

Handbook / Kit

DB 6 NT

1,3 GHz Transverter MKU 13G2B



05.2009

(C) DB 6 NT

1.3 GHz Transverter MKU 13G2B

DB6NT 5.2009

Introduction

The new transverter-kit for 23 cm represents the current status of amateur radio in the field of microwave technology. Revised by **DB6NT**, this transverter features excellent technical data and is suited for portable or stationary activities due to its small mechanical dimensions. By the use of additional power amplifiers this transverter module can be upgraded to a high performance transmit / receive system for 23 cm. All well-tried functions and features of the previous transverters are included.

Our transverter kits are especially made for the 'normal' radio amateur who wants to build high quality microwave equipment by himself. This kit has been assembled for several times, so the reproducibility of the design is assured. We wish you good luck in 'homebrewing' the kit - but please read the following instructions very carefully!

This transverter is designed for converting the frequency range 144 ... 146 MHz up to 1296 ... 1298 MHz and vice versa. The circuit is built on gold-plated FR4 substrate, which is fabricated industrially and includes metallized through hole connections (vias). The receiver features a noise figure of typical **0.6 dB NF** (max. 0.8 dB) and a gain of more than **20 dB**. Therefore an additional LNA is not necessary. If a LNA is used, the receive gain of the transverter can be reduced by the potentiometer 'RX-Gain'. The transmitter achieves an output power of **400 mW** in the frequency range of 1296 ... 1298 MHz @ 144 MHz IF. Spurious rejection is better than 60 dB, harmonic rejection is better than 40 dB. When using this transverter module without an external power amplifier an external harmonic filter should be used. The output power is adjustable continuously in the range 10 ... 400 mW by varying the gain with the potentiometer 'TX-Gain'. This output power level is sufficient for driving a MOSFET power amplifier or one to four power modules RA18H1213G (Mitsubishi).

The IF power has to be in the range of 0.5 ... 3 W and must be customized by the potentiometer 'TX-Gain' (adapting a resistor allows the use of less than 10 mW). The applied power shouldn't be too high to avoid unwanted warming effects of the unit due to IF power dissipation. The complete circuit including IF-Switch, T/R-control and LO unit is built on a single board and accomodated in a tin-plate box (55x74x30 mm).

For tuning only a simple DC voltmeter is required. All filters are helical filters with restricted tuning range, so tuning on 'false' resonance impossible.

Description

The proven Colpitts oscillator for 96 MHz uses the FET SST310 in a grounded gate circuit. The frequency is adjusted by the ferrite tuning screw of the coil. The precision crystal heater QH40A mounted on the 40° C thermostat crystal stabilizes the crystal's temperature and keeps the frequency drift in limits. Extra pads are provided for fitting additional capacitors which can be selected for temperature compensation. For normal operations in a restricted temperature change environment the stability is sufficient. But for more serious work an external OCXO (1 mW) or the PLL-stabilized oscillator MKU XO 1PLL with 96.000 MHz is required. This external signal can be fed in at the source of the SST310, as indicated in the circuit diagram. In this case the crystal and the heater have to be replaced by an additional SMA female connector.

The oscillator is followed by a quadrupler to 348 MHz which utilises a BFR92P transistor. The fourth harmonic is filtered by a helical filter and drives the tripler with the BFG93A. The output filter selects the harmonic at 1152 MHz. The power at this point is around 5 mW (7 dBm). The IF signal is conducted from the mixer to the common IF connector via separate adjustable attenuators for RX and TX which are switched by pin diodes BAR64-03W. A voltage of at least +9 V (which can be supplied by a FT290R for example) activates the T/R-switching. Other brands of 2 m 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-manual input can be accomplished. An extra output is fitted for TX+, which can be used for external coaxial relays or PA's. This output must be guarded by a 0.63 A fuse - it's not safe in case of short circuit!

Many coaxial relays have a too low isolation between the ports during the change-over. If the power amplifier (in a transmit-receive system) is switched too early, this may lead to damage or destruction of the input transistor in the preamplifier or converter.

With a sequence controller, this trouble can be avoided. The sequence controller provides a control signal for the coaxial relay and it switches the voltage supply for the power amplifier. There is a time delay between the two signals to guarantee safe switching.

The RX-chain uses a HEMT-FET amplifier and a MMIC as second stage. This combination provides an overall gain of >30 dB, which makes an extra IF-amplifier unnecessary. The received signal enters the MGF4918D via a 8.2 pF capacitor. The stages are coupled with the helical filter F4. The second stage is an ERA8-SM which is coupled to the mixer via the PIN-diode switch and the second helical Filter F3. Beyond the PIN-switch and the helical Filter F3, which is used both for receive and transmit, a ERA 3-SM MMIC drives via a second helical filter F5 the preamplifier GALI4 and the power amplifier AH102A. This amplifier delivers 400 mW output power. A directional coupler with a BAT15-03W Schottky diode provides a monitor DC 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 provisions should be obeyed.

