Take the guesswork out of exposure settings!

Exposure Meter for Electronic Flash

In recent months we have produced two very useful accessories for photographers in the form of Light-activated and Sound-activated triggers for electronic flash. But now we have produced a unit which easily surpasses these in appeal: a flash exposure meter. This is comparable with commercial units but you can build it for a fraction of the price.

by IAN POGSON

While the Light-activated and Sound-activated triggers for electronic flash have been very favourably received by amateur photographers who have an interest in electronics, our most common request from these people has been for a circuit for an electronic flash exposure meter. Now, after much trial and error, we have come up with a circuit that we are very proud of.

Keen photographers are only too aware of the fact that when using electronic flash, correct film exposure is often a hit-or-miss afair. While the exposure tables provided with most electronic flash guns are a pointer in the right direction, they are, at best, only a rough guide. And they are of no use for outdoor flash photography or in situations where two or more flash guns are used.

Here is where the flash exposure meter comes in very handy. Just set it up at the position of the subject to be photographed, set the moveable scale to the film ASA rating and pop the flash gun(s). Presto, the meter reads the light value and holds it for you until reset. Then you can read your exact exposure off the moveable scale.

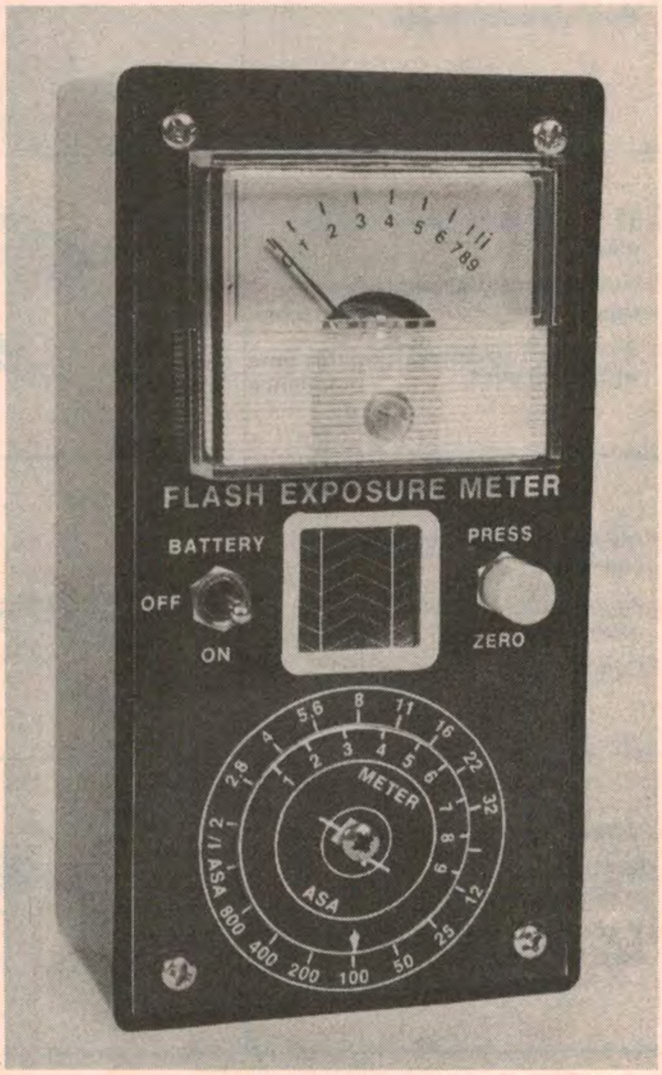
Commercial flash exposure meters range in price from $100 up to $150 or more. Our unit can be built for less than $40. What a bargain!

Now let us have a look at the circuit: While it looks fairly complicated it is really quite simple and uses just a handful of components. The heart of the unit is a silicon photovoltaic cell, identical to the cell used in our Light-activated trigger, described in the October issue.

