MA1265
INSTRUCTION MANUAL
NC600 SERIES
REV. C
JUNE 1, 1984

FORWARD:

This manual is a general instruction and specification manual used to familiarize the user with NC616 (A2391) specifications and connections. The NC616 can be used in two types of applications.

The first application is a simple torque loop which requires only the A2390 assembly and a jumper on JU1. The second application is the standard rate loop with the addition of the A2392 velocity loop assembly to the A2390 assembly. Refer to A2391, Sheet 2 titled Functional Schematic.

The NC616 is a completely plug-in PWM controller intended to be used with the specifically designed mounting chassis listed below. Each mounting chassis includes an integral power supply which provides the high voltage/high current supply, bias supplies for the NC616, and the 100 Watt continuous shunt regulator. The mounting chassis is available as a standard in three various bus voltages indicated by the suffix to the basic mounting chassis assembly number.

BASIC DESCRIPTION	BASIC ASSEMBLY #		SUFFIX
6-Axis Panel Mount	A2333	-	GO_
6-Axis Rack Mount	A2334	-	GO_
4-Axis Panel Mount	A2335	-	GO_
4-Axis Panel Mount	A2410	-	GO_
2-Axis Panel Mount	A2411	-	GO_*

The last number in the suffix represents nominal dc bus voltage:

-GO1, GO4* indicates 60 VDC Bus
-GO2, GO5* indicates 100 VDC Bus
-GO3, GO6* indicates 160 VDC Bus

NOTE: Integral shunt regulator is set to turn-on at approximately 112% of nominal dc bus voltage.

Refer to customer connection and outline drawing for details concerning wiring connection and locations.

SPECIFICATIONS - CURRENT AMPLIFIER A2389:

1.	Output Voltage Range: (Nominal Bus Less 8V)	±32 to 152 VDC
2.	Output Current: Peak (1 sec. nominal)	±25 A
	RMS	12.5 A
3.	Power Conversion Efficiency	92%
4.	Form Factor (@ Continuous Current & Min. Induct.)	1.01 Max.
5.	Minimum Armature Inductance: (For Nominal 40V to 160V bus range)	0 4mh to 1.6mh
6.	Bandwidth of Current Loop (@ RMS Current)	0 to 500 Hz Min.
7.	Deadband	0
8.	Gain	2.5A/V
9.	Current Analog Output	.4V/A
10.	Switching Frequency	5kHz

11. Inhibit Inputs:

a. Drive Enable: Optically coupled

(1) To Enable: Apply 9V DC Min. to 25V DC Max. to Enable (+) with respect to Enable (-) inputs.

(2) Time Delay on Enable: 100m Sec. nominal (allows closure of armature contactors if used).

(3) To Disable: Voltage across terminals must be less than 1.0V DC.

b. Inhibit Negative Current:

(1) To Enable: Apply 0V DC Min. to 2V DC Maximum with respect to signal common.

(2) To Disable: Open or apply 12V DC Min.

c. Inhibit Positive Current: (same conditions as Inhibit Negative)

12. Protection Features:

a. Amplifier will shut off, turn on red fault light, and the fault latch output (open collector type) will turn off if:

(1) Short of either side of armature output to ground.

(2) High Power Supply Voltage exceeds safe level of amplifier due to regeneration of motor.

(3) Overheating of amplifier due to excessive operating ambient termperature or loss of fans.

(4) Excessive RMS Current Output.

<u>NOTE:</u> A separate output labeled "OT/OI" provided by an open collector will turn off if either an overtemp. or an excessive RMS current condition occurs.

b. Amplifier will shut off with no light indication:

(1) If bias supply falls below 10% of 115V AC.
(2) If bias supplies are shorted.

<u>NOTE:</u> Under all conditions where unit shuts off with light indication, it is necessary to remove bias power, wait approximately 15 seconds, then re-apply power.

13. Cooling: Forced Convection

14. Operating Ambient Termperature: 0-50 degrees C

15. Size: 2.1"W x 9.3"H x 6.3"D

16. Weight: 2.2 Lbs or 1.0 Kg

<u>SPECIFICATIONS - VELOCITY AMPLIFIER A2392:</u>

Refer to A2392, Sheet 1 and A2391, Sheet 2 for details.

