Test Solutions Programming Manual

# Appendices & Programming Examples

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# Appendix A - Conversion Tables

## A1 - ASCII Character Codes

| Decimal | Binary | Symbol |
|---|---|---|
| 32 | 00100000 | |
| 33 | 00100001 | ! |
| 34 | 00100010 | " |
| 35 | 00100011 | # |
| 36 | 00100100 | $ |
| 37 | 00100101 | % |
| 38 | 00100110 | & |
| 39 | 00100111 | ' |
| 40 | 00101000 | ( |
| 41 | 00101001 | ) |
| 42 | 00101010 | * |
| 43 | 00101011 | + |
| 44 | 00101100 | , |
| 45 | 00101101 | - |
| 46 | 00101110 | . |
| 47 | 00101111 | / |
| 48 | 00110000 | 0 |
| 49 | 00110001 | 1 |
| 50 | 00110010 | 2 |
| 51 | 00110011 | 3 |
| 52 | 00110100 | 4 |
| 53 | 00110101 | 5 |
| 54 | 00110110 | 6 |
| 55 | 00110111 | 7 |
| 56 | 00111000 | 8 |
| 57 | 00111001 | 9 |
| 58 | 00111010 | : |
| 59 | 00111011 | ; |
| 60 | 00111100 | < |
| 61 | 00111101 | = |
| 62 | 00111110 | > |
| 63 | 00111111 | ? |
| 64 | 01000000 | @ |

| Decimal | Binary | Symbol |
|---|---|---|
| 65 | 01000001 | A |
| 66 | 01000010 | B |
| 67 | 01000011 | C |
| 68 | 01000100 | D |
| 69 | 01000101 | E |
| 70 | 01000110 | F |
| 71 | 01000111 | G |
| 72 | 01001000 | H |
| 73 | 01001001 | I |
| 74 | 01001010 | J |
| 75 | 01001011 | K |
| 76 | 01001100 | L |
| 77 | 01001101 | M |
| 78 | 01001110 | N |
| 79 | 01001111 | O |
| 80 | 01010000 | P |
| 81 | 01010001 | Q |
| 82 | 01010010 | R |
| 83 | 01010011 | S |
| 84 | 01010100 | T |
| 85 | 01010101 | U |
| 86 | 01010110 | V |
| 87 | 01010111 | W |
| 88 | 01011000 | X |
| 89 | 01011001 | Y |
| 90 | 01011010 | Z |
| 91 | 01011011 | [ |
| 92 | 01011100 | \ |
| 93 | 01011101 | ] |
| 94 | 01011110 | ^ |
| 95 | 01011111 | _ |
| 96 | 01100000 | ` |

| Decimal | Binary | Symbol |
|---|---|---|
| 97 | 01100001 | a |
| 98 | 01100010 | b |
| 99 | 01100011 | c |
| 100 | 01100100 | d |
| 101 | 01100101 | e |
| 102 | 01100110 | f |
| 103 | 01100111 | g |
| 104 | 01101000 | h |
| 105 | 01101001 | i |
| 106 | 01101010 | j |
| 107 | 01101011 | k |
| 108 | 01101100 | l |
| 109 | 01101101 | m |
| 110 | 01101110 | n |
| 111 | 01101111 | o |
| 112 | 01110000 | p |
| 113 | 01110001 | q |
| 114 | 01110010 | r |
| 115 | 01110011 | s |
| 116 | 01110100 | t |
| 117 | 01110101 | u |
| 118 | 01110110 | v |
| 119 | 01110111 | w |
| 120 | 01111000 | x |
| 121 | 01111001 | y |
| 122 | 01111010 | z |
| 123 | 01111011 | { |
| 124 | 01111100 | \| |
| 125 | 01111101 | } |
| 126 | 01111110 | ~ |

# Appendix B - Programming Examples

## B1 - Python Programming

### B1a - USB Control with 32-Bit Python

These examples demonstrate control of Mini-Circuits' PTE products using Python in the following environment:

1. Host computer running a Windows operating system
2. PTE connected by the USB interface
3. Mini-Circuits ActiveX DLL installed and registered on the computer
4. Python for Windows extension (PyWin32) installed on the computer

Note: The Python for Windows extension, PyWin32, can be downloaded from:
http://sourceforge.net/projects/pywin32/files/pywin32/Build%20217/

#### B1a.i - Power Sensor (Set Frequency/Read Power)

Set the calibration frequency and read the power.

```
import win32com.client                          # Reference PyWin32
import pythoncom

pm1 = win32com.client.Dispatch("mcl_pm.USB_PM")     # Reference the PM DLL

pm1.Open_Sensor()                               # Connect sensor

ModelName1 = pm1.GetSensorModelName()           # Read model name

SerialNo1 = pm1.GetSensorSN()                   # Read serial number

pm1.Freq = 1000                                 # Set the power meter's cal frequency
Read_Power1 = pm1.ReadPower()                   # Read the power

pm1.Close_Sensor                                # Disconnect the power sensor when finished

print "###### MODEL 1 ######"
print "Model:", ModelName1
print "Serial:", SerialNo1
print "Power:", Read_Power
```

## B1a.ii - Programmable Attenuator (Set/Read Attenuation)

Set and read a pre-defined attenuation.

```
import win32com.client                                  # Reference PyWin32
import pythoncom
import os

Att1 = win32com.client.Dispatch("mcl_RUDAT.USB_DAT")    # Reference the DLL

cn = Att1.Connect()                                     # Connect to the attenuator
print ("Connect:" + str(cn))

Attenuation = 10.25                                     # Create Attenuation string variable

cn = Att1.SetAttenuation(Attenuation)                   # Set attenuation
print ("Set Attenuation: " + str(cn))
cn = Att1.Read_Att(Attenuation)                         # Read attenuation
print ("Read Attenuation: " + str(cn))

cn = Att1.SetAttenuation(37.25)                         # Set attenuation
print ("Set Attenuation: " + str(cn))
cn = Att1.Read_Att(Attenuation)                         # Read attenuation
print ("Read Attenuation: " + str(cn))

Att1.Disconnect                                         # Disconnect the attenuator
```

The program output will be:

```
>>>
        Connect:(1, u'')
        Set Attenuation: (1, 10.25)
        Read Attenuation: (1, 10.25)
        Set Attenuation: (1, 37.25)
        Read Attenuation: (1, 37.25)
>>>
```

## B1a.iii - Programmable Attenuator (Set/Read Attenuation with User Input)

Continuously set and read the attenuation based on user inputs.

```
import win32com.client                                  # Reference PyWin32
import pythoncom
import os

Att1 = win32com.client.Dispatch("mcl_RUDAT.USB_DAT")    # Reference the DLL

Conn_Status = Att1.Connect()

if Conn_Status[0] == 1:

    run_loop = True

    Attenuation = input ("Please enter attenuation value: ")

    # Loop the following code while run loop = True
    while run_loop:

        Set_1 = Att1.SetAttenuation(Attenuation)        # Set attenuation
        print "Set Attenuation:", str(Set_1[1])

        Read_1 = Att1.Read_Att(Attenuation)             # Read attenuation
        print "Read Attenuation: ", str(Read_1[1])

        # Request next attenuation (or 999 to exit the loop)
        Attenuation = input("Please enter attenuation value (or 999 to finish): ")

        # Set run_loop to false to exit the loop if 999 entered
        if Attenuation == 999:
            run_loop = False
            print "Program finished."

else:
    print "Could not connect."

Att1.Disconnect                                         # Disconnect the attenuator
```

The program output should be as below (with 15.25, 65, and 999 entered by the user when prompted):

```
>>>
        Please enter attenuation value: 15.25
        Set Attenuation: 15.25
        Read Attenuation:  15.25
        Please enter attenuation value (or 999 to finish): 65
        Set Attenuation: 65.0
        Read Attenuation:  65.0
        Please enter attenuation value (or 999 to finish): 999
        Program finished.
>>>
```

## B1a.iv - Switch Matrices (Set/Get Switch States Based on User Input)

Continuously set and read the switches based on user input.

```
import win32com.client                                  # Reference PyWin32
import pythoncom
import os
import sys

#######################################
# Define a function to interpret the switch port values
#######################################

def Interpret_Switch_Port(Sw_Port, NoSwitches):

    # Converts decimal switch port value into bits, each indicating a switch state
    # NoSwitches should be set to the number of switches available (eg: 3 for RC-3SPDT-A18)

    # Set the initial values
    Last_Remainder = int(Sw_Port)
    Sw_State = int(0)
    This_Remainder = int(0)
    First_Loop = True
    Sw_State_List = []

    # Loop for each switch
    for n in range(int(NoSwitches), -1, -1):

        # Calculate each switch state by comparing to the byte value and the previous states
        This_Remainder = Last_Remainder - (Sw_State * (2**(n+1)))
        Sw_State = int(This_Remainder / 2**n)
        Last_Remainder = This_Remainder

        if First_Loop == False:                 # Ignore the first pass as it doesn't relate
to a switch
            Sw_State_List.append(Sw_State)      # Add each switch state to a list

        First_Loop = False

    return Sw_State_List

#######################################
# Control the switches below
#######################################

# Reference the DLL
sw1 = win32com.client.Dispatch("MCL_RF_Switch_Controller.USB_RF_Switch")

# Connect to the switch
Conn_Status = sw1.Connect()

# Carry out switching routine if connection was successful
if Conn_Status == 1:

    # Print model name/serial number
    Model_Name = sw1.Read_ModelName("")
    print "Model:", Model_Name[1]
    Serial_No = sw1.Read_SN("")
    print "SN:", Serial_No[1]

    # Loop indefinitely to keep switching based on user input
    run_loop = True
    while run_loop:

        print "------------------------------------------------------"
        print "Enter switch name ('A' to 'H') and state to set."
        print "'A0' sets switch A to position 0 (Com to port 1)."
        print "'A1' sets switch A to position 1 (Com to port 1)."
        print "Enter EXIT to finish:"
```

```
        # Read user input, strip trailing new line character
        Sw_Input = sys.stdin.readline().rstrip('\n')

        # Stop if user entered 'Exit'
        if Sw_Input == 'EXIT':
            run_loop = False
            sw1.Disconnect
            print "Program finished."
            sys.exit()

        # Get the desired switch name and state (1st and 2nd characters of the input)
        Sw_Name = Sw_Input[0:1]
        Sw_State = Sw_Input[1:2]

        # Set the switch
        Set_Sw = sw1.Set_Switch(Sw_Name, Sw_State)

        # Display the new states of all switches
        Set_State = 0
        Read_Sw = sw1.GetSwitchesStatus(Set_State)
        Sw_State_List = Interpret_Switch_Port(Read_Sw[1], 3)
        print "Switch A =", Sw_State_List[2], "Switch B =", Sw_State_List[1], "Switch C =",
Sw_State_List[0]

else:
    print "Could not connect."
```

The program output should be as below (with “A1”, “B1”, then “A0” entered by the user when prompted):

```
>>>
        Model: RC-2SPDT-A18
        SN: 11308050024
        ------------------------------------------------------------
        Enter switch name ('A' to 'H') and state to set.
        'A0' sets switch A to position 0 (Com to port 1).
        'A1' sets switch A to position 1 (Com to port 1).
        Enter EXIT to finish:
        A1
        Switch A = 1 Switch B = 0 Switch C = 0
        ------------------------------------------------------------
        Enter switch name ('A' to 'H') and state to set.
        'A0' sets switch A to position 0 (Com to port 1).
        'A1' sets switch A to position 1 (Com to port 1).
        Enter EXIT to finish:
        B1
        Switch A = 1 Switch B = 1 Switch C = 0
        ------------------------------------------------------------
        Enter switch name ('A' to 'H') and state to set.
        'A0' sets switch A to position 0 (Com to port 1).
        'A1' sets switch A to position 1 (Com to port 1).
        Enter EXIT to finish:
        A0
        Switch A = 0 Switch B = 1 Switch C = 0
        ------------------------------------------------------------
        Enter switch name ('A' to 'H') and state to set.
        'A0' sets switch A to position 0 (Com to port 1).
        'A1' sets switch A to position 1 (Com to port 1).
        Enter EXIT to finish:
        EXIT
        Program finished.
>>>
```

# B1b - USB Control with 64-Bit Python

Typical 64-bit Python distributins do not currently include support for ActiveX or .Net components, this prevents Mini-Circuits' .Net DLLs being called directly from the Python script. The typical 32-bit Python distribution does support ActiveX and therefore Mini-Circuit's ActiveX DLLs can be used (see USB Control with 32-Bit Python).

The work around on a 64-bit Python distribution is to create a separate executable program whose only function is to reference the .Net DLL, connect to the PTE device, send a single user specified command, return the response to the user, and disconnect from the DLL. This executable can then be easily called from the Python script to send as many commands as needed to the PTE device.

## B1b.i - Power Sensors

Mini-Circuits can supply on request an executable to interface with the DLL. The example source code for such an executable (C#) for Mini-Circuits' power sensors is shown here.

The below script demonstrates use of the executable in Python script to access a series of typical power sensor functions and read the responses.

```
import time
import os
import subprocess
from os import system
from subprocess import Popen, PIPE

# Read All Serial Numbers
pipe = subprocess.Popen("pwr_cs.exe -ls", stdout=subprocess.PIPE)
pipe.wait
SerialNumbers = pipe.stdout.read()
print SerialNumbers

# Set the Serial Number to Control
sn = '11109130005'

# Read Model Name
pipe = subprocess.Popen("pwr_cs.exe -sn " + sn + " -m", stdout=subprocess.PIPE)
pipe.wait
ModelName = pipe.stdout.read()
print ModelName

# Read Temperature
pipe = subprocess.Popen("pwr_cs.exe -sn " + sn + " -t", stdout=subprocess.PIPE)
pipe.wait
SerialNo = pipe.stdout.read()
print SerialNo

# Read Power (Set Compensation Frequency First)
freq = 2000
pipe = subprocess.Popen("pwr_cs.exe -sn " + sn + " -p " + str(freq), stdout=subprocess.PIPE)
pipe.wait
Power = pipe.stdout.read()
print Power
```

# B1c - Ethernet Control Using HTTP

These examples demonstrate control of Mini-Circuits' PTE products over a TCP/IP network by making use of Python's *urllib2* library.

## B1c.i - Switch Boxes (Set/Read Switch States)

Send HTTP commands to execute a pre-defined switching sequence.

```
import urllib2
import sys

########################################
# Define a function to send an HTTP command and get the result
########################################

def Get_HTTP_Result(CmdToSend):

    # Specify the IP address
    CmdToSend = "http://192.168.9.61/:" + CmdToSend

    # Send the HTTP command and try to read the result
    try:
        HTTP_Result = urllib2.urlopen(CmdToSend)
        PTE_Return = HTTP_Result.read()

        # The switch displays a web GUI for unrecognised commands
        if len(PTE_Return) > 100:
            print "Error, command not found:", CmdToSend
            PTE_Return = "Invalid Command!"

    # Catch an exception if URL is incorrect (incorrect IP or disconnected)
    except:
        print "Error, no response from device; check IP address and connections."
        PTE_Return = "No Response!"
        sys.exit()      # Exit the script

    # Return the response
    return PTE_Return

########################################
# Define a function to interpret the switch port values
########################################

def Interpret_Switch_Port(Sw_Port, NoSwitches):

    # Converts decimal switch port value into bits, each indicating a switch state
    # NoSwitches should be set to the number of switches available (eg: 3 for RC-3SPDT-A18)

    # Set the initial values
    Last_Remainder = int(Sw_Port)
    Sw_State = int(0)
    This_Remainder = int(0)
    First_Loop = True
    Sw_State_List = []

    # Loop for each switch
    for n in range(int(NoSwitches), -1, -1):

        # Calculate each switch state by comparing to the byte value and the previous
states
        This_Remainder = Last_Remainder - (Sw_State * (2**(n+1)))
        Sw_State = int(This_Remainder / 2**n)
        Last_Remainder = This_Remainder
```

```
        if First_Loop == False:                 # Ignore the first pass as it doesn't
relate to a switch
            Sw_State_List.append(Sw_State)      # Add each switch state to a list

        First_Loop = False

    return Sw_State_List


########################################
# Use switches below
########################################

# Print the model name and serial number
sn = Get_HTTP_Result("SN?")
mn = Get_HTTP_Result("MN?")
print "Switch", mn, "/", sn

# Set switches
Get_HTTP_Result('SETA=1')
Get_HTTP_Result('SETB=1')
Get_HTTP_Result('SETC=1')

# Check and output switch states
Switch_States = Interpret_Switch_Port(Get_HTTP_Result("SWPORT?"), 3)
print "Switch A =", Switch_States[2], "Switch B =", Switch_States[1], "Switch C =",
Switch_States[0]

# Set switches
Get_HTTP_Result('SETA=0')

# Check and output switch states
Switch_States = Interpret_Switch_Port(Get_HTTP_Result("SWPORT?"), 3)
print "Switch A =", Switch_States[2], "Switch B =", Switch_States[1], "Switch C =",
Switch_States[0]

# Set switches
Get_HTTP_Result('SETB=0')
Get_HTTP_Result('SETC=0')

# Check and output switch states
Switch_States = Interpret_Switch_Port(Get_HTTP_Result("SWPORT?"), 3)
print "Switch A =", Switch_States[2], "Switch B =", Switch_States[1], "Switch C =",
Switch_States[0]
```

The program output should be as below:

```
>>>
        Switch MN=RC-2SPDT-A18 / SN=11308050024
        Switch A = 1 Switch B = 1 Switch C = 1
        Switch A = 0 Switch B = 1 Switch C = 1
        Switch A = 0 Switch B = 0 Switch C = 0
>>>
```

## B1c.ii - Signal Generators (Set RF Output)

Sends HTTP commands to configure a pre-defined RF output.

```
import urllib2
import sys

########################################
# Define a function to send an HTTP command and get the result
########################################

def Get_HTTP_Result(CmdToSend):

    # Specify the IP address for the signal generator
    CmdToSend = "http://192.168.9.59/:" + CmdToSend

    # Send the HTTP command and try to read the result
    try:
        HTTP_Result = urllib2.urlopen(CmdToSend)
        SSG_Return = HTTP_Result.read()

        # The generator returns "-99..." for unrecognised commands
        if SSG_Return[0:3] == "-99":
            print "Error, command not found:", CmdToSend
            SSG_Return = "SSG: Invalid Command!"

    # Catch an exception if URL is incorrect (incorrect IP or generator disconnected)
    except:
        print "Error, no response from device; check IP address and connections."
        SSG_Return = "SSG: No Response!"
        sys.exit()      # Exit the script

    # Return the generator's response
    return SSG_Return

########################################
# Use signal generator below
########################################

# Print the model name and serial number
sn = Get_HTTP_Result("SN?")
mn = Get_HTTP_Result("MN?")
print "Generator", mn, "/", sn

# Set frequency and power
Get_HTTP_Result('FREQ:3000MHZ')
Get_HTTP_Result('PWR:-5.5')

# Check frequency and power
freq = Get_HTTP_Result("FREQ?")
pwr = Get_HTTP_Result("PWR?")

# Turn on RF output and confirm
Get_HTTP_Result("PWR:RF:ON")
status = Get_HTTP_Result("PWR:RF?")

# Output status
print "Freq", freq, "power", pwr, "set"
print "Output is", status

########################################
# Pause the program with generator on until user terminates
########################################

final_status = raw_input("Hit Enter to turn off the RF output and end program:")
Get_HTTP_Result("PWR:RF:OFF")
print "Program ended."
```

The program output should be as below:

```
>>>
        Generator MN=SSG-6000RC / SN=11402040043
        Freq 3000.000000 power -5.50 set
        Output is ON
        Hit Enter to turn off the RF output and end program:
        Program ended.
>>>
```

# B2 - C Programming

## B2a - USB Control in a Linux Environment

These examples demonstrate control of Mini-Circuits' PTE products using C in the following environment:

1. Host computer running a Linux operating system
2. PTE connected by the USB interface
3. Linux's libhid/libusb libraries installed

The examples use Linux's libhid and libusb libraries to allow communication with the PTE as a USB Human Interface Device. The package can be downloaded from the Mini-Circuits website with the programming example files, installation can be carried out in the following steps:

1. Download libhid-0.2.16.tar.gz
2. Extract libhid-0.2.16.tar.gz to a temporary folder
3. Open the Terminal on the temporary folder location
4. Type the following commands:
    a. *sudo apt-get install libusb-dev*
    b. *cd libhid-0.2.16*
    c. *./configure --enable-werror=no*
    d. *make*
    e. *sudo make install*
    f. *sudo ldconfig*

## B2a.i - Switch Boxes

Switch.c provides a simple console program to find the connected switch, read model name/serial number and set the switch states.

The libusb and libhid libraries are required to enable the program to interface with the devices by USB (see USB Control in a Linux Environment).

To compile and run the program:

1. Open the terminal
2. Type “sudo su” in order to get root privilege (necessary for control over USB)
3. Type “gcc switch.c -o Switch -lusb -lhid” to compile the code
4. Type “./Switch <state>” in order to run the code (entering the required switch state)

```
#include <hid.h>
#include <stdio.h>
#include <string.h>
#include <usb.h>

#define VENDOR_ID  0x20ce   // MiniCircuits Vendor ID
#define PRODUCT_ID 0x0022   // MiniCircuits HID USB Control For RF switch Product ID
#define PATHLEN  2
#define SEND_PACKET_LEN 64

 HIDInterface* hid;
 hid_return ret;
 struct usb_device *usb_dev;
 struct usb_dev_handle *usb_handle;
 char buffer[80], kdname[80];

const int PATH_IN[PATHLEN] = { 0x00010005, 0x00010033 };
char  PACKET[SEND_PACKET_LEN];

bool match_serial_number(struct usb_dev_handle* usbdev, void* custom, unsigned int len)
{
  bool ret;
  char* buffer = (char*)malloc(len);
  usb_get_string_simple(usbdev, usb_device(usbdev)->descriptor.iSerialNumber,
      buffer, len);
  ret = strncmp(buffer, (char*)custom, len) == 0;
  free(buffer);
  return ret;
}

static struct usb_device *device_init(void)
{
    struct usb_bus *usb_bus;
    struct usb_device *dev;
    usb_init();
    usb_find_busses();
    usb_find_devices();
    for (usb_bus = usb_busses; usb_bus; usb_bus = usb_bus->next)
    {
        for (dev = usb_bus->devices; dev; dev = dev->next)
        {
            if ((dev->descriptor.idVendor == VENDOR_ID) &&
                (dev->descriptor.idProduct == PRODUCT_ID)) {
      return dev;
       }
        }
    }
    return NULL;
}
```

```
void Get_PN (char* PNstr)
{
        int i;
        char  PACKETreceive[SEND_PACKET_LEN];
        PACKET[0]=40;  //     PN code
        ret = hid_interrupt_write(hid, 0x01, PACKET, SEND_PACKET_LEN,1000);
    if (ret != HID_RET_SUCCESS) {
      fprintf(stderr, "hid_interrupt_write failed with return code %d\n", ret);
   }
        ret = hid_interrupt_read(hid, 0x01, PACKETreceive, SEND_PACKET_LEN,1000);
        if (ret == HID_RET_SUCCESS) {
              strncpy(PNstr,PACKETreceive,SEND_PACKET_LEN);
              for (i=0;PNstr[i+1]!='\0';i++) {
                       PNstr[i]=PNstr[i+1];
                                              }
              PNstr[i]='\0';
           }
          if (ret != HID_RET_SUCCESS) {
      fprintf(stderr, "hid_interrupt_read failed with return code %d\n", ret);   }

}

void Get_SN (char* SNstr)
{
       int i;
       char  PACKETreceive[SEND_PACKET_LEN];
       PACKET[0]=41;  //     SN Code
        ret = hid_interrupt_write(hid, 0x01, PACKET, SEND_PACKET_LEN,1000);
    if (ret != HID_RET_SUCCESS) {
      fprintf(stderr, "hid_interrupt_write failed with return code %d\n", ret);
   }
        ret = hid_interrupt_read(hid, 0x01, PACKETreceive, SEND_PACKET_LEN,1000);
        if (ret == HID_RET_SUCCESS) {
              strncpy(SNstr,PACKETreceive,SEND_PACKET_LEN);
            for (i=0;SNstr[i+1]!='\0';i++) {
                       SNstr[i]=SNstr[i+1];
                                              }
            SNstr[i]='\0';
           }
   if (ret != HID_RET_SUCCESS) {
      fprintf(stderr, "hid_interrupt_read failed with return code %d\n", ret);   }


}

void Set_Switch ( unsigned char **switchingCode)
{
        int i;
        char  PACKETreceive[SEND_PACKET_LEN];
        // Writing / Reading From USB
        PACKET[0]=9;          //  switching command
        PACKET[1]= atoi(switchingCode[1]);         // switching code:
                                                // 0 - de-energize all switches
                                                // 1 to energize sw 1 & de-energize sw 2
                                                // 2 to energize sw 2 & de-energize sw 1
                                                // 3 to energize sw 1 ,2
                                                // etc.

        ret = hid_interrupt_write(hid, 0x01, PACKET, SEND_PACKET_LEN,1000);
    if (ret != HID_RET_SUCCESS) {
      fprintf(stderr, "hid_interrupt_write failed with return code %d\n", ret);
   }
        ret = hid_interrupt_read(hid, 0x01, PACKETreceive, SEND_PACKET_LEN,1000);
        //  Read packet  Packetreceive[0]=1

       if (ret != HID_RET_SUCCESS) {
       fprintf(stderr, "hid_interrupt_read failed with return code %d\n", ret);   }

}
```

```
int main( int argc, unsigned char **argv)
{
  usb_dev = device_init();

  if (usb_dev == NULL)
  {
      fprintf(stderr, "Device not found!\n");
      exit(-1);
  }
  if (usb_dev != NULL)
  {
      usb_handle = usb_open(usb_dev);
      int drstatus = usb_get_driver_np(usb_handle, 0, kdname, sizeof(kdname));
      if (kdname != NULL && strlen(kdname) > 0) {
     usb_detach_kernel_driver_np(usb_handle, 0);
      }
  }
  usb_reset(usb_handle);
  usb_close(usb_handle);
  HIDInterfaceMatcher matcher = { VENDOR_ID, PRODUCT_ID, NULL, NULL, 0 };
  ret = hid_init();
  if (ret != HID_RET_SUCCESS) {
    fprintf(stderr, "hid_init failed with return code %d\n", ret);
    return 1;
  }
  hid = hid_new_HIDInterface();
  if (hid == 0) {
    fprintf(stderr, "hid_new_HIDInterface() failed, out of memory?\n");
    return 1;
  }

  ret = hid_force_open(hid, 0, &matcher, 3);
  if (ret != HID_RET_SUCCESS) {
    fprintf(stderr, "hid_force_open failed with return code %d\n", ret);
    return 1;
  }

//////////////   Switching    //////////////////

char  PNreceive[SEND_PACKET_LEN];
char  SNreceive[SEND_PACKET_LEN];

int StrLen1;

 Get_PN(PNreceive);
 fprintf(stderr," PN=  %s .\n",PNreceive);

 Get_SN(SNreceive);
 fprintf(stderr," SN=  %s .\n",SNreceive);

  Set_Switch(argv);

 ////////////////////////////////////////////

  ret = hid_close(hid);
  if (ret != HID_RET_SUCCESS) {
    fprintf(stderr, "hid_close failed with return code %d\n", ret);
    return 1;
  }

  hid_delete_HIDInterface(&hid);

  ret = hid_cleanup();
  if (ret != HID_RET_SUCCESS) {
    fprintf(stderr, "hid_cleanup failed with return code %d\n", ret);
    return 1;
  }

  return 0;
}
```

