Chapter 1

Supplementary Material - Programming Codes

1.1 MATLAB Import *.otb File Routine

The following files were programmed to extract the appropriate information from the *.otb file generated by OT BioLab software. In within these files there are call routines of the next one using the information previously acquired. More, there are some routines commented, specially the routines that plot the data acquired.

```
%Opens otb selected file and unzips it, extracting all the files then
%comparing them. Finally chooses the appropriate xml file for further
%information processing.
%
%Version 1.0
%January 16th, 2012
%
%Alejandra Aranceta-Garza

close all
clear all
%
% %Ask to get the abstract.xml from each report

% %asks for the otb file
%
[file_name, file_path]=uigetfile('*.otb', 'Select the *.otb file');
filename2=[file_path file_name];

% %creates a temporary directory
%
% mkdir('Temp');
% cd Temp;

% %extracts the .sig files in the temporary directory
new_filename=unzip(filename2,file_path);


%Get the appropriate xml file
file1=cell2mat(new_filename(1));
file2=cell2mat(new_filename(2));
file3=cell2mat(new_filename(3));

%Define variables
c_c=[file_path,'abstract.xml'];
[pathstr1, name1, ext1]=fileparts(file1);
[pathstr2, name2, ext2]=fileparts(file2);
[pathstr3, name3, ext3]=fileparts(file3);

%Looks for the right path depending on the extension of the file
TF = strcmp(c_c,file1);
if TF==1
    if strcmp(ext2,'.xml')
        filename=file2;
    else
        New_file_path={file3};
        filename=file3;
    end
else
    if strcmp(ext1,'.xml')
        filename=file1;
    else
        TF=strcmp(c_c,file2);
        if TF==1
            if strcmp(ext3,'.xml')
```

```
                filename=file3;
            end
        else
            filename=file2;
        end
    end
end
%Looks for sig file
SIG_C = strcmp('.sig',ext1);
if SIG_C==1
    Sig_File=file1;
    else
        SIG_C = strcmp('.sig',ext2);
        if SIG_C==1
           Sig_File=file2;
         else
           Sig_File=file3;
        end
end
r=size(Sig_File);

%liberate space
clear filename2 new_filename file1 file2 file3 c_c pathstr1 pathstr2 pathstr3 name1↙
name2 name3 ext1 ext2 ext3 r SIG_C  TF
```

```
%% Get otb information v1.0
%Extracts from chosen *.otb file the information needed
%such as fsamp, number of channels, A/D bits.
%Manages the file to be used as a table
%January 16th, 2012
%Alejandra Aranceta-Garza

%
%  clear all
%  close all

 ext_check

xDoc = xmlread(fullfile(filename));

file_open = fopen(filename,'r');
%file_read=fread(file_open);
file_read_char =fread(file_open,'int8=>char');
%each char is in a separate cell vertically
a=cellstr(file_read_char);
%each char is separate cell horizontally
 b=a.';
 %whole word vertically (same cell)
c=char(b);
%whole word horizontally (same cell)
d=c.';
space_char=strfind(' ',d);
tf= isspace(d);
tf1=1-tf;
%splits word according to char found (space)
[selected_outputs]=regexp(d,' ','split');
words=regexp(d,'<|>','split');

%Automatically gets settings from abstract file

if (length(words)<45)%only good when ONE channel was saved (steps not recorded)
    Number_Channels=1;
    Sample_Frequency=str2double(words{23});

else
if strcmp(words(63),'    ')%If <Comments> is an empty cell
     Number_Channels=str2double(words{73});
     %Gain=str2double(words(107));
%      High_Pass_filter=str2double(words(111));
%      Low_Pass_filter=str2double(words(115));
     Sample_Frequency=str2double(words(77));
     AD_converted_bits=str2double(words(81));
     %Sensor_Channels=str2double(words(129));
     %Fg=1; %Flag to know which case our program falls to
     x=95; %first channel position

 else
     Number_Channels=str2double(words{75});
     %Gain=str2double(words(109));
%      High_Pass_filter=str2double(words(113));
```

```
%      Low_Pass_filter=str2double(words(117));
     Sample_Frequency=str2double(words(79));
     AD_converted_bits=str2double(words(83));
     %Sensor_Channels=str2double(words(131));
     %Fg=2; %Flag to know which case our program falls to
     x=97; %first channel position
end
end

%Need to know type of acquisition of each channel in order to treat sEMG
%channels different from AUX Channels



% if str2double(words(x+168+8*(Sensor_Channel-1))) < Number_Channels
% j=j+1;
% Sensor_Channel{j}=str2double(words(x+168+8*(Sensor_Channel-1)));
%
% else
% end
%
%
%
%

clear xDoc a b c d file_open file_path file_read_char selected_outputs space_char tf↙
tf1
```

```
%% Get type and arrays v1.0
%Extracts from *.xml file:
%
%electrode_count: number of electrodes used during acquisition
%Gain: gain detected from each array used
%HP_filter: frequency detected for high pass filter for each array used
%LP_filter: frequency detected for low pass filter for each array used
%type_of_sensor: type of sensor used in each array acquisition
%sensor_name: Name of the sensor array used
%array_counting: number of arrays
%
%
%January 25th, 2012
%Alejandra Aranceta-Garza


%  clear all
%  close all
%
Get_otb_info

%x: position of the first channel of every array
%y: position of the type of every array
%k: electrode buffer count
%el{array_counting}: number of electrodes in array
%type{array_counting}: type of sensor used in mentioned array
%z: position of # of electrodes in the array
if (length(words)<45)
   test_start=str2double(words(15));
   test_end=str2double(words(19));
else
k=1;
%Sensor_Channel{k}=str2double(words(x+34));
array_counting=1;
y=x+30;
z=x+34;
w=x+26;
gn=x+12;
hp=x+16;
lp=x+20;
electrode_count=0;
num_aux=0;

% el{array_counting}=str2double(words(z));
% type{array_counting}=words(y);
%initialize variables


if (length(words)<45)
else
    while k-1<Number_Channels
    type_of_sensor{array_counting}=words{y};
    el{array_counting}=str2double(words(z));
    electrode_count=electrode_count+str2double(words(z));
    Sensor_name{array_counting}=words{w};
```

```
    Gain{array_counting}=str2double(words(gn));
    HP_filter{array_counting}=str2double(words(hp));
    LP_filter{array_counting}=str2double(words(lp));

%Get the type of array

    if strcmp(type_of_sensor{array_counting},'AUX')
        rds=x+163;
        rds=words(rds);
        num_aux=num_aux+1;
        if strcmp(rds,'displayInPopup')
        x=x+176;
        else
            x=x+168;
        end
    else
        x=x+(168+(8*(el{array_counting}-1)))+8;

    end


    y=x+30;
    z=x+34;
    w=x+26;
    gn=x+12;
    hp=x+16;
    lp=x+20;

    if electrode_count== Number_Channels

    else
        array_counting=array_counting+1;
    end
    k=str2double(words(x));



    end
end
% if (gn+2)==0
%
% else
  m=gn+2;
mode=str2double(words{m});
if mode==0
    mode='Chained Differential';
else if mode==1
        mode='Looped Differential';
    else if mode==2
            mode='Floating Monopolar';
        else mode==3
            mode='Referenced Monopolar';
            if mode ==4
                mode='Bipolar';
            else
```

```
                mode='Hybrid';
            end
        end
    end
end
% end

end
%liberate space

clear gn hp k lp w x y z
```

```
%% Get_Signal_from_File v1.0
%Extracts from chosen *.otb file the sig file
%
%January 19th, 2012
%Alejandra Aranceta-Garza

Get_type_and_arrays

%Reads signal input

aa=fopen(Sig_File,'r');
raw_signal=fread(aa,[Number_Channels, inf],'short');
fclose all;

if (length(words)<45)
    signal=raw_signal*5/2^12/500*1000; %Change the gain depending on the subject
else
    for a_c=1:array_counting
    signal=raw_signal*5/2^AD_converted_bits/Gain{a_c}*1000;
    end
end

%Converts the signal. signal: contains the channels acquired.
%signal=raw_signal*5/2^AD_converted_bits/Gain*1000;
%where:
%5: is the A/D input range in V
%2^AD_converted_bits: resolution of the A/D
%Gain: used during acquisition
%1000: factor to convert the amplitude in mV

%Extract matrix dimentions
[nch Sig_dur]= size(signal);

%acquire time vector in seconds
time=linspace(0, Sig_dur/Sample_Frequency, Sig_dur);

% %Plots each channel.
% figure
% for i= 1:Number_Channels
%    plot(time,signal(i,:)+1*(i-1))
%    hold on;
% end
% xlabel('Time(s)');
% ylabel('Number of Channels Acquired');

if length(words)<45
    num_aux=0;
else
if electrode_count==nch
else
    error('The electrode count and the size of electrodes registered is not the same')
end
end

%liberate space
```

```
clear aa ans a_c nch raw_signal
%
% for i=1:Number_Channels
%     figure
%     plot(time,signal(i,:))
%     xlabel('Time [s]');
% ylabel('Voltage [mV]');
% hold on;
% end
% figure

% %Plot triggers
%
% i=129;
% figure
% for i=129:132
%     plot(time,signal(i,:))
%     hold on
% end
% % %

if num_aux>0
totaltrig=(num_aux-1);
for tri=1:num_aux
    Trigger{tri}=signal((Number_Channels-totaltrig),:);
    totaltrig=totaltrig-1;
end
else
end
```

1.2 Data Acquisition NI USB-6008 used for GUIs

Technical Sales
United States
(866) 531-6285
info@ni.com

Requirements and Compatibility | Ordering Information | Detailed Specifications
For user manuals and dimensional drawings, visit the product page resources tab on ni.com.

Last Revised: 2013-07-10 09:55:53.0

Low-Cost, Bus-Powered Multifunction DAQ for USB

12- or 14-Bit, Up to 48 kS/s, 8 Analog Inputs

- 8 analog inputs at 12 or 14 bits, up to 48 kS/s
- 2 analog outputs at 12 bits, software-timed
- 12 TTL/CMOS digital I/O lines
- One 32-bit, 5 MHz counter
- Digital triggering
- Bus-powered
- 1-year warranty

Overview

With recent bandwidth improvements and new innovations from National Instruments, USB has evolved into a core bus of choice for measurement applications. The NI USB-6008 and USB-6009 are low-cost DAQ devices with easy screw connectivity and a small form factor. With plug-and-play USB connectivity, these devices are simple enough for quick measurements but versatile enough for more complex measurement applications.

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Requirements and Compatibility

OS Information
Mac OS X
Windows 2000/XP
Windows 7
Windows CE
Windows Mobile
Windows Vista 32-bit
Windows Vista 64-bit

Driver Information
NI-DAQmx
NI-DAQmx Base

Software Compatibility
ANSI C/C++
LabVIEW
LabWindows/CVI
Measurement Studio
SignalExpress
Visual Basic .NET
Visual C#

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Comparison Tables

Product	Analog Inputs	Input Resolution	Max Sampling Rate (kS/s)	Analog Outputs	Output Resolution	Output Rate (Hz)	Digital I/O Lines	32-Bit Counter	Triggering
USB-6008	8 single-ended/4 differential	12	10	2	12	150	12	1	Digital
USB-6009	8 single-ended/4 differential	14	48	2	12	150	12	1	Digital

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Application and Technology

The USB-6008 and USB-6009 are ideal for applications where a low-cost, small form factor and simplicity are essential. Examples include the following:

Data logging—quick and easy environmental or voltage data logging
Academic lab use—student ownership of data acquisition hardware for completely interactive lab-based courses (Academic pricing available. Visit the academic product page for details.)
OEM applications as I/O for embedded systems

Recommended Software

National Instruments measurement services software, built around NI-DAQmx driver software, includes intuitive application programming interfaces, configuration tools, I/O assistants, and other tools designed to reduce system setup, configuration, and development time. National Instruments recommends using the latest version of NI-DAQmx driver software for application development in NI LabVIEW, SignalExpress, LabWindows™/CVI, and Measurement Studio software. To obtain the latest version of NI-DAQmx, visit ni.com/support/daq/versions.

NI measurement services software speeds up your development with features including the following:

A guide to create fast and accurate measurements with no programming using the DAQ Assistant
Automatic code generation to create your application in LabVIEW
LabWindows/CVI; SignalExpress; and C#, Visual Studio .NET, ANSI C/C++, or Visual Basic using Measurement Studio
Multithreaded streaming technology for 1,000 times performance improvements
Automatic timing, triggering, and synchronization routing to make advanced applications easy
More than 3,000 free software downloads at ni.com/zone to jump-start your project
Software configuration of all digital I/O features without hardware switches/jumpers
Single programming interface for analog input, analog output, digital I/O, and counters on hundreds of multifunction DAQ hardware devices; M Series devices are compatible with the following versions (or later) of NI application software—LabVIEW, LabWindows/CVI, or Measurement Studio versions 7.x; and SignalExpress 2.x

Every National Instruments DAQ device includes a copy of SignalExpress LE data-logging software, so you can quickly acquire, analyze, and present data without programming. The NI-DAQmx Base driver software is provided for use with Linux, Mac OS X, Windows Mobile, and Windows CE OSs.

Recommended Accessories

The USB-6008 and USB-6009 have removable screw terminals for easy signal connectivity. For extra flexibility when handling multiple wiring configurations, NI offers the USB-600x Connectivity Kit, which includes two extra sets of screw terminals, extra labels, and a screwdriver. In addition, the USB-600x Prototyping Kit provides space for adding more circuitry to the inputs of the USB-6008 or USB-6009.

NI USB DAQ for OEMs

Shorten your time to market by integrating world-class National Instruments OEM measurement products into your embedded system design. Board-only versions of NI USB DAQ devices are available for OEM applications, with competitive quantity pricing and available software customization. The NI OEM Elite Program offers free 30-day trial kits for qualified customers. Visit ni.com/oem for more information.

Information for Student Ownership

To supplement simulation, measurement, and automation theory courses with practical experiments, NI has developed the USB-6008 and USB-6009 student kits, which include the LabVIEW Student Edition and a ready-to-run data logger application. These kits are exclusively for students, giving them a powerful, low-cost, hands-on learning tool. Visit ni.com/academic for more details.

Information for OEM Customers

For information on special configurations and pricing, call (800) 813-3693 (United States only) or visit ni.com/oem. Go to the Ordering Information section for part numbers.

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Ordering Information

For a complete list of accessories, visit the product page on ni.com.

Products	Part Number	Recommended Accessories	Part Number
NI USB-6008			
NI USB-6008 with NI-DAQmx software, LabVIEW SignalExpress LE, and a USB cable.	779051-01	No accessories required.	
NI USB-6008 OEM (no enclosure)	193132-02	No accessories required.	
NI USB-6008 Student Kit with NI-DAQmx software, LabVIEW SignalExpress LE, and a USB cable. Includes LabVIEW Student Edition.	779320-22	No accessories required.	
Prototyping Kit			
NI USB-600x Prototyping Kit	779511-01	No accessories required.	
Connectivity Kit			
NI USB-600x Connectivity Kit	779371-01	No accessories required.	
NI USB-6009			
NI USB-6009 OEM (no enclosure)	193132-01	No accessories required.	
NI USB-6009 Student Kit with NI-DAQmx software, LabVIEW SignalExpress LE, and a USB cable. Includes LabVIEW Student Edition.	779321-22	No accessories required.	
NI USB-6009 with NI-DAQmx software, LabVIEW SignalExpress LE, and a USB cable.	779026-01	No accessories required.	

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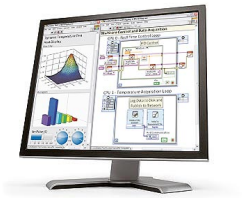
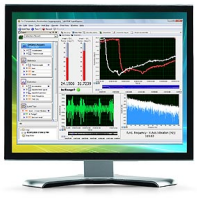
Software Recommendations

NI LabVIEW Full Development System for Windows Fully integrated graphical system design software

SignalExpress for Windows Quickly configure projects without programming
Control over 400 PC-based and stand-alone instruments



Support for a wide range of measurement hardware, I/O, and buses
Custom, event-driven user interfaces for measurement and control
Extensive signal processing, analysis, and math functionality
Advanced compiler to ensure high-performance execution and code optimization

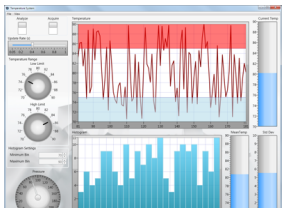


Log data from more than 250 data acquisition devices
Perform basic signal processing, analysis, and file I/O
Scale your application with automatic LabVIEW code generation
Create custom reports or easily export data to LabVIEW, DIAdem or Microsoft Excel

NI LabWindows™/CVI for Windows

Real-time advanced 2D graphs and charts
Complete hardware compatibility with IVI, VISA, DAQ, GPIB, and serial
Analysis tools for array manipulation, signal processing statistics, and curve fitting
Simplified cross-platform communication with network variables
Measurement Studio .NET tools (included in LabWindows/CVI Full only)
The mark LabWindows is used under a license from Microsoft Corporation.

NI Measurement Studio Standard Edition



Customizable graphs and charts for WPF, Windows Forms, and ASP.NET Web Forms UI design
Analysis libraries for basic signal generation
Hardware integration support with data acquisition and instrument control libraries
Project setup wizards to speed up development
Support for Microsoft Visual Studio .NET 2012/2010/2008

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Support and Services

System Assurance Programs

NI system assurance programs are designed to make it even easier for you to own an NI system. These programs include configuration and deployment services for your NI PXI, CompactRIO, or Compact FieldPoint system. The NI Basic System Assurance Program provides a simple integration test and ensures that your system is delivered completely assembled in one box. When you configure your system with the NI Standard System Assurance Program, you can select from available NI system driver sets and application development environments to create customized, reorderable software configurations. Your system arrives fully assembled and tested in one box with your software preinstalled. When you order your system with the standard program, you also receive system-specific documentation including a bill of materials, an integration test report, a recommended maintenance plan, and frequently asked question documents. Finally, the standard program reduces the total cost of owning an NI system by providing three years of warranty coverage and calibration service. Use the online product advisors at ni.com/advisor to find a system assurance program to meet your needs.

Technical Support

Get answers to your technical questions using the following National Instruments resources.

- **Support** - Visit ni.com/support to access the NI KnowledgeBase, example programs, and tutorials or to contact our applications engineers who are located in NI sales offices around the world and speak the local language.
- **Discussion Forums** - Visit forums.ni.com for a diverse set of discussion boards on topics you care about.
- **Online Community** - Visit community.ni.com to find, contribute, or collaborate on customer-contributed technical content with users like you.

Repair

While you may never need your hardware repaired, NI understands that unexpected events may lead to necessary repairs. NI offers repair services performed by highly trained technicians who quickly return your device with the guarantee that it will perform to factory specifications. For more information, visit ni.com/repair.

Training and Certifications

The NI training and certification program delivers the fastest, most certain route to increased proficiency and productivity using NI software and hardware. Training builds the skills to more efficiently develop robust, maintainable applications, while certification validates your knowledge and ability.

- **Classroom training in cities worldwide** - the most comprehensive hands-on training taught by engineers.
- **On-site training at your facility** - an excellent option to train multiple employees at the same time.
- **Online instructor-led training** - lower-cost, remote training if classroom or on-site courses are not possible.
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- **Training memberships** and training credits - to buy now and schedule training later.

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Extended Warranty

NI offers options for extending the standard product warranty to meet the life-cycle requirements of your project. In addition, because NI understands that your requirements may change, the extended warranty is flexible in length and easily renewed. For more information, visit ni.com/warranty.

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Alliance

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Detailed Specifications

FThe following specifications are typical at 25 °C, unless otherwise noted.

