The Document of System Introduction

IMMOBILIZER SYSTEM
– IM800-

Daewoo Precision Industries Co., Ltd.

Information to user : PART 15, PARAGRAPH 15.21 AND 15.105(b)

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment

FCC Notice

NOTE : This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1)this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

- Contents -

1. Introduction

This document is the technical specification of the crypto transponder based Immobilizer System for the DWMC T200 car consisting of DPI Immobilizer Control Unit, IM800, (hereinafter Immobilizer or ICU) and Engine Control Module (ECM).

The purpose of the DPI Immobilizer System is to provide additional theft deterrence to the vehicle in which it is installed and to prevent it from being driven by unauthorized users. The verification of the user authorization is done by using an ignition key with integrated transponder.

The external LED displays the Immobilizer status and has an additional theft deterrence function.

To secure the communication, the status is exchanged between the Immobilizer and the ECM in a 5 bytes of encoded data.

These 5 bytes are composed by a mixture of random data and two types of fixed code :

- a Vehicle Model Identification Number : MIN
- a Vehicle specific Identification Number : VIN

The MIN is known from the first supply of the system.
The VIN is realized by ICU on the special order from the key coding (reading of transponder code and storing it as valid key code in Immobilizer EEPROM). A different random data is computed at each key transition.

All the immobilization communication between the ECM and ICU is made on K-line.

Due to the learning of the Vehicle specific Identification Number, both ICU and ECM can stay in 3 stable modes :

- Virgin mode (VIN not learnt)
- Learnt mode (VIN learnt)
- Neutral mode (for a new VIN learning)

Every Immobilizer system has one of 65,535 possible VIN-codes, which have to be equal to release the engine running. The definition of the VIN-code is executed by the Immobilizer.

The diagnosis of the Immobilizer is realized by the ALDL-function modes(refer to DPE-AE-IM159912S). They are realized by the Daewoo ALDL test equipment. To avoid manipulation of the usage of the test

equipment, especially the use of the Key Coding procedure has to be protected against unauthorized use. So some critical services are only accessible by security access implemented in ICU diagnostic service, example for 'read/reset ICU VIN-code', 'change to neutral mode' and 'authorize one additional key', etc.

2. System Description

The T200 Immobilizer system consist of

- a maximum of 5 ignition keys with integrated transponder,
- the toroidal coil for energizing and reading the transponder mounted at the ignition lock,
- the Immobilizer control unit(ICU) with :
  - power supply (Term. 30),
  - ignition input circuit,
  - transponder modulation and demodulation unit,
  - uP with integrated EEPROM,
  - driver electronic for the external status LED,
  - serial data link hardware,
- the external status LED for displaying the Immobilizer status,
- the serial data link between Immobilizer and ECM and
- the serial data link between Immobilizer and Instrument Cluster(provision)
- the ECM itself.

3. System Function

3.1 Immobilizing Function

- **Ignition ON Immobilizer :**

Turning on the ignition triggers the Immobilizer to read out the transponder data and to compare the read code with the valid key codes stored in the Immobilizer EEPROM. Until the end of transponder reading the Immobilizer is active state(cranking is not possible).

- In case of using a valid key, the internal relay is activated (cranking is possible) and the release message communication with the ECM takes place. The LED displays the Immobilizer status 'valid key'.

- In case of receiving no ECM request within the defined time-window the internal relay is deactivated(cranking is not possible). The LED displays the Immobilizer status 'valid key'.

- At the end of the TMPVDOUT delay the immobilization communication is stopped and the internal relay is deactivated and then the Immobilizer waits for a diagnosis request from the tester.

- In case of using a invalid key, 'no release answer' communication with the ECM takes place. The LED displays the Immobilizer status 'invalid key'.

- **Ignition ON ECM :**

After turning on the ignition the ECM will control the engine in a normal way for starting and running while waiting for a valid release response message from the Immobilizer (release time period).

- After receiving a response message including the information 'ICU in learnt mode' and the correct system VIN-code the ECM enters the release state, which allows to continue the running of the engine.

- After receiving a response message including the information 'ICU in learnt mode' and a wrong system VIN-code, the ECM does not send a new request and enters the blocked state, which causes the activation of the immobilization actions of the engine.

- If the ECM doesn't receive a response message within a defined time from beginning of the

release time period and the ECM receives a no release answer, it enters the blocked state, which causes the activation of the immobilization actions of the engine.

