020 TECHNICAL NOTE

# FAST AND EASY PROGRAMMING WITH THE IQS-500 INTELLIGENT TEST SYSTEM: PDL AS A FUNCTION OF WAVELENGTH

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## Introduction

### IQS-500: Built for Automation

EXFO knows that you are expecting a reliable and powerful solution that delivers a flexible environment in which it is easy to integrate a great variety of test instruments. That is why EXFO has developed its new IQS-500 Intelligent Test System with automation in mind.

You don't have to be a programming expert to automate a test station. Using the tools available from EXFO, you can easily develop basic software to control multiple instruments and build your own customized application.

This technical note is intended to help you in that task by giving a typical example of a Microsoft Visual Basic program, designed to control EXFO's tunable laser source and PDL meter in order to measure a component's polarization-dependent loss (PDL) as a function of wavelength. If you are interested in using the code or even only parts of the code, you can do so by downloading it from the following address: http://www.exfo.com/download/EXFO_PDL.zip

## Controlling EXFO's IQS Instruments Remotely

The intention of this technical note is certainly not to thoroughly explain any programming language, but rather to briefly introduce the reader to the process of remotely controlling our instruments by providing an example and a few tips. Of course, a lot of precious information can also be found in the IQS-500 Intelligent Test System user guide.

EXFO's test instruments can be controlled either locally, directly from the IQS-500P platform, via ActiveX, or remotely, via the following interfaces:

- GPIB (General Purpose Interface Bus), if the IQS-500 is equipped with the GPIB option
- Ethernet, TCP/IP, using ActiveX commands

Figure 1 presents a schematic representation of the possible avenues for instrument control. In this document, we will focus on a solution relying on COM objects (ActiveX communication standard).

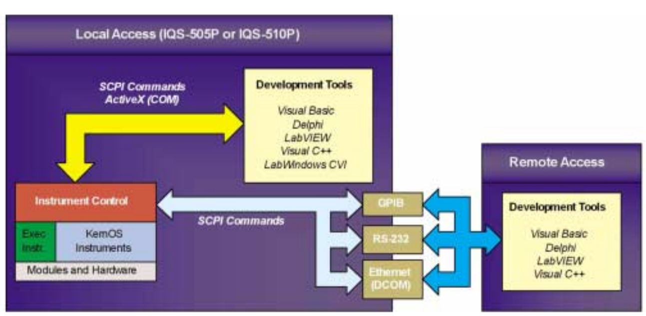



*Figure 1. Many ways to control EXFO's instruments*

## Working with EXFO's IcScpiAccess ActiveX Component

The IQS-500 Intelligent Test System provides objects based on the Microsoft® Component Object Model (COM). COM defines a common way to access and create software components and services, promoting the integration and the reuse of software components, as well as interoperability. In order to interoperate, components developed in different languages must adhere to a binary structure specified by Microsoft. OLE and ActiveX are based on COM. Also, programming languages such as C, C++, SmallTalk, Pascal, Ada, Java, Visual Basic® and LabVIEW can create and use COM components.

You can build your own programs using the provided properties, methods and events via the IcSCPIAccess interface.

In five easy steps, the communication parameters are set up directly from the IQS platform:

1. Turn on the IQS-500.
2. Launch the IQS Manager application.
3. From the Utilities tab of the IQS Manager application, set up the communication settings (see Figures 2 and 3).
4. Then, restart IQS Manager to initiate changes for ActiveX and Remote Operation.
5. Once this is done, we recommend launching the Instrument Control Monitoring application, which can also be accessed from the Utilities tab (see Figures 4a and 4b). This allows you to track commands, system responses, as well as error messages, all in real time.

