Custom Filters

CUSTOM FILTER SETUP

If the seven standard filters provided with DFP are not sufficient, you can create and use filters with virtually any characteristic, up to 1000 taps.

The required custom filter can be designed with a digital filter design or math package such as MATLAB® or Mathcad®.

The filter coefficients can then be loaded into the scope, using the DSOFilter utility. GPIB, LAN, or a serial RS-232 connection between the PC and oscilloscope is required. However, if these connections are not available, it is also possible to load the file with a diskette.

DSOFilter is an ActiveX control that can be downloaded free of charge from LeCroy's web site at www.lecroy.com.

Following are two examples of how custom filters can be created and loaded into the scope with DSOFilter. The first demonstrates a filter design using the Mathcad program. The second shows how to use an Excel spreadsheet. Both examples use the DSOFilter utility for downloading coefficients in the scope.

LeCroy Digital Filter Package

Example 1: Using Mathcad 2000 (Visual Basic Script)

Sending FIR coefficients to a DSO from Mathcad, using the LeCroy DSOFilter Control:
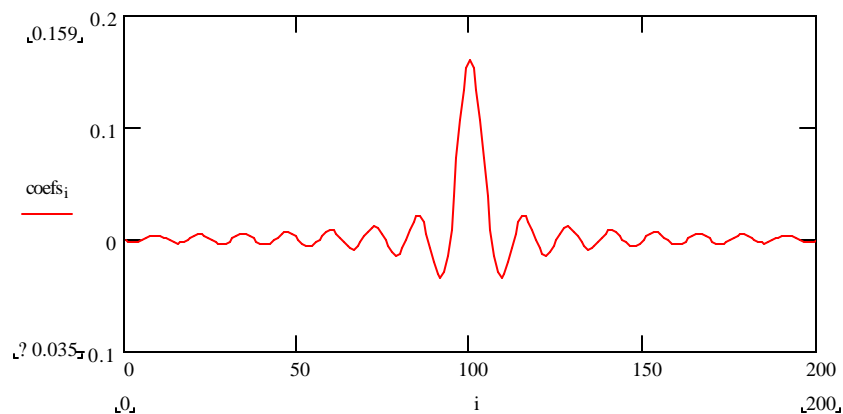
i := 0..200

sinx(x) := sin(x)/x

$$coefs_i := \frac{1}{2\pi} \sin x \left[\frac{i - 100.0001}{2} \right]$$

200 point sin(x)/x, a low-pass filter.

Note: Real world filters would either be windowed or made by the Remez exchange algorithm. The point of this example is not to make a good filter, but to show how to transfer a filter to the scope.

$$check := \sum coefs$$

check = 0.987   This is the DC gain of the filter

To send it, we need to include the LeCroy DSOFilter Control, which is an ActiveX control, as a scriptable object. Remember the name you specify for this instance of the ActiveX control. Mathcad acts as an ActiveX scripting host. It makes the methods of the object available using the name you specified. It invokes a VBScript interpreter (because this example uses VBScript as the scripting language) and calls three routines: ScriptObj_Event.Start(), ScriptObj_Event.Exec (Inputs, Outputs), and SciptObjec_Event.Stop(). Mathcad calls these three in order when calculating. Mathconnex can Start, followed by 0, 1, or many invocations of Exec, followed by Stop.

To make the connection to the ActiveX control choose Insert, Component, Scriptable Object; then click Next.

Check "New" and select "LeCroy DSOFilter Control" from the list. (If you don't see it, the control has not been installed). Click Next.

Select "VB Script Language." This tells Mathcad, the scripting host, which interpreter to load. Click Next.

Give this object a Name. For this example, accept the default name "ScriptObj". The VBScript uses this name to access the object's methods. For example: ScriptObj.Beep(). Set this object to require 2 inputs from Mathcad and to return no output values. In this example the two inputs to the script are the coefficient array, and a value specifying the number of points in the array. The destination is assumed to be M1. The connection is assumed to be at GPIB address 5. These assumptions could be eliminated. Only the "_Exec" function takes arguments, so the connect method could be called from ScriptObjEvent_Exec() instead of ScriptObjEvent_Start(), and we could pass in an extra argument to specify the connection method, as a string, from Mathcad.

