Direct Remote Control of Switch Matrix OSP via Network and Spectrum Analyzers

Application Note

This application note shows how to remote control the switching of RF and digital I/O signals by R&S®OSP Open Switch and Control Platform directly from a Vector Network Analyzer (VNA) or from a Spectrum Analyzer (SA). The R&S®ZVA, R&S®ZVB, R&S®ZNB, R&S®FSW and R&S®FSV families are covered. The application note first describes the requirements and setup procedure. It is shown how to install the software and how to set up the system in order to get highest flexibility and best usability. It is then shown how to calibrate the entire configuration and finally some practical examples are provided. Switching is explained using VNAs as an example, the appendix 5.4 provides hints regarding the differences when using SAs in a similar way.

OSP ZVx Remote control – 1MA226_1e

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Application Note

ROHDE&SCHWARZ

Contents

1 Introduction

Abstract

This application note shows how to remote control an external R&S®OSP directly from a Vector Network Analyzer (VNA) or from a Spectrum Analyzer (SA), for instance from the R&S®ZVA , R&S®ZVB, R&S®ZNB, R&S®FSW and R&S®FSV families. The application note describes the requirements and the setup procedure. It is shown how to install the software and how to setup the system in order to get highest flexibility and best usability. It is additionally shown how to calibrate the entire configuration and finally some practical examples are provided.The application note mainly addresses the use of VNAs, appendix 5.4 provides hints regarding the differences when using SAs in a similar way.

Motivation

Vector Network Analyzers (VNA) are the most flexible instruments in RF test and measurement applications. Combining generators and receivers in one single box, additionally they work in a wide frequency range at various bandwidths. Because of their capability of fast and precise data processing, needed to calculate s-parameters, they also have a powerful computer inside. Beyond the task of internal data processing this computer can also be used to control external equipment. This application note shows how to remote control an Rohde & Schwarz Open Switch and Control Platform (OSP) directly from a Vector Network Analyzer.

The combination of network analyzers and external switch matrices like the OSP increases the flexibility in terms of RF test applications. For instance, multiple test objects can be connected simultaneously and can be tested automatically without manual interaction. Complex digitally controlled RF modules can be switched into their specific operating modes while measuring RF parameters for each operation condition. Prototypes from the RF lab can be connected simultaneously while automatically comparing the RF parameters. There are hundreds of further applications for the combination of network analyzers and external switch and control units.

Once installed, the OSP panel software can be directly started and operated on a VNA as indicated in Fig. 1-1. Now the OSP switch matrix can be set while the effects of the switching can be simultaneously observed at the VNA. When the switching yields results suitable for later use, the entire switching configuration can be stored permanently. Using so called "paths" with appropriate "pathnames", for instance "Path_1", "Path_2",..., each switching configuration can be retrieved by a simple click on one of the softkeys shown at the right on VNA screen. The OSP panel software can be closed as soon as all paths are defined and stored. From now each path previously defined can be directly activated using a single click on the appropriate softkeys at the right.

When the solution of OSP remote control via VNAs was used, it became clear that a similiar solution is useful for a Spectrum Analyzer (SA) also. Especially when performing 2-port analysis by means of a tracking generator it can be useful to switch RF paths or to modify DC bias values using digital outputs for instance of a varactor diode in order to investigate the changes of its RF behaviour. Therefore the OSP remote control feature is included also for Spectrum Analyzers. Details are described in chapter 5.4 .

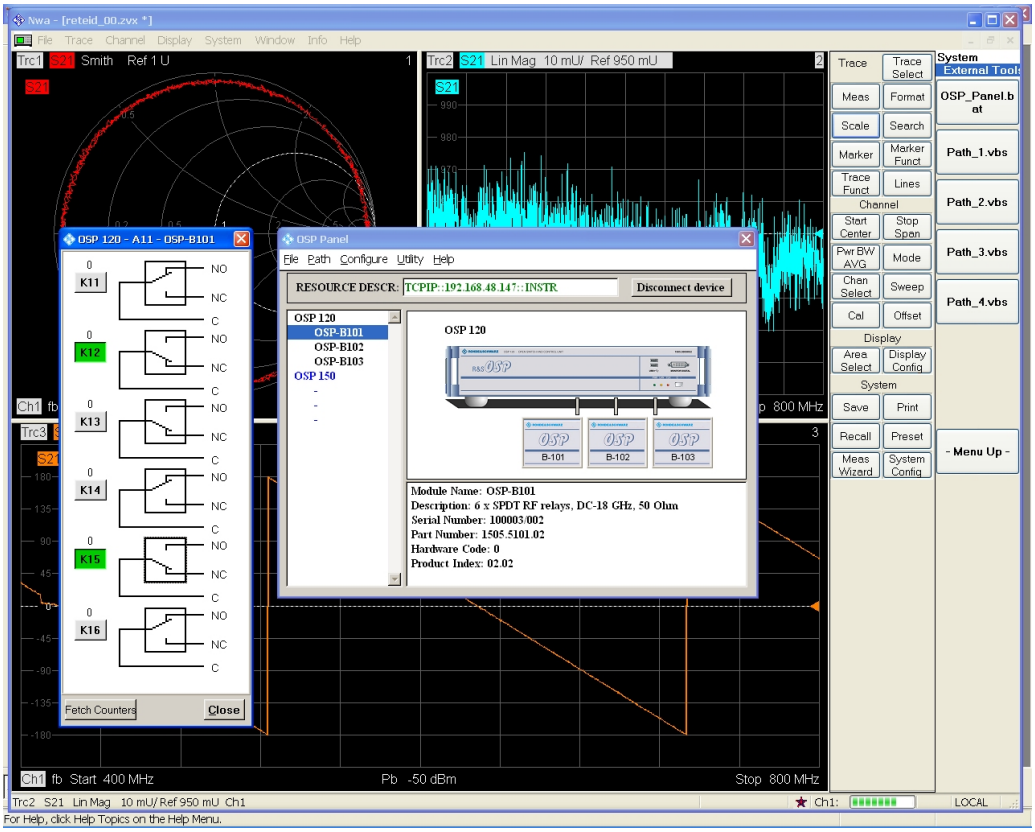


Figure 1-1: OSP Panel Software being installed on a VNA to control external switch matrices

2 Preparation

2.1 Requirements

In order to setup this application a vector network analyzer (VNA) either from the ZVA-, ZVB- or ZNB-familiy is needed along with at least one unit from the OSP family. The OSP can be equipped with any of its switching options. This application properly works with OSP Firmware Release 2.42 (and up) and OSP Panel Software Version 2.33 (and up). Both versions are available at www.rohde-schwarz.com for free. When versions of the OSP Panel Software are downloaded, the OSP firmware should also be upgraded. This can be easily done as described in the OSP manual [7], refer to chapter 5.5, "References" .

In addition to the OSP Panel Software two supplemental programs "SetPath_OSP.EXE" and "LoadStat.EXE" are provided. "SetPath_OSP.EXE" is used for remote controlled path switching. For calibration and convenient VNA remote control the software "LoadStat.EXE" is needed. Both programs can be downloaded from www.rohde-schwarz.com together with this application note. The programs "SetPath_OSP.EXE" and "LoadStat.EXE" are described in detail in the appendix of this document.

Finally it has to be stressed that an additional PC is not needed for this application, because the OSP is directly remote controlled via the VNA. However, an external PC can be used, see FAQ section of this document.

2.2 File Setup

File Organisation

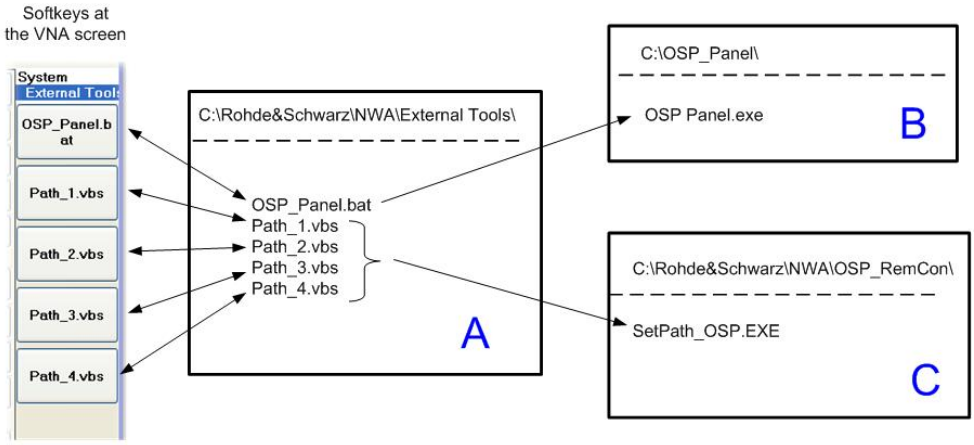


Figure 2-1: Harddisk file organisation for OSP remote control via VNA

As indicated in Fig. 2-1 the "External Tools" softkeys of the VNA are determined by the contents of the "External Tool" folder of the VNA's harddisk. Each script file entry in the "External Tool" folder results in an softkey labelled with the name of the script file, as shown in box A of the figure above. When pressing the softkey the appropriate file will be started. When pressing for instance the softkey with the name "Path_2.vbs" the program "Path_2.vbs" will be started.The name of a softkey is determined by exactly one file in the "...ExternalTools" folder of the VNA. Each softkey represents exactly one file and vice versa. Therefore the "External Tools" path, as indicated in box A, must only include command files (.bat, .vbs) according the softkeys to be displayed. For this reason all supplemental files needed to run a program, like EXE, help-file, icons and so on, have to be stored in different folders outside "ExternalTools" as indicated with box B and C in Fig. 2-1 . The OSP Panel software is installed in the folder "C:\OSP_Panel", box B. In order to avoid mixing up both programs, the "SetPath_OSP.EXE" program is installed in a different folder . This is shown in box C in Fig. 2-1. All VNA path names can be found above the dashed line in each box. To summarize the organisation, another example is given: When pressing softkey "Path_3.vbs" the appropriate file "Path_3.vbs" in the "External Tools" path is started , box A. "Path_3.vbs" itself is starting "SetPath_OSP.EXE" in the path "...\OSP_RemCon\" as indicated in box C.

