Handbook / Kit

DB 6 NT
5,7 GHz Transverter MK2

KUHNE electronic GmbH
MICROWAVE COMPONENTS

4.2003

5,7 GHz Transverter MK2

DB6NT 4.2003
3. Generation

Indroduction

In 1977 the DUBUS magazine published the first 5,7GHz SSB transverter which had been developed by Claus Neye, DL7QY. This was the begin of using narrowband techniques in the 3cm band. The construction technique at that time utilised the classical waveguide approach.

1988 the first transceiver on a PTFE-substrate has been described by DC0DA and DJ6EP. The circuits used have been realised with GaAs-FETs. Several modules were `screwed` together. The alignment effort to make this transceiver working has been considerable.

The current transverter is a singleboard construction on RO4003 substrate. The receiver has a noise figure of 1.0dB at more than 20dB gain. The transmitter achieves an output power of more than 200 mW. The IF is 144 MHz and the spurious rejection is better than 40dB.
If you will use 432 MHz IF, you have to build in a 111 MHz crystal. The capacitors of the resonant circuit have to be changed into 22pF and 82pF instead 15pF and 68pF. The helical filters F1 and F2 have to changed with the filter types 252HEP-2956A (F1) and 367MN-101A. (F2). Additional modifications of the circuit are not necessary. Then the spurious rejection is even better at least 50dB.

Everything -TX, RX, LO, IF-Switch and T/R-control is on a single board housed in a 55x148x30mm large box from tinplate. Tuning is required only for the two cavity resonators, the four helix bandfilter in the LO-Chain and the bias currents of the TX/RX amplifiers.
The restricted tuning range of the helix filters make `false`resonances not possible.

Description:

LO

The proven `simple`XO uses the FET SST310 in a grounded gate circuit. The crystal frequency for a 144MHz IF is 117MHz. The coil is tuned by a M3 brass screw, which is fitted instead of the usual ferrite tuning screw. Extra pads are provided for fitting additional capacitors which can be selected for temperature compensation. For normal use in a restricted temperature change environment the stability is sufficient. But for more serious work a special ourtboard solution like the OCXO from DF9LN is required. This can be fed in at the source of the SST310, as indicated in the circuit diagram. The crystal and the heater have to be removed in this case.

The XO is followed by a tripler to 351 MHz which utilises a BFR92A transistor. The third harmonic is filtered by a heilix bandfilter and drives the doubler with the BFP196. The output filter sieves the harmonic at 702 MHz. A second doubler with a BFP196 achieves an output frequency of 1404 MHz. The subsequent helix bandfilter is tuned to 1404MHz.

Now the chain of bipolars ends and the 1.404GHz signal driveds a GaAs-FET quadoupler with a MGF-1907. A microstrip edge coupled filter selects the LO frequency of 5616MHz and drives a further linear amplifier equipped with the ERA-2SM MMIC. The power at this point is around 5mW (7dBm).

Mixer

The LO drives a single balanced diode mixer which uses a BAT15-99 low barrier double diode. The IF-port of the mixer is terminated by selectable attenuators for transmit and receive. These are switched by PIN-Diodes BAR64-03W to a common IF-connector. A voltage of at least +9V, which can be supplied by a FT-290 for example, activates the T/R-switching. Other brands of 2m transceivers have to be modified accordingly.

Whilst this method of T/R-switching via the IF coaxial cable is quite elegant, also a separate method via the PTT-MAN input can be accomplished.

An extra output is fitted for TX+, which can be used for external coaxial relays or PAs. This output must be guarded by a 0.63A fuse. It is not safe in case of short circuit!

On the RF-port of the mixer a cavity resonator cares for sufficient suppression of spurious responses.

RX

The RX-chain uses two HEMT-Amplifiers (NE32584C) and a third stage with a ERA3 SM MMIC. The gain of >30dB makes an extra IF-amplifier obsolete. The stages are coupled with simple microstripline filters. The last stage is coupled to the mixer filter via a Wilkinson divider.

TX

Two stages with MGF-1907 follow the Wilkinson divider. A subsequent cavity resonator cares for additional selectivity in the TX-chain needed for suppression on the LO.
Two further stages with a MGF-1907 and a MGF-1601 amplify the signal to a power of 200mW. A directional coupler with a BAT15-03W Schottky diode allows for a monitor voltage of the RF output power.

Construction

To achieve a successful construction of this transverter the builder has to have experiences in the use and handling of SMD-parts. Furthermore experiences with smaller projects in microwave circuits are valuable. In any case the construction of this Transverter is not a beginners project.

The usual ESD protection measures should be obeyed. (see Fig. 5 for an excellent survey).

Construction Steps

1. Solder the walls of the tinplate box and trim the PCB for fitting into the tinplate box.
Please caution! Be careful! The tinplate has sharp edge, do not hurt you!

2. Mark the holes for the SMA-connectors.

3. Drill holes for SMA-connectors and feed-through caps.

4. Solder PCB into the box (Fig.4) Use a 10.2 mm High piece of wood as a ruler to find the right adjustment.

5. Solder the coupling rivets for the cavity resonators. They must stand upright!

6. Tin the bottom of the resonators. Mark the correct position with a pair of dividers. Fit a short M4 screw to the resonator. Put the resonator onto the position marked and heat the screw with a soldering iron. If the resonator is on the right temperature solder at the bottom.

7. Mount the parts onto the PCB (Fig.3). Mount the foodthrough caps. Solder the helix filters (Fig.4). Solder the regulators with their heatsinks to the wall of the tinplate box. Clean the finished PCB with alcohol. The tuning screws of the resonators should be removed. Dry the module in a stove (1h at 80°C) or cover night lying on a central heating.

Alignment

The following steps are necessary for the alignment of the transverter:

1. Apply 12V. Use a current limited (<0.6A) power supply. Check the voltage at the output of the fixed voltage regulators.

2. Measure the collector voltage at the BFR92A (Testpoint M1). Turn the tuning screw of the oscillator coil until the decrease of the collector voltage indicates the proper oscillation. The measurement should read around 7.2V.

