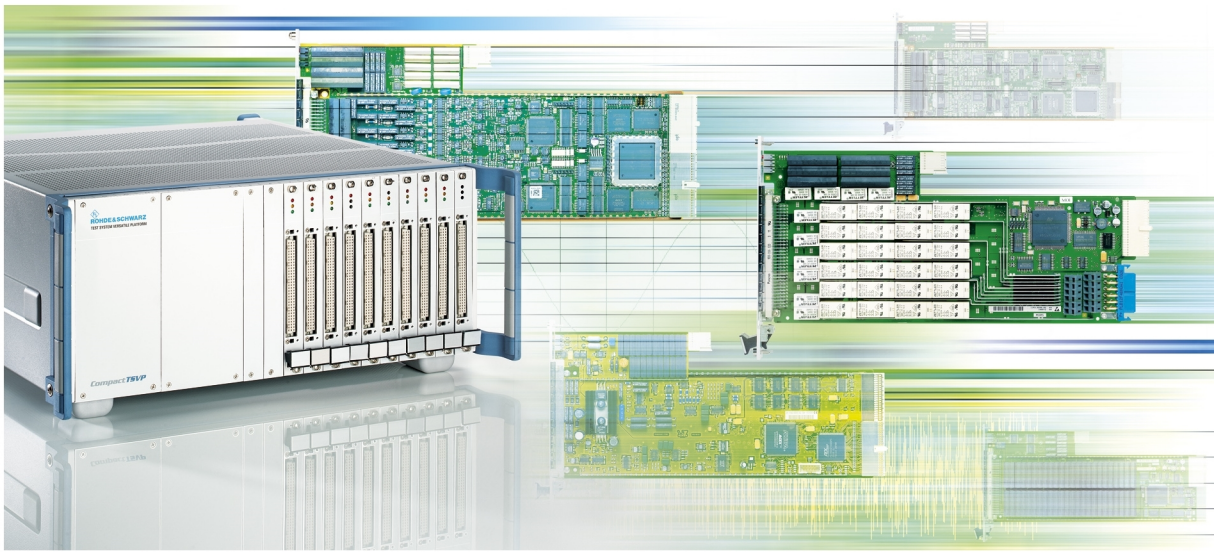
R&S®GTSL
Generic Test Software Library
User Manual



1143645042
Version 27

ROHDE&SCHWARZ
Make ideas real

This Software Description is valid for the following software versions.

- R&S®GTSL version 3.42 and higher versions

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1143.6450.42 | Version 27 | R&S®GTSL

The following abbreviations are used throughout this manual: R&S®GTSL is abbreviated as R&S GTSL.

Contents

1 General

The Generic Test Software Library R&S GTSL is a collection of libraries for specific test tasks like measurements, switching and signal generation. An ASCII file contains the relevant configuration data which can be assigned to certain test sequences. So measurement parameters can be changed and adjusted easy and quickly with a standard editor.

Any test management software may be used to control the test sequence. This software combines the individual test sequences to form an executable test program. It also adds all other functions important to the production operation, such as user administration, execution of multiple test sequences in multi-threading or parallel operation, collection and storage of relevant measurement results and report generation.

The individual test cases of the Generic Test Software Library R&S GTSL can also be combined by a C program into an executable test program.

Requirements

- Knowledge of Microsoft Windows operating systems is needed to operate and work with the Generic Test Software Library R&S GTSL.
- Knowledge of C-programming is needed to create your own test libraries.

2 Software Installation

2.1 General

The Generic Test Software Library R&S GTSL can be downloaded from R&S GLORIS server. After extracting the compressed installation file, the whole contents of the installation package can be found in the target directory.

Please read the `README.TXT` file before starting the installation by executing the `SETUP.EXE` file.

To install the Generic Test Software Library R&S GTSL under Windows, the user must be logged in as administrator or as a user with administrator rights.

For additional information on the de-installation of previous versions of the Generic Test Software Library R&S GTSL or concerning installation, consult the `README.TXT` file in the installation package and the chapter "Troubleshooting installation" of the “R&S System Manual TSVP”.

2.2 Installation

2.2.1 Runtime Setup

Before installing the Generic Test Software Library R&S GTSL the runtime environment of the computer must be setup. The installation package contains setup routines for the initial setup of the runtime environment.

It is not necessary to setup the runtime environment with each R&S GTSL installation or update, but only in the case of an initial setup, or if the version number of one of the components has changed. To get more information about whether the runtime environment has to be updated or not, please refer to the `README.TXT` file on the installation package.

The directory `Runtime Setup` on the installation package comprises some subdirectories.

Each subdirectory contains a separate installation application. Wherever more information is helpful for the proper installation of one item, there is also a `README.TXT` file located in the subdirectory. Please read this file before installing the specific runtime setup item.

2.2.2 R&S GTSL

The Generic Test Software Library R&S GTSL is installed on the computer of the TSVP Test System Versatile Platform or on any external computer via an installation routine. Start the installation as follows:

1. Extract the compressed installation zip-file to a directory on the hard disk drive.
2. Start the installation routine by executing the file `setup.exe` which is located in the directory where the compressed installation zip-file has been extracted to.
3. The following pictures describe the installation process.
   - Installation wizard welcome screen

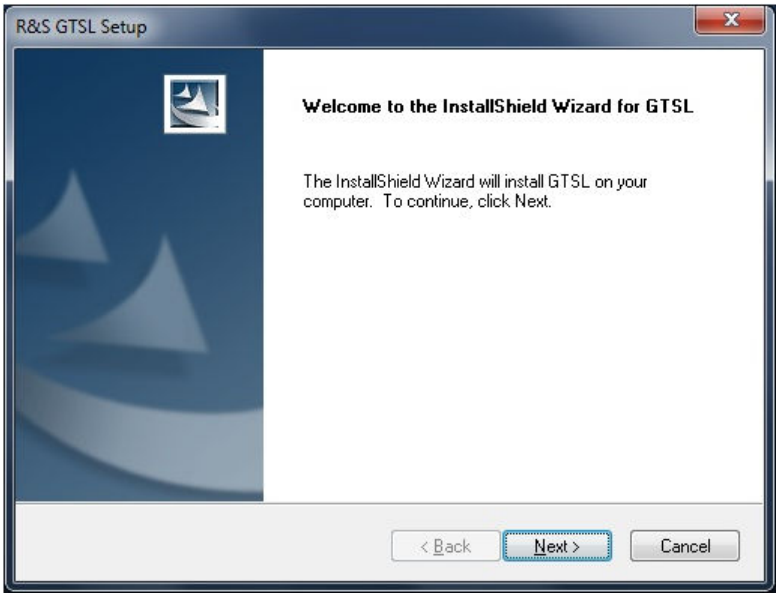


Figure 2-1: Setup Welcome Screen

   - Accept the License Agreement

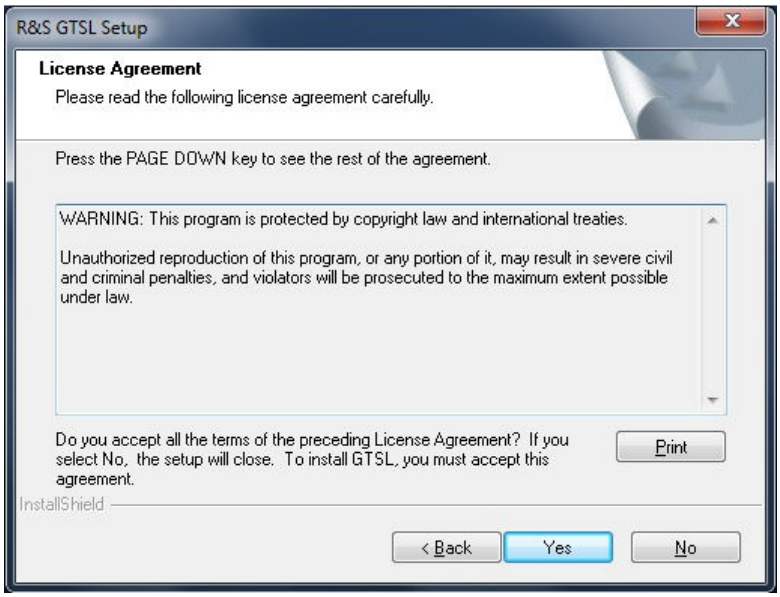


Figure 2-2: Setup License Agreement

- Enter a user name and company name

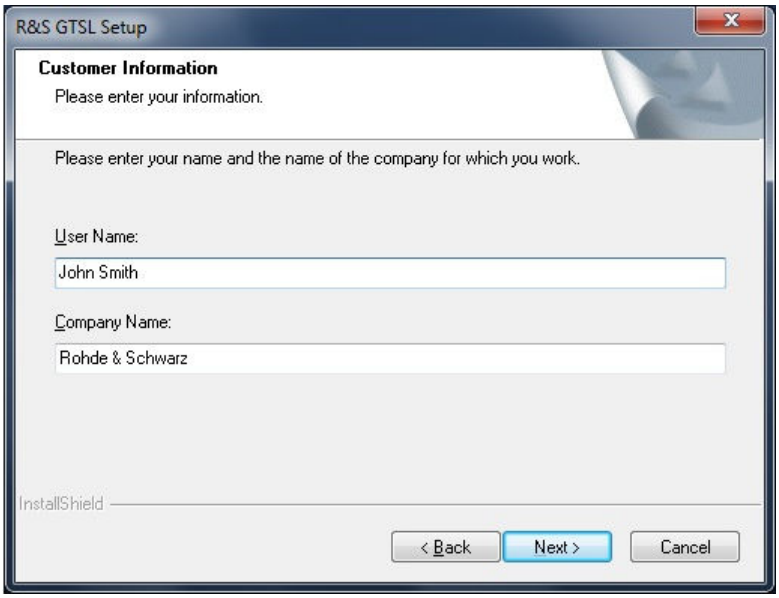


Figure 2-3: Setup Customer Information

- Select the directory, where the R&S GTSL program files are to be installed.

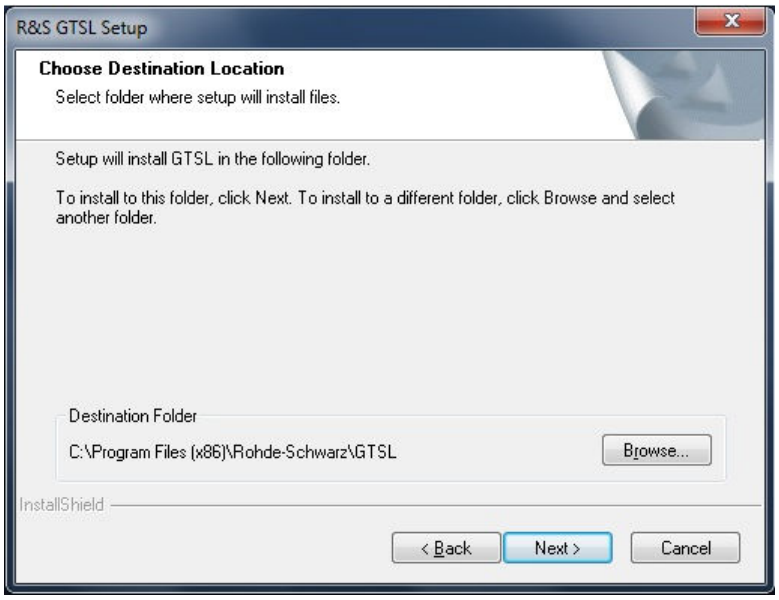


Figure 2-4: Setup Choose Destination Location

- Select the directory, where R&S GTSL application data is to be installed.

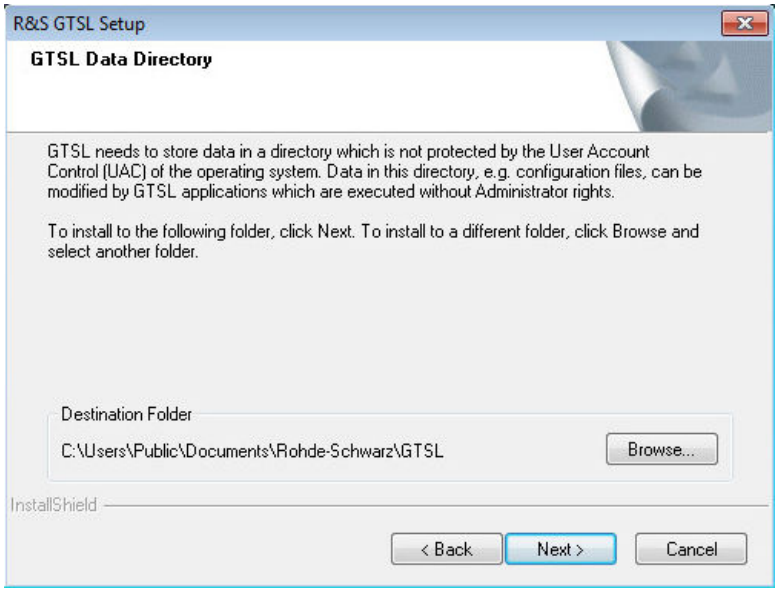


Figure 2-5: Setup Data Directory

- Select the program features to be installed

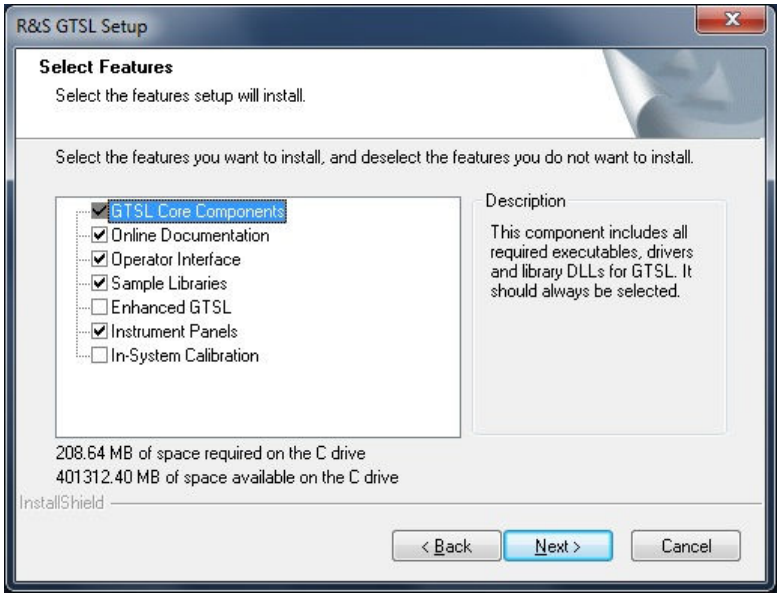


Figure 2-6: Setup Select Program Components

- Display of the current setup settings

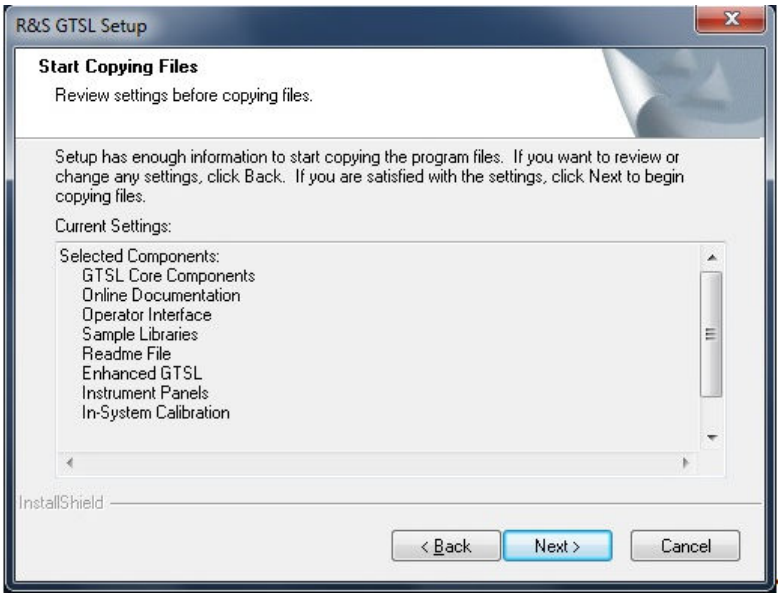


Figure 2-7: Setup Settings

- Display of the Setup Status

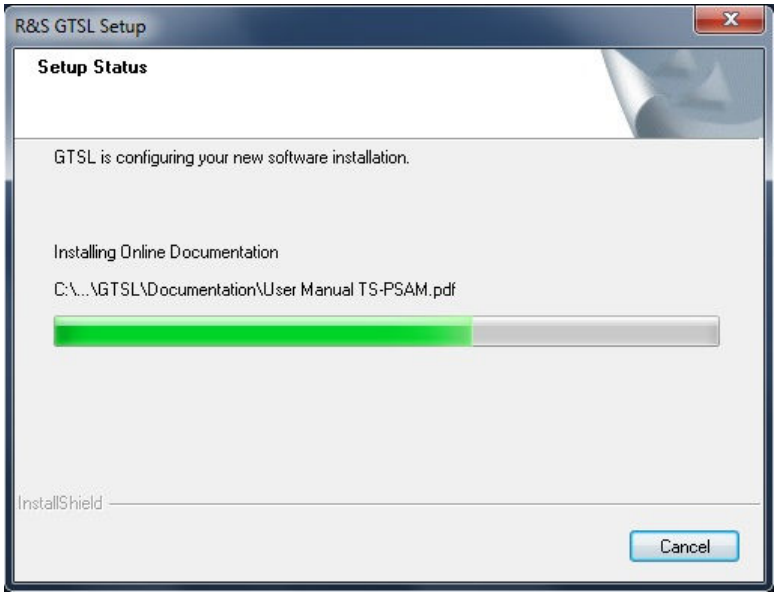


Figure 2-8: Setup Status

- Close the installation routine

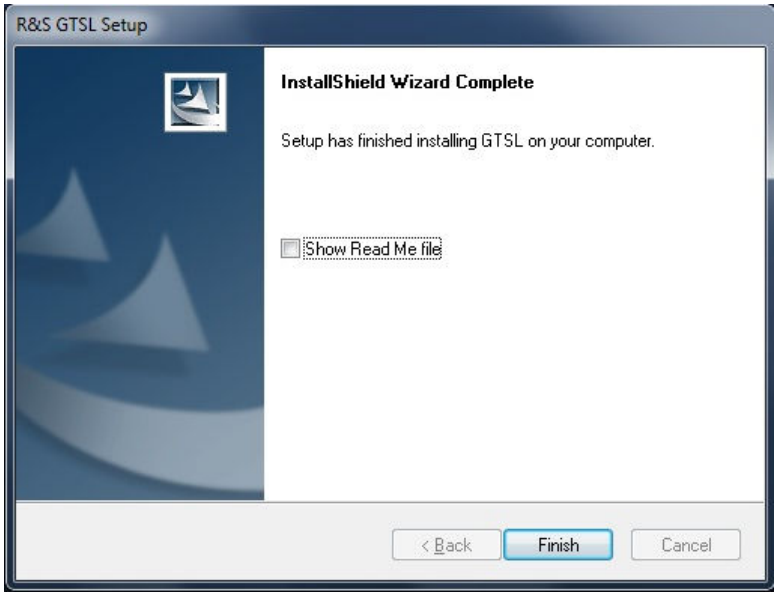


Figure 2-9: Setup Complete

2.3 File Structure

The test libraries supplied by ROHDE & SCHWARZ are stored in fixed directories at the time of installation. The following directory structure can be found as subdirectories below the R&S GTSL program files directory which was specified during the installation process.

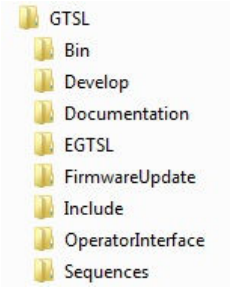


Figure 2-10: File structure program files

Description of installed R&S GTSL program files directories:

Table 2-1: File structure

Directory	Contents
GTSL	Generic Test Software Library. The root directory for the R&S GTSL software can have any name.
GTSL\Bin	Contains the test libraries (.DLL, .LIB) and the help files (.HLP, .CHM) belonging to the test libraries.
GTSL\Develop • Libraries • Sample • Tools	The directory ..\Libraries contains generally valid examples for the creation of a high-level test library and a customer-specific selftest library. The directory ..\Samples contains two sample applications that show how to call R&S GTSL functions and driver functions. The directory ..\Tools contains the R&S GTSL Selftest application.
GTSL\Documentation	Contains the various items of documentation in PDF file format.
GTSL\EGTSL	Appears only if the feature was selected at installation time. For detailed information please refer to the document 'Software Description EGTSL.pdf'.
GTSL\Firmware Update	This directory contains the firmware update application with which the firmware of all TSVP Test System Versatile Platform plug-in boards can be updated to a newer version when available.
GTSL\Include	Contains the h-files (include files) needed for the development of new test libraries.
GTSL\Operator Interface	Contains the run time module for the operator interface of TestStand. A TestStand run time licence is required.
GTSL\Sequences	Contains the test sequence examples created by ROHDE & SCHWARZ.

The application data is stored in the following directory structure below the R&S GTSL application data directory which was specified during the installation process.

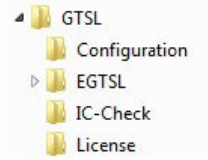


Figure 2-11: File structure application data

Description of installed R&S GTSL application data files directories.

Table 2-2: Application data files directories

Directory	Contents
`GTSL\Configuration`	Contains samples of the two configuration files `PHYSICAL.INI` and `APPLICATION.INI`.
`GTSL\EGTSL`	Appears only if the feature was selected at installation time. Contains correction data for Enhanced Generic Test Software Library. For detailed information, please refer to the document *Software Description EGTSL.pdf*.
`GTSL\IC-Check`	Contains example configuration data for the IC-Check application.
`GTSL\License`	Contains one or more subdirectories with optional license key files.

3 Functional Description

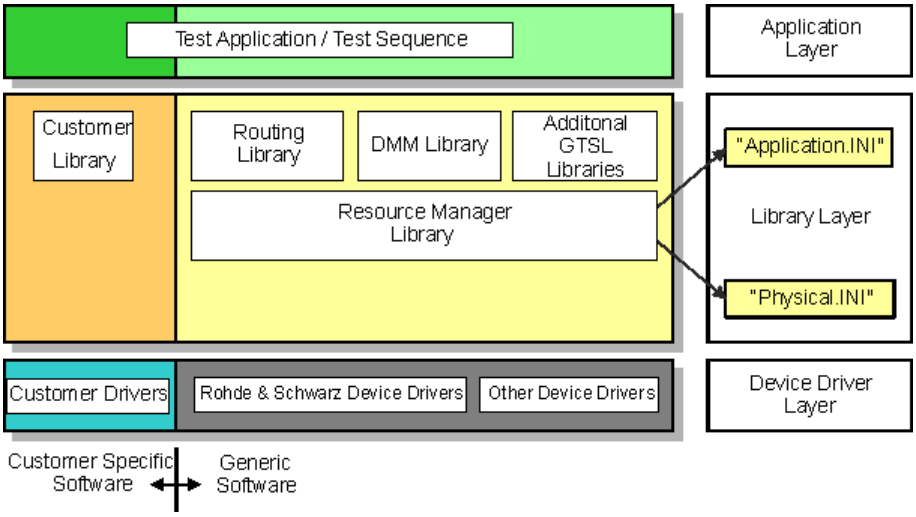


Figure 3-1: R&S GTSL layer model

In terms of its structure, the Generic Test Software Library R&S GTSL developed by ROHDE & SCHWARZ is divided into different supply components and software layers.

A distinction is made between the software components supplied by ROHDE & SCHWARZ and the components which must be supplied or adapted by the customer. The software components to be provided by the customer may for example include the following elements (specific to the customer and to the unit under test).

- device drivers
- calibration data
- test libraries
- test sequences

The software used in the R&S GTSL is divided into three different layers.

- The **lowest level** of the R&S GTSL accommodates the device drivers needed for the hardware used (Device Driver Layer). These include the device drivers for the following hardware:
  - hardware developed and used by ROHDE & SCHWARZ.
  - standard hardware.
- The **middle level** of the R&S GTSL accommodates the different test libraries (Library Layer). These test libraries provide the functions needed to execute test sequences. At this level, further information concerning the two files `PHYSICAL.INI` and `APPLICATION.INI` is transferred to the Resource Manager Library. The different device drivers of the lowest level are called from this level.
- The **highest level** accommodates the test sequences for the execution of the individual test functions (Application Layer). The test sequences call functions from the libraries in the middle level.

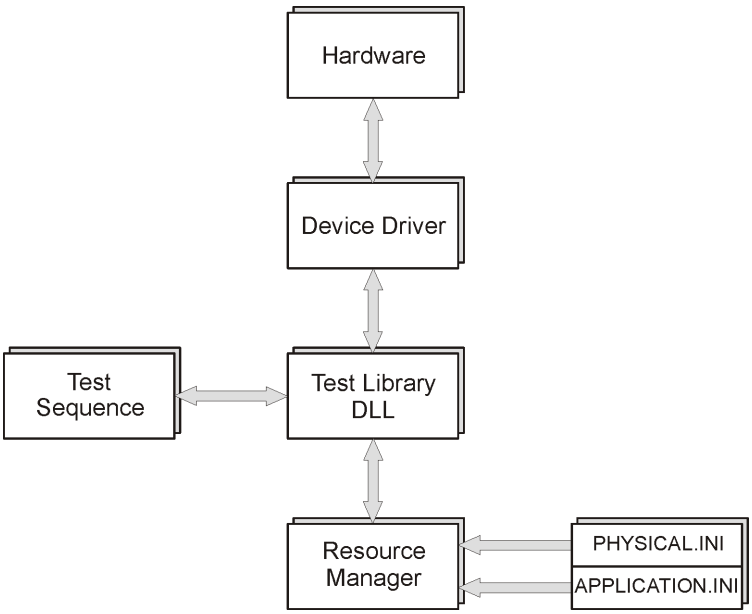


Figure 3-2: Software structure

The test libraries form the core of the software and of the test sequences. The test functions stored in the test libraries (Dynamic Link Library `.DLL`) are combined within a test sequencer into executable test sequences.

The individual test functions access the test system hardware via the device drivers.

The hardware initialized in the Generic Test Software Library is managed by the Resource Manager. The Resource Manager is likewise a `.DLL` file.

Thanks to the hardware management of the Resource Manager, the created test sequences are independent of the current hardware configuration, so test sequences do not need to be modified if the hardware or hardware settings are changed. All information needed to run the test sequences is sent to the Resource Manager via two configuration files (`.INI` files):

- `PHYSICAL.INI`
- `APPLICATION.INI`

Only these files need to be modified if the hardware or hardware settings are changed. They can be edited with any text editor.

The Resource Manager also manages the hardware during the parallel execution of test sequences. The Resource Manager prevents conflicts in accessing different test functions or test sequences on the same hardware.

When using the Generic Test Software Library R&S GTSL, the user only has to make changes to certain components of the software. In all cases, the user creates the test sequences for the test applications at the highest level (Application Layer).

The user has to adapt the configuration file `APPLICATION.INI` to the relevant test application. The user only has to adapt the configuration file `PHYSICAL.INI` in the event of a change to the hardware configuration.

Since an APPLICATION.INI configuration file normally exists for every test application performed on the system, the file name can be matched to the test application in question, e.g. APP_XXX.INI. The Resource Manager is told during setup which configuration file is to be used.

On the other hand, only one PHYSICAL.INI configuration file is ever available on the system.

For ease of comprehension, the file names APPLICATION.INI and PHYSICAL.INI are used for the configuration files in the manual.

3.1 Operation of a Test Sequence

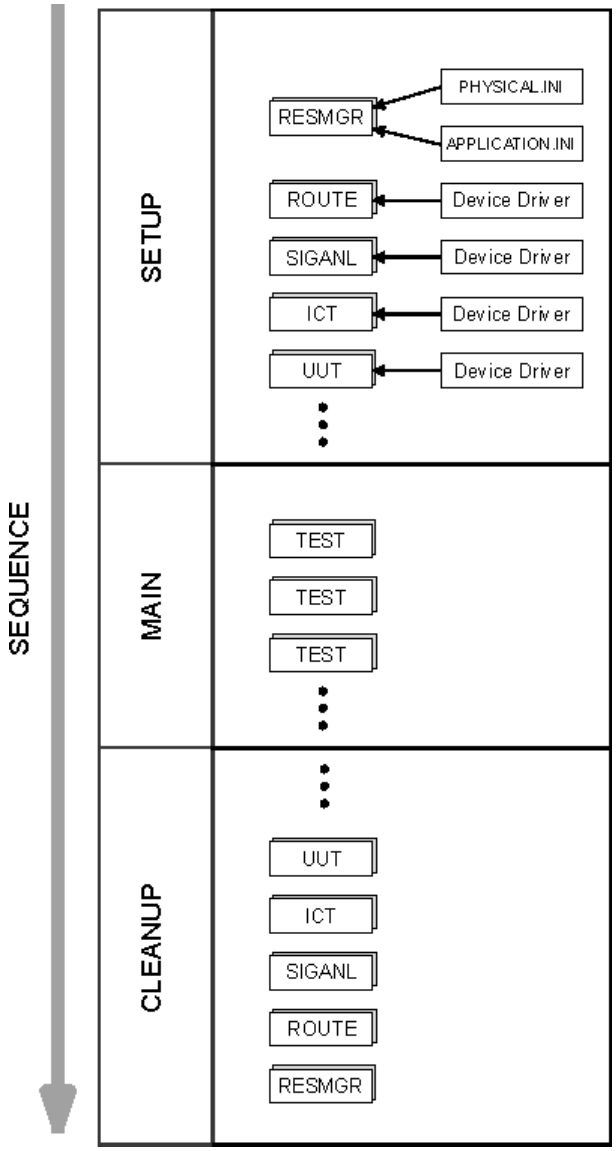


Figure 3-3: Test sequence operation

The operation of every created and executed test sequence is divided into three stages:

1. **SETUP**
   First of all, the SETUP function of the Resource Manager (RESMGR) is called. During this function call, information from the two configuration files PHYSICAL.INI and APPLICATION.INI is loaded. Then, the SETUP functions of the individual libraries needed to perform the test steps are called (ROUTE, SIGANL, ICT etc.). The necessary hardware and software components are requested, the relevant device drivers are initialized and the devices are placed in a defined state.
2. **MAIN**
   The individual test steps are performed.
3. **CLEANUP**
   The CLEANUP functions of the Resource Manager and of the used libraries are called. The system resources reserved during the setup functions and the reserved hardware are freed again. A CLEANUP call is needed for every SETUP call.
   The different CLEANUP function calls are executed even if the operation of the test steps is interrupted. This ensures that the used system resources are always freed again, and the used hardware is always returned to a defined basic state.

The division of the execution operation of a test sequence into these three subareas takes place in the test sequence control system that is used.

4 R&S GTSL License Management

Starting with GTSL 3.30, no GTSL license is required.

During the installation of the Generic Test Software Library R&S GTSL, all available test libraries are copied to the system. You need a License Key File in order to access the functions from the test libraries. Refer to Chapter 7, "Test Libraries", on page 52 for the license key required for each test library.

Without a valid License Key File, the functions of the test library will only work in „demo mode". Access to the hardware is only simulated.

Each license is bound to a system serial number. The enabled test libraries can only be run on the system with this serial number. The hardware system used is identified via the system module TS-PSYS (R&S CompactTSVP, R&S PowerTSVP).

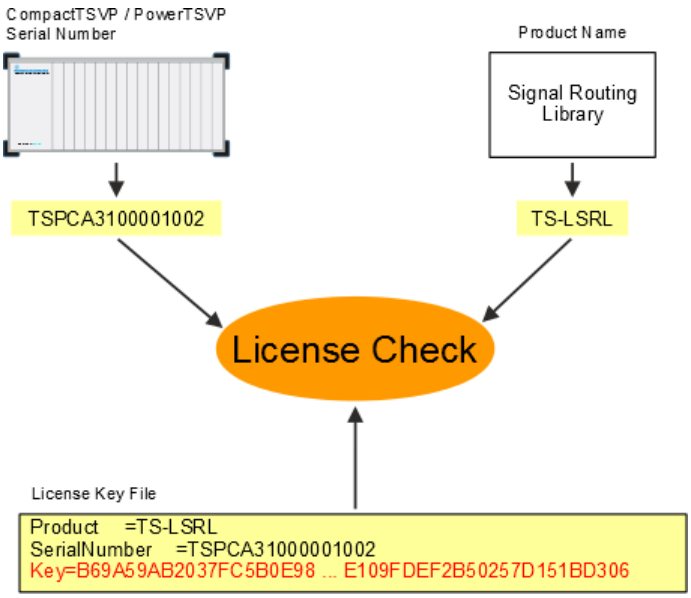


Figure 4-1: License Check

During license checking, the serial number and the name of the called test library are compared with the License Key from the License Key File. The test library in question will only be enabled if these coincide. The serial number and the name of the test library are encoded in the License Key.

Example:

License Key File

```
[Header]
FileVer=1.0
[Project]
Info=GTSL
[Modul]
Product=TS-LBAS
SerialNumber=850000008E4BD202
Key=C146648E1DEF9AD78663728A5D8E8D25885F457367D7F7C359F2C63BDB926 ...
```

The serial number is queried and a new License Key File is installed via the R&S GTSL License Viewer. To open the R&S GTSL License Viewer, select

" Start" -> "Programs" -> "GTSL" -> "License Viewer"

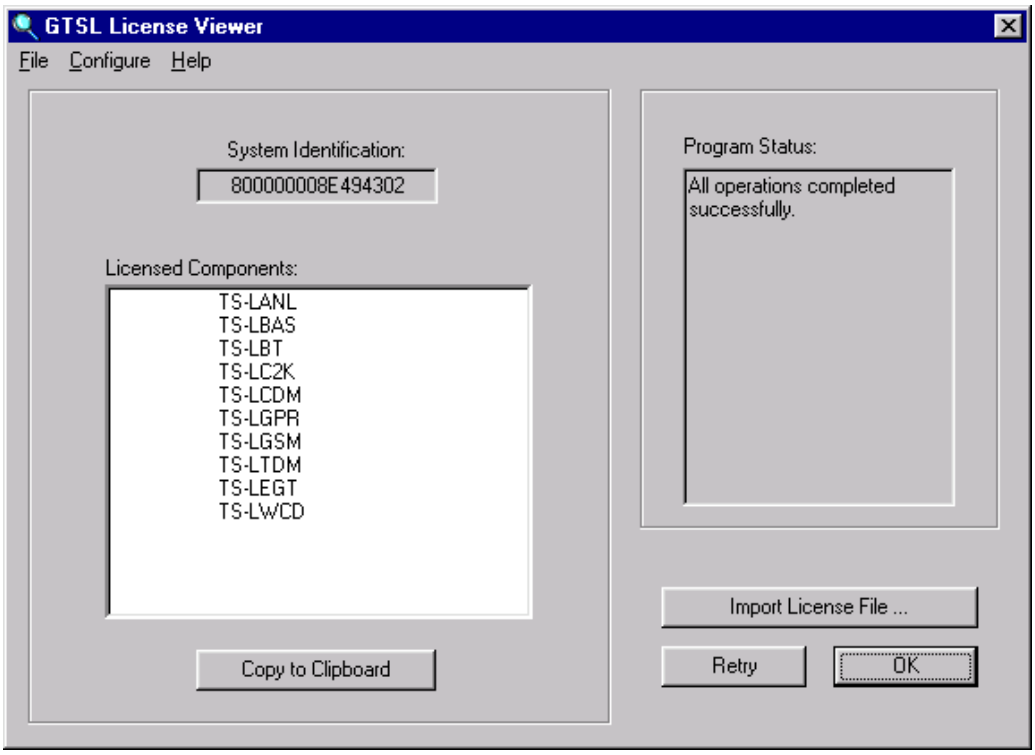


Figure 4-2: R&S License Viewer

"System Identification"	The serial number of the system
"Program Status"	Displays the current status of theR&S GTSL License Viewer.
"Licensed Components"	Displays the test libraries for which a License Key File has been imported.
Copy to Clipboard	Copies the displayed serial number to the clipboard.

Import License File ...	Imports a new License Key File into the R&S GTSL License Viewer. The path and the file name of the License Key File to be imported can be selected via a file browser dialog.
Retry	Reads the serial number into theR&S GTSL License Viewer.
OK	Closes the R&S GTSL License Viewer.
"File > Exit"	Closes the R&S GTSL License Viewer.
"Configure > System Identification"	Opens the configuration dialog (see Figure 4-3).
"Help > About License Viewer"	Shows version and copyright information about the R&S GTSL License Viewer.

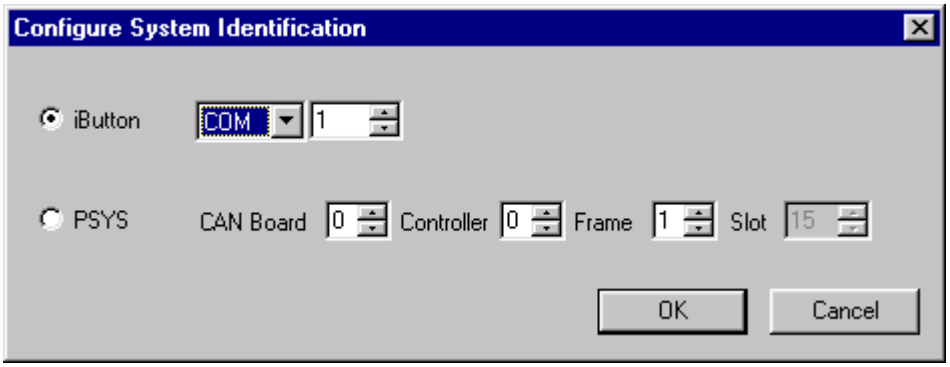


Figure 4-3: Configuration Dialog

"iButton"	This option is not available for Windows 7.
"PSYS"	"CAN Board" and "Controller" define the board and interface Id of the CAN interface controlling the R&S TS-PSYS module. Default = 0 "Frame" defines the R&S CompactTSVP or R&S PowerTSVP frame number where the R&S TS-PSYS module is located. Default = 1 "Slot": The only valid slot number for the R&S TS-PSYS module is 15.
OK	The settings made in the Configuration Dialog are accepted with the **"OK"** button.
Cancel	The settings made in the Configuration Dialog are rejected with the **"Cancel"** button.

For each installed PSYS, a subdirectory with the relevant serial number is created in the `..\GTSL\License` directory. The License Key Files installed via the R&S GTSL License Viewer are stored in the relevant subdirectory.

If further test libraries are enabled, the serial number must be sent to ROHDE & SCHWARZ. To avoid writing errors, the serial number can be copied from the R&S GTSL License Viewer via the clipboard.

The License Key File newly created by ROHDE & SCHWARZ must be installed via the R&S GTSL License Viewer. After that, unrestricted use of the test libraries is possible.

If, during a test sequence, test functions are used or called from a non-enabled test library, a warning code will be displayed upon execution in TestStand. If non-enabled functions are called during Resource Manager Setup, an error message will be displayed:

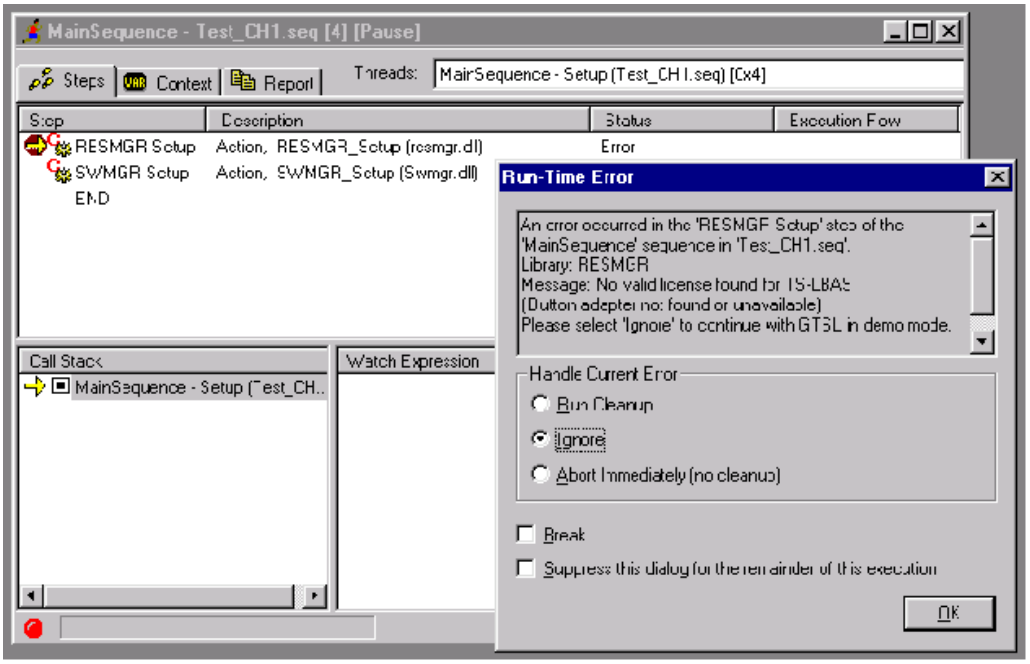


Figure 4-4: Error message from Resource Manager

If the error message is acknowledged by selecting **"Ignore"**, the test sequence will run in "demo mode".

5 Configuration Files

The required configuration files are stored by default in the `..\GTSL\Configuration directory`.

5.1 Syntax

The syntax of the Physical Layer Configuration File (`PHYSICAL.INI`) and of the Application Layer Configuration File (`APPLICATION.INI`) is identical. The only difference between the two files is in terms of how they are used (see Chapter 5.2, "PHYSICAL.INI", on page 28 and Chapter 5.3, "APPLICATION.INI", on page 32).

Both files use the standard INI file format.

Example of standard INI file format:

```
[section]

key = value
...
```

A section begins with the section name written inside closed brackets ([ ]). The following lines contain pairs of keywords and values. The keywords and the assigned values are separated by an equals sign ("=").

In the section names and keywords, no distinction is made between upper and lower case characters. However, the values after the equals sign are transferred exactly as they are written in the file. Leading and trailing spaces are truncated.

5.1.1 Naming Conventions

In the Physical Layer Configuration File and in the Application Layer Configuration File, several groups of keywords and sections are allowed. These refer to other sections and reflect the relationships and interconnections.

The section names follow the naming conventions indicated below.

The section name begins with the section type followed by an arrow ("->", a minus sign followed by a greater than sign). A unique name appears after the arrow. No spaces are permitted between the name and the arrow.

In the section names, no distinction is made between upper and lower case characters.

The following characters are permitted for the logical names, the device names and the bench names.

Table 5-1: Character set for names

"A" ... "Z"	Upper case characters
"a" ... "z"	Lower case characters

"0" ... "9"	Numbers
"_"	Underscore
"."	Decimal point

The following maximum character lengths are permitted for section names, keywords and values:

Table 5-2: Maximum character lengths

section	80 characters
key	80 characters
value	260 characters

[LogicalNames]	This section contains a list of names of devices and benches. Any name can be used to identify a device or bench (Application Layer Configuration File).
[Device->...]	A device section contains different keywords to identify the devices. These include the GPIB address, the device type etc. (Physical Layer Configuration File and Application Layer Configuration File).
[Bench->...]	This section contains a group of device entries which together form a bench. A High Level Library requires the name of a bench in its setup routine (Application Layer Configuration File).
[ResourceManager]	This section contains information for the configuration of the Resource Manager.

5.1.2 [LogicalNames] Section

The *[LogicalNames]* section is used to assign a short, meaningful name to a device or bench. Any name can be chosen. This section contains a list of unique name allocations. The values on the right side of the expressions must be valid names of a bench or of a device section.

The *[LogicalNames]* section is an optional entry and is used only in the Application Layer Configuration File.

Example:

```
[LogicalNames]
ICT = bench->ict
Power = device->psu_14
```

5.1.3 [Device] Section

The *[Device]* section contains a list of keywords and assigned values. These keywords and values precisely describe the relevant device. The name of the *[Device]* section begins with "Device->" followed by a unique name. Any name can be chosen.

There must be a *[Device]* section for each device in the Physical Layer Configuration File.

A *[Device]* section with the same name can be defined in the Application Layer Configuration File. Additional device information can be given at this point by means of further keywords and values, or device information from the Physical Layer Configuration File can be overwritten. However, it is not possible to define a *[Device]* section in the Application Layer Configuration File which is not present in the Physical Layer Configuration File.

The keywords in a *[Device]* section and their meaning depend on the libraries used by the devices.

Table 5-3: Standard keywords of [Device] section

Keyword	Description
Description	*Optional entry* Device description, remarks
Type	*Mandatory entry* Device type (e.g. CMU etc.)
ResourceDesc	*Mandatory entry* VISA device properties and device description in the form: `GPIB[card number]::[primary address]::[secondary address] PXI[segment number]::[device number]::[function]::INSTR` Examples: `GPIB0::15` or `PXI0::16::0::INSTR`
DriverSetup	*Optional entry* Special setup string for IVI driver, e.g. for simulation of devices

The "Type" and "ResourceDesc" entries are required for the test libraries. Both entries must be present in the Physical Layer Configuration File.

The information from the "Type" entry allows the test libraries to distinguish between different supported devices (such as CMD55 or CMU). This information is also needed for the system self-test.

The information from the "ResourceDesc" entry is needed to set up the device driver and create the physical connection with the indicated device.

Example:

```
[device->CMD55]
Description = Radio Communication Tester CMD55
Type = CMD55
ResourceDesc = GPIB0::4
```

5.1.4 [Bench] Section

The *[Bench]* section contains a list of keywords and assigned values which describes a group of devices and their use. The name of the *[Bench]* section begins with "Bench->" followed by a unique name. Any name can be chosen.

A *[Bench]* section can only be defined in the Application Layer Configuration File.

The keywords in a *[Bench]* section depend on the test library used by the bench. A keyword always provides at least one reference to a device entry. Other keywords may be necessary to describe the bench. The following keywords are predefined and should be present in each *[Bench]* section.

Table 5-4: Standard keywords of [Bench] section

Keyword	Description
Description	*Optional entry* Bench description, remarks
Simulation	*Optional entry* If set to **1**, the complete bench is simulated by the test library.
Trace	*Optional entry* If set to **1**, the tracing function is enabled for the test library

The *[Bench]* section can contain further useful keywords and values which are used by a test library.

Example:

```
[bench->ICT]
Simulation = 0
Trace = 0
ICTDevice1 = device->psam
SwitchDevice1 = device->pmb_15
AnalogBus = device->ABUS
AppChannelTable = io_channel->ICT
```

5.1.5 [ResourceManager] Section

The *[ResourceManager]* section contains keywords and assigned values to control the behaviour of the Resource Manager library. The following keywords are supported:

Table 5-5: Keywords of [ResourceManager] section

Key name	Remarks
Trace	Blocks the tracing function (value = 0), enables the tracing function (value = 1). The function impacts on all libraries.
TraceFile	Defines the path and the name of the trace file.
TraceToScreen	The tracing information is displayed on the standard screen (value = 1).
TraceTimeStamp	Writes the time of day at the start of each tracing line (value = 1).
TraceThreadID	Writes the ID of the current thread at the start of each tracing line (value = 1).

5.2 PHYSICAL.INI

In the file `PHYSICAL.INI` (Physical Layer Configuration File), all hardware assemblies available in the Generic Test Software Library are described along with the corresponding definitions and settings (see example `PHYSICAL.INI` file). This file also contains definitions which are applicable to all test applications to be executed on the system (e.g. type definition). The information entered in this file is used by all test libraries and thus by each test step.

The `PHYSICAL.INI` file normally exists only once in the system as it reflects the exact physical structure. The file must only be modified in the event of a hardware change.

The Resource Manager calls and administers the information from the `PHYSICAL.INI` file.

With help of the Instrument Soft Panels application you can create a physical.ini file for the current system configuration. This is useful if new modules are added, a new system controller was assembled or if the slot assignments were changed. Refer to Chapter 11.4.2, "Create Physical.ini", on page 241.

5.2.1 Example file for PHYSICAL.INI

```
                                                                    Description
[device->PAM]                                                       1
Description         = "TS-PAM, Analyzer Module, Slot 5"             2
Type                = PAM                                           3
ResourceDesc        = PXI1::13::0::INSTR                            4
DriverDll           = rspam.dll                                     5
DriverPrefix        = rspam                                         6
DriverOption        = "Simulate=0,RangeCheck=1"                     7
SFTDll              = sftmpam.dll                                   8
SFTPrefix           = SFTMPAM                                       9


[device->PSAM]                                                      1
Description         = "TS-PSAM, Source and Measurement Module, Slot 8"  2
Type                = PSAM                                          3
ResourceDesc        = PXI1::10::0::INSTR                            4
DriverDll           = rspsam.dll                                    5
DriverPrefix        = rspsam                                        6
DriverOption        = "Simulate=0,RangeCheck=1"                     7

; Note: the self test DLL and prefix keywords must be removed for the  10
first TS-PSAM module, because it is already tested in the basic
self test.

;SFTDll             = sftmpsam.dll                                  10
;SFTPrefix          = SFTMPSAM                                      10


[device->PICT]                                                      1
Description         = "TS-PICT, In-Circuit Test Extension Module, Slot  2
                    9"

Type                = PICT                                          3
ResourceDesc        = PXI2::15::0::INSTR                            4
DriverDll           = rspict.dll                                    5
DriverPrefix        = rspict                                        6
DriverOption        = "Simulate=0,RangeCheck=1"                     7
SFTDll              = sftmpict.dll                                  8
SFTPrefix           = SFTMPICT                                      9
```

		Description
[device->PMB_15]		1
Description	= "TS-PMB, Matrix Module, Slot 15"	2
Type	= PMB	3
ResourceDesc	= CAN0::0::1::15	4
DriverDll	= rspmb.dll	5
DriverPrefix	= rspmb	6
DriverOption	= "Simulate=0,RangeCheck=1"	7
SFTDll	= sftmpmb.dll	8
SFTPrefix	= SFTMPMB	9
[device->PSM1_16]		1
Description	= "TS-PSM1, Power Switch Module, Slot 16"	2
Type	= PSM1	3
ResourceDesc	= CAN0::0::1::16	4
DriverDll	= rspsm1.dll	5
DriverPrefix	= rspsm1	6
DriverOption	= "Simulate=0,RangeCheck=1"	7
SFTDll	= sftmpsm1.dll	8
SFTPrefix	= SFTMPSM1	9
[device->PSYS1]		1
Description	= "TS-PSYS1, System Module, Slot 15 (rear)"	2
Type	= PSYS1	3
ResourceDesc	= CAN0::0::5::15	4
DriverDll	= rspsys.dll	5
DriverPrefix	= rspsys	6
DriverOption	= "Simulate=0,RangeCheck=1"	7
SFTDll	= sftmpsys.dll	8
SFTPrefix	= SFTMPSYS	9
; Analog bus pseudo-device, used by ROUTE, SWMGR and EGTSL		10
[device->ABUS]		1
Description	= "Analog Bus"	2
Type	= AB	3
[io_channel->system]		11
.DMM_HI	= PSAM!DMM_HI	12
.DMM_LO	= PSAM!DMM_LO	12

5.2.2 Description of Example File PHYSICAL.INI

The description is based on the example file in Chapter 5.2.1, "Example file for PHYSICAL.INI", on page 29. The indicated numbers refer to the corresponding positions in the example file. The place-holder "XY" in the following listing stands for the corresponding entries.

Table 5-6: Description of PHYSICAL.INI

1	`[device->XY]`	Defines the name under which the device is called in the test libraries. A separate entry must be made for each device. The entry in square brackets [ ] defines a new section within which new definitions are made.
2	`Description = "XY"`	Gives a detailed description of the defined device. The entry is optional.
3	`Type = "XY"`	Gives the exact designation of the defined device. This designation is needed to call the corresponding device driver. The entry is mandatory.

4	`ResourceDesc = "XY"`	Gives the necessary hardware information required for the defined device.
		The entry is mandatory.
		Details provided at this point include, for example:
		GPIB address: `GPIB1::20::1` (example)
		`GPIB[card number]::[primary address]::[secondary address]`
		Serial interface: `COMX`
		PXI address: `PXI1::10::0::INSTR` (example)
		`PXI[segment number]::[device number]::[function]::INSTR`

5	`DriverDll = XY`	Gives the path and the file name of the device driver.
6	`DriverPrefix = XY`	Gives a prefix for the device driver.
7	`Driver Option = XY`	Gives certain options applicable to the device driver.
8	`SFTDll = XY`	Gives the path and the file name of the self test device driver.
9	`SFTPrefix = XY`	Gives a prefix for the self test device driver.
10		Text appearing after a semicolon (;) is interpreted as a comment.
11 + 12	`[IO_Channel->system]`	The following definitions of I/O channels apply to all applications executed on the system. On the right side are the physical channel names as defined by the hardware and by the device driver. On the left side are the logical channel names as used in the test libraries.
13	`ResourceDesc_XY =`	In the case of certain devices, special subassemblies can be addressed directly through their primary address and secondary address. The relevant hardware information can be indicated especially for this subassembly with the corresponding designation.

5.3 APPLICATION.INI

In the APPLICATION.INI file (Application Layer Configuration File) is a description of how the individual test libraries and the test functions use the hardware components (see example file APPLICATION.INI). Different hardware components can be combined into groups (bench). This bench can then be used within the test function. Furthermore, definitions are made in this file which apply to certain test applications to be executed on the system (e.g. definition of designations in the case of multi-channel operation).

The Resource Manager calls and administers the information from the APPLICATION.INI file.

Since an Application Layer Configuration File (APPLICATION.INI) normally exists for each test application executed on the system, the file name can be matched to the test application in question, e.g. APP_XXX.INI. The Resource Manager is told during setup which Application Layer Configuration File is to be used.

For ease of comprehension, the file name APPLICATION.INI is used for the Application Layer Configuration File in the manual.

5.3.1 Example File for APPLICATION.INI

```
                                                    Description
[ResourceManager]                                   1
; general trace settings (normally off)             2
Trace                   = 0                         3
TraceFile               = resmgr_trace.txt          4


[LogicalNames]                                      5
ICT                     = bench->ICT                6


[bench->ICT]                                        7
Description             = ICT bench                 8
Simulation              = 0                         9
Trace                   = 0                         10
ICTDevice1              = device->psam              11
ICTDevice2              = device->pict              11
SwitchDevice1           = device->pmb_15            11


; used for functional test                          2
SwitchDevice2           = device->PSM1_16           11
```

```
                                                                    Description
AnalogBus                = device->ABUS                             11


AppChannelTable          = io_channel->BenchGSM                     12
AppWiringTable           = io_wiring->ICT                           13


[io_channel->ICT]                                                   14
GND                      = pmb1!P1                                  15
INPUT                    = pmb1!P2                                  15
OUTPUT                   = pmb1!P3                                  15
TR1.B                    = pmb1!P4                                  15
TR1.C                    = pmb1!P5                                  16
TR1.E                    = pmb1!P6                                  16
VCC                      = pmb1!P7                                  16


[io_wiring->ICT]                                                    17
GND                      = F1 S15 X10A1                             18
INPUT                    = F1 S15 X10A2                             18
OUTPUT                   = F1 S15 X10A3                             18
TR1.B                    = F1 S15 X10A4                             18
TR1.C                    = F1 S15 X10A5                             18
TR1.E                    = F1 S15 X10A6                             18
VCC                      = F1 S15 X10A7                             18
```

5.3.2 Description of Example File APPLICATION.INI

The description is based on the example file in Chapter 5.3.1, "Example File for APPLICATION.INI", on page 32. The indicated numbers refer to the corresponding positions in the example file. The place-holder "XY" in the following listing stands for the corresponding entries.

Table 5-7: Description of APPLICATION.INI

1	`[ResourceManager]`	Defines a new section (identified by the square brackets [ ]) with information evaluated directly by the Resource Manager.
2		Text appearing after a semicolon (;) is interpreted as a comment.
3	`Trace = x`	Enables (value = 1) or disables (value = 0) tracing function.
4	`Tracefile = fn`	Defines the path and the name of the trace file.

