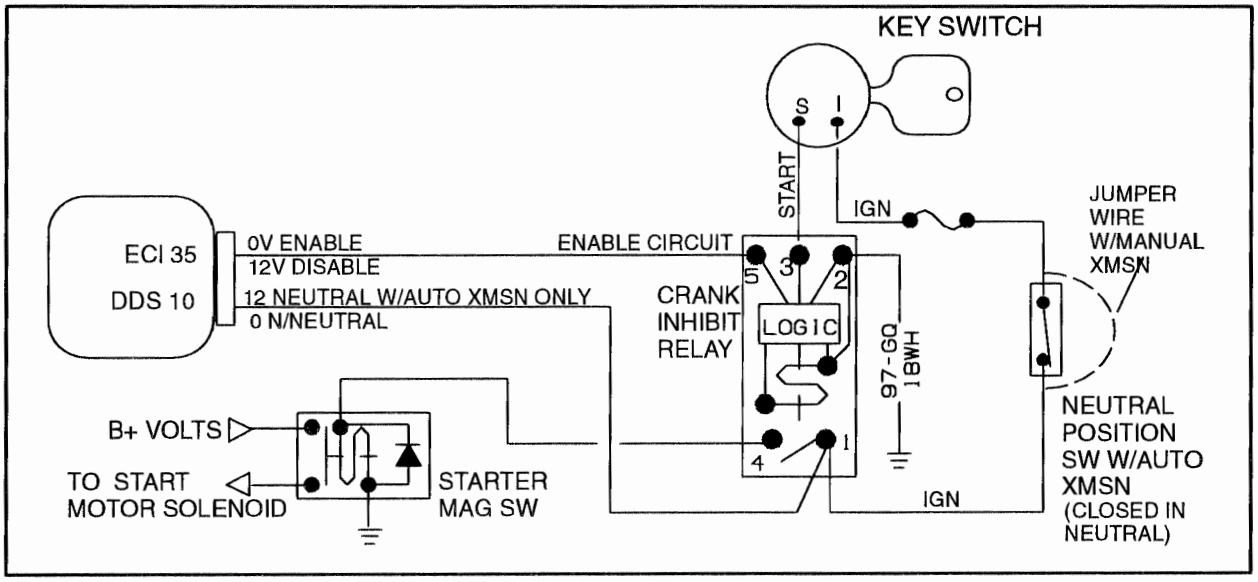
ELECTRONIC CONTROL SYSTEM DIAGNOSTICS

ENGINE CRANK INHIBIT (ECI)

ENGINE CRANK INHIBIT SYSTEM (ECI)



SIGNAL FUNCTION

The ECM uses the enable circuit to control engine cranking. The ECM prevents cranking motor operation: whenever the engine is running or whenever a vehicle with an automatic transmission is not in neutral.

ELECTRONIC CONTROL MODULE (ECM)

AUTOMATIC TRANSMISSION
With the key ON, the ECM enables the crank relay if the engine is not running and if 12 volts is present at terminal 10 with an automatic transmission.

MANUAL TRANSMISSION
With a manual transmission, the ECM programming doesn't look at terminal 10 in enabling the crank inhibit relay.

To enable the crank inhibit relay, the ECM sets terminal 35 LOW (ground state). To disable the crank relay, terminal 35 is HIGH (12 volts).

CRANK INHIBIT RELAY

Turning the key to the start position applies power to the crank inhibit relay at pin 2. If the relay is enabled by the ECM, the relay is energized and applies ignition voltage to the cranking motor magnetic switch control coil.

CRANKING MOTOR MAGNETIC SWITCH

The crank motor magnetic switch is used to switch battery power to the crank motor solenoid when the crank inhibit relay is energized. With thermo overcrank protection installed the magnetic switch is grounded through the overcrank thermo couple.

FAULT DETECTION MANAGEMENT

The ECM does not monitor the cranking system circuits. There are no fault codes for this system.

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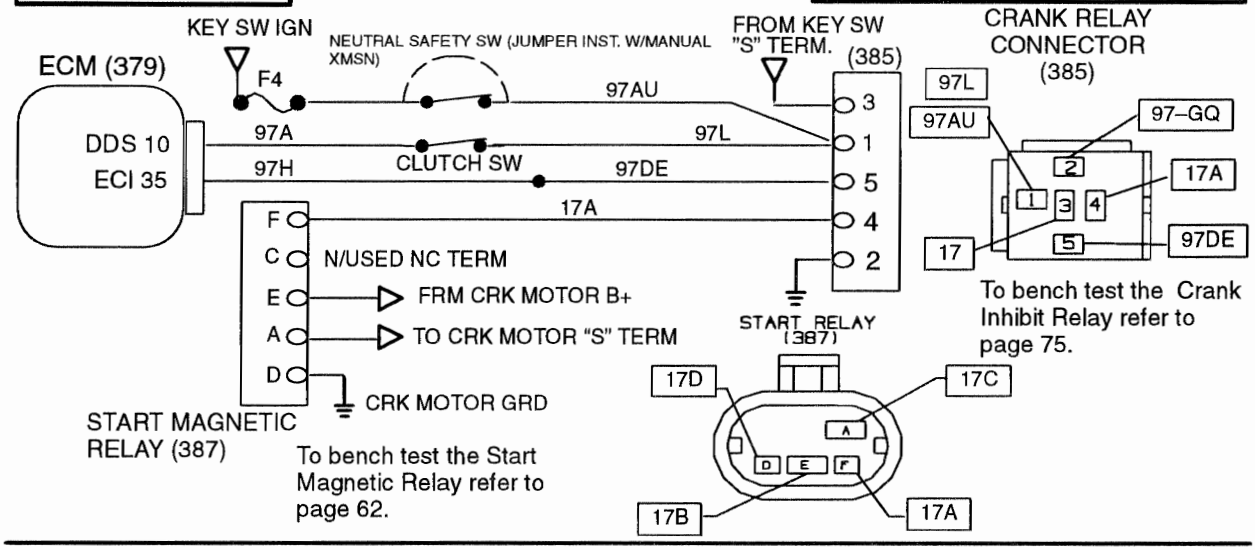
ENGINE CRANK INHIBIT (ECI)

Engine Crank Inhibit (ECI)

Refer to page 57 for complete circuit diagram.

Fault Codes: No Codes Apply To This System



ECI Relay Connector Checks (Connector 385) Relay removed, ignition Key ON, Transmission in Neutral

Test Points	Spec.	Possible Causes
1+ to Grd.	12v + 1.5v	Open F4 fuse or open 97AU circuit, defective neutral position switch, or not plugged together with manual transmission.
1+ to 2–	12v + 1.5v	Open Grd. 97GQ
1+ to 4–	12v + 1.5v	Open 17A or 17D. Defective start relay proceed to testing starter relay.
(Depress Clutch Pedal if equipped with Manual Xmsn or Place Auto Xmsn in Neutral)		
1+ to 5–	12v + 1.5v	Open 97DE circuit or ECM control open. Proceed to testing at ECM.
(Turn ignition key to start or push start button with ignition key ON)		
3+ to 2–	12v + 1.5v	Open circuit 17, defective key or start switch.
With transmission in Neutral and Clutch Depressed. To jump ECI relay, connect a jumper wire between terminal 3 and 4. Turn ign. key to start or push starter button.		

ECM (Connector 379) Checks w/Brkout. Box installed, key ON, Xmsn in Neutral, Clutch Pedal not depressed

Test Points	Spec.	Possible Causes
57+ to 60–	12v + 1.5v	Open power or ground to ECM, refer to "ECM PWR".
10+ to 60–	12v + 1.5v	Open F4 fuse, 97AU or 97L. Defective neutral position switch, clutch switch or jumpers missing.
(Depress clutch pedal if equipped with Manual Xmsn or Place Auto Xmsn in Neutral)		
57+ to 35–	12v + 1.5v	Incorrect signal at terminal 10. Incorrect VPM programming, or defective ECM.
(The following step should only be performed on vehicles with Manual Transmission) Depress clutch pedal		
10+ to 60–	< 1 volt	Improperly mounted or defective clutch switch.
With transmission in Neutral and Clutch Depressed. To jump ECM relay, connect a jmpr. wire between term. 60&35 of b.o.b. Turn ign. key to start or push starter button.		

Starter Relay Connector Checks (Connector 387) Key ON, Transmission in Neutral and Clutch Depressed

Test Points	Spec.	Possible Causes
E+ to Grd.	12v + 1.5v	Open fusible link 17L or circuit 17B.
E+ to D–	12v + 1.5v	Thermo fuse open or open Grd. circuit 17D or 17G or 11GJ.
E+ to A–	12v + 1.5v	Open 17C or defective starter solenoid.
(Turn ignition key to start or push start button with ignition key ON)		
F+ to D–	12v + 1.5v	Open 17A circuit
With transmission in Neutral and Clutch Depressed. To jump starter relay, connect a jumper wire between terminal A and terminal E. **NOTE: ENGINE SHOULD CRANK AS SOON AS JUMPER WIRE IS INSTALLED. TRANSMISSION MUST BE IN NEUTRAL OR CLUTCH DEPRESSED.**		

ELECTRONIC CONTROL SYSTEM DIAGNOSTICS

ENGINE CRANK INHIBIT (ECI)

DESCRIPTION

The engine starting system is controlled by the Electronic Control Module (ECM). While cranking the engine, vehicle battery voltage may momentarily drop below 6 volts, causing the ECM to shut down. When voltage comes back up, the ECM will resume operation. The Crank Inhibit Relay (385) has a 2-second delay feature that allows the engine to continue to crank (for up to 2 seconds) while the ECM is OFF, so the engine starts properly.

The cranking system is disabled by the ECM when:

A. The engine is running.

B. The automatic transmission is not in neutral.

C. The clutch is not depressed (only with optional customer feature requiring clutch pedal to be depressed to crank engine).

Components include:

- Start Switch (key or push button)
- Crank Inhibit Relay (385)
- Start Relay (387)
- Crank Motor and Solenoid
- Electronic Control Module (379)
- Neutral Position Switch with automatic transmission
- Clutch Switch (386) with optional "clutch depressed starting feature" previously discussed.

OPERATION

Refer to the circuit diagram on page 57 for the following discussion.

