

ANNEXURE A: NEFF 620 Series Specification Reference

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ABBREVIATIONS

ADC	Analogue to Digital Converter
CMR	Common Mode Rejection
CMRR	Common Mode Rejection Ratio
CSIR	Council for Scientific and Industrial Research
DAC	Digital to Analogue Converter
FS	Full Scale
I/O	Input/Output
LSB	Least Significant Bit
MSWT	Medium Speed Wind Tunnel
PGA	Programmable Gain Amplifier
RSS	Root of Sum of Squares
RTD	Resistance Temperature Detection
RTI	Relative to Input
RTO	Relative to Output
TAC	Test Article Controller
TEC	Tunnel Environment Controller
TTL	Transistor-Transistor Logic
URS	User Requirement Specification

1 Scope of Documentation

1.1 Purpose of Document

This appendix document is a reference documentation for the current MSWT Test Article Controller data acquisition system. The specifications to be used for the evaluation and selection of the upgrade system. This covers the current functionality and performance criteria of the TAC DAQ and will be the primary requirements for the upgrade system to either match or improve.

1.2 Background to Document

The MWST requires a wide range of measurement and control mediums in order to carry out the desired operational performance. The current NEFF 620 series DAQ is reaching end of life and majority of the technology utilised by the system has been classified as obsolete. Two NEFF data acquisition systems are utilised in the MSWT control system. The first is the test article controller processor carrying out data acquisition and control since 1989. The second DAQ forms part of the tunnel environment controller processor which carries out data acquisition and control. The first NEFF system will first be replaced by an upgraded system since this DAQ is responsible for the acquisition of test critical signals and data required for the completion of wind tunnel testing.

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2 Existing TAC NEFF 620 Series Overview

2.1 Definitions

Data acquisition system – A fundamental component used to gather, record and analyse data from the real world. The system converts physical phenomena into digital data which can be manipulated and analysed for various purposes. In addition to the acquisition of signals, the data acquisition platform carries out signal handling for more complex analog signals as well as a software interface to the real world through control algorithms. The data acquisition system referenced in this document is the NEFF 620 series system and all sub-systems related to this system.

2.2 Description: Neff 620 Series

The NEFF 620 series data acquisition is the collective name given to a family of data acquisition modules installed in a 600 series chassis to form the system utilised by the TAC. The result of this family of modules or components allows for user freedom to configure the system to the desired role. The sub-systems utilised to make up the TAC DAQ are as follows:

- 100 Series– ADC and Amplification
- 300 Series– Signal Conditioning
- 500 Series– Measurement and Control I/O Logic

Each series supports various card configurations to allow for specialised transducers, signal types and I/O interfaces required to fulfil the DAQ requirements. These cards are investigated and listed below to fully specify the current capabilities of the TAC NEFF.

3 NEFF 620 Series Sub-Series Systems

3.1 100 Series Amplifier & Multiplexer

3.1.1 Description

The 100 series modules are responsible for the acquisition of the data including pre-conversion of the analogue signals for conversion by the analogue-to-digital convertor. Each channel is amplified and filtered individually which is programmable and offers of a solid-state multiplexer.

3.1.2 Features

- Channel selectable amplification and filtering
- 64 channels expandable to 256
- Throughput rates to 50 kHz (Total rate, not per channel)
- Full scale inputs from ± 5 mV to ± 10 V
- 15-Bit resolution plus sign (1 sign, 14 data)
- Buffer architecture for analogue outputs
- Plug-in Gain Modules for amplification value
- Programmable gain functionality
- Plug-in Filter Modules for filter cut-off and type selection
- Voltage Insertion Calibration (Via external reference voltage)

3.1.3 Specifications

Programmable Gain Amplifier

- Gain Range: X1 – X32
- Gain Accuracy: See 'System Gain', below
- Gain Stability: See 'System Gain', below
- Zero Stability: ± 50 μ V RTO
 $\pm (5 \mu\text{V RTI}/^\circ\text{C} + 40 \mu\text{V RTO}/^\circ\text{C})$
- Noise: ADC Limit (99.7 % confidence)
 50 kHz $\pm(50 \mu\text{V RTI} + 2\text{mV RTO})$
 $\text{PGA Noise} = \pm[(\text{RTI} \times \text{Gain})^2 + (\text{RTO})^2]^{1/2}$
 (PGA noise adds RSS with Amplifier Filter noise for total system noise)

Specifications (cont.)

