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NF123-158B1 Series
Auxiliary Amplifier Card

SPECIFICATIONS

Inputs
4 per Channel.
Each input may be attached to either an inverting or non-inverting op-amp input.

Input Impedance:
Two inputs have fixed input resistors (100 kΩ supplied); two inputs each have a fixed resistor (51.1 kΩ supplied) plus a 20-turn, 100 kΩ potentiometer.

Signal levels:
±100 to ±100 VDC, depending on configuration.

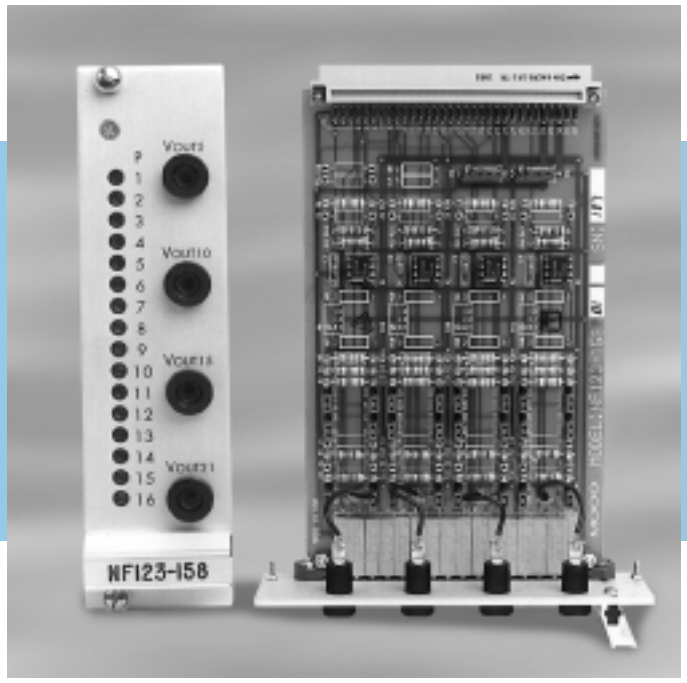
Outputs
Amplifier outputs at terminals 5, 10, 15, and 21.
Signal levels to ±10 VDC nominal.

Temperature Range:
10°C to 50°C (50°F to 120°F)

Connector:
DIN 41612 style C

Form Factor:
Eurocard 100 x 160 mm, 7 HP, 3 U

Weight:
0.38 lb (0.17 kg)



The NF123-158B1 Auxiliary Amplifier circuit card is designed to easily accommodate the special needs of unique control systems. The flexibility of this card provides the Control Engineer with a tool to design custom circuits not available in standard cards. Typical applications include buffers, summing amplifiers, differential amplifiers, oscillators, compensators, current-to-voltage converters, and dither generators.

The NF123-158B1 Auxiliary Amplifier Card is a forward compatible replacement for the F123-158-A001.

FEATURES

Flexible Configuration Options:
Each channel may be configured for any standard op-amp circuit: inverting amplifier, non-inverting amplifier, differential amplifier, inverting summing amplifier with up to 4 inputs, non-inverting summing amplifier with up to 4 inputs, current-to-voltage converter, differentiator, integrator, compensation, oscillator, etc.

Configuration of the printed-circuit board traces is accomplished through simple jumpers.

Four Independent Channels:
May be configured identically for multi-channel operations or uniquely for cascaded operations.

Front-Panel Test Points:
Allow fast access to outputs of each channel.

Front-Panel Adjustments (Four per channel):
Provide quick access to gains, scales, and biases.
Allow precise adjustments with 20-turn potentiometers.

