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DSP-93 Operations Manual

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Introduction

Please send all corrections to Ron Parsons at w5rkn@amsat.org. If a topic relevant to your DSP-93 operations is not covered, please feel free to write a draft and submit it for the next revision.

This purpose of this guide is to assist builders of the DSP-93 kit in successfully setting up the DSP-93 and operating it. It is presumed that you have assembled the kit, and satisfactorily completed the individual and final assembly checks as described in the Assembly Manual. This is a good time to review the Build Updates and make sure that you have made all the changes suggested in this document. The Build Updates are available on Internet and are also posted on Amateur Radio Satellite KO-23. Information concerning obtaining information on Internet is given below.

Internet

FTP:

TAPR maintains an ftp site at `ftp.tapr.org`. Updates and archive material relevant to the DSP-93 can be obtained via anonymous ftp from the directory `/tapr/dsp93`.

File Request:

You can get copies of all past messages distributed on the `dsp-93@tapr.org` list by sending mail to `'listserv@tapr.org'`, subject of `'list'`, message of `'index dsp-93'`. This message will request a listing of all files in the dsp-93 mail archive.

To request a specific month, send mail again to `'listserv@tapr.org'`, subject of `'request'`, message of `'request dsp-93 filename'`, where filename is the name of the file in the dsp-93 area you want to request (i.e., nov.94).

Listserv Mail Group:

You can join the DSP-93 listserv by sending mail to `'listserv@tapr.org'`, subject of `'list'`, message of `'subscribe dsp-93 First_Name Last_Name'`. This will subscribe you to the mail list.

The following notes will step you through the stages of setting up the DSP-93 for your particular radio(s) and describe how to load software, select a modem, connect the DSP-93 to a TNC, connect the DSP-93 to your radio, etc.

Loading the DSP-93 Software

If you have not already done so, now is time to load the DSP-93 software which was provided on two 3-1/2 inch diskettes with your kit. The README.NOW file on Disk No. 1 provides the DSP-93 Disk Installation Procedure and unarchiving instructions for DSP-93 files using a DOS based machine. Unarchiving instructions for DSP-93 files using a Macintosh are also provided, but you are unable to read DOS formatted disks, contact the TAPR office and request that Macintosh formatted disks be sent.

If everything has gone okay, you should now have the DSP-93 directories on your hard drive as described in the README.NOW file.

Connecting the DSP-93 to your computer

After connecting a cable between the DSP-93 and the serial port of your computer, run some type of terminal program with the data characteristics set to: **19200 bps, no parity, 8 data bits and 1 stop bit.**

The handshaking line RTS (RS-232 DB-25 pin 4) (pin 7 on the DB-9) needs to be asserted (+) to enable the DSP-93 to send data to the terminal. Set your terminal emulator for no hardware or software handshaking but the DSP-93 needs RTS to be high to send information to the terminal.

Experience has shown that the DSP-93 can accept data at 19.2 kbps without problem but not all terminals (or terminal emulators in your computer) can accept a continuous flow of data at that rate.

Monitor Test

This test has probably been carried out by you. The reason for redoing this test is to determine the Revision Number of the monitor EPROM. Record the Revision number of the EPROM as we will need this number later. At the time of writing this text two versions of EPROM exist - V 2.15 and V2.16.

Loading Files from the Monitor

Almost all the programs supplied with the DSP-93 can be run directly from the DSP-93 Monitor. You can use your favorite terminal program or, if you are using Windows, run D93WE.EXE to interface with the DSP-93. When you are in the main screen, press 'ENTER' or 'RETURN' and you will see a * monitor prompt (if the DSP-93 is connected correctly to your serial port and turned on). Then type a ? and you will see the monitor version and the commands shown below.

```
*?  
DSP-93 TAPR/AMSAT REV ##.#  
A-AR REGISTERS  
D-DUMP MEMORY  
F-FILL MEMORY  
G-FLIP & RUN PROGRAM @ 1000h  
J-JUMP TO XXXX & RUN  
H-INTEL LOADER HIGH BITS  
L-INTEL LOADER LOW BITS  
M-MODIFY WORD  
P-PROGRAM  
R-RESET  
S-SHOW WORD  
T-TEST
```

To load a file (.OBJ), the current program running in the DSP-93 must be the Monitor. Some (not all yet) DSP programs will quit and exit to the Monitor if an 'r' is received on the serial port. The Reset button on the front panel, of course, causes an exit to the Monitor.

Programs can be loaded from the DSP-93 EPROM. Type a "P" and a "?" and the Monitor will display a list of available programs. Type the single letter or number next to the desired program.

Loading files from the D93WE.EXE

Before using D93WE for the first time, you must edit D93WE.INI. The comments in the file give guidance for configuring the program to your computer configuration.

The files that are loaded into the DSP-93 are .OBJ files located in the OBJ directory. To download a .OBJ file to the DSP-93, choose Download and access the OBJ directory to download these files. The DSP-93 will reset itself prior to downloading the selected file.

Loading Files from DOS

Before you load files from DOS you should check the DSPLOAD.CFG file and change it to refer to the computer COM port to which the DSP-93 is connected.

To load a file from DOS change to the OBJ directory and type, for example: DSPLOAD FSKP1 to load the FSKP1 modem.

Loading files from a Macintosh Computer

Before using DSP-93Control for the first time, you must configure the application. See the ReadMe file for complete instructions.

Choose Load Program (Mac) [if your OBJ files are Macintosh files] or Load Program (DOS) [if your OBJ files are DOS files] from the Actions menu. Find and select the file you wish to load. Then click Open.

Loading files using the Windows program WiSP

To load the DSP-93 modems from WiSP, do the following:

1. Add FSKP1 (for example) in the Programs menu in WiSP.
The Menu Title is your choice, e.g., "FSKP1".
The Startup Directory is, e.g., "C:\WISP".
This is where the PIF is.
The Program Name is, e.g.,
"C:\WISP\FSKP1.PIF".
2. Create the FSKP1.PIF file which has the program to be run as C:\DSP93\OBJ\DSPLOAD.EXE. It has the current directory as C:\DSP93\OBJ. In the Other Parameters field, enter FSKP1 (no extension). The info in the parameters field is added as a command line entry so that it is treated as though "DSPLOAD FSKP1" had been entered.
3. Don't need a batch file.
4. Be sure that FSKP1.PIF and DSPLOAD.EXE are in directories in the PATH statement.

How to connect the DSP-93 to a TNC

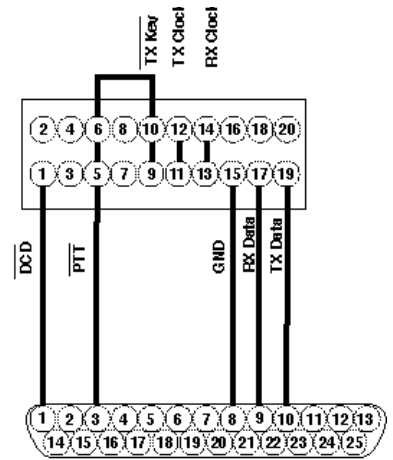
When the DSP-93 is configured as a modem, it must be attached to a TNC. The TNC performs various functions such as HDLC framing and unframing and sending data to and from the computer. Thus there must be an RS-232 connection between the computer and the TNC. The RS-232 connection between the Serial Port of the DSP-93 and a computer is used to load software into the DSP-93. This latter connection need not be in place all the time. It can be disconnected after the modem software is loaded into the DSP-93. Thus it is possible to use the DSP-93/TNC combination using only one serial port on the computer. See **Figure 1** for possible connection arrangements between the DSP-93, the TNC and your computer.

The DSP-93 is connected to a TAPR TNC-2 or one of its clones by using the Modem Disconnect header. Some TNC's or Multimode Controllers such as the AEA PK-232MBX do not have a Modem Disconnect header. However a kit is available from TAPR to add this feature.