Analogue-to-Digital Converter (ADC)

- Resolution: 15 bits, plus sign
- Throughput Rate: 50 kS/s

System Specifications (Includes Amplifier/Filter)

- Gain Selection: Amplifier/Filter gain selected by plug in module; standard gains are 1, 2, 5, 10, 20, 50, 100.
Programmable gain selected by 3-bit input code. System gain is the product of Amplifier/Filter gain and PGA gain
- Gain Accuracy: $\pm(0.012 \% + 0.0002 \% \times \text{PGA Gain})$
- Gain Stability: $\pm(0.01 \% + 0.005 \% / ^\circ\text{C})$
- Gain Calibration: Individual channel adjustment with $\pm 1 \%$ range.
- Linearity: $\pm(0.02 \% + \frac{1}{2} \text{ LSB})$
- Overload: Settles to $\pm 0.05 \%$ in less than 1 ms from 1000 % overload (exclusive of filter settling time)
- Crosstalk: For worst-case combinations of full-scale input & PGA gain change: 50 kHz: $\pm(0.01 \% + 0.0025 \% \times \text{PGA Gain})$
(Typical error without gain change is 0.001 %)
- Zero Stability: See PGA and Amplifier/Filter specifications
- Noise: Combine PGA and Amplifier/Filter specifications using RSS
- Operating Environment: 0 °C to +50 °C, 90 % relative humidity

3.2 100 Series 4-Channel Low Level Amplifier Filter (Neff Part # 620050)

3.2.1 Description

Low input signal level differential amplification and filtering card with selectable gains and filter modules for RTD transducers.

3.2.2 Features

- Four analogue input channels.
- Specialises in low signal levels ideal for strain gauges and thermocouple class transducers.
- Accepts full-scale inputs ranging from $\pm 5\text{mV}$ to $\pm 1\text{V}$ full-scale.
- Individual channel amplification selection modules (10 – 100).
- Direct conditioned analogue output from card accessible for debugging or tracking.

3.2.3 Specifications

- Gain Range: X10 –X100
- Gain Accuracy: Included with PGA (See Series 100 Specifications)
- Gain Stability: Included with PGA (See Series 100 Specifications)
- Gain Linearity: Included with PGA (See Series 100 Specifications)
- Zero Stability: $\pm (4 \mu\text{V RTI} + 15 \mu\text{V RTO})$
 $\pm (1 \mu\text{V RTI}/^\circ\text{C} + 15 \mu\text{V RTO}/^\circ\text{C})$
- Input Configuration: Guarded differential
- Input Impedance: 10 M Ω
- Input Voltage: $\pm 10 \text{ V/gain, operating.}$
 $\pm 20 \text{ V without damage}^*$
- Source current: $\pm (2 \text{ nA} + 0.5 \text{ nA}/^\circ\text{C})$
- Common Mode Voltage:
 $\pm 10\text{V dc or peak ac, operating.}$
 $\pm 20\text{V without damage}^*$
- Common Mode Rejection:
120 dB (66 dB + gain in dB), dc to 60 Hz, exclusive of
filter attenuation, with up to 350 Ω source imbalance.



Specifications (cont.)

- Noise: Bandwidth Limit (99.7 % confidence)
 - 1-10 Hz $\pm(1.0 \mu\text{V RTI} + 50 \mu\text{V RTO})$
 - 100 Hz $\pm(2.0 \mu\text{V RTI} + 50 \mu\text{V RTO})$
 - 1 kHz $\pm(6.0 \mu\text{V RTI} + 50 \mu\text{V RTO})$
- Noise: Preamp Noise = $\pm[(\text{RTI} \times \text{Gain})^2 + (\text{RTO})^2]^{1/2}$
 (350 Ω source unbalance; adds RSS with PGA noise for total
 system noise)
- Filter Type: Two-pole Butterworth
- Filter Cut-off: 1 Hz, 10 Hz, 100 Hz, 500 Hz, 1 kHz or Wideband



3.3 100 Series 4-Channel Amplifier Filter (6-Pole Bessel) (Neff Part # 620054)

3.3.1 Description

Low input signal level differential amplification and filtering card with selectable gains and set 6-pole Bessel filter. 13x 620054 cards (52 channels) are in use currently on the TAC DAQ.

