

**MAPLIN**

**PROJECT**

**PIC 16C84  
PROGRAMMER**

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**XZ25C**  
Issue 1  
.....

**PROJECT**



#### FEATURES

Low cost

Provision for optional ZIF socket

Visual indicators for power and programming state to PIC chip

#### APPLICATIONS

Experimenters and hobbyists

Development of PIC-based projects and circuits

Educational establishments

# PIC 16C84 PROGRAMMER

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Text by Chris Barlow and Maurice Hunt

*If you have an IBM-compatible PC with a parallel printer port meeting or exceeding the minimum stated specification, you can use it to program PIC16C84 microcontrollers by building this simple project.*



SPECIFICATION	
Operating voltage:	15-25V DC unregulated
Average current consumption:	25mA (during programming)
PCB dimensions:	119 × 57mm
Box dimensions:	130 × 68 × 46mm
Host computer specification:	286, 386, 486 IBM-compatible PC

**PROJECT RATING 1**

Controllers, or PICs was applied). The 16C84 is particularly useful, since its program memory is implemented in EEPROM (Electrically Erasable, Programmable Read Only Memory) technology. This gives the 16C84 a distinct advantage over conventional EPROM-type microcontrollers (and even other PIC varieties) during the prototyping stages of a project, because it can be reprogrammed virtually instantaneously (on average, it takes about 20 seconds).

The completed unit.

The PIC 16C84 Programmer is designed to provide a very low cost introduction to DIY programming of the versatile range of PIC 16C84 microcontrollers, opening up enormous possibilities for the development of PIC-based projects, as well as being highly educational. Once you have learnt how to program these popular devices (and there's a vast information base to plunder in the form of books, magazine articles and Internet sites to help you do this), the PIC-based world is your oyster!

The PIC16C84 is a relatively recent addition to Microchip Technology Incorporated's range of microcontrollers (for which the name Peripheral Interface

