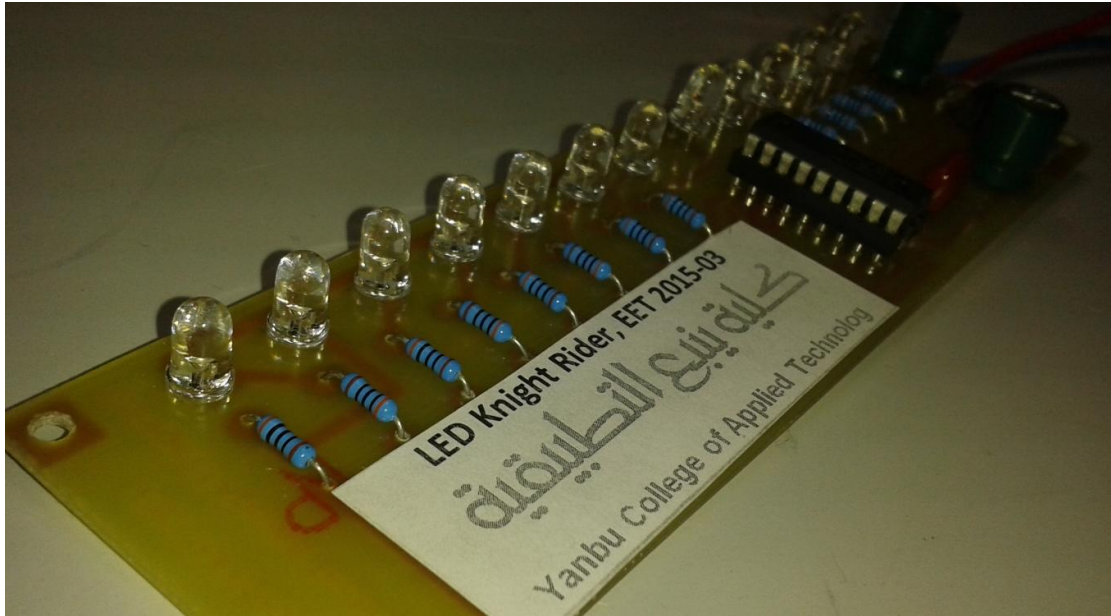


# LED Knight Rider

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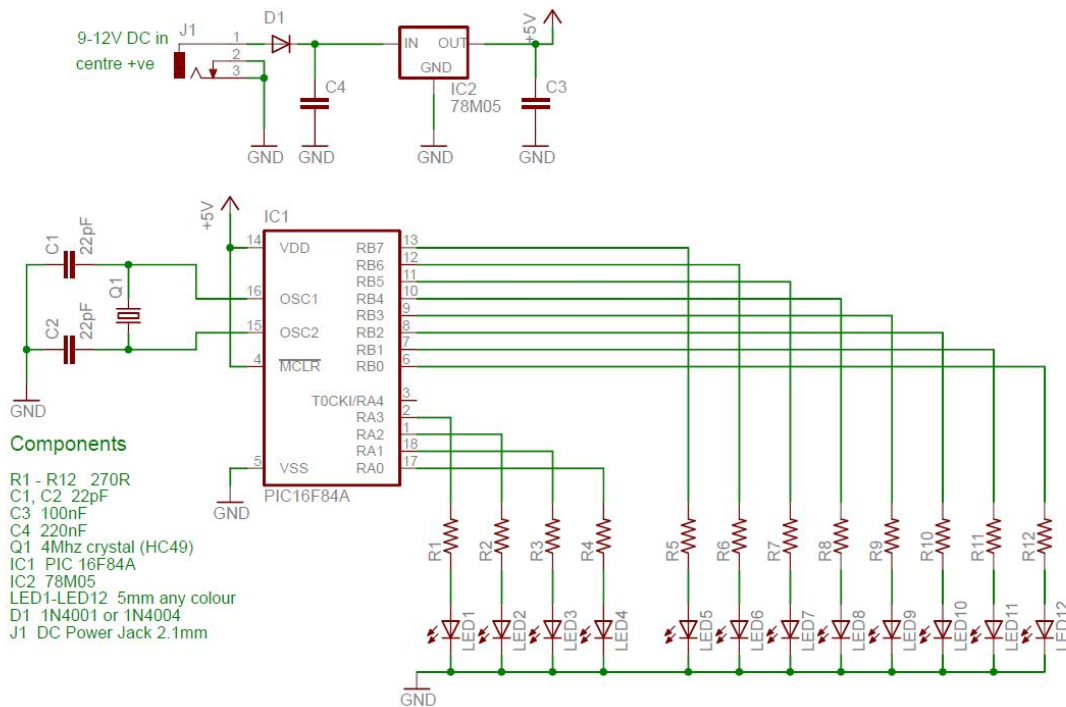
## Project Description