Installation

Installation is performed in following steps :

- Download OSP panel software and install it into the "C:\OSP_Panel\" folder, according Fig. 2-1, box B
- Recommended: Perform firmware upgrade of OSP

- Store programs "SetPath_OSP.EXE" and "LoadStat.EXE" in the folder "... OSP_RemCon\"
- Files "Path_1.vbs" ... "Path_4.vbs" and "OSP_Panel.bat" have to be stored in the "External Tools" folder as indicated in box A of figure above
- the new softkeys should appear on the VNA display now, when following the VNA menue "System" --> "External Tools"
- If there are already other "External Tools" installed on VNA it can be necessary to press the " -- Moore --" button at the bottom of the softkey column in order to see the four new softkeys

The files "Path_1.vbs" ... "Path_4.vbs" and "OSP_Panel.bat" are also provided and downloaded along with this application note.

2.3 Easy Operation

This chapter provides information for easy setup and operation without any overhead caused by instrument settings and calibration. By means of information provided in this chapter the user can switch the application specific paths just by remote controlling OSP from the instrument without the need of an external PC.

Easy Setup and Operation are both referred to as "Easy Session" .Fig. 2-2 shows the appropriate workflow, the step sequence numbers in brackets equate the blue numbers in the figure. OSP is controlled either by a Vector Network Analyzer (VNA) or by a Spectrum Analyzer (SA), herein referred to "instrument". It is assumed that the application requires path switching between two paths, called "path_1" and "path_2". Both paths can include any of OSP's switching options, for instance B-101 (6 x coax changeover relais), B-102 (2 x coax multiposition relais) and B-103 (digital inputs and outputs). Switching options B-101 and B-102 are useful to create RF switching paths. Digital outputs as provided by B-103 are useful to switch lamps or LEDs in order to identifiy switched paths.

Following steps are needed for the setup:

- perform OSP path settings using "OSP panel" (1)
- save paths using a mnemonic name (2)
- make path settings available for remote control from the instrument (3)
- invoke one of the predefined paths directly from the instrument (4)

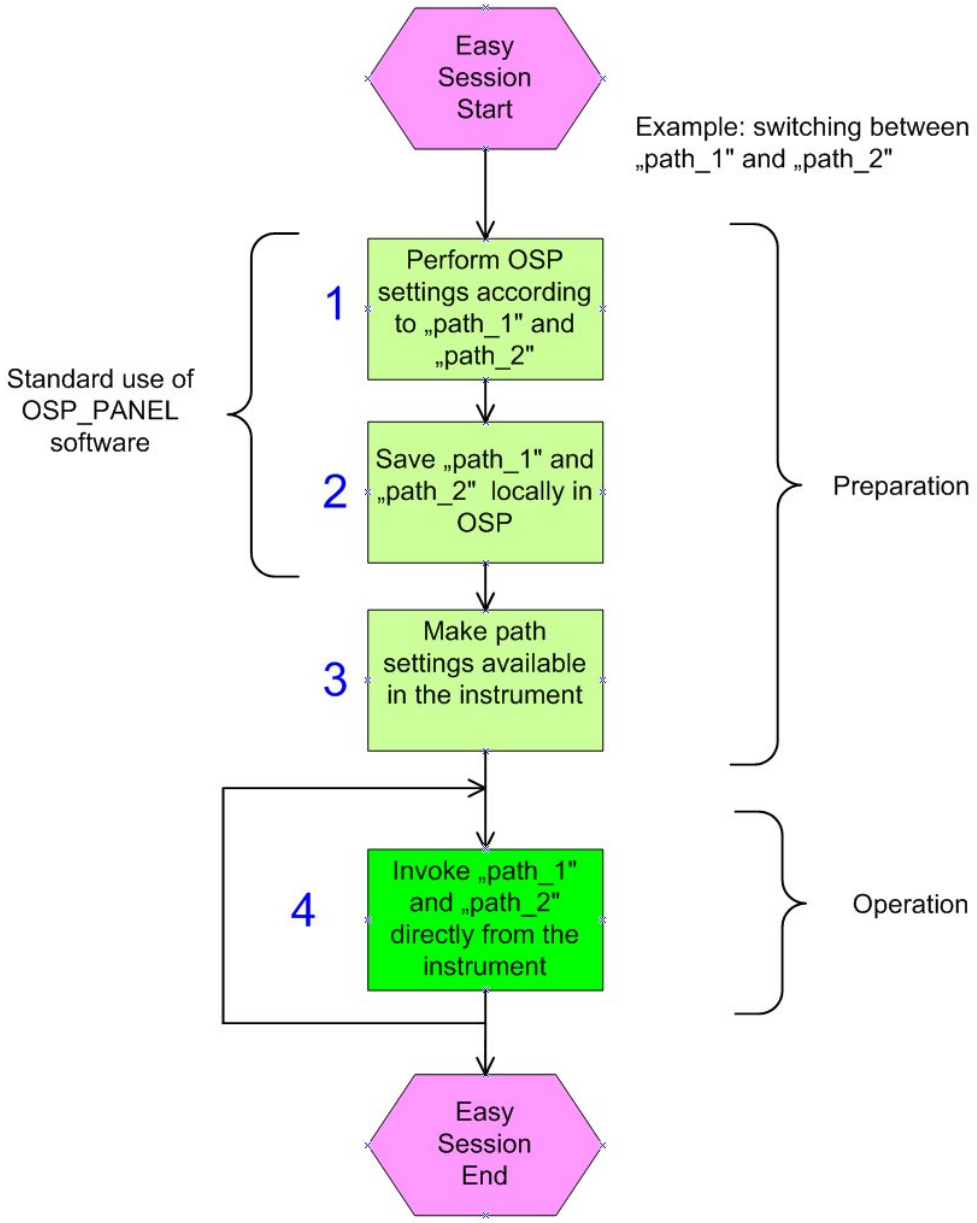


Figure 2-2: Easy workflow including preparation and operation

Steps 1 to 3 are the preparation which has to be done just once. Step 4 is the invocation of a specific path. Step 4 has to be repeated in order to switch between various paths previously defined.

Using the OSP panel software the paths have to be set according to the application requirements as shown in item 1 of figure 2-2. If a device under test (DUT) is connected to OSP, the switching results can be directly observed at the instrument.

The path definition can be saved using OSP panel software according to step 2 in fig. 2-2. In order to make the path switching available to the instrument user, a VBS file is

used. In the example of switching between the paths "path_1" and "path_2" following two VBS files have to be created:

path_1.vbs

```
'OSP path_1 setting using  VNA
Set wshShell = WScript.CreateObject ("WSCript.shell")
wshshell.run "C:\Rohde&Schwarz\Nwa\OSP_RemCon\SetPath_OSP.exe TCPIP::192.168.0.146::INSTR path_1", 6, True
set wshshell = nothing
```

path_2.vbs

```
'OSP path_2 setting using  VNA
Set wshShell = WScript.CreateObject ("WSCript.shell")
wshshell.run "C:\Rohde&Schwarz\Nwa\OSP_RemCon\SetPath_OSP.exe TCPIP::192.168.0.146::INSTR path_2", 6, True
set wshshell = nothing
```

Finally both files have to be stored as "path_1.vbs" and "path_2.vbs" to the "External-Tools" directory of the VNA in order to make it visible as softkeys. Refer also to step 3 in fig. 2-2. From now switching between "path_1" and "path_2" can be performed by simply pressing the appropriate softkey on the VNA, according to step 4 of fig. 2-2.

Don't enter the grey shaded line numbers at the beginning of the text when creating the files from the scratch, they are for documentation purpose only. See paragraph "Assigning the path and the channel setup ..." on page 11 for details on VBS files.

The next chapter describes how to perform the setup similar as described in this chapter, but additionally taking into account instrument settings. Calibration is addressed in chapter 3 of this document.

2.4 Standard Setup and Operation

After the file setup, the operation setup along with the external remote controlled OSP can start. This is divided into three independent steps :

(1) defining the paths using OSP_panel software for storing the path configuration

(2) VNA channel setup, eg. frequency, power, bandwidth, number of points

(3) Assigning the path and the channel setup to a VNA softkey

These steps are made for each single measurement of your test suite.

Defining the paths

This step only has to be done once. Later when the paths are defined, this step is not needed anymore unless the path configuration, i.e. the external switching, has to be changed or new paths have to be created. For this purpose the OSP Panel Software (OSP_PS) will be started. With exception of the program storage path there is no difference in using the OSP_PS on a VNA, as in our case, or on a PC as commonly done. The best documentation on how to operate the OSP_PS is given in [7], see References in chapter 5.5 After having started the OSP_PS a network address is needed. If the OSP is directly connected to the VNA via LAN without any DHCP-Router the address is normally

"TCPIP::192.168.48.147::INSTR"

The address

"TCPIP::192.168.0.146::INSTR"

can also be possible. The remote control address is shown on a display connected to OSP. The address changes to green color in OSP_PS if the connection was successfull. From now all switches can be operated depending on the options installed in OSP. It is useful, to do all the cabling from/to the VNA and the DUTs now. If possible, it is also useful to connect the DUTs, at least a subset. Now all switching can be done manually using OSP_PS.The VNA settings can be made in parallel in order to optimize the test configuration. If the results are adequate the settings can be saved in the VNA as well as in OSP. On the VNA the settings will be saved as *.zvx files. It will be needed later for calibration as described in chapter 3 of this document. The OSP paths are saved by names directly in the OSP instrument. Don't forget to set the green check marks in OSP in order to take the switch into account when defining the path, see Fig. 2-3. No extensions are needed for the path names in OSP. It is a good practice to use the same name for the VNA zvx file and the OSP path name. After having defined the paths, the OSP Panel Software is no longer needed and can be closed.