Construction Steps

- a. Solder the walls of the tinplate box and trim the PCB for fitting into the tinplate box.
- b. Mark the holes for the SMA-connectors and feedthrough capacitors
- c. Drill holes for SMA-connectors and feedthrough capacitors.
- d. Solder PCB into the box. Use a 10.2 mm high piece of wood as a ruler to find the right height adjustment.
- e. Insert the 7809 (B) regulator into the PCB (remove the middle pin of the regulator!). Drill two holes for the heatsink and one hole for the regulator into the side wall of the box. The heatsink should lie in the mid of the PCB. Diameter of the holes is 3 mm.
- f. Mount the parts onto the PCB. Mount the feedthrough caps. Solder the helix filters. Solder the regulator 7808 (A) with its heatsinks to the wall of the tinplate box. The FET 08P06P should be fitted to the PCB by holding it tightly down and soldered. 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.
- f. At least mount the 7809 (B).

4. Alignment

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

- a. Apply 12 V. Use a current limited (<0.5 A) power supply. Check the voltages at the output of the fixed voltage regulators.
- b. Measure the collector voltage at the BFR92P (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 5.8 V.
- c. Measure voltage at M2. Tune bandfilter F1 (348 MHz) to minimum voltage (about 5.5 V) at M2.
- d. Connect a dummy load or antenna to the input connector RX.

- e. Measure the drain voltage of the MGF4918D and adjust this voltage to 2 V by the 1k pot at the gate.
- f. Connect a 144 MHz receiver at the IF connector. Turn the RX-Gain and TX-Gain pots fully CCW. You will observe an increase in noise level. By tuning the helical filters F3 and F4 you can maximise the noise output. If there is an indication of more than S1 at the 144 MHz transceiver you should adjust the RX-Gain Pot accordingly.
- g. Connect a 50 Ohm dummy load to the TX output. Switch the transverter to transmit by grounding the PTT input. Drive the transverter with 0.5 ... 3 W on 144 MHz. Measure the monitor voltage at MON OUT. It should read 2 ... 3 V. Adjust TX-Gain pot to a reading of about 1 V. Now the helical filter F5 and the LO-filter F2 can be readjusted to maximum output.
- h. Reduce the TX-Gain by clockwise rotation of the TX-Gain pot until the TX output starts to decrease. A value 80% of the maximum assures linear operation.
- i. Connect antenna to RX input. Adjust the XO until a known beacon reads the correct frequency.
- j. Take low resistance carbonised foam and glue it into the bottom cover. This damps the resonance of the Box. The heatsink should be mounted onto a chassis plate to further reduce the thermal resistance.

A 1.3 GHz coaxial relay must be used for RX/TX switch.

Ready! Go on for OSO!

My special thanks to Friedhold **DG0EG** who made this transverter ready to get into production by his experience in assembly and many helpful suggestions. Furthermore I thank Lorenz **DL6NCI** who verified the reproducibility of the design by building this transverter.

Literature:

- 1.) "Transverter for 1.3 GHz by DB6NT" DUBUS 4.92 (Technik IV)
- 2.) "1.3 GHz Transverter MKII by DB6NT" DUBUS 2.2000 (Technik VI)
- 3.) Download of the kit description:
<http://www.kuhne-electronic.de>

Purchase:

Ready made modules and kits:

KUHNE electronic GmbH

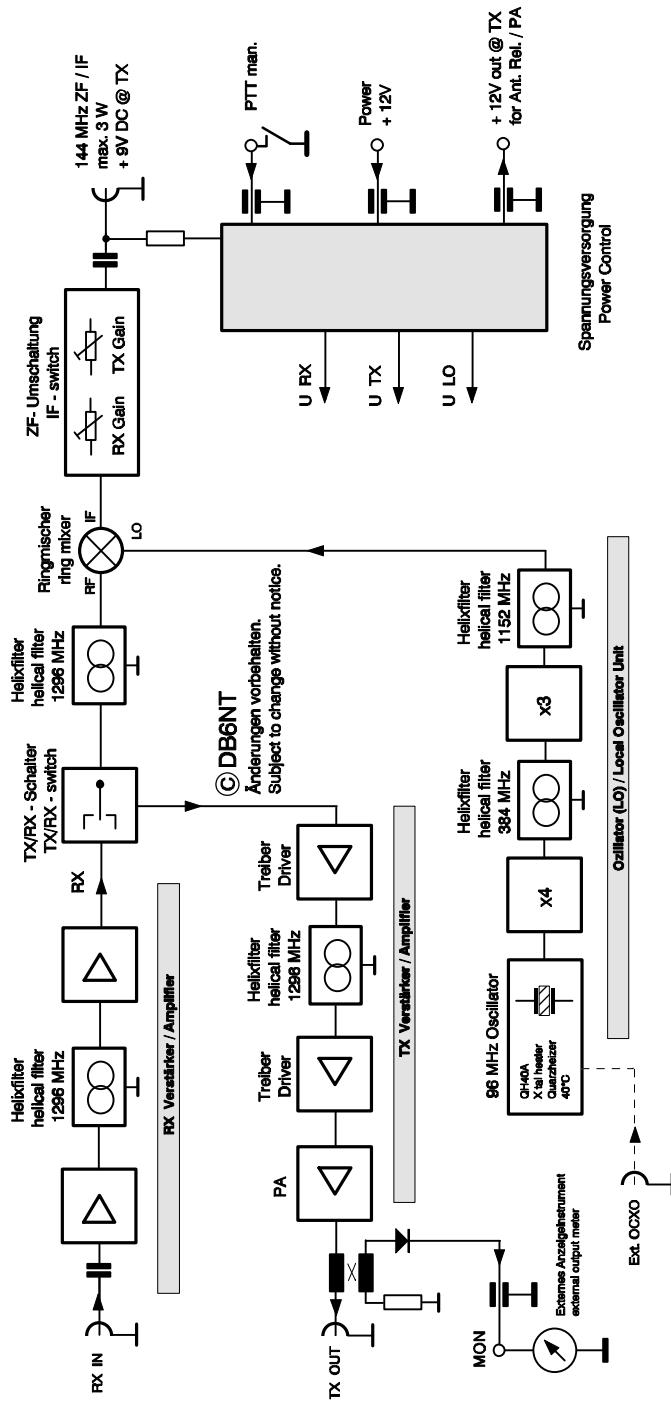
Scheibenacker 3
D-95180 BERG
Tel.: 0049 (0) 9293 800 939
Fax: 0049 (0) 9293 800 938
Email: info@kuhne-electronic.de
www.db6nt.de

