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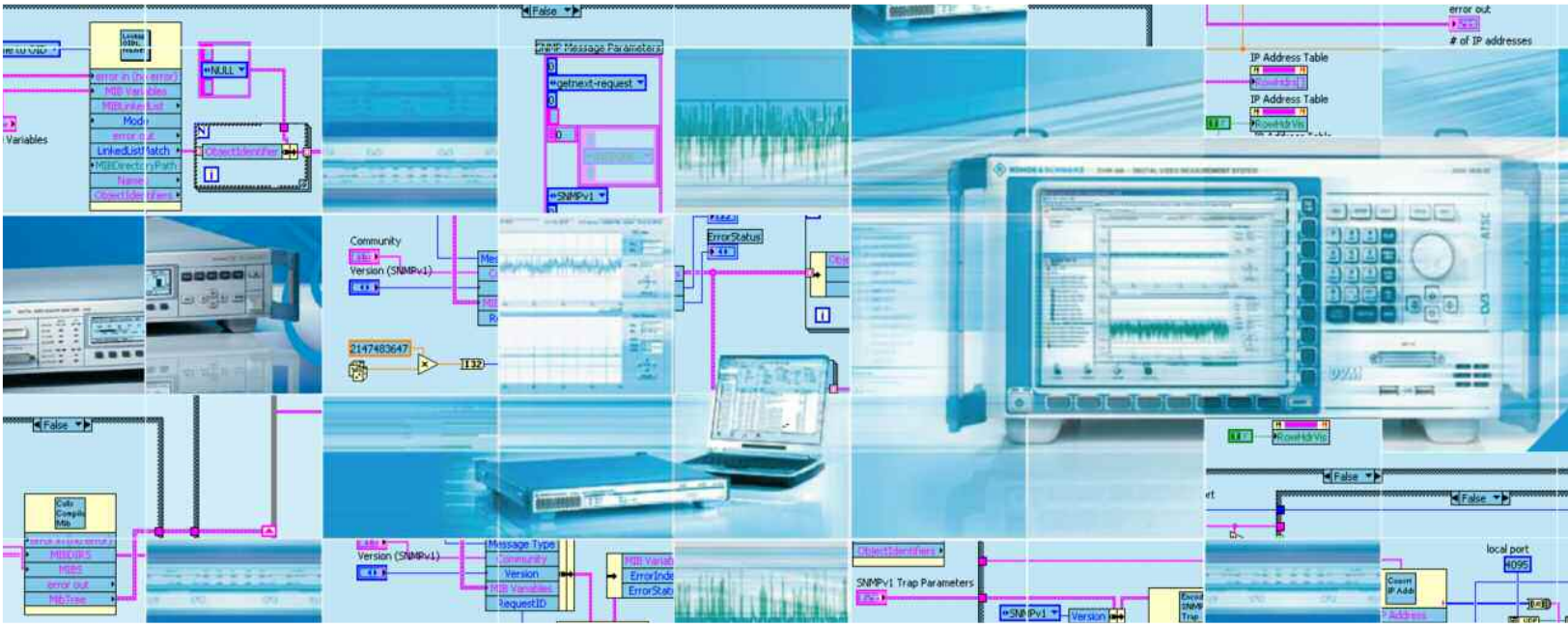

Products: R&S® DVM100/400 digital video measurement system ,
R&S® DVQ/DVQM digital video quality analyzer,R&S® ETX-T DTV monitoring receiver

LabVIEW™ SNMP Programming for the R&S®DVM, R&S®DVQ and R&S®ETX-T Made Easy With the Viodia™ SNMP Toolkit

Application Note

In the T&M world, instrument remote control over *SNMP* (*simple network management protocol)* lives in the shadow of *IEEE/GPIB (general purpose interface bus)* based remote control, and only a handful of the T&M equipment available worldwide supports the protocol. It is therefore no surprise that for most T&M engineers familiar with text-based commands over *IEEE/GPIB* (and lately LAN), the *SNMP* protocol seems a bit odd and to some even complex at first. The *SNMP Toolkit* for LabVIEW™ from *Viodia™ Inc*. can save a considerable amount of development time and furthermore helps programmers to overcome the initial complexities of *SNMP* programming.

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1 Introduction

The *simple network management protocol* found a loyal group of users in the broadcasting industry. In this world, the border between network operation and T&M equipment is often vague and it is therefore no surprise that broadcasting T&M instruments are often fitted with an *SNMP*-based remote control interface. Products that fall into this category are the *R&S®DVQ/DVQM digital video quality analyzers*, *R&S®DVM100/400 video measurement systems* and *R&S®ETX-T digital TV monitoring receivers.*

The *GPIB/IEEE* interface commonly used for remote control of T&M instruments has been around for a few decades now, and most T&M engineers are familiar with it. Unfortunately this cannot be said of *SNMP*. The unfamiliar, object-based nature of this protocol, together with the numeric variable addressing format, induce a certain degree of hesitance to use SNMP when confronted with it for the first time.

Contrary to the *GPIB/IEEE* protocol, which works with straightforward, text-based commands, commonly known as *standard commands for orogrammable instrumentation* or *SCPI, SNMP* uses an object-based approach with numeric identifiers to address variables. It also requires a certain familiarity with LAN terminology like UDP and IP.

To shorten the learning curve and simplify *SNMP* programming, *Viodia™ Inc.* developed a *LabVIEW™ Virtual Instrument* library named *SNMP Toolkit* that largely permits the T&M engineer to employ a black box approach, eliminating the need for a thorough understanding of LAN technology. In this application note we explain how to use the *SNMP Toolkit* for remote control of the *R&S®DVM100/400 video measurement systems.*

2 SNMP Terminology and Concepts

An elementary understanding of *SNMP*, *management information bases (MIBs)*, and *object identifiers (OIDs)* is required throughout this document. This application note does not have the intention to be yet another tutorial on *SNMP* programming, therefore for the newcomers to *SNMP* we would like to recommend:

- "*The Cuddletech Guide to SNMP Programming"* by Ben Rockwood.

This document explains everything a broadcasting or application engineer needs to know about *OIDs*, *MIBs,* and *SNMP* in general, without any unnecessary baggage. Some basics can also be found in the appendix as well as in:

- Application note 7BM65_1E *"Simple Network Management Protocol Remote Controlling for Monitoring Devices Basics, Tools, Examples, and Development Tips"* by Harald Gsoedl.
- Application note 7BM66_1E *"SNMP Example: DVM Management Center Monitoring in a Broadcast Network"* by Harald Gsoedl.

This document also requires reader familiarity with *LabVIEW™.* Tutorials for this programming environment and sample code are available from the manufacturer *National Instruments™.*

3 Programming Examples

3.1 Basic VIs

3.1.1 General

The *Viodia™ Inc. SNMP Toolkit* contains five elementary *Labview™* VIs which can be integrated into a larger VI in order to read and write data from and to the *R&S®DVM100/400* or any other instrument which supports *SNMP*. These five elementary VIs are:

- SNMPset-request: Writes values to the *R&S®DVM100/400* variables addressed by the passed OID.
- SNMPget-request: Returns the content of *R&S®DVM100/400* variables addressed by the passed OID.
- SNMPget-next-request: Returns the contents of an *R&S®DVM100/400* variable that's hierarchically next in line with the one previously addressed. Every time SNMPget-next-request is called the subsequent one is addressed.
- SNMPtrap: Reads the contents of a trap.
- Look-up OID, Names: Converts variable names defined inside MIBs located in the passed folder to OIDs and visa versa.

The *SNMP Toolkit* has additional VIs, like SNMPget-response, which are to be used in aich arM63 TD-0.002 Tc0.098 Tw228t0.0902 Tcw(w)9(hia- r)-7(a

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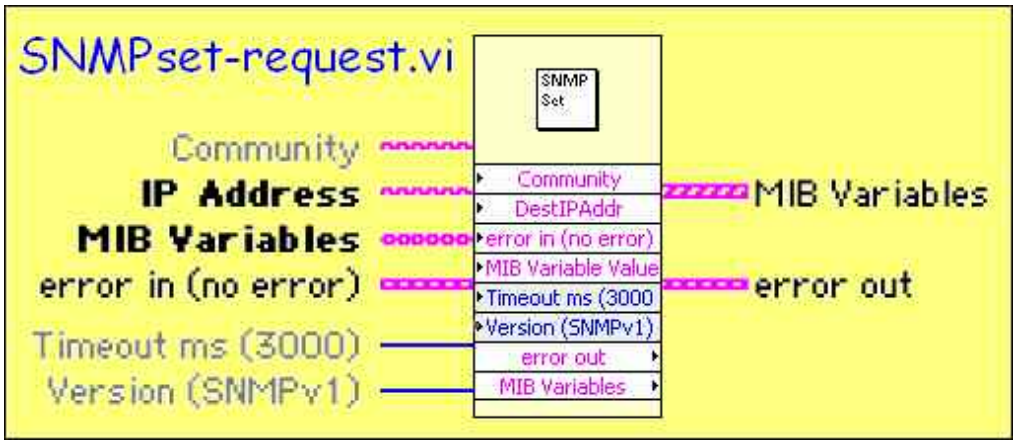

Fig. 1 SNMPset-request parameters

- Community: Communities can be thought of as user access levels. The *R&S®DVM100/400* recognizes two communities, *"public"* and *"management"*. Variables inside the *R&S®DVM100/400* which have write access belong to the *"management"* community. Therefore, pass a text string containing *"management"* to Community. The community names *"public"* and *"management"* are stored in the text file *snmpd.conf* located in *D:\usr\snmp\persist* and can be changed if required.