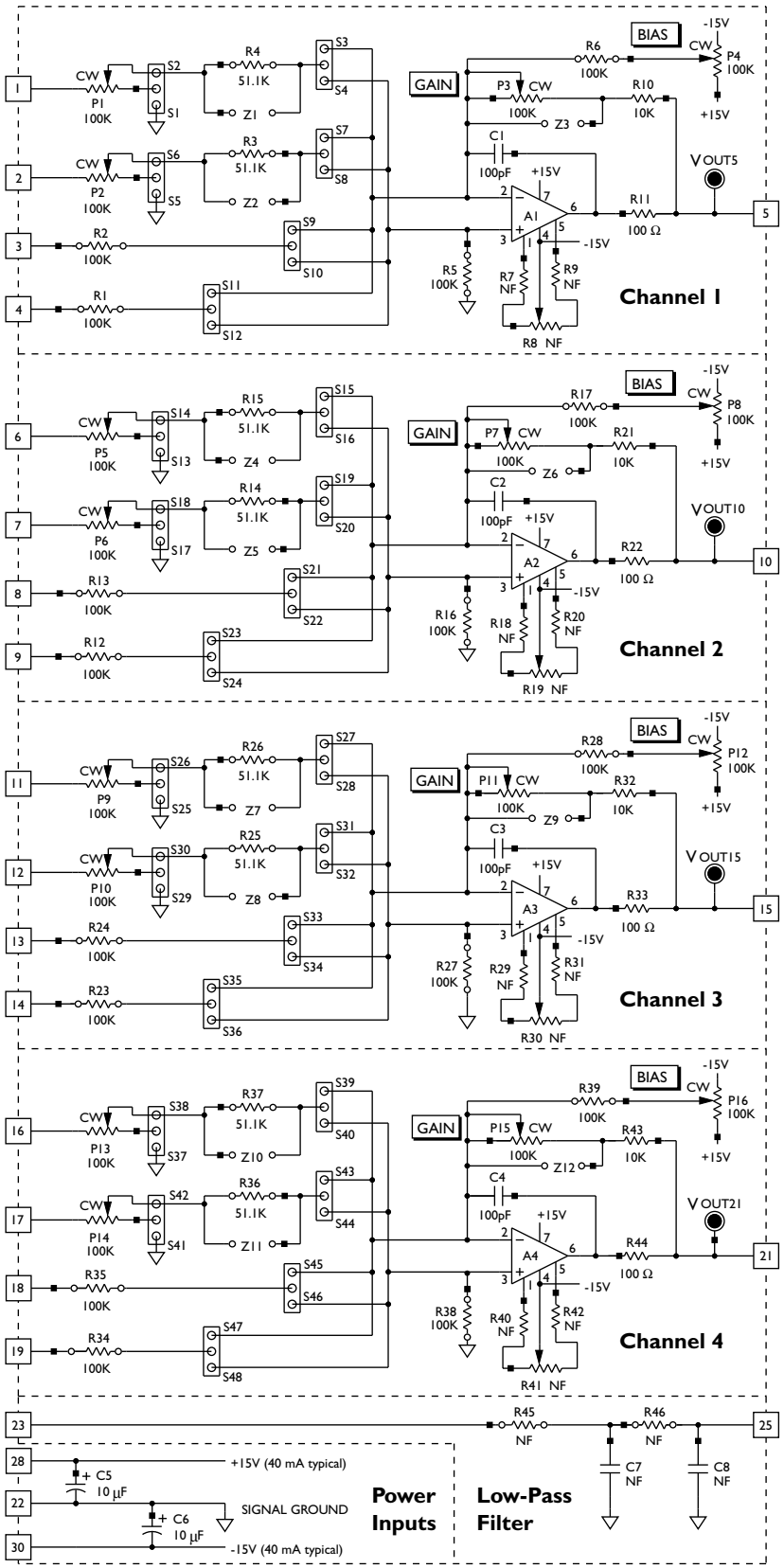
ADJUSTMENTS

Because each card is uniquely configured, it is difficult to give precise adjustment instructions. Usually, for channel 1 (V OUT5), P1 and P2 change the scaling of inputs at terminals 1 & 2; P3 changes the gain; and P4 changes the bias.

P5 through P8 control the corresponding functions of channel 2 (V OUT 10).
P9 through P12 control the corresponding functions of channel 3 (V OUT 15).
P13 through P16 control the corresponding functions of channel 4 (V OUT 21).

Set-up instructions are now available for several specific configurations including:
Conversion to dither generator (25 – 300 Hz).
Converting 4 to 20 mA input ➧ 0 to +10 V output.
Converting 4 to 20 mA input ➧ -10 to +10 V output.
Converting ±1 VDC input ➧ ±10 VDC output (non-inverting).
Converting 4 to 20 mA input ➧ 0 to -10 V output.

NF123-158B1 AUXILIARY AMPLIFIER CARD SCHEMATIC

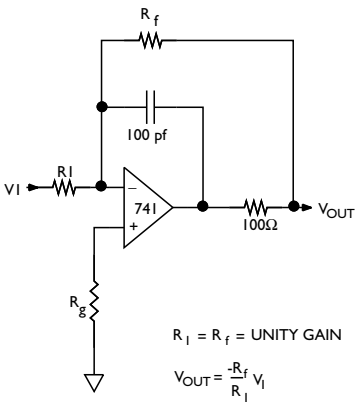


An 'Extender Card' is highly recommended to gain access to 'Test Points' and 'Adjustments' while cards are powered-up within a Eurocard Rack Assembly.