3. Measure voltage at M2 (Fig. 2) . Tune bandfilter F1 (351MHz) to minimum voltage (ca...6V) at M2.

4. Measure voltage at M3 (Fig. 2). Tune bandfilter F2 (702 Mhz) to minimum voltage (ca...4.8V) at M3.

5. Measure voltage at M4 (Fig. 2). Tune bandfilter F3 (1404 MHz) to maximum voltage (ca...4.3 V) at M4.

6. Connect dummy load or antenna at input connector of RX.

7. Adjust 10k pots for a reading of 2V at the drain of the two RX-transistors NE32584C.

8. Connect 2m receiver at IF connector. Turn RX-Gain and TX-gain pots fully CCW. Adjust M4 tuning screw at resonator in front of mixer slowly clockwise (inwards) until you observe an increase in noise level. This is the upper sideband on 5760 MHz.

For verification turn the tuning screw further inwards until you observe a second peak in noise level. This is the lower sideband on 5372 MHz. Turn back to the first maximum (Tuning screw is less inside the resonator) and lock with the security nut.

9. Switch transverter to transmit by grounding the PTT input. Connect a 50 Ohm dummy load to the RX output. Adjust all FETs in the TX-chain by the appropriate bias pots to the drain voltage given in the circuit diagram (Fig. 2). Drive the transverter with 1...3 W on 144 MHz. Measure the monitor voltage at MON OUT. Only adjust the resonator in the TX-chain to a maximum by careful tuning. There is only one maximum, because the first resonator has already been tuned in the step before. Lock the tuning screw with a security nut. A fine tuning can be carried out by optimising the first resonator (in front of the mixer) and the bias currents of the TX transistors.

10. Reduce the TX-gain by clockwise rotation of the TX-gain pot until the TX output starts to decrease.

11. Connect antenna to RX input. Adjust the XO until a known beacon reads the correct frequency.

12. Take low resistance carbonised foam and glue it into the bottom cover. This damps the resonances of the box.

Ready for use, good DX!

Acknowledgement

My special thanks to Lorenz **DL6NCI**. His support and the discussions were mandatory for the success of this development. Also my thanks to Richard, **DF5SL**, who verified the reproducibility of the design by building this transverter.

Literatur/References:

1.) ROGERS Leiterplattenmaterial Firma Mauritz Hamburg Datenblatt RO4003

2.) NEC Datenblatt NE32584C

3.) MITSUBISHI Datenbuch GaAs FET's

4.) SIEMENS Datenbuch RF- Halbleiter

5.) NEOSID Datenbuch Helixfilter

6.) TOKO Datenbuch Helixfilter

7.) „Transverter for 5,7 GHz by DB6NT" DUBUS 3.91 (DUBUS Buch III)

8.) „8 W GaAs-FET Amplifier for 6 cm" DB6NT DUBUS 3.92 (DUBUS Buch III)

9.) „P-HEMT LNA for 6 cm" DJ9BV DUBUS 1.95 (DUBUS Buch IV)

Bezug/Kits:

Ready made units or kits:

KUHNE electronic GmbH,
Scheibenacker 3
D-95180 BERG
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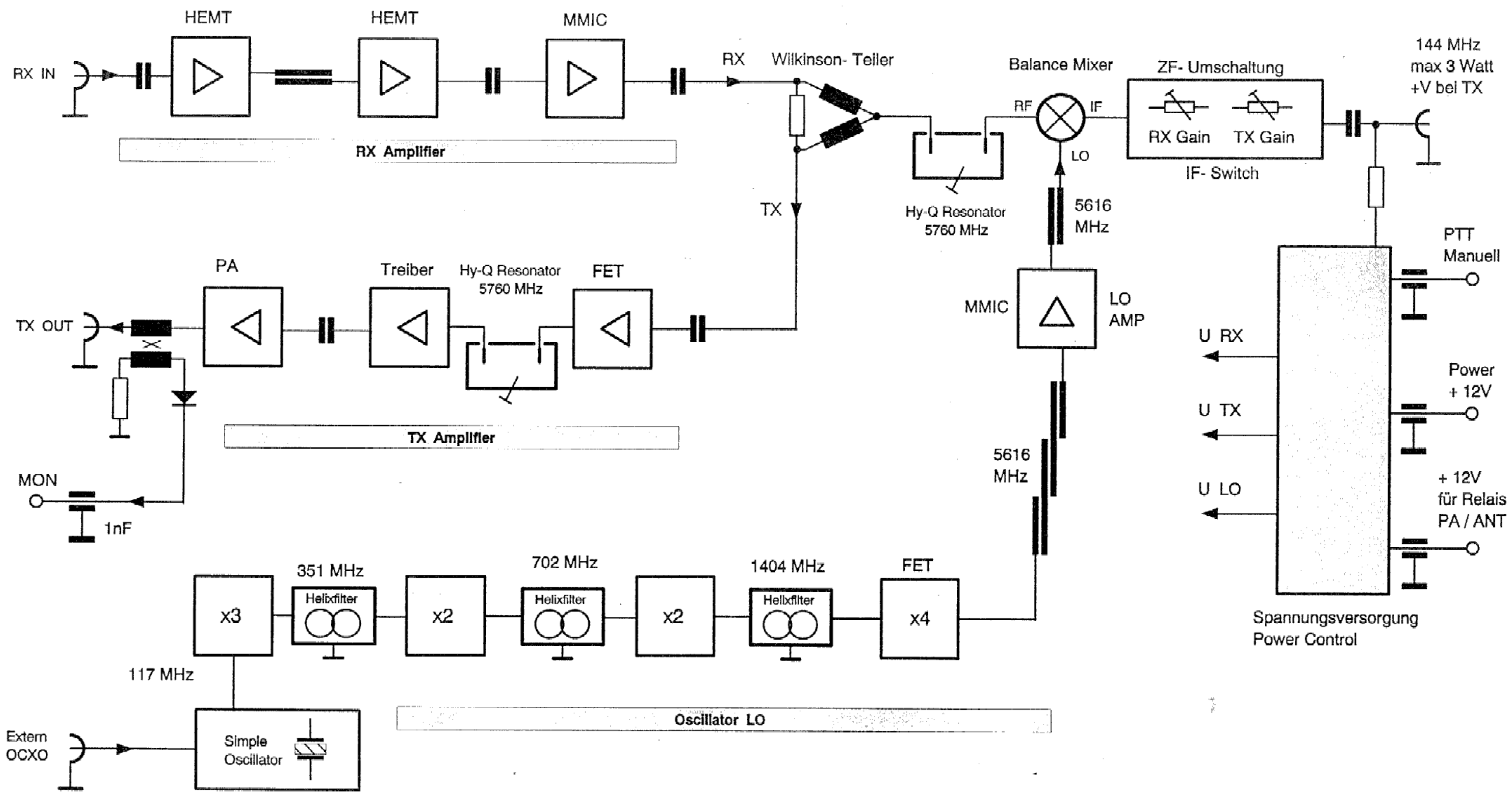
Email: kuhne.db6nt@t-online.de
http://www.db6nt.com

