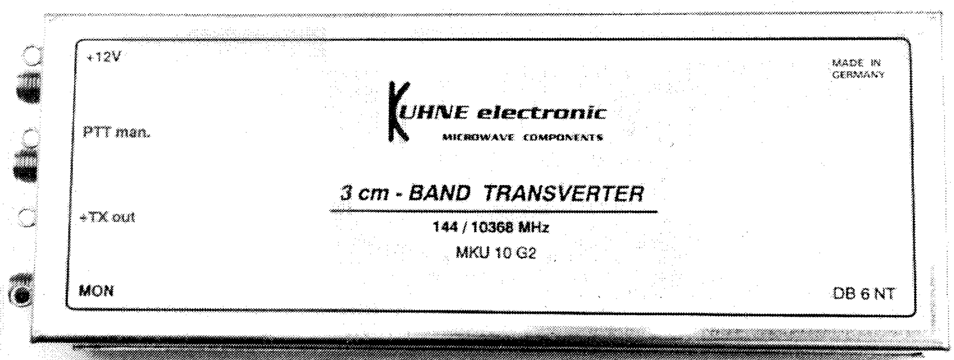
Handbook / Kit

DB 6 NT

10 GHz Transverter MK2



KUHNE electronic
MICROWAVE COMPONENTS

11.99

10 GHz Transverter MK2

DB6NT 11.99

3.Generation

1.Introduction

In 1977 the Dubus magazine puplished the first 10 GHz SSB transverter wich 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 aproach.

During the eighties several descriptions of modular approaches (LO, mixer, Amps) in seperate boxes were puplished (2. Generation).

The current transverter is a singleboard construction on RO4003 substrate. The reciever has a noise figure of 1.2 dB and the transmitter achieves an output power of more than 200mW. The IF is 144MHz and the spurious rejection is better than 40dB. A 432MHz IF can be selected just by change of the crystal in the XO. Then the spurious rejection is eaven 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.

2.Description

LO

The proven „simple“ XO uses the FET SST310 in a grounded gate circut. The crystal frequency for a 144MHz IF is 106.5MHz. The coil is tuned by a M3 brass screw, wich is fitted instead of the usual ferrite tuning screw. An extra 40°C PTC-heater improves the drift characteristic of the XO. Extra pads are provided for fitting additional capactitors wich 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 outboard 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 319.5MHz wich utilises a BFR92A transistor. The third harmonic is filtered by a helix bandfilter and drives the doubler with the BFP196. The output filter sieves the harmonic at 639MHz.
A second doubler with a BFP196 achieves an output frequency of 1278MHz. After another helix bandfilter on 1278MHz a further doubler with a BFP196 achieves an output frequency of 2556MHz. A helix filter is used for selectivity.

Now the chain of bipolars ends and the 2.5GHz signal drives a GaAs-FET quadrupler with a MGF-1902. A microstrip edge coupled filter selects the LO frequency of 10224MHz and drives a further linear amplifier equipped with the MGF-1302. 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 tranceivers have to be modified accordingly.

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

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 save in case of short circut !

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 MES-FET (MGF -1902).
The gain of 30dB renders 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-1902 follow the Wilkinson divider. A subsequent cavity resonator cares for additonal selectivity in the TX-chain needed for suppression on the LO.

Two further stages with a MGF-1902 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.

3.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 be-
ginners project.
The usual ESD protection measures should be obeyed. (see(5) for an execellent 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, to not hurt you!

2. Mark the holes for the SMA-connectors

3. Drill holes for SMA-connectors and feedthrough caps

4. Solder PCB into the box (Fig.4). Use a 10.2mm 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 feedthrough caps. Solder the helix filters (Fig.4). Solder the regulators with their heatsing 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 over night lying on a central heating.

4. Alignment

The following steps are necessary for the alignment:

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. Turn the tuning screw of the oscillator coil until the decrease of the collector voltage indicates the proper oscillation. The measurement should read around 7V.

3. Measure voltage at M1 (Fig. 2). Tune bandfilter F1 (319.5 MHz) to minimum voltage (ca. 6V) at M1.

4. Measure voltage at M2 (Fig. 2). Tune bandfilter F2 (639 MHz) to minimum voltage (ca. 5V) at M2.

5. Measure voltage at M3 (Fig. 2). Tune bandfilter F3 (1278 MHz) to minimum voltage (ca. 5.3V) at M3.

6. Measure voltage at M4 (Fig. 2). Tune bandfilter F4 (2556 MHz) to minimum voltage (ca. 4.5V) at M4.

7. Adujst 10k pot for a reading of 4V at the drain of the MGF1902 (LO-Amplifier).

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

9. Adjust bias for the HEMTs for a reading of 2V at their drain and for the MGF1902 for a reading of 3V at its drain.

10. 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 10368MHz. For verification turn the tuning screw further inwards until you observe a second peak in noise level. This is the lower sideband on 10080MHz. Turn back to the first maximum (Tuning screw is less inside the resonator) and lock with the security nut.

11. Switch transverter to transmit by grounding the PTT input. Connect a 50Ohm dummy load to the TX output. Adjust all FETs in the TX-chain by the appropiate bias pots to the drain voltage given in the circuit diagramm (Fig. 2). Drive the transverter with 1...3W 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 he 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.

12. Reduce the TX-gain by clockwise rotation of the TX-gain pot until the TX output decreases.
13. Connect antenna to RX input. Adjust the XO until a known beacon reads the correct frequency.
14. Take low resistance carbonised foam and glue it into the bottom cover. This damps resonances possible.

That`s all.

5. 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, to Gerd, DG8EB, and to Jürgen, DC0DA, who verified the reproducibility of the design by building this transverter.