- **Ignition OFF Immobilizer :**

The inactive state of the Immobilizer(valid key / invalid key) ends with turning off the ignition.

- **Ignition OFF ECM :**

The immobilizing state of the ECM (released/blocked) ends with turning off the ignition or with removing the battery voltage.

3.2 Functions for Protection against Manipulation

3.2.1 Vehicle Specific Identification Number(VIN)

The VIN-code is calculated by the Immobilizer using a random number generator.

The VIN-code is transmitted from the Immobilizer in the release message communication only in case of using an authorized key. Without an authorized key it is not possible to get the system VIN-code.

In case of ECM internal state is in virgin mode or neutral mode the ECM learns the system VIN-code automatically after receiving the first release response message.

To get a synchronized Immobilizer system (same VIN-codes in Immobilizer and ECM, authorized key) the function of Auto key learning procedure in the DWMC production line and the ALDL-test equipment has
to be used for authorization of the keys (first Key Coding) in the field.
The usage of this test equipment is restricted to authorized persons.

4. System Components

4.1 Ignition Key with Integrated Transponder

4.1.1 Transponder Mounting

The transponder is placed invisible inside the ignition key. A second ignition key with integrated transponder on the bunch doesn't affect the reading process.

4.1.2 Transponder Function

The transponder is a read/write RF transponder. The transponder contains an implementation of a crypto-algorithm with 96 bits of user configurable secret-key contained in EEPROM. It also provides a unique device identification of 32bits that can never be modified as well as 30bits of freely programmable USER-MEMORY.
Bits 15 and 14 of word 1 are used as Lock-bits. The memory can only be accessed for writing or Erasing if these two bits have the contents "10" as when they are delivered.
The transponder transmits data to the transceiver(ICU) by modulating the amplitude of the electromagnetic field, and receives data and commands in a similar way.

4.1.3 Transponder Specification

*. Mechanical data

- Length of tube	13.3 +/- 0.4mm
- Diameter of tube	3.15 +/- 0.1mm
- Storage temperature	-40 to +85℃
- Operation temperature	-40 to +85℃

*. Electrical data

- Nominal resonance frequency	RF = 125kHz +/- 3kHz
- Bit Period	256us at RF = 125kHz
- Bitcoding	Manchester
- Modulation	AM

4.2 Toroidal Coil

4.2.1 Toroidal Coil Mounting

The toroidal coil is mounted at the ignition lock in front of the key barrel. It is integrated to the ICU housing
package with a body of the coil to improve the performance of transponder reading and EMC.

4.2.2 Toroidal Coil Function

The toroidal coil and receiving coil inside the transponder built a transformer. During the reading process the coil induces energy into the transponder. The transponder charges the field and generates an amplitude modulated signal with the manchester coded data. This charge of the field is demodulated inside the Immobilizer.

4.2.3 Electrical Spec. of Toroidal Coil

- Operating temperature	-40℃ to +80℃
- Turns	80
- Inductance(not on ignition lock)	407uH +/- 2% measured at 120kHz
- Inductance(on the ignition lock)	360 ± 10 μH measured at 120kHz
- DC resistance	4.8ohm +/- 5%
- Cu-wire(diameter)	0.20mm

4.2.4 Toroidal Coil Driver

The Immobilizer contains the coil driver hardware for direct connection of the toroidal coil.

4.3 Status LED

An external LED displays the Immobilizer system status. The Immobilizer contains the LED driver hardware for direct connection of one LED.