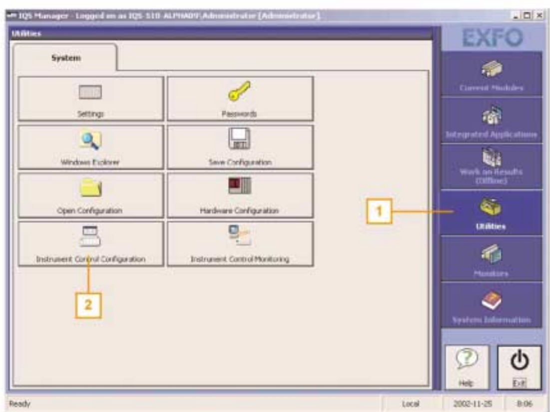



*Figure 2. From the Utilities tab in IQS Manager, click on the Instrument Control Configuration button*

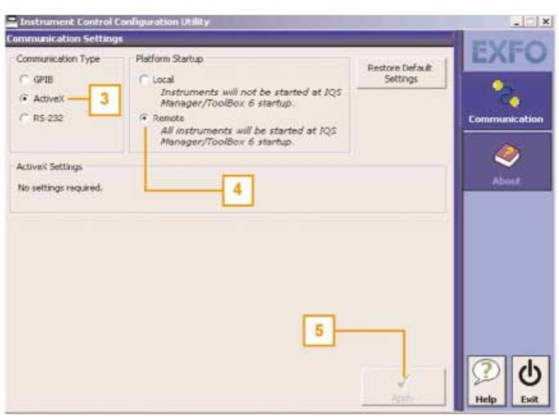



*Figure 3. Select the ActiveX Protocol and Remote Control options for any automated application*

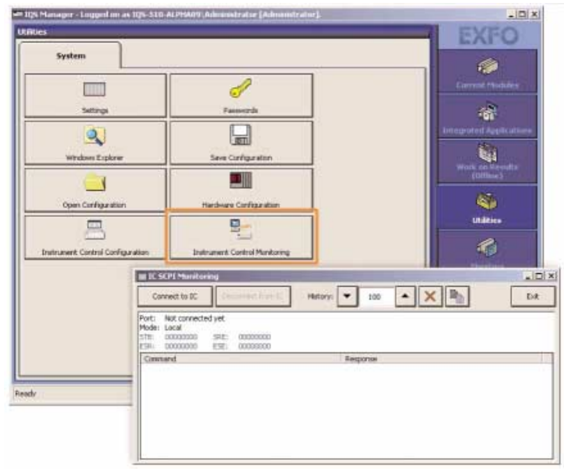



*Figure 4a. Opening the Instrument Control Monitoring window allows you to track commands, responses and error messages in real time*

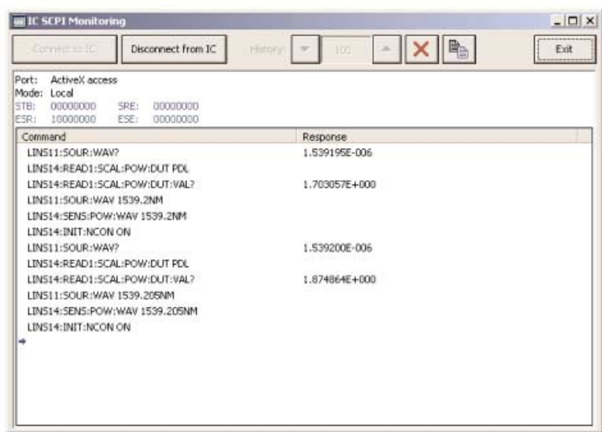



*Figure 4b. Instrument Control Monitoring window*

You are now ready to enter the programming phase.

## PDL Measurement as a Function of Wavelength

Although there are a few ways to measure the PDL of a component, things get a little trickier when characterizing this parameter as a function of wavelength. In this case, the PDL measurement has to be performed at all wavelengths of interest. Manual testing is not only time-consuming, but can also be potentially misleading since one might be tempted to reduce the number of measurements, thus adversely affecting the wavelength resolution of the results. To avoid the trade-off between lengthy multiple measurements and accuracy, EXFO has two solutions to propose:

- The first is the IQS-12004B DWDM Passive Component Test System, an integrated test system that automatically performs a Mueller Matrix calculation to very accurately determine PDL as a function of wavelength. EXFO has put a lot of effort into developing a software application that takes care of all the steps necessary to complete the characterization of a device (IL, ORL, PDL, bandwidth, central wavelength, etc.) as well as its associated reporting. Obviously, EXFO has done the integration work for you!

