Modification of FT847 for UO-12 operation
Instructions for use of the IFD demodulator

Uplink (TX): any frequency (144-146 MHz, 430-440 MHz etc.), FSK-modulation 4800 up to 19200 kBaud,
Downlink (RX): 430-440 MHz, 38400/76800 Baud FSK (153 kBaud with wider filters (optional)).

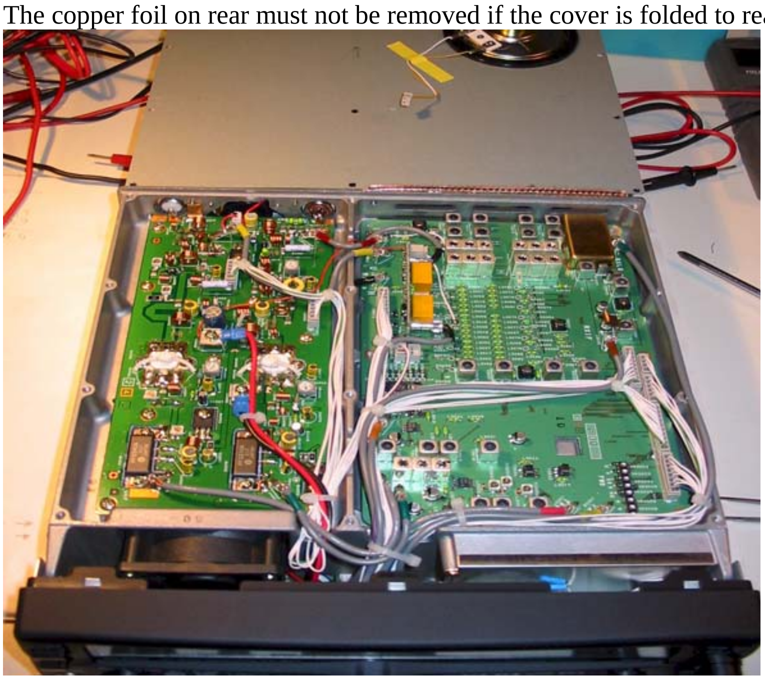
Material required:
- SYMEK IFD-B-amplifier-mixer-demodulator board option 'FT847'
- 2x30cm thin coax cable, wire, shielded audio cable and other hardware, heatshrink tube etc.

1. Transmitter (modulation) and PTT (transmitter keying):

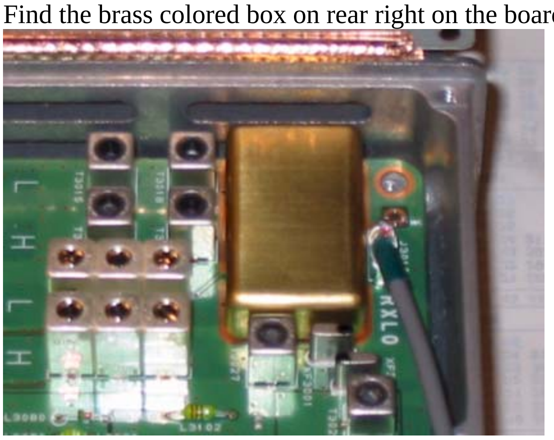
Check the manual how to operate the transmitter in 9600 Baud FSK mode and the PTT line.

3. Demodulator output:

1. Remove the handle and 2 black screws on top and on bottom. Remove 2 screws on rear. Use No. 2 Philips screwdriver.
2. Carefully pull top and bottom cover to rear and put them away.
3. Remove 12 golden screws on top to access the upper compartment. When opening, take care not to stress the loudspeaker cable. After opening the cover a bit, disconnect the speaker!
4. The copper foil on rear must not be removed if the cover is folded to rear.



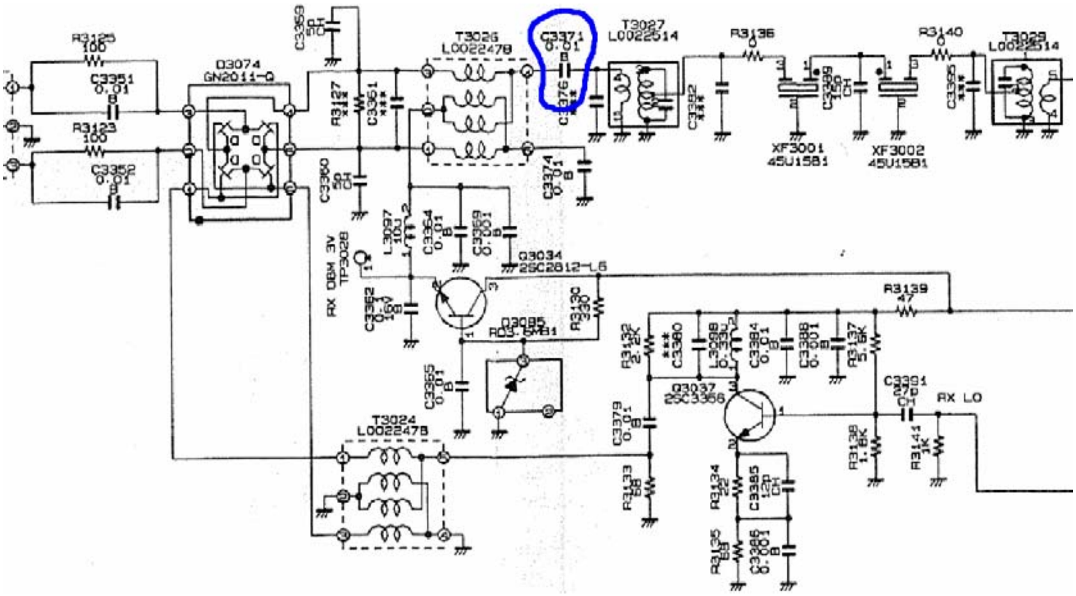
5. Now remove 6 golden screws of receiver board. Do not pinch the cables which hide the screws.
6. Find the brass colored box on rear right on the board. A coax with a green sleeve is right of it.



