ADAT
All Digital Amateur Transceivers

Release Notes
Version 1.39d

Summary:

The release 1.39 combines the two former versions 1.36 and 1.37 by a new power calibration concept and introduces some new functions.

Content

1 Introduction

The power measurement used to FW version 1.36 was based on a voltage measurement and was therefore inaccurate at load mismatch. With the FW version 1.37, a procedure was offered, which allows the transmission power is measured by means of the directional coupler. However, for this purpose, a hardware modification to the PA was required, because the directional couplers downstream AD converter have been saturated.

As of version 1.39, the application of the improved power measurement is now possible without modification of the hardware. For this purpose, the calibration subroutines have been completely re-designed. After installing the version 1.39 a recalibration of PA is required in every case. For this purpose, a power meter to measure the output power of 10W on all bands must be present.

> Please read this document before you begin the firmware upgrade

The following functionalities have been added:

- o Support for Spectrum-Analyzer V2
- o Additional AGC functions
- o Binaural CW reception
- o Broadband FM (op to 25kHz)
- o New Power Enhancer on the transmitter
- o Added Transverter-Settings
- o New display of reflected power

2 Firmware-Upgrade

For an update from a version older than 1.35k the version 1.36 must be previously installed in accordance with the document "What's New in Release 1:36".

The versions 1.36x and 1.37x can be updated directly to 1.39.

> The version 1.39 requires changes in the Personality File. Create a backup, using the ADAT Commander, so that a change to an older version will be possible.

Procedures for Versions 1.36 und 1.37:

1. Using the ADAT Commander or the terminal program TeraTerm (see manual) down load the file "Download_Code_139b_p0.dat". This process takes about 15 seconds and will be confirmed on the display.
2. Restart the transceiver and down load the file "adat_FRN_Download_126a.dat". This file is first loaded down to the DSP and then transferred in blocks of 4KBytes to the front processor. The progress can be followed in the small display.
3. Restart the transceiver, and reset all databases and memories (CONFIG / SYSTEM / RESET).
4. Select the option RESET under CONFIG / Tx / MORE / MORE / P-CAL. This will initialize all relevant tables related to the power calibration.
5. Down load the backup file "Download_Code_139b_p4.dat".

6. The firmware of the device is now on the latest stand. The next step will be the calibration of the output power and the power meter in accordance with the instructions in Chapter 4

3 Detailed Description of the new Functionalities

3.1 Spectrum-Analyzer

3.1.1 Mode of Operation

The spectral analysis is permanently assigned to VFO4. It is therefore no longer available for radio operation. The entire data processing, that is, the Fast Fourier Transform (FFT), the logarithm and scaling, take place in the DSP program. The formatted spectral data are then transferred in blocks at intervals of 10ms via USB to the PC.

The possible bandwidth per segment is intrinsically limited to 20kHz. For the representation of broader bands several 20kHz segments are sequentially treated and put together. For a displayed range of 2MHz, 100 segments are needed.

The maximum sensitivity with the preamplifier (10 dB) and a scan width of 10kHz is -150dBm (7nV) and decreases to -128dBm (0.09µV) at a scan width of 2MHz.

The vertical display accuracy is in the whole frequency range within ±1.5dB. The indicated level refers regardless of the setting of the preamplifier / attenuator always on the power at the antenna input.

3.1.2 Modifications against the Version 1

The PC program for spectral analysis has been partially redesigned. In particular, the stability of the USB data transfer has been improved.

The following functions have been added in release V2.0:
:

- ○ displays the pass band of the receiving filter, respecting the bandwidth, side band and the pass-band tuning (PBT).

- ○ By clicking anywhere in the spectrum diagram, the VFO1 will be set to the appropriate frequency.

- ○ The frequency range have been extended for transverter mode

- ○ The appearance of the spectrum (colors, styles) can be varied according to your wishes and will be stored

3.1.3 Installation

Preconditions:

- ○ The option S1 (with costs) must be built in
- ○ Firmware 1.39 or higher is required
- ○ Is compatible to MS-Windows XP, Windows7 and Windows8
- ○ MS .NET Framework 4 must be installed

○ Unpack the file ADATSpectrumAnalyzer_20.7z with a 7-zip program and store it in a separate directory. The ADATSpectrumAnalyzer.exe file can be executed directly. Always first establish the USB connection to the ADT-200A before start the program. It is recommended that you create a shortcut on the desktop.

3.1.4 Short Description of Functionalities

Once the program is started and a USB connection to the ADT-200A is established, push right up to the Connect button. The state 'Connected' must now appear. The data exchange can then be started with the Start button.

| Control	Description
Analyzer State: **Stop**	Start-/Stop button
Analyzer Center Frequency: 14123.455 kHz	Center frequency from Analyzer (VFO4)
Set TRX = CF	Move the Rx frequency to the Analyzers center frequency
Transceiver Frequency: 14182.76 kHz	Rx frequency (VFO1), defines also the cursor position
Set CF = TRX	Move the center frequency to the Rx frequency
Analyzer Scan Width: 500 kHz	Width of displayed spectrum / waterfall
Analyzer Ref Level: -60 dB	Maximum displayed signal level (top border)
Analyzer Level Range: 80 dB	Displayed dynamic range
Analyzer Exponential Average: 3x	Averaging function (3x is recommended)

