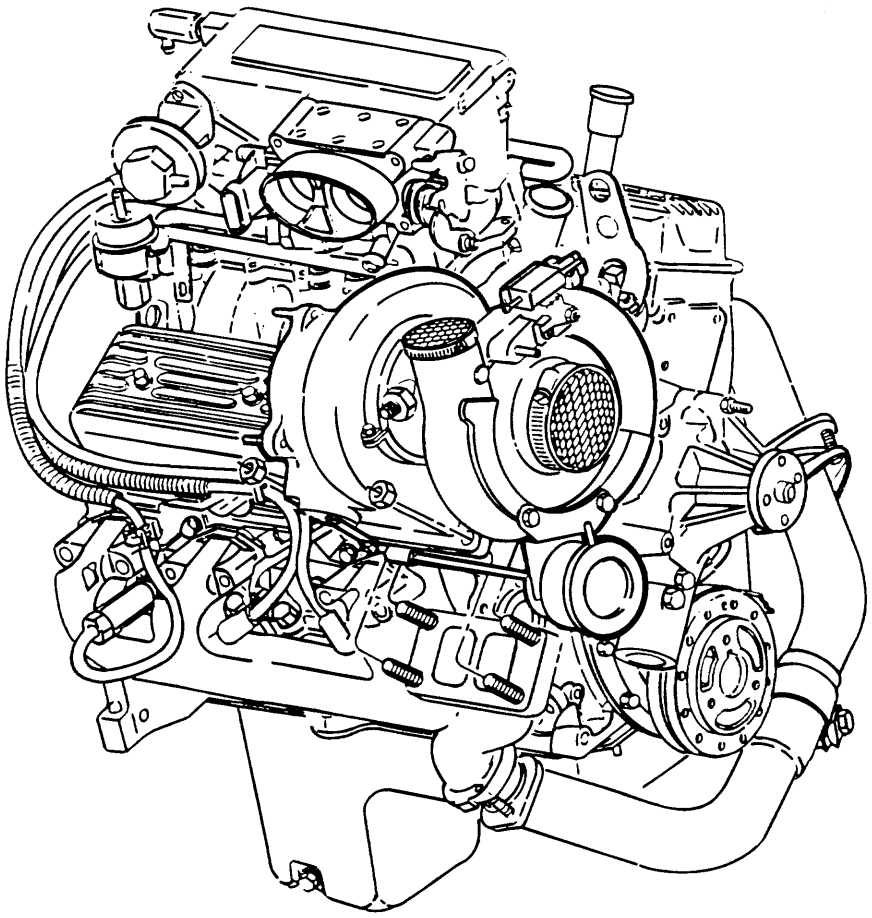
90-12 & T-9072-2

Reference Manual

SYCLONE

Service Highlights

Turbocharged 4.3L PFI Engine



285 Horsepower

360 Ft./Lbs. of Torque

CONTENTS

VIDEOTAPE INDEX

INTRODUCTION

The phrase "*It isn't just a truck any more*" just took on a whole new meaning. You may ask, "Why is GMC Truck building a high-performance truck?" Granted, performance vehicles are not our specialty. However, a GMC S-Truck with All-Wheel Drive and Four-Wheel Anti-Lock Brakes turns out to be one of the very few powertrain packages with the ability to thoroughly handle a turbocharged V6 engine with force induction. It's called *Syclone*.

That's all the hype in this Professional Performance Network videotape and Reference Manual. Frankly, you can't blame us for getting a little excited about this machine. The Syclone is a unique combination of systems and components. When you open the hood for the first time, you might want to know what these or those particular things are.

The videotape is a thorough run-down of hardware on the Syclone. It begins at the beginning — with the air system and turbocharger — and then follows through the engine, transmission, transfer case, brakes, wheels and tires, and finally the special body cladding and fascia. We stick fairly close to our PPN format of *How It Works, What Can Go Wrong*, and *How To Test It*.

This Reference Manual contains additional background material on systems and components for the Syclone — material that is not contained in the videotape. For a complete picture of what this performance truck is all about, you really have to check out both the video *and* the manual.

Specific GM-sponsored training will also be required to work on certain components and systems — port fuel injection and four-wheel anti-lock brakes.

All parts that are found only on the Syclone (and not on regular S-15 Sonoma models) have to be 100% returnable to GM. This is necessary in order to identify product concerns as quickly as possible. All Syclone parts will have their own part number and will be handled through GMSPO.

Objectives

When you have learned what's on the videotape and thoroughly read this Reference Manual, you should be able to:

1. Briefly describe differences between GMC Sonoma S/T Truck models and the GMC Truck Syclone performance truck.
2. Explain operation of the turbocharger used on the Syclone, including closed-loop boost control, and describe guidelines for diagnosis.
3. Identify the purpose of the intercooler system, engine performance symptoms that may be linked to the intercooler and inspection points.
4. Identify both PCV valves on the Syclone engine and explain what each one does (why there are two).
5. List major components of the port fuel injection system used on the Syclone. Describe how PFI compares to throttle body fuel injection.
6. Briefly explain what is different about the 4L60 transmission used for the Syclone and describe general diagnosis by the symptom.
7. Explain both the operation and important points of diagnosis relating to the All-Wheel Drive powertrain.
8. Explain basic operation and diagnosis guidelines for the limited-slip rear axle used on the Syclone.
9. Identify the major components of the four-wheel anti-lock brake system and briefly describe what they do. List the diagnostic information that can be pulled from the 4WAL system with a Tech 1 scan tool.
10. Describe the Syclone instrument cluster, as well as guidelines for diagnosis and repair.
11. Demonstrate how to replace body side fascia and cladding on the Syclone.

TURBOCHARGER

Operation

Positive intake air charge, or boost, makes more air available to the engine for more horsepower. This is the function of the turbocharger.

Syclone's turbocharger has an integral exhaust bypass valve, or **wastegate**. This controls the amount of boost (turbocharger output to the throttle body) at high engine speeds.

The center section of the turbocharger is water-cooled by the engine cooling system (Figure 1). Engine oil also provides the necessary lubrication, via oil supply and drain lines.

Warning: Do not attempt to operate the turbocharger without all air ducts and filters securely in place. Failure to do so may result in personal injury from rotating components or flying projectiles, as well as damage to the blades of the turbine and/or compressor wheels.

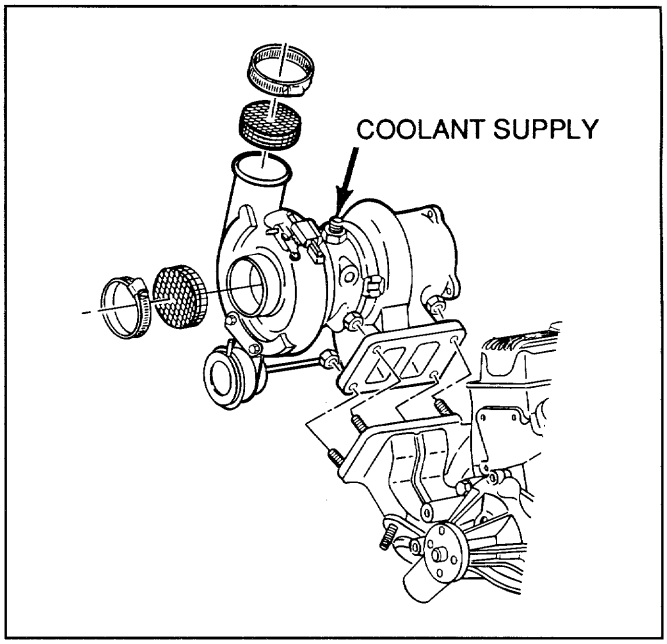


Figure 1. TD06 Turbocharger

Maintenance

Lubrication is critical to operation of the turbocharger. That's because it rotates at speeds of over 100,000 RPM. If the oil supply should become contaminated with water, restricted, or cut-off completely, severe damage to the turbocharger can result.

You should definitely change the engine oil filter any time major engine bearings have been replaced or serviced:

- Main bearings
- Connecting rod bearings
- Camshaft bearings.

At the same time, be prepared to perform a unit inspection on the turbocharger. The procedure is contained in the Syclone Service Manual Supplement. The oil filter is located at the left front of the engine compartment.

Diagnosis

Any turbocharger makes its own characteristic noise, which is normal. However, it may also be possible to diagnose certain conditions relating to the turbocharger by the noise it makes:

- **Low- or high-pitched sounds, or whistling** — When the turbocharger makes a sound that is lower or higher in pitch than normal, or a whistling noise, the air inlet ducting may be leaking. Another possibility is exhaust gas leaking from the turbine side; this as opposed to an exhaust leak in the manifold, away from the turbocharger — you know what *that* sounds like. Be advised that any exhaust leak may affect turbocharger operation and engine performance by cutting down on the normal amount of turbo boost.

- **Noise that cycles up and down** — This could be an indication of an air inlet restriction. Sooty dirt that builds up on the compressor wheel and housing causes an inlet restriction and should be carefully cleaned away.

Here's how to perform a good, complete turbocharger inspection:

1. Check all air duct connections, from the air cleaner to the turbocharger. They should be clean on the inside and tight.

2. Check the cross-over duct (the elephant's trunk) from the turbocharger to the intercooler. If it's loose, the customer may experience low power on acceleration and increased engine noise.

3. Look closely at the turbine and compressor wheels. See if there's any foreign body damage, and make sure they don't rub against the turbocharger housing. (This procedure is demonstrated on the videotape.)

4. While you're checking for free rotation of the turbocharger shaft, look for oil sludge that could slow it down. If there are any carbon-like deposits of coke on either side, again the turbocharger may not be able to rotate freely. Coking on the turbocharger is also a possible indication of engine overheating.

5. Inspect the exhaust manifold for cracks. See that the turbocharger is tightly connected to the manifold (Figure 2).

6. The oil return line must be in good condition, with no kinks or other restrictions. Any restriction in the return line will result in serious oil leaks through the turbocharger shaft seals.

7. Finally, check the oil supply line, too. It should have no kinks or restrictions.

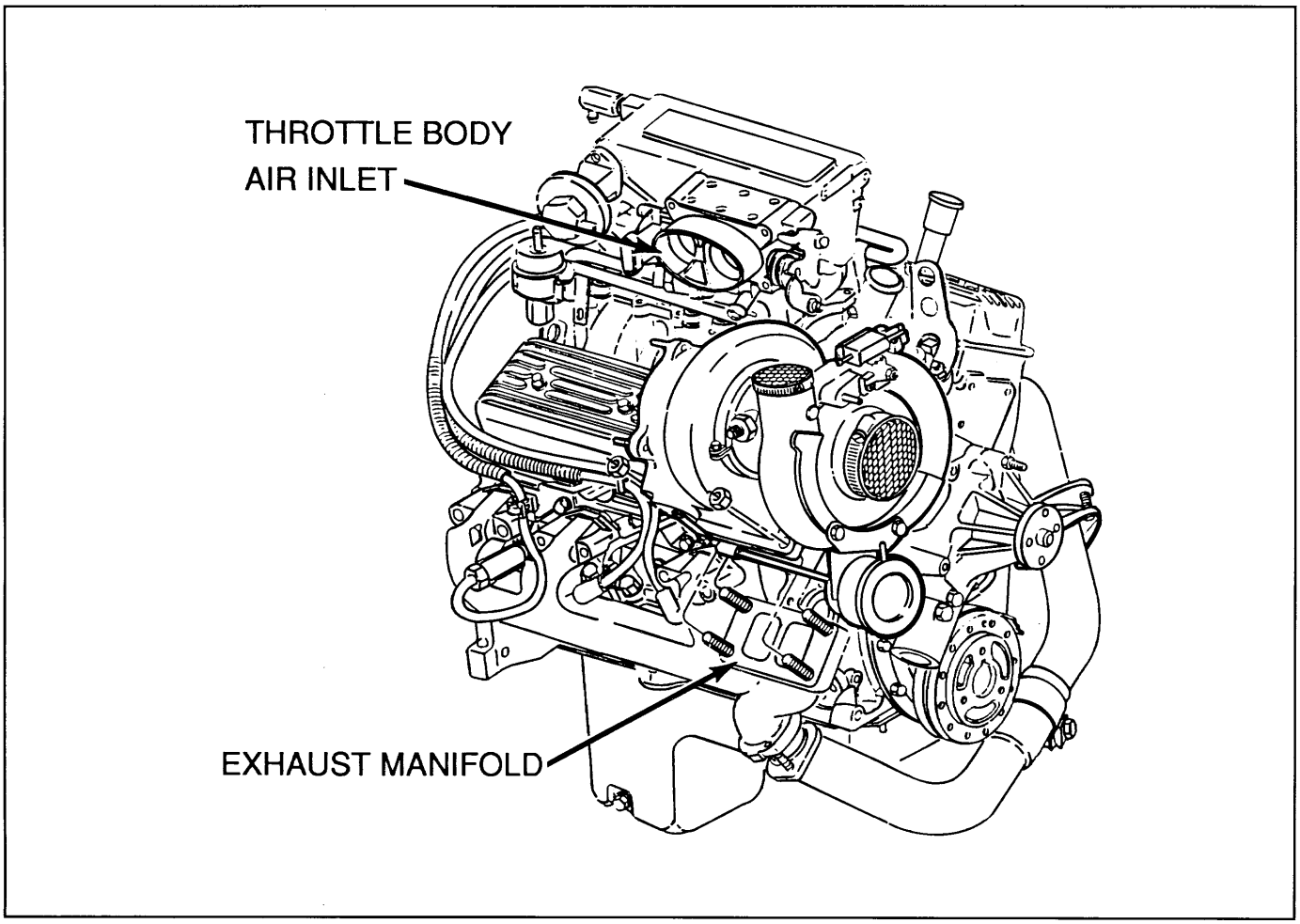


Figure 2. Turbocharger Installation — 4.3L PFI Engine

INTERCOOLER

Operation

Syclone has an entirely separate circuit of cooling components for the air supply to the throttle body. The purpose of this **intercooler** system is to dissipate additional heat generated by the turbocharger and to keep intake temperatures down.