The DSP-93 is connected to the TNC-2 Modem Disconnect Header using five and only five wires. The connecting arrangement is as shown in **Figure 2**.

Figure 2

TNC-2 Modem Disconnect Header (20-pin Male)



Male DB-25 Cable to DSP-93 Interface

It is recommended that a shielded cable be used for this application with the shield tied to Pin 15 at the TNC end of the cable and to pin 8 at the DB-25 end of the cable.

The TNC Modem Disconnect Header has PCB traces which connect several pairs of pins. These traces are usually found on the solder side of the PCB. For a TNC-2, MFJ-1270B or other TNC-2 compatible TNC's the following pins must be connected: 3 to 4, 5 to 6, 6 to 10, 9 to 10, 11 to 12 and 13 to 14. You should determine the connections on your TNC by visually inspecting the PCB and verifying them with an ohmmeter.

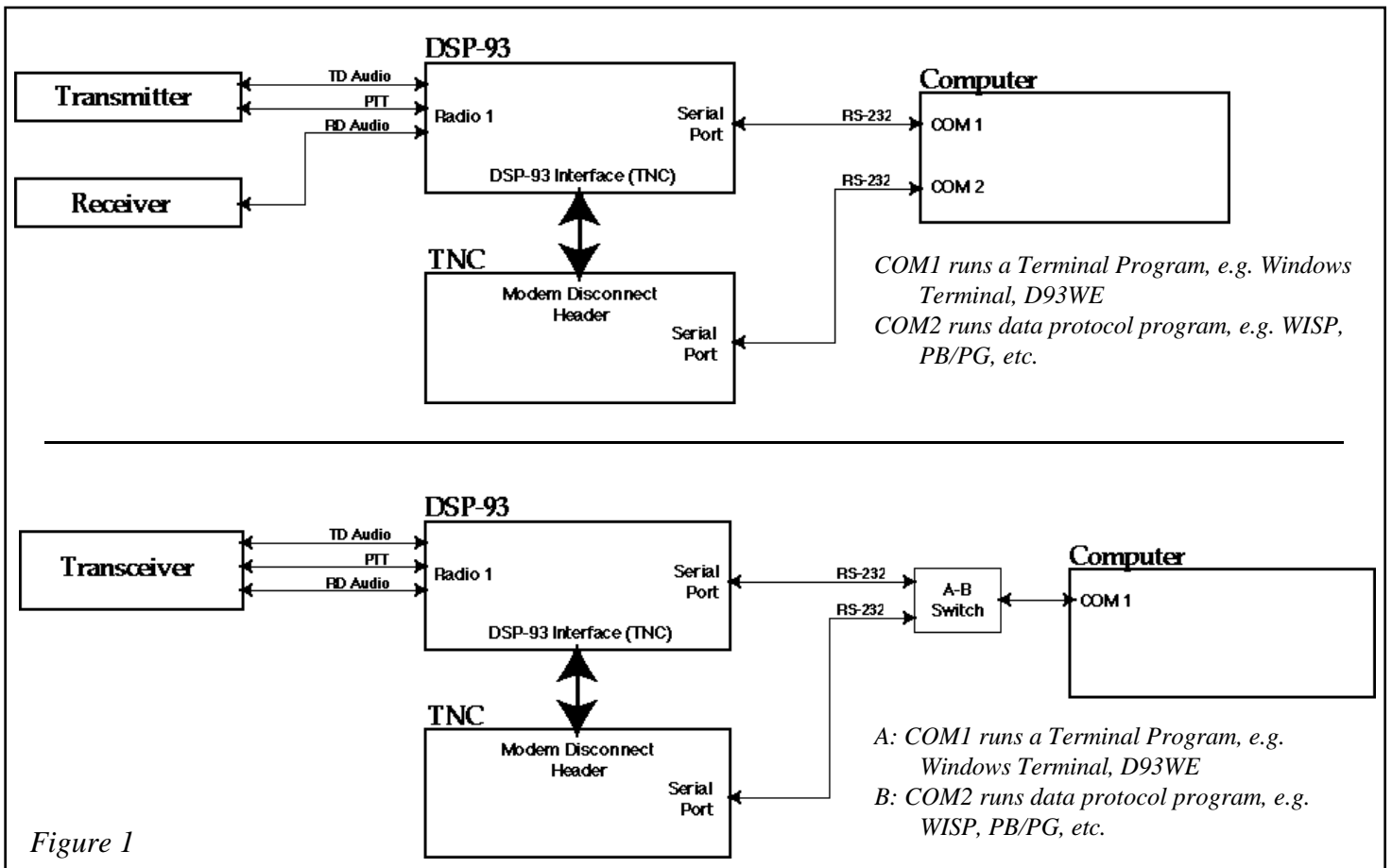


Figure 1

RADIO IO Port Configuration Setup

The Radio IO port should now be configured to a predetermined state at power up or reset by strapping certain lines on the DB-25 interfacing the TNC.

You must configure your DSP-93 properly or you may cause your radio to go into the transmit mode. In doing so it may burn out a preamplifier or damage your radio. If you read and understand the following information you will not have a problem. These are simple issues which must be considered when you allow external equipment to operate your radio.

Also, depending on your equipment, it is possible for the DSP-93 to cause your transmitter to transmit briefly when the DSP-93 is powered on. Please take precautions so this possibility does not damage your equipment.

The RADIO IO ports must be configured so that they initialize in a determined state at power up and reset. This is done by strapping certain lines on the DB-25 "Interface Port" interfacing the DSP-93 to the TNC.

If all of your equipment requires a common initialization state, the strapping may be done internally to the DSP-93. A 20 pin strapping plug is provided for this purpose which plugs into the female 20 pin connector which is mounted on the flat cable supplied with the kit.

Alternately, you may place the desired strapping in the DB-25 connector which plugs into the DSP-93 Interface Port. This way, this initialization may be changed by using different cables plugged into the Interface Port.

The monitor code checks the logical state of four lines only upon Power Up or Reset. The logical state of these lines will establish the initial output condition of the lines which control your radio's Push to Talk line and the external Frequency Shifter. It is suggested that you configure these lines with jumpers to +5V or ground according to the requirements of your radio. Refer to your radio's manual for information about how these signals will affect the radio's operation. In other words, do you ground your radio's PTT input to key your radio or do you take it to plus five volts? After you have wired the 20 pin dual row, male header, test it with your equipment to be sure things are working as you expect. If the jumpers are placed on the DB-25 Interface Port, and a plug with a different configuration is inserted, a reset is required for the changed configuration to be recognized.

The jumpers to configure the two radio control ports can be placed on a 20 pin header. This header will then be plugged into the extra connector placed on the ribbon cable between the DSP-93 TNC header and the DB-25 socket on the rear panel of the DSP-93.

Refer to section "IO Port Configuration Setup" of your assembly manual for more information.

Please refer to the ROM version number that you were instructed to record in the section entitled Monitor Test.

The initialization procedure differs for Monitor EPROM version 2.15 and for later versions. Instructions for programming the port initialization code for the IO ports are given below.

EPROM Version 2.15

At power up or reset:

PTT Port 1 ALWAYS initializes HIGH.

PTT Port 2 and both UP/DOWN lines initialize "backwards", i.e. when you strap their initialization lines (DSP-93 TNC Pins 7, 14 and 16) LOW (Gnd on pin 15), the corresponding port initializes HIGH and vice versa with their initialization lines HIGH (+5V on pin 3).

EPROM Version 2.16 and later

At power up or reset, both the radio ports initialize according to whether the corresponding pins are strapped HIGH or LOW on the DSP-93 TNC header. The state of the radio IO port is determined by strapping the DSP-93 TNC pins 7, 14, 16 and 18 either HIGH (+5V on pin 3) or LOW (Gnd on pin 15).

Signal	DB-25 Interface Port Pin No.	DSP-93 TNC Header Pin No.
+5V	2	3
Gnd	8	15
Freq 1	20	14
PTT 1	22	18
Freq 2	4	7
PTT 2	21	16

Example IO Port Configuration Setup

As an example of programming the port initialization code, let's assume you have an Icom IC-275A and IC-475A, IC-970 or Kenwood TS-790A.