Energizing the engine starting system requires a series of events by the cranking system components.

The Engine Crank Inhibit Relay (385) receives inputs from several sources and if all conditions are present, the Start Relay (387) is energized.

CRANK INHIBIT RELAY (385)

The Crank Inhibit Relay has two major functions.

1. The ECM signal must "enable" the Crank Inhibit Relay for the cranking system to operate.

2. The relay must keep the engine cranking if vehicle battery voltage drops below 6 volts during cranking, causing the ECM to go off line momentarily.

The Crank Inhibit Relay has 5 terminals. To energize the Start Relay, the Engine Crank Inhibit relay interacts with the other cranking system components.

1. **Crank Inhibit Relay Terminal #5** is connected by circuit 97DE/97AH to ECM terminal #35. For the relay to enable the cranking system, voltage at ECM terminal #35 must be 0.1 - 0.6 volts. Note that the ECM switches terminal #35 between 0.1 - 0.6 volts and battery voltage, to either "enable" or "disable" the Crank Inhibit Relay. The chart in the circuit diagram shows terminal voltages for various conditions and vehicle configurations.

   Example 1: With the engine running, ECM terminal #35 will be at battery voltage, preventing the crank system from engaging.

   Example 2: With the customer selected "Clutch Must Be Depressed To Start" feature, if the clutch pedal is not depressed when preparing to start the engine, 12V would be present at ECM terminal #35, and the crank system would not engage. Depressing the clutch would cause ECM terminal #35 to switch to 0.1 - 0.6 volts.

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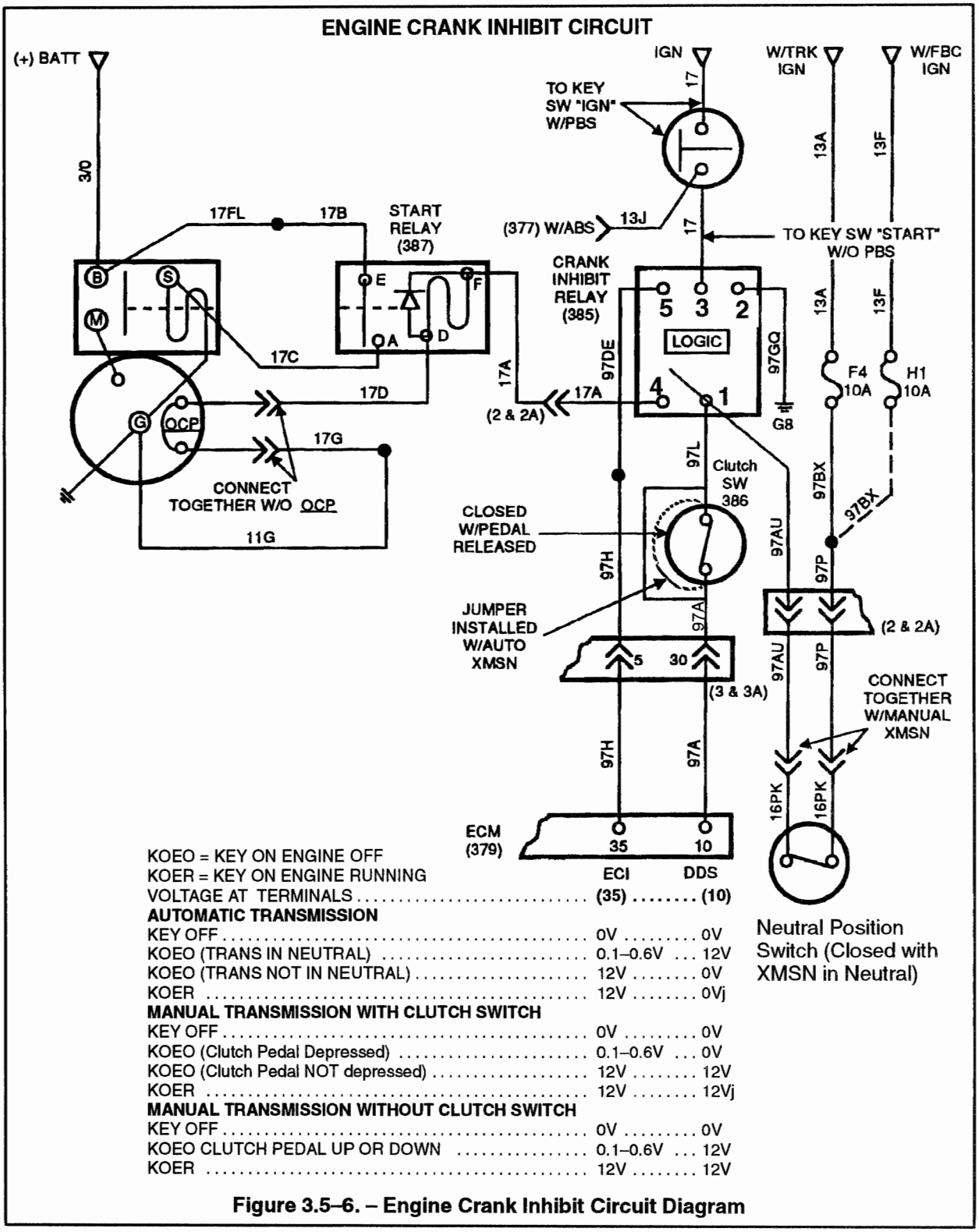
OPERATION (Continued)



KOEO = KEY ON ENGINE OFF
KOER = KEY ON ENGINE RUNNING

VOLTAGE AT TERMINALS	(35) ECI	(10) DDS
AUTOMATIC TRANSMISSION		
KEY OFF	0V	0V
KOEO (TRANS IN NEUTRAL)	0.1–0.6V	12V
KOEO (TRANS NOT IN NEUTRAL)	12V	0V
KOER	12V	0Vj
MANUAL TRANSMISSION WITH CLUTCH SWITCH		
KEY OFF	0V	0V
KOEO (Clutch Pedal Depressed)	0.1–0.6V	0V
KOEO (Clutch Pedal NOT depressed)	12V	12V
KOER	12V	12Vj
MANUAL TRANSMISSION WITHOUT CLUTCH SWITCH		
KEY OFF	0V	0V
KOEO CLUTCH PEDAL UP OR DOWN	0.1–0.6V	12V
KOER	12V	12V

Figure 3.5–6. – Engine Crank Inhibit Circuit Diagram

OPERATION (Continued)

2. **Crank Inhibit Relay Terminal #1** receives power from the F4 fuse (H1 fuse w/FBC) when the key is ON. With an automatic transmission, the power must first pass through the Neutral Safety Switch (closed when in neutral). With a manual transmission, the power from F4 (or H1 w/FBC) is present whenever the key is ON.

3. **Crank Inhibit Relay Terminal #2** is grounded by circuit 97-GQ to G8 ground point.

4. **Crank Inhibit Relay Terminal #3** receives ignition voltage when the start switch is engaged (push button or key switch). This energizes the Crank Inhibit Relay (if steps 1, 2 and 3 occurred) causing voltage from terminal 4 to energize the Start Relay (387).

5. **Crank Inhibit Relay Terminal #4** delivers output voltage on circuit 17A to the Start Relay when the Crank Inhibit Relay is energized.

START RELAY (387)

The Start Relay control coil is energized by voltage from the energized Crank Inhibit Relay on circuit 17A. When energized, battery voltage from "B" terminal of cranking motor solenoid is applied through the Start Relay contacts (E to A) to the "S" terminal of crank motor to energize the cranking motor. The Start Relay is a suppressed relay. The Start Relay has an internal diode to prevent voltage spikes from damaging electronic components in the vehicle system.

THERMO OVERCRANK PROTECTION (OCP)

On vehicles equipped with Thermo Overcrank Protection cranking motors, the ground circuit for the Start Relay is through the Thermo Overcrank thermocouple. If the cranking motor temperature reaches a certain level, the thermocouple opens, preventing further engine cranking until the cranking motor cools.

NEUTRAL POSITION SWITCH

With an Allison AT/MT automatic transmission, a normally open (NO) Neutral Position Switch is used to turn power ON or OFF in circuit 97AU.

With the transmission in neutral, the switch is closed applying power to Crank Inhibit Relay terminal #1 and to ECM terminal 10. On the circuit diagrams, ECM terminal 10 is labeled DDS (Driveline Disengagement Switch). The 12 volts at ECM terminal 10 tells the ECM that the Neutral Position switch is closed and that the transmission is in neutral.

With an Allison WT (electronic transmission controls), the neutral position switch is not used as the Allison WT Electronic Control Module determines shifter position. With the transmission in neutral, ignition power from the transmission Vehicle Interface Module (VIM) Neutral Start Relay is delivered on circuit 97AU to the Crank Inhibit Relay at terminal #1. From terminal 1, circuit 97L/97A applies the ignition voltage to ECM DDS terminal 10.

When the vehicle has an automatic transmission (AT or WT), the clutch switch connector has a jumper connecting circuits 97L and 97A, completing the circuit between Crank Inhibit Relay (385) terminal 1 and ECM terminal 10.

With an automatic transmission, ECM terminal 10 is programmed to expect 12 volts on circuit 97A when the shifter is in neutral and 0 volts when the shifter is not in neutral. The circuit diagram table shows terminal voltages for various conditions and vehicle configurations.

The Prolink 9000 can be used to monitor the Neutral Position Switch. When the switch is closed (transmission in neutral), the Prolink (using PTO/Clutch Switch Status) indicates clutch ON, meaning the driveline is disengaged.

CLUTCH PEDAL SWITCH (386)

The clutch pedal switch determines driveline disengagement status for manual transmissions. The clutch pedal switch is an active component in the "cranking" process ONLY if the customer selected the "clutch pedal must be depressed to start the engine" feature. If this feature has been selected, the circuit operates as follows:

1. With the key switch ON, voltage from Crank Inhibit Relay (385) terminal 1 is applied on circuit 97L to the normally open (N.O.) clutch switch. The clutch switch is adjusted to be CLOSED while the clutch pedal is RELEASED, and OPEN when the clutch pedal is DEPRESSED. With the clutch switch closed, 12 volts from Crank Inhibit Relay terminal #1 is applied to ECM terminal 10.

