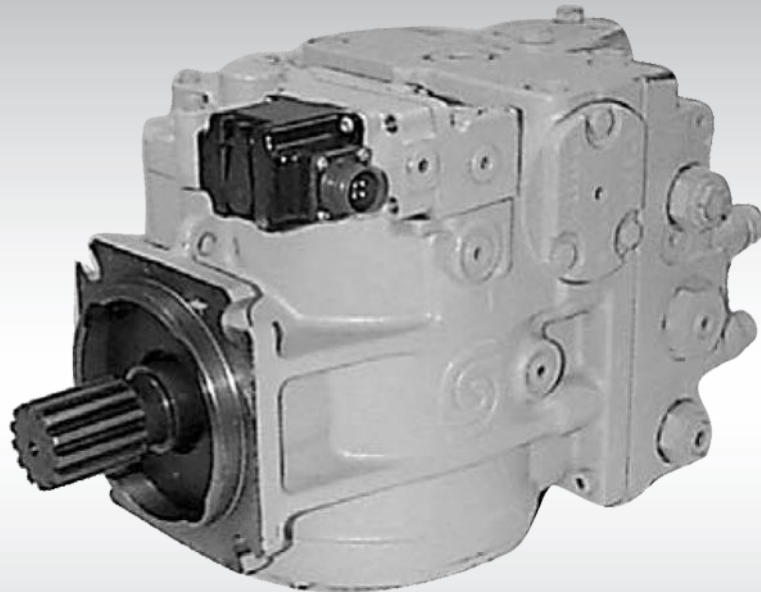




Technical Information

Series 90 Pumps

# KVEB Electrical Displacement Control



**Revision history***Table of revisions*

| <b>Date</b>   | <b>Changed</b> | <b>Rev</b> |
|---------------|----------------|------------|
| April 2015    | Danfoss layout | CA         |
| June 2013     | major revision | BA         |
| November 2003 | First edition  | -          |

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**Technical Information    KVEB Electrical Displacement Control for Series 90 Pumps**

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## General Information

### KVEB

The KVEB Electrical Displacement Control (EDC) is a two-stage electrohydraulic pump stroke control which uses mechanical feedback to establish closed loop control of the swashplate angle of Danfoss Series 90 Pumps.

The first stage, the MCV116 Pressure Control Pilot (PCP) is a torque-motor actuated, double-nozzle flapper valve that produces a differential output pressure proportional to the applied electrical signal. The second stage use the differential pressure to drive its unique spool arrangement and port oil to the pump servo cylinders. The second-stage spool configuration allows a null deadband (for machine safety) in the pump's output while maintaining optimum dynamic response to control commands.

## Features and Benefits

### Features

- Servo control deadband independent of signal null deadband: offers safety combined with accurate and responsive control
- Resistance to the environment: standard silicone oil filled torque motor, environmentally sealed first/second stage interface, full environmental testing
- Minimum long term null shift
- Dual coil torque motor can be used to sum two command sources
- Optional current (mA) ranges

### Advantages of the KVE

- Reduction in deceleration rollout characteristics
- Optional input currents (part number specific)
- Uses no loctite, which eases repair and internal parts

## Specifications

### Technical Specifications

#### **Electrical**

##### ***Full Stroke Current***

**A** Configuration  $18 \pm 1.5$  mA (single coil)

**S** Configuration  $18 \pm 2.0$  mA (single coil)

**B&E** Configuration  $14 \pm 3.0$  mA (single coil)

$42 \pm 5.6$  mA (series coils)

$85 \pm 11.3$  mA (parallel coils)

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Refer to the *Electrical Characteristics* section for a complete range of currents.

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##### ***Threshold Current***

**A** Configuration  $5 \pm 1.0$  mA

**S** Configuration  $6 \pm 1.5$  mA

**B&E** Configuration  $14 \pm 3.0$  mA

##### ***Nominal Input Impedance***

**A** Configuration 650 Ohms for A/B coil

**S** Configuration 110 Ohms for A/B coil

**B&E** Configuration 20 Ohms for A/B coil

16 Ohms for C/D coil

#### **Ratings**

##### ***Scale Factor***

**A** Configuration 6.2 psid/mA (single coil)

**S** Configuration 5.5 psid/mA (single coil)

**B&E** Configuration 1.15 psi/mA (single coil)

2.3 psi/mA (coils in series)

1.15 psi/mA (coils in parallel)

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The EDC is designed to be controlled from a dc current source or a voltage source. Pulse width modulation (PWM) is not required. But, if a PWM signal is used use a carrier frequency  $\geq 200$  Hz. Do not use a PWM current of more than 120% of that required for full output.

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## Specifications

### Fluid selection

Ratings and performance data are based on operating with hydraulic fluids containing oxidation, rust and foam inhibitors. These fluids must possess good thermal and hydrolytic stability to prevent wear, erosion, and corrosion of motor components.

**! Caution**

Never mix hydraulic fluids of different types.

Fire resistant fluids are also suitable at modified operating conditions. Please see *Hydraulic Fluids and Lubricants Technical Information, 520L0463*, for more information. Refer to *Experience with Biodegradable Hydraulic Fluids Technical Information, 520L0465*, for information relating to biodegradable fluids. Contact Danfoss for fluids not mentioned below.

The following hydraulic fluids are suitable:

| Hydraulic fluid type         | Standard, name/type           | Note  |
|------------------------------|-------------------------------|---|
| Hydraulic Oil                | ISO 11 158 – HM               | seal compatibility and vane pump wear resistance per DIN 51 524-2 must be met |
|                              | ISO 11 158 - HV               | seal compatibility and vane pump wear resistance per DIN 51 524-3 must be met |
|                              | DIN 51 524-2 - HLP            |   |
|                              | DIN 51 524-3 - HVLP           |   |
| Automatic Transmission Fluid | ATF A Suffix A (GM)           |   |
|                              | Dexron II (GM)                | which meets Allison C-3 and Caterpillar TO-2 test                             |
|                              | M2C33F and G (Ford)           |   |
| Engine oil                   | API Classification SL, SJ     | for gasoline engines  |
|                              | CI-4, CH-4, CG-4, CF-4 and CF | for diesel engines  |
| Super Tractor Oil Universal  | STOU                          | special agricultural tractor fluid  |

### Filtration system

To prevent premature wear, ensure only clean fluid enters the hydrostatic transmission circuit. A filter capable of controlling the fluid cleanliness to ISO 4406 class 22/18/13 (SAE J1165) or better, under normal operating conditions, is recommended.