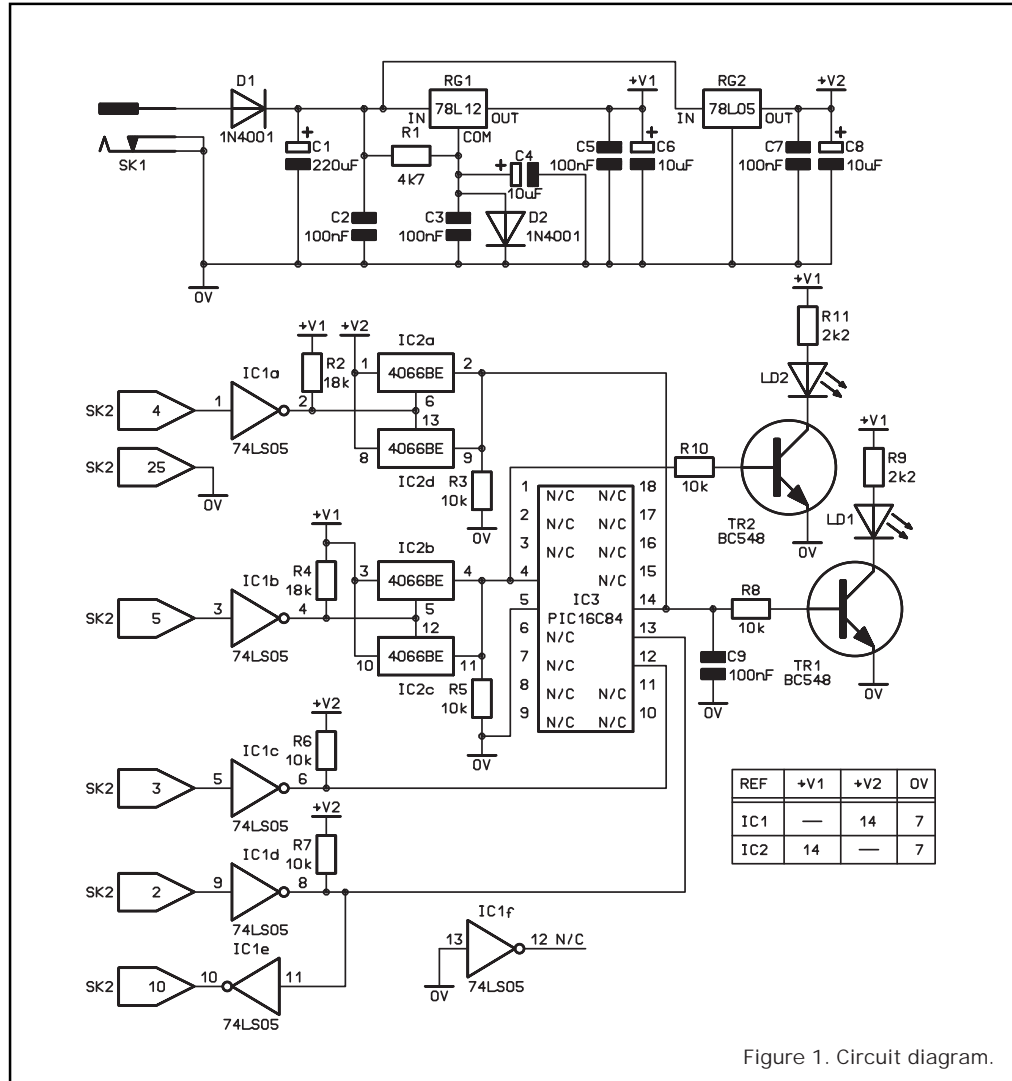
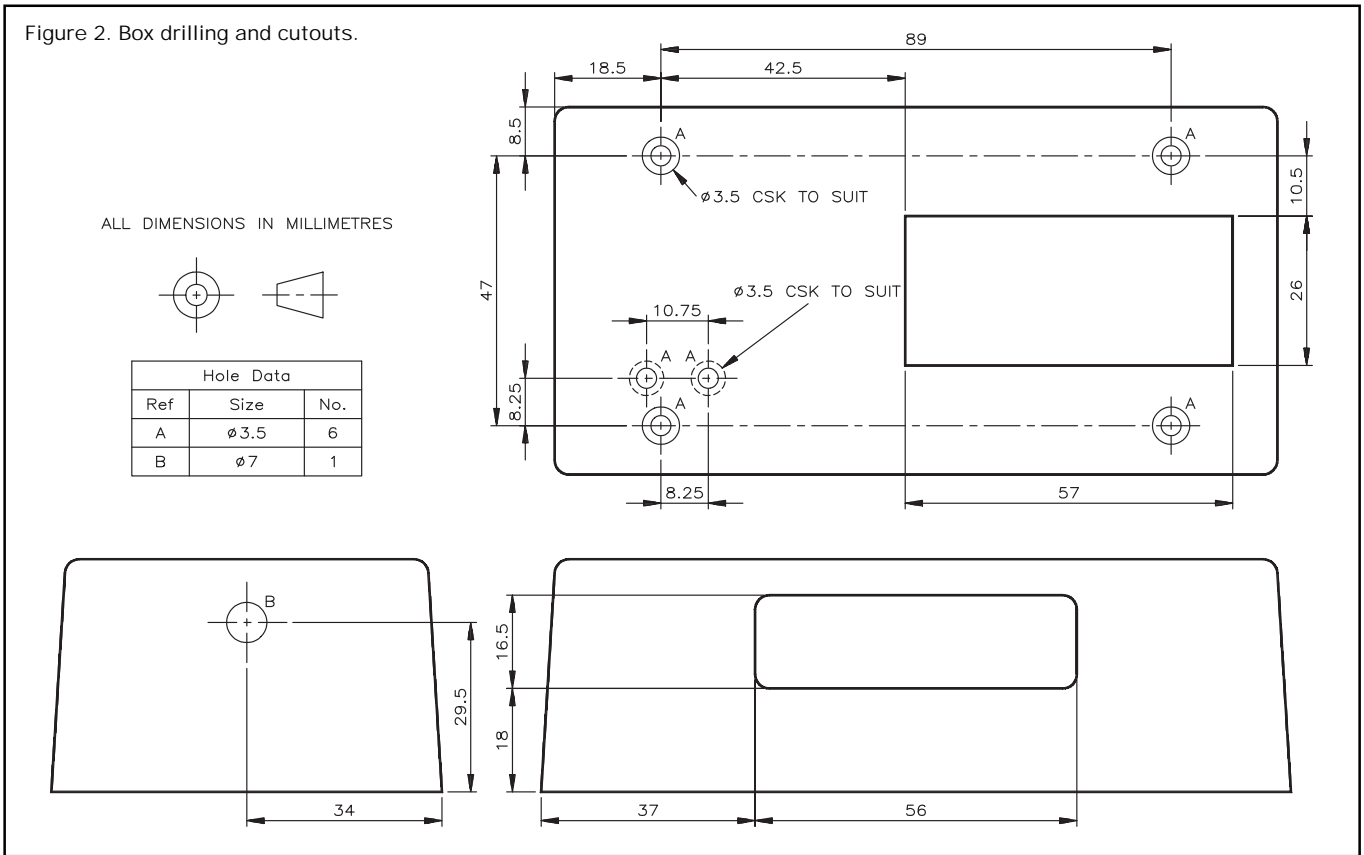


Figure 1. Circuit diagram.