The instruction manuals state that both the UP/DOWN frequency control line and the PTT control lines are grounded when either the UP/DOWN frequency line or PTT line is to be activated.

Therefore if we were using an **EPROM Version 2.16**, and we planned to connect the IC-275A and IC-475H to radio port 1, we would connect the DSP-93 header pins 14 and 18 HIGH to pin 3. This would ensure that at power up or reset when the monitor code checks the state of these lines, the TNC will neither change the frequency of the IC-475H receiver nor operate the PTT on the IC-275A transmitter.

If however, we were using **EPROM Version 2.15**, using the same radios as in the previous example, we would connect DSP-93 header pin 18 to +5V (or not make any connection to this pin because it always initializes HIGH) and connect DSP-93 pin 14 HIGH to +5V i.e., DSP-93 TNC pin 3.

As another example of programming the port initialization code, let's assume you have a Yaesu FT-736R.

The instruction manual states that the UP/DOWN frequency control line must be at a logic high to be asserted and the PTT control line is grounded when the PTT line is to be activated.

Therefore if we were using an **EPROM Version 2.16**, and we planned to connect the Yaesu FT-736R to radio port 1, we would connect the DSP-93 header pin 14 to ground and 18 to pin 3. This would ensure that at power up or reset when the monitor code checks the state of these lines, the TNC will neither change the frequency nor operate the PTT on the Yaesu FT-736R transmitter.

IMPORTANT NOTE

On shipments of the DSP-93 kit prior to May 1995, pin 3 on the DSP-93 TNC header was not connected to +5V. The fix is to solder a 10K ohm pull-up resistor on the bottom of Board 2 between pin 3 of the TNC connector and U213 pin 20 (+5V). Be careful not to short either lead to any uninsulated point on the bottom of the board.

Test to determine if the port initialization has been correctly configured

Power on the DSP-93. Connect your radio(s) to radio ports 1 and 2. Reset the DSP-93 by pressing the reset switch on the front panel. The radio(s) connected to either radio port 1 or radio port 2 should do nothing. The transmitter should not key nor should the frequency step up or down. NOTE: With EPROM Version 2.15, PTT 1 will be in a HIGH state after reset. Depending on your radio, this may or may not be a problem.

Run TESTPORT.OBJ (TESTPORY.OBJ for the Yaesu FT-736R) and check to determine if both the PTT line and the Freq lines toggle as described in the description of "TESTPORT" which is found in the DOC directory under TESTXXXX.DOC. This test should be run first with NO radio connected. Monitor the voltage on the appropriate lines. The test should then be repeated with radios connected. The radios should behave as expected, i.e., the PTT line will key the transmitter and the radios will tune when the relevant LED lights. If not, correct the problem before proceeding.

How to connect the DSP-93 to Radios which have PTT and FREQ line at voltages other than +5V

Occasionally you may encounter a situation where some or all of the radios that you wish to connect to the DSP-93 have PTT and FREQ line at voltages other than +5V. There are two situations:

1. All the radios have their PTT and FREQ lines at a voltage higher than +5V, say +12V.

In this case a solution is to

- (a) replace U205 with a 7406 and
- (b) disconnect the common end of R217 from +5V and reconnect common end of R217 to +12V.

In production Rev. 2 (3/1/95) and later boards, a pad was added to make this change. It is marked "J" and is located near R217. You will need to cut the trace which is connected to the adjacent +5V pad 7 before connecting +12V.

Note. In earlier versions of the DSP-93 a jumper had to be added between the common end of R217 and +5V. (Refer to Build Update Notes.)

2. Some radios that are to be connected to the DSP-93 have their PTT and FREQ lines at +5V while other radios have PTT and FREQ lines at +12V. First allocate the radio(s) that have +5V PTT and FREQ lines to, say, Radio Port 1. Radio Port 2 will then be used for radio(s) that have +12V PTT and FREQ lines.

In this case a solution is to

- (a) replace U205 with a 7406 and
- (b) carefully remove R217 from the PCB by flexing it until the pins break or using appropriate de-soldering equipment.
- (c) obtain six 47K 1/2 W resistors. (not supplied in the DSP-93 kit). Mount one end of each of the 47K resistors into the six holes connected to U205 pins 2, 4, 6, 8, 10 and 12. Connect the free end of resistors connected to U205 pins 2, 4 and 6 to +5V. Also connect the free end of resistors connected to pins 8, 10 and 12 to +12V.

Caution

Remember that you should only use radio's with +5V PTT and FREQ lines on the Port allocated for +5V use. The same comment applies to radios with +12V PTT and FREQ lines.

Transmitter and Receiver Interfacing

Connecting the modem to the receiver and transmitters is a vary large subject. But a few general points are worth mentioning. Attempting to use the microphone input and speaker output for PSK input and output will work, but throughput may be disappointing. You must inject and extract the modem's input and output past the pre-emphasis and de-emphasis circuits that shape the audio. Remember to turn the mic gain all the way down as any audio from the microphone may trash the digital signal.

Some rigs have digital data inputs that work fine for PSK, but not for 9600 baud FM. Here minor surgery is needed, as you must inject the modem's output into the FM varactor, and pick up the received signal from the discriminator. Use shielded cable. In general, look for the first resistor after these devices and solder the center wires to the exposed resistor wire farthest from the varactor and discriminator, and the shield to the nearest ground point. This will usually work if you have a "true FM", and not a phase modulated rig. If you do not have a deviation meter, you can use a scope for adjusting the digital deviation. Adjust the modem's output to the varactor injection point for the same transmitter PEP output that you get with 100% modulated FM audio. This should be close to 5 kHz deviation, assuming the rig's FM audio is properly adjusted for 5 kHz deviation. Then adjust back down until your PEP is approximately 80% of the PEP value where audio flat topping began. For example, in a Yaesu FT-736 which began to flat-top at 1000 mV, 800 mV gave 3 kHz deviation.

Although a wide IF filter may make 9600 baud throughput better, you may want to retain the stock narrow IF filters. Careful tuning of both uplink and downlink signals for the Doppler shift will improve 9600 baud throughput.

When you are adjusting the deviation or receive sensitivity, use an insulated tuning wand if you have one. If you accidentally loose your grip and drop a metallic screw driver in the DSP-93, you could cause shorts that may result in serious electronic damage.

Modifying your radios for 9600 bps

It is presumed that your radio(s) have been modified for 9600 bps operation. If you have not modified your radio(s) for 9600 bps operation, it is suggested that you do so now. A file 9600MODS.ZIP is included on the distribution diskette which covers many radio modifications.

Connecting your radios

Select the mode that you wish to operate e.g., 9600 bps satellites. For the 9600 bps satellites connections are required to the radio varactor for the 'transmit' input and to the radio discriminator for the 'receive' output. Connections are made to the appropriate pins in the wires from the 8-pin Mini-DIN male plug. See the DSP-93 assembly manual for more information concerning these pin assignments.

NOTE:

Refer to 9600MODS.ZIP in the DSP93\UTIL directory for specific information concerning modifications to radios for 9600 bps operation.

If you do not find your radio listed and you determine modifications and connections required, be sure to post this information in the dsp-93 mailing list on Internet or mail it to TAPR.

In a similar fashion if you wish to operate the 1200 bps satellites then you use the mic or auxiliary input for 'transmit' and the speaker or auxiliary output for 'receive'

CAUTION:

Do not attempt to use one cable for both 1200 and 9600 bps satellites! To use different modems on one port some sort of switching arrangement is required. With some slight programming changes, the Aux In connection on the radio port may be used.

Modem Documentation

FSK modems

Set TNC to 9600 bps! This is normally done by changing switch settings on the back of the TNC. Refer to your TNC manual for detailed instructions.

