## Contents

# 6 Complete Instrument

This service manual for the power meter NRVD is included in the service kit NRVD-S1. The main section 6 - Repair of the Complete Instrument - focusses on the calibration of the power meter NRVD and on checking the instrument features including a list of the test instruments and utilities required. Section 7 describes the functions of the analog components of the analog board A2 and the filter board A4 and explains in detail the utilities provided for diagnostic and service purposes. Removal of boards or measures to be taken with replacement are finally treated.

Execution of the service works mentioned in Section 6 is supported by the calibration software supplied.

Contents of the service kit NRVD-S1 (order No.: 1029.2802.02):

- Service Manual (order No.: 0857.8895.24) including layouts of the individual boards, circuit diagrams, description of the implemented service functions and diagnostic means including hints for troubleshooting as well as explanation of the calibration procedures.
- Cal adapter (order No.: 0350.7818.02) for calibration of the NRVD via the interfaces of the power sensors.
- 5.25" floppy disk (1.2 MB) + 3.5" floppy disk (1.44 MB) (order No.: 1029.2850.00) for PAT/PSA (R&S) and IBM-AT controllers and compatibles. The floppy disks contain the subsequent software:

  | | |
  |---|---|
  | INST__D.BAT | Installation program |
  | R&S BASIC | BASIC interpreter with BASIC drivers |
  | CAL__D.BAS | Calibration program (cf. 6.3.4.3) |

Installation of the above-mentioned programs is described in Section 6.3.4.3.

## 6.1 Function Description of Complete Instrument

(cf. circuit diagram 857.8150.01, block diagram 857.8008.01)

The power meter NRVD is designed as dual-channel power meter. The two test channels are completely independent of each other. The NRVD, in conjunction with a variety of probes and insertion units which can be connected, allows for precise evaluation of the signals applied from the kHz range up to the GHz range. The DC probe URV5-Z1 is provided for DC voltage measurements.

Realization of the measuring functions has been distributed on various boards, as shown by the block diagram of the complete instrument (cf. 857.8008.01).

Since the two test channels -A- and -B- are nearly identical, only the signal routing in channel A is described in detail. What is valid for measuring channel A analogously applies for channel B.

The measuring signal is received by the power sensor and converted into a DC voltage which is proportional to the measuring signal. The square-law region of the diode characteristic of the power sensor is used with small signals, the rectified output voltage is proportional to the applied measuring power. With large measuring signals, the power sensor diode works in the linear range and the output voltage is proportional to the applied measuring voltage. High accuracy across the entire dynamic range (nW to W) is achieved by storing all diode-specific data concerning transfer function, frequency response and temperature dependence in a non-volatile memory. This memory is part of the power sensor. All power sensors are provided with a temperature sensor for correction of the temperature dependence of the measuring diode. The current temperature of the power sensor is taken into account with evaluation of the measured values in the basic unit. The features of the temperature sensor are also stored in the non-volatile memory of the power sensor.

The output voltage of the thermal power sensors is always proportional to the power of the measuring signal applied due to the function of the instrument transformer. It depends on the type of power sensor whether the DC voltage supplied at its output is provided bipolar or unipolar referred to the ground reference of the instrument amplifier in the basic unit.

Evaluation of the output voltage of the power sensor is performed in the basic unit NRVD. The input interface of the basic unit is designed as easy-to-handle pin connection and allows for fast adaptation to the measuring task by simply replacing the power sensors. It depends on the type of probe, whether the DC measuring voltage is further amplified by the AC amplifier (all RF probes) or by the DC amplifier (DC-probe URV5-Z1). Subsequently, the amplified voltage is routed via an analog multiplexer to the integrated A/D converter. The A/D converter has been realized to a great extent as customer-specific circuit. Besides, this circuit contains further circuits for monitoring the input interface of the NRVD as well as bi-directional serial multiplexers. These multiplexers are used for data transfer between the controller board A1 and the analog board (A2) as well as for data exchange between the analog board and the power sensors connected. This procedure allows for transferring the calibration data of the active power sensors into the non-volatile memory of the power sensor and store them without using any special programming devices, only by means of the basic unit NRVD and a controller (cf. 7.1.3.4.4). The monitoring logic realizes changes of power sensor and adapts the power supply from the NRVD to the respective power sensor.

All power sensors connectable are supplied with + 5 V for reading of the power sensor data. The power supply is subsequently switched off with passive power sensors, with active ones, the voltage supply is switched to + 12 V/-12 V. With each replacement of a power sensor, the monitoring logic switches off all voltages for the channel concerned.

The basic unit NRVD is equipped with a test generator for testing the RF probes. The 50-MHz sinewave signal is provided with a power calibrated at 1 mW at the generator output (N-socket on the front panel) for test purposes. The test generator is switched on and off via menu keys.

The frequency information for frequency correction of the RF probes used can be transmitted to the basic unit as frequency-proportional DC voltage via the BNC socket "DC(FREQ)" (I/O Option NRVD-B2) or as numeric data via the IEEE-488 interface. Both connections are provided on the rear panel of the basic unit. The IEEE-488 interface also allows for remote control of the NRVD. The kind of communication can be switched over according to SCPI or IEEE488-1 (IEC 625-1) recommendations [SCPI/URV]. Thus, problem-free operation of the NRVD is possible even in earlier test systems without considerably modifying already existing operator routines.

If the input/output option NRVD-B2 is used, the test signal evaluated in the basic unit is provided as analog voltage at the output DC1 of test channel A and at the output DC2 of test channel B on the rear panel. The DC voltage provided is proportional to the bar graph indication. The left dead stop corresponds to 0 V, the right full-scale value on the bargraph scale is assigned 3 V. The analog outputs can also be shown on the scale by corresponding selection of the indication range (cf. operating manual, Section 3.3.2). The measuring start can be initiated also by external hardware via the trigger input. Performance of the triggered measurement is indicated by the TTL signal at the trigger output (both BNC sockets on the rear panel).

The controller module A1 controls the communication with the NRVD environment via the IEEE-488 interface, the control of the front panel, the communication with the analog board, non-volatile storage of the calibration data and the instrument settings, post-processing of the measured values as well as the power supply of the complete instrument (cf. description of the controller). The power connector of the NRVD is designed for all common voltages in the range from 90 to 264 V / 47 to 440 Hz.

Internal hardware tests of the digital and analog function groups are performed already with switching on the instrument and the results are displayed. Moreover, errors occurring during operation are displayed (cf. Section 4.3. about troubleshooting and diagnostic utilities in the operating manual).

The readout of measuring results, display of instrument state (operating mode, menu functions, IEEE state) as well as operating elements for manual operation have been concentrated on the display board A3 (cf. description of the board A3).

## 6.2 Required Test Instruments and Utilities

Table 6-1

| Item | Type of instrument | Required specifications | Suitable R&S instrument | Order No. | Application |
|---|---|---|---|---|---|
| 1 | Cal-Adapter | special NRVD interface | Contained in service-kit NRVD-S1 | 0350.7818.02 | 6.3.4<br>6.3.5 |
| 2 | DC-Calibrator [1] | ±0.01/0.0195/.05 V<br>±0.1/0.195/0.5 V<br>±1/1.95/5/10/19.5 V; (0.005 %) | -- | -- | 6.3.4<br>6.3.5 |
| 3 | Digital multimeter [2] | Ohmmeter, meas range 1 MΩ, 0.015 % [3]<br>DC; 0 to 10 V ±0.01 % | UDS5 | 349.1510.02 | 6.3.4<br>6.3.5 |
| 4 | Power meter | 1 mW ±0.4 %<br>r<0.05 % (50 MHz) | NRVD + NRV-51, (-52) extra calibrated by R&S or PTP | | 6.3.4<br>6.3.5.4 |
| 5 | DC probe | Special NRVD interface | URV5-Z1 | 395.0512.02 | 6.3.4<br>6.3.5.5 |
| 6 | BNC cable | | | | |
| 7 | Controller | IEC-625 interface, IBM compatible | PSA/PAT-fam. | | 6.3.4<br>6.3.5 |
| 8 | Printer | | PDN | 351.4512 | 6.3.4 |
| 9 | IEC-bus cable | | PCK | 292.2013 | 6.3.4 |
| 10 | Centronics cable | Centronics interface | | | 6.3.4 |

1) Further specifications of the calibrator and instructions for customization of the software of the calibration kit NRVD-S1 can be looked up in Sections 6.3.2 and 6.3.3.

2) The digital multimeter is required for adjustment of the resistor in the calibration adapter. If no UDS5 is available, adjustment, i.e. check of the 1-MΩ resistor can also be performed without CPU control (cf. 6.3.5.1). Adjustment accuracy, however, considerably influences calibration (verification) accuracy.

3) Within limited temperature range 23 ± 1°C

## 6.3 Calibration

The service kit NRVD-S1 contains the calibration adapter, the service manual and a floppy disc, which contains the calibration program among others. The calibration program in conjunction with a DC calibrator, a digital multimeter and a power meter allows for complete calibration of the basic unit NRVD or extensive testing of specifications with regard to compliance with specified data.

Calibration of the basic unit NRVD is performed via the IEEE-488 interface by means of a process controller compatible with IBM-AT (e.g. R&S controllers of the PSA family). The I/O option NRVD-B2 can be retrofitted and, therefore, calibration can also be performed via the front panel of the NRVD.

The calibration procedure can optionally be controlled automatically or interactively step by step. Selection of the functions (calibration/verification/single ranges etc.) is comprised in the menus. A report of the measuring or calibration tasks performed can be output by a printer (e.g. PDN).

