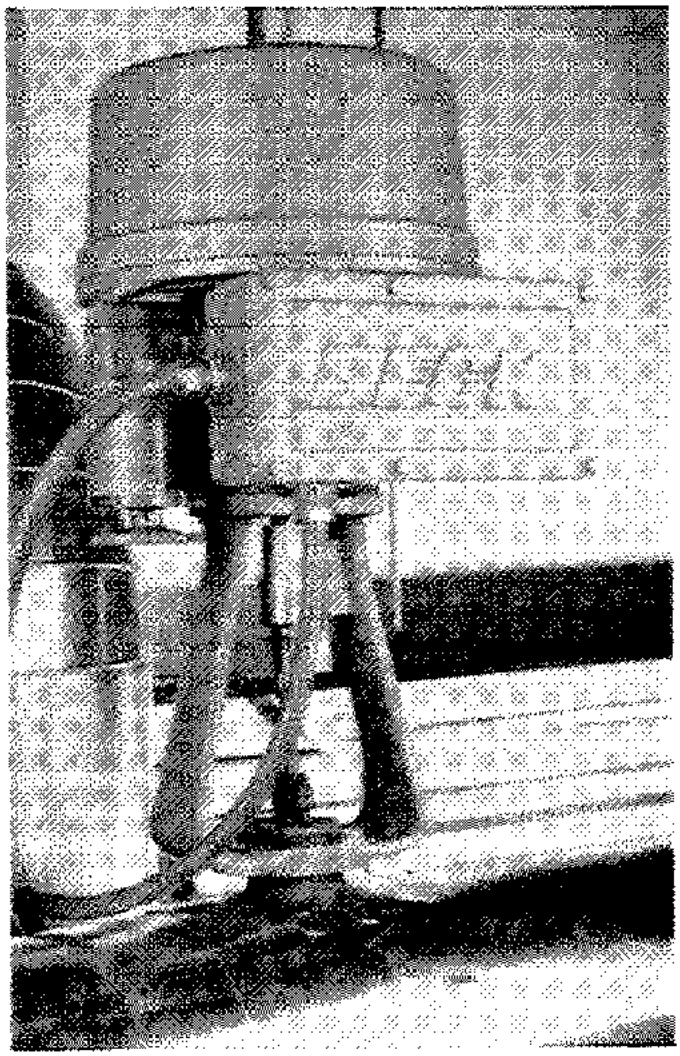
80-1400-02
Rev 03

BECK ELECTRONIC
CONTROL DRIVES

For drives built before February 2000 with FWD / REV Handswitch

GROUP 14
LINEAR
VALVE DRIVES

INSTRUCTION MANUAL

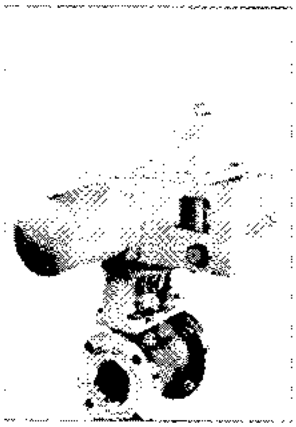


BECK®

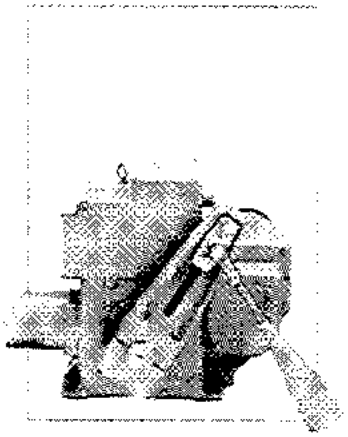
INTRODUCTION TO THE MANUAL

This manual contains the information needed to install, operate, and maintain the 14-100 Linear Electronic Control Drive, manufactured by Harold Beck & Sons, Inc. of Newtown, Pennsylvania. The Group 14 linear drive is a powerful control package designed to provide precise position control of globe valves and other devices requiring up to 1800 lb of thrust.

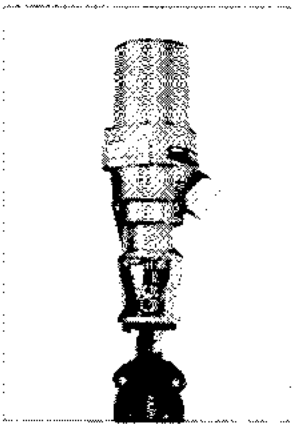
Notice: All persons responsible for the installation, operation, and maintenance of this product must read and understand the appropriate sections of this manual before attempting to use the product. The manual includes instructions on all options available on Group 14 Drives. Some topics may not apply to your particular product. Save this manual for future reference.



Group 11 quarter-turn drives are designed specifically for use with ball, plug, and butterfly valves. Direct-coupled, factory-mounted assemblies are available from Beck for easy installation.



Group 11 rotary drives are designed for valves and dampers. They are in world-wide use in applications requiring 15 to 1800 lb-ft of torque.



Group 31 rotary drives are particularly suited for coupling to ball, plug, and butterfly valves up to 4" diameter, and small dampers.

CONTENTS

PRODUCT DESCRIPTION

Beck Group 14 linear control drives are engineered for precise, reliable operation of globe valves requiring up to 1800 lb of thrust. The cool, stable operation of Beck's control motors coupled with the powerful gear train provide the tight, responsive control required by modern control loops to keep operating costs low. The motor can withstand occasional accidental stalls of up to four days without failure, and will resume instant response to control signals immediately upon removal of the condition. Mechanical stops on the output shaft prevent overtravel.

An easy-to-turn, spoke-free handwheel is incorporated into the Group 14 design to allow manual operation during installation or power outages. The handwheel can be used to open and close valves smoothly and easily under full load conditions.

The Beck Tight-Seater™ coupling is a part of the Group 14 linear drive. This preloaded disk coupling is mounted on the drive output shaft and provides positive seating of the valve plug up to the rated thrust of the drive. It eliminates high-pressure leakage, which can cause erosion of the valve seat. A patented self-locking mechanism holds the drive output shaft in position when the motor is de-energized.

A Calibar index allows simple, single-point adjustment of the length of the stroke to match valve requirements. When this adjustment is made, the position feedback signal, end-of-travel limit switches, and any auxiliary switches are all automatically adapted to the new stroke setting.

Valves may also be operated at their individual locations with a built-in electric handswitch.

Beck's ESR-4 Electronic Signal Receiver provides precise drive control from either conventional analog or computer-based control systems.

Beck's CPS-2 Contactless Position Sensor provides accurate position feedback in demanding environmental conditions, with no contacting or wiping surfaces to wear or intermittently lose contact.

Beck Group 14 electronic control drives are designed with individual weatherproof enclosures to protect the main components.

Although the Group 14 drive is normally installed in the upright position, the drives may be installed in any orientation. For installations where the piping will not support the weight of the control drive, holes are provided for mounting hardware.

TYPICAL APPLICATIONS

Beck Group 14 linear control drives are suitable for steam flow control, combustion gas control, and any other application that requires precise valve position control. A drive may be applied to any globe, cage, or diaphragm valve with a rising stem that has a stroke within the capability of the drive. An integral mounting yoke is part of each linear drive.

Beck Group 14 drives are available in stroke ranges from 5/16" to 4 1/2", and in a variety of thrust and timing combinations. See Table 1 for thrust and timing options.

TABLE 1
GROUP 14 MECHANICAL AND ELECTRICAL SPECIFICATIONS

Basic Model	Thrust (Lbs.)	Timing (sec./in.)		Motor Current [1]		Dimensional Data
		@60 Hz	@50 Hz	@120 V ac 60 Hz [2]	@240 V ac 60 Hz [2]	
14-100	340	4	5	.56	.33	Page 6, 7
	425	11	13	.37	.19	
	600	16	19	.37	.19	
	650	8	10	.56	.33	
	800	11	13	.56	.33	
	1000	27	32	.37	.19	
	1100	16	19	.56	.33	
	1620	48	57	.37	.19	
	1800	27	32	.56	.33	

[1] The unique design of Beck motors has starting and stall currents that approximate the running current, so thermal overload protection is not required — just provide normal short-circuit protection.

[2] 50 Hz motor currents do not exceed 110% of 60 Hz levels.

GENERAL SPECIFICATIONS

Input Power	120 V ac single phase 50 or 60 Hz, 48 or 72 watts 240 V ac single phase 50 or 60 Hz	Allowable Tolerance +10% -15%

Operating Temperature	-40° to 185° F 0 to 99% relative humidity
Input Signal	
Electronic Signal Receiver (ESR-4)	0-5 mA 1-5mA 4-20 mA 10-50 mA 1-5 V dc -10 to 10 V dc
Input Signal Span Adj	2 to 18 V dc
Input Signal Zero Adj.	-100 to 275% of span
Split Signal Range	4-12 mA 12-20 mA
Deadband	0.6% of span
Sensitivity	25% of dead band
Direct AC Control	120 V ac for 2-position, multi-position or modulating V ac control.

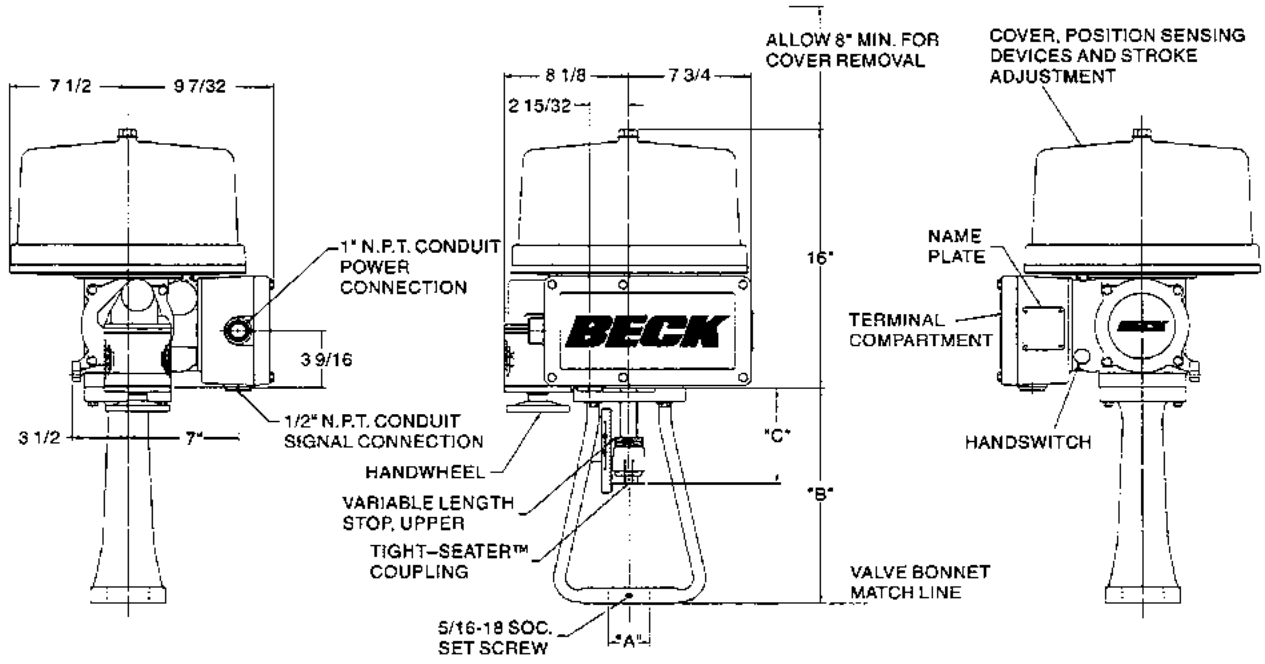
Feedback	
Contactless Position Sensor (CPS-2)	
Feedback Signal	1-5 mA 4-20 mA 10-50 mA 1-5 V dc 0-16 V dc -10 to 10 V dc
Output Stability for V ac Input Power	0.25% of span from 102 to 132 V ac
Output Stability for Temperature Change	±0.03%/°C of span for 0 to 50° C ±0.05%/°C of span for –40 to 85° C
Linearity	±1% of span*
Hysteresis	0.25% of span at any point
Isolation	Max leakage of 10µA at 60 V rms, 60 Hz from output to ground
Film Potentiometer	1000 ohms
Max Voltage	40 volts
Wattage	2 watts max
Linearity	±0.5%*
Max Wiper Current	1mA

* Electrical linearity. Actual feedback relative to output shaft position varies with shaft position up to 15% at the center of stroke range. Consult factory for details.

Action on Loss of Power	Stays in place
Action on Loss of Input Signal (Power On)	Stays in place or moves to full travel or zero position. Drives to any preset position with optional switch assembly on Models 14-107 and 14-108. Field adjustable.
Stall Sensing and Annunciation (Optional)	If the motor tries to run in one direction for more than 200 seconds, the Stall Relay contacts will change. Contacts are form C, 5 A, 120 V ac.
Limit Switches	Two SPDT, one for fully retracted and one for fully extended limit of travel.
Auxiliary Switches	Up to four 6A, 120 V ac switches available. Switches are labeled S1 to S4 and are cam operated, field adjustable. S1 and S4 are set to operate just before reaching fully extended travel limit. S2 and S3 are set to operate just before reaching fully retracted travel limit.
Handswitch	Permits local electrical operation, independent of controller signal. Standard on all units.
Handwheel	Provides manual operation without electrical power.
Motor	120 V ac, single phase, no burnout, non-coasting motor has instant magnetic braking. Requires no contacts or moving parts. Can remain stalled for 4 days without failure of motor or gearing.
Gear Train	High-efficiency, precision-cut, heat-treated alloy steel gears and bronze nut. Interchangeable gear modules permit field change of timing.
Mechanical Stops	Prevent overtravel during automatic or manual operation.
Enclosure	Precision machined aluminum alloy castings, painted with corrosion resistant polyurethane paint, provides a rugged, dust-tight, and weatherproof enclosure.
Stroke Adjustment	Calibar simultaneously adjusts the stroke length, position feedback signal, limit switches, and auxiliary switches. The new stroke displacement is produced by the full input signal.

PRODUCT DESCRIPTION

OUTLINE DRAWING
5/16" to 2 1/8" travel
(All Dimensions in Inches)

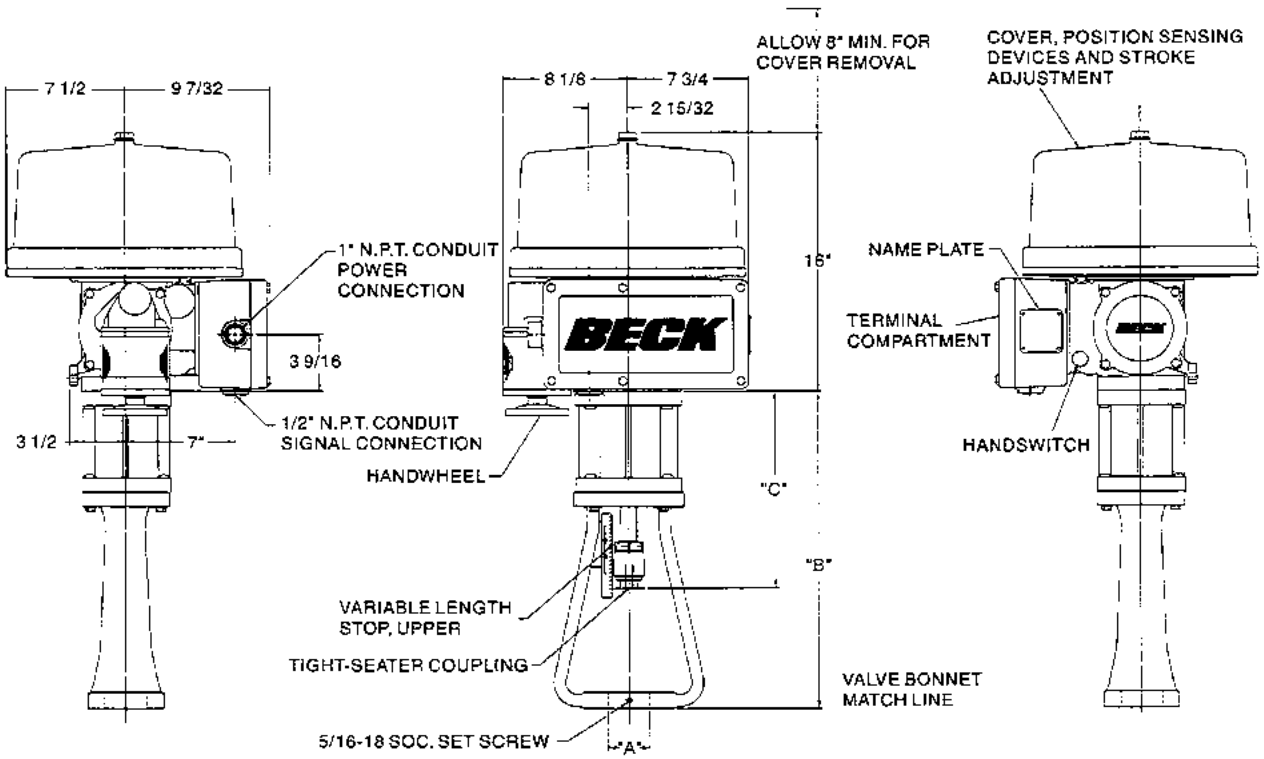


NOTE: All dimensions subject to change.
Drives may be mounted in any orientation.

Beck Model 14-100

Beck Drive Model No.	Drive Stem Travel Range In.	"A" Valve Boss Dia. Range In.	"B" Yoke Height In.	"C" Max Drive Stem Extension In.	Max. Valve Stem Extension (Valve Closed) In.	Max. Weight Lbs.
14-100	5/16 - 1 3/4	1 - 2 5/8	8	4 3/16	5 1/2	80
	3/4 - 2 1/8	1 3/8 - 3 3/4	13 1/2	6	9 1/4	92

OUTLINE DRAWING
3/4" to 4 1/2" travel
(All Dimensions in Inches)



NOTE: All dimensions subject to change.
Drives may be mounted in any orientation.