5,7 GHz Transverter MK2 DB 6 NT 4.2003

5760 / 144 MHz



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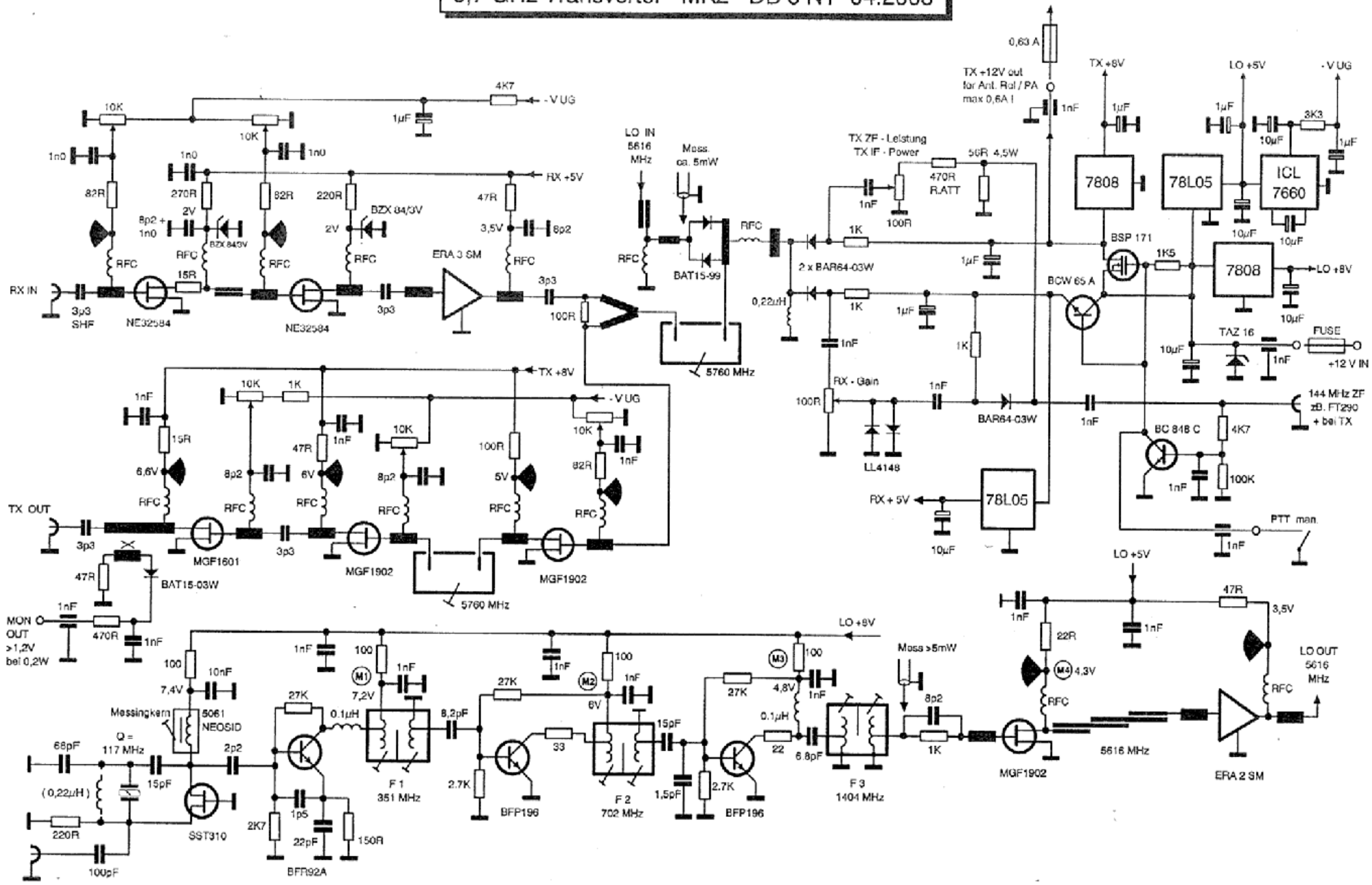

Die Spannungs- und Leistungsangaben sind Messwerte der Prototypen. Die Angaben können durch Bauteiletoleranzen stark abweichen!

