



**ND 500 DE
Operating Instructions**

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Meret Optical Communications, Inc.



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1 Introduction

The frequency synthesizer ND 500 D is a direct synthesizer RF-generator. The output frequency is set in exactly decade-related steps with 0.1Hz resolution. The accuracy of the output frequency is solely determined by the frequency reference.

Combining conventional RF-modules for greater frequency steps with a DDS (**D**irect **D**igital **S**ynthesizer) for smaller frequency steps makes possible excellent technical data for residual FM, high spectral purity and very fast frequency-switching, realized in a small packing.

Besides internal synchronization by the standard OCXO, frequency synthesizers of the ND 500 D series can be synchronized externally in order to access the same reference when operated along with other instruments or to benefit from the stability of an external standard. On the other hand, the frequency synthesizer's high precision OCXO can also synchronize other instruments.

The two differently equipped instrument types ND 500 S and ND 500 D are based upon the same technology as the base version ND 500, used along with various interfaces (BCD, RS 232, IEEE-BUS) they provide optimum match to the specific measuring problem.

Applications of the frequency synthesizers include:

- use in nuclear magnetic resonance spectroscopy, electron spin resonance spectroscopy and microwave spectroscopy.
- transmitting- and receiving section of terrestrial and satellite radio systems.
- fast automatic test systems for antenna-, instrument- and component testing.
- settable frequency reference, derived from frequency standards or used as high precision local oscillator for research and development, etc.

Besides, frequency synthesizers can replace complicated PLL-synthesizers, for which modulation of the carrier is not the key problem, but accuracy, frequency stability and spectral purity are essential. The option 'output level' of the ND 500 D offers a wider range of applications.

The Schomandl frequency standard FN-77 and the FN-GPS are particularly suitable for external 10 MHz frequency standards; the FN-77 is based upon the frequency of the long wave transmitter DCF 77 for use in Central Europe whereas the FN-GPS using signals from the GPS-satellite system can be used anywhere in the world.



2 Installation

2.1 Unpacking

Please check the instrument immediately after unpacking for possible transportation damage. When a damage has occurred, please keep packing material, invoice and transportation documents completely since all these items are required to treat that damage. Please inform your nearest dealer immediately.

Check the completeness of the delivery by means of the delivery note. In case of any discrepancy, please inform your nearest dealer.



Note:

- for shipping or storing your instrument, please use the original package, if possible. If that is not available, you are advised to use an equivalent package, offering best possible protection for your instrument.
- please always enclose a dehydrating agent to the package in order to protect your instrument from penetrating humidity.
- please observe the storing temperatures as given in the technical specifications.

2.2 Setting up the ND 500 D

- make sure your instrument gets sufficient ventilation.
- if several instruments are to be operated one atop of another, the frequency synthesizer should be on top.
- in order to avoid heat accumulation, no object should block the ventilator opening and the ventilation holes on the upper and lower surface.



Attention:

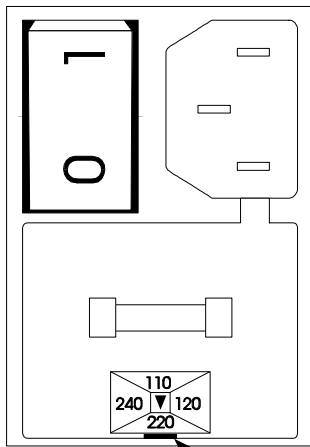
Never deposit anything on the instrument.

- in order to avoid damage to the frequency synthesizer and to the instruments connected thereto, all plug-ins and unplugs have to be carried out with AC-power off.



2.3 Mains Voltage

Before switching on the instrument, please check whether the operating voltage the instrument is set to complies with the local mains voltage.



The operating voltage set for the instrument is indicated below the power connection.

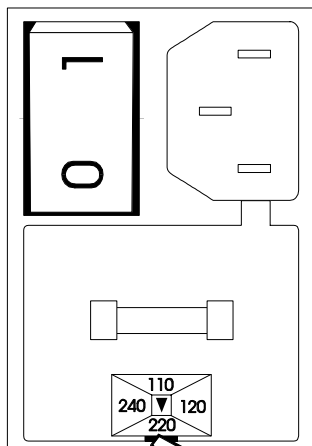
An arrow indicates the set voltage.



Attention:

Wrongly set operating voltage may destroy the instrument. Schomandl is not liable for any damage resulting from wrongly set voltage.

2.4 Replacing a Fuse / Adjusting the Mains Voltage

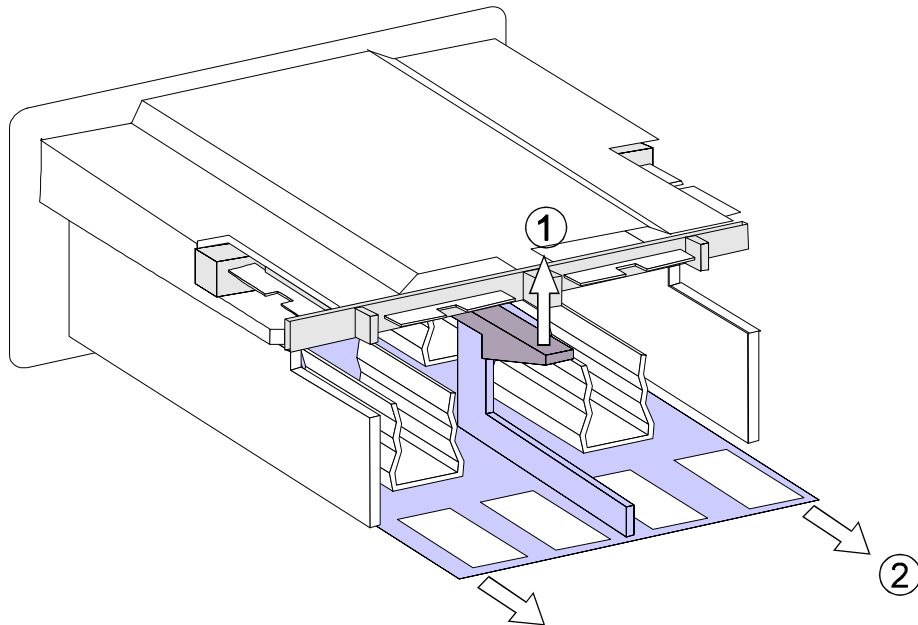


If the local mains voltage does not correspond to the mains voltage the instrument is set to, or if the mains fuse has to be replaced, proceed as follows:

Remove the fuse block from its support by inserting a screwdriver into the prepared recess below the fuse block, use it as a lever and remove the fuse block from its support.

2.4.1 Replacing a Fuse

- Press the bolt of the 'fuse compartment' slightly upwards ① and then pull out the fuse carrier ②.

**Note:**

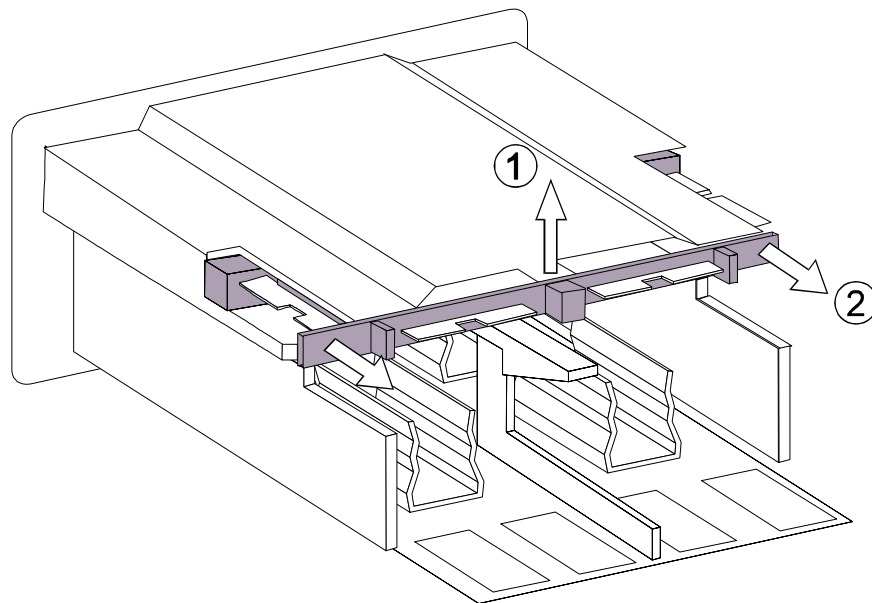
Only use the following fuse-types:

For 220...240V AC	Slow-Blow 2,0A
For 110...120V AC	Slow-Blow 5,0A

- After replacing the fuse push back the fuse carrier into its support.