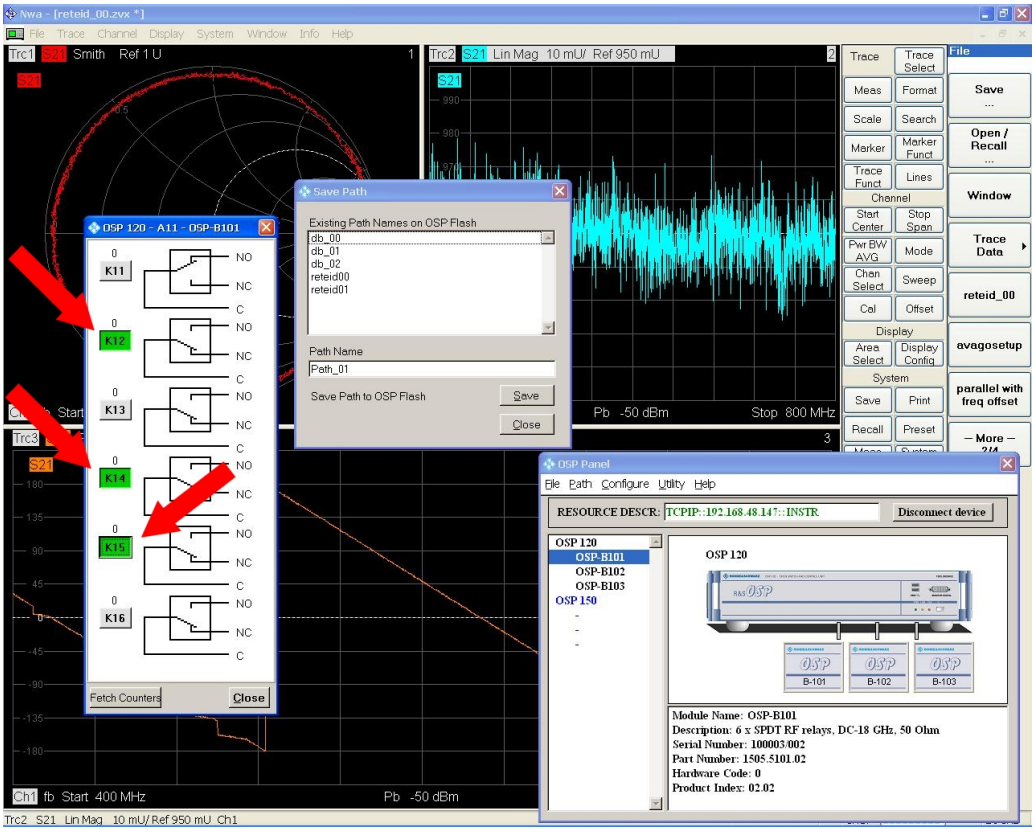


Figure 2-3: Green check marks have to be set to include the relais into the path definition (red arrows)

VNA channel setting up

In the next step the VNA channel settings, ex. frequency, power, bandwidth and number of points have to be made and have to be stored on the VNA using a file name extension ".zvx". The .zvx file should also have the same name as the path names mentioned above. For instance when setting up a filter test using a low pass filter as DUT the name FILTER_LP_00 is useful. The OSP path name "FILTER_LP_00" shall be used along with the VNA file "FILTER_LP_00.zvx". It is recommended to use upper-/lowercase letters A...Z and decimal numbers 0...9 and the underscore "_" only within names. All other signs especially "space" characters have to be avoided.

For a first approach it is useful to use the standard path names "Path_1" , "Path_2", ... because it is much easier to prepare the appropriate softkeys. In a second step it is possible to use additional names which are more comprehensive according to the application.

When optimizing the path switching of OSP and the VNA setup, it is useful to have the OSP Panel window downsized in a display corner of the VNA and to enlarge it when some switches or path definitions have to be changed.

Assigning the path and the channel setup to a VNA softkey

Previously defined path configurations shall be directly invoked by a softkey, for instance "Path_1" ... "Path_4". For this purpose a so called Visual Basic Script (VBS) file has to be created or can be downloaded with the Application Note. VBS is a standard format supported by Windows versions starting from Windows XP , Windows 7 and 8 included. The VBS file is a standard text file which can be edited using any standard text editor, for instance Windows Notepad. Using the single quote character ' comments can be written into the vbs file. The file should be of type ".vbs" and must be stored in the "External Tools" folder of the VNA, refer to fig. 2-1 above for details. Chapter "Reference Example" of this document provides some examples vbs files.

The VNA display looks as shown in the figure below with the External Tools softkeys (via the menu "System" --> "External Tools").

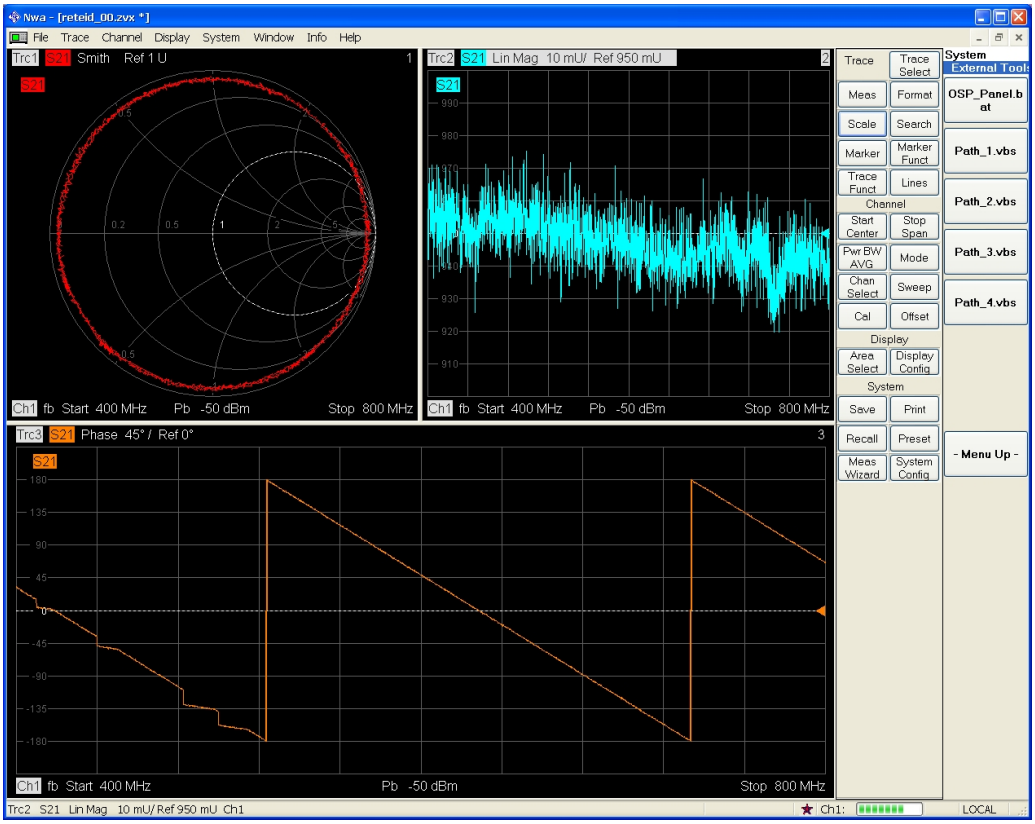


Figure 2-4: Previously defined paths now can be directly invoked using the softkeys at the right

The control setup can be easily tested by pressing the "Path..." softkeys one after each other. If the environment is not too noisy one can hear the relais switching within OSP when pressing one of the softkeys. If the path switching does not work in the expected way, following two items have to be checked first :

(1) OSP remote address correct ?

(2) is the path name exactly the same as previously defined ?

The OSP remote address must be the same as entered in the OSP panel software. The "SetPath_OSP.EXE" program is checking carefully whether proper pathnames are used as previously stored in OSP. If a path is not available when invoking "Set-Path_OSP.EXE" an appropriate error message will be generated. Refer to further hints on this in chapter 5.1.

3 Calibration

Each measurement of your test suite has its own path configuration. Thus for each measurement an appropriate calibration is required. According to the calibration requirements of the VNA, channel specific parameters as frequency range, power, bandwidth and number of points and so on need to be defined before a calibration is started. Therefore the setup of the VNA and the external path switching via OSP has to be done before starting the calibration. It is a good practice to use the same name for the OSP path and the appropriate VNA setup file, i.e. the .zvx file. Therefore the name of the calibration storage file is already available from the operation setup as created and stored along with the OSP path definition. Before beginning calibration the apporopriate zvx configuration file needs to be reloaded. Up to now the zvx configuration file doesn't have any calibration information, which will be added along with the upcoming calibration now. Finally it will be stored using the same name. When invoking the OSP path via a VNA softkey the VNA setup along with calibration data are reloaded simultaneously as described in the upcoming text.

3.1 Preparation

Calibration standards such as Through, Open, Match and Short (TOSM) are available as a set of calibration standards according to the connector system in use. For each of the four calibration steps, the calibration reference has to be manually connected. For an automatic calibration the ZV-Z5x devices are available. The calibration process for the remote controlled OSP application is the same as for every standard VNA application.

Figure 3-1: USB remote controlled cal standards of the ZV-Z5x family reduce cal time and efforts dramatically

The ZV-Z5x devices are available either in 2-port or 4-port versions. When a cal standard either as manually operated cal kit or as automatic switchable device is available, the next step of calibration can begin.

3.2 Calibration workflow

Figure 3-2 shows the calibration workflow using the test project "ABCD", which in this paragraph will be used for all file names along with setup and calibration. The OSP path switching and VNA setup are already defined and assigned to a softkey, steps 1, 2 and 3. Pressing the appropriate softkey the VNA and OSP settings are reloaded now, step 4. Now additional cables have to be connected to the OSP up to the "reference points", step 5, where the calibration standards will be connected to. Now calibration can be started using the standard calibration function of the VNA, steps 5 and 6, for instance 2-port TOSM as described in [8] and [9] and shown in a video [4]. Replacement of the cal standard according to TOSM is needed until the calibration is completed. Finally the .zvx file has to be restored, including calibration data now, step 7.

