

NOTE

Technology Trend in Remote Engine Starter

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1 Introduction

A remote engine starter is designed to provide comfortable room temperature inside a car whether that is in the winter time of cold areas such as Hokkaido or the summer time of extreme heat or desert areas such as Arizona in North America, by operating the air conditioner through activating the car engine before a driver gets into the car.

Additional benefit is that an exhaust muffler, warmed up by idling, has a better catalytic effect, and this leads to a reduction of toxic exhaust gases.

This paper will introduce the outline of our remote engine starter system and its market trend.

2 Outline of Our Remote Engine Starter System

2.1 Characteristics of Our System

Fig. 1 shows the configuration of our remote engine starter system heading for North America, which is composed of our remote engine starter ECU and gateway ECU connected to vehicle bus. Communications between in-vehicle wireless door lock system and engine control system enable an engine start from a distance.

Generally in the aftermarket remote engine starter system, a dedicated remote control for engine start causes the engine to start from a distance, but in our system, the remote control of wireless car door lock system can start the engine. In other words, users are free from the inconvenience of having two remote controls, and this is the characteristics of our system.

The door lock remote control functions within a distance of approx. 20 m to 50 m, and naturally, our remote engine starter is designed to function within the distance that a driver can recognize his / her car visually (the range where the wireless door lock system can function). Thus, our remote engine starter is suitable for use mainly at residential parking or a parking location close to an office.

2.2 Engine Start Procedure

Our remote engine starter requires three-consecutive-pushes on the lock button of a wireless door lock remote control for engine start. When a user operates three-consecutive-push (short / short / long push) on the door lock button of a remote control, an in-vehicle wireless ECU receives the door lock signal and sends the three-consecutive-push signals to the remote engine starter ECU

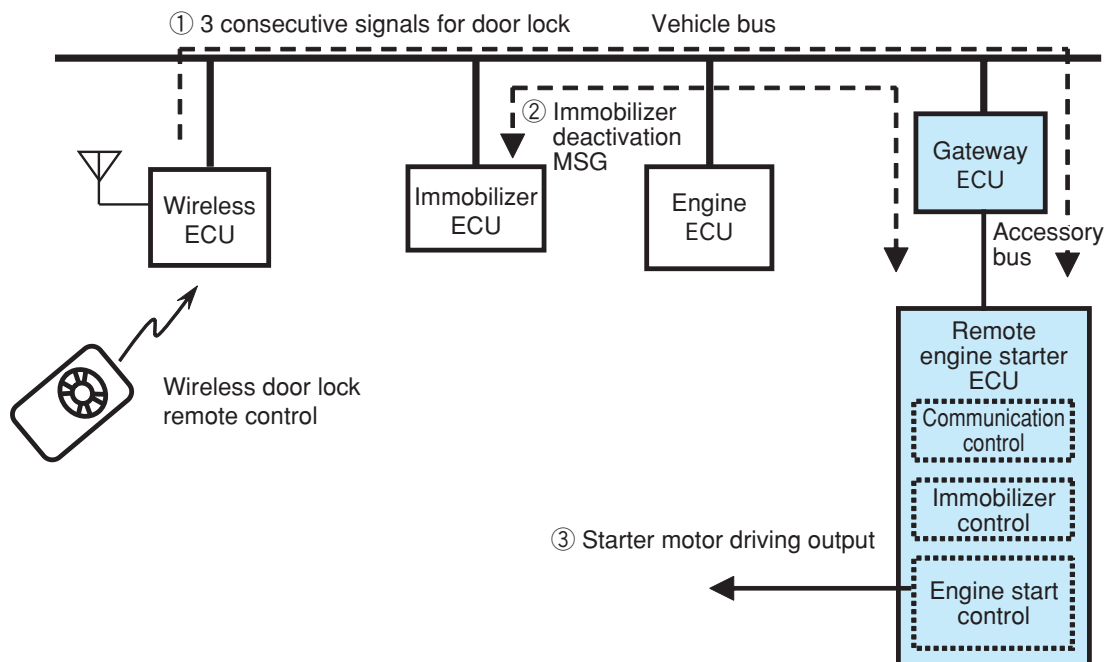


Fig.1 Configuration of FUJITSU TEN Remote Engine Starter System

through a vehicle bus. The remote engine starter ECU that received the door lock signal sends an encrypted message to deactivate the immobilizer in order to make the car get ready for engine start. After the immobilizer is deactivated, the remote engine starter ECU drives the starter motor.

