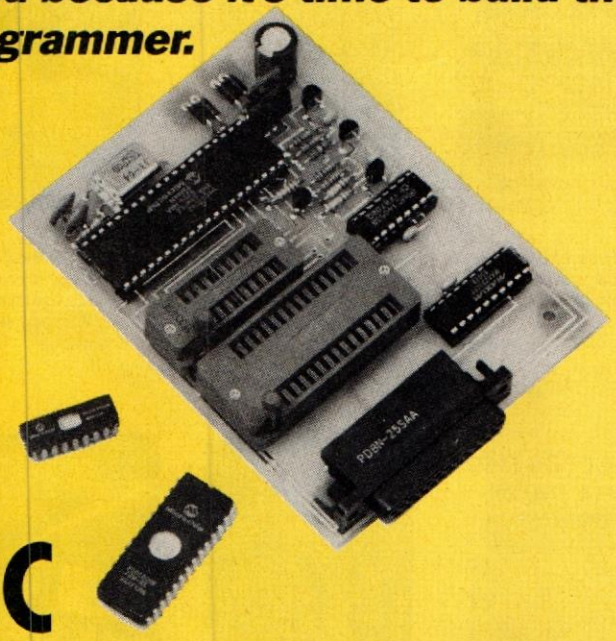
hope you [illegible]Ced [illegible]e [illegible]rts you need because it's time to build the PIC programmer.



PIC MICROCONTROLLER PROGRAMMER

FRED EADY

LAST MONTH THE OPERATING THEORY of a PIC programmer was covered. This month, complete construction details are provided, along with details on a programmer for use with PIC17C42 devices.

Programmer construction

The PIC programmer can be assembled with point-to-point wiring, but assembly time and the possibility of wiring errors can be reduced dramatically by using a PC board. If you do not have the facilities to create the double-sided PIC programmer board (the foil patterns are presented here), you can obtain a professionally manufactured one from the source mentioned in the Parts List. To guarantee that the PIC16C5X programmer will operate properly once it's complete, we will simultaneously assemble and test the PIC programmer components as we proceed. Use the parts-placement diagram in Fig. 4 as a guide.

First, build and test the power supply. Install diodes D1–D4, paying attention to the orientation of the cathode bands on the diodes. Next, install bypass capacitors C2 and C10. Install the 7805 voltage regulator, IC6, with the metal tab facing the diodes. Finally, install capacitor C6, being careful to orient the positive lead as noted in Fig. 4. Temporarily attach the 18-volt AC transformer leads to the pads marked "AC" and apply power. You should measure +27-volts DC across C6 and +5 volts DC on pin 3 of the 7805. If all is well, install the remaining capacitors, XTAL1, and all of the resistors.

Apply power and check the +27- and +5-volt points again. If the voltages are correct, disconnect power and install IC5. Apply power again and check for +5.9 volts at the output (pin 2) of IC5. Then remove power, and jumper pin 24 of IC2 to ground. (The 7805's metal tab is a good ground point.) Apply power and check for +4.9 volts at pin 3 of IC5.

If all the voltages are obtained, you have successfully installed the +5-volt supply and the switchable target V_{CC} voltages. Now remove power and install transistor Q1. Jumper IC2 pin 23 to ground, apply power, and check for 0 volts at pin 14 of target socket ZIF1. Remove the jumper from IC2 pin 23 and the voltage at IC4 pin 14 should rise to +5.5-volts DC. Remove power before continuing.

Install voltage regulator IC4, apply power, and check for +13.5 volts at pin 2. If it checks out, remove power and install transistor Q2 and IC3. You can solder ICs directly to the PC board, but IC sockets are recommended. Apply power and check for +13.5 volts DC at pin 15 of IC3. Remove power and jumper IC2 pin 28 to +5 volts DC. The voltage at IC3 pin 15 should be 0 volts with the jumper installed and +13.5 volts with the jumper removed. Remove power and install the remaining IC sockets and DB-25 connector J1. Do not install any other ICs at this time.