The intercooler works by feeding air from the turbocharger through a **charge air cooler** (CAC), which is mounted next to the throttle body. Inside, the charge air cooler looks like a heater core. A second radiator, located under the big radiator, completes the heat exchange circuit. The CAC radiator is also referred to as the **heat exchanger**.

The intercooler has its own electric circulation pump and thermostatic controls operated by the ECM.

Maintenance

Routine service for the intercooler system is basically the same as for the engine cooling system. Check the level and condition of the intercooler coolant at the same intervals as the engine coolant, and in the same manner. Be sure to take precautions — don't get scalded by hot coolant — and follow all replacement procedures as explained in the Syclone Service Manual Supplement.

Fill the intercooler system at the charge air cooler, and "burp" out air by cycling the circulation pump.

Proper installation of the heat exchanger air deflector is essential to intercooler operation and turbo boost calibration. The deflector attaches to the lower part of the exchanger by four studs. Replace the air deflector if it is damaged or missing.

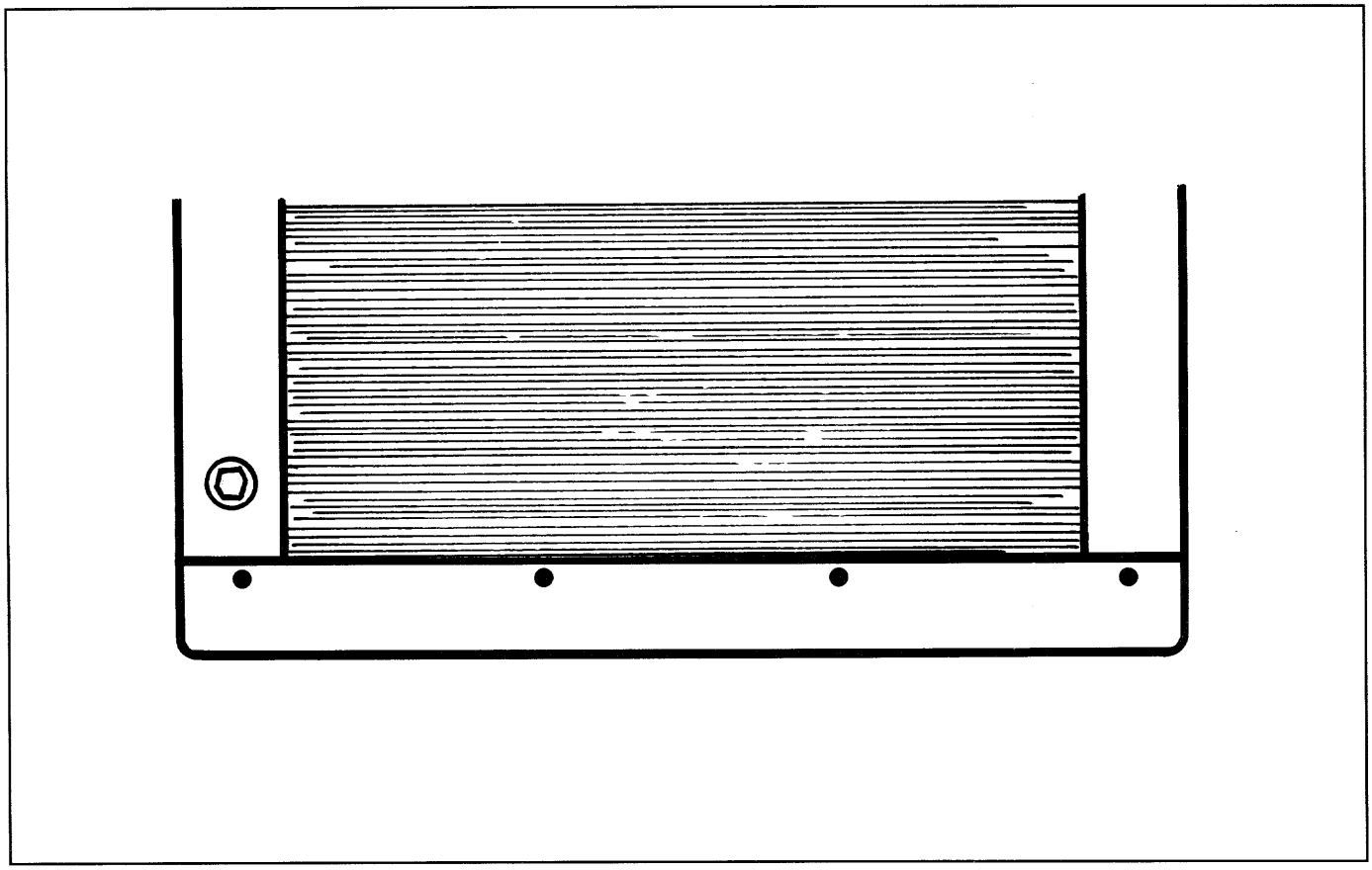


Figure 3. Intercooler Air Deflector

PORT FUEL INJECTION

Operation

Fuel injection is not a new concept for GMC Truck technicians. The **port fuel injection** system found on the Syclone has many similarities to the throttle body injection system. True, there are six injectors with PFI instead of two injectors on TBI. For the most part, however, the same system inputs and outputs are used to control fuel delivery and spark (Figure 4).

The electronic control module for Syclone is different than the standard Sonoma controller. The wiring harnesses cannot be disconnected (for testing) without actually removing the ECM from behind the kick panel.

Recall that the controller portion of the ECM does not include the Programmable Read-Only Memory (PROM) clip or calibration pack (CALPAC). Should you have to replace an ECM, you must also transfer the original PROM and CALPAC to the new controller, or obtain the correct replacements. Also, the broadcast code in the upper left-hand corner of the controller has to match the PROM. For replacement purposes, use the 7-digit GM part number, not the Delco number (Figure 5).

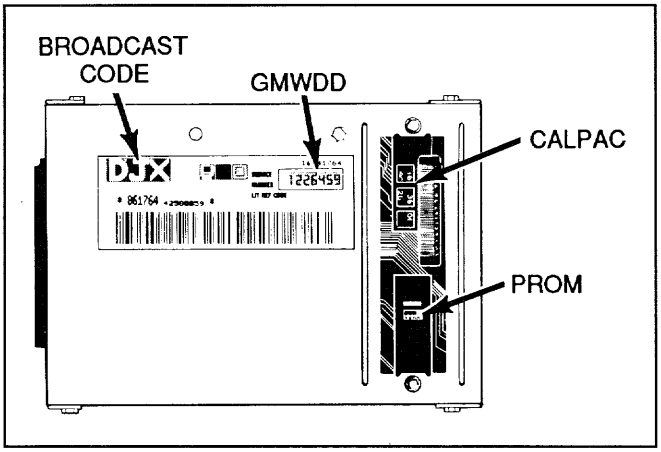


Figure 5. ECM Identification Numbers

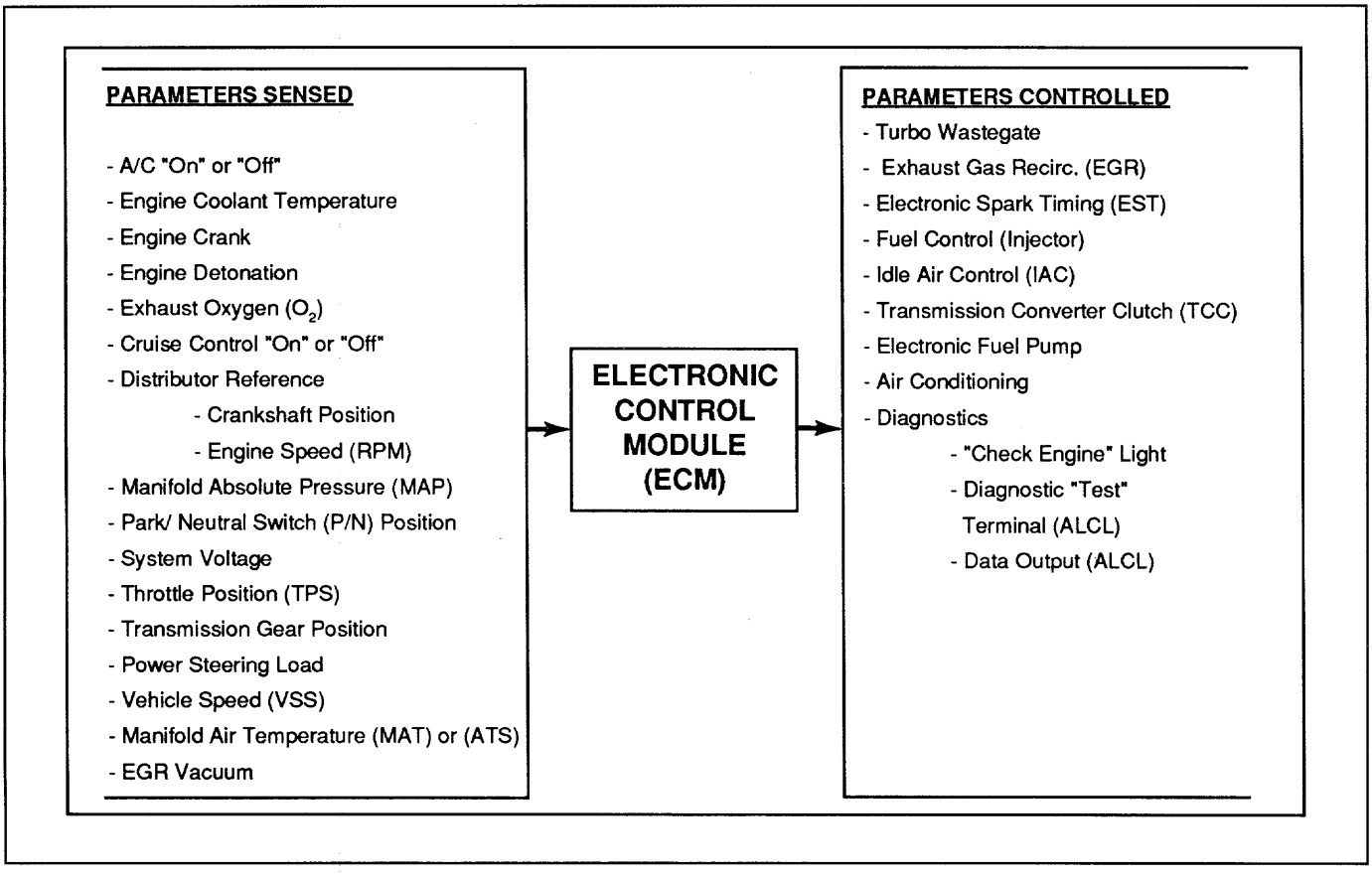


Figure 4. Port Fuel Injection — ECM Parameters

The PROM clip contains electronic programming for the Syclone, including all powertrain components and options. When replacing a PROM clip, especially with the Syclone racing calibration, be absolutely certain to match the part numbers. If a single digit or letter does not match (or cross-reference from parts lists), you're going to install wrong parts, and the truck won't run properly.

The same goes for the CALPAC. It looks much like the PROM clip and contains a calibrated network of resistors. Like the PROM, it has its own identification number. The CALPAC contains programming for basic fuel calibration (air/fuel mixture) for cold starting and engine warm-up.

The CALPAC also includes programming for the **back-up fuel circuit** mode. Back-up fuel control takes over under any of the following conditions:

- ECM voltage drops below 4.5 volts
- Cranking voltage drops below 9 volts
- Missing or nonworking PROM
- Internal system fault — ECM.

In the back-up fuel mode, the CALPAC registers signals from the throttle position sensor, coolant temperature sensor and the distributor. In this mode, only the fuel pump relay and injector pulse width are actively controlled. All other outputs are regulated according to the basic fuel calibration (another CALPAC electronic function).

The ECM output harness includes color-coded wires to all six injectors. Each injector has two wires connected to it:

- The brown wire feeds battery voltage (B+) to that injector.
- The other colored wire (black, dark or light green, pink, red or white) provides a ground path for the injector through the ECM. The adjacent color-code chart indicates which color goes with which cylinder (Figure 6).

Maintenance

Routine maintenance for the base 4.3L V6 engine still applies to the Syclone.

