Welcome to Tech Day 2019

Instrument Control

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Instrument Control and Test

Introductions

- Robert Pilat; rpilat@intrepidcs.com, Senior Sales Engineer at Intrepid Controls; BSEE Lawrence Tech 1990. Test Equipment and Test Lab experience since 1988
- Sangeetha Hariharasudhan shariharasudhan@intrepidcs.com; Software developer

Vehicle SPY to Control Instruments

- Vehicle Spy Enterprise adds “Instrument Control” to allow the control of scientific instruments while the Device Under Test (DUT) is being exercised and messages read via CAN/LIN/ ETHERNET.

What are instruments?

- Power Supplies
- Multimeters
- Oscilloscopes
- LCR Meters
- Source Meters
- Frequency Generators
- Arbitrary waveform generators
- Spectrum Analyzers
- And more….

Control and Acquire Data

- To test components in the lab or factory floor
- Component test must occur in a test lab, years before a prototype vehicle is even available. (no car = no OBD connector!)
- All OEM's require testing years before accepting production components; and OEM's also do independent component testing
- There are 3 main categories of product testing after a prototype is made
  - *Design Validation*
  - *Product Validation*
  - *Durability or Life test*

DV/PV and Durability Testing

- *Design Validation* insures the component fulfills the specification of the OEM
- *Product Validation* insures the production intent product fulfills the OEM and end user needs and usually more samples are tested than DV.
- *Durability (or Life) testing* requires larger sample sizes, (based upon safety factors) and many times it is integrated with addition Product validation. Not uncommon to test 30+ samples.

Sample of Durability Testers Two 6-UP Testers

And of course End-Of-Line Production testing

- *End of Line* testing insures the product is assembled correctly
- Typically the product is introduced to the tester with test code to speed up testing
- Many times the final application software is flashed into it at the EOL tester and another quick check is done.
- A barcode or laser marker may also be integrated into the system

Example of Two EOL (End of Line) 2 station testers

Fact: The value of Vehicle Electronics is surpassing the mechanical portion of a vehicle

- The $$ value of Electronic content in vehicles is surpassing the mechanical content; some vehicles have **well over 30 electronic modules** and more and more are being added; and these modules must work in harmony with each other to accomplish the end goal of safety and reliability.
- The link between these modules is becoming evermore important, **so much that the serial data portion (CAN, Ethernet) is consuming far more time in test development than the physical measurements like voltage, current or frequency.**

How to test an electronic module …

- Buy some type of PC to serial data converter and write your own software to stimulate (send messages) and decode the received Hexadecimal data packet
- You will also need to write a database that correlates the message headers to the ones of interest
- Then dissect the message and find the Data (or “payload”)

And write more software …

- Convert the data to scalable engineering units
- And compare it to upper and lower test limits
- And LOG the data in a popular format
- And it must be done very fast with very little acceptable latency because the serial data messages may be streaming in (and out) in less than a milli-second

You also need to control the power supply

- It is typical to control a power supply for tri-voltage testing at 9 VDC, 13.8 VDC and 16VDC or some other voltage
- Cold crank signal voltage waveform are also required to be presented to the module

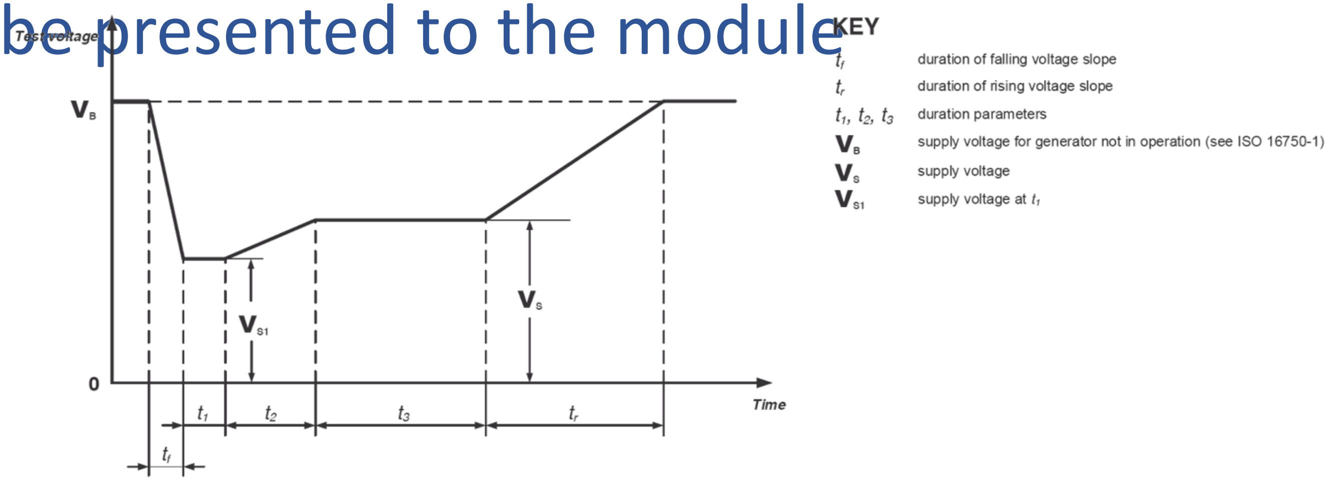


Figure 3-1: Voltage profile of a cold cranking event.

Instrument Control in Vehicle Spy

WHY USE VEHICLE SPY?

- Over 24 years of experience with vehicle data busses.
- Simplify the tester project by not requiring an additional programming language.
- Generic programming languages are NOT "tuned" toward the processing of high speed serial data streams. You have to write a lot of code yourself.
- Graphical programming languages tend to "choke" at decoding the sheer volume of continuous data on high speed busses; especially for multi-headed test stands.

VSPY Supports many protocols

- CAN
- CAN-FD
- Ethernet
- FlexRay
- K-Line
- LIN
- MOST
- ISO14229(UDS)
- J1939
- GMLAN
- KWP2000
- XCP (CAN, TCP, UDP, FlexRay*)
- UDP/TCP/IP
- DoIP