## B2a.ii - Synthesized Signal Generator

Find connected signal generator, read model name/serial number and set RF output.

```
/* ********************************************************************
This is an example code to communicate with USB Control Driver for RF generator.
The example use libusb and libhid libraries to connect to the USB ,
and are available to downlolad from the web (GNU GPL license ).
**********************************************************************/


#include <hid.h>
#include <stdio.h>
#include <string.h>
#include <usb.h>


#define VENDOR_ID  0x20ce   // MiniCircuits Vendor ID
#define PRODUCT_ID 0x0022   // MiniCircuits HID USB Control For RF generator Product ID
#define PATHLEN  2
#define SEND_PACKET_LEN 64


 HIDInterface* hid;
 hid_return ret;
 struct usb_device *usb_dev;
 struct usb_dev_handle *usb_handle;
 char buffer[80], kdname[80];


const int PATH_IN[PATHLEN] = { 0x00010005, 0x00010033 };
char  PACKET[SEND_PACKET_LEN];


bool match_serial_number(struct usb_dev_handle* usbdev, void* custom, unsigned int len)
{
  bool ret;
  char* buffer = (char*)malloc(len);
  usb_get_string_simple(usbdev, usb_device(usbdev)->descriptor.iSerialNumber,
      buffer, len);
  ret = strncmp(buffer, (char*)custom, len) == 0;
  free(buffer);
  return ret;
}


static struct usb_device *device_init(void)
{
    struct usb_bus *usb_bus;
    struct usb_device *dev;
    usb_init();
    usb_find_busses();
    usb_find_devices();
    for (usb_bus = usb_busses; usb_bus; usb_bus = usb_bus->next)
    {
        for (dev = usb_bus->devices; dev; dev = dev->next)
        {
            if ((dev->descriptor.idVendor == VENDOR_ID) &&
                (dev->descriptor.idProduct == PRODUCT_ID)) {
      return dev;
       }
        }
    }
    return NULL;
}
```

```
void Get_PN (char* PNstr)
{
        int i;
        char  PACKETreceive[SEND_PACKET_LEN];
        PACKET[0]=40;  //     PN code
        ret = hid_interrupt_write(hid, 0x01, PACKET, SEND_PACKET_LEN,1000);
    if (ret != HID_RET_SUCCESS) {
      fprintf(stderr, "hid_interrupt_write failed with return code %d\n", ret);
   }
        ret = hid_interrupt_read(hid, 0x01, PACKETreceive, SEND_PACKET_LEN,1000);
        if (ret == HID_RET_SUCCESS) {
              strncpy(PNstr,PACKETreceive,SEND_PACKET_LEN);
              for (i=0;PNstr[i+1]!='\0';i++) {
                       PNstr[i]=PNstr[i+1];
                                              }
              PNstr[i]='\0';
           }
          if (ret != HID_RET_SUCCESS) {
      fprintf(stderr, "hid_interrupt_read failed with return code %d\n", ret);   }

}

void Get_SN (char* SNstr)
{
       int i;
       char  PACKETreceive[SEND_PACKET_LEN];
       PACKET[0]=41;  //     SN Code
        ret = hid_interrupt_write(hid, 0x01, PACKET, SEND_PACKET_LEN,1000);
    if (ret != HID_RET_SUCCESS) {
      fprintf(stderr, "hid_interrupt_write failed with return code %d\n", ret);
   }
        ret = hid_interrupt_read(hid, 0x01, PACKETreceive, SEND_PACKET_LEN,1000);
        if (ret == HID_RET_SUCCESS) {
               strncpy(SNstr,PACKETreceive,SEND_PACKET_LEN);
             for (i=0;SNstr[i+1]!='\0';i++) {
                       SNstr[i]=SNstr[i+1];
                                              }
             SNstr[i]='\0';
           }
   if (ret != HID_RET_SUCCESS) {
      fprintf(stderr, "hid_interrupt_read failed with return code %d\n", ret);   }

}

void Set_GeneratorA ()
//  Energized generator A
{
        int i;
        char  PACKETreceive[SEND_PACKET_LEN];
        // Writing / Reading From USB
        PACKET[0]=1;          // 1 = Handle Generator A ; 2=Handle Generator B
        PACKET[1]= 1;         // 1 = energized 0=de-energized
        ret = hid_interrupt_write(hid, 0x01, PACKET, SEND_PACKET_LEN,1000);
    if (ret != HID_RET_SUCCESS) {
      fprintf(stderr, "hid_interrupt_write failed with return code %d\n", ret);
   }
        ret = hid_interrupt_read(hid, 0x01, PACKETreceive, SEND_PACKET_LEN,1000);
        //  Read packet  Packetreceive[0]=1

       if (ret != HID_RET_SUCCESS) {
       fprintf(stderr, "hid_interrupt_read failed with return code %d\n", ret);   }

}
```

```
int main( int argc, unsigned char **argv)
{
  usb_dev = device_init();

  if (usb_dev == NULL)
  {
      fprintf(stderr, "Device not found!\n");
      exit(-1);
  }
  if (usb_dev != NULL)
  {
      usb_handle = usb_open(usb_dev);
      int drstatus = usb_get_driver_np(usb_handle, 0, kdname, sizeof(kdname));
      if (kdname != NULL && strlen(kdname) > 0) {
     usb_detach_kernel_driver_np(usb_handle, 0);
      }
  }
  usb_reset(usb_handle);
  usb_close(usb_handle);
  HIDInterfaceMatcher matcher = { VENDOR_ID, PRODUCT_ID, NULL, NULL, 0 };
  ret = hid_init();
  if (ret != HID_RET_SUCCESS) {
    fprintf(stderr, "hid_init failed with return code %d\n", ret);
    return 1;
  }
  hid = hid_new_HIDInterface();
  if (hid == 0) {
    fprintf(stderr, "hid_new_HIDInterface() failed, out of memory?\n");
    return 1;
  }

  ret = hid_force_open(hid, 0, &matcher, 3);
  if (ret != HID_RET_SUCCESS) {
    fprintf(stderr, "hid_force_open failed with return code %d\n", ret);
    return 1;
  }

//////////////   Generating    ////////////////////////////////

char  PNreceive[SEND_PACKET_LEN];
char  SNreceive[SEND_PACKET_LEN];

int StrLen1;

 Get_PN(PNreceive);
 fprintf(stderr," PN=  %s .\n",PNreceive);

 Get_SN(SNreceive);
 fprintf(stderr," SN=  %s .\n",SNreceive);

 Set_GeneratorA();
 ////////////////////////////////////////////////////////////

  ret = hid_close(hid);
  if (ret != HID_RET_SUCCESS) {
    fprintf(stderr, "hid_close failed with return code %d\n", ret);
    return 1;
  }

  hid_delete_HIDInterface(&hid);

  ret = hid_cleanup();
  if (ret != HID_RET_SUCCESS) {
    fprintf(stderr, "hid_cleanup failed with return code %d\n", ret);
    return 1;
  }

  return 0;
}
```

## B2a.iii - Power Sensor (Single Device)

Find connected power sensor, read model name/serial number and read input power level.

```
/* ****************************************************************
This is an example code to communicate with USB Control Driver for RF sensor.
The example use libusb and libhid libraries to connect to the USB ,
and are available to downlolad from the web (GNU GPL license ).
*****************************************************************/


#include <hid.h>
#include <stdio.h>
#include <string.h>
#include <usb.h>


#define VENDOR_ID  0x20ce   // MiniCircuits Vendor ID
#define PRODUCT_ID 0x0022   // MiniCircuits HID USB Control For RF sensor Product ID
#define PATHLEN  2
#define SEND_PACKET_LEN 64


 HIDInterface* hid;
 hid_return ret;
 struct usb_device *usb_dev;
 struct usb_dev_handle *usb_handle;
 char buffer[80], kdname[80];


const int PATH_IN[PATHLEN] = { 0x00010005, 0x00010033 };
char  PACKET[SEND_PACKET_LEN];


bool match_serial_number(struct usb_dev_handle* usbdev, void* custom, unsigned int len)
{
  bool ret;
  char* buffer = (char*)malloc(len);
  usb_get_string_simple(usbdev, usb_device(usbdev)->descriptor.iSerialNumber,
      buffer, len);
  ret = strncmp(buffer, (char*)custom, len) == 0;
  free(buffer);
  return ret;
}


static struct usb_device *device_init(void)
{
    struct usb_bus *usb_bus;
    struct usb_device *dev;
    usb_init();
    usb_find_busses();
    usb_find_devices();
    for (usb_bus = usb_busses; usb_bus; usb_bus = usb_bus->next)
    {
        for (dev = usb_bus->devices; dev; dev = dev->next)
        {
            if ((dev->descriptor.idVendor == VENDOR_ID) &&
                (dev->descriptor.idProduct == PRODUCT_ID)) {
      return dev;
       }
        }
    }
    return NULL;
}
```

```
void Get_PN (char* PNstr)
{
        int i;
        char  PACKETreceive[SEND_PACKET_LEN];
        PACKET[0]=40;  //     PN code
        ret = hid_interrupt_write(hid, 0x01, PACKET, SEND_PACKET_LEN,1000);
    if (ret != HID_RET_SUCCESS) {
      fprintf(stderr, "hid_interrupt_write failed with return code %d\n", ret);
   }
        ret = hid_interrupt_read(hid, 0x01, PACKETreceive, SEND_PACKET_LEN,1000);
        if (ret == HID_RET_SUCCESS) {
              strncpy(PNstr,PACKETreceive,SEND_PACKET_LEN);
              for (i=0;PNstr[i+1]!='\0';i++) {
                       PNstr[i]=PNstr[i+1];
                                              }
              PNstr[i]='\0';
           }
          if (ret != HID_RET_SUCCESS) {
      fprintf(stderr, "hid_interrupt_read failed with return code %d\n", ret);   }

}

void Get_SN (char* SNstr)
{
       int i;
       char  PACKETreceive[SEND_PACKET_LEN];
       PACKET[0]=41;  //     SN Code
        ret = hid_interrupt_write(hid, 0x01, PACKET, SEND_PACKET_LEN,1000);
    if (ret != HID_RET_SUCCESS) {
      fprintf(stderr, "hid_interrupt_write failed with return code %d\n", ret);
   }
        ret = hid_interrupt_read(hid, 0x01, PACKETreceive, SEND_PACKET_LEN,1000);
        if (ret == HID_RET_SUCCESS) {
               strncpy(SNstr,PACKETreceive,SEND_PACKET_LEN);
             for (i=0;SNstr[i+1]!='\0';i++) {
                       SNstr[i]=SNstr[i+1];
                                              }
             SNstr[i]='\0';
           }
   if (ret != HID_RET_SUCCESS) {
      fprintf(stderr, "hid_interrupt_read failed with return code %d\n", ret);   }

}

void Set_SensorA ()
//  Energized sensor A
{
        int i;
        char  PACKETreceive[SEND_PACKET_LEN];
        // Writing / Reading From USB
        PACKET[0]=1;          // 1 = Handle Sensor A ; 2=Handle Sensor B
        PACKET[1]= 1;         // 1 = energized 0=de-energized
        ret = hid_interrupt_write(hid, 0x01, PACKET, SEND_PACKET_LEN,1000);
    if (ret != HID_RET_SUCCESS) {
      fprintf(stderr, "hid_interrupt_write failed with return code %d\n", ret);
   }
        ret = hid_interrupt_read(hid, 0x01, PACKETreceive, SEND_PACKET_LEN,1000);
        //  Read packet  Packetreceive[0]=1

       if (ret != HID_RET_SUCCESS) {
       fprintf(stderr, "hid_interrupt_read failed with return code %d\n", ret);   }

}
```

```
int main( int argc, unsigned char **argv)
{
  usb_dev = device_init();

  if (usb_dev == NULL)
  {
      fprintf(stderr, "Device not found!\n");
      exit(-1);
  }
  if (usb_dev != NULL)
  {
      usb_handle = usb_open(usb_dev);
      int drstatus = usb_get_driver_np(usb_handle, 0, kdname, sizeof(kdname));
      if (kdname != NULL && strlen(kdname) > 0) {
     usb_detach_kernel_driver_np(usb_handle, 0);
      }
  }
  usb_reset(usb_handle);
  usb_close(usb_handle);
  HIDInterfaceMatcher matcher = { VENDOR_ID, PRODUCT_ID, NULL, NULL, 0 };
  ret = hid_init();
  if (ret != HID_RET_SUCCESS) {
    fprintf(stderr, "hid_init failed with return code %d\n", ret);
    return 1;
  }
  hid = hid_new_HIDInterface();
  if (hid == 0) {
    fprintf(stderr, "hid_new_HIDInterface() failed, out of memory?\n");
    return 1;
  }

  ret = hid_force_open(hid, 0, &matcher, 3);
  if (ret != HID_RET_SUCCESS) {
    fprintf(stderr, "hid_force_open failed with return code %d\n", ret);
    return 1;
  }

//////////////   Sensoring    ////////////////////////////////

char  PNreceive[SEND_PACKET_LEN];
char  SNreceive[SEND_PACKET_LEN];

int StrLen1;

 Get_PN(PNreceive);
 fprintf(stderr," PN=  %s .\n",PNreceive);

 Get_SN(SNreceive);
 fprintf(stderr," SN=  %s .\n",SNreceive);

 Set_SensorA();
 ////////////////////////////////////////////////////////////

  ret = hid_close(hid);
  if (ret != HID_RET_SUCCESS) {
    fprintf(stderr, "hid_close failed with return code %d\n", ret);
    return 1;
  }

  hid_delete_HIDInterface(&hid);

  ret = hid_cleanup();
  if (ret != HID_RET_SUCCESS) {
    fprintf(stderr, "hid_cleanup failed with return code %d\n", ret);
    return 1;
  }

  return 0;
}
```

## B2a.iv - Power Sensors (Controlling Multiple Devices)

This example (MCL_PM2.c) demonstrates how to control 2 or more power sensors simultaneously. The source code is below and the files can be downloaded from the Mini-Circuits website.

After extracting the download files, the user can run from a Linux terminal using the following commands:
*sudo su* (for administrator privileges)
*gcc -o MCL_PM2 MCL_PM2.c libhid/*.c libusb/*.c* (to compile)
*./MCL_PM2 10* (to run, after 2 power sensors have been connected by USB)

The output will show 2 different power readings along with the serial number and model name for each device.

```
#include <hid.h>
#include <stdio.h>
#include <string.h>
#include <usb.h>

#define VENDOR_ID  0x20ce   // MiniCircuits Vendor ID
#define PRODUCT_ID 0x0011   // MiniCircuits HID Power Sensor Product ID
#define PATHLEN  2
#define SEND_PACKET_LEN 64

hid_return ret;

char buffer[80], kdname[80];
const int PATH_IN[PATHLEN] = { 0x00010005, 0x00010033 };
char  PACKET[SEND_PACKET_LEN];


bool match_serial_number(struct usb_dev_handle* usbdev, void* custom, unsigned int len)
{
  bool ret;
  char* buffer = (char*)malloc(len);
  usb_get_string_simple(usbdev, usb_device(usbdev)->descriptor.iSerialNumber,
      buffer, len);
  ret = strncmp(buffer, (char*)custom, len) == 0;
  free(buffer);
  return ret;
}


void Get_PN (char* PNstr, HIDInterface* hid)
{
        int i;
        char  PACKETreceive[SEND_PACKET_LEN];
        PACKET[0]=104;  //     PN code
        ret = hid_interrupt_write(hid, 0x01, PACKET, SEND_PACKET_LEN,1000);
    if (ret != HID_RET_SUCCESS) {
        fprintf(stderr, "hid_interrupt_write failed with return code %d\n", ret);
    }
        ret = hid_interrupt_read(hid, 0x01, PACKETreceive, SEND_PACKET_LEN,1000);
        if (ret == HID_RET_SUCCESS) {
              strncpy(PNstr,PACKETreceive,SEND_PACKET_LEN);
              for (i=0;PNstr[i+1]!='\0';i++) {
                        PNstr[i]=PNstr[i+1];
                                              }
              PNstr[i]='\0';
           }
        if (ret != HID_RET_SUCCESS) {
        fprintf(stderr, "hid_interrupt_read failed with return code %d\n", ret);    }

}
```

```
void Get_SN (char* SNstr, HIDInterface* hid)
{
       int i;
       char  PACKETreceive[SEND_PACKET_LEN];
       PACKET[0]=105;  //     SN Code
        ret = hid_interrupt_write(hid, 0x01, PACKET, SEND_PACKET_LEN,1000);
    if (ret != HID_RET_SUCCESS) {
        fprintf(stderr, "hid_interrupt_write failed with return code %d\n", ret);
    }
        ret = hid_interrupt_read(hid, 0x01, PACKETreceive, SEND_PACKET_LEN,1000);
        if (ret == HID_RET_SUCCESS) {
               strncpy(SNstr,PACKETreceive,SEND_PACKET_LEN);
             for (i=0;SNstr[i+1]!='\0';i++) {
                       SNstr[i]=SNstr[i+1];
                                              }
             SNstr[i]='\0';
           }
    if (ret != HID_RET_SUCCESS) {
        fprintf(stderr, "hid_interrupt_read failed with return code %d\n", ret);    }
}


void Get_Power (unsigned char **Freq1,char* Pwr, HIDInterface* hid)
//  Freq1 = input frequency ,  Pwr = output Power
{
        int i;
        char  PACKETreceive[SEND_PACKET_LEN];
    // Writing / Reading From USB
        PACKET[0]=102;          // 102 = code to get power
        PACKET[1]= atoi(Freq1[1])/256;
        PACKET[2]= atoi(Freq1[1])%256;
        //  Frequency   to Hex   Packet[1]=hi  packet[2]=lo
        ret = hid_interrupt_write(hid, 0x01, PACKET, SEND_PACKET_LEN,1000);
    if (ret != HID_RET_SUCCESS) {
        fprintf(stderr, "hid_interrupt_write failed with return code %d\n", ret);
    }
        ret = hid_interrupt_read(hid, 0x01, PACKETreceive, SEND_PACKET_LEN,1000);
        //  Read packet  Packetreceive[0]=102 get power  Packetreceive[1]-Packetreceive[6]
Ascii of Power ex: -10.05

        if (ret == HID_RET_SUCCESS)
        {
             strncpy(Pwr,PACKETreceive,SEND_PACKET_LEN);
            for (i=0;Pwr[i+1]!='\0';i++) {
                       Pwr[i]=Pwr[i+1];
                                             }
            Pwr[i]='\0';
        }

    if (ret != HID_RET_SUCCESS) {
        fprintf(stderr, "hid_interrupt_read failed with return code %d\n", ret);    }

}
```

```
int main( int argc, unsigned char **argv)
{
   char  PNreceive[SEND_PACKET_LEN];
   char  SNreceive[SEND_PACKET_LEN];
   char  SNreceive1[SEND_PACKET_LEN];
   char  RFpower[SEND_PACKET_LEN];

   int StrLen1;
   int CountUSB=0;

     HIDInterface* hid1;    // Declare power sensor 1 (repeat for multiple sensors)
     HIDInterface* hid2;    // Declare power sensor 2

    usb_init();
    usb_find_busses();
    usb_find_devices();
    ret = hid_init();
    HIDInterfaceMatcher matcher = { VENDOR_ID, PRODUCT_ID, NULL, NULL, 0 };
    ++CountUSB;

    // Use power sensor 1 (repeat this block of code for multiple sensors)
    hid1 = hid_new_HIDInterface();
    ret = hid_force_open(hid1, 0, &matcher, 0);
    Get_PN(PNreceive,hid1);          // Get part number
    fprintf(stderr," PN=  %s .\n",PNreceive);
    Get_SN(SNreceive,hid1);          // Get serial number
    fprintf(stderr," SN=  %s .\n",SNreceive);
    Get_Power(argv,RFpower,hid1);    // Read power
    fprintf(stderr," Power=  %s dBm.\n",RFpower);

    // Use power sensor 2
    hid2 = hid_new_HIDInterface();
    ret = hid_force_open(hid2, 0, &matcher, 0);
    Get_PN(PNreceive,hid2);          // Get part number
    fprintf(stderr," PN=  %s .\n",PNreceive);
    Get_SN(SNreceive,hid2);          // Get serial number
    fprintf(stderr," SN=  %s .\n",SNreceive);
    Get_Power(argv,RFpower,hid2);    // Read power
    fprintf(stderr," Power=  %s dBm.\n",RFpower);

    ret = hid_close(hid1);
    hid_delete_HIDInterface(&hid1);

    ret = hid_close(hid2);
    hid_delete_HIDInterface(&hid2);

    ret = hid_cleanup();
    return 0;

}
```

## B2a.v - Frequency Counter

Find connected frequency counter, read frequency and write to a text file.

Sudo rights are needed to compile and run the code, type:

- *sudo gcc FC.c -o FC -lusb -lhid* (to compile)
- *sudo ./FC* (to run)

The text file output ("FreqCounter.txt") will be created in the project folder.

```
/* ****************************************************************
The example use libusb and libhid libraries to connect to the USB ,
and are available to downlolad from the web (GNU GPL license ).
*****************************************************************/

#include <usb.h>
#include <hid.h>
#include <stdio.h>
#include <sys/types.h>
#include <sys/stat.h>
#include <fcntl.h>
#include <unistd.h>
#include <string.h>
#define VENDOR_ID  0x20ce   // MiniCircuits Vendor ID
#define PRODUCT_ID 0x0010   // MiniCircuits HID USB Freq Counter Product ID
#define PATHLEN  2
#define SEND_PACKET_LEN 64

 HIDInterface* hid;
 hid_return ret;
 struct usb_device *usb_dev;
 struct usb_dev_handle *usb_handle;
 char buffer[80], kdname[80];

const int PATH_IN[PATHLEN] = { 0x00010005, 0x00010033 };
char  PACKET[SEND_PACKET_LEN];

bool match_serial_number(struct usb_dev_handle* usbdev, void* custom, unsigned int len)
{
  bool ret;
  char* buffer = (char*)malloc(len);
  usb_get_string_simple(usbdev, usb_device(usbdev)->descriptor.iSerialNumber,
      buffer, len);
  ret = strncmp(buffer, (char*)custom, len) == 0;
  free(buffer);
  return ret;
}

static struct usb_device *device_init(void)
{
    struct usb_bus *usb_bus;
    struct usb_device *dev;
    usb_init();
    usb_find_busses();
    usb_find_devices();
    for (usb_bus = usb_busses; usb_bus; usb_bus = usb_bus->next)
    {
        for (dev = usb_bus->devices; dev; dev = dev->next)
        {
            if ((dev->descriptor.idVendor == VENDOR_ID) &&
                (dev->descriptor.idProduct == PRODUCT_ID)) {
      return dev;
       }
        }
    }
    return NULL;
}
```

```
void Get_PN (char* PNstr)
{
        int i;
        char  PACKETreceive[SEND_PACKET_LEN];
        PACKET[0]=40;  //     PN code
        ret = hid_interrupt_write(hid, 0x01, PACKET, SEND_PACKET_LEN,1000);
    if (ret != HID_RET_SUCCESS) {
      fprintf(stderr, "hid_interrupt_write failed with return code %d\n", ret);
   }
        ret = hid_interrupt_read(hid, 0x01, PACKETreceive, SEND_PACKET_LEN,1000);
        if (ret == HID_RET_SUCCESS) {
              strncpy(PNstr,PACKETreceive,SEND_PACKET_LEN);
              for (i=0;PNstr[i+1]!='\0';i++) {
                       PNstr[i]=PNstr[i+1];
                                              }
              PNstr[i]='\0';
           }
          if (ret != HID_RET_SUCCESS) {
      fprintf(stderr, "hid_interrupt_read failed with return code %d\n", ret);   }

}
void Get_SN (char* SNstr)
{
       int i;
       char  PACKETreceive[SEND_PACKET_LEN];
       PACKET[0]=41;  //     SN Code
        ret = hid_interrupt_write(hid, 0x01, PACKET, SEND_PACKET_LEN,1000);
    if (ret != HID_RET_SUCCESS) {
      fprintf(stderr, "hid_interrupt_write failed with return code %d\n", ret);
   }
        ret = hid_interrupt_read(hid, 0x01, PACKETreceive, SEND_PACKET_LEN,1000);
        if (ret == HID_RET_SUCCESS) {
               strncpy(SNstr,PACKETreceive,SEND_PACKET_LEN);
             for (i=0;SNstr[i+1]!='\0';i++) {
                       SNstr[i]=SNstr[i+1];
                                              }
             SNstr[i]='\0';
           }
   if (ret != HID_RET_SUCCESS) {
      fprintf(stderr, "hid_interrupt_read failed with return code %d\n", ret);   }


}
void ReadFreq (char* FreqStr)
{
       int i=0;
       char  PACKETreceive[SEND_PACKET_LEN];
       PACKET[0]=2;  //     Read Freq code
        ret = hid_interrupt_write(hid, 0x01, PACKET, SEND_PACKET_LEN,1000);
    if (ret != HID_RET_SUCCESS) {
      fprintf(stderr, "hid_interrupt_write failed with return code %d\n", ret);
   }
        ret = hid_interrupt_read(hid, 0x01, PACKETreceive, SEND_PACKET_LEN,1000);
        if (ret == HID_RET_SUCCESS) {

             for (i=17;i<34;i++) {
                      FreqStr[i-17]=PACKETreceive[i];
                                              }
             FreqStr[i-17]='\0';
          }

   if (ret != HID_RET_SUCCESS) {
      fprintf(stderr, "hid_interrupt_read failed with return code %d\n", ret);   }


}
```

```
int main( int argc, unsigned char **argv)
{
 int ff;
 char AttValue[3];
 float LastAtt=0.0;

 usb_dev = device_init();
 if (usb_dev == NULL)
  {
      fprintf(stderr, "Device not found!\n");
      exit(-1);
  }
  if (usb_dev != NULL)
  {
      usb_handle = usb_open(usb_dev);
      int drstatus = usb_get_driver_np(usb_handle, 0, kdname, sizeof(kdname));
      if (kdname != NULL && strlen(kdname) > 0) {
     usb_detach_kernel_driver_np(usb_handle, 0);
      }
  }
  usb_reset(usb_handle);
  usb_close(usb_handle);
  HIDInterfaceMatcher matcher = { VENDOR_ID, PRODUCT_ID, NULL, NULL, 0 };
  ret = hid_init();
  if (ret != HID_RET_SUCCESS) {
    fprintf(stderr, "hid_init failed with return code %d\n", ret);
    return 1;
  }
  hid = hid_new_HIDInterface();
  if (hid == 0) {
    fprintf(stderr, "hid_new_HIDInterface() failed, out of memory?\n");
    return 1;
  }

  ret = hid_force_open(hid, 0, &matcher, 3);
  if (ret != HID_RET_SUCCESS) {
    fprintf(stderr, "hid_force_open failed with return code %d\n", ret);
    return 1;
  }

char  PNreceive[SEND_PACKET_LEN];
char  SNreceive[SEND_PACKET_LEN];
char Freq[SEND_PACKET_LEN];
int StrLen1,j;

 Get_PN(PNreceive);
 fprintf(stderr," PN=  %s .\n",PNreceive);

 Get_SN(SNreceive);
 fprintf(stderr," SN=  %s .\n",SNreceive);

 ff=open("FreqCounter.txt",O_WRONLY | O_CREAT,0644);
    if(ff==1){
        printf("Error - file not created.\n");
        return 0;
    }

for (j=1;j<=1000;++j)
{
 ReadFreq (Freq);
 fprintf(stderr," Freq=  %s \n",Freq);
 write(ff,Freq,15);
}
```

```
close(ff);
ret = hid_close(hid);
if (ret != HID_RET_SUCCESS) {
    fprintf(stderr, "hid_close failed with return code %d\n", ret);
    return 1;
  }

  hid_delete_HIDInterface(&hid);

  ret = hid_cleanup();
  if (ret != HID_RET_SUCCESS) {
    fprintf(stderr, "hid_cleanup failed with return code %d\n", ret);
    return 1;
  }

  return 0;
}
```

