Subaru's Computerized 4WD

If you haven't accepted the automotive computer yet, you'd better re-think your attitudes and do it fast. Engineers and car designers like them so much that no end is in sight for on-board computerization.

We all know how computers have been controlling fuel and spark under the hood for quite some time. The computer lets engineers collect and sort lots of information. Since the computer can also make value judgments by comparing this info to tables stored in memory, it can be used to control not only fuel systems, but in this case a transmission. The transmission can now respond to a wider range of driving needs and conditions.

Subaru's new 4EAT transmission is a good example of the type of tranny you'll be seeing and servicing in the near future. The 4EAT's Transmission Control Unit (TCU) receives information from many sensors, makes lightning fast corrections, and chooses the correct mode and gear for the driver—*automatically.* "Beam me up, Scotty!"

select the best shift pattern, it also decides the degree of four-wheel drive application. A computer-controlled solenoid in the tailshaft regulates fluid flow to a clutch pack driving the rear drive shaft. This allows for a controlled front-to-rear torque split for better traction and reduced cornering chatter.

Before anyone panics and comes down with "Star Wars Syndrome," remember that a lot of old technology still applies here. Old principles of operation are just being controlled by electrical instead of mechanical means. The job the vacuum modulator did is now handled by the throttle position sensor. No more governor, thank you. We now rely on speed sensors to signal vehicle speed. Same game, new players.

We also have many of the old standard hard parts you're all familiar with. The 4EAT has planetary gears (two sets, to be exact), a band, clutches, a valve body, one way clutches, a ring and pinion for front drive transmission, and a transfer unit for the four wheel drive mode. Not so radical, eh?

number of things the TCU keeps track of compared to older hydraulic/mechanical trannys. The TCU can make faster, better informed, and more efficient decisions. In addition to sensing speed and load it also does the following:

- It watches engine speed or tach.
- It knows if the cruise control is on.
- It knows if the brakes are on (through the brake light switch).
- It knows what gear you've selected.
- It compares drive speed input with rear shaft output.
- It monitors battery voltage. (Purely in self-defense, I suspect.)
- It measures ATF temperature.

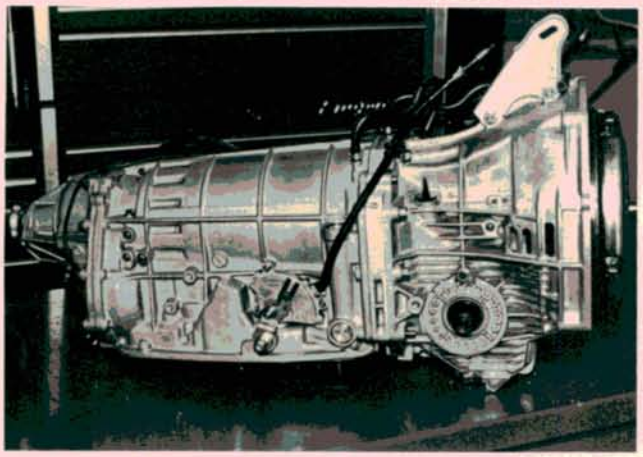
With all this added information, the TCU has a better chance of sorting through its memory to operate the tranny most efficiently.

It is this combination of old and new that makes the unit so versatile. Admittedly, diagnosis will be more complicated than before. It does not have to be impossible, however. Most of the repair practices you used in the past will still apply when dealing with hard-part failures.

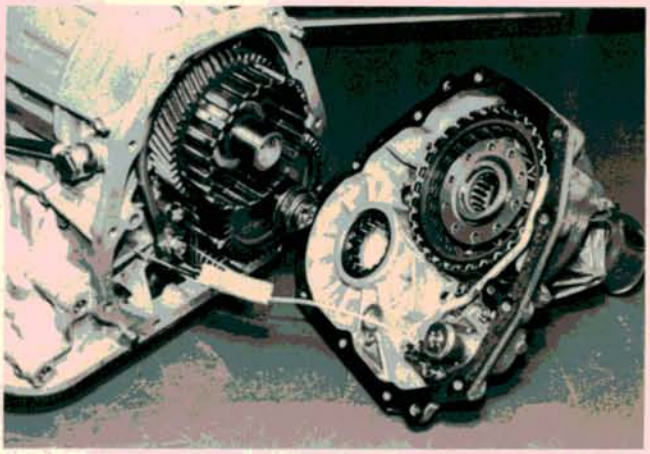
And when it comes to the electrical part, the TCU has its own built-in diagnostics. It will detect electrical problems and store them for you. Then, if you ask nicely, it will flash messages to you about what's going wrong. You always wanted a car to tell you why it was sick!