2.4.2 Setting the Mains Voltage

- press the bolt of the 'coding plug' slightly upwards ①, then pull out the coding-plug ②.
- Re-insert the coding plug in such a way, that desired voltage is shown in the front panel window of the fuse carrier.
- Make sure, desired voltage is shown in the fuse-carrier window. (see also 2.3)

**Note:**

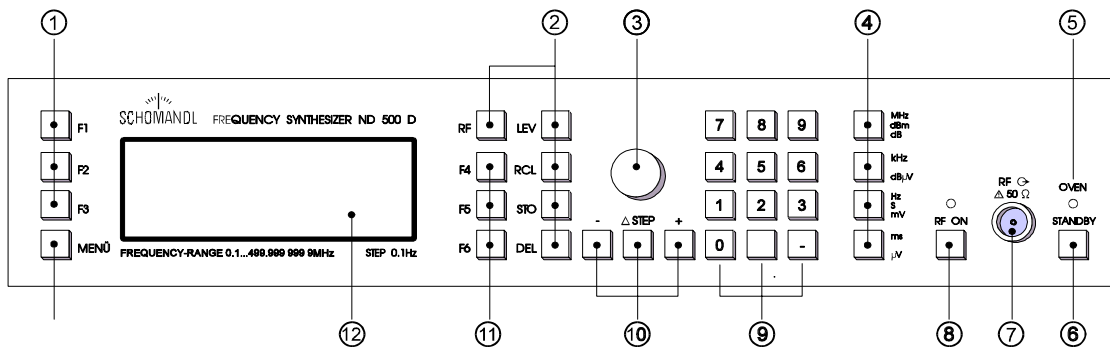
- Frequency Synthesizers of ND 500 D series are labelled 'CE'.
- Electric fields having field strengths of maximum 10V/m do not degrade performance of the instrument in any way.
- With respect to electrical safety precautions, these frequency synthesizers are tested according to standard VDE 0411, safety class 1.
- Frequency synthesizers of the ND 500 D series are manufactured according to standard ISO 9001.



3 Construction of the ND 500 D

3.1 Front Panel

All control knobs are located on the front panel.



① Function keys F1 ... F3

Calling the memory locations 01 ... 03 and the menu items if menu is active.

② Program keys RF, LEV, STO, DEL

RF: frequency input
 LEV: Power level input, continuity of level
 RCL: Calling memory location (01...99)
 STO: Storing in a memory location (01...99)
 DLE: Delete last keyboard entry

③ Control knob +, - / Δ-Step keys

Control knob +, - : Variation of frequency, level and Δ-step.
 Δ-step: Step-width entry

④ Select keys for units - frequency / level

unit to be selected after input of frequency and power level.

⑤ OVEN (LED operation status indicator of the quartz oven heating)

orange: operating temperature not yet reached.
 green: operating temperature reached.

⑥ Standby pushbutton for OCXO operation

⑦ Output socket

⑧ RF power on / off (only available with option output level)

⑨ Numerical data entry

frequencies, power levels, Δ-step, memory locations are entered manually.

⑩ Function keys F4 ... F6

Calling the memory locations 04 ... 06 and the menu items if menu is active.

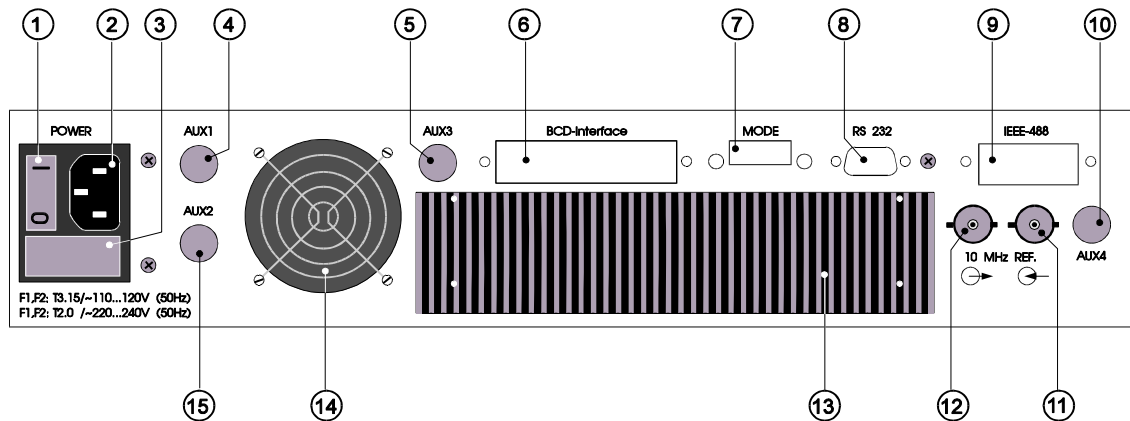
☞ LC - Display

☞ Menu key Activating the menu function



3.2 Rear Panel

On the rear panel of the ND 500 D the interfaces, frequency reference in- and outputs and the AC power connector are located.



- ① Mains switch (Power ON)
- ② AC power connector
- ③ Mains fuses
- ④ AUX 1 not being used
- ⑤ AUX 3 not being used
- ⑥ BCD-parallel-interface optional parallel interface
- ⑦ Mode DIP switch for configuration of BCD parallel-interface
- ⑧ RS 232 interface optional serial interface
- ⑨ IEEE-488 bus optional IEEE 488 interface
- ⑩ AUX 4 not being used
- ↻ 10 MHz reference input
- ↻ 10 MHz reference output
- ↻ Heat sink
- ↻ Ventilator
- ↻ AUX 2 not being used



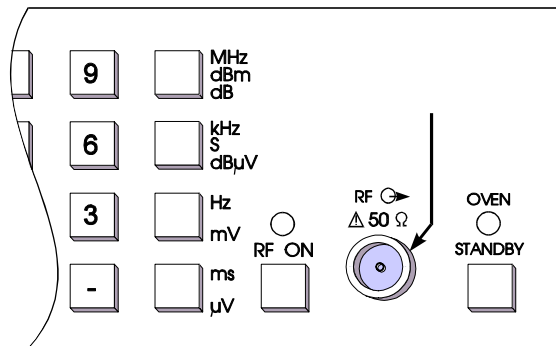
4 Connections of the ND 500 D

**Attention:**

Plugging or unplugging may only be done when instrument is switched off. Possibly occurring peak current may destroy unit.

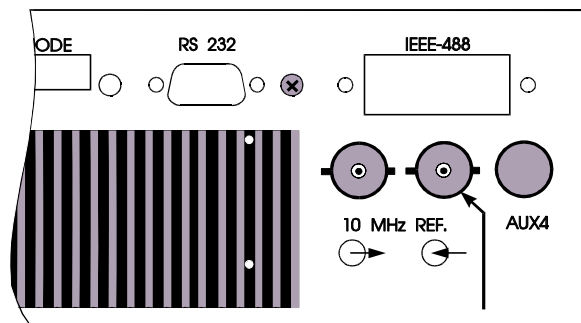
4.1 N-Connector of ND 500 D

Signal output of the ND 500 D is via N connector at front panel.



4.2 10 MHz Reference Input

External frequency reference for the ND 500 D is fed in here.