## B2a.vi - Input/Output (IO) Control Boxes

Finds a connected device, reads model name/serial number and sets the relay outputs.

```
/* ****************************************************************
This is an example code to communicate with USB Control Driver for RF switch.
The example use libusb and libhid libraries to connect to the USB ,
and are available to downlolad from the web (GNU GPL license ).
*****************************************************************/


#include <hid.h>
#include <stdio.h>
#include <string.h>
#include <usb.h>


#define VENDOR_ID  0x20ce   // MiniCircuits Vendor ID
#define PRODUCT_ID 0x0021   // MiniCircuits USB to I/O
#define PATHLEN  2
#define SEND_PACKET_LEN 64


 HIDInterface* hid;
 hid_return ret;
 struct usb_device *usb_dev;
 struct usb_dev_handle *usb_handle;
 char buffer[80], kdname[80];


const int PATH_IN[PATHLEN] = { 0x00010005, 0x00010033 };
char  PACKET[SEND_PACKET_LEN];


bool match_serial_number(struct usb_dev_handle* usbdev, void* custom, unsigned int len)
{
  bool ret;
  char* buffer = (char*)malloc(len);
  usb_get_string_simple(usbdev, usb_device(usbdev)->descriptor.iSerialNumber,
      buffer, len);
  ret = strncmp(buffer, (char*)custom, len) == 0;
  free(buffer);
  return ret;
}


static struct usb_device *device_init(void)
{
    struct usb_bus *usb_bus;
    struct usb_device *dev;
    usb_init();
    usb_find_busses();
    usb_find_devices();
    for (usb_bus = usb_busses; usb_bus; usb_bus = usb_bus->next)
    {
        for (dev = usb_bus->devices; dev; dev = dev->next)
        {
            if ((dev->descriptor.idVendor == VENDOR_ID) &&
                (dev->descriptor.idProduct == PRODUCT_ID)) {
      return dev;
       }
        }
    }
    return NULL;
}
```

```
void Get_PN (char* PNstr)
{
        int i;
        char  PACKETreceive[SEND_PACKET_LEN];
        PACKET[0]=40;  //     PN code
        ret = hid_interrupt_write(hid, 0x01, PACKET, SEND_PACKET_LEN,1000);
    if (ret != HID_RET_SUCCESS) {
      fprintf(stderr, "hid_interrupt_write failed with return code %d\n", ret);
   }
        ret = hid_interrupt_read(hid, 0x01, PACKETreceive, SEND_PACKET_LEN,1000);
        if (ret == HID_RET_SUCCESS) {
              strncpy(PNstr,PACKETreceive,SEND_PACKET_LEN);
              for (i=0;PNstr[i+1]!='\0';i++) {
                       PNstr[i]=PNstr[i+1];
                                              }
              PNstr[i]='\0';
           }
          if (ret != HID_RET_SUCCESS) {
      fprintf(stderr, "hid_interrupt_read failed with return code %d\n", ret);   }

}


void Get_SN (char* SNstr)
{
       int i;
       char  PACKETreceive[SEND_PACKET_LEN];
       PACKET[0]=41;  //     SN Code
        ret = hid_interrupt_write(hid, 0x01, PACKET, SEND_PACKET_LEN,1000);
    if (ret != HID_RET_SUCCESS) {
      fprintf(stderr, "hid_interrupt_write failed with return code %d\n", ret);
   }
        ret = hid_interrupt_read(hid, 0x01, PACKETreceive, SEND_PACKET_LEN,1000);
        if (ret == HID_RET_SUCCESS) {
               strncpy(SNstr,PACKETreceive,SEND_PACKET_LEN);
             for (i=0;SNstr[i+1]!='\0';i++) {
                       SNstr[i]=SNstr[i+1];
                                              }
            SNstr[i]='\0';
           }
   if (ret != HID_RET_SUCCESS) {
      fprintf(stderr, "hid_interrupt_read failed with return code %d\n", ret);   }


}


void Set_Relay (int RelayNo , int On_OFF )
//  Set a specific relay On or Off
{
        int i;
        char  PACKETreceive[SEND_PACKET_LEN];
        // Writing / Reading From USB
        PACKET[0]=34;          // 34 ' code for Set 1 Relay Bit
        PACKET[1]= RelayNo;         //
        PACKET[2]= On_OFF;         //
        ret = hid_interrupt_write(hid, 0x01, PACKET, SEND_PACKET_LEN,1000);
    if (ret != HID_RET_SUCCESS) {
      fprintf(stderr, "hid_interrupt_write failed with return code %d\n", ret);
   }
        ret = hid_interrupt_read(hid, 0x01, PACKETreceive, SEND_PACKET_LEN,1000);
        //  Read packet  Packetreceive[0]=1

       if (ret != HID_RET_SUCCESS) {
       fprintf(stderr, "hid_interrupt_read failed with return code %d\n", ret);   }

}
```

```
int main( int argc, unsigned char **argv)
{
  usb_dev = device_init();

  if (usb_dev == NULL)
  {
      fprintf(stderr, "Device not found!\n");
      exit(-1);
  }
  if (usb_dev != NULL)
  {
      usb_handle = usb_open(usb_dev);
      int drstatus = usb_get_driver_np(usb_handle, 0, kdname, sizeof(kdname));
      if (kdname != NULL && strlen(kdname) > 0) {
     usb_detach_kernel_driver_np(usb_handle, 0);
      }
  }
  usb_reset(usb_handle);
  usb_close(usb_handle);
  HIDInterfaceMatcher matcher = { VENDOR_ID, PRODUCT_ID, NULL, NULL, 0 };
  ret = hid_init();
  if (ret != HID_RET_SUCCESS) {
    fprintf(stderr, "hid_init failed with return code %d\n", ret);
    return 1;
  }
  hid = hid_new_HIDInterface();
  if (hid == 0) {
    fprintf(stderr, "hid_new_HIDInterface() failed, out of memory?\n");
    return 1;
  }

  ret = hid_force_open(hid, 0, &matcher, 3);
  if (ret != HID_RET_SUCCESS) {
    fprintf(stderr, "hid_force_open failed with return code %d\n", ret);
    return 1;
  }

//////////////   Switching   ////////////////////////////////////////////////////////

char  PNreceive[SEND_PACKET_LEN];
char  SNreceive[SEND_PACKET_LEN];

int StrLen1;

 Get_PN(PNreceive);
 fprintf(stderr," PN=  %s .\n",PNreceive);

 Get_SN(SNreceive);
 fprintf(stderr," SN=  %s .\n",SNreceive);

  Set_Relay(0,1); // turn on relay 0
 Set_Relay(5,1); // turn on relay 5
 Set_Relay(0,0); // turn off relay 0
 ////////////////////////////////////////////////////////////////////////////////////

  ret = hid_close(hid);
  if (ret != HID_RET_SUCCESS) {
    fprintf(stderr, "hid_close failed with return code %d\n", ret);
    return 1;
  }

  hid_delete_HIDInterface(&hid);

  ret = hid_cleanup();
  if (ret != HID_RET_SUCCESS) {
    fprintf(stderr, "hid_cleanup failed with return code %d\n", ret);
    return 1;
  }

  return 0;
}
```

## B2a.vii - Programmable Attenuator (Single Device)

RUDAT.c provides a simple console program to set the attenuation and read the attenuator model name and serial number.

The libusb and libhid libraries are required to enable the program to interface with the devices by USB (see USB Control in a Linux Environment).

To compile and run the program:

5. Open the terminal
6. Type “sudo su” in order to get root privilege (necessary for control over USB)
7. Type “gcc RUDAT.c -o RUDAT -lusb -lhid” to compile the code
8. Type “./RUDAT <attenuation>” in order to run the code (entering the required attenuation)

```
// Requires libusb and libhid libraries for USB control available under GNU GPL license

#include <usb.h>
#include <hid.h>
#include <stdio.h>
#include <string.h>

#define VENDOR_ID  0x20ce   // MiniCircuits Vendor ID
#define PRODUCT_ID 0x0023   // MiniCircuits HID USB RUDAT Product ID
#define PATHLEN  2
#define SEND_PACKET_LEN 64

 HIDInterface* hid;
 hid_return ret;
 struct usb_device *usb_dev;
 struct usb_dev_handle *usb_handle;
 char buffer[80], kdname[80];

const int PATH_IN[PATHLEN] = { 0x00010005, 0x00010033 };
char  PACKET[SEND_PACKET_LEN];

bool match_serial_number(struct usb_dev_handle* usbdev, void* custom, unsigned int len)
{
  bool ret;
  char* buffer = (char*)malloc(len);
  usb_get_string_simple(usbdev, usb_device(usbdev)->descriptor.iSerialNumber,
      buffer, len);
  ret = strncmp(buffer, (char*)custom, len) == 0;
  free(buffer);
  return ret;
}

static struct usb_device *device_init(void)
{
    struct usb_bus *usb_bus;
    struct usb_device *dev;
    usb_init();
    usb_find_busses();
    usb_find_devices();
    for (usb_bus = usb_busses; usb_bus; usb_bus = usb_bus->next)
    {
        for (dev = usb_bus->devices; dev; dev = dev->next)
        {
            if ((dev->descriptor.idVendor == VENDOR_ID) &&
                (dev->descriptor.idProduct == PRODUCT_ID)) {
      return dev;
       }
        }
    }
    return NULL;
}
```

```
void Get_PN (char* PNstr)
{
        int i;
        char  PACKETreceive[SEND_PACKET_LEN];
        PACKET[0]=40;  //     PN code
        ret = hid_interrupt_write(hid, 0x01, PACKET, SEND_PACKET_LEN,1000);
    if (ret != HID_RET_SUCCESS) {
      fprintf(stderr, "hid_interrupt_write failed with return code %d\n", ret);
   }
        ret = hid_interrupt_read(hid, 0x01, PACKETreceive, SEND_PACKET_LEN,1000);
        if (ret == HID_RET_SUCCESS) {
              strncpy(PNstr,PACKETreceive,SEND_PACKET_LEN);
              for (i=0;PNstr[i+1]!='\0';i++) {
                       PNstr[i]=PNstr[i+1];
                                              }
              PNstr[i]='\0';
           }
          if (ret != HID_RET_SUCCESS) {
      fprintf(stderr, "hid_interrupt_read failed with return code %d\n", ret);   }
}

void Get_SN (char* SNstr)
{
       int i;
       char  PACKETreceive[SEND_PACKET_LEN];
       PACKET[0]=41;  //     SN Code
        ret = hid_interrupt_write(hid, 0x01, PACKET, SEND_PACKET_LEN,1000);
    if (ret != HID_RET_SUCCESS) {
      fprintf(stderr, "hid_interrupt_write failed with return code %d\n", ret);
   }
        ret = hid_interrupt_read(hid, 0x01, PACKETreceive, SEND_PACKET_LEN,1000);
        if (ret == HID_RET_SUCCESS) {
               strncpy(SNstr,PACKETreceive,SEND_PACKET_LEN);
             for (i=0;SNstr[i+1]!='\0';i++) {
                       SNstr[i]=SNstr[i+1];
                                              }
             SNstr[i]='\0';
           }
   if (ret != HID_RET_SUCCESS) {
      fprintf(stderr, "hid_interrupt_read failed with return code %d\n", ret);   }
}

void ReadAtt (char* AttStr)
{
       int i;

       char  PACKETreceive[SEND_PACKET_LEN];
       PACKET[0]=18;  //     Ruturn attenuation  code
       ret = hid_interrupt_write(hid, 0x01, PACKET, SEND_PACKET_LEN,1000);
    if (ret != HID_RET_SUCCESS) {
      fprintf(stderr, "hid_interrupt_write failed with return code %d\n", ret);
   }
        ret = hid_interrupt_read(hid, 0x01, PACKETreceive, SEND_PACKET_LEN,1000);
        if (ret == HID_RET_SUCCESS) {
               strncpy(AttStr,PACKETreceive,SEND_PACKET_LEN);
             for (i=0;AttStr[i+1]!='\0';i++) {
                       AttStr[i]=AttStr[i+1];
                                              }
             AttStr[i]='\0';
           }

   if (ret != HID_RET_SUCCESS) {
      fprintf(stderr, "hid_interrupt_read failed with return code %d\n", ret);   }
}
```

```
void Set_Attenuation (unsigned char **AttValue)
{
        int i;
        char  PACKETreceive[SEND_PACKET_LEN];
        PACKET[0]=19;          // Set Attenuation code is 19.
        PACKET[1]= (int)atoi(AttValue[1]);
        float t1=(float)(atof(AttValue[1]));
        PACKET[2]=  (int) ((t1-PACKET[1])*4);
        ret = hid_interrupt_write(hid, 0x01, PACKET, SEND_PACKET_LEN,1000);
    if (ret != HID_RET_SUCCESS) {
      fprintf(stderr, "hid_interrupt_write failed with return code %d\n", ret);
   }
        ret = hid_interrupt_read(hid, 0x01, PACKETreceive, SEND_PACKET_LEN,1000);
        //  Read packet  Packetreceive[0]=1

       if (ret != HID_RET_SUCCESS) {
       fprintf(stderr, "hid_interrupt_read failed with return code %d\n", ret);   }

}

int main( int argc, unsigned char **argv)
{

  char AttValue[3];
  float LastAtt=0.0;
  usb_dev = device_init();

  if (usb_dev == NULL)
  {
      fprintf(stderr, "Device not found!\n");
      exit(-1);
  }

  if (usb_dev != NULL)
  {
      usb_handle = usb_open(usb_dev);
      int drstatus = usb_get_driver_np(usb_handle, 0, kdname, sizeof(kdname));
      if (kdname != NULL && strlen(kdname) > 0) {
     usb_detach_kernel_driver_np(usb_handle, 0);
      }
  }

  usb_reset(usb_handle);
  usb_close(usb_handle);
  HIDInterfaceMatcher matcher = { VENDOR_ID, PRODUCT_ID, NULL, NULL, 0 };
  ret = hid_init();

  if (ret != HID_RET_SUCCESS) {
    fprintf(stderr, "hid_init failed with return code %d\n", ret);
    return 1;
  }
  hid = hid_new_HIDInterface();
  if (hid == 0) {
    fprintf(stderr, "hid_new_HIDInterface() failed, out of memory?\n");
    return 1;
  }

  ret = hid_force_open(hid, 0, &matcher, 3);
  if (ret != HID_RET_SUCCESS) {
    fprintf(stderr, "hid_force_open failed with return code %d\n", ret);
    return 1;
  }
char  PNreceive[SEND_PACKET_LEN];
char  SNreceive[SEND_PACKET_LEN];

int StrLen1;
```

```
 Get_PN(PNreceive);
 fprintf(stderr," PN=  %s .\n",PNreceive);

 Get_SN(SNreceive);
 fprintf(stderr," SN=  %s .\n",SNreceive);

 Set_Attenuation(argv);  // set attenuation
 ReadAtt ( AttValue);
 LastAtt=(int)(AttValue[0])+(float)(AttValue[1])/4;
 fprintf(stderr," Att=  %f \n",LastAtt);



  ret = hid_close(hid);
  if (ret != HID_RET_SUCCESS) {
    fprintf(stderr, "hid_close failed with return code %d\n", ret);
    return 1;
  }


  hid_delete_HIDInterface(&hid);

  ret = hid_cleanup();
  if (ret != HID_RET_SUCCESS) {
    fprintf(stderr, "hid_cleanup failed with return code %d\n", ret);
    return 1;
  }

  return 0;
}
```

## B2a.viii - Programmable Attenuator (Single Device by Serial Number)

RUDAT_BySN2.c is a simple console program to set the attenuation of a specific programmable attenuator, specified by serial number.

The libusb and libhid libraries are required to enable the program to interface with the devices by USB (see USB Control in a Linux Environment).

To compile and run the program:

1. Open the terminal
2. Type “sudo su” in order to get root privilege (necessary for control over USB)
3. Type “gcc RUDAT_BySN2.c -o RUDAT_BySN -lusb -lhid” to compile the code
4. Type “./RUDAT_BySN [serial_number] [attenuation]” in order to run the code (entering the required serial number and attenuation)

```
#include <hid.h>
#include <stdio.h>
#include <string.h>
#include <usb.h>
#define VENDOR_ID  0x20ce   // MiniCircuits Vendor ID
#define PRODUCT_ID 0x0023   // MiniCircuits HID RUDAT Product ID
#define PATHLEN  2
#define SEND_PACKET_LEN 64

 HIDInterface* hid;
 hid_return ret;
 struct usb_device *usb_dev;
 struct usb_dev_handle *usb_handle;
 char buffer[80], kdname[80];

const int PATH_IN[PATHLEN] = { 0x00010005, 0x00010033 };
char  PACKET[SEND_PACKET_LEN];
char  PNreceive[SEND_PACKET_LEN];
char  SNreceive[SEND_PACKET_LEN];

bool match_serial_number(struct usb_dev_handle* usbdev, void* custom, unsigned int len)
{
  bool ret;
  char* buffer = (char*)malloc(len);
  usb_get_string_simple(usbdev, usb_device(usbdev)->descriptor.iSerialNumber,
      buffer, len);
  ret = strncmp(buffer, (char*)custom, len) == 0;
  free(buffer);
  return ret;
}

void Get_PN (char* PNstr)
{
        int i;
        char  PACKETreceive[SEND_PACKET_LEN];
        PACKET[0]=40;  //     PN code
        ret = hid_interrupt_write(hid, 0x01, PACKET, SEND_PACKET_LEN,1000);
       if (ret != HID_RET_SUCCESS) {
              fprintf(stderr, "hid_interrupt_write failed with return code %d\n", ret);
        }
        ret = hid_interrupt_read(hid, 0x01, PACKETreceive, SEND_PACKET_LEN,1000);
        if (ret == HID_RET_SUCCESS) {
             strncpy(PNstr,PACKETreceive,SEND_PACKET_LEN);
             for (i=0;PNstr[i+1]!='\0';i++) {
                      PNstr[i]=PNstr[i+1];
                                              }
             PNstr[i]='\0';
          }
       if (ret != HID_RET_SUCCESS) {
              fprintf(stderr, "hid_interrupt_read failed with return code %d\n", ret);   }
}
```

```
void Get_SN (char* SNstr)
{
       int i;
       char  PACKETreceive[SEND_PACKET_LEN];
       PACKET[0]=41;  //     SN Code
        ret = hid_interrupt_write(hid, 0x01, PACKET, SEND_PACKET_LEN,1000);
       if (ret != HID_RET_SUCCESS) {
              fprintf(stderr, "hid_interrupt_write failed with return code %d\n", ret);
       }
        ret = hid_interrupt_read(hid, 0x01, PACKETreceive, SEND_PACKET_LEN,1000);
        if (ret == HID_RET_SUCCESS) {
              strncpy(SNstr,PACKETreceive,SEND_PACKET_LEN);
            for (i=0;SNstr[i+1]!='\0';i++) {
                      SNstr[i]=SNstr[i+1];
                                              }
            SNstr[i]='\0';
          }
       if (ret != HID_RET_SUCCESS) {
              fprintf(stderr, "hid_interrupt_read failed with return code %d\n", ret);   }


}

void ReadAtt (char* AttStr)
{
       int i;

       char  PACKETreceive[SEND_PACKET_LEN];
       PACKET[0]=18;  //     Ruturn attenuation  code
       ret = hid_interrupt_write(hid, 0x01, PACKET, SEND_PACKET_LEN,1000);
    if (ret != HID_RET_SUCCESS) {
      fprintf(stderr, "hid_interrupt_write failed with return code %d\n", ret);
   }
        ret = hid_interrupt_read(hid, 0x01, PACKETreceive, SEND_PACKET_LEN,1000);
        if (ret == HID_RET_SUCCESS) {
              strncpy(AttStr,PACKETreceive,SEND_PACKET_LEN);
            for (i=0;AttStr[i+1]!='\0';i++) {
                      AttStr[i]=AttStr[i+1];
                                              }
            AttStr[i]='\0';
          }

   if (ret != HID_RET_SUCCESS) {
      fprintf(stderr, "hid_interrupt_read failed with return code %d\n", ret);   }


}

void Set_Attenuation (float AttValue)
{
        int i;
        char  PACKETreceive[SEND_PACKET_LEN];
        PACKET[0]=19;          // for Models: RUDAT-6000-90", RUDAT-6000-60, RUDAT-6000-30
RCDAT-6000-90", RCDAT-6000-60, RCDAT-6000-30  Set Attenuation code is 19.
        PACKET[1]= (int)(AttValue);
        PACKET[2]=  (int) ((AttValue-PACKET[1])*4);
        ret = hid_interrupt_write(hid, 0x01, PACKET, SEND_PACKET_LEN,1000);
    if (ret != HID_RET_SUCCESS) {
      fprintf(stderr, "hid_interrupt_write failed with return code %d\n", ret);
   }
        ret = hid_interrupt_read(hid, 0x01, PACKETreceive, SEND_PACKET_LEN,1000);
        //  Read packet  Packetreceive[0]=1

       if (ret != HID_RET_SUCCESS) {
       fprintf(stderr, "hid_interrupt_read failed with return code %d\n", ret);   }

}
```

```
int  device_init(char * SN1)
{
    struct usb_bus *usb_bus;
    struct usb_device *dev;
    int SNfound ;
    usb_init();

    int n=0;
    usb_find_busses();
    usb_find_devices();
    ret = hid_init();
    if (ret != HID_RET_SUCCESS)
    {
         fprintf(stderr, "hid_init failed with return code %d \n", ret);
         return 1;
    }
    for (usb_bus = usb_busses; usb_bus; usb_bus = usb_bus->next)
    {
        for (dev = usb_bus->devices; dev; dev = dev->next)
        {
            if ((dev->descriptor.idVendor == VENDOR_ID) &&
                (dev->descriptor.idProduct == PRODUCT_ID))
            {
        ////////////////////////////////////////////////////////////////////////
              n++;
              usb_handle = usb_open(dev);
              int drstatus = usb_get_driver_np(usb_handle, 0, kdname, sizeof(kdname));
              if (kdname != NULL && strlen(kdname) > 0)
                 usb_detach_kernel_driver_np(usb_handle, 0);
              usb_reset(usb_handle);
              usb_close(usb_handle);
              HIDInterfaceMatcher matcher = { VENDOR_ID, PRODUCT_ID, NULL, NULL, 0 };
              hid = hid_new_HIDInterface();
              if (hid != 0)
                {
                  ret = hid_force_open(hid, 0, &matcher, 3);
                  if (ret != HID_RET_SUCCESS)
                  {
                    fprintf(stderr, "hid_force_open failed with return code %d\n", ret);
                  }
                  else
                  {
                     Get_SN(SNreceive);
                     SNfound = strcmp (SNreceive,SN1);
                     if (SNfound!=0) hid=NULL; else return 0;
                  }
                }
        ////////////////////////////////////////////////////////////////////////
            }
        }
    }

    return 0;
}
```

```
int main( int argc, unsigned char **argv)
{
   int y=device_init(argv[1]);
   char AttValue1[3],AttValue2[3];
   float LastAtt=0.0;

        //////////////   Query devices
        ////////////////////////////////////////////////////////////////////////


char  RFpower[SEND_PACKET_LEN];
int StrLen1;
float Att1=0.0;

 Att1=(float)(atof(argv[2]));
 Set_Attenuation(Att1);  // set attenuation
 ReadAtt(AttValue1);
 LastAtt=(int)(AttValue1[0])+(float)(AttValue1[1])/4;
 fprintf(stderr," Attenuation=  %f \n",LastAtt);

        ////////////////////////////////////////////////////////////////////////

  ret = hid_close(hid);

  if (ret != HID_RET_SUCCESS) {
    fprintf(stderr, "hid_close failed with return code %d\n", ret);
    return 1;
  }

  hid_delete_HIDInterface(&hid);
  ret = hid_cleanup();
  if (ret != HID_RET_SUCCESS) {
    fprintf(stderr, "hid_cleanup failed with return code %d\n", ret);
    return 1;
  }

  return 0;
}
```

## B2a.ix - Programmable Attenuators (Multiple Devices)

RUDAT_2devices.c is a simple console program to set the attenuation of a pair of programmable attenuators. The code can be adapted to control more than 2 devices.

The libusb and libhid libraries are required to enable the program to interface with the devices by USB (see USB Control in a Linux Environment).