Beck Model 14-100

Beck Drive Model No.	Drive Stem Travel Range In.	"A" Valve Boss Dia. Range In.	"B" Yoke Height In.	"C" Max Drive Stem Extension In.	Max. Valve Stem Extension (Valve Closed) In.	Max. Weight Lbs.
14-100	3/4 - 3 1/2	1 3/8 - 3 3/4	19 13/16	12 5/16	9 1/4	100
	1 3/4- 4 1/2	1 3/8 - 3 3/4	19 13/16	12 5/16	9 1/4	100

TABLE 2
SUMMARY OF GROUP 14 CONTROL OPTIONS

Model Number	Control Type	Input Signal	ESR-4 Board No.	Integral Feedback Device	Output Signal	CPS-2 Part No. WO/Monitor	CPS-2 Part No. W/Monitor	Auxiliary Switch Options
14-108	Electronic Modulating	0–5 or 1–5 mA dc	13-2245-02	CPS-2 Contactless Position Sensor	1–5 V dc or 4–20 mA		20-3400-12	None 2 4 2+INTLOS
					16 V dc or 50 mA max		20-3400-13	
		4–20 mA dc	13-2245-03		0–15 V dc		20-3400-14	
		10–50 mA dc	13-2245-04		-10 to 10 V dc		20-3400-15	
14-107		1–5 V dc	13-2245-05	Potentiometer 20-3060-03 1000Ω	None Aux. Pot. 1000Ω			None 2 4 2+INTLOS
		–10 to 10 V dc	13-2245-08					
14-106	Direct AC Control (modulating)	120 V ac	None	CPS-2 Contactless Position Sensor	1–5 V dc or 4–20 mA	20-3400-02		None 2 4
					16 V dc or 50 mA max	20-3400-03		
					0–15 V dc	20-3400-04		
					–10 to 10 V dc	20-3400-05		
14-105	Direct AC Control (modulating)	120 V ac	None	Potentiometer 20-3060-03 1000Ω	None Aux. Pot. 1000Ω			None 2 4
14-104	5 Position	120 V ac		None	None			None
14-104	3 Position	120 V ac		None	None			None 2
14-103	2 Position Open/Close	120 V ac		None	None			None 2 4

INSTALLATION

SAFETY PRECAUTIONS

WARNING:

Installation and service instructions for use by qualified personnel only. To avoid injury and electric shock do not perform any servicing other than contained in the operation instructions unless qualified.

STORAGE INFORMATION

The drive should be stored in its shipping carton in a clean, dry area.

If it is necessary to store the drive outdoors for a long period of time, it should be removed from its shipping carton and stored above ground. A waterproof cover should be securely fastened over it. Do not stack drives on top of one another. Stored drives should be periodically checked to make sure no condensation has formed in the control compartments. Damage due to moisture while in storage is not covered by warranty.

UNPACKING

Group 14 drives are packed in standardized cardboard shipping containers. Drives mounted on valves may be packed in cardboard containers or strapped to a skid and crated, depending on size. After unpacking, the wooden platform may be used to transport the drive to the installation site.

INSTALLATION—MECHANICAL

Beck drives can be furnished with valves mounted as unitized assemblies ready for pipeline installation.

CAUTION:

Whenever a control drive is mounted on a valve, it is good practice to remove the valve from service. Observe the following precautions:

1. Know what fluid is in the line.
2. Wear the proper protective equipment.
3. Disconnect the electrical power.
4. Depressurize the pipeline.
5. Refer to the valve maintenance manual for specific instructions.

Mounting The Drive On A Valve

Refer to Figure 1 to identify the mounting parts and the steps to install the drive onto the valve.

1. Prepare the valve. It may be necessary to remove parts that are no longer used or to replace or adjust packing. Refer to the valve maintenance manual for specific instructions. Consult the Beck Valve Mounting Specification sheet that was shipped with the drive for any instructions regarding modifications to the valve stem that may be necessary.
2. Push the valve stem (12) into the valve body to the fully seated or stem down position.
3. Move the G-14 output shaft (6) up into the drive body until the upper mechanical stop (3) is tight against the lower bearing plate (1).
4. Remove the four lower bearing plate bolts (2) that hold the bottom plate to the drive body (1/2" bolt heads). Pressure from the mechanical stop will hold the plate in place when the bolts are removed. Bolt the yoke to the lower bearing plate using the longer bolts supplied with the yoke torque to 10 lb-ft.

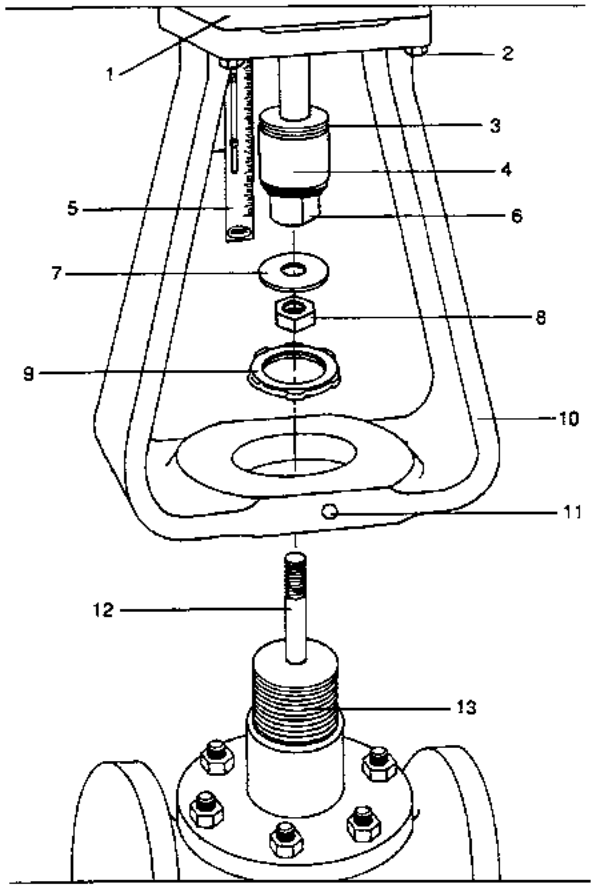


Fig. 1

5. Place the jam nut (8) and travel index (7) over the valve stem (12) before mounting the drive on the valve.
6. Remove the boss nut (9) from the valve and place the drive and yoke over the stem and onto the boss (13). Secure the yoke with the boss nut, finger-tight.
7. Using the drive handwheel, lower the drive output shaft to contact the valve stem. Thread the valve stem into the end of the drive output shaft. HINT: Rotate the whole yoke/drive assembly to get the valve stem started into the drive output shaft. Continue lowering the drive output shaft and threading the valve stem until the drive output shaft is fully down on the mechanical stop.
8. Tighten the boss nut to secure the yoke and tighten the yoke set screw (11).
9. Follow the valve seating adjustment procedure on page 16 to complete the mounting.

Removing the Drive from a Valve

1. Move the G-14 output shaft up into the drive body until the mechanical stop (3) is tight against the lower bearing plate (1).
2. Turn off all electrical power and disconnect all electrical wiring from the drive.
3. Loosen the valve stem jam nut (8). Loosen the boss nut (9) on the yoke and leave it fingertight. Loosen the yoke set screw(11).
4. Unthread the valve stem from the drive output shaft by turning the whole yoke/drive assembly.

Valve Installation

The Beck control drive can be mounted in any convenient orientation. There is no preferred operating position.

Inspect the valve body to be sure that it is clean. Be certain that other pipelines in the area are free from pipe scale or welding slag that could damage the gasket surfaces.

Tighten the flange bolts and ensure that all bolts are evenly torqued. Refer to the gasket manufacturer's instructions for specific information on tightening flange bolts.

NOTE: The valve may have experienced temperature variations in shipment. This could result in seepage past the stem seals. Refer to the valve manufacturer's maintenance instructions for packing adjustments.

INSTALLATION — ELECTRICAL

Two conduit connections are provided in every Beck Group 14 drive for supplying power and signal wiring to the unit. A sealant must be used on threaded conduit connections to keep moisture out. Conduit should be routed from below the drive so that condensation and other contaminants entering the conduit cannot enter the drive.

A large, clearly labeled terminal block on the side of the drive is enclosed in a gasketed metal enclosure. Terminals will accommodate up to 12 AWG wiring (see Figure 2, p. 11)

CAUTION:

Always close covers immediately after installation or service to prevent moisture or other foreign matter from entering the drive.

Refer to the wiring diagram furnished with your Beck drive for proper AC power and signal connections. It is advisable to provide normal short circuit protection on the AC power line. A copy of the wiring diagram is shipped with each drive and is fastened to the inside of the terminal block cover. If there is no wiring diagram available, you may obtain a copy from Beck by providing the serial number of your drive.

Your Beck drive has been supplied to match the signal source in your control loop. If it does not match, refer to the Input Signal Options section of this manual, page 15, for information on how to change the input signal.

For maximum safety, the Beck drive body should be grounded. Normally, the electrical conduit provides adequate ground protection. If not, a separate ground conductor should be connected to the drive body.

INSTALLATION *WIRING*

The Group 14 drive is available with six separate control configurations which are provided to match the control requirements of your system. Basic wiring connections for each Group 14 control option are described in the following paragraphs and diagrams. The wiring diagram specific to each drive is attached to the inside of the wiring terminal cover.

Feedback connections for drives incorporating the Contactless Position Sensor (CPS-2) for control options 6 and 8 are described on pages 13 and 14.

A Group 14 drive can be ordered with up to four auxiliary switches. Wiring connections for these are described on page 21.

To enable full handswitch operation, connect 120 V ac line to terminal C (jumper between terminals A and C). To disable handswitch, remove jumper between terminals A and C, and add jumpers between terminals N and V, M and U.

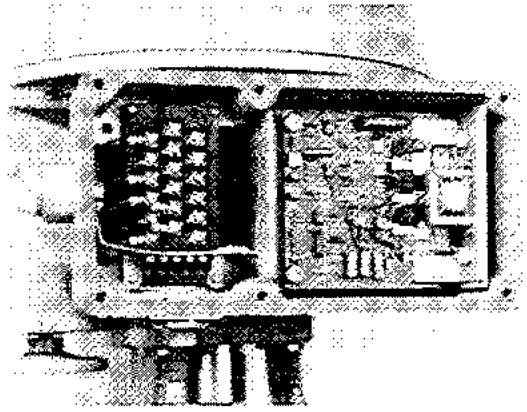
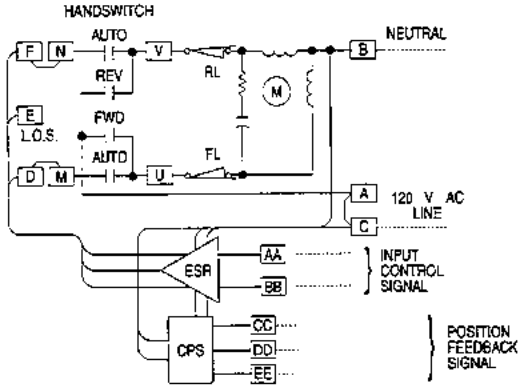


Figure 2. Location of Terminal Compartment

Option 8, Modulating

Analog Position Control with Contactless Position Sensing

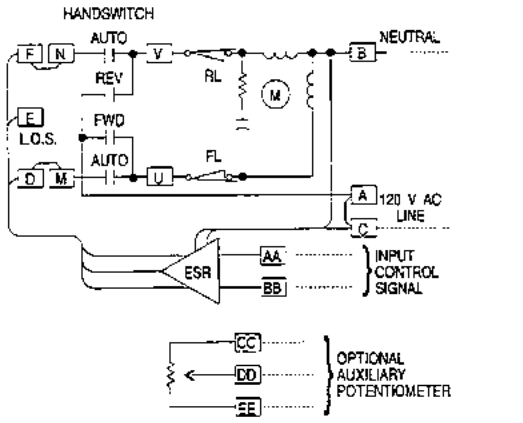
Customer must supply two wires to power the drive: One 120 V ac line (terminal C), and one neutral (terminal B). Customer must supply two wires for the modulating analog control signal: Connect to terminal AA (+) and to terminal BB(–). Customer may supply two additional wires to monitor the analog position feedback signal (see pages 13 and 14 for connections). The drive's feedback circuit power supply is derived from the 120 V ac line, therefore the feedback signal must be wired to a "4-wire" type non-powered analog input.



Option 7, Modulating

Analog Position Control with Potentiometer Position Sensing

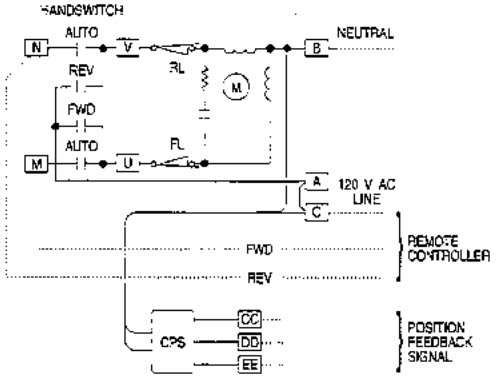
Customer must supply two wires to power the drive: One 120 V ac line (terminal C), and one neutral (terminal B). Customer must supply two wires for the modulating analog control signal: Connect to terminal AA (+) and to terminal BB (–). If position feedback monitoring is required, an optional auxiliary potentiometer can be ordered. The optional auxiliary potentiometer connects to terminals CC (Reverse), DD (Wiper), and EE (Forward) and is compatible with standard "slidewire" style inputs.



Option 6, Modulating

Direct AC Control with Contactless Position Sensing

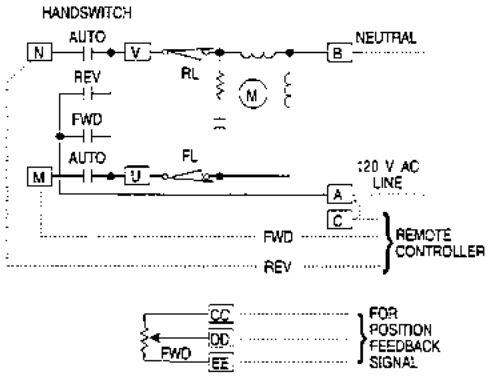
Customer must supply three wires to directly control the drive motor direction: One 120 V ac line to run Forward (terminal M), one 120 V ac line to run Reverse (terminal N), and one neutral (terminal B). Customer may supply two additional wires to monitor the analog position feedback signal (see pages 13 and 14 for connections). If position feedback monitoring is desired, a 120 V ac line must be connected to terminal C. The drive's feedback circuit power supply is derived from this 120 V ac line, therefore the feedback signal must be wired to a "4-wire" type, non-powered analog input.



Option 5, Modulating

Direct AC Control with Potentiometer Position Sensing

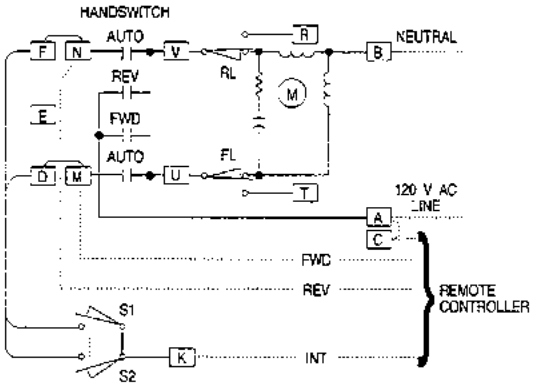
Customer must supply three wires to directly control the drive motor direction: One 120 V ac line to run Forward (terminal M), one 120 V ac line to run Reverse (terminal N), and one neutral (terminal B). The position feedback potentiometer connections are available at terminals CC (Reverse), DD (Wiper), and EE (Forward).



Option 4, Multi-Position

Direct AC Control with Cam-Operated Switches to Stop Drive Travel

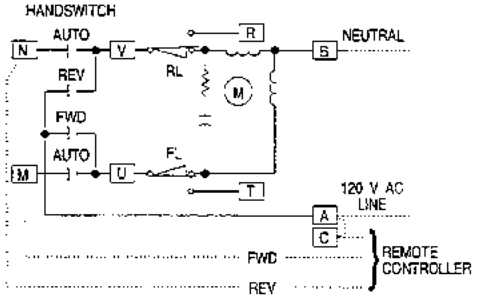
Customer must supply three wires to directly control the drive motor direction: One 120 V ac line to run Forward (terminal M), One 120 V ac line to run Reverse (terminal N), and one neutral (terminal B). Up to six intermediate stop positions may be specified, each requiring an additional 120 V ac line.



Option 3, Open/Close

Direct AC Control

Customer must supply three wires to directly control the drive motor direction: One 120 V ac line to run Forward (terminal M), one 120 V ac line to run Reverse (terminal N), and one neutral (terminal B).



240 V ac Operation

All of the Options described above are available for 240 V ac operation instead of 120 V ac operation. In all cases, the power neutral is replaced with Line 2 of the 240 V ac, and the 120 V ac line is replaced with Line 1 of the 240 V ac.

CPS-2 FEEDBACK SIGNAL CONNECTIONS

Beck Group 14 drives equipped with Contactless Position Sensors (CPS-2) are shipped ready for installation to match the proper mA or V dc feedback range in your system.

Customer connections for feedback signal wiring on each CPS-2 model are described in the following diagrams and paragraphs. Refer to APPENDIX, page 44 for a table of output signal ranges, output terminals, range-changing resistance values (R) including jumper or open circuit, and terminals to which the ranging resistor or jumper is connected.

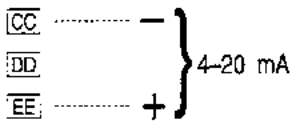
To verify that the feedback signal range is correct for your drive, connect a mA/V dc multimeter across the appropriate terminals (check model number on CPS-2 transformer and Table 15, page 44 for correct terminals CC, DD, or EE). Use the handswitch to operate the drive throughout its full travel.

Note: Ranging resistors must be connected to the control drive output terminals. If ranging resistor change is required, they may be obtained locally. If resistors with ±1% tolerance are not available, they can be ordered from Beck.

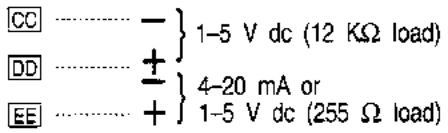
CPS-2 Model 20-3400-02, -12 Terminal Connections

1. A single 4–20 mA current output is available between terminals EE (+) and CC (–) when driving into an external load between 250 and 800 ohms. No ranging resistor is required.
2. For 4–20 mA and 1–5 V dc combined output, 4–20 mA is available across EE (+) and DD (–); 500 ohms is the maximum external load (for larger loads see Item 1 above). A 1–5 V dc signal is available across DD (+) and CC (–) into a 12 k ohm resistive load.

4-20 mA Signal Output



4-20 mA & 1-5 V dc Signal Output



CPS Model 20-3400-03,-13 Current Feedback Terminal Connections

The universal model has a voltage divider network which allows for various voltage or current signal ranges. Current output is available between terminals DD (+) and CC (-) with the proper ranging resistor connected across terminals DD and EE.

Units are factory calibrated for specified signal ranges and are provided with proper resistors installed.

The ranging resistor value is given in Table 15, page 44, or can be calculated using the equation:

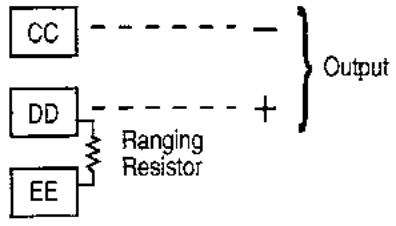
Where R = Resistor Connected DD to EE

$$R = \frac{4}{(I - .004)} \text{ ohm}$$

I = Output Current Span (Amperes)

If converting to a suppressed zero range (a range that does not include zero as an end point), refer to Adjusting the Zero Potentiometer section (page 26).

