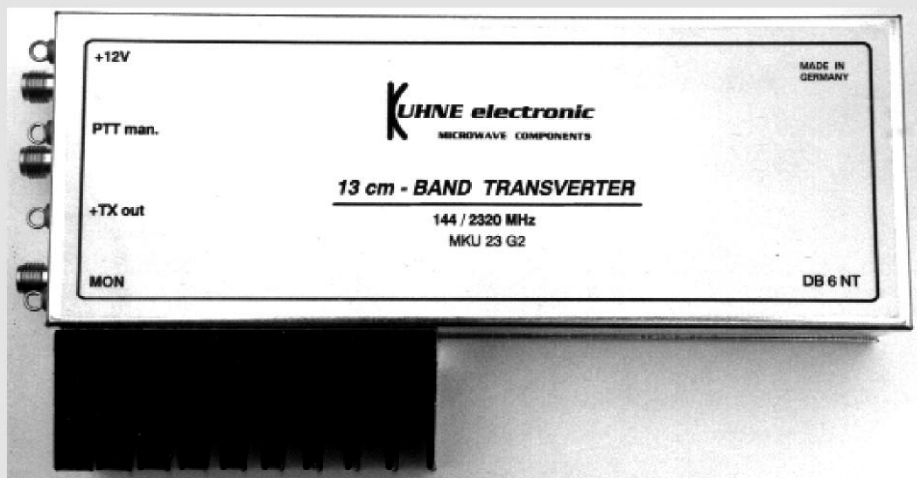


Handbook / Kit

DB 6 NT 2,3 GHz Transverter MK2



KUHNE electronic GmbH
MICROWAVE COMPONENTS

2.2009

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2.3 GHz Transverter MK2

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Introduction

This transverter is a further development of the schematic published in 1993. Technical data of the assembly were further improved by the application of modern semiconductor devices. Redesign of the printed circuit board in respect to cooling of the high power devices improves the general performance of the transverter; its duplication has been further simplified.

The circuitry has been laid out on a ceramic-filled epoxy substrate. The receiver section achieves a noise figure (NF) of less than **0.8 dB** at an **amplification of more than 20 dB**.

This eliminates the need for an external preamplifier.

The transmitter section produces an output power **>1W**; **suppression of spurious emissions is -60 dB (typ.) while harmonics are being suppressed by -30 dB (typ.)**.

The transverter has been designed for the linear transfer of the 2 m band to the narrow band amateur section of the 13 cm band (2320...2322 MHz); by some small modifications it may be tuned for the Oscar P3D frequency of 2400...2402 MHz. 2 meter driving power can be adjusted from 0.5...3 Watts; a change of a resistor will even allow a driving power of 10 mW. Driving power should not be too high; this avoids unnecessary heating of the IF-subassembly due to power dissipation.

The entire transverter fits into a tinsplate case measuring 60 x 150 x 30 mm. This includes IF switching, output control for coax-relays or final amplifier, crystal oscillator and local oscillator circuitry. No elaborate RF measuring equipment is needed for its alignment; a simple voltage measuring instrument will do.

Description of circuitry

The well proven "Simple Quartz Oscillator" with its FET SST310 operates at 120.889 MHz. Frequency tuning is achieved by the brass slug in the oscillator coil. A heater which is mounted on a 40° C thermostat crystal stabilizes the crystal temperature and keeps the frequency drift in limits. Application of relevant capacitors (TK. Marked with * in the schematic) will result a temperature compensation. Two capacitor soldering points have been provided for this feature. Stability should be sufficient for average working conditions. Should there be the need for an exact and highly stable frequency, an oven-controlled oscillator (DF9LN) with an output of approx. 1 mW may be connected to the circuitry at the marked location. For this change the original crystal must be removed.

Following the oscillator is a tripler with a BFR92. A frequency of 362 MHz is being selected by a helix filter and then is being coupled into a tripler with a BFG93A. After an additional helix filter, which is to be tuned to 1088 MHz, the signal is being passed to a frequency doubler. After a helix filter with a final local oscillator (LO) frequency of 2176 MHz a LO-power of 5 mW is available.

The IF signal is being passed through individually tunable attenuator pads for transmitter and receiver; switching occurs by PIN-diodes.

Transmit/receive switching of the entire transverter is being controlled by a positive voltage during TX of the IF control cable; e.g. such a voltage is available at the output of the FT290R. Other transceivers need a small modification: connect a positive voltage, that is being

generated within the transceiver during transmit mode, to the output connector via a 2K2 resistor. That's all! This type of control needs no additional control cables and has been well proven over the years. Naturally it is also possible to achieve conventional switchover with a PTT contact to ground.

Switching of operating voltages within the transverter is being controlled by transistors. Switching voltage of the transmitter is being externally provided and may be used for the control of coax-relays or final amplifiers (max. load 2 A). This output must be protected by a fine-wire fuse under all circumstances.

The receiving section has a preamplifier stage with a HEMT - FET and an additional MMIC with a total amplification of >30 dB. This eliminates the need for an additional IF-amplifier. The input signal is being coupled to a noise-adapted NE32584C via a 4.7 pF capacitor, The second stage with the MMIC - MGA86563 follows via the multi-layer ceramic filter F6. A RX-TX PIN diode switch is being followed by another helix filter F4 and the ring mixer.

During transmit the TX-signal is being passed to a MMIC amplifier stage via the helix filter F4 following the mixer. The signal reaches a second MMIC ERA 5-SM after passing an additional helix filter F5 used for suppression of spurious emissions. The following final stage is equipped with a GaAs power FET MGF 0904.

The transmitter output has a directional coupler with the Schottky-diode BAT62-03W. It facilitates monitoring of the output power (monitoring MON.) and supports the alignment of the circuitry.

Construction:

Experience in handling SMD-parts is absolutely essential. Under no circumstances should this become "a first" in working with SMD, as extremely small parts are being used. Also some basic knowledge concerning the construction of VHF circuits is desirable.

Some parts, for example FET's, are very susceptible to static discharges.

It is urgently recommended to adhere to "ESD" protective measures during construction.

This incorporates a grounded and temperature controlled SMD-soldering station as well as a conductive and grounded workpad.

Sequence of construction steps:

- a. Fitting of the printed circuit boards into the tinfoil case by filing down the corners.
- b. Marking of the holes on the box for insertion of the SMA-coax connectors.
- c. Drilling of holes for connectors and feed-through capacitors.
Tapping for M2 screws of the SMA-connectors.
Shortening of SMA-connector pins to approx. 2.3 mm length.
Mounting of SMA-connectors.

- d. Soldering of printed circuit boards into the case (see drawing)
Solder all the way around! A 10.2 mm thick wooden board should be used as a support to achieve uniform positioning of the printed circuit board.
- e. Applying component parts and insertion of feed-through capacitors.
Consult the component layout plan for soldering the helix filters.
The cooling flange of the constant voltage regulator L4940V10 must be soldered to the tinplate case; its middle pin should be broken off. The FET BUZ 171 should be pressed all the way down onto the printed circuit board and its pins then be soldered. Otherwise there could be the possibility of the cooling flange causing a short at the lid of the case. 0.5 mm soldering wire should be used for the SMD components. After completion of the soldering the module should be washed in alcohol. Should an ultrasound cleaning device be used, the crystal should be soldered into the circuitry after completion of the cleansing. (Crystals may be damaged by intense ultrasound.)
Drying at 80° C for one hour in an oven or overnight on a warm heater element.
- f. Insertion of the cooling block into the case and marking of the 2 holes that will later be used to hold the finned cooling block (drill diameter approx. 3.5 to 4 mm; smoothen the edges). Before bolting together, some heat conducting paste should be applied between cooling block, the wall of the case and the finned cooling block. Mounting the M3 x 25 mm hex screws as well as the four M2 x 4 mm screws around the final transistor should be done alternatively; any air gap between printed circuit board and the cooling block must be avoided. Some heat conducting paste should also be used when mounting the final transistor.