The remote engine starter has a retry function, which is to repeat an engine start when the engine can not start while the car satisfies the conditions for engine start after the control of the engine starter.

2.3 Safety of Remote Engine Starter System

2.3.1 Fail-safe Function

This remote engine starter can function only with an automatic transmission car (hereinafter referred to as an automatic car). In the automatic car, because of the transmission structure, the signal of the shift position in parking range (P position) can be used as an input signal for engine starter. In the fail-safe function, the signal is used to enhance the safety at the time of engine start in the method by judging this signal as the one output from a "stopped-state car."

With the automatic car, the remote engine starter can operate the engine only of the stopped-state car by judging this input signal as above. On the other hand, with a manual transmission car (hereinafter referred to as a manual car), it is impossible to recognize its shift lever state in a neutral position. Considering the safety of this product making the engine to start from a distance, we decided not to install the starter system on a manual car.

In addition, this system has another control function to prevent unexpected problems caused by suspicious acting around / inside a car through monitoring various car signals such as door / hood open-close signals, brake signals and engine rotation speed as well as the shift lever position signal in order to stop its engine.

2.3.2 Prevention of Error in Remote Control Operation

In our remote engine starter, since a user pushes the button of the wireless door lock remote control of a car to start its engine, the starter must have a function to deal with unintended operations by a user.

For example, to prevent the case that the engine starts unexpectedly due to the lock button in a pocket being pushed accidentally by a user, we studied the appropriate sequence for pushing the lock button several times. The more complicated the sequence becomes, the more inconvenient the operation becomes. Thus, to decide the appropriate sequence, we asked general public users to operate the remote control and studied the appropriate number of times, interval and period of a push. Then, we obtained the best sequence for operation "to start engine only when a user intends preventing errors in operation."

2.3.3 Warm-up Time

The remote engine starter has a function to stop the engine automatically after a certain period of idling. This automatic stop function is designed in consideration of environment so as not to keep an engine in an idling state for a long period.

Considering user's safety, we provide a function to stop the engine before a user gets poisoned by the carbon monoxide when exhaust fumes fill the space due to starting the engine in an enclosed parking space. With measuring the concentration of carbon monoxide at our test site, we examined the time from starting an engine to reaching 50ppm of concentration that is the level to cause symptoms of poisoning. The result shows that the concentration exceeded 50ppm in approx. 10 minutes at the measurement points around the car after an engine started. Applying this result, our remote engine starter is designed to stop an engine automatically in 10 minutes in consideration of both warm-up effect and safety time up to reaching to the risky level of carbon monoxide concentration.

2.4 Preventing Vehicle Theft

This remote engine starter requires a function to prevent car theft because this system functions to start the engine of an unmanned car.

2.4.1 Permission of Engine Start

As described in the engine start procedure (Section 2.2), the remote engine starter makes a car get ready for starting its engine by communicating with an immobilizer. When the encrypted code is matched between the remote engine starter and the immobilizer, the immobilizer gets ready for starting its engine.

The system prevents these car thefts which have a modus operandi of affixing a product other than the remote engine starter permitted by this car system and making the engine to start illegally. This is the characteristic of a genuine system.

2.4.2 Security Function

The unmanned car during a warm-up through the engine start by using a key is in danger of a car theft. On the other hand, since the remote engine starter cooperates with a door lock control and enables the car engine to be warmed up with its doors locked, it is categorized as a security product.

In general, when a key is inserted in an ignition key cylinder, doors cannot be locked due to the function of key-in-lock prevention. However, the remote engine starter cooperates with a door lock control, and during warming up an engine, doors are locked.

Our remote engine starter, cooperating with a car security function, turns the car security system into an alert state when receiving wireless door lock signals for engine start. When the security system detects a suspi-

cious intrusion during warming up the engine, the system stops the engine. This is also one of the genuine system characteristics.

3 Trend of World Remote Engine Starter

Here is the explanation of the trend of remote engine starter systems in each region of the world.

3.1 North American Market

3.1.1 Temperature in North America

Since it is cold in winter with low average temperatures in wide areas of North America, demands for remote engine starters are strong. (Fig. 2)

Especially in Canada, areas where the average temperatures in winter are -20°C or less are widespread, and the demands for remote engine starters are stronger than in America.

