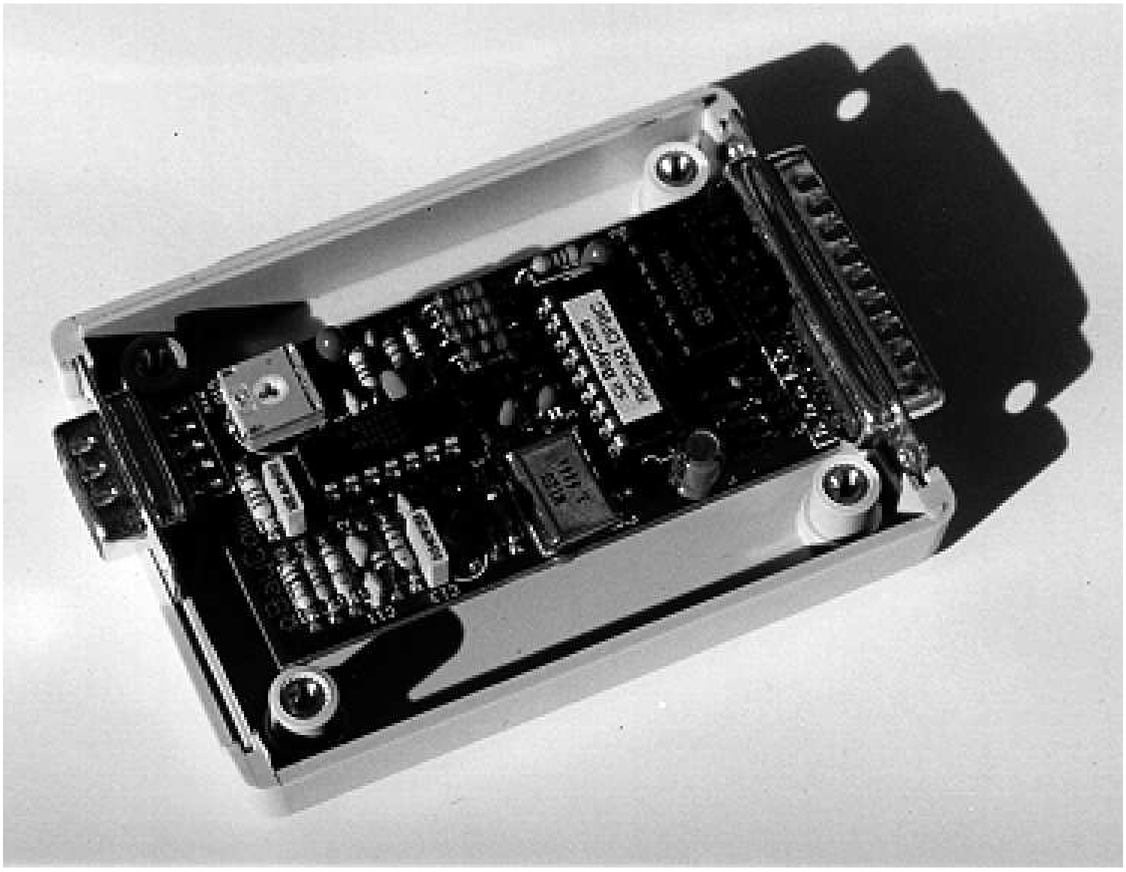
PICPAR

Printer Port FSK Modem



Hardware Documentation

BayCom

Important Notice:

BayCom GmbH
Massinger Weg 3
93107 Weillohe
GERMANY

PICPAR – a simple printer port FSK–Modem

Not too complicate and cost sensitive equipment are the basic preconditions, when a new a amateur radio operation mode is predetermined to gain a lot of friends. With the advent of simple interface modem equipment for 1200Bd AFSK at the end of the eighties, packet radio gained lots of popularity. A steadily increasing number of users and huge amounts of data called for higher transmission rates. The FSK data transmission standard, designed by James Miller, G3RUH ten years ago, soon became a world wide standard. But it still did not succeed to drive out the old fashioned slow AFSK modes.