5 to 6	`[LogicalNames]`	Defines a new section in which logical short names are defined. The short names can be used to call the libraries.
7	`[bench->XY]`	Defines a new bench with its name. The name, which is defined at this point, is called in the SETUP routine of the corresponding test library.
8	`Description = x`	Gives a detailed description of the defined bench.
9	`Simulation = x`	Blocks simulation of all entered devices (value = 0). Enables simulation of the entered devices (value = 1).
10	`Trace = x`	Blocks the tracing function for that bench (value = 0). Enables the tracing function for that bench (value = 1).
11		The listed devices with the relevant defined names are assigned to the bench. The addressed devices must be defined in the PHYSICAL.INI file with their details.
12	`AppChannelTable = xy`	Refers to a section [io_channel->…] with defined channel names in `APPLICATION.INI`.
13	`AppWiringTable = xy`	Refers to a section [io_wiring->…] with the definitions of the wiring table that is to apply for this bench.
14 to 16	`[io_channel->XY]`	Contains a list of user-specific channel names which are assigned to the physical device names and to the physical device channel names. The defined names apply only to the relevant application.
17 to 18	`[io_wiring->XY]`	The physical wiring from the UUT pins to the front connectors of the R&S TS-PMB Matrix Cards. The test points (nodes) are on the left. The front connector locations are on the right in the form: F<frame number> S<slot number> X10<column><row> F1 S15 X10A1 means: TSVP frame 1 Slot 15 Front connector X10, column A, row 1

6 Editing and Running Test Sequences

6.1 TestStand

6.1.1 General

The test sequences created by ROHDE & SCHWARZ are edited under the TestStand Sequence Editor from National Instruments.

This section provides just a brief description of how a test sequence is edited and run.

A full description of the operation and functions of the individual menu windows of the TestStand Sequence Editor will be found in the enclosed User Manual or the online documentation.

A test sequence is edited as follows:

1. Open TestStand Sequence Editor with **"Start" -> "Programs" -> "National Instruments TestStand "-> "Sequence Editor"** or by clicking the **"Sequence Editor"** icon on Windows desktop. You will now see the main screen of the Sequence Editor. Enter your user name and password (see Figure 6-1). The user name and password are stored in the user profiles of the TestStand software. Default setting:
   - User Name: administrator
   - Password: no password needed

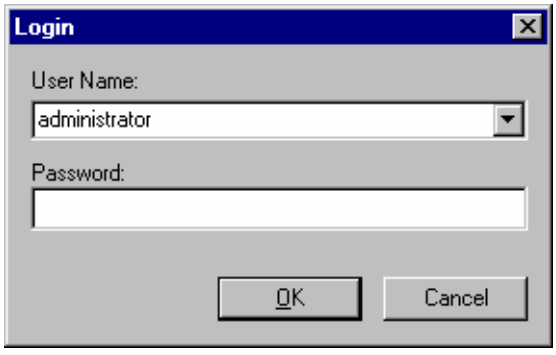


Figure 6-1: Login

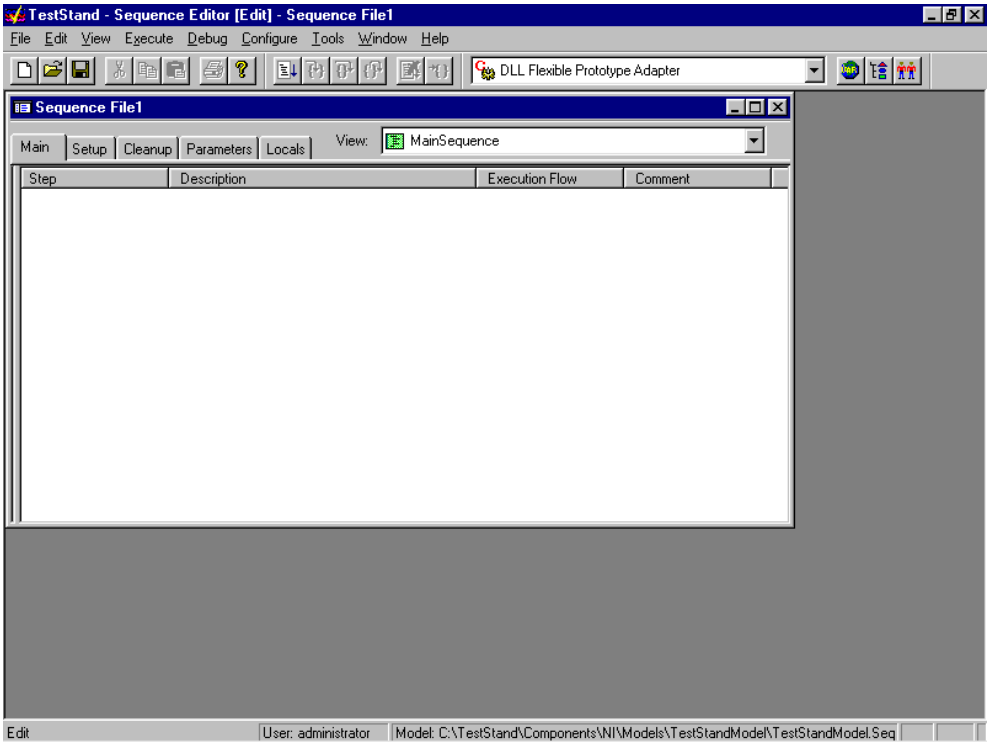


Figure 6-2: TestStand main screen

Note: User name and password can be set according to your specific company requirements.

2. Open an existing test sequence with **"File"** -> **"Open."**
   The test sequences created and supplied by ROHDE & SCHWARZ are stored by default in the directory `C:\Program Files\GTSL\Sequences`. If a different directory was specified during the software installation, the test sequences will be stored there `(...\Sequences)`.
   The opened test sequence and its steps are displayed in the working window.

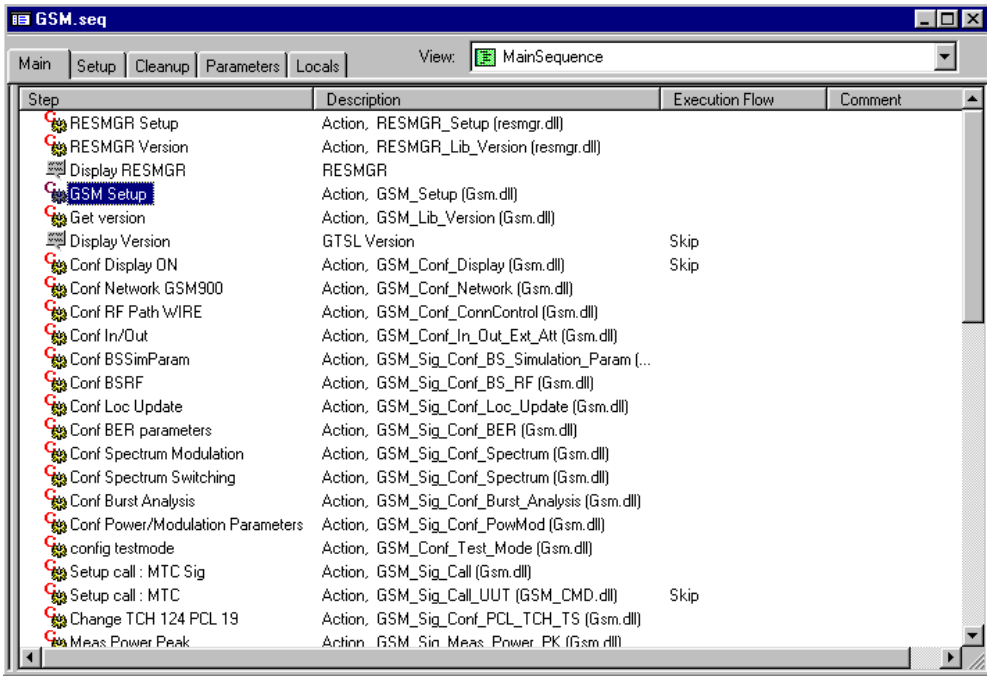


Figure 6-3: Working window

6.1.2 Editing a Test Step

Edit an individual test step as follows:

1. Double-click the test step you wish to edit in the working window. This opens the **"Test Step Setup"** menu window.

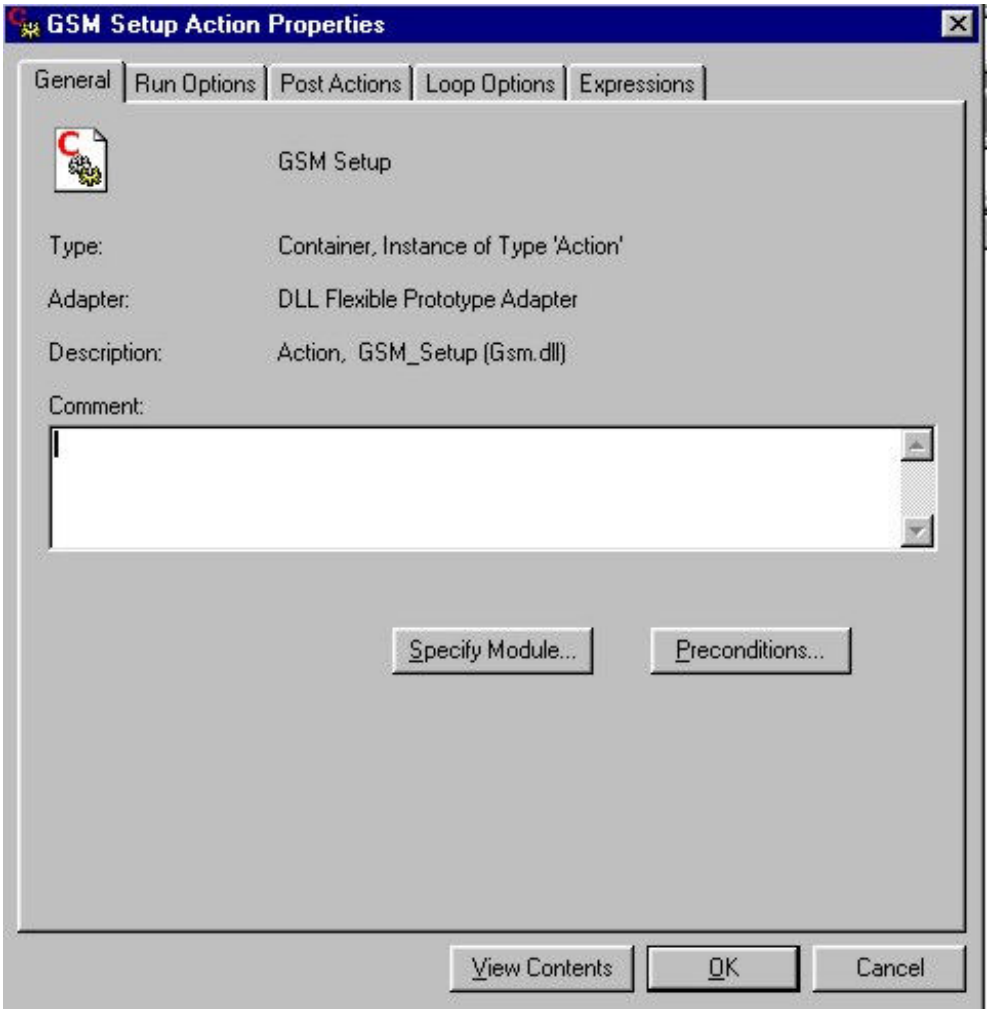


Figure 6-4: Test step setup

Settings for the selected test step are made in this window. The name of the step and the type of call are shown in the title bar.

2. Click **"Specify Module"** to open the **"Edit DLL Call"** menu window for editing the test step.

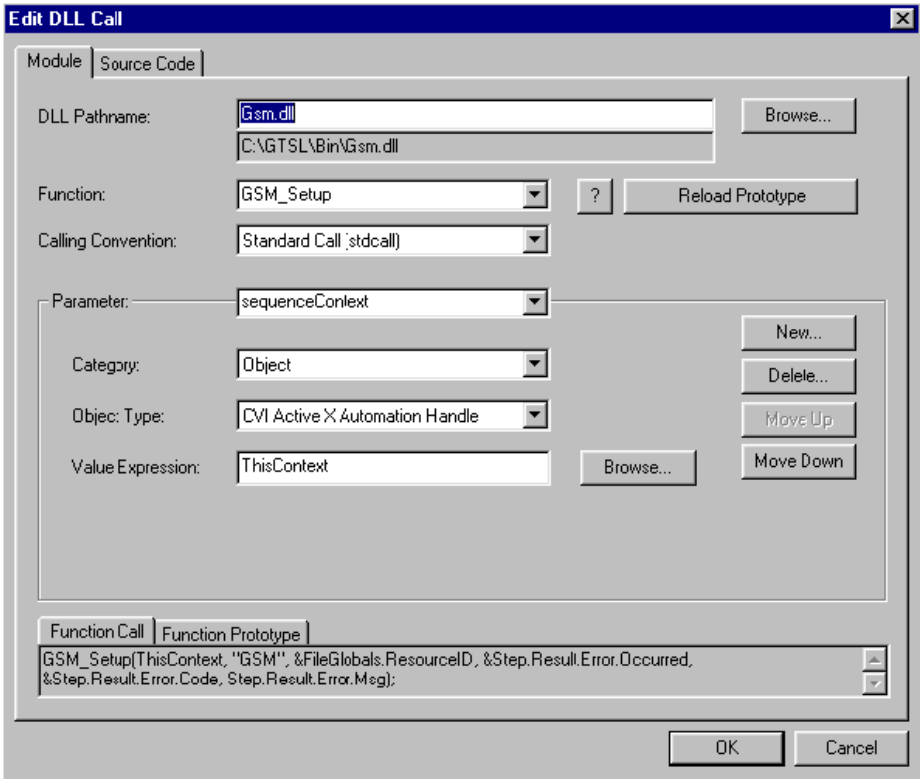


Figure 6-5: Edit DLL Call

The settings for the selected test step are made on the **"Module"** tab in this window.

"DLL Pathname:"	Shows the name of the test library or the name of the dynamic link library (DLL) of the test library. The memory path of the DLL file is displayed.
"Browse..."	Opens the directory structure for the selection of the test library (DLL)
"Function"	Shows a pick list of the test functions in the test library. The selected test function is displayed.
"?"	Shows the help text for the selected test function. The function, purpose and parameters of the test function are displayed.
"Reload Prototype"	The test function is reloaded
"Calling Convention:"	Always set to Standard Call in the case of R&S test functions
"Parameter:"	Displays a pick list of the parameters contained in the test function. The selected parameter is displayed.
"Category:"	Shows the various parameter settings. These settings are parameter specific.
"Object Type"	
"Value Expression"	

"Browse..."	
"New..."	These buttons are used to insert, delete and move parameters manually.
"Delete..."	
"Move Up"	
"Move Down"	

6.1.3 Running Test Sequences

The edited test sequence can be run directly in the TestStand Sequence Editor.

The opened test sequence is run once with **"Execute" -> "Single Pass"**.

The started test sequence is run in a separate window. The result of the test sequence is displayed in a Report Window.

Select **"Execute" -> "Test UUTs"** to run the open test sequence in a continuous loop. The operator is prompted to enter a serial number before each run. The started test sequence is run in a separate window. Clicking **"Stop"** in the serial number input window cancels the test sequences. The results of the test sequences are displayed in a Report Window with the corresponding serial number.

The Report Window must be closed when the test sequences have completed.

6.2 Generic Test Operator Interface R&S GTOP

6.2.1 General

The generated test sequences can also be executed via the Generic Test Operator Interface R&S GTOP. The R&S GTOP is a user interface, which has been specifically developed for application in multi-channel systems in the production area. R&S GTOP can only be used to run test sequences. Test sequences cannot be created or altered. Neither is it possible to debug test sequences.

The TestStand Run Time Engine and the Operator Interface Library are required to run the test sequences in the Generic Test Operator Interface (R&S GTOP). Figure 6-6 shows the integration of the R&S GTOP when performing a test sequence.

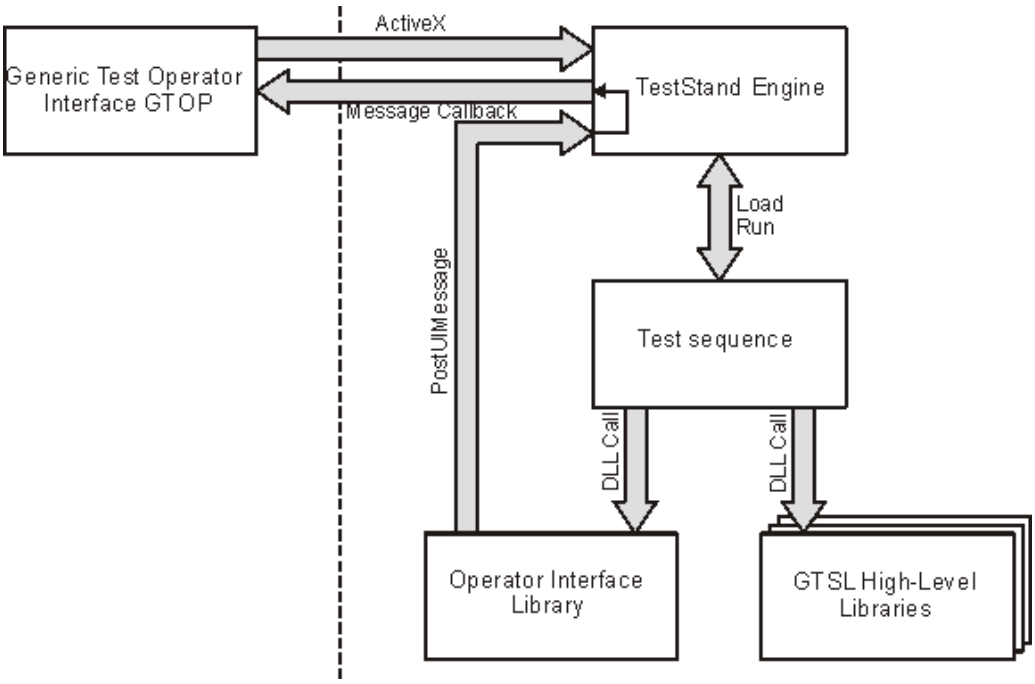


Figure 6-6: Integration of Generic Test Operator Interface R&S GTOP

The Operator Interface Library provides the functions for interaction between the test sequence in the TestStand and R&S GTOP.

The individual functions in the Operator Interface Library are described in the enclosed help file.

The directory `...\gtsl\operatorinterface\develop\gtop` contains several example files, which render the configuration and the running of R&S GTOP apparent. These files include:

- `gtop_demo.bat`
  shows how to call R&S GTOP from the command line.
- `gtop_demo.ini`
  is a sample configuration file for R&S GTOP
- `gtop_demo.seq`
  is a channel-independent sequence which shows how to
  - use the OPERINT functions in the PreUUT and PostUUT callbacks
  - use OPERINT_Get_Channel to find out if R&S GTOP is available and on which channel the sequence is running.
  - make a sequence independent from the operator interface, i.e. how it can run with optimum results on R&S GTOP and with good results on a different operator interface like the TestStand sequence editor.
- `gtop_demo_phys.ini, gtop_demo_appl.ini`
  The files are the physical and application layer ini files for the resource manager

Although R&S GTOP has been designed to meet many wishes of our customers, you may want to customize the appearance or functionality of the operator interface. Therefore, the R&S GTOP application and the OPERINT library are shipped with source code. You will find the sources in the following directories:

- `...\gtsl\operatorinterface\develop\gtop`
- `...\gtsl\develop\libraries\operint`

Do not modify the original source files. Copy all files to a different directory outside the R&S GTSL directory tree and work on the copy, otherwise your changes may be overwritten after the next R&S GTSL update.

How to modify the appearance of R&S GTOP:

Load the project file `GTOP.PRJ` in CVI and open the file `GTOP.UIR`. Modify text and colors, include your company logo etc. as required. However, be careful with modifications of size and position of any panel.

How to modify the functionality of R&S GTOP:

Load the project file `GTOP.PRJ` in CVI and modify the source code. The R&S GTOP project is based on the National Instruments CVI operator interface, which is part of TestStand. Once you understand how the CVI operator interface works, you will also be able to modify the functionality of R&S GTOP.

Most of the R&S GTOP-specific functions can be found in the source module `applspec.c`.

6.2.2 Running R&S GTOP

The Generic Test Operator Interface R&S GTOP is run using the gtop.exe file. When running the file a R&S GTOP configuration file name must also be given (see Chapter 6.2.4, "R&S GTOP Configuration File", on page 49).

Example: `gtop.exe gtop_demo.ini`

If, when run, GTOP configuration file is not specified, an error message is issued and the start of the program is canceled.

Figure 6-7: Start Error Message

If a valid R&S GTOP configuration file is present, R&S GTOP is started with the details specified within it. The start screen is displayed (see Figure 6-8) and a request to enter the user name and password (see Figure 6-9). The user name and password are specified in the TestStand software's user profile.

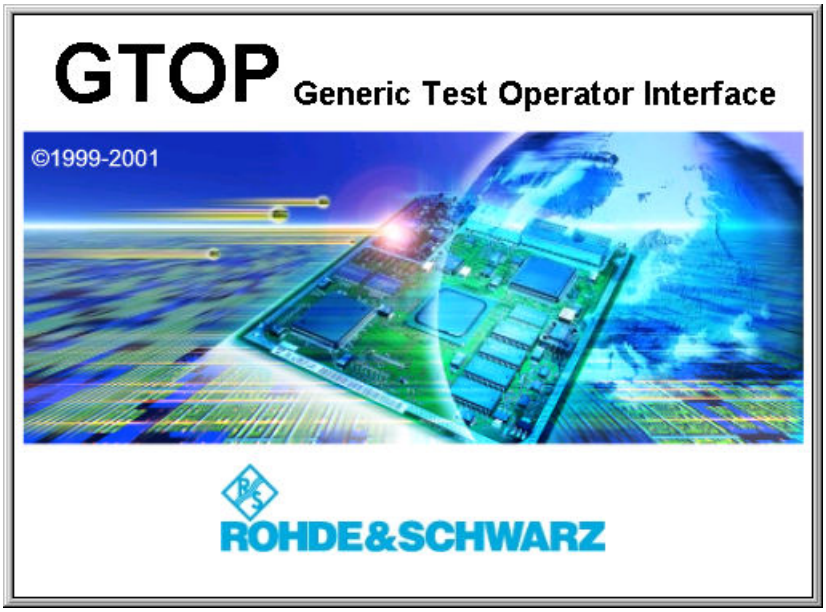


Figure 6-8: Start Screen

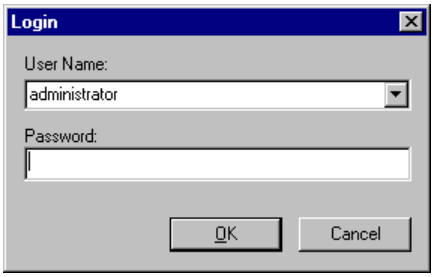


Figure 6-9: Login

Default Configuration

User Name:	administrator
Password:	No password required

User name and password can be defined in company-specific terms.

The exact procedure for defining a user name and password is described in the enclosed TestStand documentation.

After a valid user name and password is entered the test sequences contained in the R&S GTOP configuration file are loaded and automatically started. It is not possible to stop individual test sequences. It is only possible to terminate the complete Generic Test Operator Interface R&S GTOP using the **"File" -> "Exit"** menu item.

6.2.3 Operator Interface

The Generic Test Operator Interface R&S GTOP shown below is configured for a 2-channel system. If a 1-channel system configuration is used, the right-hand operator interface remains blank.

6.2.3.1 Representation

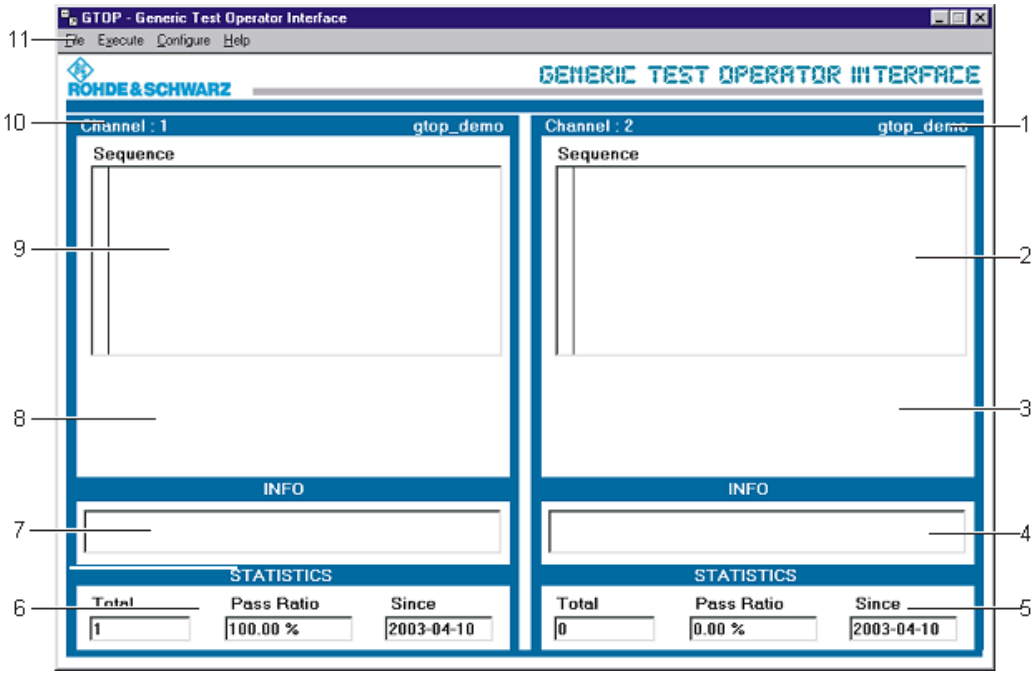


Figure 6-10: Generic Test Operator Interface R&S GTOP

1 = Display panel, channel 2
2 = Test-sequence display, channel 2
3 = Banner display, channel 2
4 = Information line, channel 2
5 = Statistic line, channel 2
6 = Statistic line, channel 1
7 = Information line, channel 1
8 = Banner display, channel 1
9 = Test-sequence display, channel 1
10 = Display panel, channel 1
11 = Menu bar

6.2.3.2 Menu Bar

The menu bar is used to call up the functions for operating and configuring the Generic Test Operator Interface R&S GTOP. The menu items called up from R&S GTOP then open the corresponding dialogs in TestStand. The menu items are enabled or blocked in accordance with the user's privileges (see also the TestStand documentation).

The table below describes the available functions.

Table 6-1: Menu Bar

File	Login	Login using another name (shift change, administrator login)
	Exit	Terminate all sequences, exit Generic Test Operator Interface R&S GTOP
Execute	Tracing Enabled	Switch tracing on and off in the test sequence display
Configure	Adapters	Default TestStand configuration dialog
	Station Options	Default TestStand configuration dialog
	External Viewers	Default TestStand configuration dialog
	Search Directories	Default TestStand configuration dialog
	Statistic Options	Configuration of statistic options (see Chapter 6.2.3.6, "Statistic Display", on page 48)
	Report Options	Default TestStand configuration dialog
	Database Options	Default TestStand configuration dialog
Help	About	Display information on Generic Test Operator Interface R&S GTOP (version number)

6.2.3.3 Test Sequence Display

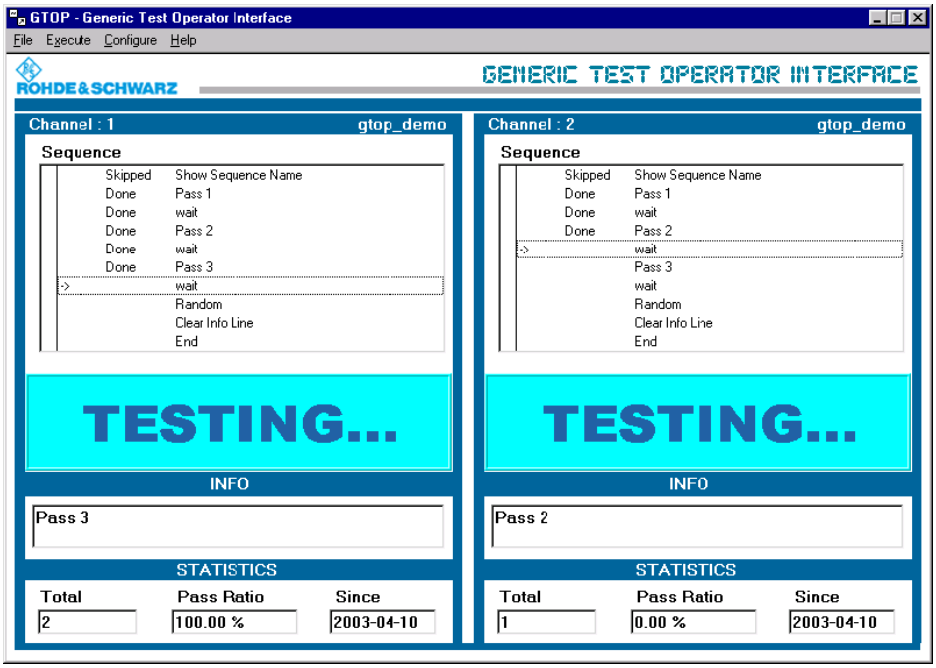


Figure 6-11: Test Sequence Display

The test sequence display represents a small section of the current test sequence. If under the <Execute> <Tracing Enabled> menu item, tracing is activated (ticked off), the current step is marked by an arrow "->". Step flags are displayed by letters (e.g. "S" for skip). This is followed by the step result (Done, Passed, Failed,..) and the name of the step. Faulty steps are displayed in another color (red).

6.2.3.4 Banner

Banners are changing, colored highlighted displays. Certain banners may cover up the test sequence display. The various banners are filed in the Operator Interface Library as functions and can be integrated into the test sequence.

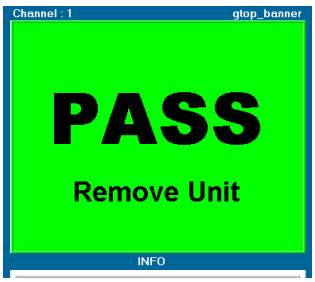
During a standard process, each channel of the test sequence process and the "Testing..." banner below are displayed. Invoking the corresponding function from the Operator Interface Library enables the selected banner to be superimposed over the test sequence and thus displayed. The selected banner is displayed until:

- the display of a new banner is invoked from the test sequence.
- the function for clearing the selected banner is invoked from the test sequence.

Banners are not placed on top of each other. Only one banner is displayed per channel. It is therefore not necessary to explicitly delete every single banner. Only when the test sequence display is to be shown again, is it necessary to delete the displayed banner.

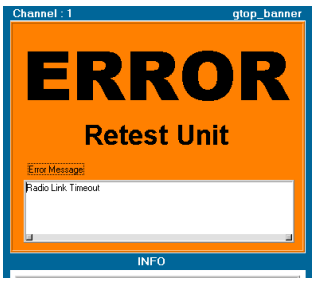
There are two types of banner:

1. Permanent banners

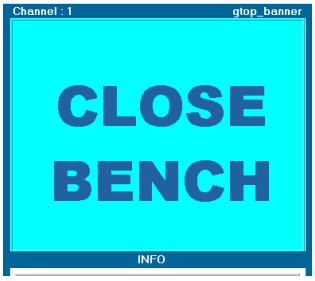


Pass Banner

Fail Banner



Error Banner

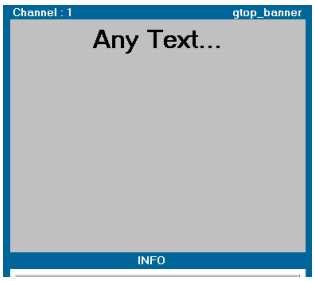


Close Bench Banner

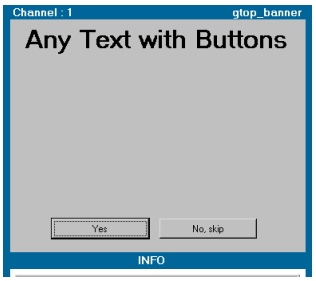
Terminated Banner

Permanent banner text is given in the appropriate function of the Operator Interface Library. The texts can be easily converted to UIR files without any modification to the source code. On the "Fail Banner" and "Error Banner" additional free text can also be displayed. The text is transferred from the test sequence to the banner. See also the help file in the Operator Interface Library.

2. Configurable banners



Text Banner



Dialog Banner

Dialog and Prompt Banner

The content of the configurable banners is transferred over the corresponding Operator Interface Library functions from the test sequence to the Generic Test Operator Interface R&S GTOP. The following configurations are possible:

- Text content
- Button inscription
- Text and background color

The "Text Banner" displays a freely selectable text. The "Text Banner" is displayed until a new banner is invoked or the banner displayed is deleted.

The "Dialog Banner" displays a freely selectable text and up to two buttons. The "Dialog Banner" is displayed until a button is clicked.
The "Dialog and Prompt Banner" displays a freely selectable text and an input capability (e.g. for entering a serial number). Here too, up to two buttons can be displayed. The data entered is returned to the test sequences. The "Dialog and Prompt Banner " is displayed until a button is clicked.
See also the help file in the Operator Interface Library.

6.2.3.5 Information Bar

The user can display freely selectable text on the information bar. The text content is given in the corresponding functions in the Operator Interface Library and integrated into the test sequence. The text in the information bar is displayed until it is overwritten by a new text.

6.2.3.6 Statistic Display

Data is collated and displayed for the statistic display throughout the test sequence process.

Total	Displays the number of tests performed.
Pass Ratio	Displays the tests demarcated as PASS as a percentage.
since	Displays the date, from which the statistic data has been collated.

In order to ensure that the statistics can continue to be collated over an extended period of time and beyond, the corresponding data is stored in the configuration file when exiting the Generic Test Operator Interface R&S GTOP (see Chapter 6.2.4, "R&S GTOP Configuration File", on page 49). The next time the R&S GTOP is started this data is then loaded again and continued.

The <Configure><Statistic Options> menu item enables the dialog window for configuring the statistic options to be called up (see Figure 6-12).

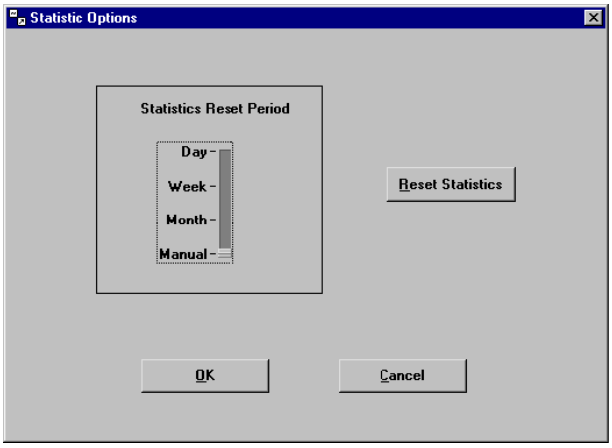


Figure 6-12: Statistic Options

Statistics Reset Period	This selector switch enables the time period to be configured for determining when the statistic data should automatically be reset.
	Day • The statistic data is automatically reset at the end of a day. Week • The statistic data is automatically reset at the end of a week. Month • The statistic data is automatically reset at the end of a month. Manual • The statistic data can only be reset manually (Button **"Reset Statistics"**)
Reset Statistics	Resets the statistic data.
OK	The configurations made are saved in the configuration file and the dialog window is closed.
Cancel	The configurations made are cancelled and the dialog window closed.

6.2.4 R&S GTOP Configuration File

The R&S GTOP configuration file is, as everywhere in the R&S GTOP, structured similar to a Windows INI file.

Example:

```
[OperatorInterface]
NumPanels = 2
Statistics_Type = "daily"

[Panel_1]
SequenceFile = "C:\Program Files\GTSL\Sequences\test.seq"
Statistics_Start = "2001-04-03"
Total_Ok = 24
Total_Tested = 48

[Panel_2]
SequenceFile = "C:\Program Files\GTSL\Sequences\test.seq"
Statistics_Start = "2001-04-03"
Total_Ok = 24
Total_Tested = 48
```

The configuration file contains a general section [OperatorInterface] and a channel-specific section [Panel_n].

[OperatorInterface]	
`NumPanels =`	Shows the number of channels which are to be displayed in the Generic Test Operator Interface R&S GTOP. A channel-specific section [Panel_n] must be given for each channel. Permissible value: 1 or 2
`Statistics_Type =`	Indicates the period when the statistic data is to be automatically reset. Permissible data: • daily • weekly • monthly • manually
[Panel_n]	
`SequenceFile =`	Indicates the path and file name of the test sequences to be performed in this channel.
`Statistics_Start =`	Indicates the date, from which the statistic data has been collated.
`Total_Ok =`	Indicates the number of tests concluded with a PASS.
`Total_Tested =`	Displays the number of tests performed.

The "NumPanels" and "SequenceFile" entries must be given in the configuration file. If these entries are missing, an error message is issued and the start of the Generic Test Operator Interface R&S GTOP is terminated.

All other entries relate to statistic data. This data is automatically entered into the configuration file using default values (see Table 6-2).

Table 6-2: Configuration file Default Value

INI File Eintrag	Standardwert
`Statistics_Type`	"manually"
`Statistics_Start`	Today's date in "yyyy-mm-dd" format
`Total_Ok`	0
`Total_Tested`	0

7 Test Libraries

The following sections briefly review the test functions which are available in the test libraries created by ROHDE & SCHWARZ.

A description of the individual test functions and their parameters will be found in the online help for the particular test library. The help files (`.HLP`, `.CHM`) are in the directory `...\GTSL\BIN`.

7.1 Generic Test Libraries

Starting with GTSL 3.30, no GTSL license is required.

7.1.1 Audio Analysis Library

7.1.1.1 General

Name of the dynamic link library (DLL):	`AUDIOANL.DLL`
Name of the help file:	`AUDIOANL.HLP`, `AUDIOANL.CHM`
License required:	R&S TS-LAAA
Supported devices:	Not required

The Audio Analysis Library offers functions to analyze audio waveform data in memory. The following analysis functions are supported:

- RMS calculation
- Single-/Multitone frequency response
- Distortion
- Filters (low-pass, high-pass, band-pass, band-stop, CCIR weighted/unweighted)
- Windows

7.1.1.2 Entries in PHYSICAL.INI

No entries required.

7.1.1.3 Entries in APPLICATION.INI

Section [bench->...]

Keyword	Value	Description
Trace	0 / 1	*Optional entry* Blocks the tracing function of the library (value = 0), enables the tracing function of the library (value = 1). Default = 0

7.1.1.4 Functions

```
Management
   Setup                          AUDIOANL_Setup
   Library Version                AUDIOANL_Lib_Version
   Cleanup                        AUDIOANL_Cleanup
Configuration
   Configure Filter               AUDIOANL_Configure_Filter

Calculation
   Frequency Response             AUDIOANL_Freq_Response
   Distortion                     AUDIOANL_Distortion
   RMS                            AUDIOANL_RMS
   Filter Delay                   AUDIOANL_Filter_Delay
```

7.1.2 DC Power Supply Test Library

7.1.2.1 General

Name of the dynamic link library (DLL):	DCPWR.DLL
Name of the help file:	CPWR.HLP, DCPWR.CHM
License required	R&S TS-LBAS
Supported devices:	R&S TS-PSAM Analog Stimulus Measurement Module R&S TS-PSU Power Supply / Load Module R&S TS-PSU12 Power Supply / Load Module 12V Any DC Power Supply with an IVI device driver

The DCPWR Library controls one or more DC power supplies with drivers that conform to the `IviDCPwr` Class specification. It provides high level functions for controlling several DC power supply devices in one bench. Each power supply device provides one or more DC power channels.

7.1.2.2 Entries in PHYSICAL.INI

Section [device->...]

Keyword	Value	Description
Type	String	*Mandatory entry* for R&S TS-PSAM : PSAM for R&S TS-PSU : PSU for R&S TS-PSU12 : PSU12 for other IviDcPwr compliant instruments : IVI_DCPWR

ResourceDesc	String	*Mandatory entry*
		VISA resource descriptor in the form
		`PXI[segment number]::[device number]::[function]::INSTR`
		`CAN[board]::[controller]::[frame]::[slot]`
		`GPIB[board]::[primary address]::[secondary address]`

DriverPrefix	String	*Mandatory entry* Prefix for the IVI driver functions for R&S TS-PSAM : rspsam for R&S TS-PSU: rspsu for R&S TS-PSU12: rspsu for others: driver dependent
DriverDLL	String	*Mandatory entry* File name of the driver DLL for R&S TS-PSAM: rspsam.dll for R&S TS-PSU: rspsu.dll for R&S TS-PSU12: rspsu.dll for others: driver dependent
DriverOption	String	*Optional entry* Option string being passed to the device driver during the driver's InitWithOptions function. See the online help file for the appropriate device driver.

7.1.2.3 Entries in APPLICATION.INI

Section [bench->...]

Keyword	Value	Description
DCPwrSupply<i>	String	*Mandatory entry* Reference to a DC power supply device section. <i> stands for a number 1,2,3,...,n. Numbers must be in ascending order without gaps. <i> may be omitted in the case it is 1.
DCPwrChannelTable	String	*Mandatory entry* Reference to the application channel table section.
Simulation	0 / 1	*Optional entry* Enables/disables library-level simulation, default = 0
Trace	0 / 1	*Optional entry* Enables/disables tracing, default = 0

Section [io_channel->...] (Mandatory entries)

Contains a list of user-defined channel names with corresponding device names and device channel names. For details about channel name syntax see Chapter 8.3.4, "Channel tables", on page 117.

Keyword	Value	Description
<user-defined name>	String	Physical channel description in the form <device name>!<device channel name>

7.1.2.4 Functions

```
Management
   Setup                              DCPWR_Setup
   Library Version                    DCPWR_Lib_Version
   Cleanup                            DCPWR_Cleanup
Configuration
   Voltage Level                      DCPWR_Conf_Voltage_Level
   Overvoltage Protection             DCPWR_Conf_OVP
   Current Limit                      DCPWR_Conf_Current_Limit
   Output Range                       DCPWR_Conf_Output_Range
   Output Enabled                     DCPWR_Conf_Output_Enabled
Information
   Query Max Current Limit            DCPWR_Query_Max_Current_Limit
   Query Max Voltage Level            DCPWR_Query_Max_Voltage_Level
   Query Output State                 DCPWR_Query_Output_State
Utility
   Reset                              DCPWR_Reset
   Reset Output Protection            DCPWR_Reset_Output_Protection
```

```
Measurement
   Measure                              DCPWR_Measure
Trigger
   Configure Trigger Source             DCPWR_Conf_Trigger_Source
   Configure Triggered Voltage Level    DCPWR_Conf_Triggered_Voltage_Level
   Configure Triggered Current Limit    DCPWR_Conf_Triggered_Current_Limit
   Initiate                             DCPWR_Initiate
   Abort                                DCPWR_Abort
   Send Software Trigger                DCPWR_Send_Software_Trigger
Instrument Driver Support
   Get Instrument Handle                DCPWR_Instrument_Get_Handle
TS-PSU Specific Functions
   Configure Mode                       DCPWR_Conf_Mode
   Configure Relay Protection           DCPWR_Conf_Relay_Protection
   Configure Remote Sensing             DCPWR_Conf_Remote_Sensing
   Configure PWM Output                 DCPWR_Conf_Output_PWM
   Configure Trigger Output             DCPWR_Conf_Trigger_Output
   Configure Measurement                DCPWR_Conf_Measurement
   Initiate Trigger                     DCPWR_Initiate_Trigger
   Acquisition
      Configure Acquisition             DCPWR_Conf_Acquisition
      Initiate Acquisition              DCPWR_Initiate_Acquisition
      Fetch Acquisition                 DCPWR_Fetch_Acquisition
      Abort Acquisition                 DCPWR_Abort_Acquisition
   Arbitrary Waveform Output
      Set Arbitrary Waveform            DCPWR_Set_Arb_Wfm
      Configure Arbitrary Waveform          DCPWR_Conf_Arb_Wfm
      Configure Arbitrary Waveform Abort DCPWR_Conf_Arb_Wfm_Abort
      Initiate Arbitrary Waveform       DCPWR_Initiate_Arb_Wfm
      Abort Arbitrary Waveform          DCPWR_Abort_Arb_Wfm
   Gated Output
      Configure Gated Output            DCPWR_Conf_Gated_Output
      Enable Gated Output               DCPWR_Enable_Gated_Output
   PAC Control
      Configure PAC Control             DCPWR_Conf_PAC_Control
   Sink Modes
      Configure Constant Current        DCPWR_Conf_Const_Current
      Configure Constant Resistance     DCPWR_Conf_Const_Resistance
      Configure Constant Power          DCPWR_Conf_Const_Power
      Query Sink State                  DCPWR_Query_Sink_State
TS-PSAM Specific Functions
   Configure Pulsed Mode                DCPWR_Conf_Pulsed_Mode
TS-PSU and TS-PSAM Specific Functions
   Configure Ground Relay               DCPWR_Conf_Ground_Relay
   Wait Until Settled                   DCPWR_Wait_Until_Settled
```

7.1.3 Digital I/O Manager Library

7.1.3.1 General

Name of the dynamic link library (DLL):	DIOMGR.DLL
Name of the help file:	DIOMGR.HLP, DIOMGR.CHM
License required:	R&S TS-LBAS
Supported devices:	R&S TS-PDFT, Digital Functional Test Module R&S TS-PIO3B, Digital I/O Module R&S TS-PIO4, Digital Functional Test Module R&S TS-PIO5, Digital Functional Test Module

The Digital I/O Manager (DIO Manager) provides high level functions for digital functional tests based on one or more R&S TS-PDFT module(s). These functions include:

- Configuration of stimulus and response channels
- Application of binary stimulus patterns
- Collection of binary response data

Stimulus and response patterns can be executed at an arbitrary rate, usually under computer control. This is referred to as "Static Execution". Application of stimulus and collection of response patterns at a fixed clock rate is referred to as "Dynamic Execution".

The "Static Execution" functions of the DIO Manager not only support R&S TS-PDFT modules, but also R&S TS-PIO3B modules.

The DIO Manager supports static and dynamic pattern execution across several R&S TS-PDFT modules and also static pattern executions across several R&S TS-PIO3B, R&S TS-PIO4 or R&S TS-PIO5 modules. Stimulus and response channels can be defined through logical channel names.

Dynamic pattern sets can be designed graphically with the waveform editor of the ALTERA "Quartus II Web Edition" software. The DIO Manager imports the waveform file, executes the pattern set and exports the results into a file. Deviations from the expected patterns can be easily located by comparing both files in the Quartus waveform editor.

7.1.3.2 Entries in PHYSICAL.INI

Section [device->...]

Keyword	Value	Description
Type	String	*Mandatory entry* R&S TS-PDFT: pdft R&S TS-PIO3B: pio3b R&S TS-PIO4: pio4 R&S TS-PIO5: pio5

ResourceDesc	String	*Mandatory entry*
		VISA resource descriptor in the form
		`PXI[segment number]::[device number]::[function]::INSTR`
		`CAN[board]::[controller]::[frame]::[slot]`

DriverPrefix	String	*Mandatory entry* prefix for the IVI driver functions, without underscore R&S TS-PDFT: rspdft R&S TS-PIO3B: rspio3b R&S TS-PIO4: rspio4 R&S TS-PIO5: rspio5
DriverDLL	String	*Mandatory entry* File name of the driver DLL R&S TS-PDFT: `rspdft.dll` R&S TS-PIO3B: `rspio3b.dll` R&S TS-PIO4: `rspio4.dll` R&S TS-PIO5: `rspio5.dll`
DriverOption	String	*Optional entry* Option string being passed to the device driver during the Driver's InitWithOptions function. See the online help file for the appropriate device driver.

7.1.3.3 Entries in APPLICATION.INI

Section [bench->...]

Keyword	Value	Description
DIODevice<i>	String	*Mandatory entry* Refers to a section with digital I/O devices in `PHYSICAL.INI` <i> stands for a number from 1,2,3,...,40. The numbers must be assigned in ascending order without gaps. <i> may be omitted in the case it is 1.
DIOChannelTable	String	*Mandatory entry* Refers to a section with defined channel names in `APPLICATION.INI`.
DIOTriggerLine	String	*Optional entry* Specifies a PXI trigger line for synchronization of two or more R&S TS-PDFT modules Valid values : 0 - 7 Default : 1
Simulation	0 / 1	*Optional entry* Blocks simulation of all entered devices (value = 0). Enables simulation of the entered devices (value = 1). Default = 0
Trace	0 / 1	*Optional entry* Blocks the tracing function (value = 0), Enables the tracing function (value = 1). Default = 0
ChannelTableCase Sensitive	0 / 1	*Optional entry* The channel names in the channel table are treated case-sensitive (value = 1) or case-insensitive (value = 0).

Section [io_channel->...] (Optional entries)

Mandatory entry

Contains a list of user-specific channel names which are assigned to the physical device names and to the physical device channel names. The defined names apply only to the relevant application. For details about channel name syntax see Chapter 8.3.4, "Channel tables", on page 117.

Keyword	Value	Description
<user-defined name>	String	Physical channel description in the form: <device name>!<device channel name>. Permissible R&S TS-PDFT channel names are: OUT1 - OUT32 (stimulus channesl) IN1 - IN32 (response channels) PO1 - PO4 (power output channels) Permissible R&S TS-PIO3B channel names are: PxIOy with x=0..7 and y=0..7(stimulus/response channels) P9TIOy with y=0..7 (stimulus/ response channels) INH (inhibit stimulus channel) Permissible R&S TS-PIO4 channel names are: OUT1 - OUT32 (stimulus channels) IN1 - IN32 (response channels) Permissible R&S TS-PIO5 channel names are: OUT1 - OUT32 (stimulus channels) IN1 - IN32 (response channels)

7.1.3.4 Functions

```
Management
   Setup                              DIOMGR_Setup
   Library Version                    DIOMGR_Lib_Version
   Cleanup                            DIOMGR_Cleanup
Configuration
   Configure Stimulus                 DIOMGR_ConfigureStimulus
   Configure Response                 DIOMGR_ConfigureResponse
   Configure Loopback                 DIOMGR_ConfigureLoopback
Static Execution
   Port Stimulus                      DIOMGR_PortStimulus
   Port Response                      DIOMGR_PortResponse
Dynamic Execution
   Configuration
      Load Waveform                   DIOMGR_LoadWaveform
      Configure Pattern Set Timing    DIOMGR_ConfigurePatternSetTiming
      Save Waveform                   DIOMGR_SaveWaveform
      Unload Waveform                 DIOMGR_UnloadWaveform
```

```
   Action
      Execute Pattern Set              DIOMGR_ExecutePatternSet
      Wait Until Pattern Set Complete DIOMGR_WaitUntilPatternSetComplete
      Abort Pattern Set                DIOMGR_AbortPatternSet
   Results
      Number of Executed Patterns      DIOMGR_GetPatternSetExecutedPatternCount
      Number of Failed Patterns        DIOMGR_GetPatternSetFailedPatternCount
      Number of Failed Channels        DIOMGR_GetPatternSetFailedChannelCount
      Failed Channel Names             DIOMGR_GetPatternSetFailedChannelNames
      High/Low Data of a Channel       DIOMGR_GetPatternSetChannelData
      Pass/Fail Results of a Channel   DIOMGR_GetPatternSetChannelResults
Instrument Driver Support
   Get Instrument Handle               DIOMGR_Instrument_Get_Handle
```

7.1.4 DMM Test Library

7.1.4.1 General

Name of the dynamic link library (DLL):	DMM.DLL
Name of the help file:	DMM.HLP, DMM.CHM
License required	R&S TS-LBAS
Supported devices:	National Instruments NI4060, any other DMM with IVI compliant driver R&S TS-PSAM

The DMM Library has been implemented to control numerous digital multimeter drivers that conform to the IviDmm Class specification. At present both the IVI-5 specification functions and those determined obsolete are supported.

The DMM Library provides high level functions for configuring and performing measurements.

7.1.4.2 Entries in PHYSICAL.INI

Section [device->...]

Keyword	Value	Description
Type	String	*Mandatory entry* NI4060 or IVI_DMM psam = R&S TS-PSAM Analog Source and Measurement Module
ResourceDesc	String	*Mandatory entry* VISA resource descriptor in the form `DAQ::[deviceNumber]::INSTR` (only NI460) `PXI[segment number]::[device number]::[function]::INSTR`
DriverPrefix	String	*Mandatory entry* Prefix for the IVI driver functions, without underscore: NI4060: niDMM IVI_DMM: driver dependent R&S TS-PSAM: rspsam
DriverDLL	String	*Mandatory entry* File name of the driver DLL NI4060: nidmm_32.dll IVI_DMM: driver dependent R&S TS-PSAM: `rspsam.dll`
DriverOption	String	*Optional entry* Option string being passed to the device driver during the Driver_Init function. See the online help file for the appropriate device driver.
PowerLineFrequency	50 or 60	*Optional entry* Sets the power line frequency in Hz, default = 60 (not for R&S TS-PSAM)

7.1.4.3 Entries in APPLICATION.INI

Section [bench->...]

Keyword	Value	Description
DigitalMultimeter	String	*Mandatory entry* Reference to multimeter device entry
Simulation	0 / 1	*Optional entry* Enables/disables library-level simulation, default = 0
Trace	0 / 1	*Optional entry* Enables/disables tracing, default = 0

7.1.4.4 Functions

```
Setup                                  DMM_Setup
Library Version                        DMM_Lib_Version
Configuration Functions
   Configure Measurement               DMM_Conf_Measurement
   Configure Trigger                   DMM_Conf_Trigger
   Configure Trigger Slope             DMM_Conf_Trigger_Slope
   Configure Auto Zero Mode            DMM_Conf_Auto_Zero_Mode
   Configure AC Bandwidth              DMM_Conf_AC_Bandwidth
   Configure Power Line Frequency      DMM_Conf_Power_Line_Frequency
   Configure Measurement Complete      DMM_Conf_Meas_Complete_Dest
   Configure Multi Point               DMM_Conf_Multi_Point
Measurement Functions
   Measure DC Voltage                  DMM_Meas_DC_Voltage
   Measure DC Current                  DMM_Meas_DC_Current
   Measure AC Voltage                  DMM_Meas_AC_Voltage
   Measure AC Current                  DMM_Meas_AC_Current
   Measure Resistance                  DMM_Meas_Resistance
   Low Level Measurement Functions
      Initiate                         DMM_Initiate
      Fetch                            DMM_Fetch
      Abort                            DMM_Abort
      Send Software Trigger            DMM_Send_Software_Trigger
Utility Functions
   Reset                               DMM_Reset
TS-PSAM Specific Functions
   Configure Lowpass Filter            DMM_Conf_Lowpass_Filter
   Configure Trigger Signal            DMM_Conf_Trigger_Signal
   Configure Analog Trigger            DMM_Conf_Analog_Trigger
   Configure Trigger Output            DMM_Conf_Trigger_Output
   Enable Trigger Output               DMM_Enable_Trigger_Output
   Send Software Signal                DMM_Send_Software_Signal
   Configure Coupling Relays           DMM_Conf_Coupling_Relays
   Configure Ground Relay              DMM_Conf_Ground_Relay
Cleanup                                DMM_Cleanup
```

7.1.5 Factory Toolbox Library

7.1.5.1 General

Name of the dynamic link library (DLL):	FTBLIB.DLL
Name of the help file:	FTBLIB.HLP, FTBLIB.CHM
License required	R&S TS-LBAS
Supported devices:	Digital IO Module 3B R&S TS-PIO3B

The "Factory Toolbox" library offers functions for identifying adapters via the Digital IO Module 3B R&S TS-PIO3B. Two methods are available for this purpose:

- Parallel adapter identification via ports
- Serial adapter identification via SPI-EEPROM

The identification of test adapters is parameterized either via entries in a configuration file for the application layer (APPLICATION.INI) or via function calls in the test program. An R&S TS-PIO3B module must be entered in the file for configuring the system (PHYSICAL.INI).

Parallel Adapter Identification via Ports

The parallel adapter identification is especially easy to implement but requires one or two complete 8 bit IO ports. For this purpose, the 8 open drain ports (P0 to P7) are available on the R&S TS-PIO3B module. To be able to identify an adapter uniquely, it is only necessary to connect wires in the adapter with GND. Port bits that have not been wired are read as "high" by the internal pull-up resistors.

Serial Adapter Identification via SPI-EEPROM

The serial adapter identification uses an SPI-EEPROM in the adapter and can be set up easily in connection with an R&S TS-PTRF. The Atmel AT25160 module, a 16 kBit (2 kByte) EEPROM for SPI is supported. In this way, all the open drain IO ports remain free and only one SPI Chip-Select signal (E_CSx) of the R&S TS-PTRF is occupied. In the following example, E_CS3 (port 3) is used for the adapter identification. In this case you have to observe that the SPI signals (E_MOSI, E_MISO and E_SCLK) as well as the selected Chip-Select signal must be connected to the front panel (X10) via jumpers on the R&S TS-PTRF module.

