

# MOOG

## N123-138 Series Snap Trac Dither Generator and General Purpose Amplifier

### SPECIFICATIONS

#### Dither Generator

Square wave at terminal 2.

Triangular wave at terminal 6.

Frequency  $\approx$  400 Hz.

Frequency range of 0.05 to 1000 Hz can be obtained by changing R9 and/or C3 (20K $\Omega$  to 10M $\Omega$  and 0.01 $\mu$ F to 5 $\mu$ F).

$$\text{freq} = \left( \frac{1}{4 \cdot R9 \cdot C3} \right) \text{ Hz}$$

Amplitude  $\approx$  16 volts peak-to-peak (each waveform).

See servovalve catalog for recommended dither amplitude and frequency.

Servoamplifier or general purpose amplifier may be used for amplitude adjustment.

Minimum load resistance: 20K $\Omega$  on terminal 2; 5K $\Omega$  on terminal 6.

#### Temperature Range:

-20°C to 50°C (-4°F to 122°F)

#### Power Required:

$\pm$ 15.0VDC at  $\pm$ 17mA, regulated, 3-wire ( $\pm$ E) at terminals 7, 8, and 9.

This power is available from Model N121-132 Snap Trac Servocontroller.

The N123-138 Snap Trac Dither Generator and General Purpose Amplifier contains a signal generator that supplies square and triangular waveforms that may be used for dither in an electrohydraulic servosystem. Dither is typically used to reduce system threshold caused by actuator and/or servovalve friction. The general purpose amplifier may be used for low level amplification of a signal, or may be custom modified if desired.

### SPECIFICATIONS

#### Amplifier

##### Inputs:

Two individual inputs at terminals 10 and 11; or differential input between terminals 10 and 11.

Input signals may range from  $\pm$ 0.1VDC to 100VDC.

##### Output:

Output at terminal 12.

Load impedance  $\geq$  5 K $\Omega$ .  $\pm$ 10VDC maximum output.

##### Gain:

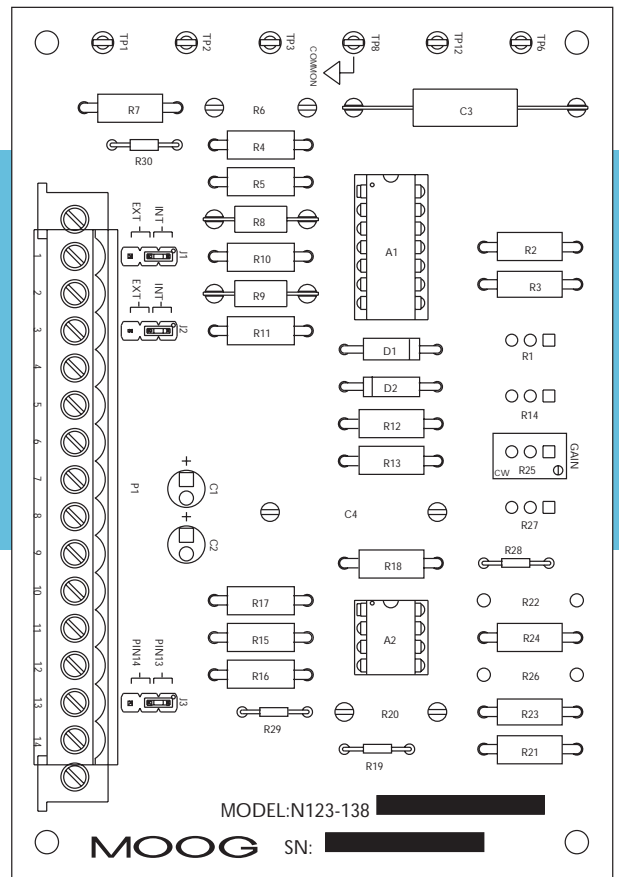
General expression for amplifier gain with R16 = R18, R15 = R17, J6 = R19 = Jumper and R25 full CW:

$$e_{12} = (e_{11} - e_{10}) \left( \frac{R_{16}}{R_{15}} \right) \left( 1 + \frac{R_{24} + R_{25}}{R_{23}} \right)$$