Current Output



CPS-2 Model 20-3400-03, -13
Voltage Feedback
Terminal Connections

The universal model has a voltage divider network which allows for various voltage or current signal ranges. Voltage output ranges are available across terminals EE (+) and CC (–) with the proper ranging resistor connected across terminals CC and DD.

Units are factory calibrated for specified signal ranges and are provided with proper ranging resistors installed. Other voltage ranges are attainable by adding a ranging resistor across terminals CC and DD.

The ranging resistor value is given in Table 15, page 44 or can be calculated using the equation:

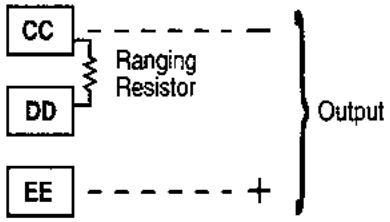
$$R = \left(\frac{V}{4} - 1\right) K\Omega$$

Where R = Resistor Connected CC to DD

V = Output Voltage Span

If converting to a suppressed zero range (a range that does not include zero as an end point), refer to adjusting the Zero Potentiometer Section (page 26).

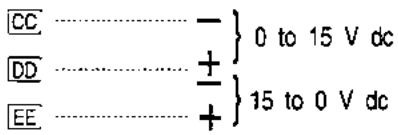
Voltage Output



CPS-2 Model 20-3400-04, -14
Terminal Connections

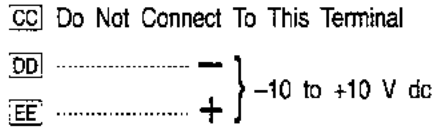
The three-terminal output from these models is provided for replacing potentiometers in three-terminal potentiometer feedback applications used in many controllers. It is suitable for either 0-15 or 0-16 V dc applications of either positive or negative polarity. CC must be connected to the negative lead from the controller, and EE to the positive lead from the controller, with DD connected to the controller lead accepting the feedback from the potentiometer wiper. These models can "source" 10 mA to the controller, or they can "sink" 2.5 mA from the controller.

Potentiometer Equivalent



CPS-2 Model 20-3400-05, -15
Terminal Connections

Voltage signal –10 +10 V dc is available across terminals EE (+) and DD (–). The maximum load is 5 mA.



INPUT SIGNAL OPTIONS

Beck Group 14 drives configured for milliamp modulating applications include an Electronic Signal Receiver (ESR-4). See page 11, Figure 2 for location of the board. A number of control options are available with the ESR-4, such as operating more than one drive with a single signal source. The instructions below apply to applications which require a signal change or to situations calling for operation of multiple drives from a common input signal.

Input Range Change to ESR-4

If it is necessary to change the range of an ESR-4 board to receive a different input signal current, the "R-in" resistor must be changed. See Table 3 for the proper value, and Figure 13 on page 29 for its location on the board. It is mounted on turrets to facilitate the change. After soldering the new resistor in place, recalibrate in accordance with instructions on page 28. If a proper resistor with ±1% tolerance cannot be obtained locally, it can be ordered from Beck.

Series Operation

Beck drives can be connected in series from the same signal for concurrent operation. Care must be taken to keep the polarity correct in each drive's input terminals. Two or three drives may usually be connected in series. The number of drives that may be connected in series is limited only by the controller's (signal source) capability to feed current into the total resistance of the circuit involved. Consult the controller manufacturer's recommendations.

No change is required to the drive's calibration for series operation. An interruption in the circuit will actuate loss of input signal (L.O.S.) on the drives in the circuit.

Parallel Operation

Beck drives can be connected in parallel to the same signal for concurrent operation. Up to four drives may be connected in parallel.

For parallel operation, use ESR-4 board no. 13-2245-05 in each drive, and add a shunting resistor across input terminals AA and BB on one of the Beck drives. The value of the resistor is:

$$\frac{\text{Input Resistance} \times 10\ \text{KW}}{10\ \text{KW} - (\text{N}) \times \text{Input Resistance}}$$

where N = the number of drives. Refer to Table 3 for the input resistance. For example, a 278 ohm shunting resistor should be used for four drives in parallel with a 4–20 mA input signal. If the calculated resistance is not a standard value then select the closest standard value.

A minor span adjustment is required to each drive in a parallel circuit. An interruption in the circuit to one drive will not prevent the other drives from functioning but there will be a slight calibration shift.

TABLE 3
ESR-4 BOARD MODELS

Input Signal	ESR-4 Board Part No.	R-in (Tolerance 1%)	Input Resistance
0–5* or 1–5 mA dc	13-2245-02	13-2511-01 1.05KΩ	1 KΩ
4–20 mA dc	13-2245-03	13-2511-03 255Ω	250Ω
10–50 mA dc	13-2245-04	13-2511-02 100Ω	100Ω
1–5 V dc**	13-2245-05	13-2512-05 20KΩ	10 KΩ
–10 to 10 V dc	13-2245-08	13-2512-05 20KΩ	50 KΩ

* Span and zero adjustment required.
** Standard: SA range (S50.1/1975).

Split Range Operation

Two or three Beck drives may be operated over their full range by a portion of the controller's output signal range. The most common arrangement involves two drives operating on equal halves of the input signal range. For example, if a 4–20 mA control signal is used, the first drive would move 100% of its stroke on a signal range of 4–12 mA, while the second operates on the 12–20 mA portion of the signal. In this case, the ESR-4 boards are the same as would be used for parallel operation (13-2245-05), but calibrated to the range required for each drive. A shunting resistor must be added across input terminals AA and BB on one of the Beck drives to produce a span between 2 and 6 volts across each board for its active portion of the range.

Follow the steps for calibration (ESR-4 page 28) for each drive unit, using half span values for the input signal. Use the proper starting point for each half-range when setting the zero, 4mA, and 12 mA. Before setting the zero on the second drive (12

mA), cut one lead of resistor R35 (See ESR-4 photo and illustration, page 29, to locate R 35).

In a split range configuration, connect terminals E and F (L.O.S. wire) to prevent undesired "stay-in-place" operation of the second or third drive due to fast downward signal changes.

When three drives are to be operated on equal portions of the input signal, the 4–20 mA range would split into 4–9.33 mA, 9.33–14.67 mA, and 14.67–20 mA signals. A 487 ohm shunting resistor (Beck P/N 13-2510-03) is adequate. Proceed as in the case of the two-way split, first setting span, then the zero. When setting the ESR-4 board in the first drive, set the zero at 4 mA. Then, on the second drive, cut the R35 resistor on the board and set its zero at 9.33 mA. Before setting zero in the board of the third drive, short out the R34 resistor by adding a jumper, adjust its zero at 14.67 mA, cut resistors R35 and R36 from the board, then remove the jumper from R34. Check operation of all drives by running the input signal through its complete range. If it is necessary to recalibrate the same board later, you may jumper resistors R35 and R36 by connecting the R35 turrets together.

START-UP INSTRUCTIONS

After the drive is mounted and its wiring connections are made, it is ready to be tested for proper operation.

Turn on the power supply. Operate the drive with the handswitch and run it through its full stroke, both directions. Observe that the driven device travels through its desired stroke. If satisfactory, set handswitch at the "auto" position.

If the drive is to be operated with automatic control, turn on the controller and operate the drive by varying the control signal. Check that the valve strokes in the proper direction for a change in control signal. An increasing control signal retracts the shaft and opens the valve. With a 100% signal, the drive is fully retracted. If the valve does not stroke in the proper direction, first check for proper wiring connections and verify the control signal at the drive. If the wiring is correct, then reverse the direction of travel (see page 23).

If the drive is to be push-button actuated, (options 3, 4, 5 or 6) operate the drive using the handswitch and observe that direction of travel is correct. When travel of the driven device is satisfactory with reference to the control signal or the push-buttons, the unit is ready for operation.

Valve Seating Adjustment

The drive has a Tight-Seater™ attached to its output shaft. The Tight-Seater™ allows tight seating of the valve plug. It is a pre-loaded coupling that allows the valve plug to seat before the drive reaches its lower limit. The additional amount of travel compresses the thrust discs inside the Tight-Seater™, causing a controlled amount of thrust to hold the valve plug on its seat when the drive stem reaches its lower limit. The Tight-Seater™ is factory-set to produce a thrust matched to the drive and should never be disassembled. Control of the amount of valve stem threaded into the Tight-Seater™ may be used to adjust the valve seating.

If readjustment of valve seating is necessary, proceed as follows:

1. With the handswitch, run the drive to a position above the 0% or lower limit position.
2. Loosen the lock nut on the valve stem and thread the valve stem into the Tight-Seater™.
3. Run the drive to the 0% position, using the handswitch.
4. Thread the valve stem out of the Tight-Seater™ until the plug seats in the valve.
5. Raise the drive shaft using the handswitch until the plug is clear of the seat and there is sufficient clearance to make the following adjustment.
6. Thread the valve stem out of the Tight-Seater™ a fraction of a turn according to the valve stem thread as listed (1/32" travel):

Thread	Turn
3/8–24	3/4
7/16–18	5/8
1/2–20	5/8
3/4–16	1/2

7. Tighten the lock nut and index disc on the valve stem.
8. Run the drive to its lower limit using the handswitch. The valve stem should stop before the drive shaft stops.
9. Reposition the travel index.

CAUTION:

If the valve stem is threaded directly into the drive shaft without a Tight-Seater™, the valve stem should be at least 1/4 turn from the seated plug position when the drive shaft reaches the lower limit. This will prevent damage to the valve stem or seat. Do not attempt to obtain tight shut-off without a Tight-Seater™ as serious valve damage may result.

OPERATION

HOUSING

All models of the Beck Group 14 Electronic Control Drive have individual cast aluminum compartments for the main components: The control motor, wiring terminal board and electronic signal receiver, drive train and feedback section. Gasketed covers and sealed shafts make the Group 14 ideally suited to outdoor and high-humidity environments.

CONTROL MOTOR

The Beck control motor is a synchronous inductor motor which operates at a constant speed of 72 RPM in synchronism with the line frequency.

Motors are able to reach full speed within 25 milliseconds and stop within 20 milliseconds; actual starting and stopping times will vary with load.

Beck motors have double grease-sealed bearings and require no maintenance for the life of the motor.

DRIVE TRAIN

The Group 14 drive train consists of a control motor, SLM, handwheel, reduction gears, main gear, and power screw output shaft. The ductile iron main gear and the bronze nut and stainless steel power screw output shaft are common to units of a particular range of thrust and timing. The alloy steel reduction gears are part of the field-changeable gear housing assembly. Different combinations of output gear, housing assemblies, and drive motors determine the drive's output thrust and timing. See Table 10, page 41 for details.

The output shaft travel is limited by mechanical stops. The mechanical stop for the fully extended or lower limit of the output shaft travel is not adjustable. The position of the retracted or upward travel mechanical stop is determined by the number of washers on the output shaft between the Tight-Seater™ and the lower bearing plate. This is factory-set for the amount of travel specified at the time of the order and is generally not changed in the field.

The amount of output shaft travel is determined by the setting of the Calibar. Moving the Calibar block away from the output shaft increases the radius where the ball bearing contacts the sector gear lever. The longer the radius the longer the vertical stroke of the output shaft for the same amount of rotation of the control end shaft. Therefore, the Calibar changes the output shaft travel but makes it unnecessary to change the switch cams, film potentiometer, or CPS-2. Field Calibar adjustment is generally used to shorten the travel. Consult the factory if a longer stroke is required.

SELF LOCKING MECHANISM (SLM)

An integral part of every Group 14 control motor is the self-locking mechanism. This mechanical device couples the motor to the gear train and transmits full motor torque when rotated in either direction. When the motor is deenergized, it instantaneously locks and holds the output shaft in position.

TIGHT-SEATER™

The Beck Tight-Seater™ assembly is a pre-loaded coupling, installed between the drive output shaft and the valve stem. It produces a controlled positive pressure against the valve seat, independent of drive thrust.

The Tight-Seater™ consists of four parts: a housing attached to the output shaft, linear thrust discs contained in the housing, a flanged coupling attached to the valve stem, and a threaded ring to contain the flanged coupling in the housing and to allow adjustment of the pre-load on linear thrust discs.

The factory pre-load, by a threaded ring, ensures that no relative motion occurs between the flanged

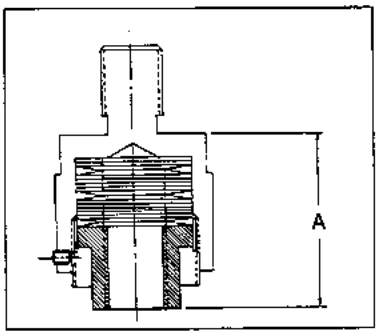


Fig. 3. Tight-Seater™ Cross-Section (See Table 11, p.41)

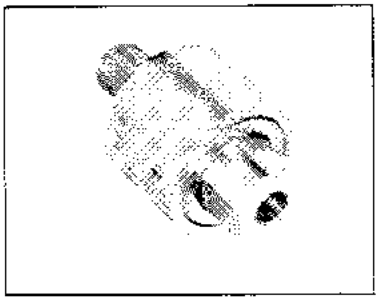


Fig. 4. Tight-Seater™

coupling and housing during normal valve operation until the pre-load thrust is exceeded in the seated plug position of the valve.

When the seated plug position of the valve is reached, the flanged coupling on the valve stem is stationary, and the output shaft exceeds the pre-loaded pressure of the Tight-Seater™. When the pre-loaded pressure is exceeded, the housing will compress the linear thrust discs, maintaining a controlled pressure on the valve seat, with the shaft stationary.

HANDWHEEL

Every Beck Group 14 linear drive is furnished with a manual handwheel for operation of the valve without electrical power. Its solid construction design includes no spokes or projections, and turns at a safe slow speed. The handwheel is located at the bottom of the control motor housing. The handwheel is coupled directly to the motor shaft and rotates when the motor runs. Manual operation of the handwheel (with electric handswitch in STOP position) turns the motor and the rest of the drive train without incorporating a clutch.

HANDSWITCH

A local electric handswitch is provided on Beck Group 14 drives to permit operation at the valve, independent of the controller. As a safety feature, the handswitch is designed so that the controller can operate the drive only when it is in the "AUTO" position. The sequence of the handswitch is: AUTO, STOP, FWD, STOP, REV.

In the AUTO position, two contacts are closed and the ESR-4 or external controller contact completes the control circuit.

In the FWD or REV positions, contacts are closed to operate the drive, independently of the controller.

In the STOP position, all contacts remain open.

SWITCHES

Two end of travel switches and up to four optional auxiliary switches are provided on Beck Group 14 Drives. Switch cams are clamped onto the control shaft which rotates in relation to the output shaft. Cam position is field adjustable. Switches are enclosed in high impact thermoplastic. Switches are rated 6 amps 120 V ac (0.5 amp 125 V dc). All auxiliary switch connectors are made on the terminal board.

CONTROL OPTIONS

Two basic types of control are available: 120 V ac contact closure (options 3, 4, 5, and 6) and milliamp modulating (options 7 and 8). Each option is described below.

Open/close option 3: For simple 2-position control using manual push-buttons or an automatic controller. Preset travel limit switches provide open/close operation upon closure of an automatic controller or manually operated switch. Travel limits are adjustable over the full range of travel and have a repeatability of 0.1% of full travel.

Multi-position option 4: Adjustable cam operated switches provide up to five discrete stop positions upon closure of an automatic controller or manually operated switch. Three, four, and five predetermined position settings are possible, with positioning repeatability of 1% of full travel over the range of operation.

Direct AC control option 5: Operated in forward/reverse from a remote location; includes a 1000 ohm film potentiometer for remote feedback.

Direct AC control option 6: Provides continuous positioning capability over the full range of drive travel by direct AC control from either an automatic controller or manually operated switches. Includes Contactless Position Sensor (CPS-2) for feedback and position indication.

Modulating option 7: For automatic operation in response to milliamp or V dc analog control; includes a film potentiometer for position sensing and feedback to the Electronic Signal Receiver (ESR-4).

Modulating option 8: For automatic operation, as in option 7 above; includes Contactless Position Sensor (CSP-2) for position sensing and feedback to the ESR-4.

INPUT / ELECTRONIC SIGNAL RECEIVER (ESR-4)

Beck modulating drives are equipped with precision electronic control modules (ESR-4) to receive conventional 4–20 mA or 1–5 V dc control signals directly, eliminating the need for contact protection devices, relays, switches, and reversing starters.

The ESR-4 provides for drive control with analog control systems, and is designed to operate continuously in temperatures up to 185° F.

A feedback signal from the drive's Contactless Position Sensor (CPS-2) or potentiometer is compared to the input signal. A difference in these signals, the error, is amplified and used to actuate either of two electronic motor power switches. These switches drive the motor in the proper direction to force the error to zero. The input signal is adjustable from 50% to 450% of the 4 volt span, with the zero adjustable from –100 to +275% of span.

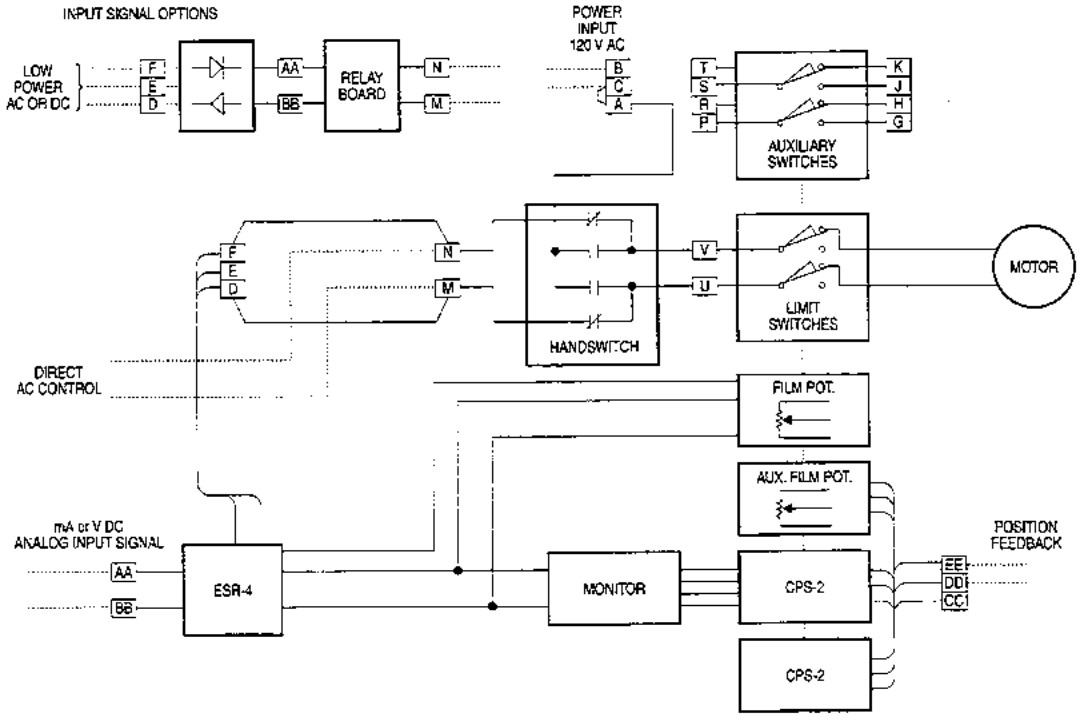
The ESR-4 permits two or more Beck drives to be operated by a single signal source, for series, parallel, or split range operation. See page 15 for details on these control options.

