

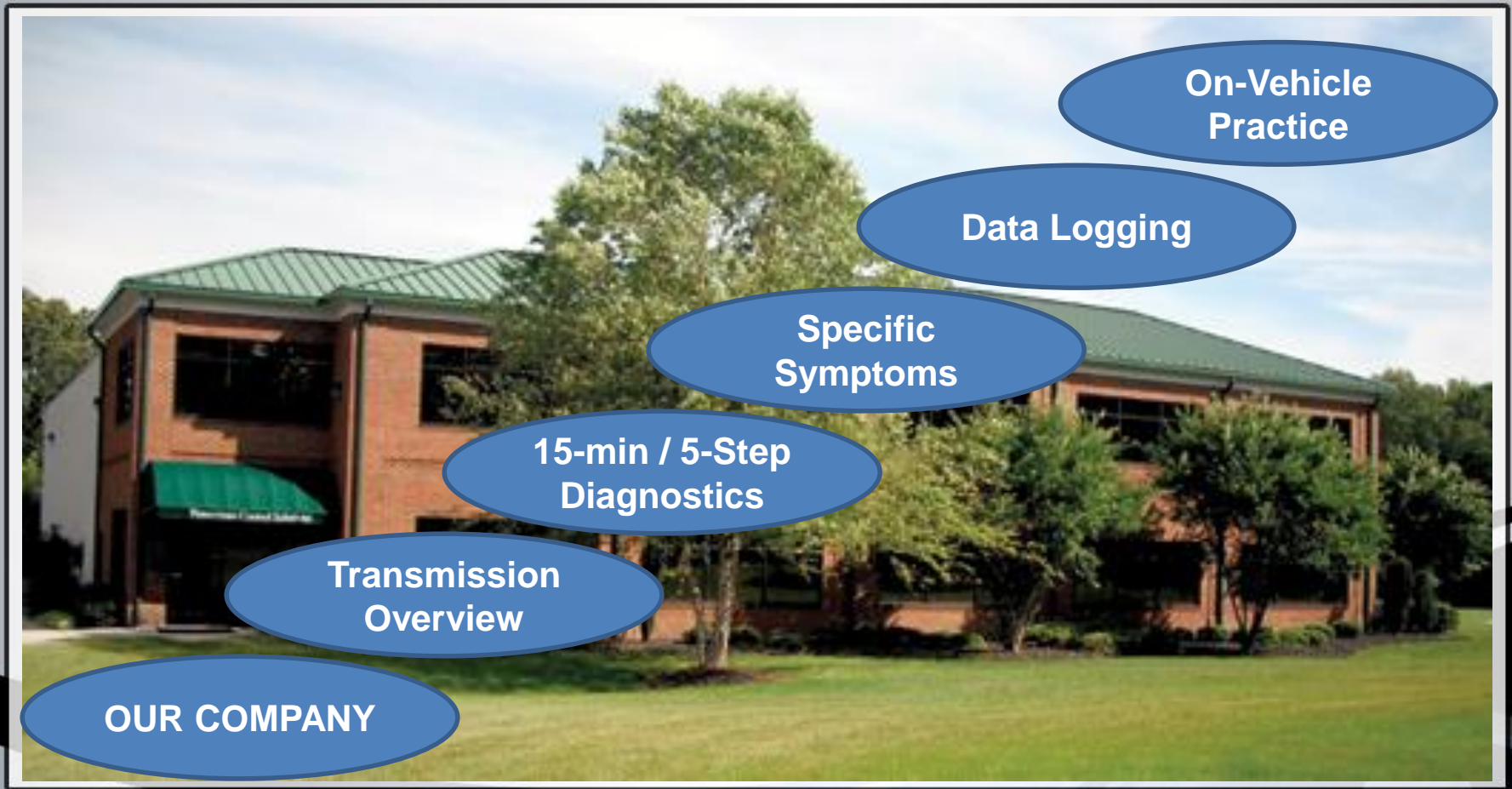
Brought to you by:
Jim Miller & Matt Petrie
2025, REV-7



Powertrain Control Solutions.com
Engineering the future of driveline control

4LHD Operation and Diagnostics

Today's Objectives



PCS OVERVIEW

PCS is an engineering and production company specializing in automotive drive line control.

100% of each PCS product is designed in-house.

100% of 16,000+ PCS modules are full functionality tested.

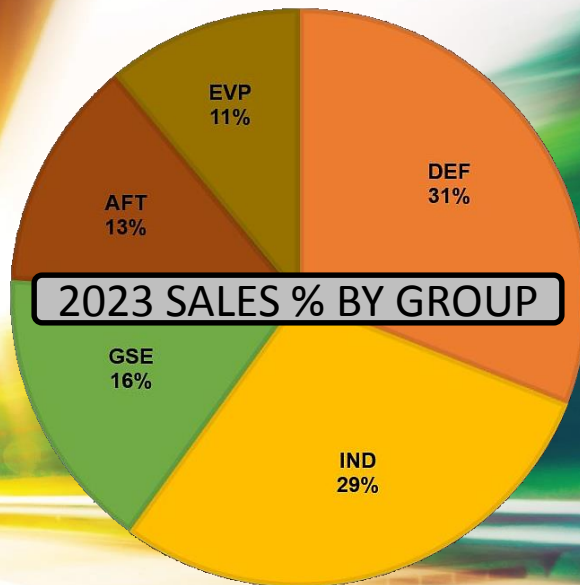
100% of 7,400+ PCS wiring harnesses are fully tested with our automated point-to-point resistance process.

Richmond VA - Family Owned - <100 Team Members

Inventory and Quality Control:

- IPC / WHMA Certified
- IATF / AIAG Certified
- ISO-9001 Certified

MEMBER OF:



Locations





ASHLAND ENGINEERING CENTER

- 38,000 ft² (3,530 m²)
- Custom built ISO Class-6 Clean-Room:
 - 45 Panel PCB / PCA Production Line
 - 94K-CPH "2X JUKI RS-1R" Pick-and-Places
 - Inline 3D AOI for 100% panel inspection
 - X-Ray for QC and Root-Cause Analysis
 - Automated conformal coating, solder, & potting applicators
- High volume wire harness production including:
 - Automated crimp center
 - Wire twisting machine
 - Ultrasonic splicer
 - Computerized point-to-point test stands
- 3D Printers
- Two training rooms
- CNC Machining center and machine shop
- Valve body development machine
- High Voltage development stand
- Transmission Dyno
- AWD and 2WD Vehicle Dynos
- Hosts & Mentors local FIRST FRC Team



ENGINEERING

Mechanical & Electrical Design

PCS engineers help clients around the world solve challenging vehicle integration issues. We have extensive experience in driveline design, transmission design, and embedded control systems. We have the tools to assist with virtually every stage of vehicle design and development including FMEA, mechanical design, CAN architecture, EMI certification, and PPAP. Our engineers are available 24 hours, 7 days a week to provide on-site engineering support.

Mechanical Design

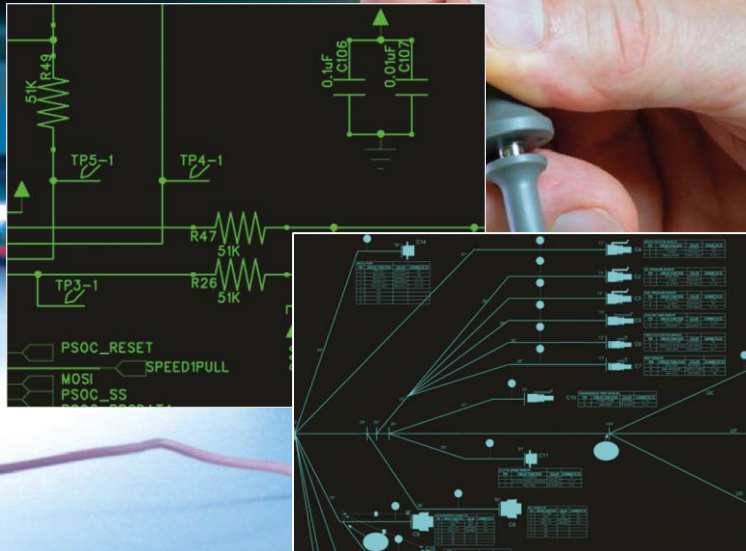
Our engineers use SolidWorks® to create your 3D design into reality. Along with our rapid prototype tools, we also have a Milltronics VM20 CNC milling machine dedicated solely for research and design projects.

Circuit Schematic Design and Layout

Our engineers use Mentor Graphics PADS® to transform your idea to an electrical design. We will perform a complete electrical analysis of the system and make suggestions if improvements can be made. Our experience has taught us how to design a robust system and avoid common pitfalls. The best circuit schematic is only as good as the layout. Careful implementation is critical at this step. Our engineers will not only consider functional and EMI factors, but also perform a thorough design for manufacturing (DFM) review to insure the board can be built using the most reliable and cost effective process.

Wire Harness Design

An often overlooked component of a system is the wire harness. A properly designed wire harness not only provides superior reliability and performance but also minimizes costs in labor to manufacture and install, weight, and other considerations to improve the overall system implementation. PCS not only provides wire harness routing, but also performs an engineering review of the harness to ensure proper wire gauge, terminals and connectors for the application.



Control Module Development



ENGINEERING

Driveline Integration & Validation

PCS provides complete driveline integration services for vehicle manufacturers. PCS can assist during the entire development cycle including component design, selection, validation, production procurement, and final assembly.

Transmission Simulation and Selection

Computer simulation of vehicle and transmission performance based vehicle specific parameters including GVW, engine, and final drive ratio. Several transmission options will be evaluated and compared. Factors also considered are cost, availability (new or reman), suitability for vehicle mission, and other implementation factors. For four-wheel-drive applications, the transfer case can be included in the analysis.

Engine to Transmission Interface

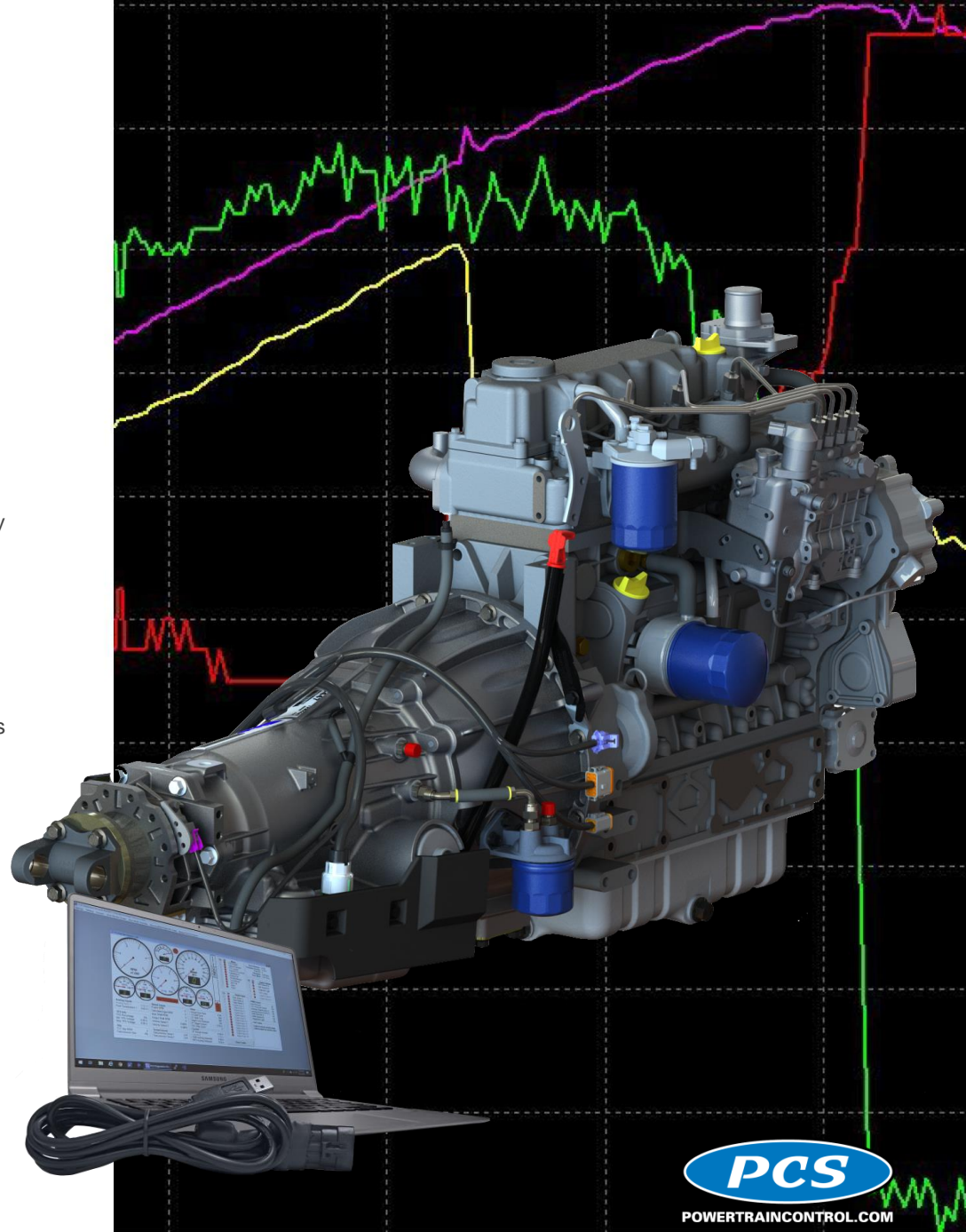
CAD design and analysis includes alignment, torque converter engagement, production feasibility, and costs. Custom bell housings can be designed to simplify installation and reduce production costs. PCS offers bell housings for popular engine/transmission combinations including SAE4 and SAE3 to GM 4L60/70.

Vehicle Fitment

CAD design and analysis of vehicle specific transmission mount loading capability, transmission field serviceability, driveline angle, transmission angle, maximum vehicle operation angle, driveshaft and axles, shift mechanism, cooling system, neutral safety, reverse indication, and parking brake.

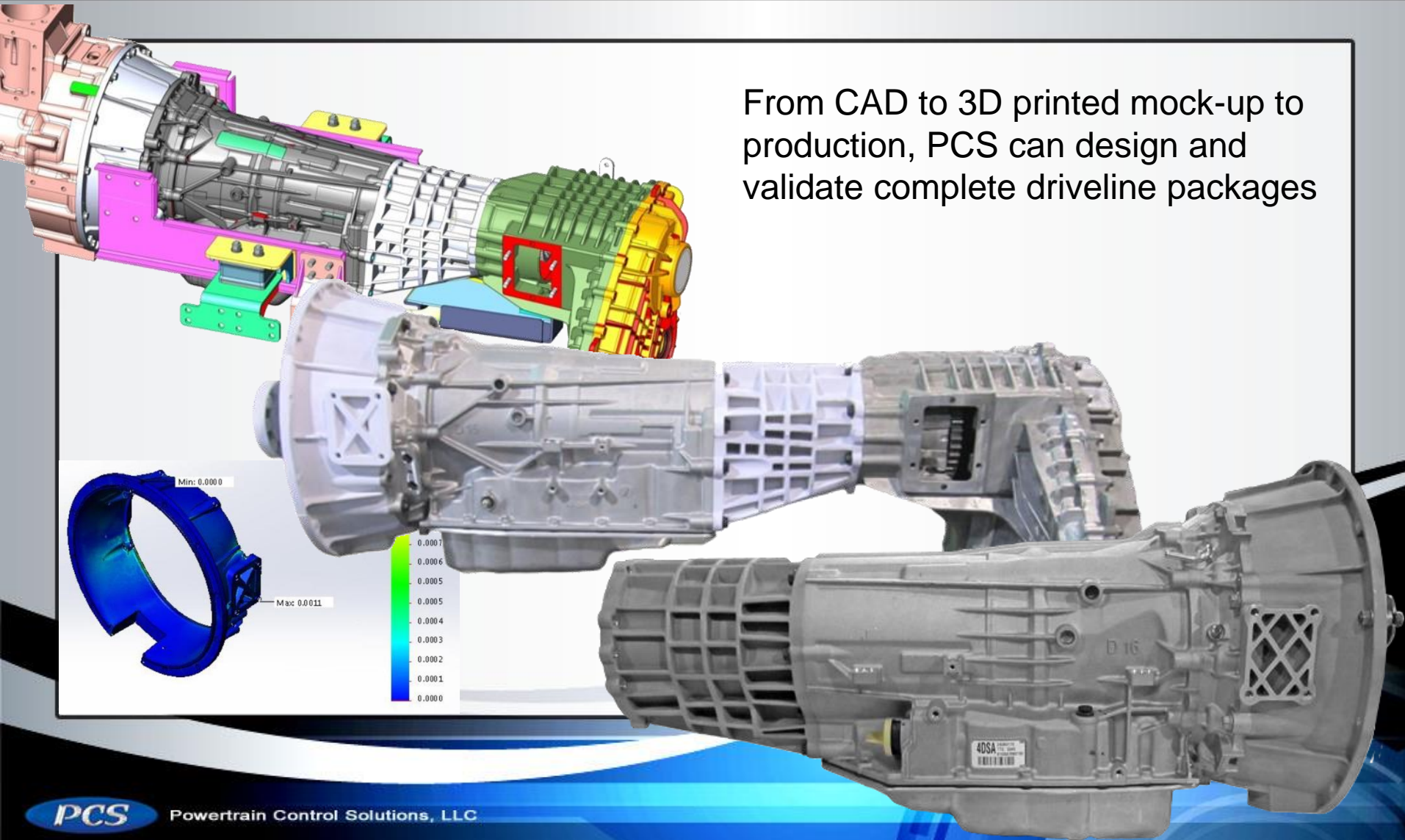
Calibration, Validation, and Durability Testing

Transmission calibration and validation is offered to insure the transmission is properly integrated into the vehicle. While continuously monitoring transmission load, slip, cooling, and other variables, durability testing can be performed to verify the transmission will withstand the mission for the expected life of the vehicle.



Powertrain Integration

From CAD to 3D printed mock-up to production, PCS can design and validate complete driveline packages



Proudly Supporting





Certificate of Excellence

PLATINUM

Supplier Status

is hereby granted to

POWERTRAIN CONTROL SOLUTIONS

ASHLAND, VIRGINIA

In Recognition for Outstanding On-Time Shipping Performance
to General Motors Customer Care and Aftersales

David Poole
General Director, Supply Chain

Wade Sheffer
Executive Director, Global Purchasing

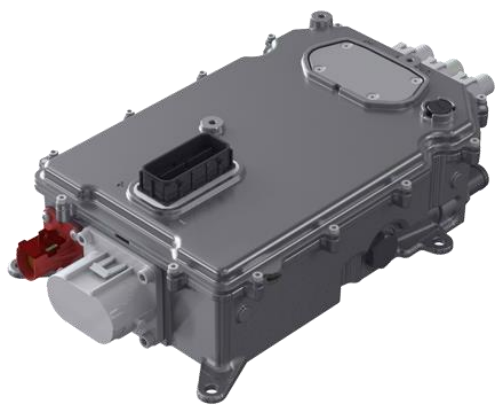
Supply Chevy
Performance with control
modules and wiring
harnesses



Aftermarket Products

- Simple Shift ¹³
- TCM2800 ³⁰⁺
- Paddle Shifters
- Push Buttons
- Gear Indicators
- Dataloggers
- Accelerometer / Gyro





INVERTERS

3-Phase Drive-Unit Control
225kW / 500A Peak / 250A Cont.
Optional 1200W 12 / 24V DC-DC
48 - 450V System Capable



DRIVE UNITS

Compact Designs
201 - 335 HP
265 - 962 FT-LBS
2,644 - 8,700 RPM



REMOTE DC-TO-DC

HV-to-12V 1400W DC Converter
12V and 24V Options
V-DC Output Configurable

**IN-HOUSE HV-CABLE
PRODUCTION!**

450V CCS1 / CCS2 ELECTRIFICATION

GSE AIRPORT TRACTORS

Providing High-Voltage Electric-Vehicle
powertrains for new and repowered
airport bag-tractors, cargo-tractors,
belt-loaders, and push-backs.



ROAD CONSTRUCTION

Developed drop-in powerplants for
previously diesel / hydraulic asphalt
pavers and powered-broom equipment.



UTV OFFROAD

Full 200HP AWD electric powertrain
developed by PCS, providing highly
versatile offroad performance for some
of the worlds fastest UTVs.





DEFENSE

HMMWV

In 2008 replaced Delphi as the supplier of the transmission control module for the HMMWV. Performed all calibration and validation using PCS produced tools. Currently the sole supplier for the TCM.



OSHKOSH JLTV

CAN based, military rated (MIL-STD-461E), control modules for accelerometer and gyro module, smart power distribution, and more.



BOEING BADGER

PCS engineered, calibrated, and validated driveline including TCM, transmission, and mil-spec transfer case module. PCS supplied transmission with custom VM Motori bellhousing and transfer case.

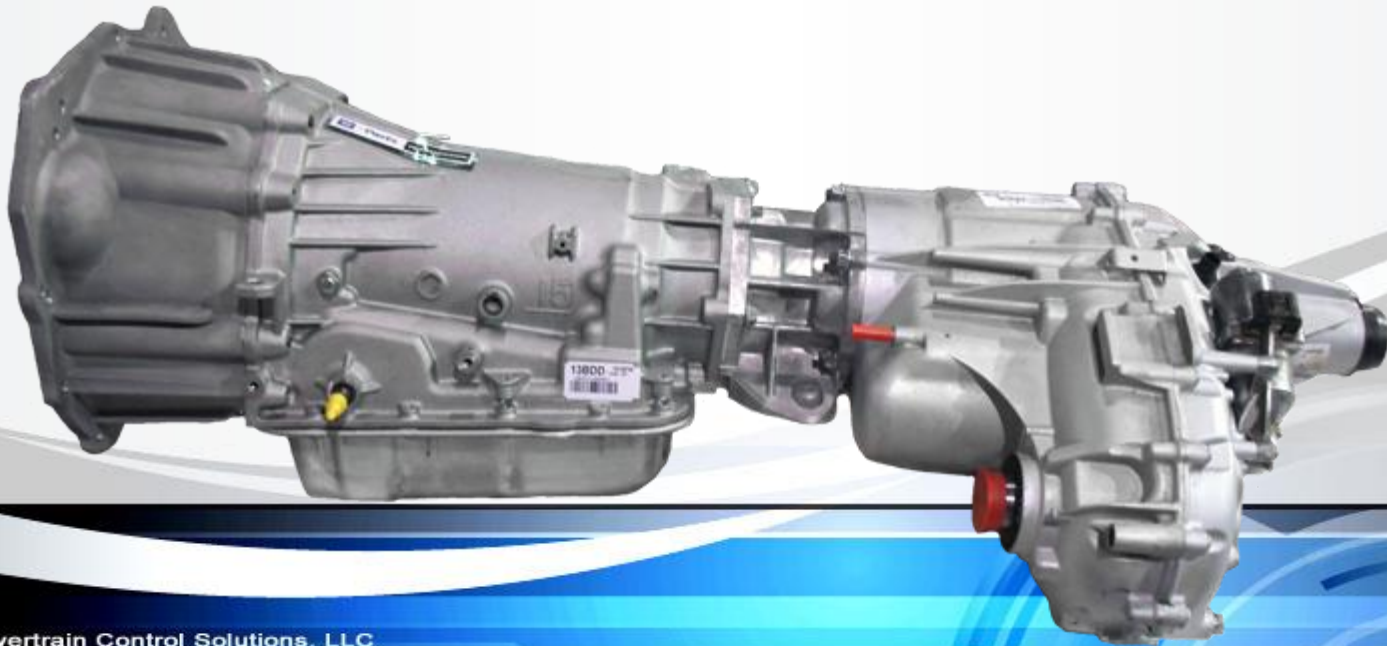


Boeing Badger



Military Integration

- Custom 4L70 bellhousing for VM Motori Engine
- Engineered, calibrated, and validated entire driveline; including our TCM and mil-spec transfer case module



Ground Support Equipment



Website

- Easy URL
- No Advertisements
- Smartphone Friendly
- Easy Contact Info
- Latest Tech Guides
- Latest TSB's
- All GSE Harnesses

This site is intended as a quick reference for technicians.
[To view the full PCS website, please click here](#)

ORDERS AND CUSTOMER SERVICE

Contact: Josh Fleming
Phone: +1 (804) 227-3023 x213
Email: gseorders@powertraincontrol.com

TECHNICAL SUPPORT

Contact: Matthew Petrie
Phone: +1 (804) 227-3023 x212
Contact: Jim Miller
Phone: +1 (804) 227-3023 x225
Email: gsetechs@powertraincontrol.com

WARRANTY ASSISTANCE

Contact: Pasquale Graziosi
Phone: +1 (804) 227-3023 x229
Email: gsewarranty@powertraincontrol.com

SOFTWARE

CURRENT DIAGNOSTIC SOFTWARE VERSION: 1.5.4

OE DIAGNOSTIC SOFTWARE

DOCUMENTATION

QUICK REFERENCE GUIDE

APPLICATION GUIDE

TECHNICIAN'S GUIDE

PARTS AND ACCESSORIES

C6 REPLACEMENT GUIDE

TDD USER GUIDE

ABUSE PROTECTION SOLENOID REPLACEMENT GUIDE

TPS INSTALLATION GUIDELINES

HARNESS DRAWINGS

If you cannot find your harness, please contact gsetechs@powertraincontrol.com to have it added to the list.

TCM-4834-001 HARNESS

TCM-4835-001 HARNESS

TCM-4861-001 HARNESS

TCM-4861-002 HARNESS

TCM-4861-003 HARNESS

Available Reference Material

- *Parts and Accessories (Full Catalog)*
- *Application Guide (Engineering Reference)*
- *Technician's Guide (Standard Maintenance Procedures)*
- *Torque Specs (Transmission & Trans Systems)*
- *Datalog Guide (As explained later)*
- *Training Powerpoint (For your later reference)*
- *Disc Brake Adjustment (As requested by field techs)*
- *All old and new TSB's and Tips & Tricks!!*

Quick Reference

DIAGNOSTIC TROUBLE CODES (DTC's)

CODE DESCRIPTION FAIL CONDITIONS

ACTION TAKEN

ACTIVE TO STORED CONDITIONS

TRANSMISSION DIAGNOSTIC DEVICE (TDD) QUICK REFERENCE

FIVE STEP TROUBLESHOOTING PROCESS

TRANSMISSION QUICK REFERENCE

PCS PCS 4-SPEED TRANSMISSION QUICK REFERENCE

THIS GUIDE IS FOR USE BY A TRAINED TECHNICIAN. FOR ADDITIONAL TECHNICAL SUPPORT, USE THE FOLLOWING:
 +1 (804) 227-3023 gsetechs@powertraincontrol.com GSEhelp.com

TRANSMISSION OVERVIEW

The PCS 4LHD/4LHDx is a four-speed, longitudinal rear-wheel drive electronically controlled automatic overdrive transmission with torque converter clutch and advanced valve body features.

| GEAR | 1st | 2nd | 3rd | 4th | R |
|-------|-------|-------|-------|-------|------|
| RATIO | 3.059 | 1.825 | 1.000 | 0.696 | 2.29 |

**The GSE industry typically only uses 2 or 3 gears.*

PREVENTATIVE MAINTENANCE

- Service interval is 1,000 hours / 12 months whichever comes first
- Filter and pan gasket should be replaced (PCS Part# TRN7090)
- Fluid must be DEXRON VI

DIAGNOSTIC TOOLS



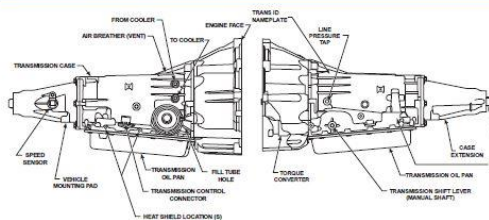
Transmission Diagnostic Device (TDD)
 PCS Part #: A-DTD5000
 Rugged COM Cable
 PCS Part #: A-TCM182

WORK (CAN)

J1939
 Diagnostic protocol used for modules. Typically ECM to TCM for fuel, and other signals. Using resistors.