=====

FSKP1.OBJ - Radio Port 1, gain 16

FSKP2.OBJ - Radio Port 2, gain 16

=====

Pressing 'r' or 'R' on the terminal or sending an 'r' or 'R' to the modem on the DSP-93 serial port will terminate the modem program and return control to the DSP-93 Monitor.

This is a 9600 bps full-duplex FSK modem, satellite compatible.

LED214 is PTT

LED215 is on

LED217 is duty cycle

LED218 is power

DCD is locked high. LED 217 is driven by the code's duty cycle. However, you would have to use an oscilloscope on U215-1 to measure it because the buffer driving LED 217 is too slow to follow the action. The duty cycle is nearly 100% so there is not much time left to add additional functionality.

The Assembly Manual shows the interconnection cable between the DSP-93 and a TNC-2 clone. It is recommend that you use a shielded cable, with the shield tied to pin 15 at each header. Note that several local jumpers (and traces on the bottom of the board) are used on the TNC modem disconnect header. Pin 6 is connected to pin 10 with a PC trace. Only five connections are made at modem disconnect on the DSP-93. **DO NOT MAKE ANY CONNECTIONS OTHER THAN THOSE SHOWN.**

To set the modem up, tune in a signal, switch the S-meter to monitor the discriminator and retune to center the meter carefully. Adjust R215 (use R215 for radio port 1; R216 for radio port 2) for 1 V p-p or a little less on pin 26 of the TLC32044, U208. A test point TP 1 is provided on the production release boards. You should immediately see data, including the distinctive packet "flag" waveform on pin 17 of the DSP-93's TNC header. You may trigger the scope from LINE. Ideally, the waveform will not drift as 9600 is a multiple of 60. In practice the waveform drifts very slowly.

Adjust the transmitter deviation by first running R214 (use R214 for radio port 1; R213 for radio port 2) down to the bottom, and slowly cranking it up until the transmitter output, monitored on another receiver, sounds "half as loud" as unscelched noise. Use a deviation meter if you are a purist. In the case of a Icom IC-275H, it wants about 0.5 V p-p to drive the transmitter "varactor" input. If you have access to a deviation meter, the deviation should be about 3.0 kHz. More deviation will not help and may make your signal harder to copy.

This version of the code attempts to lock out the PTT signal if the TNC is turned off. However, it may not work with every TNC ... beware.

```
=====
FSKISIP1.OBJ - Radio Port 1, gain 16
FSKISIP2.OBJ - Radio Port 2, gain 16
=====
```

Pressing 'r' or 'R' on the terminal or sending an 'r' or 'R' to the modem on the DSP-93 serial port will terminate the modem program and return control to the DSP-93 Monitor.

This is a 9600 bps full-duplex FSK modem, satellite compatible, with fixed ISI compensation for KO-23 received on the software author's Icom IC-475.

This version of the FSK modem utilizes a receive filter that includes ISI compensation. It is "hand-tuned" with a 9-tap zero forcing ISI compensation filter using captured KO-23 signal files convolved with the 16-tap low-pass filter used in the FSK modem. The resulting 24-tap filter definitely improves the performance of some stations. It may make things better or worse for your setup. [Editor's note: The FSKISI modem performs much worse than the FSK modem on my Icom IC-970].

Changing Gain settings on FSK modems

The following provides data to permit changing the gain settings on the FSK modems. Since TAPR does not distribute the source for these modems, you may use the following procedure to change the gain settings.

There are 7 values for the gain setting (See PORTS.INC)

GAIN0	.EQU	00h	;	FEEDBACK	Unity gain
GAIN1	.EQU	08h	;	FDBK R201	Gain = 2
GAIN2	.EQU	10h	;	FDBK R204	Gain = 4
GAIN3	.EQU	18h	;	FDBK R205	Gain = 8
GAIN4	.EQU	20h	;	FDBK R206	Gain = 16
GAIN5	.EQU	28h	;	FDBK R207	Gain = 32
GAIN6	.EQU	30h	;	FDBK R208	Gain = 64

For FSKP1.OBJ and FSKISIP1.OBJ, the required change is in the third line:

```
: 182030001180D00140256002E702FE801180C800CE37CE20D0010020CB
```

The byte that needs changing is the one (25) marked in **bold/underlined**. Use the following table:

Gain	Value
GAIN0	05
GAIN1	0D
GAIN2	15
GAIN3	1D
GAIN4	25 (default)
GAIN5	2D
GAIN6	35

For FSKP2.OBJ and FSKISIP2.OBJ, the required change is in the third line:

```
: 182030001180D00140276002E702FE801180C800CE37CE20D0010020C9
```

The byte that needs changing is the one (27) marked in **bold/underlined**. Use the following table:

Gain	Value
GAIN0	07
GAIN1	0F
GAIN2	17
GAIN3	1F
GAIN4	27 (default)
GAIN5	2F
GAIN6	37

PKT modems

Set TNC to 1200 bps!

PKTP1.OBJ - Radio Port 1, gain 16

PKTP2.OBJ - Radio Port 2, gain 16

To assemble, use the command “asm pkt.asm -dRn -dGn”

where Rn is R1 or R2 for radio ports 1 or 2 and

where Gn is one of G0, G1, G2, G3, G4, G5, or G6 to set the gain

Pressing ‘r’ or ‘R’ on the terminal or sending an ‘r’ or ‘R’ to the modem on the DSP-93 serial port will terminate the modem program and return control to the DSP-93 Monitor.

This is a 1200 bps full-duplex standard packet modem (Bell 202)

LED213 is DCD

LED214 is PTT

LED215 is ~DCD

LED216 is level indicator

LED217 is duty cycle

LED218 is power

Audio from the receiver is digitized and band-pass filtered with a 48-tap FIR filter. The band-pass filter output drives a delay line discriminator, which is then low-pass filtered with a 32 tap FIR and sliced to recover the received data stream. This stream is output on pin 17 of the DSP-93’s TNC header.

LED 215 is slaved to DCD (low = true). Detection of a 0 bit starts a 50 ms counter for DCD. LED 216 lights on incoming positive signal peaks => 75% of the desired signal level (see tuning below).

Incoming TX data is read from pin 19 of the DSP-93’s TNC header. This data stream drives a dual-frequency VCO ramp; a 1 bit runs the ramp at 2200 cycles/sec, and a 0 bit drives the ramp at 1200 cycles/sec. The ramp output indexes into a sine wave look-up table to create the AFSK output.

LED 217 is driven by the code’s duty cycle. However, you have to look at U215 pin 1 to see it; the buffer driving LED 217 is too slow to follow the action. This code runs in less than 40% of a sample period; there is plenty of time to add bells and whistles if you want to try your hand at changing the DSP code. Go for it!

The Assembly Manual shows the interconnection cable between the DSP-93 and a TNC-2 clone. It is recommended that you use a shielded cable, with the shield tied to pin 15 at each header. Note that several local jumpers (and traces on the bottom of the board) are used on the TNC modem disconnect header. Pin 6 is connected to pin 10 with a PC trace. Only five connections are made at modem disconnect on the DSP-93. **DO NOT MAKE ANY CONNECTIONS OTHER THAN THOSE SHOWN.**

The Assembly Manual shows the pins on the connector for Radio Ports 1 and 2. You should make up a cable that connects the DSP-93 Radio Port to your radio. For 1200 bps AFSK packet, you may connect the DSP-93 TD Audio to the mic or auxiliary input of the radio, the DSP-93 RD Audio to the speaker or auxiliary output of the radio, and the DSP-93 PTT to the PTT input of the radio.

To set the modem up for receive, tune in traffic on your local digipeater and crank up the receiver’s volume control and/or adjust R215 (use R215 for radio port 1; R216 for radio port 2) until LED 215 (DCD) turns off cleanly and LED 216 glows steadily at about 75% of LED 217’s brightness. You can double check this level with your scope by looking at pin 26 of the TLC32044, U208. A test point TP 1 is provided on the production release boards. Here you will see a ~3 V audio signal just going into limiting.