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OPERATION (Continued)

CLUTCH PEDAL SWITCH (386) (Continued)

If the ECM sees 12 volts at DDS terminal 10, it determines that the pedal is not depressed, then the ECM applies 12 volts to ECM ECI terminal 35, disabling the Crank Inhibit Relay (engine will not crank condition). If the clutch pedal is depressed (opening the clutch switch), then 0 volts is present at ECM terminal 10, and the ECM switches ECM terminal 35 voltage to 0.1 - 0.6 volts, enabling the Crank Inhibit Relay (if all other conditions are OK). The table in the circuit diagram shows terminal voltages for various conditions and vehicle configurations.

The Prolink 9000 EST can be used to monitor the Clutch Switch position. When the clutch switch is open (clutch depressed), the Prolink indicates clutch ON, meaning the driveline is disengaged.

ELECTRONIC CONTROL MODULE

Electronic Control Module terminals 10 and 35 are directly involved with enabling the Crank Inhibit Relay. The ECM and VPM (VPM stores information for the ECM) are programmed differently for automatic or manual transmissions.

ECM TERMINAL 10 (DDS)

ECM terminal 10 receives input (12 volts or 0 volts) from either the clutch switch with a manual transmission or neutral position indication with an automatic transmission. The ECM uses the input to determine the voltage signal on ECM terminal 35. The various expected inputs are shown in the circuit diagram.

ECM TERMINAL 35 (ECI)

ECM terminal 35 is connected by circuit 97H to Crank Inhibit Relay terminal 5. Based on inputs to ECM terminal 10 and engine operating conditions, the ECM either applies 0.1 - 0.6 volts or 12 volts to terminal 35. If the ECM applies 0.1 - 0.6 volts to terminal 35, the Crank Inhibit Relay is "enabled." If the ECM applies 12 volts to terminal #35, then the Crank Inhibit Relay is NOT "enabled."

ECM PROGRAMMING

The ECM "enables" the Crank Inhibit Relay if:

1. The engine is not running.
2. The transmission is in neutral (with automatic transmission).
3. The clutch pedal is depressed (with optional safety feature requiring clutch pedal to be depressed to crank engine).

If these conditions do not exist, the Crank Inhibit Relay is not enabled and the engine will not crank. The table in the circuit diagram shows terminal voltages for various conditions and vehicle configurations.

TROUBLESHOOTING

The ECM "enables" or "disables" the engine cranking system with the Engine Crank Inhibit (ECI) relay. **There are no ECM diagnostics available for this system.** Perform the following tests to find the cause of a No Crank condition.

BEFORE TROUBLESHOOTING

A. Before troubleshooting, make sure that the batteries are fully charged! Check battery cables and grounds for clean, tight connections free of damage. Voltage tests will give misleading readings if the batteries are not fully charged.

B. Before troubleshooting a particular circuit, inspect connectors for pushed back, loose or damaged (spread or bent) terminals, or wires with cut strands etc. The wires and connections must be free of damage or corrosion. When some connectors corrode, a light white residue will be present that must be removed.

ELECTRONIC CONTROL SYSTEM DIAGNOSTICS

ENGINE CRANK INHIBIT (ECI)

TROUBLESHOOTING (Continued)
ENGINE DOES NOT CRANK

The tests for Engine Does Not Crank are divided into two parts: Part 1, Engine Does Not Crank. Part 2, Engine Does Not Crank with Manual XMSM and Clutch Switch. Refer to the **Figure 3.5–7** while performing Part 1.

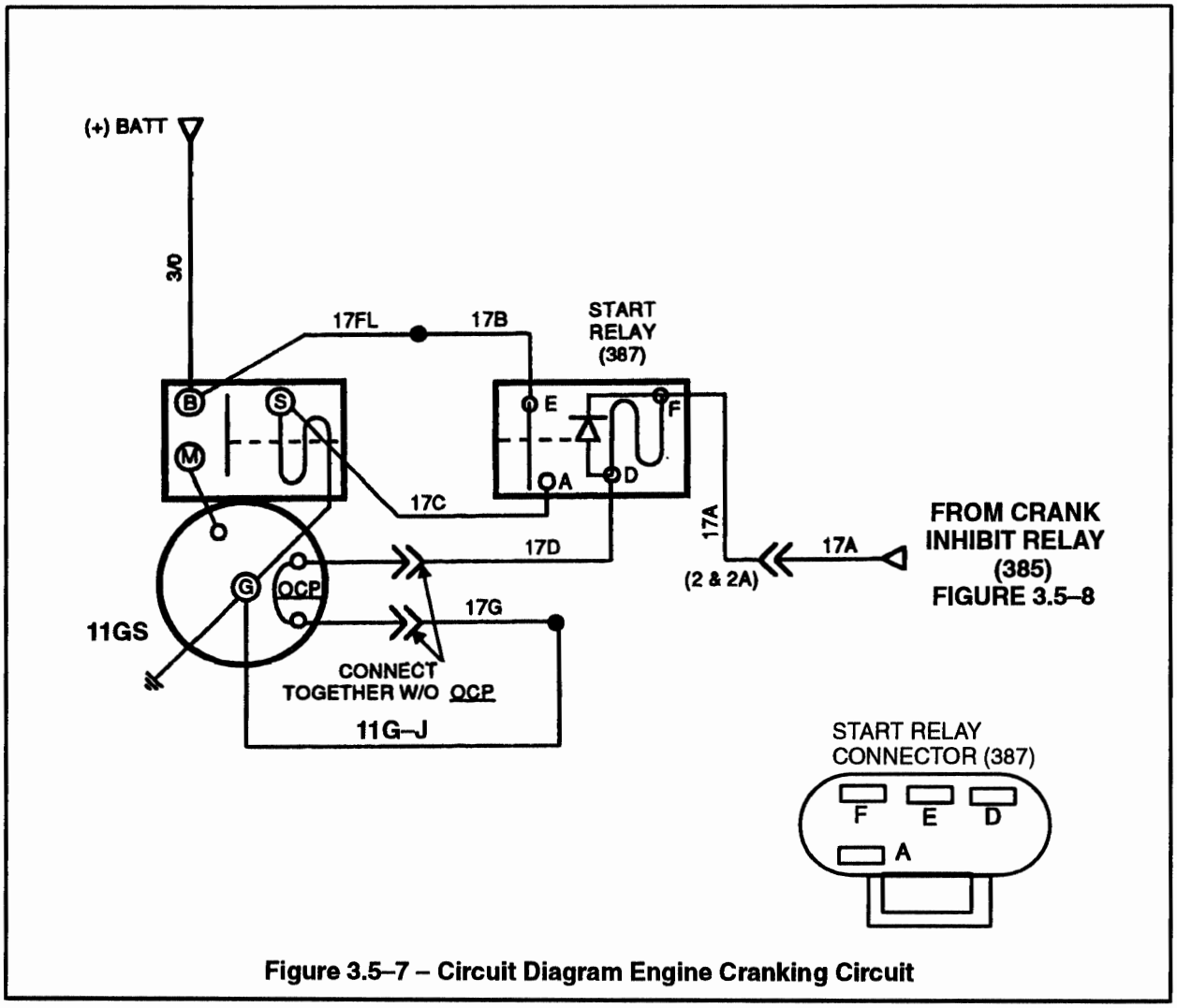

Figure 3.5–7 – Circuit Diagram Engine Cranking Circuit

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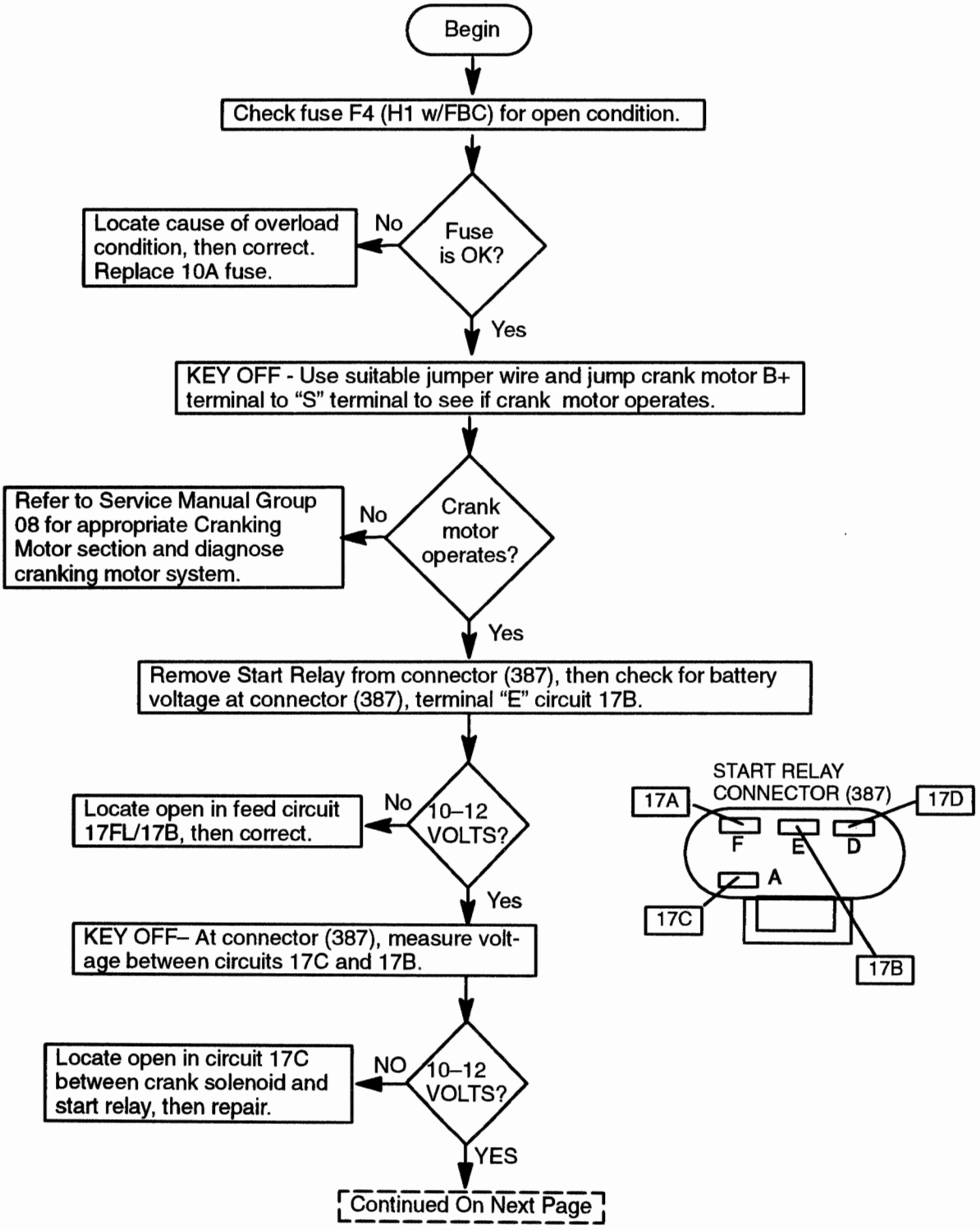
ENGINE DOES NOT CRANK TEST (PART 1)

The Part 1 troubleshooting chart is to be used with either a manual transmission (with and without clutch switch) or an Allison automatic transmission (AT, MT or WT).

