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PASTA1.0　ECU Simulation Board

Hardware/Software Specification

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Contents

1. Overview

This is hardware / software development specification of simulated ECU Printing Circuit Board (PCB) and is written for analyzing CAN communication.

2. PCB Specification

Table 1 Hardware Requirements Specification

No.	Description	Status
1	Development of ECU with a standard microcontroller	OK (Renesas RX63N)
2	Adding capability to develop Central Gateway (CGW)	OK（CAN×4 is integrated)
3	Improvement of portability	OK(lightweight small case)
4	Improvement of connectors	OK（connector with lock)
5	Linking a cool steering (with reaction force device)	OK
6	Development of dashboard	OK
7	Adding CAN transceiver: NXP TJA1050	OK
8	Adding CMC : ACT45B-510-2P (with a bypass circuit)	OK
9	Adding termination circuits(+60Ω to -60Ω, the middle point is grounded with 47nF)	OK
10	Adding Zener diodes on CAN connector for ESD protection	OK

2.1. Electrical Characteristics

Table 2 Absolute Maximum Ratings

Item	Symbol	Rated Value	Unit
Power Supply Voltage	+12V	-0.3 to +15.0	V
Analog Power Supply Voltage	AVCC	-0.3 to +4.6	V
I/O Unit Input Power Range	IOVIN	-0.3 to VCC+0.3	V
Reference Power Supply Voltage	VREFH	-0.3 to +4.6	V
Analog Input Voltage Range	AVin	-0.3 to VCC+0.3	V
CAN Input Voltage Range	CANin	-7.5 to +12.5	V
RS-232C Input Voltage Range	RSVin	±30	V
Storage Temperature Range	Tstg	-20 to +75	℃

* If the absolute maximum rating is exceeded, even for a moment, the devices on the board may be permanently destroyed.

* VCC indicates + 3.3 V generated in the board.

2.2. Recommended Operating Conditions

Table 3 Recommended Operating Conditions

Item	Symbol	Rated Value	Unit
Power Supply Voltage	+12V	+6.5 to +12.5	V
Analog Power Supply Voltage	AVCC	+3.1 to +3.5	V
I/O Unit Input Power Range	IOVIN	0 to VCC×0.3	V
Reference Power Supply Voltage	VREFH	+3.1 to +3.5	V
Analog Input Voltage Range	AVin	0.3 to VCC	V
CAN Input Voltage Range	CANin	-2 to +7	V
RS-232C Input Voltage Range	RSVin	±5 to ±15	V
Storage Temperature Range	Tstg	0 to +60	℃

* VCC indicates + 3.3 V generated in the board.

2.3. Specification of Major Parts

Item	Device	Specification
CPU	R5F563NFHDFB#V0	■Manufacturer: Renesas Electronics ■Clocks: Main Clock 12MHz System Clock(ICLK＝96MHz) Peripheral Module Clock (PCLK＝48MHz) RTC Input Clock (RTCSCLK＝32.768KHz) ■Built-in Functions: Reset and Control power supply voltage: POR,LVD Internal Memory (No wait states) - FLASH ROM (2Mbyte) - SRAM (256KByte) Internal E2 data flash - Capacity : 32Kbyte - Reprogramming/Erase cycle: 100000 Interrupt controller: interrupt vector 187 Real Time Clock Communication Function - Ether-MAC, USB2.0, CAN, I2C, SCI, SPI Watch Dog Timer A/D Converter for 1 MHz Operation 10bit D/A Converter × 2ch Up to 20 extended-function timers Data Encryption Unit (DEU) General I/O ports Sensor for measuring temperature within the chip
CAN Controller	MCP2515 For Extended CAN bus	■Manufacturer : Microchip ■SPI-I/F(Up to 10Mbps) ■Implements CAN V2.0B ■Maximum Transfer Rate : 1Mbps
CAN Driver	TJA1050 CPU Standard ×3 SPI Extension ×1	■Manufacturer: NXP, TI or equivalent ■Electrical Characteristics: Compliance with ISO11898 ■Maximum Transfer Rate: 1Mbps
RS232C Driver	SP3223EUCY or the equivalent	■Manufacture: Exar or the equivalent ■Electrical Characteristics: Compliance with ANSITIA/EIA-232-E ■Maximum Transfer Rate: 1Mbps