The following spectrum has been recorded with a signal of 14.1MHz,-20dBm (223mV, S9 +53 dB) and shows a dynamic range of >120dB (no preamp) and SFDR (Spurious Free Dynamic Range) of 100dB. The ultra-low noise generator SMBV from R&S was used as a source. At a distance of ±1 kHz the sideband noise is no longer recognizable.
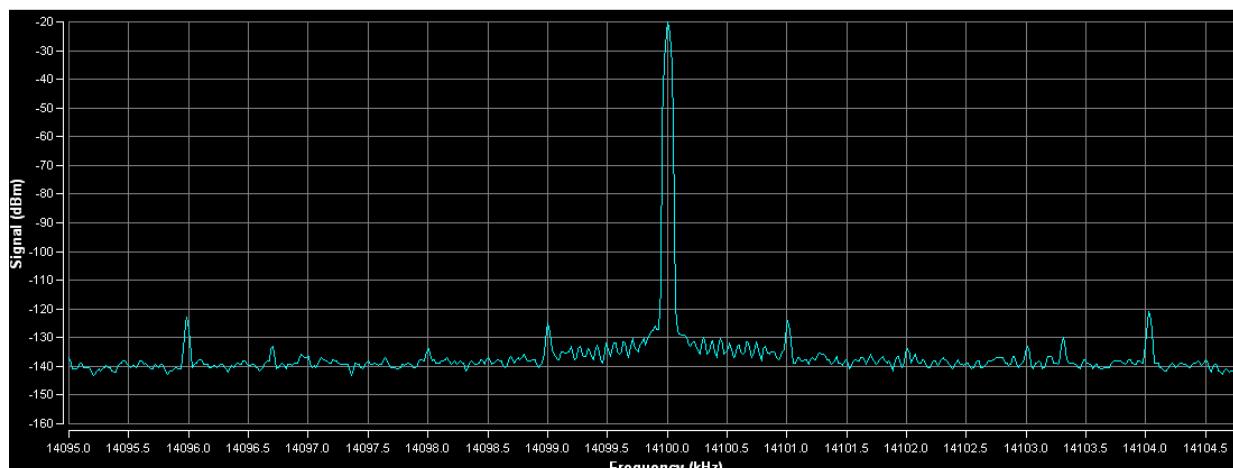
At the bottom of the analyzer following setting options are available:
:
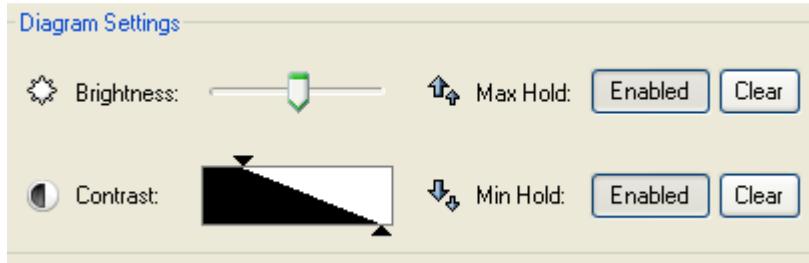
Brightness: Adjusts the brightness setting of the waterfall diagram

Contrast: Moving the left arrow to change the color of the noise level in the waterfall diagram. The right arrow defines the color of the strongest signals.

Min/Max Hold: draw a line in the spectrum depending on the weakest or strongest signals respectively. With "Clear" the process can be restarted

.

3.1.5 Toolbox

If the mouse pointer is within the spectrum display, you will get in the upper right corner of the spectrum some features to zoom in, zoom out, save and print the currently displayed spectrum.

With the icon in the upper right corner the graph can be changed, i.e. the colors of the lines and surfaces. Also, the spectral display can be changed as desired from a line chart into a bar chart:
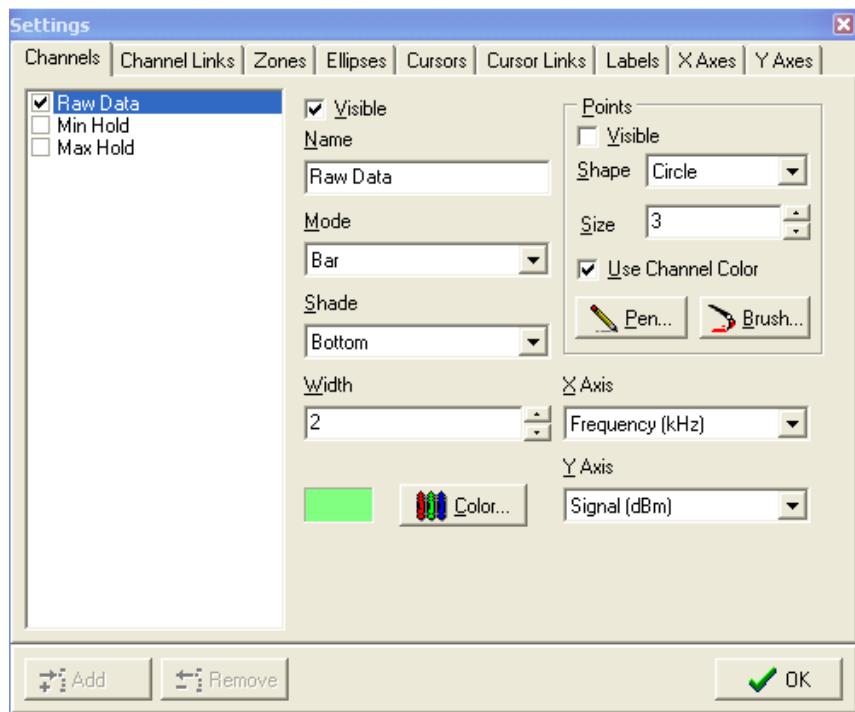
With the changes outlined above results in the following display:
:
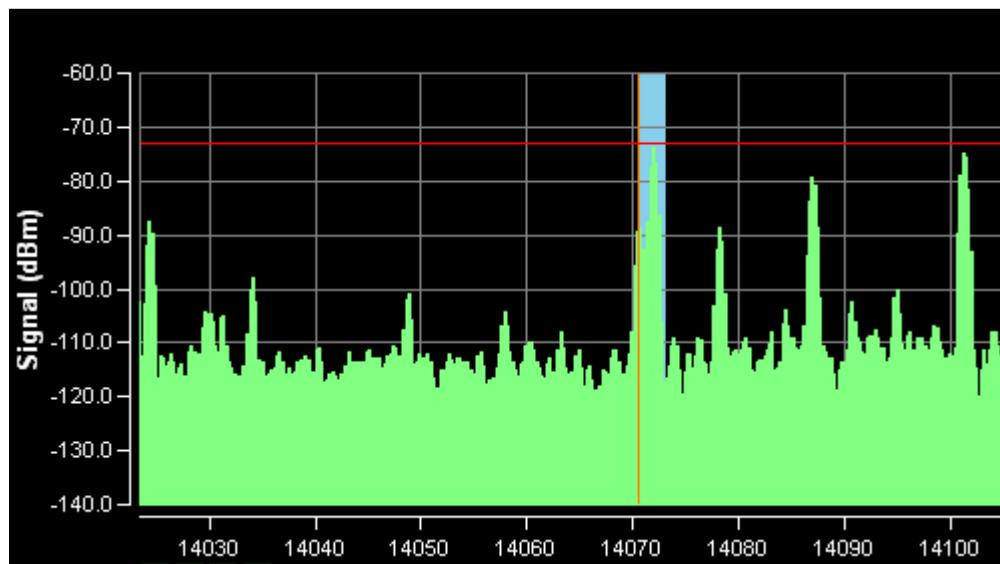
The red horizontal line corresponds to the signal level S9 (-73dBm). The blue area marks the pass band of the Rx filter and the vertical brown line, the receiving frequency.

