vacuum. (See the modulator system "In-car tests" later in this chapter for details.)

Occasionally, high line pressures are directly attributable to the pressure regulator. If pressures are extremely high, it's possible the regulator and boost valve are stuck in the boost position owing to foreign matter in the bore or incorrect assembly. If the pump was worked on recently, be aware that two different types of pressure regulator valves were commonly used. They *do not interchange*. (See "Parts interchange" in chapter 5 for details.)

If line pressures are only slightly above specifications, the regulator valve is probably not the cause of your transmission malfunction. Many shift-programming kits provide a stiffer pressure regulator spring. If your transmission is in generally good health, slightly high line pressures will do no harm.

Inconclusive results

If the results of your pressure test were inconclusive, you may want to check the contents of the oil pan (discussed earlier in this chapter) or perform a series of air pressure checks with the pan and valve body removed.

Air pressure checks

Air checks (using compressed air to check hydraulic circuits) are normally performed on transmission subassemblies during a rebuild to determine if new seals seal. Air checks can also be done in-car to diagnose a transmission ailment. When a road test or stall test indicates a slipping clutch, an air check can tell you if a clutch piston seal leaks or if a checkball is stuck.

Because most clutch piston seal leaks are small, test air pressure should be low—say 25-30 psi. Under higher pressures, the clutch piston with the leaky seal or stuck checkball might apply and trick you into thinking the trouble was somewhere else.

Most automatic transmissions are designed so they can be air tested. Turbo Hydra-matic 400 transmissions, however, are not. Because of GM's valve body design (the bottom of the case forms the upper half of the valve body), Turbo 400s are difficult, but not impossible, to air check.

With the possible exception of the rear (low/reverse) band, band servos are not typically air checked on Turbo Hydra-matic transmissions with or without the plate. You cannot hear the servo applying or see the band tightening on the drum. However, because the front (intermediate) band servos can be removed and visually inspected with the valve body removed anyway, this problem is of little significance.

Equipment

First, you need a source of compressed air. Make sure the air is filtered to remove water and dirt that might contaminate your transmission's hydraulic system. If the vehicle and the air source are at two different locations, a portable air tank can be used. Whichever air source you use, you'll need a low-pressure nozzle (regulated to 25-30 psi) with a tapered rubber tip. To get into some oil holes when not using the test plate, such as the forward clutch, you'll need another nozzle tip—about ⅜-in. OD with its end cut off at a 45° angle.

You'll also need a big drain pan. Most Turbos hold about 10 qts. of ATF. When you drop the pan, you'll drain out approximately 3-4 qts. When the valve body is removed, another 2-3 qts. of fluid will drain back out of the converter. The remaining 2-5 qts. of fluid will be lurking somewhere in the transmission. When you apply air pressure, some of that remaining oil will come flying out. So, prepare for things to get *very* messy.

With a 400, you'll have to make your checks without a plate. To my knowledge, no one has a test plate for the 400.

Air check procedure

Raise the vehicle on a lift, or with a jack and support stands. To provide ample working space, the vehicle should be at least 2-3 ft. off the ground. Drain the oil and remove the pan (as outlined under "Fluid and filter" in chapter 2). Remove the filter.

Remove the detent spring and roller. Label and disconnect the electrical leads inside the case at the case connector. When you reassemble these, remember that the vertical post is always the detent solenoid lead, and the horizontal post is for the stator solenoid ('65-'67 V/P models only) or TCS third-gear oil pressure switch.

Remove the valve body bolts and support the valve body in place. Carefully lower the valve body, disconnecting the manual valve link from the manual valve as you go. Take care not to drop the manual valve—it slides right out. If the intermediate servo or any checkballs drop out, place them aside for safekeeping. Unbolt and remove the detent solenoid. Now remove the spacer plate and two gaskets.

Apply 25-30 psi of air to the holes in the case passages. Press the nozzle's rubber tip firmly into each test hole. If the clutch in question is applying, you'll hear a dull, rubbery thud or click as the piston contacts the clutch plates. If you hear a hissing sound, or hear no sound at all, then the piston seal is leaking, or the piston or drum checkball is stuck in the open position. You need to check only the circuit or circuits that were slipping or had low pressure, but you might as well check them all for comparison.

There are two holes for the direct clutch. That's because there are two oil chambers for the piston. The inner is applied in both third gear and reverse, but the outer is applied only in reverse. You must test both piston seals. Also, the center-support retaining bolt does double duty as an apply passage for intermediate-clutch oil.

Air check results analysis

If you cannot detect movement or if you hear a hiss when you air check an apply device for a circuit that the road test, stall test or pressure test told you was slipping, it's reasonable to assume that the clutch piston seal is leaking or the checkball is stuck, necessitating a teardown of the transmission. To ease removal of the transmission, temporarily reinstall the oil pan. The pan will provide a firm platform for the transmission or floor jack, and will protect the cored passages of the case from damage.

If the apply device pumps up and holds under 25-30 psi of air pressure, chances are the leakage is in the valve body or accumulator for that circuit. (See the applicable section in chapter 7 for details.)