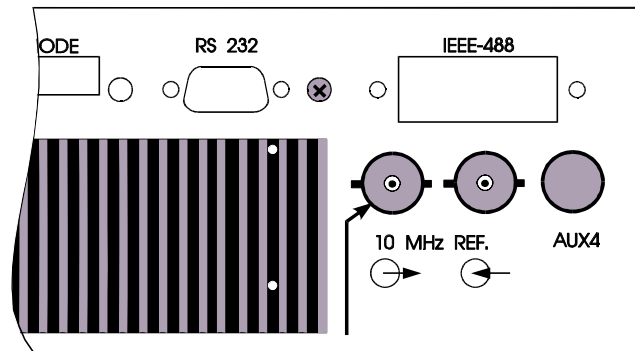
**Note:**

External frequency reference must fulfil specifications as follows:
 2 MHz, 5 MHz, 10 MHz \pm 2 Hz; 0dBm ... + 8 dBm



4.3 10 MHz Reference Output

This output can be used as frequency reference for other instruments.



The reference output of the ND 500 D has following specifications:

Frequency: 10 MHz
Temperature coefficient: $< 3 \cdot 10^{-9}/K$
Aging: $< 2 \cdot 10^{-8}/\text{month}$
Output level: + 10 dBm

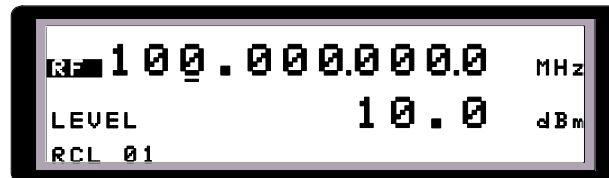
**Attention:**

Pulling of the ND 500 D's internal reference must be avoided, using external attenuators or buffers for example.

5 Operation of the Frequency Synthesizer ND 500 D

5.1 Switch-on state (MAINS on)

After switching on the frequency synthesizer ND 500 D, the LC-display shows the following (displayed values on your instrument may differ from those shown here):



The display contains the following information:

- RF: the set frequency (here: 100 MHz)
- LEVEL: the set signal level (here: +10 dBm)
- RCL: memory location in which these values are stored (here: 01)

**Note:**

The memory location 01 (on display: **RCL 01**) is always activated after switch-on of the ND 500 D.

5.2 Select Menu

The menu mode is activated by pressing the MENU key. The display shows the following:



Menu selection is done by the laterally placed keys **F1...Menu** and **RF...F6**.

F1 - BCD REMOTE

Key F1 switches the ND 500 D to frequency entry via BCD interface. With that, manual entry is inhibited, except for the MENU-key. The LC-display then shows:



To quit the BCD-REMOTE-mode press the MENU-key.

F2 (not assigned)

F3 - IEEE-ADDR

Enter the IEEE Listener address by pressing F3. The LC-display then shows:



Enter desired IEEE-listener-address via keyboard (the system accepts addresses between 00 and 30). For storing of the set IEEE listener-address the instrument has to be switched off and on again.

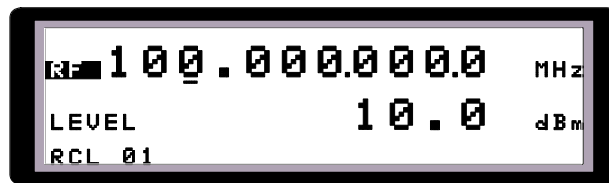
**Note:**

- Always enter the IEEE-listener-address in 2-digit form.
Enter 01 for address 1.
- use the STANDBY key to switch the instrument on/off.
- The IEEE address can also be stored by switching the instrument off by the mains switch.



MENU - MAIN

To get to the Main-entry-menu, press MENU key.



RF (not assigned)

F4 (not assigned)

F5-SCREEN

To change over to the screen-mode, press F5. Brightness and contrast control for the LC-display are done here. After pressing the F5 key, the display shows:



VIEW: Turn the control-knob to set the contrast.

LIGHT: Set the brightness of the display by the keys (+) and (-), located below the control-knob.

INVERSE: The key Δ -Step inverts the display.

MENU: Pressing the MENU-key, all settings are stored and the screen-mode is left.

Following instrument data are shown in this menu:

V1.1	Software-version
25.04.94	Date of software version
NUM	instrument identification number

F6 (not assigned)



5.3 Frequency- and Power Level Settings

The ND 500 D is designed for frequency steps of 0.1 Hz.
Frequencies between 0.1 Hz and 499.999 999.9 MHz can be entered.

Output power is settable between 0.0 and +15 dBm, for instruments with level-option between -137 and +15 dBm.

Below 100 kHz (instrument with level-option: 9 kHz) power level is not defined.
Up to 100 frequency/level settings along with appropriate delta-steps can be stored and recalled at any time.

Frequency and level entry can be done numerically (via keyboard) or by rotating the control knob or via keys.

5.3.1 Frequency Input Via Keyboard

Press **RF**-key to reach frequency input mode. The display confirms frequency input mode 'active' by the inverted 'RF'-sign.



Now enter desired frequency via keyboard. To complete entry, select desired unit (MHz, kHz, Hz).
Press the appropriate key on the right hand side next to the display.



Note:

Independent of chosen unit (Hz, kHz, MHz) the display always shows frequencies in MHz.

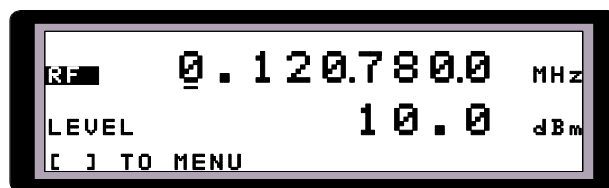


Example:

Suppose you want to enter 120.78 kHz. Proceed as follows:

- press the **RF**-key to activate the input mode.
- enter **120.78** via numerical keys.
- press the **kHz**-key
- or
- press the **RF**-key to activate the input mode.
- enter **120780** via numerical keys.
- to finalize entry: press the **Hz**-key.

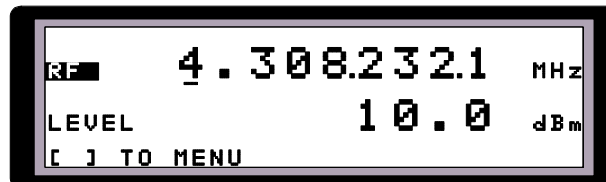
In both cases, the display will show 0.12078 MHz (120.78 kHz)



5.3.2 Δ -Step-Frequency

To set frequency- Δ -steps, proceed as follows:

- press the **RF**-key to activate the input mode.
- now enter frequency directly via keyboard.



- Press **Δ -Step**-key.
The display shows the step-width next to the inverted **RF- Δ** sign.



- Enter desired step-width numerically, to conclude entry: press appropriate unit-key (MHz, kHz, Hz).

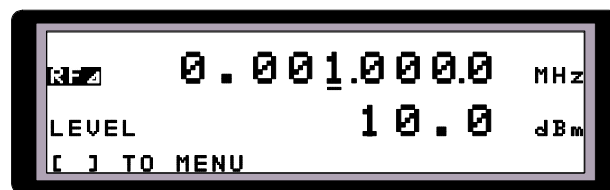


**Note:**

If decade-related steps are selected (0.1 Hz, 1 Hz, 10 Hz, etc), a cursor marks the appropriate digit. For non-decade-related steps no cursor will appear.

Example 1:

If you enter the digit 1 and the unit key kHz, the display shows the following:

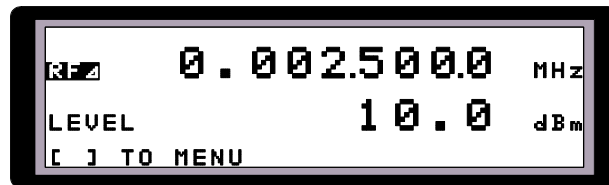


- The entered step-width can be changed by either rotating the control knob or by using the (-) and (+) keys.
- again press the key Δ -step. Now you are again in the frequency-entry mode. The location which had been marked in the Δ -mode is underlined by the cursor.
- Using the (+) and (-) keys or by rotating the control knob, the 'marked' location (decade) is increased or decreased.