3.2 AGC

3.2.1 New Calculation of the Decay Time

An unpleasant characteristic of most AGC systems is the big dependency of the decay time from the amount of level change. For example, a -20dB level change have a recovery time of 1 second, whereas a level change of -100dB results in a recovery time of 5 seconds (see figure 1).
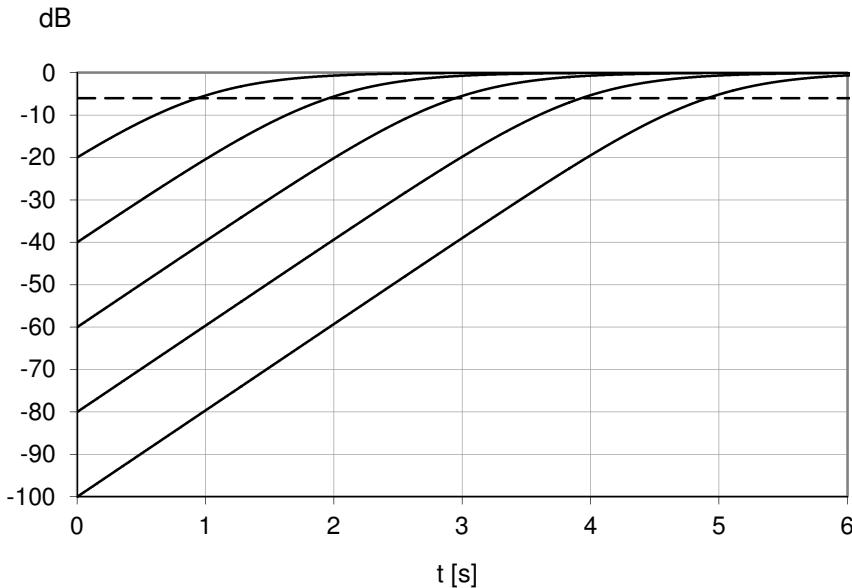
Fig. 1: Decay Time with fix time constant

A new algorithm has been developed which is measuring the level differences and then calculates the slope for a constant decay time (see figure 2).
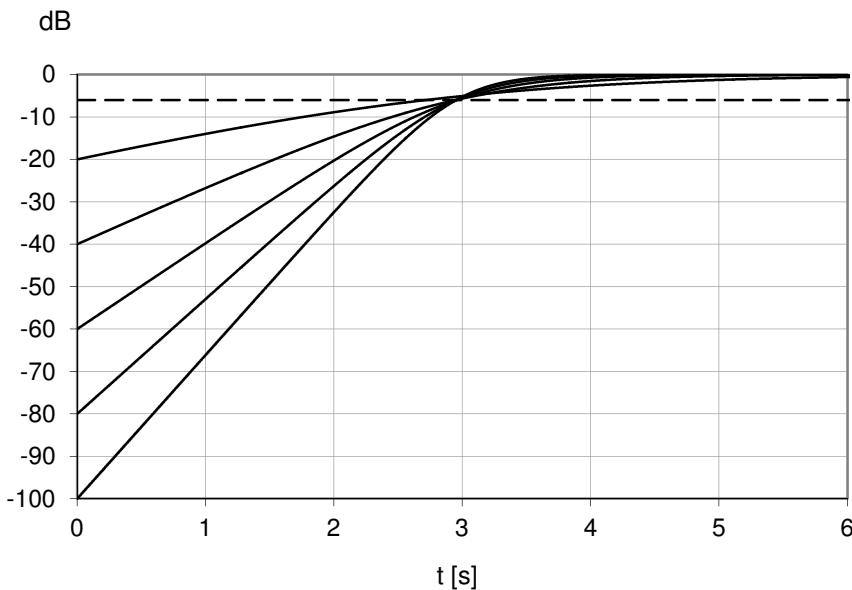
Fig. 2: corrected, adaptive slope for a constant decay time

