

CRUISE CONTROL SYSTEM - NON-TURBO

1998 Toyota Supra

1998 ACCESSORIES & EQUIPMENT
Toyota - Cruise Control Systems

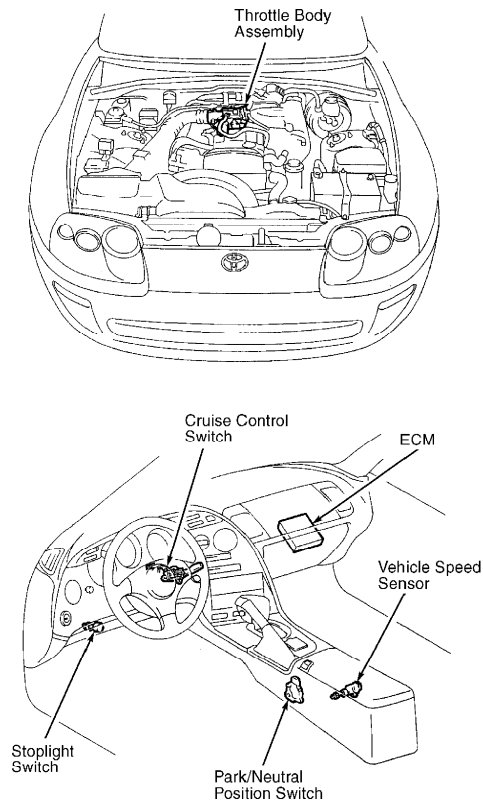
Supra Non-Turbo

DESCRIPTION

WARNING: Deactivate air bag system before performing any service operation. See AIR BAG RESTRAINT SYSTEMS article. DO NOT apply electrical power to any component on steering column without first deactivating air bag system. Air bag may deploy.

Cruise control system consists of Engine Control Module (ECM), throttle body assembly, vehicle speed sensor, cruise control switch, stoplight switch, park/neutral switch and related wiring. See Fig. 1.

System allows vehicle to cruise at a desired speed greater than 25 MPH. Speed control will cancel when brake pedal is depressed, CANCEL switch is activated or transmission shift lever is moved to any position other than "D" position. If vehicle speed slows to less than 25 MPH or drops 10 MPH less than preset speed, speed control will also cancel.



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Fig. 1: Locating Cruise Control Components
Courtesy of Toyota Motor Sales, U.S.A., Inc.

OPERATION

Pressing cruise control ON-OFF (main) switch to ON position activates cruise control system. The CRUISE indicator light in instrument cluster comes on to indicate activation of system. To set speed, increase vehicle speed to desired speed (must be more than 25 MPH). Set cruise control switch to SET/COAST position and release switch. Vehicle speed will now be maintained. To increase speed, depress accelerator pedal enough to exceed set speed. When accelerator pedal is released, speed will return to speed previously set.

To cancel set speed, set cruise control switch to CANCEL position, depress brake pedal, or place shift lever in any position other than "D" position. If vehicle speed slows to less than 25 MPH, set speed will automatically cancel. If vehicle speed drops 10 MPH less than preset speed, set speed will also automatically cancel.

Setting cruise control switch to RES/ACC position allows vehicle to return to speed set before cancellation. Setting cruise control switch to RES/ACC position and keeping it there gradually increases vehicle speed. Setting cruise control switch to SET/COAST position and keeping it there gradually decreases vehicle speed.

CRUISE CONTROL SWITCH

ON-OFF (Main) Switch

Cruise ON-OFF switch is power switch for cruise control system. When ignition is turned off, cruise ON-OFF switch is also turned off. Switch remains off even when ignition is turned on again.

SET/COAST Position

With cruise ON-OFF switch on, and vehicle speed greater than 25 MPH, set cruise control switch to SET/COAST position and release switch. Vehicle speed should decrease about one MPH (tap-down function). While in cruise control mode, if cruise control switch is set and held in SET/COAST position, vehicle will decelerate until switch is released.

RES/ACC Position

If cruise control system is canceled by any of various cancellation methods, the previously set speed can be resumed by setting cruise control switch to RES/ACC position and then releasing switch. Set speed, however, cannot be resumed if vehicle speed drops to less than 25 MPH.

CANCEL Switch

When cruise control switch is set to CANCEL position, a cancellation signal is sent to ECM, causing cruise control system to cancel.

ENGINE CONTROL MODULE

Engine Control Module (ECM) constantly monitors and compares set speed with actual vehicle speed from input sensors. When vehicle speed is different from set speed, ECM activates throttle control motor to change engine throttle valve, changing vehicle speed.

ECM includes a self-diagnostic function. If cruise control system is canceled by any condition other than driver operation, ECM assumes a malfunction has occurred and may set a corresponding trouble code. ECM is located below passenger's side of instrument panel, underneath carpet.

VEHICLE SPEED SENSOR

Vehicle speed sensor is mounted on transmission. Vehicle speed sensor may also be referred to as vehicle speed sensor No. 2.

Vehicle speed sensor monitors vehicle speed and delivers an input signal to SP2+ and SP2- terminals of Engine Control Module (ECM). The ECM uses input signal to determine vehicle speed.

