

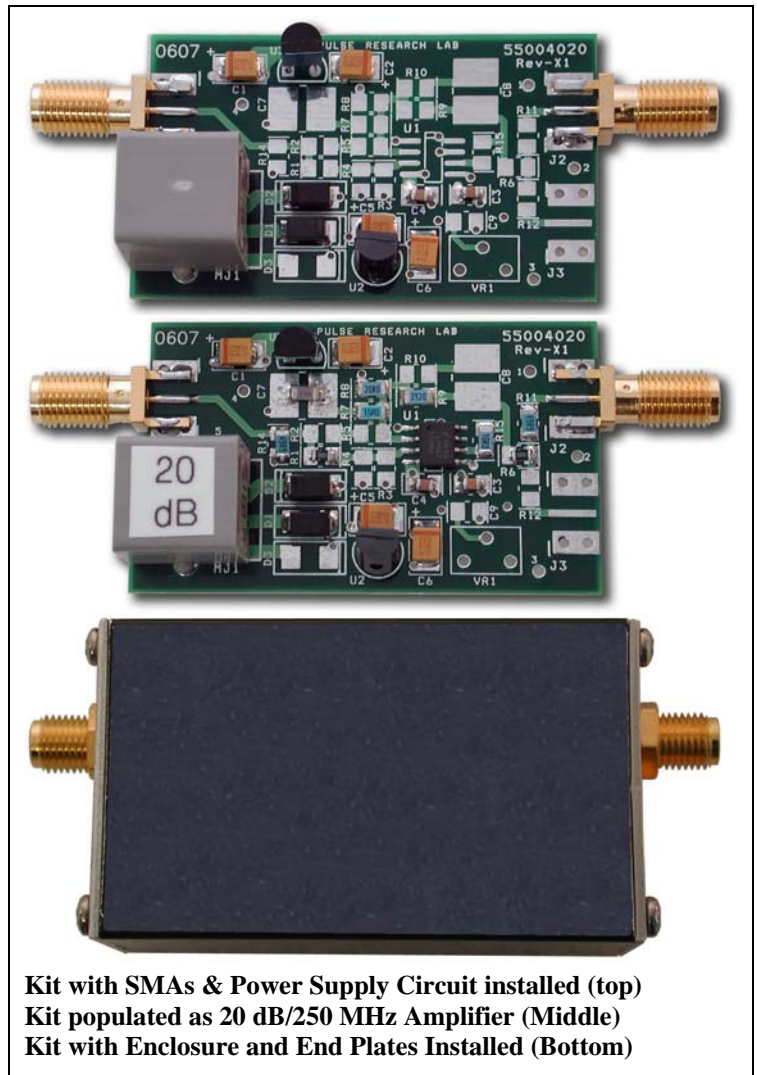
# PRL-OPANET, VERSATILE OP AMP PROTOTYPING KIT

## Build Your Own Custom Amplifiers:

- Inverting or Non-Inverting
- AC- and/or DC-Coupled
- RF or Low-Noise, Precision DC
- Single or Dual Output
- 50  $\Omega$  Cable Driver
- Diode Detector
- Hi-Z input/Lo-Z Output Buffer
- Voltage Reference
- Device Evaluation
- Experimental Teaching Kit
- Fanout (multiple units required)

## Features

- Self-contained 1.0-in. H x 1.3-in. W x 2.1-in. L module includes extruded enclosure and end plates
- Partially-assembled PCB with SMA I/O connectors, modular DC jack, input rectifiers,  $\pm 5V$  regulators and filtering circuits (as shown in photo)
- User needs only to install SO8 amplifier device, gain, termination and coupling components
- Kit also available without power supply circuit (PCB, SMA I/O connectors, and modular DC jack only)
- $>800$  MHz bandwidth depending on amplifier device, gain and circuit configuration
- Voltage cable included, plus optional  $\pm 8.5$  V/ $\pm 1.4$  A, +17 V/150 mA AC/DC adapter
- Optional Passive Component kit available for building a number of different amplifiers
- Component footprints on PCB include:
  - One SO8 Single Op Amp
  - Three End Launch SMA Connectors
  - A pair of TO-92, 3-Terminal, Voltage Regulators and Power supply Decoupling Capacitors
  - Three SBD input rectifiers for  $\pm 8.5V$  and +17V inputs from the AC/DC adapter
  - Modular DC Input Jack
  - Components for internal I/O termination and coupling
  - Components for gain-feedback/frequency compensation network
  - Two sites for capacitor trimmers, C7 and C8, #1206 or #0805 SMTs
  - Input offset trim pot and associated components (back side)



