Bulletin HY14-1483-M2/US
Installation Guide
Model 23-5030

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Supersedes: October 1, 1998

Servo Control Amplifier
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# Servo Control Amplifier

## Model 23-5030

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General Description

This printed circuit card contains a complete DC servo amplifier. It is recommended for closed loop applications having single or multiple inputs or feedback signals. The output circuit is a high performance current driver with adjustable saturation current, compatible with any hydraulic or pneumatic servovalve. Adjustable command span and feedback gain along with the built-in signal conditioner allow for configuration with many types of command and feedback signals. Combined with Hydraulic Valve Division 23-5090, a magnitude of control circuits are available.

Specifications*

<table>
<thead>
<tr>
<th>Dimensions</th>
<th>4.50&quot; X 6.75&quot; X 1.12&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight</td>
<td>0.11 kg (0.25 lbs.)</td>
</tr>
<tr>
<td>Connector</td>
<td>22 pin gold card edge fingers at .156&quot; centers</td>
</tr>
<tr>
<td>Mate</td>
<td>Optional CINCH 50-22A-20 or Parker 23-5CET</td>
</tr>
<tr>
<td>Power Requirement</td>
<td>Regulated ±15 VDC 100 mA plus load current</td>
</tr>
</tbody>
</table>

Servo Control Circuit: Reference figures 3 and 4

<table>
<thead>
<tr>
<th>Type</th>
<th>Proportional and/or integral, open or closed loop control</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inputs</td>
<td>100 KΩ command input resistance</td>
</tr>
<tr>
<td></td>
<td>10 KΩ auxiliary command input resistance</td>
</tr>
<tr>
<td></td>
<td>100 KΩ feedback input resistances</td>
</tr>
<tr>
<td></td>
<td>10 KΩ inverted inner loop input resistance</td>
</tr>
<tr>
<td></td>
<td>10 KΩ (R45 jumpered) proportional inner loop input resistance</td>
</tr>
<tr>
<td>Output</td>
<td>±325 mA DC maximum output current</td>
</tr>
<tr>
<td></td>
<td>±12 VDC maximum output voltage</td>
</tr>
<tr>
<td></td>
<td>Minimum load resistance – short circuit proof</td>
</tr>
<tr>
<td>Gain</td>
<td>20:1 mA/Volt range depending on load</td>
</tr>
<tr>
<td></td>
<td>Linearity: 3% of saturated output</td>
</tr>
<tr>
<td>Drift</td>
<td>0.1 mV per C° (referred to input) over a temperature range of +10C° to +50C° with 100K input resistance and 50 mA DC per volt setting</td>
</tr>
<tr>
<td>Dither</td>
<td>200 Hz ±20% standard</td>
</tr>
<tr>
<td>Frequency Response</td>
<td>&lt; 3 dB down at 1200 Hz within voltage saturation limits and with load inductance &lt; 1 henry</td>
</tr>
<tr>
<td>Deadband or Hysteresis</td>
<td>None</td>
</tr>
</tbody>
</table>

Signal Conditioner Circuit
Converts 4-20 mA signal into ±10V

<table>
<thead>
<tr>
<th>Input Resistance</th>
<th>240Ω (1/2W 1% Metal Film)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard Input</td>
<td>4 to 20 mA non-isolated</td>
</tr>
<tr>
<td>Standard Output</td>
<td>+10 to -10 VDC (factory setting)</td>
</tr>
<tr>
<td>Derivative Inner Loop Amplifier Circuit</td>
<td>All components are user supplied</td>
</tr>
</tbody>
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* The 23-5030 requires a regulated power supply. All qualifying measurements for specifications used a Parker Model 23-5010 ±15 VDC power supply. The 23-5030 may be powered by alternate supplies and voltages. Consult factory for further information.
Circuit Controls
Reference Figure 3

Up to ten screwdriver adjustments are available. The potentiometers are directly mounted to the printed circuit card.

Span (R2)

Adjusts the magnitude of command voltage, thereby adjusting the overall stroke, velocity or pressure of the servo loop. The range of adjustment is zero to fifty percent of rated input voltage as measured at T.P.A. This is a multi-turn potentiometer for precision circuit adjustments.

Feedback Gain (R6)

Adjusts the magnitude of the feedback signals. The effect is similar to adjusting the span. The range of adjustment is zero to one hundred percent of rated input voltage as measured at T.P.B. Factory set to fifty percent to match maximum rated span. This is a multi-turn precision potentiometer.

Bias (R8)

Provides a plus or minus offset for system nulling or for biasing the output. With standard components the bias adjustment is limited to a ±30% offset of the rated output current. Factory set to zero offset. This is a multi-turn precision potentiometer.

