Controlling External Generators and Power Meters with

Network Analyzer ZVR

Application Note 1EZ46_0E

Products:

ZVR, ZVRE, ZVRL, ZVC, ZVCE
with options ZVR-B4, ZVR-B5 or ZVR-B7

Subject to change - Johannes Ganzert 98-10

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Contents

1. Summary

With options ZVR-B4 (mixer measurements), ZVR-B5 (nonlinear measurements) and ZVR-B7 (power calibration) installed, signal generators and power meters can be controlled from ZVR network analyzers via the IEC/IEEE bus.

Customary signal generators and power meters are supported by the device firmware. This application note describes how user-specific configuration files can be generated for and adjusted to external equipment of these two categories.

2. Introduction

The configuration data are located in the directory `C:\USER\DATA`, which can be accessed by the user. Files describing the generator have the extension `.gen`, while files for power meters are of the `.pwm` type.

If other types of equipment are to be controlled, the files supplied with the equipment software can be used as a basis. The originals must not be modified because they are overwritten during firmware updates.

In the firmware selection lists, the generator or power meter is indicated by the associated file name. Example: The file describing generator SME06 is named `SME06.GEN`.

3. Structure of a Configuration File for a Signal Generator

As a prerequisite of being supported by the firmware, an external generator must be capable of performing frequency settings in the standard unit Hz. Level must be settable in dBm.

The permissible frequency and level ranges are specified in section `[EXT_SRC]:`

- `GENERATORMINFRQ` indicates the lower limit frequency in Hz;
- `GENERATORMAXFRQ` indicates the upper limit frequency in Hz.

In the same way

- `GENERATORMINPOW` and
- `GENERATORMAXPOW`

define the minimum and maximum permissible level in dBm.

The field `GENERATORINIT` contains the initializing sequence for the generator. The commands are transmitted by the network analyzer as soon as the basic settings of the generator are initialized.

`GENERATORINITDELAY` defines the wait time following initialization.

By means of the command given in the field `GENERATORINITCW,` the generator is switched to fixed-frequency mode.

The commands in the fields `GENERATORFREQ` and `GENERATORLEVEL` are used for setting frequency and level. At runtime, the characters %lf are replaced by the value to be set as a floating-point number. Hz and dBm are always used as basic units.

The synchronization mechanism on IEC/IEEE bus is selected via `GENERATORUSEOPC.` If the generator can respond to the command *OPC according to IEEE488, enter 1.
If this type of synchronization is not supported, enter 0. In this case, the time the generator has for settling after each new setting is given in seconds in the next field `GENERATORUSEDELAY`.

The key words `GENERATORREFEXT` and `GENERATORREFINTERN` describe the commands for switching to external/internal reference.

GENERATORIECAVAIL serves for defining whether the generator supports the hardware handshake mode. This field contains the value TTL only for a few generators from Rohde & Schwarz; normally it is set to IEC/IEEE (no hardware handshake). If it is set to IEC/IEEE, the entries

GENERATORLISTMAX,
GENERATORREADYINVALIDTIME,
GENERATORREADYEXACTTIME,
GENERATORFREQLIST,
GENERATORLEVELFORFREQLIST,
GENERATORLEVELLIST,
GENERATORFREQFORLEVELLIST,
GENERATORSELECTLISTBYNAME,
GENERATORDELETELISTBYNAME,
GENERATORSELECTLISTBYNUMBER,
GENERATORDELETELISTBYNUMBER,
GENERATORINITFREQLIST,
GENERATORINITLEVELLIST,
GENERATORINITFREQANDLEVELLIST
and
GENERATORRESETLIST are irrelevant.

In the field GENERATORERRORMODE, the supported error-message mode is shown. This value is SCPI for error messages according to the SCPI standard, IEEE if the registers STB and ESR according to IEEE488.2 are used and NONE if none of the mechanisms listed above is supported.

The fields GENERATORRFOFF and GENERATORRFON describe which commands are to be used for switching RF power on and off.

