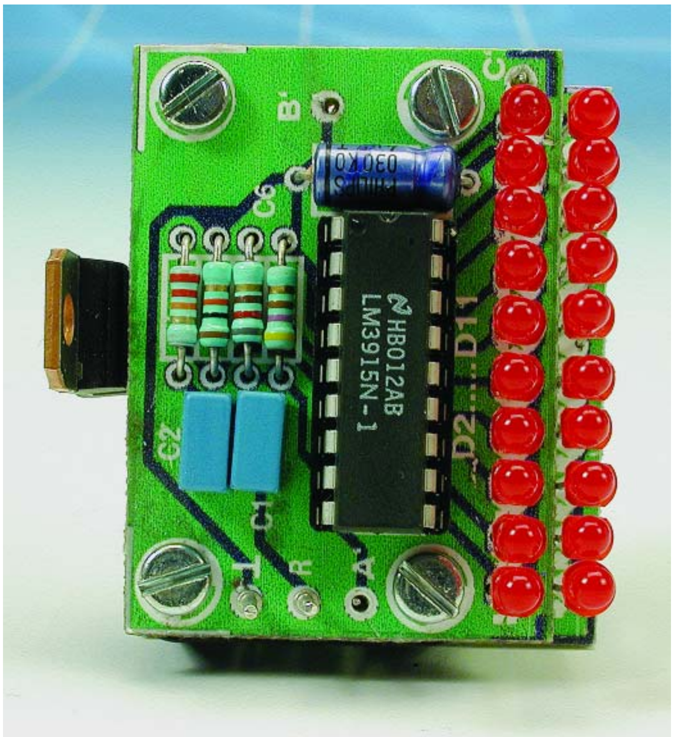
Car-Stereo LED Power (VU) Meter

041



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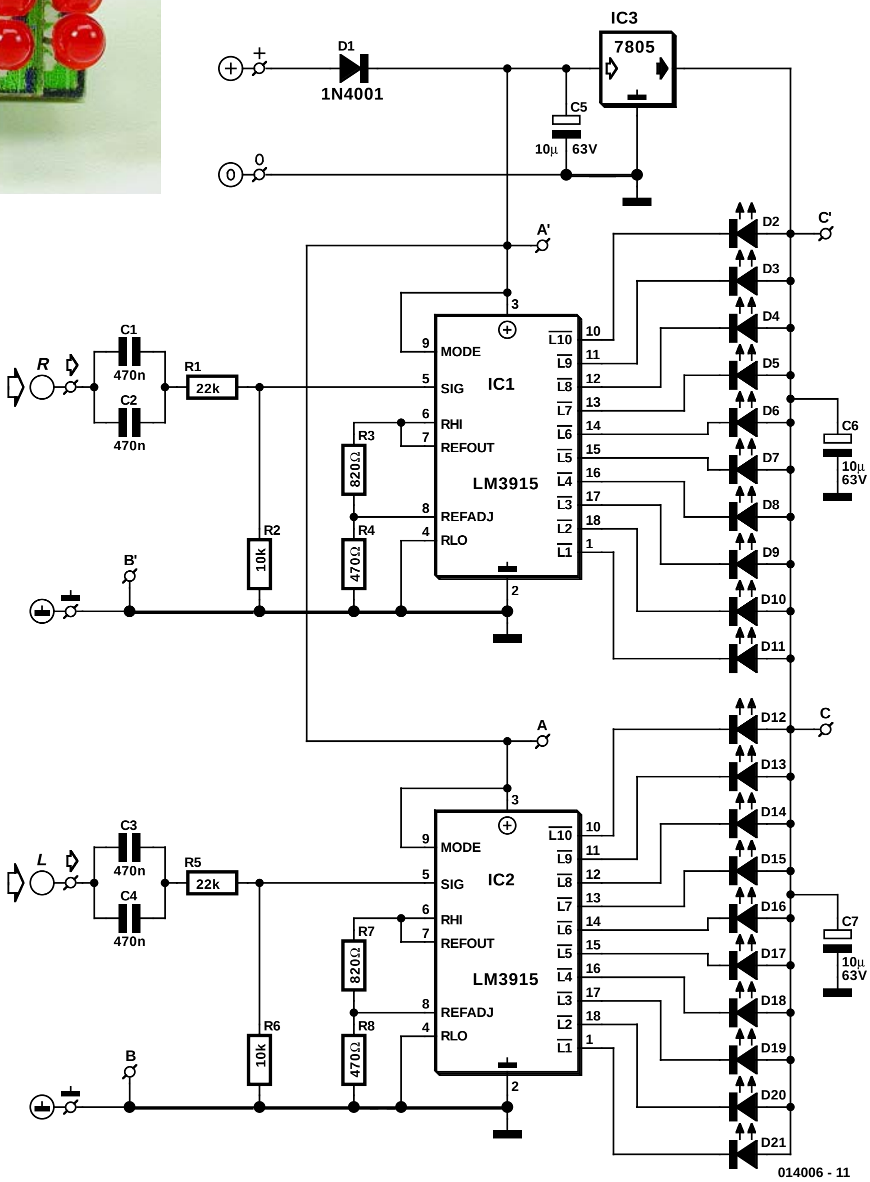
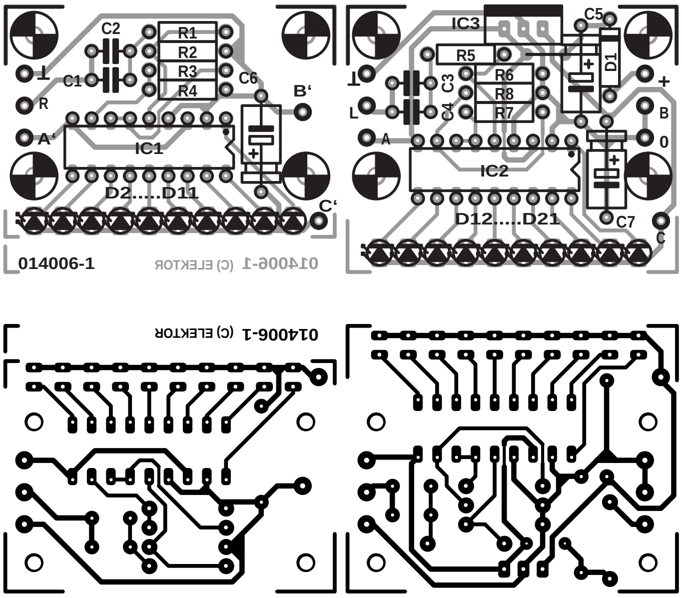
This circuit senses AC audio voltage supplied to the car-radio loudspeakers and displays it as power using a LED bar graph, achieving at the same time an attractive visual effect. It is designed to cover common car-radio output power ranges, but can easily be modified to suit different needs. It is supplied from the 12 V car electrical system and is suitable for classical CC (Capacitor-coupled) as well as BTL (Bridge Tied Load) types of amplifier with no changes to the circuitry or connections at all. In fact, only the meaning of the LEDs changes — with BTL, the LED increments equal four times the CC value on the same load.

