2-Digit Lap Counter

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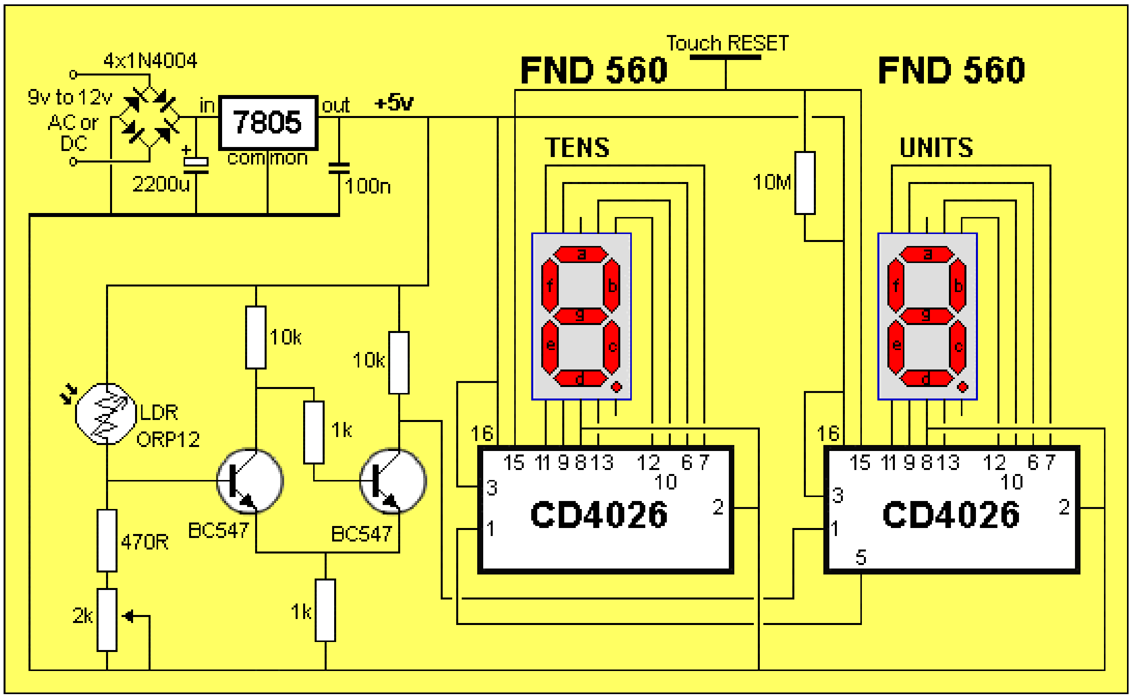
A handy 2-Digit Counter for all types of applications

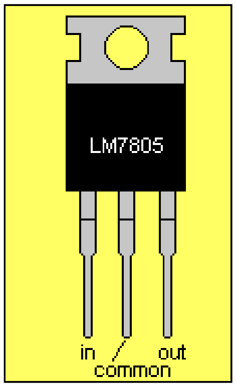
This is a low-cost 2-Digit Counter suitable for many different applications. It was originally designed for Slot Cars as a lap counter but slot cars have "bitten the dust" many years ago.
However it has many other applications and you can use it to count objects on a production-line or people entering or leaving a room. Or even how many times the lights are turned on and off in a room - to check its occupancy.
It has an optical input and when the LDR (Light Dependent Resistor) or photo transistor receives light, the circuit is ready to count. When the beam is broken, the circuit increments. A 2k pot on the board adjusts the sensitivity and the project will work with a variety of light detectors as shown in the photo below.