SELF-DIAGNOSTIC SYSTEM

When vehicle is in cruise control mode, system will cancel due to a malfunction in vehicle speed sensor or speed control switch circuit. When cruise control functions are canceled, CRUISE indicator light will blink 5 times, indicating a Diagnostic Trouble Code (DTC) is stored in Engine Control Module (ECM) memory. See DIAGNOSTIC TROUBLE CODE DEFINITIONS table under SELF-DIAGNOSTIC SYSTEM.

NOTE: Intermittent failures may cause CRUISE indicator light to flicker or come on. Light will go out after fault goes away. Fault may or may not be present at time of testing; however, a corresponding trouble code may be stored in Engine Control Module (ECM).

TROUBLE SHOOTING

SYMPTOM DIAGNOSIS

Diagnosis by symptom should only be performed if no Diagnostic Trouble Codes (DTCs) are present. Identify symptom and perform appropriate test. Perform tests in order listed.

SET Not Occurring Or CANCEL Occurring (No DTCs Present):

- * Perform DTC P1566/54: INPUT SIGNAL CIRCUIT FAULT under DIAGNOSTIC TESTS.
- * Perform CRUISE CONTROL ON-OFF (MAIN) SWITCH CIRCUIT under SYSTEM TESTS.
- * Perform DTC P0500/21 OR 23: VEHICLE SPEED SENSOR CIRCUIT under DIAGNOSTIC TESTS.
- * Perform DTC P1520/52: STOPLIGHT SWITCH CIRCUIT under DIAGNOSTIC TESTS.
- * Perform PARK/NEUTRAL POSITION SWITCH CIRCUIT under SYSTEM TESTS.
- * Replace Engine Control Module (ECM) with a known-good ECM and retest. If symptom is no longer present, replace ECM.

SET Not Occurring Or CANCEL Occurring (CRUISE Indicator Light Inoperative):

- * Replace Engine Control Module (ECM) with a known-good ECM and retest. If symptom is no longer present, replace ECM.

Actual Vehicle Speed Deviates From Set Speed:

- * Perform DTC P0500/21 OR 23: VEHICLE SPEED SENSOR CIRCUIT under DIAGNOSTIC TESTS.
- * Replace Engine Control Module (ECM) with a known-good ECM and retest. If symptom is no longer present, replace ECM.

Gear Shifting Frequent Between 3rd & Overdrive When Driving Uphill (Hunting):

- * Replace Engine Control Module (ECM) with a known-good ECM and retest. If symptom is no longer present, replace ECM.

Cruise Control Does Not Cancel Even With Brake Pedal Depressed:

- * Perform DTC P1520/52: STOPLIGHT SWITCH CIRCUIT under DIAGNOSTIC TESTS.
- * Replace Engine Control Module (ECM) with a known-good ECM and retest. If symptom is no longer present, replace ECM.

Cruise Control Does Not Cancel Even With Transmission Shifted To Neutral:

- * Perform PARK/NEUTRAL POSITION SWITCH CIRCUIT under SYSTEM TESTS.
- * Replace Engine Control Module (ECM) with a known-good ECM and retest. If symptom is no longer present, replace ECM.

Cruise Control Switch Does Not Operate (SET/COAST, RES/ACC Or CANCEL Not Possible):

- * Perform CRUISE CONTROL ON-OFF (MAIN) SWITCH CIRCUIT under SYSTEM TESTS.
- * Replace Engine Control Module (ECM) with a known-good ECM and retest. If symptom is no longer present, replace ECM.

SET Possible at 25 MPH Or Less, Or CANCEL Does Not Operate At 25 MPH Or Less:

- * Perform DTC P0500/21 OR 23: VEHICLE SPEED SENSOR CIRCUIT under DIAGNOSTIC TESTS.
- * Replace Engine Control Module (ECM) with a known-good ECM and retest. If symptom is no longer present, replace ECM.

Poor Response In ACCEL & RESUME Modes:

- * Replace Engine Control Module (ECM) with a known-good ECM and retest. If symptom is no longer present, replace ECM.

Overdrive Does Not Resume, Even Though Road Is Not Uphill:

- * Replace Engine Control Module (ECM) with a known-good ECM and retest. If symptom is no longer present, replace ECM.

DTC Memory Is Erased:

- * Replace Engine Control Module (ECM) with a known-good ECM and retest. If symptom is no longer present, replace ECM.

DTC Not Output, Or DTC Output When It Should Not Be:

- * Perform DIAGNOSTIC CIRCUIT under SYSTEM TESTS.
- * Replace Engine Control Module (ECM) with a known-good ECM and retest. If symptom is no longer present, replace ECM.

CRUISE Control Indicator Light Stays On Or Fails To Turn On:

- * Perform CRUISE CONTROL INDICATOR LIGHT CIRCUIT under SYSTEM TESTS.
- * Replace Engine Control Module (ECM) with a known-good ECM and retest. If symptom is no longer present, replace ECM.