This simple circuit functions as a 12 LED chaser. A single illuminated LED 'walks' left and right in a repeating sequence, similar to the effect seen on KITT, the car in the Knight Rider TV series. Fully commented source code and programmer ready HEX files are provided for the PIC 16F84A and 16F628A.

The circuit has been constructed on a PCB but can easily be built on strip-board, or a solderless breadboard. This project has been put together for anyone starting with their first PIC and the source code is heavily commented with references to the PIC datasheets and the MPASM assembler user guide.

Please note that the 16F84 and 16F628 without the 'A' suffix are not suitable for this project. You must use the 16F84A or 16F628A parts.

## Circuit Description



The heart of the LED chaser is the PIC microcontroller, IC1. This can be either a PIC16F84A or PIC16F628A as software code is provided for either device. The program that runs on this chip controls the LEDs attached to the output port pins. Resistors R1 thru R12 limit the current through LED1 - LED12 to a safe level that won't damage the PICs I/O ports or LEDs.

The value of the resistors has been selected to be safe rather than provide maximum brightness. If you decide to use high brightness blue, green or white 5mm LEDs you may need to change these from 270ohms to 100ohms. For all other 5mm LEDs the 270ohm resistors will be fine.

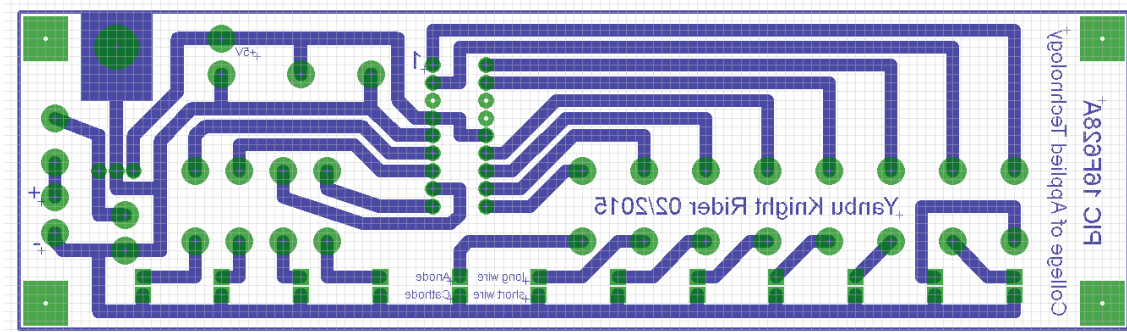
PIC 16F84A: Crystal Q1 and capacitors C1 and C2 connect to the oscillator circuit inside the PIC. This generates a stable 4Mhz clock which is used by the PIC to control the timing of the microcontroller core. If you are using the PIC 16F628A you can omit these three components and use the PIC's internal RC oscillator. However, you will also need to make a change to the source code before programming the PIC so it knows to use its internal oscillator. The programming source files for PIC 16F628A without crystal is available as KR\_16F628A\_RC.ASM and KR\_16F628A\_RC.HEX

Capacitor C3 is used to decouple the 5 volt power supply rail. If you are building the circuit on a breadboard or stripboard you should ensure it is located close to the PIC's Vdd connection (pin 14).