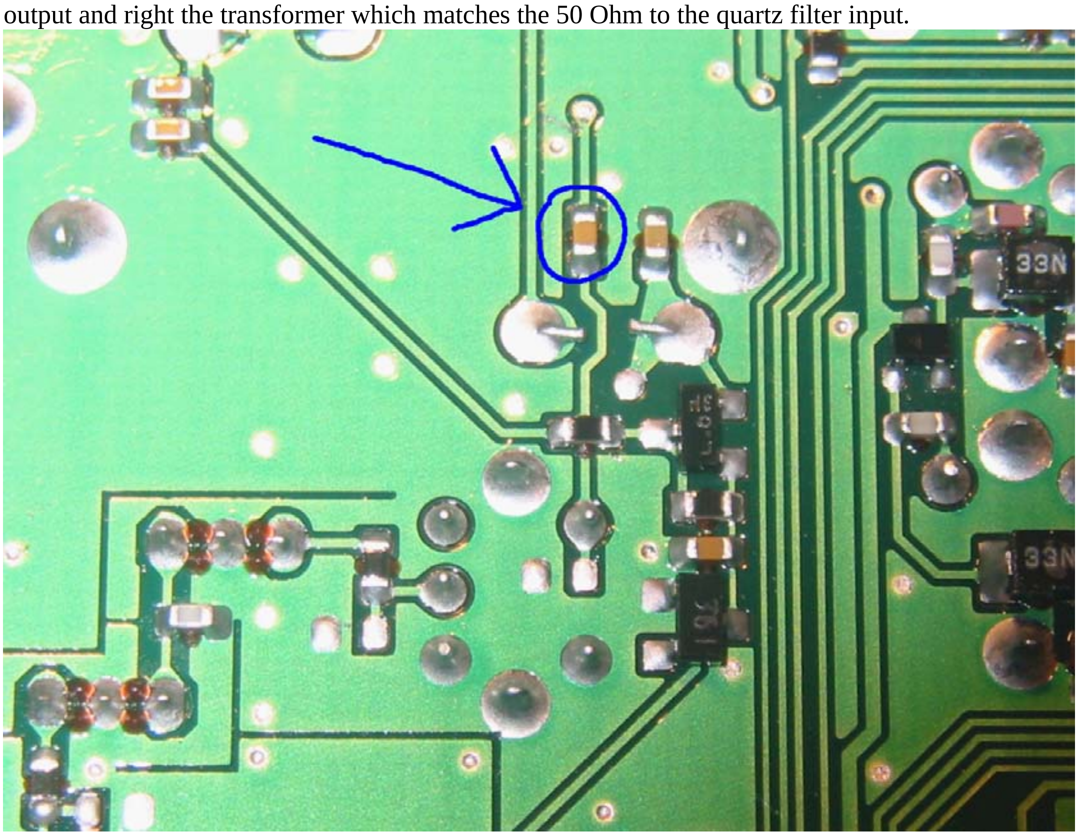
7. Now carefully fold the board to left. All cables may remain connected.
   Under the brass shielding box locate the C3371 SMD capacitor and remove it. It is glued to the board so you have to heat it and push until the glue releases the part.

The IFD has to be inserted in the 50 Ohm signal path between the balun output and the resonant transformer circuit. Remove simply the coupling capacitor C 3371 (10 nF) and connect a 50 ohm coaxial to each end of the removed capacitor.

The wire at the balun output is marked 'mixer' and goes to IFD input. The other wire marked 'filter' returns the rf from the IFD to the 50 Ohm input of the transformer and the quartz filter. Solder the shield of both cables to a ground plane nearby. Make sure not to short circuit the signals unintentionally.



Here you see the transceiver front end: left side the balanced mixer, middle the balun with its 50 Ohm output and right the transformer which matches the 50 Ohm to the quartz filter input.

