

ECROS Technology

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Prius Mini-Scanner

User Manual

Manual Revision Preliminary H

for Firmware Version 0.62

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Introduction

The Prius Mini-Scanner displays information on the operation of a Toyota Prius gasoline / electric hybrid car. You can use the information to drive the car as economically as possible, to understand how it works and to watch for any problems that might develop.

The Mini-Scanner obtains information from the various computers or “Electronic Control Units” (ECUs) in the car. It does this using the On-Board Diagnostic (OBD-II) data bus. All Prius have this, so no modifications are necessary and installation is fully reversible.



Photo 1 – The Mark II Prius Mini-Scanner

You can position the Mini-Scanner behind the steering wheel where most cars have their main instrument cluster. The driver can then glance at the display without taking his or her eyes from the road for any longer than is usual. It is also possible to locate the Mini-Scanner for use by a passenger.

Over 50 data items can be retrieved from the car's ECUs and displayed. Some represent vehicle operating data that would be present in any car, such as engine r.p.m. and coolant temperature. Other items are specific to a gasoline / electric hybrid vehicle, such as the battery state-of-charge and current and the torque of the traction motor. Finally, many items give you diagnostic and trouble-shooting information, such as the temperature of the motors, battery and inverter electronics. The Mini-Scanner can retrieve “Diagnostic Trouble Codes” (DTCs) from the main ECUs. This is the information that Toyota service centers use to locate problems with the vehicle.

Road Safety

When installed and used properly, the Prius Mini-Scanner should be no more distracting to the driver than the speedometer or Multi-Function Display. Do not try to use the Mini-Scanner when it is not properly secured or mount it in such a way that the driver must take his or her eyes off the road for more than a moment. I strongly recommend that the driver not use the buttons while the car is moving. To study the displayed information closely in this situation, have someone else drive the car and operate the Mini-Scanner from a passenger seat. A long adapter cable is available as an accessory for this purpose.

However you choose to use the Mini-Scanner, I accept no responsibility for any failure to drive your car in a safe manner. If you find the Mini-Scanner distracting to the driver, please return it for a refund of the purchase price.

About this Manual

In this User Manual, I will tell you how to install, operate and look after your Prius Mini-Scanner. All the information you can get from your car is described. In many cases its relevance to owning and driving your Prius is explained. But, before we plunge into the detailed stuff, let's take a quick look at how the Mini-Scanner works and think about what we might do with the data it will give us. If you are desperate to plug the Mini-Scanner in and start it up, follow the procedure in the printed *Read Me First / Quick Start Guide*.

Outline of Operation

Many of the ECUs in the Prius are connected to a data bus or network called the OBD II bus (On-Board Diagnostics, version 2). The main purpose of this bus is to allow service personnel using special equipment to get information that helps them diagnose problems with the car. The ECUs do not “talk” to each other on this bus. Rather, a “tester” device must be connected to the bus which sends messages to the ECUs requesting that they send back specific data. The tester plugs into a “Data Link Connector 3” (DLC3) which is under the dash near the driver's left knee. Toyota service centers use a “Toyota Hand-Held Tester” or THHT to “talk” to the car's ECUs and monitor the vehicle's operation.

When you plug the Mini-Scanner into the Prius DLC3 and turn it on, it sends a signal on the OBD II bus to “wake up” the ECUs and then begins requesting data items. Replies from the ECUs are decoded and the data is presented on the display. Much of what you will find in this User Manual has to do with choosing the data items to be requested and controlling how and when they are displayed.

As well as displaying the data from the ECU replies, the Mini-Scanner sends them to a serial port (which is like the “COM” port on a personal computer). By connecting a PC or a PDA to this serial port, you can store or “log” the data for analysis at some later time.

Using the Data

The information that the Prius Mini-Scanner gives you access to is useful in three ways:

- You can learn how to drive the car most efficiently.
- With some technical inclination, you can learn how the car works in various situations.
- You can watch for any problems that might develop and if the “check engine” light comes on you can take steps to find out why.

Details of the second and third topics are contained in the body of this User Manual, but the first deserves a little space here. The Prius achieves its remarkable fuel economy in part by shutting down the engine in city driving and recovering energy during braking to charge the battery. Both these functions are subject to technical limits. If the engine has turned off, a little too much pressure on the accelerator pedal will start it up again. Too much pressure on the brake pedal will engage the friction brakes, wasting energy instead of putting it back in the battery. Using the battery current and state-of-charge displayed by the Mini-Scanner, you can see when you are approaching these limits and over time change the way you drive to avoid them and improve your fuel economy.

Vehicle Model Years

The Prius Mini-Scanner works with North American and European Prius from the 2001 to 2003 model years. It does not work with first-generation Prius nor has it been tested with second-generation Prius sold in Japan.

In the third generation Prius, starting with model year 2004, Toyota no longer use the OBD II bus for service diagnostics. Only legally mandated information, mostly related to emissions testing, is available on that bus. All the interesting data has been removed to the Controller Area Network (CAN) bus. The Mini-Scanner does not work with the 2004 model year Prius. All the work of figuring out how to get the data from the car needs to be done again before a Mini-Scanner-like device can be made for that car.

Installing the Prius Mini-Scanner

In this chapter of the User Manual, I describe the installation of the Mini-Scanner in your car. I will assume that you want to fix the Mini-Scanner behind the steering wheel. If this isn't the case, you'll need to adapt these instructions to your needs. You should still read this section of the manual to find out how to correctly connect the cables. The level of detail I give is intended to allow people with no experience of electronic equipment to complete the installation with ease. I apologize if this makes tedious reading for some of you.

Installation as described here is completely reversible. No holes are drilled, wires cut (or even spliced) and nothing is stuck to the car. If you take the Mini-Scanner out of the car, it is impossible to tell that it was ever there.

All instructions are written with reference to a left-hand drive vehicle. Owners of right-hand drive vehicles should experience no particular problems adapting them.

Unpacking the Mini-Scanner

The printed *Read Me First / Quick Start Guide* has a list of all the parts that should be in the Mini-Scanner package. Please make sure that you have everything soon after receiving the package. Contact ECROS Technology if there is anything missing or if there are signs of damage.

Tools and Supplies

To install the Mini-Scanner in your car, you will need:

- A small (#1) Phillips screwdriver
- A flashlight (to see up behind the dash)
- A twist-tie (to tie up the spare cable)

To complete the mounting bracket, you may also need some stiff foam if you do not use the steering wheel in its fully up position (see below for details).

Concealing the Adapter Cable

The thing to do first also happens to be the trickiest. The DLC adapter cable must be threaded behind the steering wheel assembly and down inside the dash so that it hangs into the driver's footwell. The upper end is connected to the Mini-Scanner and the lower end to the DLC adapter. The cable is then concealed, leading to a tidy appearance.

Experience with this step of the installation varies widely. Some people have had no trouble at all and others have struggled for half an hour. Leave yourself plenty of time for this and try to start out in a calm frame of mind.



Photo 2 – Mark II Package Contents



Photo 3 – Adapter Cable

Begin by releasing the steering wheel tilt mechanism. Your car's User Manual contains instructions on how to do this. The release lever is on the left side of the steering wheel behind the control stalk. Push the lever down as far as it will go. Now, put the steering wheel to its lowest position by pulling it down. The plastic housing around the back of the steering wheel assembly drops away from the dash and you will see a gap of half an inch or so. Look into this gap. It appears to be blocked at the back by a sort of flange that bends up from the steering assembly housing (see Photo 4). The goal is to get the adapter cable into the gap, over the top of this flange and then down behind the dash into the space around the driver's feet.

Obviously, the cable is not going to drop down right in the middle of the steering wheel because that's where the steering mechanism is. You need to work slightly to one side or the other. With a Mark II Mini-Scanner, pass the cable to the right of the steering wheel. This is the easier side to work on (in a left-hand drive car, anyway) and the adapter cable attaches to the main unit on this side.

For the Mark I Mini-Scanner, you can choose to pass the cable on either the left or the right side. There are a number of minor reasons why you might chose the left side. The cable attaches to the Mark I main unit slightly to the left of center. The DLC3, into which the adapter plugs, is on the left side of the driver area (on left-hand drive cars). With the adapter cable on the left, the Mark I serial cable can be passed behind the dash on the right. But, this is the more difficult side on which to get your hand and arm up behind the dash. You will have an easier time if you have small hands or can find someone who has to help you. Failing this, everything works fine with the adapter cable passing to the right of the steering mechanism.

Sitting in the driver's seat, take hold of the adapter cable with the marked edge (usually a red or black stripe) to the right. The 10-pin connector on the upper end of the cable will be facing away from you. Pass this connector into the gap opened by lowering the steering wheel, see Photo 4. Work a few inches to the right of the center of the steering wheel (or to the left, if that was your choice). Angle the connector up so it clears the top of the flange. Feed the cable forward until several inches of it have disappeared behind the dash. Keep the marked edge of the cable to the right.

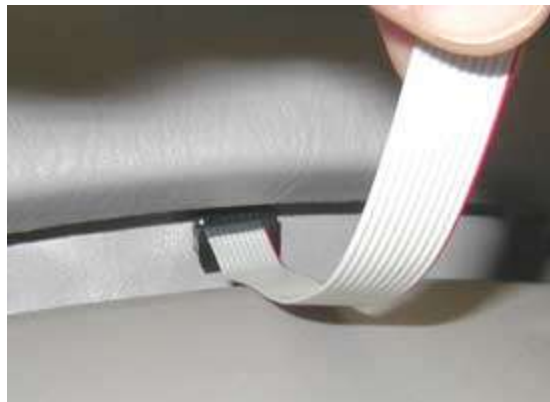


Photo 4 – Threading the Adapter Cable

Now you will have to hold or tape the rest of the cable in place while you fish for the end that has disappeared and pull it down. I found it fairly easy to reach up behind the dash from below with one hand while holding the cable with the other. I simply groped about in there while waving the cable to and fro and soon felt the cable moving and was able to get a hold on it. This may work for you if you have a good sense of where your hand is even though you can't see it and you are physically and psychologically able to wriggle your hand up into the innards of the car. Another approach, pioneered by someone close enough to drive to my house to pick up his Mini-Scanner, is to fish for the cable from below with a bent wire. This requires you to lie on your back in the driver's foot well, but with a flashlight you have the advantage of being able to see what you're doing.

When you get hold of the cable from below, pull most of it down, leaving just a couple of inches sticking out behind the steering wheel, see Photo 5. This end of the cable can be

jiggled into the right place to connect to the Mini-Scanner main unit later. Check that the marked edge of the cable is still to the right and that the 10-pin connector on the end of the cable faces away from you towards the front of the car.

<<< new photo >>>

Photo 5 – A Couple of Inches

Plugging in the DLC Adapter

The DLC adapter should next be connected to the lower end of the adapter cable that is hanging into the driver's footwell. Hold the adapter with the red plug at the top and facing towards you. Locate the “header” (a group of gold pins) in the lower right hand corner. The connector on the cable fits over these pins.

Put the connector over the header, making sure all the pins sticking up from the DLC adapter line up with holes in the connector. As pin one is snipped off and its hole in the connector is plugged up, it should not be possible to get this wrong. Squeeze the connector and adapter firmly together. The edge of the cable marked with a red stripe will be to the right and the cable will lead directly away from the adapter (rather than folding over the top of the connector) as shown in Photo 6.



Photo 6 – Mark II DLC Adapter

The Mark I DLC adapter is a little larger than the Mark II shown here, but installation is otherwise the same. Original Mark 1s (not remanufactured) do not have pin one snipped off to prevent the cable from being installed incorrectly so a little more care is needed.

Locate the Diagnostic Link Connector (DLC or DLC3). To do this, kneel on the ground outside the car next to the driver's side door. Duck your head into the pedal area and look up underneath the lower edge of the dash. You will find the DLC fixed in a recess in the plastic dash molding. (Once you know where the DLC is, it will no longer be necessary to kneel down to find it; you will be able to plug in the adapter by touch.)

Plug the DLC adapter into the DLC. It will only fit one way. Turn the adapter so that the red connector faces up and is closer to you than the side to which cable is attached. As you do this, you will put a half-twist in the cable and the marked side will now be on the left. Tip the top of the adapter towards the front of the car and align the red plug with the DLC. Press the adapter board firmly behind the red plug to seat it. Photo 7 shows the DLC adapter and cable correctly installed. The pedal in the picture marked "push on/off" is the emergency brake.

<<< new photo >>>

Photo 7 – Connecting to the DLC

You will need to tie up the slack in the adapter cable so that it does not get in the way of the driver's feet. The cable is 30 inches long, which allows some extra length for ease of installation. This results in a loop falling in front of the pedals. Tie this up with a twist-tie or in some other convenient way. Don't tie it up so that the cable is tight, just so that it doesn't hang down. You will need a little slack to install the main unit. It may be best to come back to this after completing the installation, but *don't forget it* and get your foot tangled in the cable when you drive the car.

If at this point you're wondering whether the DLC adapter will get in the driver's way, let me assure you that it has never got in my way. In fact, so that any problems in this area

are likely to happen to me first, I have not tied up the slack in the cable (but please do this yourself). Not once have I kicked the adapter or the cable while driving or getting into or out of the car.

Note for Mark I owners (skip this sidebar if you have a Mark II): The Mark I Mini-Scanner serial cable cannot be attached and detached from the main unit without opening the case. If you want to log data to a computer in the car, it may be a good idea to install the serial cable alongside the DLC adapter cable now. It can be concealed behind the dash in the same way.

Threading the DB9 connector through the gap above the lowered steering wheel is made more difficult by its larger size, but easier by its weight, which makes it find its way down more readily. I accomplished this on the right hand side of the steering wheel in just a few minutes. You may have to get creative if you have trouble, perhaps threading something else through and pulling the smaller ten-pin connector on the other end in an upward direction. Once the cable is threaded, you can route it where you want, for example over to the passenger side. Be very careful to tie it up so it cannot snag on the driver's feet.

Instructions for connecting the Mark I serial cable to the Mini-Scanner main unit are published separately.

Installing the Main Unit

Now we move our attention back to the top end of the adapter cable. We left this sticking out behind the steering wheel and we will now attach it to the main unit.

To open the main unit case, take out the four screws in the back with a small (#1) Phillips screwdriver. Lift off the front of the case by gently pulling it straight away from the back and set it to one side. The back part contains the Mini-Scanner circuitry, which will look like Photo 8. While the front is off, be careful not to damage the exposed components inside. Peel the protective plastic sheet from the front of the display.



Photo 8 – The Main Unit with the Front Off

Hold the main unit horizontally with the buttons facing up. Locate the header to which the adapter cable must be connected. It is near the lower right corner, just below the telephone-type jack. Like the header on the DLC adapter, it consists of a group of ten gold pins in two rows of five with one pin snipped off.

Move the main unit into position behind the steering wheel where the adapter cable sticks out. Place the connector on the end of the cable over the header and push it home. Make sure that all pins go into holes in the connector. With pin 1 snipped and its hole plugged, you can't get the connector backwards, but it is possible to get the top row of pins in the bottom row of holes. Take a look from the side to make sure you've not done this. Photo 9 shows a correctly fitted cable. Note the gap between the connector and the telephone-type jack. If this gap is absent, remove the connector and try again. The *Pruis Mini-Scanner Welcome* CD-ROM contains a larger photograph of the correctly fitted adapter cable and two views of an



Photo 9 – Adapter Cable

incorrectly fitted cable. Even if you turn on the car with the cable incorrectly fitted, you will not damage anything; the Mini-Scanner just won't work.

Note that the marked edge of the cable is to the right and the cable leads directly down and away from the main unit and does not fold over the top of the connector.

Note for Mark I owners (skip this sidebar if you have a Mark II): If you have a Mark I Mini-Scanner, take account of the differences noted in this section when installing the main unit.

The Mark I case has loose end panels and you need to be careful not to lose them when you open the case and to guide them back into their slots when you reassemble it.

The header to which the adapter cable must be connected is in a completely different place. It is slightly to the left of center on the lower edge of the circuit board and is labeled JP3. At the far right, there is another very similar header, labeled JP4, which is for the Mark I serial cable, not the adapter cable. If you connect the adapter cable to the wrong header you will not damage anything but the Mini-Scanner will not work and the car will set the Check Engine Light.