- **Air system** — A clean air filter is more critical to performance, due to the turbocharger. There are two PCV valves which must be replaced at scheduled intervals and corresponding crankcase breather filters for each.
- **Fuel system** — Replace the in-line fuel filter at recommended intervals.
- **Ignition system** — Syclone uses the same distributor and electronic ignition components as the production Sonoma. One difference — the spark plug cables are special high-temperature-resistant. The correct set of wires must be used when replacing them.

For more information, refer to the Maintenance Schedule included with every Syclone Owner's Manual.

CYLINDER	WIRE COLOR
1	BLACK
2	DARK GREEN
3	PINK
4	RED
5	WHITE
6	LIGHT GREEN

Figure 6. Injector Wiring Colors

Diagnosis

Test guidelines and procedures for port fuel injection are similar to those for throttle body injection. Furthermore, there is not sufficient time or space in this program to cover the topic. If you're familiar with TBI theory and diagnosis, you will be able to understand what can go wrong with the PFI system and how to test it.

The following are general symptoms that indicate something is wrong with the PFI:

- **SERVICE ENGINE light comes on** — indicates that system parameters have gone outside or beyond what is considered "normal" engine operation, and a trouble code has been set. Follow the Diagnostic Circuit Check in the Service Manual to retrieve and test the code.
- **Poor driveability or performance** — anything from especially low fuel economy, a low octane fuel rating, lack of power at acceleration, surging at cruise, etc. The Service Manual Supplement for Syclone includes specific tests for specific symptoms in the same format as the Fuel, Emissions & Driveability Manuals.
- **No-start conditions** — the engine cranks, but that's all. These tests are included in the Syclone Service Manual Supplement.

The 87-91 ECM cartridge, TK02050-C, is part of the essential tool package for testing the PFI system. When using the Tech 1, you have to manually enter the engine code "S" for the eighth digit of the VIN code. Only this will access the correct routines for the 4.3L PFI fuel and ignition system.

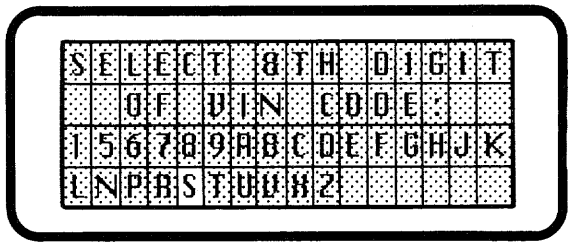


Figure 7. Enter Engine Code "S"

Wiring Repairs

Outside of general maintenance and tune-ups, 90% of all electrical conditions that affect driveability and performance can be traced to electrical wiring and connectors in the fuel or ignition system. Clean, tight connections are critical to correct voltage and resistance values in electronic systems.

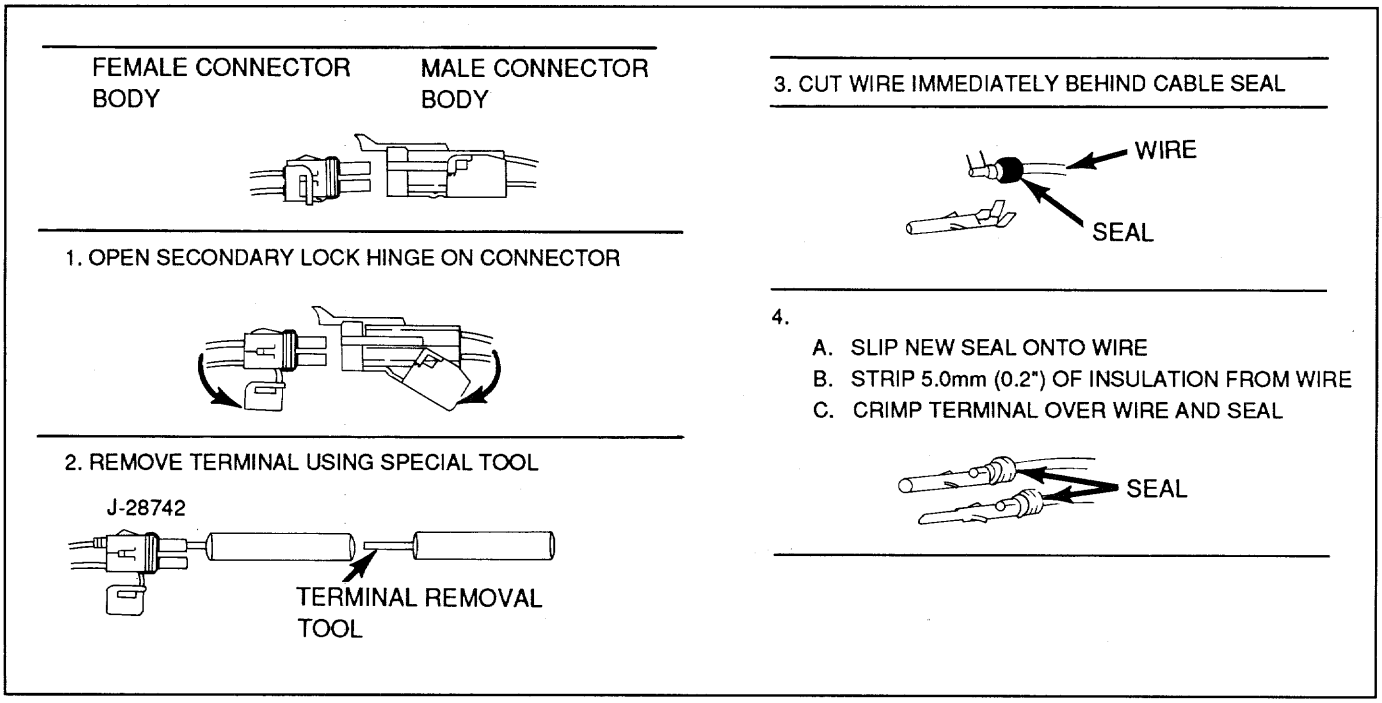
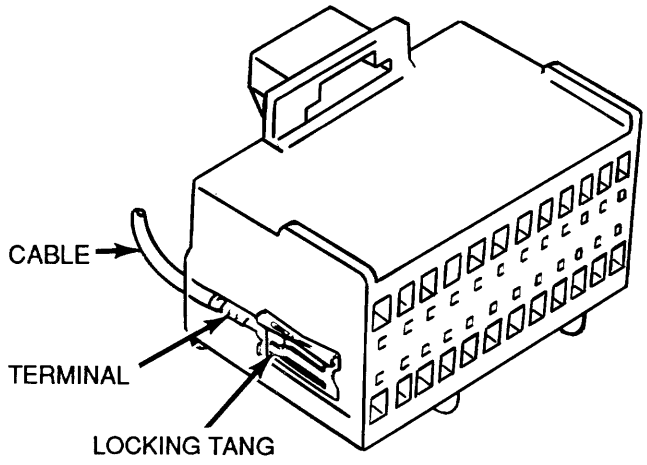
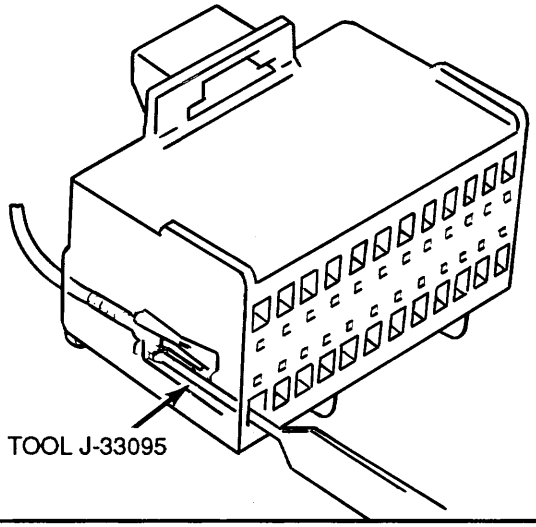


Figure 8. Weather-Pack Terminal Repair

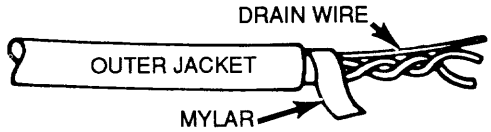




1. Grasp cable and push terminal to the most forward position.
2. Insert tool J-33095 straight onto the front of the connector cavity. Do not use conventional pick to remove terminal.
3. With tool in place, gently pull on the cable to remove terminal.
4. Visually check terminal and replace if terminal cavity or tang is damaged.
5. Install terminal into connector cavity until locking tang has snapped into position.

Figure 9. Micro-Pack Terminal Repair

TWISTED/SHIELDED CABLE



1. Remove outer jacket.
2. Unwrap aluminum/mylar tape. Do not remove mylar.

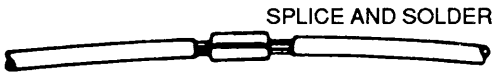
3. Untwist conductors. Strip insulators as necessary.

4. Splice wires using splice clips and rosin core solder. Wrap each splice to insulate.
5. Wrap with mylar and drain (uninsulated) wire.

6. Tape over whole bundle to secure as before.

TWISTED LEADS

1. Locate damaged wire.
2. Remove insulation as required.



3. Splice two wires together using splice clips and rosin core solder.

4. Cover splice with tape to insulate from other wires.
5. Retwist as before and tape with electrical tape and hold in place.

Figure 10. Wiring Harness Repair

AUTOMATIC OVERDRIVE — 4L60 TRANSMISSION

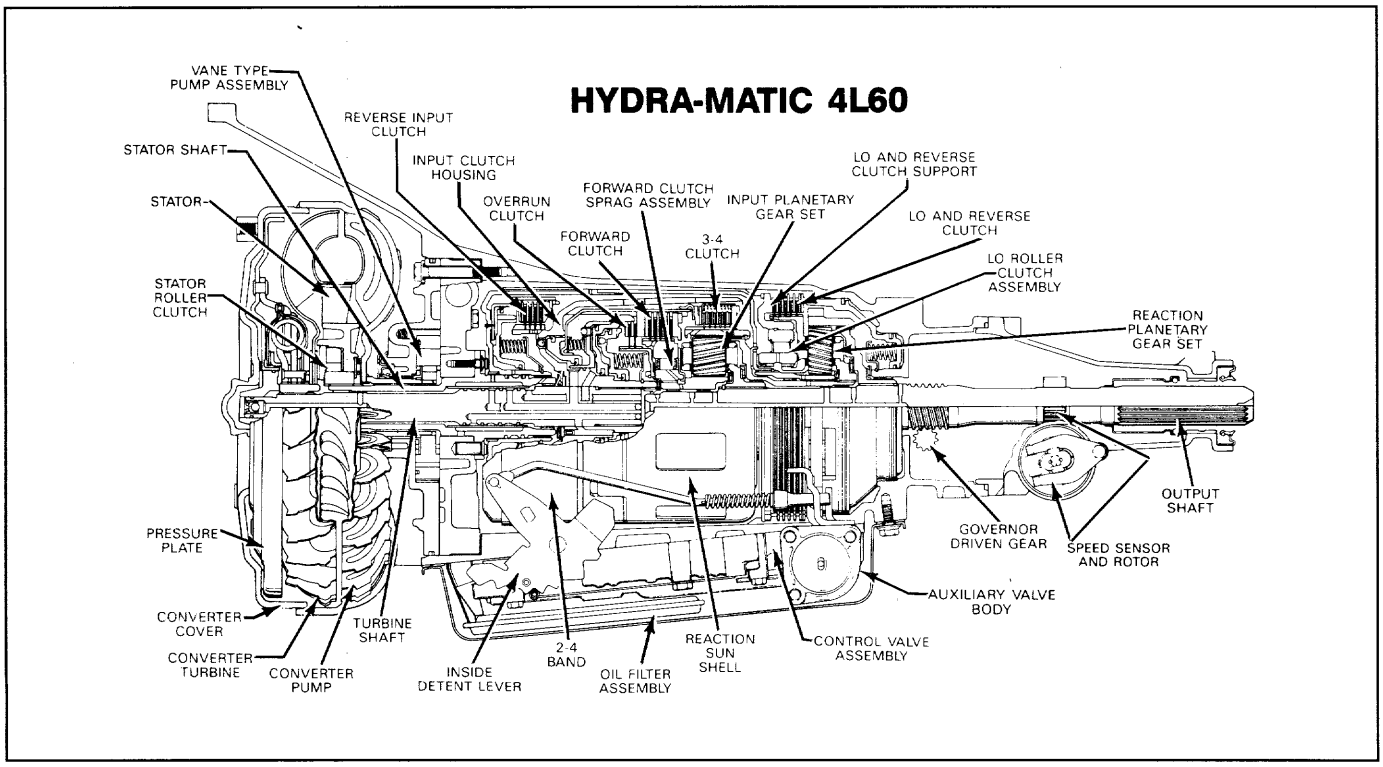


Figure 11. 700-R4 Automatic Overdrive Transmission

Maintenance

Syclone uses basically the same automatic overdrive transmission and torque converter clutch as other GMC Light Trucks (Figure 11). Shift points on the Syclone transmission are calibrated at a lower engine speed for better acceleration under performance conditions. There are also a few minor hardware differences inside the transmission, borrowed from Corvette models. For the most part, operation, maintenance, diagnosis and repair are going to be the same as for other GMC Truck models.