- The second solution implies the use of standard building blocks–tunable laser source (IQS-2600B), polarization scrambler (IQS-5100B) and PDL meter (IQS-3400B)–and the development of your own application to control these instruments. You can then measure PDL as a function of wavelength using the polarization states scrambling method. Writing your own program allows you to control the source, the polarization controller, the PDL meter, as well as the data acquisition and reporting.

If you opt for the second solution, you will be particularly interested in the example described below as it will help you eventually build your own test system.

## What You Need

### Computer and Software

You can either build your test station using the processor provided by EXFO in the IQS-500P platform or use an external computer to control the instruments. One possible configuration is described in Figure 5.

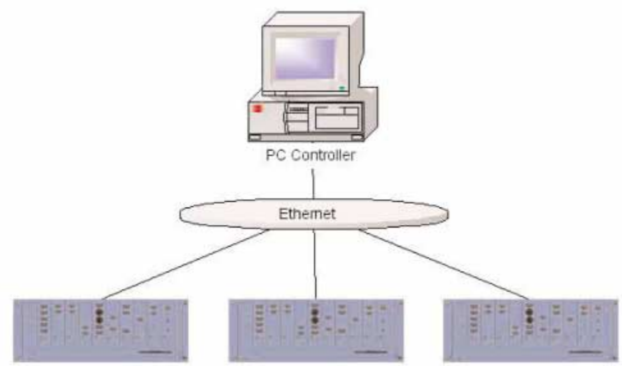



*Figure 5. Remote control of EXFO test stations over an Ethernet link*

## IQS-500P-Controlled Application

In order to control the application via the IQS-500 platform, you must select the platform option that includes a processor:

- IQS-505P Controller Unit (five modular slots and touchscreen) or an IQS-510P (ten modular slots, no screen), both including as standard features Ethernet, GPIB and RS-232 connectors for remote-control operation. A monitor, as well as a keyboard and a mouse, can always be plugged into the IQS-505P or -510P.
- Microsoft Visual Basic 6.0 development environment, installed in the IQS-500 platform or on your own PC (although, as mentioned previously, you will have to run the executable compiled program on the IQS-500P unit.)

### Computer-Controlled Application

The minimal computer characteristics recommended by EXFO are as follows:

- Pentium II 333 MHz or better
- 256 MB RAM memory or better
- Microsoft Visual Basic 6.0 software installed on the computer
- Controller or expansion unit to house the test instruments: IQS-505P, IQS-510P or IQS-510E (“05” stands for five-slot unit, “10” for ten-slot unit, “P” stands for processor, and the “E” stands for expansion unit, without processor)

**Instruments for PDL Measurement**

EXFO proposes the use of the following instruments:

- **IQS-2600B TUNABLE LASER SOURCE**. This source is designed for testing dense WDM components in the C- and L-band ranges. With a 1 pm resolution and an impressive signal-to-spontaneous-emission ratio (SSER) of 75 dB, this source is optimized for passive component testing.
- **IQS-5100B POLARIZATION SCRAMBLER**. In seconds, the polarization scrambler covers all possible states of polarization for any measurement application requiring a varying state of polarization. This makes the IQS-5100B ideal for measuring the polarization-dependent loss (PDL) of WDM and passive components.
- **IQS-3400B PDL/OL METER**. This power meter is optimized for PDL measurement with a range comprised between 0.010 dB and 30 dB.

Figure 6 presents the instruments and the IQS platform. With this complete setup, you are ready to begin the programming phase.


*Figure 6. Test station comprising the IQS-505P platform, the IQS-2600B Tunable Laser Source, the IQS-5100B Polarization Scrambler and the IQS-3400B PDL/OL Meter*

## A Visual Basic Application

Visual Basic is a very commonly used programming environment, mostly because it is simple to use and ensures fast development. Reusing the following sample program (or even parts of it) can only make development time faster. The basic structure of a program is as follows:

- A reference to the EXFO IcSCPIActiveX Type Library (see Figure 7)
- A member variable declared “WithEvents” (Code 1)
- An initialization routine (Code 2)
- The main code (Code 3)
- An object release action (optional, Code 4)