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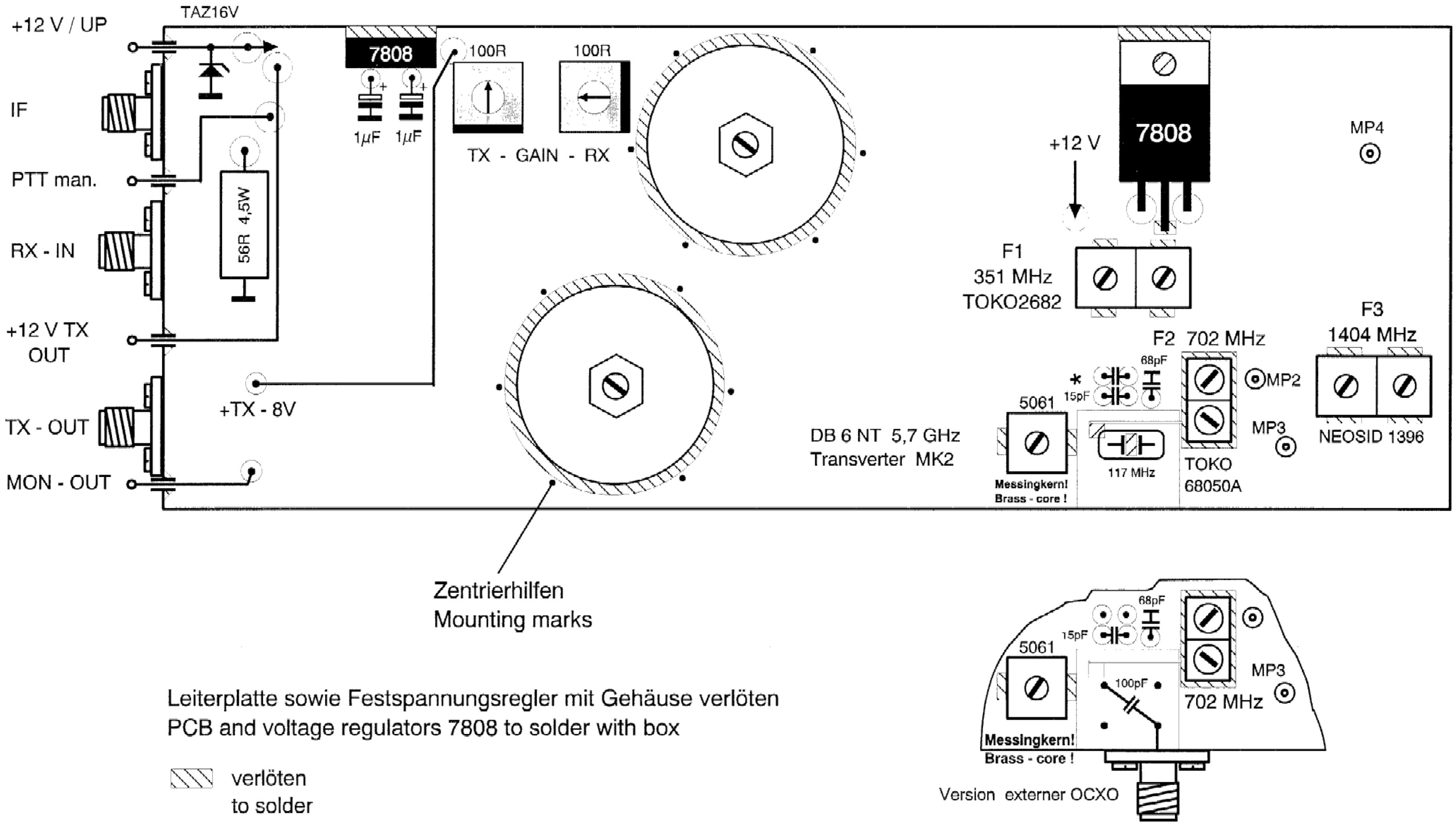
144 MHz ZF



Leiterplatte sowie Festspannungsregler mit Gehäuse verlöten
PCB and voltage regulators 7808 to solder with box

verlöten
to solder

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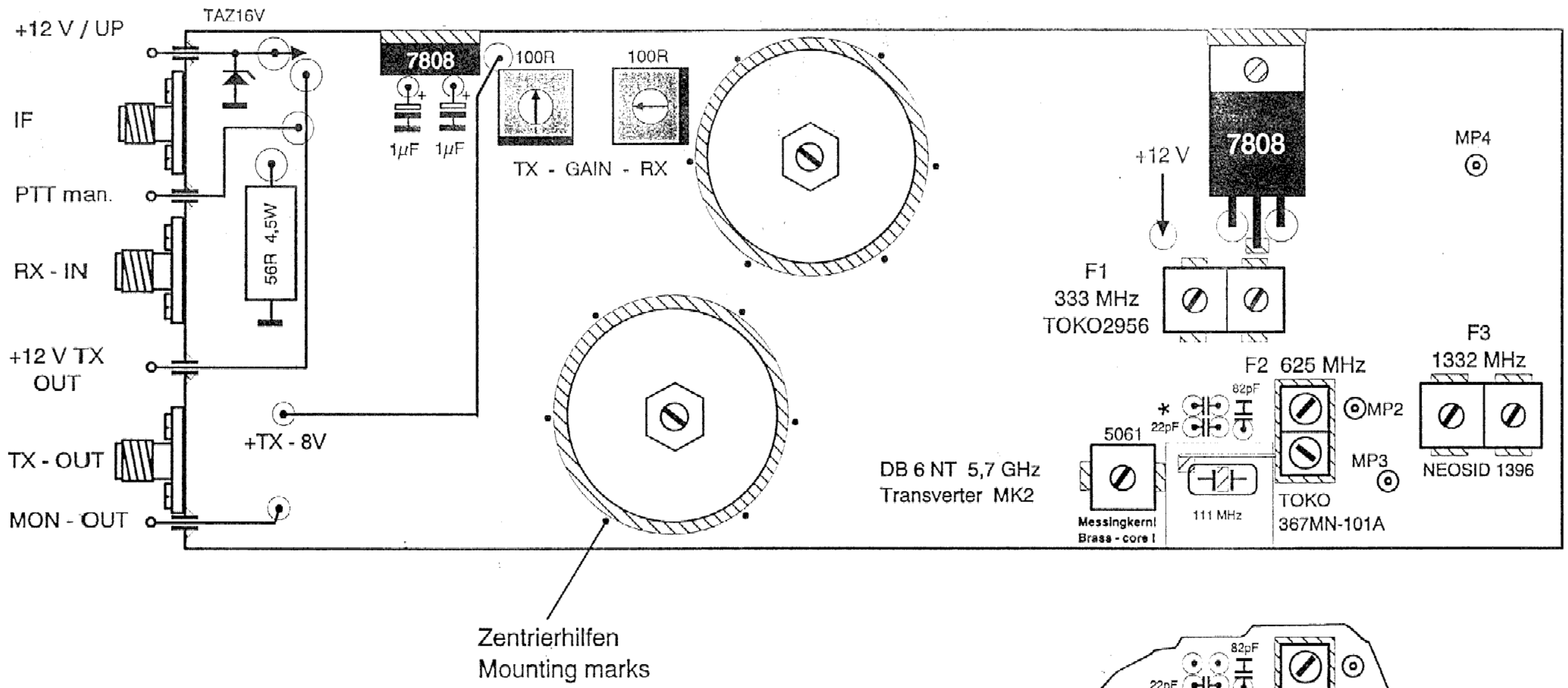
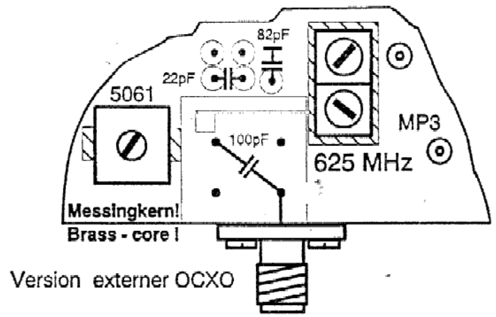
432 MHz ZF