COMPONENT TESTS

VEHICLE SPEED SENSOR

Remove Vehicle Speed Sensor (VSS) from transmission. Connect DVOM between VSS terminals. Observe DVOM and slowly pass a magnet over end of VSS. As magnet is passed over VSS, a low voltage signal should be generated. Voltage signal is extremely low. If VSS does not operate as specified, replace VSS.

STOPLIGHT SWITCH

1) Disconnect 4-pin stoplight switch connector. See Fig. 1. Depress brake pedal (stoplight switch pin free). Ensure continuity exists between stoplight switch connector terminals No. 1 (Green/White wire) and No. 2 (White wire). If continuity does not exist, replace stoplight switch and retest system. If continuity exists, go to next step.

2) Release brake pedal (stoplight switch pin pushed in). Ensure continuity exists between stoplight switch connector terminals No. 3 (Black/Orange wire) and No. 4 (Red/Blue wire). If continuity does not exist, replace stoplight switch.

SYSTEM TESTS

* PLEASE READ THIS FIRST *

NOTE: To identify Engine Control Module (ECM) connectors and terminals, see Fig. 6. To help identify all other cruise control related circuits and wire colors, see WIRING DIAGRAMS.

PARK/NEUTRAL POSITION SWITCH CIRCUIT

CAUTION: If ECM replacement is instructed in following testing, always ensure ECM connectors and ground circuit are okay. If either are suspect, repair and repeat testing to confirm ECM malfunction.

1) Access ECM below passenger's side of instrument panel, underneath carpet. Turn ignition on. Backprobing ECM connector, measure voltage between ground and specified terminal at ECM connector. See PARK/NEUTRAL POSITION SWITCH VOLTAGE table. If voltage is as specified, no problem is indicated at this time. Fault may be intermittent. If sent here from SYMPTOM DIAGNOSIS, perform next test listed. If voltage is not as specified, go to next step.

PARK/NEUTRAL POSITION SWITCH VOLTAGE TABLE

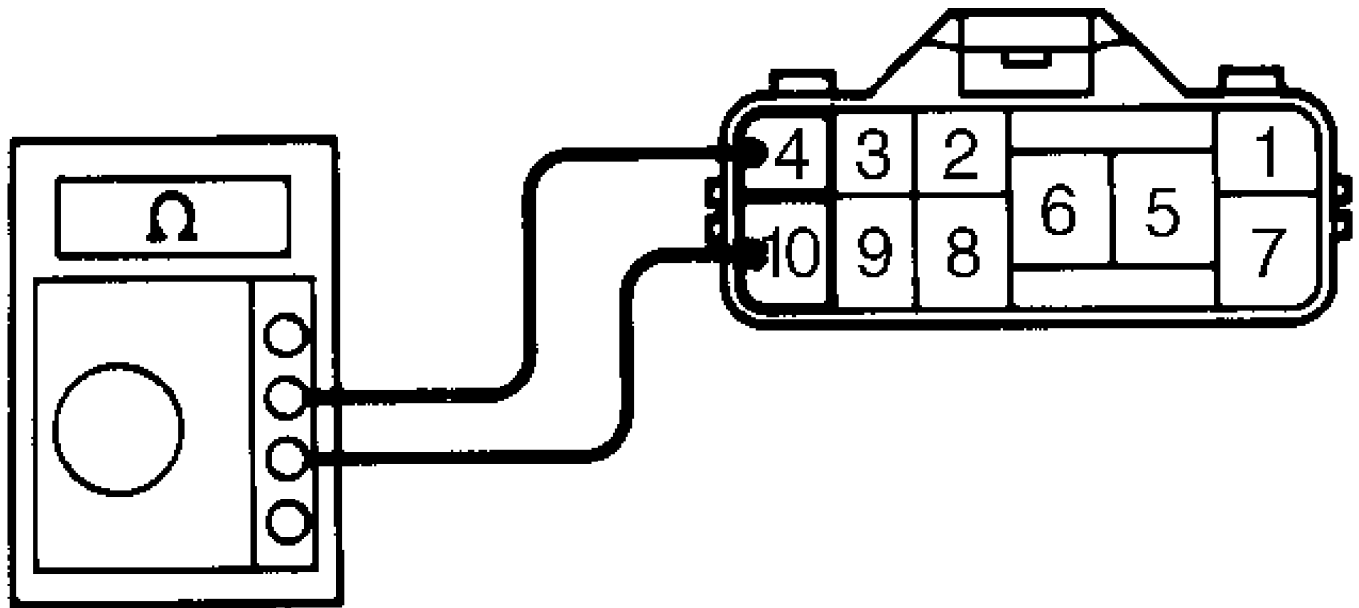
Shifter Position	Terminal No.	Volts
Park & Neutral	(1) 16	Zero
	(1) 17	Zero
	(2) 20	Zero
	(2) 21	Zero
	(3) 24	9-14
Reverse	(1) 16	(4) 9-14
	(1) 17	Zero
	(2) 20	Zero
	(2) 21	Zero
	(3) 24	9-14
Drive	(1) 16	Zero
	(1) 17	9-14
	(2) 20	Zero

	(2)	21	.....	Zero
	(3)	24	.....	9-14
2	(1)	16	.....	Zero
	(1)	17	.....	Zero
	(2)	20	.....	9-14
	(2)	21	.....	Zero
	(3)	24	.....	9-14
Low	(1)	16	.....	Zero
	(1)	17	.....	Zero
	(2)	20	.....	9-14
	(2)	21	.....	Zero
	(3)	24	.....	9-14

- (1) - Measure voltage between ground and terminal listed at ECM E13 connector. See Fig. 6.
- (2) - Measure voltage between ground and terminal listed at ECM E10 connector.
- (3) - Measure voltage between ground and terminal listed at ECM E9 connector.
- (4) - Voltage may slightly be less due to lighting of reverse lights.