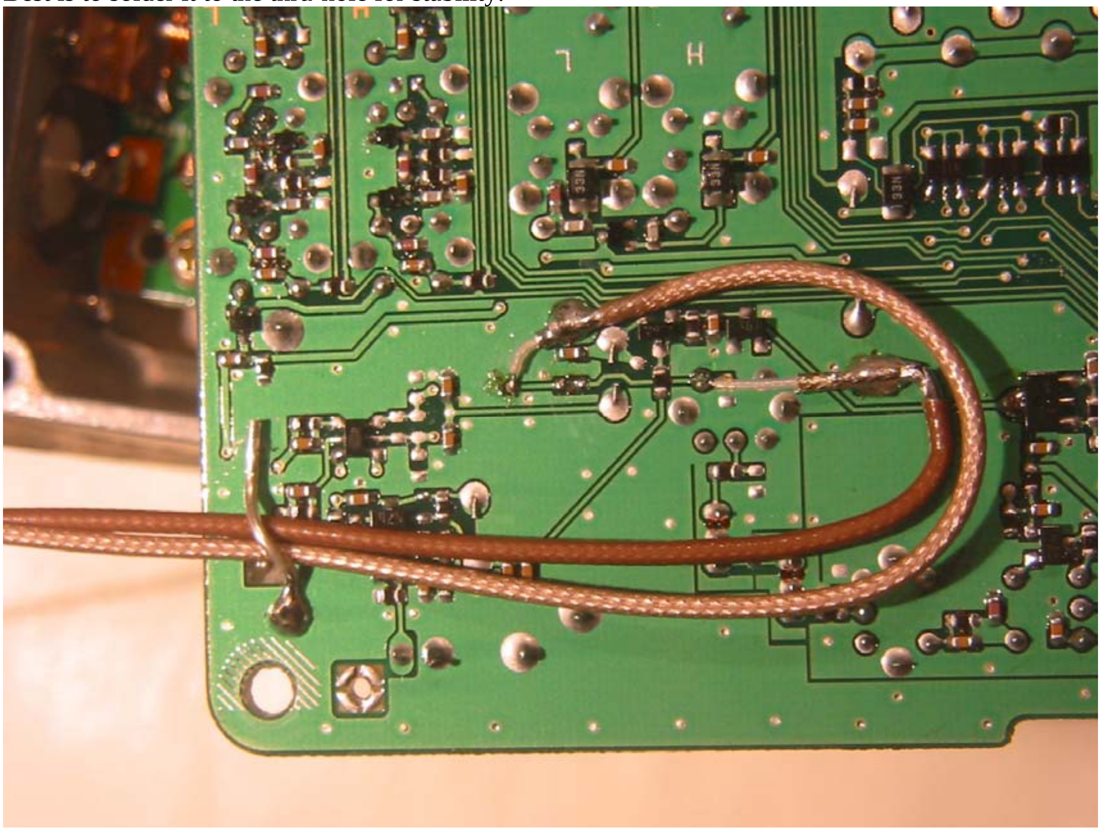


Location of the chip capacitor C3371 on the chip side of the printed circuit board

8. Prepare two coax cables: Remove 1.5 cm of the brown outer insulation. Totally solder the outer conductor with much of solder and move the excess solder to a drop at the very end of the cable. The PTFE cannot melt. Put the cable end on the table and gently press a sharp knife to the solder filled outer conductor, 5mm away from the point where the outer brown insulation ends. Turn the cable fully round while pressing the knife to get a notch in the outer conductor. Now try to bent the cable back and forth,

left and right at the point where you have nicked it. The outer conductor will break and can be pulled off easyly. Now use the knife again to cut the inner dielectric. Be carefull not to cut the inner conductor. With a wire cutter, pinch the inner insulation carefully and find the cut. Then pinch the wire cutter without cutting the wire and pull the coax to remove the inner conductor insulation. Solder the inner wire and cut the free end to 1.5 mm length.

9. It is a good idea to mark the both coax cables with color stipes to distinguish later between the "mixer" and the "filter" cable. Best is to use cables with different color insulation (light and dark brown). We always use the brighter color for "mixer" and the darker color or marking-stripe for "filter"
10. The (dark) "Filter" cable goes to the longer trace in direction to front panel, which passes under R3139 and ends on one of the 7 pads of the filter T3027 (outside of the brass box). Best is to solder it to the filter pad for stability.
11. The (bright) "Mixer" cable goes to the shorter trace (4mm) leaving C3371 in direction to the rear panel. Best is to solder it to the thru-hole for stability.