Alignment:

- a. Applying of +12 V operating voltage by using a power supply with a 1 A (approx.) current limiter. Verifying of operating voltages at the constant voltage regulators.
- b. Measuring of the collector voltage of the BFR92 doubler at test point 1. Screw the brass slug into the oscillator coil -- use a paper strip for "slug friction"! When oscillation occurs the voltage should drop to approx. 7.2 V.
- c. Measuring of the voltage at test point 2. By alternatively tuning the 362 MHz band filter -F1-, a minimum voltage of approx. 6.2 V should be achieved (max. current = optimum drive).
Should the ceramic screws be adjusted frequently, metal shavings will collect on their surface. An indication is a "jumpy" behavior when tuning. The coating can be removed with a fiber glass pen.
- d. Measuring of the voltage at test point 3. By alternatively tuning the 1088 MHz band filter -F2-, a minimum voltage of 6.6 V should be achieved (max. current = optimum drive).
- e. Screw in the brass tuning slugs according to the measurements given in the parts layout plan (Filter F3, F4 and F5).
- f. Connect a suitable antenna or a dummy load to the antenna connector of the receiver

section. Measuring of the voltage at the drain of preamp transistor NE32584C and adjustment to approx. 2 V by the 10K potentiometer at the gate of the FET's.

- g.** Connect a 2 m receiver in SSB mode to the IF output. Potentiometers for RX- and TX-gain should be in the full counter-clockwise position (max. amplification). An increase in noise level should be heard in the 2 m receiver. Maximum noise and thereby maximum receiver amplification should be achieved by alternative tuning of helix filter F4. Afterwards LO-filter F3 should be adjusted. If the S-meter of the 2 m transceiver shows more than S1, the amplification of the transverter may be adjusted with the RX-gain control. This terminates tuning of the receiver section.
- h.** Connect a suitable antenna or a dummy load to the transmitter output. Switch transverter to position "Senden" (= transmit).
Adjustment of the idling current of the final amplifier to 220 mA or 9.5 V at the drain of the transistor.
Apply a 2 m driving power of 0.5....3 Watts.
Measuring of the monitor voltage at the directional coupler. This is a DC-voltage measurement which is directly proportional to the output power.
Now helix filter F5 should be adjusted to maximum monitor voltage (= output power).

Reduction of monitor voltage to approx. 1 volt by turning TX-gain potentiometer clockwise. Maximum output power should be tuned by fine tuning helix circuit -F5- (2320 MHz) and LO-filter -F3- (2176 MHz).
- i.** Adjustment of transmitting power by tuning the TX-gain potentiometer while monitoring the voltage of the directional coupler. In order to assure operation within the linear portion of the transverter, output power should be adjusted to 80% of the maximum value.
- j.** Connect a receiving antenna. Adjustment of oscillator frequency by tuning to a known beacon. Should it not be possible to tune to the desired frequency, a choke of 0.22 μ H can be soldered in parallel to the crystal.
- k.** Install the entire transverter into an enclosure. For better cooling the transverter should be mounted onto the chassis. Specially tapped holes have been provided in the cooling block. A good cooling also prevents frequency drifting of the oscillator.
A suitable coax relay facilitates transmit-receive switching.

This is it! Ready to go on the Air!

Special thanks go to Lorenz **DL6NCI** whose “building” experience and numerous suggestions eventually led to series production standard of the transverter. I also would like to thank Gert **DG8EB**, Richard **DF5SL** and Norbert **DL4DTU** who verified 100% reproduction of the circuitry by “copying” the prototype construction.

References:

1. Rogers printed circuit board material, Mauritz Co Hamburg, data sheet RO4003
2. NEC data sheet NE32584C
3. Siemens data tables on RF semiconductors
4. NEOSID filter data tables
5. Philips semiconductor data tables
6. Toko helix filter data tables
7. Mini-Circuits data sheet on ring mixers
8. “Transverter for 2.3 GHz by DB6NT”, DUBUS 3/93 (Dubus book IV respectively)

Purchasing hints:

Complete modules or kits

KUHNE electronic GmbH,

Scheibenacker 3

D-95180 BERG

Tel.: 0049 (0) 9293 800 939

Fax: 0049 (0) 9293 800 938

Email: info@ kuhne-electronic.de

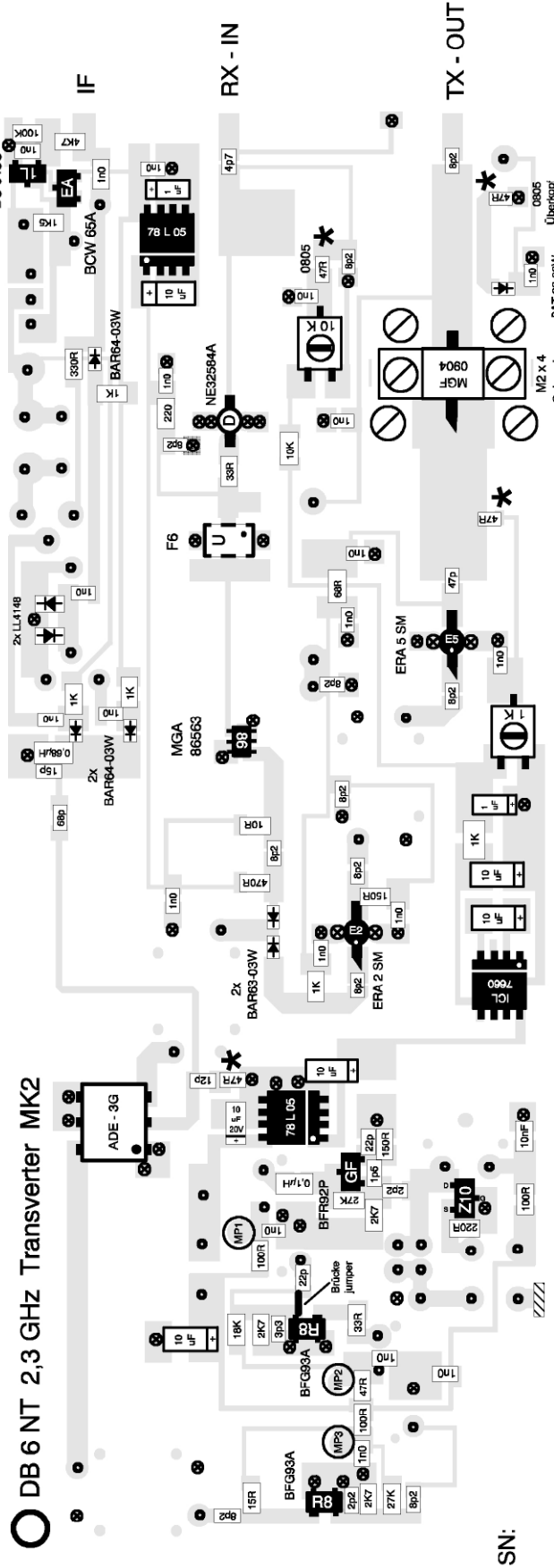
www.kuhne-electronic.de

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Transmit/receive systems may only be operated when complying with legal regulations.

2,3 GHz Transverter MK2 DB 6 NT 2.2009

Version " OSCAR P3D 2400 MHz "



Legend:

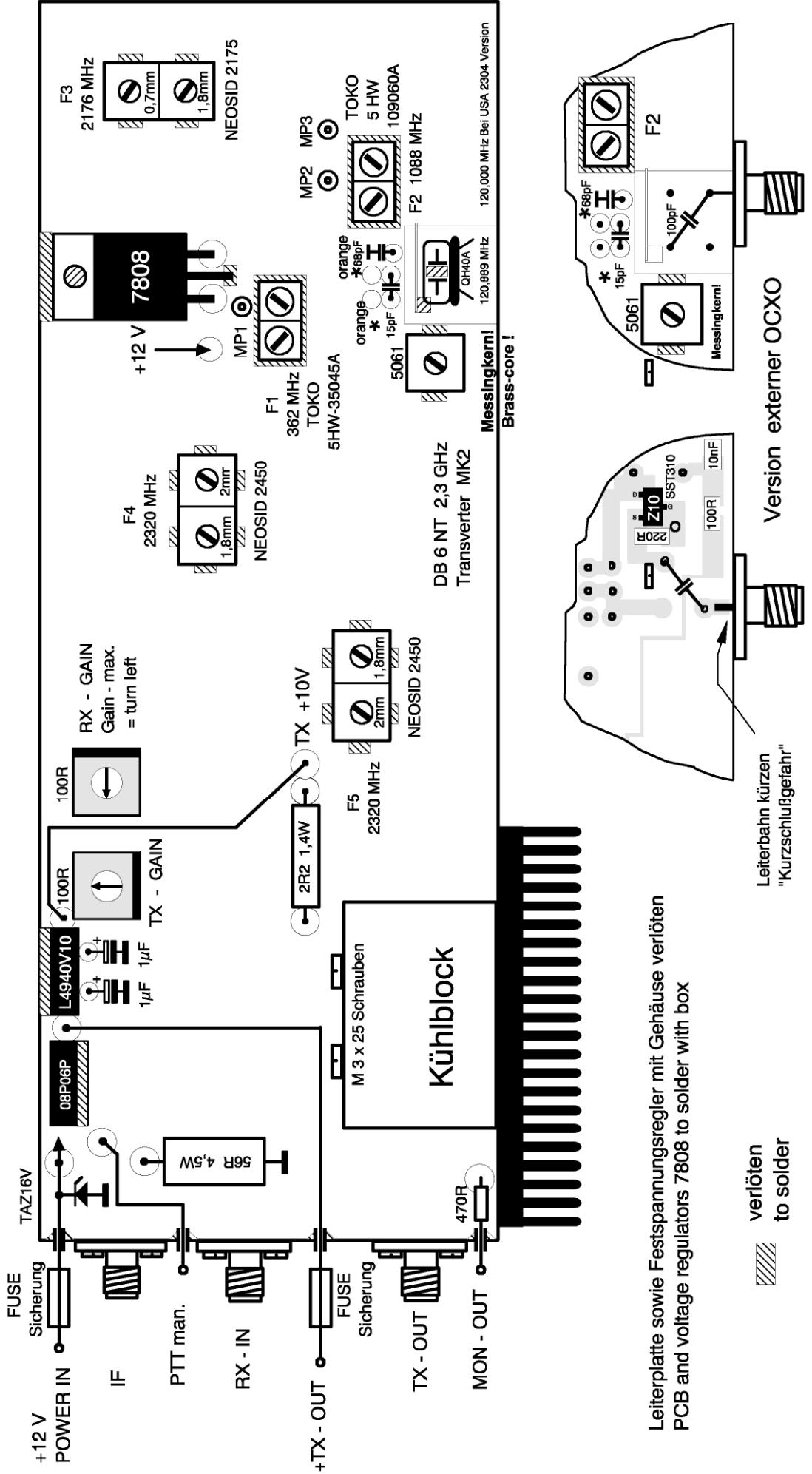
- Masse ground
- Filter
- Durchkontaktierungen Through-connection
- Mit Gehäuserahmen verlöteten To solder with box
- Widerstand Bauform 0805 Resistor footprint style 0805
- BC 848C
- MGA 86563
- ERA 2 SM
- ERA 5 SM
- BFR92P
- ADE-3G
- BFG 93A
- SST310
- BCW 65A
- NE32584A
- M2 X 4 Schrauben
- BAT 62-03W
- 0805 Überkopf upside down
- BC 848C
- BAR64-03W
- LL4148
- MGF 0904
- Tantal 10µ/16V
- Tantal 1µ/25V

* Important for BFG 93A: only the pins indicate the correct transistor orientation (wide pin is C). The orientation of the package marking may vary!

* Wichtig beim BFG 93A: für die Anschlussbelegung sind nur die Pinbreiten (der breite Pin ist C) relevant. Die Orientierung der Gehäusemarkierung kann variieren!

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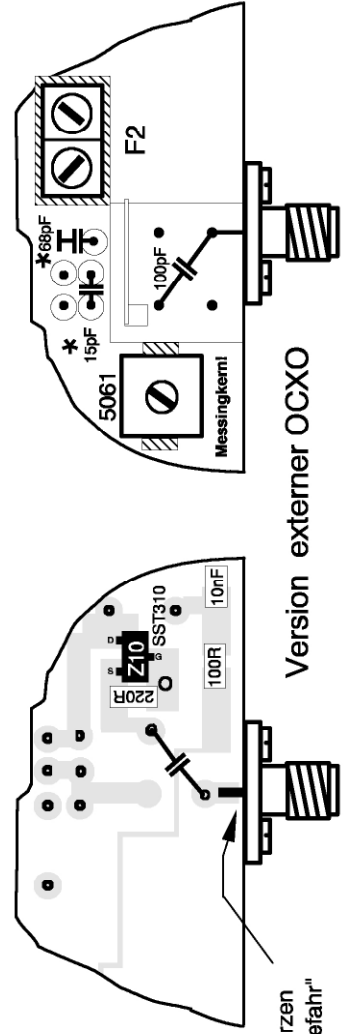
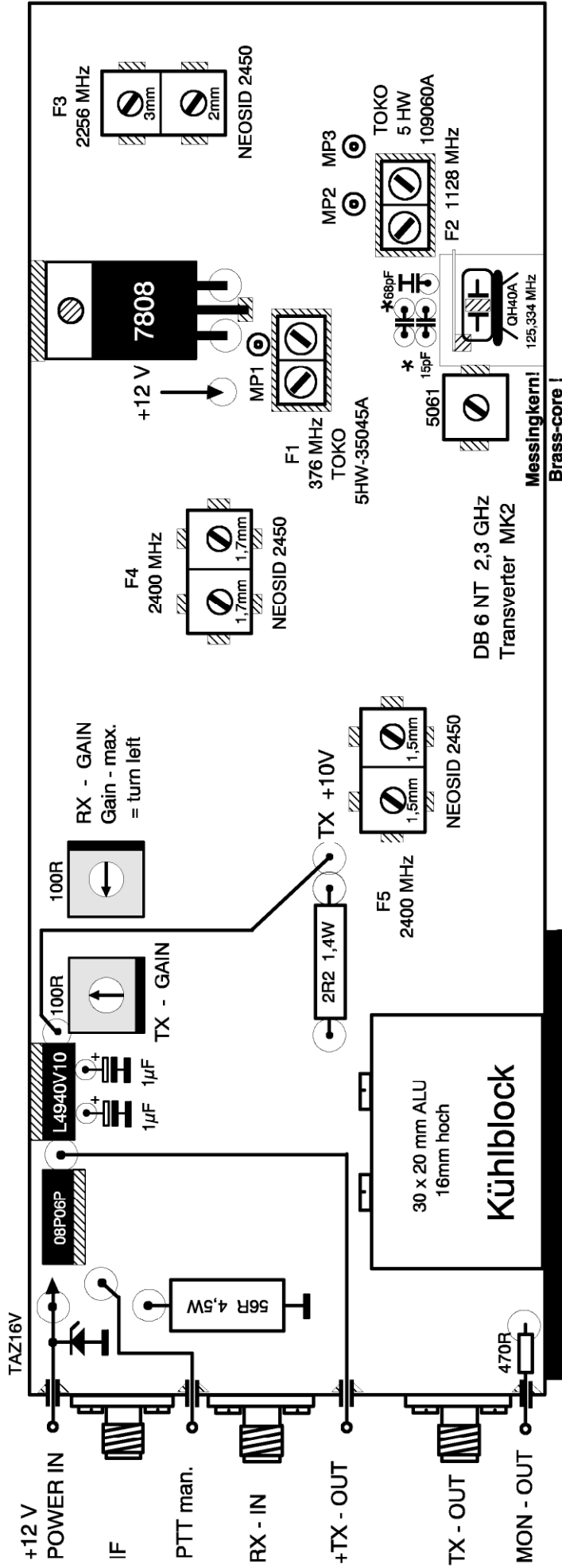
Version " 2304 / 2320 MHz "



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

2,4 GHz Transverter MK2 DB 6 NT 2.2009

Version "OSCAR P3D 2400 MHz"