For Part 2, select the appropriate troubleshooting chart for vehicle being tested: Manual Transmission With A Clutch Switch, or Manual Transmission Without Clutch Switch or Automatic Transmission.



ELECTRONIC CONTROL SYSTEM DIAGNOSTICS

ENGINE CRANK INHIBIT (ECI)

ENGINE DOES NOT CRANK TEST (PART 1) (Continued)

KEY OFF– At connector (387), measure voltage between circuits 17B and 17D.

10–12 VOLTS?

NO → Locate open in circuit 17D/17G/11G to ground, then repair. Note : If thermo overcrank is installed, check the thermocouple.

YES

KEY ON– With start switch engaged, at connector (387), measure voltage between circuits 17A and 17D.

10–12 VOLTS?

YES → Replace the start relay

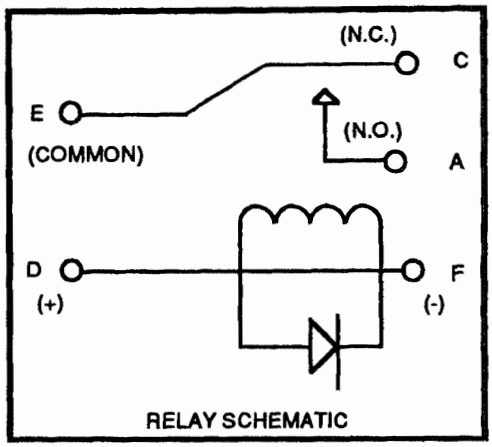
NO

Perform Start Relay Test procedure to determine relay condition, then continue with Engine Does Not Crank Part 2. (A, B or C).

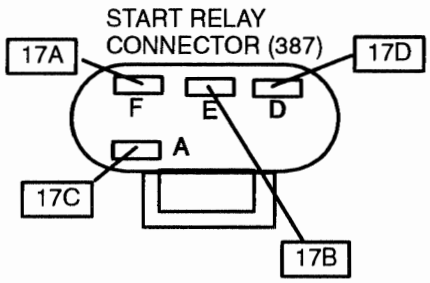
With **Manual XMSN with Clutch Switch** perform Engine Does Not Crank Part 2A p.63

With **Automatic XMSN** perform Part 2B p.66

With **Manual XMSN without Clutch Switch**, perform Part 2C p. 69

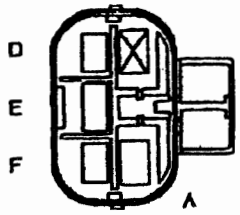


RELAY SCHEMATIC



START RELAY TEST PROCEDURE

End View Of Start Relay



TEST STEPS

1. Measure resistance between D and F.
   A. If resistance is 60 to 70 ohms go to step 2, otherwise replace the relay.
2. Measure resistance between C and E, then C and A.
   A. If continuity is present between C and E but not between C and A, go to step 3.
   B. If continuity is not present between C and E OR continuity is present between C and A, replace the relay.
3. Using test leads, connect (+) battery lead to D and (–) lead to F. Measure resistance between E and A.
   A. If relay makes audible click and there is continuity between E and A, the relay checks OK.
   B. If resistance between A and E is greater than 5 ohms, replace the relay.

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ENGINE DOES NOT CRANK (PART 2A) WITH MANUAL XMSM AND CLUTCH SWITCH

Refer to **Figure 3.5–8** while using (PART 2A) test procedure.

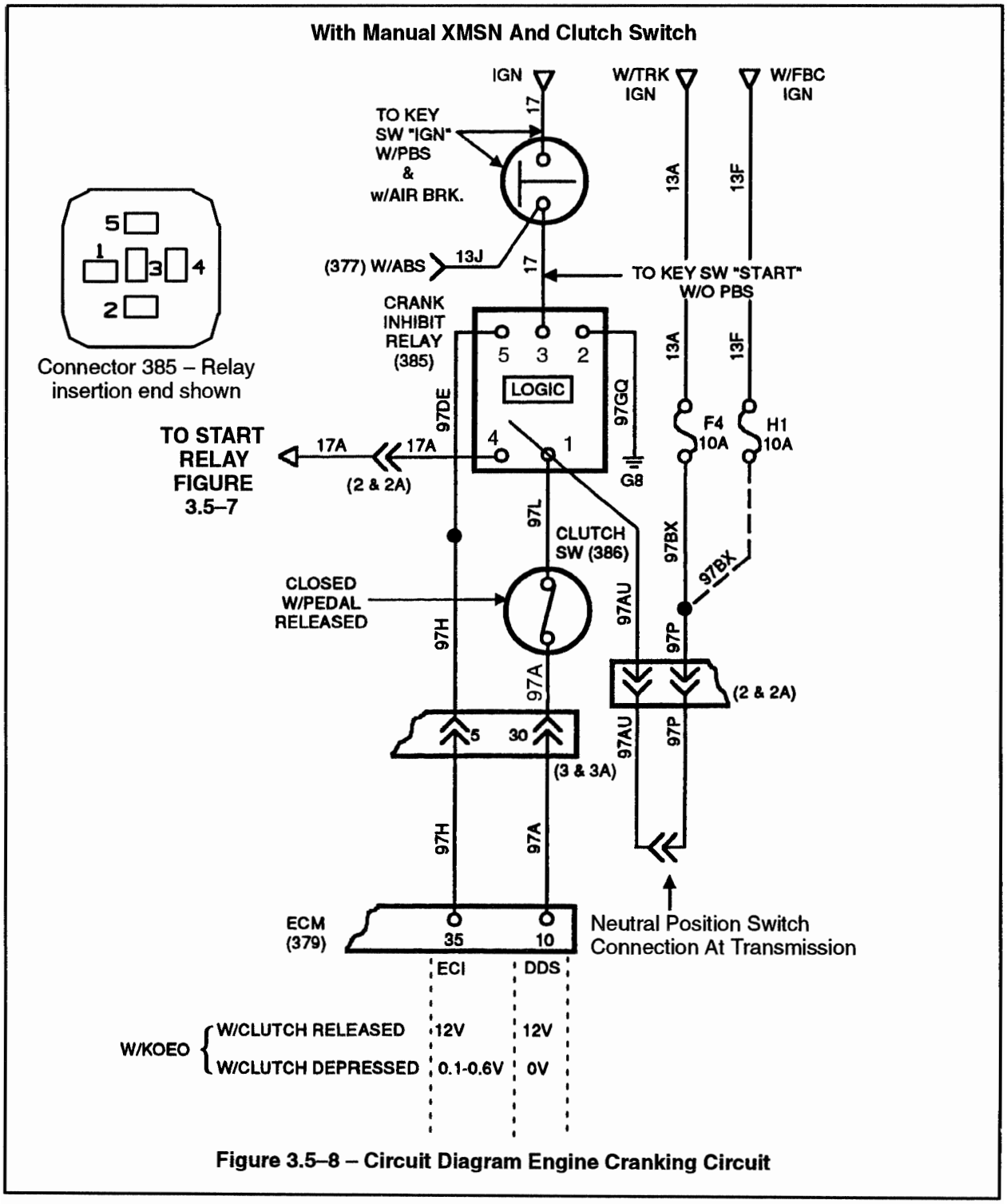


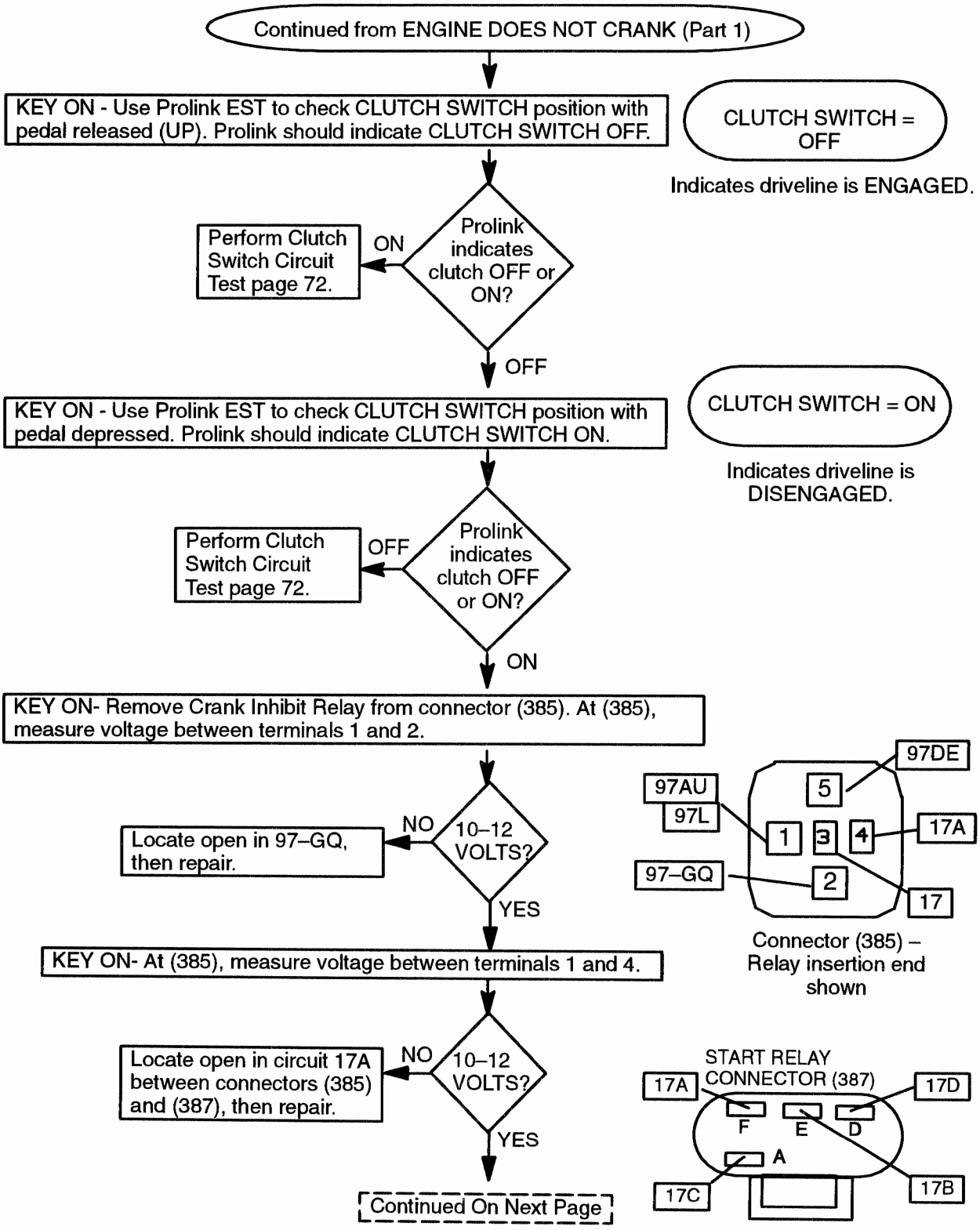
Figure 3.5–8 – Circuit Diagram Engine Cranking Circuit