The mounting bracket for the Mark I is fixed to the main unit by the bottom two screws that hold the case together. Therefore, replace the two screws closest to the buttons first and remember to put the bracket in place before inserting the remaining two screws. The adapter cable passes underneath the bracket. Make sure it is lying flat and is not folded.

Adjusting the Display

The type of display used in the Mini-Scanner is a Liquid Crystal Display (LCD). So that the text is clearly readable from the normal viewing position, it may be necessary to make an adjustment to the "contrast" setting. It is not particularly critical, but since you cannot make the adjustment once the case is closed up, you might want to fiddle with it now. Of course, if you want the drill a small hole in the case, you will be able to adjust the contrast from outside. The contrast is set during manufacture and you may not need to change it.

Hold or prop up the Mini-Scanner where you will fix it in place and make sure it points in the direction you desire (directly towards you when you are in the normal driving position in most cases). Don't lean the unit so far back that it catches reflections of the sky in the glass front of the display. Turn it on by pressing the On/Reset button, which is on its own at the left. With the car off, the Mini-Scanner will power up for about ten seconds, which is long enough to evaluate the display. You can turn the car on if you want to; you don't need to start it. Look for dark text and a clear background.

To try different contrast settings, use your #1 Phillips screwdriver to adjust the small blue variable resistor on the left hand edge of the circuit board, close to the bottom. Stick the screwdriver in from the left and twist it very slightly. One direction will darken both the text and background of the display and the other will lighten them. Find the setting that is best for you when you are seated normally and the Mini-Scanner is where you want it to be when you've secured it in place. I have found that the smallest degree of darkening of the background gives the best overall clarity. Use the border of the display, which stays clear for all settings, as a reference.

If you don't want to bother with this, the preset contrast will probably be just find for you. It is always possible to come back and adjust it later, but you will have to remove the top of the case again (unless you drill the hole).

Replace the front of the main unit case. Tip the main unit towards you, so that its face rests on the steering wheel housing. Replace the four screws that hold the case together. Tip the main unit back upright and you are ready to secure it in place.

Securing the Main Unit in the Car

You may have your own ideas about how to fix the Mini-Scanner in place, especially if you don't want to put it behind the steering wheel. In this section, I assume you do want it behind the steering wheel and also that you don't want to fix it directly to the car. For other methods of fixing, adhesive-backed Velcro™ and/or double-sided foam tape will come in handy, but are not included in the package.

The Mini-Scanner comes with a simple mounting bracket. The bottom of the bracket is intended to be trapped by the steering wheel assembly when you lift it back up into place. The top of the bracket (the larger part) provides a surface to which you can fix the back of the main unit case. It comes with a large piece of foam tape attached which will not let go once you've pressed the Mini-Scanner onto it. If you want to have a second chance, you could replace it with Velcro or perhaps only remove part of the backing to expose a smaller area of adhesive.



Photo 10 – Mounting Bracket

The padding on the bottom of the bracket as supplied will work if you use the steering wheel in the fully up position. If you use a lower position, you will need to add some more padding. A stiff foam is good for this, or you could use some more double-sided foam tape without removing the backing. The foam tape supplied here is not very sticky (unlike the tape on the top part!) and can be unwound for less padding. Only remove the backing if you want some extra stick to hold it in place in the car or if you want to use it to secure extra padding.

With your left hand, hold the padded end of the bracket in the gap between the steering wheel housing and the dash. With your right hand, raise the steering wheel into position so that it traps the bracket. You can now release the bracket and use your left hand to lock the steering wheel into position. You may have to release, adjust and reinsert the bracket a number of times until the grip is firm at your preferred steering wheel height and the top of the bracket is at a good angle for mounting the Mini-Scanner. The bracket can be easily bent with your fingers.

Remove (all or part) of the backing from the large piece of foam tape. Move the Mini-Scanner main unit up towards the bracket, guiding any spare adapter cable back behind the dash so that it is hidden. When you are happy with the position of the bracket and the main unit, allow them to touch. Press the main unit back against the bracket. By putting your fingers behind the main unit, you can press them together more firmly, or you can drop the steering wheel, take the assembly out to do this and then put it back.

Make sure that cables falling below the dash are tied up out of the way of the driver's feet. Your Mini-Scanner is now installed!

Checking the Mini-Scanner

To check that your Mini-Scanner is installed and working properly, turn it on by pressing the On/Reset button. This is on the top at the far left hand side. The display will show the firmware version, for example “**Mini-Scanner: 0.61**”, and then below it the message “**ISO9141 Slow Init...**”. If the car is not turned on, after a few seconds the display will change to “**Slow Init: no resp.**” and soon after that, the Mini-Scanner will turn itself off. If the car is turned on, the display will begin showing data being retrieved from the ECUs.

Detailed instructions on operating the Mini-Scanner can be found below. No harm can be done by pressing buttons at random, but unless you read the rest of this User Manual you will probably fail to find some useful functionality.

Diagnosing Problems

If, when you press the On/Reset button, nothing happens, the Mini-Scanner is not getting power or has been severely damaged in shipping. Check that the connectors at both ends of the adapter cable are properly seated on all header pins of the DLC adapter and the main unit. Make sure the DLC adapter is properly seated on the car's DLC. If this all looks OK, remove the Mini-Scanner from the car. Using the supplied 9 volt battery hook-up, power the Mini-Scanner from a 9 volt smoke alarm battery as described in *Using the 9 Volt Battery Hook-Up*, below. Press the On/Reset button. If nothing happens, contact ECROS Technology to arrange for the return and replacement of the Mini-Scanner.

If the Mini-Scanner displays the banner and ISO9141 slow initialization message, but then always reports no response and turns itself off, make sure the car is turned on. Start the car to be absolutely sure. Again in this case, check all connections, but this is less likely to effect a cure. Remember that the Mini-Scanner only works with model year 2001 to 2003 North American and European Prius. If your Mini-Scanner powers up but cannot communicate with the car, contact ECROS Technology to discuss the problem.

Of the 33 Mark I Mini-Scanners shipped to six countries, none failed to arrive in perfect condition nor failed to install properly in the car. If you are unlucky enough to experience a problem, ECROS Technology will work with you to get your Mini-Scanner working or give you a full refund of the purchase price.

The Serial Port

On the right hand side of the Mini-Scanner case (Mark II only) there is a telephone-type jack. The “proper” name for this is an “RJ11”, so that's what I'll call it from now on. This is the serial port, which allows the Mini-Scanner to be connected to a computer or other computing device such as a PDA.

Never connect the Mini-Scanner to a telephone circuit as this will damage it!

A telephone cable and RJ11-to-DB9 adapter are supplied with the Mini-Scanner. Using these, you can connect the serial port to a personal computer “COM” port. The type of connector used by the PC COM port is a “DB9”. You can also connect to any computing device that has this same type of connector for its serial port. If your device has a different type of connector, you will need a different adapter.

When you need to use the serial port, plug one end of the telephone cable into the RJ11 on the Mini-Scanner. Plug the other end into the RJ11 side of the adapter. Plug the DB9 side of the adapter into one of the COM ports of your computer.

You can use the serial port to:

- record or “log” data from the Mini-Scanner to a computer for later analysis
- update the firmware (software) that controls the operation of the Mini-Scanner

More information on using the serial port is given in the sections of the User Manual that deal with these functions.

Mini-Scanner Firmware

When it arrives, your Mini-Scanner contains the firmware that was most up-to-date at the time of shipment. From time-to-time, new versions of the firmware may be released to add functionality and/or correct problems. You will hear about this by e-mail. To take advantage of new releases of Mini-Scanner firmware, obtain a new firmware file and follow the procedure described in the chapter Updating Mini-Scanner Firmware.

Uninstalling the Mini-Scanner

The Mini-Scanner has been designed so that you can leave it installed in your car for however long you wish. When it is off, it takes no power from the car and will not contribute to battery drain. There will be times, however, when you want to uninstall the Mini-Scanner either completely or partially. For example, the DLC adapter must be unplugged in order for a diagnostic tester to be connected to the car. Your dealer's service department may want to connect a tester and a technician performing emissions testing will certainly need to do this. In these situations, you can simply unplug the DLC adapter from the car, but be sure not to leave it dangling in the way of the pedals.

You may not want to make it obvious to service technicians that you are using a scanner. If you unplug the DLC adapter from the car and from the adapter cable and take it away, there is nothing left to really suggest a connection to the DLC. You could also disconnect and remove the main unit if you think a technician might guess what is going on. You could also remove the adapter cable and leave no evidence at all (depending on how easy or difficult you found the installation of the cable!).

Should you decide to remove the main unit from the car, for example for a firmware upload, it is perfectly safe to leave the DLC adapter and cable plugged in. You can drive the car in this state. It is also safe to have the DLC adapter plugged in without the adapter cable attached. The Mini-Scanner has been designed not to present the risk of damage to your car.

When disconnecting the adapter cable, always pull off the connector by grasping its body and pulling straight away from the header. Never pull on the ribbon cable itself as it will become detached from the connector. Replacement cables are available from ECROS Technology. Removing the cable from the Mark II main unit is made rather difficult by the lack of space to get your fingers in. I apologize for this design problem, but I could find no solution. Lift up the cable so that you can get a finger to the lower part of the connector. If you have to use a small, flat-bladed screwdriver to pry up the connector from the pins, do so gently.

Basic Operation

In this chapter of the User Manual, I will describe basic operation of the Mini-Scanner, including how to select data items to be retrieved from the car's ECUs and displayed.

Turning the Mini-Scanner On and Off

For the Mini-Scanner to communicate with the car, the car must be turned on, although it need not actually be started. To turn the Mini-Scanner on, press the On/Reset button, which is on the far left. The Mini-Scanner will begin sending messages to the car and displaying information sent back by the car's ECUs.

If the Mini-Scanner does not receive a response from the car, it will display a diagnostic message and turn itself off. The most likely cause of this is that the car is not turned on. Turn the car on and try again. You can press the On/Reset button to restart the Mini-Scanner at any time. It is not necessary to wait for it to turn itself off.

The Mini-Scanner turns itself off soon after you turn off the car. It does this by noticing that the car has stopped responding to requests for information. A message to this effect will be displayed for a few seconds before the unit actually powers off. (If this message appears while the car is on, a problem has developed.) Should you ever find that the Mini-Scanner does not turn itself off when the car is turned off, uninstall it at once and contact ECROS Technology to arrange for repair. If you want to turn the unit off while the car is still turned on, press all three of the Left, Middle and Right buttons at the same time.

The Display Backlight

Control of the Mark II Mini-Scanner display backlight is automatic. If it gets dark, the backlight comes on and if it gets light it turns off. In dawn and dusk conditions, when there is some light but not enough to easily read the display, the backlight is bright. In deeper dark, the intensity is reduced so as to maintain readability without glare. The light sensor that makes this possible is behind the small dot on the front panel below the On/Reset button. If you cover this up, backlight control will not work properly.

Whether user controls over the Mark II backlight are necessary will be decided according to feedback from owners. Options to disable the automatic operation so that the backlight is always on or off and to adjust the average brightness can be added by a firmware update.

Note for Mark I owners (skip this sidebar if you have a Mark II): The Mark I Mini-Scanner does not have automatic backlight control. An option is available to turn the backlight on and off. Also, you can have the backlight come on when you turn on or reset the Mark I Mini-Scanner by holding down the Left button. Do not release the Left button until after you release the On/Reset button.

Left, Middle and Right Buttons

The Mini-Scanner is controlled by three buttons¹ (if we set aside the On/Reset button). These are called the Left, Middle and Right buttons.

Button Functions

The Left, Middle and Right buttons have different actions at different times according to what the Mini-Scanner is currently doing. However, each has certain common functions which help you remember how to operate the unit.

- The Middle button is associated with mode changes.

¹ Getting at all the the functionality of the Mini-Scanner with only three buttons may appear awkward and at first difficult to remember. If more buttons were used, operation might be simplified somewhat, but the cost and size of the Mini-Scanner would increase. The three buttons give a control scheme that becomes fairly easy to use after some practice and results in a small, tidy main unit. As compared to a front-mounted membrane keypad, the top-mounted “tactile” switches can be found by touch and depress with a sharp click that can be felt by your fingers. A passenger can easily operate the unit in a dark car. If, in spite of my recommendation to the contrary, a driver decides to operate the unit, he or she can find and press the buttons without taking his or her eyes off the road.

- The Left button often moves backwards through lists.
- The Right button often moves forwards through lists.

A summary of the button actions appears in tabular form later in this User Manual.

Tap and Hold

Each button can cause one of two actions, depending on whether you “tap” or “hold” it. To “tap” a button, press it only briefly. To “hold” a button, press it and hold it down for one second or more then release it. The action of a button always takes place when you release the button.

Modes

The mini-scanner has several modes of operation:

- Display mode - display the data items currently in the “Display slot”.
- Favorites mode - store items in “Favorite” slots or recall them to the “Display slot”.
- Select Line modes - choose the two data items to display in the Display slot.
- Options mode - set various options, such as the rate at which data items are requested.
- Trouble Codes mode - retrieve and clear Diagnostic Trouble Codes from ECUs.

The scanner always powers up in Display mode and returns to this mode on a reset. To cycle through the modes in the order listed above, tap the Middle button. To return to Display mode from any other mode, hold the Middle button. In some modes, the Mini-Scanner returns automatically to Display mode after a period of time in which no buttons are pressed.

Selecting Data Items to Display

This chapter of the User Manual is concerned with how data items are selected for display from the more than 50 available (see *Appendix A - Available Data Items*).

Introducing “Slots”

For reasons connected with the Mark I's two-line display, the Mini-Scanner currently lets you select data items in pairs. Each pair of data items makes up a “slot”. There are eight slots available, the “Display Slot” and seven “Favorite” slots, numbered from 1 to 7. So, you can set up the Mini-Scanner with up to sixteen data items, two in each of eight slots, and quickly switch among them as described below.

The Display Slot

The data items in the Display Slot appear in the top two lines of the display when the Mini-Scanner is in Display Mode. This is the mode in which you will normally have the Mini-Scanner and the mode entered when you turn it on or reset it. Therefore, the data items you put in the Display Slot are typically the ones you're currently interested in.

The data items in the Display Slot are the easiest to change. If you put the Mini-Scanner in a “Select Line” mode, you can browse forwards and backwards through the complete list of data items by tapping the Right and Left buttons. Therefore, you will also use the

Display Slot to hold data items that you temporarily want to watch.

When the Mini-Scanner turns off, it forgets which data items were in the Display Slot. The next time you turn it on, the two items in Favorite Slot 7 (see below) will be copied to the Display Slot. If you browse the data items in the Select Line modes and turn off the car, the next time you use it the Mini-Scanner will return to the state you deliberately set and will not be disturbed by your browsing.

Favorite Slots

Data items in Favorite Slots are changed indirectly by copying the contents of the Display Slot. However, when the Mini-Scanner turns off, it remembers the data items in all seven Favorite Slots. The next time you turn it on, the contents of the Favorite Slots are exactly as you last set them. Therefore, the data items you put in Favorite Slots are typically the ones you're most interested in. As Favorite Slot 7 is copied to the Display Slot when you turn on or reset the Mini-Scanner, this is where you should put the items you normally want to see on the top two lines of the display.

Selecting Display Items

To select the data item to be shown in the top line of the display, put the Mini-Scanner in "Select Line 1" mode. To get to this mode from Display Mode, tap Middle twice (the first tap puts you in Favorites mode, which we will discuss below). You can tell that you are in this mode because the top display line is highlighted. On the Mark I Mini-Scanner, a blinking cursor appears in the first character position. On the Mark II Mini-Scanner, the entire line blinks.

In Select Line 1 mode, tapping the Right and Left buttons scrolls forward and back through the list of items that are available for display. When a new item is first selected, no data is available for that item and the descriptive text appears with just placeholder characters where the value should be. After a moment, the Mini-Scanner requests the data and the value returned by the ECU is shown. There is no need to wait for this to happen; you can keep tapping until the item you're looking for appears. If you do wait in between taps, you can read off the current value of each item in turn (but please, not while driving).

To select the data item for the second line of the display, put the Mini-Scanner in "Select Line 2" mode. From Display mode, this takes three taps. The second display line is highlighted so that you know you are in this mode. As for the top line, tapping Right and Left scrolls through the list of items that are available. The same items are available for both display lines.