4. Configuration File for Signal Generator SME03

```
;*****************************************************************************
;
; COPYRIGHT: (c) 1996 Rohde & Schwarz, Munich
;
; Generator description file for ZVR family
;
; supports SME03
;
; $Revision:   1.4  $
;
; +-------------------------------------------------------------------------+
; | This file must not be modified!. Future changes by R&S without notice. |
; +-------------------------------------------------------------------------+
;
; You can use this file as an example to create your own generator
; descriptions. To do this copy the file to a different name! So software
; updates will not modify your files. Your new file will then automatically
; appear in the generator selection list box. We do not guarantee proper
; operation with any generator file not delivered by R&S!
;
;*****************************************************************************/
[EXT_SRC]

;  minimum output frequency [Hz]
GENERATORMINFRQ               = 5e3
;  maximum output frequency [Hz]
GENERATORMAXFRQ               = 3.0e9
;  minimum output power     [dBm]
GENERATORMINPOW               = -144
;  maximum output power     [dBm]
GENERATORMAXPOW               = 16


; IEEE 488 initialization string
: This sequence is sent to the generator to initialize it.
; You must turn the generator to external reference, if not, there might
; be problems measuring with small IF bandwidths.
; You can also set the frequency and power to initialization values.
;
GENERATORINIT                 = *RST;*CLS;:LIST:DEL:ALL;*ESE 1;*SRE 32;:POW -100DBM;:OUTP
ON;:TRIG:SLOP NEG;:ROSC:EXT:FREQ 10e6;:ROSC:SOUR EXT  ;

; time needed after initialization [sec]
GENERATORINITDELAY            = 1.0

; define continuous wave IEEE 488 command
GENERATORINITCW               = :FREQ:MODE CW
```

Frequency and level range of the generator

Initialization of the generator

```
; define frequency IEEE 488 command.
; %lf will be replaced by the instrument with the current frequency [Hz]
GENERATORFREQ                = :FREQ %lf HZ

; define power command  IEEE 488 command.
; %lf will be replaced by the instrument with the current power [dBm]
GENERATORLEVEL               = :POW %lf DBM

; select operation complete synchronization method
; 1 = Use *OPC IEEE 488 command
; 0 = Use delay time
;
GENERATORUSEOPC              = 1
; delay time [sec], if GENERATORUSEOPC = 0
GENERATORUSEDELAY            = 0.05

; set reference oscillator
GENERATORREFEXT              = :ROSC:EXT:FREQ 10e6;:ROSC:SOUR EXT
GENERATORREFINTERN           = :ROSC:SOUR INT

; Does the generator support hardware handshake?
;   IEC =  stepping with IEEE 488 commands
;   TTL =  stepping through hardware handshake.
;          Only supported with R&S generators
GENERATORIECAVAIL            = TTL


; Hardware handshake only supported with R&S generators
; ----------------------------------------------------
;
; If GENERATORIECAVAIL = TTL you must set the following keywords correctly
;
; By using hardware handshake the ZVR steps the generator by the hardware signals
; BLANK and TRIGGER. These signals must be connected to use this mode!
; In this case the generator is programmed with the stimulus values of the ZVR at
; initialization time.
: Using hardware handshake the measurement speed is improved significantly.
;
; maximum number of points for generator list mode
GENERATORLISTMAX             = 2003

; delay times for the hardware signals
GENERATORREADYINVALIDTIME    = 1200e-6
GENERATORREADYEXACTTIME      = 200e-6

; sequences for programming frequency and power list
;
GENERATORFREQLIST            = :FORM ASC;:LIST:FREQ %s
GENERATORLEVELFORFREQLIST    = :FORM ASC;:LIST:POW %lf
GENERATORLEVELLIST           = :FORM ASC;:LIST:POW %s
GENERATORFREQFORLEVELLIST    = :FORM ASC;:LIST:FREQ %lf
GENERATORSELECTLISTBYNAME    = :LIST:SEL "%s"
GENERATORDELETELISTBYNAME    = :FREQ:MODE CW;:POW -100DBM;:LIST:DEL "%s"
GENERATORSELECTLISTBYNUMBER  = :LIST:SEL "LIST%lu"
GENERATORDELETELISTBYNUMBER  = :FREQ:MODE CW;:POW -100DBM;:LIST:DEL "LIST%lu"
GENERATORINITFREQLIST        = :LIST:LEARN;:FREQ:MODE LIST;:LIST:MODE STEP;:TRIG:LIST:SOUR
                               EXT;:ABOR:LIST
GENERATORINITLEVELLIST       = :LIST:LEARN;:FREQ:MODE LIST;:LIST:MODE STEP;:TRIG:LIST:SOUR
                               EXT;:ABOR:LIST
GENERATORINITFREQANDLEVELLIST = :LIST:LEARN;:FREQ:MODE LIST;:LIST:MODE STEP;:TRIG:LIST:SOUR
                               EXT;:ABOR:LIST
GENERATORRESETLIST           = :ABOR:LIST

; Error detection on external device:
;  NONE = no error detection
;  IEEE = error detection using IEEE 488.2 Registers STB and ESR
;  SCPI = error detection using IEEE 488.2 Registers STB and ESR
;         and SCPI Error Queue.
GENERATORERRORMODE           = IEEE

; commands to turn RF output OFF and ON
GENERATORRFOFF = :OUTP:STAT OFF
GENERATORRFON  = :OUTP:STAT ON
```