2) Disconnect PNP switch connector. Using ohmmeter, check continuity of switch terminals with shift lever in specified positions. See Figs. 2 and 3. Replace PNP switch as necessary. If PNP switch is okay, go to next step.

3) Check wiring harness between battery and PNP switch, and between PNP switch and ECM. See WIRING DIAGRAMS. Repair wiring harness as necessary. If wiring harness is okay, replace ECM and retest system.



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Fig. 2: Identifying PNP Switch Terminals
 Courtesy of Toyota Motor Sales, U.S.A., Inc.

○ — ○ Continuity

Terminal Shift Position	6	5	4	7	8	10	9	2	3
P	○ — ○		○ — ○						
R			○ — ○		○				
N	○ — ○		○ — ○			○			
D			○ — ○				○		
2			○ — ○					○	
L			○ — ○						○

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Fig. 3: PNP Switch Continuity Chart
Courtesy of Toyota Motor Sales, U.S.A., Inc.

CRUISE CONTROL ON-OFF (MAIN) SWITCH CIRCUIT

1) Remove Engine Control Module (ECM) with connectors connected. See Fig. 1. Turn ignition switch to ON position. Backprobing connector, measure voltage between ground and ECM E13 connector terminal No. 24 (Red/Yellow wire). With cruise control main switch off, battery voltage should exist. With cruise control main switch on, voltage should be less than .5 volt. If voltage is not as specified, go to next step. If voltage is as specified, no problem is indicated at this time. Fault may be intermittent. If sent here from SYMPTOM DIAGNOSIS, perform next test listed.

2) Turn ignition switch to OFF position. Disable air bag system. See AIR BAG RESTRAINT SYSTEMS article. Remove steering wheel center pad (air bag module). Disconnect cruise control switch 6-pin connector. Check for continuity between cruise control switch terminals No. 3 (White/Black wire) and No. 5 (Red/Yellow wire). No continuity should exist with cruise control switch in OFF position. Continuity should exist with cruise control switch held in ON position. If continuity is as specified, go to next step. If continuity is not as specified, replace cruise control switch and retest system.

3) Check wiring harness and connectors between ECM, cruise control switch and ground. Repair as necessary and retest system. If wiring harness and connectors are okay, replace ECM and retest system.

CRUISE CONTROL INDICATOR LIGHT CIRCUIT

1) Remove Engine Control Module (ECM) with connectors connected. See Fig. 1. Turn ignition switch to ON position. Using voltmeter positive lead, backprobe ECM E12 connector terminal No. 16 (Orange wire) with negative lead to ground. With cruise control switch in OFF position, battery voltage should be present. With cruise control switch in ON position, voltage should be less than 1.2 volts. If voltage is not as specified, go to next step. If voltage is as