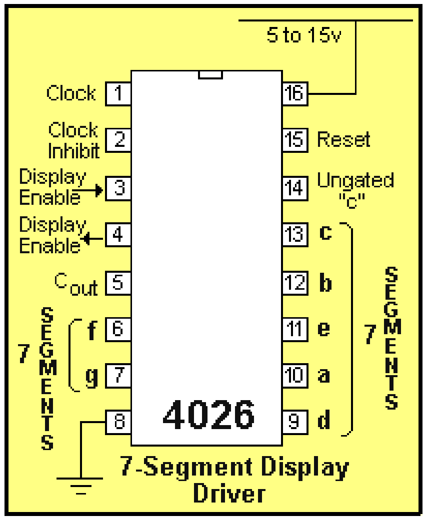
The project is designed to operate from a plug pack (9v -12v) and includes a full-wave rectifier and 7805 regulator. The input voltage can be AC or DC. The regulator does not need a heatsink as the project takes less than 50mA.
We tested the prototype with a 12v DC plug pack. The voltage from the plug pack was 13.9v and the voltage on the input of the regulator was 12.4v. The regulator got very slightly warm. If the plug pack is 12vAC, the DC voltage after rectification is 17-18v and the regulator gets quite hot. But it does not need a heatsink.
The regulator can be removed and the project can be operated from a 6v supply by connecting the positive of the 6v supply to the "OUT" hole of the regulator and the negative to the "COMMON" as shown in the photo. The 100u or 220u and 4 power diodes are not needed.

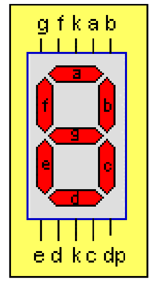
THE CIRCUIT



The circuit is powered from a plug pack. The output from the regulator is 5v and at this voltage the CD 4026 IC's will deliver 3-5mA per segment to the displays.
We have not used any current-limiting resistors on the output of each chip as the current is too low to cause any overload. The total current is about 40mA when "88" appears on the display.
The Units chip clocks on the rising edge of the waveform.
When the circuit is turned on and light is detected by the LDR, its resistance is low and the first transistor is turned on.
This causes the second transistor to turn off and the clock pin of the second IC (pin 1) sees a HIGH.
Touching the reset pad will put "00" on the display.
When the light reaching the LDR is interrupted, its resistance goes HIGH and the first transistor turns off. This causes the second transistor to turn ON.
This puts a LOW on the clock pin of the units IC. The IC does not increment during this transition.
When the LDR sees illumination its resistance goes LOW and turns on the first transistor. The second transistor turns off and this puts a HIGH on the clock pin of the unit IC to increment the count.
The two transistors are in an arrangement called a Schmitt Trigger. This has been done so that any slow change in light level will produce a fast rise for the IC. If a slow rise is received, the chip will begin to count very quickly when the waveform is passing mid-voltage and this will gave a false reading. The Schmitt arrangement increases the waveform speed as follows:
We start the description with no illumination on the LDR. The first transistor is not turned on the second transistor is turned on via the 10k and 1k base resistors. Approx 0.5v will appear across the 1k emitter resistor and about 4.5v across the 10k collector resistor of the second transistor.
The chip will see a LOW.
As the LDR receives illumination, the first transistor turns on and when the voltage between collector-emitter terminal is 06v, we have a situation where the two 10k collector load resistors will effectively be in parallel and the 1k emitter resistor will see nearly 1v. As the first transistor turns on more, its collector-emitter voltage decreases to below 0.6v and this causes the second transistor to begin to turn off. The voltage across the 1k resistor decreases and this effectively pulls the emitter of the first transistor towards the 0v rail.
In other words, the first transistor is being turned on more without any change in voltage on the base. This causes the second transistor to turn off more and the two change state very quickly without any change in resistance of the LDR.
That's how the circuit produces a very fast waveform for the IC.
The "carry" of the UNITS IC is taken to the clock of the TENS IC to produce a 00 - 99 count.
Turning the 2k mini trim pot towards the 0v rail makes the LDR sensitive to low levels of light.