(continues)

Item	Device	Specification
Secondary Battery for CPU Build-in RTC	ML-621S/ZTN or the equivalent	■Manufacturer: Panasonic or the equivalent ■Type: Manganese Lithium Coin Batteries ■Capacity: 5 mAh ■Holder: PB621 (Takachi Electronics Enclosure)
Reset	RNA51957BFP or the equivalent	■Manufacturer : Renesas Electronics or the equivalent
μSD Card	–	Only socket is mounted.

3. System Configuration

Fig.1 ECU Simulation Board Block Diagram

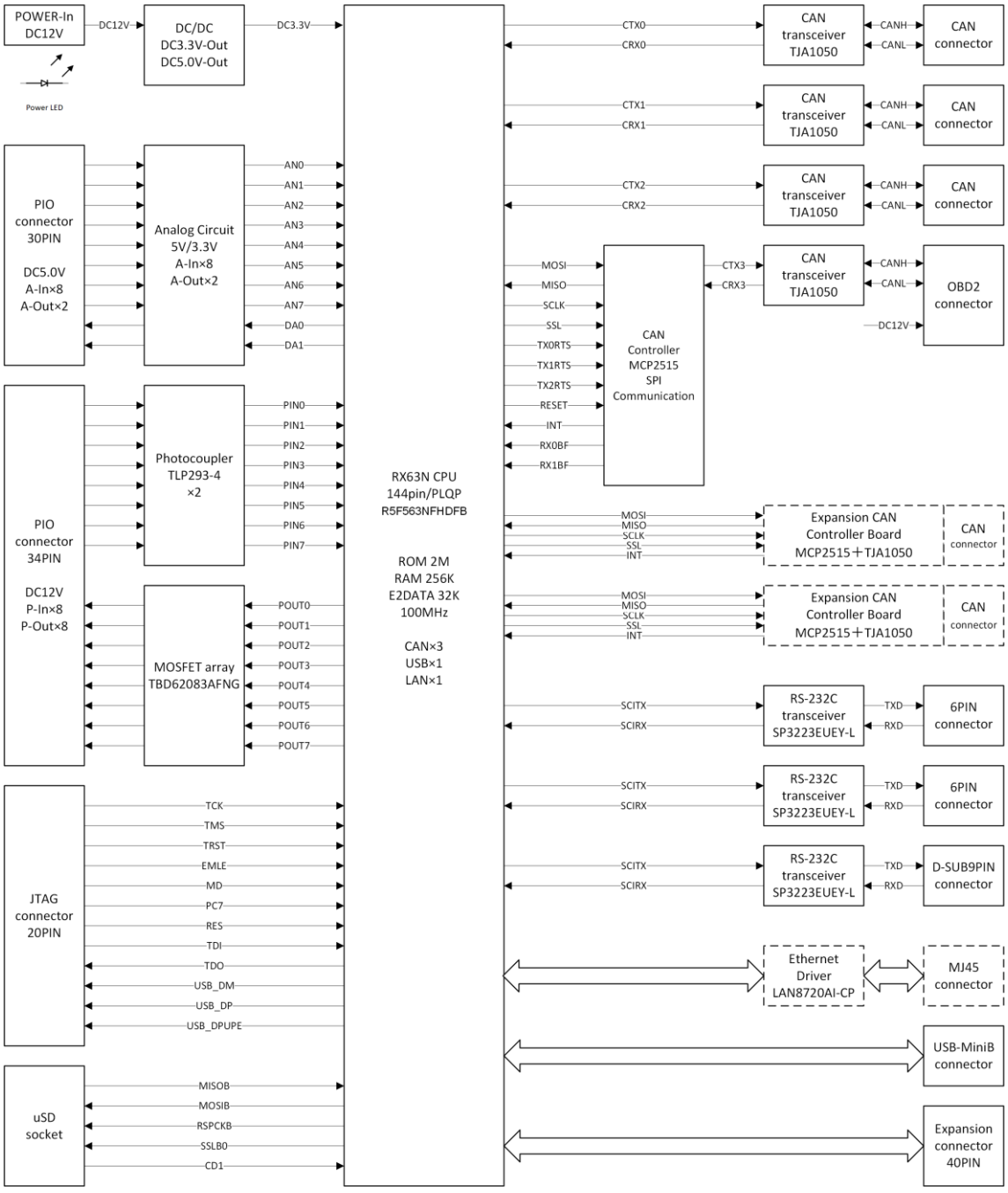
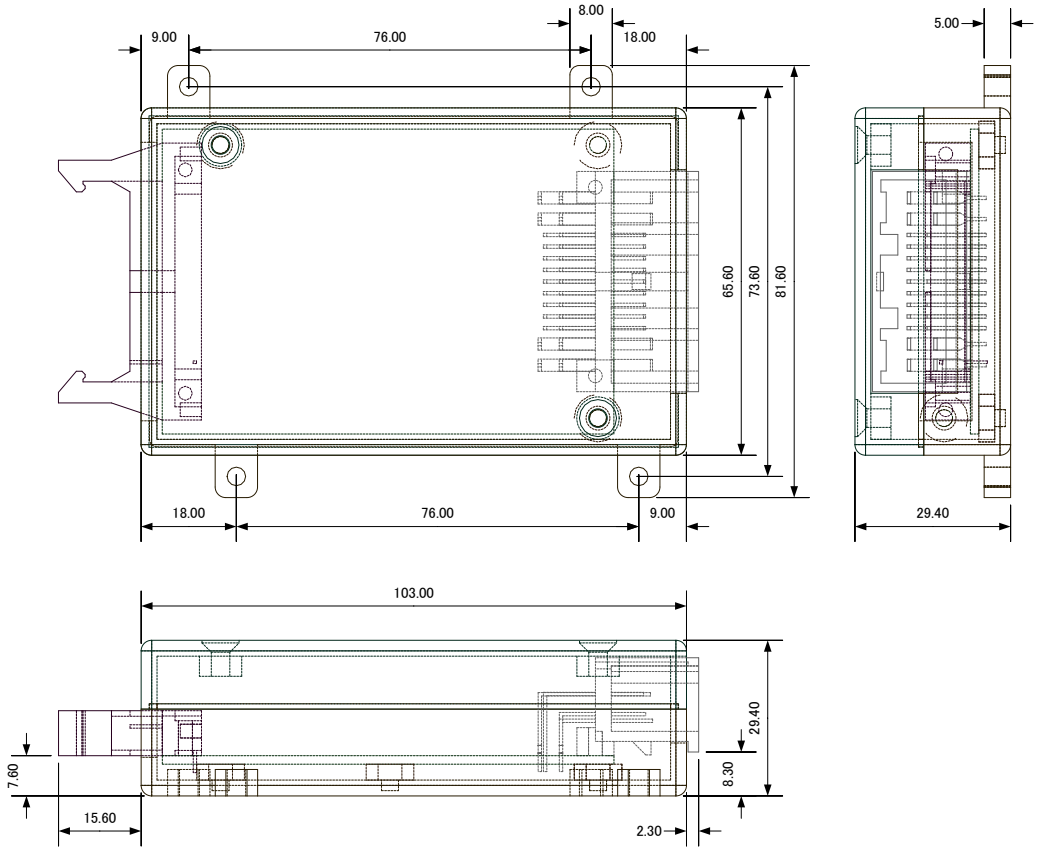
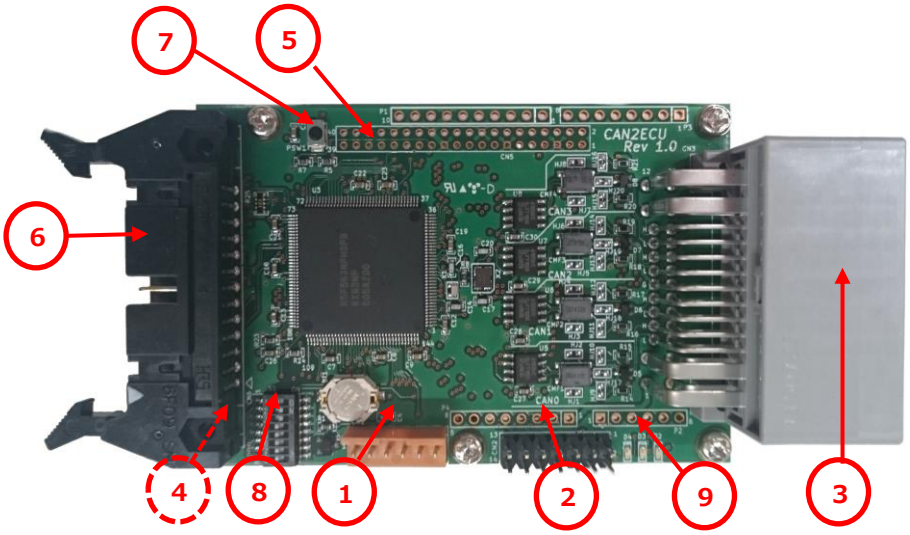