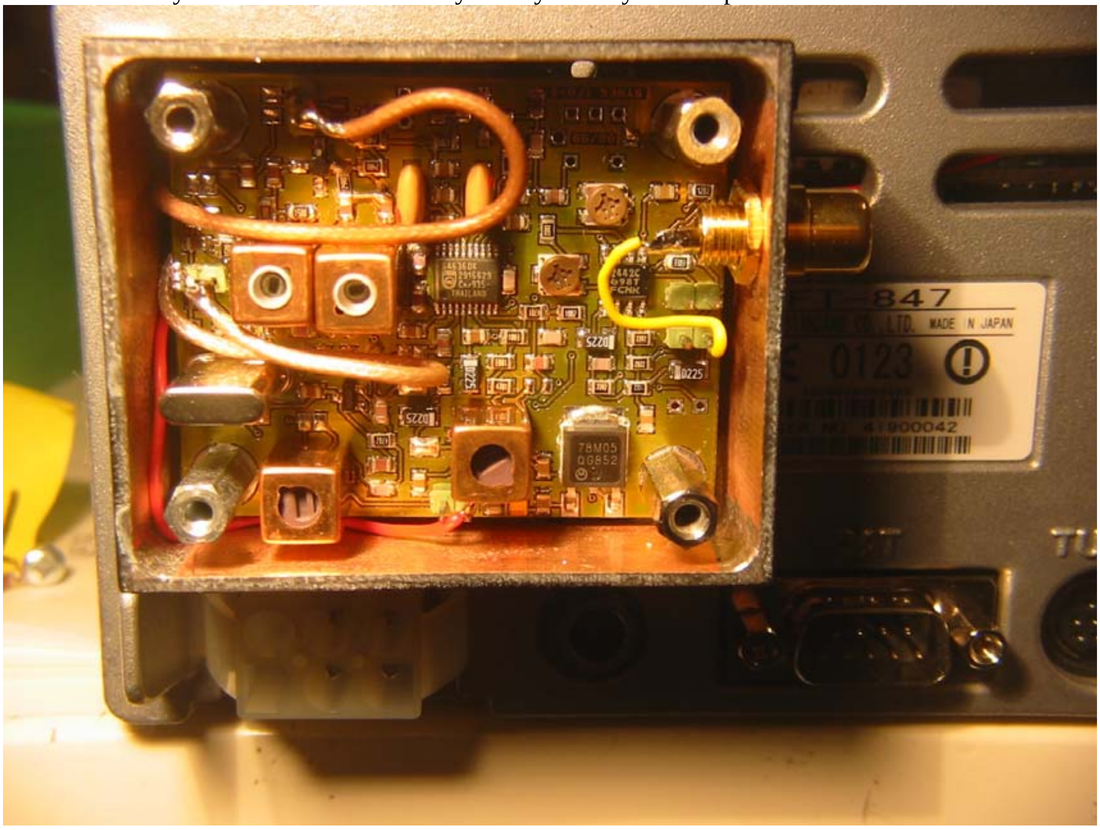


12. For soldering on the tiny pads, you need a soldering iron with a fine pointed tip. To solder the outer conductor of the cables to the ground, you should use a medium size soldering iron with a thick tip and higher temperature if possible.
13. As both cables leave the joints in direction to the front, bent them so that they can later leave the case through one of the slots in the rear panel.
14. To prevent the cables from moving or crossing under the board later, solder a bracket to the ground pad in the corner. Use a 1mm copper wire to fix the cables
15. Solder a red wire to J4005 on the PA board. There is already a red wire on this screw terminal where the thick 13.8 volt supply cable ends. It needs much heat to solder on this massive terminal!

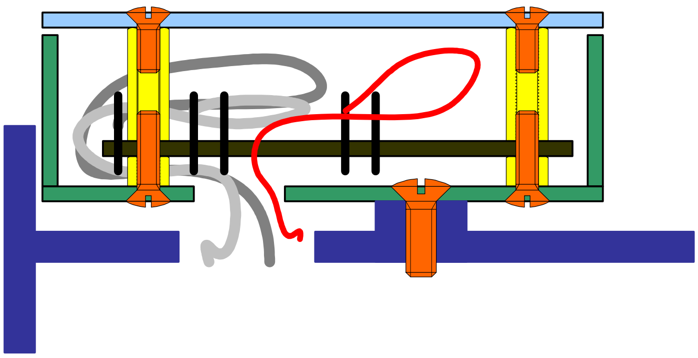
There is NO space in the transceiver case to install the IFD. Try to install it at the rear panel. If you remove the loudspeaker, it is possible to install the IFD there.

16. Feed the red cable to the lower, rightmost slot of the rear panel. Also feed both coax cables through this slot. The cables make a S bent then.
17. Slowly re-install now the receiver board while gently pulling the coax cables until the board is down in the case again. Make sure all 6 golden screws are tight and push the cables back to where they were before.
18. Close the cover now. Do not forget to connect the speaker before making all 12 golden screws tight.
19. Close the black top and bottom cover. The short screws (2x) are for bottom to front, the long ones (2x) for the handle and the rest (4x) for rear and left side.
20. The FT847 looks now exactly as before. Only three cables on the rear haven't been there before.
21. Now prepare a metal box, 62 x 50 x 22 mm inner dimensions. We use FR1.6 PCB material and solder the edges. Takes lot of time but the result is a case which fits 100%. Drill four 3.1 mm holes in tob and

bottom which align with the holes of the IFD board. Drill a 6.5 mm hole in one side for a Cynch connector (Data output). Drill a big (oval) hole in the bottom where the cables will enter the box. Instead of the Cynch connector at the box you may use any unused pin of one of the ACC connectors.



