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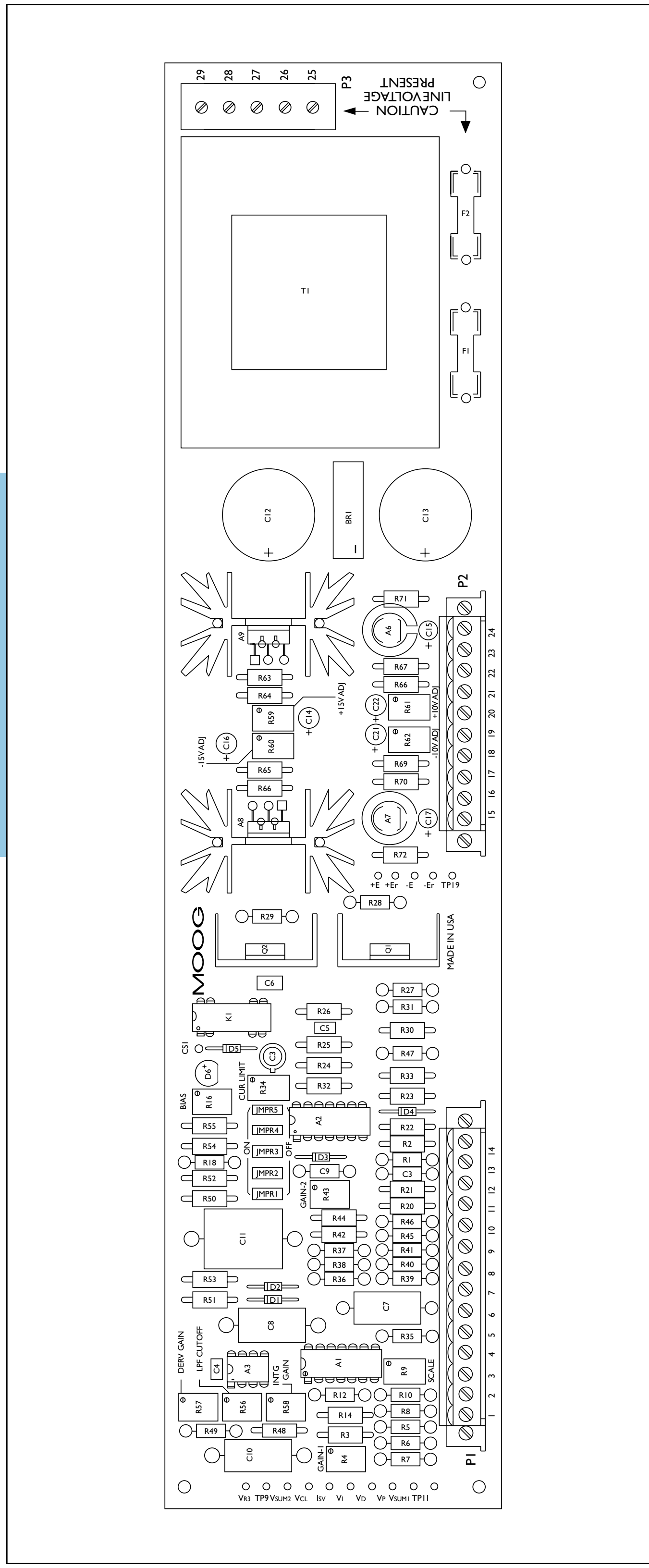
N121-132A Servocontroller
N122-142A Servoamplifier



SPECIFICATIONS

Servoamplifier

Proportional Gain:
10 to 210 mA/V

Integral Gain:
10 to 5000 mA/V-s

Derivative Gain:
0.01 to 3 mA-s/V

Input Levels:
≤ ± 15 Vdc (±10 Vdc nominal)
on terminals 1, 2, 6 & 7
≤ ± 120 Vdc on terminal 3

Voltage Drive to Valve:
≤ ± 10 Vdc nominal

Current Drive to Valve:
± 120 mAdc maximum*

Drift:
≤ 0.15 mV/°C with:
100kΩ inputs, gain ≥ 5 mA/V

Temperature Range:
-20°C to 50°C (-4°F to 122°F)