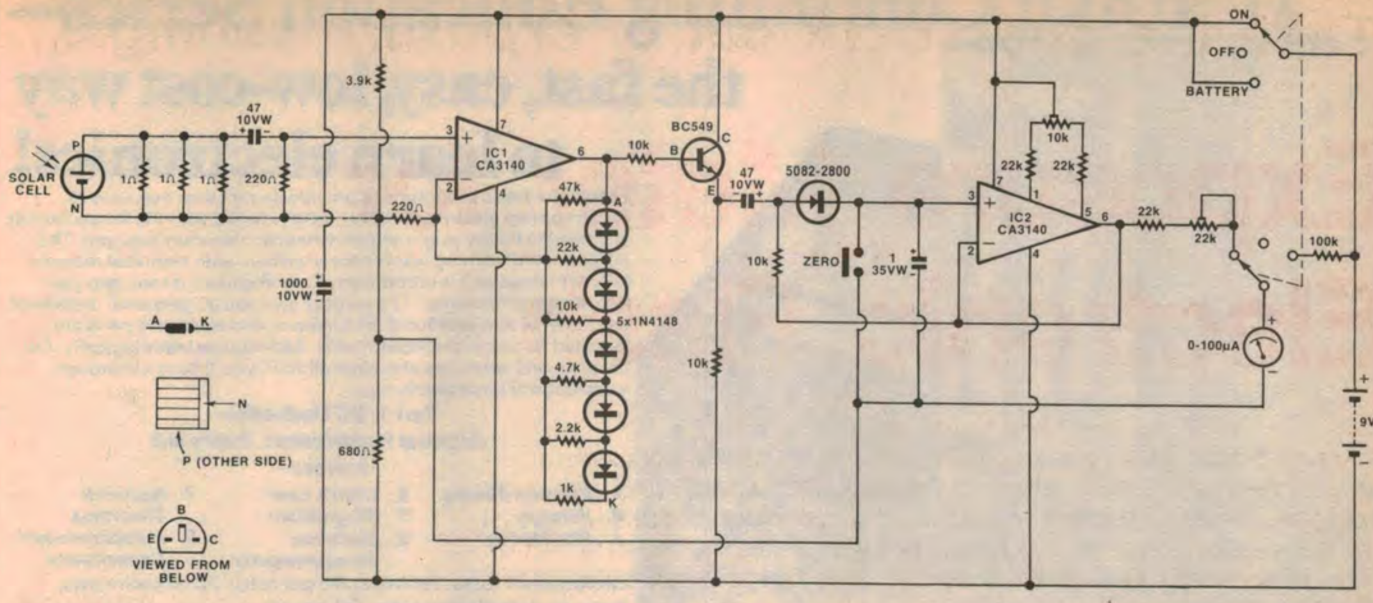
The silicon cell is ideal for the job because it has an extremely fast response time which is necessary to cope with the very brief and intense burst of light from typical flash guns. In other respects, the silicon cell is not ideal because it is really a light-to-charge transducer whereas we need a light-to-voltage conversion.

To obtain this characteristic, the silicon cell is loaded with a combination of three one-ohm resistors in parallel. This is workable because the silicon cell has a very low output impedance. The loaded output of the cell is AC coupled via a 47uF capacitor to a CA3140 op amp, AC coupling serving to eliminate any initial output of the cell due to ambient light. The mosfet-input 3140 op amp is used not because of its high input impedance but because of its high "slew-rate"– necessary to match the fast response of the silicon cell.

The 3140 op amp is arranged as a DC amplifier with a weird-looking feedback network made up of diodes and resistors. This is to provide the amplifier with a logarithmic response, which is necessary to compress the wide range of useable light values to a readable meter scale.



Handsome is as handsome does! Our new Flash Exposure Meter looks the part and takes the guesswork out of exposure settings. Here it is shown roughly full size.



FLASH EXPOSURE METER

3/EF/-

That string of diodes makes the response of IC1 logarithmic in order to handle a large range of light values.

An NPN transistor connected as an emitter-follower is used to buffer the output of the first 3140 op amp. This is necessary because the very fast pulse delivered by the op amp has to be stored in a capacitor and the op amp cannot do the job by itself.

The buffered output of the first 3140 amplifier is fed to a "sample and hold" circuit via a 47uF capacitor. This sample-and-hold circuit consists of a diode, a 1uF capacitor and a second 3140 amplifier which is used, this time, for its extremely high input impedance. The diode is a "hot carrier" type made by Hewlett-Packard. This is specified because of its low forward-conduction voltage and very low reverse leakage.

The 3140 op amp is connected as a "voltage follower". This means it has unity gain and as a result, as is indicated by the name, it produces an exact replica of its input at the output. The output of the amplifier is used to bootstrap the hot-carrier diode via a 10k resistor. This largely cancels out the very low leakage in the hot-carrier diode and means that the "sample and hold" circuit really does what it is supposed to — hold the value.

The voltage-follower has an offset voltage adjustment (the 10k trimpot) so it can be effectively zeroed. The output is fed to a 100uA meter movement via a series 22k resistor and 22k trimpot.

