2018.10.23

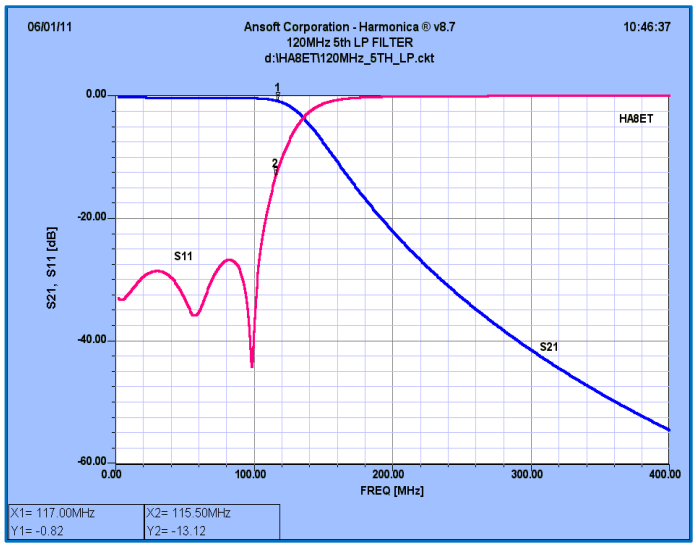
ME2T-PRO-II & ME2HT-PRO-II 144MHz Transverter

After the successful ME2T-PRO transverter project we decided to modify the -PRO version.
We built in the best Mini Circuits dual balanced mixer the HJK-3H. The new built in IF amplifier (ASF240 from ASB) has low noise, combinated with very good dinamic range on receiving section.
You can find the block diagram of the base 100mW transverter unit here.
The built in military class low phase noise TCXO provide easy work also on digital modes.
Optional AXTAL TCXO also available!
The transverter can work between 144-146MHz with low RX NF and high OIP3.
The Mitsubishi RF module provides good IMD signal and 30W output power.
The ME2HT-PRO-II basically same as ME2T-PRO-II but furnished with 80W RF module.
Before of first operation, **check the setup description**

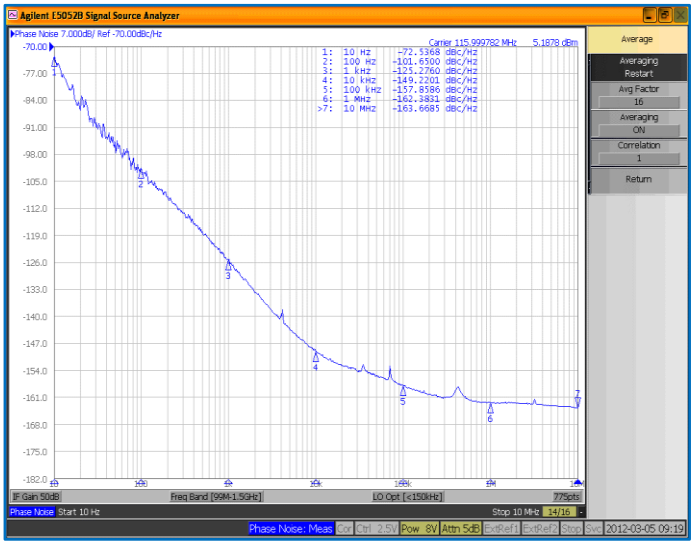
Local Oscillator

The high stability **TC23-5T** type TCXO by PDI (+/-1ppm btn 0-50 degr. C) with low phase noise gives +3dBm signal on 116.000MHz (or on 130MHz).You can choose 0.5ppm optional AXTAL TCXO with lower phase noise and better stability for example on EME operation.
The TCXO frequency can be adjusted with inner trimmer capacitor (+/-2ppm) but it's not necessary because the stability is better than +/-1ppm/Year.
TCXO stability and the phase noise is better than most modern transceiver's phase noise.
The output signal of the LO is about +23dBm, it produced by pair of ASB **ASL550** 3rd generation MMIC. The built in 2x 5th order filter provides clear output signal.