Frequency Response:
± 0 dB, 45° phase lag @ 1250 Hz
with load of 0.4 Henries

Linearity:
± 3% full scale

Relay Ratings:
consumption: 15 mA @ 24 Vdc

* Dependent on resistance of servovalve coil, R_{coil}
$I_{max} = 11v / [(R27 + 20) + R_{coil}]$
R28, 29 = 4v / Irated (Q1, Q2 collector supply)

The N121-132A Snap Trac Card contains a complete DC servo amp together with a DC power supply consisting of an AC to DC rectifier and voltage regulators. The servo amp is designed to drive a servo valve with ± DC current having high dynamic response and negligible drift.

The N121-132A Snap Trac Servocontroller contains all the features of the N122-142A Servocontroller, with the addition of a built-in power supply. It is a forward compatible replacement for both the 121A132 and 121B132.

The N122-142A Snap Trac Servoamplifier is designed to drive servovalves or proportional valves in open-loop or closed-loop servo systems. It provides any combination of proportional, integral, and derivative control (PID) and requires an external regulated power source. The N122-142A is a forward compatible replacement for both the 122A142 and 122B142.

SPECIFICATIONS

Power Supply (N121-132A only)

Input Voltage:
105 Vac to 130 Vac, 50 Hz to 60 Hz
or
210 Vac to 250 Vac, 50 Hz to 60 Hz

Power Consumption:
≤ 50 VA

Power Available:
± E: ±550 mA @ ± 15 Vdc regulated
± E_r: ±100 mA @ ± 10 Vdc regulated
± V: ±500 mA @ ± 15 to ± 22 Vdc unregulated
Note: Total load on three supplies cannot exceed ±650 mA with 100mA current drain.

Regulation:
Load Regulation: ± E
≤ ± 5 mV, 0 to 150 mA
Load Regulation: ± E_r
≤ ± 50 mV, 0 to full load
Line Regulation
≤ ± 3 mV, 105 to 130 Vac
Ripple
≤ ± 3 mV peak to peak
Temperature Stability
≤ ± 130 ppm/°C

Adjustability Range:

+E	(R59)	+14 to +16 volts
–E	(R60)	–14 to –16 volts
+Er	(R61)	+9.5 to +10.5 volts
–Er	(R62)	–9.5 to –10.5 volts

DIMENSIONS

Model N122-142A: 3.25 in x 7.50 in
Model N121-132A: 3.25 in x 14.00 in
Maximum Component Height:
2.42 in (both)

FEATURES

Construction

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

PID Control

- Jumper-selectable proportional, integral, and derivative control.
- Independent PID gain adjust.
- Adjustable low-pass filter on derivative control.
- Integrator reset function activated by external signal.

Error-Summing Input Stage

- Three standard inputs can be re-configured for differential input.
- Independently adjustable gain, scale, and bias potentiometers.
- Easily accessible test point at summed error signal for monitoring.

Current Drive Stage

- Compatible with all Moog servovalves.
- Jumper-selectable voltage drive configuration for proportional valves.
- Short-circuit (momentary) overcurrent protection.
- Adjustable current limiting to restrict maximum valve flow.

SPDT Relay Section

- Jumper-selectable HI (5 - 15 Vdc) or LOW (0 Vdc) activation logic state.
- May be used for integrator reset, signal switching, or other functions.

Auxiliary Error Summing/Signal Processing Section

- Two standard inputs can be re-configured for differential input.
- User-configurable signal frequency compensation, inverter, or buffer possible.
- Independent gain control allows scaling of external signals.

Inner-Loop Inputs

- Proportional input for control of inner-loop, such as 3rd stage spool control.
- Second input can be used for Feed-Forward or Dynamic Pressure Feedback.