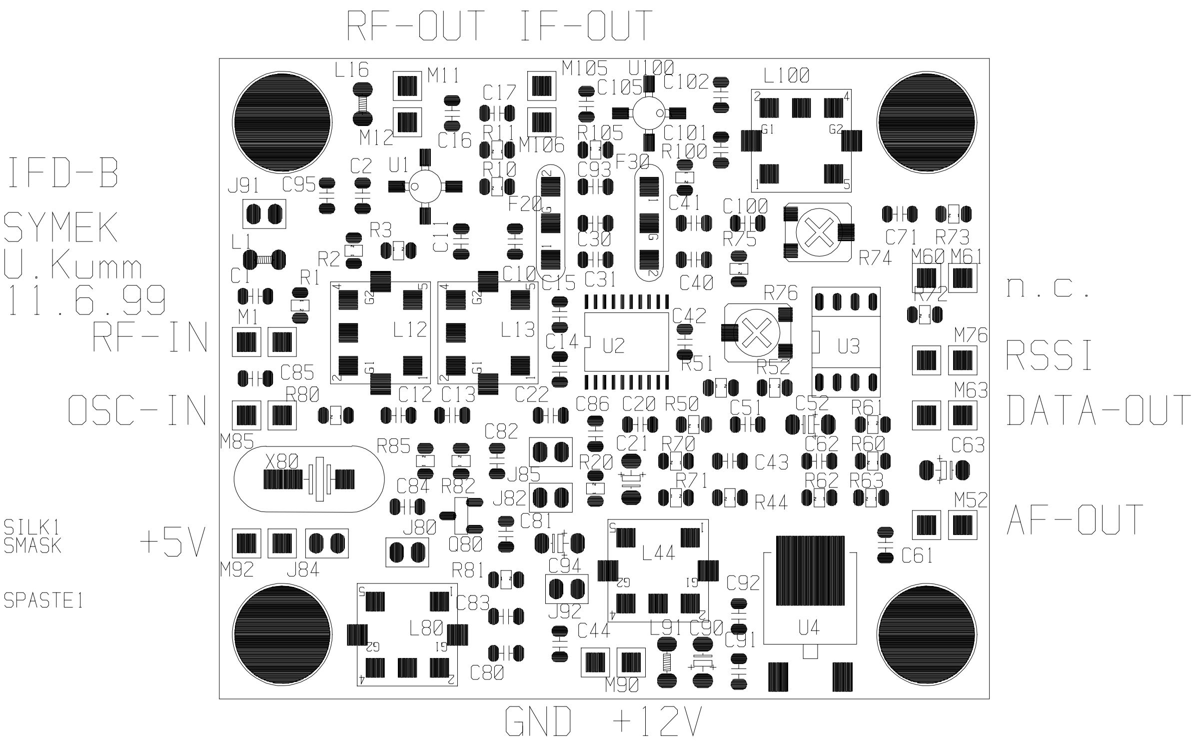
22. Use a 10 mm M3 screw in the bottom holes and install a 4mm hex nut spacer inside the box. Then install the IFD in the box and fix it with 4 15mm spacers. The cover of the box can be fixed with 4 screws which fit into these long spacers. It is necessary that the length of the spacers and the height of the case match exactly. If the spacers would be too long, there is a bad gap between case and cover.



23. The external IFD-Box can be easyly fixed to the M4 ground screw. If the box touches the "fin" of the transceiver case it cannot move or turn, even if it is fixed by a single screw only.
BE SURE TO CONNECT YOUR TRANSCEIVER TO GROUND EVEN IF THE ORIGINAL GROUND TERMINAL IS NOW OCCUPIED. INSTALL AN ALTERNATIVE GROUND CONNECTION FOR SAFETY REASONS!
24. Inside the box, solder the two coax cables to the RF IN and RF OUT. Also connect +13.5 V to the red wire. Make absolutely sure that the correct pin is used as the would be a very high current if you short circuit the supply wire.
25. Connect the Data Out to the cynch connector. – Ready.
26. Test: Check if the sensitivity of the receiver is the same as before. There should be no difference.
27. Generate a RF signal at 433 MHz, modulated with 1 kHz and up to 40 kHz FM deviation. The demodulated signal should be visible on the Cynch Data Output using an oscilloscope.

28. Congratulation! Your FT847 is now ready for wide band FSK data reception!

29. To connect the TNC, make a simple cable to the Cynch connector. Inner (Signal) conductor goes to pin 4 (Demod) and outer conductor goes to pin 2 (GND of TNC). When receiving a 19200, 38400 or 76800 baud signal, there will be a perfect eye at the data output. The output voltage at 38400 Baud is typically 0.5 volt pp.
30. To modulate the FT847, use a standard DIN5 to mini-DIN6 cable for 9600 baud. Transmitting on 9600 baud requires to switch the transceiver to "9600" (No. 25 of the setup menu, see manual). A middle setting of the TNC 9600 baud modem trimmer results in a reasonable deviation. Better use a special deviation meter for alignment (see manual). Adjust the output level of the TNC to get the desired frequency deviation / modulation index. Do not overmodulate. Note: the input voltage determines the bandwidth of the transmit signal.



Questions and Answers:

Q: why is the IF signal fed through the IFD? Wouldn't it be easier to connect the IFD in parallel to the mixer output?
A: directly after the mixer, the signal passes a quartz filter. As, with every filter, the input impedance varies significantly with frequency: within the passband, the filter is matched, outside the passband, the filter reflects the signal. The amplitude spectrum at the filter input shows a sharp notch at the passband. Attaching a parallel demodulator here would cause severe distortions due to the varying load. So, the signal after the mixer has to be buffered. The amplified signal is attenuated again to get the same (or a few dB more) signal level as without amplifier.

Q: is a AFC output available?
A: There is an unconnected pair of pins on the printed circuit board (M60/M61). These pins can be connected to the joint of R52/C52 (DET out) via a 100 kΩ resistor to pin M60. The voltage measured at this pin will depend on the center frequency of the received FM signal.

