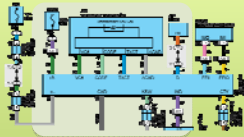
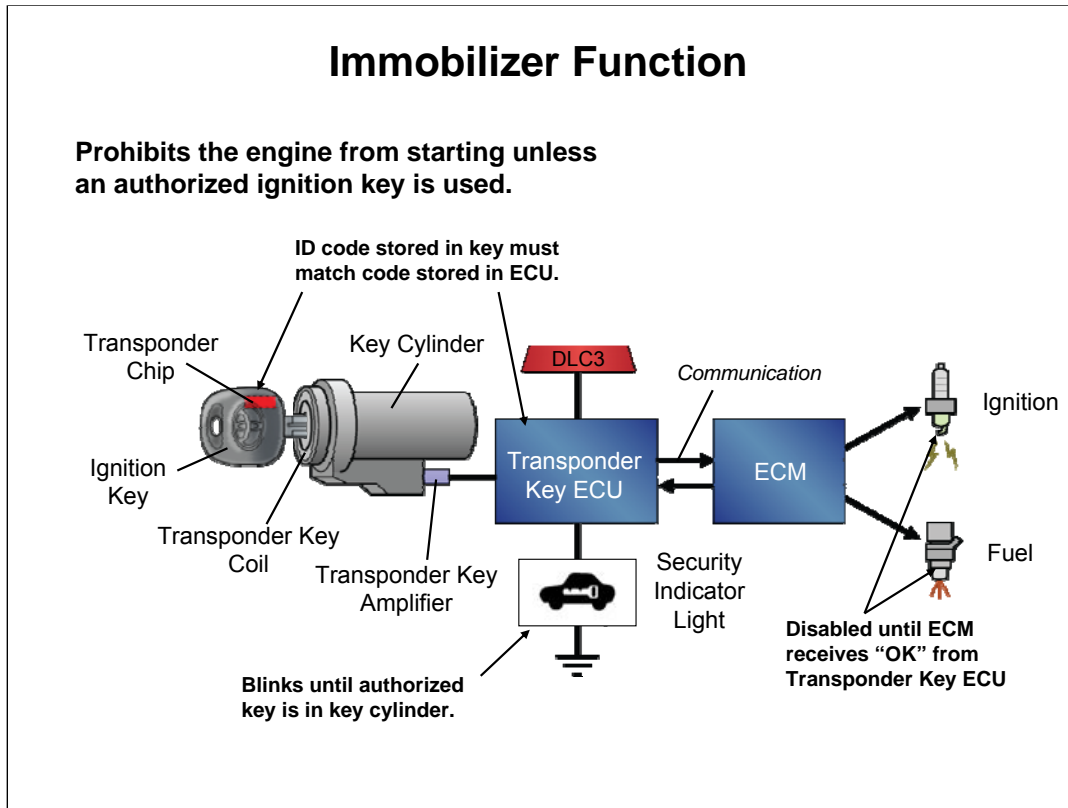


## Section 8 Topics

### Electronic Systems



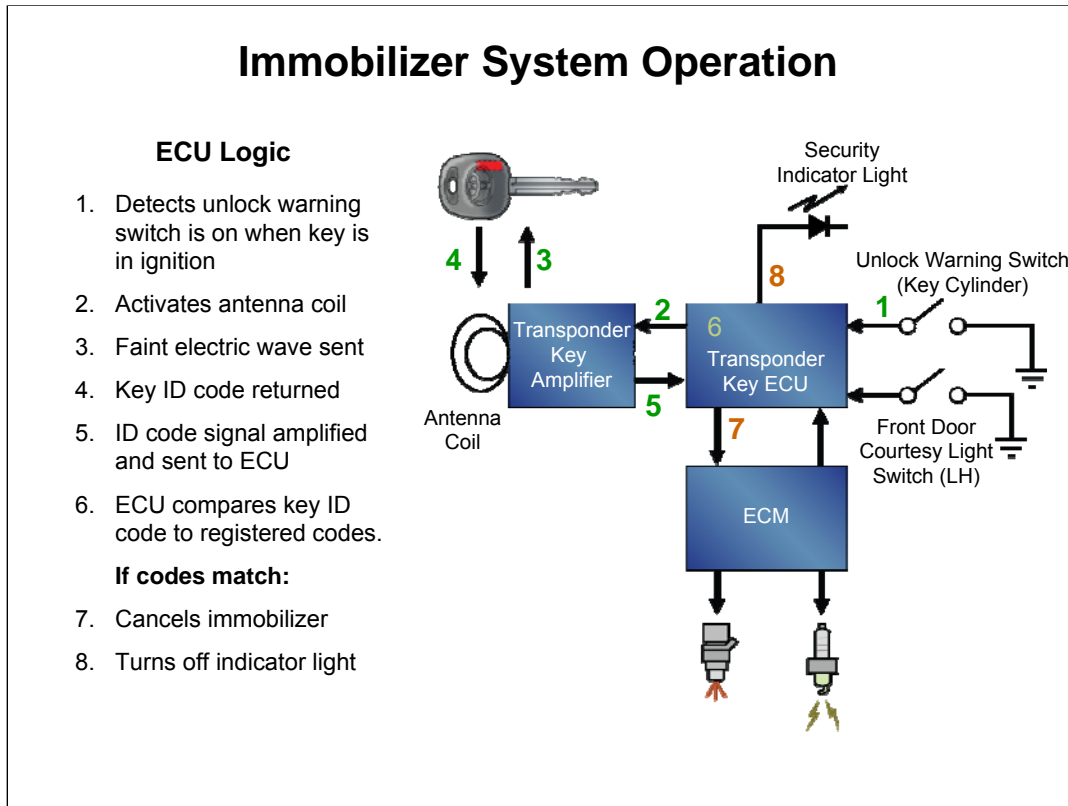
- Engine Immobilizer
- **WORKSHEET:** Immobilizer System
- Power Distributor
- Smart Junction Box (MICON)
- HID Headlights
- Dynamic Laser Cruise Control



### Engine Immobilizer Function

The engine immobilizer system is designed to prevent the vehicle from being stolen. When the immobilizer system is set, the ECM disables the fuel delivery and ignition systems. Only an authorized key can unset the immobilizer.

The Transponder Key ECU assembly stores the codes of authorized ignition keys. When an authorized key is used to start the engine, the ECU sends a signal to the ECM to unset the immobilizer and permit fuel delivery and ignition.



## Engine Immobilizer Operation

When a key is inserted in the key cylinder, the Transponder Key ECU detects the unlock warning switch is closed and sends a signal to activate the antenna coil in the transponder key amplifier. The antenna generates a faint electric wave activating the transponder chip in the key grip to transmit its ID code.

The transponder key amplifier receives and amplifies the ID code signal, then transmits it to the Transponder Key ECU. The ECU compares the key's ID code to the registered codes stored in its memory. If the codes match, the ECU sends a signal to the ECM to unset the immobilizer and switches off the security indicator light.

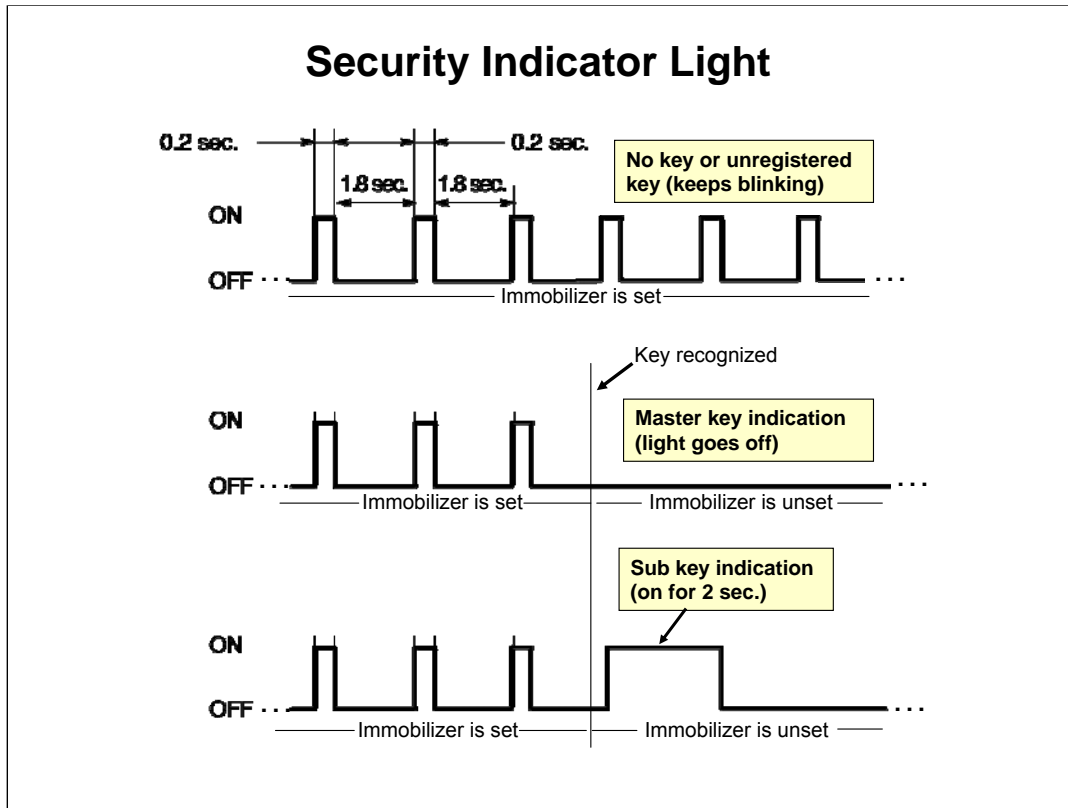
## Key Code Registration

For the immobilizer system to operate, authorized keys must be registered with the Transponder Key ECU. The system provides three types of key code registration procedures.