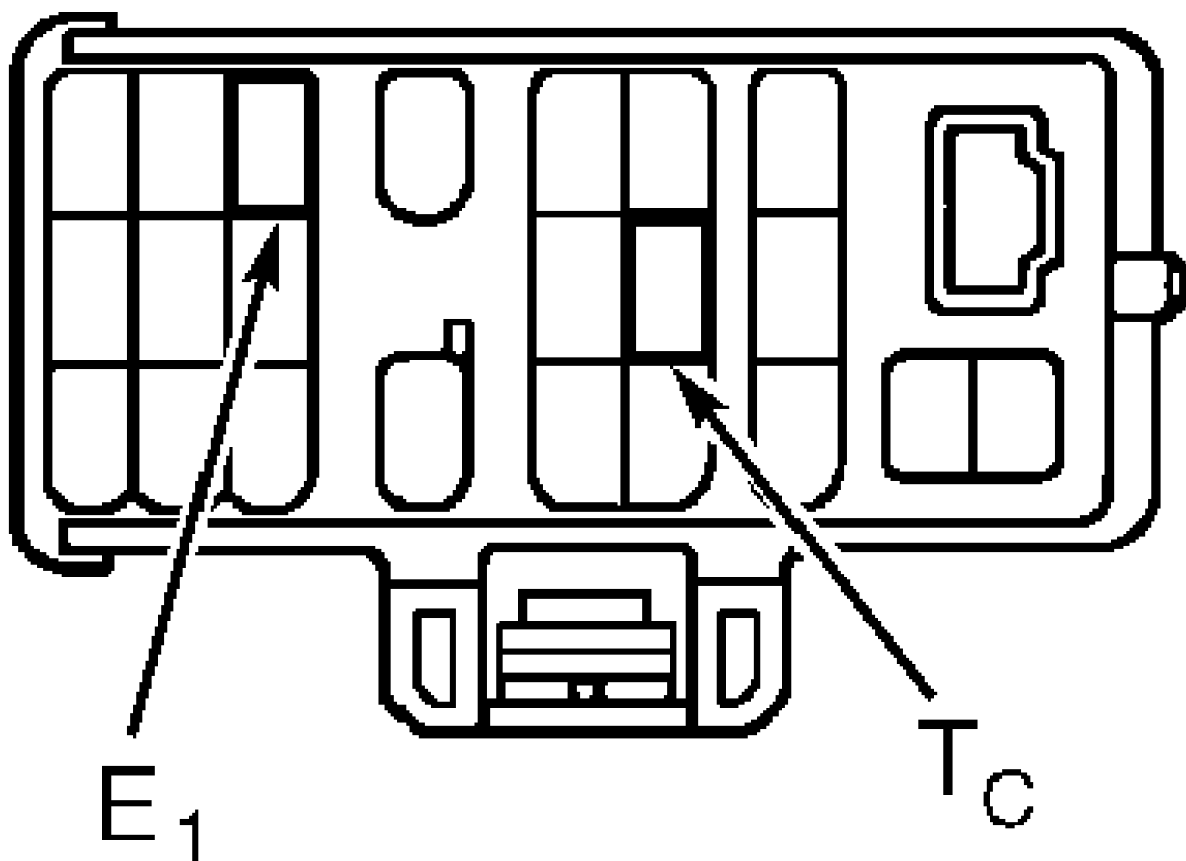
specified, no problem is indicated at this time. Fault may be intermittent. If sent here from SYMPTOM DIAGNOSIS, perform next test listed.

2) Check instrument cluster. See INSTRUMENT PANELS article. Repair as necessary. If instrument cluster is okay, replace ECM and retest system.

DIAGNOSTIC CIRCUIT

1) Locate Data Link Connector (DLC) No. 1 in right rear of engine compartment, on firewall. Connect voltmeter positive lead to terminal Tc and negative lead to terminal E1. See Fig. 4. Turn ignition switch to ON position. If battery voltage is not present, go to next step. If battery voltage is present, no problem is indicated at this time. Fault may be intermittent. If sent here from SYMPTOM DIAGNOSIS, perform next test listed.

2) Check for open or short circuit in wiring harness between Engine Control Module (ECM) and DLC No. 1, or between DLC No. 1 and ground. If wiring harness and connectors are okay, replace ECM and retest system.



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Fig. 4: Identifying DLC No. 1 Terminals
Courtesy of Toyota Motor Sales, U.S.A., Inc.

*** PLEASE READ THIS FIRST ***

WARNING: Deactivate air bag system before performing any service operation. See AIR BAG RESTRAINT SYSTEMS article. DO NOT apply electrical power to any component on steering column without first deactivating air bag system. Air bag may deploy.

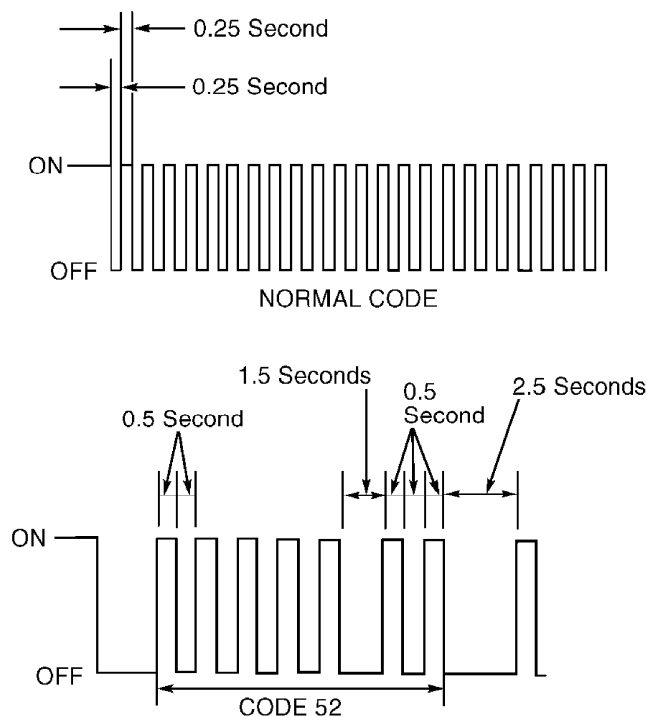
DIAGNOSTIC PROCEDURE

When cruise control functions are canceled, CRUISE indicator light will blink 5 times, indicating a fault is present and trouble code(s) are stored in Engine Control Module (ECM) memory. See RETRIEVING TROUBLE CODES and retrieve trouble code(s). For DTC definitions, see DIAGNOSTIC TROUBLE CODE DEFINITIONS table. Perform appropriate DTC test under DIAGNOSTIC TESTS. If a fault or symptom is present, but no trouble codes were set, identify symptom and perform appropriate test. See SYMPTOM DIAGNOSIS under TROUBLE SHOOTING.