6. Literatur / References:

(1) Michael Kuhne, DB6NT, „Simple 10 GHz Transverter“, DUBUS Technik III, DUBUS Verlag, pp. 324-336

(2) Michael Kuhne, DB6NT, and Uwe Nitschke, DF9LN, „LNA for 10 GHz“, DUBUS Technik V, DUBUS Verlag, pp. 191-195

(3) Michael Kuhne, DB6NT, „12 GHz LO“, DUBUS Technik V, pp. 166-174

(4) Uwe Nitschke, DF9LN, „Oscillator for 2,5 GHz“, DUBUS 1/1998, Vol. 27, pp.42-52

(5) Charles Suckling, G6WDG, „Modern 10 GHz Transverter System“, DUBUS Technik IV, pp. 332

(6) ROGERS Leiterplattenmaterial Firma Mauritz Hamburg, Datenblatt RO4003

(7) NEC, Datenblatt NE32584C

(8) MITSUBISHI, Datenbuch GaAs FET´s

(9) SIEMENS, Datenbuch RF-Halbleiter

(10) NEOSID, Datenbuch Helixfilter

(11) TOKO, Datenbuch Helixfilter

Source of supply:

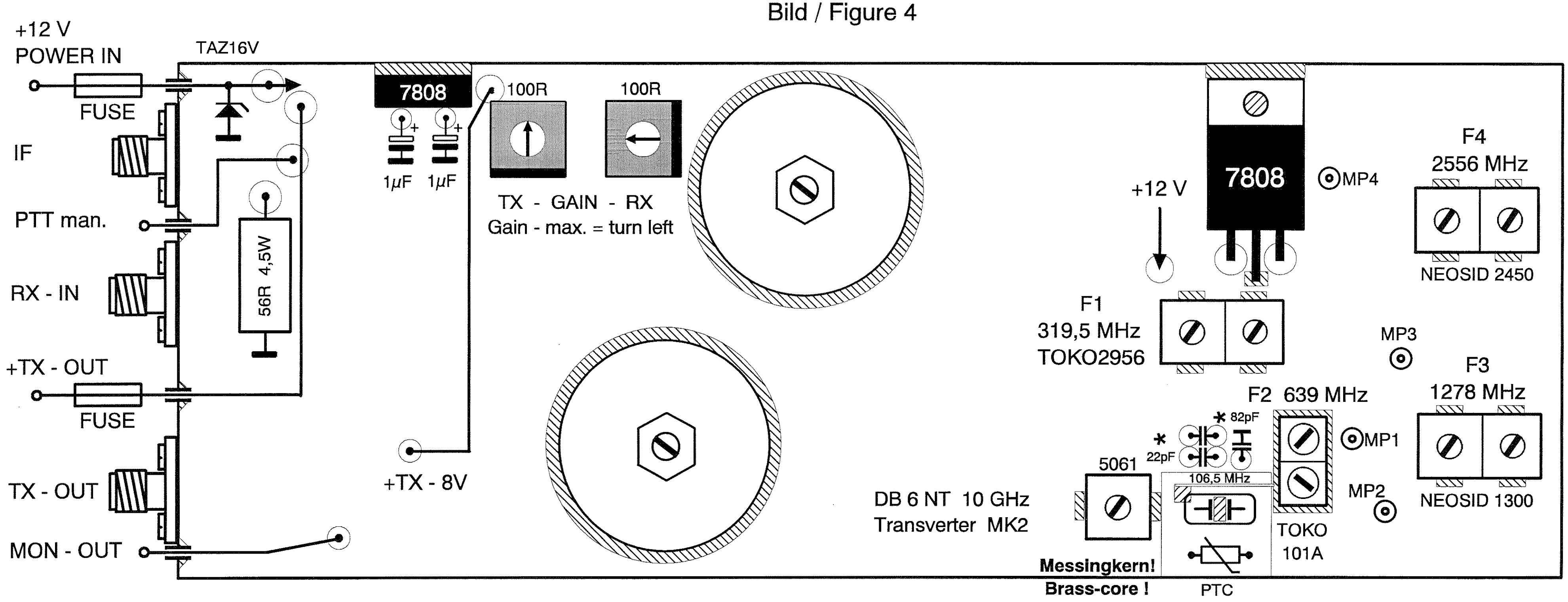
Ready made units or kits:

KUHNE electronic,
Birkenweg 15,
D-95119 NAILA/ Hölle
Tel.: 0049 (0) 9288 8232
Fax: 0049 (0) 9288 1768
Email: kuhne.db6nt.hof.baynet.de
Homepage: www.db6nt.com

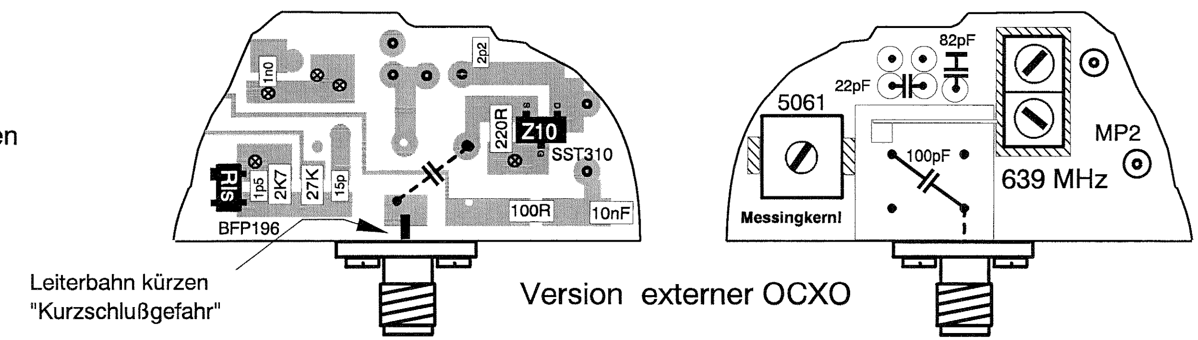
For operating the high frequency modules the legal instructions have to be considered.