Say Ahhhhhh . . .

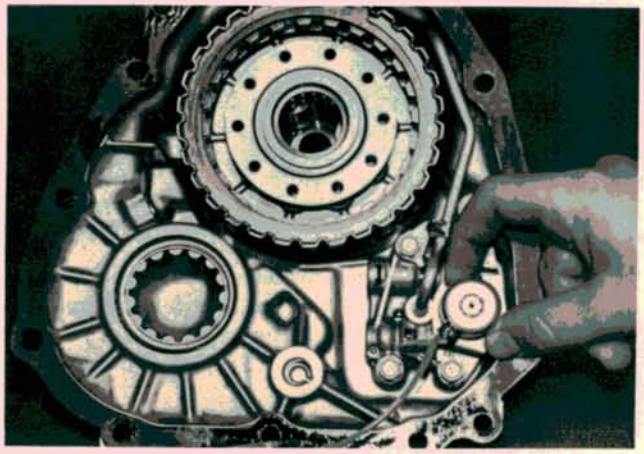
Let's say you want to get at those failure codes stored in the TCU. The customer will tell you that he



The 4EAT, cleaner than *you'll* ever see it. To the far right a lock-up torque converter. The bell housing encloses the ring/pinion combination and FWD stub axles. Note the location of the inhibitor switch to the left of the filler neck boss.



Here's the MPT system and its electrical connection. Take care not to pinch this baby on reassembly. Note the multiple discs at right.



The Multi-plate Transfer System (MPT) clutches and solenoid are inside the tailshaft. To control apply pressure to the clutches, the TCU switches the solenoid on and off. Clutches apply progressively to reduce chatter during cornering and offer better hydraulic control of 4WD transmis-

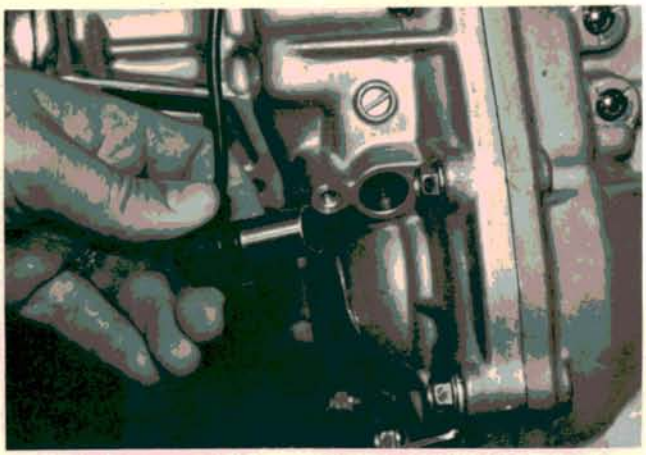
came out to start the car, but that the POWER light on the dash stayed on. This warned him of a malfunction.

Since the TCU is instructed not to annoy the driver by "Morse-coding" all the particulars of the failure, you will have to proceed as follows to retrieve the codes:

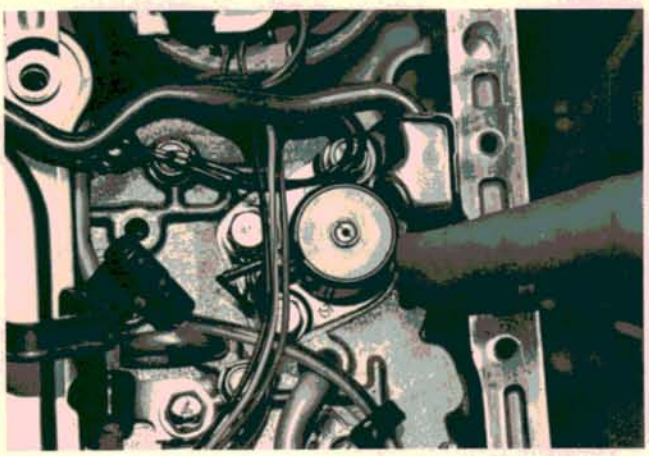
- Warm up the engine with the selector in Park.
- Turn the ignition off.
- Turn the ignition back on. At this point, the Power light should come on and stay on as a bulb check.
- Turn the ignition back off.
- Shift to Drive. (Ignition still off.)
- Depress the 1-Hold button.
- Turn the ignition back on.
- Shift to manual 3 on the selector.
- Turn off the 1-Hold button.
- Shift to manual 2.
- Depress the 1-Hold button again.
- Depress the accelerator pedal about half way to the floor and wait for the codes to flash on the Power light.