A detailed description of the required specifications of the DC calibrator is given in Section 6.3.2. The use of other test instruments which comply with the required specifications (cf. Section 6.2) with regard to integration into the existing calibration program is explained in Section 6.3.3.
Fig. 6-1 Test setup for calibration (verification) of the NRVD

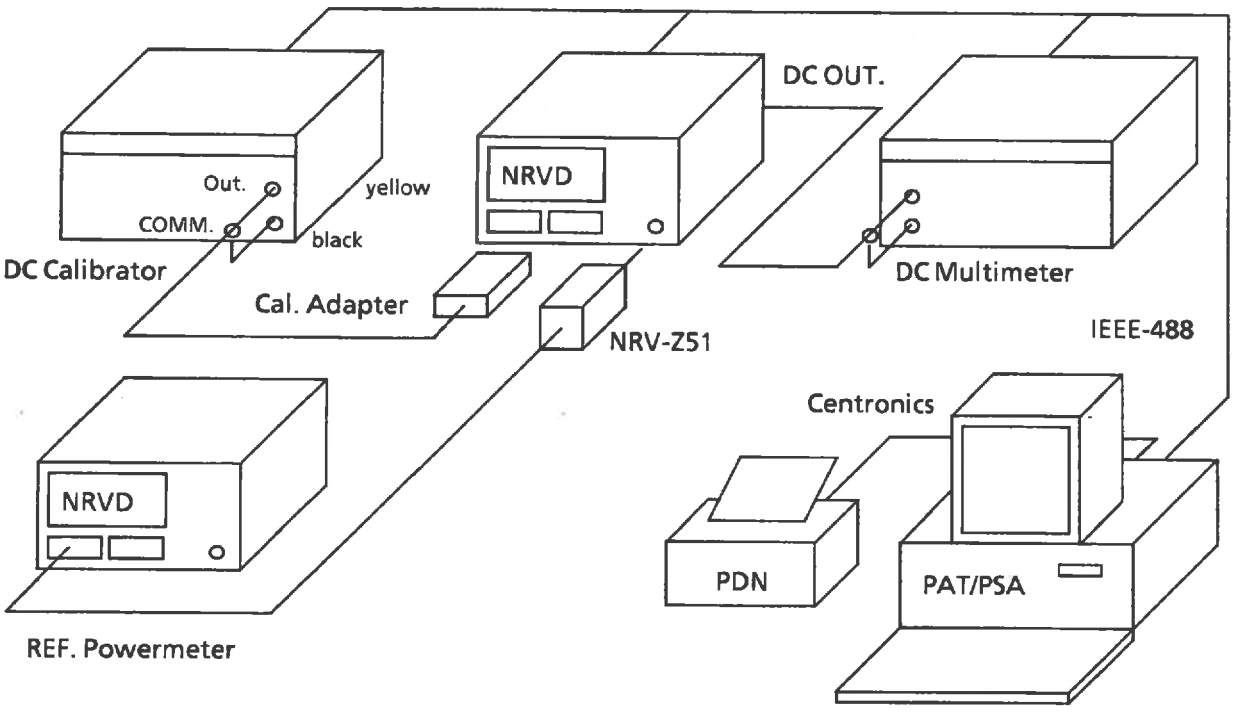


Fig. 6-1 Test setup to calibrate (test) the NRVD.

## 6.3.1 Calibration (Verification) of the NRVD

This section briefly illustrates the calibration and test procedure used for the NRVD.

Test probes of the NRVD convert the input parameter (RF power, voltage) into proportional voltages or currents and pass them on to the basic unit, which is why verification and calibration of the amplifiers in the basic unit is performed in analog form by means of DC voltages. Each of the two test channels (A, B) is provided with a DC amplifier with 11 measuring ranges for the RF probes. Both channels are provided with a common current-voltage converter with 4 measuring ranges and input selection in the basic unit for the DC probe URV5-Z1.

Each of the two test channels has a separate input for measuring the output voltages of the temperature sensors of the probes connected.

All function groups or specifications to be calibrated are listed in table 6-2.

Table 6-2 Survey of calibrated specifications

| Calibrated specification (group) | Cal command |
|---|---|
| AC amplifier + 11 meas. ranges 1) | CAL:AMPL AC, $U_i$ |
| AC amplifier - 11 meas. ranges 1) | CAL:AMPL AC, $U_i$ |
| DC amplifier 4 meas. ranges | CAL:AMPL DC, $U_i$ |
| Input temperature sensor 0.1 mA 1) | CAL:AMPL TEMP, -0,3 |
| Input temperature sensor 1.0 mA 1) | CAL:AMPL TEMP, -3,0 |
| DC (FREQ) input 2) | CAL:AMPL FREQ, $U_i$ |
| Test generator 50 MHz 1 mW/50 Ω | CAL:ROSZ SET—50 MHz, $P_i$ |
| DC output (Option NRVD-B2) 1) 3) | CAL:AMPL OUTP, 0 4) |

1) Calibrated (verified) separately in each channel (A, B)
2) BNC input DC (FREQ) on the rear panel is part of the I/O option NRVD-B2. If this option is not fitted, the input can be calibrated at the connector X103 (3 + 1 way) on the analog board A2.
3) I/O option NRVD-B2
4) The DC outputs are calibrated interactively with reference to the DC (FREQ) input directly from the frontpanel of the NRVD (cf. 6.3.5.5). Software version 1.30 and later versions also allow for calibration via IEEE bus. The parameters 0 or 1 can be input to start the calibration procedure which is equivalent to that from the front panel, entering "2" only calibrates the D2 output.

The calibration voltage of the calibrator is applied to the respective measuring inputs via the CAL adapter. The latter contains two relays, which are set automatically by the basic unit according to the function to be calibrated (cf. circuit diagram 350.7818.01 - Cal adapter). The required calibration voltages of the individual measuring ranges are listed in the table 6-3. The current source required for calibration of the DC amplifier is replaced by the calibrated 1-MΩ resistor of the CAL adapter.

Calibration voltages of opposite polarity are required for calibration of the AC amplifier (cf. table 6-3). The power sensors NRV-Z3, -Z4, -Z7 as well as the insertion units URV5-Z2, -Z4, -Z7 have balanced outputs, the others are unbalanced and supply a unipolar test voltage. The AC amplifiers are designed as instrument amplifiers with two separate inputs, which are used either both (symmetrical) or individually. Due to the wide dynamic range each of the two inputs is provided with a voltage divider. Since the dividing factors of the two voltage dividers are different due to the different tolerances of components, both inputs ( + and -) must be calibrated and tested separately.

Each calibration step consists of two stages to avoid errors caused by offset voltages:

- The output voltage of the calibrator is set to zero in the same range as the subsequent rated value, if possible. The sum of the inherent offset voltage and the offset voltage of the calibrator is measured in the basic unit.

- The rated value is set on the calibrator according to table 6-3. Subsequently, the actual value (rated value + offset) is measured in the basic unit. The calibration factor is calculated from the voltage deviation and stored in the basic unit.

Table 6-3 Measuring ranges and calibration values of the analog inputs, $T_A$ = 23 ± 1 °C

| Calibrated function [1] [CAL command] | Pol. | Rated value Ui [V] | Permitted tolerance [%] | Max. offset [mV] | Measuring range |
|---|---|---|---|---|---|
| AC amplifier [CAL:AMPL AC, $U_i$] [2] | ± | 0.01 | 0.12 | 0.05 | 1 |
| | | 0.02 | 0.12 | 0.05 | 2 |
| | | 0.05 | 0.12 | 0.05 | 3 |
| | | 0,10 | 0.12 | 0.05 | 4 |
| | | 0.20 | 0.12 | 0.05 | 5 |
| | | 0.50 | 0.12 | 0.2 | 6 |
| | | 1.0 | 0.12 | 0.2 | 7 |
| | | 2.0 | 0.12 | 0.5 | 8 |
| | | 5.0 | 0.12 | 1 | 9 |
| | | 10.0 | 0.12 | 2 | 10 |
| | | 20.0 | 0.12 | 5 | 11 |
| DC probe amplifier [CAL:AMPL DC, $U_i$] [2] | + | 0.1 | 0.12 | 0.5 | 1 |
| | | 1.0 | 0.12 | 0.5 | 2 |
| | | 10.0 | 0.12 | 5 | 3 |
| | | 40.0 | 0.12 | 50 | 4 |
| Temperature sensor [CAL:AMPL TEMP, $U_i$] | - | 0.300 | 0.1 | 1.0 | --- |
| | | 3.0 | 0.1 | 5.0 | --- |
| DC-FREQ [CAL:AMPL FREQ, $U_i$] | + | 10.0 | 0.12 | 50 | --- |

1) The calibration date must be entered in the calibration mode (not prior to the previous date). The date is not required for reading the calibration data.

2) $U_i$ is entered with the polarity sign! Rated values Ui < = 100 mV: DC calibrator about 100 mV

When the DC(FREQ) input is used, the measured offset voltage is stored for the internal correction in addition to the calibration factor.

The required measuring accuracy is ensured even without adjustment of components by the correction values determined by calibration together with continuous meas.-value correction. The entry of the date of calibration protects the calibration data against erroneous destruction. The new date entered must not be prior to the latest calibration date.

Check or readout of the NRVD calibration data is possible without entering the date. In this case, the date requested by the program is only used for printout of the report.

All function groups of the NRVD, except for the I/O option NRVD-B2, can only be calibrated via the IEEE bus. Calibration of the retrofitted option is performed interactively via the operating menu of the NRVD. The user is only requested to provide for the required external connection between the DC output to be calibrated and the DC(FREQ) input (cf. 6.3.5.5).

### 6.3.2 DC Calibrator

The calibration and test routine for the NRVD supports the calibrators listed below:

- Analogic (Data Precision)
- Datron 4000
- Fluke 5700

With Analogic 8200, voltages < 104 mV must be tapped at the 100-mV output on the rear. The user is informed thereof by a message on the display during the program-controlled test run. If another DC calibrator is used, the following requirements must be met:

- Voltages according to Section 6.2 must be settable with the required accuracy.
- It must be possible to set the output voltage to zero in the relevant output voltage range (offset handling, cf. Section 6.3.1).
- All output voltages, irrespective of their polarity, must be available at one pair of clamps without changing the connections of the Cal adapter.
- The calibrator must be a current sink with a capacity of at least 2 mA (see fig. 6-2 with explanation) for the output voltages -3 V, -0.3 V, 0 V.
- The calibrator must be controllable via IEEE bus.

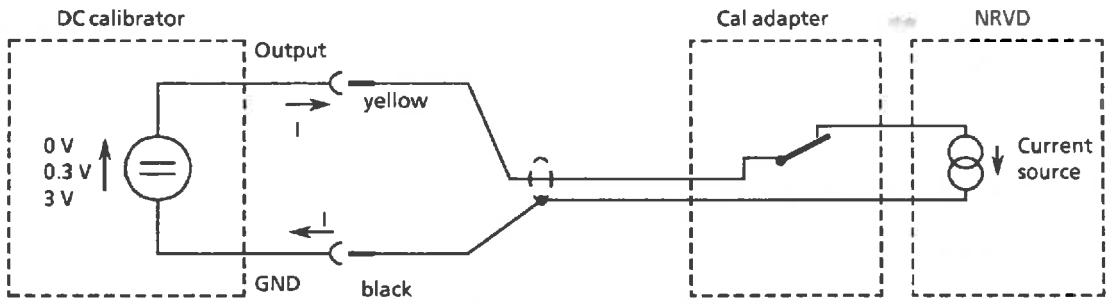


Fig. 6-2 Current conditions/ratio with calibration of the temperature sensor input

Except for calibration of the temperature sensor inputs, the Cal adapter connected to the basic unit represents a real load of 1 to 10 MΩ. With calibration or verification of the temperature sensor inputs, the measuring current supplied by the basic unit (cf. fig. 6-2, table 6-4) must be compensated without changing the output voltage of the calibrator.