Frequency and level setting

Synchronization mechanism

External reference

Hardware handshake

Error handling

5. Creating a Configuration File for a Power Meter

As a prerequisite of being supported by the firmware, an external power meter must be capable of indicating frequency ranges in the standard unit Hz. The level range must be settable in dBm.

The measurement ranges for frequency and level are specified in the [POWERMETER] section:

- POWERMEASMINFRQ indicates the lower limit frequency in Hz;
- POWERMEASMAXFRQ indicates the upper limit frequency in Hz.

In the same way

- POWERMEASMINPOW and
- POWERMEASMAXPOW

define the minimum and maximum measurable level in dBm.

The field POWERMEASINIT contains the initializing sequence for the power meter. The commands are transmitted by the network analyzer as on the initialization of the basic settings of the power meter.

POWERMEASINITDELAY defines the wait time following initialization.

The command given in the field POWERMEASZEROADJUST serves for zeroing the power meter.

The command in the field POWERMEASQUERY triggers level measurement and is followed by the measurement-result query.

The value in the field POWERMEASUSECORR indicates whether the power meter carries out frequency correction at the sensor (= 1) or whether the table in the network analyzer is to be used (=1). In the latter case, the frequency of the signal to be measured is transmitted by means of the command POWERMEASCORR. At runtime, the characters %lf are replaced by the value to be set as a floating-point number. Hz is always used as a basic unit.

The command in the field POWERMEASEXIT is transmitted after the measurement sequence has been completed. This field may remain blank.

The synchronization mechanism via IEC/IEEE bus is selected via POWERMEASUSEOPC. If the power meter can respond to the command *OPC according to IEEE488, enter 1.
If this type of synchronization is not supported, enter 0. In this case, the time the power meter has for settling after each new setting is given in seconds in the next field POWERMEASUSEDELAY.

In the field POWERMEASERRORMODE, the supported error-message mode is shown. This value is SCPI for error messages according to the SCPI standard, IEEE if the registers STB and ESR according to IEEE488.2 are used and NONE if none of the mechanisms listed above is supported.