1. Signal 1 Input:

   a. Configuration: Differential
   b. Signal Magnitude: ±10V Max.
   c. Common Mode Voltage: ±10V
   d. Input Impedence: 10K Ohm
   e. DC Gain (Adjustable): 0 to 3300 V/V

2. Signal 2 Input (Tach):

   a. Configuration: Single-ended
   b. Signal Magnitude: ±100V
   c. Input Impedence: 10K Ohm
   d. DC Gain (Adjustable): 80-1000 V/V

3. Offset: Adjustable to zero

4. Drift (referred to input-max): 10uV/Degrees C

5. Adjustable Current Limit 2.5 - 25 A

INSTALLATION PROCEDURES:

I. The equipment should be installed in an environment where:

1.) The equipment ambient temperature does not exceed 50 degrees C.

2.) The equipment atmosphere is free of highly flammable or combustable vapors, corrosive chemical fumes, oil vapor, steam, excessive moisture, and particulants.

II. WIRING:

Proper wiring techniques are essential for successful system installation. To insure personnel safety against electric shock and to reduce the effects of electrical noise interference, the procedure outlined in this section must be strictly adhered to. To minimize electrical interference problems, the interconnecting wires should be arranged into groups. As a minimum two groups should be used:

1.) High-current/High-voltage power wiring such as main power inputs, 115V AC for fans, relays, contactors, etc., DC power wiring such as controller bus wiring and armature wiring.

2.) Low-level signal wiring such as speed commands, tachometer feedback, current command, inhibit/enable signals, etc.

The wire groups should be separated by at least one foot or run in separate grounded conduits. All wiring should be kept as short as possible. As a general rule, use only wires of adequate size for their length and current being carried. Specific recommendation for each major group follows.

A. POWER WIRING:

All power wiring for the armature and power supply connections should be 12 gauge, MTW or equivalently rated wire. The wire used for the 115V AC supply for the cooling fan and bias circuits can be 16AWG.

Power wires should be run as twisted pairs, i.e., twist the wire carrying current with the same wire returning the current. Armature circuit wires must be twisted to reduce radiated electrical noise from servo controllers. In systems particularly sensitive to electrical noise, use of shielding for the armature wiring may be required.

Wiring between the transformer secondary and the power supply assemblies should be 12 gauge (MTW) or larger.

B. GROUNDING:

Proper grounding helps guard against electric shock to personnel and can reduce the effects of electrical noise interference. Each mounting assembly and motor must have a separate connection to earth ground in the customer A-C distribution network. Each of the chassis ground wires should have green or green with a yellow stripe insulation. In addition to the chassis grounds, the cabinet which houses the NC6ØØ equipment must have a separate connection directly to earth ground at the power distribution panel. Additionally, the 115VAC low and the D-C bus PWR Common must also be connected to ground to provide zero volt references and to insure proper operation of the servo controller protector circuits. However, these common lines are not intended to function as chassis or cabinet grounds.

The system ground should be designed in a tree fashion, with individual ground wires converging to a single earth ground point. Ground wires should be as short as practical and large enough to carry maximum short-circuit current rating of the circuit, as determined by the fuse rating. The customer should consult local governing codes for compliance with safety regulation befor finalizing the grounding system.

C. SIGNAL WIRING:

All signal and limit circuit wiring need not be larger than 22 gauge. Signal circuits, including the tachometer, must employ twisted shielded pair with a minimum of 25 twists per foot.

Proper termination of shielded cables is important to avoid creating ground loops or otherwise degrading the noise immunity of the servo controller. Cable shields should be terminated at one end only. The other end should be left floating but insulated by electrical tape or some other means to prevent contact with any other metallic parts. In most applications satisfactory noise immunity will be realized with the signal line shields terminated at the respective signal sources. In some cases, however, terminating the individual shields at the servo controller will yield better noise immunity. Always reference the shield to the low side of the signal wires which the shield is to protect. Earthing or grounding the shield does little good unless the signal is also referenced to the same point.

It is important to maintain the continuity of cable shields through any intervening connectors and/or terminal blocks. Also, attempts to minimize the length of unshielded cable at these interconnections.

SET UP PROCEDURE

WARNING!!

> Dangerous power levels exist throughout the NC600 Series equipment. Only qualified technicians should work on this equipment. At all times during the initial set-up be prepared to remove power if a mechanical or electrical problem occurs.

I. POWER SUPPLY TEST:

With all installation and wiring finished, perform the following power supply tests:

a. Remove hold down bars or cover panel to allow removal of any controller assemblies plugged into chassis.

b. Check fuses to verify proper value and type throughout the drive system. The correct fuses are shown on customer connection and outline drawing.

c. Check the power transformer for proper connection.

d. Momentarily apply AC power to the power transformer and measure the voltage from pin 1 to pin 2 on the white power edge connector for each controller axis. The polarity should be correct and the voltage for the different chassis suffix's should be approximately as follows:

G01, GO4* - 60 VDC
G02, GO5* - 100 VDC
G03, GO5* - 160 VDC

*For A2411 Chassis only.

e. Again apply AC power. Verify the presence of 115V AC bias supply by checking for proper operation of the cooling fans.