With regard to this kind of load, it should be checked, whether the internal impedance of the calibrator used is low enough, such that the required voltage accuracy is still ensured.

Table 6-4 Calibrator load by the temperature sensor input

| Calibr. range | Load current | |
|---|---|---|
| -0.3 V | 100 µA | with offset determination ($U_k$ = 0)<br>in the calibration phase ($U_k$ = -0,3 V) |
| -3.0 V | 2 mA<br>1 mA | with offset determination ($U_k$ = 0)<br>in the calibration phase ($U_k$ = -3 V) |

### 6.3.3 Adapting the Software to Other Test Systems

**DC calibrators:**

Control variables of the three calibrators supported by the program are given in the control section 15420 to 15940 (variables for calibrator...). The control variables of another calibrator may replace one of these blocks.

The name of the calibrator should be entered in the lines 12270 to 12330, if required, and the address line of the modified block is to be entered in line 12450. The letter combination "An" is used in the program as identification for the output of notes about how to reverse the calibrator outputs with the type Analogic 8200.

If the IEEE address of the calibrator is different, it need not be corrected, since it is requested in the program run. Subsequently, it is checked, whether an instrument can be addressed at the given address.

**Power meter:**

The name of the power meter and the default IEEE-bus address are to be entered in the program lines 12730 to 12780. The IEEE bus address is offered in the program run and can be overwritten.

The destination address of the initialization routine is passed by means of the instruction ON Q GOSUB .. and must be entered in line 12920. The initialization routines provided are comprised in lines 11970 to 12120.

The test routine Pwmtr (12940 to 13020) contains the control commands of the power meter and is expanded analogously, if required.

#### 6.3.3.1 Controller Requirements

- AT-compatible PSA/PAT controller (R&S) or IBM-PC
- IEEE-bus board and driver PAT-B1, order No.: 1007.1150.02 (function-compatible with PCIIA/National)
- Parallel interface for connection of a printer (Centronics, LPT 1)
- Graphics card Herkules/EGA/VGA.
- Min. memory space: 250 kB RAM, 300 kB hard disk

### 6.3.4 Program-controlled Calibration/ Verification Measurement

#### 6.3.4.1 General Remarks on Calibration

The test setup can be looked up in fig. 6-1. If a report of the test results is not requested, a printer is not required. The digital multimeter UDS5 is provided for adjustment of the CAL adapter. If a UDS5 is not available, the CAL adapter must be adjusted according to Section 6.3.5.1.

***Note:*** *The ambient temperature during calibration should be 23 ± 1° C. The instruments used for calibration should be running for at least one hour. The power voltage must not deviate more than ± 10% from the rated value and relative humidity should not reach 80%.*

### 6.3.4.2 Installation and Start of the Programs Supplied

The calibration program CAL__D.BAS in the subdirectory \SER-D is written in R&S BASIC and is contained on the supplied floppy disk (service kit NRVD-S1) together with the required BASIC drivers and the installation program INST__D.BAT.

Started from the floppy disk, the program INST__D.BAT carries out the complete installation on the hard disk. First, all service programs are copied into the subdirectory C:\SER-D just created. The service programs only run in conjunction with the R&S BASIC interpreter. If the latter is not yet stored, it can now be installed. Therefore, the main program BASIC.COM is copied into the directory C:\RS-BASIC. All utility programs and drivers are stored in the subdirectory C:\SER-DRIV just created. The files AUTOEXEC:BAT and CONFIG.SYS are extended and the two original files are copied into the subdirectory "C:\RS-BASIC*.OLD".

Installation procedure:

- Insert floppy disk in drive A or B.
- Changeover to drive A or B: (C:\> A: (B:))
- Start the installation program: enter A:\>INST_D and press the ENTER key.
  The installation procedure is designed interactively.
- Remove the floppy disk from drive A (or B).
- Restart the controller system. (CTRL + ALT + DEL or STRG + ALT + ENTF).
  This action is indispensable, since it enables the computer to load all drivers required.
- Computer with Hercules graphics card installed:
  Prior to loading the BASIC interpreter the utility program HERCSUP.COM must be activated:
  enter C:\HERCSUP (from DOS level)
  or enter HERCSUP into the AUTOEXEC.BAT file.
- Change to the directory C:\SER-D and start R&S Basic (C:\> BASIC)
- Load the calibration program (LOAD "CAL_D").
  (Or press the function key F5 ("LOAD") and add CAL_D). The extension BAS is added automatically by Basic.

  ***Note:*** *Program names must be entered with the full pathname, if Basic was not started from C:\SER-D.*
- Start the program using the function key F2 or enter "RUN" and press the RETURN key.

### 6.3.4.3 Calibration program CAL__D.BAS

Program operation is mainly menu-controlled. The program continues with the next menu item by entering the identification character (letter or number) assigned to the desired program section. Letters can be uppercase or lowercase, pressing the RETURN key is only required with data entry.

Following program start (cf. 6.3.4.2), the program head with subsequent main menu is displayed for approx. 1.5 S:

| | |
|---|---|
| Cal-Adapter Adjustment | <A> |
| Verification | <V> |
| Calibration | <C> |
| Calibration Faktors | <F> |
| Calibration Date | <D> |
| | |
| End of Programm | <E> |

Fig. 6-3 NRVD calibration, menu 1

The sequence of sections in menu 1 is not a random sequence but corresponds to the usual calibration run.

- Before starting calibration or verification, the CAL adapter as test equipment should be checked with regard to accuracy of the 1MΩ resistor. Therefore, "Cal-Adapter Adjustment" →<A> is selected in menu 1. A detailed description of testing and adjustment is given in Section 6.3.4.4.
- The specifications of the EUT are determined by means of a verification measurement ("Verification" →<V>) prior to calibration. This allows for the user to decide, whether there is a fault or a drift within the permitted tolerance and whether the instrument will be subject to calibration. The procedure or special features of a verification measurement are described in Section 6.3.4.5.
- Calibration is initiated by entering C for "calibration". The procedure and differences compared to the verification measurement are explained in Section 6.3.4.7.
- The calibration factors substitute a hardware adjustment, which would be required otherwise and allow for a quick evaluation of the instrument state. Calibration factors determined with calibration are stored in a non-volatile memory in the NRVD and can be called under the menu item "Calibration Factors" <F>. The data are either displayed on the screen or output on a printer (Fig. 6-15). The sign ">" is used in the report to mark parameters which have been calibrated at the actual calibration date. Parameters calibrated prior to this date are not marked. The stored parameters of the manually calibrated DC outputs (from the frontpanel) are not provided with the mark (">").
- The menu item "Calibration Date" allows for calling the latest calibration date. It is absolutely required for calibration to enter the current date and this must be the latest calibration date.

### 6.3.4.4 Computer-controlled Adjustment of the Cal Adapter

The current source required for verification measurement and calibration of the DC amplifier is replaced by the calibrated 1-MΩ resistor of the Cal adapter in conjunction with the DC calibrator. The resistor data thus directly influences calibration accuracy. Its value (1000.0 ± 0.05 kΩ) must therefore be checked at regular intervals and readjusted, if necessary.

- Following program start, the option "Cal-Adapter Adjustment" <A> is selected in the main menu (cf. fig. 6-3).

  Subsequently, the required test setup is displayed (cf. fig. 6-4). After acknowledgement of the correct setup by <SPACE key> the program checks via the IEEE bus, whether the required instruments (NRVD + UDS5) are available and determines their IEEE-bus addresses for further program run. In case of an error (e.g., UDS5 was not found) the program waits until the error has been eliminated (UDS5 is identified after acknowledgement of performed test-setup correction by <Space key>.

***Attention:*** The accuracy of the UDS5 considerably influences adjustment, which is why the calibration date of the UDS5 used should not be earlier than one year from the date of adjustment.

*Note:* *If two instruments with the same IEEE-bus address have been found, a message is output in the monitor line and the program waits until correction has been acknowledged.*

If the NRVD is identified more than once, a warning is read out in order to prevent the EUT to be confused with the calibrated power meter with calibration. With verification measurement or calibration, selection of the power meter is requested by the program in the first run.

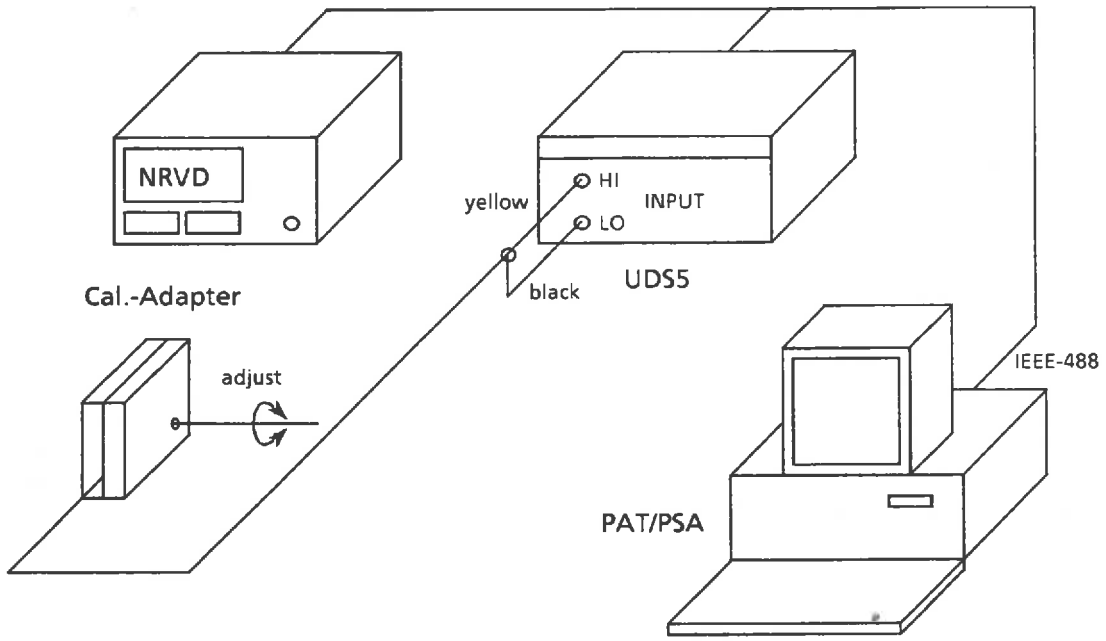


Fig. 6-4 Test setup for adjustment of the Cal adapter

Further operation depends on the test run and becomes a dialog:
Upon acknowledgement of the realized test setup displayed, the user is requested by the program to connect the Cal adapter to channel A of the NRVD[1]. The program automatically configures the Cal adapter for measurement of the 1-MΩ resistor/shunt and requests removal of the Cal adapter from the NRVD and connection of the Cal adapter inputs (yellow/black banana plugs) to the UDS5 [1]. Execution of the program instructions is checked and the resistance value is displayed. The measured value is marked, if the resistance value is beyond the tolerance (cf. fig. 6-5).

| Cal-Adapter Adjustment |
| --- |
| 999.95 < 1000.01 < 1000.05<br>Return to Main-Menu with <R> |

Fig. 6-5 Cal adapter adjustment

According to the display instructions, adjust the trimming resistor of the CAL adapter such that the resistance is within the tolerance range displayed. The potentiometer for adjustment of the 1000-kΩ resistor is accessible via a hole in the Cal adapter housing (cf. fig. 6-4).