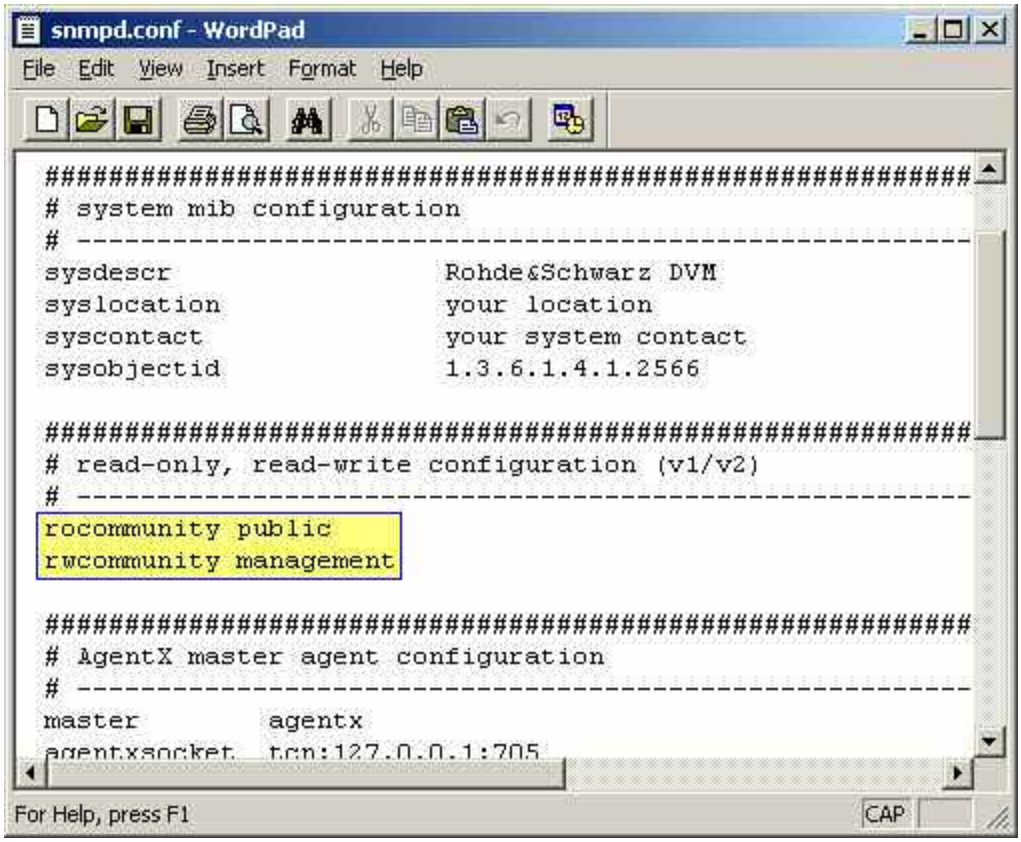

Fig. 2 Assigned community names in R&S®DVM's snmpd.conf file

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- IP Address: Note down the IP address setting in the Network Connections of the Windows OS on your *R&S®DVM100/400* and pass this as a text string to the IP Address parameter.

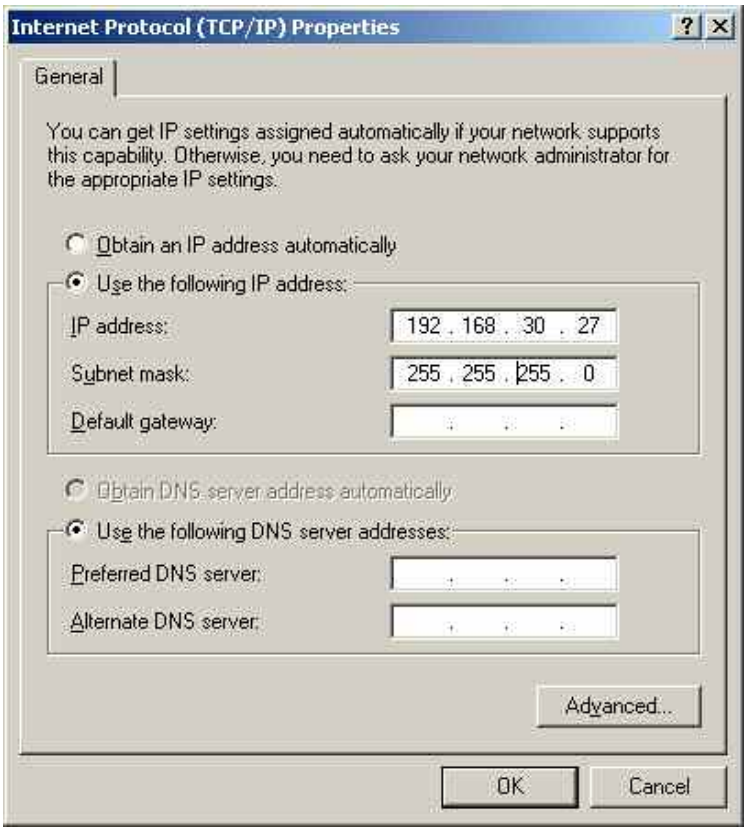

Fig. 3 IP address settings

The instrument has more than one LAN adapter. Make sure this is the IP address setting of the main network adapter instead of the local adapter used to communicate with the analyzer boards and *R&S®DVM120* extension units.

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- MIB variable values: SNMPset-request can write multiple variables in one single SNMPset-request call. To support this, the MIB variable values parameter represents an array of clusters. One single cluster contains the:
  - MibVariable: OID of the variable you want to write to; e.g., "1.3.6.1.4.1.2566.127.1.1.157.3.1.1.1.0." for the Sitename in the instrument. *LabVIEW™* type: string. This parameter also accepts the variable name associated with the OID when Look-up OIDs, Names has successfully initialized a resident MIB. See Look-up OIDs, Names.
  - Syntax: Variable type. Pass the enum from the table below that corresponds to the respective variable type. *LabVIEW™* type: U16 enum.

Items	Digital Display
INTEGER	0
OCTET STRING	1
OBJECT IDENTIFIER	2
IpAddress	3
Counter32	4
Counter64	5
Gauge32	6
TimeTicks	7
Opaque	8
NULL	9
noSuchObject exception	10
noSuchInstance exception	11
endOfMibView exception	12

Fig. 4 Enumerations of different SNMP variable types

  - Variable value: The variable value is passed as a string irrespective of the actual type addressed by the respective OID.

The full variable type is depicted in figure 4. Remember that the variable must be an array type. Single clusters are not accepted. To write single variables, fill out array element 0 only.

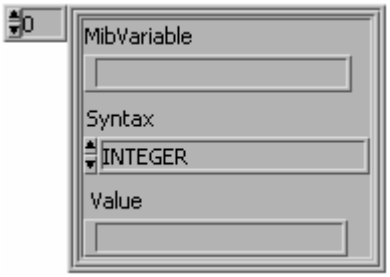

Fig. 5 Array of MIB variable values cluster

The number of variables is limited by the MTU.

- Time-out: Time-out value in milliseconds. SNMPset-request returns with error code 56 in Error-out when the operation could not be completed within the specified time. The default value is 3 seconds. Type: I32.

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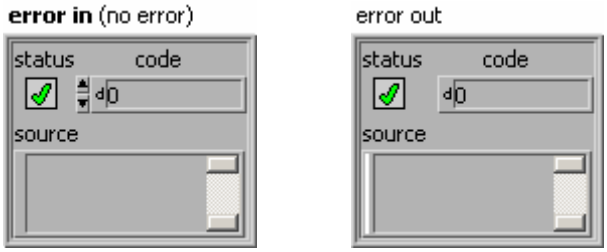
- Version: The *R&S®DVM100/400* supports *SNMP* version 1 and 2. Set this parameter to 1 (Version 2). Type: U16.
- Error-in: Connect this terminal to the error output of the preceding component. If SNMPset-request is the first one, connect it to a standard *LabVIEW™* Error-in cluster which is set to zero (No error).