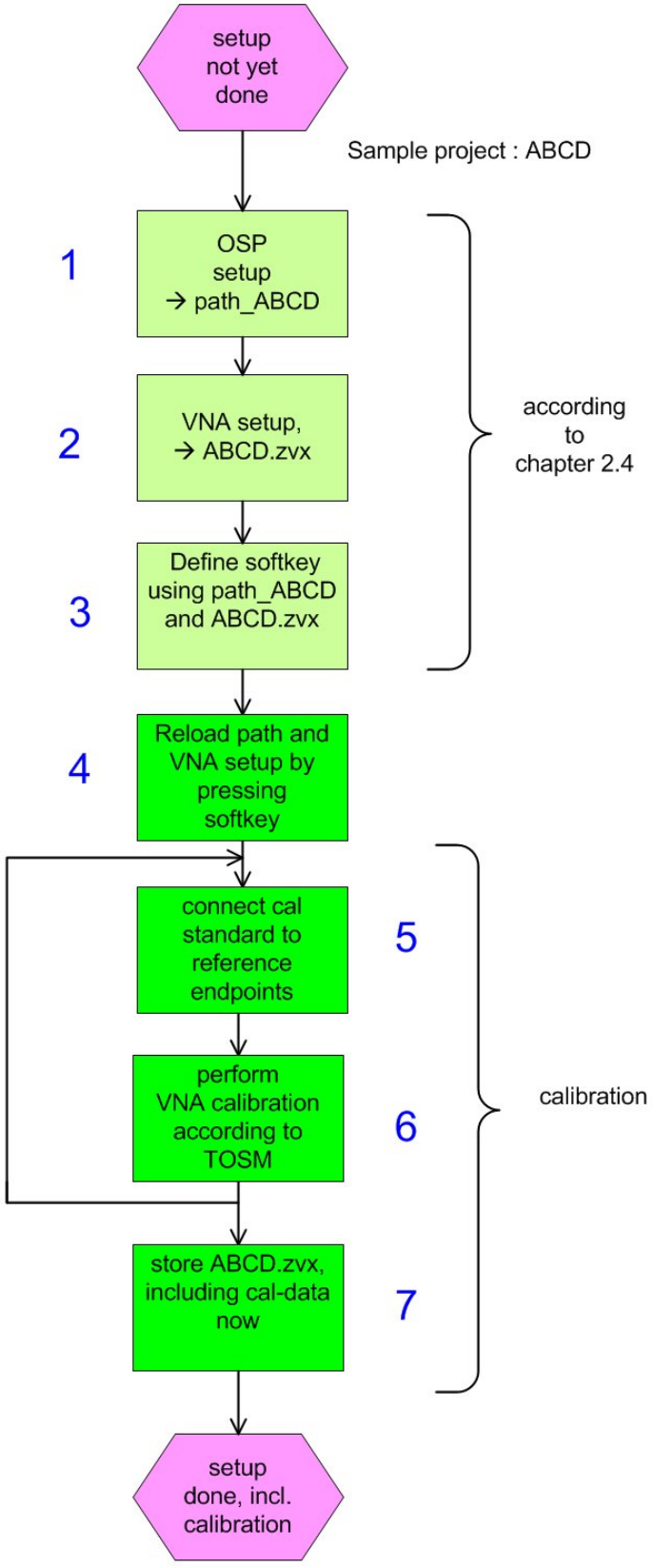


Figure 3-2: Calibration workflow to extend ABCD.zvx by calibration data

4 Reference Example

This chapter provides one example for this application note. The goal is to test three different devices (DUTs) with one two port vector network analyzer (VNA) and to switch between the DUTs and the appropriate VNA setups by means of softkey buttons. The three DUTs are a quarz (8 MHz), a bandpass filter (~430 MHz) and an amplifier (1 GHz). For the amplifier a full path calibration is needed in order that the reference plane is directly at the connectors of the amplifier. Because of their lower operating frequencies no calibration is needed for the quarz and the filter.

Fig. 4-1 provides a block diagram of the test setup in the upper left. The left orange line represents a 50 Ohm coax cable which links OSP-B102/Relais K1, "C" (common) connector to the VNA transmitter port. The right orange line represents a 50 Ohm coax cable which links OSP-B102/Relais K2, "C" (common) connector to the VNA receiver port. Relais K1 and K2 provide 6 positions each.Each Relais can connect the common connector "C" to one of the surrounding connectors.

The three DUTs are shown in the lower left of Fig. 4-1. Reading example for the amplifier, shown at the bottom of Fig. 4-1: The input is connected via blue coax cable (see photo in the upper right) to connector 3 of OSP relais K1. The amplifier's output is connected via coax cable to connector 3 of OSP relais K2. The reference planes for the calibration of the amplifier paths are directly at the input and the output of the DUT, indicated by green points, thus taking all cables into account. The VNA setup including calibration data is stored in the file using the arbitrary name " reteid_3.zvx", where "reteid_3" without .zvx is specified in the appropriate vbs file only, see Fig. 4-4. For the amplifier test the OSP path settings are stored in the OSP using the path name "db_03".

Fig. 4-2 shows how to define the OSP path "db_02" using the OSP panel software running on the VNA. Position 2 is selected for relais K1 and K2, according to the filter connections as shown in Fig. 4-1, photo (brown/yellow cable). The green buttons K1 and K2 shown in Fig. 4-2 indicate, that the appropriate relais is belonging to the path definition, they are therefore both activated. After being defined, the path can directly be stored in the OSP.

Fig. 4-3 along with its text gives an overview of the path calibration of the amplifier test. The appropriate calibration data is stored along with the VNA setup in the file "reteid_3.zvx". The successfull calibration can be easily verified by the "CAL" id on the VNA screen and additionally by the open / match / short results as shown in the Smith Chart display of the VNA when connecting appropriate cal standards to the cable's endpoints. Refer to the Smith Chart shown on the poster "Microwave and beyond", reference [5].

Fig. 4-4 finally shows the contents of the four vbs-files, which are called by the VNA's external tool softkeys. "Path_2.vbs" for instance represents the filter test. The appropriate OSP path "db_02" and the appropriate VNA setup "reteid_02" are defined accordingly. Therefore, when pressing the "Path_2" softkey button the OSP path and the VNA setup will both be activated along with the instrument setup which is stored in the VNA setup "reteid_02". Fig. 4-4 is shown in landscape format to avoid line breaks which must not appear in vbs files.

In order to provide more convenience to operate the whole configuration, the four vbs files "Path_1.vbs", "Path_2.vbs", "Path_3.vbs" and "Path_4.vbs" can be easily renamed to more intuitive names.In our example it would be useful to rename it to "Qrz_test.vbs", "BpF_test.vbs", "Amp_test.vbs" and "unused.vbs"". After renaming using Windows Explorer, the new names will also appear on the softkeys making it much easier to operate the whole configuration. If the file "unused.vbs" will be deleted from the "External Tools" folder, the entire softkey disappears.

Fig. 4-5 finally shows the results. When pressing the red marked softkey at the right, the appropriate DUT will be activated and tested. The VNA display will change accordingly. After the first new complete VNA sweep the test results are stable and are shown on the screen of the VNA. Calibration was just done for the amplifier test in this example. For sure it can be done for all other DUTs and the appropriate paths in the same way.

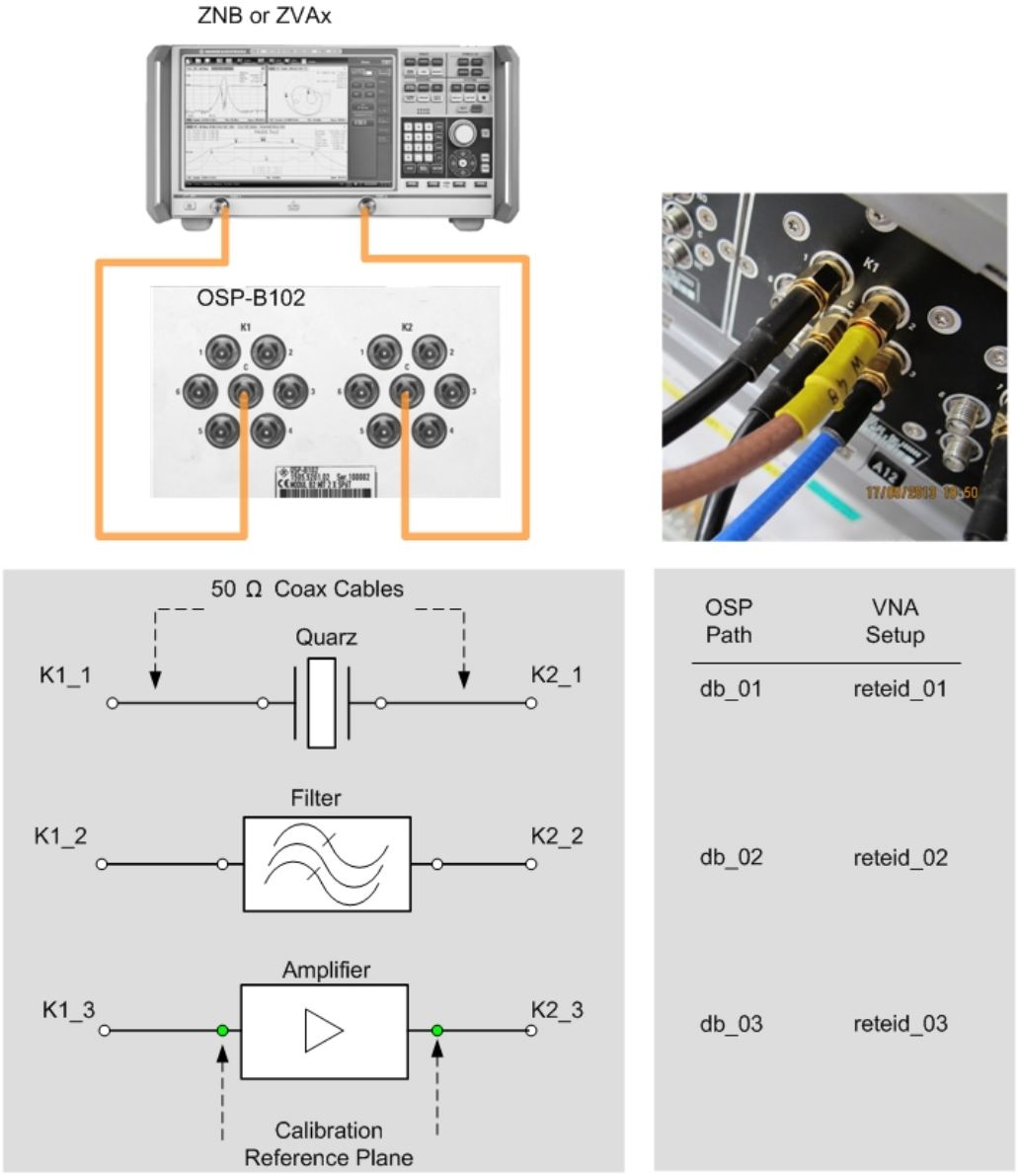


Figure 4-1: The figure shows the block diagram, upper left, connections to the OSP K1-Port, photo in the upper right, DUTs and connections, lower left and the OSP PATH names along with the appropriate VNA setup according to each DUT, table in the lower right.

