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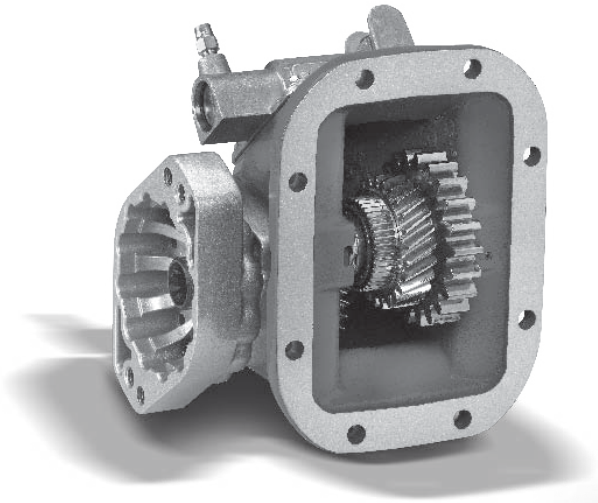

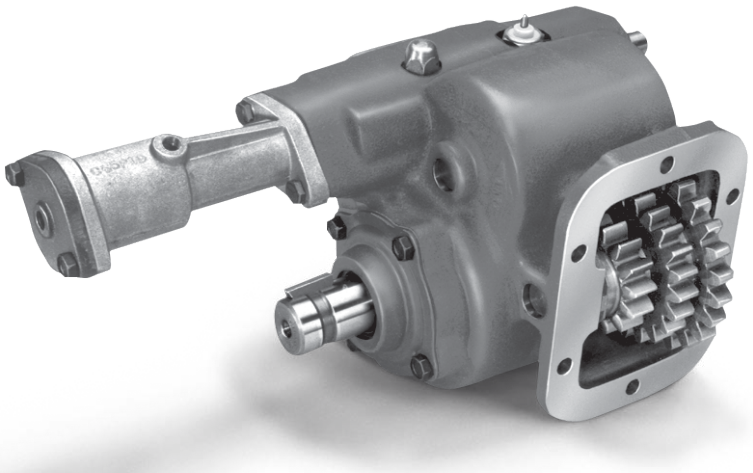

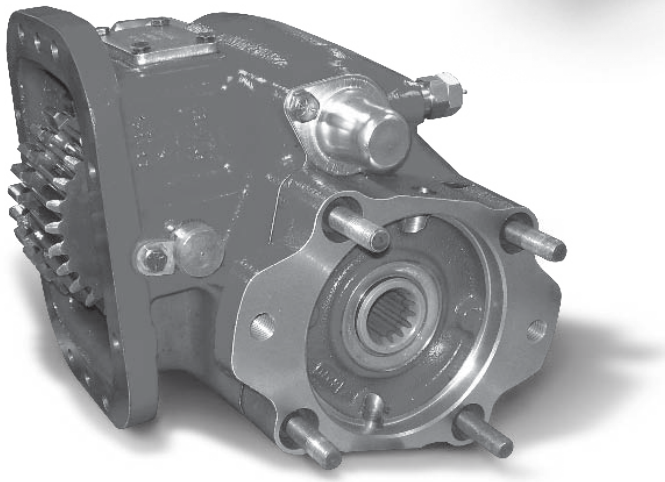

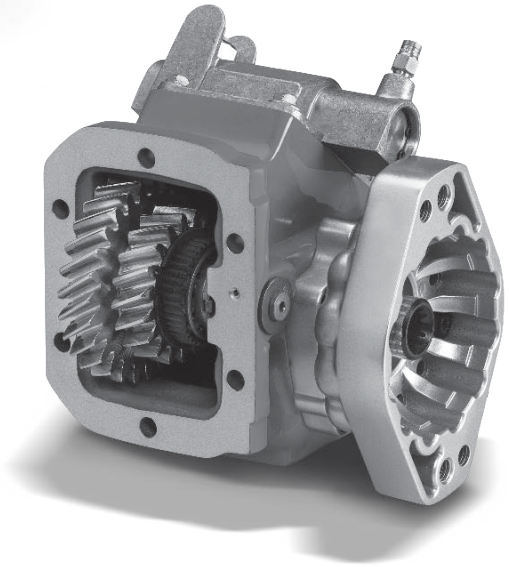

Power Take-Offs Owner's Manual

221, 290, 340, 348, 352, 442, 447, 489, 660, 680, 823, 863, 880 Series

Parker Chelsea

ENGINEERING YOUR SUCCESS.

⚠ WARNING — User Responsibility

FAILURE OR IMPROPER SELECTION OR IMPROPER USE OF THE PRODUCTS DESCRIBED HEREIN OR RELATED ITEMS CAN CAUSE DEATH, PERSONAL INJURY AND PROPERTY DAMAGE.

This document and other information from Parker Hannifin Corporation, its subsidiaries and authorized distributors provide product or system options for further investigation by users having technical expertise.

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To the extent that Parker or its subsidiaries or authorized distributors provide component or system options based upon data or specifications provided by the user, the user is responsible for determining that such data and specifications are suitable and sufficient for all applications and reasonably foreseeable uses of the components or systems.

Offer of Sale

The items described in this document are hereby offered for sale by Parker Hannifin Corporation, its subsidiaries or its authorized distributors. This offer and its acceptance are governed by the provisions stated in the "Offer of Sale".

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Parker Hannifin Corporation
Chelsea Products Division
Olive Branch, MS 38654 USA

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Foreword

This booklet will provide you with information on correct installation of Chelsea® Power Take-Offs (PTOs). Proper installation and set up procedures will help you get additional and more profitable miles from your truck equipment and components.

It is important that you be sure that you are getting the right transmission/PTO combination when you order a new truck. An inadequate transmission will overwork any PTO in a short period of time. In addition, a mismatched transmission and PTO combination can result in unsatisfactory performance of your auxiliary power system from the start.

If you have questions regarding correct PTO and transmission combination, please contact your local Chelsea® Auxiliary Power Specialist. They can help you select the properly matched components to ensure correct and efficient applications.

Safety Information

These instructions are intended for the safety of the installer, operator & supporting personnel. Read them carefully until you understand them.

General Safety Information

To prevent injury to yourself and/or damage to the equipment:

- Read carefully all owner's manuals, service manuals, and/or other instructions.
- Always follow proper procedures, and use proper tools and safety equipment.
- Be sure to receive proper training.
- Never work alone while under a vehicle or while repairing or maintaining equipment.
- Always use proper components in applications for which they are approved.
- Be sure to assemble components properly.
- Never use worn-out or damaged components.
- Always block any raised or moving device that may injure a person working on or under a vehicle.
- Never operate the controls of the Power Take-Off or other driven equipment from any position that could result in getting caught in the moving machinery.

Proper Matching of PTO

WARNING: A Power Take-Off must be properly matched to the vehicle transmission and to the auxiliary equipment being powered. An improperly matched Power Take-Off could cause severe damage to the vehicle transmission, the auxiliary driveshaft, and/or to the auxiliary equipment being powered. **Damaged components or equipment could malfunction causing serious personal injury to the vehicle operator or to others nearby.**

To avoid personal injury and/or equipment damage:

- Always refer to Chelsea catalogs, literature, and owner's manuals and follow Chelsea recommendations when selecting, installing, repairing, or operating a Power Take-Off.
- Never attempt to use a Power Take-Off not specifically recommended by Chelsea for the vehicle transmission.
- Always match the Power Take-Off's specified output capabilities to the requirements of the equipment to be powered.
- Never use a Power Take-Off whose range of speed could exceed the maximum.

This symbol warns of possible personal injury.

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Safety Information (Continued)

Cold Weather Operation of PowerShift PTO

WARNING: During extreme cold weather operation [32°F (0°C) and lower], a disengaged PowerShift Power Take-Off can momentarily transmit high torque that will cause unexpected output shaft rotation. This is caused by the high viscosity of the transmission oil when it is extremely cold. As slippage occurs between the Power Take-Off clutch plates, the oil will rapidly heat up and the viscous drag will quickly decrease.

The Power Take-Off output shaft rotation could cause unexpected movement of the driven equipment resulting in serious personal injury, death, or equipment damage.

To avoid personal injury or equipment damage:

- Driven equipment must have separate controls.
- The driven equipment must be left in the disengaged position when not in operation.
- Do not operate the driven equipment until the vehicle is allowed to warm up.

Rotating Auxiliary Driveshafts

WARNING:

- Rotating auxiliary driveshafts are dangerous. You can snag clothes, skin, hair, hands, etc. This can cause serious injury or death.
- Do not go under the vehicle when the engine is running.
- Do not work on or near an exposed shaft when the engine is running.
- Shut off the engine before working on the Power Take-Off or driven equipment.
- Exposed rotating driveshafts must be guarded.

Guarding Auxiliary Driveshafts

WARNING: We strongly recommend that a Power Take-Off and a directly mounted pump be used to eliminate the auxiliary driveshaft whenever possible. If an auxiliary driveshaft is used and remains exposed after installation, it is the responsibility of the vehicle designer and PTO installer to install a guard.

Using Set Screws

WARNING: Auxiliary driveshafts may be installed with either recessed or protruding set screws. If you choose a square head set screw, you should be aware that it will protrude above the hub of the yoke and may be a point where clothes, skin, hair, hands, etc. could be snagged. A socket head set screw, which may not protrude above the hub of the yoke, does not permit the same amount of torquing as does a square head set screw. Also, a square head set screw, if used with a lock wire, will prevent loosening of the screw caused by vibration. Regardless of the choice made with respect to a set screw, an exposed rotating auxiliary driveshaft must be guarded.

Important: Safety Information and Owner's Manual

Chelsea Power Take-Offs are packaged with safety information decals, instructions, and an owner's manual. These items are located in the envelope with the PTO mounting gaskets. Also, safety information and installation instructions are packaged with some individual parts and kits. **Be sure to read the owner's manual before installing or operating the PTO** Always install the safety information decals according to the instructions provided. Place the owner's manual in the vehicle glove compartment.

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Safety Information (Continued)

WARNING: Operating the PTO with the Vehicle in Motion

Some Power Take-Offs may be operated when the vehicle is in motion. To do so, the PTO must have been properly selected to operate at highway speeds and correctly matched to the vehicle transmission and the requirements of the driven equipment.

If in doubt about the PTO specifications and capabilities, avoid operating the PTO when the vehicle is in motion. Improper application and/or operation can cause serious personal injury or premature failure of the vehicle, the driven equipment, and/or the PTO.

Always remember to disengage the PTO when the driven equipment is not in operation.

Chelsea PTO Safety Label Instructions

1. The two black and orange on white 5" x 7" pressure sensitive vinyl labels, part number 379274, must be placed on the vehicle frame rails (one (1) on each side), in a position that would be **HIGHLY** visible to anyone that would go under the truck near the PTO rotating shaft. If the vehicle is to be painted after these labels are installed, cover them with two (2) blank masking covers. Remove the masking covers after painting.
2. Place the one (1) black and orange on white 3.5" x 5" pressure sensitive vinyl label, part number 379275, on the visor nearest the operator of the vehicle, this must be placed near the PTO visor label.
3. Place the one (1) red and white with black lettering 3.5" x 7" pressure sensitive vinyl label, part number 379915, on the opposite side of the visor from the above label part number 379275.
4. Place the one (1) white and black heavy duty card, part number 379276, in the vehicle glove box in a position highly visible to the operator. For example, try to place this card on top of whatever may be in the glove box.

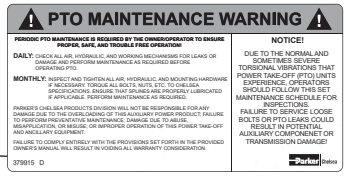
If you require labels, please order part number 328946X at no charge from your local Chelsea Warehouse or send request direct to:

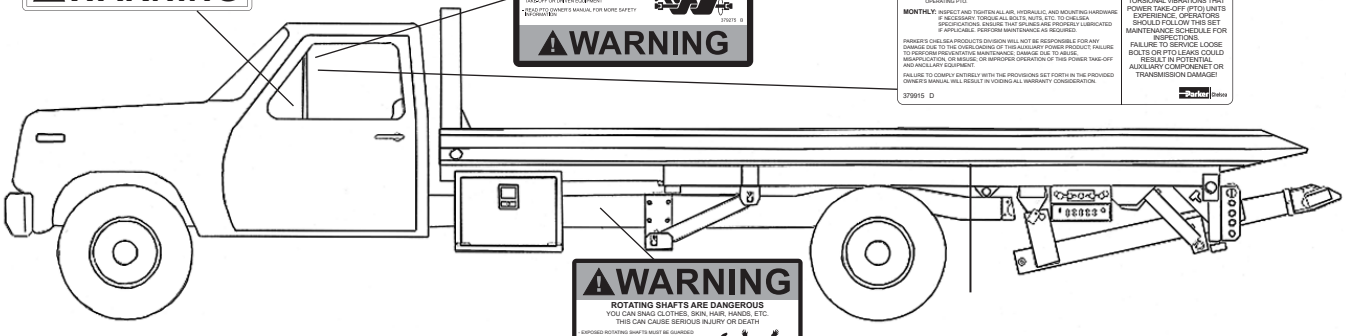
Parker Hannifin Corporation
Chelsea Products Division
8225 Hacks Cross Road
Olive Branch, MS 38654
Customer Service: (662) 895-1011

Part #379276

Part #379275

Part #379915





Part #379274

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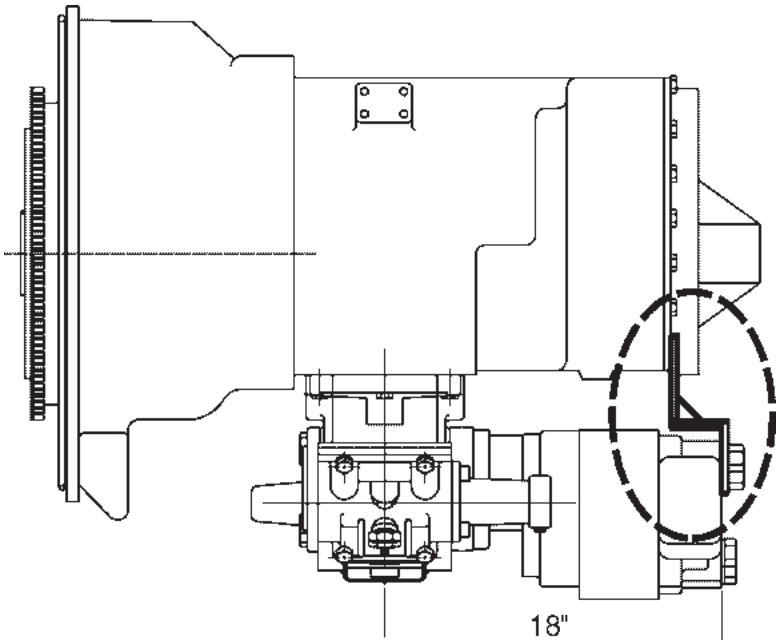
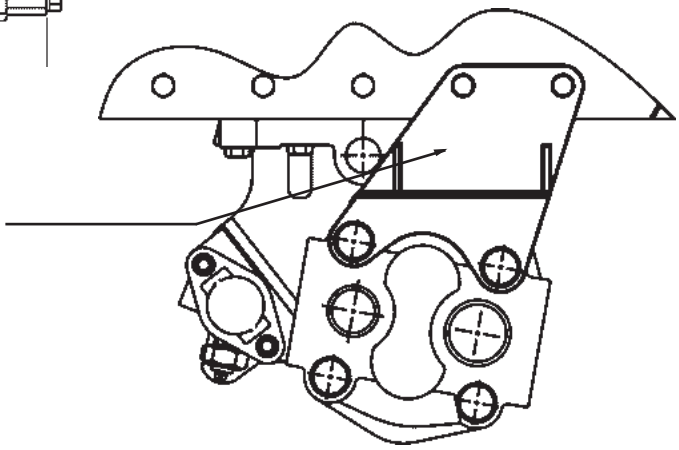
Direct Mount Pump Support Requirements (Universal)



NOTE:
For Proper Bracketing, Attach at 2 or More Transmission Bolt Locations and 2 or More Pump Locations. Contact Transmission Manufacturer for Proper Bracket Mounting Locations.



Use CAUTION to ensure the support bracket does not pre-load pump / PTO mounting. When mounting the pump, it should be fully supported by a jack until the support bracket is secured in place, then the jack can be released. This will make sure the PTO is not being stressed by the bracket.

Chelsea requires the use of pump supports (Support Brackets) in all applications to ensure the Maximum Bending Moment (MBM) of the PTO / Pump assembly is not exceeded. Exceeding the MBM can result in damage to PTO, transmission, driven equipment, and / or personnel. It is the responsibility of the installer to ensure that adequate support is implemented. All applications are unique and it is important to consider all parameters in designing a proper support bracket.

PTO warranty will be void if a pump bracket is not used when one of the following conditions are present:

1. The combined weight of pump, fittings and hose exceed 40 pounds [18.14 kg].

2. The combined length of the PTO and pump is 18 inches [45.72 cm] or more from the PTO centerline to the end of the pump.

ALSO: Remember to pack the female PTO shaft with grease before installing the pump on the PTO (reference Chelsea grease pack 379688).

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Function of Auxiliary Power Shafts

An auxiliary power shaft transmits torque from the power source to the driven accessory. The shaft must be capable of transmitting the maximum torque and RPM required of the accessory, plus any shock loads that develop.

An auxiliary power shaft operates through constantly relative angles between the power source and the driven accessory. Therefore, the length of the auxiliary power shaft must be capable of changing while transmitting torque. This length change, commonly called "slip movement", is caused by movement of the powertrain due to torque reactions and chassis deflections.

Joint operating angles are very important in an auxiliary power shaft application. In many cases, the longevity of a joint is dependent on the operating angles. (See chart below)

This information is limited to 1000 through 1310 Series applications. For applications requiring a series larger than 1310, contact your local Chelsea distributor.

Determining Shaft Type

1) Solid or tubular?
   a) In applications requiring more than 1000 RPM or where the application necessitates a highly balanced auxiliary power shaft, a tubular shaft should be used.
   b) Spicer's solid shafting auxiliary power joints are designed for 1000 or less RPM intermittent service such as:
      Driving small hydraulic pumps
      Driving winches
      Driving low speed product pumps
2) Joint Series should be determined using the chart on the following page.

SPICER® UNIVERSAL JOINT OPERATING ANGLES			
Prop. Shaft RPM	**Max. Normal Operating Angle**	**Prop. Shaft RPM**	**Max. Normal Operating Angle**
3000	5° 50'	1500	11° 30'
2500	7° 00'	1000	11° 30'
2000	8° 40'	500	11° 30'
Above based on angular acceleration of 100 RAD/SEC^2			

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Spicer® Universal Joint Engineering Data

Joint Series	**1000**	**1100**	**1280**	**1310**
Torque Rating				
Automotive (Gas or Diesel Engine) lbs-ft Continuous	50	54	95	130
Tubing				
Diameter	1.750"	1.250"	2.500"	3.00"
Wall Thickness	.065"	.095"	.083"	.083'
W = Welded S = Seamless	W	S	W	W
Flange Diameter (Swing Diameter)				
Rectangular Type	3.500"	3.500"	3.875"	3.875"
Bolt Holes - Flange Yoke				
Circle	2.750"	2.750"	3.125"	3.125"
Diameter	.312"	.312"	.375"	.375"
Number	4	4	4	4
Male Pilot Dia.	2.250"	2.250"	2.375"	2.375"
Distance Across Lugs				
Snap Ring	2.188"	2.656"	3.469"	3.469"
Construction	2.188"	2.656"	3.469"	3.469"
Bearing Diameter	.938"	.938"	1.062"	1.062"

Maximum Operating Speed * By Tube Size, Solid Shaft Size, and Length
***(For speed below 500 RPM or over 2500 RPM, contact your Chelsea Distributor)**

Tubing Dia. & Wall Thickness Joint & Shaft (W=Welded S=Seamless)	Max. Installed Length in Inches for Given RPM Centerline to Centerline of Joints for a Two Joint Assembly or Centerline of Joint to Centerline of Center Bearing for a Joint & Shaft RPM - Revolutions per Minute				
	500	**1000**	**1500**	**2000**	**2500**
1.750" x .065" W	117"	82"	67"	58"	52"
1.250" x .095" S	91"	64"	52"	45"	40"
2.500" x .083" W	122"	87"	70"	62"	55"
3.000" x .083" W	-	-	-	85"	76"
Solid Shaft Diameter					
.750"	60"	42"	35"	30"	27"
.812"	62"	44"	36"	31"	28"
.875"	65"	46"	37"	32"	29"
1.000"	69"	49"	40"	35"	31"
1.250"	77"	55"	45"	39"	35"

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Mounting the PTO

CAUTION: Oil may be hot.

