TOYOTA

Toyota Motor Engineering & Manufacturing North America, Inc.

Vehicle Safety & Compliance
Liaison Office
Mail Stop: W4-2D
6565 Headquarters Drive
Plano, TX 75024

June 24, 2020

DEFECT INFORMATION REPORT

1. Vehicle Manufacturer Name:

Toyota Motor Corporation ["TMC"]
1, Toyota-cho, Toyota-city, Aichi-pref., 471-8571, Japan

Affiliated U.S. Sales Company:

Toyota Motor North America, Inc. ["TMNA"]
6565 Headquarters Drive, Plano, TX 75024

Manufacturer of Hybrid Control ECU:

DENSO CORPORATION
1-1, Showa-cho, Kariya-city, Aichi, 448-8661, Japan
Telephone: + 81-566-25-5511

DENSO TEN Limited
2-28, Gosho-dori 1-chome, Hyogo-ku, Kobe-city, Hyogo, 652-8510, Japan
Phone: +81-78-671-5081

Country of Origin: Japan

2. Identification of Involved Vehicles:

Make/Car Line	Model Year	Manufacturer	Production Period
Toyota / Prius	2013-2015	TMC	March 15, 2013 through November 9, 2015
Toyota / Prius *v*	2014-2017		June 20, 2014 through November 30, 2017

Applicability	Part Number	Part Name	Component Description
MY2013-2015 Toyota Prius	89681-47440 89681-47441 89681-47250 89681-47251	Computer, Power Management Control	Hybrid Control ECU
MY2014-2017 Toyota Prius *v*	89681-47030 89681-47422 89981-47630	Computer, Power Management Control Computer, Hybrid Vehicle Control (2017MY)	

NOTE: (1) Although the involved vehicles are within the above production period, not all vehicles in this range were sold in the U.S.
(2) Other Toyota or Lexus vehicles do not use the same hybrid control ECU and software as the involved vehicles or are involved in Safety Recall 18V-684.

3. Total Number of Vehicles Potentially Involved:

Prius : 204,835
Prius *v* : 61,802
Total : 266,637

4. Percentage of Vehicles Estimated to Actually Contain the Defect:

Unknown. Toyota is unable to provide an estimate of the percentage of vehicles to actually contain the defect. Whether the issue in each case will lead to damage of the transistor within the inverter assembly and subsequently lead to a shutdown of the hybrid system, creating an unreasonable risk to safety, depends on each vehicle's operating conditions.

5. Description of Problem:

The subject vehicles were not involved in Safety Recall 18V-684 because they were originally equipped with a version of the software, used to control the boost converter in the Intelligent Power Module (IPM) within the inverter assembly of the vehicle's hybrid system, that contains improved thermal management. Repeated driving under certain identified high-load driving patterns (e.g., from a stop, applying nearly full throttle and then gradually further accelerating to full throttle) could cause higher thermal stress in specific transistors in the IPM, resulting in damage to those transistors over time. This can lead to illumination of various warning lights and the display of a warning message on the instrument panel. In cases where a specific transistor fails in a certain way during a high-load driving condition, such as during hard acceleration, there is a possibility for an abnormally high voltage to be generated that could

exceed a certain limit in the software and IPM circuit design causing the hybrid system to shut down instead of entering a failsafe driving mode that would provide reduced motive power and allow the vehicle to be driven for certain distances. In this condition, power steering and braking will not be affected. However, a hybrid system that shuts down without entering a failsafe mode could result in the vehicle losing motive power while driving at higher speeds, increasing the risk of a crash.

6. Chronology of Principal Events:

October 2018

On October 4, 2018, Toyota filed Safety Recall 18V-684, which did not include the subject vehicles. Because the subject vehicles contained the improved thermal management logic when new, Toyota judged that it was unlikely that they would be affected by the condition in that recall. However, Toyota continued monitoring the field information for the subject vehicles and collecting field parts for analysis.

August 2019 - January 2020

By this time, Toyota had recovered a number of inverter assemblies from the subject vehicles from the U.S market indicating potential hybrid inverter failure. Toyota investigated the recovered inverter assemblies and found certain damaged transistors in the IPM. However due to extent of the damage, the cause of the damage was not able to be identified.

As the field cases, up to this point, occurred predominantly in North America, Toyota hypothesized that there could be a previously unknown difference in the driving conditions in North America that could explain the different field experience in North America.