Now you know how to select the two items in the Display slot. These will be shown when the Mini-Scanner is in Display mode. To get back to Display mode and stop the blinking, you can tap Middle and go past Options mode and Trouble Codes mode or you can just hold Middle which sends you from any mode straight to Display mode. If you are selecting the item for the second line and you change your mind about what you want to see in the top line, you need to get back to Select Line 1 mode. You can't go backwards through the modes, so the easiest thing to do is to hold Middle (getting back to Display mode) and then tap Middle twice.

Setting and Saving Favorite Items

As mentioned above, Favorite slots are different from the Display slot in that they cannot be set directly but the Mini-Scanner remembers the items in them when it is turned off. So, the next thing is to learn how to set the items in Favorite slots. After you have used the Mini-Scanner for a while, it is best to come up with a plan of what items you will store. If you don't yet have a plan, pick any items just to get used to using Favorites.

Let's start by setting the items in Favorite Slot 1. Perhaps we want to store in this slot the engine r.p.m. and coolant temperature. First, set these items into the Display slot as explained in the previous section. Next we need to go to Favorites mode. From Display mode, this is one tap of the Middle button. When you enter this mode, the display will announce the current Favorite slot, from 1 to 7, for a moment and then begin retrieving and displaying the data items in that slot. There is no explicit indication that you are in Favorites mode, so you have to keep track of this.

You always enter Favorites mode in Favorite slot 1. The two data items you set into the Display slot are no longer visible, but they are still there. To copy them to the current Favorite slot, hold the Right button. Now you have set the items in this slot. The Mini-Scanner returns to Display mode ready for you to select new items and save them in another Favorite slot.

In Favorites mode tapping the Right and Left buttons moves forwards and backwards through the Favorite slots. For example, if when we entered Favorites mode above we had tapped Right twice before holding right, we would have copied the items in the Display slot into Favorites slot 3 instead of 1.

If you should want to copy the items from a Favorite slot into the Display slot, go to that slot and hold the Left button (instead of the Right, which copies from the Display slot to the Favorite slot).

Using Favorite Slots

Now that we have described how to set the data items in the Display slot and the Favorite slots, it is time to explain what Favorite slots are for. This will be easier to appreciate once you've formed a plan of what items you're most interested in. If possible, make a tentative plan now and set up a few slots with data items you'll recognize.

If you go to Favorites mode (one tap of Middle from Display mode) and go to a Favorite slot (tap Right and Left) but don't hold any buttons to copy the slot, the Mini-Scanner just retrieves and displays the data items in that slot. So, as well as watching the items in the Display slot, you can, with just a few quick taps, watch any two items you have saved in a Favorite slot.

Suppose, for example, you are interested in the torque produced by the motor/generators when you are going up a hill. Normally, you watch other items, so these torques are not usually displayed. Choose a Favorite slot, say slot 3, and set the items in that slot to MG1 torque and MG2 torque. Now, before you go up that hill you can quickly set the Mini-Scanner to show you the torques by tapping Middle once and Right twice (assuming you start in display mode). At the top of the hill, you can return to normal by holding Middle.

Although a slot only contains two items, the Mark II Mini-Scanner is able to display four lines of information. As shipped, it only displays two because only two data items are

requested from the car. If you use the Options mode to increase the number of items requested (see *Items to Request/Log*), the other two lines will start to fill up. But, what will they fill up with? The answer is that they will display the items in the next slot beyond the one you've selected. If you've set the Mini-Scanner to Favorite slot 3, the items in that slot will appear on the top two lines. If you've chosen to request four data items, the items in slot 4 will appear on the next two lines. For the purposes of defining the "next slot", the Display slot is slot zero. So, in Display mode, the bottom two lines will show the items in Favorite slot 1. Also, the Display slot is "next" after slot 7. By tapping Right and Left in Favorites mode, you can effectively scroll down and up your list of favorite items two at a time.

Recall that in Favorites mode, you cannot immediately tell by looking at the display that you are not in Display mode. However, the function of the Right and Left buttons is to scroll through the Favorite slots. In Display mode, these buttons have other functions as described elsewhere in this manual.

If you set the Mini-Scanner to request more than four items, only the first four are displayed but the additional items are retrieved from the car and logged via the serial port.

Favorite Slot 7

Recall that the Mini-Scanner does not remember the items in the Display slot. This is so that you can use this slot to browse data items that temporarily catch your interest. If you climb a long steep hill, for example, you may want to know if the motor/generators have heated up. Using the Select Line modes you can find this out (after pulling off the road) by tapping Right and Left to find the relevant data items. But, you probably don't want to see the MG temperatures the next day in your garage. So, the data items in the Display slot are discarded when you turn off the car. When the Mini-Scanner is next turned on, the Display slot data items are copied from Favorite slot 7. This is therefore where you should store the two items you want to see at the top of the display by default.

Choosing Options

In Options mode, the Mini-Scanner allows you to set various options. Details of the options themselves are given below. First, we describe here the general mechanism of choosing options. To get to Options mode from Display mode, tap Middle four times.

Upon entering this mode, the mode announcement will display for a short time. Then, the first option will be presented. The top line of the display shows the option name, for example "Items to Request/Log". The second line of the display shows the available choices for that option, for example " [2] 3 4 5 6 ". The currently selected choice is shown in brackets. So, the display described above means that the number of items to be requested and logged is 2.

Use the right button to change the selected choice. Tapping the Right button moves the selection forward through the list of choices. Holding the button sets the selection to the default choice. It is not possible to go backwards through the list of choices. Therefore, options will be arranged to have a small number of choices. In our example, tapping Right twice will change the selected choice to 4 and the bottom line of the display will appear thus: " 2 3 [4] 5 6 ".

Selecting an option choice does not put that choice into effect. To do this, hold the Left

button. The choice is now effective and the bottom line of the display reads “Option Choice Made”. In our example, if we hold the Left button after tapping Right twice, the number of items to be requested and logged will change from 2 to 4. Some option choices are saved at power-down, but others are lost when the Mini-Scanner turns off. See the description of the various Options for details.

Tapping the Left button moves forwards through the list of options. The display will show the next option's name on the top line and its list of choices on the second line. It is not possible to move backwards through the list of options. If you change the selected choice for an option and move to the next option by tapping Left, that change of selected choice is lost and if you return to that option the original (and currently effective) choice will be shown.

Example

This example describes how to select the “Fast” request rate on a Mini-Scanner that is currently set for the “Normal” request rate and has just been turned on.

Tap Middle until the “Select Options” announcement indicates that you have entered Options mode.

- Tap Left until the top line of the display shows “Item Request Rate”, i.e. the option you wish to change.
- Tap Right once to change the selected choice from “Norm” to “Fast”. The brackets will move to confirm the change in selection.
- Hold Left. “Option Choice Made” will appear on the bottom line of the display and the request rate will change to fast (but perhaps not immediately, see below for details).
- Hold Middle to return to Display mode.

Prius Mini-Scanner Options

This section of the Prius Mini-Scanner User Manual discusses the options that can be set in Options mode.

Items to Request/Log

This option sets the number of data items that will be requested from the vehicle. The default is two, so that the two data items selected into the current slot are requested and displayed. In Display mode, these are the items in the Display slot. In Favorites mode, these are the items in the current Favorite slot. Other choices for the option are from 3 up to 6. The additional data items requested are defined by the next sequential slot(s) to the current slot. For example, in Display mode the third requested item is the first from Favorite slot 1, the fourth is the second in Favorite slot 1, etc.

Normally, only the first two data items are displayed. (Four items would be displayed if the Display Method is set to Compress or if a 4-line display unit is installed.) However, if logging via the serial port is active, all requested items are logged. After the first two items in columns two and three of the log file, additional items appear in order in consecutive columns. For example, if the number of items is set to three, the third item will appear in column four.

The selected choice for this option is saved at power-down and will be effective at the next power-up.

Display Method

This option is only for use in the Mark I Mini-Scanner.

Item Request Rate

This option sets the rate at which the Mini-Scanner sends requests for data items to the vehicle. Choices for the option are Slow, Normal and Fast. The default is Normal. The selected choice for this option is saved at power-down and will be effective at the next power-up.

The request rate is controlled in the Mini-Scanner by changing two parameters of the communication protocol. The "inter-byte" time (P4) is the time that the Mini-Scanner waits after completing the transmission of one octet of a request message before it begins the transmission of the next. ISO9141 requires this time to be in the range 5 to 20 ms. The "inter-message" time (P3) is the time that the Mini-Scanner waits after receiving the last octet of a response message from the vehicle before it begins the transmission of the first octet of the next request message. ISO9141 requires this time to be in the range 55 to 5000 ms. The values of these parameters for the three request rates are shown in the following table:

<i>Rate</i>	<i>Slow</i>	<i>Normal</i>	<i>Fast</i>
P4 (inter-byte time)	15 ms	10 ms	5 ms
P3 (inter-message time)	1000 ms	350 ms	55 ms

The Prius seems to be perfectly happy with the Fast request rate all the time. So, the slower rates might end up not being very useful, except to limit the length of log files taken over a long period of time. I will probably scrunch the three choices up closer together at some time by decreasing P3 to 500 ms and 160 ms for Slow and Normal, respectively.

Display Backlight

This option is not effective in the Mark II Mini-Scanner. The backlight is controlled automatically by a light sensor.

Clear Trouble Codes

This option controls whether or not you can clear Diagnostic Trouble Codes (DTCs) when in Trouble Codes mode. The default is disabled. You need to change it to enabled if you want to clear DTCs. The selected choice for this option is saved at power-down and will be effective at the next power-up. However, you should be very sure about what you're doing when you clear DTCs and keeping this option disabled is a good idea.

Max. Request Retries

This option sets the number of times that the Mini-Scanner will retry a message to the vehicle after getting no response. Choices for the option are 0 to 5 in increments of 1. The default is 2.

The selected choice for this option is saved at power-down and will be effective at the next power-up.

PowerOff Delay (sec)

This option sets the length of time that the Mini-Scanner pauses after having decided to turn itself off before it actually powers off. This pause gives the user a chance to see what is happening and read displayed messages. Choices for the option are 2 to 7 seconds in 1 second increments. The default is 5 seconds. The selected choice for this option is saved at power-down and will be effective at the next power-up. If the Mini-Scanner needs to save new settings (favorites or option choices), the power-down delay will be increased by 50% to accommodate the additional message on the display.

Logging Data via the Serial Port

This chapter of the Prius Mini-Scanner User Manual describes the recording or “logging” of data using the serial port.

Data retrieved from the vehicle by the Mini-Scanner can be sent to a computer via the serial port. The data items sent are the same as those selected for display. However, only numerical data is sent, the descriptive text and units that you see on the display are not sent. You must remember what data was being displayed on each line when you examine the data. This purely numerical data is very easy to import into a spreadsheet.

The format of the data is plain ASCII text. In other words the number 62.5 will be sent as the four ASCII characters '6', '2', '.' and '5'.

The serial port operates at 9,600 bit/s, 8 data bits, no parity and one stop bit. These are the same setting used by the Flash Loader, so if you have a terminal emulator set up for firmware updates, you can use it to view the serial port data. Just connect the computer up and start the terminal emulator as if you were going to update the firmware (but don't hold down the escape key). Using the terminal emulator's capture features, you can save the data to a file for later analysis or charting in a spreadsheet program.

Timestamp

Each data value is associated with a “timestamp”. This indicates the approximate time at which the data item was sampled and had that value. The timestamp is given in seconds. Timestamps start at zero when you turn on or reset the Mini-Scanner and do not represent real-world or “wall-clock” time. The long-term accuracy of the timestamps has not been measured, but will be of the order of a second per hour.

The resolution of the timestamp is one millisecond, but this is not its short-term accuracy. Do not assume that the logged data samples are as precisely placed in time as the timestamp resolution suggests. When the data is actually sampled by an ECU in the vehicle is not known. It could be sampled at some regular rate so that a request for the data returns the most recent sample, whenever that was taken. Or, it is also possible that the sampling of data is triggered by the request on the OBD-II bus. But, exactly when this happens in relation to the request message and response is not know. The Mini-Scanner records the timestamp from an internal clock when the first octet of the vehicle's response is received.

Log Format

The format in which timestamps and data are sent to the serial port is designed to be logged in a file and then imported into a spreadsheet. The data can then be analyzed and visualized as a chart. The timestamps and data values are separated by tab characters, so when importing to a spreadsheet program, specify the file type as a tab-delimited text file. The format is best explained by an example:

```
126.456 14.84
126.927      14.0
127.394 17.18
127.861      14.5
128.329 19.53
128.796      14.0
129.263 19.92
129.730      6.0
130.197 20.31
130.668      1.5
131.135 19.92
131.606     -4.0
132.074 19.92
132.540     -8.5
```

Each line begins with a timestamp in the first column. Data values are placed in columns after the timestamp, separated from the timestamp by one or more tab characters. The values of the data item selected for display in line one appear in the second column and are separated from the timestamp by a single tab. The values of the data item selected for display in line two appear in the third column and are separated from the timestamp by two tabs. When you capture the serial port data to a file and import the file into a spreadsheet program, the timestamp, line one data and line two data will appear in columns A, B and C, respectively.

As you pass 999.999 seconds (a little more than sixteen minutes) since the Mini-Scanner was turned on or reset and the timestamp length steps up to eight digits, the data columns will appear to jump one column to the right. This has no effect when the data is imported into a spreadsheet.

If you select for display two data items that are retrieved from the same vehicle ECU using the same parameter ID (PID), then each vehicle response updates both display lines. The effect on the serial port data is that twice as much data will appear and consecutive lines will have the same timestamp.

Creating a Chart in a Spreadsheet

Creating a chart from data in this format imported into most spreadsheet programs is very easy. Simply select the block of data you want to chart, both rows and columns, and instruct the program to make a chart from it. Specify the type of chart as X-Y or "scatter" so that the first column is used as X axis values. You may also be able to specify that data points are joined by a line, though some low-end spreadsheets mishandle the blank cells. By default, both data columns will be plotted against the same Y axis, so if they differ in scale (for example engine r.p.m. varying from 0 to 4000 and throttle varying from 15 to 60) you will have some more work to do to plot each column against its own Y axis.

Control of Logging

Logging can be controlled using the Right button when the Mini-Scanner is in Display mode. Holding the right button toggles logging off and on. Logging is always on after powering up or resetting the Mini-Scanner. If you turn it off, this selection will not be saved and it will be on again after a power cycle or reset. The only reason you'd turn it off would be if you have a computer connected and are capturing data and you want to reduce the file size by not logging during uninteresting driving periods.

So that you can find interesting events in a log file, you can drop a mark into the file by tapping the Right button. This happens even if logging is off, so you can drop the mark and then turn logging on to keep the mark outside your data. The format of the mark is "Mk_n", where *n* is the mark number. The mark number starts at zero for the first mark after power on or reset and increases by one for each mark you drop. Should you use 255 marks, the next number will go back to zero. So that you know which mark number to look for in the file, it is briefly shown on the display. You can write it down, together with a description of the interesting driving event (but if you're driving, you should of course have someone else write it down). Marking the log file can be more useful than turning logging off and on because you can drop a mark after the interesting thing happened, when it would be too late to turn logging on.

The above actions of the Right button are effective only in Display mode. In all other modes, you have no control over logging.

Trouble Codes Mode

Trouble Codes mode allows you to see any Diagnostic Trouble Codes (DTCs) that the car's ECU have recorded. These indicate problems with the vehicle ranging from the trivial (the fuel filler cap is loose) to the catastrophic (the engine won't start). If the check engine light or "Malfunction Indicator Lamp" (MIL) comes on, it is very useful to find out why by retrieving DTCs. Sometimes you can fix the problem yourself but at the very least you can tell your service center something about the problem. You may be able to decide how urgent a trip to the shop might be.

To put the Mini-Scanner in Trouble Codes mode, tap the middle button until the display registers "Diag Trouble Codes". From Display mode, this will be five taps.