The ESR-4 board requires a feedback signal source. Either the Contactless Position Sensor (CPS-2) or a Film Potentiometer can be provided for this purpose. The CPS-2, with a monitor/isolator board, produces an isolated position feedback signal for the ESR-4 board. The Monitor function monitors the CPS-2 position signal and compares it to established limits. If the output exceeds normal signal conditions, the monitor relay contact opens. This relay may be used for either a remote signal indication or activation of Loss of Signal operation of the drive.

POSITION FEEDBACK/ CONTACTLESS POSITION SENSOR (CPS-2)

The CPS-2 provides a continuous feedback signal proportional to the position of the drive's output shaft. It is used for remote position indication as well as for automatic control loop feedback to the Electronic Signal Receiver (ESR-4). When used with the ESR-4, the CPS-2 includes a monitor/ isolator board. The monitor detects and provides indication of high/low out-of-limit feedback signal conditions. The isolator provides a separate position feedback signal to the ESR-4 which is isolated from the CPS-2 output.

The position sensing function of the CPS-2 is provided by a ferrite magnetic sensing element consisting of two parts: a ferrite stator mounted on



Control Drive Block Diagram

the CPS-2 circuit board and a ferrite rotor mounted on the control shaft, driven by the Beck drive's output shaft through the Calibar assembly. The electronic circuit translates the signal from the ferrite magnetic sensor into an analog position feedback signal designed to interface with electronic control systems and indicating instruments.

POSITION FEEDBACK/ FILM POTENTIOMETER

The film potentiometer produces a voltage that is some fraction of the voltage applied across its resistive element. That voltage fraction is determined by the position of the wiper on the resistive element. The potentiometer assembly also includes two fixed resistors, one on each end of the resistive element. These resistors permit suppressed ranges as well as zero-based position feedback voltages. If position feedback is desired on drives equipped with an ESR-4 board, two film potentiometers are required; one for position feedback and the second to supply a feedback signal to the ESR-4.

LOSS OF CONTROL SIGNAL (L.O.S.)

Beck drives equipped with the ESR-4 have the ability to move to a predetermined position upon loss of input control signal. When the input signal drops to 12% of span below the zero setting, the ESR-4 provides an annunciating signal with one of the following options:

1. STALOS = Stay in place, lock in last position. (Triac output available for remote alarm)
2. REVLOS = Reverse to the fully extended shaft travel limit switch position. Connect terminal E to F.
3. FWDLOS = Forward to the fully retracted shaft travel limit switch position. Connect terminal E to D.
4. INTLOS = Move to pre-determined intermediate auxiliary switch position. Consult factory.

When the input signal is lost but the power remains on, the L.O.S. switch on the ESR-4 board is energized, a red LED on the board lights and the FWD and REV switches are turned off. The output of the L.O.S. switch is connected to terminal E which is wired for one of the predetermined operating modes listed above.

SWITCH ADJUSTMENTS

All Group 14 control drives are shipped with end of travel limit and all auxiliary switches factory-adjusted for 100% of travel unless otherwise specified at time of order. Switches must be set inside the range of the built-in mechanical stops to prevent stalling of the motor.

Although the switches may be reset through adjustment of the cam position, it is usually advisable to change the valve travel by using the Calibar index feature described on page 22.

Each switch should open the motor circuit before the mechanical stop is reached. Use the travel index on the output shaft to check the setting. Three percent or more between the mechanical and electrical limits is satisfactory. To check, drive to the electrical limit using the handswitch, and then turn the handwheel until the mechanical stop is reached.

All switches are SPDT and are rated at 6 amps 120 V ac (0.5 amps 125 V dc). Switches are operated by cams which are clamped on to the control shaft. Setting the switch involves loosening the cam, moving the output shaft to the desired position, and positioning the cam so that it just operates the switch at that point. In the following procedure, the use of a continuity meter is recommended to determine when the switch opens or closes. If such a meter is not available, it is possible to hear the switch click as the contacts open and close.

CAUTION:

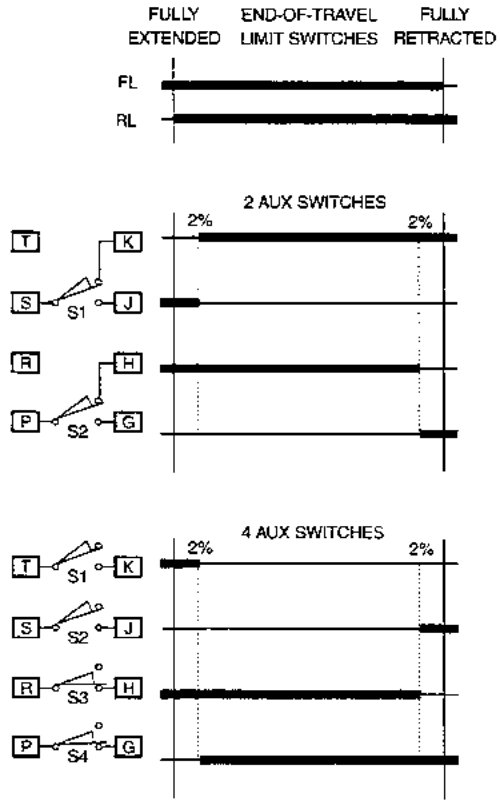
Do not attach the meter or attempt to move the switch cams until the drive is disconnected from the line voltage and auxiliary switches are disconnected from external power sources.

STANDARD SWITCH SETTINGS

Switch contacts below are shown at midpoint of shaft travel.

Setting Travel Limit Switches FL and RL

This procedure should be used if the factory end of travel switch settings must be changed in the field. It is advisable to operate the drive fully each direction, using the electric handswitch to check switch settings before attempting to change them. Follow these instructions if they require adjustment.



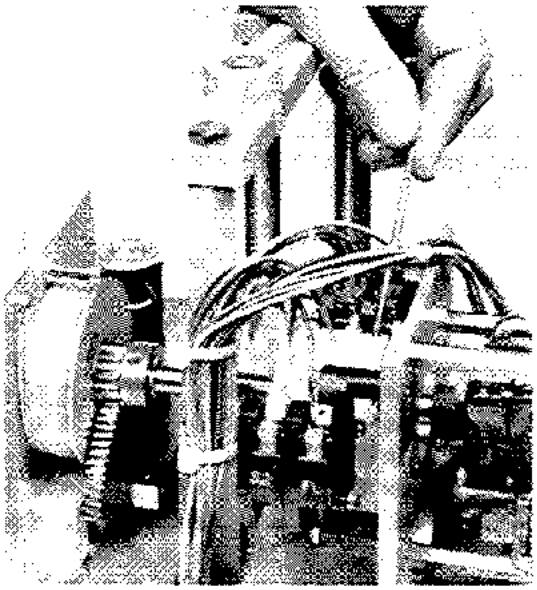


Fig. 5 Cam Adjustment

1. Remove the top cover (15/16" bolt head). The O-ring seal will remain in the rim of the top cover when removed. Open the terminal block cover (1/2" bolt head).
2. Use the electric handswitch to drive the control shaft so that the RL switch cam is accessible. Using a 7/64" hex wrench, loosen the screw so that the cam is just snug to the shaft. See Figure 5.
3. Use the handwheel to position the control shaft so that the lever of the lever-sector gear assembly is parallel with the upper bearing plate. See Figure 6 for location of lever and bearing plate.

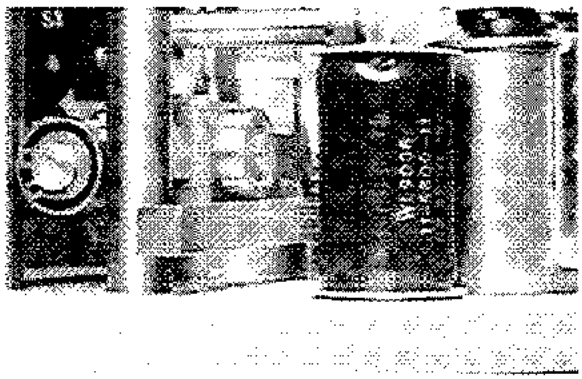


Fig. 6 Sector-Lever Gear

4. Disconnect power from the drive.
5. Connect the continuity meter across terminals B and V. Rotate the cam until the meter shows no continuity (a switch contact opens; switch clicks).
6. Tighten the cam locking screw to 5 lb-in torque.
7. Disconnect the meter and reconnect switch wires and drive power.
8. Using the handswitch, drive the output shaft to the fully up position. Note the direction of rotation of the lobe of the cam. The correct cam lobe motion is away from the switch lever with the switch lever on the lower part of the cam. If this is not correct, return to step 2 and reset the cam to the proper orientation.
9. Drive the output shaft again to the fully extended travel limit. If the correct stopping point is reached (lever parallel with the upper bearing plate), the switch is properly set.
10. Manually position the control shaft position indicator dial to zero.
11. With the handswitch, move the control shaft until the position indicator dial reaches the 150° position.
12. Repeat the instructions for setting the FL travel limit except that the direction of motion is opposite to that used for the RL switch setting. Connect the continuity meter across terminals B and U.
13. Close the covers and tighten the terminal cover bolt to 10 lb-ft. Tighten the top cover bolt just enough to compress the O-ring seal.

Setting Auxiliary Switches

Standard switch settings for drives with 2 or 4 auxiliary switches are shown on the diagram on page 21. The operating point of all auxiliary switches is defined as a percent of output shaft travel. 100% is defined as the retracted limit of shaft travel. The heavy line indicates a closed circuit. Follow these instructions to change the operating point of auxiliary switches.

NOTE: In the following procedure, it is assumed that switch settings are to be adjusted so that contacts open when the desired position is achieved. If they are to be adjusted to close, it may be necessary to reverse the operating mode of the switch by reversing the leads on the switch itself. Be sure to disconnect power from the switch terminals first.

1. Remove the top cover (15/16" bolt head). The O-ring seal will remain in the rim of the cover when removed. Open the terminal block cover (1/2" bolt heads).
2. Use the electric handswitch to drive the shaft so that the switch cam is accessible. Using a 7/64 hex wrench, loosen the screw so that the cam is just snug on the shaft.
3. Move the output shaft to the desired position.
4. Disconnect power from the drive.
5. Connect the continuity meter across the appropriate terminals. See the chart on page 21 or the drive wiring diagram. Rotate the cam until the meter shows no continuity (switch contacts open, switch clicks).
6. Tighten the cam locking screw to 5 lb-in torque.
7. Disconnect the meter and reconnect power.
8. Move the drive's output shaft in the desired direction so that the cam lobe moves away from the switch lever. If not correct, return to step 2 and reset the cam to the proper orientation.
9. Reconnect the meter.
10. Move the output shaft again toward the desired switch position. If the contacts open, the switch is properly set.
11. Close covers and tighten the terminal cover bolts to 10 lb-ft torque. Tighten the top cover just enough to compress the O-ring seal.

STROKE CHANGE — CALIBAR

Adjustment of the total drive stroke within the factory-set travel range is easily accomplished by the use of the Beck Calibar, Figure 7. The switches and feedback device are simultaneously adjusted to maintain full input span when the calibar setting is changed. For stroke lengths longer than the factory-set travel limits, consult the factory. Adjust the drive stroke as follows:

1. Remove the top cover. The protective O-ring seal will remain in the rim of the top cover when removed.
2. Use the handswitch to move the output shaft to the fully extended position.
3. Loosen the two locking screws on the calibar block with a 1/8" hex wrench.
4. Slide the calibar block to the desired stroke on its index, and tighten the set screws. The Calibar index is graduated directly in inches, with zero being the seated plug position of the valve.
5. Use the handswitch to operate the drive and check the stroke on the travel index of the valve yoke.
6. Replace the top cover after making adjustments. Tighten the top cover just enough to compress the O-ring seal.

NOTE: The limit switches and feedback device are adjusted automatically when the calibar setting is changed. Do not adjust the limit switch cams to change the drive stroke.

STROKE AND SPAN ADJUSTMENTS

The Calibar adjustment is designed to allow field changes of the total drive stroke with the same maximum input signal applied (e.g., a change from 1 1/2" stroke with 20 mA input signal to a 1" stroke with 20 mA input signal).

The span adjustment on the ESR-4 board is used to maintain the drive stroke when a change

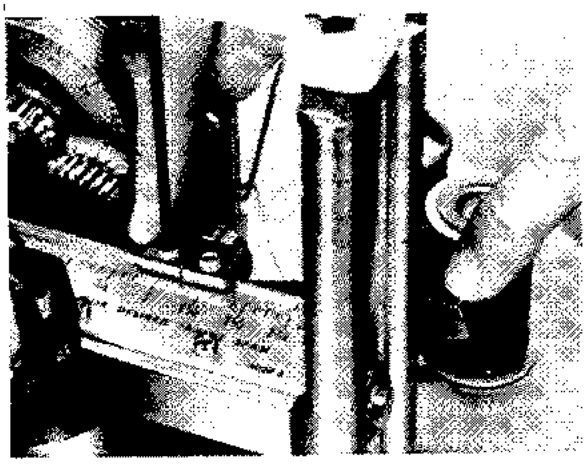


Fig. 7. Calibar Adjustment

in input signal (or span) is required (e.g., a change from 3/4" stroke with a 20 mA maximum input signal applied to 3/4" stroke with an 18 mA maximum input signal applied.)

CHANGING DIRECTION OF TRAVEL

Forward direction of travel is defined as the direction of output shaft motion produced by an increasing signal. Unless otherwise specified at the time of order, the output shaft is factory-set to retract in response to an increasing signal to open the valve.

The procedure to change the direction of travel of the output shaft varies by model number. The model number is listed on the drive name plate. Determine the model number and refer to the proper procedure below.

CAUTION:

Be sure that the drive is disconnected from the line voltage and that all auxiliary switches are disconnected from the external power sources before beginning the direction change procedure.

Models 14-103 and 14-104

1. Remove the top cover (15/16" bolt head). The O-ring seal will remain in the rim of the top cover when removed.
2. Interchange the yellow and black wires on the common terminals of the FL and RL travel limit switches.
3. Replace the top cover. Tighten the cover bolt just enough to compress the O-ring seal.

Models 14-105 and 14-107

NOTE: On model 14-107 units equipped with an auxiliary film potentiometer, the auxiliary potentiometer is mounted closest to the sector gear end of the control shaft.

1. Remove the top cover (15/16" bolt head). The O-ring seal will remain in the rim of the top cover when removed.
2. Interchange the yellow and black wires on the common terminals of the FL and RL travel limit switches.
3. Interchange the wires connected to the ends of the potentiometer. The wire on terminal 1 or 5 should be moved to the opposite terminal. Also move the wire on terminal 2 or 4 to the opposite terminal. The wire to terminal 3 remains unchanged.

Auxiliary Potentiometer Only

4. Reverse the wires connected to the ends of the potentiometer. The wire on terminal 1 or 5 or on terminal 2 or 4 should be moved to the opposite terminal.
5. Replace the top cover. Tighten the cover bolt just enough to compress the O-ring seal.

Models 14-106 and 14-108

1. Open the terminal compartment (1/2" bolt heads) and remove the top cover (15/16" bolt head). The O-ring seal will remain in the rim of the top cover when removed.
2. Interchange the yellow and black wires on the common terminals of the FL and RL travel limit switches.
3. Install a mA meter in series with a 200 ohm load resistor for current outputs or a voltmeter across the CPS-2 output terminals for voltage outputs. See Table 14, page 44.
4. Reconnect drive power.
5. Drive the output shaft until the CPS-2 output is 50% of the range (e.g. for 4–20 mA signal range, set output to 12 mA).
6. Set handswitch to STOP position.
7. Using a 7/64 inch hex wrench, loosen the CPS-2 rotor clamp.
8. Rotate the CPS-2 rotor 180° and set the output back to the mid-range (e.g. 12 mA).
9. Tighten the rotor clamp. See Figure 8, page 27.
10. Run the drive to the FWD and REV limits with handswitch. Record CPS-2 output at limits.
11. Subtract outputs recorded at the two limits and compare with the desired output signal span (e.g. 16 mA or 4 V dc).
12. Move the drive to the FWD limit.
13. Divide the difference between the measured span, step 11, and the desired span by 2. Adjust the Span Potentiometer by this amount. See Figure 10, page 27. NOTE: CW movement of the Span Potentiometer moves the ends of the signal range out away from each other. CCW movement of the Span Potentiometer moves the ends of the signal range in toward each other.
14. Loosen the rotor clamp and adjust the rotor position to achieve the desired value of maximum output signal (e.g. 10 mA or 5 V dc). NOTE: Rotor adjustment moves the entire signal span up or down.

CHANGING DIRECTION OF TRAVEL, CONT'D.

15. Tighten rotor clamp and run output shaft to FWD and REV limits to check CPS-2 signal for desired span. If not correct, repeat procedure from step 11.
16. Tighten rotor clamp to 5 lb-in torque. Maintain 0.031 inch clearance between rotor clamp and stator.
17. Remove meter and resistor and reconnect output wiring.
18. Close covers and tighten the terminal cover bolts to 10 lb-ft torque. Tighten the top cover just enough to compress the O-ring seal.
19. Model 14-108: recalibrate ESR-4 Board.

FEEDBACK SIGNAL CALIBRATION

Feedback signal calibration is necessary to ensure that signal current or voltage correctly corresponds to the drive's output shaft position. All Group 14 products are shipped with the feedback calibrated for full retraction of the output shaft unless otherwise specified at the time of order.

The procedure to check and set feedback calibration varies by model number. The model number is listed on the drive name plate. Determine the model number and refer to the proper procedure below.

NOTE: The shaft travel limit switches must be properly adjusted before the feedback signal is calibrated. The feedback signal must be calibrated before the input signal can be calibrated.

FILM POTENTIOMETER CALIBRATION

Models 14-105 and 14-107

NOTE: On model 14-107 units equipped with an auxiliary film potentiometer, the auxiliary potentiometer is mounted closest to the sector gear end of the control shaft.

When properly adjusted, the auxiliary potentiometer feedback signal should be maximum with the drive shaft in the fully retracted (maximum input signal) position. At 50% of travel the signal should be mid-span. At full extension, the signal should be minimum.