To compile and run the program:

1. Open the terminal
2. Type "sudo su" in order to get root privilege (necessary for control over USB)
3. Type "gcc RUDAT_2devices.c -o RUDAT_BySN -lusb -lhid" to compile the code
4. Type "./RUDAT_2devices [attenuation_1] [attenuation_2]" in order to run the code (entering the attenuation values to set for the 2 attenuators)

```
#include <hid.h>
#include <stdio.h>
#include <string.h>
#include <usb.h>

#define VENDOR_ID  0x20ce   // MiniCircuits Vendor ID
#define PRODUCT_ID 0x0023   // MiniCircuits HID RUDAT Product ID
#define PATHLEN  2
#define SEND_PACKET_LEN 64

 HIDInterface* hid1;
 HIDInterface* hid2;

 hid_return ret;
 struct usb_device *usb_dev;
 struct usb_dev_handle *usb_handle;
 char buffer[80], kdname[80];

const int PATH_IN[PATHLEN] = { 0x00010005, 0x00010033 };
char  PACKET[SEND_PACKET_LEN];

bool match_serial_number(struct usb_dev_handle* usbdev, void* custom, unsigned int len)
{
  bool ret;
  char* buffer = (char*)malloc(len);
  usb_get_string_simple(usbdev, usb_device(usbdev)->descriptor.iSerialNumber,
      buffer, len);
  ret = strncmp(buffer, (char*)custom, len) == 0;
  free(buffer);
  return ret;
}
```

```
int  device_init(void)
{
    struct usb_bus *usb_bus;
    struct usb_device *dev;
    usb_init();

    int n=0;
    usb_find_busses();
    usb_find_devices();
    ret = hid_init();
    if (ret != HID_RET_SUCCESS)
    {
         fprintf(stderr, "hid_init failed with return code %d \n", ret);
         return 1;
    }
    for (usb_bus = usb_busses; usb_bus; usb_bus = usb_bus->next)
    {
        for (dev = usb_bus->devices; dev; dev = dev->next)
        {
            if ((dev->descriptor.idVendor == VENDOR_ID) &&
                (dev->descriptor.idProduct == PRODUCT_ID))
            {
        ////////////////////////////////////////////////
              n++;
              usb_handle = usb_open(dev);
              int drstatus = usb_get_driver_np(usb_handle, 0, kdname, sizeof(kdname));
              if (kdname != NULL && strlen(kdname) > 0)
                 usb_detach_kernel_driver_np(usb_handle, 0);
              usb_reset(usb_handle);
              usb_close(usb_handle);
              HIDInterfaceMatcher matcher = { VENDOR_ID, PRODUCT_ID, NULL, NULL, 0 };

              if (n==1)
              {
                hid1 = hid_new_HIDInterface();
                if (hid1 != 0)
                {
                  ret = hid_force_open(hid1, 0, &matcher, 3);
                  if (ret != HID_RET_SUCCESS)
                  {
                    fprintf(stderr, "hid_force_open failed with return code %d\n", ret);
                  }

                }
        ////////////////////////////////////////////////
               }
               else // n=2
               {
                hid2 = hid_new_HIDInterface();
                if (hid2 != 0)
                {
                  ret = hid_force_open(hid2, 0, &matcher, 3);
                  if (ret != HID_RET_SUCCESS)
                  {
                    fprintf(stderr, "hid_force_open failed with return code %d\n", ret);
                  }
        ////////////////////////////////////////////////
                 }
              }
            }
        }
    }
    return 0;
}
```

```
void Get_PN (char* PNstr,HIDInterface* hid)
{
        int i;
        char  PACKETreceive[SEND_PACKET_LEN];
        PACKET[0]=40;  //     PN code
        ret = hid_interrupt_write(hid, 0x01, PACKET, SEND_PACKET_LEN,1000);
       if (ret != HID_RET_SUCCESS) {
              fprintf(stderr, "hid_interrupt_write failed with return code %d\n", ret);
        }
        ret = hid_interrupt_read(hid, 0x01, PACKETreceive, SEND_PACKET_LEN,1000);
        if (ret == HID_RET_SUCCESS) {
             strncpy(PNstr,PACKETreceive,SEND_PACKET_LEN);
             for (i=0;PNstr[i+1]!='\0';i++) {
                      PNstr[i]=PNstr[i+1];
                                              }
             PNstr[i]='\0';
          }
       if (ret != HID_RET_SUCCESS) {
              fprintf(stderr, "hid_interrupt_read failed with return code %d\n", ret);   }
}

void Get_SN (char* SNstr,HIDInterface* hid)
{
       int i;
       char  PACKETreceive[SEND_PACKET_LEN];
       PACKET[0]=41;  //     SN Code
        ret = hid_interrupt_write(hid, 0x01, PACKET, SEND_PACKET_LEN,1000);
       if (ret != HID_RET_SUCCESS) {
              fprintf(stderr, "hid_interrupt_write failed with return code %d\n", ret);
        }
        ret = hid_interrupt_read(hid, 0x01, PACKETreceive, SEND_PACKET_LEN,1000);
        if (ret == HID_RET_SUCCESS) {
              strncpy(SNstr,PACKETreceive,SEND_PACKET_LEN);
            for (i=0;SNstr[i+1]!='\0';i++) {
                      SNstr[i]=SNstr[i+1];
                                              }
            SNstr[i]='\0';
          }
       if (ret != HID_RET_SUCCESS) {
              fprintf(stderr, "hid_interrupt_read failed with return code %d\n", ret);   }
}

void ReadAtt (char* AttStr,HIDInterface* hid)
{
       int i;

       char  PACKETreceive[SEND_PACKET_LEN];
       PACKET[0]=18;  //     Ruturn attenuation  code
       ret = hid_interrupt_write(hid, 0x01, PACKET, SEND_PACKET_LEN,1000);
    if (ret != HID_RET_SUCCESS) {
      fprintf(stderr, "hid_interrupt_write failed with return code %d\n", ret);
   }
        ret = hid_interrupt_read(hid, 0x01, PACKETreceive, SEND_PACKET_LEN,1000);
        if (ret == HID_RET_SUCCESS) {
              strncpy(AttStr,PACKETreceive,SEND_PACKET_LEN);
            for (i=0;AttStr[i+1]!='\0';i++) {
                      AttStr[i]=AttStr[i+1];
                                              }
            AttStr[i]='\0';
          }

   if (ret != HID_RET_SUCCESS) {
      fprintf(stderr, "hid_interrupt_read failed with return code %d\n", ret);   }
}
```

```
void Set_Attenuation (float AttValue,HIDInterface* hid)
{
        int i;
        char  PACKETreceive[SEND_PACKET_LEN];
        PACKET[0]=19;          // Set Attenuation code is 19.
        PACKET[1]= (int)(AttValue);
        PACKET[2]=  (int) ((AttValue-PACKET[1])*4);
        ret = hid_interrupt_write(hid, 0x01, PACKET, SEND_PACKET_LEN,1000);
    if (ret != HID_RET_SUCCESS) {
      fprintf(stderr, "hid_interrupt_write failed with return code %d\n", ret);
   }
        ret = hid_interrupt_read(hid, 0x01, PACKETreceive, SEND_PACKET_LEN,1000);
        //  Read packet  Packetreceive[0]=1

       if (ret != HID_RET_SUCCESS) {
       fprintf(stderr, "hid_interrupt_read failed with return code %d\n", ret);   }
}

int main( int argc, unsigned char **argv)
{
   int y=device_init();
   char AttValue1[3],AttValue2[3];
   float LastAtt=0.0;

char  PNreceive[SEND_PACKET_LEN];
char  SNreceive[SEND_PACKET_LEN];
char  RFpower[SEND_PACKET_LEN];
int StrLen1;
float Att1=0.0;
float Att2=0.0;

 Get_PN(PNreceive,hid1);
 fprintf(stderr," PN1=  %s .\n",PNreceive);
 Get_PN(PNreceive,hid2);
 fprintf(stderr," PN2=  %s .\n",PNreceive);

 Get_SN(SNreceive,hid1);
 fprintf(stderr," SN1=  %s .\n",SNreceive);

 Get_SN(SNreceive,hid2);
 fprintf(stderr," SN2=  %s .\n",SNreceive);

 Att1=(float)(atof(argv[1]));
 Set_Attenuation(Att1,hid1);  // set attenuation
 ReadAtt(AttValue1,hid1);
 LastAtt=(int)(AttValue1[0])+(float)(AttValue1[1])/4;
 fprintf(stderr," Attenuation1=  %f \n",LastAtt);

 Att2=(float)(atof(argv[2]));
 Set_Attenuation(Att2,hid2);  // set attenuation
 ReadAtt(AttValue2,hid2);
 LastAtt=(int)(AttValue2[0])+(float)(AttValue2[1])/4;
 fprintf(stderr," Attenuation2=  %f \n",LastAtt);

  ret = hid_close(hid1);
  ret = hid_close(hid2);

  if (ret != HID_RET_SUCCESS) {
    fprintf(stderr, "hid_close failed with return code %d\n", ret);
    return 1;
  }

  hid_delete_HIDInterface(&hid1);
  hid_delete_HIDInterface(&hid2);
  ret = hid_cleanup();
  if (ret != HID_RET_SUCCESS) {
    fprintf(stderr, "hid_cleanup failed with return code %d\n", ret);
    return 1;
  }

  return 0;
}
```

# B3 - Visual Basic Programming

## B3a - USB Control Using the ActiveX DLL

These examples demonstrate control of Mini-Circuits' PTE products using Visual Basic in the following environment:

1. Host computer running a Windows operating system
2. PTE connected by the USB interface
3. Mini-Circuits ActiveX DLL installed and registered on the computer

### B3a.i - Synthesized Signal Generator

Set the RF output of the generator.

```
' mcl gen.dll should be loaded as a reference file to the project

Dim MyGen As New MCL_Gen.USB_Gen

MyGen.Connect

x = MyGen.SetFreqAndPower(1000, -5, 0)
MyGen.SetPowerON

MyGen.Disconnect
```

### B3a.ii - Power Sensor

Set the calibration frequency of the power sensor and read the power.

```
' mcl pm.dll should be loaded as a reference file to the project

Dim pm1 As New mcl_pm.usb_pm, Status As Short

Dim SN As String = ""           ' Serial Number needed if more than 1 sensor connected
Dim ReadResult As Single

Status = pm1.Open_Sensor(SN)    ' Open connection
pm1.Freq = 3000                 ' Set the Frequency cal factor in MHz
ReadResult = pm1.ReadPower()    ' Read the power in dbm
pm1.Close_Sensor()              ' Close connection
```

### B3a.iii - Frequency Counter

Read the frequency measurement.

```
' mcl_freqcounter.dll should be loaded as a reference file to the project

Dim FCTR As New MCL_FreqCounter.USB_FreqCounter,Status as integer
dim Freq as double

Status=FCTR.Connect
Status = FCTR.ReadFreq(Freq)

FCTR.Disconnect
```

## B3a.iv - Input/Output (IO) Control Boxes

Set the I/O Control Box relay output.

```
' mcl usb to io.dll should be loaded as a reference file to the project

Dim IO1 As New mcl_USB_To_IO.USB_IO,Status as integer

Status=IO1.Connect
Status = IO1.Set_Relay(5,1) ' Set Relay5 ON

IO1.Disconnect
```

## B3a.v - USB & RS232 to SPI Converters

Send SPI data from the USB port.

```
' mcl_usb_rs232_to_spi.dll should be loaded as a reference file to the project

Dim SPI1 As New MCL_RS232_USB_To_SPI.USB_To_SPI
Dim ReceivedData as double, DataToSend as double
Dim x as integer

x = SPI1.Connect                              ' Open the connection

' Send the value 56 in 8 bits and read 8 bits from SPI
DataToSend = 56
ReceivedData = SPI1.Send_Receive_SPI(8, DataToSend, 1, 0)

SPI1.Disconnect                               ' Close the connection
```

## B3a.vi - Programmable Attenuators

Set and read the attenuation level.

```
' mcl rudat.dll should be loaded as a reference file to the project

Dim att1 As New mcl_RUDAT.USB_DAT, Status As Short

Dim SN As String = ""                 ' Serial Number needed for multiple attenuators
Dim Attenuation As Single = 0

Status = att1.Connect(SN)             ' Open connection

att1.SetAttenuation(37)               ' Set attenuation
att1.Read_Att(Attenuation)            ' Read attenuation

att1.Disconnect()                     ' Close connection
```

## B3a.vii - Switch Boxes

Identify connected switches, set and read switch states.

```
Public objSwitch1 As New MCL_RF_Switch_Controller.USB_RF_Switch
    'Instantiate new switch object, assign to variable objSwitch1


Private Sub ConnectSwitchBox()

'Look for any connected switch matrices and connects to the first one found
'Note: -Not strictly necessary here as Connect with no argument will achieve the same
'      -Demonstrates the concept if there is a need to identify a specific switch

    Dim st_SN_List As String
    Dim array_SN() As String
    Dim intStatus As Integer

    'Find any connected serial numbers
    If objSwitch1.Get_Available_SN_List(st_SN_List) > 0 Then
        'Get list of available SNs
        array_SN() = Split(st_SN_List, " ")
        'Split the list into an array of serial numbers
    End If

    intStatus = objSwitch1.Connect(array_SN(0))
        'Creates connection to the first switch matrix found above

End Sub


Private Sub DisconnectSwitch()

'Close the connection to the switch matrix
'This is recommended before terminating the programme

    Call objSwitch1.Disconnect

End Sub


Private Sub ReportSwitchCondition()

'Report the model name, serial number and current temperature

    Dim stModel As String
    Dim stSerial As String

    If objSwitch1.Read_ModelName(stModel) > 0 And objSwitch1.Read_SN(stSerial) > 0 Then
        MsgBox ("The connected switch is " & stModel & ", serial number " & stSerial & ".")
        'Display a message with the part number and serial number
    End If

    MsgBox ("Device temperature is " & objSwitch1.GetDeviceTemperature(1))
    'Display a message box with the device temperature

    If objSwitch1.GetHeatAlarm > 0 Then
        MsgBox ("Device temperature has exceeded specified limit")
        'Display a warning message
    End If

End Sub
```

```
Private Sub SetSwitchState(stSwitch as String, intState as Integer)

'The user specifies the switch, A to H (model dependent), and the state (0 or 1)

    Dim intStatus As Integer

    If Len(stSwitch) > 1 Or Asc(stSwitch) < 65 Or Asc (stSwitch) > 72 Then
        'Check specified switch is one character with ASCII value between 65 and 72 (A to H)
        MsgBox ("Invalid switch specified.")
        Exit Sub
    End If
    If intState > 1 Then
        'Check specified switch state is 0 or 1
        MsgBox ("Invalid switch state specified.")
        Exit Sub
    End If

    intStatus = objSwitch1.Set_Switch(stSwitch, intState)

    If intStatus = 0 Then
        MsgBox ("Unable to communicate with switch box.")
    Else
    If intStatus = 2 Then
        MsgBox ("Switching did not complete.  The 24V DC supply is disconnected.")
    Else
        'Switching completed successfully
    End If
    End If

End Sub


Private Sub GetSwitchState()

'Get the switch status and interpret the decimal value as a series of binary bits

    Dim intState As Integer
    Dim intSwitchState(8) As Integer
    Dim intBit As Integer

    intBit = 7      'Assume 8 switches (0 to 7)

    If objSwitch1.GetSwitchesStatus(intState) = 1 Then  'Communication successful

        'Loop bit by bit to calculate each switch state, starting at MSB
        Do Until intBit + 1 = 0

            If intState / (2 ^ (intBit)) >= 1 Then
                    'If >0 then the binary bit is 1 (the remainder is for LSBs)
                intSwitchState(intBit) = 1
                    'Store the switch state in the array of switch states
                intState = intState - (2 ^ (intBit))
                    'Remove this bit value from the equation for the next bit
            End If

            Select Case intSwitchState(intBit)
                    'Report the switch state in plain English
            Case 0
                MsgBox "Switch " & Chr(intBit + 65) & " is set Com to Port 1"
            Case 1
                MsgBox "Switch " & Chr(intBit + 65) & " is set Com to Port 2"
            End Select
            'The Chr function converts an ASCII code to the text character
            'The +65 offset brings 0 to 7 in line with the ASCII codes for A to H

            intBit = intBit - 1       'Decrement the bit number and keep looping
        Loop

    Else
        MsgBox ("Unable to communicate with switch box")
    End If

End Sub
```

# B3b - RS232 Control

These examples demonstrate control of Mini-Circuits' PTE products using Visual Basic in the following environment:

1. Host computer running a Windows operating system
2. PTE connected by the RS232 serial interface

## B3b.i - Programmable Attenuators

Read model name and serial number.

```
Private Sub OpenRS232Port(PortNo As Integer)
On Error GoTo err1
'Set MSComm1 = CreateObject("MSCommLib.MsComm")
If MSComm1.PortOpen Then MSComm1.PortOpen = False
 MSComm1.CommPort = PortNo ' 1
    ' 9600 baud, N parity, 8 data, and 1 stop bit.
    MSComm1.Settings = "9600,N,8,1"
    MSComm1.InputLen = 1
    MSComm1.PortOpen = True
    Exit Sub
err1:
' MsgBox Error$, vbCritical
 Exit Sub
End Sub


Private Sub ReadModel_SN_RS232()
' Read Model Name and SN
On Error GoTo err1
 Dim Instring As String
 Dim str1$, model$, SN$
    str1$ = "M"
    MSComm1.Output = str1$ & Chr$(13)
    model$ = ""
    Instring = MSComm1.Input
    j = 0
    While Instring <> Chr$(13) And j < 10000
     If Len(Instring) > 0 Then If Asc(Instring) <> 10 Then model$ = model$ & Instring
    Instring = MSComm1.Input
    j = j + 1
    Wend

   While MSComm1.Input <> "": Wend  ' empty buffer

    str1$ = "S"
    MSComm1.Output = str1$ & Chr$(13)
    SN$ = ""
    Instring = MSComm1.Input
    j = 0
    While Instring <> Chr$(13) And j < 10000
    If Len(Instring) > 0 Then If Asc(Instring) <> 10 Then SN$ = SN$ & Instring
    Instring = MSComm1.Input
    j = j + 1
    Wend


   While MSComm1.Input <> "": Wend  ' empty buffer

 Exit Sub
err1:
 Exit Sub
End Sub
```

## B3b.ii - RS232 to SPI Converters

Read model name/serial number and send SPI data.

```
Private Sub OpenRS232Port(PortNo As Integer)
On Error GoTo err1
'Set MSComm1 = CreateObject("MSCommLib.MsComm")
If MSComm1.PortOpen Then MSComm1.PortOpen = False
 MSComm1.CommPort = PortNo ' 1
    ' 9600 baud, E parity, 8 data, and 1 stop bit.
    MSComm1.Settings = "9600,E,8,1"
    MSComm1.InputLen = 1
    MSComm1.PortOpen = True
    Exit Sub
err1:
' MsgBox Error$, vbCritical
 Exit Sub
End Sub


Private Sub ReadModel_SN_RS232()
' Read Model Name and SN
On Error GoTo err1
 Dim Instring As String
 Dim str1$, model$, SN$
    str1$ = "M"
    MSComm1.Output = str1$ & Chr$(13)
    model$ = ""
    Instring = MSComm1.Input
    j = 0
    While Instring <> Chr$(13) And j < 10000
     If Len(Instring) > 0 Then If Asc(Instring) <> 10 Then model$ = model$ & Instring
    Instring = MSComm1.Input
    j = j + 1
    Wend

   While MSComm1.Input <> "": Wend  ' empty buffer

    str1$ = "S"
    MSComm1.Output = str1$ & Chr$(13)
    SN$ = ""
    Instring = MSComm1.Input
    j = 0
    While Instring <> Chr$(13) And j < 10000
    If Len(Instring) > 0 Then If Asc(Instring) <> 10 Then SN$ = SN$ & Instring
    Instring = MSComm1.Input
    j = j + 1
    Wend


   While MSComm1.Input <> "": Wend  ' empty buffer

 Exit Sub
err1:
 Exit Sub
End Sub
```

```
Private Sub SendSPI_RS232()
On Error GoTo err1
   Dim Instring As String
    Dim SPI_STR as string
    SPI_STR="10110111"
    While MSComm1.Input <> "": Wend  ' clean buffer
    str1$ = "B" & SPI_STR & "E"
    MSComm1.Output = str1$ & Chr$(13)
   ' str11$ = MSComm1.Input
    Ret$ = ""
    Instring = MSComm1.Input
    j = 0
    While Instring <> Chr$(13) And j < 100000
   ' Ret$ = Ret$ & Instring
    If Len(Instring) > 0 Then If Asc(Instring) <> 10 Then Ret$ = Ret$ & Instring
    Instring = MSComm1.Input
    j = j + 1
    Wend
  ' If Ret$ = "ACK" Then OK else Fail

       Exit Sub
err1:
Shape1.BackColor = vbRed
       Exit Sub

End Sub
```

# B4 - C++ Programming

## B4a - USB Control Using the ActiveX DLL

These examples demonstrate control of Mini-Circuits' PTE products using C++ in the following environment:

1. Host computer running a Windows operating system
2. PTE connected by the USB interface
3. Mini-Circuits ActiveX DLL installed and registered on the computer

### B4a.i - Power Sensors

Set calibration frequency and read power.

```
// mcl_pm.dll should be loaded as a reference file to the project

mcl_pm::USB_PM ^pm1 = gcnew mcl_pm::USB_PM();

short Status = 0;
System::String ^SN = "";        // Serial Number needed if more than 1 sensor connected
float ReadResult = 0;

Status = pm1->Open_Sensor(SN);  // Open a connection
pm1->Freq = 3000;               // Set the Frequency cal factor in MHz
ReadResult = pm1->ReadPower();  // Read the power in dbm
pm1->Close_Sensor();            // Close the connection
```

### B4a.ii - Synthesized Signal Generators

Set a pre-defined RF output.

```
// mcl gen.dll should be loaded as a reference file to the project

mcl_Gen::USB_Gen ^MyGen = gcnew mcl_Gen::USB_Gen();

short Status = 0;
System::String ^SN = "";

Status = Gen1->Connect(SN);

Gen1->SetFreqAndPower(1000,-5,0);

Gen1->Disconnect();
```

### B4a.iii - Frequency Counter

Read the frequency measurement.

```
// mcl_freqcounter.dll should be loaded as a reference file to the project

MCL_FreqCounter::USB_FreqCounter ^FCTR = gcnew MCL_FreqCounter::USB_FreqCounter();

short Status = 0;
double Freq;
System::String ^SN = "";

Status = FCTR->Connect(SN);
Status = FCTR->ReadFreq(Freq);

FCTR->Disconnect();
```

### B4a.iv - Input/Output (IO) Control Boxes

Set the relay output.

```
// mcl usb to io.dll should be loaded as a reference file to the project

mcl_USB_To_IO::USB_IO ^IO1 = gcnew mcl_USB_To_IO::USB_IO();

short Status = 0;
System::String ^SN = "";

Status = IO1->Connect(SN);
Status = IO1->Set_Relay(5,0); 'Set Relay5 OFF

IO1->Disconnect();
```

### B4a.v - RS232 & USB to SPI Converters

Send SPI data from the USB port.

```
// mcl usb rs232 to spi.dll should be loaded as a reference file to the project

MCL_RS232_USB_To_SPI.USB_To_SPI SPI1 = new MCL_RS232_USB_To_SPI.USB_To_SPI();

double DataToSend = 0;
double ReceivedData = 0;

short x = 0;

SPI1->Connect;                              // Open connection

// Send the value 56 in 8 bits and read 8 bits from SPI
DataToSend = 56;
ReceivedData = SPI1->Send_Receive_SPI(8, DataToSend, 1, 0);

SPI1->Disconnect();                         // Close the connection
```

## B4a.vi - Programmable Attenuators

Set and read the attenuation.

```
// mcl_rudat.dll should be loaded as a reference file to the project

mcl_RUDAT::USB_DAT ^att1 = gcnew mcl_RUDAT::USB_DAT();

short Status = 0;
System::String ^SN = "";              // Serial Number needed for multiple attenuators
float Attenuation = 0;

Status = att1->Connect(SN);           // Open a connection

att1->SetAttenuation(37);             // Set attenuation
att1->Read_Att(Attenuation);          // Read attenuation

att1->Disconnect();                   // Close the connection
```

# B4b - Ethernet Control Using HTTP

## B4b.i - Signal Generators

This example demonstrates how to send HTTP Get commands in order to control the signal generator over an Ethernet connection and read the response.

```
#include "stdafx.h"
#include <iostream>

using namespace System;
using namespace System;
using namespace System::Net;
using namespace System::IO;
using namespace System::Text;
using namespace System::Web;

public ref class HttpPostRequest
{
public:
  static String^ HttpMethodPost(String^ postUrl)
  {
    // A function to send an HTTP command and read the response as an array of chars
    HttpWebRequest^ httpRequest = nullptr;
    HttpWebResponse^ httpResponse = nullptr;
    Stream^ httpPostStream = nullptr;
    BinaryReader^ httpResponseStream = nullptr;
    StringBuilder^ encodedPostData;
    array<Byte>^ postBytes = nullptr;
    String^ SSG_Return;
    try
    {
      httpRequest = (HttpWebRequest^)WebRequest::Create(postUrl);
      httpRequest->Method = "POST";
      httpPostStream = httpRequest->GetRequestStream();
      httpPostStream->Close();
      httpPostStream = nullptr;
      httpResponse = (HttpWebResponse^)httpRequest->GetResponse();
      httpResponseStream = gcnew BinaryReader(httpResponse->GetResponseStream(), Encoding::UTF8);
      array<Char>^ readSCPIChars;
      while (true)
      {
        readSCPIChars = httpResponseStream->ReadChars(64);       // Read the response
        if (readSCPIChars->Length == 0)
          break;
        for( int a = 0; a < readSCPIChars->Length; a = a + 1 )
        {
          SSG_Return += readSCPIChars->GetValue(a);      // Create a string for the response
        }
      }
    }
    catch (WebException^ wex)
    {
      Console::WriteLine("HttpMethodPost() - Exception occurred: {0}", wex->Message);
      httpResponse = (HttpWebResponse^)wex->Response;
    }
    finally
    {
      // Close any remaining resources
      if (httpResponse != nullptr)
      {
        httpResponse->Close();
      }
    }
    return SSG_Return;
    }
};
```

```
int main()
{
  //  SCPI command to send to SSG eg: IP 192.168.9.78; protocol HTTP; command to get serial number
  String^ urlToPost = "http://192.168.9.78/:SN?";
  Console::WriteLine("Sending: " + urlToPost);
  try
  {
    String^ SSG_Response = HttpPostRequest::HttpMethodPost(urlToPost);
    Console::WriteLine(SSG_Response);
  }
  catch (Exception^ ex)
  {
    Console::WriteLine("Main() - Exception occurred: {0}", ex->Message);
  }
  Console::WriteLine("Complete.  Hit enter to finish.");
  std::cin.ignore();            // Keep the console screen open until the user hits enter
  return 0;
}
```

# B5 - C# Programming

## B5a - USB Control Using the ActiveX DLL

These examples demonstrate control of Mini-Circuits' PTE products using C# in the following environment:

1. Host computer running a Windows operating system
2. PTE connected by the USB interface
3. Mini-Circuits ActiveX DLL installed and registered on the computer

### B5a.i - Power Sensor

Set the calibration frequency and read the power.

```
// mcl pm.dll should be loaded as a reference file to the project

mcl_pm.usb_pm pm1 = new mcl_pm.usb_pm();

double ReadResult;
short Status = 0;
string pm_SN = "";                  // Serial Number needed if more than 1 sensor connected

Status = pm1.Open_Sensor(pm_SN);    // Open connection
pm1.Freq = 3000;                    // Set the Frequency cal factor in MHz
ReadResult = pm1.ReadPower() ;       // Read the power in dbm
pm1.Close_Sensor();                 // Close the connection
```

### B5a.ii - RS232 & USB to SPI Converter

Send SPI data from the USB port.

```
// mcl usb rs232 to spi.dll should be loaded as a reference file to the project

MCL_RS232_USB_To_SPI.USB_To_SPI SPI1 = new MCL_RS232_USB_To_SPI.USB_To_SPI();

double DataToSend = 0;
double ReceivedData = 0;

short x = 0;

SPI1.Connect;                                   // Open connection

// Send the value 56 in 8 bits and read 8 bits from SPI
DataToSend = 56;
ReceivedData = SPI1.Send_Receive_SPI(8, DataToSend, 1, 0);

SPI1.Disconnect();                              // Close the connection
```

## B5a.iii - Programmable Attenuator

Set and read the attenuation.

```
// mcl_rudat.dll should be loaded as a reference file to the project

mcl_RUDAT.USB_DAT att1 = new mcl_RUDAT.USB_DAT();

double Attenuation = 0;
short Status = 0;
string SN = "";                         // Serial Number needed for multiple attenuators

Status = att1.Connect(SN);              // Open connection

att1.SetAttenuation(37);                // Set attenuation
att1.Read_Att(Attenuation);             // Read attenuation

att1.Disconnect();                      // Close the connection
```

## B5a.iv - Programmable Attenuator (2 Devices)

Demonstration of how to control a pair of programmable attenuators, refered to by serial number.

```
string sn1 = "11310090001";
string sn2 = "11406170049";
int status1 = 0, status2 = 0;

// Declare 2 instances of the switch class and assign them to 2 objects

mcl_RUDAT.USB_DAT Att1;
mcl_RUDAT.USB_DAT Att2;

Att1 = new mcl_RUDAT.USB_DAT();
Att2 = new mcl_RUDAT.USB_DAT();

// Connect the 2 attenuators by serial number (check return code, if 0 do not continue)

status1 = Att1.Connect(sn1);    // status1 = 1 if connection was successful
status2 = Att2.Connect(sn2);    // status2 = 1 if connection was successful

// Carry out the rest of the program as required

float fAttenuation1 = 15.75F;    // Need the F suffix to initialize as a float
float fAttenuation2 = 0.25F;

status1 = Att1.SetAttenuation(ref fAttenuation1);   // Set attenuation
fAttenuation1 = -1;
status1 = Att1.Read_Att(ref fAttenuation1);         // Read attenuation
MessageBox.Show("Attenuator 1 set to " + fAttenuation1);

status2 = Att2.SetAttenuation(ref fAttenuation2);   // Set attenuation
fAttenuation2 = -1;
status2 = Att2.Read_Att(ref fAttenuation2);         // Read attenuation
MessageBox.Show("Attenuator 2 set to " + fAttenuation2);

// Disconnect the attenuators on completion

Att1.Disconnect();
Att2.Disconnect();
```

# B5b - USB Control Using the .Net DLL

These examples demonstrate control of Mini-Circuits' PTE products using C# in the following environment:

1. Host computer running a Windows operating system
2. PTE connected by the USB interface
3. Mini-Circuits .Net DLL installed

## B5b.i - ZTM Series Modular Test Systems

The below example is a simple executable program that connects to the DLL, sends a user specified SCPI command to the ZTM Series test system, returns the response, then disconnects from the DLL and terminates.

```
namespace ZTM
{
    class Program
    {
        static int Main(string[] args)
        {
            int x = 0;
            string SN = null;
            string SCPI = null;
            string RESULT = null;
            int Add = 0;
            ModularZT64.USB_ZT ZT;           // Reference the DLL
            if (args.Length == 0) return 0;
            ZT = new ModularZT64.USB_ZT ();  // Declare a class (defined in the DLL)
            SCPI = args[2];
            if (args[0].ToString().Contains("-help"))  // Print a help file
            {
                Console.WriteLine("Help ZTM.exe");
                Console.WriteLine("-----------------------------------------");
                Console.WriteLine("ZTM.exe -s SN command :Send SCPI command to S/N");
                Console.WriteLine("ZTM.exe -a add SCPI :Send SCPI command to Address");
                Console.WriteLine("-----------------------------------------");
            }
            if (args[0].ToString().Contains("-s"))   // User want to connect by S/N
            {
                SN = args[1];
                x = ZT.Connect(ref SN);                    // Call DLL connect function
                x = ZT.Send_SCPI(ref SCPI, ref RESULT);    // Send SCPI command
                Console.WriteLine(RESULT);                 // Return the result
            }
            if (args[0].ToString().Contains("-a"))   // User wants to connect by address
            {
                Add = Int16.Parse(args[1]);
                x = ZT.ConnectByAddress(ref Add);
                x = ZT.Send_SCPI(ref SCPI, ref RESULT);
                Console.WriteLine(RESULT);
            }
            ZT.Disconnect();                // Call DLL disconnect function to finish
            return x;
        }
    }
}
```