Browsing ECUs

When you enter Trouble Codes mode nothing much happens at first. By tapping the Right and Left buttons, you can browse forward and back in the list of ECUs with which the Mini-Scanner can communicate. These ECUs are:

- the Engine ECU, also known as the ECM (Engine Control Module), at address 10₁₆
- the Hybrid Vehicle ECU, at address 16₁₆
- the Battery ECU, at address D5₁₆

Data items are still being requested and logged. In order to retrieve DTCs from an ECU, select that ECU (by tapping the Right and Left buttons) and then hold the Right button. The result will appear on the display after a short pause. The requesting and logging of data items will stop. This is because the Mini-Scanner has to enter into a different mode of communication with the ECUs to retrieve the DTCs. If you accidentally enter Trouble

Codes mode while logging, you will not miss any information as long as you don't hold either the Right or Left buttons. You can just leave this mode by tapping or holding the Middle button.

Once you have started the retrieval of DTCs by holding the Right button, the information is refreshed at intervals of about one second. So, if a Trouble Code arises, you will see it on the display. If you tap the Right or Left buttons to select a different ECU, DTCs will then be retrieved from that ECU and displayed. So, you can browse through the ECUs inspecting their DTCs in turn.

Interpreting DTCs

The display shows three DTCs, each consisting of a prefix letter and four digits. The code P0000 means that there is no Trouble Code, so when there are no DTCs in an ECU you will see "P0000 P0000 P0000". If you have one DTC, it will appear in the first position. For example, if you remove the Service Plug from the high voltage battery and turn the car on, the Hybrid Vehicle ECU will show "P3140 P0000 P0000". The code P3140 means "Interlock Malfunction" and can be looked up in the Diagnostic Repair Manual. Much of the information from this manual is included in *Appendix B - Prius Diagnostic Trouble Codes*, below.

Leaving Trouble Codes Mode

When you leave Trouble Codes mode (by tapping or holding the Middle button), if you started the retrieval of DTCs then the Mini-Scanner has to get back to the mode of communication in which it can talk to all the ECUs and get data items. To do this, it will repeat the ISO9141 slow initialization that it did when you turned it on. After a few seconds, if you go back to Display mode, the display and logging of data items will resume. Changed settings have not been stored and the Display mode slots are as you left them. The slow initialization is purely to get back in touch with all the ECUs.

Peculiar Quirk

Experimentally, I have found that if you return to Display mode while retrieving data from the Battery ECU, ISO9141 slow initialization may fail and the Mini-Scanner will then turn itself off. This is probably a quirk of the vehicle and may not be present on all model years. If it is important to you that this not happen, go to the Hybrid Vehicle or Engine ECU before you leave trouble codes mode.

Clearing DTCs

In Trouble Codes mode it is possible to clear DTCs as well as display them. In general, this is not a good idea as your service department may need this information to diagnose problems with your car. Therefore, to clear DTCs, the Mini-Scanner makes you jump through a few hoops. First, you must have Clearing Trouble Codes enabled in the Options mode. Refer to the section on Options for how to do this. Now, select the ECU in which you want to clear DTCs by tapping the Right and Left buttons as before. It doesn't matter if you are retrieving DTCs or not, this will be started when you clear the DTCs. Hold the Left button. A message will appear asking you if you really want to clear the DTCs. (If Clearing Trouble Codes is not enabled in the Options mode, you will be informed of this instead.) If you decide to continue and clear the DTCs, hold the Left

button a second time. The DTCs will be cleared and the Mini-Scanner will retrieve the DTCs from that ECU, which naturally will all be P0000. If you change your mind about clearing DTCs, any button action other than holding the Left button will cancel the request.

Updating Mini-Scanner Firmware

The Prius Mini-Scanner contains a very small, highly integrated computer system called a “microcontroller”. The software program running on the microcontroller defines what the Mini-Scanner does. It looks to see if you've pressed a button, communicates with the car and puts information on the display. A computer has many different programs stored on disk, one or more of which are loaded into memory on your command. By contrast, a microcontroller has just one program fixed directly into memory that always runs when the system is turned on. For this reason, what you probably think of as software is given the slightly different name of “firmware”. It is firm, rather than soft, because it takes a little more effort to change. (Hardware, of course, is hard because you're stuck with it.) Nevertheless, firmware can be changed with the right facilities and this chapter tells you how to go about just that.

From time to time, ECROS Technology may release a new version of the Mini-Scanner firmware. Just as with Microsoft® products, the purpose of this is to introduce new bugs and obscure essential functionality with unnecessary features. No, of course what I hope to do is correct any problems that might arise and add more useful features. (I was just joking, Bill, please don't sue me.) Unless you ask to be removed from mailing lists, you will be notified of new firmware versions by e-mail. This will include a description of what problems are fixed or new features added, so you can make up your mind whether or not to update your Mini-Scanner. The actual firmware is posted on the Mini-Scanner Web site and must be downloaded to a computer.

Downloading Firmware

All released firmware for the Mini-Scanner, both Mark I and Mark II, is posted on the Mini-Scanner Web site. As well as the most recent version, many earlier versions are also available in case you want to go back to them. Brief notes list the major changes at each version, but you might want to save the version announcement e-mails for detailed information if you think you will be bouncing between firmware versions.

The CD-ROM that comes with your Mini-Scanner contains the firmware installed on the Mini-Scanner during manufacture and all earlier releases.

If you are familiar with downloading Zipped files from the Internet, you can skip the rest of this section.

To download firmware, begin by browsing to the firmware page from the Mini-Scanner Web site at <http://miniscanner.ecrostech.com>. There are separate pages for Mark I and Mark II Mini-Scanners. Locate the version of the firmware you want to download. Do not click its link but instead use your browser's facility to save the link target on your computer's disk. In Internet Explorer, right-click on the link and select Save Target As... from the pop-up menu. Browse to a suitable folder on your computer and save the file.

When the download is complete, locate the file and unZip it (that is, extract the contents of the Zip archive). You can do this with WinZip, many other utilities or features built

into recent versions of Microsoft Windows. What pops out of the archive is the firmware file or files you will use below to update the Mini-Scanner.

The Flash Loader

The microcontroller in the Mini-Scanner stores its program in a type of memory called “Flash”. This is the same memory as is used in CompactFlash cards, FlashDrives, etc. The name, I think, originally suggested that you could change the contents of this memory “in a flash”, as compared to other technologies available when Flash was introduced. A small utility called a “Flash Loader” is built into the Mini-Scanner during manufacture. This runs before the Mini-Scanner program and normally does nothing but wait for a fraction of a second before continuing. However, if you hook up a computer to the serial port and hold down a key, as described below, the Flash Loader takes control and the main program does not run. You can then use simple commands to remove the current firmware and install your new version.

The rest of this chapter describes in detail how to use the Flash Loader to update Mini-Scanner firmware.

Power to the Mini-Scanner

To update firmware, the Mini-Scanner must have a source of power. Normally, it gets its power from the car via the DLC connector. This is perfectly fine for updating firmware, but it does mean that you have to take your computer, with the firmware file, to the car. If this is not convenient, you can remove the Mini-Scanner from the car, take it to your computer and power it from a 9 volt smoke alarm battery.

Updating Firmware in the Car

The easiest way to update the firmware is to use a portable device such as a notebook computer. Make sure the new firmware file is stored on this computer, that it has a serial (“COM”) port and a terminal emulator program is available on it. It is best to run the computer from battery power. If you power it from the car using an adapter, make sure the output of the adapter is isolated from the car's electrical system. The Mini-Scanner is, of necessity, directly connected to the electrical ground of the car.

Using the 9 Volt Battery Hook-Up

Not everyone has a notebook computer or other portable computing device. If you want to take the Mini-Scanner to a computer to perform a firmware update, special provision has been made for this. Follow the uninstallation instructions to remove the main unit from the car. You will need the 9 volt battery hookup that was included in your Mini-Scanner package and a fairly fresh 9 volt alkaline smoke alarm battery or a well charged nickel metal hydride battery of the same size.

As you have left the adapter cable in the car, the header to which this cable connects will be open. The battery connects to the left-most two pins of this header. The photograph at right shows the 9 volt battery hookup connected to a Mini-Scanner and to a battery. The red wire goes to the pin in the top row, closer to the buttons, but the connector will not fit the other way round so it should not be possible to get this wrong. Additional photographs of higher resolution are included on the CD-ROM.

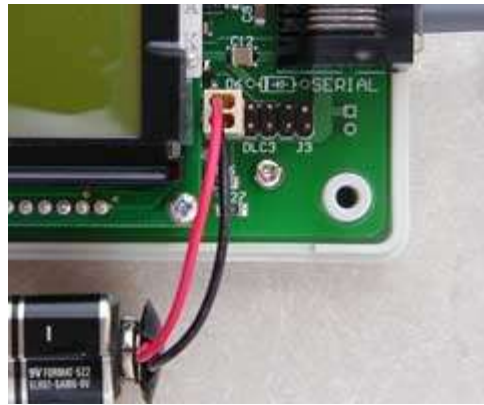


Photo 10 – 9 Volt Battery Connection

If the display backlight is on, the current drawn by the Mini-Scanner is higher than is normal for a battery of this type. It is best, therefore, to work in a well lighted room so that the backlight remains off.

Connecting the Serial Cable

The Mini-Scanner serial cable consists of a telephone cord and an adapter. Plug either end of the telephone cord into the adapter and plug the adapter into the COM port of your computer. Plug the other end of the telephone cord into the jack on the right hand side of the Mini-Scanner main unit.

Remember that although the Mini-Scanner uses telephone-type connectors and cords, you should *never connect it to a telephone circuit* or it will be damaged.

Note for Mark I owners (skip this sidebar if you have a Mark II): The Mark I Mini-Scanner does not have the externally accessible RJ11 jack for the serial cable. Instead, the case must be opened and the cable attached inside, much like the adapter cable. For details, refer to the Mark I Web site.

If you are using an extension serial cable for extra reach, you should make sure you have the right type of extension. If you are planning to power your computer from the car, look out for grounding problems. <<To do – expand and clarify>>

Terminal Emulator Programs

The computer or other device you use to update firmware must be able to run a kind of program called a “terminal emulator”. This allows the computer to act as a “terminal”. Whatever you type on the keyboard is transmitted to some other device that you have connected to and anything that device sends back is displayed on the screen. Above, we have connected to the Mini-Scanner using the serial (“COM”) port, but typically terminal emulators will also work with other connections such as the Internet.

The Microsoft® Windows™ operating system includes a terminal emulator program called HyperTerminal. The *Prius Mini-Scanner Welcome* CD-ROM includes a freeware terminal emulator called TeraTerm Pro. ECROS Technology recommends that you use TeraTerm Pro. Not only is it easier to use but it completes the update in a quarter of the time as compared to HyperTerminal. Other terminal emulators are available for the Windows, Linux and Mac operating systems and will all work for firmware updates.

HyperTerminal

Versions of Microsoft® Windows™ since about Windows 95 have included a Terminal

Emulator called “HyperTerminal”. On Windows XP, you can find it at Start → Programs → Accessories → Communications → HyperTerminal. In other versions it may be in different places; consult the Windows documentation for details (OK, realistically just look around until you find it). I will now try to tell you how to use HyperTerminal, although frankly I'd rather you not use it because it is an appallingly badly designed piece of software.

Start HyperTerminal (from the **Start** button, depending on where it is on your version of Windows™). The **Connection Description** dialog will appear. Click Cancel to get rid of it. Now you just have the HyperTerminal main window.

Select File → Properties on the menu to bring up the **New Connection Properties** dialog. On the Connect To tab of this dialog, bring down the Connect using: pick list and select COM1 or COM2, etc., according to which serial port you are using on your computer. Then, click the Configure... button to bring up the **COMn Properties** dialog. Set the five pick lists as follows: Bits per second: to 9600, Data bits: to 8, Parity: to None, Stop bits: to 1 and Flow control: to None. Click the OK button to accept these new settings and get rid of this dialog. Now go to the Settings tab of the **New Connection Properties** dialog, which should still be on the screen. Bring down the Emulation pick list and select TTY. Click the ASCII Setup... button and the **ASCII Setup** dialog appears. Check the Send line ends with line feeds checkbox. Click the OK button to finish this dialog. Everything else can be left at its default value. Click the OK button to finish up configuration. You should once again be back to the main window.

Select File → Save As... on the menu to bring back the **Connection Description** dialog. In the Name edit box, type a suitable name that will allow you to remember what this “connection” is for. For example, you might type “Mini-Scanner Update”. If you wish, you can choose an icon from those presented. I rather like the one with the picture of an atom. Click the OK button, whereupon the dialog will disappear and be replaced with the Save As... browser dialog. HyperTerminal is offering to save a file describing the connection in a place of its choosing on your computer. The filename is already filled in from what you entered in the previous dialog. Accept this filename and location by clicking Save. Again, you are back at the main window.

Now, exit HyperTerminal. It sounds silly, but do it. You can use File → Exit or click the Close button (the one at top-right with a cross in it). Don't try to use HyperTerminal to communicate with the Mini-Scanner at this point.

Go back to start HyperTerminal again, but now as you reach the end of your exploration of the **Start** menu you will see two “HyperTerminal”s. The new one is a folder, (which you can tell from the icon and the arrow pointing to another menu level). Continue to this menu level and you should find the connection you just set up under the name you gave it. Select this, and HyperTerminal will start up with all the configuration already done.

At this point, you have completed the configuration mentioned in step 3 of *Firmware Update Procedure*, below. In future, at step 3, just start HyperTerminal using your pre-configured connection as described.

In step 6 of *Firmware Update Procedure*, you will need to send the firmware file to the Mini-Scanner Flash Loader. To do this, select Transfer → Send Text File... on the menu to bring up the **Send Text File** file browser dialog. Using this browser, locate the firmware file on your computer, click on it to select it and then click the Open button. The dialog will close and the file transfer will begin. You should see dots begin to appear in the main HyperTerminal window as each record passes from the file to the Mini-Scanner and

is acknowledged as correct. Do not touch the keyboard until the file upload is complete and the Flash Loader presents you with a new prompt. The upload will take several minutes.

TeraTerm Pro

The terminal emulator program TeraTerm Pro is included with the Mini-Scanner on the *Prius Mini-Scanner Welcome* CD-ROM. It is freeware, which means that you can use it without registering or paying any money to anyone. About the only thing you can't do with it is redistribute modified versions. Unfortunately, this is exactly what I've done as I've pre-configured the program for the Mini-Scanner. I hope that the program's author does not consider changing the default settings to be “modification”.

TeraTerm Pro consists of a couple of dozen files which are in the TeraTermPro folder of the CD-ROM. You can run the terminal emulator from the CD-ROM by double-clicking the file `ttermpro.exe`. It is probably better, however, to install it on your computer. To do this, just create a new folder somewhere of your choosing and copy to it all the files in the TeraTermPro folder on the CD-ROM. For example, you might decide to install TeraTerm Pro in `C:\Program Files\TeraTermPro`. You can run the program by double-clicking the file `ttermpro.exe` in this new folder or you can create a shortcut in the **Start** menu or on the desktop. Consult your operating system documentation for details.

There is a configuration change that you must make *only* if you are *not* using the COM1 port of your computer. Select **S**etup → **S**erial port... on the menu to bring up the **TeraTerm Serial Port Setup** dialog. In the **P**ort: pick list, select COM2 or COM3, etc. according to which serial port you are using. Click **O**K. To save this change so that you don't have to make it every time, select **S**etup → **S**ave setup... on the menu to bring up the **TeraTerm Save Setup** dialog. Browse to the directory into which you copied the TeraTerm Pro files and click **S**ave. This will overwrite the original configuration and in future when you start TeraTerm Pro it will use the serial port you selected.

In step 6 of *Firmware Update Procedure*, you will need to send the firmware file to the Mini-Scanner Flash Loader. To do this, select **F**ile → **S**end File... on the menu to bring up the **TeraTerm: Send File** file browser dialog. Using this browser, locate the firmware file on your computer, click on it to select it and then click the **O**pen button. The browser dialog will close, a different **TeraTerm: Send File** dialog will open and the file transfer will begin. You should see dots begin to appear in the main TeraTerm Pro window as each record passes from the file to the Mini-Scanner and is acknowledged as correct. It will probably be necessary to move the dialog out of the way to see this. Do not touch the keyboard or click the dialog buttons until the file upload is complete and the Flash Loader presents you with a new prompt. The upload will take a minute or so.

Other Terminal Emulators

You can update the Mini-Scanner firmware using any terminal emulator program that can send a file in plain text format. Configure the serial port for 9,600 bit/s, 8 data bits, 1 stop bit and no parity. Disable flow control. Make sure you select the COM port to which the Mini-Scanner is connected.