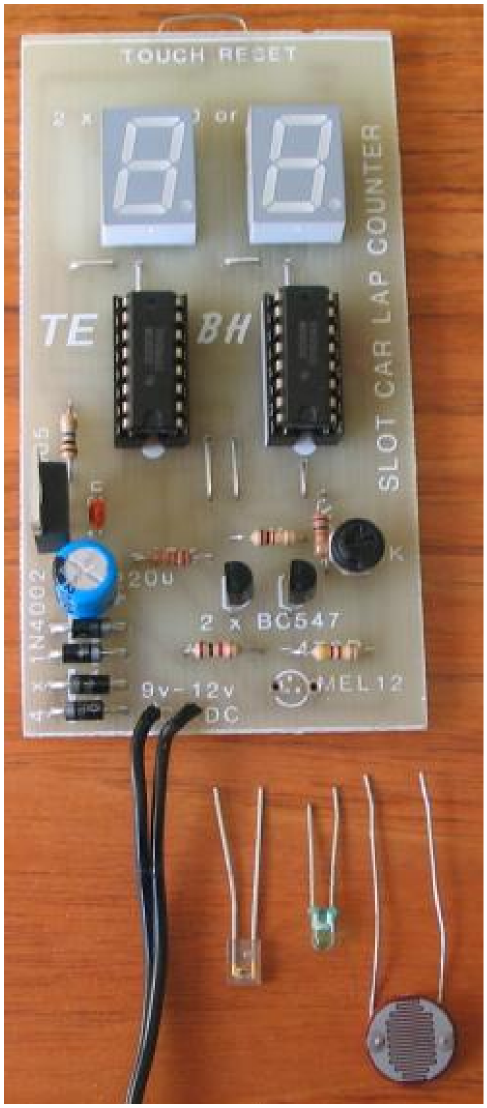




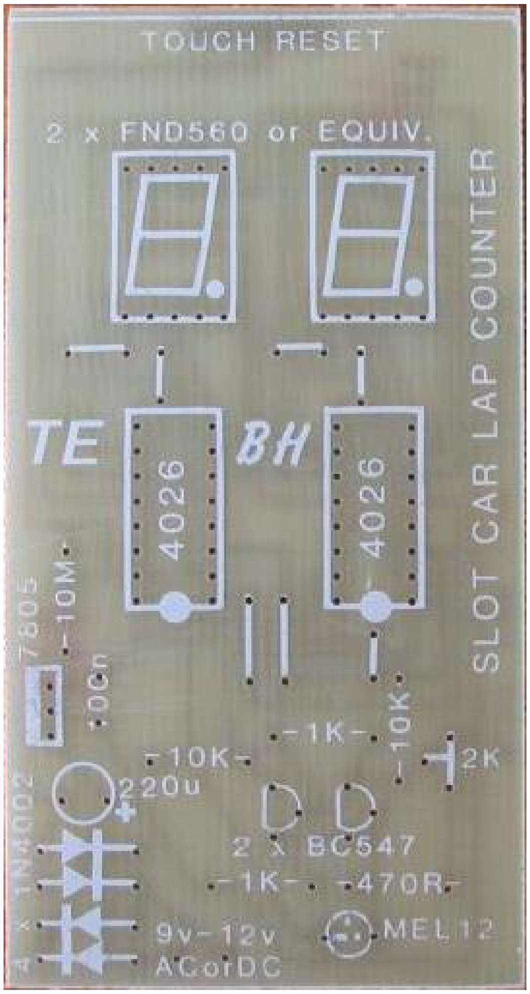
The counter is reset by touching the "TOUCH PAD" on the top of the project. The reset pin is high impedance and it sees 5v via a 10M resistor. When the reset is touched, your body removes the 5v and both chips reset.