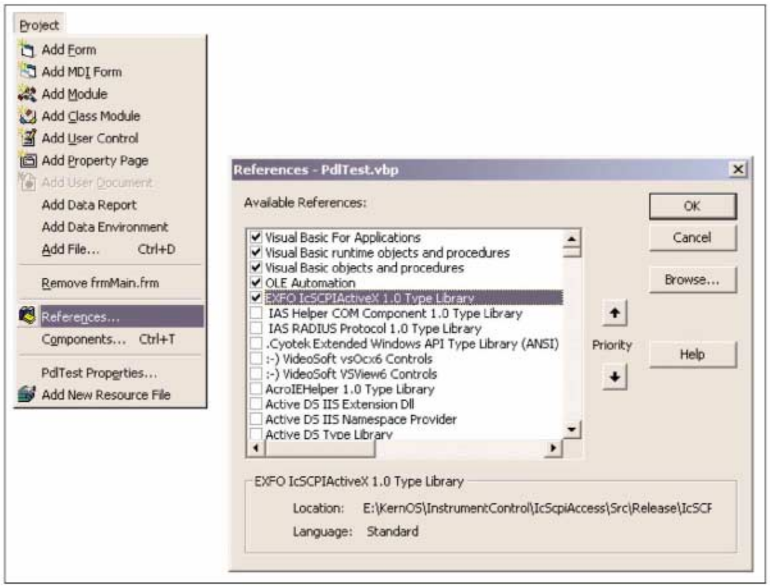



*Figure 7. In the Visual Basic IDE, select the "References" item from the "Project" menu, then locate and check the "EXFO IcSCPIActiveX 1.0 Type Library" item*

**Understanding the Source Code**

*Code 1 Section: Defining a Variable*

The Code 1 section shows how to define a member variable that can respond to the events generated by the IcSCPIActiveX component. A Sleep API function declaration is also needed in the main application code.

```
Option Explicit

' Object used to communicate with the instruments using SCPI commands.
Private WithEvents m_oScpi As IcSCPIActiveX.IcSCPIAccess

' Windows API functions declaration
Private Declare Sub Sleep Lib "kernel32" (ByVal dwMilliseconds As Long)

Private Type MODULEPOSITION
    UnitNumber As Long
    SlotNumber As Long
End Type

Private m_lIQS2600B As MODULEPOSITION
Private m_lIQS5100B As MODULEPOSITION
Private m_lIQS3400B As MODULEPOSITION

Private m_bTimerDone As Boolean
Private m_bTestStopped As Boolean
```

*Code 2 Section: Initialization*

The Code 2 section describes how the member variable is created (using either the “Set ... = New ...” or the “CreateObject” method). Then, the initialization method is called, passing a timeout value parameter. Before the initialization takes place, some controls are disabled to avoid any user manipulation error. Once the initialization is complete, most of the controls can be enabled and the initialization controls must be locked to avoid an undesired call to the initialization routine.

```
'-------------------------------------------------------------------
' Initialization of the SCPI component and enabling of the application
' controls.
'-------------------------------------------------------------------

Private Sub cmdInit_Click()

    On Error GoTo errHandler

    Set m_oScpi = New IcSCPIActiveX.IcSCPIAccess

    'To link this program to a remote IQS-500 via DCOM, use the command below
    'instead of the previous command,
    'and replace the IP address with that of the remote station.

    'Set m_oScpi = CreateObject("Exfo.IcSCPIActiveX.IcSCPIAccess", "192.34.26.12")

    m_oScpi.Initialize 100000

    '------------------------------
    'Initialize the module position.
    '------------------------------
    '--> IQS-2600B
    m_lIQS2600B.UnitNumber = CLng(cboUnit(0).Text)
    m_lIQS2600B.SlotNumber = CLng(cboSlot(0).Text)
    '--> IQS-5100B
    m_lIQS5100B.UnitNumber = CLng(cboUnit(1).Text)
    m_lIQS5100B.SlotNumber = CLng(cboSlot(1).Text)
    '--> IQS-3400B
    m_lIQS3400B.UnitNumber = CLng(cboUnit(2).Text)
    m_lIQS3400B.SlotNumber = CLng(cboSlot(2).Text)

    EnableAllControlsExceptInit

    Exit Sub

errHandler:
    MsgBox Err.Description, vbCritical, App.Title

End Sub
'-------------------------------------------------------------------
' Set each control's "Enabled" property to the required value, to allow
' the user to perform a test.
'-------------------------------------------------------------------
Private Sub EnableAllControlsExceptInit()
(...)
End Sub
```