The TX output audio level is set by first running R214 (use R214 for radio port 1; R213 for radio port 2) down to the bottom, and slowly cranking it up until the transmitter output, monitored on another receiver, sounds about as loud as a strong digipeater. In the case of a Icom IC-275H, it wants about 50 mV p-p (unloaded) at the microphone input. NOTE that this level is much lower than when running FSK into the varactor input!!! If you have access to a deviation meter, the deviation should be about 2.8 kHz on the high (about 2200 Hz) tone. More deviation will not help and may make your signal harder to copy.

This code also attempts to lock out the PTT signal if the TNC is turned off. However, it may not work with every TNC ... beware.

How to connect the DSP-93 to your Radio

A general interface cable from the DSP-93 Radio

Ports to the radio

In order to have the most operational flexibility using all the DSP-93 modes, construct a mini-DIN cable that connects to your DSP-93 radio port so that the cable lines from pins 5 (TD audio), 8 (RD audio), and 3 (aux in) each splice into its own short audio cable that terminates in RCA plugs. The TD and RD lines have male RCA plugs and are connected to an RCA stereo audio switch so you can switch between your PSK/AFSK and FSK in/out connectors on rig. The aux line should have an in-line female RCA connector so it can safely flop around without shorting to anything, and can be easily connected to a standard RCA audio cable for use with other DSP functions, such as the scope or signal generator. Another 4 line shielded cable that will go to the mic connector is spliced to this DSP cable at this same junction.

If you will not be using one of your DSP-93 radio ports for an HF radio, you could use one port for PSK/AFSK and the other for FSK, to simplify your wiring. This would also permit fully automated operation on both PSK and FSK as no stereo switch will be needed to change modes.

Use heat-shrink tubes over each spliced wire so that the spliced wires are well insulated from each other. Once all the wires are spliced, bundle them all together so they are neatly side by side with all their shields lying together, pointing 90 degrees from the bundled cables. Secure all these cables together with a self-locking wire-wrap zip-tie just beyond their exposed outer shields, where all the spliced cables lie together and the cable outer coverings are uncut. Then twist all these shields together and solder them so they are electrically and mechanically one common thick shield, sticking up from the bundled cables. Now squeeze the spliced wires tightly together with 2 or 3 snug wraps of thin vinyl electrical tape.

Collect the shield from the mini-DIN cable and twist it to make it into a thick wire and tin it. Wrap the taped splices with aluminum foil, overlapping the shielded cables on both ends onto the uncut cable ends. Then wrap solid bare tinned wire around one cable shield end, then around the foil, and then onto the other cable shield end. Solder this connecting ground wire to both shield ends and press this wire and shielding snuggle against the foil. Wrap another layer of foil over these shields and connecting wire,

overlapping 3/8 to 1/2 inch onto the uncut cables at both ends. Now tightly wrap a couple of layers of vinyl tape over this foil shielding, overlapping the foil at both ends onto the cables' outer jackets, and secure the tape end and cables at the end where all the bundled cables are secured together with another self-locking wire-wrap zip-tie. The first zip-tie should be taped over, so only the last zip-tie is visible. The resulting splice will be mechanically and electrically solid, RF tight, and look good.

IC-275/IC-475

MODIFICATION FOR SATELLITE PACKET OPERATION AND INTERFACE TO THE DSP-93

Roy — W0SL

Here is the way I cabled out the IC-475 & IC-275 rigs for 1200 bps and 9600 bps. The AQS and ACC are the sockets on the rear of the sets. BE CAREFUL OF AQS PIN 13 AND ACC(1) PIN 7. They carry 13.8 volts and can damage things if accidentally shorted to other pins! I cut them off on the solder side of my cable plugs.

By the way it will be necessary to disable the beep tone that occurs when you depress a key on the IC-475. The beep tone is sent through the speaker system and will interfere with the 1200 bps data signal otherwise. The beep tone is disabled by rotating R348 (Beep Sound Level Adjustment) counter clockwise. See Section 9, p42 of the users instruction manual for a photo.

In my IC-475, I have also changed out the FL4 (Murata CFW455-E) for a wider filter. The CFW455-E is a +/- 7.5kHz (15kHz) filter. I first tried using a CFW455-D, a +/- 10.0kHz (20kHz) filter with a definitely noticeable and welcome improvement. I then changed out this filter for a SFH455-D Gaussian shape filter designed for data reception. There seems to be a further small improvement with this filter but not such that I can place numbers on it. In addition the S-Meter must be recalibrated if you want it to read correctly with this last filter. It reads low. I think the CFW455-D is the way to go and still have the S-Meter behave.

CABLE PINOUTS — DSP-93 TO IC-475 & IC-275 — FOR 9600 BPS OPERATION

FUNCTION	DSP-93 RADIO PORT	IC-475 AQS	IC-275 AQS
TX AUDIO	5	-	2 ##
GROUND	6	9	-
	6	-	1
PTT	2	-	7
RCV AUDIO	8	5 #	-

Existing shielded lead to AQS socket pin 5 is re-terminated inside IC-475 to IC6 pin 9 through 5 to 10 mfd non-polarized capacitor. This lead is labeled AQAO on plug P13 on IC-475 schematic and can be removed easily from plug housing by CAREFULLY, slightly lifting plastic retaining tab on the side of P13. IC6 pin 9 is available on a bare wire between P13 and IC6 (they are about 1-1/2 inch apart). It comes out on the component side of the board, goes about 1/2 inch and goes back in the board. It is easier to solder the capacitor to this bare wire than the IC itself and much more desirable I think. The other capacitor lead is slipped into the female P13 sleeve just removed from P13. Nothing is cut! The bottom of the rig is removed to get access to P13 and IC6.

Transmit audio can be input on AQS socket pin 2 without mods. It goes to P12 on lead AQTN and drives Q33 through trim pot R152. Q33 provides plenty of gain to modulate the rig and doesn't seem to distort the transmit audio. You can adjust the transmit gain either in the modem or by using R152. I use R152 because I use the modem to drive both the IC-275 on the satellites and the IC-475 on local 9600bps packet. That way I can independently set the transmit audio level for both rigs and switch it between them.

DIN PLUG PIN LOCATIONS AS SEEN FROM BACK OF PLUG

DSP-93 RADIO PORT	IC-475/275 AQS PORT
8 7 6	X X 2 1
5 4 3	X 7 X 5
2 1	X X X 9
	X

CABLE PINOUTS — DSP-93 TO IC-475 & IC-275 — FOR 1200 BPS OPERATION

FUNCTION	DSP-93 RADIO PORT	IC-475 ACC(1)	IC-275 ACC(1)
UP/DOWN	4	1 *	-
GROUND	6	2	-
	6	-	2
PTT	2	-	3
TX AUDIO	5	-	4
RCV AUDIO	8	5	-

DIN PLUG PIN LOCATIONS AS SEEN FROM BACK OF PLUG

DSP-93 RADIO PORT	IC-475/275 ACC(1) PORT
8 7 6	X X
5 4 3	3 X 1
2 1	5 4
	2

* Wire added from mic connector pin 3 to ACC(1) pin 1 in IC-475. The mic connector pin 3 is available on a small circuit board immediately behind the mic socket. The socket is wired to this board via a small ribbon cable. ACC(1) pin 1 is not connected to anything, so the new wire must be soldered directly to pin 1 on the back of ACC(1). Fortunately it is on the side of the socket nearest the side of the rig and accessible with a bit of care. This wire is necessary only if you don't want to access it through the mic socket. I like all my cables on the rear of the set. Also, this wire is needed only if you are using the PSK modem UP/DOWN pulsing capability to keep your rig tuned into the downlink signals.

Users of units from the Decembr 1994 production and prior, see the "Note to users of Icom transceivers" in the DSP-93 Assembly Manual.