Vacuum modulator system tests

Failure symptoms

Problems with your transmission's vacuum modulator system can show up in one or several of the following ways:

- Late upshifts, regardless of throttle position
- Harsh upshifts and downshifts
- Soft upshifts and downshifts
- Slippage in Low, Drive and Reverse
- Engine burning transmission fluid, resulting in a white exhaust cloud, *detonation* (pinging) and a lumpy idle
- Overheating

However, before you spend $10-$30 for a new modulator, make sure it's the culprit. Except for your engine burning ATF, all of the other symptoms listed can be from other transmission malfunctions. Following are tests that can help isolate the problem.

Road test

In the case of an extremely late upshift or no upshift at all, the road test can help nail down the problem area. With the engine and transmission warmed up, and the transmission fluid at its proper level, shift to Drive and accelerate to 40 mph. If the vehicle remains in first gear while cruising at 40 mph, try shifting momentarily into Low, then immediately back to Drive. If a 1-2 shift now occurs, the problem is in the modulator system. If not, check governor or detent-downshift operation.

Oil pressure test

If you performed the oil pressure tests, the data can be used to isolate a modulator system malfunction. For example, suppose there is no part-throttle 1-2 upshift until 40-50 mph. Upon comparing your test results to the Oil Pressure Chart, you notice the following:

- In Neutral, at 1000 rpm, oil pressure is normal
- In Drive, both at idle and at 1000 rpm, oil pressure is high
- In Super (L2) or Low (L1), at 1000 rpm, oil pressure is slightly high but still in the normal range
- In Reverse, at 1000 rpm, oil pressure is high

These readings profile a problem in the modulator circuit. Your next step is to make the following modulator system tests.

In-car tests

Although modulators often do fail within 20,000 miles, especially on '75-and-later catalytic-converter-equipped vehicles, there are other problems that can make a perfectly good modulator appear to be faulty. The first thing to do is to check the vacuum at the modulator. You'll need a 0-30-in. mercury vacuum gauge.

Vacuum supply check

Locate the modulator on the right side of the case. Except on trucks and four-wheel drives, you'll probably have to jack up the vehicle. Watch out for hot exhaust pipes. Disconnect the vacuum hose at the modulator and install a T-fitting with a short piece of extra hose. Make sure all connections are tight, or the readings will be off. With the gauge connected to the T-fitting, you're ready for the test.

Your vacuum source (the engine) should be warmed to operating temperature and the choke should be off fast idle. With the engine idling at 600-800 rpm in Neutral or Park, the gauge should show 16-20 in. of mercury at sea level—less at higher altitudes. Fully depress the throttle momentarily; the gauge needle should go quickly toward 0, then recover to its original reading after the engine returns to idle.

A vacuum reading that is low or slow to respond to changes in throttle position indicates a problem somewhere in the vacuum supply. Hook up the vacuum gauge with the T-fitting at the modulator vacuum source at the manifold or carburetor spacer plate, and conduct the test again. Don't forget to reconnect the hose at the modulator.

On *diesel* engines, the vacuum source for your test is the *vacuum regulator valve* in the engine compartment. However, this vacuum valve depends on an engine-driven vacuum pump. If this pump cannot deliver 22 in. of mercury to the vacuum regulator valve, replace the pump.

If the vacuum reading is still low or slow to respond, the problem could be an accumulation of carbon or grease in the manifold nipple orifice. You can isolate a clogged orifice by pulling off the modulator vacuum supply hose at the manifold and listening for an increase in engine speed. If rpm doesn't increase, shut off the engine and open up the vacuum nipple with a hand-held 3/32-5/32-in. drill bit.

Insufficient vacuum can also be caused by an engine that simply won't develop enough vacuum owing to late ignition timing, late valve timing, a worn camshaft, worn piston rings, a restricted exhaust system (stuck heat riser or clogged catalytic converter) or a *vacuum leak* (air leaking *into* the vacuum). Leaks can occur at the intake manifold gasket, in vacuum-operated heater/air conditioning controls, power brakes, distributor vacuum-advance/retard mechanisms, retractable headlamps or emission control plumbing.

If your test showed higher vacuum and quicker response at the manifold or carburetor spacer plate than at the modulator, the problem is in the line to the modulator. As most GM vehicles use a steel vacuum line with rubber hose at the ends, there are many possible points of leakage. Look for leaking joints, a cracked or pinched rubber hose, or pinched metal tubing. Rubber-to-metal joints can look tight when they aren't. Make sure they fit snugly by fitting the rubber hose over the bead in the steel line or, better, installing small hose clamps.

Modulator canister leakage checks

If your vacuum supply is good and all connections are airtight, but the transmission still displays modulator-related symptoms, the next battery of tests centers on the modulator itself.

Visual tests With the vehicle raised on its right side, properly supported, and the engine switched off, make a visual check of the modulator canister, looking for road damage. Replace the canister if it is bent or dented. Pull off the vacuum hose and check for the presence of ATF. With the large, black-can OEM canister, loosen the retaining bolt and rotate the modulator 180° so the offset vacuum nipple is down. If ATF drips out, the diaphragm is damaged and the modulator is trash.