**New Key Registration.** This procedure is used if the registered master keys are lost, and when the Transponder Key ECU must be replaced for other reasons. An initial set of keys can be automatically registered immediately after the new ECU is installed.

**Additional Key Registration.** New keys (up to a certain total number of keys based on vehicle model) can be added to those already registered in the Transponder Key ECU.

**Key Code Erasure.** For lost keys, key codes can be erased. This procedure erases all codes except the master key. The remaining authorized keys must be reregistered.

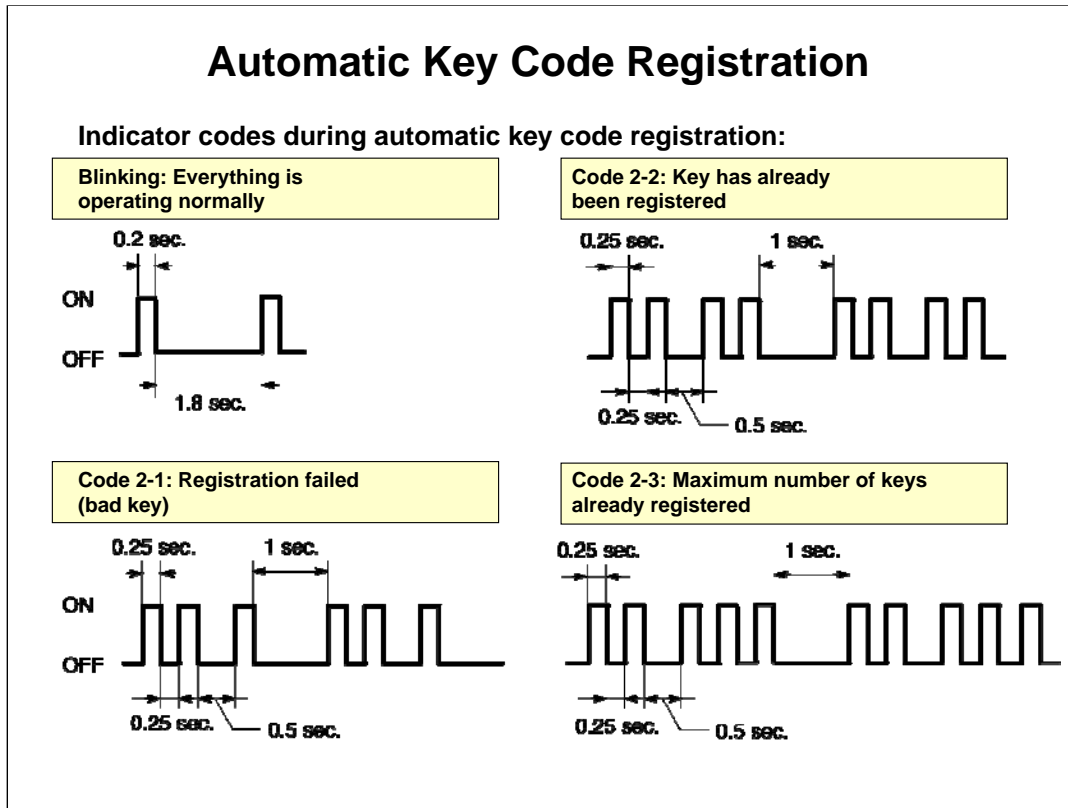


### Master Keys and Sub Keys

The difference between a master key and a sub key is that a sub key cannot be duplicated. This is a security feature that helps customers feel safer about leaving a key with parking attendants.

You can distinguish between a master key and sub key by observing the security indicator light when the key is inserted in the ignition switch.

- When a **master key** is placed in the ignition switch. The indicator light turns off.
- When a **sub key** is placed in the ignition switch, the indicator light remains illuminated for 2 seconds before turning off



## Automatic Key Code Registration

When the Transponder Key ECU is replaced, the new unit is preset to automatically register keys. To take advantage of automatic key code registration:

- After replacing the transponder key ECU, insert the first key into the ignition key cylinder. It takes about one second for the transponder key ECU to register the key's code.
- Remove the key and insert the next key.
- Repeat until all keys have been registered.

## Watch for Error Codes

If an error occurs during automatic key code registration, the security light blinks a two-digit code:

**Code 2-1:** Key code registration failed, most likely because a code could not be read from the key's transponder chip. The key should be discarded.

**Code 2-2:** The key has already been registered.

**Code 2-3:** The maximum number of keys have already been registered.

## Ending Automatic Registration

Automatic key code registration ends automatically after the maximum number of keys have been registered. If registering fewer than the maximum number of keys, the automatic registration process **has to be terminated manually**.

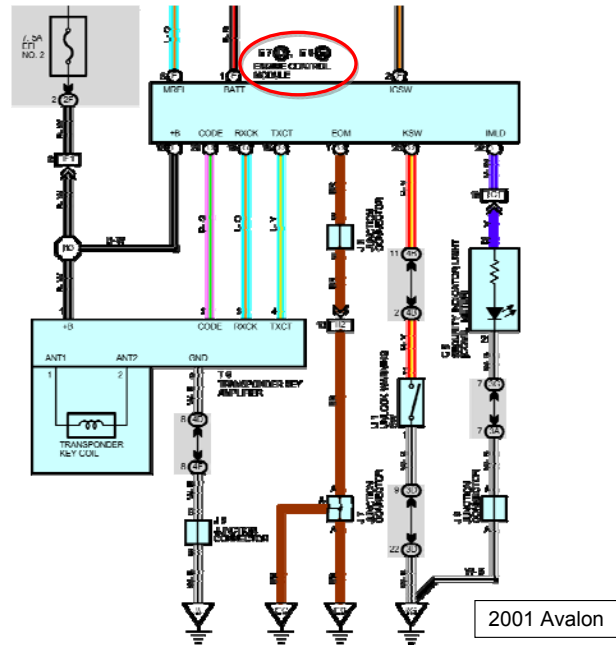
- Use Techstream to end automatic key code registration.
- Turn the ignition switch ON and OFF five times within 10 seconds to force automatic key code registration to end.

**NOTE**

Failing to terminate key code registration can result in abnormal system operation.

### Configuration in Earlier Models

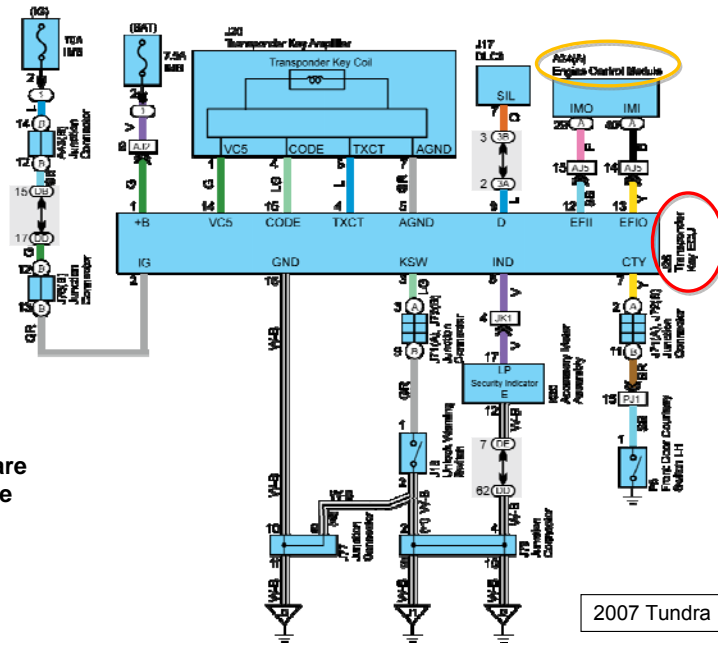
In earlier models, the immobilizer functions are built into the ECM.



### Configuration in Earlier Models

Engine immobilizer was introduced in the 1998 model year. The first vehicles with this feature have the immobilizer functions built into the Engine Control Module. This configuration exists in model years as late as 2004.

### Configuration in Later Models



In later models, the immobilizer functions are controlled by a separate Transponder Key ECU.

2007 Tundra

### Configuration in Later Models

In later models, a separate Transponder Key ECU was added to control the immobilizer functions in place of the ECM. The advantage of a separate, special ECU is that it is less expensive to replace than an ECM in the event of lost keys or an ECU malfunction.