Under normal use, transmission fluid should be changed every 30,000 miles, along with the filter. However, there are certain conditions where the fluid should be changed more frequently — at least every 15,000 miles:

- Urban areas with a lot of stop-and-go driving
- Hot climates, where temperatures are higher than 90°F
- Mountainous or very hilly regions
- Commercial or other severe use (racing applications, volunteer fire departments, etc.).

Shift linkage should be checked and adjusted as needed at regular intervals. Suspect the linkage adjustment and check it first when the transmission has the following symptoms:

- Jumps out of gear
- Does not perform automatic shifts properly
- Does not engage quickly and firmly.

The **park-neutral switch** should also be checked at least once a year. The engine should not start with the shift lever in any positions other than PARK or NEUTRAL.

The same switch also provides a signal to the ECM to control idle speed and spark advance. If the engine runs rough or surges at idle, the park-neutral switch may be out of adjustment. Adjustment procedures are in the Service Manual.

Diagnosis

Perform these preliminary checks for any condition relating to the transmission:

- Check that engine performance is normal (properly tuned, etc.). Also, that idle speed is correct.
- Hydraulic fluid level and condition — check with the engine and trans warmed up, in PARK or NEUTRAL.
- T.V. cable adjustment — should be set to spec. New adjustment procedures are in the Syclone Service Manual Supplement.
- Shift linkage adjustment — procedures are also in the Syclone Supplement.

When performing a road test, check for proper shifting and engagement of clutches and bands. Shifts should be smooth, firm and consistent. If the engine is properly tuned and running well, brisk acceleration means that the torque converter is multiplying torque properly. If acceleration is poor but the engine is not a factor, check the one-way clutch inside the torque converter. You should be able to rotate the torque converter in one direction only on the hub. Also, if the rear clutch inside the transmission is slipping, acceleration may be poor. This is because the transmission will be slipping in every forward gear.

The torque converter clutch should lock up on light throttle at about 35 MPH. Check it with a Tech 1 in the (open) road-test mode.

T.V. LINE PRESSURE TESTING

The transmission uses hydraulic pressure — **line pressure** — to operate clutches and bands, and for lubrication. There are two gage ports, or taps, for measuring line pressure, one on either side of the transmission (Figure 12).

To check line pressure:

1. Set the parking brake and block the wheels.
2. Connect oil pressure gage(s) to the line pressure port.
3. Start the engine and read minimum line pressure with the transmission warmed up and the T.V. cable:
   - Shifter in park, neutral, overdrive and manual 3rd; hold engine at 1000 RPM
   - Shifter in reverse with engine at 1000 RPM
   - Shifter in manual 2nd and manual low at 1000 RPM.

In each case, line pressure readings should match the **Normal Pressure at Minimum T.V.** column in the chart on the following page.

4. Tie or hold the T.V. cable at the full range of its travel and read maximum T.V. line pressure.
   - Shifter in park, neutral, overdrive and manual 3rd; hold engine at 1000 RPM
   - Shifter in reverse with engine at 1000 RPM
   - Shifter in manual 2nd and manual low at 1000 RPM.

Caution: Do not run this portion of the test for longer than two minutes at a time. Make sure the brakes are applied.

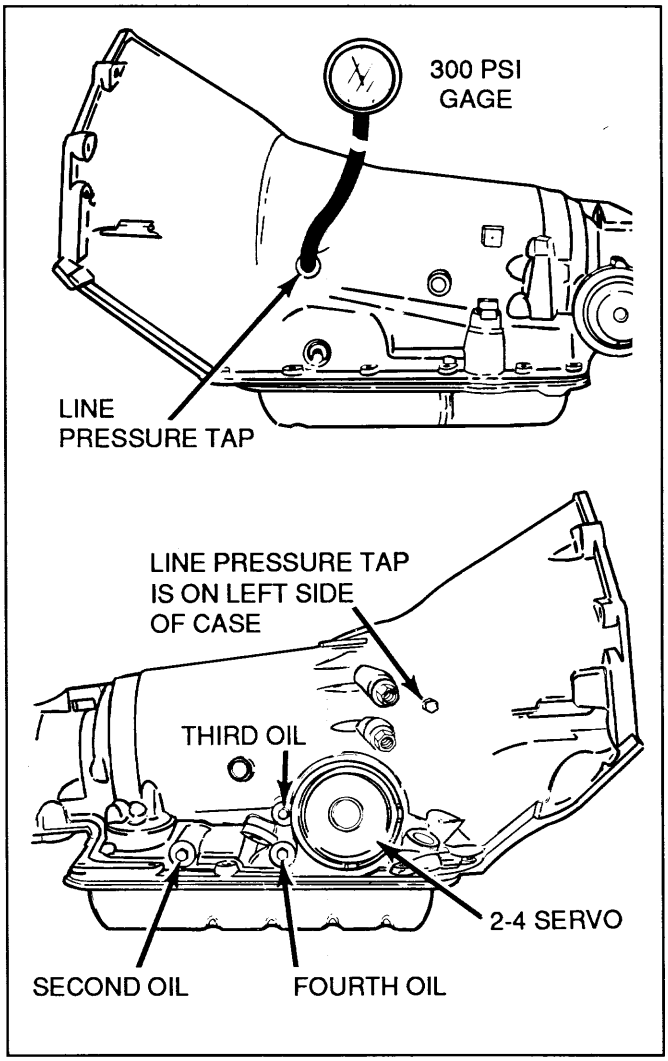


Figure 12. Line Pressure Test Ports

1990 HYDRA-MATIC 4L60 TRANSMISSION PRESSURES					
RANGE	MODEL	NORMAL PRESSURE AT MINIMUM T.V.		NORMAL PRESSURE AT FULL T.V.	
		kPa	PSI	kPa	PSI
PARK, NEUTRAL, OVERDRIVE & MANUAL 3RD @ 1000 RPM	BAM, FTM	451-515	65-75	816-1016	118-147
	BPM	451-515	65-75	1025-1306	149-189
	CAM, CBM, HCM, HDM, KAM, MJM, MNM, WAM	451-515	65-75	851-1063	123-154
	CCM, CFM, KBM, WBM	451-515	65-75	947-1185	137-172
	CHM, CJM, KCM, RAM, WCM	451-515	65-75	914-1149	133-167
	DBM	483-622	70-90	883-1170	128-170
	FBM	451-515	65-75	918-1146	133-166
	FUM, FZM	451-515	65-75	1073-1354	155-196
	HBM, HFM, HHM	451-515	65-75	1029-1308	149-190
	LAM, LBM, LCM, LDM, LFM	451-515	65-75	899-1134	130-164
	MBM, SAM	451-515	65-75	845-1068	123-155
	MSM	483-622	70-90	797-1079	116-157
	SHM, TLM	451-515	65-75	969-1231	141-179
	YDM	384-444	56-64	1049-1359	152-197
REVERSE @ 1000 RPM	BAM, FTM	742-847	108-123	1342-1670	195-242
	BPM	742-847	108-123	1686-2146	245-311
	CAM, CBM, HCM, HDM, KAM, MJM, MNM, WAM	742-847	108-123	1400-1747	203-253
	CCM, CFM, KBM, WBM	742-847	108-123	1556-1948	226-283
	CHM, CJM, KCM, RAM, WCM	742-847	108-123	1503-1889	218-274
	DBM	793-1023	115-148	1451-1924	210-279
	FBM	580-662	84-96	1180-1472	171-214
	FUM, FZM	742-847	108-123	1763-2225	256-323
	HBM, HFM, HHM	742-847	108-123	1691-2150	245-312
	LAM, LBM, LCM, LDM, LFM	741-845	107-123	1474-1860	214-270
	MBM, SAM	580-662	84-96	1085-1372	157-199
	MSM	793-1023	115-148	1311-1773	190-257
	SHM, TLM	742-847	108-123	1593-2023	231-293
	YDM	632-730	92-106	1724-2234	250-324
MANUAL 2ND & MANUAL LO @ 1000 RPM	BAM, BPM, CAM, CBM, CCM, CFM, CHM, CJM, FBM, FTM, FUM, FZM, HBM, HCM, HDM, HFM, HHM, KAM, KBM, KCM, MBM, MJM, MNM, RAM, SAM, SHM, TLM, WAM, WBM, WCM	1127-1286	163-186	1127-1286	163-186
	DBM, MSM	1205-1554	175-226	1205-1554	175-226
	LAM, LBM, LCM, LDM, LFM	1191-1359	173-197	1191-1359	173-197
	YDM	1120-1293	162-187	1120-1293	162-187

Figure 13. Transmission Pressures

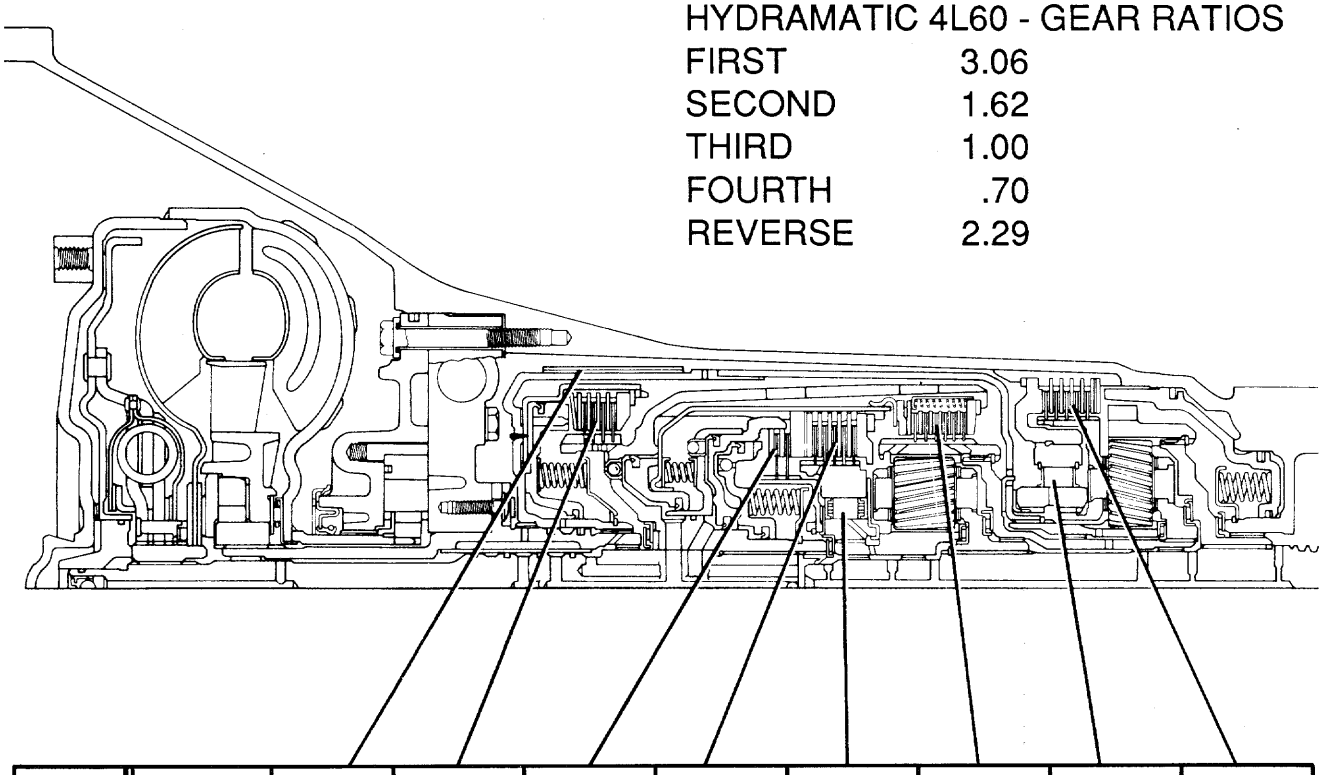
Line pressure readings should match the **Normal Pressure at Full T.V.** specifications in the chart (Figure 13).

If the line pressures do not agree with the specifications on the chart, check the hydraulic circuits in the valve body, clutches and bands affecting those gear ranges. The clutch application chart on page 12 indicates which clutches and bands are applied on specific gear ranges.

Other test ports on the transmission enable you to measure clutch apply pressures for 2nd, 3rd and 4th gears, as well as the 2-4 servo. These pressures should be at least the amount of line pressure within 10 PSI either way. If these clutch apply pressures are significantly lower, there is a leak somewhere in the affected hydraulic circuit.

Repair

Conditions like slippage, that involve clutches and bands, generally require an overhaul — diagnose the definite cause, and again, make a repair. A number of tests performed during the tear-down are designed to pinpoint the cause of a slipping clutch or band.



RANGE	GEAR	2-4 BAND	REVERSE INPUT CLUTCH	OVERRUN CLUTCH	FORWARD CLUTCH	FORWARD SPRAG CL. ASSEMBLY	3-4 CLUTCH	LO-ROLLER CLUTCH	LO-REV. CLUTCH
P-N									
D	1st				APPLIED	HOLDING		HOLDING	
	2nd	APPLIED			APPLIED	HOLDING			
	3rd				APPLIED	HOLDING	APPLIED		
	4th	APPLIED			APPLIED		APPLIED		
D	1st			APPLIED	APPLIED	HOLDING		HOLDING	
	2nd	APPLIED		APPLIED	APPLIED	HOLDING			
	3rd			APPLIED	APPLIED	HOLDING	APPLIED		
2	1st			APPLIED	APPLIED	HOLDING		HOLDING	
	2nd	APPLIED		APPLIED	APPLIED	HOLDING			
1	1st			APPLIED	APPLIED	HOLDING		HOLDING	APPLIED
R	REVERSE		APPLIED						APPLIED

Figure 14. Clutch Application Chart

TRANSMISSION END PLAY

Measure end play before disassembling the gear train. If it's over the specification, some of the thrust surfaces will probably be worn.