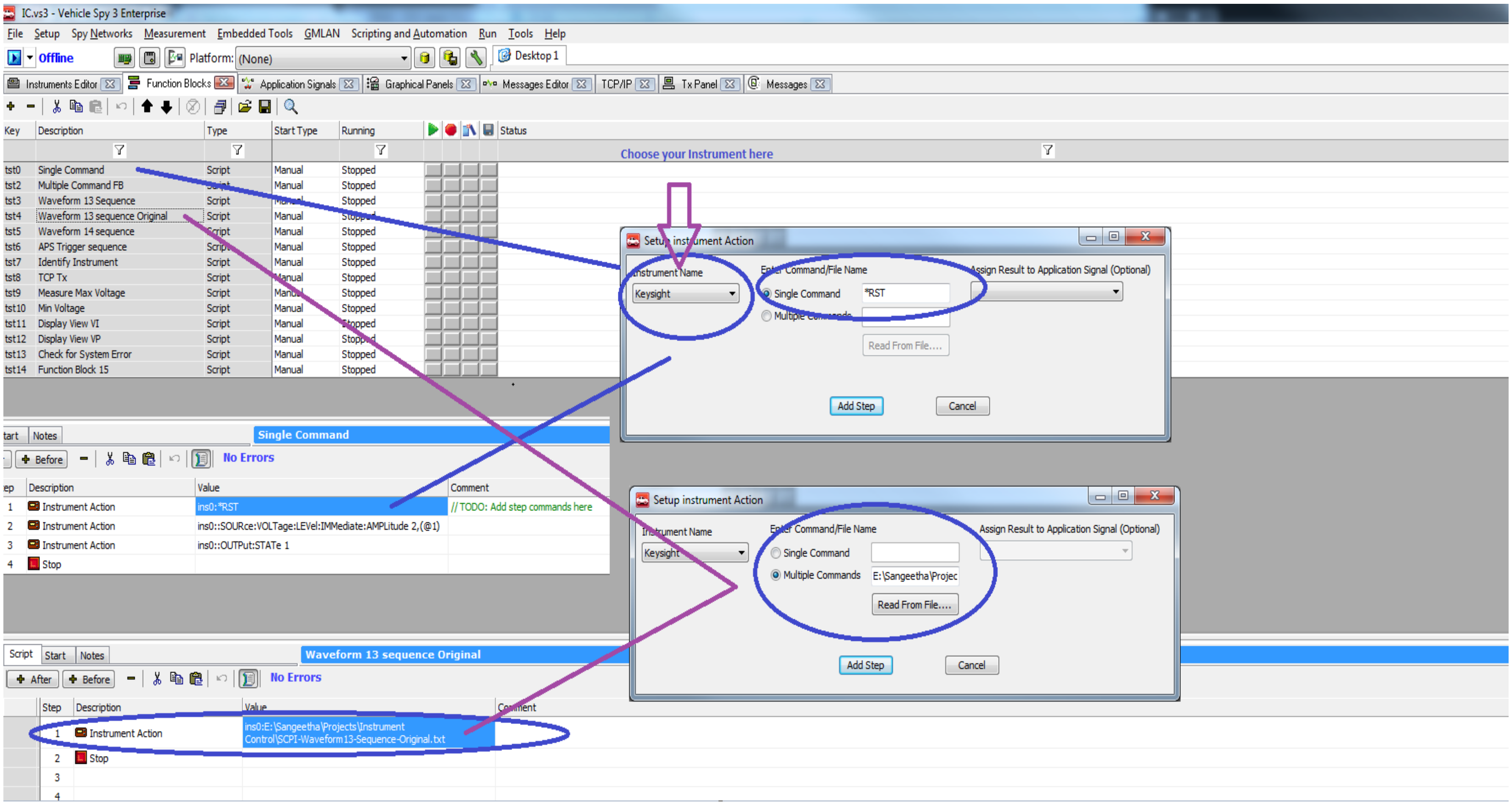
Features of Vehicle SPY

- Vehicle SPY is designed for **high speed** manipulation of Hexadecimal "string"data from a vehicles data bus, and includes many basic features that could take man-years of programming with traditional text and graphical programming languages.
- Automatic decoding the Data (or "payload") from the rest of the message
- Loading existing decoding files like DBC files, LDF, FIBEX, VSDB, ARXML for human readability and logging
- These files allow conversion and scaling of data into Base10 engineering units for comparison to product test limits.

“Programming” Vehicle SPY

- In addition to communicating via the vehicle bus, Vehicle Spy program allows the user to take control of the application and write function blocks
- Then call the function blocks from inside of other function blocks
- Allow conditional looping and testing of the data.
- Which allows sequenced and conditional based “programming” of the device under test.
- **Vehicle Spy utilizes this same function block method to control instruments.**

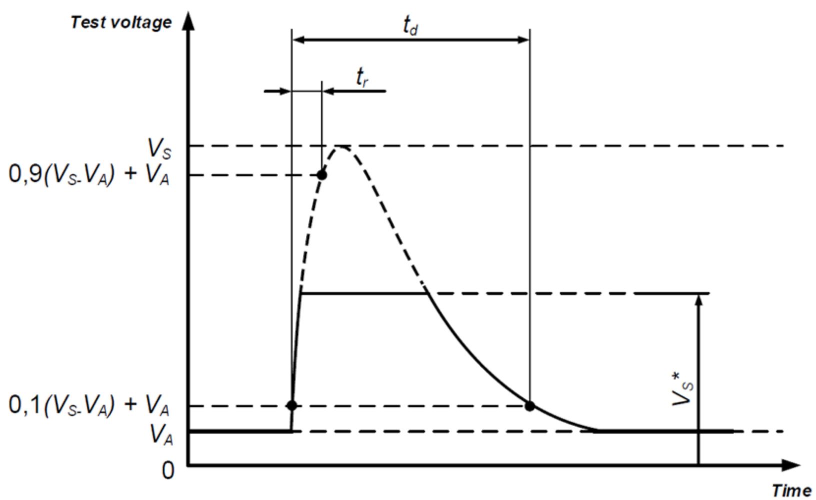
The Solution: Vehicle SPY!



Instrument Control in VSPY

Control power supply setpoints

- Simple tri-voltage testing or cold-crank waveforms.
- As well as reverse polarity voltage
- Simulate an alternator load dump…



KEY

t	time
t_d	duration of pulse
t_r	duration of rising slope
V_A	supply voltage for generator in operation (see ISO 16750-1)
V_S	supply voltage
$V_S{}^*$	supply voltage with load dump suppression

Figure 3-2: A voltage profile for a load dump, without (dotted line) and with (solid line) an alternator voltage suppression device.

Many also have the need for precision measurements from sources external to the DUT, like multimeters and oscilloscopes.

How does Vehicle Spy perform Instrument Control?

- Vehicle Spy with Instrument control utilizes TCP/IP or UDP and gives the user primitives or function blocks to send control signals via Ethernet to the instruments
- At the root of these function blocks is a simple ASCII like command called SCPI, pronounced “SKIPPY”.
- With our alliance with Keysight, we anticipate many of the Keysight instruments to have the SCPI primitives or function blocks pre-written, to further save time.

What is SCPI?

- **S**tandard **C**ommands for **P**rogrammable **I**nstruments

- First released in 1990 SCPI was defined as an additional layer on top of the IEEE 488.2-1987 specification.
- SCPI is a pure software standard.
- SCPI syntax is ASCII text, and therefore can be attached to any computer test language
- For example, all SCPI-compatible voltmeters, regardless of manufacturer or model, respond to the same command for reading AC voltage.

What is SCPI?

- SCPI defines several classes of instruments.
- These commands are grouped into subsystems.
- SCPI introduced generic commands (such as CONFigure and MEASure) that could be used with any instrument manufacturer in that class.
- However there are some manufacturers specific commands if additional features warrant it
- It was originally intended for the IEEE-488 Bus and RS232, Intrepid supports it via Ethernet.

SCPI Products

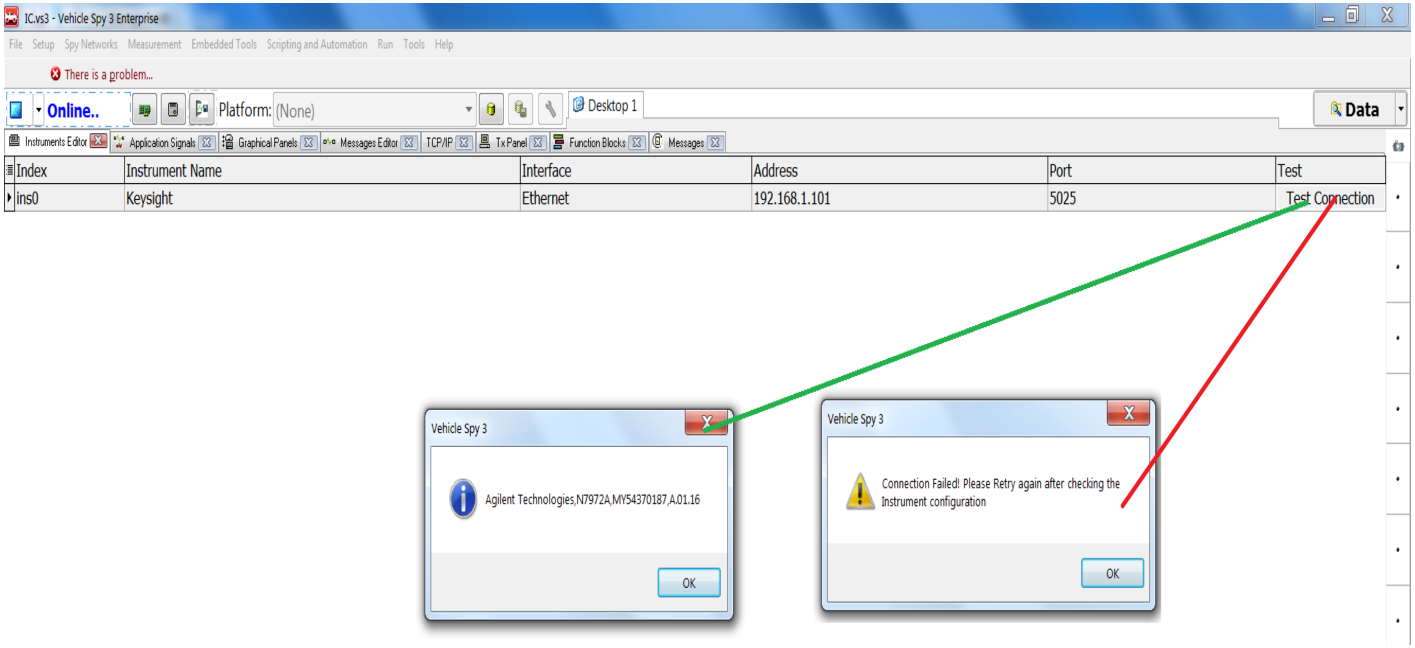
- The SCPI Consortium voted to become part of the IVI Foundation in late 2002
- http://www.ivifoundation.org/scpi/default.aspx
- In contrast to IVI drivers, SCPI is ASCII based and totally application independent
- Thousands of instruments accept SCPI commands