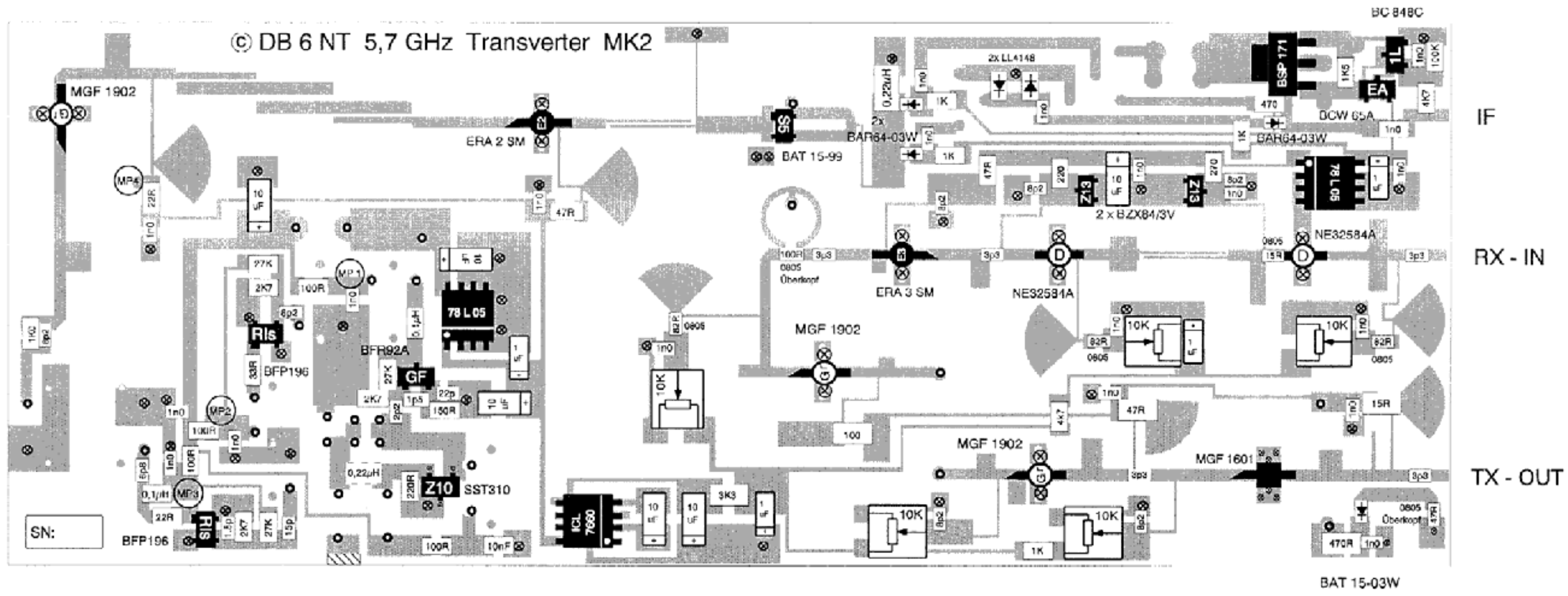


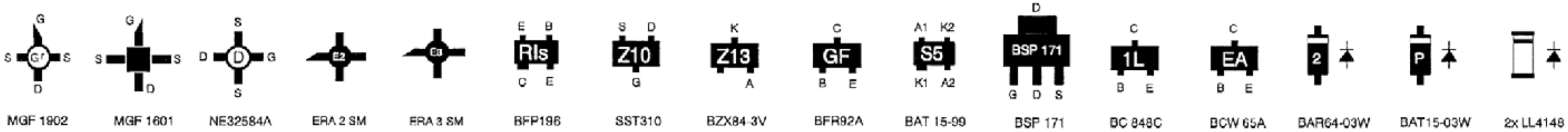
Version externer OCXO

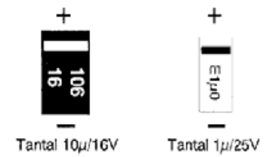
Leiterplatte sowie Festspannungsregler mit Gehäuse verlöten
PCB and voltage regulators 7808 to solder with box