Figure 2. Box drilling and cutouts.



The 16C84 can be programmed in a serial mode which requires very few connections between the chip and programmer. This is the approach adopted for this project (despite being connected to the PC via a parallel port, the PIC is actually programmed in serial mode). The hardware can be attached to any available parallel port, provided it is at one of the standard port addresses.

The component count of the Programmer hardware has been purposely minimised to keep the costs of this project as low as possible and enable easy construction. This has been possible by making the host computer do most of the 'work', by means of appropriate software, supplied with the kit. A range of optional parts is offered to allow you to customise the project to suit your requirements and budget.

The Programmer uses a convenient standard TTL connection to an available printer port on the computer. The only additional items required (not supplied in the kit) are an unregulated DC power supply, and of course, the 16C84 PIC chips that are to be programmed, which are available separately from Maplin – see current Catalogue for details.

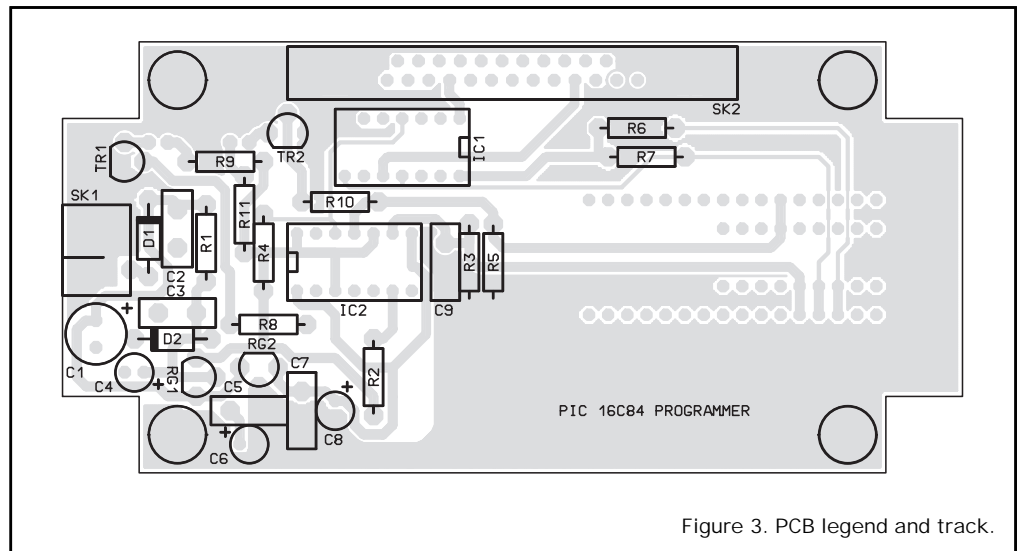


Figure 3. PCB legend and track.

## Circuit Description

Refer to Figure 1, showing the circuit diagram. The Programmer circuit basically consists of power supply regulation and decoupling stages, a pair of twinned bi-directional analogue switches, data buffering and two visual indicators.

The unregulated 15 to 25V DC power is passed via SK1 into the 12V regulator RG1 and 5V regulator RG2. Diode D1 protects the circuit from accidental reverse polarity, C1, C4, C6 and C8 provide low frequency supply decoupling,

while C2, C3, C5, C7 and C9 are for high frequency decoupling.