Example 2:

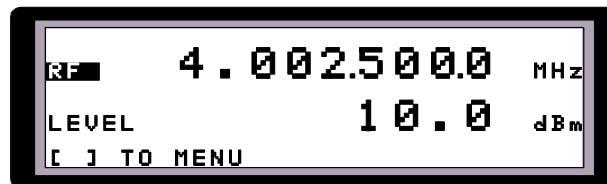
When entering the step-width 2.5 and the unit-key kHz, the display will show:



- the entered step-width can be changed by either rotating the control knob or by using the (-) and (+) keys.
- again press the key Δ -step. Now you are again in the frequency entry mode.

**Note:**

The frequency location is not marked, since the step-width of 2.5 kHz is not decade-related.



- the step width set to 2.5 kHz, you can lower the frequency by pressing the (-)-key or by rotating the control knob counterclockwise by 2.5 kHz. Pressing the (+)-key or by rotating the control knob clockwise increases the frequency by 2.5 kHz.



5.3.3 Power Level Input Via Keyboard

Press the **LEV**-key to get into the power input mode. The LC-display then shows the inverted 'LEVEL'-sign.



- Now enter desired value via keyboard.
- Press the appropriate key **dBm**, **dB μ V**, **mV** or **μ V**.

**Note:**

- RF power range is between 0.0 and +15 dBm for the ND 500 D.
- Instruments with level option have an extended range: -137.0 to +15.0 dBm.

Example:

Suppose you want to enter a level of 30mV. Proceed as follows:

- Press the **LEV** key if input mode is not yet active.
- enter the digits 30 numerically.
- to conclude entry, press the **mV** key.

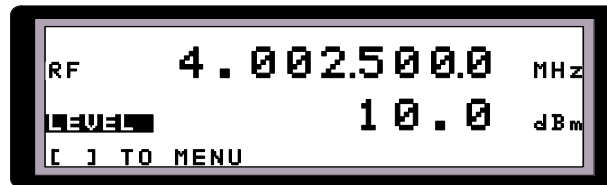
The LC-display now shows the corrected true value of 29.8 mV.



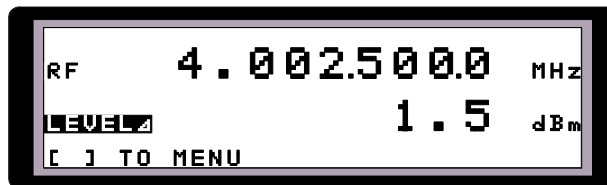
5.3.4 Δ -Step Level

Varying the power level is done as follows:

- Press the **LEV** key to activate the level input. You can directly enter the level numerically.



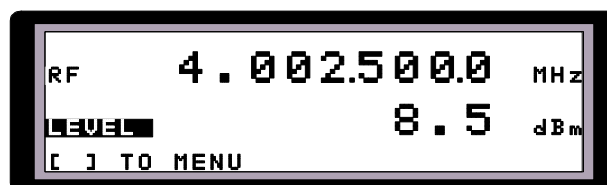
- Press the **Δ -Step** key. The LC-display shows the set step-width (here: 1.5 dB) next to the inverted 'LEVEL- Δ '-sign.



- Enter desired step-width via keyboard and press the unit-key **dB** to conclude the entry.
- after the Δ -step entry is concluded, the display switches back to the active power-level. Incrementing of the level with the new Δ -step is possible right away.

Example:

Power level step width being set to 1.5 dB, you can decrease the level by 1.5 dB either by pressing the (-) key or by rotating the control knob counterclockwise. Pressing the (+) key or rotating the control knob clockwise increases the level by 1.5 dB.

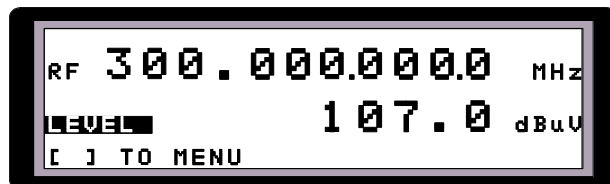


5.3.5 Converting Signal Levels

The input mode 'LEVEL' allows the conversion of the signal levels shown. To do this, just press the keys **dBm**, **dB μ V**, **mV** or **μ V**.

**Example:**

The present signal level is 0.0 dBm. Pressing the **dB μ V**-key converts the display to 107.0 dB μ V.



The present signal level is 107.0 dB μ V. Pressing the **mV**-key converts the display to 224 mV.



5.4 Storing Frequencies and Levels

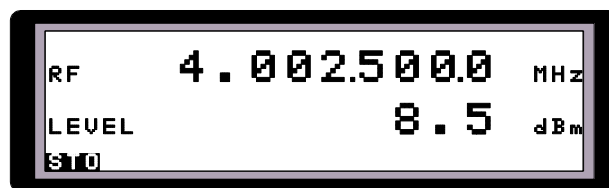
After having entered frequency and level, you can store these to memory along with the appropriate Δ -steps. The ND 500 D has 100 (00...99) memory locations available.

5.4.1 Assignment of the Memory Locations

Besides the 'normal' memories, the ND 500 D has 6 memory locations, for which frequency, level and Δ -steps can be recalled directly by the function keys 01 to 06.

Storing frequency and level values (RF and Level), proceed as follows:

- enter desired frequency and level.
- to store, press the **STO**-key. The LC-display shows the inverted 'STO'-sign.

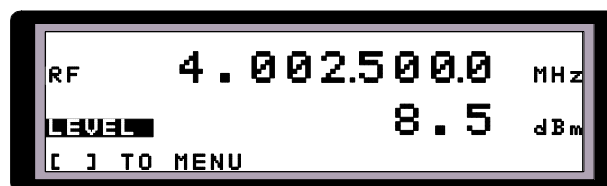


- define desired memory location (00...99) via keyboard.



Note:

- always enter the memory location in 2-digit form. For memory location 1 enter the digits 0 and 1.
- new input will overwrite the previously stored data of the memory location.
- The values are stored after complete input of the memory location without further confirmation. The 'STO'-sign on display is switches back to 'TO MENU' after storing of the values.

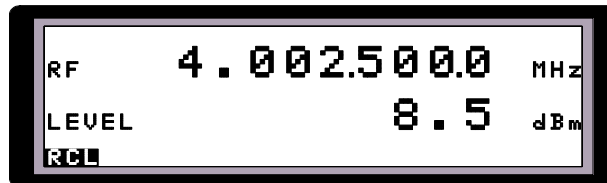


5.5 Recalling stored values

The frequencies and levels stored in the memories 01 to 06 can be recalled directly by pressing the function keys **F1** to **F6**.

All other memories are recalled as follows:

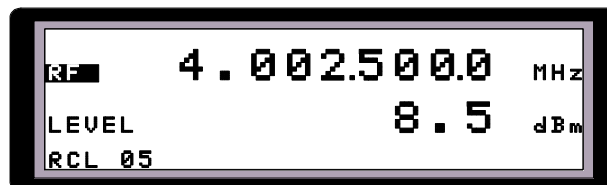
- activate the memory locations by pressing the **RCL** key (Recall). The display shows the inverted 'RCL'-sign:



- enter desired memory location (00...999)

Example:

After having selected memory location 05, the stored values for frequency and level is shown on the display. In addition to this, the display shows the memory location number.



5.6 Uninterrupted level variation

Power level setting of the ND 500 D is done by a high precision mechanical step attenuator in 5 dB steps as well as by an electronic attenuator having 20 dB setting range. Certain measurement problems, such as tracing the FM-squelch threshold, require a variation of the power level range without switching the high precision mechanical attenuator, that means, that a discontinued carrier signal must be present. That option can be activated in the level-input-mode by pressing once again the **LEV**-key. The display then additionally shows 'cont'.



Now, the presently active power level can be varied by 20 dB maximum either by thumbwheel or by the + / - keys. Repressing the **LEV**-key or by exceeding the 20 dB level variation range switches off the Level-cont function. The 'cont'-sign goes off the display.

5.7 Switching RF-level ON and OFF

The toggle-key RF ON/OFF the RF-signal can be switched on and off in all active menus. The LED located above that switch indicates 'RF Signal ON' when LED is 'ON'. In the main menu this level function is indicated by 'LEVEL OFF' or by 'LEVEL'.

**Note:**

Presetting or varying the level can be done in LEVEL-OFF mode as well.