- Error-out: Contains the error code when SNMPset-request reports an error. Pass this output to any subsequent functions, or if SNMPset-request is the last call, connect it to an Error-out cluster.

3.1.2.2 Sample Program

The sample code below sets the current site name at "My Site" (OID = 1.3.6.1.4.1.2566.127.1.1.157.3.1.1.1.0.) on an *R&S®DVM100/400* with IP address 168.198.30. 27. The time-out value is 3000 milliseconds.

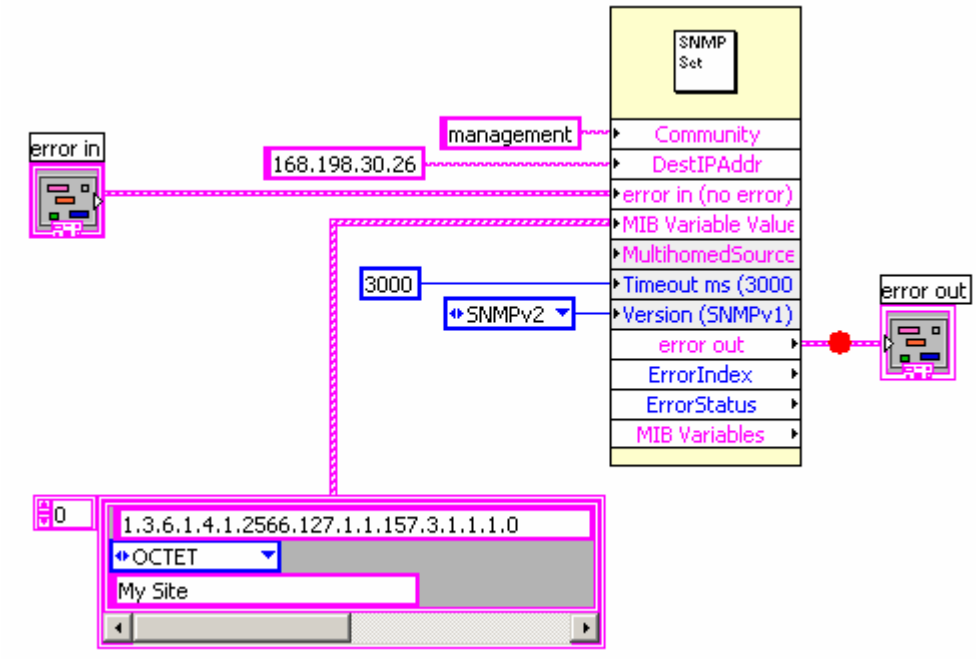


Fig. 6 SNMPset-request sample code

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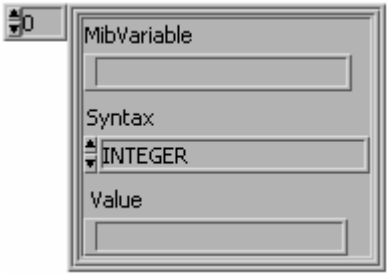
3.1.3 SNMPget-request

3.1.3.1 Parameter Description

The parameters of SNMPget-request are almost identical to the ones of SNMPset-request. The difference lies in the passing of the MIB variables parameter.

- MIB variables input: SNMPget-request only needs to know the OID(s) for a read operation. This parameter is therefore passed as an array of OIDs or variable name strings instead of cluster types containing OID, type, and value.
- MIB variables output: Identical to SNMPset-request. The returned values and types are passed back to the second and third fields of the cluster (Syntax and Value) of the MIB variables output parameter after successful completion of the operation.



- When reading the variable content with SNMPget-request, like in the example on the next page, use "Public". Read-only variables are members of the "Public" community.

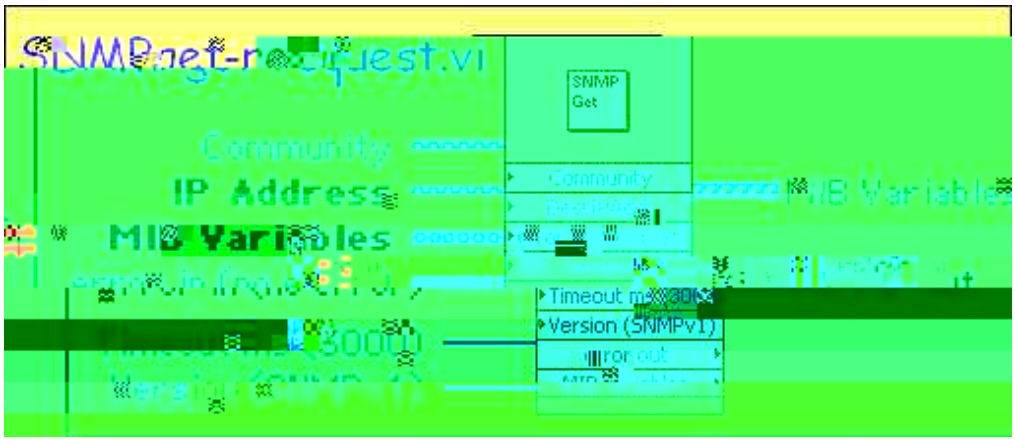


Fig. 7 SNMPget-request parameters

3.1.3.2 Sample Program

The sample code below reads:

- The Upper period limit setting of the PAT repetition in a Monitoring Configuration named "Config (DVB)".
- The Loss after packets limit of the TS Synchronization setting in the "Config (ATSC)".

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If Monitoring Configurations with such names are available in the instrument, the MIB Variables output parameter contains the requested values. Refer to the appendix to understand how the object identifiers
1.3.6.1.4.1.2566.127.1.1.157.3.1.3.3.1.3.67.111.110.102.105.103.32.40.68.86.66.41.1301 and
1.3.6.1.4.1.2566.127.1.1.157.3.1.3.3.1.3.67.111.110.102.105.103.32.40.65.84.83.67.41.1101 for
these variables are formed.

