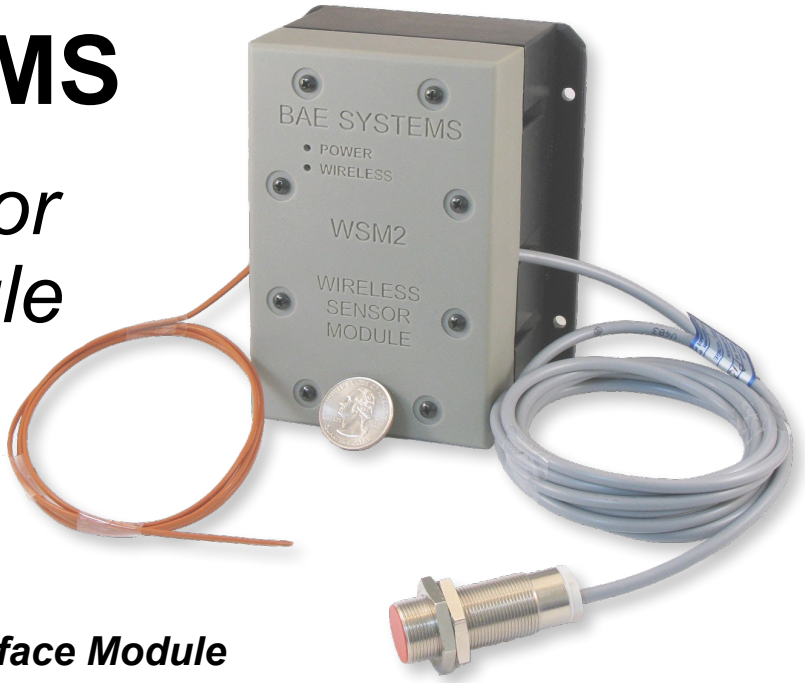
BAE SYSTEMS

BAE Systems has developed a Wireless Sensor Module (WSM) for health and usage monitoring applications. The WSM has an advanced analog front end and can interface with almost any sensor (temperature, pressure, vibration, acoustic, etc). It is designed for low power operation and includes an integrated battery pack and innovative features to minimize power usage. If an external power source is available, the battery module can be replaced with a power conditioning module to accept vehicle power. The unit incorporates a ZigBee wireless transceiver so that it can off-load data or be programmed wirelessly. If wireless is not desirable, the wireless module can be un-populated and data can be off-loaded or the unit can be reprogrammed with a standard USB interface to a laptop. The newest version of the WSM, termed the DSM (DSP Sensor Module), includes a low power DSP so that complex data processing algorithms can be hosted on the DSM. This allows large quantities of sensor data to be reduced to key health features on the device.

BAE SYSTEMS

Wireless Sensor Interface Module

WSM / DSM



ZigBee Wireless Sensor Interface Module

- Supports TC, RTD, Pressure, Flow, Strain & Proximity Sensors
- Supports ICP Accelerometers using Low Noise Coax Connections
- 4 Independent Sensor Channels based on Wheatstone Bridge
  - Allows for Quarter, Half or Full Bridge Configurations
  - Programmable Constant Current Source Sensor Excitation
  - Logs Sensor Data using Per Channel User Specifiable Rates
  - Universal Input Channel Design supports Almost Any Sensor Type*
- 2 Accelerometer Channels with Variable Gain/Cutoff AntiAlias Filters
- Power/Wireless LEDs indicate Current WSM/DSM Operational State

* Contact BAE Systems with your specific sensor type requirements

WSM / DSM Features

- Wireless ZigBee/IEEE 802.15.4 Compliant
- 0 dBm RF Transmit Power achieves up to 100' Urban Range
- 4 MByte Data Logging Flash Memory
- Battery Backed Real-Time Clock with Scheduled Logging Options
- Dual 3.6V D-Cell Lithium Batteries or Vehicle Powered Option
- Low Sleep Power achieves Extended Battery Life
- USB 2.0 Interface for WSM/DSM Maintenance and Configuration
- Wide Temperature Range Operation for Harsh Environments
- Rugged Urethane Boot Cover provides High Water Resistance
- Anodized Aluminum Base provides Secure Vehicle Attachment
- Sensor Cables Feed to Screw Terminals under Protective Boot