[North American Temperature data (Average temperature in January)]

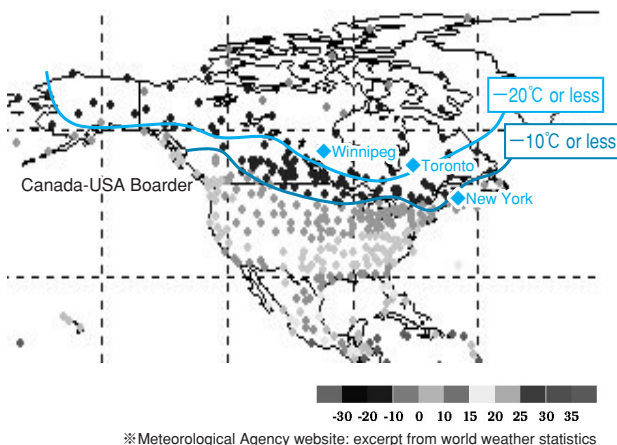


Fig.2 North American Temperature Data (January 2008)

3.1.2 System Trend

[Aftermarket System]

Since remote engine starters have been released as aftermarket systems in North America since the relatively early years in the late 1980's, the starters now have a lot of visibility. Naturally, North American users have a good knowledge of remote engine starters, and at the same time, have a variety of demands to the system. Aftermarket manufacturers provide various systems to attend to various users' demands. They provide various systems in functions and cost, for example, two-way communication system (high functionality and high price) that users can check the car conditions on a remote control by using two-way communication between in-vehicle engine starter ECU and a remote control with a liquid crystal display, and one-way communication system (low functionality and low price) with a remote control only to control the engine start.

An aftermarket system is basically composed of a

special remote control with an engine start button, antenna being attached to a window glass and an ECU. The mainstream frequency band for a remote control is 300MHz / 400MHz, which conform to FCC (American radio law) and IC (Canadian radio law).

The remote control can operate in the range approx. 100m to 300m around a car, for example in the large parking lot of a shopping mall or a hotel. Nowadays, in accordance with FCC revision, the output power up to 1W in 900MHz band, which is opened for a spread spectrum system, is now available. Thus, some new aftermarket systems provide a long distance operation; 1 mile (approx. 1.6km) according to their catalogs, and the demands for longer distance operation in remote engine starters are increasing year by year.

[Genuine system]

As for automakers' trends, starting with the Malibu 2003 model in which GM provided the first remote engine starter as a genuine line option, each automaker has expanded the adoption of remote engine starters as genuine options.

The GM genuine system is convenient for use with no need to have another remote control because its wireless door lock remote control is equipped with the remote engine starter button.

Other automakers provide remote engine starters as dealer options, but in some cases, the systems sold as genuine systems are just the ones that aftermarket systems are simply changed in their appearance designs. The efforts to develop remote engine starter systems vary according to automakers.

The mainstream genuine system in North America is a one-way communication system with approx. 100m to 200m operation distance, but these years, GM and Honda have improved its performance in a car condition display and others, and have released a two-way communication system with a remote control with a liquid crystal display as a genuine system.

[Immobilizer deactivation method]

The immobilizer deactivation methods are different between the genuine system and the aftermarket system.

The genuine system enables an engine to start by communicating with an immobilizer as explained in Section 2.4.1, but the aftermarket system requires a special "immobilizer bypass kit" to be installed. This is because the aftermarket system cannot communicate with an immobilizer to cooperate with a car for control, differing from the genuine system.

For the deactivation, to read the ID code of the immobilizer, the aftermarket system requires a connection between a spare key and an ignition key cylinder by attaching to a coil antenna. When the remote engine starter sends a code for engine start, the system reads an ID code from the spare key and sends the ID code to the

ignition key cylinder, which enables the immobilizer to be deactivated artificially. The aftermarket system is inferior to the genuine system in safety and reliability because the spare key has to be kept inserted in a car, and at some attached positions of the coil antenna, the immobilizer cannot be deactivated.

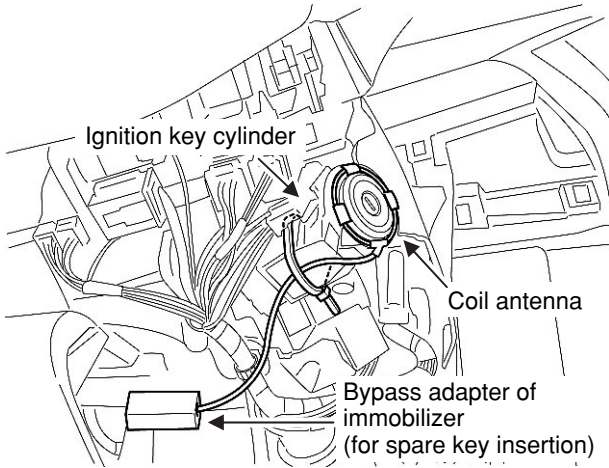


Fig.3 Immobilizer Deactivation Method of Aftermarket System

To solve these problems, some aftermarket manufacturers adopt the system that reads communication signals from a car connector and stores the immobilizer signals on a remote engine starter directly. As above, the aftermarket systems are improving these days.