(Moog ref P/N A81750-1)

TYPICAL APPLICATIONS

Buffer Amplifier–Inverting

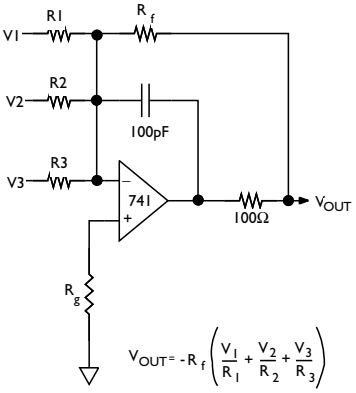


$R_I = R_f$ = UNITY GAIN

$$V_{OUT} = \frac{-R_f}{R_I} V_I$$

$$\text{set } R_g = \frac{R_I * R_f}{R_I + R_f}$$

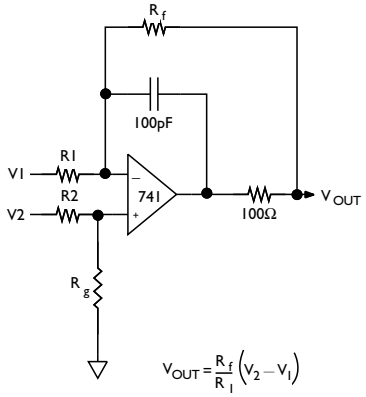
Inverting Summing Amplifier



$$V_{OUT} = -R_f \left(\frac{V_1}{R_I} + \frac{V_2}{R_2} + \frac{V_3}{R_3} \right)$$

$$\text{set } R_g = \frac{R_I \cdot R_2 \cdot R_3 \cdot R_f}{R_I R_2 R_3 + R_I R_2 R_f + R_I R_3 R_f + R_2 R_3 R_f}$$

Differential Amplifier



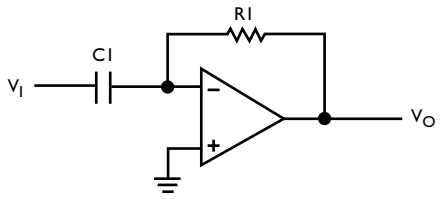
$$V_{OUT} = \frac{R_f}{R_I} (V_2 - V_I)$$

for $R_f = R_g$ and $R_I = R_2$

NOTES:

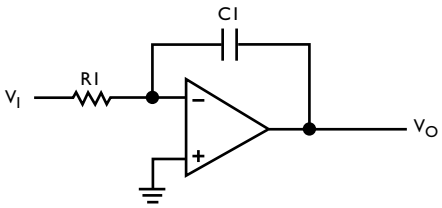
1. NF – NOT FURNISHED
2. ■ – PIN 1 (SQUARE PAD ON PCB)
3. CW – CLOCKWISE
4. -O- – INDICATES COMPONENT STANDOFF