This executable can be called from a command line prompt or within a script. The following command line calls demonstrate use of the executable (compiled as ZTM.exe), connecting by serial number or address, to set and read attenuation:

- `ZTM.exe -s 11401250027 :RUDAT:1A:ATT:35.75` (serial number 11401250027)
- `ZTM.exe -a 255 :RUDAT:1A:ATT?` (USB address 255)

## B5b.ii - Programmable Attenuator (2 Devices)

Demonstration of how to control a pair of programmable attenuators, refered to by serial number.

```
string sn1 = "11310090001";
string sn2 = "11406170049";
int status1 = 0, status2 = 0;

// Declare 2 instances of the switch class and assign them to 2 objects

mcl_RUDAT64.USB_RUDAT Att1;
mcl_RUDAT64.USB_RUDAT Att2;

Att1 = new mcl_RUDAT64.USB_RUDAT();
Att2 = new mcl_RUDAT64.USB_RUDAT();

// Connect the 2 attenuators by serial number (check return code, if 0 do not continue)

status1 = Att1.Connect(ref sn1);    // status1 = 1 if connection was successful
status2 = Att2.Connect(ref sn2);    // status2 = 1 if connection was successful

// Carry out the rest of the program as required

float fAttenuation1 = 15.75F;    // Need the F suffix to initialize as a float
float fAttenuation2 = 0.25F;

status1 = Att1.SetAttenuation(fAttenuation1);   // Set attenuation
fAttenuation1 = -1;
status1 = Att1.Read_Att(ref fAttenuation1);         // Read attenuation
MessageBox.Show("Attenuator 1 set to " + fAttenuation1);

status2 = Att2.SetAttenuation(fAttenuation2);   // Set attenuation
fAttenuation2 = -1;
status2 = Att2.Read_Att(ref fAttenuation2);         // Read attenuation
MessageBox.Show("Attenuator 2 set to " + fAttenuation2);

// Disconnect the attenuators on completion

Att1.Disconnect();
Att2.Disconnect();
```

## B5b.iii - Power Sensor

This example is a simple executable program that connects to the DLL, uses a pre-defined DLL function to communicate with the power sensor, returns the response from the sensor, then disconnects from the DLL and terminates.

```
using System;
using System.Collections.Generic;
using System.Linq;
using System.Text;
using System.Threading.Tasks;

namespace PWR_CS
{
    class Program
    {
        static int Main(string[] args)
        {
            int x = 0;
            string Serial_Number = null;
            string Temp_Str = "";
            float Temp_Flt = 0;
            double Temp_Dbl = 0;
            if (args.Length == 0) return 0;
            mcl_pm64.usb_pm pwr_sen;            // Reference the DLL
            pwr_sen = new mcl_pm64.usb_pm();

            // Look for the command line arguments and generate the appropriate response
            if (args[0].ToString().Contains("-ls"))     // List available sensors by serial number
            {
                x = pwr_sen.Get_Available_SN_List(ref(Serial_Number));
                Console.WriteLine(Serial_Number);
            }
            if (args[0].ToString().Contains("-sn"))                 // Connect to a sensor
            {
                Serial_Number = args[1];                            // Get the serial number

                // Each needed DLL function must be added below

                x = pwr_sen.Open_Sensor(ref Serial_Number);         // Connect by serial number
                if (args[2].ToString().Contains("-m"))              // Return model name
                {
                    Console.WriteLine(pwr_sen.GetSensorModelName());
                }
                else if (args[2].ToString().Contains("-t"))         // Return temperature
                {
                    Temp_Str = "C";
                    Temp_Flt = pwr_sen.GetDeviceTemperature(ref Temp_Str);
                    Console.WriteLine(Temp_Flt);
                }
                else if (args[2].ToString().Contains("-p"))         // Read power
                {
                    // Format: -sn xxxxxxxxxxx -p freq

                    Temp_Dbl = Convert.ToDouble(args[3]);           // Get the frequency
                    pwr_sen.Freq = Temp_Dbl;                        // Set the frequency
                    Console.WriteLine(pwr_sen.ReadPower());         // Read the power
                }

                pwr_sen.Close_Sensor();

            }

            return x;
        }

    }
}
```

The purpose of the executable is to enclose the .NET DLL interaction and functionality within a simple console application that can be called from elsewhere. This allows the executable to act as a middle layer between a programming environment which does not provide .NET support (typical Python 64-bit distributions for example) and one that does (Visual C#) so that the power sensor's functionality can be used in the former without directly accessing the DLL.

To run the application, the command line takes the below form (assuming the executable is compiled as pwr_cs.exe and the power sensor has serial number 1150825015):

- `pwr_cs.exe -ls` List all serial numbers for connected sensors
- `pwr_cs.exe -sn 11508250015 -m` Return the model name
- `pwr_cs.exe -sn 11508250015 -t` Return the temperature
- `pwr_cs.exe -sn 11508250015 -p 1500` Read power at 1500 MHz

# B5c - Ethernet Control Using HTTP

## B5c.i - Switch Boxes

This example demonstrates how to send HTTP Get commands in order to control the switch box over an Ethernet connection.

The System, System.Net and System.IO namespaces need to be used:

```
using System;
using System.Net;
using System.IO;
```

The below function takes the switch's IP address and the control command as arguments, creates the URL and uses the WebRequest library to get the URL.  The response is read as a string:

```
private void Send_HTTP_Get(string IP_Address_To_Send, string Command_To_Send)
{

      string URL_To_Send = "http://" + IP_Address_To_Send + "/" + Command_To_Send;
      txtCommandSent.Text = URL_To_Send;

      WebRequest wrGETURL;
      wrGETURL = WebRequest.Create(URL_To_Send);

      Stream objStream;
      objStream = wrGETURL.GetResponse().GetResponseStream();

      StreamReader objReader = new StreamReader(objStream);

      string Switch_Response = objReader.ReadLine();

}
```

# B6 - Perl Programming

## B6a - USB Control with 32-Bit Perl

These examples demonstrate control of Mini-Circuits' PTE products using Perl in the following environment:

1. Host computer running a Windows operating system
2. PTE connected by the USB interface
3. Mini-Circuits ActiveX DLL installed and registered on the computer

### B6a.i - Programmable Attenuator

Set the attenuation to a specific value.

```
use feature ':5.10';

say "Programmable Attenuator Set to 12.75 dB";

use Win32::OLE;
use Win32::OLE::Const 'Microsoft ActiveX Data Objects';

my $Att = Win32::OLE->new( 'mcl_RUDAT.USB_DAT' );

$Att->Connect();
$Att->SetAttenuation (12.75);
$Att->Disconnect;
```

# B6b - USB Control with 64-Bit Perl

Some typical 64-bit versions of Perl do not include support for .Net components, this prevents Mini-Circuits' .Net DLLs being called directly from Perl script on these systems. 32-bit Perl distributions typically support ActiveX and therefore Mini-Circuit's ActiveX DLLs can be used (see USB Control with 32-Bit Perl).

The work around when using a 64-bit Perl distribution is to create a separate executable program whose only function is to reference the .Net DLL, connect to the device, send a single user specified command, return the response to the user, and disconnect from the DLL. This executable can then be easily called from Perl script to send as many commands as needed to the PTE device.

## B6b.i - ZTM Series Modular Test Systems

Mini-Circuits can supply on request an executable to interface with the DLL. For ZTM Series test systems, and all customer specific designs based on the same controller, the example source code for such an executable (C#) is shown at ZTM Series Control Using .Net.

The below script demonstrates use of the executable in Perl script to send a SCPI command to a ZTM Series test system (specified by serial number or address) and read the response.

```
#!/usr/bin/perl
use strict;
use warnings;

my $serial_number = 11404280010;      # The ZTM Series serial number
my $att_list = "1A,2A,3A,4A";         # The list of attenuator locations in the ZTM
my @att_location = split /,/, $att_list;
my $value = 40;

my $exe = "ZTM.exe";    # The .exe providing an interface to the ZTM DLL
my @cmd;

foreach my $att_location (@att_location) {

    # Loop for each attenuator location

    # Set attenuator in this location
    @cmd = ($exe, "-s $serial_number :RUDAT:$att_location:ATT:$value");
    my $return_value = qx{@cmd};
    print "ZTM Series response: $return_value\n";

    # Confirm attenuation setting for this attenuator
    @cmd = ($exe, "-s $serial_number :RUDAT:$att_location:ATT?");
    $return_value = qx{@cmd};
    print "Attenuator $att_location set to $return_value\n";

}
```

# B6c - Ethernet Control Using HTTP

These examples demonstrate control of Mini-Circuits' PTE products over a TCP/IP network by making use of Perl's *LWP Simple* interface.

## B6c.i - ZTM Series Modular Test Systems

Send HTTP commands to set and read attenuators within the ZTM Series test system.

```
#!/usr/bin/perl
use strict;
use warnings;
use LWP::Simple;                        # Use the LWP::Simple interface for HTTP

my $value = 40;
my $ip_address = "192.168.9.74";        # The ZTM Series serial number

my $att_list = "1A,2A,3A,4A";           # The list of attenuator locations in the ZTM
my @att_location = split /,/, $att_list;

foreach my $att_location (@att_location) {

        # Loop for each attenuator location

        # Set attenuator in this location
        my $return_value = get("http://$ip_address/:RUDAT:$att_location:ATT:$value");
        print "ZTM Series response: $return_value\n";

        # Confirm attenuation setting for this attenuator
        $return_value = get("http://$ip_address/:RUDAT:$att_location:ATT?");
        print "Attenuator $att_location set to $return_value\n";

}
```

# B7 - LabVIEW Worked Examples

## B7a - USB Control Using the ActiveX DLL

### B7a.i - Power Sensors

These instructions demonstrate control of Mini-Circuits power sensors in LabVIEW using Mini-Circuits' supplied ActiveX DLL file. The same methodology applies to the full range of Mini-Circuits' PTE (Portable Test Equipment); substituting the relevant DLL file and functions into the instructions below.

**1. Install and Register the DLL**

Install the supplied DLL file (mcl_pm.dll) to the relevant Windows system folder and register using the Windows regsvr32 program (see the product Programming Manual for full details).

**2. Create a New VI (Virtual Instrument) and Reference the DLL**

a. Open LabVIEW with a new, blank VI.
b. In the Block Diagram window (accessible by pressing Ctrl+E), select Functions Palette from the "View" menu at the top of the screen.
c. Click through the Connectivity palette to the ActiveX sub-palette. Select the **Automation Open** function and place it on the block diagram.

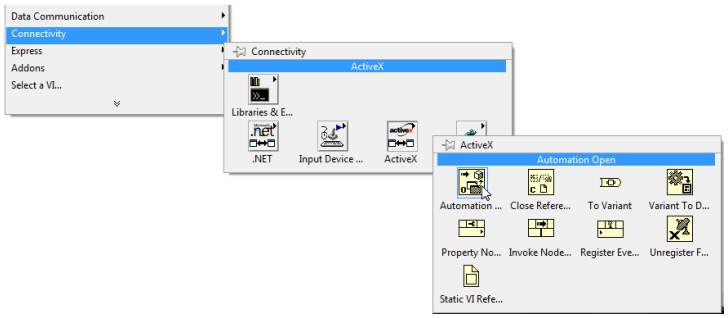



*Fig B7-i - Place an ActiveX Automation Open function*

d. Right click on the *Automation Refnum* terminal on the left of the **Automation Open** function and create a control.
e. Right-click on the new control, choose "Select ActiveX Class" to the object selection window.

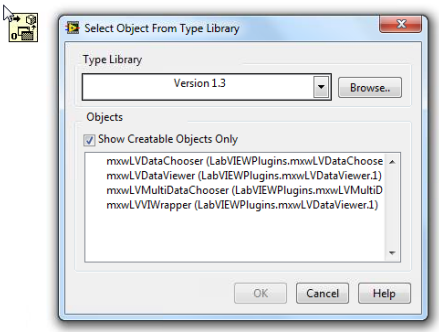



*Fig B7-ii - LabVIEW object selection window*

f. Click "Browse..." and select the mcl_pm.dll file from the compluter's system folder.
g. The object selection window will show all of the available classes contained in the DLL; highlighting the "Show Creatable Objects Only" option should limit the list to the correct class, shown as "USB_PM (mcl_pm.USB_PM)". Select this and cick OK.

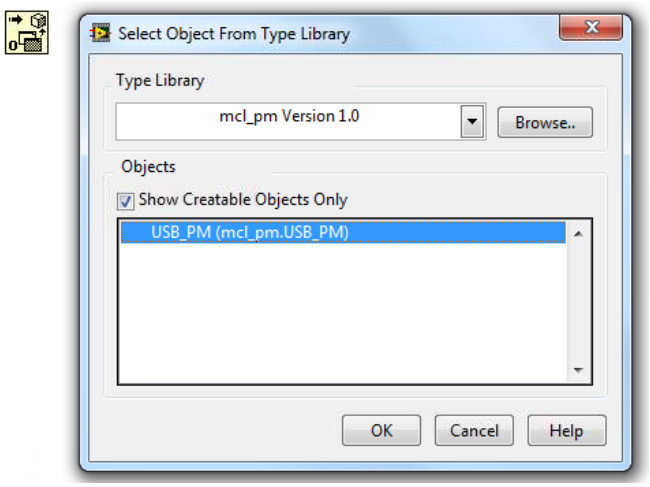



*Fig B7-iii - Select the USB_PM class*

h. Right click on the *Error In* terminal of the **Automation Open** function and create a new control, **Error In**.

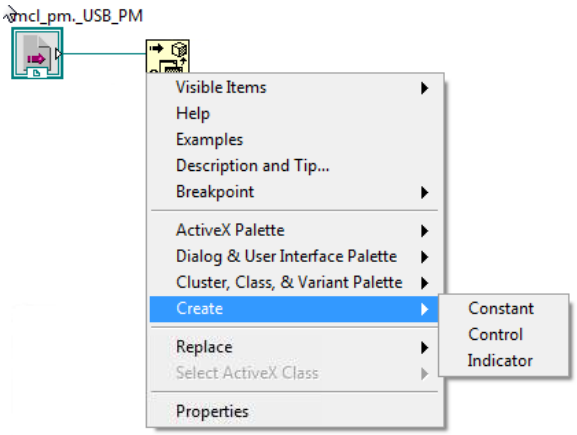



*Fig B7-iv - Create Error In control*

## 3. Connecting to the Power Sensor

a. From the ActiveX sub-palette, choose **Invoke Node** and place the node on the block diagram.

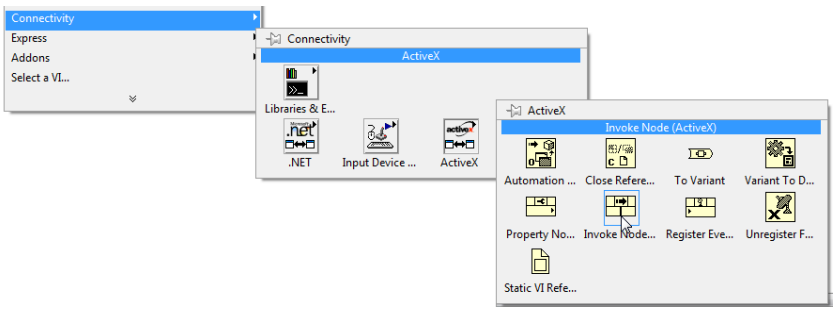



*Fig B7-v - Create the first Invoke Node*

b. Connect the right *Automation Refnum* terminal of the **Automation Open** function to the *Reference* terminal on the **Invoke Node**.
c. Connect the *Error Out* terminal of the **Automation Open** function to the *Error In* terminal of the **Invoke Node**.
d. Click on the Method of the **Invoke Node** to display a list of all available functions and select "Open_Sensor".

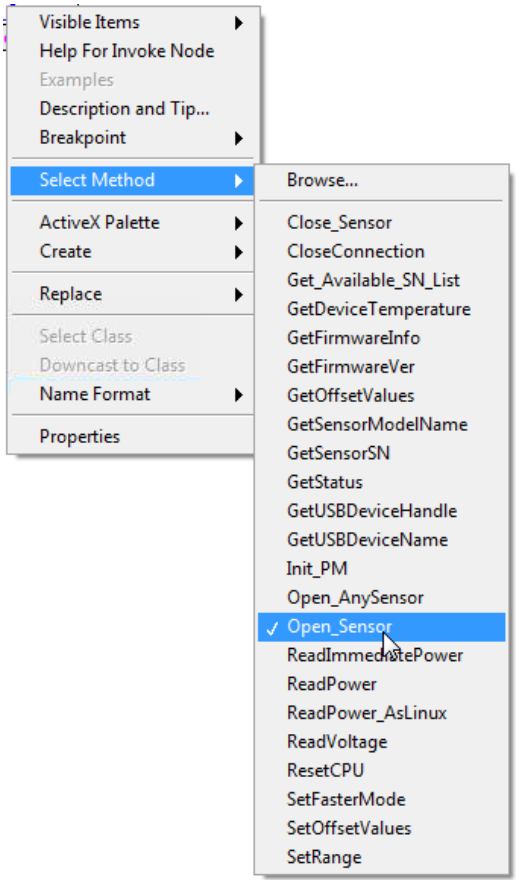



*Fig B7-vi - The available power sensor functions, defined in the DLL*

e. Right-click the *Input* terminal of the SN_Request parameter and create a numeric control.

f. An indicator can be added to the **Open_Sensor Node** to confirm whether the operation was successful; click through the Programming palette to the Comparison sub-paletter and select the "Not Equal to 0?" operation. Place this on the block diagram and connect to the *Output* terminal of the **Open_Sensor Node**.

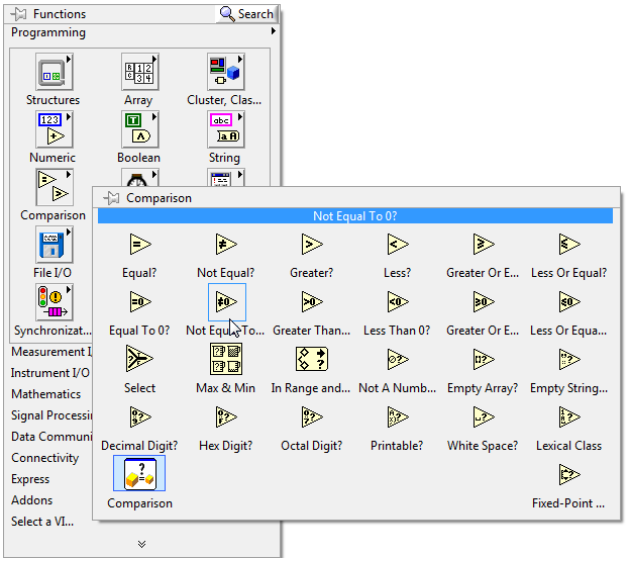



*Fig B7-vii - Place the "Not Equal to 0?" comparison operator*

g. Right click on the output of the "Not Equal to 0?" comparison operation and create an indicator.

h. If multiple power sensors are to be connected then a serial number should be entered in the numeric control, otherwise it can be left blank.

i. Following the **Open_Sensor Node**, the user can place any number of additional nodes in sequence to perform all operations required of the power sensor. The *Reference In* and *Error In* terminals of each new node should be connected to the *Reference Out* and *Error Out* terminals of the previous nodes.

## 4. Setting the Calibration Frequency

a. Select **Invoke Property** from the Connectivity palette, ActiveX sub-palette and place it on the block diagram.

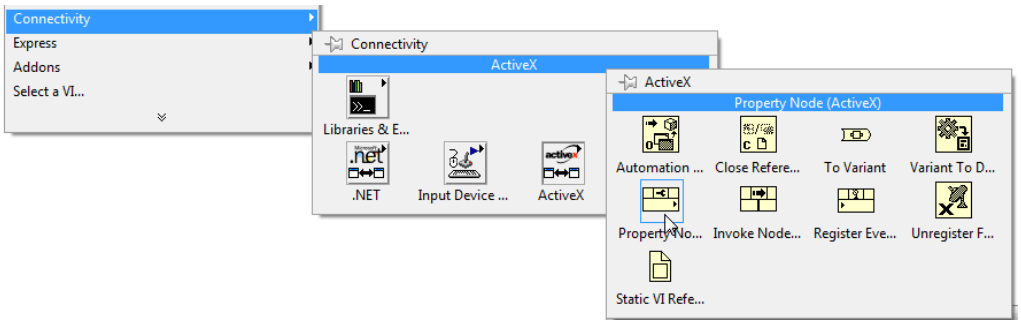



*Fig B7-viii - Creating an ActiveX Property Node*

b. Right-click on the new property node and select "Freq" from the "Select Property" menu option.

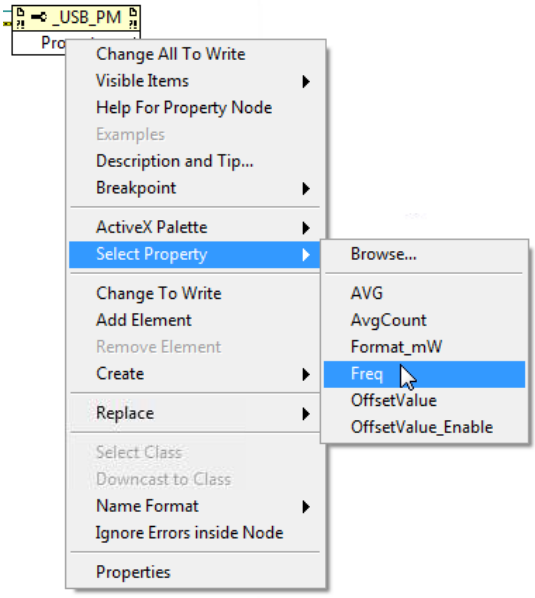



*Fig B7-ix - The available power sensor properties, defined in the DLL*

c. The LabVIEW default for the property is to read so right-click on it and select "Change To Write".

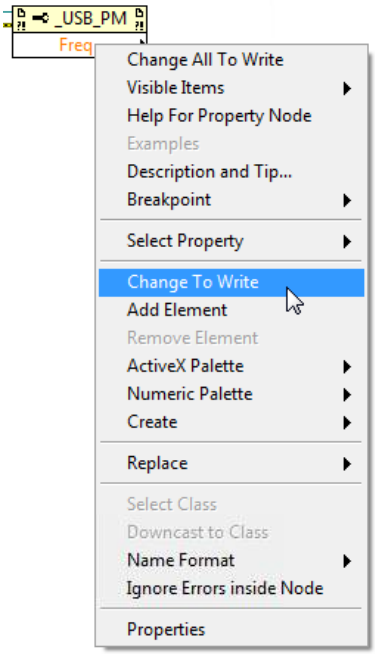



*Fig B7-x - Set the property to "write" rather than "read"*

d. Right-click on the *Input* terminal of the **Set Frequency Property** and create a constant so that the user can specify the frequency.
e. Connect the *Reference In* and *Error In* terminals of the property to the *Reference Out* and *Error Out* terminals of the **Open_Sensor Node**.

## 5. Reading the Power Sensor

a. Create a new Invoke Node and set the method to "ReadPower".
b. Create a numeric control on the *Output* terminal of the Read Power Node to display the power.
c. Create a further Invoke Node and set the method to "GetDeviceTemperature".
d. Create a numeric control on the *Output* terminal of the GetDeviceTemperature Node to display the temperature.
e. Connect the *Reference* and *Error* terminals in sequence.

## 6. Disconnecting

a. The final Invoke Node in the program should be set with the “Close_Sensor” function in order to properly close the USB connection to the power sensor.
b. The final step in the LabVIEW sequence is to create a Close Reference function from the Connectivity palette to terminate the reference to the DLL file. The *Reference In* and *Error In* terminals of the Close Reference function should be connected to the respective terminals of the Close_Sensor Node.

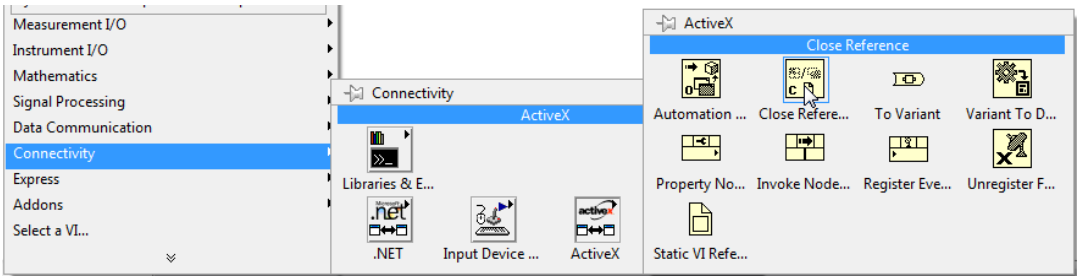



*Fig B7-xi - Creating the Close Reference function from the ActiveX sub-palette*

## 7. Continuous Readings

a. The read power and temperature sequence can be configured to run continuously until stopped by the user. To do this, select "While Loop" from the Programming palette, Structures sub-palette.

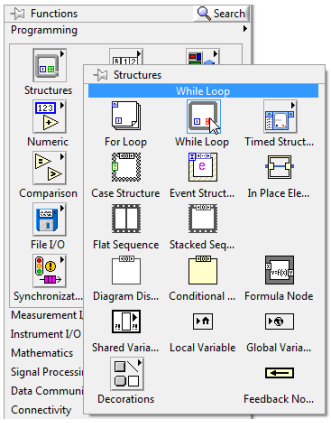



*Fig B7-xii - LabVIEW's programming structures*

b. Drag the while loop so that it encompasses the **Set Frequency Property**, the **ReadPower Node** and the **GetDeviceTemperature Node** but not the open/close nodes.

c. If a **Stop Button** was not created automatically then right-click on the loop condition and select “Create Control” to place the button in the loop.

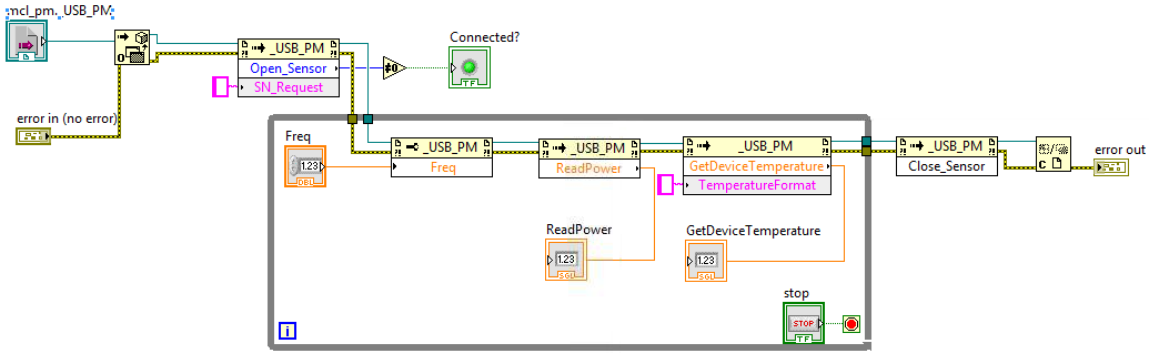



*Fig B7-xiii - Complete VI including the While loop for continuous reading*

## B7a.ii - Programmable Attenuators

These instructions demonstrate control of Mini-Circuits programmable attenuators in LabVIEW using Mini-Circuits' supplied ActiveX DLL file. The same methodology applies to the full range of Mini-Circuits' PTE (Portable Test Equipment); substituting the relevant DLL file and functions into the instructions below.

