

# MATLAB EXPO 2016

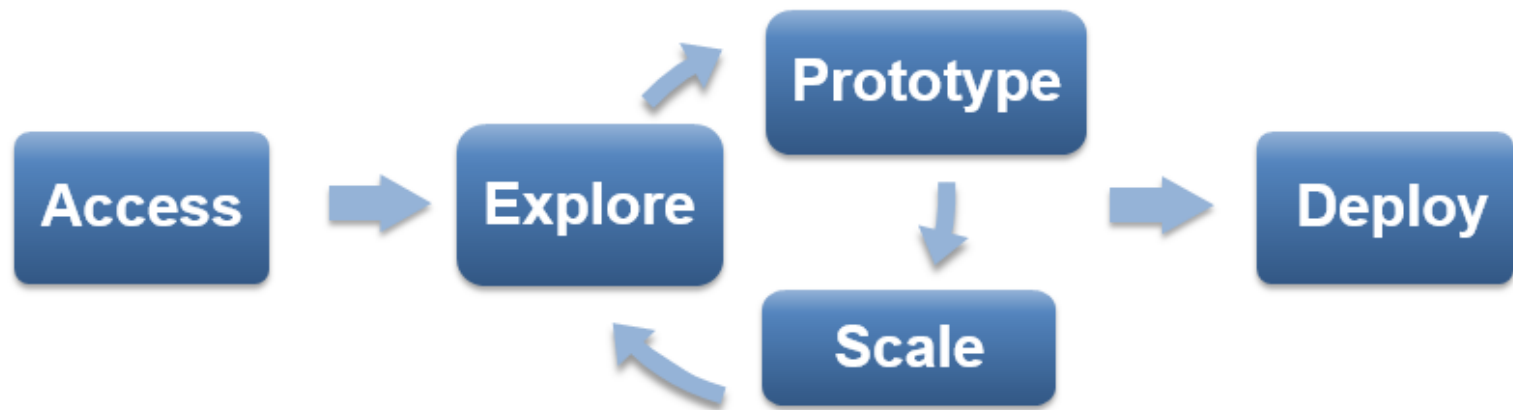
Messdatenerfassung mit MATLAB –  
so einfach geht's

Dr. Frank Graeber



# Typical challenges in Test & Measurement

- Integrating hardware not straightforward
- Multiple tools for accessing, analyzing and sharing data
- Data format conversions necessary
- Handling of streaming data
- Automation of workflow
- Application deployment



# Hardware Support - Web Page

## Hardware Support

Overview **Search Hardware Support** Request Hardware Support

### Refine by Vendor

3D Robotics	1	↑
3S-Smart Software Solutions	1	
Adimec	3	
ADLINK	3	
Advantech	2	
Agilent	4	
Aldebaran	1	↓
Allied Vision	8	

### Refine by Application

Control Systems	40	↑
Digital Signal Processing	42	
Embedded Systems		

### Refine by Protocol or Standard

Audio Standards	8	↑
Bluetooth	5	
CAN	8	
Ethernet	20	
I2C/SPI	8	
Safety Standards	9	
Serial	16	↓
USB	33	

### Refine by Product Family

Results 1 - 25 of 168



#### Adimec Camera Support from Image Acquisition Toolbox

Use Adimec cameras with MATLAB and Simulink to acquire video and images.

Vendors: Adimec

Tags: MathWorks Supported



#### ADLINK Support from Data Acquisition Toolbox

Create your own waveforms, measurement and analysis routines, and applications for ADLINK DAQ hardware using MATLAB and Data Acquisition Toolbox

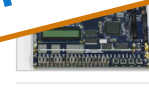
Vendors: ADLINK

Tags: Connections Program



#### Altera DE2 Support from Image Acquisition Toolbox

Use Simulink to acquire video and images

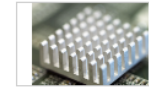


#### Altera DE2 Support from Simulink

Digital circuit development platform for hardware design and verification

Vendors: Altera

Tags: HDL Code Generation, MathWorks Supported



#### Altera Development Board Support from HDL Coder

Automatically generate HDL code from MATLAB and Simulink for Altera development boards.

Vendors: Altera

Tags: HDL Code Generation, MathWorks Supported, Support Package Installer Enabled

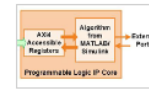


#### Altera FPGA Board Support from HDL Verifier

Use HDL Verifier for FPGA-in-the-loop (FIL) support for FPGA-based verification on Altera FPGA boards.

Vendors: Altera

Tags: MathWorks Supported, Support Package Installer Enabled

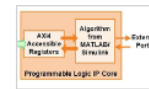


#### Altera SoC FPGA Support from Embedded Coder

Use Simulink and Embedded Coder to generate C/C++ code for Altera Cyclone V SoCs.

Vendors: ARM, Altera

Tags: C/C++ Code Generation, Connections Program, MathWorks Supported, Support Package Installer Enabled



#### Altera SoC FPGA Support from HDL Coder

Use Simulink and HDL Coder to configure programmable logic on Altera Cyclone V SoCs.