WARNING: PTOs for the EATON ENDURANT™ transmission (including PACCAR models) which include the 489, 680, 880 Series (**Fig. 1**) have UNIQUE main housings, gears, piloting studs, as well as, a special molded PTO-to-transmission mounting seal. See **Supplemental Installation Instructions (P/N 69-P-27)** included in the Installation Kit (328948-48X) for proper installation. **These special PTOs do NOT require the addition of extra gaskets/shims for backlash adjustment!** If there are any questions during the installation, stop and call your local Chelsea Distributor for assistance.

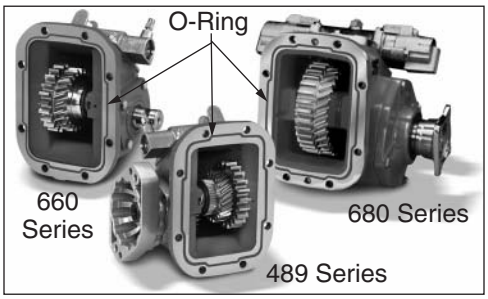

Fig. 1

1. Drain the oil from the transmission and remove the PTO aperture cover plate (**Fig. 2**).

Fig. 2

2. Discard the cover plate and cover plate gasket then clean the aperture pad using a putty knife or wire brush (**Fig. 3**).

NOTE: Stuff a rag in the aperture opening to prevent dirt from entering the transmission while you are cleaning it.

Fig. 3

3. Using your hand, rock the PTO driver gear in the transmission (**Fig. 4**) and the driven gear in the PTO assembly (**Fig. 5**). Rocking the gears provides two important factors.

   a) It shows you the amount of backlash that has been designed into each unit.

   b) It is helpful in establishing the proper backlash when installing the PTO.

Fig. 4

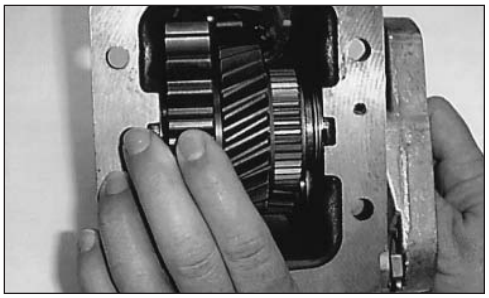
Fig. 5

Mounting the PTO (Continued)

4. Install the proper studs (furnished with PTO) in the PTO aperture pad using a stud driver. Studs may have either interference fit threads (plain) or preapplied locking/ sealing compound For installation method (**Fig. 6**).

   Where holes are tapped through the transmission case, use studs with preapplied locking & sealing compound Loctite 290 to prevent leaks.

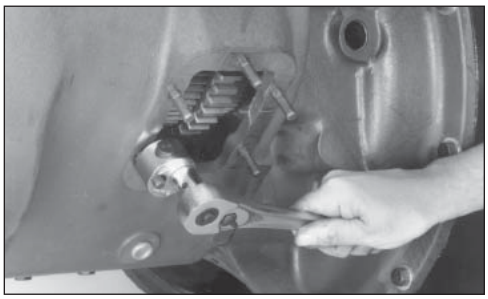

Fig. 6

NOTE: Avoid contact of Permatex with automatic transmission fluid in automatics. Always check to be sure that the studs do not interfere with transmission gears.

5. Studs should be threaded into the transmission holes until the stud shank is even with transmission mounting surface. DO NOT install studs with shank below the aperture surface. Install studs with hand tools. DO NOT use power tools to install studs.

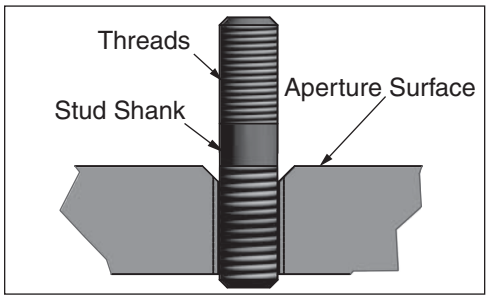

Fig. 7

CAUTION: Over tightening of studs or running the shoulder past the transmission mounting surface may damage stud and/or transmission. Use of air impact tools is not recommended (**Fig. 7**).

6. Place the correct number of gaskets over studs (**Fig. 8**). Do not use Permatex between gaskets because you may want to add or subtract gaskets to obtain proper backlash.

   - When mounting a PTO use gaskets between all mounting surfaces.
   - Do not stack more than 3 gaskets together.
   - Usually one thick gasket .020 (.50mm) will be required.
   - Remember the lubricant in the transmission also lubricates the PTO. Therefore, at least one gasket must always be used on either side of filler blocks, adapter assemblies or adapter plates. More gaskets may be required when establishing proper backlash.

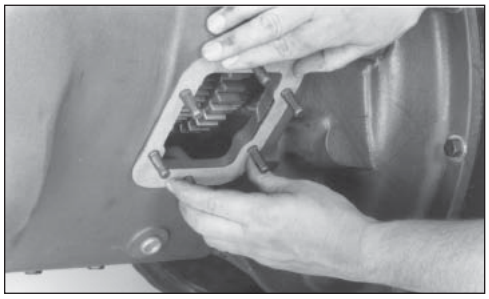

Fig. 8

7. Secure PTO to the transmission.

   - Use Self-Locking nuts and/or capscrews provided with PTO (**Fig. 9**).

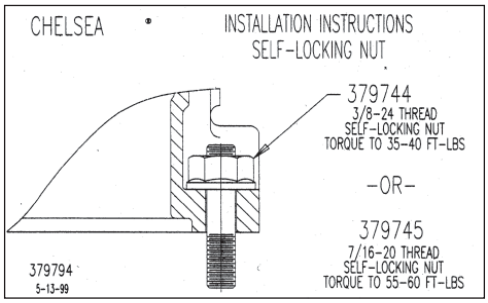

Fig. 9

CAUTION: When installing the 489 Series PTO several direct mount pump flange options may interfere with the mounting fasteners directly under the flange. The nut must be threaded far enough onto the stud before the remaining (6) six capscrews and other nut are tightened to prevent interference with the flange and possible breakage of the PTO housing.

Mounting the PTO (Continued)

8. Torque fasteners to their proper specifications (**Fig. 10**).
   Self-Locking Nuts:
   - (3/8" - 24) for 6-Bolt applications 35-40 lbs-ft [47-54 Nm]
   - (7/16" - 20) for 8-Bolt applications 55-60 lbs-ft [75-81 Nm]

   Capscrews:
   - (3/8") for 6-Bolt to 30-35 lbs-ft [40-47 Nm]
   - (7/16") for 8-Bolt to 45-50 lbs-ft [60-61 Nm]

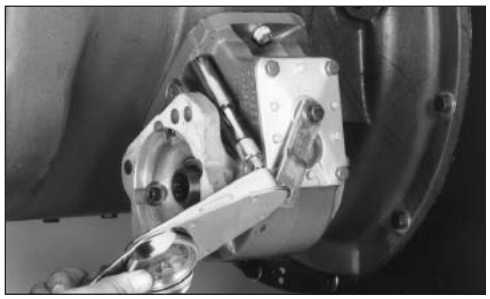
Fig. 10

Checking Backlash

WARNING: PTOs for the EATON ENDURANT™ transmission (including PACCAR models) which include the 489, 680, 880 Series (**Fig. 11**) have UNIQUE main housings, gears, piloting studs, as well as, a special molded PTO-to-transmission mounting seal. See **Supplemental Installation Instructions (P/N 69-P-27)** included in the Installation Kit (328948-48X) for proper installation. **These special PTOs do NOT require the addition of extra gaskets/shims for backlash adjustment!** If there are any questions during the installation, stop and call your local Chelsea Distributor for assistance.

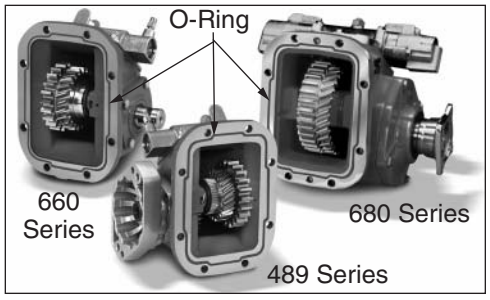

Fig. 11

To check for proper backlash on PTOs with shift cover.

1. Remove the PTO shift housing and/or inspection plate.

2. Mount the dial indicator so that it registers movement of the input gear (driven gear) of the PTO (**Fig. 12**).

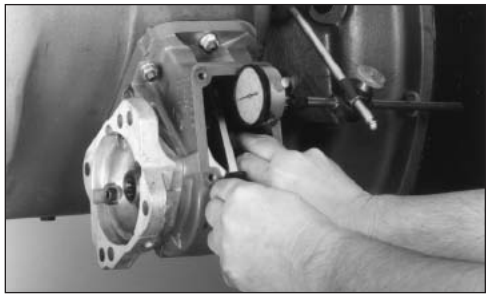
Fig. 12

NOTE: For proper location of dial indicator contact point (See **Fig. 13**). (Two common type dial indicators shown).

3. Hold the PTO driver gear in transmission with a screwdriver or bar and rock the PTO input gear (driven gear) back and forth with your hand. Note the total movement on the dial indicator.

4. Establish backlash at .006"-.012" [.15mm-.30mm] by adding or subtracting gaskets.

   General rule: A Chelsea .010" gasket will change backlash approx. .006". A .020"gasket changes backlash approx. .012".

5. Replace the shift housing and/or inspection plate and retorque (4) four capscrews to 24-28 lbs-ft [33-39 Nm].

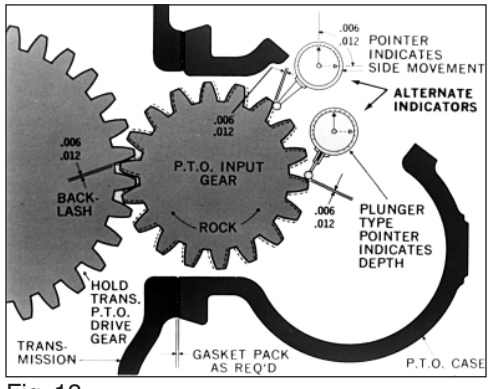

Fig. 13

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Mounting the PTO (Continued)

Checking Backlash (Continued)

NOTE: Use a crossing pattern when torqueing the bolts (**Fig. 14**).

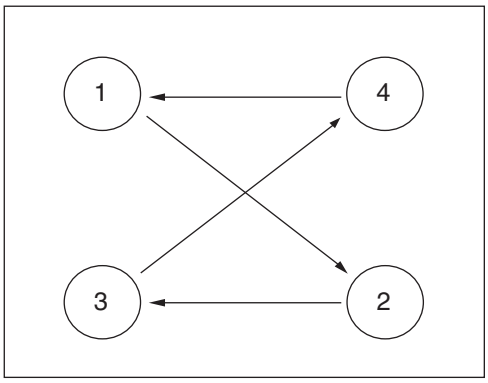

Fig. 14

NOTE: Apply a drop of Loctite 290 on each capscrew before reinstalling. Capscrews that are furnished with a conversion kit and are being installed for the first time do not require the drop of Loctite.

NOTE: When using a 221 Series PTO with the AJ gear designation on an Allison Automatic transmission with a six bolt opening, a special gasket is supplied. When installed with the PTO this gasket reduces the need for backlash adjustment.

863 Series

An inspection hole is provided in the PTO housing for feeling the mounted backlash.

Rock the PTO Input Gear with your hand and correlate this backlash to the unmounted backlash found in step 3 on page 9. Use Gaskets to get backlash feel as close to unmounted condition as possible. (**Fig. 15**).

Fig. 15

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Mounting the PTO (Continued)

Final Installation Steps

1. Remove the filler plug from the transmission and add recommended transmission lubricant to the level prescribed by the transmission or truck manufacturer (**Fig. 16**).

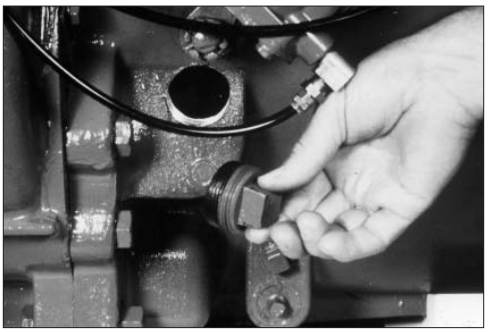
Fig. 16

NOTE: If the PTO is mounted below oil level, additional lubricant will be required.

2. Run the PTO for 5-10 minutes and check for oil leaks and noise.

3. Should a quiet PTO become noisy after the universal joint connection is made, check the PTO driveline components for an out of phase condition, excessive or unequal joint angles or possibly worn parts in the driven accessory.

4. Re-torque all mounting bolts, nuts, cap screws and set up inspection routine of the PTO driveline components and the driven auxiliary equipment.

NOTE: Anticipate slight increase in PTO noise level as oil thins out at operating temperatures.

PTO Installation Tips for Automatic Transmissions

The procedure for installing a PTO on an automatic is basically the same as for a mechanical transmission. Power Take-Offs for automatic transmissions are assembled with a special drilled input shaft which allows the input gear to be pressure lubricated during operation. (See page 35).

After installing a PTO on an automatic transmission, connect pressure lubrication hose to the PTO and the transmission per installation instructions shown on pages 35-38 of this booklet.

WARNING: Adapter assemblies are never used on an automatic transmission, unless specified on the application page, because they do not have pressure lubricated design features.

WARNING: Use only wire control with PTO made for wire cable control. If lever is desired, order PTO for lever control. The internal shifting mechanism for wire is not designed for heavy forces usually encountered with lever control linkage.

This symbol warns of possible personal injury.

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Mounting the PTO (Continued)

912 Series Split Shaft – Top Mounted 880 w/ Self-Lube Option

1. Drain split shaft oil at drain plug (**A**). Filter or screen oil & reuse if desired.

2. Remove top split shaft aperture cover plate at (**B**) or air shift Assembly (**C**) & reassemble to either side of split shaft in place of shipping cover. Install PTO on split shaft & set backlash at .006" to .012". (See page 9 for checking proper backlash) Follow instructions Mounting the PTO on the transmission in this manual.

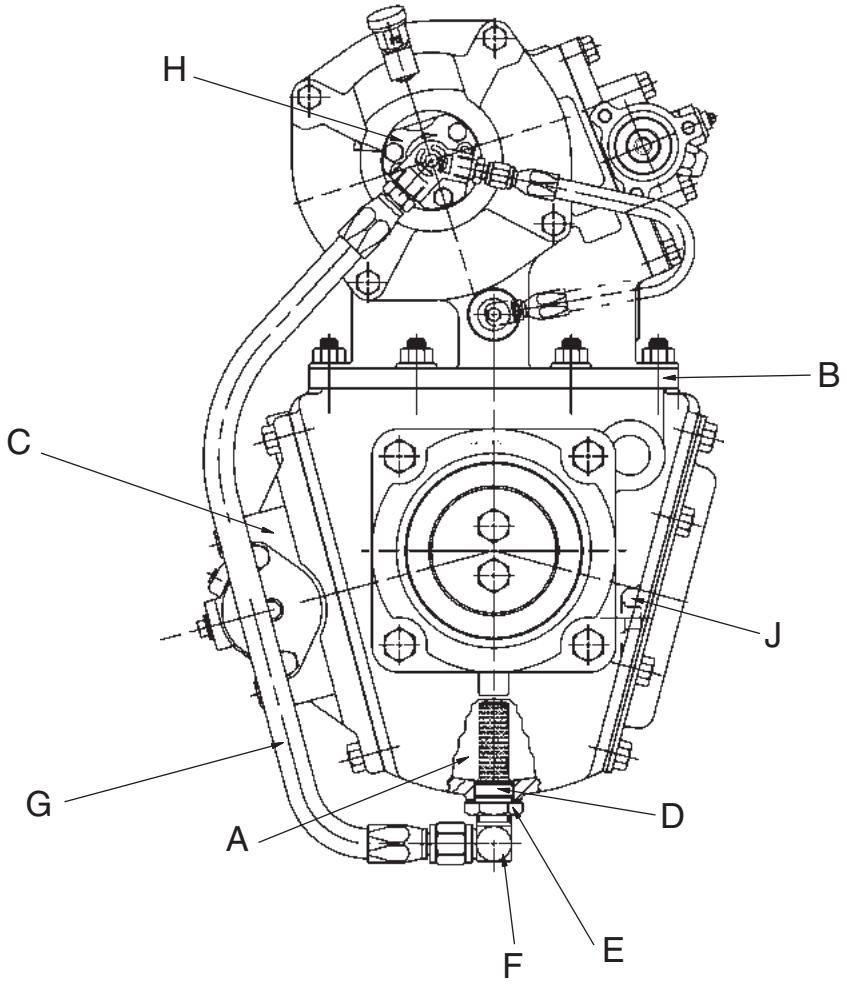
3. Install copper gasket (**D**), screened strain plug (**E**) & 90° elbow (**F**) in place of drain plug at (**A**). Also install pressure lube hose (**G**) between elbow (**F**) and pump (**H**). (Use pipe sealant on all pipe threads).

4. Fill split shaft with filtered, screened or new oil at fill plug (**J**), until oil reaches plug level, then reinstall plug.

5. Finish PTO & split shaft installation per owner's manual. Also install shaft and/or pump to be driven by PTO.

6. After brief PTO operation, remove fill plug (**J**), add oil until it reaches plug level, then reinstall plug.

Important: Lube pump (**H**) must rotate clockwise (engine rotation) as view from front of vehicle.



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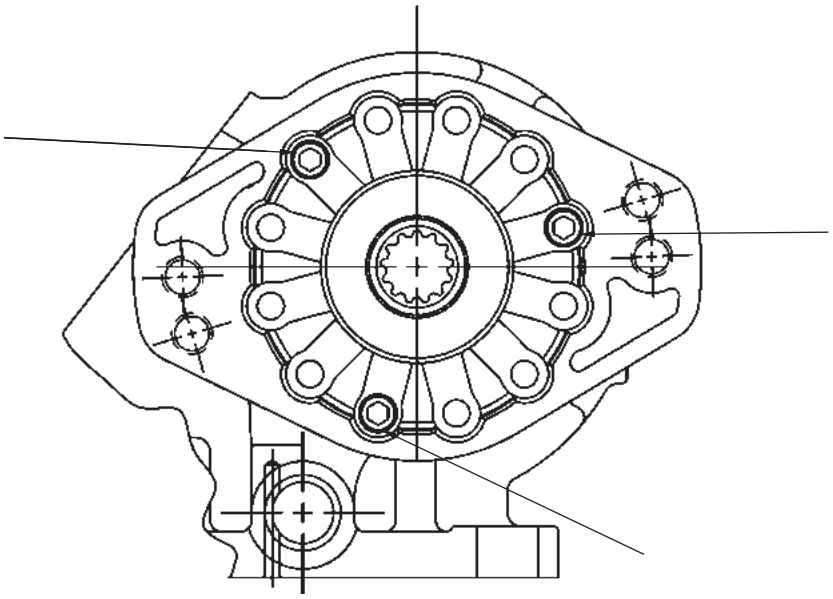
Installing Rotatable Flanges

The rotatable flange is shipped loose with the PTO units for ease of installation. After determining the flange position, attach the flange to the PTO bearing cap using the capscrews provided in the bag kit.

After installing the capscrews make sure to torque the screws to the proper specifications (See chart below).

