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TAPR PIC-Encoder

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1 The PIC-E is based on two chips: a Microchip, Inc.
 2 PIC16F84 microcontroller and a MX-COM, Inc.
 2 MX614 Bell 202 modem chip. The PIC16F84 is a
 3 general purpose “computer on a chip” that can be
 4 programmed and reprogrammed by the end user. The
 8 PIC-E has an on-board PIC programmer. It is only
 8 necessary to connect a short serial cable between the
 10 PIC-E and a PC serial port and run the appropriate
 13 programming software.
 13 The PIC can be programmed to receive an incoming
 14 data stream and reformat it for transmission as AX.25
 15 frames. The PIC sends the formatted data to the
 16 MX614 that generates tones necessary to transmit 1200
 bps packet over the radio’s audio channel. The MX614
 contains an energy detect circuit. Receive audio can
 be routed to the MX614 and it can determine whether
 the channel is in use and send this information back
 to the microcontroller. As a result, no additional VOX
 or carrier detect circuitry is required to prevent the
 PIC-E from colliding with other users on the channel.
 The MX614 can detect both digital signals and voice,
 so it is suitable for applications where digital and
 audio signals are mixed on the same frequency.

Introduction

The TAPR PIC-Encoder (PIC-E) is a general-purpose packet radio encoder based on the Microchip, Inc. PIC16F84 PIC microcontroller. The PIC-E was designed to provide a generic interface between the digital world (in the form of serial data streams) and the amateur packet radio world (in the form of AX.25 packets) and is fully programmable by the user. For example, the user can program the PIC microcontroller to take serial data from a GPS receiver or weather station and transmit it as formatted packet frames. Virtually any data that can be provided to the device as a serial input stream can be reformatted and transmitted as 1200 bps packet radio.

The PIC-E is an open system and it is hoped that many hams will use it as a platform for developing new and innovative applications. Almost any application that involves point to point or point to multi-point

transmission of low-density data is a candidate for PIC-E development. To write applications for the PIC-E you will need to learn how to develop PIC firmware. Don't worry, it is not all that difficult. Most of what you will need to get started is readily available at little or no cost. The software to get started in PIC development is available for free at <http://www.microchip.com>. A discussion of the basics of getting started in PIC programming can be found in an article by W2FS in the October 1998 issue of QST. The Proceedings of the 1998 TAPR/ARRL Digital Communications Conference contains information on how to implement AX.25 UI frames in PIC microcontroller. While the 16F84 contains only 1K of program space, it turns out that this provides enough room not only to decode incoming serial data and construct outgoing packets, but to do a significant amount of processing and reformatting of the data as well.

As PIC-E programs are developed they will be displayed or linked from the TAPR PIC-E web site located at <http://www.tapr.org/taprf/html/Fpice.html>. If you've created a project and would like to display or link to it, contact TAPR at tapr@tapr.org.

Updated documentation can be found at <http://www.tapr.org/taprf/html/Fpice.html> or <ftp://ftp.tapr.org/picsig/docs/>.

Contributed files can be found at <ftp://ftp.tapr.org/picsig/software/>. Files can be anonymously uploaded to <ftp://ftp.tapr.org/picsig/upload/>.

PIC-E is discussed on the PIC special interest group. You can join PIC SIG via the web at <http://www.tapr.org/cgi-bin/lyris.pl?join=picsig>.

Acknowledgements

The Tucson Amateur Packet Radio PIC-Encoder Kit was made possible by the pioneering efforts of (in alphabetical order):

Steve Bible, N7HPR	Project Manager
Joe Borovetz, WA5VMS	Parts Liaison
Steve Dimse, K4HG	Conceptual Design
Byon Garrabrant, N6BG	Programmer, Conceptual Design
John Hansen, W2FS	Programmer, Conceptual Design
Greg Jones, WD5IVD	TAPR Project Liaison
John Koster, W9DDD	PCB Design
Dan Welch, W6DFW	Conceptual Design, Documentation

PARTS LIST

The parts list is organized by quantity and part type. Verify that all parts are present by checking in the space [] provided as you locate the part in the list. You may wish to take this opportunity to sort the parts into a compartmented container such as an egg carton or muffin tin as you inventory them. This will aid you in kit building.

Resistors (1/4 w, 5% Carbon Film):

[] (4)	1.2K ohm (brown-red-red-gold)	R11,R14,R15,R18
[] (3)	2.2K ohm (red-red-red-gold)	R4,R5,R7
[] (9)	10K ohm (brown-black-orange-gold)	R3,R9,R10,R13,R16,R17,R19,R20,R21
[] (2)	22K ohm (red-red-orange-gold)	R2,R6
[] (3)	100K ohm (brown-black-yellow-gold)	R1,R8,R12

Resistor, (Trimpot, 25-Turn)

[] (1)	10K ohm Trimpot (103)	V1
---------	-----------------------	----

Capacitors

Capacitors may be marked in various ways. The typical markings are listed but may vary. Find all that match and the remaining ones, if any, should become apparent by elimination.

Mylar or Monolithic

[] (5)	0.1 uf (104)	C2,C5,C6,C7,C8
---------	--------------	----------------

Electrolytic or Tantalum

[] (2)	1uF (105)	C3,C4
[] (1)	100 uf	C1

Diode

[] (1)	1N34 Germanium Diode	D6
[] (3)	1N4002 Silicon Diode	D7,D9,D11
[] (2)	1N4148 Silicon Diode	D1,D10
[] (1)	1N5231BDICT-ND 5.1V Zener Diode	D2

Light Emitting Diodes

[] (1)	Green T1	D8
[] (2)	Yellow T1	D3,D4
[] (1)	Red T1	D5

Integrated Circuits

NOTE: Do not handle the ICs at this time! Carefully remove the black foam carrier with ICs from the bag and verify the ICs against this list. Do not touch the ICs!

[] (1)	PIC16F84	U1
[] (1)	MX614	U3

Transistors

[] (1) 2N3904 NPN Transistor

Q1

Voltage Regulators

[] (1) 7805

U2

Ceramic Resonators

Ceramic Resonators look very much like a dipped capacitor, but have three leads.

[] (1) 3.58 MHz

X2

[] (1) 10 MHz

X1

IC Sockets

[] (2) 16-pin DIP Socket

U3, J3

[] (1) 18-pin DIP Socket

U1

[] (1) 16-pin Machine Tooled DIP Socket

J3

Connectors

[] (3) 1x2-pin male header

[] (2) 1x3-pin male header

[] (3) 1x8-pin male header (or (1) 1x8 and (1) 2x8)

[] (12) 2-pin Jumper, Push-On

[] (1) DB9 Female PCB right angle mount

[] (1) DB9 Male PCB right angle mount

[] (2) 8-pin RJ-45 jack PCB right angle mount

[] (1) 2.1 mm Coaxial Jack

[] (1) 2.1 mm Coaxial Plug

Miscellaneous

[] (1) Printed Circuit Board

[] (1) Assembly Manual (this document)

[] (1) Cable Assembly with RJ-45 connectors

[] (2) Miniature Toggle Switches

[] (4) 4-40 x 3/8" screws

[] (4) 4x40 nuts

[] (1) Solid wire

CONSTRUCTION NOTES

You are now ready to begin construction of the PIC-Encoder. Follow standard construction practices when building the unit.