Check further for ATF on all but the small, brass-can aftermarket canister—it has an adjusting screw inside the vacuum nipple. Insert a pipe cleaner or small cotton swab in the vacuum nipple as far as it will go. If it comes out with even a drop of ATF on it, your engine is sucking ATF past a broken diaphragm and burning it. Symptoms include loss of transmission fluid with no external leakage, engine detonation, lumpy idle and white exhaust smoke.

ATF is not the only liquid that can get in a modulator canister. Under cold, humid climatic conditions, water and gasoline vapors may condense in the intake manifold and eventually settle in the vacuum side of the modulator diaphragm. These liquids do not indicate a faulty modulator, but they should be drained from the canister. Gasoline, especially unleaded, will damage the diaphragm, leading to modulator failure.

Water, when it freezes, can jam a modulator valve, doubling or tripling line pressures. This can tear a transmission apart. If liquid is present in the modulator, don't panic; use your senses of sight, smell and touch. ATF is red or reddish brown and will feel oily. Water and gasoline will be relatively colorless, but not oily. Gasoline has its own smell.

Vacuum diaphragm test An accurate modulator vacuum diaphragm check can be made within a hand-operated vacuum pump. It can find a pinhole leak, too small to suck detectable amounts of ATF into the vacuum chamber, but large enough to cause transmission malfunctions.

Firmly attach the vacuum pump hose to the modulator. When using a grease-gun type of vacuum pump (one with a knob-type plunger at one end and the gauge at the other), be sure to close the pump's shutoff valve to prevent vacuum loss. Pump only *up to* 20 in. of mercury—***more vacuum may cause diaphragm damage.*** The modulator should hold it for at least 30 seconds. If leak-down occurs, replace the modulator.

Bench tests

Bench testing requires that the modulator be removed from the transmission. To minimize fluid leakage, raise the right side of the vehicle higher than the left side, or stuff a wad of vaseline into the modulator valve bore.

A loose or disconnected vacuum hose will cause late, harsh shifts and engine roughness.

Also check for small, hairline cracks in rubber hose at the intake-manifold T-fitting.

Vacuum diaphragm leakage check

Again, hook up a vacuum pump to the modulator. This time, as you evacuate the canister, observe the movement of the plunger inside the sleeve at the case end of the canister—it should move inward, toward the diaphragm.

If the plunger doesn't move, the diaphragm is leaking and the modulator must be replaced. This shows up as excessive leakdown. If the plunger moves at 8 in. of mercury or less, the canister spring is too weak to reuse. If the plunger doesn't move at less than 20 in. of mercury, the plunger is binding in the sleeve. Don't try to free it up; replace the modulator. On a healthy modulator, the plunger should move at about 12–18 in. of mercury and should be fully retracted *before* 20 in. of mercury is reached. Fully retracted, the plunger should be about $\frac{5}{8}$ in. from the top of the sleeve.

Release the vacuum and remove the tool.

Canister leakage check

In addition to diaphragm failure, the canister may not be airtight at its crimped or soldered joints. No special tools are needed for this check—just good old lung power.

Coat the modulator canister with a soap-and-water solution. Use a length of rubber hose that is long enough so you can focus on the modulator and blow on the hose. *Blow* into the hose. Do not use compressed air for this check; more than 6 psi will rupture the diaphragm.

Look for air bubbles at the nipple-to-modulator seam, the crimped or soldered housing seam, and the adjusting screw seal (large, black-can OEM type only). Replace the modulator if air bubbles appear.

Spring force check

This check is made to see if the diaphragm spring meets design specifications. After years of use, the spring may weaken, leading to low modulated line pressure which results in early shifts, soft shifts and possible clutch plate burning.

There are two acceptable ways of doing the modulator spring force check.

GM method GM recommends checking the modulator against a new one of the same part number. To do this, you would need a 1-in.-long, $\frac{13}{32}$-in.-OD, $\frac{3}{8}$-in.-OD or 10-mm-OD steel or hardwood dowel, with a mark scribed around the circumference of the dowel. Scribe this mark at the dowel's middle—exactly $\frac{1}{2}$ in. from either end. The ends of the dowel must be cut square to within $\frac{1}{64}$ in.

Insert the dowel between the two modulators, and slowly push them together. As the two plunger sleeves nearly touch, the scribed centerline should remain centered between them. If the line does not remain centered, it will be closest to the modulator with the weakest spring.

I would not buy a new modulator just to make this check. Instead, take your old modulator and checking dowel to the parts store. If your modulator is bad, then buy the new one.

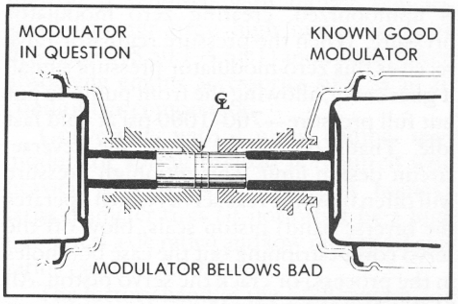
Theory and reality don't always agree. This method assumes that your old modulator was the correct one, and that your engine's vacuum characteristics haven't changed as a result of wear or modification. And, if your old modulator is the adjustable type, you can turn its adjusting screw in (clockwise) to adjust for a weakened spring.