3.3.2 Features

- Four analogue input channels
- Individual amplification (10 to 100) and low-pass filter cut-off per channel.
- Six-pole filtering sharpening bandwidth limitation at the cost of decreased sampling rates.
- Cut-off frequencies (1 Hz to 1 kHz) can be selected individually for each channel.
- Direct conditioned analogue output from card accessible for debugging or tracking.

3.3.3 Specifications

- Gain Range: X10 –X100
- Gain Accuracy: Included with PGA (See Series 100 Specifications)
- Gain Stability: Included with PGA (See Series 100 Specifications)
- Gain Linearity: Included with PGA (See Series 100 Specifications)
- Zero Stability: $\pm (4 \mu\text{V RTI} + 15 \mu\text{V RTO})$
 $\pm (1 \mu\text{V RTI}/^\circ\text{C} + 15 \mu\text{V RTO}/^\circ\text{C})$
- Input Configuration: Guarded differential
- Input Impedance: 10 M Ω
- Input Voltage: ± 10 V/gain, operating.
 ± 20 V without damage*
- Source current: $\pm (2 \text{ nA} + 0.5 \text{ nA}/^\circ\text{C})$
- Common Mode Voltage: ± 10 V dc or peak ac, operating.
 ± 20 V without damage*



Specifications (cont.)

- Common Mode Rejection:

120 dB (66 dB + gain in dB), dc to 60 Hz, exclusive of filter attenuation, with up to 350 Ω source imbalance.

- Noise:

Bandwidth	Limit (99.7 % confidence)
1-10Hz	$\pm(1.0 \mu\text{V RTI} + 50 \mu\text{V RTO})$
100Hz	$\pm(2.0 \mu\text{V RTI} + 50 \mu\text{V RTO})$
1kHz	$\pm(6.0 \mu\text{V RTI} + 50 \mu\text{V RTO})$

- Noise:

Preamp Noise = $\pm[(\text{RTI} \times \text{Gain})^2 + (\text{RTO})^2]^{1/2}$
 (350 Ω source unbalance; adds RSS with PGA noise for total system noise)

- Filter Type: Six-pole Bessel
- Filter Cut-off: 1 Hz, 10 Hz, 100 Hz, 1 kHz

3.4 100 Series 4-Channel Amplifier Filter (with Sample and Hold) (Neff Part # 620055)

3.4.1 Description

Low input signal level differential amplification and filtering card with selectable gains and set 2-pole Butterworth filter. This card makes use of the Sample and Hold acquisition methodology. 16x 620055 cards (64 channels) are in use currently on the TAC DAQ.

3.4.2 Features

- Simultaneous sampling of 4 input analogue channels.
- Sample and hold per channel with selectable differential amplification module (10 – 100) and selectable filter cut-off.
- Accepts inputs ranging from ± 5 mV to ± 1 V full-scale.
- Maximum droop in hold is 0.6 % in 3.2 ms.

3.4.3 Specifications

- Gain Range: X10 – X100
- Gain Accuracy: Included with PGA (See Series 100 Specifications)
- Gain Stability: Included with PGA (See Series 100 Specifications)
- Gain Linearity: Included with PGA (See Series 100 Specifications)
- Zero Stability: $\pm(4 \mu\text{V RTI} + 15 \mu\text{V RTO})$
 $\pm(1 \mu\text{V RTI}/^\circ\text{C} + 15 \mu\text{V RTO}/^\circ\text{C})$
- Input Configuration: Guarded differential.
- Input Impedance: 10 M Ω .
- Input Voltage: ± 10 V/gain, operating.
 ± 20 V without damage*
- Source current: $\pm(2 \text{ nA} + 0.5 \text{ nA}/^\circ\text{C})$
- Common Mode Voltage:
 ± 10 V dc or peak ac, operating.
 ± 20 V without damage*
- Common Mode Rejection:
120 dB (66 dB + gain in dB), dc to 60 Hz, exclusive of
filter attenuation, with up to 350 Ω source imbalance.
Filter increases CMR depending on bandwidth.

Specifications (cont.)