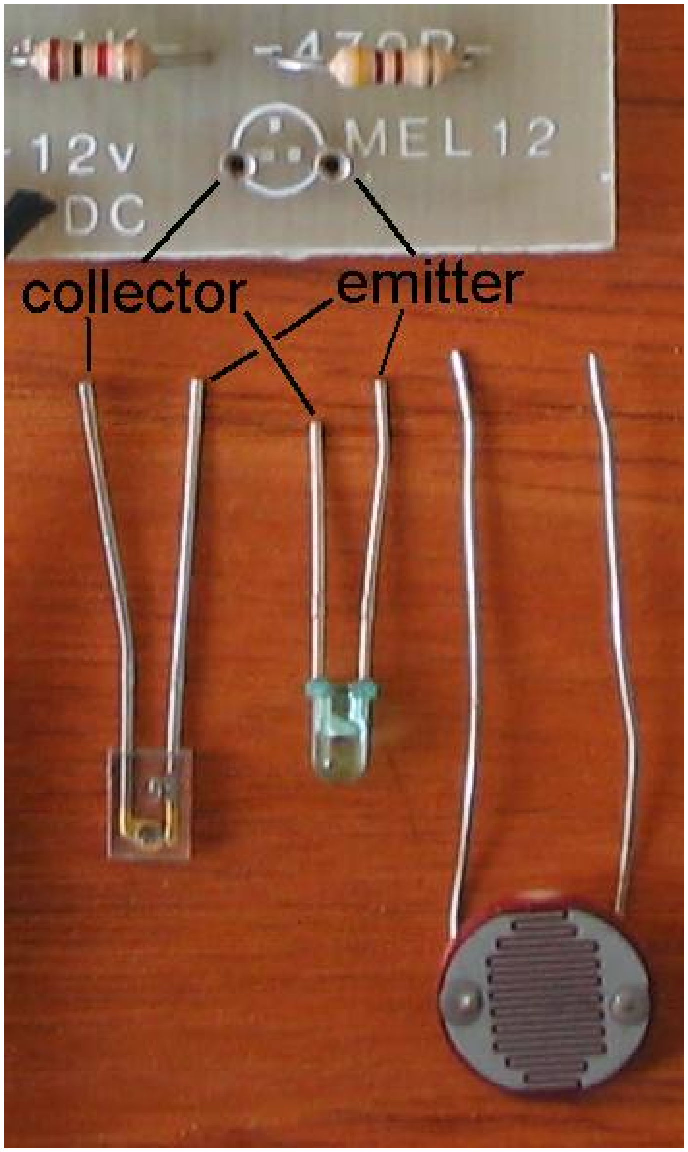
CONSTRUCTION

All the parts fit on the board and you should fit the links first then the sockets and displays.
The holes for the power diodes, regulator and mini trim pot may have to be increased in size by using a 0.9mm or 1mm drill.
The reset pad is created from tinned copper wire so that it is easy to touch.
The LDR is included in the kit and can be fitted via lengths of hook-up wire and located where the objects are to be detected.
The mini trim pot is turned fully anti-clockwise to give the LDR maximum sensitivity.

