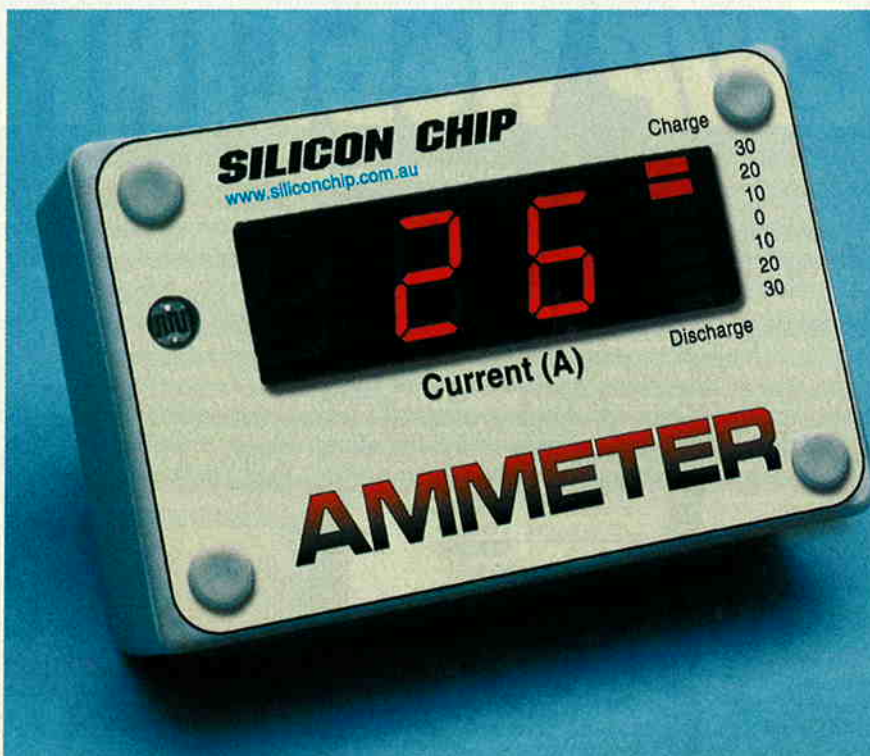




Keep tabs on your car's battery charge and discharge currents with this dual-display ammeter. It includes a 3-digit display to indicate the current in amperes, as well as a bargraph to show the charge/discharge trend at a glance.

By JOHN CLARKE

Compact 0-80A automotive ammeter

IT'S NOW RARE TO SEE an ammeter installed in a car. Instead, virtually all modern (and not so modern) cars have an "idiot" light to indicate battery charging. Normally, this light is off when the engine is running and only comes on if the alternator fails; ie, when no charge is being delivered.

Apart from that, it doesn't provide any other information during normal driving.

This means that when the light is out, you have no idea how much current is going into the battery or is being pulled out. And even when an ammeter was fitted, it was hardly what you would call a precision instrument. Most only gave a very rough idea of what happening.

However, if you are an enthusiast, you will want to know more about battery charge and discharge rates. This Automotive Ammeter can pro-

vide this information with a high degree of accuracy.

Why is it important?

Knowing the charging state of the battery is important since it's a major component of the cars' electrical system. If the battery isn't charging properly, you could be left stranded.

When the engine is running, the alternator normally provides all the power for the electrical loads and keeps the battery topped up. However, if there is insufficient charging current, the battery will gradually discharge. This can typically occur if the electrical load is high while the engine is idling, or if the connections to the battery are faulty or the battery itself is on the way out.

Measuring the battery current involves measuring the current flowing in all the leads to one of the battery's terminals. In addition, it's necessary

MAIN FEATURES

- Compact size
- Includes 7-LED bargraph display plus 2-digit readout
- $\pm 0-30A$ indication on bargraph in 5A steps
- 1A resolution on 2-digit display
- Typical 80A maximum reading
- Dual indication for charge and discharge
- Automatic display dimming in low light conditions

to determine the direction of the current, so that we know whether the battery is being charged or discharged.