NOTE: It is recommended that 115V AC bias supply come off the same transformer as high voltage supply.

f. Remove AC power. Allow 1 minute minimum for discharge of high voltage filter capacitors before inserting any controllers or servo mounting chassis.

II. SERVO CONTROLLER SET-UP PROCEDURE:

Each servo axis should be completely set-up according to the procedure outlined below before inserting the next axis controller into its mounting assembly.

A. VISUAL INSPECTION:

Check and secure all connections to the motor and feedback units. Verify that the mechanical system is not obstructed in any way. Extreme care must be exercised when applying these procedures to machine mounted motors to avoid incurring damage to the machine drive components and/or motor. If at all possible, the initial set-up should be performed with the motor decoupled from the machine and/or drive components.

B. BIAS VOLTAGE CHECKS:

NOTE: Throughout this procedure various signal measurements or points will be specified which can be made either at the 18 position terminal block, (TB), or at the 26 pin mass termination header, (J). Refer to customer connection and outline drawing for typical connections. The customer may choose which point to use.

a. Remove the DC bus fuse for the axis under test.

b. Plug the controller for the axis under test into its mating connectors.

c. Apply AC power and measure the controller ±15V DC bias supplies. The voltages should be within 15V ±.75V.

C. INHIBIT/ENABLE CIRCUIT CHECKS:

1. If positive and negative inhibit functions are not used in conjunction with overtravel limits, the positive and negative inhibits should be tied to signal common, position 2 on the terminal block. However, if an overtravel limit is used, the overtravel limit contact should be wired such that when an overtravel limit is reached, the contact opens its connection to common. Verify that this happens on both the positive and negative inhibits.

2. The drive enable signal can be activated by two different modes of operation. One method is by connecting the Enable (+) input to +15V and shorting the Enable (-) input to signal common to activate the drive. The other method is by connecting the enable (-) input to signal common and shorting the Enable (+) input to +15 to activate the drive.

3. Remove AC power. Allow 1 minute minimum for discharge of the filter capacitors. Replace the DC bus fuse for the axis under test.

turns in the CCW direction. For critical application optimum response can be achieved using the following procedure:

a. Provide the controller with a low frequency, bi-directional square-wave velocity command (a 0.5Hz ±5.0V waveform is a good choice.)

b. Apply power to the controller, and while monitoring the tachometer signal *, gradually adjust the Resp. pot in the CW direction until optimum response is obtained. Figure 1 illustrates the types of waveforms observed for various settings of the Resp. pot.

If optimum response cannot be obtained with the above procedure, different compensation components must be chosen using the following procedure:

a. Short C2 on Velocity Loop Board with a jumper wire.

b. Replace R9 on Velocity Loop Board with a resistor substitution box.

c. Initially set the box resistance at 10K.

d. Set the Resp. potentiometer at approximately midrange.

e. Input a low frequency bi-directional square wave velocity command signal to the controller (amplitude approximately 2 Volts).

f. Apply power. While monitoring the tachometer signal, gradually increase the value of the box until near optimum response is achieved.

g. Substitute the closest standard discrete resistor for R9.

h. Remove the shorting jumper across C2 and again check the response using the square wave test signal. If near optimum results are obtained trim the Resp. potentiometer for optimum.

i. If step (h) does not yield satisfactory results, substitute a larger value for C2 if there is overshooting and a smaller value for C2 if the response is overdamped. Reiteration of these steps (h) and (i) should yield an optimum choice for C2.

This completes the basic set-up of the controller.

*If the tachometer signal is excessively noisy, and RC network (150K ohm resistor in series with a 0.002uF capacitor) can be used to obtain a cleaner tach signal. If this network is used, monitor the voltage across the capacitor.

D. INITIAL POTENTIOMETER ADJUSTMENTS:

The five adjustment potentiometers located on the velocity loop board assembly, A2392, should initially be set as listed below:

Signal 1	Full CCW
Signal 2 (Tack)	Full CW
High Freq. Gain (Resp)	Full CCW
Offset	Midrange
Current Limit	Full CW

Refer to A2391, Sheet 2 titled Functional Schematic for location of 20 turn adjustment potentiometers.