Overview of Instrument Control

Instruments View: (Vehicle Spy -> Measurements -> Instruments)

This is a Table view that enables the user to add their own instrument in the Instrument Editor (Similar to adding messages into Messages Editor). User needs to Input the below information as part of this view.



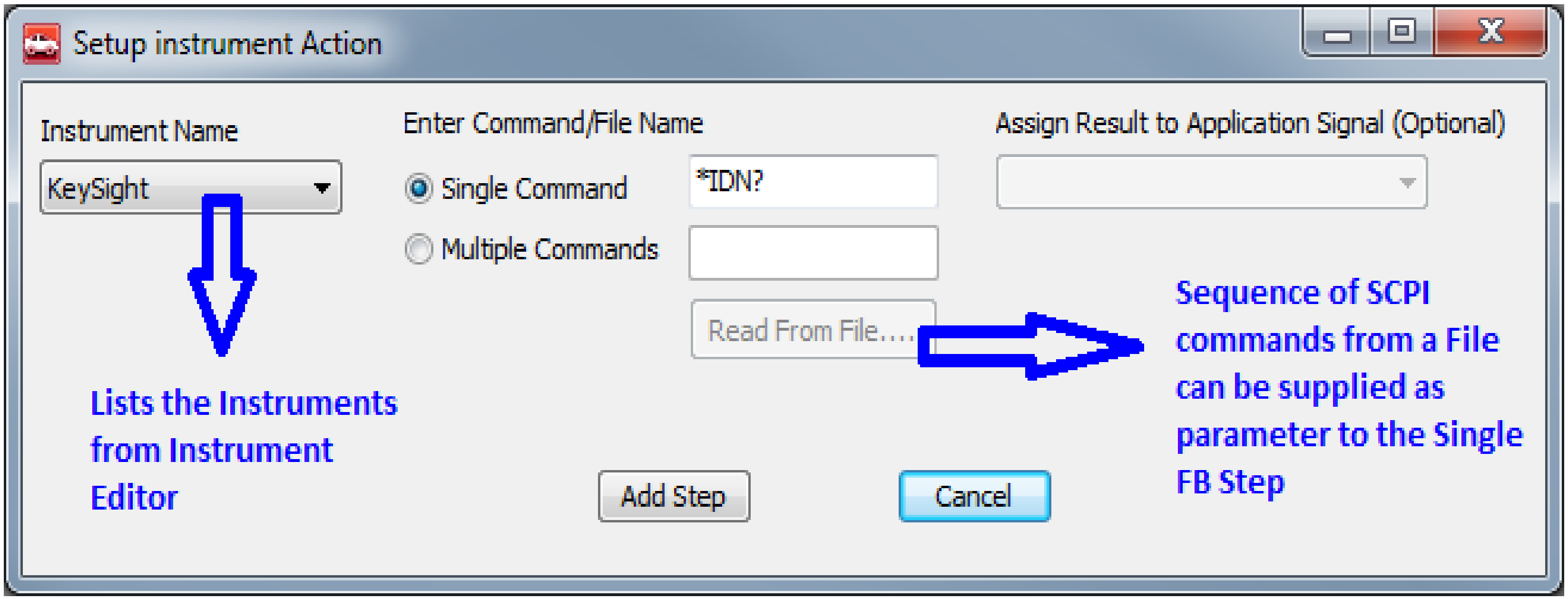
Instruments Editor Screen

- Instrument Name: Instrument Name or Manufacturer name
- Interface: RS232/Ethernet/GPIB
- IP Address: IP Address for Ethernet interface, GPIB address for GPIB
- Port: Port number for RS232 or TCP
- Test Connection: Button to implicit connectivity test and if it is successful, Instrument name will be displayed to the user. Otherwise,Connection error will be displayed.

*Note: **“Use PC Ethernet interface”** needs to be checked under Vehicle Spy-> Tools -> Options -> Spy Networks in order to use the instruments connected to Ethernet Interface*

New Function block command in Vehicle Spy

New Step Command called "Instrument Action" will be created in order to send commands to the instrument:



“Instrument Action” Function Block

- **Instrument Name:** This will be listed from the Instrument Editor and available for users to just select their Instrument in this view.

- Enter Command/Filename
  - ✓ **“Single Command:”** Enter or Manually Type the exact command in the text box
  - ✓ **“Multiple Commands:”** User can import a text file which has list of SCPI Commands in it

- **“Assign Result to Application Signal”** If it is a Single command (Leave it blank if the command has no response)

“Instrument Action” Function Block

If the command is going to have a response from instrument, then User can choose to store the result in the Application signal which can then be displayed in Graphical Panels. This option is available only for Single Command case right now.

- **“Add Step”:** Clicking this button will add the command to the Function block with all the user provided details.

NOTES:
Single Command Entry will be replaced later with an option to select it from Instrument Database rather than manually typing it.

Multiple Commands - Usage Instructions:

- Only Text file format is supported.
- Text files can be made manually or exported from different applications.
- In order to make a file manually, enter the commands in order in separate line.
- The <Enter> key is important between the lines in order to read it properly. Keysight Command Expert does this automatically when you export the command sequence from their application.