## TIS Immobilizer Reset

Immobilizer reset is not supported on all vehicles. Refer to the Support Chart for more information.

### Immobilizer Reset

Because of the original system design for the immobilizer function, losing all the keys to the vehicle meant that the ECM or Transponder Key ECU had to be replaced. Later systems were modified so that the ECM or Transponder Key ECU could be reset to accept registration of new keys.

Resetting the immobilizer to accept new keys requires obtaining a passcode through TIS. For security reasons, only Master Technicians and MDTs are authorized to request an immobilizer reset passcode. For theft prevention and security monitoring, each time a passcode is requested, it is logged into a national database.

Once a passcode is obtained, it's entered into the ECU through Techstream or a scan tool. When the ECU is successfully reset, the master key in the ignition becomes registered to the vehicle and all previous key codes are erased.



## Immobilizer Reset Support Chart

From TIS Immobilizer Reset Page

Toyota Models												
Summary of Toyota / Scion Models that Support Immobilizer Reset												
■ = Full Support (Review TSB SS003-01 and SS003-02) □ = No Support (Review PANT Bulletin GI03-09) X = Does Not Have Immobilizer NA = Not Applicable For This Model / Engine												
Land Cruiser	2UZ-FE	NA	■	■	■	■	■	■	■	■	□	□
	3UR-FE	■	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Matrix	1ZZ-FE	■	■	NA	NA	NA	NA	NA	NA	NA	NA	NA
MR2 Spyder	1ZZ-FE	NA	NA	NA	■	■	■	■	1	1	NA	NA
Prius	1NZ-FXE	■	■	■	■	■	□2	□2	□2	NA	NA	NA
	1AZ-FE	NA	NA	NA	NA	NA	■	■	1	NA	NA	NA

1 Requires a special procedure - review TSB SS003-01  
 2 Equipped with an Immobilizer ECU. Does not require Engine ECM replacement.  
 3 Resettable providing it has immobilizer - only available as an option.

### Immobilizer Reset Support Chart

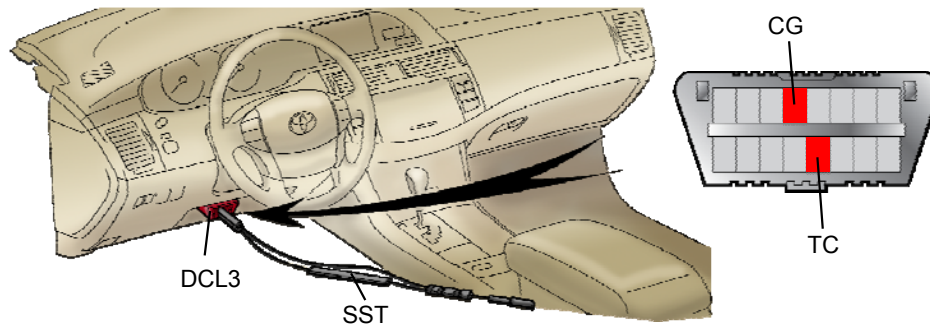
The blue boxes on the support chart indicate which vehicle models have the immobilizer reset feature. The legend at the top of the chart describes applicable TSBs.

Immobilizer systems that do not have immobilizer reset are indicated by the white boxes. In these vehicle models, either the Transponder Key ECU or ECM must be replaced if all the keys to the vehicle are lost. In these cases, whether the ECM or Transponder Key ECU must be replaced depends on the system configuration. If the vehicle has a separate Transponder Key ECU, then that is the component that must be replaced. If the immobilizer functions are controlled within the ECM, then the ECM must be replaced.

PANT Bulletin GI03-09 (referenced next to the white square in the legend) describes conditions under which the ECU or ECM replacement cost can be subsidized.

## ECM Communication ID Registration

In vehicles with a separate Transponder Key ECU, the ECM Communication ID must be registered whenever the ECM or Transponder Key ECU is replaced.



### Example Procedure:

1. Using SST, connect TC to CG.
2. Turn the ignition switch ON (do not start the engine) and leave it for 30 minutes.
3. Turn the ignition switch OFF and disconnect TC and CG.
4. Check that the engine starts.

2005 Avalon

## ECU Communication ID Registration

For security reasons, immobilizer systems with a separate Transponder Key ECU are designed so that the vehicle will not start if either the ECM or ECU have been replaced. This security is provided by a unique ECU communication ID stored in both the ECM and Transponder Key ECU. Therefore, when either unit is replaced, the ECU communication ID has to be registered between them.

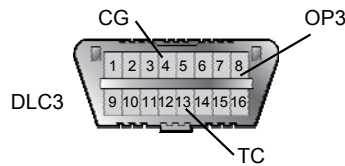
### NOTE

The code registration procedure described above is an example that may not apply to all vehicles. Be sure to refer to the Repair Manual for the correct procedure for the vehicle being serviced.

## DTC Check/Clear

Immobilizer diagnostic methods and procedures may vary between vehicle models. Examples:

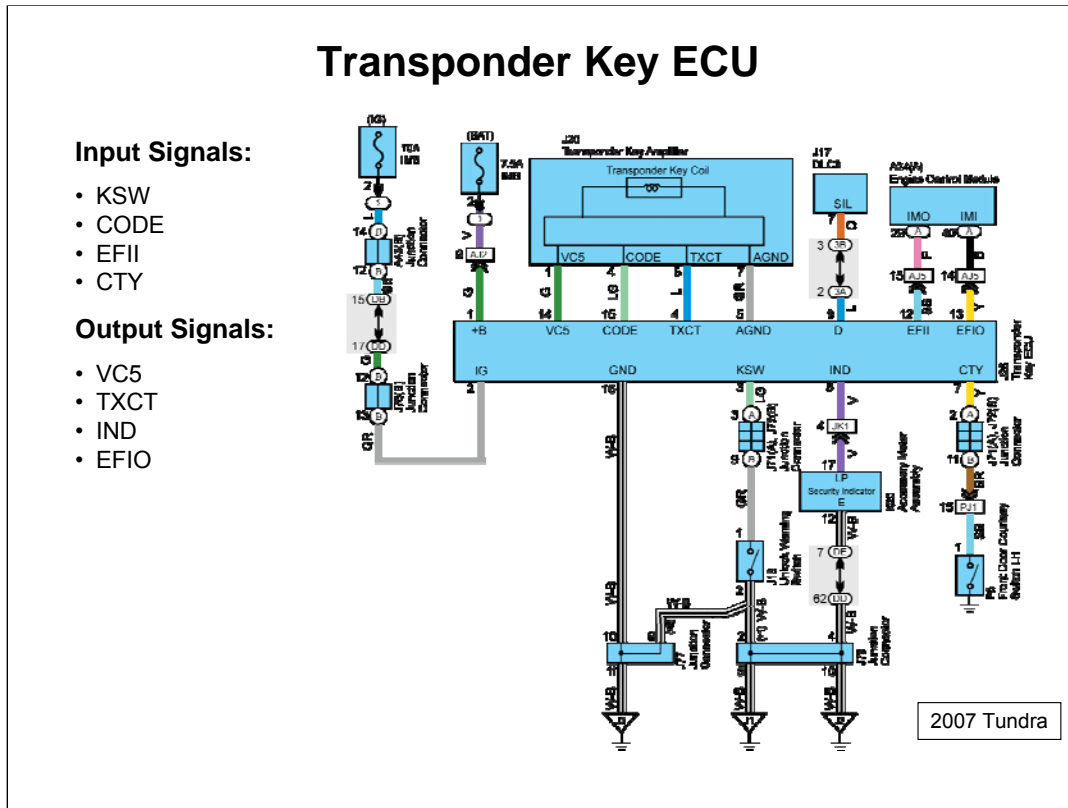
Vehicle Model	To check DTCs w/check wire on DLC3	To clear DTCs w/o Techstream	Techstream supported?
2005 Avalon	• TC to CG	• Remove the EFI No. 1 fuse	Yes
2006 Sequoia	• TC to CG for DTC 99 • CG to OP3 for other DTCs	• Remove the ECU-B fuse and EFI No. 2 fuse from the engine room J/B for 1 minute or more.	No
2006 Tacoma	• Not supported	• Not supported	Yes
2006 Tundra	• CG to OP3	• Remove the ECU-B fuse from the driver side J/B for 1 minute or more.	Yes



### Be Wary of Differences between Models

While the concepts of immobilizer components and operation are similar among all systems, the specifics of each system can vary significantly. The example above demonstrates how different the diagnostic methods and procedures can be between different models.

The bottom line is that when diagnosing the immobilizer system, it's especially risky to assume that one vehicle model is the same as another. Always refer to the repair manual for the specifics of the vehicle being serviced.



## Analyzing ECU Input and Outputs

In diagnosing an engine immobilizer malfunction, you may need to verify the Transponder Key ECU is receiving the correct input signals and is sending the correct output signals. Remember that in earlier model vehicles without a Transponder Key ECU, you'll be verifying the immobilizer system signals flowing into and out of the ECM.

