Model VV100B
Wideband Pulse Amplifier

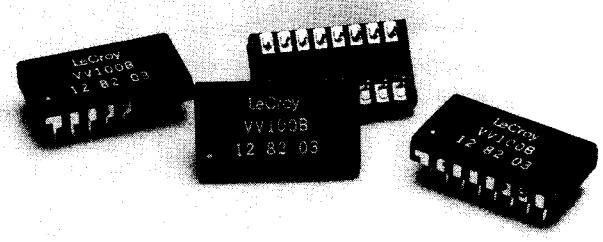
- **Wide Bandwidth** risetime: <2 nsec VV100B
- **Direct-Coupled Design** permits high rate application without baseline shifts.
- **10 × Gain, Cascadable** to 1000 × for direct compatibility with a wide range of input amplitude applications.
- **Excellent DC Stability** (<1 mV long term) assures optimum performance in DC coupled applications.
- **±0.2%, Integral Linearity**
- **Low Impedance Output** designed to drive two 50 Ω loads, allowing the amplified signal to be used directly for both logic and analog functions.
- **Compact Packaging** permits the complete amplifier to be mounted near the pulse source in a standard 16-pin DIP socket, thereby reducing amplification of extraneous noise.
- **Ideal for Fast Photomultipliers**

The LeCroy Model VV100B is a wide bandwidth, gain-of-10 pulse amplifier packaged as a standard 16-pin DIP hybrid circuit. Representing a major advance in fast amplifier bandwidth, stability, dynamic range, and general utility, the VV100B provides unprecedented performance in demanding direct-coupled, high-duty-cycle applications.

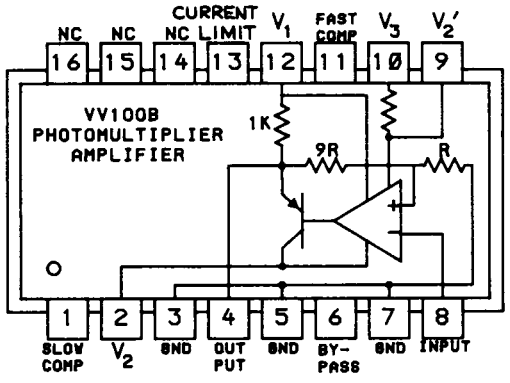
A new high speed amplifier circuit design makes the performance of the VV100B virtually independent of external variables such as supply voltages or temperature. Shifts in the DC output level remain negligibly small even when the amplifier is subjected to extremes of operating temperature or variations in power supplied. There is virtually no warmup drift at turn-on.

An ideal "tranparent gain" element would simply magnify the input signal without significant distortion of operating constraints. The VV100B performance is very close to this ideal by virtue of its extraordinary stability, speed, linearity, and noise characteristics.

PACKAGING



LOGIC DIAGRAM (TOP VIEW)