After all of the IC sockets are soldered in place, check for +5 volts at pin 7 of the IC1 socket and pin 1 of the IC2 socket. Recheck your work, looking for solder bridges and cold solder joints. Once you are satisfied that everything is correct, install the remaining ICs in their sockets and permanently connect the transformer leads to the board.

For the final test, apply power to the completed PIC programmer board, but do not install any target PICs at this time. Check all components for overheating or any other obvious malfunctions, and correct any problems. Connect the PIC programmer to the serial port (COM1 or COM2) of an IBM-

standard computer. Run the PICPROG terminal program (it is available on the Electronics Now BBS, 516-293-2283, 1200/2400, 8N1, as a file called PICPROG.ZIP) by typing PICPROG and pressing the enter key. You should get a screen full of descriptive text explaining how to use the PICPROG program. Enter "PICPROG B 54 1" if you are using COM1. Enter "PICPROG B 54 2" for COM2. Press the enter key. You should get a banner followed by "PIC IS NOT BLANK" or "PIC IS BLANK." This verifies that the serial port and PIC17C42 on the PIC programmer are functioning. At this point you can install ZIF (zero insertion force) sockets into the target IC sockets. They allow for easy insertion and extraction of target PICs during the program-development process. Your PIC16C5X Microcontroller Programmer is now ready for use. Figure 5 shows what the completed programmer looks like.

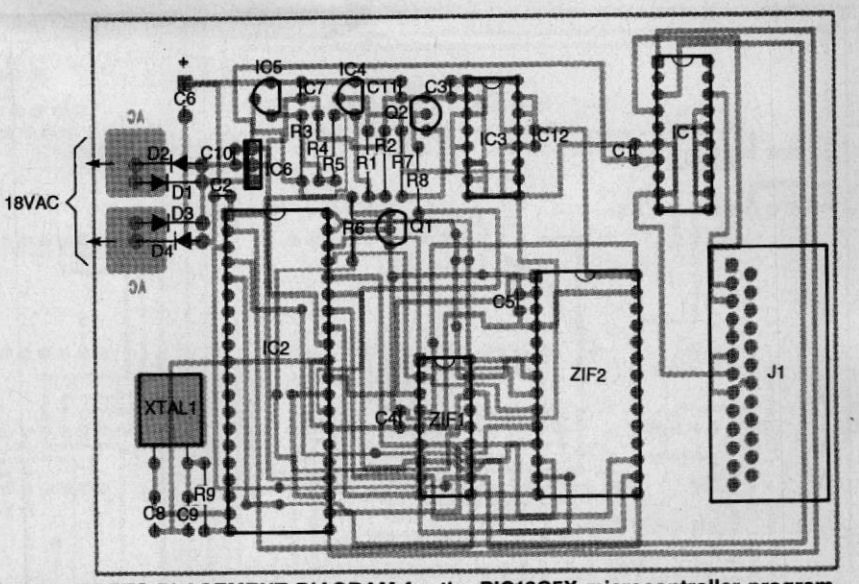


FIG. 4—PARTS-PLACEMENT DIAGRAM for the PIC16C5X microcontroller programmer. You can make your own board or you can obtain one from the source mentioned in the parts list.

Using the programmer

To use the PICPROG terminal, simply type "PICPROG" which will display a command syntax screen with an example entry. The PICPROG terminal program is designed to help you use it automatically. For example, if you enter "PICPROG B," an incomplete blank-check command, the program will respond with an error message informing you that you left out a parameter. The correct blank-check command syntax is displayed, and an example blank-check entry is offered to help you enter the correct command. There is very little left to chance when using PICPROG. To make it even easier, many of batch files are included to simplify the PIC programming process. For instance, to blank check a PIC16C54, execute B54.BAT. Likewise, P54.BAT is used to program a PIC16C54 and R54.BAT will read the same device. You can custom tailor the batch files to match your system parameters.