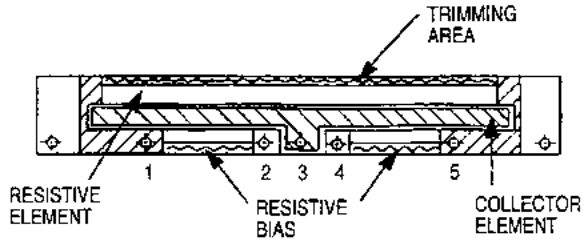
On option 7 units, potentiometer feedback to the ESR-4 board should read 0.54 V dc at the minimum input signal and 2.66 V dc at the maximum input signal.

If either the auxiliary or main potentiometers on option 7 units is out of calibration, or if the feedback potentiometer on option 5 units is out of calibration, the procedure to recalibrate is the same.

1. Open the terminal block cover (1/2" bolt heads) and remove the top cover (15/16" bolt head).
2. Loosen the clamping screw (use 9/64 hex wrench) on the potentiometer wiper so that it is just snug on the shaft.
3. Operate the drive to the electrical limit corresponding to maximum input signal.
4. Set the wiper so that the voltage reaches its maximum value. Auxiliary feedback signals are read by a multimeter at the terminal block (CC, DD, EE). Feedback signals to the ESR-4 board are read on the board at TP3 and TP2 (see Figure 13, page 29 for location).

NOTE: Be sure that the wiper spans the resistor and collector elements equally, and does not touch the areas of low resistance at either end of the film element.

5. Tighten the clamping screw to 5 lb-in torque.
6. Operate the drive between the electrical limits. Verify that the feedback signal is properly adjusted.



7. Use the manual handwheel to run the drive to the mechanical limit; do not overtorque, as damage may result.
8. Check that the wiper does not come off the resistive element or output voltage does not fall from maximum value. If not correct, return to step 2.
9. Replace the top cover and close the terminal block cover. Torque the terminal cover bolts to 10 lb-ft. Tighten the top cover bolt just enough to compress the O-ring seal.

CPS-2 CALIBRATION
Model 14-106 and 14-108

These models are equipped with a Contactless Position Sensor (CPS-2) for position sensing and feedback. On model 14-108, the CPS-2 also delivers a feedback signal to the Electronic Signal Receiver (ESR-4). Adjusting the remote feedback signal also automatically adjusts the signal to the ESR-4 on models so equipped. CPS-2 units are designed to provide position feedback without contacting or wiping surfaces. On option 8 units, the CPS-2 includes a Monitor/Isolator board which detects high and low out-of-limit conditions. The Monitor function monitors the CPS-2 position signal and compares it to established limits. If the output exceeds normal signal conditions, the monitor relay contact opens. This relay may be used for either a remote signal indication or activation of Loss of Signal operation of the drive.

The CPS-2 provides infinite resolution by incorporating a ferrite rotor on the control shaft and a ferrite stator mounted on the position sensing circuit board. To make feedback signal adjustments, adjust the span, then change the position of the rotor on the control shaft to adjust the zero.

CHECK FEEDBACK SIGNAL CALIBRATION

The following procedure should be followed to check CPS-2 calibration:

Tools required:

- mA/V dc Multimeter
- 1/2" Combination Wrench
- 15/16" Combination Wrench
- 200 Ω Resistor

1. Put electric handswitch in STOP position.
2. Open the terminal block cover (1/2" bolt heads) and top cover (15/16" bolt head).
3. Determine the correct feedback terminals from the wiring diagram supplied with your drive (CC, DD, EE).
4. Install a mA meter in series with a 200 ohm load resistor for current outputs, or a voltmeter across the CPS-2 output terminals for voltage outputs. See Table 14, page 44.
5. Drive the output shaft through its full range and check the feedback signal.

When properly adjusted, the feedback signal should be maximum with the drive's output shaft in the fully retracted (maximum input signal) position. At 50% travel the signal should be mid-span. At full extension the signal should be minimum. If not correct, proceed with the calibration procedure.

CALIBRATION PROCEDURE

Adjustment of the CPS-2 is necessary if the signal range requires an increase or decrease in value relative to the drive's output shaft stroke. Calibrate by turning the Span Potentiometer CW to increase the gain of the CPS-2. This has the effect of increasing the output at the high end and lowering the output at the low end equally.

Signal Span is determined by the CPS-2 model and ranging resistor selected.

CAUTION:

Do not adjust the zero potentiometer to shift the span.

To adjust the span, turn the Span Potentiometer on the CPS-2 circuit board. The Span Potentiometer adjusts the CPS-2 so that the drive output shaft motion produces the specified output signal range.

Tools required for calibration:

- mA/V dc Multimeter
- 3/32" Screwdriver
- 7/64" Hex Wrench
- 5/16" Open End Wrench
- 1/2" Combination Wrench
- 15/16" Combination Wrench
- 1/32" Thickness Feeler Gauge
- 200 Ω Resistor

1. Put electric handswitch in STOP position.
2. Open the terminal block cover (1/2" bolt heads) and top cover (15/16" bolt head). The O-ring seal will remain in the rim of the top cover when removed.
3. Determine the correct feedback terminals from the wiring diagram supplied with your drive (CC, DD, EE).
4. Install a mA meter in series with a 200 ohm load resistor for current outputs or a voltmeter across the CPS-2 output terminals for voltage outputs. See Table 14, page 44.
5. Move the drive to the fully extended position and record the signal voltage or current.
6. Move the drive to the fully retracted position and record the signal voltage or current.
7. Subtract the two signal readings and compare to the desired output signal span. For example, 16 mA for 4–20 mA signal range. Divide the difference between the measured and desired

Cont'd

CPS-2 CALIBRATION, CONT'D

span by 2. Adjust the Span Potentiometer by this amount with the drive at the 100% position. CW movement of the Potentiometer increases the span equally at both ends. CCW movement of the Potentiometer decreases the span equally at both sides. See Figure 9, page 27 for location of Span Potentiometer.

8. Loosen the rotor clamp and reset its position (use the thickness gauge; see Figure 8) to achieve the desired value of maximum output signal. For example, 20mA. NOTE: Rotor adjustment moves the entire span up or down. Also note meter as you rotate the rotor to ensure that the signal is changing in the proper direction.
9. Tighten the rotor clamp to 5 lb-in torque.
10. Move the output shaft to the fully extended and fully retracted positions and check the output signal for desired span. If not correct, repeat the procedure from step 5.
11. Remove the meter and resistor, reconnect feedback wires, and replace covers.
12. Torque the terminal cover bolts to 10 lb-ft. Tighten the top cover bolt just enough to compress the O-ring seal.
13. Return electric handswitch to AUTO position and process controller to automatic mode.
14. On Model 14-108, recalibrate the ESR-4 board.

Adjusting the Zero Potentiometer

The Zero Potentiometer is provided on CPS-2 models 20-3400-03 and -13 to change from a zero based to a suppressed zero range (e.g. from 0 to 16 V dc to 1 to 5 V dc). The zero is adjustable from –5% to +30% of span.

NOTE: Do not adjust the zero potentiometer to shift calibration. Adjust the rotor position only to shift calibration.

CAUTION:

The zero is factory sealed on all CPS-2 units except 20-3400-03 and -13. Do not attempt to adjust the zero on other models as misadjustment of feedback signal and monitor/isolator functions of the ESR-4 will result.

The following example is given to illustrate how the zero is adjusted to effect a range change from 0 to 16 V dc to 1 to 5 V dc.

1. Install the 0 to 16 V dc unit as a 0 to 16 V dc range. Do not make any adjustments other than setting the rotor position.
2. Short terminal CC to DD (see Table 14 on page 44). This shifts the range to 0 to 4 V dc.
3. Using a voltmeter at the appropriate output terminals, adjust the Zero Potentiometer with the drive at minimum input signal position so that output reads 1 V dc. This changes the range to 1-5 V dc.

Feedback Signal Monitor/Isolator

CPS-2 models 20-3400-12, -13, -14, and -15 are provided with a Monitor/Isolator board which delivers an isolated position feedback signal to the Electronic Signal Receiver (ESR-4). The Monitor function monitors the CPS-2 position signal and compares it to established limits. If the output exceeds normal signal conditions, the monitor relay contact opens. This relay may be used for either a remote signal indication or activation of Loss of Signal operation of the drive.

No adjustments should be made on the Monitor/Isolator board.

Signal Monitor Sensing Operation

A red LED indicator and an SPDT relay are mounted on the Monitor/Isolator board to indicate that power is on and that the CPS-2 output signal is within normal range. Normal operating range is –1% to +101% (contacts closed) and –4% to +104% (contacts open).

The SPDT relay is rated for 0.1 amp resistive at 100 V dc and can be used for remote monitoring of the drive's power or to signal a system failure.

Loss of Signal Operation

Group 14 drives equipped with Electronic Signal Receivers (ESR-4) are configured so that the input control signal is connected through the relay on the monitor board of the CPS-2. The Loss of Signal (L.O.S.) function of the ESR-4 may therefore be activated when the CPS-2 signals are outside the normal range (see above). To have an out-of-range CPS-2 signal trigger the L.O.S. mode, remove the jumper across the relay contacts on the monitor board. See the schematic on page 46 for jumper location. For details on L.O.S. function, review the following section on Input Signal Calibration.

INPUT SIGNAL CALIBRATION

All Group 14 drives equipped for milliamp modulating applications include a fourth generation Electronic Signal Receiver (ESR-4). It is located in the Terminal Compartment. The ESR-4 board consists of a

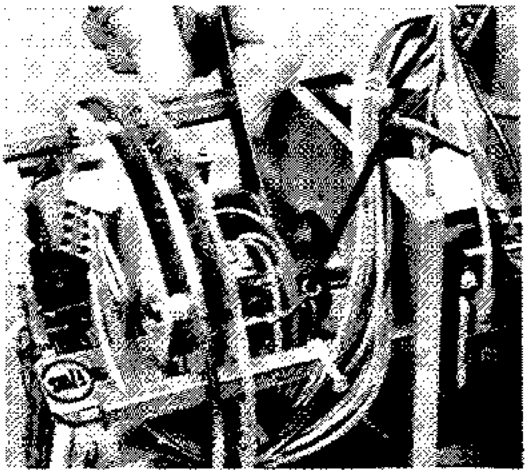


Fig. 8

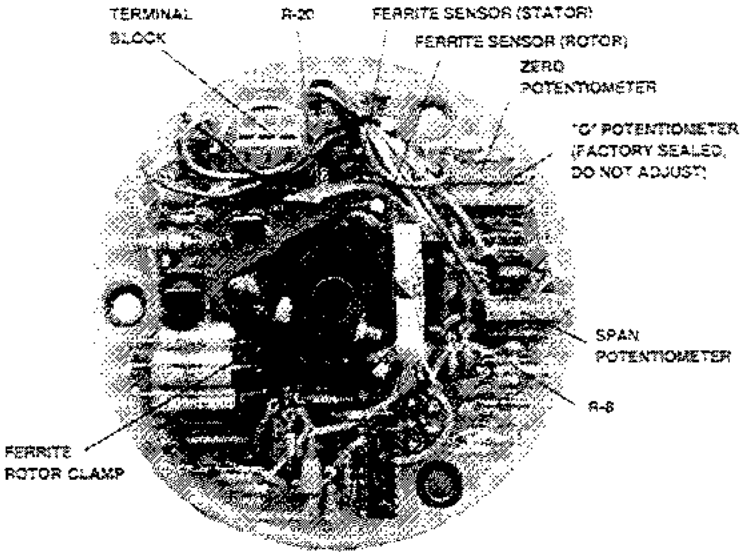


Figure 10. CPS-2 Position Sensor (Rear View) for Models 20-3400-03, -13

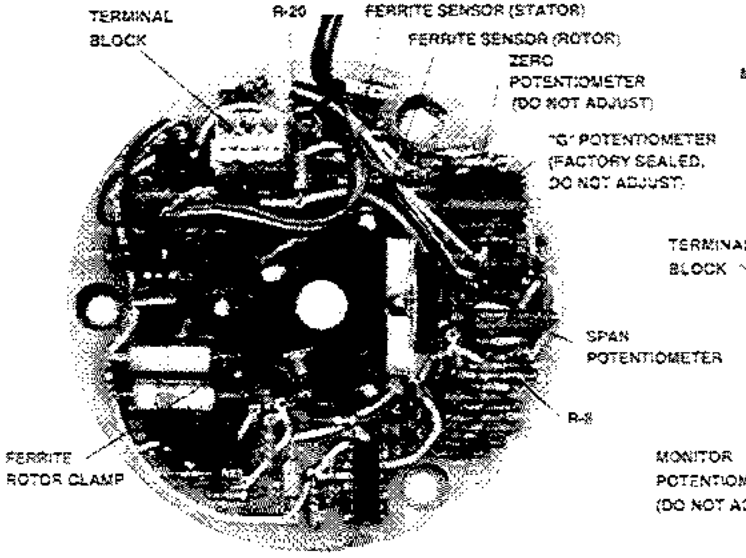


Figure 9. CPS-2 Position Sensor (Rear View) for Models 20-3400-02, -04, -05, -12, -14, -15

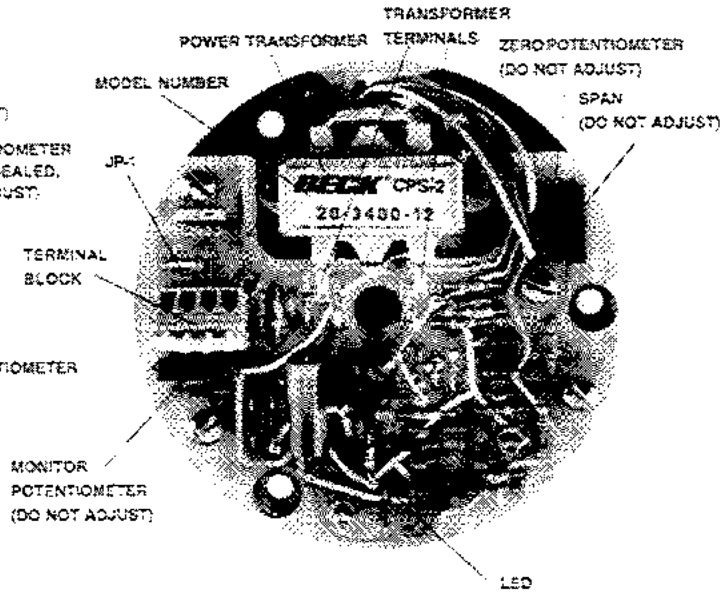


Figure 11. CPS-2 Monitor/Isolator Assembly Models 20-3400-12, -13, -14, -15

voltage regulator, a signal amplifier, an error amplifier, and three output switches.

The ESR-4 board controls the position of the Beck drive according to the input signal it receives. A feedback signal is delivered to the board from either a potentiometer or the CPS-2, which is compared with the input signal. The error signal is then amplified and used to actuate either of two switches to drive the output shaft forward or reverse until the signals balance and the error is zero.

The third output switch is energized when the signal is lost or falls below a given setting. The L.O.S. switch drives the output shaft to a predetermined position. See section on L.O.S. on page 29 for further details.

Checking Calibration

Using the input control signal, drive the output shaft through its complete range. If minimum input signal (4 mA) delivers 0% position, or full extension,

CALIBRATION *INPUT SIGNAL*

NOTE: The input signal is calibrated relative to the output (feedback) signal. Therefore, the shaft travel limit switches must be properly adjusted and the feedback signal calibrated before the input signal can be calibrated.

CAUTION:

The signal circuit on ESR-4 units is not grounded. If grounding is required, connect terminal BB in the terminal compartment to ground, either on the drive body or externally.

mid signal (12 mA) delivers 50% position, and maximum signal (20 mA) delivers 100% position, then calibration is not necessary. If, however, the drive shaft positions do not correspond to the appropriate input signals, then the ESR-4 must be calibrated.

Calibration Tips

The input signal can be varied by the automatic controller, but if that is impractical, a test box may be used. Connect the test box to positive terminal AA and negative terminal BB of the terminal block in place of the controller input.

Span and zero adjustments are located near the edge of the ESR-4 board (see Figure 13, page 29). Monitor the FWD and REV lamps to make adjustments. When the drive is balanced or in L.O.S. mode, both lamps are on. When the output shaft is moving, the lamp designating its direction of travel goes out. When the drive reaches its end of travel before balance is achieved, the lamp will stay out. Trim the adjustment so that the drive balances at the limit with the lamp on. Clockwise rotation of either span or zero adjustment causes the output shaft to drive toward the zero (minimum input signal) position.

CALIBRATION PROCEDURE

The following procedure should be followed to calibrate the ESR-4 board.

Tools required:

3/32" Screwdriver
1/2" Combination Wrench

1. Open the Electronic Signal Receiver and Terminal compartment cover (1/2" bolt heads).
2. Short input terminals AA and BB.
3. Turn electric handswitch to AUTO position.
4. Short out resistor R35 temporarily with a clip lead (see Figure 13, page 29 for location of R35). **NOTE: Drive will retract.**
5. Using 3/32" screwdriver, turn zero adjustment potentiometer clockwise to its maximum position. Drive will run to zero position travel limit (full extension).
6. Remove short on input terminals and, using controller or test box, apply an input signal equal to span (e.g. 16 mA for 4-20 mA span). **NOTE: Drive may run.**
7. Using a 3/32" screwdriver, turn span adjustment potentiometer clockwise until drive runs, then counterclockwise until drive just reaches 100% position.
8. Remove the clip lead on resistor R35 so that it is not shorted. Apply 100%, full range, position signal (e.g. 20 mA).
9. Turn zero potentiometer counterclockwise to position the drive at the 100% position (may require 10-15 turns).
10. Drive the output shaft to the minimum input signal position (e.g. 4 mA). If necessary, turn the zero potentiometer to trim the zero position.
11. Return the drive to the 100% position. If necessary, position the drive using the span potentiometer.
12. Repeat steps 10 and 11 until satisfied with adjustment. Reinstall the input signal wires, remove the test box (if used), close the compartment covers and tighten cover bolts to 10 lb-ft torque.

Span

The basic span adjustment of the ESR-4 is 2 volts to 6 volts dc. This is adjustable with the 20-turn span trim potentiometer. To make the span adjustable from 2 to 9.5 volts dc, remove resistor R-4. To make the span adjustable from 9.5 to 16 volts dc, remove R-4 and cut jumper wire J-1. See Figure 13, page 29, for location of R4 and J1.

Zero

The basic zero adjustment is –20% to 100% of span. This is adjustable with the Zero Potentiometer. For 2-way split range applications, remove resistor R-35 to shift the zero adjustment to 20% to 150% of span. For 3-way split range operation, remove resistors R-35 and R-36 to shift the zero adjustment to 150% to 275%. For other split range applications, consult factory for adjustment. See Figure 13, page 29, for location of R35 and R36.

Filter Adjustment

The filter is adjusted (full CW) at the factory for maximum attenuation of disturbances on the input signal. This introduces a 1% drift (with 4" travel at 16 sec/in timing) in the response to a loss of input signal when "Stay-in-place" is selected. If this is objectionable or if livelier response is desired, the filter action can be reduced by turning the filter adjustment Potentiometer CCW a sufficient amount. Full CCW takes the filtering out completely but in some cases may lead to undesirable cycling. If this happens, turn the adjustment CW until the cycling is damped out.