Terminate adjustment by pressing the key → "R" for return to the main menu.

1) not applicable, if already performed

### 6.3.4.5 Verification

Upon selection of the option "NRVD Verification" by pressing the key "V" ("v"),
a verification run is initiated. All function blocks are measured by the verification measurements. However, the verification measurement does not influence the stored calibration data of the NRVD.

After selection of the verification measurement, the program determines addresses of available instruments with corresponding messages in the monitor range on the screen. First, the test setup (cf. fig. 6-1) is displayed. After acknowledgement of correct setup, the measuring instruments supported by the program are selected:

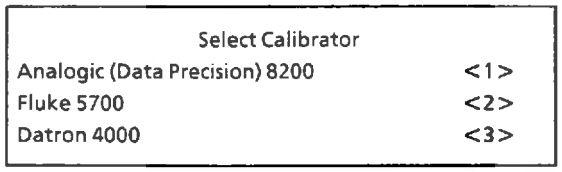


Fig. 6-6 NRVD calibration, selection of calibrator

In the next menu, the IEEE-bus address of the calibrator selected is recommended. The offer or a new entry (terminate by "Return") is accepted and, immediately following the entry, it is checked, whether an addressable instrument is available at the given address. If this is not the case, an error is signalled acoustically and correct entry is waited for.

Analogously, a power meter supported by the program is specified in the subsequent menu:

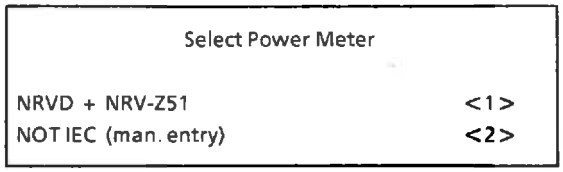


Fig. 6-7 NRVD calibration, selection of power meter

In the next menu, the IEEE-bus address of the power meter selected is proposed. The proposal or a new entry (terminate using "Return") is accepted and, immediately following the entry, it is checked, whether an addressable instrument is available at the given address. If this is not the case, an error is signalled acoustically and correct entry is waited for.

The instrument identification of the power meter (NRVD + NRV-Z51) is displayed, correct connection of the probe is checked and initialization is carried out (cf. fig. 6-8). If the result of the check is negative, the user is requested to correct, correct connection is acknowledged by "Sensor no error".

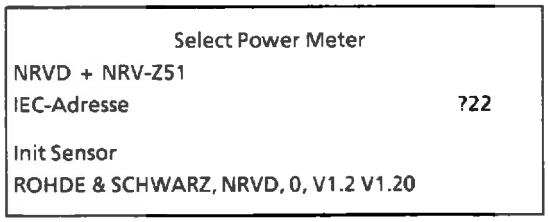


Fig. 6-8 NRVD calibration, selection of power meter

Analogously, the IEEE-bus address of the EUT is requested by the program.
The next menu offered by the program (cf. fig. 6-9) indicates the last calibration date of the EUT and requests for entry of the current test date, the name of the test engineer and information on the EUT (serial No., instrument version).

Starting with software version V1.30, the serial number of the instrument is contained in the instrument identification (cf. fig. 6-16). The entry is explained in Section 6.3.4.6.

The current test date is derived from the real-time clock of the controller, it can, however, be overwritten. The date is absolutely required for calibration and it must not precede the previous calibration date (otherwise, no calibration is possible, error messages). With verification measurement, the date is required only for the report.

| NRVD Calibration (Last calibrated 1991, JUL, 31) | |
|---|---|
| Date (dd. mm. yy) | ?21.11.92 |
| Tested by (Name) | ?Fuchs |
| NRVD Serial No. | ?101324/001 |
| NRVD Var. | 857.8008.?02 |

Fig. 6-9 NRVD calibration, administration data

Subsequently, the user determines the extent of the verification measurement (cf. fig. 6-10). If the complete measurement <7> is selected, the verification procedure is only interrupted by requests for reconnecting the Cal adapter or for connecting the DC(FREQ) input to the current DC output. The procedure is continued after the execution of the respective request has been acknowledged and verified. In contrast to calibration, the DC amplifiers in both channels are checked.

When the verification measurements have been performed, the results can be either displayed or output on a printer in the form of a report (cf.6.3.4.8) or stored as ASCII file.

***Note:*** *A verification measurement should be performed before the calibration measurement in order to store the actual state of the NRVD.*

The drift compared to the latest calibration can thus be evaluated and repair of a faulty instrument is not replaced by a calibration which could be avoided.

### 6.3.4.6 Entry of Serial No.

Starting with the software version 1.30, the serial No. of the NRVD is contained in the instrument identification (cf. figs. 6-8, 6-16). The entry of the serial number is made with first calibration of the NRVD and cannot be modified any more. The entry (starting with software version 1.30) can be made with a later calibration, if the serial number entered is 0. The serial number of the EUT is derived directly from the NRVD identification and entered in the menu 2 (administration data) by the calibration program, taking into account the software version. If the serial No. cannot be read from the identification, it must be entered. It consists of max. 11 characters, digits (0 to 9) and one special character ["/", "." and " " (space)] may be entered.

### 6.3.4.7 Calibration

The inherent calibration is initiated in the main menu (cf. fig. 6-3) by entering "C". The sequence of menus offered is similar to that of the verification measurement. If a calibrator or reference power meter has already been selected, the program checks whether it is correct and continues with the next step up to selection of the calibration extent (cf. fig. 6-10).

When entry of the administration data has been terminated, the required test setup for the test path selected in menu 1 (calibration or verification) is displayed (cf. fig. 6-1). If the verification measurement has already been performed, the calibration or the verification menu is displayed upon acknowledgement of the test setup, otherwise, the DC calibrator and the power meter are first selected.

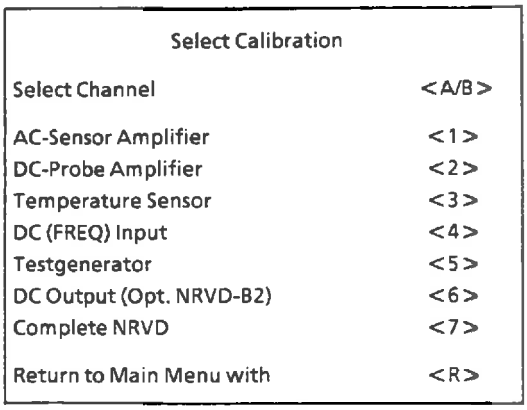


Fig. 6-10 Calibration and verification menu NRVD

Channel A is proposed as test channel by the program for calibration or verification of the individual blocks. The channel can be changed by a corresponding entry (B,A), if desired. The current channel is displayed in the "Select Channel" line. The type of test is selected by entry of the respective number. In contrast to the verification measurement, calibration of the DC-probe amplifier is only performed in test channel A (cf. 6.3.1). If the Cal adapter is not plugged in correctly, the user is requested to connect the Cal adapter to the selected channel on the NRVD.

Calibration of the DC outputs (DC1, DC2) is automatically offered by the program, depending on the NRVD configuration. It is only indicated in the menu, if the I/O option NRVD-B2 is fitted.

It depends on the software version of the EUT, how the test procedure is continued:
a) Calibration is performed directly from the front panel of the NRVD acc. to Section 6.3.5.5 and corresponding program instructions (software version of the controller prior to 1.30).
b) Starting with software version 1.30 (determined by the calibration program), the calibration is made directly by the controller.

The user is requested by the program to provide the external connection (BNC cable) between the output D1, which is to be calibrated, and the input DC(FREQ). The calibration procedure is started as soon as completion of the connection has been acknowledged. Subsequently, the DC2 output is calibrated analogously. If an error occurs, the type of error is indicated on the display and the user either repeats the calibration or continues with the next calibration item.

### 6.3.4.8 Test Reports

The subsequent possibilities of putting out the calibration and verification report are offered:

- Verification report optionally on screen, printer or as file
- Calibration report optionally on screen, printer or as file
- Error report on screen, printer or as file
- Output of calibration factors on screen, printer or as file.

The report is output to the printer via the first Centronics interface ("LPT1") of the controller. The calibration program does not contain any printer-specific sequences in order to ensure that any printer which contains the standard IBM character set can be used.
The reports can be filed sequentially as ASCII file. The file name is assigned the serial number (e.g., 101324.001 from fig. 6-9) and can be overwritten, if desired. Each modification of the name leads to creation of a new file. If the file name is deleted, the program returns to the menu selection of the kind of output.

The measured values determined during calibration or verification measurement are filed internally in a table. They can be called and are provided in the form of a report. The verification or calibration report contains the rated calibration values for each measuring range of a calibrated function group in the left column, permissible tolerances of the measured values, the measured values of the calibration voltage applied as well as the percentage of deviation from the rated value. This percentage is displayed in the next column for measuring results obtained in channel A followed by columns containing the measured values and percentage of deviation for measuring results obtained in channel B.

Both reports (cf. figs. 6-11, 6-13) contain information about the EUT, the calibration date and the overall evaluation of the measurement performed as well as space for signature of the test engineer.

The error report contains information about errors which may have occurred for each range of the tested function. The errors are documented by output of the concerned measuring range, rated value of the calibration voltage, measured values of the offset voltage and the rated voltage (cf. fig. 6-14). If the offset voltage exceeds the permitted value, it must be checked, whether the output zero voltage of the calibrator used is too high (perform adjustment, if required). The actual value (rated voltage) is provided with correction of the offset voltage and corresponds to the deviation of the applied calibrator voltage. If the calculated calibration factor is outside the range 0.95 to 1.05, an error is signalled and the actual value is entered in the column "Measured/V" in the error report.

