

Hardware-User-Manual for the 16 bit High Speed Packet-Radio-Controller

TNC31S



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PREFACE

The expression 'packet-radio' appeared first in 1982. From the first experiments, a world-wide data net for amateur radio has been developed.

Meanwhile, packet-radio has become one of the most important operating modes. The reason therefore is that packet radio is not only used by amateurs with a special interest on digital operating modes, but also by a increasing number of amateurs who prefer packet-radio as a very useful tool for information interchange and spreading all kinds of news regarding all fields of the hobby.

To be up to date as a radio-amateur, it is important to read the mailboxes occasionally. To write a short memo to a friend, there is nothing better as to write a mail via packet-radio. While lying in wait for a rare short-wave dx-station, it is necessary to have access to a packet-dx-cluster.

Until 1992, the TNC2-series of packet-radio-controllers with the 8 bit Z80 processor had been standard. The demand for higher speed and smarter software lead to the development of the TNC3S by the students Joachim Scherer, DL1GJI and Roland Alber, DG8GAD. The final layout for series production and the modem design was added by Ulf Kumm, DK9SJ with the SYMEK company.

With the TNC31S, you own a device which represents the top of today's packet-radio technology. It is suited for operating a user's standard packet station as well as for special applications as digipeater, mailbox-tnc, high-speed-controller, satellite operation etc.

The manual will help you to use the *hardware* of TNC31S. About connecting the radio, please refer to the manuals supplied with the modems, for information on the software, please use the software manual supplied with the TNC or with the updates. If there are problems to set up and operate the TNC3 please read this manual carefully. If your problem cannot be solved with the manual, ask your dealer for help.

This hardware manual supplied with your TNC remains valid, even when the software has been changed. So keep it and replace only the software-manual when updating the programs in Flash-EPROM.

16. Dec. 1999 Ulf Kumm, DK9SJ

Important: The information in this manual is valid only for printed circuit board version TNC31S-B.

TECHNICAL DATA TNC31S

(valid for pcb version B, manufactured from 1998)

Power Supply:

12 v DC (min. 9,0 V, max peak 30 v), reverse-polarity-protection diode
current typ. 65 mA (without modems), 75 mA (with AFSK1200) and 190mA (FSK-modem)
Internal supply voltage: 5 v. Linear regulator.

Dimensions: ca. B=105, T=130, H=42 mm, mass ca. 300 gram

Computer Interface:

RS232 (+/- 10 v signals), 8 pin RJ connector.
Baud rate: 75, 150, 300, 600, 1200; 2400; 4800; 9600 baud; 19,2; 38,4; 57,6; 115,2 kbaud
Default: 19200 baud (see software manual, command 'rsconf')
Parity: none, word length 8 Bit (may be altered by software settings),
Connections: Data out (TxD), Data in (RxD), ground. No hardware-handshake.

Modem Interface 1:

CMOS -level 5 volt. TXData, TXClock, RXData, RXClock, RTS CTS, DCD, + 5 volt, reset, ground. The TNC31 is able to deliver up to 150mA supply current for the modem.
Connection to the TNC31 motherboard via 20 pin connectors and a 20 wire ribbon cable.
1 modem board (120x80mm) may be built-in.

LED-Display:

Power (5 Volt), Error/Reset, STA 1, CON 1 + Modem-LEDs

Microprocessor:

CPU Motorola MC 68302-15 MHz, in 132-pin SMD-case with microprogrammable on-chip RISC Proces-

sor for data communication, internal data bus, 6 DMA-channels, programmable chip-select outputs, 24 Bit address, internal 32/16 bit data bus, external bus: 8 bit.

Program memory (Flash-EPROM):

8 bit wide, Standard: 128 kbytes Flash-EPROM, TNC31SX has 512kbytes.

Data memory (CMOS-RAM): (battery buffered)

8 bit wide, 128k or 512kbytes with TNC31SX

RTC real time clock (optional, only with TNC31SX):

Battery buffered (year, month, day, hour, minute, second).