These instructions were prepared using LabVIEW 8.5 to demonstrate compatibility with older versions of the environment.

### 1. Install and Register the DLL

Install the supplied DLL file (mcl_rudat.dll) to the relevant Windows system folder and register using the Windows regsvr32 program (see the product Programming Manual for full details).

### 2. Create a New VI (Virtual Instrument) and Reference the DLL

a. Open LabVIEW with a new, blank VI.
b. In the Block Diagram window (accessible by pressing Ctrl+E), select Functions Palette from the "View" menu at the top of the screen.
c. Click through the Connectivity palette to the ActiveX sub-palette. Select the **Automation Open** function and place it on the block diagram.
d. Right click on the *Automation Refnum* terminal on the left of the **Automation Open** function and create a control.
e. Right-click on the new control, choose "Select ActiveX Class" and click "Browse…"

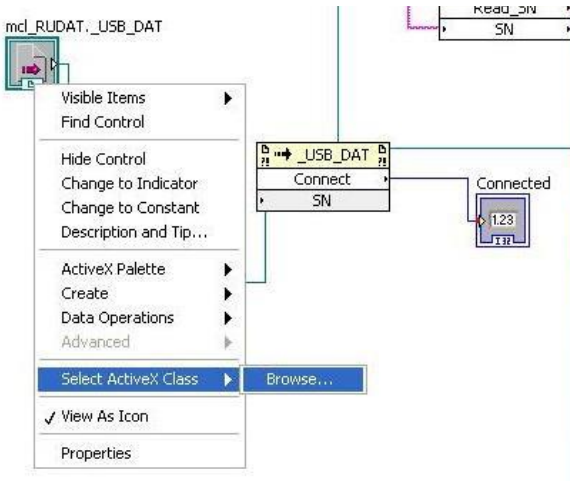



*Fig B7-xiv - Place an Automation Open function and select the ActiveX class*

f. Browse to the computers system folder and select the mcl_rudat.dll file.

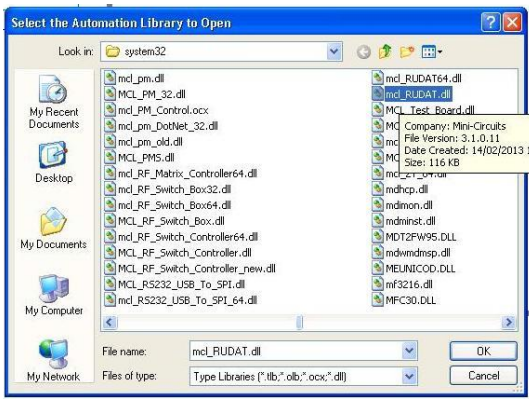



*Fig B7-xv - Select the mcl_rudat.dll file*

g. Select the “USB_DAT (MCL_RUDAT.USB_DAT)” class when prompted.

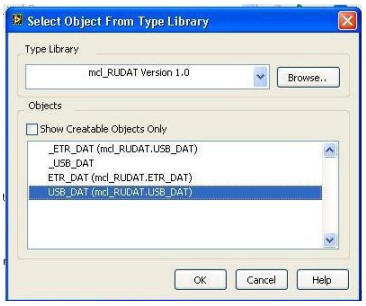



*Fig B7-xvi - Select the USB_DAT class*

h. Right click on the *Error In* terminal of the **Automation Open** function and create a new control.

i. To save space on the block diagram, right-click the **Error In** icon and uncheck the “View As Icon” option.

### 3. Connecting to the Attenuator

a. From the ActiveX sub-palette, choose **Invoke Node** and place the node on the block diagram.
b. Connect the right *Automation Refnum* terminal of the **Automation Open** function to the *Reference* terminal on the **Invoke Node**.
c. Connect the *Error Out* terminal of the **Automation Open** function to the *Error In* terminal of the **Invoke Node**.
d. Click on the Method of the **Invoke Node** to display a list of all available functions (defined in the mcl_rudat.dll file), select “Connect”.

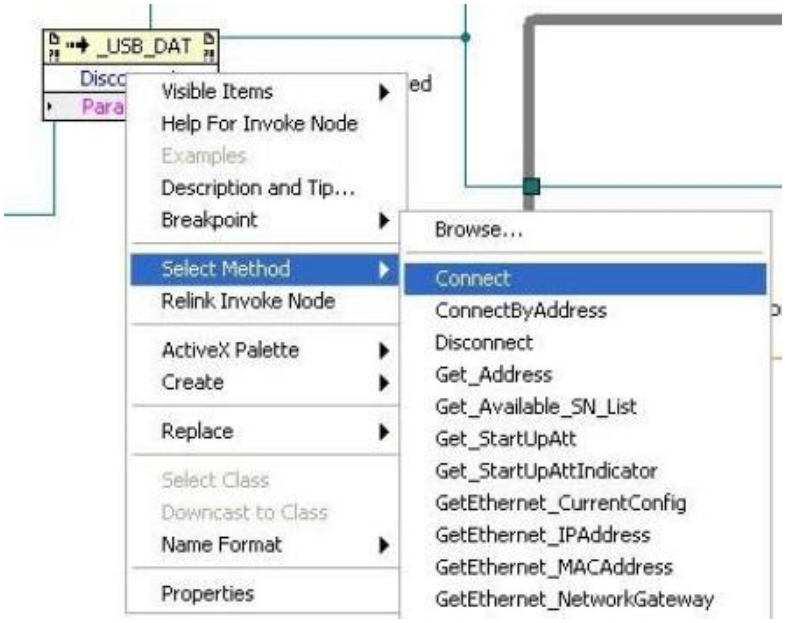



*Fig B7-xvii - Select the Connect method for the Invoke Node*

e. Right-click the *Input* terminal of the SN parameter and create a numeric control.
f. If multiple attenuators are to be connected then a serial number should be entered in the numeric control, otherwise it can be left blank.
g. Following the **Connect Node**, the user can place any number of additional nodes in sequence to perform all operations required of the attenuator. The *Reference In* and *Error In* terminals of each new node should be connected to the *Reference Out* and *Error Out* terminals of the previous nodes.

### 4. Setting Attenuation

a. Create a new **Invoke Node** and set the method to "SetAttenuation".
b. Connect the Input terminal of the Set Attenuation **Invoke Node** to the Connect **Invoke Node**.
c. Create a numeric control to allow the attenuation to be adjusted and connect this to the "TotalAtt" input terminal of the Set Attenuation node.

**5. Reading Attenuation**

a. Create a new **Invoke Node** and set the method to "Read_Att".
b. Connect the Input terminal of the Read Attenuation **Invoke Node** to the Connect **Invoke Node**.
c. Select method Read_att.
d. Create a numeric control to display the attenuation and connect it the "CAtt1" Output terminal of the Read Attenuation node.

**6. Disconnecting**

a. The final **Invoke Node** in the program should be set with the “Disconnect” function in order to properly close the connection to the attenuator.
b. The final step in the LabVIEW sequence is to create a **Close Reference** function from the Connectivity palette to terminate the reference to the DLL file. The *Reference In* and *Error In* terminals of the **Close Reference** function should be connected to the respective terminals of the **Disconnect** function.

## B7a.iii - ZTM Series Modular Test Systems

These instructions demonstrate control of Mini-Circuits ZTM-X modular test systems in LabVIEW using Mini-Circuits' supplied ActiveX DLL file. The same methodology applies to the full range of Mini-Circuits' PTE (Portable Test Equipment); substituting the relevant DLL file and functions into the instructions below.

### 1. Install and Register the DLL

Install the supplied DLL file (ModularZT.dll) to the relevant Windows system folder and register using the Windows regsvr32 program (see the product Programming Manual for full details).

### 2. Create a New VI (Virtual Instrument) and Reference the DLL

a. Open LabVIEW with a new, blank VI.
b. In the Block Diagram window (accessible by pressing Ctrl+E), select Functions Palette from the "View" menu at the top of the screen.
c. Click through the Connectivity palette to the ActiveX sub-palette. Select the **Automation Open** function and place it on the block diagram.

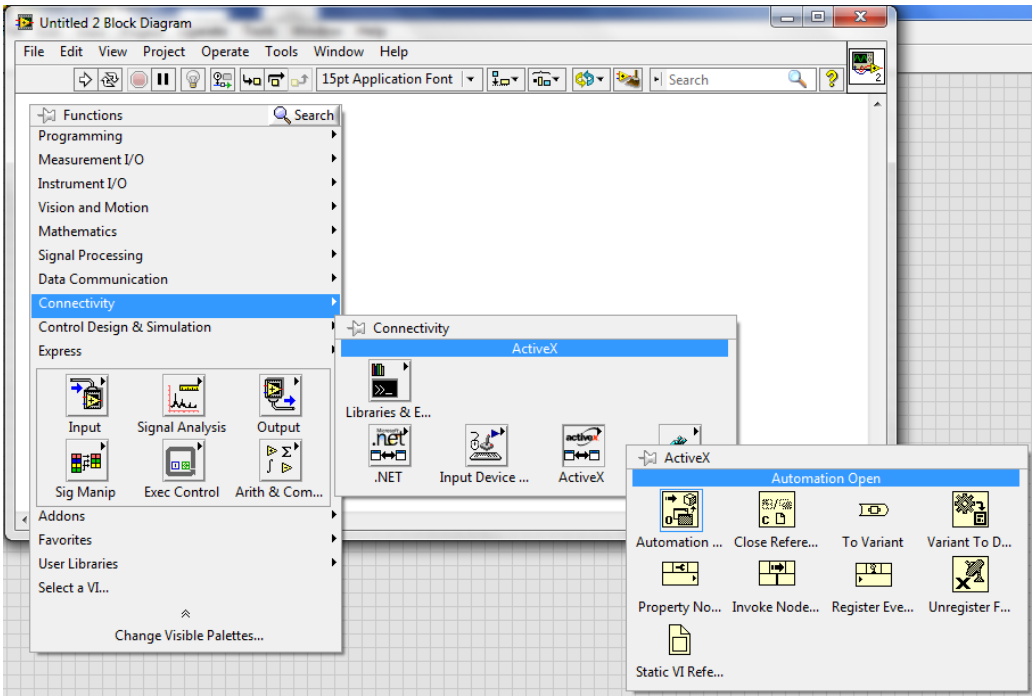



*Fig B7-xviii: Path to Automation Open in the ActiveX sub-palette, with Automation Refnum highlighted*

d. Right click on the *Automation Refnum* terminal on the left of the **Automation Open** function and create a control.

e. Right click on the new control, choose the 'Select ActiveX Class' option and browse to the location of the ModularZT.dll file.

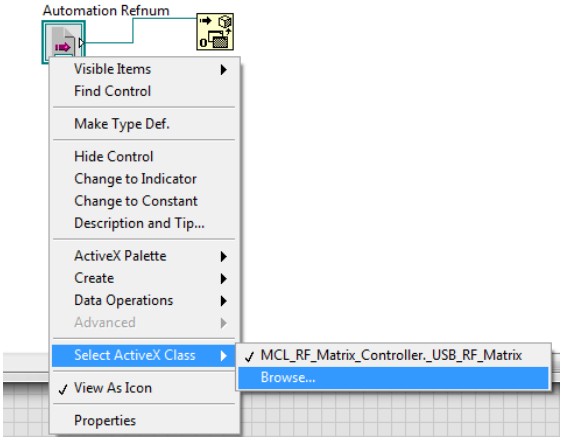



*Fig B7-xix: Menu options for the Automation Refnum terminal*

f. After selecting the DLL file, choose "USB_Control" from the list of objects presented.
g. Right click on the *Error In* terminal of the **Automation Open** function and create a new control.
h. To save space on the block diagram, right-click the **Error In** icon and uncheck the "View As Icon" option.

### 3. Identifying the Serial Numbers of all Connected ZTM-X Systems

This section makes use of the Get_Available_SN_List DLL function to provide a drop-down list of all connected serial numbers, allowing the user to choose which system to connect. If the serial numbers are already known or only a single system is connected then this process can be omitted.

a. From the ActiveX sub-palette, choose **Invoke Node** and place the node on the block diagram.
b. Connect the right *Automation Refnum* terminal of the **Automation Open** function to the *Reference* terminal on the **Invoke Node**.
c. Connect the *Error Out* terminal of the **Automation Open** function to the *Error In* terminal of the **Invoke Node**.
d. Click on the Method of the **Invoke Node** to display a list of all available functions (defined in the ModularZT.dll file), select "Get_Available_SN_List".
e. Right-click the *Input* terminal of the SN_List parameter and create a blank constant. The constant will provide the SN_List parameter to the Get_Available_SN_List function.

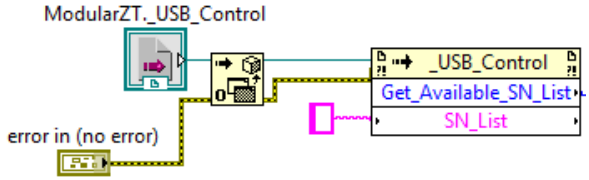



*Fig B7-xx: Block diagram including Automation Refnum and Invoke Node controls*

f. From the Programming palette, go to the Comparison sub-palette. Select the **Not Equal To 0** function and place it on the block diagram.

g. Connect the *Get_Available_SN_List* terminal of the **Invoke Node** to the input of the **Not Equal To 0** function.
h. Create an **Indicator** at the *Output* terminal of the **Not Equal To 0** function. The output of the Get_Available_SN_List function will be 0 (failure to connect) or 1 (successfully connected) so the indicator should light up when the retrieval of the serial numbers is successful.
i. Right-click on the **Indicator** and rename to "Get SN List Success?".

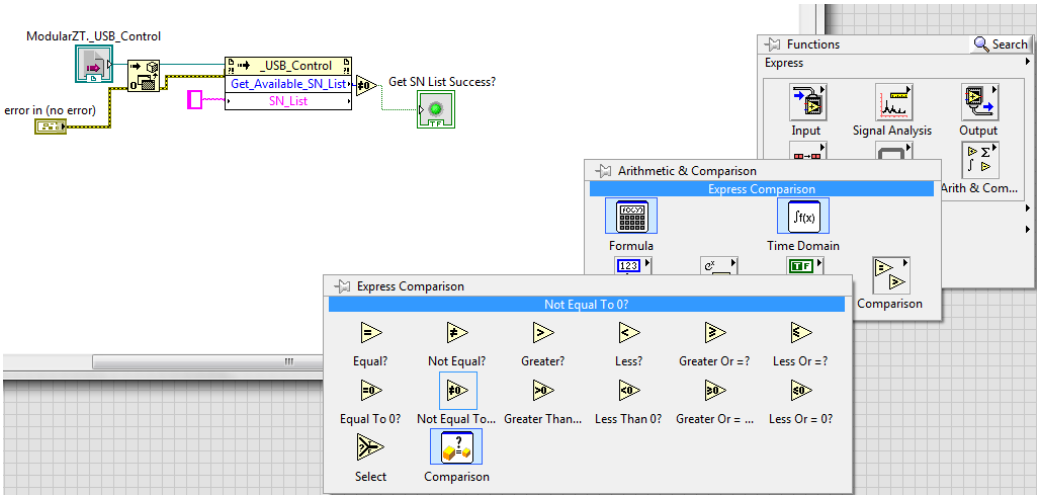



*Fig B7-xxi: Adding the Not Equal To 0 function and "Get SN List Success?" indicator*

j. Place a **While Loop** (found in the Programming palette, Structures sub-palette) on the block diagram, external to the previous objects.
k. Delete the stop button if it was included automatically but not the loop condition (the red dot).
l. Place a **Match Pattern** function (found in the Programming palette, String sub-palette) inside the **While Loop**.
m. Connect the output of the "SN_List" parameter (from the Get_Available_SN_List node) to the *String* input terminal of the **Match Pattern** function.
n. Create another empty string constant outside the **While Loop**, connected to the *Regular Expression* terminal of the **Match Pattern** function. This is because each SN that the Node outputs will be separated by a blank space.
o. Connect the *Before Substring* terminal of the **Match Pattern** function to the right-hand edge of the **While Loop**.
p. Right-click on the **Loop Tunnel** between the "SN_List" parameter and the *String* input terminal of the **Match Pattern**, select 'Replace with Shift Register'. The mouse cursor will automatically change to signify the other end of the **Shift Register**, click on the **Loop Tunnel** at the right-hand edge of the **While Loop** to place it.

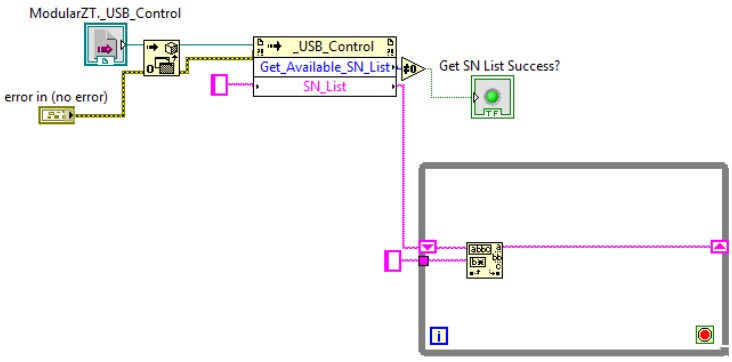



*Fig B7-xxii: Block diagram with While Loop and Shift Register*

q. Place a **Trim Whitespace.vi** from the String sub-palette inside the **While Loop**.
r. Connect the *After Substring* terminal of the **Match Pattern** function to the input of the **VI**.
s. Place a **Build Array** function (found in the Programming palette, Array sub-palette) in the **While Loop** and expand it to have two inputs by dragging the bottom edge down
t. An empty **String Array** constant is needed for the **Build** Array function. Select **Array** constant from the Array sub-palette and place it outside the **While Loop**.
u. Place another **String** constant on the block diagram and drag it into the **Array** constant box to create the empty **String Array**.
v. Connect the **String Array** constant to the first *Input* terminal of the **Build Array** function.
w. Connect the *Trimmed String* terminal of the **Trim Whitespace** VI to the second terminal of the **Build Array** function.
x. Connect the output of the **Build Array** function to the edge of the **While Loop** and create another **Shift Register**, with the other end at the empty **String Array Loop Tunnel**.
y. Place a **String Length** function (from the String sub-palette) inside the **While Loop**.
z. Connect the *Input* terminal of the function to the *After Substring* terminal of the **Match Pattern** function. This will form a junction since the *After* Substring terminal is also connected to the **Trim Whitespace** VI.
aa. Connect the *Length* output terminal of the **String** Length function to the input of a new **Equal to 0** function (found in the Comparison sub-palette).
bb. Connect the output of the **Equal to 0** function to the loop condition. If the output of the **String Length** function is 0 it will indicate that there are no more serial numbers and the **Equal to 0** operator will cause the loop to stop.

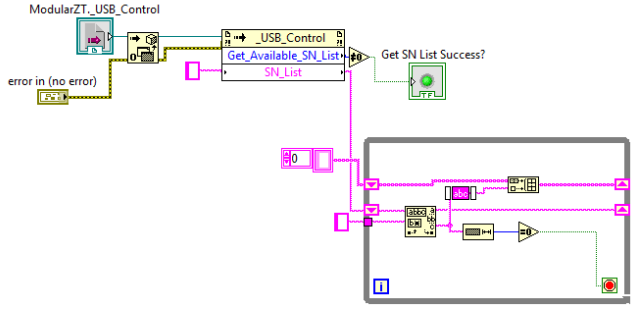



*Fig B7-xxiii: While loop with exit check*

cc. On the Front Panel of this VI, create a drop-down menu by placing a **System Combo Box** function (found in the Systems palette, String & Path sub-palette).
dd. On the Block Diagram, right click the corresponding **System Combo Box** function, create a **Strings[] Property Node** by selection “Create”, “Property Node”, then “Strings[]”. Place the **Strings[] Property Node** outside the **While Loop**.

ee. Right click the **Strings[] Property Node** and select "Change to Write".
ff. Rename the **System Combo Box** function to "SN_List". Right-click and un-tick "View As Icon" to save space on the block diagram.
gg. Connect the output from the **Shift Register** that follows the **Build Array** function to the input of the **Strings[] Property Node**.
hh. Connect the *Error Out* terminal of the **_USB_Control Node** to the *Error In* terminal of the **Strings[] Node**.
ii. Create another **While Loop** and arrange it so that it encompasses everything from the **Automation Open** function onwards.
jj. If a **Stop Button** was not created automatically then right-click on the loop condition and select "Create Control" to place the button in the loop.

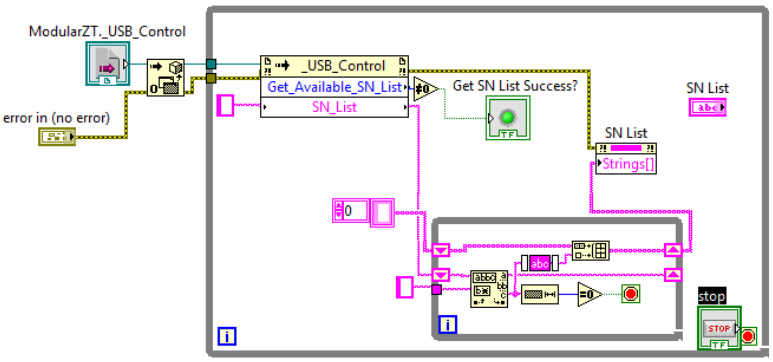



*Fig B7-xxiv: While Loop encompassing the steps to get the serial number list*

kk. On the Front Panel, change the **Stop Button** text from "Stop" to "Connect".

## 4. Connecting to a ZTM-X Test System

a. Create a new **Invoke Node** outside the **While Loop**.
b. Connect the *Reference Out* terminal of the **Get_Available_SN_List Node** to the *Reference* terminal of the new **Invoke Node**.
c. Select "Connect" as the method for the new node.
d. Connect the *Error Out* terminal of the **Strings[]** node to the *Error In* terminal of the **Connect** node.
e. Connect the output terminal of the SN_List combo box to the *SN* input terminal of the **Connect Node**.
f. During execution, the program will not get to this stage until the **While Loop** has exited, the result being that the program will populate the drop-down box with all serial numbers and wait for a user input. The program will continue when the user selects the desired serial number and clicks the **Connect** button. If the process of identifying serial numbers is not required (see step 3 above) then the "Connect" function can be used in place of the "Get_Available_SN_List" function and everything that followed.
g. Following the **Connect Node**, the user can place any number of additional nodes in sequence to perform all operations required of the ZTM-X system. The *Reference In* and *Error In* terminals of each new node should be connected to the *Reference Out* and *Error Out* terminals of the previous nodes.
h. The final **Invoke Node** in the program should be set with the "Disconnect" function in order to properly close the connection to the ZTM-X system.
i. The final step in the LabVIEW sequence is to create a **Close Reference** function from the Connectivity palette to terminate the reference to the DLL file. The *Reference In* and *Error In* terminals of the **Close Reference** function should be connected to the respective terminals of the **Disconnect** function.

j. An **Error Out** indicator should be added by right clicking on the *Error Out* terminal of the **Close Reference** function and creating an indicator to show the result.

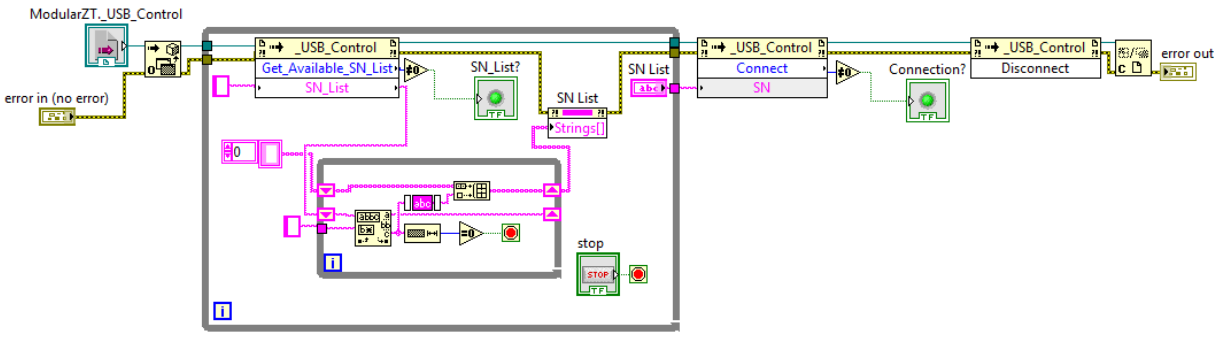



*Fig B7-xxv: Final program (additional functions to be placed after "Connect")*

# B7b - USB Control Using the .Net DLL

## B7b.i - Programmable Attenuators

These instructions demonstrate control of Mini-Circuits programmable attenuators in LabVIEW using Mini-Circuits' supplied .Net DLL file. The same methodology applies to the full range of Mini-Circuits' PTE (Portable Test Equipment); substituting the relevant DLL file and functions into the instructions below.

### 1. Install the DLL

Install the supplied DLL file (mcl_rudat64.dll) to the relevant Windows system folder (see the product Programming Manual for full details). Since this is a .Net DLL rather than ActiveX, it should not be registered.

### 2. Create a New VI (Virtual Instrument) and Reference the DLL

a. Open LabVIEW with a new, blank VI.
b. In the Block Diagram window (accessible by pressing Ctrl+E), select Functions Palette from the "View" menu at the top of the screen.
c. Click through the Connectivity palette to the .Net palette. Select the **Constructor Node** and place it on the block diagram.

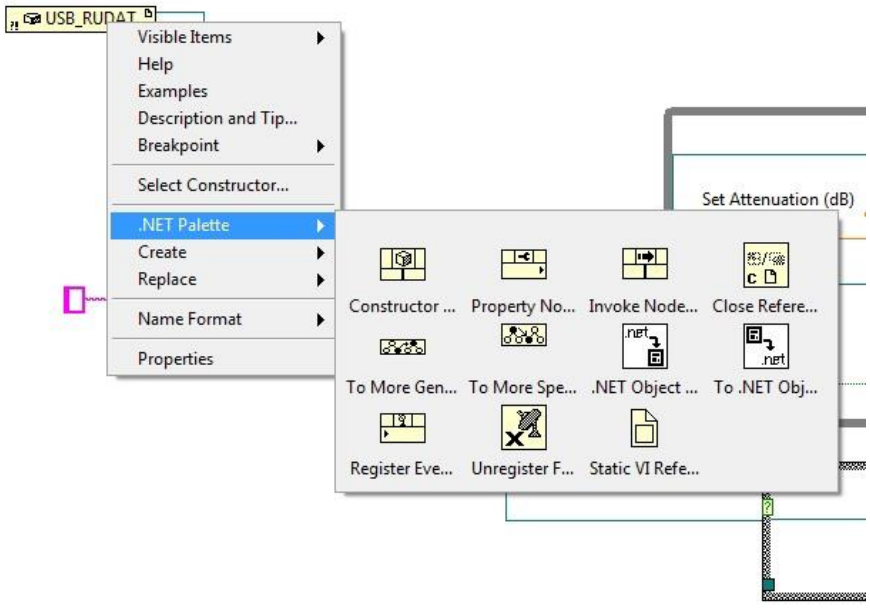



*Fig B7-xxvi - Path to the Constructor Node in the .Net palette*

d. Right-click on the new control, choose the "Select Constructor" option and browse to the location of MCL_rudat64.dll file.