AN H and CAN L must be 600.

TRANSMISSION FEATURE LOCATIONS



COOLER FITTINGS

Two variants of case cooler interfaces exist within the fleet.

VARIANT 1

Tapped -6ORB
 (ø116-18" w/O-Ring)
 Recommended Fitting:
 PCS Part #: TRN212
 -6ORB Male to -6JIC Male

VARIANT 2

Tapped 1/4" NPS
 (Straight Pipe, 0.54-18")
 Recommended Fitting:
 PCS Part #: TRN215
 1/4" NPS Male to -6JIC Male

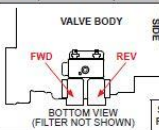
PART NUMBER LOCATOR

TRANSMISSION (See Trans ID Nameplate Above)



IDENTIFY GEN 2 OR GEN 3 VALVE BODY

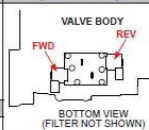
GEN 2 (used for abuse protection)



- ID Methods Below (Choose 1):**
- Remove pan, filter, and compare to image.
 - Measure solenoid resistance: Trans Pin E to Pin R1 ~ 5.4Ω
 - Trans Pin E to Pin S1 ~ 5.4Ω
 - Use TDD to confirm reverse solenoid operation.

| SOLENOID PCS PART# | FWD | REV |
|--------------------|---------|---------|
| | HDW7225 | HDW7230 |

GEN 3 (used for abuse protection, inching, e-shift, and anti-collision)



- ID Methods Below (Choose 1):**
- Remove pan, filter, and compare to image.
 - Measure solenoid resistance: Trans Pin E to Pin R1 ~ 10.9Ω
 - Trans Pin E to Pin S1 ~ 10.9Ω
 - Use TDD to confirm reverse solenoid operation.

| SOLENOID PCS PART# | FWD | REV |
|--------------------|---------|---------|
| | VBM1050 | VBM1050 |

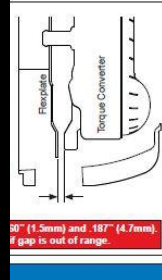
ABLE FOR DIAGNOSTICS.

Pressure gauge for transmission lines should exceed 300 PSI.
 Pressure between 100 - 200 PS.

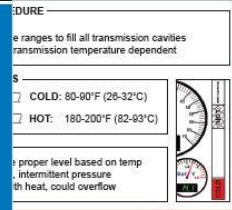
| 4LHDX / 4LHD | AMP | PSI |
|--------------|-----|---------|
| 0 | 0 | 170-193 |
| 0.5 | 0.5 | 135-168 |
| 1 | 1 | 54-80 |
| 0 | 0 | 198-227 |
| 0.5 | 0.5 | 154-193 |
| 1 | 1 | 53-85 |

Test in Neutral with the brakes at 1500 RPM. Failure to do so may result in excess of 300 PSI that could result in serious injury.

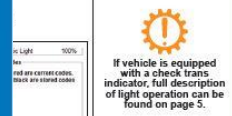
Row out.



60" (1.5mm) and 187" (4.7mm). If gap is out of range.



Temperature ranges to fill all transmission cavities transmission temperature dependent



If vehicle is equipped with a check trans indicator, full description of light operation can be found on page 5.

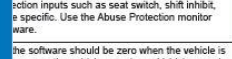
On harness schematic is strongly recommended during this step. It can be obtained from: powertraincontrolsolutions.com

Using the software and verify the following items:

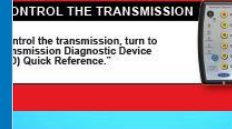
- Reported lever position.
- TPS matches the reported TPS. Must be 0% at idle throttle. Abuse protection typically set at 15%.
- TPS reports engine RPM. Abuse protection 0%.

When the software should be zero when the vehicle is at rest. As the vehicle speeds up, vehicle speed should increase - this is intentional for calibration.

Control the transmission, turn to Transmission Diagnostic Device (TDD) Quick Reference.



Control the transmission, turn to Transmission Diagnostic Device (TDD) Quick Reference.



will control the transmission without could move suddenly and without until it is desired for the vehicle to device.



Figure 1

SOLENOID TEST

Reverse (abuse protection)

| TCC | SSA | SSB |
|-----|-----|-----|
| OFF | ON | ON |

Vehicle with REV ON. The vehicle should

Vehicle should not move.

SOLENOID TEST

Reduces transmission when switch ON provides 1A to the

| TCC | SSA | SSB |
|-----|-----|-----|
| OFF | ON | ON |

Vehicle with Line OFF. Move forward and the vehicle should shift with

Neutral.

Vehicle with Line, SSA, and SSB ON. Shift into 2nd gear. The vehicle

converter clutch.

| TCC | SSA | SSB |
|-----|-----|-----|
| OFF | ON | ON |

Vehicle while firmly applying the brakes. Vehicle should stall.

in trans temp drops w 148°C for 5 mins.

in trans temp goes w -35°C for 5 mins.

in trans temp goes w -35°C for 5 mins.

Valid communication received or anti-collision fault cleared.

in Engine RPM is above 300 RPM

Calculate and Key Cycle

When the ignition is active and stored

Key Cycle

When Input Speed goes above 75 RPM for 2 seconds.

Clears when system voltage is greater than the following conditions for 4 seconds:

40°F (-40°C) +7.3V
 134°F (62°C) +10.3V
 302°F (150°C) +11.7V

When Input Speed goes above 75 RPM for 2 seconds.

Clears when system voltage is greater than the following conditions for 4 seconds:

40°F (-40°C) +7.3V
 134°F (62°C) +10.3V
 302°F (150°C) +11.7V

When trans temp falls below 265°F (130°C) for 5 seconds.

When Fault condition removed for 2 seconds.

When Fault condition removed for 2 seconds.

When Fault condition removed for 2 seconds.

Key Cycle

Key Cycle

Key Cycle

Key Cycle

Key Cycle

Key Cycle

Key Cycle

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Key Cycle

Key Cycle

For Technical Help



gsetechs@powertraincontrol.com

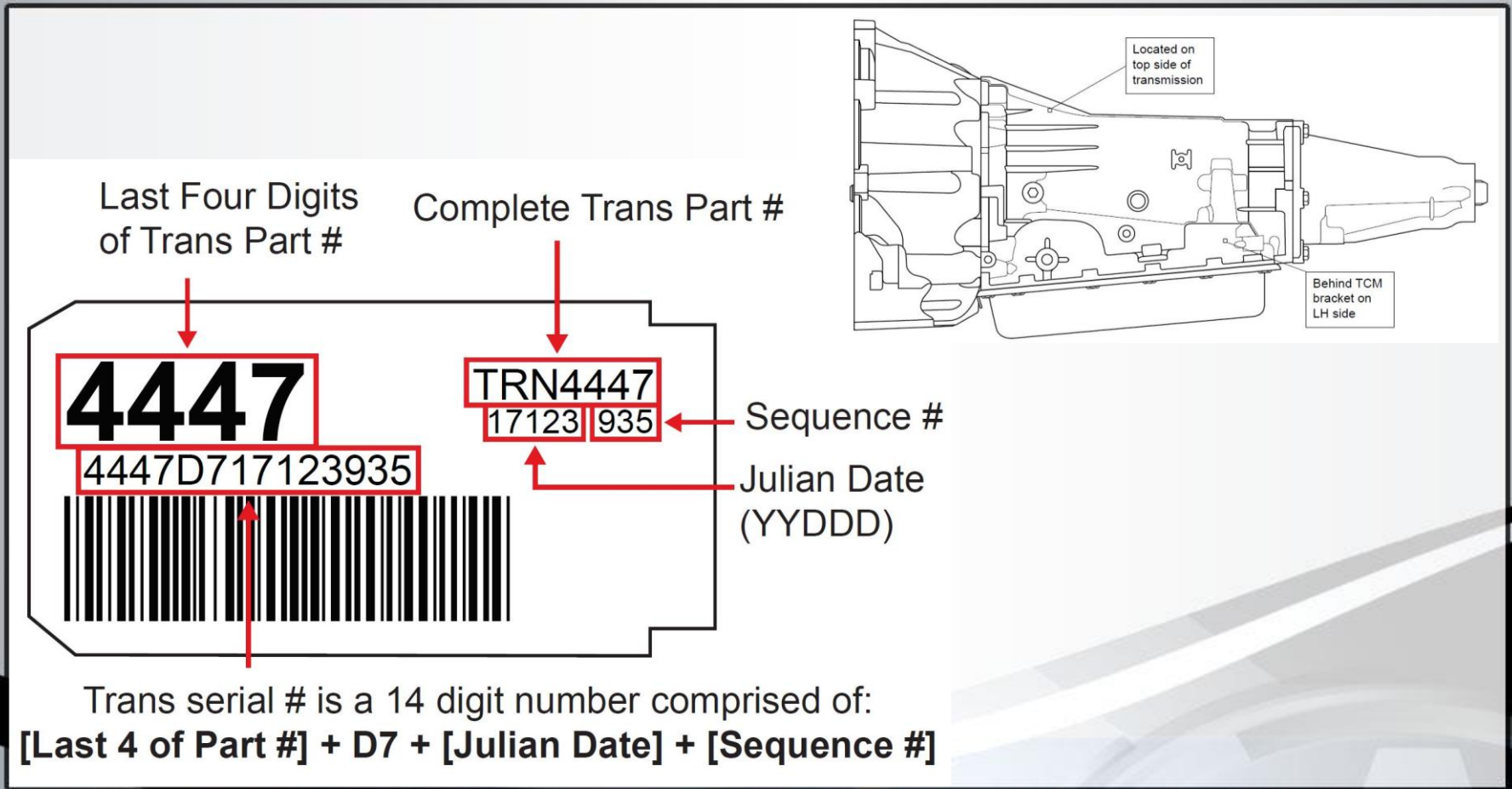


GSEhelp.com



+1 (804) 227-3023

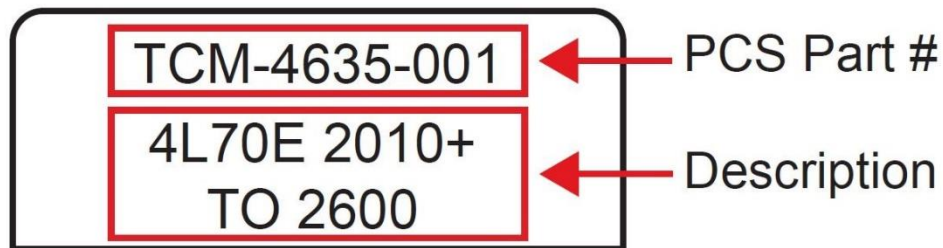
Transmission ID



Harness ID



Located at the TCM breakout



TCM2600 / 2800, Firmware, Calibration

TCU Monitor Version: 1.4.3

The interface displays several gauges: RPM x1,000 (approx. 1.2), TCC (2), Speed MPH (24), TPS (28), CLT (0), in.Hg PSI (-18), Trans (77), and Bat V (14.1). A 'Connected' status bar is visible.

Analog Inputs

| | |
|---------------------|--------|
| TPS | 2.17 V |
| Fluid Temperature 1 | 3.66 V |

TPS Info

| | |
|-----------------|--------|
| TPS Percentage | 28% |
| Min TPS Voltage | 1.49 V |
| Max TPS Voltage | 3.90 V |

Speed Inputs

| | |
|----------------------|--------|
| Engine RPM | 1036 |
| Calculated Input RPM | 511 |
| Input Shaft RPM | 511 |
| Output Shaft RPM | 1833 |
| Vehicle Speed 1 | 24 MPH |
| Vehicle Speed 2 | 15 MPH |

Slip

| | |
|-------------------|------|
| TCC Slip RPM | 525 |
| Transmission Slip | -84% |

Other

| | |
|----------------------|--------|
| Actual Gear Ratio | 0.27 |
| 1-2 Shift Time | .102 |
| 2-3 Shift Time | .000 |
| Target Line Pressure | 0% |
| LP Target Current | 4.26 A |
| TCC Duty Cycle | 0 |

Temperatures

| | |
|---------------------|--------|
| Transmission Temp 1 | 77 °F |
| Transmission Temp 2 | 295 °F |

Mode

| On | Off | Mode |
|----------------------------------|----------------------------------|-------------------|
| <input type="radio"/> | <input checked="" type="radio"/> | Full Throttle |
| <input type="radio"/> | <input checked="" type="radio"/> | Cancel Overdrive |
| <input checked="" type="radio"/> | <input type="radio"/> | TCC Locked |
| <input type="radio"/> | <input checked="" type="radio"/> | Cancel TCC Lockup |
| <input type="radio"/> | <input checked="" type="radio"/> | Calibration B |
| <input type="radio"/> | <input checked="" type="radio"/> | Analog Fail |
| <input type="radio"/> | <input checked="" type="radio"/> | Simple Manual |
| <input type="radio"/> | <input checked="" type="radio"/> | True Manual |
| <input type="radio"/> | <input checked="" type="radio"/> | 4wd Low |
| <input type="radio"/> | <input checked="" type="radio"/> | Dyno |
| <input type="radio"/> | <input checked="" type="radio"/> | Snow |

Digital Input

| On | Off | Digital Input |
|----------------------------------|----------------------------------|-----------------|
| <input checked="" type="radio"/> | <input type="radio"/> | Gear Select 1 |
| <input type="radio"/> | <input checked="" type="radio"/> | Gear Select 2 |
| <input type="radio"/> | <input checked="" type="radio"/> | Gear Select 3 |
| <input type="radio"/> | <input checked="" type="radio"/> | Digital Input 4 |
| <input type="radio"/> | <input checked="" type="radio"/> | Digital Input 5 |
| <input type="radio"/> | <input checked="" type="radio"/> | Digital Input 6 |
| <input type="radio"/> | <input checked="" type="radio"/> | Digital Input 7 |
| <input type="radio"/> | <input checked="" type="radio"/> | Digital Input 8 |

Digital Outputs

| On | Off | Digital Outputs |
|----------------------------------|----------------------------------|-------------------|
| <input checked="" type="radio"/> | <input type="radio"/> | Shift Solenoid A |
| <input checked="" type="radio"/> | <input type="radio"/> | Shift Solenoid B |
| <input type="radio"/> | <input checked="" type="radio"/> | Diagnostic Light |
| <input checked="" type="radio"/> | <input type="radio"/> | TCC Lockup |
| <input type="radio"/> | <input checked="" type="radio"/> | Digital Outputs 5 |
| <input type="radio"/> | <input checked="" type="radio"/> | Digital Outputs 6 |

System Information

Serial Number: 10025
Firmware Version: 3.126.6
 Prom ID: 7053
 Odometer: 20,000 Miles
 Hour Meter: 6.86 Hours

PWM Outputs

| | |
|--------------------------|------|
| Line Pressure | 98% |
| TCC Pressure Control | 96% |
| Inching Forward Clutch C | 78% |
| Inching Reverse Clutch D | 0% |
| Shift Solenoid A | 100% |
| Shift Solenoid B | 100% |
| Diagnostic Light | 0% |

Current

| | |
|----------------------|--------|
| LP Actual Current | 0.04 A |
| Current 2 | 0.00 A |
| FWD Inching Solenoid | 0.00 A |
| REV Inching Solenoid | 0.51 A |

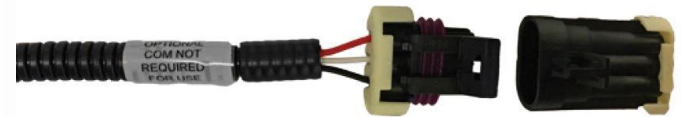
Fail Codes

Codes in red are current codes.
 Codes in black are stored codes

Clear Codes

Check for Codes – PCS Software

- Transmission controller is accessed via a serial data interface and a laptop
- The serial data interface cable kit is available from PCS, part number TCM4640
- The Diagnostic Software is available from GSEhelp.com



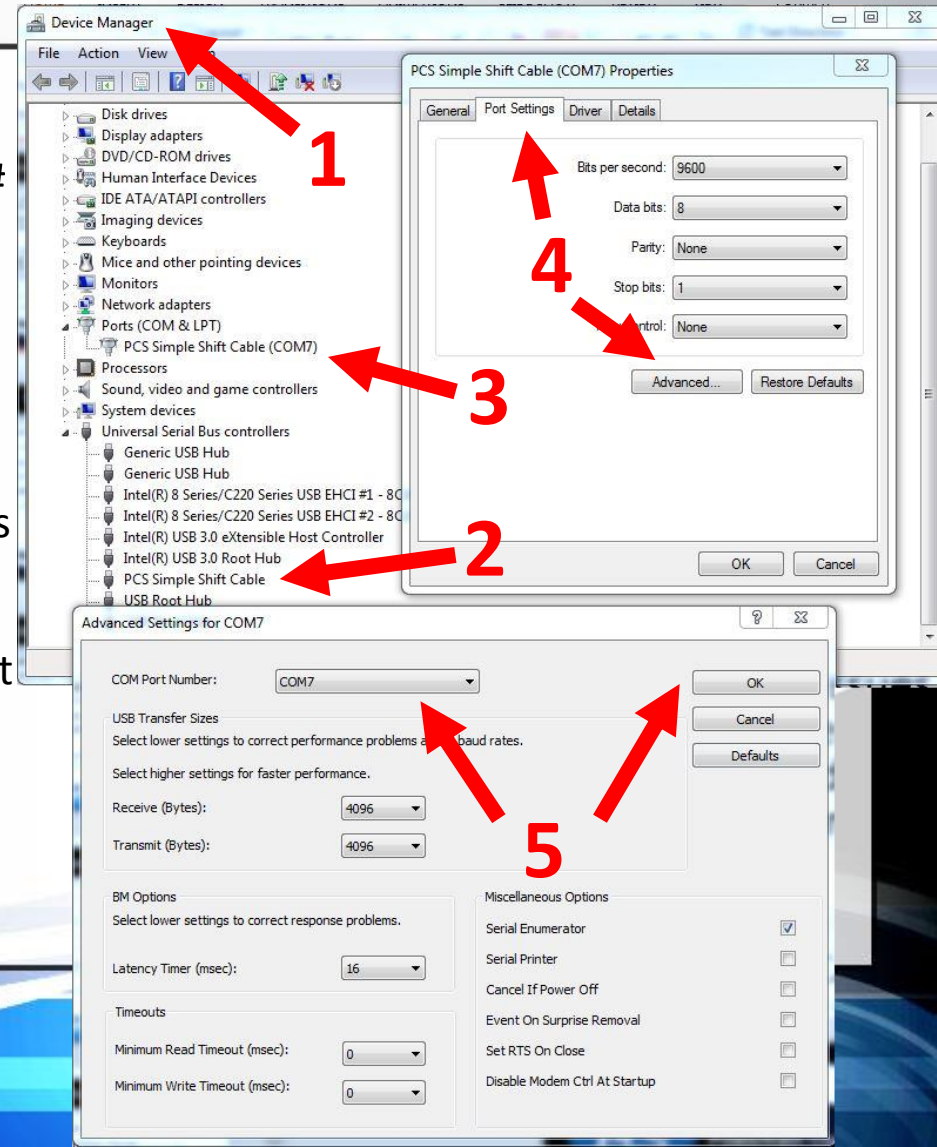
Labeled "OPTIONAL COM NOT REQUIRED FOR USE."

When not in use cap is required.



Serial Communication Cable

- TCM is accessed via a serial data interface and a Windows laptop
- Replacement is available from PCS. PN# TCM4180
- Comm issues
 - Step-1: Hit the Windows button and type “Device Manager”.
 - Step-2: Verify that the device & driver is installed and no errors.
 - Step-3: Ports (Com & LPT) 5-15... Windows often defaults to com-3. If not 5-15, right-click & Properties.
 - Step-4: Port-Settings, Advanced
 - STEP-5: Select an available com 5-15.



4-Speed Offerings

- 4L60E / 4L70E Hybrid Core:
 - 4LHD (258mm), 4LHDX (300mm)
 - 4-Speed Transmission w/ Lockup Converter
 - 4L60/70 GM Transmission with upgrades for industrial use and abuse protection valvebody.
 - GSE typically only uses 2 or 3 speeds.

| GEAR | 1st | 2nd | 3rd | 4th | R |
|-------|-------|-------|-------|-------|------|
| RATIO | 3.059 | 1.625 | 1.000 | 0.696 | 2.29 |

Great Lakes ferry story!

4L60E Legacy Upgrades

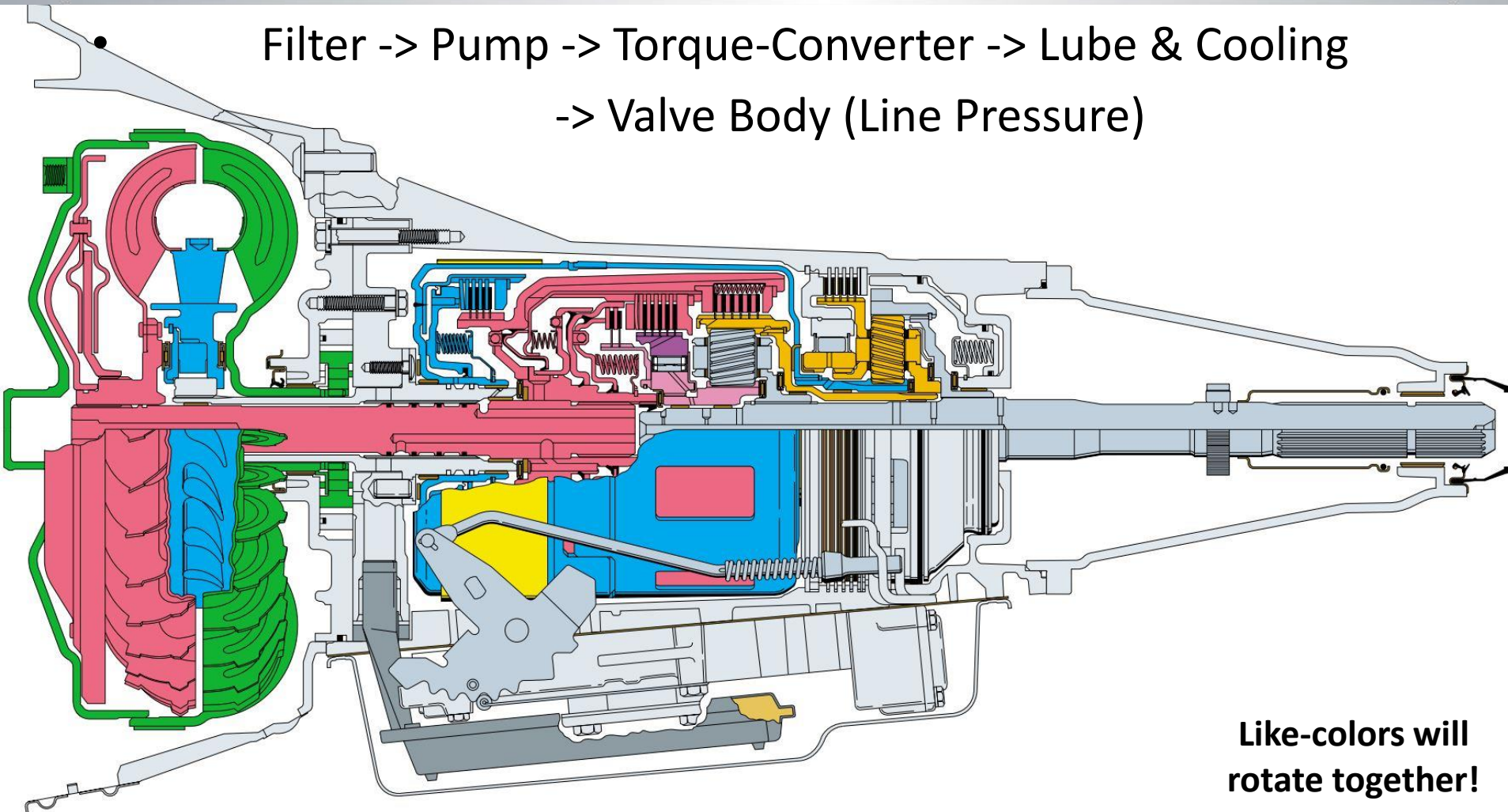
- GM oversight on all Production Processes & Quality Control
- 100% Full functionality tested on trans-dyno test stands
- GM/PCS 2yr or 2,000hr warranty
 - Does not cover shipping damages, improper installation, improper operation / maintenance
- Heat Treated input / output shafts
- Induction hardened input / output shaft splines
- Latest 4L70E electronics for diagnostics & control
- 7-plate 3-4 Clutch
- Heavy-Duty low/reverse roller clutch
- Heavy-Duty needle-type thrust bearings
- Five pinion rear planets
- Hardened reaction sun gear shell

Standard 4L60E, with PCS Options

- Bellhousings:
 - GM/LS, SAE4, C6 (SAE3 and SAE5 adapters available)
- Torque Converters:
 - 300mm, 258mm, C6-258mm
- Output:
 - 2WD Slip Yoke, FFO w/ Disc, C6 w/Drum, and 4WD
- Valve body:
 - Gen 2 (Abuse protection), Gen 3 (Electronic range, inching, anti-collision)
- New or Reman
- 72 unique transmission part numbers (Transmission Listing on website)

Transmission Systems & Operation 1

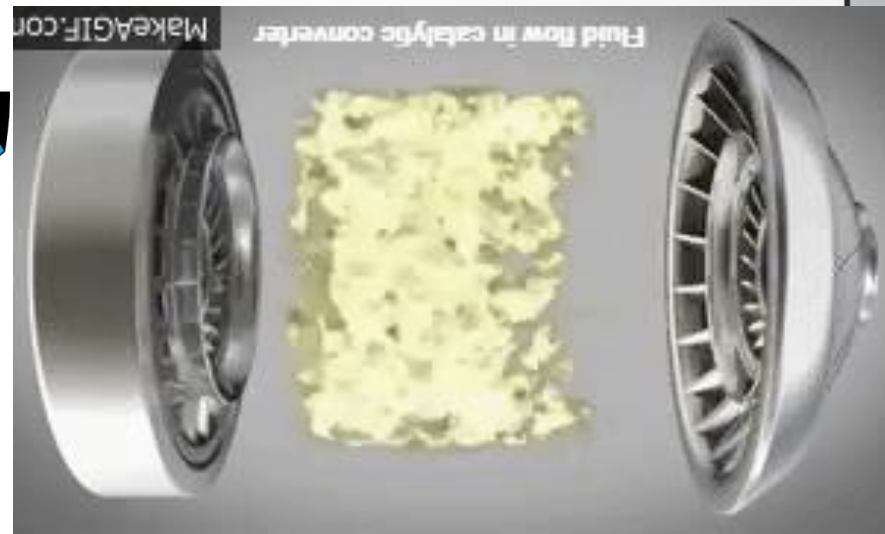
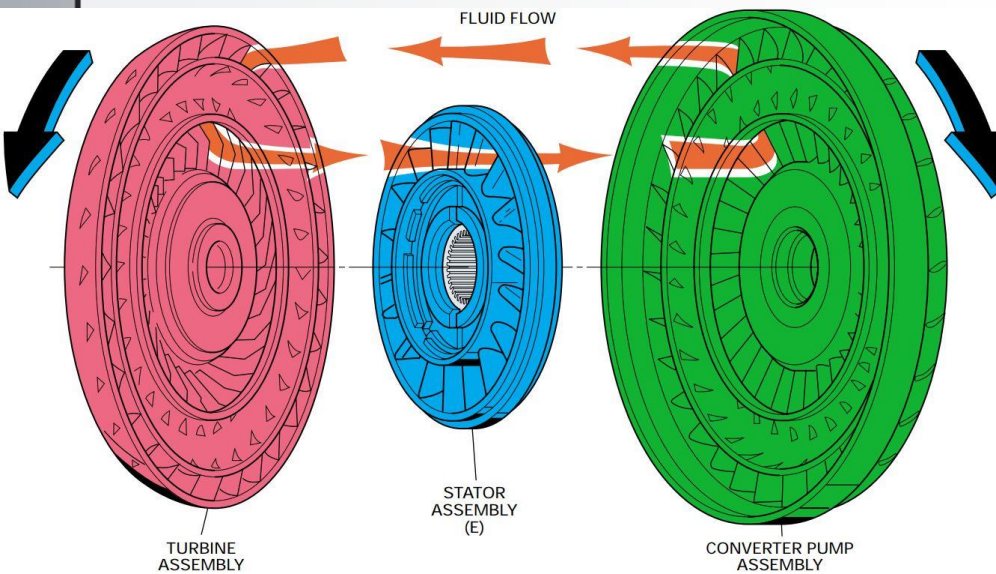
- Filter -> Pump -> Torque-Converter -> Lube & Cooling
-> Valve Body (Line Pressure)