1. Take out one of the bolts from the oil pump. Install a bolt 11 inches long or special tool J-25075-7A to hold the dial indicator.
2. Attach the fixture adapter in the O-ring groove on the turbine shaft as shown. Then attach the fixture J-24773-A on the adapter.
3. Attach a dial indicator and zero it with the button on the fixture (Figure 15).
4. Pull up on the fixture to read end play. It should be .005" - .036".

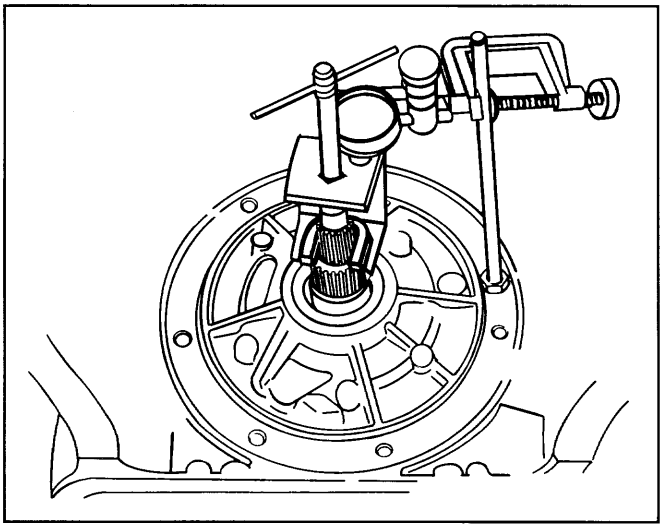


Figure 15. Transmission End Play Tool

REVERSE INPUT CLUTCH

This clutch applies by means of pressure through the oil pump cover and hub. The transmission will slip in reverse if this clutch is burnt or severely worn.

To perform the air test on the reverse input clutch, block the feed hole in the center of the clutch housing and apply air pressure through the check ball hole.

The piston must apply with air pressure, and stay applied as long as the inner hole is blocked.

The clutch must release when you take your finger off of the feed hole. If the clutch releases when you take the air away (but still have the feed hole blocked) the check valve is not sealing. If the clutch doesn't apply at all, inspect the piston seals.

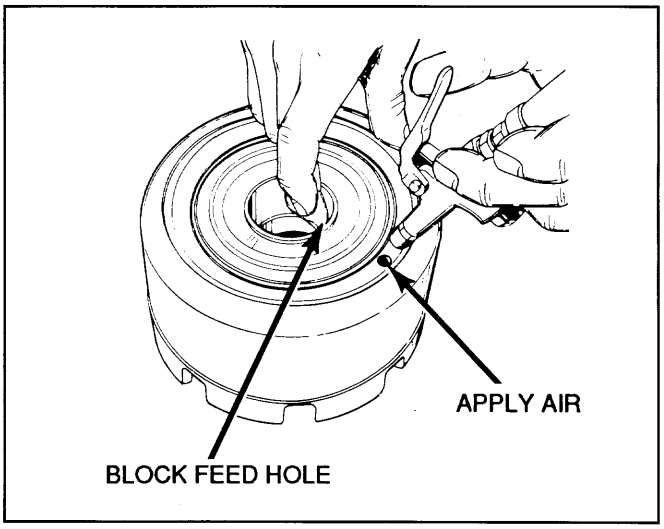


Figure 16. Reverse Input Clutch Check

LOW-REVERSE CLUTCH

This clutch gets pressure from the valve body through two small holes in the transmission case (Figure 17).

- Passage A feeds the small piston area in manual low.
- Passage B feeds the large piston area in both manual low and in reverse.

Apply air into each passage — A and B — separately. The piston should move with pressure on, and pull back with pressure off.

If the clutch does not respond to air pressure at either passage, check the small or large piston seal accordingly.

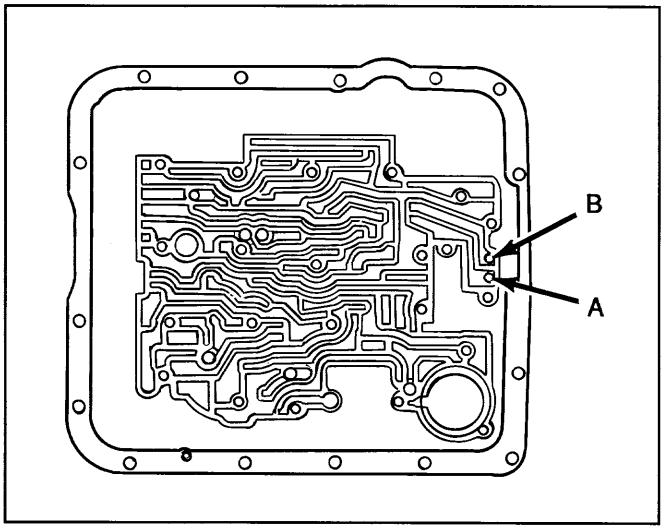


Figure 17. Low-Reverse Clutch Test

3-4 CLUTCH

This clutch gets pressure through passages in the oil pump and hub, and then through the turbine shaft between seals.

1. Air-test the 3-4 clutch by blocking the air bleed orifice cup plug with your middle finger, and the oil hole on the turbine shaft with your index finger (Figure 18).

2. Apply a short blast of air to the check valve hole.

3. Take your finger off the hole on the turbine shaft. You should be able to hear air hissing — meaning that the piston and check valve assembly are O.K.

If you don't hear air escaping, take out the 3-4 clutch piston assembly and check for damage. Also inspect the check ball to see if it's sealing properly.

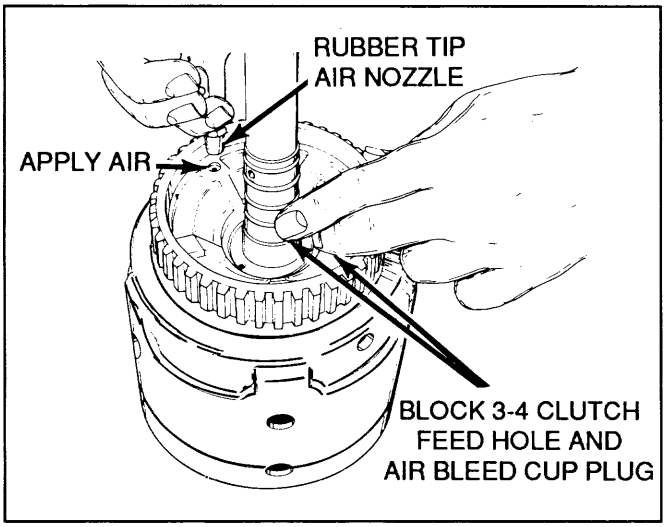


Figure 18. 3-4 Clutch Test

OVERRUNNING AND FORWARD CLUTCH

Pressure to these clutches feeds in a manner similar to the 3-4 clutch, through the turbine shaft. Test operation of these clutches by applying air through the feed holes (Figure 19).

- **Overrunning clutch** — Block the forward clutch passage and apply air to the overrunning clutch feed hole. The piston should apply and stay applied as long as you block the overrunning clutch feed hole.

- **Forward clutch** — Block the overrunning clutch passage with your finger and apply air to the forward clutch passage. Again, the piston should apply and hold as long as you block the overrunning clutch feed hole.

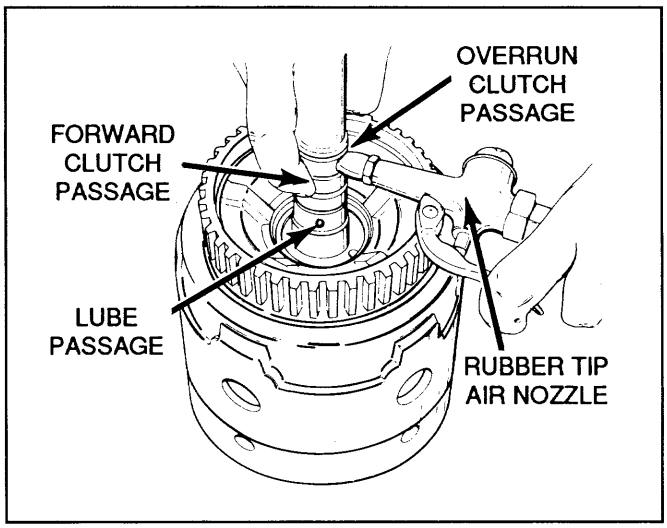


Figure 19. Overrunning and Forward Clutch Test

OIL PUMP AND CASE

Pressure leaks in the oil pump assembly or in the transmission case passages from the valve body to the pump can cause clutches and bands to not apply, or to slip (and burn up). This is why the passages in the case, as well as the pump body itself, should be tested for leaks.

If the pump tests O.K., the oil passages are not blocked and all cup plugs are installed correctly. Use compressed air for leak-testing when you suspect total blockage. Use a pistol-type oiler when only partial restriction is suspected.

The adjacent illustration (Figure 20) goes with the chart on the following page. Apply air or oil at each hole, and check for air or oil at the corresponding location.

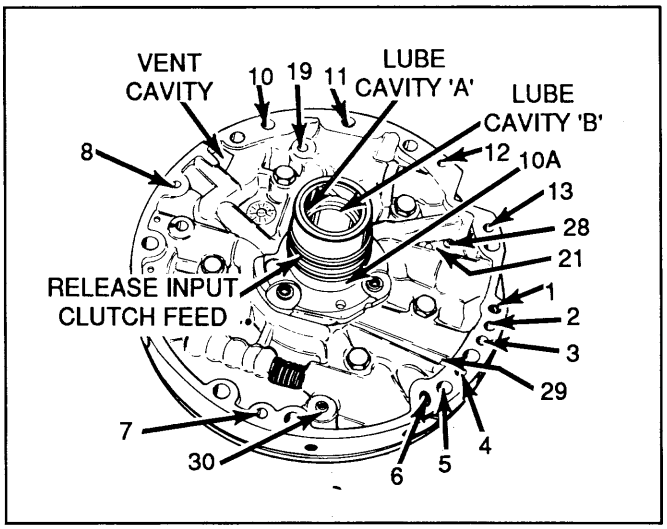


Figure 20. Oil Pump Air Test

PLANET PINION GEAR END PLAY

Each planetary carrier in the transmission has thrust washers that may wear. Check for brass particles in the transmission pan:

- Brass shavings in the front of the pan point to the input planetary carrier.
- Brass shavings in the rear of the pan point to the reaction planetary carrier.

Check each planetary carrier for wear and damage — the thrust- bearing inside, as well as the pinion gears themselves.

End play at each pinion should be .008" to .024" (Figure 21). If end play exceeds the spec, the entire planetary carrier should be replaced.

When reassembling the transmission, be sure to check operation of the parking pawl, overrunning clutch, 3-4 clutch clearance, as well as for proper movement in the gear train. Additional testing, diagnosis and repair information is in section 7A1 of the Manual.

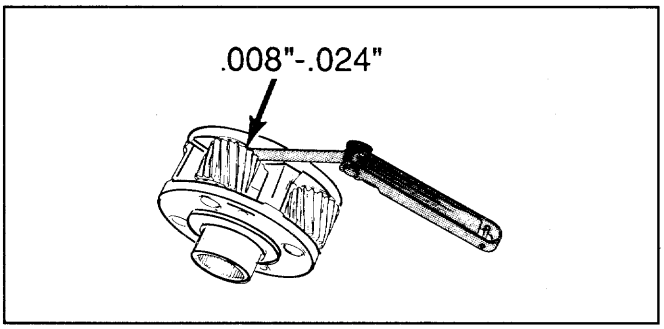


Figure 21. Pinion Gear End Play

BLOW AIR IN:	CHECK FOR AIR OUT:
#1: Forward	The 2nd hole down inside the stator shaft.
#2: M.T.V.	Block hole #6 with your finger. Insert short blasts of air into hole #2. The M.T.V. valve will click with each blast of air.
#3: 3-4 Clutch	The 1st hole down inside the stator shaft The air will also seat the 3-4 clutch check ball capsule #29.
#4: Reverse	The reverse input feed hole between the two oil seals on the outside of the pump hub. The air seats the reverse check ball capsule #30.
#5: Line (To Valve Body)	The #7 feed hole.
#6: Reverse Boost	Air will seat the reverse check ball capsule #30 and move the pressure regulator valve.
#7: Line (To Pressure Tap)	The #5 feed hole. **CAUTION: Hold the line pressure screen in the pump cover or the air will blow it out, possibly causing personal injury.**
#8: Vent	The vent cavity.
#10: Lube (from Cooler)	The lube cavity "A" in the top of the stator shaft.
#10A: Lube (Reverse Input Bushing)	The lube cavity "B" in the top of the stator shaft.
#11: Converter Apply	Between the stator shaft and the oil pump body seal assembly.
#12: Converter Signal	The hole in the stop valve located in the converter clutch apply valve bore.
#19: Converter Release	Insert a hex wrench through the hole in the converter clutch stop valve. Push on the hex wrench to move the converter clutch apply valve against the spring pressure. Air will then come out of the bottom hole inside stator shaft.
#13: Overrun Clutch	The 3rd hole down inside the stator shaft. The air also seats the overrun check ball capsule #28.
#21: Seal Drain-back	Between the stator shaft and the oil pump body seal.