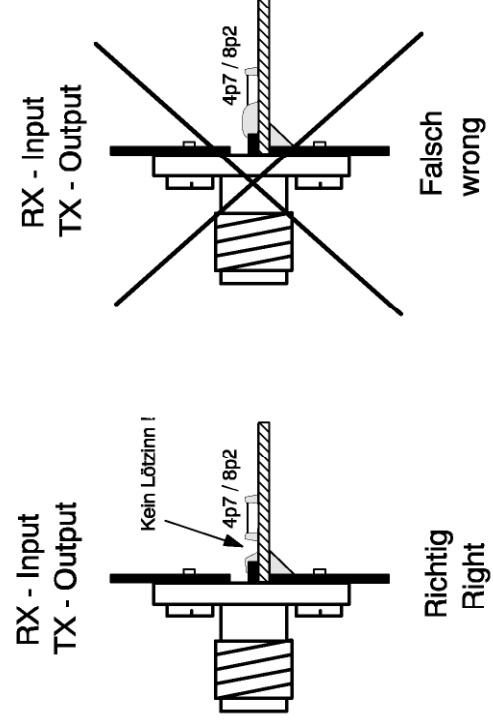
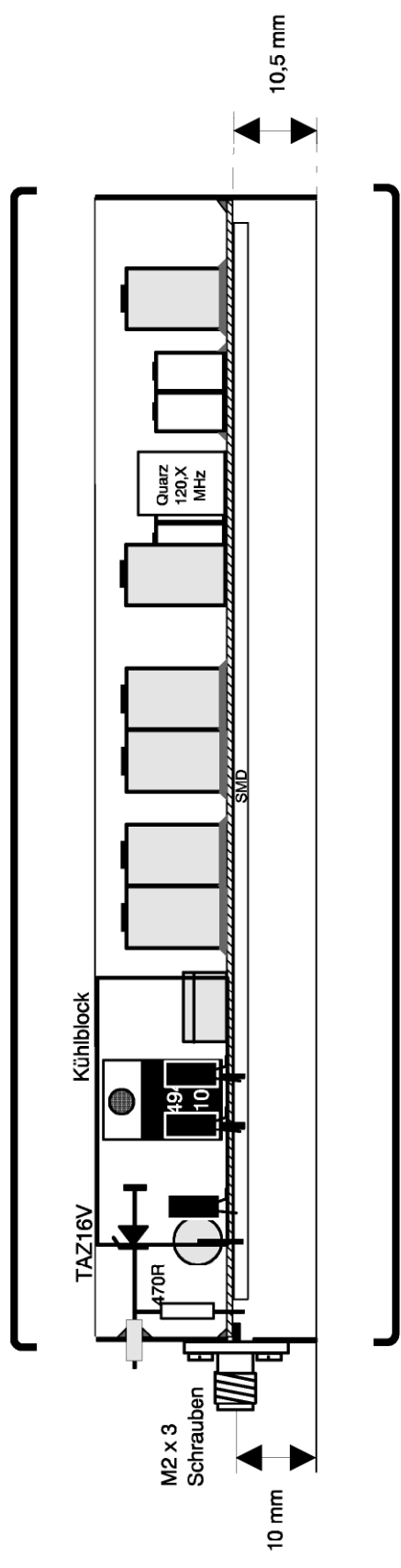


Leiterplatte sowie Festspannungsregler mit Gehäuse verlöten
 PCB and voltage regulators 7808 to solder with box

verlöten
 to solder

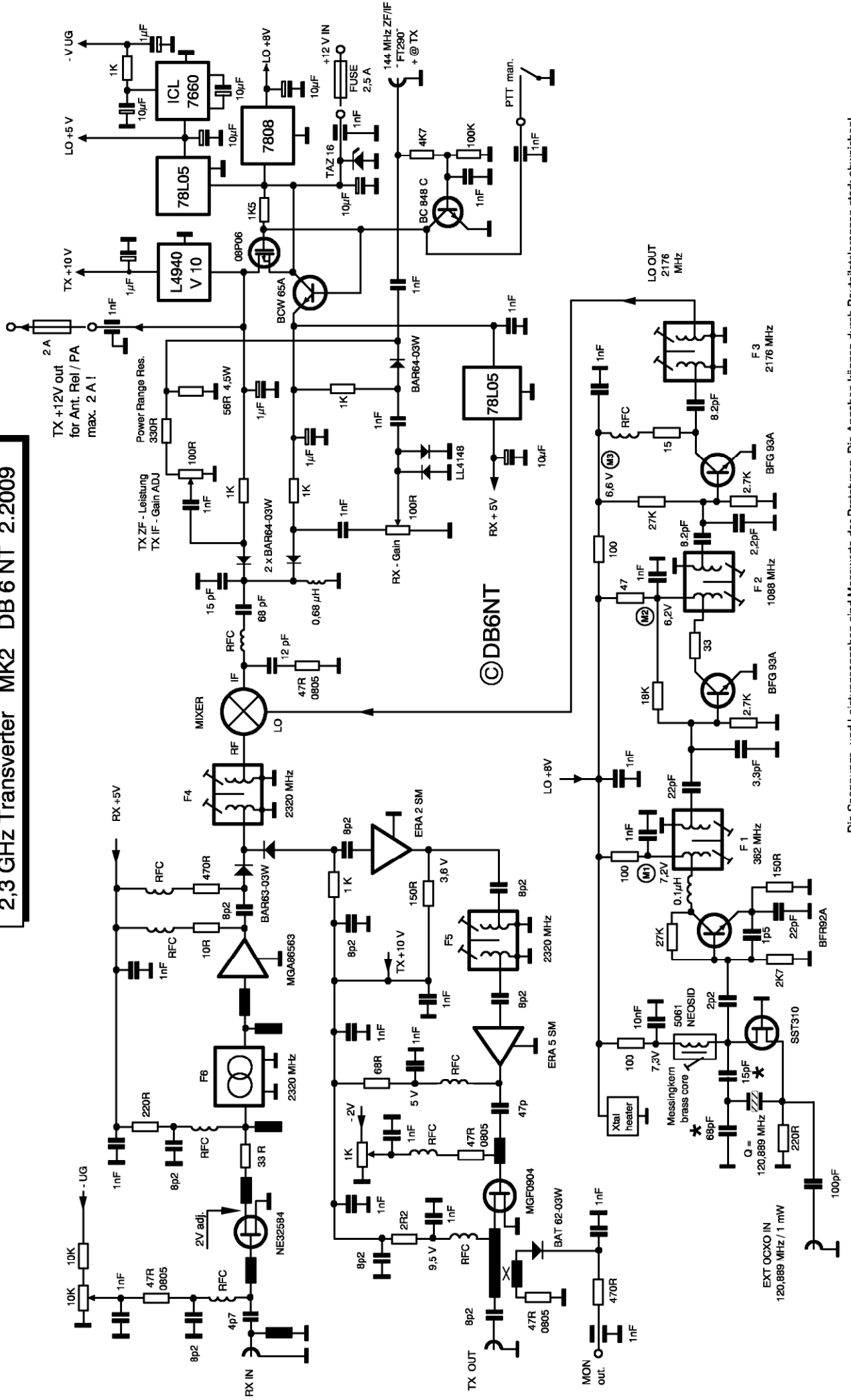
Leiterbahn kürzen
 "Kurzschlußgefahr"