The input voltage can be anywhere from 9 to 12 volts but the PIC requires a precisely controlled 5 volt supply. This is provided by IC2, a 7805 3-terminal 5 volt regulator. Capacitor C4 decouples the input to the regulator. Diode D1 protects the circuit from accidental reverse polarity of the input voltage.

## PCB Layout and soldering

The PCB Board is designed to use the PIC 16F628A without crystal and load capacitors. The board is also designed to use 3mm LEDs. The Cathode (-) for all LEDs is connected together to ground (-).



### 1. Surface Preparation:

A clean surface is very important if you want a strong, low resistance solder joint. All surfaces to be soldered should be cleaned well.

### 2. Component Placement

It is best to start with the smallest and flattest components and then work up to the larger components after the small parts are done. Bend the leads as necessary and insert the component through the proper holes on the board. To hold the part in place while you are soldering, you may want to bend the leads on the bottom of the board at a 45 degree angle.

### 3. Apply Heat and solder

It normally takes a second or two to get the joint hot enough to solder. Once the component lead and solder pad has heated up, you are ready to apply solder. Touch the tip of the strand of solder to the component lead and solder pad, but not the tip of the iron. If everything is hot enough, the solder should flow freely around the lead and pad.

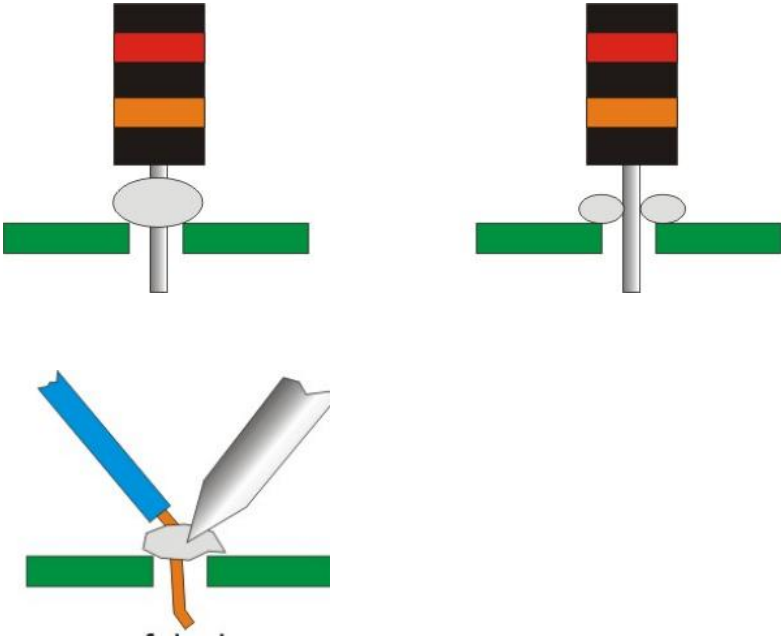
### 4. Inspect The Joint and Cleanup

Once the joint is made you should inspect it. Check for cold joints, shorts with adjacent pads or poor flow. If the joint checks out, move on to the next.