Built-in Regulated Power Supply (N121-132A only)

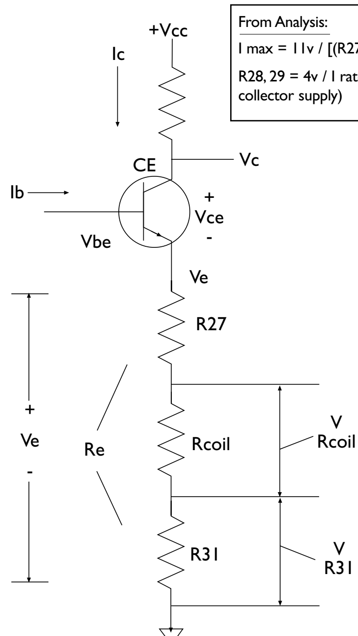
- Four independently adjustable regulated outputs and two unregulated outputs.
- Industry standard regulators bolster overload current protection.
- Plug-in connector for powering external devices or other Snap Trac modules.
- Reference voltage output for load cell or other strain gauge transducer excitation.
- Power fuses protected by snap-on plastic covers for personal safety.

CIRCUIT ANALYSIS

From Analysis:

$I_{max} = 11v / [(R27 + 20) + Rcoil]$

R28, 29 = 4v / I rated (Q1, Q2 collector supply)



Common-Emitter Configuration:

$Ic = Vcc / (Re + RL + Rb/B)$
$Vce = Vc - Ve$
$Ve = Ic \times Re$
$Ic = Vcc / (Re + RL + Rb/B)$
$Ve = Ie \times Re = Ic \times Re$
$Ie = Ic$

ADJUSTMENTS

Servoamplifier

R4 GAIN-1 Changes gain of error-summing input stage if Proportional Jumper is on. Turn CW to increase gain. Adjust for closed-loop system stability. Provides 1:21 gain range.

R9 SCALE Changes authority of signal on terminal 3. Turn CW to increase authority. Adjust to provide scaling of the higher magnitude signal (command or feedback) at terminal 3. Provides 0 to 110% sensitivity for input at terminal 3.

R16 BIAS Changes the bias voltage to the current drive amplifier. Turn CW for positive bias voltage. Adjust for desired offset between command and feedback, or to electrically null a servovalve. Change R18 (20K to 10M) to adjust range of bias adjustment if necessary. A lower value of R18 will increase range of bias.

R34 CURRENT LIMIT Adjusts maximum current deliverable to the servovalve. Can be used to restrict valve flow and velocity in a positional servo system. Turn CW to increase maximum current. Adjusts max servovalve current between ≈9 mAdc and full output.

R43 GAIN-2 Changes gain of the auxiliary error-summing/signal processing input stage. Turn CW to increase gain. Provides 1:21 gain range.

R56 FILTER FREQUENCY Changes the corner frequency of low-pass filter on differentiator. Turn CW to decrease frequency and increase filtering action. Adjust to reduce excessive noise from derivative section.

R57 DERIVATIVE GAIN Changes derivative gain if Derivative Jumper is on. Turn CW to increase gain.

R58 INTEGRAL GAIN Changes integral gain if Integral Jumper is on. Turn CW to increase gain.

JMPR1 MODE JUMPER Places servoamplifier into either current or voltage drive mode, dependent on valve requirements. Select "OFF" for current drive mode, select "ON" for voltage drive mode.

JMPR2 DERIVATIVE JUMPER Select "ON" to add derivative control.

JMPR3 INTEGRAL JUMPER Select "ON" to add integral control.

JMPR4 PROPORTIONAL JUMPER Select "ON" to add proportional control.

JMPR5 RELAY LOGIC JUMPER Changes activation state of relay. Select "OFF" for active-low state; grounding terminal 14 will cause relay to activate, resetting integrator. Select "ON" for active-hi state; supplying +5 to +15 Vdc to terminal 14 will cause relay to activate.