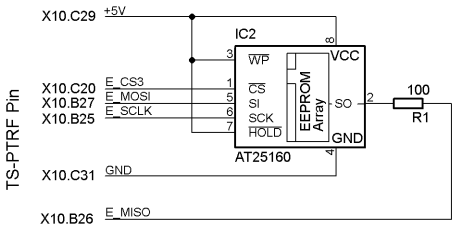


Figure 7-1: Serial adapter identification via SPI-EEPROM

7.1.5.2 Entries in PHYSICAL.INI

An R&S TS-PIO3B module must be installed in the system and the related entry must be available in the configuration file for the system.

Key	Value	Description
Type	String	*Mandatory entry* PIO3B
ResourceDesc	String	*Mandatory entry* resource descriptor in the form `CAN[board]::[controller]::[frame]::[slot]`
DriverPrefix	String	*Mandatory entry* Prefix for the IVI driver functions, without underscore: rspio3b
DriverDll	String	*Mandatory entry* File name of the driver DLL `rspio3b.dll`
DriverOption	String	*Optional Entry* Option string being passed to the device driver during the Driver_Init function. See the online help file for the appropriate device driver.
Description	String	*Optional Entry* Gives a detailed description of the defined device.

7.1.5.3 Entries in APPLICATION.INI

This configuration file is usually created individually for each unit under test / each test program. It can be assigned any name and stored in any directory. The following table provides an overview of the keywords.

Section [bench->...]

Key	Value	Description
AdaIdentDevice	String	*Optional entry* Refers to the device section of the TS-PIO3B (e. g. AdaIdentDevice = device->rspio3b_1) if the adapter identification functionality.
AdaIdentParPortLo	0...7	*Optional entry* R&S TS-PIO3B port from which the lower 8 bits of the adapter identification are read. Default = 0

Key	Value	Description
AdaIdentParPortHi	0...7	*Optional entry* R&S TS-PIO3B port from which the higher 8 bits of the adapter identification are read. If only one 8-bit identification is to be used, the same port as in the "AdaIdentPortLo" parameter is specified here. The higher 8 bits in the result will then be set to 0. Default = 0 (8 bit identification via port 0)
AdaIdentSpiPort	0..7	*Optional entry* Controls the Chip-Select generation via an R&S TS-PTRF module for the adapter identification with R&S TS-PIO3B via an SPI EEPROM. If the R&S TS-PTRF module is not available, this parameter will be ignored. Default = 0
Simulation	0 / 1	*Optional entry* Blocks the simulation of the entered devices (value = 0). Enables simulation of the entered devices (value = 1). Default = 0
Trace	0 / 1	*Optional entry* Blocks the tracing function of the library (value = 0). Enables the tracing function of the library (value = 1). Default = 0

7.1.5.4 Functions

The following routines are available for identifying a test adapter. Refer to the help file (`FTBLIB.HLP`) for a description.

```
Management

Setup                              FTBLIB_Setup
Library Version                    FTBLIB_Lib_Version
Cleanup                            FTBLIB_Cleanup

Adapter Identification
Parallel Port

Parallel Config Port               FTBLIB_AdaIdentParConfigPort
```

```
Parallel Read                    FTBLIB_AdaIdentParRead

SPI EEPROM

SPI Config Port                  FTBLIB_AdaIdentSpiConfigPort
SPI Read                         FTBLIB_AdaIdentSpiRead
SPI Write                        FTBLIB_AdaIdentSpiWrite
```

7.1.6 Function Generator Library

7.1.6.1 General

Name of the dynamic link library (DLL):	`FUNCGEN.DLL`
Name of the help file:	`FUNCGEN.HLP`, `FUNCGEN.CHM`
License required	R&S TS-LBAS
Supported devices:	R&S TS-PFG Arbitrary Waveform Generator Any other waveform generator with IVI compliant driver.

The Function Generator Library provides functions for waveform generators:

- Standard Waveforms
- Arbitrary Waveforms
- Arbitrary Waveform Sequences

7.1.6.2 Entries in PHYSICAL.INI

Section [device->...]

Keyword	Value	Description
Type	String	*Mandatory entry* PFG = R&S TS-PFG Arbitrary Waveform Generator IVI_FGEN = other IVI compliant generator
ResourceDesc	String	*Mandatory entry* VISA resource descriptor in the form `PXI[segment number]::[device number]::[function]::INSTR`

Keyword	Value	Description
DriverPrefix	String	*Mandatory entry* Prefix for the IVI driver functions, without underscore: IVI_FGEN: driver dependent R&S TS-PFG: rspfg
DriverDll	String	*Mandatory entry* File name of the driver DLL IVI_FGEN: driver dependent R&S TS-PFG: `rspfg.dll`
DriverOption	String	*Optional entry* Option string being passed to the device driver during the Driver_Init function. See the online help file for the appropriate device driver.

7.1.6.3 Entries in APPLICATION.INI

Section [bench->...]

Keyword	Value	Description
FunctionGenerator	String	*Mandatory entry* Reference to the device entry of the function generator in `PHYSICAL.INI`.
Simulation	0 / 1	*Optional entry* Blocks the simulation of the entered devices (value = 0). Enables simulation of the entered devices (value = 1). Default = 0
Trace	0 / 1	*Optional entry* Blocks the tracing function of the library (value = 0), enables the tracing function of the library (value = 1). Default = 0

7.1.6.4 Functions

```
Setup                                   FUNCGEN_Setup
Library Version                         FUNCGEN_Lib_Version
Basic Instrument Operation
   Configure Operation Mode             FUNCGEN_ConfigureOperationMode
   Configure Output Mode                FUNCGEN_ConfigureOutputMode
```

Configure Ref Clock Source	FUNCGEN_ConfigureRefClockSource
Configure Output Impedance	FUNCGEN_ConfigureOutputImpedance
Configure Output Enabled	FUNCGEN_ConfigureOutputEnabled
Initiate Generation	FUNCGEN_InitiateGeneration
Abort Generation	FUNCGEN_AbortGeneration
Standard Function Output	
Configure Standard Waveform	FUNCGEN_ConfigureStandardWaveform
Arbitrary Waveform Output	
Query Arb Waveform Capabilities	FUNCGEN_QueryArbWfmCapabilities
Create Arbitrary Waveform	FUNCGEN_CreateArbWaveform
Configure Arbitrary Waveform	FUNCGEN_ConfigureArbWaveform
Configure Sample Rate	FUNCGEN_ConfigureSampleRate
Clear Arbitrary Waveform	FUNCGEN_ClearArbWaveform
Arbitrary Frequency	
Configure Arbitrary Frequency	FUNCGEN_ConfigureArbFrequency
Arbitrary Sequence Output	
Query Arb Sequence Capabilities	FUNCGEN_QueryArbSeqCapabilities
Create Arbitrary Sequence	FUNCGEN_CreateArbSequence
Configure Arbitrary Sequence	FUNCGEN_ConfigureArbSequence
Clear Arbitrary Sequence	FUNCGEN_ClearArbSequence
Clear Arbitrary Memory	FUNCGEN_ClearArbMemory
Triggering	
Configure Trigger Source	FUNCGEN_ConfigureTriggerSource
Software Triggering	
Send Software Trigger	FUNCGEN_SendSoftwareTrigger
Burst Configuration	
Configure Burst Count	FUNCGEN_ConfigureBurstCount
Utility Functions	
Import Waveform Data	FUNCGEN_ImportWaveformData
Reset	FUNCGEN_Reset
TS-PFG Specific Functions	
Configure Trigger Delay	FUNCGEN_ConfigureTriggerDelay
Configure Filter	FUNCGEN_ConfigureFilter
Configure Arbitrary Marker	FUNCGEN_ConfigureArbMarker
Configure Marker Output	FUNCGEN_ConfigureMarkerOutput
Configure Coupling Relays	FUNCGEN_ConfigureCouplingRelays
Configure Ground Relay	FUNCGEN_ConfigureGroundRelay
Cleanup	FUNCGEN_Cleanup

7.1.7 Operator Interface Library

7.1.7.1 General

Name of the dynamic link library (DLL):	OPERINT.DLL
Name of the help file:	OPERINT.HLP, OPERINT.CHM

License required	R&S TS-LBAS
Supported devices:	not usable

The Operator Interface Library offers functions for interaction between the TestStand sequence and the R&S GTSL Operator Interface:

- Display of Banners and other Information
- Dialog Boxes
- User Input

If the R&S GTSL Operator Interface is not available (e.g. when a sequence is started from the TestStand Sequence Editor), the dialog boxes are replaced by simple pop-up dialogs.

This library requires TestStand as test executive, it cannot be run in other environments.

7.1.7.2 Entries in PHYSICAL.INI

No entries

7.1.7.3 Entries in APPLICATION.INI

Section [bench->...]

Keyword	Value	Description
Trace	0 / 1	*Optional entry* 0 : Disable tracing 1 : Enable tracing Default: 0

7.1.7.4 Functions

```
Setup                                OPERINT_Setup
Library Version                      OPERINT_Lib_Version
Information
   Get Associated Channel Number     OPERINT_Get_Channel
Display Functions
   Show Banner                       OPERINT_Show_Banner
   Show Customized Banner            OPERINT_Show_Custom_Banner
   Hide Banner                       OPERINT_Hide_Banner
   Customized Dialog                 OPERINT_Custom_Dialog
   Customized Input Prompt           OPERINT_Custom_Prompt
   Display Info Line                 OPERINT_Display_Info
Cleanup                              OPERINT_Cleanup
```

7.1.8 Resource Manager Library

7.1.8.1 General

Name of the dynamic link library (DLL):	RESMGR.DLL
Name of the help file:	RESMGR.HLP, RESMGR.CHM
License required	R&S TS-LBAS
Supported devices:	not usable

The Resource Manager Library provides functions for managing the hardware used in the test system.

7.1.8.2 Entries in PHYSICAL.INI

No entries

7.1.8.3 Entries in APPLICATION.INI

Section [Resource Manager]

Optional entry

Controls the tracing properties of the Resource Manager.

Keyword	Value	Description
Trace	0 / 1	Blocks the tracing function (value = 0), enables the tracing function (value = 1). Default = 0
TraceFile	String	Defines the path and the name of the trace file. Default = ""
TraceToScreen	0 / 1	The tracing information is displayed on the standard screen (value = 1). Default = 0
TraceTimeStamp	0 / 1	Writes the time of day at the start of each tracing line (value = 1). Default = 0
TraceThreadID	0 / 1	Writes the ID of the current thread at the start of each tracing line (value = 1). Default = 0

Keyword	Value	Description
TraceAppend	0 / 1	Appends lines to existing trace file (value = 1) Overwrites trace file (value = 0, default)
TraceAutoFlush	0 / 1	Writes trace lines immediately to disk (value =1) Buffers disk write operations (value = 0, default) Note that enabling this feature may degrade application performance significantly.

7.1.8.4 Functions

Management	
Setup	RESMGR_Setup
Library Version	RESMGR_Lib_Version
Cleanup	RESMGR_Cleanup
Resource Functions	
Allocate Resource	RESMGR_Alloc_Resource
Free Resource	RESMGR_Free_Resource
Informational	
Resource Type	RESMGR_Get_Resource_Type
Resource Name	RESMGR_Get_Resource_Name
Get Value	RESMGR_Get_Value
Compare Value	RESMGR_Compare_Value
Number of Sections	RESMGR_Number_Of_Sections
Nth Section Name	RESMGR_Nth_Section_Name
Number of Keys	RESMGR_Number_Of_Keys
Nth Key Name	RESMGR_Nth_Key_Name
Key Value	RESMGR_Get_Key_Value
Device Sessions	
Open Session	RESMGR_Open_Session
Get Session Handle	RESMGR_Get_Session_Handle
Set Session Handle	RESMGR_Set_Session_Handle
Close Session	RESMGR_Close_Session
Open Sub-Session	RESMGR_Open_SubSession
Get Session Sub-Handle	RESMGR_Get_Session_SubHandle
Set Session Sub-Handle	RESMGR_Set_Session_SubHandle
Close Sub-Session	RESMGR_Close_SubSession

Dynamic memory Management	
Allocate Memory	RESMGR_Alloc_Memory
Get Memory Pointer	RESMGR_Get_Mem_Ptr
Free Memory	RESMGR_Free_Memory
Allocate Shared Memory	RESMGR_Alloc_Shared_Memory
Lock Shared Memory	RESMGR_Lock_Shared_Memory
Unlock Shared Memory	RESMGR_Unlock_Shared_Memory
Free Shared Memory	RESMGR_Free_Shared_Memory
Locking	
Lock Device	RESMGR_Lock_Device
Unlock Device	RESMGR_Unlock_Device
Support Functions	
Read System Identification	RESMGR_Read_ROM
Enable Tracing	RESMGR_Enable_Tracing
Trace	RESMGR_Trace
Set Trace Flag	RESMGR_Set_Trace_Flag
Get Trace Flag	RESMGR_Get_Trace_Flag

7.1.9 Self Test Support Library

7.1.9.1 General

Name of the dynamic link library (DLL):	SFT.DLL
Name of the help file:	SFT.HLP, SFT.CHM
License required	R&S TS-LBAS
Supported devices	Self Test Multimeter: National Instruments NI4060 with Self Test Matrix Card R&S TS-PMA or Self Test Multimeter with integrated matrix R&S TS-PSAM

The self test support library contains functions which are common for all self test modules like measurements, report generation, run-time state handling and operator dialog functions.

7.1.9.2 Entries in PHYSICAL.INI

Section [device->...]

Keyword	Value	Description
SFTDLL	String	*Mandatory entry* File name of the self test DLL R&S TS-PAM : `sftmpam.dll` R&S TS-PDFT : `sftmpdft.dll` R&S TS-PFG : `sftmpft.dll` R&S TS-PICT : `sftmpict.dll` R&S TS-PIO2: `sftmpio2.dll` R&S TS-PMA : `sftmpma.dll` R&S TS-PMB : `sftmpmb.dll` R&S TS-PRL1 : `sftmprl1.dll` R&S TS-PSAM : `sftmpsam.dll` R&S TS-PSM1 : `sftmpsm1.dll` R&S TS-PSM2 : `sftmpsm2.dll` R&S TS-PSM3 : `sftmpsm3.dll` R&S TS-PSM4 : `sftmpsm4.dll` R&S TS-PSM5 : `sftmpsm5.dll` R&S TS-PSU : `sftmpsu.dll` R&S TS-PSU12 : `sftmpsu.dll` R&S TS-PSYS : `sftmpsys.dll`
SFTPrefix	String	*Mandatory entry* Prefix for the self test functions, without underscore. This entry is case sensitive: R&S TS-PAM : SFTMPAM R&S TS-PDFT : SFTMPDFT R&S TS-PFG : SFTMPFT R&S TS-PICT : SFTMPICT R&S TS-PIO2: SFTMPIO2 R&S TS-PMA : SFTPMA R&S TS-PMB : SFTMPMB R&S TS-PRL1 :SFTMPRL1 R&S TS-PSAM : SFTMPSAM R&S TS-PSM1 : SFTMPSM1 R&S TS-PSM2 : SFTMPSM2 R&S TS-PSM3 : SFTMPSM3 R&S TS-PSM4 : SFTMPSM4 R&S TS-PSM5 : SFTMPSM5 R&S TS-PSU : SFTMPSU R&S TS-PSU12 : SFTMPSU R&S TS-PSYS : SFTMPSYS

Example:

```
[device->RelayCard1]
Description = TS-PRL1 in Slot 7
Type = PRL1
ResourceDesc = PXI0::1::17
DriverDll = rsprl1.dll
DriverPrefix = rsprl1
SFTDll = SFTMPRL1.DLL
SFTPrefix = SFTMPRL1
```

Example of a physical layer .ini file for a R&S CompactTSVP system:

If the recommended self test hardware is installed, the following device section must be added:

```
[device->psam]
Description  = "TS-PSAM, source and measurement module, Slot 3"
Type         = PSAM
ResourceDesc = PXI1::15::0::INSTR
DriverDll    = rspsam.dll
DriverPrefix = rspsam
DriverOption = "Simulate=0,RangeCheck=1"
; Note: the self test DLL and prefix keywords must be removed for the
;       first TS-PSAM module, because it is already tested in the
;       basic self test.
;SFTDll       = sftmpsam.dll
;SFTPrefix    = SFTMPSAM
```

The type of the digital multimeter and the self test switch device must be "PSAM".

The "ResourceDesc" keys must match your hardware configuration.

Because this device is the self test instrumentation and under control of the self test library, this sections must not have the keys "SFTDll" and "SFTPrefix".

In order to test a Rohde & Schwarz CompactTSVP module (R&S TS-PFG, R&S TS-PMB, ...) the device section of these modules must contain the entries "SFTDll and SFTPrefix". The following sections show the entries for a R&S TS-PFG and a R&S TS-PMB module:

```
[device->pfg]
Description  = "TS-PFG, arbitrary function generator module, Slot 4"
Type         = PFG
ResourceDesc = PXI1::14::0::INSTR
DriverDll    = rspfg.dll
DriverPrefix = rspfg
SFTDll       = sftmpfg.dll
SFTPrefix    = SFTMPFG

[device->pmb]
Description  = "TS-PMB, matrix module, Slot 10"
Type         = PMB
ResourceDesc = CAN0::0::1::10
DriverDll    = rspmb.dll
```

```
DriverPrefix = rspmb
SFTDll       = sftmpmb.dll
SFTPrefix    = SFTMPMB
```

The values of the keys "SFTPrefix" and "DriverPrefix" are case sensitive.

The files `CompactTSVP_physical.ini` and `SFT_CompactTSVP_application.ini` in the `GTSL\Configuration` subdirectory are an example for the self test configuration of a R&S CompactTSVP test system.

Example of a physical layer .ini file for a Classic TSVP system:

If the recommended self test hardware is installed, the following two device sections must be added:

```
[device->SftRelayCard]
Description = "Self Test Matrix Card"
Type = PMA1
ResourceDesc = PXI2::11::0::INSTR
DriverPrefix = rspma
DriverDll = rspma.dll
DriverOption = "Simulate=0,DriverSetup=MCR:FFFFFFF6 CRAuto:1 BusSel:0"

[device->SftDMM]
Description = "Self Test Digital Multimeter"
type = NI4060
ResourceDesc = DAQ::2::INSTR
DriverPrefix = niDMM
DriverDll = nidmm_32.dll
DriverOption = "Simulate=0,DriverSetup=PXI-4060"
PowerLineFrequency = 50
```

The type of the switch device must be "PMA1"

The DriverSetup attribute in the DriverOption string of the PMA1 card must have the parameter setting "CRAuto:1"

The type of the digital multimeter must be "NI4060"

The "ResourceDesc" keys must match your hardware configuration

Because these two devices are the self test instrumentation and under control of the self test library these sections must not have the keys "SFTDll" and "SFTPrefix".

In order to test a Rohde & Schwarz TSVP module (R&S TS-PRL1, R&S TS-PMA) the device section of these cards must contain the new entries "SFTDll and SFTPrefix". The following sections show the entries for a R&S TS-PRL1 and a R&S TS-PMA card:

```
[device->RelayCard1]
Description = "Relay Card 1"
Type = PRL1
ResourceDesc = PXI3::10::0::INSTR
```

```
DriverPrefix = rsprl1
DriverDll = rsprl1.dll
DriverOption = "Simulate=0"
SFTDll = SFTMPRL1.DLL
SFTPrefix = SFTMPRL1

[device->MatrixCard1]
Description = "Matrix Card 1"
Type = PMA1
ResourceDesc = PXI1::11::0::INSTR
DriverPrefix = rspma
DriverDll = rspma.dll
DriverOption = "Simulate=0,DriverSetup=MCR:FFFFFFF6 CRAuto:0 BusSel:0"
SFTDll = SFTMPMA.DLL
SFTPrefix = SFTMPMA
```

The values of the keys "SFTPrefix" and "DriverPrefix" are case sensitive

The DriverSetup attribute in the DriverOption string of a PMA card must have the parameter setting "CRAuto:0" for self test! This can also be configured in the self test `application.ini` file.

The files `demo_physical.ini` and `sft_7100_application.ini` in the `GTSL\Configuration` subdirectory are an example for the self test configuration of a single channel TS7100 test system.

7.1.9.3 Entries in APPLICATION.INI

Section [bench->SFT]

Keyword	Value	Description
DigitalMultimeter	String	*Mandatory entry* Bench device link to the device entry of the multimeter: For R&S TSVP: National Instruments DMM 4060 For R&S CompactTSVP: R&S TS-PSAM
SwitchDevice	String	*Mandatory entry* Bench device link to the device entry of the matrix for the multimeter (R&S TS-PMA1)
Trace	0 / 1	*Optional entry* Enables/disables tracing, default = 0

Section [SftOptions]

Keyword	Value	Description
SystemName	String	The Name of the system to be tested. This Name appears in the header of the self test report. Default "-"
SFTFixture	0 / 1	1 : TSVP self test fixture is connected to the modules 0 : no SFT fixture present Default 1
ManualInterventions	0 / 1	1 : Additional tests which require user interaction 0 : SFT runs without further interaction. Default 1
ReportFile	String	Path and filename of report file Default `C:\TEMP\SFT_Report.txt`
ReportStyle	1 / 2 / 3 /...	1 : Only errors are reported 2 : Only a short report is generated 3 : Generates a full report all other entries: A full report is generated Default 1
ReportAppend	0 / 1 / 2	0 : Existing report file is overwritten 1 : Report is appended to existing file 2: A time stamp string is inserted in the given “Report File” name. This leads to a unique name (e.g. SFT_Report_2021_08_26_09_29_43.txt). Default 0
SuppressDialog	0 / 1	1 : Options dialog is not displayed 0 : Options dialog is displayed Default 0
StopOnFirstFailure	0 / 1	1 : SFT is aborted on first test case failure 0 : SFT is not aborted on first test case failure Default 0

Section [SftParts]

PartX	<PartName>, <BenchName>,<SelectFlag>

The keys have the format "PartX". Where X ist a continuous counter starting at 1. The values are comma separated lists with the following entries:

Part Name	An arbitrary name for a part to test. All parts must have a unique name.
Bench Name	Name of the corresponding bench
Select Flag	Default value for the selection 1: Part selected 0: Part not selcted

7.1.9.4 Functions

```
Management
     Setup                              SFT_Setup
     Library Version                    SFT_Lib_Version
     Cleanup                            SFT_Cleanup
  Measurement
     Dmm_reset                          SFT_Dmm_reset
     Dmm_Connect                        SFT_Dmm_Connect
     Dmm_Disconnect                     SFT_Dmm_Disconnect
     Dmm_DisconnectAll                  SFT_Dmm_DisconnectAll
     Dmm_MeasDelay                      SFT_Dmm_MeasDelay
     Dmm_WaitForDebounce                SFT_Dmm_WaitForDebounce
     Dmm_ConfigureMeasurement           SFT_Dmm_ConfigureMeasurement
     Dmm_ConfigureAutoZeroMode          SFT_Dmm_ConfigureAutoZeroMode
     Dmm_Read                           SFT_Dmm_Read
     Dmm_AverageMeasurement             SFT_Dmm_AverageMeasurement
     Dmm_checkForExternVoltage          SFT_Dmm_checkForExternVoltage
     Dmm_MeasureContact                 SFT_Dmm_MeasureContact
     Dmm_MeasureIsolation               SFT_Dmm_MeasureIsolation
  Trigger
     Dmm_TriggerConfSignal              SFT_Dmm_TriggerConfSignal
     Dmm_ConfigureTrigger               SFT_Dmm_ConfigureTrigger
     Dmm_EnableTriggerline              SFT_Dmm_EnableTriggerline
     Dmm_Initiate                       SFT_Dmm_Initiate
     Dmm_trig_SendSoftwareSignal        SFT_Dmm_trig_SendSoftwareSignal
     Dmm_Fetch                          SFT_Dmm_Fetch
  DC_Source
     dcs_ConfigureVoltageLevel          SFT_dcs_ConfigureVoltageLevel
     dcs_ConfigureCurrentLimitRange     SFT_dcs_ConfigureCurrentLimitRange
     dcs_ConfigureCurrentLimit          SFT_dcs_ConfigureCurrentLimit
     dcs_ConfigureOutputEnabled         SFT_dcs_ConfigureOutputEnabled
     dcs_QueryOutputState               SFT_dcs_QueryOutputState
  CNX
     cnx_ConfigureSwitches              SFT_cnx_ConfigureSwitches
     cnx_Gnd                            SFT_cnx_Gnd
     cnx_DmmToGnd                       SFT_cnx_DmmToGnd
     cnx_Matrix                         SFT_cnx_Matrix
```

cnx_Coupling	SFT_cnx_Coupling
Report	
CommentAddItem	SFT_CommentAddItem
WarningAddItem	SFT_WarningAddItem
ErrorAddItem	SFT_ErrorAddItem
ResultTextAddItem	SFT_ResultTextAddItem
ProgramErrorAddItem	SFT_ProgramErrorAddItem
TableAddItem	SFT_TableAddItem
TableColumnSetAttrInt	SFT_TableColumnSetAttrInt
TableColumnSetAttrString	SFT_TableColumnSetAttrString
TableCellSetValueInt	SFT_TableCellSetValueInt
TableCellSetValueDouble	SFT_TableCellSetValueDouble
TableCellSetValueString	SFT_TableCellSetValueString
ResultTabAddItem	SFT_ResultTabAddItem
ResultTabLineGetAttrInt	SFT_ResultTabLineGetAttrInt
ResultTabLineSetAttrDouble	SFT_ResultTabLineSetAttrDouble
ResultTabLineSetAttrString	SFT_ResultTabLineSetAttrString
ResultTabSetAttrInt	SFT_ResultTabSetAttrInt
ResultTabColumnSetAttrInt	SFT_ResultTabColumnSetAttrInt
ResultTabLineCalcAttrStatus	SFT_ResultTabLineCalcAttrStatus
Run-time State	
OptionGetAttrInt	SFT_OptionGetAttrInt
PartSelect	SFT_PartSelect
PartGetAttrInt	SFT_PartGetAttrInt
PartGetAttrString	SFT_PartGetAttrString
PartSetAttrInt	SFT_PartSetAttrInt
ComponentAddItem	SFT_ComponentAddItem
ComponentSelect	SFT_ComponentSelect
ComponentSelectByIndex	SFT_ComponentSelectByIndex
ComponentSetAttrInt	SFT_ComponentSetAttrInt
ComponentGetAttrInt	SFT_ComponentGetAttrInt
ComponentSetAttrString	SFT_ComponentSetAttrString
ComponentGetAttrString	SFT_ComponentGetAttrString
TestCaseAddItem	SFT_TestCaseAddItem
TestCaseSelect	SFT_TestCaseSelect
TestCaseSelectByIndex	SFT_TestCaseSelectByIndex
TestCaseSetAttrInt	SFT_TestCaseSetAttrInt
TestCaseGetAttrInt	SFT_TestCaseGetAttrInt
TestCaseSetAttrString	SFT_TestCaseSetAttrString
Dialog	
ComponentShowDialog	SFT_ComponentShowDialog
DlgProgressPrintInfo	SFT_DlgProgressPrintInfo
Utility	
Dmm_Test	SFT_Dmm_Test
Dmm_writeRegister	SFT_Dmm_writeRegister
Dmm_readRegister	SFT_Dmm_readRegister

7.1.10 Signal Analyzer Library

7.1.10.1 General

Name of the dynamic link library (DLL):	SIGANL.DLL
Name of the help file:	SIGANL.HLP, SIGANL.CHM
License required	R&S TS-LBAS
Supported devices:	R&S TS-PAM, Analyzer Module Any other module with IVI Scope compliant driver.

The Signal Analyzer Library provides configuration and measurement functions for waveform analyzers / digital oscilloscopes compliant with the IVI-4.1 IviScope instrument class. Furthermore it offers generic waveform analysis and utility functions.

These functions include:

- Channel configuration
- Time base configuration
- Trigger configuration
- Waveform acquisition
- Waveform parameter measurement (Average, RMS)
- Frequency measurement
- Event counting (Slope, Peak)
- Time measurement between events
- Waveform comparison
- Calculation of reference waveforms
- Waveform import/export as file
- Waveform display

Passing a waveform with NaN values (indicating an overrange condition) to an analysis function may lead to unexpected results.

By using the entry UseTssValOverflow = 1 in the appropriate bench section of the used application.ini configuration file, all NaN numbers (overflow values) returned by the acquisition functions in a waveform array are replaced by the special value 1.7E38. Be aware that this is only a different representation of an overrange value. There is no indication whether the overrange appeared in positive or negative direction.

7.1.10.2 Entries in PHYSICAL.INI

Section [device->...]

Keyword	Value	Description
Type	String	*Mandatory entry* for R&S TS-PAM: PAM for other IviScope compliant instruments: IVI_SCOPE
ResourceDesc	String	*Mandatory entry* VISA resource descriptor in the form PXI[segment number]::[device number]::[function]::INSTR
DriverPrefix	String	*Mandatory entry* prefix for the IVI driver functions, without underscore for R&S TS-PAM: rspam for others: driver dependent
Driver DLL	String	*Mandatory entry* File name of the driver DLL for R&S TS-PAM: `rspam.dll` for others: driver dependent
DriverOption	String	*Optional entry* Option string being passed to the device driver during the Driver's InitWithOptions function. See the online help file for the appropriate device driver.

7.1.10.3 Entries in APPLICATION.INI

Section [bench->...]

Keyword	Value	Description
SignalAnalyzer	String	*Mandatory entry* Reference to the device entry of the signal analyzer in `PHYSICAL.INI`
Simulation	0 / 1	*Optional entry* Blocks simulation of all entered devices (value = 0). Enables simulation of the entered devices (value = 1). Default = 0

Keyword	Value	Description
Trace	0 / 1	*Optional entry* Blocks the tracing function (value = 0). Enables the tracing function (value = 1). Default = 0
UseTssValOverflow	0 / 1	Optional entry All NaN numbers (overflow values) returned by the device drivers in a waveform array are replaced by the special value 1.7E38 (value = 1). Overrange values are retuned as NaN entries by the waveform acquiring functions (value = 0) Default = 0

7.1.10.4 Functions

```
Setup                                SIGANL_Setup
Library Version                      SIGANL_Lib_Version
Basic Instrument Operation
   Configure Acquisition Type        SIGANL_ConfigureAcquisitionType
   Configure Acquisition Record      SIGANL_ConfigureAcquisitionRecord
   Sample Rate                       SIGANL_SampleRate
   Actual Record Length              SIGANL_ActualRecordLength
   Configure Channel                 SIGANL_ConfigureChannel
   Configure Chan Characteristics    SIGANL_ConfigureChannelCharacteristics
   Configure Trigger                 SIGANL_ConfigureTrigger
   Configure Trigger Coupling        SIGANL_ConfigureTriggerCoupling
   Configure Edge Trigger Source     SIGANL_ConfigureEdgeTriggerSource
   Read Waveform                     SIGANL_ReadWaveform
   Initiate Acquisition              SIGANL_InitiateAcquisition
   Acquisition Status                SIGANL_AcquisitionStatus
   Abort                             SIGANL_Abort
   Fetch Waveform                    SIGANL_FetchWaveform
   TS-PAM specific functions
      Configure Coupling Relays      SIGANL_ConfigureCouplingRelays
      Configure Ground Relay         SIGANL_ConfigureGroundRelay
      Configure Trigger Output       SIGANL_ConfigureTriggerOutput
      Enable Trigger Output          SIGANL_EnableTriggerOutput
      Configure Trigger Pattern      SIGANL_ConfigureTriggerPattern
      Send Software Trigger          SIGANL_SendSoftwareTrigger
      Get Trigger Status             SIGANL_GetTriggerStatus
      Configure Scan                 SIGANL_ConfigureScan
      Actual Scan                    SIGANL_ActualScan
      Fetch Trigger                  SIGANL_FetchTrigger
Waveform Measurements
```

Configure Reference Levels	SIGANL_ConfigureRefLevels
Read Waveform Measurement	SIGANL_ReadWaveformMeasurement
Fetch Waveform Measurement	SIGANL_FetchWaveformMeasurement
Waveform Analysis	
Find Event in Waveform	SIGANL_FindWaveformEvent
Count Events in Waveform	SIGANL_CountWaveformEvents
Get Waveform Value	SIGANL_GetWaveformValue
Calculate Limit Lines	SIGANL_CalculateLimitLines
Compare Waveform	SIGANL_CompareWaveform
Calculate Waveform Parameter	SIGANL_CalculateWaveformParameter
Calculate Frequency	SIGANL_CalculateFrequency
Waveform Display	
Display Waveform in Diagram	SIGANL_ShowWaveform
Display Waveform with Marker	SIGANL_ShowWaveformMarker
Display Waveform with Limits	SIGANL_ShowWaveformLimits
Utility Functions	
Reset	SIGANL_Reset
Is Invalid Waveform Element	SIGANL_IsInvalidWfmElement
Import Waveform Data	SIGANL_ImportWaveformData
Export Waveform Data	SIGANL_ExportWaveformData
Cleanup	SIGANL_Cleanup

7.1.11 Signal Routing Library

7.1.11.1 General

Name of the dynamic link library (DLL):	ROUTE.DLL
Name of the help file:	ROUTE.HLP, ROUTE.CHM

License required	R&S TS-LSRL
Supported devices:	R&S TS-PAM R&S TS-PDFT R&S TS-PFG R&S TS-PIO2 R&S TS-PMB R&S TS-PSAM R&S TS-PSM1 R&S TS-PSM2 R&S TS-PSM3 R&S TS-PSM4 R&S TS-PSM5 R&S TS-PSU R&S TS-PSU12 R&S TS-PSYS1 R&S TS-PSYS2 and all other switch devices that provide an IVI?C driver of the IviSwtch class.

The Signal Routing Library makes it possible to set up complex switched connections by means of switching commands. Switched connections can be automatically routed by the analog measurement bus, i.e. the software searches for free analog measurement bus lines and automatically switches the relays in the switching path.

Extensive switched connections can also be saved under a user-specific name and then called in the test program.

Refer to Chapter 8, "Signal Routing", on page 107, for a detailed description of the Signal Routing Library.

The Signal Routing Library cannot be used together with the Switch Manager.

7.1.11.2 Entries in PHYSICAL.INI

Section [device->...]

Mandatory entry

Describes the properties of the switch modules installed in the system.

Keyword	Value	Description
Type	String	*Mandatory entry* for R&S TS-PAM:PAM for R&S TS-PDFT:PDFT for R&S TS-PFG: PFG for R&S TS-PIO2: PIO2 for R&S TS-PMB: PMB for R&S TS-PSAM: PSAM for R&S TS-PSM1: PSM1 for R&S TS-PSM2: PSM2 for R&S TS-PSM3: PSM3 for R&S TS-PSM4: PSM4 for R&S TS-PSM5: PSM5 for R&S TS-PSU: PSU for R&S TS-PSU12: PSU12 for R&S TS-PSYS1: PSYS1 for R&S TS-PSYS2: PSYS2 for other IviSwtch compliant instruments : IVI_SWITCH

ResourceDesc	String	*Mandatory entry*
		VISA resource descriptor in the form:
		`PXI[segment number]::[device number]::[function]::INSTR`
		`CAN[board]::[controller]::[frame]::[slot]`
		`GPIB[board]::[primary address]::[secondary address]`

Keyword	Value	Description
DriverPrefix	String	*Mandatory entry* Prefix for the IVI driver functions for R&S TS-PAM: rspam for R&S TS-PDFT: rspdft for R&S TS-PFG: rspfg for R&S TS-PIO2: rspio2 for R&S TS-PMB: rspmb for R&S TS-PSAM: rspsam for R&S TS-PSM1: rspsm1 for R&S TS-PSM2: rspsm2 for R&S TS-PSM3: rspsm3 for R&S TS-PSM4: rspsm4 for R&S TS-PSM5: rspsm5 for R&S TS-PSU: rspsu for R&S TS-PSU12: rspsu for R&S TS-PSYS1: rspsys for R&S TS-PSYS2: rspsys for others: driver dependent

Keyword	Value	Description
DriverDLL	String	*Mandatory entry* File name of the driver DLL for R&S TS-PAM: `rspam.dll` for R&S TS-PDFT: `rspdft.dll` for R&S TS-PFG: `rspfg.dll` for R&S TS-PIO2: `rspio2.dll` for R&S TS-PMB: `rspmb.dll` for R&S TS-PSAM: `rspsam.dll` for R&S TS-PSM1: `rspsm1.dll` for R&S TS-PSM2: `rspsm2.dll` for R&S TS-PSM3: `rspsm3.dll` for R&S TS-PSM4: `rspsm4.dll` for R&S TS-PSM5: `rspsm5.dll` for R&S TS-PSU: `rspsu.dll` for R&S TS-PSU12: `rspsu.dll` for R&S TS-PSYS1: `rspsys.dll` for R&S TS-PSYS2: `rspsys.dll` for others: driver dependent
DriverOption	String	*Optional entry* Option string being passed to the device driver during the driver's InitWithOptions function. See the online help file for the appropriate device driver. **NOTE:** For R&S TS-PMB modules, the option "DriverSetup=CRAuto:1" must not be used.

Section [device->ABUS]

Mandatory entry

Device section for the analog bus.

Keyword	Value	Description
Type	String	*Mandatory entry* AB

Section [io_channel->system]

Optional entry

The system channel table contains a list of user-specific channel names which are assigned to the physical device names and to the physical device channel names. The defined names apply to all test applications running on the system.

Keyword	Value	Description
<logical channel name>	String	Physical channel description in the combination <device name>! <physical device channel name>

7.1.11.3 Entries in APPLICATION.INI

Section [bench->...]

Mandatory entry

Contains a list of switch devices, options and links to the channel table and switch settings.

Keyword	Value	Description
SwitchDevice<i>	String	*Mandatory entry* Refers to a device entry section of a switch device in `PHYSICAL.INI`. <i> stands for a number from 1,2,3,...,n. The numbers must be assigned in ascending order without gaps. <i> may be omitted in case it is 1.
AnalogBus	String	*Mandatory entry* Refers to the device section of the analog bus in `PHYSICAL.INI`.
AppChannelTable	String	*Mandatory entry* Refers to a section [io_channel->...] with defined channel names in `APPLICATION.INI`.
SwitchSettings	String	*Optional entry* Refers to a section [switch->...] with defined switch settings in `APPLICATION.INI`.
Simulation	0 / 1	*Optional entry* Blocks the simulation of the entered devices (value = 0). Enables simulation of the entered devices (value = 1). Default = 0
Trace	0 / 1	*Optional entry* Blocks the tracing function of the library (value = 0). Enables the tracing function of the library (value = 1). Default = 0

Keyword	Value	Description
ChannelTableCaseSensitive	0 / 1	*Optional entry* The channel names in the channel table are treated case-sensitive (value = 1) or case-insensitive (value = 0). Default = 0
SignalRoutingDisplay	0 / 1	*Optional entry* Displays a window with actual signal routing information (value=1). Default = 0

Section [io_channel->...]

Mandatory entry

Contains a list of user-specific channel names which are assigned to the physical device names and to the physical device channel names. The defined names apply only to the relevant application. For details about channel name syntax see Chapter 8.3.4, "Channel tables", on page 117.

Keyword	Value	Description
<logical channel name>	String	Physical channel description in the combination <device name>! <physical device channel name>
<logical channel name>	String	Logical channel name from the section [io_channel->system] from `PHYSICAL.INI`.

Section [switch->...]

Optional entry

Contains a list of user-specific switch setting names which are assigned to signal routing command strings. Refer to Chapter 8.3.4, "Channel tables", on page 117 for details.

Keyword	Value	Description
#<switch setting name>	String	Signal routing command

7.1.11.4 Functions

```
Setup                          ROUTE_Setup
Library Version                ROUTE_Lib_Version
Signal Routing
   Execute                     ROUTE_Execute
Cleanup                        ROUTE_Cleanup
```

7.1.12 Switch Manager Library

7.1.12.1 General

Name of the dynamic link library (DLL):	SWMGR.DLL
Name of the help file:	SWMGR.HLP, SWMGR.CHM
License required	R&S TS-LBAS
Supported devices:	R&S TS-PAM R&S TS-PDFT R&S TS-PFG R&S TS-PIO2 R&S TS-PMA R&S TS-PMB R&S TS-PRL0 R&S TS-PRL1 R&S TS-PSAM R&S TS-PSM1 R&S TS-PSM2 R&S TS-PSU R&S TS-PSU12 and all other switch devices that provide an IVI-C driver of the IviSwtch class.

The Switch Manager Library provides functions for the switching of signals. It controls the device drivers of the relevant switching modules (e.g. R&S TS-PRL1, R&S TS-PMA). The Test Library changes switch requests with channel names (standard I/O channels or system/application specific channels) into calls to the device drivers of the existing switch modules.

7.1.12.2 Entries in PHYSICAL.INI

Section [device->...]

Mandatory entry

Describes the properties of the switch cards installed in the system.

Keyword	Value	Description
Type	String	*Mandatory entry* pam = R&S TS-PAM Analyzer Module pdft = R&S TS-PDFT Digital Functional Test Module pfg = R&S TS-PFG Function Generator Module pio2 = R&S TS-PIO2 Analog/Digital IO Module 2 pma1 = R&S TS-PMA Matrix Module with R&S TS-PMA1 Relay Modules pma2 = R&S TS-PMA Matrix Module with R&S TS-PMA2 Relay Modules pmb = R&S TS-PMB Matrix Module prl0 = R&S TS-PRL0 Universal Relay Module prl1 = R&S TS-PRL1 Universal Relay Module psam = R&S TS-PSAM Analog Source and Measurement Module psm1 = R&S TS-PSM1 Power Switch Module psm2 = R&S TS-PSM2 Multiplex/Switch Module 2 psu = R&S TS-PSU Power Supply/Load Module psu12 = R&S TS-PSU12 Power Supply/Load Module 12V ivi_switch = any other switching module or any other switchpanel card with an IVI device driver.

ResourceDesc	String	*Mandatory entry*
		VISA device properties and device description in the form:
		`PXI[segment number]::[device number]::[function]::INSTR`
		`CAN[board]::[controller]::[frame]::[slot]`

Keyword	Value	Description
DriverPrefix	String	*Mandatory entry* Prefix for the IVI driver functions R&S TS-PAM: rspam R&S TS-PDFT: rspdft R&S TS-PFG: rspfg R&S TS-PIO2: rspio2 R&S TS-PMA: rspma R&S TS-PMB: rspmb R&S TS-PRL0: rsprl0 R&S TS-PRL1: rsprl1 R&S TS-PSAM: rspsam R&S TS-PSM1: rspsm1 R&S TS-PSM2: rspsm2 R&S TS-PSU: rspsu R&S TS-PSU12: rspsu Other designations: Dependent on the drivers used
Driver DLL	String	*Mandatory entry* File name of the driver DLL R&S TS-PAM: `rspam.dll` R&S TS-PDFT: `rspdft.dll` R&S TS-PFG: `rspfg.dll` R&S TS-PIO2: `rspio2.dll` R&S TS-PMA: `rspma.dll` R&S TS-PMB: `rspmb.dll` R&S TS-PRL0: `rsprl0.dll` R&S TS-PRL1: `rsprl1.dll` R&S TS-PSAM: `rspsam.dll` R&S TS-PSM1: `rspsm1.dll` R&S TS-PSM2: `rspsm2.dll` R&S TS-PSU: `rspsu.dll` R&S TS-PSU12: `rspsu.dll` Other designations: Dependent on the drivers used
DriverOption	String	*Optional entry* Optional indications which are passed to the device driver during the Driver_Init function. See the online help of the relevant switch device drivers.

Section [device->ABUS]

Mandatory entry

Device section for the analog bus.

Keyword	Value	Description
Type	String	ab = Analog Bus

Section [io_channel->system]

Optional entry

Contains a list of user-specific channel names which are assigned to the physical device names and to the physical device channel names. The defined names apply to all test applications running on the system.

Keyword	Value	Description
<user-defined name>	String	Physical channel description in the combination <device name>! <device channel name>

7.1.12.3 Entries in APPLICATION.INI

Section [bench->...]

Mandatory entry

Contains a list of switch devices

Keyword	Value	Description
SwitchDevice<i>	String	*Mandatory entry* Refers to a section with switch devices in `PHYSICAL.INI` <i> stands for a number from 1,2,3,...,n. The numbers must be assigned in ascending order without gaps. <i> may be omitted in the case it is 1.
AnalogBus	String	*Optional entry* Refers to the device section of the analog bus in `PHYSICAL.INI`.
AppChannelTable	String	*Optional entry* Refers to a section with defined channel names in `APPLICATION.INI`.
Simulation	0 / 1	*Optional entry* Blocks simulation of all entered devices (value = 0). Enables simulation of the entered devices (value = 1).

Keyword	Value	Description
Trace	0 / 1	*Optional entry* Blocks the tracing function (value = 0), enables the tracing function (value = 1). Default = 0
ChannelTableCase Sensitive	0 / 1	*Optional entry* The channel names in the channel table are treated case-sensitive (value = 1) or case-insensitive (value = 0).

Section [io_channel->...]

Optional entry

Contains a list of user-specific channel names which are assigned to the physical device names and to the physical device channel names. The defined names apply only to the relevant application. For details about channel name syntax see Chapter 8.3.4, "Channel tables", on page 117.

Keyword	Value	Description
<user-defind name>	String	Physical channel description in the combination <device name>! <device channel name>
<user-defind name>	String	Channel names from the list [io_channel->system] from the `PHYSICAL.INI`.

7.1.12.4 Functions

`Management`	
`Setup`	`SWMGR_Setup`
`Library Version`	`SWMGR_Lib_Version`
`Cleanup`	`SWMGR_Cleanup`
`Configuration Functions`	
`Configure Coupling Mode`	`SWMGR_ConfigureCouplingMode`
`Configure Coupling Relays`	`SWMGR_ConfigureCouplingRelays`
`Route Functions`	
`Connect Channels`	`SWMGR_Connect`
`Disconnect Channels`	`SWMGR_Disconnect`
`Disconnect All Channels`	`SWMGR_DisconnectAll`

Switch Is Debounced?	SWMGR_IsDebounced
Wait For Debounce	SWMGR_WaitForDebounce

7.1.13 Utility Library

7.1.13.1 General

Name of the dynamic link library (DLL):	UTIL.DLL
Name of the help file:	UTIL.HLP, UTIL.CHM
License required	R&S TS-LBAS
Supported devices:	not usable

Miscellaneous utility functions.

7.1.13.2 Entries in PHYSICAL.INI

No entries

7.1.13.3 Entries in APPLICATION.INI

No entries

7.1.13.4 Functions

Library Version	UTIL_Lib_Version
Information	
GTSL Version	UTIL_GTSL_Version
GTSL Registry Value	UTIL_GTSL_Registry_Value
Time Functions	
Delay (obsolete)	UTIL_Delay
High-resolution Timer	
Sleep	UTIL_Hrestim_Sleep
Sleep Until	UTIL_Hrestim_Sleep_Until
Get Time Stamp	UTIL_Hrestim_Time_Stamp
Get Timer Resolution	UTIL_Hrestim_Resolution
TSVP Module Information	
Module Search	UTIL_Module_Search
Sort Module List	UTIL_Module_Sort_List
Get Attribute (Integer)	UTIL_Module_Get_Attribute_Int
Get Attribute (String)	UTIL_Module_Get_Attribute_String
Free Module List	UTIL_Module_Free_List
HTML Help	

Show HTML Help	UTIL_Show_Html_Help
Close HTML Help	UTIL_Close_Html_Help

7.2 In-Circuit Test Libraries

For further information on the In-Circuit-Test, R&S EGTSL and R&S IC-Check see *Software Description Enhanced Generic Test Software Library R&S EGTSL* and *Software Description Generic Test Software Library R&S IC-Check*.

7.2.1 IC-Check Library

7.2.1.1 General

Name of the dynamic link library (DLL):	ICCHECK.DLL
Name of the help file:	ICCHECK.HLP, ICCHECK.CHM
License required	R&S TS-LBAS and R&S TS-LICC
Supported devices:	R&S TS-PMB Matrix Module R&S TS-PSAM Source and Measurement Module

The IC-Check Test Library offers functions for the IC check using the R&S GTSL software and the R&S TS-PSAM and R&S TS-PMB modules. The functions allow to

- load, run and debug ICC programs
- generate a report

7.2.1.2 Entries in PHYSICAL.INI

Section [device->...]

Keyword	Value	Description
Type	String	*Mandatory entry* pmb = R&S TS-PMB Matrix Module psam = R&S TS-PSAM Source and Measurement Module

ResourceDesc	String	*Mandatory entry*
		VISA resource descriptor in the form
		`PXI[segment number]::[device number]::[function]::INSTR`
		`CAN[board]::[controller]::[frame]::[slot]`

DriverPrefix	String	*Mandatory entry* prefix for the IVI driver functions, without underscore R&S TS-PMB: rspmb R&S TS-PSAM: rspsam
DriverDll	String	*Mandatory entry* File name of the driver DLL R&S TS-PMB: `rspmb.dll` R&S TS-PSAM: `rspsam.dll`
DriverOption	String	*Optional entry* Option string being passed to the device driver during the driver's InitWithOptions function. See the online help file for the appropriate device driver.

7.2.1.3 Entries in APPLICATION.INI

Section [bench->...]

Keyword	Value	Description
ICCDevice	String	*Mandatory entry* Refers to the device section of the R&S TS-PSAM
SwitchDevice<i>	String	*Mandatory entry* Refers to a device sections of a switch device R&S TS-PMB in `PHYSICAL.INI`. <i> stands for a number from 1,2,3,...,n. The numbers must be assigned in ascending order without gaps. <i> may be omitted in the case it is 1.
AppChannelTable	String	*Mandatory entry* Refers to a section with defined channel names in `APPLICATION.INI`.
Simulation	0 / 1	*Optional entry* Blocks the simulation of the entered devices (value = 0). Enables simulation of the entered devices (value = 1). Default = 0
Trace	0 / 1	*Optional entry* Blocks the tracing function of the library (value = 0). Enables the tracing function of the library (value = 1). Default = 0
ChannelTableCaseSensitive	0 / 1	*Optional entry* The channel names in the channel table are treated case-sensitive (value = 1) or case-insensitive (value = 0).

Section [io_channel->...]

Contains a list of user-specific channel names (or ATG-defined channel names) which are assigned to the physical device names and to the physical device channel names. The defined names apply only to the relevant application. For details about channel name syntax see Chapter 8.3.4, "Channel tables", on page 117.

Keyword	Value	Description
<user-defined name>	String	Physical channel description in the form: <device name>!<device channel name>.

7.2.1.4 Functions

Setup	ICCHECK_Setup
Cleanup	ICCHECK_Cleanup
Library Version	ICCHECK_Lib_Version
Program Control	
Load Program	ICCHECK_Load_Program
Run Program	ICCHECK_Run_Program
Debug Program	ICCHECK_Debug_Program
Report Generation	
Write Report to File	ICCHECK_Write_Report
Load Detailed Report	ICCHECK_Load_Detailed_Report
Get Detailed Report Entry	ICCHECK_Get_Detailed_Report_Entry
Attribute Information	
Get Attribute Int	ICCHECK_Get_Attribute_Int
Get Attribute Real	ICCHECK_Get_Attribute_Real
Get Attribute String	ICCHECK_Get_Attribute_String

7.2.2 In-Circuit-Test Library

7.2.2.1 General

Name of the dynamic link library (DLL):	ICT.DLL
Name of the help file:	ICT.HLP, ICT.CHM
License required	R&S TS-LBAS and R&S TS-LEGT or R&S TS-LEG2
Supported devices:	R&S TS-PICT ICT Extension Module R&S TS-PMB Matrix Module R&S TS-PSAM Source and Measurement Module R&S TS-PSU Power Supply / Load Module R&S TS-PSU12 Power Supply / Load Module 12V

The in-circuit test library offers functions for the in-circuit test using the R&S GTSL software and the R&S TS-PSAM, R&S TS-PICT, R&S TS PSU, R&S TS-PSU12 and R&S TS-PMB modules.

The functions allow to

- load, run and debug ICT programs
- load limit files
- generate a report

7.2.2.2 Entries in PHYSICAL.INI

Section [device->...]

Keyword	Value	Description
Type	String	*Mandatory entry* pict = R&S TS-PICT ICT Extension Module pmb = R&S TS-PMB Matrix Module psam = R&S TS-PSAM Source and Measurement Module psu = R&S TS-PSU Power Supply/Load Module psu12 = R&S TS-PSU12 Power Supply/Load Module 12V

ResourceDesc	String	*Mandatory entry*
		VISA resource descriptor in the form
		`PXI[segment number]::[device number]::[function]::INSTR`
		`CAN[board]::[controller]::[frame]::[slot]`

DriverPrefix	String	*Mandatory entry* Prefix for the IVI driver functions, without underscore: R&S TS-PICT : rspict R&S TS-PMB : rspmb R&S TS-PSAM : rspsam R&S TS-PSU: rspsu R&S TS-PSU12: rspsu
DriverDLL	String	*Mandatory entry* File name of the driver DLL R&S TS-PICT : `rspict.dll` R&S TS-PMB : `rspmb.dll` R&S TS-PSAM : `rspsam.dll` R&S TS-PSU : `rspsu.dll` R&S TS-PSU12 : `rspsu.dll`
DriverOption	String	*Optional entry* Option string being passed to the device driver during the Driver_Init function. See the online help file for the appropriate device driver.

7.2.2.3 Entries in APPLICATION.INI

Section [bench->...]

Keyword	Value	Description
ICTDevice1	String	*Mandatory entry* Refers to the device section of the R&S TS-PSAM
ICTDevice2	String	*Optional entry* Refers to the device section of the R&S TS-PICT or R&S TS-PSU / R&S TS-PSU12
ICTDevice3	String	*Optional entry* Refers to the device section of the R&S TS-PICT or R&S TS-PSU / R&S TS-PSU12
SwitchDevice<i>	String	*Mandatory entry* Refers to a section with switch devices in `PHYSICAL.INI`. <i> stands for a number from 1,2,3,...,n. The numbers must be assigned in ascending order without gaps. <i> may be omitted in the case it is 1.
AppChannelTable	String	*Mandatory entry* Refers to a section with defined channel names in `APPLICATION.INI`.
Simulation	0 / 1	*Optional entry* Blocks the simulation of the entered devices (value = 0). Enables simulation of the entered devices (value = 1). Default = 0
Trace	0 / 1	*Optional entry* Blocks the tracing function of the library (value = 0). Enables the tracing function of the library (value = 1). Default = 0
ChannelTableCase Sensitive	0 / 1	*Optional entry* The channel names in the channel table are treated case-sensitive (value = 1) or case-insensitive (value = 0).

Section [io_channel->...]

Contains a list of user-specific channel names (or ATG-defined channel names) which are assigned to the physical device names and to the physical device channel names. The defined names apply only to the relevant application. For details about channel name syntax see Chapter 8.3.4, "Channel tables", on page 117.

Keyword	Value	Description
<user-defined name>	String	Physical channel description in the combination <device name>! <device channel name>

7.2.2.4 Functions

```
Setup                                ICT_Setup
Library Version                      ICT_Lib_Version
EGTSL Runtime Version                ICT_Runtime_Version
Program Control
   Load Program                      ICT_Load_Program
   Run Program                       ICT_Run_Program
   Debug Program                     ICT_Debug_Program
   Unload Program                    ICT_Unload_Program
Report Generation
   Write Report to File              ICT_Write_Report
   Load Detailed Report              ICT_Load_Detailed_Report
   Get Detailed Report Entry         ICT_Get_Detailed_Report_Entry
   Get Detailed Report Entry (Extended)
                                     ICT_Get_Detailed_Report_Entry_Ex
   Get TestStand Report Entry        ICT_Get_TestStand_Report_Entry
   Transfer Report to QUOTIS         ICT_Transfer_Quotis_Report
Limit Loader
   Load Limits                       ICT_Load_Limits
Error Handling
   Get Error Log                     ICT_Get_Error_Log
Cleanup                              ICT_Cleanup
```

7.2.3 Vacuum Control Library

7.2.3.1 General

Name of the dynamic link library (DLL):	VACUUM.DLL
Name of the help file:	VACUUM.HLP, VACUUM.CHM
License required:	R&S TS-LBAS
Supported devices:	R&S TS-PSYS1, System Module R&S TS-PSYS2, System Module

The Vacuum Library offers functions for one or more vacuum control units R&S TS-PVAC.