Consideration should be taken on the size and weight of the pump being installed (See page 4).



RA Flange Shown

NOTE: Reinstalling or tightening of a rotatable flange after it has become loose is not recommended. If a PTO has run for a length of time after the flange has become loose, the flange and/or bearing cap may not be to manufacturing tolerance and should be replaced.

Torque Chart

Outputs	Family	Pump Flange to Bearing Cap Capscrew P/N	Qty.	Size Capscrew	Capscrew Bag Kit	Recommended Capscrew Torque
GA, GB, PA, PF, RA, RB, RE, & RF	6-Bolt	378447-6	3	0.312" - 18 x 1.000"	328170-207X	24-28 lbs-ft [33-39 Nm]
RC, RD, & RH	6-Bolt	378446-4	6	0.250" - 20 x 0.750"	328170-210X	8-12 lbs-ft [11-16 Nm]

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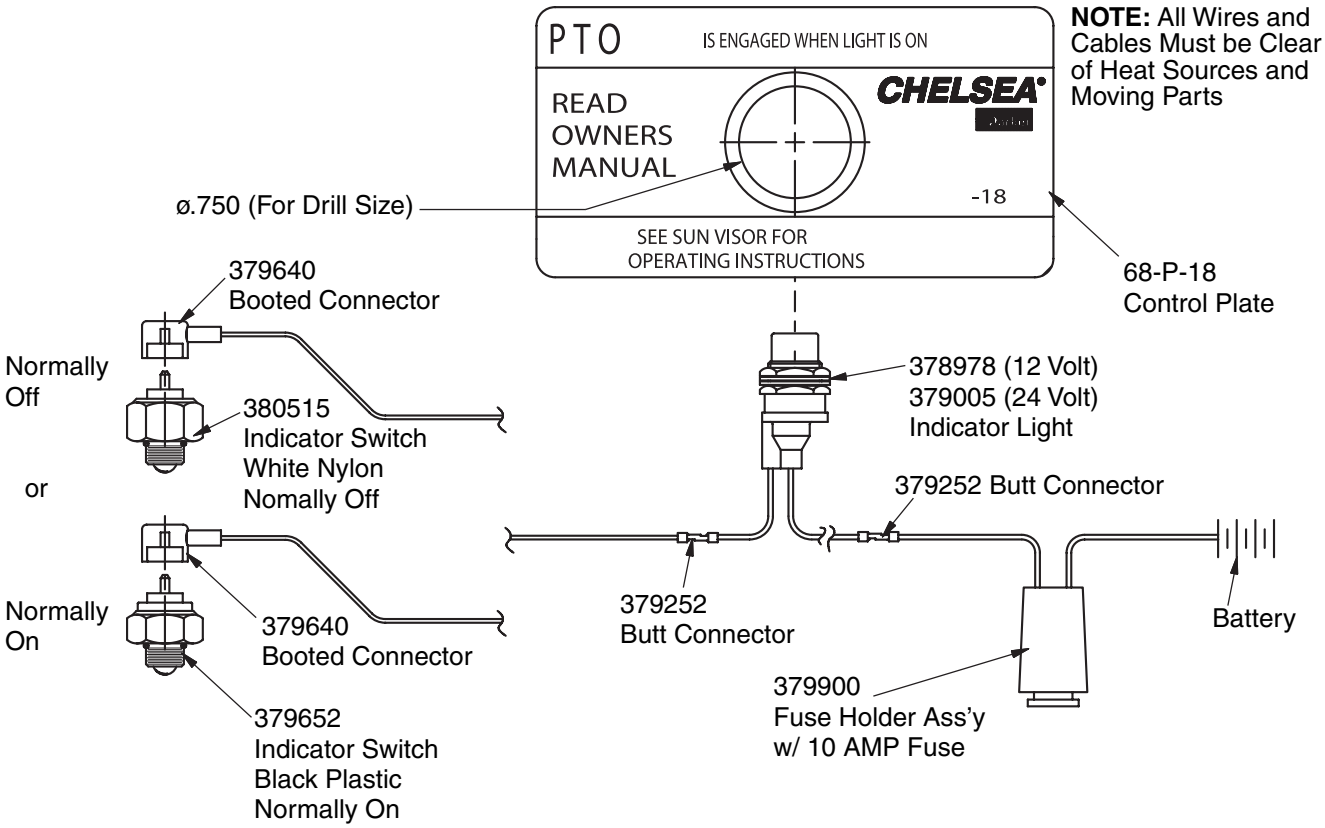
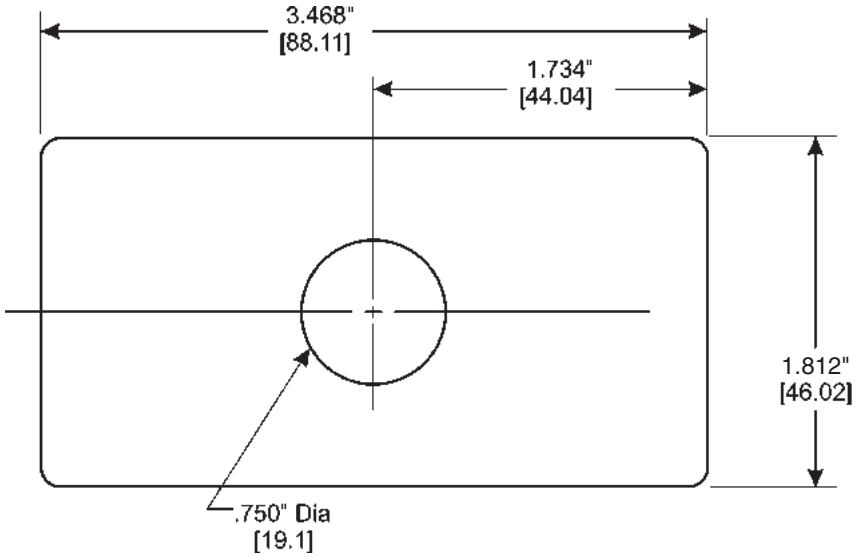
Indicator Light Installation & Dash Drilling Template (SK-286 Rev G)



Dash Drilling Template (SK-168)



Parker Chelsea

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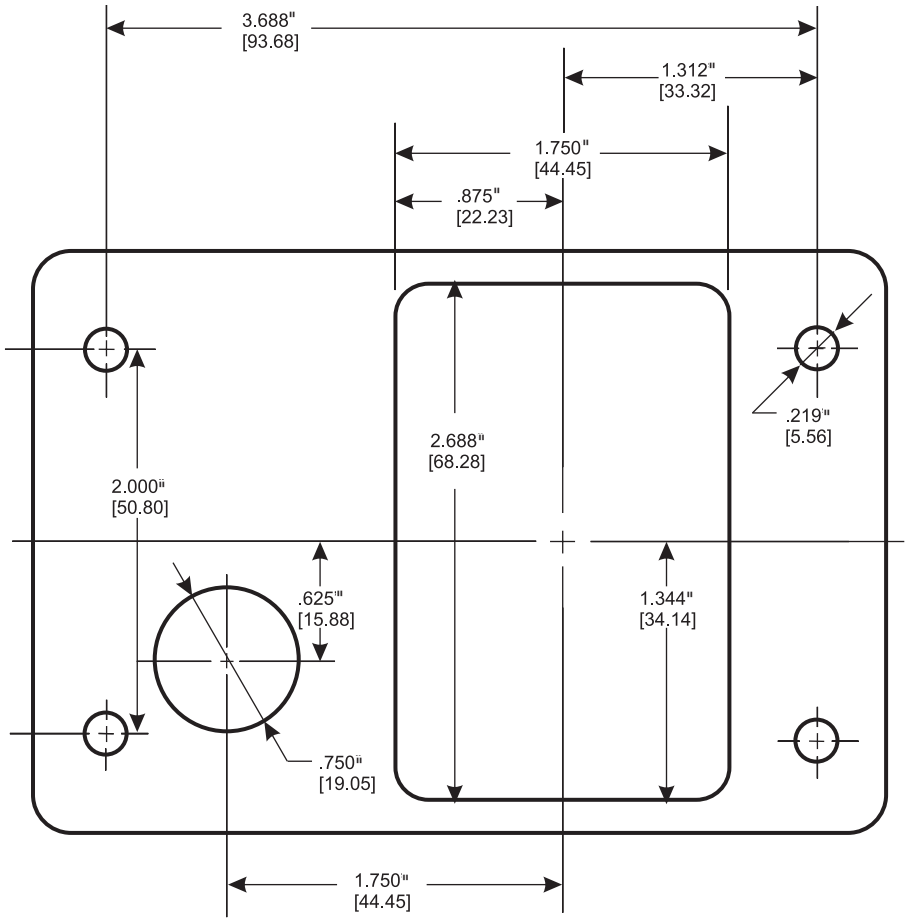
Dash Drilling Template for 6 & 8-Bolt Air Shift for Williams Valve (SK-204 Rev C)



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Adapter Plates

Adapter plates are used to permit mounting a 6-Bolt PTO on a transmission that has an 8-Bolt aperture.

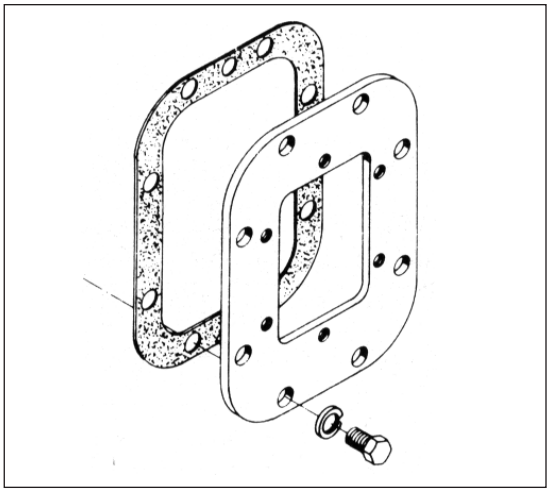

Fig. 17

Filler Blocks / Spacers (7-A-XX & 8-A-XX)

Filler blocks may be required where it is necessary to use a spacer to mount the PTO to a particular transmission.

NOTE: When using 7-A & 8-A spacer, .050" max gasket permissible between spacer and mounting surface.

*A gasket must be used on both sides of all spacers.

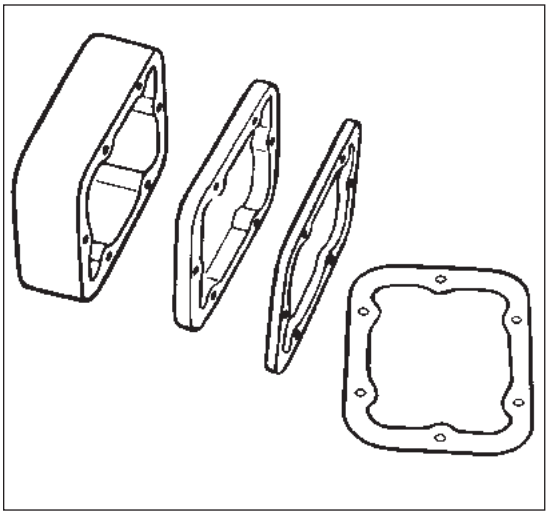

Fig. 18

PTO Application and Adapter Assembly

Figure 17 illustrates typical adapter assembly configurations. Some PTO applications require adapter assemblies because it is impossible to reach the PTO driver gear in the transmission without this assembly. An adapter assembly will change the rotation of the PTO and this may be necessary for driving pumps or other accessory equipment. Obstructions, such as bulge in the transmission, exhaust pipes or motor mounts can sometimes be compensated for through the use of an adapter.

Refer to Adapter Gears Owners Manual HY25-1670-M1/US.

Fig. 19

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Cable Control Installation Instructions*

1. Find a suitable area on the dash to install the cable control (328346-10X) and the control plate (68-P-18) indicator light.

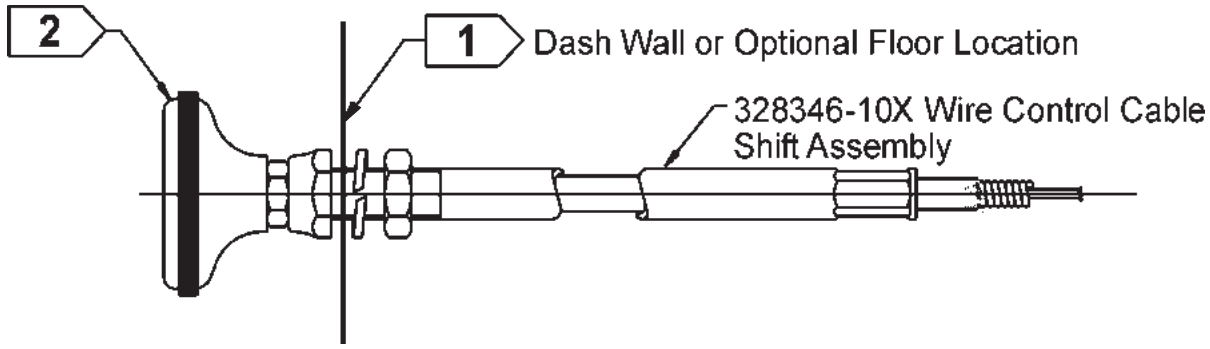
   Optional Location: As an option the control cable and knob can be located through floor. Using this option the control plate and indicator light should still be located on dash, in close proximity.

NOTE: The location of the cable control and the control plate should be as close to each other as possible and easily accessible by the driver or operator, but should not be an obstacle to driver movement nor interfere with other controls, instruments, or equipment.

2. **CAUTION:** Before drilling any holes, make sure there is adequate room on both sides through dash wall, drill a 1/2" (12.7 mm) diameter hole for the control cable. [**1**]

3. Install the control cable on the dash using the hex nuts supplied with the cable. The knob can then be screwed into place [**2**]. The length of cable can then run through the firewall and back to the PTO — making sure it is kept away from the exhaust, moving parts, etc.

NOTE: Do not kink the cable. In order for the cable to operate properly, there can be no bends smaller than 6 inch radius. Total bends in the cable should not exceed 360° (example - four 90° bends in cable).



4. Using the template found on page 14 (SK-168) drill the necessary holes for the control plate-indicator light.

5. Install the control plate (68-P-18) stick on decal and indicator light on the dash using the hardware supplied in the 328751-1X installation kit (**Fig. 20**).

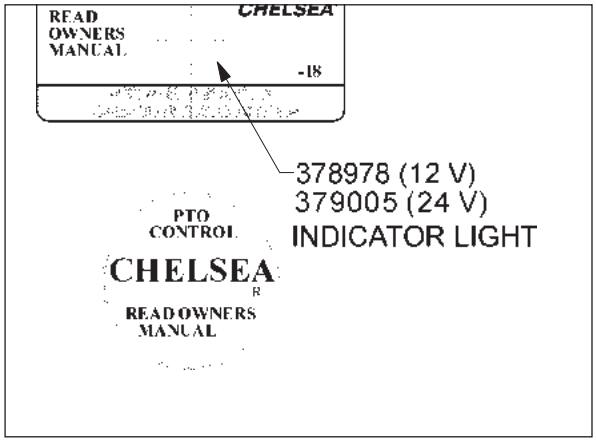


Fig. 20

*All six bolt wire shifts with the exception of the reversible, dual shift units, and some gear boxes.

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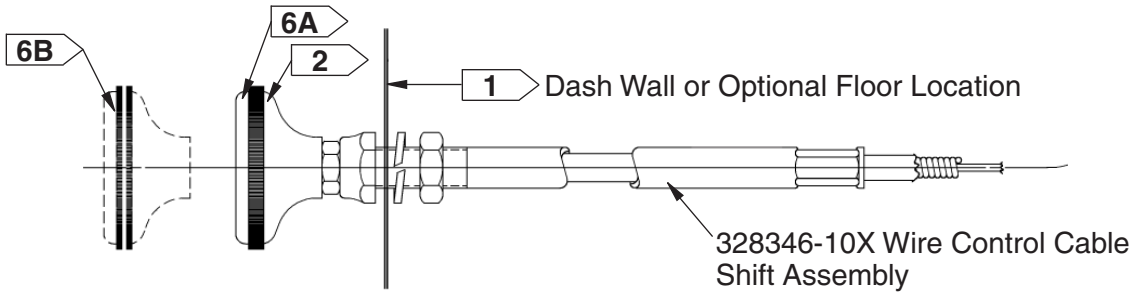
Cable Control Installation Instructions* (Continued)

6. Determine from which direction the cable must come in order for the unit to be disengaged when the knob is all the way in.

NOTE: The shifter must always be installed in the following manner:

CABLE IN: PTO DISENGAGED [**6A**]: OUT OF GEAR POSITION
CABLE OUT: PTO ENGAGED [**6B**]: IN GEAR POSITION



7. Install the wire control bracket found in either the 328380X or 328380-1X wire control parts bag. [**7**]

8. Line the cable up with the wire control bracket and shifter lever (disengaged position) on the PTO cover assembly. [**8**]

NOTE: It may be necessary to change the position of the shifter lever on the PTO To do this, remove the shifter cover from the unit. This will prevent the possible loss of the poppet and/or spring into the transmission if the shifter post assembly should be pushed through the cover when reinstalling the lever.

9. Shift the PTO to the engaged position to see how much of the cable casing must be cut to allow the lever enough travel to shift in and out completely. The casing need only go just beyond the bracket, whereas, the wire must be long enough to go through the swivel pin in the shifter lever. [**9**]

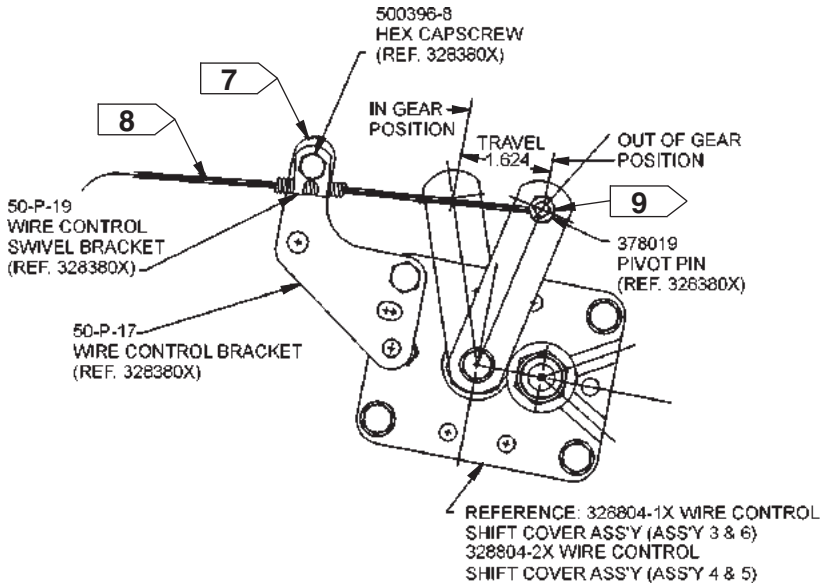
NOTE: In some instances the cable control may not be long enough. Chelsea has available four longer lengths than the standard ten-foot cable. These come in five foot increments (i.e., 328346-15X = 15-foot cable).

10. When the length of the casing has been determined, pull the wire back through until the case can be cut without cutting the wire. Use a hacksaw or heavy pair of side cutters to cut the casing.

NOTE: The cable can be held by a bench vise as long as the jaws are not tightened to the point where the case mushrooms. If a vise is not accessible, a pair of vise grips will do the job.