6. Configuration File for Power Meter NRVS

```
;*****************************************************************************
;
; COPYRIGHT: (c) 1996 Rohde & Schwarz, Munich
;
; Power meter description file for ZVR family
;
; supports NRVS
;
; $Revision:   1.2  $
;
; +-------------------------------------------------------------------------+
; | This file must not be modified!. Future changes by R&S without notice. |
; +-------------------------------------------------------------------------+
;
; You can use this file as an example to create your own power meter
; descriptions. To do this copy the file to a different name! So software
; updates will not modify your files. Your new file will then automatically
; appear in the power meter selection list box. We do not guarantee proper
; operation with any power meter file not delivered by R&S!
;
;*****************************************************************************/
```

```
[POWERMETER]

;  minimum input frequency      [Hz]
POWERMEASMINFRQ               = 10e6
;  maximum input frequency      [Hz]
POWERMEASMAXFRQ               = 20e9
;  minimum input power          [dBm]
POWERMEASMINPOW               = -20
;  maximum input power          [dBm]
POWERMEASMAXPOW               = 10


; IEEE 488 initialization string
; This sequence is sent to the power meter to initialize it.
;
POWERMEASINIT                 = C1,W5,U1,N1,A0,Q1,KF1

; time needed after initialization [sec]
POWERMEASINITDELAY            = 1.0

; define zero adjust IEEE 488 command.
POWERMEASZEROADJUST           = O1

; define power query IEEE 488 command.
; POWERMEASSETUP (not required)
POWERMEASQUERY                = X1

; Power meters are able to correct the
; frequeny-dependent losses for the power sensor.
; The calibration factor for the power sensor is
; saved in nonvolatile memory in the device.
;
; 1 = the power meter  c a n  do the correction,
;     the SENSOR X CAL FACTOR LIST is  n o t  used
; 0 = the power meter  c a n n o t  do the correction,
;     the correction is done by the ZVR software
;     using the SENSOR X CAL FACTOR LIST
;
POWERMEASUSECORR              = 1

; IEEE 488 command frequency for the correction of power sensor losses
; %lf will be replaced by the instrument with the current frequency [Hz]
POWERMEASCORR                 = DF %lf


; IEEE 488 exit string
; This sequence is sent to the power meter when
; the ZVR stops using it.
;
POWERMEASEXIT                 =

; select operation complete synchronization method
; 0 = Use delay time
; 1 = Use *OPC IEEE 488 command
; 2 = Wait for SRQ, but do not add *OPC to commands
;
POWERMEASUSEOPC               = 2
; delay time [sec], if POWERMEASUSEOPC = 0
POWERMEASUSEDELAY             = 0.5
;
; Error detection on external device:
;  NONE = no error detection
;  STB5 = Bit 5 in Status Byte indicates an error (old R&S instruments)
;  IEEE = error detection using IEEE 488.2 Registers STB and ESR
;  SCPI = error detection using IEEE 488.2 Registers STB and ESR
;         and SCPI Error Queue.
POWERMEASERRORMODE            = STB5
```

Frequency and level range of the power meter

Initialization of the power meter

Zeroing

Query of measurement results

Synchronization mechanism

Error handling

7. References

[1] H.-G. Krekels: Automatic Calibration of Vector Network Analyzer ZVR, Appl. Note 1EZ30_2E.

[2] O. Ostwald: 3-Port Measurements with Vector Network Analyzer ZVR, Appl. Note 1EZ26_1E.

[3] O. Ostwald: 4-Port Measurements with Vector Network Analyzer ZVR, Appl. Note 1EZ25_1E.

[4] T. Bednorz: Measurement Uncertainties for Vector Network Analysis, Appl. Note 1EZ29_1E.

[5] P. Kraus: Measurements on Frequency-Converting DUTs using Vector Network Analyzer ZVR, Appl. Note 1EZ31_1E.

[6] J. Ganzert: Accessing Measurement Data and Controlling the Vector Network Analyzer via DDE, Appl. Note 1EZ33_1E.

[7] J. Ganzert: File Transfer between Analyzers FSE or ZVR and PC using MS-DOS Interlink, Appl. Note 1EZ34_1E.

[8] O. Ostwald: Group and Phase Delay Measurements with Vector Network Analyzer ZVR, Appl. Note 1EZ35_1E.

[9] O. Ostwald: Multiport Measurements using Vector Network Analyzer ZVR, Appl. Note 1EZ37_1E.

[10] O. Ostwald: Frequently asked questions about Vector Network Analyzer ZVR, Appl. Note 1EZ38_3E.

[11] A. Gleißner: Internal Data Transfer between Windows 3.1 / Excel and Vector Network AnalyzerZVR, Appl. Note 1EZ39_1E.

[12] A. Gleißner: Power Calibration of Vector Network Analyzer ZVR, Appl. Note 1EZ41_2E.

[13] O. Ostwald: Pulsed Measurements on GSM Amplifier SMD ICs with Vector Network Analyzer ZVR, Appl. Note 1EZ42_1E.

[14] O.Ostwald: T-Check - Measurement Accuracy Test for Network Analyzers with a Tee, Appl. Note 1EZ43_0E.