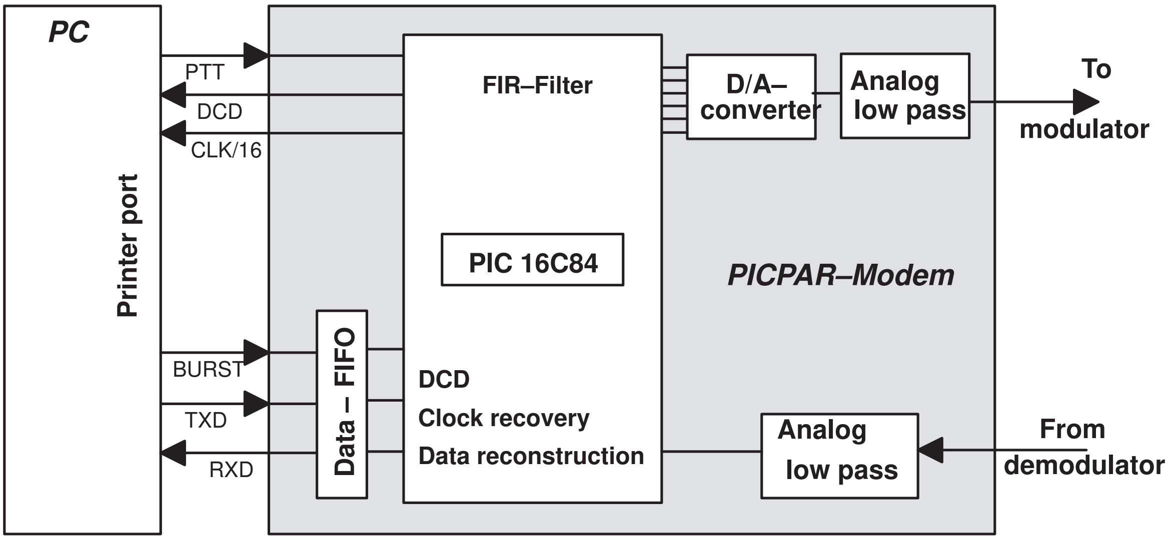
The reasons were twofold: To get started with 9600Bd, at least a PC slotcard or a TNC instead of a simple modem was required. Also, there were only few radios suitable for 9600Bd, modifications often proved difficult. Unfortunately, the last has not yet changed. On the modem sector, the BayCom PAR96 first brought some life into the house: This was a simple FSK modem, directly connected to the PC's printer port and much cheaper than a TNC. To reduce the interrupt load on the PC, this modem featured an internal FIFO, transmitting 16 bit collected in single serial bursts from and to the modem. Per burst one interrupt was required, thus reducing the thrilling 9600 interrupts per second to as less as 600 interrupts per second, half of the rate required for the old 1200Bd AFSK modems. Scrambling of the data and the DCD were performed by the PC. All other functions like filtering, clock regeneration and data reconstruction were implemented in the modem, using standard CMOS ICs and low density programmable devices like GALs and EPROMs. This resulted in a modem half the size of a standard euro PCB (80*100mm) and a power consumption of about 160mA@5V.

The new PICPAR modem presented here is a successor of the PAR96. Our intention was to design a low–power, low–cost version of this modem, especially to abandon the need for an external power supply. But it should be compatible with the PAR96 to conserve all the precious software work done for the PAR96 drivers.

The highest cost in the original PAR96 design was the digital FIR filter, the FIFO control and the clock regeneration. Here an idea raised to integrate these functions into a small low cost microcontroller. Our choice was the PIC16C84 by Microchip. This is a full 8 bit microprocessor in an 18 bit DIL housing. It offers 13 I/O ports, 36 byte RAM, 1k EEPROM an integrated oscillator and a lot of other bells and whistles, making it an ideal device for this purpose. This processor also starts operation at 2 volts and requires only 2mA supply current at 4 MHz clock, making it a good starter for an interface powered modem with only 3–5mA total power consumption.

Modem schematics

The figure on the next page shows a block diagram of the modem. The printer interface connection is realized with 6 wires. An excellent DCD could also be integrated into the PIC, thus utilizing the already specified, but not yet used DCD line on the PAR96 interface. The modem provides an interrupt clock with a 16 times RX–/TX clock period. Within the next half clock period, the PC is expected either to clock 16 new transmission bits into the modem or to empty the FIFO containg 16 bit newly received bits.



Both is realized via a burst clock generated by the PC. The PIC performes the transmitter FIR filter an the incoming data and passes the result to a 7 bit D/A converter. On the receiver branch, a lot more functions have to be carried out: First, a clock signal has to be recovered from incoming data. Then data have to be reconstructed and a carrier detection has to be performed. The regenerated data are fed into a FIFO, from where they are handed over to the PC.