- Noise: Bandwidth Limit (99.7 % confidence)
 1-10Hz $\pm(1.0 \mu\text{V RTI} + 50 \mu\text{V RTO})$
 100Hz $\pm(2.0 \mu\text{V RTI} + 50 \mu\text{V RTO})$
 1kHz $\pm(6.0 \mu\text{V RTI} + 50 \mu\text{V RTO})$
- Noise: Preamp Noise = $\pm[(\text{RTI} \times \text{Gain})^2 + (\text{RTO})^2]^{1/2}$
 (350 Ω source unbalance; adds RSS with PGA noise for total system noise)
- Filter Type: Two-pole Butterworth
- Filter Cut-off: 1 Hz, 10 Hz, 100 Hz, 500 Hz, 1 kHz or Wideband



3.5 100 Series Amplifier Filter (High Level) (Neff Part # 620060)

3.5.1 Description

High input signal level differential amplification and filtering card with selectable gains and set 2-pole Butterworth filter. 3x 620060 cards (12 channels) are in use currently on the TAC DAQ.

3.5.2 Features

- Four analogue input channel.
- Accepts inputs ranging from ± 25 mV to ± 10 V full-scale.
- Standard gains (1, 2, 5 and 10) selected by module.
- Standard bandwidths are 1 Hz, 10 Hz, 100 Hz, 500 Hz, 1 kHz or wideband.

3.5.3 Specifications

- Gain Range: X1 –X10
- Gain Accuracy: Included with PGA (See Series 100 Specifications)
- Gain Stability: Included with PGA (See Series 100 Specifications)
- Gain Linearity: Included with PGA (See Series 100 Specifications)
- Zero Stability: $\pm 150 \mu\text{V RTO}$
 $\pm (30 \mu\text{V RTI}/^\circ\text{C} + 100 \mu\text{V RTO}/^\circ\text{C})$
- Input Configuration: Guarded differential
- Input Impedance: 10 M Ω .
- Input Voltage: ± 10 V/gain, operating.
 ± 20 V without damage*
- Source current: $\pm (25 \text{ nA} + 2 \text{ nA}/^\circ\text{C})$
- Common Mode Voltage:
 ± 10 V dc or peak ac, operating;
 ± 20 V without damage
- Common Mode Rejection:
66 dB + gain in dB, dc to 60 Hz, exclusive of
filter attenuation, with up to 350 Ω source imbalance.
Filter increases CMR depending on bandwidth



Performance (cont.)

- Noise: Bandwidth Limit (99.7 % confidence)
 1-10 Hz $\pm 100 \mu\text{V RTO}$
 100 Hz $\pm 150 \mu\text{V RTO}$
 1 kHz $\pm 200 \mu\text{V RTO}$
- Noise: Preamp Noise = $\pm[(\text{RTI} \times \text{Gain})^2 + (\text{RTO})^2]^{1/2}$
 (350 Ω source unbalance; adds RSS with PGA noise for total system
 noise)
- Filter Type: Two-pole Butterworth
- Filter Cut-off: 1 Hz, 10 Hz, 100 Hz, 500 Hz, 1 kHz or Wideband



3.6 100 Series 8-Channel Output Buffer Option (Neff Part # 620040)

3.6.1 Description

Eight channel output buffers with amplification which forms part of the optional hardware package of the TAC DAQ. 1x 620040 card (8 channels) in use in the TAC DAQ.

3.6.2 Features

- Direct analogue outputs with amplification by single-ended buffer amplifiers from the systems channel address logic.
- Amplifier gain of 1 or 10 for each channel is set by select switches.

3.6.3 Performance

- Full-scale output of the buffer amplifiers:
 $\pm 10\text{ V}$, 10 mA
- Output frequencies:
from dc (0 Hz) to 5kHz



3.7 300 Series Signal Conditioner (Neff Part # 620300)

3.7.1 Description

Data acquisition sub-system that conditions the various transducer signals for acquisition in the form of analogue signals. The TAC DAQ currently makes use of 1x 300 series signal conditioner with 16x strain gauge mode cards with 64 channels.

3.7.2 Features

- Constant voltage excitation for Wheatstone bridge transducers.
- Constant current excitation for RTD's and potentiometers.
- Programmable voltage calibration.
- Accommodates full, half and quarter bridges.
- Wheatstone bridge, RTD and thermocouple calibration.
- 64 input channels across the sub-system.
- Excitation supply (one per channel) provides constant voltage or constant current excitation as appropriate for the transducer type.