In case your frequency synthesizer is **NOT** yet equipped with a level option, the signal-LED located above the RF ON-key is permanently ON.

When the RF ON-key is pressed, in that case the LC-display will show the following:



5.8 SPECIAL-Menü

Press the **F6** key to branch to the submenu **SPECIAL** where the level offset can be entered and press the **F5** key retrofitted options. The display will be as follows:



5.8.1 Entering level offset

A level offset of -10dB to +10dB can be programmed to compensate for any attenuations or amplifications downstream from the RF channel.

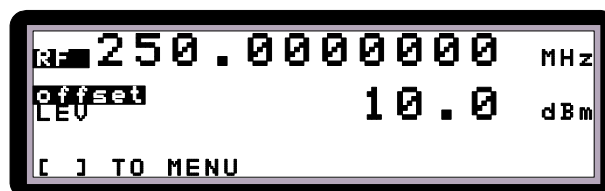
Example:

The RF cable has 2 dB damping effect.

- Press the **LEV** key to activate entry mode. LEV OFFSET will be displayed inverse as confirmation:
- Now enter a 2 and **dB** as units. The damping caused by the cable is now compensated for by a level offset of +2dB.



“offset” is displayed inverse in the MAIN menu.

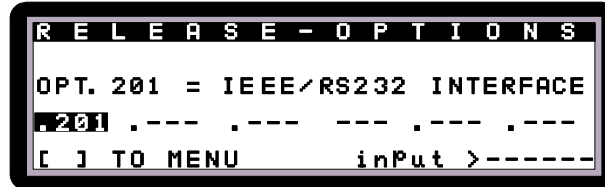
**Note:**

For no offset at all enter 0 dB. An indication of an offset in the MAIN menu will then be removed.



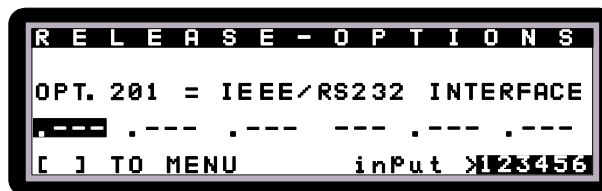
5.9 Enabling options

Press the **F5** key in the SPECIAL menu to call up the submenu **RELEASE OPTIONS**. All options will then be displayed. Enabled options are displayed with the relevant order No. (in this case 201) blocked options with .---

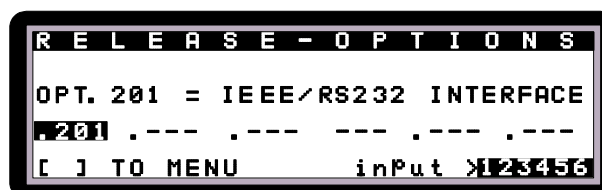


Proceed as follows to enable option:

- Press the **F5** key to activate entry mode.
- Select the desired option using the **+** and **-** keys.
- Enter the six digit code number in the input field.



If the code number is valid the option number (in this case .201) will appear in the option field.

**Note:**

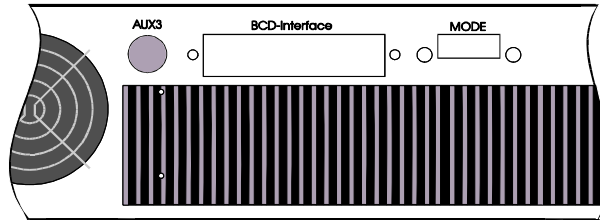
On payment of the appropriate fee, code number can be obtained from Schomandl Vertriebs GmbH for the enablement of options.



6 Interfaces

6.1 BCD Interface

The optionally available parallel BCD interface allows extremely fast setting or frequency control by a remote control. The 50-pin BCD interface is being configured by the mode DIP switch.



6.1.1 BCD modes and pin assignment

The DIP switches configure the BCD interface.

Mode	Configuration	DIP - Switch					
		6	5	4	3	2	1
1	BCD-parallel mode (positive logic with store)	-	ON	-	ON	ON	ON
2	BCD-parallel mode (positive logic transparent)	-	ON	-	ON	ON	OFF
3	BCD-parallel Modus (negative logik transparent)	-	OFF	-	ON	OFF	ON
4	BCD-parallel Modus (negative logik transparent mit 'Latch Enable' und 'Remote Enable')	-	OFF	-	ON	OFF	OFF
5	BCD-parallel Modus (double buffering, negative logic with store and 'Remote-Enable')	-	OFF	-	OFF	ON	OFF

**Note:**

The DIP-switch 5 activates 10kΩ-Resistors to pull-down (to GND) or to pull up (against +5V) the plug inputs pin 1...21 and pin 23...49 for Dip-switch 5 setting ON or OFF respectively.

**Attention:**

New interface configurations are initialized only after switching the instrument off and then on again.



6.1.2 Pin Assignment of the BCD Interface mode 1:
positive logic with store

PIN	Function	PIN	Function
1	100 kHz	26	400 kHz
2	200 kHz	27	800 kHz
3	10 kHz	28	40 kHz
4	20 kHz	29	80 kHz
5	1 kHz	30	4 kHz
6	2 kHz	31	8 kHz
7	100 Hz	32	400 Hz
8	200 Hz	33	800 Hz
9	10 Hz	34	40 Hz
10	20 Hz	35	80 Hz
11	1 Hz	36	4 Hz
12	2 Hz	37	8 Hz
13	0,1 Hz	38	0,4 Hz
14	0,2 Hz	39	0,8 Hz
15	10 MHz	40	40 MHz
16	20 MHz	41	80 MHz
17	1 MHz	42	nc
18	2 MHz	43	100 MHz
19	4 MHz	44	200 MHz
20	8 MHz	45	nc
21	nc	46	nc
22	nc	47	nc
23	nc	48	take over (pos. slope)
24	nc	49	400 MHz
25	nc	50	GND



Note:

Storing takes place at positive slope of UALL signal. Rise time must be less than 500ns at TTL-level.



6.1.3 Pin Assignment of the BCD Interface mode 2 and 3
Mode 2 positive logic transparent
Mode 3 negative logic transparent

PIN	Function	PIN	Function
1	100 kHz	26	400 kHz
2	200 kHz	27	800 kHz
3	10 kHz	28	40 kHz
4	20 kHz	29	80 kHz
5	1 kHz	30	4 kHz
6	2 kHz	31	8 kHz
7	100 Hz	32	400 Hz
8	200 Hz	33	800 Hz
9	10 Hz	34	40 Hz
10	20 Hz	35	80 Hz
11	1 Hz	36	4 Hz
12	2 Hz	37	8 Hz
13	0,1 Hz	38	0,4 Hz
14	0,2 Hz	39	0,8 Hz
15	10 MHz	40	40 MHz
16	20 MHz	41	80 MHz
17	1 MHz	42	nc
18	2 MHz	43	100 MHz
19	4 MHz	44	200 MHz
20	8 MHz	45	nc
21	nc	46	nc
22	nc	47	nc
23	nc	48	nc
24	nc	49	400 MHz
25	nc	50	GND

The diagram shows a vertical 50-pin connector. Pin 1 is at the bottom left, pin 25 is at the top right, pin 26 is at the bottom left (next to pin 1), and pin 50 is at the top left. The pins are numbered sequentially from 1 to 50.

6.1.4 Pin Assignment of the BCD Interface mode 4 latch enable and remote enable

PIN	Function	PIN	Function
1	100 kHz	26	400 kHz
2	200 kHz	27	800 kHz
3	10 kHz	28	40 kHz
4	20 kHz	29	80 kHz
5	1 kHz	30	4 kHz
6	2 kHz	31	8 kHz
7	100 Hz	32	400 Hz
8	200 Hz	33	800 Hz
9	10 Hz	34	40 Hz
10	20 Hz	35	80 Hz
11	1 Hz	36	4 Hz
12	2 Hz	37	8 Hz
13	0,1 Hz	38	0,4 Hz
14	0,2 Hz	39	0,8 Hz
15	10 MHz	40	40 MHz
16	20 MHz	41	80 MHz
17	1 MHz	42	REM
18	2 MHz	43	100 MHz
19	4 MHz	44	200 MHz
20	8 MHz	45	nc
21	nc	46	LE 10 Hz - 800 Hz
22	nc	47	LE 0,1 Hz - 8 Hz
23	LE 10 MHz - 400 MHz	48	nc
24	LE 100 kHz - 8 MHz	49	400 MHz
25	LE 1 kHz - 80 kHz	50	GND

The image shows a smartphone screen with a menu interface. At the top, it says 'GENERAL'. Below that, there are three main menu items: 'LEV OFFSET: -10.0 dB', 'RELEASE OPTIONS (F5)', and 'TO MENU'.