Vendors: Altera, ARM, Arrow Electronics

Tags: Connections Program, HDL Code Generation, MathWorks Supported, Support Package Installer Enabled

## Hardware Support

Overview **Search Hardware Support** Request Hardware Support

## Connect MATLAB and Simulink to Hardware

— Explore hardware by vendor —

Popular: ARM, Arduino, Altera, National Instruments, Renesas, STMicroelectronics, Keysight

## Live Data Streaming to and from Hardware

Directly receive and send real-world inputs and outputs from MATLAB and Simulink.

## Generating

Automatically generate algorithms, and

$$P = \Phi^T P \Phi + Q$$

[www.mathworks.com/hardware-support](http://www.mathworks.com/hardware-support)

# Hardware Support - Add-On Explorer

The screenshot displays the 'Add-On Explorer' window with a search for 'Hardware Support Packages' resulting in 234 items. The 'Support Package Installer' dialog is open, showing a list of support packages for selection. The 'Support for:' list includes various hardware categories like DirectSound Audio, Freescale Kinetis Microcontrollers, and Raspberry Pi. The 'Support packages:' table shows the selected package for installation.

Action	Installed Version	Latest Version	Description	Required Base Product	Supported Host Platforms
1 <input checked="" type="checkbox"/> Install		16.1.0	<a href="#">Control instruments using Keysight (Agilent) VISA.</a>	Instrument Contr...	Win64

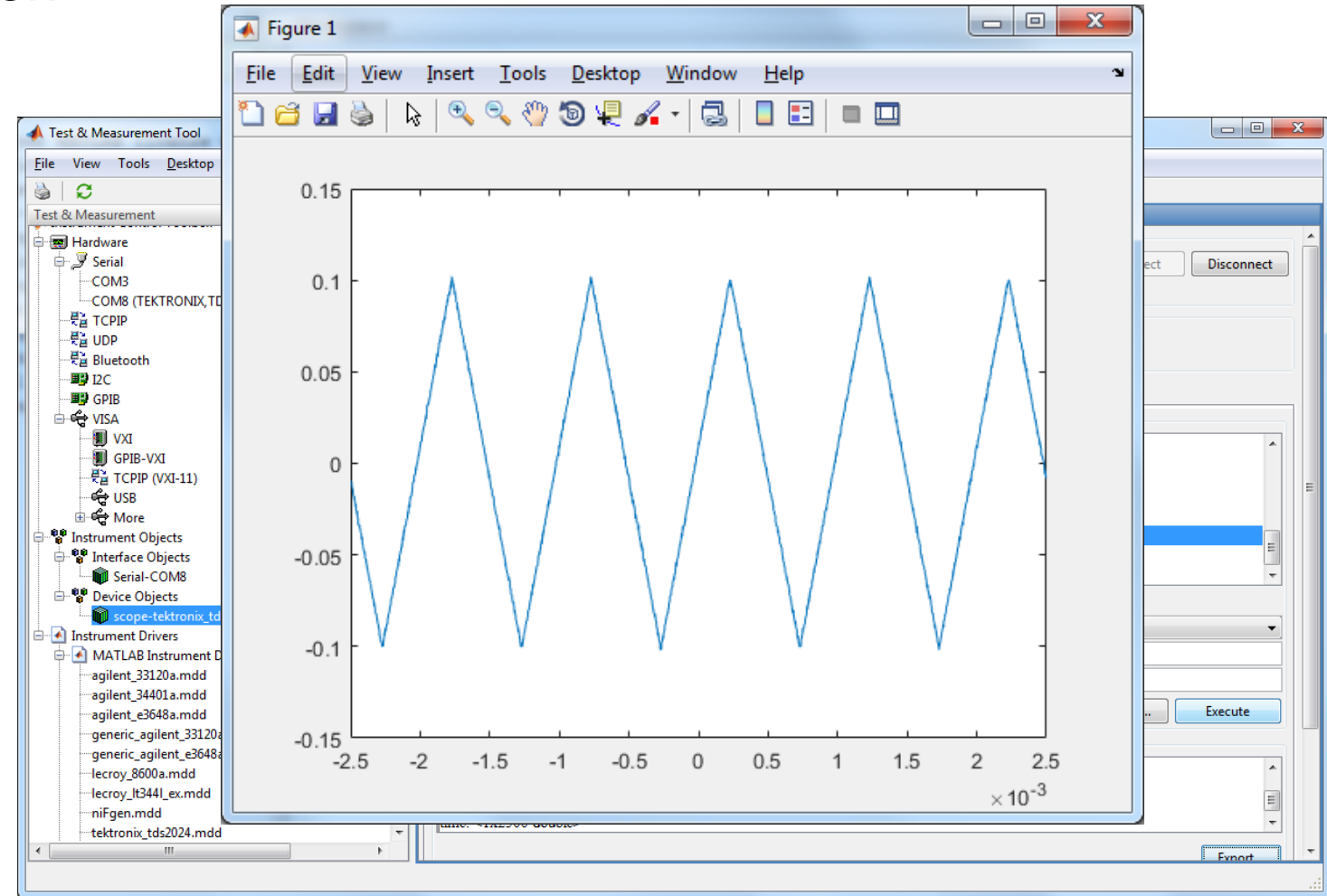
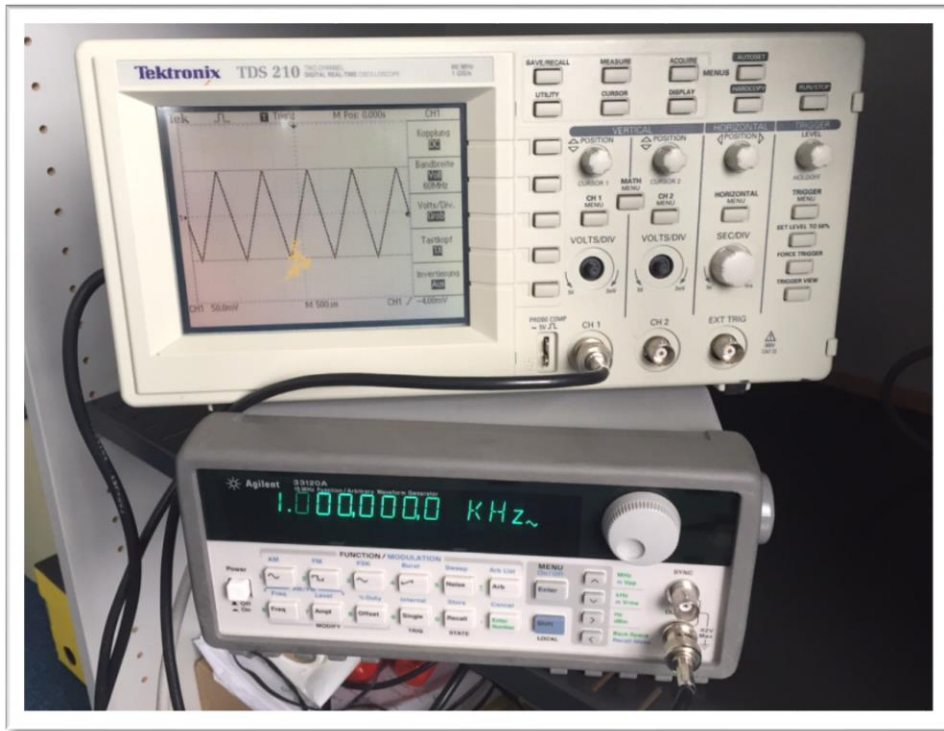
Installation folder: C:\MATLAB\SupportPackages\R2016a  
[More about Installation folder](#)