Kit with SMAs & Power Supply Circuit installed (top)  
Kit populated as 20 dB/250 MHz Amplifier (Middle)  
Kit with Enclosure and End Plates Installed (Bottom)

## DESCRIPTION

The PRL-OPANET is a family of versatile Op Amp Network prototyping kits, designed for use with standard SO8 single amplifier devices (not included). The standard kit (PRL-OPANET-1) is a self-contained module with a 4-layer PCB, partially-assembled with two SMA I/O connectors, a modular power input jack, a pair of  $\pm 5$  V regulators with the necessary power supply decoupling capacitors, and a pair of Schottky rectifiers for reversed-polarity DC input protection. The kit also includes a 1.0-in. H x 1.3-in. W x 2.1-in. L extruded aluminum enclosure, two end plates, eight mounting screws and a voltage input cable. In most cases, the user needs only to install the SO8 amplifier device, the I/O termination resistors, the gain resistors and two 0  $\Omega$  jumpers. The entire amplifier module can typically be built in less than 20 minutes (20 dB example shown above).

Fig. 1 shows the complete schematic of the amplifier, and Figs. 2A and 2B show the component placement diagrams. Depending on the amplifier configuration selected, not all components shown in the schematic are used. For example, in the simplest case of a DC-coupled non-inverting amplifier, R2, R3, R4, R5, R10 and C8 are not needed. R15 is typically 10 $\Omega$ , and

R1 and R6 are 0  $\Omega$  jumpers. If AC-coupled I/Os' are desired, R1 and R6 are replaced by coupling capacitors. R14, R3 and R4 may all be needed depending on the input bias circuit chosen. Rectifier D3 can be used instead of D1 for connecting the input of the +V regulator to the +17 V input pin of the power jack for higher voltage applications.

Component values optimized for a number of amplifier configurations and gain values together with the test results are shown in Tables I & II, using mainly the LMH6703 device. The LMH6703 was chosen for its superior pulse response performance compared to a number of other devices tested. More test results using other amplifier devices and gain values will be made available at a later date. If a dual output configuration is desired a second SMA and a dual SMA end plate are offered as optional accessories.

The optional PRL-760B  $\pm 8.5$  V/ $\pm 1.4$  A, +17 V/150 mA AC/DC adapter is recommended for easy power input connection. If more than one amplifier module is to be used at a given time, one can either add a PRL-730 eight-modular jack voltage distribution module or use the PRL-760C, four-output AC/DC adapter instead.

For applications requiring supply voltages other than  $\pm 5$  V, a kit without the power supply components is offered (PRL-OPNET-0). It has a pair of assembled I/O SMAs and a modular power jack only. Unused components can be bypassed. For this kit, the ideal power supply is the PRL-742 triple variable output power supply module (0 to  $\pm 6$ V and 0 to +14V), which must be powered by a PRL-760 series AC/DC adapter. Either the PRL-742 or the PRL-760 series AC/DC adapters can be plugged directly into the OPANET modular power jack as they have compatible power plugs and pinout.

The offset trim circuit, consisting of VR1, R16-R21 and C9, can accommodate a number of different offset trim configurations, depending on the device used. For example, if the amplifier device is an OP27, then pins 1 and 8 should be connected to VR1 via R16, R20 and R21, and a 0  $\Omega$  R18 for the connection to a positive trim voltage. Similarly, it can be configured for a pin-1-to-pin-5 connection using a negative trim voltage with R19. Since the offset trim feature is not always used, those circuit components are placed on the back side of the PCB, so the user does not need to work on both sides of the PCB.

The PRL-OPANET Op Amp Prototyping kits are ideally suited for making one-of-a-kind amplifiers for lab use or for verifying new designs. It is a valuable tool for teaching engineering students how to build, test and characterize amplifiers. Once the design is done, the entire amplifier can be built in less than 20 minutes, and the end result is a professional looking product. A finished example is shown in the photo as the PRL-301NEV-20dB, amplifier evaluation module. The PRL-OPANET is a new addition to the popular MNET, PINET, TNET and SPLITNET family of prototyping kits.