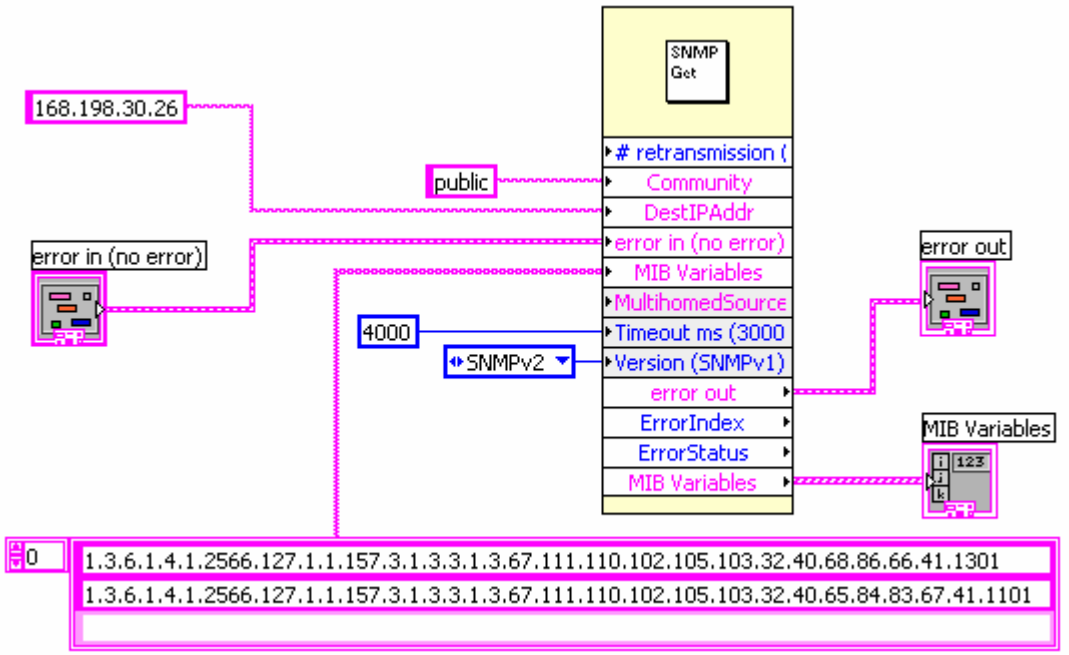

Fig. 8 SNMPget-request sample

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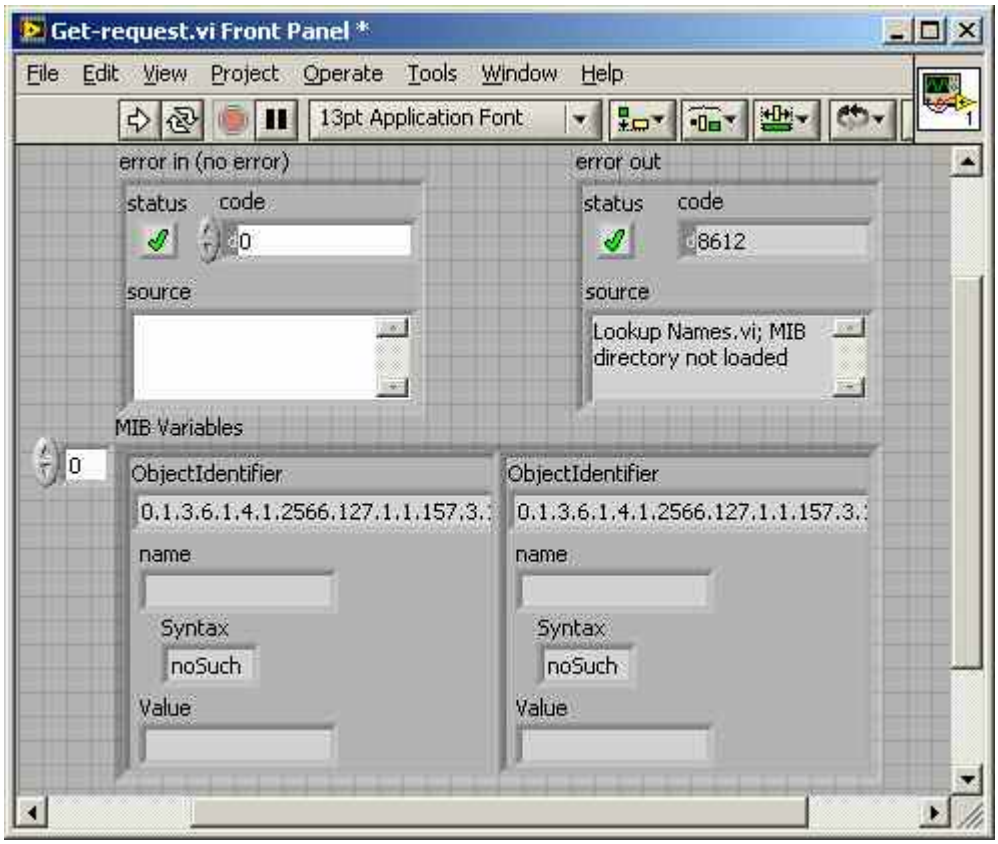

Fig. 9 The front panel of the sample code

3.1.4 SNMPget-next-request

3.1.4.1 Parameter Description

The number, types, and function of the parameters of SNMPget-next-request are identical to the ones of SNMPget-request. SNMPget-next-request returns the contents of an *R&S®DVM100/400* variable that's hierarchically next in line with the one previously addressed. Every time SNMPget-next-request is called the subsequent one is addressed.

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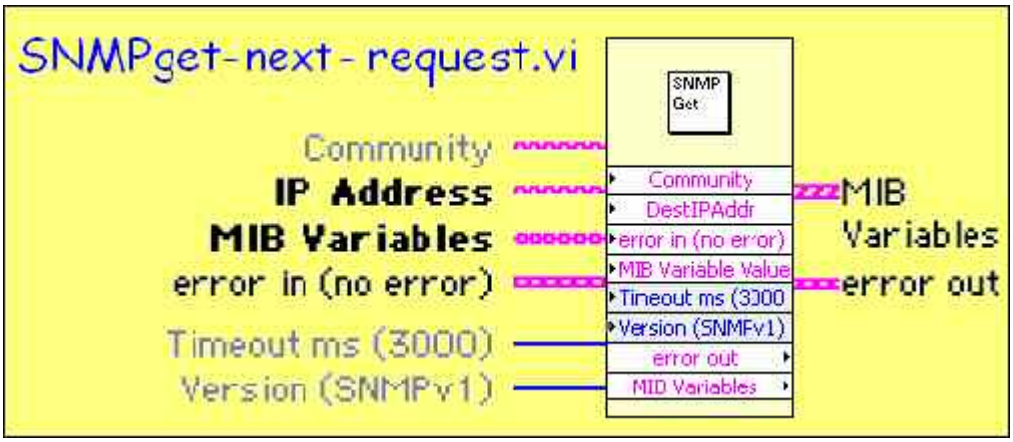

Fig. 10 SNMPget-next-request parameters

3.1.5 Look-Up OIDs, Names

3.1.5.1 Parameter Description

Look-up OIDs, Names converts the variable names passed via the MIB variables values input to OIDs. This allows the programmer to make use of variable names, which are easier to handle and far more readable than OIDs. SNMPget-request, SNMPget-next-request, and SNMPset-request call Look-up OIDs, Names internally. This means that there's no need for an additional external call anymore. It is however useful to understand its parameters and operation.

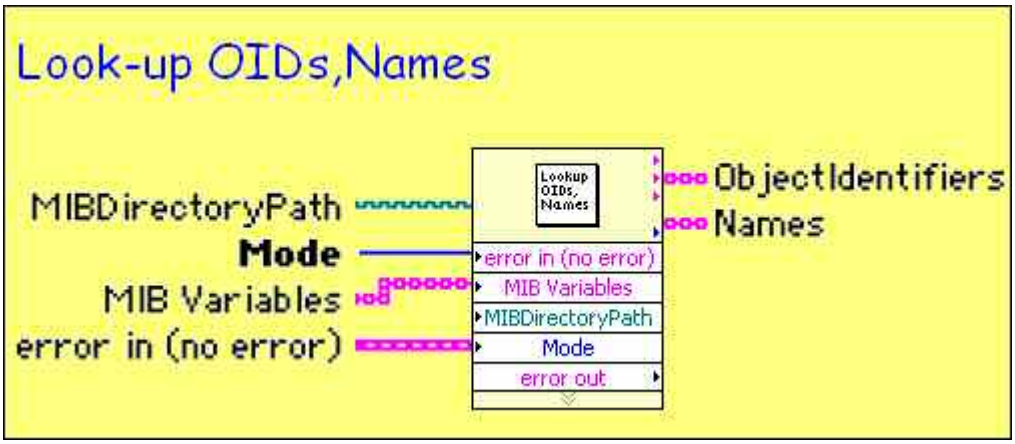

Fig. 11 Look-up OIDs, Names parameters

Look-up OIDs, Names makes use of the *UC Davis Open Source* MIB compiler to convert a variable name to an OID. This compiler comes in the form of DLLs included in the *SNMP Toolkit.* It therefore must have access to the RS-DVM-MIB.mi2 and RS-COMMON-MIB.mi2 files on the *R&S®DVM100/400.* These files contain all the instrument's variables and corresponding OIDs. Copy these files onto the computer that runs your

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LabVIEW™ program (manager) and rename them to RS-DVM-MIB.mib and RS-COMMON-MIB.mib. Renaming is necessary since the MIB compiler only recognizes MIBs with a *.MIB extension.

Variable names are never carried over the SNMP protocol. If the compiler for whatever reason is unable to perform a successful conversion, no OID is available at the output. If an OID is passed to Look-up OIDs, Names, no conversion takes place and the OID is passed directly to the ObjectIdentifiers output.

- Mode: Determines operational mode of Look-up OIDs, Names. There are 3 modes:
  1) Init: Initializes the *UC Davis Open Source* MIB compiler. Look-up OIDs, Names must be called at least once in this mode to compile the MIBs present in the MIBDirectoryPath prior to use in any of the two other modes.
  2) Name to OID: Converts the names in the MIB variables input to OIDs.
  3) OID to Name: Converts OIDs to the corresponding names in the MIB variables.
- MIBDirectoryPath: Pass the path variable C:\MIBS of the folder in which you have copied DVM-MIB.mib and RS-COMMON-MIB.mib. This folder must also contain the SNMPv2-SMI.mib, SNMPv2-TC.mib, and SNMPv2-TM.mib SNMP foundation included in the *SNMP Toolkit.*
- MIB variables: This parameter is a string array to support conversion of multiple variables in one single call.
- ObjectIdentifiers: Only applies to OID to Name mode. Array of strings containing the OIDs after successful conversion of the variable names. ObjectIdentifiers is an array of simple strings and can't be wired directly to the MIB variable input of SNMPget-request and other VIs. Use a conversion method like the following one to convert the simple array type to an array of clusters.

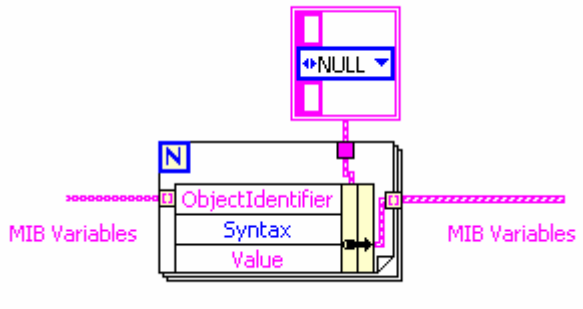

Fig. 12 MIB variable conversion

- Names: Array containing the names of the OIDs after successful Name to OID conversion.