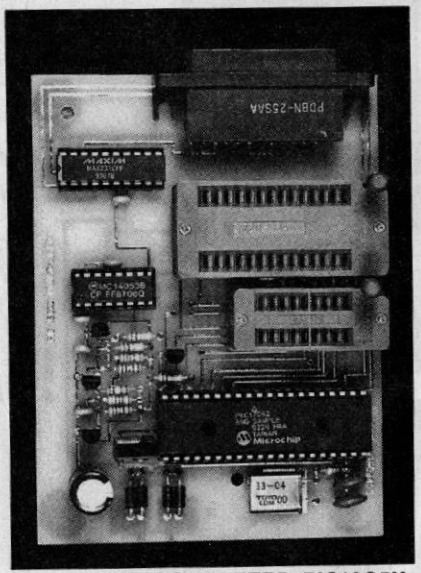


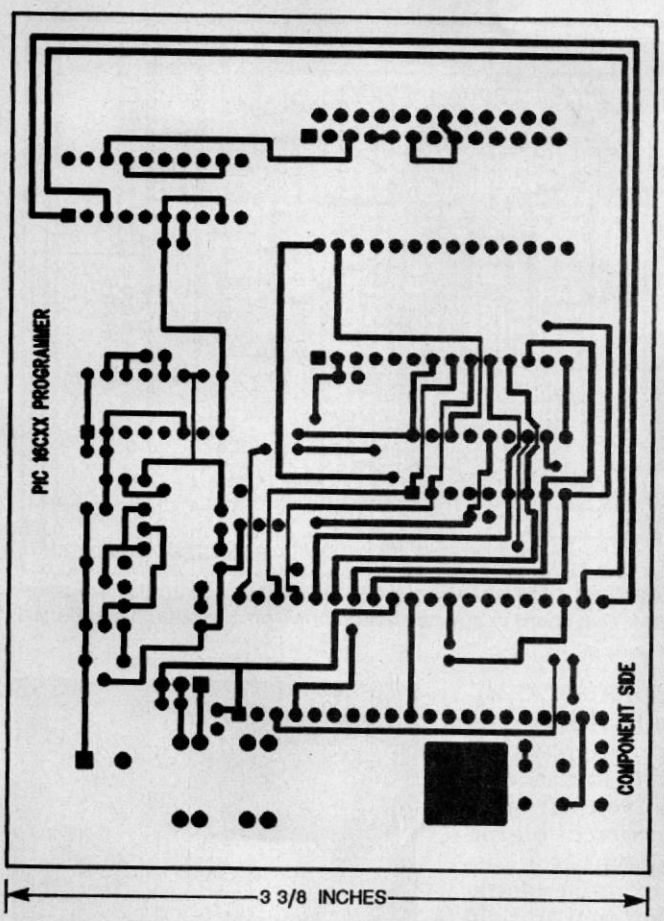
FIG. 5—THE COMPLETED PIC16C5X programmer. The ZIF sockets allow for easy insertion and extraction of target PICs during the program development process.