2,3 GHz Transverter MK2 DB 6 NT 2.2009



Verlöteten Solder

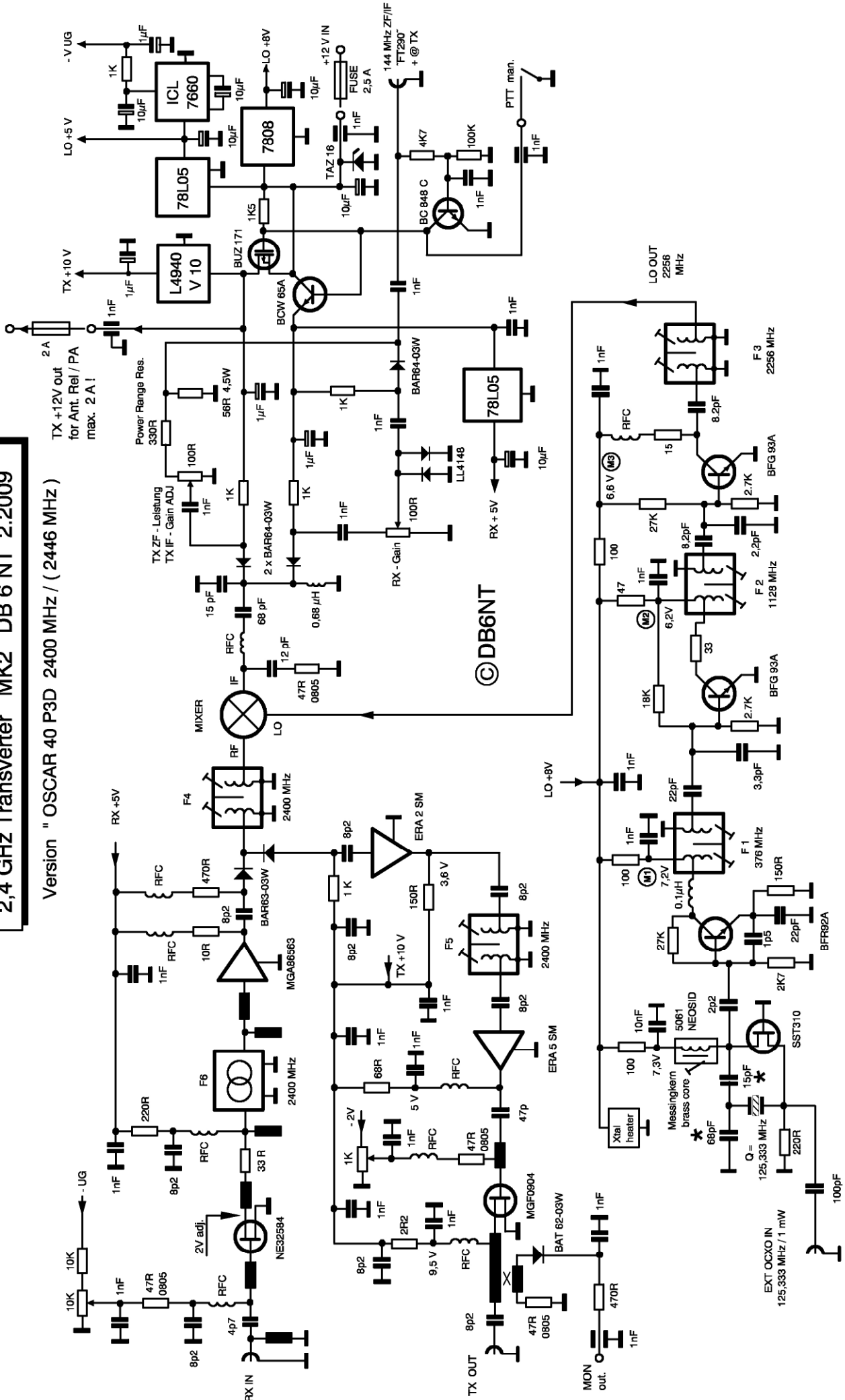
2,3 GHz Transverter MK2 DB 6 NT 2.2009



Die Spannungs- und Leistungsangaben sind Messwerte der Prototypen. Die Angaben können durch Bauteiltoleranzen stark abweichen!
 The voltage and power data are measured values of the prototypes. The data can differ widely due to component tolerances.

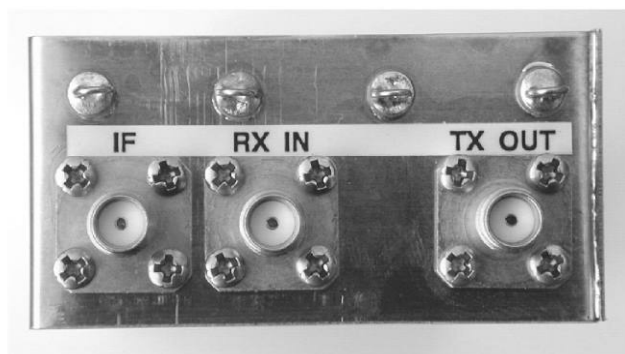
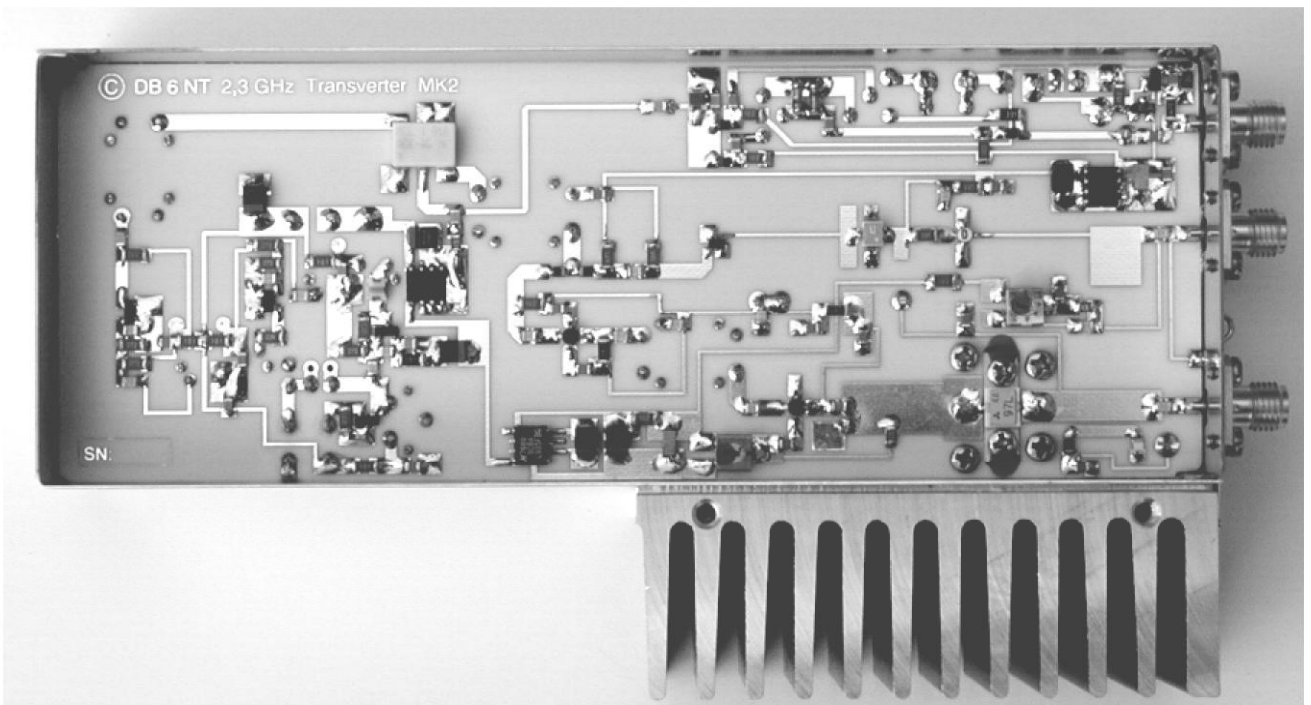
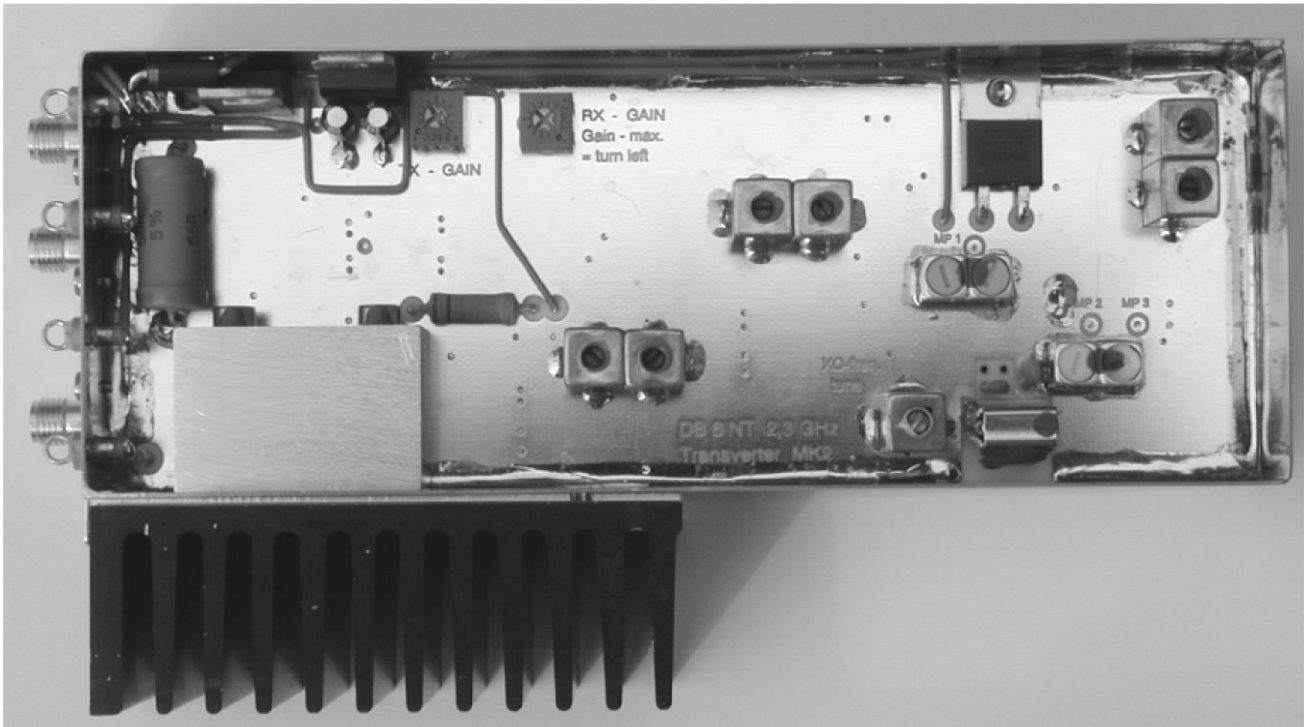
2,4 GHz Transverter MK2 DB 6 NT 2.2009