Error Gain (R14)

Sets the servo loop gain throughout a 20:1 range. Other ranges are available. Consult factory for alternate requirements.

Current Limit (R25)

Adjusts the current saturation level of the output amplifier. This adjustment is used to match the output to the rated full flow current requirement of the valve. R25 may also be used to limit a servovalve's output flow by adjusting the current output to be below the rated full flow requirement. Factory set to 50 mA.

Dither Amplitude (R32)

Adjusts the dither output level from 0 to 10% of the net output current.

Signal Conditioner Balance (R43)

Adjusts the offset voltage of the conditioned signal. This is a multi-turn precision potentiometer.

Signal Conditioner Gain (R40)

Adjusts the magnitude of the conditioned signal output. This is a multi-turn precision potentiometer.

Inside Loop Gain (R20A)

Sets the error gain level of the forward loop on double loop applications. Potentiometer supplied by customer. Requires removal of resistor R20.

Inside Loop

This control is user supplied. It is can be used to attenuate a forward command signal, or as feedback gain for an inside loop. Some applications require a jumper wire in this location.
Servo Control Circuit

The servo control circuit contains six operational amplifier stages. Command input (connector pin 17) is attenuated by R1 and multi-turn potentiometer R2, and applied to buffer amplifier A1 pin 3. Amplifier output can be checked at test point A (T.P.A.). Feedback signal inputs at pins 15 and 16 are added together and adjusted for amplitude by feedback gain potentiometer R6 and inverting amplifier A2 pin 6. Amplifier output can be checked at test point B (T.P.B.). Diodes D1 and D2 protect the feedback gain amplifier from inadvertent over voltage conditions. Potentiometer R8 adds a DC bias to the servo error summing point where command and feedback signals converge. Auxiliary input (connector pin 4) is also added at this point and the combined signal is applied to loop gain amplifier A1 pin 6. Servo loop gain is adjusted with potentiometer R14. The error signal which is determined by servo loop gain, is added to the dither signal at A1 pin 9. A reverse phase (180 degrees) signal may also be added at this point (connector pin 3). The added signals are then applied to amplifier A1 pin 13 where a proportional inner loop signal can be added (connector pins 1 and 2). Replacement of resistors R17 or R20 with higher values will increase the range of error gain adjustment.

Proportional inner loop signal may be attenuated by R45 (not included). The final control signal is then converted to current by amplifier A3, a high performance monolithic power operational amplifier. The current saturation of the output may be adjusted by R25, thus limiting the maximum flow rate of the servovalve and protecting the valve input coils from over current.

Circuit Modifications

The bias signal input location may be changed from the error summing junction to a forward loop location by moving resistor R9 to the R9A position. The gain of the forward loop may be made variable by replacing resistor R20 with potentiometer R20A (not included). Potentiometer R45 (not included) may be added as an adjustable input for the forward loop. Components C1 and R7 may be added to the proportional loop gain amplifier for phase compensation.

Dither Generator

The dither generator is a multi-vibrator circuit around 1/4 of amplifier A2. Standard components produce a 200 Hz dither signal. Other frequencies can be obtained by changing the R.C. product of R29 & C3. Dither is applied to a stage of the servo amplifier that is unaffected by loop gain. Dither amplitude is adjustable at R32 to a maximum of ±10% of servovalve rated current.

Signal Conditioner Circuit

One of the amplifiers in A2 is designed for use as a signal conditioner. Printed circuit card connector pin 10 will accept a 4-20 mA input signal. The signal passes through R38 to signal common at connector pin 8. The current through resistor R38 produces a 960 mV to 4.8 volt signal across the resistor depending on the current level of the input. The voltage divider of R41, R42, and R43 produce a -2.9 volt signal. The two signals are added through R37 and R39, resulting in a ±1.9 volt signal at amplifier input A2 pin 9. The amplifier gain will produce an output of +10 volts at 4 mA and -10 volts at 20 mA when adjusted properly.

Derivative Inner Loop Circuit

A signals mathematical derivative may be produced and added to the control signal at one of the inner loop inputs. This method of control is sometimes used to improve stability of a servo loop by adding velocity feedback from a position signal, or adding acceleration feedback from a velocity signal. Select and insert suitable components: C4, R34, C5, R35, and R36.
Calibration Procedure

Calibration of the 23-5030 Control Amplifier is unique to each control system it is installed in and therefore always required for optimum performance. Factory calibration will usually provide nominal loop closure for most systems. This section describes calibration of the 23-5030 in general. Refer to the applications section of this manual for typical set-up procedures of specific servo control applications.