**Optional Passive Component Kit (PRL-PCK1)  
for building configurations listed in Table I:  
(See Figs'. 1, 2A and 2B for amplifier  
configurations and component locations)**

| Description           | PRL P/N     | Marking | Qty |
|-----------------------|-------------|---------|-----|
| 0 $\Omega$ , #0805    | 13210000    | 000     | 50  |
| 10 $\Omega$ , #1206   | 13211001    | 10R0    | 50  |
| 15 $\Omega$ , #1206   | 13211501    | 15R0    | 50  |
| 39.2 $\Omega$ , #1206 | 13213921    | 39R2    | 50  |
| 49.9 $\Omega$ , #1206 | 13214991    | 49R9    | 50  |
| 68.1 $\Omega$ , #1206 | 13216811    | 68R1    | 50  |
| 95.3 $\Omega$ , #1206 | 13219531    | 95R3    | 50  |
| 100 $\Omega$ , #1206  | 13211002    | 1000    | 50  |
| 107 $\Omega$ , #1206  | 13211072    | 1070    | 50  |
| 182 $\Omega$ , #1206  | 13211822    | 1820    | 50  |
| 392 $\Omega$ , #1206  | 13213922    | 3920    | 50  |
| 562 $\Omega$ , #1206  | 13215622    | 5620    | 50  |
| 619 $\Omega$ , #1206  | 13216192    | 6190    | 50  |
| 750 $\Omega$ , #1206  | 13217502    | 7500    | 50  |
| 953 $\Omega$ , #1206  | 13219532    | 9530    | 50  |
| SBD Rectifier         | 5000014     | CS40M50 | 10  |
| 0.1 uf, 50 V SMT      | 08174104-50 | None    | 50  |
| 2.2 uf, 20 V SMT      | 08024225-20 | 225D    | 50  |
| 1 uf, 35 V SMT        | 08174104-50 | 105-35  | 10  |

**Optional Components and Accessories  
Applicable to Prototyping Needs**

(See also Universal Signal Conditioning Kits at:  
<http://www.pulseresearchlab.com/products/SCK>)

| Description  | PRL P/N         |
|--|-----------------|
| Passive component kit (see itemization at left)                      | PRL-PCK1        |
| 8-Modular Jack Voltage Distribution module with 7 cables             | PRL-730-7C      |
| $\pm 8.5$ V/ $\pm 1.4$ A/+17V/150mA AC/DC Adapter                    | PRL-760B        |
| $\pm 8.5$ V/ $\pm 1.8$ A/+17V/200mA 4-output AC/DC Adapter           | PRL-760C        |
| LMH6703, SO8 Hi-Speed Op Amp (bag of 5)                              | 24101169        |
| OP27, SO8 Precision Op Amp (bag of 5)                                | 24101001        |
| RG174-3/5, 50 $\Omega$ Coaxial Cable, with SMA Plugs, 3ft/5ft        | 88001350-3/5    |
| End Launch SMA Connector for dual output configuration               | 31002177        |
| End Plate for Dual SMA Outputs                                       | 38001055-20     |
| 0.1 uf DC Block, SMA M/F   | PRL-SC-104      |
| 2.2 uf DC Block, SMA M/F   | PRL-SC-225      |
| 6 dB (2X) Attenuator, SMA M/F  | PRL-DCX-6dB     |
| 14 dB (5X) Attenuator, SMA M/F                                       | PRL-DCX-14dB    |
| 20 dB (10X) Attenuator, SMA M/F                                      | PRL-DCX-20dB    |
| 20 dB/250 MHz BW Amplifier Evaluation module                         | PRL-301NEV-20dB |
| 4- $\phi$ TTL Clock Generator, 4-140 MHz                             | PRL-177         |
| Sinewave Generator Module, 65-150MHz**                               | PRL-178-150     |
| 3-Output Power supply, 0 to $\pm 6$ V/ $\pm 0.8$ A, 0 to 14 V/0.15 A | PRL-742         |
| Precision VCO tuning Source, 0-16 V, 150 ppm Stability               | PRL-745         |