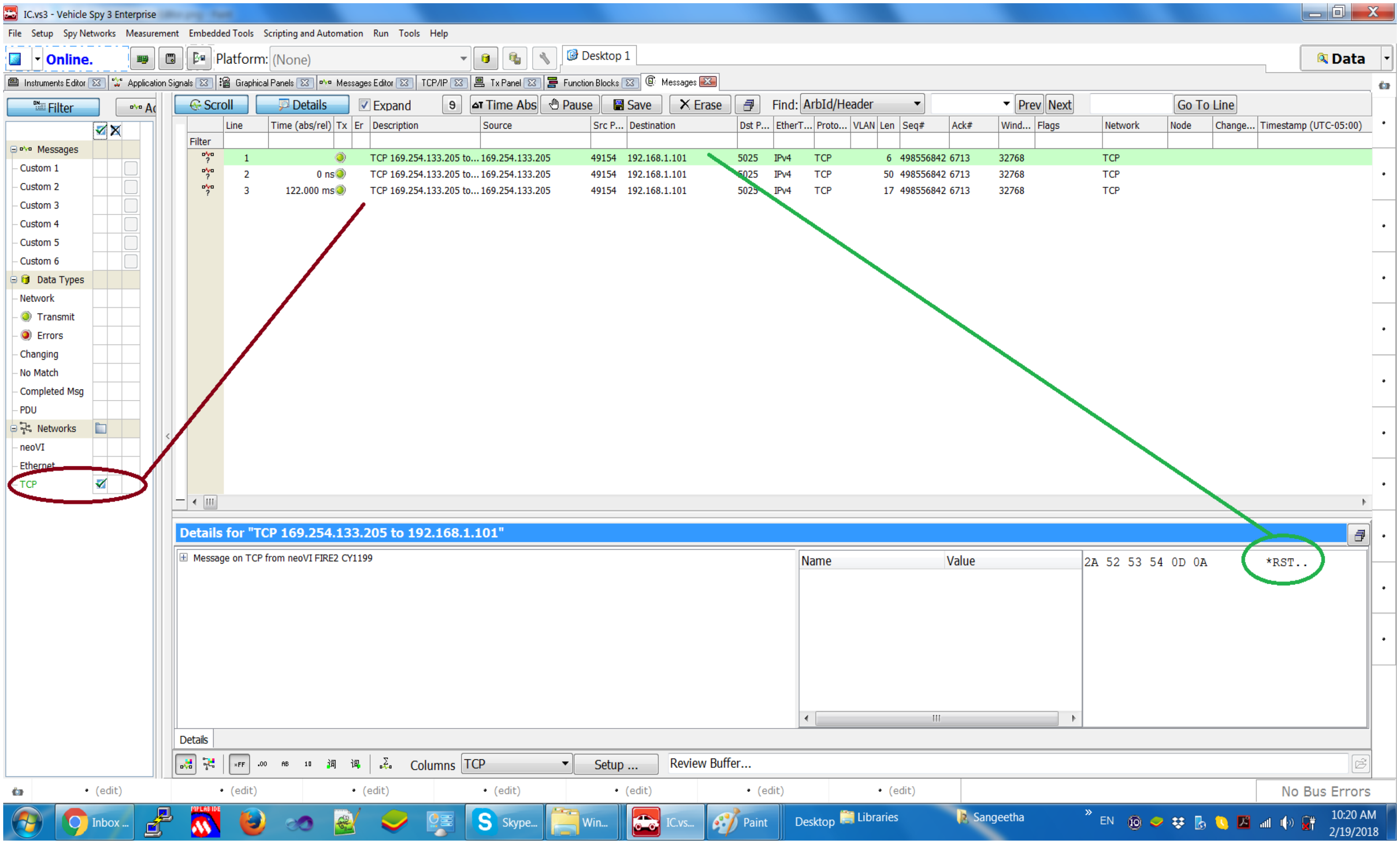
```
(Connect "N7973A", "TCPIP0::192.168.2.102::inst0::INSTR", "APS - Advanced Power System / A.01.13")
:OUTPut:STATe 1
:INITiate:TRANsient
:TRIGger:ARB:SOURce BUS
*TRG
```

SCPI Command File to Trigger the sequence

Example of complex waveform data file

```
(Connect "N7972A", "TCPIP0::192.168.1.101::inst0::INSTR", "APS - Advanced Power System / A.01.13")
*RST
*CLS
:SOURce:FUNCtion VOLTAGE
:SOURce:ARB:FUNCtion:TYPE VOLTage
:SOURce:VOLTage:MODE ARB
:SOURce:ARB:COUNt 1
:SOURce:CURRent:LIMit:POSitive:IMMediate:AMPLitude 1
:SOURce:ARB:VOLTage:CDWell:LEVel
12,12,12,12,12,12,12,12,12,12,12,12,12,12,12,12,12,12,12,12,12,12,12,12,12,12,12,12,12,12,12,12,12,1
12,12,12,12,12,12,12,12,12,12,12,12,12,12,12,12,12,12,12,12,12,12,12,12,12,12,12,12,12,12,12,12,12,1
8,8.6,8.4,8.2,8,7.8,7.6,7.4,7.2,7,6.8,6.6,6.4,6.2,6,5.8,5.6,5.4,5.2,5,4.8,4.6,4.4,4.2,4,4,4,4,4,4,4,
875,7.15,7.4125,7.675,7.9375,8.2,8.4625,8.725,8.9875,9.25,9.237692308,9.225384616,9.213076924,9.2007
5388,9.102307696,9.090000004,9.077692312,9.06538462,9.053076928,9.040769236,9.028461544,9.016153852,
917692316,8.905384624,8.893076932,8.88076924,8.868461548,8.856153856,8.843846164,8.831538472,8.81923
936,8.720769244,8.708461552,8.69615386,8.683846168,8.671538476,8.659230784,8.646923092,8.6346154,8.6
36153864,8.523846172,8.51153848,8.499230788,8.486923096,8.474615404,8.462307712,8.45000002,8.4376923
84,8.339230792,8.3269231,8.314615408,8.302307716,8.290000024,8.277692332,8.26538464,8.253076948,8.24
4615412,8.14230772,8.130000028,8.117692336,8.105384644,8.093076952,8.08076926,8.068461568,8.05615387
```

What does it look like in Messages View



Configure Vehicle Spy for Instrument Control

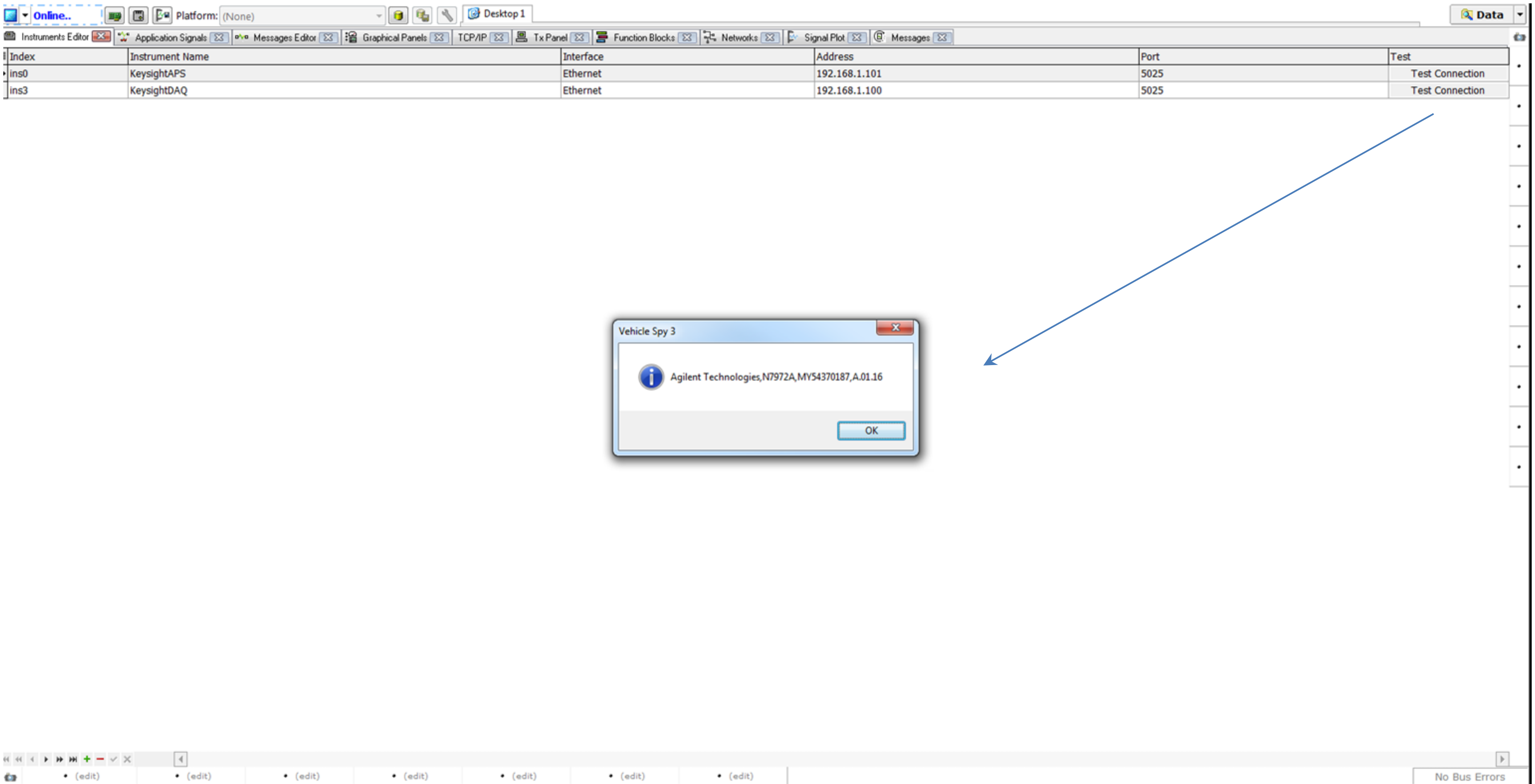
- You can easily configure Vehicle Spy for Instrument Control. Below are the Interfaces you need!