Navigation buttons: < Back, Next >, Cancel, Help

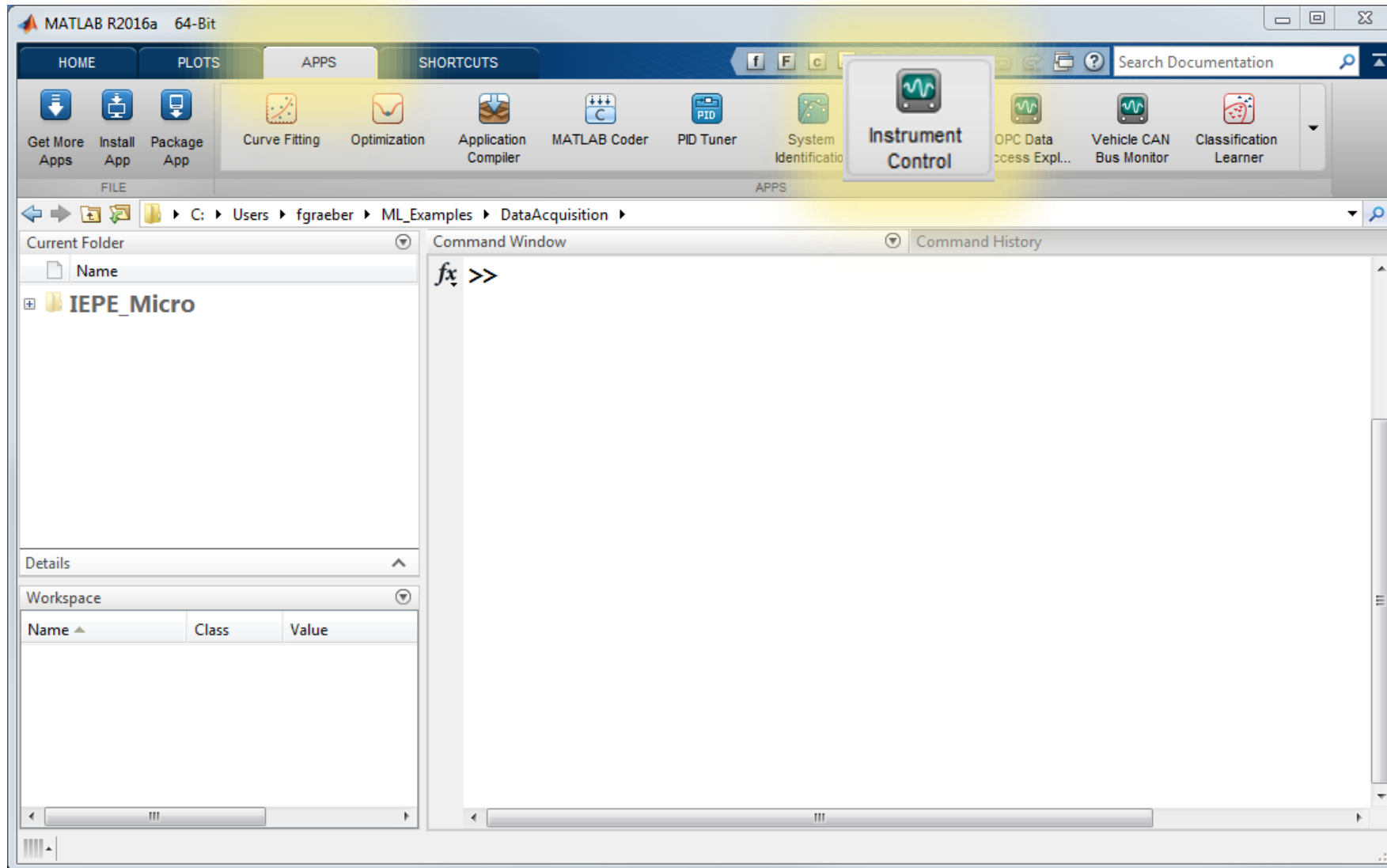
# Example: Read Waveform from Instruments