E. POLARITY (PHASING) DETERMINATION:

The polarity of the NC616 Servo Controller, A2391, is such that a positive signal applied at Signal 1 (-) with respect to Signal 1 (+) input results in a positive voltage at the Arm (+) terminal with respect to the Arm (-) terminal. If the motor and tachometer polarities are known, proper connection to the controller can be made. A positive input signal should cause the motor to run in the plus machine direction and should yield a negative tachometer feedback signal on Signal 2 input.

If polarities are unknown, the following procedure can be used:

1. Lift one end of the 100 ohm resister (R20) on velocity loop board.

2. Disconnect all speed command inputs including the tachometer input from mounting chassis.

3. Connect the auxiliary +15 volt supply to Signal 1 input.

4. Check that all adjustment potentiometers are set as in Section C.

5. Secure controller in position and apply power. The motor should run the machine in the plus direction. Signal 1 potentiometer may have to be turned in the CW direction slightly. If the machine does not run in the plus direction, remove power and reverse the armature leads of the motor.

6. With the motor correctly phased, reapply power and measure the tachometer feedback signal. It should have a negative polarity. Remove power.

7. Unplug controller and resolder R20 in position. Remove +15V DC connection to Signal 1 (-) position. Reconnect Signal 1 leads. Connect the tachometer lead which was determined to be negative in Step 7 to Signal 2 (+) position. Connect the other tachometer lead to Signal 2 (-).

F. BASIC SET-UP:

Assuming the procedures in the preceding sections were carried out successfully, momentarily apply power to the controller without any signal command applied. If upon application of power, the motor rapidly accelerates, a runaway condition exists, due most likely to a reversal of either the motor or tachometer polarities. Repeat the procedure of Section D if this is the case. If the motor and tachometer are properly connected, and the controller is functioning normally otherwise, the motor shaft should remain stationery, or at most drift slightly in either direction, when power is applied.

1. OFFSET ADJUSTMENT:

Apply a zero speed signal command to the controller and adjust the OFFSET potentiometer until any rotation of the motor shaft ceases.

NOTE: It may be necessary to repeat the Offset adjustment after the gain adjustment.

2. CURRENT LIMIT ADJUSTMENT:

The NC616 Controller contains a current limit potentiometer that is used to set the peak magnitude of current supplied by the controller. If peak current is required, adjust the current limit pot full CCW.

3. GAIN ADJUSTMENT:

The normal velocity loop scaling procedure is as follows:

a. Input a DC voltage into Signal 1 (-) input with respect to Signal 1 (+) having an amplitude equal to the maximum velocity command signal magnitude.

b. Monitor the tachometer signal using a VOM or oscilloscope. The tachometer scale factor in Volts/1000 RPM must be known to make this adjustment.

c. Gradually adjust the Signal 1 potentiometer CW until the desired maximum motor speed is obtained as measured by monitoring the tachometer signal. If desired maximum speed is not obtained with Signal 1 full CW, gradually adjust the TACH potentiometer in the CCW direction until desired motor speed is reached.

4. SERVO RESPONSE ADJUSTMENT:

The Resp. (High Freq. Gain) potentiometer is used to adjust servo stability. For non-critical applications, simply adjust the Resp. pot in the CW direction until an audible squal is heard with the motor stationery. Then turn the Resp. pot four full

