DIY Kit 89. STEREO VU METER

This VU (volume-unit) meter is capable of monitoring and displaying power levels present at the speaker terminals of an stereo audio power amplifier. The levels are displayed in ten discrete steps. This meter is not designed to give an accurate display of the power levels (Kit 73 has been designed to do this.) It is designed to give an approximate visual indication of the audio power output of each channel. For many situations - disco, parties - this is all which is required: the flashing LED's add atmosphere to the situation. No calibration is required.

The kit is constructed on single-sided printed circuit board. It contains two identical circuits, one for each channel of the amplifier. It is based on the LM3915 IC. Protel Autotrax & Schematic were used to design it.

LM3915. This is a monolithic Dot/Bar Display Driver IC made by National Semiconductor. It takes an analog voltage input on pin 5 then drives 10 LED's providing a logarithmic 3dB/step analog display. When measuring power, a 3dB increase means that the power input has doubled. As the power doubles, an additional LED will be lit until the maximum is reached. The display can be bar or moving dot depending on the connection of pin 9 to the positive supply. The LED drive current is regulated which eliminates the need for current limiting resistors. The supply voltage can be between 3V to 25V. You can download the data sheet from the National Semiconductor website at:

http://www.national.com/

The IC is suited to signals with a wide dynamic range such as audio, power, light intensity. In many applications a bar-graph meter is faster, more rugged and has higher visibility than an analog (moving coil) or LCD meter.

Vref. The IC contains an adjustable voltage reference. A nominal 1.25V is developed across pins 7 and 8. Two external resistors (R2 & R3 below) programs the full scale from between 1.2V and 12V applied to pin 5. We have chosen 10.5V to turn on all 10 LED's. The voltage required to turn on all the LEDs is set by R2 and R3. The IC develops a nominal 1.25V reference voltage (Vref) across pins 7 and 8. Since this voltage is constant then the current through R3 is also constant. This current also flows through R2. The total voltage across R2 and R3 is given by

V = Vref. (1 + R2/R3) + Iadj.R2

The last term is due to a small adjust current (75-120uA) flowing out of pin 8. For the values shown the voltage is approximately 10.5 volts. Since pins 6 and 7 are joined then this is the voltage applied across the internal voltage divider network. Therefore when the voltage on pin 5 equals 10.5V all ten LEDs will be lit. Vref is independent of the supply voltage.

Resistor Chain. Internally this chip consists of ten voltage comparators. The non-inverting (+) input of each comparator is connected to an accurate ten-step voltage divider network. Each comparator will therefore trigger on a different comparison level. The inverting (-) inputs of each comparator are commoned together and connected to an incoming DC signal via a high impedance input buffer. The resistance values of the voltage divider network are such that the comparators progressively turn on their LEDs for each 3dB increase of input signal level. There are ten LEDs so the total range indicated is 30dB.

The output of each comparator drives an LED via a current-limited npn transistor. Outputs may be run in saturation so that logicinputs on other IC's may be direct driven.

Current. LED This is given by the equation:

ILED = 12.5V/R1 + Vref/2K2.

This works out to about 9.4mA.

The signal to be measured is fed to the input of IC1 (pin 5) via a voltage doubling network consisting of C1, C2, D1 and D2. This gives the circuit more sensitivity to low level input signals.

Capacitor C2 is charged towards twice the peak-to-peak value of the input signal (less 1.2V for the drop across D1 & D2). However, resistor R1 tends to discharge C2 between the signal peaks. Hence the DC voltage at pin 5 is equal to approximately twice the RMS value of the input signal.

The actual value of the power level displayed depends not only on the voltage across the speakers but also the resistance of the speakers themselves. The equation for calculating power is P = E2 / R. The following gives the range of power levels displayed for common speaker resistances:

8 ohm speakers	5.6 milliwatts to 2.87 watts
4 ohm speakers	11.2 milliwatts to 5.75 watts
2 ohm speakers	22.4 milliwatts to 11.48 watts

Note that the combination of R1 and C2 makes the circuit non-linear. The power values given above are for a frequency of 1 Khz. Frequencies below 1 Khz tend to be displayed lower than their actual level while frequencies above 1 Khz tend to be displayed higher.

Construction.
Add the lowest height components to the board first - the resistors, diodes and the two links. The links are indicated by a white line next to pin 9 of each IC. For the four diodes make sure that the bar on the diode corresponds to the bar printed on the overlay at each diode position. Then add the two IC sockets. Be careful to get the four electrolytic capacitors in the correct way around.

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LED's. We have supplied 7 green & 3 red LED's per audio channel.We suggest you use the three red LED's to indicate when the power is at its highest. This is at positions L8 L9 & L10 for IC1, and L18 L19 & L20 for IC2. Before you solder the LED's into place you must do three things: first decide how high you need to have the LED's above the PCB for the particular application or case you have in mind.

Secondly, you must determine which lead of the LED is the cathode & which is the anode. The short lead of the LED indicates the cathode. This is the lead which corresponds to the bar on the LED symbol on the overlay.

Thirdly, & **very important**: you want the LED's to all be in a nice neat line, correct. Well soldering by hand will not give this result. Use a piece of sticky tape to hold the LED's securely in place while you solder. This will also help you get the desired height above the PCB. After the LED's are in place add the IC sockets & the IC's. Solder the power and audio cables to the pads as indicated. After a final check turn on the power and the audio input. If you have an audio frequency generator set it up to deliver about 6V on a sinewave of 1kHz. Eight or nine of the LED's should turn on. If this is not the case check that all components are in their correct positions and with the right orientation. Are the two links in the board? Are the IC's around the correct way.

Prescaling. Higher power levels can be displayed by adding a voltage divider network at the input to the meter. For example, a 2-to-1 voltage divider means that the maximum power able to be displayed would be increased by four times. A 3-to-1 divider means an increase of 9 times, etc. (See Reference 3 for a circuit to do this.)

References:

1. The full data sheets on the LM3915 can be found in the SpecialPurpose Linear Devices, data book from National Semiconductor,page 5-240. Better still download it from their website as given above.

2. **Optoelectronics Circuits Manual** by R. M. Marston, published by Newnes. Pages 52 - 65.

3. Build This Audio Power Meter & Worry No More, by Darren Yates. *Silicon Chip*, April 1993, pages 22 - 25.

COMPONENTS		
Resistors, 5%, 1/4W:		
18K brown grey orange	R2 R5	2
2K7 red violet red	R3 R6	2
10K brown black orange	R1 R4	2
1uF 50V ecap	C1 C2 C3 C4	4
Green rectangular LED		14
Red rectangular LED		6
LM3915	IC1 IC2	2
18 pin IC socket		2
K89 PCB		1

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