TransGo method A more definitive method of checking a modulator spring is suggested by TransGo of El Monte, California. This approach is used by Ford to check its modulators, and it enjoys wide acceptance among many transmission rebuilders.

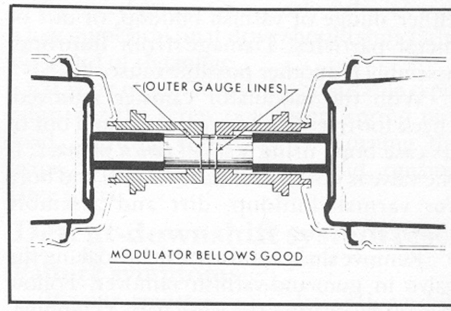
Required for this test are a 0–25-lb. platform-type postal scale, a spare modulator valve (or the one out of your transmission) and an idea of how much modulator spring preload your particular engine/vehicle combination requires. With the advent of adjustable modulators, it's not so much a question of installing the right modulator as it is adjusting the screw to the right spring settings.

To make the check, place the scale on a flat, hard surface. Position the modulator valve vertically on the scale platform, with its large-diameter end down. Set the modulator on the scale and zero the scale to compensate for the weight of the valve. Place the modulator over the valve so the valve enters the modulator plunger sleeve without binding.

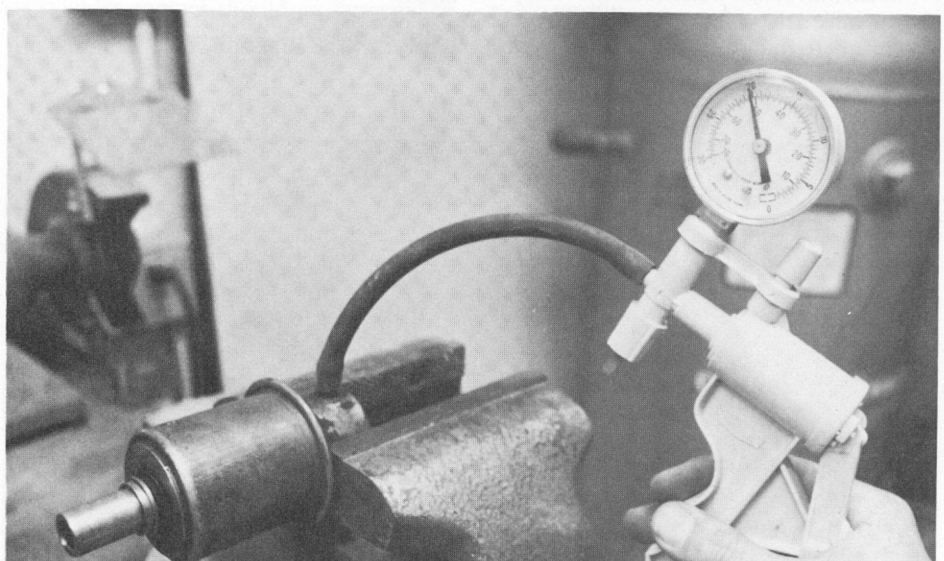
Now, while observing the position of the valve in the sleeve, press down on the modulator. Depending on calibration, you should exert 12–17 lbs. downforce on the modulator *just before* the valve starts to compress the spring. The modulator should then have a "spongy" feel, and you will be able to compress and relax the spring without moving the dial on the scale appreciably.



GM recommends checking modulator spring force against that of another good modulator. With a dowel (with its centerline marked) inserted between the modulator sleeves, push the modulators together. If modulator spring force is weak, its sleeve will retract. General Motors



However, if modulator spring force is to specifications, the dowel will remain centered. General Motors



Modulator plunger sleeve should move at 12-18 in. of mercury if the plunger is free of binding and the diaphragm is functional.

If, for example, your old modulator is a nonadjustable type, and the spring compresses at 10–11 lbs., it's too weak to reuse. However, if the modulator is an adjustable type and it comes in at 14 lbs., but you need 16 lbs., simply turn the screw clockwise to increase spring preload.

Conversely, if the scale bottoms out at 25 lbs. and the valve still hasn't moved, chances are the plunger is jammed in the sleeve. Look for a bent or misaligned modulator sleeve. (See "Modulator tuning procedures" later in this chapter for more details on modulator spring settings.)

Sleeve alignment check

Occasionally, a modulator will get bumped, causing the plunger to jam inside the sleeve. Visually check runout by rolling the modulator can on a flat surface while observing the sleeve. If the sleeve is concentric and the plunger is free in its bore, the modulator is OK.

Stuck modulator valve check

Though uncommon, it is possible for the modulator valve to stick in its bore, owing to either sludge or varnish buildup, or dirt or metal particles. Damage from improper assembly is another possible cause.

With the modulator canister removed, check for free valve movement in and out of its case bore, using a small *pencil magnet*. If the valve is not free, check the valve and bore for varnish buildup, dirt and assembly damage.