Verification Report

POWER METER NRVD 857.8008.02 Serial No.: 101010/002
Last calibrated 1991,OKT,10

| Funct. | Range | Nom./V | Tol./% | Channel : - A - Measured/V | Dev./% | Channel : - B - Measured/V | Dev./% |
|---|---|---|---|---|---|---|---|
| AC AMP | | | | | | | |
| | 1 | 0.01 | 0.12 | 1.0001E-2 | 0.01 | 1.0003E-2 | 0.03 |
| | | - 0.01 | 0.12 | -9.9980E-3 | - 0.02 | -9.9960E-3 | - 0.04 |
| | 2 | 0.02 | 0.12 | 2.0001E-2 | 0.01 | 2.0002E-2 | 0.01 |
| | | - 0.02 | 0.12 | -1.9997E-2 | - 0.01 | -1.9998E-2 | - 0.01 |
| | 3 | 0.05 | 0.12 | 5.0001E-2 | 0.00 | 5.0006E-2 | 0.01 |
| | | - 0.05 | 0.12 | -4.9998E-2 | - 0.00 | -5.0002E-2 | 0.00 |
| | 4 | 0.10 | 0.12 | 1.0000E-1 | 0.00 | 1.0001E-1 | 0.01 |
| | | - 0.10 | 0.12 | -9.9999E-2 | - 0.00 | -1.0001E-1 | 0.01 |
| | 5 | 0.20 | 0.12 | 1.9996E-1 | - 0.02 | 1.9996E-1 | - 0.02 |
| | | - 0.20 | 0.12 | -2.0004E-1 | 0.02 | -2.0004E-1 | 0.02 |
| | 6 | 0.50 | 0.12 | 4.9994E-1 | - 0.01 | 4.9996E-1 | - 0.01 |
| | | - 0.50 | 0.12 | -5.0002E-1 | 0.00 | -5.0002E-1 | 0.00 |
| | 7 | 1.00 | 0.12 | 9.9994E-1 | - 0.01 | 9.9997E-1 | - 0.00 |
| | | - 1.00 | 0.12 | -1.0000E0 | 0.00 | -1.0000E0 | 0.00 |
| | 8 | 2.00 | 0.12 | 2.0000E0 | 0.00 | 2.0000E0 | 0.00 |
| | | - 2.00 | 0.12 | -2.0001E0 | 0.00 | -2.0000E0 | 0.00 |
| | 9 | 5.00 | 0.12 | 5.0001E0 | 0.00 | 5.0002E0 | 0.00 |
| | | - 5.00 | 0.12 | -5.0002E0 | 0.00 | -5.0001E0 | 0.00 |
| | 10 | 10.00 | 0.12 | 1.0000E1 | 0.00 | 1.0000E1 | 0.00 |
| | | -10.00 | 0.12 | -1.0000E1 | 0.00 | -1.0000E1 | 0.00 |
| | 11 | 20.00 | 0.12 | 2.0000E1 | 0.00 | 2.0001E1 | 0.01 |
| | | -20.00 | 0.12 | -2.0001E1 | 0.01 | -2.0001E1 | 0.00 |
| DC AMP | | | | | | | |
| | 1 | 0.10 | 0.12 | 1.0001E-1 | 0.01 | | |
| | 2 | 1.00 | 0.12 | 9.9998E-1 | - 0.00 | | |
| | 3 | 10.00 | 0.12 | 1.0000E1 | 0.00 | | |
| | 4 | 40.00 | 0.12 | 4.0000E1 | - 0.00 | | |
| TEMP SENS | | | | | | | |
| | | - 0.30 | 0.12 | -2.9994E-1 | - 0.02 | -3.0006E-1 | 0.02 |
| | | - 3.00 | 0.12 | -2.9998E0 | - 0.01 | -3.0001E0 | 0.00 |
| Testgenerator | | | | | | | |
| | | 1.000mW | 0.7 | 1.0004E-3 | 0.04 | | |
| DC (FREQ) | | | | | | | |
| | | 10.00 | 0.12 | 1.0000E1 | 0.00 | | |
| DC OUT | | | | | | | |
| | | 3.00 | 0.16 | 3.0005E0 | 0.02 | 3.0008E0 | 0.09 |

Result: No error

Tested by Date Signature

Beranek 11.08.92

Fig. 6-11 Verification report (NRVD without error)

Verification Report

POWER METER NRVD 857.8008.02 Serial No.: 101000/003
Last calibrated 1991,AUG,13

| Funct. | Range | Nom./V | Tol./% | Measured/V | Dev./% | Measured/V | Dev./% |
|---|---|---|---|---|---|---|---|
| | Channel : | | | - A - | | - B - | |
| AC AMP | | | | | | | |
| | 1 | 0.01 | 0.12 | 9.9968E-3 | - 0.03 | 1.0002E-2 | 0.02 |
| | | - 0.01 | 0.12 | -9.9978E-3 | - 0.02 | -9.9986E-3 | - 0.01 |
| | 2 | 0.02 | 0.12 | 1.9999E-2 | - 0.01 | 1.9999E-2 | - 0.00 |
| | | - 0.02 | 0.12 | -1.9999E-2 | - 0.01 | -1.0137E-4* | -99.49 |
| | 3 | 0.05 | 0.12 | 4.9992E-2 | - 0.02 | 4.9526E-2* | - 0.95 |
| | | - 0.05 | 0.12 | -4.9988E-2 | - 0.02 | -4.9994E-2 | - 0.01 |
| | 4 | 0.10 | 0.12 | 9.9978E-2 | - 0.02 | 9.9990E-2 | - 0.01 |
| | | - 0.10 | 0.12 | -9.7089E-2* | - 2.91 | -9.9990E-2 | - 0.01 |
| | 5 | 0.20 | 0.12 | 1.9171E-1* | - 4.15 | 1.9999E-1 | - 0.00 |
| | | - 0.20 | 0.12 | -1.9998E-1 | - 0.01 | -2.0000E-1 | - 0.00 |
| | 6 | 0.50 | 0.12 | 4.9986E-1 | - 0.03 | 4.9983E-1 | - 0.03 |
| | | - 0.50 | 0.12 | -4.9986E-1 | - 0.03 | -4.9994E-1 | - 0.01 |
| | 7 | 1.00 | 0.12 | 9.9985E-1 | - 0.02 | 9.9966E-1 | - 0.03 |
| | | - 1.00 | 0.12 | -9.9987E-1 | - 0.01 | -9.9989E-1 | - 0.01 |
| | 8 | 2.00 | 0.12 | 3.4299E-3* | -99.83 | 1.9992E0 | - 0.04 |
| | | - 2.00 | 0.12 | -1.9990E0 | - 0.05 | -1.9997E0 | - 0.02 |
| | 9 | 5.00 | 0.12 | 4.9990E0 | - 0.02 | 3.0193E0* | -39.61 |
| | | - 5.00 | 0.12 | -4.9991E0 | - 0.02 | -4.9993E0 | - 0.01 |
| | 10 | 10.00 | 0.12 | 9.9983E0 | - 0.02 | 9.9970E0 | - 0.03 |
| | | -10.00 | 0.12 | 6.4063E-2* | -99.99 | -9.9991E0 | - 0.01 |
| | 11 | 20.00 | 0.12 | 1.9995E1 | - 0.02 | 1.9992E1 | - 0.04 |
| | | -20.00 | 0.12 | -1.9996E1 | - 0.02 | -1.9996E1 | - 0.02 |
| DC AMP | | | | | | | |
| | 1 | 0.10 | 0.12 | 9.9944E-2 | - 0.06 | 1.1925E-3* | -98.81 |
| | 2 | 1.00 | 0.12 | 9.9996E-1 | - 0.00 | 9.9996E-1 | - 0.00 |
| | 3 | 10.00 | 0.12 | 9.9982E0 | - 0.02 | 9.9983E0 | - 0.02 |
| | 4 | 40.00 | 0.12 | 6.3232E-3* | -99.98 | 3.9994E1 | - 0.01 |
| TEMP SENS | | | | | | | |
| | | - 0.30 | 0.12 | -2.9988E-1 | - 0.04 | -3.0000E-1 | 0.00 |
| | | - 3.00 | 0.12 | -2.9994E0 | - 0.02 | -2.9998E0 | - 0.01 |
| Testgenerator | | | | | | | |
| | | 1.000mW | 0.7 | 9.9970E-4 | - 0.03 | | |
| DC (FREQ) | | | | | | | |
| | | 10.00 | 0.12 | ** Option NRVD-B2 not available | | | |
| DC OUT | | | | | | | |
| | | 3.00 | 0.16 | ** Option NRVD-B2 not available | | | |

Result: ** NRVD exceeds limits **

Tested by Date Signature

Beranek 14.08.92

Fig. 6-12 Verification report (NRVD exceeds tolerance)