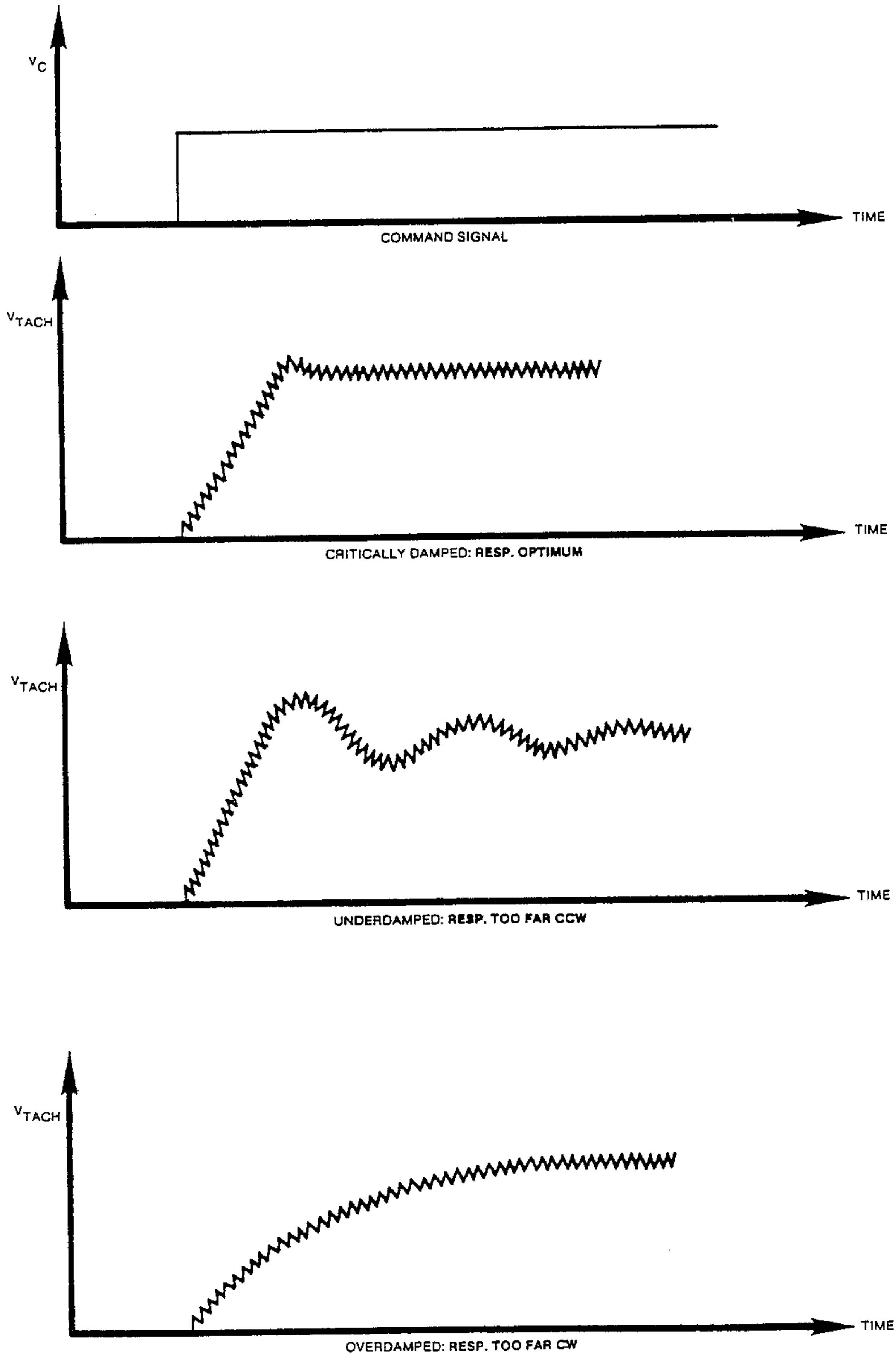
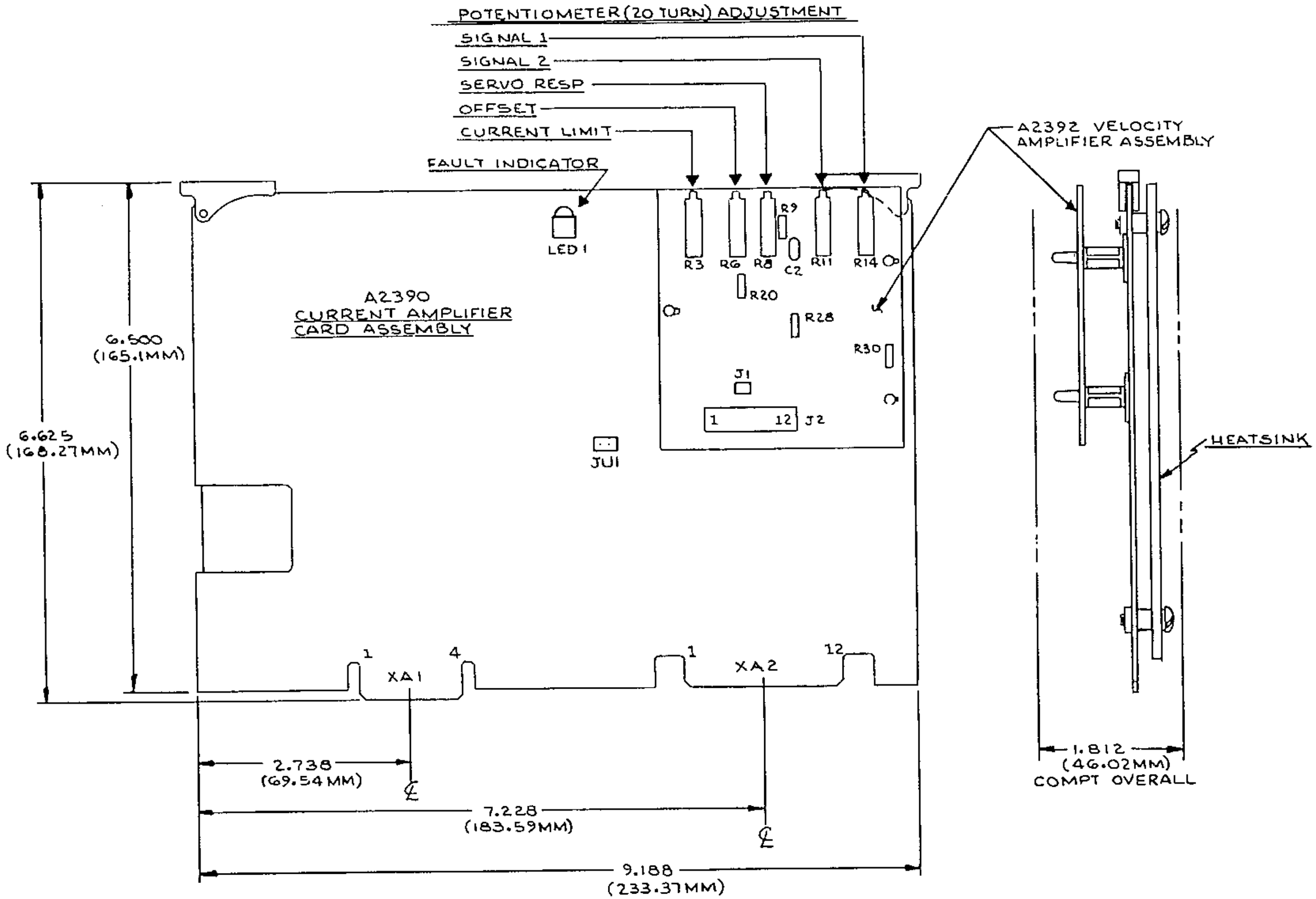