TABLE 1—FUSE DETAILS

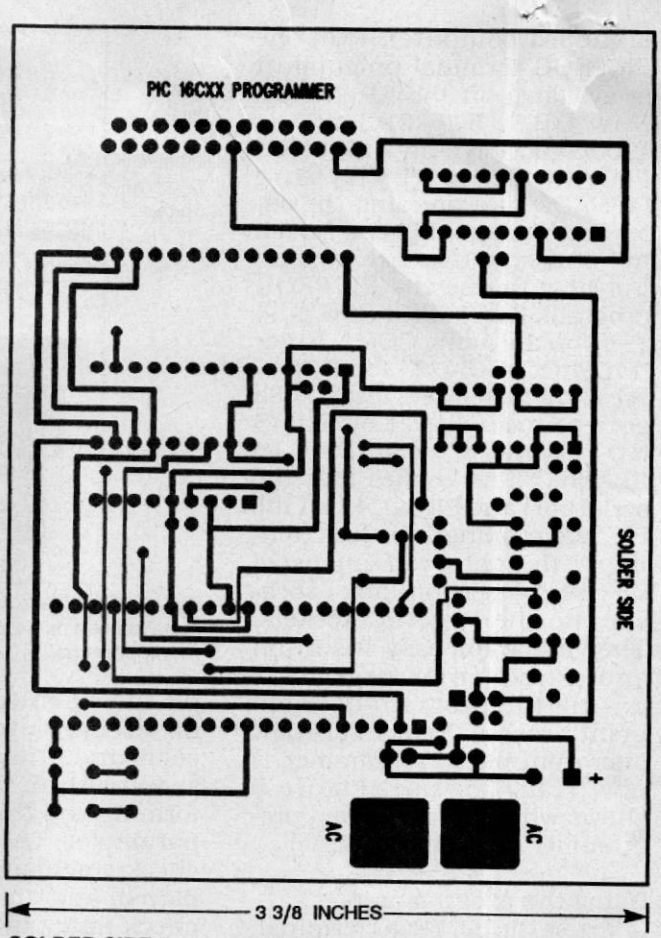
Fuse	S1 Position	Address	Function
FOSC0 FOSC1	1 2	FE00h FE01h	FOSC1, FOSC0: 00 : LP oscillator mode 01 : RC oscillator mode 10 : XT oscillator mode 11 : EC (external clock mode)
FWDT0 FWDT1	3 4	FE02h FE03h	FWDT1, FWDT0: 10 : WDT prescale is 256 01 : WDT prescale is 64 11 : WDT prescale is 1 00 : WDT is a normal timer
FPMM0 FPMM1	5 7	FE04h FE06h	FPMM1, FPMM0: 00 : Microcontroller mode (code protected) 10 : Micrcontroller mode 01 : Extended microcontroller mode 11 : Microcontroller mode
FGLWP	6	FE05h	FGLWP: 0 Global write protection on 1 Global write protection off

PIC17C42 programmer

For those of you who want to build the programmer entirely from scratch, Fig. 6 is a schematic for a PIC17C42 programmer module. All of the 8749H microcode and the PIC17C42



COMPONENT SIDE for the PIC16C5X programmer PC board.



SOLDER SIDE for the PIC16C5X programmer PC board.

PIC16C5X PROGRAMMER PARTS LIST

All resistors are ¼-watt, 5%, unless otherwise noted
R1, R3—237 ohms, 1%
R2—2320 ohms, 1%
R4—866 ohms, 1%
R5—3090 ohms, 1%
R6–R8—10,000 ohms
R9—430 ohms

Capacitors
C1–C5, C7, C10–C12—0.1 µF, 25 volts, monolithic
C6—330 µF, 35 volts, electrolytic
C8, C9—27 pF, 5 volts, NPO

Semiconductors
IC1—MAX233 RS-232 transceiver (MAXIM)
IC2—Pre-programmed PIC17C42 microcontroller (Microchip)
IC3—CD4053B CMOS multiplexer
IC4, IC5—LM317LZ voltage regulator
IC6—7805 5-volt regulator
D1–D4—1N4002 diode
Q1, Q2—PN2222A NPN transistor

Other components
ZIF1—18-pin zero-insertion-force socket for PIC16C54/56 target microcontroller
ZIF2—28-pin zero-insertion-force socket for PIC16C55/57 target microcontroller
XTAL1—10 MHz crystal
T1—18 VAC transformer, 500 mA
J1—PC-mount female DB-25 connector
Miscellaneous: PC board, IC sockets, 25-conductor ribbon cable, etc.

Note: The following items are available from E D Technical Publications, P.O. Box 541222, Merritt Island, FL 32954, Phone/Fax 24 hours 407-454-9905:

- **Complete PIC16C5X kit including PC board, transformer, female DB-25 connector, and all electronic parts (no ZIF sockets or cables)—$69.95**
- **PC board only—$30**
- **Programmed PIC17C42—$30**
- **Software on diskette—$10**

Please add $7.50 shipping for the full kit and $3.00 shipping for parts and software. Check, money order or COD only.

terminal program, both source and executable code, can be obtained from the Electronics Now BBS (516-293-2283) or from the E-D Technical Publications BBS (407-454-3198).