These cleanliness levels can not be applied for hydraulic fluid residing in the component housing/case or any other cavity after transport.

The filter may be located on the pump (integral) or in another location (remote). The integral filter has a filter bypass sensor to signal the machine operator when the filter requires changing. Filtration strategies include suction or pressure filtration.

The selection of a filter depends on a number of factors including the contaminant ingress rate, the generation of contaminants in the system, the required fluid cleanliness, and the desired maintenance interval. Filters are selected to meet the above requirements using rating parameters of efficiency and capacity.

Filter efficiency can be measured with a Beta ratio<sup>1)</sup> ( $\beta_x$ ). For simple suction filtered closed circuit transmissions and open circuit transmissions with return line filtration, a filter with a  $\beta$ -ratio within the range of  $\beta_{35-45} = 75$  ( $\beta_{10} \geq 2$ ) or better has been found to be satisfactory.

For some open circuit systems, and closed circuits with cylinders being supplied from the same reservoir, a considerably higher filter efficiency is recommended. This also applies to systems with gears or clutches using a common reservoir.

<sup>1)</sup> Filter  $\beta_x$ -ratio is a measure of filter efficiency defined by ISO 4572. It is defined as the ratio of the number of particles greater than a given diameter (" $x$ " in microns) upstream of the filter to the number of these particles downstream of the filter.

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**Technical Information    KVEB Electrical Displacement Control for Series 90 Pumps**


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**Specifications**

For these systems, a charge pressure or return filtration system with a filter  $\beta$ -ratio in the range of  $\beta_{15-20} = 75$  ( $\beta_{10} \geq 10$ ) or better is typically required.

Because each system is unique, only a thorough testing and evaluation program can fully validate the filtration system.

Please see *Design Guidelines for Hydraulic Fluid Cleanliness Technical Information, 520L0467* for more information.

*Filtration, cleanliness level and  $\beta_x$ -ratio (recommended minimum)*

|   |   |
|---|---|
| <b>Cleanliness per ISO 4406</b>   | 22/18/13                                      |
| <b>Efficiency <math>\beta_x</math> (charge pressure filtration)</b>         | $\beta_{15-20} = 75$ ( $\beta_{10} \geq 10$ ) |
| <b>Efficiency <math>\beta_x</math> (suction and return line filtration)</b> | $\beta_{35-45} = 75$ ( $\beta_{10} \geq 2$ )  |
| <b>Recommended inlet screen mesh size</b>                                   | 100 – 125 $\mu\text{m}$                       |

**Performance Specifications**

**Hysteresis** - Less than 7 psi divided by the scale factor. Measured at a frequency of .01 Hz at 30% of rated current when run from plus to minus 98 psi divided by the scale factor.

**Symmetry** - The differences in the currents to drive to either side of rated output will not exceed 15%.

**Linearity** - No point plotted on the current/washplate angle curve shall fall outside the area defined by a  $\pm 10\%$  slope deviation from the scale factor, exclusive of the deadband.

**Fail Safety** - The spool will return to neutral if the electrical signal is disconnected or if the pilot output pressure goes to case pressure. Mechanical feedback must be present.

**Frequency Response** (except for 130 cc pumps)

2-3 Hz minimum with .052 pressure limiter orifices

3-4 Hz minimum without pressure limiter orifices (with pressure limiters inoperative)

Under 500-1000 psi load at 90° phase lag with 10 mA signal at 45 mA offset

**Time Response** (75 CC pumps)

B Configuration: 0 to full stroke 0.78 seconds (0.18 seconds without PL orifices)

Full to full stroke 1.40 seconds (0.30 seconds without PL orifices)

Full to 0 stroke 0.38 seconds (0.15 seconds without PL orifices)

E Configuration (All models are shipped without PL orifices)

0 to full stroke 0.13 seconds

Full to full stroke 0.24 seconds

Full to 0 stroke 0.13 seconds

**Sensitivity** - The valve will respond to a 2% change in input current throughout the rated current range except for the deadband region.

**Environmental Specifications**

**Shock** - 50 Gs for 11 milliseconds. Three shocks in both directions of the three mutually perpendicular axes for a total of 18 shocks.

**Vibration** - Withstands a vibration test designed for mobile equipment control consisting of two parts:

1. Cycling from 5 to 2000 Hz in each of the three axes.
2. Resonance dwell for one million cycles for each resonance point in each of the three axes.

## Specifications

Subject to acceleration levels of 1 G to 46 Gs.

Acceleration level varies with frequency.

**Humidity** - After being placed in a controlled atmosphere of 95% humidity at 49° C (120° F) for 10 days, the EDC will perform within specification limits. Meets MIL-STD-810B.



**Electrical Characteristics**
**A Configuration**

INPUT SHAFT ROTATION VS. TERMINAL CONNECTION VS. OUTPUT FLOW

|                      |   |   |                           |   |
|----------------------|---|---|---------------------------|---|
| Input Shaft Rotation |   |   | Produces Flow Out Of Port |   |
| Clockwise            | A | B | A                         | B |
| Counter Clockwise    | A | B | B                         | A |

| Start Current (mA) | Full Stroke Current (mA) | Start Voltage (Vdc) | Full Stroke Voltage (Vdc) | Coil $\Omega$ 75° F | Coil $\Omega$ 220 ° F |
|--------------------|--------------------------|---------------------|---------------------------|---------------------|-----------------------|
| ±4.5 - 5.5         | ±16.5 - 19.5             | ±2.9 - 3.6          | ±11 - 12.6                | 650                 |                       |
| ±4.5 - 5.5         | ±16.5 - 19.5             | ±3.8 - 4.7          | ±14.0 - 16.5              |                     | 650                   |