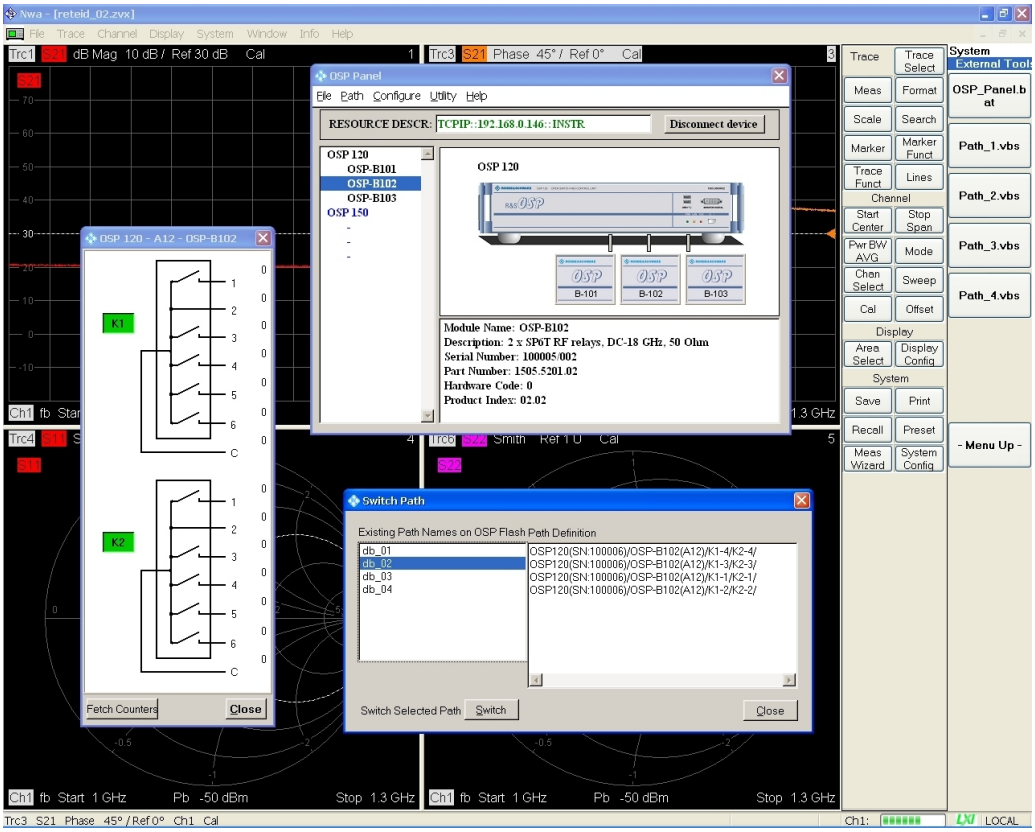
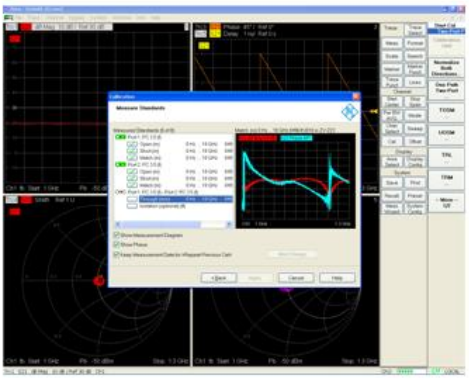


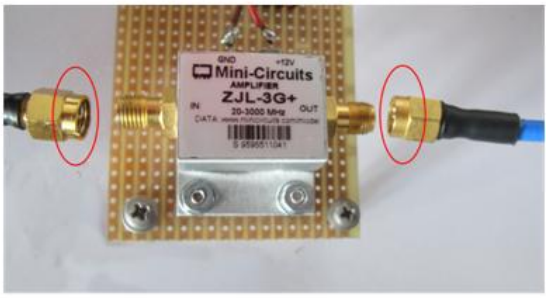
Figure 4-2: Shows the definition of the path for the band filter test using the OSP Panel Software installed on the VNA. The settings of OSPs K1 and K2 are finally stored in the OSP path named "db_02"

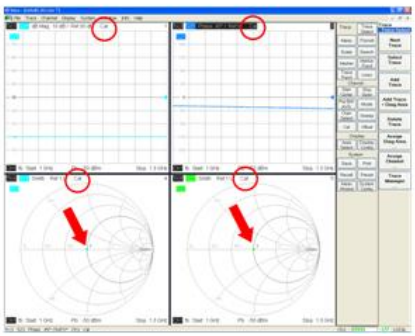
Calibration standards have to be mounted at the ends of both cables in order to perform calbration including all paths up to the DUT.

Even though two cabels and the switching platform OSP are in between the VNA and the DUT, calibration is done in a normal way as provided by the VNA.



The calibration is finally done up to the very end of the connectors, directly up to the DUT. The so called „Reference Plane“ is marked by red ellipsoids.





After calibration the CAL id is set (red circles) and the S11 and S22 results are close to the center of the Smith Chart (red arrows), according to the very good 50 Ohms impedance of the DUTs input and output.

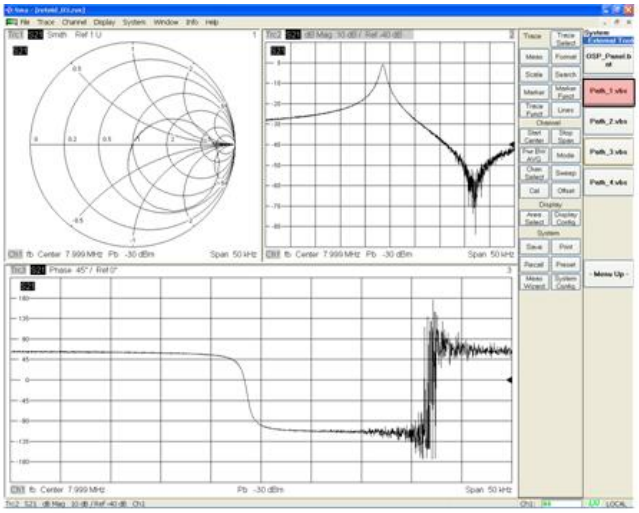
Calibration data is reloaded each time by single press button along with loading the OSP path settings.

Figure 4-3: Summary of calibration which includes the whole path from the VNA ports directly up to the DUT.

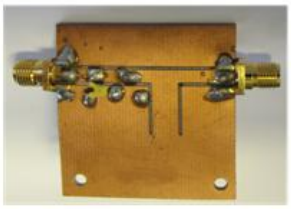
```
'Path_1.vbs
'OSP path and VNA setup for quarz 8 MHz
Set wshShell = WScript.CreateObject ("WSCript.shell")
wshshell.run "C:\Rohde&Schwarz\Nwa\OSP_RemCon\SetPath_OSP.exe TCPIP::192.168.0.146::INSTR db_01", 6, True
wshshell.run "C:\Rohde&Schwarz\Nwa\OSP_RemCon\LoadStat.exe reteid_01", 6, True
set wshshell = nothing


'Path_2.vbs
'OSP path and VNA setup for bandpassfilter 430 MHz
Set wshShell = WScript.CreateObject ("WSCript.shell")
wshshell.run "C:\Rohde&Schwarz\Nwa\OSP_RemCon\SetPath_OSP.exe TCPIP::192.168.0.146::INSTR db_02", 6, True
wshshell.run "C:\Rohde&Schwarz\Nwa\OSP_RemCon\LoadStat.exe reteid_02", 6, True
set wshshell = nothing


'Path_3.vbs
'OSP path and VNA setup for amplifier 1 GHz,  calibration included
Set wshShell = WScript.CreateObject ("WSCript.shell")
wshshell.run "C:\Rohde&Schwarz\Nwa\OSP_RemCon\SetPath_OSP.exe TCPIP::192.168.0.146::INSTR db_03", 6, True
wshshell.run "C:\Rohde&Schwarz\Nwa\OSP_RemCon\LoadStat.exe reteid_03", 6, True
set wshshell = nothing


'Path_4.vbs
'OSP path and VNA setup for ...  --- currently unused ---
Set wshShell = WScript.CreateObject ("WSCript.shell")
wshshell.run "C:\Rohde&Schwarz\Nwa\OSP_RemCon\SetPath_OSP.exe TCPIP::192.168.0.146::INSTR db_04", 6, True
wshshell.run "C:\Rohde&Schwarz\Nwa\OSP_RemCon\LoadStat.exe reteid_04", 6, True
set wshshell = nothing
```

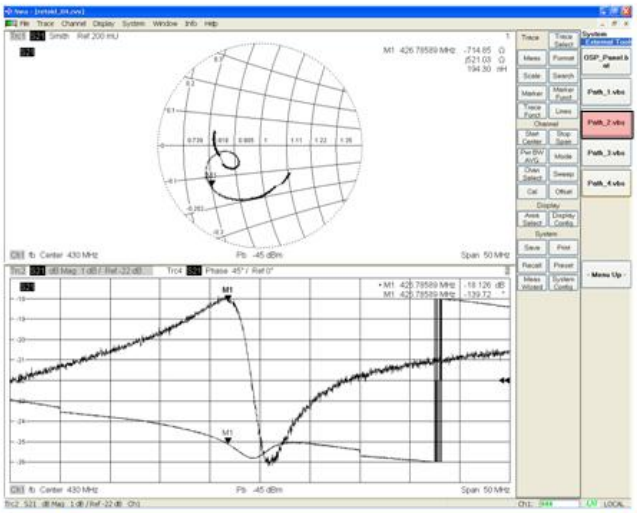
Figure 4-4: Contents ot the softkey definition files Path_1.vbs ... Path_4.vbs. Softkeys at the right.