Note for Mark I owners (skip this sidebar if you have a Mark II): The Mark I Mini-Scanner has an earlier version of the Flash Loader than the Mark II and an additional configuration step is needed. Set the terminal emulator so that line ends are transmitted as <i>both</i> a carriage return <i>and</i> a line feed.
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When you send the firmware file to the Mini-Scanner Flash Loader in step 6 of *Firmware Update Procedure*, make sure you send it as plain text. Do not use a file transfer protocol such as kermit or xmodem.

Firmware Update Procedure

To perform a firmware update, follow the numbered steps below. In all cases of pressing or holding down a key, it is a key on the computer keyboard to which I am referring. When I say “you will see”, I mean on the computer screen. You are basically interacting with the computer and terminal emulator program from steps 3 to 7 and need not touch or look at the Mini-Scanner except to press the On/Reset button in step 4.

1. Make sure the Mini-Scanner has power. If you are in the car and the DLC adapter and cable are connected normally, this is already done. There is no need to turn the car on. If you have removed the Mini-Scanner from the car, use a 9 volt battery as described in *Using the 9 Volt Battery Hook-Up*, above.
2. Connect the serial cable to the Mini-Scanner and to a serial (“COM”) port on your computer (see *Connecting the Serial Cable*, above, for details).
3. Turn on the computer and run the terminal emulator application. If you have not already done this, set it to connect via the COM port to which you connected the Mini-Scanner in step 2 and configure the serial port for 9600 bit/s, eight data bits, no parity, one stop bit and no flow control as described in *Terminal Emulator Programs*, above.
4. Hold down the escape (Esc) key (see note, below), wait a second or two and, *while continuing to hold down the escape key*, press and release the On/Reset button of the Mini-Scanner. This will get you into the Flash Loader and you will see a banner message and then a prompt (“>”).
5. To erase the existing firmware in the Mini-Scanner, press 'z'. You will see the message “erasing” and after a few seconds a new prompt.

Note for Mark I owners (skip this if you have a Mark II as it happens automatically): Put the Flash Loader in “program” mode by pressing “p”. You will see the message “prgm” and a new prompt.

6. Using the terminal emulator application, send the new firmware file to the Mini-Scanner in plain ASCII text format. As each record in the file is read, you will see a dot appear. It may take several minutes to complete the update. Do not interrupt the update by resetting the Mini-Scanner, unplugging the cable or quitting the terminal emulator application. When it is finished, a new prompt will appear.
7. Press “q” to quit the Flash Loader (the “q” will not be echoed). The Mini-Scanner will immediately run the new firmware. (Of course if you are not in a car, or the car is not turned on, the Mini-Scanner will not get a vehicle response and so it will turn itself off. Either now or later, re-install the Mini-Scanner in the car or turn the car on and then press the On/Reset button to start the new firmware.)
8. Disconnect the serial cable (if desired).

That's all there is to it. The rest of this chapter discusses problems that might occur and how to solve them and advanced and expert use of the Flash Loader. In most cases, if you are not experiencing problems, you can skip the remaining material.

Problems and Errors

This section attempts to identify some problems that might occur with firmware updates and tells you how to go about solving them. The Flash Loader includes diagnostics to detect bad firmware files and hardware problems in the Mini-Scanner and the errors it issues are listed and explained here. If you are using a 9 volt battery and experience any problems, make sure the battery is not the problem. It does not have to be new, but it should not be on the last half of its life. Try a new battery if you have one.

Nothing Happens When I Reset the Mini-Scanner

If, when you release the On/Reset button in step 4, you see nothing at all in the terminal emulator window and the Mini-Scanner starts normally, check the following:

- Make sure the COM port of your computer is working. In many computers, the COM ports can be disabled in the BIOS.
- Check that you have configured the terminal emulator to use the COM port into which you have plugged the Mini-Scanner serial cable.
- Check all other configuration settings of the terminal emulator. You should be using 9,600 bit/s, 8 data bits, no parity and 1 stop bit. Flow control should be disabled.
- Make sure the plugs on the telephone cable are fully seated into the jacks in the Mini-Scanner and serial port adapter. They will click when they are all the way in.
- If you have a Mini-Scanner Mark I, make sure the 10-pin connector is properly seated over all ten pins of the serial port header inside the main unit.
- If you have a Mini-Scanner with a debug port and have used it to replace the firmware, you will have erased the Flash Loader. You will need to put it back before you can use it again. A ZiLOG ZDS II project to accomplish this was e-mailed to you at about the time you received your Mini-Scanner.
- Check the items in the next section also.

I Get a Short Burst of Garbage

If, when you release the On/Reset button in step 4, you get something in the terminal emulator window but it consists of punctuation and other garbage characters, check the following:

- Check the serial port configuration settings of the terminal emulator. You should be using 9,600 bit/s, 8 data bits, no parity and 1 stop bit.
- If you are using a telephone cord other than the one supplied with the Mini-Scanner Mark II, make sure it is of the “cross-over” kind. If you hold up the little clear plastic plugs, turn them the same way round and peer inside, you should see the colored wires arranged in the opposite order at each end.
- If you are using a serial cable extension, make sure it is of the “straight-through” kind and not a “null-modem” cable. Try without the extension.

I Get a Row of Dots

If, when you release the On/Reset button in step 4, you get a row of dots in the terminal

emulator window and the Mini-Scanner starts up normally, the serial port and terminal emulator are correctly set up. However, the Flash Loader is not detecting the escape character you are trying to send it. It pauses only briefly during startup to look for this character. The reason that step 4 tells you to hold down the escape key is to activate the auto-repeat of your computer keyboard. This sends many escape characters quite quickly so that one is noticed by the Flash Loader before it gives up and starts the Mini-Scanner main program. If sometimes you get to the Flash Loader banner/prompt and sometimes you don't, there is nothing wrong with trying repeatedly until you get in. If you cannot activate the Flash Loader at all, check the following:

- Make sure that you still have the escape key held down when you release the On/Reset button of the Mini-Scanner.
- Make sure that before you release the On/Reset button, you have held the escape key down long enough to start the auto-repeat feature of your keyboard. Check the repeat delay setting of the keyboard in the Windows Control Panel.
- Check the keyboard repeat rate in the Windows Control Panel. If it is set too low, the Flash Loader might begin and end looking for an escape in between repeats. Try increasing the repeat rate.
- There may be a break between the computer's TXD (transmit data) pin and the Mini-Scanner's RXD (receive data) pin. Look for damage to the cables, dirty or bent contacts, etc.

I Don't Get Dots in Step 6

Very important note for Mark I owners (skip this section if you have a Mark II): About half of Mark I owners hit the problem described here. They were people who knew how to set up HyperTerminal and therefore did not follow the instructions. If you are reading this before performing a firmware update, please set up HyperTerminal exactly as described or, even better, use TeraTerm Pro. In the Mark II, the Flash Loader has been improved so that the problem cannot occur.

If you get to the Flash Loader banner and everything seems to be working but when you send the firmware file to the Mini-Scanner in step 7 you don't get dots as each record is processed, your terminal emulator program may be suppressing line feed characters. To test this, start again. You'll have to stop the file transfer or quit the terminal emulator program. Once you have the terminal emulator going again, try pressing the escape key to get back to the Flash Loader prompt. If this does not work, you will have to reset the Mini-Scanner again. Once at the prompt, hit the Enter key several times. If the mode announcement and prompt appear each time, see "I Still Don't Get Dots", below. If nothing happens, the line feeds are not getting through. Explore the settings of your terminal emulator looking for line end processing options. Choose line feed or both carriage return and line feed. Carriage return on its own will not work. Instructions for setting up HyperTerminal correctly are included in *Terminal Emulator Programs*, above. TeraTerm Pro is supplied already properly configured.

I Just Don't Get Those Dots

If you have a Mark II Mini-Scanner or your terminal emulator is set up to pass line feeds (that is, when you hit the Enter key you get the mode announcement and prompt) and you don't get dots in Step 6, the next thing to check is that the Mini-Scanner is listening for Intel Hex records. Go to verify mode and at the computer keyboard, type the following, (remember the final Enter):

:0000000000 (colon and ten zeros then Enter)

:00000001FF (colon, seven zeros, a one, two Fs then Enter)

After the first line, you should get a dot. After the second line, you should be back at the idle prompt. If this test does not work, the Mini-Scanner is probably at fault and may require repair. If it does work, the problem is with the file you're trying to load or the terminal emulator's file send function. Make sure you're using the right firmware file, that it has been un-zipped (the file extension should be .hex) and that the file contains lots of separate lines of numbers, some lines quite long, all starting with a colon character.

Get back the attention of the Flash Loader by starting again at step 4 or hitting Escape and Enter so that the prompt reappears. Make sure your terminal emulator application is working properly. If you turn on its “local echo” option, you will see the file being sent, but this will obscure the responses of the Flash Loader somewhat. The last line of data sent from the file should look something like this: :00000001FF.

Windows NT and HyperTerminal have been reported to malfunction in the way we're now discussing. The only known solution is to forget HyperTerminal and get a decent terminal emulator such as TeraTerm Pro.

I Get Some Dots, Then They Stop

Inspect the firmware file to make sure it's all there. If somehow part of the file has been chopped off, the firmware update will just stop in the middle. Look at the last line of the file in a text editor such as Notepad. It should be the end-of-file record, which looks something like this: :00000001FF. The 01 in the eighth and ninth positions are the end-of-file record type and must be correct although other characters may be different. If the file is corrupt, you will need to get another one. Another possibility is that the file send operation was terminated somehow. If the terminal emulator program allows you to abort a transfer, did you accidentally do this?

I don't want to beat this point to death, but if you're using a 9 V battery you did make sure it's not on its last gasp, didn't you? It hasn't just died, has it?

New Program Does Not Run

If, after successfully following the basic update procedure, you get the message “no user program!” when you type “q”, the update did not take place. Look for error messages during the file upload. Note that if all is well, then the “q” is not echoed. The Mini-Scanner just starts right up.

Note for Mark I owners (skip this if you have a Mark II): If there are only dots (no errors) during the file upload, a possible cause is that you did not type “p” to put the Flash Loader into program mode.

Lots of “5” or “Error 7” Messages

This error means that you are attempting to overwrite data that is already in the Mini-Scanner. A possible cause is that you missed out step 5 in the update procedure (erasing the current firmware).

Flash Loader Errors

This section explains error messages you might see from the Flash Loader if something goes wrong. If you follow the update procedure carefully and use an unZipped firmware file obtained from ECROS Technology, you are very, very unlikely to ever see an error.

Note for Mark I owners: whereas the Mark II prints just a number, such as “1”, in place of the dot when an error occurs, the Mark I prints something like “error 4”. The error numbers in the Mark I were in no particular order but for the Mark II were rearranged to give an indication of how severe the problem is. In summary, but format and number differ. In the error descriptions, the Mark I error message is shown in brackets, e.g. [Mark I: error 4], after the Mark II error number, e.g. 1.

no user program! - The Mini-Scanner does not contain a user program. Repeat the update procedure.

1 [Mark I: error 4] - A mismatch was detected during a verify operation. This error is issued for each record containing data that does not match the current Mini-Scanner firmware. The Mini-Scanner does not contain the same firmware as the selected file.

2 [Mark I: error 2] - A record in the input file had a bad checksum. The file is not in the correct format or is corrupt. Obtain a new firmware file. Note that an Intel Hex32 file is likely to cause this error. The Flash Loader only reads Intel Hex16 files.

3 [Mark I: error 3] - A record in the input file had a bad value in the record type field. The file is not an Intel Hex file, is not in the correct format or is corrupt. Obtain a new firmware file. Note that an Intel Hex32 file is likely to cause this error. The Flash Loader only reads Intel Hex16 files.

4 [Mark I: error 1] - A record in the input file contained a character that is not a hexadecimal digit. The file is not an Intel Hex file, is not in the correct format or is corrupt. Obtain a new firmware file.

5 [Mark I: error 7] - Data from the firmware file cannot be programmed because it is at an address in the Mini-Scanner memory that is not empty and does not already contain that data. If you are performing a full update of the firmware, start again and be sure to erase the old firmware first. If this error recurs, return the Mini-Scanner for repair.

6 [Mark I: error 5] - The microcontroller was unable to unlock its programming hardware. Return the Mini-Scanner for repair.

7 [Mark I: error 8] - The microcontroller failed to write the new firmware into its memory. Return the Mini-Scanner for repair.

8 [Mark I: error 6 or 9] - The firmware file contains data to be written to an address reserved by the Flash Loader for its own use. It has been constructed without proper regard for the rules that allow it to work with the Flash Loader. Obtain a new firmware file.

The difference between errors 6 and 9 in the Mark I are subtle and not helpful to the user.

9 [Mark I: error 0A] - You aborted a download by pressing the escape key.

Advanced Use of the Flash Loader

In addition to updating firmware, you can use the Flash Loader to verify that the firmware in the Mini-Scanner corresponds to a particular file. This is useful to make absolutely sure that an update worked and also to find out what firmware you are running if you lose track. Follow the basic procedure, but in step 5 don't erase the firmware and instead, type 'v' for verify. You will see the message “vrify” and a new prompt. When you send the file using the terminal emulator, dots should appear just as before. If there is a difference between the file and what is in the Mini-Scanner, the message “1” (or, for the Mark I,

“error 4”) will appear instead of a dot for each record of the file in which there is a mismatch.

To perform a verify operation immediately after a new upload, repeat step 6 before proceeding to step 7. The Mark II Flash Loader is automatically in verify mode after the upload, but Mark I owners must type 'v'.

If a firmware update is interrupted, for example by accidentally resetting the Mini-Scanner or a computer crash, it should be sufficient to simply start again. Try to be sure to get into the Flash Loader on your first reset attempt (step 4) as otherwise you will run the part of the user program that was loaded. There is a very, very small chance that this could be harmful to the Mini-Scanner or Flash Loader program.

Expert Use of the Flash Loader

The Flash Loader has three modes of operation, test, program and verify. This controls what happens to the data read from an input file. A mode announcement message, “test”, “prgm” or “vrfy”, appears each time the prompt is issued to tell you what mode you are in. If you hit the enter key, the prompt is repeated, including the mode message. Other input is not echoed so nothing will happen unless you hit a valid command key.

On activating the Flash Loader from system reset, it is in test mode. Typing “p” puts you in program mode, typing “v” puts you in verify mode and typing “t” puts you in test mode. You can switch between these modes at any time. An erase operation puts the Flash Loader into program mode. After reading in an Intel Hex16 file and detecting the end-of-file record, the Flash Loader changes to verify mode.

Note for Mark I owners (skip this if you have a Mark II): the Flash Loader in the Mark I indicates test mode with the message “idle”, although it still functions as described above. Modes are not changed automatically and you have to type “p” to go to program mode and “v” to go to verify mode. There is no command to return to test mode, other than restarting the Flash Loader.
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If you send a file to the Flash Loader when it is in idle mode, the basic syntax of the file is checked but nothing is programmed or verified. The safest way to check an unknown file is to upload it in idle mode. If you get nothing but dots, the file is in Intel Hex16 format and should be safe to program into the Mini-Scanner.

You can upload and program a new file to the Mini-Scanner without erasing the existing program. This will work if either the new program file is a strict superset of the existing one or if the two files are disjoint. In the first case, the Flash Loader will simply ignore all the bytes in the new file that have already been programmed in the same place by a previous upload. In the second case, all locations programmed by the second file are still in the unprogrammed state from a previous erasure. This way of using the Flash Loader could be useful to add data to tables in the firmware in which space has been reserved for this purpose.

Summary of Button Functions

The following table summarizes the functions of the Left and Right buttons in the various modes in which the Mini-Scanner operates:

<i>Left Button</i>		<i>Mode</i>	<i>Right Button</i>	
<i>Hold</i>	<i>Tap</i>		<i>Tap</i>	<i>Hold</i>
(none)	(none)	Display	Mark Log	Toggle Logging
Copy to Display	Previous Slot	Favorites	Next Slot	Set from Display
(none)	Previous Item	Select Line 1	Next Item	(none)
(none)	Previous Item	Select Line 2	Next Item	(none)
Make Choice	Next Option	Options	Next Choice	Default Choice
Clear DTCs	Previous ECU	Trouble Codes	Next ECU	Get DTCs

To move from one mode to the next, tap the Middle button. To return from any mode to Display mode, hold the Middle button.