Use a temperature-controlled, fine-tipped soldering iron of relatively low wattage (25 watts maximum, 15 watts is ideal) and a good quality 60/40 or 63/37 rosin-core solder for construction. Keep the tip of your soldering iron bright and clean, wiping it frequently on a wet rag or sponge. Make solder joints carefully, but swiftly. Prolonged heat on a PC board pad can be

as disastrous as it can ruin the PC board. Two to three seconds should be enough time to apply heat to any joint. Due to the proximity of some of the traces on the PC board, solder bridges are a very distinct possibility. Following these points could eliminate several hours of troubleshooting (or worse). This is good practice when working on any kit.

You will need small flush or semi-flush cutting pliers and small-tipped long nosed pliers. A magnifying glass may prove helpful to identify the values of the small components.

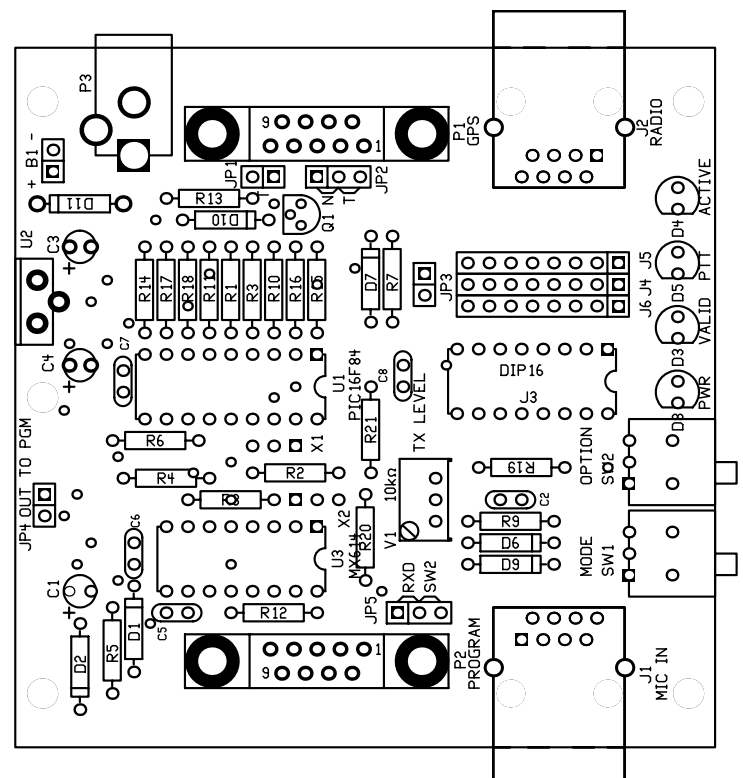
Pay careful attention to the directions that follow. Pay close attention to the following:

1) Read this entire document prior to starting construction of your kit.

2) Identifying the pins on headers - Pin 1 is identified by the square pad on silk-screen.

Electrostatic Protection

The Integrated Circuits are susceptible to static discharge. Observe anti-static precautions when assembling the PIC-Encoder.



CONSTRUCTION

Refer to the layout diagram for clarification of parts placement.

Resistors

Resistors have a lead spacing of 0.4" and should lie flat on the PC board. You may wish to use a lead former to pre-form the resistor leads for neatest appearance.

Install the following resistors:

- R14 1.2K ohm (brown-red-red-gold)
- R17 10K ohm (brown-black-orange-gold)
- R18 1.2K ohm (brown-red-red-gold)
- R11 1.2K ohm (brown-red-red-gold)

WARNING! Be careful when clipping leads, as they have a tendency to fly towards your eyes! Take appropriate precautions (grasp leads and wear eye protection).

- Solder and clip the leads (8 total)

- R1 100K ohm (brown-black-yellow-gold)
- R3 10K ohm (brown-black-orange-gold)
- R10 10K ohm (brown-black-orange-gold)
- R16 10K ohm (brown-black-orange-gold)
- R15 1.2K ohm (brown-red-red-gold)

- Solder and clip the leads (10 total)

- R13 10K ohm (brown-black-orange-gold)
- R7 2.2K ohm (red-red-red-gold)
- R5 2.2K ohm (red-red-red-gold)

- Solder and clip the leads (6 total)

- R6 22K ohm (red-red-orange-gold)
- R4 2.2K ohm (red-red-red-gold)
- R8 100K ohm (brown-black-yellow-gold)
- R2 22K ohm (red-red-orange-gold)

- Solder and clip the leads (8 total)

- R12 100K ohm (brown-black-yellow-gold)
- R9 10K ohm (brown-black-orange-gold)

CAUTION! Diode D6 and D9 are next to resistor R9. Make certain that you install resistor R9 in its proper place.

- R19 10K ohm (brown-black-orange-gold)
- R20 10K ohm (brown-black-orange-gold)
- R21 10K ohm (brown-black-orange-gold)

- Solder and clip the leads (10 total)

Now check your work. All leads should be soldered. There should be no solder bridges or cold solder connections.

- OK so far.

This completes the resistor installation. You should have no remaining resistors.

- No resistors remaining.

Diode

Diodes are polarity sensitive devices. Diodes are mounted flat near the surface of the board like the resistors previously installed. The cathode end of the diode is banded and corresponds to the banded silk-screen legend on the PCB.

Install the following diodes:

- D1 1N4148
- D2 1N5231 Zener

- Solder and clip the leads (4 total)

- D7 1N4002
- D6 1N34
- D9 1N4002

- Solder and clip the leads (6 total)

- D10 1N4148
- D11 1N4002

- Solder and clip the leads (4 total)

Now check your work. All leads should be soldered. There should be no solder bridges or cold solder connections.

- OK so far.

This completes the diode installation. You should have no remaining diodes.

- No diodes remaining.

IC Sockets

NOTE: If any socket pins are bent, carefully straighten them with a pair of long-nose pliers before assembly. Some types of IC sockets have crimps in the pins to hold them in place when automatic wave soldering is performed. These sockets may be tricky to install if you are not familiar with them. If your kit contains these sockets, you may want to straighten the pins before attempting to insert them into the PC board.