**Like-colors will
rotate together!**

TORQUE CONVERTER

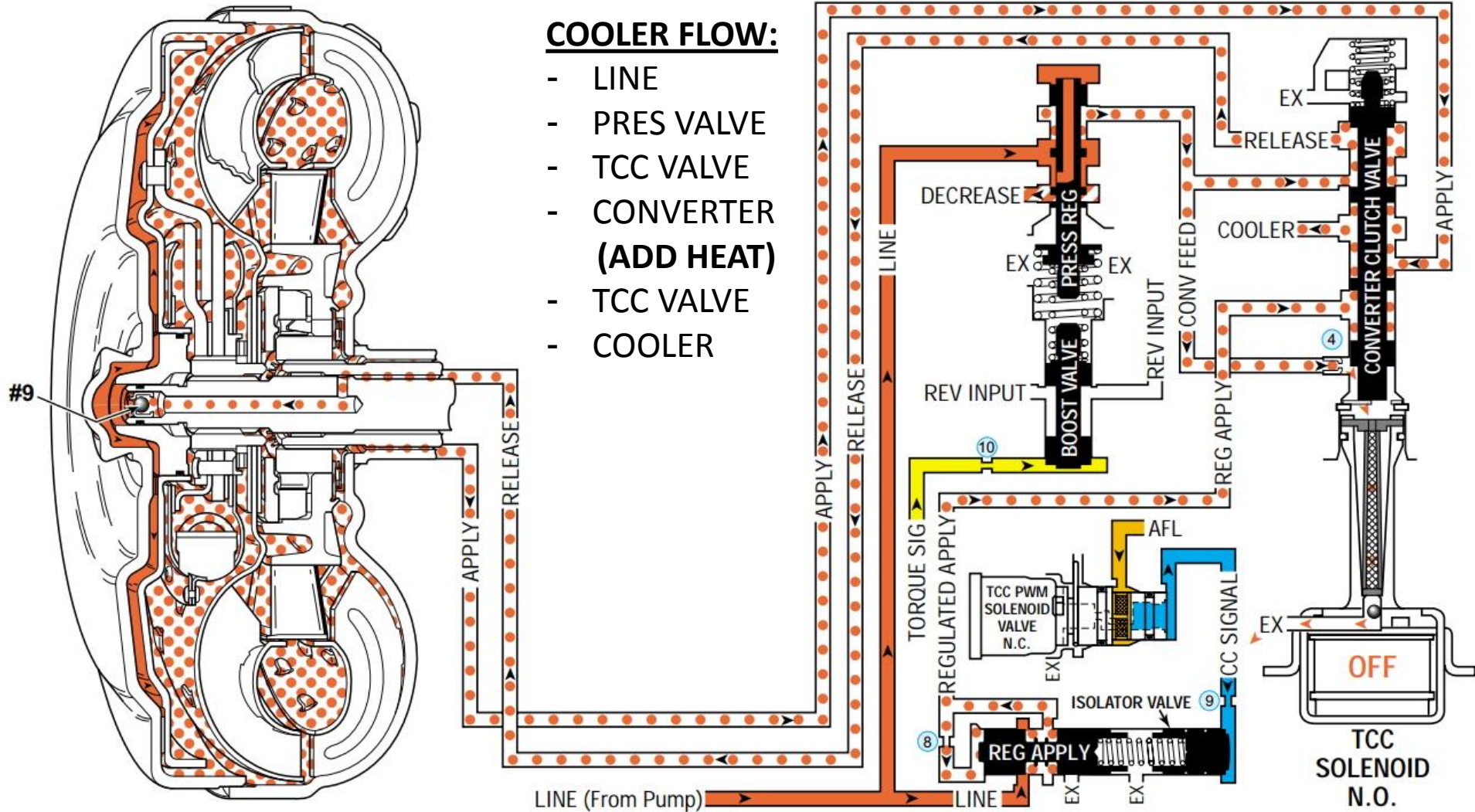
- FLUID COUPLING.
- ALLOWS ENGINE TO SLIP / RUN AT IDLE WHILE IN GEAR.
- ~2X TORQUE MULTIPLICATION.
- LOWER EFFICIENCY; GENERATES HEAT THROUGH FRICTION.
- PUMP DESIGNED TO FILL IMMEDIATELY ON ENGINE STARTUP.
- PHYSICALLY DRIVES THE PUMP, OUTER CASE AT ENGINE-RPM.
- INTEGRATED LOCKUP CLUTCH FOR GEAR 3 / 4.



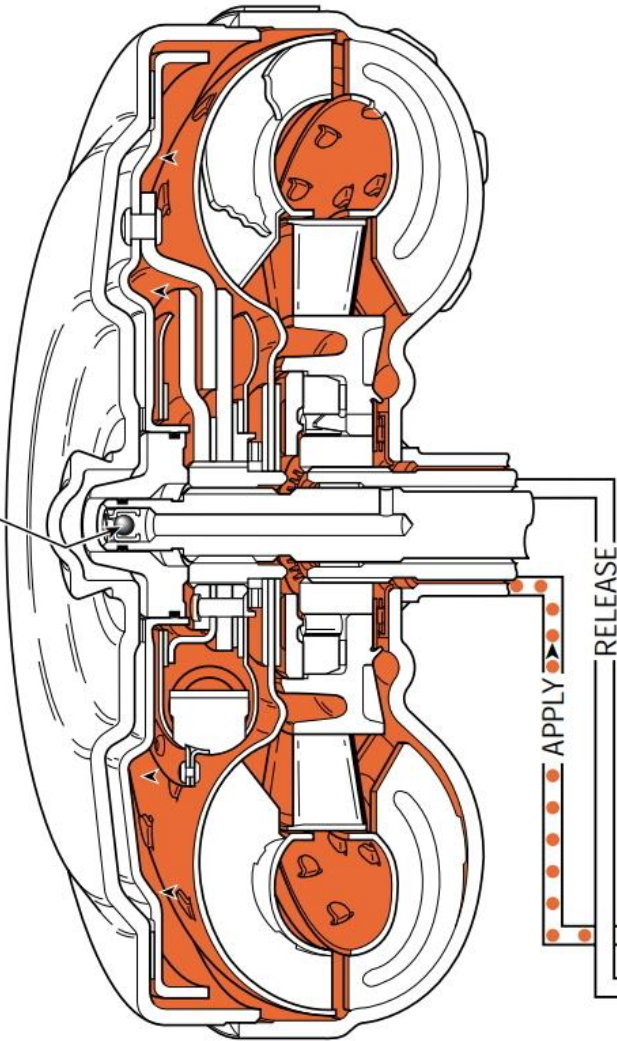
CONVERTER – UNLOCKED / RELEASED

COOLER FLOW:

- LINE
- PRES VALVE
- TCC VALVE
- CONVERTER (ADD HEAT)
- TCC VALVE
- COOLER

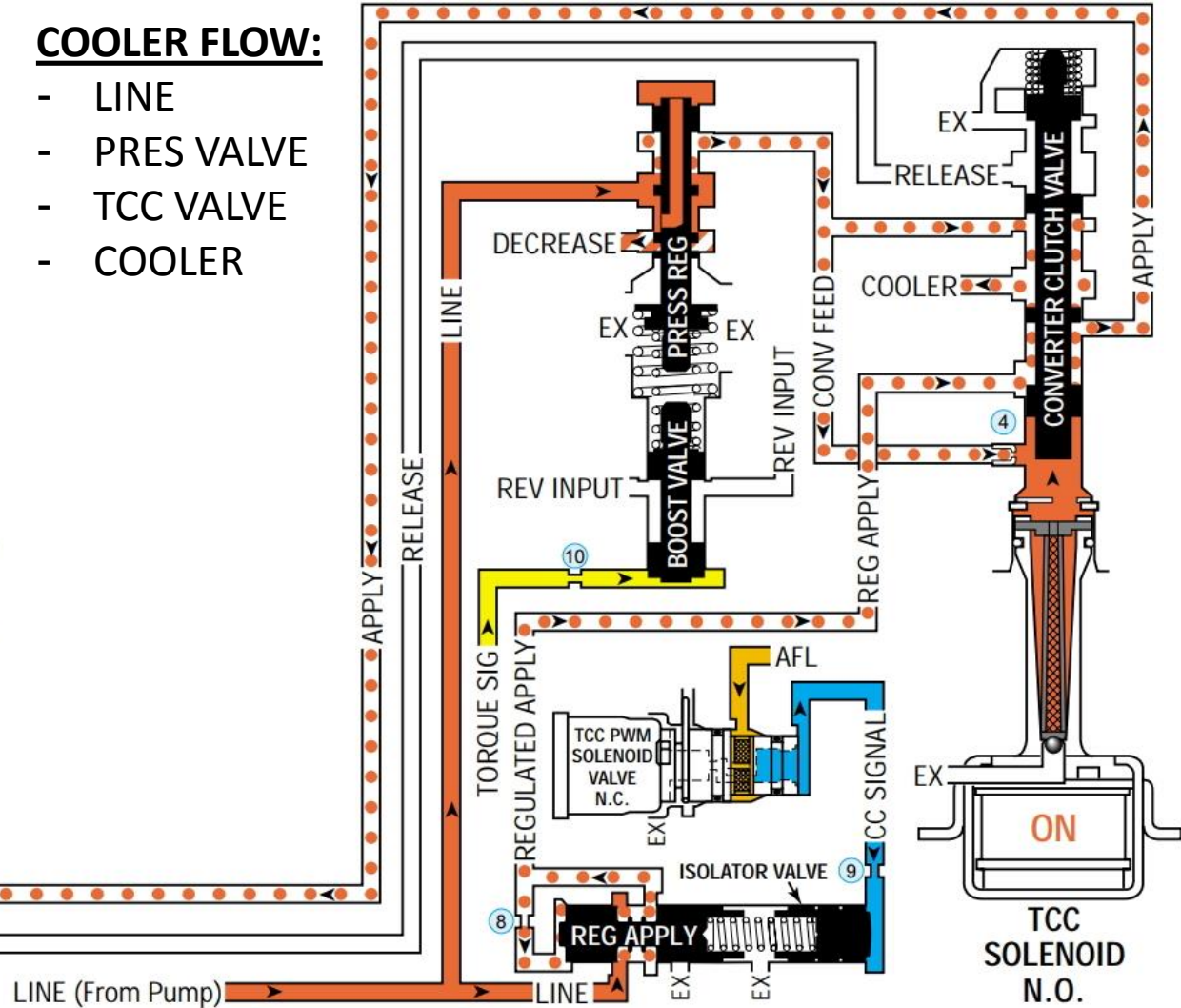


CONVERTER – LOCKED / APPLIED



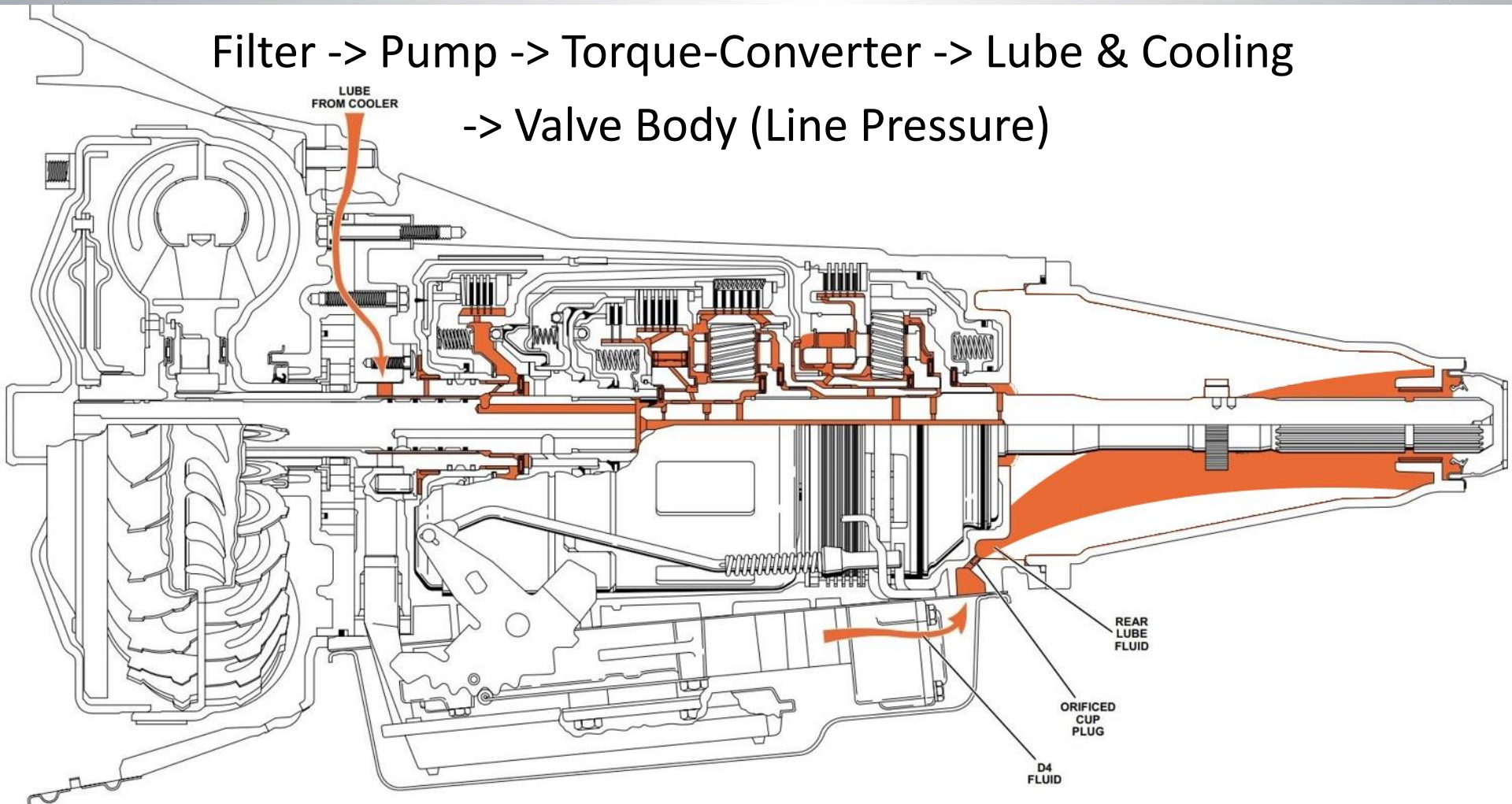
COOLER FLOW:

- LINE
- PRES VALVE
- TCC VALVE
- COOLER

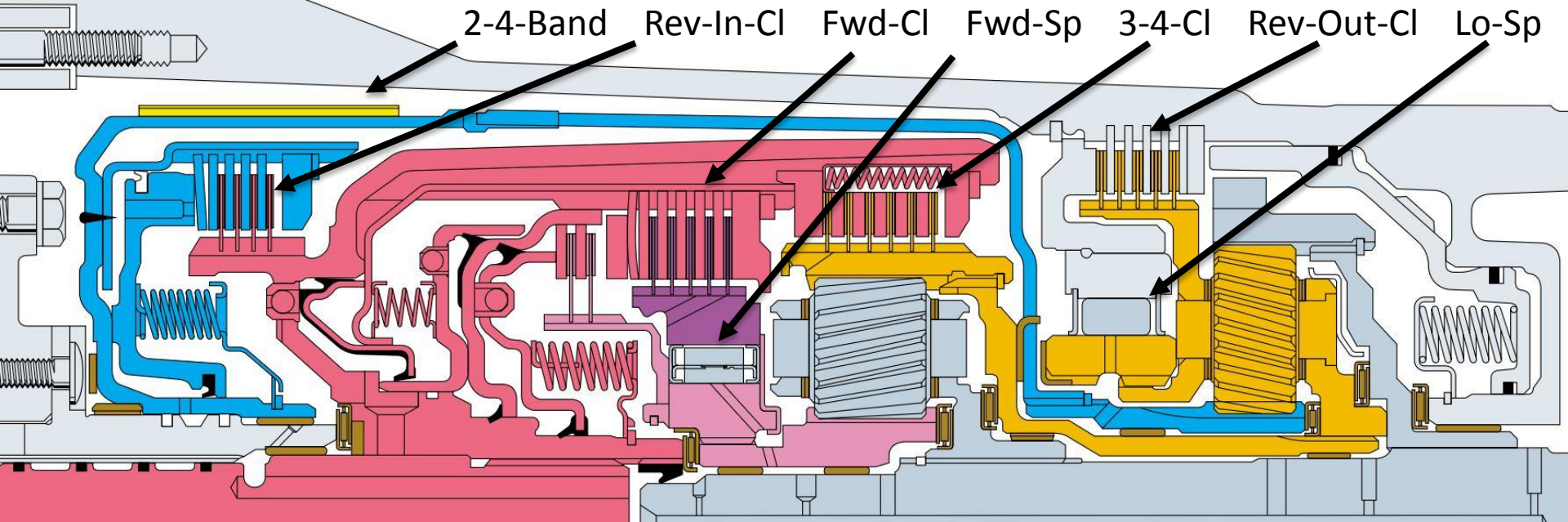


COOLING AND LUBRICATION CIRCUIT

Filter -> Pump -> Torque-Converter -> Lube & Cooling
-> Valve Body (Line Pressure)

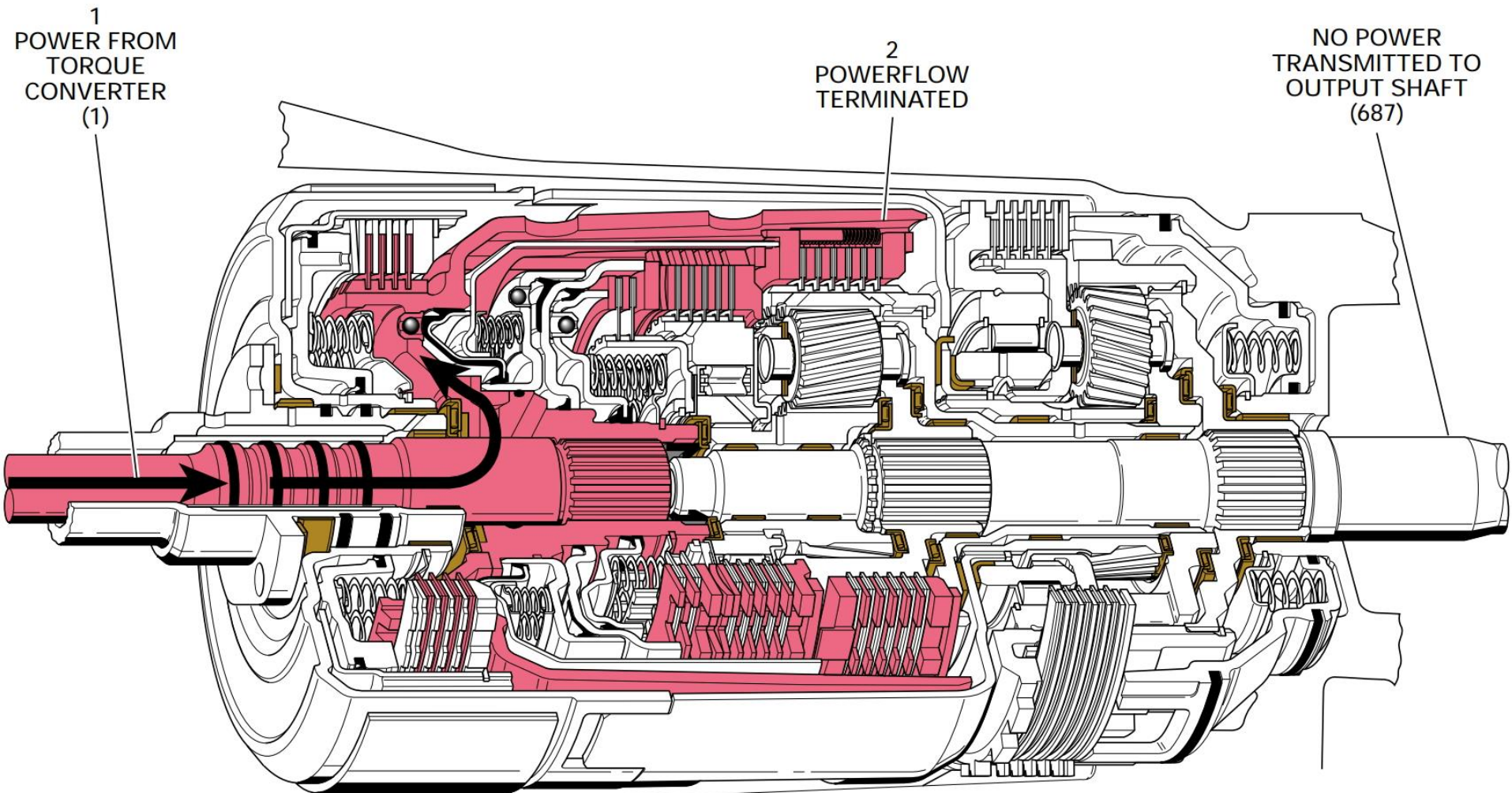


Transmission Systems & Operation 2

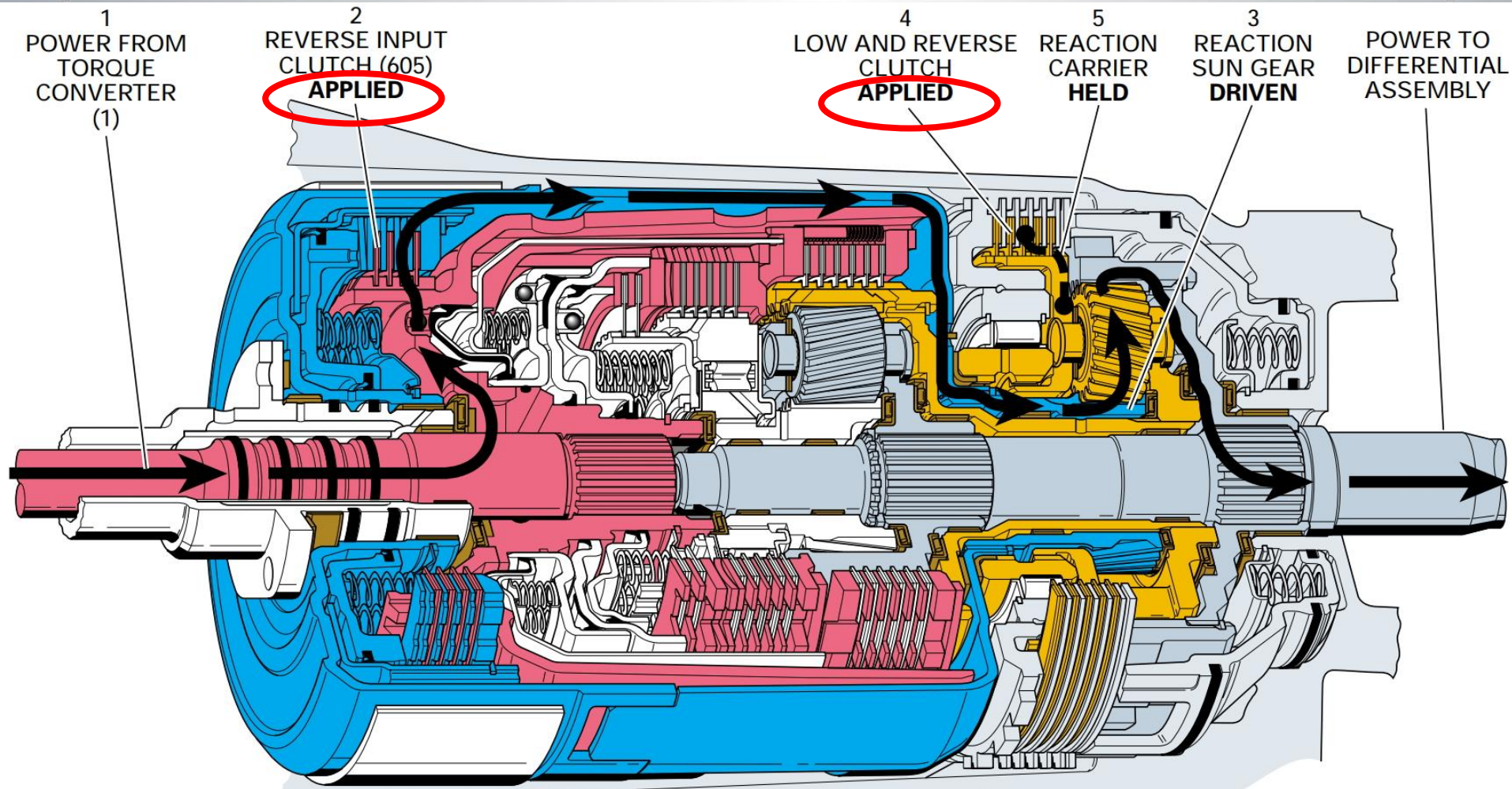


| RANGE | GEAR | SHIFT SOLENOID VALVES | | 2-4 BAND | REVERSE INPUT CLUTCH | OVERRUN CLUTCH | FORWARD CLUTCH | FORWARD SPRAG CL. ASSEMBLY | 3-4 CLUTCH | LO ROLLER CLUTCH | LO/REV. CLUTCH |
|---------|------|-----------------------|-----|----------|----------------------|----------------|----------------|----------------------------|------------|------------------|----------------|
| | | 1-2 | 2-3 | | | | | | | | |
| PARK | | ON* | ON* | | | | | | | | APPLIED |
| REVERSE | | ON* | ON* | | APPLIED | | | | | | APPLIED |
| NEUTRAL | | ON* | ON* | | | | | | | | |
| D | 1st | ON | ON | | | | APPLIED | HOLDING | | HOLDING | |
| | 2nd | OFF | ON | APPLIED | | | APPLIED | HOLDING | | | |
| | 3rd | OFF | OFF | | | | APPLIED | HOLDING | APPLIED | | |
| | 4th | ON | OFF | APPLIED | | | APPLIED | | APPLIED | | |