3.2.2 Fast Decay of AGC while Tuning

For SSB operation usually a long AGC decay time is applied. This can be annoying when weaker stations cannot be heard during the decay time when tuning out from a strong station. This can be avoided with a new function. Under CONFIG / Rx / AGC, a new menu item RECVRY has been created. There, the following options are available:

NONE   no change

-12dB   when tuning the AGC is immediately set to a level of -12dB

-6dB   when tuning the AGC is immediately set to a level of -6dB

FULL   when tuning the AGC is immediately set to the full level

The following audio screen shots show the effectiveness of this function:
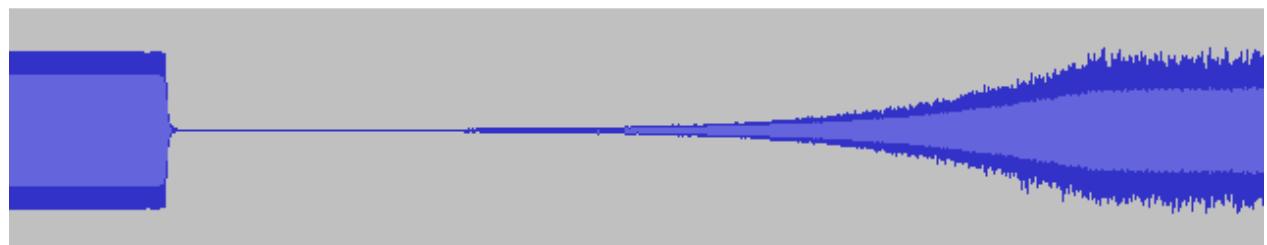
Position NONE: full decay time
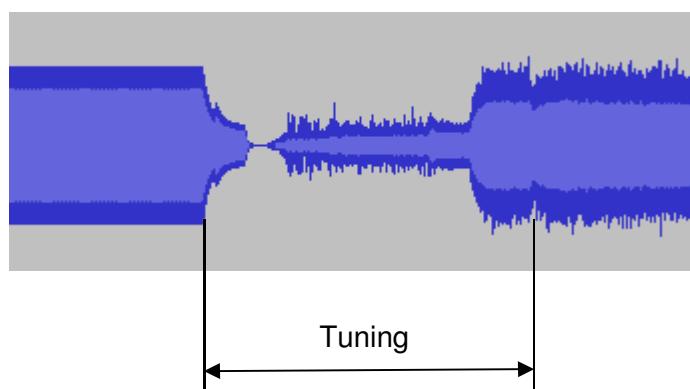
Position -12dB: the noise floor is immediately hearable, attenuated by 12dB
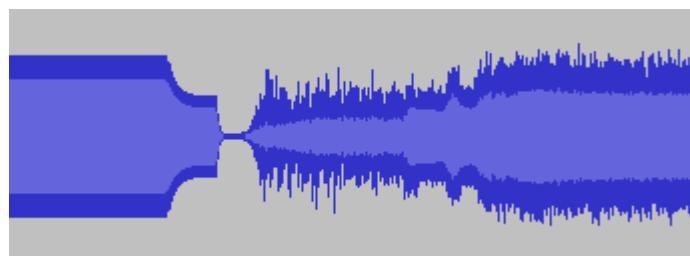
Position -6dB
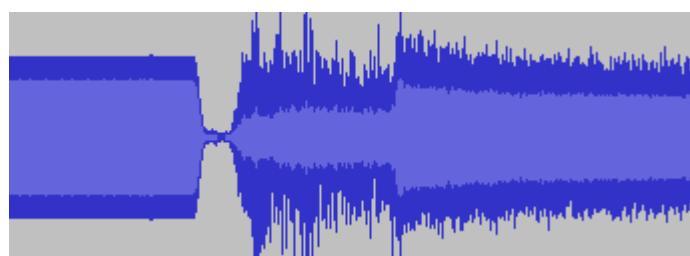
Position FULL

For this function, the front-firmware 1.26a or higher is required. The appropriate USB command is $CSF.

3.3 Broadband FM-Reception

In the FM mode the filter bandwidths of 12, 15, 20 and 25kHz have been added. If one of these bandwidths is selected, a new FM demodulator is used. This makes it possible to realize a data transfer rate of up to 19.2kbit/s for transverters, operating in the UHF and SHF range (see Figure 3).

This mode is only available in VFO1. In VFO2 and VFO3 an error message is generated when an FM bandwidth of 12kHz or greater is selected.
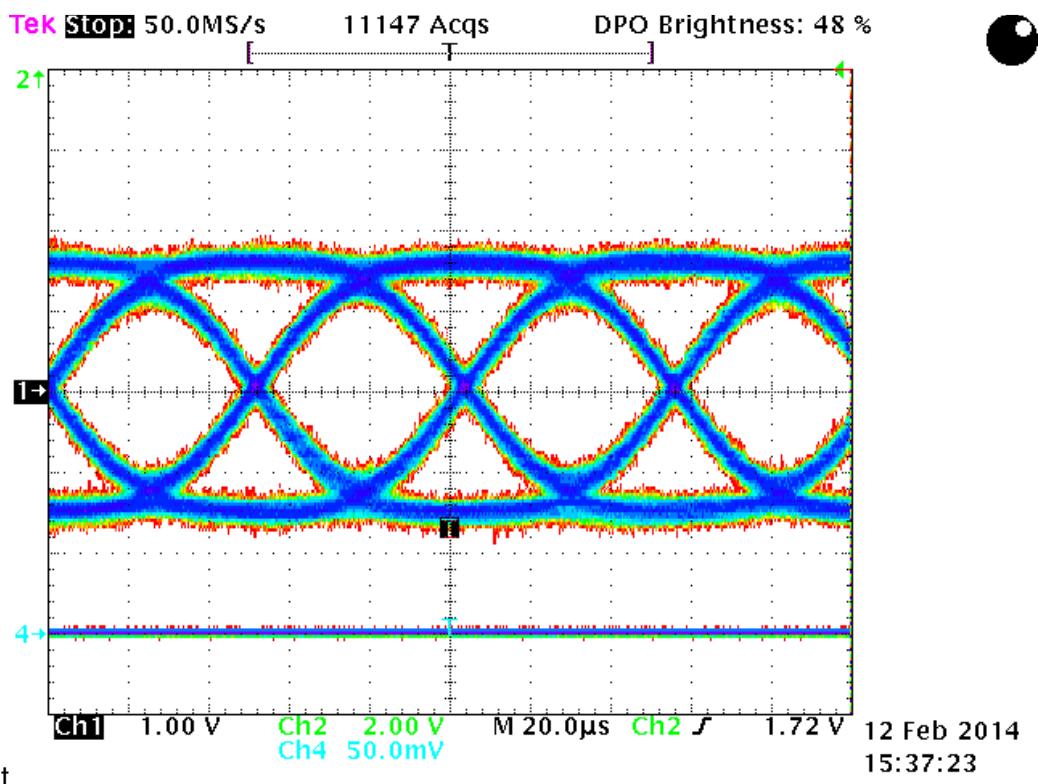
Fig..3: Eye diagram from a GMSK-modulated signal with 19.2kbit/s
(B = 25kHz; Source: R&S SMIQ with Gauss filter, α = 0.65)