Reset and Watchdog: MAX 818 supervisory circuit with software-triggered watchdog

Battery: 3 v lithium-battery with automatic switchover by MAX818

GETTING STARTED

You are already familiar with TNC and packet-radio? This page will give you all necessary information to start using your TNC31.

Power Supply:

12 volt (9-30 volt), max. ca. 150 mA. Connector 5 mm. Positive inner, negative outer contact.

Computer connection, Interface

RJ45 via a 4 wire cable 1:1. . with a RJ45 to SubD9-pin male adapter or equivalent 25 pin adapter connector to the PC serial interface. Used are only the 4 center pins of the RJ45 connector (3,4,5 and 6): 3=transmit data (from TNC to PC), 4+5=ground, 6=receive data (from PC to TNC)

Baudrate etc

The default setting is 19200 baud 8 bit no parity and can be changed by use of the PC.

If the reset button inside the TNC31 is pressed at power-on, the TNC31 will start this time with these settings, independent of the setting.

Connection of the Radio

Connection identical to other TNC with a 5 pin DIN connector. See the specific modem manuals.

Pin	Name	Function (radio connection pin)
1	MIC	microphone, modulator, output of the TNC (audio)
2	GND	ground, 0 volt, screen.
3	PTT	push-to-talk key, , closes to ground when transmitting.
4	SPKR	loudspeaker, demodulator, audio input of TNC.

Start

Connect everything (radio, computer, power) - start PC-program - ready.

Note: All timer settings are given in ms (milliseconds) with TNC31, e.g. TX-Delay = 250 ms!

Problems?

Normally there should be no problem so far. If anything does not run as expected, you should go on reading the manuals for specific information on TNC3 operation.

CONNECTING THE TNC31S TO PC

Cable to PC

For serial interfaces, modern equipment use 8 pin RJ45 instead of the big 25 pin Sub-D. You find cables and adapters for this in the computer shops everywhere. Here some details about this technique:

3 = transmit data from TNC to computer (output of TNC)

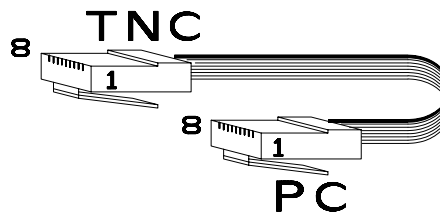
6 = transmit data from computer to TNC (input of TNC)

4+5 = ground

As the RJ45 cables are not soldered but crimped to the connector with a special tool, you have to use the low cost ready-made cables, which are available in computer or telephone shops. They are called "ISDN-cable" or 'patch-cable' in normal and shielded versions. For extension there are tiny adapters with two female connectors available. Sometimef you find cables with only 6 or 4 of the 8 pins wirde. These cables may be used as well because the TNC31 uses the inner 4 contacts only. Even the 4-pin or 6-pin connectors will fit into the larger 8 pin receptacle.

Names: 8-wire flat cable / modular-cable with two RJ-45 connectors, ISDN-cable RJ 45, patch-cable, cable with 8-pin Western-connector.

The both connectors are made in a way, that the lock of the transparent plastic connectors is at one side of the cable up, at the other side down. So, the order of the pins remains unchanged.



Bold: wire No. 8, connected to pin 8 at both ends

Note: There exists cables whith a so-called 'Roll-Over-Connection' with pins 1 and 8, pins 2 and 7 etc. are connected. Since the ISDN cables are common, this version is found only with special applications.

Most PC use a 9 pin male connector as serial COM port. To connect the RJ45 cable to it, a adapter has to be used. Here the circuit of the adapter. (RJ-connector as shown above, view from the rear side to the receptacle in the adapter).

RJ-45 Re-ceptacle	Wire Color in-side of adap-ter	Sub-D 25 female	Sub-D 9 female	signal
3	black	3	2	RxD (TNC to PC)
4	red	7	5	ground
5	green	7 / n.c.	5 / n.c.	ground
6	yellow	2	3	TxD (PC to TNC)

The TNC31 uses TxD, RxD (pins 3 + 5) and GND only, other contacts are not connected. In the 25 pin adaptor, the pins 4+5 and the pins 6+8+20 are connected (or the pins 7+8 and pins 1+ 4+6 in the 9 pin adaptor). Some (windows-based) programs (e.g. TCP/IP or Hyperterm) use these signals for hardware handshake.