READING TROUBLE CODES

Using CRUISE Indicator Light

Trouble codes are displayed as flashes of CRUISE indicator light. All trouble codes are 2-digit numbers. Trouble codes are output from lowest to highest numbered code. These codes indicate current faults in system and should be serviced in order of appearance. Pay careful attention to length of pauses in order to read codes correctly. See Fig. 5.



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Fig. 5: Reading Trouble Codes (Using CRUISE Indicator Light)
Courtesy of Toyota Motor Sales, U.S.A., Inc.

RETRIEVING TROUBLE CODES

Using CRUISE Indicator Light

1) Locate Data Link Connector (DLC) No. 1 in right rear of engine compartment, on firewall. Turn ignition switch to ON position. Turn cruise control main switch on. If CRUISE indicator light turns on, leave ignition on and go to next step. If CRUISE indicator light does not turn on, check cruise indicator light circuit. See CRUISE CONTROL INDICATOR LIGHT CIRCUIT under SYSTEM TESTS.

2) Turn cruise control main switch off. Connect a jumper wire between terminals E1 and Tc at DLC No. 1. See Fig. 4. If any DTCs are present, perform appropriate DTC test under DIAGNOSTIC TESTS. See DIAGNOSTIC TROUBLE CODE DEFINITIONS table.

3) If no codes are present and CRUISE indicator light begins flashing on and off every .25 second, system is operating normally at this time. If no codes are present and cruise control system fault still exists, perform SYMPTOM DIAGNOSIS under TROUBLE SHOOTING.

Using Toyota Or OBD-II Scan Tool

1) Locate Data Link Connector (DLC) No. 3 below left side of instrument panel. Connect scan tool to DLC No. 3. Turn ignition on with engine off. Turn scan tool on. Using scan tool manufacturer's instructions, check for DTCs.

2) If any DTCs are present, perform appropriate DTC test under DIAGNOSTIC TESTS. See DIAGNOSTIC TROUBLE CODE DEFINITIONS table. If no codes are present and cruise control system fault still exists, perform SYMPTOM DIAGNOSIS under TROUBLE SHOOTING.

CLEARING CODES

Without Scan Tool

DTCs may be cleared by removing EFI fuse from engine compartment fuse block. Check for normal code after reinstalling fuse. If problem has not been corrected or fault is still present, code will reset in Engine Control Module (ECM) memory. DTCs may also be cleared by disconnecting negative battery cable. However, other memory functions (clock, radio, alarm, seats, etc.) will be cancelled and must be reset.

With Scan Tool

After performing repairs, clear ECM memory of all stored DTCs by using scan tool and scan tool manufacturer's instructions.

DIAGNOSTIC TROUBLE CODE DEFINITIONS TABLE

DTC	System Affected	Probable Cause
P0500/21 Or 23	Vehicle Speed Sensor Circuit	Instrument Cluster, Wiring Harness, Vehicle Speed Sensor Or ECM
P1520/52	Stoplight Switch Circuit	Stoplight Switch, Wiring Harness Or ECM
P1565/32	Cruise Control Switch Circuit	Cruise Control Switch, Wiring Harness Or ECM
P1566/54	Input Signal Circuit	ECM

DIAGNOSTIC TESTS

*** PLEASE READ THIS FIRST ***

NOTE: To identify Engine Control Module (ECM) connectors and terminals, see Fig. 6. To help identify all other cruise control related circuits and wire colors, see WIRING DIAGRAMS.

DTC P0500/21 OR 23: VEHICLE SPEED SENSOR CIRCUIT

- 1) Test drive vehicle and check speedometer operation. If speedometer is not functioning correctly, see INSTRUMENT PANELS article. If speedometer is functioning correctly, go to next step.
- 2) Turn ignition off. Access ECM below passenger's side of instrument panel, underneath carpet. Disconnect ECM E12 connector. Measure resistance between terminals No. 5 (Blue/Yellow wire) and No. 11 (Red/Yellow wire) at ECM E12 connector. If resistance is 560-680 ohms, replace ECM. If resistance is not 560-680 ohms, go to next step.
- 3) Remove Vehicle Speed Sensor (VSS) from transmission. Connect DVOM between VSS terminals. Observe DVOM and slowly pass a magnet over end of VSS. As magnet is passed over VSS, a low voltage signal should be generated. Voltage signal is extremely low. If VSS does not operate as specified, replace VSS. If VSS operates as specified, check for open or short circuit in wiring harness between ECM and VSS. See WIRING DIAGRAMS. Repair wiring harness as necessary.

DTC P1520/52: STOPLIGHT SWITCH CIRCUIT

- 1) Check stoplight switch. See STOPLIGHT SWITCH under COMPONENT TESTS. Replace stoplight switch as necessary. If stoplight switch is okay, go to next step.
- 2) Check wiring harness and connectors between ECM and stoplight switch, and between stoplight switch and junction block No. 1 behind left kick panel. Repair as necessary and retest system. If wiring harness and connectors are okay, replace ECM and retest system.