  ✓ Instruments Editor (Add your Instruments)

  ✓ Function Blocks (Add your commands)

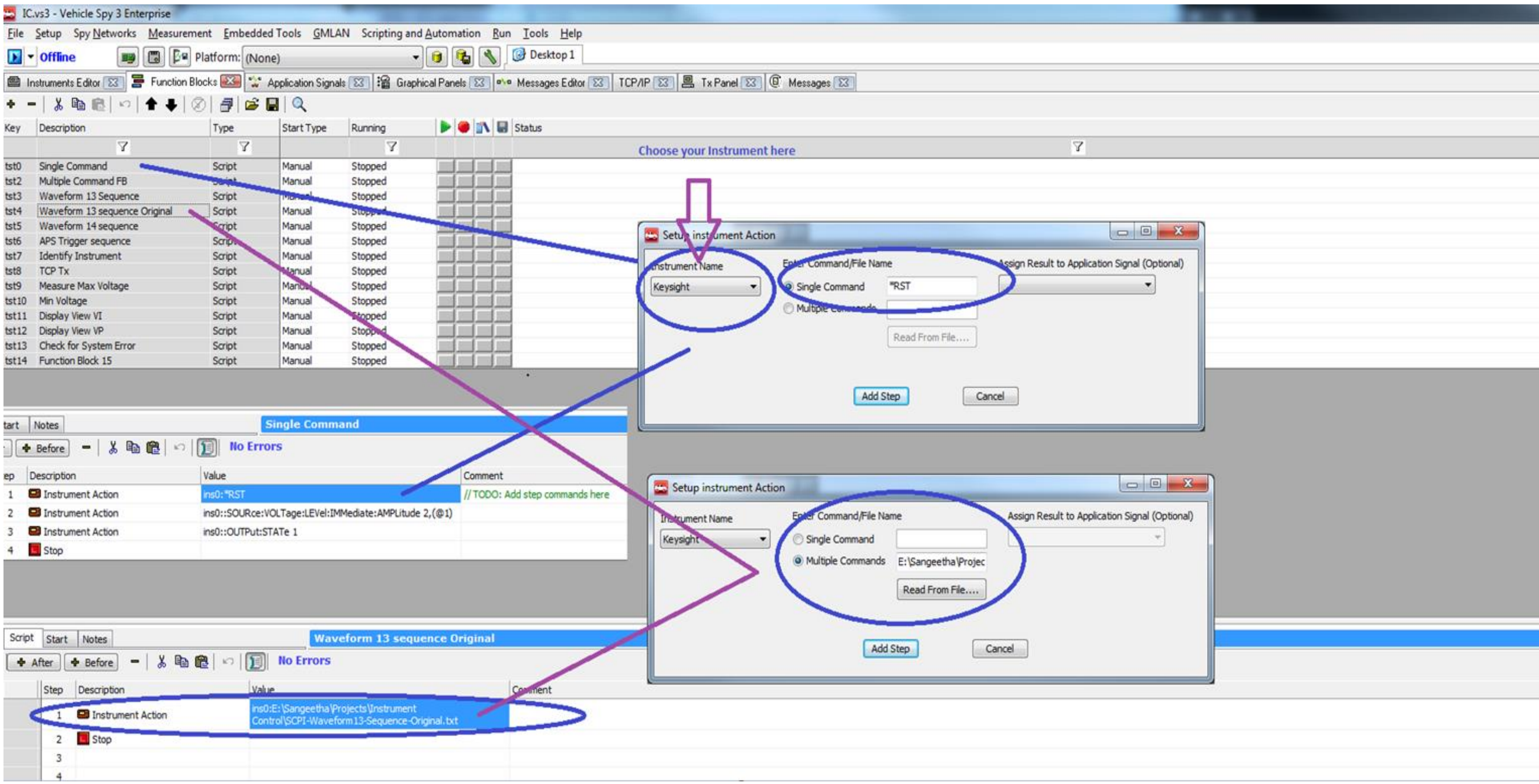
  ✓ Graphical Panels (Make it User Interactive)