 MAXIMUM CONTINUOUS VOLTAGE @ 93.9 °C (200 °F): 24 Vdc. A and B
**B and E Configuration**

|                         |                     | One of Dual Coils               | Dual Coils in Parallel   | Dual Coils in Series       | Produces Flow Out of Pump Port |   |
|-------------------------|---------------------|---------------------------------|--|----------------------------|--------------------------------|---|
|                         |                     | <br>+ phasing to terminals      | <br>+ phasing to terminals   | <br>+ phasing to terminals |                                |   |
| PUMP SHAFT ROTATION     | Clockwise           | A or C                          | A and C  | A                          | A                              |   |
|                         | Clockwise           |                                 |  | B and D                    | D                              | B |
|                         | Counterclockwise    | A or C                          | A and C  | A                          |                                | B |
|                         | Counterclockwise    |                                 |  | B and D                    | D                              | A |
| ELECTRICAL REQUIREMENTS | Start Current       | A/B 14 mA with 0.3 Vdc ± 3 mA   | 14 mA with 0.13 Vdc  | 7 mA with 0.25 Vdc         |                                |   |
|                         | Full Stroke Current | A/B 85 mA with 1.7 Vdc ± 11 mA  | 85 mA with 0.75 Vdc  | 43 mA with 1.55 Vdc        |                                |   |
|                         | Start Current       | C/D 14 mA with 0.23 Vdc ± 3 mA  | (These Vdc levels are at 75 °F (24 °C). At this temperature the coil resistance is approximately 16 $\Omega$ for C/D and 20 $\Omega$ for A/B.) |                            |                                |   |
|                         | Full Stroke Current | C/D 85 mA with 1.36 Vdc ± 11 mA |  |                            |                                |   |

MAXIMUM CONTINUOUS VOLTAGE @ 93.9 °C (200 °F): 6 Vdc, if one coil or parallel, 12 Vdc, if coils in series.

B and E

## Design Parameters

## Application

The KVE is intended as a direct replacement for the MCV111. But when 2 or more EDC are used in a vehicle propel application they should all be of one type or the other, don't mix them for reasons as described in this application section. The KVE and MCV use a torque-motor based electrical actuator scheme that is designed to work with a current (dc mA) signal, i.e., 75 mA will produce the same pump flow every time. However, the KVE and MCV have different electrical coil arrangements, resulting in the following precautions:

- Both are dual coil, but have different coil values (KVE 16 $\Omega$  and 20 $\Omega$ /MCV 25 $\Omega$  and 25 $\Omega$ ). This may cause problems in applications where there is a mix of KVE and MCV, they are controlled simultaneous and electrically tied together in a parallel arrangement. In those parallel circuits the KVE pump will be stroked ahead of the MCV by approximately 25%. Therefore to ensure that KVE and MCV pumps stroke at the same rate use a series electrical connection, which will ensure that all EDCs receive the same electrical current.
- The MCV coils are arranged on a T-bar-style armature. This allows the coils to be physically separated by a small air gap. The KVE coils are arranged on a stand-up style armature (which is the same used on all other dual coil EDCs and servovalves) and they are stacked one atop the other. In some rare instances, this may induce current changes resulting from the magnetic effects of one coil on another (see Precautions When Driving Dual Coil PCs With A PWM Drive). Contact Danfoss for applications concerns.

### **KVEBXXXXX REPLACES KVEAXXXXX**

The new control will be identified by a new letter in the control part number. The control will be designated KVEB, whereas the previous control p/n was designated as KVEA.

When servicing the new EDC, a different pilot valve part number will be required (as compared to the existing EDC) when replacement is necessary.

As a product improvement, design changes to the Series 90 Electric Displacement Control have been made:

- Improvements in the area of the control spool and feedback mechanism.
- Revisions in the nozzle area/clearance with related part of the pilot valve.

These changes will not affect form or fit. In nearly all cases, function is not affected. There is one exception:

When one side of the pilot valve is tapped to utilize the absolute pressure to pilot external devices such as a one line motor control (see details below).

- Abnormal case drain pressures.
- Oil cleanliness.

This change went into effect January 1, 1999. Various pump frame sizes may incorporate this change at different times dependent upon the manufacturing location and initial control availability.

One line motor controls: It is always best to use a two line motor control when phasing a variable motor hydraulically with a Series 90 pumps (via the X1 and X2 ports). Applications using only a one line hydraulic control rely on controlling the variable motor with pressure from only one of the EDC ports, either X1 or X2, but not both. The pump phasing in these applications will be adversely affected by this EDC change. Although the delta pressure (X1 - X2) versus coil current is not affected by this change, the individual gage pressures at X1 and X2 are significantly reduced. Depending on fluid temperature and viscosity, and the pump charge pressure setting, this reduction in gage pressures will be in the range of 60 - 80 psig (current range of 120 - 160 psig).

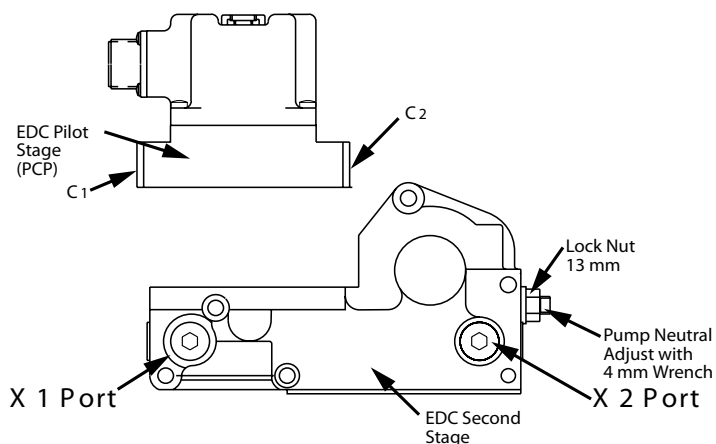
If no change is made to the motor control threshold, and/or ramp in a one-line controlled motor, the motor shift will not occur until coil current reaches much higher levels. In fact, it may not even be possible to fully shift the motor with any coil current level. Therefore, any applications phasing a one-line

## Technical Information **KVEB Electrical Displacement Control for Series 90 Pumps**

### Design Parameters

hydraulically controlled motor with a Series 90 pump with one of the above controls, the motor threshold and/or ramp levels must be changed, and coordinated with the timing of the Series 90 pump EDC change. In the case of Series 51 motors with one line controls, the threshold setting, and likely the threshold spring and ramp spring will have to be changed. Please contact Danfoss Applications Engineering for assistance in determining the new motor specifications required.

Since the delta pressure versus coil current relationship is not affected by this nozzle change, the phasing of motors with two line controls (controls which change motor displacement based on the difference between X1 and X2) are not affected.