A momentary-contact pushbutton switch is connected across the 1uF sample-and-hold capacitor to discharge it before each reading is made.

Both op amps require positive and negative supplies and this is provided by "splitting" the nine volts from the battery with a voltage divider consisting of a 3.9k and 680-ohm resistor. This uneven division gives a higher value for the positive rail than for the negative. This is desirable to give the best possible signal handling for the positive pulse from the silicon cell.

On casual inspection it may appear that the polarity of the second 47uF, at the output of the emitter-follower, is incorrectly marked on the circuit diagram. It is correct. By virtue of the fact that both op amps have their outputs set at the reference potential provided by the above-mentioned voltage divider, then the emitter of the BC549 is actually 0.6 volts below this reference potential.

The diode side of the capacitor is held at reference by the bootstrapping 10k resistor, so this side is positive with respect to the BC549 emitter.

> We estimate that the current cost of parts for this project is approximately
>
> **$38.00**
>
> This includes sales tax.

A 1000uF capacitor is connected across the battery to ensure a low impedance supply. The circuit allows reasonable accuracy to be maintained until the battery drops below 7 volts. This means that the battery life should be quite long, in line with the intermittent use of the unit. The on-off switch has a battery check position, so you are unlikely to be caught out with a flat battery.

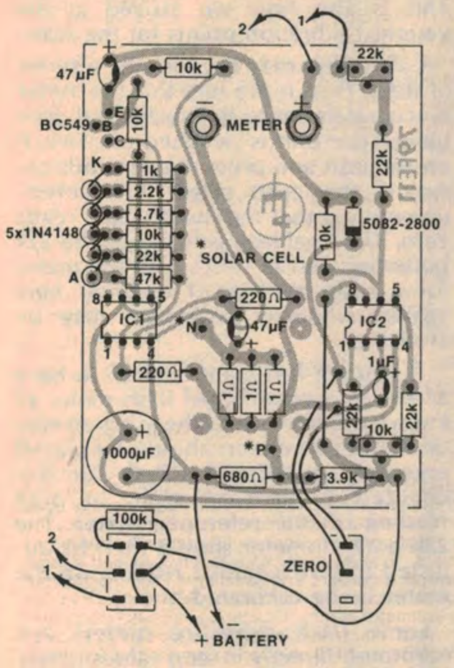
Well that completes the circuit description but before touching on constructional details, perhaps a few comments on some of the components may be helpful. The very important silicon solar cell may not be available from all stockists but we have used cells from Dick Smith Electronics and David Reid Electronics and both are quite suitable for the Flash Exposure Meter; both are 20mm square. They differ slightly in appearance, particularly in the pattern of the electrodes on the front face. The unit sold by Dick Smith does not have any leads attached but the unit from David Reid has two thin foil strips for connection to the external circuitry. More will be said about installing the cell later on.

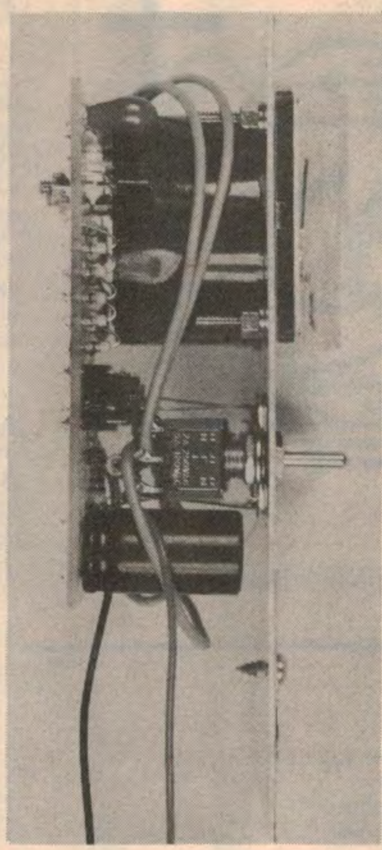
The meter which we used is sold under the University brand and was supplied by Radio Despatch Service. Other brands of meter may be used, provided they are 100uA FSD and are physically compatible.