Remove sludge and varnish by soaking the valve in gum-and-varnish remover. Follow this up by coating the valve with a combination of ATF and gum-and-varnish remover, and working the valve in and out of its bore repeatedly. Blow out the bore with compressed air and recheck valve operation.

Small burrs and scratches can be removed from a valve using a fine-grit bench stone. Be careful not to round off the edges of the valve lands. If possible, replace a damaged valve with a good used one. Contact your local transmission rebuilder for this.

Water and gasoline checks

Water in the modulator Under cold, humid climatic conditions, condensed water vapor may enter the modulator canister. If the vehicle is left in subfreezing temperatures overnight, the vacuum orifice may become restricted with ice, or the diaphragm may freeze solid.

Symptoms will range from late upshift to no upshift at all until the transmission warms up, or to no reverse operation. The upshifting problem can be caused by ice restricting or eliminating the vacuum signal reaching the diaphragm. When things warm up, the ice melts and normal upshifts return.

The no-reverse condition is much more serious, usually involving removal and teardown of the transmission. If the diaphragm freezes solid, the modulator valve in the case is immobilized, creating zero modulator pressure. When the pressure regulator valve receives this zero-modulator-pressure signal, it goes crazy, allowing the front pump to put out full pressure—700–1000 psi at cold fast idle. That's double or triple the reverse-circuit design limit. This ultrahigh pressure will often blow the rear servo (which operates the reverse band) piston seals, blow off the servo cover (stripping out the case bolt holes in the process) or crack the servo piston. All of this means no reverse.

If you encounter the late- or no-upshift problem, or if you find water in the modulator, there are several things you can do to save the modulator. If you have the large, black-can modulator, drain the water, then add several drops of ethylene glycol antifreeze with an eyedropper through the vacuum nipple.

If your's is the small, brass-can modulator (especially the adjustable type), internal orifices may prevent you from getting all of the water out. Try adding antifreeze. If that doesn't work, replace the modulator. Don't jeopardize the case just to save a few dollars on an old modulator. Make sure that the modulator pipe-to-canister connection is watertight and airtight. Loose connections allow air to leak out and water to get in. Use a pair of small hose clamps, if necessary.

Gasoline in the modulator Just as water may enter the modulator canister through the intake manifold, so may gasoline droplets—especially when the vehicle is used for short trips in cold weather where the choke stays on for a long time. The gasoline may restrict vacuum flow, leading to erratic upshifts. The solution is to raise the vacuum line as high as possible near the firewall, without loosening its connections. This will let the fuel run back into the manifold, and not into the modulator.

Adjustable modulators

Not all modulators are adjustable. How do you identify one? You look for the adjusting screw. There are two types of adjustable modulators available.

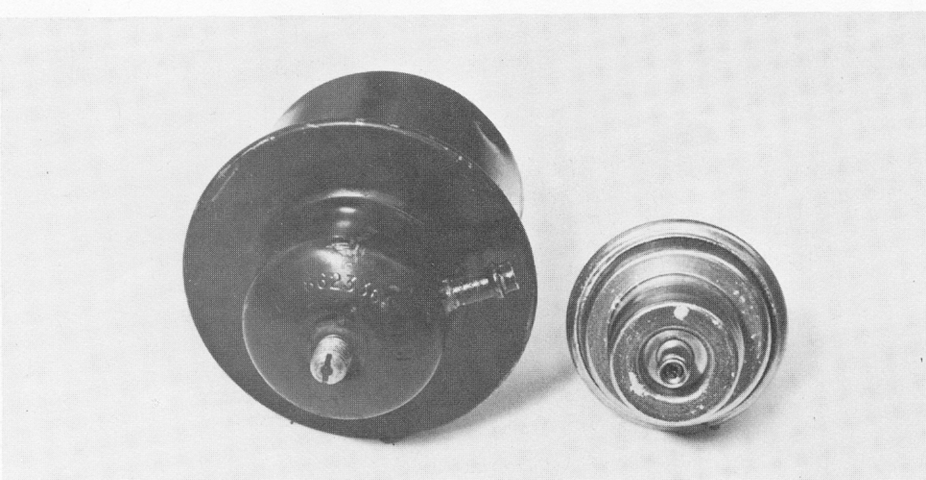
Many of the large, black-can OEM modulators used on most 400s were adjustable. I say *were* adjustable because once the factory determined its spring setting, the screw was often spot-welded in position. To change the adjustment, you must break the spot welds by turning the adjusting screw with Vise-Grip pliers. Even the stoutest of screwdrivers can't break the welds. After making the adjustment, seal the screw threads with a dab of silicone sealer.

More common today in the aftermarket are the short, brass-can-type adjustable modulators. Their popularity stems from their compact design and lower cost. Not all short, brass-can modulators are adjustable. However, a quick check can be made by looking for a threaded screw inside the nipple. It looks like a small carburetor jet. Use a small, flat-blade screwdriver to turn the screw. Some of these modulators offer a wide adjusting range (12–18 lbs.), which will cover 95% of vehicle applications.