DIFFERENTIATOR



$$V_O = -R1C1 \frac{\Delta V_I}{\Delta t}$$

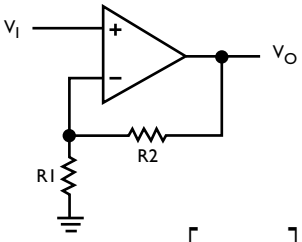
INTEGRATOR



$$V_{OUT} = -\frac{1}{R1C1}\int_{t_1}^{t_2} V_{IN} dt$$

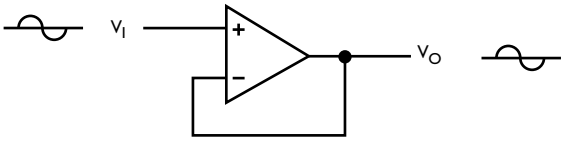
$$f_c = \frac{1}{2\pi R1C1}$$

BASIC NONINVERTING AMPLIFIER CIRCUIT

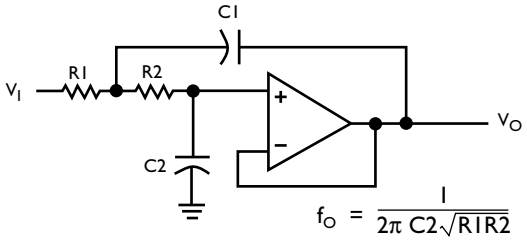


$$V_O = \left[1 + \frac{R2}{R1}\right](V_I)$$

VOLTAGE FOLLOWER

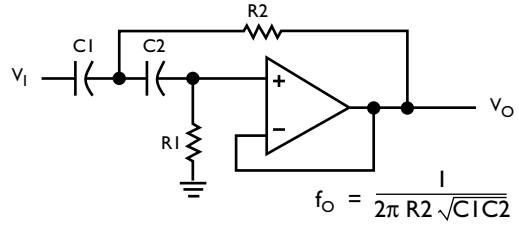


HIGH-PASS AND LOW-PASS FILTER CIRCUITS



$$f_O = \frac{1}{2\pi\, C2\sqrt{R1R2}}$$

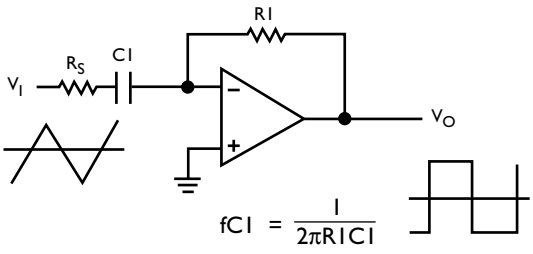
(a) LOW-PASS FILTER



$$f_O = \frac{1}{2\pi\, R2\sqrt{C1C2}}$$

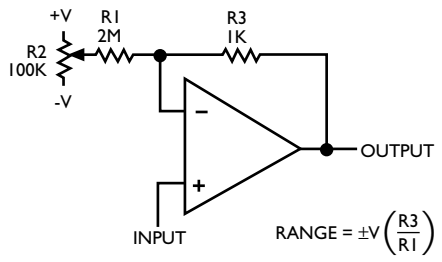
(b) HIGH-PASS FILTER

DIFFERENTIATOR WITH HIGH FREQUENCY NOISE CORRECTION



$$fC1 = \frac{1}{2\pi R1C1}$$

OFFSET VOLTAGE ADJUSTMENT FOR VOLTAGE FOLLOWERS



SET-UP INSTRUCTIONS

1. Converting Channel-1 & 2 ⇒ Dither Generator w/Dither Freq ≈ 25 to 300Hz
   - Adjustable Dither Frequency (Sq Wave) and Amplitude
   - Select Ch1 and Ch2 for circuit configuration
   - Refer to Schematic Diagram – Figure 'A'
   - A1 of Ch1 is NOT used (Remove from circuit)
   - A2 of Ch2 is configured as a Free-Running Astable Multivibrator Circuit or Square Wave Generator
   - Dither Frequency ⇒ $f_{DITHER} = 1/t_1 = 1 / 2 [C1 \times (P7 + R21)]$
   - Channel-1:
     - Remove R1 (100K) & replace with C2, 1mf, 35 VDC capacitor
     - Install jumper Z1
     - Insert jumper S3, S5, S7 & S12 Only
     - Ensure jumpers S1, S2, S4, S6, S8, S9 to S11 are NOT connected
     - Remove R5 (100K) Resistor
     - Remove R10 (10K) Resistor
     - Remove R6 (100K) Resistor
     - Remove R11 (100Ω) Resistor
     - Jumper Pin-1 to Pin-5 of Ch1
     - Connect jumper S4/Ch1 to Pin-2/Ch1
     - Connect Pin-4/Ch1 to Pin-10/Ch2
     - Set pot P1 of Ch1 to full CW position (Zero)
   - Channel-2:
     - Insert jumpers S22 & S23
     - Ensure jumpers S13 to S21 and S24 are NOT connected
     - Remove R13 (100K) & replace with 49.9K, 1% resistor
     - Remove R12 (100K) & replace with C1, 0.33mf, 35 VDC capacitor
     - Remove R17 (100K) resistor
     - Remove R22 (100Ω) resistor & replace with 'jumper'
     - Remove R21 (10K) & replace with 8.2K, 1% resistor
     - Remove R16 (100K) & replace with 20K, 1% resistor
     - Connect Pin-10/Ch2 to Pin-8/Ch2 and Pin-9/Ch2 to Pin-22/Sig Gnd
   - Monitor output voltage & frequency at Pin-5/Ch1 (Frequency should range from 25 to 300Hz by adjusting pot P7)
   - Check circuit & repeat set-up instructions if I/O conditions are NOT achieved