10 GHz Transverter MK2 DB 6 NT 11.99

Bild / Figure 4



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

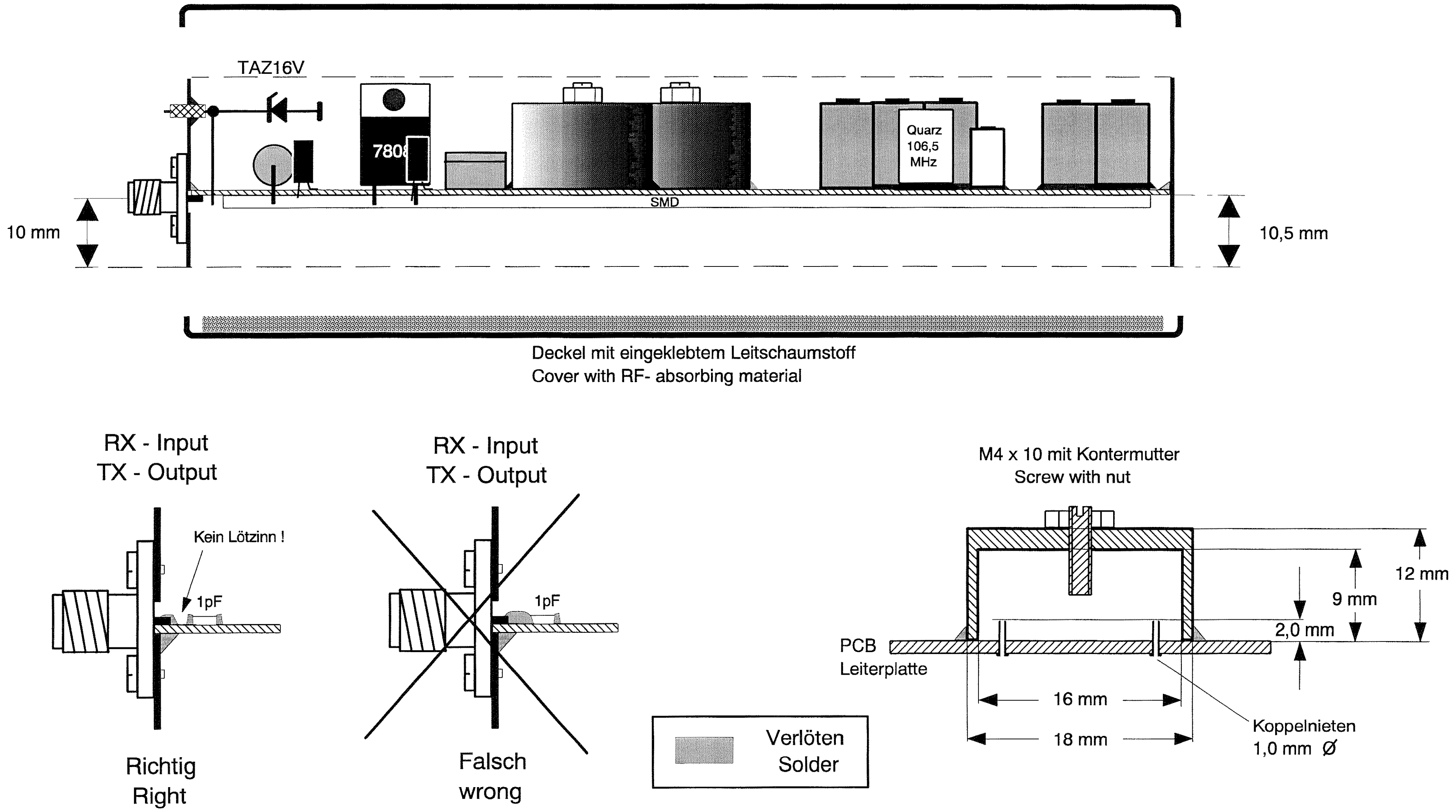


Version externer OCXO

verlöten
to solder

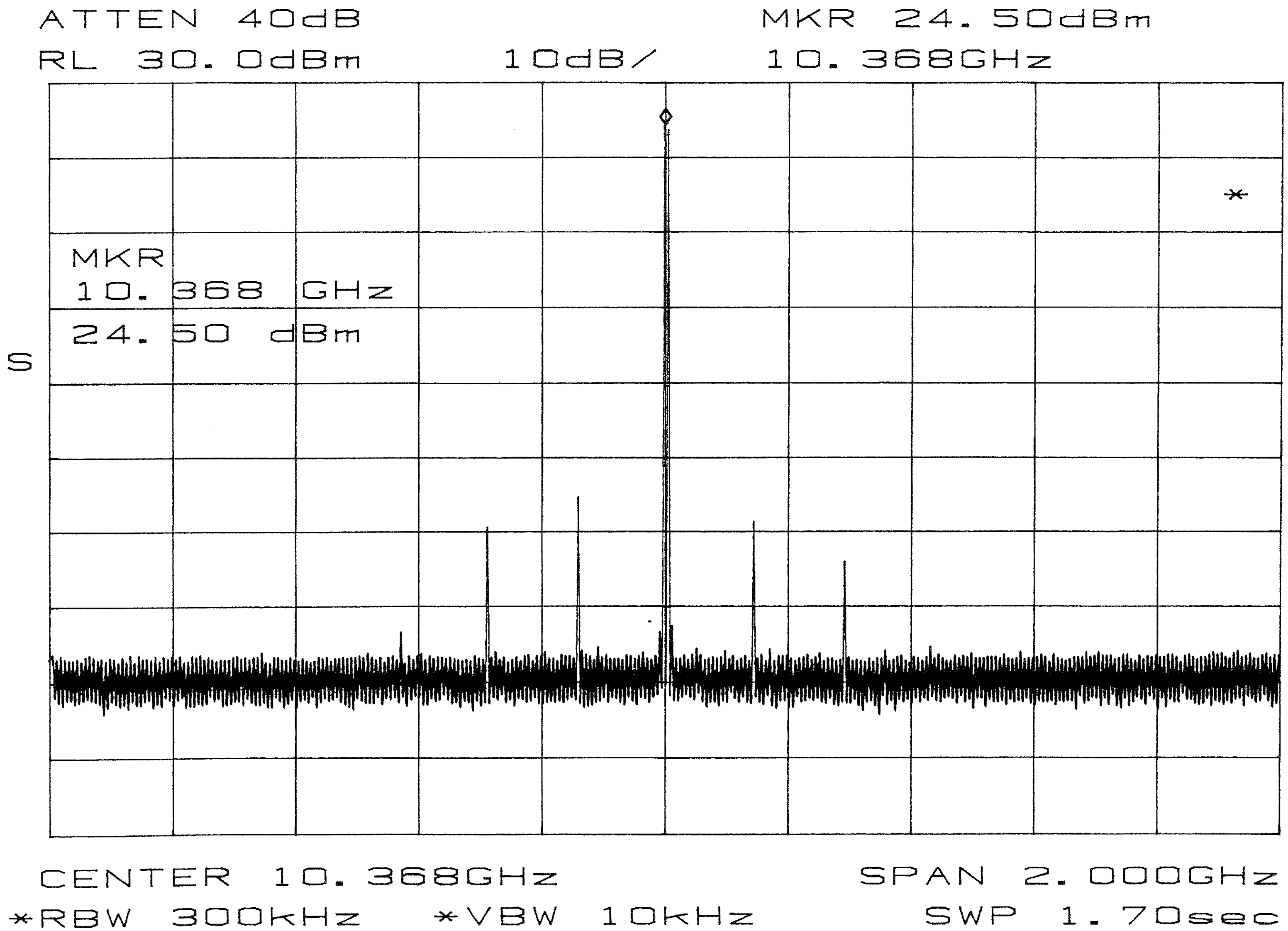
10 GHz Transverter MK2 DB 6 NT 11.99