DTC P1565/32: CRUISE CONTROL SWITCH CIRCUIT

- 1) Remove Engine Control Module (ECM) with connectors connected. See Fig. 1. Turn ignition switch to ON position. Backprobing connector, measure voltage between ECM E13 terminal No. 23 (Blue wire) and ground with switch in specified positions. See CRUISE CONTROL SWITCH VOLTAGE SPECIFICATIONS table. If voltage is not as specified, go to next step. If voltage is as specified, no problem is indicated at this time. Fault may be intermittent. If sent here from SYMPTOM DIAGNOSIS, perform next test listed.

CRUISE CONTROL SWITCH VOLTAGE SPECIFICATIONS TABLE

Switch Position	Volts
Off	10-16
RES/ACC On	0.6-2.3
SET/COAST On	1.9-4.7
CANCEL On	3.4-7.2

- 2) Turn ignition switch to OFF position. Disable air bag system. See AIR BAG RESTRAINT SYSTEMS article. Remove steering wheel center pad (air bag module) and disconnect CRUISE control switch 6-pin connector. Measure resistance between cruise control switch connector terminals No. 3 (White/Black wire) and No. 4 (Blue wire) with switch in specified positions. See CRUISE CONTROL SWITCH RESISTANCE table. If

resistance is as specified, go to next step. If resistance is not as specified, replace cruise control switch and retest system.

CRUISE CONTROL SWITCH RESISTANCE TABLE

Switch Position	Ohms
Off	One Megohm Or Greater
RES/ACC On	50-80
SET/COAST On	180-220
CANCEL On	400-440

3) Check wiring harness and connectors between ECM, cruise control switch and ground. Repair as necessary and retest system. If wiring harness and connectors are okay, replace ECM and retest system.

DTC P1566/54: INPUT SIGNAL CIRCUIT FAULT

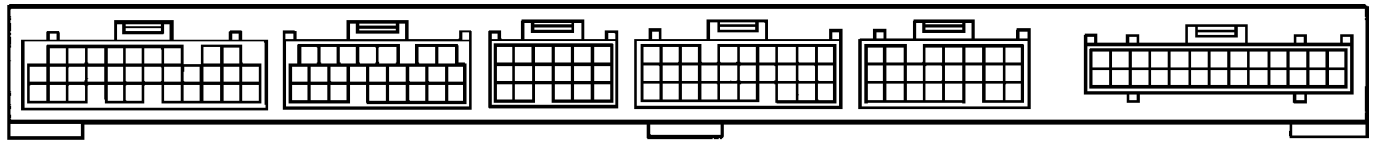
If DTC P1566/54 is present, check Engine Control Module (ECM) connectors and terminals. Repair as necessary. If connectors and terminals are okay, replace ECM and retest system.

PIN VOLTAGE TESTS

Pin voltage test is used for diagnosing intermittent symptoms and faults that are unable to be resolved during self-diagnostics. Pin test ensures ECM is receiving and transmitting proper voltage signals. To perform pin voltage test, remove ECM with connectors connected. See Fig. 1. Test ECM voltages by backprobing between appropriate ECM connector terminals, Use a DVOM with ignition switch in ON position, unless otherwise specified. If voltage readings are as specified, ECM may be faulty. See PIN VOLTAGE TESTING table. See Fig. 6.

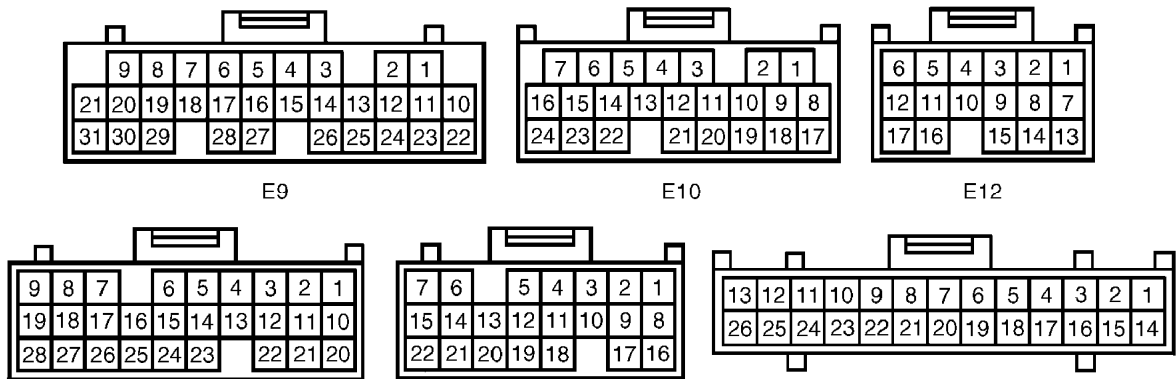
PIN VOLTAGE TESTING TABLE

ECM Connector/ Terminal No.	Condition	Volts
E13/6 & E10/17	Depress Brake Pedal	10-16
	Release Brake Pedal	Less Than One
E13/23 & E10/17	Ignition Switch On	10-16
	Ignition Switch On, CANCEL Switch On	3.6-7.2
	Ignition Switch On, SET/COAST Switch On ..	2.1-4.9
	Ignition Switch On, RES/ACC Switch On ....	.7-2.6
	Ignition Switch On, Main Switch Off	10-16
	Ignition Switch On, Main Switch On	Less Than .5
E13/24 & E10/17	Ignition Switch On, Main Switch Off	Less Than One
	Ignition Switch On, Main Switch On	10-14
E12/16 & E10/17	Ignition Switch On, Main Switch Off	10-14
	Ignition Switch On, Main Switch On	Less Than One
E15/14 & E10/17	Depress Brake Pedal	Less Than One
	Release Brake Pedal	10-14



