FY04 CPP Muli-channel high speed data acquisition system

Signal Conditioner Specifications

NSWCDD will procure signal conditioning equipment for use in vibration and explosive testing of missile components. The system will be procured through a competitive process. Candidate systems must meet all of the following technical requirements.

Technical Requirements
General
The signal conditioning equipment will consist of modular cards that plug into a rack-mounted chassis. The system is controlled by computer software. The requirement is for two rack-mounted chassis, 4 channels of bridge signal conditioning, 64 channels of IEPE signal conditioning and 104 channels of thermocouple conditioning. Detailed specifications for each component follow.

i. Chassis and Control Software

1) Shall have the ability to be controlled remotely using TCP/IP.
2) Must be entirely controlled and configured using a MS Windows-based GUI.
3) Equipment setup and test parameters must be saved and recalled for future use.
4) Mounts in a standard 19" rack and occupy 12 in. or less of vertical space.
5) Must have an internal test and calibration system that can
    a. Perform a Go / no go test that includes
        i. Gain accuracy
        ii. Cutoff accuracy
        iii. Common Mode Rejection Ratio (CMRR)
        iv. Maximum input level
        v. The ability to report the results in a text file or MS Word document
    b. Perform a NIST traceable factory acceptance test that includes
        i. CMRR
        ii. Noise
        iii. Auto balance
        iv. Gain accuracy
        v. AC/DC coupling
        vi. Filter FRF
        vii. Amplitude and phase matching across channels
        viii. Shunt calibration
        ix. Offset voltage correction accuracy

x. The ability to report the results in a text file or MS Word document

6) Accommodate at least 16 conditioning cards in any combination of bridge, thermocouple or IEPE. Design shall be modular to allow insertion and removal of cards without access to the rear of the chassis.
7) Include all power supplies, cooling fans and cabling to operate a full rack of conditioning cards. Software or hardware shall monitor condition of chassis and warn of power failure or temperature faults.
8) Connections for inserting calibration signals and monitoring outputs of conditioners.

B. **Bridge Conditioners**

9) Require delivery of 4 channels of bridge conditioning with two stage amplifiers, bridge completion and filtering capability. At least 4 channels of signal conditioning per chassis card or module.
    a. The input stage shall be balanced differential and have the following minimum specifications:

CMRR: 120 dB, DC to 60 Hz with full bridge input and input gain of x8 or greater.
Input Impedance: 15 MΩ 100 pF per side, 1000 MΩ 24 pF common mode
Max Level: +/-10 Vpk for $f \leq 50$ kHz; +/-10 Vpk/f for $f > 50$ kHz
Common Mode Rejection Ratio: 110 dB min, 120 dB typical with full bridge input and input gain of x8 or greater.
Common Mode Level: 10 V
Input Protection: 50 V
Noise: <10 nV per rt. Hz at 1 kHz, RTI
Shield: Programmable (driven, open or grounded)

    b. The input shall have programmable AC/DC coupling. The input stage, when AC coupled, shall have the following specifications:

Impedance: (0.1 μF & 1.58 MΩ) 100 pF per side (1 Hz)
CMRR: 90 dB, 60 Hz with input gain greater than x8
    c. Noise: 14 nV per rt. Hz at 1 kHz, RTI

10) The input shall have an input short test mode in order to ground the input stage so that amplifier noise and DC offset may be examined.
11) The input shall have a programmable switch used to inject test signals without having to disconnect any signal cables.
12) The excitation supply to the bridge shall have the following specifications:

Programmable bridge supply of up to 20V and 30 mA

Local or remote sense capability
Accuracy: +/- 5 mV, +/- 0.01%

13) The excitation supply shall have an “off” setting so that noise in the absence of excitation can be examined. Full functionality of the amplifier and filter stages will be available when excitation is off.
14) Bridge completion modules shall plug onto the bridge card and accommodate completion for all channels on the card. Soldering of completion resistors is not acceptable.
15) User must be able to verify bridge completion configuration and impedance from the graphical user interface.
16) Bridge completion for 350 Ohm 1, 2 or 4-arm bridges shall be provided. Bridge configuration (1, 2 or 4-arm) shall be reported by the GUI.
17) The amplifier input shall be equipped with automatic bridge balance with resolution of +/-0.05% of span
18) The amplifier shall be equipped with programmable 4096-step (or better) voltage insertion bipolar shunt calibration that may be used to simulate a bridge unbalance. Single shunt calibration of any arm of the bridge and double shunt calibration of opposing bridge arms shall be supported.
19) The programmable amplifier shall have gain distributed both before and after a programmable filter to provide protection from large out-of-band energy or transients that could cause clipping prior to filtering. The amplifier shall have the following specifications:

    Pre-Filter Gain: x1 to x512
    Post-Filter Gain: x1/16 to x16
    Overall Gain: x1/16 to x8192
    DC Accuracy: 0.1% after auto calibration at any gain setting
    DC Linearity: +/-0.005% referenced to full-scale
20) Each bridge conditioning channel shall be equipped with a programmable low-pass filter with the following characteristics:

    Type: 6-pole, linear phase low-pass filter. Phase Distortion: < 3°, DC to Fc
    Cutoff Frequencies: Programmable from 5 Hz to 1275 Hz in 5 Hz steps and 1.5 kHz to 127,500 Hz in 500 Hz steps.