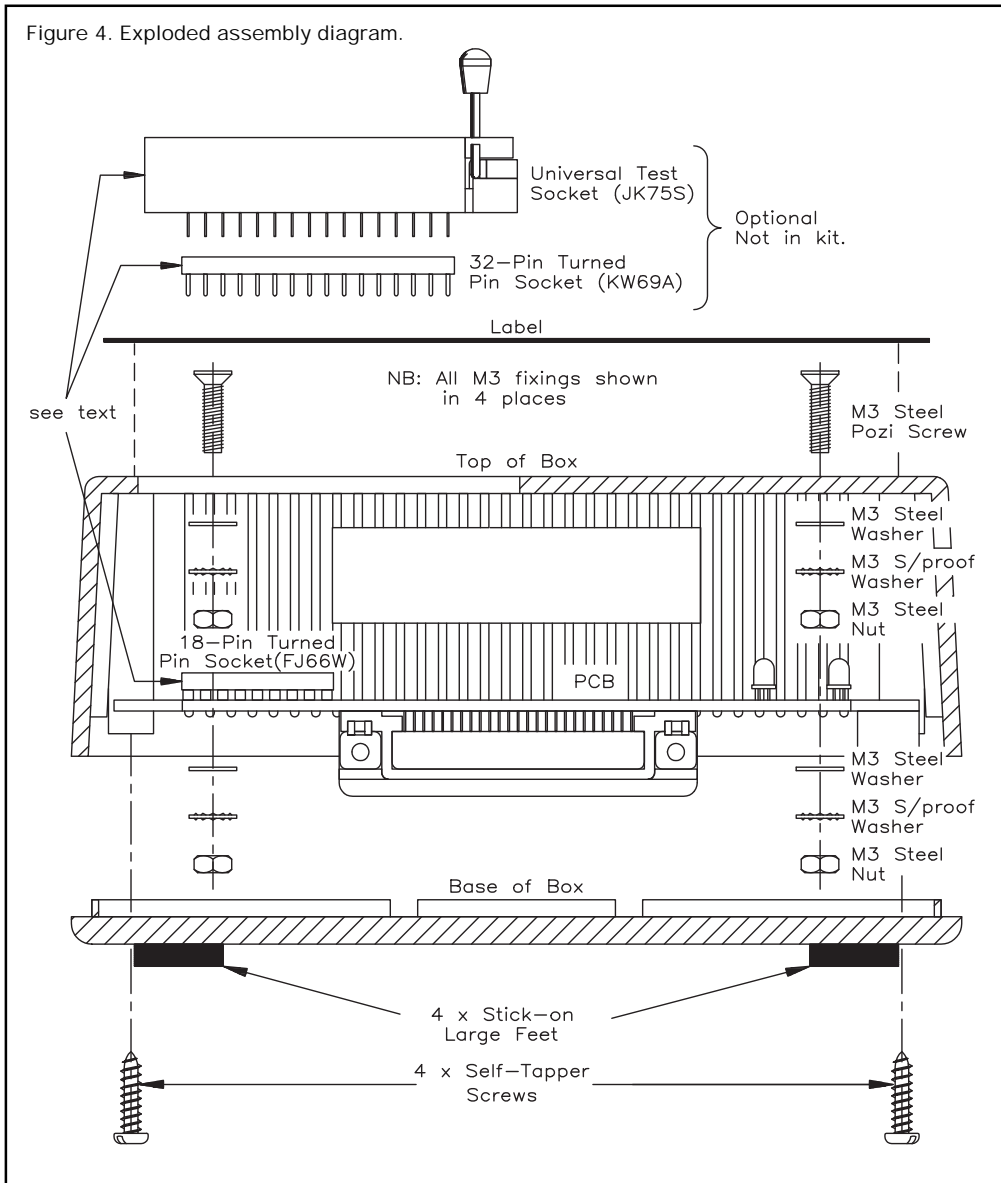
Five of the six elements of IC1, a low-power Schottky TTL hex inverting buffer chip, are employed as data buffers for the input and output lines on the parallel printer port. IC1e provides an echo of the signal appearing at the input of IC1d, which is fed back to the host computer. IC1f is unused.

IC2 is a quad bi-directional analogue switch chip, and the switches are arranged as twinned (paralleled) pairs, to effectively double their current handling capacity and halve their 'on' resistance. Their

'contacts' close when a logic '1' appears on their control input, which occurs when the inputs to IC1a & IC1b are low.

The outputs of the analogue switches are fed into the  $V_{DD}$  (+) and  $MCLR$  pins of the PIC to be programmed (IC3), and the states of these inputs are indicated by means of the transistor-driven LEDs, LD1 and LD2, respectively. The software thus controls when power is supplied to the PIC, so that it is only powered up during the programming duration, leaving it powered down (and therefore, safe to plug in and out of its holder) before or after programming it.

