



# QPO-1-EVAL5

## QPO-1 Evaluation Board, Mini Foot Print DC-DC Converters

### Description

The QPO-1-EVAL5 is designed to allow full testing of the QPO-1 and its various performance settings to optimize final system design. The board offers switch settings for the user to select preset values for the Rhr, Rsc, and Rsa resistors. Solder pads are available to mount user-selected values of these components if required. Please refer to the QPO-1 product data sheet and the following pages for the proper application of this board. The EVAL5 accommodates Vicor's Mini DC-DC converters with an input up to 72 Vdc.

The QPO-1 output ripple attenuator SiP uses active filtering to reduce output ripple and noise (PARD) over 20 dB from 50 Hz to 500 kHz. The QPO-1 operates over a voltage range from 3 to 30Vdc and supports load currents as high as 10A. Output regulation is maintained with remote sense or trim adjustment of the power supply. The closed loop architecture improves transient response and ensures precise point-of-load regulation.

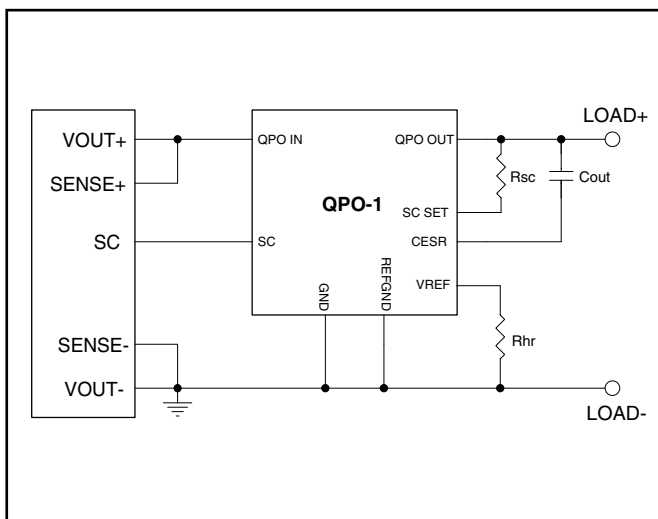
Other eval boards (see [www.picorpower.com](http://www.picorpower.com)) allow easy evaluation with other DC-DC converters or power supplies with standard terminations.

### Features of the QPO-1

- >30 dB PARD attenuation, 1 kHz to 500 kHz
- >20 dB PARD attenuation, 50 Hz to 500 Hz <sup>1</sup>
- 10A rating over a 3-30 Vdc operating range
- Supports precise point-of load regulation
- Up to 99% efficiency with power limit protection
- User selectable optimization of attenuation, power dissipation & transient load response
- Peak detector function optimizes for ripple amplitude variation automatically
- 1.0 x 1.0 x 0.2" SiP with BGA or LGA mounting
- Improves transient response of most DC-DC converters and power supplies
- Reduces required number of output capacitors to support dynamic loads.
- Patents Pending

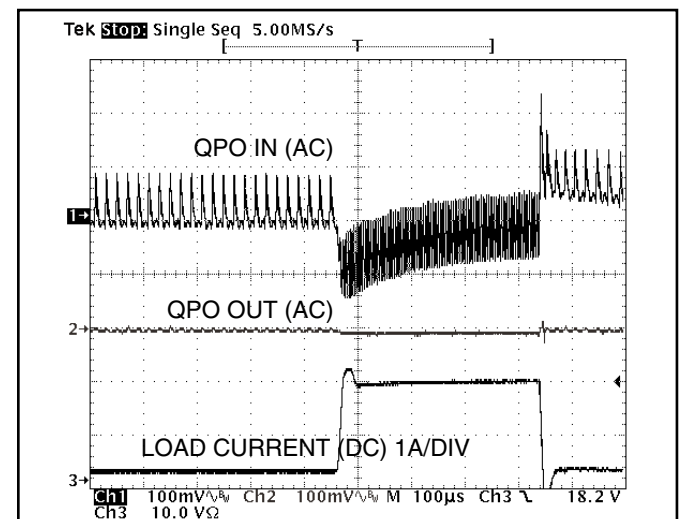
*Note 1: For off-line supplies 20dB attenuation can be achieved down to 50Hz with additional capacitance added from the VREF pin to the REFGND pin.*