SPECIFICATIONS
Hybrid Circuit Model VV100B
WIDEBAND PULSE AMPLIFIER

Gain:	10 FIXED, ±5% tolerance, non-inverting, long term stability ±1%
Linearity:	±0.2% integral (0 to −3 V)
Maximum Output Swing:	−5 V at 200 mA [Note 1] +250 mV at 5 mA [Note 3]
Output Impedance:	<0.2 Ω for negative outputs
Frequency Response: Full Signal Bandwidth (3 dB)	⩾170 MHz for 2 voltage operation [Notes 4, 7] ⩾200 MHz for 3 voltage operation
Risetime (10% to 90%):	⩽2 nsec
Input Signal Range: Maximum Safe Input Signal Linear Range	±1 V; external clamp diodes recommended [Note 6] −0.5 V to +0.01 V
Wideband Output Noise: (referred to input)	<50 μV rms
Input Impedance:	>1 kΩ
Input Bias Current: Drift vs. Temperature	−25 μA 250 nA/°C
Input Offset Voltage: Typical Drift vs. Temperature Drift vs. Supply Voltage Drift vs. Time	 2 mV, adjustable to 0 10 μV/°C (max) <100 μV, for ±1% variation <100 μV, long term
Coupling: Input Output	 Direct Direct
Temperature Range:	0°C to 70°C
Power Supply Rejection Ratio:	90 dB at 120 Hz
Power Supply: Rated Voltage, Quiescent Current	(Two Voltage Operation) [Note 4] V_1 = 30 mA at +6 V V_2 = −20 mA at −6 V to −12 V (Tie pin 9 to pin 2)
Power Supply: Rated Voltage, Quiescent Current	(Three Voltage operation) [Note 5] V_1 = 30 mA at +6 V V_2 = −28 mA at −6 V to −12 V V_3 = −8 mA at V_2 − 12 V (e.g., −24 V when V_2 = −12 V and pin 9 open)
Overload Recovery:	Operation with V_2 = −12 V supply: saturated for approximately 15 nsec after 10× overload.
Package:	Standard 16-pin dual in-line hybrid integrated circuit. [Note 8]

NOTES:

1. Overload protected to limit the average output current to <60 mA. See application notes.
2. No overload protection. Average output current should be <50 mA to avoid damage to the unit.
3. For increased positive swing, see applicaiton notes.
4. Three voltage operation recommended for most applications.
5. Three voltage operation provides increased bandwidth.
6. See Figure 1.
7. For two voltage operation install a 6.8 μF capacitor from pin 13 to ground with the positive lead grounded.
8. The VV100B is not pin-for-pin compatible with the VV100. Please contact LeCroy for details.

APPLICATION NOTES

The LeCroy model VV100B is a hybrid circuit designed as a high bandwidth amplifier primarily intended for amplification of negative pulses such as those from photomultiplier tubes. It has a fixed gain of 10 and a risetime of less than 2 nsec. The output is capable of driving two 50 Ω loads (25 Ω). The linear range of the VV100B is +200 mV to −5 V.

The user may supply suitable input impedance for his particular needs. The unit requires an input terminating resistor, power supply bypass capacitors, input and output DC trims and an output shape capacitive trim.

Figure 1 shows a typical application circuit for the VV100B and is the circuit on the LeCroy VV100BTB amplifier. Here input trim T1 is accomplished by the series combination of a 27 kΩ resistor and a 500 kΩ potentiometer. Trim T2 is set by the 1 MΩ potentiometer and series 100 kΩ fixed resistor. A fixed resistor to ground sets the low frequency gain trim (T3). High frequency compensation is set by the 51 Ω, 6-35 pF combination.

The VV100B contains output protection circuitry which limits the average output current to 60 mA. The time constant of the limiting circuit is approximately 6 μsec.

The internal current limiting of the VV100B may be defeated by placing a jumper between pins 13 and 2. This connection allows bipolar operation if an additional resistor is connected from the output to a positive supply voltage. All positive current delivered to the load is through this additional resistor. The DC value of this added current should be held to less than 40 mA.

If internal current limiting is not defeated, the maximum positive voltage excursion into a load R_L is

$$V^{+}_{Max} = \frac{6\ R_L}{R_P + R_L}$$

The most negative will be given by

$$V^{-}_{Min} = (0.06\ V)\ \frac{R_P\ R_L}{R_P + R_L}; \qquad V^{-}_{Min} \geq -5\ V$$

LAYOUT

Because of the extremely high bandwidth of the VV100B, care should be used in layout of the printed circuit board. Continuous ground plane construction is essential. To ensure minimum inductance, low profile sockets like the TI or AUGAT should be used. Insertion pins (Berg 75315-001 or equivalent) are even better. Input busses should be separated from the output. Interconnections to other circuitry greater than 3 cm away should be made only by properly terminated coaxial cable. Input protection circuitry and bypass capacitors as described below should be located as close to the hybrid as possible.