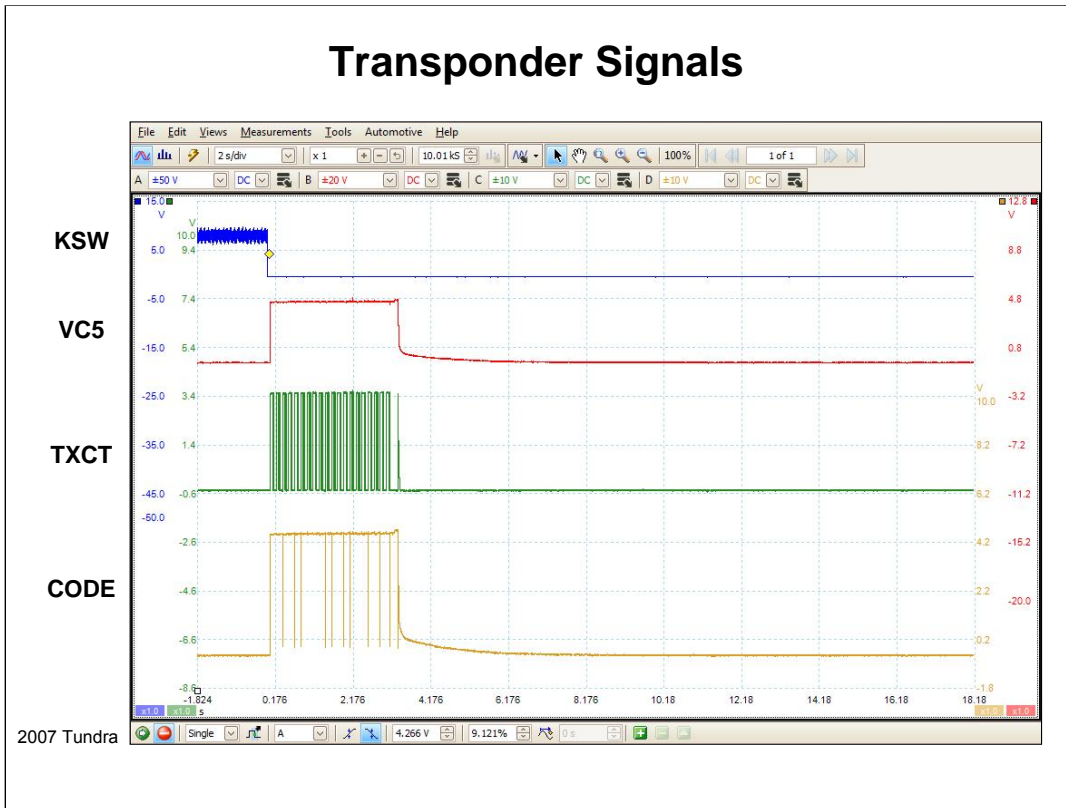
You can identify the inputs and outputs using the system description and looking at the wiring diagram and TERMINALS OF ECU section of the Repair Manual. For our example, we'll be using the 2007 Tundra to illustrate diagnostic concepts. Note that these may not translate exactly to other vehicle models.

### Inputs:

- KSW – ignition key cylinder unlock warning switch
- CODE – key ID code from transponder key amplifier
- EFII – ECM communication input signal
- CTY – front door courtesy switch LH (required for registration only)

### Outputs:

- VC5 – five-volt power supply to transponder key amplifier
- TXCT – communication signal to transponder key amplifier
- IND – security indicator light signal
- EFIO – ECM communication output signal

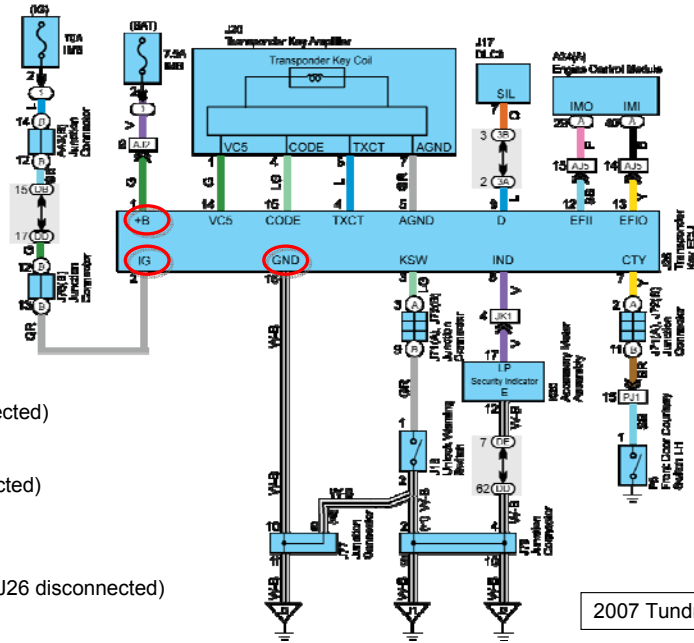


- Transponder Signals**
- KSW.** When a key is inserted in the key cylinder, the key switch closes. The voltage on KSW drops to zero, alerting the Transponder Key ECU.
  - VC5.** The Transponder Key ECU immediately supplies power to the transponder key amplifier so it can operate.
  - TXCT.** The Transponder Key ECU commands the transponder key amplifier to begin pulsing for the key code.
  - CODE.** The amplifier sends the code to the Transponder Key ECU.
- After the transponder key amplifier transmits the key code, the Transponder Key ECU stops requesting the code and shuts off the power to the amplifier.

**NOTE**

The example is for a 2007 Tundra. This does not work exactly the same for all models.

## Transponder Key ECU – Power & Ground



### Power & Ground

**+B to GND:** (J26 disconnected)

- Always – 11V to 14V

**IG to GND:** (J26 disconnected)

- Ignition OFF – below 1V
- Ignition ON – 11V to 14V

**GND to Body ground:** (J26 disconnected)

- Always – below 1Ω

### Power and Ground Circuits

Several of the Transponder Key ECU's terminals are for power and ground circuits. Diagnosis also involves testing at these terminals to be sure the ECU is receiving the proper voltage and has a good ground.

## Transponder Key ECU – Input & Output

### Input

#### KSW to GND: (J26 disconnected)

- No key in cylinder – 10KΩ or higher
- Key In cylinder – below 1Ω

#### CTY to GND: (J26 connected)

- Door closed – 10KΩ or higher
- Door open – below 1Ω

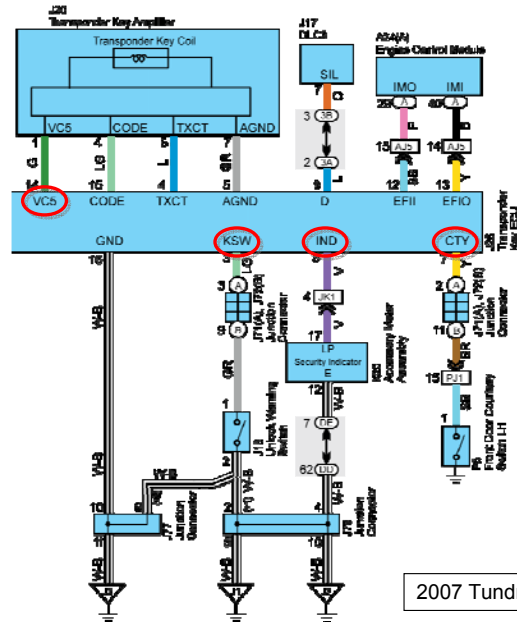
### Output

#### IND to GND: (J26 connected)

- Immobilizer set (blinking) – alternates between 11V to 14V and below 1V
- Immobilizer unset (off) – below 1V

#### VC5 to GND: (J26 connected)

- No key in cylinder – below 1V
- Key In cylinder
  - 4.6V to 5.4V until Transponder Key ECU receives key code (<0.5 sec.)
  - Below 1V after key code received



2007 Tundra

### Terminal Values and Conditions

An understanding of the system's operation and inputs and outputs, makes diagnosis at the terminals easier.

**KSW.** This ground-side switch closes when a key is inserted in the key cylinder. With no key in the cylinder, a continuity test between the terminal and ground would show an open circuit. With a key in the cylinder, the circuit would show continuity to ground and very low resistance.

**CTY.** This ground-side switch opens and closes according to the driver door position. Resistance testing shows an open circuit when the door is closed, and a closed circuit when the door is open.

**IND.** This terminal supplies power to the indicator light. It has battery voltage when the lamp is ON, and zero volts when the lamp is OFF. When the lamp is blinking, the voltage alternates.

**VC5.** The TERMINALS OF ECU specifies that this terminal supplies nominal 5V power to the transponder key amplifier only when there is a key in the key cylinder. Power is only supplied until the Transponder Key ECU receives the key code, then it is switched off. This may take less than 0.5 second.

### NOTE

If the oscilloscope trigger is not set up properly, it's possible to miss seeing the VC5 signal because the voltage switches on and off so quickly.