### DIMENSIONS

3.25 in width x 4.70 in length

Maximum Component Height: 0.69 in

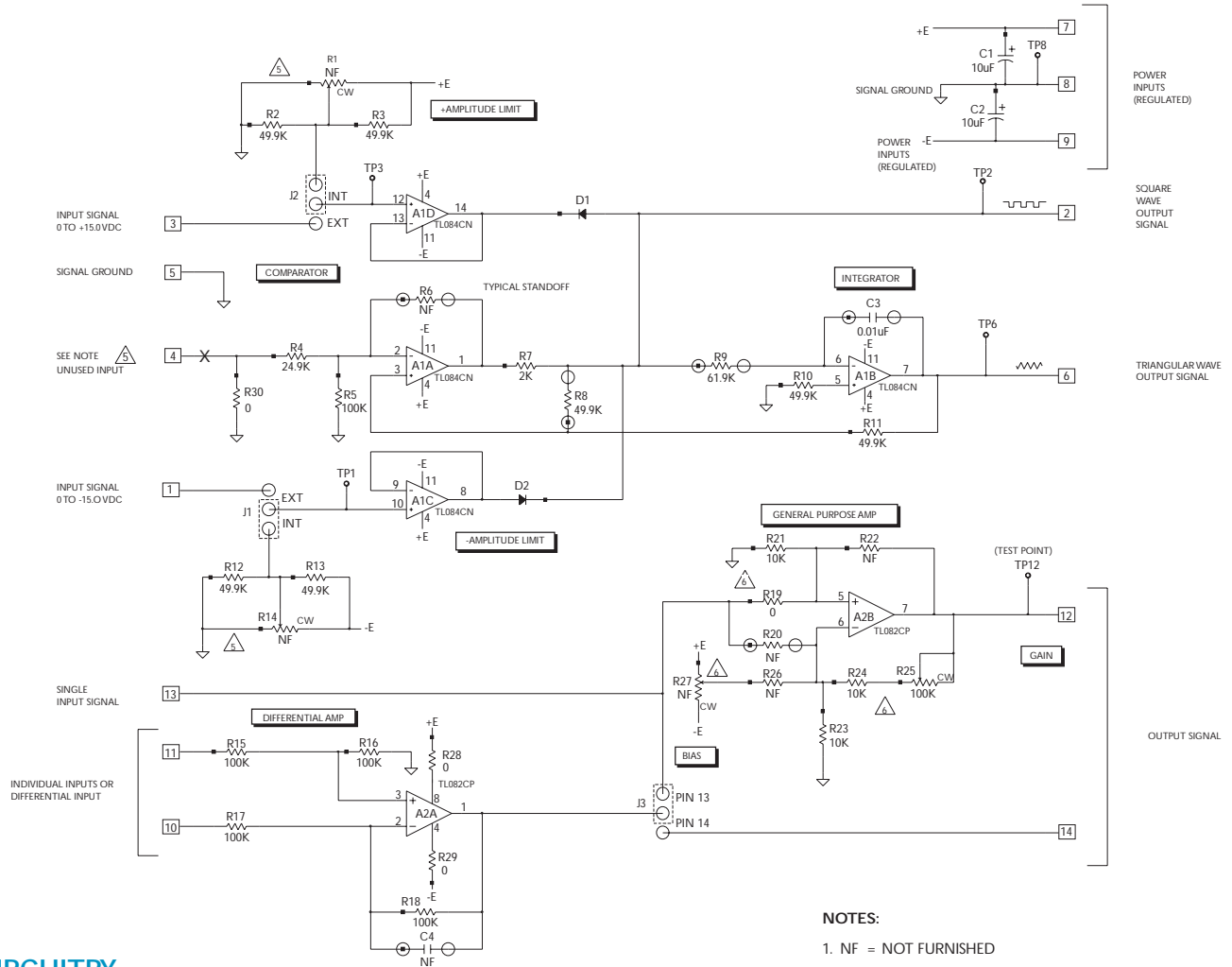


### FEATURES

#### Construction

- Plug-in connectors for quick installation of board.
- Test points on all critical signals.
- Component standoffs on all user-configurable components.
- Twenty-turn potentiometers for all adjustable controls.
- Rugged construction with solder mask.

# N123-138 DITHER GENERATOR AND GENERAL PURPOSE AMPLIFIER



## CIRCUITRY

### Dither Generator

The dither generator consists of a comparator stage (A1A), amplitude limiting stages (A1C/D2 and A1D/D1) and an integrating amplifier stage (A1B). Upon startup, A1A will attempt to go to + or - saturation. However, the peak voltage will be limited to approximately  $\pm 8$  VDC by D1/A1D or D2/A1C. A1B ramps up or down, as the case may be, until the output voltage is sufficient to cause the feedback voltage at the comparator (through voltage divider R8, R11) to change polarity. At this point, A1A switches polarity and A1B begins to ramp in the opposite direction.