Figure 22. Oil Pump Air Check Chart

ALL-WHEEL DRIVE

Operation

Syclone makes use of the GMC Truck All-Wheel Drive drivetrain to distribute engine torque to all four wheels. Traction, handling and control are noticeably improved, and can be physically measured.

All-Wheel Drive is made possible by means of an interaxle differential inside the Borg-Warner 4472 transfer case. The differential has a planetary design; it allows the front and rear axles to rotate independently as needed. There is no gear reduction through this planetary (Figure 23).

A viscous clutch connected to the planetary differential prevents either axle from breaking away and spinning due to loss of traction (on ice, mud, etc.). The effect is essentially the same as a limited-slip rear differential, only it is between two axles instead of just two wheels. This anti-spin feature does not affect or impede normal differential action between the axles.

All-Wheel Drive also makes use of the same front driving axle as used on GMC Truck Safari Vans with AWD and 4WD T-Trucks (Figure 24). The only difference from the T-Truck front axle is that there's no 4WD solenoid or actuator. All-Wheel Drive is a full-time system that does not need to be engaged and disengaged.

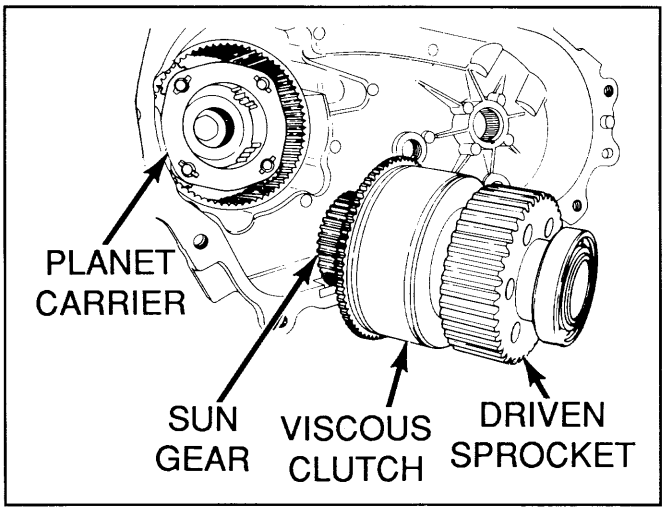


Figure 23. Planetary Differential and Viscous Clutch

Maintenance

Check the lubrication oil of the transfer case, as well as the front and rear axles at each oil change. Lubrication oil must be maintained at specified levels, especially in this performance application.

At each oil change, check the transfer case vent hose for proper installation, kinks, wear and other signs of damage.

Repack the front wheel bearings with grease at every brake job.

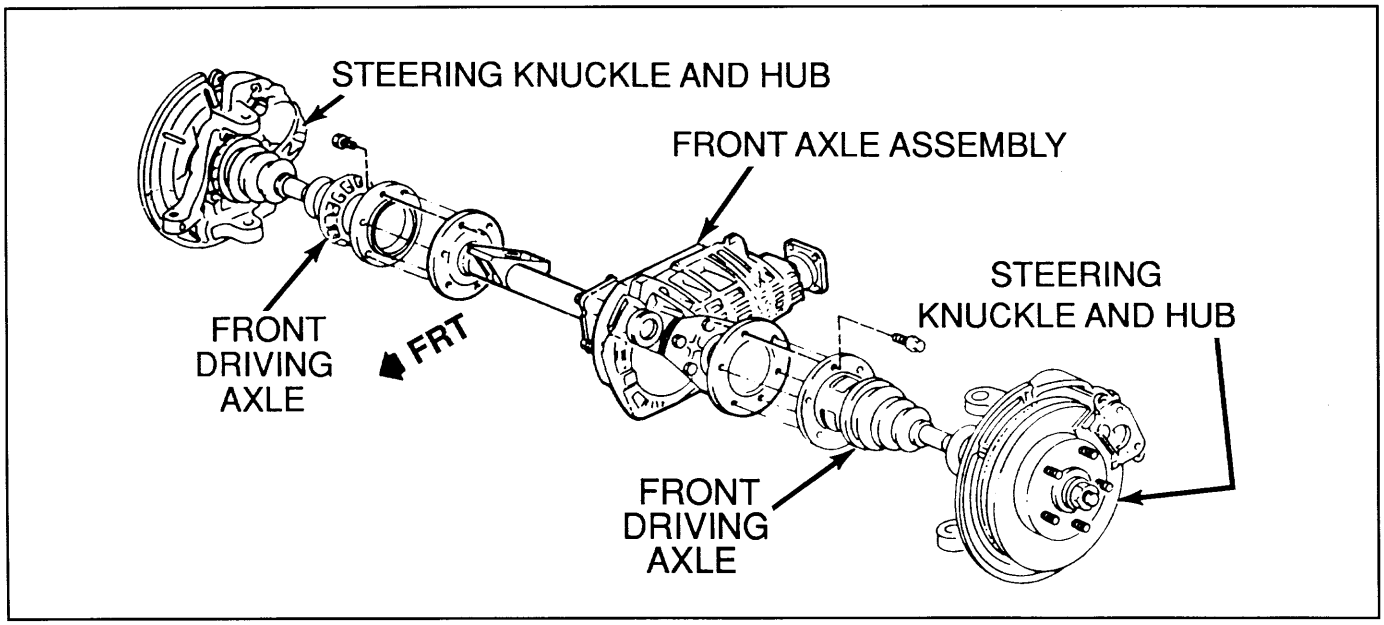


Figure 24. Front Driving Axle

Diagnosis

The only failure mode identified for the viscous clutch is if it cracks or literally blows apart, which would require extremely severe abuse. Even so, the clutch will still do its job, even if damaged. The silicone clutch fluid won't be any harm to other transfer case components should it leak.

The most serious condition to be concerned about regarding All-Wheel Drive is a leak from the transfer case or either axle. Carefully inspect the transfer case in these locations when a leak is suspected:

- Front and rear output shaft seals
- Input shaft seal (a leak here is the least likely, but still check)
- Joint formed by the front and rear case halves
- Extension housing where it bolts to the main case
- Vehicle speed sensor O-ring.

Also inspect the case itself for signs that is has become porous — oil seeps directly through minute holes in the casting.

Noise and vibration in the powertrain are rarely the fault of the transfer case. Most often it's due to wheels and tires — imbalance, runout or radial force variation. Another possibility is excess runout or imbalance in either propshaft. Also, the engine, torque converter and transmission should be suspected along with the transfer case. The 4.3L engine design is susceptible to inherent shaking forces that set up vibration. Be sure to qualify all vibration conditions against a "known good," similarly equipped model.

If the transfer case is truly suspect in a powertrain vibration, inspect the front output needle bearing. If it is worn, there may be a growling noise accompanying the vibration. Worn slip yoke bushings will also set up noise and vibration; they could be due to a bent propshaft, so check these, too (Figure 25).

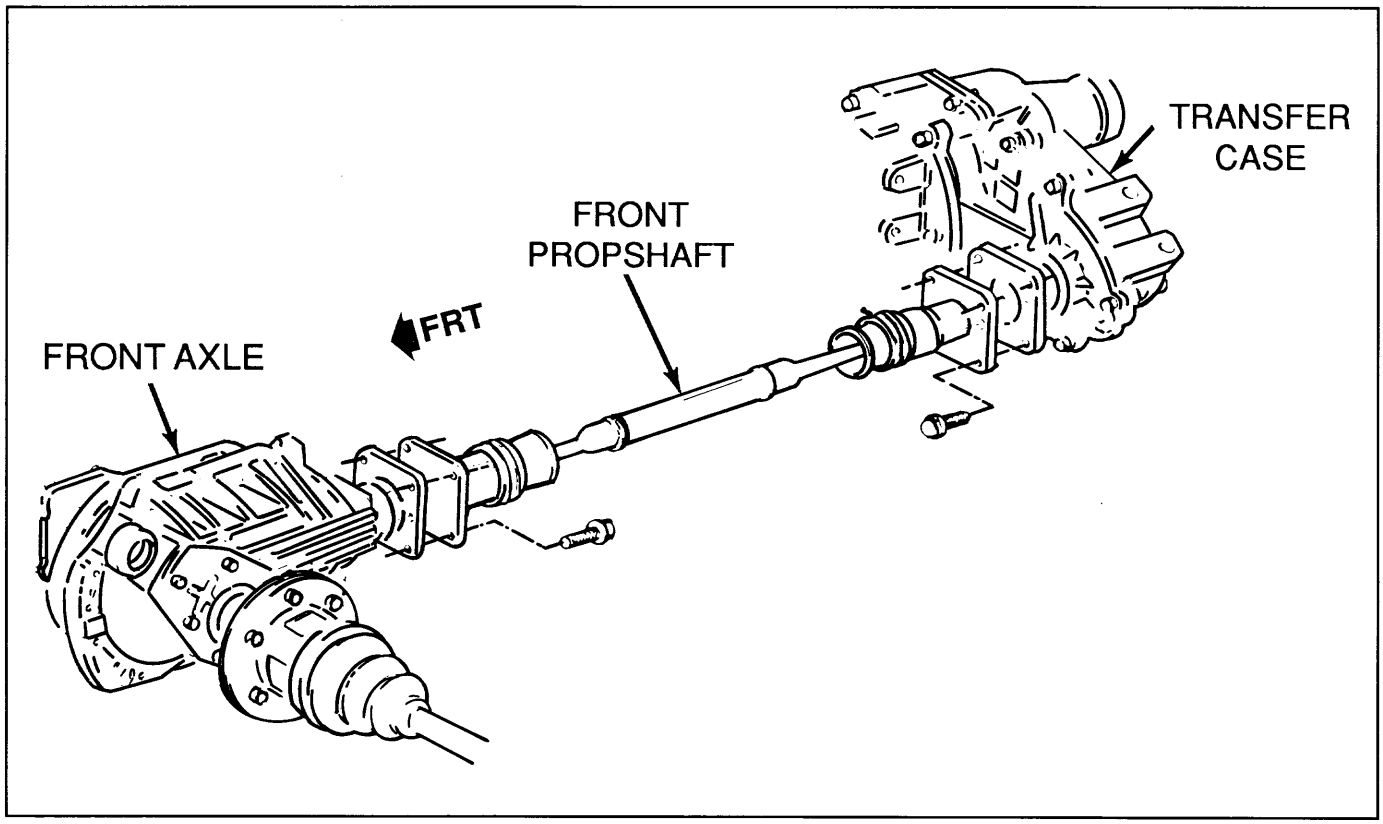


Figure 25. Front Axle, Propshaft and Transfer Case

Repair

The All-Wheel Drive transfer case can go at least 200,000 miles before needing an overhaul. This is only a guideline, however. The actual interval could be significantly shorter depending on how the truck is used — after all, it's a high-performance vehicle.

The transfer case must be completely disassembled if necessary to check for internal wear and damage. Clean components with a solvent, and blow out all oil passages with compressed air.

To reassemble the transfer case, begin with the rear output shaft, its bearing and the planetary differential. Then turn the unit upside down; the remaining components will come together on top of this initial assembly. The front output shaft, bearing and case cover go on as a unit. For complete disassembly and reassembly procedures, see section 7D in the Syclone Service Manual Supplement.

SPORT SUSPENSION

Description

Both the front and rear suspension on Syclone use production GMC T-Truck (Sonoma) components. There are specially tuned Bilstein shocks, 2-stage rear springs and a special, low-rate front torsion bar (Figure 26).

Trim heights on the Syclone are 8/10ths of an inch lower on the front suspension than on the 2WD Sonoma. For this reason, the rear pinion nose must be shimmed down 6° in front. This maintains front and rear working angles for the rear propshaft within .5° of each other.

Keep in mind that the Syclone is **not** intended to be an off-road vehicle, notwithstanding the All-Wheel Drive. Ground clearance is insufficient for off-road driving in this application.

Maintenance

All serviceable suspension components must be lubricated at intervals specified in the maintenance schedule. Be sure to inspect all suspension components for signs of wear, damage and proper alignment.