7.2.3.2 Entries in PHYSICAL.INI

Section [device->...]

Keyword	Value	Description
Type	String	*Mandatory entry* psys1 = R&S TS-PSYS1, System Module psys2 = R&S TS-PSYS2, System Module
ResourceDesc	String	*Mandatory entry* resource descriptor in the form `CAN[board]::[controller]::[frame]::[slot]`
DriverPrefix	String	*Mandatory entry* Prefix for the IVI driver functions, without underscore: R&S TS-PSYS1, R&S TS-PSYS2 : rspsys
DriverDLL	String	*Mandatory entry* File name of the driver DLL R&S TS-PSYS1, R&S TS-PSYS2: `rspsys.dll`
DriverOption	String	*Optional entry* Option string being passed to the device driver during the Driver_Init function. See the online help file for the appropriate device driver.

7.2.3.3 Entries in APPLICATION.INI

Section [bench->...]

Keyword	Value	Description
VacuumControl<i>	String	*Mandatory entry* Refers to a section with devices in `PHYSICAL.INI` <i> stands for a number from 1,2,3,...,40. The numbers must be assigned in ascending order without gaps. <i> may be omitted in the case it is 1.
Simulation	0 / 1	*Optional entry* Blocks the simulation of the entered devices (value = 0). Enables simulation of the entered devices (value = 1). Default = 0
Trace	0 / 1	*Optional entry* Blocks the tracing function of the library (value = 0), enables the tracing function of the library (value = 1). Default = 0

7.2.3.4 Functions

```
Management
   Setup                          VACUUM_Setup
   Library Version                VACUUM_Lib_Version
   Cleanup                        VACUUM_Cleanup

Control
   Control                        VACUUM_Control
Status
   Status                         VACUUM_Status
```

7.2.4 Fixture Compensation Library

7.2.4.1 General

Name of the dynamic link library (DLL):	`FIXTCOMP.DLL`
Name of the help file	`FIXTCOMP.CHM`

The fixture compensation library together with the in-circuit test library offers functions to acquire and handle compensation values automatically for ICT measurements of small capacitors.

The application “ICT fixture compensation” shows the usage of this library.

7.2.4.2 Functions

```
FIXTCOMP_Setup
FIXTCOMP_Lib_Version
Open_TestAdapter
 FIXTCOMP_Open_Set_Description
 FIXTCOMP_Open_Set_MaxCap
 FIXTCOMP_Open_Set_Option
 FIXTCOMP_Open_Write
ICT_Manipulation
 FIXTCOMP_Ict_Add_CompValues
 FIXTCOMP_Ict_Add_HistoryRecord
 FIXTCOMP_Ict_Get_Description
 FIXTCOMP_Ict_Set_Description
 FIXTCOMP_Ict_Write
FIXTCOMP_Cleanup
```

8 Signal Routing

This chapter describes switching of measurement signals in R&S CompactTSVP / R&S PowerTSVP systems making use of the Signal Routing Library.

8.1 R&S GTSL software for switched connections

There are three libraries in R&S GTSL that can make switched connections:

- Signal Routing Library `ROUTE.DLL`
- Switch Manager Library `SWMGR.DLL`
- The library for In-Circuit Test `ICT.DLL` (R&S EGTSL)

All three libraries can simultaneously administer a large number of measurement, stimulus, and switch modules. These different modules appear together in the test program as a large switch panel.

8.1.1 Signal Routing Library

The Signal Routing Library makes it possible to set up complex switched connections by means of switching commands. Switched connections can be automatically routed by the analog measurement bus, i.e. the software searches for free analog measurement bus lines and automatically switches the relays in the switching path.

Extensive switched connections can also be saved under a user-specific name and then called in the test program.

A R&S TS-LSRL software license is required for the Signal Routing Library.

The Signal Routing Library cannot be used together with the Switch Manager.

8.1.2 Switch Manager Library

The Switch Manager Library is the predecessor of the Signal Routing Library. It is a useful tool when compatibility is required with earlier applications created with the Switch Manager Library. Unlike the Signal Routing Library, the Switch Manager has no built-in "intelligence" and is not capable of routing switching paths automatically.

The Switch Manager is already included in the basic license for R&S TS-LBAS.

The Switch Manager cannot be used together with the Signal Routing Library.

8.1.3 ICT Library / R&S EGTSL

The In-Circuit Test Library and R&S EGTSL user interface (R&S EGTSL IDE) make internal connections for the In-Circuit Test. They use the same entries in the configuration files to do this as the two other libraries. However it is not possible to use R&S EGTSL for general connection tasks, such as in the functional test.

8.2 Analog measurement bus concept

The R&S CompactTSVP and R&S PowerTSVP systems allow for use of a large number of measurement and stimulus modules. These modules can be connected with the UUT (unit under test) either directly or through switch modules.

The *analog measurement bus* of the R&S CompactTSVP and R&S PowerTSVP systems connects measurement, stimulus, and switch modules with each other. The analog measurement bus offers eight lines, which are available on all slots. In this manner, UUT signals can be flexibly connected with the measurement and stimulus modules through the switch modules.

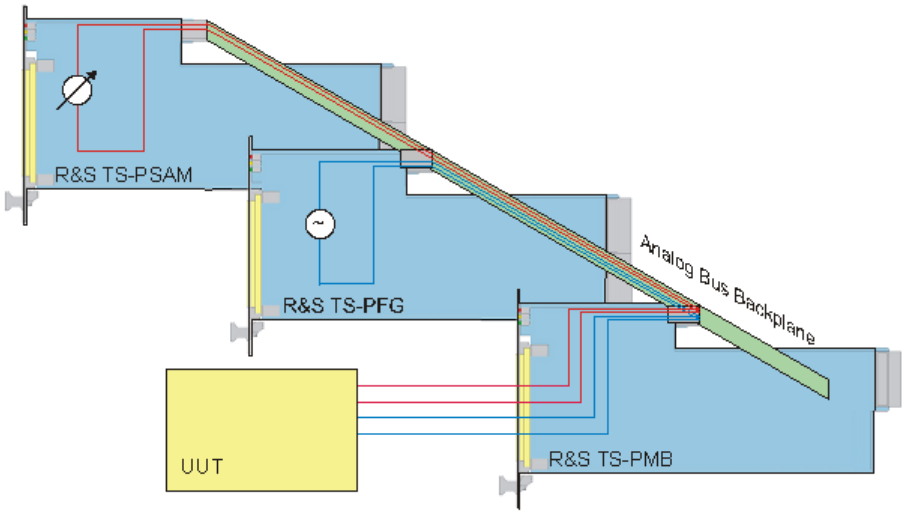


Figure 8-1: Analog measurement bus concept

The following table shows an overview of modules of the R&S CompactTSVP product line with switching elements:

Table 8-1: Modules of the R&S CompactTSVP product line

Module name	Module type	Analog measurement bus access	Local multiplexers	Special features
R&S TS-PAM	Measurement module	x	x	
R&S TS-PDFT	Measurement/ stimulus module		x	Digital test module
R&S TS-PFG	Stimulus module	x		

Module name	Module type	Analog measurement bus access	Local multiplexers	Special features
R&S TS-PIO2	Measurement/ stimulus module	x	x	
R&S TS-PMB	Switch module	x		
R&S TS-PSAM	Measurement module	x	x	
R&S TS-PSM1	Switch module	x		Power switching module
R&S TS-PSM2	Switch module	x		Power switching module
R&S TS-PSM3	Switch module	x		Power switching module
R&S TS-PSM4	Switch module	x		Power switching module
R&S TS-PSM5	Switch module	x		Power switching module
R&S TS-PSU R&S TS-PSU12	Stimulus module	x	x	Power module
R&S TS-PSYS1/2	System module			

Most of the modules provide access to the analog measurement bus. Some modules provide *local multiplexers*. If only a few signals need to be switched to test a UUT, the multiplexer in the module is frequently sufficient. If numerous channels are involved, however, multiplexing is performed by the analog measurement bus and switching modules.

The analog measurement bus consists of eight lines with identical capabilities, ABa1, ABa2, ABb1, ABb2, ABc1, ABc2, ABd1, and ABd2. All modules with analog measurement bus access can be switched to the analog measurement bus by means of coupling relays. These coupling relays are located directly on the analog measurement bus connector of the module so that the capacitive load of the analog measurement bus resulting from the module with the coupling relay open remains minimal.

After the coupling relay, the global analog measurement bus is continued on the module as a *local analog bus*. The measurement inputs or signal outputs of the relevant module can be connected with the local analog bus by means of a relay matrix.

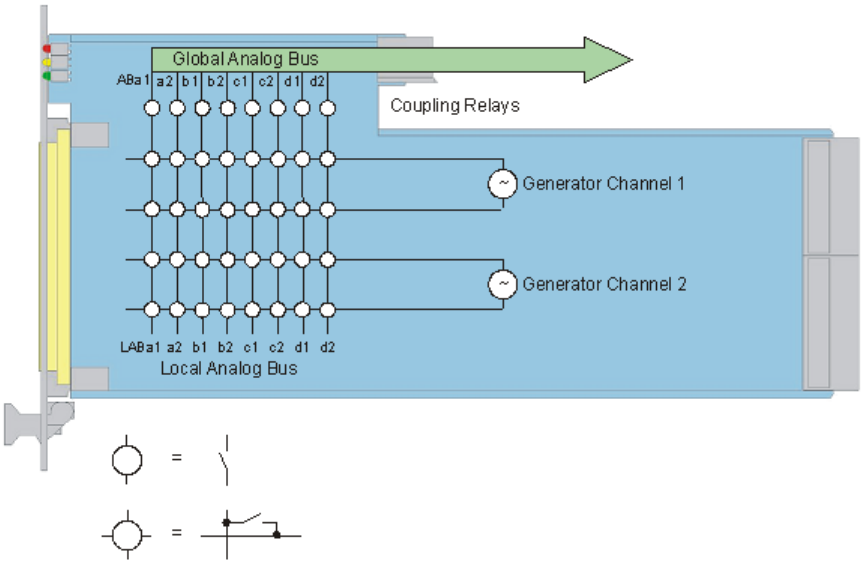


Figure 8-2: Analog measurement bus access via coupling relay

When connecting signals via the analog measurement bus or local analog bus, make sure not to exceed the specifications of the module or device.

Higher currents can be connected directly with the UUT through modules specially designed for that purpose (R&S TS-PSU, R&S TS-PSU12, R&S TS-PSM1, R&S TS-PSM2, R&S TS-PSM3, R&S TS-PSM4, R&S TS-PSM5).

8.3 Configuration files

A test program contains switching commands that consist of a combination of *channel names* and *switching operations*.

The channel names in the test program correspond to names as they appear in the test specification or in the schematics of the UUT. These names are *logical channel names*. The software converts these names into *physical channel names*, i.e. into channel names as they are "understood" by stimulus, measurement, or switch modules.

Physical channel names are assigned to logical channel names in a UUT-specific *channel table*. This channel table is stored along with other information in a configuration file. It describes how connections from the UUT with the test system are made, i.e. it describes adapter wiring.

Using configuration files offers the advantage that the test program can concentrate on the actual measurement task. The adapter wiring and system configuration are defined outside of the test program in the configuration files.

Use of configuration files makes it possible to modify the adapter wiring or port the test program to a system with a different configuration without having to change the test program.

The R&S GTSL software uses two configuration files: one for the physical layer and the other for the application layer. The general layout of these two files is described in Chapter 5, "Configuration Files", on page 24.

8.3.1 Physical layer

For each test system there is exactly one file that describes the physical layer, i.e. the configuration of the system. This file's name is `PHYSICAL.INI` and it resides in the directory `..\GTSL\Configuration`. It contains the following information:

- Which hardware modules are present in the system?
- How are the hardware modules addressed?
- What software is responsible for the hardware modules?
- Options for device drivers, for example simulation mode
- Optionally a system-specific channel table

This file must be adjusted every time a change is made to the system configuration.

8.3.1.1 Example of a PHYSICAL.INI file

The following example shows a segment of a `PHYSICAL.INI` file. Some entries with no relevance to this chapter have been left out.

```
[device->PSAM]
Type         = PSAM
ResourceDesc = PXI1::10::0::INSTR
DriverDll    = rspsam.dll
DriverPrefix = rspsam
DriverOption = "Simulate=0,RangeCheck=1"

[device->PMB_10]
Type         = PMB
ResourceDesc = CAN0::0::1::10
DriverDll    = rspmb.dll
DriverPrefix = rspmb
DriverOption = "Simulate=0,RangeCheck=1"

[device->ABUS]
;analog measurement bus pseudo-device
;used by ROUTE, SWMGR and EGTSL
Type         = AB

[io_channel->system]
```

```
.DMM_HI       = PSAM!DMM_HI
.DMM_LO       = PSAM!DMM_LO
```

There is a [device->*Name*] section for each hardware module (device). There are no constraints on *Name*, but it must be unique within `PHYSICAL.INI`. The "Type" entry that defines the module type must be present for each device. The "ResourceDesc" entry must also be present. The software is able to access the module through this entry. The only exception is the pseudo device ABUS, which stands for analog measurement bus.

A system-specific channel table may optionally be present. On the left side it contains the logical channel name as it is permitted to occur in switching commands of the test programs. The name of the hardware module and the physical channel name in the form expected by the device driver of the corresponding module type appear on the right side (see Chapter 8.3.4, "Channel tables", on page 117.)

8.3.2 Application layer

This configuration file is usually created individually for each UUT or test program. It can be assigned any name and be placed in any directory. For ease of comprehension, the file name `APPLICATION.INI` is used for this configuration file in the manual. It contains the following information:

- Which hardware modules are required for the test program?
- Options for libraries, for example simulation, tracing
- The application-specific channel table

This information is combined in a *bench*. A *bench* thus defines which physical resources of the system are required for a UUT in what way.

An `APPLICATION.INI` file may also contain more than one bench and more than one channel table if multiple UUTs of the same type will be tested, for example in a panel test (see Chapter 8.3.4, "Channel tables", on page 117).

8.3.2.1 Example of an APPLICATION.INI file

```
[bench->test]

; hardware modules
DigitalMultimeter = device->PSAM
FunctionGenerator = device->PFG
SwitchDevice1     = device->PSAM
SwitchDevice2     = device->PMB_10
SwitchDevice3     = device->PFG
AnalogBus         = device->ABUS

; options
Simulation        = 0
Trace             = 0
```

```
; link to channel table
AppChannelTable    = io_channel->test

; channel table
[io_channel->test]
INPUT              = PMB_10!P1
GND                = PMB_10!P2
OUTPUT             = PMB_10!P3
MONITOR            = PMB_10!P65
```

In the first section, the hardware modules required for the test are listed. The various R&S GTSL libraries recognise the devices they should work with by means of the keywords on the left side. The right side contains references to the corresponding device entries in `PHYSICAL.INI`.

The second section includes options for the R&S GTSL libraries.

The third section contains a reference to the channel table that will be used.

The channel table in the fourth section contains (on the left side) logical channel names as they occur in the switching commands of the test program. The name of the device and the physical channel name in the form expected by the device driver of the corresponding module type appear on the right side.

8.3.3 Special entries for switched connections

There are three libraries in R&S GTSL that can make switched connections:

- The Signal Routing Library `ROUTE.DLL` (see also Chapter 7.1.11, "Signal Routing Library", on page 84)
- The Switch Manager `SWMGR.DLL` (see also Chapter 7.1.12, "Switch Manager Library", on page 91)
- The library for In-Circuit Test `ICT.DLL` (see also Chapter 7.2.2, "In-Circuit-Test Library", on page 100)

All three libraries use the same entries of `APPLICATION.INI` in terms of switched connections. The following table shows an overview of keywords.

Keyword	Value	Description
SwitchDevice<i>	String	*Mandatory entry* Refers to a device entry section of a switch device in `PHYSICAL.INI`. <i> stands for a number from 1,2,3,…,n. The numbers must be assigned in ascending order without gaps. <i> may be omitted in case it is 1.
AnalogBus	String	*Mandatory entry* Refers to the device section of the analog bus in `PHYSICAL.INI`.

Keyword	Value	Description
AppChannelTable	String	*Mandatory entry* Refers to a section [io_channel->…] with defined channel names in `APPLICATION.INI`.
SwitchSettings	String	*Optional entry* Refers to a section [switch->…] with defined switch settings in `APPLICATION.INI`.
Simulation	0 / 1	*Optional entry* Blocks the simulation of the entered devices (value = 0). Enables simulation of the entered devices (value = 1). Default = 0
Trace	0 / 1	*Optional entry* Blocks the tracing function of the library (value = 0). Enables the tracing function of the library (value = 1). Default = 0
ChannelTableCaseSensitive	0 / 1	*Optional entry* The channel names in the channel table are treated case-sensitive (value = 1) or case-insensitive (value = 0). Default = 0
SignalRoutingDisplay	0 / 1	*Optional entry* Displays a window with actual signal routing information (value=1). Default = 0

8.3.3.1 SwitchDevice<i>

These mandatory entries are references to the corresponding device sections in `PHYSICAL.INI`. Based on the mandatory "Type" entry in `PHYSICAL.INI`, the libraries determine whether the corresponding module type is supported. The entries `ResourceDesc`, `DriverDLL` and `DriverPrefix` must also be present.

The suffix <i> represents a sequential numbering, i.e. SwitchDevice1, SwitchDevice2, etc. Instead of SwitchDevice1, SwitchDevice can also be written.

ICT Library / R&S EGTSL: Only SwitchDevice entries of type PMB are considered. All others are ignored.

Switch Manager: The Switch Manager supports the same module types as the Signal Routing Library plus modules R&S TS-PMA and R&S TS-PRL1 of the R&S ClassicTSVP.

Signal Routing Library: The Signal Routing Library supports the following module types:

Table 8-2: Module types supported by the Signal Routing Library

Type	Module designation
PAM	R&S TS-PAM Analyzer Module
PDFT	R&S TS-PDFT Digital Functional Test Module
PFG	R&S TS-PFG Function Generator Module
PIO2	R&S TS-PIO2 Analog/Digital IO Module 2
PIO3B	R&S Digital I/O Module
PMB	R&S TS-PMB Matrix Module
PSAM	R&S TS-PSAM Analog Source and Measurement Module
PSM1	R&S TS-PSM1 Power Switching Module 1
PSM2	R&S TS-PSM2 Multiplex/Switch Module 2
PSM3	R&S TS-PSM3 Power Switching Module 3
PSM4	R&S TS-PSM4 Power Switching Module 4
PSM5	R&S TS-PSM5 Power Switching Module 5
PSU	R&S TS-PSU Power Supply/Load Module
PSU12	R&S TS-PSU12 Power Supply/Load Module 12V
PSYS1	R&S TS-PSYS1 System Module
PSYS2	R&S TS-PSYS2 System Module
IVI_SWITCH	Any generic switching module that provides an IVI-C driver of the IviSwtch class

8.3.3.2 AnalogBus

This mandatory entry is a reference to the pseudo device "ABUS" of `PHYSICAL.INI`.

Switch Manager: The AnalogBus entry is optional. If it is not present, no connections via the analog measurement bus are possible.

8.3.3.3 AppChannelTable

This mandatory entry is a reference to the application-specific channel table. See also Chapter 8.3.4, "Channel tables", on page 117.

Switch Manager: The AppChannelTable entry is optional. If it is not present, switched connections can only be made with physical channel names.

8.3.3.4 SwitchSettings

This optional entry is a reference to the switch settings. Switch settings are pre-defined switching commands. They are supported only by the Signal Routing Library. Refer to Chapter 8.4.3, "Switch settings", on page 127.

8.3.3.5 Simulation

This optional entry turns simulation mode of the libraries on and off. There is no access to hardware in simulation mode and the device drivers are not loaded. Since the Signal Routing Library must have access to the device drivers to search for paths, however, it behaves differently in simulation mode. This means it is unable to report errors if connections are not possible.

On the other hand, the R&S device drivers for TSVP modules also support a simulation mode. It might be useful to operate the Signal Routing Library in "real" and the called device drivers in "simulation" mode to increase error checking when no hardware is available for software development. To do this, make sure that all needed device driver DLLs and the underlying interface DLLs are installed on your development machine. Leave simulation disabled in the application layer configuration file (`APPLICATION.INI`). In the physical layer configuration file (`PHYSICAL.INI`) enable the driver level simulation by changing the "DriverOption" string. See example below.

```
[device->PMB_10]
Type = PMB
ResourceDesc = CAN0::0::1::10
DriverDll = rspmb.dll
DriverPrefix = rspmb
DriverOption = "Simulate=1,RangeCheck=1"
```

8.3.3.6 Trace

This optional entry turns tracing of the libraries on and off. When tracing is activated, the libraries write information to a file or screen window during execution. The Resource Manager library makes various options available for tracing; see Chapter 7.1.8, "Resource Manager Library", on page 71.

8.3.3.7 ChannelTableCaseSensitive

This optional entry determines whether upper/lower case should be distinguished for logical channel names. If the entry is missing or has a value of 0, there is no distinction between upper and lower case. The channel names "Input" and "INPUT" will be treated identically.

If the relevant entry has a value of 1, "Input" and "INPUT" represent two different channels.

8.3.3.8 SignalRoutingDisplay

This optional entry indicates whether the Signal Routing Library displays a window in which the current switched connections are represented. See also Chapter 8.4.5, "Display switched connection", on page 129.

8.3.4 Channel tables

R&S GTSL libraries for switched connections use two channel tables to assign the logical channel names used in the test program to physical channel names of the test system:

- the application-specific channel table that is referenced in `APPLICATION.INI` with the keyword "AppChannelTable".
- optionally a system-specific channel table stored in `PHYSICAL.INI` in the [io_channel->system] section.

The Signal Routing Library and Switch Manager Library combine both tables into a general channel table. The ICT library / R&S EGTSL loads only the application-specific channel table.

The two tables are identical in general structure. They have an entry for each logical channel name to assign a physical channel name to it, for example:

```
GND = PMB_10!P2
```

The logical channel name on the left side must be unique. This means that it must only occur once in the two channel tables. The "ChannelTableCaseSensitive" option determines whether or not to distinguish between upper and lower case.

Logical channel names must be no more than 80 characters long and may only contain the following characters:

Table 8-3: Character set for logical channel names

"A"..."Z"	uppercase letter
"a"..."z"	lowercase letter
"0"..."9"	digit
"_"	underscore
"."	decimal point/period
"!"	exclamation mark
"#"	number sign
"$"	dollar sign
"%"	percent
"&"	ampersand
"*"	asterisk
"+"	plus

"-"	minus
"/"	slash
"\"	backslash
":"	colon
"?"	question mark
"@"	at sign
"^"	caret
"|"	vertical bar
"~"	tilde
"("	opening paranthesis
")"	closing paranthesis
"{"	opening curly brace
"}"	closing curly brace
"["	opening square bracket
"]"	closing square bracket
"<"	opening angle bracket/less than
">"	closing angle bracket/greater than

The physical channel name (made up of the device name and the device-specific channel name) is on the right side. Only device names that are referenced in a "SwitchDevice<i>" entry can be used. The "device->" prefix of this entry has been omitted to make the channel table easier to read.

The device name is separated from the device-specific channel name by an exclamation mark. This is a channel name that is accepted by the device driver. For the specific name, see the device driver documentation (usually the description of function *xyz_Connect*).

Although logical channel names must be unique, the same does not apply to physical channel names. It is permissible to assign several logical channel names to the same physical channel (*alias names*).

The following rules apply to physical names of analog measurement bus lines:

- The physical names of global analog measurement bus lines are ABUS!ABa1 to ABUS!ABd2. ABUS is the pseudo device analog measurement bus of type = AB.
- The physical names of the local analog measurement bus lines are device!LABa1 to device!LABd2. In this case device stands for a device of any other type. This rule also applies if the device driver does not accept the physical names "LABxy", but only accepts "ABxy" (for example R&S TS-PSAM).

Example:

```
ABa1 = ABUS!ABa1
PSAM.LABa1 = PSAM!LABa1
PSM1.LABA1 = PSM1!LABa1
```

Channel attributes can optionally be assigned for channels. Channel attributes separated by commas are appended to the physical channel names, for example:

```
.ABa1 = ABUS!ABa1,nonrouting
```

Channel attributes are described in Chapter 8.4.4, "Channel attributes", on page 129.

A *comment* can optionally be provided for a channel. It is introduced by a semicolon. Anything after the semicolon to the end of the line is comment:

```
VCC = PMB_10!P75 ; +5 V supply
```

8.3.4.1 System-specific channel table

The system-specific channel table is optional. It is stored in `PHYSICAL.INI` in the [io_channel->system] section.

The channel names that are required in many test programs and are not application-specific are defined in the system-specific channel table. Examples include

- Inputs of measuring devices, for example the DMM_HI and DMM_LO inputs of the R&S TS-PSAM multimeter.
- Outputs of stimulus devices, for example the CH1_HI and CH1_LO outputs of the R&S TS-PSAM function generator.
- Channels of switch modules that have a fixed connection with external devices, for example power channels of the R&S TS-PSM1 module that are connected with external power supplies.

The system-specific channel table thus describes the fixed wiring of the system.

To ensure that logical channel names are unique and to avoid duplicate names with the application-specific channel table, it is recommended that all logical channel names of the system-specific channel table begin with a period.

8.3.4.2 Application-specific channel table

The application-specific channel table is stored in `APPLICATION.INI` in the [io_channel->*Name*] section. There are no constraints on *Name*, but it must be unique within `APPLICATION.INI`.

Channel names that are required especially for the UUT are defined in the application-specific channel table. These are:

- Measurement points on the UUT that are connected with switch modules.
- Measurement points on the UUT that are connected with local multiplexers of measurement or stimulus modules.

The application-specific channel table therefore describes the adapter wiring for the relevant UUT.

Entries of the application-specific channel table may also contain logical names of the system-specific channel table on the right side.

8.4 Signal Routing Library

8.4.1 Example of a switched connection

The following example demonstrates the functionality of the Signal Routing Library by way of a simple switched connection task.

A signal is applied to the input of an amplifier and then measured at the output of the amplifier.

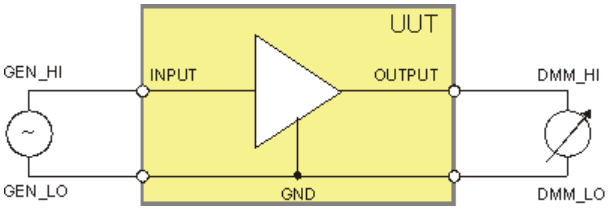


Figure 8-3: Measurement task

The `PHYSICAL.INI` file contains entries for devices PSAM, PFG and PMB_10. No system channel table will be used in this example. The corresponding `APPLICATION.INI` appears as follows:

```
[bench->test]
DigitalMultimeter = device->PSAM
FunctionGenerator = device->PFG
SwitchDevice1     = device->PSAM
SwitchDevice2     = device->PMB_10
SwitchDevice3     = device->PFG
AnalogBus         = device->ABUS
AppChannelTable   = io_channel->test

[io_channel->test]
; UUT channels
INPUT             = PMB_10!P1
GND               = PMB_10!P2
OUTPUT            = PMB_10!P3
MONITOR           = PMB_10!P65  ; used in later  example
; system channels
GEN_HI            = PFG!CH1_HI
GEN_LO            = PFG!CH1_LO
DMM_HI            = PSAM!DMM_HI
DMM_LO            = PSAM!DMM_LO
```

Devices PSAM, PFG, and PMB_10 are required for switching. Therefore they are entered as SwitchDevice<i>. The channel table contains the channel names of the UUT and the channels within the system that will be connected with the UUT.

Devices PSAM and PFG are also used as a digital multimeter and function generator (libraries `DMM.DLL` and `FUNCGEN.DLL`). They are therefore also entered as Digital-Multimeter and FunctionGenerator respectively.

The following switching commands are executed to set up the switched connection:

```
GEN_LO > GND
GEN_HI > INPUT
GND > DMM_LO
OUTPUT > DMM_HI
```

For each switching command, the Signal Routing Library searches for a suitable free analog measurement bus and sets up the following switched connection:

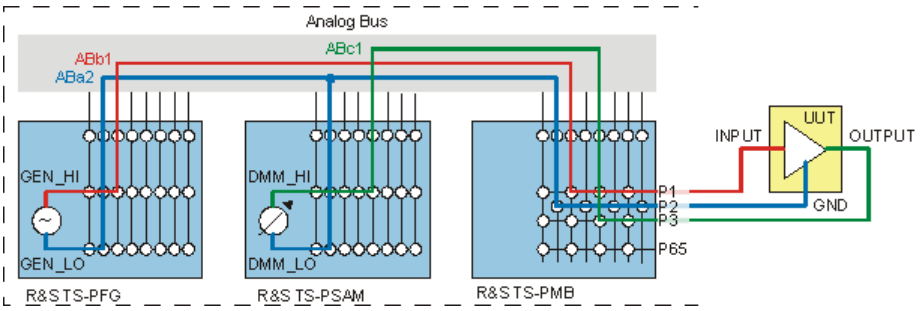


Figure 8-4: Switched connection for measurement task

The corresponding test program is roughly as follows. The sections of code for handling errors have been omitted for the sake of clarity:

```
// Variables
short errorOccurred;
long  errorCode
char  errorMessage[GTSL_ERROR_BUFFER_SIZE];
long  resourceId;

// setup libraries
RESMGR_Setup ( 0, "physical.ini", "testApplication.ini",
               &errorOccurred, &errorCode, errorMessage  );

ROUTE_Setup ( 0, "bench->test", &resourceId,
              &errorOccurred, &errorCode, errorMessage  );

// connect generator and DMM
ROUTE_Execute ( 0, resourceId,
                "GEN_LO > GND, GEN_HI > INPUT,  GND > DMM_LO, OUTPUT >DMM_HI",
                &errorOccurred, &errorCode, errorMessage  );

// apply generator signal and measure output (not  shown here)
// ...
```

```
// disconnect all
ROUTE_Execute ( 0, resourceId, "||", &errorOccurred, &errorCode,errorMessage );

// Close libraries
ROUTE_Cleanup ( 0, resourceId, &errorOccurred, &errorCode, errorMessage );
RESMGR_Cleanup ( 0, &errorOccurred, &errorCode,  errorMessage );
```

At the beginning of the program the requiredR&S GTSL libraries are initialised. The Resource Manager must always be called first. `RESMGR_Setup` loads the two configuration files `physical.ini` and `testApplication.ini`. `ROUTE_Setup` then loads the channel tables and prepares the hardware modules for use.

Then come the actual switching commands with a `ROUTE_Execute` call and the remainder of the test program (not shown here). This part of the program can be repeated several times if several UUTs need to be tested.

At the end of the test program, the corresponding cleanup function must be called for each setup function that was called at the beginning. `RESMGR_Cleanup` is the last R&S GTSL function that is called.

8.4.2 Switching commands

The `ROUTE_Execute` function of the Signal Routing Library performs switching commands. The following switching commands are possible:

Table 8-4: Simple switching commands

Switching command	Function
a > b	Connect channels a and b
a | b	Disconnect channels a and b
a || b	Disconnect all connections in the path between channels a and b
a ||	Disconnect all connections previously made with channel a.
||	Disconnect all existing connections
%	Disconnect all obsolete connections
#s	Make switched connection of switch setting s
#s |	Break switched connection of switch setting s
#s ||	Break switched connection of switch setting s; all connections along the path are disconnected.
?n	Wait n milliseconds
?#	Wait for debounce of all switch modules
?#n	Wait for debounce of all switch modules with timeout n milliseconds

Switching command	Function
,	Delimiting character for switching commands
;	Comment at the end of a switching command

a and **b** stand for logical channel name which must be present in the application-specific table or system channel table or for system names. **s** stands for the name of a switch setting (see Chapter 8.3.3.4, "SwitchSettings", on page 116) and **n** stands for a real numeric literal.

Multiple switching commands separated by commas can be combined to form a single switching command. A comment may optionally be placed at the end of a switching command. Comments are introduced by a semicolon.

The following compound switching commands are available to simplify entry of complex switching commands. They are separated into simple commands during processing as shown in the table below:

Table 8-5: Compound switching commands

Switching command	Corresponds to simple commands	Function
a > b > c > d	a > b, b > c, c > d	Extended connection
a | b | c | d a || b || c || d	a | b, b | c, c | d a || b, b || c, c || d	Multiple disconnection
a * b * c * d	a > b, a > c, a > d	Star connection

Compound switching commands contain the same simple switching command multiple times. It is not permitted to combine switching commands of different types to form a compound switching command.

8.4.2.1 Channel names in switching commands

Channel names used in switching commands may be:

- Logical channel names from the application-specific channel table
- Logical channel names from the system channel table
- System names

The logical channel names are defined in the corresponding channel tables (see Chapter 8.3.4, "Channel tables", on page 117).

System names are channel names that have been identified to the Signal Routing Library without the names having to be explicitly defined in the channel tables. System names always start with a "$" sign.

Table 8-6: System names

System names	Description
$ABa1, $ABa2 $ABb1, $ABb2 $ABc1, $ABc2 $ABd1, $ABd2	System names for analog measurement bus lines of the global analog measurement bus.
$LABa1, $LABa2 $LABb1, $LABb2 $LABc1, $LABc2 $LABd1, $LABd2	System names for the local analog measurement bus lines of a device.

The system names for the global analog measurement bus stand for physical channel names ABUS!ABa1, ABUS!ABa2, etc and are unique within the entire system. By contrast, system names of local analog measurement buses may not be assigned uniquely to a device if multiple devices are present in the system. The assignment is based first on the context of the switched connection command.

Example:

```
DMM_HI > $LABa1 > $ABa1
```

Since DMM_HI is assigned to the PSAM device, i.e. the physical channel name is PSAM!DMM_HI, $LABa1 is also assigned to the PSAM device.

```
$LABa1 > $LABa2
```

In this case no assignment can be made to a device. An error is reported.

```
DMM_HI > $LABa1 > INPUT
```

In this case the context is different on the left and right side. $LABa1 can be assigned to either the PSAM device or the PMB_10 device. The software is not capable of deciding which local local analog measurement bus is meant. An error is also reported in this case.

If a logical channel name contains any special characters reserved for switching commands, it must be enclosed in single quotes. This rule applies for the following character set:

> | % * # ? $ -

8.4.2.2 Connecting channels

Command **`a > b`** connects channel a with channel b.

The connection can be routed either directly or via local and global analog measurement bus lines.

There is a *direct connection* present if channel a and channel b can be connected by closing a single relay. Direct connections must have either both channels on the same device or else a global analog measurement bus as one of the two channels.

The Signal Routing Library is able to set up complex switched connections via automatic routing. Local and global analog measurement bus lines are used for automatic routing to connect the two channels together.

An automatically routed connection may always be seen as a sequence of direct switched connections:

```
OUTPUT > DMM_HI
OUTPUT > $LABb1 > $ABb1 > $LABb1 > DMM_HI
```

8.4.2.3 Disconnecting channels

Commands **a | b** and **a || b** disconnect the existing connection between channel a and channel b.

The difference between the two commands is that **a | b**disconnects the connection at precisely one point and allows partial connections to remain in place. Command **a || b** opens all connections along the switching path. Partial connections that remain intact after channels are disconnected are called *obsolete connections*.

Command **a | b** is more efficient, since only one connection needs to be opened. It may be possible to use the partial connections that remain intact in a subsequent switching command. That would minimise the number of relays to be switched in this case as well. This procedure avoids unnecessary switching cycles of relays, thus extending their service life.

It is only possible to disconnect channels that were previously connected with each other in the same manner, i.e. the command **a | b** must be preceded by the command **a > b**, otherwise a warning will be reported. It is also permissible to exchange the order of channels. In other words, the command **b | a** is also permitted.

After disconnecting connections, to ensure that all connections are actually disconnected before setting up new connections, it is recommended to use the command **?#** (Wait for Debounce).

8.4.2.4 Other disconnect commands

The command **a || b** disconnects all existing connections that had previously been made with channel a. At the same time, all connections along the switching paths are opened. This isolates channel a from all other channels.

Example:

```
a > b > c, d > a > e, a||
```

Channel a was connected with b, d and e. Disconnect command **a||** thus corresponds to commands

```
a || b, a || d, a || e
```

The command **||** disconnects all existing active and obsolete connections. It resets the relays of all devices administered by the Signal Routing Library. This command resets all relays on the module responsible for the switched connection, including the coupling relays. Relays that create the ground reference of stimulus and measurement devices are not affected. These are not considered part of the switched connection and therefore cannot be either switched or opened by the Signal Routing Library.

The command **%** breaks all obsolete connections. For more information, see Chapter 8.4.6.7, "Obsolete connections", on page 136.

After disconnecting connections, to ensure that all connections are actually disconnected before setting up new connections, it is recommended to use the command **?#** (Wait for Debounce).

The two commands **||** and **%** affect all switch modules that are configured in any bench as SwitchDevice<i>.

8.4.2.5 Switch setting commands

Switch settings are switching commands that are stored in `APPLICATION.INI` under a user-defined name and can be called and executed in the test program with their names. Switch settings are explained in detail in Chapter 8.4.3, "Switch settings", on page 127.

8.4.2.6 Wait commands

The purpose of wait commands is to delay execution of the switched connection for a certain amount of time. This may be necessary to ensure that a connection has actually been made before performing a measurement, or to ensure that one connection has been opened before another one is closed ("Break-Before-Make").

The Signal Routing Library recognises two types of wait commands:

- Fixed wait time
- Wait until all relays have switched and are debounced

The command **?n** delays all subsequent switching commands by n milliseconds. The command **?#** waits until all previously switched relays are debounced. Optionally in the command **?#n**, a maximum time n may be specified in milliseconds. If all relays are not debounced after this time, the command is aborted with an error. If no maximum time is specified, the default value of 100 ms is used.

In both cases, n stands for a real numeric that must be greater than 0 with a maximum value of 10000 (10 seconds).

Example:

```
POWER | P1, ?#, POWER > P2, ?#
```

This switching command disconnects POWER from P1 and waits until the connection is debounced, i.e. confirmed opened, before making the connection to P2. Then the function waits until the new connection has been set up before the `ROUTE_Execute function` returns and e.g. a voltage measurement can be performed.

8.4.2.7 Compound commands

Individual switching commands can be combined to form longer switching commands. The commands are separated from each other by commas:

Example:

```
GEN_LO > GND, GEN_HI > INPUT, DMM_LO > GND, ?#
```

8.4.2.8 Comment

A comment in a switching command is introduced by a semicolon. All following characters are ignored by the command interpreter. Comments are especially helpful in switching commands that are saved as switch settings in `APPLICATION.INI`.

8.4.3 Switch settings

Switch settings are switching commands that are stored in `APPLICATION.INI` under a user-defined name and can be called and executed in the test program with their names.

The advantage of switch settings is being able to save very complex switched connections under a meaningful name. These switched connections can be set up and disconnected again in the test program by passing their name to the switching command.

Switch settings are checked for correct syntax when the Signal Routing Library is loaded and prepared for runtime optimisation. This makes it possible for them to run faster in `ROUTE_Execute` than the corresponding directly transferred switching command.

8.4.3.1 Entries in APPLICATION.INI

Like channel tables, switch settings are saved in `APPLICATION.INI` in the [switch->*Name*] section. There are no constraints on the *Name* entry, but it must be unique within the `APPLICATION.INI`. The name of this section is referenced in the bench with the keyword SwitchSettings:

```
[bench->test]
DigitalMultimeter = device->PSAM
```

```
FunctionGenerator = device->PFG
SwitchDevice1     = device->PSAM
SwitchDevice2     = device->PMB_10
SwitchDevice3     = device->PFG
AnalogBus         = device->ABUS
AppChannelTable   = io_channel->test

SwitchSettings    = switch->test
```

On the left side, the switch setting table contains the names of the switch settings, which must begin with a **#** sign. The switching command is on the right side.

The switch setting name on the left side must be unique. It must be no more than 80 characters long and may only contain the following characters:

Table 8-7: Character set for switch setting names

"#"	Switch setting prefix
"A" ... "Z"	Upper case characters
"a" ... "z"	Lower case characters
"0" ... "9"	Numbers
"_"	Underscore
"."	Decimal point

The character **#** introduces the name and is only permitted as the first character.

The switching command is on the right side. It may contain simple and compound switching commands as well as a comment. However, it may not contain additional switch setting commands.

The maximum length of the switching command is 260 characters. Switching commands that contain more than 260 characters must be broken up into several lines. This can be done by entering a switch setting with the same name in the following line and continuing the switching command there.

Example:

```
[switch->test]

#ConnectGenerator = GEN_LO > GND,  GEN_HI > INPUT  ; Generator  HI and LO to UUT

#ConnectDMM       = DMM_LO > GND,  DMM_HI > OUTPUT ; DMM HI and LO to UUT

#ConnectAll       = GEN_LO > GND,  GEN_HI > INPUT,
#ConnectAll       = DMM_LO > GND,  DMM_HI > OUTPUT,
#ConnectAll       = ?# ; Connect generator and DMM to UUT and wait for debounce
```

8.4.3.2 Making switch settings

Switch settings are performed by specifying the name in the switching command:

```
#ConnectAll
```

Switch settings can be combined with switching commands and additional switch settings:

```
#ConnectGenerator, #ConnectDMM, DMM_LO | GND,  ?#
```

Appending one of switching commands | or || breaks the switched connection of switch settings. With these commands, all > commands for connecting channels are replaced by | or ||:

```
#ConnectAll |
```

If the switch setting already contains commands for disconnecting the connections, they remain unchanged, but the `ROUTE_Execute` function returns a warning.

8.4.4 Channel attributes

Channel attributes define certain properties of a channel. They are optional and can be entered in the channel tables. Channel attributes separated by commas are appended to the physical channel names, for example:

```
.ABa1 = ABUS!ABa1,nonrouting
```

8.4.4.1 Channel attribute "nonrouting"

The channel attribute *nonrouting* can be used for global and local analog measurement bus lines. If it is specified, it makes it impossible for the analog measurement bus line of the Signal Routing Library to be used for automatic path search.

This attribute can be used, for example, if an analog measurement bus line has a fixed connection with a signal fed in externally, which therefore must not be connected automatically with other signals.

8.4.5 Display switched connection

During the development and test phase of a test program, it is helpful to be able to display the current state of switched connections. This display can be activated by specifying the option

```
SignalRoutingDisplay = 1
```

in `APPLICATION.INI`. If the display is activated, a window appears when `ROUTE_Setup` is called. The window continues to be displayed until `ROUTE_Cleanup` is called. The window can be minimised during this time, but cannot be closed.

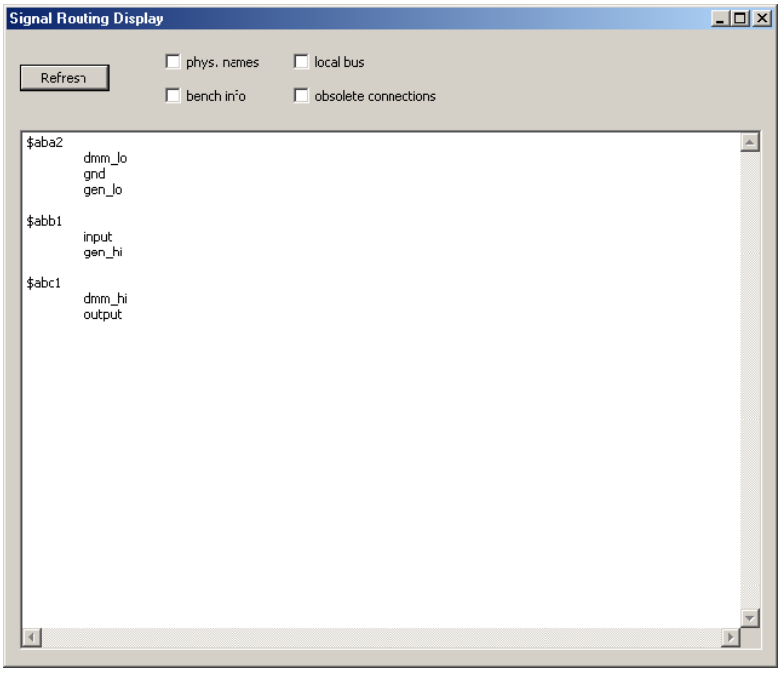


Figure 8-5: Signal Routing Display

Clicking on the "Refresh" button or pressing the "F5" key updates and shows current switched connections.

The scope of information that appears can be changed by selecting the options in the upper display area:

phys. names	displays in addition the physical channel names
local bus	displays in addition the connection via local analog measurement buses
bench info	displays in addition the name of the bench
obsolete connections	displays in addition existing obsolete connections

The switched connection is displayed sorted according to analog measurement bus lines. For each analog measurement bus, a list of channels connected to it is shown. The example above shows the switched connection of Figure 8-4.

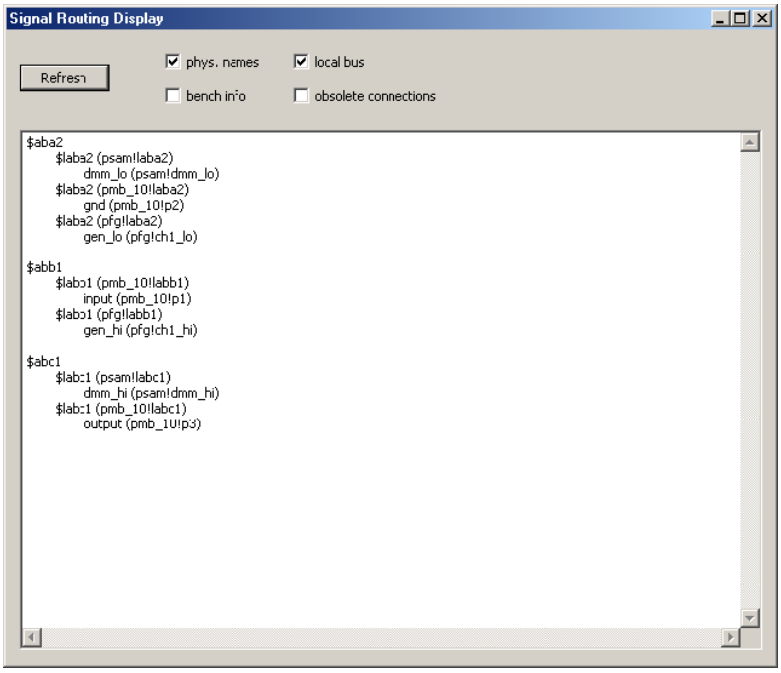


Figure 8-6: Display with local analog measurement buses and physical channel names

The indentation of channel names indicates over how many sub-paths the channels are connected with each other.

8.4.6 Switched connection algorithms

This chapter treats switched connection algorithms, i.e. the rules that define how switched connections in the Signal Routing Library are set up and broken.

8.4.6.1 Connecting channels

There are three possible results when two channels are to be connected:

- A direct connection between the channels is possible
- No connection is possible
- A connection via local/global analog measurement bus line is possible

To make a *direct connection* only a single switching process is required. In technical terms, a direct connection can be made by calling the `xyz_Connect` function of the device driver. If a direct connection between two channels is possible, the Signal Routing Library will create it.

In direct connections, the two channels are always on the same module. For modules with analog measurement bus access, one of the two channels may also be on the analog measurement bus.

On third-party modules, i.e. modules of type IVI_SWITCH, the Signal Routing Library can only apply direct connections.

If a direct connection is not possible, the Signal Routing Library can search for a connection through local and global analog measurement buses.

If no such connection is found either, the switched connection cannot be made and the `ROUTE_Execute` function returns with an error.

If two channels need to be connected to each other and there is already a connection between them, the `ROUTE_Execute` returns with a warning. The current connection is not changed.

8.4.6.2 Routing via analog measurement buses

The Signal Routing Library can make connections automatically via free local and global analog measurement bus lines. This makes it easy to connect two channels on different modules together. The coupling relays are switched automatically.

The Signal Routing Library first searches for analog measurement buses with which a connection is potentially possible. Not any channel may be connected with any analog measurement bus. The following table gives an overview of the number of analog measurement bus access points per channel:

Table 8-8: Analog measurement bus access of various module types

Module type	Channels	Analog measurement bus access points per channel
R&S TS-PAM	CHA1_HI, …, CHA4_HI, CHB1_HI, …, CHB4_HI	4
R&S TS-PFG	CH1_HI, CH1_LO, CH2_HI, CH2_LO	8
R&S TS-PIO2	CH1_IN, … CH16_IN	2
R&S TS-PMB	P1, …, P90 IL1, …, IL3	4 8
R&S TS-PSAM	DMM_HI, DMM_LO, DMM_SHI, DMM_SLO	8
R&S TS-PSM1	CH1com, …, CH16com, CH1no, …, CH16no LPBA, …, LPBD, IL1com, IL2com, IL1no, IL2no	1 or 2
R&S TS-PSM2	CH1_HI, …, CH8_HI, CH1_LO, …, CH8_LO	2
R&S TS-PSM3	CH1_NO, …, CH8_NO CH9_NO, ..., CH16_NO, CH9_COM, ..., CH16_COM CH1_COM, ..., CH8_COM, CH9_IV, ..., CH16_IV	3 2 1
R&S TS-PSM4	CH1_NO, …, CH20_NO CH9_COM, ..., CH20_COM CH1_COM, ..., CH8_COM	3 2 1

Module type	Channels	Analog measurement bus access points per channel
R&S TS-PSM5	CH1_NO, ..., CH4_NO CH5_NO, ... , CH8_NO, CH5_COM, ..., CH8_COM CH1_COM, ..., CH4_COM, CH5_IV, ... , CH8_IV	3 2 1
R&S TS-PSU R&S TS-PSU12	CH1_HI, CH1_LO, CH1_SHI, CH1_SLO CH2_HI, CH2_LO, CH2_SHI, CH2_SLO	4 4

It is possible there is already a connection with the desired signal to an analog measurement bus. In this case an attempt is made to make a connection to this analog measurement bus. Otherwise a free analog measurement bus is selected from potentially available buses and the connection is made through that bus.

Modules with few analog measurement bus access points should always be connected before modules with many analog measurement bus access points. This will ensure the routing algorithm is still able to find enough potential analog measurement buses for the switched connection.

The analog measurement bus line is selected to minimise "cost" as much as possible. The system-wide analog measurement bus is the most expensive resource, followed by the local analog measurement buses. There are special switching options for R&S TS-PMB modules that are explained in greater detail in Chapter 8.4.6.9, "Routing on R&S TS-PMB matrix modules", on page 138.

8.4.6.3 Manual and automatic routing

Complex (i.e. non-direct) switched connections can be routed manually or automatically. *Manual routing* means the switching command contains exclusively direct connections:

```
GEN_HI > $LABa1 > $ABa1 > $LABa1 > INPUT
```

The connection `GEN_HI > $LABa1` is a direction connection, as is `$LABa1 > $ABa1`, etc.

It is also possible to perform the switching command with automatic routing. In this case the Signal Routing Library selects a suitable analog measurement bus line for the connection:

```
GEN_HI > INPUT
```

Which analog measurement bus line is suitable depends on the actual switching state of the system. Therefore it cannot be assumed that `GEN_HI > INPUT` will always select the same analog measurement bus line for automatic routing. If another signal is already assigned to $ABa1, for example, a different free analog measurement bus line must be found. Automatic routing is only possible via local and global analog measure-

ment bus lines. Switched connections over local multiplexer or power buses can only be routed manually.

8.4.6.4 Manually and automatically routed channels

A channel that is explicitly listed in a switching command is said to be *manually routed*. By contrast, channels, which were automatically selected by the routing algorithm rather than being explicitly listed, are said to be *automatically routed*.

Connections to automatically routed channels are not permitted. Example:

```
GEN_HI > INPUT
POWER > $ABa1 > VCC
```

The first switching command establishes a connection between `GEN_HI` and `INPUT`. The second switching command connects the POWER signal via the analog measurement bus $ABa1 with the VCC channel of the UUT. Assuming the first switched connection automatically selects analog measurement bus $ABa1, the second command would result in a short circuit between `GEN_HI` and `POWER`. This connection is therefore not permissible and the `ROUTE_Execute` function reports an error.

On the other hand, if the first switching command is routed via $ABb1 and $ABa1 is still free, for example, the second switching command can be performed.

8.4.6.5 Multiple assignment of switching paths

In the following example, the generator signal from `GEN_HI` will be directed to the input of the UUT and also to a monitor output to connect an oscilloscope, for example. The corresponding switching commands are:

```
GEN_HI > INPUT
GEN_HI > MONITOR
```

The Signal Routing Library first sets up the connection `GEN_HI > INPUT` via a free analog measurement bus line, for example $ABa1.

The already existing switched sub-connection from GEN_HI to LABa1 of the R&S TS PMB module can be used for the second connection `GEN_HI > MONITOR`. Then the Signal Routing Library only needs to make the connection between LABa1 and MONITOR.

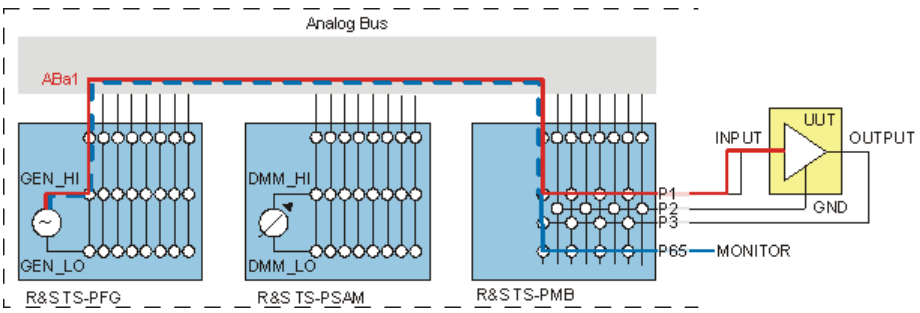


Figure 8-7: Multiple assignment of a switching path

The section between GEN_HI and LABa1 is now used by two switched connection paths. The Signal Routing Library administers a *reference counter* for each partial section of a switched connection. The counter shows how many switched connections use the partial section. The reference counters for the partial sections used in common (represented in the figure by red and blue dashed lines) are set by the switched connection `GEN_HI > MONITOR` to 2.

The reference counters are important when breaking the connection:

```
GEN_HI || INPUT
```

If `GEN_HI` is disconnected from `INPUT`, it must still be ensured that the connection `GEN_HI` to `MONITOR` remains intact. Therefore the sections that are used in common must not be disconnected.

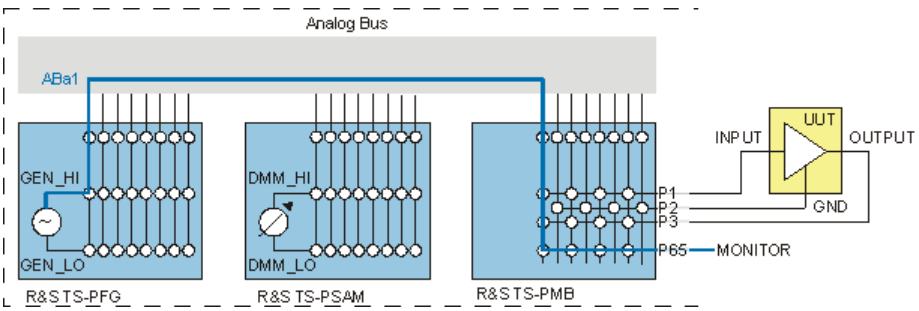


Figure 8-8: Multiple assignment after breaking the connection to INPUT

Disconnection causes all reference counters along the switched connection to be decremented, but only those whose reference counters are now 0 may be opened. The relays along the entire path of the switched connection are not opened until the other connection has also been disconnected:

```
GEN_HI || MONITOR
```

If a switching command is performed for an already existing connection, a warning is reported and the reference counter is not incremented:

```
GEN_HI > INPUT
GEN_HI > INPUT
```

The following command disconnects the connection because the reference counter has not been changed for the second switching command:

```
GEN_HI || INPUT
```

8.4.6.6 Disconnecting connections

Only connections that were previously set up with the same two channels can be disconnected with the commands `|` and `||`. Otherwise a warning is reported.

When connections are disconnected, multiple assignment of switching paths is taken into consideration. The connection can only be disconnected at this point (i.e. this relay can only be opened) if the reference counter of a section (i.e. of a relay) becomes zero.

The command **a || b** opens all relays along the path between a and b, provided their reference counters are not greater than 1.