E9 E10 E12 E13 E14 E15

IDENTIFYING ECM CONNECTOR LOCATIONS



E9

E10

E12

E13

E14

E15

IDENTIFYING ECM CONNECTOR TERMINALS

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Fig. 6: Identifying Engine Control Module (ECM) Connectors
Courtesy of Toyota Motor Sales, U.S.A., Inc.

WIRING DIAGRAMS

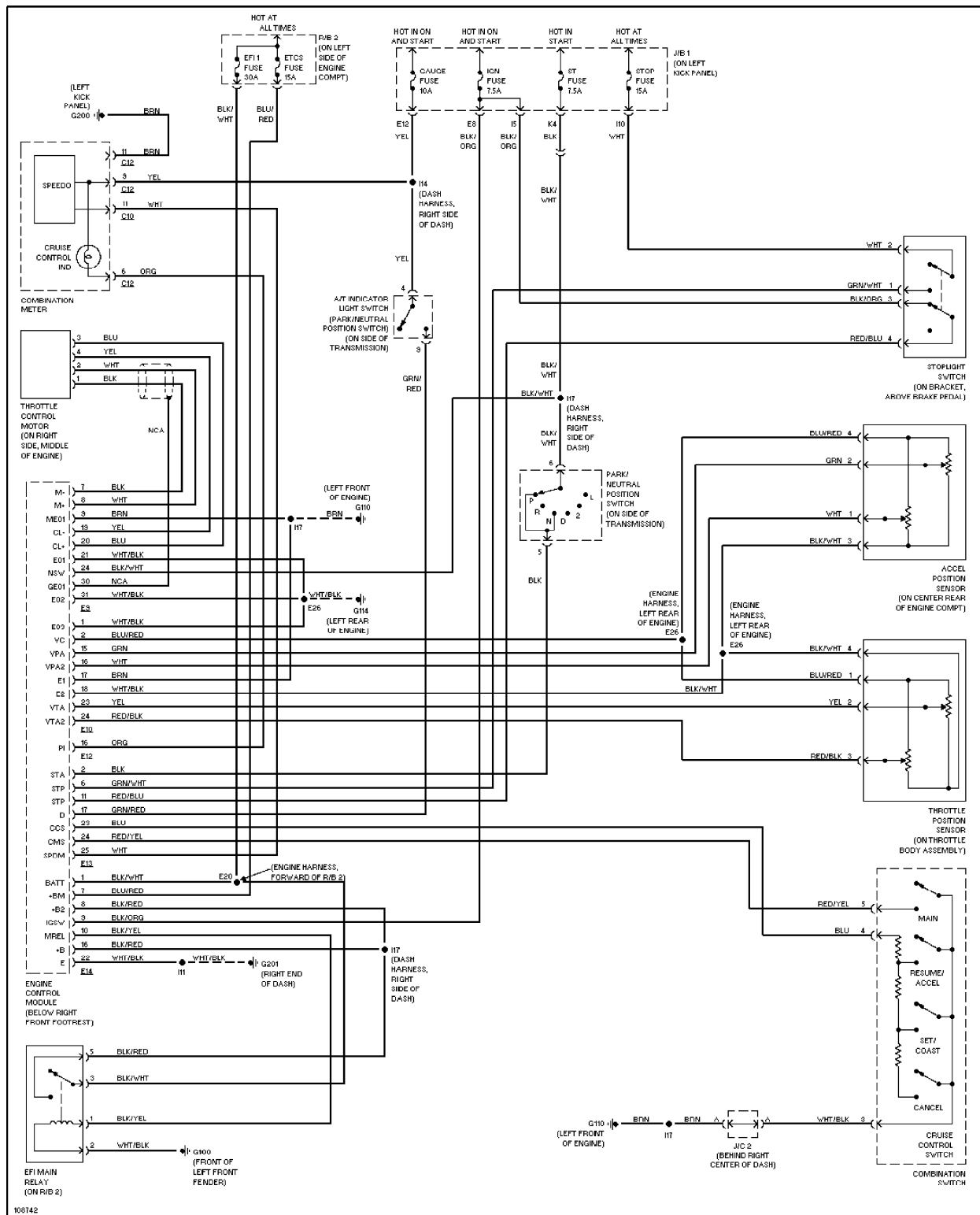


Fig. 7: Cruise Control System Wiring Diagram