**Note:**

- **GND:** Ground
- **LE:** **High:** The data enters the latches, the latches are transparent.
Low: The latches store the information that was present on the data inputs during the HIGH-to-LOW transition of LE.
- **REM: High:** Remote Control is disabled. The data enters the input-latches, but the output frequency is set to 0 Hz (no output signal).
Low: Remote Control is enabled.

**Attention:**

The REM-Pin does not override the BCDREM menu of the ND 500D. That means, that you must set the ND 500D to 'Local' mode, if the frequency control via front panel is used and you must set the ND 500D to 'Remote' mode, if the remote frequency control is used.

PIN 45 has to be set to HIGH-level using either the DIP-switch (DIP5=OFF) or an external voltage. (+5V)



6.1.5 Pin Assignment of the BCD Interface mode 5
double buffering, negative logic with store and remote enable

PIN	Function	PIN	Function
1	100 kHz	26	400 kHz
2	200 kHz	27	800 kHz
3	10 kHz	28	40 kHz
4	20 kHz	29	80 kHz
5	1 kHz	30	4 kHz
6	2 kHz	31	8 kHz
7	100 Hz	32	400 Hz
8	200 Hz	33	800 Hz
9	10 Hz	34	40 Hz
10	20 Hz	35	80 Hz
11	1 Hz	36	4 Hz
12	2 Hz	37	8 Hz
13	0,1 Hz	38	0,4 Hz
14	0,2 Hz	39	0,8 Hz
15	10 MHz	40	40 MHz
16	20 MHz	41	80 MHz
17	1 MHz	42	REM
18	2 MHz	43	STROBE
19	4 MHz	44	nc
20	8 MHz	45	400 MHz
21	nc	46	RSTR 10 Hz - 800 Hz
22	nc	47	RSTR 0,1 Hz - 8 Hz
23	RSTR 10 MHz - 800 MHz	48	200 MHz
24	RSTR 100 kHz - 8 MHz	49	100 MHz
25	RSTR 1 kHz - 80 kHz	50	GND

**Note:**

- **GND:** Ground
- **RSTR:** A LOW-to-HIGH transition of the register strobe input will store the data into the first rank of buffers.
- **REM: High:** Remote Control is disabled.
The data enters the input-latches, but the output frequency is set to 0 Hz (no output signal).
Low: Remote Control is enabled.
- **STROBE:** A LOW-to-HIGH transition of the strobe no sooner than 100ns after the LOW-to-HIGH transition of the RSTR lines will clock the data into the second rank of buffers to start the change of frequency.

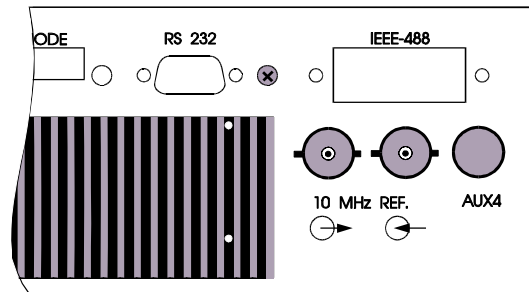
The REM pin does not override the BCDREM menu item of the ND500D respectively. That means, that you must set the synthesizer to 'Local' mode, if the frequency control via front panel is used and you must set the synthesizer to 'Remote' mode, if the remote frequency control is used. Changes of state of REM pin and of STROBE pin must differ 200ns minimum.

PIN 44 has to be set to HIGH-level using either the DIP-switch (DIP5=OFF) or an external voltage. (+5V)



6.2 RS 232 Interface

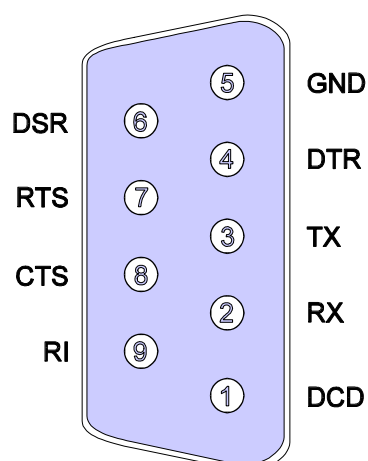
The optionally available serial RS 232 interface is a standard 9-pin connector. This interface is used to control the frequency synthesizer via PC software.



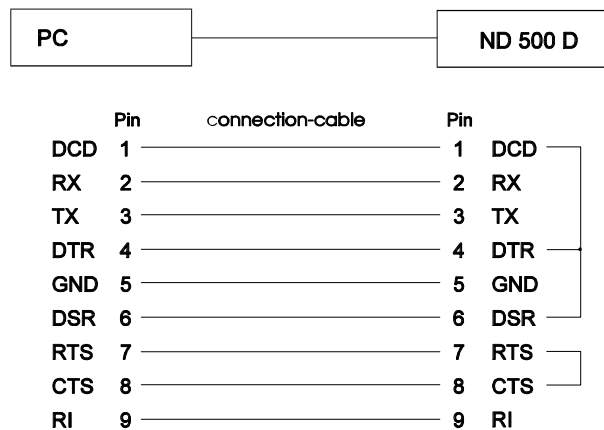
6.2.1 Definition of the RS 232 interface

DCD	=	data transmission identified
RX	=	data receiver
TX	=	data transmitter
DTR	=	data terminal ready
DSR	=	Data set ready
RTS	=	Ready to send
CTS	=	standby for data transmission
RI	=	identification

6.2.2 Pin Configuration of the RS 232 Interface



6.2.3 Connecting the ND 500 D to Personal Computer



6.2.4 Programming of the RS 232 Interface

**Attention:**

Simultaneous operation of IEEE- and RS 232-interface is not allowed!

6.2.4.1 Composition of a data block

The RS 232 interface is operated in following mode:

Baudrate: 4.8 k Baud
 start bit 1 bit
 data bits 8 bits
 stop bit 1 bit
 parity bit no bit

Every valid RS 232 instruction from the PC is followed by an echo from the ND 500 D containing the new setting.

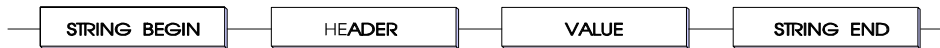
In case of invalid RS 232 instruction, no new setting is transmitted; the message '\$ERROR CR+LF' is transmitted to PC.



6.2.4.2 Structure of RS 232 command PC → ND 500 D



6.2.4.3 Structure of RS 232 message (echo) ND 500 D → PC



String Begin: consists of the \$-sign

Header: The header is the actual instruction and always consists of 4 characters.

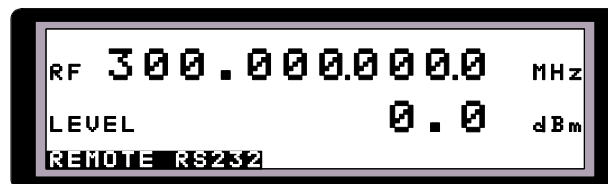
Value: value assigned to instruction. The number of characters depends on the instruction.

String End: has to follow the last character of the value and consists of CR and LF (13+10)

6.2.5 Local / Remote mode of the ND 500 D

If the frequency synthesizer ND 500 D is operated as listener, its state switches over to REMOTE. Manual entry keys are then inhibited except for the **MENU** key (Back to Local).

The display shows on bottom left: **REMOTE RS 232**:



You can return to manual operation in two ways:

- by means of the addressed instruction **gtlc** (Go to Local).
The REMOTE sign on display is replaced by LOCAL after the instruction gtlc. After the first operation on the instrument, the LOCAL-sign goes off.
- by pressing the **MENU**-key (Back to Local)
The REMOTE-sign goes off.