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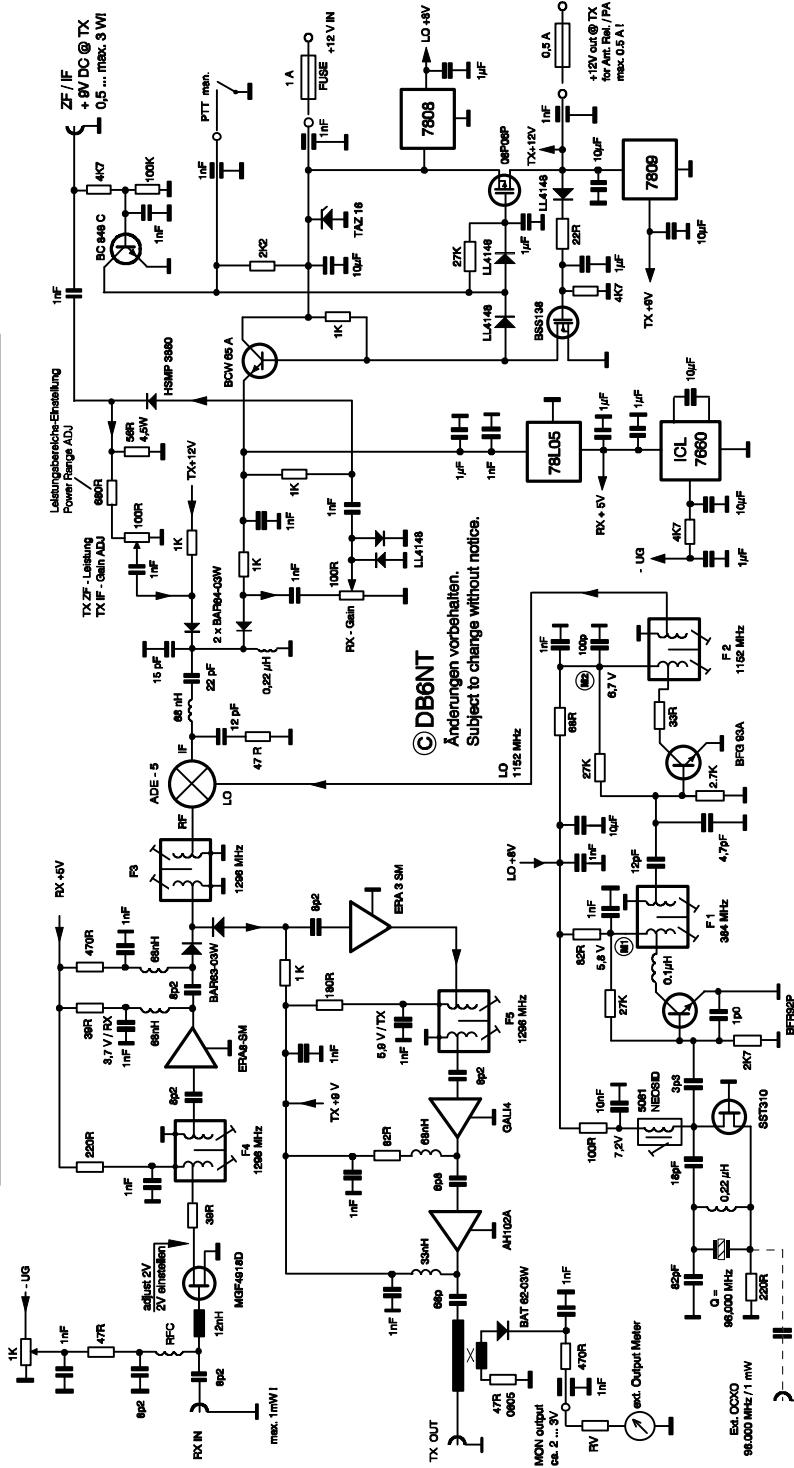
For operating the high frequency modules the legal instructions have to be considered.