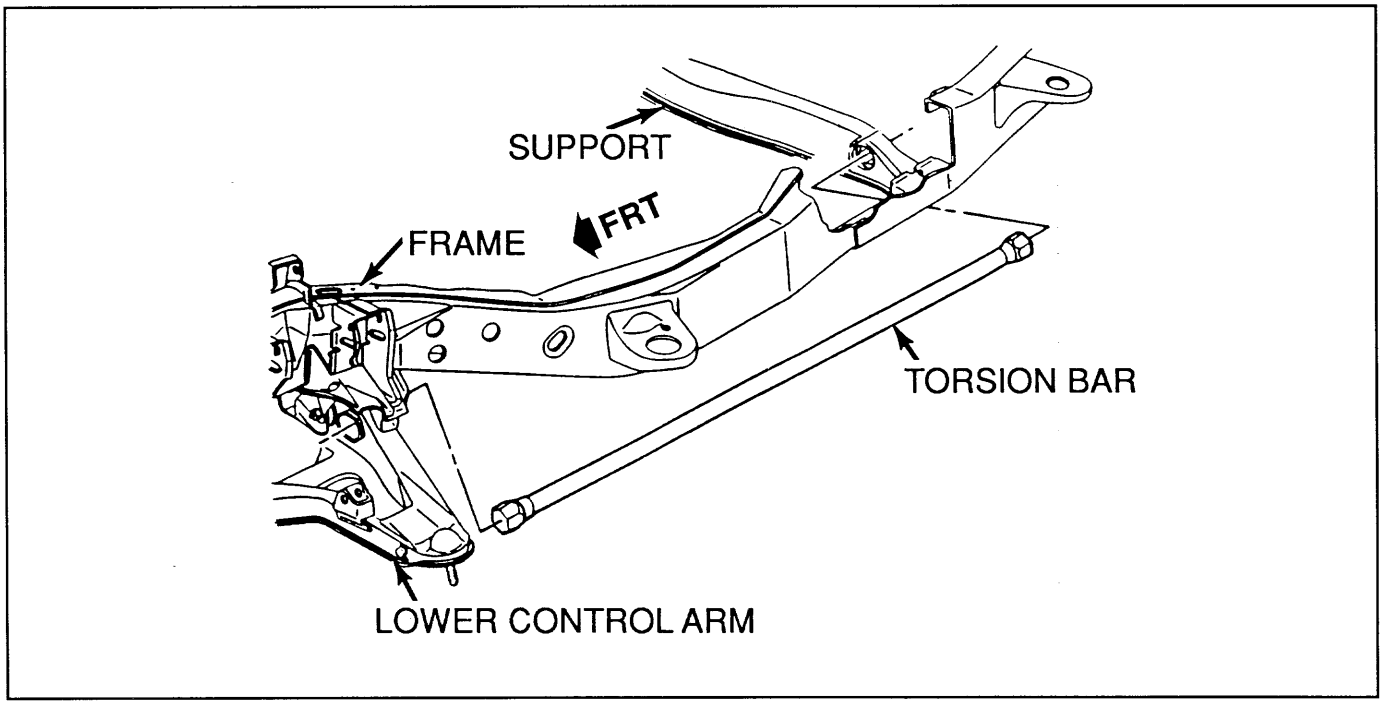


Figure 26. Front Torsion Bar Installation

Diagnosis

Rear two-stage springs on the Syclone are stiffer than on other models to prevent rear axle wind-up and launch shudder on jack-rabbit starts. This stiffer suspension may provide a transmitting path for vibration on sensitive vehicles. Be aware of this, and be prepared to qualify any vibration against another similarly equipped Syclone.

As with all trucks, the front and rear working angles on both propshafts should be equal to within 1/2° of each other.

Syclone's sport suspension is not rated or validated for trailering. The customer may choose to install a trailer hitch all the same, but any effect on noise and vibration when pulling a trailer will not be serviceable under warranty. Syclone has a 500-pound payload and a maximum tongue weight spec of only 200 pounds. Trailering with the Syclone should be discouraged.

Repair

The most important guideline for repair regarding the suspension is truly "*If it isn't broke, leave it alone.*" Do not attempt to correct any condition unless you are certain there is something definitely wrong. Certain noises and vibrations excite the natural frequency of the suspension components. Check for accessories and exhaust components "grounded out" against the suspension.

Also check the caster, camber and toe-in of the front suspension as described in Section 3 of the S/T Truck Service Manual.

LIMITED-SLIP DIFFERENTIAL

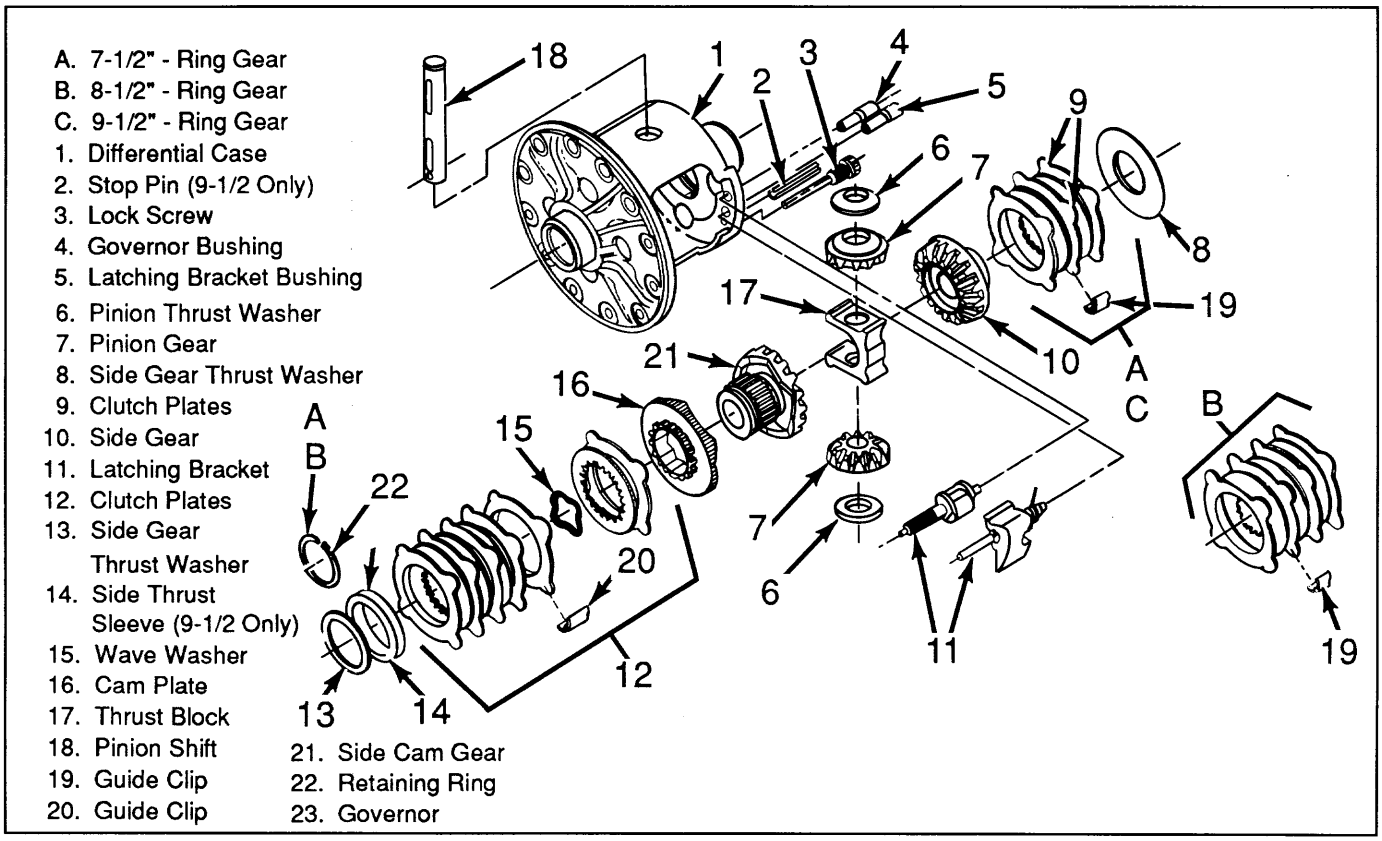


Figure 27. Limited-Slip Differential

Operation

This type of axle has a ring and pinion gearset like all common differentials. In addition, there are also:

- Right and left side clutch packs adjacent to each side gear
- Cam plate and matching "camforms" (mating surfaces) on the right side gear
- Heavy-duty governor mechanism for engaging the locking mechanism (Figure 27).

When driving straight ahead, there is a certain amount of side thrust against the differential side gears. This is due to the simple mechanics of bevel gears meshing together in that 4-corner arrangement typical to most differentials. This side thrust, or load, transfers to the clutch plates, which are next to each side gear. Thrust or load against these plates has the effect of "locking" the axle shafts, through the side gears, to the differential case. As you know, there is no differential action during straight-ahead driving — it's not needed.

When cornering, a difference in the amount of torque distributed to either axle overcomes the side thrust locking the clutch plates. The inside wheel in a turn receives more torque and rotates slower. The outside wheel receives less torque, and spins faster. This allows the limited-slip differential to work like a normal differential for smooth turning.

On the other hand, if either rear wheel hits a patch of ice or mud, and loses traction completely, that wheel may begin to spin much faster than the other wheel. The end result is that neither wheel receives any torque, and control is lost. When the rotational speed of either wheel is 100 RPM more than the other, the lock-up feature comes into play.

- Flyweights in the governor mechanism are thrown outward by centrifugal force; they engage the latching bracket.
- Flyweights in this outward position slow the rotation of the cam plate by locking it against the clutch plates and side gears.
- This, in turn, locks up the clutch plates to the differential case. It causes the complete differential assembly to rotate as a unit. Both axle shafts are likewise locked to the case through the clutch plate; they then rotate together as a solid assembly.

The 100 RPM difference in rotating speeds before the locking mechanism goes to work allows for differential action in curves.

PROBLEM	POSSIBLE CAUSE	CORRECTION
Does Not Lock	1. Little or no spring preload on the latching bracket. 2. Flyweights on the governor assembly stuck closed. 3. Broken drive teeth on the governor and/or cam gear assembly. 4. Broken clutch plates.	1. Replace the governor assembly and the latching bracket. 2. Replace the governor assembly and the latching bracket. 3. Replace the cam plate, governor assembly and latching bracket. 4. Replace the clutch plates and the wave spring.
Locks In Turns	1. Governor assembly tight in case. 2. Broken or weak governor flyweight spring. 3. Flyweight in governor assembly stuck open. 4. Broken cam plate and/or governor drive teeth.	1. Free up the governor assembly. 2. Replace the governor assembly and the latching bracket. 3. Replace the governor assembly and the latching bracket. 4. Replace the cam plate, governor assembly and latching bracket.
Chatters In Turns	1. Lubricant contaminated. 2. Clutch plates deteriorated.	1. Drain lube when hot. Wipe carrier clean. Refill with lube specified in MAINTENANCE AND LUBRICATION (SEC. 0B) of SERVICE MANUAL. 2. Replace clutch plates.
Noise (In Addition To Normal Clutch Engagement)	1. Broken clutch plates. 2. Broken thrust block. 3. Damaged case. 4. Broken differential gears.	1. Replace clutch plates. 2. Replace thrust block with a block of identical thickness. Check closely for other damage. 3. Replace unit. 4. Replace gears.

Figure 28. Limited-Slip Rear Differential Diagnosis Chart

FOUR-WHEEL ANTI-LOCK BRAKES

Operation

4WAL brakes are one step more sophisticated than the RWAL brake system which has been included on many GMC Light Trucks for the past several model years. This system has an **electro-hydraulic control unit,** or EHCU to operate (cycle) the brakes for anti-lock stops (Figure 29). The EHCU, is made up of two main parts:

- 4WAL electronic controller — the brake system computer
- Hydraulic control assembly — the brake combination valve, etc.

The hydraulic control assembly links the 4WAL brake system to the master cylinder, as well as the front and rear brake channels (hydraulic circuits). It contains the working components (control valves) of the 4WAL system. The hydraulic control assembly also contains safety mechanisms in the event of a hydraulic leak in the brake system.

The brakes' electronic controller is grounded directly to the negative battery cable on Syclone models. The intent of this feature is to eliminate false services codes indicating an EHCU fault from being set.

The 4WAL system also uses individual **wheel speed sensors** instead of the vehicle speed sensor for anti-lock braking (Figure 30). There is still a vehicle speed sensor on the Syclone, but it's used by the speedometer/odometer, the torque converter clutch and the cruise control system.

The wheel speed sensors work essentially the same as the vehicle speed sensor, or from the magnetic pickup inside an electronic distributor. Each wheel has its own speed sensor, and each speed sensor works on the principle of magnetic reluctance.

- A cogged metal wheel rotates next to a magnetic coil pickup.
- Each time a cog passes over the pickup, it breaks the magnetic field at the coil.
- Each time the magnetic field at the coil collapses and rebuilds, a small amount of voltage is generated.
- The 4WAL controller counts the number of pulses from the speed sensor, divides that number into the time interval, and translates it into a speed value.