The command **a | b**opens the connection at one point only. This command can be performed more quickly than **a || b** because only one switching process is necessary. Connections that are currently no longer required remain intact. These connections are referred to as *obsolete connections*, in contrast to *active connections*.

8.4.6.7 Obsolete connections

An obsolete connection remains intact if an automatically routed connection is opened with the switching command **a | b**.

Example:

```
GEN_HI > INPUT
GEN_HI | INPUT
```

Assuming the first switching command sets up a connection via $ABa1, there are several ways for the second switching command to disconnect the connection:

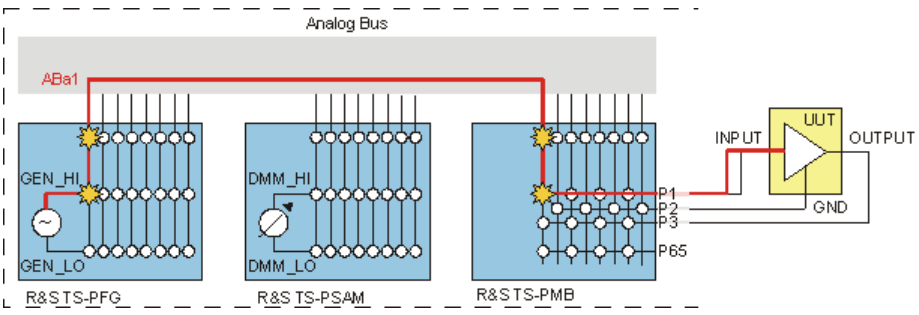


Figure 8-9: Ways to disconnect the GEN_HI > INPUT switched connection

The Signal Routing Library always attempts to disconnect the connection as close as possible to the UUT. In the example this means that the connection $LABa1 to INPUT will be opened on the matrix module. The remainder of the switched connection GEN_HI to $LABa1 of the R&S TS-PMB matrix module remains as an obsolete connection. The reference counter of an obsolete connection is 0, but the connection is still present physically.

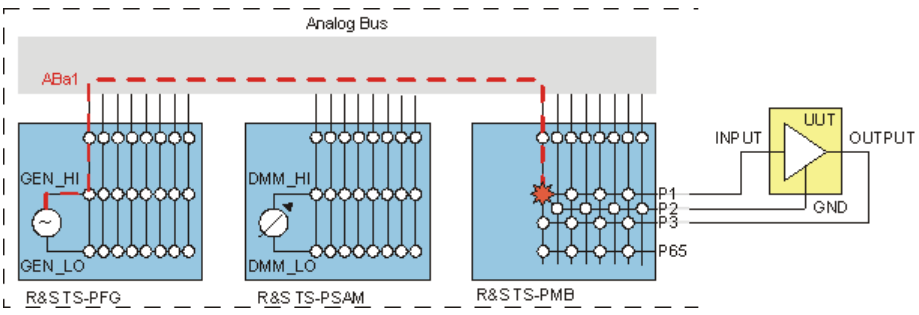


Figure 8-10: Obsolete connection GEN_HI > $LBABa1

In many cases, obsolete connections can be reused in subsequent switching commands.

Example:

```
GEN_HI > MONITOR
```

Since the GEN_HI signal is already switched to $LABa1 of the R&S TS?PMB matrix module, it is sufficient to create the connection between $LABa1 and MONITOR by closing a single relay. In this manner obsolete connections can contribute to improved performance. This method extends the relay's life cycle, since switching processes are avoided.

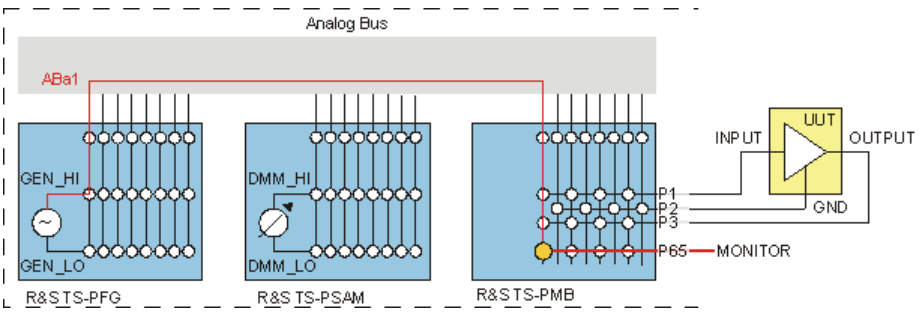


Figure 8-11: Reusing an obsolete connection

On the other hand, obsolete connections can block the analog measurement bus with signals that are no longer used. If the Signal Routing Library cannot find any more free analog measurement buses for automatic routing, it can release all obsolete connections by itself. That means that all obsolete connections are physically disconnected, i.e. the corresponding relays are opened. Only the active connections remain intact. The switching command `%` is used to selectively break all obsolete connections.

8.4.6.8 Analog measurement buses and coupling relays

All modules with analog measurement bus access have a local analog bus that can be connected with the global analog measurement bus. If a channel of a module needs to be connected with a global analog measurement bus, the coupling relays are automatically switched:

```
GEN_HI > $ABa1
```

This switching command first connects **`GEN_HI`** with the local analog measurement bus line LABa1 and then closes the coupling relay to connect LABa1 with ABa1.

```
GEN_HI || $ABa1
```

This switching command opens all connections between **`GEN_HI`** and ABa1, i.e. the relay that connects **`GEN_HI`** with the local analog bus line LABa1 is opened as well as the coupling relay between LABa1 and ABa1.

If only the coupling relay for analog measurement bus line ABa1 on the R&S TS-PFG module needs to be closed, the switching command should be as follows:

```
$LABa1 > $ABa1
```

This command is not possible because the assignment of the system name $LABa1 to the R&S TS-PFG module is not evident from the context. In this case the local analog measurement bus line must be explicitly added to the channel table:

```
[io_channel->test]
PFG.LABa1 = PFG!LABa1
```

The following switching commands closes the coupling relay for the analog measurement bus line ABa1 on module R&S TS-PFG:

```
PFG.LABa1 > $ABa1
```

The Signal Routing Library accepts the physical channel names "LABa1" to "LABd2" uniformly for all modules with analog measurement bus access. The same is true if the device driver of the module does not accept that channel name. This serves to standardise the differing treatment of coupling relays by device drivers in the Signal Routing Library.

8.4.6.9 Routing on R&S TS-PMB matrix modules

R&S TS-PMB matrix modules have two special features that must be taken into considerations for switched connections:

1. The even/odd rule applies to direct connections
2. Local analog buses can be connected in pairs via sense relays

The *even/odd rule* states that a matrix channel (P1 to P90) with an even number can only be connected to a local analog measurement bus that also has an even number. The same applies to channels and buses with odd numbers.

This rule does not apply to Instrument Lines IL1 to IL3. They can be connected with each local analog measurement bus.

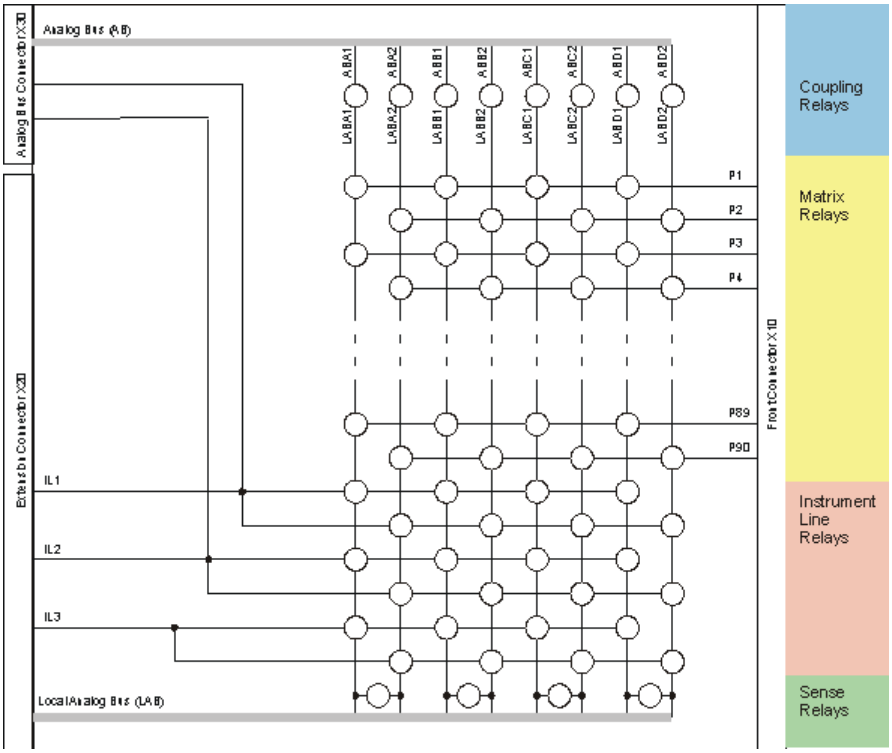


Figure 8-12: Block diagram R&S TS-PMB matrix

To make it possible nevertheless to connect an odd channel (for example P1) with an even local analog measurement bus (for example LABa2), there is an option to connect an analog measurement bus pair with each other via a relay. The four so-called *sense relays* connect LABa1 - LABa2, LABb1 - LABb2, LABc1 - LABc2 and LABd1 - LABd2 respectively.

The following example illustrates the switching possibilities. The application channel table contains the following entries:

```
[io_channel->test]
P1      = PMB_10!P1
P2      = PMB_10!P2
P3      = PMB_10!P3
P4      = PMB_10!P4
; etc.
P89     = PMB_10!P89
P90     = PMB_10!P90
```

Channel P2 will be connected with global analog measurement bus ABa1:

```
P2 > $ABa1
```

To do this, P2 is first switched to LABa2. Then it is connected with LABa1 via the sense relay and is directed through the coupling relay to ABa1.

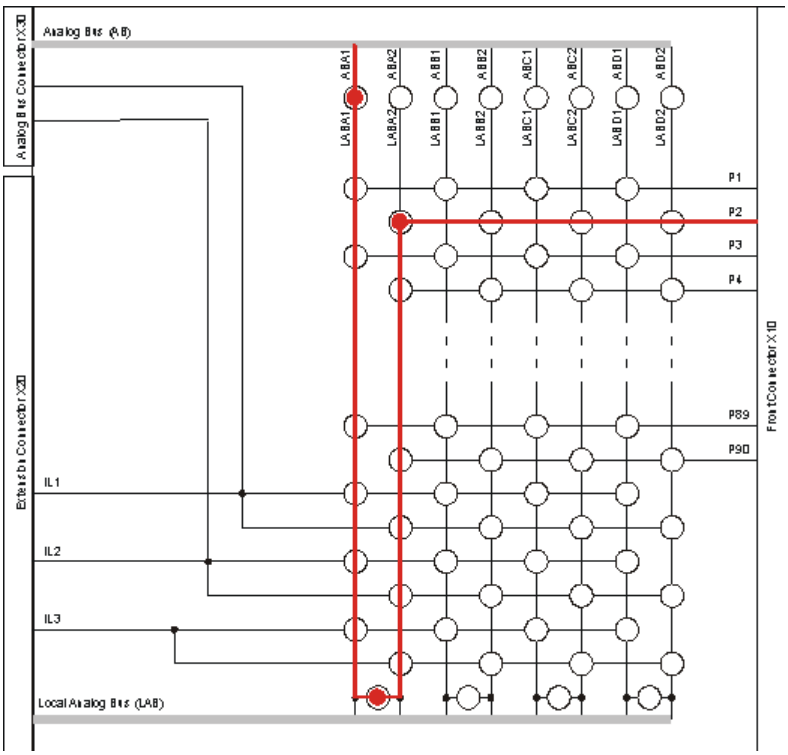


Figure 8-13: Switched connection P2 > $ABa1

The Signal Routing Library is capable of creating switched connections automatically via sense relays and coupling relays. A requirement for the example shown here is that other signals must not already be assigned to the two local analog measurement bus lines LABa1 and LABa2.

Local switched connections of channels to an R&S TS-PMB matrix module can be made in the same way:

```
P1 > P3, P4 > P89
```

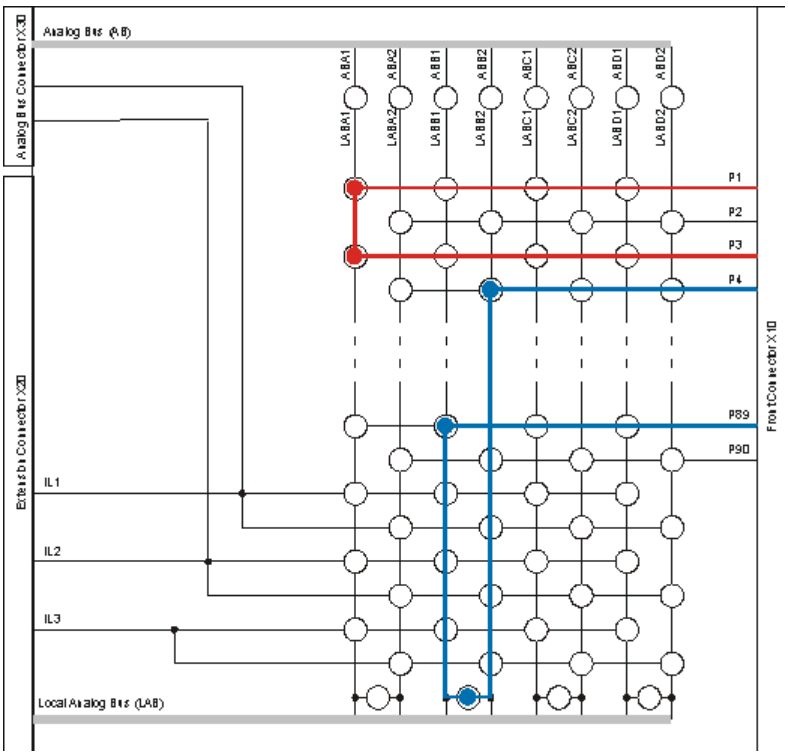


Figure 8-14: Switched connection P1 > P3, P4 > P89

The first connection leads from P1 through LABa1 to P3. Since both channels are odd, only a local analog measurement bus is required. An odd and an even channel are involved in the second connection. In this case the connection leads from P4 to LABb2, then via the sense relay to LABb1 and from there to P89.

8.4.6.10 Routing on power switching modules

A special rule related to local switching of channels applies to the power switching modules R&S TS-PSM1, R&S TS-PSM2, R&S TS-PSM3, R&S TS-PSM4 and R&S TS-PSM5. If both channels are on the same module, only direct connections are permitted. Connections over the local analog measurement bus are not automatically routed.

The reason is that the local analog measurement bus is only suitable for currents up to maximum 1 A, but some channels of the power switching modules can switch up to 16 A. To prevent these high currents from being accidentally directed over the local analog measurement bus, automatic routing over the local analog measurement bus is not allowed for these modules.

However, this rule does not apply to connections between the switching module and the global analog measurement bus or other modules. Switched connections such as CH1_COM > $ABa1 or CH1_COM > DMM_HI are possible and are automatically directed via the coupling relays and the local and global analog measurement bus.

8.4.7 Using the Signal Routing Library with other libraries

The Signal Routing Library retains an image of the complete switched connections of the system in active memory. This makes it possible to calculate a new switched connection quickly, since no data transfer is required between the modules and the computer. This process does require, however, that no switched connections be performed outside the Signal Routing Library.

Faulty Switched Connections and Short Circuits

Calling functions that change the switching state of modules outside of the Signal Routing Library may result in faulty switched connections and short circuits.

Because of this, the following calls are not permitted when using the Signal Routing Library:

- Calls to Switch Manager functions
- Direct calls to device drivers that change the switched connection
- Calls to functions in libraries that switch the coupling relays
- Use of the automatic coupling relay mode with R&S TS-PMB modules.

Special instructions must be followed in the following cases:

- Performing In-Circuit Tests (R&S EGTSL)
- Using the VACUUM Library
- Calling functions in device drivers or libraries that reset modules.

8.4.7.1 Switch Manager

The Switch Manager Library SWMGR is the predecessor of the Signal Routing Library. The Switch Manager offers less functionality and is significantly more difficult to use. It can be used instead of the Signal Routing Library if compatibility with earlier R&S GTSLversions is required. The Signal Routing Library and Switch Manager are not designed for simultaneous use in a test program.

8.4.7.2 Device drivers

Functions in device drivers that affect the switched connections of modules must not be called if these modules are also administered by the Signal Routing Library, i.e. if they are configured as "SwitchDevice<i>". Examples of these functions are:

- *prefix*_Connect
- *prefix*_Disconnect
- *prefix*_DisconnectAll
- *prefix*_SetPath

The placeholder *prefix* stands for the function prefix of the device driver, for example rspsam or rspmb. Some device drivers offer additional switching functions, for example `rspsam_cnx_Matrix`, which also must not be used. Functions that affect the ground

reference of a device, such as `rspsam_cnx_Gnd` or `rspfg_ConfigureGround`, are exceptions to this rule.

8.4.7.3 Coupling relays

Functions in R&S GTSL libraries that affect switched connections must not be called. These functions are:

- DMM_Conf_Coupling_Relays (`DMM.DLL`)
- FUNCGEN_ConfigureCouplingRelays (`FUNCGEN.DLL`)
- SIGANL_ConfigureCouplingRelays (`SIGANL.DLL`)

Device driver functions that affect switched connections of coupling relays must not be used.

Note that with R&S TS-PMB modules the automatic mode of the coupling relays must not be used together with the Signal Routing Library. Therefore the `RSPSAM_ATTR_CR_AUTO` attribute must not be set to `VI_TRUE`. Use of `DriverSetup=CRAuto:1` in the DriverOption entry of `PHYSICAL.INI` is also not permitted. The Signal Routing Library ensures that the setting of the coupling relay mode is correct in the `ROUTE_Setup` function.

8.4.7.4 In-Circuit Test

The In-Circuit Test Library `ICT.DLL` may be used together with the Signal Routing Library if the following rules are observed:

Function **`ICT_Load_Program`** prepares the modules entered as ICTDevice<i> and the R&S TS PMB matrix modules entered as SwitchDevice<i> for use in the In-Circuit Test. At the same time the modules are reset. This function may only be called if the Signal Routing Library has not switched any connections.

The functions **`ICT_Run_Program`** and **`ICT_Debug_Program`** also reset the modules and change the coupling relays. When the In-Circuit Test is being performed, make certain that no signals are switched to the global analog measurement bus lines.

1. Disconnect all components from the analog bus.
2. **NOTICE!** Damaged test system. Signals on global analog measurement bus lines when an In-Circuit Test is called may result in incorrect measurements, faulty switched connections or short circuits.
   Before the ICT functions named above are called, all active and obsolete connections of the Signal Routing Library must be opened with the switching command `||` (Disconnect All). This may in turn damage the test system.
   Prepare the ICT with the `ICT_Load_Program` command.
3. Run the ICT with the `ICT_Run_Program` or `ICT_Run_Program` command.

If the ICT program is terminated and these functions return, the configured modules (ICTDevice<i> and R&S TS-PMB matrix modules entered as SwitchDevice<i>) are in reset state.

The function **ICT_Unload_Program** also resets configured modules to the basic state. They may only be called if the Signal Routing Library has not switched any connections.

When using **ICT Extension Libraries** the same instructions apply for the modules that are used by those libraries.

8.4.7.5 VACUUM Library

The Vacuum Library VACUUM.DLL can be used together with the Signal Routing Library if the R&S TS-PSYS1 or R&S TS-PSYS2 modules configured as VacuumControl<i> are not also configured as SwitchDevice<i>. If these rules are not observed the switching command || causes the vacuum to be deactivated.

8.4.7.6 Reset modules

Functions that trigger a reset of modules must only be called if it is assured that the Signal Routing Library on these modules has no more active or obsolete connections. It is recommended to perform the switching command || (Disconnect All) previously.

8.4.8 Panel test

A *panel test* is a test of a number of identical test units, called UUTs or units under test, which are arranged on a panel, i.e. a carrier shared by the units. The UUTs are tested either one after the other or simultaneously.

Therefore the test programs for the individual UUTs on the panel differ only in adapter wiring, not in sequence. This makes it efficient to create a single test program that is used for all UUTs and to control the variable switched connection with configuration files. This procedure minimises the effort required to maintain the test program, because each change affects all UUTs simultaneously.

A separate bench in APPLICATION.INI and a separate application-specific channel table has to be created for each UUT on the panel. The logical channel names are the same, but the assignment to physical channel names differs according to adapter wiring.

In the following example, differences between the two benches are highlighted in colour:

```
[bench->test1]

DigitalMultimeter = device->PSAM
FunctionGenerator = device->PFG
SwitchDevice1     = device->PSAM
SwitchDevice2     = device->PMB_10
SwitchDevice3     = device->PFG

AnalogBus         = device->ABUS

AppChannelTable   = io_channel->test1

[io_channel->test1]
INPUT             = PMB_10!P1
GND               = PMB_10!P2
OUTPUT            = PMB_10!P3
MONITOR           = PMB_10!P65
```

```
[bench->test2]

DigitalMultimeter = device->PSAM
FunctionGenerator = device->PFG
SwitchDevice1     = device->PSAM
SwitchDevice2     = device->PMB_10
SwitchDevice3     = device->PFG
SwitchDevice4     = device->PMB_14
AnalogBus         = device->ABUS

AppChannelTable   = io_channel->test2

[io_channel->test2]
INPUT             = PMB_14!P33
GND               = PMB_14!P34
OUTPUT            = PMB_14!P35
MONITOR           = PMB_10!P65
```

Devices used in common such as PSAM and PFG and PMB_10 occur in both benches. Bench "test2" also uses matrix module PMB_14.

The logical channel names in the two channel tables are identical. Physical channel names differ depending on different adapter wiring. The MONITOR channel is the same for both channel tables. In this case, an oscilloscope will be connected to make it possible to monitor the test signals of both UUTs.

The even/odd relationship of channels should be retained in all channel tables for the panel test. This means either only even or only odd physical channels should be assigned to a logical channel on an R&S TS-PMB matrix module.

The program sequence for the panel test is such that the `ROUTE_Setup` function is is called once at the beginning for each UUT passing the appropriate bench name. This results in a separate resource ID for the Signal Routing Library for each UUT.

The corresponding resource ID for the each UUT is passed in all subsequent switching functions.

Example:

```
#define NUM_UUTS   2

short errorOccurred;
long  errorCode
char  errorMessage[GTSL_ERROR_BUFFER_SIZE];
long  resourceId[NUM_UUTS];

// setup libraries
RESMGR_Setup ( 0, "physical.ini", "testApplication.ini",
               &errorOccurred, &errorCode, errorMessage  );

// setup library for each UUT in the panel
for ( i = 0; i < NUM_UUTS; i++ )
{
  char benchName[80];
  sprintf ( benchName, "bench->test%d", i+1  );
  ROUTE_Setup ( 0, benchName, &resourceId[i],
                &errorOccurred, &errorCode, errorMessage  );
```

```
}

// call tests for each UUT
for ( i = 0; i < NUM_UUTS; i++ )
{
  // connect generator
  ROUTE_Execute ( 0, resourceId[i], "GEN_LO > GND,  GEN_HI > INPUT",
                  &errorOccurred, &errorCode, errorMessage  );

  // connect DMM
  ROUTE_Execute ( 0, resourceId[i], "GND > DMM_LO,  OUTPUT > DMM_HI",
                  &errorOccurred, &errorCode, errorMessage  );

  // disconnect all
  ROUTE_Execute ( 0, resourceId[i], "||",
                  &errorOccurred, &errorCode,  errorMessage );
}

// close library for each UUT
for ( i = 0; i < NUM_UUTS; i++ )
{
  ROUTE_Cleanup ( 0, resourceId[i], &errorOccurred, &errorCode,
                  errorMessage );
}

RESMGR_Cleanup ( 0, &errorOccurred, &errorCode,  errorMessage);
```

In the example above, the number of UUTs is defined as a constant NUM_UUTS. The resource IDs for the individual UUTs are kept in an array resourceId[NUM_UUTS] The relevant UUT is selected by means of the index variable i. In this manner the program can easily be adapted to another number of UUTs on the panel by defining NUM_UUTS appropriately. In addition, the appropriate number of benches and channel tables must also be added to `APPLICATION.INI`.

Switch settings can also be used in the panel test. Since they contain only logical channel names it is sufficient to create a table used in common with switch settings and to add a reference to the table to each bench.

All switching commands affect only the SwitchDevice<i> configured in the relevant bench by the resource ID, with the following exception:

The two commands `||` and `%` affect all hardware elements, i.e. all switch modules that are configured in any bench as SwitchDevice<i>.

8.4.9 Error cases

If an error occurs in a switching command, the command is aborted and the error is reported. In addition, the switching state that was present before the `ROUTE_Execute` function was called is restored.

Some switching commands cannot be undone once they are complete. These are `||` (Disconnect All) and `%` (Disconnect all obsolete connections). Because of this it is not guaranteed that all connections will still be in existence after an error.

If a warning occurs during a switching command, the execution of the command continues and the warning is reported. If more than one warning occurs in a command, only the first warning is reported.

8.4.10 Integrating third-party modules

In addition to R&S CompactTSVP modules, the Signal Routing Library can also control third-party switch modules. A requirement in this case is that the modules provide a IVI-C driver of class *IviSwtch*. A section with the following information must be entered in `PHYSICAL.INI` for each external module:

Table 8-9: Entries in PHYSICAL.INI for third-party modules

Keyword	Value	Description
Type	String	*Mandatory entry* IVI_SWITCH
ResourceDesc	String	*Mandatory entry* Resource descriptor string
DriverDll	String	*Mandatory entry* File name of the device driver DLL
DriverPrefix	String	*Mandatory entry* Prefix for the IVI driver functions
DriverSetup	String	*Optional entry* Optional indications which are passed to the device driver during the prefix_InitWithOptions function.

Refer to the documentation for the module about the entries required for ResourceDesc, DriverDll, DriverPrefix and DriverSetup.

Sample entry for an NI2565 switch module:

```
[device->NI2565]
Type         = IVI_SWITCH
ResourceDesc = PXI1::15::INSTR
DriverDLL    = niswitch_32.dll
DriverPrefix = niSwitch
```

8.4.11 Examples

8.4.11.1 Scanner

In the following example, three voltages will be measured between two channels HI and LO. To do this, channels DMM_HI and DMM_LO are connected with the corresponding UUT channels and the voltage is measured. Then the connections are disconnected.

Example:

```
[io_channel->scanner]
DMM_HI = psam!dmm_hi
DMM_LO = psam!dmm_lo
HI1    = pmb_10!P1
HI2    = pmb_10!P2
HI3    = pmb_10!P3
LO1    = pmb_10!P4
LO2    = pmb_10!P5
LO3    = pmb_10!P6
```

The corresponding switching commands are:

```
DMM_HI > HI1, DMM_LO > LO1,  ?#
```

(Perform measurement)

```
DMM_HI | HI1, DMM_LO | LO1,  ?#
```

Then the same process is performed for channel pairs HI2 / LO2 and HI3 / LO3.

```
DMM_HI > HI2, DMM_LO > LO2, ?#
DMM_HI | HI2, DMM_LO | LO2, ?#
DMM_HI > HI3, DMM_LO > LO3, ?#
DMM_HI | HI3, DMM_LO | LO3, ?#
```

For the first measurement, DMM_HI through $ABa1 is connected with HI1 (odd channel) and DMM_LO through $ABb2 is connected with LO1 (even channel):

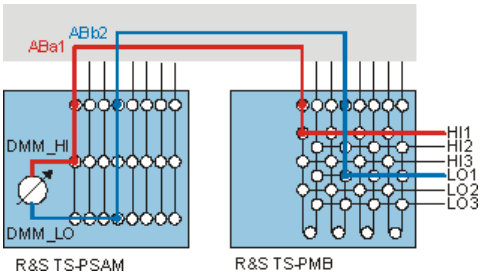


Figure 8-15: Scanner, measurement on HI1 and LO1

HI2 (even channel) and LO2 (odd channel) are used for the second measurement. Now a direct connection from $ABa1 to HI2 is no longer possible. The connection to HI2 is now made via the sense relay or the R&S TS-PMB module and the local analog measurement buses $LABa1 and $LABa2. The connection to LO2 is also made by a sense relay.

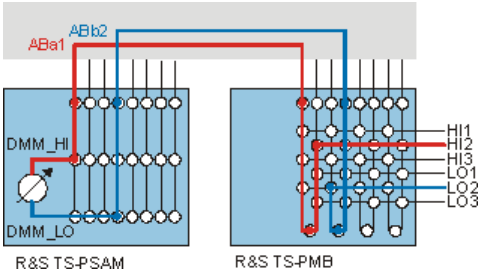


Figure 8-16: Scanner, measurement to HI2 and LO2 via sense relays

In the following measurement on HI3 and LO3 both channels can again be connected directly, i.e. without sense relays, with the analog measurement buses. The connections which are still set up through the sense relays remain in existence as obsolete connections.

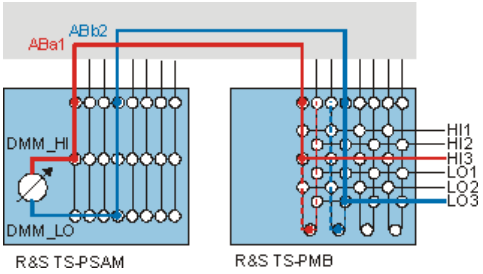


Figure 8-17: Scanner, measurement on HI3 and LO3 with obsolete connections.

Active and obsolete connections can be seen in the switched connection display:

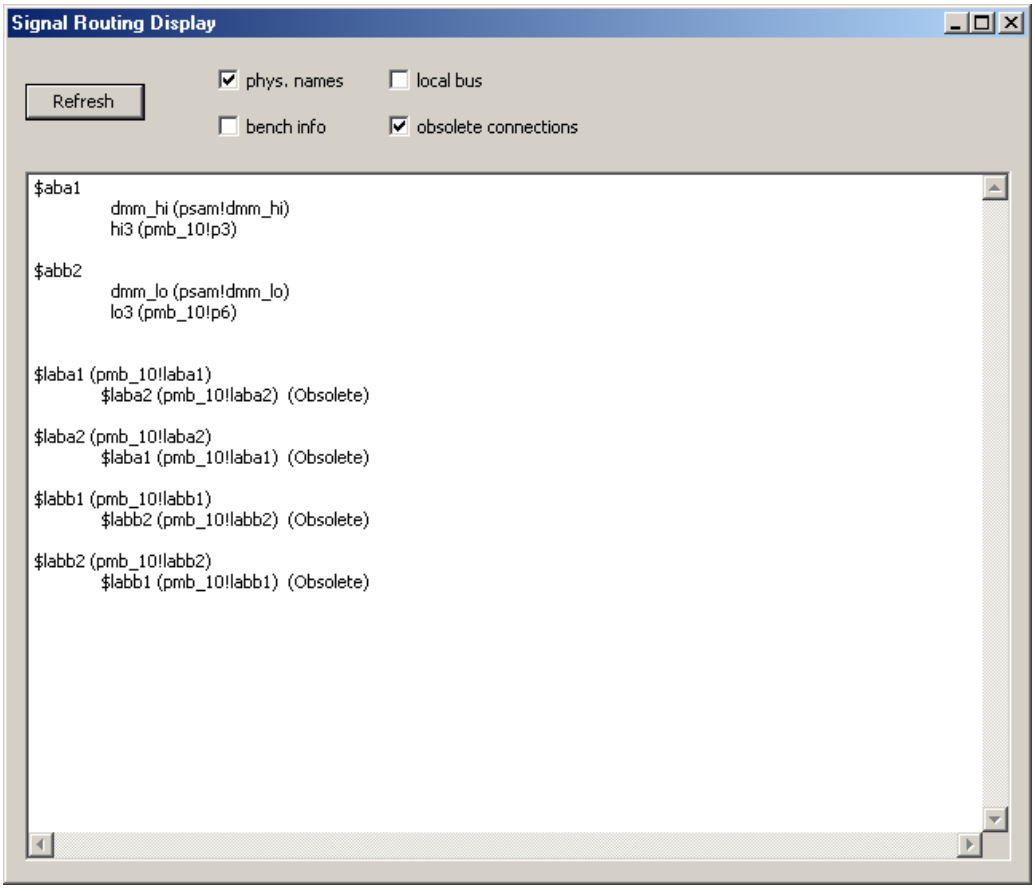


Figure 8-18: Switched connection display for measurement on HI3 and LO3

8.4.11.2 Current measurement via shunt

Power switching module R&S TS-PSM1 offers the possibility of measuring high currents with a voltage measurement on the integrated shunt resistors.

When setting up the connections for this measurement, note that the channel name is the same *on both sides* of the shunt resistor, for example CH1no for channel 1. To ensure that DMM_HI and DMM_LO are directed to the two different connections of the shunt resistor, however, the analog measurement bus lines must be explicitly specified:

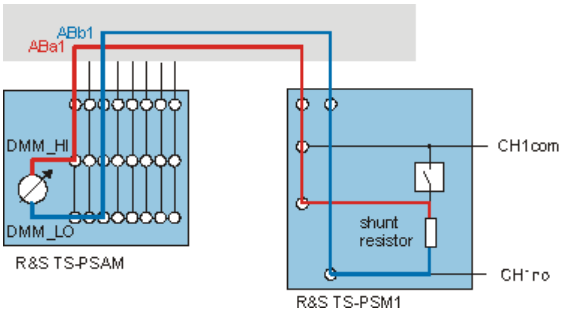


Figure 8-19: Current measurement via R&S TS-PSM1 shunt resistor

The lower connection of the shunt resistor in Figure 8-19 can only be reached through analog measurement bus ABb1. The upper connection can only be reached through ABa1. The switching command is therefore as follows:

```
DMM_HI > $ABa1 > CH1no
DMM_LO > $ABb1 > CH1no
```

9 Creation of Test Libraries

Knowledge of C programming is needed to create test libraries.

Do not modify the original Sample Self Test Library project. Instead, make a copy of the `sample` directory and make your modifications in the copy.

Be careful when you put your private DLLs in the `gtsl\bin` directory. Always keep a copy, because they may be overwritten by an update to R&S GTSL if there is a DLL with the same name. It is safer to keep your projects and DLLs in a completely separate location beside the R&S GTSL. Be sure to add the directory where your DLLs reside to the `PATH` environment variable of your computer.

9.1 Scope

9.1.1 Identification

This chapter describes how to write a high-level library for the R&S GTSL software. The NI LabWindows/CVI programming environment is used to create the dynamic link library (DDL).

9.1.2 System Overview

A high-level library offers a group of functions which cover the needs for testing a specific class of UUTs.

In this tutorial NI TestStand is used as test management software and is the executeable program. The library functions are called from a TestStand sequence. The functions themselves interact with the resource manager library and the device drivers.

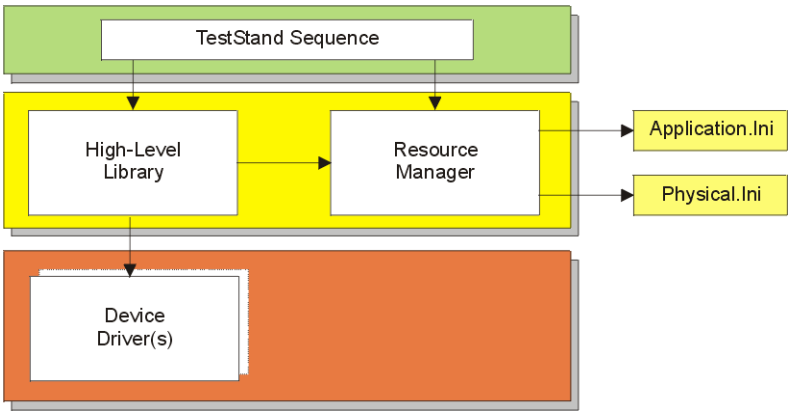


Figure 9-1: R&S GTSL software overview

9.2 Referenced Documents

[INSTR]	LabWindows/CVI Instrument Driver Developers Guide, National Instruments, February 1998 Edition
[RESMGR]	Resource Manager online help file (`resmgr.hlp`)

9.3 Software Design Decisions

The design of any R&S GTSL high-level library must meet the following requirements:

- The library must be delivered as a Dynamic Link Library (`.DLL`), including type library information, a function panel and a Windows help file.
- The function call interface must follow the template.
- Each library must offer a Setup and a Cleanup function as well as a Lib_Version function.
- The library must use the resource manager functions (if applicable).
- The library must be thread safe.
- The library must support device sharing using the lock/unlock functions of the resource manager.

These requirements are described in detail in the following sections.

9.4 Architectural Design

9.4.1 Components

The basic components of each high-level library are:

- High-level Library "xyz": (deliverable items)
  - `xyz.h` - include file
  - `xyz.lib` - import library
  - `xyz.dll` - dynamic link library
  - `xyz.fp` - CVI function panel
  - `xyz.hlp` - Windows help file
- High-level Library "xyz" (non-deliverable items)
  - `xyz.c` - source file
  - `xyz.prj` - CVI project file
  - ... - additional source/include files (if applicable)

9.4.2 Concept of Execution

The high-level library functions are called from the TestStand sequencer using the DLL flexible prototype adapter. The function prototypes follow the TestStand default template for the DLL flexible prototype adapter and allow easy integration into the TestStand environment.

Each high-level library offers a setup function, which identifies the device(s) and options to be used, initializes the appropriate device drivers and puts the device(s) into a proper operating state. The setup function must be called from the TestStand sequence before any other library function. The cleanup function must be called at the end of all tests, it releases the devices and frees the resources. The Lib_Version function returns the version string of the library.

The setup function returns a resource id, i.e. a unique identifier, which must be used for all subsequent function calls of the high-level library.

A set of functions is provided depending on the purpose of the library. Each function can be seen as a single test step (or test case) in the TestStand sequence. Therefore, it should execute a single operation (like a measurement) and return a single value (like a power level, a bit error rate, etc...). In this case, the measured value can be compared and logged in a single test step in the TestStand sequence, keeping the sequence short and readable. Some measurement functions may return more than one value (like an amplitude and a phase) if necessary. In this case, an additional comparison step is required in the TestStand sequence.

The library functions should be 'high-level', which means not too simple (requiring a lot of steps in the sequence to set up a device or to take a measurement) and not too complicated (returning a bunch of measured values which must be stored by the TestStand sequence and validated by several subsequent steps).

The functions are based on the functionality of the underlying device driver. Depending on the complexity of the function and the features of the device driver, this may be a simple call of a single device driver function or a complex piece of code dealing with several device drivers and a large number of driver calls.

There are a number of benefits to using a high-level library instead of calling a device driver directly:

- the library can handle more than one device (bench concept)
- the library can switch between different types of devices without modification of the TestStand sequence
- the library implements device sharing between several processes or threads (locking)
- standard INI-file concept for resource description (physical/application layer)
- standard error handling mechanism, suited for use with TestStand

The required functionality is provided by the Resource Manager library. The resource manager is one of the central parts of the R&S GTSL software. It coordinates the interaction between all the libraries, especially in parallel test scenarios. Therefore it is mandatory to include the resource manager in each high-level library.

9.4.3 Interface Design

9.4.3.1 Interface Identification and Diagrams

A high-level library has the following interfaces:

- Export functions (interface to TestStand sequence)
- Driver calls (interface to device drivers)
- Resource Manager calls (interface to resource manager)
- Resource Description (physical/application layer, via resource manager)
- Function Panel User Interface

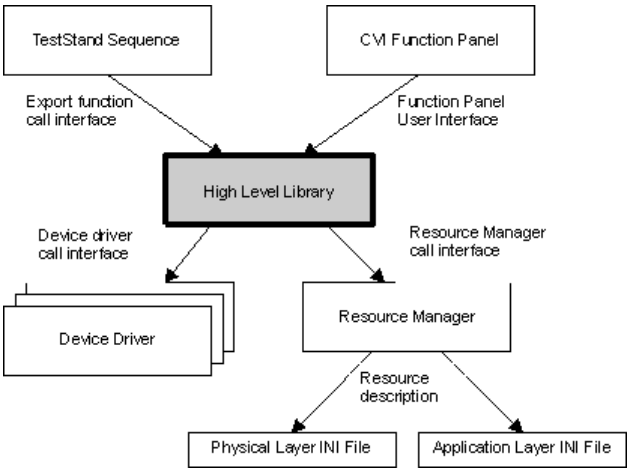


Figure 9-2: Interface diagram

9.4.3.2 Export Functions

The export function prototype follows the default template for the DLL flexible prototype adapter, which is defined by National Instruments in the TestStand software. This prototype allows easy integration of the export functions into the TestStand environment, especially for automatic error handling.

The R&S GTSL template follows the default template, but is more flexible in terms of the number and types of the parameters.

Naming conventions

Each function of a library begins with the library prefix followed by an underscore character. The prefix is normally the same as the name of the library and must be written in uppercase characters. For example, all function names of a "GSM" library begin with 'GSM_'.

The function name shall clearly show the action behind it. If the functions are arranged in groups, the group shall also be part of the function name. For example, the name for a measurement function for the peak power in non-signaling mode in the GSM library may be 'GSM_NonSig_Meas_Power_PK'. In this case, 'GSM_' is the library prefix,

'NonSig_' is a function group for non-signaling mode, 'Meas_' is a sub-group for measurement functions, and 'Power_PK' is the parameter to be measured. The function name is written in mixed uppercase/lowercase with underscores to make it more readable.

Function type and calling conventions

The function type is void DLLEXPORT DLLSTDCALL, i.e. there is no return value. The function is exported to the export library (DLLEXPORT) and the call interface is the standard call interface (DLLSTDCALL). The DLLEXPORT and DLLSTDCALL defines are taken from the cvidef.h include file and are compiler independent, while the constructs ”__declspec(dllexport)” and ”__stdcall” may be a problem when the compiler is not LabWindows/CVI or Microsoft Visual C.

Function parameters

sequenceContext	The first parameter is always "CAObjHandle sequenceContext". When a library function is called from TestStand, the built-in variable "ThisContext" is passed. When the library is used outside TestStand, this parameter must be set to zero. The sequence context allows access to the TestStand sequence and variables from within the library using the ActiveX properties and methods of TestStand. Normally, a high-level library will not use the sequence context. However, it must be passed to the resource manager functions as a parameter.

resourceId	A number which identifies the resource, i.e. the bench or device.

The second parameter is the resource ID, which is obtained when the library setup function is called. The resource ID must be stored in the TestStand sequence after the call of the setup function, and it must be passed to all subsequent function calls into the library.

...	Additional parameters

Additional parameters like setup parameters and pointers to result values are inserted in the second, third,... place as required. Input parameters should precede output parameters.

pErrorOccurred	output parameter, passed by reference Error flag, is set to 1 if an error occurred, otherwise 0.
pErrorCode	output parameter, passed by reference < 0 : Error code in case of pErrorOccurred = 1 = 0 : Function returned successfully, pErrorOccurred = 0 > 0 : Indicates a warning when pErrorOccurred = 0.
errorMessage	output parameter The error message will be copied to this buffer in case of an error or warning, the contents remain unchanged if the function completes successfully. The minimum size of this buffer must be GTSL_ERROR_BUFFER_SIZE (1024 bytes).

The last three parameters are used for error handling in TestStand. They are defined as 'short *pErrorOccurred', 'long *pErrorCode' and 'char errorMessage[]'.

Example:

The following example shows the prototype of a function for a capacitor measurement. There are three additional input parameters (measMode, stimVoltage and stimFrequency) and two output paramters (capacitance and phase).

```
void DLLEXPORT DLLSTDCALL SAMPLE_Meas_Capacitance
( CAObjHandle sequenceContext,
long resourceId
int measMode,
double stimVoltage,
double stimFrequency,
double * capacitance,
int * phase
short * pErrorOccurred,
long * pErrorCode,
char errorMessage[]);
```

Setup function

The setup function is mandatory. The name of the setup function is defined as the library prefix with underscore followed by the word 'Setup'. The parameter list is shown below. ResourceName (input parameter) is a character string which identifies the resource(s) in the application and physical layer INI files. This may be a logical name, the name of a bench or the name of a device.

ResourceID is an output parameter. If the function returns successfully, a resource ID for the allocated resources is returned here.

```
void DLLEXPORT DLLSTDCALL SAMPLE_Setup
( CAObjHandle sequenceContext,
char * resourceName,
long * resourceId,
short * pErrorOccurred,
```

```
long * pErrorCode,
char errorMessage[] );
```

Cleanup function

The cleanup function is mandatory. The name of the cleanup function is defined as the library prefix with underscore followed by the word 'Cleanup'. The parameter list is described in "Function parameters" on page 156, there are no additional parameters.

```
void DLLEXPORT DLLSTDCALL SAMPLE_Cleanup
( CAObjHandle sequenceContext,
long resourceId
short * pErrorOccurred,
long * pErrorCode,
char errorMessage[]);
```

Library version function

The library version function is mandatory. The name of the library version function is defined as the library prefix with underscore followed by the words 'Lib_Version'. This function may be called any time, i.e. even before calling the setup function. Therefore, there is no resourceId parameter to this function. The version string is copied to the string buffer libraryVersion.

```
void DLLEXPORT DLLSTDCALL RESMGR_Lib_Version
( CAObjHandle sequenceContext,
char libraryVersion[80],
short * pErrorOccurred,
long * pErrorCode,
char errorMessage[] );
```

9.4.3.3 Device Driver Interface

The interface to the device driver is mainly dependent on the device driver itself. A device driver may be conforming to

- the IVI standard
- the VISA standard
- none of the above

and it may be

- written by Rohde & Schwarz
- written by a third-party developer

The Resource Manager supports device drivers using the VISA and IVI standards (the session functions support a data type ViSession, which is the session handle to a VISA session). Non-standard drivers may be supported as long as there is something comparable to the ViSession handle (like a file pointer or handle for a serial interface in the Windows API, as long as its size does not exceed 32 bits).

A high-level library may deal with more than one device driver in two cases:

- The library supports several devices as an alternative.
- The library requires several devices concurrently to perform a task.

The Setup function of the high-level library must call the Initialize function of the device(s) and establish a connection to the hardware. It may also be necessary to setup the device to a known state.

The Cleanup function of the high-level library must call the Close function of the device driver, closing the connection to the hardware. It may be necessary to reset the device to a known state before.

Both functions must implement the cooperative session handle concept (see Chapter 9.5.2.2, "Cleanup Function", on page 173). This means that the Setup function must not initialize the driver if a session already exists, and the Cleanup function must not close the driver if there is still another session open to the device. This concept is important in parallel test scenarios with device sharing.

9.4.3.4 Resource Manager interface

The Resource Manager interface is described in the RESMGR.HLP file.

How the interface is to be used, will be described in the following sections of this document. The SAMPLE project includes the mandatory functions of a high-level library (Setup, Cleanup, Lib_Version) as well as one measurement function. These functions show how to use the Resource Manager interface.

9.4.3.5 Resource Description

The syntax of the Resource Description is defined in Chapter 5, "Configuration Files", on page 24. The resources are described in two INI-file style text files, the physical layer INI-file and the application layer INI-file.

The physical layer contains physical device information like the device type and the IEEE address:

```
[device->CMD55]
Description = Radio Communication Tester CMD55
Type = CMD55
ResourceDesc = GPIB0::15
```

The application layer contains application-specific information, which may vary for different UUTs:

```
[LogicalNames]
GSM = bench->Radiocom_GSM
[bench->Radiocom_GSM]
Description = Bench for GSM library
RadioComTester = device->CMD55
Simulation=0
```

The Setup function of a high-level library reads the configuration information and determines the hardware which is actually present. The meaning of these entries is described in detail in Chapter 9.5.3, "Resource Description", on page 184.

9.4.3.6 Function Panel User Interface

The Function Panel User Interface is an interactive graphical interface that assists the software developer in understanding what each particular library function does and how to use the programmatic developer interface to call each function.

See the “National Instruments documentation” for details on the LabWindows/CVI function panels, the Function Tree Editor and the Function Panel Editor.

The function tree contains the three standard functions Setup, Lib_Version and Cleanup. The other functions are grouped into subtrees (like Measurement, Configuration, Signaling, Non-signaling etc.).

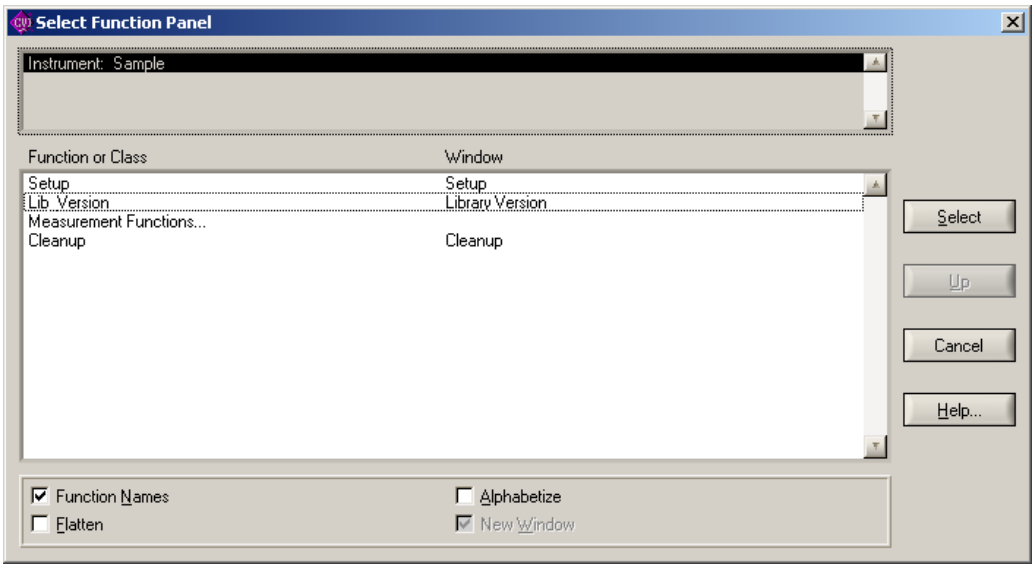


Figure 9-3: Function tree of the SAMPLE project

There is a function panel window for each function:

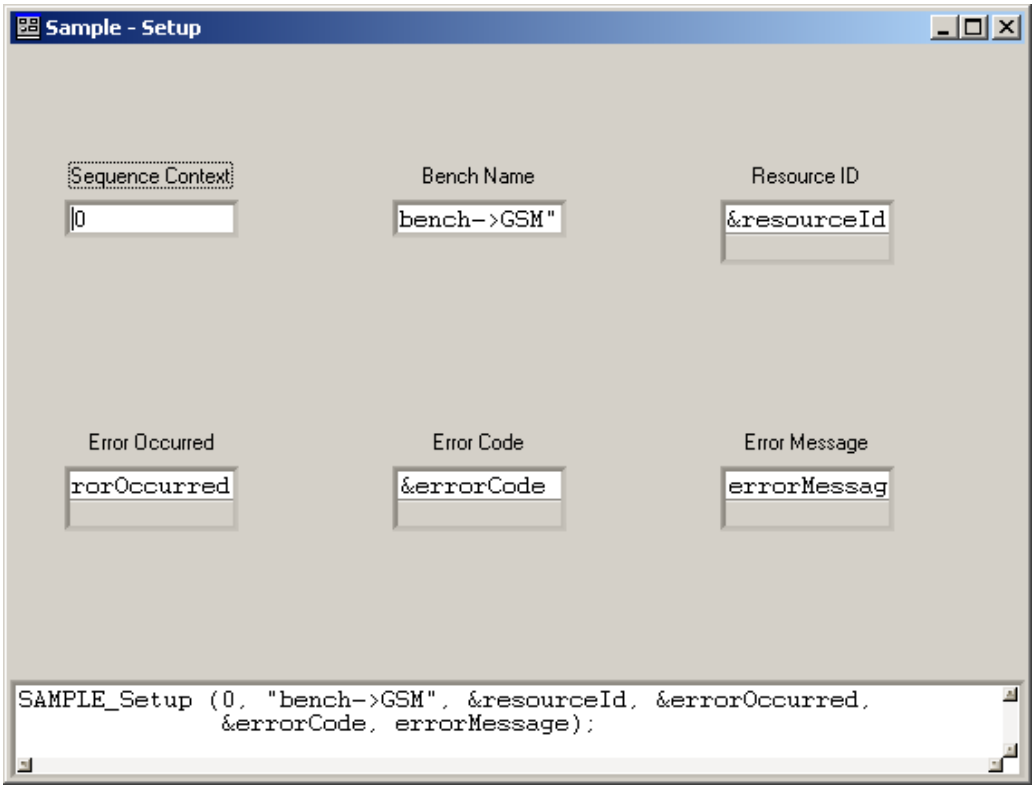


Figure 9-4: Panel window of the SAMPLE_Setup function

The online help system provides a short description for the library, for each function and for each parameter:

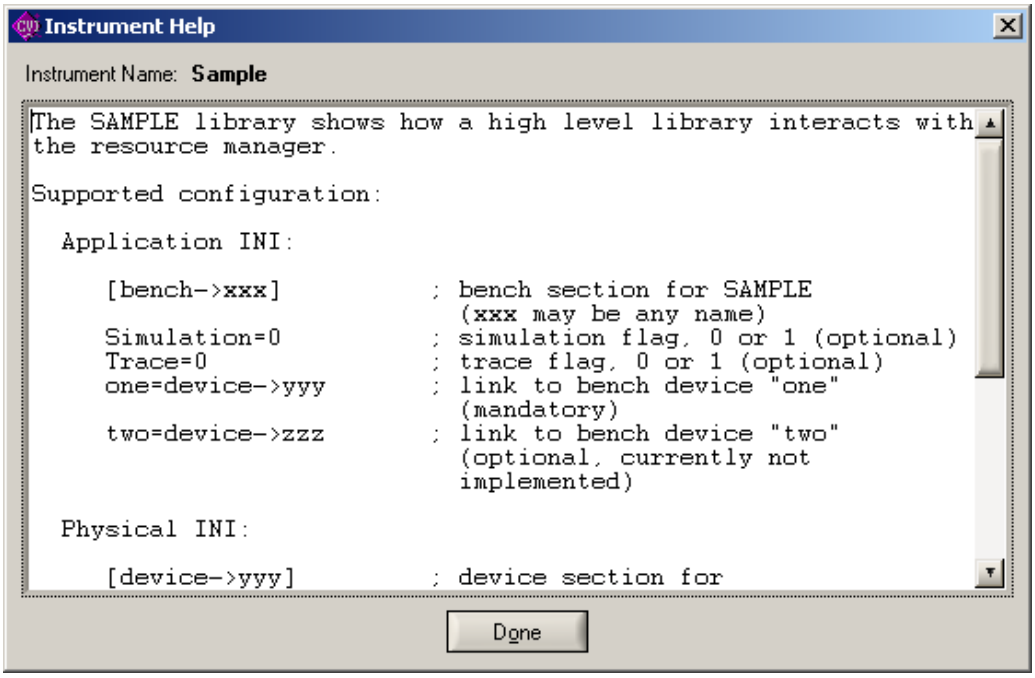


Figure 9-5: Library Help

Library Help (in CVI called 'Function Help') gives an overview of the purpose of the library, lists the hardware requirements (if applicable) and describes the supported entries in the application and physical layer INI files.

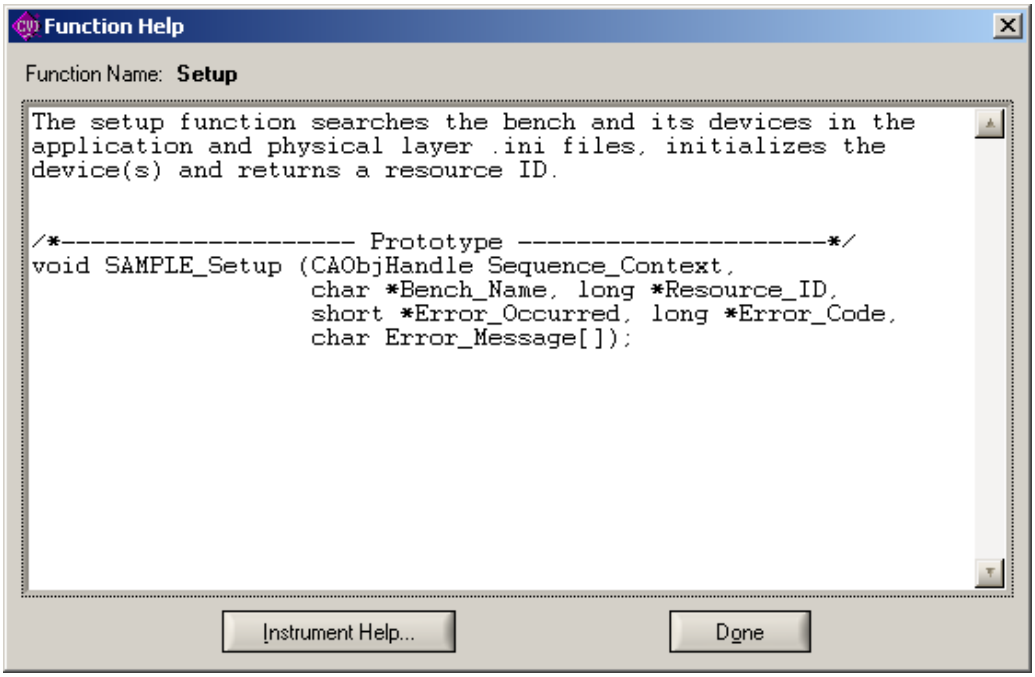


Figure 9-6: Function Help

Function Help gives a short summary of the task of the function.