Hall effect sensor

The SILICON CHIP Automotive Am-

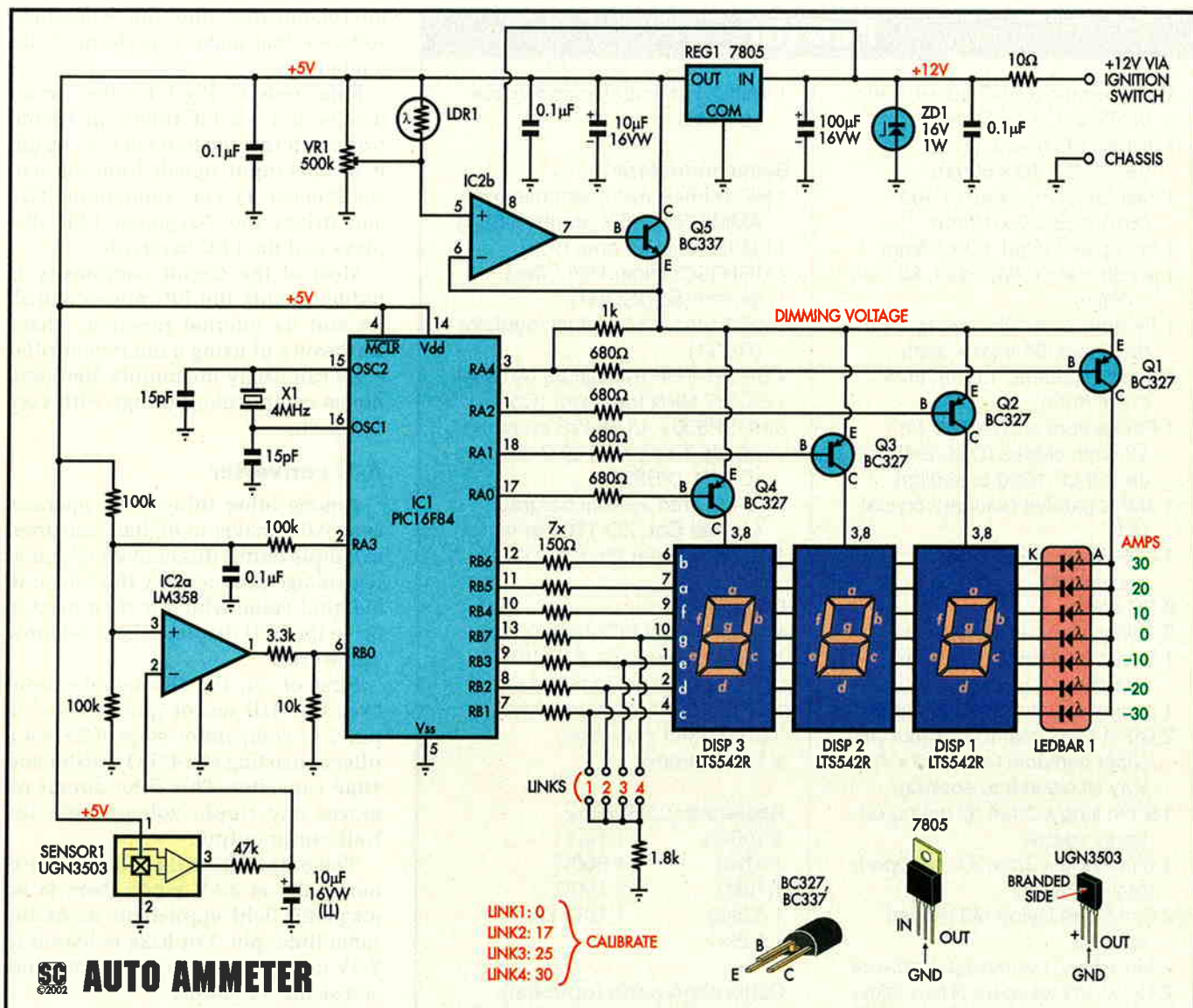


Fig.1: the PIC microcontroller (IC1) processes the signal from the Hall effect sensor (Sensor 1) and drives the 7-segment LED displays and the LED bargraph. LDR1, VR1 & IC2b automatically vary the display brightness according to the ambient light conditions.

meter measures the battery current using a Hall effect sensor. This monitors the magnetic field produced by current flow in the battery leads.