Quarz, 8 MHz



Bandpass Filter
430 MHz





Amplifier
1 GHz,
including calibration

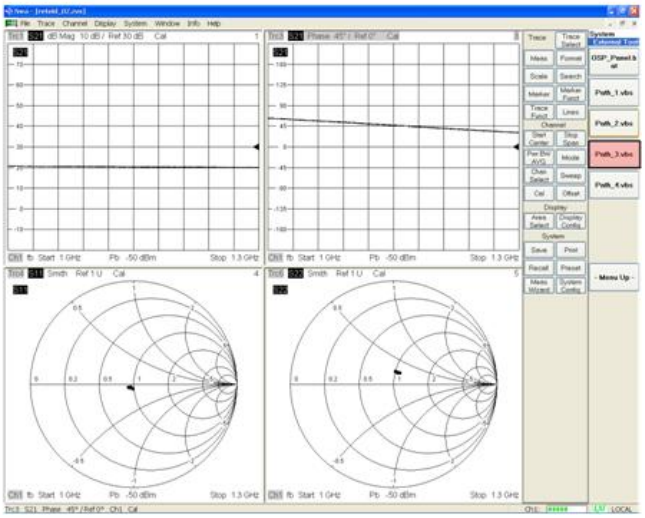


Figure 4-5: Results are immediately displayed when pressing the red marked softkeys at the right of the VNA

5 Appendix

5.1 Documentation of "SetPath_OSP.EXE"

Using the software "SetPath_OSP.EXE", the predefined paths of OSP can be switched. The software "SetPath_OSP.EXE" is herein referred to as "software" in short. The software needs at least two parameters which both have to be specified before starting.

Parameter_1 is the remote control address of the OSP. For example "TCPIP::10.110.10.253::INSTR" starts with the letters "TCPIP", indicating that the instrument is remote controlled via LAN, followed by the LAN address (10.110.10.44) and terminated by "::INSTR". The termination "::INSTR" must always be provided . The letters "TCPIP" have to be replaced by "GPIB" when using a GPIB remote control interface. The address info depends on the instrument.

Valid example for parameter_1 using LAN: **TCPIP::10.110.10.253::INSTR**

Valid example for parameter_1 using GPIB: **GPIB::20::INSTR**

On OSP the remote control address will be dislayed when connecting an external monitor.

Parameter_2 is the name of the OSP path to be switched. The OSP path name must start with a letter A-Z and can include numbers between 0 and 9, additionally the underscore "_" character is allowed to be used in OSP pathnames.Other characters especially dots, commas, spaces are not allowed to be used within OSP path names. Figure 4-4 provides an example how to invoke "SetPath_OSP.EXE" along with proper OSP pathnames.

In order to install the software the appropriate file "SetPath_OSP.EXE" has to be copied to a path on the harddisk of the instrument as shown if figure 2-1 above. The user must have write access to the selected path. This is normally the case in the "user" area on the harddiks of the instrument.

The software performs a careful check whether the specified OSP path is defined in OSP. The software generates an appropriate message, if the specified OSP path can't be find in OSP. However, for the sake of convenience all outputs from the software are omitted under normal operating conditions. In order to display the output from the software an additional parameter has to be specified when invoking the software, as following example shows :

SetPath_OSP.EXE TCPIP::10.110.10.253::INSTR path_A 128

The third parameter "128" is a numeric code informing the software to display some kind of debug information which can be useful if the entire configuration does not work as expected. The screenshot below shows an example of an appropriate output.

```
OSP remote path switching, v. 1.00, R&S 1MAA_DB, Sept 19th, 2013

**1** number of command line parameters:   3

**2** commands detected :
1: TCPIP::10.110.10.253::INSTR
2: db_02
3: 128

**3** path switching command to OSP :
ROUT:CLOS "db_02"

**4** remote instrument detected :
Rohde&Schwarz, OSP120, 100006, 2.42


**5** paths available on OSP :
"db_01","db_02","db_03","db_04"


**6** OSP status byte & error status register :
Status STB :0
Status ESR :0

**7** final status :
OSP path setting successfull !

Drücken Sie eine beliebige Taste . . .
```

Figure 5-1: Debug information from SetPath software

The very first line provides the version message of "SetPath_OSP". The areas below starting with "**" have following meaning according to their numbers :

(1) number of command line parameters detected when the program is invoked. There are 3 parameters in this example.

(2) list of parameters accounted according to their sequence of appearance, the third parameter "128" is the code in order to show all this information.

(3) OSP SCPI command as assembled from parameter nr. 2

(4) instrument response to "*IDN?"

(5) available paths from OSP as reported from ROUT:PATH:CAT? request

(6) OSP status byte and error status register after writing the path close command according to item (3), both zeros means operation successfull

(7) the interpretation of (6) in clear language

If the second parameter "128" is not specified, the software is working in a quiet mode. Following command for instance

SetPath_OSP.EXE TCPIP::10.110.10.253::INSTR path_A

invokes the software while all outputs are omitted, which is appropriate when the configuration is working properly.

5.2 Documentation of "LoadStat.EXE"

Using the software "LoadStat.EXE", a predefined instrument setup can be reloaded. The software can be operated along with ZVxx series of VNAs and with spectrum analyzers of the FSW series. The instrument is automatically detected by means of the response send by the "*IDN?" request. The impact of LoadStat is equal to reloading a setup files via the front panel of the instrument. For VNAs the setup can also include calibration data. The software "LoadStat.EXE"is hereinafter referred to as "software" in short. The software needs at least one parameter which has to be specified before starting.

Parameter_1 is the body of the setup file where the settings are stored. The file type is detected automatically according to the instrument type. Therefore the extension must not be specified, i.e. the name must n o t include a point. For example when the setup has been stored using the name ABCD the software invocation is as follows :

LoadStat.EXE ABCD

Similar as described above a second parameter, Parameter_2, can be specified. If it is set to "128" a set of diagnostic information is provided being useful if the configuration doesn't work as expected. The figure below shows an example of the output.

```
Instrument status reload  v. 1.0, R&S 1MAA_DB, October 31th, 2013

**1** number of command line parameters:  3

**2** commands detected :
1: reteid_02
2: 128
3: TCPIP::10.110.10.144::INSTR


**3** remote instrument detected :
Rohde&Schwarz,ZVT8-8Port,1300000008100390,3.00


**4** status load command to INSTR :
MMEM:LOAD:STAT 1,'C:\Rohde&Schwarz\NWA\RecallSets\reteid_02.zvx'

**5** INSTR status byte & error status register :
Status STB :0
Status ESR :32

**6** final status :
INSTR status reload successfull !
```

By means of a third parameter, Parameter_3, a remote control address can be specified which is used when the remote control is performed using an external PC. If Parameter_3 is not specified, the address used is always "TCPIP::LOCALHOST::INSTR", which applies when the instrument is controlled internally.

Complete invocation example:

LoadStat.EXE reteid_02 128 TCPIP::10.110.10.144::INSTR

The very first line provides the version message of "LoadStat". The areas below starting with "**" have following meaning according to their numbers :

(1) number of command line parameters detected when the program is invoked. There are 3 parameters in this example.

(2) list of parameters accounted according to their sequence of appearance, the second parameter "128" is the debug code in order to show all this information.

(3) instrument response to "*IDN?". The result is used to identify the instrument and to send appropriate calls for setup reload.

(4) Instrument SCPI command as assembled from parameter nr. 1 and the instrument type

(5) Instrument status byte and error status register after writing the command according to item (4), both zeros means operation successfull

(6) The status byte information written in clear language

5.3 FAQ

Q1: How can I get the TCPIP remote control addresses for OSP and for the VNA ?

A1: When connecting an external display to the appropriate connector of OSP the address is directly shown on the screen behind "Address: ...".

On the VNA the address can be shown via the menue "System --> System Config --> LXI Configuration". When the VNA is internally remote controlled, i.e. without external PC, the remote address "TCPIP::LOCALHOST::INSTR" is always being used.

The R&S Commander (App-Note 1MA74) software is also usful to find remote control addresses especially if more tha two instruments are connected to the remote control bus.

- - -

Q2: After callibration the CAL ID is not shown on the VNA's display and the configuration behaves like being uncalibrated when invoking a measurement setup by means of a softkey.

A2: The calibration information has to be added to the VNA setup file after calibration. You should first load a VNA setup via a softkey, then perform the calibration and finally write the setup back to the same file loaded before (File --> Save). The question "replace it" need to be answered with "Yes".

- - -

Q3: After powering up the configuration it happens sometimes that the softkeys to switch the OSP and to reload calibration setup don't work anymore. When invoking, they appear and I don't hear any "clack" from the OSP. What can I do ?

A3: The OSP sometimes has to be re-initialized after power up. Invole the OSP_panel using the appropriate softkey (System --> ExternalTools), make a connection ("Connect to device") and manually activate one of the defined paths in OSP (Path --> Switch Path and switch one of the defined paths). After leaving OSP panel, the softkeys should work if there is no other cause.

- - -

Q4: What is the program "SetPath" good for ?

A4: By means of this program OSP paths can be switched via remote control. The path name can be directly specified in the command line when invoking "SetPath"

along with the remote control address of OSP. The program is used on the VNA when switching OSP paths using softkeys.

- - -

Q5:: What is the program "LoadStat" good for ?

A5: By means of this program setups from a VNA or SA can be loaded via remote control. The setup file to be loaded can be directly specified in the command line when invoking "LoadStat" along with the remote control address of the VNA or SA. The program is especially used on the VNA in order to restore calibration values when switching OSP paths.

- - -

Q6: Can I start and test the both programs "SetPath_OSP.EXE" and "LoadStat.EXE" outside the environment of softkeys and .vbs files ?

A6: Yes, you can do it either via an external PC or by connecting a USB keyboard to the VNA and use its internal controller. If you are using a Windows keyboard including a Windows button

you can activate the Start Window by simultaneously pressing the Windows button and the letter "R". Now you can enter the program name SetPath_OSP.EXE or LoadStat.EXE respectively followed by the command line parameters as described in the previous sections. When pressing OK the program will start along with the specified parameters. For this interactive operation it is useful to set the "128" debug parameter in order to get the diagnostic outputs, otherwise the program will work "silently" without any outputs.

- - -

Q7: Where can I get the supplemental software tools from ?