verlöten
to solder

5,7 GHz Transverter MK2 DB 6 NT 5.2000





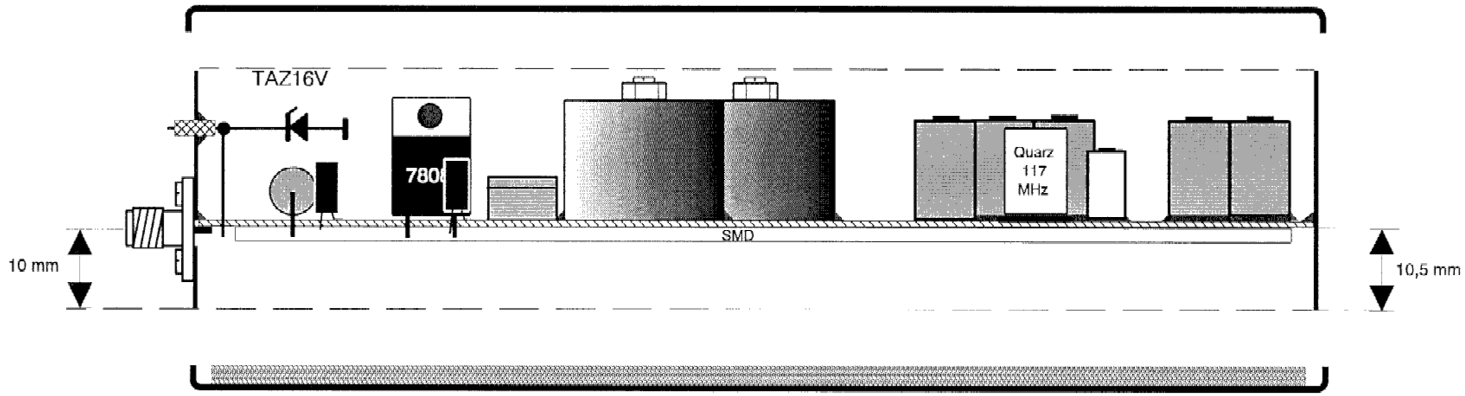


⊗ Durchkontaktierungen
Through-connection

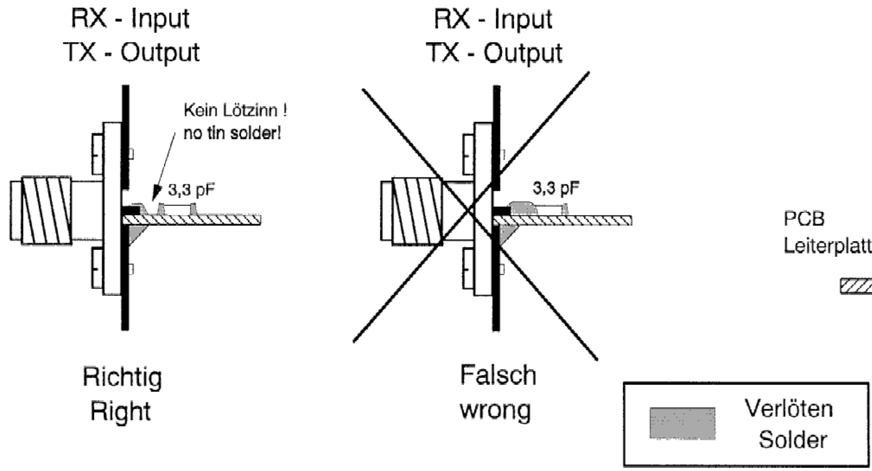
Mit Gehäuserahmen verlöten
To solder with box

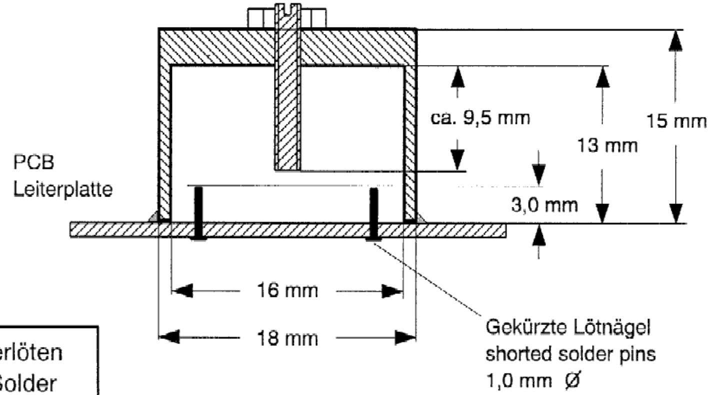
* Widerstand Bauform 0805
Resistor foodprint style 0805