Analog Input	
Converter type	Successive approximation
Analog inputs	8 single-ended, 4 differential, software selectable
Input resolution	
NI USB-6008	12 bits differential, 11 bits single-ended
NI USB-6009	14 bits differential, 13 bits single-ended
Max sampling rate (aggregate) [1]	
NI USB-6008	10 kS/s
NI USB-6009	48 kS/s
AI FIFO	512 bytes
Timing resolution	41.67 ns (24 MHz timebase)
Timing accuracy	100 ppm of actual sample rate
Input range	
Single-ended	±10 V
Differential	±20 V [2] , ±10 V, ±5 V, ±4 V, ±2.5 V, ±2 V, ±1.25 V, ±1 V
Working voltage	±10 V
Input impedance	144 kΩ
Overvoltage protection	±35
Trigger source	Software or external digital trigger
System noise [3]	
Single-ended	
±10 V range	5 mVrms
Differential	
± 20 V range	5 mVrms
±1 V range	0.5 mVrms

Absolute accuracy at full scale, single-ended		
Range	**Typical at 25 °C (mV)**	**Maximum over Temperature (mV)**
±10	14.7	138

Absolute accuracy at full scale, differential [4]		
Range	**Typical at 25 °C (mV)**	**Maximum over Temperature (mV)**
±20	14.7	138
±10	7.73	84.8
±5	4.28	58.4
±4	3.59	53.1
±2.5	2.56	45.1
±2	2.21	42.5
±1.25	1.70	38.9
±1	1.53	37.5

Analog Output	
Analog outputs	2
Output resolution	12 bits
Maximum update rate	150 Hz, software-timed

Output range	0 to +5 V
Output impedance	50 Ω
Output current drive	5 mA
Power-on state	0 V
Slew rate	1 V/µs
Short circuit current	50 mA
Absolute accuracy (no load)	7 mV typical, 36.4 mV maximum at full scale

Digital I/O

Digital I/O	
P0.<0..7>	8 lines
P1.<0..3>	4 lines
Direction control	Each channel individually programmable as input or output
Output driver type	
NI USB-6008	Open collector (open-drain)
NI USB-6009	Each channel individually programmable as active drive (push-pull) or open collector (open-drain)
Compatibility	TTL, LVTTL, CMOS
Absolute maximum voltage range	–0.5 to 5.8 V with respect to GND
Pull-up resistor	4.7 kΩ to 5 V
Power-on state	Input

Digital logic levels

Level	Min	Max	Units
Input low voltage	–0.3	0.8	V
Input high voltage	2.0	5.8	V
Input leakage current	—	50	µA
Output low voltage (I = 8.5 mA)	—	0.8	V
Output high voltage			
Active drive (push-pull), I = –8.5 mA	2.0	3.5	V
Open collector (open-drain), I = –0.6 mA, nominal	2.0	5.0	V
Open collector (open-drain), I = –8.5 mA, with external pull-up resistor	2.0	—	V

External Voltage

+5 V output (200 mA maximum)	+5 V typical, +4.85 V minimum
+2.5 V output (1 mA maximum)	+2.5 V typical
+2.5 V accuracy	0.25% max
Reference temperature drift	50 ppm/°C max

Counter

Number of counters	1
Resolution	32 bits
Counter measurements	Edge counting (falling-edge)
Counter direction	Count up
Pull-up resistor	4.7 kΩ to 5 V
Maximum input frequency	5 MHz
Minimum high pulse width	100 ns
Minimum low pulse width	100 ns
Input high voltage	2.0 V

Input low voltage	0.8 V

Power Requirements

USB	
4.10 to 5.25 VDC	80 mA typical, 500 mA max
USB suspend	300 µA typical, 500 µA max

Physical Characteristics

Dimensions	
Without connectors	6.35 cm × 8.51 cm × 2.31 cm (2.50 in. × 3.35 in. × 0.91 in.)
With connectors	8.18 cm × 8.51 cm × 2.31 cm (3.22 in. × 3.35 in. × 0.91 in.)
I/O connectors	USB series B receptacle, (2) 16 position terminal block plug headers
Weight	
With connectors	84 g (3 oz)
Without connectors	54 g (1.9 oz)
Screw-terminal wiring	16 to 28 AWG
Torque for screw terminals	0.22–0.25 N · m (2.0–2.2 lb · in.)

Safety

If you need to clean the module, wipe it with a dry towel.

Safety Voltages

Connect only voltages that are within these limits.

Channel-to-GND	±30 V max, Measurement Category I

Measurement Category I is for measurements performed on circuits not directly connected to the electrical distribution system referred to as MAINS voltage. MAINS is a hazardous live electrical supply system that powers equipment. This category is for measurements of voltages from specially protected secondary circuits. Such voltage measurements include signal levels, special equipment, limited-energy parts of equipment, circuits powered by regulated low-voltage sources, and electronics.

Caution Do not use this module for connection to signals or for measurements within Measurement Categories II, III, or IV.

Safety Standards

This product is designed to meet the requirements of the following standards of safety for electrical equipment for measurement, control, and laboratory use:
IEC 61010-1, EN 61010-1
UL 61010-1, CSA 61010-1

Note For UL and other safety certifications, refer to the product label or visit ni.com/certification, search by model number or product line, and click the appropriate link in the Certification column.

Hazardous Locations

The NI USB-6008/6009 device is not certified for use in hazardous locations.

Environmental

The NI USB-6008/6009 device is intended for indoor use only.

Operating temperature	
(IEC 60068-2-1 and IEC 60068-2-2)	0 to 55 °C
Operating humidity	
(IEC 60068-2-56)	5 to 95% RH, noncondensing
Maximum altitude	2,000 m (at 25 °C ambient temperature)
Storage temperature	
(IEC 60068-2-1 and IEC 60068-2-2)	–40 to 85 °C
Storage humidity	
(IEC 60068-2-56)	5 to 90% RH, noncondensing
Pollution Degree (IEC 60664)	2

Electromagnetic Compatibility

This product is designed to meet the requirements of the following standards of EMC for electrical equipment for measurement, control, and laboratory use:
EN 61326 EMC requirements; Minimum Immunity

EN 55011 Emissions; Group 1, Class A
CE, C-Tick, ICES, and FCC Part 15 Emissions; Class A

Note For EMC compliance, operate this device with double-shielded cables.

CE Compliance

This product meets the essential requirements of applicable European Directives, as amended for CE marking, as follows:
2006/95/EC; Low-Voltage Directive (safety)
2004/108/EC; Electromagnetic Compatibility Directive (EMC)

Note Refer to the Declaration of Conformity (DoC) for this product for any additional regulatory compliance information. To obtain the DoC for this product, visit ni.com/certification, search by module number or product line, and click the appropriate link in the Certification column.

Environmental Management

National Instruments is committed to designing and manufacturing products in an environmentally responsible manner. NI recognizes that eliminating certain hazardous substances from our products is beneficial not only to the environment but also to NI customers.

For additional environmental information, refer to the *NI and the Environment* Web page at ni.com/environment. This page contains the environmental regulations and directives with which NI complies, as well as other environmental information not included in this document.

Waste Electrical and Electronic Equipment (WEEE)

EU Customers At the end of their life cycle, all products *must* be sent to a WEEE recycling center. For more information about WEEE recycling centers and National Instruments WEEE initiatives, visit ni.com/environment/weee.htm.

电子信息产品污染控制管理办法 （中国 RoHS）

中国客户 National Instruments 符合中国电子信息产品中限制使用某些有害物质指令 (RoHS)。
关于 National Instruments 中国 RoHS 合规性信息，请登录 ni.com/environment/rohs_china。
(For information about China RoHS compliance, go to ni.com/environment/rohs_china.)

[1] System dependent.

[2] ±20 V means that |AI+ – (AI–)| ≥ 20 V. However, AI+ and AI– must both be within ±10 V of GND.

[3] System noise measured at maximum sample rate.

[4] Input voltages may not exceed the working voltage range.

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1.3 Detailed Programming for the Main Menu for the GUI Developed in LabVIEW

Inital_VI_feedback_control_2.vi
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Inital_VI_feedback_control_2.vi

Calibrate

Start

STOP

Background colour

Start DEMO?

MVC Middle
MVC value of the middle finger from the Calibration GUI.

MVC Index
MVC value of the index finger from the Calibration GUI.

MVC Pinky
MVC value of the pinky finger from the Calibration GUI.

MVC Ring
MVC value of the ring finger from the Calibration GUI.

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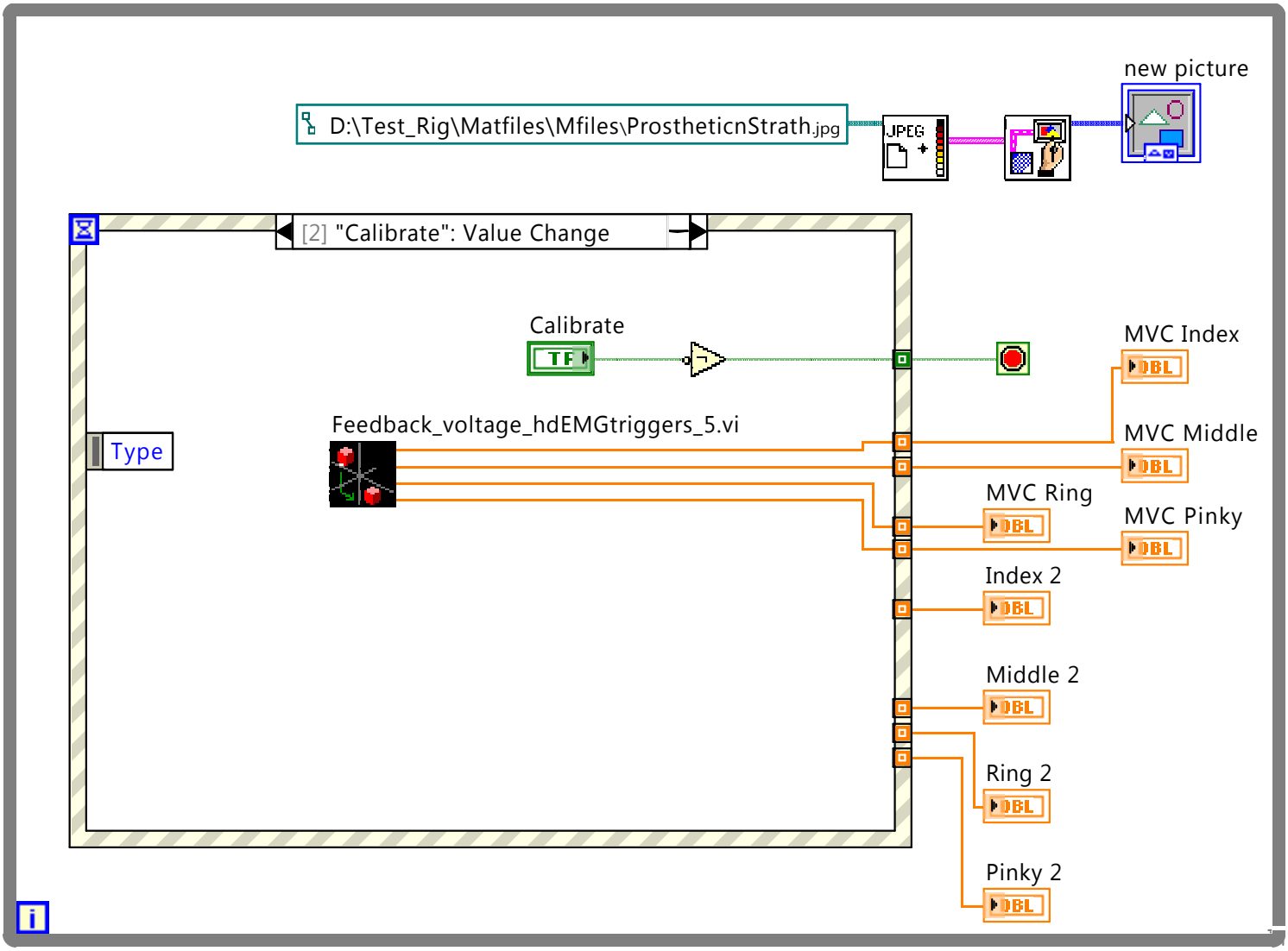
new picture
<B>new picture</B> is the picture that contains the new image. You can wire this output to any other <B>picture</B> input to add more drawing instructions to the picture.

Index 2
MVC value of the index finger from the Calibration GUI.

Middle 2
MVC value of the middle finger from the Calibration GUI.

Ring 2
MVC value of the ring finger from the Calibration GUI.

Pinky 2
MVC value of the pinky finger from the Calibration GUI.



Background colour

Inital_VI_feedback_control_2.vi
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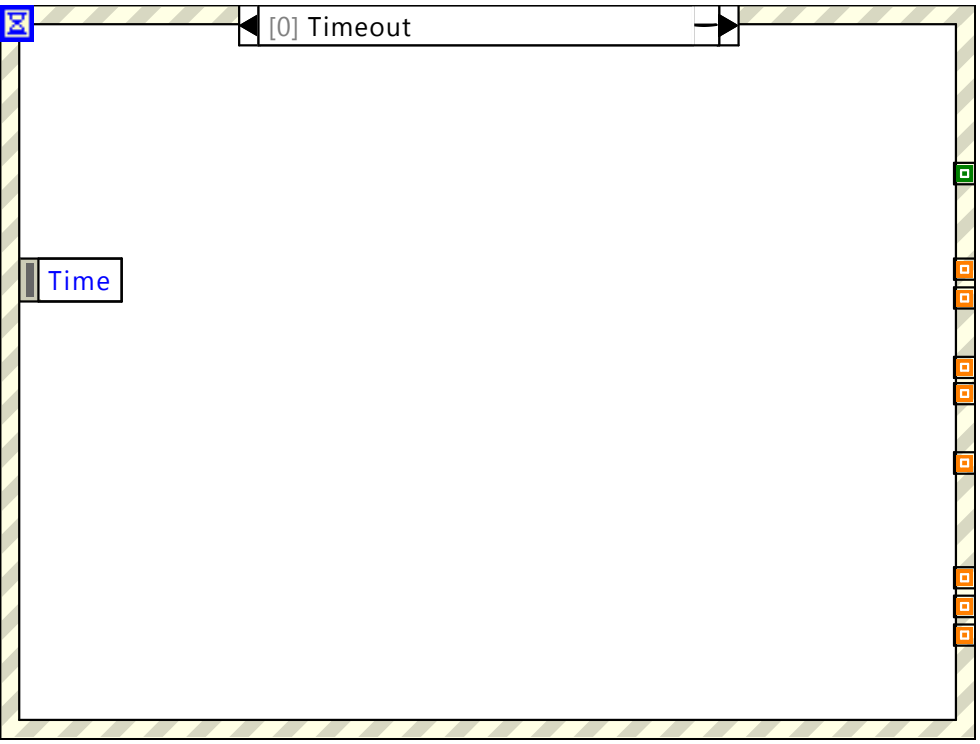

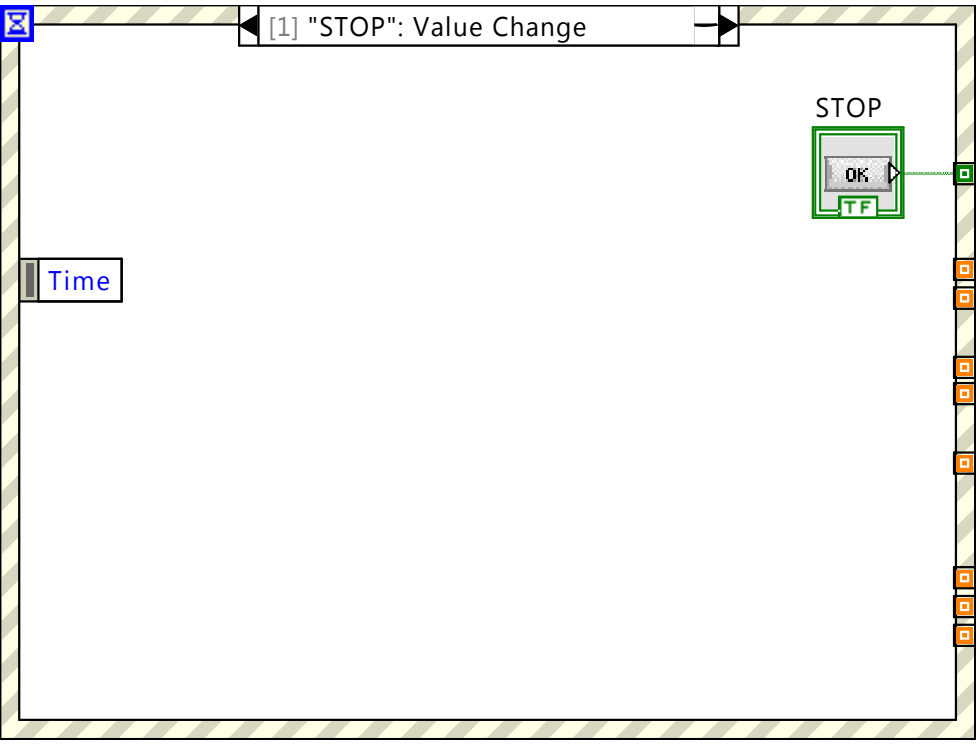

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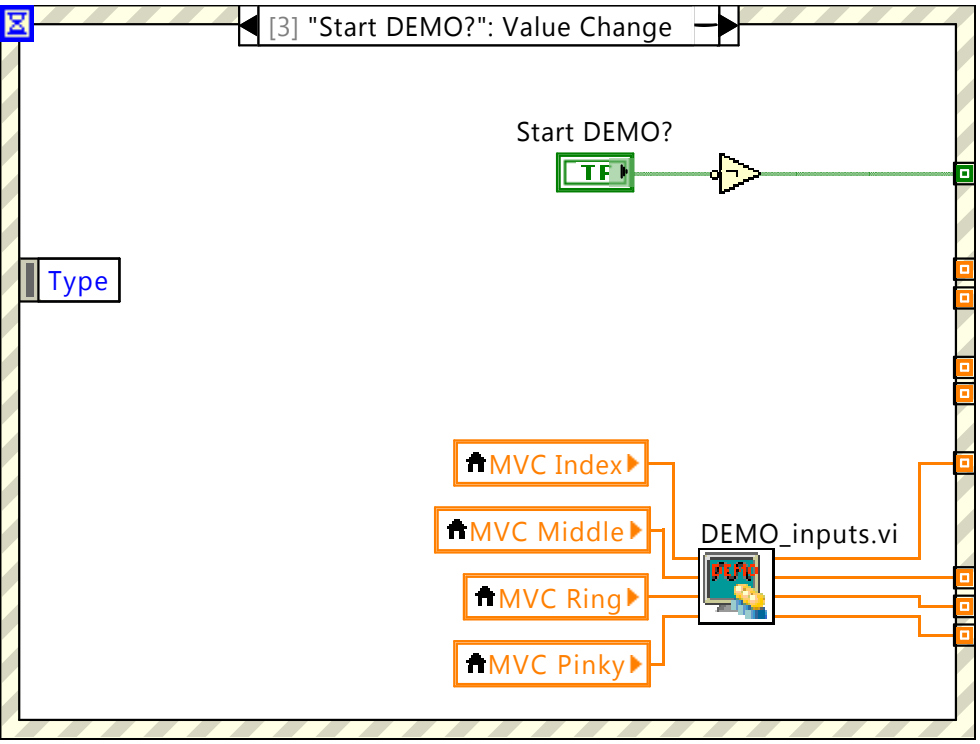