Figure 4. Exploded assembly diagram.



Use the relevant pre-punched labels (but DON'T stick them on yet), according to the type of IC holder you will be using for IC3 (DIL or the larger ZIF type), as templates to mark up the cutouts in the box. At this point, you can move onto the more interesting task, perhaps, of assembling the PCB, but return to read the final paragraph of this section when you have completed it, so that the box preparation may also be finished.

The next stage is to cut slots in the box to match the label cutouts. To do this, carefully drill a series of holes as close together as possible around the perimeter of the slot, use a blade/small saw (e.g. pad saw) to cut the slot, then use a flat file to tidy up the edges. Aim to make the slot slightly too small to begin with, and enlarge it to suit – regularly check for correct alignment using the assembled PCB as a guide. Now read the section entitled Final Assembly.

## PCB Assembly

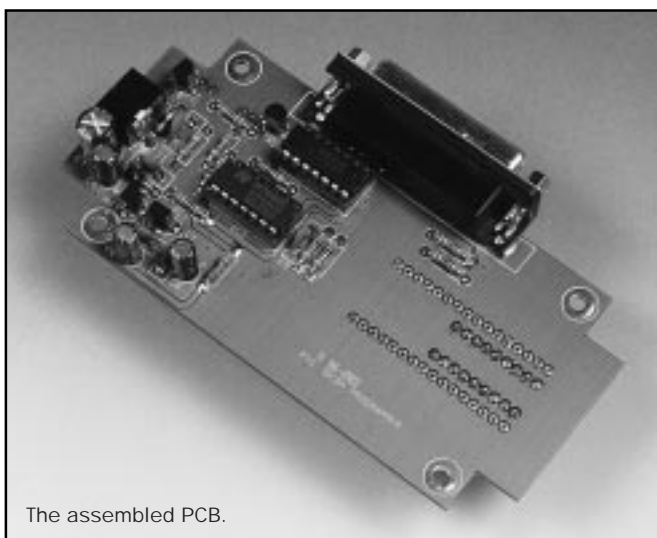
Do NOT build up the board until you have drilled the box, since the unassembled board is used as a drilling template.

Refer to Figure 3, showing the PCB legend and track. Note that while most of the components are fitted onto one side of the board (the side that is printed with their component reference), the DIL holder/ZIF socket for IC3 and the LEDs LD1 & LD2 are fitted on the reverse side.

Assemble the board in order of ascending component size/height, but DO NOT fit the LEDs yet. Ensure that the polarised components (diodes, transistors, voltage regulators and electrolytic capacitors) and DIL holders are orientated correctly as per the legend. At this stage, DO NOT fit the ICs IC1-3.

Fit the 25-way D-type socket facing outwards, and remember to solder in both of its end ground terminals – these hold the socket rigidly onto the PCB.

If you are using the optional ZIF socket with the Programmer, a 32-pin DIL socket should be fitted in the IC3 position, and the ZIF socket plugged into it. This is to allow the ZIF socket to be easily removed for replacement should it ever wear out, or if you wish to use it in another project. The DIL socket beneath also raises the ZIF socket so that it sits above the box, for easy access to the release lever.



The assembled PCB.

The only other connections to the PIC chip are to pin 5 ( $V_{SS}$  or GND), pin 12 (RB6) and pin 13 (RB7). It is via the latter two pins that the programming data is serially fed into, through the buffers IC1c & IC1d.

## Box Preparation

Figure 2 shows the drilling and cutout positions for the specified box. Lay the *unassembled* PCB into the box, so that the side printed with

legends for IC3, LD1 & LD2 faces down. Centralise the PCB in the box, and the holes at each corner of the board then give the correct drilling positions for the four fixing holes – mark them with a pencil or similar, remove the board, then drill the (M3-size) holes using a 3mm ( $\frac{1}{8}$ in. approx.) drill bit. Holes must also be drilled for the LEDs in the front panel, and the power socket on one side of the box. With the drilling done, the LED holes must then be countersunk, from INSIDE the box (to help guide the LEDs into position), and the four PCB mounting screw holes countersunk from OUTSIDE the box, as per the diagram. If the holes are slightly too big, don't despair, as the labels can be used to hide minor mistakes! Ensure that the countersunk M3 screws sit flush with the box face, else there will be an unsightly bump (or dip) when the label is stuck on.

However, if you do not wish to use a ZIF socket, use the 18-pin turned pin socket (supplied in the kit) in the IC3 position. Ensure correct alignment of the end notch.