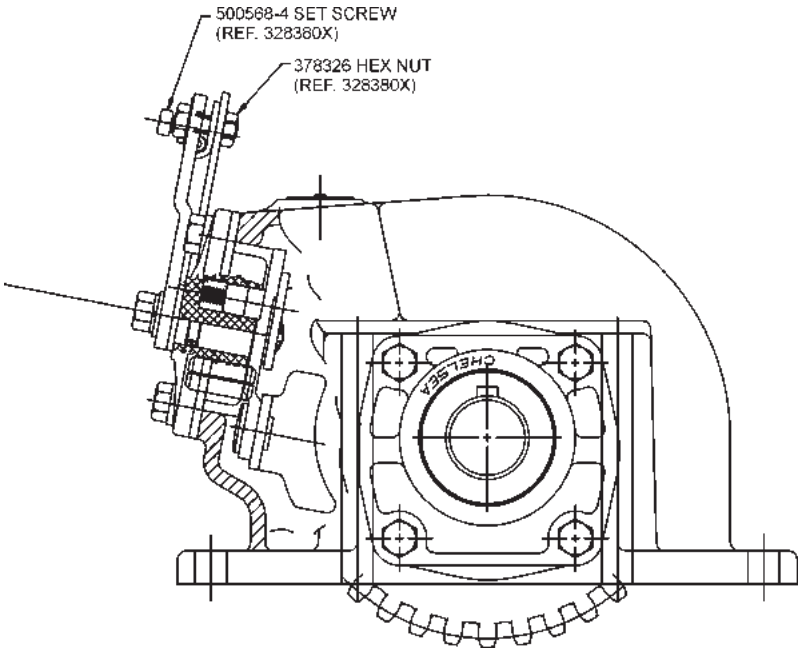
*All six bolt wire shifts with the exception of the reversible, dual shift units, and some gear boxes.

Cable Control Installation Instructions* (Continued)



11. Push the wire back through and install the cable using the hardware from the previously mentioned wire control parts bag (328380X).

12. Cut the excess wire after the cable casing and wire have been installed and tightened.



*All six bolt wire shifts with the exception of the reversible, dual shift units, and some gear boxes.

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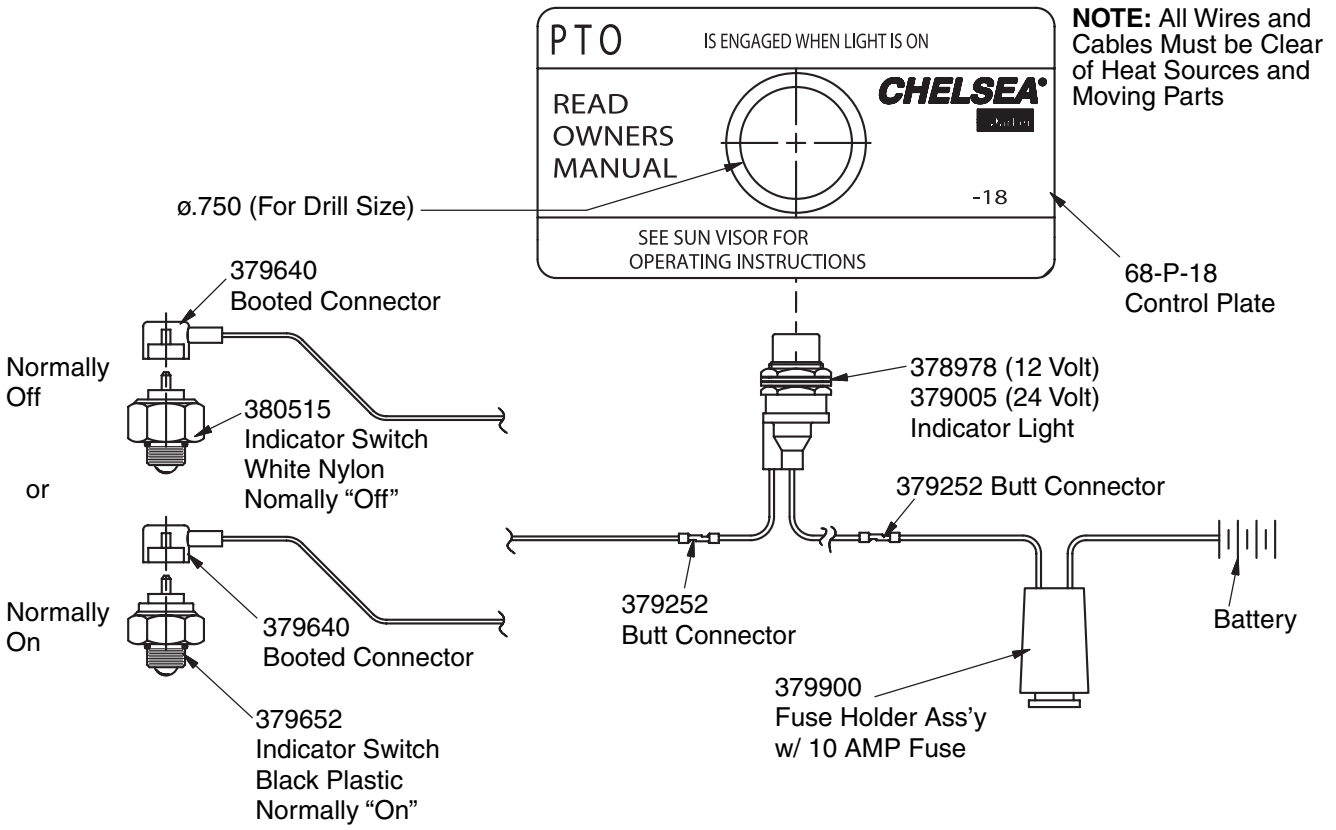
Cable Control Installation Instructions* (Continued)

Indicator Light Installation Sketch (SK-286 Rev G)



CAUTION: Indicator switches are capable of 0.5 amps maximum.

NOTE: All wires and cables must be clear of heat source and moving parts.

13. Shift the PTO to ensure enough casing has been removed to allow full gear engagement.

14. Install the wiring for the indicator light using the schematic above (SK-286 Rev G).

NOTE: Check both the cable and indicator light wires to be certain that they are not near the exhaust system or any moving parts. Carefully fasten to stationary parts of the vehicle if necessary.

15. Shift the PTO The following should be adhered to:

[**15A**] **CABLE IN:** PTO DISENGAGED: LIGHT OUT

[**15B**] **CABLE OUT:** PTO ENGAGED: LIGHT ON

NOTE: The PTO should be checked for continuity as per the instructions in this manual.

NOTE: Cable must be rigidly mounted-possibly to the transmission within 12-24" of the PTO.

*All six bolt wire shifts with the exception of the reversible, dual shift units, and some gear boxes.

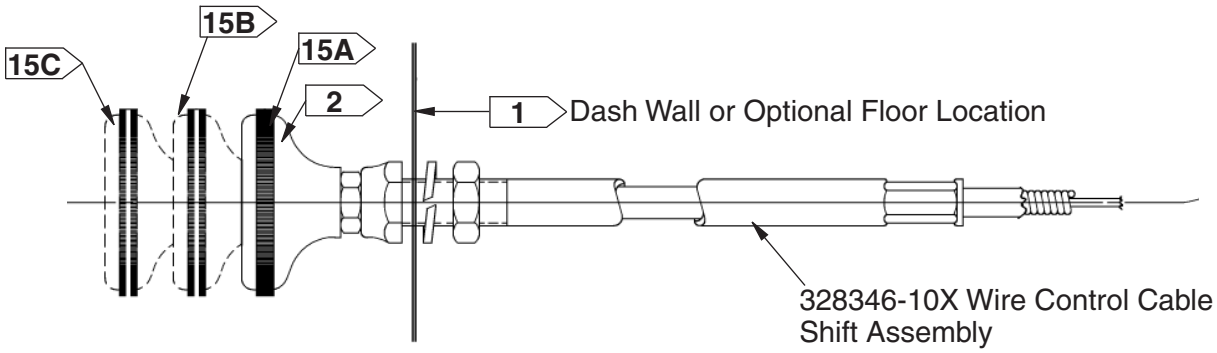
Cable Control Installation Instructions (Continued)
(Reversibles, dual shift units, and some gear boxes)

1. Use steps #1-#5 from previous instructions.
2. In step #6 the cable can come from either direction since the PTO will always be engaged when all the way in or out.
3. Follow step #7 and #8.
4. In step #9 shift the PTO from forward to reverse or vice versa to determine the amount of travel needed and the length of casing to be cut.
5. Follow step #10-#14.
6. Step #15 will show the folding:

   CABLE IN: PTO ENGAGED: LIGHT ON [**15A**]

   CABLE OUT (1st position): PTO DISENGAGED: LIGHT OUT [**15B**]

   CABLE OUT (2nd position): PTO ENGAGED: LIGHT ON [**15C**]



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Indicator Switch Continuity Check

In order to ensure that the switch is functioning properly, the following procedure can be used with the unit on a bench, or installed.

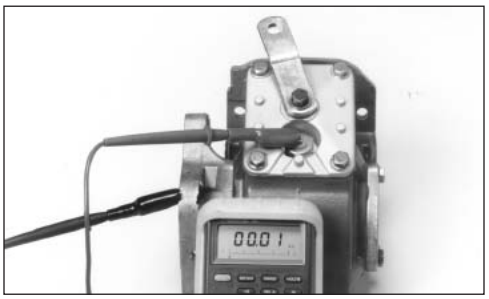

Fig. 21

1. Use a continuity checker, battery type, either meter or light. Attach one (1) probe to the screw on the Indicator Switch.

2. With the other probe, make contact with the shifter cover or housing (**Fig. 21**).

3. Actuate shifting device and the meter or light* should be actuated when PTO gear is engaged.

4. Shift unit out of gear and the meter or light* should return to normal as shown.

This test procedure can be used to check Chelsea wire, lever, and air shifter covers, although an air source would be necessary for the latter.

* If a meter is not available the light in the 328751-1X can be used. A six volt battery is all that is necessary for a power source.

CAUTION: Indicator switches are capable of 0.5 amps maximum.

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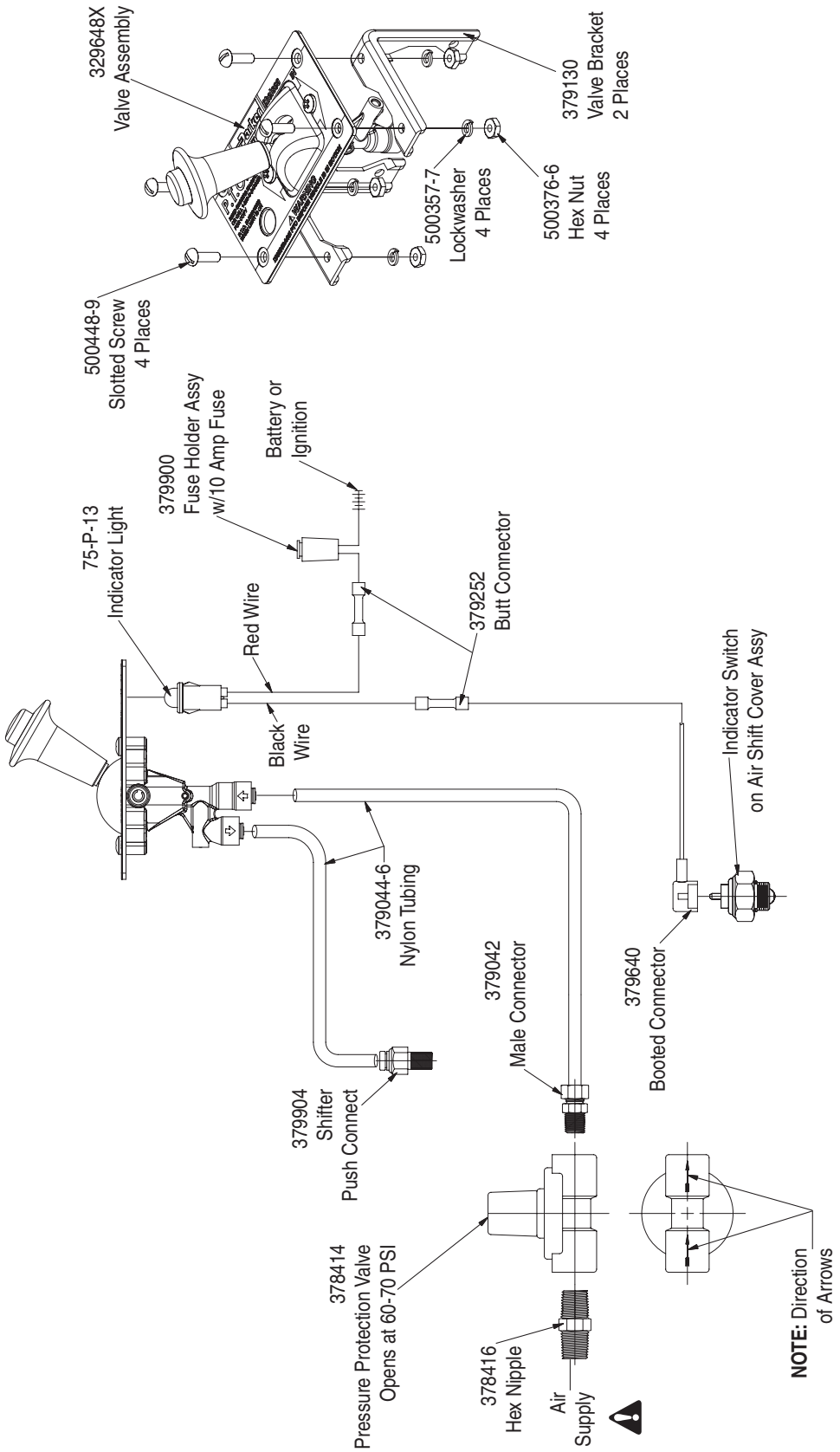
Air Shift – A Shift
221, 442, 447, 489, 660 and 680 Series

(SK-462)



Installation Kit: 328388-98X
See SK-204 Drilling Template for Control Plate

NOTE: When this installation is used on vehicles with automatic transmissions the PTO drive must be stopped before shifting.

WARNING: Connect directly to air supply. Do not use tubing between air supply and pressure protection valve.

CAUTION: When installing nylon tubing avoid sharp angles, exhaust and manifold systems.

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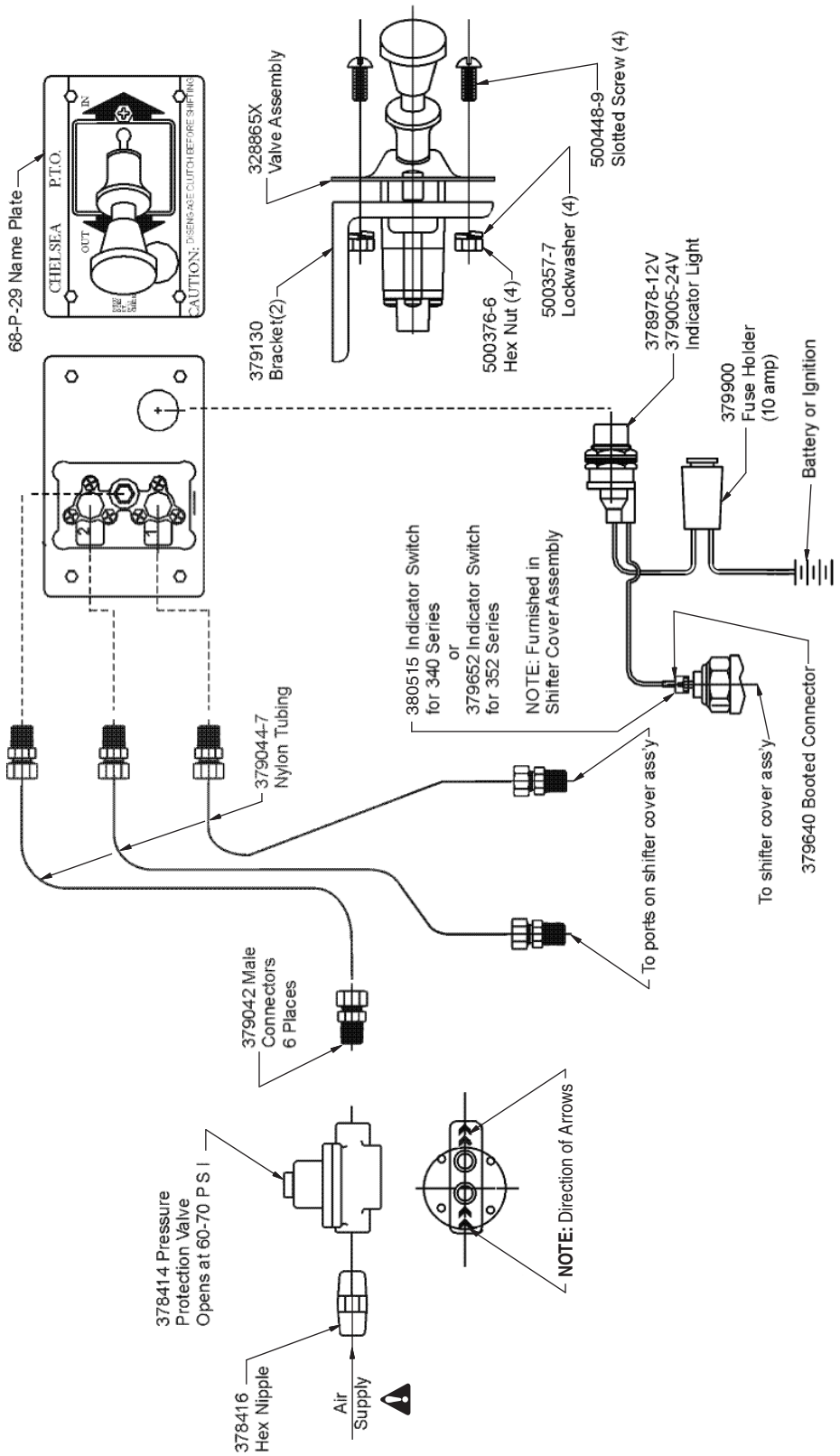
Air Shift – A Shift
340/348 and 352 Series

(SK-228 Rev H)



WARNING: Connect directly to air supply. Do not use tubing between air supply and pressure protection valve.
CAUTION: When installing nylon tubing avoid sharp angles, exhaust and manifold systems.
NOTE: Tube nut is reusable as long as nylon tubing is not removed from the tube nut.
NOTE: Template for control plate on page 17.

Installation Kit: 328388-40X

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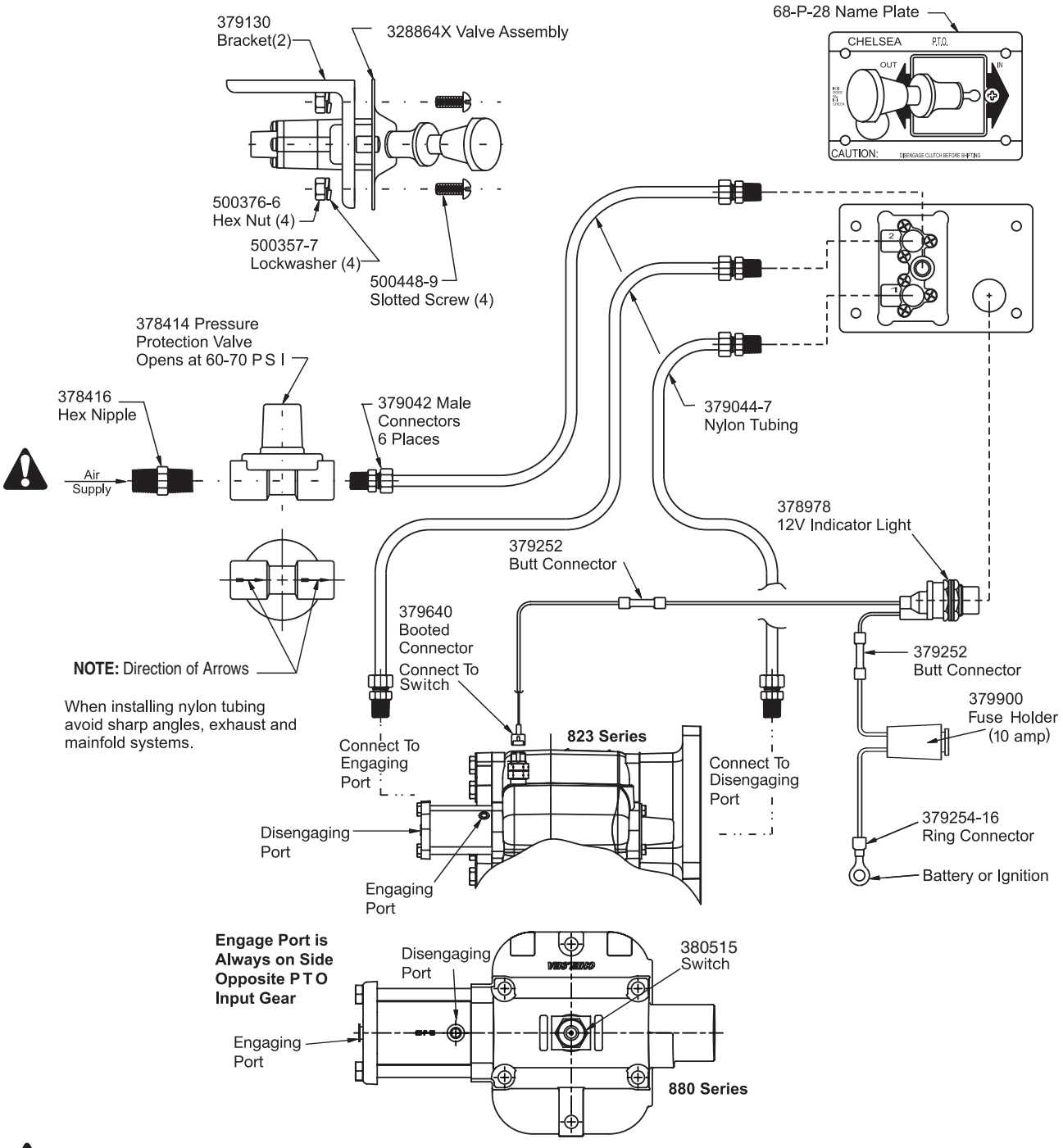
Air Shift – A Shift
823 and 880 Series

(SK-276 Rev K)

Installation Kit: 328388-61X



WARNING: Connect directly to the air supply. Do not use tubing between the air supply and the pressure protection valve.