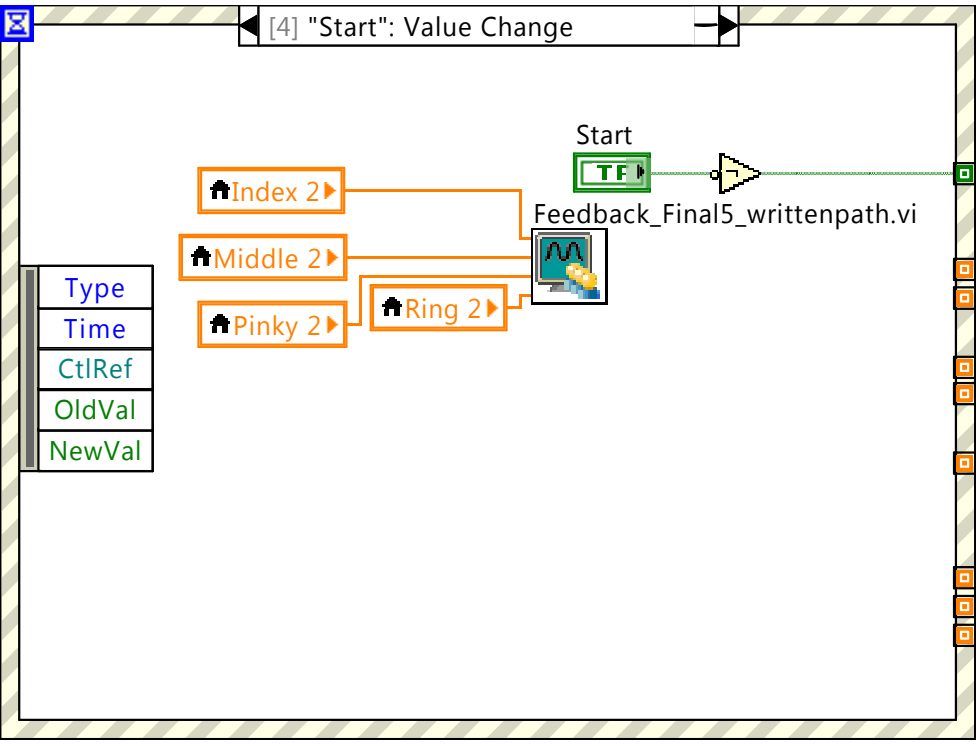

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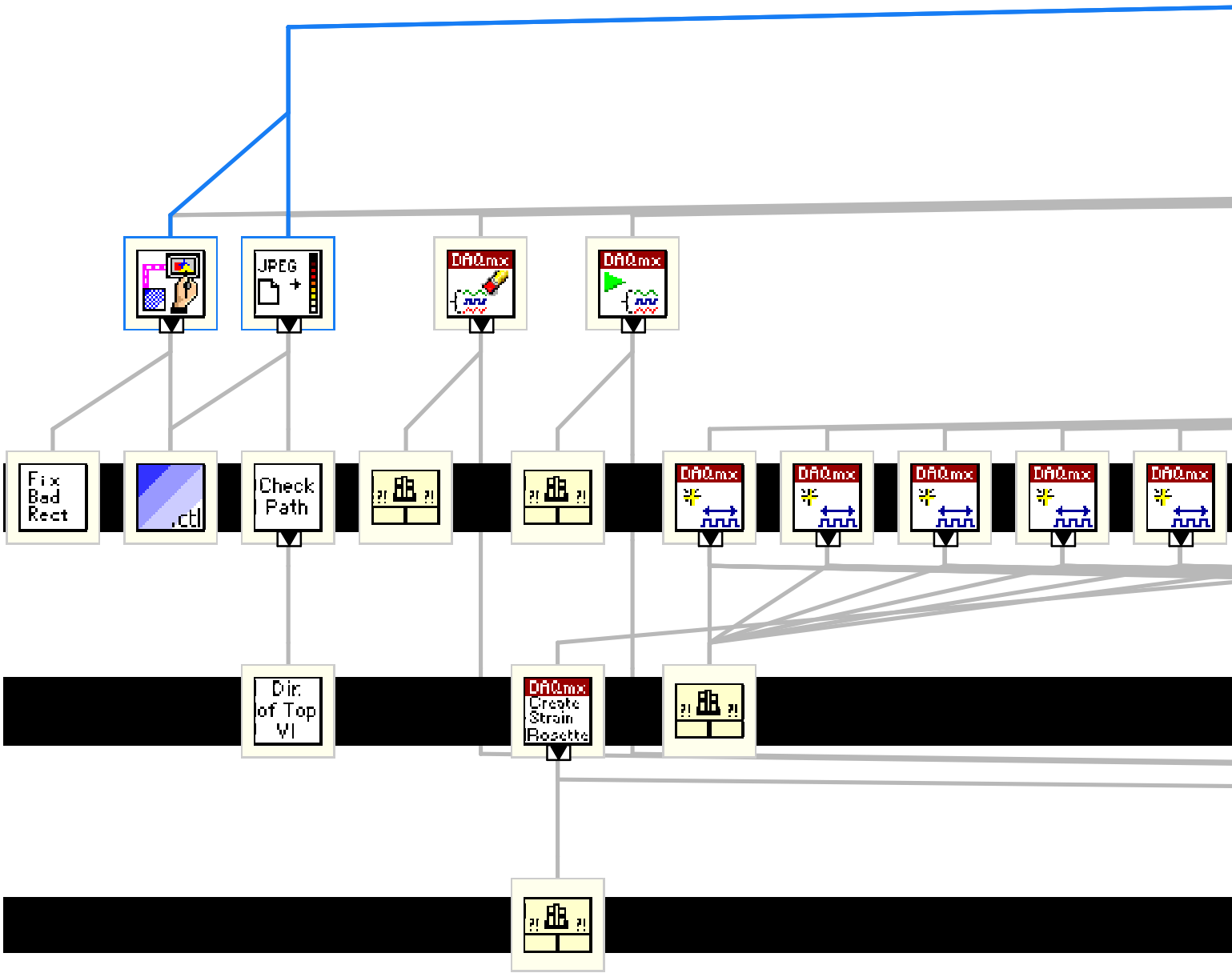

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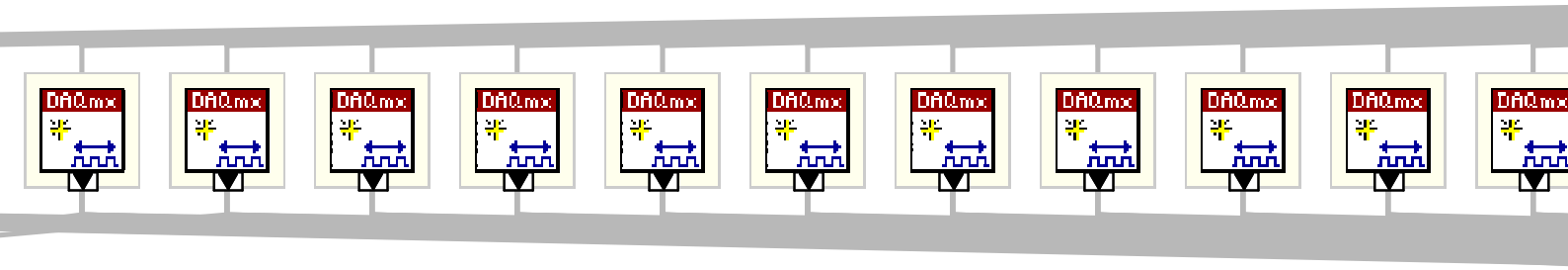
Printed on 13/03/2014 at 17:37



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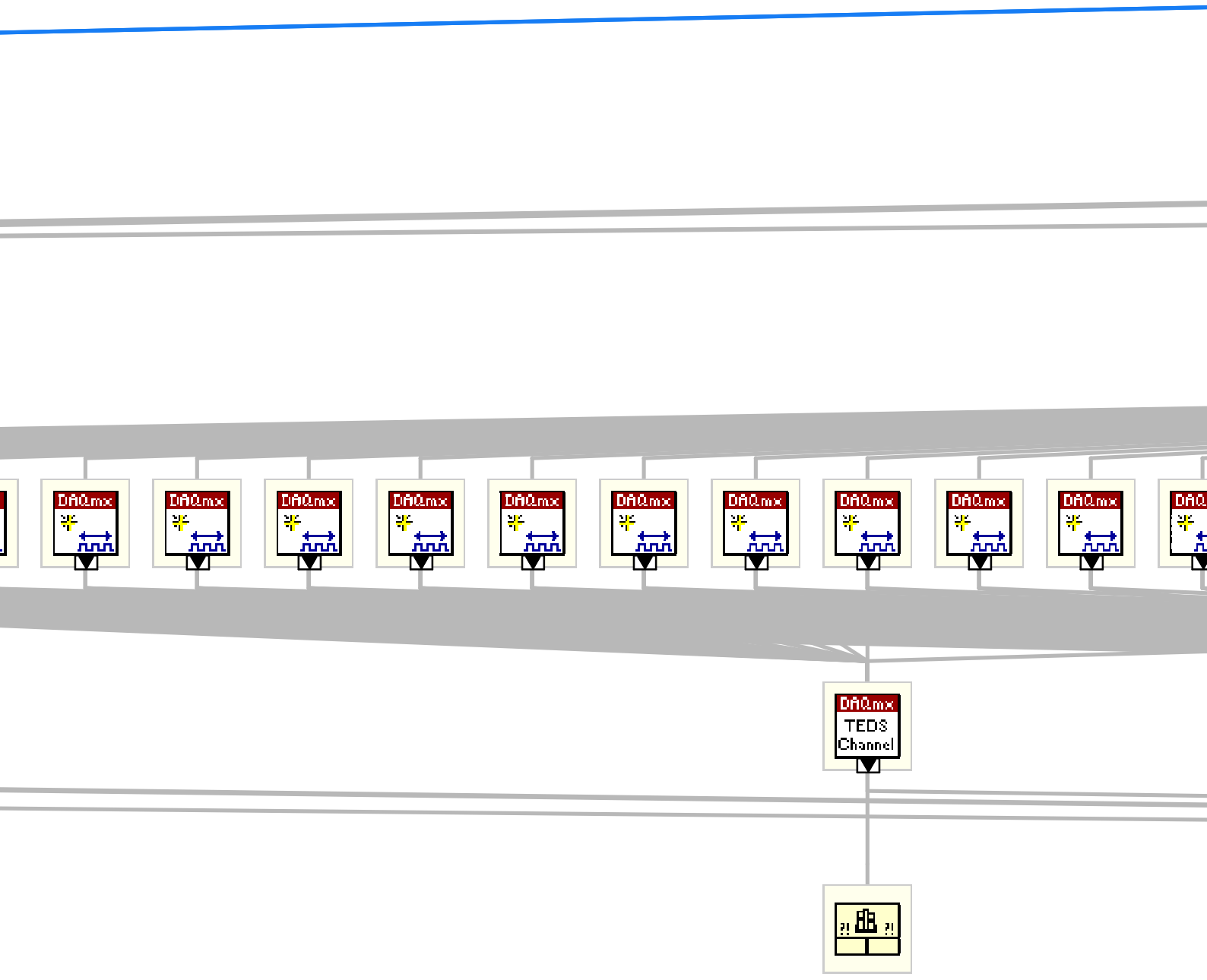

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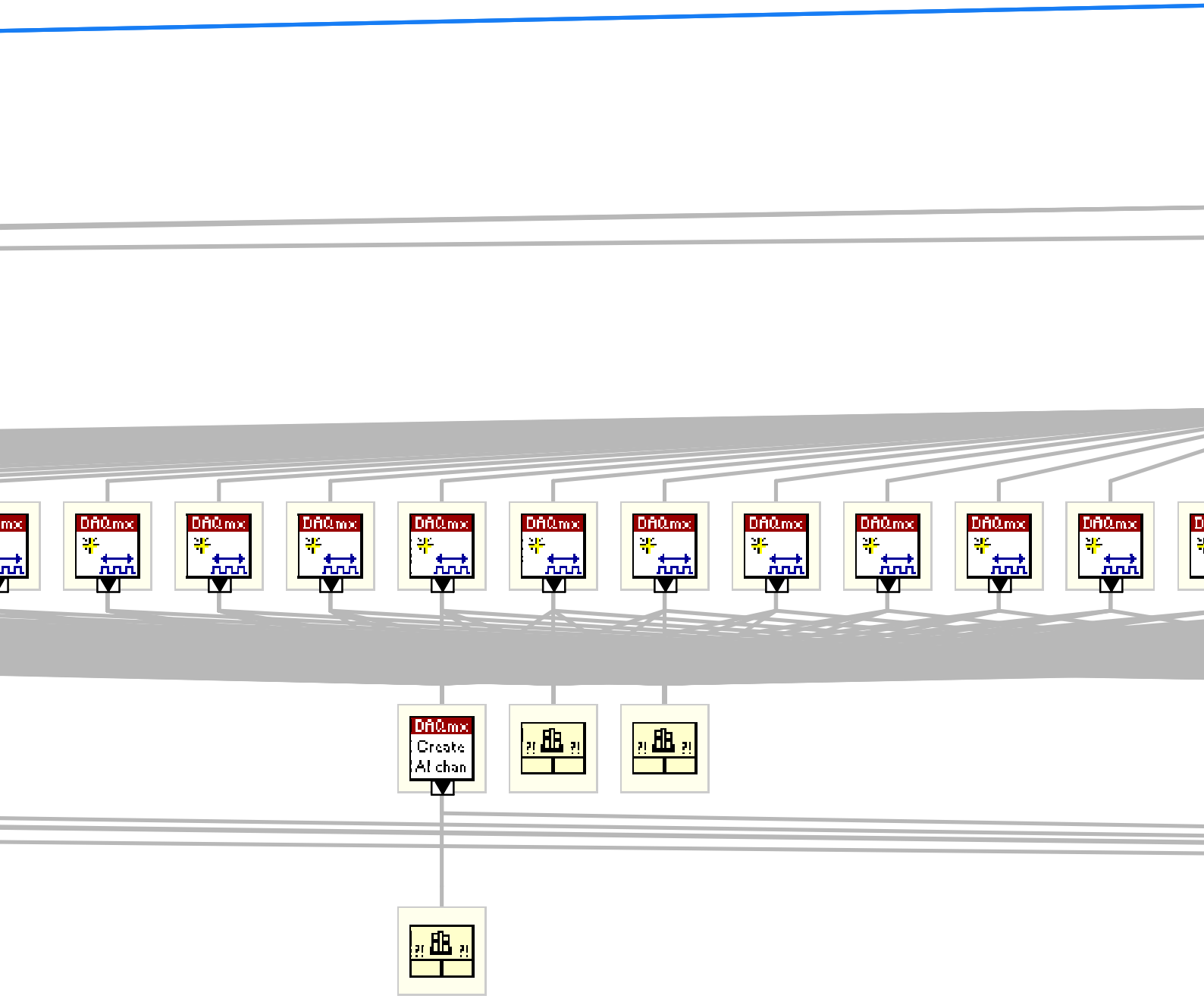

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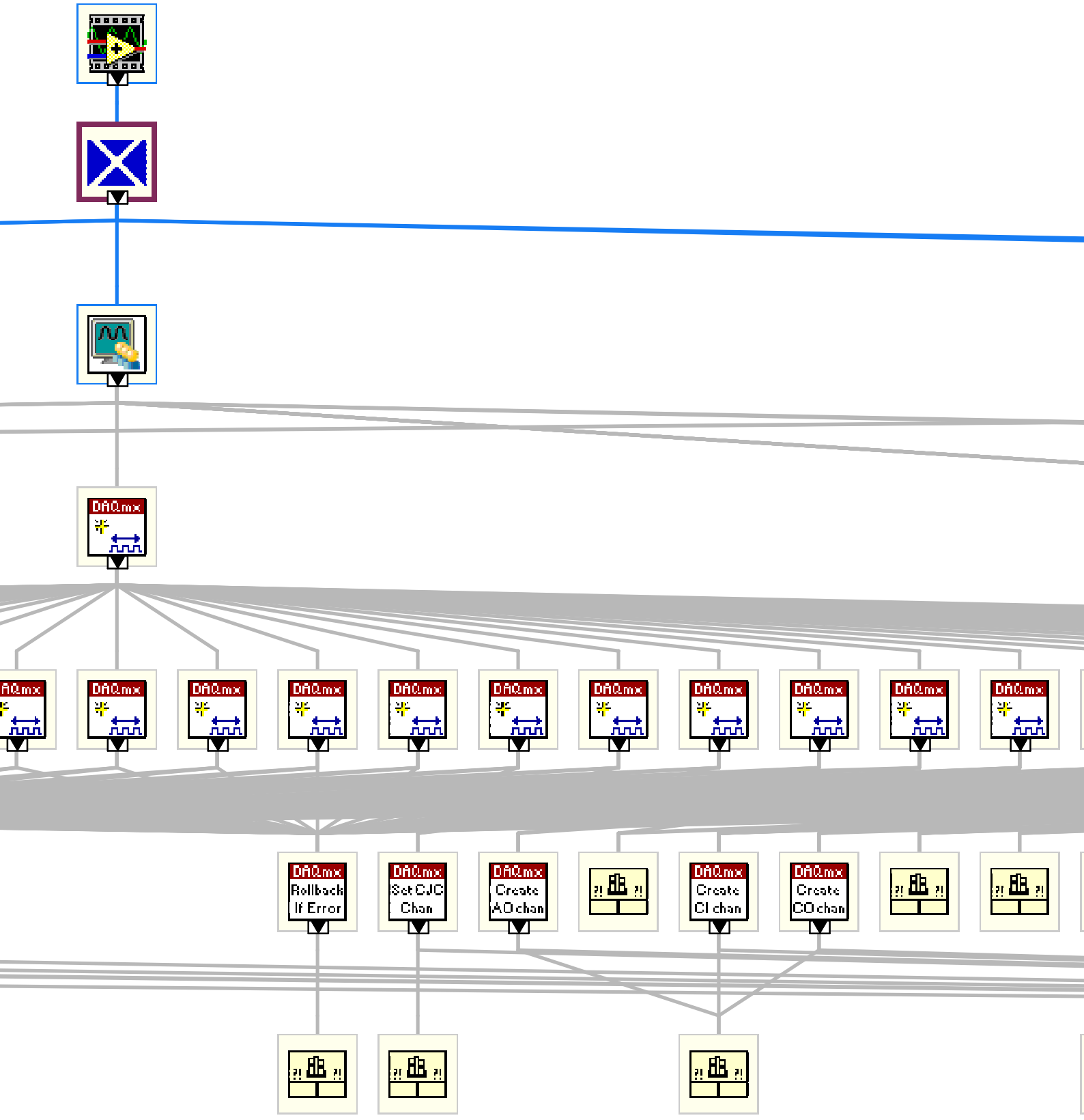