Three possible things will happen at this point:

voltage or a voltage supply problem.
2) No codes will flash at all. This will probably indicate a problem with the 1-Hold button or the range switch (AKA the inhibitor switch).
3) After an initial two-second flash, you will start receiving codes from each of the 11 monitored inputs. If the component tests OK, the light will flash for 0.1 of a second and be off for 0.9 of a second, or a total test interval for each sensor of one second.



This is not a bug in the American embassy in Moscow. Speed sensor #1 acts like a TDC sensor in a fuel or ignition system. It sends speed signals to the TCU. Sensor wire is RFI shielded to prevent erroneous signals, so please do not fold, spindle, or mutilate!



Duty solenoid B controls lock-up. Located in the lower valve body, it switches fluid on or off, or gives graduated control at shift points to minimize shift shock.

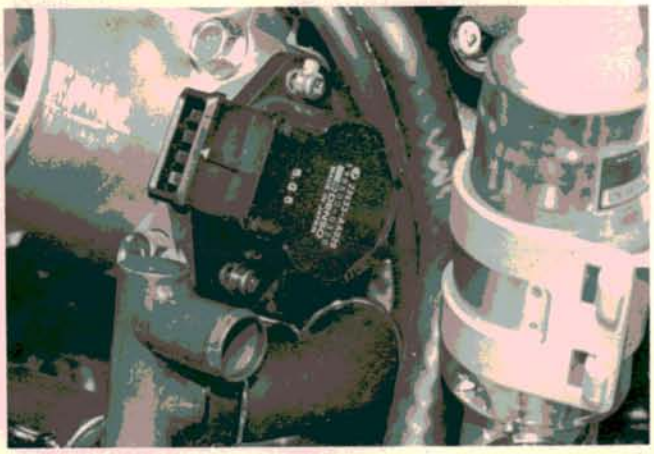
If a sensor is bad, the light will stay on for 0.6 of a second and go off for 0.4 of a second. The total test interval is still one second. You'll have to keep track of the test order for the inputs to know which one tests bad.

Components are tested in the following order:
1) Speed sensor #1

ATF temperature sensor prevents 3-4 shift when cold to keep engine RPM's higher for faster warm-ups. Sensor also turns on dashboard overheat light if fluid gets too warm.

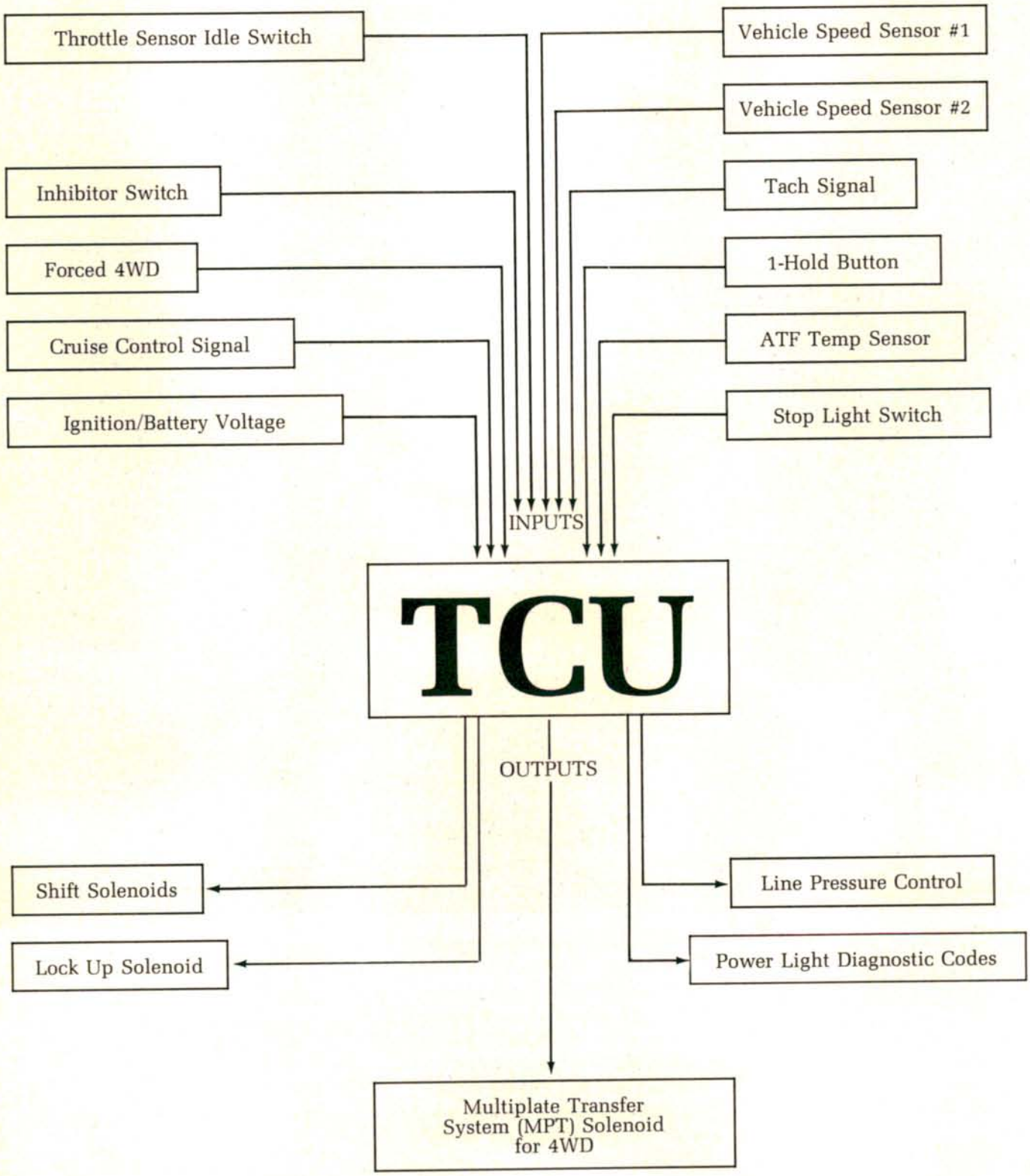
2) Speed sensor #2
3) Throttle sensor
4) Shift solenoid #1
5) Shift solenoid #2
6) Shift solenoid #3
7) Duty solenoid B
8) Duty solenoid C
9) ATF temperature sensor
10) Ignition pulse
11) Duty solenoid A