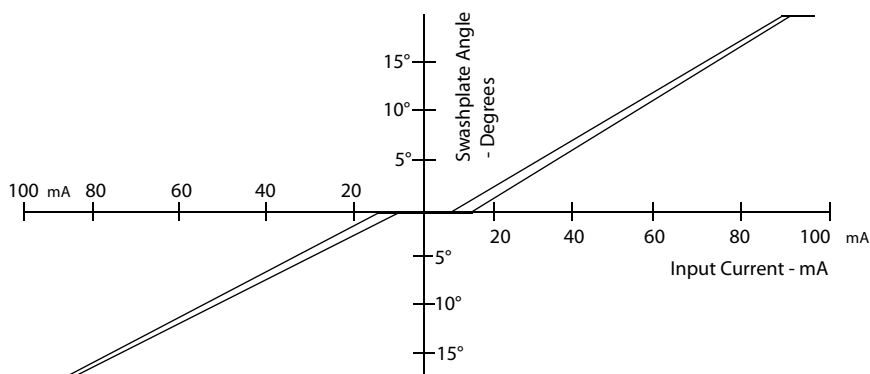


Note: C1/X1 are internally connected

X1 - X2 Ports-3

| PCP New Part Number | Pressure Range psig | Where Used EDC P/N | PCP Replaces Part Number | Pressure Range psig | Where Used EDC P/N |
|---------------------|---------------------|--------------------|--------------------------|---------------------|--------------------|
| MCV116G4201         | 60-80               | KVEBXXXXX          | MCV116F4201              | 120-160             | KVEAXXXXX          |
| MCV116G4204         | 60-80               | KVEBXXXXX          | MCV116F4204              | 120-160             | KVEAXXXXX          |
| MCV116G4211         | 60-80               | KVEBXXXXX          | MCV116F4211              | 120-160             | KVEAXXXXX          |
| MCV116H4201         | 60-80               | MCV114XXXXX        | MCV116A4201              | 120-160             | MCV114XXXXX        |
| MCV116H4204         | 60-80               | MCV114XXXXX        | MCV116A4204              | 120-160             | MCV114XXXXX        |

### Current vs Swashplate Angle of the Single Coil KVEA (B&E configuration)



## Design Parameters

### Precautions when driving dual coil PCPs with a PWM driver

Danfoss dual coil PCPs are constructed in such a manner that magnetic flux generated in the circuit flows through the windings of both coils. This phenomenon is basic to the torque motor technology used. This is different from some magnetic actuators, such as most proportional valves, that have two distinctly separate magnetic circuits. Since the flux generated in one coil flows through the other coil, the device operates like, and in fact is, a transformer. This fact is generally insignificant when the coils are driven with dc currents, such as when the device is driven from a potentiometric control handle or from dc current drivers such as the valve drivers in Danfoss DC2 and SUSMIC microcontrollers. Many controllers are set up to drive proportional solenoids through Pulse Width Modulation (PWM). These controls send an oscillating pulse width modulated dc current to the coil. This design has the advantages of providing dither to the actuator and, in some cases, can simplify the electronics since they operate in a digital mode. This can reduce heat output from the device.

#### **Trade-offs or unwanted side effects:**

Items 1 through 3 apply to all electrohydraulic actuators. Items 4 and 5 relate more specifically to PCPs.

1. The pulsing current generates unwanted electromagnetic radiation, which can interfere with related devices.
2. The actuators are generally responsive to current. PWM valve drivers are generally low impedance voltage drives. As the coils heat up the resistance changes (typically by as much as 50%), thus altering the response of the device. For given PWM frequency and duty cycle, both peak and average current into the driven coil may strongly affect the coil's L/R (inductance/resistance) time constant, potentially reducing both accuracy and linearity. The effects vary considerably with valve type and with temperature and are quite different between Danfoss MCV116 and MCV110. PWM drivers often require "current feedback" to maintain sufficient accuracy as the temperature varies over the operating range.
3. Some controllers are designed to diagnose shorts or opens in the output circuit. The PWM-induced voltage can affect some common detection schemes.
4. In the case of the PCP, a PWM signal is just like an alternating current applied to the primary of a transformer. A voltage is induced in the secondary coil proportional to the turns ratio of the coils less losses in the magnetic circuit. If the secondary coil is open circuited, there is no effect since no current flows, and hence no magnetic field is generated. However, if current is allowed to flow in the secondary coil, it flows in a direction which will reduce the output of the actuator.
5. Most electronic drivers will conduct current when back driven with excessive voltages. One example is a drive that contains non-linear devices such as diodes or zener diodes for re-circulatory currents. The induced voltages may be sufficient to cause these devices to conduct thereby causing current flow in the non-driven coil.

In position control systems where the control drives toward null this generally is not a problem. However, in propel systems, especially dual path propel systems, the change in output velocity could be severe limitation. In some cases filters can be designed to correct the problem. A limitation of filters is this adds a lag in the circuit which will adversely affect high response systems. Also it is impossible to design one filter to fit all applications.

---

In summary, the ability to drive the Danfoss PCP depends on many circumstances which must be understood and accounted for by the user.

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## Operation

### Theory of Operation

A command source such as a joystick, control handle or electronic controller applies current signals to the pilot stage of the KVEB Electrical Displacement Control, which results in flow out of the pump. The input current commands the pilot's torque motor stage, a bridge network consisting of an armature mounted on a torsion pivot and suspended in the air gap of a magnetic field. Two permanent magnets polarized together with two pole pieces form a frame for the magnetic bridge. At null the armature is centered in the air gaps between the magnets' opposing poles by the equivalence of their magnetic forces and the null adjust centering springs. As the input differential current rises to the dual coils, the end of the armature becomes biased either north or south, depending on the magnitude of the current differential. The resulting armature movement is determined by the amperage of control current, the spring constant and the differential pressure feedback forces, explained below. See the Schematic Diagram for a complete system illustration.

The magnetic bridge output, flapper torque, in turn controls the hydraulic bridge ratio. At null, the flapper is centered between two nozzles. Upstream from each nozzle is an orifice which provides a nominal pressure drop when the system is at null. Between the nozzle and the orifice on each side is a control port. As the torque motor shifts the flapper away from one nozzle toward the other, a differential control pressure results, the high side being the one nearer the flapper. Fluid pressure rises on this side and moves the flapper back towards null. When the torque output from the motor equals the torque output from the pressure feedback, the pilot system is in equilibrium. It is this pressure feedback that makes the pilot a stand-alone closed loop pressure control valve. The pilot stage is silicone oil filled for protection against the environment and for proper valve operation.