Inserting a key that has no transponder chip (or a faulty chip) forces VC5 to stay powered, providing adequate time for measuring voltage. Another option is to wrap the key-grip in foil to block its signal.

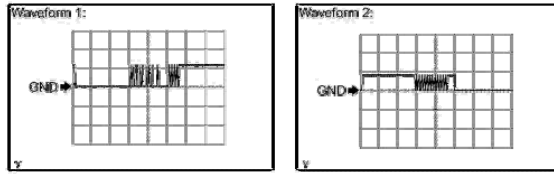
## Transponder Key Amplifier

### VC5 to AGND: (J20 connected)

- No key in cylinder – below 1V
- Key In cylinder
  - 4.6V to 5.4V until Transponder Key ECU receives key code (<0.5 sec.)
  - Below 1V after key code received

### CODE to AGND: (J20 connected)

- No key in cylinder – below 1V
- Key In cylinder – Waveform 1 (<0.5 sec.)

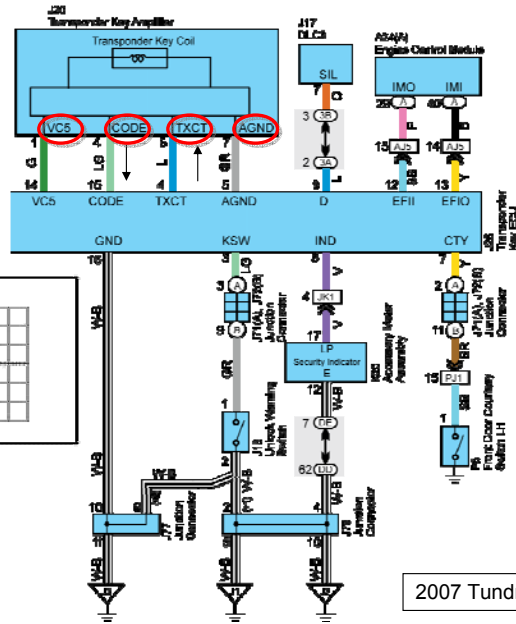


### TXCT to AGND: (J20 connected)

- No key in cylinder – below 1V
- Key In cylinder – Waveform 2 (<0.5 sec.)

### AGND to Body ground: (J20 connected)

- Always – below 1Ω



2007 Tundra

### Terminal Values and Conditions (cont'd)

While testing the Transponder Key ECU terminals, you would also test the CODE, TXCT, and AGND terminals at the J26 connector, if warranted.

**CODE.** This is a communication signal sent to the Transponder Key ECU transmitting the key's ID code. The waveform shows a digital signal appearing as a momentary burst of data (less than 0.5 second) shortly after the key is inserted in the key cylinder.

**TXCT.** This is the communication signal from the Transponder Key ECU to the transponder key amplifier. This waveform is also digital and appears as a momentary signal transmitted shortly after the key is inserted in the key cylinder.

**AGND.** Because this is the ground circuit for the transponder key amplifier, it should show continuity to ground.

### Transponder Key Amplifier Terminal Values

At the transponder key amplifier, the values for terminals VC5, CODE, TXCT, and AGND should be identical to those at the corresponding ECU terminals. By verifying the correct values are on the other ends of the wires, you eliminate the possibility of problems in the wire harness between the two components.

#### NOTE

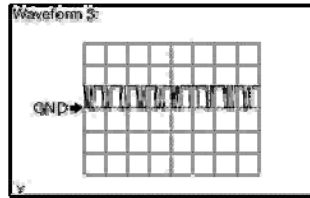
If the correct signal is verified on the CODE terminal of the Transponder Key ECU, it is not necessary to test the CODE terminal of the transponder key amplifier. Since the CODE signal is output by the amplifier, verifying the ECU is receiving it proves both that the signal is being output at the amplifier and the wiring between the two components is intact.



## Engine Control Module

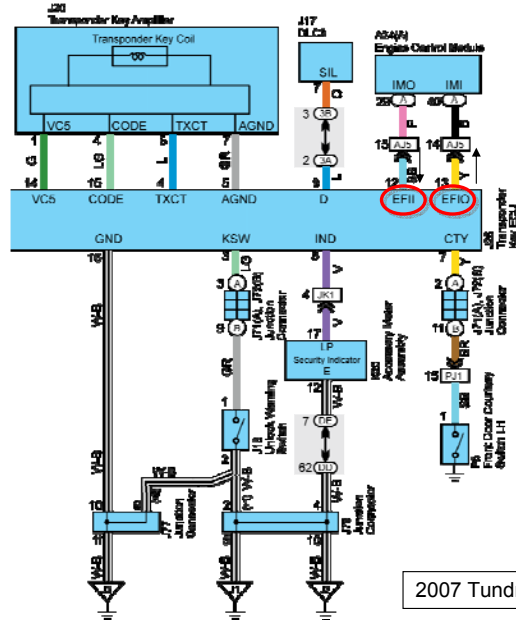
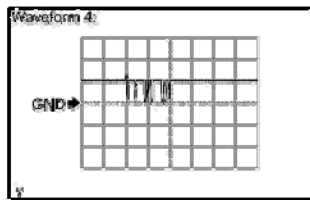
### EFIO to GND: (J26 connected)

- Ignition switch OFF – below 1V
- Ignition switch ON – Waveform 3



### EFII to GND: (J26 connected)

- Always – Waveform 4



2007 Tundra

### ECM Terminal Values

The TERMINALS OF ECU description indicates that EFII and EFIO are communication circuits. Therefore you expect to see digital data signals on these lines.

Since EFII is the input signal from the ECM, a good signal at the Transponder KEY ECU verifies the ECM is transmitting and the wire to the ECM IMO terminal is intact.

Similarly, a good signal at the IMI terminal of the ECM verifies the Transponder Key ECU is transmitting and the connection between the two is good.

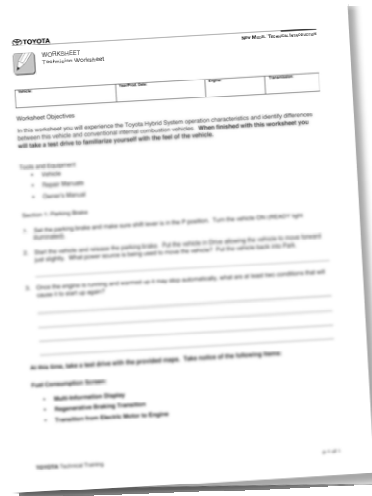
# Worksheet

## Immobilizer

### Shop Worksheet:

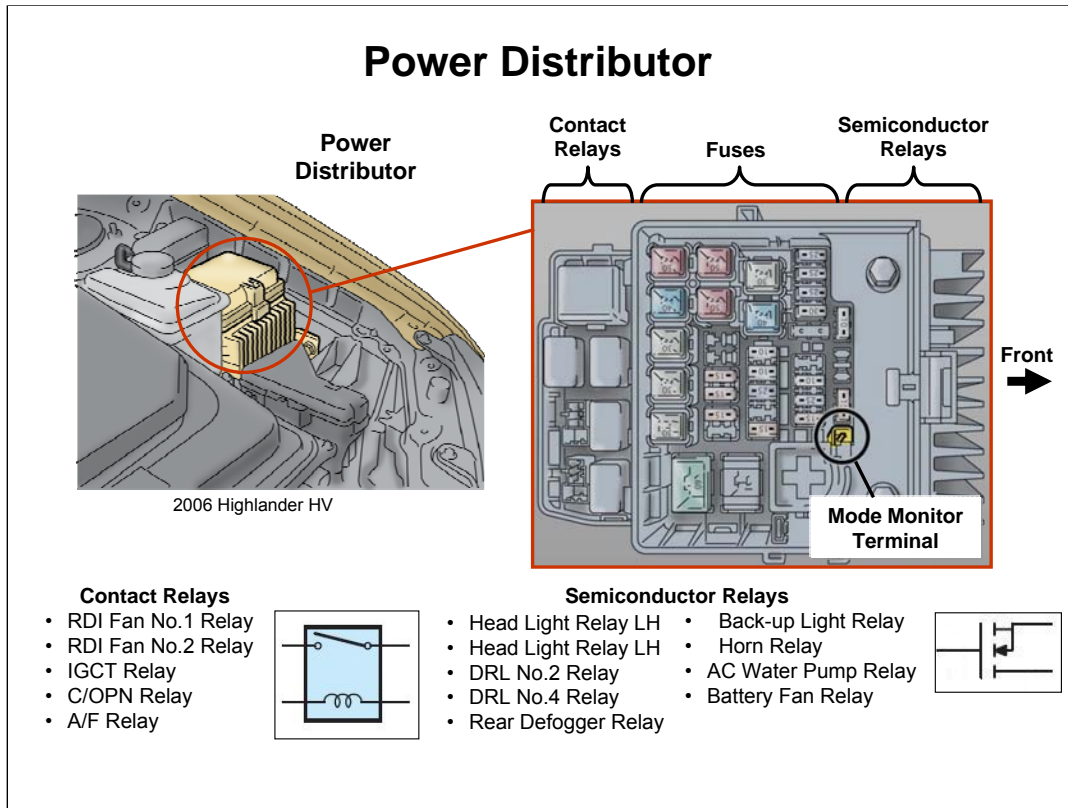
In this worksheet you will:

- Use Techstream DATA LIST to make determinations related to the ID Code of the transponder chip embedded in the ignition key
- Use a PicoScope to observe Immobilizer System waveforms under varying conditions and compare them to those in the Repair Manual.