The prototype for this programmer was assembled with wire-wrap techniques. The power system and serial I/O subsystem contained on the PIC16C5X board were used, and the power, data, and control connections were jumpered, via a 40-pin header and matching socket, across to the PIC17C42 programmer module. That makes for quick and easy assembly. You can also build up all the power system and other components on one breadboard if you wish. A 7407 open-collector buffer (IC5) emulates the open-collector pins on the PIC16C5X programmer.

Be sure to provide adequate heatsinking for the LM7805 regulator (IC6) as it is supplying power for most of the non-CMOS parts. Bypass capacitors C2–C5 are a must. Although parts placement is not critical, it is recommended that you stick close to the prototype layout shown in Fig. 7.

An 8749H (IC2) controls the programming process, and an 8255 (IC3) provides the extra I/O pins that are necessary to accommodate the 16-bit data bus

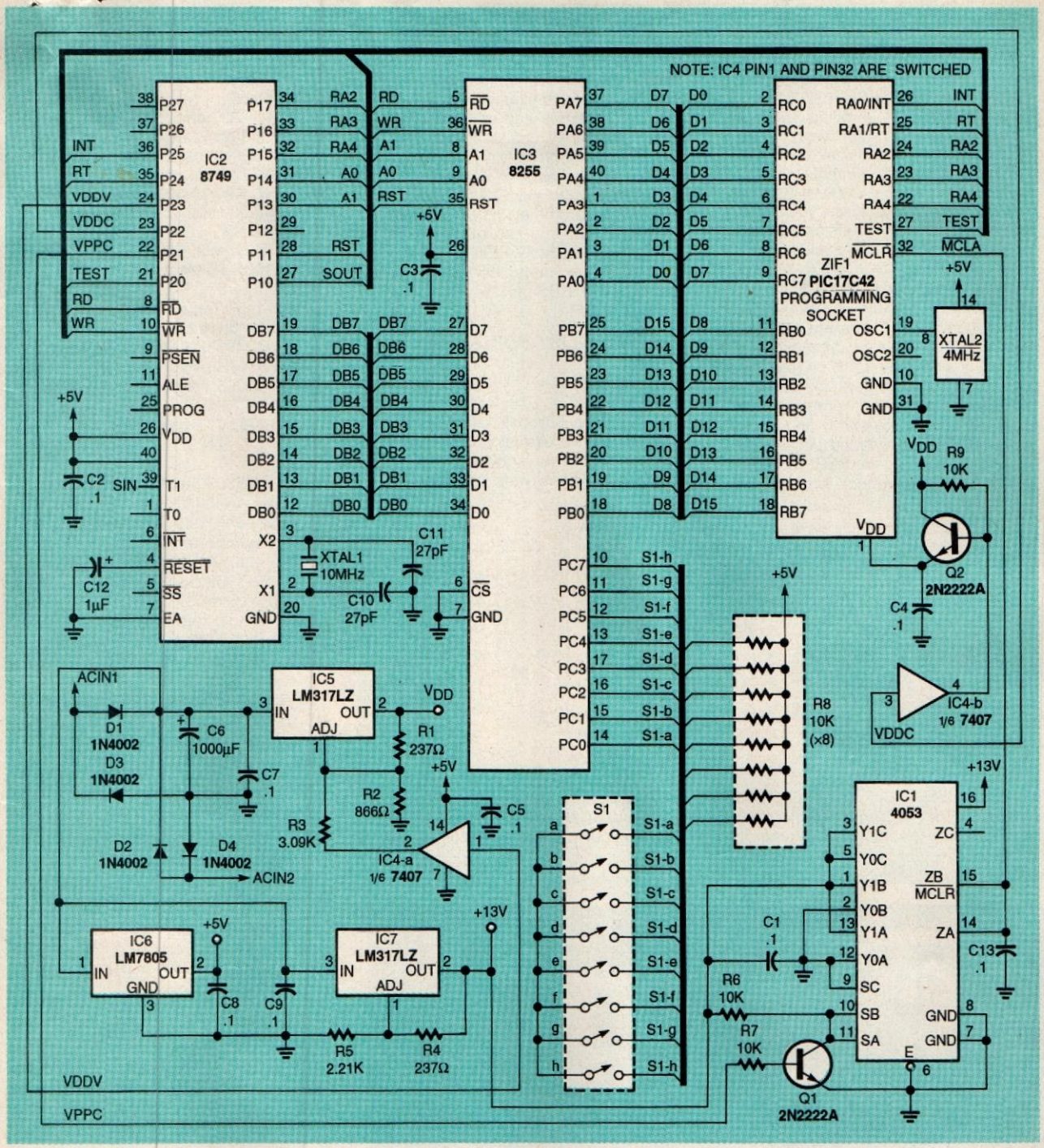


FIG. 6—PIC17C42 PROGRAMMER MODULE. The PIC16C5X programmer uses a pre-programmed PIC17C42, and this module will let you program it yourself.

of the PIC17C42. Most of the control functions are provided by the on-board I/O of the 8749H. The completed PIC17C42 programmer communicates via a serial connection to the terminal program. You can use the same MAX233 serial I/O circuit that was used on the PIC16C5X programmer. Also note that T1 is the input pin on the PIC17C42 programmer.

The PIC17C42 is programmed like other PIC16C5X MCUs, with the exception that an internal ROM-programming routine built into the PIC17C42 eliminates much of the programming overhead that is usually required for such devices. Data is transferred via the 8749H data bus to the data bus of the 8255 I/O subsystem. The 8255 passes the 16-bit programming between the target PIC17C42 and the 8749H. The 8255 also reads the configuration fuse settings that are set up by DIP switch S1. Table 1 gives the fuse details. Setting a switch to read "0" at the 8255 input port pin will blow (set to "0") that particular fuse.