Bild / Figure 5

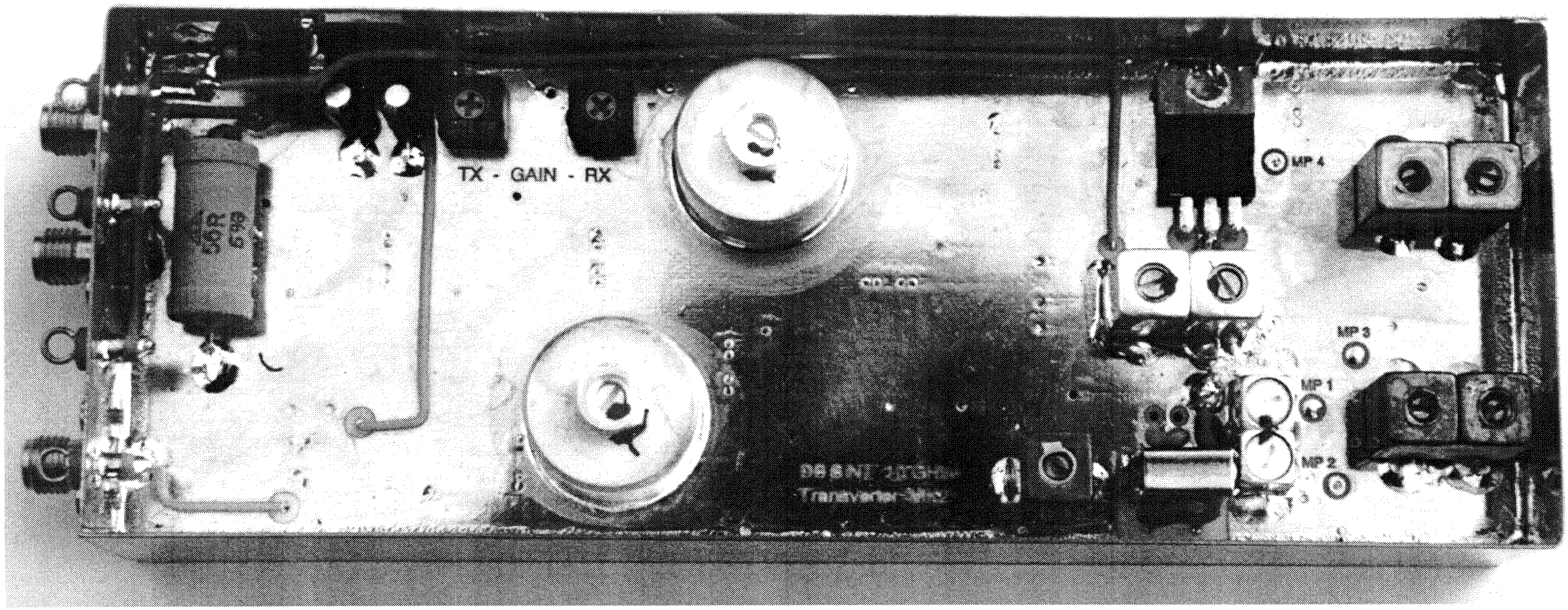


Ausgangssignal des 10 GHz Transverters

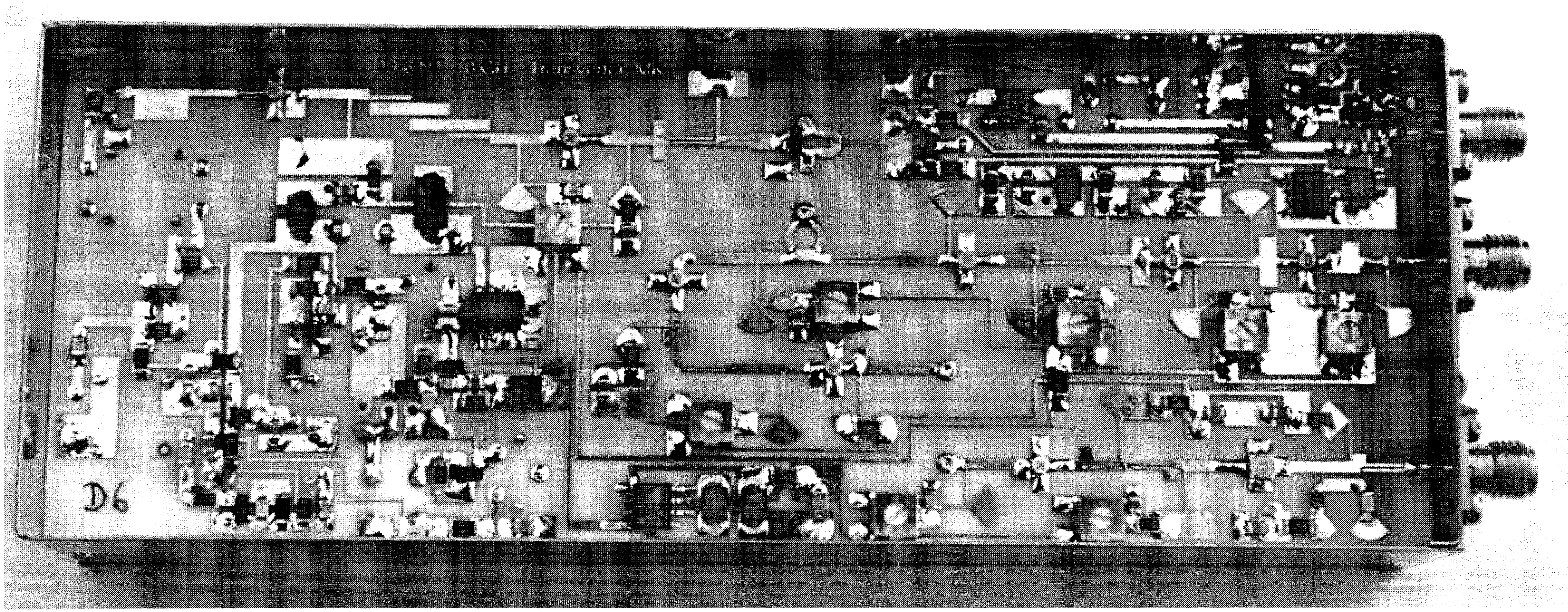
Bild / Figure 6



10 GHz Transverter MK2 DB 6 NT 8.98



10 GHz Transverter MK2 DB 6 NT 8.98



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.