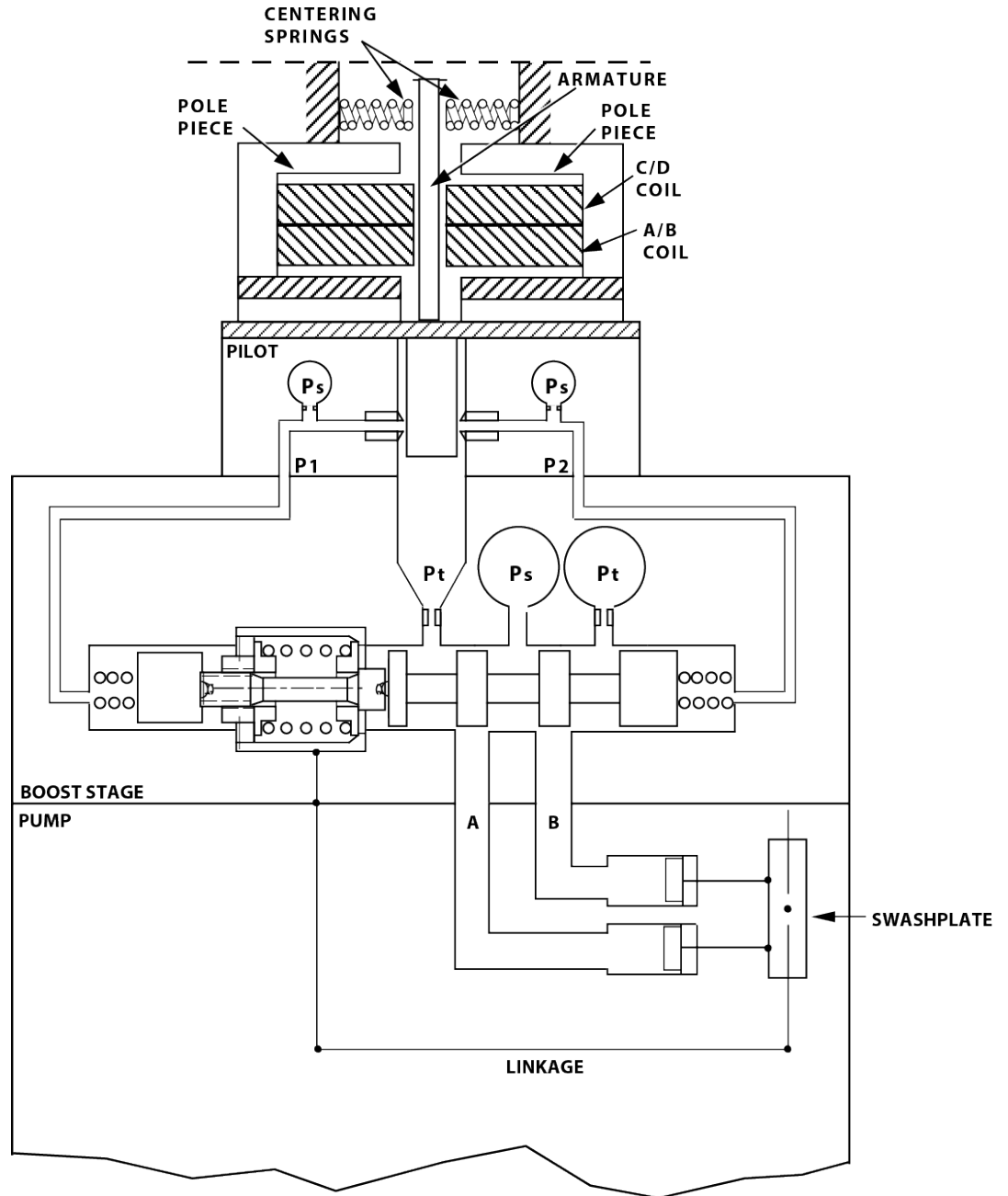
The second stage of the EDC uses a unique spool-barrel feedback arrangement that serves to separate the null deadband from the feedback, giving both safety against null drift and quick dynamic response to command changes.

The second stage's null adjust is set with a feedback spring compressed to a 16 psi threshold (measured at the center of the hysteresis loop), which is the amount of differential pressure required to begin to move the actuator spool one direction or the other. The threshold is a factory setting. By tightening or loosening the main null adjust screw, the fixed deadband is adjusted so that the pump starts to stroke with equal output current on either side of null.

As differential control pressure input from the pilot rises beyond the 16 psi deadband (KVEBB and KVEBE models), the spool moves in one direction or the other, opening one of the control ports to supply charge pressure to the pump's servo-cylinders, moving the swashplate. As the swashplate moves, the linkage follows, moving the barrel in the opposite direction of the spool's original motion. The barrel's feedback movement tends to drive the spool back toward neutral through its internal feedback spring. Oil returns from the servo cylinders through the spool to the case.

Operation

Schematic Diagram



Schematic

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**Technical Information    KVEB Electrical Displacement Control for Series 90 Pumps**


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**Model Code**
**KVEB - EDC**

|                |   |   |   |               |           |       |
|----------------|---|---|---|---------------|-----------|-------|
|                |   |   |   | Configuration | Pump size | Pilot |
| <b>Product</b> |   |   |   |               |           |       |
| K              | V | E | B |               |           |       |

*Configuration*

| Code | Current range      | Remarks   |
|------|--------------------|---|
| A    | 4-20 (Single coil) |   |
| B    | 14-85 (Dual coil)  |   |
| C    | 14-85 (Dual coil)  | High response, no pressure limiter (PL) orifices, annular housing |

*Pump size*

| Code | Description      |
|------|------------------|
| 05   | 55 cc            |
| 07   | 75 cc            |
| 10   | 100 cc           |
| 13   | 130 cc S/N       |
| 14   | 130 cc S/N       |
| 18   | 180 cc or 250 cc |

*Pilot*

| Code | Description                  |
|------|------------------------------|
| 02   | MS connector (14-85 mA)      |
| 04   | Packard connector (14-85 mA) |
| 07   | MS connector (4-20 mA)       |
| 09   | Deutsch connector (14-85 mA) |

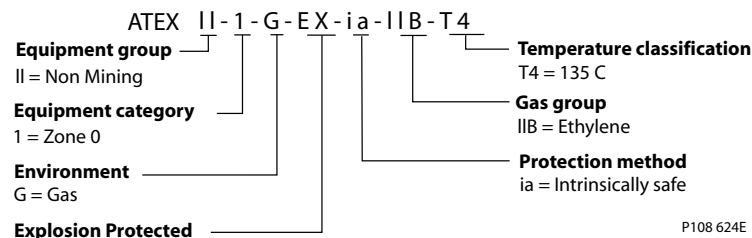
## Options

### Intrinsically Safe Control

In industrial processes where flammable materials are handled, any leak or spillage may lead to an explosive atmosphere. To protect both property and personnel, precautions must be taken to ensure that this atmosphere cannot be ignited. The areas at risk are known as hazardous areas and the materials that are commonly involved include crude oil and its derivatives, alcohol, natural and synthetic process starch, grain, fibers and dust.