To turn off the Mini-Scanner without turning off the car, press the Left, Middle and Right buttons at the same time.

On the Mark I Mini-Scanner only, to have the display backlight come on when you turn on or reset the unit, hold the left button down until you have released the On/Reset button.

Appendix A - Available Data Items

This appendix presents a listing of the data items that you can display with the Prius Mini-Scanner. For methods of selecting which items to display, see above. Any items that appear to be available for display but are not described here are unsupported, which means I probably haven't figured out what they are yet.

The “||” symbols are placeholders for the actual values. You will see them when a data item is first selected to a display line, but they will then be overwritten with the actual item value retrieved from the vehicle. For example, “Battery SoC: || %” will be replaced with something like “Battery SoC: 57.5 %” when the vehicle responds to a request for the value of the SoC.

Listing of Data Items

The order in which items are listed here corresponds to the order in which they appear in the Mini-Scanner's Select Line modes. I have tried to keep the more interesting items early in the list and also at the very end (since you can go backwards around the list). Until the list stabilizes, a new release may mess up your favorite selections, so you might want to keep a written record of your favorites and check them after uploading new firmware.

Main Battery State-of-Charge (SoC)

Battery SoC: ` %

Main (traction) battery state of charge (SoC), in percent. Experiments suggest that this percentage is referenced to the full rated capacity of the battery, which is 6.5 ampere.hours.

You can use the SoC value to estimate how “willing” the car will be to run on battery power only. For example, at 60% or higher, you can draw up to about 30 amps from the battery before the engine starts up. At lower SoC, the current at which the engine starts is

reduced.

Correlating the indicated SoC with the battery icon on the Energy Monitor display results in some surprises. The table below shows the SoC points at which the icon changes state in the charging and discharging directions. These were determined by independent experiments on US and UK Prius. The EMPTY icon was not seen down to 22% SoC. The maximum SoC achieved was 80%.

<i>Charging (Rising SoC)</i>		<i>Discharging (Falling SoC)</i>	
<i>SoC</i>	<i>Battery Icon</i>	<i>SoC</i>	<i>Battery Icon</i>
74.5% → 75%	3/4 → FULL	72% → 71.5%	FULL → 3/4
57.5% → 58%	1/2 → 3/4	55% → 54.5%	3/4 → 1/2
44.5% → 45%	1/4 → 1/2	42% → 41.5%	1/2 → 1/4
(not known)	EMPTY → 1/4	(below 22%)	1/4 → EMPTY

Two things immediately stand out:

The range of SoC represented by each icon state is not uniform. The 3/4 icon covers an SoC range of 17% but the 1/2 state covers only 13%. The 1/4 icon appears to cover 20% or more and the FULL icon less than 10% if the maximum possible SoC is indeed 80%.

There is a hysteresis of 3% between icon state changes in the charging and discharging directions. As a result, the 3/4 icon can be displayed for SoCs in the range 55% to 74.5%. If the car is not driven at low speed for many miles the SoC will not fall below 55% so it is no wonder that some people report that their battery icon never changes.

The battery icon should therefore be interpreted only as a very rough measure of battery SoC.

Main Battery Charge Current

Current: -||`|| A

Main (traction) battery current, in amperes. The displayed value is positive for charge (current into the battery) and negative for discharge (current out of the battery). You can use this value in conjunction with the battery state of charge to influence whether the car runs on battery power only or starts the engine. In city driving, especially with small hills, you can obtain a noticeable improvement in fuel economy by extending periods of battery only driving and using the engine in a “pulsed” fashion to accelerate and climb hills. You can also use this value to learn a braking strategy that avoids the use of the friction brakes and therefore maximizes the energy recovered by regenerative braking.

Vehicle Speed

Speed: ||| km/hr

Vehicle speed, in kilometers per hour. The Toyota Repair Manual Volume 1 (Diagnostics) says that when the vehicle is stopped the value should be 0 km/hr. How much does that manual cost, again?

Vehicle Speed in Miles per Hour

Speed: |||`| m.p.h.

Vehicle speed, in miles per hour. Since the ECUs respond to a request for vehicle speed in kilometers per hour, this number is computed by dividing the result by 1.6. This should be accurate enough for Europeans to know by how much they're exceeding the speed limit in the United Kingdom. However, if you're recording speed via the serial port

to perform some off-line calculations, it is better to obtain the speed in kilometers per hour and compute the figure in miles per hour yourself, if necessary.

Engine Spin Rate (Tachometer)

Engine: ||||`|| rpm

Engine spin rate, in revolutions per minute.

Throttle Position

Throttle: ||`|| %

Throttle position sensor output, in percent. Note that the throttle we're talking about here is not the pedal under your right foot, which is the accelerator pedal, but the valve that restricts the flow of air into the engine inlet manifold. The Toyota Repair Manual Volume 1 (Diagnostics) describes this item as "Voltage Output of Throttle Position Sensor Calculated as a percentage". It goes on to say that 0V corresponds to 0% and 5V to 100%. When the throttle is fully closed we should see 0 - 5% and when the throttle is fully open, 90 - 100%. This makes me suspect that I am not scaling the data properly. With my scaling, the rest position of the throttle sensor seems to be at about 15%. I obtained this scaling from Alex Peper's scan tool, which I assume follows the standard for OBD II mandated items such as this one.

Calculated Engine Load

Calc. Load: ||`|| %

Calculated load, in percent. This is a standard OBD-II data item. The Toyota Repair Manual Volume 1 (Diagnostics) describes this as "Calculator Load", but explains that it is the "Current intake air volume as a proportion of max. intake air volume". This makes a lot of sense if you substitute "mass flow rate" for "volume". The manual goes on to say that when idling you can expect a value of 5.4 - 19.2% and when "Racing without load (2,250 rpm)" you should expect 6.9 - 16.2%.

Engine Coolant Temperature

Engn. Coolant: ||| °C

Engine coolant temperature, in degrees Celsius. With city driving in hot weather, my engine temperature rises to 89 °C, which I presume is the point at which the thermostat opens. The Toyota Repair Manual Volume 1 (Diagnostics) describes this as "Engine coolant Temp. Sensor Value" and goes on to say that after warming up you should expect values in the range 80 - 95°C (176 -203°F).

The blue "cold engine" light goes out when the engine coolant temperature reaches about 50 °C. The car will not stop the engine and run on battery power until the temperature reaches about 71 °C. However, once this has happened, the engine can cool to about 59 °C before the car insists on running the engine again.

Ignition (Spark) Advance

Spark Advnce: ||`| °

Cylinder one spark timing advance, in degrees of crankshaft rotation. It is very interesting to watch this during the first minute after you start the car. It goes negative, representing a timing retard. The fuel/air mixture is being ignited as the piston descends. Very little energy is extracted, which is why the car runs on battery power at this time (watch the battery current also). So, the exhaust gas remains very hot and quickly heats up the oxygen sensors and catalytic converter to gain control over emissions. The Toyota Repair Manual Volume 1 (Diagnostics) describes this as "Ignition Timing of Cylinder No. 1" and goes on to say that when idling you should expect to see values of "BTDC 7

-15 deg.”

Temperature of Air Entering Engine

Int. Air Temp: || °C

Temperature of air flowing into the engine intake manifold, in degrees Celsius. The temperature sensor for this data item is built into the mass air flow sensor (see below). It is not the sensor behind the front bumper that measures ambient air temperature for display on the Multi-Function Display.

Rate of Air Flow into Engine

Air Flow: ||`|| gm/s

Rate of air flow into the engine intake manifold, in grammes per second. Since the emissions control system keeps the fuel to air ratio fairly constant at all times, this air flow is a strong indicator of fuel flow as well. Except, that is, when the engine is spinning without fuel or spark.

MG2 Spin Rate

MG2 Spin: |||| rpm

MG2 spin rate, in revolutions per minute. Since MG2 is connected to the front wheels of the vehicle via a fixed gear train, there is a simple fixed relationship between the spin rate of MG2 and the vehicle speed. Depending on the rolling radius of your tires, you will see about 58 to 60 r.p.m. at MG2 for each one m.p.h. of vehicle speed. Assuming standard US tires (Potenzas) and nominal inflation for an effective rolling radius of 11.1 inches, the exact ratio from MG2 spin rate to vehicle speed is 6000 (r.p.m.) to 163.27 (km.hr). Although speed always has a positive value, the spin rate of MG2 shows negative when the vehicle moves backwards.

MG2 Torque

MG2 Torq: |||`| N.m

MG2 torque in newton.metres. This needs to be verified, or at least checked. I guessed the scaling of the data by blocking the wheels of my car and watching this figure (scaled) climb to just over 200 before the car surged up onto the blocks. Maybe someone could creep up a hill of known slope on battery power at constant speed. In fact, I'm now starting to think that the scaling factor is wrong and the Mini-Scanner reads torque low by 20%. For example, when it shows 100 N.m, the torque is really 125 N.m.

Note that generally when a motor/generator's spin and torque are in the same direction, it is acting as a motor. When they are in opposite directions, i.e. one is positive and the other negative, it is acting as a generator. The only time that the foregoing is not true is during brief transition periods, for example when the direction of spin is being changed by the application of power.

MG1 Spin Rate

MG1 Spin: |||| rpm

MG1 spin rate, in revolutions per minute. This is an interesting figure to watch when you're interested in how the Prius manages without having gears to shift. The faster MG1 spins forwards, the faster the engine can spin for a give vehicle speed and the more electrical power can be passed to MG2 to increase the total driving torque. This is how the car simulates a lower mechanical gear. By reducing MG1's spin rate, the vehicle speed increases in relation to the engine spin rate, but less electrical power is available to pass to MG2. This is how the car simulates moving to higher mechanical gears. When the car is up to speed and power demand is low, you will see MG1 reverse direction.

Now it is actually taking up power, acting as a motor to increase the vehicle speed relative to the engine spin, putting the car in what amounts to overdrive. This power comes from MG2, which contrary to expectations, now acts as a generator, actually holding the car back. Take a look at MG2 torque while you are cruising and you'll see a negative value.

MG1 Torque

MG1 Torq: |||`| N.m

MG1 torque in newton.metres. This needs to be verified, or at least checked. I guessed the scaling of the data by observing a (scaled) figure of -8 when MG1 was spinning at 4700 r.p.m. and charging the battery at 13 amps with the car stationary. Both mechanical and electrical powers work out to be a bit less than 4 kW. Again, I'm starting to think that the current scaling is 20% low.

Actual Regenerative Braking Torque

Regen Act.?: ||| N.m

Actual regenerative braking torque in newton.metres. This needs to be verified. Both this value and the requested regenerative braking torque, below, only move away from zero during braking. However, which is the request and which is actual is guesswork. What I've guessed to be actual has greater resolution than the request and tends to take a lower value than the request when they get over 100. The scaling to newton.metres is, I think, correct as the actual regenerative braking torque tracks the negative torque at MG2 quite closely. Of course, this assumes that the scaling of MG2 torque is correct.

Requested Regenerative Braking Torque

Regen Req.?: ||| N.m

Requested regenerative braking torque in newton.metres. This needs to be verified, see actual regenerative braking torque, above.

Main Battery Voltage

Bat. voltage: ||| V

The main (traction, high voltage) battery voltage. Although we think of the battery as having 38 modules of six cells at 1.2 volts each for a total nominal voltage of 273.6 volts, don't expect to see this voltage in practice. With not much in the way of charge or discharge current, you are more likely to see something around 300 volts. This will drop when current is drawn from the battery and rise when it is charged. It will also vary with the battery state-of-charge.

Temperature of MG1 Inverter

Inv Temp MG1: ||| °C

The temperature registered by the sensor in MG1's inverter. The inverter is the electronic system that converts the main battery DC power into three-phase AC power to drive the MG as a motor. It also performs the reverse conversion when the MG acts as a generator. Since it is not 100% efficient, lost energy appears as heat, increasing the inverter's temperature. The Prius inverters are water-cooled.

Temperature of MG2 Inverter

Inv Temp MG2: ||| °C

The temperature registered by the sensor in MG2's inverter.

Temperature of MG1

MG1 Temp.: ||| °C

The temperature of MG1 itself.

Temperature of MG2

MG2 Temp. : ||| °C

The temperature of MG2 itself. I recall it was discovered that there are multiple temperature sensors buried in the stator windings of MG2 and this reading is probably some sort of average.

Requested Engine Power

Req ? Power: ||||| W

The engine power requested by the Hybrid Vehicle ECU of the Engine ECU. Or so it seems to me.

Target Engine Spin Rate

Target eng spd: ||||

The engine spin rate requested by the Hybrid Vehicle ECU of the Engine ECU. Or so it seems to me. The actual engine spin rate is usually close to this figure. When engine power is cut off due to low demand but the car is moving at more than 42 m.p.h., the value goes to 1000 r.p.m. So, the Engine ECU does not interpret this figure as a demand to run the engine at that speed using fuel.

Discharge Request SoC

Dchg Rqsr SoC: |||||

This seems to be stuck at zero. If anyone sees anything else, especially if it changes with some identifiable condition, please let me know.

Accelerator Pedal Position, Main Sensor

Acc Sensr Main: |`||

Accelerator pedal main position sensor output, probably in volts. The value typically ranges from 0.6 with no pedal displacement to 3.4 with the pedal pushed all the way to the floor.

Accelerator Pedal Position, Sub Sensor

Acc Sensor Sub: |`||

Accelerator pedal subordinate position sensor output, probably in volts. The value typically ranges from 1.5 with no pedal displacement to 4.2 with the pedal pushed all the way to the floor.

Mode Selector Lever Position, Sensor 2

Shift Sensor 2: |`||

Shift lever (a.k.a. Mode Selector Lever) position sensor output, probably in volts. Typical values in 'P', 'R', 'N', 'D', and 'B', respectively, are 0.6, 2.9, 3.5, 4.0 and 4.6.

Mode Selector Lever Position, Sensor 1

Shift Sensor 1: |||

Shift lever (a.k.a. Mode Selector Lever) position sensor output, decoded into a one-hot binary code. The values in 'P', 'R', 'N', 'D', and 'B', respectively, are 1, 2, 4, 8 and 16. When the lever is in between valid positions, the value is zero.

Hybrid Powertrain Operating State

Drive Condition: |||

The Toyota Repair Manual Volume 1 (Diagnostics) lists the values of this item thus:

0	When engine is stopped
1	When stopping engine
2	When starting engine

0	When engine is stopped
3	When cranking engine or engine is operating (see below)
4	While generating power or load driving
5	-
6	While racing engine in P position

I see values of 0, 1, 2 and 4 most frequently and occasionally I see 3. I think 2 means that the engine is being spun up by the motors prior to applying fuel and spark and 1 means the engine is being forcibly spun down and its kinetic energy returned to the battery.

A Mini-Scanner owner who has paid more attention to this item than I have suggests that 3 means that the engine is running for a reason other than those covered by 4. That is, engine power is not driving the car nor is it being used to generate electrical power. This value is therefore seen during pre-heat (the first phase of engine warmup when the ignition timing is retarded), low-load driving at more than 42 m.p.h. when the engine must spin to protect MG1 and when the engine runs to turn the air-conditioning compressor.

Highest Battery Cell Temperature

Cell Tmp Max: ||| °C

This might be the highest sensor temperature passed to the Hybrid Vehicle ECU by the Battery ECU.

Lowest Battery Cell Temperature

Cell Tmp Min: ||| °C

This might be the lowest sensor temperature passed to the Hybrid Vehicle ECU by the Battery ECU.

Fuel Injector Opening Time

Injector: ||`||| ms

The Toyota Repair Manual Volume 1 (Diagnostics) describes this as “Fuel injection time for cylinder No. 1” and goes on to say that when idling it should be in the range 1.0 - 3.0 ms. I would describe it as the time for which the fuel injectors are open each time they fire. It is interesting that the value tends to settle to around 7 ms above a certain power, additional fuel being drawn only by an increase in engine spin rate, not injector opening time.

Abnormal Revolution Variation

Cyl 1: ?? ||| ??