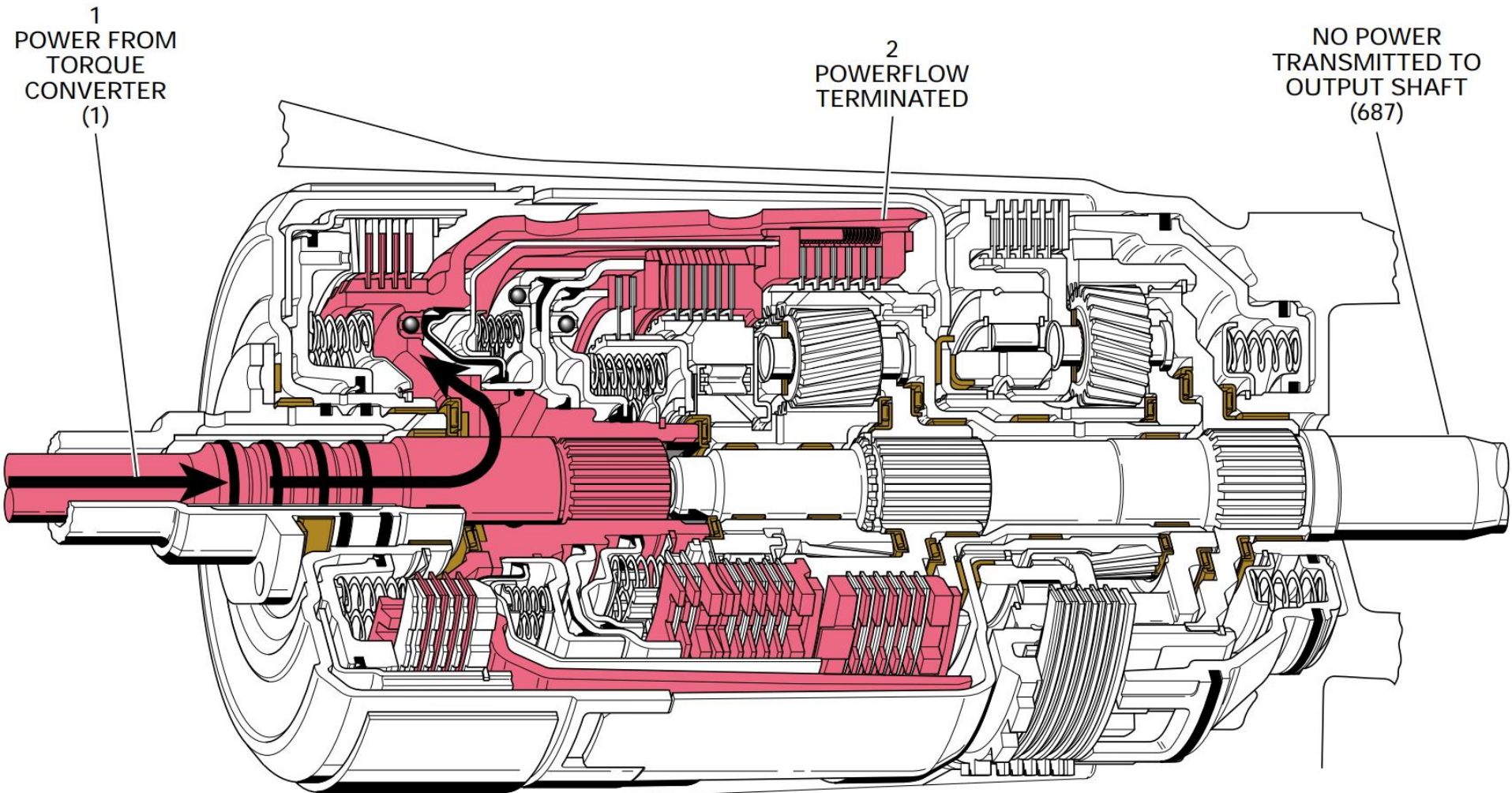
STARTUP, PARK / NEUTRAL



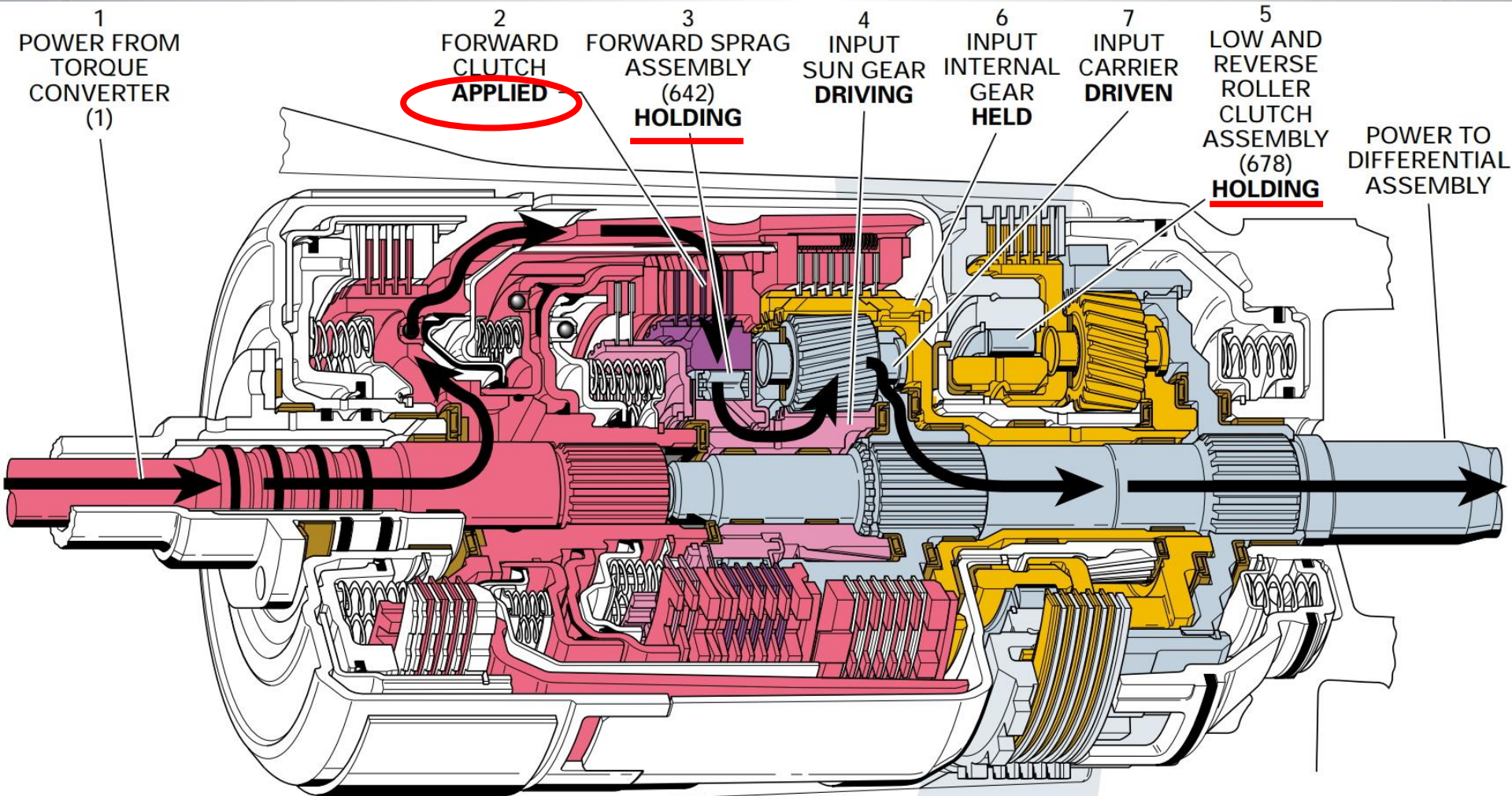
REVERSE "REV" – 2.29:1



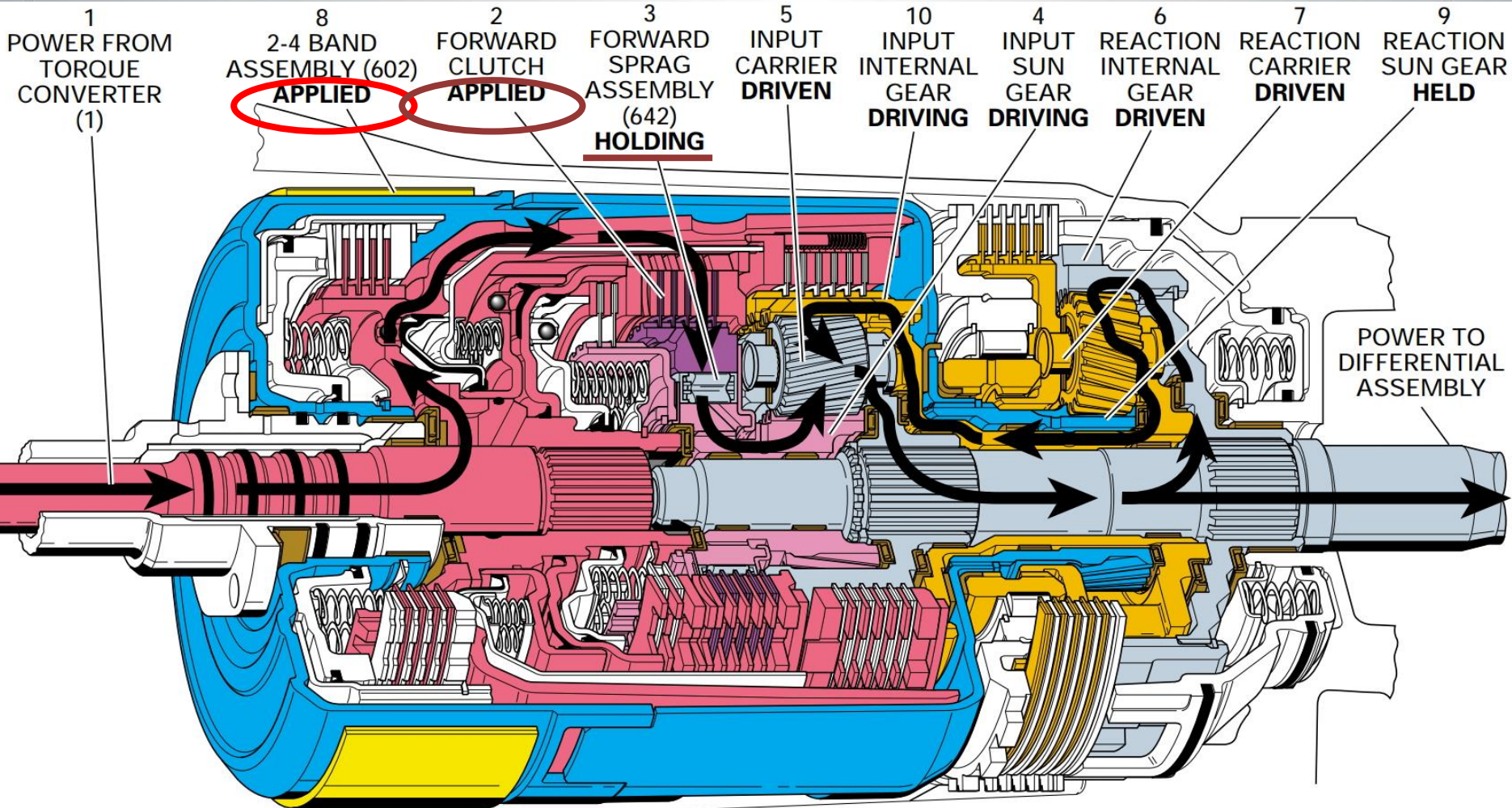
STARTUP, NEUTRAL



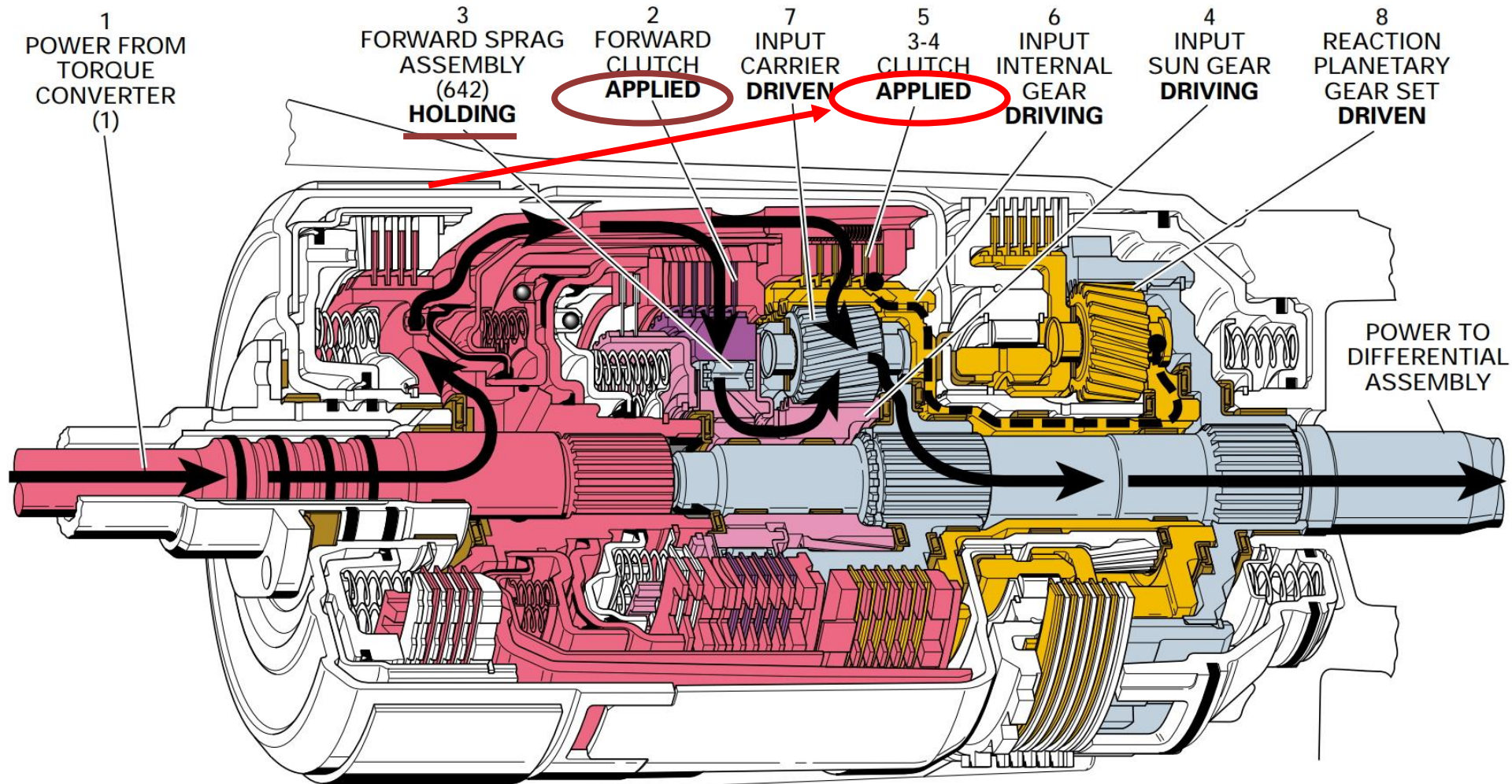
FWD – 1ST GEAR – 3.06:1



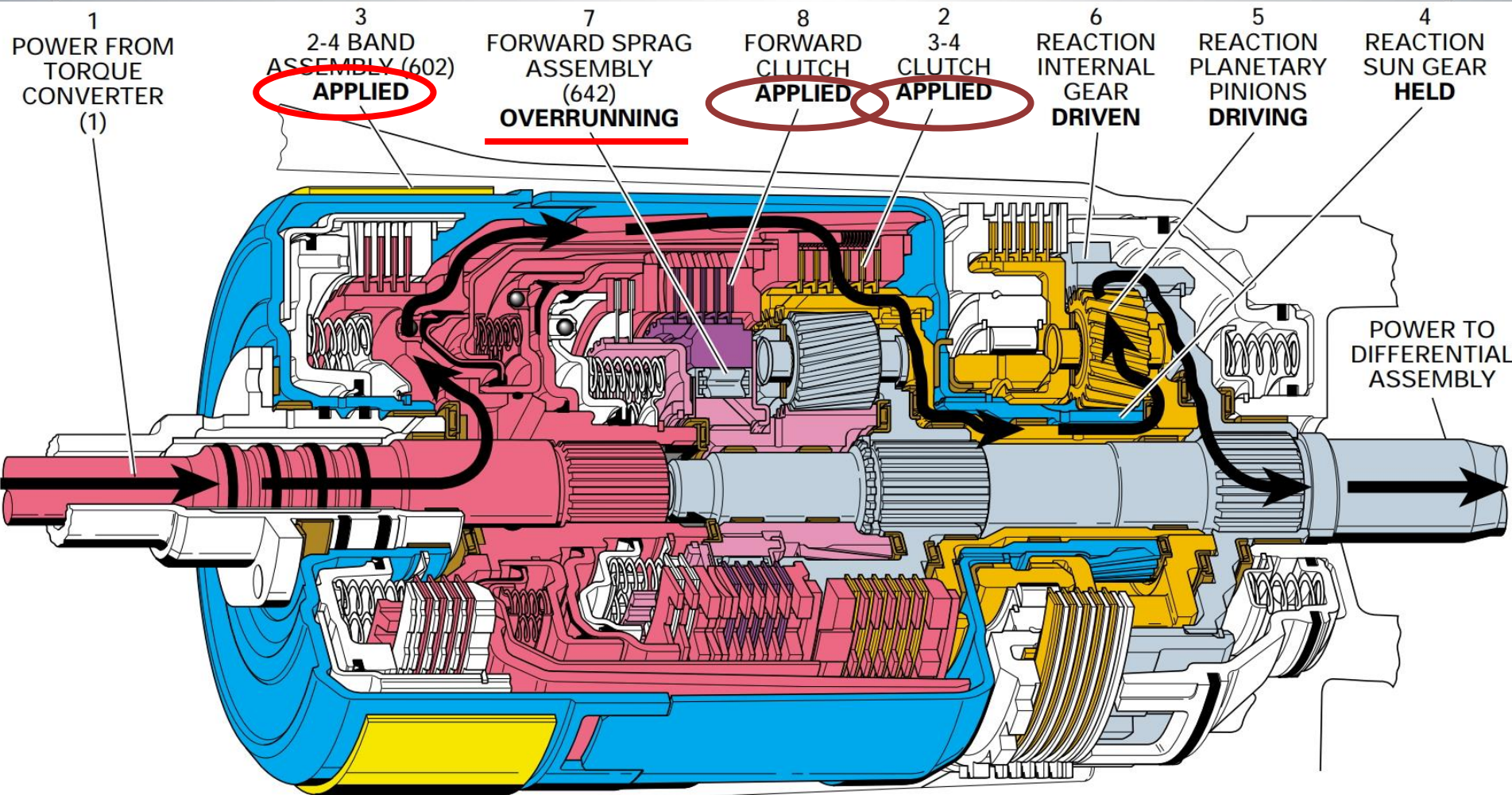
FWD – 2ND GEAR – 1.63:1



FWD – 3RD GEAR – 1.00:1

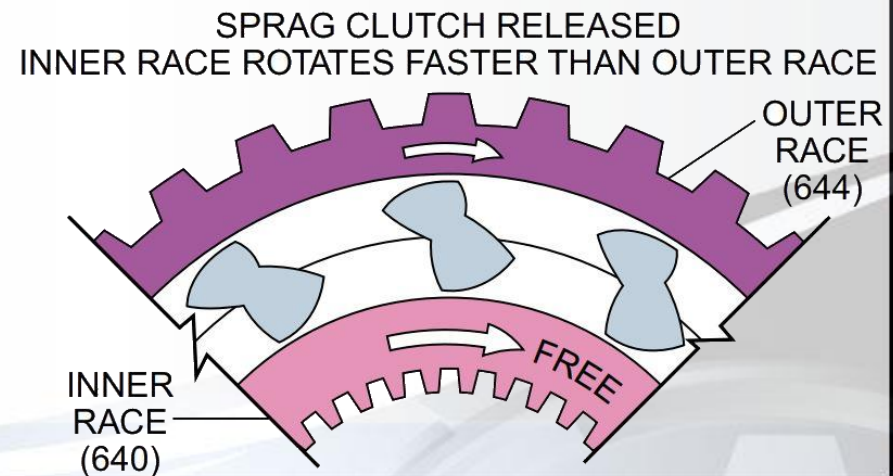
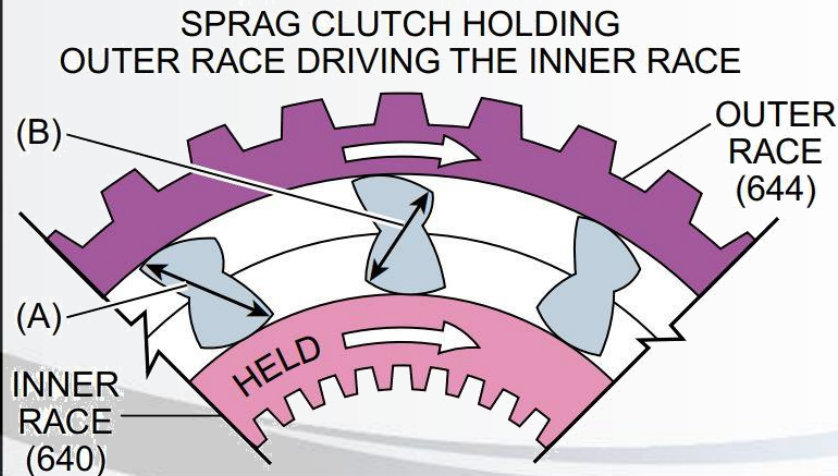


FWD – 4TH GEAR – 0.69:1



DOWNSHIFTS ARE ALL “OVERRUN”

- When downshifting and/or decelerating, the Forward Sprag Assembly will coast / freewheel / overrun until the engine RPM and the driveshaft RPM meet at the correct gear's ratio.



TRN4240 / TRN5240 (GEN-2)

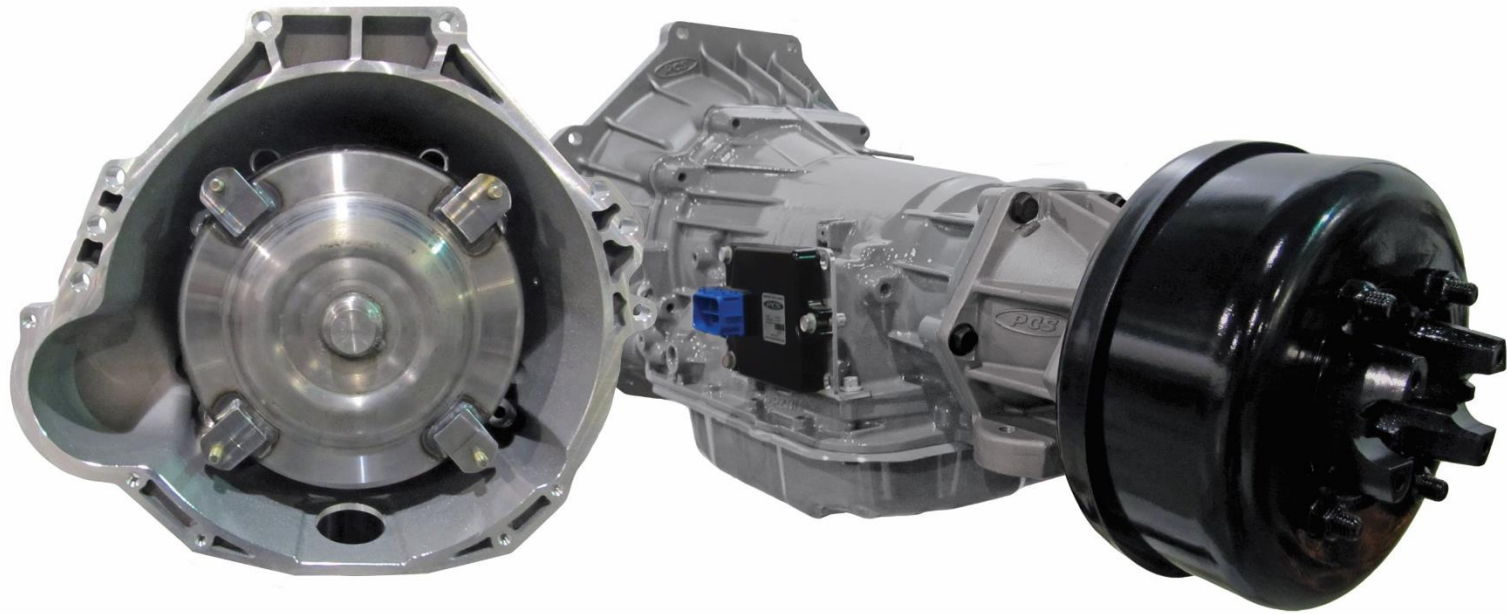
- Very common in 2013-2018 vehicle builds
- Looks like a 4L60E. LS Bell & Slip Yoke
- 258mm Converter
- GEN-2 VB



- Also 14T2D
- and similar numbers

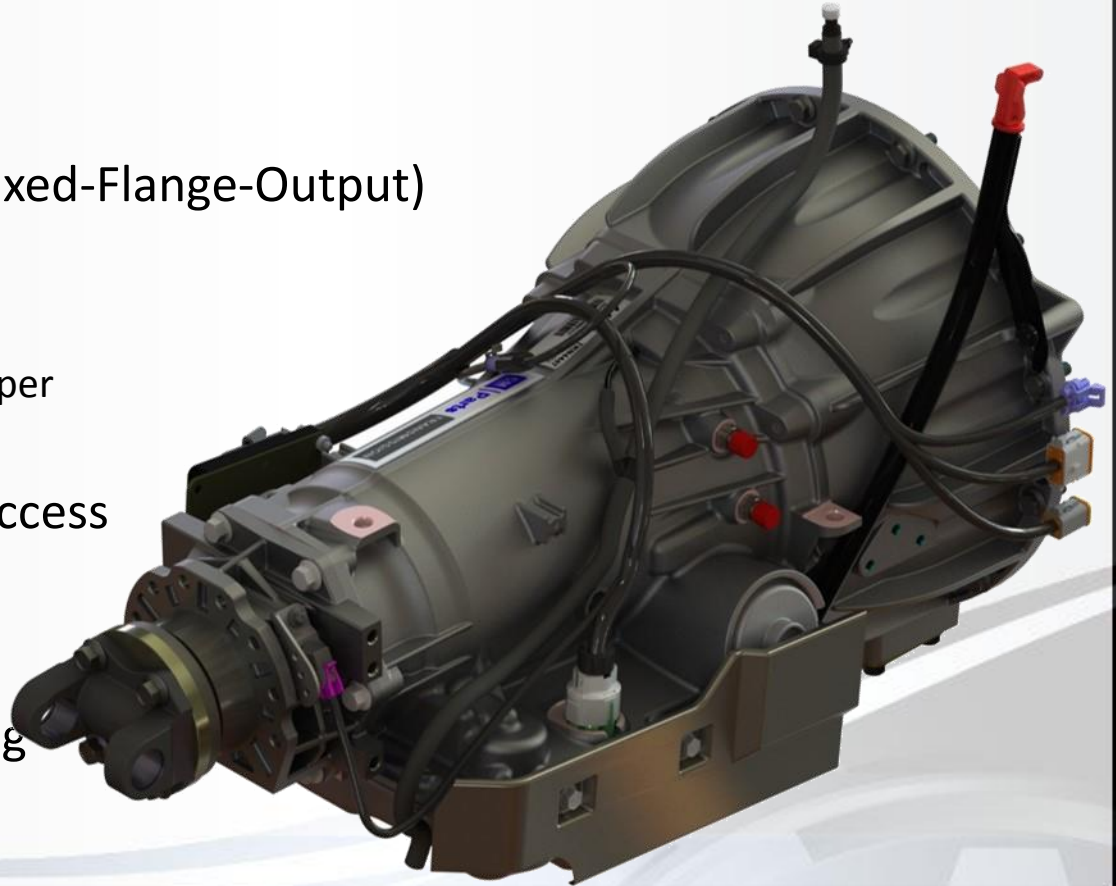
TRN4265 / 5265 “Ford C6 Replacement” (GEN-3)

- New, GM 4-speed that will bolt-in where a Ford C6 fits!