WSM / DSM Features

WSM / DSM Standard Supported Sensors

- TC (Thermocouple)
  - Types: E, J, K, N, R, S, T
  - Ranges: −25C to +50C, −50C to +100C, −100C to +200C, −200C to +400C, −200C to +800C
- RTD
  - Types: Pt100-385, Pt200-385, Pt100-3926, Ni120-672
  - Configurations: 2-Wire, 3-Wire, 4-Wire
  - Ranges: −100C to +100C, −200C to +400C
- Strain
  - Types: 1Kohm / GF=2
  - Configurations: Quarter, Half, Full Bridge
  - Ranges: ±125με, ±250με, ±500με
- Analog Voltage
  - Configurations: Bipolar, Unipolar, Logic
  - Ranges:
    - Bipolar: ±0.1V, ±0.2V, ±0.5V, ±1.0V, ±2.5V
    - Unipolar: 0.2V, 0.4V, 1.0V, 2.0V, 5.0V
    - Logic: 3.3V, 5V, 12V
- Pressure
  - Types: Gage, Absolute, Differential, Vacuum
  - Configurations: Full Bridge, Customized*
  - Models: Omega PX180B, Customized*
  - Ranges: 0PSI to 40PSI / 100PSI, Customized*
- Proximity
  - Types: Inductive w/Open Collector*
  - Configurations: 3-Wire / PNP, NPN
  - Models: Omega PRX102-18P/N, Customized*
- Accelerometer
  - Types: ICP
  - Configurations: Peak-G, Fundamental Frequency
  - Models: Endevco 7251A, IMI 608A11, Customized*
- Standard 4-20 mA
  - Ranges: 0mA to 10mA, 0mA to 20mA

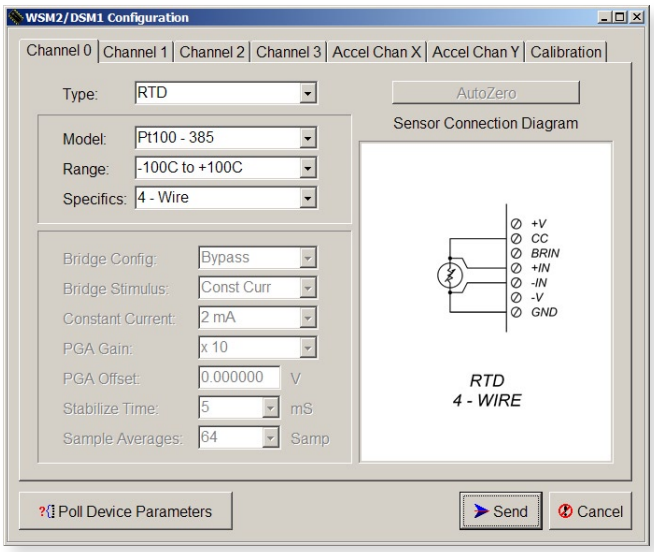
* Contact BAE Systems with your specific sensor type requirements

DSM1 with Top Boot Removed shows USB 2.0 Mini-B Configuration Connector and Sensor Cable Exit Channels

WSM / DSM Unique Functionality

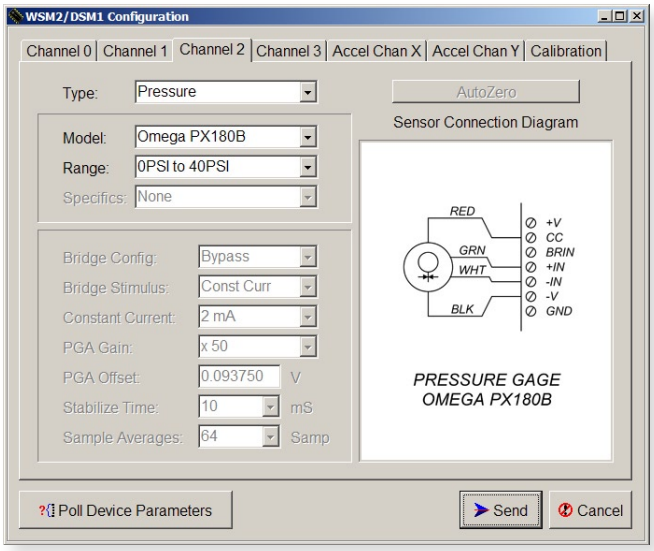
- Independent Channels allow configuring 4 Different Sensor Types on a single DSM Unit
- Floating Differential Input Channels provide Isolation and High CMRR for Attached Sensors
- 7-Screw Terminal Channel Connector leverages attachment of Various Sensor Types
- Selectable Ranges for TCs provide Cold Junction Compensated Hi-Resolution Dynamic Ranging
- Selectable Ranges for RTD, Strain and Analog Voltage Sensors increases Readout Resolution
- Modular Top Section allows powering from either Battery or Vehicle Power Bottom Section
- Optional API Development Library allows user to create Custom DSP Firmware Scripts