The Toyota Repair Manual Volume 1 (Diagnostics) describes these items as “Abnormal revolution variation for each cylinder”. It should normally be 0%, which is certainly the case for me. A careful reading of the manual suggests that a non-zero value for these items would indicate that the cylinder is not contributing its fair share of drive power due, for example, to persistent mis-fire, abnormality in ignition or incorrect injection of fuel.

Cyl 2: ?? ||| ??

Cyl 3: ?? ||| ??

Cyl 4: ?? ||| ??

DC Inhibit Time

DC Inhib Time: |||||

This may be the time for which the DC-to-DC converter has been turned off to reduce the drain on the high-voltage battery during periods of heavy use. Or, it could be the number of times this has happened. For me, it always reads zero. If anyone sees anything else,

especially if it changes with some identifiable condition, please let me know.

Main Battery Too Low

Batt Low Time: |||||

This item is described in the repair manual Volume 1 as “Cumulative number of times of battery dies”. For me, it always reads zero. It has been reported to increase to 1 after running the car out of fuel and continuing driving to a very low battery SoC. No apparent harm came to the car as a result of this. In particular, the car started right up after fueling. So “dies” in the Toyota description can probably be interpreted as “falls to a lower SoC than is permitted in normal operation”. This “battery dies” threshold could be anywhere in the range less than 33% to greater than or equal to 23% according to experimental results from multiple sources.

Main Battery Too High

Batt Too High: |||||

This may be the time for which the battery has risen above the maximum state of charge, which is thought to be 80%. Or, it could be the number of times this has happened. For me, it always reads zero. If anyone sees anything else, especially if it changes with some identifiable condition, please let me know.

Delta SoC

Delta SoC: ||`| %

This seems to be stuck at 20%. If anyone sees anything else, especially if it changes with some identifiable condition, please let me know. (This item sounds as if it's computed by the Mini-Scanner from other data, but it is not. It comes directly from the ECU.)

Ignition Off Time

Ig Off Hour: ||||| h

The average time, in hours, for which the vehicle ignition is off. This is *not* the time the ignition was off before you turned it back on. The value is set to zero by clearing DTCs in the Battery ECU. How the average is computed has not been determined. A very large number here might suggest to service personnel that you are not driving the car often.

Number of Battery ECU Trouble Codes

Battery DTCs: |||||

Presumably, the number of Diagnostic Trouble Codes stored in the Battery ECU. This number seems to hover in the 20s. These DTCs are not retrieved by the Mini-Scanner in Trouble Codes mode, so maybe they are in some sort of yet-to-be-confirmed state. If you clear DTCs in the Battery ECU, the number does go to zero, but soon increases again. The relevance of this data item has not been determined. Further investigation is needed.

Battery Air Temperature Sensor

Batt Air Temp: || °C

The air temperature inside the main battery housing, or something like that. Maybe the exhaust air temperature, that is the temperature of the air blown out by the fans. Anyway, this and the following four data items are going to give you an indication of how hot the battery is and perhaps explain a “Mister Turtle” lamp on the dash.

Battery Temperature, Sensor 1

Battery Temp 1: || °C

The temperature registered by battery temperature sensor number 1.

Battery Temperature, Sensor 2

The temperature registered by battery temperature sensor number 2.

Battry Temp 2: || °C

Battery Temperature, Sensor 3

The temperature registered by battery temperature sensor number 3.

Battry Temp 3: || °C

Battery Temperature, Sensor 4

The temperature registered by battery temperature sensor number 4.

Battry Temp 4: || °C

Lowest Battery Block Voltage

The lowest voltage of all battery “blocks”, in volts.

A battery “block” is a pair of modules that are monitored as a unit by the battery ECU. Each module consists of six cells, so with twelve cells in total, a block has a nominal voltage of $12 \times 1.2 = 14.4$ volts. In spite of this, you are much more likely to see 15 to 16 volts when the battery is at rest (no charge or discharge current).

Min Bat Blk: ||`|| V

Lowest Battery Block Number

The reference number of the battery block that has the lowest voltage. In a healthy battery, this number is likely to move around between several blocks having the same voltage.

Min Bat Block #: ||

Highest Battery Block Voltage

The highest voltage of all battery "blocks", in volts. In a healthy battery, the difference between the highest and lowest block voltages will be around 0.1 volts.

Max Bat Blk: ||`|| V

Highest Battery Block Number

The reference number of the battery block that has the highest voltage. In a healthy battery, this number is likely to move around between blocks having the same voltage.

Max Bat Block #: ||

Auxiliary Battery Voltage.

Auxiliary (12 V) battery voltage. With the car on but not started, this will be around 12 volts, but with it “Ready” it will be close to 13.8 volts as a result of the DC-to-DC converter supplying power from the main battery.

Aux Bat Volt: ||`| V

Oxygen Sensor, Bank 1, Sensor 1

Output, in millivolts, of oxygen sensor "Bank 1, Sensor 1".

Oxygen B1,S1: ||| mV

Fuel Trim due to Oxygen Sensor

Fuel trim due to the output of oxygen sensor “Bank 1, Sensor 1”.

O2 Fuel Trim: ||| %

Oxygen Sensor, Bank 1, Sensor 2

Output, in millivolts, of oxygen sensor “Bank 1, Sensor 2”.

Oxygen B1,S2: ||| mV

Appendix B - Prius Diagnostic Trouble Codes

This appendix lists the Diagnostic Trouble Codes (DTCs) for the 2001-2003 model year Prius (NHW11). They may or may not be accurate for the 2004 Model Year and beyond (NHW20).

This information has been manually transcribed from the repair manual. Many thanks go to the person who did this and sent the text to me in e-mails. There may be the occasional error in the transcription or I may have messed something up in converting the e-mails to Web pages, but most of the weird stuff you'll find here was in the manual. So, don't correct my grammar or ask me what a "harf" is. It's Toyota's grammar and only they know what a "harf" is.

I have not tried to distinguish comments inserted by the transcriber from material actually in the manual for fear that I might make a mistake. It should be fairly obvious because the grammar and spelling will be correct and there will be words like "presumably" which presumably don't appear in the original manual. Anything I have inserted myself, however, is set off by an italic font.

Battery ECU Diagnostic Trouble Codes

P1600 - Backup power source circuit malfunction

The battery ECU receives 12 volts from two sources. P1600 signifies the absence of 12 volts at terminal AM, which is normally kept live even with the steering wheel switch off.

P3001 - Battery ECU malfunction

P3002 - HV ECU communication malfunction

P3005 - High voltage fuse snapped [sic]

Presumably P3005 would also be recorded if an attempt was made to start up with the service plug removed, as the high voltage fuse is physically located inside the plug.

P3006 - Battery SOC are uneven

P3006 - not too sure about this, but criterion appears to be maximum permitted difference between highest block voltage and lowest block voltage at any instant (not including transients) is 1.2 volts.

P3009 - Leak detected

P3009 - "Leak detected", meaning a current leakage path the high voltage circuitry to the chassis has been detected. Trigger level not known, but the criterion for manual testing is insulation resistance not less than 10M ohms when tested at 500V DC.

P3010 - Battery total resistance malfunction

P3011 to P3029 - Battery block malfunction

The traction battery consists of 38 physical modules, each containing 6 cells. For the

purposes of monitoring by the battery ECU, modules are paired into 19 "blocks". DTCs P3011 to P3029 appear to indicate the "malfunction" of a particular block, although what "malfunction" means is not clear.

P3030 - Battery voltage detective line snapped [sic]

P3030 - presumably means open circuit of one of the twenty voltage sense lines which are connected to the cell string at the ends and between each block.

P3060 - Battery temperature sensor circuit malfunction

P3076 - Abnormal air flow by battery cooling fan

P3077 - Battery cooling fan motor circuit malfunction

P3115 - HV battery current sensor malfunction

Engine ECU Diagnostic Trouble Codes

Engine ECU - SAE Controlled

These items are taken from the table "Engine Diagnostics, SAE controlled" on pages DI-14 to DI-16 in the Engine Diagnostics chapter of the Repair Manual.

P0100 - Mass Air Flow Circuit Malfunction

P0101 - Mass Air Flow Circuit Range/Performance Problem

P0110 - Intake Air Temp Circuit Malfunction

P0115 - Engine Coolant Temp. Circuit Malfunction

P0116 - Engine Coolant Temp. Circuit Range/Performance Problem

P0120 - Throttle/Pedal Position Sensor/Switch "A" Circuit Malfunction

P0121 - Throttle/Pedal Position Sensor/Switch "A" Circuit Range/Performance Problem

P0125 - Insufficient Coolant Temp. for Closed Loop Fuel Control

P0128 - Thermostat Malfunction

P0130 - Heated Oxygen Sensor Circuit Malfunction (Bank 1 Sensor 1) (Except Calif.)

P0133 - Oxygen Sensor Circuit Slow Response (Bank 1 Sensor 1)

P0135 - Oxygen Sensor Circuit Malfunction (Bank 1 Sensor 1)

P0136 - Oxygen Sensor Circuit Malfunction (Bank 1 Sensor 2)

P0141 - Oxygen Sensor Heater Circuit Malfunction (Bank 1 Sensor 2)

P0171 - System too Lean (Fuel Trim)

P0172 - System too Rich (Fuel Trim)

P0300 - Random/Multiple Cylinder Misfire Detected

P0301 - Cylinder 1 Misfire Detected

P0302 - Cylinder 2 Misfire Detected

P0303 - Cylinder 3 Misfire Detected

P0304 - Cylinder 4 Misfire Detected

P0325 - Knock Sensor 1 Circuit Malfunction (Bank 1)

P0335 - Crankshaft Position Sensor "A" Circuit Malfunction

P0340 - Camshaft Position Sensor Circuit Malfunction

P0420 - Catalyst System Efficiency Below Threshold (Bank 1)

P0440 - Evaporative Emission Control System Malfunction

This and the following two DTCs can occur if you drive around for a while with a loose fuel filler cap. I did this to test retrieving DTCs with the Prius Mini-Scanner and it took more than a day for the problem to be detected.

P0441 - Evaporative Emission Control System Incorrect Purge Flow

P0446 - Evaporative Emission Control System Vent Control Malfunction

P0450 - Evaporative Emission Control System Pressure Sensor Malfunction

P0451 - Evaporative Emission Control System Pressure Sensor Range/Performance

P0500 - Vehicle Speed Sensor Malfunction

P0505 - Idle Control System Malfunction

Engine ECU - Manufacturer Controlled

These items are taken from the table “Engine Diagnostics, manufacturer controlled” on pages DI-17 and DI-18 in the Engine Diagnostics chapter of the Repair Manual.

P1125 - Throttle Control Motor Circuit Malfunction

P1127 - ETCS Actuator Power Source Circuit Malfunction

P1128 - Throttle Control Motor Lock Malfunction

P1129 - Electric Throttle Control System Malfunction

P1300 - Igniter Circuit Malfunction (No. 1)

P1305 - Igniter Circuit Malfunction (No. 2)

P1310 - Igniter Circuit Malfunction (No. 3)

P1315 - Igniter Circuit Malfunction (No. 4)

P1346 - VVT Sensor/Camshaft Position Sensor Circuit Range/Performance Problem (Bank 1)

P1349 - VVT System Malfunction (Bank 1)

P1430 - Vacuum Sensor for Adsorber and Catalyst System Circuit Malfunction

P1431 - Vacuum Sensor for Adsorber and Catalyst System Circuit Range/Performance Problem

P1436 - Variable Valve Malfunction

P1437 - Vacuum Line Malfunction

P1455 - Vapor Reducing Fuel Tank System Leak Detected (Small Leak)

P1525 - Resolver Circuit Malfunction

P1600 - ECM BATT Malfunction

P1633 - ECU Malfunction (ETCS Circuit)

P1636 - HV ECU Malfunction

P1637 - EGSTP Signal Malfunction

P1656 - OCV Circuit Malfunction (for VVT-i)

P3190 - Poor Engine Power

P3191 - Engine does not start

Hybrid Vehicle ECU Diagnostic Trouble Codes

In addition to the letter-plus-four-digit DTC, the HV-ECU generates “information codes”

consisting of three digits. These give a more finely detailed definition of the problem. They can be retrieved by the THHT (Toyota Hand-Held Tester) but not by a normal OBD-II scanner. How the THHT retrieves information codes has not been determined, therefore they cannot be retrieved by the Prius Mini-Scanner.

From pages DI-199 through to DI-205, in the Hybrid Vehicle Control System chapter of the Repair Manual.

B2799 - Immobilizer Malfunction

101 No input of signal from transponder key ECU

C2692 - Regenerative Brake Check

102 Regenerative Brake Check

C2693 - Regenerative Brake Check

103 Regenerative Brake Check

P1120 - Accelerator Pedal Position Sensor Circuit Malfunction

This DTC has been caught in the wild on an early 2001 model year Prius. The accelerator pedal position sensor is know to cause problems on these cars and there is a TSB out on it.

104 Open or short circuit in main accelerator sensor circuit

105 +B short in main accelerator sensor circuit

106 Main sensor internal error

107 Open or short in sub accelerator sensor circuit

108 +B short in sub accelerator sensor circuit

109 Sub sensor internal error

110 When difference between main sensor value and sub sensor value is large

111 When sub sensor value changes while main sensor value does not

112 When main sensor value changes while sub sensor value does not

113 When any of information code 104-112 continues to appear

114 Accelerator pedal not smoothly returning to original position

P1520 - Stop Light Switch (Cruise Control System) Malfunction

115 Open or short in stop light switch circuit

P1566 - Cruise Control System Malfunction

116 When STP signal of HV ECU is inconsistent with that of brake ECU, with cruise control indicator ON

P1600 - BATT Malfunction

117 HV ECU back-up power source circuit malfunction

P1780 - Park/Neutral Position Switch System Malfunction

118 When more than 2 main signals are ON

119 When main signal is not turned ON even though sub signal has been input

120 Open or short in sub sensor circuit

121 When shift position detected by main signal is different from that detected by sub signal

P3000 - HV Battery Malfunction

123 Input of abnormal signal from battery ECU (HV Battery System Malfunction)

124 Input of abnormal signal from battery ECU (high voltage fuse blown out)

388 Discharge Inhibition Control Malfunction. When charged battery is low due to leaving the vehicle in N position, gas shortage or HV system malfunction

389 Drop of high voltage. When main battery is dead or main battery is dead due to HV system malfunction

P3001 - HV Battery ECU Malfunction

129 Battery ECU malfunction

P3004 - Power Cable Malfunction

130 HV Battery Malfunction. When HV battery voltage becomes lower than inverter voltage

131 Power Cable Malfunction. When main fuse is blown out, service plug is disconnected or limiter resistance is cut off

133 HV Battery Malfunction. When inverter voltage sensor is malfunctioning or limiter resistance value increases

P3100 - HV ECU Malfunction

127 IB Circuit Malfunction. +B short in IB terminal circuit of HV ECU

128 IB Circuit Malfunction. Open or short in IB terminal circuit of HV ECU

134 HV ECU Internal Error

135 HV ECU Internal Error

136 GO Signal Error. Open or short in GO circuit

137 Engine Speed Sensor Malfunction

138 IB Circuit Malfunction. When the difference between current of HV ECU and current of battery is large

139 HV ECU internal error. IG Signal Circuit Malfunction

140 HV ECU internal error. RAM Braked

141 HV ECU internal error. ROM Braked

142 ST Signal Circuit Malfunction. When ST signal of HV ECU is ON, with ignition

switch turned OFF

- 143 HV ECU internal error. Immobilizer Malfunction
- 144 HV ECU internal error. Primary Check Malfunction
- 145 HV ECU internal error. Primary Check Malfunction
- 146 HV ECU internal error. Primary Check Malfunction
- 147 HV ECU internal error. Primary Check Malfunction
- 148 HV ECU internal error. HV CPU Malfunction
- 149 HV ECU internal error. HV CPU Malfunction
- 150 HV ECU internal error. Motor CPU Malfunction
- 151 HV ECU internal error. Motor CPU Malfunction
- 152 HV ECU internal error. Motor CPU Malfunction
- 153 HV ECU internal error. Motor CPU Malfunction
- 154 HV ECU internal error. Motor CPU Malfunction
- 155 HV ECU internal error. Motor CPU Malfunction
- 156 HV ECU internal error. Motor CPU Malfunction
- 157 HV ECU internal error. Motor CPU Malfunction
- 158 HV ECU internal error. Motor CPU Malfunction
- 159 HV ECU internal error. Motor ECU Communication Circuit Malfunction
- 160 HV ECU internal error. Motor ECU Communication Circuit Malfunction
- 161 HV ECU internal error. Motor ECU Power Source Malfunction
- 162 HV ECU internal error. Motor ECU Power Source Malfunction
- 163 HV ECU internal error. Motor ECU Power Source Malfunction
- 164 HV ECU internal error. Motor ECU Power Source Malfunction
- 165 HV ECU internal error. Motor ECU Power Source Malfunction
- 166 HV ECU internal error. Motor R/D Malfunction
- 167 HV ECU internal error. Motor R/D Malfunction
- 168 HV ECU internal error. Motor R/D Malfunction
- 169 HV ECU internal error. Motor R/D Malfunction
- 170 HV ECU internal error. Motor R/D Malfunction
- 171 HV ECU internal error. Motor REF Signal Malfunction
- 172 HV ECU internal error. Motor REF Signal Malfunction
- 173 HV ECU internal error. Motor REF Signal Malfunction
- 174 HV ECU internal error. Motor Inverter Current Sensor Malfunction
- 175 HV ECU internal error. Motor Inverter Current Sensor Malfunction