IC-970

MODIFICATION FOR SATELLITE PACKET OPERATION AND INTERFACE TO THE DSP-93

Ron — W5RKN

Here is the way I cabled out the IC-970 rig for 1200 bps and 9600 bps. The DATA and ACC(1) are the sockets on the rear of the set. BE CAREFUL OF DATA PIN 13 AND ACC(1) PIN 7. They carry 13.8 volts and can damage things if accidentally shorted to other pins!

By the way it will be necessary to disable the beep tone that occurs when you depress a key on the IC-970. The beep tone is sent through the speaker system and will interfere with the 1200 bps data signal otherwise. The beep tone is disabled by turning power OFF; then while pushing [FUNCTION] and [.] (MHz), turn power ON. See Section 15, p41 of the users instruction manual.

In my IC-970, I have also changed out FL13 and FL14 15kHz filters in the MAIN and SUB bands for wider filters. I changed out these filters for Murata SFH455-D 20 kHz Gaussian shape filters designed for data reception. The S-Meter must be recalibrated if you want it to read correctly with this filter. It reads low.

Icom IC-970 9600 bps FSK Mods

The following describes mods for 9600 bps FSK for an Icom IC-970. The mods require NO soldering or cutting on the IC-970, and are thus easily reversible.

Icom suggested mods for 9600 were:

- TX mod input at collector of Q59 on the main unit.
- RX Main at DET output in J29 (main unit).
- RX Sub at TSAOS output in J9 (main unit).

I made slight mods to Icom's mods:

- TX mod input at collector of Q59 on the main unit. This is available at the top of R60 with a micro clip. Ground is at the top of R51 with a micro clip. These resistors are about 3" back from the front of the Main unit and 2" from the right. The micro clips were attached to a length of RG-174 mini coax. No mods to board! The leads of the resistors appear to be painted. Scrape the paint off with a small, sharp knife (a small mod).
- RX Main output at TSAOM at J29 (main unit). Available on P85 (tone squelch option socket) under the top cover.
- RX Sub output at TSAOS at J9 (main unit). Available on P87 (tone squelch option socket) under the top cover.

Two lengths of RG-174 mini coax were connected to a 6-pin headers with the center conductor on pin 3 and ground on pin 4. The headers were covered with heat-shrink tubing. The headers plug into P85 (MAIN) and P87 (SUB).

The three coax cables were routed to the back-right of the IC-970 case. The two TVJ hole covers were removed and replaced by two dual RCA jack boards. These boards were attached with a small bolt through the hole for the TVJ screws. The coax was attached to three of these jacks.

I cabled from the IC-970 DATA connector for 1200 bps and from the IC-970 ACC(1) connector for 9600 bps operation.

CABLE PINOUTS — DSP-93 TO IC-970 — FOR 9600 BPS OPERATION

FUNCTION	DSP-93 RADIO PORT	IC-970 ACC(1)
TX AUDIO	5	TX mod input
GROUND	6	2
PTT	2	3
RCV AUDIO	8	RX output

(See note below)

- TX mod input at collector of Q59 on the main unit. This is available at the top of R60 with a micro clip. Ground is at the top of R51 with a micro clip. These resistors are about 3" back from the front of the Main unit and 2" from the right. The micro clips were attached to a length of RG-174 mini coax. No mods to board! The leads of the resistors appear to be painted. Scrape the paint off with a small, sharp knife (a small mod).
- RX Main output at TSAOM (MAIN) at J29 (main unit). Available on P85 (tone squelch option socket) under the top cover.
- RX Sub output at TSAOS (SUB) at J9 (main unit). Available on P87 (tone squelch option socket) under the top cover.

Note: An external switch must be provided to choose between MAIN or SUB band audio from the IC-970 depending on the choice of simplex (MAIN) or cross-band (SUB) operation.

CABLE PINOUTS — DSP-93 TO IC-970

FOR 1200 BPS OPERATION

FUNCTION	DSP-93 RADIO PORT	IC-970 DATA
UP/DOWN	1	8 #
	7 (through 470 ohms)	8 #
GROUND	6	2
	6	9
PTT	2	7
TX AUDIO	5	1
RCV AUDIO	8	5
	(for MAIN band)	10
	8	(for SUB band)
		(See note below)

Users of units from the Decembr 1994 production and prior, see the "Note to users of Icom transceivers" in the DSP-93 Assembly Manual.

Note: An external switch must be provided to choose between MAIN of SUB band audio from the IC-970 depending on the choice of simplex (MAIN) or cross-band (SUB) operation.

DIN PLUG PIN LOCATIONS AS SEEN FROM BACK OF PLUG

DSP-93 RADIO PORT	IC-970 ACC(1) PORT
8 7 6	7 6
5 4 3	3 8 1
2 1	5 4
	2

DIN PLUG PIN LOCATIONS AS SEEN FROM BACK OF PLUG

DSP-93 RADIO PORT	IC-970 DATA PORT
8 7 6	4 3 2 1
5 4 3	8 7 6 5
2 1	12 11 10 9
	13

KENWOOD TS-790A

MODIFICATION FOR SATELLITE PACKET OPERATION AND INTERFACE TO THE DSP-93 Mark — KC4EBR

Here is the way I cabled out the TS-790A rig for 1200 bps and 9600 bps. I chose to add an additional 5 pin DIN socket to the rear of the radio in order to make a dedicated port for interfacing the rig for 9600 bps FSK and 1200 bps AFSK operation and to use the microphone connector for 1200 bps PSK operation. Keep in mind the user could easily use the microphone connector for 1200 AFSK as well. You make the choice. How good or how bad your radio looks when you are finished is entirely up to you. This is how I did my hookups, and I have been quite satisfied with the results. Be careful, and check out everything before you do anything.

By the way it will be necessary to turn down the volume of the beep tone that occurs when you depress the up or down frequency lines on the microphone connector of the TS-790A. The beep tone is obnoxious and will pester you to death otherwise during 1200 PSK operation. The beep tone volume is decreased by adjusting VR5 on the bottom of the rig (you will have to remove the bottom panel to do the mods anyhow). See p65 of the users instruction manual for more details and a diagram.

For the Kenwood TS-790A, it appears that the factory installed filters are quite acceptable for reception of the 9600 bps FSK satellites. Reception filters were not changed or modified in my rig.

MODS FOR 9600 BPS FSK

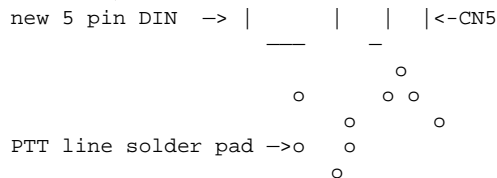
The installation of the 5 pin DIN socket to the rear panel of the TS-790A is not a trivial nor an extremely difficult task. First, I removed the bottom half (gold-colored) of the rear panel completely from the rig. Remove the covers and screws as necessary to have the bottom half of the panel totally removed. Next, I cut a hole to fit a 5 pin DIN socket (from Radio Shack) and used two small bolts to hold the new socket securely to the panel. Placement is very critical as the spacing is quite tight. I found that the socket will fit and not touch other components if it is installed so that the 5 PIN DIN socket almost touches ACC3. I had to install mine at about a 45 degree angle to make it fit. I had to install one bolt/nut in the little ventilation slots on the rear panel. I used a file and heavy metal clippers to remove the necessary metal.

While we are hacking on your new \$2000 radio, we might as well go ahead and put in a micro SPDT toggle switch on the rear panel as well. I installed my switch next to ACC4, right in the middle of the little ventilation slots. This switch will be used to select MAIN or SUB band receive audio from the TS-790A to the DSP-93.

After installation of the 5 pin DIN socket connector and the micro SPDT switch, I wired up the lines necessary for 9600 bps operation. Five lines were used in my hookup: PTT, TX audio, SUB BAND Rx audio, MAIN BAND Rx audio, and ground. I replaced the real panel prior to the hookup of the wires to the new 5 pin DIN socket.