A7: The entire set of supplemental software tools are attached to the Application Note 1MA226. Therefore the files SetPath_OSP.EXE, LoadStat.EXE, and Path_1.vbs ... Path_4.vbs can be downloaded from http://www.rohde-schwarz, search topic "1MA226 , along with the pdf file according to this document.

The C++ sources (MS Visual Studio and DevCPP environment) for SetPath_OSP.EXE and LoadStat.EXE are available from the author on request.

5.4 How to remote control OSP via Spectrum Analyzers

Introduction

The OSP remote control feature so far described for Vector Network Analyzers (VNAs) can also be used along with Spectrum Analyzers (SAs), for instance from the R&S®FSW family. Fig. 5-2 shows an example.

Following conditions have to be taken into account when using a SA for remote control OSP of:

- Spectrum Analyzers don't provide an inherent calibration as VNAs do. Therefore no direct calibration data is included in the dataset reloaded from SAs.
- The extension of reloaded data files is "dfl" for SAs rather than "zvx" for VNAs. However, the extension must **not** be specified when using the LoadStat.EXE tool. The instrument type is detected automatically and the file extension is selected accordingly. Refer to chapter 5.2 for details.
- The user accessible directory is "C:\R_S\Instr\user\" for SAs rather than "C:\Rohde&Schwarz\Nwa" for VNAs. This has to be taken into account when installing and operating the tools LoadStat.EXE and SetPath_OSP.EXE.
- SAs don't provide External Tools in order to start programs. However, the Windows task line can be used in SAs for this purpose. The VBS files have to be created first. In a second step they can be drawn using a mouse to the SA's task line in order to be available for direct invocation using a mouse.
- An external LAN Router / Multiplexer is needed in order to remote control R&S®OSP from a SA.

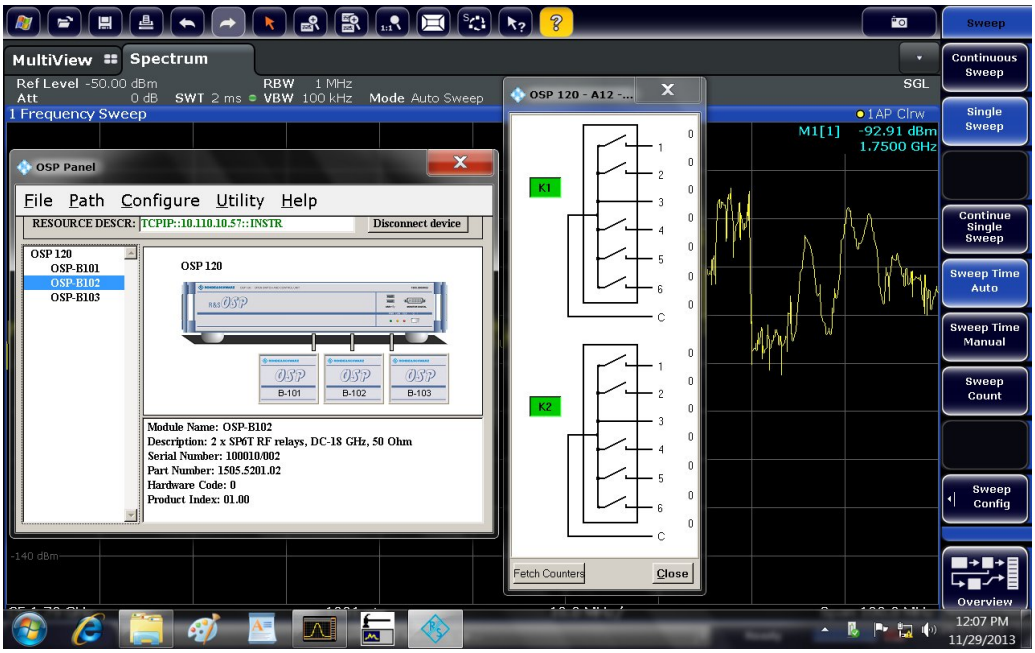


Figure 5-2: Direct remote control of the switch matrix OSP via spectrum analyzer FSW and an external LAN Router

Example using Signal Analyzer FSV

Signal Analyzers from the FSV family are supported up from LoadStat.EXE version 1.1. This example shows a complete setup and measurement application how to use the Open Switch and Control Platform OSP along with FSV. Even though the application was build up, tested and described for demonstration purpose, it has practical relevance.

Measurement task:

Two different signal generators have to be tested using the signal analyzer FSV. As shown in Fig. 5-3 one generator provides a 1.57542 GHz GPS signal, the other a simple AM modulated signal in the 434 MHz ISM band. Both signals require completely different settings of the signal analyzer regarding frequency, span, bandwidth and level. Along with the Open Switch and Control Platform OSP and the application note at hand path switching and FSV settings can be performed by just pressing a button.

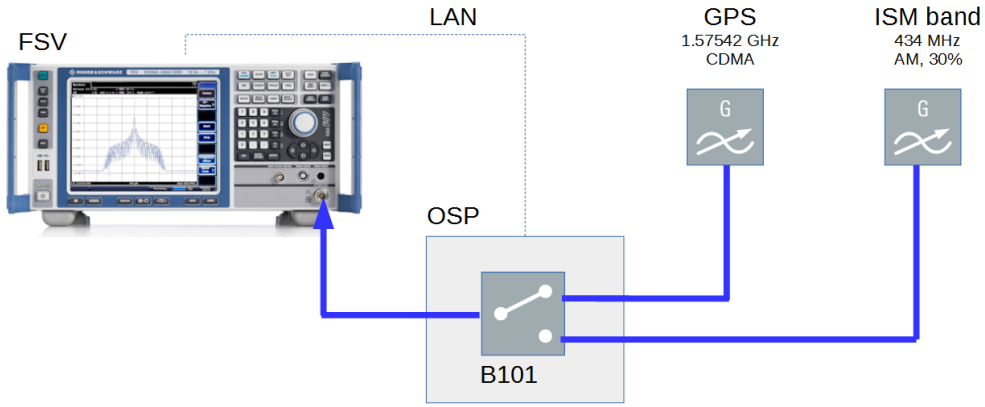


Figure 5-3: Reference example using FSV along with two generators

Equipment preparation:

FSV and OSP have to be connected via a LAN cable first as shown in Fig. 5-3 This is needed because the OSP is remote controlled from the FSV. For the setup process it is recommended to connect also a personal computer to the LAN by means of a LAN router. The PC is not shown in Fig. 5-3 because it is not needed anymore when the setup process is completed.

Software preparation:

First we define following names:

number	name	definition
1a	PT_AM	OSP switch path for AM measurement,
		created by means of OSP panel software
1b	PT_GPS	OSP switch path for GPS measurement,
		created by means of OSP panel software
2a	ST_AM	FSV settings for AM measurement, created within FSV
2b	ST_GPS	FSV settings for GPS measurement, created within FSV
3a	FSV_AM.vbs	Windows script file, created using a standard text editor
3b	FSV_GPS.vbs	Windows script file, created using a standard text editor

All names are arbitrary but it is recommended to choose comprehensive names doing easy this way to remember later what is on behind when using the names. The order should be followed as given above, i.e. create item 1a first and end with item 3b. Defining the switch paths first has the advantage that the appropriate paths already can be used when defining the instrument settings, i.e. step 2a and 2b.

Steps 1a and 1b are done by means of the panel software belonging to OSP. Fig.5-4 and 5-5 show the appropriate settings within OSP Panel. Fig. 5-6 shows the three cable connectors at OSP. The brown one in the center is linked to the RF input of FSV, the upper black comes from the GPS generator and the lower black from the AM generator.