\*Price includes the PRL-760B,  $\pm 8.5$ V/ $\pm 1.4$ A/+17V/150mA AC/DC Adapter. If AC adapter is not needed append “-OEM” to the model number. Sharing a common AC adapter by multiple modules, subject to total current load, requires using either the PRL-760C, 4-output AC adapter or the PRL-760B connected to a PRL-730-7C 8-modular jack voltage distribution module ([www.pulseresearchlab.com/download/PRLPowerSupplySolutions.pdf](http://www.pulseresearchlab.com/download/PRLPowerSupplySolutions.pdf))

\*\*This is a ready to use, 1 x 1.3 x 2.2-in., VCO sine wave generator module. A stable 0-16V tuning voltage, such as that from the PRL-745, is required to vary the frequency over one octave range. Other similar VCO module kits, for sine wave and non-sine wave outputs, with frequencies up to 3GHz are also available.



## OPANET Op Amp Proto Kit, 55004020X0, Evaluation, 5/21/07

| Parameter                               | Value   |
|---|---|
| V <sub>CC</sub> /V <sub>EE</sub> to DUT | ±5V   |
| Input for Gain >0 dB                    | PRL-434C, V <sub>o</sub> =800mVp-p, t <sub>r</sub> /t <sub>f</sub> =150 ps/150 ps         |
| Input for Gain =0 dB                    | PRL-470B, output adjusted to ±2.5V (5Vp-p), t <sub>r</sub> /t <sub>f</sub> =700 ps/900 ps |
| Input Frequency                         | 50 MHz  |
| Input Attenuator to DUT                 | Selected for the specified DUT output (see Input dB in table below)                       |

**Table I. Small Signal Response Test Results, V<sub>o</sub> = ±0.5V (1 Vp-p), except for 0 dB Gain, where V<sub>o</sub> = ±200 mV (400 mVp-p)**

| Configuration           | DUT     | R14  | R9    | R8     | R9/R8 | A <sub>o</sub> (OC) | Input dB | R7   | C7 (pf) | R2  | R5   | T <sub>r</sub> (ps)/OVS | 3 dB BW | I <sub>CC</sub> /I <sub>EE</sub> |
|-------------------------|---------|------|-------|--------|-------|---------------------|----------|------|---------|-----|------|-------------------------|---------|----------------------------------|
| 0 dB (1X) Splitter, NI  | LMH6703 | 49.9 | 562   | 562    | 1     | 2                   | 5        | X    | X       | X   | X    | 400/400/18%             | 875     | 20/-20                           |
| 0 dB (1X) Splitter, NI  | LMH6703 | 49.9 | 953   | 953    | 1     | 2                   | 5        | X    | X       | X   | X    | 400/400/10%             | 875     | 20/-20                           |
| 0 dB (1X) Splitter, NI  | LMH6703 | 49.9 | 1.21k | 1.21k  | 1     | 2                   | 5        | X    | X       | X   | X    | 400/400/16%             | 875     | 20/-20                           |
| 0 dB (1X) Splitter, NI  | LT1395  | 49.9 | 274   | 274    | 1     | 2                   | 14       | X    | X       | X   | X    | 2400/2400/<5%           | 145     | 20/-20                           |
| 6 dB (2X), NI           | LMH6703 | 49.9 | 562   | 182    | 3.088 | 4.088               | 9        | X    | X       | X   | X    | 750/900/10%             | 466     | 20/-20                           |
| 12 dB (4X), NI          | LMH6703 | 49.9 | 750   | 107    | 7.009 | 8.009               | 9        | 75   | 1-5 pf  | X   | X    | 700/700/10%             | 500     | 20/-20                           |
| 14 dB (5X), NI          | LMH6703 | 49.9 | 619   | 68.1   | 9.089 | 10.089              | 11       | 68.1 | 1-4.5   | X   | X    | 800/800/<5%             | 437     | 20/-20                           |
| 14 dB (5X) Splitter, NI | LMH6703 | 49.9 | 619   | 68.1   | 9.089 | 10.089              | 11       | 33   | 1-4.5   | X   | X    | 1100/1100/<2%           | 318     | 20/-20                           |
| 20 dB (10X), NI         | LMH6703 | 49.9 | 750   | 39.2   | 19.13 | 20.13               | 17       | 15   | 4-18    | X   | X    | 1400/1400/<2%           | 250     | 20/-20                           |
| 0 dB (1X) Splitter, IV  | LMH6703 | 68.1 | 392   | 1-5 pf | X     | -2                  | 5        | X    | X       | 100 | 95.3 | 600/600/14%             | 580     | 20/-20                           |