CAUTION: When installing nylon tubing avoid sharp angles, exhaust and manifold systems.

IMPORTANT: When this installation is used on vehicles with automatic transmissions, the PTO drive gear must be stopped before shifting.

NOTE: Tube nut is reusable as long as nylon tubing is not removed from the tube nut.

NOTE: The template for the control plate is on page 17.

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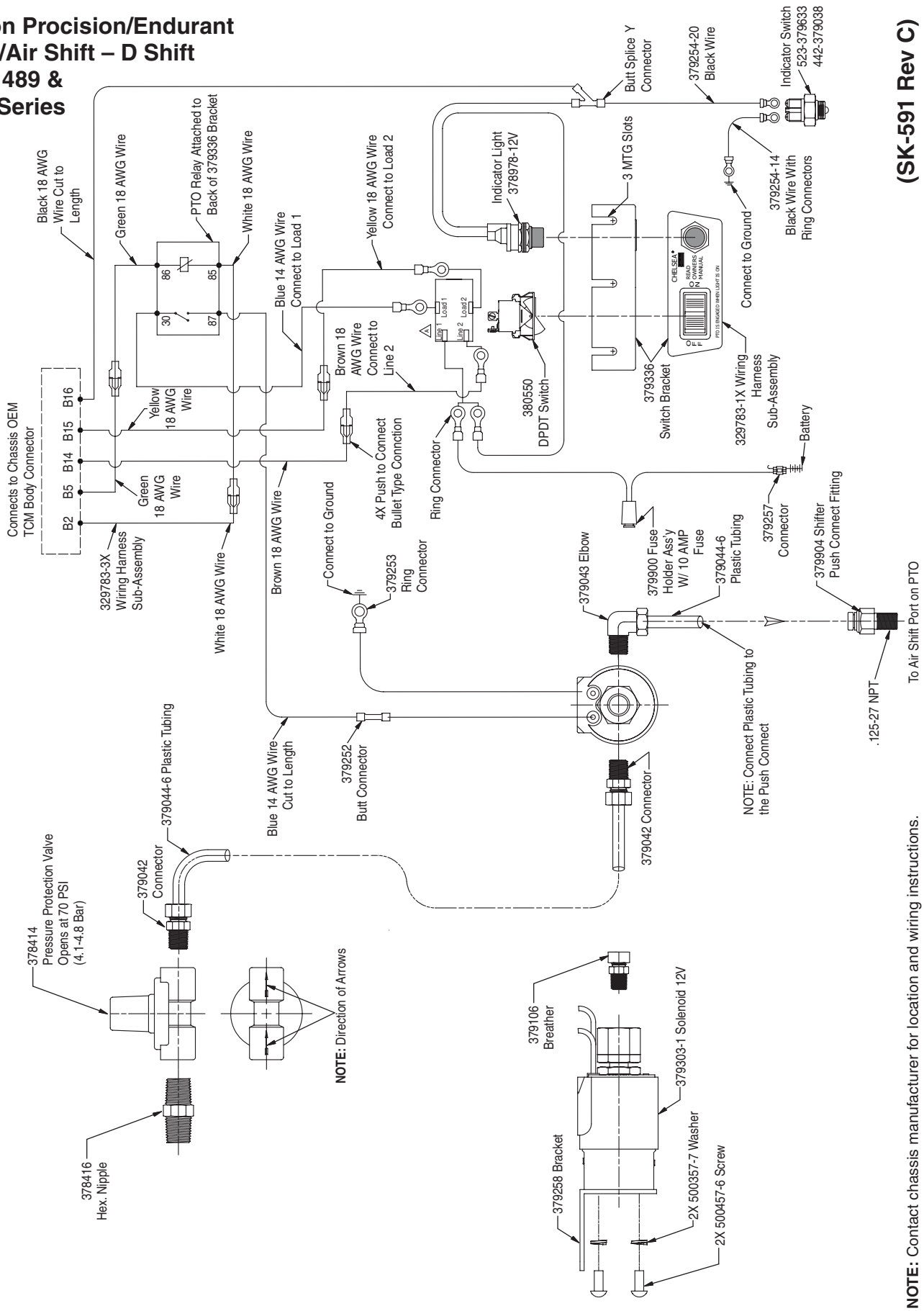
Eaton Procision/Endurant Elec/Air Shift – D Shift 442, 489 & 680 Series

(SK-591 Rev C)



Wiring Harness Kit: 329896X (12V)
Electric/Air Kit: 329874X (12V)

NOTE: Contact chassis manufacturer for location and wiring instructions.

Parker Chelsea

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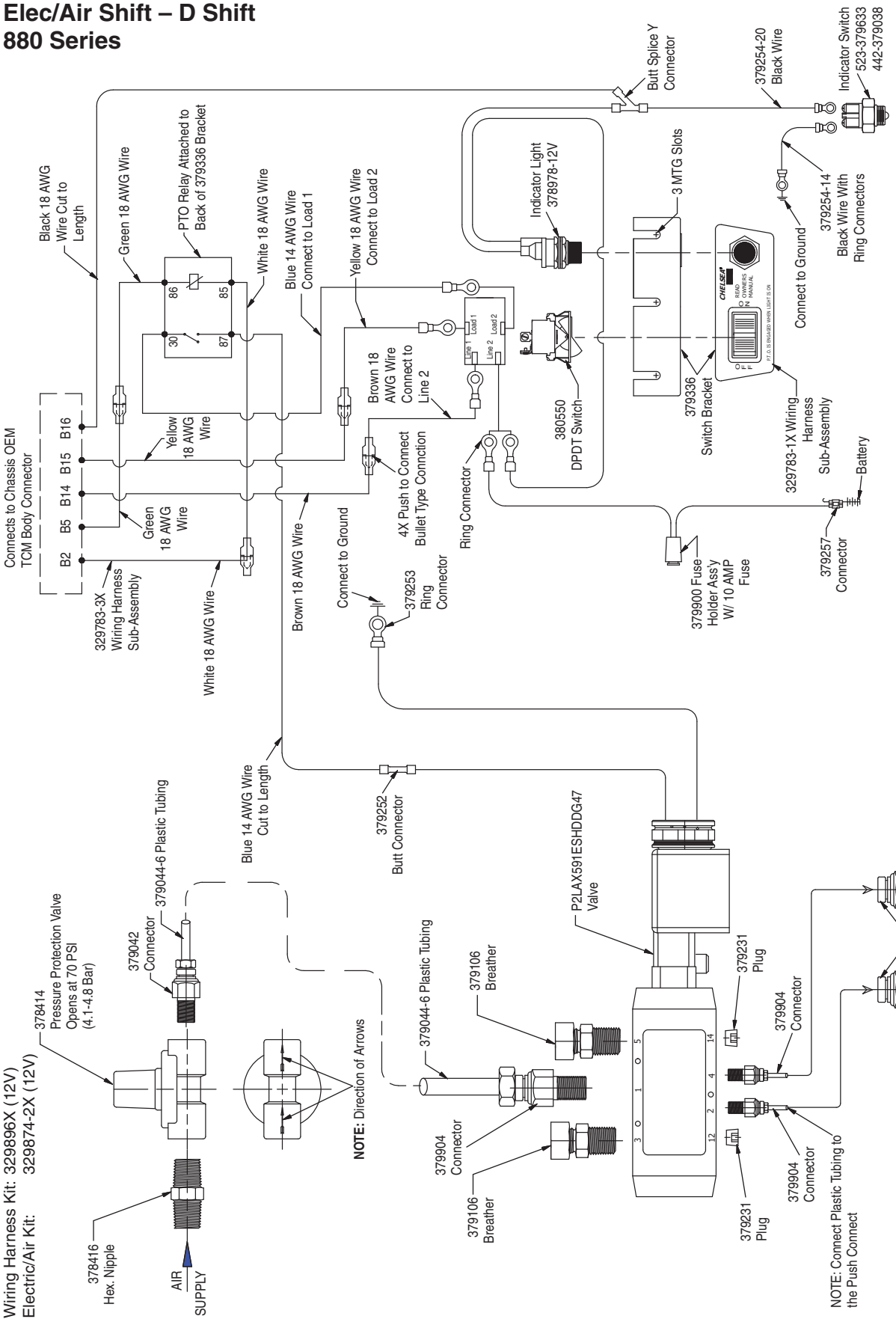
Eaton Endurant
Elec/Air Shift – D Shift
880 Series

(SK-631 Rev A)



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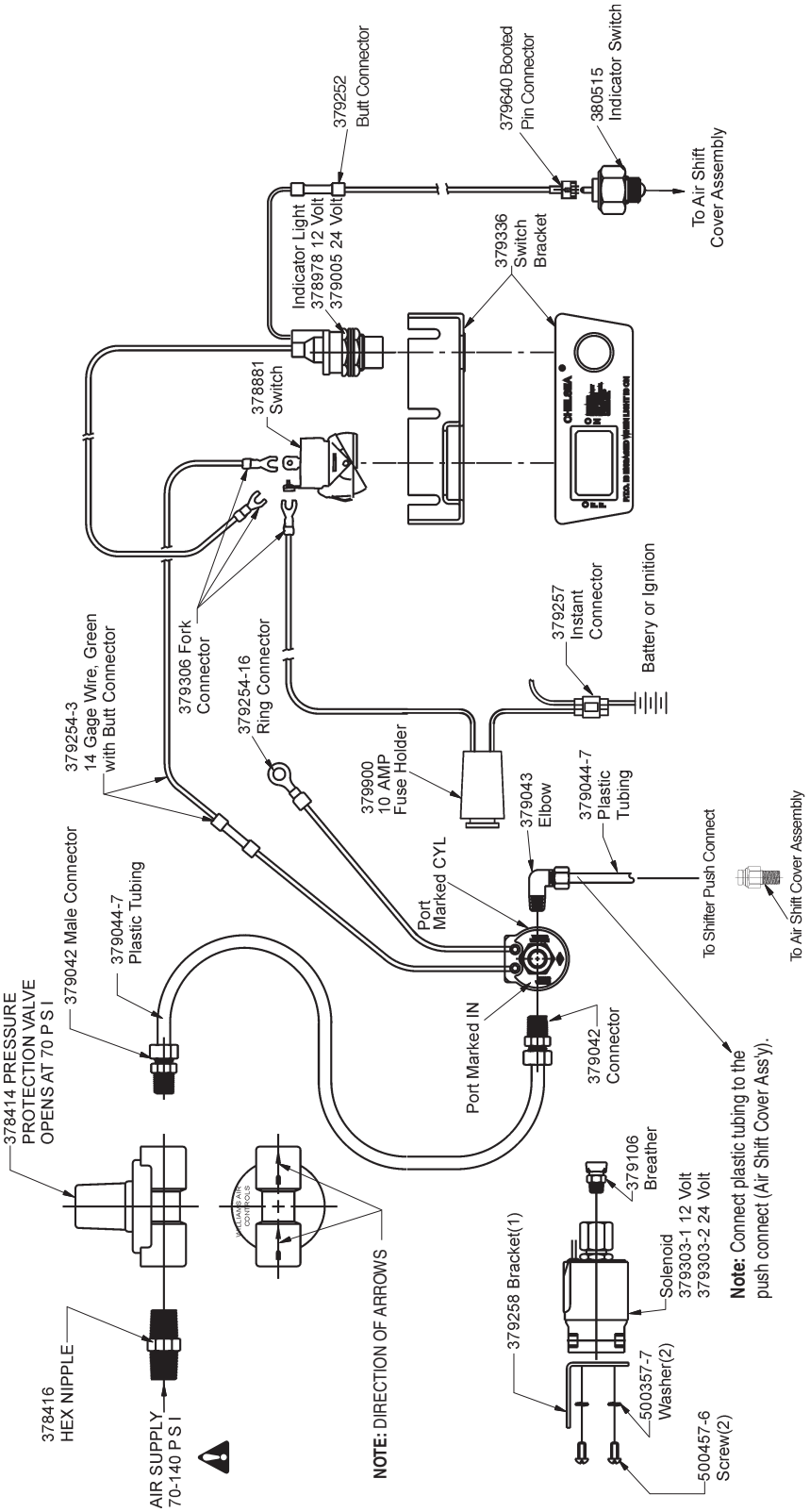
Elec/Air Shift – P or Q Shift
221, 442, 447, 489, 660 and 680 Series

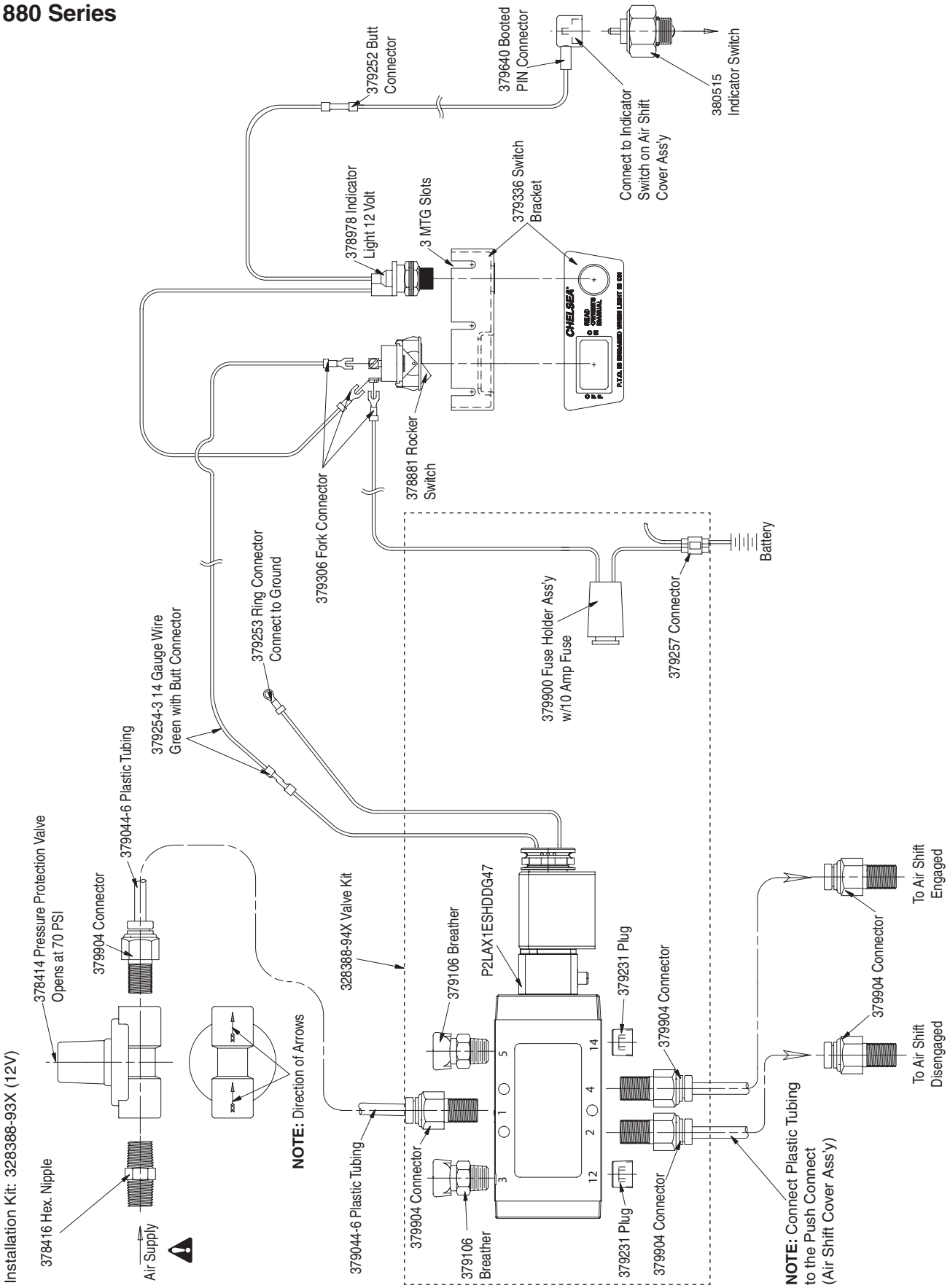


(SK-238 Rev H)

Installation Kits: 328388-47X - 12V
328388-48X - 24V

WARNING: Connect directly to air supply. Do not use tubing between air supply and pressure protection valve.
CAUTION: When installing nylon tubing avoid sharp angles, exhaust and manifold systems.
IMPORTANT: When this installation is used on vehicles with automatic transmissions the PTO drive gear must be stopped before shifting.
NOTE: Tube nut is reusable as long as nylon tubing is not removed from the tube nut.

Elec/Air Shift – P or Q Shift
880 Series



(SK-447 Rev B)

WARNING: Connect directly to air supply. Do not use tubing between air supply and pressure protection valve.