THE INPUT

Proper termination and protection must be supplied to the input. In most cases, input to the amplifier will be via 50 Ω cable. In this case, a 50 Ω resistor from the input (pin 8) to ground should be employed. In addition, three 1N4448 or equivalent diodes to ground as shown in Figure 1 will provide overload protection. The input DC level must be trimmed to zero by a trim resistor (T1) to a negative supply. Where the best DC stability is required, this supply should be regulated. Note that fluctuations in the input offset will appear at the output amplified 10 fold.

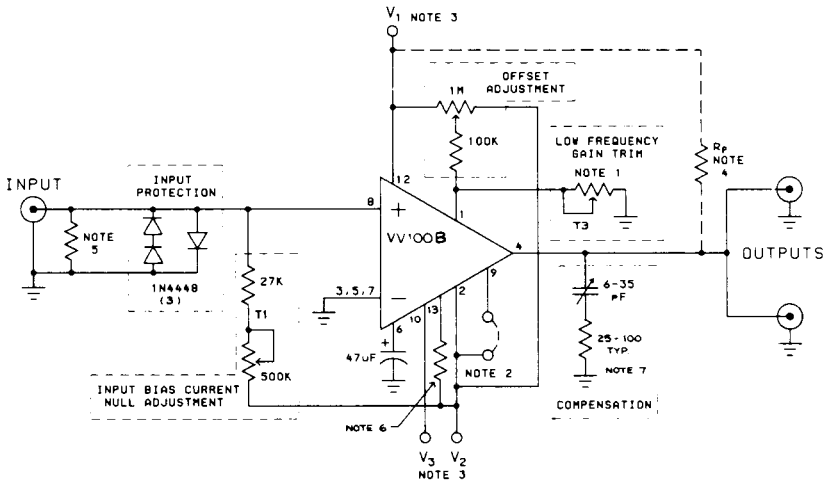


Figure 1

NOTES:

1. Typical value = 7.5 kΩ
2. Add jumper for 2-supply operation
3. All power supply voltage lines should include a high frequency bypass, typically a 6.8 μF capacitor to ground and a 50 μH series choke.
4. Optional pull-up for extended positive voltages excursions.
5. Input termination resistor, chosen to match input cable impedance.
6. 10 Ω current limiting resistor should be added when driving 25 Ω load.

POWER

A current of about 30 mA from +6 V must be supplied at pin 12. In addition, two negative supplies, V_2 and V_3, are recommended. V_2 (pin 2) requirement is 20 mA at a voltage between −6 and −12. V_3 (pin 10) is to be set 12 V more negative than V_2. For example, with V_2 set to −12 V, V_3 should be −24 V. The VV100B requires about 8 mA from the V_3 supply. Proper bypass requires at least 6.8 μF tantalum capacitors to ground from pins 2, 12, (and 10 if three voltages are used) and 47 μF on pin 6. Minimum length leads should be employed. Be sure to observe proper polarity. See Figure 1. Model VV100B can be operated with only two proper power supplies at the expense of risetime and linearity. For this configuration, tie pin 2 to pin 9, set $V_2 = -6$ V to −12 V, V_3 is omitted and $V_1 = +6$ V.

THE OUTPUT

The VV100B is optimized for a 25 Ω load in order to drive two 50 Ω cables simultaneously. If only one cable is to be driven, a 50 Ω resistor should be connected from the output of the VV100B to ground, to provide a net 25 Ω load. Other numbers of cables, and cables of impedances other than 50 Ω may be driven, always taking care to maintain the required 25 Ω through the use of additional series or shunt resistance. For example, three 91 Ω cables require an additional 142 Ω shunt to ground; five 50 Ω cables may be driven via five 75 Ω series resistors (yielding reduced gain and output swing as the price of the additional fan-out). Driving loads other than 25 Ω will cause output shape and stability problems. Loads less than 25 Ω degrade risetime, gain, and linear range; loads larger than 25 Ω produce ringing and oscillation.