The format of the string would be, for example, either "GPIB: 5" or "COM1: 19200,8,N,1" (RS-232 on COM1, at 19200 baud, 8 bits per character, no parity, one stop bit; the other choices for parity are E for even or O for odd) or "IP: 128.211.87.234". Similarly, if ScriptObjEvent_Exec() took four arguments, the fourth could be a string specifying the destination. This fourth string would be passed to the SetFilter method of the DSOFilter control instead of the fixed string "M1". The script uses the inputs from Mathcad to invoke the SetFilter method of the object.

LeCroy Digital Filter Package

DSOFilter
(coefs 201)

The script that is run to connect Mathcad to the DSOFilter Active X control for this example is:

```
Sub ScriptObjEvent_Start()
  REM Set up - tell the DSOFilter how to talk to the scope
  ScriptObj.Connect("GPIB: 5")
End Sub

Sub ScriptObjEvent_Exec(Inputs,Outputs)
  REM Get the inputs
  numcoefs = Inputs(1).Value
  REM Need numcoefs as Long
  numcoefs = CLng(numcoefs)
  REM Send the coefficients to M1 - have to put them in an array
  Dim coefs(999)
  Dim foo
  foo = inputs(0).value     ' assign inputs(0).value to a local variable
  For i = 0 to numcoefs-1
    dtmp = foo(i)
    coefs(i) = CSng(dtmp)  ' they can be double, too; but single is enough
  Next
  retval = ScriptObj.SetFilter( "M1", numcoefs, coefs)
  If (retval = False) Then
    MsgBox( "SetFilter returned False - problem")
  End If
  REM Make the scope beep to make sure we got here
  ScriptObj.Beep()
End Sub
Sub ScriptObjEvent_Stop()
  REM Nothing to do for clean-up
End Sub
```

Example 2: Sending FIR Coefficients from Excel

When you start the DSOFilt utility, an Excel spreadsheet similar to the following one opens. (You must enable macros beforehand in the pop-up dialogue box.) In this example, a low-pass filter with 200 coefficients is specified on the Excel spreadsheet. The PC is connected to the oscilloscope via a GPIB connection. Click the "Make Scope Beep" button to check this connection. A beep will be heard after a few seconds.

After ensuring that the connection works properly, the coefficients may be sent. First, a destination must be specified (such as memories M1–M4 in the DSO). It is also possible to send the coefficients to a file. In that case, a filename must be specified.

> **Note:** If other than GPIB serial connection between the PC and the scope is used (such as RS-232 or Ethernet 10/100 MB/s), GPIB: 5 should be set for the correct connection type.
>
> ### RS-232
>
> ? COM1: 19200,8,N,1   (COMn: baud, bits, parity, stop)
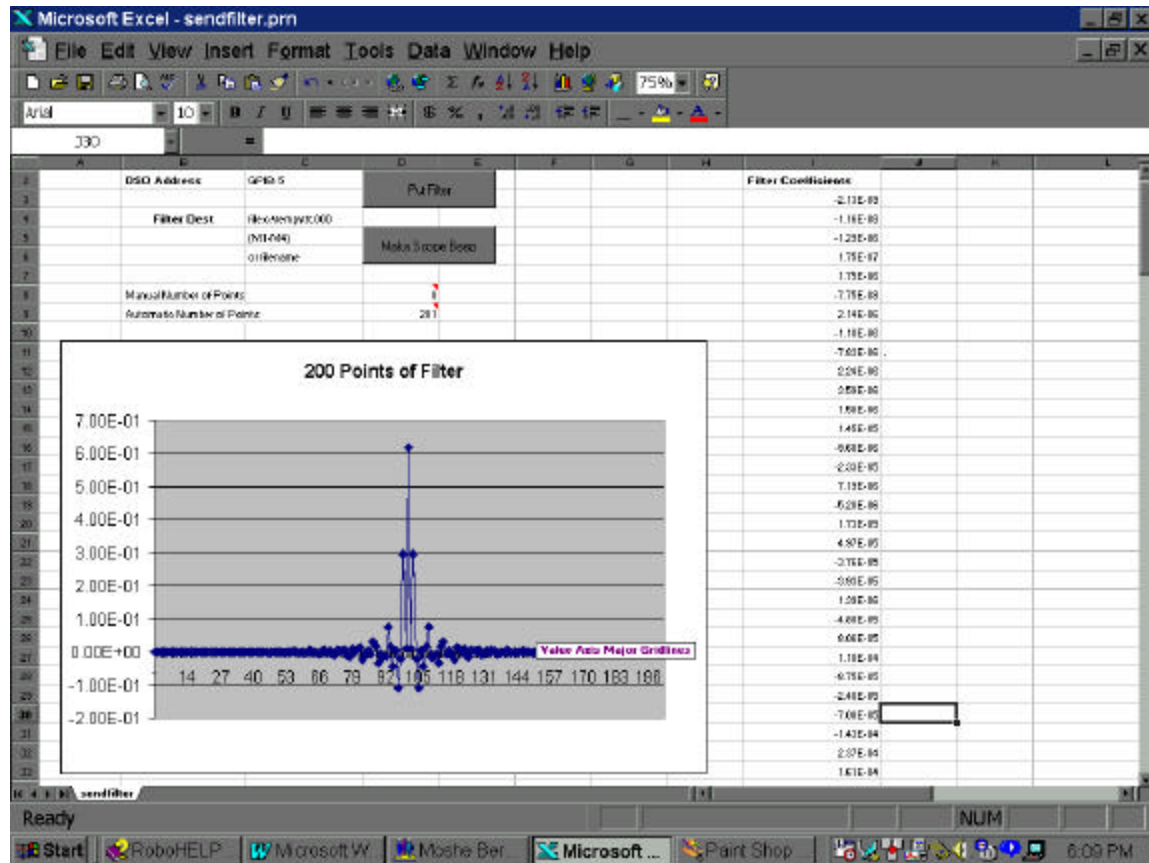>
> ### LAN (Ethernet 10/100)
>
> ? IP: 128.211.87.234   (IP: a,b,c,d)