176 HV ECU internal error. Motor Gate Shutdown Signal Line Connection Malfunction
177 HV ECU internal error. Motor Main CPU Malfunction
178 HV ECU internal error. Motor Main CPU Malfunction
179 HV ECU internal error. Motor Main CPU Malfunction
180 HV ECU internal error. Rotation Angle Check CPU Malfunction
181 HV ECU internal error. Rotation Angle Check CPU Malfunction
182 HV ECU internal error. Rotation Angle Check CPU Malfunction
183 HV ECU internal error. Rotation Angle Check CPU Malfunction
184 HV ECU internal error. Rotation Angle Check CPU Malfunction
185 HV ECU internal error. Rotation Angle Check CPU Malfunction
186 HV ECU internal error. Rotation Angle Check CPU Malfunction
187 HV ECU internal error. Important RAM Malfunction
188 HV ECU internal error. Generator CPU Malfunction
189 HV ECU internal error. Generator CPU Malfunction
190 HV ECU internal error. Generator CPU Malfunction
191 HV ECU internal error. Generator CPU Malfunction
192 HV ECU internal error. Generator CPU Malfunction
193 HV ECU internal error. Generator CPU Malfunction
194 HV ECU internal error. Generator CPU Malfunction
195 HV ECU internal error. Generator CPU Malfunction
196 HV ECU internal error. Generator CPU Malfunction
197 HV ECU internal error. Generator R/D Malfunction
198 HV ECU internal error. Generator R/D Malfunction
199 HV ECU internal error. Generator R/D Malfunction
200 HV ECU internal error. Generator R/D Malfunction
201 HV ECU internal error. Generator R/D Malfunction
202 HV ECU internal error. Generator R/D Malfunction
203 HV ECU internal error. Generator Shutdown Signal Line Connection Malfunction
271 HV ECU internal error. Motor PWN Line Connection Malfunction
310 HV ECU internal error. Generator PWN Line Connection Malfunction
390 HV ECU internal error. Charge Inhibition Control Malfunction
391 HV ECU internal error. Motor CPU malfunction
392 HV ECU internal error. Motor CPU malfunction
393 HV ECU internal error. HV CPU Operation Malfunction

P3101 - Engine System Malfunction

204 Input of abnormal signal from the ECM (abnormal engine output)

205 Input of abnormal signal from the ECM (engine unable to start)

238 Transaxle Malfunction. When engine does not start even though cranking it

P3105 - Battery ECU Communication Circuit Malfunction

206 When communication between battery ECU and HV ECU is abnormal 1 sec. after ignition is turned ON

207 When communication between battery ECU and HV ECU is abnormal 1 sec. after ignition is turned ON

208 When communication between battery ECU and HV ECU is abnormal 1 sec. after ignition is turned ON

P3106 - ECM Communication Circuit Malfunction

209 When communication between ECM and HV ECU is abnormal 1 sec. after ignition is turned ON

210 When communication between ECM and HV ECU is abnormal 1 sec. after ignition is turned ON

211 When communication between ECM and HV ECU is abnormal 1 sec. after ignition is turned ON

212 Input of abnormal signal from ECM

394 When ECM does not operate

P3107 - Airbag ECU Communication Circuit Malfunction

213 When communication between airbag ECU and HV ECU is abnormal 10 sec. after ignition is turned ON

214 When communication between airbag ECU and HV ECU is abnormal 10 sec. after ignition is turned ON

215 When communication between airbag ECU and HV ECU is abnormal 10 sec. after ignition is turned ON

P3108 - A/C Amplifier Communication Circuit Malfunction

216 When communication from A/C amplifier to HV ECU is abnormal

217 When communication from A/C amplifier to HV ECU is abnormal

P3109 - Brake ECU Communication Circuit Malfunction

218 When communication between brake ECU and HV ECU is abnormal 1.5 sec. after ignition is turned ON

219 When communication between brake ECU and HV ECU is abnormal 1.5 sec. after ignition is turned ON

220 When communication between brake ECU and HV ECU is abnormal 1.5 sec. after

ignition is turned ON

221 When communication between brake ECU and HV ECU is abnormal 1.5 sec. after ignition is turned ON

222 When abnormal data is received from brake ECU

P3110 - IGCT Relay Malfunction

223 When IGCT relay is always closed

P3115 - System Main Relay Malfunction

224 SMR Cont 1 Malfunction. Open or +B short in system main relay No. 1 circuit

225 SMR Cont 1 Malfunction. Short in system main relay No. 1 circuit

226 SMR Cont 2 Malfunction. Open or +B short in system main relay No. 2 circuit

227 SMR Cont 2 Malfunction. Short in system main relay No. 2 circuit

228 SMR Cont 3 Malfunction. Open or +B short in system main relay No. 3 circuit

229 SMR Cont 3 Malfunction. Short in system main relay No. 3 circuit

231 Deposit of SMR. System main relay + terminal deposited

232 Deposit of SMR. System main relay - terminal deposited

233 Deposit of SMR. System main relay + & - terminal deposited

P3120 - HV Transaxle Malfunction

234 Energy Balance Malfunction. Small reduction of motor magnetism

235 Energy Balance Malfunction. Large reduction of motor magnetism

236 Energy Balance Malfunction. Small reduction of generator magnetism

237 Energy Balance Malfunction. Large reduction of generator magnetism

239 HV Transaxle Malfunction. Shaft damaged

240 HV Transaxle Malfunction. Generator locked

241 HV Transaxle Malfunction. Torque limiter sliding

242 HV Transaxle Malfunction. Planetary gear locked

243 Motor Resolver Malfunction. Motor resolver inter-phase short

244 Motor Resolver Malfunction. Motor resolver inter-phase short (When there is a history that the state of malfunction continued during inverter fail safe mode)

245 Motor Resolver Malfunction. Open or short in motor resolver circuit

246 Motor Resolver Malfunction. Open or short in motor resolver circuit (When there is a history that the state of malfunction continued during inverter fail safe mode)

247 Motor Temperature Sensor Malfunction. GND short in motor temperature sensor

248 Motor Temperature Sensor Malfunction. Motor temperature sensor malfunction

249 Motor Temperature Sensor Malfunction. Open or +B short in motor temperature

sensor

250 Motor Temperature Sensor Malfunction. Motor temperature sensor performance problem

253 Generator Resolver Malfunction. Generator resolver inter-phase short

254 Generator Resolver Malfunction. Generator resolver inter-phase short (When there is a history that the state of malfunction continued during inverter fail safe mode)

255 Generator Resolver Malfunction. Open or short in generator resolver circuit

256 Generator Resolver Malfunction. Open or short in generator resolver circuit (When there is a history that the state of malfunction continued during inverter fail safe mode)

257 Generator Temperature Sensor Malfunction. GND short in generator temperature sensor

258 Generator Temperature Sensor Malfunction. Generator temperature sensor malfunction

259 Generator Temperature Sensor Malfunction. Open or +B short in generator temperature sensor

260 Generator Temperature Sensor Malfunction. Generator temperature sensor performance problem

P3125 - Converter & Inverter Assembly Malfunction

263 DC/DC Converter Malfunction. +B short in DCDC converter NODD wiring

264 DC/DC Converter Malfunction. DCDC converter malfunction

265 DC/DC Converter Malfunction. Open or GND short in DCDC converter NODD wiring

266 VM Malfunction. Open or GND short in inverter voltage signal circuit

267 VM Malfunction. +B short in inverter voltage signal circuit

268 VM Malfunction. Inverter voltage signal is inconsistent with battery voltage

269 VM Malfunction. Inverter voltage sensor malfunction

270 VM Malfunction. Abnormality of line connection of inverter voltage signal circuit (When there is a history that the state of malfunction continued during inverter fail safe mode)

272 Motor PWN Line Connection Malfunction. Abnormality of the line connection of motor PWM (When there is a history that the state of malfunction continued during inverter fail safe mode)

273 Motor Inverter Gate Malfunction. Motor inverter malfunction

274 Motor Inverter Temperature. Open or +B short in motor inverter temperature sensor

275 Motor Inverter Temperature. GND short in motor inverter temperature sensor

276 Sensor Malfunction. Motor inverter temperature sensor malfunction

277 Sensor Malfunction. Motor inverter temperature sensor performance problem

- 278** Motor Inverter Sinv. +B short in motor inverter stop signal circuit
- 279** Motor Inverter Sinv. Over voltage of inverter
- 280** Motor Inverter Sinv. Open or GND short in motor inverter stop signal circuit
- 281** Motor Inverter Sinv. Voltage drop of inverter power source
- 282** Motor Inverter Sinv. Inverter circuit broken
- 283** Motor Inverter Finv. +B short in motor inverter fail signal circuit
- 284** Motor Inverter Finv. Inverter overheating
- 285** Motor Inverter Finv. Open or GND short in motor inverter fail signal circuit
- 286** Motor Inverter Finv. Inverter circuit broken
- 287** Motor Inverter Finv. Inverter internal short
- 288** Motor Inverter Current Sensor Malfunction. Motor inverter current sensor malfunction (V phase sub sensor)
- 289** Motor Inverter Current Sensor Malfunction. Open in inverter current sensor (V phase sub sensor)
- 290** Motor Inverter Current Sensor Malfunction. Motor inverter current sensor malfunction (V phase main sensor)
- 291** Motor Inverter Current Sensor Malfunction. (when there is a history that the state of malfunction continued during inverter fail safe mode)
- 292** Motor Inverter Current Sensor Malfunction. Open in motor inverter current sensor (V phase main sensor)
- 293** Motor Inverter Current Sensor Malfunction. (when there is a history that the state of malfunction continued during inverter fail safe mode)
- 294** Motor Inverter Current Sensor Malfunction. Motor inverter current sensor V phase performance problem
- 295** Motor Inverter Current Sensor Malfunction. (when there is a history that the state of malfunction continued during inverter fail safe mode)
- 296** Motor Inverter Current Sensor Malfunction. Motor inverter current sensor malfunction (W phase sub sensor)
- 297** Motor Inverter Current Sensor Malfunction. Open in motor inverter current sensor (W phase sub sensor)
- 298** Motor Inverter Current Sensor Malfunction. Motor inverter current sensor malfunction (W phase main sensor)
- 299** Motor Inverter Current Sensor Malfunction. (when there is a history that the state of malfunction continued during inverter fail safe mode)
- 300** Motor Inverter Current Sensor Malfunction. Open in motor inverter current sensor (W phase main sensor)
- 301** Motor Inverter Current Sensor Malfunction. (when there is a history that the state of malfunction continued during inverter fail safe mode)

- 302** Motor Inverter Current Sensor Malfunction. Motor inverter current sensor W phase performance problem
- 303** Motor Inverter Current Sensor Malfunction. (when there is a history that the state of malfunction continued during inverter fail safe mode)
- 304** Motor Gate Shutdown Signal Line Connection Malfunction. +B short in motor gate shutdown signal circuit
- 305** Motor Gate Shutdown Signal Line Connection Malfunction. Open or GND short in motor gate shutdown signal circuit
- 306** Failure in Monitoring Motor Torque Performance.
- 307** Abnormal Current Value of Motor
- 308** Detection of Collision Signal
- 309** Motor PWM Line Connection Malfunction. Open or short in generator inverter switching wiring (GUU, GVU, GWU)
- 311** Generator Inverter Malfunction
- 312** Generator Inverter Temperature Sensor Malfunction. Open or +B short in generator inverter temperature sensor
- 313** Generator Inverter Temperature Sensor Malfunction. GND short in generator inverter temperature sensor
- 314** Generator Inverter Temperature Sensor Malfunction. Generator inverter temperature sensor malfunction
- 315** Generator Inverter Temperature Sensor Malfunction. Generator inverter temperature sensor performance problem
- 316** Generator Inverter Sinv. +B short in generator inverter stop signal circuit
- 317** Generator Inverter Sinv. Over voltage of inverter
- 318** Generator Inverter Sinv. Open or GND short in generator inverter stop signal circuit
- 319** Generator Inverter Sinv. Voltage drop of inverter power source
- 320** Generator Inverter Sinv. Inverter circuit broken
- 321** Generator Inverter Finv. +B short in generator inverter fail signal circuit
- 322** Generator Inverter Finv. Inverter overheating
- 323** Generator Inverter Finv. Open or GND short in generator inverter fail signal circuit
- 324** Generator Inverter Finv. Inverter circuit broken
- 325** Generator Inverter Finv. Inverter internal short
- 326** Generator Inverter Current Sensor Malfunction. Generator inverter current sensor malfunction (V phase sub sensor)
- 327** Generator Inverter Current Sensor Malfunction. Open in generator inverter current sensor (V phase sub sensor)
- 328** Generator Inverter Current Sensor Malfunction. Generator inverter current sensor

malfunction (V phase main sensor)

329 Generator Inverter Current Sensor Malfunction. (when there is a history that the state of malfunction continued during inverter fail safe mode)

330 Generator Inverter Current Sensor Malfunction. Open in generator inverter current sensor (V phase main sensor)

331 Generator Inverter Current Sensor Malfunction. (when there is a history that the state of malfunction continued during inverter fail safe mode)

332 Generator Inverter Current Sensor Malfunction. Generator inverter current sensor V phase performance problem

333 Generator Inverter Current Sensor Malfunction. (when there is a history that the state of malfunction continued during inverter fail safe mode)

334 Generator Inverter Current Sensor Malfunction. Generator inverter current sensor malfunction (W phase sub sensor)

335 Generator Inverter Current Sensor Malfunction. Open in generator inverter current sensor (W phase sub sensor)

336 Generator Inverter Current Sensor Malfunction. Generator inverter current sensor malfunction (W phase main sensor)

337 Generator Inverter Current Sensor Malfunction. (when there is a history that the state of malfunction continued during inverter fail safe mode)

338 Generator Inverter Current Sensor Malfunction. Open in generator inverter current sensor (W phase main sensor)

339 Generator Inverter Current Sensor Malfunction. (when there is a history that the state of malfunction continued during inverter fail safe mode)

340 Generator Inverter Current Sensor Malfunction. Generator inverter current sensor W phase performance problem

341 Generator Inverter Current Sensor Malfunction. (when there is a history that the state of malfunction continued during inverter fail safe mode)

342 Motor Gate Shutdown Signal Line Connection. +B short in generator gate shutdown signal

343 Motor Gate Shutdown Signal Line Connection. Open or GND short in generator gate shutdown signal circuit

344 Failure in Monitoring Generator Torque Performance

345 Abnormal Current Value of Generator

P3130 - Inverter Cooling System Malfunction

346 Water pump system malfunction

347 Electric cooling fan system malfunction

P3135 - Circuit Breaker Sensor Malfunction

348 GND short in circuit breaker sensor

349 Open or +B short in circuit breaker sensor

P3140 - Interlock Malfunction

You can make this DTC happen quite easily and safely by removing the service plug from the main battery and turning the car on.

350 Safety devices operating with vehicle is stopped (ILK signal ON)

351 Open circuit in interlock signal circuit while vehicle is running

P3145 - Vehicle Speed Sensor Circuit Malfunction

352 No input of vehicle speed signal during cruise control driving