OUTPUT PROTECTION

The output of the VV100B is protected against sustained shorts to ground in the presence of DC inputs. This short circuit protection is implemented by an integrating stage which senses output current and limits it to an average current of 60 mA. The time constant of the limiting stage is approximately 6 μsec. The maximum pulse output current is a function of the input pulse width, amplitude and repetition rate.

When limiting occurs, this integrating stage must recover before linear operation may resume. Longer averaging times can be achieved by adding capacitance from pin 13 to ground. Current limiting may be defeated by a jumper from pin 2 to pin 13. Under this condition, safe operation requires $(V_{out} - V_2)\ i_{out} < 1$ W.

The limiting circuitry is based upon the average output current of the VV100B. The maximum output swing for pulses less than the averaging time will be

$$d_{max} = \frac{(60\ mA)}{D}$$

Here, D is the duty factor. For larger widths the VV100B output will begin to shut down after a time t_{limit} and approach 60 mA with a 6 μsec time constant.

2

TRIMS

The VV100B requires three separate trims: input DC level, output DC level, and fast compensation.* The values of these trims must be selected for each VV100B and hence must be reset if the VV100B is replaced. All trims should be made with the VV100B output loaded with 25 Ω.

The first trim, T1, is used to set the input DC offset. With no input to the VV100B, install a resistor between the input connector and a regulated negative supply. The value of the resistor should be chosen to set the input voltage to 0.0 mV. Typical values of this trim are 30 kΩ to 300 kΩ.

The second trim, T2, is used to set the output DC level to zero. This trim is a resistor from pin 1 to either the negative or positive supply, depending upon the polarity of the initial DC offset. Typical values of this trim are 100 kΩ to 1 MΩ.

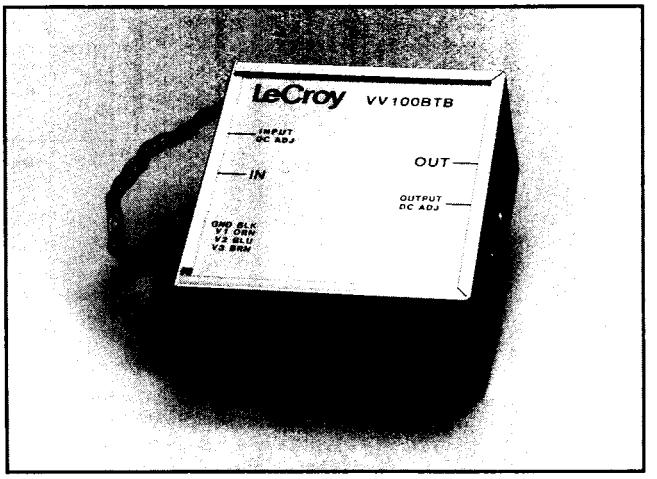
The last trim is an RC adjustment of the overshoot of the output. A 6-35 pF trimmer capacitor in series with a 25-100 Ω resistor is required to minimize the overshoot. Using a fast risetime input pulse, observe the output of the VV100B. Adjust the trim capacitor to give the best output pulse shape.

* Occasionally an additional slow compensation trim (T3) is required. To make this trim, a flat-topped pulse of about 10 μsec duration is applied to the VV100B input. A resistor in the range of 10 kΩ to 300 kΩ connected from pin 1 to pin 4 (or ground as required) is used to trim the output pulse to a flat top.

ORDERING INFORMATION

The LeCroy Model VV100BTB provides the high bandwidth circuitry, shown in Figure 1, in a ready-to-use format. The 3 inch × 3 inch × 1.6 inch enclosure size of the device allows one to use the Model VV100B in locations too small for many fast amplifiers. The amplifiers employ Lemo type coaxial cable connectors. The units may be purchased with a Model VV100B. The trim and compensation variables are factory adjusted for optimum high-speed performance.

MODEL	DESCRIPTION
VV100B	Amplifier hybrid.
VV100BTB	VV100B mounted in circuit board. Lemo connectors.



Model VV100BTB wideband amplifier module.