It is inadvisable to retrofit a ZIF socket to a board that has had the 18-pin socket fitted, since the smaller socket would first have to be removed, which is likely to result in damage to the PCB tracks.

On completion of the PCB, check your work for misplaced components, solder whiskers, bridges and dry joints, then clean excess flux off the board using a suitable solvent.

## Final Assembly

Fit the four M3 screws, together with nuts, washers and shakeproof washers as shown in the exploded assembly diagram, Figure 4. Place the assembled PCB onto them (angling it so as to pass the D-type connector through its slot in the side of the box), and check that the sockets align properly with the drilled holes and cutouts; use a file/drill as required to make adjustments as necessary.

Fit the LEDs into their holes on the PCB (observing polarity), but don't solder them in yet. Now install the PCB into the box (taking care to avoid the LEDs falling out!), secure it in place using shakeproof washers, washers and nuts, and manipulate

Device	I/O pins/features	EPROM words	RAM bytes	Max. clock speed (MHz)	Package	Order Code
16C84-04	13	1k	64 + 36	4	18-pin DIP	AY31J
16LC84-04	13	1k	64 + 36	4	18-pin DIP	AD53H
16C84-10	13	1k	64 + 36	16	18-pin DIP	AD50E

Table 1. Variants of the PIC 16C84 microcontroller.

the protruding LED leads until the LEDs fit into their holes in the box – push them in as far as possible. Next, solder the LED leads to the board, and trim the leads flush. The LEDs should now align with the holes in the box, even if the board is removed again for testing.

If everything fits in place as it should, wipe the box clean and apply the appropriate labels (see Figure 5). Fit the base onto the box with the four screws provided, and stick rubber feet onto each corner (leave the screws accessible, in case you need to remove the base in the future).

## Initial Testing

Do NOT connect the Programmer at this stage. With ICs IC1-3 still omitted, connect a suitable power supply to the unit and test for the following voltage levels with respect to ground (e.g. available from the metal studs on the D-type connector):  
Pin 1 of IC2 = +5V DC  
Pin 3 of IC2 = +12-7V DC

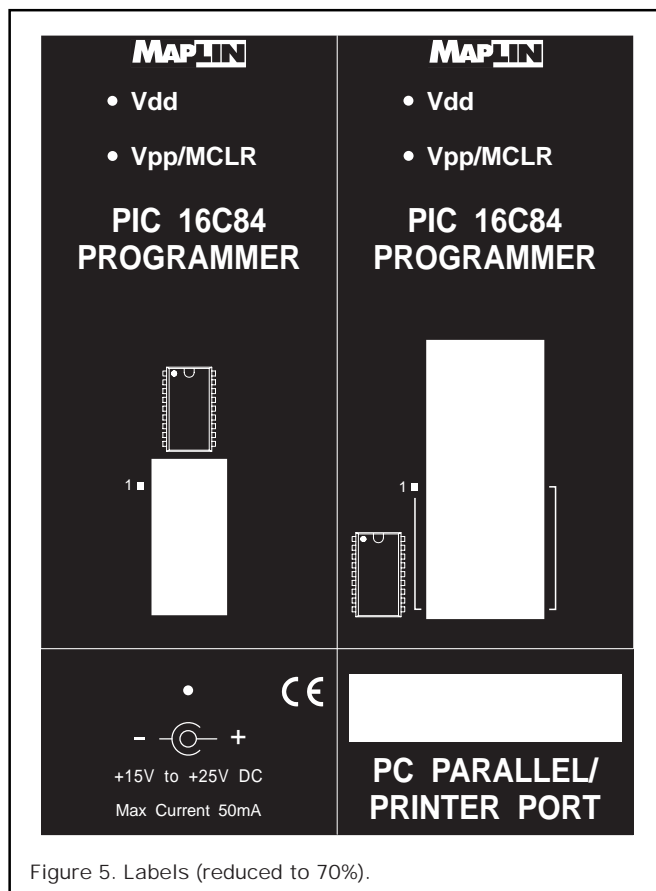


Figure 5. Labels (reduced to 70%).