3.4   Binaural CW Reception

The I / Q signal is fed through the full processing chain to the audio output, and can be picked up as a stereophonic audio output (such as line-out) with a headset. Binaural reception of CW signals has the advantage, that under pile-up conditions, the CW signals are hearable in a virtual three-dimensional space and thus are better distinguished from each other.

This function can be set in the M-SPEC menu for CW. The corresponding USB command is $OCB: 01 (= on) or $OCB: 00 (= off).

3.5 Frequency setting / requesting via USB Port

The remote frequency control has been enhanced by the following functions:

- o Frequency inputs are assigned to a HAM band
- o The PA harmonic filters are operated correctly according the frequency input
- o All inputs are tested against the band limits (when option B0 is inoperative)
- o A read out of frequencies is possible
- o Frequency inputs for inactive VFO's are possible

3.5.1 Remote Frequency Input

The frequencies of all VFO's can be set by the command $FRx: <freq_Hz, where 'x' corresponds to the VFO number. The entered value is assigned to the corresponding band. If the B0 option is inactive, an error message is issued if the value is outside an amateur band. By assigning the bands up to 9 frequencies per VFO can be entered, which are active after the selection of the band.

Example:

```
$FR1:3705000
$FR1:7125000
$FR1:14245000
$FR2:7124000
$FR3:28445000
```

If the entered frequency lies outside the band limits (option B0 not active), then a message is displayed:

```
$FR2:7300000
$INF 5 Freq out of HAM Band!
```

If the option B0 (no band limits) is unlocked, all entries will be accepted in the range between 10kHz and 30MHz. The harmonic filter of the transmitter will be switched according to the frequency input, the allocation to the bands is no longer guaranteed.

3.5.2 Remote Frequency Read Back

The stored frequencies can be queried by the $FRx command, where 'x' corresponds to the VFO:
:

```
$FR1?
$FR1    29500000
```

To read a specific frequency (e.g. VFO3, 20m band), the following commands are required:

```
$VFO:02                 (select VFO3)
$BHM:04                 (20m band)
$FR3?
$FR3    14236000
```

With this command structure, the entire frequency database can be read out. The currently received frequency can be determined using the following command:

```
$FRA?
$FRA  1  29.500000MHz
```

The digit after the $FRA string indicates the active VFO. The other, inactive VFO's can be queried with the command $FRB and $FRC. The difference to the commands $ FR1, 2 and 3 is that $FRA is always associated to the active VFO. When working with the VFO2, $FRA shows ist frequency, $FRB that of VFO1 and $FRC that of VFO3.

3.6 Operation with an external Transverter

Since the version 1.36, the settings for Transverter via the USB interface have been expanded:

- ○ If an input with $FRx: is above 40MHz, it will automatically be treated as a transverter receiving frequency

- ○ Up to 3 local oscillator frequencies in the range of 10MHz and 3GHz can be set

- ○ All settings can be read out

- ○ The precision for frequency calculations have been improved, resulting in an error of ±1Hz

- ○ Split operation is now also possible in transverter mode

3.6.1 Activating the Transverter Operation

The commands CONFIG / SYSCON and options ‚ext-TVL' or ‚ext-TVH' will enable the transverter operation. Possible options are:

- ext-TVL   →   Low Power Mode (-10…+10dBm)
- ext-TVH   →   High Power Mode (0.1…2W)

The ext-TVx setting applies to all VFO's and configuration sets. This prevents that the PA is erroneously turned on.

The choice of the transmission power (POWER and P-TUNE) is altered to the range of 0.1 ... 10 mW in low-power and 0.1 ... 2W high-power mode.

When low power transverter operation (ext-TVL) is selected, the PA is bypassed, so the transmit / receive switch is no longer effective.

As IF output is ANT 1 and as IF input serve Rx In or ext ANT. While the high-power mode (ext-TVH) is selected, the transmit / receive switch is in use, but it is recommended to use Rx In or ext ANT as IF input.
.
It is recommended to operate the preselector in the mode BYPS, since it can be assumed that the upstream transverter has sufficient selectivity. This allows, that the internal spurious interferences are greatly reduced.

Transverter configurations can be stored in memory. The system configuration under SYSCON is then automatically set to Transverter operation.