3.7.3 Excitation Power Supply Specifications: Constant Voltage Mode

- Output Voltage:
Continuously adjustable from 2-10 V by resistor adjuster on mode card.
- Output Current:
100 mA max per channel, 3.8 A max per 64 channels.
Each channel unconditionally short-circuits protected.
- Response Time:
Excitation supply output will settle to within 1 % of setting in less than 20 μ s from a no load to a full load change. Turn-on overshoots less than 10 % of setting.
- Line Regulation:
Less than 0.01 % or 200 μ V, whichever is greater, for a ± 10 % input line voltage variation.
- Load Regulation:
Less than 0.01 % or 200 μ V, whichever is greater, for a no load to full load change.
- Ripple:

Less than 100 μV peak-to-peak in a dc to 1 kHz bandwidth.

- Stability:

$\pm 0.01\%$ at constant temperature, $\pm 0.005\%/^{\circ}\text{C}$.

- Remote Sensing:

Positive and ground sense leads are provided for remote sensing. Sense lead current less than 100 μA .

3.7.4 Excitation Power Supply Specifications: Constant Current Mode

- Output Current:

Adjustable from 2-50 mA by resistor adjuster on mode card.

- Compliance voltage:

0-7 V.

- Response Time:

Output settles to within 1 % of setting in less than 50 μs from a no load to a full load change. Output terminals unconditionally short-circuit protected. Turn-on overshoot less than 10 %.

- Line Regulation:

$\pm 0.01\%$ or 0.1 μA , whichever is greater, for a $\pm 10\%$ input line voltage variation.

- Output Impedance: $R_o = 5 \times 10^3 / I_o$ to 1 M Ω maximum.

- Ripple: Less than 2 μA over the bandwidth dc to 1 kHz.

- Output Stability: $\pm 0.01\%$ at constant temperature, $\pm 0.005\%/^{\circ}\text{C}$.



3.8 300 Series Strain Gauge Mode Card (Neff Part # 620360)

3.8.1 Description

Mode card that controls the configurations of each individual channel of the four channels of the conditioning cards. These are designed to accommodate strain gauge transducers.

3.8.2 Features

- Provides constant Voltage excitation.
- Additional remote sensing.
- Conditions full, half and quarter bridges.
- Terminals are provided for mounting resistors for excitation scaling, bridge completion, balance limit and calibration.

3.8.3 Specifications

- Excitation voltage: 4 to 10 V adjustable with screwdriver with 10 mV resolution.
- Balance Control:
 - 25,000 Ω , 15-turn Cermet potentiometer with screwdriver adjustment.
 - Temperature coefficient is ± 100 ppm/ $^{\circ}\text{C}$. Terminals provided for mounting balance limiting resistor.
- Bridge Completion: Terminals provided for four completion resistors.
- Input wiring: Up to 8 conductors with shield.
- Test Points:
 - Front-mounted jacks for monitoring excitation voltage and channel output.
- Calibration:
 - Shunt resistive calibration, optional voltage substitution calibration, or normal operation selected by TTL logic.
- Transducer Calibration:
 - Terminals for mounting calibration resistor for single-point shunt calibration



3.9 300 Series RTD/Potentiometer Mode Card (Neff Part # 620361)

3.9.1 Description

Mode card that controls the configurations of each individual channel of the four channels of the conditioning cards. These are designed to accommodate resistance-temperature devices or potentiometers with two, three or four-wire configurations.

3.9.2 Features

- Provides constant current excitation.
- Two, three or four-wire configurations.
- Resistance substitution calibration.

3.9.3 Specifications

- Excitation current:
Continuously adjustable from 5-15 mA with 30 μ A resolution using screwdriver adjustment.
- Compliance Voltage:
7 V maximum.
- Input wiring:
Up to 4 conductors with shield.
- Test Points:
Front-mounted jacks for monitoring excitation current and channel output.
- Calibration:
Resistance substitution calibration, optional voltage substitution calibration, or normal operation selected by TTL logic
- Transducer Calibration:
RTD or potentiometer is replaced by precision calibration resistor mounted on Mode card terminals to accomplish single-point upscale calibration



3.10 500 Series Measurement and Control I/O System (Neff Part # 620500/620502)

3.10.1 Description

NEFF sub-system required for communication between controlling computer and other members of the 620 series family including the analogue systems and cards.