Version " OSCAR 40 P3D 2400 MHz / (2446 MHz)



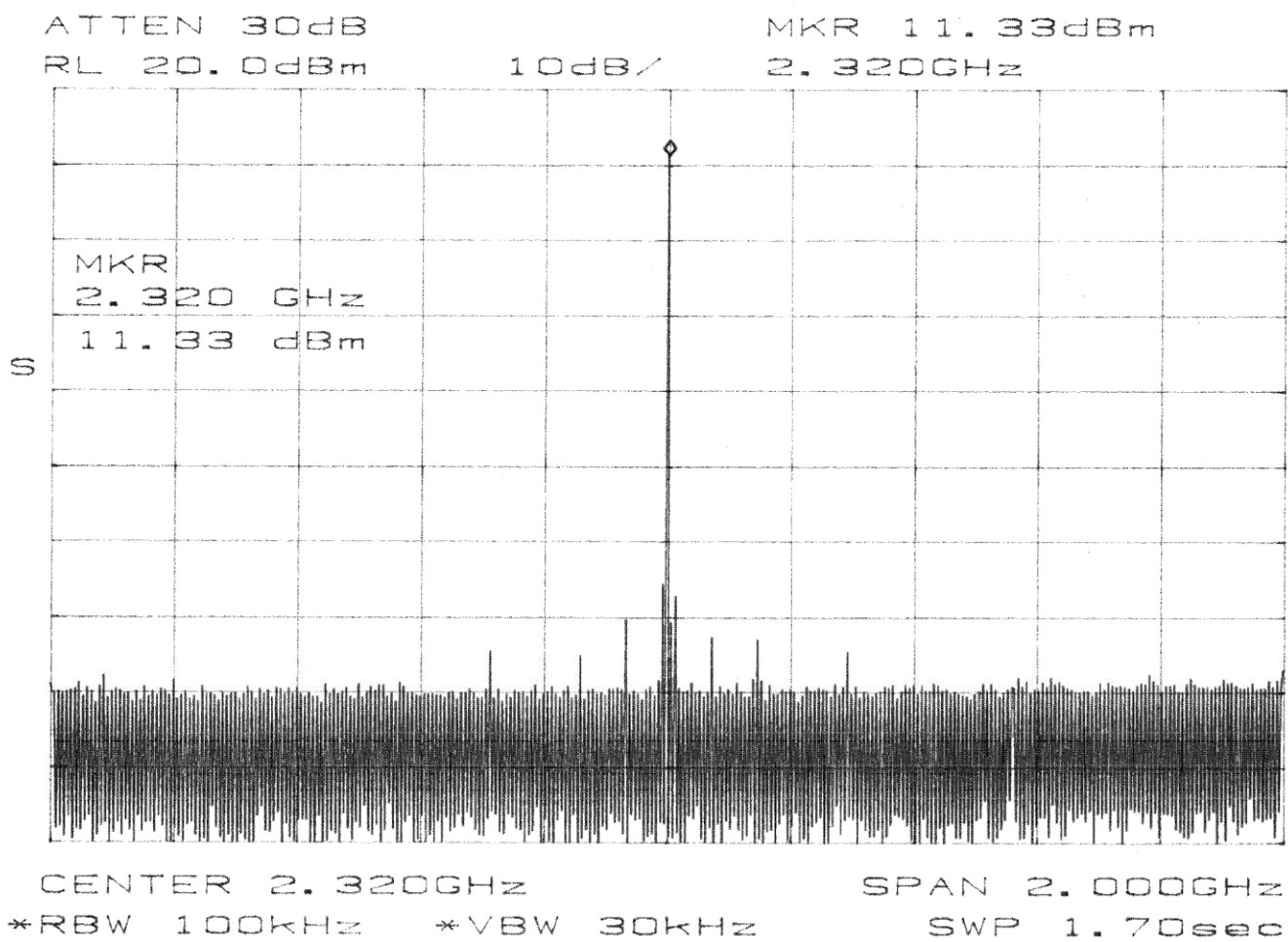
Die Spannungs- und Leistungsangaben sind Messwerte der Prototypen. Die Angaben können durch Bauteiltoleranzen stark abweichen!
 The voltage and power data are measured values of the prototypes. The data can differ widely due to component tolerances.

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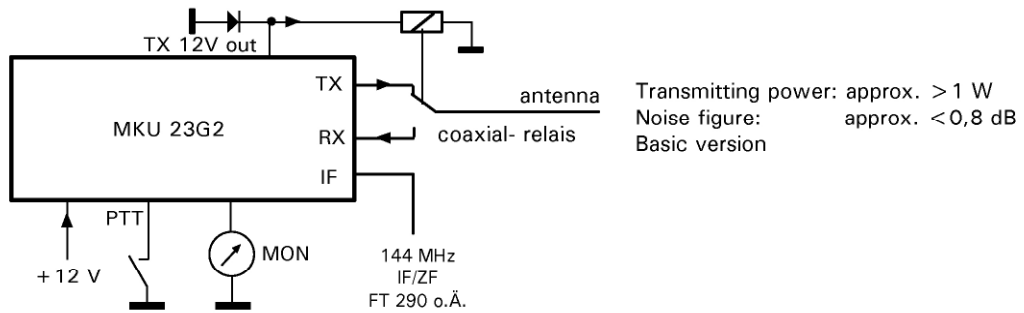
2,3 GHz Transverter MK2 DB 6 NT 2.2009