Information requested	Example of input	Comment
LPT Port	1	(Available printer port on PC)
Hex Type	16	(Number of bits in the file, 8 or 16)
Program Hex File	a:\file.obj	(The hex file you wish to download)
Data Hex File	leave blank	(No data)
Osc: LPXT,HS,RC (LP)	XT	(crystal-based clock)
Enable Watchdog Timer	Y	
Power-up Timer	Y	
Enable Code Protection	N	(If 'Y', the PIC code remains hidden)

Table 2. Programmer requested information.

Having confirmed these voltage levels to be correct, disconnect the PSU and insert IC1-3 into their sockets.

## Testing in Use

Refer to Figure 6. Connect the PIC 16C84 Programmer unit to an IBM-compatible PC using a 25-way (Centronix type) cable between it and the computer's serial printer port. Connect a suitable power supply to the Programmer unit and insert the PIC microcontroller to be programmed into the socket, ensuring it is the correct way round (see Table 1, showing the various forms of PIC 16C84 microcontrollers available).

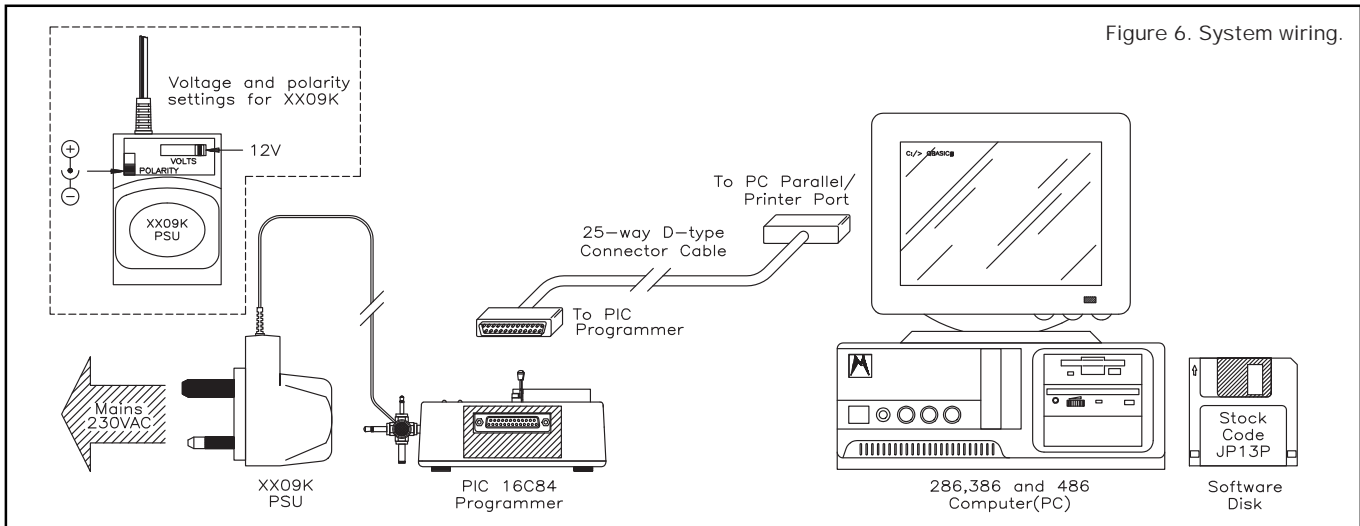
Install the software provided in the kit onto the computer's

hard disk drive, while in the MS-DOS™ environment.

The file supplied on the software disk, pp.c, is no-frills Turbo-C software to control the programmer hardware. Alternatively, there is a QBASIC program, pp.bas, which is basically a translation of the C source. Read the comments in the programs for some instructions on their use. The file pp.exe is an executable version of pp.c.

Type **qbasic** at the hard drive prompt, i.e. **c:>qbasic**. With the software disk inserted in an appropriate drive, open up the file **pp.bas**, i.e. **a:\pp.bas**. Note, if this file will not run on your PC, instead, use the file entitled **ppnew.bas**.

Figure 6. System wiring.



Start the program by selecting from the **qbasic** pull-down menu, and enter the information requested, see Table 2.

Once you have done this, and the computer has accepted the data you have entered (error messages will be displayed if there are any false entries or faults in the hardware connection or microcontroller), the system will then download the selected program into the PIC microcontroller. During programming, the two LEDs on the Programmer will be lit; the 'Vpp/MCLR' LED will go out first, followed by that marked 'Vdd', probably within about 20 seconds. Both LEDs are extinguished when the program has been downloaded and power has been (automatically) removed from the PIC

microcontroller; ONLY then should it be removed from its socket, else damage may result.