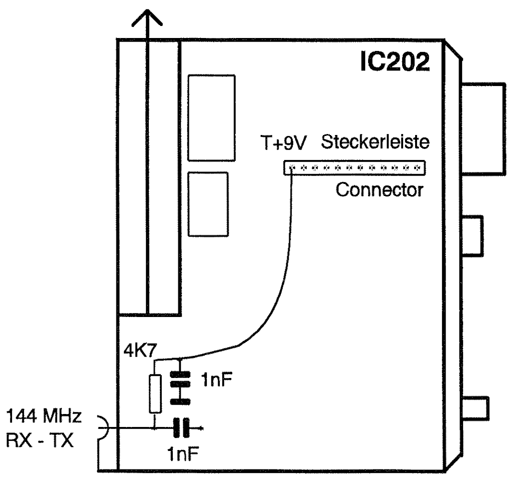
Switch the port "PTT" on the transverter to ground.

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.



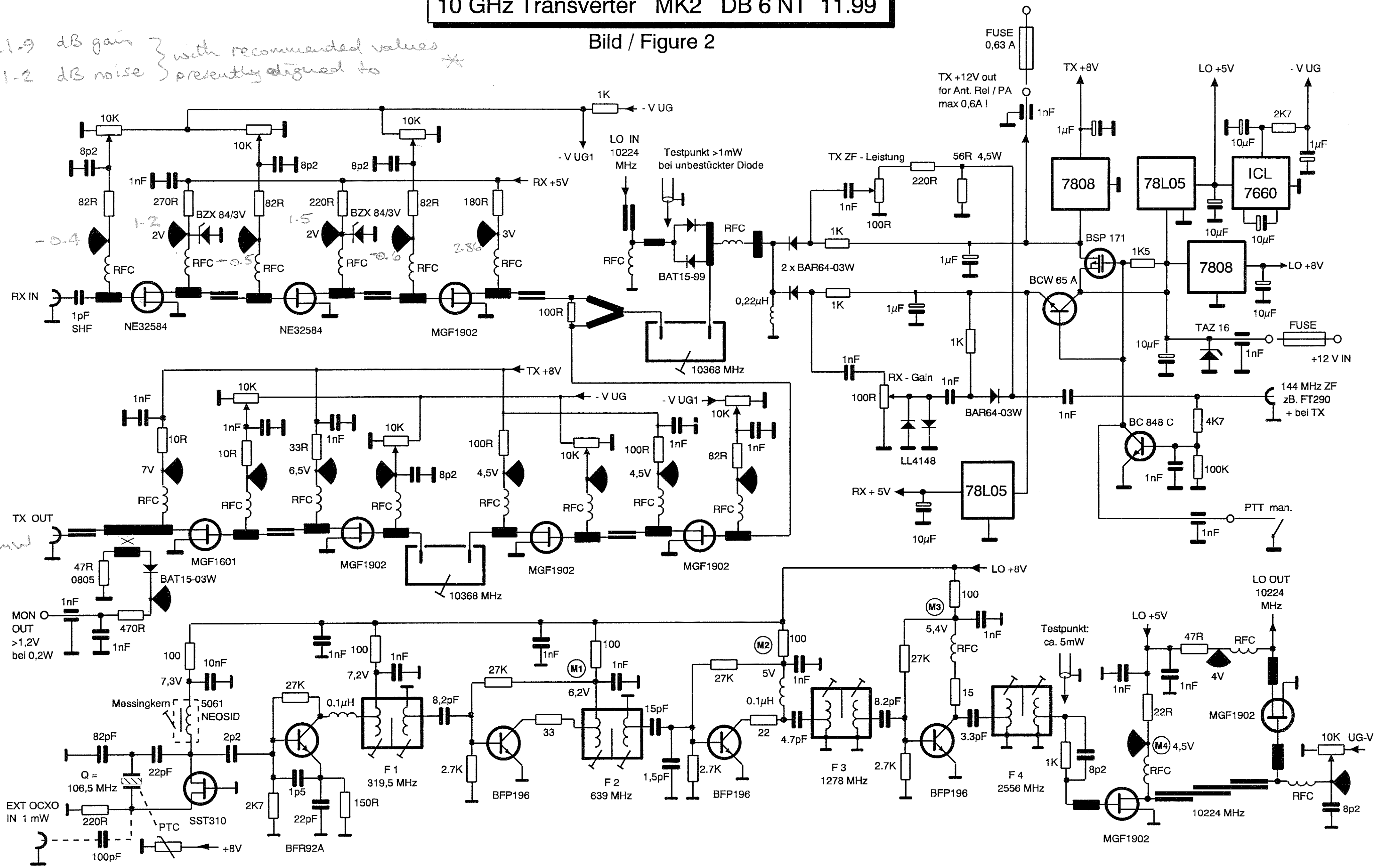
Umbau des IC202 auf richtige RX/TX Umschaltung.
Modification of T/R - Switching in IC202