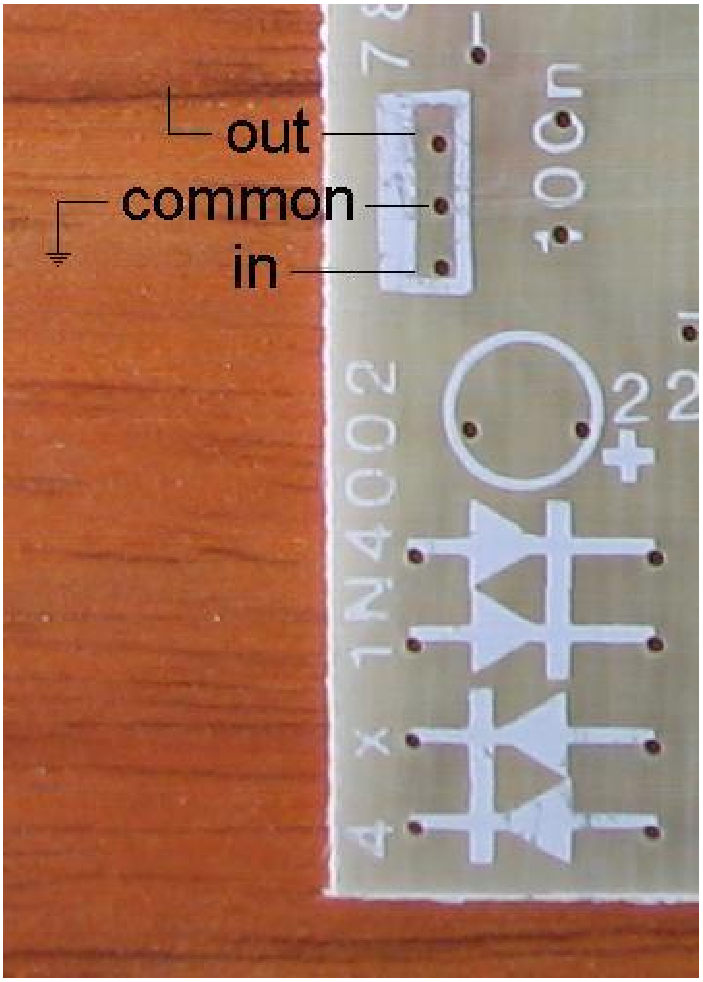


The first photo device is an Infra-red photo transistor. The lead on the left of this device is the collector and it is laying with the detecting lens UP. The second device is a photo Darlington transistor with the collector lead is on the left. The third device is a Light Dependent Resistor. It can be placed either way around.


TOUCH RESET
2 x FND560 or EQUIV.
SLOT CAR LAP COUNTER
TE
BH
4026
4026
7805
10M
100n
1N4002
220u
10K
1K
10K
2K
2 x BC547
1K
470R
9v-12v
ACorDC
MEL12



Close-up of the photo devices showing the collector and emitter leads and connection to the PC board



The pin-out for the 7805 regulator

Lap Counter

PARTS LIST

Cost $15.00 plus $6.50 postage

1 - 470R 1/4 watt
2 - 1k "
2 - 10k "
1 - 10M "
1 - 2k mini trim pot

1 - 100n ceramic (monoblock)
1 - 100u or 220u 25vw electrolytic

4 - 1N4004 power diodes
2 - BC 547 transistors or similar
1 - 7805 regulator
1 - LDR as shown in photo
2 - 7-segment displays FND 500 or 560
2 - CD 4026 ICs
2 - 16 pin IC sockets
1m - very fine solder
20cm fine tinned copper wire