Gain Adjustment

The gain of the amplifier is fixed to prevent possible drive instability resulting from an inadvertent increase in gain. The deadband values of 0.6% for CPS-2 or film potentiometer operation are chosen to satisfy the requirements of most control systems. When erratic signal conditions exist, excess cycling can be reduced by increasing the deadband. Remove R39 to increase the deadband to 1%. Further change of the deadband is possible by changing the value of R42, but only after R39 is removed. Various values and corresponding deadbands are listed below:

TABLE 4

R39	R42	Deadband
Remove	4.99 MΩ	1.0%
Remove	3.30 MΩ	1.6%
Remove	2.20 MΩ	2.4%
Remove	1.50 MΩ	3.5%

Higher gains (reduced deadband) are also possible with the ESR-4. Consult your factory representative for details. See Figure 13 for location of R39 and R42.

CHANGING L.O.S. TRIP POINT

If the input signal drops below a predetermined value, the L.O.S. feature is activated. The standard setting of this signal value is approximately 12% of the signal span below the zero signal value. For example: 12% of a 16 mA signal span is 1.92 mA (4.0 mA–1.92 mA). The trip point is determined by the value of two resistors on the ESR-4 board. To change the trip point, resistors R20 and R21 must be replaced. See Figure 13 for location of R20 and R21.

TABLE 5: L.O.S. TRIP POINT AND RESISTOR VALUES

L.O.S. Trip Point mA	% of Span	L.O.S. Reset Point, mA	% of Span	Resistor Values R20 KΩ	Resistor Values R21 KΩ
3.0	-6	3.5	-3	20.0	1.50
2.8	-7	3.6	-2	32.4	2.55
2.2	-11	3.5	-3	30.1	4.42
2.0	-12	3.7	-1	40.2	5.90
1.[illegible]	-18	3.7	-2	38.3	9.31
.7	-20	3.3	-4	30.1	10.2

Table 5 gives representative values of the trip point and R20 and R21 for both film potentiometer and CPS-2 drives equipped with the 13-2245-03 ESR-4 board. For other ESR-4 boards, or trip points not on the chart, contact the factory. NOTE: If the input signal is restored to a value above the L.O.S. reset point, the L.O.S. feature is deactivated.

The L.O.S. function can be disabled by removing R19. See Figure 13 below for location of R19.

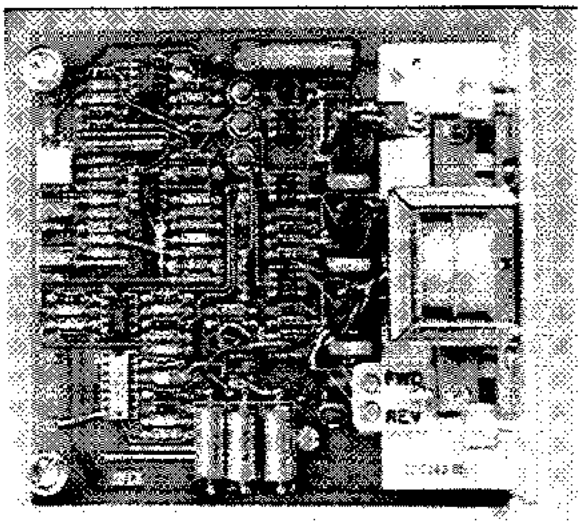


Fig. 12. ESR-4 Board

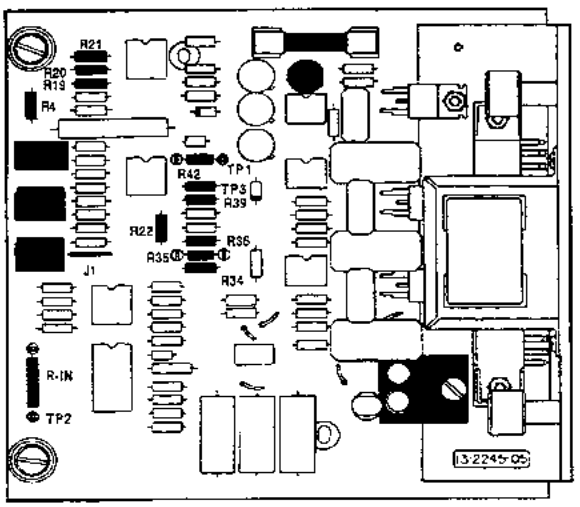


Fig. 13. ESR-4 Components

MAINTENANCE

The Beck Group 14 Drive requires only a minimum of routine maintenance. A visual inspection is in order to verify that the connection to the valve is intact and operating normally. If vibration is present, check the electrical terminal connections and other hardware for tightness. This section covers repair or replacement of many components of the Group 14 Drive, as well as a trouble-shooting section to help identify and solve possible operating faults after installation and start-up. Note that some components are not field repairable.

If it should ever be necessary to replace the output gear, shaft, or output shaft bearings, a major overhaul is required and the drive should be returned to the factory. During a major overhaul, the factory repair department will update the drive to include all possible engineering improvements.

LUBRICATION

The drive train parts of the Beck Control Drive are factory lubricated and in normal service will not need relubrication for five years. Control drives in more active service will require more frequent relubrication. Any drive operating near its rated thrust and with a frequency of operation greater than one per minute on a 24 hour schedule should be inspected every two years.

CAUTION:

Before removing the gear housing assembly, block the valve stem to prevent the gear train from moving when the housing assembly is removed.

To lubricate the main gears, remove the cover plate (1/2" bolt heads) on the side opposite the motor. To inspect the gears, remove the gear housing assembly, and clean the gears thoroughly, removing all old lubrication.

Examine the gear teeth, shaft bore and gear shafts for signs of excessive wear, scoring or other damage. If evidence of this damage is present, a detailed examination of the main gear is recommended. This requires a complete disassembly of the drive. Clean all parts thoroughly, removing all old lubrication. All damaged or worn parts should be replaced.

Recoat the teeth and shaft bores of all gears with a heavy layer of Fiske Lubriplate GR-132 or equivalent. GR-132 is an E.P. grease with polymer additives and a temperature range of –40° F to +350° F. Apply SAE 30 oil to the gear bushings for additional lubrication (they are self-lubricating). Apply SAE 30 oil to the power screw also. The ball bearing on the output shaft and crown gear shaft have double grease seals and require no maintenance for the life of the bearings. Inspect all grease seals and replace any that show wear, then reassemble the drive.

REPAIR AND REPLACEMENT

The following sections describe the procedures to follow to remove and replace various components of the BECK Group 14 control drives. Refer to the drive outline dimension drawings on pages 6 and 7 for location of components on the drive and to the body section drawings on page 42 and 43 for part numbers.

Gaskets

During routine service, inspect the gaskets and O-rings for wear or damage. In order to protect internal components, worn or damaged gaskets and O-rings should be replaced.

To remove the main gear cover, terminal compartment, or the motor gaskets, scrape off all of the old adhesive and gasket material from the body housing and cover. Cement the new gasket to the drive body using a gasket cement such as 3M #847 Rubber and Gasket Adhesive, or equivalent.

O-ring seals are used between the body and the top and bottom bearing plates. Before installing a new O-ring, lubricate it with light machine oil.

The large top cover is sealed with rubber foam gasket material, 5/16" in diameter. To replace this material, scrape the old gasket material and cement from the groove. Cement the new foam gasket into the groove with 3M #847 Rubber and Gasket Adhesive, or equivalent. Cut the ends of the material on an angle and cement them together with this same adhesive.

Seals

Worn or damaged output shaft, control end shaft and motor shaft seals should be replaced to prevent damage to internal bearings and drive train parts.

To remove the shaft seal, push the blade of a small screwdriver along the shaft and under the

seal lip. CAUTION: The seal is approximately 1/4" wide. Do not force the screwdriver blade beyond the width of the seal, or damage to the shaft bearing could result. Pry up on the seal and force it out of the housing. Clean the shaft and housing and press in the replacement seal with closed side facing outward.

Bearings

There are some field-replaceable bearings in the Group 14 Drive. Consult factory for details.

Motor

The Beck control motor is not field repairable. Disassembly of the motor will result in a loss of torque that can only be restored by returning the motor to the factory for remagnetizing.

CAUTION:

Before removing the motor assembly, while the process is running, block the valve stem to prevent the gear train from moving when the motor is removed.

To remove the motor, first disconnect the motor wires in the terminal compartment of the control drive. The wiring is under the terminal board. Remove the black wire from the terminal post, cut the green motor wire near the green-yellow-red butt joint and disconnect the red wire from the red-green-blue butt connection. Remove the three 10-32 socket head cap screws that secure the motor. Carefully slide the motor down and out of the drive body.

To install the motor, insert the three-wire sleeve through the wire hole in the motor mount and into the terminal compartment. Carefully slide the motor into the drive body, rotate the motor shaft if necessary to engage the pinion with the first combination gear. Install motor mounting screws and torque to 6 lb-ft. Reconnect the motor wires.

Motor Resistor and Capacitor

The motor resistor and capacitor are located in the top compartment beside the Calibar. To replace a resistor or capacitor, remove the top cover(15/16" bolt head). Remove the existing part and transfer the wires one at a time to the replacement part. Inspect the top cover gasket and replace if necessary. Replace the top cover. Tighten the top cover bolt just enough to compress the O-ring seal.

Limit and Auxiliary Switch

Complete switch assemblies may be replaced. It is not possible to replace individual switches. To replace switch assemblies, remove the top cover (15/16" bolt head). Remove the screws holding the switch assembly to the plate and slide it out to the side. Note the configuration of the assembly, Right Hand or Left Hand. Right Hand assemblies have assembly screws in the "R" holes and left hand assemblies have screws in the "L" holes.

Transfer the wires one at a time to the replacement assembly using the push-on lugs provided. Install the replacement assembly and note that it rotates around one screw to permit an adjustment of the cam to switch lever spacing and switch operating point. To properly set the switch, use a .060 inch shim between the cam and switch lever and loosely position the switch assembly so that the switch is fully compressed. The switch lever should be on the high or maximum radius portion of the cam when setting the switches. DO NOT overstress the actuating lever. Tighten both screws to 20 lb-in torque and remove the shim. When properly adjusted the switch lever should remain in contact with the cam throughout the control drive travel.

Adding Switches

It is usually possible to add switches to a control drive in the field. Remove the top cover (15/16" bolt head). If the drive has no auxiliary switches, it is possible to add 6, 4, or 2 more switches. Determine the configuration of the switch assembly to be added. Right hand switches are set to operate at the retracted control shaft limit and left hand switches at the extended limit.

If the control drive shaft does not have unused switch cams, extra switches may be added but additional parts will be required. Consult the factory, giving the control drive model and serial number so that a correct list of parts required may be supplied to you.

Install wiring onto the switch push-on lugs and route the wires into the control drive terminal area. Remove the terminal cover and solder wires to the underside of the terminal assembly per the wiring diagram included with the new switch assembly. Install the new switch assembly and adjust per the instructions above. See Table 8, page 40 for switch part numbers.

SLM Friction Surface

In normal service, the SLM friction surface will last for five to ten years. Faster rates of wear can occur in any drive operating near its rated thrust and with a frequency of operation greater than one per minute on a 24-hour schedule. The following procedure can be used to determine the amount of wear life remaining on the friction surface. Turn the handswitch to STOP. Carefully turn the handwheel back and forth. If there is free play in the handwheel (up to one tenth of a full handwheel rotation) the SLM has sufficient wear life. If there is no free play in the handwheel, the drive may not hold position and the friction surface should be replaced.

If the friction surface needs to be replaced you should order the appropriate SLM kit as shown in Table 6, depending on the motor. Two kits are available: SLM Friction Kit and SLM Rebuild Kit.

The SLM Friction Kit typically consists of friction material, spring pin, steel shims, control motor gasket, thrust bearing, terminal joints and instruction sheet.

The SLM Rebuild Kit typically consists of friction material, spring, spring pin, thrust bearing, pinion, steel balls, locking disc, steel shims, control motor gasket, terminal joints and instruction sheet.

See Figure 14 for component identification.

Table 6

Motor Part Number	SLM Friction Kit	SLM Rebuild Kit	Instruction Sheet Only
20-2702-31	12-8060-09	12-8060-19	80-0016-09
20-2703-31	12-8060-09	12-8060-19	80-0016-09
20-2703-34	12-8060-09	12-8060-20	80-0016-09

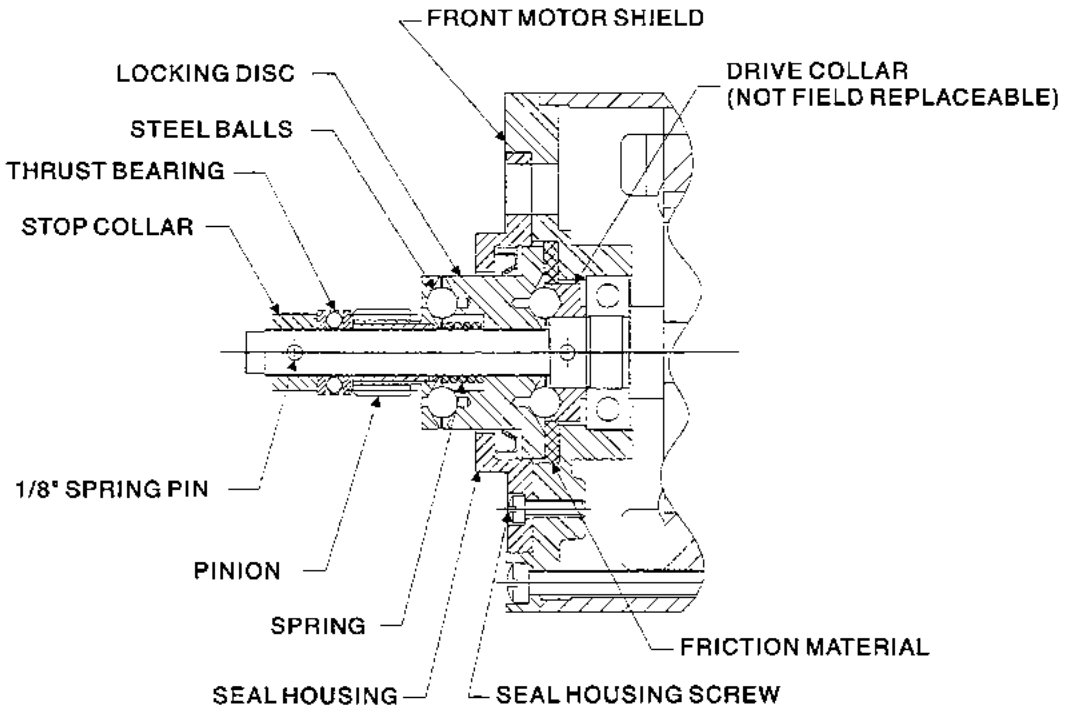


Figure 14. SLM

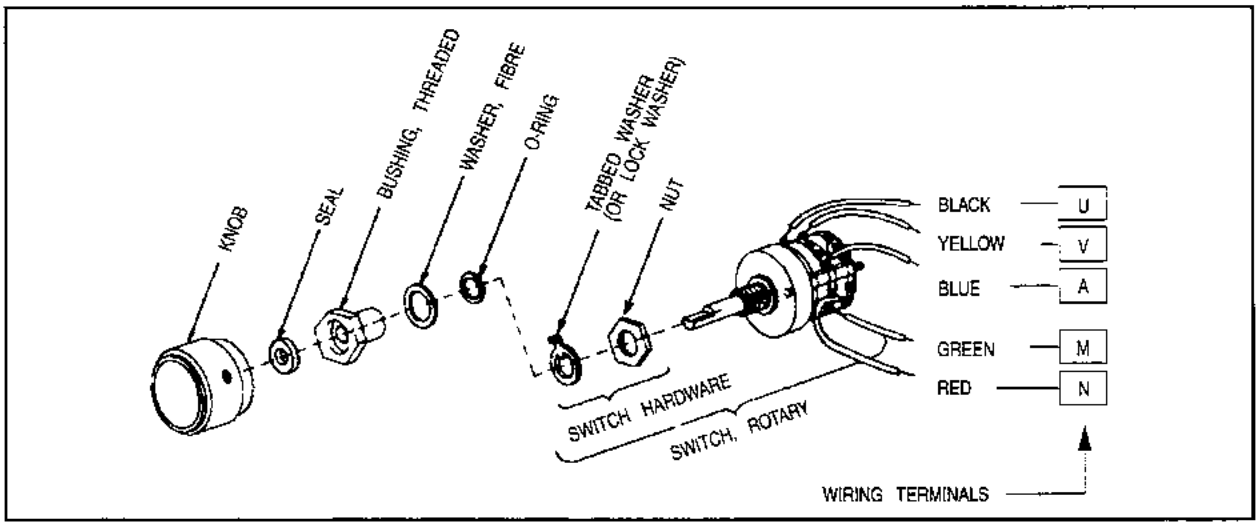


Figure 15. Handswitch

Handswitch

To replace the handswitch, remove the terminal cover. Clip the five wires from the old handswitch. Remove the knob and the nut under the knob to remove the switch. Install the new handswitch as shown in Figure 15. Splice the wires color for color. Replace the terminal cover. Torque bolts to 10lb-ft.

NOTE: The AUTO position on the handswitch knob must be straight up when the switch is fully clockwise. Handswitch part number 20-3300-07.

ESR-4 Board

Field service of the ESR-4 board is not recommended. The factory maintains a stock of replacement boards for immediate shipment. To replace the ESR-4 board, open the terminal compartment cover (1/2" bolt heads). Loosen the four captive screws holding the board to its mounting pads. Note the "L" shape mounting bracket on the end of the board. To remove this board, pull the mounting bracket away from its mating service.

To install an ESR-4 board, lightly press the board connector into its receptacle until the mounting bracket is flush with its mounting surface. Tighten the six captive screws and close the compartment cover. Torque the cover bolts to 10 lb-ft.

CPS-2

Field repair of the CPS-2 assembly is not recommended. The factory maintains a stock of replacement assemblies for immediate shipment. If it is necessary to replace the CPS-2, replace both the rotor and stator/circuit board assembly.

When returning the CPS-2 to the factory for service, please include the rotor and stator/circuit board assembly. Do not separate the stator or circuit boards from their mounting plate. It is recommended that the rotor be held inside the stator with rubber bands and the hex studs be reattached to the mounting plate for protection during shipment.

To remove the CPS-2, remove the top cover and run the drive to the 0% position (100% for Model 20-3400-04, -14 if used for 0 to 15 V dc signal). Note direction of shaft rotation. Turn the handswitch to STOP and turn off all AC power to the drive. Disconnect the wires from transformer and spring-clamp terminals. See Figures 9 and 10, page 27. Note wire colors and locations. Pull wires through the mounting plate hole. Loosen the rotor coupling and remove the three hex stud nuts supporting the CPS-2 assembly. Support the inboard hex stud when removing nuts. Remove the CPS-2 stator/circuit board assembly and rotor.