WSM / DSM Configuration Software



Key Features

- Intuitive Configuration Screens
- Immediate Updates of the Device
- Configures Device via USB or Wireless
- Settings are retained within the Device's NonVolatile Memory



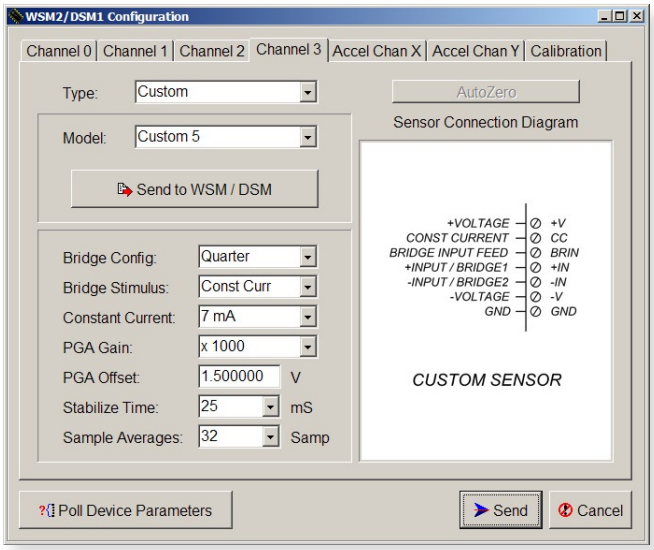
Standard Sensors

- Convenient On-Screen Sensor Connection Wiring Diagrams
- Separate Tab for each Sensor Channel
- Allows Selection of various Models, Ranges & Specifics for each Sensor Type
- Displays Internal Device Channel Parametrics Setup

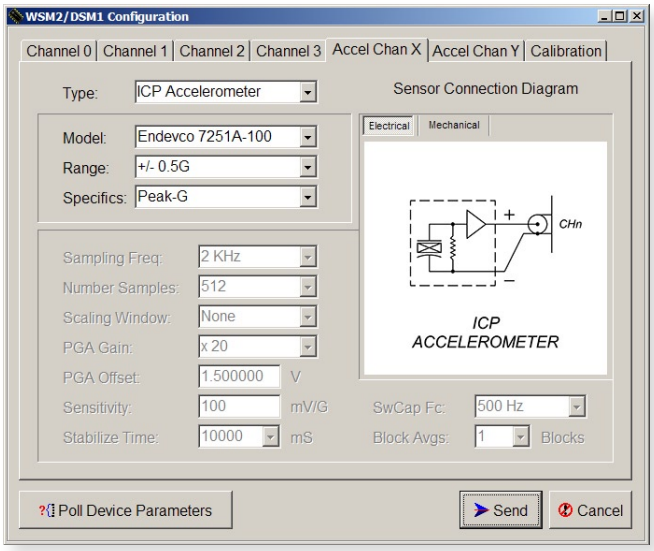
Custom Sensors

- Allows User to directly set up Sensor Channel Parametrics
- 8 Custom Profiles can be stored directly within the Device
- Custom Profiles are available across all Sensor Channels
- Device provides Raw A/D Voltages or Customized Scaling / Linearization for each Custom Sensor Model*

* Contact BAE Systems with your specific sensor support requirements

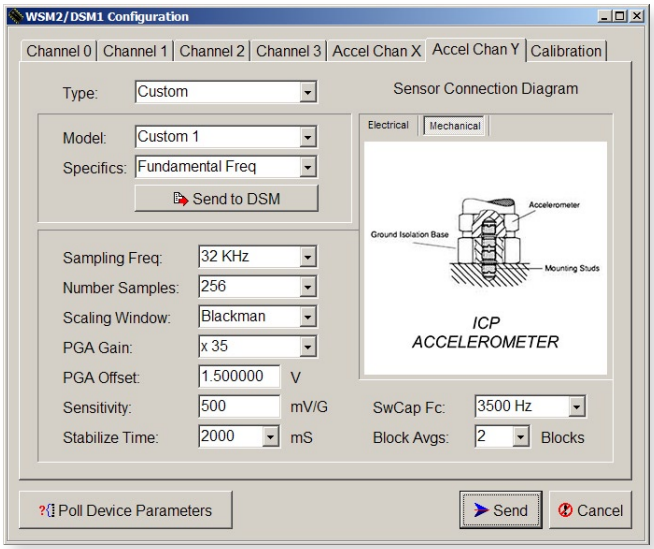


WSM / DSM Configuration Software



Standard Accelerometers

- Separate Tab for each Accelerometer
- Allows Selection of various Models, Ranges & Parametric Specifics for each Accelerometer Type
- Displays Internal Device Accelerometer Channel Parametrics