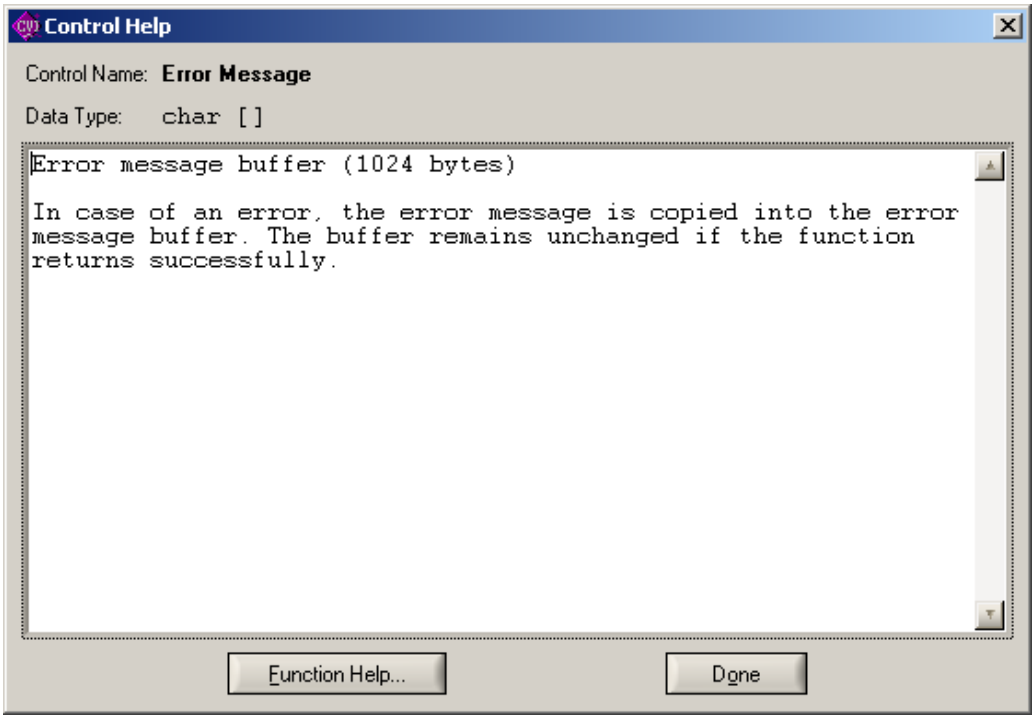


Figure 9-7: Parameter Help

9.5 Software Detailed Design

9.5.1 Coding Rules

9.5.1.1 Language

The R&S GTSL software is developed in many different locations worldwide. This means that the language for code, comments and documentation has to be English (even for variable names, typedefs, define etc.)

9.5.1.2 Programming Environment

Code is written in ANSI C. The target compiler is LabWindows/CVI, where the compiler options are set to 'Visual C/C++ compatibility'. Non-standard extensions may be used only if absolutely necessary (like the calling convention and DLL export keywords in the function prototype).

A high-level library must meet the design specifications for a LabWindows/CVI device driver library, i.e. it is to be supplied with:

- an include file (`.h` file)

- a function panel (`.fp` file)
- a windows help file (`.hlp` file)
- an import library file (`.lib` file)
- a dynamic link library file (`.dll` file)

9.5.1.3 Templates

The Rohde & Schwarz templates for C modules, include files and function headers shall be used.

9.5.2 Library Reference

9.5.2.1 Setup Function

The function call interface of the setup function is described in "Setup function" on page 157. The setup function has the following tasks:

1. Look up the given resource name in the application layer INI-file and allocate a resource ID for it.
2. Retrieve the configuration of the bench and device(s) from the INI files.
3. Store configuration-dependent data in a memory block in the resource manager.
4. Open the session(s) in the Resource Manager, initialize the appropriate device driver(s)and store the session handle(s) in the Resource Manager.

See the source file `sample.c` in the SAMPLE project for details on the Setup function.

```
#define SAMPLE_BENCH_DEVICE_ONE     "one"
#define SAMPLE_BENCH_DEVICE_TWO     "two"
#define SAMPLE_TYPE_ONE             "type1"
#define SAMPLE_TYPE_TWO             "type2"

typedef struct
{
   int owner;         /* memory block owner      */
   int typeOne;       /* device type one present */
   int typeTwo;       /* device type two present */
   int simulation;    /* driver simulation       */

}  BENCH_STRUCT;

void DLLEXPORT DLLSTDCALL SAMPLE_Setup ( CAObjHandle sequenceContext,
                                         char        * pBenchName,
                                         long        * pResourceId,
                                         short       * pErrorOccurred,
```

```
                                        long        * pErrorCode,
                                        char        errorMessage[] )
{
  char         buffer [BUFFER_MEDIUM] = "";
  char         traceBuffer [BUFFER_LARGE] = "";
  int          resourceType = 0;
  int          written = FALSE;
  int          matched = FALSE;
  BOOL         sessionExists = FALSE;
  BOOL         deviceLocked = FALSE;
  BOOL         trace = FALSE;
  BENCH_STRUCT * pBench = NULL;
  ViSession    sessionHandle = 0;
  ViStatus     viStatus = 0;
```

Allocate the resource

In the first step, the resource name given by the parameter 'benchName' must be looked up in the configuration file and a resource ID must be allocated for it. Note that 'resourceId' is a pointer to the resource ID (see function call interface above).

```
  /*-------------------------------------------------------------------*/
  /   Allocate the resource:
  /     Check whether "pBenchName" can be found in the INI files and
  /     return a resource ID for the bench. This resource ID is the
  /     "ticket" for any subsequent action dealing with this bench.
  /-------------------------------------------------------------------*/
  RESMGR_Alloc_Resource (sequenceContext, pBenchName, pResourceId,
                         pErrorOccurred, pErrorCode, errorMessage);
```

Retrieve the configuration

In this step, we retrieve some bench properties, bench devices and device properties and check whether the library can handle them. Here, the trace flag and the resource type are checked.

```
  /*-------------------------------------------------------------------*/
  /  Check for trace flag:
  /    The "Trace" key in the bench section is searched and its
  /    value is checked. The result is recorded in the static
  /    variable trace
  /-------------------------------------------------------------------*/
  if ( ! * pErrorOccurred )
  {
    RESMGR_Compare_Value ( sequenceContext, * pResourceId, "", RESMGR_KEY_TRACE,

                           pErrorOccurred, pErrorCode, errorMessage );
  }
  if ( ! * pErrorOccurred )
  {
    RESMGR_Set_Trace_Flag ( * pResourceId, trace );
```

```
  if ( trace )
  {
    RESMGR_Trace ( ">>SAMPLE_Setup begin" );
    RESMGR_Trace ( "Tracing for SAMPLE.DLL enabled" );
    sprintf ( traceBuffer, "Bench name %s -> Resource ID %ld", pBenchName,
                      * pResourceId );
    RESMGR_Trace ( traceBuffer );
  }
}

/*---------------------------------------------------------------------*/
/   Check the resource type:
/     The SAMPLE library requires that pBenchName refers to a bench,
/     not to a single device. It is always recommended to use a bench
/     instead of a device, because a bench makes it easy to add
/     a device in future and to work with alternative devices
/     like a CMD55 or a CMU.
/---------------------------------------------------------------------*/
if ( ! * pErrorOccurred )
{
  RESMGR_Get_Resource_Type ( sequenceContext, * pResourceId, &resourceType,
                             pErrorOccurred, pErrorCode, errorMessage );
  if ( ! * pErrorOccurred )
  {
    if ( resourceType != RESMGR_TYPE_BENCH )
    {
      * pErrorOccurred = TRUE;
      * pErrorCode = SAMPLE_ERR_NOT_A_BENCH;
      formatError ( errorMessage, *pErrorCode, * pResourceId, NULL );
    }
  }
}
```

Store configuration-dependent data

In this step, a memory block is created and attached to the resource ID. In this example, the memory block keeps a structure where the state of the simulation flag and the presence of two bench devices is stored.

```
/*---------------------------------------------------------------------*/
/   Allocate a memory block:
/     The SAMPLE library uses a structure to store some private
/     information along with the resource ID. This information can
/     be retrieved in subsequent calls to the measurement functions.
/---------------------------------------------------------------------*/
if ( ! * pErrorOccurred )
{
  RESMGR_Alloc_Memory ( sequenceContext, * pResourceId, sizeof ( BENCH_STRUCT ),
                        ( void ** ) ( &pBench ), pErrorOccurred, pErrorCode,

  if ( ! * pErrorOccurred )
```

```
  {
    /* set the memory block owner field to a unique value
       which identifies the SAMPLE library as the owner of the memory.
    */
    pBench->owner = SAMPLE_ERR_BASE;

    /* set default values */
    pBench -> typeOne = FALSE;
    pBench -> typeTwo = FALSE;
    pBench -> simulation = FALSE;
  }
}


/*---------------------------------------------------------------------------/
/   Check supported bench devices:
/     Look for bench device "one" and "two" and check the "Type" key
/     in the device sections of the physical layer.
/     The presence is recorded in the memory block.
/---------------------------------------------------------------------------*/

/* 1) bench device 'one', device type 'type1'

      For device 'one', we read the type into a local buffer
      and compare it with the supported values
*/
if ( ! * pErrorOccurred )
{
  RESMGR_Get_Value ( sequenceContext, * pResourceId, SAMPLE_BENCH_DEVICE_ONE,
                     RESMGR_KEY_TYPE, buffer, sizeof ( buffer ), &written,
                     pErrorOccurred, pErrorCode, errorMessage );
  if ( ! * pErrorOccurred )
  {
    if ( written == 0 )
    {
      /* no "Type" key entry found */
      * pErrorOccurred = TRUE;
      * pErrorCode = SAMPLE_ERR_NO_TYPE;
      formatError ( errorMessage, * pErrorCode, * pResourceId,
                                SAMPLE_BENCH_DEVICE_ONE );
    }
  }
  if ( ! * pErrorOccurred )
  {
    if ( CompareStrings ( buffer, 0, SAMPLE_TYPE_ONE, 0, 0 ) == 0 )
    {
      /* found bench device "one", type "type1" */
      pBench -> typeOne = TRUE;
      if ( trace )
      {
```

```
        RESMGR_Trace ( "Bench device 'one' of 'type1' found" );
      }
    }
    else
    {
      /* no supported type key entry found */
      * pErrorOccurred = TRUE;
      * pErrorCode = SAMPLE_ERR_NO_SUPP_TYPE;
      formatError ( errorMessage, * pErrorCode, * pResourceId,
                              SAMPLE_BENCH_DEVICE_ONE );
    }

  }
  /* 2) bench device 'two', device type 'type2'

        For device 'two' (which is optional) we can do a quick check
        by just calling the function RESMGR_Compare_Value
  */
  if ( ! * pErrorOccurred )
  {
    RESMGR_Compare_Value ( sequenceContext, * pResourceId,

                           RESMGR_KEY_TYPE, SAMPLE_TYPE_TWO, &matched,
                           pErrorOccurred, pErrorCode, errorMessage );
  }
  if ( ! * pErrorOccurred )
  {
    if ( matched )
    {
      /* found bench device "two", type "type2" */
      pBench -> typeTwo = TRUE;
      if ( trace )
      {
        RESMGR_Trace ( "Bench device 'two' of 'type2' found" );
      }
    }
  }
}
/*-------------------------------------------------------------------------/
/   Check for simulation flag:
/     The "Simulation" key in the bench section is searched and its
/     value is checked. The result is recorded in the memory block.
/     Any other library-specific information like calibration,
/     path for calibration files etc. may be handled the same way
/     (not shown in the example).
/-------------------------------------------------------------------------*/
if ( ! * pErrorOccurred )
{
  RESMGR_Compare_Value ( sequenceContext, * pResourceId, "",
```

```
                          &matched, pErrorOccurred, pErrorCode, errorMessage );
  if ( ! * pErrorOccurred )
  {
    if ( matched )
    {
      pBench -> simulation = TRUE;
      if ( trace )
      {
        RESMGR_Trace ( "Simulation is enabled" );
      }
    }
  }
}
```

Initialize the device driver

The following block of code must be repeated for each device driver. First, the device is locked to ensure exclusive access during the driver initialization phase. The flag 'deviceLocked' is set to remember the lock state and ensure that the device is properly unlocked at the end of the setup procedure.

```
/*---------------------------------------------------------------------*/
/   Lock the device:
/     The device must be locked to prevent another process or thread
/     from accessing it.
/---------------------------------------------------------------------*/
if ( ! * pErrorOccurred )
{
  RESMGR_Lock_Device ( sequenceContext, * pResourceId,

                       SAMPLE_TIMEOUT, pErrorOccurred, pErrorCode,

  if ( ! * pErrorOccurred )
  {
    deviceLocked = TRUE;
  }
}
```

Next, a device session is opened in the resource manager.

```
/*---------------------------------------------------------------------*/
/   Open the device session(s): (Not in simulation)
/     For each device in the bench, a session must be opened.
/     The code shown handles only bench device "one". The code for
/     device "two" would be just a copy with some small modifications.
/---------------------------------------------------------------------*/
if ( ! * pErrorOccurred )
{
  if ( ! pBench -> simulation )
  {
    RESMGR_Open_Session ( sequenceContext, * pResourceId,
```

```
                        &sessionExists, &sessionHandle,
                        pErrorOccurred, pErrorCode, errorMessage );
  }
}
/*---------------------------------------------------------------------*/
/   A device session can be shared among all threads in the same
/   process. This means, that only one thread must initialize the
/   device driver and store the session handle in the resource manager.
/   Other threads can use the same session handle to communicate with
/   the device. This information is returned in the variable
/   "sessionExists". If a session already exists, we are done with
/   the job; The session handle is returned in "sessionHandle" and
/   we can start working with it. If no session exists, we must
/   initialize the device driver and store the session handle.
/
/   Opening a session increments a "usage counter" for the device
/   in the resource manager data structure. This prevents other
/   threads to call the device driver's close function which would
/   cause the session handle to become invalid as long as we are
/   using it.
/---------------------------------------------------------------------*/
```

The device driver initialization routine is called only if the bench is not in simulation mode and if no session handle was returned by the resource manager. The device driver uses the 'ResourceDesc' device property from the physical layer INI file. The VISA session handle from the device driver is then passed to the resource manager and stored there.

```
/*---------------------------------------------------------------------*/
/   Initialize the device driver:
/     If a session handle does NOT exist and we are NOT in simulation
/     mode, we must now initialize the device driver and store the
/     session handle in the resource manager.
/---------------------------------------------------------------------*/
if ( ! * pErrorOccurred )
{
  if ( ( ! sessionExists ) && ( ! pBench -> simulation ) )
  {

    /*-----------------------------------------------------------------*/
    /   Read the resource descriptor from the ini file:
    /     This is a mandatory key. Without it, it is not possible to
    /     initialize the device driver
    /-----------------------------------------------------------------*/
    RESMGR_Get_Value ( sequenceContext, * pResourceId,

                       RESMGR_KEY_RESOURCE_DESC, buffer, sizeof ( buffer ),

                       pErrorOccurred, pErrorCode, errorMessage );
    if ( ! * pErrorOccurred )
    {
```

```
  if ( written == 0 )
  {
     /* no resource descriptor found */
     * pErrorOccurred = TRUE;
     * pErrorCode = SAMPLE_ERR_NO_RESOURCE_DESC;
     formatError ( errorMessage, * pErrorCode, * pResourceId,
                                       SAMPLE_BENCH_DEVICE_ONE );
  }
}
/*---------------------------------------------------------------------*/
/   Initialize the device driver:
/     Calling the init function of the device driver
/     with the resource descriptor returns a session handle
/---------------------------------------------------------------------*/
if ( ! * pErrorOccurred )
{
  if ( trace )
  {
     sprintf ( traceBuffer,
               "Initialize device driver with ResourceDesc = %s",
               buffer );
     RESMGR_Trace ( traceBuffer );
  }
  viStatus = DRV_init ( buffer, 1, 1, &sessionHandle );
  if ( viStatus != VI_SUCCESS )
  {
     * pErrorOccurred = TRUE;
     * pErrorCode = GTSL_ERR_DRIVER_ERROR;
     formatError ( errorMessage, * pErrorCode, * pResourceId,
                                       SAMPLE_BENCH_DEVICE_ONE );
     /* append driver specific error message */
     sprintf ( errorMessage + strlen ( errorMessage ),
               "\nDRV_init failed with status 0x%X", ( int ) viStatus );
  }
}
if ( ! * pErrorOccurred )
{
  if ( trace )
  {
     sprintf ( traceBuffer, "Session handle = %ld", sessionHandle );
     RESMGR_Trace ( traceBuffer );
  }
}
/*---------------------------------------------------------------------*/
/   Store the session handle
/     The session handle is stored in the resource manager.
/     Other threads in the same process can now open a session
/     and re-use the handle.
/---------------------------------------------------------------------*/
RESMGR_Set_Session_Handle ( sequenceContext, * pResourceId,
```

```
                                    SAMPLE_BENCH_DEVICE_ONE, sessionHandle,
                                    pErrorOccurred, pErrorCode, errorMessage );
  }
}
```

Cleanup and error handling

Depending on the ´deviceLocked´ flag, the device must be unlocked. If an error was detected in the setup function, the error code and message are written to the trace file.

```
/*---------------------------------------------------------------------*/
/   Cleanup and error handling
/---------------------------------------------------------------------*/
/*---------------------------------------------------------------------*/
/   Unlock the device
/     The device must be unlocked, otherwise it cannot be accessed
/     from another thread or process.
/---------------------------------------------------------------------*/

if ( deviceLocked )
{
  /*-------------------------------------------------------------------*/
  /   be careful not to overwrite the error info in case of
  /   a problem before, otherwise it is not reported
  /   to the user. Local variables are therefore used here.
  /-------------------------------------------------------------------*/
  short occ = FALSE;
  long  code = 0;
  char  msg[GTSL_ERROR_BUFFER_SIZE] = "";

  RESMGR_Unlock_Device ( sequenceContext, * pResourceId,

                         &occ, &code, msg );
  if ( ( occ ) && ( ! * pErrorOccurred ) )
  {
    /* An error occurred during unlock. We report this error ONLY
       if no previous error exists.
    */
    * pErrorOccurred = occ;
    * pErrorCode = code;
    strcpy ( errorMessage, msg );
  }
}
if ( trace )
{
  if ( * pErrorOccurred )
  {
     sprintf ( traceBuffer, "Error %ld : %s", * pErrorCode, errorMessage );
     RESMGR_Trace ( traceBuffer );
  }
  RESMGR_Trace ( "<<SAMPLE_Setup end" );
```

```
  }
}
```

9.5.2.2 Cleanup Function

The function call interface of the cleanup function is described in "Cleanup function" on page 158. The cleanup function has the following tasks:

- Close the device drivers
- Free the session in the resource manager
- Release the memory block
- Free the resource ID

See the source file `sample.c` in the SAMPLE project for details on the Cleanup function.

```
void DLLEXPORT DLLSTDCALL SAMPLE_Cleanup ( CAObjHandle sequenceContext,
                                           long        resourceId,
                                           short       * pErrorOccurred,
                                           long        * pErrorCode,
                                           char        errorMessage[] )
{
  ViSession    sessionHandle = 0;
  ViStatus     viStatus = 0;
  BENCH_STRUCT * pBench = NULL;
  int          canClose = FALSE;
  int          deviceLocked = FALSE;
  char         traceBuffer [BUFFER_LARGE] = "";
  BOOL         trace = FALSE;

  trace = RESMGR_Get_Trace_Flag ( resourceId );
  * pErrorOccurred = FALSE;
  * pErrorCode = 0;

  if ( trace != 0 )
  {
    RESMGR_Trace ( ">>SAMPLE_Cleanup begin" );
  }
```

Retrieve configuration

Configuration data is stored in a memory block during the Setup function. A pointer to this memory block is retrieved. The cleanup actions have to be taken depending on the configuration data.

```
  /*---------------------------------------------------------------------/
  /   Retrieve the memory pointer:
  /     Get a pointer to the memory block to check the configuration
  /---------------------------------------------------------------------*/
  RESMGR_Get_Mem_Ptr ( sequenceContext, resourceId, ( void * * ) ( &pBench ),
                       pErrorOccurred, pErrorCode, errorMessage );
```

```
/*---------------------------------------------------------------------*/
/   Check for memory block owner:
/     To be sure that the given resource ID belongs to the SAMPLE
/     library, we check the "owner" field of the memory block if it
/     contains the "magic number" we have stored there in the
/     SAMPLE_Setup function
/---------------------------------------------------------------------*/
if ( ! * pErrorOccurred )
{
  if ( pBench -> owner != SAMPLE_ERR_BASE )
  {
    * pErrorOccurred = TRUE;
    * pErrorCode = GTSL_ERR_WRONG_RESOURCE_ID;
    formatError ( errorMessage, * pErrorCode, resourceId, NULL );
  }
}
```

Retrieve the session

The session handle for each device must be retrieved before the device driver can be closed. The device must be locked to ensure exclusive access.

```
/*---------------------------------------------------------------------*/
/   check if type one is present:
/    (code for typeTwo is not included in this example)
/---------------------------------------------------------------------*/
if ( ! * pErrorOccurred )
{
  if ( pBench -> typeOne )
  {
    /*-----------------------------------------------------------------*/
    /   Lock the device:
    /     prevent access from other threads or processes to the device
    /-----------------------------------------------------------------*/
    RESMGR_Lock_Device ( sequenceContext, resourceId,

                         SAMPLE_TIMEOUT, pErrorOccurred, pErrorCode,

    if ( ! * pErrorOccurred )
    {
      deviceLocked = TRUE;
    }
    /*-----------------------------------------------------------------*/
    /   Get the session handle:
    /     We need the session handle to close the instrument driver
    /     unless we are in simulation mode.
    /-----------------------------------------------------------------*/
    if ( ! * pErrorOccurred )
    {
      if ( ! pBench -> simulation )
      {
```

```
    RESMGR_Get_Session_Handle ( sequenceContext, resourceId,
                                SAMPLE_BENCH_DEVICE_ONE, &sessionHandle,
                                pErrorOccurred, pErrorCode, errorMessage );
  }
}
```

Close the session and the driver

The session handle for each device must be retrieved before the device driver can be closed. The device must be locked to ensure exclusive access.

```
/*---------------------------------------------------------------------*/
/   Close the session (not in simulation)
/   - Tell the resource manager, that we no longer use this device.
/     If the usage count reachs zero (i.e. no other thread uses
/     the session handle) the resource manager tells us that we
/     are responsible for closing the instrument session. If any
/     other thread in the same process has an open session to the
/     device, it is up to HIM to call the close function of the
/     driver. In this case, it would be a failure if we closed
/     the driver, because this action invalidates the session
/     handle. The other thread would get into large trouble when
/     trying to communicate with the device next time!
/---------------------------------------------------------------------*/
if ( ! * pErrorOccurred )
{
  if ( ! pBench -> simulation )
  {
    RESMGR_Close_Session ( sequenceContext, resourceId,

                           &canClose, pErrorOccurred, pErrorCode,

  }
}
if ( ! * pErrorOccurred )
{
  if ( ( canClose ) && ( ! pBench -> simulation ) )
  {
    /*-----------------------------------------------------------------*/
    /   Close the driver
    /     We are the last user of the device, so we are responsible
    /     for closing the driver
    /-----------------------------------------------------------------*/
    if ( trace )
    {
      RESMGR_Trace ( "Close the device driver" );
    }
    viStatus = DRV_close ( sessionHandle );
    if ( viStatus != VI_SUCCESS )
    {
      *pErrorOccurred = TRUE;
```

```
            *pErrorCode = GTSL_ERR_DRIVER_ERROR;
            formatError ( errorMessage, *pErrorCode, resourceId,
                          SAMPLE_BENCH_DEVICE_ONE );
            /* append driver specific error message */
            sprintf ( errorMessage + strlen(errorMessage),
                      "\nDRV_close failed with status 0x%X", ( int ) viStatus );
          }
        }
      }
```

Free the resource

The device is unlocked, the memory block is released and the resource ID is freed.

```
      /*-------------------------------------------------------------------*/
      /   Unlock the device
      /-------------------------------------------------------------------*/
      if ( ! * pErrorOccurred )
      {
        RESMGR_Unlock_Device ( sequenceContext, resourceId,

                               pErrorOccurred, pErrorCode, errorMessage);
        if ( ! * pErrorOccurred )
        {
          deviceLocked = FALSE;
        }
      }
    }
  }
  /*-------------------------------------------------------------------*/
  /   Dispose memory:
  /     Free the memory block associated with the resource ID.
  /     Note that pBench is no longer valid now because it points
  /     to dynamic memory that has been released!
  /-------------------------------------------------------------------*/
  if ( ! * pErrorOccurred )
  {
    RESMGR_Free_Memory ( sequenceContext, resourceId, pErrorOccurred,
                         pErrorCode, errorMessage );
  }
  pBench = NULL;

  /*-------------------------------------------------------------------*/
  /   Free resource:
  /     The resource ID (our "ticket") is given back to the resource
  /     manager and may be reused in a subsequent RESMGR_Alloc_Resource
  /     call.
  /-------------------------------------------------------------------*/
  if ( ! * pErrorOccurred )
  {
    RESMGR_Free_Resource ( sequenceContext, resourceId, pErrorOccurred,
```

```
                          pErrorCode, errorMessage );
}
if ( ! * pErrorOccurred )
{
  if ( trace )
  {
    sprintf ( traceBuffer, "Free Resource ID %ld", resourceId );
    RESMGR_Trace ( traceBuffer );
  }
}
```

Cleanup and error handling

The device must be unlocked unless this has been done before.

```
/*---------------------------------------------------------------------*/
/   Cleanup and error handling
/---------------------------------------------------------------------*/

/*---------------------------------------------------------------------*/
/   Unlock the device, if there was an error.
/     If no error occured before, then the device is already unlock
/     (see code above).
/---------------------------------------------------------------------*/
if ( deviceLocked )
{
  /*-------------------------------------------------------------------*/
  /   be careful not to overwrite the error info in case of
  /   a problem before, otherwise it is not reported
  /   to the user. Local variables are therefore used here.
  /-------------------------------------------------------------------*/
  short occ = FALSE;
  long  code = 0;
  char  msg[GTSL_ERROR_BUFFER_SIZE] = "";

  RESMGR_Unlock_Device ( sequenceContext, resourceId,

                         &occ, &code, msg );
  if ( ( occ ) && ( ! * pErrorOccurred ) )
  {
    /* An error occurred during unlock. We report this error ONLY
       if no previous error exists.
    */
    * pErrorOccurred = occ;
    * pErrorCode = code;
    strcpy ( errorMessage, msg );
  }
}
if ( trace )
{
  if ( * pErrorOccurred )
```

```
    {
       sprintf ( traceBuffer, "Error %ld : %s", * pErrorCode, errorMessage );
       RESMGR_Trace ( traceBuffer );
    }
    RESMGR_Trace ( "<<SAMPLE_Cleanup end" );
  }
}
```

9.5.2.3 Library Version Function

The function call interface of the setup function is described in "Library version function" on page 158. The library version function returns a text string indicating the library name and the version number of the library. This string is copied into the string buffer 'libraryVersion'. The length must not exceed 80 characters, including the terminating null character.

The library name is the same as the library prefix.

Example:

SAMPLE 02.00

See Chapter 9.5.4.6, "Version Handling", on page 194 for details about version number handling.

```
static const char LIB_VERSION[] = "SAMPLE 02.00"; /* Library Version String */

void DLLEXPORT DLLSTDCALL SAMPLE_Lib_Version ( CAObjHandle sequenceContext,
                                               char        libraryVersion[],
                                               short       * pErrorOccurred,
                                               long        * pErrorCode,
                                               char        errorMessage[] )
{
  * pErrorOccurred = FALSE;
  * pErrorCode = 0;
  strcpy ( libraryVersion, LIB_VERSION );
}
```

9.5.2.4 Measurement Functions

The measurement functions follow the call interface described in Chapter 9.4.3.2, "Export Functions", on page 155. The term 'measurement function' includes not only functions that take measurements, but also any function which communicates with a stimulus device, a measurement device or the UUT. Such a function may modify device settings and/or take one or more measurements, dealing with one or more devices and drivers.

The measurement function in general has the following tasks:

- Get a pointer to the memory block and retrieve configuration data
- Handle simulation mode
- Get the session handle(s) for the device(s)

- Call the device driver function(s)
- Return the measured value(s)

See the source file `sample.c` in the SAMPLE project for details on the Measurement function.

The following example shows a simple measurement function, taking no additional parameters and returning a single measured value.

```
void DLLEXPORT DLLSTDCALL SAMPLE_MeasFunc ( CAObjHandle sequenceContext,
                                            long        resourceId,
                                            double      * measuredValue,
                                            short       * pErrorOccurred,
                                            long        * pErrorCode,
                                            char        errorMessage[] )
{
  ViSession    sessionHandle = 0;
  ViStatus     viStatus = 0;
  BENCH_STRUCT * pBench = NULL;
  int          deviceLocked = FALSE;
  int          retVal = 0;
  int          retFromFct = 0;
  char         traceBuffer [BUFFER_LARGE] = "";
  BOOL         trace = FALSE;

  * pErrorOccurred = FALSE;
  * pErrorCode = 0;

  trace = RESMGR_Get_Trace_Flag ( resourceId );

  if ( trace )
  {
    RESMGR_Trace ( ">>SAMPLE_MeasFunc begin" );

  }
```

Retrieve configuration data

```
  /*--------------------------------------------------------------------*/
  /   Retrieve the memory pointer:
  /     The SAMPLE library keeps important information about its
  /     configuration in the memory block. This information is
  /     associated with the resource ID. If SAMPLE_Setup is called
  /     more than once, it returns different resource IDs. That means
  /     that each resource ID (i.e. each call of SAMPLE_Setup) has its
  /     own copy of the memory block.
  /--------------------------------------------------------------------*/
  RESMGR_Get_Mem_Ptr ( sequenceContext, resourceId, ( void * * ) ( &pBench ),
                       pErrorOccurred, pErrorCode, errorMessage );
  /*--------------------------------------------------------------------*/
  /   Check for memory block owner:
```

```
/     To be sure that the given resource ID belongs to the SAMPLE
/     library, we check the "owner" field of the memory block if it
/     contains the "magic number" we have stored there in the
/     SAMPLE_Setup function
/-------------------------------------------------------------------*/
if ( ! * pErrorOccurred )
{
  if ( pBench -> owner != SAMPLE_ERR_BASE )
  {
    * pErrorOccurred = TRUE;
    * pErrorCode = GTSL_ERR_WRONG_RESOURCE_ID;
    formatError ( errorMessage, * pErrorCode, resourceId, NULL );
  }
}
```

Handle simulation mode

In simulation mode, a default measured value is returned without any interaction with the device driver.

```
/*-------------------------------------------------------------------/
/   Check for simulation:
/     In simulation mode, the device driver must not be called.
/     Just return some value.
/-------------------------------------------------------------------*/
if ( ! * pErrorOccurred )
{
  if ( pBench -> simulation )
  {
    /* simulation value */
    *measuredValue = STD_SIMU_RESULT;

    if ( trace )
    {
       sprintf ( traceBuffer, "Simulation value = %f", *measuredValue );
       RESMGR_Trace ( traceBuffer );
    }
  }
  else
  }
```

Retrieve session handle

Depending on the configuration information, the session handles for the required devices must be retrieved from the Resource Manager. The device must be locked.

```
    /*-------------------------------------------------------------------/
    /   Check for currently used device:
    /     The BENCH_STRUCT keeps information about the devices that
    /     have been configured during SAMPLE_Setup. We check if device
    /     typeOne has been setup.
    /     (Code for typeTwo is not included in this example)
```

```
/-------------------------------------------------------------------------*/

if ( pBench -> typeOne )
{
  /*-----------------------------------------------------------------------/
  /   Lock the device:
  /     The device must be locked to prevent another process or
  /     thread from accessing it.
  /-----------------------------------------------------------------------*/
  RESMGR_Lock_Device ( sequenceContext, resourceId,
                       SAMPLE_BENCH_DEVICE_ONE, SAMPLE_TIMEOUT,
                       pErrorOccurred, pErrorCode, errorMessage );
  if ( ! * pErrorOccurred )
  {
    deviceLocked = TRUE;
  }
  /*-----------------------------------------------------------------------/
  /   Get the session handle
  /     Retrieve the session handle for device "one".
  /-----------------------------------------------------------------------*/
  if ( ! * pErrorOccurred )
  {
    RESMGR_Get_Session_Handle ( sequenceContext, resourceId,
                                SAMPLE_BENCH_DEVICE_ONE, &sessionHandle,
                                pErrorOccurred, pErrorCode, errorMessage );
  }
```

Device driver call

The device driver is called with the session handle from the Resource Manager.

```
  /*-----------------------------------------------------------------------/
  /   Call the driver function(s):
  /     It may be necessary to call more than one function.
  /     Because the device is locked, we can be sure that no other
  /     thread or process can access the device now.
  /-----------------------------------------------------------------------*/
  /*-----------------------------------------------------------------------/
  /   Driver function call, Sample 1: (e.g. for CMD)
  /-----------------------------------------------------------------------*/
  if ( ! * pErrorOccurred )
  {
    viStatus = DRV_meas_1 ( sessionHandle, measuredValue );
    if ( viStatus != VI_SUCCESS )
    {
      * pErrorOccurred = TRUE;
      * pErrorCode = GTSL_ERR_DRIVER_ERROR;
      formatError ( errorMessage, *pErrorCode, resourceId,
                    SAMPLE_BENCH_DEVICE_ONE );
      /* append driver specific error message */
      sprintf ( errorMessage + strlen(errorMessage),
```

```
                    "\nDRV_meas failed with status 0x%X\n", ( int ) viStatus );
      /* read and append driver specific error message */
      retFromFct = DRV_ErrorMessage ( sessionHandle, viStatus,
                                      errorMessage + strlen(errorMessage) );
    }
    else
    {
      if ( trace )
      {
        sprintf ( traceBuffer, "Measured value = %f", *measuredValue );
        RESMGR_Trace ( traceBuffer );
      }
    }
  }
  /*-------------------------------------------------------------------------/
  /   End of Driver function call, Sample 1
  /-------------------------------------------------------------------------*/


  /*-------------------------------------------------------------------------/
  /   Driver function call, Sample 2: (e.g. for CMU)
  /-------------------------------------------------------------------------*/
  if ( ! * pErrorOccurred )
  {
    viStatus = DRV_meas_2 ( sessionHandle, measuredValue, errorMessage );
    if ( viStatus != VI_SUCCESS )
    {
      * pErrorOccurred = TRUE;
      * pErrorCode = GTSL_ERR_DRIVER_ERROR;
      formatError ( errorMessage, *pErrorCode, resourceId,
                    SAMPLE_BENCH_DEVICE_ONE );
    }
    else
    {
      if ( trace )
      {
        sprintf ( traceBuffer, "Measured value = %f", *measuredValue );
        RESMGR_Trace ( traceBuffer );
      }
    }
  }
  /*-------------------------------------------------------------------------/
  /   End of Driver function call, Sample 2
  /-------------------------------------------------------------------------*/
 }
}
}
```

Cleanup and error handling

The device must be unlocked if it has been locked before.

```
  /*-------------------------------------------------------------------------/
  /   Cleanup and error handling
  /-------------------------------------------------------------------------*/

  /*-------------------------------------------------------------------------/
  /   Unlock the device
  /     The device must be unlocked, otherwise it cannot be accessed
  /     from another thread or process.
  /-------------------------------------------------------------------------*/

  if ( deviceLocked )
  {
    /*-----------------------------------------------------------------------/
    /   be careful not to overwrite the error info in case of
    /   a problem before, otherwise it is not reported
    /   to the user. Local variables are therefore used here.
    /-----------------------------------------------------------------------*/
    short occ = FALSE;
    long  code = 0;
    char  msg[GTSL_ERROR_BUFFER_SIZE] = "";

    RESMGR_Unlock_Device ( sequenceContext, resourceId,

                           &occ, &code, msg );
    if ( ( occ ) && ( ! * pErrorOccurred ) )
    {
      /* An error occurred during unlock. We report this error ONLY
         if no previous error exists.
      */
      * pErrorOccurred = occ;
      * pErrorCode = code;
      strcpy ( errorMessage, msg );
    }
  }
  if ( trace )
  {
    if ( * pErrorOccurred )
    {
       sprintf ( traceBuffer, "Error %ld : %s", * pErrorCode, errorMessage );
       RESMGR_Trace ( traceBuffer );
    }
    RESMGR_Trace ( "<<SAMPLE_MeasFunc end" );
  }
}
```

9.5.3 Resource Description

The physical and application layer INI-files contain the resource description for the test system. The general structure of these files is described in Chapter 5, "Configuration Files", on page 24. The key names and the meaning of their values, however, are defined by the high-level library that uses them. Because most high-level libraries perform similar tasks, there is a need for standardization of the resource description.

The following example shows some library-specific entries in boldface:

```
[LogicalNames]
GSM = bench->Radiocom_GSM

[bench->Radiocom_GSM]
Description = Bench for GSM library
RadioComTester = device->CMD55
Simulation=0

[device->CMD55]
Description = Radio Communication Tester CMD55
Type = CMD55
ResourceDesc = GPIB0::15
```

There are three different types of resource entries:

1. A link to a device entry (bench device). The key RadioComTester (left side) identifies a device type, which is supported by the high-level library. The value *device -> CMD55* (right side) is the name of the device section, where the properties of the device can be found.
2. A property of a bench. The key Simulation identifies the simulation property of the bench, the value 0 means that simulation is switched off.
3. A property of a device. The key ResourceDesc identifies the resource descriptor, the value GPIB0::15 means that the device can be addressed via GPIB card 0, address 15.

Because device entries can be referenced by several high-level libraries, there must be a set of standard properties, which can be understood by each of these libraries. The same applies to bench properties like simulation or tracing, which are standard properties and are supported by each library. Only the bench device names are library-specific.

The following tables describe the standard keys, values and usage.

Table 9-1: Standard bench properties

Key name	Remarks
Description	bench description, comment
Simulation	if set to '1', the complete bench is simulated by the library
Trace	if set to '1', tracing is enabled for the library

Table 9-2: Standard device properties

Key name	Remarks
Description	Device description, comment
Type	Device type like CMD55, etc. (mandatory).
ResourceDesc	VISA resource descriptor like 'GPIB0::15' or 'PXI0::16::0' (mandatory). The given value must be passed to the device drivers init function (IVI and VISA).
DriverOption	Special setup string for IVI driver, e.g. for device-level simulation. If this entry is present and the device driver is an IVI driver, it must be initialized using the InitWithOptions function, passing the given setup string. If this entry is missing, the normal Init function can be used.

The 'Type' and 'ResourceDesc' keys are mandatory, they must be defined for each device section. All other keys are optional. Binary switches like 'Simulation' and 'Trace' are activated by the value '1' and deactivated by any other value. The switch is also deactivated if the key is not present.

The Resource Manager exports the key names in the `resmgr.h` file as RESMGR_KEY_... constants, e.g. RESMGR_KEY_SIMULATION for 'Simulation'. There is also a list of common device types; these string constants begin with RESMGR_DEVTYPE_...

9.5.4 Miscellaneous

9.5.4.1 Error Handling

Error handling is done through the three output parameters pErrorOccurred, pErrorCode and errorMessage of each export function of the library as described in "Function type and calling conventions" on page 156.

There are several possible sources of an error:

- Error from the high level library
- Error from a support library, e.g. the resource manager
- Error from a device driver

The pErrorCode and errorMessage should reflect the source and the reason of an error, so the user can take appropriate measures to eliminate the problem. The error codes should be unique throughout the R&S GTSL software to avoid confusion. This means, that each library has its own set of error codes. The error message should also state very clearly, which library issued the error, the name of the bench and the bench device. The following figure shows an example of an error message as it is shown in TestStand:

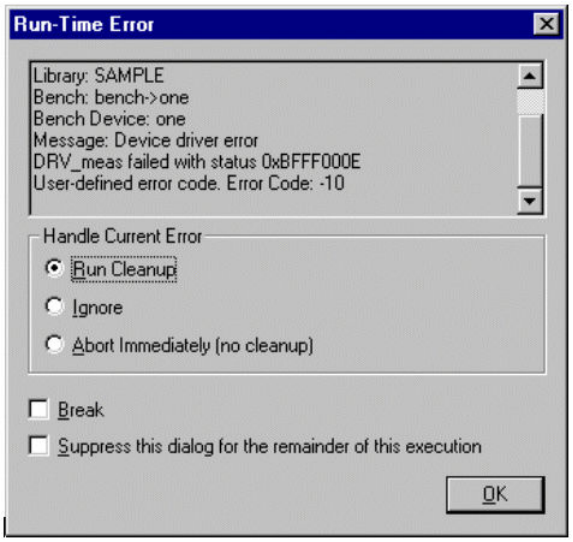


Figure 9-8: Run-Time error message in TestStand

The first lines (not shown above) list the name of the sequence and the step. After that, the contents of the errorMessage variable is shown, followed by the decimal representation of the pErrorCode (the last line).

The error message is broken into several lines, each beginning with a prefix like 'Library', 'Bench' etc. The error message may contain additional information like the driver status code in the example above.

Include files

Error codes are defined in the include file of the high level library. All error codes are based on a base number, which is defined in `GTSLERR.H`. It is important to include this file in the include file for the high level library. The following code is taken from the `sample.h` file:

```
#include 'gtslerr.h'   /* GTSL error handling */

/* DEFINES ************************************************************************/

/* Error codes */
#define SAMPLE_ERR_BASE                GTSL_ERROR_BASE_SAMPLE
#define SAMPLE_ERR_NOT_A_BENCH     (SAMPLE_ERR_BASE - 1)     /* -4001 */
#define SAMPLE_ERR_NO_RESOURCE_DESC (SAMPLE_ERR_BASE - 2)     /* -4002 */
```

GTSL_ERROR_BASE_SAMPLE is defined in `gtslerr.h` as -4000. If a new high-level library is developed, a new GTSL_ERROR_BASE_XXX constant has to be defined. Use the constant GTSL_ERROR_BASE_USER as a base for error codes in your own projects. Codes between 0 and GTSL_ERROR_BASE_USER are reserved for libraries developed by Rohde & Schwarz..

The `gtslerr.h` include file defines several general-purpose error codes and messages which can be used in all high-level libraries. Library-specific error codes are defined as constants in the include-file of the library. The names start with

XXX_ERR_... where XXX is the library name. The integer error numbers should be written in comment after each definition (remember not to use the '//' comment delimiter !!!). This makes it easy for the user to find the error definition by just doing a 'grep' or file search over all include files.

Error table

A table of error codes and corresponding error messages is kept in a static structure array in the high-level library. The type definitions GTSL_ERROR_TABLE and GTSL_ERROR_ENTRY can be found in `gtslerr.h`. This error table contains the library-specific codes and messages as well as all general-purpose codes:

```
/* Error code to message reference table */
static GTSL_ERROR_TABLE errorTable =
{
    /* library specific error codes and messages */
  {
    SAMPLE_ERR_NOT_A_BENCH,      "The given resource is not a bench" },
  {
    SAMPLE_ERR_NO_RESOURCE_DESC, "ResourceDesc entry missing in physical INI file" },
  {
    SAMPLE_ERR_NO_TYPE,          "Type entry missing in physical INI file" },
  {
    SAMPLE_ERR_NO_SUPP_TYPE,     "Type entry in physical INI file is not supported" },

    /* include common GTSL error codes and messages */
   GTSL_ERROR_CODES_AND_MESSAGES,

    /* this must be the last entry ! */
  {
    0, NULL }
};
```

The table initialization consists of three parts

- library-specific codes and corresponding messages
- common error codes and messages (represented by GTSL_ERROR_CODES_AND_MESSAGES macro)
- the terminating entry { 0, NULL }

Signaling an error

The following examples show different cases of how errors are signaled and handled. The simplest case is an error coming from a lower level library like the resource manager:

```
  RESMGR_Get_Resource_Type ( sequenceContext, * pResourceId, &resourceType,
                             pErrorOccurred, pErrorCode, errorMessage );
    if ( ! * pErrorOccurred )
    {
      ....
    }
```

The three error parameters pErrorOccurred, pErrorCode and errorMessage are just passed from the resource manager library. In case of an error in the resource manager, all error information has already been set. The high-level library just checks the pError-Occurred flag and skips the following code if the flag is set.

When the high-level library detects an error, it sets the pErrorOccurred flag and the pErrorCode variable and calls an internal function 'formatError' which builds the error message from the given information and copies it into errorMessage.

```
if ( resourceType != RESMGR_TYPE_BENCH )
{
  * pErrorOccurred = TRUE;
  * pErrorCode = SAMPLE_ERR_NOT_A_BENCH;
  formatError ( errorMessage, *pErrorCode, * pResourceId, NULL );
}
```

The parameter interface and the implementation of the format_error function in the SAMPLE library are just a proposal. Some libraries need some more elaborate error message generation and, perhaps, additional parameters to this function. See the following section for details on this function.

When an error occurs in a device driver function, the driver error status cannot just be returned as pErrorCode, because drivers use a somewhat different numbering scheme. Therefore, a general GTSL_ERR_DRIVER_ERROR code is returned and the error status from the driver is appended to the error message in hex display. Most drivers offer a function to convert the status value to an error string. This function is called here to append the driver-specific error message at the end:

```
if ( ! * pErrorOccurred )
{
  viStatus = DRV_meas_1 ( sessionHandle, measuredValue );
  if ( viStatus != VI_SUCCESS )
  {
    * pErrorOccurred = TRUE;
    * pErrorCode = GTSL_ERR_DRIVER_ERROR;
    formatError ( errorMessage, *pErrorCode, resourceId,
                  SAMPLE_BENCH_DEVICE_ONE );
    /* append driver specific error message */
    sprintf ( errorMessage + strlen(errorMessage),
              "\nDRV_meas failed with status 0x%X\n", ( int ) viStatus );
    /* read and append driver specific error message */
    retFromFct = DRV_ErrorMessage ( sessionHandle, viStatus,
                                    errorMessage + strlen(errorMessage) );
  }
}
```

The code is very similar to the example above, except that the sprintf and DRV_error_message function calls have been added to append the driver function name, the status and the driver-specific error message.

Formatting the error message

The format_error function shown here is just an example of how it can be done. Each high-level library may require a different set of parameters. The main task of this function, however, is always the same: Generate the error message and put it into the error buffer.

```
static void formatError ( char buffer[],
                          int  code,
                          long resId,
                          char * benchDevice )
{
  char             * pMsg = NULL;
  char             resourceName[RESMGR_MAX_NAME_LENGTH + 1] = "";
  char             tempMsg[GTSL_ERROR_BUFFER_SIZE] = "";
  short            tempOcc = FALSE;
  long             tempCode = 0;
  int              written = 0;
  GTSL_ERROR_ENTRY * pErr = errorTable; /* pointer into error entry table */
```

First, the error message corresponding to the given code must be searched in the error table:

```
/* find the error message for a given error code */
  while ( pErr -> string != NULL )
  {
    if ( pErr -> value == code )
    {
      pMsg = pErr -> string;
      break;
    }
    pErr ++;
  }
  if ( pMsg == NULL )
  {
    /* should never happen */
    pMsg = "(no message available for this code)";
  }
```

Next, the error message is built line by line:

```
/* setup the error message */

  /* 1) Library name */
  strcpy ( buffer, GTSL_ERRMSG_PREFIX_LIBRARY );
  strcat ( buffer, GTSL_LIBRARY_NAME );
  strcat ( buffer, "\n" );
```

The name of the bench is returned by the resource manager function RESMGR_Get_Resource_Name. It takes the resource ID as a parameter. In this example, the parameter resid may be set to RESMGR_INVALID_ID. In this case, the line 'Bench: ' will not be output:

```
/* 2) Bench name, only if a valid ID is given */
  if ( resId != RESMGR_INVALID_ID )
  {
    /* read the resource name into a local buffer */
    RESMGR_Get_Resource_Name ( 0, resId, resourceName, sizeof ( resourceName ),
                               &written, &tempOcc, &tempCode, tempMsg );
    if ( ( ! tempOcc ) && ( written > 0 ) )
    {
      /* append the name */
      strcat ( buffer, GTSL_ERRMSG_PREFIX_BENCH );
      strcat ( buffer, resourceName );
      strcat ( buffer, "\n" );
    }
  }
```

If the parameter bench_device is not NULL, it is output in the next line:

```
/* 3) Bench device, if given */
  if ( benchDevice != NULL )
  {
    strcat ( buffer, GTSL_ERRMSG_PREFIX_BENCH_DEVICE );
    strcat ( buffer, benchDevice );
    strcat ( buffer, "\n" );
  }
```

Finally, the error message is appended to the message buffer:

```
/* 4) Error message */
  strcat ( buffer, GTSL_ERRMSG_PREFIX_ERRMSG );
  strcat ( buffer, pMsg );
```

9.5.4.2 Locking

The implementation of device locking is mandatory for each high-level library. Locking is done using the RESMGR_Lock_Device and RESMGR_Unlock_Device functions of the Resource Manager Library.

The Setup, Cleanup and Measurement functions must lock a device prior to the first driver call and unlock the device after the last driver call inside the function to ensure exclusive access to the device.

See `RESMGR.HLP` and the source code of the SAMPLE project for details.

Special care must be taken to guarantee the same number of lock and unlock calls inside the functions, also in case of an error returned by a function call. If a device is not unlocked correctly, it may stay locked forever, blocking another parallel test process.

The lock function requires a timeout value, i.e. the maximum amount of time which is spent waiting for the device to become free. This value must be selected depending on the maximum time it takes for a measurement with this device. A standard value is 5000 ms. The timeout value should not exceed about 20 or 30 seconds, this is the maximum time a user is willing to wait for a reaction of the system.

9.5.4.3 Tracing

During the development phase of a library module, the tracing of information is an important feature. The Resource Manager offers convenient functions for tracing, which can be used with the following benefits:

- No need to write additional code
- Tracing can be switched on and off dynamically
- Tracing from different libraries is directed to a single output file or to screen

See the description of the RESMGR_Trace function and Set/Get TraceFlag in `RESMGR.HLP` for details.

- Tracing may be enabled in two ways:
- by a compiler switch in the high-level library
- by the 'Trace = 1' entry in the application INI file

Using a compiler switch allows tracing during the development and debug phase. Tracing is then switched off for the release version. There is no performance loss in the release version, but there is also no easy way to re-enable tracing at a customer site in case of a problem. The library must be rebuilt with the compiler switch, which is a problem because the customer normally does not have the source code.

Using an entry in the application INI file is more convenient, because tracing may be enabled easily by adding the line 'Trace = 1' in the appropriate bench section of the INI file. The performance degradation can be kept to a minimum if a tracing flag is used in each function as shown in the following code example:

```
BOOL trace = FALSE;
```

In the Setup function, the 'Trace' property of the bench is checked and the flag is set:

```
RESMGR_Compare_Value ( sequenceContext, * pResourceId, "", RESMGR_KEY_TRACE, "1", &trace,
                       pErrorOccurred, pErrorCode, errorMessage );
```

At the beginning of each other function the actual value of the trace flag is read:

```
trace = RESMGR_Get_Trace_Flag ( resourceId );
```

Depending on the flag, tracing is done:

```
if ( trace )
{
  RESMGR_Trace ( "Close the device driver" );
}
```

Formatted output cannot be done in the RESMGR_Trace function directly. A temporary trace buffer is used to format the message first:

```
#define BUFFER_LARGE 1088
char traceBuffer [BUFFER_LARGE] = "";
if ( trace )
{
  sprintf ( traceBuffer, "Measured value = %f", *measuredValue );
```

```
  RESMGR_Trace ( traceBuffer );
}
```

9.5.4.4 Simulation

The implementation of simulation is mandatory for each high-level library. The reasons for running a library in simulation mode are:

- A sequence can be programmed and tested without hardware.
- Parallel tests can be programmed and run if only a single set of hardware is available. One test process uses the real hardware, the others run in simulation mode.
- Presentation of a test sequence to a customer without hardware (e.g. on a laptop).

Simulation is done at a very high level in the library. During simulation mode, the high-level library must not call any device driver function or any other function requiring more than the standard PC hardware resources. The library functions should return some 'typical' measured values to generate a 'Pass' condition in the calling TestStand sequence.

Simulation is enabled by the 'Simulation' keyword in the appropriate bench section. The simulation flag for each bench must be kept in the memory block associated with the resource ID. In contrast to the tracing capability (refer to Chapter 9.5.4.1, "Error Handling", on page 185), the usage of a static simulation flag is not allowed. The following code example shows how simulation is handled.

In the Setup function, the presence of the 'Simulation' keyword is checked and the value of the simulation flag is stored in the memory block:

```
/* NOTE: error handling is omitted in this short example */

typedef struct
{
  /* ... other entries ... */
  int simulation;   /* driver simulation */
}  BENCH_STRUCT;

/* pointer to the memory block */
BENCH_STRUCT * pBench = NULL;

/* allocate the memory block */
RESMGR_Alloc_Memory ( sequenceContext, * pResourceId, sizeof ( BENCH_STRUCT ),
                      ( void * * ) ( &pBench ), pErrorOccurred, pErrorCode, errorMessage );

/* set the simulation flag in the memory block */
/* according to the 'simulation' bench property */
pBench -> simulation = FALSE;
RESMGR_Compare_Value ( sequenceContext, * pResourceId, "", RESMGR_KEY_SIMULATION, "1",
                       &matched, pErrorOccurred, pErrorCode, errorMessage );
if ( matched )
{
```

```
  pBench -> simulation = TRUE;
}
```

Each measurement function must read the value of the simulation flag and determine whether to simulate the measurement or take the measurement with the real hardware:

```
/* NOTE: error handling is omitted in this short example */

/* pointer to the memory block */
BENCH_STRUCT * pBench = NULL;

/* get the memory block pointer */
RESMGR_Get_Mem_Ptr ( sequenceContext, resourceId, ( void * * ) ( &pBench ),
                     pErrorOccurred, pErrorCode, errorMessage );

/* check for simulation flag */
if ( pBench -> simulation )
{
  *measuredValue = 1.0; /* simulation value */
}
else
{
  /* call the device driver to get a value from the instrument ... */
}
```

9.5.4.5 Bench versus Device

When a high-level library requires the concurrent use of more than one device, these devices must be entered in a bench section. On the other hand, there may be a case where a library uses only a single device. Is there a reason to have a bench with only one device entry or could I just pass the name of this device to the library?

Even if only a single device is used, a bench has many advantages:

- A bench can have bench properties like simulation and tracing, a device does not have these properties.
- The library may be extended in the future to support more than one device. Migration from a device section to a bench section is harder than just adding the second device to the bench section which already exists.

Summary: It is most advantageous to work with benches, even if there is only a single device in the bench.

The high-level library must check in the Setup function to see if the resource name refers to a bench or to a device and return an error if the type is not correct:

```
RESMGR_Get_Resource_Type ( sequenceContext, * pResourceId, &resourceType,
                           pErrorOccurred, pErrorCode, errorMessage );
if ( ! * pErrorOccurred )
{
  if ( resourceType != RESMGR_TYPE_BENCH )
  {
    * pErrorOccurred = TRUE;
```

```
        * pErrorCode = SAMPLE_ERR_NOT_A_BENCH;
        formatError ( errorMessage, *pErrorCode, * pResourceId, NULL );
      }
    }
```

9.5.4.6 Version Handling

The version number of a library is handled in two separate places. First, there is a version string which is returned by the Lib_Version Function. Second, there is a built-in version number in each DLL, which can be set during the DLL build.