Altitude-compensating modulators

Some adjustable modulators are marketed as being *altitude compensating*. Most of these aftermarket-type altitude-compensating modulators will compensate only in the sense that they can be manually adjusted to perform at their original calibration at a specific altitude. If a person were commuting between a mountaintop home and a valley every day, he or she would have to crawl under the vehicle twice a day to make the adjustment.

But why would anyone want to make these adjustments? Because at high altitude, lower air density reduces engine vacuum. The vacuum modulator mistakenly reads this lower vacuum signal as an increase in throttle opening. The transmission responds by "hanging" in the lower gears longer and by increasing the line pressure to the clutches or bands, which results in a harsh shift.



With an adjustable modulator, preload can be adjusted by turning a screw inside the vacuum nipple (right) or at end of the canister (left). Original-equipment canister at left has had its screw spot-welded in place.

The only way for a modulator to "read" altitude and compensate for it automatically is if it uses an *aneroid bellows*. The bellows is an evacuated copper-alloy diaphragm which reacts to changes in atmospheric pressure. Located on the opposite side of the diaphragm's vacuum chamber, the bellows employs an extra spring to oppose diaphragm return-spring movement.

At the high atmospheric pressures encountered at sea level, the bellows contracts, forcing the diaphragm to move toward the modulator valve, thus raising modulator pressure. However, as atmospheric pressure drops at high altitudes, the bellows contracts less, reducing modulator pressure and compensating for the reduced vacuum signal. The result is a more uniform shift feel and shift spacing, regardless of elevation.

Altitude-compensating modulators are available only in the large, black-can OEM style. Other than size and color, there is no external identification for the altitude-compensating modulator. The bellows-type modulator is manufactured by Harrison Radiator Division of General Motors. It is available at GM and AMC/Jeep dealers, and at other parts outlets selling the Delco line.

Ultrahigh-performance engine applications

If your street-driven vehicle has a radically modified engine, chances are no vacuum-operated modulator will work satisfactorily—even an adjustable type with its screw setting backed all the way out. Engines equipped with wild, long-duration camshafts develop little vacuum. High-rise single-runner intake manifolds will cause an uneven, pulsing vacuum signal. On supercharged and turbocharged engines, the situation is even more extreme. Under boost, the air/fuel mixture is forced into the engine, not sucked in as with a normally aspirated system; hence, positive pressure and no vacuum.

The modulator reads this reduced or nonexistent vacuum signal as a wide-open throttle. Consequently, line pressure and shift points are increased to the maximum. When you take your street rod to the local convenience store for a quart of milk, you may want to get out of first gear before you exceed the national speed limit. A mechanically operated modulator system is what's needed to bypass this problem. (See chapter 9 for details.)

Modulator tuning procedures

If you would like to review how a modulator works, turn to the "Power flow" section of chapter 3. If not, just keep in mind that high modulator spring preload *or* low manifold vacuum (manifold vacuum is *inversely proportional* to throttle plate opening or power output) causes early modulator actuation. This causes late upshifts, early part-throttle downshifts, and higher clutch and band clamping forces to satisfy the engine's power demands as controlled by the driver.

Now take a look at the practical aspects of modulator spring *preload* (the resisting force of the spring against the vacuum force on the modulator diaphragm) from two angles: engine and vehicle.

All other things being the same, *higher* spring preload is desirable with large-displacement engines, engines having low-rpm torque output and engines having relatively high manifold vacuum—say over 15 in. of mercury. It follows that *lower* spring preload works best with small-displacement engines, low-output engines and those with low manifold vacuum—12 in. of mercury and less.

Because manifold vacuum is an indication of an engine's pumping ability, low vacuum can be caused by increased valve *overlap* (camshaft holds intake and exhaust valves open longer *at the same time*), poor ring or valve sealing, the addition of an EGR (exhaust gas recirculation) system or high altitude. These items also reduce power output.

With a given engine, *less* modulator spring preload is required with lighter vehicles, small-diameter tires, high numerical final-drive ratios (3.50:1-4.55:1) and added power-absorbing engine accessories such as an air conditioner compressor.

Conversely, with a given engine, *more* modulator spring preload is required with heavier vehicles (such as motor homes), large-diameter tires (if not offset by a high numerical axle ratio) and low numerical axle ratios (such as 2.29:1-3.00:1).

The factory handles the EGR system and high-altitude factors by installing larger-area diaphragms in its modulators. The larger diaphragm helps read the reduced vacuum signal under these conditions.

On-the-scale method

Using the spring force check, it's easy to get a ballpark spring setting on an adjustable modulator. Modulators used with four- and six-cylinder engines should go "spongy" at 13-15 lbs. Small V-8s—250-350 cid (cubic inch displacement)—should start to compress the spring at 14-16 lbs., and larger V-8s at 15-17 lbs. If the vehicle is heavier, has a numerically low final-drive ratio or has large-diameter tires, go to the high side of the range. If the vehicle is light, is equipped with air conditioning, has a good deal of piston ring or valve guide wear, is equipped with a high-overlap cam or has high numerical gearing, stick to the low side of the range.