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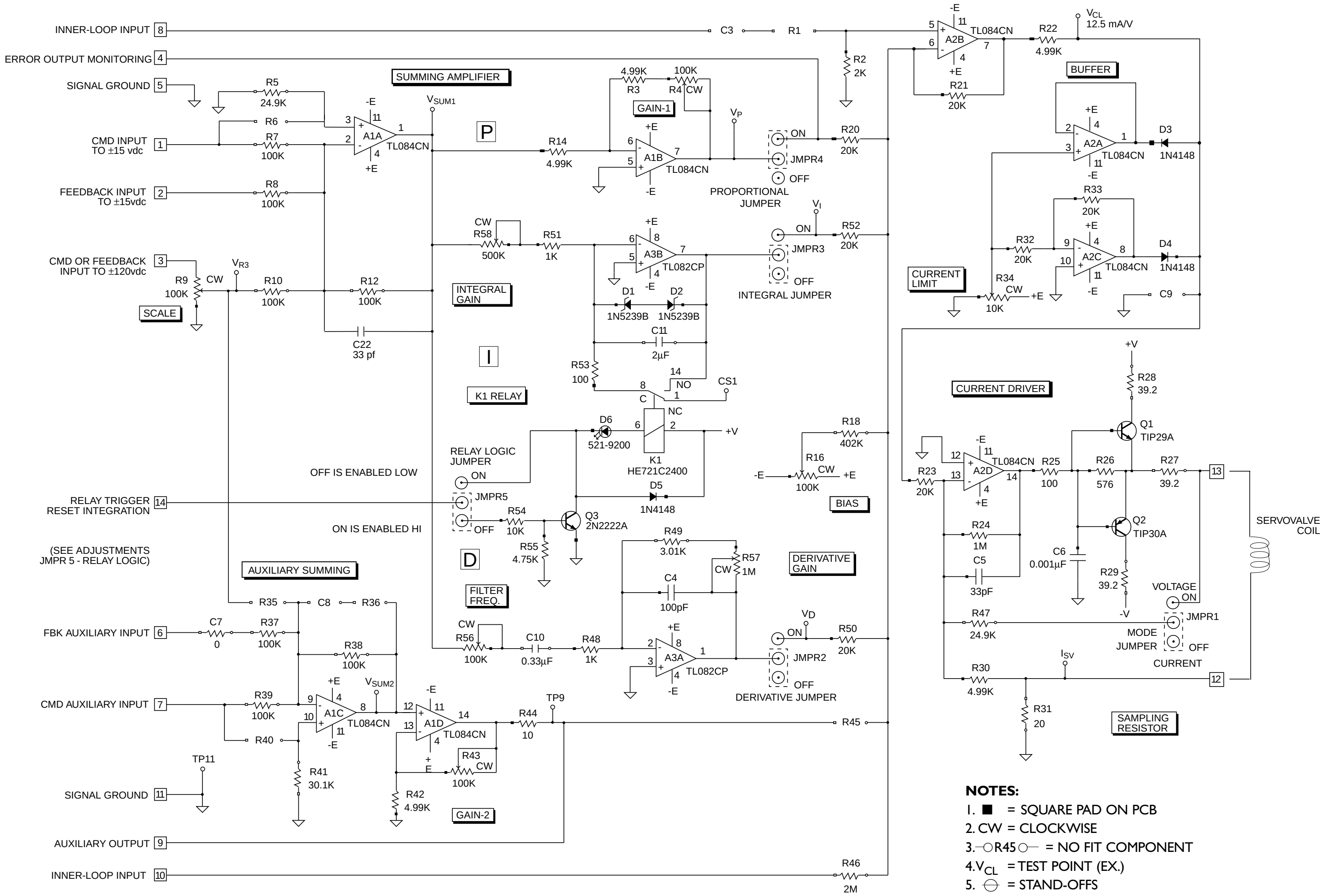
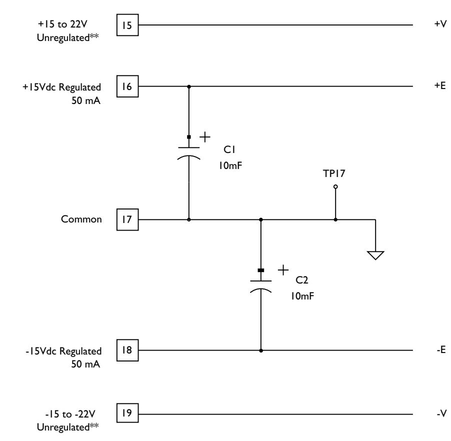
SERVOAMPLIFIER/SERVOCONTROLLER SCHEMATIC