ELECTRONIC CONTROL SYSTEM DIAGNOSTICS

ENGINE CRANK INHIBIT (ECI)

ENGINE DOES NOT CRANK (PART 2A) (Continued)

Use this test with manual transmission equipped with a clutch switch. While performing this test, you may be directed to perform the Clutch Switch Circuit Test on page 72.



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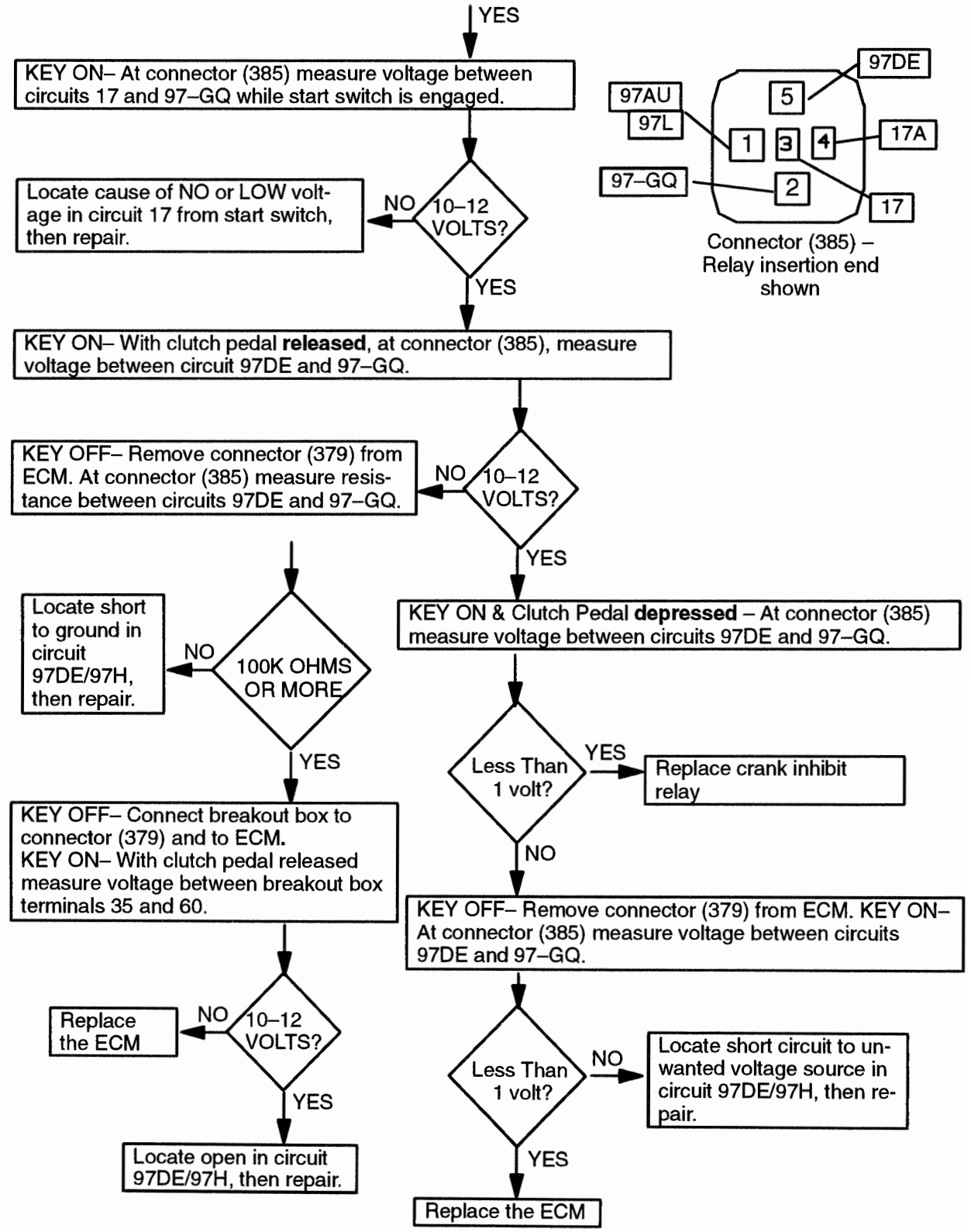
ENGINE DOES NOT CRANK (PART 2A) (Continued)



ENGINE DOES NOT CRANK (PART 2B) WITH ALLISON AT/MT TRANSMISSION

Refer to **Figure 3.5–9** while performing test.