5,7 GHz Transverter MK2 DB 6 NT 5.2000

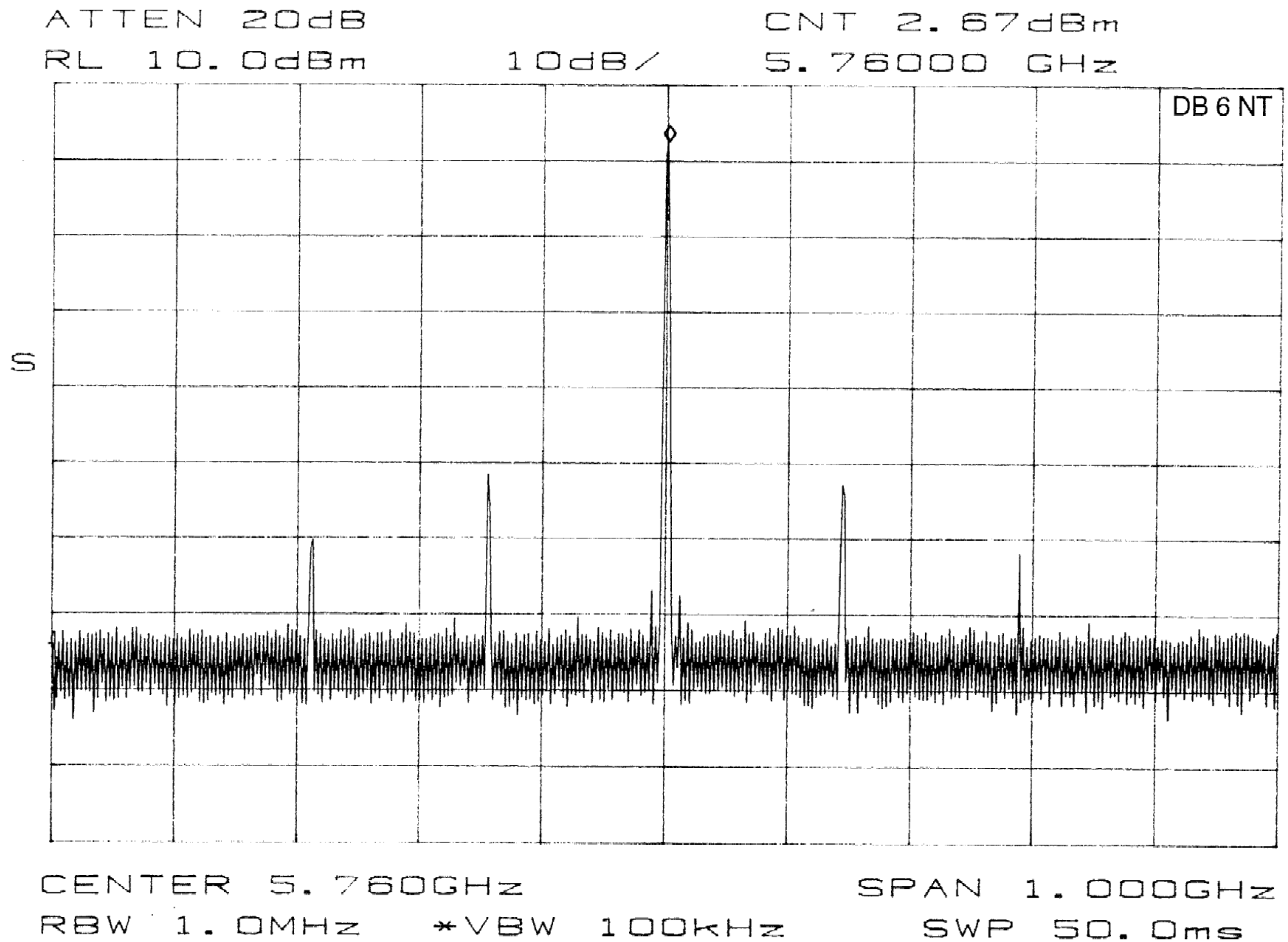


Deckel mit eingeklebtem Leitschaumstoff
Cover with RF- absorbing material



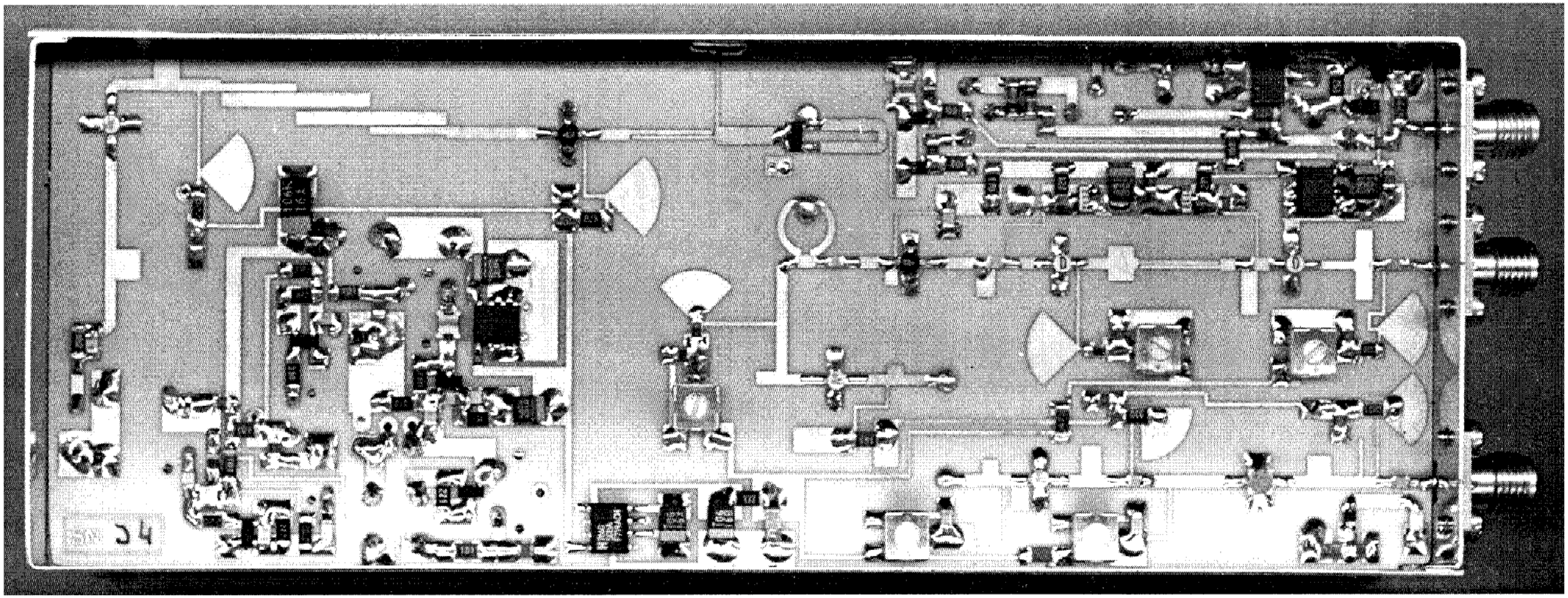


Ausgangssignal des 5,7 GHz Transverters 57 G2



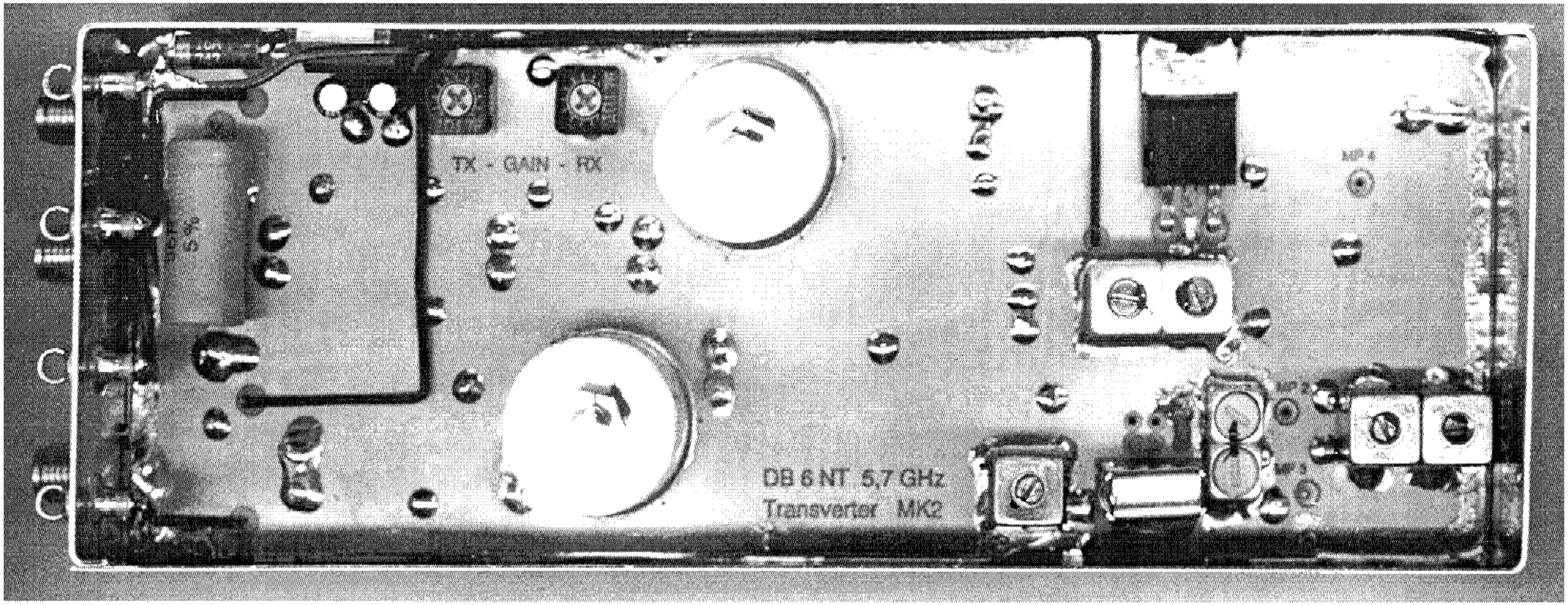
5,7 GHz Transverter MK2 DB 6 NT 11.98

5760 / 144 MHz



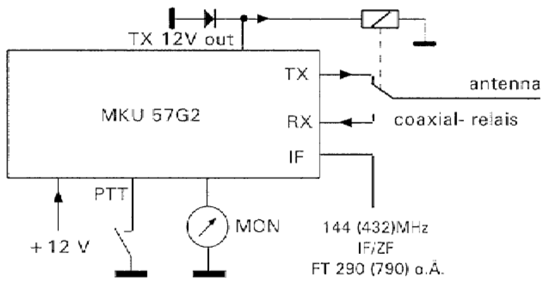
5,7 GHz Transverter MK2 DB 6 NT 11.98

5760 / 144 MHz



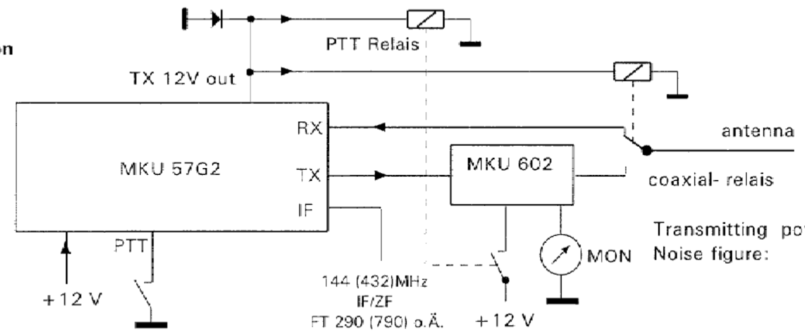
5,7 GHz TRANSVERTER VERSIONS

1.) Version



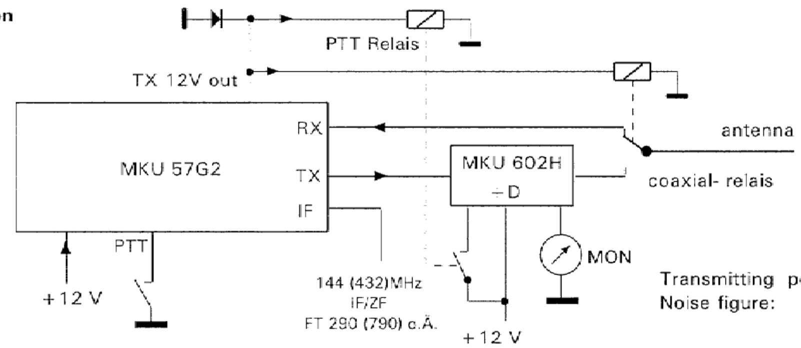
Transmitting power: approx. 0.2 W
Noise figure: approx. 1.2 dB
Basic version

2.) Version



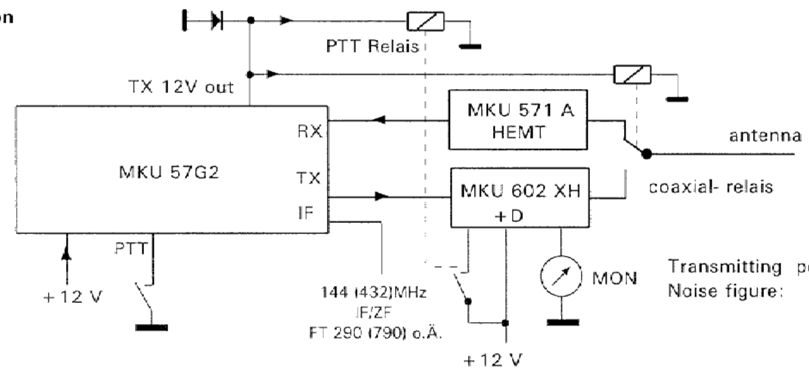
Transmitting power: >4 watt RF
Noise figure: approx. 1.2 dB

3.) Version



Transmitting power: >8 watt RF
Noise figure: approx. 1.2 dB

4.) Version



Transmitting power: typ 15 watt RF
Noise figure: approx. 0.8 dB

Information zur Sende - Empfangsumschaltung der DB6NT Transverter

Um DB6NT Transverter von Senden auf Empfang Umzuschalten sind zwei Möglichkeiten vorgesehen. Zum einem besitzen die Transverter einen " PTT - Anschluss " der bei Sendebetrieb über einen Kontakt nach Masse zu schalten ist. Des weiteren ist die Umschaltmöglichkeit über das ZF - Kabel vorgesehen. Dazu ist eine Spannung von ca. +3...12V im Sendefall auf den Innenleiter der ZF - Buchse zu legen. Das erspart eine zusätzliche Verbindungsleitung zwischen Transceiver und Transverter.