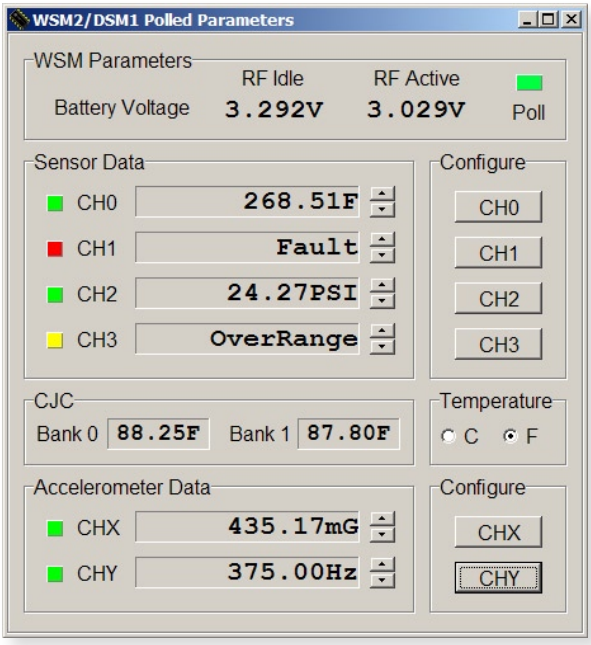


Custom Accelerometers

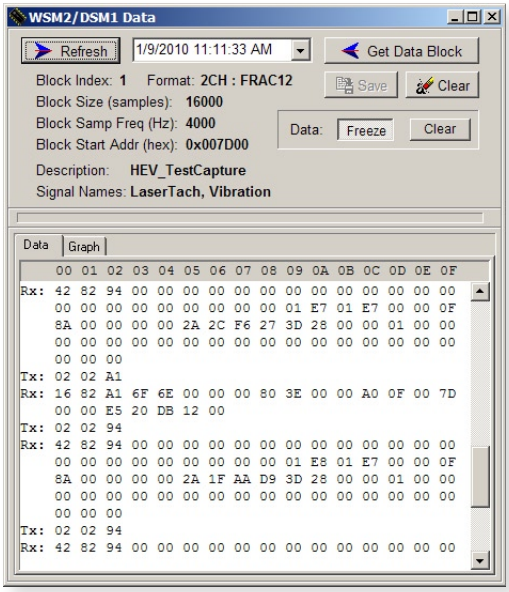
- Allows User to directly set up Device Accelerometer Channel Parametrics
- 8 Custom Profiles can be stored directly within the Device
- Custom Profiles are available across all Accelerometer Channels
- Device provides Specific Formulated Parameter in G -or- Hz units

Sensor/Accelerometer Polling Dialog

- Poll and View All Sensor Parametric Values via USB or Wireless
- *Quick-Scale* Up/Down Arrows for each Channel Value with 10^3 Incr/Decr
- Per Channel Fault/OverRange Indicators
- Battery Voltage / Polling Indicators
- Cold Junction Compensation Temperatures for CH0/1 (Bank 0) and CH2/3 (Bank 1)
- Convenient *Quick-Launch* Configuration Buttons for All Channels