*Use this space to write down any questions you may have for your instructor.*

### NOTES:



### Power Distributor

In some vehicle models, a power distributor replaces the conventional relay box (engine room J/B). Whereas conventional relay boxes use contact-type mechanical relays, a power distributor replaces some of the mechanical relays with semiconductor relays. A semiconductor relay is a completely electronic circuit, reducing the size and weight of these components.

### Protect Mode

A feature of many power distributors is a *protect mode*. To protect semiconductor relay circuits in the event of overcurrent or overheating, the power distributor stops current flow through the circuit's semiconductor relay when an abnormality occurs. The power distributor soon restores current to the relay, but if the problem still exists, the power distributor again stops the semiconductor relay current flow. The power distributor continues this ON/OFF operation (protect operation) at a fast cycle until the problem is corrected.

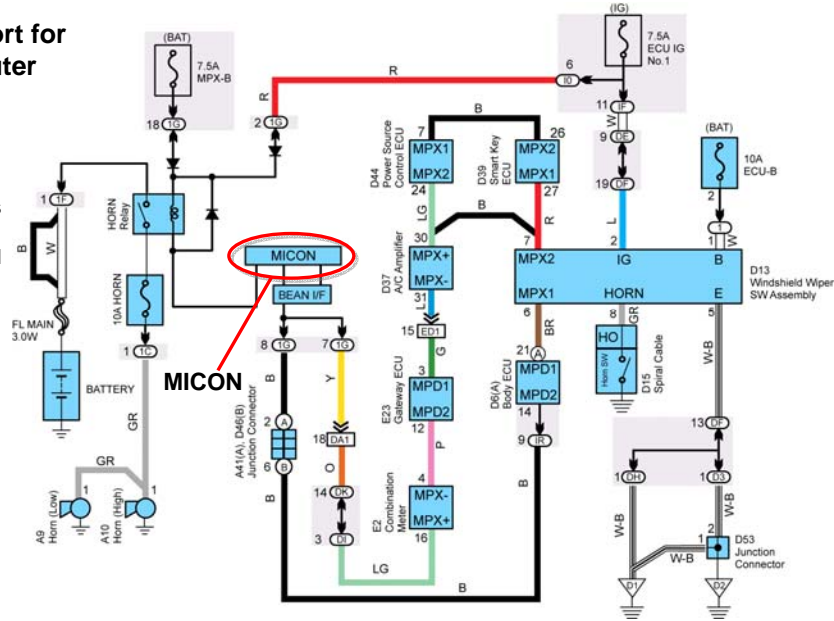
### Mode Monitor Terminal

Some models feature a mode monitor terminal on the power distributor. When the power distributor is operating normally, the voltage at the mode monitor terminal is approximately 6V. When the power distributor is operating in protect mode, the mode monitor terminal voltage is approximately 1V. Though this indicates protect mode is operating, it does not indicate which circuit is experiencing a problem.

## Smart Junction Box (MICON)

**MICON is short for “Microcomputer Controlled.”**

These specialized electronic circuits can perform various functions such as converting electrical signals into multiplex data. They are typically located inside a relay block or junction block.



2005 Avalon

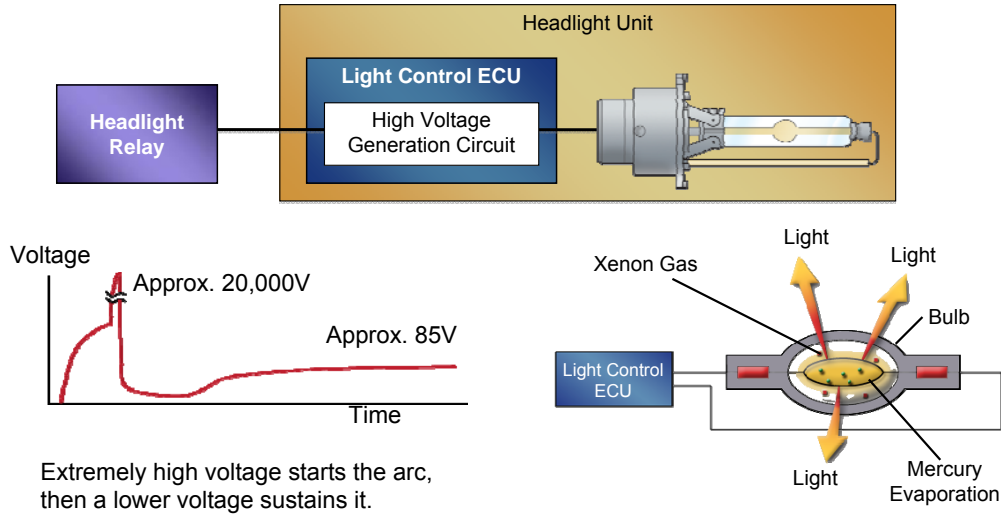
### Smart Junction Box (MICON)

Junction boxes sometimes have programmable electronic circuits inside enabling them to carry out specific electronic tasks. These special circuits are represented inside junction boxes on electrical wiring diagrams with the label MICON (short for “microcomputer controlled” circuit).

The specific function of any particular MICON is not described in the Repair Manual or EWD, and in fact is not important to diagnosis. Where measuring MICON signals is called for in a diagnostic procedure, the normal values are provided in the Repair Manual.

## High Intensity Discharge (HID) Headlights

High-voltage arcing inside the metal halide bulb causes the metal atoms to emit light.



### High Intensity Discharge (HID) Headlights

High intensity discharge (HID) headlights produce a very bright light using an electric arc to excite atoms of xenon gas, mercury and metal halide. The light an HID headlight produces is very white and twice as bright as a comparable halogen bulb, but consumes almost half the power.

Starting these lamps requires as much as 20,000 volts for the xenon gas to begin glowing. As the bulb warms up, the mercury evaporates and separates into mercury and halide atoms, creating an even brighter light.

A light control ECU under each headlight provides:

- High starting voltage necessary to ignite the lamp
- Active control of current and voltage after startup to maintain optimum light output
- A fail-safe function to stop headlamp operation in the event of an electrical fault or missing bulb.

#### CAUTION

High voltages in this circuit can damage test equipment and cause injury. Observe the safety precautions listed in the Repair Manual when servicing components in or near the HID headlight system.

#### NOTE

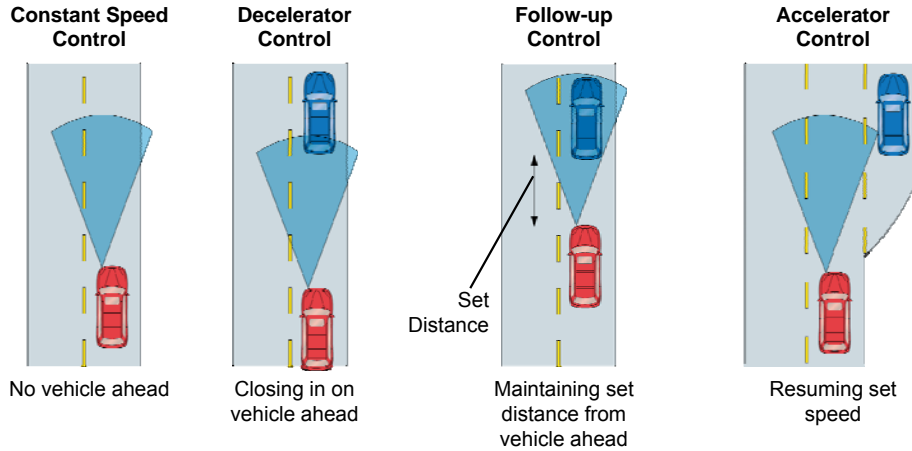
The HID bulb and HID ECU service parts for 2004 – 2005 model year are NOT compatible with 2006 and later model year vehicles. Installing a 2004 or 2005 model year HID Bulb or HID ECU on a 2006 or later model year vehicle may cause an intermittent operation/flickering of the HID bulb.

In most cases, when replacing the HID bulb, the HID ECU does NOT need to be replaced. In the event of HID ECU replacement, order the following part numbers: 81107-51050 (2004 – 2005 model year) or 81107-47150 (2006 – 2008 model year). (Refer to T-SB-0030-08 for more information.)

## Dynamic Laser Cruise Control

**Operates in one of two modes:**

- Constant Speed Control Mode (same as conventional cruise control)
- Vehicle-to-Vehicle Distance Control Mode (uses the four controls shown below)



### Dynamic Laser Cruise Control Operation

The Dynamic Laser Cruise Control has two operating modes.