### Typical Application



**Figure 1** – SC/Trim supports applications without the use of remote sense.

### QPO-1 Performance



**Figure 2** – Typical performance with a 3.3 Volt converter.

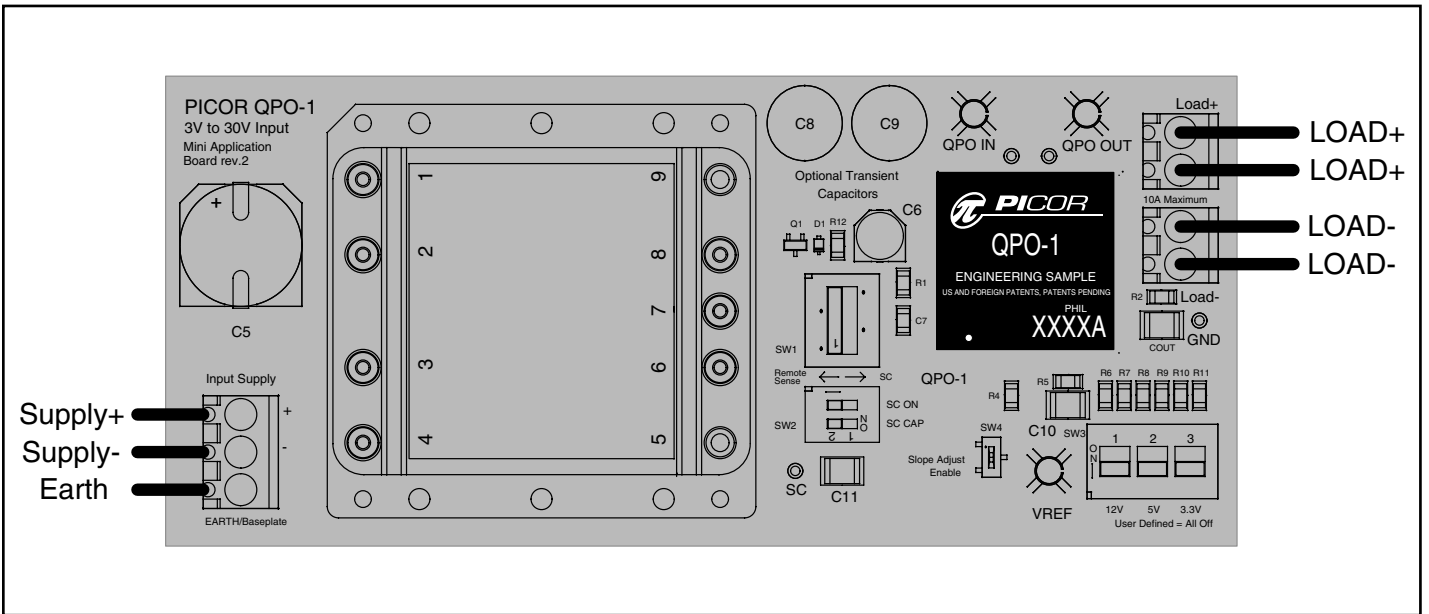


Figure 3 – EVAL5 layout and measurement locations

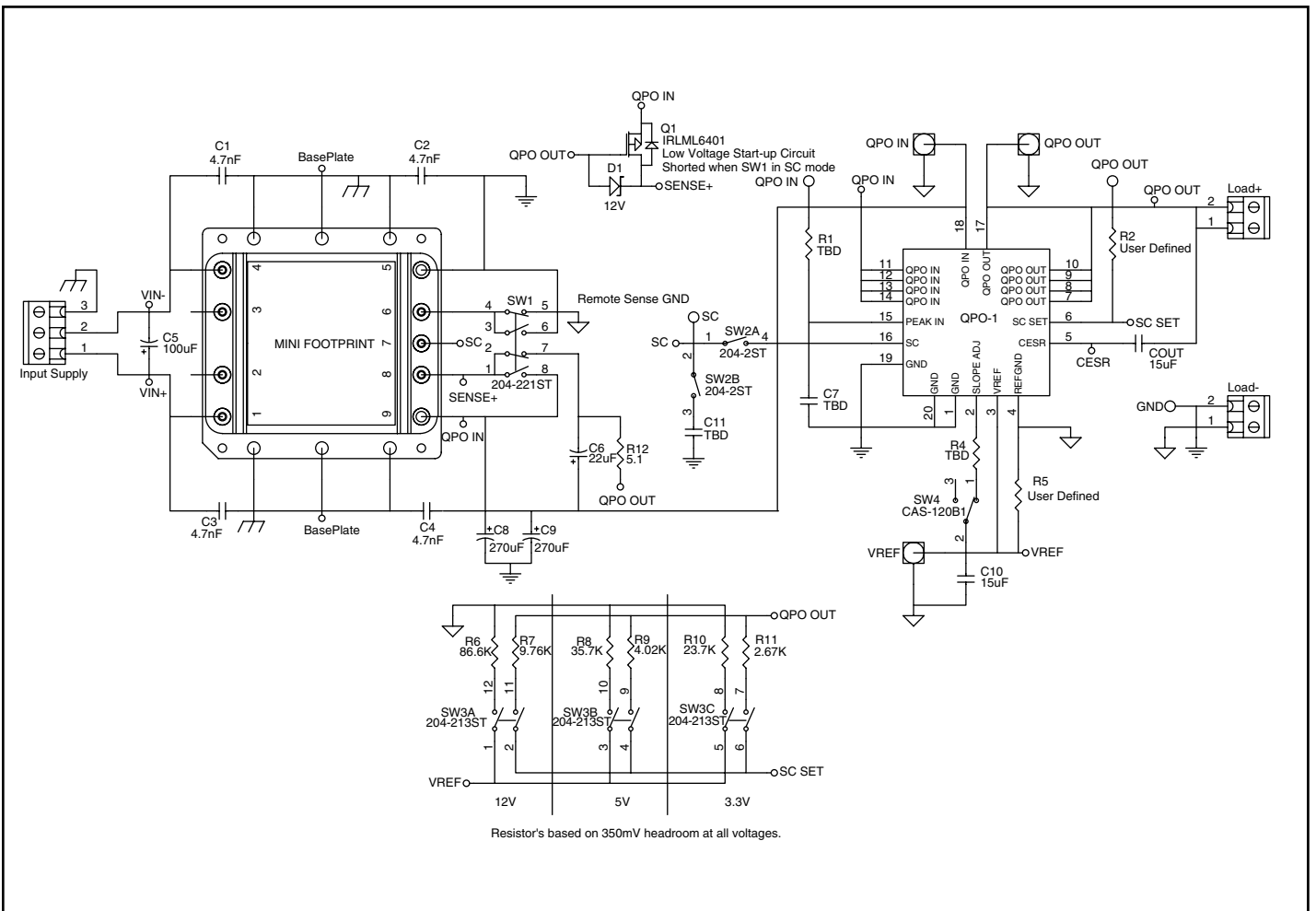


Figure 4 – Schematic of EVAL5 board

## Switch Tables

The QPO-1-EVAL5 board has been designed to accommodate a wide range of output voltages from a Vicor Mini DC-DC converter. Please refer to the QPO-1 datasheet for description of the product.

**SW1** is used to select the method of regulating the output voltage of the converter. When switched to the left, the converter is operating in "Remote Sense" mode where the sense pins of the converter monitor the point of load to regulate the converter's output voltage. When switched to the right, the converter's sense pins are tied directly to their respective output pins. The QPO trims the SC pin of the converter to compensate for its voltage drop. If the SC mode is selected SW2 should be set to have the SC function connected to the converter as described below.

**SW2** has two switches. One engages the SC control function. The second adds a capacitor to the SC pin of the converter. In the "on" position (right), the first switch of SW2 connects a 3.3uF capacitor (C11) between the SC pin of the converter and ground. C11 extends the soft start time of the converter. This capacitor should only be needed with low voltage converters (<12V) that startup before the QPO can establish proper operation. The second switch of SW2 in the "on" position (right) connects the SC control circuit of the QPO to the SC pin of the converter. When the switches are in the "off" (left) position, the capacitor and SC connection are opened and out of the circuit.