Q: how do I decode a fast packet-radio signal of 38kBaud or more?
A: The TNC2 with the Z80 processor cannot decode signals beyond 19200 Baud. The newer TNC3 or TNC31 series is capable of receive and transmit baudrates up to 1 Mbit/s. There are modems with all common baudrates (9600, 19200, 38400, 76800, 153600 and above). Special modems with different RX and TX speed (e.g. TX 9600 / RX 38400 for UO-12) are also available. When using WISP software with a TNC3 packet controller, you may use the modem 2 for receiving and modem 1 for transmitting. As WISP uses kiss-mode, both modems are received simultaneously, the data will be transmitted via the default port 1.

Q: When receiving a wideband signal, the S-meter goes down and there is only noise in the loudspeaker but the FSK signal can be decoded properly.
A: This in OK because the FT847 cannot decode such signals. Even the S-meter does not measure this signal: Most of the bandwidth is cut' by the narrow filters of the receiver. If you reduce the deviation of the test signal to zero, the S-meter will rise to normal and a clean carrier is heard again.

Some notes I made installing the Symek IFD on an FT-847...
"It works fine, I located the IFD in the space left vacant after I removed the internal speaker. Trust me, it is the ONLY space available for it. In addition I replaced the keyer plug on the 847 with the full size 5 pin DIN expected by most TNCs, it makes for a very clean installation. The IFD stays in the circuit at all times, but it does not interefere with operation at all." - Mark West

First thing to say is be very, very, careful!! It's the most heart stopping surgery I've ever done on my FT-847: and I've done the INRAD filter, the headphone volume mod, fitted a new power switch, and a TX expansion mod. The IFD mod makes the other mods look like an walk in the park.
On the face of it it doesn't seem a very big deal - all you're doing is tapping into the radio's IF, just a couple of bits of miniature coax. It took me six hours plus a night's rest from start to finish. …
The IFD fits on the outside of the radio fairly neatly at the rear in a small metal box (not supplied). Trouble is it's a struggle getting the normal PKT and RS232 cables in now as the new box gets in the way somewhat. I believe someone's managed to get the unit inside the FT-847 by removing the speaker as an alternative.
In conclusion be very very careful! Seems to work a treat now. Haven't used it much on the sat as there's hardly been a convenient time yet! Talking to myself at 38,400 is very nice (I really should get out more). Netmeeting with video works a treat at this speeed! I'd be interested in others' experiences of course. My experience is likely not indicative of a general concensus. 73 Howard G6LVB

The filters F20 and F30 are selected according to the desired IF bandwidth:

Baudrate FSK	IF-Bandwidth	AF-Bandwidth	Filter type
19200 Baud	40 kHz	12 kHz	SFE 10.7 MFP or MV
38400 Baud	80 kHz	25 kHz	SFE 10.7 MT
76800 Baud	110 kHz	40 kHz	SFE 10.7 MHY-A
153600 Baud	230 kHz	80 kHz	SFE 10.7 MS2

With FT847, 35.005MHz quartz (fundamental mode) is used. The IF of FT847 is 10.7 MHz above (45.705MHz)