Interface setting

The serial COM-port of the PC has to be initialised as follows:

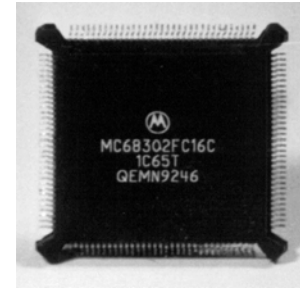
baudrate:	19200 (same as TNC)
parity:	N (none)
bits/character:	8
Xon/Xoff, protocol:	off
RTS/CTS handshake:	aus
stop bits:	1

How to set these parameters depends on PC-software. In most cases, the values are set in a config-file.

RESET TO DEFAULT

The RS232-interface settings depend on the 'rsconf' command which is defined in the file DIP1.scr and executed at power-on. If you do not know this setting, it is a problem to communicate with the TNC31 and to find out the correct RS232-settings. For this, there exists a button, which can be accessed through a hole in the rear panel of the TNC31.

To start the TNC31 with the default settings (19200-N-8, no firmware started), connect the TNC31 to a PC and run the RS-program or similar terminal software with 19200 baud, 1 stop bit, no parity. If the TNC31 does not prompt correctly at power-on, disconnect power, press the little button and connect power again (while pressing the button). The TNC starts now, skipping the execution of the DIP1.scr script and prompts `x:` in the TNC3 operating system mode. You may now check, edit and replace DIP1.scr as desired. Note: No data is changed when using the 'reset' button. Only the startup-script is skipped.



Microprocessor of TNC3S

POWER SUPPLY OF TNC31

The TNC31S is supplied with direct current (DC). The current drain is about 75 to 200 mA at 12 Volt, the TNC needs a supply voltage in the range of 9 Volt but not exceeding 30 Volt. Depending on the modems, you should not use voltages beyond 20 volts for continuous operation.

The best is to supply the TNC31 from a regulated 12 or 13,5 Volt supply as used for radio transmitters etc. In most cases, such a supply is available in every amateur station.

If the supply voltage is too low, the microprocessor will not start properly. Check the supply voltage to make sure it is within the limits.

The power drain is constant and does not depend on the supply voltage. The power consumption of the TNC may depend on the software which runs on the processor. The e.g. Turbo-Firmware utilises the low-power-mode of the 68302 microprocessor and saves a lot of current. The built-in modems consume a significant part of the total supply current. (see the data of the modems)

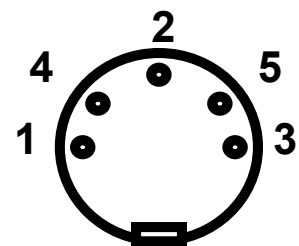
Depending on the supply voltage and current drain, the TNC31 may get lukewarm.

CONNECTING THE RADIO TO TNC3

The connection of the receiver and transmitter is explained in detail in the manuals of the modems. In general, the radio is connected by a 5 pin DIN-connector with the following pinning:

Pin 1: MIC	af input of radio, output of TNC
Pin 2: GND	Ground
Pin 3: PTT	ptt, transmit-switch, closed to ground
Pin 4: SPK	af-output of the radio receiver
Pin 5: not used	see modem-manual

(View to solder side of plug)



Important: the five pins are not numerated in row.
You find tiny figures on the black insulating body of the plug.

INSTALLATION OF A MODEM BOARD

First read the manual which is supplied with the modem. There are sometimes configurations necessary which can be done only before the modem is installed and all parts of the modem are accessible.

Disconnect the TNC31 from the supply. Remove the TNC31 front panel (4 screws) and pull the top panel fully towards you. After installing the 20-pin ribbon connector to the modem correctly, fasten the modem top side down on the 4 (or only 2) hex bolt spacers with M3 screws. The DIN receptacle and the controls (trimmers, switches) must appear exactly behind the access hole in the rear panel. Now close the TNC31 case again. Make sure, that the LED's fit exactly in the front panel holes.