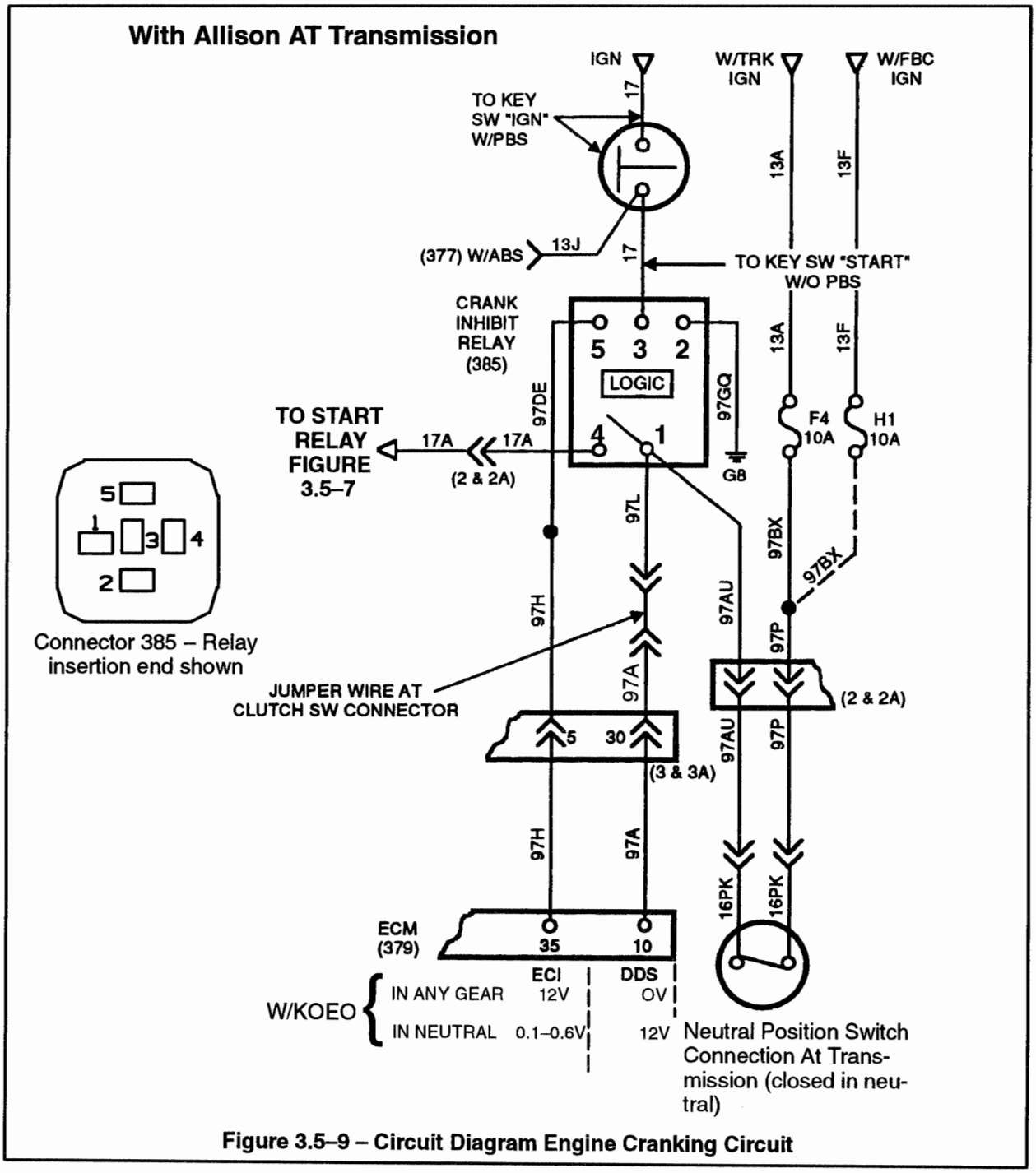


Figure 3.5–9 – Circuit Diagram Engine Cranking Circuit

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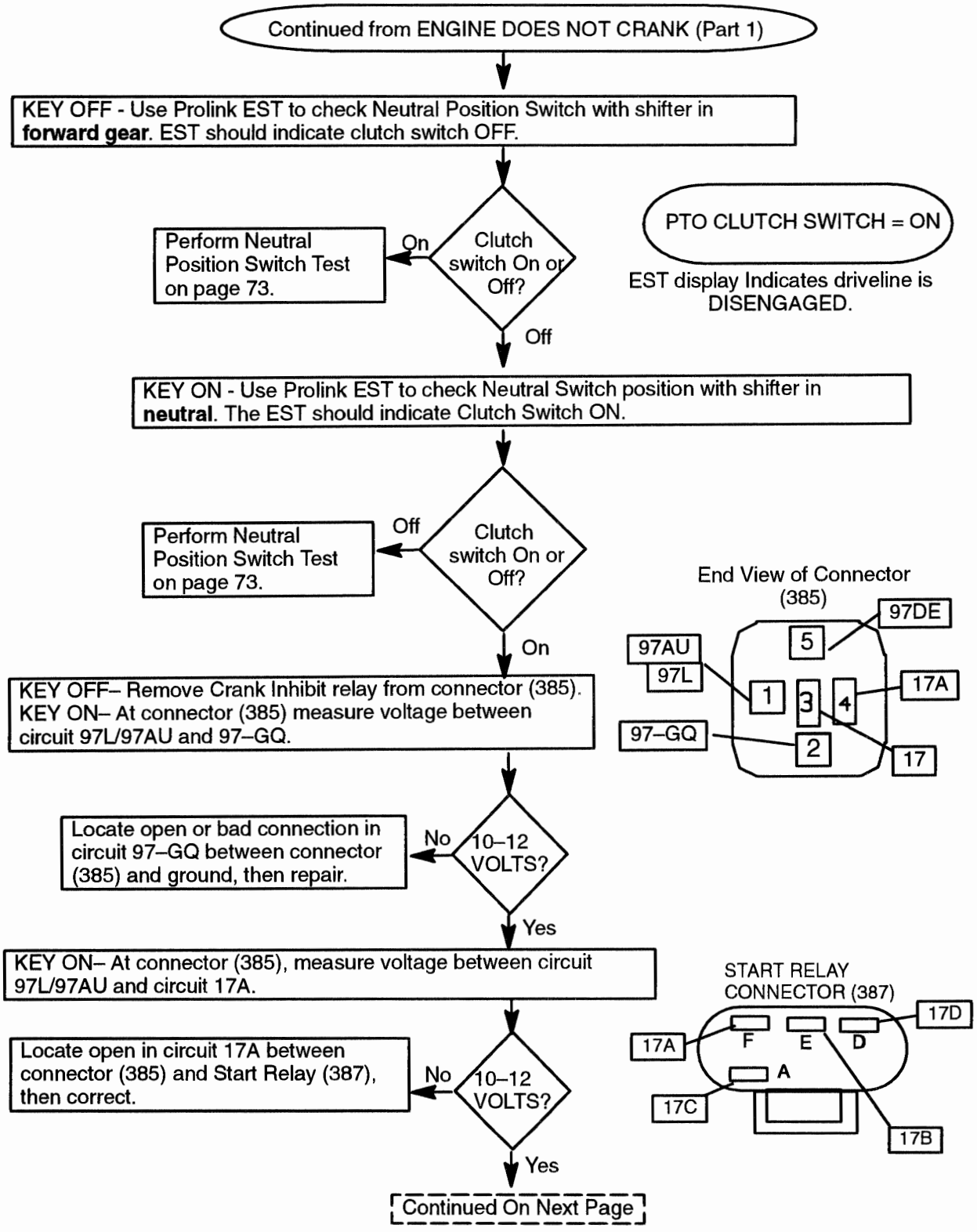
ENGINE DOES NOT CRANK (PART 2B) (Continued)

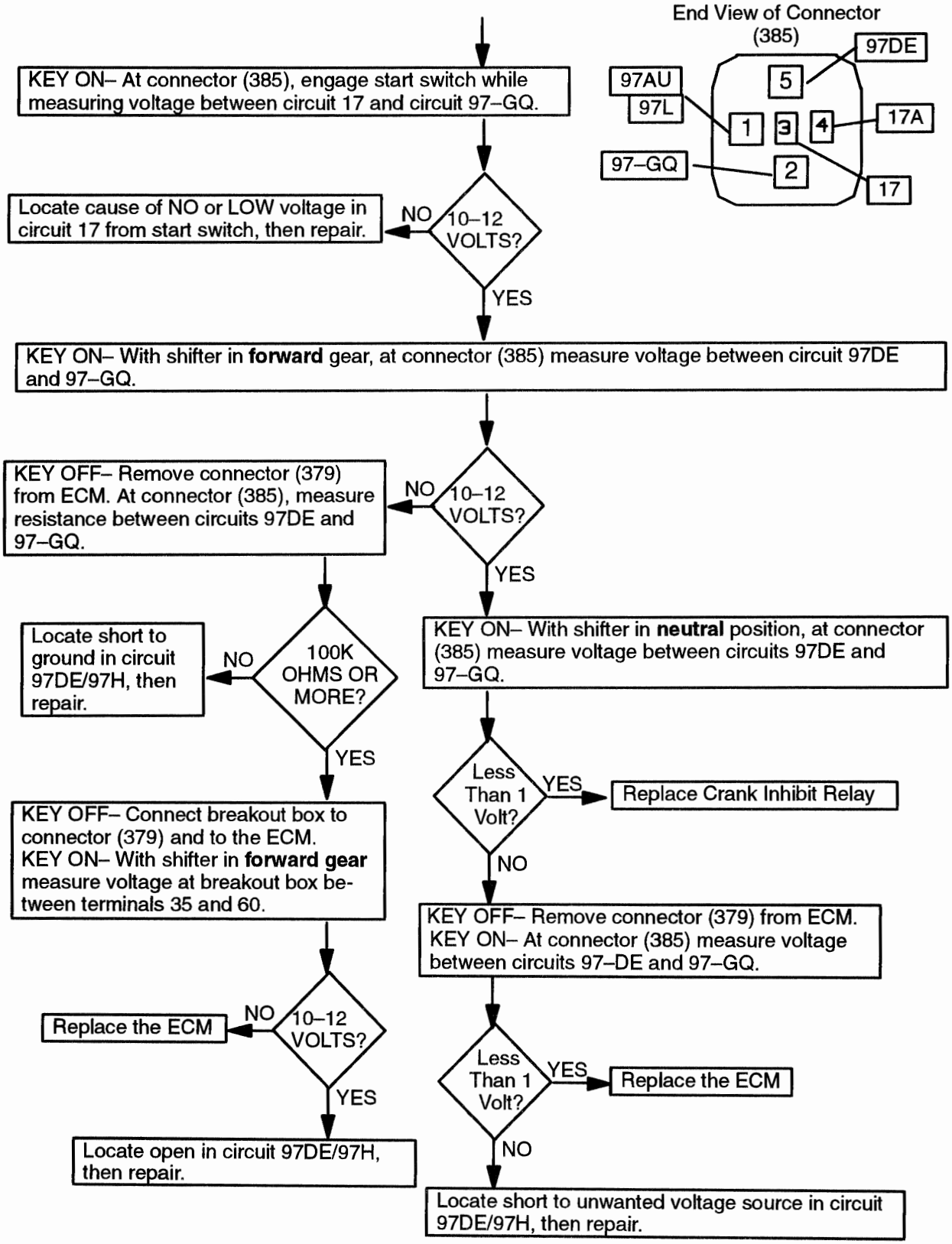
Use this test with automatic transmission. While performing this test, you may be directed to perform the Neutral Position Switch Circuit Test on page 73.



ELECTRONIC CONTROL SYSTEM DIAGNOSTICS

ENGINE CRANK INHIBIT (ECI)

ENGINE DOES NOT CRANK (PART 2B) (Continued)



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ENGINE DOES NOT CRANK (PART 2C) WITH MANUAL TRANSMISSION WITHOUT CLUTCH SWITCH

Refer to **Figure 3.5–10** while performing test.