Now you know, if on the third one-second test interval, the light flashes on for 0.6 second and off again for 0.4 second that the third component, the throttle sensor, is the faulty signal. Check the component and its wiring for problems.



This is the throttle sensor/idle switch combination. Unit acts like the old modulator valve—it signals load changes. If you mash the pedal to the floor, the switch senses your aggression and signals the TCU to activate the Power Mode.

If the test sequence indicates the same intervals for all the components (0.1 second on—0.9 second off) then the vehicle passes the test.


Throttle Sensor Idle Switch
Vehicle Speed Sensor #1
Vehicle Speed Sensor #2
Inhibitor Switch
Tach Signal
Forced 4WD
1-Hold Button
Cruise Control Signal
ATF Temp Sensor
Ignition/Battery Voltage
Stop Light Switch
INPUTS
TCU
OUTPUTS
Shift Solenoids
Line Pressure Control
Lock Up Solenoid
Power Light Diagnostic Codes
Multiplate Transfer System (MPT) Solenoid for 4WD

FACTS AND FIGURES

Lock-up: All forward gears except 1st
Drive wheels: FWD or full-time 4WD
Selector lever: Floor mount
P— Park
R— Reverse
N— Neutral
D— Gears 1, 2, 3, 4
3— Gears 1, 2, 3
2— Gears 1, 2 (TCU will shift to 3 to avoid engine over-rev)
1— Hold button depressed selector at 2 = manual first gear (TCU will shift through 2, 3 to prevent over-rev)

GEAR RATIOS

Reverse—2.272
1st— 2.785
2nd—1.545
3rd— 1.00
4th— 0.694

POWER-ECONOMY RANGES

Power range selected by TCU depending on driver need (rapid movement of gas pedal delays up-shifts).

SPECIAL FEATURES

Computer overrides provide over-rev protection in manually selected lower gears; variable displacement oil pump; solenoid control of transfer clutches, shift points, and lock-up clutches; TCU self-diagnosis capacity; monitoring of ATF temperature and vehicle system voltage; provisions for fail-safe operation in the event of input failure.

COMPONENT FUNCTIONS

Throttle/Idle Sensor—Electrical throttle pressure
Vehicle Speed Sensor #1—Electrical governor pressure
Vehicle Speed Sensor #2—In-dash speedometer backup for sensor #1 in FWD—front output shaft sensor in 4WD
Tach Sensor—Controls shift points at kick-down by comparing engine with vehicle speed
Inhibitor Switch—Signals TCU about gear selection; prevents starting of engine in drive gear
AFT Sensor—Prevents 3-4 shift when fluid is cold to help warm engine; acts as warning device to activate combination meter warning light in the event of an ATF overheat
Cruise Control Switch—Alerts TCU of cruise mode to keep trans in 4th gear longer for better fuel economy ■