4.3.1 Status LED Modes

Mode	Status LED	Immobilizer System status	Note
Mode A	Blinking (f = 1Hz) Duty cycle 1 : 7	Immobilizer active	-. Ignition OFF -. Auto Key Learning is enable
Mode B	Blinking (f = 1Hz) Duty cycle 7 : 1	Immobilizer active	-. Ignition ON -. Invalid key detected or invalid learnt mode -. Learnt or Virgin mode
Mode C	OFF	Immobilizer inactive	-. Ignition ON -. Valid key detected -. Learnt mode
Mode C	OFF	Immobilizer active	-. Ignition OFF -. Any ICU status except in case of Mode A
Mode C	OFF	Learning in progress	-. Ignition OFF or ON -. Learning non successful or key yet learnt
Mode D	ON	Immobilizer active	-. Ignition ON -. Transponder doesn't detected
Mode E	Blinking (f = 0.5Hz) Duty cycle 5 : 5	Immobilizer active	-. Ignition ON -. Virgin state -. Entry to the Auto key learning
Mode F	Blinking (f = 1Hz) Duty cycle 5 : 5	Immobilizer active	-. Ignition ON -. VIN-code/MIN-code are different between ICU and ECM in learnt state
Mode G	Blinking(f = 2Hz) Duty cycle 5 : 5	Learning in progress	-. Ignition ON -. Auto learning of first key is successful
Mode H	Blinking(f = 4Hz) Duty cycle 5 : 5	Learning in progress	-. Ignition ON -. Auto learning of second key is successful

4.4 Immobilizer Electronic Control Unit (ICU)

4.4.1 Tasks

The function of the Immobilizer System is shared between the ICU and the ECM.
The tasks of the Immobilizer Electronic Control Unit(ICU) are :

- Reading of the input information 'Ignition ON/OFF'.
- Controlling the states LED.
- Controlling the transponder read/write process (modulation, demodulation, decoding, comparison of the read code with the codes of the valid keys).
- Communication with the ECM after ignition ON (receiving of the ECM-request and transmission of release message).
- Controlling the internal relay to connect 510ohm pull-up resistor or not.
- Special functions for calculation and handling of the VIN-code.
- Communication with the ALDL-test equipment. Main functions are the Key Coding procedure, the VIN-code handling and the support for system test functions.
- Handling of the software watchdog.
- Realization of functions for reducing the power consumption(cyclic wake up).
- Message encryption

4.4.2 Function

4.4.2.1 Normal Operation

- In the active mode of Immobilizer(engine off, ignition turned off) the status LED turned OFF as Mode C.

- When ignition is turned on, the system wakes up and tries to read out the transponder. The timing for all system is defined in the chapter 5.

- In case of the detection of a valid key, the release message communication with the ECM takes place. The status LED displays the Immobilizer state 'valid key' as Mode C. The maximum duration of the release message communication is restricted to a calibration time TMPVDOUT. This value must be defined until fixing of the Immobilizer software.

  - After receiving request message including the information 'ECM in virgin mode' and 'ECM in neutral mode' the ICU will send response message 'ICU in learnt mode' and will change to the inactive mode.
    The status LED is turned off.

  - After receiving request message including the information 'ECM in learnt mode' and the correct VIN-code, the ICU will send response message 'ICU in learnt mode' and will change to inactive mode. The status LED is turned off.

  - After receiving request message including the information 'ECM in learnt mode' and incorrect VIN-code, the ICU will send response message 'no release answer' and will change to active mode. The status LED displays the Immobilizer state 'different VIN-code'. And then in order to crank a vehicle the ICU should be changed to neutral mode by Tester equipment(change to neutral mode).

  - In case of no request from the ECM is received within the defined time TMPVDOUT, the Immobilizer stays in the active mode. The status LED is still displaying the Immobilizer state 'valid key'.

- In case of the detection of a invalid key, the ICU will send response message 'no release answer' and will change to active mode.
  The status LED displays the Immobilizer state 'invalid key'.

- After turning off the ignition (ignition OFF detection similar to the ECM ignition OFF detection), the Immobilizer changes to the active mode. The status LED is turned off as Mode C.

4.4.2.2 ALDL-mode

During ignition ON the Immobilizer ALDL-mode can be activated with one of the defined Immobilizer ALDL-Function modes.
Until the deactivation with the ALDL Function Mode 'Stop Communication Service' or detection of a time-out the Immobilizer stays in the ALDL mode. Cyclic transmissions of ALDL-function modes (same as Tester Present service) keep the Immobilizer in the ALDL-mode. The normal operation of the system (reading of transponder after turning ignition on, communication with the ECM, blinking of the status LED) is disabled during ALDL-mode.

- The status LED is turned off during ALDL-mode.
- The Immobilizer will answer all correct messages, which are defined as Immobilizer messages.
- Activation of ALDL-Mode after TMPVDOUT time delay may not cause a bus collision.