Caution: When a memory channel is recalled, which has been stored with SYSCON = NORMAL, the unit will return to normal operation.

Attention: full power is possible!!

3.6.2 Setting the Local Oscillator Frequency

Each VFO can be assigned a local oscillator (LO) frequency:

$FV1:-78000000	for VFO1
$FV2:116000000	for VFO2
$FV3:2292000000	for VFO3

The entries must always be in Hz, without decimal point. Valid values are in the range of 10MHz to 3GHz. A negative value means that the LO frequency is higher than the reception frequency.

Theas entries can be recalled by the command:

$FV3?

$FV3 22920000000

The formula for the displayed frequency is:

$$f_{Display} \;=\; abs(\pm f_{LO} + f_{VFO})$$ f_{VFO} : VFO frequency from ADT-200A

A positive value of f_{LO} means, that f_{LO} is lower than f_{Rx} and a negative value, when f_{LO} is higher than f_{Rx} .

abs(+116.000000MHz + 28MHz) = 144MHz

abs(-172.000000MHz + 28MHz) = 144MHz

3.6.3 Rx Frequency setup

The receiving frequency can be set manually on the transceiver or remotely via the USB interface. The Transverter input frequency is always shown in the display. If the B0 option is not available, the (intermediate) frequencies are limited to the band limits of the respective amateur bands.

Commands for Rx-Frequencies for VFO1 to VFO3:

```
$FR1:50400000

$FR2:144400000

$FR3:232041200
```

The calculation of 9-digit frequency values is done in high precision, so that the error is below 1 Hz.
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3.7 Adaptive Predistortion

The adaptive predistortion has been improved through a re-adjustment of the time delays. In addition, the control of the phase difference between the transmitted and the reference signal has been improved to avoid phase jumps.
During the calibration of the two-tone power amplifier, the adaptive control of the amplitude is constantly monitored and in a possible overload, the output power is reduced in small increments, until the compression of the transmission signal is less than 2%.

3.8 New Power Enhancer

The Power Enhancer has been completely redesigned. In this case, the transmission signal is analyzed, and the weaker parts are enhanced by 3dB to 12dB in steps of adjustable 3dB, which leads to an increase in the average transmission power. This produces a more penetrating modulation. In contrast to the known compressors, the high amplitudes are not compressed, resulting in distortion, but merely linearly scaled. Thus the transmission spectrum is not affected.

A special algorithm ensures that no overshoot can occur over the set power. The Power Enhancer is only effective in SSB mode.

The following examples illustrate the effectiveness of the enhancer:

Enhancer
switched off

Enhancement
6dB

Enhancement
12dB
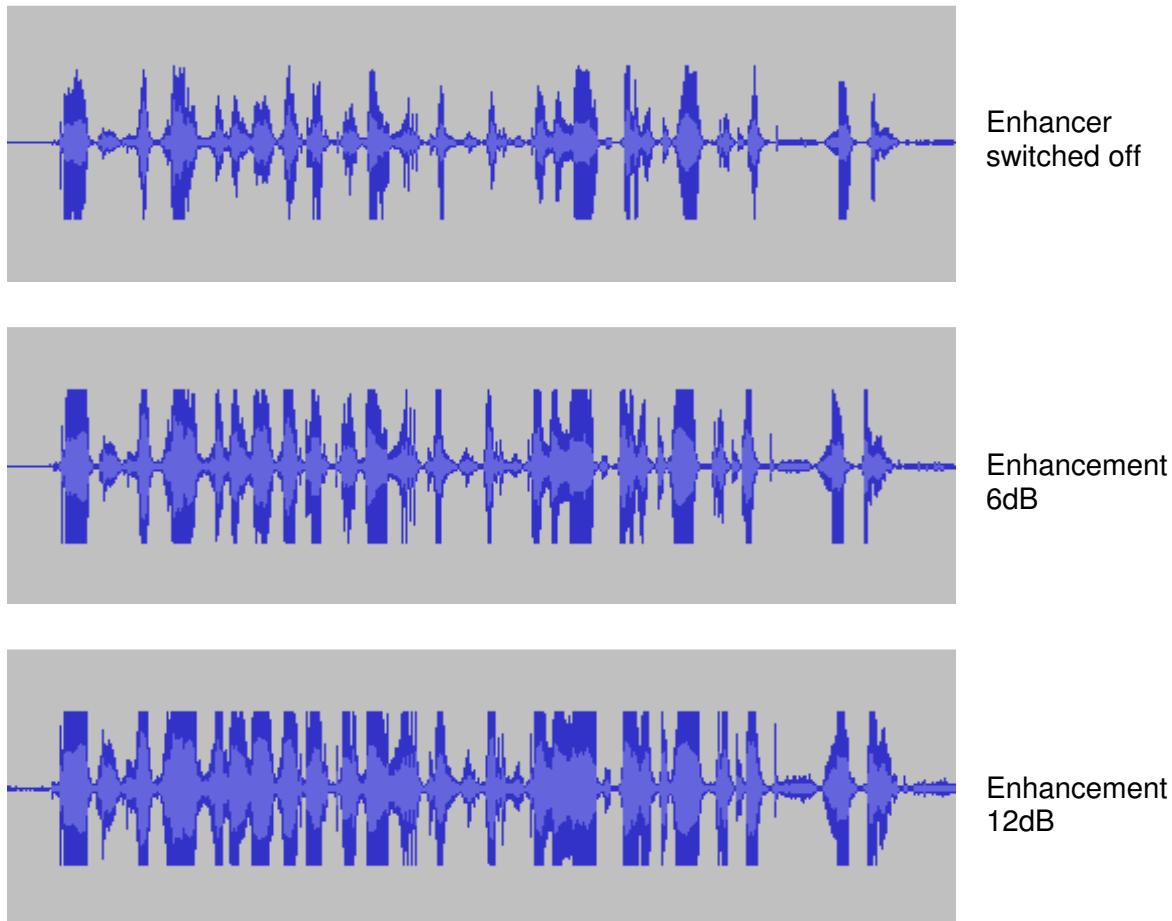
3.9 New Display of Transmit Power

The new power indicator, introduced already with the version 1.37 is still used. The medium power Pmed is no longer displayed, but replaced by a second bar display, which shows five times the value of the reflected power.