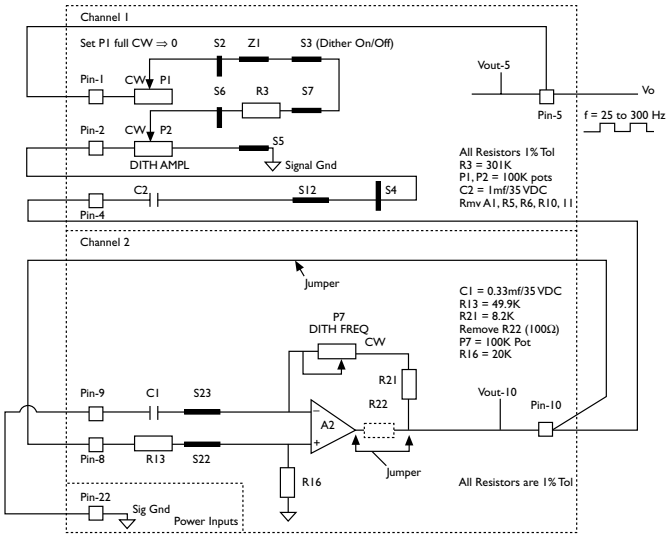


Fig.A – Model NF123-158B1; Converting Channel 1 &2 ⇒ Dither Generator w/Adj Sq Wave Freq = 25 to 300 Hz

SET-UP INSTRUCTIONS

1. Converting 4 to 20mA Input Command Signal ⇒ 0 to +10 VDC Output Signal
   - Select Ch1 and Ch2 for circuit configuration
   - Refer to Schematic Diagram – Figure 'A'
   - A1 of Ch1 is configured as a Differential Amplifier with a Gain of 2X
   - A2 of Ch2 is configured as an Inverting Amplifier with Zero Bias (offset) and Span (Gain) Adjust
   - Channel-1:
     - Remove R6(100K) Resistor
     - Install jumper Z3
     - Insert jumper S9 & S12 Only
     - Ensure jumpers S3, 4 and S7, 8 are NOT connected
     - Remove R5 (100K) & replace with 200K, 1% resistor
     - Remove R10 (10K) & replace with 200K, 1% resistor
     - Jumper Pin-5/Ch1 to Pin-8/Ch2
     - Install 250Ω, 1% resistor across Pins-3 and Pin-4 of Ch1 Input
   - Channel-2:
     - Install jumper S21
     - Ensure jumpers S15, 16 & S19, 20 & S23, 24 are NOT connected
     - Remove R16 (100K) & replace with 1K, 1% resistor
   - Apply a 4 to 20mA Input Signal to Pins 3 & 4
   - Measured voltage across Pins 3 & 4 should range from 1 VDC to 5 VDC (Voltage drop across 250Ω input resistor)
   - Monitor output voltage at A1/Pin-6 (Voltage should range from 2 VDC to 10 VDC)
   - Set Current Driver input signal to +4mA
   - Adjust BIAS (Zero Offset) pot (P8) to obtain 0 VDC at Test Point 'Vout-10'
   - Set Current Driver input signal to +20mA
   - Adjust GAIN (Span) pot (P7) to obtain +10 VDC at Test Point 'Vout-10'
   - Verify output voltage at Test Point 'Vout-10' is +10V
   - Ensure Span output (A2) does not enter saturation
   - Span & Zero interaction is Normal. Multiple iterations may be required. Continue to repeat adjustment until both are within specification (0 to +10V) without further adjustment.
   - Adjust Input Command from 4 to 20mA
   - Verify voltage range at Pin-10 is 0 to +10V as Current Input varies from 4 to 20mA
   - Check circuit & repeat set-up instructions if I/O conditions are NOT achieved