Fig.2 shows the sensor details. A ferrite core is placed around the battery leads, with the Hall sensor positioned in the air-gap. The leads from the battery produce a magnetic flux when ever current flows and this is induced into the ferrite core. This magnetic flux then passes through the sensor, which in turn produces a voltage that's proportional to the current in the leads.

What's more, the output of the Hall effect device goes positive for one direction of current and negative for the other. So the same sensor can deter-

mine both the magnitude of the current and its direction.

Main features

The SILICON CHIP Automotive Ammeter is housed in a small plastic case and matches the style of our previous PIC-based automotive projects. As before, the readout uses LED displays set behind a Perspex window in the lid. In this unit, there are three 7-segment LED displays and one bargraph display. The 7-segment displays show the current, with the lefthand digit showing a minus sign when the battery is being discharged.

The vertical LED bargraph on the righthand side of the front panel consists of seven LEDs and operates in

dot mode. The centre LED indicates zero amps (0A) while the three LEDs above this progressively light in 10A-steps for currents of 10-19A, 20-29A and 30A and above.

The bargraph resolution is increased somewhat by making it possible for more than one LED come on at a time. Thus, the 0A and 10A LEDs both light for currents from 5-9A; the 10A and 20A LEDs both light for currents from 15-19A; and the 20A and 30A LEDs both light for currents from 25-29A.

The three LEDs below the 0A LED indicate the discharge current and operate in exactly the same manner – but in the opposite direction.

As with our previous instruments, we've included automatic dimming and this varies the display brightness according to the ambient light level. That way, the displays are nice and bright for daytime viewing but are

Parts List

- 1 microcontroller PC board, code, 05106021, 78 x 50mm
- 1 display PC board, code, 05106022, 78 x 50mm
- 1 Hall Effect PC board, code 05106023, 20 x 12mm
- 1 front panel label, 80 x 53mm
- 1 plastic case utility case, 83 x 54 x 30mm
- 1 Perspex or Acrylic transparent red sheet, 56 x 20 x 3mm
- 2 plastic spacers, 1.5mm thick (12 x 7mm)
- 1 Ferrite core suppressor for 12.5mm cables (DSE D-5375, Jaycar LF-1290 or similar)
- 1 4MHz parallel resonant crystal (X1)
- 1 LDR (Jaycar RD-3480 or equivalent)
- 8 PC stakes
- 3 7-way pin head launchers
- 1 5-way 2.54mm DIL jumper launcher
- 1 jumper shunt (2.54mm spacing)
- 2 DIP-14 low cost IC sockets with wiper contacts (cut for 3 x 7-way single in-line sockets)
- 1 9mm long x 3mm ID untapped brass spacer
- 1 6mm long x 3mm ID untapped brass spacer
- 2 6mm long Nylon M3 tapped spacers
- 2 M3 x 6mm countersunk screws
- 2 Nylon M3 washers (1mm thick) or 1 Nylon M3 nut (2mm thick)
- 2 M3 x 15mm brass screws
- 4 150mm cable ties
- 1 2m length of red automotive wire
- 1 2m length of black or green automotive wire (ground wire)
- 1 2m length of 2-core screened cable

- 1 500k Ω horizontal trimpot (code 504) (VR1)