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1296 / 144 MHz

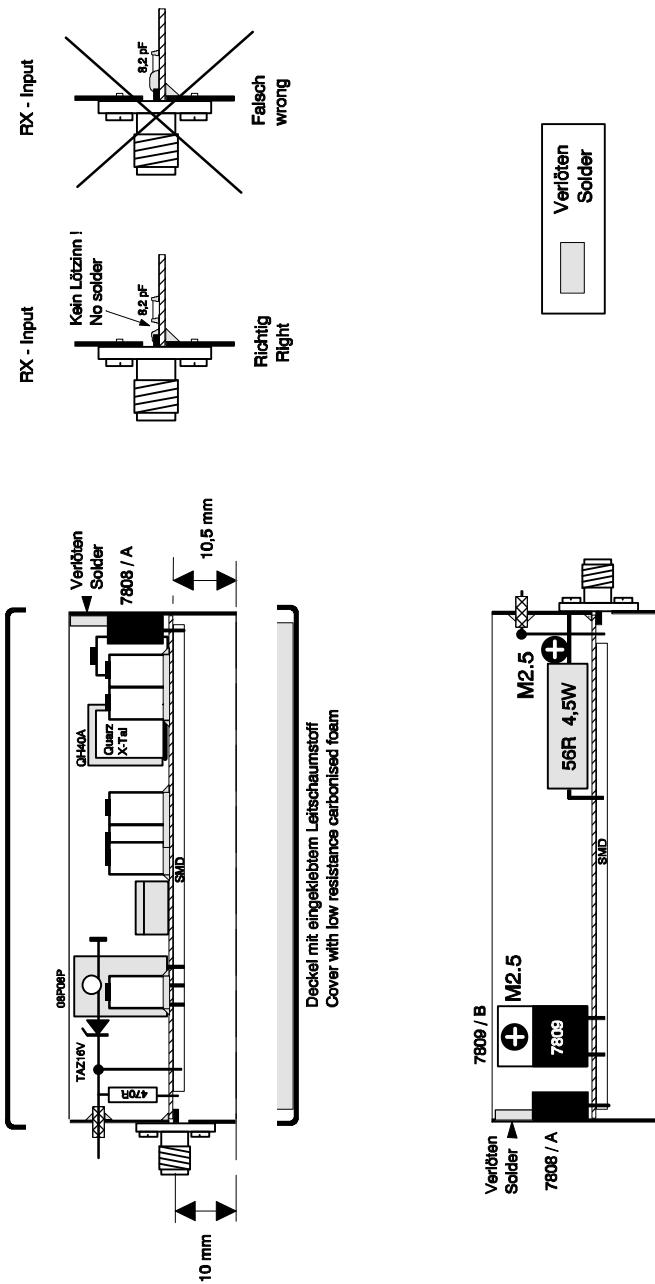


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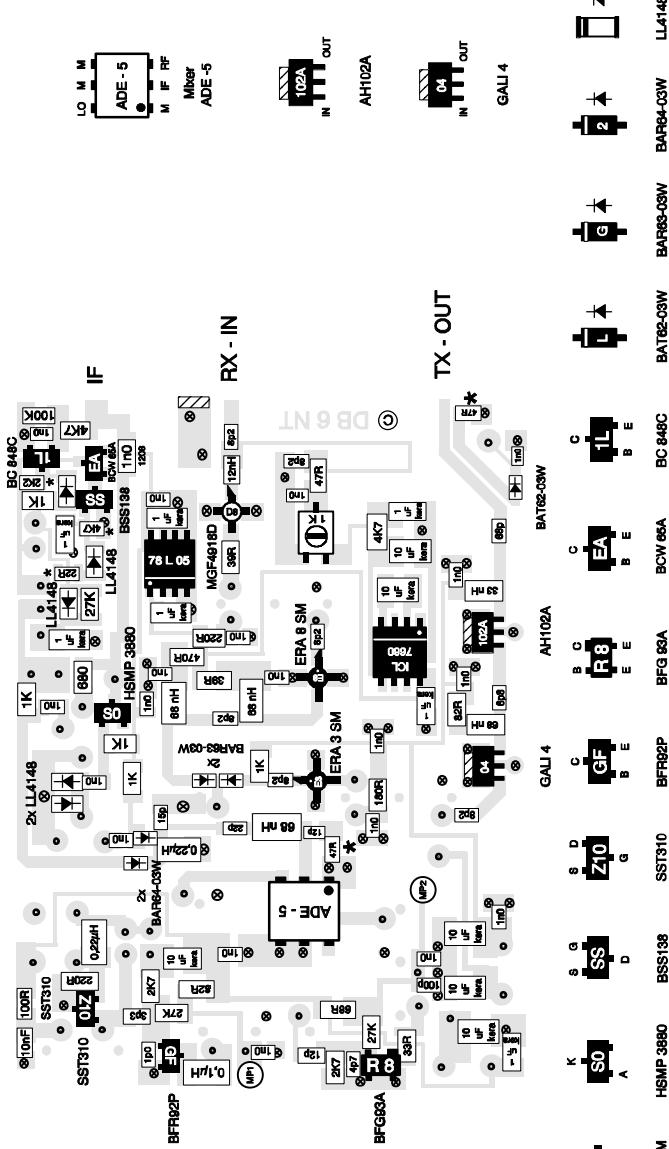
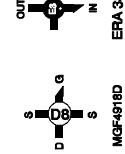
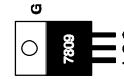
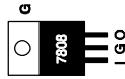
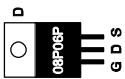


Die Spannungs- und Leistungsangaben sind Messwerte der Prototypen. Die Angaben können durch Bauteiletoleranzen stark abweichen!