The version number consists of four digits, the first two digits being separated by a decimal point. The first two digits indicate the major version of the software (with leading zero). It is incremented if the functionality changes significantly. The third and fourth digit indicate the minor version. The last digit is normally zero for a software release with new functions and is incremented for bug fix releases.

Whenever the version of a library changes, the correct version number must be specified during the build of the DLL. The version number of the DLL is very important for the software setup program. The setup program can ensure that a newer DLL version is not overwritten by an old one using the built-in version number. The version information for a DLL can be shown in the 'Properties' dialog box in Windows Explorer (only the text information). Setup programs uses the numeric 'File Version' information.

The following figure shows the dialog box for the DLL version information:

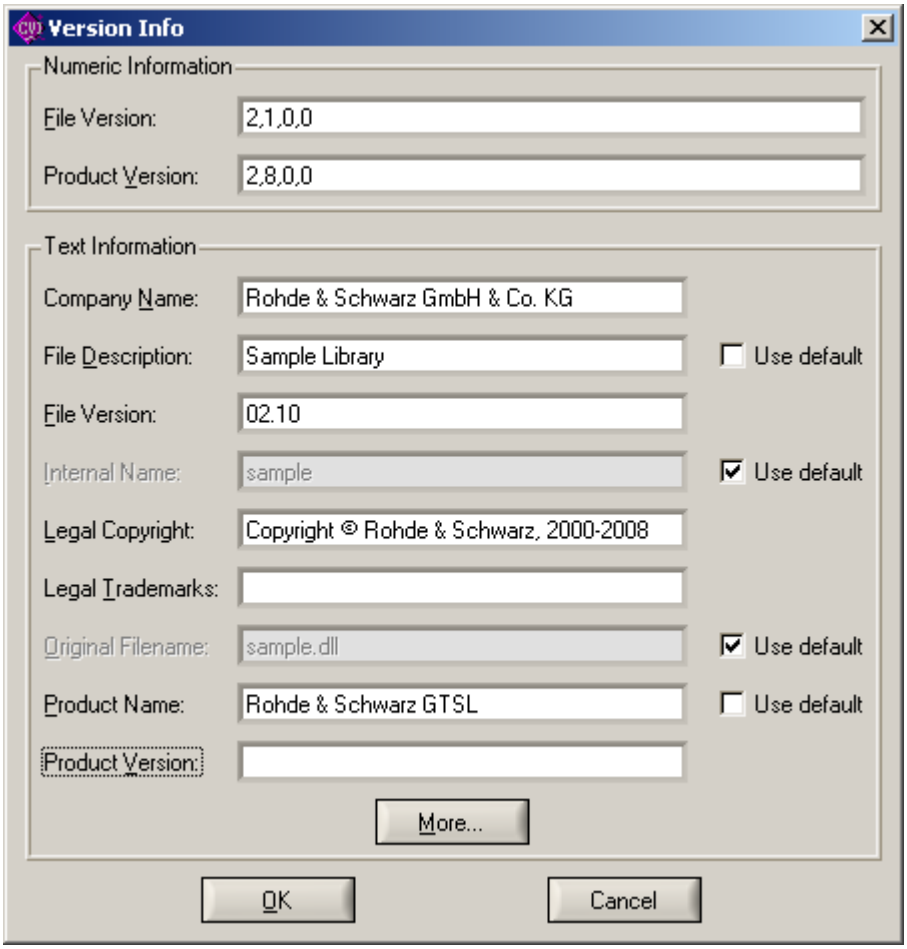


Figure 9-9: Version Info during DLL build

The following fields must be modified to build a new DLL version:

File Version (numeric)	only the first three digits are used for the version number
Product Version (numeric)	like File Version
File Version (text)	Version number like in the Library Version function
Product Version (text)	same as file version

The following example shows the hypothetical life cycle of the 'SAMPLE' library. Note that the version number must grow from release to release.

Version String	**Version number**	**Comment**
SAMPLE 01.00	1,0,0,0	first official release
SAMPLE 01.01	1,0,1,0	bug fixes
SAMPLE 01.02	1,0,2,0	more bug fixes
SAMPLE 01.10	1,1,0,0	official release

Version String	Version number	Comment
SAMPLE 01.11	1,1,1,0	bug fixes
SAMPLE 02.00	2,0,0,0	official release with new functionality
SAMPLE 02.10	2,1,0,0	official release

9.5.5 CVI Project Structure

Do not modify the original Library project. Instead, make a copy of the Libraries directory and make your modifications in the copy.

Be careful when you put your private DLLs in the gtsl\bin directory. Always keep a copy, because they may be overwritten by an update to R&S GTSL if there is a DLL with the same name. It is safer to keep your projects and DLLs in a completely separate location beside the R&S GTSL tree. Be sure to add the directory where your DLLs reside to the PATH environment variable of your computer.

9.5.5.1 Directory Structure

The directory structure of the R&S GTSL software is as follows:

GTSL is the root directory of the tree. It may be located anywhere in the system, e.g. under `C:\Program Files\GTSL` or `E:\GTSL`.

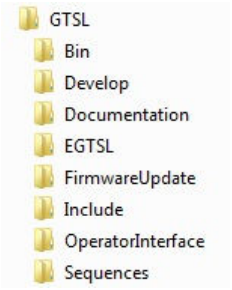


Figure 9-10: R&S GTSL directory tree

Bin contains the following files for all libraries and drivers:

- `.DLL`, Dynamic Link Library
- `.LIB`, Import Library for the DLL, Microsoft C/C++ compatible
- `.FP` and `.SUB`, CVI Function Panel
- `.CHM`, Windows Help File
- `.CDD`, CVI DLL Debugger Information (for development versions only)

Include contains the (`include.h`) files for all libraries and drivers.

Develop contains all files required to build the libraries and drivers. There is a separate subtree for the libraries and one for the drivers. Each library or driver project has its own directory, like UUTLIB and SAMPLE in Figure 9-10.

9.5.5.2 CVI Project Files

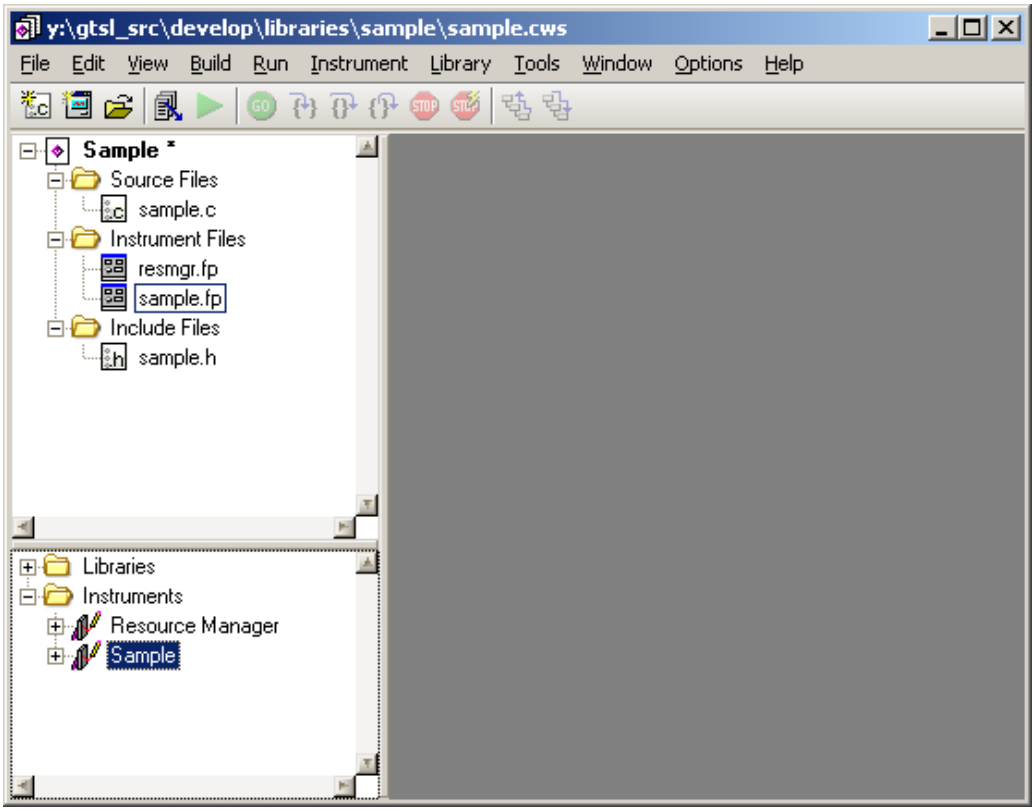


Figure 9-11: CVI project window

A library project under CVI contains the following files:

- The source files for the library (`sample.c`)
- The function panel for the library (`sample.fp`)
- The include file containing the library export functions (`sample.h`)
- The function panel files for all subsidiary libraries and drivers (`resmgr.fp`). These files are taken from the Bin directory.

9.5.5.3 Configuration

The system must known the location of the Bin and Include directories in order to work correctly with the R&S GTSL software.

The Bin directory must be added to the PATH environment variable. This is done by the Setup program when you install R&S GTSL on your computer. When a library DLL requires a subsidiary DLL (like SAMPLE requires the `RESMGR.DLL`), the operating sys-

tem finds the subsidiary DLL using the standard DLL search algorithm. If the Bin directory is not included in the PATH, SAMPLE cannot find the `RESMGR.DLL` and fails if it is loaded. This must be done for a development system as well as for a run-time system.

You may add the Bin directory to the Path system variables (for all users of the computer: preferred setting) or for the currunt user only.

The Include directory must be added to the list of include paths in the CVI development environment.

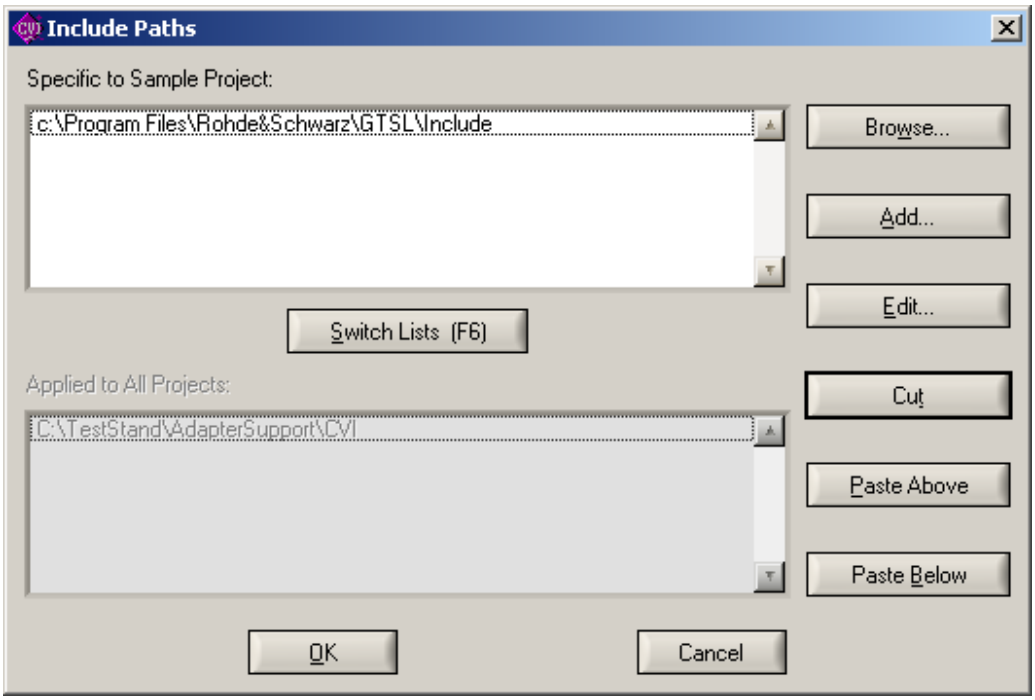


Figure 9-12: Adding the Include Path

You may enter the Include directory in the upper part of the dialog box (specific to the current project: preferred setting) or in the lower part (applied to all projects).

9.5.5.4 Building the DLL

The project settings for a high-level library are shown in the following figure:

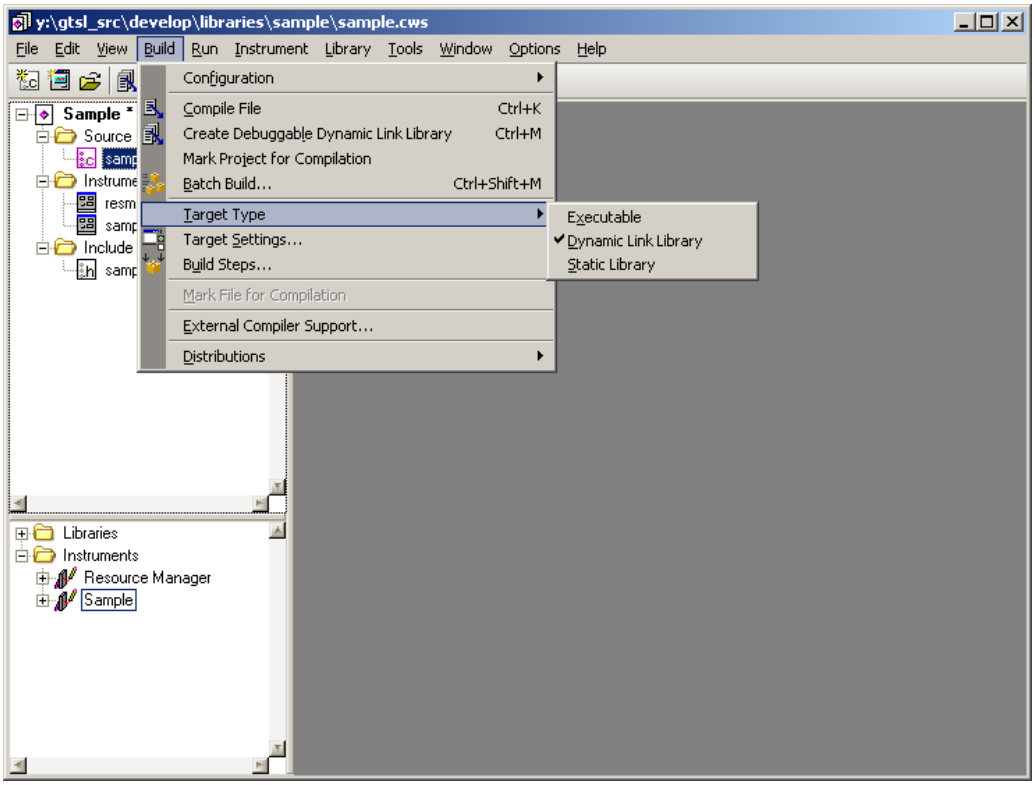


Figure 9-13: Build settings

The Target Type must be set to Dynamic Link Library.

Configuration is normally set to Debug during the development phase of the library, it is set to Release for the release version.

The Target Settings dialog box is shown below:

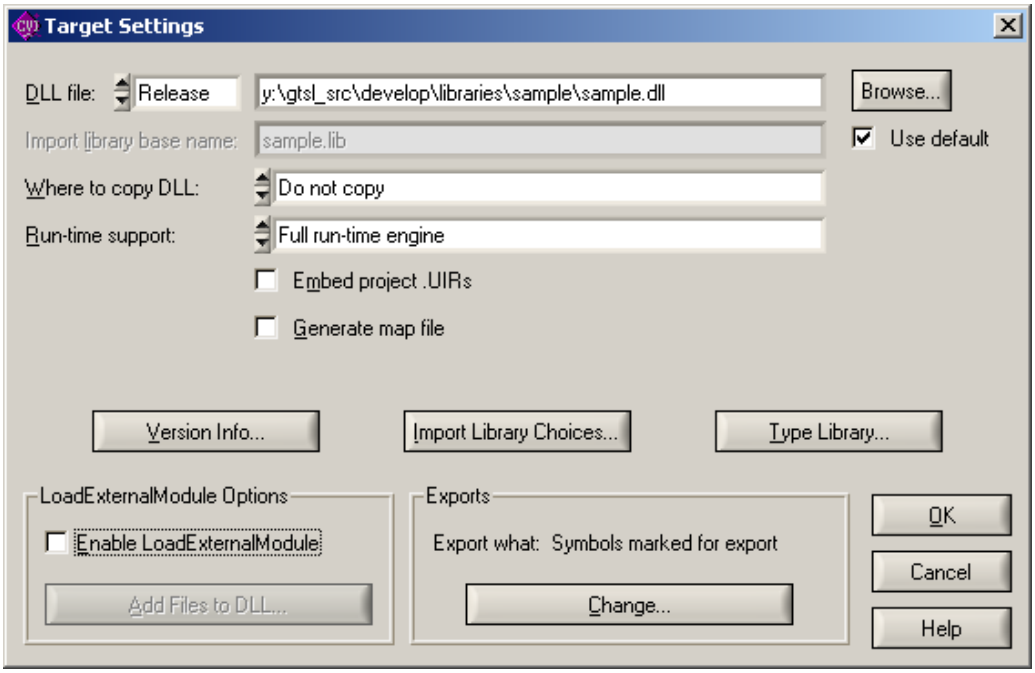


Figure 9-14: Target Settings dialog

`Build...Create Release Dynamic Link Library` starts the building process for the DLL. The DLL file is built in the project directory. Note that the necessary files (DLL, LIB, CDD) must be copied manually to the Bin directory after the build.

How to complete the Version Info dialog box is shown in Figure 9-9 in Chapter 9.5.4.6, "Version Handling", on page 194.

In Import Library Choices, check the current compatibility mode (which must be Microsoft Visual C/C++). Only a single LIB file is generated with this option.

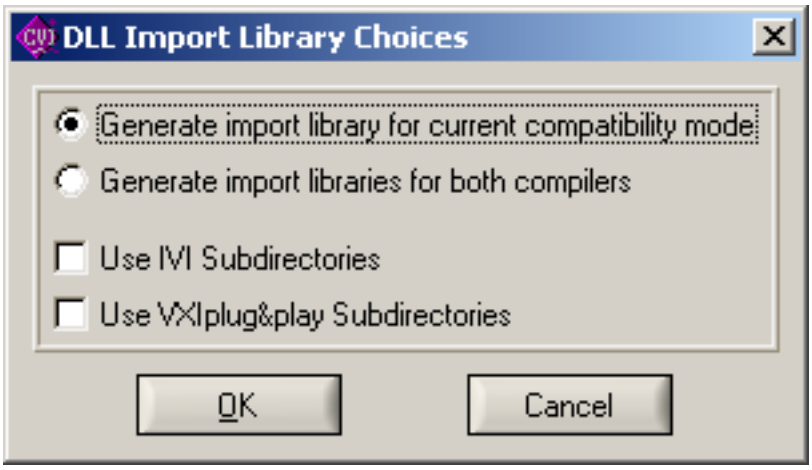


Figure 9-15: DLL Import Library Choices

The Type Library dialog must be completed like shown in the following figure. Adding the type library resource to the DLL enables TestStand to access the function names and prototypes in the DLL. The links to the help file enables TestStand to show function

help for each function in the DLL. The path of the function panel file is the same as the path for the project. Note that the FP file must be copied to the Bin directory manually.

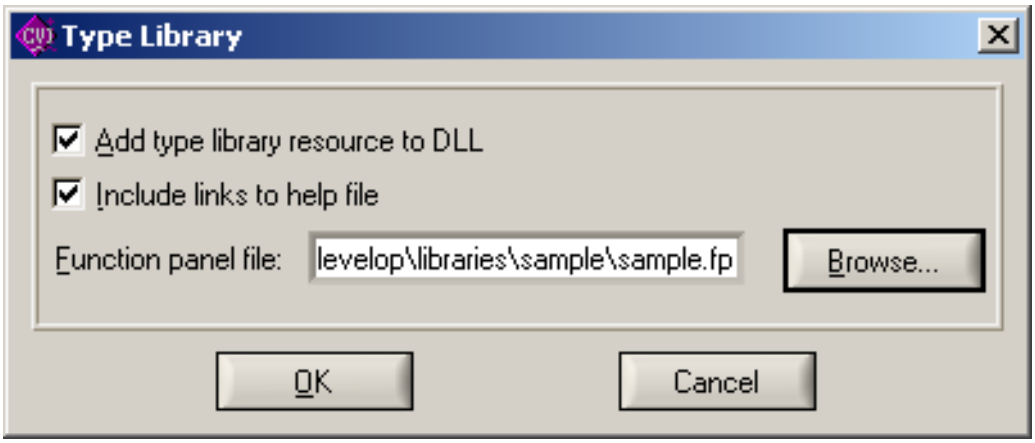


Figure 9-16: Type Library

The Add Files To DLL dialog is not required for build of the high-level library.

The Export Options are set to Symbols Marked for Export. All library functions marked with DLLEXPORT are exported from the DLL.

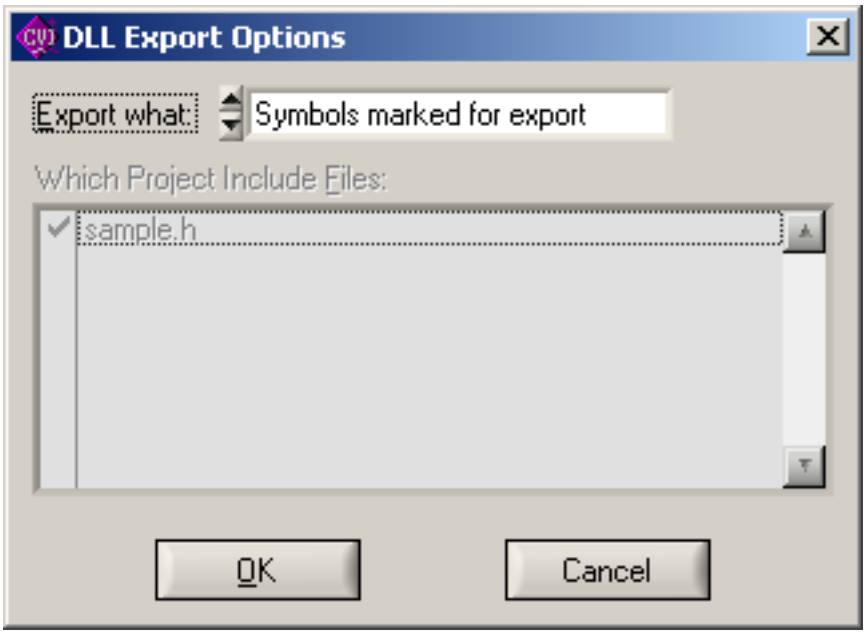


Figure 9-17: DLL Export Options

9.5.5.5 Building Help

Open the FP file for the high-level library and apply the command `Options ... Generate Documentation ... HTML`.

Select "C" for the language. After pressing the "OK" button, the documentation is created from the information in the FP file. You can use an HTML help compiler application to create a Microsoft Compiled Help file (`.chm`) with the generated `.hhp` file.

9.6 SAMPLE Project

The SAMPLE project shows how a library interacts with the resource manager during setup, measurement and cleanup. It consists of a sample sequence and a CVI project which creates a DLL. The C source code contains comments for each step and may be used as a framework to build a high-level library.

The sample project is available in the following path:`...\Gtsl\Develop\Libraries\Sample`

10 Creation of Self Test Libraries

Knowledge of C programming is needed to create self test libraries.

Do not modify the original Sample Self Test Library project. Instead, make a copy of the `sftcsample` directory and make your modifications in the copy.

Be careful when you put your private DLLs in the `gtsl\bin` directory. Always keep a copy, because they may be overwritten by an update to R&S GTSL if there is a DLL with the same name. It is safer to keep your projects and DLLs in a completely separate location beside the R&S GTSL tree. Be sure to add the directory where your DLLs reside to the PATH environment variable of your computer.

10.1 Scope

10.1.1 Identification

This guide describes how to write a self test library for the R&S GTSL software.

10.1.2 System overview

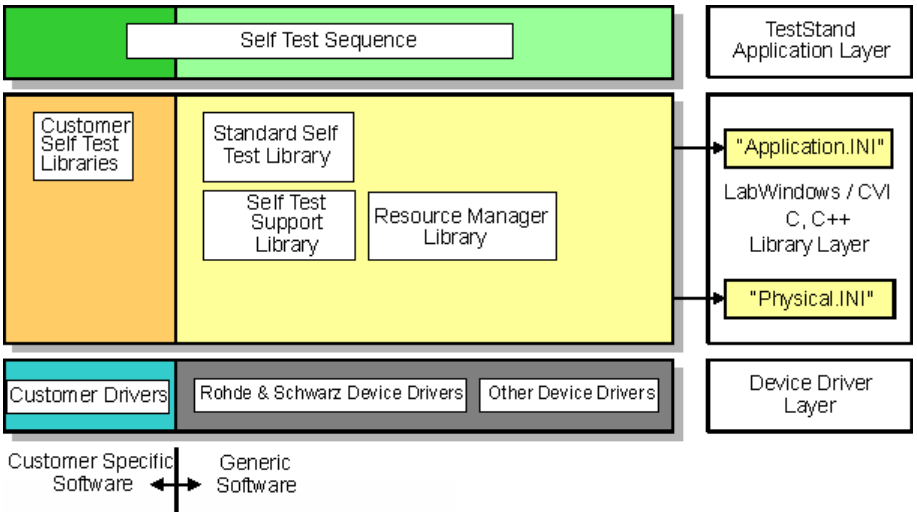


Figure 10-1: R&S GTSL Software Overview

A self test library offers a group of functions which cover the needs for testing a specific device or some equipment in a test system.

The library functions are called from a test sequencer. The functions themselves interact with the resource manager library, the self test support library and the device driver(s).

This chapter describes, how a self test library interacts with the R&S GTSL software and how to write such a library.

10.2 Referenced documents

[RESMGR]	Resource Manager online help file (`resmgr.hlp`)
[SFTSUP]	Self Test Support Library online help file (`sft.hlp`)
[INSTR]	LabWindows/CVI Instrument Driver Developers Guide, National Instruments, February 1998 Edition

10.3 Overview

The design of any R&S GTSL self test library must meet the following requirements:

- The library must be delivered as a Dynamic Link Library (DLL), including type library information and a function panel
- The name of a system self test library starts with *sfts*
- The name of a customer self test library starts with *sftc*
- The function call interface must follow the template.
- The library must use the resource manager functions (if applicable).
- The library must use the self test support library functions (if applicable).

These requirements are described in detail in the following sections.

10.3.1 Test System Configuration

The self test of a production test system based on the TSVP platform must be able to verify the correct functionality of the complete system. The self test library must be able to identify and report a defective part or component in the system. A part may be a device (like a CMU or a power supply), a cable (connecting a CMU to a relay card or to the fixture), a fixture or any other component inside the system (a serial or parallel interface) or outside the system (e.g. a barcode reader). A component may be a built-in card (like a relay card R&S TS-PSM1 or a PXI multimeter card) or an option in a device like CMU.

The actual configuration of the production test system can vary in a wide range. The only common part of all systems is the TSVP frame:

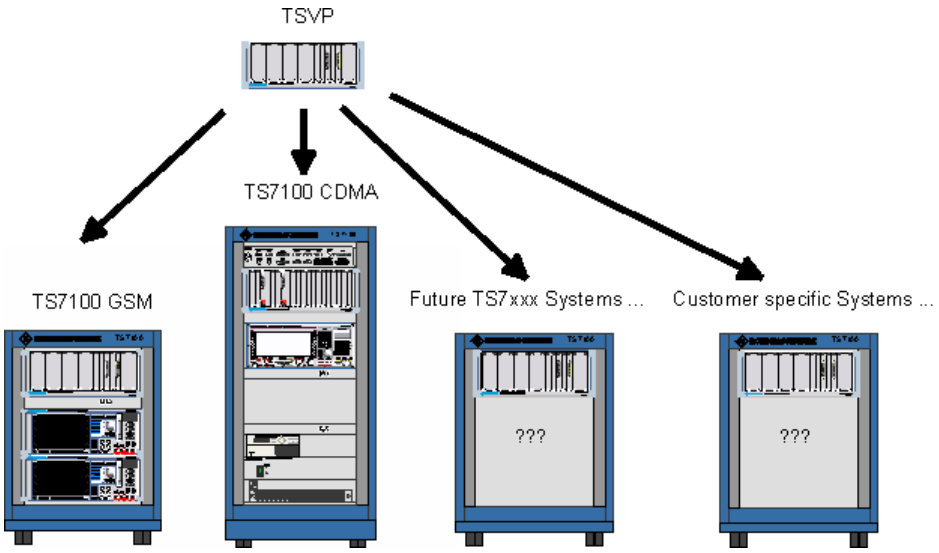


Figure 10-2: Production Test Systems based on the TSVP Platform

The concept for the TSVP self test provides functions to identify the testable components and to test these components. This can be done easily because there are no cross-tests between the components. Each component can be tested independent on the others, and the test is well defined. The self test software of a TSVP standard component is not open to the user, because there is no need to modify it.

On the other hand, the system and overall self test must be open to the user, because we do not known today, how each system will look at the customer site tomorrow. If a test system is modified and expanded by a system integrator, he is also responsible to supply the corresponding self test software part for it.

10.3.2 Self Test Levels

There are several levels of self test:

The module self test ensures that a module (e.g. a CPCI card) inside the TSVP frame is working well. The only resources for the module self test are the module under test itself, a self test board on the front connector of the module (if necessary) and the TSVP system/self-test instrumentation. A module self test will be supplied for each card developed by Rohde & Schwarz (e.g. R&S TS-PAM, R&S TS-PMB etc.).

The system self test consists of the TSVP self test and further tests, including the external devices (e.g. GPIB bus devices), the cabling between the devices and the TSVP frame. The system self test is specific to a standard test system like the TS7100 GSM. The system self test may use any resource which has been tested before. This is necessary to perform the cabling test.

The overall self test consists of the system self test and includes tests for customer-specific extensions and modifications of the system like fixture tests, environment tests (e.g. external interfaces, barcode readers, line integration etc.)

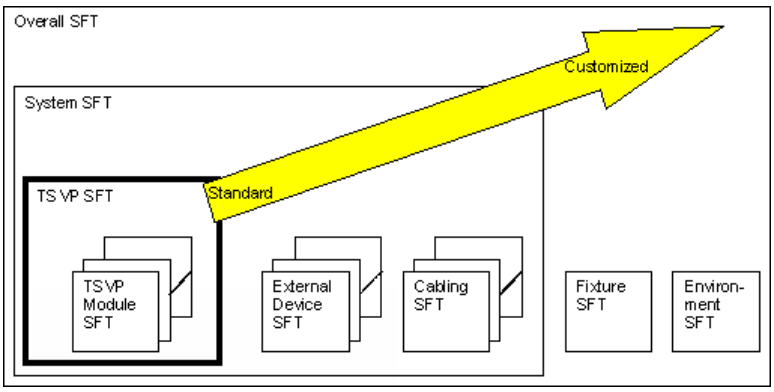


Figure 10-3: Self Test Levels

The inner levels are independent from the actual system configuration to a great extent, that means that the TSVP module self test will run on all systems. The outer levels are very system-specific and have to be customized for each system.

10.4 Software architectural design

10.4.1 Software Components

The basic components of each self test library are:

- `sftxyz.h` include file
- `sftxyz.lib` import library
- `sftxyz.dll` dynamic link library
- `sftxyz.fp` LabWindows CVI function panel
- `sftxyz.c` source file
- `sftxyz.prj` CVI project file
- ... additional source/include files (if applicable)

10.4.2 Concept of Execution

The basic self test concept is not very different from any other test application. There is a test sequence, there is a set of DLLs where the test cases are coded, there is the Resource Manager which coordinates the actions and there are the device drivers which connect the software to the devices. This makes it easy for the user, since there is no difference between loading and running a test program and running the self test. It makes it easy for the programmer, since the self test libraries are written the same way as the high-level test libraries.

The self test is configured by entries in the Resource Manager's physical and application INI files. The physical layer describes the devices, the application layer contains information about the parts to test, the self test benches and options.

10.4.2.1 Self Test Sequence

The self test sequence calls functions from the standard and customer self test libraries:

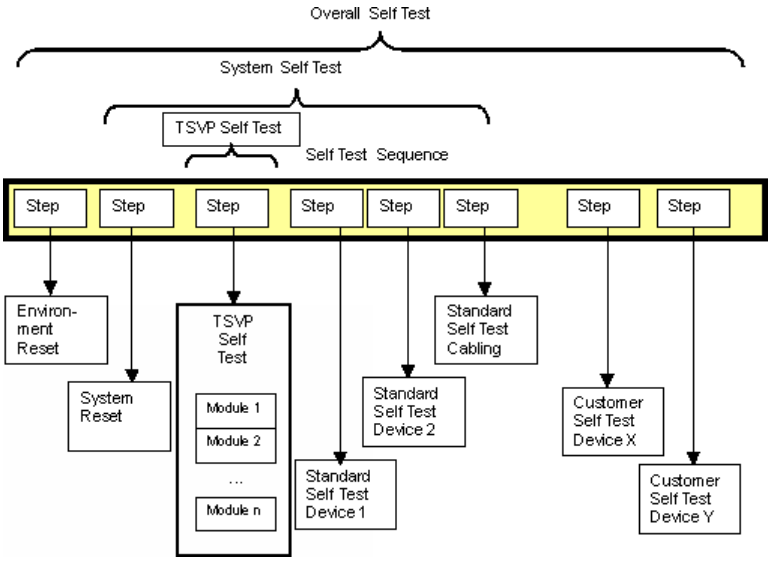


Figure 10-4: Self Test Sequence

What is the difference between a function in a self test library and a function in a device driver? Why don't we call the device driver from the sequence directly? There is a number of benefits using a self test library instead of calling a device driver directly:

- the library can handle more than one device (bench concept)
- the library can switch between different types of devices without modification of the TestStand sequence
- standard INI-file concept for resource description (physical/application layer)
- standard error handling mechanism, suited for use with TestStand
- the library can handle the provided functions of the self test support library more effective

The required functionality is provided by the Resource Manager library (see [RESMGR]) and the self test support library (see [SFTSUP]). These libraries are the central parts of the R&S GTSL self test software. They coordinate the interaction between all the self test libraries. Therefore it is mandatory to use them in each self test library.

10.4.2.2 TSVP Self Test

The TSVP self test is completely kept outside the self test sequence, because it may become quite complex. The TSVP self test must identify all testable modules, load the module SFT libraries and call the appropriate test functions. This task is better implemented in C, because test sequencer level is not suitable. The TSVP self test consists of the TSVP Self Test Frame and a TSVP Module Self Test for each type of hardware module.

This part of the self test is not a subject of this document.

10.4.2.3 Standard Self Test Libraries

The Standard Self Test Libraries offer functions for testing standard devices and cabling. Each function is called directly from the self test sequence.

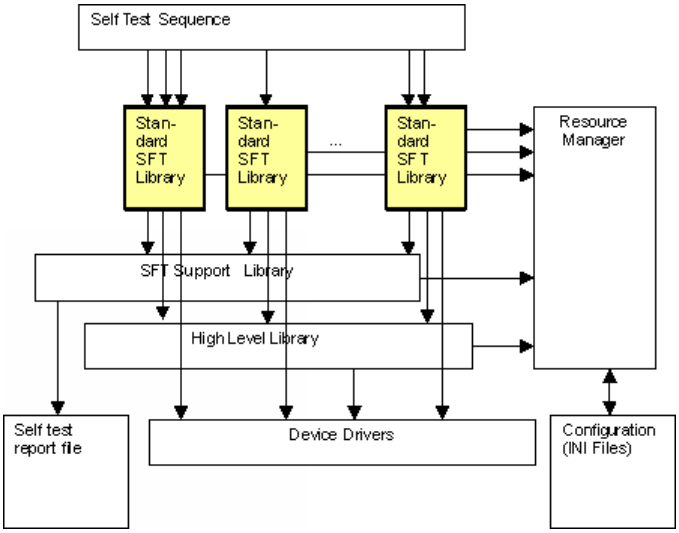


Figure 10-5: Standard Self Test Libraries

Standard self test functions are grouped into several libraries. The functions communicate with the self test support library, the Resource Manager and the device drivers. These libraries are very similar to the "high-level libraries" described in Chapter 9, "Creation of Test Libraries", on page 152. A self test library may also call any other high level library (like the switch manager) to perform it's task.

10.4.2.4 Customer Self Test Libraries

Customer Self Test Libraries are implemented the same way as standard self test libraries, except that they are written by the customer or an integration center. These libraries contain tests for "non-standard" system extensions.

10.4.2.5 Self Test Support Library

The self test support library contains common functions for all other self test libraries, like writing to a report file, dialog boxes, basic measurements etc. (see [SFTSUP]).

10.4.2.6 Configuration Information

The self test uses the configuration information from the physical and application layer INI files. The physical layer describes the devices and device types. The application layer INI file describes the self test benches, user options and selectable self test parts.

10.4.3 Interface design

10.4.3.1 Interface Identification and Diagram

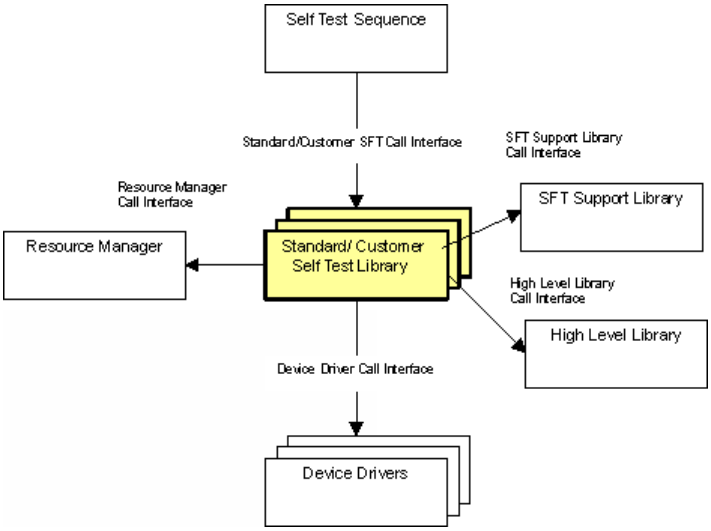


Figure 10-6: System/Overall Self Test Interfaces

10.4.3.2 Standard/Customer SFT Call Interface

The Standard/Customer SFT Call Interface conforms to the rules for the interfaces for high-level libraries and is described in chapter 9.

Because the library normally exports only a single self test function, it is legal to omit the Setup and Cleanup functions from the call interface and include them at the beginning and at the end of the self test routine. A XXX_Lib_Version() is also not necessary because the actual version of a self test library is written directly to the report file.

10.4.3.3 Resource Manager Call Interface

The Resource Manager Call Interface is described in [RESMGR]. The SFT libraries use this interface to access information from the configuration INI files and to handle resource ID's, session handles and locking.

10.4.3.4 Device Driver Call Interface

The Device Driver Call Interface is defined by the IVI, VISA or other device drivers for the modules under test.

10.4.3.5 High Level Library Call Interface

See Chapter 10.4.3, "Interface design", on page 209.

10.4.3.6 SFT Support Library Call Interface

The SFT Support library provides a Setup and a Cleanup function. The Setup function must be called from the SFT sequence before any other function (TSVP self test, standard and customer self test function) can be called. The Cleanup function must be called at the end of the self test sequence.

The **Setup function** initializes the library and reads configuration information from the application layer and physical layer INI files. Information about the run-time state of the self test is also initialized in this function. Next, it calls the Dialog function which displays a dialog window where the user can set the self test options. A list of all available self test parts is displayed which can be selected or deselected. When the user closes the dialog window, the information is stored in the run-time state of the self test support library and all self test libraries can read that information.

A set of **Get/Set Attribute functions** is provided to access and modify the run-time state of the library. These functions can be called by the self test modules to get information about the selected SFT options and to set information about the test result (Pass/Fail).

A set of **Report functions** is provided to write the test results to the report file in a standardized form.

User Interface functions display the test progress on the screen and provide standardized dialogs (e.g. for component selection).

A set of **Measurement functions** is provided to access the basic measurement equipment for the self test like voltage, current, resistor measurements and functions to switch the DMM to the analog bus.

10.5 Software detailed design

10.5.1 Coding Rules

See Chapter 9.5.1, "Coding Rules", on page 163.

10.5.2 Self Test Sequence

The self test of the system is done by a self test sequence.

10.5.2.1 MainSequence Setup

- RESMGR_Setup loads the physical INI and the self test application INI file
- SFT_Setup initializes the self test support library and displays the self test dialog windows

10.5.2.2 MainSequence Main

- other standard/customer SFT library calls
- SFTSTSVP_Test performs the TSVP self test

10.5.2.3 MainSequence Cleanup

- SFT_Cleanup closes the self test support library
- RESMGR_Cleanup closes the resource manager

10.5.3 Standard and Customer Self Test Libraries Reference

10.5.3.1 Overview

There is an naming convention for the self test libraries:

- `SFTSxxxx.DLL` (standard)
- `SFTCxxxx.DLL` (customer-specific)

where xxxx identifies the system or module. The name of the DLL in uppercase characters is identical to the prefix used for every exported symbol and every internal defined constant value of the library. The prefix must also be used in the function panel file for LabWindows CVI and therefore it must contain only alphanumeric characters.

The interface and internal structure of Standard and Customer Self Test Libraries are identical. The libraries conform to the architecture described in the other chapters.

Because a self test library normally exports only a single function, it is legal to omit the Setup and Cleanup functions from the call interface and include them at the beginning and at the end of the self test routine. A XXX_Lib_Version() is also not necessary because the actual version of a self test library is written directly to the report file.

The following chapters show how a customer self test library could look like. See the source file `sftcsample.c` in the SFT sample project for details.

10.5.3.2 Self Test Concept

All results of a self test library function call are written in a common report file (see `Sft_report.txt` of the sample project). The name and location of that file can be configured in the application layer INI file and changed via dialog at runtime. The report consists of the following elements:

- parts
- components
- test cases
- test case informations
- run-time errors

All self test parts, components, test cases and test case information objects are hold in a tree structure. All items within one level must have unique names. The run – time error messages and the objects on the lowest level have no names.

```
run – time errors
- part 1
    - component 1
        - test case 1
            comment
            comment
            table
            comment
            table
    - component 2
        - test case 1
            comment
            result
            result
    + component 3
+ part 2
+ part 3
```

Part

Parts are defined in the application layer INI file. The information from the [SftParts] section is kept in the part list in the self test support library. This list is generated by the SFT_Setup function. A self test part may be a device in a measurement system or the cabling. Read and write access is accomplished by Get/Set Attribute functions. This

functions work on the active part. There is a function to select a part. If components are added to the self test, they are associated to the selected part.

Component

To perform tests for a part at least one "component" must be added. A component may be a simple device (Power Supply), a option in a device (CMU) or a plug in card in the TSVP. The SFT support library provides functions to add, select and modify component items. All component items are stored in an internal list of the self test support library. Additionally there is a dialog function which allows the user to select the components before the self test for that part is started. The programmer of the self test library can decide whether to show this dialog or not. The dialog shows all component items in the list and the user can modify the "selected" attribute. If test cases are added to the self test, they are associated to the active component.

Test case

To do tests for a component the self test library has to create at least one test case item. The self test support library provides functions to add, select or modify test case items. All items are stored in an internal list of the self test support library.

Test case information

A self test library can associate any of the following objects to the activated test case using the report functions:

- comment
- text result
- error message
- warning
- flexible table
- measurement result table

Run - time error

Unexpected or severe errors are handled in the way described in Chapter 9.5.4.1, "Error Handling", on page 185. Such errors will cause TestStand to pop up a Run – Time Error dialog. Additionally the programmer of the self test library is responsible that this error text is written to the self test report by using the appropriate function in the self test support library.

10.5.3.3 Configuration Information

The configuration information for each self test library is similar to the configuration information for a high-level library (cf. [RESMGR]). Each library requires a bench section, where the device under test and the devices required to perform the self test are described.

Additionally the self test support library requires some entries in the application layer INI file for the SFT_Setup function. See Chapter 7.1.9, "Self Test Support Library", on page 73.

To show the concept of a self test library a sample project is added to the R&S GTSL software. The entry "SAMPLE" in section [SftParts] in the application layer INI file is created for that library.

The sample library tests two imaginary components. One is called "AUX" the other one "DCS". With the AUX component some report functions of the self test support library are shown. The DCS component is a imaginary device. To test this device it is necessary to open a session with the device driver. The ports DCS_HI and DCS_LO of the device DCS are connected to the relay card TS-PSM1 via channels CH9com and CH10com. The Switch Manager is used to perform signal routing tasks.

This library requires the following entries in the physical and application layer INI file.

physical layer INI file:

```
[device->PSAM]
Description  = "TS-PSAM Module in Frame 1 Slot 8"
Type         = PSAM
ResourceDesc = PXI6::10::INSTR
Frame        = 1
Slot         = 8
DriverDll    = rspsam.dll
DriverPrefix = rspsam
DriverOption = "Simulate=0,RangeCheck=1"
RioType      = PDC
; Note: the self test DLL and prefix keywords must be removed for the first
;       TS-PSAM module, because it is already tested in the basic self test.
; SFTDll     = sftmpsam.dll
; SFTPrefix  = SFTMPSAM
 [device->SampleDcs]
Description  = "Imaginary Sample Device"Type = DCS_SAMPLE
ResourceDesc = PXI2::4::0::INSTR;
 [device->PSM1_16]
Description  = "TS-PSM1 Module in Frame 1 Slot 16"
Type         = PSM1
ResourceDesc = CAN0::0::1::16
Frame        = 1
Slot         = 16
DriverDll    = rspsm1.dll
DriverPrefix = rspsm1
DriverOption = "Simulate=0,RangeCheck=1"
SFTDll       = sftmpsm1.dll
SFTPrefix    = SFTMPSM1
; mantadory analog bus entry
 [device->ABUS]
Description  = "Analog Bus"
Type         = ab
```

application layer INI file:

```
[ResourceManager];
; Global tracing flags
Trace                  = 1
```

```
TraceFile               = Trace.txt

[bench->SFT]
;
; The bench SFT contains the device required to run the
; complete self test: The TS-PSAM source and measurement module
; which includes the switch matrix for analog bus access
;
DigitalMultimeter       = device->psam
SwitchDevice            = device->psam
Trace                   = 0

[SftOptions]
;
; The SftOptions section defines default values for the self test dialog
;
SystemName              = TS7100
ReportFile              = .\Selftest_Report.txt
; ReportStyle options:
; 1 = report only errors,
; 2 = short report,
; 3 = full report
ReportStyle             = 3
; Self Test Fixtures are available: 0 or 1
SFTFixture              = 0
; Allow manual interventions, i.e. selection of subtests: 0 or 1
ManualInterventions     = 1

[SftParts]
;
; The SftParts section contains a list of parts to test
;
; Format: "PartX" = PartName, BenchName, SelectFlag
; The PartName must be unique for the whole section
; The name for Part 1 must be "TSVP".
;
Part1                   = TSVP, TSVP, 1
Part2                   = SAMPLE, SAMPLE, 1

[bench->TSVP]
;
; Bench for TSVP self test
;
Trace                   = 1
Simulation              = 1

[bench->SAMPLE]
;
; Self test bench for the sample library
;
```

```
Trace                   = 1
Simulation              = 1
AnalogBus               = device->ABUS
DCS                     = device->SampleDcs
SwitchDevice1           = device->PSM1_16
AppChannelTable         = io_channel->SampleChannelTab

[io_channel->SampleChannelTab]
DCS_HI                  = PSM1_16!CH9com
DCS_LO                  = PSM1_16!CH10com
UUT_VCC                 = PSM1_16!CH9no
UUT_GND                 = PSM1_16!CH10no
```

The keys "Trace" and "Simulation" are all set to "1" to allow debugging without any hardware.

10.5.3.4 Self test library structure

The exported "self test function" has the following structure:

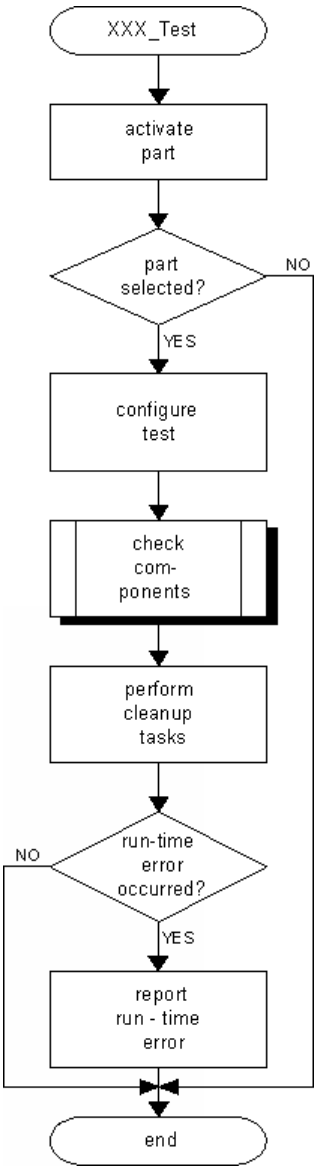


Figure 10-7: Exported self test function

The subroutine "check components" has the following structure:

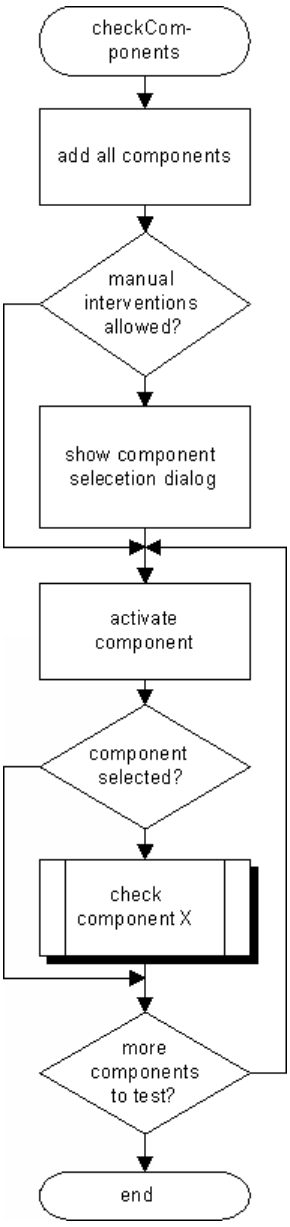


Figure 10-8: Check components function

The subroutine "check component X" has the following structure:

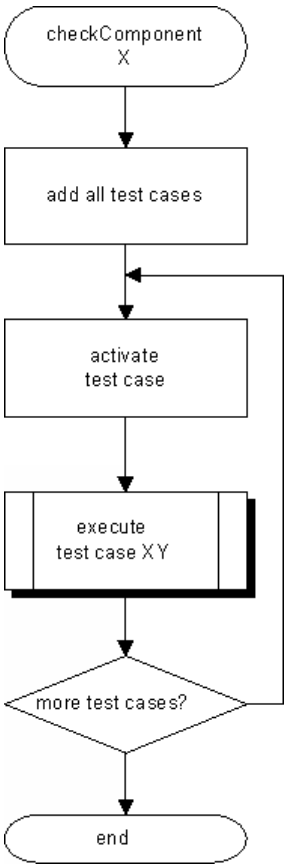


Figure 10-9: Check single component

The subroutine "execute test case X" has the following structure:

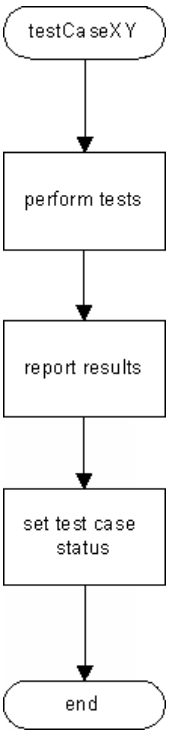


Figure 10-10: Test Case Function

Self Test Function

This function is called from the self test sequence. Be sure that the SFT_Setup function was called before. It performs the following tasks:

- Selects the given part
- Checks whether the given part is selected
- Gets the bench name related to the given part
- Allocates the bench resource
- Checks for tracing flag
- Checks the resource type
- Checks for simulation flag
- Opens the Switch Manager
- Gets the option flags set for the whole self test sequence
- Calls the function to perform the tests
- Closes the Switch Manager
- Frees the bench resource
- If an severe error occured it writes a message to the self test report

See function "SFTCSAMPLE_Test" in the sample project.

Components creation and dispatch function

This function is called from the exported self test function if the part is selected to be tested. It performs the following tasks:

- Creates all components for that part
- Shows the component select dialog if allowed
- Checks whether a component is selected to be tested
- Calls the appropriate component test function.

See function "checkComponents" in the sample project.

Component test function

If a component is selected to be tested, this function will be called by the component dispatch function. It executes all the test cases for the component. It creates all the test cases in the self test support library. The test cases are selected and the tests are done in this routine or by calling a test case function. It is the responsibility of this function to check some preconditions before calling a test case routine. If a test case can't be executed a comment is added to the report to inform the user for the reason.

See functions "checkComponentDcs" and "checkComponentAux" in the sample project.

Test case function

It is called from the test case dispatcher (the component test function).

The test case is already created and selected by the dispatch routine. The preconditions are already chekked. It normally performs some measurements (e.g. with the SFT_Dmm_ functions) and reports the results with help of the self test support library. Finally it sets the test case status.

See functions "testDcsVoltage", "testDcsDeviceSft", "testAuxErrorItem" or "testAuxTableItem" in the sample project.

10.5.4 Resource Description

See Chapter 9.5.3, "Resource Description", on page 184

10.5.5 Miscellanous

10.5.5.1 Error Handling

Error handling in a self test library is a little bit different from the handling in high - level libraries. The programmer must decide how to report errors from the underlying drivers or libraries.

Only unexpected or severe errors are handled in the way described in Chapter 9.5.4.1, "Error Handling", on page 185. Such errors will cause the test sequencer to pop up a

“Run – Time Error" dialog. Additionally the programmer of the self test library is responsible that this error text is written to the self test report by using the appropriate function in the self test support library.

Error messages from device drivers or the resource manager that come from a faulty configuration in the INI files should be written to the self test report in an appropriate test case. Such an error should cause the test case to fail.

All functions of the self test support library report warnings (ErrorOccured is FALSE and ErrorCode is greater than zero) if the user aborts the self test or a test case failed and the option “Stop on first failure" is active. This warnings must lead to a immediate normal termination of the self test function. See Chapter 10.5.5.6, "Self test abort", on page 223 for details.

10.5.5.2 Locking

See Chapter 9.5.4.2, "Locking", on page 190 for details.

10.5.5.3 Tracing

See Chapter 10.5.5.3, "Tracing", on page 222 for details.

10.5.5.4 Simulation

The implementation of simulation is not mandatory for a self test library. But it is recommended to support it. The reasons for running a self test library in simulation mode are:

- The self test sequence can be programmed and tested without hardware
- Presentation of the self test sequence without hardware
- Generation of a full report with all test cases passed

Simulation is done at a very high level in the library. During simulation mode, the high-level library must not call any device driver function or any other function requiring more than the standard PC hardware resources. The library functions should return some "typical" measured values to generate a "Pass" condition.

Simulation is enabled by the "Simulation" keyword in the appropriate bench section.

In the Setup section of the self test routine, the presence of the "Simulation" keyword is checked and the value of the simulation flag is stored.

10.5.5.5 Version Handling

The version number of a library is handled in two separate places.

- First, there is a version string which is written to the self test report.
- Second, there is a built-in version number in each DLL, which can be set during the DLL build. See Chapter 9.5.4.6, "Version Handling", on page 194 for details.

10.5.5.6 Self test abort

While the self test sequence is running a dialog with a "Abort "button is shown. When this button is activated by the user the event is stored in the self test support library. Every subsequent call will then return a warning. Another warning will be returned if a test case fails and the option "stop on first failure" is active. This warnings must lead to a immediate normal termination of the self test function. When all self test functions of the sequence will act in the same way the self test will terminate immediately.

10.5.6 CVI project structure

See Chapter 9.5.5, "CVI Project Structure", on page 196 for details.

10.6 SFT Sample Project

The self test sample project shows how a library interacts with the resource manager, the self test support library and the device driver functions.

The sample project is available in the following path

```
...\Gtsl\Develop\Libraries\Sftcsample
```

11 Instrument Soft Panels

The Instrument Soft Panels permit interactive operation of all TSVP hardware modules. The Soft Panels can be used to perform all the setting, switching and measuring functions.