2320 / 144 MHz

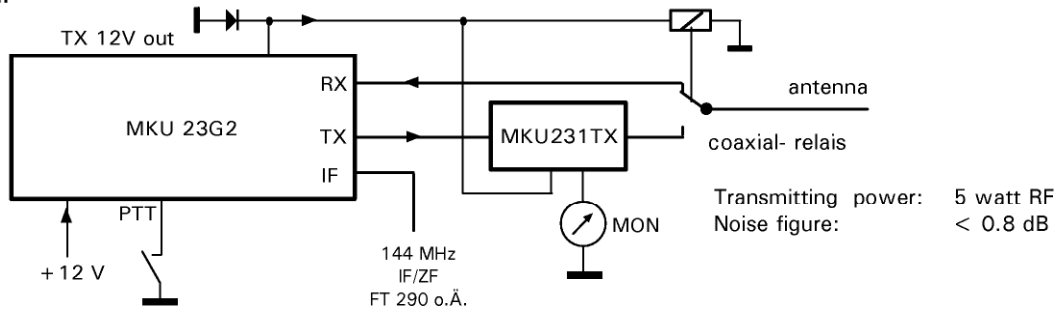


2,3 GHz TRANSVERTER VERSIONS

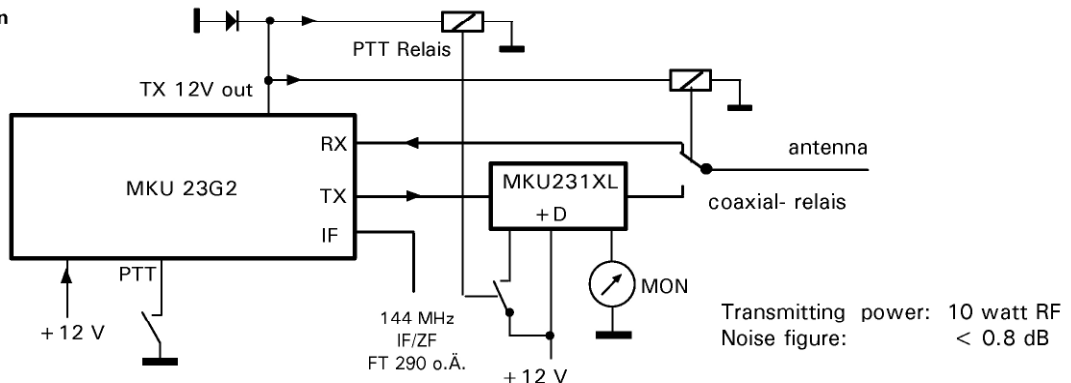
1.) Version



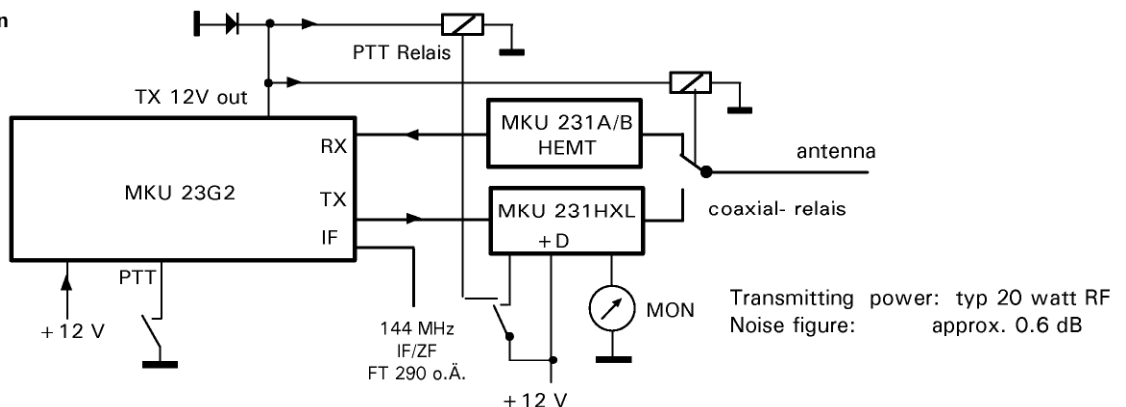
2.) Version



3.) Version



4.) Version



Attention! Many coaxial-relays have too small uncoupling between transmitting and receiving ports of this during the change or process can to the destruction of the input transistor in the converter or the preamplifier lead. The relay should achieve an uncoupling of approx 50dB. The performance on the RX input may not exceed 1mW.



Urgently the use of a sequence controllers is recommended.

Achtung! Viele Koaxial-Relais haben während des Umschaltvorganges eine zu geringe Entkoppelung zwischen Send- und Empfangskontakt. Dieses kann zur Zerstörung des Eingangstransistors im Konverter oder des Vorverstärkers führen. Das Relais sollte eine Entkoppelung von 50 dB erreichen. Die Leistung auf den RX - Eingang darf 1mW nicht überschreiten.



Es wird dringend die Verwendung einer Sequenzsteuerung empfohlen.

Information zur Sende - Empfangsumschaltung der DB6NT Transverter

Um DB6NT-Transverter von Empfang auf Senden umzuschalten, sind zwei Möglichkeiten vorgesehen. Zum einen 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 FT 290R und dem IC 402 ist diese Umschaltsteuerung bereits eingebaut. Bei dem FT290RII muß diese Schaltung nachträglich eingebaut werden. Einbauanleitung von G4DDK auf seiner Internet Seite: www.btinternet.com/~jewell/

Bei dem IC 202 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 IC 202 erforderlich.

Für den Transverterbetrieb mit dem YAESU FT 817 hat Peter Vogl, DL1RQ eine Umbauanleitung verfasst. Sie ist im Internet abrufbar unter: www.bergtag.de/technik_18.html

Information about RX-TX switching of DB6NT Transverters

To switch the DB6NT transverter from RX to TX there are two possibilities.

The first: switch the port "PTT" of the transverter to ground for TX.

The second: supply +3 ... 12 V DC to the core (center conductor) of the IF cable for TX. This method saves an additional PTT cable between transverter and transceiver.

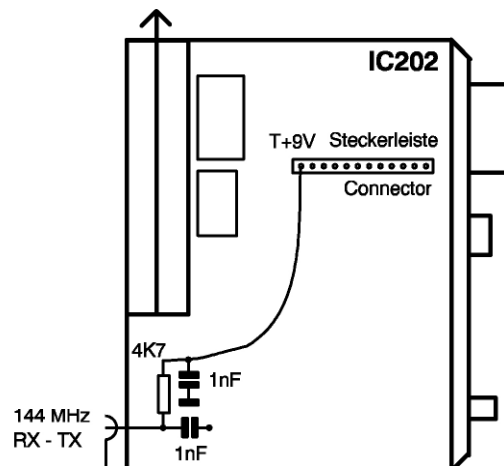
A suitable control circuit is already included in the transceivers FT 290R (old model) from YAESU and IC 402 from ICOM. They provide +12 V DC on the coaxial output connector (core) at TX.

The FT 290RII (new model) from YAESU does not provide this function, but it can be modified. The modification is described on G4DDK's website: www.btinternet.com/~jewell/

IMPORTANT!

The IC 202 from ICOM provides +12 V at RX! So if you connect a DB6NT transverter to a IC 202 then the transverter will switch to TX! A small modification is necessary (see picture below). Then the IC 202 will supply +12 V at TX.

The YAESU FT 817 must also be modified for transverter operation. Peter Vogl, DL1RQ, has written a small tutorial, how to do this modification: www.bergtag.de/technik_18.html



Umbau des IC 202 auf richtige RX/TX-Umschaltung.
Modification of RX/TX switching of IC 202

Präzisions-Quarzheizer QH40A

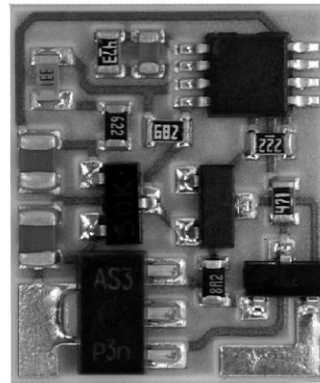
Dieser Präzisionsquarzheizer dient zur Temperaturkompensation von Quarzen (Quarzoszillatoren). Die auf Al_2O_3 -Keramiksubstrat aufgebaute Hybridschaltung wird mittels Schrumpfschlauch auf einen 40° Thermostatenquarz montiert. Die Schaltung heizt den Quarz auf eine Temperatur von $40,8^\circ C$ mit einer hohen Regelgenauigkeit von besser $0,1^\circ C$. Diese bewirkt eine hohe Frequenzstabilität über einen großen Temperaturbereich von $-5...+40^\circ C$. Der Quarzheizer stellt eine preiswerte Alternative zu den komplett beheizten OCXO's dar, dessen Werte aber nicht erreicht werden können.

Zum Anschluss der Schaltung sollten möglichst dünne Drähte verwendet werden um einen Wärmeabfluss und mechanische Belastung zu vermeiden. Bei Betriebstemperaturen von $10^\circ C$ und darunter sollte eine zusätzliche Wärmeisolierung mit Styropor eingebaut werden.

Falsche Polung der Betriebsspannung führt zur Zerstörung der Hybridschaltung.