3.2 Japanese Market
3.2.1 Cold Areas in Japan

In Japan, remote engine starters are essential for people in cold areas such as Hokkaido and Tohoku. In Hokkaido, approx. 70% of users buy a remote engine starter at the time of buying a car, and thus, automakers must prepare the remote engine starters as lineups.

3.2.2 System Trend

[Aftermarket system]

In Japan, the special remote controls of specified low power type are used in many systems. In the specified low power type, output voltage and antenna gain performance of a remote control can be set higher than those for the weak radio wave type. Thus, this system is available even under such a residential environment as high-rise condominium or parking at several kilometers away from home.

Domestic aftermarket manufacturers provide various product lineups, and users buy and install these products normally at car equipment retailers or dealers. Japanese users tend to favor an advanced system, and the mainstream is a two-way communication system using a remote control of specified low power type equipped with a liquid crystal display and a LED. Among Japanese users, expensive systems made by overseas manufactur-

ers, as well as by domestic manufacturers, are high in visibility.

The aftermarket system requires the "immobilizer deactivation adapter" of an aftermarket option to be installed to the car with an immobilizer in the same manner as in North America, but the aftermarket system is impossible to be set to a push-start car that differs in an immobilizer deactivation system.

[Genuine system]

Unlike North American automakers, many domestic automakers including light car automakers provide remote engine starters as their dealer options.

In the genuine system, as well as the aftermarket system, products with the two-way communication system of the specified low power type are provided. But the remote controls of the genuine system, as their features, are designed in appearance to be matched to the cars in cooperation with automakers. For example with Toyota products, the designs of controls are different between Toyota brands and Lexus brands. (Fig. 4) The designs also follow their car design concepts in waterproof property, durability and so forth.

In Japan, the remote controls for wireless car door lock operation use weak radio waves, and the range of approx. 3m to 10m is available. Thus, the use environment of remote controls for engine start is different from that in North America, we have not yet provided car manufactures with the remote controls for engine start like North American types, as in-built system.



Fig.4 Remote Controls of Japanese Automakers

3.3 Other areas

In Europe, reflecting the strong consciousness of environmental regulations, most countries have rules for idling. Thus, it is prohibited to start an engine under the unmanned situation (where the use of a remote engine

starter is suitable), and even in low-temperature areas the market of the remote engine starters is still small.

As for the areas other than cold areas, the engine starters are in demand in Middle East area. In contradiction to the cold areas, Middle East is a desert area and the highest temperature is over 40°C in a daytime. So, the remote engine starter is used for cooling a car inside.

4

Future Effort**4.1 Tasks in Our Remote Engine Starter System**

Since the release of the remote engine starter as a genuine system for Toyota in 2005, we have investigated users' requests to our remote engine starters by having questionnaires to the users who bought our product or by holding hearings at dealers. Through the investigation, we received demands for more advanced functions such as two-way communication system and cooperation with smart entry system, as well as for larger available range of remote controls and advanced operation methods. We have set our future tasks to develop products conforming to these various users' demands.

4.2 Future Market Growth

The remote engine starter market has been growing around North America and Japan, and in the future, it will be growing in developing countries such as BRICs. In fact, the remote engine starters are receiving more interest among people in China and Russia. We need to address the investigation of their market environments and clarify the performances / functions conforming to their market demands.

4.3 Engine Starter System in Future

The remote engine starter functions away from a car, but in the future, the environment is being ready for this system to function at further distance than the present remote control operation range as a car-outward communication technology is improving. Through reviewing the conventional concept of safety, it is possible to develop a more convenient system. Besides, in accordance with the development of hybrid cars and battery cars, the future role of the remote engine starter will be changing. To make the environment inside a car comfortable, we should not stick to the concept of the conventional method for engine start. We need to keep addressing the development so as to provide users' comforts and added values in accordance with advanced car functions.

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