CC-type amplifiers have the loudspeaker connected via a DC-decoupling capacitor at the output and ground (negative). BTL-type amplifiers, on the other hand, have the loudspeaker DC-coupled and 'stretched' between two equal, parallel, but phase-reversed outputs. The result compared to 'CC' is twice the voltage swing, hence quadrupling the power being fed to the same loudspeaker load.

It is necessary to know to which of the two types this circuit is connected to only in order to correctly assign power levels (W) to the LEDs. CC-type have no DC voltage to ground at the outputs and return wires. The return wires are actually connected to the common ground (negative). BTL-type have approximately Vcc/2 at outputs and on the return wires too, explaining at the same time why no DC-decoupling capacitors are needed.

The LM3915N integrated circuit used in this circuit has been the subject of numerous publications in this magazine so will not will not be discussed again. In this application, the two LM3915Ns are configured as a LED bar graph drivers (pin 9 connected to pin 3), The ICs share the same power supply section. The audio input signal is fed via network C1/C2, R1, R2 (C3/C4, R5, R6) to pin 5 of IC1 (IC2). Only positive half-waves are processed by the ICs. Internally, the buffered input voltage is compared using comparators to the voltages along a resistor ladder network. The nominal +1.25 V reference source volt-





COMPONENTS LIST

Resistors:
R1,R5 = 22kΩ
R2,R6 = 10kΩ
R3,R7 = 820Ω
R4,R8 = 470Ω

Capacitors:
C1-C4 = 470nF, lead pitch 5mm
C5,C6,C7 = 10µF 63V radial

Semiconductors:
D1 = 1N4001
D2-D21 = LED, 3mm dia. or rectangular-face
IC1,IC2 = LM3915N-1 (National Semiconductor)
IC3 = 7805

Miscellaneous:
Heatsink for IC3 (10 K/W)

age (between pins 7 and 8) is applied across R3 (R7) to program the LED current. The programming current flows through R4 (R8) to achieve the desired reference voltage between pin 7 and ground. Here, only 2.0 V is developed, allowing this circuit to be used with low power amplifiers too. This voltage is applied to the 'top' of the on-chip resistor array (pin 6) and so determines the threshold at which the LED connected to the $\overline{\text{L10}}$ output comes on. The other (low) side of the array (pin 4) is connected to ground. So, for an input voltage equal to or greater than the voltage at pin 6, all LEDs are on. At input voltages below the threshold set up for the lowest LED (89.3 mV or –27dB below the top LED) all LEDs are off.
In order to limit power dissipation of IC1 and IC2, the LED voltage is stepped down to +5 V using IC3, C6 and C7. Diode D1 protects the circuit against reversed polarity.
If a 'dot' mode graph is preferred pins 9 of IC1 and IC2 should be left open circuit.
Using the listed value for R1 (R5), the indicator range covers audio power levels of 10 W into 4 Ω (CC) or 40 W into 4 Ω (BTL). Each 'lower' LED indicates half the power of the previous 'higher' LED Only R1 (R5) needs to be redimensioned for different power levels. The value can be calculated from

$$R1 = [R2 \sqrt{(P_O Z_L)} / (k * V_{RefOut})] – R2$$

where

P_O = maximum output power to be indicated (LED D2 or D12)
Z_L = loudspeaker impedance
R2= R6
V_{RefOut} = 2.0 V
k = constant; 2 for BTL, 1 for CC

The condition $\sqrt{(P_O Z_L)} / (k V_{RefOut}) \geq 1$ must be met.

A small printed circuit board has been designed to allow a stereo version of the power indicator to be built. The board is cut in two to separate the channels. The boards may be assembled in a sandwich construction with three inter-board connections A-A', B-B' and C-C' made in stiff wire. IC3 should be secured to a small heatsink (10 K/W). Rectangular-face LEDs are recommended for this circuit. If on the other and 3-mm dia. LEDs are used, these may have to be filed down a bit to be able to fit them in a straight row.
The connection to the car radio should not present any problems. The audio signal is taken from the (+) loudspeaker connector for each channel and ground. The power supply leads to the indicator circuit are connected in parallel with car radio power supply.
At a supply voltage of 14.4 V, the maximum and quiescent current consumption of the circuit was measured at 171 and 22 mA respectively.

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