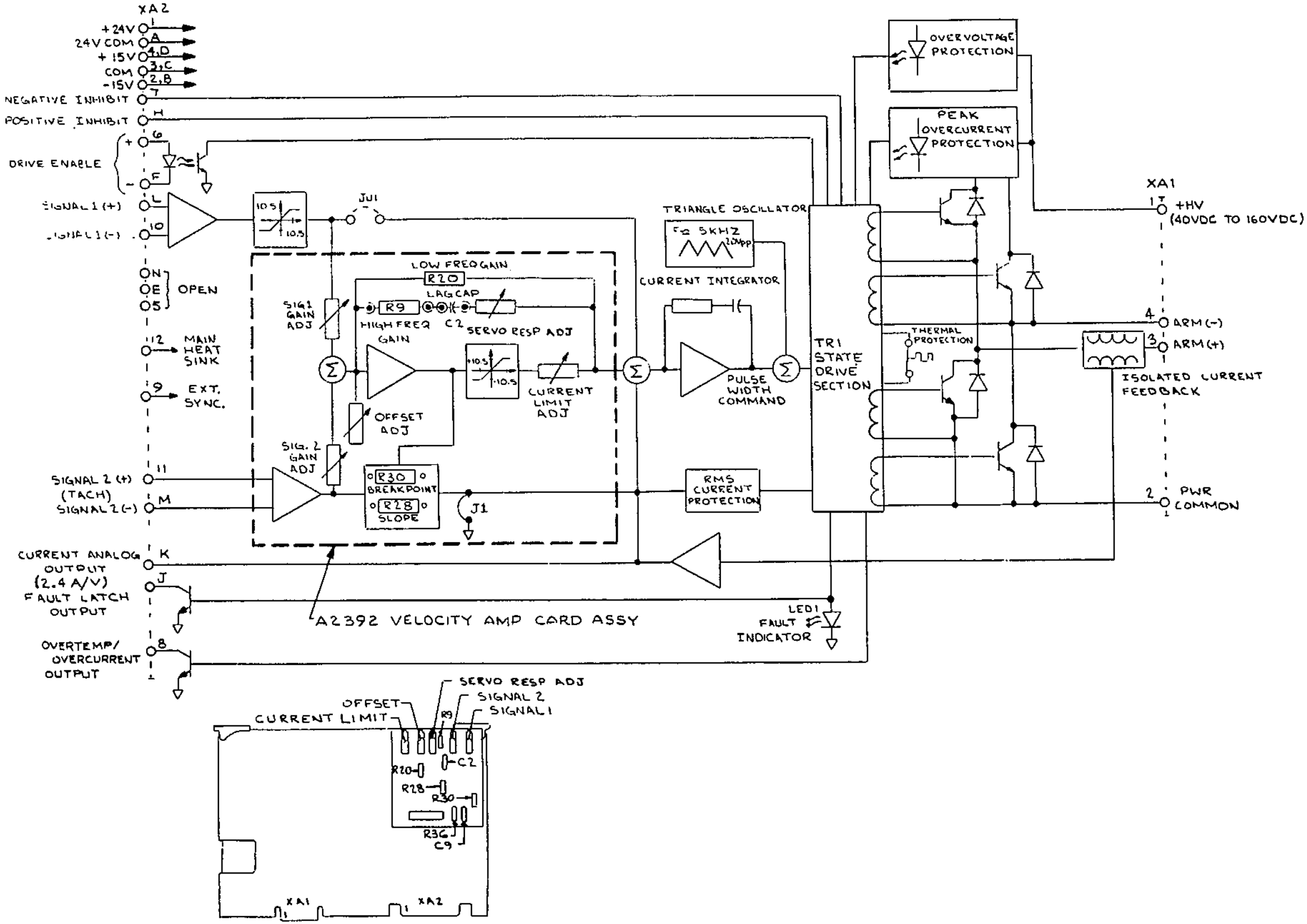
Figure 1

TYPICAL VELOCITY RESPONSE WAVEFORMS VS. SETTING OF RESP POTENTIOMETER