Calibration Report

POWER METER NRVD 857.8008.02 Serial No.: 101010/001
Next calibration: 8 - 94

| Channel : | | | - A - | | - B - | |
|---|---|---|---|---|---|---|
| Funct. | Range | Nom./V | Tol./% | Measured/V | Dev./% | Measured/V | Dev./% |
| AC AMP | | | | | | | |
| | 1 | 0.01 | 0.12 | 1.0001E-2 | 0.01 | 1.0001E-2 | 0.01 |
| | | - 0.01 | 0.12 | -9.9990E-3 | - 0.01 | -9.9990E-3 | - 0.01 |
| | 2 | 0.02 | 0.12 | 2.0001E-2 | 0.01 | 2.0002E-2 | 0.01 |
| | | - 0.02 | 0.12 | -1.9997E-2 | - 0.01 | -1.9998E-2 | - 0.01 |
| | 3 | 0.05 | 0.12 | 5.0001E-2 | 0.00 | 5.0006E-2 | 0.01 |
| | | - 0.05 | 0.12 | -4.9998E-2 | - 0.00 | -5.0002E-2 | 0.00 |
| | 4 | 0.10 | 0.12 | 1.0000E-1 | 0.00 | 1.0001E-1 | 0.01 |
| | | - 0.10 | 0.12 | -9.9999E-2 | - 0.00 | -1.0001E-1 | 0.01 |
| | 5 | 0.20 | 0.12 | 2.0000E-1 | - 0.00 | 1.9999E-1 | - 0.00 |
| | | - 0.20 | 0.12 | -2.0000E-1 | 0.00 | -2.0000E-1 | 0.00 |
| | 6 | 0.50 | 0.12 | 4.9994E-1 | - 0.01 | 4.9996E-1 | - 0.01 |
| | | - 0.50 | 0.12 | -5.0002E-1 | 0.00 | -5.0002E-1 | 0.00 |
| | 7 | 1.00 | 0.12 | 9.9994E-1 | - 0.01 | 9.9997E-1 | - 0.00 |
| | | - 1.00 | 0.12 | -1.0000E0 | 0.00 | -1.0000E0 | 0.00 |
| | 8 | 2.00 | 0.12 | 2.0000E0 | 0.00 | 2.0000E0 | 0.00 |
| | | - 2.00 | 0.12 | -2.0001E0 | 0.00 | -2.0000E0 | 0.00 |
| | 9 | 5.00 | 0.12 | 5.0001E0 | 0.00 | 5.0002E0 | 0.00 |
| | | - 5.00 | 0.12 | -5.0002E0 | 0.00 | -5.0001E0 | 0.00 |
| | 10 | 10.00 | 0.12 | 1.0000E1 | 0.00 | 1.0000E1 | 0.00 |
| | | -10.00 | 0.12 | -1.0000E1 | 0.00 | -1.0000E1 | 0.00 |
| | 11 | 20.00 | 0.12 | 2.0000E1 | 0.00 | 2.0001E1 | 0.01 |
| | | -20.00 | 0.12 | -2.0001E1 | 0.01 | -2.0001E1 | 0.00 |
| DC AMP | | | | | | | |
| | 1 | 0.10 | 0.12 | 1.0001E-1 | 0.01 | | |
| | 2 | 1.00 | 0.12 | 9.9998E-1 | - 0.00 | | |
| | 3 | 10.00 | 0.12 | 1.0000E1 | 0.00 | | |
| | 4 | 40.00 | 0.12 | 4.0000E1 | - 0.00 | | |
| TEMP SENS | | | | | | | |
| | | - 0.30 | 0.12 | -2.9997E-1 | - 0.01 | -3.0003E-1 | 0.01 |
| | | - 3.00 | 0.12 | -2.9998E0 | - 0.01 | -3.0001E0 | 0.00 |
| Testgenerator | | | | | | | |
| | | 1.000mW | 0.7 | 1.0002E-3 | 0.02 | | |
| DC (FREQ) | | | | | | | |
| | | 10.00 | 0.12 | 1.0000E1 | 0.00 | | |
| DC OUT | | | | | | | |
| | | 3.00 | 0.16 | 3.0002E0 | 0.01 | 2.9999E0 | -0.00 |

Result: No error

Tested by Date Signature

Beranek 11.08.92

Fig. 6-13 Calibration report

Error Report

POWER METER NRVD 857.8008.02 Serial No.: 101010/003
Last calibrated 1992,AUG,13

| Function | Chann: | - A - | | - B - | |
|---|---|---|---|---|---|
| Range | Nom./V | Offset/V | Measured/V | Offset/V | Measured/V |
| AC AMP | | | | | |
| 1 | 0.01 | | | | |
| | - 0.01 | | | | |
| 2 | 0.02 | | | | |
| | - 0.02 | . | . | . | -1.014E-4 |
| 3 | 0.05 | . | . | . | 4.953E-2 |
| | - 0.05 | | | | |
| 4 | 0.10 | | | | |
| | - 0.10 | . | -9.709E-2 | | |
| 5 | 0.20 | . | 1.917E-1 | | |
| | - 0.20 | | | | |
| 6 | 0.50 | | | | |
| | - 0.50 | | | | |
| 7 | 1.00 | | | | |
| | - 1.00 | | | | |
| 8 | 2.00 | . | 3.430E-3 | | |
| | - 2.00 | | | | |
| 9 | 5.00 | . | . | . | 3.019E0 |
| | - 5.00 | | | | |
| 10 | 10.00 | | | | |
| | -10.00 | . | 6.406E-2 | | |
| 11 | 20.00 | | | | |
| | -20.00 | | | | |
| DC AMP | | | | | |
| 1 | 0.10 | . | . | . | 1.192E-3 |
| 2 | 1.00 | | | | |
| 3 | 10.00 | | | | |
| 4 | 40.00 | . | 6.323E-3 | | |
| TEMP SENS | | | | | |
| | - 0.30 | | | | |
| | - 3.00 | | | | |
| Testgenerator | | | | | |
| | 1.00mW | | | | |
| DC (FREQ) | | | | | |
| | 10.00 | ** Option NRVD-B2 not available | | | |
| DC OUT | | | | | |
| | 3.00 | ** Option NRVD-B2 not available | | | |

Result: ** NRVD exceeds limits **

Tested by Date Signature

Beranek 14.08.92

Fig. 6-14 Error report

The calibration factors essentially replace the required hardware adjustment and are calculated as the ratio between the actual and rated values for each measuring range. The calculated amount is approx. 1 and is used for internal correction of the measured values.

The complete table of determined calibration factors (cf. fig. 6-15) can be called via the IEEE-interface using the following commands:

- `"SYST:LANG 'TO_CAL'"` (set calibration mode)
- `"CAL:INFO?"` (request Cal information)

```
-------------------------------------------------------------------
  NRVD-CAL-DATA                  last calibrated ('>')  1992,JUL,03
-------------------------------------------------------------------

>>>>>>    (AC+)    -CHN A-    (AC-)  |  (AC+)    -CHN B-    (AC-)
-------------------------------------------------------------------
AC[ .01]  >  .991311     >  .991283     >  .989827     >  .989824
AC[ .02]  >  .997952     >  .997945     >  .999277     >  .999278
AC[ .05]  >  .993545     >  .993541     >  .992689     >  .992699
AC[ .10]  >  .997853     >  .997854     >  .995071     >  .995067
AC[ .20]  >  .994071     >  .994075     >  .994602     >  .994629
AC[ .50]  >  .989028     >  .989415     >  .990648     >  .993396
AC[ 1.0]  >  .994106     >  .994487     >  .998620     > 1.001287
AC[ 2.0]  >  .989402     >  .989765     >  .991684     >  .994383
AC[ 5.0]  >  .996736     >  .997119     >  .997110     >  .999858
AC[10.0]  >  .992848     >  .993356     >  .996593     >  .999347
AC[20.0]  >  .991364     >  .991546     >  .995412     >  .997288

>>>>>>    CF[-.30] -CHN A-  CF[-3.0] |  CF[-.30] -CHN B-  CF[-3.0]
-------------------------------------------------------------------
TEMP/UC   >  .997531     >  .997704     >  .997531     >  .997704

>>>>>>       CF[ .10] |     CF[ 1.0] |     CF[10.0] |     CF[40.0]
-------------------------------------------------------------------
  DC      > 1.003150     >  .997609     >  .991353     >  .995430

>>>>>>        OFFSET  |     CF[10.0]
-------------------------------------------------------------------
FREQ(DC)  >  .002803     >  .995145

>>>>>>       CF[50MHz]
-------------------------------------------------------------------
 ROSZ     > 1.024200

>>>>>>      DC1(MIN)  |    DC1(MAX)  |    DC2(MIN)  |    DC2(MAX)
-------------------------------------------------------------------
OUTP(DC)    -.686573       3.985521       -.685852       3.988939

------------------------------------------------------------ END --
```

Fig. 6-15 NRVD, calibration data

***Note:*** *Only the data marked ">" were calibrated on the date displayed. Data without this identification are of earlier date.*

### 6.3.5 Manual Calibration

Calibration of the option NRVD-B2 is implemented as semi-manual procedure, since it can be retrofitted. Calibration of the complete basic unit can also be performed in single steps by means of the calibration adapter; this procedure is explained in the next Section. The BASIC program (see 6.3.4) can thus be duplicated. The subsequent Section also allows for partial calibration, which is required, e.g., in case of repair or if no IEEE-bus compatible power meter of the required accuracy is available.

***Note:*** *Prior to calibration, the thermal settling time of approx. 1 hour shall be adhered to, the ambient temperature shall be 23 ± 1° C and humidity shall not exceed 80%. Make sure that the power voltage does not deviate more than 10% from the rated value.*

#### 6.3.5.1 Adjustment of the Cal Adapter

For verification and calibration of the DC amplifier, the Cal adapter is equipped with an adjustable resistor, which directly influences the measuring accuracy. Therefore, its value (1000.0 kΩ) should be checked regularly and readjusted, if necessary. The resistance can be measured with particular setting of the relays in the Cal adapter.

- Setting the Cal adapter (relays):
  Switch on NRVD and connect Cal adapter to channel A.
  NRVD display: `"READ SENSOR, CAL. ADAPTER"`
  Set calibration mode: `"SYST:LANG 'TO_CAL'"`
  Configure Cal adapter: `"CAL:SENS:NMOD 4"`

- How to determine the resistance:
  Remove Cal adapter from the NRVD and measure the input impedance of the Cal adapter (banana plug) and adjust, if necessary (R = 1000 ± 0.05 kΩ), fig. 6-4.

***Attention:*** *The accuracy of the ohmmeter considerably influences the adjustment. The requested accuracy of the ohmmeter acc. to Section 6.2. has to be adhered to.*

#### 6.3.5.2 Entry of Serial No.

Starting with software version 1.30, the serial No. of the NRVD is contained in the instrument identification (cf. fig. 6-16). With first calibration of the NRVD, the serial No. of the NRVD is entered subsequent to entry of the calibration date (cf. table 6-6) and cannot be modified any longer *). If the serial No. entered = 0, the entry (starting with software version 1.30) can be made with later calibration:

```
"SYST:LANG 'TO_CAL'"
"CAL:DATE yyyy,mm,dd"
"CAL:SER '0123745/019'"
```

The length of the serial No. may be max. 11 charaters. Entry of digits (0 to 9) and one special character ("/","." and " "(space)] is permitted.

*) Exception: Loss of the RAM data due to a faulty RAM back-up battery on the controller board implies loss of the serial No. information. The first calibration following repair is assumed by the firmware to be the very first calibration (cf. Section 7.3.2.1).

The instrument identification (fig. 6-16) including the serial No. and the software versions of the controller and the analog boards is output upon the addressed IEEE-bus query "*IDN".