*Code 3 Section: Main Application*

The function of the Main Application section is to perform the wavelength-scanning PDL measurement by applying the selections made by the user in the Wavelength Setup and Measurement Setup portion of the program interface. The program either directs a single PDL measurement at 1550 nm or a range of PDL measurements bounded by the spectral range selected (C, L, C+L or user-defined) and the selected measurement resolution (5, 10, 50, 100 pm). The PDL measurement precision is dependent upon the magnitude of the PDL of the device being measured; the Average Time setting of 2.5 seconds is the normal measurement time for PDL measurements (see page 106 of the IQS-3400B user guide for details on the PDL measurement precision). Details regarding this section of the application code have been greatly abridged; however, the VB program can be accessed directly from EXFO's website.

Two routines in particular may be very useful if you attempt to run the program on a PC that does not have the "." as a decimal separator (often "," in Europe). Those functions (FromRegOptionDecToUS, FromUSDecToRegOptionDec) will replace the "." with the proper decimal separator, as defined in the Regional Options of the PC or the IQS-500P unit.

In Appendix 1, you will find a table identifying the controls defined in this application.

```
'----------------------------------------------------------------------
' Convert a string containing a fractional value which uses the
' Regional Option number format (like a ",") for its decimal separator
' to the US format (.)
' Ex.: 2,54 (French Canada) --> 2.54
'----------------------------------------------------------------------

Public Function FromRegOptionDecToUS(ByVal sRegionalizedValue As String) As String
    Dim sSep As String
    Dim lPos As String

    'Determine the regional oprion decimal separator
    sSep = Mid$(Format$(1.1, "0.0"), 2, 1)

    'Locate it in the string
    lPos = InStr(1, sRegionalizedValue, sSep)

    'Found!
    If lPos > 0 Then
        FromRegOptionDecToUS = Replace(sRegionalizedValue, sSep, ".")
    Else
        FromRegOptionDecToUS = sRegionalizedValue
    End If

End Function

'----------------------------------------------------------------------
' Convert a US number formatted string value to a regionalized format.
' Ex.: 2.54 --> 2,54 (in French Canada)
'----------------------------------------------------------------------

Public Function FromUSDecToRegOptionDec(ByVal sDotSepValue As String) As String
    Dim sSep As String
    Dim lPos As String

'Determine the regional oprion decimal separator
sSep = Mid$(Format$(1.1, "0.0"), 2, 1)
```

```
     'Locate the point in the string
     lPos = InStr(1, sDotSepValue, ".")

     'Found!
     If lPos > 0 Then
          FromUSDecToRegOptionDec = Replace(sDotSepValue, ".", sSep)
     Else
          FromUSDecToRegOptionDec = sDotSepValue
     End If

End Function
```

*Code 4 Section: Releasing the Object Before Quitting the Application (good practice)*

```
Private Sub Form_QueryUnload(Cancel As Integer, UnloadMode As Integer)
     'Release the SCPI ActiveX object.
     Set m_oScpi = Nothing
End Sub
```

## Results

In order to demonstrate and, in turn, help you appreciate the possibilities of this program, we measured the PDL of a multiplexer channel using both this VB application and EXFO's integrated test system (IQS-12004B).

Using the VB application is fairly simple and each step can be completed directly from the user interface (see Figure 8 below). First, the selected modules are initialized (it is important to remember to do this before performing any test). Then, the test conditions are selected (wavelength setup, measurement setup), and the source and IQS-5100B are turned on. Data acquisition can be started once the process is initiated, there is no need to intervene in the data acquisition process. The measurements are written in the main interface window and can be copied onto an Excel spreadsheet.

In our example, we selected a user-defined wavelength range (1541 to 1545 nm), a standard scan period and measurement time of 2.5 seconds (see IQS-5100B user guide for more information on polarization scrambler settings) and a resolution of 5 pm. Data acquisition is complete in a little over 30 minutes.