In addition, they offer a range of useful tools, such as:

- **Pin Location**: Using this tool, you can verify the correct wiring and contacting of a test adapter.
- **Create Physical.ini**: Tool for automatically creating a `PHYSICAL.INI` configuration file.

11.1 Starting the Soft Panels

Proceed as follows to start the Soft Panels:

1. Start the TSVP Soft Panel application via the Windows start menu by selecting the entry "Instrument Soft Panels".
   First, the software will determine the modules available in the system and display them:

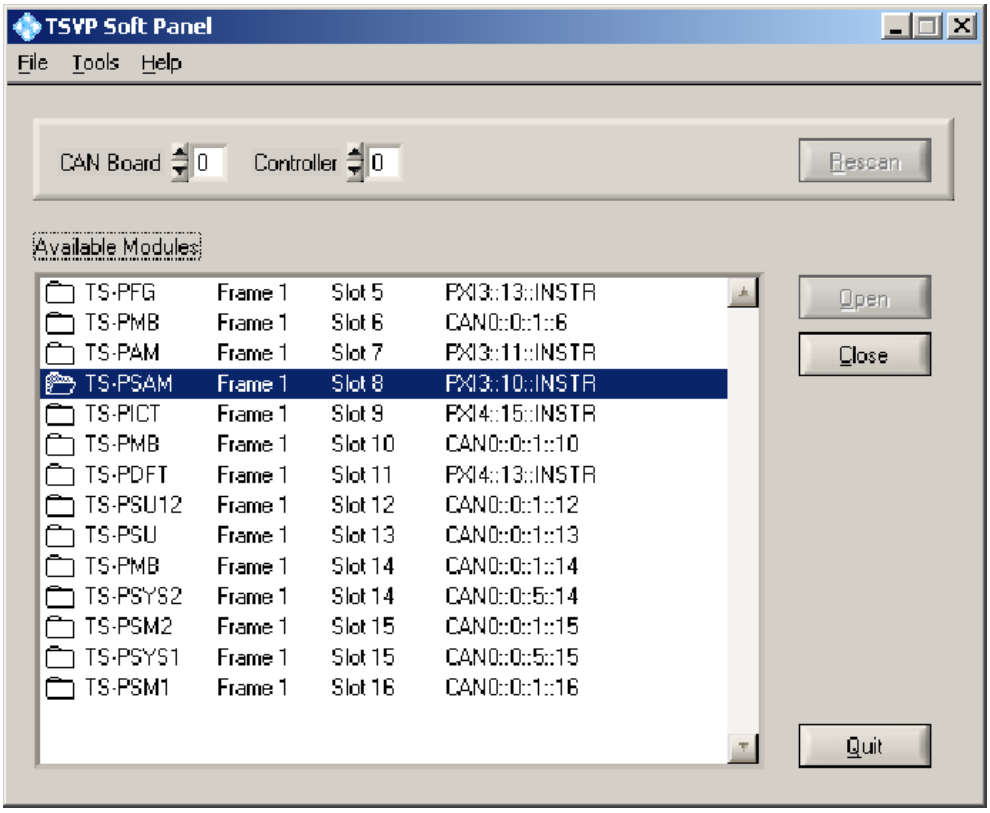


Figure 11-1: TSVP Soft Panel, main window

2. Select a module in the list and click **"Open"**. The instrument panel for the module is displayed.
   The module can only be operated via the instrument panel. In the main window you can start other instrument panels at any time.

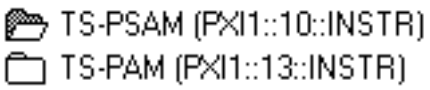
Once the Instrument Soft Panels have been started, no other application must be active that also require the hardware modules, such as the self-test or a test application.

If hardware modules are not found, theTSVP Soft Panel displays a simulation module for each TSVP module type.

11.2 Main Window

11.2.1 Controls

The main window displays all the TSVP modules available in the system. The associated instrument panels are started via the **"Open"** button or simply by doubleclicking the desired list entry.

	An already open instrument panel is represented by an open 'folder'. Doubleclick a list entry of that type to move the panel to the foreground.

Click the **"Close"** button to close an open panel.

The **"Quit"** button terminates the TSVP Soft Panel and closes any open instrument panels.

The **"CAN Board"** and **"Controller"** settings refer to the configuration of the CAN bus for the TSVP modules. The default value for these settings is 0. For special system configurations, a different CAN controller can be selected in these fields. The **"Rescan"** button triggers a new search for CAN modules in the system.

11.2.2 Menus

The **<File><Exit>** menu command terminates the TSVP Soft Panel and closes any open instrument panels.

The **<Tools>** menu provides various help programs such as automatically creating a "`Physical.ini`" file that describes the hardware configuration of the R&S CompactTSVP. For more information on this topic, please refer to Chapter 11.4, "Tools", on page 232 in this manual.

The **<Help><Usage...>** menu command provides information on the command line parameters of the Soft Panel, please refer to the following chapter.

The **<Help><About>** menu command displays the version number of the TSVP Soft Panel and of the R&S GTSL software currently used on the system.

11.2.3 Command Line Parameters

The TSVP Soft Panel can be started with the following command line parameters:

`-simulation`	In addition to the hardware modules found, a simulation module is displayed for each TSVP module type. It permits operation in simulation mode, i.e. without any physical hardware present.

`-nocan`	The CAN bus is not scanned upon start of the TSVP Soft Panel. This option accelerates the start of the Soft Panel if there are no CAN modules.

`-nopxi`	The PCI/PXI bus is not scanned upon start of the TSVP Soft Panel. This option accelerates the start of the Soft Panel if there are no PCI modules.

`-can<b>::<c>`	This parameter is used for pre-assigning the settings CAN Board and Controller, where <b> stands for theCAN board number and <c> for the controller number. This option is useful if the CAN bus is not controlled via the standard controller. Example: -can1::1

The TSVP Soft Panel can be started with command line parameters in two ways:

1. By opening a prompt and entering a call, e.g.
   `C:\> tsvp_panel -simulation`
2. By creating a shortcut on the desktop:
   - Right-click the desktop and select the menu command **"New -> Shortcut"**. In the following dialog, select the file `C:\Program Files\Rohde&Schwarz\GTSL\Bin\tsvp_panel.exe`. In the next step, assign a name to the shortcut, e.g. "TSVP Panel Simulation".
   - Right-click the new shortcut and select the menu command **"Properties."**

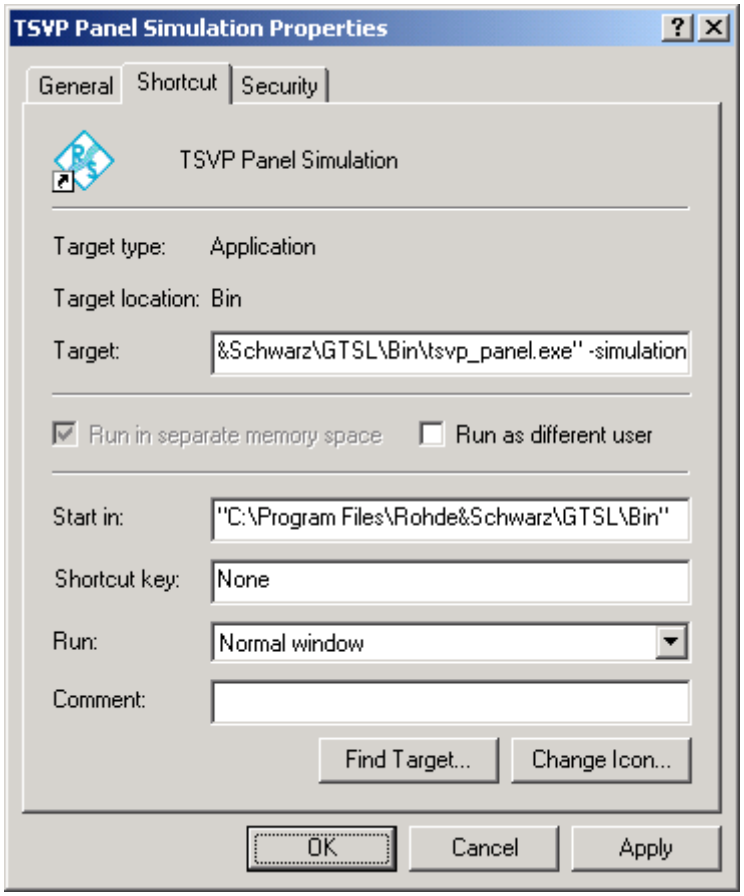


Figure 11-2: Shortcut to TSVP Soft Panel

- Now enter the command line parameter(s) in the "Target" field behind the file name.
- Doubleclick the new shortcut to start the TSVP Soft Panel with these new command line parameters.

11.3 Instrument Panels

The individual instrument panels permit interactive operation of the respective module, such as setting, switching and measuring. An instrument panel is made up of a **main window** accommodating the most frequently used controls. Further subdialog windows and functions can be called via **menus**.

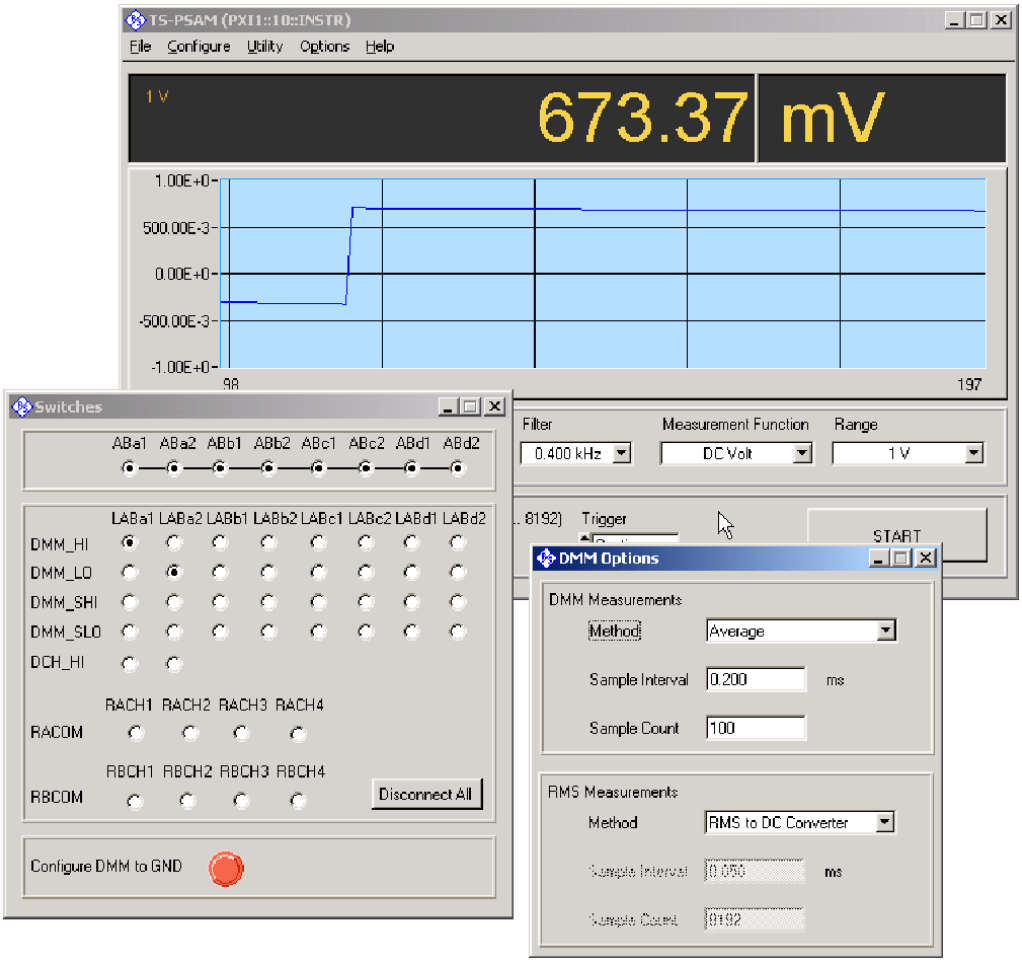


Figure 11-3: R&S TS-PSAM instrument panel with subdialog windows

The instrument panels feature a similar design. For this reason, the following chapters describe the properties common to all the instrument panels.

11.3.1 Menu Structure

The **<File><Close>** menu command closes the instrument panel.

The **<Configure>** menu command provides a number of additional menu commands for displaying the subdialog windows for the switching, triggering and the like.

The **<Utility><Revision Query...>** menu command displays information on the serial number, the firmware version and the software version of the module.

The **<Utility><Reset>** menu command resets the module to the default setting.

The **<Help><About>** menu command displays the version number of the TSVP Soft Panel and of the R&S GTSL software currently used on the system.

11.3.2 Settings

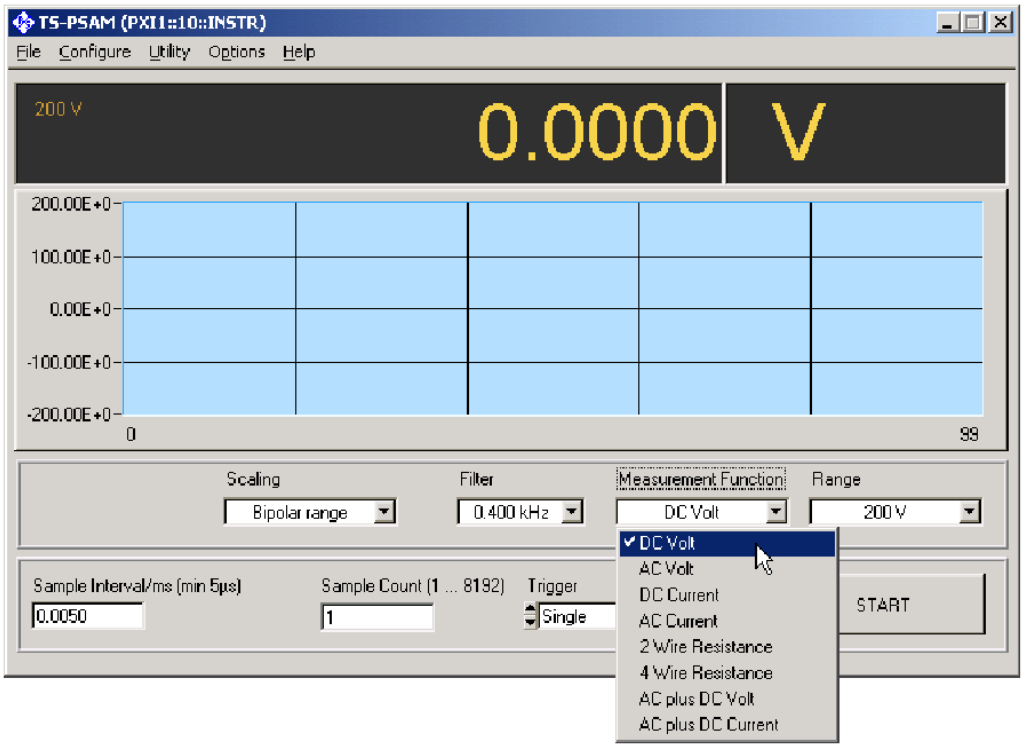


Figure 11-4: Settings, R&S TS-PSAM

There are various input possibilities for configuring the modules.

- Drop-down list boxes for selecting individual options, e.g. the Measurement Funcion as shown in Figure 11-4.
- Text input fields for numeric values.
- Buttons and slide controls.

The setting is effective as soon as the entry has been made. Subdialog boxes with an **"Apply"** button are an exception. In this case, the data are accepted only when **"Apply"** is pressed.

11.3.3 Subdialog Window

A subdialog window offers extended settings such as Triggering that can be called via the main window menu (Figure 11-4). Figure 11-5 shows a submenu window for setting the triggering.

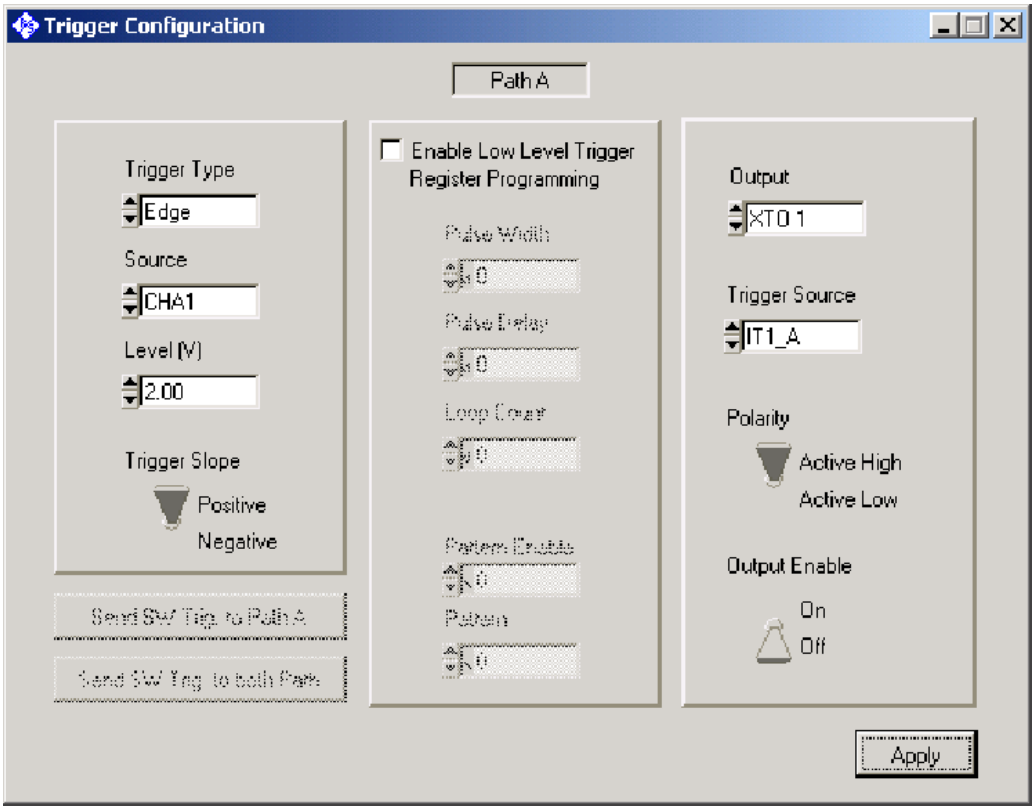


Figure 11-5: Subdialog window, R&S TS-PAM trigger setting

The subdialogs are called via the **<Configure>** menu. The subdialogs are displayed in parallel to the main window of the instrument panel. If a subdialog window has an **"Apply"** button, the data will be sent to the instrument only when **"Apply"** has been clicked.

Subdialog windows are closed by clicking the ☒ button in the title bar.

11.3.4 Relay Matrix

Depending on the module, the connections are either made in the main window or via a subdialog window in the **Configure><Switches...>** menu.

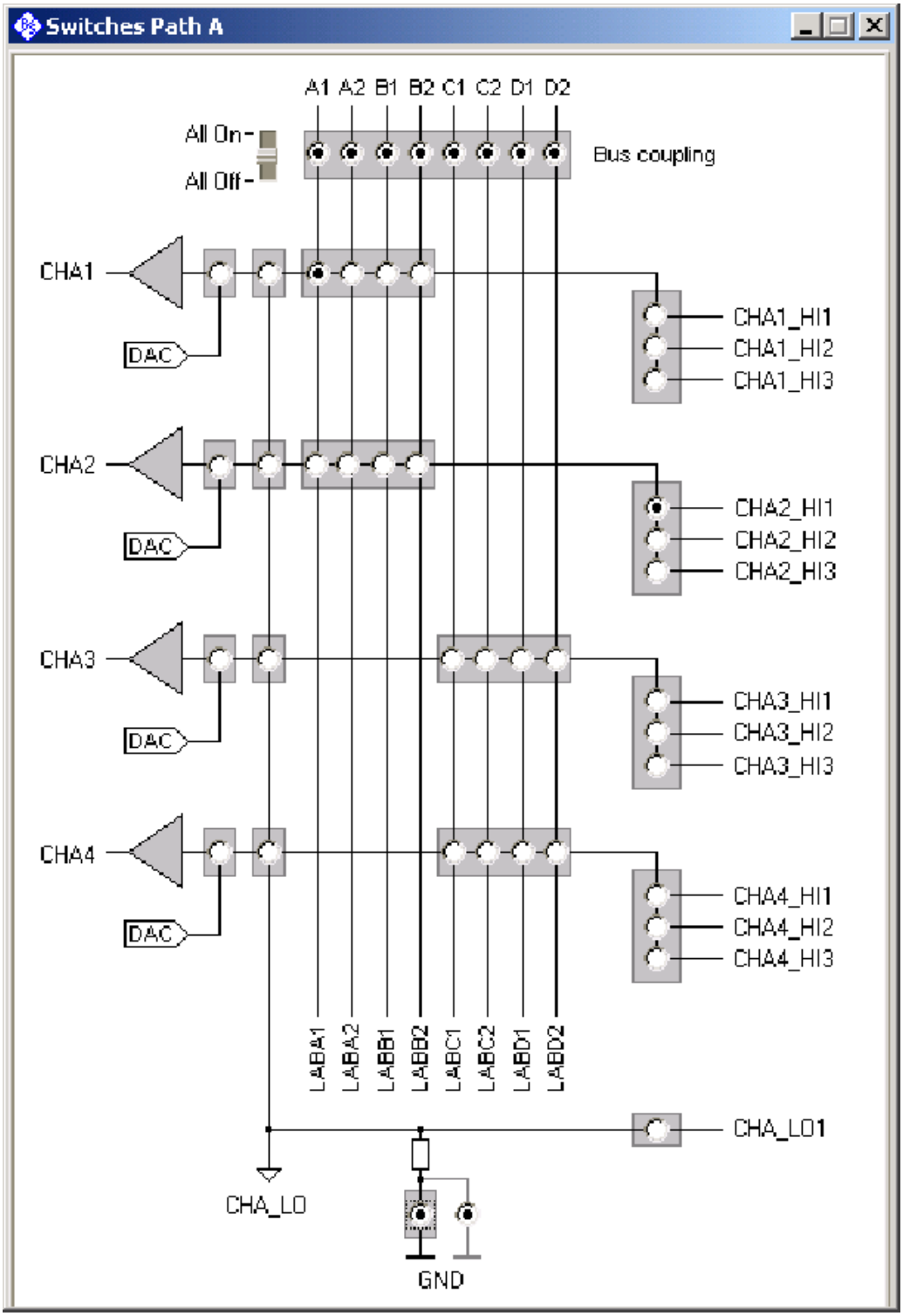


Figure 11-6: Relay matrix, R&S TS-PAM

The relay matrix of the modules to the analog bus and the front connector is displayed in the form of a graphics. The controls at the junctions of the lines are relays. The

relays can be opened and closed by clicking the controls. Closed relays are represented with a dot.

11.4 Tools

The following software tools can be accessed via the **<Tools>** menu of the TSVP Soft Panel:

<Tools><Pin Location...>	Tool for checking the adapter wiring. Refer to Chapter 11.4.1, "Pin Location", on page 232.
<Tools><Create Physical.ini...>	Tool for automatically creating a "Physical.ini" file for the current system. Refer to Chapter 11.4.2, "Create Physical.ini", on page 241.
<Tools><Front Connectors>	Tool for displaying module front connectors. Refer to Chapter 11.4.3, "Front Connectors", on page 243.

11.4.1 Pin Location

Pin Location is used to verify the adapter wiring using a probe. A pin can be identified rapidly by touching it with a probe. This tool is also useful in the case of contact problems.

11.4.1.1 Hardware required

Pin Location requires a Source and Measurement Module R&S TS-PSAM for measuring the resistance and one or more R&S TS-PMB matrix modules to which the unit under test (UUT) or adapter is connected.

11.4.1.2 Connecting the Proble

The probe is directly connected to the front connector of the R&S TS-PSAM module. The following connections are possible:

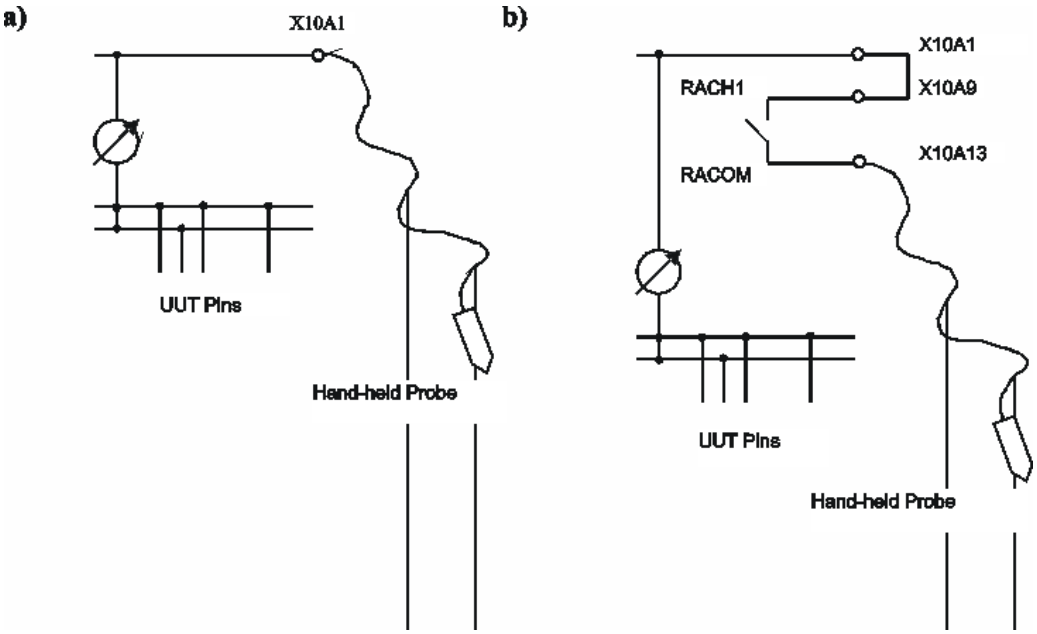


Figure 11-7: Connecting the probe (example)

Option **a)** is suited primarily for a "fast" verification of the adapter wiring. It merely requires a cable with a probe.

The cable must be disconnected again as soon as the test program or another application (e.g. the self-test) is started. Otherwise faulty measurements may result since the probe is permanently connected to the ABa1 analog bus.

Option **b)** should always be selected when the probe or a socket for the probe is integrated in the adapter. In this case the probe is disconnected from analog bus ABa1 via a relay multiplexer of the R&S TS-PSAM module when it is not being used. For this purpose, the adapter must be fitted with an additional wire bridge.

11.4.1.3 Measurement Principle

After starting Pin Location, the software first discharges the pins to be tested individually towards each other and towards ground. If the residual voltage of a pin is still too high after it has been discharged, it cannot be included in the scan list. If the highest residual voltage measured exceeds 5 V, Pin Location cannot be started since the measuring system could be at risk with this setting.

After discharging, the software configures the R&S TS-PSAM module as an Ohmmeter and the DMM_HI connector is coupled with the probe via the local analog bus LABa1.

The DMM_LO connector is coupled to all the UUT pins, i.e. they are short-circuited towards each other. The Ohmmeter continuously measures the resistance. As long as the probe does not have contact to one of the test pins, the measurement will yield a high-resistance result.

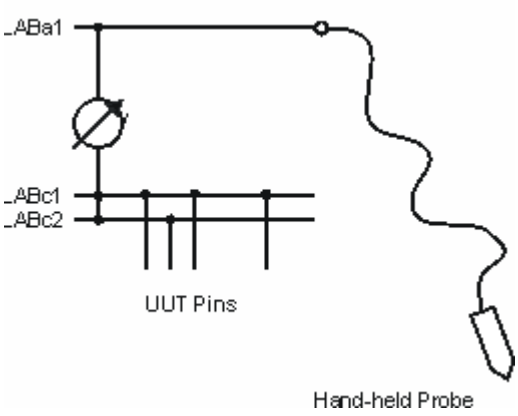


Figure 11-8: Measurement Principle

As soon as the probe touches a test pin, the measurement will supply a low resistance that depends on the resistances of the matrix relays, the supply lines and the contact resistance of the probe. As soon as this resistance is lower than 10 Ohm, the actual scan is started. This requires that the contact remains until the pin has been located.

For the scan, first all the test pins are disconnected from the DMM_LO connector of the Ohmmeter. Thereafter, they are individually connected to DMM_LO one after the other, and the resistance is measured again. If a low value is measured here, the connected pin has been found and the information is output.

As soon as the scan has been completed, all the pins are reconnected to DMM_LO and the program waits for another contact.

11.4.1.4 Starting Pin Location

Pin Location is started via the menu command **<Tools><Pin Location...>** of the TSVP Soft Panel or via function key **F2**.

11.4.1.5 Configuration Dialog

The Configuration dialog is displayed after Pin Location has been started (Figure 11-9).

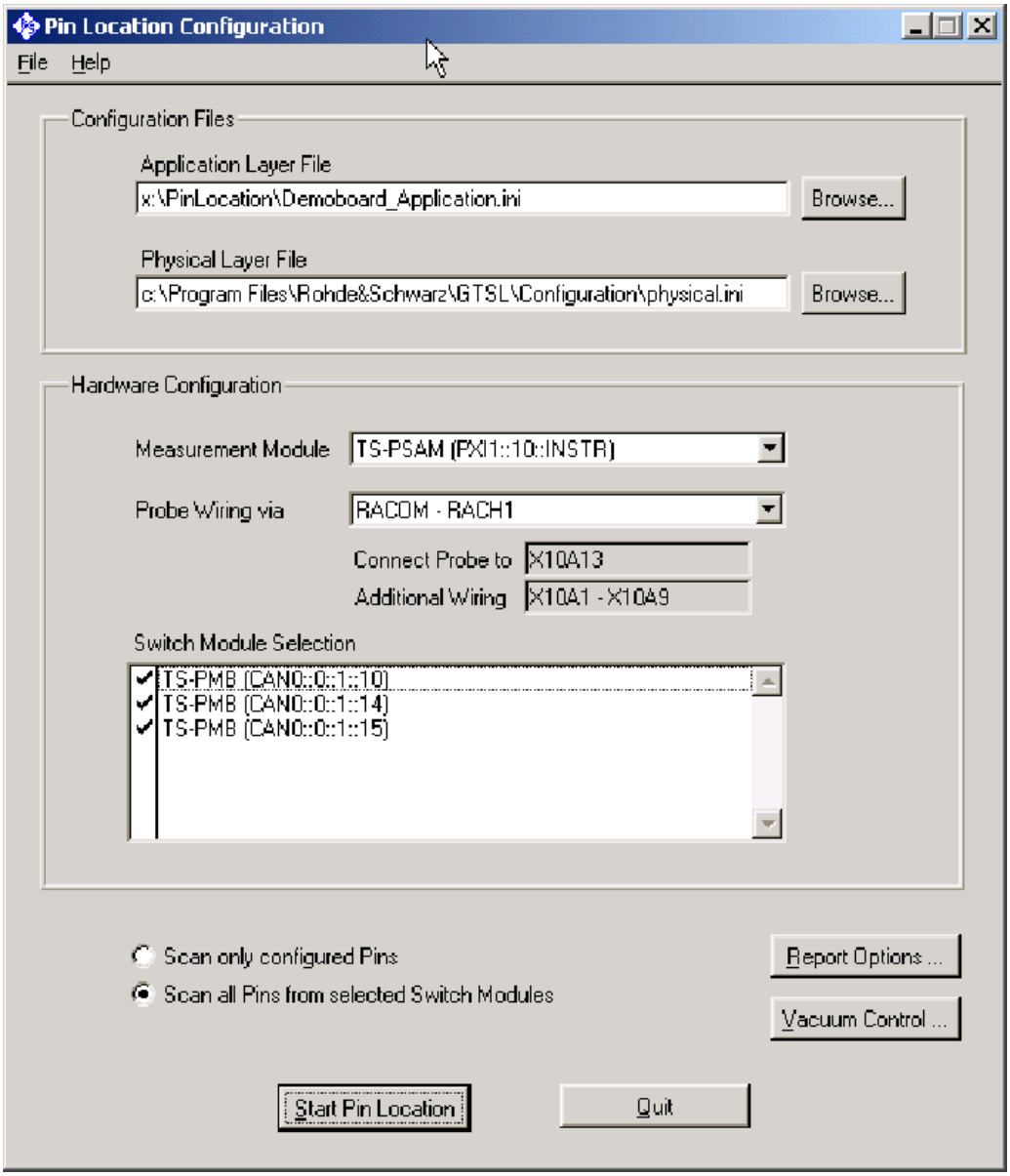


Figure 11-9: Configuration Dialog

"Configuration Files"	In this window area, the configuration files for the physical and application layers can optionally be entered. These files are required to be able to display the logical node names (from `application.ini`) and the device names (from). Use the **"Browse..."** button to select the files.
"Application Layer File"	In this field, enter the path and the name of the `application.ini` file, in which the name assignment of the adapter to be tested is stored. Pin Location reads all the name tables (i.e. sections starting with [io_channel->]) from this file and uses them for displaying the logical node names. If a file is not specified here, the logical node names are not converted and only the physical names will be displayed.
"Physical Layer File"	In this field, enter the path and the name of the `physical.ini` file, in which the configuration of the test system is stored. By default, this is the file `physical.ini` in the folder `C:\Program Files\Rohde& Schwarz\GTSL\Configuration`. If a file is not specified in this field, the device names are not converted. The file must always be specified, when an `application.ini` file is specified.
"Hardware Configuration"	The hardware modules and the probe wiring are selected in this window area.
"Measurement Module"	Select the R&S TS-PSAM module that is to be used for the measurements and to which the probe is to be connected.
"Probe Wiring via"	Select how the probe is to be connected. The fields below this field show, to which pins of the front connector the probe and the bridge must be connected. The following connection possibilities have been provided:

Connection via	Connection of the probe	Connection of the bridge
LABA1	X10 A 1	NA
RACOM - RACH1	X10 A 13	X10 A 1 - X10 A 9
RACOM - RACH2	X10 A 13	X10 A 1 - X10 A 10
RACOM - RACH3	X10 A 13	X10 A 1 - X10 A 11
RACOM - RACH4	X10 A 13	X10 A 1 - X10 A 12
RBCOM - RBCH1	X10 B 13	X10 A 1 - X10 B 9
RBCOM - RBCH2	X10 B 13	X10 A 1 - X10 B 10
RBCOM - RBCH3	X10 B 13	X10 A 1 - X10 B 11
RBCOM - RBCH4	X10 B 13	X10 A 1 - X10 B 12

"Switch Module Selection"	Select the switch module(s) to be included in the scan. By default, all the switch modules are selected.
"Scan Options"	The option **Scan only configured Pins** limits the scan to those pins that are listed in a name table in the Application Layer File. You can narrow down the scan further by delecting swith modules in the Switch Module Selection field. This option is available only if an Application Layer File has been specified. The option **Scan all Pins from selected Switch Modules** lets Pin Location perform a scan across all the pins of the selected switch modules.

11.4.1.6 Report Options

Report Options ...	This dialog permits the recording of a report file. The report format is described in Chapter 11.4.1.10, "Report Format", on page 240.

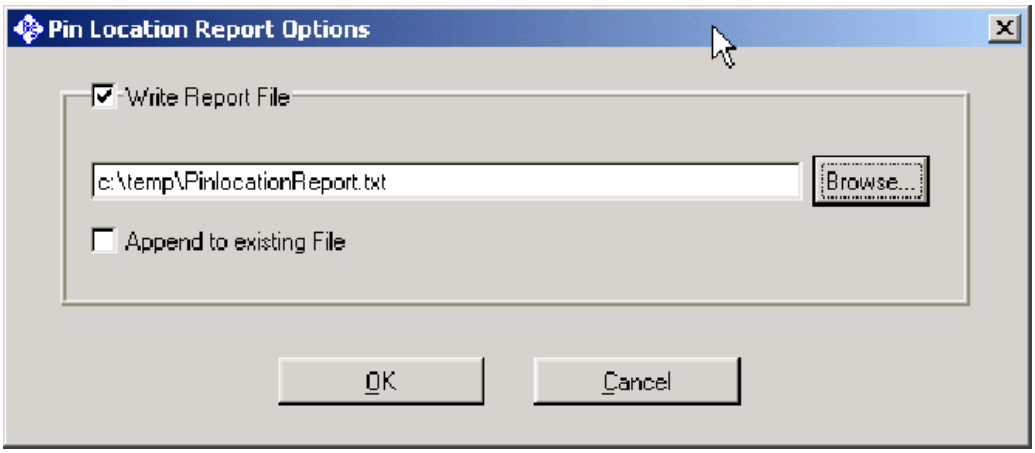


Figure 11-10: Report Options

"Write Report File"	Enable this checkbox if you want to create a report file. Enter the path and file name for the report file. Use the Browse... button to select the path.
"Append to Existing File"	Enable this checkbox if you want to append the report to an existing report. Otherwise, any existing report will be overwritten after a warning prompt. Confirm the dialog by clicking the OK button to create the report file.

11.4.1.7 Vacuum Controller

Vacuum Control ...	This dialog permits the selection of a R&S TS-PVAC vacum controller.

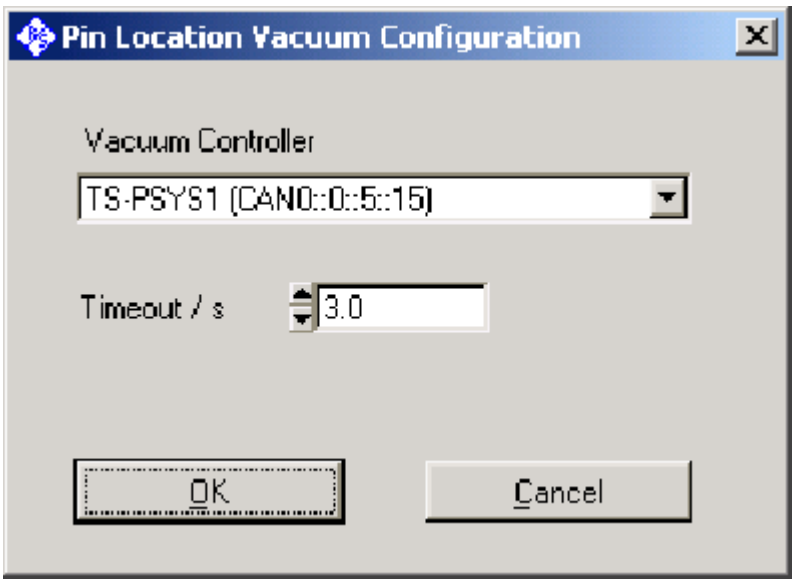


Figure 11-11: Vacuum Controller

" Vacuum Controller"	Select a R&S TS-PSYS module in the list for controlling the vacuum controller or select (**no vacuum**) if there is no vacuum controller.
"Timeout / s"	Enter the maximum wait time in seconds for the maximum permissible interval between the actuation of the vacuum valve and the 'Switch closed' feedback, before an error is reported. When you confirm the dialog by clicking the **"OK"** button, the vacuum is not yet enabled. This is done only directly before the scanning procedure is started.

11.4.1.8 Starting the Scanning Procedure

Start Pin Location	The **"Start Pin Location"** button starts the scanning procedure. First, the modules are initiated and the vacuum is enabled. Thereafter, the discharge procedure is started. Once all the pins have a potential of zero, the measurement dialog will be displayed.

11.4.1.9 Measurement Dialog

The measurement dialog shows the status of the scanning procedure and the pins located, and it offers various options.

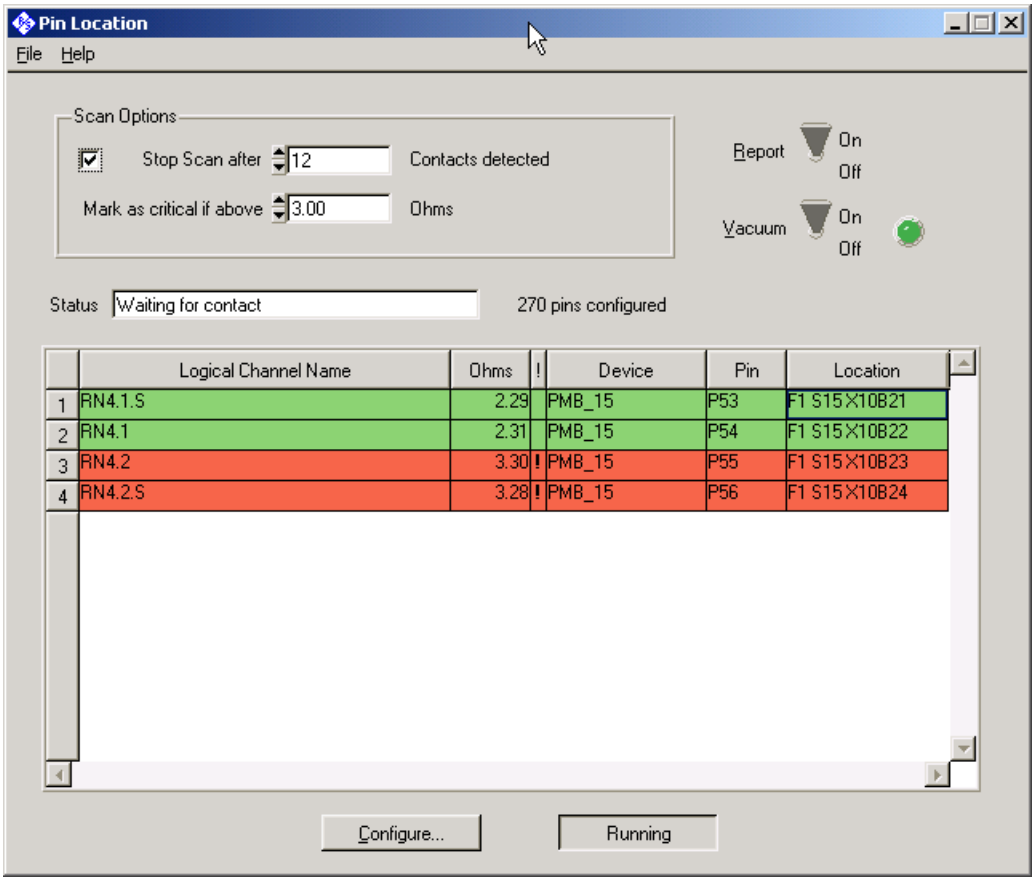


Figure 11-12: Measurement dialog

Table of Contents	The display of the contacts located takes up the main part of the dialog. For each contact, it shows the logical channel name, the value measured, the name of the switch module, the physical pin name and the designation of the location on the front connector of the TSVP system. Example: F1 S15 X10B21 means: • F1 - TSVP frame 1 • S15 - Slot 15 • X10B15 - Connector X10, column B, row 15 Some of the fields of the table will remain empty if a configuration file is not specified. • Logical Name is empty if no `Application.ini` file is specified or if the pin is not referenced in any name table. • Device is empty if no `Physical.ini` file is specified or if the switch module is not contained in the `Physical.ini` file.

"Status"	The status is shown above the table (Discharging, Waiting for Contact, Scanning, n Pins found, Paused), next to it the number of pins configured for the scan operation.
"Scan Options"	The option **Stop scan after n Contacts detected** aborts a scan as soon as the number of contacts specified has been detected. This can reduce the scanning period. When the checkbox is disabled, all the configured pins will be scanned. The option **Mark as critical if above n Ohms** marks a contact as "critical", if its value exceeds the threshold specified. It will have a red background in the table and will be identified with an exclamation mark in the table as well as in the report.
"Report"	This switch is used to enable/disable the recording of the report. The switch is disabled if a report was not created.
"Vacuum"	This switch is used to enable/disable the vacuum. The LED to the right shows the current vacuum status.
	The **Running** button is used to pause the contact measurement, e.g. to correct the wiring in the adapter. In this case, the caption will change to **Paused**. Click the button again to resume the scan operation.
	The **Configure** buton closes the measurement dialog and the configuration dialog is displayed again.
Menus	Use the menu command **<File><Exit>** to exit Pin Location. The **<Help><About>** menu command displays the version number of the TSVP Soft Panel and of the software currently used on the system.

11.4.1.10 Report Format

The following is an example of a Pin Location report.

```
Pin Location started at 2005-07-05 16:51:35

Configuration Files
   Application :  x:\PinLocation\Demoboard_Application.ini
   Physical    :  c:\Program Files\Rohde&Schwarz\GTSL\Configuration\physical.ini

Measurement Module
   TS-PSAM (PXI1::10::INSTR)
   Probe connected via RACOM - RACH1

Switch Modules
   TS-PMB (CAN0::0::1::10)
   TS-PMB (CAN0::0::1::14)
   TS-PMB (CAN0::0::1::15)
```

```
Options
  Scan all pins from selected switch modules

Discharge 270 pins

Scan 270 pins
  Critical resistance : 2 Ohms

              Logical Name  Resistance  Physical Name  Location
================================================================================
-                    RN5.3  0.98 Ohms   PMB_15!P48   F1 S15 X10B16
-                    RN5.4  0.93 Ohms   PMB_15!P49   F1 S15 X10B17
-                    RN5.5  0.97 Ohms   PMB_15!P50   F1 S15 X10B18
-                   CTRQ0R  0.97 Ohms   PMB_15!P72   F1 S15 X10C8
-                   CTRQ2R  0.95 Ohms   PMB_15!P74   F1 S15 X10C10
-                    CTRTC  0.97 Ohms   PMB_15!P77   F1 S15 X10C13
-                    RN5.3  0.95 Ohms   PMB_15!P48   F1 S15 X10B16
-                    RN5.5  0.96 Ohms   PMB_15!P50   F1 S15 X10B18
-                       nc  1.00 Ohms   PMB_15!P52   F1 S15 X10B20
-                  RN4.1.S  1.15 Ohms   PMB_15!P53   F1 S15 X10B21
+                    RN4.1  0.98 Ohms   PMB_15!P54   F1 S15 X10B22
+                    RN4.2  2.12 Ohms ! PMB_15!P55   F1 S15 X10B23
+                  RN4.2.S  2.12 Ohms ! PMB_15!P56   F1 S15 X10B24

Pin Location finished at 2005-07-05 16:58:18
```

At the beginning of the report, the configuration is described and any problems with the discharging of the pins. Thereafter a list of the pins detected is displayed in the form of a table.

Lines beginning with "-", identify the beginning of a new scan. Subsequent lines with "+" contain further pins detected in the same scan operation.

Resistance values exceeding the critical resistance are identified with a "!" at the end.

11.4.2 Create Physical.ini

Using the **<Tools><Create Physical.ini...>** menu item, you can create a configuration file `Physical.ini` for the current system configuration. This is useful if new modules are added, a new system controller was assembled or if the slot assignments were changed.

A dialog field is displayed prompting you to select the destination path.

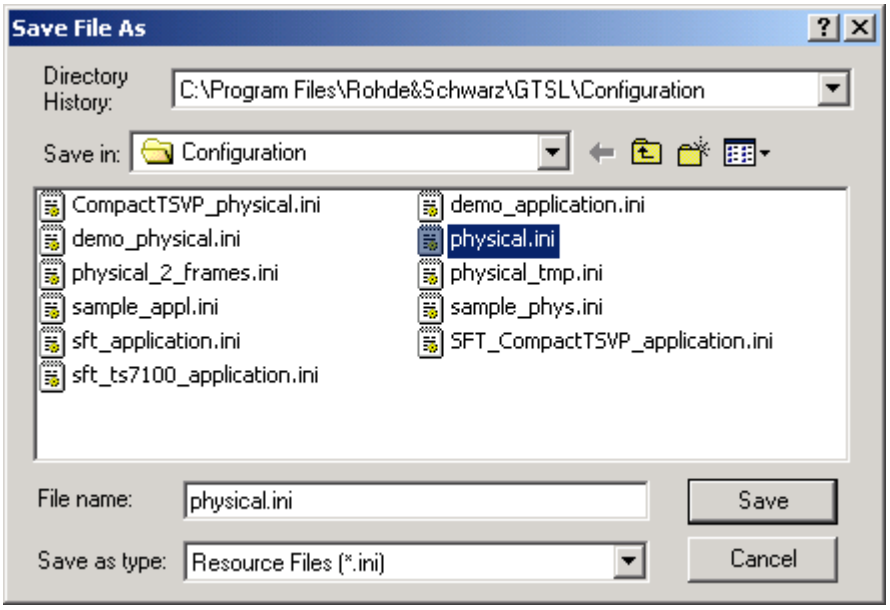


Figure 11-13: Saving physical.ini

Select the desired destination path for saving the new file to be created.

Overwrite the standard file only if you are positive that you have not made any important changes or additions!

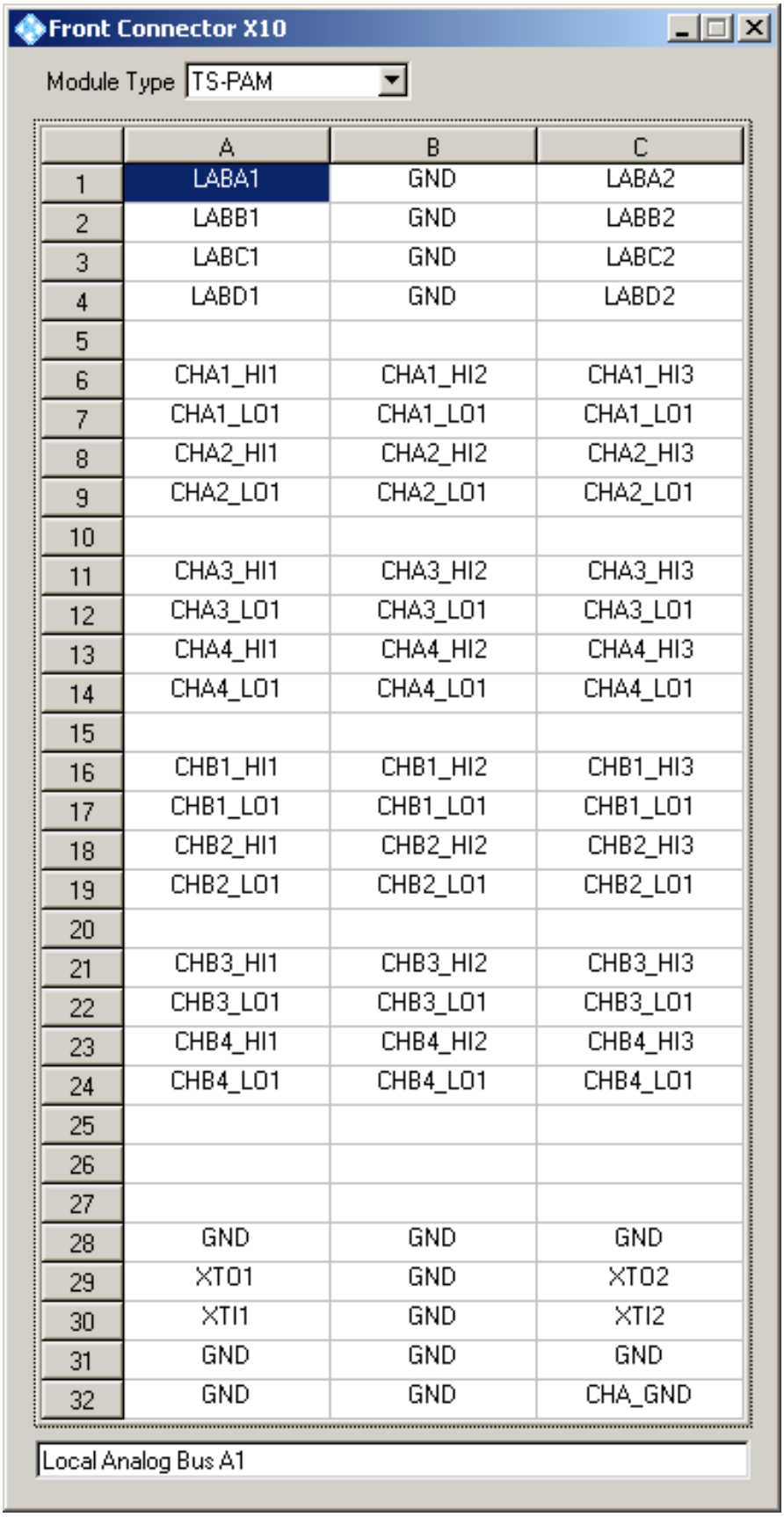
The following is an excerpt from an automatically generated `Physical.ini` file:

```
;; Created by tsvp_panel Version 01.12
;
[device->PSAM]
Description    = 'TS-PSAM Module 1'
Type           = PSAM
ResourceDesc   = PXI1::10::INSTR
DriverDll      = rspsam.dll
DriverPrefix   = rspsam
DriverOption   = 'Simulate=0,RangeCheck=1'
; Note: the self test DLL and prefix keywords must be removed for the first
;       TS-PSAM module, because it is already tested in the basic self test.
; SFTDll       = sftmpsam.dll
; SFTPrefix    = SFTMPSAM

. . . . . .

[device->PMB_10]
Description    = 'TS-PMB Module in Frame 1 Slot 10'
Type           = PMB
ResourceDesc   = CAN0::0::1::10
DriverDll      = rspmb.dll
DriverPrefix   = rspmb
```

```
DriverOption    = 'Simulate=0,RangeCheck=1'
SFTDll          = sftmpmb.dll
SFTPrefix       = SFTMPMB

[device->PMB_14]
Description     = 'TS-PMB Module in Frame 1 Slot 14'
Type            = PMB
ResourceDesc    = CAN0::0::1::14
DriverDll       = rspmb.dll
DriverPrefix    = rspmb
DriverOption    = 'Simulate=0,RangeCheck=1'
SFTDll          = sftmpmb.dll
SFTPrefix       = SFTMPMB

[device->PMB_15]
Description     = 'TS-PMB Module in Frame 1 Slot 15'
Type            = PMB
ResourceDesc    = CAN0::0::1::15
DriverDll       = rspmb.dll
DriverPrefix    = rspmb
DriverOption    = 'Simulate=0,RangeCheck=1'
SFTDll          = sftmpmb.dll
SFTPrefix       = SFTMPMB

[device->PSYS1_15]
Description     = 'TS-PSYS1 Module in Frame 1 Slot 15'
Type            = PSYS1
ResourceDesc    = CAN0::0::5::15
DriverDll       = rspsys.dll
DriverPrefix    = rspsys
DriverOption    = 'Simulate=0,RangeCheck=1'
SFTDll          = sftmpsys.dll
SFTPrefix       = SFTMPSYS

; The analog bus entry is mandatory if the GTSL Switch Manager or EGTSL is used
[device->ABUS]
Type            = AB
```

11.4.3 Front Connectors

Using the **<Tools><Front Connectors>** menu item, you can display the front connector X10 pin assignment for a module. The front connector panel is also accessible using the **<Utility><Display Front Connector>** menu item from the instrument panels, or by pressing the **<F10>** key.



	A	B	C
1	LABA1	GND	LABA2
2	LABB1	GND	LABB2
3	LABC1	GND	LABC2
4	LABD1	GND	LABD2
5			
6	CHA1_HI1	CHA1_HI2	CHA1_HI3
7	CHA1_LO1	CHA1_LO1	CHA1_LO1
8	CHA2_HI1	CHA2_HI2	CHA2_HI3
9	CHA2_LO1	CHA2_LO1	CHA2_LO1
10			
11	CHA3_HI1	CHA3_HI2	CHA3_HI3
12	CHA3_LO1	CHA3_LO1	CHA3_LO1
13	CHA4_HI1	CHA4_HI2	CHA4_HI3
14	CHA4_LO1	CHA4_LO1	CHA4_LO1
15			
16	CHB1_HI1	CHB1_HI2	CHB1_HI3
17	CHB1_LO1	CHB1_LO1	CHB1_LO1
18	CHB2_HI1	CHB2_HI2	CHB2_HI3
19	CHB2_LO1	CHB2_LO1	CHB2_LO1
20			
21	CHB3_HI1	CHB3_HI2	CHB3_HI3
22	CHB3_LO1	CHB3_LO1	CHB3_LO1
23	CHB4_HI1	CHB4_HI2	CHB4_HI3
24	CHB4_LO1	CHB4_LO1	CHB4_LO1
25			
26			
27			
28	GND	GND	GND
29	XTO1	GND	XTO2
30	XTI1	GND	XTI2
31	GND	GND	GND
32	GND	GND	CHA_GND

Figure 11-14: Front Connector X10