**Table II. Large Signal Response Test Results, V<sub>o</sub> = ±1.25V (2.5Vp-p)**

| Configuration           | DUT     | R14  | R9  | R8     | R9/R8 | A <sub>o</sub> (OC) | Input dB | R7   | C7 (pf) | R2  | R5   | T <sub>r</sub> (ps)/OVS | 3 dB BW | I <sub>CC</sub> /I <sub>EE</sub> |
|-------------------------|---------|------|-----|--------|-------|---------------------|----------|------|---------|-----|------|-------------------------|---------|----------------------------------|
| 0dB (1X) Splitter, NI   | LMH6703 | 49.9 | 562 | 562    | 1     | 2                   | 14       | X    | X       | X   | X    | 600/750/12%             | 580     | 25/-26                           |
| 0dB (1X) Splitter, NI   | LMH6703 | 49.9 | 750 | 750    | 1     | 2                   | 14       | X    | X       | X   | X    | 650/800/8%              | 538     | 25/-26                           |
| 0dB (1X) Splitter, NI   | LMH6703 | 49.9 | 953 | 953    | 1     | 2                   | 14       | X    | X       | X   | X    | 700/900/8%              | 500     | 25/-26                           |
| 0dB (1X) Splitter, NI   | LT1395  | 49.9 | 274 | 274    | 1     | 2                   | 14       | X    | X       | X   | X    | 2400/2400               | 145     | 22/-24                           |
| 6dB (2X), NI            | LMH6703 | 49.9 | 562 | 182    | 3.088 | 4.088               | 14+6     | X    | X       | X   | X    | 750/900/10%             | 466     | 21/-20                           |
| 12 dB (4X), NI          | LMH6703 | 49.9 | 750 | 107    | 7.009 | 8.009               | 14+12    | 75   | 1-5 pf  | X   | X    | 800/950/8%              | 437     | 21/-20                           |
| 14 dB (5X), NI          | LMH6703 | 49.9 | 619 | 68.1   | 9.089 | 10.089              | 14+14    | 68.1 | 1-4.5   | X   | X    | 900/1100/<5%            | 437     | 20/-20                           |
| 14 dB (5X) Splitter, NI | LMH6703 | 49.9 | 619 | 68.1   | 9.089 | 10.089              | 14+14    | 33   | 1-4.5   | X   | X    | 1100/1200/<2%           | 318     | 24/-26                           |
| 20 dB (10X), NI         | LMH6703 | 49.9 | 750 | 39.2   | 19.13 | 20.13               | 14+20    | 15   | 4-18    | X   | X    | 1250/1300/<2%           | 280     | 20/-20                           |
| 0 dB (1X) Splitter, IV  | LMH6703 | 68.1 | 392 | 1-5 pf | X     | -2                  | 14       | X    | X       | 100 | 95.3 | 950/800/10%             | 368     | 25/-25                           |