When installing IC sockets double check to ensure that the socket is seated properly against the board with the notch matching the silk-screen. Pin 1 (nearest the socket notch) has a square solder pad. Be sure that all IC socket pins are showing on the solder side of the board. Next, tack-solder two diagonally opposite corners first (such as pins 1 and 8 on a 14-pin socket).

Then solder the remaining pins of that socket before proceeding to the next one. If you find a socket is difficult to install, remove it and double-check for a bent pin.

CAUTION! Take care to avoid solder bridges!

NOTE: Do not solder the 16-pin Machine IC Socket to the PCB. It will be plugged into the socket J3 as a programming header later.

Install the following IC sockets:

- U1 18-pin
- U3 16-pin
- J3 16-pin

Now check your work. All leads should be soldered. There should be no solder bridges (a blob of solder that shorts two adjacent soldered connections) or cold (gray and/or grainy looking) solder connections.

- OK so far.

This completes the IC socket installation. You should have one 16-pin Machined IC sockets remaining.

- One 16-pin Machined IC socket remaining.

Trimpots

Align the trimpot according to the silkscreen.

Install the trimpot:

- V1 10K ohm

- Solder and clip the leads (3 total)

Capacitors

All capacitors should be mounted as nearly flush to the board surface as practical without stressing the leads.

Install the following capacitors:

- C2 0.1 uF (104)

- C5 0.1 uF (104)

- C6 0.1 uF (104)

- C7 0.1 uF (104)

- C8 0.1 uF (104)

- Solder and clip the leads (10 total)

Electrolytic and Tantalum capacitors are polarized. The positive lead goes in the hole on the board marked with a "+". Be careful! Typically the negative lead is marked and sometimes the positive lead is marked.

- C3 1 uF

- C4 1 uF

- Solder and clip the leads (4 total)

- C1 100 uF

- Solder and clip the leads (2 total)

Now check your work. All leads should be soldered. There should be no solder bridges or cold solder connections.

- OK so far.

This completes the capacitor installation. You should have no remaining capacitors.

- No capacitors remaining.

Ceramic Resonators

Ceramic resonators are not polarity sensitive.

Install the following ceramic resonators:

- [] X1 10 MHz
- [] X2 3.58 MHz

- [] Solder and clip the leads (6 total)

Transistor

NOTE: Transistors are polarized components. Match the body of the transistor with the silk-screened outline and carefully bend the transistor leads to match the hole pattern on the PC board. The bottom of the body of the transistor should not be more than 1/4" above the PC board.

- [] Q1 2N3904 NPN Transistor

- [] Solder and clip the leads (3 total)

Voltage Regulator

NOTE: Voltage regulators are polarized components. Match the body of the voltage regulator with the silk-screened outline and carefully bend the leads to match the hole pattern on the PC board. The bottom of the body of the voltage regulator should not be more than 1/4" above the PC board.

NOTE: position the 7805 with the heatsink positioned toward the edge of the PCB

- [] U2 7805

- [] Solder and clip the leads (3 total)

Male Headers

The 2-, 3-, and 8-pin male headers will be installed next. The plastic body of the part should rest flush with the top surface of the PC board. The short end of the pins goes into the PC board, the long end sticks up.

WARNING! Do not hold these parts with your fingers as they quickly get very hot while soldering in place.

Place a 2-pin jumper on the header to insulate your finger from the pins, hold the header in place and tack solder one pin. Check for proper alignment. If alignment is off, you can reheat the one pin to adjust.

Once the alignment is correct, solder the rest of the pins and then reflow (reheat) the first pin you soldered.

- [] JP1 1x2 pin
- [] JP3 1x2 pin
- [] JP4 1x2 pin

- [] JP2 1x3 pin
- [] JP5 1x3 pin

Place two or more 2-pin jumpers on the three 1x8 male headers (between J5 and J6 and from J6 to J4) to interlock them together and then tack solder. Check for proper alignment. Once alignment is correct, solder the rest of the pins.

NOTE: Your kit may contain (1) 1x8 header and (1) 2x8 header. Follow the same general procedure. Solder them side-by-side using two 2-pin jumpers to interlock and align them for soldering.

- [] J4 1x8 pin
- [] J5 1x8 pin
- [] J6 1x8 pin

Connectors

CAUTION! Soldering the coaxial power connector is a bit tricky because of the large mounting holes.

- [] P3 Coaxial power connector

Install the DB-9 connectors in their respective locations. First, secure the connector using two screws and nuts. Next, solder the leads.

- [] P1 DB-9 male (GPS)
- [] P2 DB-9 female (Program)

Gently rock the RJ-45 connectors until they snap into place and solder the leads.

- [] J1 RJ-45 connector
- [] J2 RJ-45 connector

Switches

Install two miniature toggle switches. Position them according to the silkscreen and solder the leads and body mounting pins.

- [] SW1
- [] SW2

Light Emitting Diodes (LEDs)

LEDs are polarized components. The flat side on the body and the shorter lead of the two identifies the cathode lead. Insert the LED according to the silk-screen outline.

- D8 Green LED (Power)
- D3 Yellow LED (Valid)
- D5 Red LED (PTT)
- D4 Yellow LED (Active)

- Solder and clip the leads (8 total)

Jumpers

Install push-on jumpers in the following locations:

- JP2 – N
- JP3
- JP4
- JP5 – SW2
- Eight between J4/J6

Voltage Checks

It is best to do a preliminary voltage check before installing the Integrated Circuits. This is a relatively easy check to make and can save you headaches later but first you need to supply power to the PIC-E.

The PIC-E can be powered via two methods, either from an external power supply or batteries. The onboard 7805 voltage regulator can accept an input voltage from 7 to 20 volts. The output of the 7805 is +5 volts at 1Amp. A power adapter (wall wart) that supplies 9 or 12 volts DC rated at least 100 mA with a 2.1 mm coaxial connector will work fine. *Make certain that the center conductor is positive.* Batteries can also power the PIC-E. A 9 volt transistor battery works great.

Power can be applied to the PIC-E via two methods, either through the 2.1 mm coaxial power connector P3 or B1 (two solder holes near P3). As mentioned before, the center pin of P3 is positive. Observe the polarity markings when connecting power to B1.

- Apply 7 to 20 Volts DC power to P3 or B1.

- The green power LED should light.

NOTE: JP4 must be installed.

Measure +5VDC at the following locations:

- JP4
- U1 pin 14
- U3 pin 16

If the above measurements are incorrect, carefully inspect the PIC-E for solder bridges, parts placement, polarity of parts, anything that looks unusual. Use the PIC-E schematic to trace the flow of power through the PIC-E to locate and correct the problem.

If the above measurements are correct, proceed to the next section.

Integrated Circuits

Observing static precautions and polarity, install the following ICs in their sockets. Pay particular attention to aligning the notch of the IC with the socket:

WARNING! Remove all power before installing ICs.

- Remove power from the PIC-E.