NOTES:

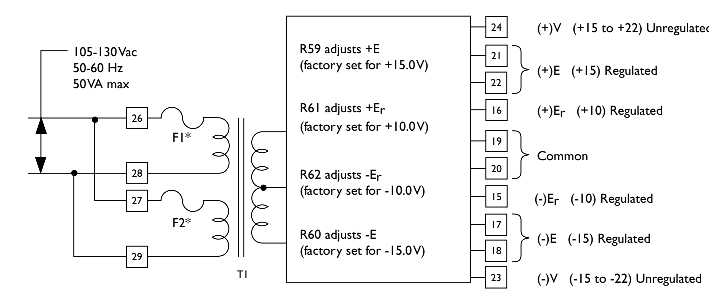
1. ■ = SQUARE PAD ON PCB
2. CW = CLOCKWISE
3. –○R45○– = NO FIT COMPONENT
4. V_{CL} = TEST POINT (EX.)
5. ⊖ = STAND-OFFS

POWER INPUT (N122-142A ONLY)

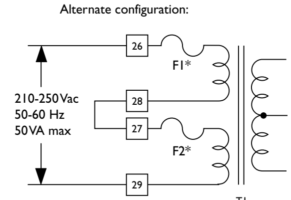


** @ rated valve current. The unregulated power (±V) can be supplied from the regulated power source (± E) if adequate capacity is available.

POWER SUPPY SECTION (N121-132A ONLY)



Alternate configuration:



* F1 and F2 are 0.5A slow-blow fuses.

CAUTION: Polarities must be observed-serious damage or personal injury may result.

CIRCUITRY

The Servoamplifier consists of several main control stages including an Input Summer stage (AIA). independent PID control stages - proportional gain (AIB). integral gain (A3B) & adjustable low-pass filter control on derivative stage (A3A) - an Inner Loop input stage (A2B). and a Current Driver output stage (A2D and Q1/Q2) with current limiting amplifiers (A2A / A2C). An additional auxiliary input stage (AIC) and gain control stage (A1D) is provided for enhanced configuration options. The Input Stage (AIC) Is available for such configuration options as a summer or lag / delay compensation. The Gain Stage (AID) is available for such functions as proportional, integral, lag-lead, lag only compensation or derivative-lag control of inner loop feedback signals. R56 changes the corner frequency of the low-pass filter & reduces noise from the derivative loop section. R57 changes derivative 'Gain'. R4 changes proportional 'Gain' from 1:21 range. R58 is used to change integral loop 'Gain'. Refer to 'GAIN' section for technical analysis & details.

The input stage (AIA) 'sums' signals applied to terminals 1, 2 and 3. Servo feedback is normally connected to terminal 2 and servo command to terminal I. An additional feedback or command may be connected to terminal 3 which can provide 'scaling' of higher magnitude signals.

Null Bias of the servoamp is accomplished by adjusting Bias Pot (R16). Jumper select PID Control is provided for servovalve control set-up and 'tuning'. An Integrator reset function may be activated by external signals. A SPDT Relay is provided which may be used for integrator reset, signal switching, or other function.

Inputs to stages AIA and auxiliary stage AIC may be configured as a 'Differential Amplifier' if desired. The auxiliary stage (AIC) may also provide other useful configurations or options Including signal frequency compensation, polarity inverter or Buffer capabilities.

The Output of Summing stage (AIA) is amplified by Proportional Gain Stage (Al B) and is also available at terminal 4 which can also be used for Error Output Monitoring. Terminal 8 is provided as an Inner-Loop input option with components C3 and Rl (Not Furnished) used for differentiation of the feedback signal. C22 (across R12 of AIA) provides frequency compensation & stability.