With the system test program you should check if the TNC recognises the built-in modem properly. If all is ok, connect the radio to the modem.

Note: As the modems are built-in top side down, the DIP-switches are enumerated in the opposite way to the DIP-switches of the TNC3 main board.

Modem Interface, Connection of other Modems

Digital Interface, (Modem-Disconnect-Connector)

The Modems are connected to the TNC3S main board with a 20 wire ribbon cable. The cables are supplied with the main boards, not with the modems.

If you intend to connect another modem with an HDLC-interface (e.g. Vanessa-board, RMNC or special modems), a longer cable may be used and the modem may be mounted externally. The cable length is not critical, but the radio interference (EMI) may become worse when using longer, unshielded connections.

The pin assignment of the modem disconnect cable is the same as recommended by DF9IC high-speed-modems. All even numbered pins are connected to ground, which gives a good shielding effect. The digital signals use CMOS-TTL-levels (0 / 5 Volt), the modems are supplied with 5 V DC via the 20 pin connection. (rating max 300 mA for both modems)

Pin Assignment Modem-Disconnect

Pin	Signal	Function	Pin	Signal
1	+ 5 Volt	Power Supply of the modems by the TNC	2	Ground
3	+ 5 Volt	Power Supply of the modems by the TNC	4	Ground
5	Reset	Reset-from / to TNC (both directions, low=reset)	6	Ground
7	DCD	AF carrier detect (from Modem to TNC)	8	Ground
9	CTS	Transmitter clear to send (from modem to TNC)	10	Ground
11	PTT	Transmitter keying (from TNC to modem)	12	Ground
13	TxD	Transmit Data (from TNC to modem)	14	Ground
15	RxD*	Receive Data (from modem to TNC)	16	Ground
17	TXC	Transmitter Clock (from modem to TNC)	18	Ground
19	RXC*	Receiver Clock (from modem to TNC)	20	Ground

*: RxD and TxD are NRZI-coded !

NRZ and NRZI-Coding

The AFSK-modem e.g. transmits one of two possible sine wave tones. With packet-radio, the changing of one tone to the other represents the transmission of a logical "1" (HI). If a "0" (LO) is to be transmitted, the tone remains unchanged. With this way of encoding (NRZI) it makes no difference *which* tone is transmitted. Important is only the fact, that the tones *changes*.

The former TNC2 however, generates at its modem-interface not this NRZI-Signal, but the digital data stream itself. So, all TNC2 modems have a flip-flop for transmitter and receiver which take care of this NRZ/NRZI-translation.

The TNC3 generates already the NRZI-signals, there is no need to make any NRZ-NRZI translation within the modem circuit. In simple (e.g. AFSK-) modems, you may feed the data signal before or behind the corresponding flip-flop, generally, a 74HC107 is used for that. With DF9IC-derived FSK (G3RUH) modems, the NRZ-NRZI translation is done by the T and R GALs. Whether these modems generate / use NRZ or NRZI data depends only on the contents of these two GALs.

Special Interfaces + Modems

For modem development, a breadboard PCB is available (80 x 120 mm), which fits exactly in the TNC31 modem slot.

Meaning of the Light Emitting Diodes

On the front panel, there are 5 LED's to display the operation status.

The PWR-LED (yellow)

This LED is operated by the regulated 5 V of the TNC, whenever the supply voltage is connected.

The CON-LED (green)

This LED is controlled by software and may have different meanings, dependant of the selected software. When using Turbo-Firmware or TF, it means: there is a connect at the selected radio channel.

The STA-LED (red)

This LED is controlled by software and may have different meanings, dependent on the selected software. When using Turbo-Firmware or TF it means: the TNC has data in its receive buffers, which has not been transferred to the computer. With the TNC3BOX software, flashing STA-LEDs mean: Mail for the box-operator arrived. To cancel flashing: read and erase the mail.