Besides PIC and FIFO some analog functions are required. The raw signal from the D/A–converter has to be smoothed by an analog low pass filter, passing the data via a deviation control to the radio modulator. Incoming data first pass an anti–aliasing filter, before they are digitalized by a comparator stage and fed into the PIC processor.

Schematics

The modem schematics on this manual's center page mirrors the block diagram. For an efficient practical realization some tricks were required which are explained in this section. The power supply for the modem is gained from the output ports of the centronics interface via the Schottky diodes D1–D3. Typically an operating voltage of 4.5V can be gained, even from laptops, but the circuit already operates from 3V and up. Stabilization is not required, C1 and C5 are used to smooth the power supply.

The FIFO utilizes a CMOS 4517 circuit. This is a 64 bit shift register with an auxiliary output at 16 bit. Clock lines are shared by PIC and PC. When the PIC switches it's output into high impedance, the PC becomes clock master.

R22 and C2 generate a reset signal for the PIC processor, which operates on a 3.686 MHz clock. T1 inverts the low active PTT, T2 switches the radio PTT. A MOS transistor is used to achieve proper switching at low gate current.

To minimze power consumption, we use a R–2R resistor network as DA–converter instead of an integrated solution (R5–R11). 1% tolerance metal film resistors are mandatory to achieve a proper output signal.

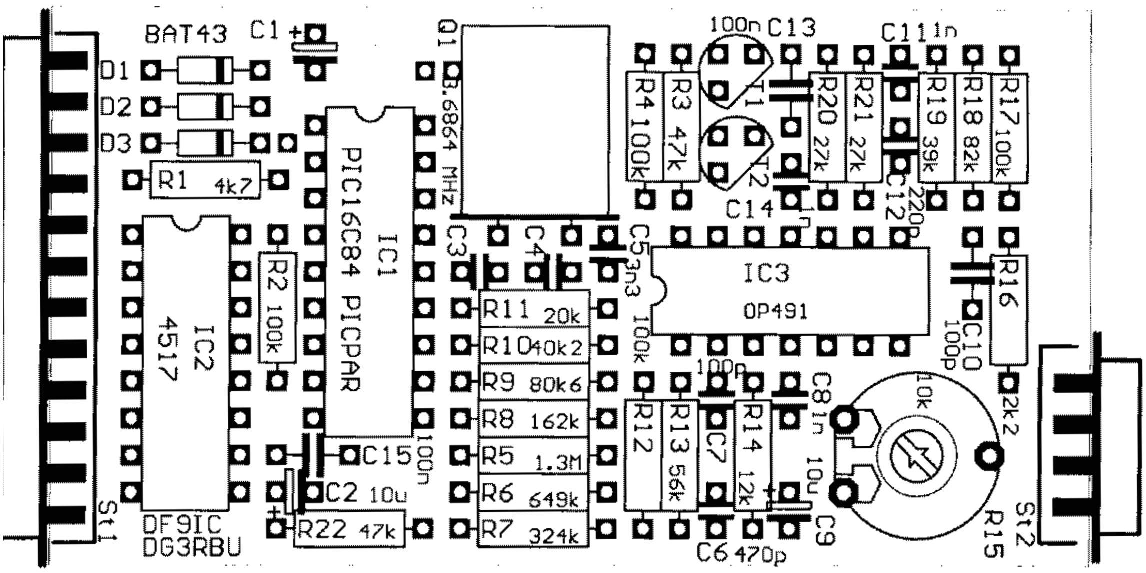
The following active filter and amplifier net is already well known from similar modem implementations. We utilize a 4–way integrated amplifier OP491. This type is a bit more expensive than the usual bulk OP's, but it shows low power consumption, rail–to–rail–operation to achieve a maximum of deviation. It's low tendency for oscillations saves external load resistors, again reducing power consumption. Just one simple 1k–Ohm load would just double the modem's supply current!