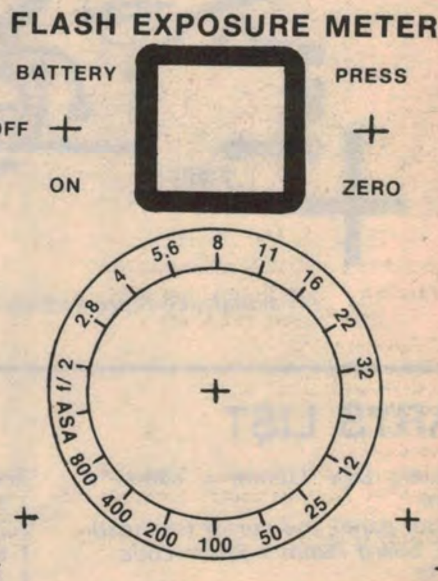
The plastic box which houses the unit is available from Dick Smith Electronics and Radio Despatch Service and may also be available from other sources. The PCB should be available from all the usual suppliers of boards by the time this appears in print.

The front panel, rotor for the calculator and the meter scale were made up by the "Scotchcal" process. This gives quite a good professional finish. Radio Despatch Service are making Scotchcal duplicates of these items available for readers making this and other projects. Also, we understand that special meter scales are to be made available for University meters. These will also be available from Radio Despatch Service.

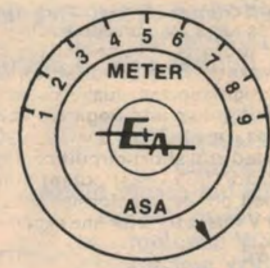
Although the unit is a small one, construction does call for some special care, particularly when handling the solar cell and the two ICs. The usual care should also be taken when soldering, to make good joints and to avoid overheating any components. It is also important to make sure that the ICs, transistor, capacitors, diodes, battery and the solar cell are correctly polarised.



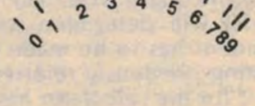




This wiring diagram and internal photo show most of the details of assembly.



Shown in this column is the full-size artwork for the front panel and meter scale.



The PCB may be assembled by making reference to the overlay diagram. As usual, the smallest components should be fixed first, starting with the jumper wire and resistors, followed by the diodes, capacitors etc. While it is quite in order to solder the ICs directly onto the board, I favour the use of sockets. If you should decide to solder the ICs straight in, make sure that the barrel of the soldering iron is connected to the negative supply line of the PCB, via a clip lead.

That part of the construction which demands the maximum care is mounting the solar cell on the board. The cell must be stood off the PCB so that when the whole unit is assembled, the cell is just beneath the front panel opening. To do this, we used two pieces of 26 gauge tinned copper wire. The two pieces were bent in the form of a "U", with sharp corners. The dimensions are such that the middle part of the wire is a little shorter than the metal backed dimensions of the cell. As the cell will need to be about 26mm from the board, the "legs" should be left a few millimetres longer than this for the time being.

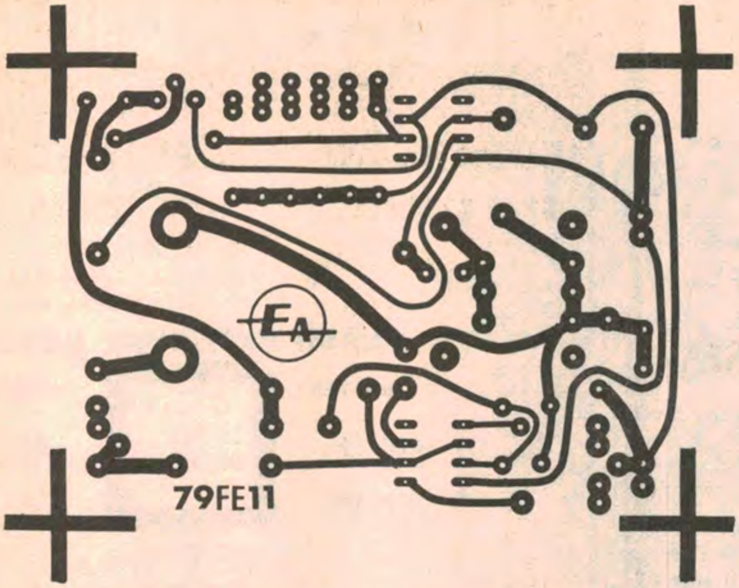
The distance between the four legs should be made to match the mounting holes provided on the PCB. The dimension 26mm, should be considered as a tentative one until the final assembly into the box.

If you get a solar cell with flying leads, then the one connected to the metal backing plate should be removed before adding the "U" pieces previously mentioned. The second flying lead may be soldered to a short piece of wire soldered to the respective point on the PCB. When no flying leads are provided, the connection to the front of the cell may be made with another piece of 26 gauge tinned copper wire straight from the PCB.