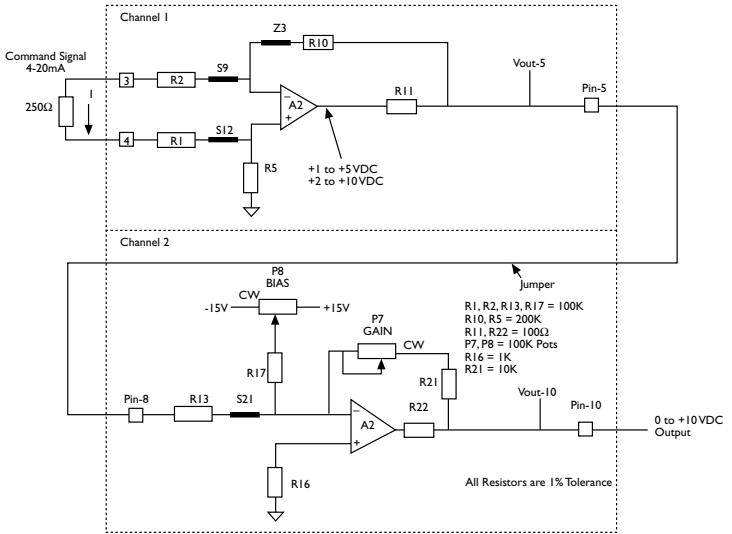


Fig.A – Model NF123-158B1; Converting 4 to 20 mA Input Command Signal ⇒ 0 to +10 VDC Output Signal

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2. Converting 4 to 20mA Input Command Signal ⇒ -10 to +10 VDC Output Signal (±10V)

- Requires selection of all 4-Channels for circuit configuration
- Refer to Schematic Diagram – Figure 'B'
- A1 of Ch1 is configured as an Inverting Unity-Gain Amp
- A2 of Ch2 is NOT used
- A3 of Ch3 is configured as a Differential Amp with a Gain of 1X
- A4 of Ch4 is configured as a Summer Amp with BIAS Adjust & fixed Gain of -5X
- Low-Pass Filter Section is re-configured as a +10 VDC Reference Supply
- Channel-1:
  - Install jumper Z3
  - Insert jumper S9 ONLY
  - Ensure jumpers S1 to S8 and S10 to S12 are NOT installed
  - Remove R10 (10K) & replace with 100K, 1% resistor
  - Remove R12 (100K) & replace with 2K, 1% resistor
  - Remove R5 (100K) & replace with 50K, 1% resistor
  - Jumper Pin-5 of Ch1 to Pin-4 of Ch1
  - Connect 'center' pin of jumper S11, 12 to Pin-6 of Ch2
  - I/O conditions:
    - Ch1/Pin-3 ⇒ +10 VDC Input
    - Ch1/Pin-5 ⇒ -10 VDC Output
    - Ch1/Pin-4 ⇒ -10 VDC Input
- Channel-2:
  - Install jumper Z4
  - Insert jumper S16 & S24 ONLY
  - Ensure jumpers S13 to S15 & S17 to S23 are NOT installed
  - Remove resistor R12 & R13 & replace with 2k, 1%
  - Connect 'center' pin of jumper S13, 14 to 'center' pin of S21,22
  - Connect Pin-8/Ch2 to Pin-28 ⇒ Power Supply Input Section
  - I/O conditions:
    - Ch2/Pin-6 ⇒ -10 VDC Input
    - Ch2/Pin-8 ⇒ +15 VDC Power Input
    - Ch2/Pin-9 ⇒ -3 VDC Bias Voltage Setting
- Channel-3:
  - Install jumper Z9
  - Insert jumper S33 & S36 ONLY
  - Ensure jumpers S25 to S32 & S34, 35 are NOT installed
  - Remove resistor R23, R24, R27 & R28 (100K) and R32 (10K)
  - Replace resistor R23, R24, R27 and R32 with 200K, 1%
  - Remove R28 (100K) resistor
  - Install 250Ω, 1% precision resistor across Pin-13 and Pin-14 of Ch3 Input
  - Connect Pin-15/Ch3 to Pin-18/Ch4 ⇒ A4 – Output Gain Stage
  - I/O conditions:
    - Ch3/Pin-13, 14 ⇒ +1 VDC @ 4mA to +5 VDC @ 20mA (250Ω load)
    - Ch3/Pin-15 ⇒ +1 to +5 VDC Voltage Swing
- Channel-4:
  - Install jumper Z12
  - Insert jumper S45 ONLY
  - Ensure jumpers S37 to S44 and S46 to S48 are NOT installed
  - Remove resistor R35, R38, R39 (100K) and R43 (10K)
  - Replace resistors R35 with 2K; R38 with 5K and R43 with 10K (1% toll)
  - Connect Pin-9/Ch2 to R39 (Pin-2) of Ch4
  - I/O conditions:
    - Ch4/Pin-18 ⇒ +1 to +5 VDC Input Range
    - Ch4/Pin-21 ⇒ ±10 VDC Output
- Low-Pass Filter Section:
  - Install jumper across R45 (NF = Not Furnished)
  - Replace resistor R46 (NF) with 27.4K, 1%
  - Replace capacitor C7 (NF) with a 10.0V Zener Diode – LM4040 type or equivalent (Anode to Gnd) – Label as DZ1 designation
  - Connect Pin-25 (Low-Pass Filter Section) to Pin-28 (Power Input Section)
  - Connect Pin-23 (Low-Pass Filter Section) to Pin-3 (Ch1)
  - I/O conditions: Low Pass Filter Section
    - Pin-23 ⇒ +10 VDC Ref Output
    - Pin-25 ⇒ +15 VDC Power Input
- Check circuit & repeat set-up instructions if I/O conditions are NOT achieved