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⊗ Durchkontaktierungen
Through-connection

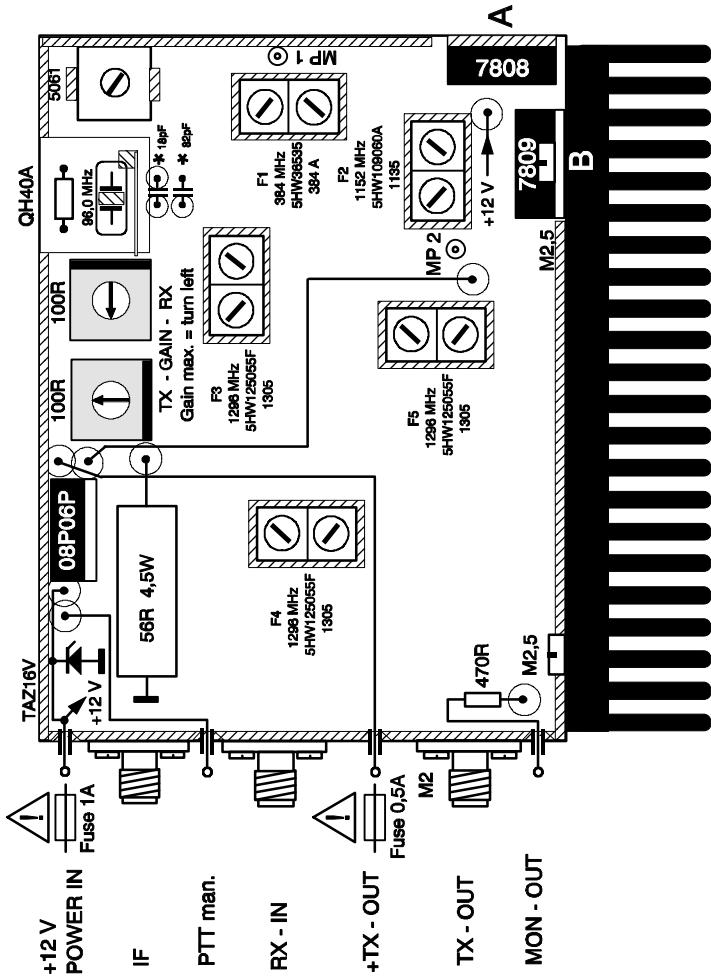
□ Mit Gehäuserahmen verlöten
To solder with box

* Widerstand Baiform 0805
Resistor footprint style 0805

Important: only the pins indicate the correct transistor orientation. The orientation of the package marking may vary!
Wichtig: für die Anschlussbelegung sind nur die Pinbreiten relevant. Die Orientierung der Aufdrucke kann variieren!