The additional auxiliary input stage (AIC) 'sums' signals applied to terminals 6 & 7. This 'summed' signal is applied to the +positive or non-inverting terminal of Al D to obtain a non-inverted amplifier signal at test point TP9 or auxiliary output terminal 9. An output signal can be provided at terminal 9 or may be summed at stage A2B with the insertion of 'plug-in' resistor R45 usually set to 20K. This resistor can easily be inserted using the provided component 'stand-offs'. A 'Lag' or 'Delay' network may be configured using input stage (A1C) and feedback components C8 and R38.

The input at terminal 10 (Inner-Loop Input) is typically used to provide 'Dither' on the output current as required. Component locations are provided for R22 and C9 which may be used to add a first-order roll off filter. Operational Amplifier stages (A2A & A2C) can limit the output current by limiting the voltage input to the Current Driver stage (A2D).

The 'Current Driver' output stage (A2D) controls the voltage across the sampling resistor (R31) when a load (servo valve coil) is connected across Terminal 12 & 13. Since R31<< R30, the current through the 'load' (I_{SV}) is approximately equal to the voltage across the sampling resistor divided by its resistance (R31 = 20Ω) in ohms. This current drive output stage makes the servoamplifier 'Gain' independent of changes in coil resistance and minimizes the dynamic effects of servovalve coil inductance. By monitoring voltage at Test Point - I_{SV} to Ground, the current through the load or coil can be calculated. Current Drive to Valve rating is ±12OmA dc Maximum. The Driver may be configured for ±6OmA by properly sizing components R27, 28 & 29. Current range capability is dependent on the resistance of the servovalve coil (R_{COIL}) See Specifications.

Resistors R27, 28 and 29 provide momentary ground shorting protection.

GAIN

Proportional Loop Gain: Inverting Amp (A1B)

- Gain = -[(R4 + R3) / R3]
- Min Gain = 1; Max Gain = 21

Integral Loop Gain: Inverting Amp (A3B)

- $R_{IN} = R_{58} + R_{51}$
- $e_o = -(1/R_{IN}\, C_{11}) \int e_{IN}\, dt$ ⇨ $-(e_{IN} / R_{IN}\, C_{11})\, t + C_{11}$
- $e_o / t\, e_{IN} = 1 / R_{IN}\, C_{11}$ ⇨ where V / V-sec = $1 / R_{IN}\, C_{11}$

Differential Loop Gain: Inverting Amp (A3A)

- $e_o = -Rf\, C_{10}\, d/dt\, e_{IN}$ ⇨ where $Rf = R_{49} + R_{57}$
- $e_o / e_{IN} = Rf\, Cs / R_{IN} Cs + 1$ ⇨ Lag
- $e_o = -e_{IN}\, (Rf\, Cs)$ ⇨ Rf_{MIN} = 3.01K; Rf_{MAX} = 1Meg; C = 0.33µf

Inner-Loop Gain - Input at Terminal 10:

- $i_o \approx [R_{21}\, R_{30} / R_{31}\, (R_{22} + R_{23})] \times [e_{10} / R_{46}]$

Inner-Loop Gain - Input at Terminal 8:

- $i_o \approx [R_2\, R_{30} / R_{31}\, (R_{22} + R_{23})] \times [C_3\, e_8 / (R_1 + R_2)\, C_3 + 1]$

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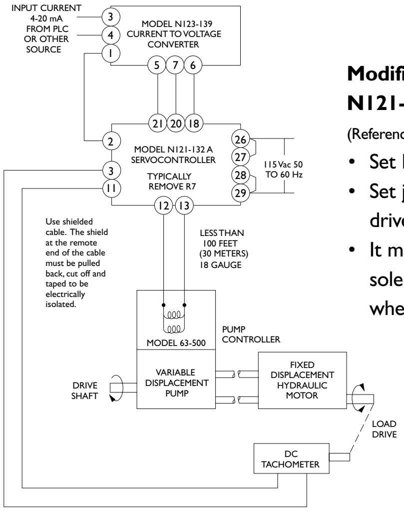
CLOSED-LOOP VELOCITY CONTROL WITH ACCELERATION LIMIT