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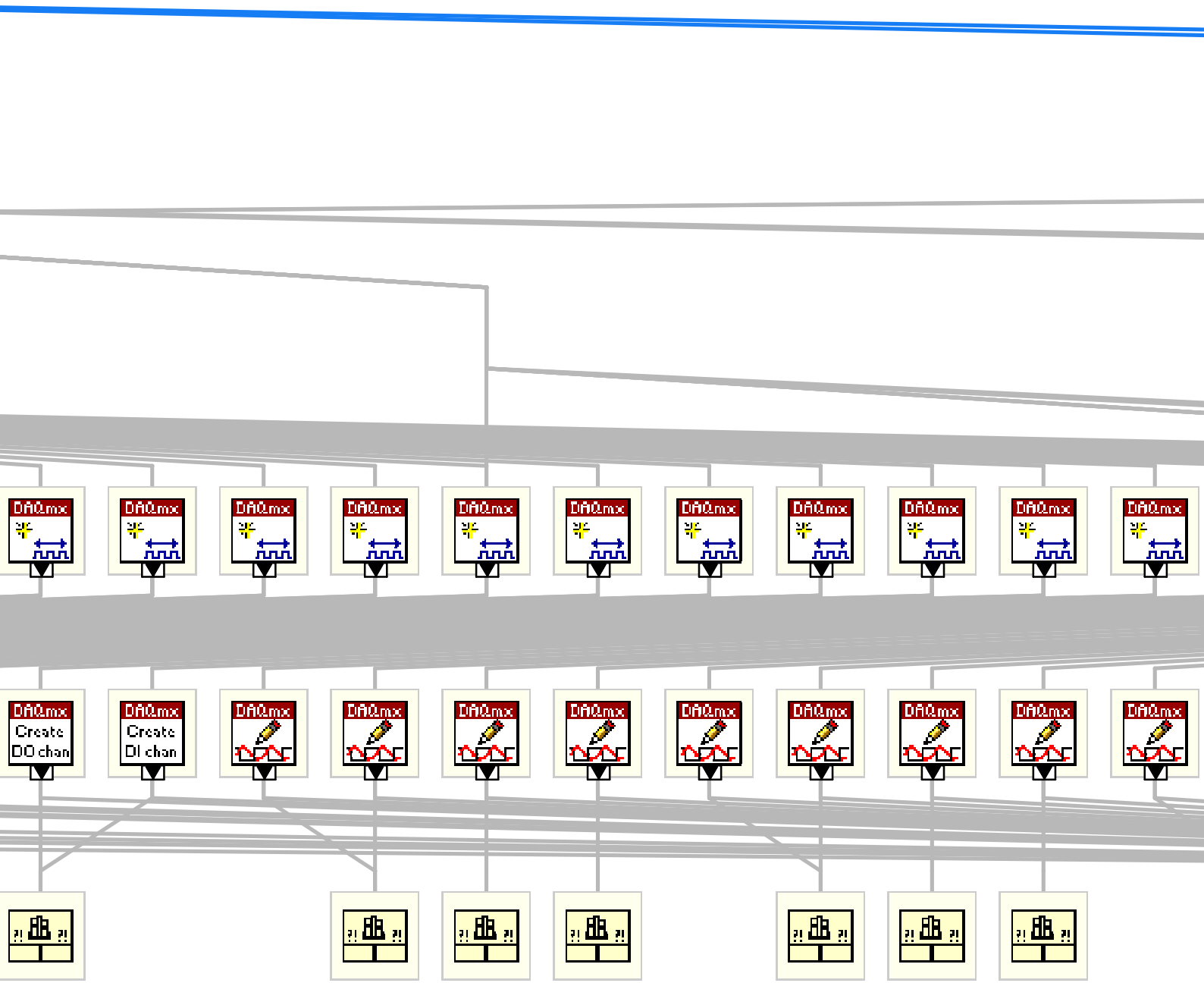

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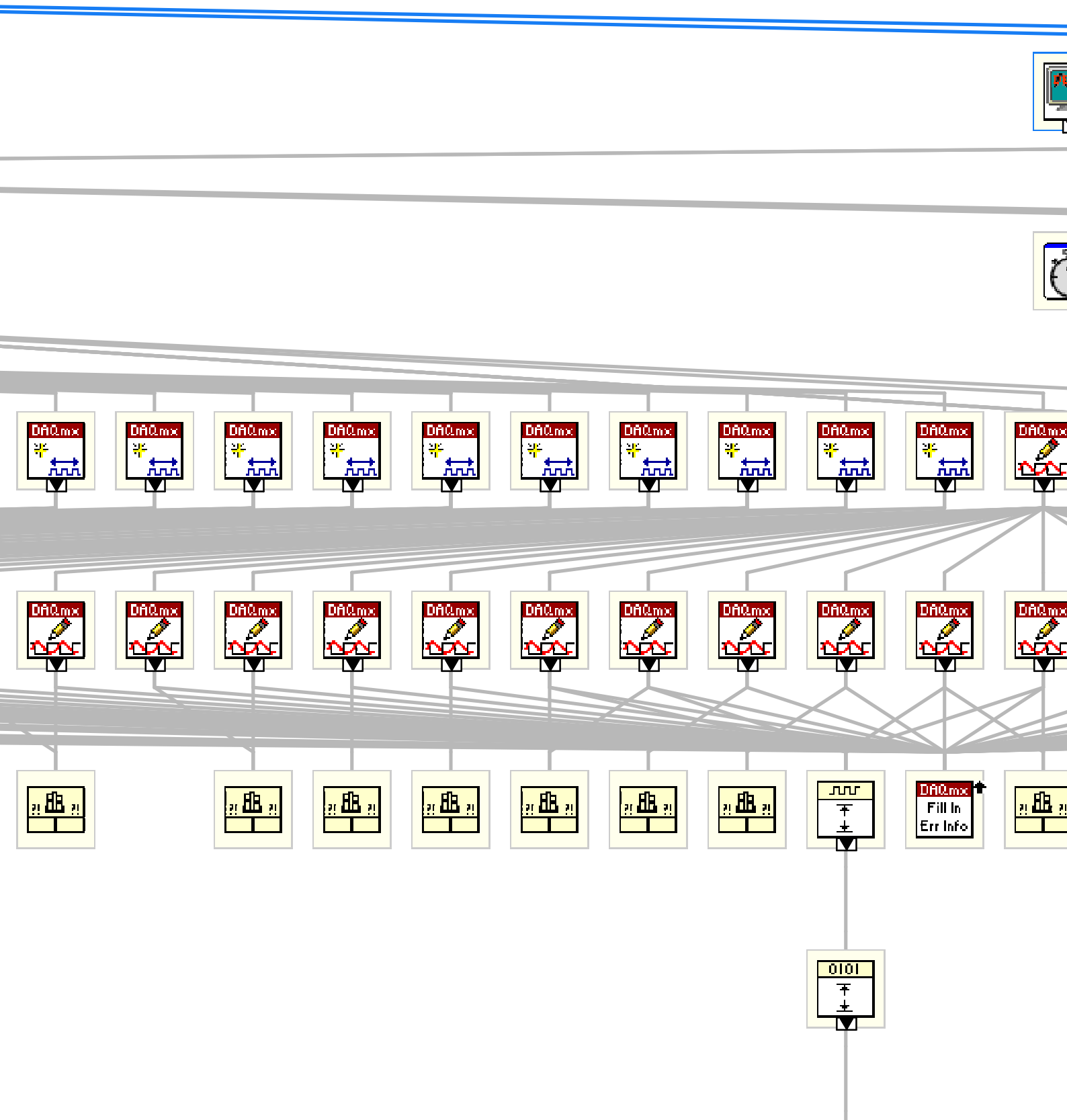
Printed on 13/03/2014 at 17:38



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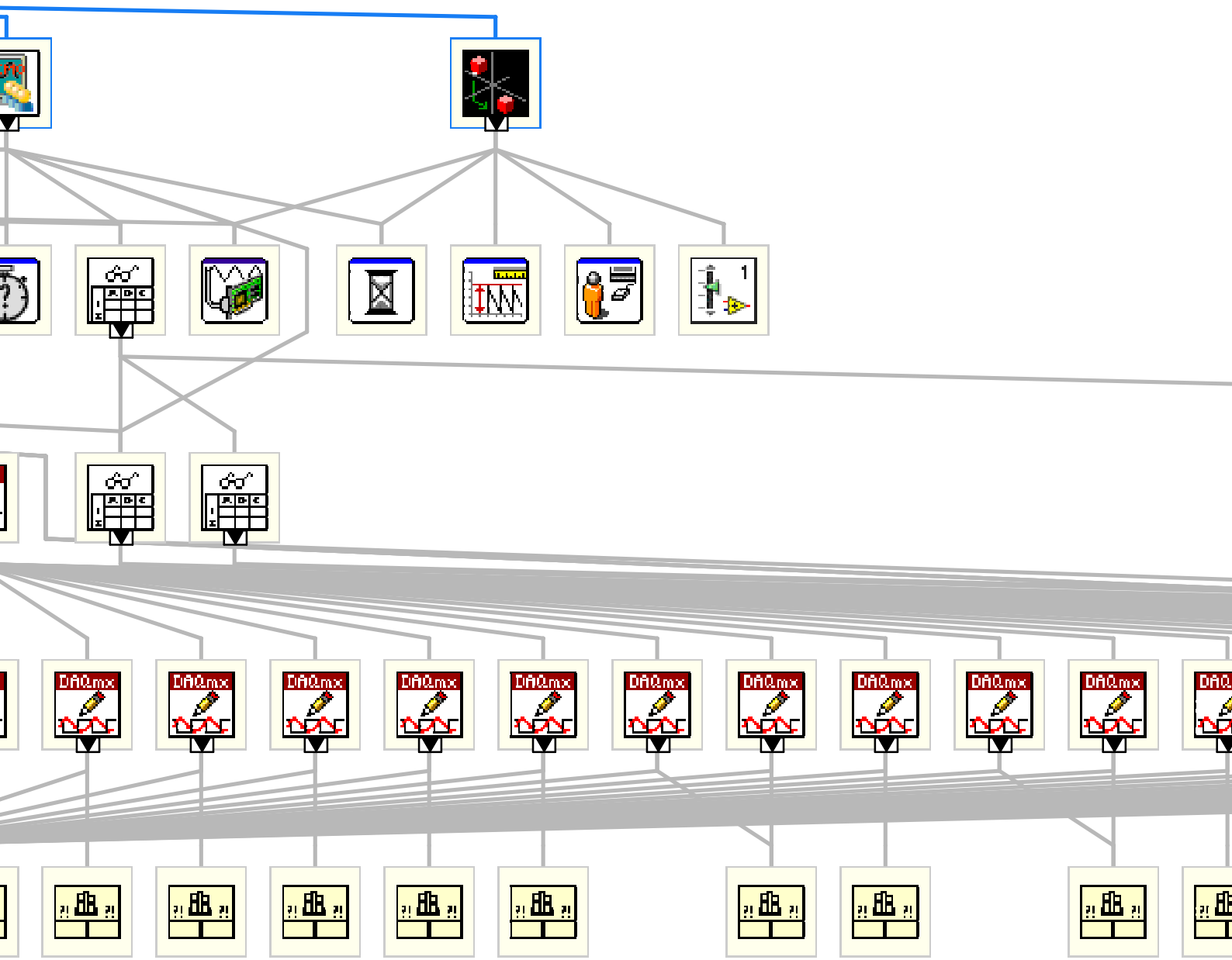

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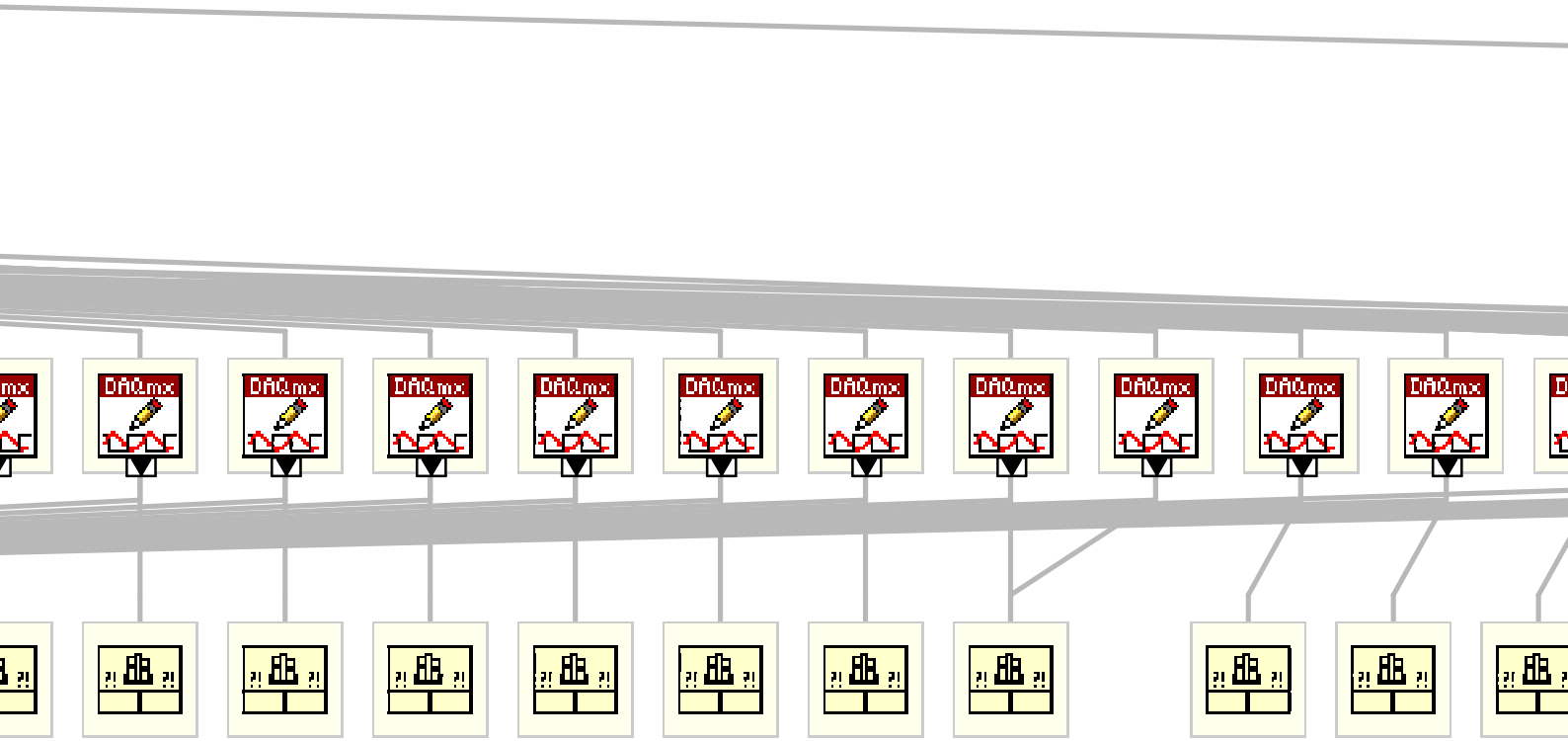

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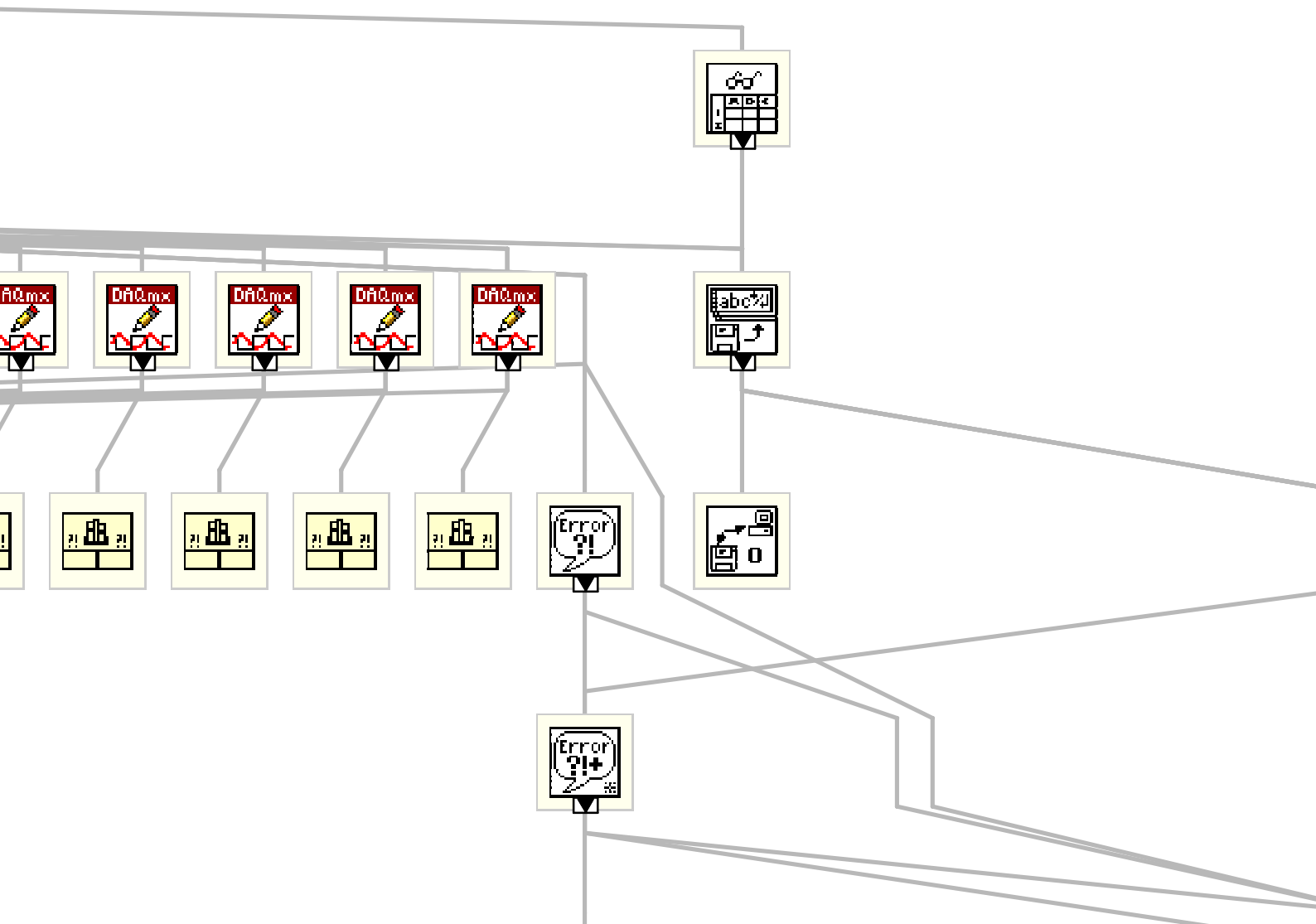

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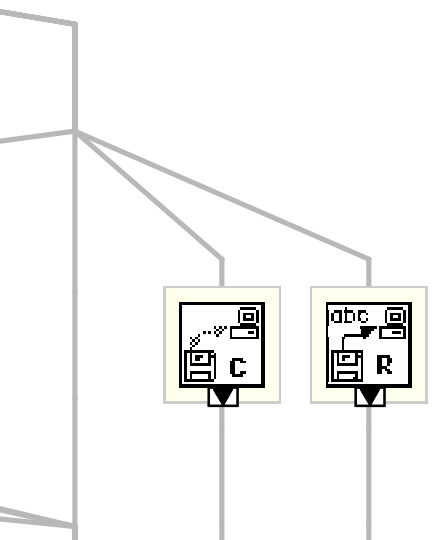

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Feedback_Final5_writtenpath.vi
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Draw Flattened Pixmap.vi
C:\Program Files\National Instruments\LabVIEW 2012\vi.lib\picture\picture.llb\Draw Flattened Pixmap.vi

Read JPEG File.vi
C:\Program Files\National Instruments\LabVIEW 2012\vi.lib\picture\jpeg.llb\Read JPEG File.vi

DEMO_inputs.vi
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Feedback_voltage_hdEMGtriggers_5.vi
C:\Users\Ale\Documents\LabView_AAG\Feedback_voltage_hdEMGtriggers_5.vi

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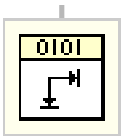