Bei dem Transceiver FT290R und dem IC402 ist diese Umschaltsteuerung bereits eingebaut.
Bei dem FT290RII muß diese Schaltung nachträglich eingebaut werden.
Bei dem IC202 vom ICOM ist diese Steuerung leider Invers eingebaut. Das heißt wenn der Transceiver auf Empfang ist und an den Transverter angesteckt wird schaltet dieser auf Senden!
Es ist eine kleine Änderung im IC202 erforderlich.

Information about RX-TX switching of DB6NT Transverters

To switch the DB6NT transverter from RX to TX you have two possibilities.

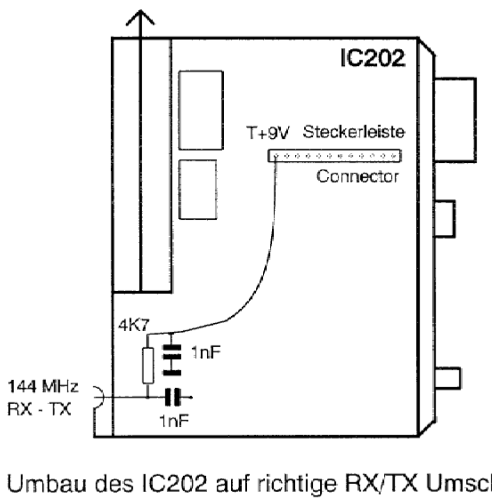
Switch the port "PTT" on the transverter to ground.

Via the IF cable, please apply 3...12 Volt to the center conductor.

You save one additional PTT patch cord between the transverter and transceiver.

In the YAESU FT-290R (old model) and ICOM IC-402 transceiver is the switch over to +12 V at TX on the center conductor build in. For the YAESU FT-290RII (new model) you have to build in a switch over.

IMPORTANT!
The ICOM IC-202 deliver +12 Volt at RX! If you connect a DB6NT transverter to a ICOM IC-202 the transverter will switch over to TX !
With a small modification the ICOM IC-202 will apply +12 Volt on TX.



Umbau des IC202 auf richtige RX/TX Umschaltung.
Modification of T/R - Switching in IC202