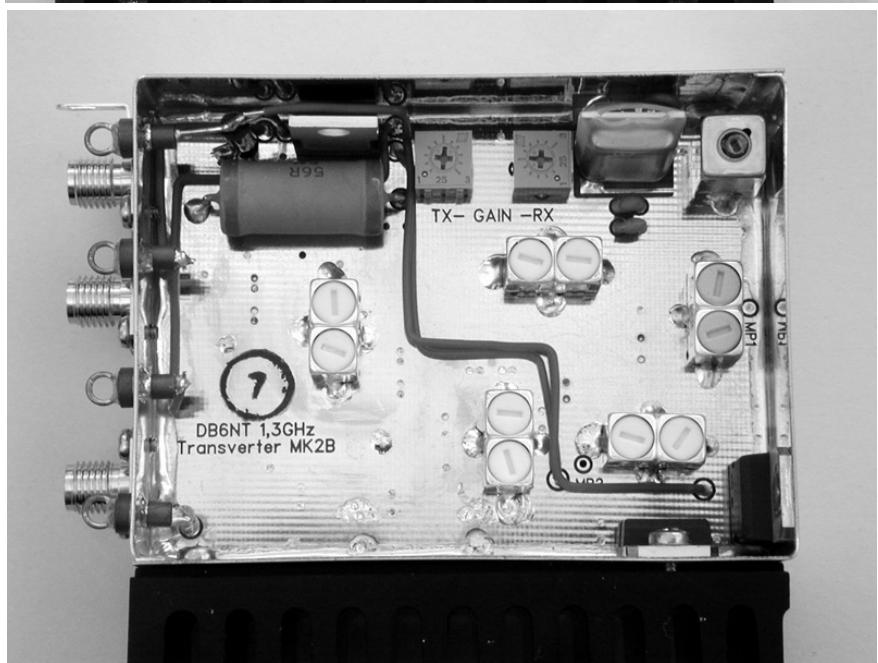
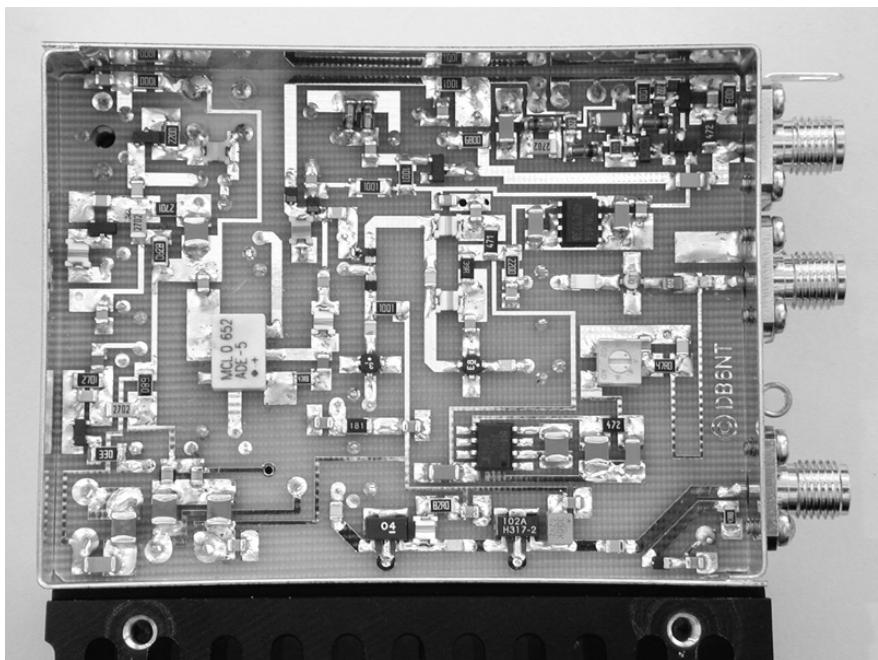
1,3 GHz Transverter MKU 13G2B DB 6 NT 20.05.2009



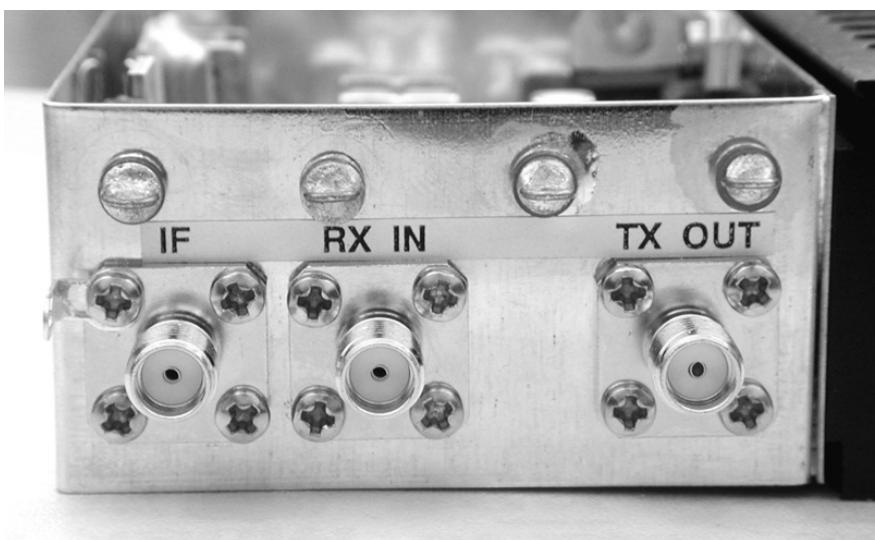
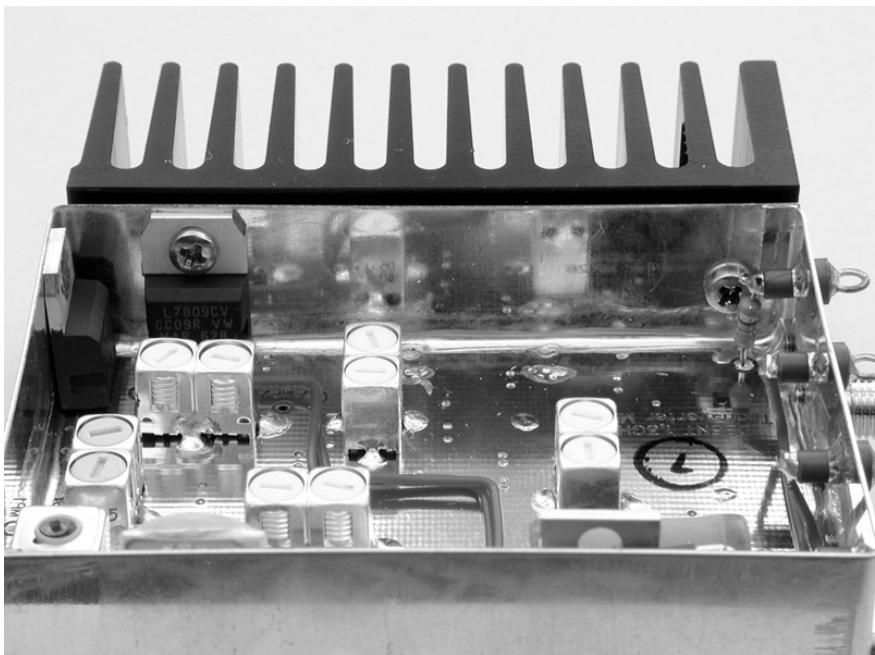
verlöten
to solder