Intrinsic safety is based on the principle of restricting the electrical energy available in hazardous-area circuits such that any sparks or hot surfaces that may occur as a result of electrical faults are too weak to cause ignition. Factory Mutual Research (FM) has approved the following model listed below for use in Class I, Division 1, Group C and D hazardous locations as defined by the National Electrical code, NEC 500/505 when used with approved barriers. If a given application requires only Division 2 approval, an inline barrier may not be required.

As of June 2012, the controls listed above have also been approved for use in hazardous locations in accordance with European Directive 60079-11. The example model code shown below lists the parameters that these controls have been qualified to meet.



### Wiring Options

Common wiring styles are mentioned as follows: MS, Packard Weather-Pack, and Deutsch. The MS Connector (MS3102C14S-2P) has four pins. See the MS Connector Diagram for pin locations. See the Electrical Characteristics section for pump phasing. Mating connectors must be ordered separately. For the MS connector order part number K08106. The mating Packard connector is a bag assembly part number K03384, comprised of :

- (4) 14-16 gauge sleeves
- (4) 18-20 gauge sleeves
- (1) plastic housing
- (4) green cable seals
- (accept 2 2-2, 8 mm wire diameter)
- (4) gray cable seals (accept 2 81-3, 49 mm wire diameter)
- (4) blue cable seals (accept 3 50-4, 21 mm wire diameter)

#### Assembling the Female Tower Connector

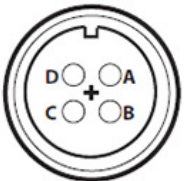
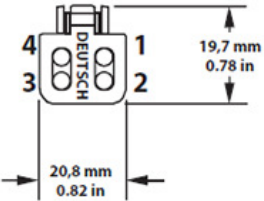
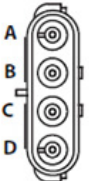
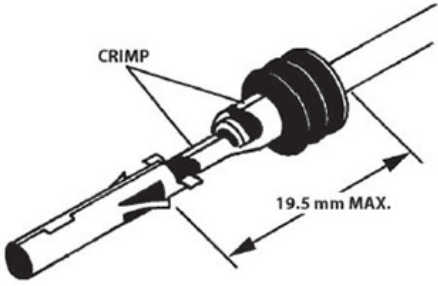
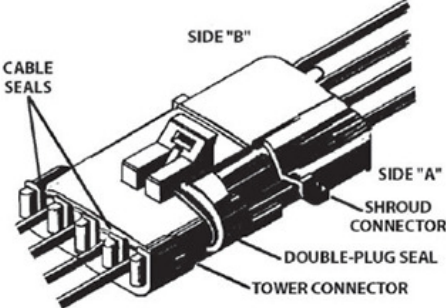
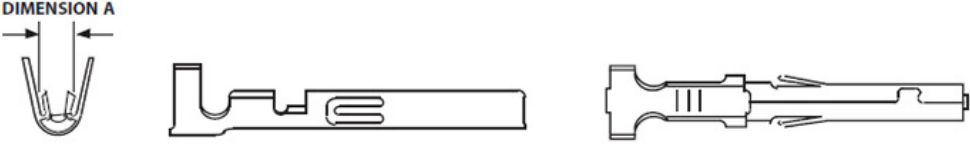
1. Isolate the wires that extend from the command source to the EDC.
2. Strip back the insulation 5.5 millimeters on both wires.
3. Push a ribbed cable seal over each of the wires with the smaller diameter shoulder of the seals toward the wire tip. Select the pair of seals that fits tightly over the wires. The distance from the tip of the



**Options**

wires of the first (nearest) rib should be 9.5 millimeters. Thus the insulation should just protrude beyond the seal.

4. Select the larger of the two sets of pins, as measured at Dimension A (see the Dimension A drawing), if using 14-16 gauge wire. Choose the smaller if using 18-20 gauge. Place the wire into the socket so that the seal edge is pushed through and extends slightly beyond the circular tabs that hold it in place. Crimp in the locations shown in the Packard Connector Crimp drawing with a Packard 12014254 crimp tool. The distance from the back of the tangs to the furthest rib may not exceed 19,5 mm.
5. Manually insert the assembled wires into the back end (large hole) of the plastic housing. Push until the wire detents with an audible click, then pull back slightly to ensure proper seating (Observe the proper phasing of the wires when installing: Black wire to "A", Red wire to "B", Black to "C" and Red to "D"). Terminals may be removed from the connector bodies with a Packard 12014012 removal tool.
6. Swing the holder down into the detented position to trap the wires in the housing. The third rib should be sealed into the housing.
7. Plug the shroud connector from the valve into the tower connector just constructed. They are sealed with a quadruple plug seal over the quadruple barrel of the tower assembly. The two connector halves should detent into each other. See the Packard Connector Parts drawing.

| MS CONNECTOR   | DEUTSCH DT SERIES   | PACKARD CONNECTOR   |
|--|---|---|
|  <p>Pin Orientation of the Optional MS Connector. This Part is not Field Replaceable.</p>      |  <p>Pin orientation of the Mating 4-pin Deutsch Plug DT06-4S Series Connector. Part number K23511.</p> |  <p>Pin orientation of the optional Packard Weather-Pack connector. Part number K03384.</p> |
| PACKARD CONNECTOR CRIMP  |   | PACKARD CONNECTOR PARTS   |
|  <p>Crimp Location and Distance from Tang to Third Rib of Packard Weather-Pack Connector.</p> |   |  <p>Packard Weather-Pack Interlocked Connector Halves with Parts Identified.</p>           |
| DIMENSION A  |   |   |
|  <p>Dimension A for Selecting Correct Terminal.</p>  |   |   |

## Mounting the Control

### Mounting Procedure

**⚠ Warning**

Exercise care when placing the valve on a surface before mounting on a transmission. Dropping or otherwise forcefully setting the valve down may damage the pin.

Clean all external surfaces of the pump with steam or solvent. Remove the six hex head cap screws from the housing using a 5 mm internal hex wrench. Remove the manual control or plate from the pump.