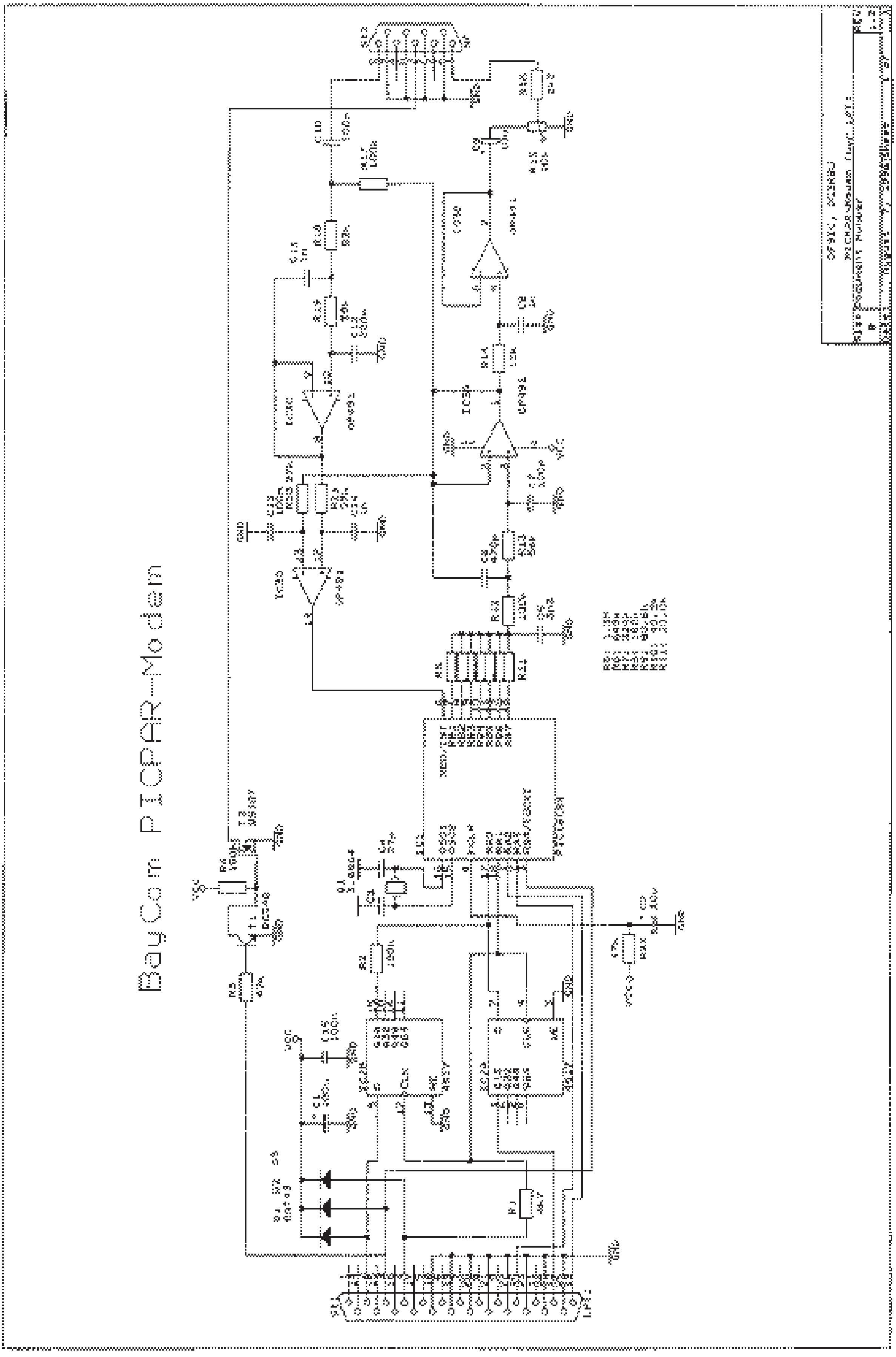
For the receiver, the OP can also be used as a comparator (IC3D). To gain the reference voltage for the input signal sampling we use the first stage of the transmitter filter together with a software generated suitable output of the D/A converter.

The modem output is DC decoupled via C9. All radio signals are led to a 9p. D–Sub connector.

Assembly

The whole modem is assembled on a double sided PCB of size 30 * 72mm (see below). There are only a few feed throughs to connect if you should use a home–brew PCB. The assembly itself is fairly uncritical. At first all the lower passive components are placed and soldered. Then all other passive and active components are assembled and soldered. *Do not yet solder the connectors*. For the ICs, precision sockets should be used. When the assembly is finished, check the board for bad solderings or short circuits. Finally, the three ICs are inserted into their sockets, take care for correct orientation.