On-the-vehicle method

The real test of any modulator is how it performs on the vehicle. The key here is in the *minimum-throttle shift points.* These are the *road speeds* at which a transmission shifts with the slightest throttle opening.

After you've installed the modulator with a new O-ring, do a road test and note the shift points. Minimum-throttle 1-2 upshifts should occur at 5-18 mph, and 2-3 upshifts at 16-35 mph. Because these shift point ranges cover everything from a 2.29:1 to a 4.11:1 final-drive ratio, vehicles with high numerical ratios should shift at the lower end of the speed range. Conversely, vehicles with a low numerical final-drive should shift at the high end of the range.

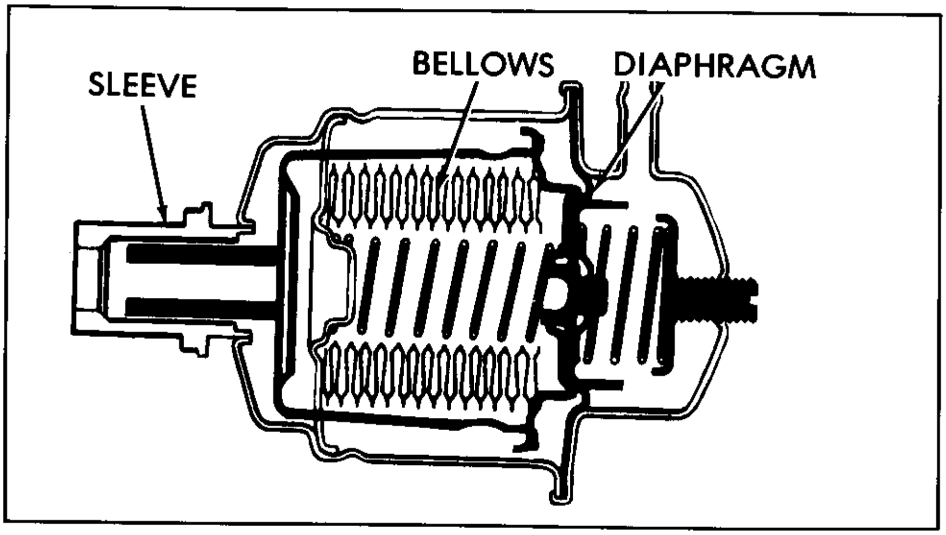
If your modulator is the adjustable type, adjusting the screw out lowers spring preload, allowing earlier shifts. Turning the screw in increases spring preload, causing later shifts.

Detent-downshift system tests

Failure symptoms

If your transmission's detent-downshift system is not functioning properly, not only might it not downshift properly, but other seemingly unrelated problems may occur, such as the following:

- Early or late upshifts
- No upshifts
- 1-2 upshift at WOT only



Copper aneroid bellows in an altitude-compensating modulator allow it to provide correct shift timing regardless of elevation. General Motors filter then becomes the only filter in the transmission. The problem is that when it clogs, fluid ceases to flow and the transmission ceases to operate.

Spin-on type

The spin-on cartridge-type in-line filter is just like an engine oil filter. In fact, it uses engine oil filter replacement cartridges. As such, it benefits from a large-capacity paper filtering medium and an internal bypass valve. If this filter should become clogged, the bypass valve will unseat and allow cooler return oil to enter the lubrication circuit.

To install, locate the filter adapter bracket in the engine compartment near where the cooler lines enter the radiator. Bolt the adapter to the body or frame in an accessible location. Cut the applicable cooler line with tubing cutters, and connect the filter with the high-pressure hose and clamps provided.

For replacement cartridges, A/C's PF13 "shorty" or PF2 standard engine oil filters or equivalents will work fine—or any cartridge-type engine oil filter having ¾-16 threads. Just be sure that the filter cartridge does not hang down below the engine cross-member. Use the PF13 filter if there's a ground clearance problem.

Installation

Most GM vehicles use crossflow radiators. With this system, the cooler feed line is the lower line. If you are not sure which line is which, trace the lines from the transmission. Remember, the feed line exits the case at the bottom, and the return line enters at the top.

There are two schools of thought about which cooler line to plumb an in-line filter into. When using a new or freshly rebuilt transmission with the old cooler, a filter in the return line will filter out contaminants that may break loose and enter the new transmission. On the other hand, if you are installing a new cooler, a filter fitted to the feed line can help prevent the cooler from getting contaminated in the first place. This also applies to a new vehicle or to one having a transmission relatively free of contaminants.

Adjustable vacuum modulators

There have been several dozen differently calibrated modulators installed in Turbo 400s since '64—and they were serviced separately. However, these modulators are now serviced by a few *adjustable* modulators.

An adjustable modulator can be adjusted to compensate for changes in an engine's manifold vacuum. Also, transmission shift points can be raised or lowered 2-5 mph. Generally, the higher the modulator pressure, the later the shifts will be. To make the shifts occur later, run the adjusting screw (located inside the vacuum nipple) in by turning clockwise. Softer and earlier shifts can be obtained by backing the screw out. One full turn of the adjusting screw can change modulator pressure plus or minus 2-3 psi.