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

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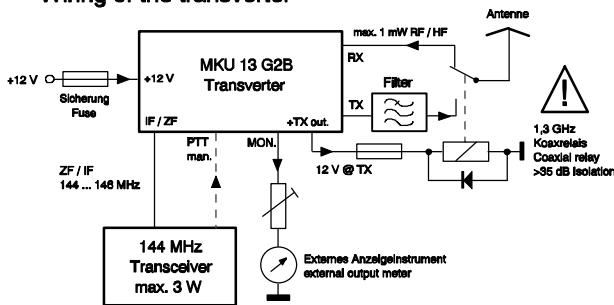


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Beschaltung des Transverters Wiring of the transverter



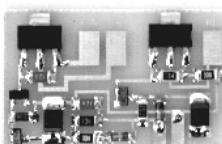
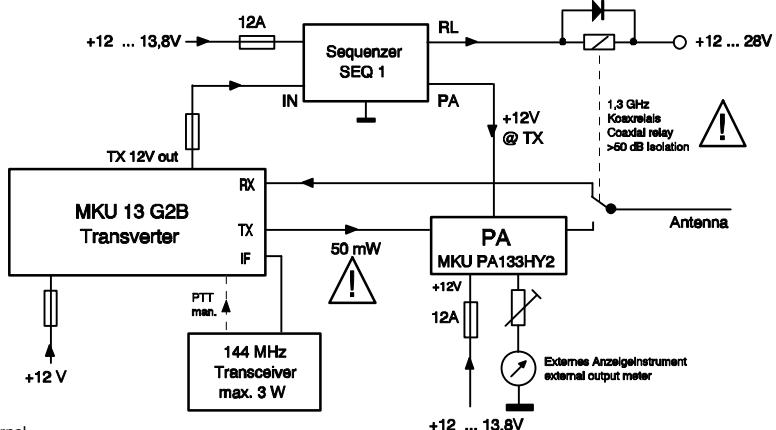
The output power of the transverter MKU 13G2B should be adjusted to 50 mW with the internal potentiometer 'TX-Gain' when using the power amplifier MKU PA 133 HY2. These components can be installed together with the coaxial relay in a weather-proof case direct at the antennae to reduce cable losses.

Achtung! Viele Koaxial- Relais haben während des Umschaltvorganges eine zu geringe Entkopplung zwischen Sende- und Empfangskontakt. Dieses kann zur Zerstörung des Eingangstransistor im Konverter oder des Vorverstärkers führen. Das Relais sollte eine Entkopplung von 50 dB erreichen. Die Leistung auf den RX - Eingang darf 1mW nicht überschreiten.
Es wird dringend die Verwendung einer Sequenzsteuerung empfohlen.

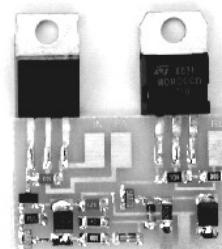
Attention! Many coaxial relays have a too low isolation between the ports during the change-over. If the power amplifier is switched too early, this may lead to damage the input transistor of the RX-path of the transverter. The relay should achieve an isolation of 50dB. The RF power that leads the RX input must not exceed 1mW!

The use of a sequence controller is strongly recommended.

Transverter mit Endstufe Transverter with power amplifier



SEQ 1



SEQ 2 / 3

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.

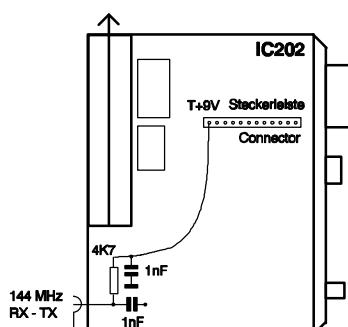
The second: supply +3 ... 12 V DC to the core (center conductor) of the IF cable for TX. This method saves an additional PTT cable between transverter and transceiver.

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

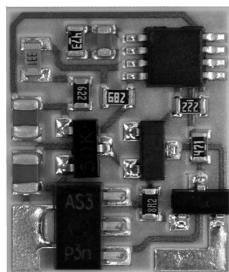
Precision crystal heater QH40A

This precision crystal heater provides temperature compensation for crystals, usually found within crystal oscillators. The assembled circuit, which is built on Al_2O_3 ceramic substrate, should be mounted against the crystal using heat shrink tubing. The circuit heats the crystal to a temperature of 40.8°C with an accuracy of better than 0.1°C . This provides high frequency stability over the temperature range of -5 to $+40^\circ\text{C}$. This crystal heater is a reasonable alternative to completely heated OCXO's. Thin wires should be used for the connections to avoid heat transfer and mechanical load. For operation in ambient temperatures of 10°C or below, add some polystyrene insulation.