Click the "Put Filter" button to send the list of coefficients. Upon completion, the beep is sounded again.

Number of Points: If "Manual Number of Points" is set to 0, the "Automatic Number of Points" is determined by the number of coefficients, However, if "Manual Number of Points" is other then 0, it overrides the Automatic setting, making it possible to examine the results with only a limited number of coefficients before employing the full filter.

> **Notes:** 1. The chart is used only as a display tool. It shows the filter in the time domain, but it has no influence on operation.
> 2. You may simply replace the coefficients in the example with your filter's coefficients.

§ § §

Custom Filters

CUSTOM FILTER SETUP

If the seven standard filters provided with DFP are not sufficient, you can create and use filters with virtually any characteristic, up to 1000 taps.

The required custom filter can be designed with a digital filter design or math package such as MATLAB® or Mathcad®.

The filter coefficients can then be loaded into the scope, using the DSOFilter utility. GPIB, LAN, or a serial RS-232 connection between the PC and oscilloscope is required. However, if these connections are not available, it is also possible to load the file with a diskette.

DSOFilter is an ActiveX control that can be downloaded free of charge from LeCroy's web site at www.lecroy.com.

Following are two examples of how custom filters can be created and loaded into the scope with DSOFilter. The first demonstrates a filter design using the Mathcad program. The second shows how to use an Excel spreadsheet. Both examples use the DSOFilter utility for downloading coefficients in the scope.

LeCroy Digital Filter Package

Example 1: Using Mathcad 2000 (Visual Basic Script)

Sending FIR coefficients to a DSO from Mathcad, using the LeCroy DSOFilter Control:
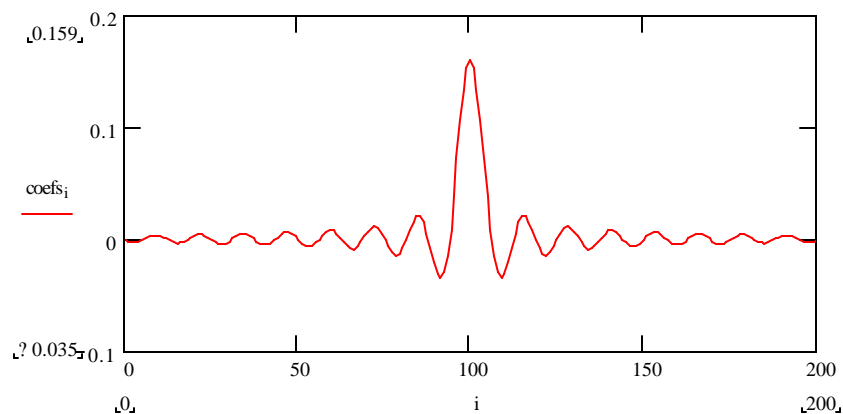
i := 0..200

sinx(x) := sin(x)/x

$$coefs_i := \frac{1}{2\pi} \sin x \left[\frac{i - 100.0001}{2} \right]$$

200 point sin(x)/x, a low-pass filter.