The DCD-LED of the Modem (yellow)

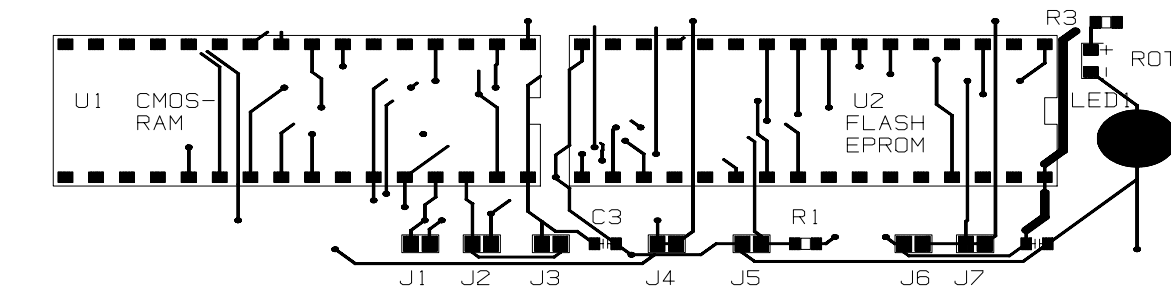
This LED will light whenever the modem recognises the radio channel busy. (see modem manual)

The PTT-LED of the Modem (red)

This LED shows if the transmitter is keyed. (see also the modem manual)

JUMPERS IN TNC31

The solder jumpers for selecting the different memory options can be found at the left side edge right of the 'Power' LED before the Lower EPROM socket. Open the case by removing the front completely. The jumpers are 9 pairs of solder eyes, which can be closed easily by soldering the two halves together with a tiny drop of solder. To open the connection, it is best to turn the board upside down and let the solder flow on the soldering iron tip. Vacuum desoldering equipment or other unsoldering methods may be used as well. If you are not familiar with such, you should consult a specialist for help. All normal precautions, which are usual when working with electronic circuits like the TNC3, should be observed carefully. (valid for printed circuit board revision TNC3S-K)



Location of the programming jumpers J1 to J7 for configuration of memory size

Jumpers J1, J4, J6 and J7: 'EPROM size'

Different sizes of (Flash-) EPROM may be used with TNC31, but the AM29F010 / 29F040 EEPROMs are standard. When installing the 32-pin Flash-EPROM, make sure to align pin 1 with the notch of the socket. Pin 1 is always oriented towards the front panel.

When changing the EPROMs, the jumpers have to be set according to the following table. Note: old UV-EPROMs may be used as well but with these EPROMs you cannot take advantage of the flash-specific commands.

EPROM-type	size	J1	J4	J6	J7	remarks
27 C 1000	128 KByte	◆	✂	●	✂	UV-EPROM;
27 C 2000	256 KByte	◆	✂	●	✂	UV-EPROM
27 C 4000	512 kByte	✂	●	●	✂	UV-EPROM
AM 29 F 010	128 kByte	◆	✂	✂	◆	Flash
AM 29 F 040	512 kByte	◆	✂	✂	◆	Flash

● : jumper closed, ✂ : jumper open ◆ : default closed by copper trace

Jumper J5 and J6: 'RAM size'

Different sizes of CMOS-RAM types may be used with TNC31S. Depending on the size, the jumpers have to be set.