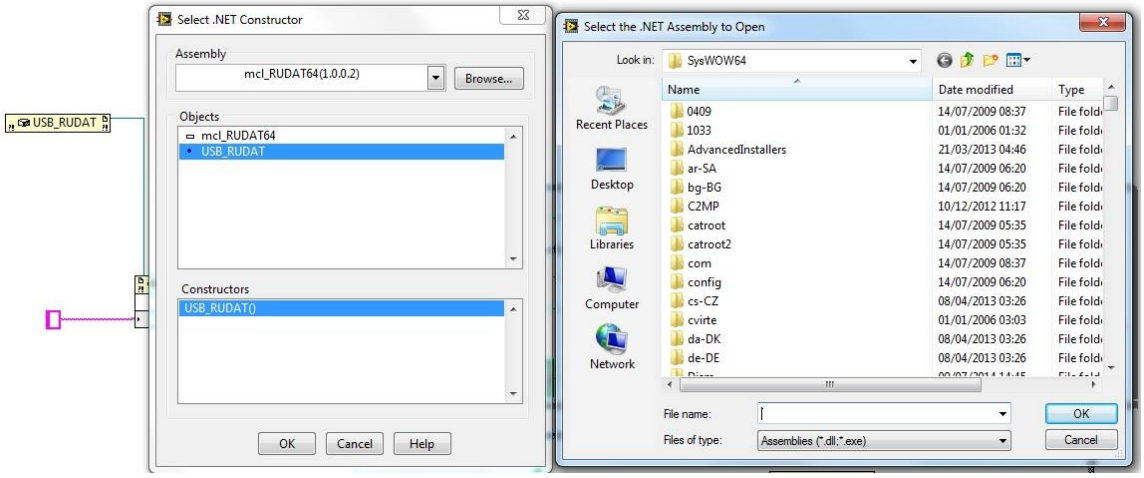



*Fig B7-xxvii - Selecting the mcl_rudat64.dll .Net assembly*

e. After selecting the DLL file, choose “USB_RUDAT” from the list of objects presented.
f. Right-click on the *Error In* terminal of the **Constructor Node** and create a new control.
g. Choose **Invoke Node** from the .Net Palette.
h. Connect the **Constructor Node** to the **Invoke Node** control.

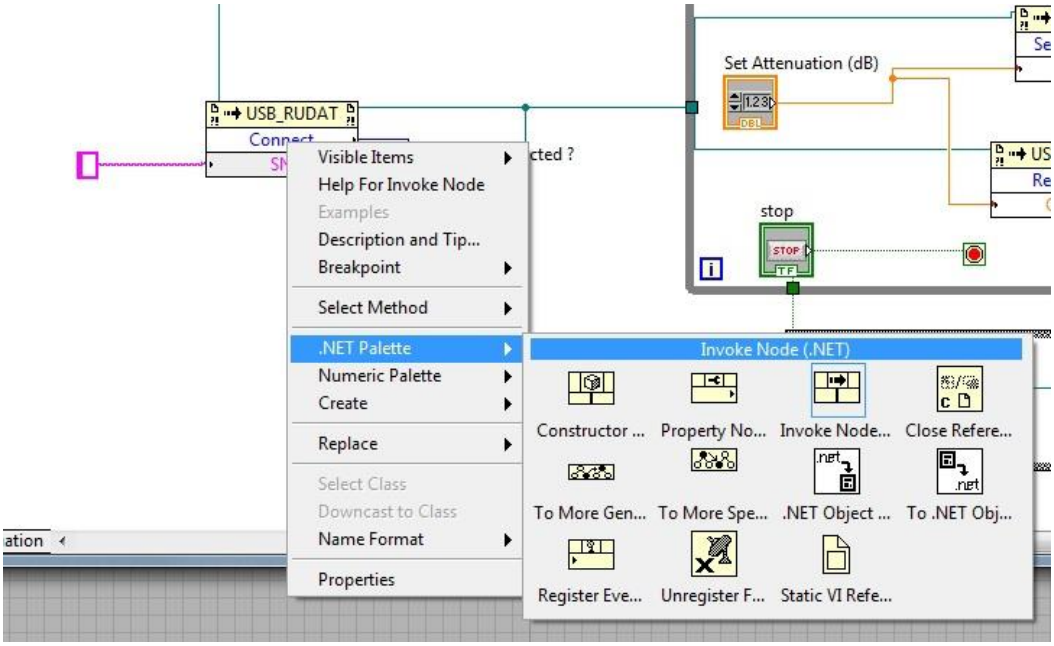



*Fig B7-xxviii - Placing an Invoke Node*

i. Right-click on the Invoke Node and choose the "Select Method" option to view all functions defined in the mcl_rudat64.dll DLL.
j. Select the "Connect" function.

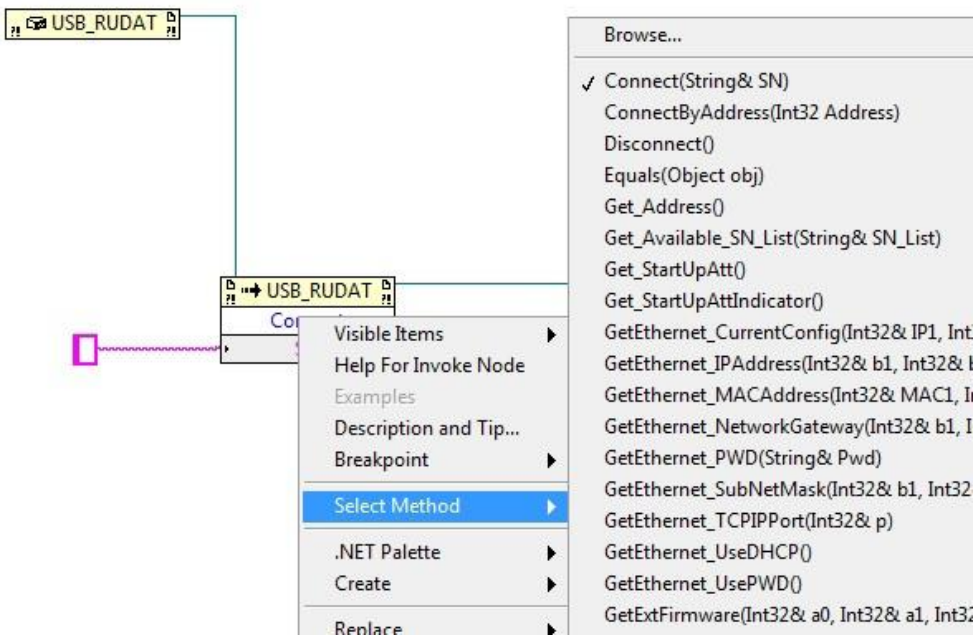



*Fig B7-xxix - Select the attenuator's Connect function*

k. If more than one attenuator will be physically connected then the Connect function requires the serial number of the relevant attenuator to be supplied. Create a numeric control to store the serial number and connect it to the input terminal of the "SN" parameter. This control can be left blank if only one attenuator is connected.

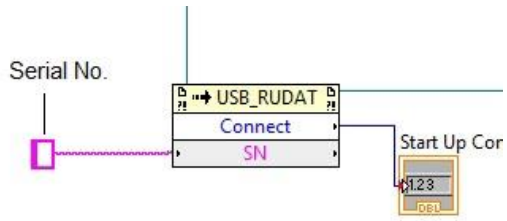



*Fig B7-xxx - Create a numeric control for the attenuator's serial number*

## 3. Setting Attenuation

a. Create a new **Invoke Node** and set the method to "SetAttenuation".
b. Connect the Input terminal of the Set Attenuation **Invoke Node** to the Connect **Invoke Node**.
c. Create a numeric control to allow the attenuation to be adjusted and connect this to the "TotalAtt" input terminal of the Set Attenuation node.

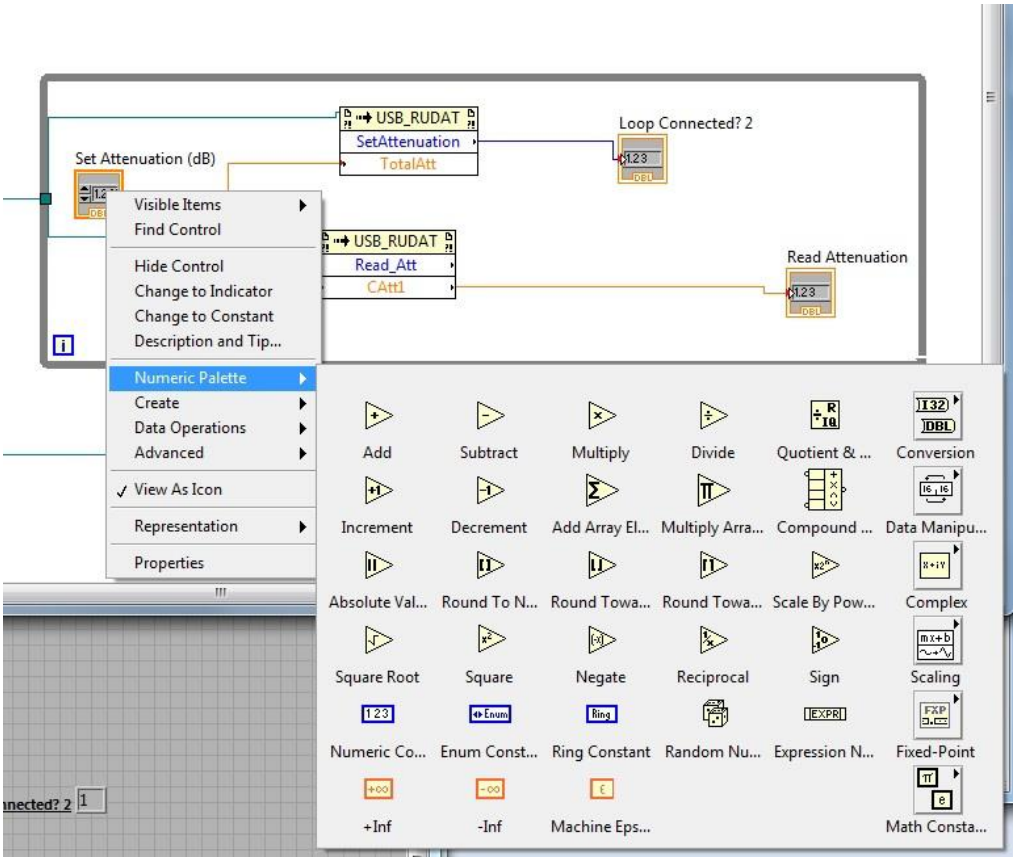



*Fig B7-xxxi - Placing the "SetAttenuation" node and numeric control to set attenuation*

## 4. Read Attenuation

a. Create a new **Invoke Node** and set the method to "Read_Att".
b. Connect the Input terminal of the Read Attenuation **Invoke Node** to the Connect **Invoke Node**.
c. Select method Read_att.
d. Create a numeric control to display the attenuation and connect it the "CAtt1" Output terminal of the Read Attenuation node.

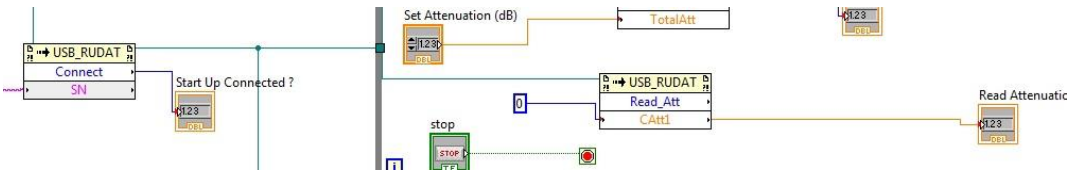



*Fig B7-xxxii - The Read Attenuation Invoke Node with the numeric control to display the value*

# B7c - Ethernet Control Using HTTP

## B7c.i - Switch Boxes

These instructions demonstrate control of Mini-Circuits switch boxes in LabVIEW using HTTP communication over an Ethernet network. The same methodology applies to the full range of Mini-Circuits' PTE (Portable Test Equipment), by sending the HTTP commands detailed in the respective programming manuals.

The Mini-Circuits DLL file is not required for HTTP communication since LabVIEW provides an HTTP GET function in the standard package.

### 1. Create a New VI (Virtual Instrument)

a. Open LabVIEW with a new, blank VI.
b. In the Block Diagram window (accessible by pressing Ctrl+E), select Functions Palette from the "View" menu at the top of the screen.

### 2. Create a new HTTP GET function

a. In the Functions menu, click through *Data Communications*, to the *HTTP Client* sub-pallette and place an **HTTP Get** function on the block diagram.

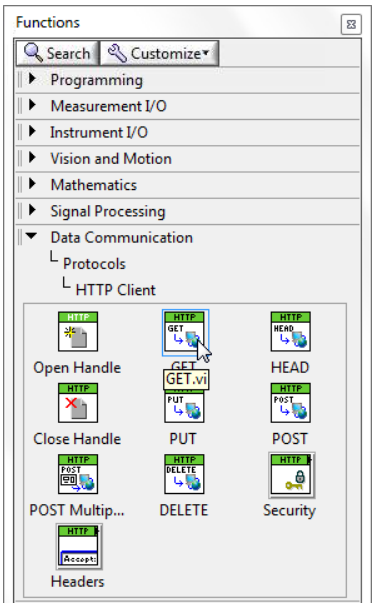



*Fig B7-xxxiii - Finding the HTTP Get function block*

b. Right-click on the *URL* input terminal of the **HTTP Get** function and select *Create* > *Constant*

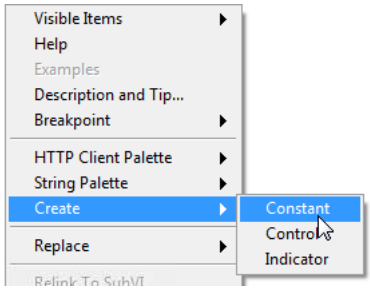



*Fig B7-xxxiv - Create the string input constant to store the command*

c. Place the string constant on the block diagram and enter the HTTP command to send (omitting the "HTTP://"); for example "192.168.9.67/:MN?" to read the model name of a switch with IP address 192.168.9.67.

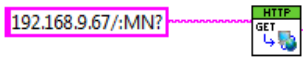



*Fig B7-xxxv - The HTTP command to read model name*

d. Right-click on the *Body* output terminal of the **HTTP Get** function and select *Create* > *Indicator* to store the return value of the HTTP command

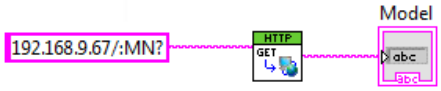



*Fig B7-xxxvi - HTTP Get function with output indicator*

### 3. Add additional HTTP Get commands

a. Step 2 above can be repeated to add as many HTTP Get functions as needed
b. HTTP Get can also be used to set the switch by sending the relevant command in the string constant, for example "192.168.9.67/:SETA=1" to set switch A to state 1; the return value in that case would be 0 or 1 to indicate whether the command was successful

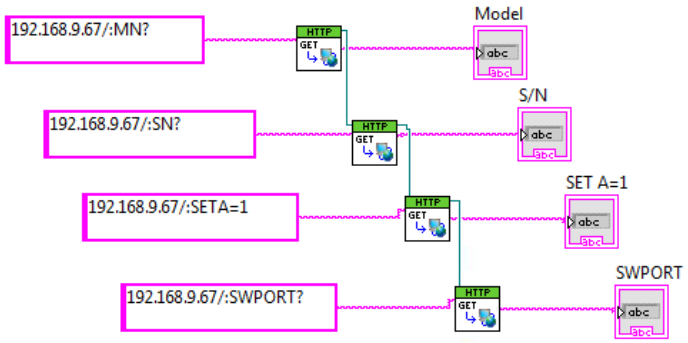



*Fig B7-xxxvii - HTTP commands to read model name/serial number, set switch state and confirm result*

# B8 - MATLAB Worked Examples

## B8a - USB Control Using the ActiveX DLL

### B8a.i - Switch Boxes

**Overview**

These instructions demonstrate how to control any Mini-Circuits USB switch box in MatLab using the ActiveX DLL. The same methodology applies for the full Mini-Circuits range of PTE (Portable Test Equipment); substituting the relevant DLL file and functions into the instructions below.

**1. Install and Register the DLL**

Install the switch box's DLL file (mcl_rf_switch_controller.dll) to the relevant Windows system folder and register using the Windows regsvr32 program (see the product Programming Manual for full details).

**2. Declare the DLL Class**

Use the `actxserver` function in Matlab to declare the DLL class and assign it to an object that will represent the switch. The object can be given any name (eg: "sw1") as long as it complies with the naming rules in MatLab.

This process can be repeated in order to control multiple switch boxes simultaneously with MatLab.

For example, to control two switch boxes that are to be referred to as "sw1" and "sw2", the following 2 commands would be needed:

```
>>     sw1 = actxserver('MCL_RF_Switch_Controller.USB_RF_Switch')
>>     sw2 = actxserver('MCL_RF_Switch_Controller.USB_RF_Switch')
```

The program should respond with:

```
sw1 = COM.MCL__RF__Switch__Controller_USB__RF__Switch
sw2 = COM.MCL__RF__Switch__Controller_USB__RF__Switch
```

**3. Connect the Switch Boxes by Serial Number**

The physical switch hardware must now be assigned to the software switch objects just created (sw1 and sw2). Use the "`Connect`" function (defined in the switch DLL) with the hardware serial numbers. In this example, the 2 switch boxes have serial numbers 11308230011 and 11308230015. MatLab will respond with "`ans = 1`" on success.

```
>>     sw1.Connect('11308230011')
ans = 1
>>     sw2.Connect('11308230015')
ans = 1
```

## 4. Send Commands

The 2 switch boxes are now configured for use and can be commanded as required. Use the "sw1" or "sw2" name before each command sent in order to address the correct hardware.

A full explanation of the available commands is included in the switch chapter of the Programming Manual at http://www.minicircuits.com/softwaredownload/Prog_Manual-2-Switch.pdf but some brief examples are below:

1) Set sw1 to state 4 and sw2 to state 0:

```
>>      sw1.Set_SwitchesPort(char(4))
ans = 1
>>      sw2.Set_SwitchesPort(char(0))
ans = 1
```

2) Confirm switch states (first define 2 variables "Status" and "SwState" which can accept the return values of the DLL function):

```
>>      [Status,SwState]=sw1.GetSwitchesStatus(SwState)
ans = 1
>>      SwState
ans = 4
>>      [Status,SwState]=sw21.GetSwitchesStatus(SwState)
ans = 1
>>      SwState
ans = 0
```

## 5. Disconnect the Switch Boxes

The switch boxes should be disconnected on completion of the switching routine using the "Disconnect" function in the DLL:

```
>>      sw1.Disconnect
>>      sw2.Disconnect
```

## 6. Display all Commands

If required, MatLab can print the full list of available commands to the console using the "invoke" command:

```
>>      sw1.Invoke
GetConnectionStatus = Variant GetConnectionStatus(handle)
GetDeviceTemperature = [single, int16] GetDeviceTemperature(handle, int16)
Get_Available_SN_List = [int16, string] Get_Available_SN_List(handle, string)
Get_Available_Address_List = [int16, string] Get_Available_Address_List(handle, string)
…
…
```

## 7. Summary

The above sections have been summarized as a complete series of commands below:

```
>>      sw1 = actxserver('MCL_RF_Switch_Controller.USB_RF_Switch')
sw1 = COM.MCL__RF__Switch__Controller_USB__RF__Switch

>>      sw2 = actxserver('MCL_RF_Switch_Controller.USB_RF_Switch')
sw2 = COM.MCL__RF__Switch__Controller_USB__RF__Switch

>>      sw1.Connect('11308230011')
ans = 1

>>      sw2.Connect('11308230015')
ans = 1

>>      sw1.Set_SwitchesPort(char(4))
ans = 1

>>      sw2.Set_SwitchesPort(char(0))
ans = 1

>>      [Status,SwState]=sw1.GetSwitchesStatus(SwStatw)
ans = 1

>>      SwState
ans = 4

>>      [Status,SwState]=sw21.GetSwitchesStatus(SwState)
ans = 1

>>      SwState
ans = 0

>>      sw1.Disconnect

>>      sw2.Disconnect
```

# B8b - USB Control Using the .Net DLL

## B8b.i - Switch Boxes

**Overview**

These instructions demonstrate how to control any Mini-Circuits USB switch box in MatLab using the .Net DLL. The same methodology applies for the full Mini-Circuits range of PTE (Portable Test Equipment); substituting the relevant DLL file and functions into the instructions below.

**1. Install the DLL**

Install the switch's DLL file (mcl_rf_switch_controller64.dll) to the relevant Windows system folder (usually \sysWOW64\); there is no need to register .Net DLLs.

**2. Provide the Location of the DLL File to MatLab**

Use the `NET.addAssembly` function in Matlab to provide a handle to the DLL (so that MatLab can locate it). The handle can be given any name that complies with MatLab's naming rules (eg: "MCL_SW"). This step only needs to be taken once, even if multiple switches are to be commanded simultaneously.

```
>>
MCL_SW=NET.addAssembly('C:\Windows\SysWOW64\mcl_RF_Switch_Controller6
4.dll')
```

MatLab will acknowledge the command with some generic information about .Net assemblies.

**3. Reference the .NET assembly**

Declare an object that will represent the switch and then assign it to the USB_RF_SwitchBox class defined in the DLL. This process can be repeated in order to control multiple switch boxes simultaneously with MatLab. For example, to control two switch boxes that are to be referred to as "sw1" and "sw2", the following 2 commands would be needed:

```
>> sw1 = mcl_RF_Switch_Controller64.USB_RF_SwitchBox
>> sw2 = mcl_RF_Switch_Controller64.USB_RF_SwitchBox
```

**4. Connect the Switch Boxes by Serial Number**

The physical switch box hardware must now be assigned to the software objects just created (sw1 and sw2). Use the "`Connect`" function (defined in the DLL) with the hardware serial numbers. In this example, the 2 switch boxes have serial numbers 11504210025 and 11504210026. MatLab will respond with "`ans = 1`" on success.

```
>>    sw1.Connect('11504210025')
ans = 1
>>    sw2.Connect('11504210026')
ans = 1
```

## 5. Send Commands

The 2 switch boxes are now configured for use and can be commanded as required. Use the "sw1" or "sw2" name before each command sent in order to address the correct hardware.

A full explanation of the available commands is included in the relevant chapter of the Programming Manual at http://www.minicircuits.com/softwaredownload/Prog_Manual-2-Switch.pdf but some brief examples are below:

1) Assume switch box 1 and 2 are both model RC-2SP6T-A18 (dual switch boxes):

```
>>    sw1.Set_2SP6T_COM_To(3, 0)
ans = 1
>>    sw2.Set_2SP6T_COM_To(6, 6)
ans = 1
```

The above commands set the following switch states:

- Switch box 1
  - Switch A = state 3 (Com port connected to port 3)
  - Switch B = state 0 (all ports disconnected)
- Switch box 2
  - Switch A = state 6 (Com port connected to port 6)
  - Switch B = state 6 (Com port connected to port 6)

2) Confirm the above switch states were set using the below commands:

```
>>    sw1.Get_2SP6T_State('A')
ans = 3
>>    sw1.Get_2SP6T_State('B')
ans = 0
>>    sw2.Get_2SP6T_State('A')
ans = 6
>>    sw2.Get_2SP6T_State('B')
ans = 6
```

## 6. Disconnect the Switch Boxes

The switch boxes should be disconnected on completion of the switching routine using the "Disconnect" function in the DLL:

```
>>    sw1.Disconnect
>>    sw2.Disconnect
```

## 7. Summary

The above sections have been summarized as a complete series of commands below:

```
>>      MCL_SW=NET.addAssembly('C:\Windows\SysWOW64\mcl_rf_switch_controller64.dll')

>>      sw1 = mcl_rf_switch_controller64.USB_RF_SwitchBox
sw1 =
        mcl_RF_Switch_Controller64.USB_RF_SwitchBox handle with no properties.
        Package: mcl_RF_Switch_Controller64

        Methods, Events, Superclasses

>>      sw2 = mcl_rf_switch_controller64.USB_RF_SwitchBox
sw2 =
        mcl_RF_Switch_Controller64.USB_RF_SwitchBox handle with no properties.
        Package: mcl_RF_Switch_Controller64

        Methods, Events, Superclasses

>>      sw1.Set_2SP6T_COM_To(3, 0)
ans = 1

>>      sw2.Set_2SP6T_COM_To(6, 6)
ans = 1

>>      sw1.Get_2SP6T_State('A')
ans = 3

>>      sw1.Get_2SP6T_State('B')
ans = 0

>>      sw2.Get_2SP6T_State('A')
ans = 6

>>      sw2.Get_2SP6T_State('B')
ans = 6

>>      sw1.Disconnect

>>      sw2.Disconnect
```

## B8b.ii - IO Control Boxes

### Overview

These instructions demonstrate how to control any Mini-Circuits USB Input/Output Control box in MatLab using the .Net DLL. The same methodology applies for the full Mini-Circuits range of PTE (Portable Test Equipment); substituting the relevant DLL file and functions into the instructions below.

### 1. Install the DLL

Install the control box's DLL file (MCL_USB_To_IO_64.dll) to the relevant Windows system folder (usually \sysWOW64\); there is no need to register .Net DLLs.

### 2. Provide the Location of the DLL File to MatLab

Use the `NET.addAssembly` function in Matlab to provide a handle to the DLL (so that MatLab can locate it). The handle can be given any name that complies with MatLab's naming rules (eg: "USB_IO"). This step only needs to be taken once, even if multiple control boxes are to be commanded simultaneously.

```
>> USB_IO=NET.addAssembly('C:\Windows\SysWOW64\mcl_USB_To_IO_64.dll')
```

MatLab will acknowledge the command with some generic information about .Net assemblies.

### 3. Reference the .NET assembly

Declare an object that will represent the control box and then assign it to the USB_IO class defined in the DLL. This process can be repeated in order to control multiple control boxes simultaneously with MatLab. For example, to control two input/output control boxes that are to be referred to as "io1" and "io2", the following 2 commands would be needed:

```
>> io1 = mcl_USB_To_IO_64.USB_IO
>> io2 = mcl_USB_To_IO_64.USB_IO
```

### 4. Connect the Control Boxes by Serial Number

The physical control box hardware must now be assigned to the software objects just created (io1 and io2). Use the "`Connect`" function (defined in the DLL) with the hardware serial numbers. In this example, the 2 control boxes have serial numbers 11308230011 and 11308230015. MatLab will respond with "`ans = 1`" on success.

```
>>    io1.Connect('11308230011')
ans = 1
>>    io2.Connect('11308230015')
ans = 1
```

## 5. Send Commands

The 2 control boxes are now configured for use and can be commanded as required. Use the "io1" or "io2" name before each command sent in order to address the correct hardware.

A full explanation of the available commands is included in the relevant chapter of the Programming Manual at http://www.minicircuits.com/softwaredownload/Prog_Manual-7-IO_Control.pdf but some brief examples are below:

1) Set the "byte A" output of io1 to state 52 and io2 to 48:

```
>>    io1.Set_ByteA(52)
ans = 1
>>    io2.Set_ByteA(48)
ans = 1
```

2) Confirm the output states (first define 2 variables, arbitrarily called "Status" and "ioValue", which can accept the return values of the DLL function):

```
>>    [Status,ioValue]=io1.ReadByteA(ioValue)
ans = 1
>>    ioValue
ans = 52
>>    [Status,ioValue]=io2.ReadByteA(ioValue)
ans = 1
>>    ioValue
ans = 48
```

## 6. Disconnect the Control Boxes

The control boxes should be disconnected on completion of the routine using the "Disconnect" function in the DLL:

```
>>    io1.Disconnect
>>    io2.Disconnect
```

## 7. Summary

The above sections have been summarized as a complete series of commands below:

```
>>      USB_IO=NET.addAssembly('C:\Windows\SysWOW64\mcl_USB_To_IO_64.dll')

>>      io1 = mcl_USB_To_IO_64.USB_IO
io1 =
        mcl_USB_To_IO64.USB_IO handle with no properties
        Package: mcl_USB_To_IO_64

        Methods, Events, Superclasses

>>      io2 = mcl_USB_To_IO_64.USB_IO
io1 =
        mcl_USB_To_IO64.USB_IO handle with no properties
        Package: mcl_USB_To_IO_64

        Methods, Events, Superclasses

>>      io1.Connect('11308230011')
ans = 1

>>      io2.Connect('11308230015')
ans = 1

>>      io1.Set_ByteA(52)
ans = 1

>>      io2.Set_ByteA(48)
ans = 1

>>      [Status,ioValue]=io1.ReadByteA(ioValue)
ans = 1

>>      ioValue
ans = 52

>>      [Status,ioValue]=io2.ReadByteA(ioValue)
ans = 1

>>      ioValue
ans = 48

>>      io1.Disconnect

>>      io2.Disconnect
```

# B9 - Agilent VEE Worked Examples

## B9a - USB Control Using the ActiveX DLL

### B9a.i - Switch Boxes

**Overview**

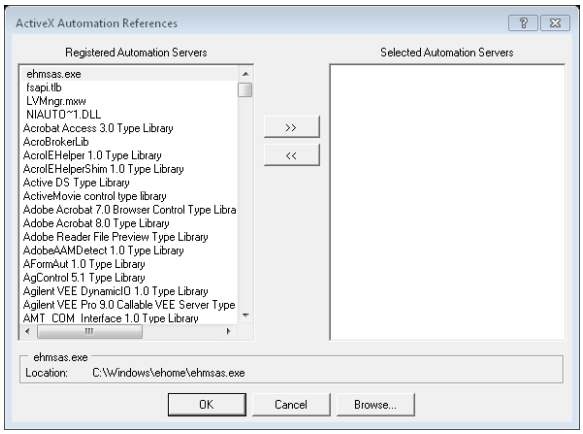
These instructions demonstrate how to control any Mini-Circuits USB switch box in Agilent VEE using the ActiveX DLL. The same methodology applies for the full Mini-Circuits range of PTE (Portable Test Equipment); substituting the relevant DLL file and functions into the instructions below.