Thus, Toyota sought to compare the driving conditions between Japan and North America. To do so, Toyota collected and analyzed driving data from a number of vehicles that were of another Toyota hybrid model, capable of communicating driving data wirelessly, that is sold in both regions. (As the subject Prius and Prius *v* vehicles are not capable of communicating driving data wirelessly, a different hybrid model was used.) Through this data, Toyota identified that there are potential differences between Japan and North America, in terms of vehicle speed and accelerator pedal application angle, under certain driving conditions, e.g., accelerator application patterns used to achieve rapid acceleration from very low speed.

Based on these findings, Toyota began testing to understand the potential effects of this type of driving pattern (where full throttle is applied from a stop) on the relevant transistors in the subject vehicles. In parallel, in order to determine whether the driving patterns observed from the other hybrid model are similar to the driving patterns of Prius and Prius *v* drivers who have experienced these transistor failures, Toyota began collecting driving data from some customers who previously experienced this type of transistor failure by installing a recording device with the customer’s permission.

February 2020 – Early-June 2020

At this time, Toyota concluded the aforementioned testing to understand the potential effects on these transistors in the subject vehicles when they are exposed to a driving pattern where full throttle is applied from a stop. In this testing, temperature in the transistors for the boost converter did not increase to a point which could cause damage to the transistors.

Based on this result, Toyota believed that there may be further differences in the driving pattern which could contribute to generating a higher temperature in these transistors. Based on closer analysis of the driving data of the Prius customers who agreed to have a recording device installed, it was found that the unique driving pattern from these customers was not an application of full throttle from a stop. Instead it was a pattern where, from a stop, the driver would apply the accelerator pedal rapidly up to approximately two third opening position and then gradually further accelerate to full throttle.

Further testing and analysis were conducted using this newly identified driving pattern and similar driving patterns. This revealed that if the driver applies nearly full throttle from a stop and then gradually further accelerates to full throttle, the temperature generated in transistors for the boost converter could increase unexpectedly, beyond the levels created under prior testing where full throttle is applied directly from a stop.

Throughout this investigation, Toyota was also able to collect data from some vehicles that potentially experienced hybrid inverter failure that was retrieved when the vehicle was serviced by a dealer (i.e., freeze frame data contained within the hybrid control ECU). At this time, Toyota was able to complete its detailed review and analysis of the available freeze frame data. Through this analysis, Toyota identified eight data records that indicated that the hybrid system in a subject vehicle shut down instead of entering a failsafe driving mode due to an abnormally high voltage being generated.

Based on a result of the investigation above, it was found that, in spite of the improved thermal management logic in the software that was originally equipped in the subject vehicles, thermal damage could occur in certain transistors if the vehicle is exposed to repeated driving under certain identified high-load driving patterns over time. In cases where a specific transistor fails in a certain way during a high-load driving condition, such as during hard acceleration, a large counter-electromotive voltage could be generated by the motor/generator at a capacitor within the IPM. This large voltage, higher than the system limit, could be generated by the increase in RPM of the internal combustion engine and the motor generator attached to the engine. If this were to occur, the hybrid system could shutdown, by design, in order to protect the system from electrical damage. In this condition, power steering and braking will not be affected. However, a hybrid system that shuts down without entering a failsafe mode could result in the vehicle losing motive power while driving at higher speeds, increasing the risk of a crash.

June 18, 2020

Toyota decided to conduct a voluntary safety recall campaign.

As of June 10, 2020, based on a diligent review of records, Toyota's best engineering judgment is that there is one Toyota Field Technical Report and there are seven warranty claims that have been received from U.S. sources that relate to the condition investigated in this chronology and which were considered in the decision to submit this report.

7. Description of Corrective Repair Action:

To address the safety defect, all known owners of the subject vehicles will be notified by first class mail to return their vehicles to a Toyota dealer to have a software update for the hybrid system performed at no cost.

For customer satisfaction, if the vehicle has experienced an inverter failure with certain hybrid system faults related to this condition, the inverter assembly will be repaired or replaced, prior to software update, at no cost.

Reimbursement Plan for pre-notification remedies

The owner letter will instruct vehicle owners who have paid to have this condition remedied prior to this campaign to seek reimbursement pursuant to Toyota's General Reimbursement Plan.

8. Recall Schedule:

Notifications to owners will be sent by August 23, 2020. A copy of the draft owner notification will be submitted as soon as it is available.

9. Distributor/Dealer Notification Schedule:

Notifications to distributors/dealers will be sent by June 24, 2020. Copies of dealer communications will be submitted as they are issued.

10. Manufacturer's Campaign Number:

[Interim / Remedy] 20TB10 / 20TA10