The example below is taken with a resistive load of 24Ω and an output power of 10W:
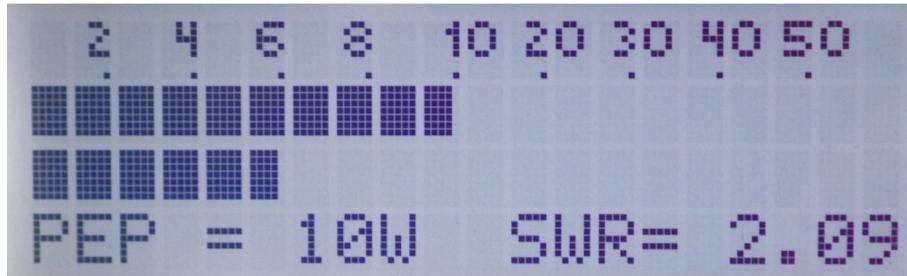
R$_{Load}$ = 24Ω leads to an SWR = 2.08 and a reflection factor | Γ | = 0.351

The reflected power is therefore Γ^2 = 0.123 or 1.23W. Since the five-time value is displayed, the lower bar shoes about 6W.

4 PA Calibration

The measurement of power used to FW version 1.36 is based on a voltage measurement and is therefore inaccurate at load mismatch. With the FW version 1.37, a procedure was offered, which allows a power measurement using the directional couplers. As the only tool a calibrated power meter was required. In the simplest case, a single power measurement of a single-tone (CW) signal was sufficient. However, a hardware modification was required in the PA.
As of version 1.39, the application of the improved performance measurement is now possible without modification of the hardware.

4.1 Preparation

After you reinstall the version 1.39 the following steps must be performed:

1. Back up the existing personality file with the ADAT Commander (File / Backup Personality Data).

2. Execute a reset of the database "system" (SYST-DB) and "frequency" (FRE-DB) and reset the calibration tables (CONFIG / Tx / MORE / MORE / P-CAL = RESET)

3. Connect an external power meter (2 ... 30MHz. 10W min) to the output ANT1

4. Connect the transceiver via USB cable to your PC and then start the program TeraTerm

5. Test the USB channel by changing the AF gain. Then $PMU messages must appear on the TeraTerm

4.2 Manual Calibration

1. Select the 160m band and set P-TUNE to 10W. Then press the MOX and F-TUNE buttons to get a carrier signal on the output.

2. Read the power on the power meter and enter the value in the TeraTerm in the form
   $XP2: 8.63
   (assuming the power meter has displayed 8.63W)

3. Check the power on the power meter. You should now read 10W. If not, then repeat the step

4. Select the next higher band and repeat the procedure from point 2. To the 10m band

5. Finally, save the measurements into the Personality File, using the command
   $XPC: 00

Thus, the manual calibration is complete.

4.3 Automatic Calibrations

If the power meter endures max. 50W, it can remain be connected to the transceiver for monitoring the output power. Otherwise, a dummy load should be connected.

The next calibration steps are running in an automated from:

1. Select under CONFIG / Tx / MORE / MORE / P CAL the first option 1T-PWR and confirm the appearing dialog window by pressing the SELECT button. After that, all P-TUNE (single-tone) powers for all bands are set (144 steps), wherein the determined 10W-points in the previous step serve as a reference.

2. Select and confirm the option 2T-PWR. Then a 2-tone signal is generated for the following settings:
   - Alignment of the predistortion (9 steps)
   - Setting the 20W point for all bands (9 steps)
   - Calibration of all power levels on all bands (144 steps)
   - Storage of the results

3. Connect the power meter / dummy load to the output ANT2 and select the ANT2 option in the P-CAL menu. This calibrates the output ANT2 (9 steps)

4. leave ANT1 ANT2 unconnected and select the SWR oo option. Then the SWR = infinity or Return Loss = 0 is calibrated for all bands.

Now, the calibration is complete. The RSTCAL option can be used to reset the calibration to default values to start a new calibration.

As long as the calibration has not been fully carried out, the following message appears when the device is

„Pls Run PA-Calibration"

4.4 Interpretation of Power Measurements

In Amateur Radio the power is mostly given as peak value or peal envelope power (PEP). Depending of the measurement principle, a two tone signal with a power of 10Wpep is producing a different readout as shown in the following table:

Instrument	Power Adapter	CW-Signal	Two Tone Signal
R&S URV	Diode adapter Z2	10.72W	9.54W
R&S URV	Power Adapter Z4	10.02W	6.65W
HP 437B	Thermal Power Adapter 8482A	10.00W	5.0W

The exact measuring can only be done with a thermal power adapter which is indication the true power. Please respect, that a two tone signal of 10Wpep consists oft two carriers with -6dBp (=2.5W). The voltage addition results in a peak of twice the voltage of a single carrier (+6dB). Therefore the peak power is 10Wpep whereas the mean power is the sum of 2 * 2.5W = 5W. This power is only indicated correct by meter with a thermal power adapter.

5   Changes in the Version 1.39d

5.1 Power Calibration

The automatic power calibration has been further improved. The following graphics are taken from a reference unit. Due to tolerances, a bigger amount of deviations is possible.