Install the following ICs:

- U1 PIC16F84
- U3 MX614

OPERATION

The PIC-E is a flexible and versatile device. There are several ways to interface and configure it. The PIC-E can be interfaced to a serial device, such as a GPS receiver or weather station, a microphone and radio. A typical PIC-E installation will use a serial device and a radio. Interfacing a microphone to the PIC-E is not mandatory.

Now that your PIC-E is fully assembled, it's time to learn how to program and interface it to radios and serial devices. First, you'll learn how to program the PIC-E with a small diagnostic program that will test various functions. Once these are completed, you'll learn how to interface the PIC-E to radios and serial devices.

Programming the PIC-E

The onboard serial programmer on the PIC-E receives power from the serial port.

WARNING! WARNING! WARNING!
DO NOT power the PIC-E during programming.

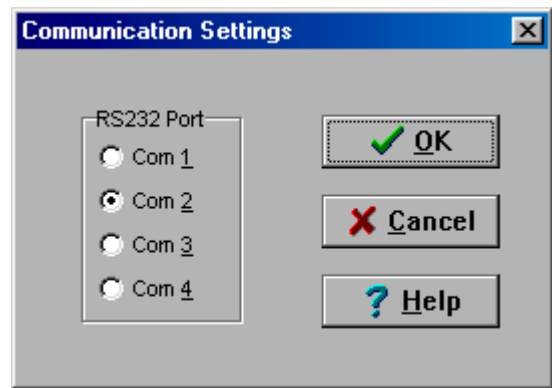
Serial ports differ from computer to computer and there may not be sufficient voltage to power the PIC-E during programming. If you have difficulty programming the PIC, remove the jumper on JP4 during programming. This will remove programming power from the rest of the PIC-E circuitry during programming.

NOTE: JP4 must be installed during normal PIC-E operation. If you forget to install JP4 prior to operating the PIC-E, the power LED will not light when power is applied.

The programming circuitry on the PIC-E is based on the Ludipipo programmer designed by Ludwig Catta. John Hansen, W2FS, wrote about this programmer in an article in the October 1998 QST, "Using PIC microcontrollers in Amateur Radio projects." There are several software programs that interface to the Ludipipo circuitry. Two have been tested on the PIC-E: PiX and PicProg. PiX is a DOS based programmer and PicProg is Windows based. For this example we'll use PicProg. John illustrates how to use PiX in his QST article.

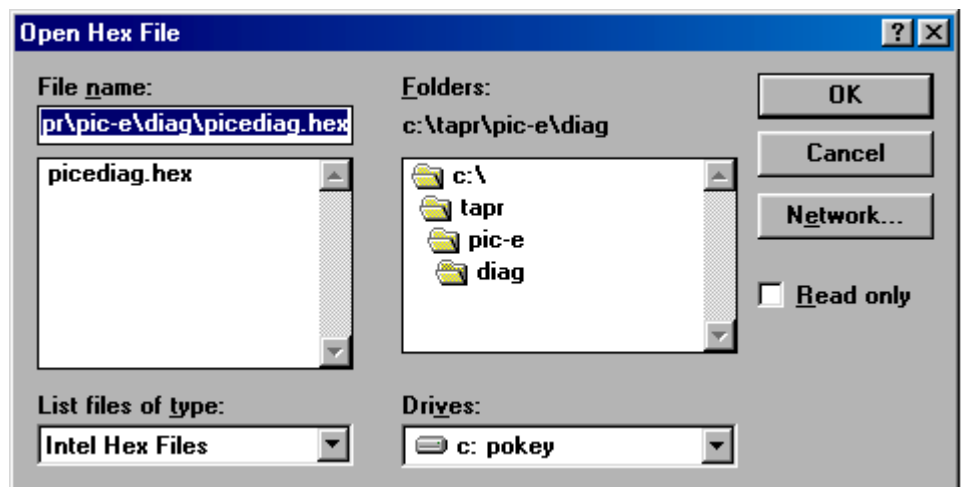
Loading PicProg onto your computer

PicProg is a Windows PIC16C84 programmer that can program the PIC-E. Unzip the `picprg06.zip` file into a suitable directory on your computer. Run PicProg and set the communications port by selecting **Setup | Com Port** from the menu bar. The following window will pop up:

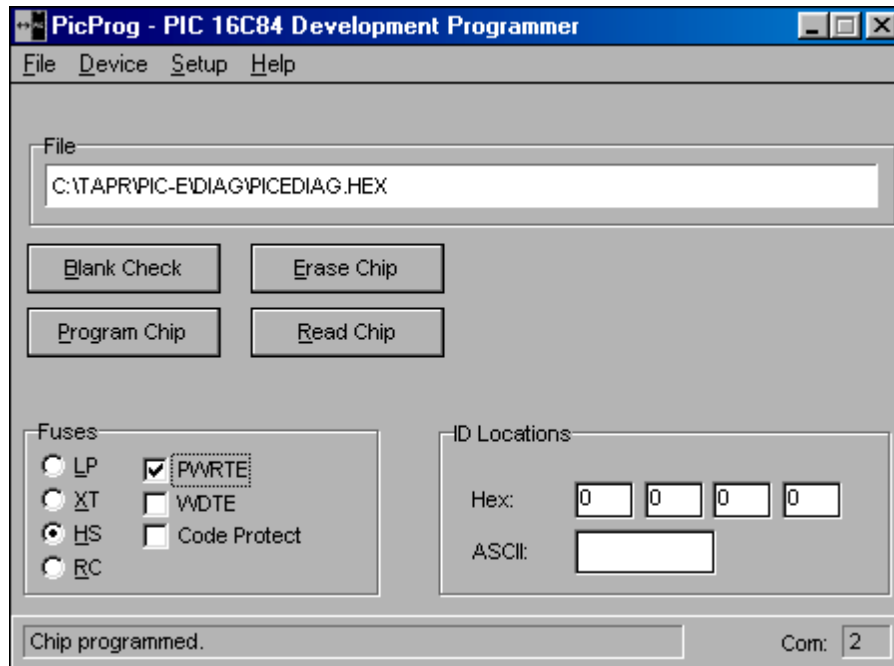


Click on the radio button corresponding to the computer comm port connected to the PIC-E. Connect a serial cable to the PIC-E Program P2 jack and your computer's serial port.

Next, open the diagnostic hex file `picdiag.hex` by selecting **File | Open File** from the menu bar. The following window will pop up:



Browse to the directory containing `picdiag.hex` and click **OK**. PicProg is now ready to program the PIC-E.



Check the box next to **PWRTE** to select **Power-up Timer** option of the PIC. To program the PIC-E click on the **Program Chip** button. The status line in the lower left will indicate the programming status. The power LED on the PIC-E will glow slightly while programming is in progress. In about a minute, if all goes well, the status line will report "Chip programmed" when completed.