Technische Daten:

Abgleichtoleranz:	$40,8^\circ C \pm 1,5^\circ C$
Regelgenauigkeit:	besser $0,1^\circ C$
Betriebsspannung:	$8...12 V DC$
Einschaltstrom:	ca. $80 mA$
Abmessungen:	$10,5 \times 14,0 \times 3,5 mm$



Einbau:

1. Anschlussbeinchen an die dafür vorgesehenen Punkte anlöten.
Die S-Form der Drähte (Bild 1) hält mechanische Belastungen von der Heizerplatine fern.
2. Schaltung auf den Quarz aufschumpfen (Bild 2), wobei auf nicht zu hohe Temperatur zu achten ist.
3. Einbau des Quarzheizers (Bild 3).

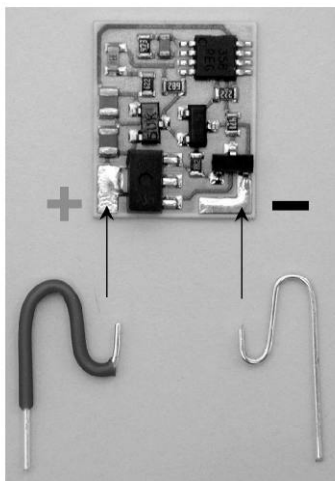


Bild 1

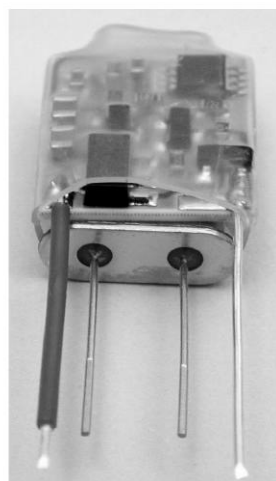


Bild 2

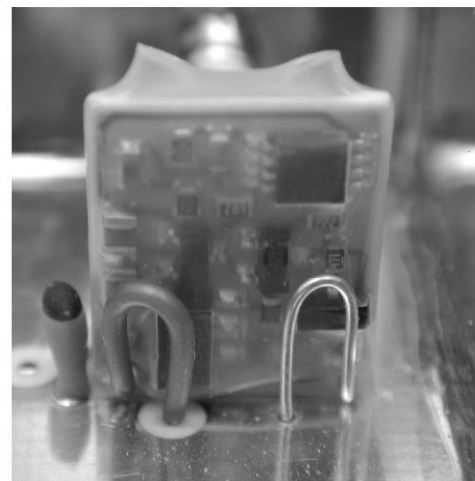


Bild 3



Sicherheitshinweise – für Fertigmodule, Bausätze, Bauteile

Achtung: Verletzungsgefahr!

Weißblech / Neusilbergehäuse / Kühlkörper sind sehr scharfkantig. Bitte vorsichtig damit umgehen. Darf nicht in die Hände von Kindern gelangen. Vorsicht bei Deckelmontage, Quetschungsgefahr der Finger, Schnittgefahr.

Benutzung der Baugruppen, Montage der Bausätze darf nur durch autorisiertes Fachpersonal oder lizenzierte Funkamateure erfolgen.

Bausätze / Fertigmodule enthalten Kleinteile, dürfen nicht in die Hände von Kindern und unbefugten Personen gelangen. Verletzungsgefahr! Verschluckungsgefahr von Kleinteilen. Teile dürfen nicht in den Mund genommen werden!

Elektronikbaugruppen dürfen nur innerhalb der Spezifikation betrieben werden. Maximale Versorgungsspannung darf nicht überschritten werden!

Verpackungsmaterial (Plastiktüten, Styropor usw.), Kleinteile, dürfen nicht in die Hände von Kindern gelangen. Erstickungsgefahr, Verschluckungsgefahr, kein Spielzeug!

Die Anleitung / das Messprotokoll bitte für späteren Gebrauch aufbewahren.

Entsorgen Sie die Module / Bauteile nur bei den vorhergesehenen Sammelstellen.

Safety instructions – for readymade modules, kits, units

Caution: Risk of injury!

Tin plate / German Silver / cases / heat sink are very sharp-edged. Please handle with care. It should not get into the hands of children. Be careful when assembling the top cover, danger of contusion and cutting.

Using of the components and assembling the kits should only be done by authorized and qualified personnel or licensed radio amateurs.

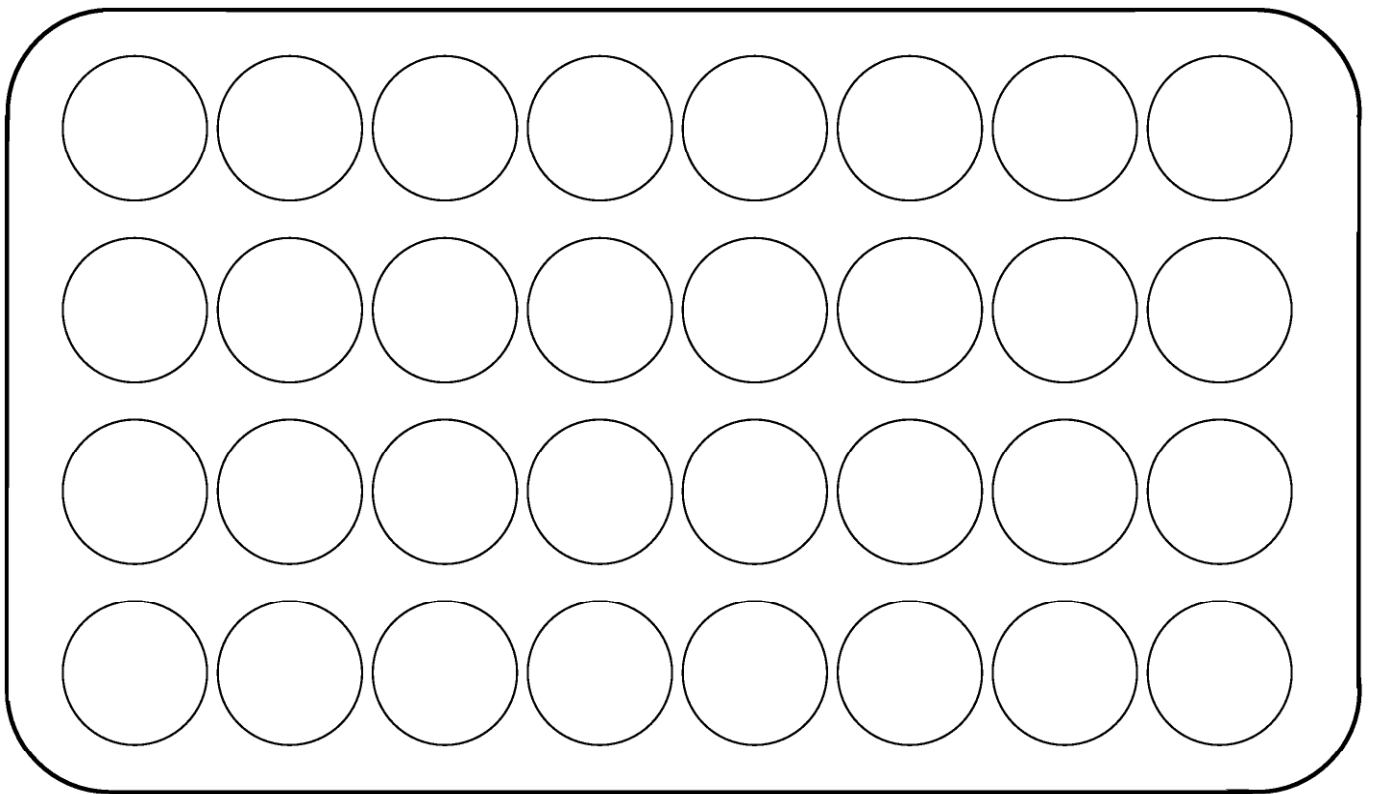
Kits / readymade modules contain small parts, and should not get into the hands of children or unauthorized persons. Risk of injury! Danger of swallowing small parts. The parts should not be taken into the mouth!

Electronic components are only to be run within the specifications. Maximum supply voltage should not be exceeded!

Packing material (plastic bags, polystyrene etc.), small parts, should not get into the hands of children. Danger of suffocation and swallowing – no toys!

Please keep the manual / measuring report for future use.

Please dispose the modules / components only at collection points which are designated for it.



SMD Sortierkasten für weitere Verwendung 73 de DB6NT