Semiconductors

- 1 PIC16F84P microcontroller with AMMETER.HEX program (IC1)
- 1 LM358 dual op amp (IC2)
- 1 UGN3503 linear Hall Effect sensor (SENSOR1)
- 1 7805 5V 1A 3-terminal regulator (REG1)
- 4 BC327 PNP transistors (Q1-Q4)
- 1 BC337 NPN transistor (Q5)
- 3 HDSP5301, LTS542R common anode 7-segment LED displays (DISP1-DISP3)
- 1 10-LED red vertical bargraph (Jaycar Cat. ZD-1704 or equiv.)
- 1 16V 1W zener diode (ZD1)

Capacitors

- 1 100 μ F 16VW PC electrolytic
- 1 10 μ F low leakage (LL) 16VW PC electrolytic or tantalum
- 1 10 μ F 16VW PC electrolytic
- 3 0.1 μ F MKT polyester
- 2 15pF ceramic

Resistors (0.25W 1%)

- 3 100k Ω 1 1k Ω
- 1 47k Ω 4 680 Ω
- 1 10k Ω 7 150 Ω
- 1 3.3k Ω 1 10 Ω 1W
- 1 1.8k Ω

Calibration parts (optional)

- 1 8m length of 0.25mm diameter enamelled copper wire
- 1 56 Ω 5W resistor
- 1 3.9 Ω 5W resistor

Miscellaneous

Automotive connectors, automotive cable, neutral cure Silicone sealant, heatshrink tubing, cable ties, etc.

turned down at night so that they don't become distracting. The degree of display dimming is adjustable with a trimpot.

The accompanying panel shows the other features of the unit. In particular, the maximum reading is 80A and the resolution is 1A. If the current goes above 80A, the unit overloads and displays "OL" on the middle and left 7-segment readouts.

Best of all, you don't need to be a

rocket-scientist to use it, as there are no controls to operate. It's turned on and off with the ignition and you just read the displays. Simple!

Circuit details

As already indicated, the circuit is based on a PIC microcontroller which minimises both the cost and the parts count. In fact, the circuit is similar to our previous PIC-based automotive projects. It's the bits that hang off the

microcontroller and the embedded software that make it perform its intended role.

Refer now to Fig.1 for the circuit details. IC1 – a PIC16F84 microcontroller – forms the basis of the circuit. It accepts input signals from the sensor (Sensor 1) via comparator IC2a and drives the 7-segment LED displays and the LED bargraph.

Most of the circuit complexity is hidden inside the PIC microcontroller and its internal program. That's the beauty of using a microcontroller – we can easily do complicated (and not so complicated) things with very few parts.

A-D converter

Among other things, IC1 operates as an A/D (analog-to-digital) converter. In simple terms, this converts the analog voltage produced by the sensor to a digital value which is then used to drive the LED displays. Let's see how this works.

First of all, the DC signal output from the Hall sensor (pin 3) is fed to pin 2 of comparator stage IC2a via a filter consisting of a 47k Ω resistor and 10 μ F capacitor. This filter circuit removes any ripple voltage from the Hall sensor output.

The output from the Hall sensor is nominally at 2.5V when there is no magnetic field applied to it. At the same time, pin 3 of IC2a is biased to 2.5V using two series 100k Ω resistors across the 5V supply.

The associated 100k Ω resistor to RA3 of IC1 (pin 2) pulls IC2a's pin 3 input to 1.67V when RA3 is at ground or to 3.33V when RA3 is at 5V. However, if RA3 is repeatedly switched between +5V and ground at a fast rate, it follows that pin 3 of IC2a can be set to any voltage between 1.67V and 3.33V, depending on the duty cycle of the switching waveform.

In operation, the A/D converter uses IC1 to ensure that the voltage applied to pin 3 of IC2a matches the sensor output voltage applied to pin 2. It does this by producing a 1953Hz pulse width modulated (PWM) signal at its RA3 output, the duty cycle of which is continually adjusted to produce the required voltage on pin 3 of IC2a.

For example, if the duty cycle at RA3 is 50%, the average voltage output will be 2.5V. This is filtered by a 0.1 μ F capacitor and applied to pin 3. Other voltages are obtained by using