[15] O. Ostwald: Time Domain Measurements using Network AnalyzerZVR, Appl. Note 1EZ44_1E.

[16] J. Simon: Virtual Embedding Networks for Vector Network AnalyzerZVR, Appl. Note 1EZ45_1E.

8. Ordering Information

Ordering designation	Short desig.	Frequency band	Order number
Network Analyzers (test set contained) *			
3-channel unidir. 50 Ω, passive	ZVRL	9 kHz to 4 GHz	1043.0009.41
3-channel bidir. 50 Ω, passive	ZVRE	9 kHz to 4 GHz	1043.0009.51
3-channel bidir. 50 Ω, active	ZVRE	300 kHz to 4 GHz	1043.0009.52
4-channel bidir. 50 Ω, passive	ZVR	9 kHz to 4 GHz	1043.0009.61
4-channel bidir. 50 Ω, active	ZVR	300 kHz to 4 GHz	1043.0009.62
3-channel bidir.50 Ω, active	ZVCE	20 kHz to 8 GHz	1106.9020.50
4-channel bidir. 50 Ω, active	ZVC	20 kHz to 8 GHz	1106.9020.60
Alternative test sets *			
75 Ω bridge for ZVRL (instead of 50 Ω) [1]			
75 Ω, passive	ZVR-A71	9 kHz to 4 GHz	1043.7690.18
75 Ω bridge pairs for ZVRE and ZVR (instead of 50 Ω) [1]			
75 Ω, passive	ZVR-A75	9 kHz to 4 GHz	1043.7755.28
75 Ω, active	ZVR-A76	300 kHz to 4 GHz	1043.7755.29
Options			
AutoKal	ZVR-B1	0 to 8 GHz	1044.0625.02
Time Domain Transformation	ZVR-B2	as analyzer	1044.1009.02
Mixer Measurements [2]	ZVR-B4	as analyzer	1044.1215.02
Reference Channel Ports	ZVR-B6	as analyzer	1044.1415.02
Power Calibration [3]	ZVR-B7	as analyzer	1044.1544.02
3-Port Adapter	ZVR-B8	0 to 4 GHz	1086.0000.02
Virtual Embedding Networks [4]	ZVR-K9	as analyzer	1106.8830.02
4-Port Adapter (2xSPDT)	ZVR-B14	0 to 4 GHz	1106.7510.02
4-Port Adapter (SP3T)	ZVR-B14	0 to 4 GHz	1106.7510.03
Controller (German) [5]	ZVR-B15	-	1044.0290.02
Controller (English) [5]	ZVR-B15	-	1044.0290.03
Ethernet BNC for ZVR-B15	FSE-B16	-	1073.5973.02
Ethernet AUI for ZVR-B15	FSE-B16	-	1073.5973.03
IEC/IEEE-bus interface for ZVR-B15	FSE-B17	-	1066.4017.02
Generator Step Attenuator PORT 1	ZVR-B21	as analyzer	1044.0025.11
Generator Step Attenuator PORT 2 [6]	ZVR-B22	as analyzer	1044.0025.21
Generator Step Attenuator PORT 1	ZVR-B23	as analyzer	1044.0025.12
Generator Step Attenuator PORT 2	ZVR-B24	as analyzer	1044.0025.22
External Measurements 50 Ω [7]	ZVR-B25	10 Hz to 4 GHz (ZVR/E/L) 20 kHz to 8 GHz (ZVC/E)	1044.0460.02

[1] To be ordered together with ZVR/E/L.
[2] Harmonics measurements included.
[3] Power meter and sensor required.
[4] Only for ZVR or ZVC with ZVR-B15.
[5] DOS, Windows 3.11, keyboard and mouse included.
[6] For ZVR or ZVC only.
[7] Attenuators required.

*** Note:**
Active test sets, in contrast to passive test sets, contain internal bias networks, eg to supply DUTs.

ROHDE&SCHWARZ

ROHDE & SCHWARZ GmbH & Co. KG · P.O.B. 80 14 69 · D-81614 München
Telephone +49 89 4129 -0 · Telefax +49 89 4129 - 3777 · Internet: http://www.rsd.de