Fig.2 ECU Appearance





No.	Description
1	CN1 : RS-232C
2	CN2 : JTAG
3	CN3 : CAN/12V
4	CN4 : µSD (Back)
5	CN5 : Extended I/O
6	CN6 : I/O
7	Reset Button
8	DIP Switch
9	LED Indicator

4. CPU PIN Assignment

CPU PIN number – Function list

PIN #	Port#	Function Module	Description
1		AVSS0	Analog Grand（0V）
2	P05	DA1	Analog Output D/A-1
3		VREFH	Reference Voltage H
4	P03	DA0	Analog Output D/A-0
5		VREFL	Reference Voltage L
6	P02		RS-232C Port COM6-RTS
7	P01	RXD6	RS-232C Port COM6-RXD
8	P00	TXD6	RS-232C Port COM6-TXD
9	PF5		Expansion Connector / S1-8 (DIP Switch Input)
10		EMLE	JTAG Signal EMLE
11	PJ5		Expansion Connector / S1-7 (DIP Switch Input)
12		VSS	Logic Power Supply 0V
13	PJ3	CTS6	RS-232C Port COM6-CTS
14		VCL	External 0.1uF
15		VBATT	Backup Power line 3.3V
16		MD/FINED	JTAG Signal MD（CPU Mode Setting）/ S1-1 Input
17		XCIN	External Crystal Oscillator（32.768KHz）Input
18		XCOUT	External Crystal Oscillator（32.768KHz）Output
19		RES#	Chip Reset (JTAG Signal nRES)　Input
20	P37	XTAL	External Crystal Oscillator（12MHz）Output
21		VSS	Logic Power Supply 0V
22	P36	EXTAL	External Crystal Oscillator（12MHz）Input
23		VCC	Logic Power Supply 3.3V
24	P35		Expansion Connector / NMI
25	P34	TRST#	JTAG Signal nTRES Input
26	P33	CRX0	CAN0 Receive Port
27	P32	CTX0	CAN0 Transmit Port
28	P31	TMS	JTAG Signal TMS Input
29	P30	TDI	JTAG Signal TDI Input（RXD1）
30	P27	TCK/FINEC	JTAG Signal TCK Input
31	P26	TDO	JTAG Signal TDO Output（TXD1）

CPU PIN number – Function list (continues)

