Load voltage range	5 to 48 VDC
Switching current.....	100 mA, max
Inrush current.....	600 mA, max
Maximum output frequency	400 kHz
Minimum output pulse width	1 μ s
Output-to-output, output-to-input, and output-to-PC ground isolation	60 VDC peak, continuous, verified by a 620 Vrms dielectric withstand test, 5 sec
Typical switching times (with a 5 V, 100 Ω load)	
LOW to HIGH.....	150 ns
HIGH to LOW	500 ns
Output LOW maximum voltage	0.47 V at 10 mA, 0.75 V at 100 mA
Output leakage current when OFF.....	60 μ A max

Protection

Short circuit (on output pins)	0.6 A min, 1.1 A max (stays off after detecting a short circuit and retries to operate every 250 ms, then automatically recovers after removing the short)
Reverse and overvoltage on output and V_{dd} pins	± 60 VDC max, continuous

Physical Characteristics

Dimensions.....	8.89 cm \times 2.92 cm \times 1.85 cm (3.50 in. \times 1.15 in. \times 0.73 in.)
Mass	28.6 g (1.0 oz)
I/O connectors	One 20-pin right-angle male connector, one 7-pin screw terminal
Field-wiring diameter.....	28 to 16 AWG

Environmental

Operating temperature.....	0 to 50 °C
Storage temperature	-20 to 70 °C
Humidity	10 to 90% RH, noncondensing
Maximum altitude	2,000 m
Pollution Degree (indoor use only)	2

Safety

The SCC-CTR01 meets the requirements of the following standards of safety for electrical equipment for measurement, control, and laboratory use:

- IEC 61010-1, EN 61010-1
- UL 61010-1
- CAN/CSA-C22.2 No. 61010-1



Note For UL and other safety certifications, refer to the product label, or visit ni.com/certification, search by model number or product line, and click the appropriate link in the Certification column.

Electromagnetic Compatibility

EmissionsEN 55011 Class A at 10 m
FCC Part 15A above 1 GHz

ImmunityEN 61326:1997 + A2:2001,
Table 1

CE, C-Tick, and FCC Part 15 (Class A) Compliant



Note For full EMC compliance, operate this device with shielded cabling.

CE Compliance

This product meets the essential requirements of applicable European Directives, as amended for CE marking, as follows:

Low-Voltage Directive (safety).....73/23/EEC

Electromagnetic Compatibility
Directive (EMC)89/336/EEC



Note You must ground the system hosting your DAQ device to meet regulatory emission requirements.



Note Refer to the Declaration of Conformity (DoC) for this product for any additional regulatory compliance information. To obtain the DoC for this product, visit ni.com/certification, search by model number or product line, and click the appropriate link in the Certification column.

SCC-SCTR01 Module Pin Assignments

Figure 6 shows the I/O connector on the bottom of the SCC-CTR01.

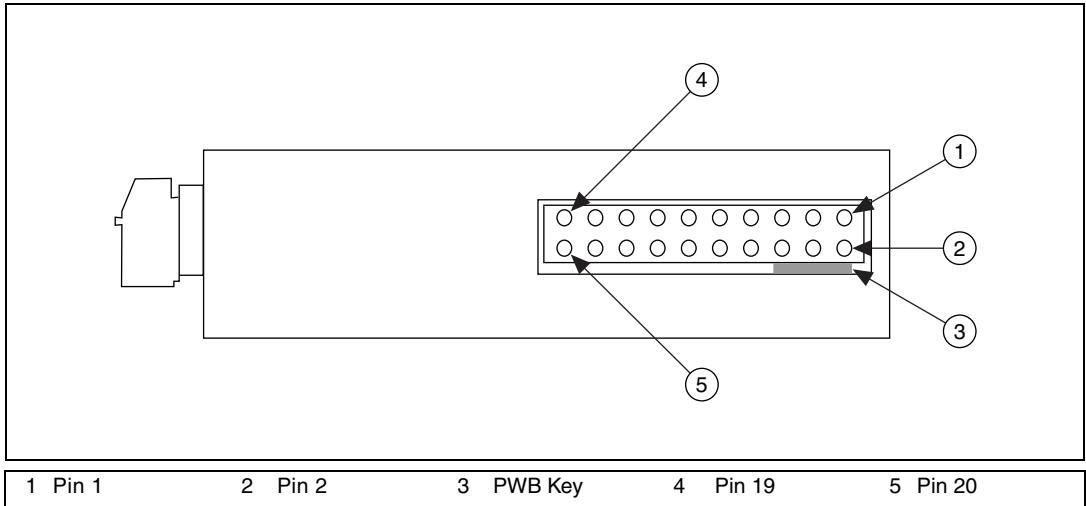


Figure 6. SCC Module, Bottom View

Table 3 lists the signal connection corresponding to each pin. GND is the reference for the +5 V supply.

Table 3. SCC-CTR01 Pin Signal Connections

Pin Number	J19–J20: GPCTR 0	J19–J20: GPCTR 1
1	CTR 0 OUT	CTR 1 OUT
2	—	—
3	PFI 9/CTR 0 GATE	PFI 4/CTR 1 GATE
4	—	—
5	PFI 8/CTR 0 SOURCE	PFI 3/CTR 1 SOURCE
6	—	—
7	—	—
8	—	—
9	+5 V	+5 V
10	GND	GND
11	—	—
12	—	—
13	—	—
14	—	—
15	—	—
16	—	—
17	—	—
18	—	—
19	—	—
20	—	—

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