1) **PTT LINE** - I connected a short tiny wire from a small solder pad on the PCB that is connected to pin 9 of the factory installed 13 pin DIN connector, to pin 5 of the newly installed 5 pin DIN socket. Basically, I "snatched" the PTT line from the factory 13 pin DIN socket (see your TS-790A users manual for pinouts of this jack.) You can verify the correct solder pad by use of a continuity meter across the solder pad and pin 9 of the 13 pin DIN.

My solder pads look something like this:
(rear panel of radio, bottom side up, bottom panel removed)



Each "o" indicates a solder pad. CHECK FOR CONTINUITY TO VERIFY YOU HAVE THE RIGHT SOLDER PAD!! The correct solder pad is connected to pin 9 of the factory installed 13 pin DIN connector!! The absolute spacing between solder pads and the above diagram are not exact or in correct proportions, but I think this will help you find it quicker. Connect this solder pad to pin 5 of the 5 pin DIN socket.

2) **TX AUDIO LINE** - feeding the transmit audio from the DSP-93 into the TS-790A radio is accomplished by feeding the audio from the DSP-93 through a 4.7K ohm resistor in series to the banded end of D81 on the IF UNIT. You can find D81 in the upper left corner of the PCB, near crystal X2.

I carefully soldered a 4.7K ohm resistor with short leads to the solder pad at D81, near the orange-banded end. The other end of the 4.7K resistor was connected to the center conductor of a piece of RG-174/U coax. The shield of the minicoax was carefully soldered to the corner of the can portion of nearby L62. The cable was routed over the long aluminum heat sink to keep cable lengths short. (The cable could be routed around the end of the heat sink, but I find that the bottom cover does not contact the minicoax.) The other ends of the minicoax were connected to pin 2 (center conductor) and pin 3 (shield/ground) of the 5 pin DIN socket.

For the TAPR 9600 bps modem, I used a 1K ohm resistor in series. For the TAPR/AMSAT DSP-93, I seem to find the 4.7K resistor works better on the uplinks to KO-23 and KO-25. Your mileage may vary.....experiment to determine your best value.

3) **SUB BAND Rx audio** - SUB band receive audio is taken from pin 9 of IC1 on the IF UNIT. This is the corner pin of an MC3357P chip located nearest to L11 in my unit. I carefully soldered the center conductor of a short piece of RG-174/U minicoax to pin 9 of IC1, and the shield to a nearby solder pad that is ground found between the silkscreen labels for L11 and C85. The other end of the (center conductor) minicoax was connected to one outside contact of the tiny SPDT microswitch attached to the rear panel of the radio. The shield/ground of the coax near the switch will be tied to two other shields; one from the main band minicoax, and one from the minicoax used to connect the switch to 5 pin DIN socket.

-OR- If you wish ONLY to receive the SUB band audio from this new port, you may attach the center wire directly to pin 1 and the shield to pin 3 of the new 5 pin DIN socket rather than the switch. This might be the case if you are SURE you ONLY want to work cross-band full duplex (9600 bps birds, for example).

4) **MAIN BAND Rx audio** - MAIN band receive audio is taken from pin 9 of IC8 on the IF UNIT. This is the corner pin of an MC3357P chip located nearest to L55 in my unit. I carefully soldered the center conductor of a short piece of RG-174/U minicoax to pin 9 of IC8, and the shield to a

nearby solder pad that is ground found between the silkscreen labels for L55 and B2/18. The other end of the (center conductor) minicoax was connected to the other outside contact of the tiny SPDT microswitch attached to the rear panel of the radio. The shield/ground of the coax near the switch will be tied to two other shields; one from the sub band minicoax, and one from the minicoax used to connect the switch to 5 pin DIN socket.

CABLING FOR 9600 PBS AND 1200 PBS AFSK

DIN PLUG PIN LOCATIONS AS SEEN FROM BACK OF PLUG

DSP-93 RADIO PORT TS-790A NEW 5 PIN
DIN

8 7 6	2
5 4 3	4 5
2 1	1 3

CABLE PINOUTS — DSP-93 TO TS-790A FOR 9600 BPS AND 1200 AFSK OPERATION

FUNCTION	DSP-93 RADIO PORT	NEW 5-PIN DIN SOCKET
TX AUDIO	5	2 TX mod input
GROUND	6	3
PTT	2	5
RCV AUDIO	8	1 RX output (See note below)

-OR- If you wish ONLY to receive the MAIN band audio from this new port, you may attach the center wire directly to pin 1 and the shield to pin 3 of the new 5 pin DIN socket rather than the switch. This might be the case if you are SURE you ONLY want to work simplex (9600 terrestrial packet, for example).

5) TOGGLE Switch - the micro SPDT toggle switch can be used to switch between MAIN and SUB band receive audio. Attach a short piece of minicoax from the switch to the 5 pin DIN socket. Attach the center wire to the center pin of the microswitch, and the shield to the other two shields from the two receive coax runs. Connect the other center conductor end to pin 1 and the shield/ground to pin 3 of the 5 pin DIN socket.

6) GROUND - ground is provided by the shields of the RG-174/U minicoax through connections at the other ends. I used pin 3 of the new 5 pin DIN socket to tie together the shield from the coax running to the xmit injection point and the shield from the coax running to the micro switch.

CAVEATS: I had to reduce the FM mic gain on my TS-790A for voice operation. The connection of the radio to the DSP-93 made my audio "hot". A slight reduction of the FM mic gain using pot VR32 made the voice audio level sound fine again. With this hookup, I can use my MC-80 desk microphone for that rare repeater contact (or maybe FO-20?) and leave the 9600 bps cable in place.

- TX mod input - inject audio from DSP-93 through a 4.7K ohm resistor in series to the banded end of D81 on the IF unit. You can see D81 near Q73 in your TS-790A schematics.
- RX MAIN output is from pin 9 of IC8
- RX SUB output is from pin 9 of IC1

Note: An external switch must be provided to choose between MAIN or SUB band audio from the TS-790A for the 9600 FSK and 1200 AFSK modes depending on the choice of simplex (MAIN) or cross-band (SUB) operation. I put a small SPDT micro switch on the rear panel for this purpose. This switch is very beneficial and worth installing while you are making the other mods. I have mine so DOWN provides audio from the SUB band discriminator and UP provides audio from the MAIN band discriminator. (Be a nonconformist and reverse them...it works either way.) Keep in mind that audio from this source is not affected by squelch settings and requires the use of code that supports DCD detection for half-duplex operation. Otherwise your radio may rudely transmit while it is receiving.

CABLING FOR 1200 BPS PSK (AND 1200 BPS

AFSK IF YOU WISH)

I cabled from the TS-790A microphone connector for 1200 bps PSK operation. (I have problems printing the 1200 bps PSK birds using the factory 13 pin DIN connector for this mode - this may be unique to my radio, who knows.)

PLUG PIN LOCATIONS AS SEEN FROM BACK OF PLUG

DSP-93 RADIO PORT	TS-790A MICROPHONE PORT
8 7 6	1 7
5 4 3	2 8 6
2 1	3 5
	4

CABLE PINOUTS — DSP-93 TO TS-790A FOR 1200 BPS PSK OPERATION

FUNCTION	DSP-93 RADIO PORT	TS-790A MIC
FREQ DOWN	1	3
FREQ UP	7	4
GROUND	6	7
	6	8
PTT	2	2
TX AUDIO	5	1
RCV AUDIO	8	6
	(supplies both MAIN band and SUB band audio; the squelches determine which audio is fed to DSP-93) (see note below)	

Note: An external switch DOES NOT need to be provided to choose between MAIN or SUB band audio from the TS-790A depending on the choice of simplex (MAIN) or cross-band (SUB) operation. In fact, users may want to use this microphone connector for both 1200 bps AFSK and 1200 bps PSK modes for this very reason.

YAESU FT-736R

MODIFICATION FOR SATELLITE PACKET OPERATION AND INTERFACE TO THE DSP-93

Howard — W6SHP

Operation at 1200 baud PSK is very straight forward. Check the DSP-93 build document for the pin-out of the mini-DIN connector as they are not obvious.