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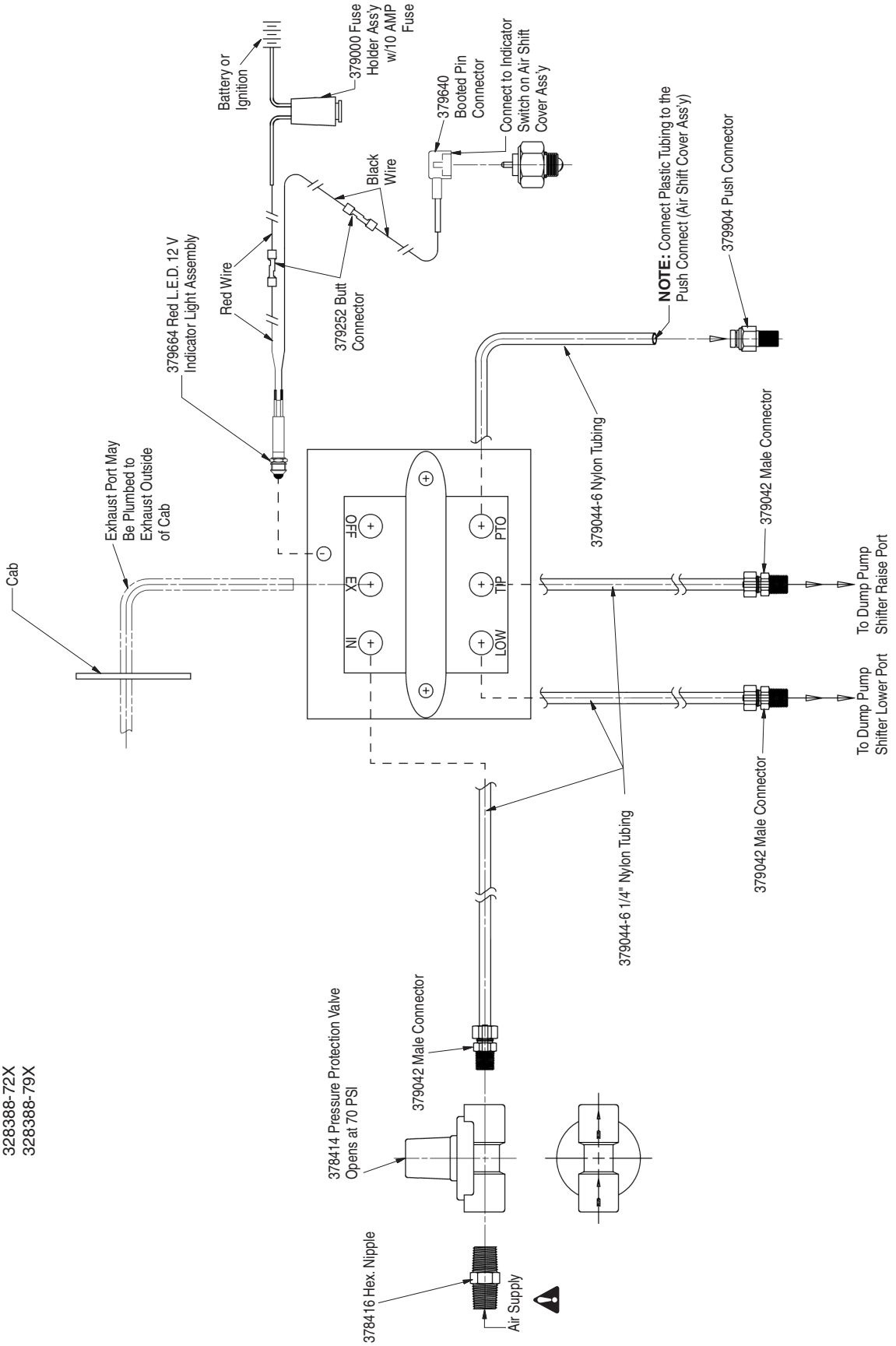
Chelsea Products Division
Olive Branch, MS 38654 USA

Elec/Air Shift – S, T or U Shift
221, 290, 442, 447, 489, 660 and 680 Series

(SK-297 Rev J)



Air Shift Installation Kits: 328388-65X
328388-72X
328388-79X

WARNING: Connect directly to air supply. Do not use tubing between air supply and pressure protection valve.
CAUTION: When installing nylon tubing avoid sharp angles, exhaust and manifold systems.
IMPORTANT: When this installation is used on vehicles with automatic transmissions the, PTO drive gear must be stopped before shifting.
NOTE: Air control value must be fitted inside a waterproof housing when instlled outside the driver's cab.

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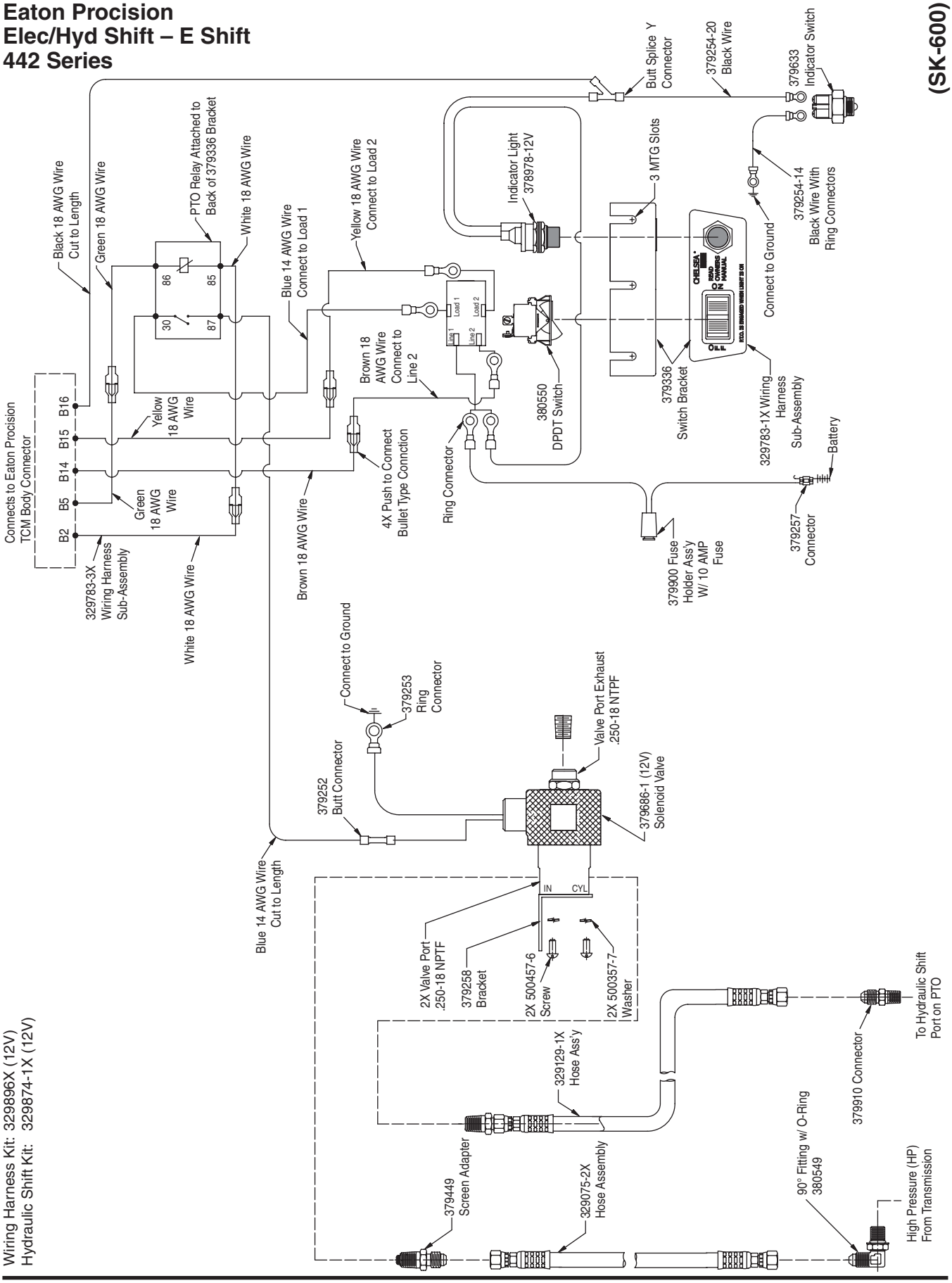
Eaton Procision
Elec/Hyd Shift – E Shift
442 Series

(SK-600)



Wiring Harness Kit: 329896X (12V)
Hydraulic Shift Kit: 329874-1X (12V)

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Notes

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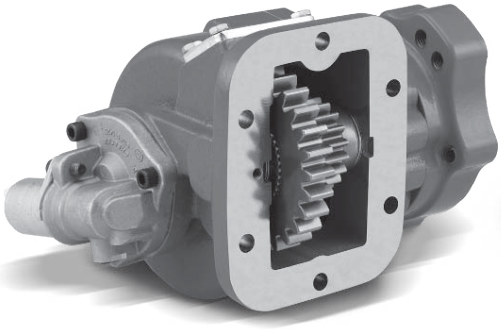
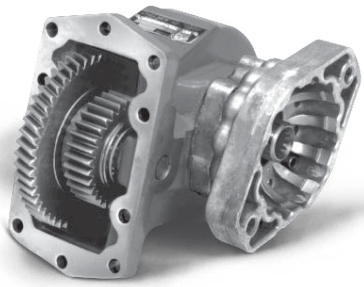
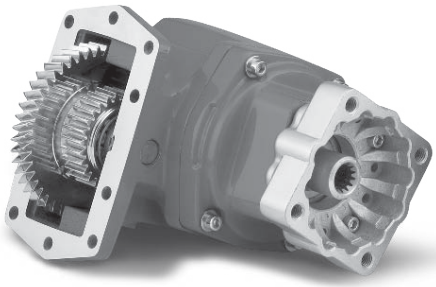
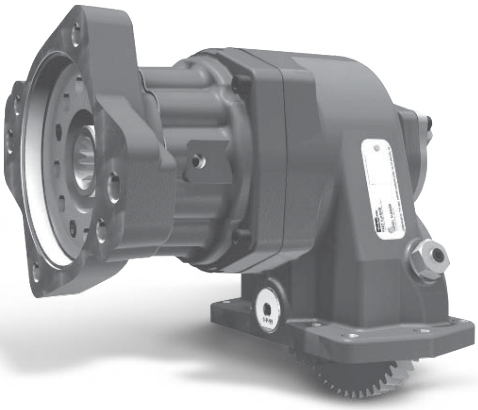
ALLISON









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PTO Shifting Procedure – Automatic Transmission

With Manual Shift PTO (Includes Air Shift)

NOTE: On automatic transmissions, the gears in the transmission turn when the transmission is in neutral, therefore, gear clashing will occur if the Power Take-Off (PTO) is shifted into gear at this time.

With Converter Driven Gear

1. Shift transmission lever into any of the drive positions (this will stop transmission gear from turning).
2. Shift PTO into gear.
3. Shift transmission into neutral (this will start gears turning).

With Engine Driven Gear

1. Shift PTO into gear before starting engine. This procedure should eliminate gear clash.

With PowerShift PTO

1. Engage PTO with engine at idle speed.
2. See transmission manufacturer's instructions for special procedures.

WARNING: Use only wire control with PTO made for wire cable control.

Do not attempt to work on an installed PTO with the engine running. Make sure to block any moving or raised device that may injure a person working on or under the truck. A lever or its linkage may be accidentally moved causing movement of the device which could cause injury to a person near the device.

This symbol warns of possible personal injury.

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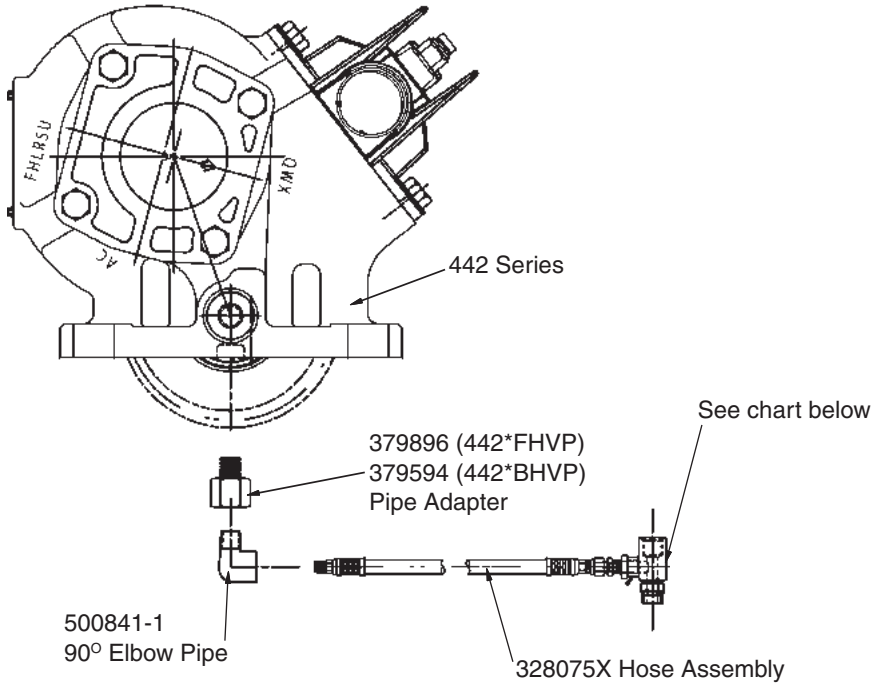
Pressure Lube for Allison 1000, 2000/2400 Series 442 Series (SK-382 Rev B)



Pressure Lube Hose Connection

Chart I

Dimensional Information				
TEE FITTING	**378840**	**378880**	**378970**	**378897**
D	.750-16 UNF 2A	.875-14 UNF 2A	1.062-12 UNF 2A	1.312-12 UN 2A
E	.250-18 NPTF	.250-18 NPTF	.250-18 NPTF	.250-18 NPTF
F	.750-16 NPTF	.875-14 UNF 2NB	1.062-12 UNF 2B	1.312-12 UN 2B

Allison 1000, 2000/2400 Series Converter Housing Options

Converter Housing Group Number	SAE Number	Description	1000	2000	2400	Chelsea Fitting
34-561	#3	Integral Cooler Ports	STD.	—	—	378840
34-562	#2	Manifold Pad	OPT.	STD.	STD.	378970
34-563	#3	Manifold Pad	OPT.	STD.	STD.	378970
34-565	#3	Integral Cooler Ports	STD.	—	—	378840
34-566	#2	Manifold Pad	OPT.	STD.	STD.	378970
34-567	#2	Manifold Pad	OPT.	STD.	STD.	378970
34-572	#3	Integral Cooler Ports	STD.	—	—	378840
34-573	#3	Integral Cooler Ports	STD.	—	—	378840

The specific T fitting for each Automatic Transmission is called out at the bottom of each transmission's application sheet. If a T fitting is not called out, then a standard pipe tee will adapt.

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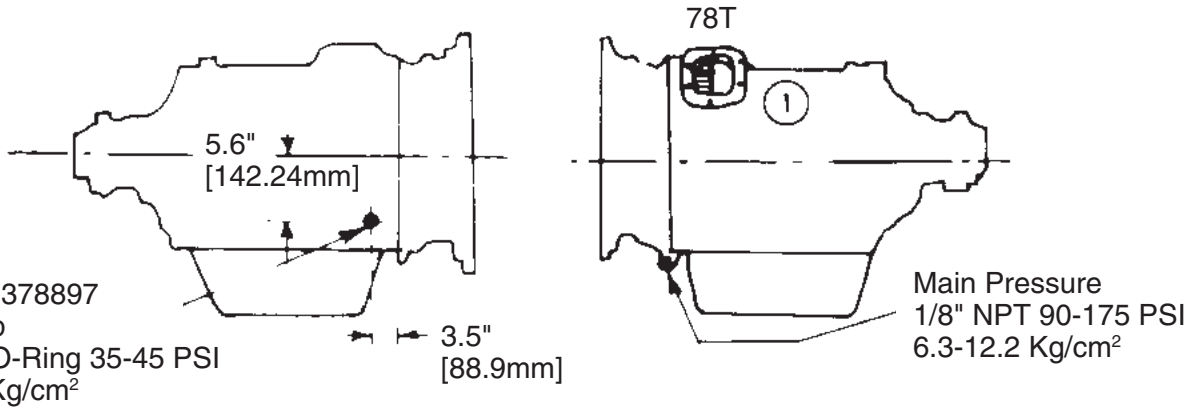
PTO Openings

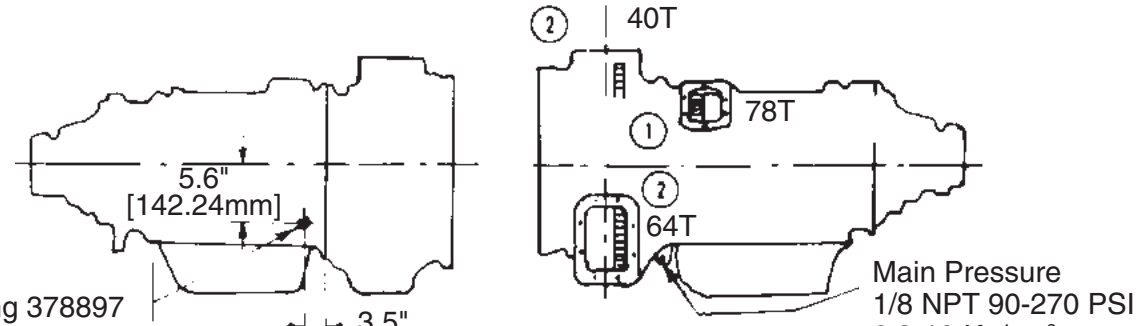
HT-740
HT-750D



T Fitting 378897
Lube Tap
1-5/16" O-Ring 35-45 PSI
2.4-3.2 Kg/cm^2

Main Pressure
1/8" NPT 90-175 PSI
6.3-12.2 Kg/cm^2

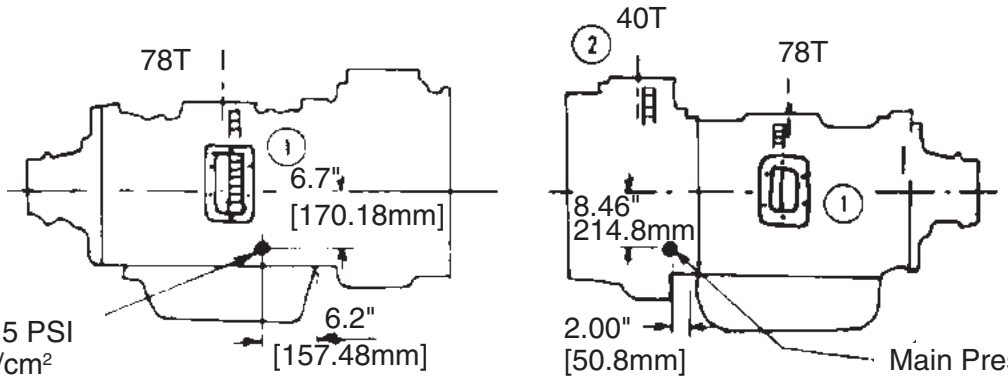
CLT-750



T Fitting 378897
Lube Tap
1-5/16 O-Ring 35-45 PSI
2.4-3.2 Kg/cm^2

Main Pressure
1/8 NPT 90-270 PSI
6.3-19 Kg/cm^2

HT-70



Lube Tap
1/8 NPT 5-15 PSI
.35-1.05 Kg/cm^2

Main Pressure
1/8 NPT 90-240 PSI
7.7-16.8 Kg/cm^2

1. Converter driven PTO Drive Gear.
2. Engine driven PTO Drive Gear.

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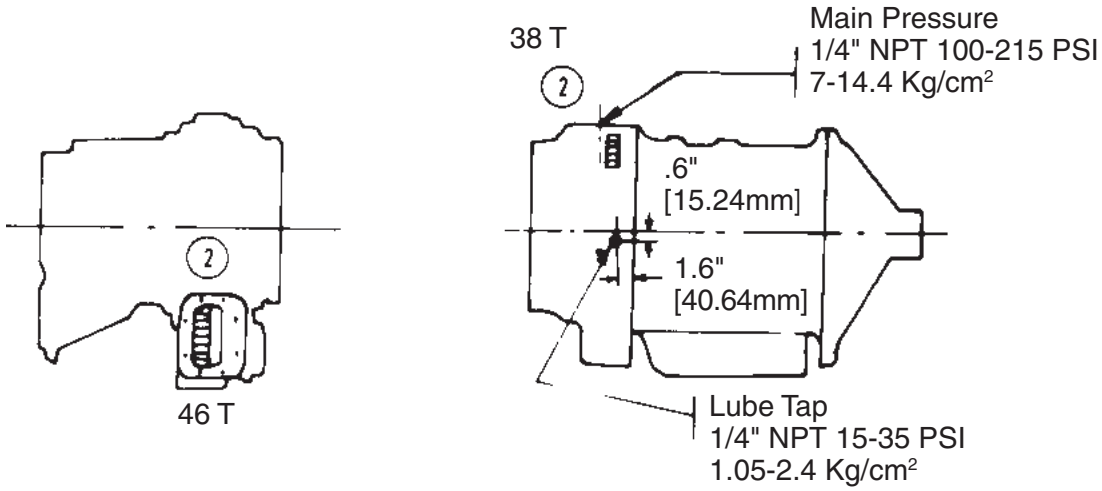
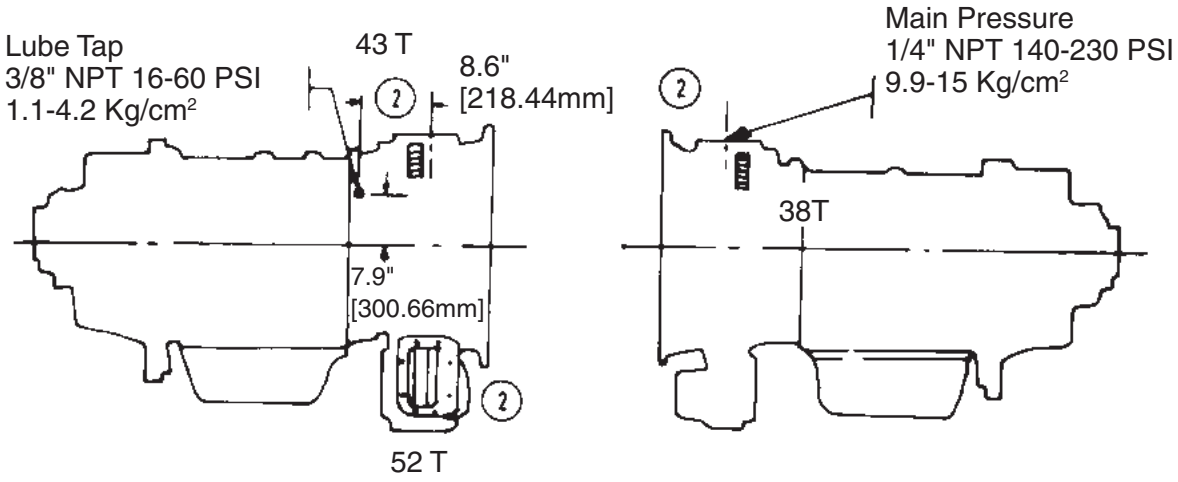
PTO Openings (Continued)