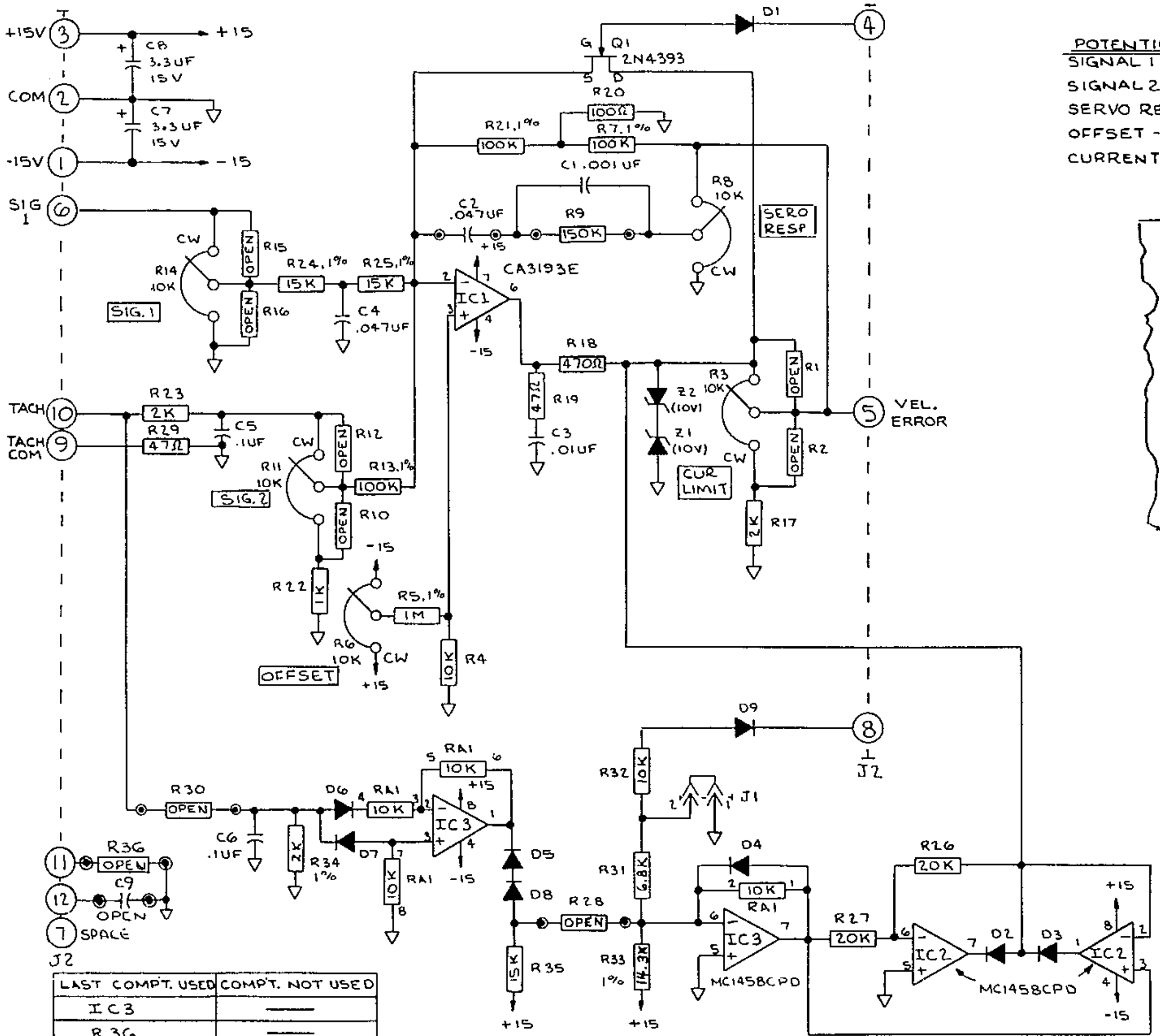
A2391: NC600 SERIES SERVO CONTROLLER ASSEMBLY OUTLINE