1). Add your Instruments



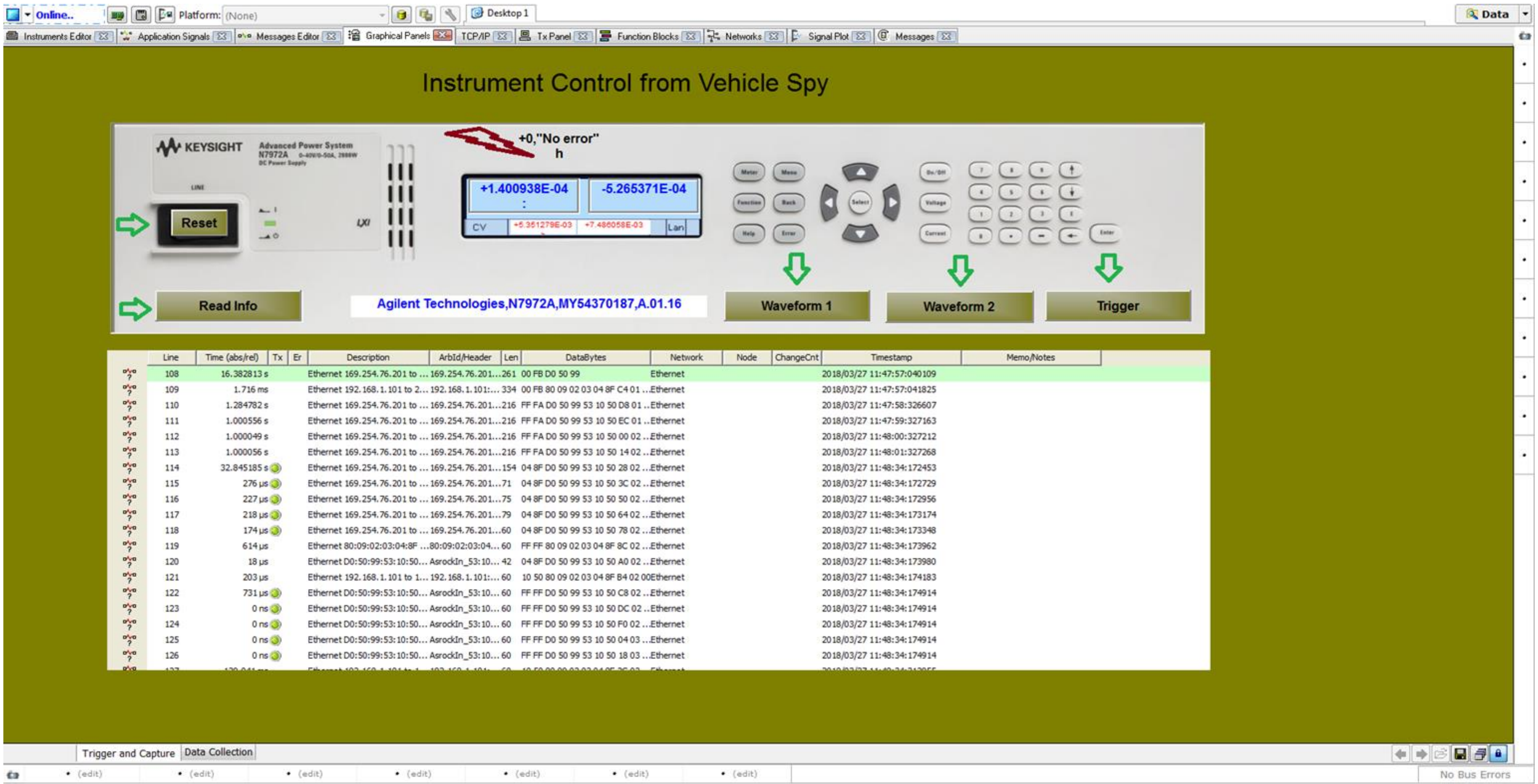
Vehicle Spy Version v3.8.3.xx

2). Create Function Blocks

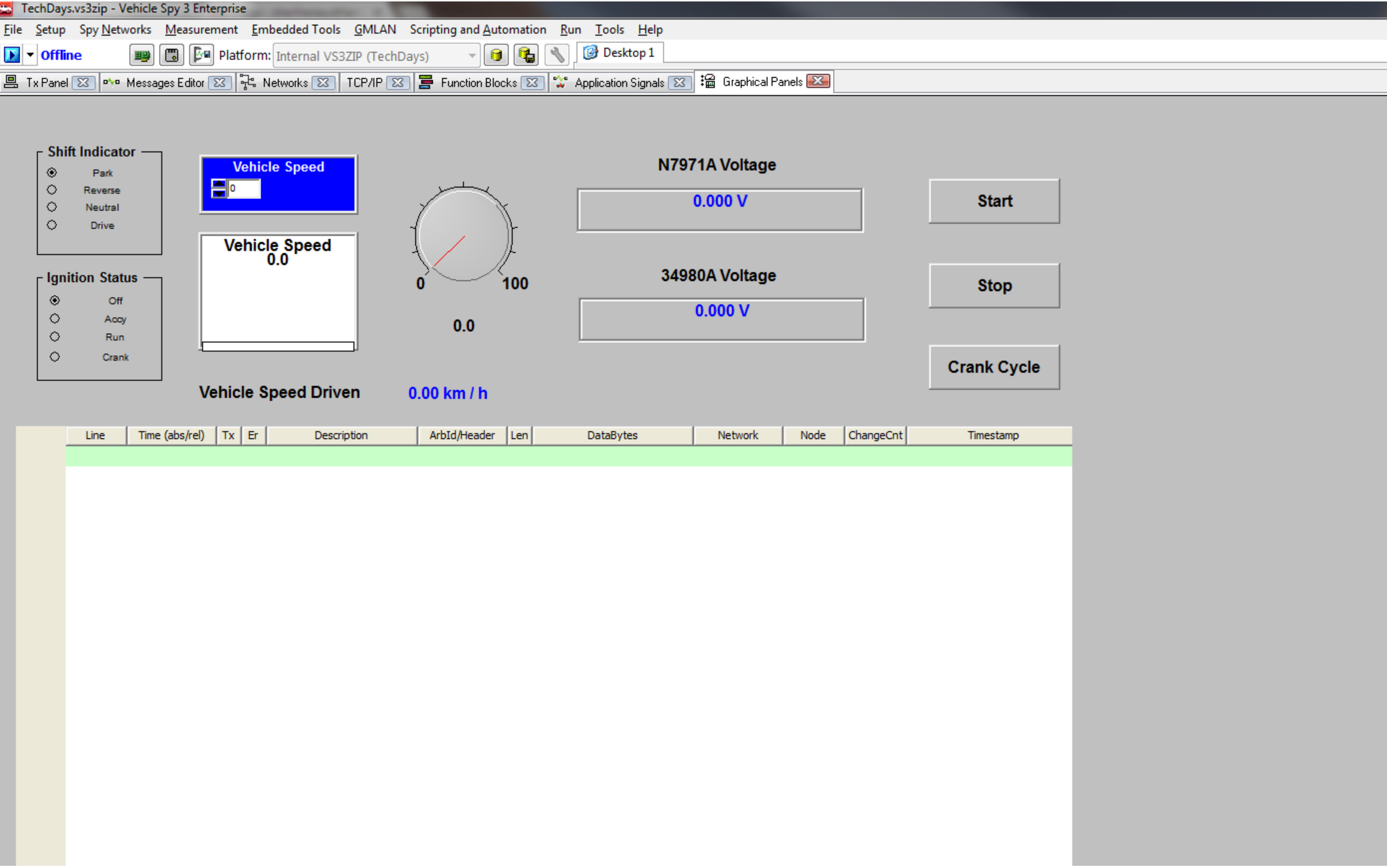


Vehicle Spy Version v3.8.3.xx

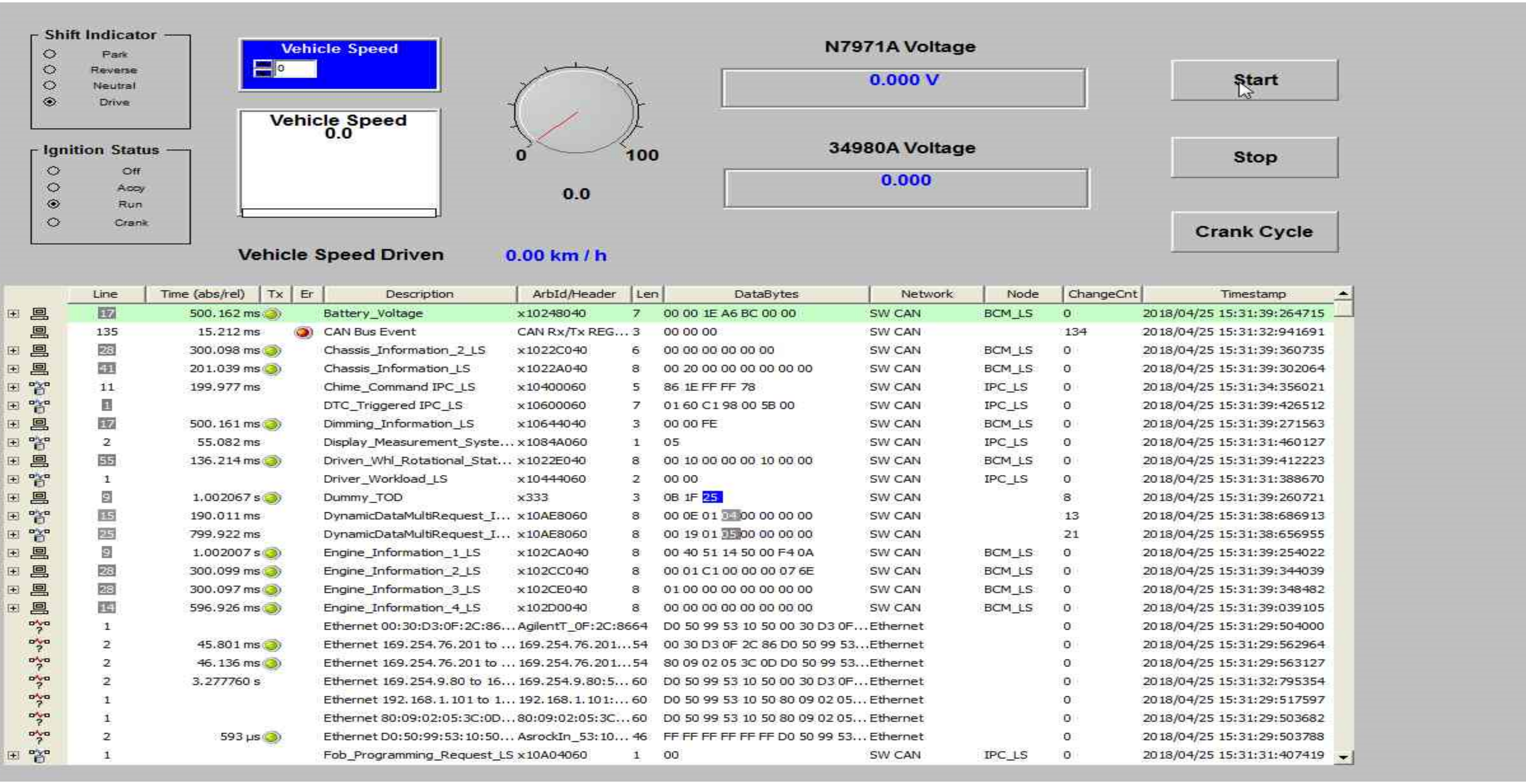
Create Graphical Panels



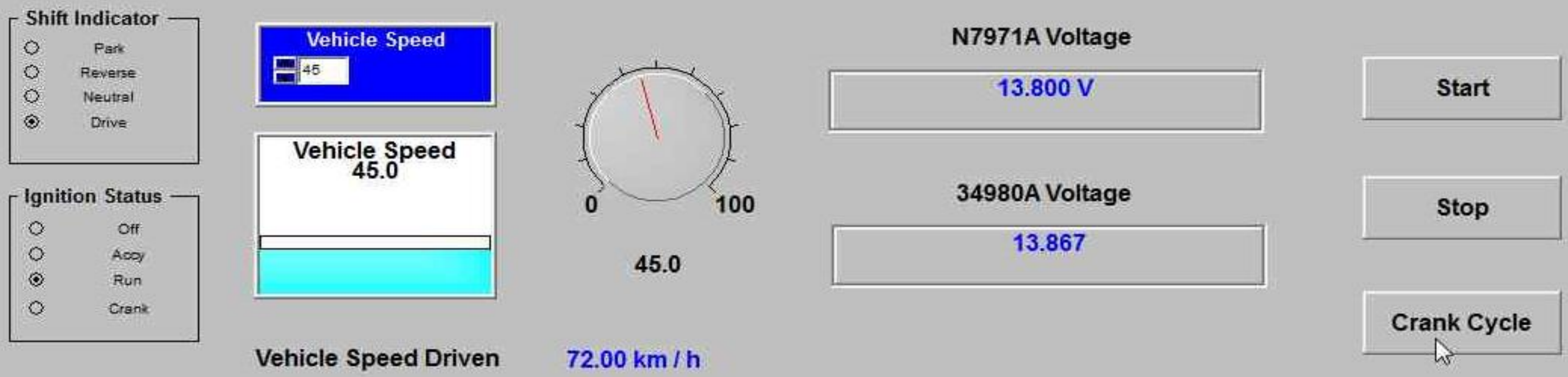
Vehicle Spy Version v3.8.3.xx


TechDays.vs3zip - Vehicle Spy 3 Enterprise
File Setup Spy Networks Measurement Embedded Tools GMLAN Scripting and Automation Run Tools Help
Offline
Platform: Internal VS3ZIP (TechDays)
Desktop 1
Tx Panel
Messages Editor
Networks
TCP/IP
Function Blocks
Application Signals
Graphical Panels
Shift Indicator
Park
Reverse
Neutral
Drive
Ignition Status
Off
Accy
Run
Crank
Vehicle Speed
0
Vehicle Speed
0.0
0
100
0.0
N7971A Voltage
0.000 V
34980A Voltage
0.000 V
Start
Stop
Crank Cycle
Vehicle Speed Driven
0.00 km / h
Line
Time (abs/rel)
Tx
Er
Description
ArbId/Header
Len
DataBytes
Network
Node
ChangeCnt
Timestamp