To install the CPS-2, slide the rotor onto the control shaft, clamp end toward the limit switches. Leave the clamp loose. Assemble the CPS-2 over rotor and mounting studs, transformer out and at approximately 4 o'clock. Secure assembly with three hex nuts. Torque to 60 lb-in. Reconnect wires.

To set CPS-2 rotor position, open the terminal cover (1/2" bolt heads) and connect a mA/V dc multimeter to the feedback terminals. See wiring diagram supplied with drive or Table 15, page 44, for correct terminals. Run drive to 0% position (100% for model 20-3400-04, -14 if used for 0 to 15 V dc signal). Note direction of control shaft rotation. Put handswitch in STOP. Insert .031" thickness gauge between rotor clamp and stator. See Figure 8, page 27. Position the rotor so that the slot in the rotor is aligned with the wire holes and transformer on CPS-2 board.

Set 0% rotor position by rotating the rotor 15 degrees in the direction that the control shaft moves when the output shaft moves toward the 100% position on increasing signal (on CPS-2 models 20-3400-04, -14 rotate rotor 15 degrees in direction control shaft moves when the output shaft moves toward 0% position on decreasing signal).

While reading the meter, position the rotor for the exact specified 0% output from the CPS-2. Tighten the rotor clamp to 5 lb-in torque and remove the thickness gauge.

Run the drive and check the CPS-2 output signal span. If it is acceptable, no further adjustments are necessary. If not, refer to page 25, CPS-2 Calibration Procedure, for further instructions. On units equipped with an ESR-4, check input signal calibration.

Remove the meter and replace the top cover. Tighten the cover bolt just enough to compress the O-ring seal. Close the terminal cover and torque bolt to 10 lb-ft.

MAINTENANCE *TROUBLESHOOTING*

CONDITIONS	POSSIBLE CAUSES	CORRECTIONS
1. Control drive will not run in either direction with input signal applied to ESR-4 board. No lamps lit on ESR-4 board.	a. Handswitch left in wrong position. b. No 120V ac line supply. c. Fuse F-1 open. d. External auto/man switch in wrong position (Position-All). e. ESR-4 board failure. f. Jumpers between terminals F–N and D–M are not connected.	a. Return handswitch to auto position. b. Check fuses and switches in power panel. c. Check for possible shorts, then replace fuse. Use only Beck part no.13-2230-03 for proper protection of triacs. d. Return switch to auto position. e. Replace ESR-4 circuit board. See page 33. f. Connect jumpers.
2. Control drive will not run in either direction with input signal applied to ESR-4 board. CPS-2 LED light out and jumper removed from monitor board relay.	a. No power. b. Control drive positioned beyond calibrated limits. c. CPS-2 rotor position not set properly. d. CPS-2 not calibrated correctly. e. CPS-2 failure.	a. Check power source. Check CPS-2 power supply voltage. Check CPS-2 power transformer. b. Position drive with handwheel and check limit switch settings. c. Set CPS-2 rotor position. See page 33. d. Calibrate CPS-2. See page 25. e. Replace CPS-2. See page 33.
3. Control drive runs in one direction only in auto and both directions with handswitch on FWD and REV.	a. ESR-4 zero adjustment incorrect. b. Handswitch failure. c. Loss of input signal with "Drive to Zero" or "Drive to full travel" selected. d. ESR-4 circuit board failure. e. Loss of feedback signal.	a. Readjust ESR-4 zero. See Input Signal Calibration, page 26. b. Check continuity from terminal N to V and M to U with handswitch in auto position. See wiring diagram c. Check input signal. d. Replace ESR-4 circuit board. See page 33. e. Check signal from CPS-2 or potentiometer at TP3 on ESR-4.

CONDITIONS	POSSIBLE CAUSES	CORRECTIONS
4. Loss of ESR-4 signal lamp lights (red LED) with input signal applied.	a. ESR-4 zero adjustment incorrect. b. Input signal reversed. c. ESR-4 circuit board failure. d. Slidewire equipped drive with ESR-4 board calibrated for CPS-2. e. Incorrect film potentiometer setting. f. Control signal wired through CPS-2 monitor relay.	a. Readjust ESR-4 zero. See Input Signal Calibration, page 28. b. Check polarity of input signal. Terminal AA (+), Terminal BB (–). c. Replace ESR-4 circuit board. See page 33. d. Cut R-22 and R-39 resistors and recalibrate the ESR-4 board. See page 28. e. Reset film potentiometer. See page 24. f. Control drive position beyond calibrated range. Use hand switch or handwheel to put drive within normal operating range.
5. Control drive runs in the wrong direction with input signal applied.	a. Input signal reversed. b. Drive configured for wrong direction of travel.	a. Check polarity of input signal. Terminal AA (+), terminal BB (–). b. See page 23 for changing direction of travel.
6. Control drive does not follow input signal until maximum or minimum signal is reached, then drives uncontrollably to limit.	a. Yellow and black wires on FL and RL limit switches reversed or potentiometer end connections reversed. b. CPS-2 feedback out of phase with control motor.	a. Change direction of travel; see page 23. Check correct film potentiometer connections. See page 24. b. Restore proper phasing of CPS-2 feedback with control motor. See page 24-25.
7. Control drive motor oscillates in auto mode.	a. Feedback potentiometer dirty. b. Excessive noise on input signal. c. Physical obstruction (e.g. valve jammed or load greatly exceeds rating of drive). d. ESR-4 circuit board failure. e. Excessive wear in gear train or bearings.	a. Clean or replace potentiometer. b. Check setting of input filter. May require lower gain setting if oscillation remains with maximum filter setting, see page 28. c. Check operation with hand-switch and remove obstruction if present. Handswitch bypasses ESR-4 board. d. Replace ESR-4 circuit board. See page 33. e. Replace worn drive train parts.

CONDITIONS	POSSIBLE CAUSES	CORRECTIONS
8. Control drive motor erratic or runs in wrong direction in automatic or manual operation.	a. Control motor winding open. b. Control motor capacitor shorted or open. c. Control motor resistor open.	a. Replace control motor. See page 31. b. Replace capacitor. See page 31. c. Replace resistor. See page 31.
9. Control drive will not run in either direction or one direction in automatic or manual operation.	a. Limit switch failure. b. Handswitch failure.	a. Replace limit switch. See page 31. b. Replace handswitch. See page 33.
10. Control drive erratic while closing valve and runs normally while opening in auto.	a. Feedback potentiometer dirty. Loss of feedback voltage drives the unit in FWD direction.	a. Clean feedback potentiometer with mild soap and water.
11. Control drive runs uncontrollably to some position, then oscillates.	a. Feedback potentiometer open.	a. Replace feedback potentiometer.
12. Control drive does not stop at normal or desired limit of shaft travel.	a. ESR-4 span or zero adjusted incorrectly. b. Limit switches adjusted incorrectly. c. Loss of input signal.Check LED on ESR-4 circuit board. d. Limit switch failure. e. CPS-2 calibration incorrect.	a. Recalibrate ESR-4 board. See page 28. b. Readjust limit switches. See page 20. c. Restore input signal to control drive. d. Replace limit switch. See page 31. e. Calibrate CPS-2. See page 25.
13. Loss of input signal feature does not function.	a. CPS-2-equipped control drive used with ESR-4 board calibrated for slidewire. b. Incorrectly set potentiometer. c. CPS-2 calibration incorrect.	a. Reconnect R-22 and R-39 resistors and recalibrate. See page 29. b. Reset potentiometer. See page 24. c. Calibrate CPS-2. See page 25.
14. Control drive drives to FWD limit with small change in input signal.	a. Feedback potentiometer power supply shorted. b. ESR-4 circuit board failure of 2.7V power supply (feedback potentiometer only). c. Wiper and low end of feedback potentiometer reversed.	a. Check potentiometer and wiring for shorts. b. Replace ESR-4 circuit board. See page 33. c. Check wiring on feedback potentiometer for proper connections.

CONDITIONS	POSSIBLE CAUSES	CORRECTIONS
	d. Open potentiometer element. e. CPS-2 feedback out of phase with control motor.	d. Replace potentiometer. e. Restore proper phasing of CPS-2 feedback with control motor. See page 24-25.
15. Control drive drives to 100% and stays.	a. Handswitch left in FWD position. b. Potentiometer open or complete loss of contact with wiper. c. Loss of input signal when FWDLOS is selected. ESR-4 LED on. d. ESR-4 zero adjustment incorrect. e. ESR-4 circuit board failure. f. CPS-2 feedback out of phase with control motor. g. Jumper between terminal F–N not connected. h. Reverse limit switch failure.	a. Return handswitch to auto position. b. Check potentiometer and replace if necessary. c. Restore input signal to drive. d. Readjust ESR-4 zero. See Input Signal Calibration, page 26. e. Replace ESR-4 circuit board. See page 33. f. Restore proper phasing of CPS-2 feedback with control motor. See page 25. g. Connect jumper. h. Replace limit switch. See page 31.
16. Control drive travel very nonlinear, a. e.g.4–19 mA change on input causes drive to drive from 9% to 30%; 19–20 mA change drives 30% to 100%. b. Response normal from zero to mid-range; then runs to 100%.	a. Wiper and high end of feedback potentiometer reversed. b. CPS power supply failure.	a. Check feedback potentiometer for proper connections. b. Check CPS power supply voltage. See 21-b of this chart.
17. L.O.S. operates at too high a signal level.	a. Special requirement.	a. Change L.O.S. trip point. See page 29.
18. CPS-2 LED goes out during normal travel.	a. CPS-2 not calibrated correctly.	a. Calibrate CPS-2. See page 25.
19. Potentiometer or CPS-2 output decreases when it should increase.	a. CPS-2 rotor position not set for proper rotation. b. End connections on potentiometer reversed.	a. Reset CPS-2 rotor position. See page 33. b. See potentiometer calibration, page 24.

CONDITIONS	POSSIBLE CAUSES	CORRECTIONS
20. CPS-2 output nonlinear.	a. CPS-2 rotor position not set properly. b. CPS-2 zero potentiometer misadjusted.	a. Reset CPS-2 rotor position. See page 33. b. Refer to factory.
21. CPS-2 output does not reach maximum signal, but low end calibration is correct.	a. Output is overloaded: — load resistance is too low for voltage range. — load resistance is too high for current range. b. Low voltage — CPS power supply failure. c. CPS-2 rotor not set properly. d. CPS-2 zero potentiometer misadjusted.	a. Check load resistance against suggested feedback signal terminal hook-up. See page 44. b. Check line voltage at CPS-2 transformer terminals 1 and 3. Check CPS-2 voltage at resistor. Check CPS-2 power supply voltage across capacitors C8 (13 V, except –05: 15V), C9(15V), C10 and C11 (28V). c. Reset CPS-2 rotor position. See page 33. d. Refer to factory.
22. CPS-2 out of calibration.	a. CPS-2 zero potentiometer inadvertently reset.	a. Refer to factory.
23. CPS signal will not calibrate down to 4 mA.	a. Not enough load on meter circuit. b. Unit being calibrated for shorter than 80° rotation.	a. Connect 200 Ω resistor in series with meter. b. Remove R-8. See Calibration Procedure, page 25.
24. Control drive does not stay in place with power off.	a. SLM friction surface worn.	a. Replace SLM friction surface. See page 32.
25. Control motor runs but output shaft does not move in one or both directions.	a. SLM failure.	a. Replace control motor. See page 31.
26. Control drive equipped with Modulating option 5 or 6 and an optional Relay Board does not run reliably in one or both directions in AUTO.	a. Controller output requires a greater holding courrent than the Relay Board load draws.	a. Check the controller output required AC holding current. If greater than 10 mA, additional load must be provided.

SERVICE

RECOMMENDED SPARE PARTS

It is recommended that certain replacement parts be stocked for quick availability in the event that service of your BECK control drive is required. The types of parts are listed in Table 7.

HOW TO ORDER SPARE PARTS

Select the needed parts from the spare parts list given below. Specify the drive's model/serial number (example: 14-108-031891 -01-02) given on the nameplate to allow the factory to verify the part selection. Parts may be ordered by mail, telephone or fax, with the confirming order sent to the factory (see back cover).

TABLE 7
SPARE PARTS

Description	Part No.	Description	Part No.
Switch Assembly	20-3200-03 RH 20-3200-04 LH	Fuse, 6A, 250V	13-2230-03
Gasket Set: Model 14-100	20-3110-13	ESR-4 circuit board: (Model 14-107 and 14-108 only)	13-2245-XX. See Table 3, page 15 for part no. based on output signal.
Control Motor	See Table 8.		
Motor resistor	See Table 8.	CPS-2: (Model 14-106 and 14-108 only)	20-3400-XX. See Table 2, page 8 for part no. based on input signal.
Motor capacitor	See Table 8.		
Film potentiometer: (Model 14-105 and 14-107 only)	20-3060-03	SLM Friction Kit	12-8060-09
		Cork Disk	13-0080-01

TABLE 8
GROUP 14 MOTORS, CAPACITORS, AND RESISTORS

Motor Part No.	Motor Design	Voltage	Hz	Amp.	Capacitor Part No.	Capacitor Value	Resistor Part No.	Resistor Value	Use Only With Timing
20-2702-21, -31	E	120	60	.37	14-2840-16	5 µf	11-5800-11	220 Ω	10 sec. or higher
			50	.37	14-2840-19	7 µf	11-5800-11	220 Ω	10 sec. or higher
20-2703-21, -31	G	120	60	.56	14-2840-05	8 µf	11-5800-01	100 Ω	10 sec. or higher
			50	.56	14-2840-06	10 µf	11-5800-01	100 Ω	10 sec. or higher
20-2703-24, -34	G	120	60	.56	14-2840-05	8 µf	11-5800-01	100 Ω	8 sec. or lower
			50	.56	14-2840-06	10 µf	11-5800-01	100 Ω	8 sec. or lower

APPENDIX *COMPONENTS*

TABLE 9 GEARS

Spur Gearing Ratio/1	Nominal Speed Sec./In.		Gear Part Number		
	60 Hz 72 RPM	50 Hz 60 RPM	Gear Housing Assembly	Main Gear Assembly Including Internal Worm	
				Std.Travel	4 Max. Travel
4.14	4	5	10-6670-36	13-0710-06	14-0220-03
7.90	8	10	10-6670-26	13-0710-05	14-0220-05
10.65	11	13	10-6670-24	13-0710-03	14-0220-06
15.70	16	19	10-6670-13	13-0710-04	14-0220-04
25.90	27	31	10-6670-23	13-0710-02	14-0220-02
45.80	48	57	10-6670-07	13-0710-02	14-0220-02

TABLE 10 GROUP 14 TOP ASSEMBLY

Travel	Tapped Thread	Shaft & Calibar Assembly	Calibar Index	Sector-Lever Assembly	Pivot Loc.	Top Cover	Stud	Guide Bar	Pinion
5/16" to 1 1/4"	3/4-16	20-0330-09	14-0200-01	14-0140-02	A	13-1483-01	14-0100-02	14-0090-02	14-0330-01
5/16" to 1 3/4"	3/4-16	20-0330-04	14-0200-02	14-0140-02	A	13-1483-01	14-0100-02	14-0090-02	14-0330-01
3/4" to 2 1/8"	3/4-16	20-0330-03	14-0200-03	14-0140-02	B	13-1483-01	14-0100-02	14-0090-02	14-0330-01
3/4" to 3 1/2"	3/4-16	20-0330-06	14-0200-04	14-0140-04	A	13-1483-01	14-0100-02	14-0090-02	14-0160-01
1 3/4" to 4 1/2"	3/4-16	20-0330-07	14-0200-05	14-0140-05	B	13-1483-01	14-0100-02	14-0090-02	14-0160-01

TABLE 11 TIGHT-SEATER™ PART NUMBERS

Valve Stem Size	Tight-Seater™ Length "A" in Fig. 3, p. 17 (in)	Tight-Seater™ Assembly Part Number		
		Thrust 0-600 lb	Thrust 601-1200 lb	Thrust 1201-1800 lb
1/4-28	2 1/4	14-0560-01	-	-
5/16-24	2 1/2 2	14-0560-02 14-0560-06	- -	- -
3/8-16	2 1/4	14-0560-03	-	-
3/8-24	2 1/4 2 3/4	14-0560-04 14-0560-05	14-0561-01 14-0561-02	14-0562-01 -
7/16-20	2 1/4 2 3/4	14-0560-07 14-0560-08	- 14-0561-03	- 14-0562-02
1/2-20	2 1/4 2 3/4 2 7/8	14-0560-09 14-0560-10 14-0560-11	14-0561-04 - -	14-0562-03 14-0562-04 -
9/16-18	2 1/4	14-0560-12	14-0561-05	14-0562-05
5/8-11	2 1/4	14-0560-13	-	-
5/8-18	2 1/4	14-0560-14	14-0561-06	14-0562-06
11/16-16	2 1/4 3 3/4	14-0560-15 14-0560-16	14-0561-07 -	14-0562-07 -
3/4-10	2 1/4	14-0560-17	-	14-0562-08
3/4-16	2 1/4 2 3/4 2 7/8 3 3/4	14-0560-18 14-0560-19 14-0560-20 -	14-0561-08 - - -	14-0562-09 - - 14-0562-10
7/8-14	2 1/4	14-0560-21	14-0561-09	14-0562-11

APPENDIX *CONTROL ASSEMBLY*

(Top View)

