ME4T-PRO 70MHz Transverter

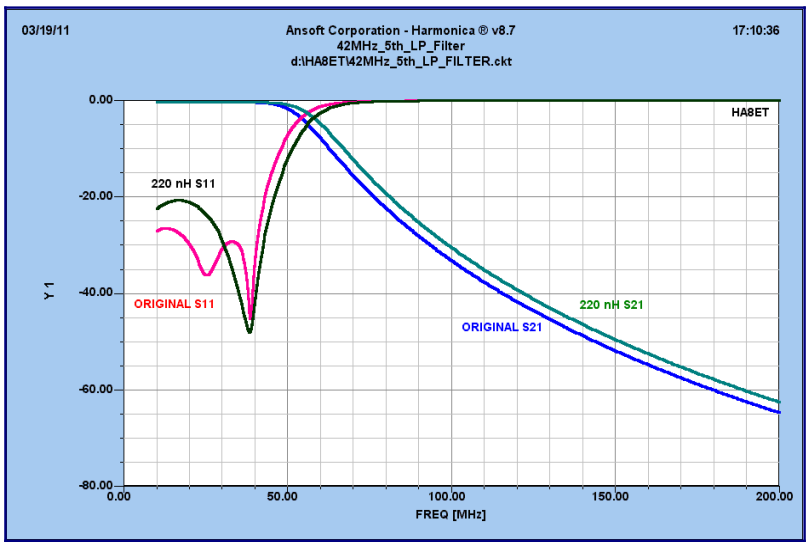
ME4T-PRO High Performance 4m transverter

After the successful ME4-T transverter project we decided to build the -PRO version of this transverter. The ME4T-PRO is a new generation high performance transverter with modern 3rd generation components, has low noise, very good dynamic range on receiving section and clear and very stable transmitting signal.
The built in low phase noise TCXO provides easy work also on digital modes.(Optional AXTAL 0.5ppm TCXO is available!)
The transverter can work between 69.9-72MHz with low RX NF and high IIP3 and OIP3.
The Mitsubishi RF module provides good IMD signal and 30W output power.
Special thanks for HA8ET for the RF simulations and the most RF design.
You can find the block diagram of the mixer unit here:
Before first operation check the **transverter setup** description.

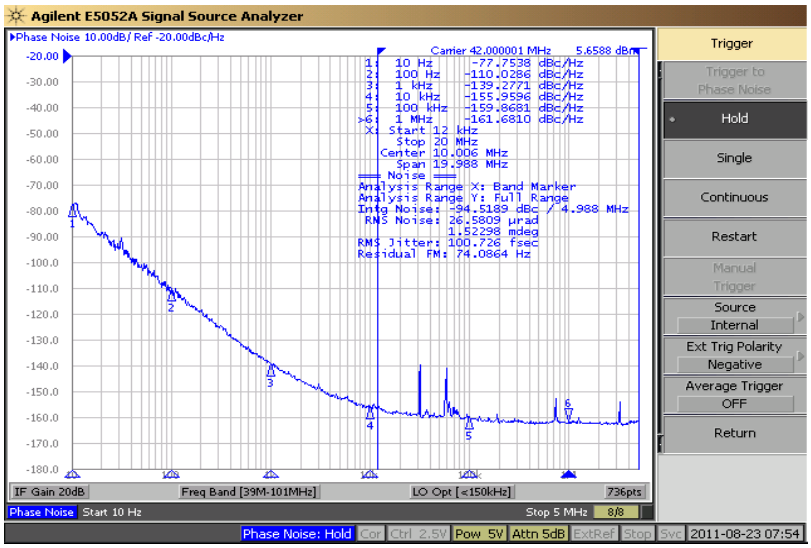
Local Oscillator

The high stability **TC23-5T** type PDI TCXO (<1ppm btn 0-50degr. C) with low phase noise gives 3dBm signal on 42.000MHz. The TCXO frequency can be adjusted with inner trimmer capacitor (+/-2ppm) but it's not necessary because the stability is better than +-1ppm/Year.
AXTAL 0.5ppm TCXO is also available for request.
The output signal of the LO is about +7dBm, it produced by ASB **ASL550**3rd generation MMIC. The built in 2x 5th order filter provides clear output signal,, the 2nd harmonics is lower than -70dB. We using two stage LO amplifier on case high lever RF mixers(SBY-2S +23dBm)

The simulated characteristics of the 5th LPF filter:



The measured 42.000MHz TCXO phase noise:

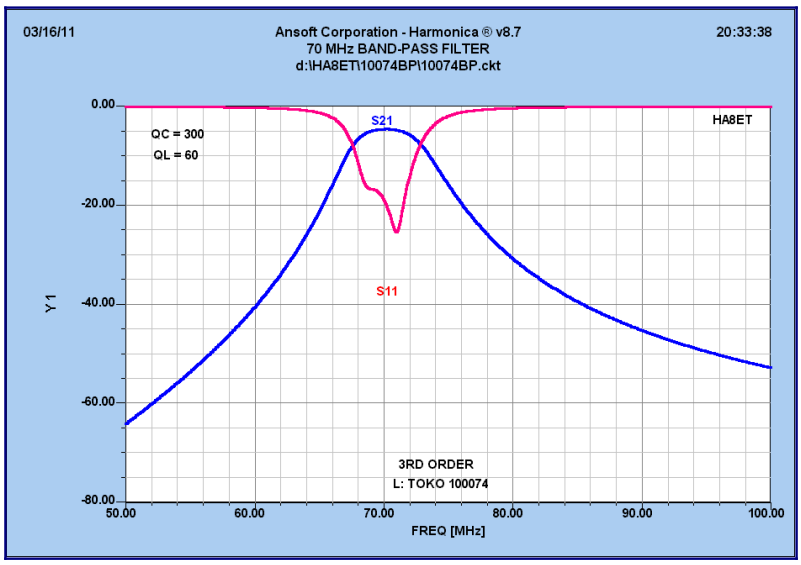


We can check the output signal on M3 measuring pin. This signal is attenuated by 0 and -3dB attenuators to the RX and TX balance mixers.
We using **SRA-1H** type +17dBm RX mixer. Optional +23dBm(SBY-2S) mixer is available as option.
We can check the LO RX and TX signals on M2 and M1 points with DC voltmeter too.

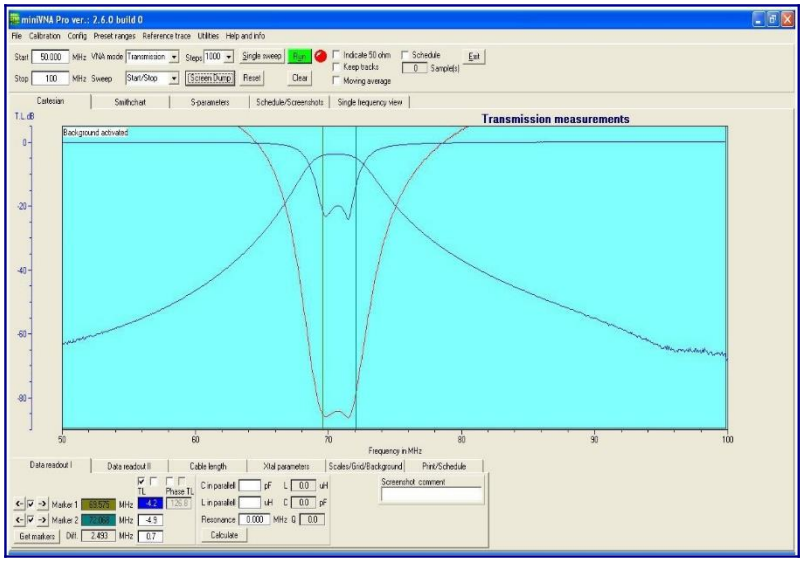
RX

The 69.9-72MHz input signal passes through the input filter to the input of **PGA-103+** LNA. The gain is approx. 20 dB, the noise figure is 0.8dB the OIP3 is about 26dBm! PGA-103+ has an exceptional performance of low noise figure, high gain, high OIP3, and low bias current. The stability factor is always kept more then unity over the application band in order system environment. Impedance of the MMIC is 50 Ohm both I/O - it provides easy connect on the output to 3rd order BPF. **PGA-103+** low noise and high dynamic range version is available from January 2013.