BayCom PICPAR-Modem

Part List:

R1	4k7
R2	100k
R3	47k
R4	100k
R5	1.30M*
R6	649k*
R7	324k*
R8	162k*
R9	80.6k*
R10	40.2k*
R11	20.0k*
R12	100k
R13	56k
R14	12k
R15	10k trimmer
R16	2k2
R17	100k
R18	82k
R19	39k
R20	27k
R21	27k
R22	47k
C1	100uF, 10V electrolyt, 2,54ls
C2	10u, 6.3V tantalum, 2,54ls
C3	27pF ceramics 2,54 ls
C4	27pF ceramics 2,54 ls
C5	3n3 ceramics 2,54 ls
C6	470p ceramics 2,54 ls
C7	100p ceramics 2,54 ls
C8	1n ceramics 2,54 ls
C9	10u, 6.3V tantalum, 2,54 ls
C10	100n Folie, 5,08 ls
C11	1n ceramics, 2,54 ls
C12	220p ceramics, 2,54 ls
C13	100n, 5,08 ls
C14	1n ceramics, 2,54ls
C15	100n, 5,08 ls
D1	BAT43
D2	BAT43
D3	BAT43
T1	BC548 or equivalent
T2	BS107 or equivalent
IC1	PIC16C84, programmed
IC2	OP491
IC3	CD4517
St1	Sub–D 25p., male
St2	Sub–D 9p., male
F1	IC–socket, 18p.
F2	IC–socket, 16p.
F3	IC–socket, 14p.
Q1	Crystal 3.686 MHz

PCB PICPAR
Case AGM25

Resistors marked with *: 1% tolerance (E96), all others: 5% tolerance
ls means ”lead space”

Mounting the case

The size of the PCB was dimensioned for a small plastic case (AGM25, available from several distributors). This compact housing is dedicated for PCBs carrying Sub–D connectors, carrying the board. The connectors are fixed between both halfes of the case.

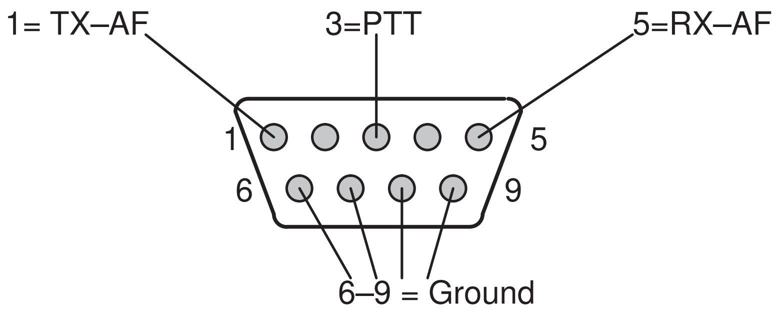
To achieve a proper fitting into the case, both sub–D connectors are slipped onto the board pads, but not yet soldered. Then the PCB is put into one of the case halfes and the connectors are adjusted to match the required distance. Then all connector pads are soldered properly. On the upper half of the case, a 4mm hole can be drilled to allow access to the deviation adjustment trimmer.

Connecting computer and radio radio

St 1 of the modem is directly connected to the printer port of your computer. Plug the modem direclty onto your DB–25 interface or use a shielded 1:1 cable as short as possible.

All leads required to connect the radio to the modem are available on a 9–pin sub–D male socket on the modem. Only four lines need to be connected: Audio to transmitter (TX–AF), audio to receiver (RX–AF), PTT and ground.

The transmitting signal is fed directly into the radio's modulator. The PTT is active low, i.e., it switches to GND during transmission. The received signal is taken directly from the demodulator. At this stage it is appropriate to mention that most radios must be converted for 9600Bd operation. So far, only very few radios are available commercially that allow for the direct connection of 9600 Bd FSK modems such as this one. However, some of the major manufacturers have recently presented radios that feature a 9600Bd packet connector. When choosing a radio, please keep in mind that the switching times for 9600Bd signals on most synthesizer radios are very long and will hence affect your throughput as you will require a rather long TXDELAY. Whenever possible, a crystal controlled radio should be used, such as, e.g., the TEKK KS–960.



Getting started

The PICPAR modem can be used with all drivers that were designed for the BayCom PAR96 modem. The BayCom L2–driver (from version 1.60) is one possible alternative, the TFXPAR driver by DB7KG for the use with hostmode programs is another one. Drivers are also included in the latest UNIX kernels and in PC–FLEXNET. A first functional check of the modem should be done using the BayCom L2 driver. Start INSTALL and select the ”PAR96” when prompted for the hardware on the corresponding interface. Start L2. If an error message should be prompted, start L2.EXE again. Because the first start of L2 switches on the modem’s power supply, the modem might not react fast enough. Other drivers might behave similarly. When L2.EXE responds with a flashing rectangle in the upper right screen corner, the modem is working properly and generates regular data interrupts (even when no radio is connected). After starting the BayCom terminal SCC.EXE and connecting the radio, it should be possible to monitor the channel.