In case of problems, check the serial cable and connections. Try a shorter (or shorten) the cable. Try removing jumper JP4. This removes power to the surrounding circuitry and applies it only to the PIC. The PIC-E programmer uses the serial port for power and not all serial ports are the same from computer to computer. If the power output is low, the programming of the PIC can fail. Remember to reinstall JP4 when programming is complete.

Run diagnostic

The diagnostic program tests the MX614 modem chip and lights the VALID LED. Place both toggle switches to the right. Apply power to the PIC-E. The switch functions are:

Mode Switch right – Off
Mode Switch left – Toggle tones at 1200 bps and assert PTT

Option Switch right – Off
Option Switch left – light VALID LED

- [] Apply power to the PIC-E.
- [] Move the Option Switch to the left. The VALID LED should light.
- [] Without a radio connected to the PIC-E, move the Mode Switch to the left, the PTT LED should light.
- [] Move both toggle switches to the right.
- [] Remove power to the PIC-E.

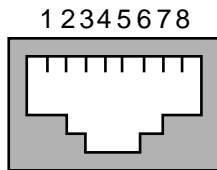
Radio and Microphone Interfacing

This section discusses interfacing the PIC-E to a radio and microphone.

[] Install the 16-pin machine tooled DIP socket in J3.

J1 Microphone/J2 Radio Jacks

Microphone jack J1 and Radio jack J2 are 8-pin RJ-45 jacks. Pins 1 through 8 of J1 and J2 correspond to pins 1 through 8 of J3 (see Figure 1). The pin-out of J1 and J2 is:



Looking into RJ-45 jack

A cable assembly with a RJ-45 plug on each end is included in the kit. If you are interfacing the PIC-E to a radio that already has a RJ-45 connector, connect the cable between the PIC-E and radio. If the radio you are interfacing to does not have a RJ-45 jack, you can cut the cable to length and solder on a microphone connector that mates to your radio.

J3/J4/J5/J6 – Microphone/PTT Programming Header

Jumpers J3/J4/J5/J6 configure your microphone and radio to the PIC-E. A microphone connects to Jack J1 (RJ-45) and a radio to J2 (RJ-45). Figure 1 illustrates the signal flow through the PIC-E.

Programming Header J3 is a machined-tooled 16-pin DIP socket that plugs into DIP socket J3. The user inserts wire jumpers between one side of the socket (pins 1-8) to the other side (pins 9-16) connecting signals between the microphone, radio, and the PIC-E.

[] Using Table 1 on the next page, write in the signal name corresponding to the pin number of your radio's microphone jack in right-hand column.

[] Draw a line between the microphone jack signal name in the right-hand column to the corresponding PIC-E signal name in the left-hand column. These lines will become wire jumpers on the DIP programming header J3. Mandatory signals (indicated by * on Table 1) to be connected to the PIC-E are:

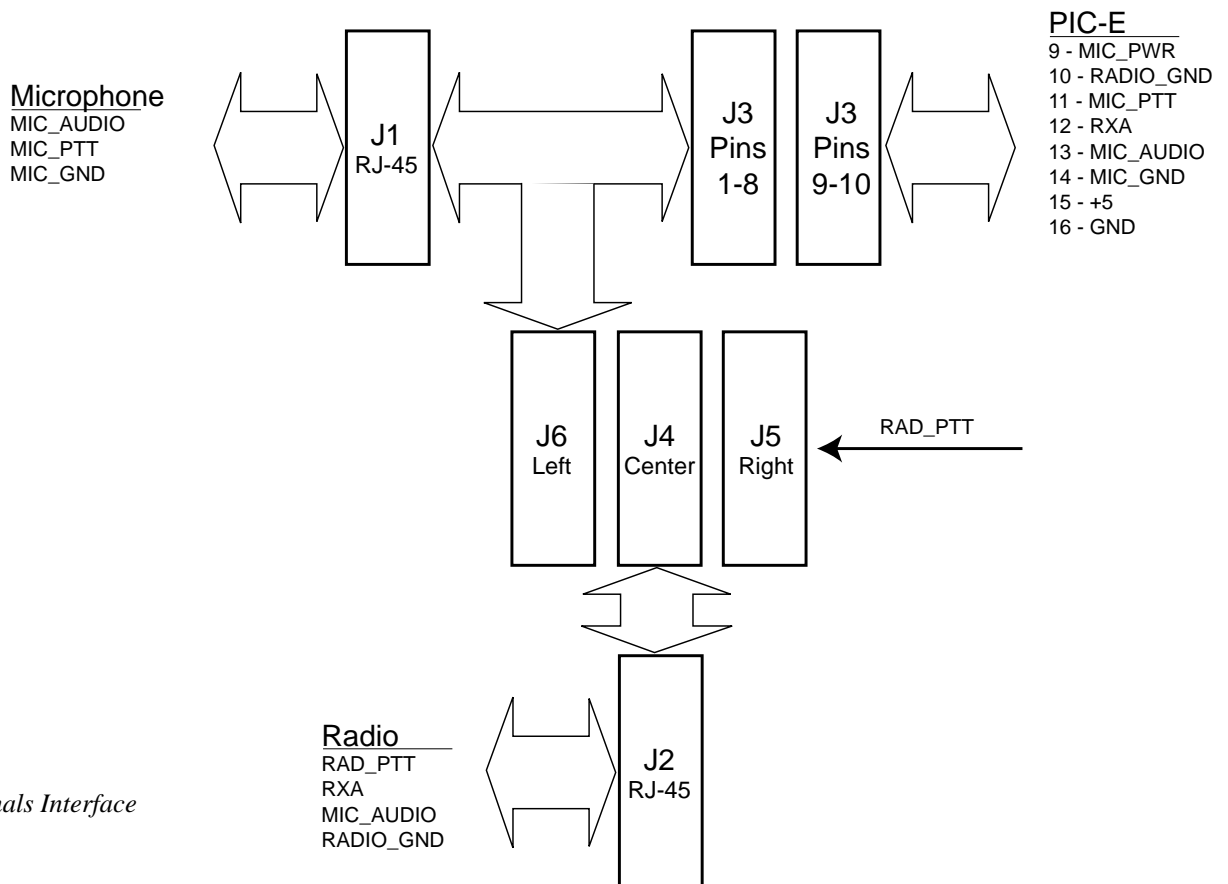


Figure 1 – Signals Interface

- Ground (either Radio_Ground, MIC_Ground, or Ground)
- Mic_Audio (PIC-E TX Audio to Radio)
- MIC_PTT (Microphone Push-to-Talk)

Optional signals are:

- +5V (PIC-E voltage to user equipment, no greater than 50 mA)
- RXA (Radio speaker audio to PIC-E for data/carrier sense)
- MIC_Power (Radio voltage to power PIC-E)

[] Cut and strip the solid wire supplied in the kit for jumpers between the pin holes of the machined-tooled DIP socket corresponding to the lines drawn on Table 1.