22.6 dB gain } with pencilled values.
1.2 dB noise } best achieved

21.9 dB gain } with recommended values
1.2 dB noise } presently aligned to *

10 GHz Transverter MK2 DB 6 NT 11.99

Bild / Figure 2

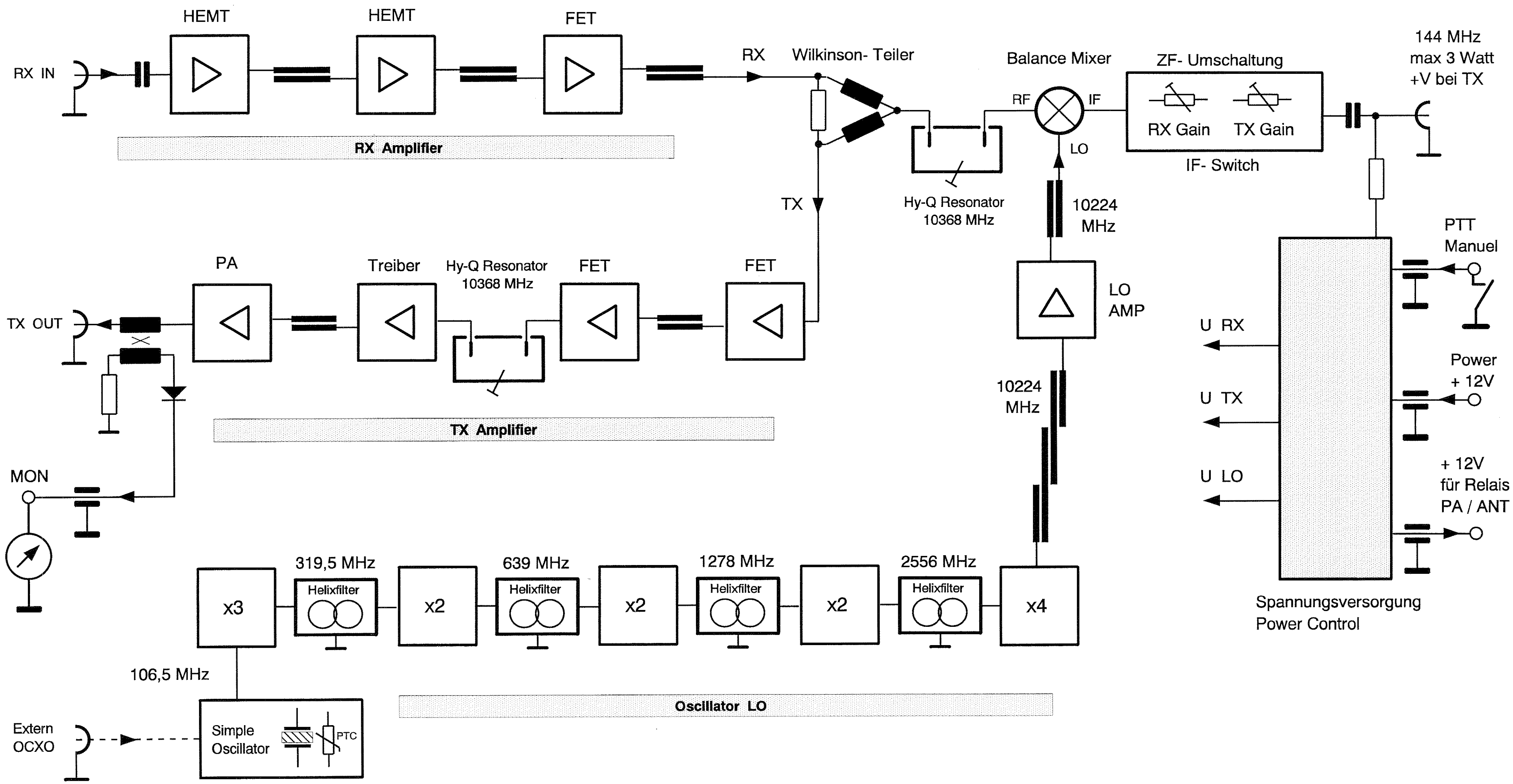


Die Spannungs- und Leistungsangaben sind Messwerte der Prototypen. Die Angaben können durch Bauteiletoleranzen stark abweichen!