4.4.2.3 VIN-code Handling

The VIN-code is stored in the Immobilizer uP-EEPROM. At the end of the electronic unit production line the Immobilizer VIN-code has to be erased. The erased VIN-code(=0FFFFh) enables the VIN-code calculation procedure of the Immobilizer. The VIN-code can only be erased with the special Immobilizer ALDL-function 'Reset Immobilizer VIN-code'. It is not possible to change the VIN-code with the standard Key Coding procedure. The VIN-code can be read with the diagnostic function 'Read VIN-code service' and 'Read ICU & ECM mode service' for external comparison with the ECM VIN-code.

The VIN-code is a two byte random value in the range from 0000h to 0FFFFh. The VIN-code is fix for one car, but it has 65,535 variations in field. The value 0FFFFh is reserved to enable the VIN-code calculation procedure.

If the VIN-code calculation procedure is enabled, the first Key Coding procedure(normally the Key Coding procedure at DWMC production line) is followed by the VIN-code calculation procedure. The new VIN-code is transmitted to the ECM via the release message communication during the first starting with a valid key. The system timing in this case is the same as in case of the normal use of a valid key.

4.4.2.4 Calibration Parameter

- TMPVDOUT :

It represents the maximum duration of the release message communication between the ECM and the ICU. The timer starts with detection of Ignition on. On the ECM side the time allowed to the Immo. Function is limited to a maximum value C_MAX_DLY_ACT_IMOB(typical value 768ms) which starts with the end of Tini time.

If no request from ECM was received during limited time, TMPVDOUT, the release message communication is finished.

- Timeout = TMPVDOUT * 100 ms
- Calibration range =

  10 .. TMPVDOUT .. 254

  1 sec .. Timeout .. 25.4 sec
- Default value

  TMPVDOUT = 20

  Timeout = 2 sec
- EEPROM address TMPVDOUT = 31h

4.4.3 Connector for the ICU

The Immobilizer has two connectors. The terminal function is shown in the following table:

Terminal No	Function	Type
A1	Ignition (Term. 15)	Input
A2	Battery Power (Term. 30)	Power
A3	Serial data link(Instrument Cluster) - provision	Bidirectional data
A4	Vehicle GND (Term. 31)	Power
A5	Serial data link(ALDL Tester)	Bidirectional data
A6	Serial data link(ECM)	Bidirectional data
A7	External Status LED	Output

4.4.4 General Specification

Test item	Contents
Nominal voltage	12V
Test voltage	13.5V +/- 0.1V
Operating voltage	8 - 16 V
Undervoltage protection	Reset if U < 6V
Overvoltage protection	18V+/-0.1V 1hr, 24V 2min
Reverse battery protection	-13V+/-0.1V, 2min
Standby current	< 3mA (by using mask controller)
Operation current	< 200mA
Storage temperature range	-40℃ to +85℃
Operating temperature range	-40℃ to +80℃
Installation position	Passenger compartment
Resonance capacitance	adjusted to the toroidal coil
Outputs	All outputs are short circuit protected
LED driver current Ipeak	3.3 mA

4.4.5 Environmental Test Specification

Test Items	Contents
Rapid change of temperature test	According to EDS-T-5426 20 cycles -40℃ to +80℃ 30sec recovery time / 1h duration
Endurance test (Change of temperature test)	According to EDS-T-5426 -40℃ to +80℃ 12h per cycle (7h at +80℃ / 1h at –40℃) 50,000 cycles(5sec : ON, 5sec : OFF)
Frost test	According to EDS-T-5426 -20℃ 95% humidity 8 hours
Humidity test	According to EDS-T-5426 +40℃ 95% humidity 250 hours
Dust test	According to EDS-T-5426 Agitation : 5 sec each cycle Duration : 20 minute(1 cycle) 8 hours
Vibration test	According to EDS-T-5426 Duration : 8 hours each axis Frequency & Acceleration : 25Hz – 4.34G/Hz 1000Hz – 0.1G/Hz Total acceleration : 2G
Drop test	According to EDS-T-5426 Height : 1m Ground : concrete surface 2 shocks each direction (6 total)
EMC	
Functional Status Classifications : class C according to GM9100P	
Transients	EDS-T-5011
Load dump	EDS-T-5011
EMI test	EDS-T-5524
EMS test	EDS-T-5512 : Bulk Current Injection EDS-T-5514 : Magnetic Immunity EDS-T-5006 : Sinusoidal Burst
ESD test	EDS-T-5005