The PIC17C42 requires that a clock signal be fed into CLKIN (pin 19) for programming, and

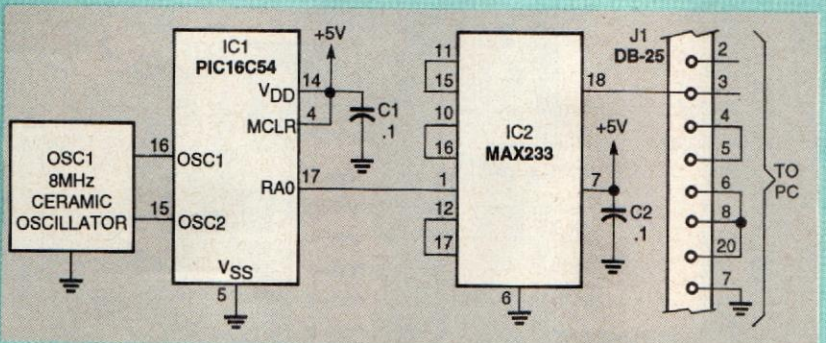
SEEPIC

The author has developed a simple program and hardware combination (shown here) for the PIC16C5X Microcontroller Programmer called SEEPIC. It will execute a PIC instruction or set of PIC instructions and display the resulting PIC register file contents on your terminal or PC with a 9600 BPS serial link. To use SEEPIC insert your small test program into the skeleton SEEPIC code and program the resulting compiled code into a PIC16C54. A MAX233 allows a connection to be made to your PC's serial port. Run whatever communication software you are comfortable with, and you should get a binary display of all of the PIC16C54 registers including the W register on screen. SEEPIC runs your test program only once, so you must remove and apply power to the programmed test PIC to run the program again. SEEPIC is designed as a learning tool. Writing code and seeing a result is the best way to learn how any microcontroller works. SEEPIC provides examples of a 9600 bps serial routine and many common functions you will use when you apply the PIC in your projects.

The author has also written a PIC cross-assembler that is included with the PIC programmer PICPROG software package. You can obtain all the batch files, PICPROG, SEEPIC, and the PIC cross-assembler from the Electronics Now BBS as the file called PICPROG.ZIP.

PARTS LIST FOR SEEPIC

IC1—PIC16C54
IC2—MAX233
C1, C2—0.1 µF bypass
8-MHz ceramic oscillator, DB-25 shell connector, perforated construction board, serial cable, wire, solder, etc.