The simulated characteristics of the 3rd BPF::

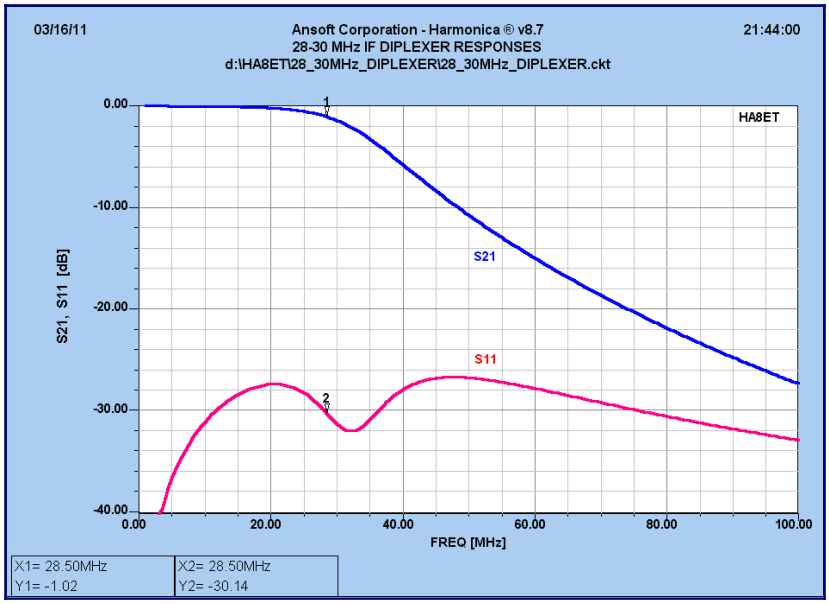


Measured 3rd order BPF:

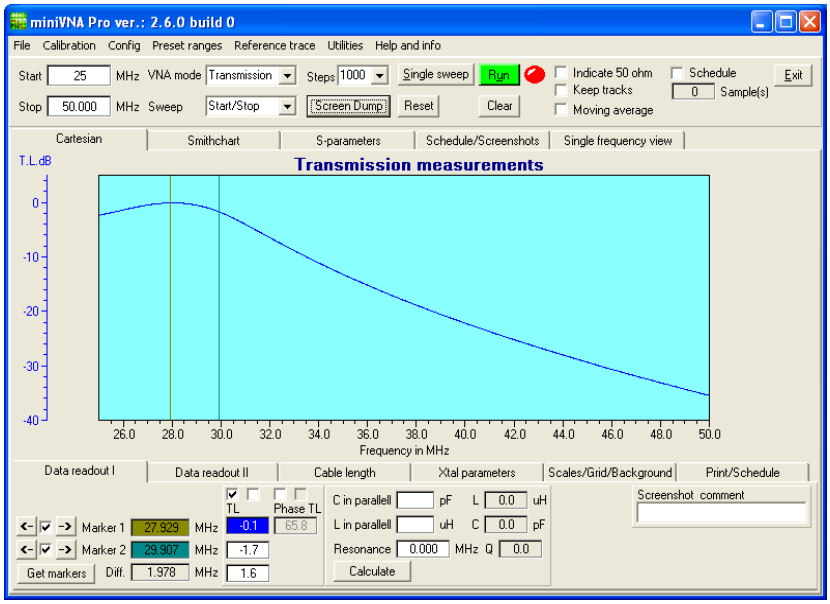


The 69.9-72MHz signal goes through the band pass filter providing a suitable selectivity. The balanced mixer MX1 mixes the input signal down to 27.9-30MHz loosing approx. 3-4 dB in the process. The IF signal is amplified approx. 10 dB in a low noise high current J-FET's (2x J310). The final PI filter increases the selectivity considerably. The output signal is can set to optimal value with the RX gain potentiometer.

Characteristics of diplexer unit:



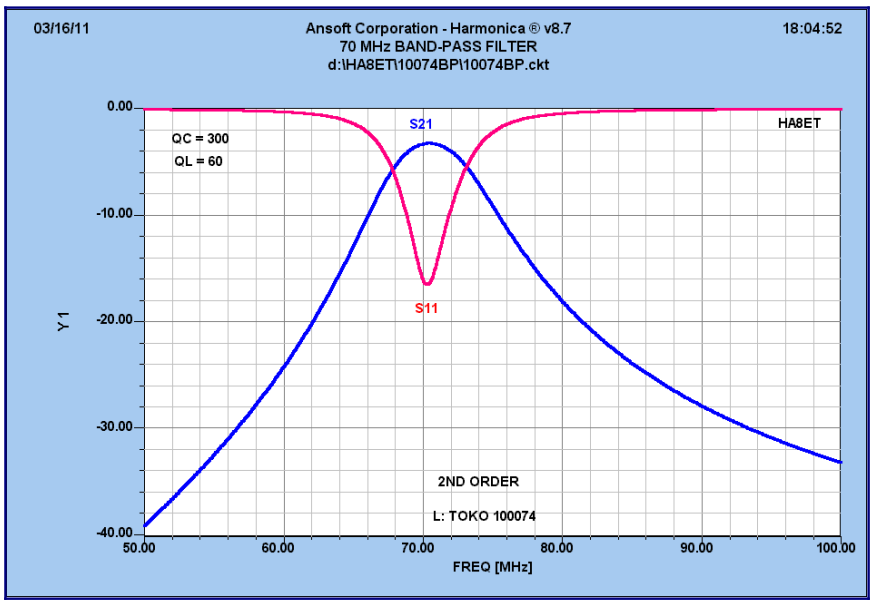
Measured diplexer characteristics:



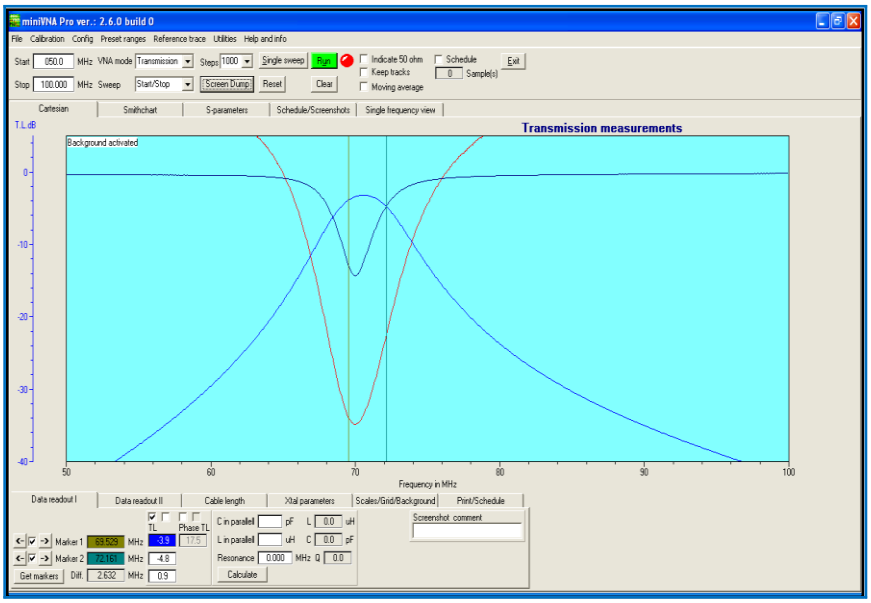
TX

The transmit mixer, MX2 only needs approx. -10dBm 28 MHz IF signal from the transceiver. A suitable level can be achieved by adjusting P2(TX) in the attenuator. Lot of transceivers has lower or much higher IF output level. To solve this problem we built in an built in additional jumperable and variable 5W/-20dB attenuator. You can switch on/off easy the attenuator with different jumpers.
The fine level setting possible with the potentiometer P1 on the attenuator unit across the slots of the top cover.
We solved the very low level IF output problem of most ICOM radios. We built in jumperable IF amp
So, ME4T-PRO is usable with -20dBm IF input level radios.
The 70 MHz TX signal behind the MX2 mixer is filtered through a two-stage band-pass filter before being amplified in a BF996.

Simulated characteristics of the 2nd order BPF:

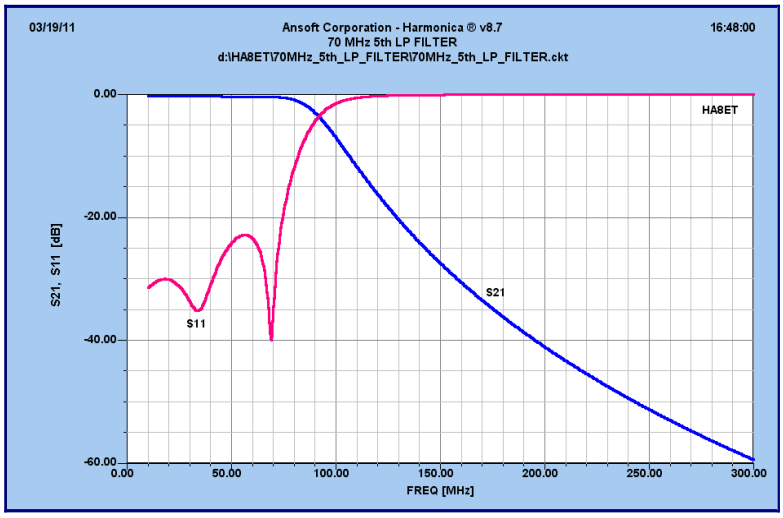


The measured characteristics:

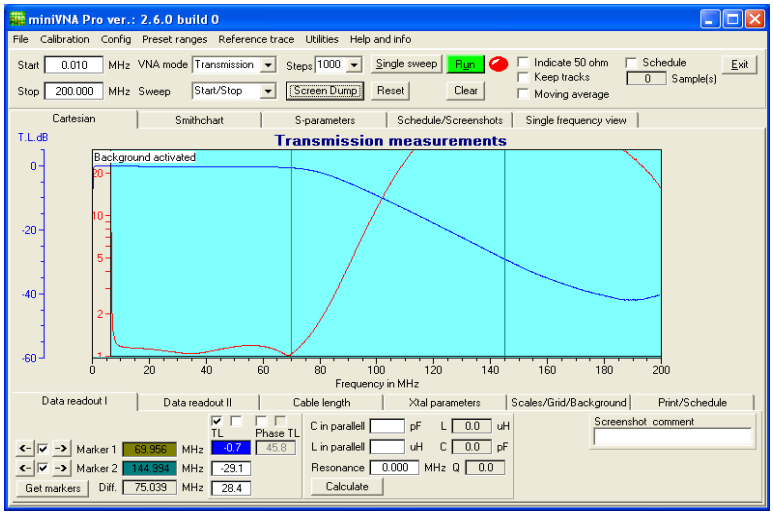


The G2 of the BF996 connects to the ALC circuit on the control unit and to the rear panel PWR potentiometer. We can reduce the final output power to about 5-6Watts.
The controlled gain BF996 amplifier continues the final ASL550 amplifier to a level exceeding more then 100 mW. Through the final pi-filter we can reduce the harmonics of the TX signal.

Simulated 70MHz LPF :



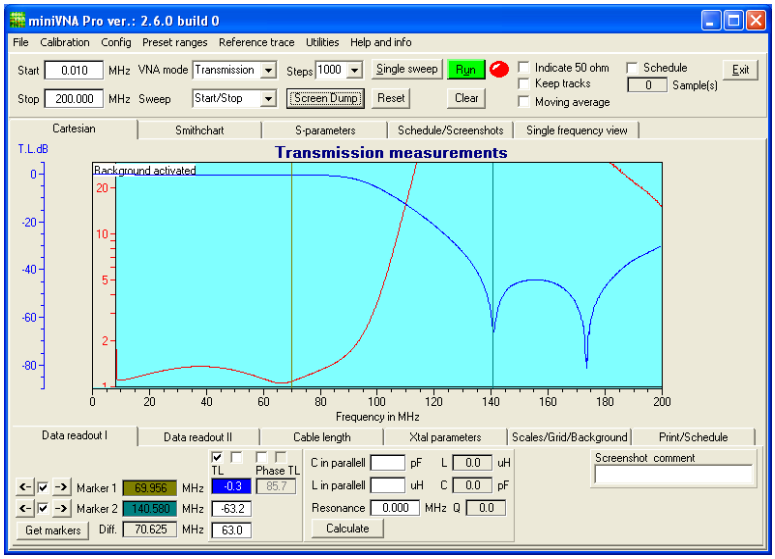
Measured 70MHz LPF:



4m module PA unit

We constructed >25W output amplifier to the base transverter unit. It's built with RA30H0608M Mitsubishi module, by Mitsubishi datasheet and applications.
The output signal of the transverter drives the RF module across -3dB attenuator. We set the RF module to AB1 class by a simple circuit applicated by Mitsubishi.
The output signal led to "N" type 4m ant connector across a harmonics filter and a built in NEC EB2-12NU type SMD RF relay.
The final unit has MONI output to check the output power connecting to the control unit LED bar graph PWR meter and ALC circuit.
The PA contains simple temperature sensor to check the temperature of the heatsink.

4m final LPF filter:



ME4T-PRO spectrum: ME4T-PRO_spectrum (pdf)

CONTROL UNIT

In order to monitor output power, we use an LM3419 based LED bar graph, implemented on the DP6 control unit. You can find the high current DC relay too on this PCB, together with the ALC circuit and the circuit of the external fan speed regulator. The external (optional) fan's speed is reduced by 50% during RX state.
In case of long TX periods, when the final PA module's heatsink temperature exceeds normal, then the circuit increases the speed of the DC fan. . The speed depends on the heatsink temperature. We can calibrate the normal fan speed with the P2 , the ALC level with the P3 potentiometer.
The LEG-12F relay is switching the Vpp voltage to the PA unit. The calibration of the output power is possible with P1 PWR potentiometer on the DP6 controller unit.