### General Purpose Amplifier

A differential input amplifier (A2A) and a non-inverting amplifier (A2B) are mounted on this board for general signal amplification. Input signals are applied to terminal 10 and 11, with the output signal at terminal 12. Amplification of each stage should be between 0.1 and 10 volts/volt with resistor values between  $10\text{K}\Omega$  and  $100\text{K}\Omega$ .

## NOTES:

1. NF = NOT FURNISHED
  2. ■ = PIN 1 (SQUARE PIN)
  3. ⊕ = INDICATES COMPONENT MOUNTED ON STANDOFFS
  4. CW = CLOCKWISE
- ⚠ DO NOT CONNECT DC SIGNAL TO PIN-4. REFER TO SET-UP INSTRUCTION SECTION FOR ADDITIONAL INFORMATION.  
 ⚠ REFER TO "SPECIAL MODIFICATION" OPTIONS

## ADJUSTMENTS

**Gain (R25)** – provides 12:2 amplification range of A2B.

**Bias (R27)** – not furnished. (Recommended size is 100K)

## SPECIAL MODIFICATIONS / SET-UP / OPTIONS

Refer to section on set-up instructions and technical information for additional assistance on card usage and application. R1, R14, R27, R26, R24, R19 sizing options are located in set-up instruction section of literature.

## MOUNTING:

Mount using Curtiss type TR-3 plastic track (Moog P/N 65419-1)

## SET-UP INSTRUCTIONS

The card is factory built to supply a Dither Frequency of Approx. 400Hz

### Calculated Outputs

- > Determine required Dither frequency needed
- > Calculate Dither Frequency ➔  
 $f_{DITHER} = [1 / (4 \times R9 \times C3)] \text{Hz}$  (using Triangle waveform)
- > Refer to Servovalve Catalog for recommended dither amplitude & frequency; Consult factory as required
- > Use Square Waveform for most valve applications
- > Steady State Triangular Waveform output at Pin-6:  
 $E6 = (R5 / R4 + R5) E4$   
 Vdc (Error Correction)
- > Slope of Output:  
 $\text{Slope} = (-E2 / R9 \times C3)$   
 Volts/Sec  
 Pos Slope Rate = +12V/msec  
 Neg Slope Rate = -12V/msec

### Preliminary Test Set-Up

- > R25 full CCW
- > Set Jumpers J1 & J2 to INT (Internal) position
- > Set J3 to PIN-13 position

### EXT (External) Control of Ramp Rate

- > For + Slope, J1 = EXT
- > Rate controlled by input signal at Pin-1 (0 to -15V)
- > For - Slope, J1 = EXT
- > Rate controlled by input signal at Pin-1 (0 to +15V)

### Frequency Test Set-Up

- > Verify Dither Frequency signal at TP2 is 400±40 Hz
- > Verify factory set Amplitude at TP2 is 16Vp-p

### For Slope or Ramp Adjust Capability over 12:2 range

- > Install a 100K pot in the R1 & R14 position
- > Remove R2, R3, R12 & R13 (49.9K) resistors
- > Adjusting R1 will increase the Neg Slope of the waveform
- > Adjusting R14 will increase the Pos Slope of the waveform
- > Offset Voltage may be provided by R1 & R14 which will result in unsymmetrical waveforms

### Setting the (+) Amplitude Limit

- > R2 & R3 (49.9K) resistors provides a balanced positive voltage divider (+15V)
- > This along with D1 / A1D limits the Pos. Peak voltage to +8Vdc (Approx. 1/2 of +15V)

### Setting the (-) Amplitude Limit

- > R12 & R13 (49.9K) resistors provide a balanced negative voltage divider (-15V)
- > This along with D2 / A1C limits the Neg Peak voltage to -8Vdc (Approx. 1/2 of -15V)

### General Purpose Amplifier

- > The General Purpose Amplifier can be used for Dither Amplitude Adjustment using R25 of A2B Non-Inverting Stage ➔ provides 12:2 amplification range
- > Auxiliary Non-Inverting Amplifier (A2B): Gain Equation  

$$A_v = \text{Gain} = e12 / e13 = [1 + (R24 + R25) / R23]$$

- > A differential input Amp (A2A) & a Non-Inverting Amp (A2B) are supplied for general signal amplification
- > J3 provides jumper select options to "combine" or "isolate" stages A2A & A2B