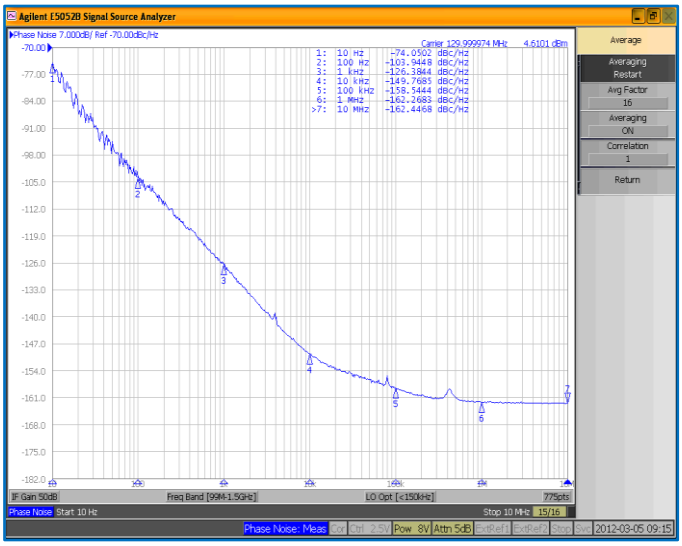
The simulated caracteristics of the 5th order 120MHz LPF filter:



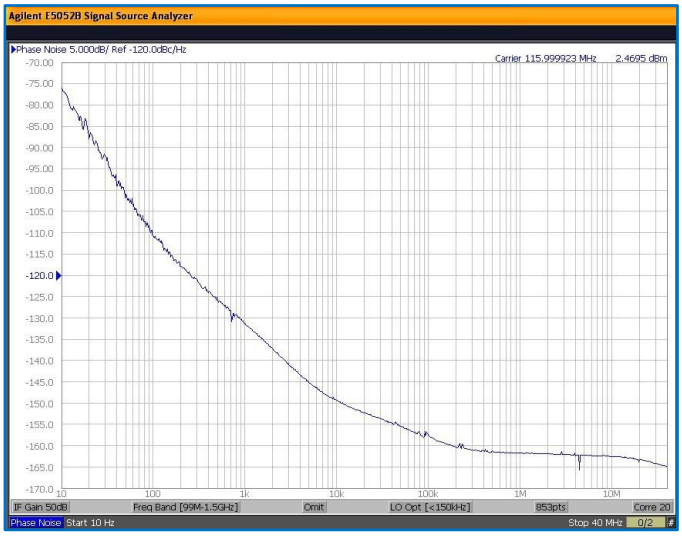
The measured TCXO phase noises:



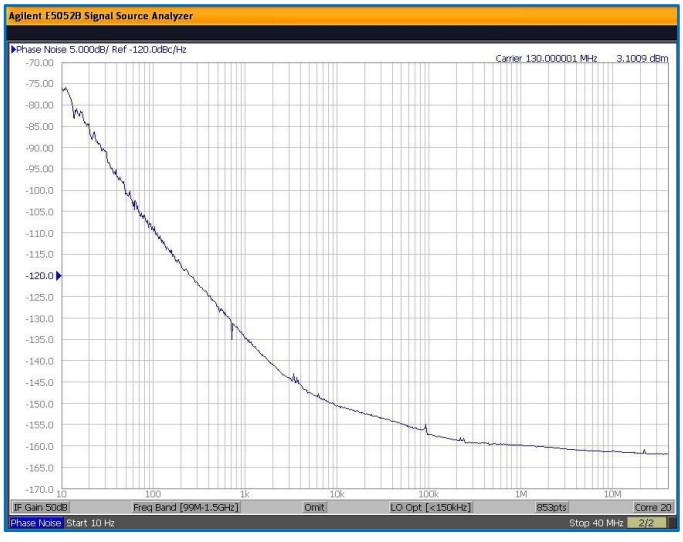
PDI 116MHz phase noise



PDI 130 MHz phase noise



AXTAL 116MHz phase noise



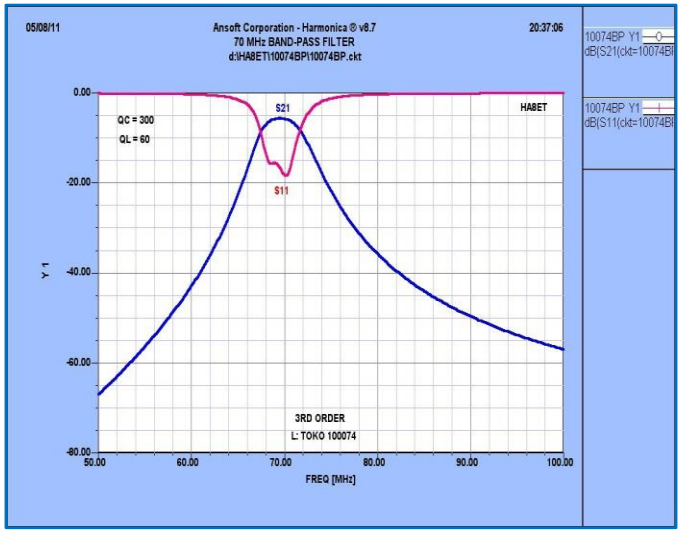
AXTAL 130MHz phase noise

We can check the +23dBm output signal on M3 measuring pin. This signal is attenuated by -10dB to the TX balance mixer (CSYM-1815).
We are using **HJK-3H+** type (+37dBm IP3) mixer in the RX side. We can check the real RX and TX LO signals on M2 and M1 points with DC voltmeter.

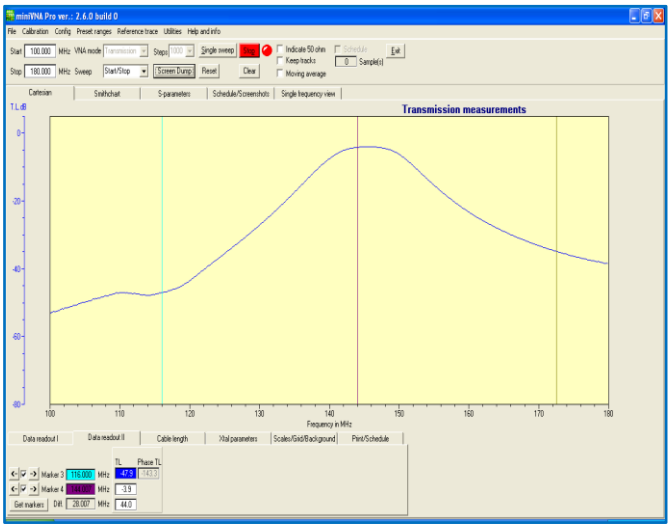
RX/TX

The 144-146MHz input signal passes through the input filter to the input PGA103+ LNA. The gain is approx. 20dB, the front end noise figure is 0.7dB, the OIP3 is >30dBm! PGA103+ 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 3rd order BPF.
PGA-103+ produces about +9..10dBm IIP3!

The characteristics of the 3rd order BPF:



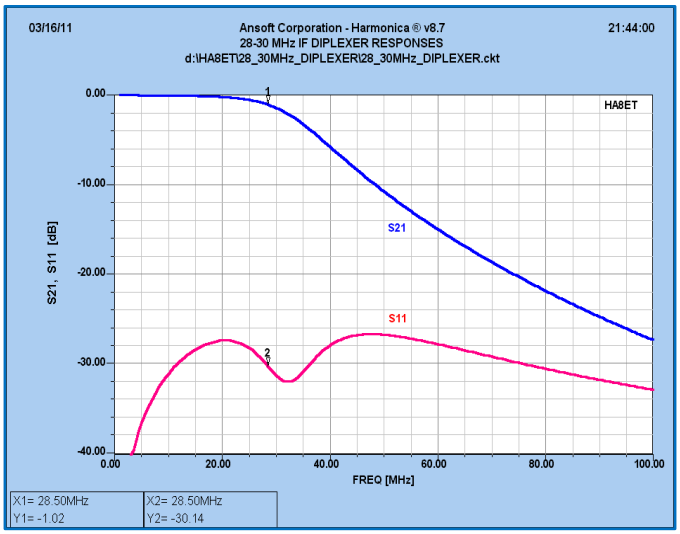
Simulated 3rd BPF characteristics



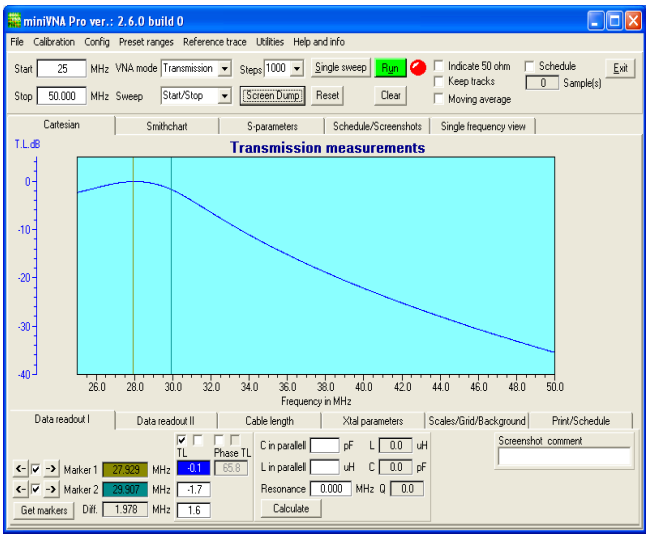
Measured characteristics

The 144-146MHz signal goes through the band pass filter providing a suitable selectivity.
The balanced mixer MX1 mixes the input signal down to 28-30MHz (or 14-16MHz) loosing approx. 6 dB in the process. The IF signal is amplified by approx.17dB in a low noise, high dinamics ASB ASF240 IF amplifier.
The final PI filter increase the selectivity considerably. The output signal is can set to optimal value with the RX gain potentiometer.

Measuring of diplexer and 28MHz LPF unit:



Caracteristics of diplexer unit

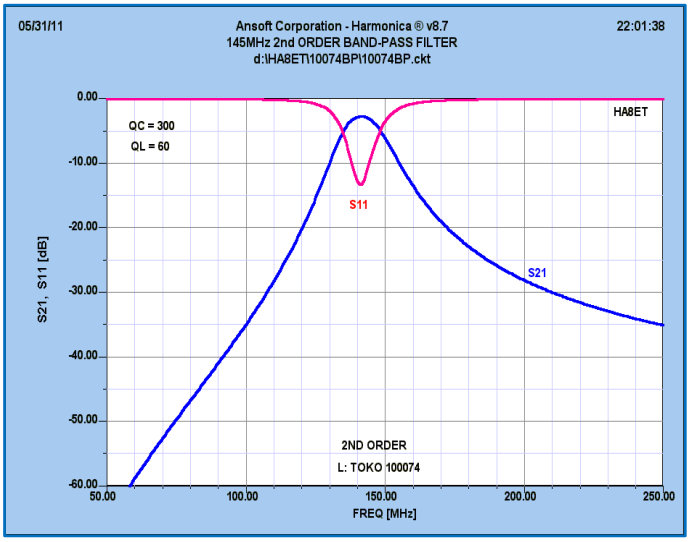


Caracteristics of 28MHz IF amp. & LPF filter

Diplexer full **simulation**

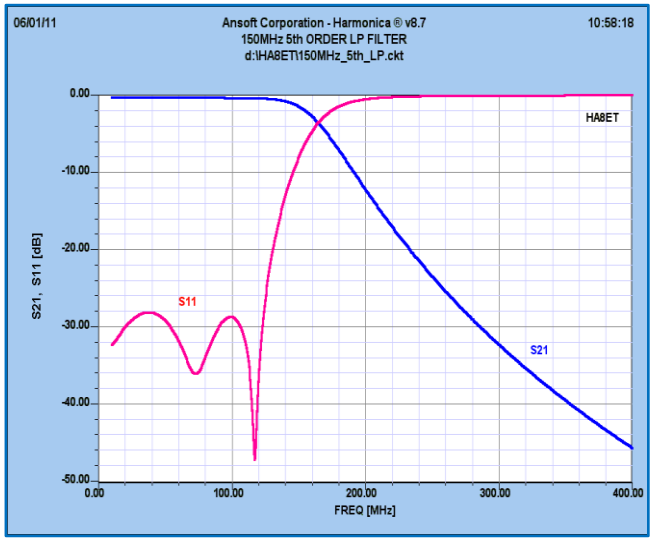
The transmit mixer, MX2 only needs approx. -10dBm 28 MHz IF signal from the transceiver. A suitable level can be achieved by adjusting P2(TX) in the attenuator. Lot of transceivers has lower or much higher IF output level. To solve this problem we built in an additional jumperable and variable 5W/-20dB 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 very low level IF out problem of most ICOM radios (-20dBm).
We built in +15dB gain jumperable IF amplifier so ME2T-PRO-II is usable easy to this radio types.
The 144 MHz TX signal behind the MX2 mixer is filtered through a three-stage band-pass filter before being amplified in a BF966.