Switch/attenuator panel

People use different IF level transceivers from home or / portable operation. The jumper selectable attenuator solves the problem; let it be either high or low level IF signal transceiver.
You can either set ON or OFF the 5W attenuator, what is more, and you can also easily choose single or dual cable IF operation with these built in jumpers.
The unit contains switching circuit associated to the external PA's (red color RCA, SND output, (capable to switch max +50V,1A)

The PTT circuit uses two MJD127 devices on the tranverter unit for the RX/TX switching. TX when the PTT is grounded.
The PA circuit includes a sequencer, providing suitable delay in the TX key signal when activating first the relays of the external PA relay, then the antenna relay and first stage of RF module of the transverter. This means that the TX output is delayed approx. 50 ms after the antenna relay is activated.
The antenna relay of the ME4T-PRO and the external PA switches without any TX signal present.

Position of built in attenuator jumpers

Low PWR IF input (-20..+27dBm) 2x IF cable connection		Low PWR IF input (-20..+27dBm) 1x IF cable connection
J1	ON	ON
J2	OFF	ON
J3	OFF	OFF
J4	OFF	ON
J5	ON	OFF(ON-2nd RX)

High PWR IF input (27..+37dBm) 2x IF cable connection		High PWR IF input (27..+37dBm) 1x IF cable connection
J1	OFF	OFF
J2	ON	ON
J3	ON	ON
J4	OFF	ON
J5	ON	OFF(ON -2nd RX)

If you use single IF cable between your radio and the transverter, you connect it to transverter IFin BNC. In this case the IF-out connector is not in use. If you want to use a 2nd (e.g. SDR) RX, then switch J5 into ON state. (Only in case of single IF cable mode!)

Don't forget to connect the PTT cable between radio SND connector and ME4T-PRO PTT input! Otherwise the IF power (5W) kills the transverter IF output part.(in case single IF cable high IF level mode) The RX output is protected by antiparallel diodes but it does not help in case high IF power!
Never apply more than 5W IF level to the attenuator!

In order to protect the RX of those who forget to connect the PTT line, we built in an IF RF VOX circuit. (issued following Sept. 2012).
The RF VOX interacts at an IF level exceeding +27dBm, but only in case single IF cable mode.

Construction
The base transverter is built on a 1,5 mm double sided glass-fibre epoxy PCB; it is fitted into a standard metal sheet box measuring 148 x 74 x 30mm.PA unit is fitted into 148 x 55 x 30mm standard box. Both are manufactured with SMD technics.
The external box of the transverter is constructed from 1mm painted iron plate. The heatsink is 150x55mm ALU heatsink material.
If you use the ME4T-PRO continuously on digital modes you can order optional fan module (2pcs 50x50mm DC fans on holder plate).
No overheating problem occurs in case normal room temperature while operating on CW, or SSB and contest mode.
You can find on the front panel the ON/OFF switch, the LED bargraph power meter, the PWR potentiometer. The potentiometer reduces the output power to a desired level, max. down to t 5-6 Watts to drive for example an external FET PA's.

TECHNICAL PARAMETERS

Frequency range	69.9-72MHz
IF frequency range	27.9-30MHz
Emission modes	CW, SSB, FM, Digital
I/O impedance	50 Ohm/unbalanced, Ant-"UHF" type, IF 2x BNC
Operating temp. range	0-+50C
LO accuracy @ 20C	LO accuracy @ 20C
LO accuracy @ 0-50C	+/-1ppm PDI TCXO (+/-0.5ppm AXTAL TCXO opt.)
Input voltage	13.8V +/-5%
Power consumption	0.45A on RX, 5.5A/TX
IF power input	-20...+37dBm
IF input VSWR	1:1,1typ, max 1:1,3
Output PWR	30W, variable from 5W to peak PWR
TX harmonics	min. -70dB
IM3	-33dBc/ 25W output
PTT control	Contact closure to GND
SND output	Open collector, +50V/1A max.
RF VOX	Available, starts >27dBm IF input
RX noise figure @ 20C	1.2dB (overall)
RX gain	max 22dB (variable)
RX OIP3	typ. +25dBm, min. +22dBm
RX IIP3	typ. +3dBm
Image rejection	>85dB
Dimensions	240x260x70mm (incl. optional fans)
Weight	2.2kg
Case	Iron plate, @1mm