Suggested Setup Procedure:

1. Turn off hydraulic power and relieve pressure.
2. Set the GAIN pot (R4) and the INTEGRATOR pot (R58) on the N121-132A card approximately five turns from full counter-clockwise.
3. Set the SCALE pot (R9) on the N121-132A card fully clockwise.
4. Remove the tachometer connection from terminal [3] on the N121-132A card.
5. Apply electrical power.
6. Adjust ZERO (R8) and SPAN (R11) on the N123-139 card so that 4-20 mA input corresponds to ± 10V output to the N121-132A card. Refer to the N123-139 line card.
7. Re-connect the tachometer lead to terminal [3] on the N121-132A card.
8. Adjust the GAIN pot (R4) and (R58) on the N121-132A card for maximum (clockwise) with stable controller coil current (no oscillation).
9. Set the SCALE pot (R9) on the N121-132A card for desired speed range vs command signal range. Check the stability of the system throughout full speed and load range.
10. Adjust the BIAS pot (R16) on the N121-132A card for zero load speed at zero command input.



Modifications to the N121-132A card:

(Reference Moog Document N121-132A)

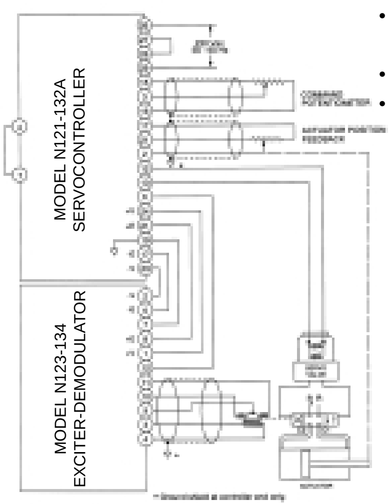
- Set PID jumpers for I control.
- Set jumper JMPR1 for current drive.
- It may be desirable to activate solenoid to short out integrator when "0" RPM is commanded.

CLOSED-LOOP POSITION CONTROL (3-STAGE VALVE)

Suggested Setup Procedure:

(Reference Moog Documents N121-132A and N123-134)

1. Turn off hydraulic power and relieve pressure.
2. Set the GAIN pots (R4 and R43) on the N121-132A card approximately five turns from full counter-clockwise.
3. Set the SCALE pot (R9) on the N121-132A card full clockwise.
4. Apply electrical power.
5. On the N121-132A card, temporarily remove the feedback connection from terminals [2] and [6]. Adjust the BIAS pot (R16) for zero coil current at midstroke of the command pot. Re-connect terminal [2].
6. Apply hydraulic pressure.
7. Adjust the N123-134 Exciter/Demodulator card for proper GAIN (R5) and PHASE (R16) by monitoring the voltage at terminal [12].
8. Re-connect terminal [6] of the N121-132A card. Turn the SCALE pot (R9) full counter-clockwise.
9. Increase the GAIN pots (R4, R43) clockwise until the system exhibits the desired sensitivity. Check the stability of the system throughout the full load range.
10. Adjust the BIAS pot (R16) for mid actuator position at zero command signal, or as desired.



Modifications to the N121-132A card:

(Reference Moog Document N121-132A)

- Set the jumpers for proportional control only.
- Insert R45=20KΩ.
- Remove R20.

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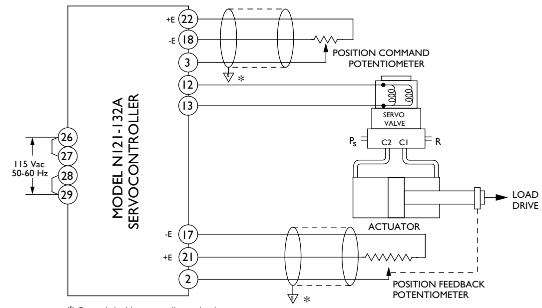
MODEL N121-132A SERVOCONTROLLER
MODEL N122-142A SERVOAMPLIFIER

TYPICAL APPLICATION: CLOSED-LOOP POSITION CONTROL (2-STAGE VALVE)