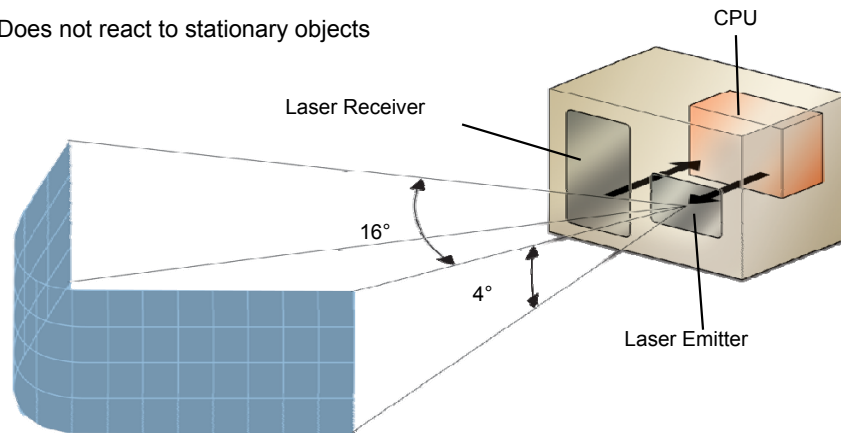
The constant speed control mode operates the same as conventional cruise control. The driver chooses a set speed and the cruise control works to maintain that speed.

In the vehicle-to-vehicle distance control mode, Dynamic Laser Cruise Control employs a laser sensor to detect a slower-moving vehicle in the same lane and reduces the vehicle speed as necessary to maintain a fixed distance from the vehicle ahead. When the other vehicle is no longer in the path of travel, the cruise control accelerates to resume traveling at the set speed.

## Laser Sensor

### The Laser Sensor CPU:

- Uses data from the reflected laser beams to calculate information on the vehicle ahead
- Does not react to stationary objects



**Note:** When installing, removing or changing the laser sensor, be sure to adjust the laser beam axis.

### Laser Sensor

The laser sensor's principle components are the laser emitter, laser receiver, and the CPU.

- The laser emitter radiates laser beams forward.
- The laser receiver receives the laser beams reflected by the vehicle ahead.
- Based on the duration and input angle of the reflected beams, the CPU calculates the information on the vehicle ahead, and transmits this information to the Distance Control ECU. The CPU is designed so that it does not react to stationary objects.

## Indicators and Error/Cancellation Codes

### Constant Speed Control

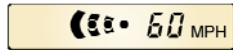


Operating

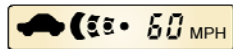
### Vehicle-to-Vehicle Distance Control



Ready



Operating (no vehicle ahead)



Operating (vehicle ahead)

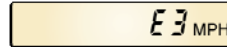
### Distance Setting



Long Middle Short

### Error/Cancellation Codes

Any of the following cancels cruise control. Cruise control is prohibited until the conditions are remedied or the MAIN switch is turned on again.



- Malfunction in the laser sensor or control system



- Laser sensor dirty



- Adverse environmental condition (weather, sunlight)

### Indicators

The driver is able to set the following parameters and sees the related indicators on the display:

**Mode** – Constant speed control mode or vehicle-to-vehicle distance control mode.

**Distance** – Long, middle, or short. (The actual distance represented by each setting is based on vehicle speed. At 55 mph, the distances would be approximately 245 ft., 165 ft., and 100 ft.)

**Set Speed** – Above approximately 25 mph. (In vehicle-to-vehicle distance control mode, the set speed cannot exceed approximately 85 mph.)

### Error/Cancellation Codes

Certain conditions will cancel cruise control operation and display a code on the cruise control indicator.

The **C1 code** is set when the laser sensor is dirty.

The **C2 code** is set when:

- The wipers operate at HI or LO speed (including AUTO mode).
- The laser sensor receives a strong light from the front of the vehicle, such as sunlight.
- The measurement becomes extremely unstable due to poor weather conditions.

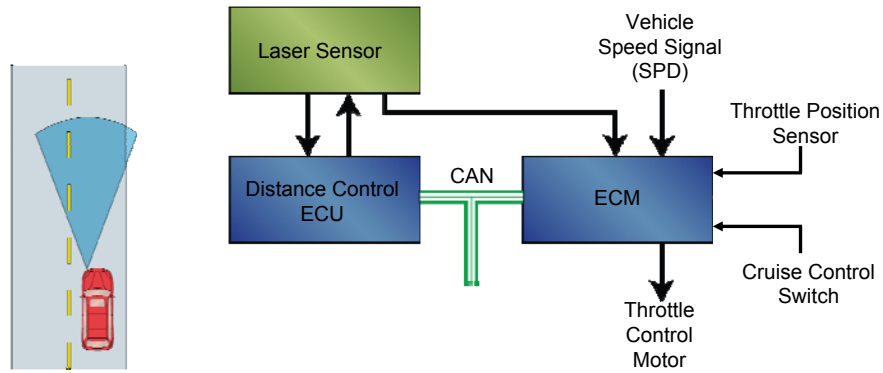
The following conditions set the **E3 code**:

- Malfunction in the laser sensor
- Displacement of the axis of the laser sensor
- Other malfunction in the dynamic radar cruise control system



## Constant Speed Control

- The Distance Control ECU signals the ECM to maintain the set vehicle speed.
- The ECM compares actual speed with the set speed and regulates the throttle to maintain the set speed.

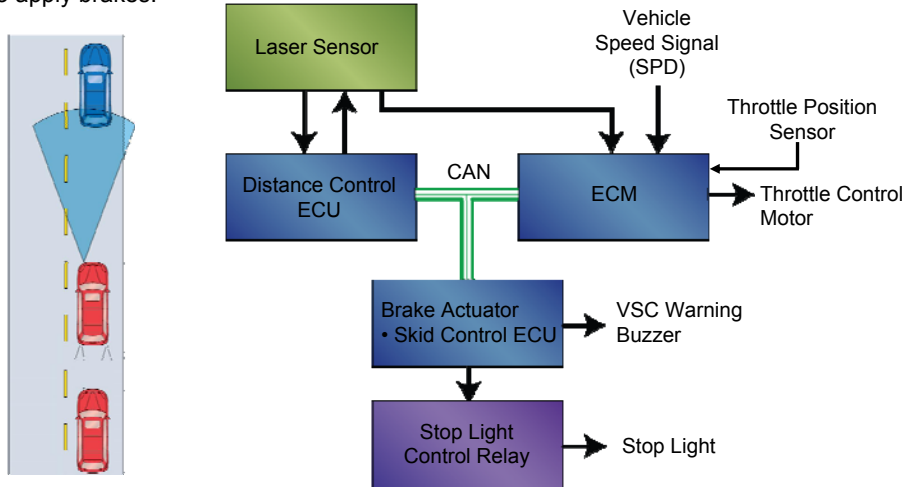


*While no vehicle is detected in the path ahead, the system operates similarly to conventional cruise control.*

**NOTES:**

## Decelerator Control

- A deceleration request is sent to the ECM. The ECM closes the throttle valve.
- If further deceleration is needed, a brake request is sent to the ECM. The ECM sends a brake request to the Skid Control ECU.
- If deceleration is not adequate, the VSC warning buzzer sounds to alert the driver to apply brakes.

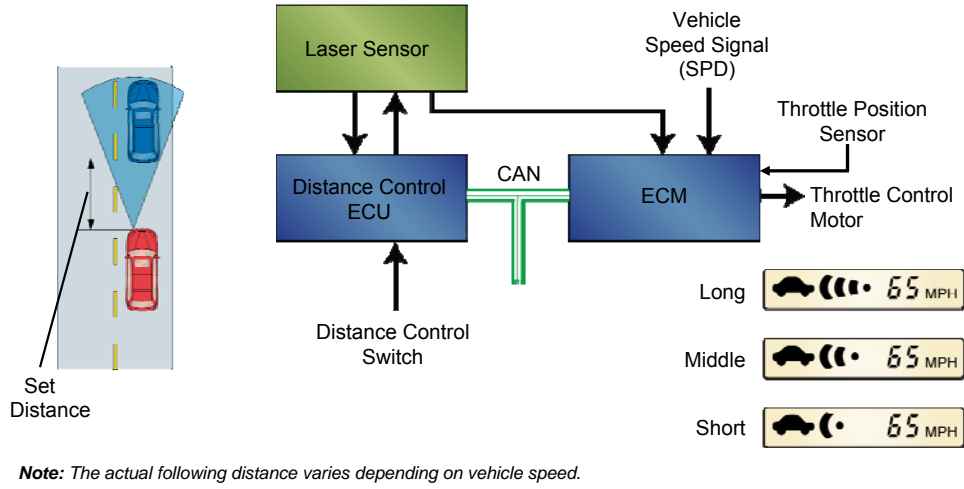


*Decelerator control occurs when a slower moving vehicle is detected in the path ahead.*

**NOTES:**

## Follow-Up Control

- With the distance control switch, the driver selects between long, middle, and short following distance.
- When the set distance is achieved, the ECM regulates the throttle to maintain the set distance between vehicles.