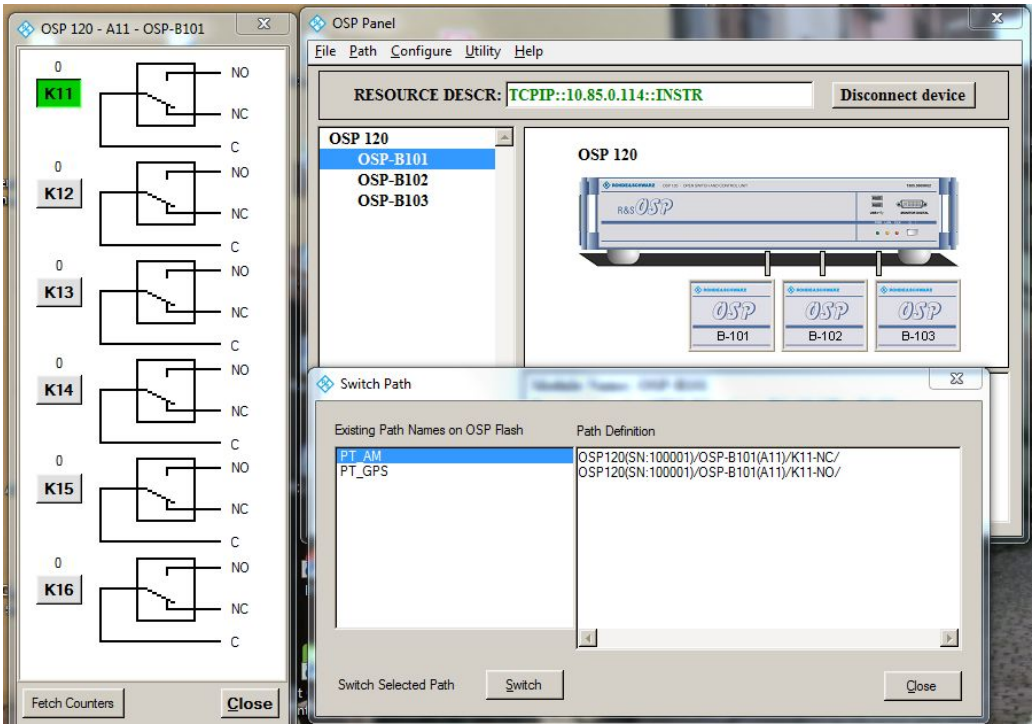


Figure 5-4: Path definition for AM using OSP panel software

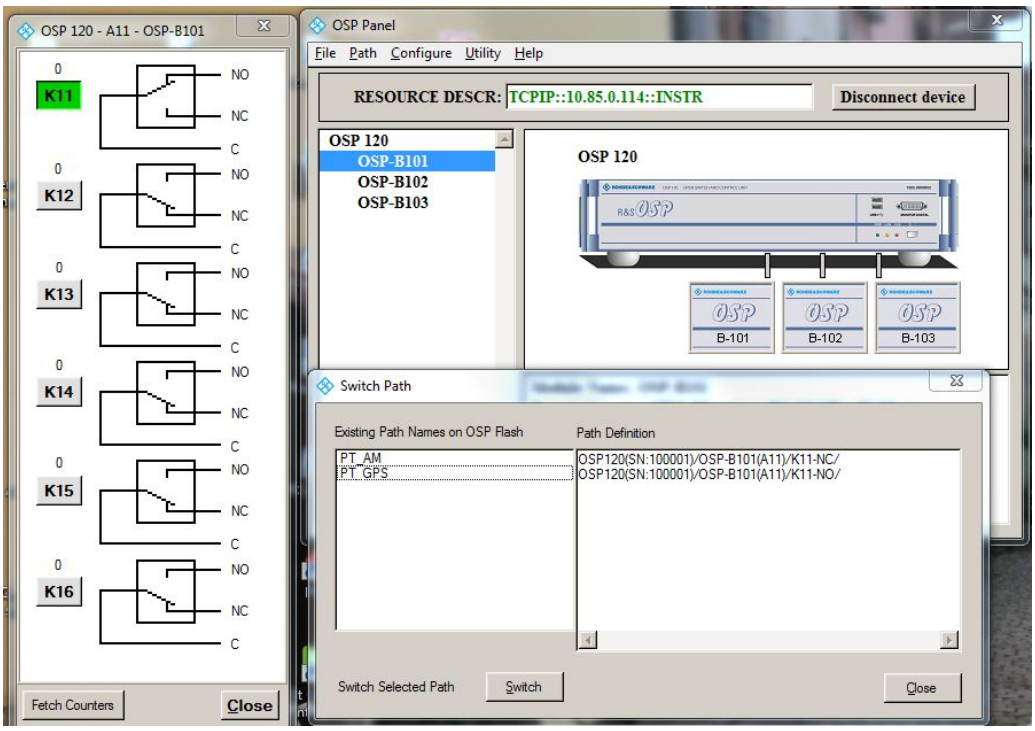


Figure 5-5: Path definition for GPS using OSP panel software

Figure 5-6: OSP connectors and cables from/to generators/FSV

In the actual example we are using only the relais K11. However, in more complex applications any arbitrary combination of relais from OSP can be combined and switched by using just a single path name.

Steps 2a and 2b are setups of FSV related to the measurement task GPS or AM. First the measurement path is switched by means of OSP panel software. Then all setting at FSV like frequency, bandwidth and span are done. Finally the settings are saved on

FSV using the SAVE/RCL button at the front panel of FSV giving the names ST_AM and ST_GPS related to the two measurements. When the settings are done and stored on FSV, the OSP panel software can be closed, because it ist not needed anymore. In the final application OSP panel is remote controlled by FSV.

Items 3a and 3b named FSV_AM.vbs and FSV_GPS.vbs are text files created by a standard text editor, e.g. NOTEPAD++. They are listed in Fig. 5-7 and Fig 5-8. The file extension "vbs" stands for "visual basic script", which is a command file for MS windows. When invoking command vbs files windows processes the contents line by line. Both vbs files are normally created on a PC and then transferred to FSV via USB stick. It is recommended to create the files on a PC because normally there are better tools like keyboard, mouse and a big screen available. However, small modifications on the files can also be made directly on FSV using window's standard editor. The freely available editor NOTEPAD++ has the advantage to identify elements of the vbs language and to display it in appropriate colors, as shown in Fig. 5-7 and 5-8. Both text files are very similar. The first two lines are just comments, indicated in green. Lines 3 and 6 are special commands expected by Windows. All blue words are keywords for Windows, detailed information on this is availabe on Google using search term "vbscript language". Line 4 sets the OSP path via LAN remote control, therefore the LAN address of OSP is specified along with the path to be switched. In line 5 finally the settings according to the measurement, either GPS or AM, are loaded into FSV.

```
1  'FSV_AM.vbs
2  'OSP path and FSV setup for AM measurement
3  Set wshShell = WScript.CreateObject ("WSCript.shell")
4  wshshell.run "SetPath_OSP.exe TCPIP::10.85.0.114::INSTR PT_AM", 6, True
5  wshshell.run "LoadStat.exe ST_AM", 6, True
6  set wshshell = nothing
```

Figure 5-7: Command file for AM

```
1  'FSV_GPS.vbs
2  'OSP path and FSV setup for GPS measurement
3  Set wshShell = WScript.CreateObject ("WSCript.shell")
4  wshshell.run "SetPath_OSP.exe TCPIP::10.85.0.114::INSTR PT_GPS", 6, True
5  wshshell.run "LoadStat.exe ST_GPS", 6, True
6  set wshshell = nothing
```

Figure 5-8: Command file for GPS

When the two files FSV_AM.vbs and FSV_GPS.vbs are stored on FSV the vbs files can be directly invoked as shown in Fig. 5-9 It is recommded to store both files into a directory of FSV which has been especially created for this purpose. The two setups AM and GPS can be selected from now just by the cursor up and cursor down keys to select the appropriate vbs file and then finally to start it by pressing FSV's front panel ENTER key.

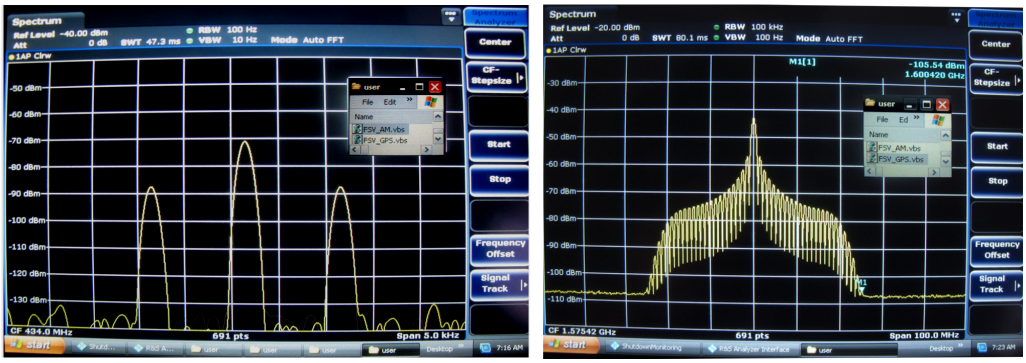


Figure 5-9: Simultaneously switching the test path and FSV settings

Trouble shooting hints

This section provides some hints if problems should occur along with the setup.

Before the two vbs files are operated on FSV they can be tested on a PC which is connected to the LAN using a LAN router. The two vbs files need a small modification when being operated on a PC. Fig. 5-10 and 5-11 show the modifications marked using grey shades. There is a "0" followed by the LAN address of FSV. The LAN address of FSV must be specified because it is operated remotely via LAN. In case of the vbs files are operated directly on FSV, the LAN address must not be specified in order that the FSV takes it's own local host address.

```
1  'PC_AM.vbs
2  'OSP path and FSV setup for AM measurement
3  'running on external PC
4  Set wshShell = WScript.CreateObject ("WScript.shell")
5  wshshell.run "SetPath_OSP.exe TCPIP::10.85.0.114::INSTR PT_AM", 6, True
6  wshshell.run "LoadStat.exe ST_AM 0 TCPIP0::fsv7-102622::inst0::INSTR", 6, True
7  set wshshell = nothing
```

Figure 5-10: VBS file for AM measurement running on a PC

```
1  'PC_GPS.vbs
2  'OSP path and FSV setup for GPS measurement
3  'running on external PC
4  Set wshShell = WScript.CreateObject ("WScript.shell")
5  wshshell.run "SetPath_OSP.exe TCPIP::10.85.0.114::INSTR PT_GPS", 6, True
6  wshshell.run "LoadStat.exe ST_GPS 0 TCPIP0::fsv7-102622::inst0::INSTR", 6, True
7  set wshshell = nothing
```

Figure 5-11: VBS file for GPS measurement running on a PC

Further debugging information can be obtained, when the "0" is replaced by "128" which initiates the LoadStat.exe function to display debugging information as described in chapter 5.2 of this application note. The appropriate vbs files are named PC_AM_debug.vbs and PC_GPS_debug.vbs and are shown in Fig. 5-12 and 5-13.

```
1  'PC_AM_debug.vbs
2  'OSP path and FSV setup for AM measurement
3  'running on external PC
4  Set wshShell = WScript.CreateObject ("WScript.shell")
5  wshshell.run "SetPath_OSP.exe TCPIP::10.85.0.114::INSTR PT_AM 128", 6, True
6  wshshell.run "LoadStat.exe ST_AM 128 TCPIP0::fsv7-102622::inst0::INSTR", 6, True
7  set wshshell = nothing
```

Figure 5-12: VBS file for AM measurement with debug information, running on a PC

```
1  'PC_GPS_debug.vbs
2  'OSP path and FSV setup for GPS measurement
3  'running on external PC
4  Set wshShell = WScript.CreateObject ("WScript.shell")
5  wshshell.run "SetPath_OSP.exe TCPIP::10.85.0.114::INSTR PT_GPS 128", 6, True
6  wshshell.run "LoadStat.exe ST_GPS 128 TCPIP0::fsv7-102622::inst0::INSTR", 6, True
7  set wshshell = nothing
```

Figure 5-13: VBS file for GPS measurement with debug information, running on a PC

When starting the files a small icon appears at the bottom of the PC. When clicking the icon all information from LoadStat.exe are shown as explained in chapter 5.2.

After the debugging work is completed the special debug entries like "128" and "0" respectively and the FSV LAN address from line 5, behind LoadStat.exe, have to be removed before the vbs files are directly operated on FSV. Please compare the command structure of the vbs files to Fig. 5-7 and Fig 5-8 before loading it to FSV. Pay attention also to FAQ Q3/A3 in chapter 5.3 if the OSP does not work as expected.

Specifying a wrong OSP remote control address is another common pitfall. The best way to find the OSP remote control address is by connecting a monitor to OSP's monitor port when the OSP is powered off. When the instrument is powered on, the remote control address is displayed on the monitor. Afterwards the monitor is not needed anymore and can be plugged off.

5.5 References

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