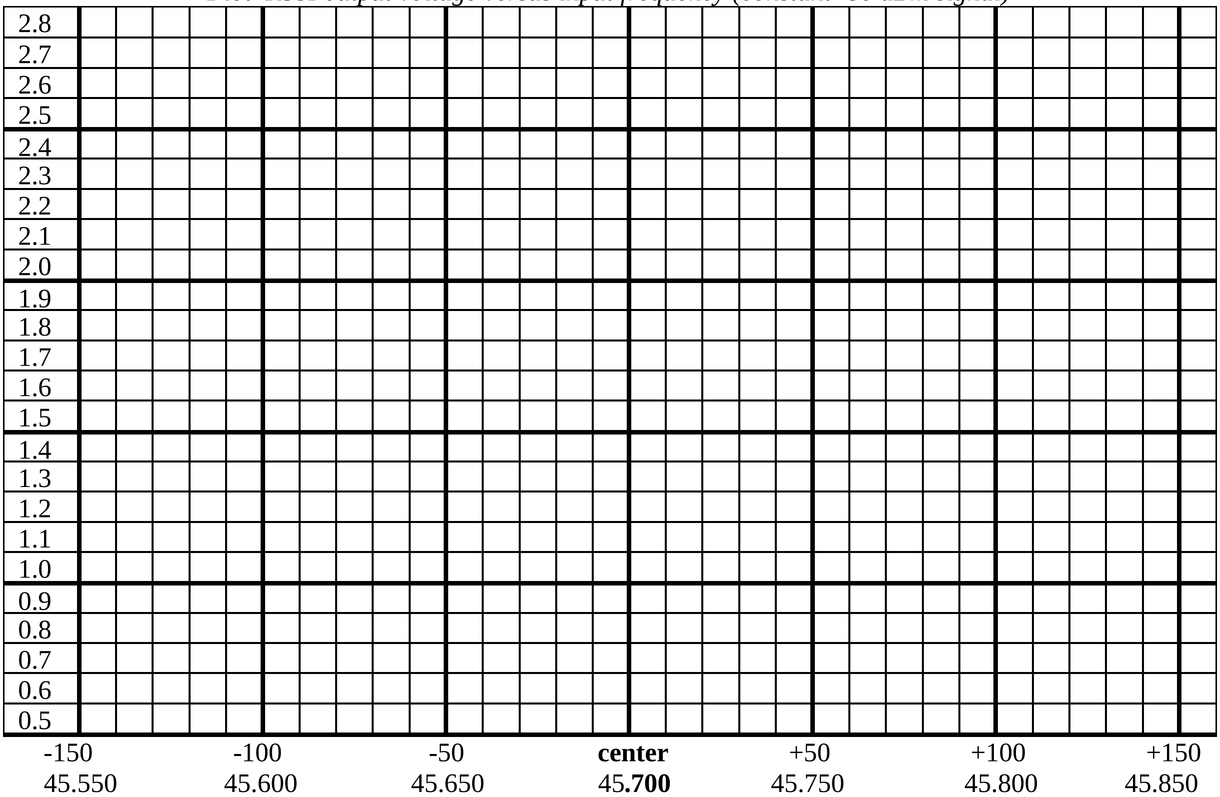
IFC Option FT847

IF-Frequency: 45.705 MHz, Filter impedance: 50 Ohm. Acessory parts: 2 pcs thin coax cable (30 cm each)
XTAL: 35.005 MHz. Band filter L12, L13: 850nH, C10: 82p, C11: 15p, C12=C13: 2.7p; C14: 27p, C15: 22p.
XO: L80: 1000nH, C80: 47p, C81: 47p, C82: 47p, C86: 33p, R80: none R1=R3=150E, R2=39E.
IF-Filter: 76800: SFE 10.7 MHY (red dot, BW110kHz) or for 153600: SFE 10.7 MA (light blue, BW230kHz)

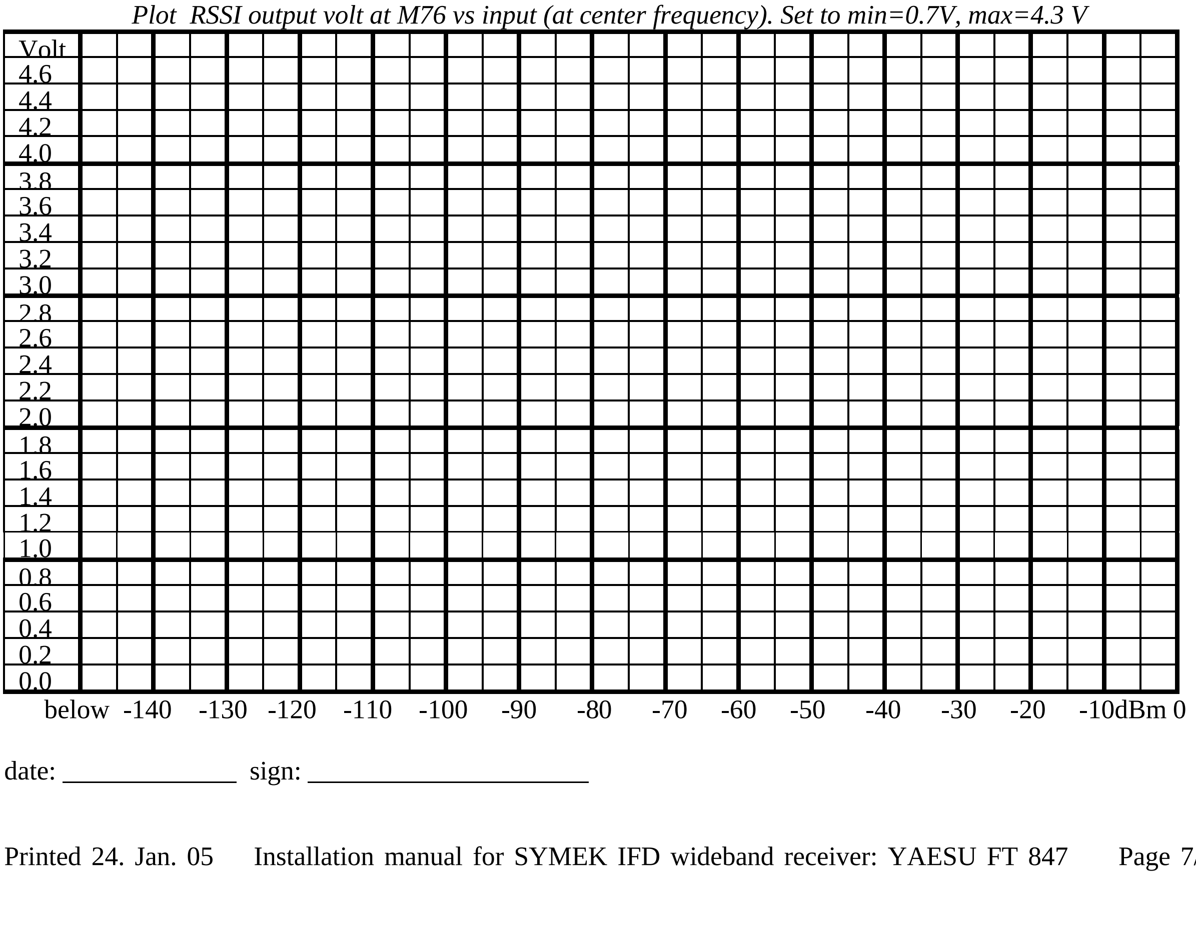
Supply voltage: 12 volt; supply current: ______ mA, total gain input to output: ________ dB

Plot discriminator output voltage (at R51 / R52) versus input frequency (-80 dBm signal)