Note: Real world filters would either be windowed or made by the Remez exchange algorithm. The point of this example is not to make a good filter, but to show how to transfer a filter to the scope.

$$check := \sum coefs$$

check = 0.987   This is the DC gain of the filter

To send it, we need to include the LeCroy DSOFilter Control, which is an ActiveX control, as a scriptable object. Remember the name you specify for this instance of the ActiveX control. Mathcad acts as an ActiveX scripting host. It makes the methods of the object available using the name you specified. It invokes a VBScript interpreter (because this example uses VBScript as the scripting language) and calls three routines: ScriptObj_Event.Start(), ScriptObj_Event.Exec (Inputs, Outputs), and SciptObjec_Event.Stop(). Mathcad calls these three in order when calculating. Mathconnex can Start, followed by 0, 1, or many invocations of Exec, followed by Stop.

To make the connection to the ActiveX control choose Insert, Component, Scriptable Object; then click Next.

Check "New" and select "LeCroy DSOFilter Control" from the list. (If you don't see it, the control has not been installed). Click Next.

Select "VB Script Language." This tells Mathcad, the scripting host, which interpreter to load. Click Next.

Give this object a Name. For this example, accept the default name "ScriptObj". The VBScript uses this name to access the object's methods. For example: ScriptObj.Beep(). Set this object to require 2 inputs from Mathcad and to return no output values. In this example the two inputs to the script are the coefficient array, and a value specifying the number of points in the array. The destination is assumed to be M1. The connection is assumed to be at GPIB address 5. These assumptions could be eliminated. Only the "_Exec" function takes arguments, so the connect method could be called from ScriptObjEvent_Exec() instead of ScriptObjEvent_Start(), and we could pass in an extra argument to specify the connection method, as a string, from Mathcad.

The format of the string would be, for example, either "GPIB: 5" or "COM1: 19200,8,N,1" (RS-232 on COM1, at 19200 baud, 8 bits per character, no parity, one stop bit; the other choices for parity are E for even or O for odd) or "IP: 128.211.87.234". Similarly, if ScriptObjEvent_Exec() took four arguments, the fourth could be a string specifying the destination. This fourth string would be passed to the SetFilter method of the DSOFilter control instead of the fixed string "M1". The script uses the inputs from Mathcad to invoke the SetFilter method of the object.

LeCroy Digital Filter Package

DSOFilter
(coefs 201)

The script that is run to connect Mathcad to the DSOFilter Active X control for this example is:

```
Sub ScriptObjEvent_Start()
  REM Set up - tell the DSOFilter how to talk to the scope
  ScriptObj.Connect("GPIB: 5")
End Sub

Sub ScriptObjEvent_Exec(Inputs,Outputs)
  REM Get the inputs
  numcoefs = Inputs(1).Value
  REM Need numcoefs as Long
  numcoefs = CLng(numcoefs)
  REM Send the coefficients to M1 - have to put them in an array
  Dim coefs(999)
  Dim foo
  foo = inputs(0).value      ' assign inputs(0).value to a local variable
  For i = 0 to numcoefs-1
    dtmp = foo(i)
    coefs(i) = CSng(dtmp)  ' they can be double, too; but single is enough
  Next
  retval = ScriptObj.SetFilter( "M1", numcoefs, coefs)
  If (retval = False) Then
    MsgBox( "SetFilter returned False - problem")
  End If
  REM Make the scope beep to make sure we got here
  ScriptObj.Beep()
End Sub
Sub ScriptObjEvent_Stop()
  REM Nothing to do for clean-up
End Sub
```

Example 2: Sending FIR Coefficients from Excel

When you start the DSOFilt utility, an Excel spreadsheet similar to the following one opens. (You must enable macros beforehand in the pop-up dialogue box.) In this example, a low-pass filter with 200 coefficients is specified on the Excel spreadsheet. The PC is connected to the oscilloscope via a GPIB connection. Click the "Make Scope Beep" button to check this connection. A beep will be heard after a few seconds.

After ensuring that the connection works properly, the coefficients may be sent. First, a destination must be specified (such as memories M1–M4 in the DSO). It is also possible to send the coefficients to a file. In that case, a filename must be specified.