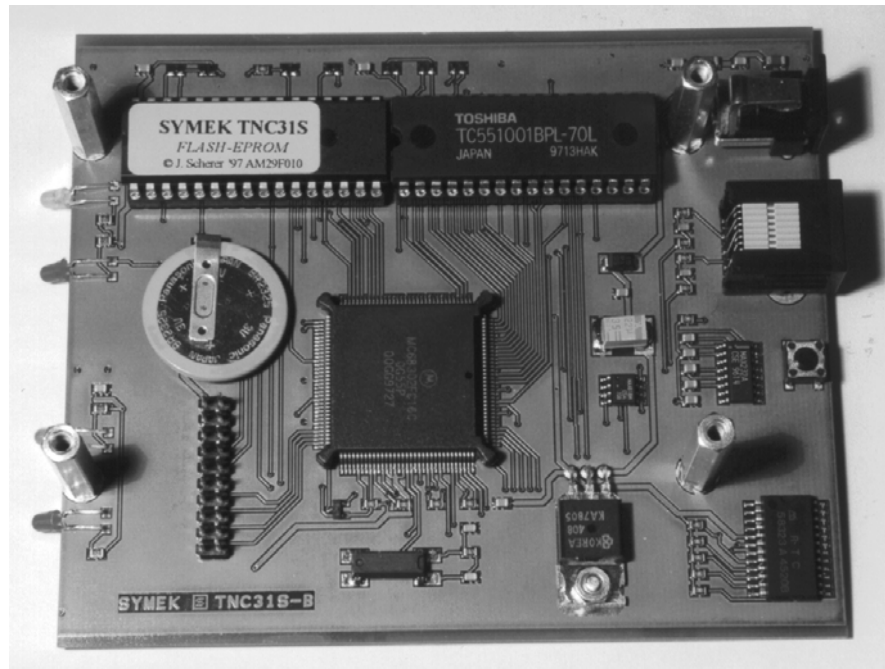
The sockets for the RAM-IC have 32-pins. Insert the IC in a way, that pins 1 and 32 are pointing towards the front (LED's).

RAMs of any manufacturers may be used. The RAMS are called 'Static CMOS RAM', the case is a 'Standard 600 mil Dual-In-Line Package', they are organised Byte-wise (e.g. 128k x 8 Bit) and they should have a low standby-current (Suffix 'L' or 'LP'). The access-time is not critical, 100 ns would be fast enough but all the RAMs have access times of 80 ns or faster.

RAM	size	J3	J2	remarks
TC551001, KM681000	128 kB	●	✕	small RAM
TC554001, KM684000	512 kB	✕	●	full RAM

● : jumper closed, ✕ : jumper open

Jumper 5 is not used and remains open.



RF-INTERFERENCE?...

All inputs and outputs of the TNC31 are bypassed with a R-C-R or L-C-L filter to suppress RF interference. The board has solid ground areas, which results in very efficient screening against unwanted radiation. If the TNC and the receiver antenna are too close, it might be that the reception will be disturbed by the clock frequencies of the TNC. In that case, ground the case first and check if the interference is still present. In many cases, the interference is not caused by the TNC but by any other digital equipment (computer) nearby and are transferred by the cables between computer and TNC to the radio receiver. Interference usually affects the 144 MHz band or lower frequencies.

In low-power-mode (see Turbo-Firmware) the remaining radiation is significantly reduced by the slower clock of the processor.

The TNC31 meets the German regulations for the electromagnetic compatibility (EMVG) and is CE-approved. The emission-levels are in the range between 150 kHz and 30 MHz at typically 50 dB μ V (accepted are: 60 dB μ V), the emission field strength between 30 MHz to 1 GHz is about 20 dB below the CE-limits (40-45 dB μ V/m)

The CE sign on the TNC31 certifies that the instrument complies with the European regulations for electromagnetic compatibility. Prerequisite is the proper operation according the following rules:

All connections have to use shielded cables. The shield must be connected to ground or minus supply.

All connected instruments (PC, radio, power supply) must have a shielded and grounded case.

In case of unapropriate shielding and cabling, the strong electromagnetic fields of high power radio transmitters may cause malfunction of the TNC31.

The TNC complies with EMC rules only if it is in ist original state and not modified in any way. The operation of the TNC31 requires technical knowledge as e.g. radio amateur license.

The TNC31 is supplied with 12 volt DC power. The user has to make sure to use apropiate power supplies which comply with the corresponding safety regulations.

UPDATES, NEW EPROMs

If you like to receive the most recent version of TNC3-EPROMs, just call us and ask, which issue is newest. Check the Internet www-page <http://symek.com> for more information.