TRN4347 / 5347 “SAE4 Standard Package” (GEN-3)

- TRN4347 Transmission
- SAE4 Bellhousing
- FFO Extension Housing (Fixed-Flange-Output)
- Disc Brake compatibility
 - Mechanical Caliper
 - Mechanical / Hydraulic Caliper
 - Electric / Hydraulic Caliper
- Better torque converter access
- Smallest overall package
- Heavy-duty output seal
- Heavy-duty output bearing

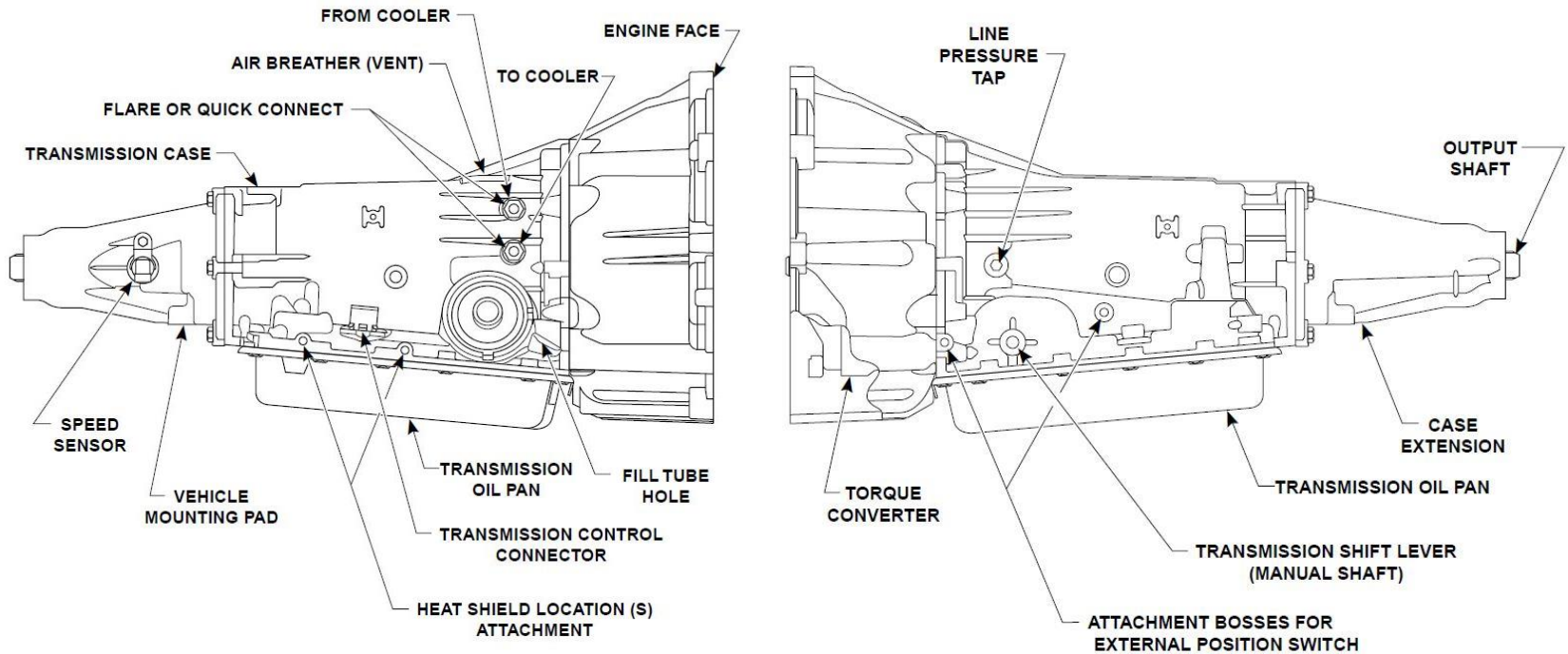


“IES” Industrial Electronic Shifter

- “Morse” shifter replacement
 - Same bolts & same mounting
- Abuse Lockout Solenoid
 - Trans vs Vehicle issue indication
- IP66 Ingress/Weather Rating
 - Vacuum tested
- LED Range Position
- LED Trans / Shifter Fault
 - Shifter faults red, trans faults yellow
- Automatic Brake-Failure detection
 - Blinks Range LED’s after 30s
- 3x 12v 10A Fuse requirement
- 10A Reverse Light Relay
- 10A Neutral Safety Relay



External Feature Locations



TCM - TRANSMISSION CONTROL MODULE

- LINE PRESSURE
- SHIFT POINTS
- TOP GEAR CONTROL (1, 2, 3, OR 4)
- FWD / REV RANGE CONTROL (IES VS IMS)
- GEN-2 vs GEN-3
- DATA I/O FOR ENGINE
- DIAGNOSTICS
- SAFETY INTERLOCKS
- **EVERYTHING ABOVE CHANGES PER VEHICLE!!!**

TCM – ENGINEERING RECAP “A”

- LINE PRESSURE
- SHIFT POINTS
- CAL-A TOP GEAR CONTROL (1, 2, 3, OR 4)
- CAL-B TOP GEAR CONTROL (Normally limits to 1st)
- TORQUE CONVERTER LOCKUP (FIRMNESS AND TIMING)
- FWD / REV RANGE CONTROL (IES VS IMS)
- GEN-2 vs GEN-3 VALVEBODY
- THROTTLE POSITION (J1939, Analog 1, or Analog 1+2)
- REDLINE-PER-GEAR (J1939: 1st-3200, 2nd-3200, 3rd-2600)
- SAFETY INTERLOCKS (Brake, Parking-Brake, Seat, BL-Boom...)
- BODY CONTROL MODULE FEATURES (Engine Shutdown, Accessory Control...)

TCM – ENGINEERING RECAP “B”

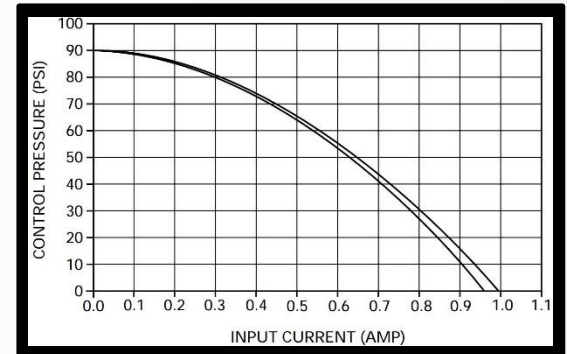
- Regarding Shift-Points, CAL-A / B Tables are where we control and Adjust:
 - TOP GEAR CONTROL (MAX SPEED)
 - OPTIMIZING LOADED TRACTOR PERFORMANCE
 - OPTIMIZING UNLOADED TRACTOR PERFORMANCE
 - ENSURING UPSHIFTS WHEN ENGINE-RPM / POWER HAS PEAKED
 - ENSURING DOWNSHIFTS WHEN LOAD / GRADE INCREASES

TCM – ENGINEERING RECAP “C”

- Doing Calibration Validation you normally tune and optimize Shift Points and Line Pressures to meet the following criteria:
 - **High-Throttle vs High-Load** (no clutch slippage) with good performance and reasonably FIRM shifts
 - **High-Throttle vs Low-Load** (no clutch slippage) with comfortable "enough" shifts
 - **Low-Throttle vs High-Load** (no clutch slippage)
 - **Low-Throttle vs Low-Load** (no clutch slippage) with reasonable "cruise around" performance and reasonably light shifts

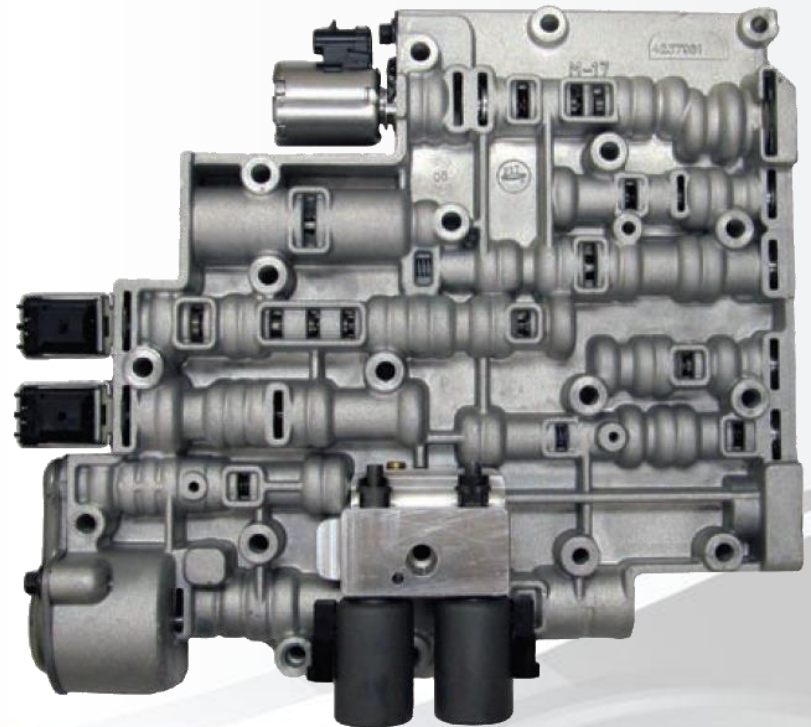
Line Pressure – Factory Settings

- Vehicle Weight / Tow-Capacity specific!
 - Big difference between Belt Loader & Cargo... weight and differential ratio
- Based on Throttle Position
- Too Low – Clutches slip & burn
 - Shifting Into Gear vs Steady State
- Too High – **Hard** shifts & premature part wear
- Pump is capable of 300+ PSI
- Clutches normally take 54-193 PSI steady state



PCS 4LHD Valve Body Enhancements

- Abuse Protection – requirement for ground support industry
 - Reverse lockout
 - Neutral drop prevention
- Anti-Collision
- Neutral Idle
- Electronic Range
- Inching Mode

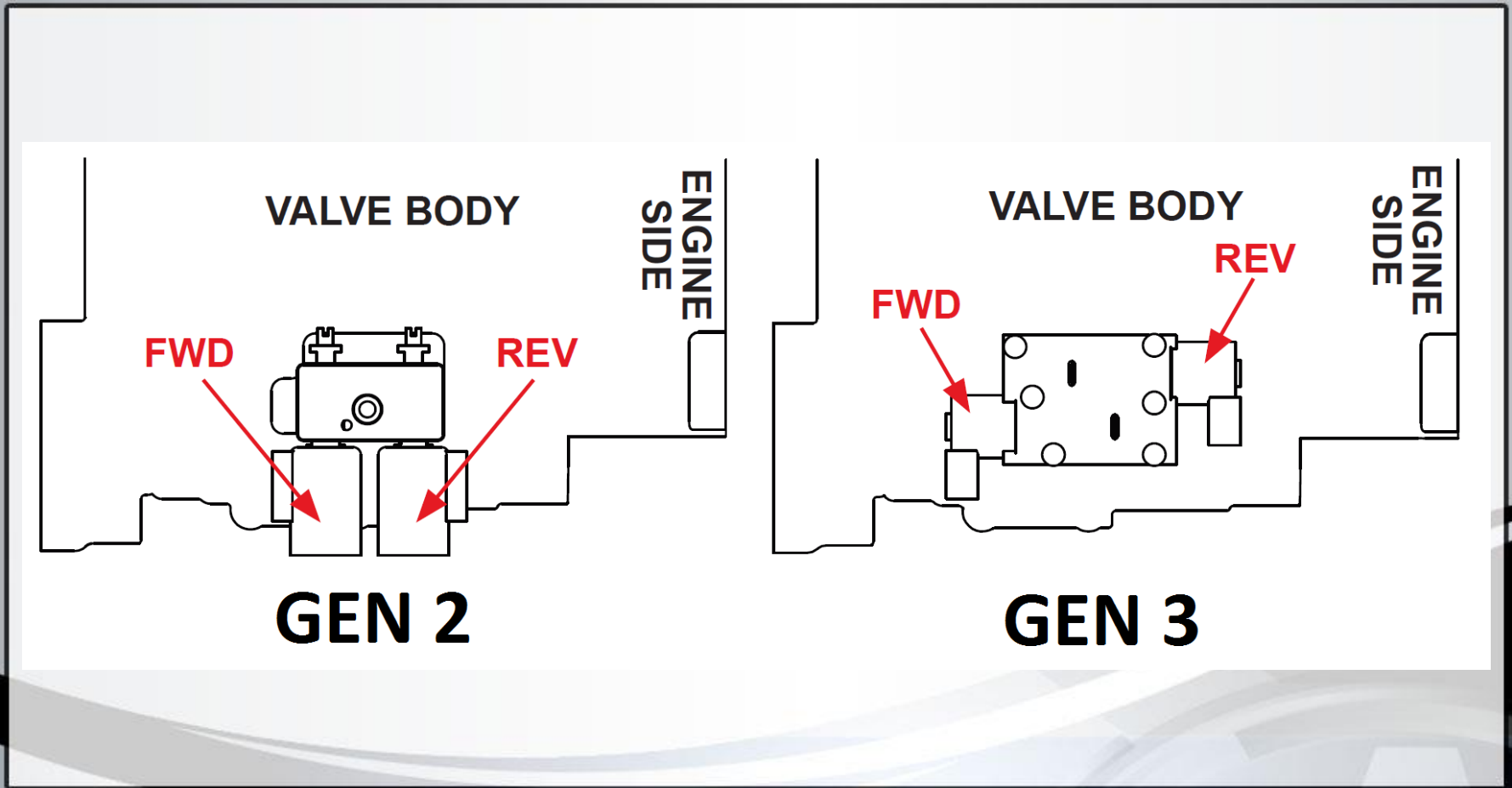


Patent 9,777,829

Gen 2 vs Gen 3 Valve Body

- Gen 2: Abuse Protection.
- Gen 3: Abuse Protection, inching, electronic shift, anti-collision.
- To identify:
 - Measure solenoid resistance:
 - Pin E to Pin R (Gen 2: 3-6 ohms / Gen 3: 10-15 ohms)
 - Pin E to Pin S (Gen 2: 3-6 ohms / Gen 3: 10-15 ohms)
 - Use TDD for reverse solenoid operation.
 - Remove pan and filter and compare images.

Gen 2 vs Gen 3 Valve Body



Preventative Maintenance

- Recommended service interval for industrial use is 1,000 hours or 12-months whichever comes first.
- Filter and pan gaskets should be replaced.
- Transmission fluid must be DEXRON VI.
- PCS stocks filter and pan gasket kits for PM, PCS Part Number TRN7090.

PRE-RAMP CHECK LIST

KEY OFF PHYSICAL INSPECTION

| | |
|------------------------------|---|
| Fastener Torque: | Inspect all mounting bolts, torque converter bolts, flywheel bolts, and all other driveline hardware for proper torque. |
| Position Lever Check: | Move the shift lever through all ranges and verify that the transmission shift arm is centered in the detent for each position. |

KEY ON, ENGINE OFF SOFTWARE VERIFICATION

| | |
|-------------------------------------|---|
| Connect: | Connect to the TCM with the PCS TCM Diagnostic software. To download the software, please visit: www.GSEhelp.com . |
| Position Lever Verification: | Move the shift lever through the ranges and verify the actual shift lever position matches the position shown in the software. |
| Throttle Position Sensor: | Verify the throttle position reading is zero when the pedal is not press and 100% when fully depressed. |

STATIONARY ENGINE RUNNING CHECKS

| | |
|---------------------------|--|
| Fluid Level Check: | Start the engine and check the fluid level is sufficient. |
| Engine RPM: | Verify the engine RPM on the software matches the actual engine RPM. |
| DTC Check: | Verify there are no diagnostic codes set. |

TEST DRIVE (Operate the vehicle until trans is at operating temp)

| | |
|-----------------------|---|
| Vehicle Speed: | Move the vehicle and verify that the vehicle speed operates properly. |
| Shifting: | Check proper transmission operation in all gears. |

*Data log recommended. For help, view "How to Datalog."

POST DRIVE CHECK

| | |
|----------------------------------|---|
| DTC Verification: | Check for diagnostic codes. |
| Fluid Level Verification: | Verify the fluid level is correct and no fluids are leaking from the vehicle. |

Pre-Ramp Check

- Commissioning new equipment.
- Preventative Maintenance (all maintenance if possible).
- Transmission replacement.

BREAK..

Break?



Electronic Transmission Diagnosis

- Generally, if a C6 transmission didn't shift – it needed to be replaced.
- With electronic transmissions, there are numerous causes for a transmission not to shift – outside the transmission – such as an engine sensor.
- GSE Engines are nowhere near the torque/power output of the 4L60E's capacity.
- Isolating the problem requires you to answer the simple question – “*inside or outside?*”

Field Service Five Step Approach

1. Check fluid level & condition
2. Check for codes
3. Check the basics – power and shift linkage
4. Check the signals
5. Directly control the transmission

Field Service Five Step Approach

- 1. Check fluid level & condition**
2. Check for codes
3. Check the basics – power and shift linkage
4. Check the signals
5. Directly control the transmission

Transmission Fluid

- Transmission fluid must be DEXRON VI (6).
- Fluid should be red in color .
 - A brown color is also normal.
- Burnt smelling fluid (Dark Color) most likely indicates internal abnormal transmission operation.
- Fluid that has a cloudy or milky appearance is possibly contaminated with water from engine coolant or an external source.
 - Transmission vent
 - Radiator
 - Fluid Storage Container

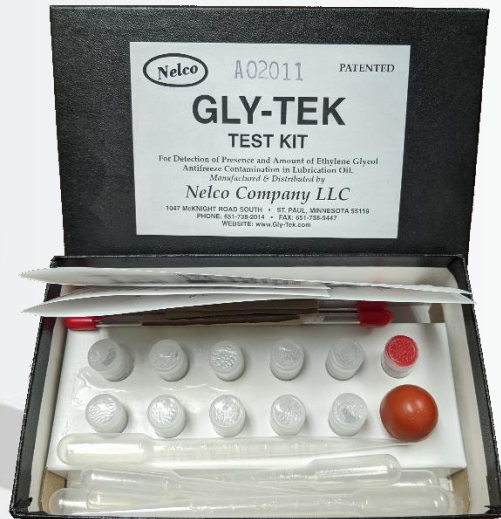
Transmission Fluid



1000 hrs

100 hrs

NEW



Nelco A02011 PATENTED
GLY-TEK
TEST KIT
For Detection of Presence and Amount of Ethylene Glycol
Antifreeze Contamination in Lubrication OIL
Manufactured & Distributed by
Nelco Company LLC
1947 MIDNIGHT ROAD SOUTH • ST. PAUL, MINNESOTA 55119
PHONE: 651-708-2014 • FAX: 651-708-2447
WEBSITE: www.Gly-Tek.com



Transmission Fluid

- Proper level check procedure must be performed:
 - Engine at idle.
 - Move lever to ranges N-F & N-R for 3-5 sec each
 - “Proper” level is very transmission temperature dependent.

Transmission Fluid

FILL CONVERTER (DRAINBACK)

LUBE FROM COOLER

FILL LUBE & COOLING

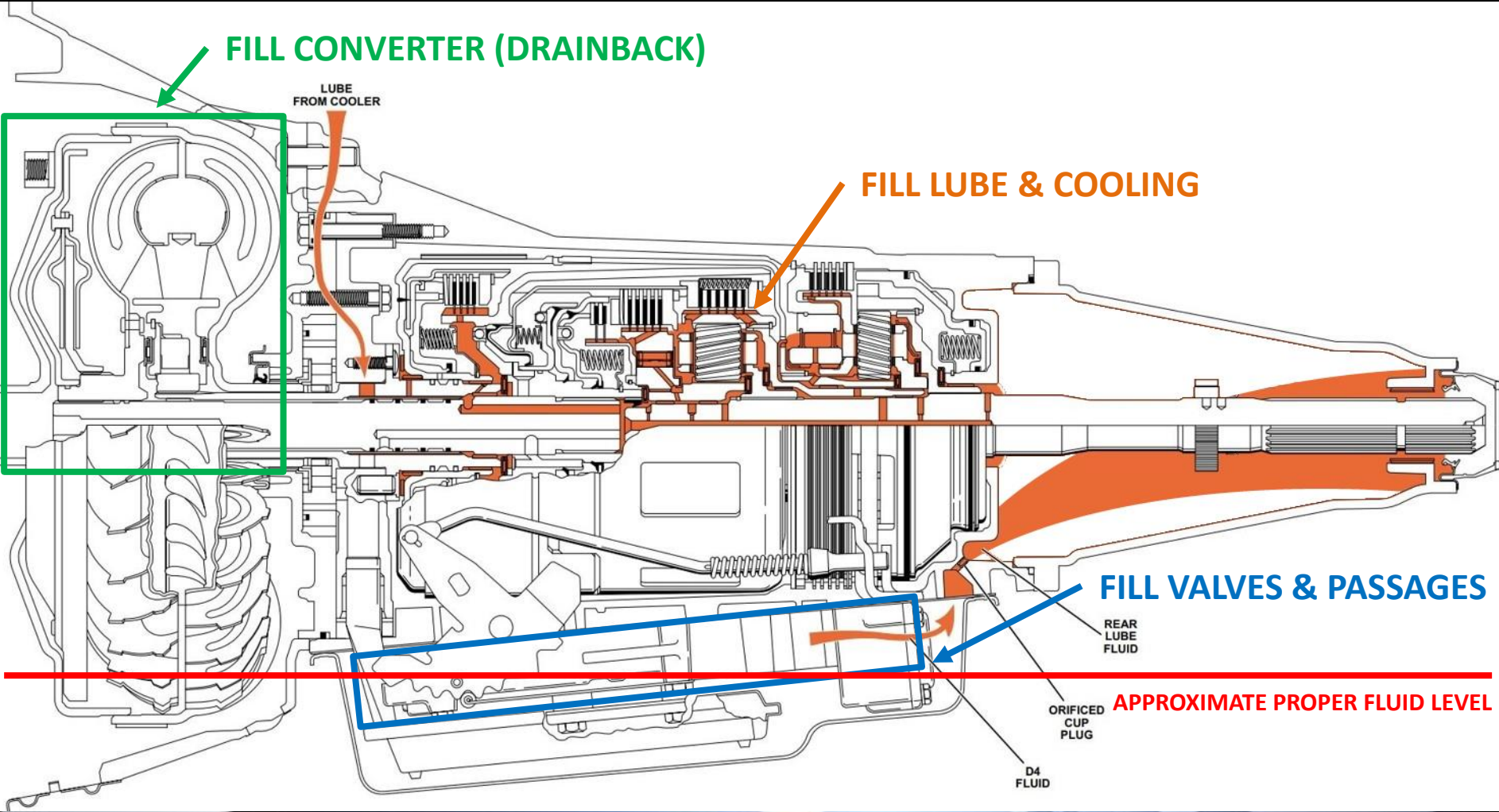
FILL VALVES & PASSAGES

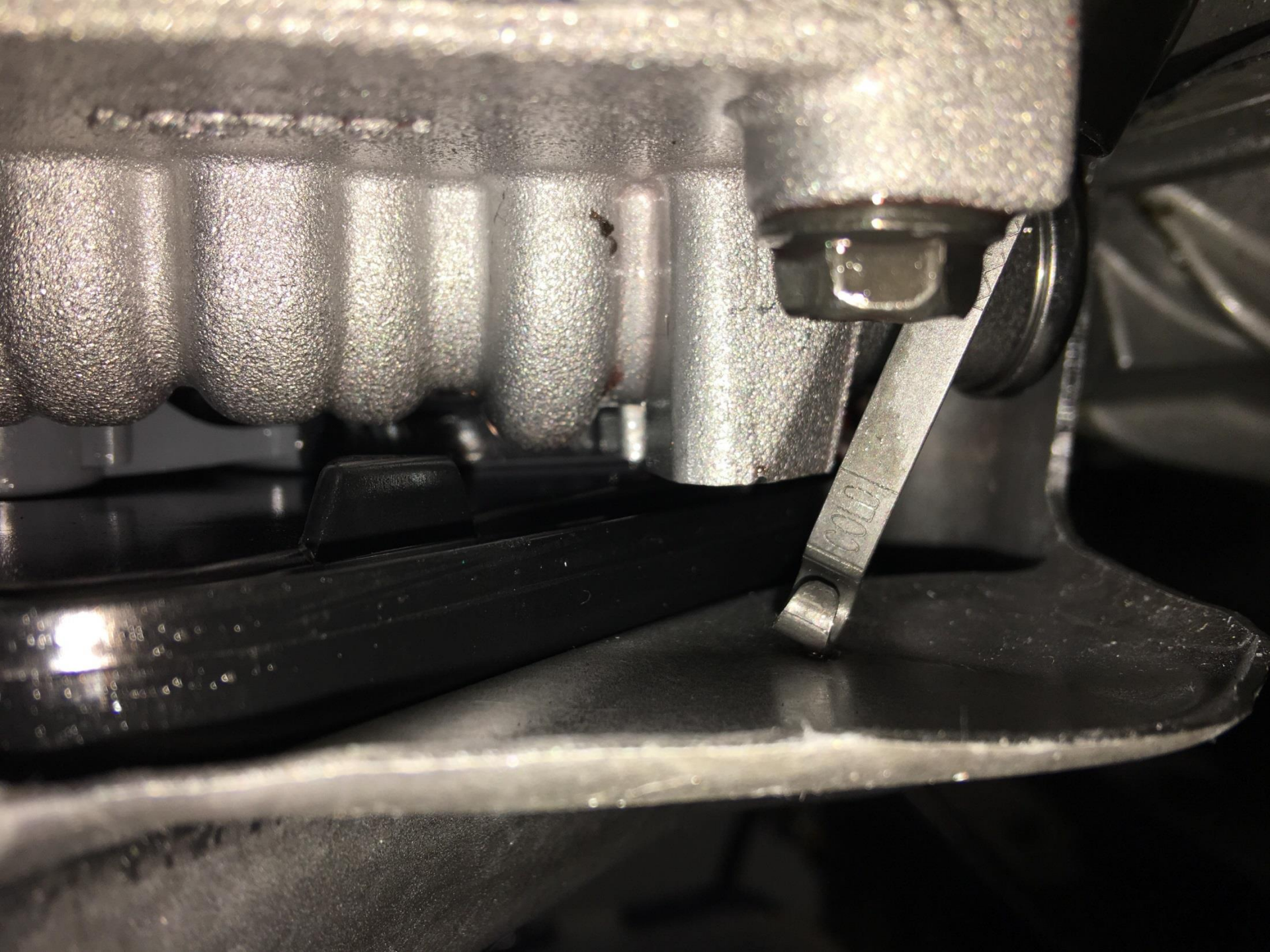
REAR LUBE FLUID

APPROXIMATE PROPER FLUID LEVEL

ORIFICED CUP PLUG

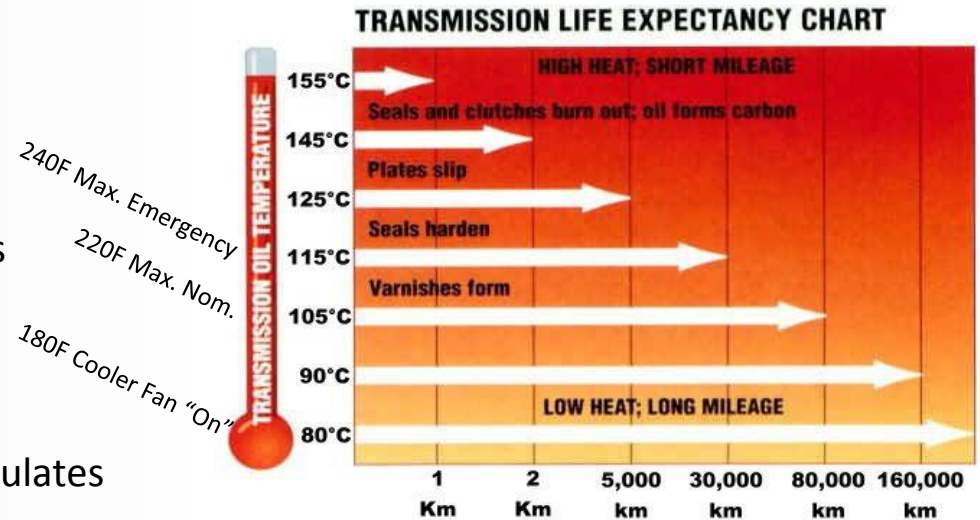
D4 FLUID





Purpose of Transmission Fluid

- Hydraulic Actuation
 - Moving Pistons and valves
- Lubrication
 - Metal-on-metal, clutches, seals
- Detergent
 - Preventing Oxidation
 - Absorbing and removing particulates
- Cooling
 - Pulling heat; planets, clutches, and converter
- Friction Modifier
 - Aiding proper clutch and band engagement
 - (loss or too little causes harsh shifts / shudder)



Development of Transmission Fluid

| YEAR | NAME | REV | MILES | TYPE | NOTES |
|------|------------------|-----|---------|------|---------------------------------------|
| 1940 | Hydra-Matic | 0 | 2,500 | 1 | Renamed "Fluid" vs motor oil |
| 1949 | Type "A" | A | 5,000 | 1 | Standardized, longer service interval |
| 1957 | Type "A" suf "A" | AA | 7,500 | 1 | Improved for multi-converter elements |
| 1967 | Dexron B | B | 12,000 | 1+ | Hydro-treating oil introduced |
| 1973 | Dexron-II (2) | C | 25,000 | 1+ | Whale oil lubricant removed |
| 1975 | Dexron-II (2) | D | 25,000 | 1+ | 4-Speeds & Converter Lock |
| 1990 | Dexron-II (2) | E | 50,000 | 2 | Full synthetic introduced |
| 1993 | Dexron-III (3) | F | 50,000 | 2 | Cold temp improvements |
| 1998 | Dexron-III (3) | G | 50,000 | 2+ | TCC shudder improvement |
| 2003 | Dexron-III (3)* | H | 50,000 | 2+ | Further shudder improvement |
| 2006 | Dexron-VI (6) | J | 100,000 | 4 | GM & Ford standardized formula |

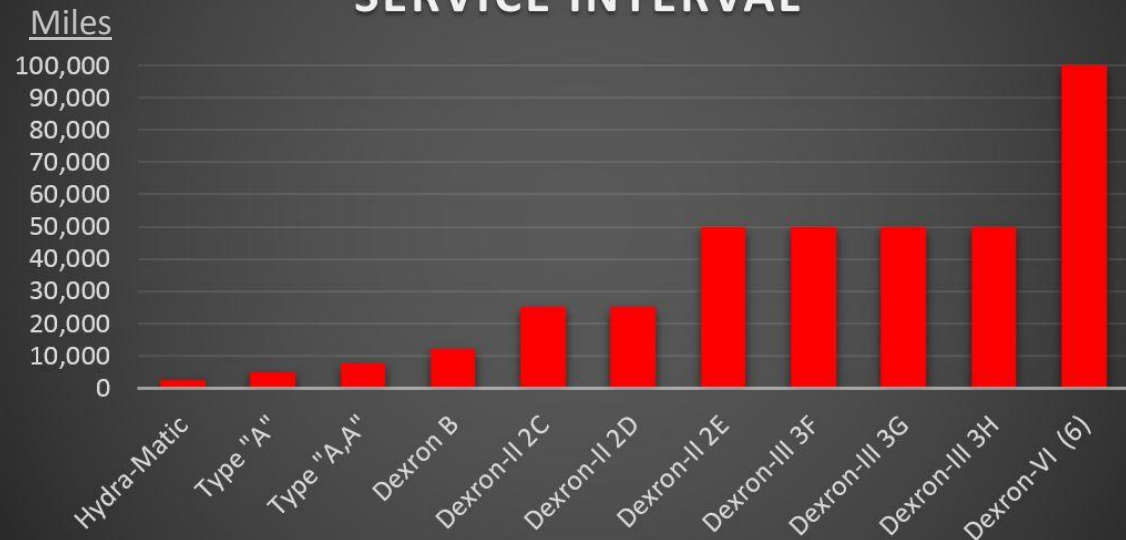
*Dex-3 "H" spec discontinued in 2011

Fascinating history:

Info on this page is very watered down!