6.2.6 Instrument message for ND 500 D

Following instructions are required to control the frequency synthesizer ND 500 D:

Start	Header	Value	End	Unit	Description
\$	frq_	xxx.xxxxxx	CR+LF	[MHz]	set RF-frequency
\$	lev_	xx.x	CR+LF	[dBm]	set level
\$	gtlc		CR+LF		

**Note:**

- The Header always consists of 4 characters, meaning that frq and lev always must be programmed followed by a (_).
- Setting range for RF-frequencies: 0.0000001 ... 499.9999999 MHz
- Setting range for RF-levels: 0.0...+15 dBm
- Setting of appropriate units is not required, since always MHz and dBm are being used.

Example:

Programming 10.1234567 MHz: \$frq__10.1234567CRLF

Programming 100.1234567 MHz:\$frq_100.1234567CRLF

Programming +10 dBm: \$lev_10.0CRLF



6.2.7 Additional instrument messages for the ND 500 D with optional Output level

In case your ND 500 D is equipped with the option output level -137... +15 dBm, this power range can as well be programmed via RS 232 interface.

For controlling the frequency synthesizer ND 500 D with power level option, the following instructions are required:

Start	Header	Value	End	Unit	Description
\$	freq_	xxx.xxxxxxx	CR+LF	[MHz]	set RF-frequency
\$	lev_	xxxx.x	CR+LF	[dBm]	set RF-level
\$	lev_	on order off	CR+LF		RF power on/off
\$	gtlc		CR+LF		

**Note:**

- Setting-range for power level: -137.0...+15 dBm
- entry of power level unit not required, since always dBm is being used.

Example:

Programming -120.0 dBm: \$lev_-120.0CRLF
 Programming + 10.0 dBm: \$lev__10.0CRLF

Programming RF power level off: \$lev_off
 Programming RF power level on: \$lev_on



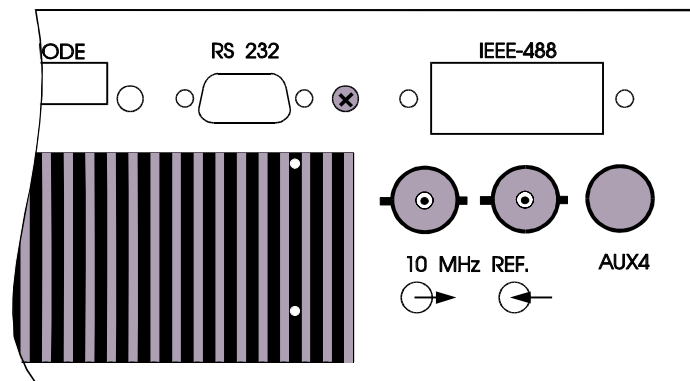
6.3 IEEE 488 Interface

The optional IEEE 488 interface complies with standard IEC 625 and IEEE 488. It enables various measurement instruments and computers to exchange data via the data bus. All connected instruments are parallel to this bus and access all data lines.

The instruments connected to the IEEE bus can, according to their function, send or receive messages (Talker and Listener respectively).

The instruments connected to an IEEE bus system are distinguished as follows:

- **Listener:** can only receive data
- **Talker:** can only transmit data
- **Talker/Listener:** can as well receive and transmit data
- **Controller:** controls the functions and exchange of information between the instruments. (i.e. computers)

**Note:**

The ND 500 D are operated in Listener mode.

Data transfer between the individual connected instruments is done serial by byte. In order to make instruments with different execution speed operate on the bus, data exchange is done in connection with a three-step handshake process.

The bus employs negative logic and can be operated with a maximum cable length of 20 meters.

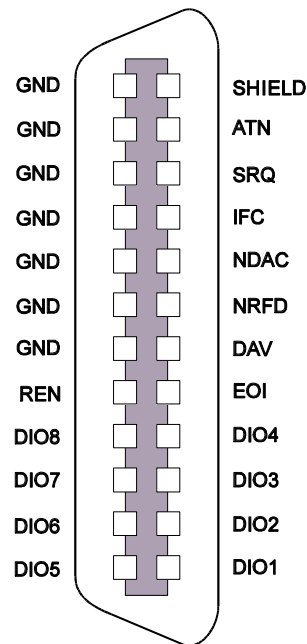
**Attention:**

Simultaneous operation of IEEE- and RS 232-interface is not allowed!



6.3.1 Description of the IEEE 488 Interface

The IEEE 488 connection socket is located at the rear panel of the frequency synthesizer. The interface contains 16 bus lines which can be combined in 3 groups (data bus, control bus, handshake bus).



6.3.1.1 Data Bus

The data bus consists of 8 lines

- DIO 1... DIO 8
- LSB = DIO 1

6.3.1.2 Control Bus

The control bus consists of 5 lines

- **ATN (Attention):** ATN is activated when addresses, universal and addressed instructions are being sent.
- **REN (Remote Enable):** Switches on or off the remote control of the instrument.
- **SRQ (Service Request):** The instrument sends an operation call to the controller.
- **IFC (Interface Clear):** This signal is activated by the controller to preset the instruments connected to IEEE bus to a defined state. ATN signal the controller calls for parallel scan.
- **EOI (End or Identify):** The last byte of a data transfer is transmitted. In conjunction with ATN, the controller requests for a parallel search.



6.3.1.3 Handshake Bus

The handshake bus consists of 3 lines:

- **DAV (Data valid):** The DAV signal is activated whenever new valid data are available on the bus.
- **NRFD (Not ready for Data):** signalizes to the talker, that data cannot yet be accepted (active at logic LOW)
- **NDAC (Not Data Accepted):** One of the listeners has not yet accepted offered data.

6.3.2 Structure of the IEEE 488 interface

The IEEE 488 interface is according to IEEE standard 488-1978 and contains the following equipment:

SH1:	Talker's Handshake	NO	
AH1:	Listener's Handshake	YES	
L4:	no listen only	YES	
	unlisten by addressing as talker	YES	
T8:	Serial Poll		NO
	Talker only		NO
SRO:	Service Request	NO	
PPO:	Parallel Poll	NO	
RL2:	Local lock out	NO	
DC1:	Device clear	YES	
	Select driver clear		YES
DTO:	Device Trigger	NO	



6.3.3 Interface Functions

6.3.3.1 Setting of the IEEE Listener address at the ND 500 D

Setting of the IEEE listener address can be done in the IEEE menu.

- menu mode is activated by the **MENU** key
- pressing **F3** key shows you on LC-display the IEEE Listener Address



- Enter the desired IEEE listener address via keyboard (the system accepts addresses between 00 and 30).
- For storing the IEEE address you have to switch off the ND 500 D. After switching on the instrument again, the new IEEE address is initialized.

**Note:**

- The factory setting for IEEE listener address is 10.
- always enter the IEEE listener address in two-digit-form. For address 1 enter the digits 0 and 1.
- always use the **STANDBY** key to switch the instrument on and off to store the new IEEE listener address.

6.3.3.2 Local / Remote mode of the ND 500 D

If the frequency synthesizer ND 500 D is operated as listener, its state switches over to REMOTE. Manual entry keys are then inhibited except for the **MENU** key (Back to Local). The display shows on bottom left: **REMOTE IEEE**



You can return to manual operation in two ways:

- by means of the addressed instruction **GTL** (Go to Local).
The REMOTE sign on display is replaced by LOCAL after the instruction GTL. After the first operation on the instrument, the LOCAL-sign goes off.
- by pressing the **MENU**-key (Back to Local)
The REMOTE-sign goes off.



6.3.4 Interface Messages

Interface messages are transferred to the data lines of the ND 500 D when ATN (Attention) is active. They are used to control the instruments connected to the IEEE bus; that means, these instruments are set to an instrument-specific state. These data can be classified in two different groups:

- universal instructions
- addressed instructions

6.3.4.1 Universal Instructions

Universal instructions are valid for all connected IEEE bus users. For the ND 500 D only the instruction DCL is relevant.