**GOOD EXAMPLES**



**WRONG, BAD SOLDERING**



## Components list

Component	Description
R1 - R12	270R 0.25W CF RESISTOR (you have to calculate new value, if LEDs with more current or voltage are used)
C1, C2 (not including of the kit)	22PF 2.5MM PITCH CERAMIC CAPACITOR RC (only if PIC 16F84A is used)
C4, C5	220 $\mu$ F, 35V
C3	100nF CERAMIC DISC CAPACITOR RC
Q1 (not including of the kit)	4.00MHZ HC-49/S CRYSTAL +-20PPM (only if PIC 16F84A is used)
D1	1N4001A 1A 50V RECTIFIER DIODE or similar
IC2	L7805CV +5V 1A VOLTAGE REGULATOR
LED1 - 12	LED 3MM RED, WHITE, GREEN, 3V, 10mA (You can use almost any type of LEDs of any color with this circuit.)
J1	PCB DC POWER SOCKET
socket for IC1	18 PIN 0.3IN TURNED PIN SOCKET
IC1 (not including of the kit)	PIC16F84A-04/P MICROCONTROLLER (The PIC16F628A will need programming, see chapter firmware)
IC1	PIC16F628A-I/P MICROCONTROLLER (The PIC16F628A will need programming, see chapter firmware, for the kit the PIC is programmed.)
Screw and nut	M3 5mm for mounting the heat sink of the 7805 voltage regulator
Power supply (not including of the kit)	9V-13V DC about 60mA, for example a car battery or a 9V battery block or 6x 1.5V batteries, etc.

## Assembling

### 1. Series resistors for LEDs

Solder the 12 series resistors for the LEDs. The value of the resistors is not critical. The values of our resistors are calculated to use 3V and 10mA LEDs. If you will use other LEDs, for example with more or less current or voltage, so you have to calculate the value of these serial resistors again.

## 2. Diode

Solder the diode. Note the silver (or black) band on the body of the diode. Ensure it is fitted in the correct way. The side with the band on the body of the diode is called the cathode. This side should connect to the capacitor C1. The other side of the diode, the anode, should connect to the DC connector.

## 3. IC socket

Solder the 18 PIN socket for IC2. Note the notch in one end of the socket. On this side, the first PIN on the left side is PIN number 1. This PIN should connect to the pad, marked with the 1.

## 4. Voltage regulator

Now solder the voltage regulator IC1. Use a 3mm screw to fix the heat sink directly to the PCB board.

## 5. DC connector

Solder the green 2 pin DC connector.

## 6. Capacitors

Solder the three capacitors, C1, C2 and C3. If you're assembling from the kit, C1 and C2 are the same value, 220 $\mu$ F. This value is not critical. It should be more than 100  $\mu$ F. The value of C3, the ceramic capacitor is also not critical and should be more than 100 nF.

## 7. LEDs

At the end solder the 12 LEDs. You will see that one lead is shorter than the other. The short lead is the cathode. All 12 LEDs are connected together with the cathode. The longer leads are connected to the series resistors. :Later, the Light of these LEDs 'walks' left and right in a repeating sequence



## 8. Voltage test

With the PCB assembled but without the PIC installed in the socket, apply power to the board and check that the regulator isn't warm. If you have a voltmeter handy, make sure it measures a nominal 5 volts between pins 5 and 14 of the IC socket. (Between 4.8V to 5.2V is normal)

## 9. Insert PIC

With everything is assembled and having tested the 5 volt supply, disconnect power from the board. Then insert the PIC microcontroller, IC2 into the socket. Be sure to fit it the correct way round.

### PIC programming without crystal

If you are using a PIC 16F628A you can use the PIC's internal RC oscillator, in which case you don't need to fit these components. If you do this you will need to edit the 'ledchaser16F628A.asm' file.

Locate the line that says:

```
__CONFIG _CP_OFF & _WDT_OFF & _PWRTE_ON & _HS_OSC & _LVP_OFF
```

and change it to:

```
__CONFIG _CP_OFF & _WDT_OFF & _PWRTE_ON & _INTRC_OSC_NOCLKOUT & _LVP_OFF
```

### Firmware

You can use either a PIC 16F84A or PIC 16F628A microcontroller with this circuit. The HEX files are ready to program straight into the PIC. The ASM files are the source code which you can modify or just view to see how it works. If you are going to modify the code I recommend you download and install the Microchip MPLAB IDE which will allow you to edit, modify and program the PIC seamlessly.