**SW3** is located in the lower-right corner of the pc board. It is used to set the appropriate headroom voltage and SC current for converters 12V, 5V, or 3.3V outputs. A "user defined" position for converter voltage and headroom settings is provided to support other output voltages. The user can also adjust other operating parameters with the "user defined" position

With all switches in the "down" position (open circuit), the board is set to a "user defined" setting for use with any output voltage between 3 and 30V. The QPO-1-EVAL5 board lets the user populate the R2 and R5 locations to adjust headroom (Rhr) and SC current, (Rsc) with appropriate resistors. The user must calculate a value for the headroom voltage setting resistor ( $R5 = Rhr$  in the product datasheet and formula below) and the SC current setting resistor ( $R2 = Rsc$  in the product datasheet and formula below).

With the first switch position of **SW3** in the "up" position, and the rest in the "down" position, the headroom voltage and SC current setting is adjusted to work with a 12V converter. With the second switch of **SW3** in the "up" position, the rest "down", the converter is set to work with a 5V converter. With the third switch "up", the rest "down", the board is set to work with a 3.3V converter. This switching network will parallel the switched in resistors with connections to the R5 and R2 positions. If a predefined voltage is to be used, R5 and R2 should not be populated. At no time should more than one switch be in the "up" position to get accurate results. The user defined values for R2 and R5 will have to be connected once their values have been determined using the formulas that follow.

**SW4** is used to engage the optional Slope Adjust resistor (R4) when in the "up" position. Please refer to the QPO-1 datasheet for further explanation of this function.

## Instructions for Use

The terminal block in the lower left-hand corner of the pc board (labeled "Input Supply") is used to provide the input voltage to the DC-DC converter. The Earth connection serves as the converter shield that is the common node for the Y capacitors that are on the bottom of the board. The converter should be mounted to the EVAL board with screws and a heat sink to ensure a good electrical connection to the bypass capacitors on the bottom of the board. If this step is not taken, common mode noise may be excessive. The output load should be connected to the terminal block on the right, labeled "External Load" and should not exceed 10 Amps.

The QPO application board has Johnson Jacks, to reduce the effect of radiated noise on measurements. The jacks allow three key measurements; **QPO IN** is the input to the QPO from the DC-DC converter; **QPO OUT** is the output of the QPO where effects of the various settings can be analyzed; **VREF** is the reference voltage that the QPO uses to maintain a desired output voltage.

If **SW3** is not used as described above, a resistor in position R5 will determine the QPO's headroom voltage. If the user decides to use a headroom setting other than what is preset by **SW3**, select a headroom resistor for R5 using the following equation:

$$R_{hr} = \frac{QPO_{out}}{V_{hr}} * 2.5k\Omega$$

where;

R<sub>hr</sub> is headroom resistor value,  
 QPO<sub>out</sub> is the voltage seen on the QPO's output,  
 V<sub>hr</sub> is the target headroom voltage.

The R<sub>sc</sub> resistor is tied between QPOOUT and SC SET pin and sets the correction current used to trim up the converter to maintain a constant output voltage on the QPO's output. The value for the SC SET resistor is calculated by the following equation:

$$R_{sc} = \frac{R_{in} * V_{out}}{V_{rpt}}$$

where;

R<sub>sc</sub> is SC SET resistor value,  
 R<sub>in</sub> is the input resistance of the SC or TRIM input of the converter,  
 V<sub>out</sub> is the desired QPO output voltage,  
 V<sub>rpt</sub> is the pre-trimmed reference of the SC

or TRIM.

On the application board there are two spots for additional capacitors (C8 and C9) to be added to the QPO's input. Extra output capacitors maybe required in applications with converters with output voltages over 10V that are subjected to high transient load steps. Experiment with these components to obtain the desired result.

The peak detector function is enabled on the evaluation board. A low value for R1 (less than 10 ohms) is on the board and C7 is not populated. To disable the peak detector function, use R1= 1K and C7 = .1uF as shown in the datasheet. The QPO's peak detector circuit will increase the headroom of the QPO by roughly half of the peak-to-peak ripple on the QPO's input. Excessive ripple with low voltage converters could create enough additional headroom as to cause the converter's output to increase to the point where it is in an over-voltage fault and shut down.

## Ordering Information

Part Number	Description
QPO-1-EVAL5	Evaluation board for QPO-1 for Mini footprint DC-DC Converters

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