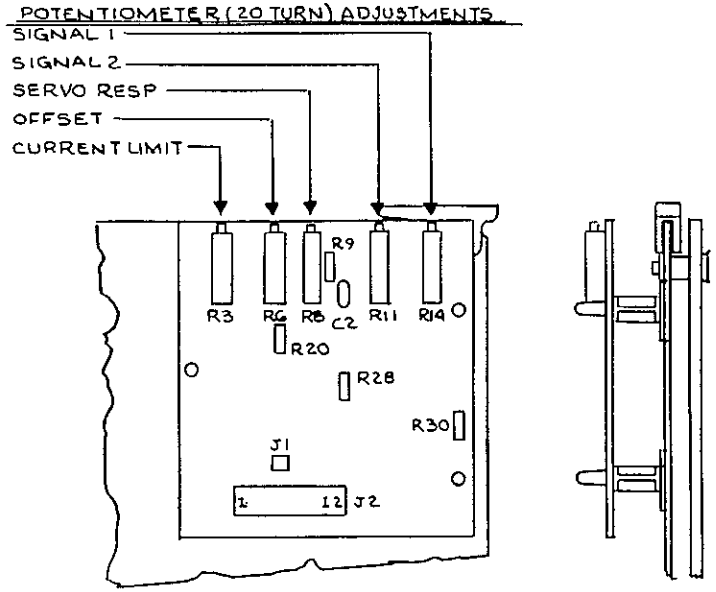
FIGURE #1



A2391: NC600 SERIES SERVO CONTROLLER FUNCTIONAL SCHEMATIC

FIGURE #2





NOTE: A2392 LOCATED ON STANDOFFS UPPER RIGHT HAND CORNER OF CURRENT AMPLIFIER ASSEMBLY (A2390)

NOTE: REMOVAL OF J1 FOLDS-BACK OUTPUT CURRENT DURING RMS FAULT

LAST COMPT. USED	COMPT. NOT USED
IC3	—
R36	—
C9	—
Q1	—
D9	—
Z2	—
RA1	—

A2392: NC600 SERIES VELOCITY AMPLIFIER CARD ASSEMBLY SCHEMATIC

FIGURE #3

NC600 SERIES

SERVO CONTROLLERS

(Part No's. A2390 & A2391)

INSTRUCTION SHEET GID-0001 Rev. A

1.0 IMPORTANT SHIPPING INFORMATION

CONTRAVES, Motion Control Division, cannot accept any responsibility for shipping and handling damage once the equipment has left our facility. Since damages caused during shipment are not covered under warranty, we recommend that the receiver of this equipment thouroughly inspect for both physical and stress damage prior to accepting and signing the transporter's bill of lading.

2.0 EQUIPMENT STORAGE

It is advisable to store equipment in its original shipping container and place in a clean dry area until ready for use. If equipment should require service at a later date, using the original shipping container may help prevent further repair costs.

3.0 RETURN FOR REPAIR

In the event of the need for repair of this equipment, we advise that you contact our factory in Pittsburgh, Pa. (Customer Service Department), or one of our authorized repair agents. Obtain authorization prior to return of the equipment; we are not responsible for equipment returned to us without notice.

4.0 INSTALLATION AND USE

The NC600 series plug-in, PWM servo controllers are designed to be mated with a matched mounting chassis. It is assumed here that the chassis has already been installed, wired and tested. Information relating to the installation and operation of the chassis assemblies is provided in the documentation that accompanies them.

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