10 GHz Transverter MK2 DB 6 NT 8.98

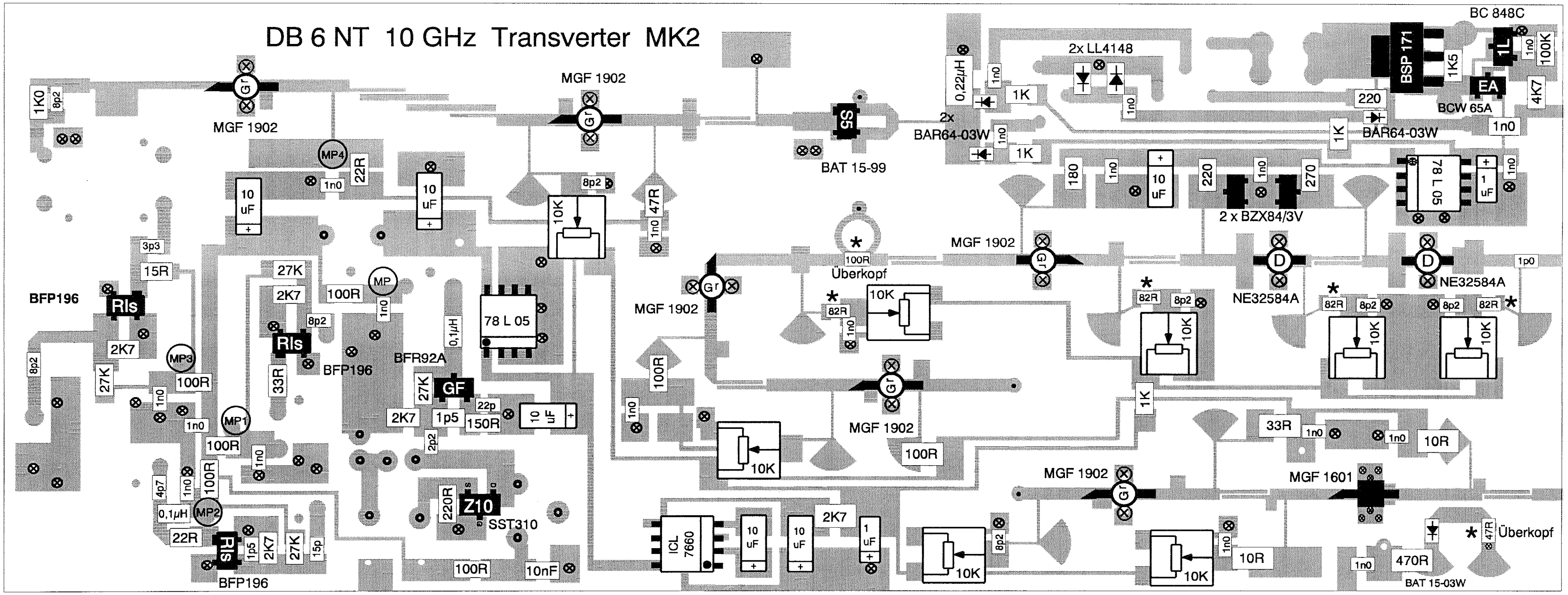
10368 / 144 MHz

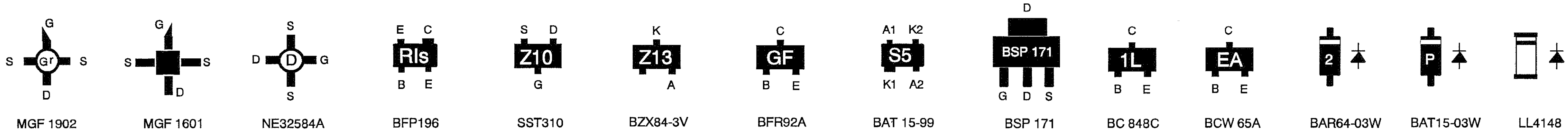
Bild / Figure 1

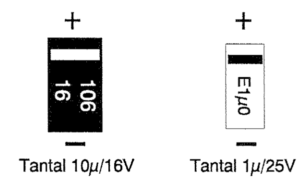


10 GHz Transverter MK2 DB 6 NT 11.99

Bild / Figure 3



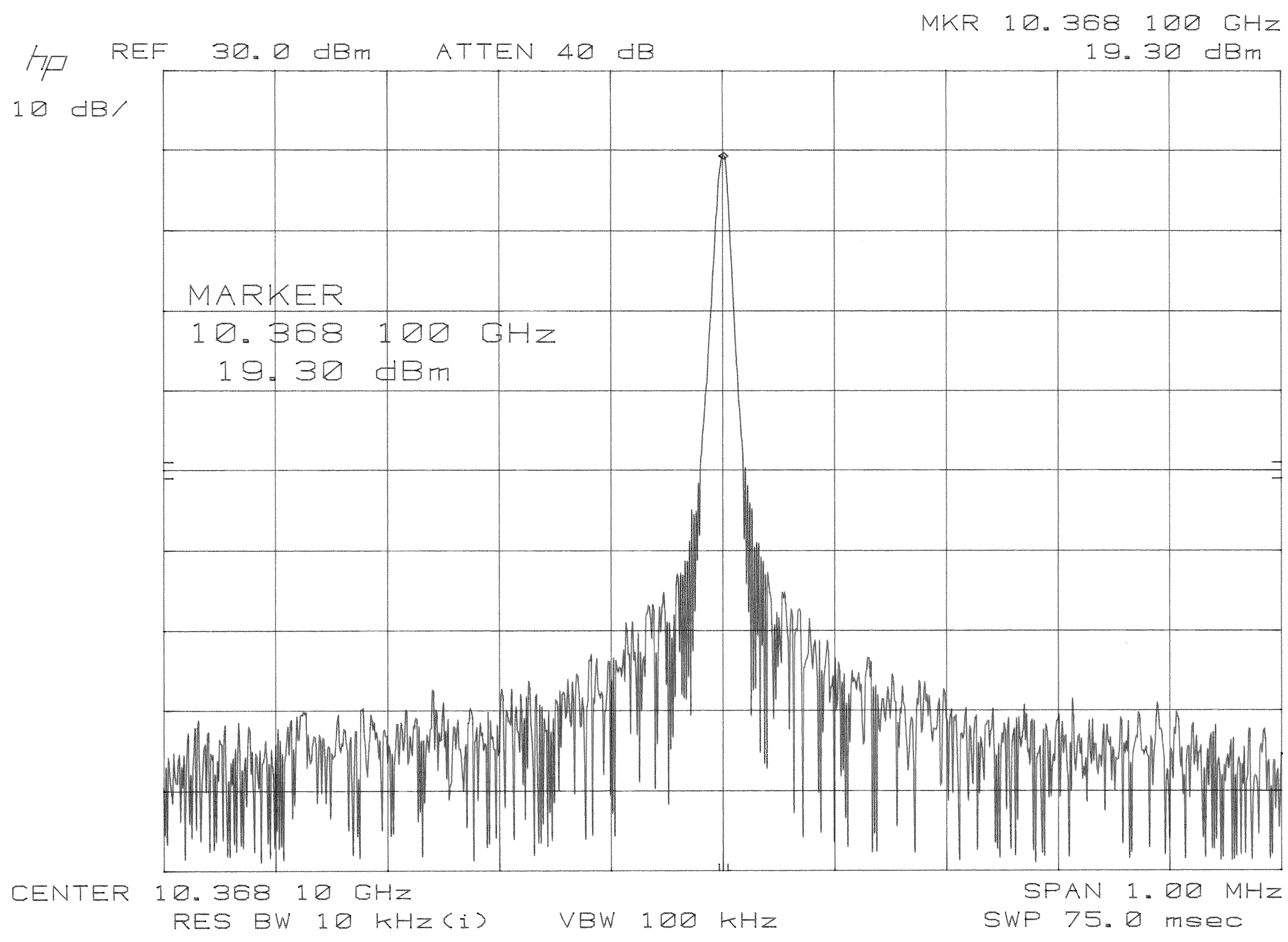


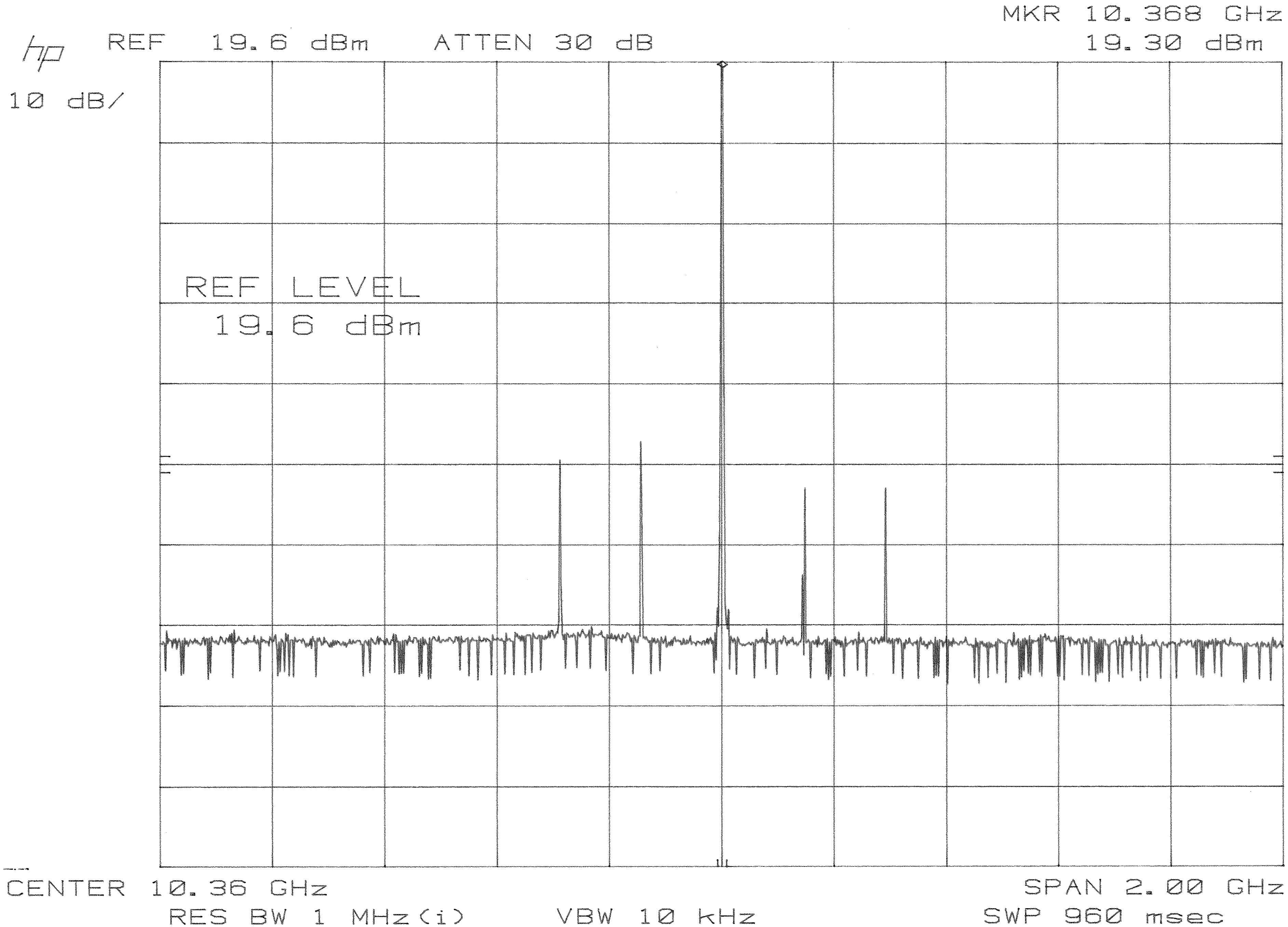


⊗ Durchkontaktierungen
Through-connection

Mit Gehäuserahmen verlöten
To solder with box

* Widerstand Bauform 0805
Resistor foodprint style 0805


hp
REF 30.0 dBm ATTEN 40 dB
MKR 10.368 100 GHz
19.30 dBm
10 dB/
MARKER
10.368 100 GHz
19.30 dBm
CENTER 10.368 10 GHz
RES BW 10 kHz(i) VBW 100 kHz
SPAN 1.00 MHz
SWP 75.0 msec


hp
REF 19.6 dBm
ATTEN 30 dB
MKR 10.368 GHz
19.30 dBm
10 dB/
REF LEVEL
19.6 dBm
CENTER 10.36 GHz
SPAN 2.00 GHz
RES BW 1 MHz(i)
VBW 10 kHz
SWP 960 msec