There are tons of online resources for the curious!

RECOMMENDED STANDARD-DUTY SERVICE INTERVAL



Field Service Five Step Approach

1. Check fluid level & condition
- 2. Check for codes**
3. Check the basics – power and shift linkage
4. Check the signals
5. Directly control the transmission

Check for Codes

- Codes can be read by:
 - PCS Software interface on laptop.
 - “Check Trans” indicator on dash.
 - Diagnostic screen.

Check for Codes – PCS Software

TCU Monitor Version: 1.4.3

Mode

| On | Off | Mode |
|----------------------------------|----------------------------------|-------------------|
| <input type="radio"/> | <input checked="" type="radio"/> | Full Throttle |
| <input type="radio"/> | <input type="radio"/> | Cancel Overdrive |
| <input checked="" type="radio"/> | <input type="radio"/> | TCC Locked |
| <input type="radio"/> | <input checked="" type="radio"/> | Cancel TCC Lockup |
| <input type="radio"/> | <input checked="" type="radio"/> | Calibration B |
| <input type="radio"/> | <input checked="" type="radio"/> | Analog Fail |
| <input type="radio"/> | <input checked="" type="radio"/> | Simple Manual |
| <input type="radio"/> | <input checked="" type="radio"/> | True Manual |
| <input type="radio"/> | <input checked="" type="radio"/> | 4wd Low |
| <input type="radio"/> | <input checked="" type="radio"/> | Dyno |
| <input type="radio"/> | <input checked="" type="radio"/> | Snow |

Digital Input

| On | Off | Digital Input |
|----------------------------------|----------------------------------|-----------------|
| <input checked="" type="radio"/> | <input type="radio"/> | Gear Select 1 |
| <input type="radio"/> | <input type="radio"/> | Gear Select 2 |
| <input type="radio"/> | <input type="radio"/> | Gear Select 3 |
| <input type="radio"/> | <input checked="" type="radio"/> | Digital Input 4 |
| <input type="radio"/> | <input checked="" type="radio"/> | Digital Input 5 |
| <input type="radio"/> | <input checked="" type="radio"/> | Digital Input 6 |
| <input type="radio"/> | <input checked="" type="radio"/> | Digital Input 7 |
| <input type="radio"/> | <input checked="" type="radio"/> | Digital Input 8 |

Digital Outputs

| On | Off | Digital Outputs |
|----------------------------------|----------------------------------|-------------------|
| <input checked="" type="radio"/> | <input type="radio"/> | Shift Solenoid A |
| <input checked="" type="radio"/> | <input type="radio"/> | Shift Solenoid B |
| <input type="radio"/> | <input checked="" type="radio"/> | Diagnostic Light |
| <input checked="" type="radio"/> | <input type="radio"/> | TCC Lockup |
| <input type="radio"/> | <input checked="" type="radio"/> | Digital Outputs 5 |
| <input type="radio"/> | <input checked="" type="radio"/> | Digital Outputs 6 |

Serial Number: 10035
Firmware Version: 3.126.6
Prom ID: 7053
Odometer: 84.61 Miles
Hour Meter: 6.86 Hours

PWM Outputs

| | |
|--------------------------|------|
| Line Pressure | 98% |
| TCC Pressure Control | 96% |
| Inching Forward Clutch C | 78% |
| Inching Reverse Clutch D | 0% |
| Shift Solenoid A | 100% |
| Shift Solenoid B | 100% |
| Diagnostic Light | 0% |

Current

| | |
|----------------------|--------|
| LP Actual Current | 0.04 A |
| Current 2 | 0.00 A |
| FWD Inching Solenoid | 0.00 A |
| REV Inching Solenoid | 0.51 A |

Fail Codes

Codes in red are current codes.
 Codes in black are stored codes.

Clear Codes

Connected

Speed Inputs

| | |
|----------------------|--------|
| Engine RPM | 1036 |
| Calculated Input RPM | 511 |
| Input Shaft RPM | 511 |
| Output Shaft RPM | 1833 |
| Vehicle Speed 1 | 24 MPH |
| Vehicle Speed 2 | 15 MPH |

Other

| | |
|----------------------|--------|
| Actual Gear Ratio | 0.27 |
| 1-2 Shift Time | .102 |
| 2-3 Shift Time | .000 |
| Target Line Pressure | 0% |
| LP Target Current | 4.26 A |
| TCC Duty Cycle | 0 |

Temperatures

| | |
|---------------------|--------|
| Transmission Temp 1 | 77 °F |
| Transmission Temp 2 | 295 °F |

Analog Inputs

| | |
|---------------------|--------|
| TPS | 2.17 V |
| Fluid Temperature 1 | 3.66 V |

TPS Info

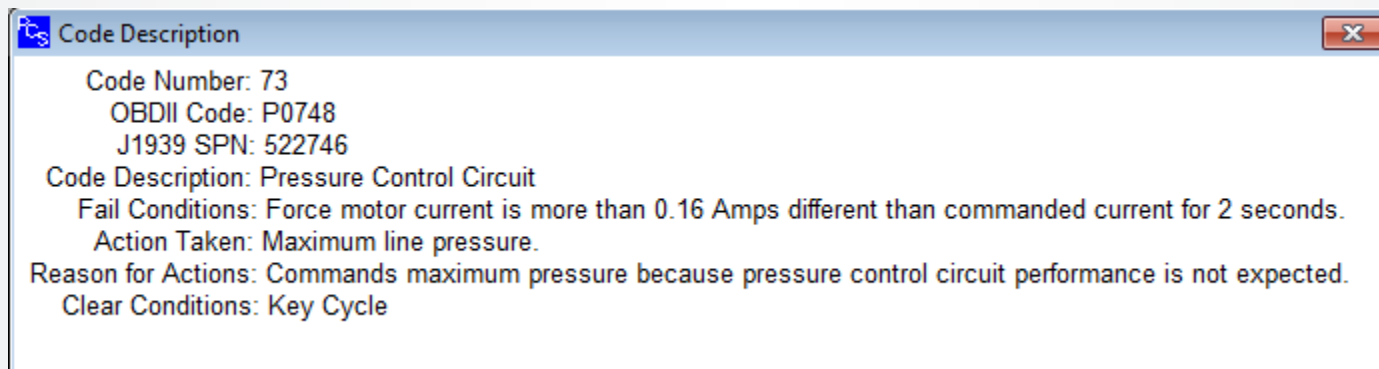
| | |
|-----------------|--------|
| TPS Percentage | 28% |
| Min TPS Voltage | 1.49 V |
| Max TPS Voltage | 3.90 V |

Slip

| | |
|-------------------|------|
| TCC Slip RPM | 525 |
| Transmission Slip | -84% |

Check for Codes - Software

- Clicking on the code number will open a code description window with full description, action taken, and clear conditions.



CODES ARE INDICATORS, NOT ROOT-CAUSES!

Check for Codes - Light

- Labels vary for the “Check Trans” light.
 - “Trans Overtemp” is common.
- If DTC is active and engine is running, light will be solid on.
- If DTC is active or stored and engine is not running, but ignition is on, the DTC’s will flash.
 - Slow is the first digit, fast is the second digit.
 - See Quick Reference Page 5 and 6 for trouble code list.
- Disconnecting the battery will clear DTC’s.

Field Service Five Step Approach

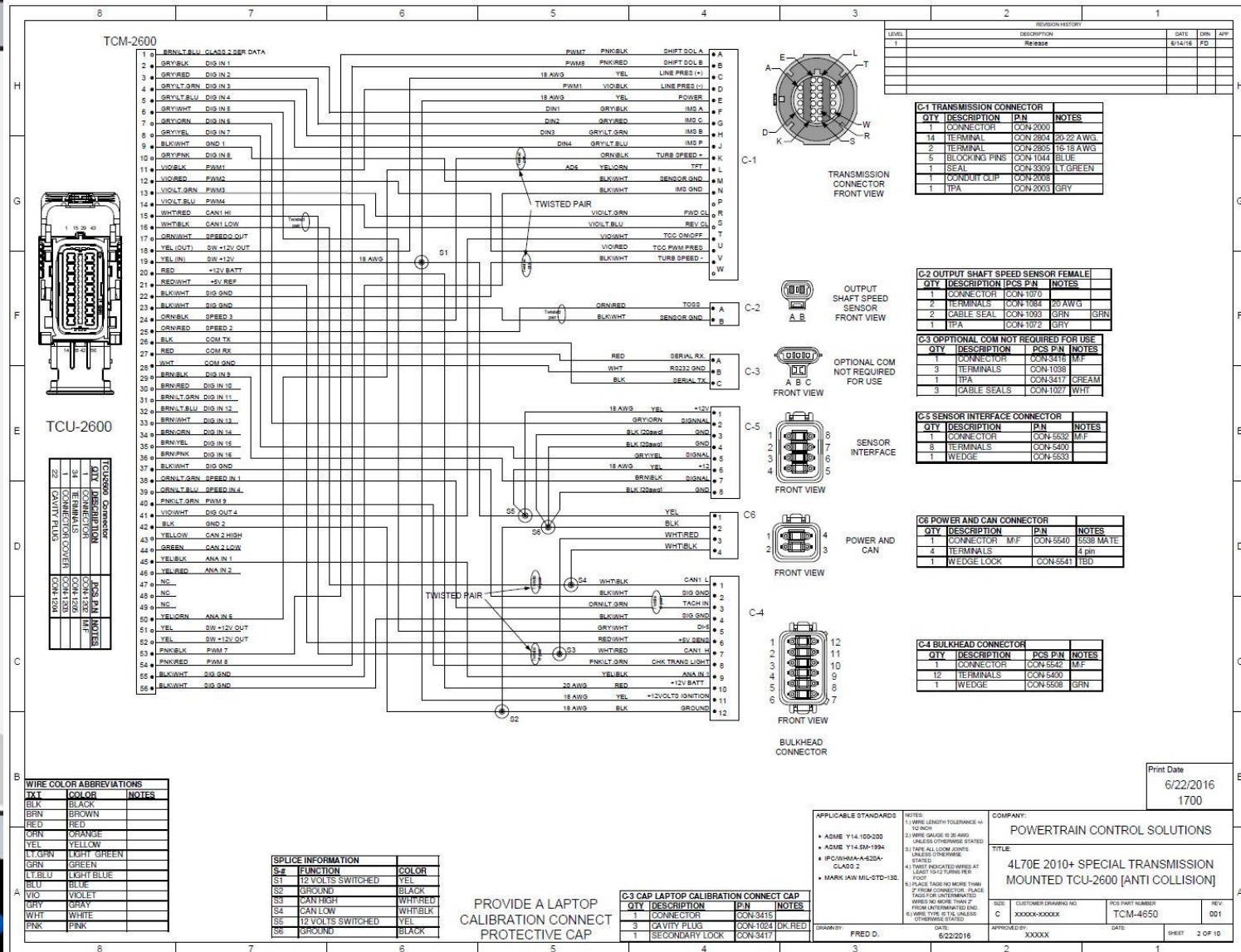
1. Check fluid level & condition
2. Check for codes
3. Check the basics – power and shift linkage
- 4. Check the signals**
5. Directly control the transmission

Check the Input Signals

REQUIRED INPUT SIGNALS TO THE TCM

- **INSIDE** the transmission:
 - Transmission Mode Switch (IMS)
 - Transmission Temperature
 - Output Shaft Speed (OSS)
 - Input Shaft Speed (ISS)
- **OUTSIDE** the transmission:
 - +12V Constant and Switched Ignition (To TCM and Transmission)
 - Ground (To TCM and Transmission)
 - Throttle Position (CAN or hardwired)
 - Engine RPM (CAN or hardwired)
 - Neutral Input (Discrete input)

Download the Harness Drawing



Check the Signals - Software

TCU Monitor Version: 1.4.3

1

2

3

4

5

Connected

HOT

COLD

Mode

| On | Off | Mode |
|----------------------------------|----------------------------------|-------------------|
| <input type="radio"/> | <input checked="" type="radio"/> | Full Throttle |
| <input type="radio"/> | <input checked="" type="radio"/> | Cancel Overdrive |
| <input checked="" type="radio"/> | <input type="radio"/> | TCC Locked |
| <input type="radio"/> | <input checked="" type="radio"/> | Cancel TCC Lockup |
| <input type="radio"/> | <input checked="" type="radio"/> | Calibration B |
| <input type="radio"/> | <input checked="" type="radio"/> | Analog Fail |
| <input type="radio"/> | <input checked="" type="radio"/> | Simple Manual |
| <input type="radio"/> | <input checked="" type="radio"/> | True Manual |
| <input type="radio"/> | <input checked="" type="radio"/> | 4wd Low |
| <input type="radio"/> | <input checked="" type="radio"/> | Dyno |
| <input type="radio"/> | <input checked="" type="radio"/> | Snow |

Digital Input

| On | Off | Digital Input |
|----------------------------------|----------------------------------|-----------------|
| <input checked="" type="radio"/> | <input type="radio"/> | Gear Select 1 |
| <input type="radio"/> | <input checked="" type="radio"/> | Gear Select 2 |
| <input type="radio"/> | <input checked="" type="radio"/> | Gear Select 3 |
| <input type="radio"/> | <input checked="" type="radio"/> | Digital Input 4 |
| <input type="radio"/> | <input checked="" type="radio"/> | Digital Input 5 |
| <input type="radio"/> | <input checked="" type="radio"/> | Digital Input 6 |
| <input type="radio"/> | <input checked="" type="radio"/> | Digital Input 7 |
| <input type="radio"/> | <input checked="" type="radio"/> | Digital Input 8 |

Digital Outputs

| On | Off | Digital Outputs |
|----------------------------------|----------------------------------|-------------------|
| <input checked="" type="radio"/> | <input type="radio"/> | Shift Solenoid A |
| <input checked="" type="radio"/> | <input type="radio"/> | Shift Solenoid B |
| <input type="radio"/> | <input checked="" type="radio"/> | Diagnostic Light |
| <input checked="" type="radio"/> | <input type="radio"/> | TCC Lockup |
| <input type="radio"/> | <input checked="" type="radio"/> | Digital Outputs 5 |
| <input type="radio"/> | <input checked="" type="radio"/> | Digital Outputs 6 |

Serial Number: 10035
Firmware Version: 3.126.6
Prom ID: 7053
Odometer: 84.61 Miles
Hour Meter: 6.86 Hours

PWM Outputs

| | |
|--------------------------|------|
| Line Pressure | 98% |
| TCC Pressure Control | 96% |
| Inching Forward Clutch C | 78% |
| Inching Reverse Clutch D | 0% |
| Shift Solenoid A | 100% |
| Shift Solenoid B | 100% |
| Diagnostic Light | 0% |

Current

| | |
|----------------------|--------|
| LP Actual Current | 0.04 A |
| Current 2 | 0.00 A |
| FWD Inching Solenoid | 0.00 A |
| REV Inching Solenoid | 0.51 A |

Fail Codes

Codes in red are current codes.
 Codes in black are stored codes

Clear Codes

Analog Inputs

| | |
|---------------------|--------|
| TPS | 2.17 V |
| Fluid Temperature 1 | 3.66 V |

TPS Info

| | |
|-----------------|--------|
| TPS Percentage | 28% |
| Min TPS Voltage | 1.49 V |
| Max TPS Voltage | 3.90 V |

Speed Inputs

| | |
|----------------------|--------|
| Engine RPM | 1036 |
| Calculated Input RPM | 511 |
| Input Shaft RPM | 511 |
| Output Shaft RPM | 1833 |
| Vehicle Speed 1 | 24 MPH |
| Vehicle Speed 2 | 15 MPH |

Slip

| | |
|-------------------|------|
| TCC Slip RPM | 525 |
| Transmission Slip | -84% |

Other

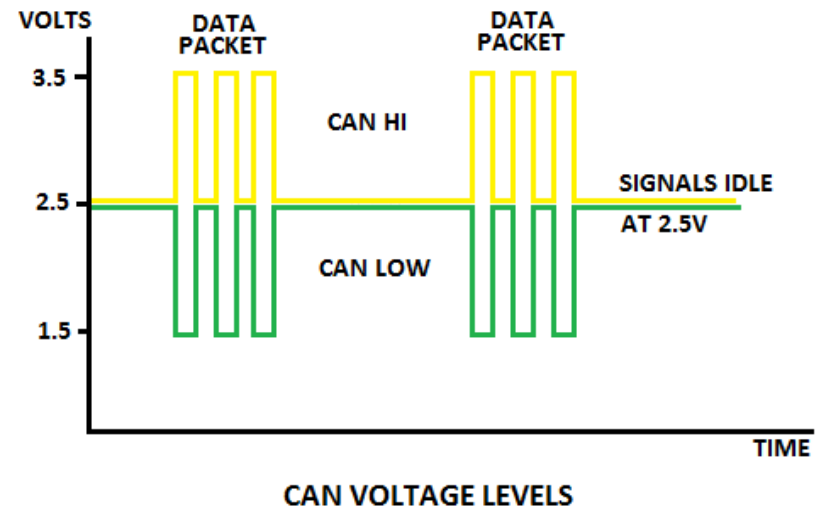
| | |
|----------------------|--------|
| Actual Gear Ratio | 0.27 |
| 1-2 Shift Time | .102 |
| 2-3 Shift Time | .000 |
| Target Line Pressure | 0% |
| LP Target Current | 4.26 A |
| TCC Duty Cycle | 0 |

Temperatures

| | |
|---------------------|--------|
| Transmission Temp 1 | 77 °F |
| Transmission Temp 2 | 295 °F |

Side note on CAN

- CAN – Controller Area Network
- Most industrial CAN applications use J1939.
- High speed, two wire communication protocol.
- Twisted wire, 120-ohm terminating resistors.
- CAN H (pin 7 of bulkhead), CAN L (pin 1).
- Tools available for monitoring CAN, scopes & PeakCAN.



Abuse Protection Limits

- All 4LHD/4LHDX transmissions contain the PCS abuse protection valve body.
- To engage forward or reverse from neutral:
 - TPS less than 15%.
 - RPM less than 1500.
 - Not moving in the opposite direction.
 - Optional (but common) brake must be pressed, parking brake released, and more.

Abuse Protection

Diagnosics

Settings Datalog Connect Show Monitor Screen **Show Abuse Protection Status** Show Mode Overrides Show Available Diagnostic Codes Request Remote Support

Abuse Protection Status

Information

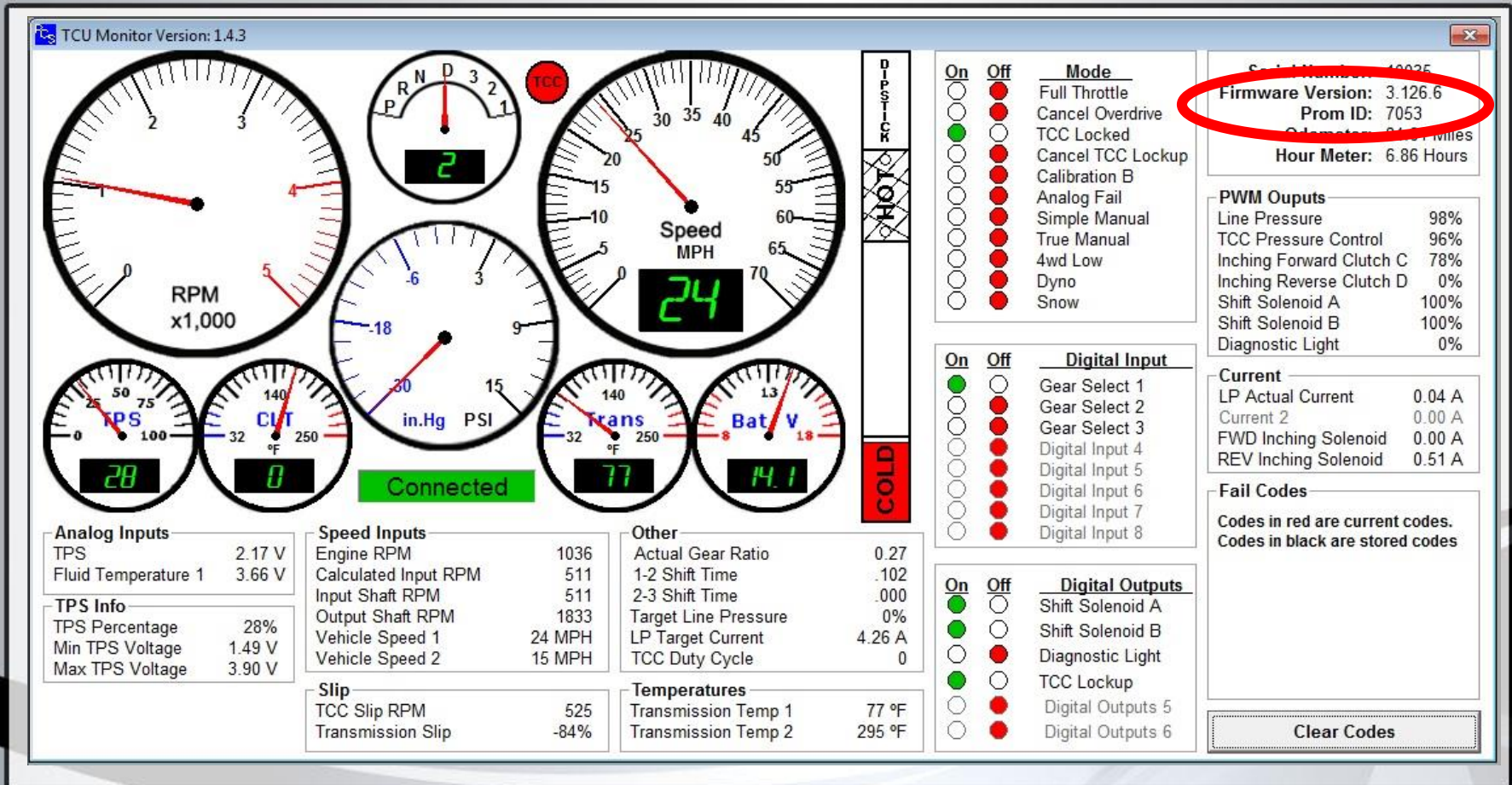
The information contained on this screen will help in diagnosing if the transmission won't engage due to the abuse protection function. If the abuse protection status indicator is green when shifting into a forward gear or reverse the transmission should engage. If the abuse protection status indicator is red then the abuse protection function is active and the abuse parameter status indicators must be checked. If any of the indicators have turned red then the requirements have not been met. All listed abuse parameter status indicators must be green in order to engage the selected gear.

| | | |
|-----------------------------------|-----------------------------------|--|
| Lever Position 4 | Commanded Gear 1 | Abuse Parameter Status <ul style="list-style-type: none">● Throttle Position● Engine RPM● Vehicle Speed● Shift Inhibit |
|-----------------------------------|-----------------------------------|--|

Abuse Protection Status

●

Verify TCM & Calibration is Original



DO NOT SWAP OR REPROGRAM TCM'S

- Step-1, confirm if TCM is OEM original.
- Step-2, if damaged I/O is suspected; confirm.
 - Optional, swap TCM with exact vehicle replica to confirm. Prom-ID, Firmware, Vehicle Harness, Trans Harness, engine, manufacturing month must all match!!!
- Step-3, purchase/warranty exact replacement.

DO NOT SWAP OR REPROGRAM MVP'S

- Critical for proper TPS functionality on many Kubota / Deutz builds.
- EPS / Vehicle OEM's change these per vehicle, for options and bug resolutions.
- Functional and Display-Only variants.

EPS Kubota / Deutz
Dash Interface



CONTACT ENGINE POWER SOURCE "EPS" OR DEUTZ IF THIS IS IN QUESTION!!!

Verify TCM & Calibration is Original

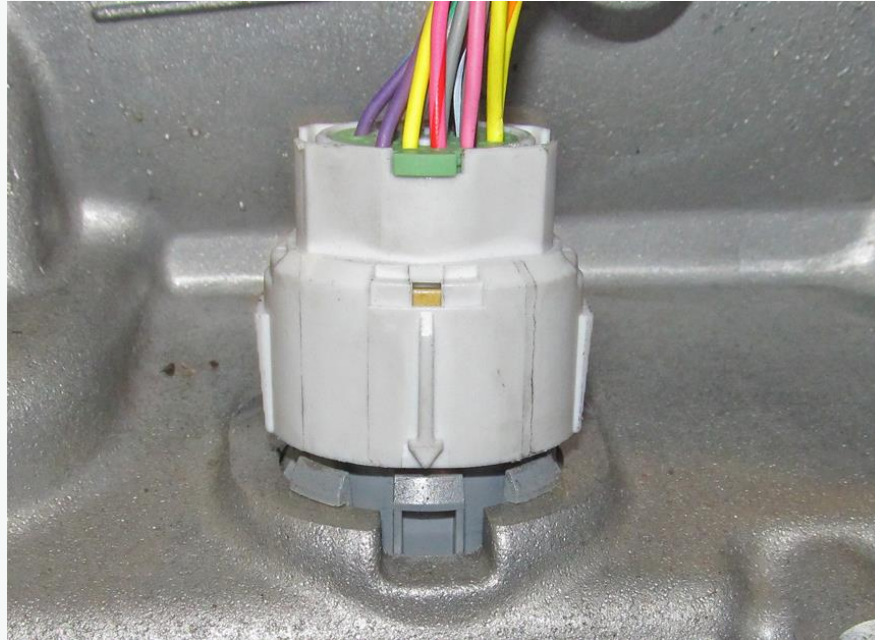
- TCM Model (TCM2600 vs TCM2800)
- TCM Firmware (3.xxx.6 vs 3.xxx.8)
- TCM Prom-ID / SOF / Calibration / Program

**4L60E / 4LHD STRATEGIES ARE NOT ADAPTIVE LIKE SIX-SPEEDS!!!
THE CONTROLLERS MUST NOT BE UPDATED UNLESS PCS / OEM APPROVES!!!**

Field Service Five Step Approach

1. Check fluid level & condition
2. Check for codes
- 3. Check the basics – power and shift linkage**
4. Check the signals
5. Directly control the transmission

Transmission Connector



Click-Pull
Test Method!