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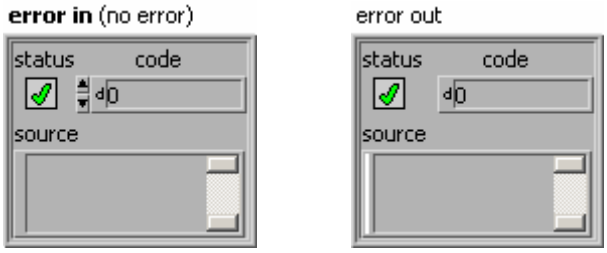
- Error-in: Connect this terminal to the error output of the preceding circuit. If Look-up OIDs, Names is the first one, connect it to the Error-in cluster which is set to zero (No error).



- Error-out: Contains the error code and index when Look-up OIDs, Names reports an error. Pass this output to any subsequent functions.

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3.1.5.2 Sample Code

The *LabVIEW™* sample code below converts the Sitename and Analyzer Serial Number (declared as "siteName" and "analyzerSerialNumber" inside the *R&S®DVM100/400* MIB DVM-MIB.mib) to their respective OIDs.

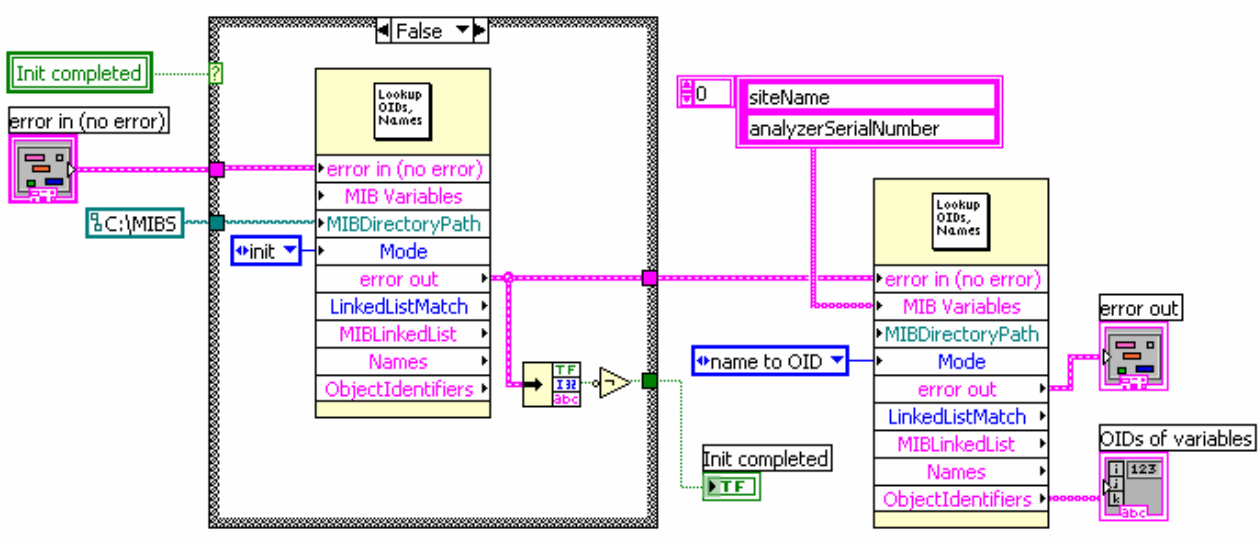

Fig. 13 LabVIEW™ code to convert variable name to OID

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4 Appendix: OID Formation of the Most Common R&S®DVM100/400 Variable Types

4.1 Simple Variables

Simple variables like the Sitename in the *R&S®DVM100/400* follow the general SNMP OID principles; i.e., the full OID is formed by appending the OIDs of the individual objects in the instrument's variable structure separated by periods.

Figure 14 The instrument's current site name *"Rohde & Schwarz"*

Example: Fig. 15 shows the hierarchical variable structure of the Sitename. Sitename is a member of site, preferences, rsDvmObjs, rsDvmMIB, ….

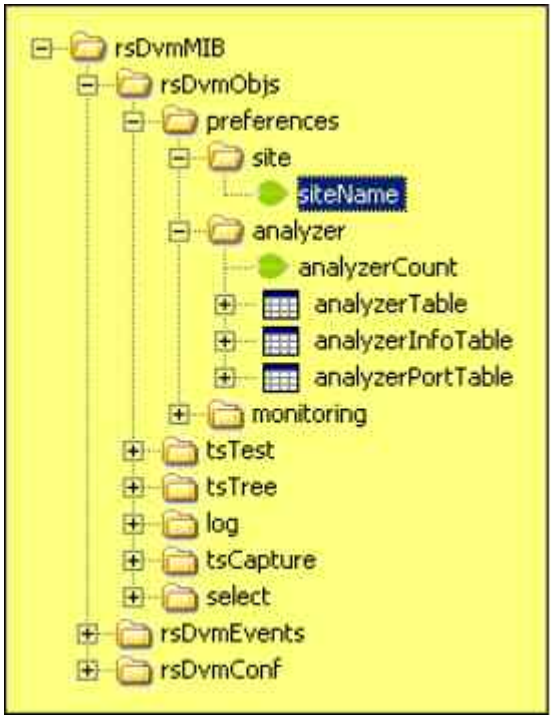

Fig. 15 Location of "Sitename" in the R&S®DVM100/400 variable structure

The individual OIDs of the objects are given in table 1 and can be found in the MIBs RS-DVM-MIB.mi2 and RS-COMMON-MIB.mi2, both of which are stored in the instrument. The contents can be observed with a MIB browser or plaintext editor.

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Table 1 OID of "Sitename"

Variable	OID
Rohde&Schwarz GmbH & Co.KG	2566
rsRoot (Rohde&Schwarz GmbH & Co.KG)	2566
rsProducts	127
rsProdBroadcast	1
rsProdBroadcastMeasurement	1
rsDvmMIB	157
rsDvmObjs	3
Preferences	1
Site	1
siteName	1

To assemble the full OID to access the Sitename, append all OIDs, separated by periods, in hierarchical order and terminate the string with a 0 trailer "1.3.6.1.4.1.2566.127.1.1.157.3.1.1.1.0". The final string can be passed to the MIB variables parameter of the respective VI as explained in the previous chapter. The full formation process is shown in figure 16.

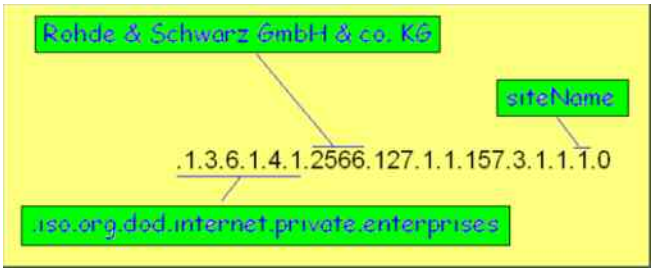

Fig. 16 OID formation process of simple variable

4.2 Monitoring Configuration Variables

The OID formation of Monitoring Configuration variables is more complex than that of simple variables.

A Monitoring Configuration allows logging and reporting of certain MPEG transport stream parameters that go beyond a predefined limit. A Monitoring Configuration includes configuration of these predefined limits, classification of the seriousness, disabling/enabling of reporting, and more. Multiple Monitoring Configurations can be saved under different names and recalled at a later stage.

- Manual control: From a user interface point of view, the parameters that are configurable in a Monitoring Configuration can be seen as a parameter or property of the actual MPEG transport stream parameter to be monitored. For example, the maximum limit or Upper Period, Class,

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etc., of the PAT (Program Association table), are all grouped under the same header PAT as shown in the figure below.