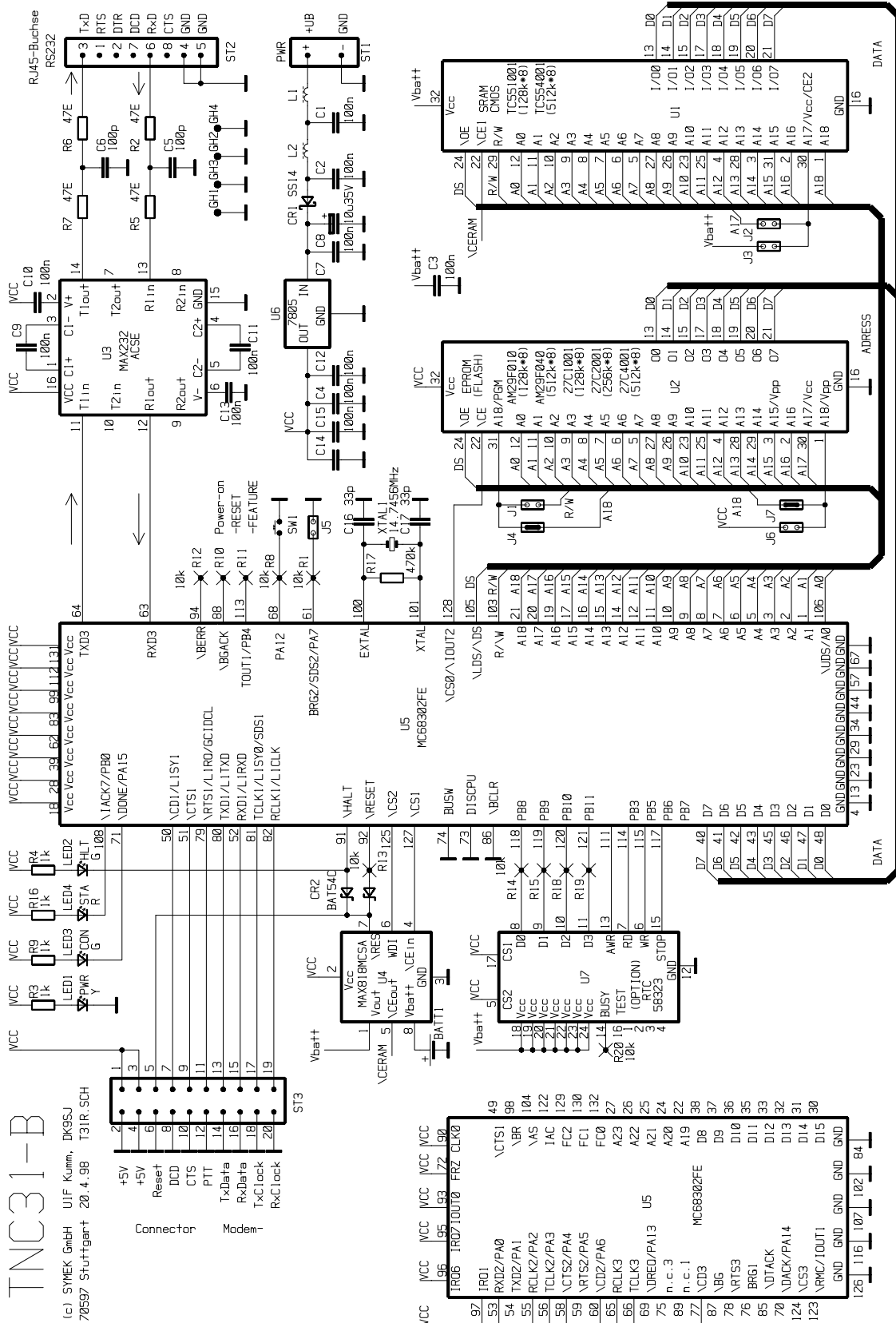
COPYRIGHT ON TNC HARD AND SOFTWARE

The basis for all programs running on the TNC3 is the 'TNC3-Betriebssystem' (operating system). For those programs there exists copyright to Joachim Scherer, all other rights (board layout and schematics) belong to SYMEK GmbH or to Ing. Büro Kumm, Stuttgart.