PIC-E Signals		Microphone Jack Signals	
9	Ground (*)		8
10	+5V		7
11	MIC Ground		6
12	MIC Audio (*)		5
13	RXA		4
14	MIC PTT (*)		3
15	Radio Ground		2
16	MIC Power		1

Table 1 - Jumper J3

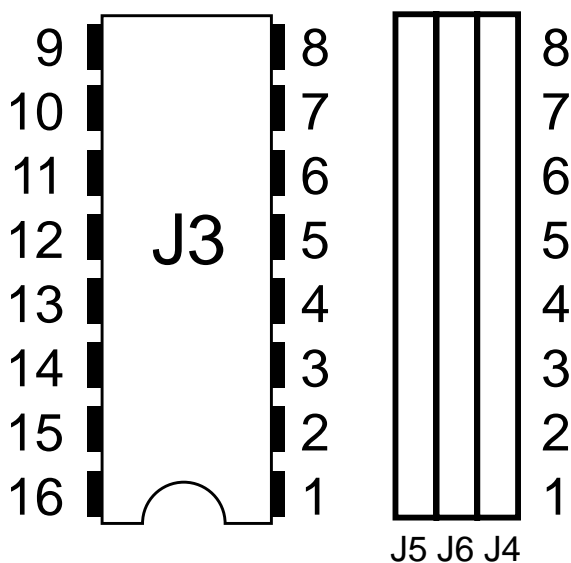


Figure 2 – Programming Jumpers

PTT Selection

Jumpers on the eight rows of pins on J4 and J6 pass through microphone signals from J1 (MIC IN) to J2 (RADIO). The user installs seven 2-pin jumpers to pass all microphone signals with the exception of Push to Talk (PTT). The pin corresponding to PTT is jumpered between J4 and J5 using a 2-pin connector. This action disconnects the PTT signal between the microphone and radio and allows the PIC-E to control PTT.

[] Find the pin number of the microphone PTT.
Pin number _____.

[] Remove the 2-pin jumper across J4/J6 corresponding to the PTT pin.

[] Install the 2-pin jumper across J4/J5 corresponding to the PTT pin.

Handie-Talkie Interfacing

If you plan to interface a handie-talkie to the PIC-E and require a resistance inline with the PTT line (such as Yaesu and Icom radios), remove jumper JP3. This will insert a 2.2K ohm resistance inline with the PIC-E RAD_PTT signal. Figure 3 shows a typical handie-talkie interface for Alinco, ICOM, Standard, Tandy, and Yaesu radios.

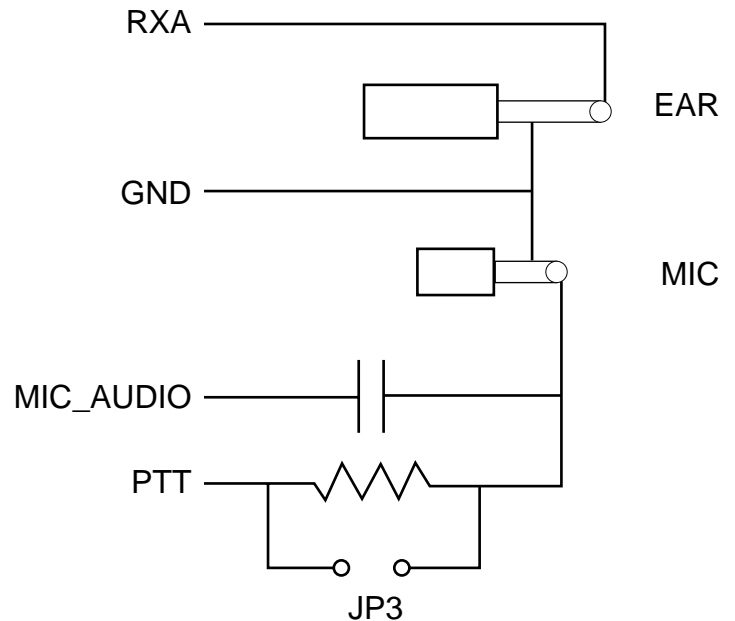


Figure 3. Typical HT Interface

Setting Deviation

Setting the PIC-E audio output sets the deviation of the packet signal. This is an important setting. If the audio output is too low the receiving station will not decode packets. If the audio output is too high the radio will be over-deviated and cause splatter.

You can set the deviation via one of three methods: manual, voltage measurement, or deviation meter.

Manual

If you do not have access to an oscilloscope, service monitor, or deviation meter, you can set the deviation using manual method with good results. Set the deviation as follows:

- [] Connect the PIC-E to your radio.
- [] Attach a dummy load to the radio's antenna connection.
- [] Set the PIC-E audio output to minimum by turning V1 fully counter-clockwise.
- [] Power up the PIC-E with the diagnostic program loaded.
- [] Use a second radio to monitor the output of the transmitter connected to the PIC-E.
- [] Set the MODE SW to the right. PTT LED should light and the radio starts transmitting.
- [] Slowly turn V1 clockwise. Tones should be heard on the monitoring radio.
- [] Continue to turn V1 clockwise until the volume of the tone stops changing. Turn V1 slightly counter-clockwise.
- [] Set the MODE SW to the left.
- [] Remove power to the PIC-E.

This completes deviation setting. Skip to Serial Device Interfacing.

Voltage Measurement

If you have access to an oscilloscope or peak-to-peak measuring voltmeter, set the deviation as follows:

- [] Connect the oscilloscope to the MIC_AUDIO line of the PIC-E.
- [] Set the PIC-E audio output to minimum by turning V1 fully counter-clockwise.
- [] Power up the PIC-E with the diagnostic program loaded.
- [] Set the MODE SW to the right. PTT LED should light and the radio starts transmitting.
- [] Slowly turn V1 clockwise.
- [] Set the MIC_AUDIO output to 850 millivolts, peak to peak.
- [] Set the MODE SW to the left.
- [] Remove power to the PIC-E.

This completes deviation setting. Skip to Serial Device Interfacing.

Deviation Meter

If you have or have access to a service monitor or deviation meter such as the AEA (now Timewave) DM-1, set the deviation as follows:

- [] Connect the output of the radio to a service monitor or deviation meter.
- [] Set the PIC-E audio output to minimum by turning V1 fully counter-clockwise.
- [] Power up the PIC-E with the diagnostic program loaded.
- [] Set the MODE SW to the right. PTT LED should light and the radio starts transmitting.
- [] Slowly turn V1 clockwise.
- [] Set deviation to 3.5 – 4.0 kHz.
- [] Set the MODE SW to the left.
- [] Remove power to the PIC-E.