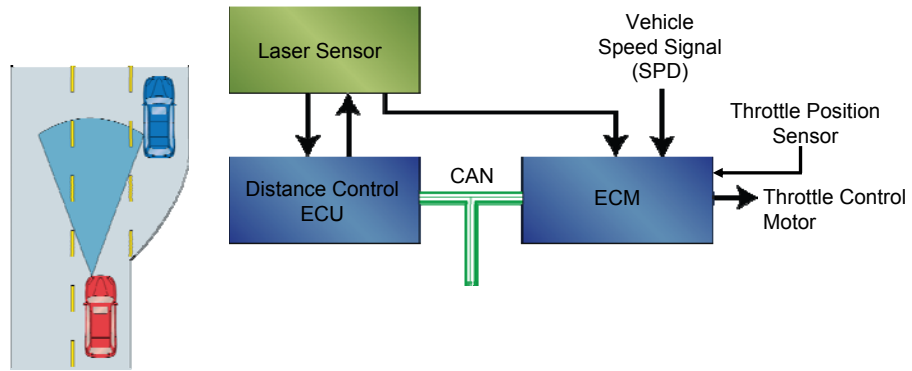


*Follow-up control maintains the set distance between the vehicles.*

**NOTES:**

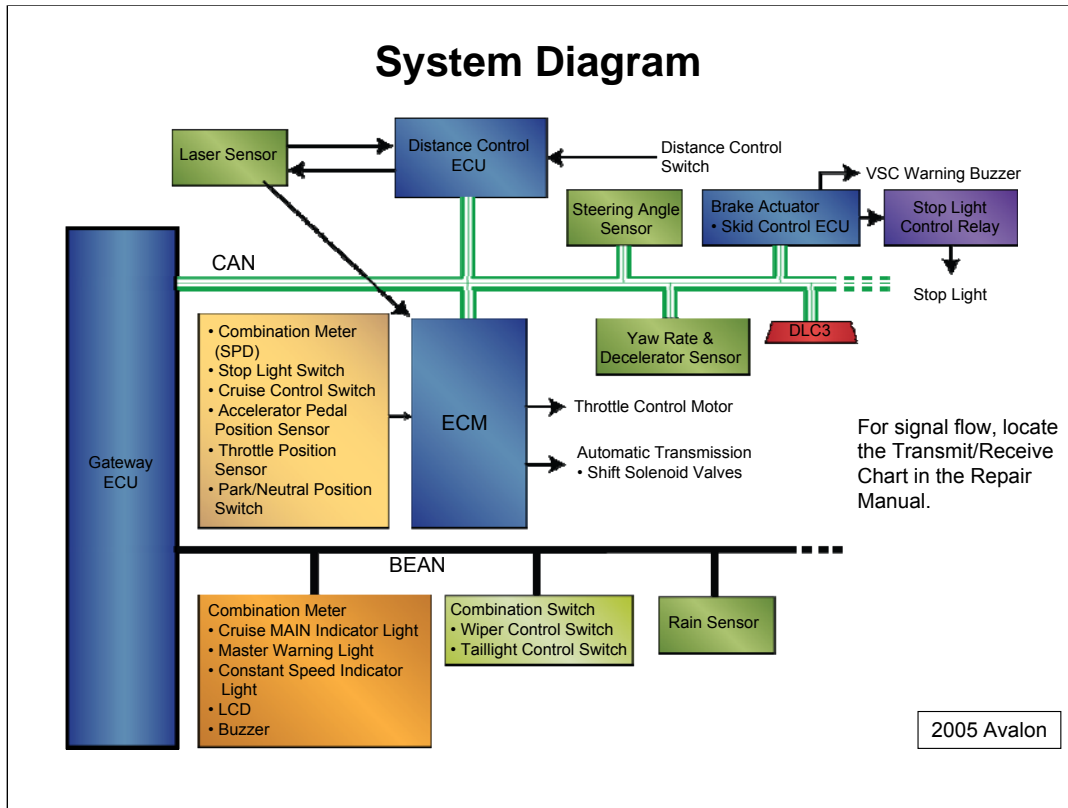
## Accelerator Control

- When there is no longer a vehicle ahead, an acceleration request is sent to the ECM.
- The ECM regulates the throttle to reach and maintain the set speed.



*Accelerator control resumes the set speed when the slower moving vehicle is no longer in the path ahead.*

**NOTES:**

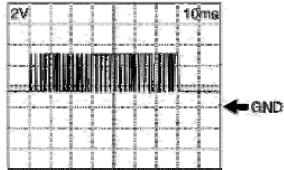


*Communication between the laser sensor and the Distance Control ECU is serial data, although it is not part of the vehicle's standard multiplex networks.*

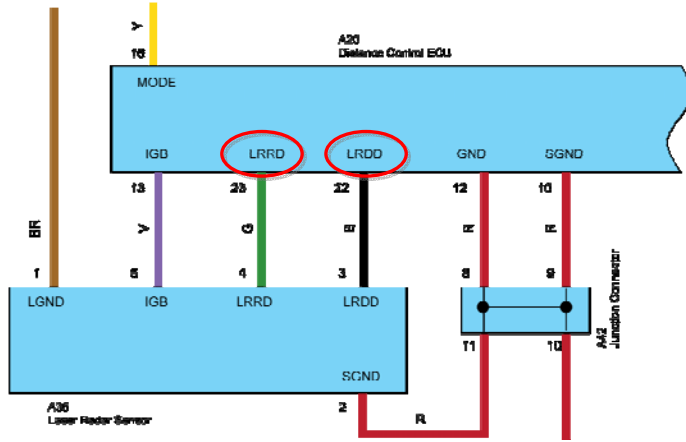
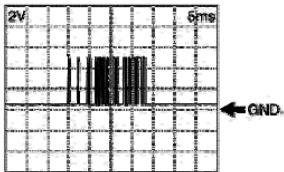
**NOTES:**

## Distance Control ECU Waveforms

- LRDD – GND
- Ignition ON



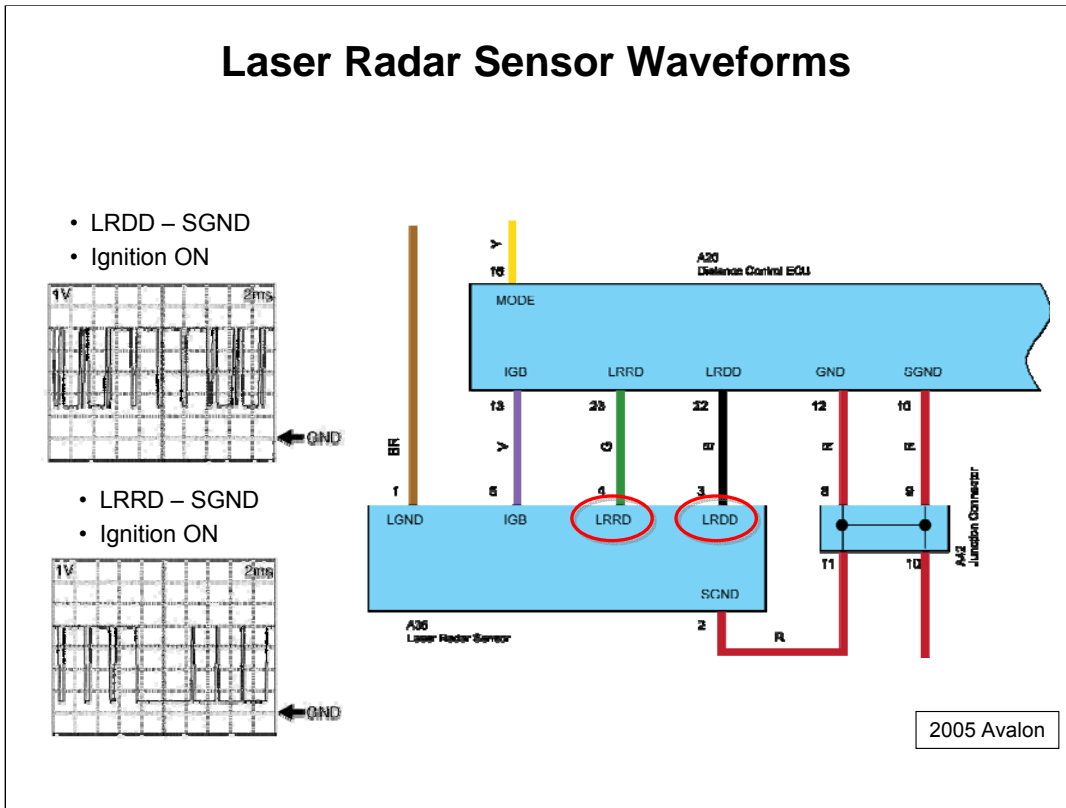
- LRRD – GND
- Ignition ON



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*These are waveforms for the serial data flowing between the laser sensor and the Distance Control ECU.*

**NOTES:**



*These are the same serial data signals as before, except now measured at the laser sensor and viewed at different voltage and time scales.*

**NOTES:**

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