PIN #	Port #	Function Module	Description
32	P25	RXD3	RS-232C Port COM3-RXD
33	P24		RS-232C Port COM3-CTS
34	P23	TXD3	RS-232C Port COM3-TXD
35	P22		RS-232C Port COM3-RTS
36	P21	RXD0	RS-232C Port COM0-RXD
37	P20	TXD0	RS-232C Port COM0-TXD
38	P17		RS-232C Port COM2-CTS
39	P87		RS-232C Port COM0-CTS
40	P16	USB0_VBUS	Expansion Connector / USB Signal VBUS Input
41	P86		RS-232C Port COM0-RTS
42	P15		RS-232C Port COM2-RTS
43	P14	USB0_DPUPE	Expansion Connector / USB Signal DPUPE Output
44	P13	TXD2	RS-232C Port COM2-TXD
45	P12	RXD2	RS-232C Port COM2-RXD
46		VCC_USB	USB Power Supply 3.3V
47		USB0_DM	Expansion Connector / USB Signal D−
48		USB0_DP	Expansion Connector / USB Signal D+
49		VSS_USB	USB Power Supply 0V
50	P56		Expansion Connector / EXRES Signal for LF62 Port
51	P55	CRX1	CAN1 Receive Port CRX1
52	P54	CTX1	CAN1 Transmit Port CTX1
53	P53		Expansion Connector / S1-6（DIP Switch Input）
54	P52		Expansion Connector / S1-5（DIP Switch Input）
55	P51		Expansion Connector / S1-4（DIP Switch Input）
56	P50		Expansion Connector / S1-3（DIP Switch Input）
57		VSS	Logic Power Supply 0V
58	P83	ET_CRS	Expansion Connector / Ethernet-CRS_DV/MODE2
59		VCC	Logic Power Supply 3.3V
60	PC7		Mode Input（PULL-UP/L=Serial-Mode）JTAG / S1-2
61	PC6		Expansion Connector / Expansion CAN5-CS（Output）
62	PC5		Expansion Connector / Expansion CAN4-CS（Output）

CPU PIN number – Function list (continues)

PIN #	Port #	Function Module	Description
63	P82	ET_TXD1	Expansion Connector / Ethernet-TXD1
64	P81	ET_TXD0	Expansion Connector / Ethernet-TXD0
65	P80	ET_TXDEN	Expansion Connector / Ethernet-TXEN
66	PC4	SCK5	Expansion Connector / Expansion SPI-SCK（Output）
67	PC3	SMOSI5	Expansion Connector / Expansion SPI-MOSI (Output)
68	P77	ET_RXER	Expansion Connector / Ethernet-RXER/PHYAD0
69	P76	REF50CK	Expansion Connector / Ethernet-#INT/REFCLKO
70	PC2	SMISO5	Expansion Connector / Expansion SPI-MISO（Input）
71	P75	ET_RXD0	Expansion Connector / Ethernet-RXD0/MODE0
72	P74	ET_RXD1	Expansion Connector / Ethernet-RXD1/MODE1
73	PC1	IRQ12	Expansion Connector / Expansion SPI-INT1（Input）
74		VCC	Logic Power Supply 3.3V
75	PC0	IRQ14	Expansion Connector / Expansion SPI-INT0（Input）
76		VSS	Logic Power Supply 0V
77	P73		CAN3 silent control（High-Speed＝L/Silent=H）
78	PB7		Port Input PIN7
79	PB6		Port Input PIN6
80	PB5		Port Input PIN5
81	PB4		Port Input PIN4
82	PB3		Port Input PIN3
83	PB2		Port Input PIN2
84	PB1		Port Input PIN1
85	P72	ET_MDC	Expansion Connector / Ethernet-MDC
86	P71	ET_MDIO	Expansion Connector / Ethernet-MDIO
87	PB0		Port Input PIN0
88	PA7		Port Input POUT7
89	PA6		Port Input POUT6
90	PA5		Port Input POUT5
91		VCC	Logic Power Supply 3.3V
92	PA4		Port Input POUT4
93		VSS	Logic Power Supply 0V

CPU PIN number – Function list (continues)