Great care must be taken with the foregoing operation, as any rough or careless handling may result in fracture of the cell.

With all the components fixed on the board, before it is ready to be fitted into the box, leads for the switches and the battery must be added. Also, the 100k battery metering resistor should be connected to the three position toggle switch.

To protect the solar cell from possi-



An acutal-size reproduction of the PCB artwork.

PARTS LIST

1 Plastic box 130mm x 68mm x 41mm
1 Front panel and cursor (see text)
1 PC board 76mm x 59mm code 79FE11
1 9V battery No. 216
1 Meter 100uA 48mm x 42mm with special scale
1 Solar cell 20mm square (see text)
1 Switch push-button SPDT
1 Switch double pole 3-position toggle
2 CA3140 ICs
2 IC sockets 8-pin DIL
1 BC549 transistor
1 5082-2800 hot-carrier diode
5 1N4148 silicon diodes
1 1uF/35VW tantalum
2 47uF/10VW tantalum
1 1000uF/10VW electrolytic
1 10k miniature vertical trimpot
1 22k miniature vertical trimpot

Resistors (all ½W or ¼W)
3 1 ohm
2 220 ohms
1 680 ohms
1 1k
1 2.2k
1 3.9k
1 4.7k
4 10k
4 22k
1 47k
1 100k
Hookup wire, solder, 26 gauge TC wire, battery clip and leads.

NOTE: Ratings are those used on the prototype. Components with higher ratings may generally be used providing they are physically compatible. Components with lower ratings may also be used in some cases, provided the ratings are not exceeded.

ble damage later on, it is wise to give it some protection by cementing a piece of clear plastic, or even a thin piece of glass, over the cutout for the cell and at the back of the board. The thickness of this material will determine whether any adjustment has to be made to the cell mounting previously referred to.

The rotor for the calculator has to be positioned on the front panel. We will assume that you have the front panel and cursor made from Scotchcal and that the piece has already been fitted to the panel. The cursor has to be cut out to a circle and this can be conveniently done with a pair of scissors and a little care. This done, a clearance hole is drilled in the exact centre of the rotor. The corresponding hole on the panel will be of a suitable size for the method of mounting. We used a self-tapping screw, with a washer between the panel face and the rotor, with the screw tightened just so that the rotor can be conveniently turned with the fingers.

To complete the assembly. the two switches and the meter are fixed to the front panel and the PCB is fixed to the panel assembly by means of the two meter terminals. The leads between the PCB and the switches and battery are now connected. The complete assembly is ready to be fitted to the box but before doing so, the matter of calibration has to be considered.

The way calibration is to be done will depend upon available facilities. We calibrated the prototype against a professional unit known to be accurate. This is also how we arrived at the various calibration points for the scale.

Calibration may be done by a series of steps. First, make sure that the meter is accurately set to its mechanical zero before the unit is switched on. Switch on the unit and press the zero button. Adjust the zero offset 10k potentiometer so that the meter again reads zero. The final step is to adjust the 22k potentiometer in series with the meter for a scale reading of eight or nine against whatever reference may be available.

If you are fortunate enough to have access to a commercial flash meter of known accuracy, then the job is an easy one. The two meters should be placed together, zeroed and a flash gun discharged to give an eight or nine reading on the reference meter. The 22k potentiometer should then be adjusted to give a similar reading on the meter being calibrated.

Some flash exposure meters are calibrated directly in stop values rather than the naught to nine numbering system. If this is the case, then an indirect approach will need to be taken. Set both meters to say, 50 ASA. The scale on your new meter indicates that a stop between f/22 and f/32 corresponds to a meter reading of eight. A flash giving these values should be aimed at.

Most readers will not be able to calibrate against another flash exposure meter and so other means will have to be adopted. Perhaps the most readily available method is to calibrate at least tentatively against the table or calculator of the flash gun to be used with the meter.

The flash gun should be discharged at a fairly close range from the flash exposure meter and the 22k potentiometer should then be adjusted to make the meter agree with the flash gun's table or calculator. This step should be carried out indoors in a typical room to take account of the fact that the guide table on a flash gun is a compromise for this situation.

Whatever calibrating method is used, it will have to be evaluated by actual use and the exposure results which are obtained, It may be necessary to make a further adjustment to the 22k potentiometer, or the arrow for the ASA scale may need to be moved to suit.

Well, that about wraps it up. We are sure that anyone who builds this flash meter will be very pleased with the final result. It works well and looks the part!