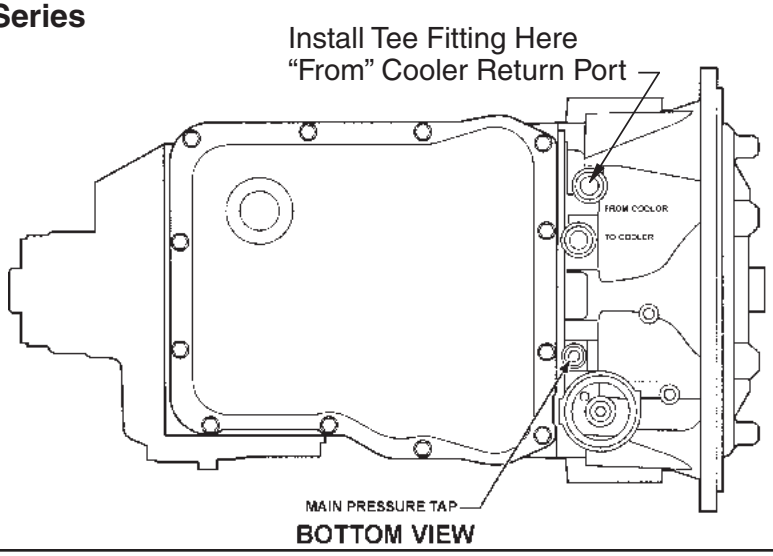
5000 Series



8000 Series



1000, 2000/2400 Series



1. Converter driven PTO Drive Gear.
2. Engine driven PTO Drive Gear.

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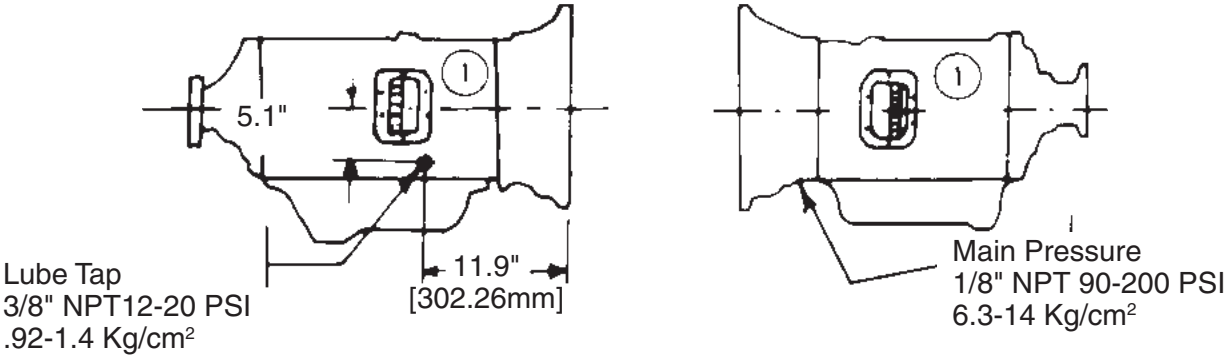
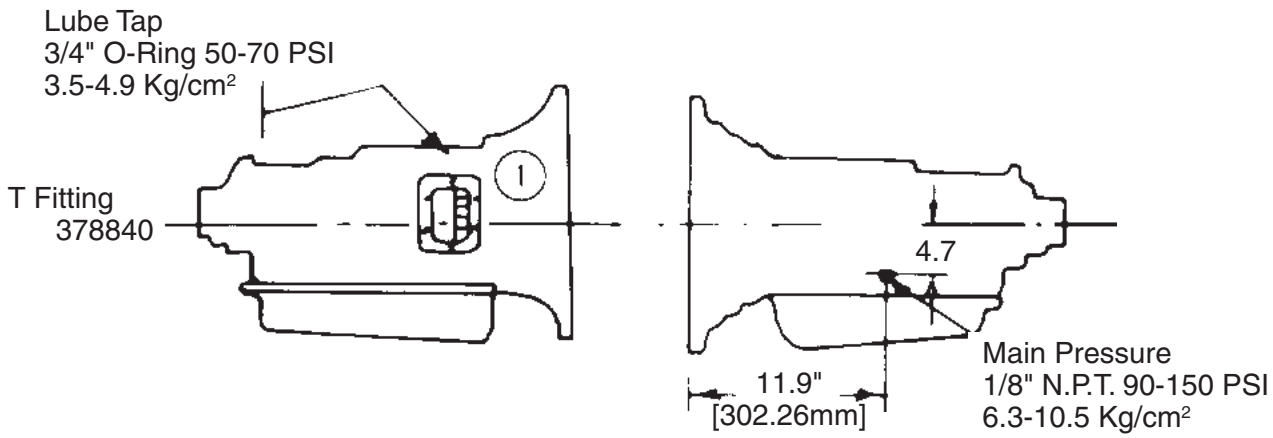
PTO Openings (Continued)

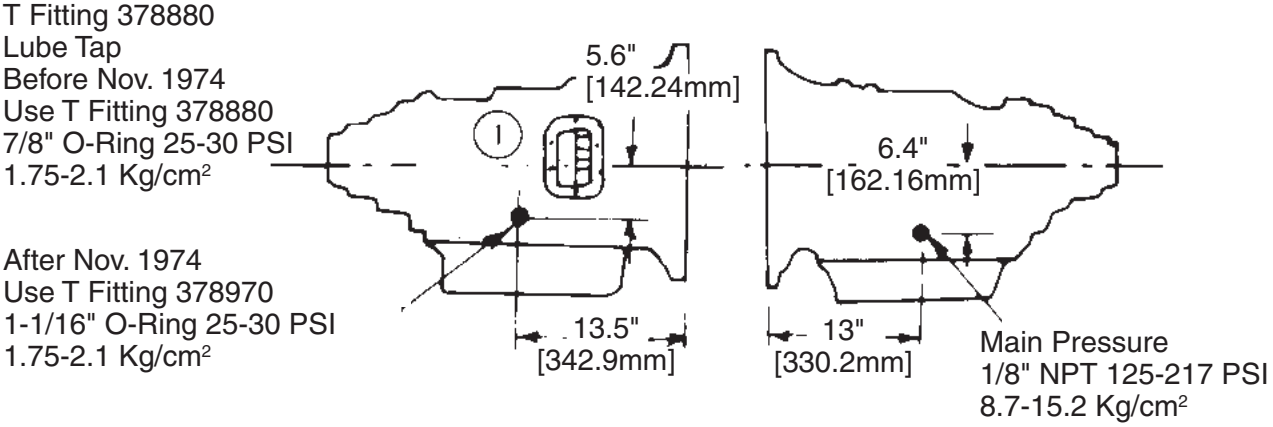
MT-30-42 (57 Teeth)
6 Speed



3341 - 3441 (55 Teeth)
AT-540



4 Speed (64 Teeth)
MT-640



NOTE: Use cooler return port for PTO lubrication. The T fitting is to be installed in the port that is coming from the cooler back to the transmission.

1. Converter driven PTO Drive Gear.

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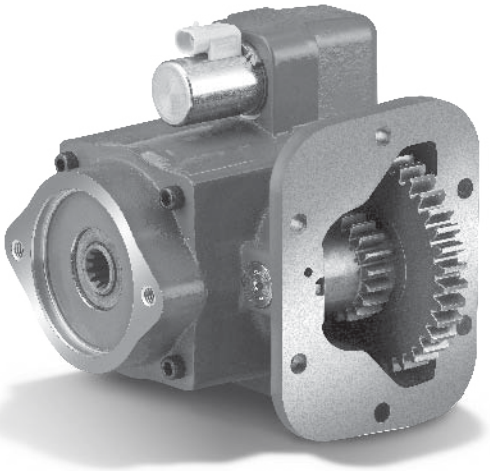
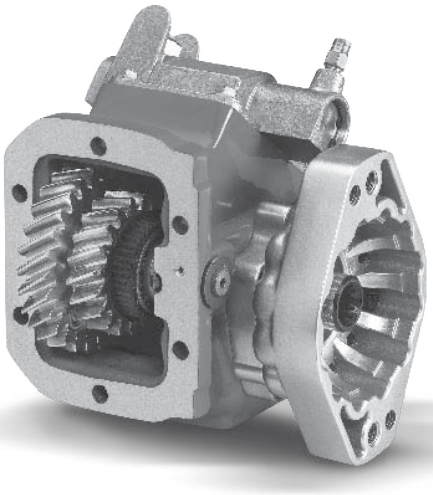
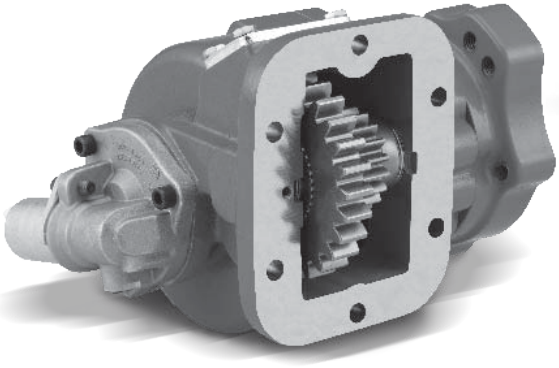
DODGE/RAM







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Overview

PTO Operation

The 3500/4500/5500 Dodge Chassis Cab vehicle, when equipped with either the automatic Aisin 6 speed or manual G56 6 speed transmissions, will allow for an aftermarket upfit with a transmission driven PTO (Power Take-Off). The customer will have the ability to operate the PTO in either a "stationary" or "mobile" mode. The vehicles will be factory set to the "stationary" mode. In order to select the "mobile" mode a Daimler Chrysler Dealership is required to modify the vehicles settings using their proprietary Dealer service tool.

Stationary Mode

To operate the PTO in this mode the vehicle must meet the following conditions:

- Be in park positions (vehicles equipped with automatic transmission)
- Up fitter provided (on/off) switch has been activated
- Parking brake applied (vehicles equipped with manual transmission)
- Vehicle must be running
- No vehicle, brake or clutch switch faults present
- PTO must be correctly installed using the vehicle provided circuits

The customer has the choice to operate the PTO by utilizing the cruise control switches or by utilizing a remote control (provided by the PTO supplier). To operate the feature using the cruise control switches the customer must first activate the up fitter provided on/off switch. Next, the cruise control "on" switch is selected. Following this step the "set" switch must be depressed. The vehicle is now in the PTO mode and is ready for use. In order to increase or decrease the engine idle speed, to optimize the PTO function, the "accel" and "decel" cruise switches can be used respectively. To disengage PTO operation and return to standard vehicle operation simply turn the up fitter provided on/off switch to the off position.

To operate the PTO via a remote switch the customer must make sure the above conditions are met. It is vital for proper operation that the PTO and remote have been installed correctly paying special attention to ensure the vehicle provided wiring has been connected properly. This is the responsibility of the installer of the PTO and switches/remote system. It is the responsibility of the PTO manufacturer to ensure that their electrical (switches and remote) system is compatible with the vehicle's electrical architecture and software functionality.

Overview (Continued)

Mobile Mode

To operate the PTO in this mode the vehicle must meet the following conditions:

- Dealer selected mobile mode activated via Dealer proprietary service tool
- Up fitter provided (on/off) switch has been activated
- Vehicle must be in "park" or "drive" position (vehicles equipped with automatic transmission)
- Parking brake must not be applied
- No vehicle, brake or clutch switch faults present
- Vehicle must be running
- PTO must be correctly installed using the vehicle provided circuits

The customer may choose to use the PTO while the vehicle is moving. To do so the PTO function must be activated before putting the vehicle in gear and moving. This is accomplished by activating the up fitter provided PTO on/off switch. At this point the customer may place the vehicle in a forward or reverse gear and have PTO operation. To disengage PTO operation and return to "standard vehicle operation" simply turn the up fitter provided on/off switch to the off position. Since this is a torque converter driven gear in the transmission, PTO function will not occur until the wheels start moving at a rate of approximately 5-7 mph.

NOTE: For application specific information with respect to PTO and pump requirements and additional vehicle information (wiring schematics, preset idle values, engine speed limits, and vehicle hardware and software requirements) please refer to the Dodge Body Builders Guide by accessing "Wiring Diagrams" and choosing the appropriate links.

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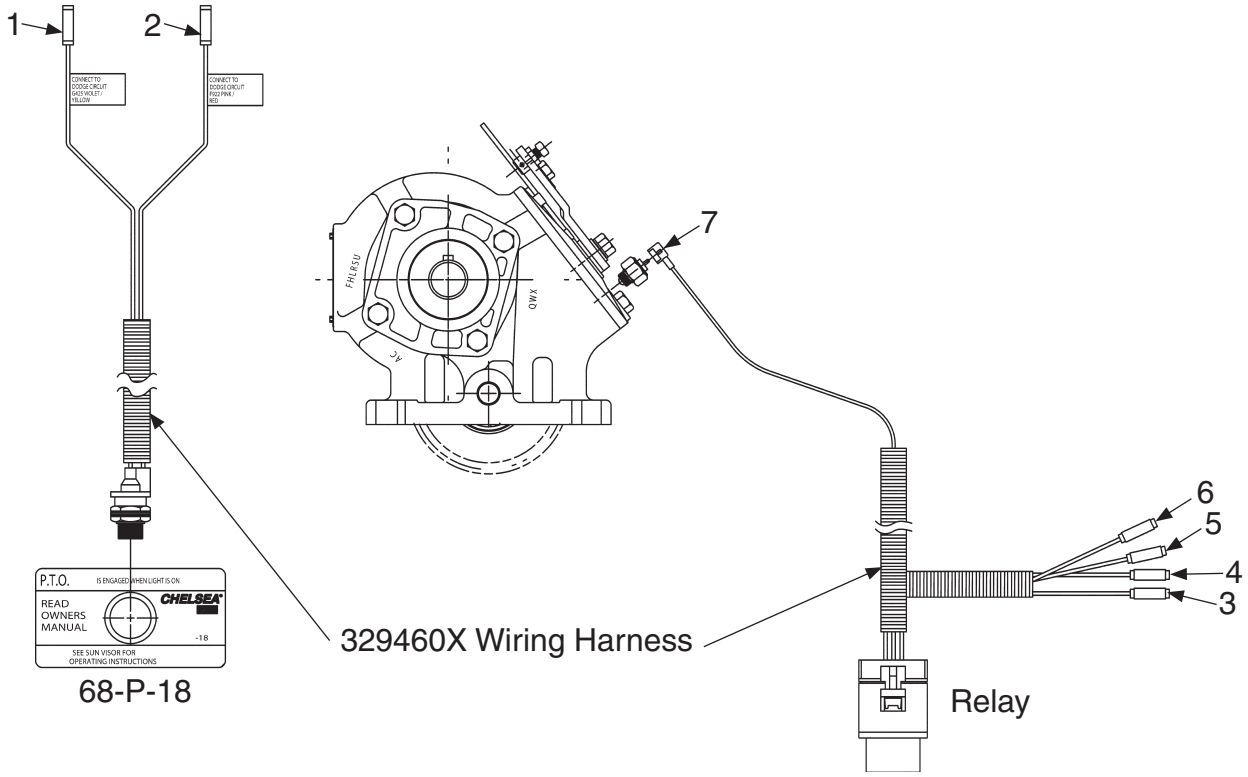
Wiring Chart - Model Year 2007-2010 Dodge/Sterling Chassis Cab, 6.7L w/G56 Transmission

	Chelsea Wire	Connected to Dodge Wire	Location
1	Violet	G425 Violet w/ Yellow Stripe	Upfitter Connector Near Brake Pedal inside Cab
2	Pink	F922 Pink w/ Red Stripe	Upfitter Connector Near Brake Pedal inside Cab
3	Violet	G425 Violet w/ Yellow Stripe	Upfitter Connector Near Brake Pedal inside Cab
4	Pink	K425 Pink w/ Yellow Stripe	Upfitter Connector Near Brake Pedal inside Cab
5	Violet	V937 Violet w/ Brown Stripe	Upfitter Connector Near Brake Pedal inside Cab
6	Pink	F922 Pink w/ Red Stripe	Upfitter Connector Near Brake Pedal inside Cab
	Chelsea Wire	**Connected To Dodge Wire**	**Location**
7	Black w/Booted Connector	Indicator Switch	PTO

Wiring Installation 442 Series w/o EOC (SK-433 Rev A)



NOTES:

a. Using Butt Connectors, Join Chelsea Light Wire #1 G425 to Chelsea Relay Harness Wire #3 G425
b. Using a Splice Connector, Join Chelsea Light Wire #2 F922 to Chelsea Relay Harness Wire #6 F922 to Ram Gray Connector Harness F922 Pink w/Yellow Stripe (Do Not Cut Ram F922 Pink w/Yellow Stripe Wire)
c. Using Butt Connectors, Join Chelsea Relay Wire #4 K425 to Ram Black Connector Harness Wire K425 Orange w/ Brown Stripe
d. Using Butt Connectors, Join Chelsea Relay Wire #5 V937 to Ram Black Connector Harness Wire V937 Violet w/ Brown Stripe
e. Pass Black Booted Connector Through Fire Wall and Attach to Indicator Switch on PTO