Simulated characteristics of the 3rd order BPF:

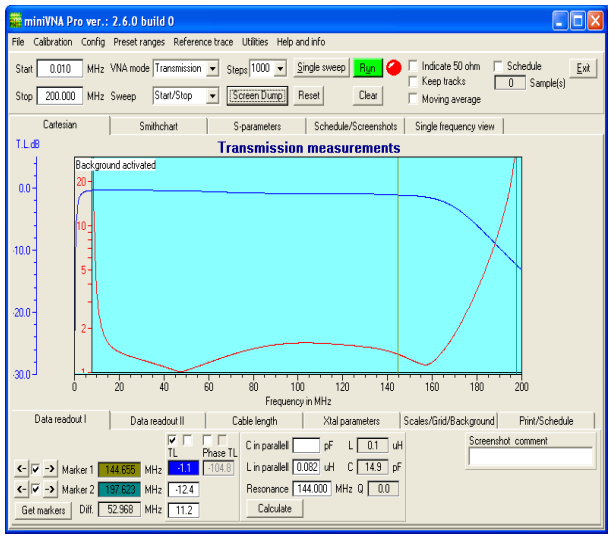


ME2T-PRO spectrum: ME2T-PRO_spectr (pdf)

The G2 of the BF966 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 than 100 mW. Through the final pi-filter we can reduce the harmonics of the TX signal.



Simulated 144MHz LPF



Measured 144MHz LPF

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2m module PA unit

We constructed >25W output amplifier to the base transverter unit. It's built with RA30H1317M 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 ME2HT-PRO-II model PA contains RA80H1415M type 80W RF module.
The output signal led to "N" type 2m ant connector across a harmonics filter and a built in NEC EB2-12NU type smd RF relay.
The final unit has MON 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.
The external heater fan module is standard in case 50W transverters, option in case the 30W model.

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, than 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-12 relay is switching the Vpp voltage to the PA unit. The calibration of the output power on the bar graph, is possible with P1 pwr potentiometer on the DP6 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, 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 transverter 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 RF module first stage of the transverter. This means that the TX output is delayed approx. 50 ms after then antenna relay is activated.
The antenna relay of the ME2T-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 ME2T-PRO PTT input! Otherwise the IF power (5W) kills the transverter IF output part (single IF cable high IF power version). The 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 in the new version.
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 ME2T-PRO continuously on FSK mode 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 bar graph power meter the PWR potentiometer. The latter reduces the output power to a desired level, down to 5-6 Watts to drive an external FET PA's.

High performance contest station with **ME14-X** or **ME28-X** RX/TX crystal preselector:

TECHNICAL PARAMETER

Frequency range	144-146MHz
IF frequency range	28-30MHz or 14-16MHz
Emission modes	CW, SSB, FM ,Digital
I/O impedance	50 Ohm/unbalanced Ant-"N" type, IF 2x BNC
Operating temp. range	0-+50C
LO accuracy @ 20C	1ppm PDI TCXO, <0.2ppm on optional AXTAL TCXO
LO accuracy @ 0-50C	+/-1ppm PDI TCXO (+/-0.5ppm with AXTAL TCXO)
Input voltage	13.8V +/-5%
Power consumption	0.48A on RX, 5.5A/TX (10.5A, ME2HT-PRO-II 50W)
IF power input	-20...+37dBm
IF input VSWR	1:1,1typ, max 1:1,3
Output PWR	ME2T-PRO-II=30W, ME2HT-PRO-II=50W variable
TX harmonics	min. -60dB
IM3	-33dBc/ 25W output, or 50Watt output (HT version)
PTT control	Contact closure to GND
SND output	Open collector, +50V/1A max.
RF VOX	Available, starts >27dBm IF input
RX noise figure @ 20C	1dB (overall)
RX gain	max 25dB (variable)
RX OIP3	typ. +35dBm, min. +30dBm
RX IIP3	typ. +10dBm, min. +8dBm
Image rejection	>85dB
Dimensions	240x260x70mm (incl. optional fans)
Weight	1.6kg