If the ZIF socket is fitted, removal of the PIC microcontroller simply entails flicking up the release lever and lifting out the chip. However, an IC Extractor Tool (optional) should be used to unplug the PIC chip from the turned pin DIL socket, if fitted. Likewise, an IC Insertion Tool (optional) should be used to plug in the PIC chip, having pre-bent the pins using the IC Lead Straightening Tool (also optional). In each case, take suitable anti-static precautions before handling the device, for instance, wear an earthed wrist strap (once again, see Optional Parts List), or discharge yourself by holding an unpainted metal cold water pipe or similar.

Check out this ftp site: [ftp.mcc.ac.uk/pub/micro-controllers/PIC/](ftp://ftp.mcc.ac.uk/pub/micro-controllers/PIC/).

If you are using a web-browser use the following URL: <ftp://ftp.mcc.ac.uk/pub/micro-controllers/PIC/>. Try this web page to find links to other PIC related web/ftp/telnet sites: <http://www.man.ac.uk/~nbhstd/piclinks.html>. For details of the latest range of PIC devices, support hardware and literature, see the new Maplin Catalogue. PIC assembler software, useful source code libraries and application notes can be down-loaded from the Micro Chip BBS, call the Maplin Technical Sales Helpline for details of how to connect to this BBS.



## PROJECT PARTS LIST

### RESISTORS: All 0.6W 1% Metal Film

R1	4k7	1	(M4K7)
R2,4	18k	2	(M18K)
R3,5-8,10	10k	6	(M10K)
R9,11	2k2	2	(M2K2)

### CAPACITORS

C1	220µF 25V Radial Electrolytic	1	(AT49D)
C2	100nF 50V Ceramic Disc	1	(BX03D)
C3,5,7,9	100nF 16V Ceramic Disc	4	(YR75S)
C4,6,8	10µF 63V Radial Electrolytic	3	(AT77J)

### SEMICONDUCTORS

D1,2	1N4001	2	(QL730)
LD1,2	Low Current 3mm Red LED	2	(CJ55K)
TR1,2	BC548	2	(QB730)
RG1	LM78L12ACZ	1	(WQ77J)
RG2	LM78L05ACZ	1	(QL26D)
IC1	SN74LS05N	1	(YF05F)
IC2	HCF4066BEY	1	(OX23A)
IC3	PIC16C84 See Text		

### MISCELLANEOUS

SK1	2.5mm PCB-mounting DC Power Socket	1	(FK06G)
SK2	Right-angled PCB-mounting D-Range 25-way Socket	1	(FG27E)
	14-pin DIL Socket	2	(BL18U)
	18-pin Turned Pin Socket	1	(FJ66W)
	ABS Box Type H2853	1	(BZ730)
	M3 10mm Pozi-drive Screw	4	(LR57M) ★
	M3 Steel Nut	8	(JD61R) ★
	M3 Shakeproof Washer	8	(BF44X) ★

M3 Steel Washer	8	(JD76H) ★
Stick-on Feet Large	4	(FW38R) ★
Software Disk	1	(JP13P)
PCB	1	(GJ74R)
Label	1	(KV22Y)
Instruction Leaflet	1	(XZ25C)
Constructors' Guide	1	(XH79L)

### OPTIONALS

32-pin Turned Pin Socket	1	(KW69A)
Universal ZIF Test Socket	1	(JK75S)
D25P/D25P Lead	1	(JC12N)
AC Adaptor Unregulated 300mA	1	(XX09K)
IC Lead Straightening Tool	1	(KU42V)
IC Extraction Tool	1	(FD54J)
IC Insertion Tool	1	(FR25C)
ESD Wrist Strap	1	(FE29G)

The Maplin 'Get-You-Working' Service is available for this project, see Constructors' Guide or current Maplin Catalogue for details.

**The above items (excluding optional) are available as a kit. Order As LU29G (PIC 16C84 Programmer)**

Please Note: Items in the Parts List marked with a ★ are supplied in 'package' quantities (e.g., packet, strip, reel, etc.), see current Maplin Catalogue for full ordering information.

The following new items (which are included in the kit) are also available separately, but are not shown in the 1996 Maplin Catalogue.

PIC 16C84 Programmer PCB **Order As GJ74R**  
 PIC 16C84 Programmer Label **Order As KV22Y**  
 PIC 16C84 Programmer Software Disk **Order As JP13P**



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