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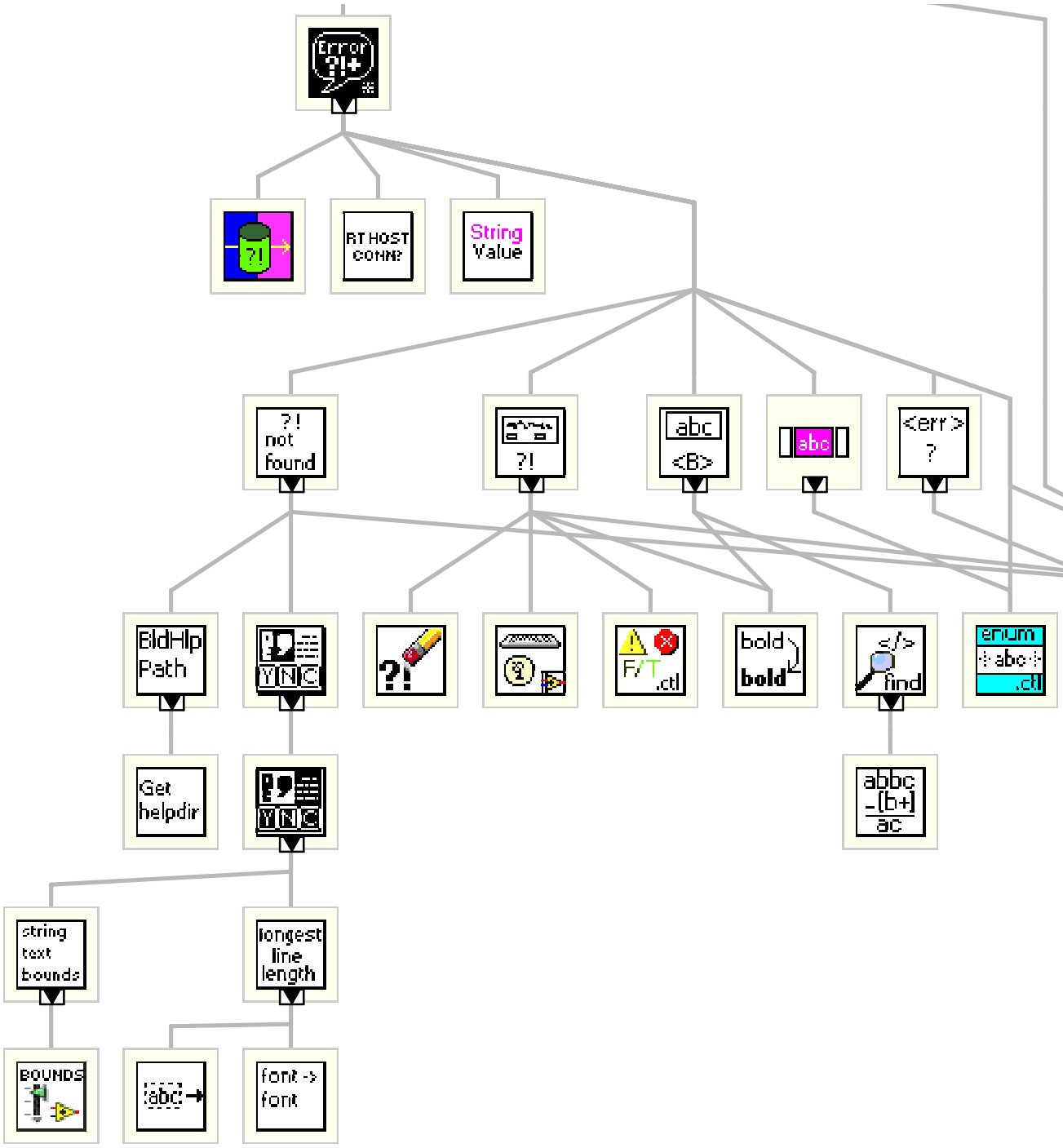

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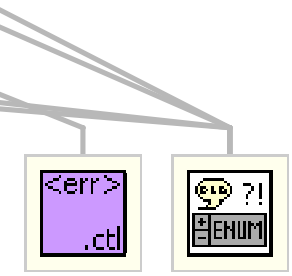

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"Inital_VI_feedback_control_2.vi History"
Current Revision: 21

1.4 Detailed Programming for GUI-Calibration Developed in LabVIEW

Feedback_voltage_hdEMGtriggers_5d.vi
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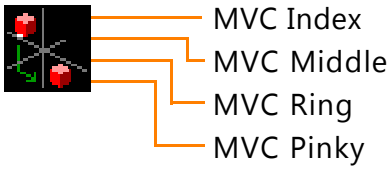
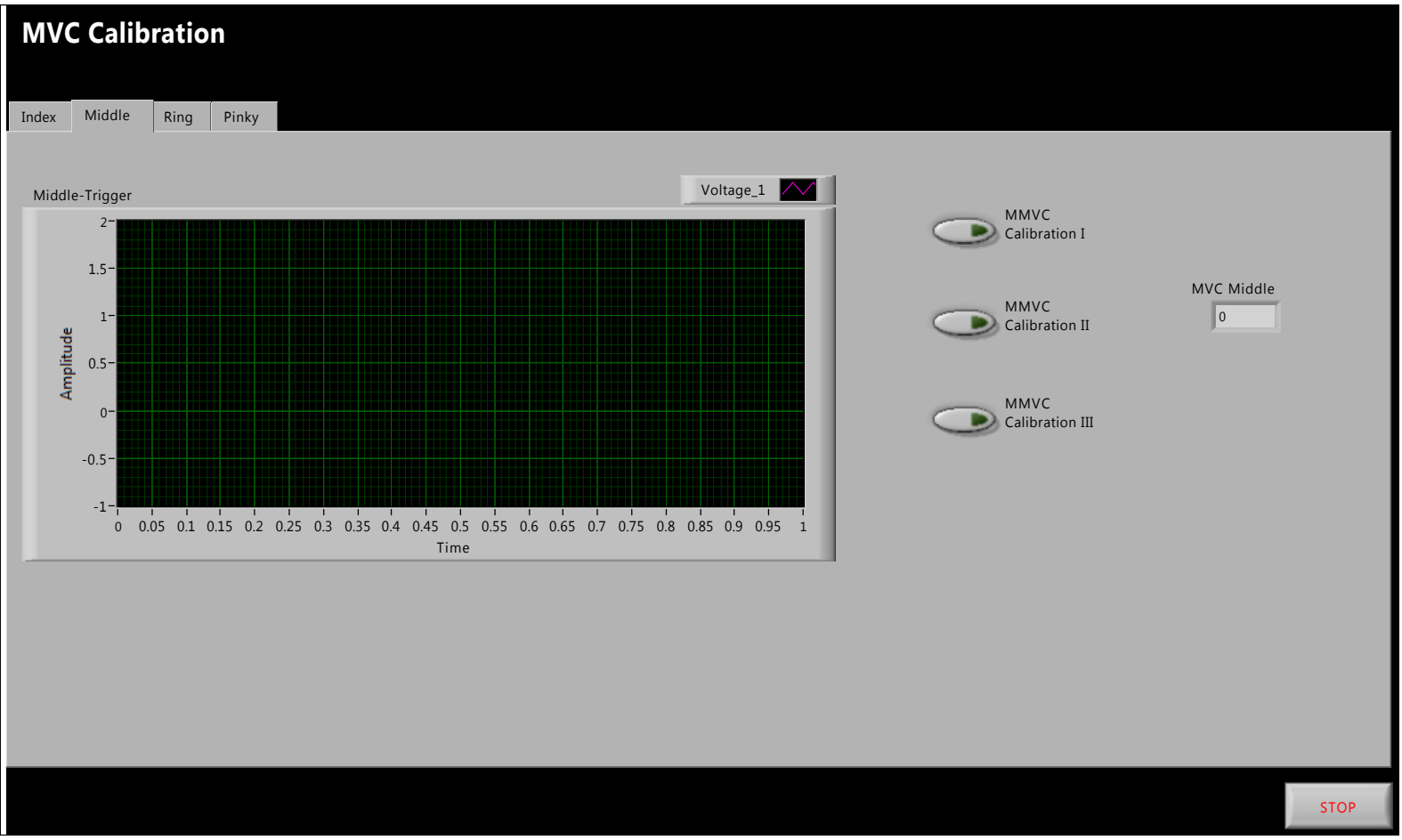
Connector Pane

Feedback_voltage_hdEMGtriggers_5d.vi



Test rig load sensor resistors calibration GUI. Calibration is performed based on three trials of MVC where the be
is kept for the next stages of the study.

Front Panel



Controls and Indicators

Finger Trigger Selection

IMVC Calibration I
Push button in charge of recording the value of first attempt for MVC while the LSR corresponding to the index finger was being pressed.

MMVC Calibration I
Push button in charge of recording the value of first attempt for MVC while the LSR corresponding to the middle finger was being pressed.

RMVC Calibration I
Push button in charge of recording the value of first attempt for MVC while the LSR corresponding to the ring finger was being pressed.

Feedback_voltage_hdEMGtriggers_5d.vi
C:\Users\Ale\Documents\LabView_AAG\Feedback_voltage_hdEMGtriggers_5d.vi
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MVCP Calibration I
Push button in charge of recording the value of first attempt for MVC while the LSR corresponding to the pinky finger was being pressed.

IMVC Calibration II
Push button in charge of recording the value of second attempt for MVC while the LSR corresponding to the index finger was being pressed.

IMVC Calibration III
Push button in charge of recording the value of third attempt for MVC while the LSR corresponding to the index finger was being pressed.

MMVC Calibration II
Push button in charge of recording the value of second attempt for MVC while the LSR corresponding to the middle finger was being pressed.

MMVC Calibration III
Push button in charge of recording the value of third attempt for MVC while the LSR corresponding to the middle finger was being pressed.

RMVC Calibration II
Push button in charge of recording the value of second attempt for MVC while the LSR corresponding to the ring finger was being pressed.

RMVC Calibration III
Push button in charge of recording the value of third attempt for MVC while the LSR corresponding to the ring finger was being pressed.

MVCP Calibration II
Push button in charge of recording the value of second attempt for MVC while the LSR corresponding to the pinky finger was being pressed.

MVCP Calibration III
Push button in charge of recording the value of third attempt for MVC while the LSR corresponding to the pinky finger was being pressed.

stop
Stop GUI application button.

IMVC
Indicator of the first value recorded for the MVC corresponding to the index finger.

Index-Trigger
Graph displaying the user's exertion force applied the load sensor resistor corresponding to the index finger.

MMVC
Indicator of the first value recorded for the MVC corresponding to the middle finger.

Middle-Trigger
Graph displaying the user's exertion force applied the load sensor resistor corresponding to the middle finger.

RMVC
Indicator of the first value recorded for the MVC corresponding to the ring finger.

Ring-Trigger
Graph displaying the user's exertion force applied the load sensor resistor corresponding to the ring finger.

Feedback_voltage_hdEMGtriggers_5d.vi
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PMVC
Indicator of the first value recorded for the MVC corresponding to the pinky finger.

Pinky-Trigger
Graph displaying the user's exertion force applied the load sensor resistor corresponding to the pinky finger.

IMVC 2
Indicator of the second value recorded for the MVC corresponding to the index finger.

IMVC 3
Indicator of the third value recorded for the MVC corresponding to the index finger.

MVC Index
Indicator of the maximum value recorded for the MVC corresponding to the index finger.

MMVC 2
Indicator of the second value recorded for the MVC corresponding to the middle finger.

MMVC 3
Indicator of the third value recorded for the MVC corresponding to the middle finger.

MVC Middle
Indicator of the maximum value recorded for the MVC corresponding to the middle finger.

RMVC 2
Indicator of the second value recorded for the MVC corresponding to the ring finger.

RMVC 3
Indicator of the third value recorded for the MVC corresponding to the ring finger.

MVC Ring
Indicator of the maximum value recorded for the MVC corresponding to the ring finger.

PMVC 2
Indicator of the second value recorded for the MVC corresponding to the pinky finger.

PMVC 3
Indicator of the third value recorded for the MVC corresponding to the pinky finger.

MVC Pinky
Indicator of the maximum value recorded for the MVC corresponding to the pinky finger.

Feedback_voltage_hdEMGtriggers_5d.vi
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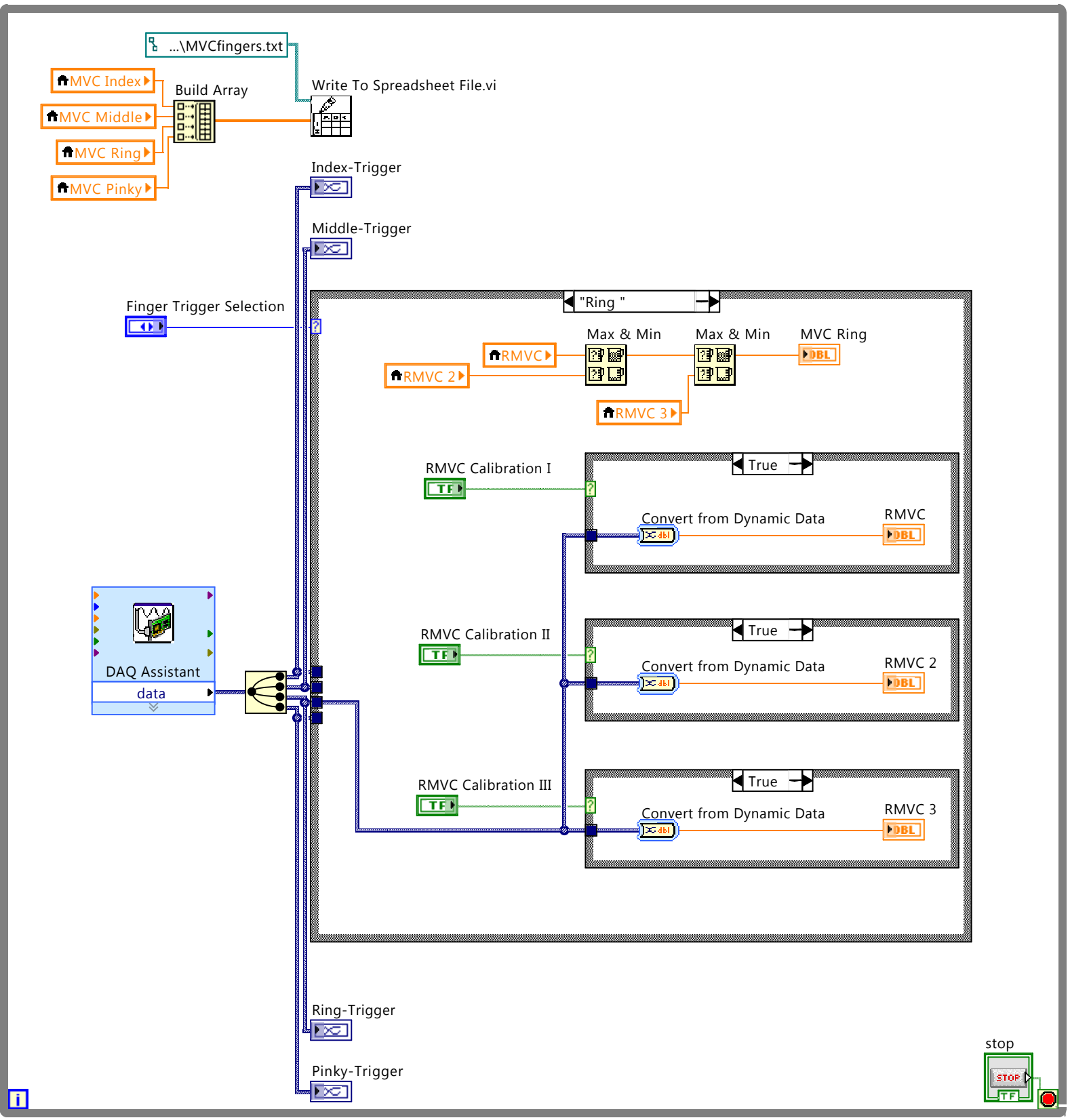
Block Diagram



Position in Hierarchy

Feedback_voltage_hdEMGtriggers_5d.vi
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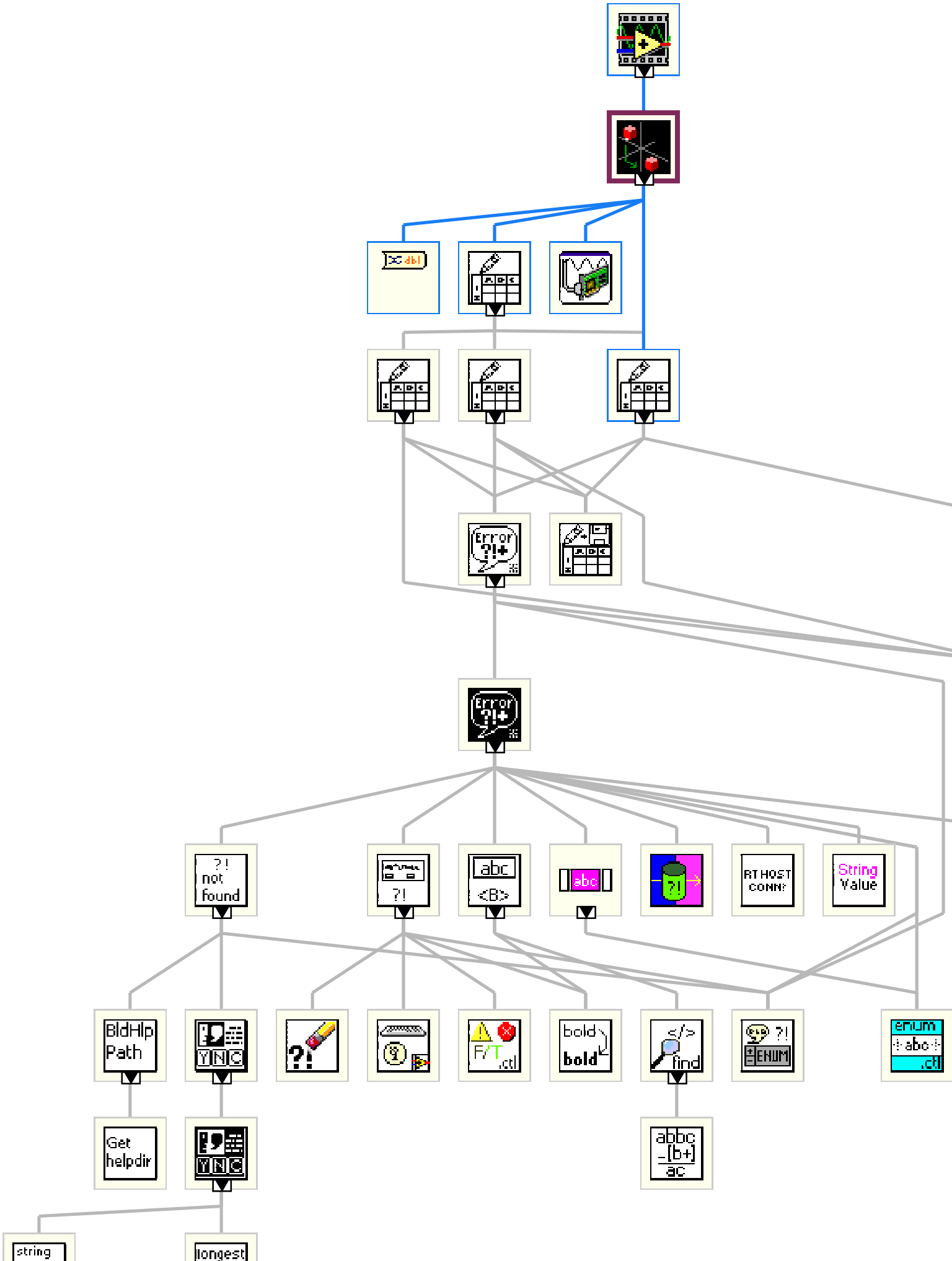

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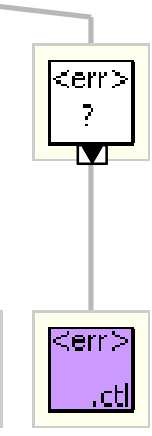

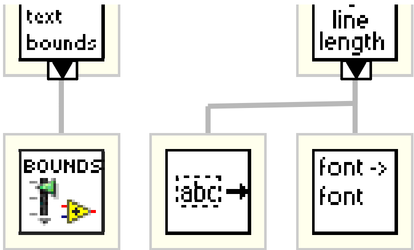

List of SubVIs and Express VIs with Configuration Information

Convert from Dynamic Data
Convert from Dynamic Data
Converts the dynamic data type to numeric, Boolean, waveform, and array data types for use with other VIs and functions.

Convert from Dynamic Data
Convert from Dynamic Data
Converts the dynamic data type to numeric, Boolean, waveform, and array data types for use with other VIs and functions.

Convert from Dynamic Data
Convert from Dynamic Data
Converts the dynamic data type to numeric, Boolean, waveform, and array data types for use with other VIs and functions.

Convert from Dynamic Data
Convert from Dynamic Data
Converts the dynamic data type to numeric, Boolean, waveform, and array data types for use with other VIs and functions.