PIN #	Port #	Function Module	Description
94	PA3		Port Output POUT3
95	PA2		Port Output POUT2
96	PA1		Port Output POUT1
97	PA0		Port Output POUT0
98	P67	CRX2	CAN2 Receive Port CRX2
99	P66	CTX2	CAN2 Transmit Port CTX2
100	P65		Expansion Connector
101	PE7	MISOB	uSD Card Signal DI（Input）
102	PE6	MOSIB	uSD Card Signal DO（Output）
103		VCC	Logic Power Supply 3.3V
104	P70		Expansion Connector
105		VSS	Logic Power Supply 0V
106	PE5	RSPCKB	uSD Card Signal SCLK（Output）
107	PE4	SSLB0	uSD Card Signal CS（Output）
108	PE3		uSD Card Signal CD1（Input）
109	PE2		Expansion Connector
110	PE1		Expansion Connector
111	PE0		Expansion Connector
112	P64		Expansion Connector / Expansion SPI-EXP
113	P63		CAN3 Silent control SW（High-Speed＝L/Silent=H）
114	P62		CAN2 Silent control SW（High-Speed＝L/Silent=H）
115	P61		CAN1Silent control SW（High-Speed＝L/Silent=H）
116		VSS	Logic Power Supply 0V
117	P60		CAN0 Silent control SW（High-Speed＝L/Silent=H）
118		VCC	Logic Power Supply 3.3V
119	PD7	IRQ7	SPI Communication Auxiliary（CAN3 : RX1BF input）
120	PD6	IRQ6	SPI Communication Auxiliary（CAN3 : RX0BF input）
121	PD5	SSLC1	SPI Communication Chip Select 1
122	PD4	SSLC0	SPI Communication Chip Select 0（CAN3 : CS）
123	PD3	RSPCKC	SPI Communication Clock
124	PD2	MISOC	SPI Communication Master In Slave Out (Input)

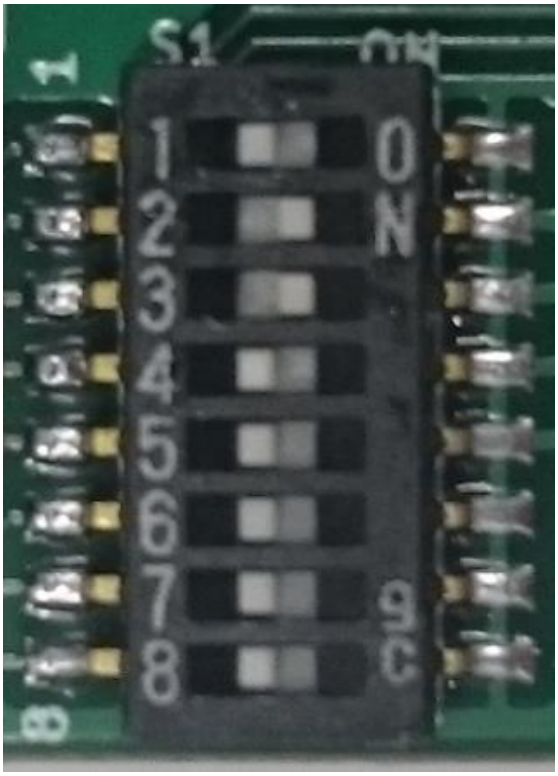
CPU PIN number – Function list (continues)

PIN #	Port #	Function Module	Description
125	PD1	MOSIC	SPI Communication Master Out Slave In（Output）
126	PD0	IRQ0	SPI Communication Auxiliary（CAN3 : INT Input）
127	P93		SPI Communication Auxiliary（CAN3 : RSET Output）
128	P92		SPI Communication Auxiliary（CAN3 : TX2RTS Output）
129	P91		SPI Communication Auxiliary（CAN3 : TX1RTS Output）
130		VSS	Logic Power Supply 0V
131	P90		SPI Communication Auxiliary（CAN3 : TX0RTS Output）
132		VCC	Logic Power Supply 3.3V
133	P47	AN007	Analog Input AN007
134	P46	AN006	Analog Input AN006
135	P45	AN005	Analog Input AN005
136	P44	AN004	Analog Input AN004
137	P43	AN003	Analog Input AN003
138	P42	AN002	Analog Input AN002
139	P41	AN001	Analog Input AN001
140		VREFL0	Reference Voltage L
141	P40	AN000	Analog Input AN000
142		VREFH0	Reference Voltage H
143		AVCC0	Analog Power Supply 3.3V
144	P07		Expansion Connector

5. Operation Modes

RX63N has 4 operation modes which can be set with MD Terminal, PC7 Terminal, and System Control Register 0 (SYSCR0).