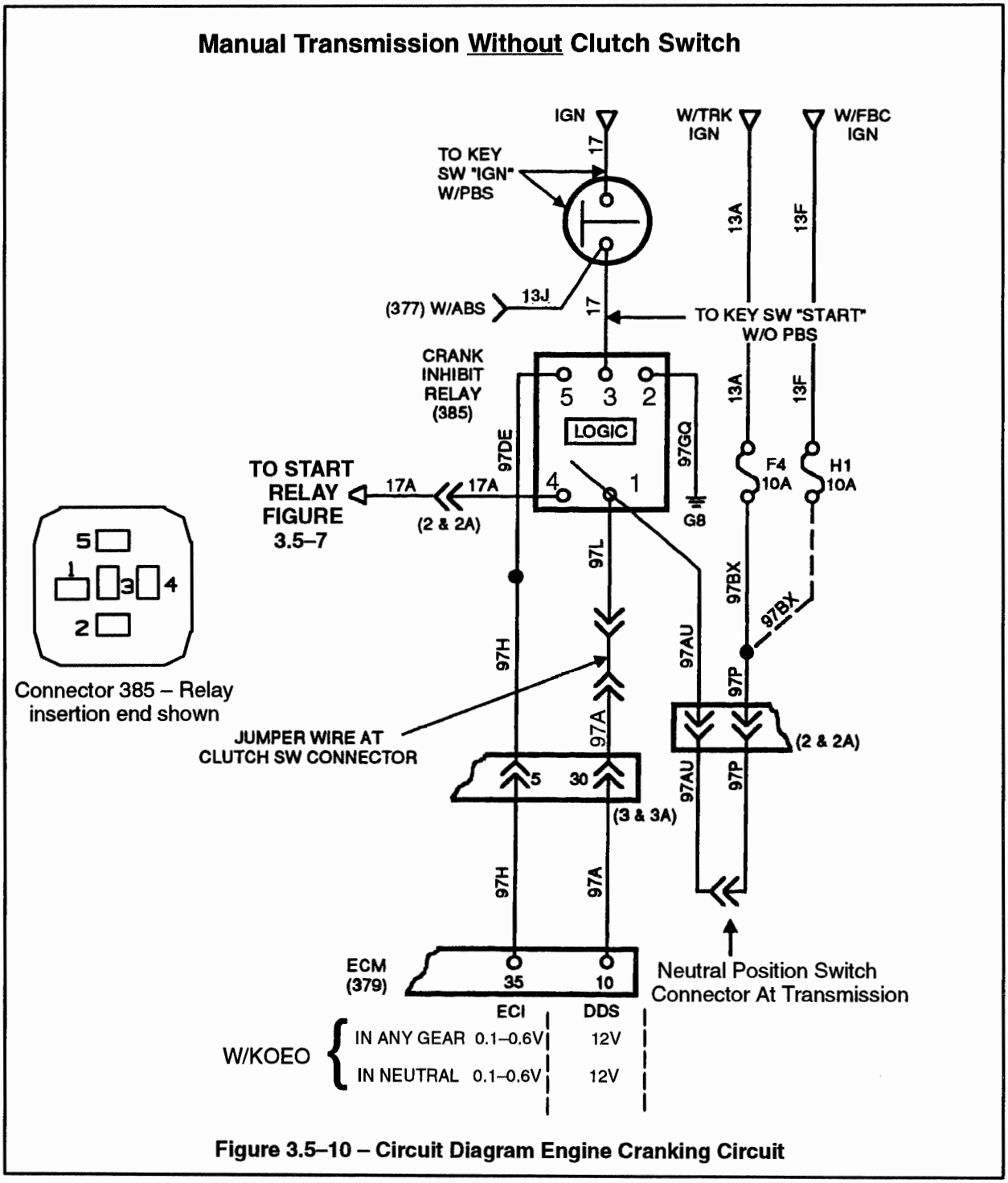

Figure 3.5–10 – Circuit Diagram Engine Cranking Circuit

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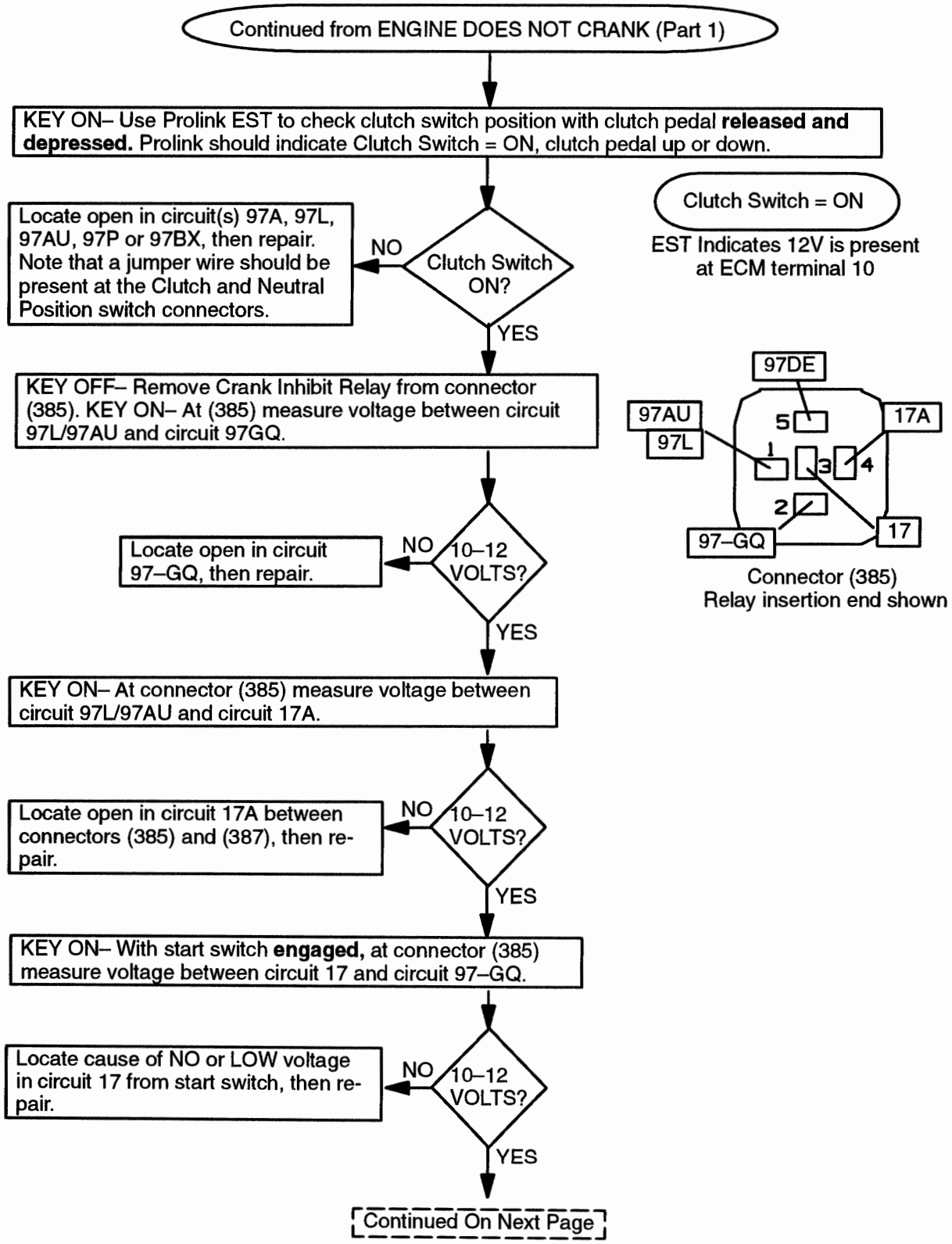
ELECTRONIC CONTROL SYSTEM DIAGNOSTICS

ENGINE CRANK INHIBIT (ECI)

ENGINE DOES NOT CRANK (PART 2C) (Continued)

Use this test with manual transmission without a clutch switch.



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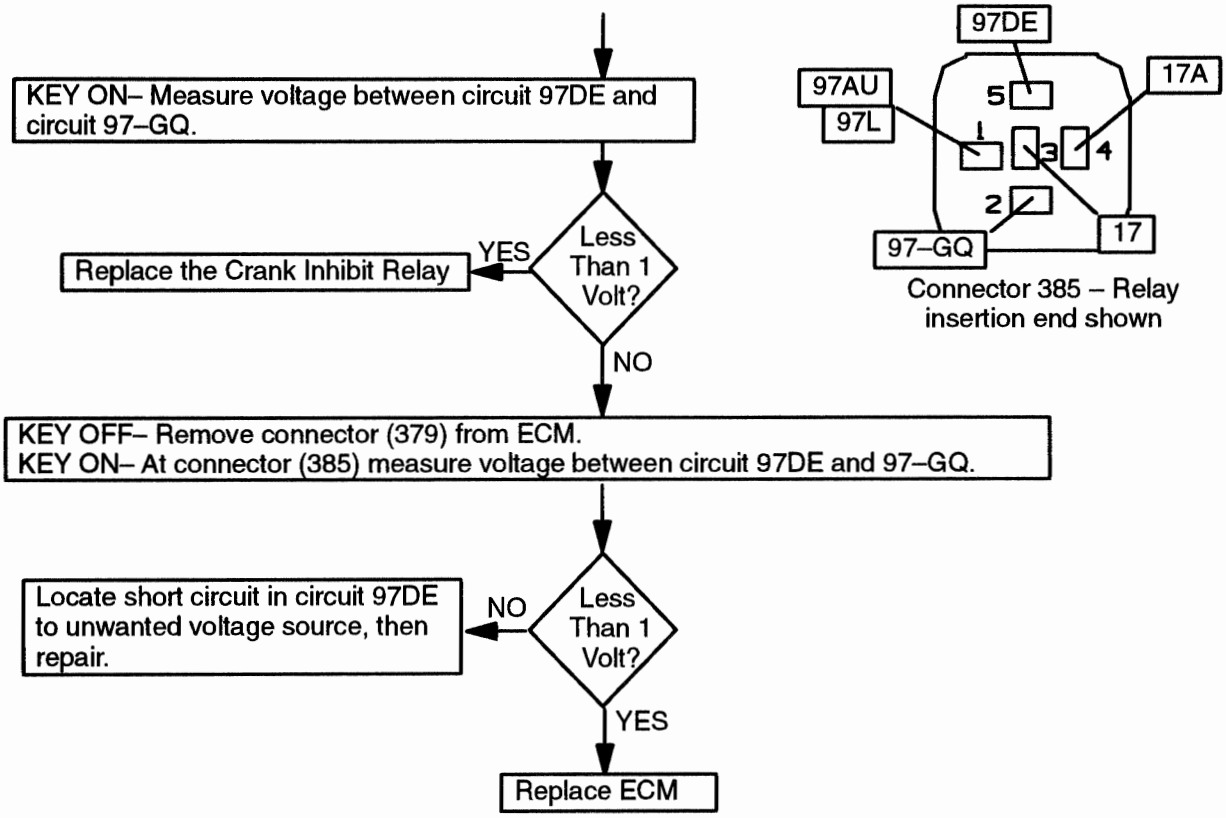
ENGINE DOES NOT CRANK (PART 2C) (Continued)

