Accurate, portable strobe illumination for turntables.

(Note: the schematic prior to Mar08,06 had an error, PCB artwork however was correct always)

- Battery powered, long battery life of several years.
- Quartz referenced, typical uncalibrated accuracy of 50ppm.
- Cheap! (Component cost excluding case and battery us$2.60)
- Set by crystal choice for either 50Hz or 60hz strobe discs.

Uses only 2 widely available ICs:
CD4060BC binary ripple counter
CD4013BC dual D-flip-flop

The oscillator section of the 4046 is stabilised by a quartz crystal - which gives a typical frequency accuracy of 50ppm (0.005%). A trimmer capacitor is included, although may be of little use unless an accurately calibrated frequency counter is available. Hand-held DMMs are inherently no more accurate than this strobe light, and so serve no value as calibration tools.
The trimmer (C1) can be omitted and both load capacitors (C2, C3) for the crystal made equal (around 27pF, although the value is not critical. Anthing from 15p to 47p should work. At low battery voltages (5v), oscillation is less reliable and may be less tolerant of non-optimal capacitor values.

The ripple counter/divider section of the 4060 divides by 2^n, and the divided frequency is available on the corresponding Qn output pin.

Pin 9 of IC1 is a testpoint (tp1) and gives the crystal frequency. Do not try to measure the crystal frequency by clipping a probe onto any of the pins of the crystal or of C1..C3 - the probe's effect will halt the oscillator.

The divider's Q14 gives 200Hz when used with a 3.2768MHz crystal, or 240hz when the crystal used is 3.932160MHz.

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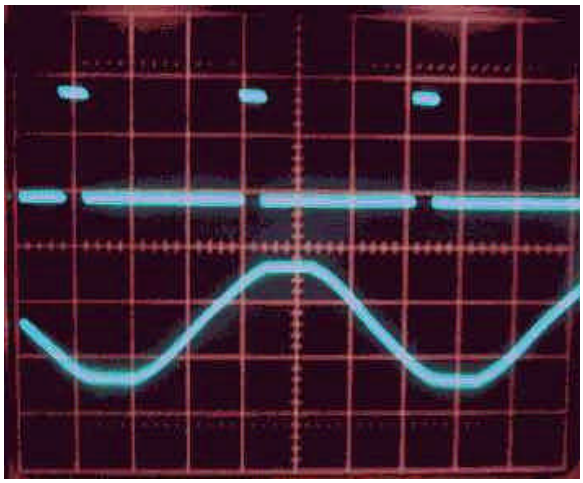
This 200Hz or 240Hz is further divided by 2 by one half of the CD4013 D-flip-flop, giving 100Hz, (or 120Hz). Test point tp2 gives 100Hz (or 120Hz).

Conventionally, a strobe disc is illuminated by a miniature neon light (characteristic orange colour) or an ordinary incandescent room light. Both of these give light on the positive- and negative going cycles of the AC mains waveform, so in fact they give 100 flashes of light per second (or 120 flashes per second on 60Hz AC).
An LED (light emitting diode) only conducts unidirectionally, so to get 100 flashes per second, it must be driven by a 100Hz wave, hence the division down to only 100 Hz (or 120Hz) and not 50 or 60Hz.
The shorter the illumination pulse, the sharper will be the edges of the black bars on the strobe disc.

The first D-flip-flop output is a square wave of on-duration 10mS, (8.3ms on 120Hz), and 50% duty cycle.
The second D-flip-flop is used to gate the 10mS on-period by means of the Q13 output of the CD4060 - a 400Hz squarewave - which has an on period of 1.25mS. (For 60Hz, read Q13 as 480Hz, and on-period of 1.04ms)

The oscillograph opposite shows the strobe output (top trace) illustrating its 1/8 duty-cycle. Below is the 50Hz AC mains waveform.



Finally, the maximum current source or sink of the 4013B is around 800uA. A single high-gain PNP transistor configured as an emitter-follower provides current gain for the LED. Almost any PNP transistor with a current gain of more than around 160 will work.
Since the LED is only on for 1.25ms, 100 times per second, the average current is 1000/125=8, so the actual LED current can be 8 times larger than the usual recommended maximum for the device.
This gives a very intense light pulse with good illuminating powers. The prototype used a single ultra-bright red LED, it is uncomfortably bright to stare at, and good enough for use in anything but direct sunlight - which your LPs should be kept away from anyway!

Several LEDs can be driven in series for more light output, by reducing the value of the current-limiting series resistor from the specified 56 ohm. Make R5=47 ohm for 2 LEDS, or 39 ohm for 3 LEDs)
If you want to use only 1 or 2 LEDs, solder a shorting link across each un-used pair of LED pads.

The power source can be anything from 6V up to 14V (perhaps taken from the turntable's onboard power supply if the strobe is to be built in) with no component changes needed, EXCEPT to increase the LED series resistor (R5) for supply voltages higher than 9V. (make R5=75R for 12V supply, R5=82R for 14V supply)
Blue LEDs will require a smaller value R5 than other colour LEDs.
At low supply voltages (5V or less) the CD4060 does not oscillate reliably.

Typical current consumption at 9v is around 18mA. This will give a battery life of several years if the unit is switched with a momentary-action pushbutton and used a few seconds several times a day to trim the turntable speed at the start of each record.