    Minimum Attenuation shall be -70dB above 5 times Fc
    Overshoot: <= 5%
    10% to 90% Rise time: <0.4/Fc
    0.1% Settling Time: < 2.5/Fc seconds
    1% Settling Time: < 1.5/Fc seconds
    Transition Band Slope: >25 dB/octave
    Amplitude Accuracy: +/- 0.1 dB Max, DC to Fc
    Amplitude Match: +/- 0.05 dB Max, DC to Fc (Fc ≤ 20 kHz)
    +/- 0.1 dB Max, DC to Fc (Fc > 20 kHz)
    Phase Match: +/- 0.5 degree Max, DC to Fc (Fc ≤ 20 kHz)

+/- 1 degree Max, DC to Fc (Fc > 20 kHz)

21) A wideband mode of operation shall be supported. In wideband mode, the filter shall be bypassed but the amplifier shall be fully operational. The –3. dB bandwidth of the amplifier in wideband mode shall be 250 kHz.
22) The signal conditioner shall be equipped with an output stage with the following specifications:
    Type: DC-coupled, single-ended output.
    Impedance: 50 Ω
    Max Output: +/-10 Vpk, +/-20 mApk
    Noise: <5 µVrms RTI + <500 µVrms RTO 0.1 Hz to 127.5 kHz
23) The signal conditioner shall support automatic adjustment of offset and gain for the entire channel. Offset and gain shall be corrected for any signal conditioner setting.
24) Each signal conditioner module shall have the model number and serial number residing in non-volatile RAM that may be read by the host computer.

C. Thermocouple Conditioners

1. Thermocouple conditioners shall plug into the chassis described above to provide 64 channels of thermocouple conditioning. Each conditioner card shall accommodate at least 8 thermocouples.
2. The input stage shall be balanced differential, DC Coupled with Open Thermocouple Detection and shall have the following specifications:

    Type: 3-Wire Differential (High, Low and Shield), DC Coupled
    Offset Temperature Coefficient: 0.5 uV/C max.
    Input Impedance: 1000 Mohm 100 pF per side
    Protection: +/- 40 V
    Common Mode Voltage: +/- 10 Vpk
    Common Mode Rejection (DC to 100 Hz): >90 dB, for input gain > 100
    Max Input: +/-10 Vpk to 5 kHz, +/- 10 Vpk*(5 kHz/f), f > 5 kHz
    Noise (0.1 Hz to 100 Hz): <0.5 uVrms RTI
3. The input shall have an input short test mode in order to ground the input stage so that amplifier noise and DC offset may be examined.
4. The input shall have a programmable switch used to inject test signals without having to disconnect any signal cables.
5. The programmable amplifier shall have gain distributed both before and after a programmable filter to provide protection against large out-of-band energy or transients that could cause clipping prior to filtering. The amplifier shall have the following minimum specifications:
    Gain prior to filter: x1, 10, 100, 1000
    Gain after filter: x1, 10, 100
    DC Accuracy: 0.1%,
    DC Linearity: at least 0.005%

6. The signal conditioner shall be equipped with an output stage with the following specifications:
   Type: Single-Ended
   Level: +/- 10 Vpk, +/- 5 mApk
   Output Impedance: 10 Ohms

   Offset: Less than 3 mV after auto adjust
   Overload Detection: Overload at channel output is indicated by front panel LEDs and by indicators in the computer GUI.
   Noise (0.1 Hz to 100 kHz), Fc = 100 Hz: 250 uVrms RTO at Gain = 1000
7. An output monitor bus shall be provided to allow monitoring of system outputs without disconnecting any signal output cables.

8. Cold Junction Compensation: The Isothermal Block provides screw terminal connections for at least eight thermocouples (2 wires plus shield on each channel) and the reference junction temperature sensor. The following specifications apply to the isothermal block:

   ii. Standard Thermocouple Types Supported: E, J, T, K, N, S, R and B
   iii. Hardware Bow Correction: Polynomial approximation to the thermoelectric voltage of a thermocouple verses temperature is utilized to reduce thermocouple "Bow" errors.
   iv. Isothermal block Temperature Reading Sampling Period: <30 Sec
   v. support readout of reference junction temperature by user.
   vi. Isothermal Block Sensor Accuracy: +/- 0.5 °C, -10 to 85 °C
   vii. Isothermal block operating temperature range: -10 to 100 °C

D. IEPE Conditioners

1. Integral Electronic PiezoElectric (IEPE) conditioners shall plug into the chassis described above to provide 64 channels of IEPE conditioning. Each card shall accommodate at least 16 channels.
2. The input stage shall be AC coupled with impedance greater that 1 Meg ohm 100 pF.
3. The input shall have a switch used to inject test signals without having to disconnect any signal cables.

4. The IEPE current shall be user selectable from the GUI from 0 to 20 mA.
5. A sensor bias detector shall be provided to determine if the sensor bias level is within limits.
6. A sensor fault detector shall be provided in order to detect open and short conditions.
7. An AC test current shall be provided to measure sensor output impedance.
8. A programmable amplifier with gains of x1, 2, 4, …, x128 shall be provided.

9. Amplifier gain accuracy shall be better than 0.5%.
10. An output monitor bus shall be provided to allow monitoring of system outputs without disconnecting any signal output cables.
11. Overload detectors shall be provided to detect signal overloads.
12. Programmable 4-pole Bessel low-pass filters shall be provided with cutoff frequencies programmable to 100 Hz, 300 Hz, 1 kHz, 3 kHz, 10 kHz and Bypass.