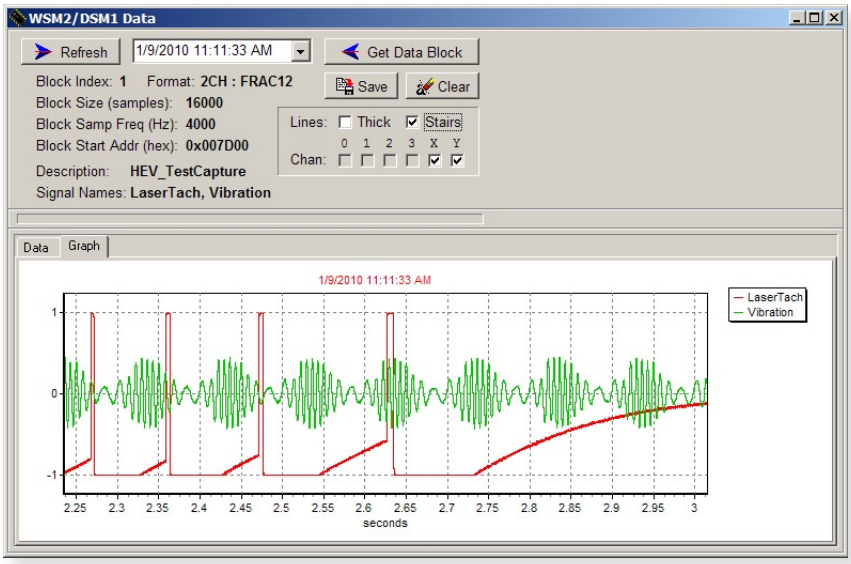


WSM / DSM
Raw Data Capture



Capture Raw Signal Channel Waveforms

- Multiple Raw Data Block Capture Capability
- Access Data via Wireless or USB
- Display of Block Capture Statistics
- Descriptions / Signal Names as defined within User Defined Script
- Zoomable / Panable Multi-Channel Plots
- Individual Channel Plot Enables

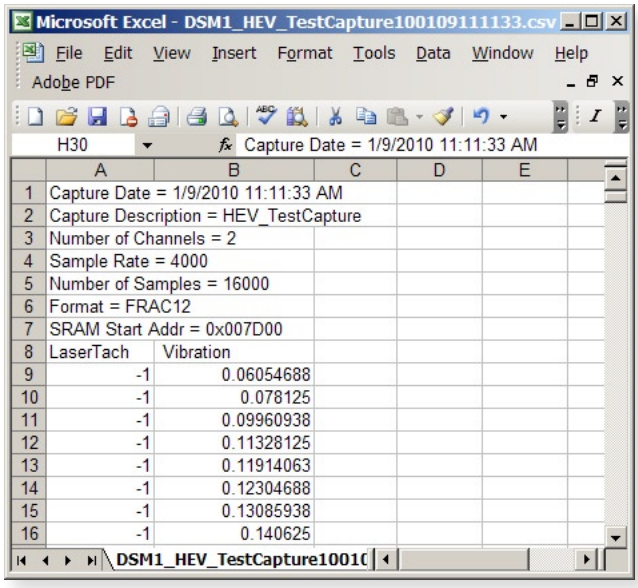


View Device Comm Traffic

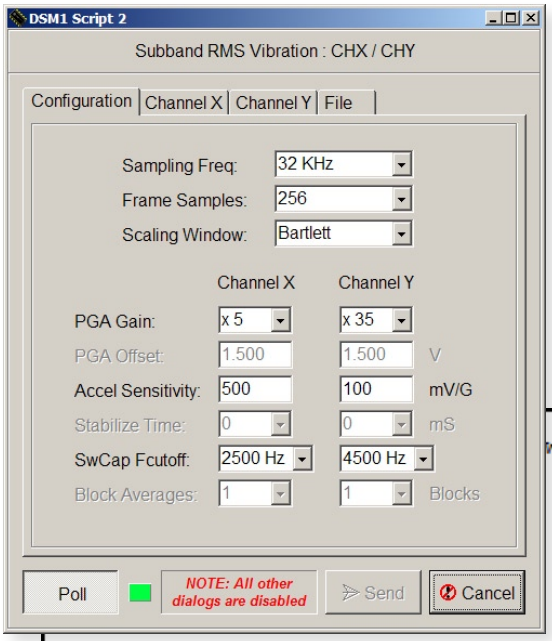
- Displays RealTime Update of all Communication Data
- Convenient Development Aid during Script Development
- Data Trace Freeze and Clear