## Use App for Instrument Connection

- Using MATLAB instrument driver
- Using SCPI commands



# Instrument Control App



# Set up Connection using MATLAB Instrument Driver

The screenshot shows the 'Test & Measurement Tool' interface. The left pane displays a tree view of hardware and instrument objects. The 'Hardware' folder is expanded, and the 'Serial' folder is selected, with the specific COM3 port highlighted. The right pane shows the configuration for this port, including connection status, communication settings, and a data table.

**Test & Measurement Tool**

File View Tools Desktop Window Help

**scan**

Test & Measurement

Instrument Control Toolbox

- Hardware
  - Serial
    - COM3 (TEKTRONIX,TDS 210,0,CF:91.1CT FV:v2.03 TDS2MM:MMV:v1.04)
  - UDP
  - Bluetooth
  - I2C
  - GPIB
  - VISA
  - VXI
  - GPIB-VXI
  - TCPIP (VXI-11)
  - USB
  - More
- Instrument Objects
  - Interface Objects
    - Serial-COM3
  - Device Objects
    - scope-tektronix\_tds210
- Instrument Drivers

COM3 (TEKTRONIX,TDS 210,0,CF:91.1CT FV:v2.03 TDS2MM:MMV:v1.04)

Connection

Connection status to COM3: **Disconnected** Connect Disconnect

Last identification request on 17-Nov-2015 11:50:08: TEKTRONIX,TDS 210,0,CF:91.1CT FV:v2.03 TDS2MM:MMV:v1.04

Communicate Configure Session Log

**Sending data**

Data type: ASCII

Data format: %s\n

Data to write:

Evaluate in workspace before write

Interpret data as hex (0x...)

Query Write

**Receiving data**

Data type: ASCII

Data format: %c

Size (optional):

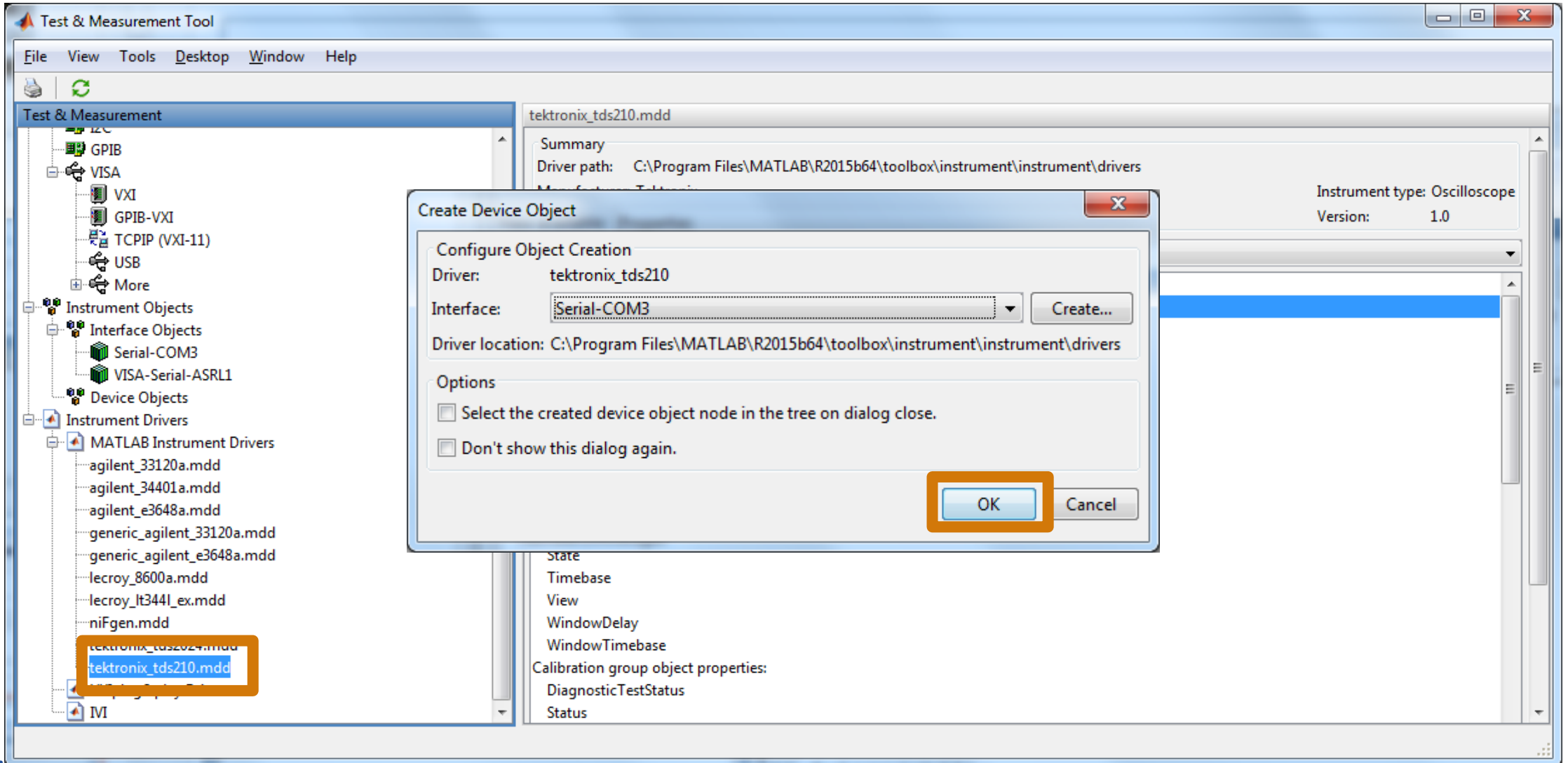
Response:

Read data as hex string

Read Export Flush

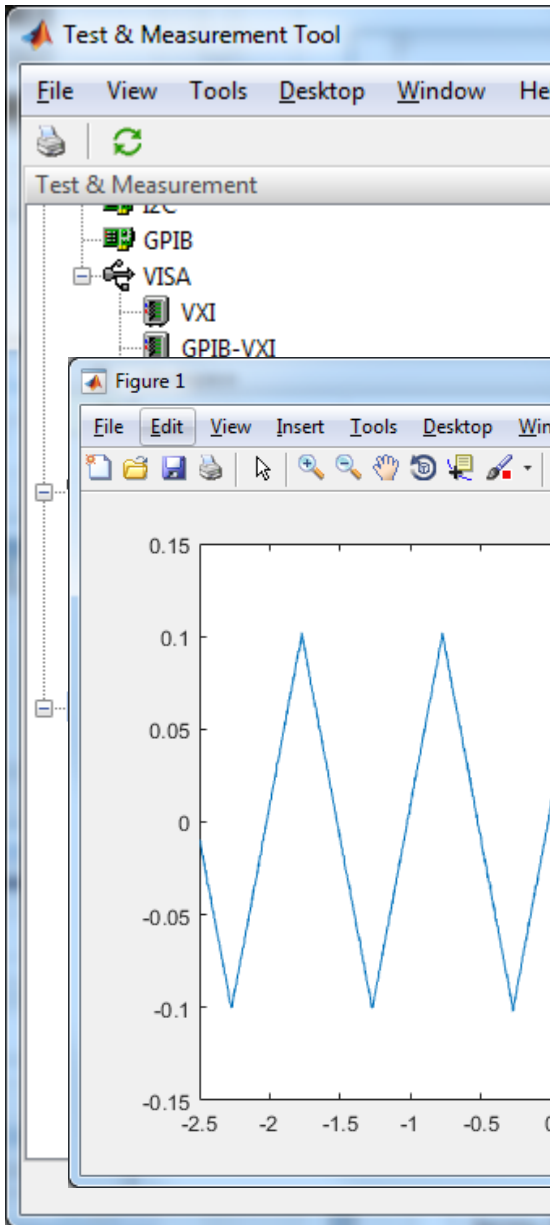
Action	Data	Size	Format

# Select MATLAB Instrument Driver (\*.mdd files)





# Read Wavefo



```

Editor - C:\Data\Demo\MATLAB\Demo\TM\IEPEmicro\IEPE_NEW\untitled.m
EDITOR PUBLISH VIEW
New Open Save Find Files Compare Print FILE
Go To Find NAVIGATE
Insert Comment Indent EDIT
Breakpoints Run Run and Advance RUN
Run Section Advance Run and Time

untitled.m x +
24 % See also ICDEVICE.
25 %
26 %
27 % Creation time: 17-Nov-2015 13:09:37
28 %
29 %
30 % Create a SERIAL object.
31 interfaceObj = instrfind('Type', 'serial', 'Port', 'COM3', 'Tag', '');
32
33 % Create the SERIAL object if it does not exist
34 % otherwise use the object that was found.
35 if isempty(interfaceObj)
36     interfaceObj = serial('COM3');
37 else
38     fclose(interfaceObj);
39     interfaceObj = interfaceObj(1);
40 end
41
42 % Create a device object.
43 deviceObj = icdevice('tektronix_tds210.mdd', interfaceObj);
44
45 % Connect device object to hardware.
46 connect(deviceObj);
47
48 % Execute device object function(s)
49
50 groupObj = g
51 [data, time] = icread(groupObj, 'channel1');
52
53 % Delete objects.
54 delete([deviceObj interfaceObj]);
55
    
```

The MATLAB Command Window and Editor interface shows the 'Execution' area with a blue bar. The 'Run' button is highlighted with an orange box. The 'Export...' button is also highlighted with an orange box. The 'Help' button is visible below the 'Run' button.