Measurement and Calibration Terminology

It is necessary to understand the terminology used to describe the testing and adjustment procedures. This will also be required in the applications section of this manual. Most applications require the use of a voltage/current measuring device. A hand held Digital Multi-Meter (DMM) is ideal for required measurements.

Voltage measurements require that the negative input lead of the DMM be connected to signal common of the control system. Signal common is available at the output connector of the 23-5010 Power Supply (pins 5 through 8) or one of the signal common connections on the 23-5030 connector (pins 6, 8, 14 or 20). The positive DMM input lead is connected to the point in the circuit being measured.

Current measurements require the DMM to be connected in series with the circuit being measured. This means that a wire in the current loop must be spliced into. This is most easily accomplished in the wiring harness of the control system. Often DMMs require the input lead to be in a different socket on the DMM for current measurements than for voltage measurements. Refer to your DMM owners manual for information.

The 23-5030 control circuit contains five test points, labeled T.P.A through T.P.E. When referred to, connect the DMM positive lead to that point in the circuit. There are also three integrated circuit amplifiers, A1, A2, and A3, that are referred to for taking measurements. When an amplifier is referred to for a measurement, the amplifier number and pin number will be noted. Amplifiers A1 and A2, denoted as quad operational amplifiers, are 14 pin devices. The pin numbers increase counter-clockwise from the locating notch or point. To locate the test point, refer to Figure 3 to determine the location of the amplifier and then locate the pin number for the measurement. The only other place referred to for measurement are the circuit board connector pins. Connect the DMM positive lead to the connector pin designated for these measurements.
Figure 3 - Model 23-5030-B Circuit Board Assembly
Figure 4 - Model 23-5030-B Schematic Diagram
**Command and Feedback Alignment**

The command and feedback sources should be selected for a maximum output of ±10.00 volts DC if possible. Command and feedback signals must be aligned so the maximum signal of each is equal in magnitude, but opposite in polarity at the test points. Since the feedback signal is inverted automatically, these signals are required to be of the same polarity at input to the circuit card (pins 15 & 17). Magnitude alignment is accomplished by adjusting the command span (R2) and feedback gain (R6) potentiometers.

Typical calibration is as follows:

1. With the hydraulic supply turned off and the servovalve electrically disconnected, apply 120 VAC to the 23-5010 Power Supply (or ±15V to the 23-5030 Amplifier).
2. Adjust the bias potentiometer (R8) for 0.0 VDC at T.P.E.
3. Apply full stroke feedback and command signals to the appropriate connector pins.
4. Adjust span (R2) such that the voltage at T.P.A. is 50% of the command input at connector pin 17 or +10 VDC, whichever is less. If 50% cannot be reached, adjust to fully clockwise.
5. Adjust R6 such that the voltage at T.P.B. is equal in magnitude, but opposite in polarity to the T.P.A. voltage.
6. Reset the command and feedback signals to 0.00 VDC. Adjust the error gain (R14) to 1/4 turn clockwise. There should be 0.0 VDC at T.P.A., T.P.B., and amplifier A1 pin 7.
7. Reconnect servovalve.

**Current Driver Adjustment**

The current driver is factory calibrated for ±50 mA output. If re-calibration is required, use the following procedure:

1. Insure that appropriate jumper wires are installed in the servovalve mating connector, and that the servovalve is wired properly (see section on servovalve wiring).
2. Note mA current rating on servovalve name plate.
3. Connect a current meter in series, between the servovalve and the amplifier (amplifier connector pin 21 or 22).
4. Adjust current limit (R25) fully counterclockwise (minimum output).
5. Adjust error gain (R14) to 50% nominal rotation.
6. With command or feedback at 0.0 VDC, adjust the other to its maximum level.
7. Adjust R25 clockwise until the meter displays the mA rating of the servovalve.
8. Return both command and feedback to 0.0 VDC. Current output should be 0.0 mA.

---

**Energizing a servovalve over its rated current will seriously damage the servovalve!**

**Signal Conditioner Calibration**

When properly adjusted an input of 20 mA will produce an output of -10 volts, an input of 4 mA will produce an output of +10 volts, and a 12 mA input will produce a zero volt output.

1. Connect the positive output of a 4-20 mA source to connector pin 10, and the negative (return) to signal common of the servovalve power supply.
2. Connect the positive lead of a DMM to connector pin 11 and the negative lead to signal common of the servovalve power supply. (DMM set to DC voltage input)
3. Adjust current input to +12 mA signal from the 4-20 mA source.
4. Adjust balance potentiometer R43 for an output as close to zero volts as possible.
5. Adjust current input to +4 mA signal from the 4-20 mA source.
6. Adjust gain potentiometer R40 for an output as close to +10 volts as possible.
7. Repeat steps 3-6 as necessary, until consistent ±10V output is achieved.
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2. Payment: Payment shall be made by Buyer net 30 days from the date of delivery of the items purchased hereunder. Amounts not timely paid shall bear interest at the maximum rate permitted by law for each month or portion thereof that the Buyer is late in making payment. Any claims by Buyer for omissions or shortages in a shipment shall be waived unless Seller receives notice thereof within 30 days after Buyer’s receipt of the shipment.