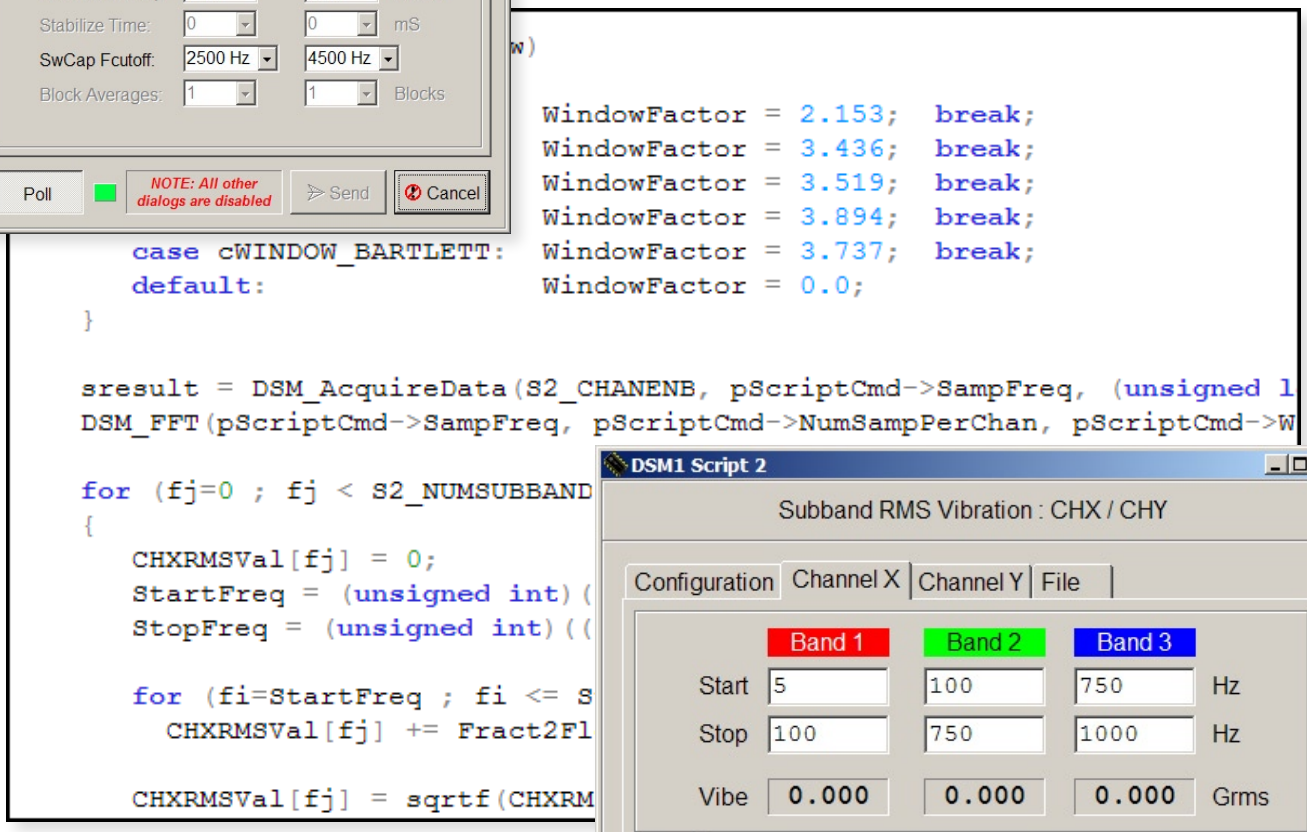
Export Raw Data Files into MS Excel

- Date / Time Stamped Raw Data Block Capture Statistics Header
- Raw Data from all Enabled Channels appears within Separate Columns
- .CSV Standard File Format
- Automatically Generated Optional Default Filenames
- Floating Point Precision based on User Specified Engineering Units