**1. Install the DLL**

Install the DLL file (mcl_rf_switch_controller.dll) to the relevant Windows system folder and register using the Windows regsvr32 program (see the product Programming Manual for full details).

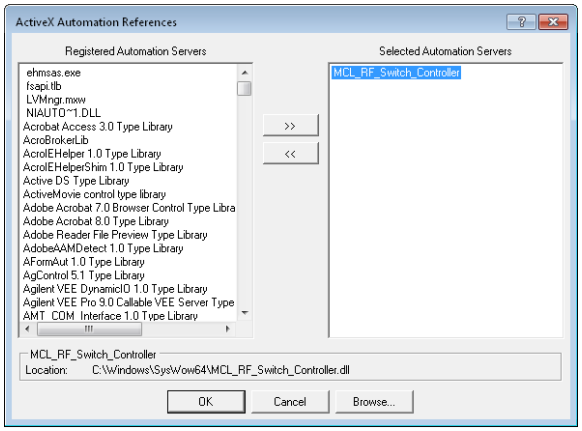
**2. Create the Switch Object in Agilent VEE**

a. Open the Agilent VEE program as an administrator (right-click the icon on the Windows Start Menu and select “Run as administrator”)
b. Select Device >> ActiveX Automation References from the VEE main menu:




c. Click Browse, navigate to the DLL (MCL_RF_Switch_Controller.dll) and click Open

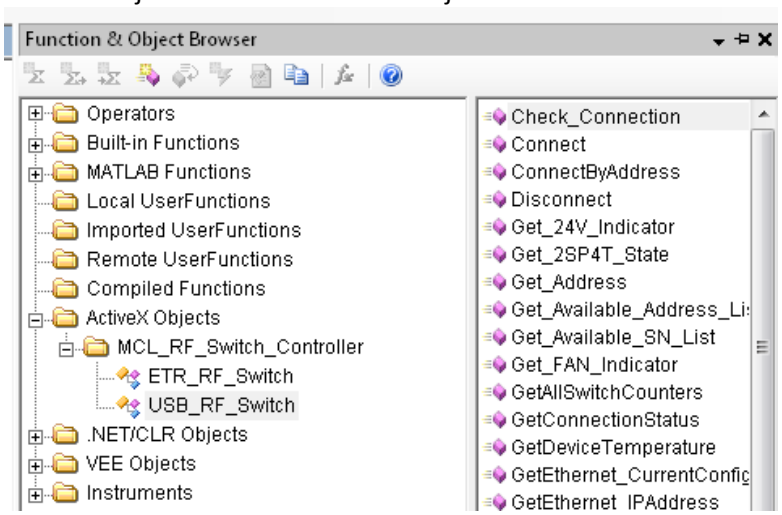
d. MCL_RF_Switch_Controller should appear in the list of Select Automation Servers, click OK:



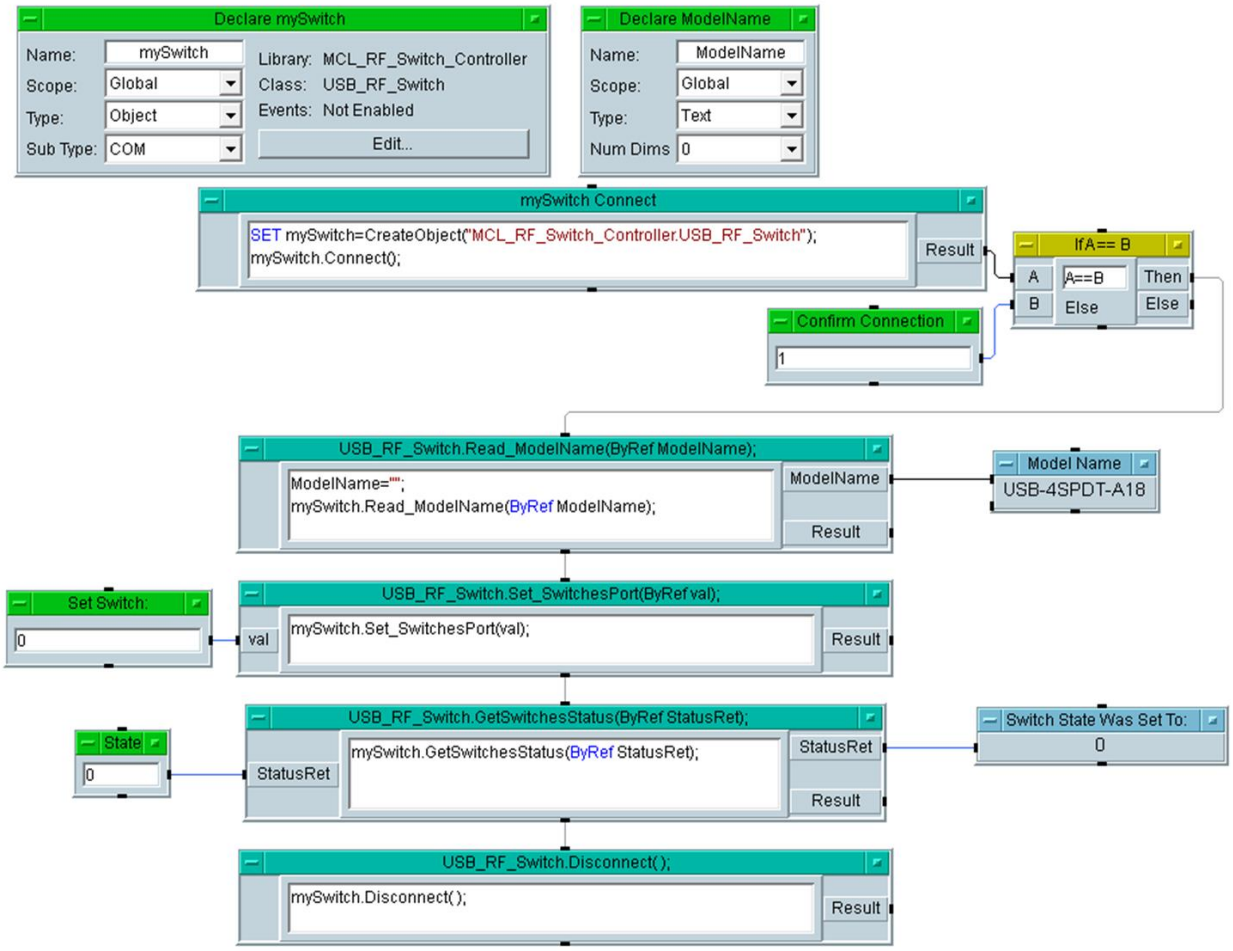

e. Click OK when the switch DLL appears in the Selected Automation Servers column

## 3. Create the Program

Agilent VEE can now access the switch DLL and will display all the switch functions under ActiveX Objects in the Function & Object Browser:



The functions can be arranged in the VEE workspace as required to create the switching routing. A simple example is shown below:




The program takes the following steps:

a. Declare global variables:
    a. mySwitch – the switch object, linked to the ActiveX COM object
    b. ModelName – a variable to store the switches model name
b. Use the CreateObject function to declare the switch software object, then use Connect to connect the hardware
c. Check that the return value from Connect is 1 before continuing
d. Check and output the model name of the switch
e. Set the switch state using a numeric value entered by the user in SetSwitch
f. Confirm the switch state and output it to the screen
g. Disconnect the switch

# B9b - USB Control Using the .Net DLL

## B9b.i - Switch Boxes

**Overview**

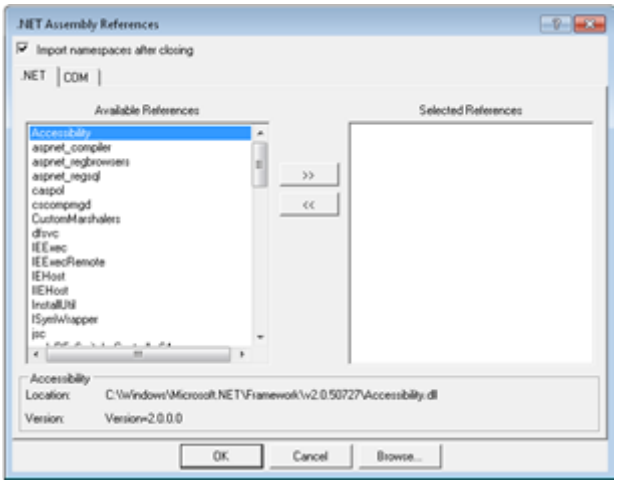
These instructions demonstrate how to control any Mini-Circuits USB switch box in Agilent VEE using the .Net DLL. The same methodology applies for the full Mini-Circuits range of PTE (Portable Test Equipment); substituting the relevant DLL file and functions into the instructions below.

**1. Install the DLL**

Install the DLL file (MCL_RF_Switch_Controller64.dll) to the relevant Windows system folder (usually \sysWOW64\); there is no need to register .Net DLLs.

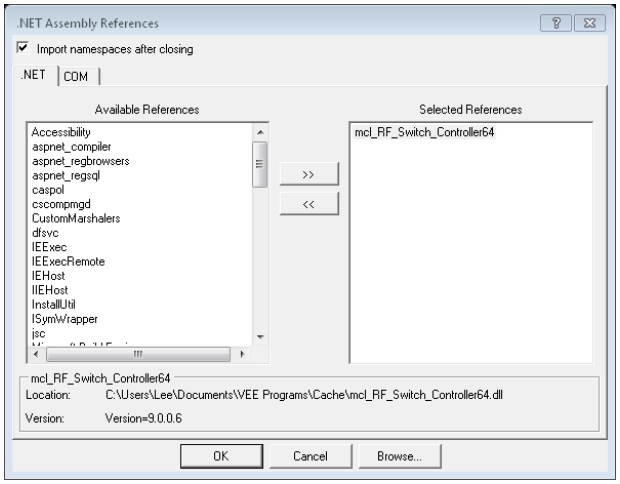
**2. Create the Switch Object in Agilent VEE**

a. Open Agilent VEE and select Device >> .NET Assembly References from the main menu:

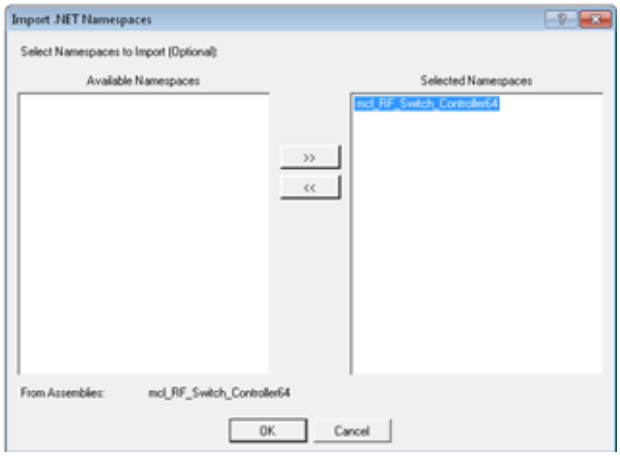



b. Click Browse, navigate to the DLL (MCL_RF_Switch_Controller64.dll) and click Open

c. MCL_RF_Switch_Controller64 should appear in the list of Selected References, click OK:

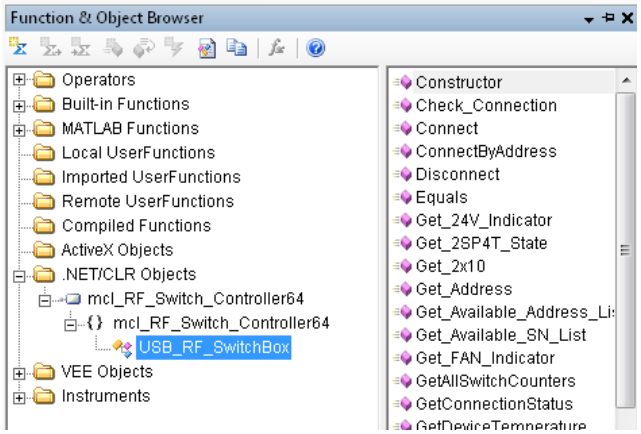



d. mcl_RF_Switch_controller64 should appear in the list of Available Namespaces; double-click on it to move it to Selected Namespaces and then click OK:

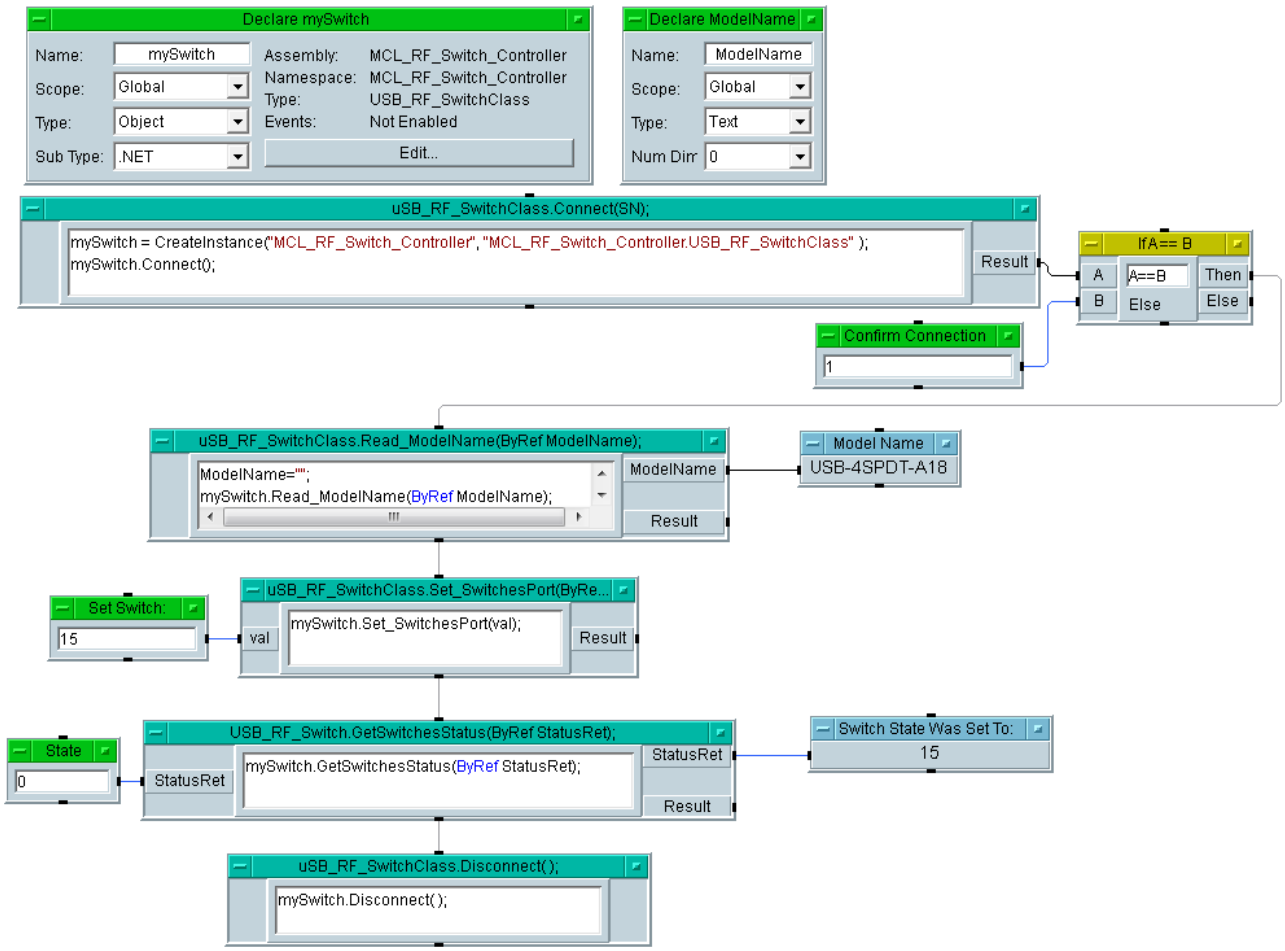



## 3. Create the Program

Agilent VEE can now access the switch DLL and will display all the switch functions under .NET/CLR Objects in the Function & Object Browser:



The functions can be arranged in the VEE workspace as required to create the switching routing. A simple example is shown below.




The program takes the following steps:

h. Declare global variables:
   a. mySwitch – the switch object, linked to the .NET object
   b. ModelName – a variable to store the switches model name
i. Use the CreateInstance function to declare an instance of the switch software object, then use Connect to connect the hardware
j. Check that the return value from Connect is 1 before continuing
k. Check and output the model name of the switch
l. Set the switch state using a numeric value entered by the user in SetSwitch
m. Confirm the switch state and output it to the screen
n. Disconnect the switch

# Appendix C - Troubleshooting

## C1 - Working with the DLL Files

### C1a - File Placement

**32-bit Operating Systems**

The default DLL file location is the System32 sub-folder of the Windows root directory, usually:
`C:\Windows\System32\`

- ActiveX DLL files must be placed in this directory
- .NET DLL files can generally be placed in any directory as long as the correct reference is set within the programming environment. However, if there is an issue with using the DLL then we would recommend placing it in the default directory as the first step in troubleshooting.

**64-bit Operating Systems**

The default DLL file location is the SysWoW64 sub-folder of the Windows root directory, usually:
`C:\Windows\SysWOW64\`

- ActiveX DLL files must be placed in this directory
- .NET DLL files can generally be placed in any directory as long as the correct reference is set within the programming environment. However, if there is an issue with using the DLL then we would recommend placing it in the default directory as the first step in troubleshooting.

## C1b - Windows File Blocking

Windows will occasionally block system files downloaded from the Internet when it is not sure of the source. In this state the DLL file can be placed in the relevant directory but it will not be useable from the programming environment. To review and unblock a DLL, right-click on the file in Windows Explorer and select Properties:

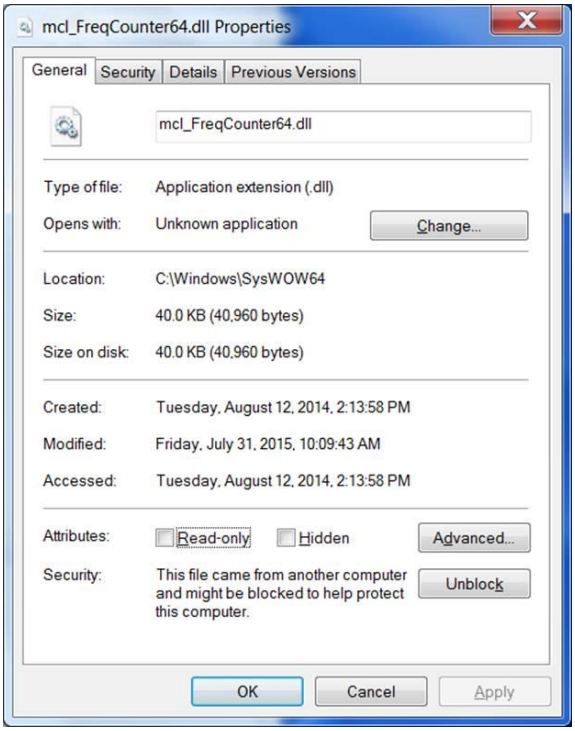



*Fig C1-i - Windows file properties dialog for a blocked DLL (see Security comment at the bottom)*

A Security comment will appear at the bottom of the dialog if the file is blocked, advising "This file came from another computer and might be blocked to help protect this computer." Click the Unblock button to enable the DLL.

## C1c - File Registration

The .NET DLL does not need to be registered in the operating system; an error will be returned if this is attempted.

The ActiveX DLL must be registered in the operating system using the Windows regsvr32.exe program. This can be done using the Windows command prompt in elevated mode (right-click on the icon and select "run as administrator").

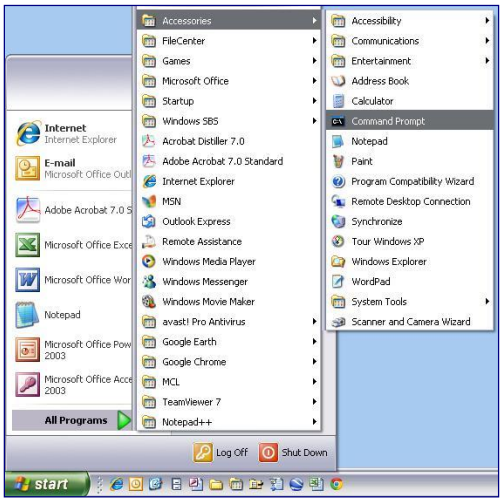



*Fig C1-ii - Opening the Command Prompt in WIndows XP (left-click on Command Prompt)*

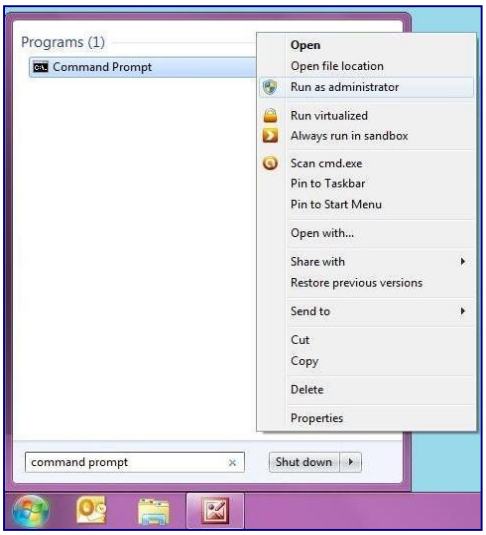



*Fig C1-iii - Opening the Command Prompt in Windows 7 (right-click and select "Run as administrator")*

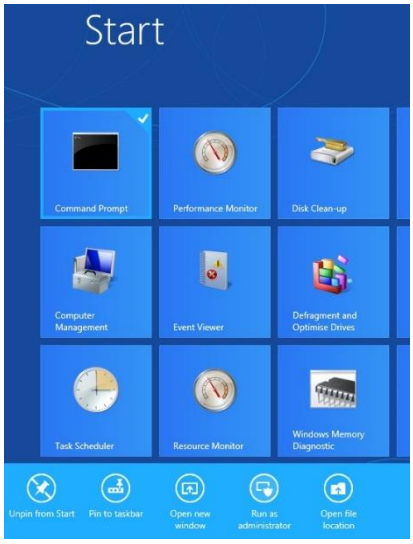



*Fig C1-iv - Opening the Command Prompt in Windows 8 (right-click and select "Run as administrator")*

**32-bit Operating Systems**

The command to enter into the command prompt is as below (where "dll_filename.dll" is replaced with the dll to register, eg: "mcl_pm.dll"):

- Type `regsvr32 dll_filename.dll`

**64-bit Operating Systems**

64-bit Windows operating systems have 2 versions of the regsvr32.exe program and 2 default directories for DLL files (the System32 and SysWOW64 folders) so it is important to be explicit with the pathnames to ensure the correct program and DLL are found.

1. Type `cd \windows\syswow64` to move from the current directory to the SysWOW64 directory
2. Type `regsvr32 dll_filename.dll` to register the DLL (where "dll_filename.dll" is replaced with the dll to register, eg: "mcl_pm.dll")

## C1c.i - Successful Registration

When a DLL file is successfully registered using the instructions above, the below message (or similar) will be displayed:

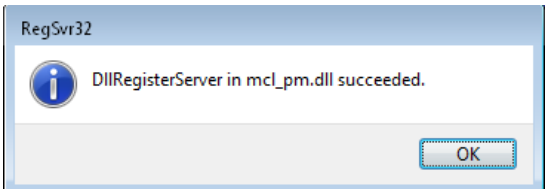



*Fig C1-v - Successful registration message*

## C1c.ii - Common Registration Error Messages

Some commonly encountered error messages when attempting to register DLL files are summarised below.

**DLLRegisterServer Was Not Found**

The below error indicates that the regsvr32 program found the DLL but could not locate the necessary section in order to register it. This is commonly encountered for Mini-Circuits' DLL files when attempting to register a .NET DLL.

**Solution:** Mini-Circuits' .NET DLLs should not be registered so you can ignore this error and start using the DLL without doing anything further.

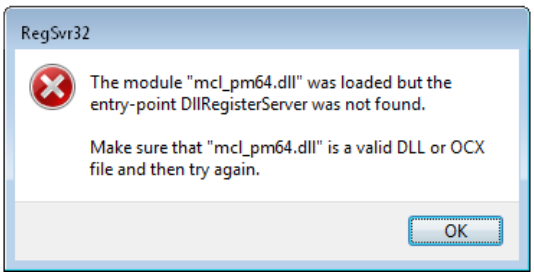



*Fig C1-vi - "DLLRegisterServer was not found" Error*

**DLLRegisterServer Failed**

The below error indicates that the regsvr32 program found the DLL and attempted to register it but was unable to do so. The most common occurrence of this error when attempting to register Mini-Circuits' DLL files is that the command prompt does not have the necessary administrator priviledge to change Windows' system settings.

**Solution:** Close the command prompt and re-open it in "elevated mode" by right-clicking on the icon and selecting "Run as administrator". Then repeat the registration process as described above.

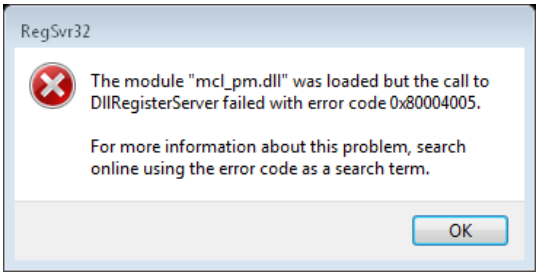



*Fig C1-vii - "DLLRegisterServer failed" Error*

**Module Failed to Load**

The below error indicates that the regsvr32 program was unable to find the DLL file.

**Solution:** Check that the DLL path and filename were entered correctly. On 64-bit machines, ensure that the command prompt is at the correct directory (`\Windows\SysWOW64`).

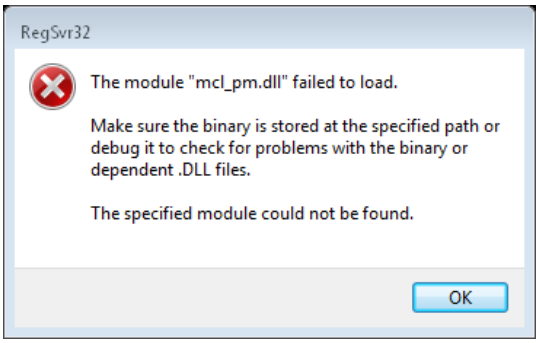



*Fig C1-viii - "Module ... failed to load" Error*