Convert from Dynamic Data
Convert from Dynamic Data
Converts the dynamic data type to numeric, Boolean, waveform, and array data types for use with other VIs and functions.

Convert from Dynamic Data
Convert from Dynamic Data
Converts the dynamic data type to numeric, Boolean, waveform, and array data types for use with other VIs and functions.

Convert from Dynamic Data
Convert from Dynamic Data
Converts the dynamic data type to numeric, Boolean, waveform, and array data types for use with other VIs and functions.

Convert from Dynamic Data
Convert from Dynamic Data
Converts the dynamic data type to numeric, Boolean, waveform, and array data types for use with other VIs and functions.

Convert from Dynamic Data
Convert from Dynamic Data
Converts the dynamic data type to numeric, Boolean, waveform, and array data types for use with other VIs and functions.


Feedback_voltage_hdEMGtriggers_5d.vi
C:\Users\Ale\Documents\LabView_AAG\Feedback_voltage_hdEMGtriggers_5d.vi
Last modified on 13/03/2014 at 15:42
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Convert from Dynamic Data
Convert from Dynamic Data
Converts the dynamic data type to numeric, Boolean, waveform, and array data types for use with other VIs and functions.

Convert from Dynamic Data
Convert from Dynamic Data
Converts the dynamic data type to numeric, Boolean, waveform, and array data types for use with other VIs and functions.

Convert from Dynamic Data
Convert from Dynamic Data
Converts the dynamic data type to numeric, Boolean, waveform, and array data types for use with other VIs and functions.

Write To Spreadsheet File (DBL).vi
C:\Program Files\National Instruments\LabVIEW 2012\vi.lib\Utility\file.llb\Write To Spreadsheet File (DBL).vi

Write To Spreadsheet File.vi
C:\Program Files\National Instruments\LabVIEW 2012\vi.lib\Utility\file.llb\Write To Spreadsheet File.vi

DAQ Assistant
DAQ Assistant
Creates, edits, and runs tasks using NI-DAQmx. Refer to the NI-DAQmx Readme for a complete listing of devices NI-DAQmx supports.

When you place this Express VI on the block diagram, the DAQ Assistant launches to create a new task. After you create a task, you can double-click the DAQ Assistant Express VI to edit that task. For continuous measurement or generation, place a while loop around the DAQ Assistant Express VI.

For continuous single-point input or output, the DAQ Assistant Express VI might not provide optimal performance. Refer to the Cont Acq&Graph Voltage-Single Point Optimization VI in examples\DAQmx\Analog In\Measure Voltage.llb for an example of techniques to create higher-performance, single-point I/O applications.

VI Revision History

"Feedback_voltage_hdEMGtriggers_5d.vi History"
Current Revision: 57

Iconified Cluster Constants

1.5 Detailed Programming for GUI-Task Opposition of the Thumb

Feedback_Final5_writtenpath.vi
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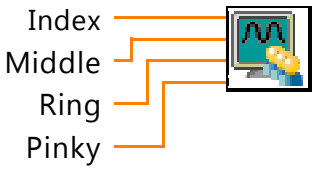
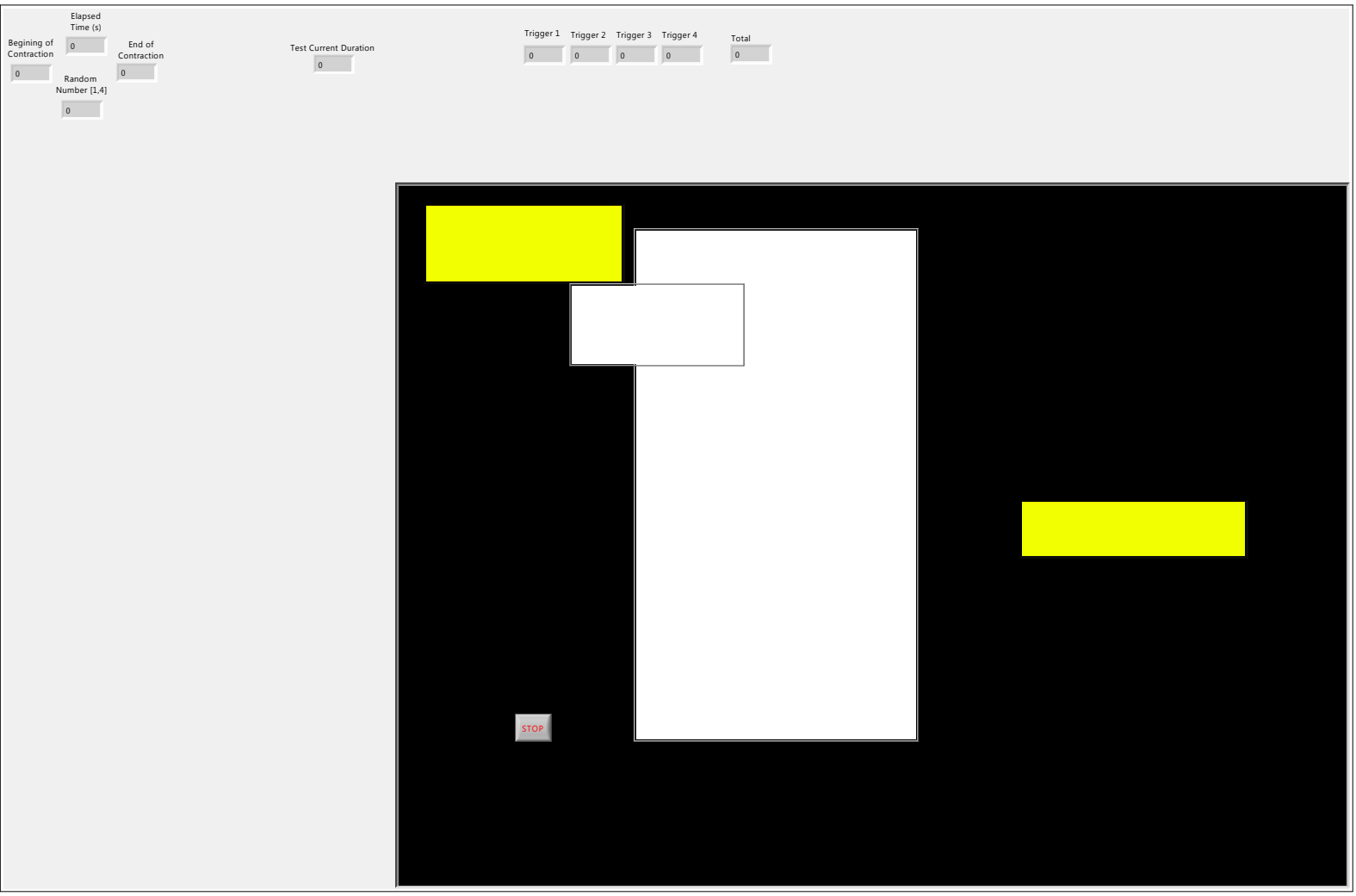
Feedback_Final5_writtenpath.vi





stop

Index

Middle

Ring

Pinky

Minimum Value[Minimum Value]

Maximum Value[Maximum Value]

Elapsed Time (s)[Elapsed Time (s)]
Displays the amount of time in seconds that has elapsed since the start time and the <B>Present (s)</B> time.

Color Box

Coundown

Feedback_Final5_writtenpath.vi
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FingerPrints
<B>new picture</B> is the picture that contains the new image. You can wire this output to any other <B>picture</B> input to add more drawing instructions to the picture.

Press

Relax

Index

Middle

Ring

Pinky

End of Contraction

Begining of Contraction

Rest Phase Duration

Contraction Phase Duration

Trigger 1

Trigger 2

Trigger 3

Trigger 4

Arrow 1
<B>new picture</B> is the picture that contains the new image. You can wire this output to any other <B>picture</B> input to add more drawing instructions to the picture.

Reset[Reset]
Controls the initialization of the internal state of the VI. The default is FALSE.

Arrow 2
<B>new picture</B> is the picture that contains the new image. You can wire this output to any other <B>picture</B> input to add more drawing instructions to the picture.

Arrow 3
<B>new picture</B> is the picture that contains the new image. You can wire this output to any other <B>picture</B> input to add more drawing instructions to the picture.

Arrow 4
<B>new picture</B> is the picture that contains the new image. You can wire this output to any other <B>picture</B> input to add more drawing instructions to the picture.

Random Number [1,4]

Total

Elapsed Time (s)[Test Current Duration]
Displays the amount of time in seconds that has elapsed since the start time and the <B>Present (s)</B> time.

Trial [0,119]

Feedback_Final5_writtenpath.vi
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Last modified on 22/01/2013 at 15:22
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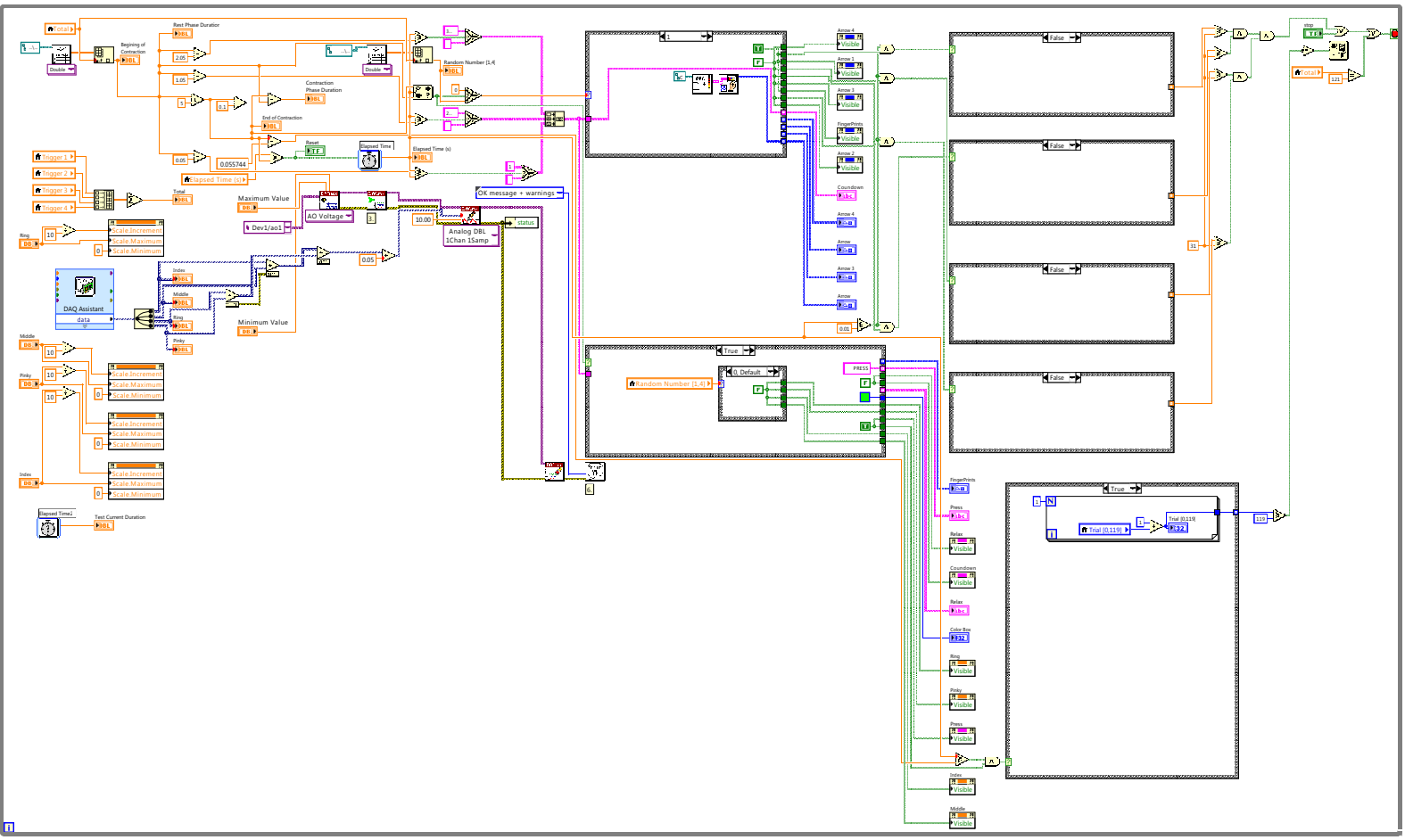

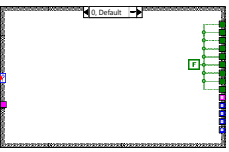

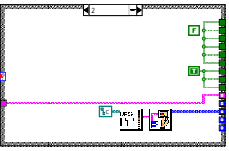

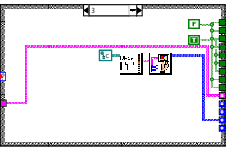

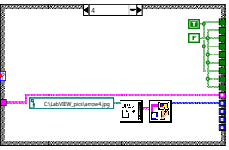

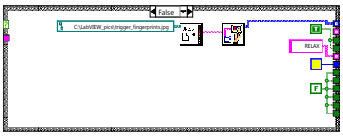

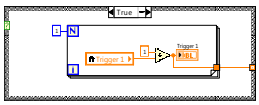

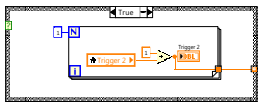

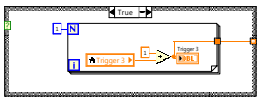

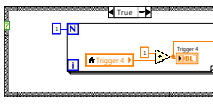

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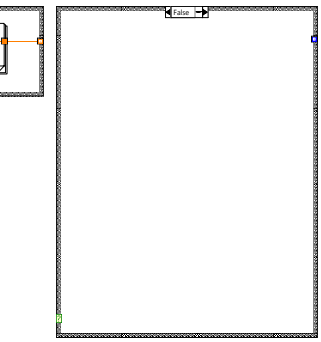

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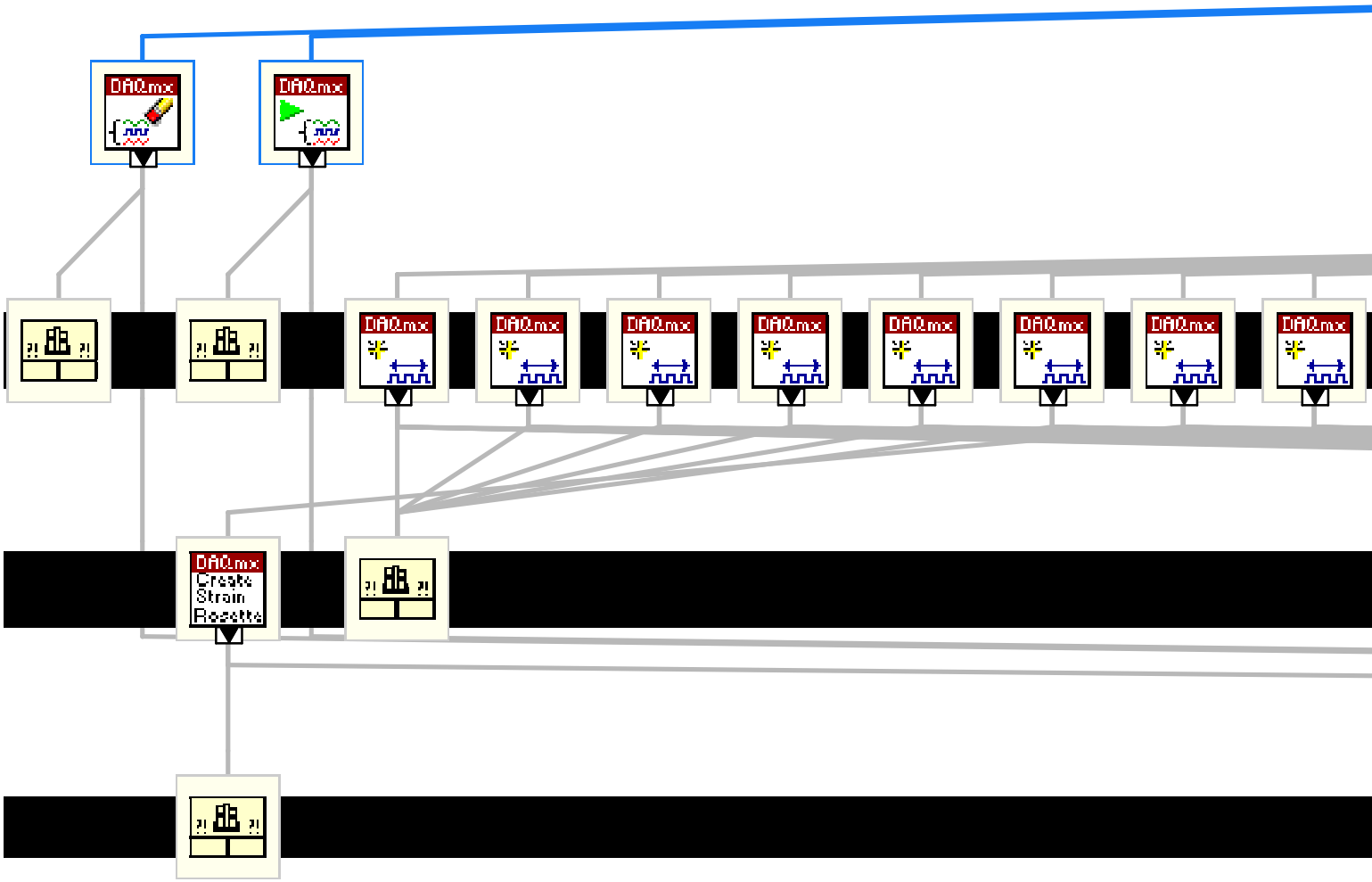

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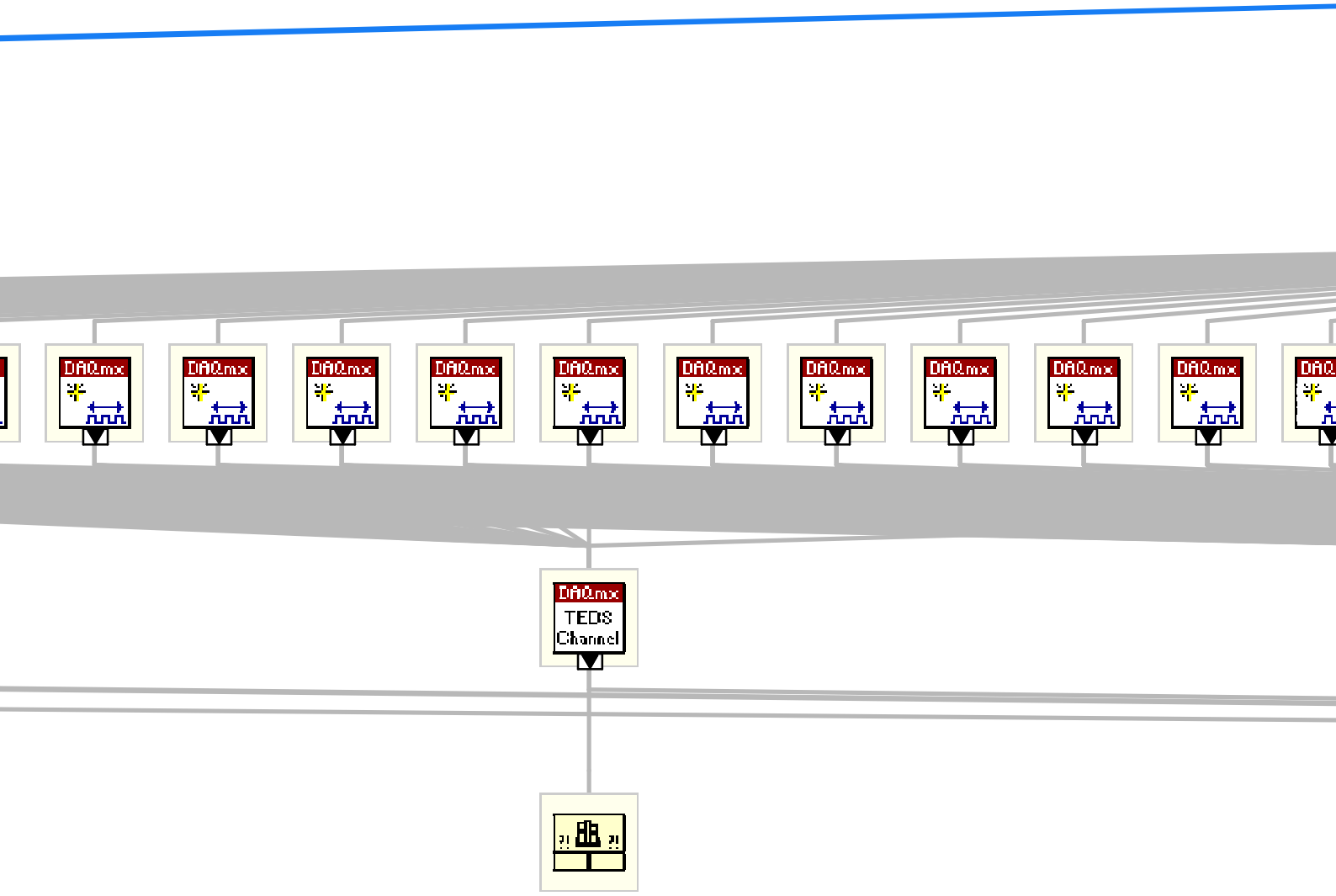