This completes deviation setting.

Serial Device Interfacing

The PIC-E can be interfaced to any serial device such as GPS receivers or weather stations. Since the PIC-E is fully programmable, you can parse the serial stream into any format you desire and output it via the radio port at Bell 202 tones.

P1 is configured as a Data Terminal Equipment (DTE) serial port (i.e. computer port). Any Data Communications Equipment (DCE) device can connect pin-for-pin to the port. The pin outs are (labels are with respect to the PIC-E):

P1 Pin Number	Description
2	Serial In (RXD)
3	Serial Out (TXD)
4	Data Terminal Ready (DTR)
5	Ground

For normal serial connections, configure the following jumpers:

JP1 – open
JP2 – jumper across N

A Delorme Tripmate GPS receiver can be interfaced to the PIC-E by placing jumpers in the following locations:

JP1 – closed
JP2 – jumper across T

Applications

That completes the interfacing of the PIC-E. All that remains is to program the PIC-E for the application of interest. You can choose to load an already written program or write one of your own. As PIC-E programs are developed they will be displayed or linked from the TAPR PIC-E web site located at <http://www.tapr.org/taprf/html/Fpice.html>. If you've created a project and would like to display or link to it, contact TAPR at tapr@tapr.org.

Updated documentation can be found at <http://www.tapr.org/taprf/html/Fpice.html> or <ftp://ftp.tapr.org/picsig/docs/>.

Contributed files can be found at <ftp://ftp.tapr.org/picsig/software/>. Files can be anonymously uploaded to <ftp://ftp.tapr.org/picsig/upload/>.

PIC-E is discussed on the PIC special interest group. You can join PIC SIG via the web at <http://www.tapr.org/cgi-bin/lyris.pl?join=picsig>.

JUMPERS

The following tables summarize the jumper selections on the PIC-E.

JP1, JP2 – Tripmate Selection

Delorme's Tripmate GPS receiver can be used with the PIC-E. Install jumpers JP1 and JP2 according to the table below. JP1 will apply +5VDC to pin 4 of P1 and JP2 will jumper pins 2 and 3 together. To configure P1 for normal serial operations, install jumpers JP1 and JP2 according to the table below.

	JP1	JP2
Normal Serial	N	Open
Tripmate	T	Closed

JP3 – Handi-Talkie

JP3 provides a 2.2 Kohm resistor in series with the PTT line. If a handie-talkie is interfaced to the PIC-E and resistance is needed inline with PTT, JP3 should be open. If resistance is not need, JP3 should be jumpered (closed).

	JP3
Normal	Closed
Resistor	Open

JP4 – Programming

The onboard serial programmer of the PIC-E receives its power from the serial port. It is not necessary to power the PIC-E during programming. However, serial ports differ from computer to computer and there may not be sufficient voltage to power the PIC-E during programming. If you have difficulty programming the PIC, remove the jumper on JP4 during programming. This will allow you to remove programming power from the rest of the PIC-E circuitry during programming. JP4 must be installed (closed) during normal PIC-E operation.

	JP4
Normal	Closed
Programming	Open

JP5 – MX614 Receive/Option Switch SW2

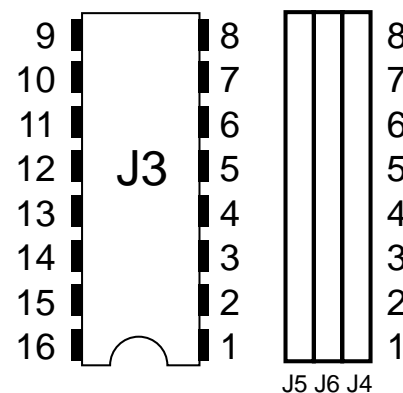
The PIC16F84 microcontroller has a finite number of I/O pins. Jumper JP5 allows you to select whether you want PIC port RB4 (pin 10) to be configured to receive digital data from the MX614 modem chip or switch SW2.

	JP5
MX614 Receive	RXD
Option Switch	SW2

J3/J4/J5/J6 – Microphone/PTT Programming Header

Jumpers J3/J4/J5/J6 configure your microphone and radio to the PIC-E. A microphone connects to Jack J1 (RJ-45) and a radio to J2 (RJ-45). Refer to the Radio and Microphone Interfacing section to configure these headers.

PIC-E Signals		Microphone Jack Signals	
9	Ground (*)	8	
10	+5V	7	
11	MIC Ground	6	
12	MIC Audio (*)	5	
13	RXA	4	
14	MIC PTT (*)	3	
15	Radio Ground	2	
16	MIC Power	1	