3. Delivery: Unless otherwise provided on the face hereof, delivery shall be made F.O.B. Seller’s plant. Regardless of the method of delivery, however, risk of loss shall pass to Buyer upon Seller’s delivery to a carrier. Any delivery dates shown are approximate only and Seller shall have no liability for any delays in delivery.

4. Warranty: Seller warrants that the items sold hereunder shall be free from defects in material or workmanship for a period of 18 months from date of delivery. This warranty comprises the sole and entire warranty pertaining to items provided hereunder. Seller makes no other warranty, guarantee, or representation of any kind whatsoever. All other warranties, including but not limited to, merchantability and fitness for purpose, whether express, implied, or arising by operation of law, trade usage, or course of dealing are hereby disclaimed. Notwithstanding the foregoing, there are no warranties whatsoever on items built or acquired wholly or partially, to Buyer’s designs or specifications.

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6. Changes, Reschedules and Cancellations: Buyer may request to modify the designs or specifications for the items sold hereunder as well as the quantities and delivery dates thereof, or may request to cancel all or part of this order, however, no such requested modification or cancellation will become part of the contract between Buyer and Seller unless accepted by Seller in a written agreement to this Agreement. Acceptance of any such requested modification or cancellation shall be at Seller’s discretion, and shall be upon such terms and conditions as Seller may require.

7. Special Tooling: A tooling charge may be imposed for any special tooling, including without limitation, dies, fixtures, molds and patterns, acquired to manufacture items sold pursuant to this contract. Such special tooling shall be and remain Seller’s property notwithstanding payment of any charges by Buyer. In no event will Buyer acquire any interest in the apparatus belonging to Seller which is utilized in the manufacture of the items sold hereunder. Even if such apparatus has been specially converted or adapted for such manufacture and notwithstanding any charges paid by Buyer. Unless otherwise agreed, Seller shall have the right to alter, discard or otherwise dispose of any special tooling or other property in its sole discretion at any time.

8. Buyer’s Property: Any designs, tools, patterns, materials, drawings, confidential information or equipment furnished by Buyer or any other items which become Buyer’s property, may be considered obsolete and may be destroyed by Seller in the event there are no future orders for such items. This privilege is exercisable without Buyer placing an order for which the items are manufactured using such property, Seller shall not be responsible for any loss or damage to such property while it is in Seller’s possession or control.

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10. Indemnity For Infringement of Intellectual Property Rights: Seller shall have no liability for infringement of any patents, trademarks, copyrights, trade dress, trade secrets or similar rights except as provided in this Part 10. Seller will defend and indemnify Buyer against allegations of infringement of U.S. Patents, U.S. Trademarks, copyrights, trade dress and trade secrets (hereinafter ‘Intellectual Property Rights’). Seller will defend at its expense and will pay the cost of any settlement or damages awarded in an action brought against Buyer based on an allegation that an item sold pursuant to this contract infringes the Intellectual Property Rights of a third party. Seller’s obligation to defend and indemnify Buyer is contingent on Buyer notifying Seller within ten (10) days after Buyer becomes aware of such allegations of infringement, and Seller having sole control over the defense of any allegations or actions including all negotiations for settlement or compromise. If an item sold hereunder is subject to a claim that it infringes the Intellectual Property Rights of a third party, Seller may, at its sole expense and option, procure for Buyer the right to use such item and on the condition that Buyer agrees to the following conditions. If an item is rendered noninfringing by such license, or offer to accept return of said item and remove the purchase price less a reasonable allowance for depreciation. Seller shall have no liability for claims of infringement based on information provided by Buyer, or directed to items delivered hereunder for which the designs are specified in whole or part by Buyer, or infringements resulting from the modification, combination or use in a system of any item sold hereunder. The foregoing provisions of this Part 10 shall constitute Seller’s sole and exclusive liability and Buyer’s sole and exclusive remedy for infringement of Intellectual Property Rights. If a claim is based on information provided by Buyer or if the design for an item delivered hereunder is specified in whole or in part by Buyer, Buyer shall defend and indemnify Seller for all costs, expenses or judgments resulting from any claim that such item infringes any patent, trademark, copyright, trade dress, trade secret or any similar right.

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