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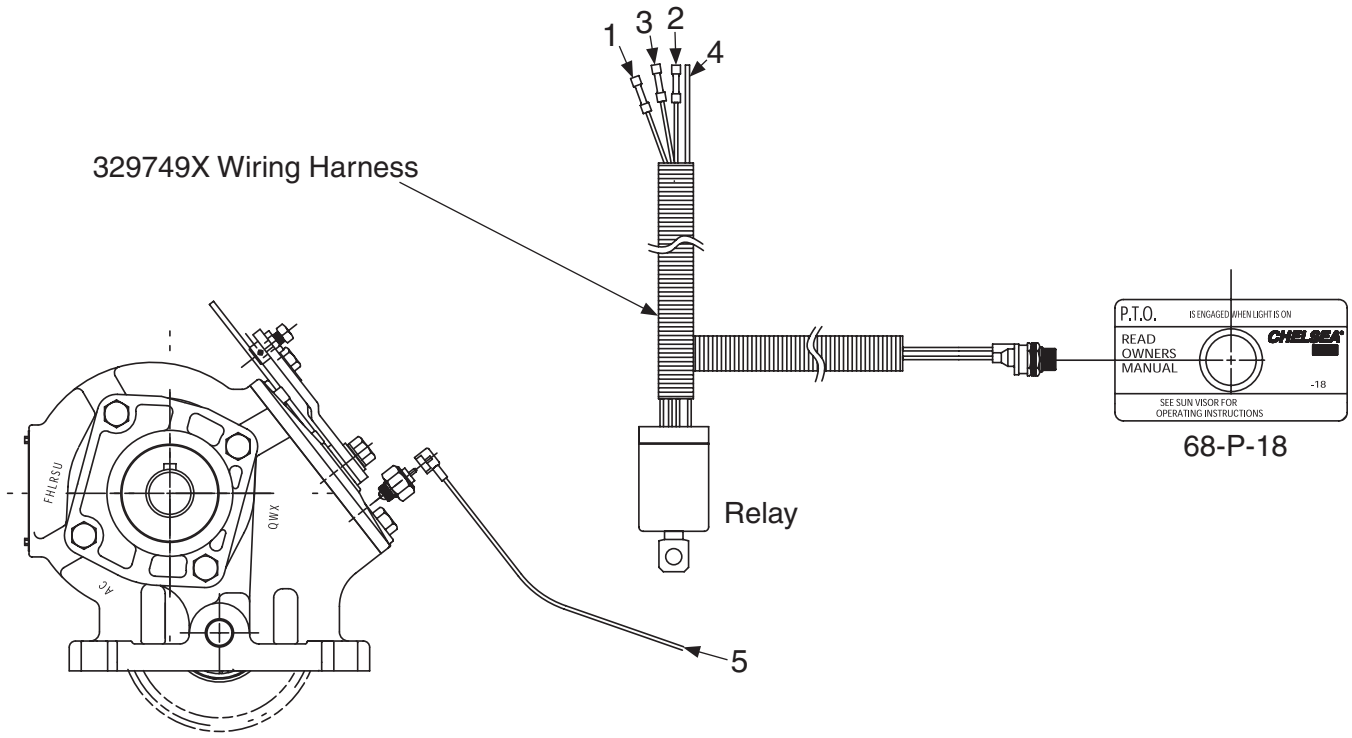
Wiring Chart - Model Year 2011+ Ram (Dodge) Chassis Cab, 6.7L w/G56 Transmission

	Chelsea Harness Wire	Connected To Ram Wire	Upfitter Harness	Location
1	Black	Chelsea Booted Connector		Through Firewall inside Cab
2	Orange	K425 Orange w/ Brown Stripe	Black Connector Harness	Upfitter Connector Near Brake Pedal inside Cab
3	Violet	V937 Violet w/ Brown Stripe	Black Connector Harness	Upfitter Connector Near Brake Pedal inside Cab
4	Pink	F922 Pink w/ Yellow Stripe	Gray Connector Harness	Upfitter Connector Near Brake Pedal inside Cab
	Chelsea Wire	**Connected To Wire**	**Upfitter Harness**	**Location**
5	Black w/ Booted Connector	Chelsea Black Harness Wire	Pass Through Firewall	PTO

Wiring Installation 442 Series w/o EOC (329749X)



NOTES:

a. Using a Splice Connector, Join Chelsea Pink Wire F922 Ram Gray Connector Harness F922 Pink w/ Yellow Stripe
b. (Do Not Cut Ram F922 Pink w/ Yellow Stripe Wire)
c. Using Butt Connectors, Join Chelsea Orange Wire K425 to Ram Black Connector Harness Wire K425 Orange w/ Brown Stripe
d. Using Butt Connectors, Join Chelsea Violet Wire V937 to Ram Black Connector Harness Wire V937 Violet w/ Brown Stripe
e. Pass Blunt End of Black Booted Connector From PTO Through Fire Wall
f. Using Butt Connectors, Join Chelsea Black Wire to Chelsea Booted Connector Blunt End Coming through Firewall

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Delay Relay Switch

The 329749X includes an Adjustable Delay Relay. The factory setting for the relay is 2.5 seconds. The 1 and 2 switches from the factory will be in the ON position with the PTOs knob to the farthest clockwise position. This will represent a 2.5 second delay from the engagement of the Power Take-Off to the sending of the signal to the Ram Control Module to disable the ODB II Monitoring System (**Fig. 22**).

If the clutch pedal is not released in 2.5 seconds, the Ram Control Module will deactivate Power Take-Off Mode and return Engine Throttle to Idle Condition. If a larger delay period is required, Turn the Number 1 Position Switch to the Off Position and turn the PTOs knob to the farthest counter-clockwise position. This will again set the delay to 2.5 seconds. From this point, turn the PTOs knob clockwise until an appropriate delay is met. The farthest clockwise position will now represent a 14 second delay. See chart on side of relay for switch settings (**Fig. 23**).

Fig. 22

Fig. 23

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General Power Take-Off Operation – Vehicle Stationary

Manual Transmission

1. A Power Take-Off (PTO) is, and should be, operated as an integral part of the main transmission.
2. Before shifting the PTO into or out of gear, disengage the clutch and wait for the transmission or PTO gears to stop rotating.
3. Set parking brake.
4. Shift the transmission into NEUTRAL (N).
5. Shift PTO into gear.
6. Release the clutch pedal.

Automated Manual Transmission (AMT)

See transmission manufacture's recommended procedure for proper PTO operation and shifting sequence.

Mechanical Shift PTOs

1. The transmission clutch must be disengaged prior to shifting the PTO into gear.

Clutch-type PTOs

1. The PTO can be engaged without the transmission clutch being disengaged, but the engine RPMs must be at or under 1000.

Important: Failure to follow proper shifting or operating sequences will result in premature PTO failure with possible damage to other equipment.

WARNING: Do not attempt to work on an installed Power Take-Off with the engine running.

Do not attempt to work on an installed Power Take-Off with the engine running. Make sure to block any moving or raised device that may injure a person working on or under the truck. A lever or its linkage may be accidentally moved causing movement of the device which could cause injury to a person near the device.

This symbol warns of possible personal injury.

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EATON Procision – Transmission Power Take-Off (PTO)

Stationary PTO Operation:

1. Confirm vehicle parking brake is applied and:
   - Shift Lever – Park is selected.
   - Push Button – Neutral is selected.
2. Confirm engine is running at idle RPM.
3. Depress and hold service brake.
4. Select transmission PTO switch.
5. Increase engine RPM to a minimum of 950 RPM to operate PTO.

NOTE: PTO is engaged when PTO indicator lamp illuminates if using the Chelsea supplied PTO switch and light.

NOTE: If PTO indicator lamp does not illuminate, momentarily raise engine speed by 200-300 RPM. If the PTO still does not engage, turn off the PTO switch and confirm vehicle parking brake is applied, service brake is depressed and Park or Neutral is selected. Momentarily raise engine RPM by 200-300 RPM, return engine to idle RPM and repeat steps 3-5.

PTO Quick Disengage – Stationary PTO Operation automatically disengages if Reverse or a Drive mode is selected.

Mobile PTO Operation:

1. Confirm vehicle parking brake is applied and:
   - Shift Lever – Park is selected.
   - Push Button – Neutral is selected.
2. Confirm engine is running at idle RPM.
3. Depress and hold service brake.
4. Select desired mode.
5. Confirm transmission is in the desired mode.
6. Select transmission PTO switch.

NOTE: PTO is engaged when PTO indicator lamp illuminates if using the Chelsea supplied PTO switch and light.

7. Release vehicle parking brake.

NOTE: Mobile PTO Operation automatically disengages if vehicle speed and/or engine RPM exceeds 9 MPH (14 KPH) or 2700 RPM.

NOTE: If PTO indicator lamp does not illuminate, turn off the PTO switch and confirm vehicle parking brake is applied, service brake is depressed and Park or Neutral is selected. Momentarily raise engine RPM by 200-300 RPM, return engine to idle RPM and repeat steps 3-7.

NOTE: Stationary PTO is available when configured for Mobile PTO Operation. Follow Stationary PTO Operation instructions. Stationary PTO does not automatically disengage if Reverse or a Drive mode is selected.

Important: Follow PTO manufacturer instructions for proper use and operation.

Due to the normal and sometime severe torsional vibrations that Power Take-Off units experience, operators should follow a set maintenance schedule for inspections. Failure to service loose bolts or Power Take-Off leaks could result in potential auxiliary Power Take-Off or transmission damage.

Periodic PTO MAINTENANCE is required by the owner/operator to ensure proper, safe and trouble free operation.

Daily: Check all air, hydraulic and working mechanisms before operating PTO Perform maintenance as required.

Monthly: Inspect for possible leaks and tighten all air, hydraulic, and mounting hardware, if necessary. Torque all bolts, nuts, etc. to Chelsea specifications. Ensure that splines are properly lubricated, if applicable. Perform maintenance as required.

With regards to the direct mounted pump splines, the PTO requires the application of a specially formulated anti-fretting, high pressure, high temperature grease. The addition of the grease has been proven to reduce the effects of the torsional vibrations, which result in fretting corrosion on the PTO internal splines as well as the pump external splines. Fretting corrosion appears as a rusting and wearing of the pump shaft splines. Severe duty applications, which require long PTO running times and high torque may require more frequent regreasing. Applications such as Utility Trucks that run continuously and are lightly loaded also require frequent regreasing due to the sheer hours of running time. It is important to note that service intervals will vary for each and every application and are the responsibility of the end user of the product. Chelsea also recommends that you consult your pump owners manuals and technical services for their maintenance guidelines. Fretting corrosion is caused by many factors and without proper maintenance the anti-fretting grease can only reduce its effects on components.

Chelsea offers the grease to our customers in two packages. The first is a 5/8 fluid ounce tube (379688), which is included with every applicable PTO, and the second is a 14-ounce grease cartridge (379831). Chelsea also offers greaseable shafts for most output option designators for select PTO Series.

Warranty: Failure to comply entirely with the provisions set forth in the appropriate Owner's Manual will result in voiding of ALL Warranty consideration.

Notes

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1. Terms and Conditions. Seller's willingness to offer Products, or accept an order for Products, to or from Buyer is subject to these Terms and Conditions or any newer version of the terms and conditions found on-line at www.parker.com/saleterms/. Seller objects to any contrary or additional terms or conditions of Buyer's order or any other document issued by Buyer.

2. Price Adjustments; Payments. Prices stated on Seller's quote or other documentation offered by Seller are valid for 30 days, and do not include any sales, use, or other taxes unless specifically stated. Unless otherwise specified by Seller, all prices are F.C.A. Seller's facility (INCOTERMS 2010). Payment is subject to credit approval and is due 30 days from the date of invoice or such other term as required by Seller's Credit Department, after which Buyer shall pay interest on any unpaid invoices at the rate of 1.5% per month or the maximum allowable rate under applicable law.

3. Delivery Dates; Title and Risk; Shipment. All delivery dates are approximate and Seller shall not be responsible for any damages resulting from any delay. Regardless of the manner of shipment, title to any products and risk of loss or damage shall pass to Buyer upon placement of the products with the shipment carrier at Seller's facility. Unless otherwise stated, Seller may exercise its judgment in choosing the carrier and means of delivery. No deferment of shipment at Buyers' request beyond the respective dates indicated will be made except on terms that will indemnify, defend and hold Seller harmless against all loss and additional expense. Buyer shall be responsible for any additional shipping charges incurred by Seller due to Buyer's acts or omissions.

4. Warranty. Seller warrants that all products sold, other than the 590 Series, conform to the applicable Parker Chelsea standard specification for the lesser period of 2 years (24 Months) from date of service or 2-1/2 years (30 Months) from date of build (as marked on the product name plate). Seller warrants that the 590 Series will conform to the applicable Seller standard specification for the lesser period of 2 years (24 Months) from date of service or 2000 hours of usage. The prices charged for Seller's products are based upon the exclusive limited warranty stated above, and upon the following disclaimer: **DISCLAIMER OF WARRANTY: THIS WARRANTY COMPRISES THE SOLE AND ENTIRE WARRANTY PERTAINING TO PRODUCTS PROVIDED HEREUNDER. SELLER DISCLAIMS ALL OTHER WARRANTIES, EXPRESS AND IMPLIED, INCLUDING DESIGN, MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE.**

5. Claims; Commencement of Actions. Buyer shall promptly inspect all Products upon delivery. No claims for shortages will be allowed unless reported to the Seller within 10 days of delivery. No other claims against Seller will be allowed unless asserted in writing within 30 days after delivery. Buyer shall notify Seller of any alleged breach of warranty within 30 days after the date the defect is or should have been discovered by Buyer. Any action based upon breach of this agreement or upon any other claim arising out of this sale (other than an action by Seller for an amount due on any invoice) must be commenced within 12 months from the date of the breach without regard to the date breach is discovered.

6. LIMITATION OF LIABILITY. UPON NOTIFICATION, SELLER WILL, AT ITS OPTION, REPAIR OR REPLACE A DEFECTIVE PRODUCT, OR REFUND THE PURCHASE PRICE. IN NO EVENT SHALL SELLER BE LIABLE TO BUYER FOR ANY SPECIAL, INDIRECT, INCIDENTAL OR CONSEQUENTIAL DAMAGES ARISING OUT OF, OR AS THE RESULT OF, THE SALE, DELIVERY, NON-DELIVERY, SERVICING, USE OR LOSS OF USE OF THE PRODUCTS OR ANY PART THEREOF, OR FOR ANY CHARGES OR EXPENSES OF ANY NATURE INCURRED WITHOUT SELLER'S WRITTEN CONSENT, EVEN IF SELLER HAS BEEN NEGLIGENT, WHETHER IN CONTRACT, TORT OR OTHER LEGAL THEORY. IN NO EVENT SHALL SELLER'S LIABILITY UNDER ANY CLAIM MADE BY BUYER EXCEED THE PURCHASE PRICE OF THE PRODUCTS.

7. User Responsibility. The user, through its own analysis and testing, is solely responsible for making the final selection of the system and Product and assuring that all performance, endurance, maintenance, safety and warning requirements of the application are met. The user must analyze all aspects of the application and follow applicable industry standards and Product information. If Seller provides Product or system options, the user is responsible for determining that such data and specifications are suitable and sufficient for all applications and reasonably foreseeable uses of the Products or systems.

8. Loss to Buyer's Property. Any designs, tools, patterns, materials, drawings, confidential information or equipment furnished by Buyer or any other items which become Buyer's property, will be considered obsolete and may be destroyed by Seller after two consecutive years have elapsed without Buyer ordering the items manufactured using such property. Seller shall not be responsible for any loss or damage to such property while it is in Seller's possession or control.

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

10. Buyer's Obligation; Rights of Seller. To secure payment of all sums due or otherwise, Seller shall retain a security interest in the goods delivered and this agreement shall be deemed a Security Agreement under the Uniform Commercial Code. Buyer authorizes Seller as its attorney to execute and file on Buyer's behalf all documents Seller deems necessary to perfect its security interest.

11. Improper use and Indemnity. Buyer shall indemnify, defend, and hold Seller harmless from any claim, liability, damages, lawsuits, and costs (including attorney fees), whether for personal injury, property damage, patent, trademark or copyright infringement or any other claim, brought by or incurred by Buyer, Buyer's employees, or any other person, arising out of: (a) improper selection, improper application or other misuse of Products purchased by Buyer from Seller; (b) any act or omission, negligent or otherwise, of Buyer; (c) Seller's use of patterns, plans, drawings, or specifications furnished by Buyer to manufacture Product; or (d) Buyer's failure to comply with these terms and conditions. Seller shall not indemnify Buyer under any circumstance except as otherwise provided.

12. Cancellations and Changes. Orders shall not be subject to cancellation or change by Buyer for any reason, except with Seller's written consent and upon terms that will indemnify, defend and hold Seller harmless against all direct, incidental and consequential loss or damage. Seller may change product features, specifications, designs and availability with notice to Buyer.

13. Limitation on Assignment. Buyer may not assign its rights or obligations under this agreement without the prior written consent of Seller.

14. Force Majeure. Seller does not assume the risk and shall not be liable for delay or failure to perform any of Seller's obligations by reason of circumstances beyond the reasonable control of Seller (hereinafter "Events of Force Majeure"). Events of Force Majeure shall include without limitation: accidents, strikes or labor disputes, acts of any government or government agency, acts of nature, delays or failures in delivery from carriers or suppliers, shortages of materials, or any other cause beyond Seller's reasonable control.

15. Waiver and Severability. Failure to enforce any provision of this agreement will not waive that provision nor will any such failure prejudice Seller's right to enforce that provision in the future. Invalidation of any provision of this agreement by legislation or other rule of law shall not invalidate any other provision herein. The remaining provisions of this agreement will remain in full force and effect.

16. Termination. Seller may terminate this agreement for any reason and at any time by giving Buyer thirty (30) days written notice of termination. Seller may immediately terminate this agreement, in writing, if Buyer: (a) commits a breach of any provision of this agreement (b) appointments a trustee, receiver or custodian for all or any part of Buyer's property (c) files a petition for relief in bankruptcy on its own behalf, or by a third party (d) makes an assignment for the benefit of creditors, or (e) dissolves or liquidates all or a majority of its assets.

17. Governing Law. This agreement and the sale and delivery of all Products hereunder shall be deemed to have taken place in and shall be governed and construed in accordance with the laws of the State of Ohio, as applicable to contracts executed and wholly performed therein and without regard to conflicts of laws principles. Buyer irrevocably agrees and consents to the exclusive jurisdiction and venue of the courts of Cuyahoga County, Ohio with respect to any dispute, controversy or claim arising out of or relating to this agreement.

18. Indemnity for Infringement of Intellectual Property Rights. Seller shall have no liability for infringement of any patents, trademarks, copyrights, trade dress, trade secrets or similar rights except as provided in this Section. Seller will defend and indemnify Buyer against allegations of infringement of U.S. patents, U.S. trademarks, copyrights, trade dress and trade secrets ("Intellectual Property Rights"). Seller will defend at its expense and will pay the cost of any settlement or damages awarded in an action brought against Buyer based on an allegation that a Product sold pursuant to this Agreement infringes the Intellectual Property Rights of a third party. Seller's obligation to defend and indemnify Buyer is contingent on Buyer notifying Seller within ten (10) days after Buyer becomes aware of such allegations of infringement, and Seller having sole control over the defense of any allegations or actions including all negotiations for settlement or compromise. If a Product is subject to a claim that it infringes the Intellectual Property Rights of a third party, Seller may, at its sole expense and option, procure for Buyer the right to continue using the Product, replace or modify the Product so as to make it noninfringing, or offer to accept return of the Product and return the purchase price less a reasonable allowance for depreciation. Notwithstanding the foregoing, Seller shall have no liability for claims of infringement based on information provided by Buyer, or directed to Products delivered hereunder for which the designs are specified in whole or part by Buyer, or infringements resulting from the modification, combination or use in a system of any Product sold hereunder. The foregoing provisions of this Section shall constitute Seller's sole and exclusive liability and Buyer's sole and exclusive remedy for infringement of Intellectual Property Rights.

19. Entire Agreement. This agreement contains the entire agreement between the Buyer and Seller and constitutes the final, complete and exclusive expression of the terms of sale. All prior or contemporaneous written or oral agreements or negotiations with respect to the subject matter are herein merged.

20. Compliance with Law, U. K. Bribery Act and U.S. Foreign Corrupt Practices Act. Buyer agrees to comply with all applicable laws and regulations, including both those of the United Kingdom and the United States of America, and of the country or countries of the Territory in which Buyer may operate, including without limitation the U. K. Bribery Act, the U.S. Foreign Corrupt Practices Act ("FCPA") and the U.S. Anti-Kickback Act (the "Anti-Kickback Act"), and agrees to indemnify and hold harmless Seller from the consequences of any violation of such provisions by Buyer, its employees or agents. Buyer acknowledges that they are familiar with the provisions of the U. K. Bribery Act, the FCPA and the Anti-Kickback Act, and certifies that Buyer will adhere to the requirements thereof. In particular, Buyer represents and agrees that Buyer shall not make any payment or give anything of value, directly or indirectly to any governmental official, any foreign political party or official thereof, any candidate for foreign political office, or any commercial entity or person, for the purpose of influencing such person to purchase products or otherwise benefit the business of Seller.

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