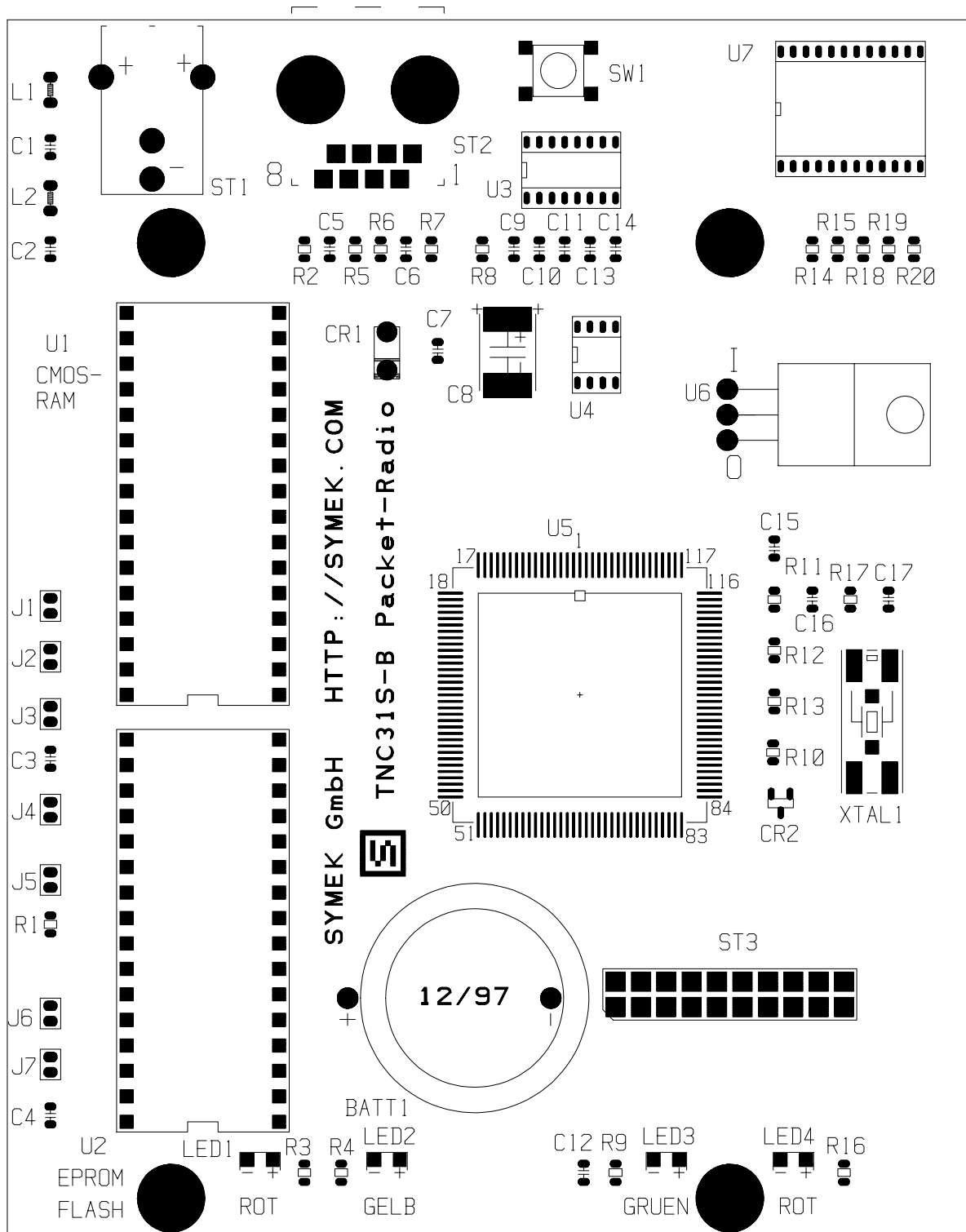
The content of this manual may be published and spread, as long as there is a indication of the source. It is our aim to give a fresh impetus to packet-radio and to inspire as many radio-amateurs on this fascinating subject as possible.

The TNC3S meets the electromagnetic compatibility regulations (EMVG) when operated as directed and has the CE-sign. It is intended to be used with amateur radio or cb-radio equipment and needs no special permission to be operated. We are not liable for any damage or injury caused by use of our products or by wrong information in the manuals.

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