DIP Switch S1



S1 (8 ports)			Operation Mode	SYSCR0 Register Initial Setting	
1(MD)	2(PC7)	3(RXE)		ROME Bit	EXBE Bit
OFF	OFF	—	Single Tip Mode	1 Enable built-in ROM	0 Disable External Bus
ON	ON	ON	Boot Mode (FWRITE2)		
	OFF	—	USB Boot Mode		
		OFF	User Boot Mode		

Note:

1. Turn Bit 1, 2 and 3 “ON” when using FWRITE2.
2. Turn Bit 1 and 2 “OFF” when using YSCOPE or running programs.
3. Turn Bit 3 off when using JTAG.

6. External Interface

6.1. CAN Port

This board has 3 CAN ports integrated into CPU and 1 CAN port via SPI.

A central gateway (CGW) can be constructed with all four ports. In addition, all CAN ports support 1 Mbps high-speed communication. ECUs other than CGW can also be assigned relay functions by routing map settings.

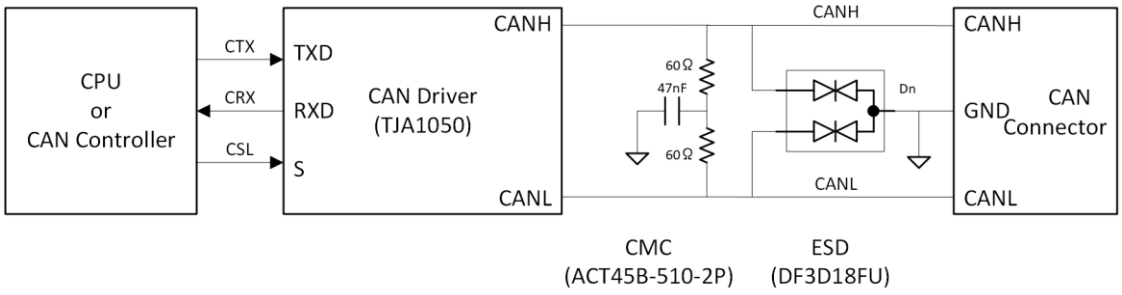
Please note that twisted pair shield cable is necessary for 1 Mbps.

ECU - CAN Port List

S1-4,5,6	0	1	2	3 to 6	7	Speed
Port #	Power Train	Chassis	Body	–	CGW	
CAN0	○	○	○	○	○	500Kbps
CAN1	–	–	–	–	○	500Kbps
CAN2	–	–	–	–	○	500Kbps
CAN3	–	–	–	–	OBD2	500Kbps

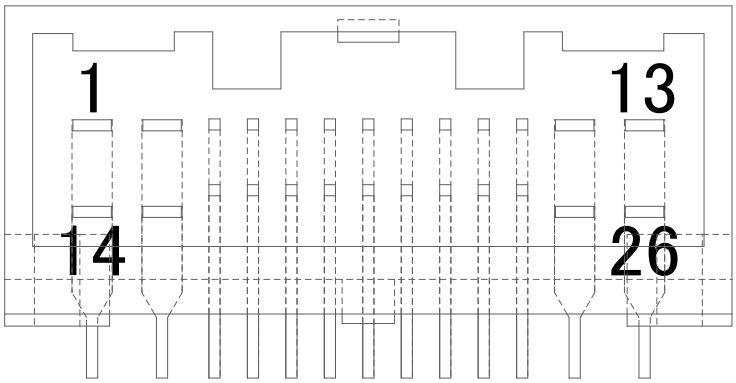
Note: CAN 3 is the MCP 2515 (CAN controller) connection port via SPI.

Fig. 1 CAN Interface Connection Diagram



Filters and terminating resistors can be disabled by cutting and shorting solder jumpers.

6.2. CAN・PWR Connector



The CAN / PWR connector provides both the CAN port × 4 and power supply input.