- **DCL (Device Clear)** Resets the ND 500 D into its original state. Thus, it has the same effect as switching on the instrument again.

6.3.4.2 Addressed Instructions

Addressed instructions are effective only on IEEE-bus users which are addressed as listeners. For the ND 500 D only two instructions are relevant.

- **SDC (Select Device Clear)** Resets the ND 500 D in its original state. Thus, it has the same effect as switching on the instrument again.
- **GTL (Go to Local)** Switches the ND 500 D to manual operation.

Please refer to following IEC-character-set table to see the IEEE instructions:

controlcode					digits and special characters				capital letters				small letters				
0	NUL		16	DLE		32	SP	48	0	64	@	80	P	96	'	112	p
1	SOH	GTL	17	CD1		33	!	49	1	65	A	81	Q	97	a	113	q
2	STX		18	DC2		34	"	50	2	66	B	82	R	98	b	114	r
3	ETX		19	DC3		35	#	51	3	67	C	83	S	99	c	115	s
4	EOT	SDC	20	DC4	DLC	36	\$	52	4	68	D	84	T	100	d	116	t
5	ENQ	PPC	21	NAK	PPU	37	%	53	5	69	E	85	U	101	e	117	u
6	ACK		22	SYN		38	&	54	6	70	F	86	V	102	f	118	v
7	BEL		23	ETB		39	'	55	7	71	G	87	W	103	g	119	w
8	BS	GET	24	CAN	SPE	40	(	56	8	72	H	88	X	104	h	120	x
9	HT	TCT	25	EM	SPD	41	)	57	9	73	I	89	Y	105	i	121	y
10	LF		26	SUB		42	*	58	:	74	J	90	Z	106	j	122	z
11	VT		27	ESC		43	+	59	;	75	K	91	[	107	k	123	{
12	FF		28	FS		44	,	60	<	76	L	92	\	108	l	124	|
13	CR		29	GS		45	-	61	=	77	M	93	]	109	m	125	}
14	SO		30	RS		46	.	62	>	78	N	94	^	110	n	126	~
15	SI		31	US		47	/	63	UNL	79	O	95	_	111	o	127	DEL
addressed instructions			universal instructions			listener address				memory address				secondary addresses and -instructions			



6.3.5 Instrument Messages

In contrast to the interface messages, instrument messages are actually those instructions transferring data to the IEEE bus users. Instrument messages are transferred to the data lines of the ND 500 D when ATN (Attention) is **not active**. For these messages, the ISO-7-Bit ASCII Code is used.

6.3.5.1 Structure of an instrument message

The messages which can be received in listener-mode are composed of the following items:



- **Header:** The header corresponds to the instruction and always consists of 4 characters.
- **Value:** the value corresponding to the header used. Number of characters depends on the instruction.
- **EOI (End or Identify):** The last byte of a data transfer is transmitted.

6.3.5.2 Instrument messages for the ND 500 D

Operation of the ND 500 D requires two instructions.

Header	Value	Unit	Description
frq_	xxx.xxxxxxx	[MHz]	set RF-frequency
lev_	xx.x	[dBm]	set RF-level



Note:

- The header always consists of 4 characters; frq and lev always have to be programmed with a following (_).
- Setting range for frequencies: 0.0000001 ... 499.9999999 MHz
- Setting range for level: 0,0...+15 dBm (without level option)
- Entering units is not required, since always MHz and dBm are used.

Examples:

Programming 10.1234567 MHz: frq__10.1234567
 Programming 100.1234567 MHz: frq_100.1234567
 Programming 10.1 dBm: lev_10.1
 Programming 0.0 dBm: lev_00.0



6.3.5.3 Additional Instrument Messages for the ND 500 D with Optional Output Level

In case your ND 500 D is equipped with the option output level -137 dBm... +15 dBm, this power range can as well be programmed via IEEE-interface.

To control the frequency synthesizer ND 500 D following instructions are required:

Header	Value	Unit	Description
frq_	xxx.xxxxxxx	[MHz]	set RF-frequency
lev_	xxxx.x	[dBm]	set power level
lev_	on or off		RF power on/off

**Note:**

- setting-range for power level: -137.0 dBm ... +15 dBm
- Entry of units is not required, since dBm is always used.

Examples:

Programming -120.0 dBm: lev_-120.0

Programming +10.0 dBm: lev___10.0

Programming level off: lev_off

Programming Level on: lev_on



7 Appendix

7.1 Technical Specifications ND 500 D

Reference Frequency:

Frequency:	10 MHz
Temperature coefficient:	$< 3 \times 10^{-9}/K$
Temperature influence: (+5°C ... +45°C)	$< \pm 1.5 \times 10^{-8}$
Ageing:	$< 2 \times 10^{-8}/\text{month}$
Warm-up-time:	15 minutes at 25°C
Reference output level:	+10 dBm
Reference input level:	2 MHz, 5 MHz, 10 MHz ; 0dBm...+8dBm
Injection-lock range:	$\leq 2 \times 10^{-7}$
Connector:	BNC

Carrier Frequency:

Frequency range:	100 kHz...499.999 999 9 MHz
(option output level)	9 kHz...499.999 999 9 MHz
Resolution:	0.1 Hz
Frequency accuracy:	as reference
Frequency setting:	via keyboard, control knob
.....	(option) BCD parallel
.....	(option RS 232)
.....	(option IEEE bus)
Settling time for new frequency (< 1MHz step width)	$< 1 \mu\text{s}$
Settling time for new frequency (≥ 1 MHz step width)	$< 20 \mu\text{s}$
Phase stability (<1 MHz step width):	continuous

Spectral purity:

Harmonics (levels $\leq +13$ dBm):	< -30 dBc
Spurious (discrete):	< -72 dBc
Sub-harmonics:	none
Residual FM (CCITT, RMS):	< 0.1 Hz
SSB-noise (10 kHz offset from carrier)	< -126 dBc/Hz
Noise floor (level: +13 dBm)	< -138 dBc/Hz

Output:

Output level:	+13 dBm \pm 1dB
Level setting range: (overrange*)	0 dBm...+15 dBm
Impedance:	50 Ω
VSWR:	< 1.5
Connector:	N-Type

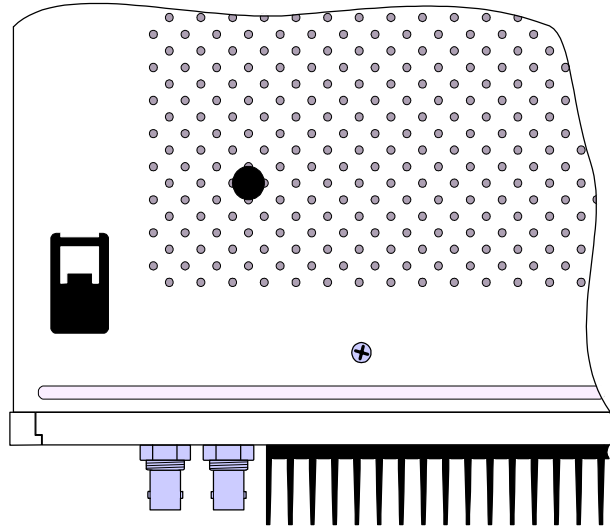
* These specifications are related to a level setting of + 13 dBm.



7.2 Service: Reference frequency calibration

With respect to the xtal's aging, an annual control/correction is recommend. An adequate reference source, e.g. Schomandl FN77 or FN-GPS, and an oszilloscope to represent the Lissajous's figure, are required for comparison.

In order to do this, check for a plug on bottom-side, nearby the reference-output.



Open the plug and calibrate with an ironless screwdriver (plastic) e.g. Bernstein 1-306.

**Attention:**

This calibration requires an authorized technician.

7.3 Ordering Specifications ND 500 Series

Frequency Synthesizer ND 500 D.....	BN 86303.000
Option IEEE-Bus.....	BN 86302.102
Option RS 232	BN 86302.103
Option BCD-Interface.....	BN 86302.104
Option Output level -137 dBm...+13 dBm	BN 86302.101
Option 19"-adapter.....	BN 86302.101