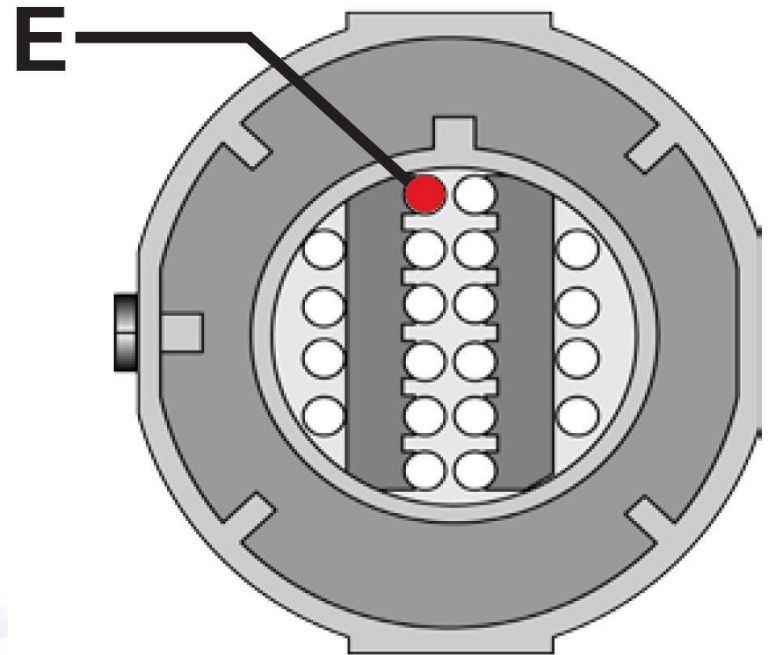
Arrow Out

(CODES: 59, 73, 83, 94)

Check the Basics - Power

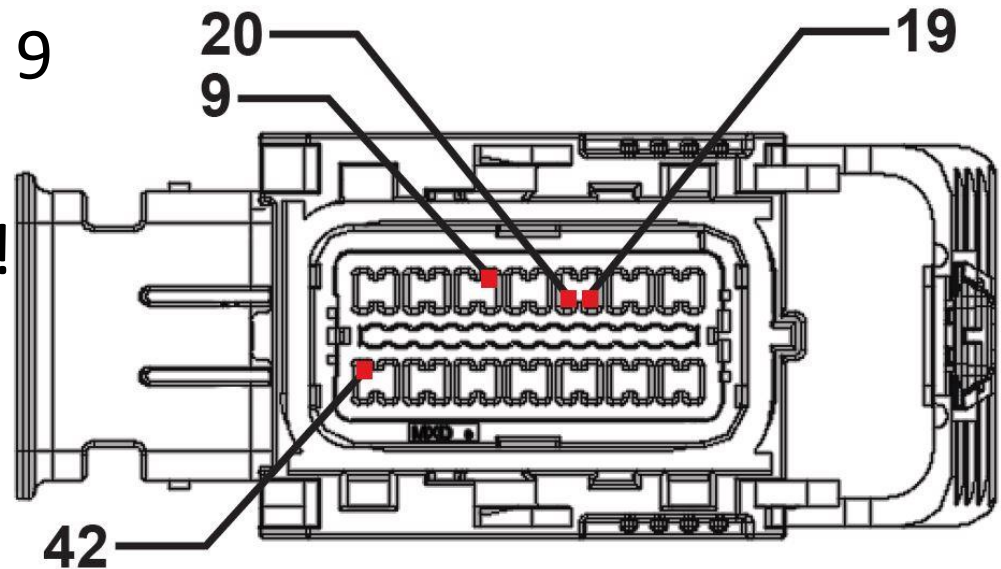
- Transmission Power
 - Switched power (10A), Pin E
 - Ground to case

- Use a multimeter!



Check the Basics - Power

- TCM Power
 - Battery Power (3A or 10A), Pin 20
 - Switched Ignition (10A), Pin 19
 - Ground, Pin 42 or 9
 - Use a multimeter!



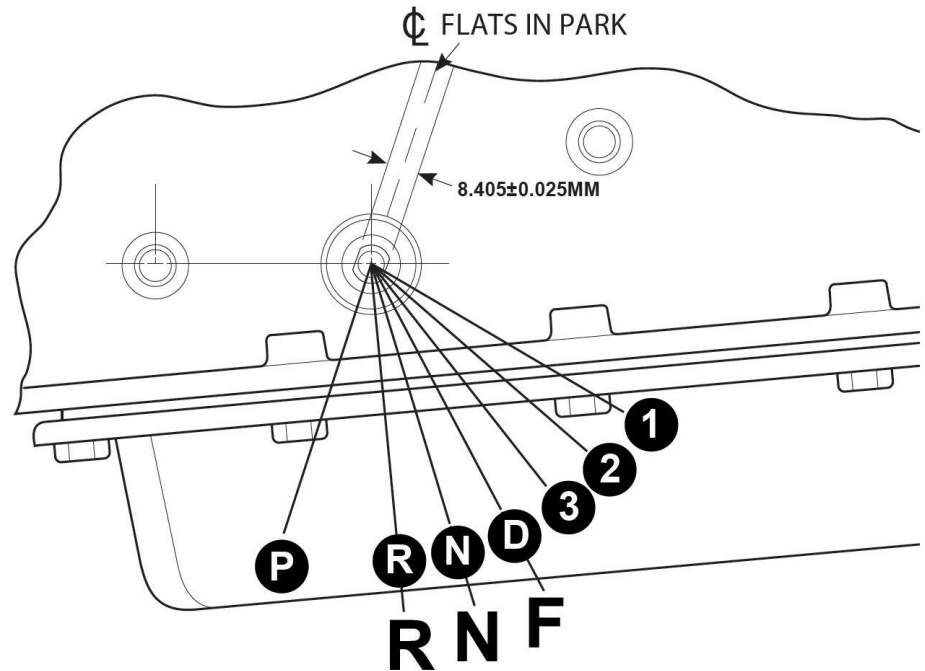
Check the Basics - Power

- No Power Operation “Limp-Mode”:
 - Gen 2:
 - One forward gear (3rd)
 - Reverse
 - Min pressure
 - Transmission will slip under load
 - *Damage will occur if put under load*
 - Gen 3:
 - No forward
 - No reverse

Cold McDonalds story!

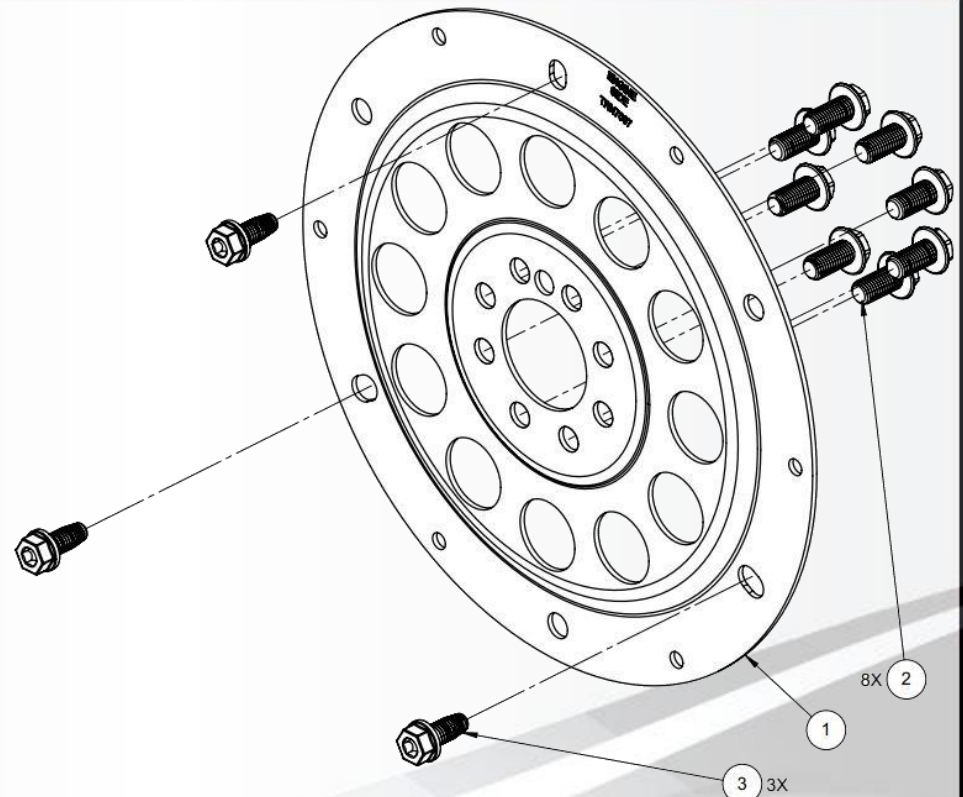
Check the Basics - Linkage

- Linkage (if applicable)
 - Shifter physically moves the transmission shift lever
 - Cable connection to transmission lever
 - Connected
 - Adjusted properly



Check the Basics - Driveline

- Flexplate & Bolts
- Driveshaft & Bolts
- Broken Diff / Axle
- Threadlocker on anything rotating!



BREAK..

Break?



Field Service Five Step Approach

1. Check fluid level & condition
2. Check for codes
3. Check the basics – power and shift linkage
4. Check the signals
- 5. Directly control the transmission**

Transmission Diagnostic Device

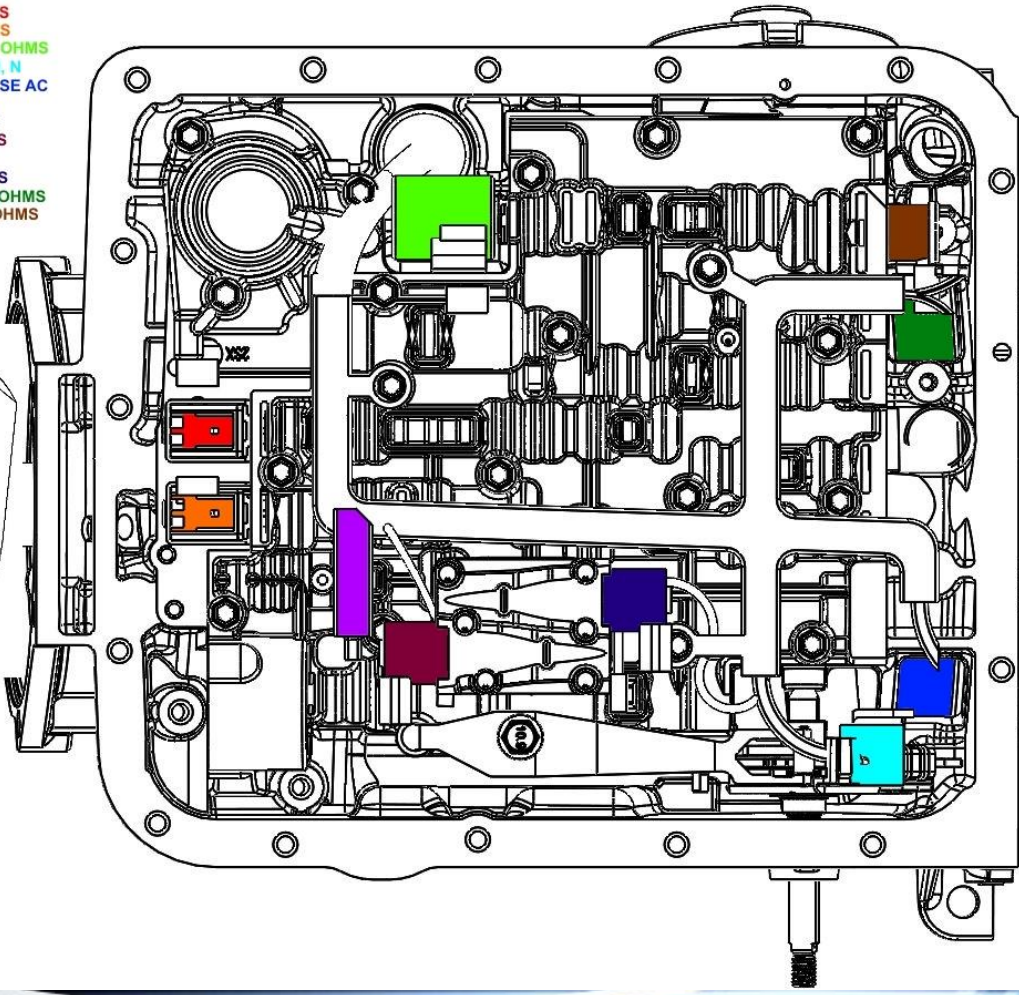
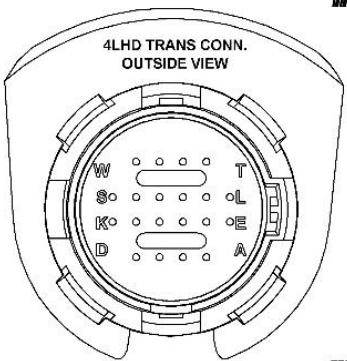
- **SAFETY IS CRITICAL!**
 - Read the disclaimer at the top of page-4!
 - All of the **safety features** have been **bypassed!**
- **Do the test on the ground, not jack-stands!**
 - Feel the vehicle reaction
- **2-Man operation!**
 - Driver & TDD operator
 - Help each other work through the problem

Transmission Diagnostic Device

1. Connect diagnostic device to harness
2. Connect diagnostic device to transmission
3. Connect diagnostic device to power

Transmission Diagnostic Device

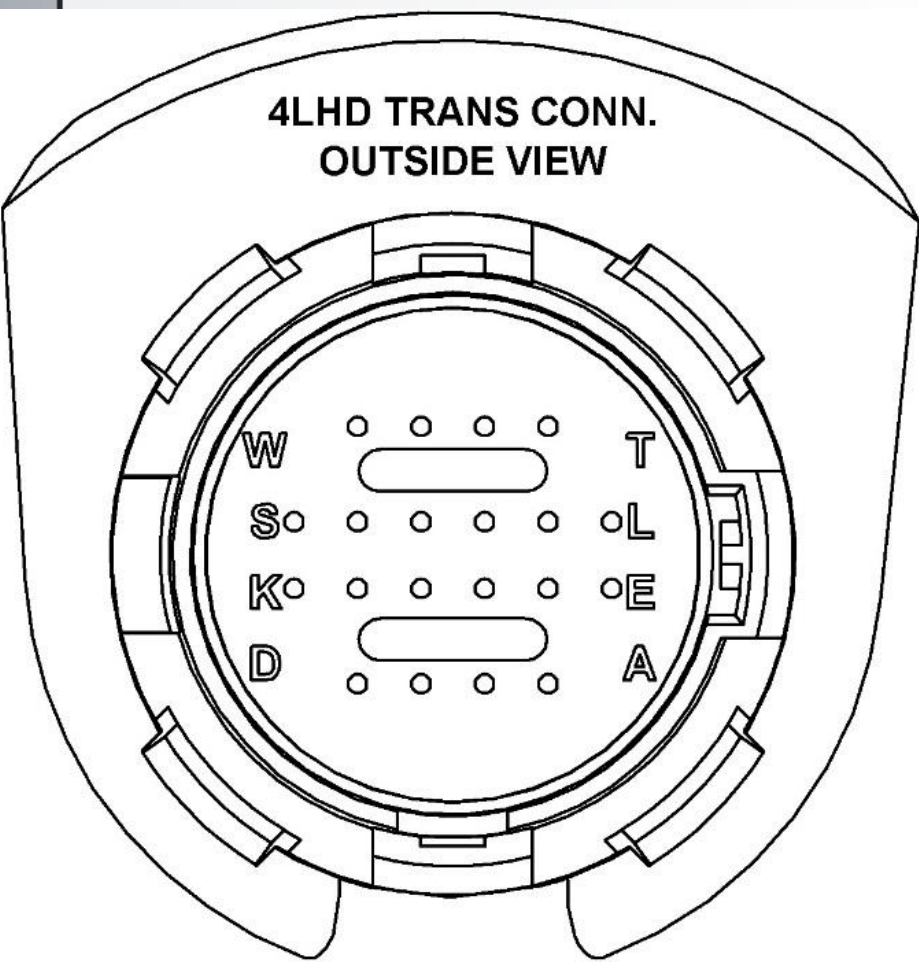
SHIFT SOLENOID A, PINS A/E, 20-40 OHMS
 SHIFT SOLENOID B, PINS B/E, 20-40 OHMS
 LINE PRES. SOLENOID, PINS C/D, 3.5-4.6 OHMS
 INTERNAL MODE SWITCH, PINS F, G, H, J, N
 INPUT SPEED SENSOR, PINS K/V, 15-PULSE AC
 TRANS. FLUID TEMP SENSOR, PINS L/M
 FORWARD CLUTCH SOLENOID, PINS R/E
 GENII (2) 3-6 OHMS, GENIII (3) 10-15 OHMS
 REVERSE CLUTCH SOLENOID, PINS S/E
 GENII (2) 3-6 OHMS, GENIII (3) 10-15 OHMS
 TCC ON/OFF SOLENOID, PINS T/E, 20-40 OHMS
 TCC PWM SOLENOID, PINS U/E, 10-11.5 OHMS



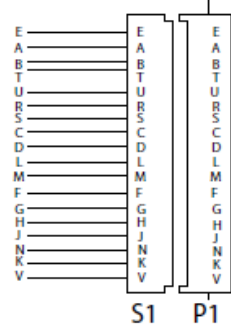
Application Guide:

Page 18

4LHD TRANS CONN.
OUTSIDE VIEW

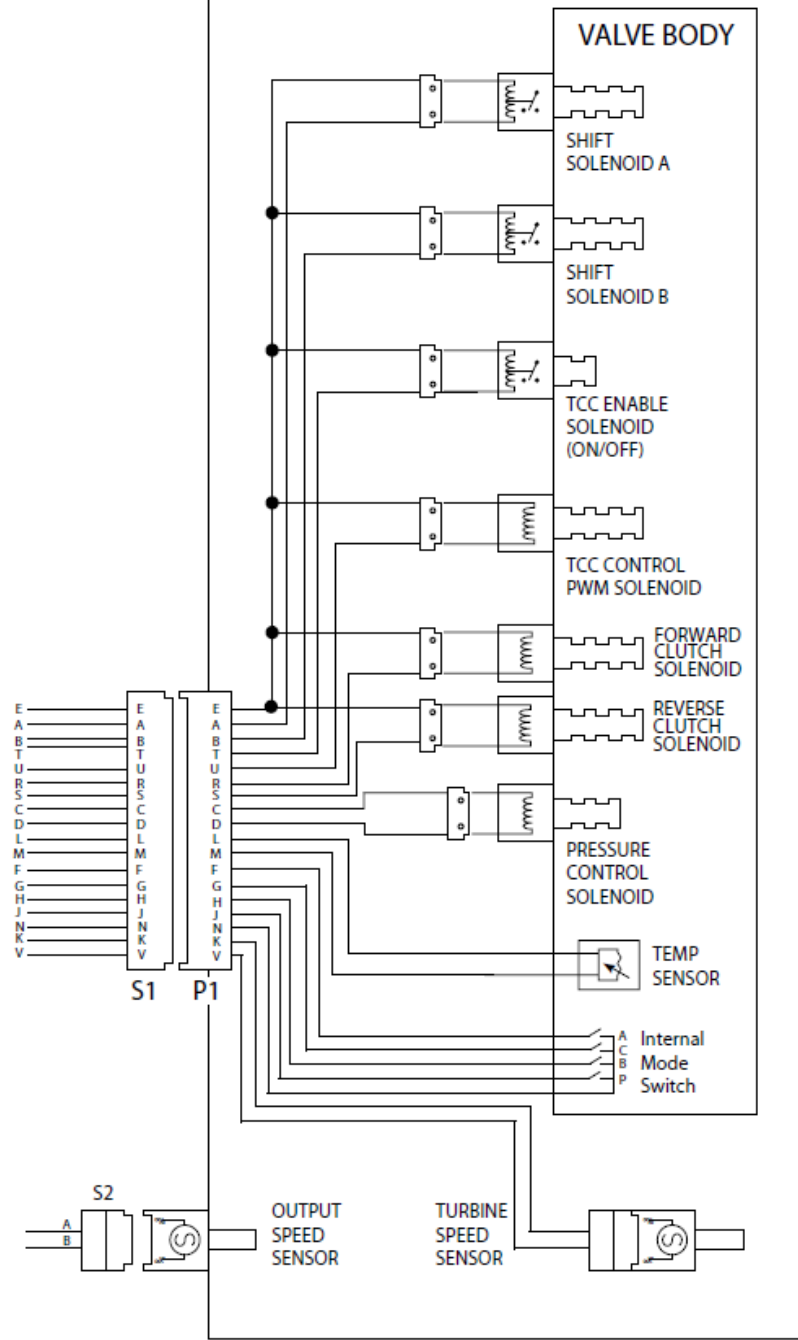


VEHICLE CONNECTOR



TRANSMISSION

VALVE BODY



Transmission Diagnostic Device

Internal solenoid check

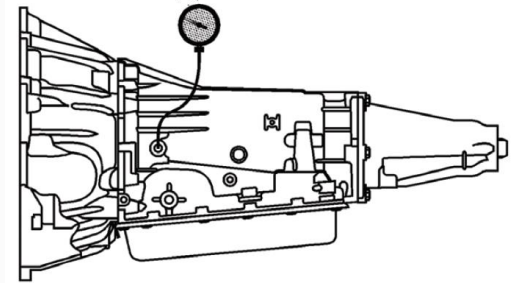
- Reverse Clutch (Abuse, GEN2 vs GEN3)
- Forward Clutch (Abuse solenoid)
- Line Pressure (min/max pressure)
- Torque Converter (lock/unlock)
- Shift Solenoid A & B (to verify all gears, 1-3 works)

Further Options, Pump or TCM

- If the problem has not been identified with the Diagnostic Device:
 - Disconnect the Diagnostic Device.
 - Reconnect the harness to the transmission.
 - Connect to the TCM with the Diagnostic Software.
 - Clear the codes (set from using the Diagnostic Device).

Line Pressure Check

- Line pressure tap (1/8" NPT)
 1. Remove pressure plug.
 2. Install appropriately rated pressure gauge for transmission line pressure measurement. Pressures could exceed 300 PSI.
 3. Command current using PCS software.
 4. Start the engine.
 5. Perform test in Neutral at 1200 RPM between 100 – 200 deg F.



| | AMP | PSI |
|-------|-----|---------|
| 4LHD | 0 | 170-193 |
| | 0.5 | 135-166 |
| | 1 | 54-80 |
| 4LHDX | 0 | 198-227 |
| | 0.5 | 154-193 |
| | 1 | 53-85 |

! **WARNING:** Only perform this test in Neutral with the brakes applied and engine speeds below 1500 RPM. Failure to do so may result in extremely high pressures (in excess of 300 PSI) that could damage the transmission or the gauge and result in serious injury.

Beyond the 5-Step Procedure

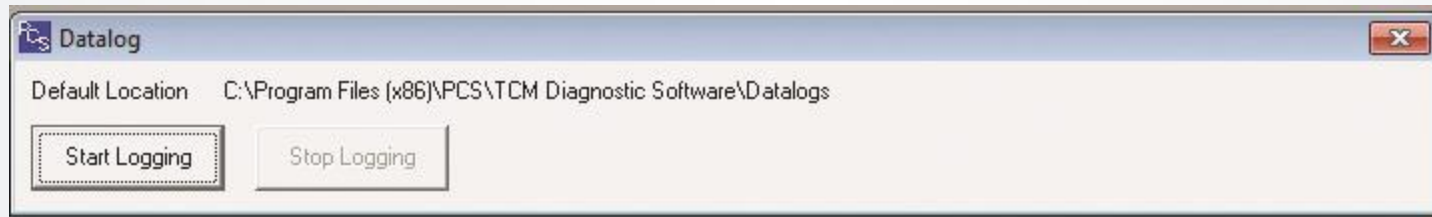
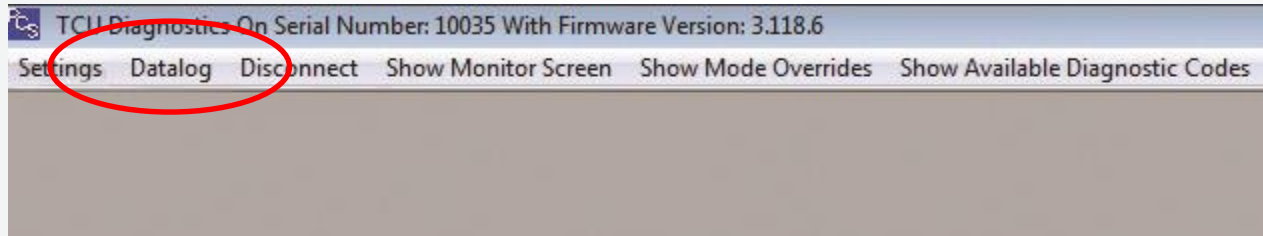
- If the problem was still not diagnosed using the 5-step procedure, there are a few more options.
- Record a data log of the issue and send to PCS for analysis.
- Contact PCS for remote assistance.

REPLACING A TRANSMISSION WITHOUT DETERMINING THE ROOT CAUSE MAY NOT SOLVE THE ISSUE AND COULD DAMAGE ANOTHER TRANSMISSION.

What to Log / Save?