3.10.2 Features

- Local 500 series bus.
- Computer I/O card and memory control.
- Function I/O (includes analogue “front ends” and 500 series analogue and digital function cards).
- Easy expansion.
- Local or remote data acquisition.

3.10.3 Specifications

- Buses: 18-bit input bus and 16-bit data bus.
- Analog Subsystem Control:
Dual Buffered Control.
- Function I/O:
Standard function cards used at CSIR with their performance specifications are listed below.



3.11 500 Series 32-Bit TTL Output (Neff Part # 620530)

3.11.1 Description

TTL output function card that is used in the TAC DAQ to drive the EDC voltage standard.

3.11.2 Features

- 32 Outputs from 500 series bus for driving external devices (30 V Maximum).
- Variable word length (four 8-bit words, two 16-bit words, or one 32-bit word).
- Selectable logic polarity.

3.11.3 Specifications

- Output characteristics:
Open Circuit Voltage – +30 V maximum.
- Output characteristics:
Sink Current – 40 mA maximum.
- Bus characteristics:
Operating Mode – Half duplex.
- Bus characteristics:
Bus Loading - One TTL load.
- Bus characteristics:
Data Rate – 100 kHz.



3.12 500 Series 32-Point Isolated DC Sense (Neff Part # 620561)

3.12.1 Description

Isolated DC sense function card with 32 digital input in use in the TAC DAS.

3.12.2 Features

- Transfers 32 DC Inputs (Relay Contacts, Control Signals, etc) to the 500 series bus.
- Optical coupling to bus.
- Voltage level selection.
- Interrupt request capability.

3.12.3 Specifications

- Data Format:

32 data points read as two 16-bit words. Data points 00 - 15 become data bus bits DB00 - DB15.
- Input Levels:

Contact closures or two voltage levels selected by jumper.
- Common Mode:

1000 V can be applied between each input and ground.
- Interrupt Capability:

Activated by switch for each input point; interrupt occurs after 10 ms window.



3.13 500 Series Isolated Latch (Neff Part # 620563)

3.13.1 Description

Isolated latch function card.

3.13.2 Features

- Flip-flop type latches for 32 input points.
- Optical coupling.
- Voltage level selection.
- Interrupt request capability.

3.13.3 Specifications

- Data Format:

32 data points read as two 16-bit words. Data points 0 - 15 become data bus bits DB00 - DB15.
- Input Levels:

Contact closures or voltage level selected by jumper.
- Common Mode:

1000V can be applied between input and ground.
- Interrupt Capability:

Activated by switch for each input point.



3.14 500 Series Programmable Voltage Source (Neff Part # 620580)

3.14.1 Description

Precision voltage source for automatic calibration.

3.14.2 Features

- Provides precise calibration voltage for use by the 300 series signal conditioner for transducer calibration or by the 100 series 64-channel calibration assembly for 100 series analogue system calibration.
- The 620580 package consists of:
 - EDC programmable voltage standard.
 - NEFF 620530 TTL output function card.
 - Cabling
- Calibration voltage is programmed by the computer via the 500 series bus with outputs delivered.

3.14.3 Specifications:

- Calibrator: EDC 501J.
- Logic Lines: 20 lines + strobe + return.
- Accuracy: $\pm(0.005\% \text{ of programmed value} + 0.0005\% \text{ of range} + 3 \mu\text{V})$ worst case accuracy statement; includes following non-additive specifications.
- Stability:
 - 24 hours: $\pm 0.001\%$.
 - 90 days: $\pm 0.0025\%$.
 - 6 months: $\pm 0.005\%$.
- Regulation: Line and load: $\pm 0.001\%$.
- Temperature coefficient:
 - Ambient: $\pm 0.0005\% / ^\circ\text{C}$.
 - Operating limit: $\pm 0.001\% / ^\circ\text{C}$.
- Ranges: 2; 100 mV and 10 V.
- Resolution:
 - 1 μV on 100 mV range (10 ppm).
 - 100 μV on 10 V range (10 ppm).



Specifications (cont.)

- Settling time: Voltage change: 100 μ S max (50 μ S nominal).
 From Short circuit: 10 mS.
 Polarity change: 100 μ S max.
 Range change: 10 mS max.