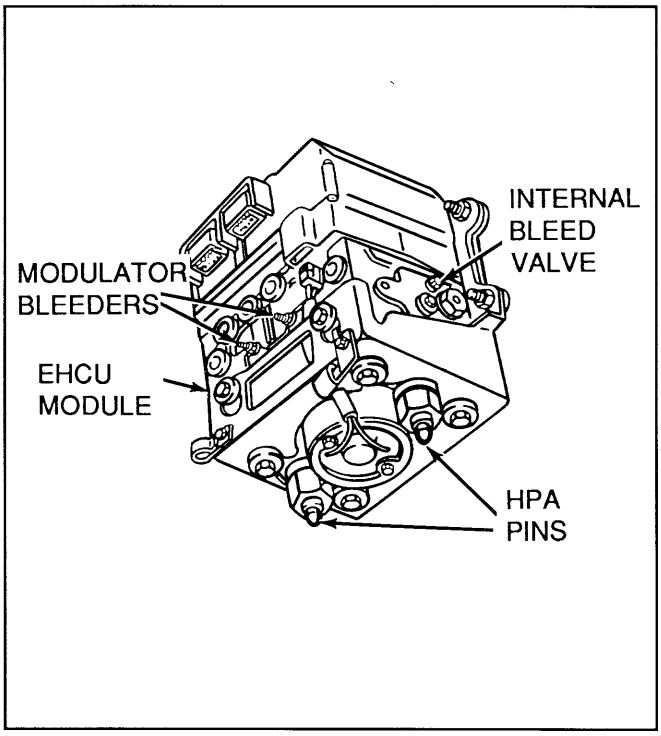


Figure 29. 4WAL Electro-Hydraulic Control Unit

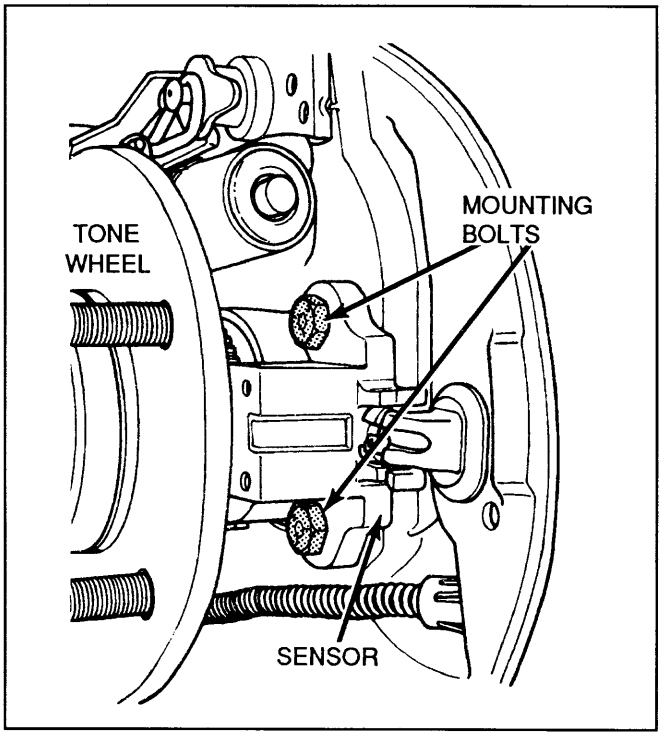


Figure 30. Speed Sensor — Rear Wheel

Diagnosis

The 4WAL brake system has its own telltale warning light. When the 4WAL controller detects a system or circuit fault, the ANTI-LOCK warning light comes on, and a trouble code will be stored. The BRAKES warning light comes on if either the front or rear brake channel loses hydraulic pressure, or if the master cylinder is low on fluid.

- The ANTI-LOCK warning light pertains only to the 4WAL system.
- The BRAKES warning light pertains only to the foundation brake system.
- Both warning lights should come on for a moment with the ignition key ON, then go out.

There is a diagnostic circuit check for testing the 4WAL controller. Part of the circuit check involves retrieving codes from the controller. Diagnostic test charts for the 4WAL system are in the Syclone Service Manual Supplement. There are also separate branches in the circuit check:

- One test sequence applies when the ANTI-LOCK warning light comes on and stays on with the ignition key ON.
- The other test sequence applies when the ANTI-LOCK warning light does not come on (prove out) with the ignition key ON.

You can also monitor 4WAL system operational data with a Tech 1 scanner, in the same manner as for fuel system testing:

- Wheel speed sensor — see if the wheel speed sensor output agrees with the speedometer.
- Brake switch operation — open or closed? It should scan "closed" when you press the brake pedal.
- Switch status inside the EHCU — internal controller functions.
- ANTI-LOCK warning lamp status — tells if the warning lamp should be on or off.
- Intermittent conditions — broken wires, open connections, etc.

The Tech 1 also enables you to perform a functional test of the electro-hydraulic control unit. All diagnostic procedures are contained in the Syclone Service Manual Supplement, Section 5A4.

Repair

The 4WAL system uses high-pressure brake tubing made of steel. We do not recommend trying to make your own brake lines from straight tubing on any GMC Truck model with 4WAL brakes. Damaged or kinked brake tubing should be replaced with specific replacement parts, custom made for the Syclone. Part numbers will be in the Syclone parts catalog.

There is also a special procedure for bleeding the brakes on vehicles equipped with the 4WAL system:

- Bleed the EHCU first, through internal bleed valves and modulator pins (Figure 29).
- Bleed the wheel cylinders and calipers second.

You may use any acceptable method to bleed the brakes — pressure bleeding or manual bleeding.

See the Syclone Service Manual Supplement for complete repair procedures. Also check Service Bulletin 90-5E-48.

INSTRUMENT CLUSTER

Syclone's instrument cluster has full analog gages for the speedometer, fuel, engine temperature, oil pressure and turbo boost. It is a remove-and-replace item only. You won't have to replace individual gages on the cluster if it does not work. Service Manual procedures for testing the cluster will center on isolating circuit faults:

- In the gage sending unit — oil pressure, fuel and engine temperature sender; vehicle speed sensor and digital ratio adapter
- In the wiring between the sending unit and the cluster
- In the gage itself.

The fuel sender has to be removed from the fuel tank along with the electric fuel pump, although the two components can be serviced separately. The harness adapter must be installed correctly in order for the instrument cluster to work at all (Figure 31).

Also, there is a new housing for the instrument cluster. The instrument cluster attaches to two brackets, and the brackets attach to the dash panel assembly (Figure 31).

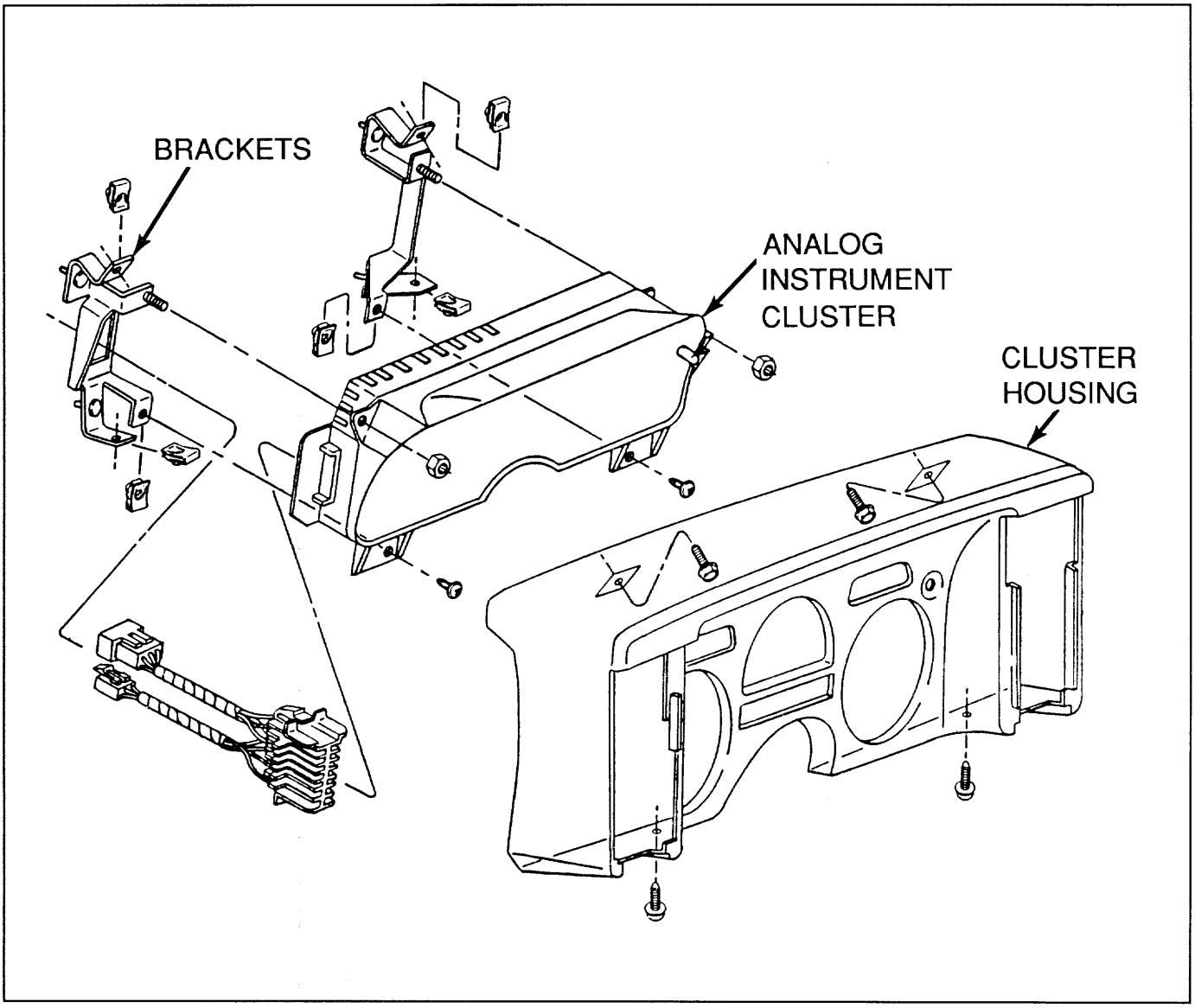
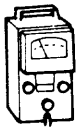
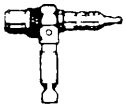
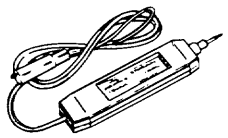
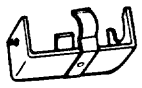
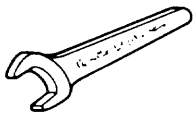
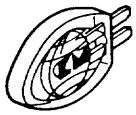
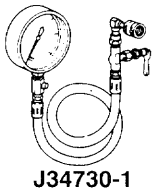
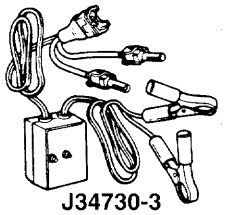


Figure 31. Instrument Cluster and Housing

SPECIAL TOOLS FOR PORT FUEL INJECTION

 J23738/BT7517	**VACUUM PUMP (20 IN. HG MINIMUM)** Use gauge to monitor manifold engine vacuum. Check vacuum sensors, solenoids and valves with hand pump.
 J28742/BT8234-A	**WEATHER-PACK TERMINAL REMOVER** Used to remove terminals from Weather-Pack connectors. Refer to wiring harness service for removal procedure.
 J33095/BT8234-A	**ECM CONNECTOR REMOVER** Used to extract a terminal from connectors at the ECM.
	**UNPOWERED TEST LIGHT** Used to check wiring for complete circuit. Connect lead wire to good ground. Probe with test prod to connector or component terminal. Bulb will light if voltage is present.
	**JUMPER WIRES (#16, 18 OR 20 GAUGE WIRE)** ●Clip jumper wire used to complete a circuit by by-passing an open. ●Set of jumper wires used to insert between Weather-Pack connectors to permit access to the connector terminals for circuit checking. Six wires approximately 6 inches long. Use terminals 12014836 and 12014837. One set – female terminals both ends; one set – male at both ends; and four sets – male terminals at one end and female terminals at the opposite end.
	**TACHOMETER** Use either a crankshaft harmonic balance pickup type or electronic coil trigger signal pickup type.
 J26792/BT7220-1	**HFI SPARK TESTER** Used to check HEI spark voltage. Also called ST125.
 J34730-A	**PORT FUEL INJECTION DIAGNOSTIC KIT** Used to diagnose and service port fuel injection systems. The kit includes: ●Fuel Pressure Gauge – to check fuel pump pressure and compare injectors for equal fuel distribution. ●Test Light – to check electrical impulses to an injector. ●Injector Tester – to evaluate an injector.

 J34636	**CIRCUIT TESTER** Used to check all relays and solenoids before connecting them to a new ECM. Measures the circuit resistance and indicates pass or fail via green or red LED. Amber LED indicates current polarity. Can also be used as a nonpowered continuity checker.
 J28687-A/BT8220	**OIL PRESSURE SWITCH WRENCH** Used to remove or install oil pressure gauge switch on engine.
 J33095/BT8234-A	**ECM CONNECTOR TERMINAL REMOVER** Used to remove terminal from Micro-Pack connectors. Refer to wiring harness service for removal procedure.
 J29533-A/BT8127	**OXYGEN SENSOR WRENCH** Used to remove or install the oxygen sensor.
 J33031/BT8130	**IDLE AIR CONTROL WRENCH** Used to remove or install IAC valve on throttle body.
 J34730-2	**INJECTOR TEST LIGHT** Used to test injector signal from ECM.
 J34730-1	**FUEL PRESSURE GAGE** Used to check and monitor fuel line pressure of fuel system.
 J34730-3	**INJECTOR TESTER** Used to perform injector balance test chart C-2A.

NOTES

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