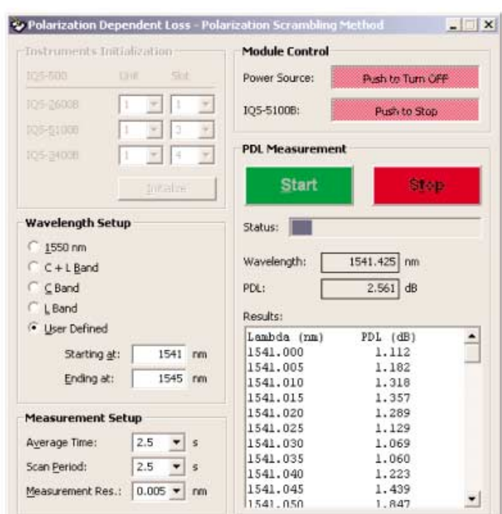



*Figure 8. The application's user interface*

The same measurements were performed with the IQS-12004B, with the same 5 pm resolution, all within one minute. The superposed results are presented in Figure 9.

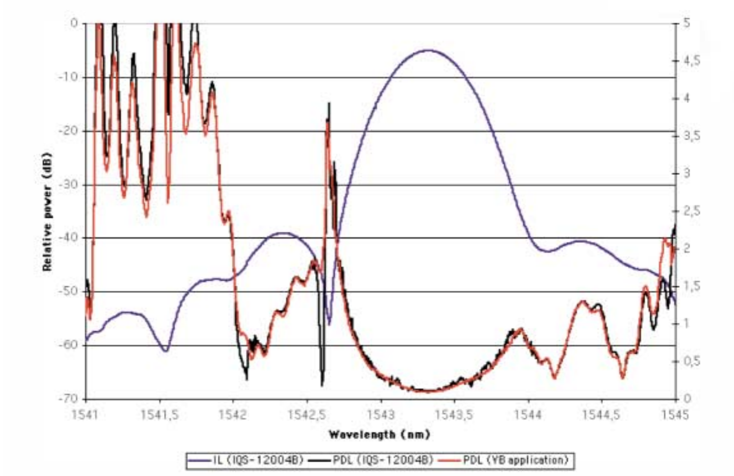



*Figure 9. Superposed results of PDL measurements of a MUX channel taken with two instruments; smoother curve (in red) was the result of measurement taken using VB application*

The results from both test systems do compare extremely well. There is, nevertheless, a slight smoothness difference between the two PDL curves. This difference is due to the fact that one is a step-and-measure system (tunable source + polarization scrambler + PDL meter), while the other is a swept-wavelength system (IQS-12004B). For this system, the tuning speed of the source not being perfectly linear, any tiny discrepancy from a perfect speed generates some discrepancies in the measurement. This is mostly apparent in areas where PDL varies sharply as a function of wavelength. The step-and-measure system provides more accurate results overall.

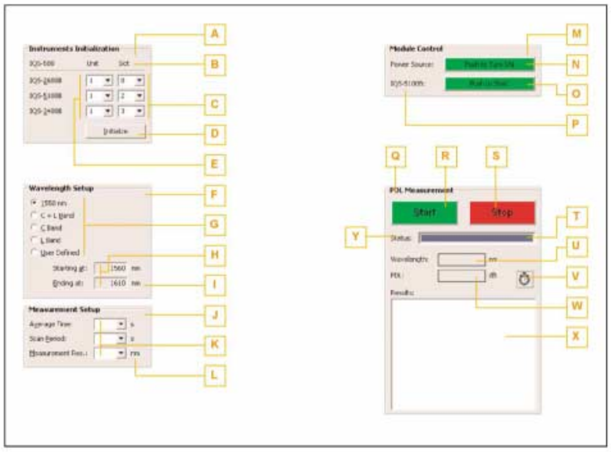
## Conclusion

Over the years, EXFO has developed a complete line of test instruments that are designed to work together and help you achieve the most efficient test stations. Now, with the IQS-500 Intelligent Test System, we also provide an easy-to-control system using any development environment.

This simple example illustrates how you can automatically perform some repetitive tasks to accurately measure the PDL of a component. Integrated test systems are extremely efficient tools, especially in a production environment where time is of prime value. But in a development environment, where you don't depend so much on time and productivity, a custom test system can be a valuable option. The choice is yours!