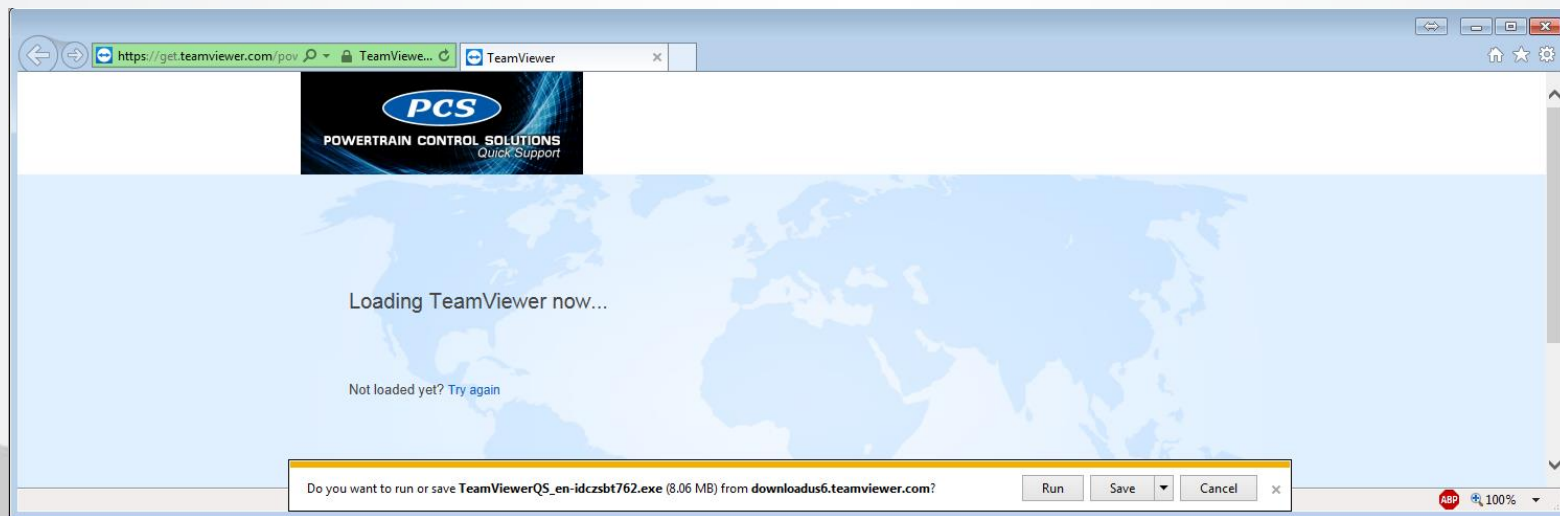
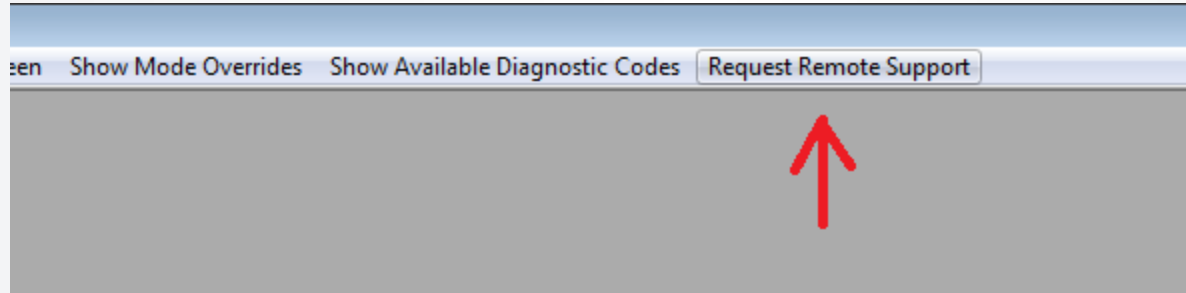
- Key the vehicle on.
- Start / Save Datalog.
- Start the engine.
- Either drive up through the gears and down to a stop, end datalog. Should be ~30-60 sec.
- Or drive the vehicle in the manner that an issue is occurring. End datalog after issue so the “time of issue” is known.

Data Log – See Additional Guide!



- Note the file location to find the file later for review and email.
- Default path is Documents folder.

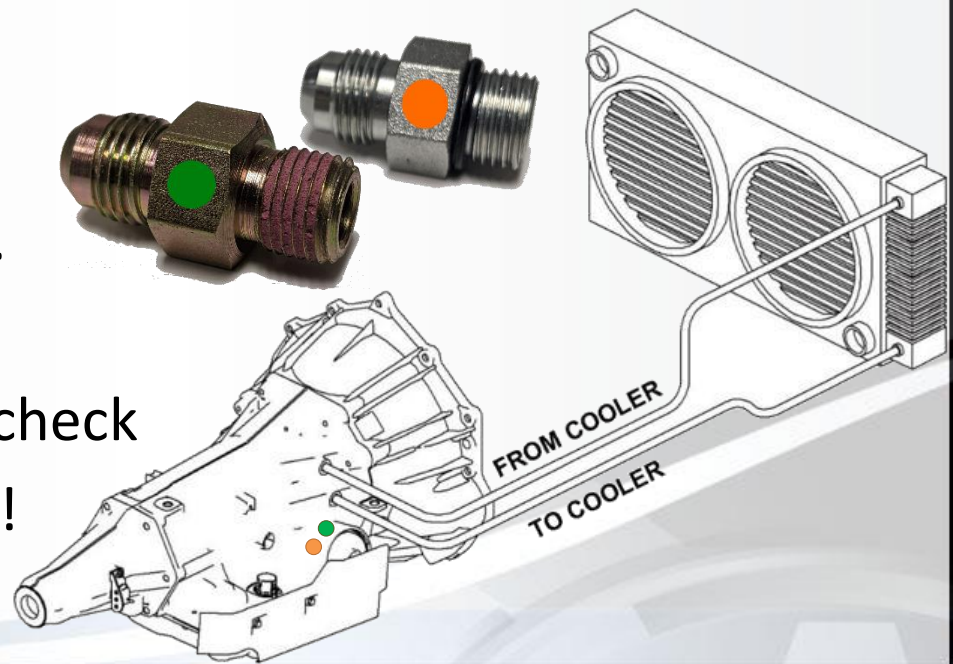
PCS Remote Assistance



Field Replacement Considerations Cooler and Cooler Line Contamination

If a replacement transmission is installed:

- Cooler and cooler lines must be flushed free and clear of debris – “my new replacement transmission failed too”.
- Cooler / Line replacement recommended if affordable.
- If not JIC-6 fittings, double check if they are ¼-NPS or ORB-6!

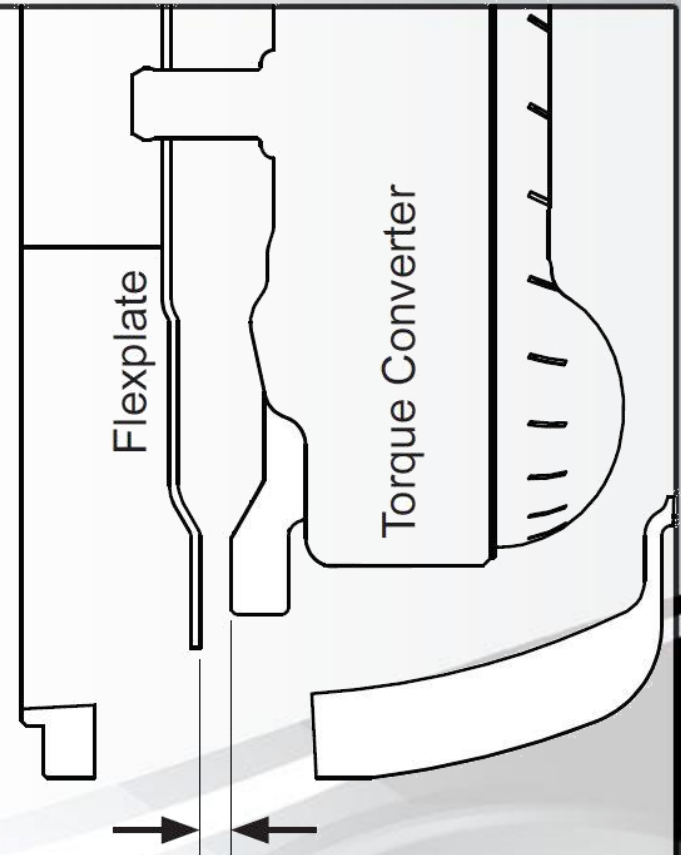


Field Replacement Considerations

Torque Converter Pullout

1. Align and install the bellhousing/transmission to the engine. Before tightening the bellhousing fasteners, check to be sure converter **rotates freely**.
2. Torque bellhousing fasteners to spec. Push the torque converter back into the transmission as far as possible.
3. Measure the gap between the flexplate mounting surface and the torque converter mounting pads.

**DRILL BITS ARE
EASY GAP
TOOLS!!**

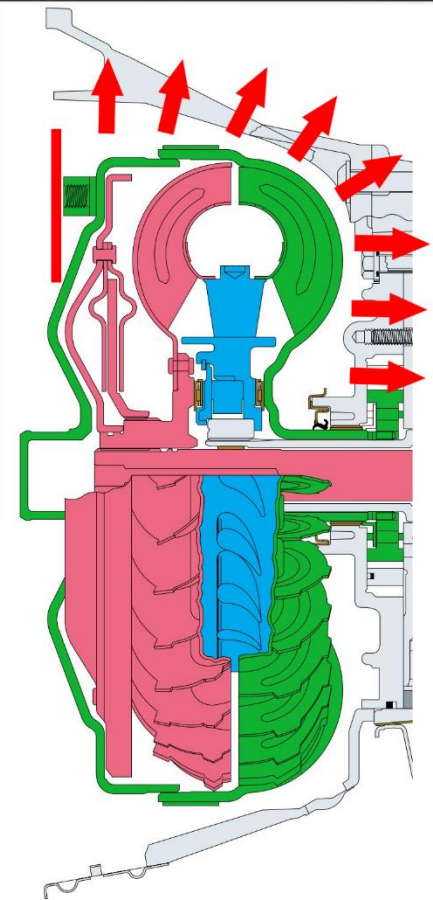
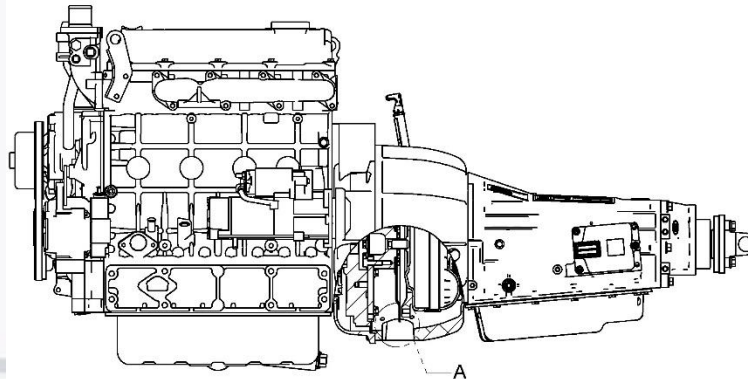


**Gap distance must be between .060" (1.5mm) and .187" (4.7mm).
Do not proceed and contact PCS if gap is out of range.**

Field Replacement Considerations

Torque Converter Pullout

- Converter Clutch Application
- Thermal Expansion
- Engine Build Tolerances
- Converter Type
 - 300mm vs 258mm
- Crankshaft
- Flywheel
- Flywheel-Housing
- Flywheel Adapter
- Engine Spacer
- Flexplate
- Bellhousing



Field Replacement Considerations Transmission Pump Components

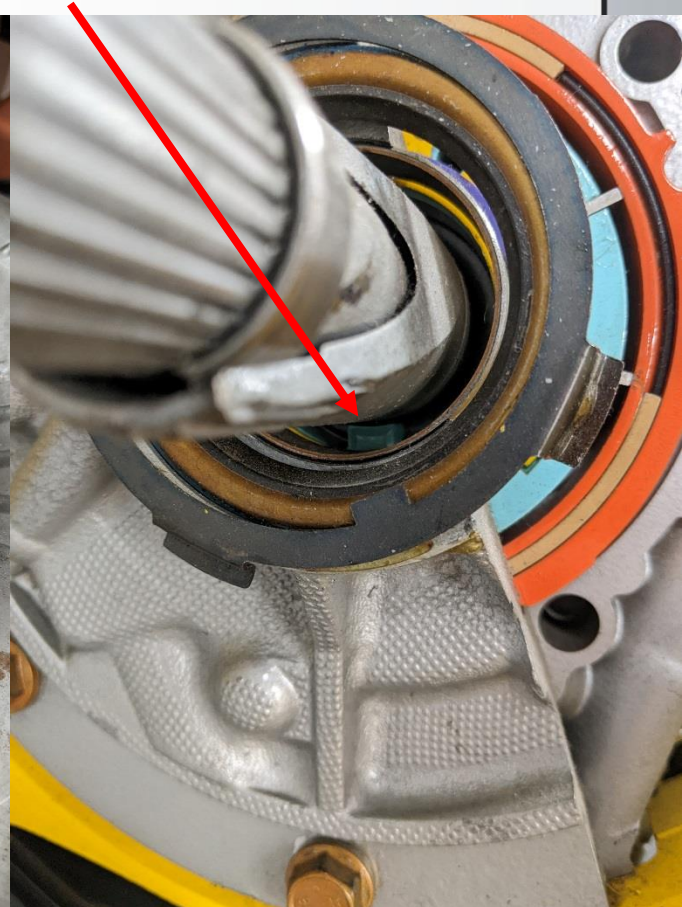
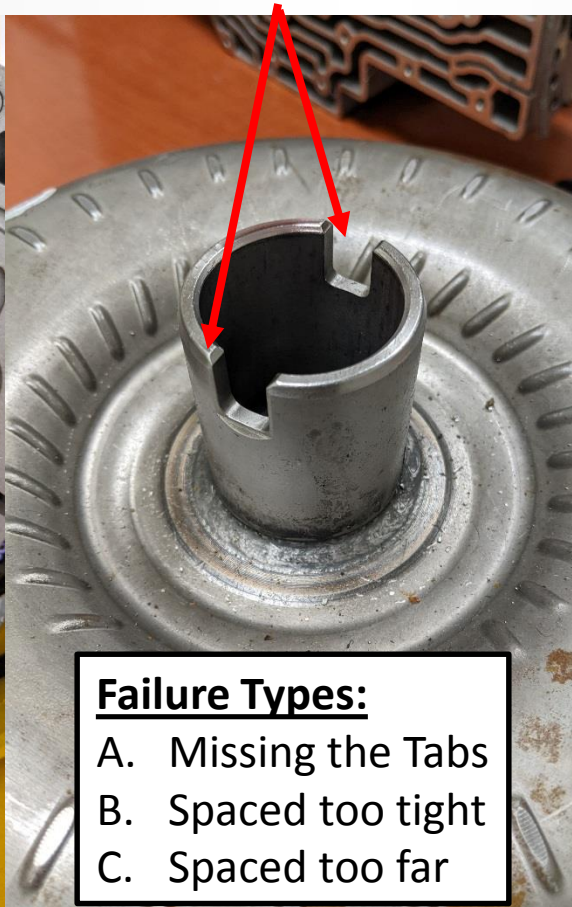
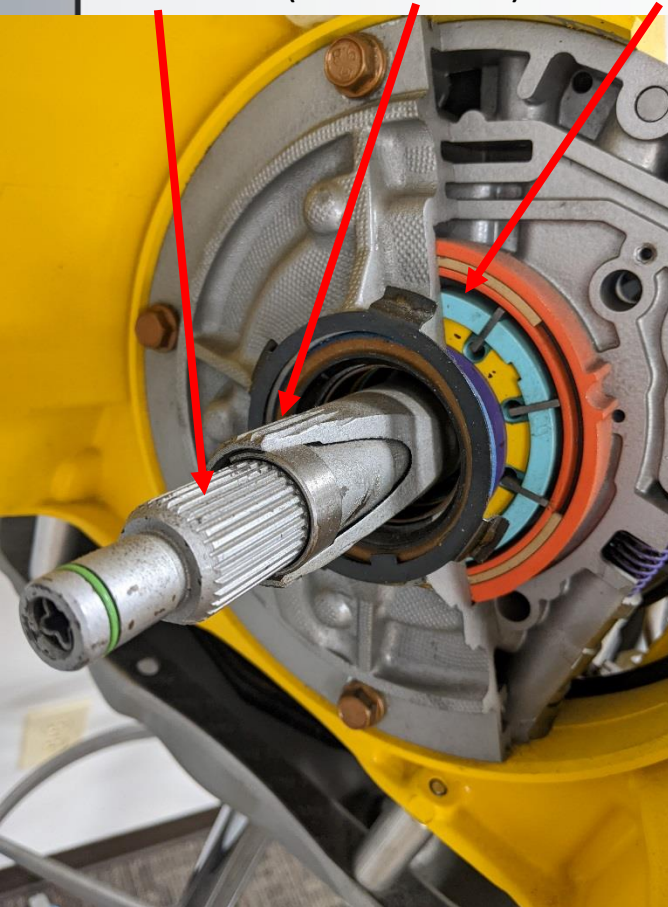
INPUT
SHAFT

TURBINE SHAFT
(STATIONARY)

13-VANE
ROTOR/PUMP

CONVERTER
SLOTS

PUMP
TABS (2X)



Failure Types:

- A. Missing the Tabs
- B. Spaced too tight
- C. Spaced too far

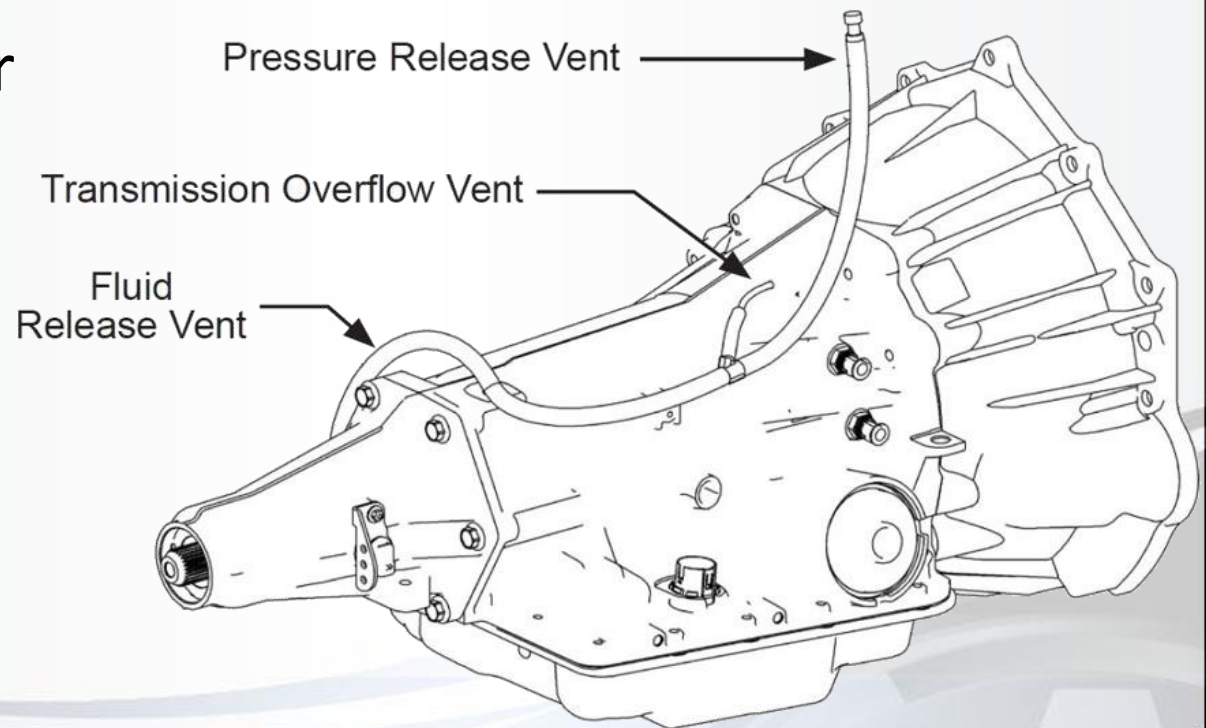
**Pump
Damage**



Field Replacement Considerations

Proper Vent Hose Installation

1. Vertical Rattle-cap
2. Flamethrower
3. Puddles
4. Low-points
5. Zip-ties



Field Experiences

With 16,000+ in the field, issues are **statistically low**, but these are some descriptions we have heard from customers:

- “Transmission moves, but won’t pull”
- “Transmission will not shift out of 1st”
- “Transmission doesn’t move forward or reverse”
- “Transmission doesn’t move in reverse”
- “Transmission loses forward when hot”

“Transmission moves, but won’t pull”

1. Check fluid level & condition.
 - **Level is critical here**, fluid may be burnt as a result of this failure – if the unit is operated it will burn up the transmission.
2. Check for codes.
 - Verify communication with the TCM.
3. Check the basics – power and shift linkage.
 - Over 90% of these failures are **no power – blown fuse**, no fuse, etc.
 - If a power reset solves the problem, then a power mod is required - older firmware.
4. Check the signals.
 - Observe **TPS** and RPM.
5. Directly control the transmission.
 - If there is a solenoid issue, it will be discovered here.

“Will not shift out of 1st”

1. Check fluid level & condition.
 - Probably fine
2. Check for codes.
 - **Could be SSA or SSB Solenoids or a failed band / clutch.**
3. Check the basics – power and shift linkage.
4. Check the signals.
 - **Observe OSS / VSS. Very likely the Output Speed Sensor or wiring.**
5. Directly control the transmission
 - If there is a solenoid issue, it will be discovered here.

“Transmission doesn’t move forward or reverse”

1. Check fluid level & condition.
 - **Level is critical here**, without enough fluid there will not be line pressure to operate the transmission.
2. Check for codes.
 - Verify communication with the TCM and check codes.
3. Check the basics – power and shift linkage.
 - **Gen 3 no power condition** is no forward and no reverse.
 - Shift linkage disconnected?
4. Check the signals.
 - Observe TPS, RPM – Incorrect high TPS or RPM is most likely the cause – the transmission is in **abuse protection**.
5. Directly control the transmission.
 - There is not one electrical failure (solenoid) that can prevent forward or reverse, but you may have a mechanical failure, i.e broken pump or shaft.
 - **Perform line pressure check.**

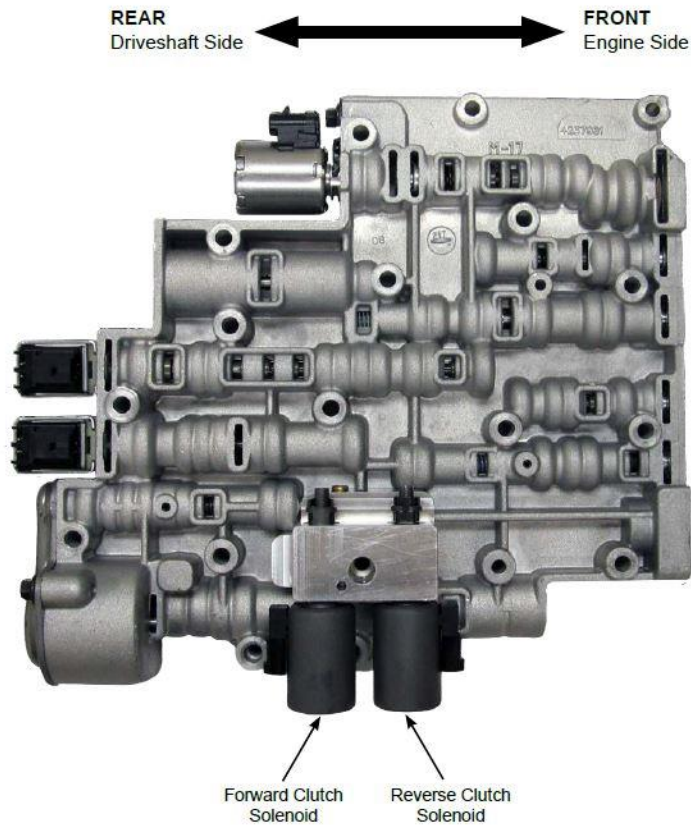
“Transmission doesn’t move in reverse”

1. Check fluid level & condition.
 - Check fluid condition. Level is probably OK since forward is working but burnt fluid could indicate burnt reverse clutch.
2. Check for codes.
 - Verify communication with the TCM and check codes.
3. Check the basics – power and shift linkage.
 - Does **shift linkage** place the shifter into reverse detent?
4. Check the signals.
 - Verify TCM is reporting reverse when the shift lever is moved. This is probably not abuse protection because forward engages.
5. Directly control the transmission.
 - There is one solenoid that controls reverse so it is likely the cause.

*-Model years **2015-2016 had a GEN-2 REV-solenoid** that could have a manufacturing issue, causing it to stick (no reverse) in the first 100 hours. **Replacing the solenoid** solves this issue.*

*-Model years **2019-2020 had a GEN-3 REV-solenoid** that locks up under extreme pressure, such as high line pressure in reverse. A **calibration update fixes this**, contact PCS for help.*

GEN-2 Forward and Reverse Solenoids



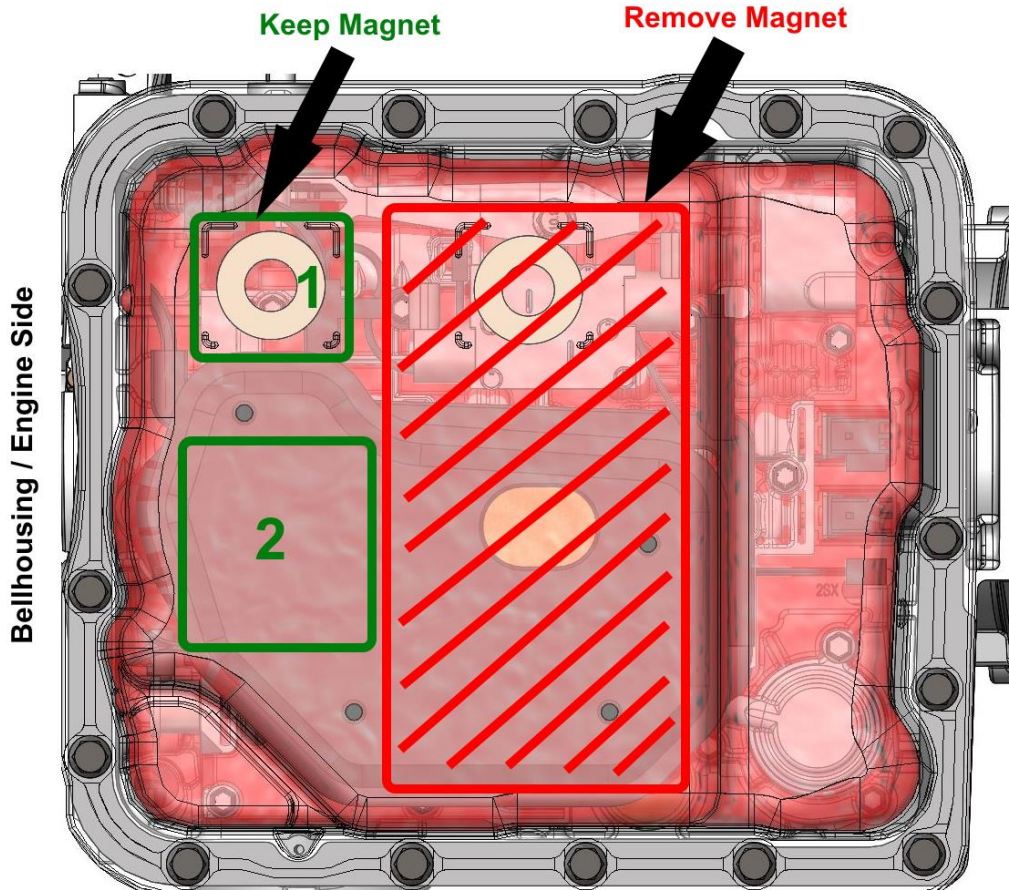
- Reverse solenoid should be marked “reverse” as shown above.
- There is no adjustment of the solenoid in the field.

“Transmission Loses Forward at Temp”

1. Check fluid level & condition.
 - Check fluid condition. Level is probably OK since forward is working but burnt fluid could indicate burnt forward clutch.
2. Check for codes.
 - Verify communication with the TCM and check codes.
3. Check the basics – power and shift linkage.
 - Does **shift linkage** place the shifter directly in the forward detent?
4. Check the signals.
 - Verify TCM is reporting forward when the shift lever is moved. This is probably not abuse protection because forward engages.
5. Directly control the transmission.
 - There is one solenoid that controls forward so it is possibly the cause.

2019+ GEN-3 4LHD Transmissions with this very specific symptom has a significant 90%+ performance improvement when the rear pan magnet is removed, new aux-block installed, and software-patch verified by PCS Technical Support! Send the datalog to our gsetechs support email for verification!

Magnet, GEN-3 Block, and TCM Update



- Remove the magnet from the pan as shown on the left.
- Replace the entire aux block. New ones are tested and wear free.
- Detailed step-by-step instructions on gsehelp.com for this procedure

Tools Every Shop Should Have

- Cable and Software (preprogrammed laptop available)
- Transmission Diagnostic Device
- Volt/Ohm Meter
- Pressure Gauge, 1/8-NPT, 400 PSI
- Fluid Evacuators



Want to learn more?

- GM 4L60E Technicians Guide
- ATSG 4L60E Repair and Overhaul Manual
- Precision Transmission (YouTube)
 - Tear downs and root cause analysis
- Weber Auto (YouTube)
 - History of Transmission Fluid
 - Description of Transmission Operation
- SIU Automotive (Youtube)
 - Description of Transmission Operation

The Keys to Troubleshooting

- Have the right tools!
- Follow the 5-step process!
- Add a transmission check to every maintenance event!
- Transmission “inside or outside” diagnosis should be a 15 minute task!

Any Questions?

(Next let's look at a data-log!)