1. Connect the DSP-93's mini-DIN cable line from pin 5 (TD audio) to the ring, and DSP-93 pin 8 (RD audio) to the tip of a mini stereo plug. This plugs into the jack marked "data in/out", on the rear panel of the 736. Use RCA connectors on the DSP-93's mini-DIN cable and the line from the 736's mini-stereo plug if you want to be able to switch the DSP-93's cable to other plugs, such as for FSK operation.
2. Connect the cable line from pin 2 (PTT) to mic connector pin 6. Cable lines from DSP-93 pin 7 (freq. up) goes to mic connector pin 1, and DSP-93 pin 1 (freq. down) goes to mic connector pin 3. Cable line for DSP-93 pin 6 (ground) goes to mic connector pin 7. Pin numbers are marked on the mic connector.
3. Disconnect your microphone and connect the DSP-93's mic connector, and connect your TD and RD lines to the 736 directly or through an RCA stereo switch, if used.

PTT is activated when it is grounded, and the mic-click frequency up/down is activated when +5 volts is applied. Most rigs activate the up/down lines by grounding, so DSP-93 software that uses this function needs to be modified so +5 volts, and not ground, is supplied for frequency control. See the DSP-93 diskettes for these 736 modified files.

9600 baud operation will require minor surgery that can be easily done if you take your time and double check everything before you proceed.

1. Unplug your AC line and remove the handle, top and bottom covers. Be careful when you remove the top cover to not break the wire that runs from the top cover mounted speaker to connector J16. You can easily disconnect the speaker at this connector.
2. Decide how you want your FSK in/out cables to connect to the DSP-93. Some just stick the FSK interface cables out through any convenient opening and let it hang with a connector

attached. I preferred to drill a hole in the rear panel so I could mount another mini-stereo jack near the PSK jack. If you do this, be sure to position the 736 so drill shavings will fall out of the rig, and use masking tape to secure rags over the 736 innards to catch any metal shaving that may fly off in unexpected directions. Place a scrap of wood inside, behind where the drill will come out, so the drill will hit wood and not the 736 when it comes through the panel. Drill at a slower than normal speed, and you will have no problems. Do not be in a hurry.

3. The Rx Unit is the vertical module on the left. Locate R91. It is on end and near 2 glass diodes and the square IF can TO09 (about 1" (2.5cm) from the top and 3-3/4" (9.5cm) from the rear). Carefully scrape the paint off the wire on the resistor's upper end and tin it.
4. Solder the center of a length of mini-coax (RG174/U) to this tinned resistor wire, and it's shield to nearby IF can TO09. If you do not want to solder the shield to the IF can, you could use the nearby PCB mounting screw. A solder lug on the coax shield can be easily secured under this screw. Solder the other end to the connector you installed on the back of the 736. If you use a mini-stereo jack, solder the center conductor to the tip terminal.
5. Locate C82 which is next to rectangular CD01, between R91 and R86. Rock C82 back and forth until it breaks off. Removing this audio shaping capacitor will improve your throughput and audio fidelity by making the audio response flatter.
6. The Tx Unit is the module flat on the left (not the one tucked down the side vertically). Locate R32, just to the left of the rectangular shielded enclosure (about 2 1/4" (6 cm) from the front metal plate, 2" (5 cm) from the side). Carefully scrape the paint off the wire on the resistor's upper end and tin it.
7. Solder the center of another length of mini-coax (RG174/U) to this tinned resistor wire, and it's shield to nearby rectangular shielded enclosure. Solder the other end to the connector you installed on the back of the 736. If you use a mini-stereo jack, solder the center conductor to the ring terminal. You can route this cable through the hole in the metal frame by JO7 on the receiver module (near your FSK rx tap), so the cable will not be pinched with the covers on.

Adjusting Deviation

The best way to adjust the deviation of your FSK TD signal from the DSP-93 is with an FM deviation meter. Adjust your FSK deviation by loading an FSK program to your DSP-93. Load your terminal program and set your TNC to UNPROTO so you can send unconnected packets. Press any key and you will see bursts of data being transmitted. DSP-93's R214 will adjust Radio #1, and R213 will adjust Radio #2. Turn the adjustment screw clockwise to increase deviation and counter-clockwise to reduce it. Adjust your deviation for 3 kHz.

If you cannot get an FM deviation meter, you can make an acceptably close adjustment with an oscilloscope. Screw off the outer cover of your FSK's mini-stereo plug and slide it back onto the cable. Attach scope probes to the plug's ring terminal (TD) and ground. Insert the plug into your FT-736's FSK mini-stereo jack. Set up your DSP-93 and terminal program as instructed above and begin sending unproto packets by pressing any key. Adjust R214 or R213 for a setting that displays 800 mV peak to peak on your scope.

As FSK drives your varactor directly, without any amplification within your FT-736, all other modes will require less drive from the DSP-93. Therefore you may wish to use one radio port for FSK and another radio port for other modes.

Receiver IF Filter Options

The standard IF filter that comes with the FT-736 can be used with satisfactory results. The 6 dB IF bandwidth for "FM-N" is 8 kHz and for "FM" it is 15 kHz. Because of Doppler shift during a satellite pass, and the improved wide band audio demodulation needed for 9600 baud FSK, it is necessary to use "FM" and make many tuning adjustments during a pass.

Automatic Doppler tuning adjustments are required to get optimal downlink throughput, unless you are willing to tune continuously to keep the deviation needle centered. Uplink signal tuning is not as critical as the satellites' uplink receivers have wide front ends. Acceptable uplinks can be made with the uplink tuned to the center of the uplink bandpass. But uploads near the horizons will be improved with at least 3 upload frequency adjustments for the beginning, middle, and end of each pass.

There are optional filters available that give a wider downlink bandwidth and flatter bandpass frequency response. The original filters were designed for optimizing audio, not data. Digital signals are less tolerant on nonlinear responses and requires a wider audio frequency bandwidth. With a wider filter, manual downlink tuning is not as critical. I have improved my throughput by using automatic Doppler tuning with my Trakbox. Other Doppler tuning devices are advertised in the amateur satellite journals. The PSK software for the DSP-93 tunes only the downlink signal.

If you want to optimize your FT-736R for data communications, optional 20 kHz replacement filters are available from Yaesu:

PCB component-function	Device	Yaesu Part #
XF01 - front end crystal filter	13M-20A	H1102126
CF01 - FM ceramic IF filter	CWF455D	H3900203
CF01 - FM ceramic IF filter	LFH20S	H3900205

The two IF filter are similar, but from different manufactures. Yaesu assured me this would not compromise cw, ssb and voice FM operation as the other filters are selected for these modes.

Credits

My 9600 baud modifications are based on a bulletin by James Miller, G3RUH. I expanded on this information based on messages from other users and from my own experimentation.

Errata

Although my manual was correct, there were errors reported in earlier manuals.

1. Pin-outs for the CAT port was in error in early manuals and in a old Yaesu "Application Note". The correct pins are Pin 1- Ground, Pin 2- Serial Data In, Pin 3- Radio Port Busy, Pin 4-Serial Data Out, Pin 5- No Connection, and Pin 6- 13.8 volts.

Note that the pins are not numbered sequentially:



(rear view of male plug)

2. In some Yaesu manuals the data in/out jack pins are listed in reverse of what they actually are. The mini-stereo tip is the received data (RD) and the ring is transmitted data (TD).
3. I received reports that R91 has been mounted in reverse on some production runs, so that the discriminator must be tapped at pin 10 on the FM scanner board. Yaesu assured me this has never been the case. Although Pin 10, which comes directly from the discriminator, reportedly works for some, the recommended tap is on R91's side opposite the discriminator, as described above, to provide some isolation between your modem and discriminator diodes. I found that with my G3RUH modem the original 100 nf input blocking capacitor had to be replaced by a 1 uf capacitor to get adequate drive for the modem. Perhaps similar matching problems are the basis for these reports. It is not a good idea to load your discriminator diodes.