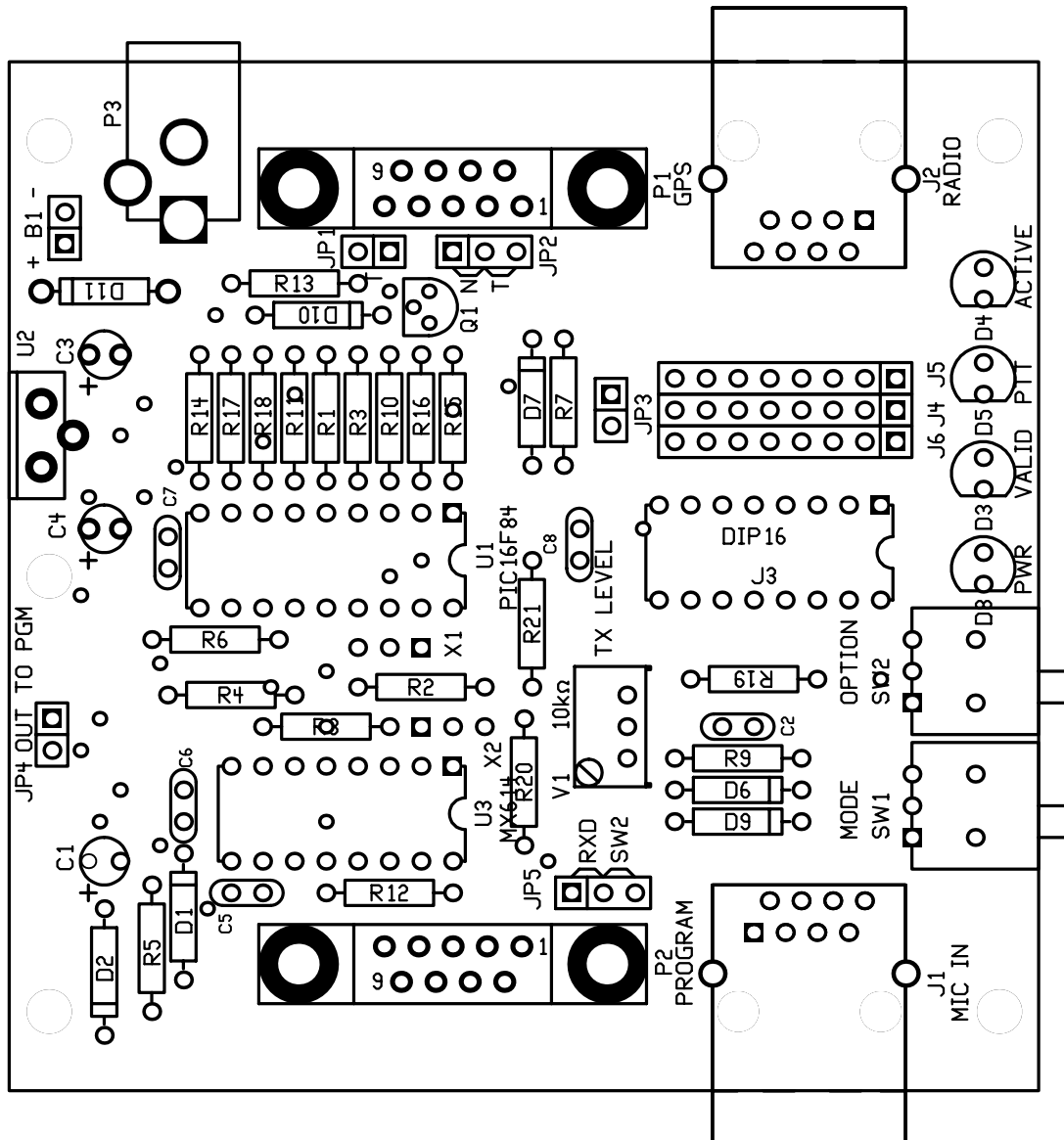


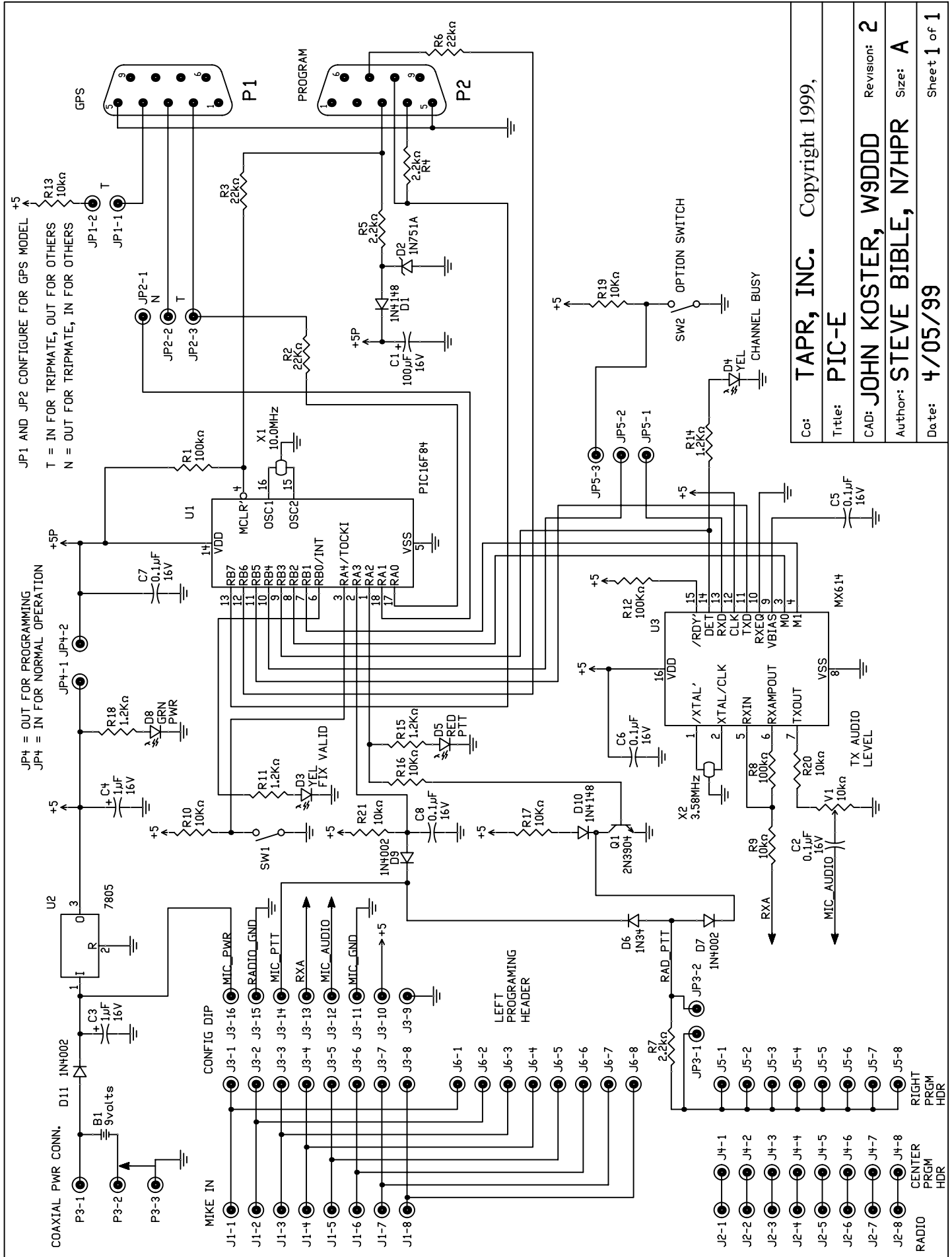
TROUBLESHOOTING

Most problems stem from bad solder connections. Inspect all solder connections. Make certain that there are no solder bridges or cold solder joints with a dull gray appearance. All solder joints should be smooth and shiny.

Check parts placement paying particular attention to components that are polarity sensitive such as the voltage regulator U2, transistor Q1, LEDs, and diodes. Check that ICs U1 and U3 are inserted with the notch on the chip matching the notch on the socket.

Power Problems - If the PIC-E is not operating correctly, check that the output of the 78L05 voltage regulator U2 is outputting +5 volts. You can measure this on pin 1 of JP4. Check that +5 volts are available on U1 pin 14 of the PIC and U3 pin 16 the MX614 chip. Trace the voltage signal using the schematic.





JP1 AND JP2 CONFIGURE FOR GPS MODEL
 T = IN FOR TRIPMATE, OUT FOR OTHERS
 N = OUT FOR TRIPMATE, IN FOR OTHERS

JP4 = OUT FOR PROGRAMMING
 JP4 = IN FOR NORMAL OPERATION

Co:	TAPR, INC. Copyright 1999,
Title:	PIC-E
CAD:	JOHN KOSTER, W9DDD
Author:	STEVE BIBLE, N7HPR
Revision:	2
Date:	4/05/99
Size:	A
Sheet	1 of 1