Reverse polarity of the supply voltage can lead to the destruction of the circuit.

Specifications:

Adjustment tolerance:	$40.8^\circ\text{C} \pm 1.5^\circ\text{C}$
Regulation accuracy:	better 0.1°C
Operating voltage:	8...12 V
Inrush current:	ca. 80 mA
Dimensions:	$10.5 \times 14.0 \times 3.5$ mm



Assembling:

1. Solder the wires to the pins provided.
The S-shape of the wires (Fig. 1) reduces the mechanical load on the heater plate.
2. Warm the heat shrink tubing to hold the circuit next to the crystal (Fig. 2), ensure that the temperature is not too high.
3. Install the crystal heater (Fig. 3).

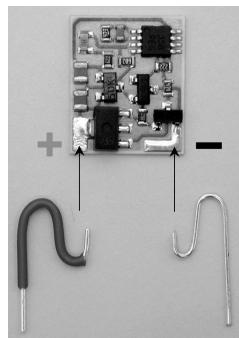


Fig. 1



Fig. 2

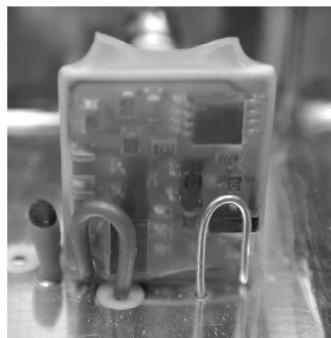
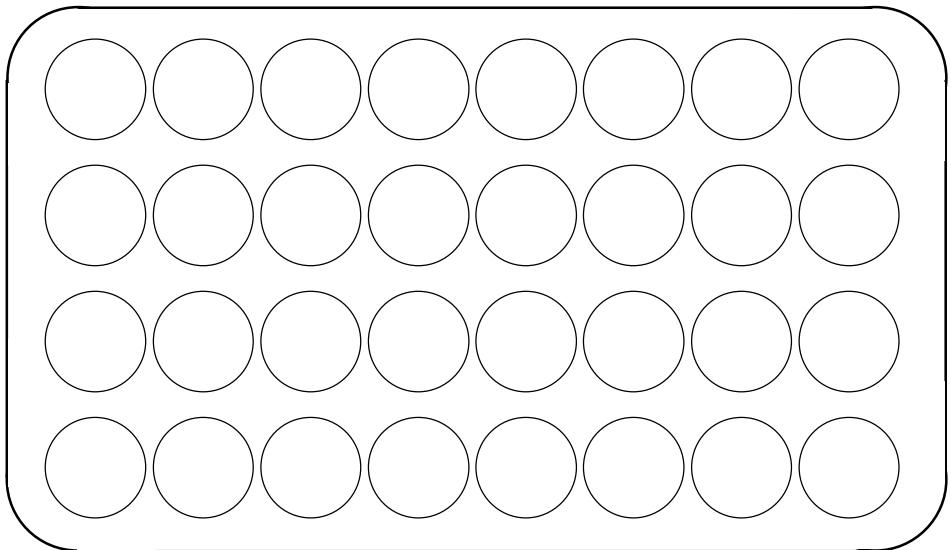
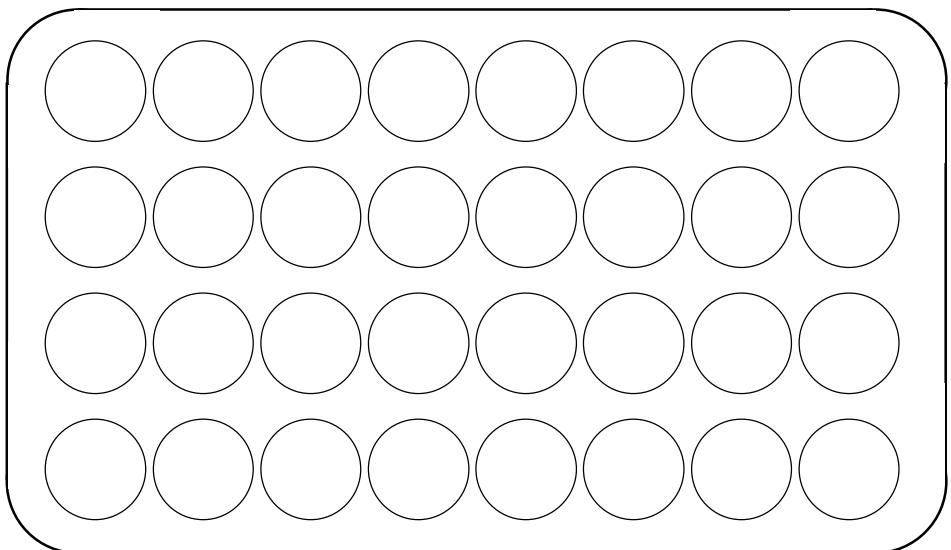


Fig. 3



SMD Sortierkasten für weitere Verwendung 73 de DB6NT



Sortierkisten für weitere Verwendung 73 de DB6NT

A blank 8x5 grid for drawing or writing practice. The grid consists of 40 empty squares arranged in 8 rows and 5 columns.



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.