# MATLAB Connects to Your Hardware Devices

## Instrument Control

Instruments and RS-232 serial devices



## Data Acquisition

Plug-in data acquisition devices and sound cards

## Image Acquisition

Image capture devices



## Vehicle Networks / CAN bus devices

CAN bus devices using CAN and XCP protocols



## MATLAB

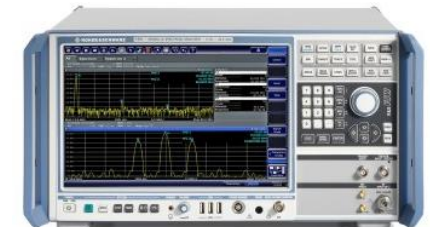
External Interfaces for connecting other devices



# Instrument Control Toolbox

*Enables MATLAB to configure, control, and transfer data with instruments such as oscilloscopes, signal generators, and spectrum analyzers*

- Integrate instruments into MATLAB applications and Simulink models
- Interactive tool for detecting and controlling instruments
- Automatic code generation for faster and easier implementation
- Support for IVD, VXI plug&play, and MATLAB instrument drivers
- Support for common communication protocols



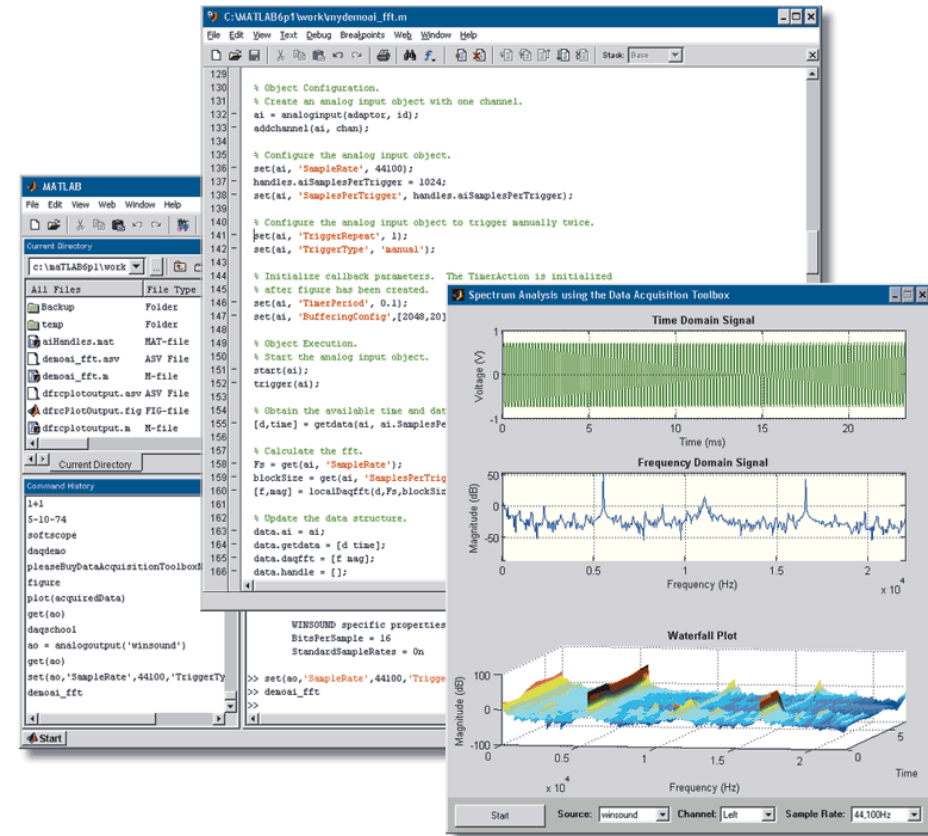
R&S®RTO



# Data Acquisition Toolbox

*Acquire and output data from data acquisition boards*

- Immediately analyze live or acquired data in MATLAB and Simulink
- Configure hardware without leaving MATLAB
- Incorporate custom analysis into PC-based digital oscilloscope
- Ability to do “one-shot” or continuous acquisition
- Support multiple data acquisition devices and vendors