One difference between the PICPAR and the old PAR96 modem is that it provides a proper hardware DCD. This should be considered when setting the MODE command. This parameter is configured to :MODE 9600c by default (software DCD). With the PICPAR modem, it should be set to :MODE 9600. Then the modem’s hardware DCD is used.

As the only adjustment, the deviation has to be set properly. R15, accessible on the top of the modem should be set to the correct output level for your radio. Either refer to your radio manual or try to find the correct deviation (+/– 3 kHz) by trying. At this deviation, the noise generated when a packet is transmitted (set high TXDELAY for better observability) should match the noise to be heard in your radio on an unused channel at opened squelch. If there should be retries during your practical work with your modem, try to optimize the adjustment of R15. Please note again, that you need a special radio prepared for 9600Bd or a proper modified radio to achieve good transmission quality for 9600Bd FSK. Especially switching times, PLL behaviour and AF bandwidth are important factors, which might corrupt your signal when your radio does not meet the 9600Bd requirements.

Troubleshooting

The modem assembly is pretty simple, there are no critcal parts. Possible assmbly errors should be easy to localize. If L2 does not recognize the modem (error message after starting L2.EXE) check the modem's power supply first. The voltage between pin 8 and 16 of IC2 should range between 3 and 5 V *after* first start of L2.EXE. After powering up the modem, is there a correct RESET at pin 4 of the modem (voltage should rise to supply voltage shortly after powering up). Does the crystal oscillate? If the modem responds, but the PTT does not switch, a wrong assembly of T1 or T2 might be the reason. If there is no transmission or receiving, first check the path between R12 and the output of the modem on the transmitter branch with an oscilloscope. On the receiver branch, check the signal between the modem input to pin 14 of the OP491. In most cases a short circuit or a bad soldering will eliminate the analogue signal. If your centronics connector should have very low impedance pullups on the PE input line (we use it for data receiving) the shift register output might be overloaded. In this case a small driver (inverting or non inverting) beween pin 1 of the 4517 shift register and pin 12 of the centronics connector might cure the problem.

Further recommendations

Usually, the modem can be put directly onto the centronics port. If you use a printer cable, it should be as short as possible and shielded. Also the radio cable should be properly shielded and as short as possible. The shield should always be connected to ground only on one side of the cable. A proper grounding with an extra cable between PC and radio improves signal quality and reduces damage in case of a lightning strike into your antenna. The modem itself is only designed for half duplex operation, full duplex operation with concurrent transmission and receiving is not possible.

Drivers for the modem exist not only in the BayCom software. The program TFXPAR by DB7KG operates the modem together with any hostmode programs. A driver is also included in the most recent Linux kernels, written by HB9JNX. BayCom itself is a DOS application, but on most computers an operation under Windows 3.x should be possible by first loading the L2.EXE driver and then starting windows. The terminal itself then can be operated in any DOS window.

Enjoy the assembly and the use of the PICPAR modem!

Your BayCom team.

BayCom ordering information

Ordering of BayCom Hard– and Software

You can order all BayCom products directly from the BayCom–team, address see below. Please ask for our catalogue and price information.
BayCom products can also be obtained by authorized dealers all over the world.

Order Information:

8500 PICPAR, kit with standard components, including case
8600 PICPAR, assembled, in case
8601 PICPAR, PCB +programmed PIC–processor

Technical Support and Service

For all BayCom kits we offer a repairing service. Surely you will understand, that this service cannot be provided for free, but we will try to do it as cheap as possible. We know about the amateurs need having assembled a kit that does not work! Note that we are a part time "just for fun" company and cannot provide any 24 hour services or telephon hotlines. If you have a question, send us a FAX or send an e–mail to baycom@baycom.de
If there is a major damage (more than half of the kit price) we will ask you before we do the repair. Please send all equipment for repair to the following address:

BayCom GmbH
Johannes Kneip (DG3RBU) **Tel. ++49 5105 585050**
Bert–Brecht–Weg 28 **FAX ++49 5105 585060**
30890 Barsinghausen
GERMANY

You also can get technical information from Johannes!

BayCom

BayCom Hard– und Software GmbH
Massinger Weg 3 **Tel. 09453/9819**
D–93107 Weillohe **FAX 09453/9829**