Single Tone Verification
Tolerance of Output Power vs. Desired Power
Unit Nr. 902022 (NEW _CAL) 07-31-2014

Dual Tone Verification
Tolerance of Power Meter vs. Measured Power
Unit Nr. 902022 (NEW _CAL) 07-31-2014
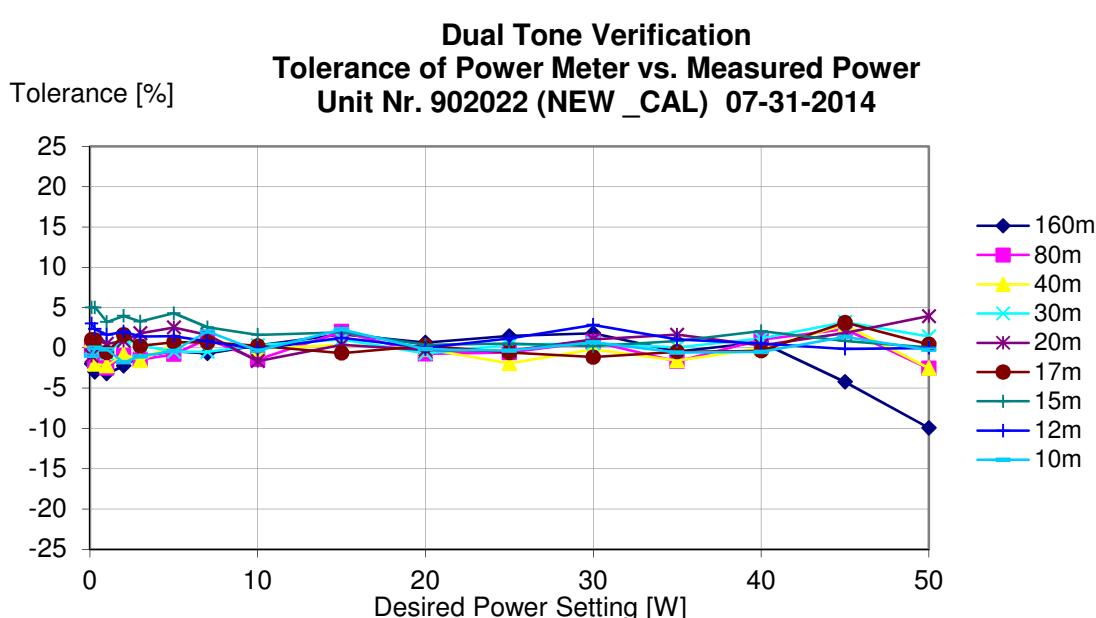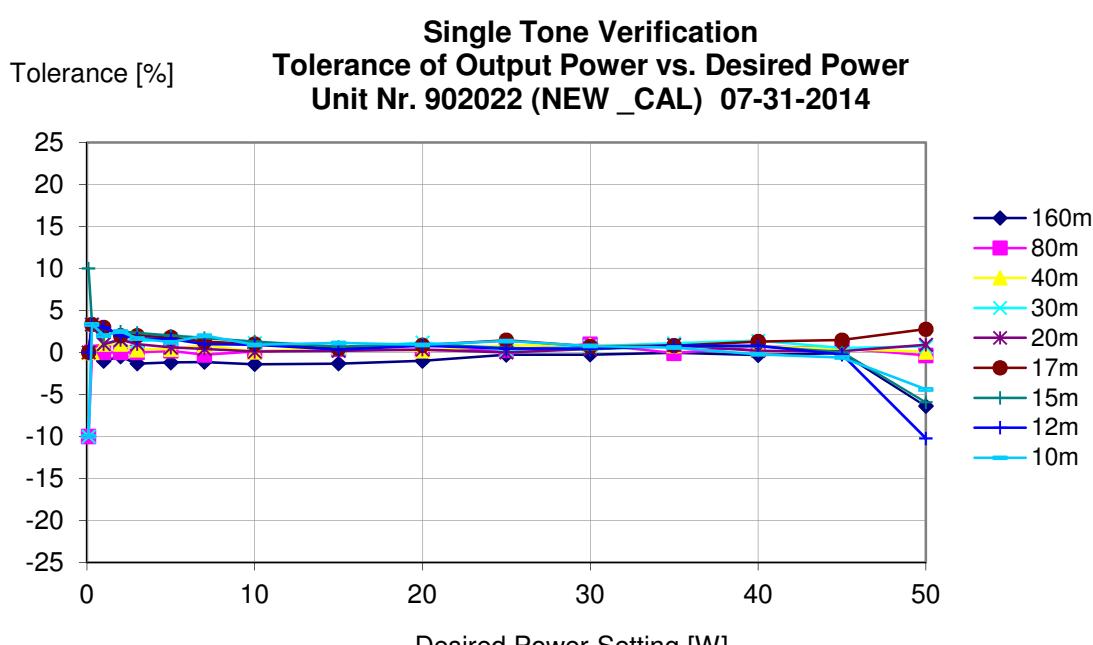
The following improvements have been done:

- The first two steps of the two tone calibration routine (predistortion open loop gain and 20W point setting) will be repeated once.
- A new EXIT function was added to terminate a running calibration step.
- The differentiation between unmodified (SPEC) and modified (NEW) power amplifiers can be requested by the command $XPE:00, or can be set by $XPE:SPEC.
- The saturation point of the power amplifier (decreasing output power at increasing drive) is monitored during the calibration and the process is stopped when the saturation is reached.
- The intermediate step at 20W after switching on an internally generated two tone signal is suppressed at the status "NEW".
- The power indication is limited to 60W.

5.2 Other Modifications

- Setting the Transverter Mode on after the firmware update is now avoided.