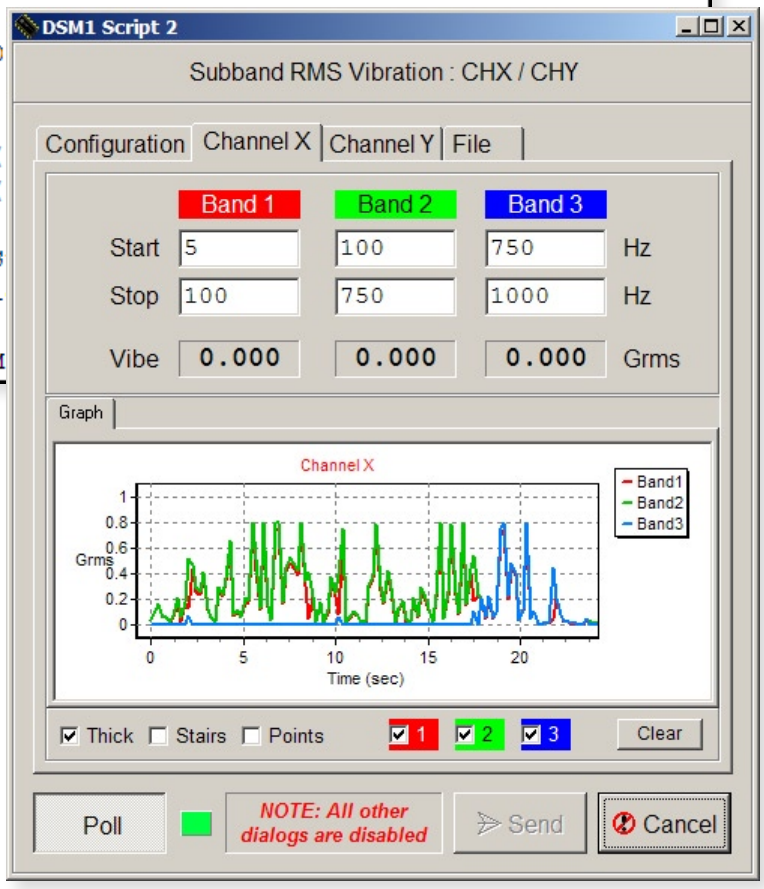


WSM / DSM Custom DSP Scripts





```
w)

                                WindowFactor = 2.153;  break;
                                WindowFactor = 3.436;  break;
                                WindowFactor = 3.519;  break;
                                WindowFactor = 3.894;  break;
    case cWINDOW_BARTLETT:      WindowFactor = 3.737;  break;
    default:                    WindowFactor = 0.0;
}

sresult = DSM_AcquireData(S2_CHANENB, pScriptCmd->SampFreq, (unsigned l
DSM_FFT(pScriptCmd->SampFreq, pScriptCmd->NumSampPerChan, pScriptCmd->W

for (fj=0 ; fj < S2_NUMSUBBAND
{
    CHXRMSVal[fj] = 0;
    StartFreq = (unsigned int)(
    StopFreq = (unsigned int)((

    for (fi=StartFreq ; fi <= S
      CHXRMSVal[fj] += Fract2Fl

    CHXRMSVal[fj] = sqrtf(CHXRM
```



Execute Custom User Scripts

- OnBoard DSP Allows for Custom Scripts to be Executed in Real-Time and perform User Specific Processing

Link to Custom User GUIs

- Allows Support for Various Custom Designed GUIs

WSM / DSM API Library

WSM2 / DSM1 Technical Specifications (Preliminary)

General

- Power Requirements -		
Battery Power:	**2.5VDC to 5.5VDC**	**: 440µA typ @ 3.6V (Idle - Sleep)**
		: 280mA typ @ 3.6V (Sensors Active)[1]
		: 90mA typ @ 3.6V (Sensors Inactive)[2]
Isolated Vehicle Power:	**5VDC to 24VDC**	**: *tbd*µA typ @ 12V (Idle - Sleep)**
		: *tbd*mA typ @ 12V (Sensors Active)[1]
Wireless:	**IEEE 802.15.4 Compliant : 2.4GHz : 250Kb/s Raw**	
	0dBm Transmit Power : 2dBi Chip Antenna	
Enclosure:	**ABS Sensor Interface Module : Black color**	
	Aluminum Battery Compartment : Black Anodize	
	Urethane Boot : Red color	
User Interface:	**WSM/DSM Power/Wireless LEDs ► Red/Yel/Grn**	
USB Interface:	**v2.0 Compliant, Full Speed (12Mb/s)**	
	Type-MiniB (Peripheral) Connector	
	Bus powered device @ 500mA peak	
Firmware Upgrade Support:	**Flashable program memory via USB or Wireless**	
Enclosure Dimensions:	**4.9″L x 3.2″W x 2.7″H w/ 0.4″W Mounting Flanges**	
Battery(s):	**Dual 3.6V Lithium D-Cell : 19Ah each**	
	***tbd*hr full-charge duration typ[3]**	
Battery(s) Connector:	**Molex SL Series : PN 70543-0001**	
- Weight -		
Battery Power Unit:	**approx 33 oz (2.06 lb)**	
Vehicle Power Unit:	**approx tbd oz**	
Environmental:	**-40C to +85C temp ambient**	
	20% to 95% RH, Non-Condensing	

[1] Average power reqt with sensor circuitry active : typ logging profile using 4 TCs
[2] Average power reqt with sensor circuitry inactive : typ logging profile using 4 TCs
[3] Based on typical WSM/DSM configuration @ 10 sec sampling of 4 TCs

Sensor Interface

Bridge:	**4 Independent Wheatstone Bridge Input Channels**	
	Isolated/Differential	**: +/-7.5V max (WSM/DSM Ground - Referenced)**
		: 15Vp-p max (WSM/DSM Ground - Floating)
	7 Terminals per Channel	**: +In/-In/BridgeIn**
		: +7.5V/-7.5V/CCStim/Gnd
		: AWG20-AWG26 nominal CSA Wire
	Internal 1Kohm +/-0.1% bridge completion resistors	
Bridge Stimulus:	**Gated Prog Const Current(CC)**	**: 10mA max per Chan**
		: 256 steps @ ~39µA resolution
	+7.5V/-7.5V Gated Constant Voltage Support[4]	
A/D:	**10-Bit : 0V to 3V : 100µS max sampling period : DC to 1KHz BW**	