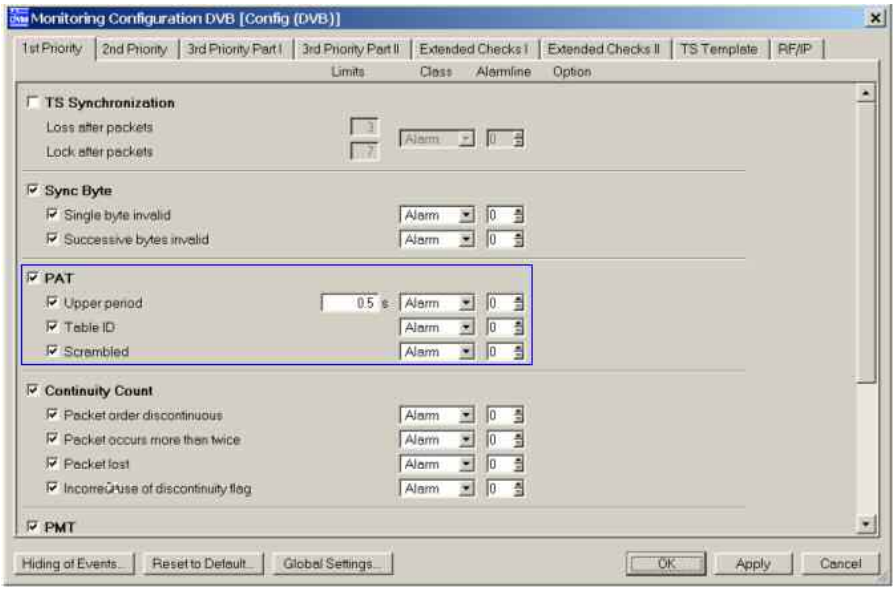

Fig. 17 R&S®DVM100/400 monitoring parameters settings from a user interface point of view

- Remote control: The situation is different from a remote control point of view. Here the parameter to be monitored (e.g., PAT) is a property of the Monitoring Configuration filename under which it is saved on disk. The filename of the Monitoring Configuration itself is a member of the actual variable (Upper Period, Class) that is to be accessed.

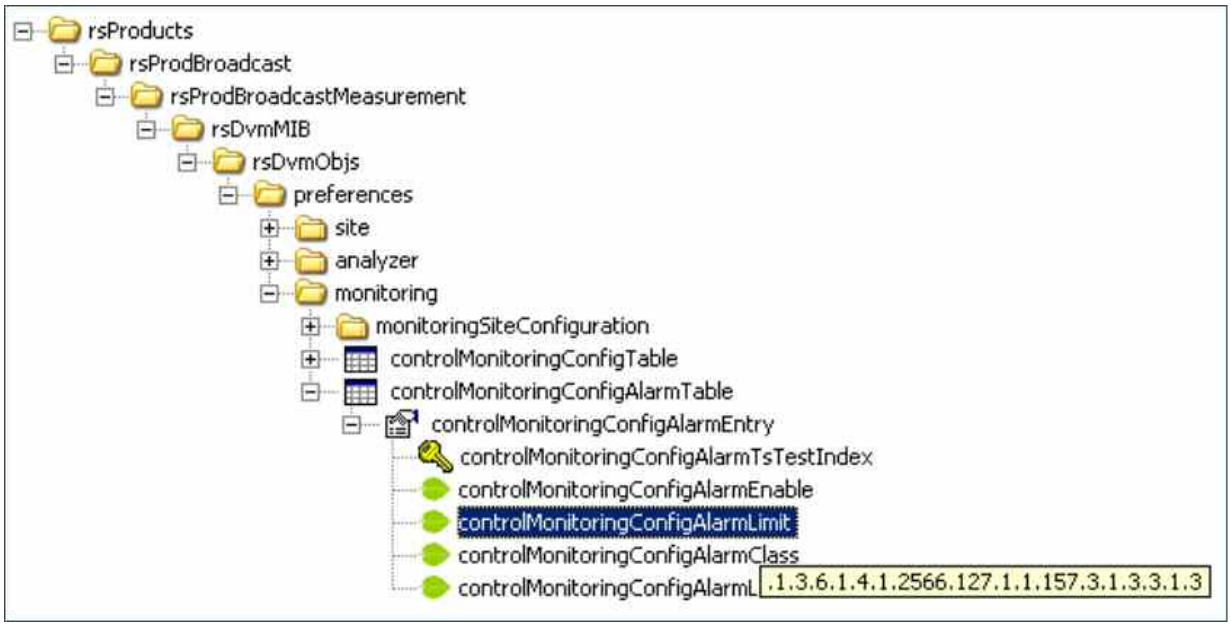

Fig. 18 Variable structure of monitoring configuration

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From a MIB point of view, a parameter Parameter to be monitored is an element of a two-dimensional array indexed as:

[Name monitoring configuration][Parameter to be monitored]

This array is defined in the MIB as controlMonitoringConfigAlarmTable. The matching row object defines controlMonitoringConfigName, which serves as a row index; i.e., for every Monitoring Configuration, there exists an instance or row element in the table. The Parameter to be monitored is addressed with the column index controlMonitoringConfigAlarmTsTestIndex via fixed enumerations defined in IndexTransportStreamTestConfig. A graphical representation of this concept is shown below.

This also means that the variable structure is dynamic and the number, length, and precise OID depend on the available Monitoring Configurations and names stored on disk.

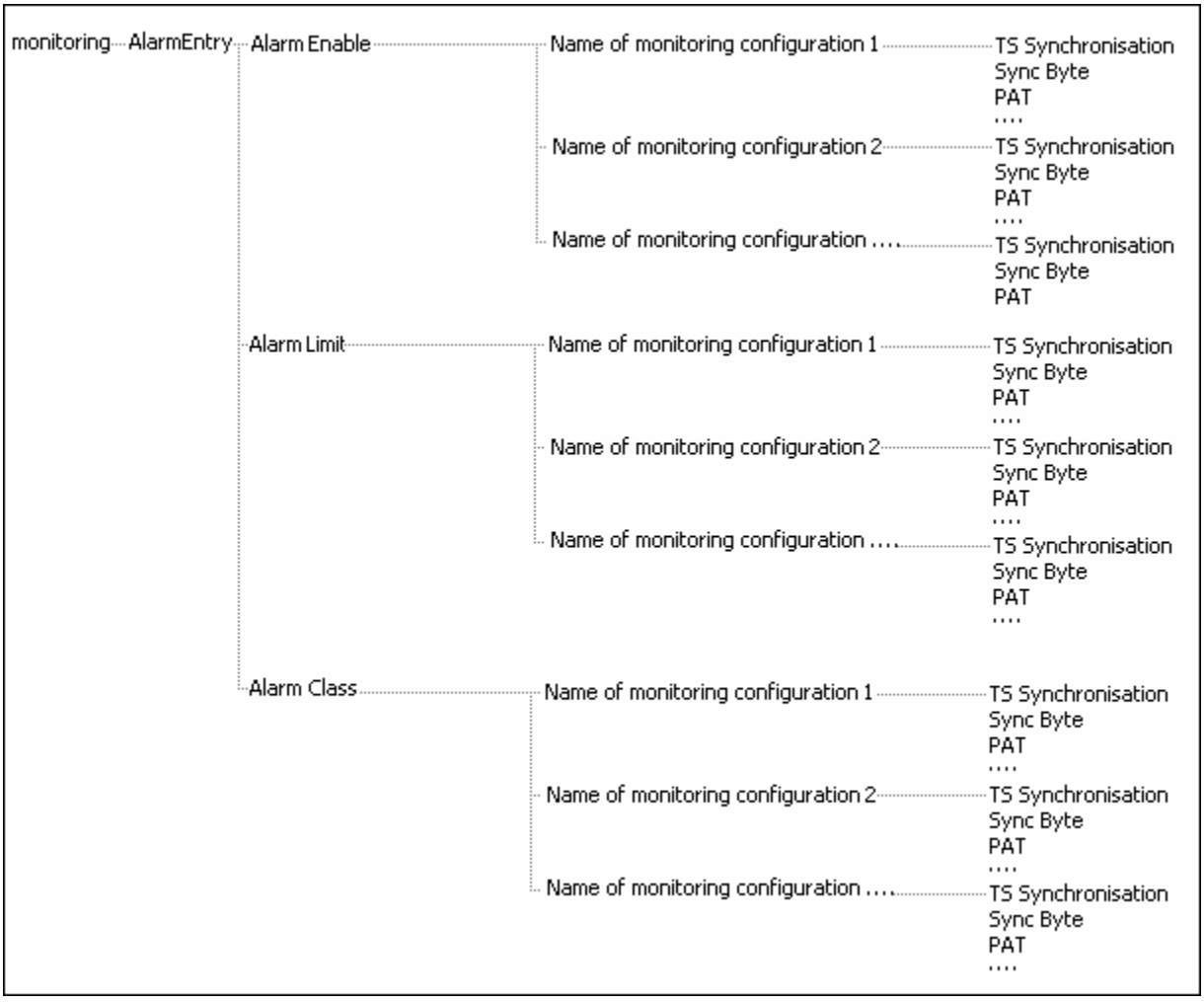

Fig. 19 R&S®DVM/100/400 monitoring parameters settings from a remote control point of view

When we bear the previous in mind, we can determine how to form an OID to access a particular Monitoring Configuration variable via SNMP remote control.

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Example: The TS Synchronization alarm determines after how many TS packets with a missing sync byte (0x47) a loss of synchronization is reported. The OID for the Loss After Packets setting of the TS Synchronization parameter is formed by appending the OID of tsSyncLoss (1101) (refer to the *R&S®DVM/100/400* manual) to the ASCII values (decimal) of the current Monitoring Configuration; e.g., Config (DVB).