Run your Application

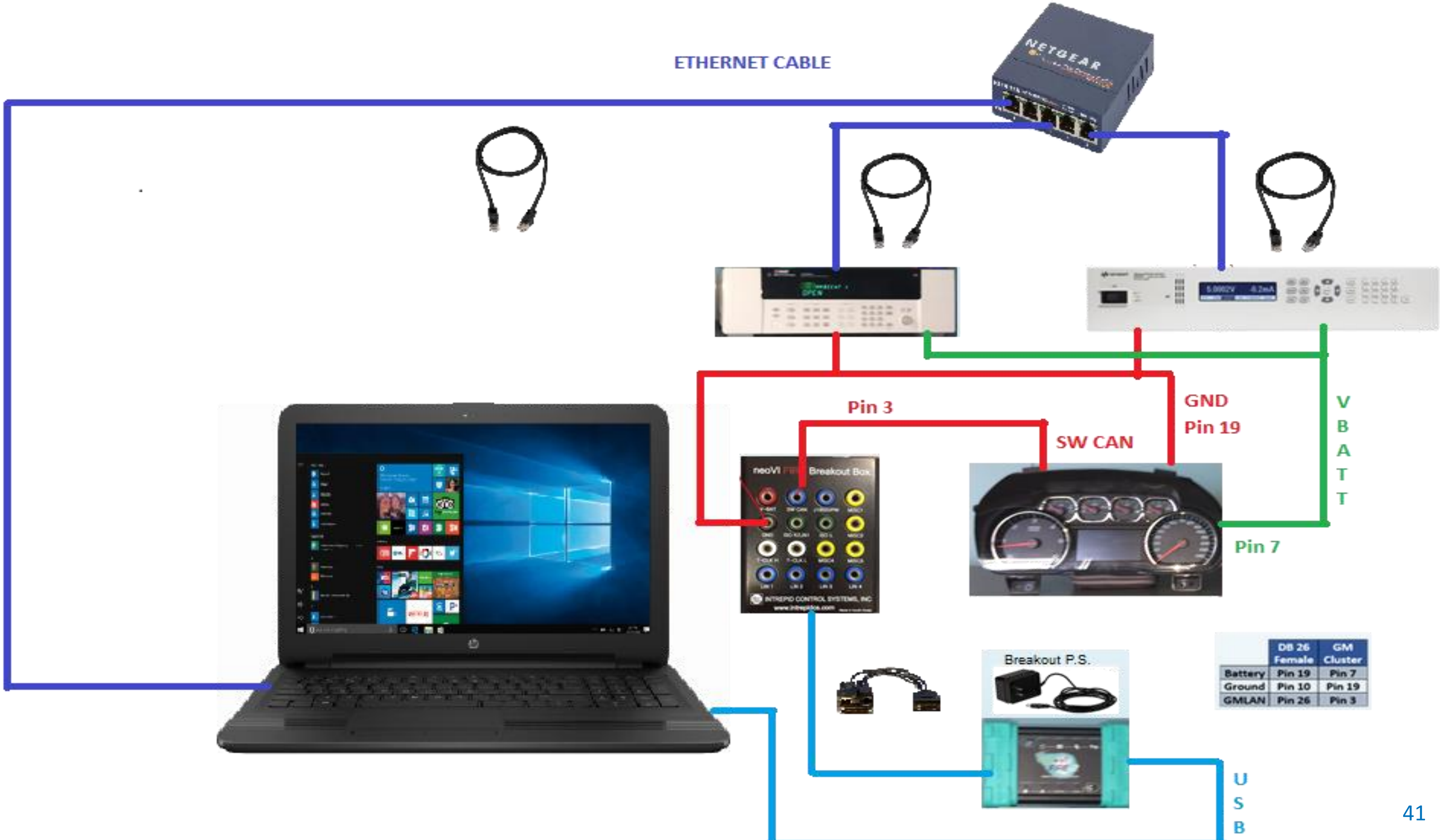


Line	Time (abs/rel)	Tx	Er	Description	ArbId/Header	Len	DataBytes	Network	Node	ChangeCnt	Timestamp
17	500.162 ms			Battery_Voltage	x10248040	7	00 00 1E A6 BC 00 00	SW CAN	BCM_LS	0	2018/04/25 15:31:39:264715
135	15.212 ms			CAN Bus Event	CAN Rx/Tx REG...	3	00 00 00	SW CAN		134	2018/04/25 15:31:32:941691
28	300.098 ms			Chassis_Information_2_LS	x1022C040	6	00 00 00 00 00 00	SW CAN	BCM_LS	0	2018/04/25 15:31:39:360735
41	201.039 ms			Chassis_Information_LS	x1022A040	8	00 20 00 00 00 00 00 00	SW CAN	BCM_LS	0	2018/04/25 15:31:39:302064
11	199.977 ms			Chime_Command IPC_LS	x10400060	5	86 1E FF FF 78	SW CAN	IPC_LS	0	2018/04/25 15:31:34:356021
1				DTC_Triggered IPC_LS	x10600060	7	01 60 C1 98 00 5B 00	SW CAN	IPC_LS	0	2018/04/25 15:31:39:426512
17	500.161 ms			Dimming_Information_LS	x10644040	3	00 00 FE	SW CAN	BCM_LS	0	2018/04/25 15:31:39:271563
2	55.082 ms			Display_Measurement_Syste...	x1084A060	1	05	SW CAN	IPC_LS	0	2018/04/25 15:31:31:460127
55	136.214 ms			Driven_Whl_Rotational_Stat...	x1022E040	8	00 10 00 00 00 10 00 00	SW CAN	BCM_LS	0	2018/04/25 15:31:39:412223
1				Driver_Workload_LS	x10444060	2	00 00	SW CAN	IPC_LS	0	2018/04/25 15:31:31:388670
9	1.002067 s			Dummy_TOD	x333	3	0B 1F 25	SW CAN		8	2018/04/25 15:31:39:260721
15	190.011 ms			DynamicDataMultiRequest_I...	x10AE8060	8	00 0E 01 04 00 00 00 00	SW CAN		13	2018/04/25 15:31:38:686913
25	799.922 ms			DynamicDataMultiRequest_I...	x10AE8060	8	00 19 01 05 00 00 00 00	SW CAN		21	2018/04/25 15:31:38:656955
9	1.002007 s			Engine_Information_1_LS	x102CA040	8	00 40 51 14 50 00 F4 0A	SW CAN	BCM_LS	0	2018/04/25 15:31:39:254022
28	300.099 ms			Engine_Information_2_LS	x102CC040	8	00 01 C1 00 00 00 07 6E	SW CAN	BCM_LS	0	2018/04/25 15:31:39:344039
28	300.097 ms			Engine_Information_3_LS	x102CE040	8	01 00 00 00 00 00 00 00	SW CAN	BCM_LS	0	2018/04/25 15:31:39:348482
14	596.926 ms			Engine_Information_4_LS	x102D0040	8	00 00 00 00 00 00 00 00	SW CAN	BCM_LS	0	2018/04/25 15:31:39:039105
1				Ethernet 00:30:D3:0F:2C:86...	AgilentT_0F:2C:86	64	D0 50 99 53 10 50 00 30 D3 0F...	Ethernet		0	2018/04/25 15:31:29:504000
2	45.801 ms			Ethernet 169.254.76.201 to ...	169.254.76.201...	54	00 30 D3 0F 2C 86 D0 50 99 53...	Ethernet		0	2018/04/25 15:31:29:562964
2	46.136 ms			Ethernet 169.254.76.201 to ...	169.254.76.201...	54	80 09 02 05 3C 0D D0 50 99 53...	Ethernet		0	2018/04/25 15:31:29:563127
2	3.277760 s			Ethernet 169.254.9.80 to 16...	169.254.9.80:5...	60	D0 50 99 53 10 50 00 30 D3 0F...	Ethernet		0	2018/04/25 15:31:32:795354
1				Ethernet 192.168.1.101 to 1...	192.168.1.101:...	60	D0 50 99 53 10 50 80 09 02 05...	Ethernet		0	2018/04/25 15:31:29:517597
1				Ethernet 80:09:02:05:3C:0D...	80:09:02:05:3C...	60	D0 50 99 53 10 50 80 09 02 05...	Ethernet		0	2018/04/25 15:31:29:503682
2	593 µs			Ethernet D0:50:99:53:10:50...	AsrockIn_53:10...	46	FF FF FF FF FF FF D0 50 99 53...	Ethernet		0	2018/04/25 15:31:29:503788
1				Fob_Programming_Request_LS	x10A04060	1	00	SW CAN	IPC_LS	0	2018/04/25 15:31:31:407419



Line	Time (abs/rel)	Tx	Er	Description	ArbId/Header	Len	DataBytes	Network	Node	ChangeCnt	Timestamp
62	496.606 ms				x10248040	7	00 00 1E A6 BC 00 00	SW CAN	BCM_LS	0	2018/04/25 15:32:01:838120
135	15.212 ms				CAN Rx/Tx REG...	3	00 00 00	SW CAN		134	2018/04/25 15:31:32:941691
103	302.815 ms				x1022C040	6	00 00 00 00 00 00	SW CAN	BCM_LS	0	2018/04/25 15:32:01:925114
154	196.616 ms				x1022A040	8	00 20 00 00 00 00 00 00	SW CAN	BCM_LS	0	2018/04/25 15:32:02:087527
38	835.243 ms				x10400060	5	86 28 01 FF 58	SW CAN	IPC_LS	1	2018/04/25 15:32:01:725836
7	1.524902 s				x10600060	7	01 60 93 70 06 5B 00	SW CAN	IPC_LS	6	2018/04/25 15:31:48:571294
62	496.608 ms				x10644040	3	00 00 FE	SW CAN	BCM_LS	0	2018/04/25 15:32:01:844968
2	55.082 ms				x1084A060	1	05	SW CAN	IPC_LS	0	2018/04/25 15:31:31:460127
205	149.227 ms				x1022E040	8	00 10 00 00 00 10 00 00	SW CAN	BCM_LS	0	2018/04/25 15:32:02:044582
1					x10444060	2	00 00	SW CAN	IPC_LS	0	2018/04/25 15:31:31:388670
31	1.007836 s				x333	3	0B 1F 3B	SW CAN		30	2018/04/25 15:32:01:303314
33	56.953 ms				x10AE8060	8	00 0E 01 05 00 00 00 00	SW CAN		29	2018/04/25 15:31:57:720577
54	30.038 ms				x10AE8060	8	00 19 01 05 00 00 00 00	SW CAN		45	2018/04/25 15:31:57:631603
31	1.003392 s				x102CA040	8	00 40 51 14 50 00 F4 0A	SW CAN	BCM_LS	0	2018/04/25 15:32:01:292232
103	302.815 ms				x102CC040	8	00 01 C1 00 00 00 07 6E	SW CAN	BCM_LS	0	2018/04/25 15:32:01:908417
103	302.815 ms				x102CE040	8	01 00 00 00 00 00 00 00	SW CAN	BCM_LS	0	2018/04/25 15:32:01:912862
52	595.683 ms				x102D0040	8	00 00 00 00 00 00 00 00	SW CAN	BCM_LS	0	2018/04/25 15:32:01:877552
1					AgilentT_0F:2C:8664		D0 50 99 53 10 50 00 30 D3 0F...	Ethernet		0	2018/04/25 15:31:29:504000
126	214.037 ms				169.254.76.201...	90	00 30 D3 0F 2C 86 D0 50 99 53...	Ethernet		0	2018/04/25 15:32:00:454444
389	5.927 ms				169.254.76.201...	54	80 09 02 05 3C 0D D0 50 99 53...	Ethernet		0	2018/04/25 15:32:00:405102
196	14.260 ms				169.254.9.80:5...	70	D0 50 99 53 10 50 00 30 D3 0F...	Ethernet		0	2018/04/25 15:32:00:409044
210	188.101 ms				192.168.1.101:...	68	D0 50 99 53 10 50 80 09 02 05...	Ethernet		0	2018/04/25 15:32:00:275286
1					80:09:02:05:3C...	60	D0 50 99 53 10 50 80 09 02 05...	Ethernet		0	2018/04/25 15:31:29:503682
2	593 µs				AsrockIn_53:10...	46	FF FF FF FF FF FF D0 50 99 53...	Ethernet		0	2018/04/25 15:31:29:503788
1					x10A04060	1	00	SW CAN	IPC_LS	0	2018/04/25 15:31:31:407419

The Demo System



	DB 26 Female	GM Cluster
Battery	Pin 19	Pin 7
Ground	Pin 10	Pin 19
GMLAN	Pin 26	Pin 3

Questions?

Please visit the Intrepid Small Instrument table for a demo and additional information.
Also please visit our partner Keysight to view hardware

Please visit https://www.intrepidcs.com/SCPI for more details.