1 - Lap Counter PC board

IR transistor $2.50 extra

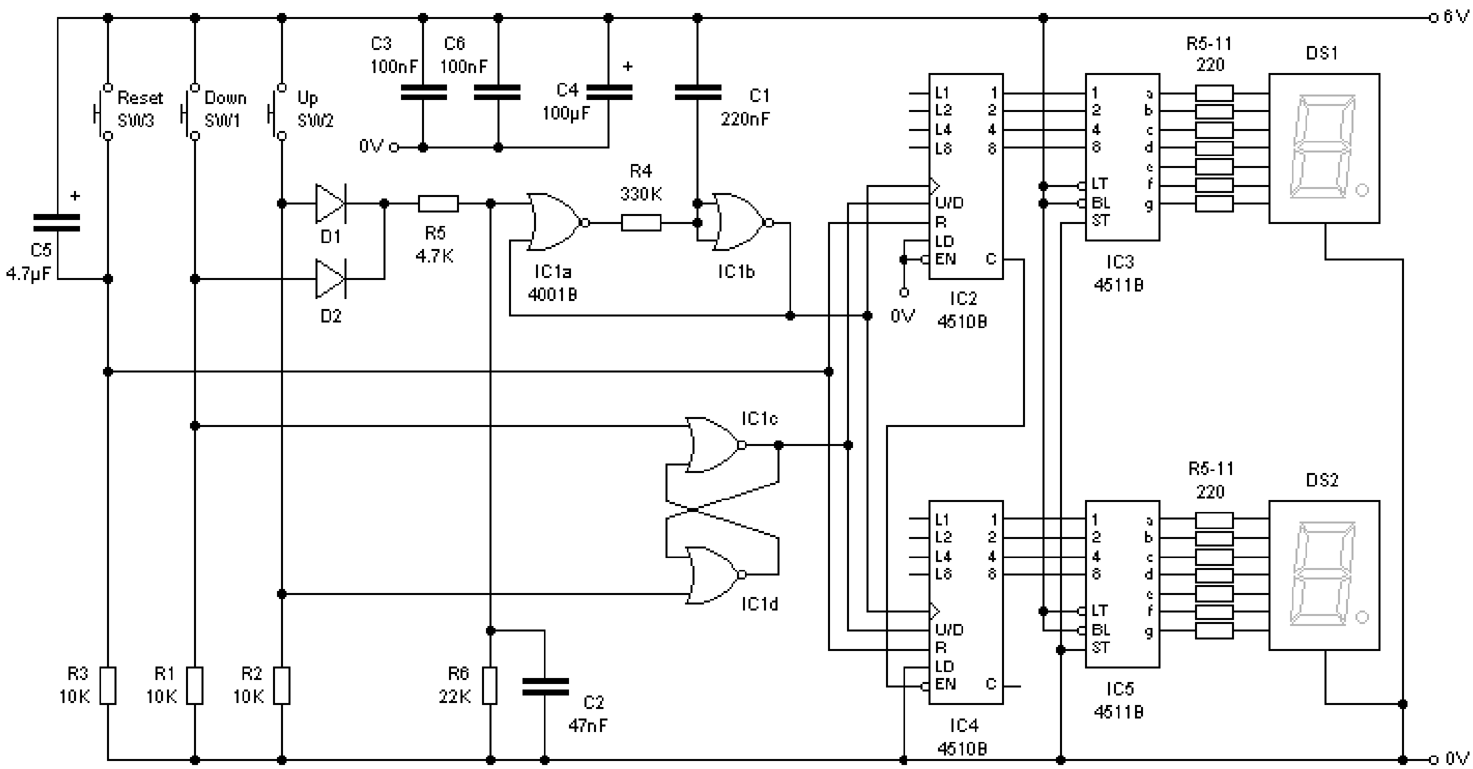
Buy a kit

ADAPTING THE COUNTER

You can use a switch as the input device or create an Infra-red beam by using an Infra-red transmitting diode and the IR receiver shown in the photo above.

If you want an UP-DOWN counter, you will need to go to a microcontroller project (Talking Electronics has a 4 digit Up-Down Counter) or use individual chips as designed by Phil Townsend on his website:
http://www.edutek.ltd.uk/Circuit_Pages/DualDigitCounter.html

Here is his circuit:



The switches to make the counter count up or down are both connected via diodes D1/2 to a short delay network formed by R5/6,C2 of about 120us. This ensures that the U/D input has stabilised in the counter ICs before the clock pulse arrives. This then triggers IC1c/d, 2-input NOR gates, which form a monostable circuit. This provides debouncing of the buttons when clocking the counters by producing a pulse of around 150ms to the clock inputs.

The bistable formed by IC1c/d sets the direction of the counters. The up/down buttons set or reset the U/D signal before the final clock signal reaches the counters.

The remainder of the circuit consists of the counters and decoders. They are connected in synchronous mode - not that it really matters - and the outputs from the counters are decoded by IC3/5. No special features of the decoders are used such as Strobe, Ripple Blanking etc.

At 6v with red high brightness displays, 220ohm resistor gives about 18mA per segment. This circuit will drive up to 1" high brightness displays really well.

Here is the circuit .pdf

1/5/2017