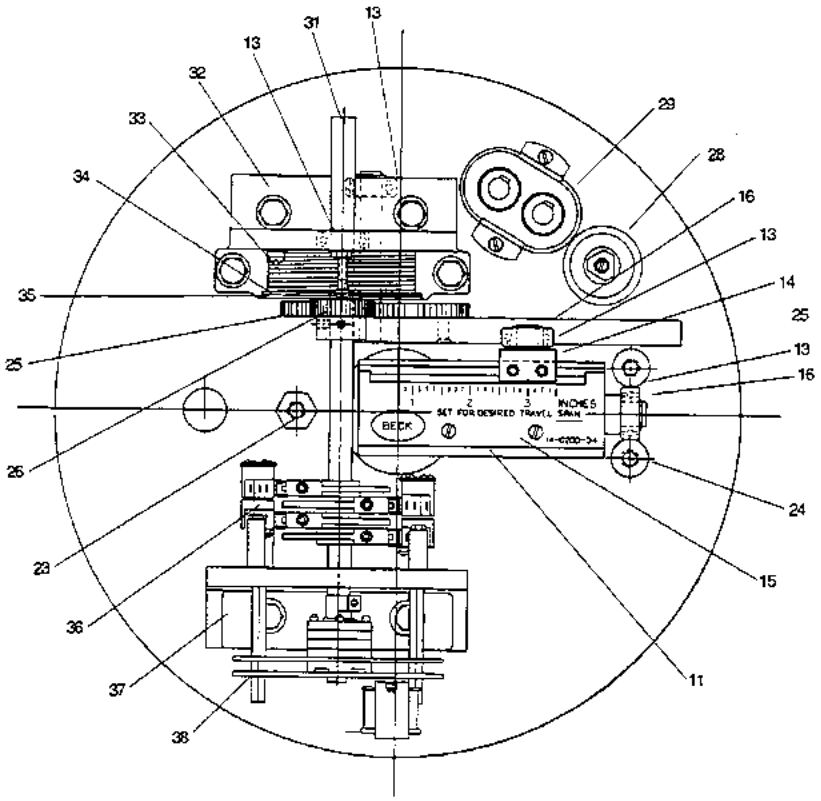
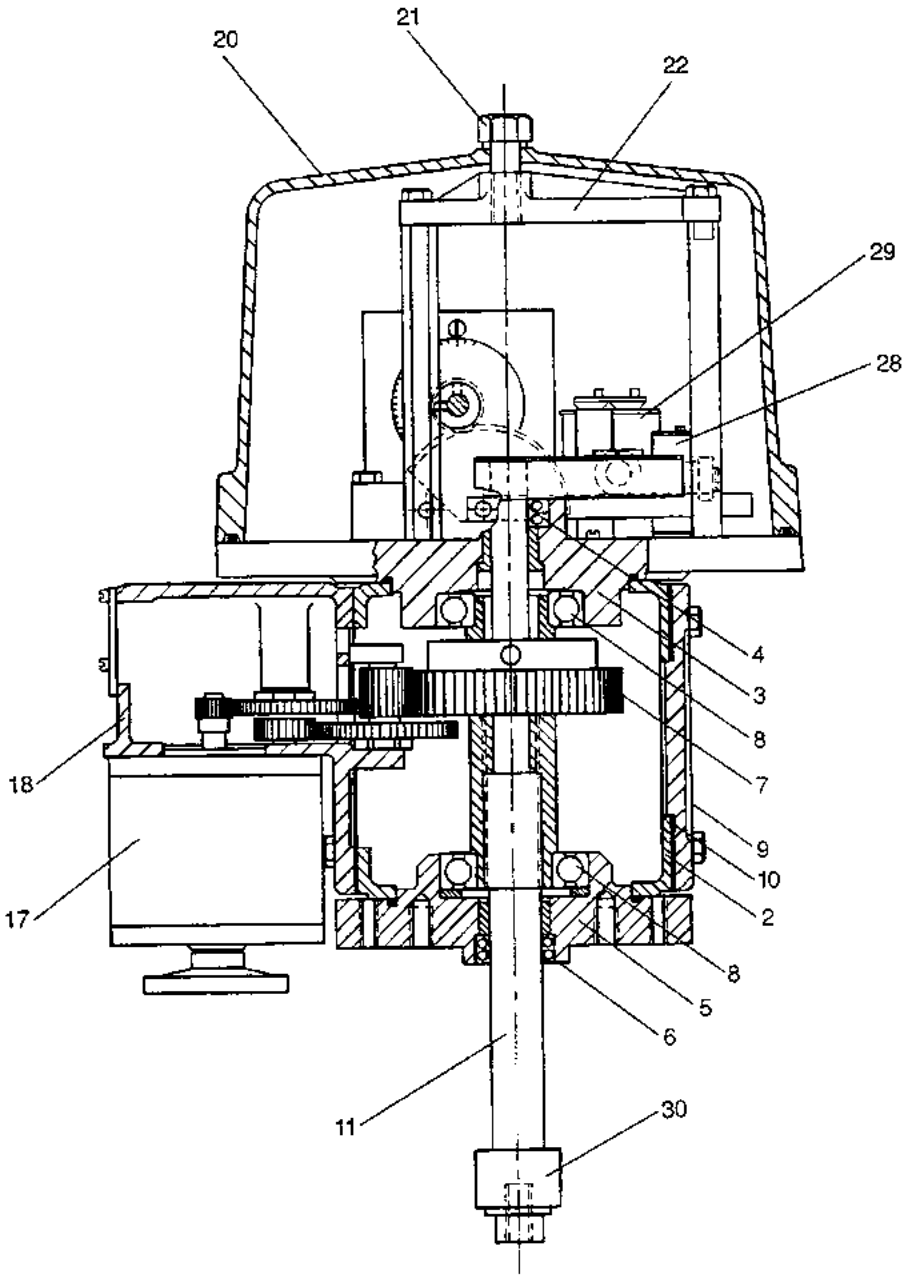


TABLE 12
PARTS FOR CONTROL ASSEMBLY AND DRIVE TRAIN

Item No.	Beck P/N	Description	Item No.	Beck P/N	Description
1	10-6092-XX	Body assembly (A major overhaul is required to change most body parts)	17	20-270X-XX	Motor assembly—select from Table 8 (sold only as complete assembly)
2	10-6090-05	Body	18	10-6670-XX	Gear housing assembly—select from Table 9 (Sold only as complete assembly)
3	13-1161-02	Top bearing plate with bushing and seals	20	13-1483-01	Top cover with gasket
4	12-0400-01	Seal for top bearing plate	21	13-1500-01	Top cover bolt
5	14-0340-02	Bottom bearing plate with bushing and seals	22	13-3540-01	Top bar
6	12-0400-02	Seal for bottom bearing plate	23	14-0100-02	Hex stud—select from Table 10
7	13-0710-XX	Maingear assembly: select from Table 9	24	14-0090-02	Guide bar—select from Table 10
8	13-1180-01	Mainshaft bearing	25	14-0140-XX	Sector-lever gear assembly—select from Table 10
9	10-7890-01	Cover plate	26	14-XXXX-01	Pinion—select from Table 10
10	10-8080-01	Cover plate gasket	28	11-5800-XX	Resistor—select from Table 8
11	20-0330-XX	Shaft assembly—Select from Table 10 (Sold only as complete assembly, except index)	29	14-2480-XX	Capacitor—select from Table 8
			30	14-056X-XX	Tight Seater—see Table 11
13	13-1250-02	Ball bearing	31	14-0190-01	Shaft
14	13-1280-02	Calibar slider	32	14-0020-03	Bracket
15	14-0200-XX	Calibar index—select from Table 10	33	14-0210-01	Spring
			34	14-0120-01	Mandrel
	14-7720-01	Spacer	35	14-0170-01	Switch shaft indicator
	14-9620-01	Pin	36	20-3200-XX	Switches—see Table 7
16	13-1270-01	Retaining ring	37	14-0010-01	Bracket
			38		CPS or film potentiometer



CONTROL ASSEMBLY AND DRIVE TRAIN

APPENDIX *CPS-2 DATA*

TABLE 13
CPS-2 SYSTEM APPLICATION DATA SUMMARY

Feedback Signal Options	CPS-2 Model	External Load Resistance	Compatible Control Systems
CURRENT			
4 to 20 mA	20-3400-02 &-12	800Ω (Max)	Industry Std (ISA)
	20-3400-03 &-13*	500Ω (Max)	
10 to 50 mA	20-3400-03 &-13*	200Ω (Max)	Foxboro
1 to 5 mA	20-3400-03 &-13*	2kΩ (Max)	General Use
VOLTAGE			
1 to 5 V dc	20-3400-02 &-12	12kΩ (Min)	Industry Std (ISA) &
	20-3400-03 &-13*	250Ω (Min)	Beck *Position-All*
			(27-301,-401,-501)
0 to 5 V dc	20-3400-03 &-13*	250Ω (Min)	Leeds and Northrup
0 to 10 V dc	20-3400-03 &-13*	1kΩ (Min)	Bailey, Foxboro, & Westinghouse
0 to 16 V dc	20-3400-03 &-13*	1kΩ (Min)	Leeds and Northrup
	20-3400-04 &-14	6 kΩ (Min)	Leeds and Northrup
0 to 15 V dc	20-3400-04 &-14	6kΩ (Min)	Leeds and Northrup
-10 to 10 V dc	20-3400-05 &-15	2kΩ (Min)	Bailey

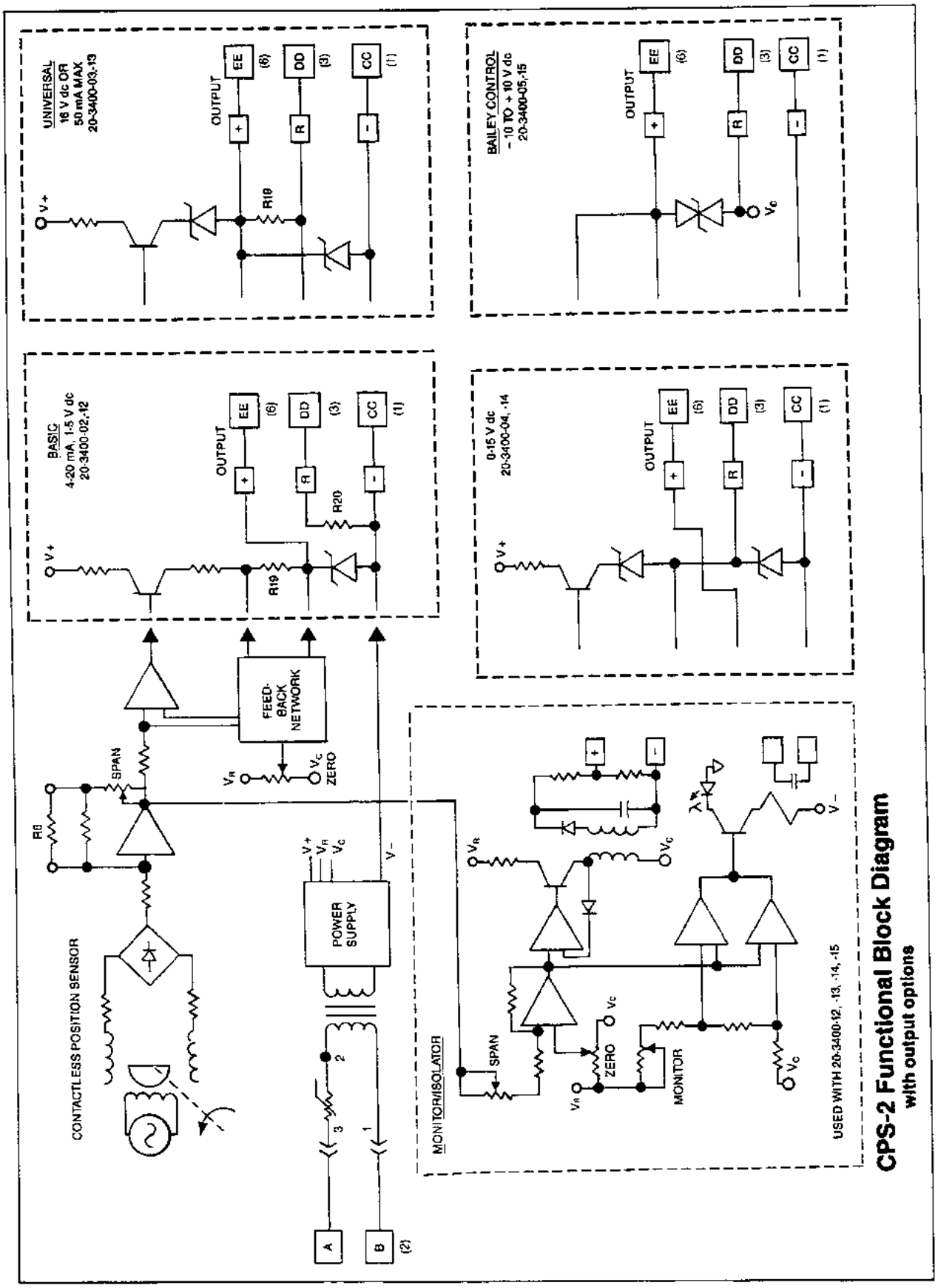
* The 20-3400-03 and -13 may be connected for signal ranges so noted. See Wiring Diagrams on pages 13-14 for details.

TABLE 14
CPS-2 SIGNAL OUTPUT TERMINAL CONNECTIONS AND LOADING

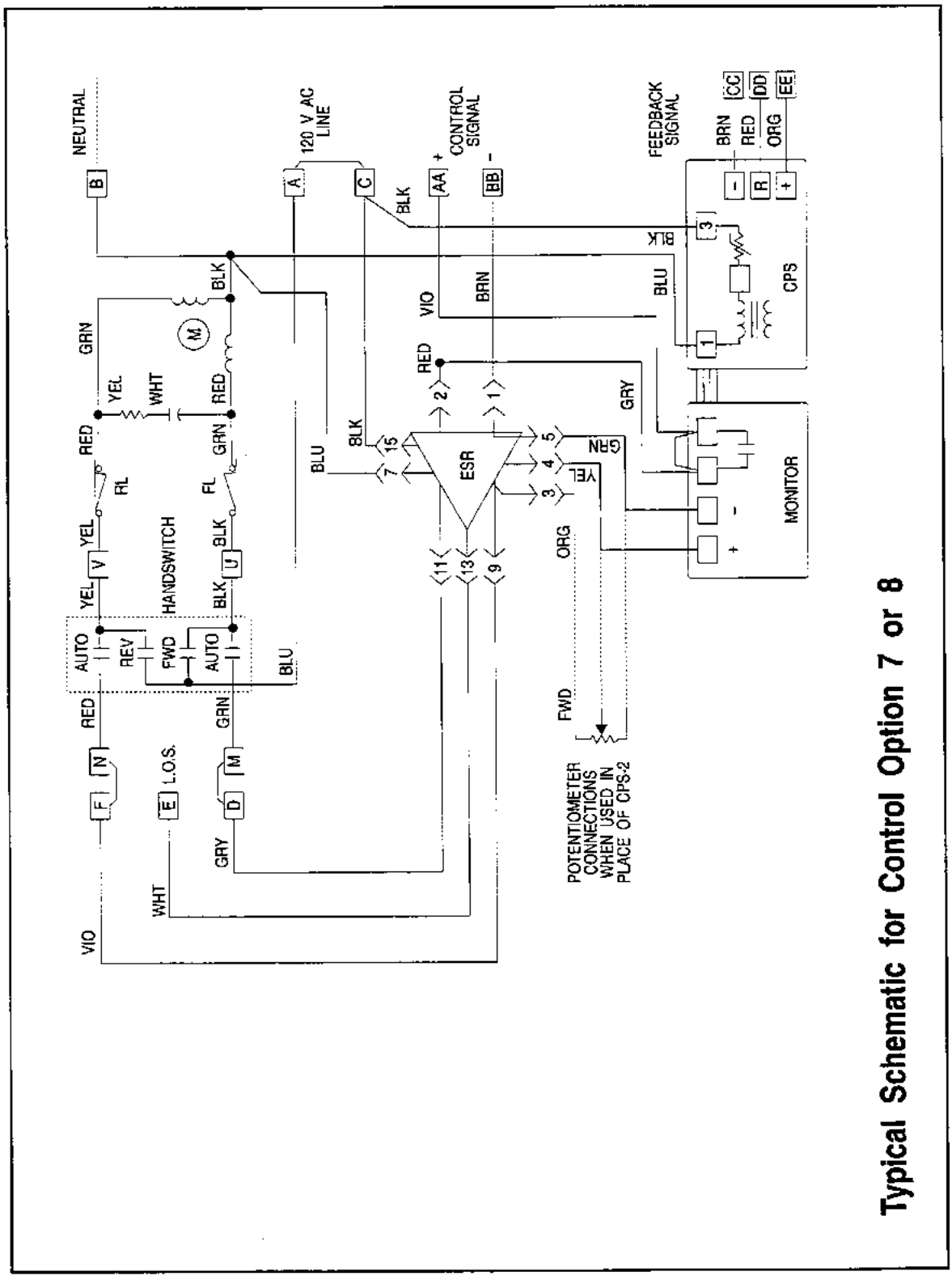
Signal Range	Output Terminals		Ranging Resistor		Resistor Connections		Maximum External Load
			Value	Beck Part No.			
MODEL 20-3400-02 & -12	ESR-4 (+) (–)	ESR-3 (+) (–)			ESR-4	ESR-3	
4 to 20 mA	EE — CC	6 — 1	Open				800Ω
4 to 20 mA	EE — DD	6 — 3	Open				500Ω
1 to 5 V dc	DD — CC	3 — 1	Open				400µA
One or Two							
1 to 5 V dc	DD — CC	3 — 1	255Ω	13-2511-03	DD — EE	3 — 6	400µA
Signals	EE — DD	6 — 3	Open				400µA
MODEL 20-3400-03 & -13							
Current Output	(+) (–)	(+) (–)					
0 to 4 mA	DD — CC	3 — 1	Open				2 kΩ
1 to 5 mA*	DD — CC	3 — 1	Open				2 kΩ
4 to 20 mA*	DD — CC	3 — 1	332Ω	13-2511-06	DD — EE	3 — 6	500Ω
10 to 50 mA*	DD — CC	3 — 1	110Ω	13-2510-25	DD — EE	3 — 6	200Ω
Voltage Output							
0 to 4 V dc	EE — CC	6 — 1	Jumper				16µA
0 to 5 V dc	EE — CC	6 — 1	249Ω	13-2511-08	CC — DD	1 — 3	16µA
0 to 10 V dc	EE — CC	6 — 1	1.50 kΩ	13-2512-02	CC — DD	1 — 3	16µA
0 to 15 V dc	EE — CC	6 — 1	2.74 kΩ	13-2513-42	CC — DD	1 — 3	16µA
1 to 5 V dc*	EE — CC	6 — 1	Jumper		CC — DD	1 — 3	16µA
2 to 10 V dc*	EE — CC	6 — 1	1.00 kΩ	13-2512-01	CC — DD	1 — 3	16µA
0 to 16 V dc	EE — CC	6 — 1	3.01 kΩ	13-2513-26	CC — DD	1 — 3	16µA
MODEL 20-3400-04 & -14	(–) (+)	(–) (+)					
0 to 15 V dc	CC — DD — EE	1 — 3 — 6	Open				2.5µA
MODEL 20-3400-05 & 15							
–10 to 10 V dc	(+) (–) EE — DD	(+) (–) 6 — 3	Open				5µA

* If factory set for 0–16 V dc or 0–4 mA, zero adjustment is required after installation.

CPS-2 FUNCTIONAL BLOCK DIAGRAM



CPS-2 Functional Block Diagram
with output options



Typical Schematic for Control Option 7 or 8

INDEX

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The Seller warrants that the equipment sold hereunder shall conform to Seller's standard specifications. The Seller warrants said equipment to be free from defects in materials and workmanship. This warranty applies to normal recommended use and service for one year from the date on which the equipment is shipped. The Seller's sole obligation under this warranty, and Buyer's exclusive remedy, will be the repair or replacement, without charge, at the Seller's factory, of any defective equipment covered by this warranty. In no event will the Seller's liability exceed the contract price for the goods claimed to be defective.

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Beck Group 14 Linear Drives are covered by the following patents: 3,667,578 and 4,690,168.

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