Fig. 20 Loss after packets setting for TS Synchonization parameter

Since we are referring to the limit setting, this string is then appended to the OID of the controlMonitoringConfigAlarmLimit object. Figures 21 and 22 show the process in detail.

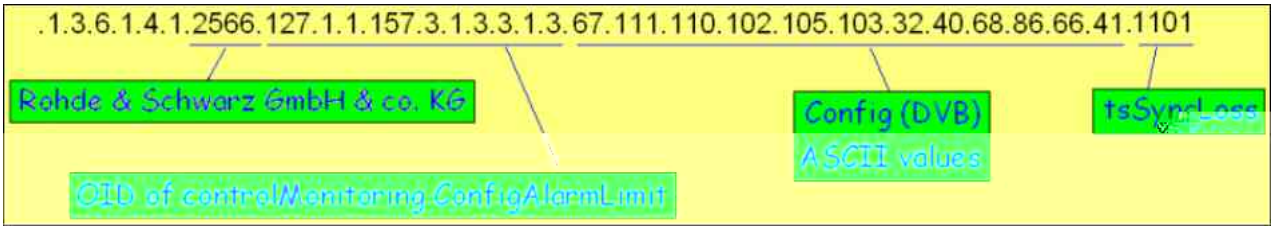

Fig. 21 OID formation process of a monitoring configuration variable

The process applies to all the parameters in the Monitoring Configuration.

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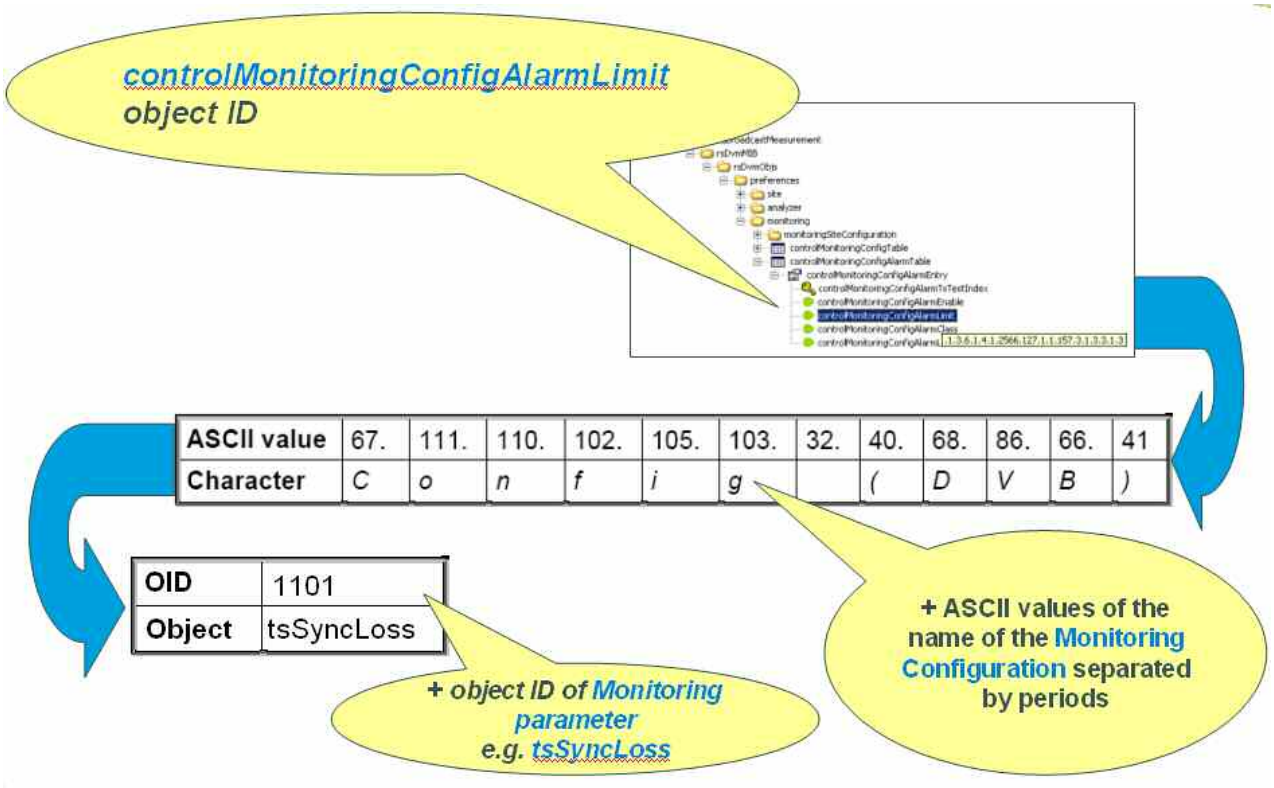

Fig. 22 OID formation process of a monitoring configuration variable

SNMPset-request and SNMPset-request return with an error when the OID is formed with ASCII codes of a non-existent Monitoring Configuration.

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4.3 Log Entries

If necessary, the Statistics & Log contents can be retrieved via SNMP. Just like the Monitoring Configuration, the Statistics & Log variable structure in the *R&S®DVM/100/400* is dynamic in nature.

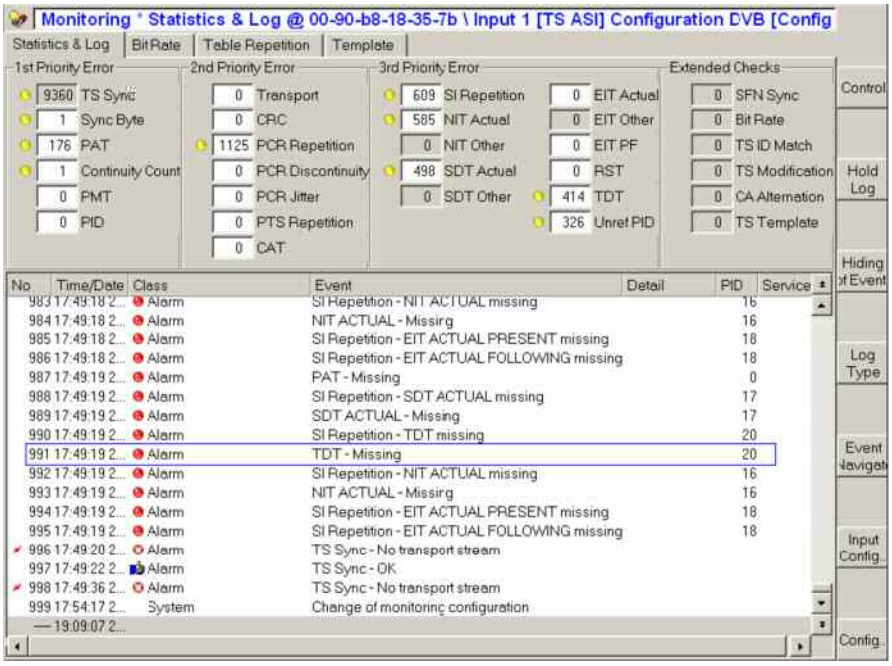

Fig. 23 Statistics & log content

From a remote control point of view, the different columns (Time, Class, Event, Detail, …) of one single line in a Statistics & Log entry are split up. In addition, entries are to be addressed line by line. For example, the full content of entry 991 “TDT missing” in Fig. 23 requires 7 SNMPset-request operations.

The OID is formed by appending the Log Sequence number, say the sequential order of entry (First column), to the analyzer input port (1, 2, 3, 4) to which the TS stream that generated the log is connected. This OID is then appended to the hexadecimal representation of the MAC address of the analyzer board on which the port resides, and subsequently to the OID of the actual parameter to be read (Time, Class, Event, Detail, …).

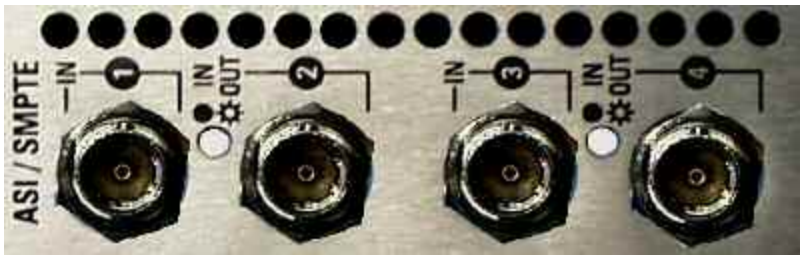

Fig. 24 Analyzer input port numbering

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The full formation process is depicted below.