Always install a new mounting gasket. If going from a manual control to an EDC the same mounting bolts can be used. If going from a blanking plate to an EDC new mounting bolts are required because of the different lengths. To help avoid a mounting problem it may be necessary to order a mounting kit. See Series 90 Parts Manuals for mounting kit numbers.

**⚠ Warning**

The KVEB EDC cannot be hydraulically connected with another device through the servo ports (X1 and X2). Do not disconnect the SAE servo port fittings for this purpose. Doing so may cause the EDC to go on stroke. The fittings are to be used only for troubleshooting purposes. When hydraulic connections are required, such as for a staging function, the MCV114S must be used. Also an orifice (Danfoss orifice fitting part number 9002875-0039) must be located in each of the hydraulic connections.

### Installing the Control

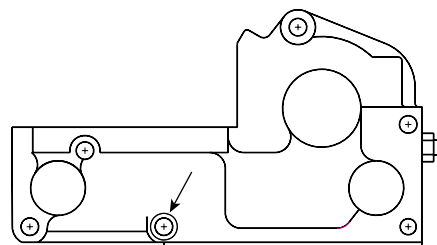
1. Place a new gasket on the pump housing. If a charge pressure control orifice is used ensure that the orifice and spring are in the proper position in the control.
2. While setting the control into position, engage the pin on the control linkage into the mating hole in the link attached to the pump swashplate.
3. Check pin engagement can be checked by:
  - a) Move control assembly left and right from center position, slight resistance will be noted if properly engaged.
  - b) Place a finger under the control connector and lift away from pump housing.

If control tilts away more than approximately 1/4 to 3/8 of an inch, the pin is not engaged.

4. Repeat steps 2 and 3 in case of non engagement.

**⚠ Warning**

Ensure positive pin engagement. Failure to do so may result in unintended vehicle movement.



Location of Seal Washer on 180, and 250 cc Pump EDCs  
P108 628E

## Adjustment Procedure

### Pump Neutral Adjustment

Use the following procedure to bring the pump to neutral once the electrical displacement control has been mounted.

1. Install a 600 psi gauge into the charge pressure gauge port on the pump. See the Pump Port Location drawing.
2. Using a 13 mm wrench, loosen the hex lock nut on the null adjustment screw. See the Dimension drawings.
3. Disconnect the electrical source at the connector.
4. Start the prime mover and run at low idle.

 **Warning**

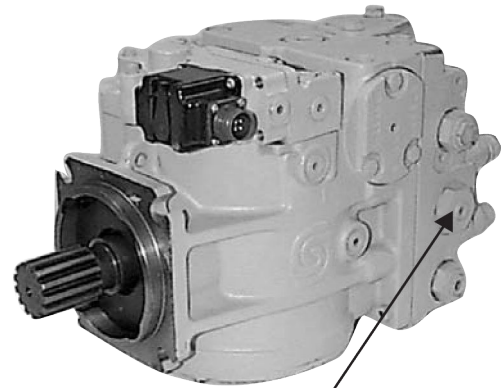
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To adjust neutral requires operating the pump. Take the necessary safety precautions, such as having unnecessary personnel stand away from the machine. Maximum system pressure may occur upon start-up, and the machine may move. Ensure that the operator is not in a position to be injured should the machine move.

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5. Warm the system up for several minutes to bleed air.
6. Slowly increase the prime mover speed to rated rpm.
7. If the transmission operates as indicated by motor shaft rotation, reduce speed to idle. Using a 4 mm internal hex wrench, slowly turn the null adjustment screw clockwise or counterclockwise until the transmission does not operate. Repeat step 6. Note that charge pressure should drop with forward or reverse stroking of the pump swashplate due to the shifting of the shuttle valve in the motor manifold. Slowly turn the null adjustment screw clockwise until charge pressure decreases.
8. If the transmission operates as indicated by motor shaft rotation, reduce speed to idle. Using a 4 mm internal hex wrench, slowly turn the null adjustment screw clockwise or counterclockwise until the transmission does not operate. Repeat step 6. Note that charge pressure should drop with forward or reverse stroking of the pump swashplate due to the shifting of the shuttle valve in the motor manifold. Slowly turn the null adjustment screw clockwise until charge pressure decreases.
9. If the transmission operates as indicated by motor shaft rotation, reduce speed to idle. Using a 3 mm internal hex wrench, slowly turn the null adjustment screw clockwise or counterclockwise until the transmission does not operate. Repeat step 6. Note that charge pressure should drop with forward or reverse stroking of the pump swashplate due to the shifting of the shuttle valve in the motor manifold. Slowly turn the null adjustment screw clockwise until charge pressure decreases.
10. With a 4 mm internal hex wrench, slowly turn the null adjustment screw counterclockwise, observing the wrench angle rotation, until charge pressure decreases again (charge pressure will rise in neutral and drop when going into stroke).
11. Turn the adjustment screw clockwise half the amount of the turn observed in step 8. This should be the center of neutral.
12. Hold the adjustment screw and securely tighten the hex lock nut on the adjustment screw to 14-18 foot-pounds. Note that if a motor is used that does not have a manifold, neutral should be adjusted (steps 8 - 10) by observing the motor shaft rotation without a load.
13. Stop the prime mover.
14. Reconnect the electrical signal source.
15. Run the system briefly to ensure that it operates proportionally on both sides of null. Swashplate movement can be verified by watching motor shaft rotation without a load.

**Adjustment Procedure**



← CHARGE PRESSURE  
GAUGE PORT

P108 632E

## Troubleshooting

### Pump Fails to Stroke Properly

If the pump does not reach its expected output flow with the proper input electrical signal when measured across the coils (approximately 2 to 2.5 Vdc and 12 to 15 Vdc for configuration A), the following should be checked:

1. Ensure pump maintains approximately 270 psi minimum charge pressure.
2. Actuate the EDC manual operator several times from side to side, but first take the necessary safety precautions in the event the pump reaches full output.

| Pump Phasing With EDC Manual Operator (MO) |                   |                    |
|--|-------------------|--------------------|
| Pump Rotation                              | MO Rotation       | Pump Flow Out Port |
| CW   | Towards Connector | B                  |
| CCW  | Towards Connector | A                  |

3. If the pump fails to reach full output flow with the manual operator, shut the system off and place two 0-500 psi pressure gages in the control ports X1 and X2 of the EDC (see Service Parts). Once the gages are in place start the system. Observe the gage readings. X1 and X2 should read between 45 to 85 psi for the KVEB and 90 to 170 psi for the KVEA and be within 5 psi of each other.