# Appendix

## Definition of Controls Used in the Application




### Controls as Defined in the Sample Application

| ID | Control Type | Property | Value |
|---|---|---|---|
| A | Frame | Name | fraInit |
| | | Caption | "Instruments Initialization" |
| B | Label | Name | lblInit |
| | (6 times) | Index | 0, 1, 2, 3, 4, 5 |
| | | Caption | 0 ="IQS-500", 1 ="Unit", 2 ="Slot", 3 ="IQS-2600B", 4 ="IQS-5100B", 5 ="IQS-3400B" |
| C | Dropdown Combo | Name | cboSlot |
| | (3 times) | Index | 0, 1, 2 |
| | | List | Each item has values from 0 to 9 in their "List" properties |
| D | CommandButton | Name | cmdInit |
| | | Caption | "Initialize" |
| E | Dropdown Combo | Name | cboUnit |
| | (3 times) | Index | 0, 1, 2 |
| | | List | Each item has values from 0 to 9 in their "List" properties |
| F | Frame | Name | fraWL |
| | | Caption | "Wavelength Setup" |
| G | OptionButton | Name | optWavelength |
| | (5 times) | Index | 0, 1, 2, 3, 4 |
| | | Caption | 0 ="1550 nm", 1 ="C + L Band", 2 ="C Band", 3 ="L Band", 4 ="User Defined" |
| H | TextBox | Name | txtUserWl |
| | (2 times) | Index | 0, 1 (0 is the starting value, 1 is the ending value) |
| I | Label | Name | lblWl |
| | (4 times) | Index | 0, 1, 2, 3 |
| | | Caption | 0 ="Starting at:", 1 ="nm", 2 ="Ending at:", 3 ="nm" |
| J | Frame | Name | fraMeas |
| | | Caption | "Measurement Setup" |
| K | Dropdown Combo | Name | cboMeas |
| | (3 times) | Index | 0, 1, 2 (0 is the Average Time value, and so on.) |
| L | Labels | Name | lblWl |
| | (6 times) | Index | 4, 5, 6, 7, 8, 9 |
| | | Caption | 4 ="Average Time:", 5 ="s", 6 ="Scan Period:", 7 ="s", 8 ="Measurement Res.:", 9 ="nm" |

| ID | Control Type | Property | Value |
|---|---|---|---|
| M | Frame | Name | fraCtrl |
| | | Caption | "Module Control" |
| N | CheckBox | Name | chkPower |
| | | Caption | "Push to Turn ON" |
| | | Style | 1-Graphical |
| | | BackColor | &H0000FF00& |
| O | CheckBox | Name | chk5100B |
| | | Caption | "Push to Start" |
| | | Style | 1-Graphical |
| | | BackColor | &H0000FF00& |
| P | Label (2 times) | Name | lblWl |
| | | Index | 10, 11 |
| | | Caption | 10 ="Power Source:", 11 ="IQS-5100B:" |
| Q | Frame | Name | fraResults |
| | | Caption | "PDL Measurement" |
| R | CommandButton | Name | cmdStart |
| | | Caption | "Start" |
| | | BackColor | &H0000FF00& |
| | | Style | 1-Graphical |
| S | CommandButton | Name | cmdStop |
| | | Caption | "Stop" |
| | | BackColor | &H000000FF& |
| | | Style | 1-Graphical |
| T | ProgressBar | Name | ProgressBar1 |
| | | Scrolling | 1-ccScrollingSmooth |
| U | TextBox | Name | txtPdlLambda |
| | | Appearance | 0-Flat |
| | | BackColor | &H8000000F& |
| | | Locked | True |
| V | Timer | Name | Timer1 |
| | | Enabled | False |
| | | Interval | 0 |
| W | TextBox | Name | txtPDL |
| | | Appearance | 0-Flat |
| | | BackColor | &H8000000F& |
| | | Locked | True |
| X | RichTextBox | Name | RichTextBox1 |
| | | Font | Courier New, Regular, 9pt |
| Y | Label (6 times) | Name | lblWl |
| | | Index | 12, 13, 14, 15, 16, 17 |
| | | Caption | 12 ="Status:", 13 ="Wavelength:", 14 ="nm", 15 ="PDL:", 16 ="dB", 17 ="Results:" |

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