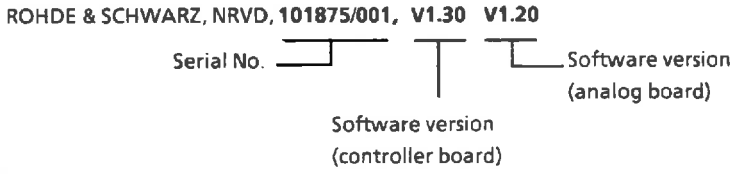


Fig. 6-16 NRVD identification

Calibration of the individual test functions is carried out according to the following scheme:

Table 6-5 Schedule of NRVD calibration procedure

| User operation | NRVD |
|---|---|
| Call the desired calibr. function<br>Input of rated value and polarity of the calibration voltage $V_C$ | Hardware setting<br>Setting of measuring range |
| Apply 0 V<br>Initiate offset determination | ---<br>Offset measurement ($\rightarrow V_0$) *) |
| Apply calibration voltage $V_C$<br>Initiate calibration measurement | ---<br>Measurement of actual value ($\rightarrow$Vm)<br>Calculate and store calibration factor:<br>$K = \frac{V_C}{Vm - V_0}$ *). |

*) The offset voltage is only stored for the input DC(FREQ). For the other functions, adherence to the tolerances is checked only. The calibration factors are all stored.

The calibration data of the NRVD are protected against unintentional deletion by entry of the calibration date in the calibration mode implemented at the start of calibration. The individual calibration procedure is thus initiated, followed by selection of the individual calibration functions as shown in table 6-6. Calibration is terminated by entering `"CAL:END"`.

The query `"CAL:INFO?"` in the calibration mode without entering the date is sufficient for reading of the calibration data (verification) (cf. 6.3.4.8, Test Reports/calibration data), the data can, however, not be modified.

Table 6-6 NRVD calibration procedure

| User operation | Entry on the controller: IECOUTadr. | NRVD display |
|---|---|---|
| Connect Cal adapter to NRVD (LOC-MODE) | ---<br>1) | READ SENSOR<br>CAL-ADAPTER |
| Initiate calibration<br>Enter calibration date<br>Select measuring function | "SYST:LANG 'TO__CAL'"<br>"CAL:DATE yyyy, mm, dd"<br>"CAL:AMPL AC, $U_C$" 2) | CAL.-MODE<br><br>AC $U_C$ OFFS O.K |
| DC calibrator → 0 V<br>(offset measurement)<br><br>DC calibrator → +0,5 V<br><br>DC calibrator → -0 V<br>(offset measurement)<br><br>DC calibrator → +10 V | "CAL:AMPL AC, 0.5"<br>"CAL:TRIG" 3)<br><br>"CAL:TRIG"<br><br>"CAL:AMPL AC, -0.5"<br>"CAL:TRIG" 3)<br><br>"CAL:TRIG" | AC 0.50 OFFS O.K<br>AC 0.50 run<br>AC 0.50 AMPL O.K<br>AC 0.50 run<br>CAL-MODE O.K<br>-AC 0.50 OFFS O.K<br>-AC 0.50 run<br>-AC 0.50 AMPL O.K<br>-AC 0.50 run<br>CAL-MODE |
| DC calibrator → 0 V<br>(offset measurement)<br><br>DC calibrator → +10 V | "CAL:AMPL DC, 10"<br>"CAL:TRIG" 3)<br><br>"CAL:TRIG" 3) | DC 10.0 OFFS O.K<br>DC 10.0 run<br>DC 10.0 AMPL O.K<br>DC 10.0 run<br>CAL-MODE O.K |

1) The sensor connected is automatically initialized in the "Local Mode".
In the "Remote Mode", the reconnected sensor must be initialized:
"CAL:SENS:INIT(?)" (cf. Operating Manual, Section 3.8.1.7).

2) Calibration of further function blocks is initiated analogously using the following commands:

| | |
|---|---|
| "CAL:AMPL DC, rated value" | for DC amplifier, |
| "CAL:AMPL TEMP,-0.3" (-3.0) | for temperature measuring input 0.1 (1)mA |
| "CAL:ROSZ SET__50 MHZ,POUT" | for test generator (cf. 6.3.5.4) |
| "CAL:AMPL FREQ, 10" | for DC (FREQ) input |
| "CAL:AMPL OUTP, 0 (1) or 2" | for DC outp. (0 (1) = sequential, DC1 to DC2; 2 = only DC2; cf. 6.3.5.5) |
| "CAL:END" | End of calibration |

The rated values of the calibration voltages are listed in table 6-3.

3) The trigger command "CAL:TRIG" switches over to calibration of the rated value automatically following the offset measurement or terminates the calibration step.
During calibration, intermediate results (offset measurement, actual value measurement) can be inquired immediately upon the trigger command by entering: "CAL:INFO? MEAS" and be read, in order to find the causes of errors, which might occur.

Query for intermediate results "CAL:INFO? MEAS with calibration of the DC amplifier in the measuring range 10 V (cf. table 6-6) following a correctly performed offset measurement:

```
0;CAL:TRIG  O.K.  OFFS= 79.32E-06;AMPL=0,"not valid";CF=0,"not valid"
```

Upon correct measurement of rated value ("CAL:TRIG"):

```
0;CAL:TRIG  O.K.  OFFS= 71.39E-06;AMPL= 10.00024;CF=  .999164
```

The same inquiry for correct offset measurement and faulty calibration (amplitude of measured value and cal. factor faulty → error bit set):

```
0;CAL:TRIG  O.K.  OFFS=-19.83E-06;AMPL=0,"not valid";CF=0,"not valid"

1;CAL:TRIG   ER   OFFS=-19.83E-06;AMPL=  .000040;CF=  .000006
```

***Note:*** *If offset measurement is faulty, measurement of the rated value is automatically indicated to be faulty, too.*

### 6.3.5.3 Calibration / Verification of DC(FREQ) Input

Calibration is performed according to the described schedule (cf. table 6-5) at 0 V and 10 V acc. to table 6-3. Verification is performed in Cal mode acc. to table 6-7 at the same voltages.

Table 6-7 Test schedule for DC(FREQ) input

| Action | Entry on the controller: IECOUT Adr, | Reaction of NRVD |
|---|---|---|
| Switch on DC (FREQ) measurement | "CAL:AMPL FREQ, 10" | FREQ 10.0 OK |
| Apply 0 V from the calibrator to DC (FREQ) | | |
| Measure the offset | "*TRG" | Displ. measured value |
| Apply 10 V from the calibrator to DC (FREQ) | | |
| Measure the actual value | "*TRG" | Displ. measured value |

The offset error may be ±5 mV, the final value should amount to 10 ±0.020 V.

### 6.3.5.4 Test Generator

The test setup acc. to fig. 6-17 illustrates how the current output power of the test generator is measured using a particularly calibrated power meter (see 6.2). The actual value of the power output is transferred to the NRVD via the controller, the NRVD calculates the calibration factor which was specified to be the ratio between the actual value and the rated value, and adjusts the test signal at the output (N-socket on the front panel) with corrected power. The signal is measured once again and the preceding step repeated, if required.

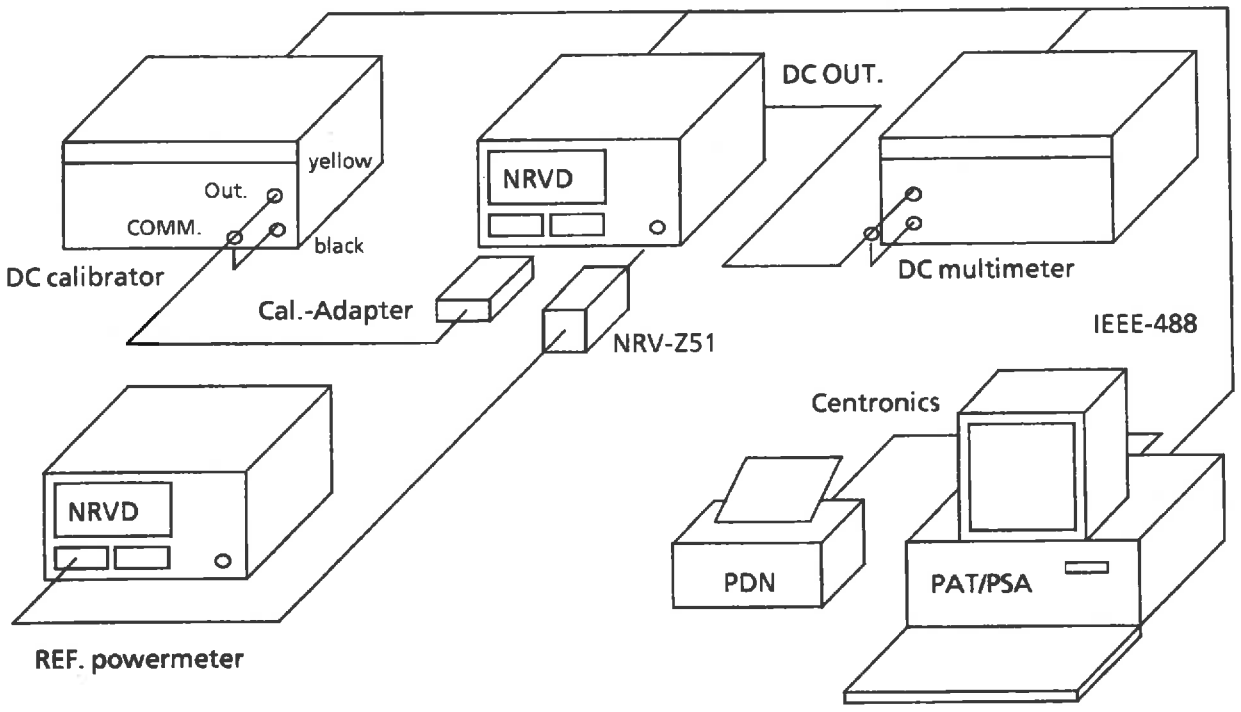


Fig. 6-17 Test setup for calibration of the test generator

Table 6-8 Calibration procedure - test generator

| User operation | Entry on the controller: IECOUT Adr, | Reaction of NRVD |
|---|---|---|
| Initiate calibration | "SYST:LANG 'TO__CAL'"<br>"CAL:DATE yyyy, mm, dd" | *CAL-MODE* |
| Switch off NRVD test generator | "CAL:ROSZ:STAT OFF" | LED<br>"OUTPUT" →OFF |
| Reference power meter (NRVD) zero correction (A) | "SENS:CORR:STATE ON" | ZERO CHN.A |
| Switch on NRVD test generator | "CAL:ROSZ:STAT ON" | LED<br>"OUTPUT" →ON |
| Transfer the measured power $P_{out}$ to the NRVD | "CAL:ROSZ SET__50 MHz, $P_{out}$" | $P_{out}$ corrected |
| Check the power output $P_{out}$:<br>$0.999 \leq P_{out} \leq 1.001$ mW, repeat preceding step, if required | ("CAL:ROSZ SET__50 MHz, $P_{out}$") | ($P_{out}$ corrected) |
| Terminate calibration | "CAL:END" | Test mode, REM |

Remark:
With software version V1.0, the output power must be determined in the test mode. Tranfer of the actual value is performed in the calibration mode.