- > Input signals are applied to Differential Pin-10 & Pin-11 with output signal at Pin-12

OR

- > Connect Pin-2 (Sq Wave output) or Pin-6 (Triangle Wave output) to Pin-13 (Single Input Signal) for Amplitude Adjust using R25 with output signal at Pin-12

- > With Input applied to Pin-11 and Pin-10 grounded, a positive output will result
- > Adjust R25 for 12:2 ratio amplification ➔ ±10Vdc max output is possible
- > Zero Offset pot (R27) may be installed for Bias control of signal; Set R27 to 100K Pot and R26 to 100K / 1% resistor
- > Set Gain Pot R25 (Amplitude Adj) full CCW for min Gain / full CW for max Gain

### Special Modification Information / Options

- > Comparator Stage (A1A)  
 Configured as a 'Square-Wave' Generator providing a 400Hz Square Wave output signal at Pin-2. A 'Triangular-Wave' output signal at Pin-6 is provided via use of Integrator Stage (A1B) with frequency dependent on selection of R9 & C3.
- > No Input Signal is required at Pin-4 with R30 connected to ground via 0Ω jumper
- > R9 & C3 are installed at factory to provide a fixed 400Hz frequency at approximately 16VP-P amplitude. Amplitude may be varied by using General Purpose Amplifier Stage.
- > Other frequencies from 0.05Hz to 1KHz are available by changing R9 & C3

### General Purpose Amplifier (A2B)

- > Gain ➔  $e_o / e_{in} = [1 + (R24 + R25) / R23]$
- > Configured as a 'Non-Inverting' Amplifier for general signal amplification with optional NF component selection / sizing & re-configuration options
- > Input Amplification resulting in Output Voltage >10Vdc are limited by Saturation
- > R25 provides 12:2 amplification range of A2B
- > R19 may be adjusted to obtain Custom Signal Scaling (See Application Example)
- > R24 may be adjusted to obtain a different amplification range including:

Examples

R24	Min Gain	Max Gain	Max Output @ Pin-12
0Ω jumper	1	11	±10Vdc
1K	0.1	11.1	±10Vdc