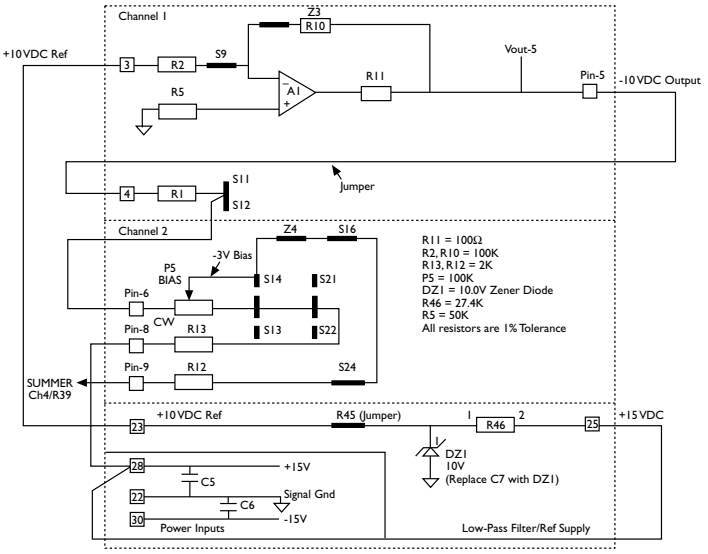

Fig. B – Model NF123-158B1; Converting 4 to 20 mA Input Command Signal ⇒ -10 to +10 VDC Output Signal (±10 VDC)

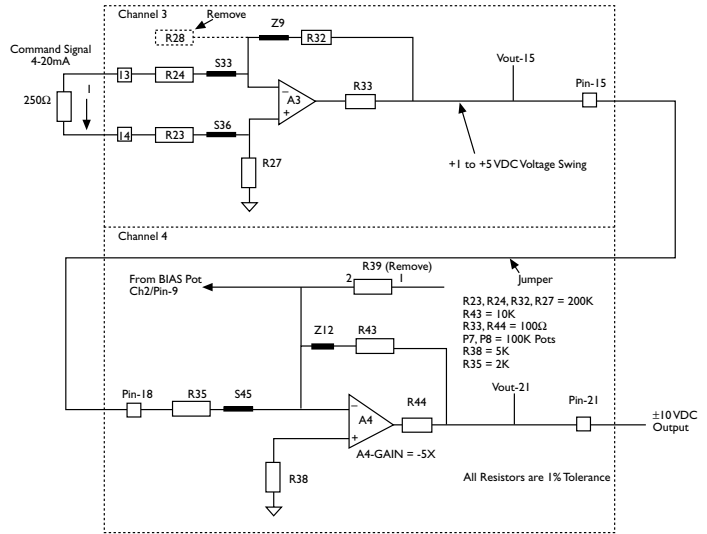

Fig. B – Model NF123-158B1; Converting 4 to 20 mA Input Command Signal ⇒ -10 to +10 VDC Output Signal (±10 VDC)

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SET-UP INSTRUCTIONS

Converting Channel-1 & 2 ⇒ 4 to 20mA Input Command = 0 to -10 VDC Output Signal

1. Select Ch1 and Ch2 for circuit configuration
2. Refer to Schematic Diagram – Figure 'C'
3. Install jumpers between Pin-5 (Ch1) & Pin-6 (Ch2) and Pin-15 (Ch3) & Pin-16 (Ch4) for proper operation
4. Refer to diagram for component installation/values including jumper locations
5. Channel-1: Connect current source to Input Pins 4 (+) & 3 (-)
   - Set Current to 0.0mA
   - Monitor voltage at Vout-5
   - Adjust P4 for 0 VDC
6. Set current Input to +20.0mA
   - Adjust P3 for +10.0 VDC at Vout-5
   - Set Current to +4.0mA
   - Verify +2.0 VDC at Vout-5
7. Channel-2: Adjust P5 fully 'CW' and P7 fully 'CCW'
   - Set Current to +4.0mA
   - Adjust P8 for 0.0 VDC at Vout-10
8. Set current to +20mA
   - Adjust P7 for -10.0 VDC at Vout-10
   - Verify 0.0 VDC at +4.0mA Input
9. Check circuit & repeat set-up instructions if I/O conditions are NOT achieved