1. Ensure electrical and hydraulic power is off.
2. Set the GAIN-1 pot (R4) on the N121-132A card approximately five turns from full counter-clockwise.
3. Set the SCALE pot (R9) on the N121-132A card full clockwise.
4. Apply electrical power to the N121-132A.
5. Temporarily remove the feedback connection from terminal [2]. Adjust the BIAS pot (R16) for zero coil current when command pot is set to zero volts. Re-connect terminal [2].
6. Gradually apply hydraulic pressure. If the actuator extends fully hardover, reverse terminals [12] and [13].
7. Increase the GAIN pot (R4) clockwise until the system exhibits the desired sensitivity. Check the stability of the system throughout the full load range.
8. Adjust the BIAS pot (R16) for mid actuator position at zero command signal, or as desired.
9. Adjust the SCALE pot (R 9) for the desired command sensitivity.

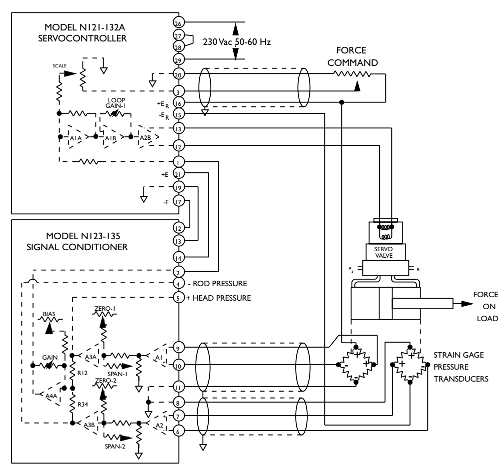


* Ground shield at controller end only.

Initial Set-up of the N121-132A card:
- Set MODE jumper to "OFF" (current drive).
- Set PROPORTIONAL jumper to "ON".
- Set INTEGRAL jumper to "OFF".
- Set DERIVATIVE jumper to "OFF".

FORCE SERVO WITH UNBALANCED ACTUATOR

1. Ensure hydraulic power is off and actuator control ports are at atmospheric pressure.
2. Turn the gain pots down fully.
3. On N121-132A, temporarily disconnect the FORCE FEEDBACK at pin 1.
4. Turn on electrical power.
5. On N121-135 adjust ZERO-1, ZERO-2 and BIAS pots for zero Vdc at pins 5, 4 and 2.
6. On N121-132A, adjust BIAS for zero current with zero COMMAND.
7. Gradually apply hydraulic power. The actuator will move to full extend or full retract position.
8. Increase command until the servovalve current is approximately 20% of its rated signal and the head end pressure is equal to the system pressure.
9. On N123-135, adjust SPAN-1 and GAIN pots for the desired sensitivity at pins 5 and 2.
10. Change the command until the servovalve current is approximately 20% of its rated signal and the rod end pressure is equal to the system pressure.
11. On N123-135, adjust SPAN-2 pot for the desired sensitivity at pin 4. NOTE: span and zero pots are interactive. Several iterations (steps 4 to 11) may be required.
12. Turn off hydraulic and electrical power.
13. On N121-132A, re-connect the FORCE FEEDBACK at pin 1.
14. Turn on electrical power.
15. Gradually apply hydraulic power.
16. Increase the GAIN-1 pot until the system response is at the desired level.
17. Adjust the N121-132A BIAS pot for zero FORCE FEEDBACK with the desired COMMAND.
18. Adjust SCALE pot for the desired COMMAND vs. FORCE FEEDBACK ratio.



Initial Set-up of the N121-132A card:
- Set MODE jumper to "OFF" (current drive).
- Set PROPORTIONAL jumper to "ON".
- Set INTEGRAL jumper to "OFF".
- Set DERIVATIVE jumper to "OFF".

Initial Set-up of the N123-135 card:
- Select and insert $\frac{R34}{R12} = \frac{\text{head end area}}{\text{rod end area}}$

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

The products described herein are subject to change at any time without notice, including, but not limited to, product features, specifications, and designs.

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