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The level of these readings will vary with respect to charge pressure and oil temperature but should always be within approximately 5 psi or less of each other. If gage differential readings are greater than 10 psi with no command signal, the Pilot Valve should be replaced because of either contamination or a null pressure shift, the effect of which would likely be pump creep in one direction. If gage readings are less than 80 psi, charge pressure is either low or is not getting to the EDC, which could be caused by a number of things, such as a blockage at either the EDC Pilot Stage inlet filter or EDC inlet (charge pressure) orifice if applicable.

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If adequate pressure is noted at X1 and X2 as stated above, but the X1 and X2 differential pressure (psid) reading fails to reach a minimum 100 psid (example, X1 of 35 psi and X2 of 135 psi) with either the manual operator or with full rated electrical signal, then replace the PCP.

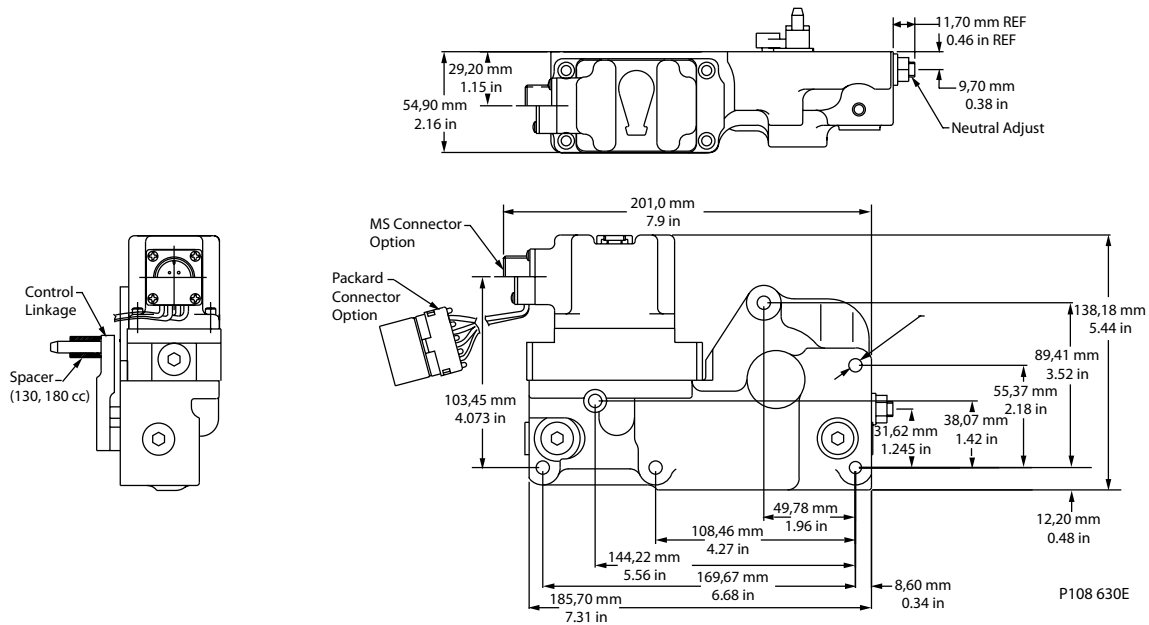
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A small percentage of the KVEA style PCPs between date codes 9549 through 9753 may experience a condition in which the manual operator will not bring the pump to full stroke in one direction (see Service Bulletin 9833 for details).

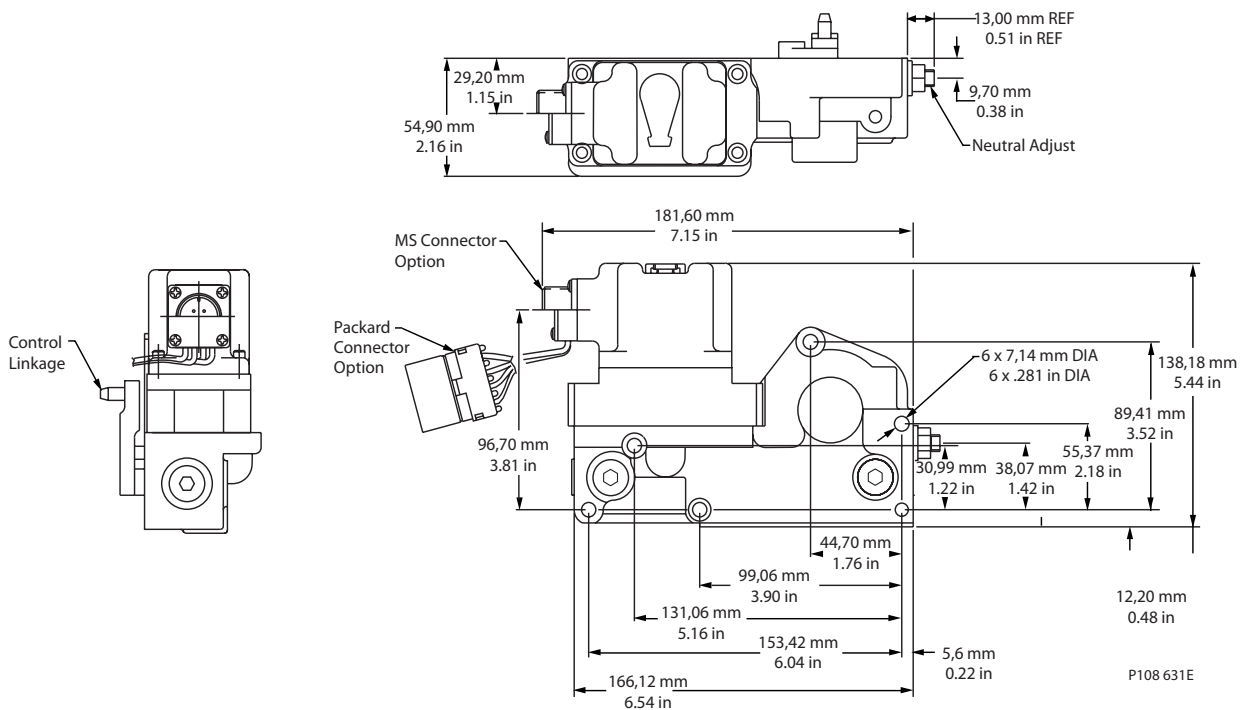
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**Installation Drawings**

**75cc, 100cc, 130cc, 180cc and 250cc pumps - EDC**



**55cc pumps - EDC**













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