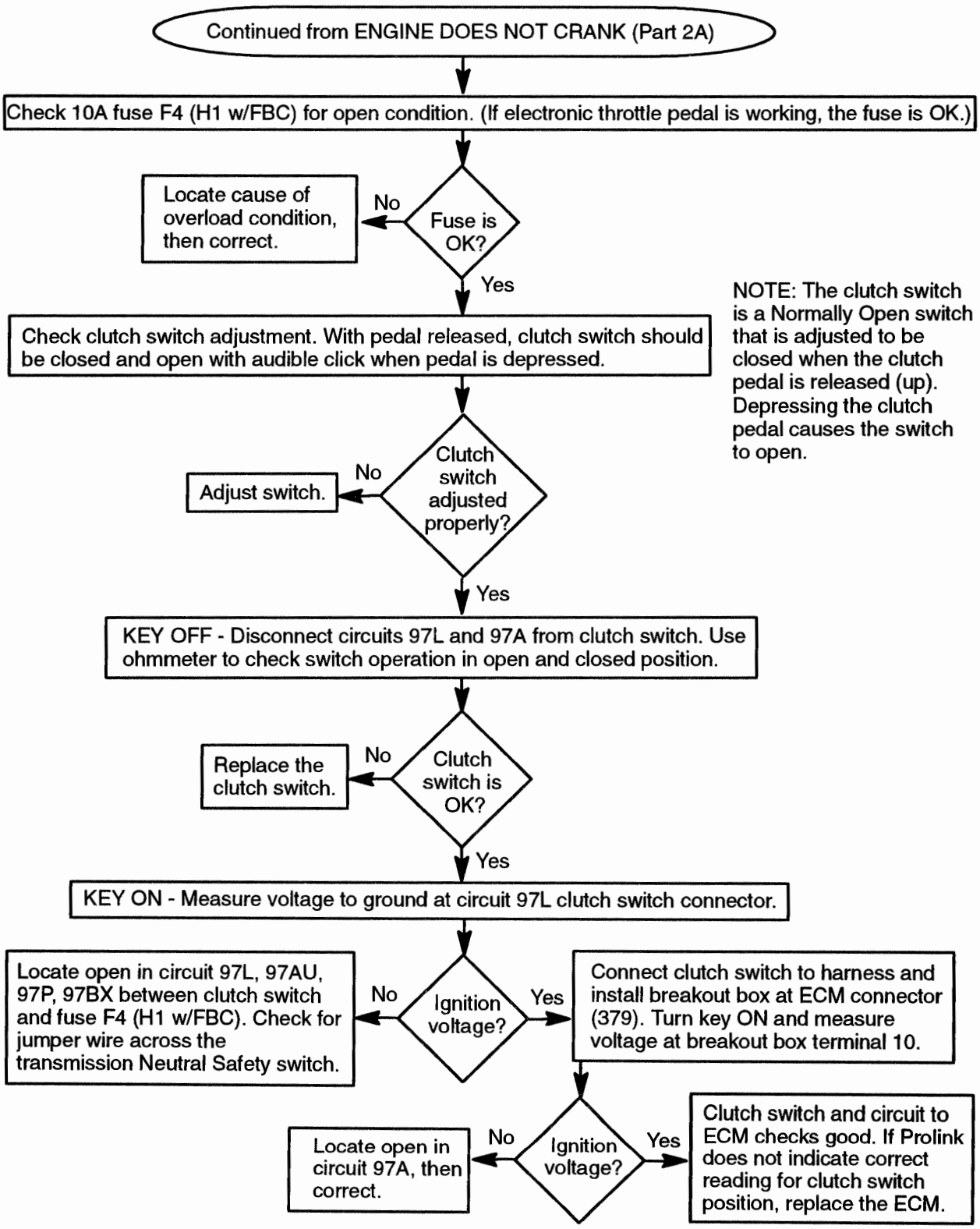


ELECTRONIC CONTROL SYSTEM DIAGNOSTICS

ENGINE CRANK INHIBIT (ECI)

CLUTCH SWITCH CIRCUIT TEST WITH CLUTCH SWITCH

Perform this test if directed by other test or if Prolink EST indicates the clutch switch is not functioning properly.



NOTE: The clutch switch is a Normally Open switch that is adjusted to be closed when the clutch pedal is released (up). Depressing the clutch pedal causes the switch to open.

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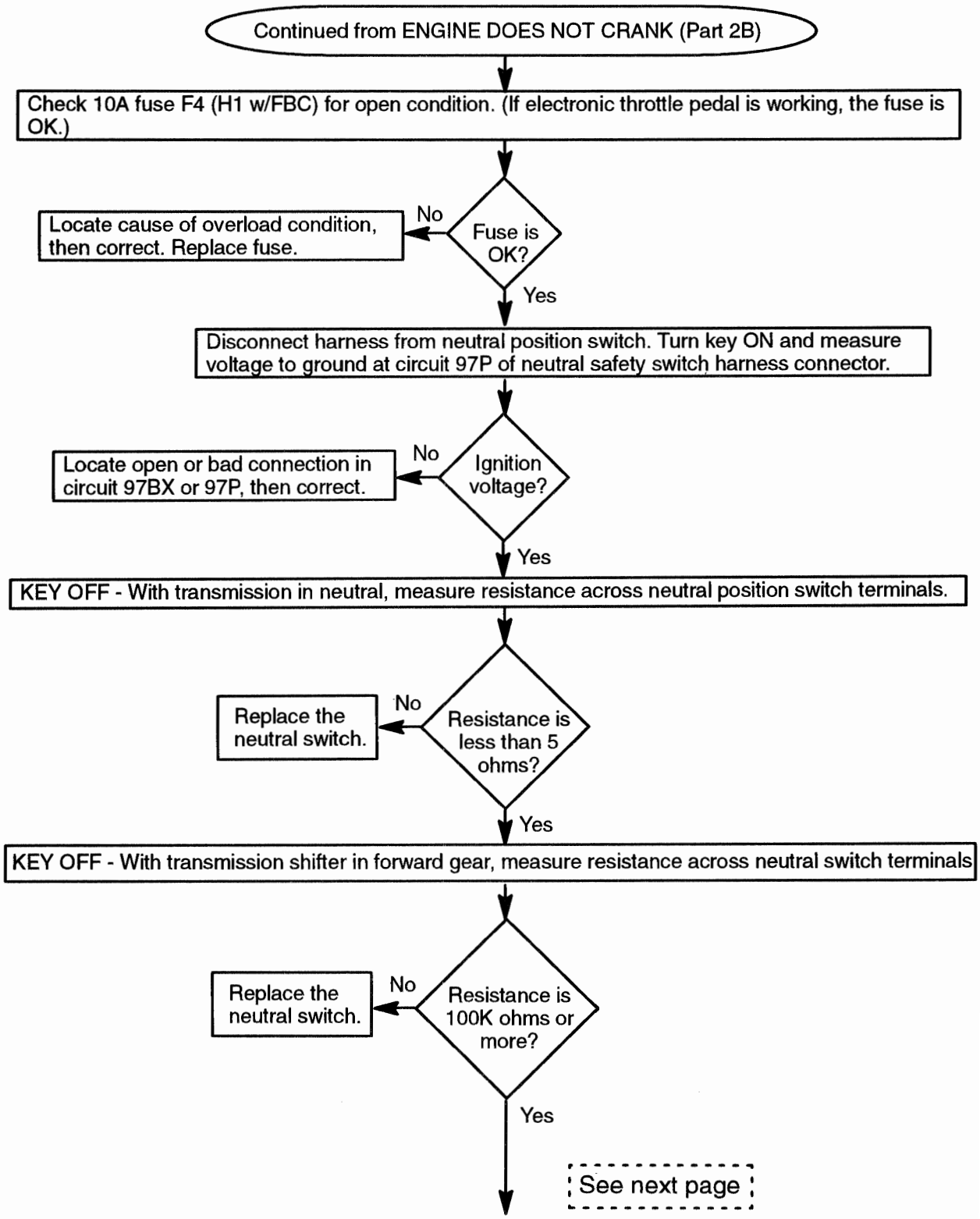
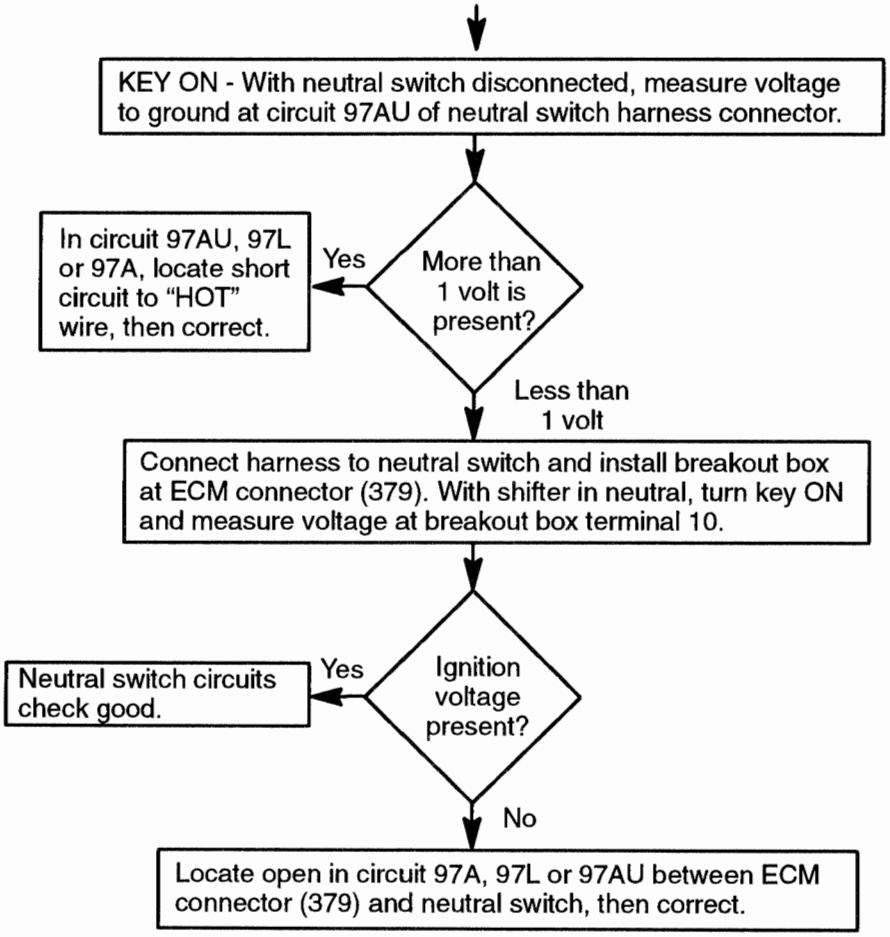
NEUTRAL POSITION SWITCH TEST WITH ALLISON AT/MT AUTOMATIC TRANSMISSION



ELECTRONIC CONTROL SYSTEM DIAGNOSTICS

ENGINE CRANK INHIBIT (ECI)

NEUTRAL POSITION SWITCH TEST WITH ALLISON AT/MT AUTOMATIC TRANSMISSION (Continued)



ENGINE CRANK INHIBIT (ECI) RELAY TEST

This procedure provides a method to bench test the ECI relay. The terminal numbers are marked on the relay.