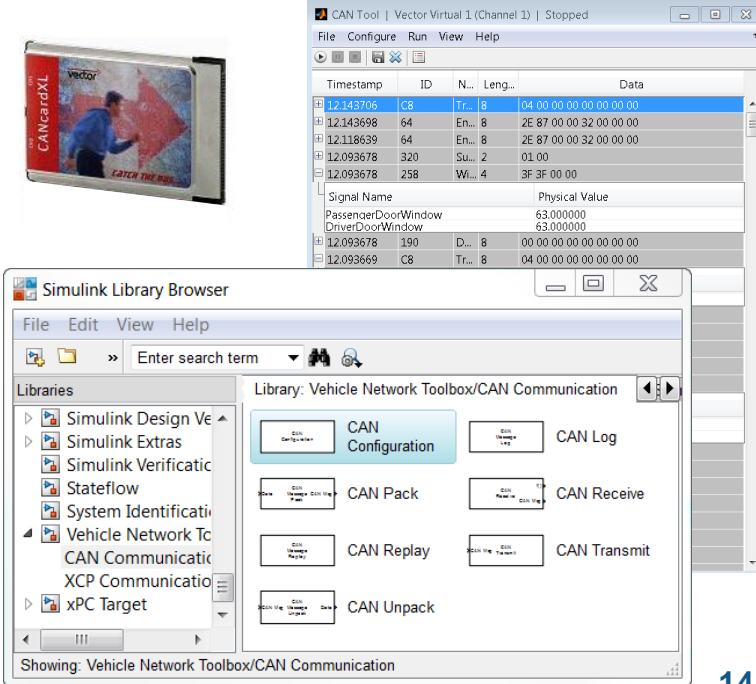




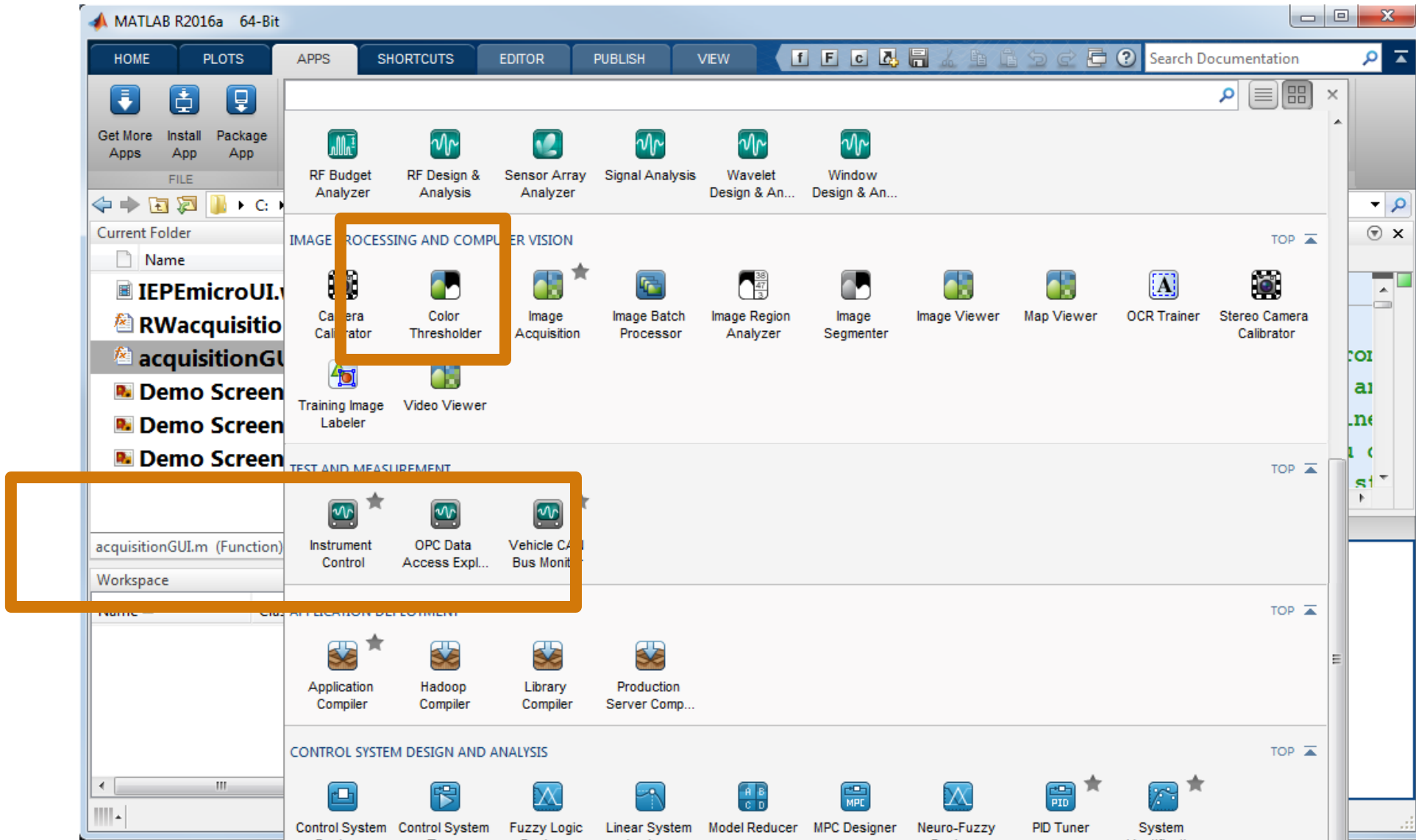
# Vehicle Network Toolbox

*Communicate with in-vehicle networks using CAN and XCP protocols*

- MATLAB functions for transmitting and receiving CAN and XCP messages
- CAN and XCP Simulink blocks for interfacing Simulink to a CAN bus or ECU
- Bit packing and unpacking functions and blocks for simplified encoding and decoding of CAN messages
- CAN bus app for visualizing live CAN traffic
- Ability to filter, log and replay CAN messages
- Support for Vector, Kvaser and NI interface hardware
- Support for A2L Description Files and Vector CAN Database