### 6.3.5.5 DC Output (NRVD-B2 Option)

**Verification**

The two analog outputs DC1 and DC2 of the NRVD-B2 option supply a DC voltage in the range of approx. -0.6 V to 3.8 V which is proportional to the bargraph indication. Scaling of the two outputs is freely selectable due to free selection of the indication range. The left end of the bargraph scale is assigned the output voltage 0 V, the right full-scale value is assigned the output voltage +3 V. If the test voltage is constant (calibrator) in the test setup acc. to fig. 6-18 the voltage values are both verified with corresponding scaling. Verification can be performed either from the front panel or via the IEEE-interface.

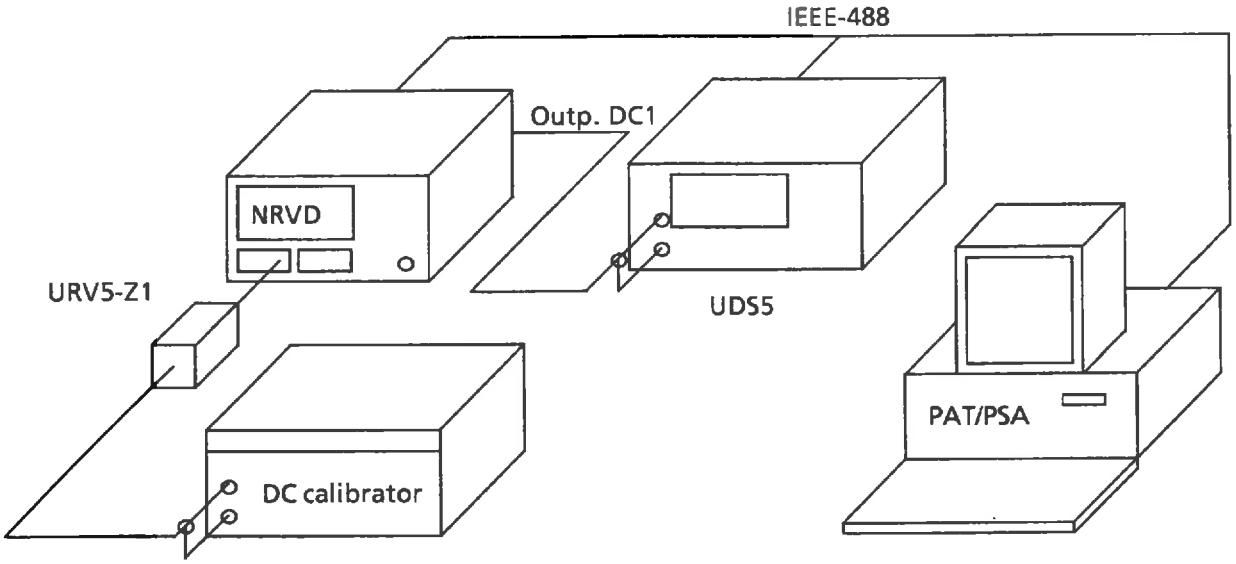


Fig. 6-18 Test setup for verification of the DC outputs of the NRVD-B2

**Preparation**

- Connect DC probe URV5-Z1 in test channel A and apply 1 V from the calibrator.
- Connect DC voltmeter to the analog output DC1.
- NRVD: → Store measured value as reference value: **MEAS → REF.**
  → Select display V/Vr: **"UNIT" → "REL → more → more → V/Vr"**
  → Define the left scale value of the bargraph to be 1, the right one to be 2:
  **"DISP" → "BARGRPH → SCALE→ 1 → STO →2 → STO"**
- The output voltage at DC1 must be 0.000 V ± 5 mV.
  → Define the left scale value of the bargraph to be 0, the right one to be 1.
- The output voltage at DC1 must be 3.000 V ± 5 mV.
- Verify test channel B and DC2 analogously.

### Verification via IEEE bus and controller

Table 6-9 Verification schedule/analog outputs (NRVD-B2 option)

| User operation | Entry on the controller: IECOUT Adr, | Reacion of NRVD |
|---|---|---|
| Calibrator → + 1 V | | |
| Initialize probe | **"INP:SENS:INIT"** | READ SENSOR |
| Switch on DC1 | **"OUTP:DC:STAT ON"** | |
| Switch on relative display | **"SENS:VOLT:UNIT REL"** | $V/V_r$ |
| Measured input voltage (NRVD) | **"*TRG"** | Displ. measured value (e. g. 1.002 V) |
| Measured value →reference value | **"VOLT:REF:MVAL"** | Displ.:1.000 |
| Carry out scaling | **"DISP:ANN:BARG:SCAL:LOW 1; UPP 2"** | DC1 →0 V |
| Measure output voltage (Volt meter, V = 0 ±0.005 V) | **"*TRG"** | Displ.: 1.000 |
| Carry out scaling | **"DISP:ANN:BARG:SCAL:LOW 0; UPP 1"** | Displ.: 1.000, DC1 →3 V |
| Measure output voltage (Volt meter; V = 3 ±0.005 V) | **"*TRG"** | Displ.: 1.000 |

- Plug DC probe URV-Z5 in test channel B, connect DC voltmeter to the output DC2. Verify channel B correspondingly.

### Calibration

The analog outputs DC1 and DC2 of the NRVD-B2 option are calibrated via the DC(FREQ) input. The user is requested on the NRVD display to provide a connection between the output to be calibrated (DC1, DC2) and the DC(FREQ) input (BNC cable on the rear panel). Entry of the date with calibration of the NRVD-B2 option from the NRVD front panel is not required. The calibration procedure is shown in table 6-10.

Starting with software version 1.30 (controller board, see also 6.3.5.2), calibration of the analog outputs is also possible via the IEEE bus (additional identification of the cal. factors/cf. fig. 6-15) The procedure is shown in table 6-10.

Table 6-10 Calibration of the analog outputs (NRVD-B2 option, local mode)

| User operation | NRVD display/reaction |
|---|---|
| Initiate calibration (**LOC-MODE**):<br>Key →**"SPEC"** +<br>Menu keys → **"more"** →**"DC-OUTP"**→**"DC-OUT *CAL"** | DC1-DC (FREQ) *EXEC |
| Connect output DC1 to the input DC (FREQ) via BNC cable | \| |
| Press menu Key →**"*EXEC"** | DC1-CAL-RUNNING<br>DC2-DC (FREQ) *EXEC ← |
| Connect output DC2 to the input DC (FREQ) via BNC cable | \| |
| Press menu Key →**"*EXEC"** | DC2-CAL-RUNNING<br>(WRNG. 20/CAL OUT O.T. *)<br>DC-OUTP ON OFF |
| Remove connections on the rear panel, end of calibration. | |

*) When an error occurs, the program returns to the beginning of the respective calibration step. Use the key "→ MEAS" to interrupt calibration.

Table 6-11 Calibration of the analog outputs (NRVD-B2 option, rem. mode)

| User operation | Entry on the controller:IECOUTadr. | NRVD display |
|---|---|---|
| Connect Cal. adapter to NRVD (LOC-MODE) | ---<br>1) | READ SENSOR<br>CAL-ADAPTER |
| Initiate calibration<br>Enter calibration date<br>Determine cal. function | **"SYST:LANG 'TO_CAL'"**<br>**"CAL:DATE yyyy, mm, dd"**<br>**"CAL:AMPL OUTP 0"** 2),3) | CAL.-MODE<br><br>*OUTP.DC1 O.K.* |
| Connect DC1 to DC(FREQ) | | |
| Trigger calibration | **"CAL:TRIG"** | DC1-CAL RUNNING<br>*OUTP.DC2 O.K.* |
| Connect DC2 to DC(FREQ) | | |
| Trigger calibration | **"CAL:TRIG"** | DC2-CAL RUNNING<br>*CAL-MODE O.K.* |

1) In REM mode, the sensor connected must be intialized (cf. table 6-6)

2) Starting with software version 1.30 (controller board)

3) The parameter 2 (instead of "0" or "1") calibrates only DC2.

## 6.3.5.6 Overview of the NRVD Calibration Commands

Table 6-12 Overview of the NRVD calibration commands

| Cal command | Function/NRVD |
|---|---|
| **"SYST:LANG'TO_CAL'"** | Calibration mode set (inevitable for subsequent commands) |
| **"CAL:INFO? (AC)"** | Output of the cal. data for function given (AC ampl.; DC, TEMP, FREQ, ROSZ). If no function is entered, all calibration data are output. |
| **"CAL:DATE YYYY,mm,dd"** | Entry of calibration date; not required for reading old calibration data |
| **"CAL:SER '"_NR"** | Entry of serial No. "S_NR"; max. 11 characters (cf. 6.3.5.2) |
| **"CAL:AMPL AC, rated value"** | Sets required measuring range automatically and calibrates the AC amplifier with the rated value entered (cf. tables 6-3 and 6-6) |
| **"CAL:AMPL DC, rated value"** | DC amplifier like AC amplifier |
| **"CAL:AMPL FREQ 10"** | Calibrates DC(FREQ) input with 10 V |
| **"CAL:AMPL TEMP,-0.3" (-3.0)** | Calibrates input of temperature sensor for 0.1 (1) mA sensors (cf. 6.3.1) |
| **"CAL:AMPL OUTP, Nr"** | Calibrates DC outputs via IEEE bus (starting with software version1.30/controller)<br>No = 0 (1) →Seq. calibration DC1,2<br>No = 2 →calibrates only DC2 |
| **"CAL:TRIG"** | Performs a measurement in the selected measuring range:<br>1st output offset acquisition<br>2nd output Actual-value measurement (cf. table 6-6) |
| **"CAL:INFO? MEAS"** | Output of current measured value determined by "CAL:TRIG" (cf. table 6-6) |
| **"CAL:ROSZ:STAT ON" (OFF)** | Switches test generator on (off) (except software versions up to V1.20) |
| **"CAL:ROSZ SET_50 MHz, $P_{OUT}$"** | Corrects the output power upon indication of the actual value $P_{out}$ on 1 mW |
| **"CAL:END"** | Terminates the calibration mode |
| **"CAL:SENS:INIT (?)"** | Initializes sensors connected (? → with ACTUAL-state output) |
| **"CAL:INP:NSEL (1)"** | Selects the current, i.e. the indicated (1,2) test channel |
| **"CAL:SENS:NMOD 4"** | Configures the Cal adapter connected for measurement or adjustment of the 1-MΩ resistor (see 6.3.5.1) |