### Example: Custom Signal Scaling Application using Aux Amp

- > Scaling ±8Vdc Input Square Wave ➔ ±1Vdc at Output Pin-12
- > Refer to Fig. A

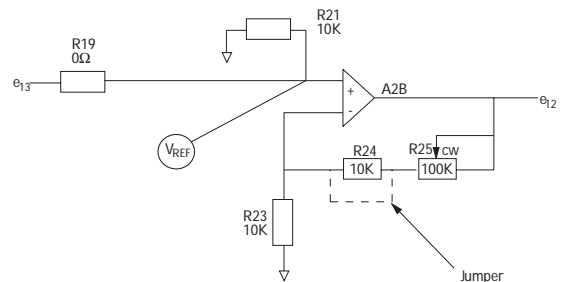


Fig A - General Purpose Amp Configuration

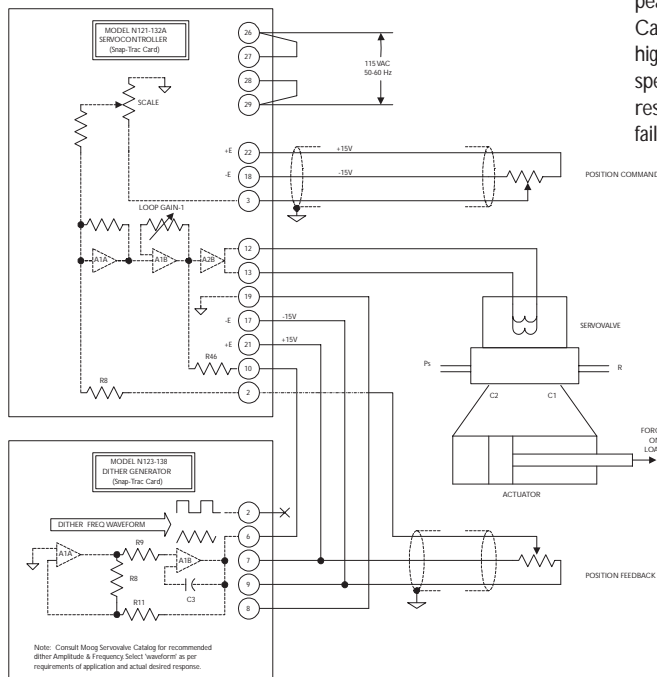
## SET-UP INSTRUCTIONS

- Determine  $V_{REF}$  needed to reduce +8v to +1v
- Calculate resistor value R19
- Jumper R24 (This changes Gain Ratio from 12:2 to 11:1)
- Remove R19 (0 $\Omega$ ) & replace with 70K, 1% resistor
- Set R25 Pot full CCW for 'Min' Gain of '1'
- Verify +1Vdc Output at Pin-12

### Calculations

- @1Vdc =  $V_{REF}$     ➔     $V_{REF} = +e_{13} [R21 / (R21 + R19)]$
- Solve for R19       ➔     $R19 = 70K$
- Calculate Gain      ➔     $e_{12} / e_{13} = [1 + (R24 + R25) / R23]$
- With R24 = 0       ➔    Min Gain = 1 @ R25 full CCW
- ➔    Max Gain = 11 @ R25 full CW
- Resultant Output   ➔    +1Vdc Output @ Pin-12 @ +8Vdc Input

## CLOSED LOOP POSITION CONTROL



Position Servo with Dither Generator Application

## Questions & Answers

**Question:** Can the Dither Frequency be set-up for either a 'square wave' or 'triangular wave'?

**Answer:** The valve is usually run with the square wave output signal but will depend on the actual desired response. Square wave will provide a more abrupt control from hard over position whereas the Triangular wave will provide a softer control response. It will depend on valve 'friction' or 'sticking' action caused by actuator or servovalve response. Research indicates that the type of waveform, whether sine, square or triangular shape, will not significantly effect the valve performance. It is strictly related to required frequency & amplitude for the specified valve hardware.

**Question:** Does the type of servovalve used determine the frequency & amplitude?

**Answer:** The card is factory set for 400Hz frequency with an amplitude of 16Vp-p. The Moog Servovalve Catalog should be consulted for recommended dither amplitude & frequency. If a competitors valve is used, consult the appropriate Factory as required. The actual frequency / amplitude will also be determined on the system set-up. Fine tuning may need to be applied to reach satisfactory results. As an example, a 760 Series valve may require a dither frequency of approximately 400Hz at a current amplitude of 10mA peak-to-peak (series coil configuration). Caution is advised since the use of higher dither frequency other than specified, can excite internal valve resonance which may lead to valve failure or degrade the valve life. Proper

amplitude (% of valve current) should also be stressed so as not to exceed 20% of rated current.

**Question:** What purpose do the NF (non-furnished) components provide in the circuit such as pots R1, R14 and R27? What are the recommended component sizes for setting up these feature adjustments?

**Answer:** Installation of R1 provides adjustment of the 'negative' slope or ramp rate over a 12:1 ratio. R14 provides adjustment of the 'positive' slope or ramp rate over a 12:1 range. Recommended size is 100K for each. The voltage divider resistors must be removed for this feature to operate. (Remove R2, 3, 12 & 13)

**Question:** What is the purpose of the Auxiliary general purpose amp?

**Answer:** This stage is used for Dither Amplitude Adj using R25 (Gain) pot of A2B Non-Inverting Stage. Connect Output Pin-2 (Sq Wave) or Pin-6 (Triangle Wave) to Pin-13 (Single Input Signal) for amplitude adjustment using R25 for a 12:2 ratio amplification. A Zero Offset pot (R27) may be installed for 'Bias' signal control. Set R27 to 100K Pot & R26 to 100K / 1% resistor.

**Question:** How much Dither should be applied?

**Answer:** If external dither is applied to Pin-1 or Pin-3, typically adjust for  $\pm 10\%$  of valve rated current. J1 & J2 MUST be in the appropriate position. This follows true for Internal dither. Internal dither  $\pm$ Slope is adjusted by pots R1 & R14 (customer installed). Dither current thru a servovalve should NOT exceed 20% of rated current.

**MOOG**  
Industrial Controls Division  
Moog Inc., East Aurora, NY 14052-0018  
Telephone: 716/655-3000  
Fax: 716/655-1803  
Toll Free: 1-800-272-MOOG