If you are making the adjustments with the modulator installed, access can be a problem. A small offset screwdriver may be required.

After making the adjustment, make sure the vacuum hose fits tightly to the modulator vacuum nipple, and that the steel line fits into the recess in the modulator. If the joint is not airtight, the vacuum signal at the modulator will be weak. The modulator will read this as wide-open throttle and increase line pressure, leading to late, harsh part-throttle shifts.

A final note: I've included adjustable modulator information in this chapter because many readers may desire crisper, more positive shifts. However, it is possible to abuse the adjustable modulator feature by tuning the modulator for softer, ultrasmooth shifts. I say "abuse" because lowering modulator pressure substantially below factory settings will lower line pressure to the point where clutches and bands will slip, resulting in excessive friction material wear.

B&M Modulink

The B&M Modulink is a cable-operated mechanical device designed to replace the vacuum modulator used on automatics behind highly modified engines in street-driven vehicles. When an engine is supercharged or turbocharged, or when it is equipped with a long-duration camshaft or a single-plane intake manifold, an engine's manifold vacuum is unsuitable for controlling part-throttle shifts. The manifold vacuum/pressure sends a false signal to the modulator, often resulting in erratic or late, harsh shifts. If you want to retain automatic shifting with predictable, modulated shifts at part-throttle openings, you must bypass this bogus vacuum signal.

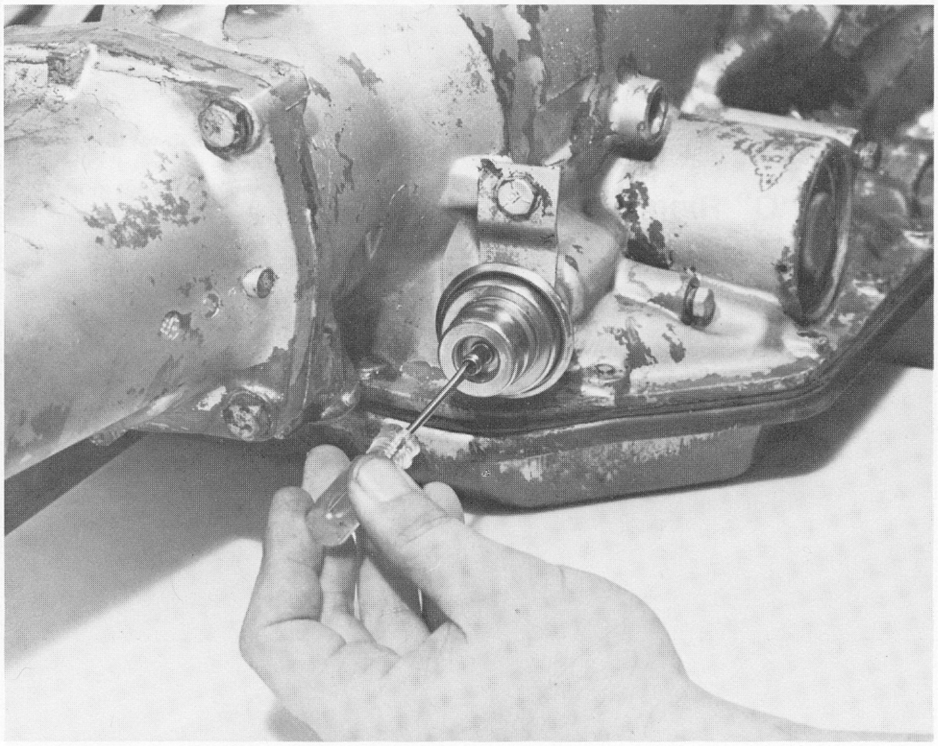
The B&M Modulink replaces the vacuum modulator and hose with a throttle cable setup similar to that used in the Turbo Hydra-matic 125, 200 and 325. The cable connects directly to the carburetor throttle lever at the top end. Down at the transmission, things get a bit more complicated. The cable—through a lever/cam and plunger assembly enclosed in a case that mounts to the transmission case—works against the modulator valve.

Transmission-to-engine adapter plates

A transmission case is one item you *never* want to buy new, unless you have to. However, Chevrolet and Jeep/AMC engine-bolt-pattern cases are rare finds in junkyards. When you do find one, it will probably be expensive.

The transmission-to-engine adapter plate allows you to bypass these costly cases and use the more common (and considerably less expensive) "twin-ears" Buick, Oldsmobile and Pontiac (BOP) case behind the Chevrolet or Jeep/AMC engines. The adapter plate also comes in handy for engine swaps—such as Chevrolet V-8 conversions in BOP cars. Twin-ears cases were originally used behind '65-and-later Pontiac and Oldsmobile V-8s, all '66-and-later Buick V-6s and V-8s, and '68-and-later Cadillacs. The junkyards are full of them.

Adapter plates are available from a number of aftermarket sources, including Trans-Tool, Fairbanks, Kenne-Bell and TCI. All come with excellent instructions. However, there are a few things you should keep in mind if you plan to use an adapter plate.



An adjustable modulator (shown here on a Turbo 350 transmission) lets you fine tune shift harshness and shift points 5-10 mph.