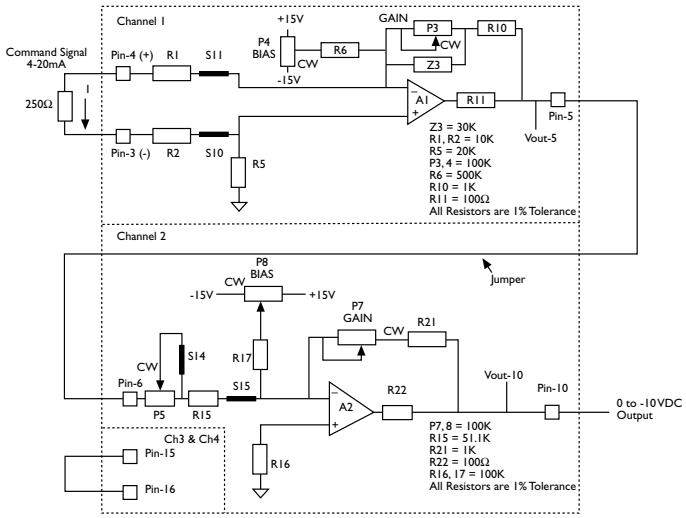

Fig. C – Model NF123-158B1; Converting 4 to 20 mA Input Command Signal ⇒ 0 to -10 VDC Output Signal

SET-UP INSTRUCTIONS: INVERTING AMP TO NON-INVERTING AMP

Converting ±1 VDC Input Command Signal ⇒ ±10 VDC Output (Non-Inverting) Signal

- Select Ch1 for circuit configuration
- Refer to Schematic Diagram
- A1 of Ch1 is configured as a Non-Inverting Amplifier with a Gain of 1X to 21X
- Channel-1:
  - Insert jumper Z1, S1, S3 & S10 Only
  - Ensure jumpers S2, S4, S5 thru S9, S11, S12 & Z2, 3 are NOT connected
  - Remove R2 (100K) resistor & replace with jumper
  - Remove R5 (100K) resistor from circuit
  - Remove R10 (10K) resistor & replace with jumper
  - Set P1 potentiometer to 5K
  - Connect Pin-15/NF122-202A1 to Pin-3/Ch1
  - Connect Pin-22 (Gnd)/NF122-202A1 to 'Gnd' side of R5 resistor (Pin-2)
  - DO NOT use Pin-1/Ch1 of the NF123-158B1
- Apply a ±1 VDC Input Signal across Pin-3 to Ground (Pin-22)
- Measured voltage across Pin 3 to Ground (Pin-22) should range from ±1 VDC to -1 VDC (Input Signal from NF122-202A1 Card)
- Monitor output voltage at Pin-5/Ch1
- Gain = e_o/e_{in} = (1 + P3/P1) ⇒ Non-Inverting Amplifier Configuration
- Calculated Gain Range = 1 min to 21 max
- With ±1 VDC Input Signal @ Pin-3/Ch1, adjust P3 (GAIN) pot for ±10 VDC Output (Non-Inverting) @ Pin-5/Ch1. Verify.
- Check circuit & repeat set-up instructions if I/O conditions are NOT achieved

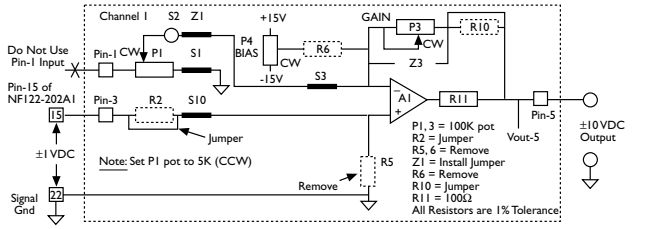

Fig. D – Model NF123-158B1; Converting ±1 VDC Input Command Signal ⇒ ±10 VDC Output (Non-Inverting) Signal

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