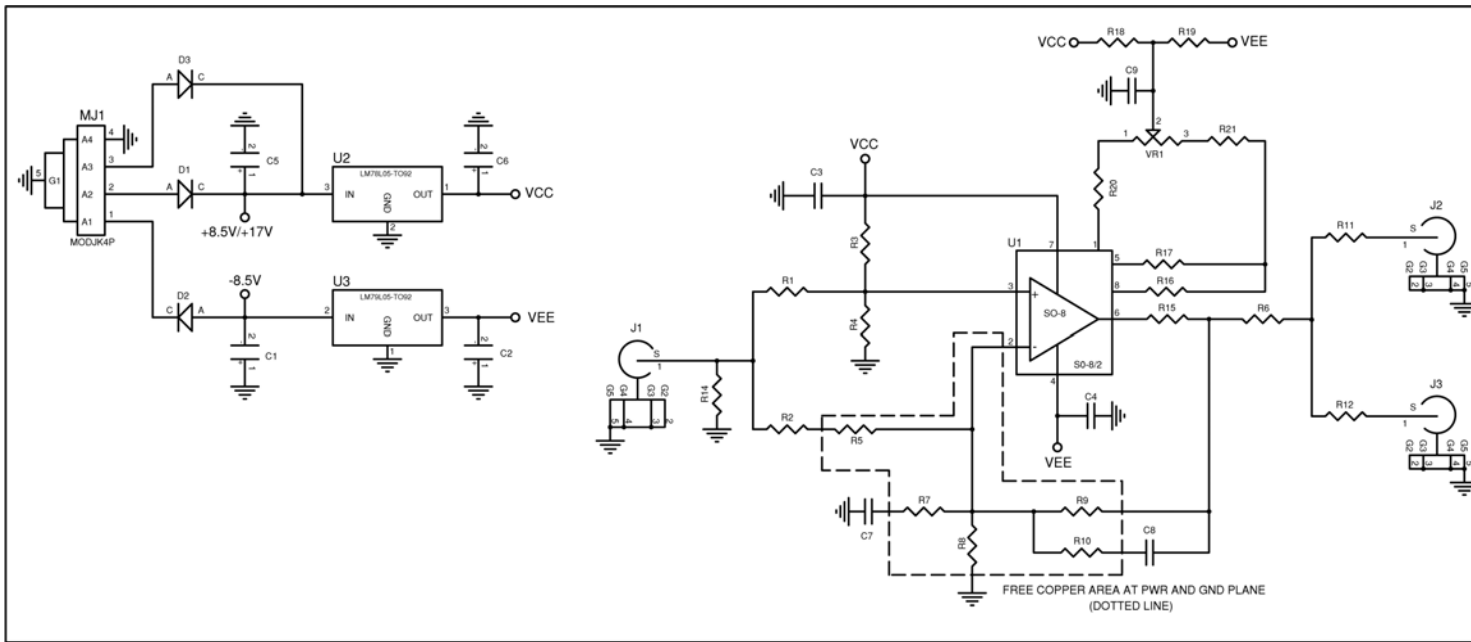


Fig. 1: PRL-OPANET Schematic

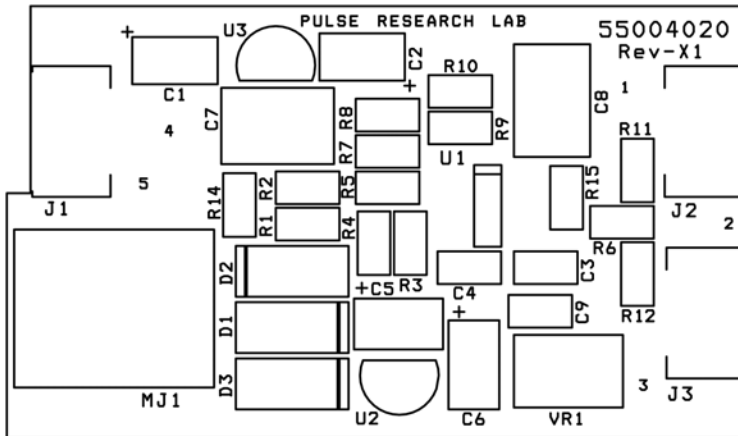


Fig. 2A: Top Silkscreen

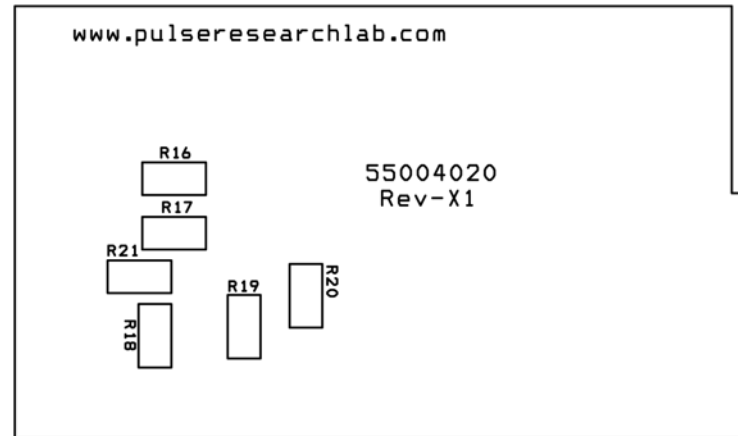


Fig. 2B: Bottom Silkscreen