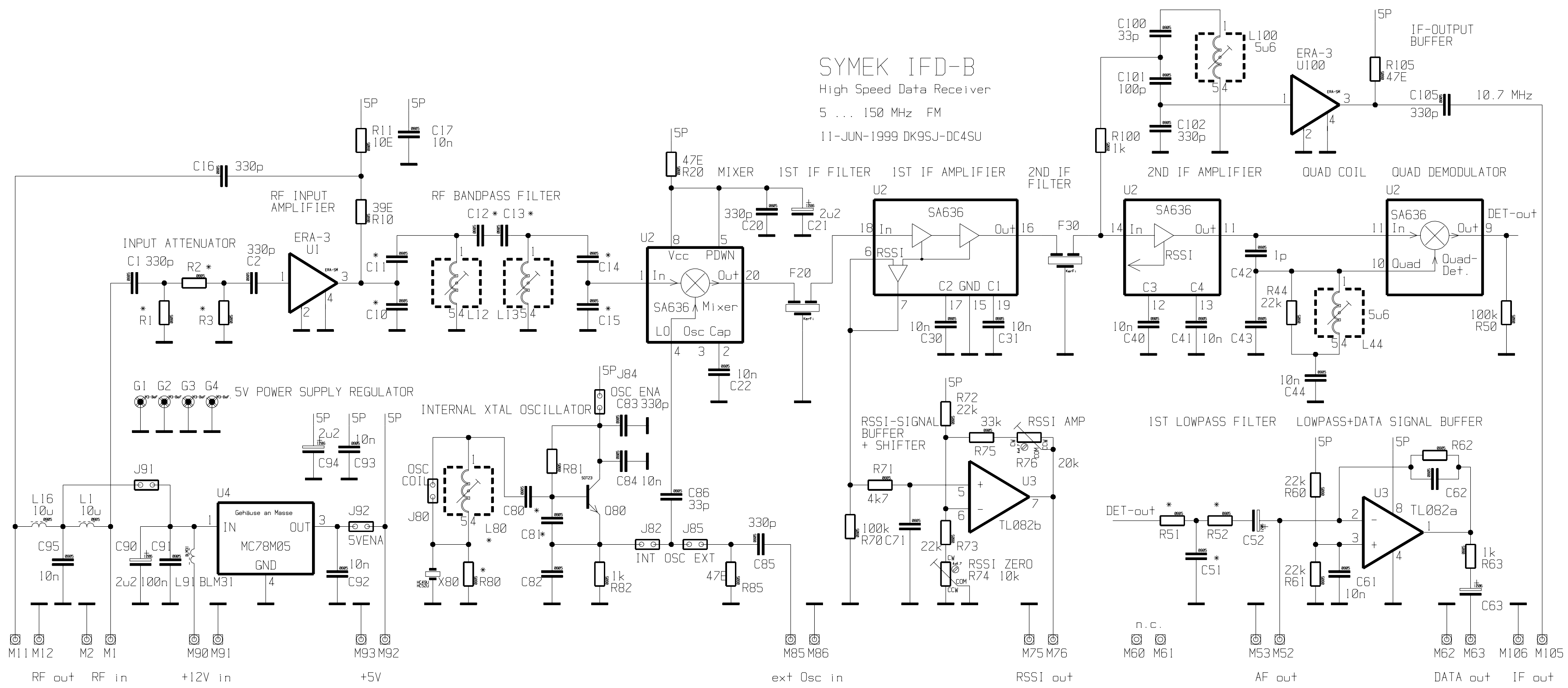
Plot RSSI output voltage versus input frequency (constant -80 dBm signal)



Plot RSSI output volt at M76 vs input (at center frequency). Set to min=0.7V, max=4.3 V



date: _____________ sign: _____________________



Modifications IFD option FT 847: Oscillator: quartz TQ730518 / 35.005 MHz for IF 45.705 MHz, R80: 560Ohm, L80: 0,4 uH, C80: 18pF, C81: 22pF, C82: 27pF. Values for the band filter: C10: 39pF, C11: 10pF, L12: 0,4uH, C12: 1.5pF, (C13: 2,7pF), L13: 0,4uH, C14: 18pF, C15: 22pF. R72: 330kOhm, R73: 12kOhm, R75: 22kOhm
Between joint U1 Pin 3 / R10 and the joint C11 / C10 a 22 Ohm resistor was added to reduce influence of the filter input impedance on amplifier gain. R10 and R11 are changed to 22 Ohm and another 22 Ohm resistor is connected in series with C16 to get better 50 Ohm output impedance.

Typical voltages (measured wit dc voltmeter):

U1 (ERA-3 Amplifier) Pin 1: 2.6 V	U2 (IF-IC) Pin 1: 1.1 V	U2 (IF-IC) Pin 18: 1.3 V	
U1 (ERA-3 Amplifier) Pin 3: 3.5 V	U2 (IF-IC) Pin 4: 4.2 V	U2 (IF-IC) Pin 16: 1.3 V	
Q 80 (Oscillator) Base 3.2 V	U2 (IF-IC) Pin 8: 4.6 V	U2 (IF-IC) Pin 14: 1.3 V	
Q 80 (Oscillator) Emitter 2.8 V	U2 (IF-IC) Pin 20: 2.6 V	U2 (IF-IC) Pin 11: 1.5 V	