# Test & Measurement Apps



# MATLAB Advanced Analytics Algorithms

## Extensive toolboxes and apps

- MATLAB programming
- Point-and-click Apps

Live Editor - C:\Data\Demo\MATLAB\Demo\MISC\exampleEstimateCircuitTF\_ADALM1000\_pictures.mlx

exampleEstimateCircuitTF\_ADALM1000.mlx x exampleEstimateCircuitTF\_ADALM1000\_nt2c.mlx x exampleEstimateCircuitTF\_ADALM1000\_pictures.mlx x

```
figure(3)
spectrogram(MeasuredSignal, 1024, 1000, 1024, Fs, 'yaxis')
title('Frequency domain view of the measured signal')
```

**Calculate the Transfer Function of the circuit**  
Use knowledge of the measured signal and the stimulus signal to calculate the transfer function of the R-C circuit and plot the magnitude response.

Remove DC offset before processing.

```
MeasuredSignal = MeasuredSignal - mean(MeasuredSignal);
ExcitationSignal = ExcitationSignal - Offset;
[TFxy, Freq] = tfestimate(ExcitationSignal, MeasuredSignal, [], [], Fs);
Mag = abs(TFxy);
```

Compare the estimated transfer function to the theoretical magnitude % response.

```
R = 1e3; % Resistance (Ohms)
C = 0.1e-6; % Capacitance (Farads)
TFMagTheory = abs(1 ./ (1 + (1i * 2 * pi * Freq * C * R)));

figure(4);
semilogy(Freq, TFMagTheory, Freq, Mag);
xlim([0 20e3])
xlabel('Frequency (Hz)')
ylim([0.05 1.1])
ylabel('Magnitude')
grid on
legend('Theoretical frequency response', 'Measured frequency response')
title('Magnitude response of the theoretical and estimated transfer function')
```

**Magnitude response of the theoretical and estimated transfer function**

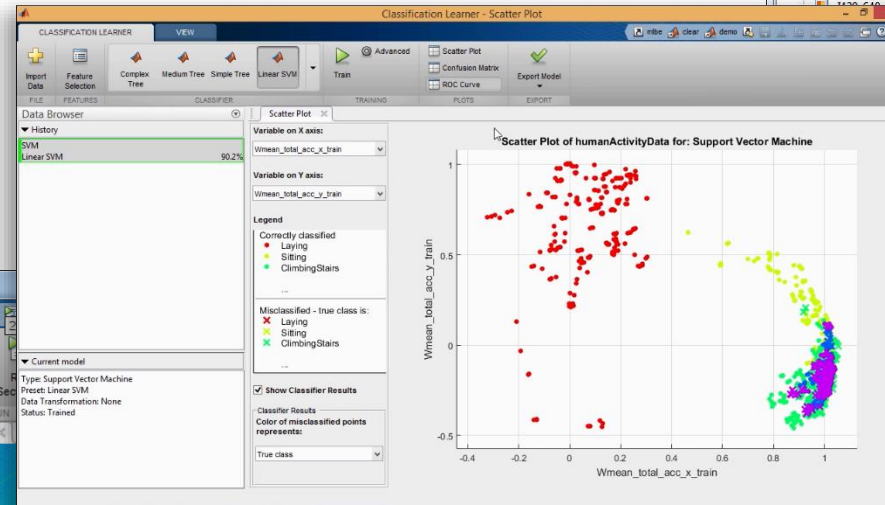


Image Acquisition Tool

Preview - Logitech QuickCam Pro 9000 (winvideo-1): RGB24\_1280x800

4.99 FPS Preview Ready to start acquisition. 16:32:59.849

Acquisition Parameters

General: Frames per trigger: 1 frames

Session Log - Logitech Quick...

```
4 vid.FramesPerTrigger
5 6 preview(vid);
7
8
```

Timestamp	ID	Name	Length	Data
51.148644	123	HEV	2	60 03
Signal Name		Physical Value		
VehSpd		8.640000		
51.145327	567	Generator	8	D3 06 D3 36 6D...
51.144155	456	Motor	8	37 79 93 AD 00 ...
51.138978	234	Battery	6	7E 03 D6 17 52 ...
51.133850	345	Engine	4	00 A0 05 00
Signal Name		Physical Value		
EngineSpeed		0.000000		
EngineTemp		90.000000		
FuelRate		0.000000		



# Summary

- Easy driver installation through hardware support packages
- Data acquisition from a range of devices
- Handling, visualizing and processing data made easy
- One environment covering the whole Test & Measurement workflow