[4] Contact BAE Systems for available support options

Sensor Channel Standard Parametrics

Bridge Config:	**Bypass, Quarter, Half, Full, PullDown**
Bridge Stimulus:	**Disable, Const Curr, +7.5V/-7.5V, +7.5V/Gnd**
Constant Current:	**Disable, 1mA to 10mA : 9 steps @ 1mA resolution**
PGA Gain:	**x0.5, x1, x2, x5, x10, x20, x50, x100, x125, x200, x250, x500, x1000**
PGA Offset:	**0V to 3V : 256 steps @ ~11.7mV resolution**
Stabilize Time:	**0mS to 30mS : 6 steps @ 5mS resolution**
Sample Averages:	**1, 2, 4, 8, 16, 32, 64, 128 : @ ~100µS sampling rate**

WSM/DSM Devices were designed by Yashu Systems www.yashu.com

WSM2 / DSM1 Technical Specifications (Preliminary)

ICP Accelerometer Interface

Connection:	2 Input Channels : 20Vp-p max : AC Coupled : 1.6Hz Fmin
	8 Pole Elliptic (r=1.5) SwCap LP Filter : 82dB Stopband Rejection
	10-32 Coax Connector per Channel : Tip + : Shell -
Stimulus:	3.55mA nominal Gated Const Current(CC) per Chan
	+12.5V/-7.5V (20Vp-p) Gated Voltage
A/D:	12-Bit : 0V to 3V : 500KHz max sampling rate : 1.6Hz to 5KHz BW

ICP Accelerometer Channel Standard Parametrics

Sampling Freq:	1KHz, 2KHz, 4KHz, 8KHz, 16KHz, 32KHz
Number Samples:	32, 64, 128, 256, 512
Scaling Window:	Hamming, Hanning, Blackman, Bartlett
PGA Gain:	x2, x5, x10, x20, x35
PGA Offset:	0V to 3V : 256 steps @ ~11.7mV resolution
Sensitivity:	1mV/G to 5V/G : 1mV/G resolution
Stabilize Time:	0S to 10S : 10 steps @ 1S resolution
SwCap Fc:	500Hz to 5KHz : 9 steps @ 500Hz resolution
Block Averages:	1, 2, 4, 8

Standard Sensor Support

Thermocouple:	Types: E,J,K,N,R,S,T : Any combination of types : 2 Wire Intfc
RTD:	Types: Pt100-385, Pt200-385, Pt100-3926, Ni120-672
	: Any combination of types
	2, 3 or 4 Wire Intfc
Strain Gage:	1K Ohm : GF=2 : Quarter/Half/Full Bridge
Analog Voltage:	Bipolar : Unipolar : Logic
Pressure:	Full Bridge : 4 Wire Intfc : CC/CV Stimulus Support
Accelerometer:	ICP

Standard Sensor Sampling Accuracies (-40C to +85C Unless Otherwise Specified)

Thermocouple:	+/-1%FS plus/minus 2.5DegC @ -40C to +70C ambient
	+/-1%FS plus/minus 4DegC @ +70C to +85C ambient
	-25C to +50C range only valid for -20C to +70C ambient
RTD:	+/-1%FS plus/minus 1DegC
Strain:	+/-1%FS plus/minus 2με
Analog Voltage:	+/-2%FS
Pressure:	+/-1%FS plus/minus 1PSI

Processor Engine / Peripherals

Microcontroller:	Microchip dsPIC33FJ256GP710 @ 80MHz Fosc (40 MIPS)
Memory:	Cypress 16Mb SRAM : Atmel 32Mb DataFlash
Real Time Clock:	Accuracy: +/-2min/yr typ max (1st year)
	: +/-10min/yr typ max (2nd-10th year)
	Rechargeable Battery Backed : Manganese-Lithium @ 3V, 1mAh
	Trickle charge @ 24hr full-charge time typ
	1500hr full-charge duration typ

ESD/Transient Protection

Vehicle Power:	Transorb @ 600W peak pulse, 35Vbr nom, 48V @ 12A max clamp
(Preliminary)	In case of primary protection breech, 2nd stage protection is
	60V load dump [1mS pulse & <100mS time constant typ] and
	will reset the DSP to avoid irreparable WSM/DSM unit damage
Sensor Bridge:	SCR/Diode pair - IEC 61000-4-2 Direct&Air Discharge
USB D+/D-:	ESD Suppressor - IEC 61000-4-2 Direct&Air Discharge
USB Pwr/Gnd:	Varistor @ 0.1J non-repetitive surge - 17V @ 1A max clamp

WSM/DSM Devices were designed by Yashu Systems www.yashu.com