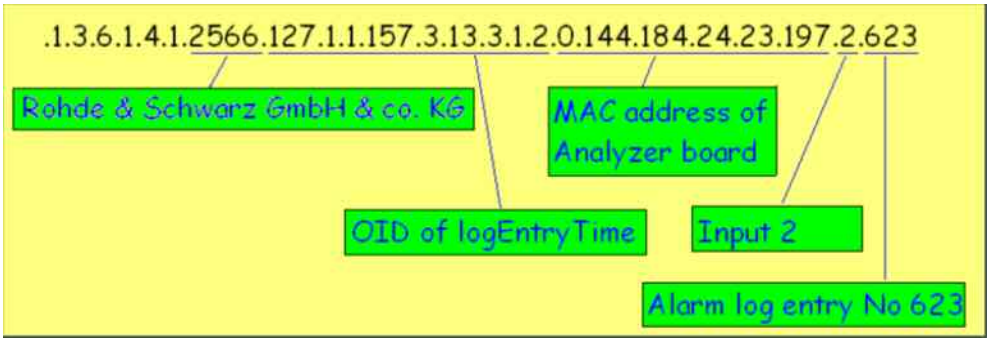

Fig. 25 OID formation process to access a log entry

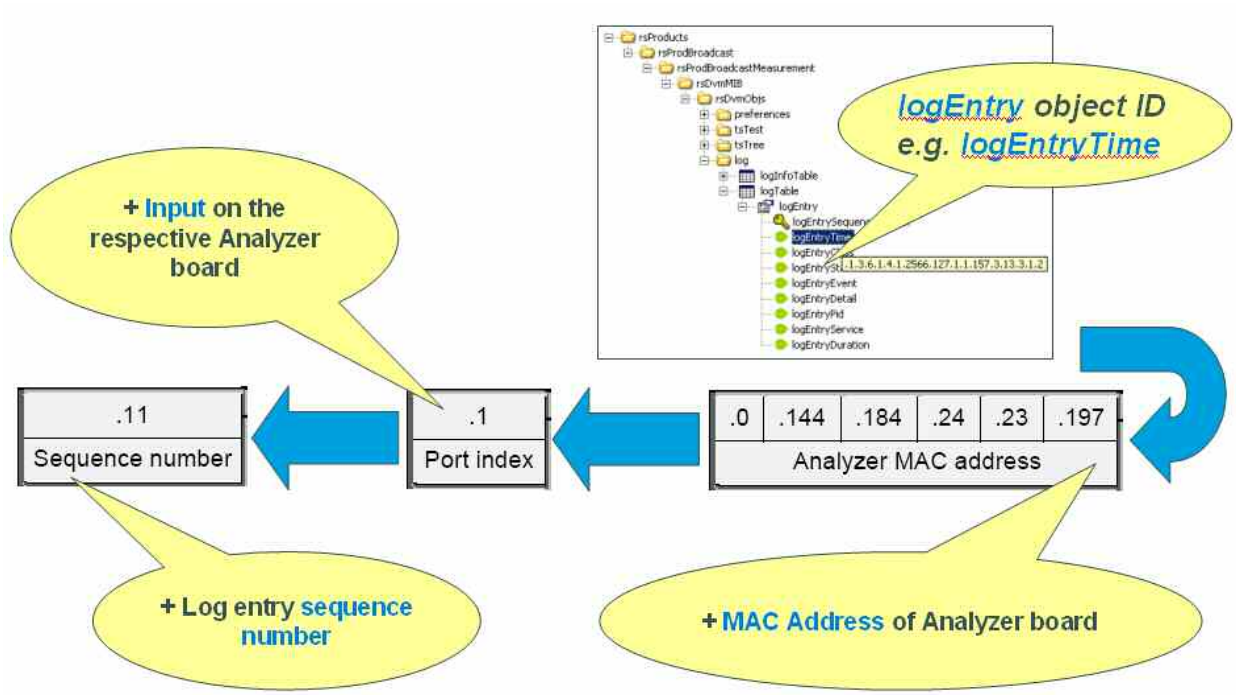

Fig. 26 OID formation process to access a log entry

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5 Summary

LabVIEW™ programming enthusiasts who want to control the *R&S®DVM100/400, DVQ, DVQM, ETX-T*, and other instruments which support SNMP from a host computer will find a great tool in the *Viodia® SNMP Toolkit.* It not only shortens the learning curve, and therefore development time, but also reduces the required network programming know-how to the essentials. This is beneficial, especially for the RF and broadcasting engineer who rarely deals with computer network technology.

6 Literature

User's manuals:

[1] "SNMP Toolkit for LabVIEW™", reference manual, version 2.01, August 2002, Chris Clark, Viodia Inc. and Steve Arendt, Sunrise LLC, Viodia Boulder, CO. www.viodia.com

[2] "LabVIEW™ V8.0 Help file" National Instruments™. www.ni.com

[3] "R&S®DVM Video Test System", operating manual, version 8.0 2110.2522.12–08, Rohde & Schwarz. www.rohde-schwarz.com

[4] "R&S®DVQ/DVQM Digital Video Quality Analyzer/ Multi-Channel Quality Analyzer", operating manual, version 3.0 Operating 2079.6003.03, Rohde & Schwarz. www.rohde-schwarz.com

Articles, books and application notes:

[5] "The Cuddletech Guide to SNMP Programming", Ben Rockwood, 17 November 2004.

[6] Application note 7BM65_1E *"Simple Network Management Protocol Remote Controlling for Monitoring Devices Basics, Tools, Examples, and Development Tips",* Rohde & Schwarz, H. Gsoedl.

[7] Application note 7BM66_1E *"SNMP Example: DVM Management Center Monitoring in a Broadcast Network"*, Rohde & Schwarz, H. Gsoedl.

7 Additional Information

Our application notes are regularly revised and updated. Check for any changes at http://www.rohde-schwarz.com.

Please send any comments or suggestions about this application note to Broadcasting-TM-Applications@rsd.rohde-schwarz.com

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8 Ordering Information

R&S®DVM family

Option		Number
DVM100	Description	2085.1600.03
DVM100L	MPEG2 Monitoring System	2112.7050.02
DVM120	MPEG2 Monitoring System	2085.1700.03
DVM-B1	MPEG Analysis Board	2085.3283.02
DVM-K1	TS-Monitoring	2085.5211.02
DVM-K2	TS-Capture	2085.5234.02
DVM-K10	In Depth Analysis	2085.5228.02
DVM-K11	Data Broadcast Analysis	2085.5311.02
DVM-K12	Template Monitoring	2085.5328.02
ZZA-111	Rack mount kit	1096.3254.00
DVM50	MPEG2 Monitoring System	2085.1900.03
DVM50-K10	In Depth Analysis	2085.5434.02
DVM400	Digital Video Measurement System	2085.1800.03
DVM400-B1	MPEG Analysis Board	2085.5505.02
DVM400-B2	TS Generator	2085.5511.02
DVM400-B3	Upgrade TS Generator TRP Recorder/Player	2085.5528.03
DVM400-B4	Upgrade TS Generator TRP Recorder/Player (214MBIT/S)	2085.5534.03
IP		
DVM400-B40	Gigabit Ethernet interface module	2085.5557.02
Decoder		
DVM-B30	Video and audio hardware decoder	2085.5570.02
DVM400-B30	Video and audio hardware decoder	2085.5540.02
DVM-K30	HD/SD-SDI output	2085.5440.02
DVM-K31	Video and audio monitoring	2085.5457.02
DVM-K32	HDTV decoding upgrade	2085.5486.02
RF		
DVM-B50	DVB-C, J83.A/C Receiver Module	2085.5605.02
DVM-B51	DVB-S/DVB-S2 Receiver Module	2085.5611.02
DVM-B52	DVB-T/H Receiver Module	2085.5628.02
DVM-K52	Second DVB-T/H receiver path	2085.5470.02
DVM-B500	RF carrier board	2085.5634.02
DVM-B520	RF carrier board	2085.5640.02
DVM400-B500	RF carrier board and decoder extension	2085.5563.02
Streams		
DV-HDTV	HDTV Sequences	2085.7650.02
DV-DVBH	DVB-H Stream Library	2085.8704.02
DV-H264	H.264 Stream Library	2085.9052.02
DV-TCM	Test Card M Streams	2085.7708.02
DV-ASC	Advanced Stream Combiner	2085.8804.02/03

R&S®ETX-T

Option		Number
ETX-T	DTV Monitoring Receiver	2068.0109.40
ETX-B2	MPEG2 Real Time Analysis w/o Decoder Output	2068.0415.02
ETX-B3	MPEG2 Real Time Analysis w/ Decoder Output	2068.0450.02
ETX-B11	6MHZ-Saw-Filter	2068.0421.02
ETX-B12	7MHZ-Saw-Filter	2068.0438.02
ETX-B13	8MHZ-Saw-Filter	2068.0444.02
ETX-K10	SFN Option	2068.0480.02
ETX-DCV	Documentation of ETX	2082.0490.28

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