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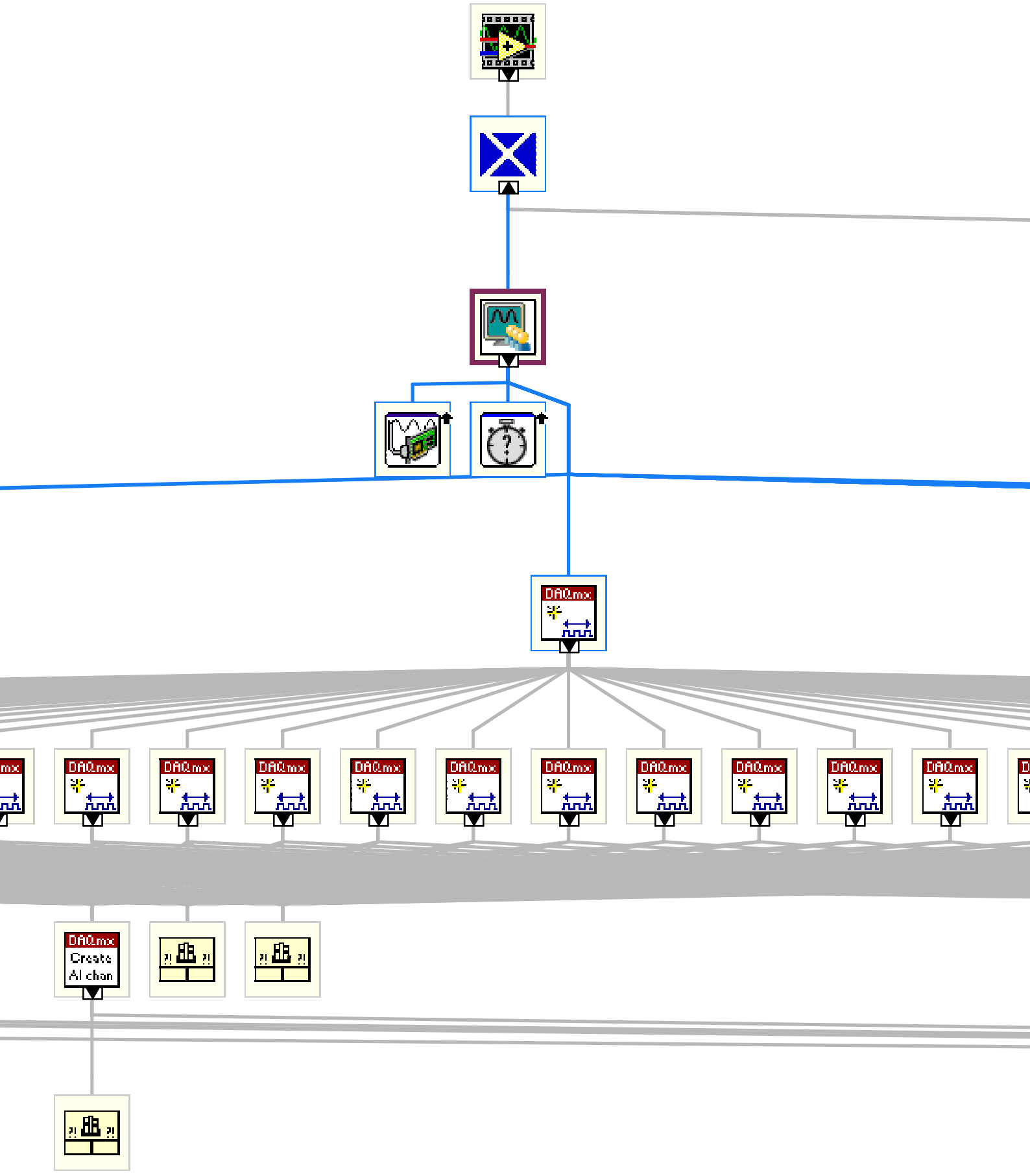

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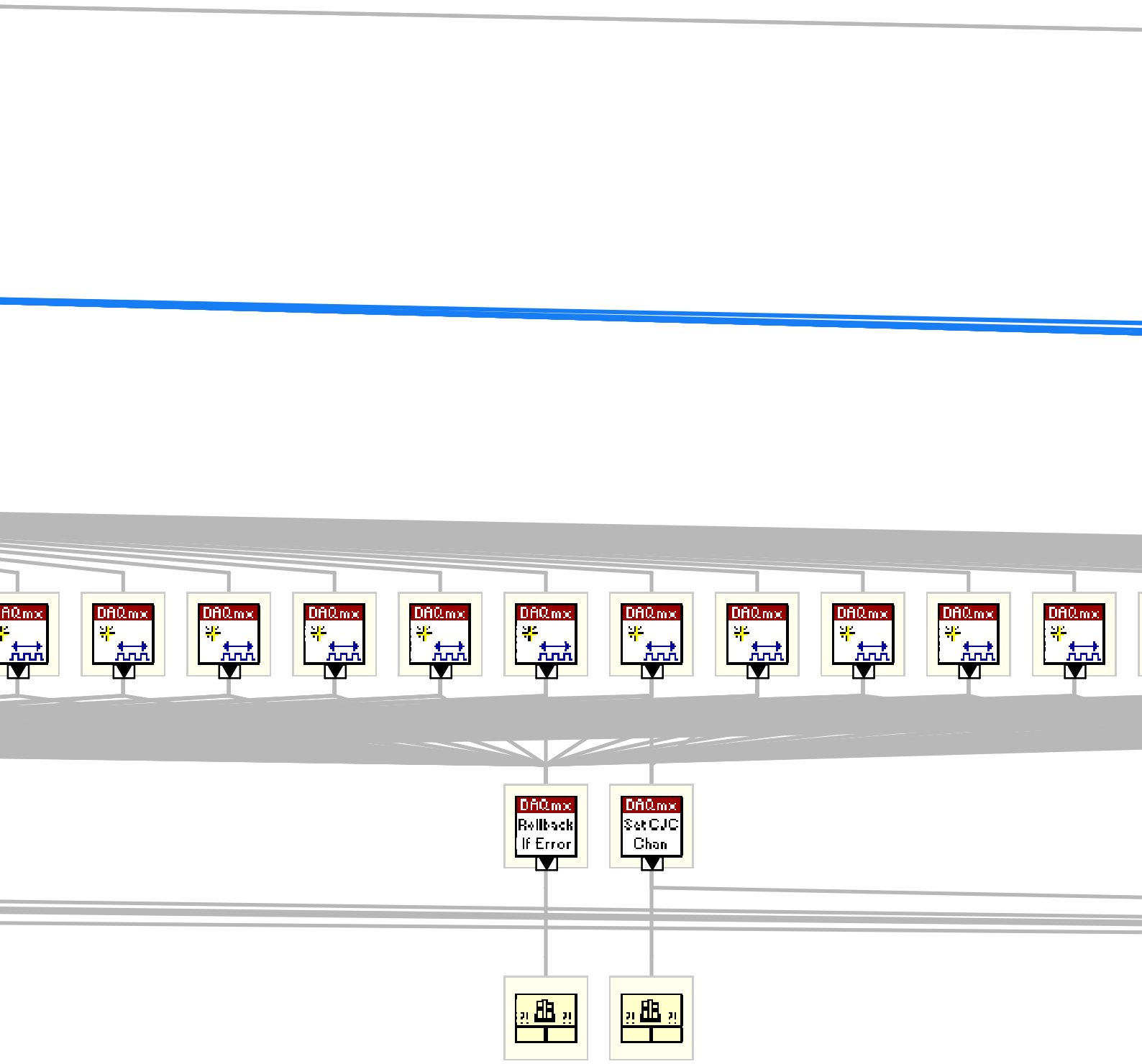

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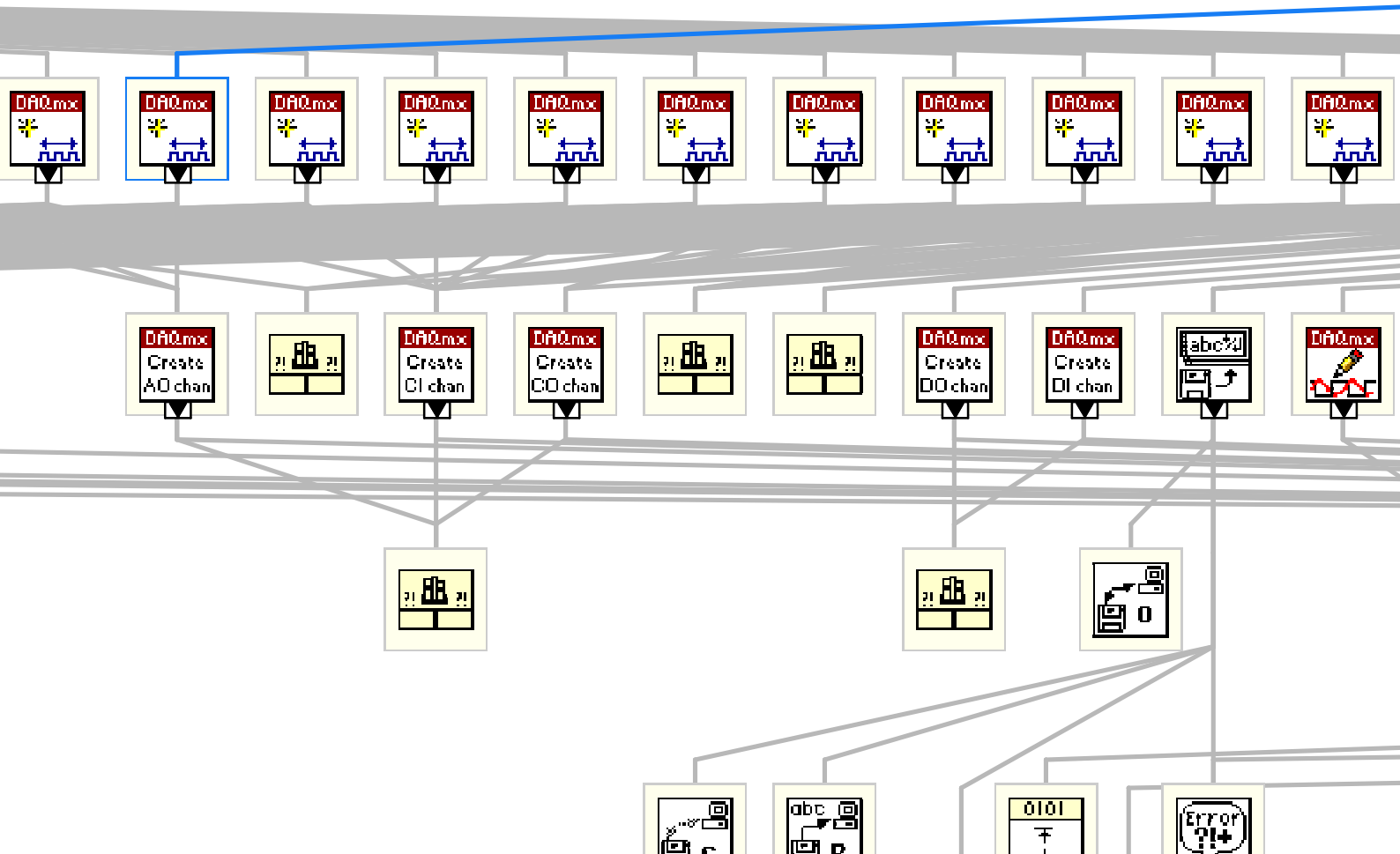

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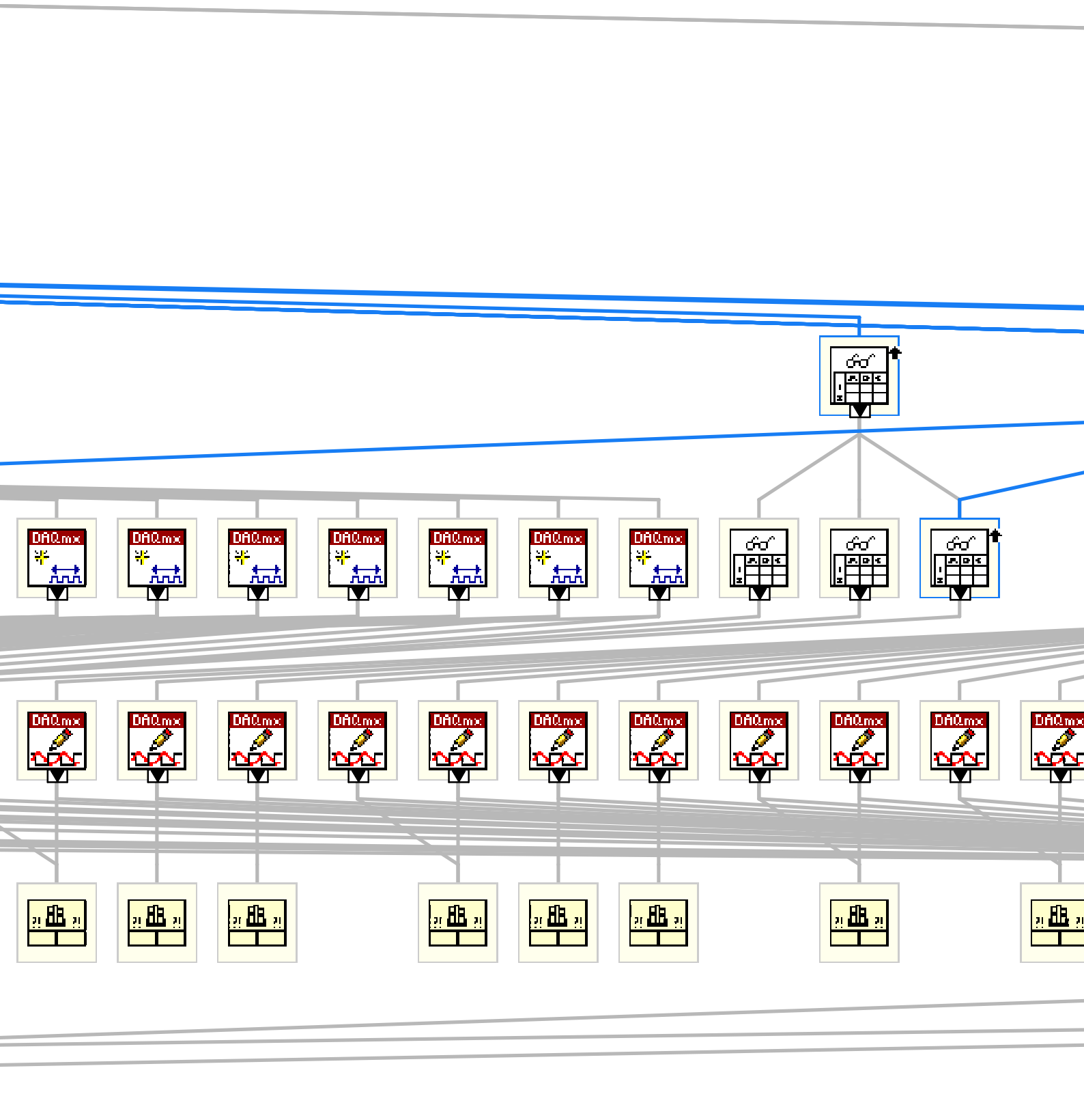

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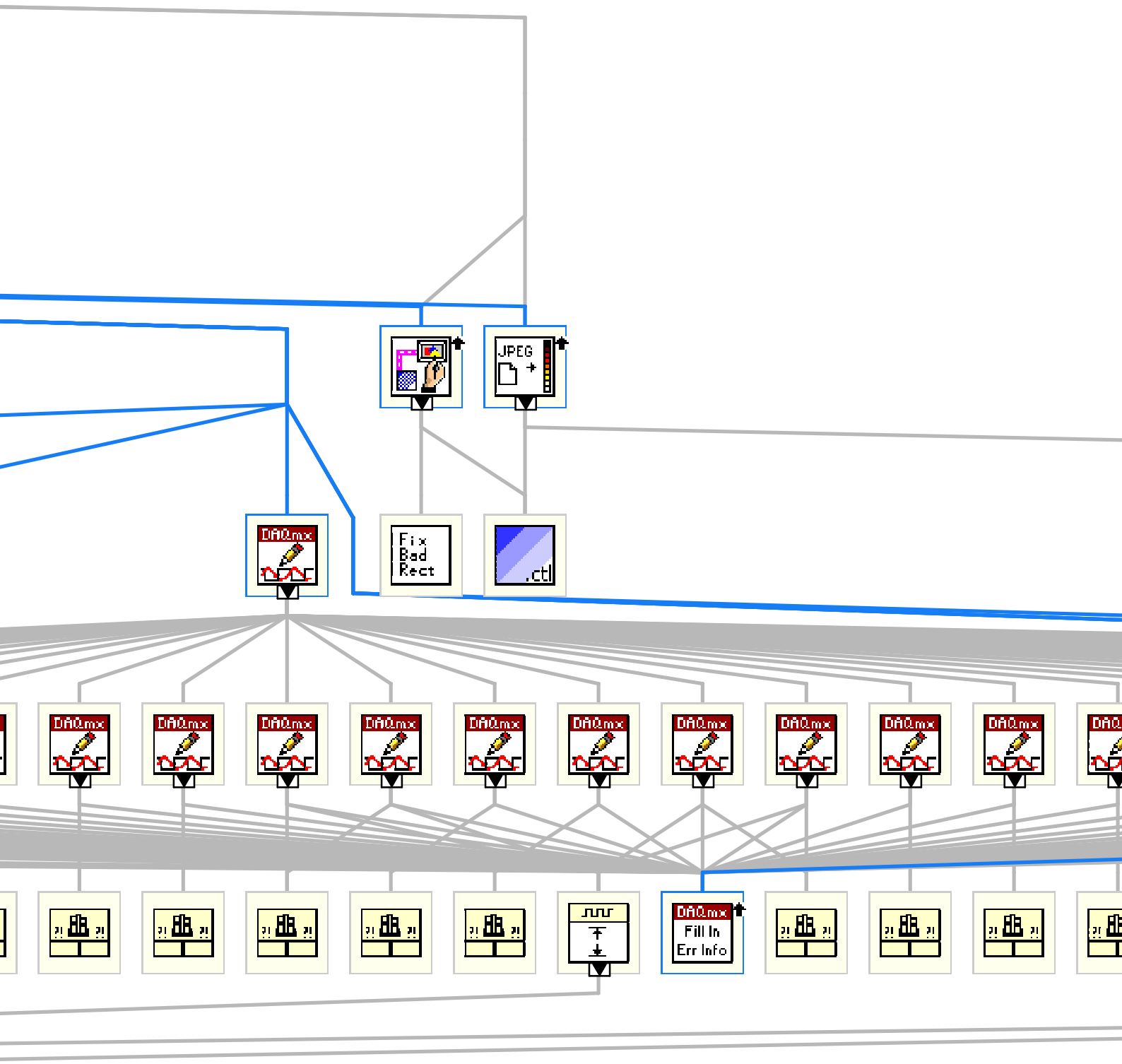