LIST OF PARTS:

IC1	CD4060B or HCF4060B
IC2	CD4013B or HCF4013B
Q1	BC327 or any general purpose high-gain, small-signal Silicon PNP transistor: BC328, BC560, ZTX550, 2SB716
D1..D3	Hi-brightness / superbright light emitting diode (LED), any colours.
XT	quartz crystal 3.2768MHz for '50Hz' strobe or 3.93216MHz for '60Hz' strobe.
C1	5..20pF trimmer capacitor
C2	22pF ceramic capacitor
C3	10pF ceramic capacitor
C7,8	0.1uF ceramic (or polystyrene or polyester) capacitor
C6	470uF 16V radial aluminium electrolytic capacitor
R1	1M2, 0.25W carbon / metal film resistor
R2	1k5, 0.25W carbon / metal film resistor
R5	56R, 0.25W carbon / metal film resistor (see notes)
S1	miniature SPST pushbutton switch

- PP6 9V alkaline battery, and wired battery clip
- printed circuit board, or Veroboard (stripboard)
- plastic or wood case to suit
- 16-pin DIP socket, 14-pin DIP socket for IC1, IC2.
- Crystal socket (if desired)

CONSTRUCTION NOTES:

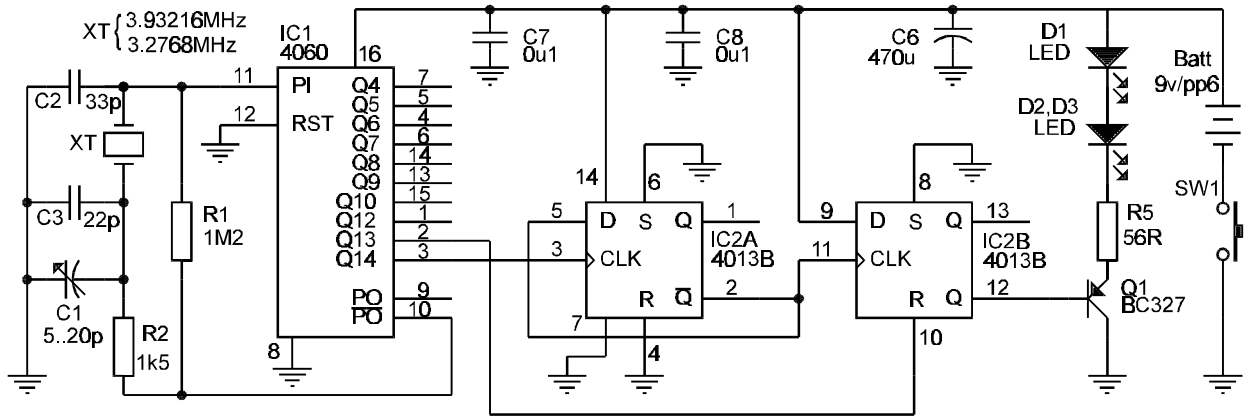
The two ICs are static-sensitive, and must be kept in their special protective packages until used. Do not handle or install them in a high-static environment (nylon carpets, furnishings etc.) and don't accept them from the supplier if they are not in special static-protective sleeves.

Be sure to align the ICs correctly - the left edge (pin1 end) is marked on the circuit board overlay.
Be sure to align the LEDs correctly, the flat side is the cathode, the longer pin is the anode.
Be sure to align the + and - of C6 (470uF) correctly.
The transistor, if not a BC327, may have a different pin order (C-B-E, B-C-E, E-B-C etc.). Be sure to check the data sheet for the transistor to be used to ensure correct pin alignment.

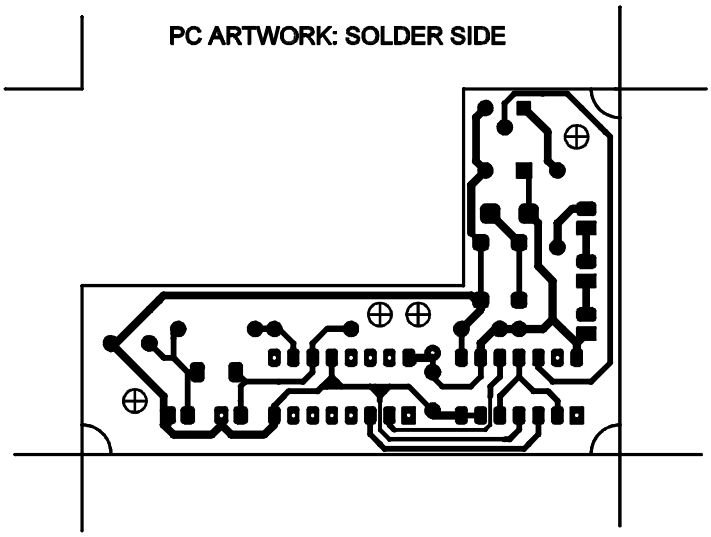
The printed circuit board has extra holes for certain components, since different manufacturers produce components of different sizes.
Veroboard or stripboard can be used in place of a printed circuit board. Once-off professional printed circuit boards are VERY costly, but if you can be persuasive, ask your friendly PCB-maker to add this one onto the edge of another client's large PCB - you might be able to get it done for nothing.
Otherwise, "Press-'n'-Peel" emulsion sheet is a means of making single PCBs easily and cheaply with a

laser printer. If you use this PDF file to generate PCB photographic artwork, be sure to correct for any scaling factor the printer/PDF-viewer may introduce. Pad spacing on the ICs should be 0.10 inch.

The case is a general purpose utility plasic box (designation AC1), but any plastic or wood box that is approximately the right size will work.



PC ARTWORK: SOLDER SIDE



COMPONENT OVERLAY