> **Note:** If other than GPIB serial connection between the PC and the scope is used (such as RS-232 or Ethernet 10/100 MB/s), GPIB: 5 should be set for the correct connection type.
>
> ### RS-232
>
> ? COM1: 19200,8,N,1 (COMn: baud, bits, parity, stop)
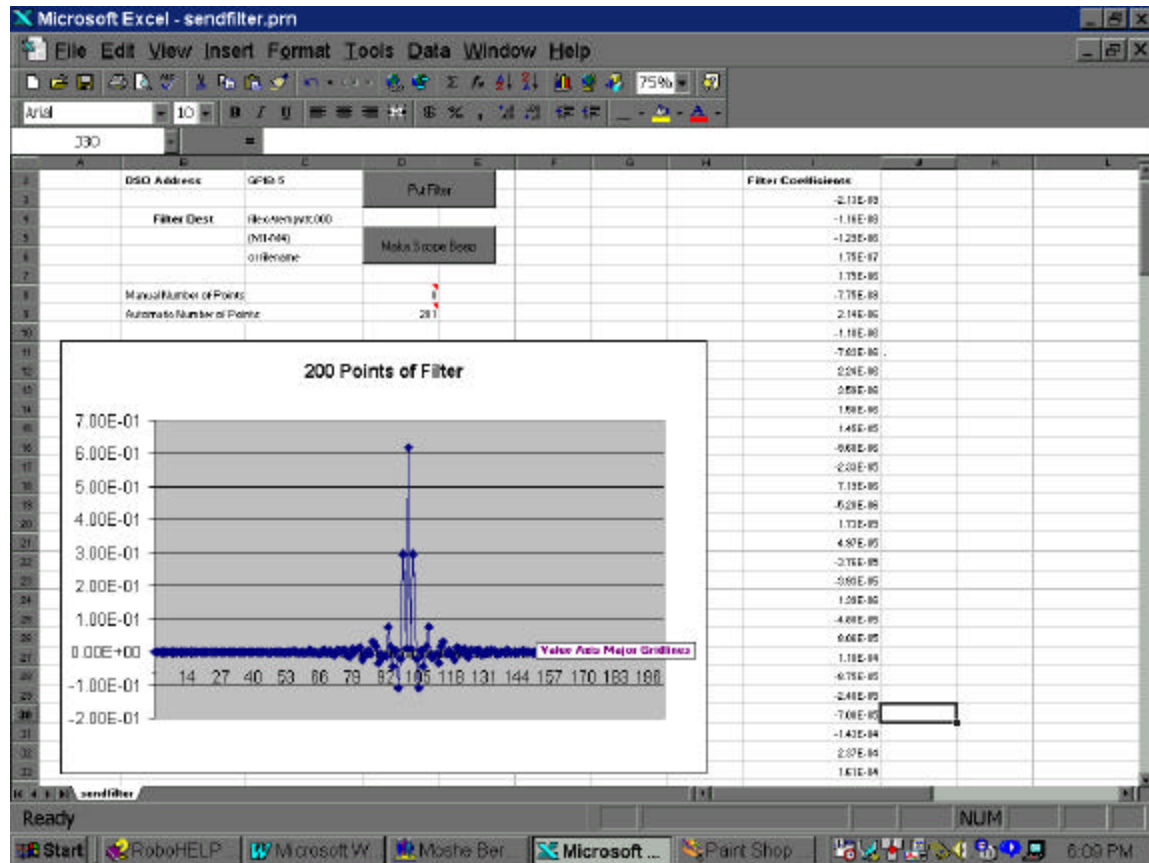>
> ### LAN (Ethernet 10/100)
>
> ? IP: 128.211.87.234 (IP: a,b,c,d)

Click the "Put Filter" button to send the list of coefficients. Upon completion, the beep is sounded again.

Number of Points: If "Manual Number of Points" is set to 0, the "Automatic Number of Points" is determined by the number of coefficients, However, if "Manual Number of Points" is other then 0, it overrides the Automatic setting, making it possible to examine the results with only a limited number of coefficients before employing the full filter.

> **Notes:** 1. The chart is used only as a display tool. It shows the filter in the time domain, but it has no influence on operation.
> 2. You may simply replace the coefficients in the example with your filter's coefficients.

§ § §