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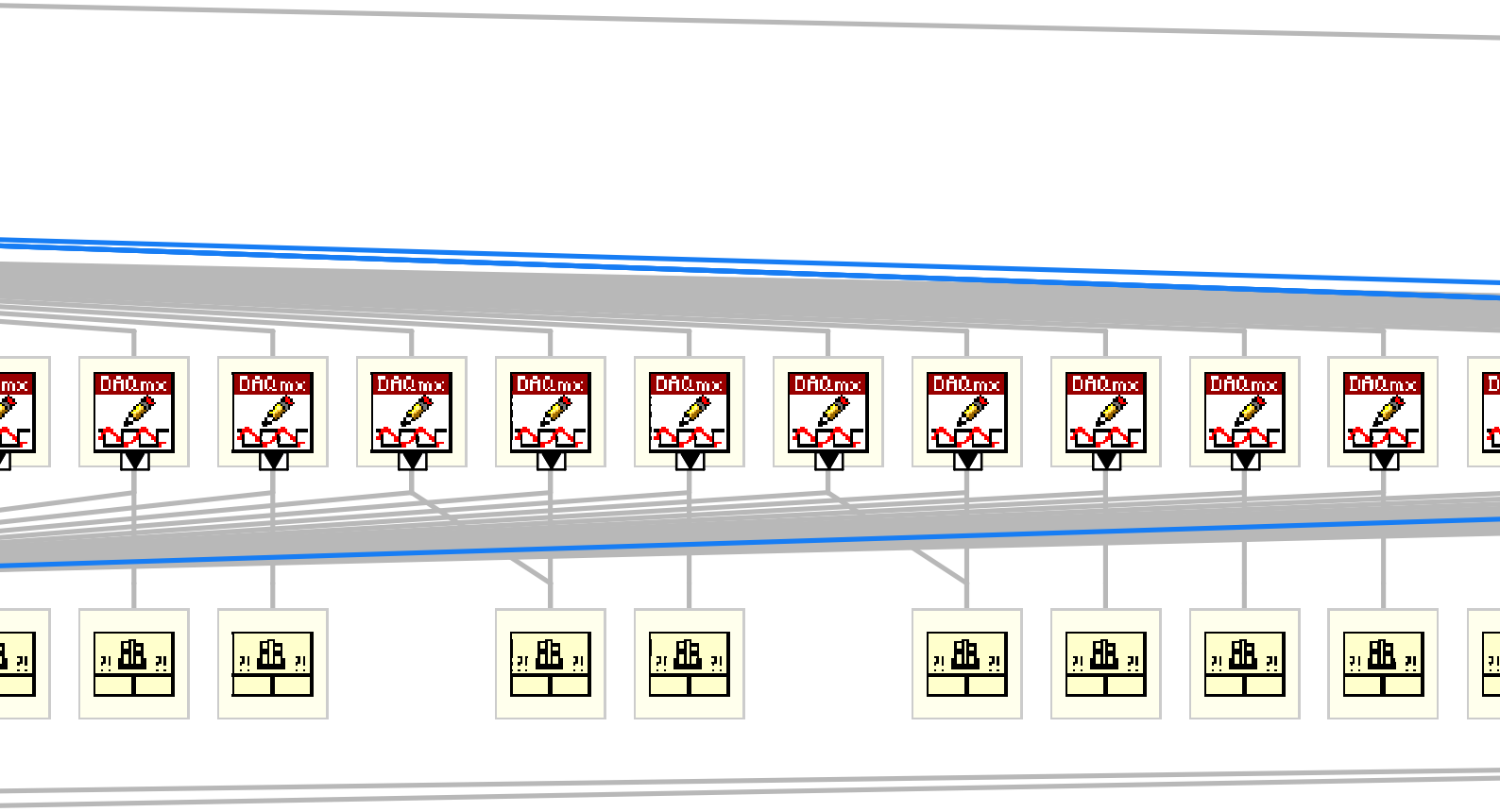

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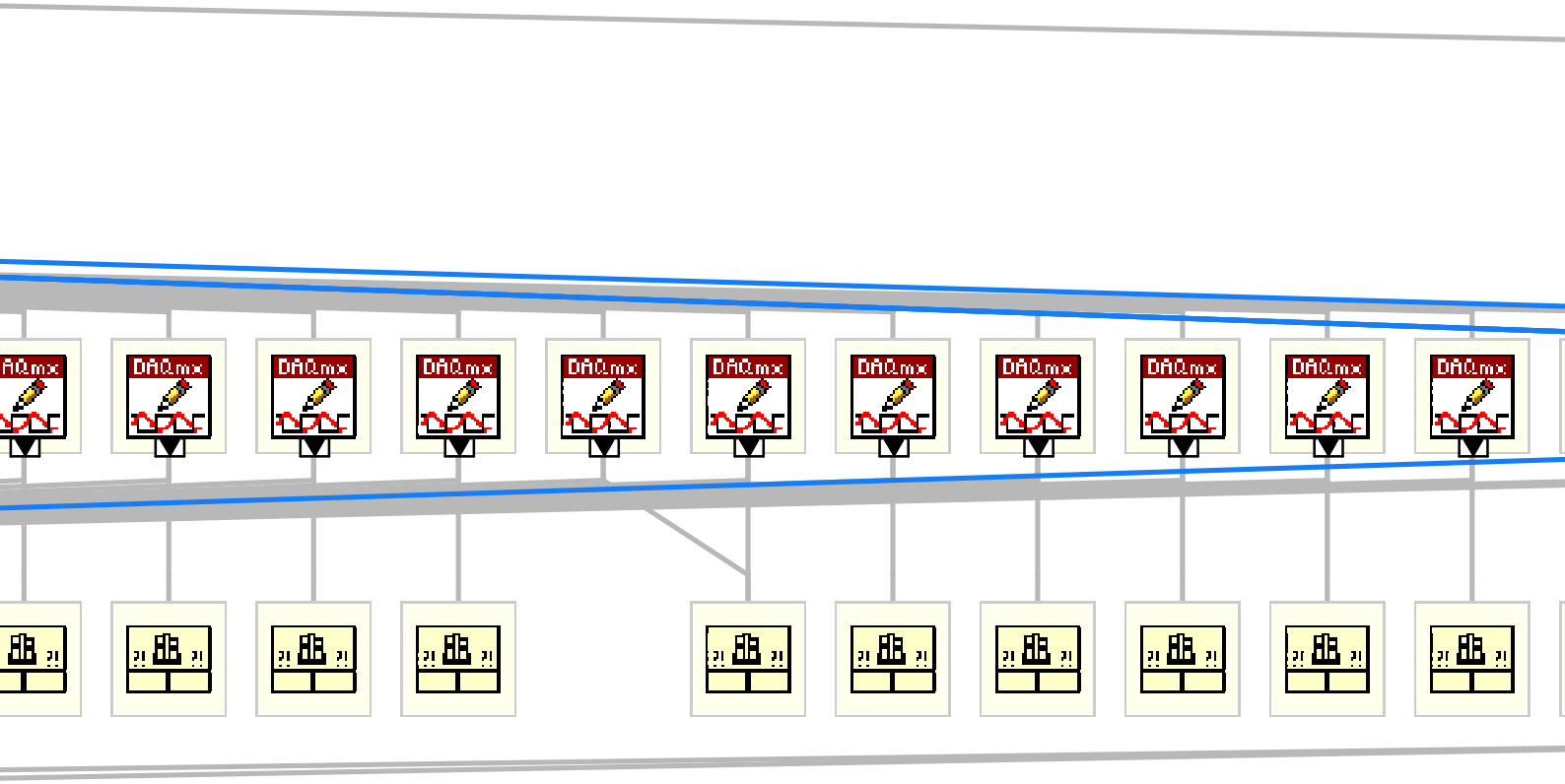

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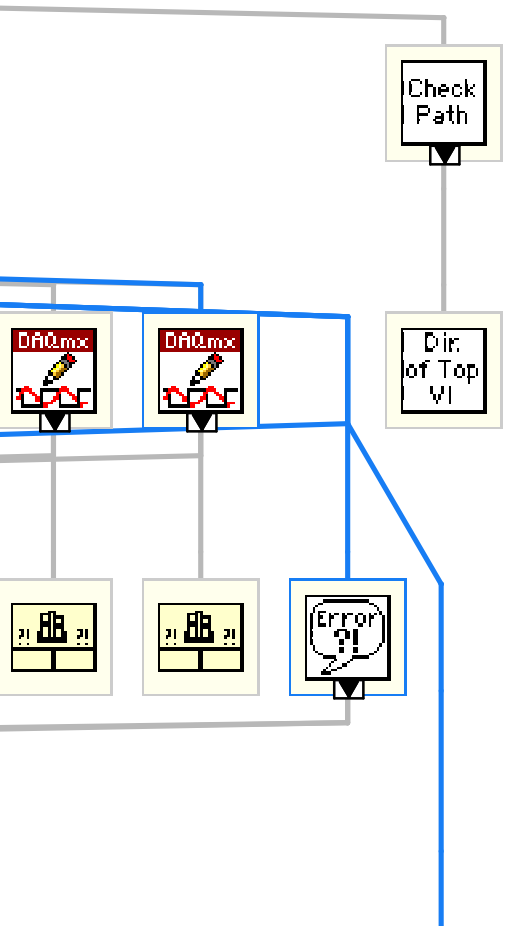

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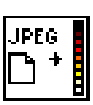
Draw Flattened Pixmap.vi
C:\Program Files\National Instruments\LabVIEW 2012\vi.lib\picture\picture.llb\Draw Flattened Pixmap.vi



Read JPEG File.vi
C:\Program Files\National Instruments\LabVIEW 2012\vi.lib\picture\jpeg.llb\Read JPEG File.vi

Simple Error Handler.vi
C:\Program Files\National Instruments\LabVIEW 2012\vi.lib\Utility\error.llb\Simple Error Handler.vi

DialogType.ctl
C:\Program Files\National Instruments\LabVIEW 2012\vi.lib\Utility\error.llb\DialogType.ctl


Feedback_Final5_writtenpath.vi
C:\Users\Ale\Documents\LabView_AAG\Feedback_Final5_writtenpath.vi
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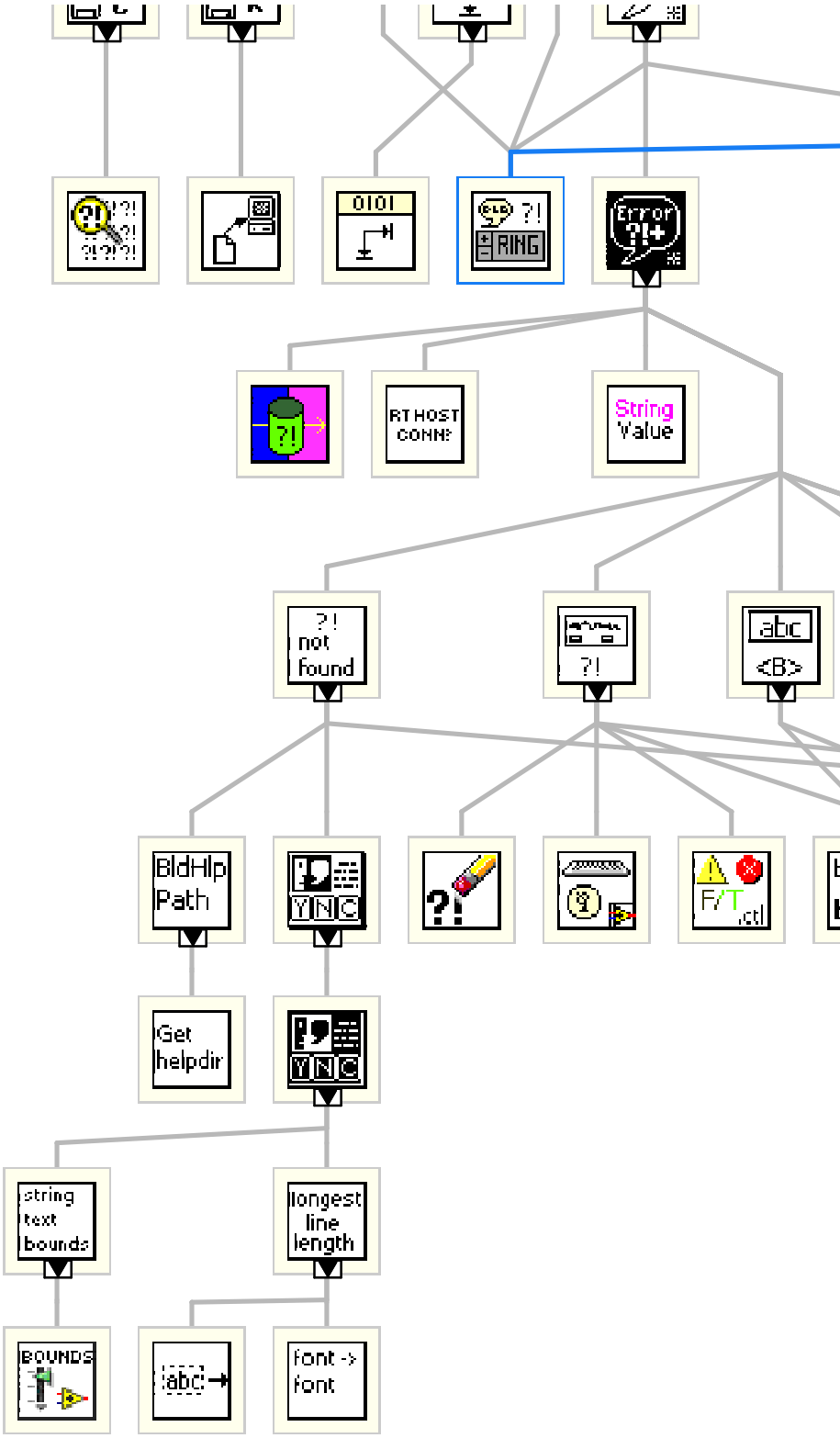

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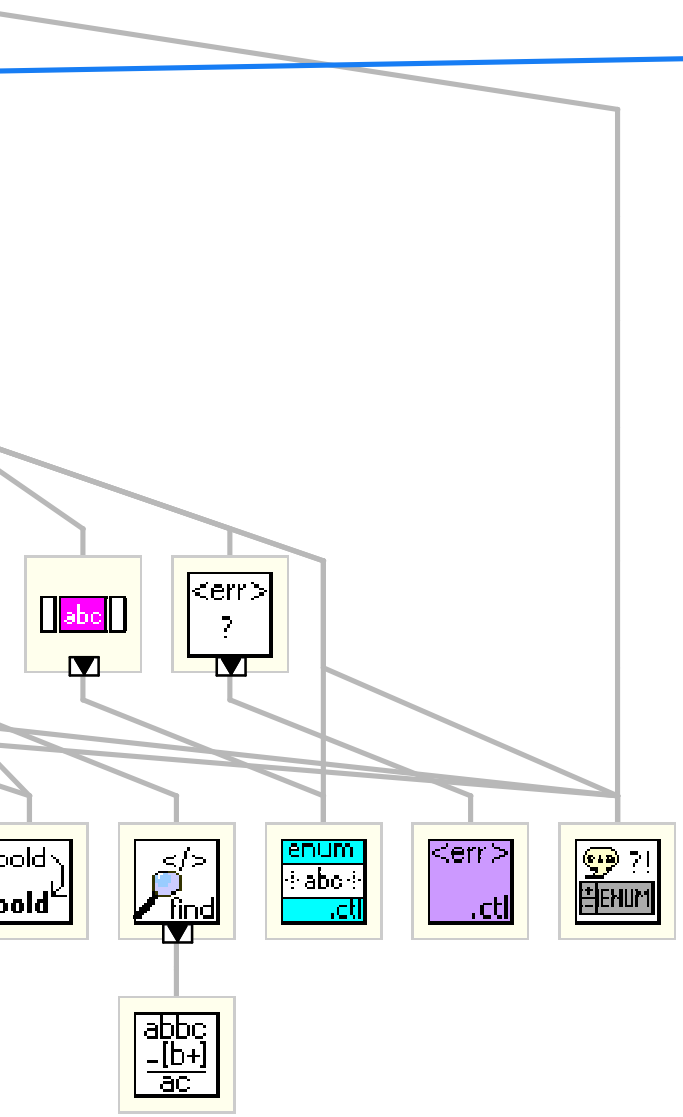


Feedback_Final5_writtenpath.vi
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C:\Users\Ale\Documents\LabView_AAG\Feedback_Final5_writtenpath.vi
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DAQmx Clear Task.vi
C:\Program Files\National Instruments\LabVIEW 2012\vi.lib\DAQmx\configure\task.llb\DAQmx Clear Task.vi

DAQ Assistant
DAQ Assistant
Creates, edits, and runs tasks using NI-DAQmx. Refer to the NI-DAQmx Readme for a complete listing of devices NI-DAQmx supports.

When you place this Express VI on the block diagram, the DAQ Assistant launches to create a new task. After you create a task, you can double-click the DAQ Assistant Express VI to edit that task. For continuous measurement or generation, place a while loop around the DAQ Assistant Express VI.

For continuous single-point input or output, the DAQ Assistant Express VI might not provide optimal performance. Refer to the Cont Acq&Graph Voltage-Single Point Optimization VI in examples\DAQmx\Analog In\Measure Voltage.llb for an example of techniques to create higher-performance, single-point I/O applications.

DAQmx Start Task.vi
C:\Program Files\National Instruments\LabVIEW 2012\vi.lib\DAQmx\configure\task.llb\DAQmx Start Task.vi

DAQmx Create Virtual Channel.vi
C:\Program Files\National Instruments\LabVIEW 2012\vi.lib\DAQmx\create\channels.llb\DAQmx Create Virtual Channel.vi

DAQmx Create Channel (AO-Voltage-Basic).vi
C:\Program Files\National Instruments\LabVIEW 2012\vi.lib\DAQmx\create\channels.llb\DAQmx Create Channel (AO-Voltage-Basic).vi

Elapsed Time
Elapsed Time
Indicates the amount of time that has elapsed since the specified start time.

This Express VI is configured as follows:

Time Target: 450 s
Auto Reset: Off

Elapsed Time2
Elapsed Time
Indicates the amount of time that has elapsed since the specified start time.

This Express VI is configured as follows:

Time Target: 450 s
Auto Reset: Off

Read From Spreadsheet File (DBL).vi
C:\Program Files\National Instruments\LabVIEW 2012\vi.lib\Utility\file.llb\Read From Spreadsheet File (DBL).vi

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C:\Users\Ale\Documents\LabView_AAG\Feedback_Final5_writtenpath.vi
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Read From Spreadsheet File.vi
C:\Program Files\National Instruments\LabVIEW 2012\vi.lib\Utility\file.llb\Read From Spreadsheet File.vi

DAQmx Write (Analog DBL 1Chan 1Samp).vi
C:\Program Files\National Instruments\LabVIEW 2012\vi.lib\DAQmx\write.llb\DAQmx Write (Analog DBL 1Chan 1Samp).vi

DAQmx Write.vi
C:\Program Files\National Instruments\LabVIEW 2012\vi.lib\DAQmx\write.llb\DAQmx Write.vi

DAQmx Fill In Error Info.vi
C:\Program Files\National Instruments\LabVIEW 2012\vi.lib\DAQmx\miscellaneous.llb\DAQmx Fill In Error Info.vi

"Feedback_Final5_writtenpath.vi History"
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