SEEPIC SCHEMATIC. This simple hardware/software combination for the PIC16C5X Microcontroller Programmer will execute a PIC instruction or set of PIC instructions, and display the resulting PIC register file contents on your terminal or PC with a 9600 BPS serial link.

PIC17C42 PROGRAMMER PARTS LIST

Resistors
R1, R4—237 ohms, 1%
R2—866 ohms, 1%
R3—3090 ohms, 1%
R5—2320 ohms, 1%
R6, R7, R9—10,000 ohms, 5%
R8—10,000 ohms × 8, 9-pin SIP
Capacitors
C1–C5, C7–C9, C13—0.1 µF, bypass
C6—1000 µF, electrolytic
C10, C11—27 pF, ceramic
C12—1 µF, Tantalum
Semiconductors
IC1—CD4053B CMOS multiplexer
IC2—8749H microcontroller
IC3—82C55 programmable peripheral interface
IC4—7407 TTL hex buffer
IC5, IC7—LM317LZ adjustable regulator
IC6—LM7805 5-volt regulator
D1–D4—1N4002 diode
Q1, Q2—PN2222A NPN transistor
Other components
XTAL1—10 MHz crystal
XTAL2—4 MHz oscillator
S1—8-position DIP switch
ZIF1—40-pin zero-insertion-force socket for PIC17C42 target microcontroller

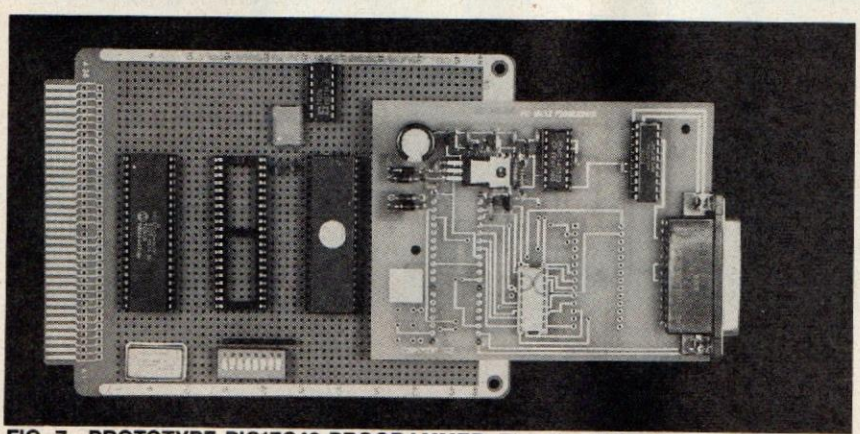


FIG. 7—PROTOTYPE PIC17C42 PROGRAMMER. The circuit is point-to-point wired.

XTAL2, a 4 MHz oscillator, is provided for this purpose. For a detailed bit-by-bit account of how the PIC17C42 programmer works, study the fully commented source code.

Using the PIC17C42 programmer should be a snap. There is only one caution to observe: never apply or remove power to the programmer module with a target PIC17C42 socketed. It could damage the target device. With that in mind, apply power to the programmer module and start the terminal program (17C42.EXE). A "READY FOR COMMAND" should be displayed as a flashing message indicating that the terminal program has made contact with the programmer module. Load the binary image of what is to be programmed (PICPRGR.BIN if you want to build the PIC16C5X project), insert a blank target PIC17C42, and press P to program. The programming algorithm will execute and end successfully with a "VERIFY OK" message. The PIC17C42 is then ready for service.

Conclusion

We hope you have "PICed" up enough information to realize what fantastic devices PIC microcontrollers really are, and how easy they are to use. For more PIC details, get your hands on the Microchip Data Book and the Microchip Embedded Control Handbook (Microchip Technology, Inc., 2355 W. Chandler Blvd., Chandler, AZ 85224-6199, 602-963-7373).

The author is always happy to offer readers any assistance he can, so you should feel free to PIC up the phone and direct your PIC-related questions to the HELPLINE at 407-454-9905. Ω