Table 4 CN3 : CAN・PWR Connector PIN Assignment

#	Terminal	Function
1	+12V	DC+12V Power Supply
2	GND	Power Supply GND（0V）
3	CAN0L	CAN Channel 0 – CANL Signal
4	CAN0H	CAN Channel 0 – CANH Signal
5	CAN1L	CAN Channel 1 – CANL Signal
6	CAN1H	CAN Channel 1 - CANH Signal
7	GND	Power Supply GND（0V）
8	CAN2L	CAN Channel 2 - CANL Signal
9	CAN2H	CAN Channel 2 - CANH Signal
10	CAN3L	CAN Channel 3 - CANL Signal
11	CAN3H	CAN Channel 3 - CANH Signal
12	GND	Power Supply GND（0V）
13	+12V	Power Supply DC+12V
14	+12V	Power Supply DC+12V
15 to 25	GND	Power Supply GND（0V）
26	+12V	Power Supply DC+12V

6.3. RS232C Port

This PCB has three RS232C ports and communicates to external modules. External modules include powertrain LCD, body LCD, instrument panel LCD, etc. Two ports are assigned to I/O connectors (HIF 26 Pin).

* The specification of RS-232C for I/O connector is 9600 bps, D 8, S 2, no parity, no handshake.

In addition, it has an RS-232C port for firmware rewriting and debugging.

* The specification of RS-232C for REM-MON is 38400 bps, D8, S1, No parity, No handshake.

To use this port, turn on DIP switch 3 (S1-3) and activate RS-232C.

Note: It cannot be used together with JTAG.

Table 5 CN1: RS-232C port for firmware rewriting and debugging connector (6Pin)

PIN	Signal	I/O	Description
1	TXD1	Output	RS232C（SCI1） Transmit Data（JTAG : TDO compatible)
2	RTS1*	Output	—
3	RXD1	Input	RS232C（SCI1）Reviving Data（JTAG : TDI compatible)
4	CTS1*	Input	—
5	GND	—	Power Supply 0V
6	+5V	—	Power Supply 5V (Please open this for normal use)

* Not used for F/W rewriting and remote debugging. RTS 1 can be used as TXD 12 and CTS 1 can be used as RXD 12.

6.4. I/O Connector

I/O Connector is a 26-pin connector with communication between external input / output devices and extended I/O terminals. ECUs other than CGW connect SCI0 and I/O simulator with LCD display (LF 74 board).

Table 6 CN6 : I/O（26Pin）Connector

PIN	Signal	I/O	Description
1	TXD0	Output	RS-232C（SCI0）Transmit Data
2	RTS0	Output	RS-232C（SCI0）Transmit Request
3	RXD0	Input	RS-232C（SCI0）Receiving Data
4	CTS0	Input	RS-232C（SCI0）Transmit Permission
5	GND	—	Power Supply 0V
6	+5V	Output	Power Supply +5V（Output）
7	TXD 2	Output	RS-232C（SCI2）Transmit Data
8	RTS 2	Output	RS-232C（SCI2）Transmit Request
9	RXD 2	Input	RS-232C（SCI2）Receiving Data
10	CTS 2	Input	RS-232C（SCI2）Transmit Permission
11	GND	—	Power Supply 0V
12	+5V	Output	Power Supply +5V（Output）
13	VCC	Output	Analog Power Supply +3.3V（Output）
14	GND	—	Analog Power Supply Grand（0V）
15	AN000	Input	Analog Input 0 to 3.3V
16	AN001	Input	Analog Input 0 to 3.3V
17	DA0	Output	Analog Output 0 to 3.3V
18	DA1	Output	Analog Output 0 to 3.3V
19	IRQ14	Output	PC0 Expansion Port（any signal, like IRQ, can be assigned.）
20	IRQ12	Output	PC1 Expansion Port（any signal, like IRQ, can be assigned.）
21	SMISO5	Input	PC2 Expansion Port（any signal, like SPI, SCI, IIC, other I/O, can be assigned.）
22	SMOSI5	Output	PC3 Expansion Port（any signal, like SPI, SCI, IIC, other I/O, can be assigned.）
23	SCK5	Output	PC4 Expansion Port（SPI, other I/O can be assigned.）
24	SS0	Output	PC5 Expansion Port（SPI, other I/O can be assigned.）
25	SS1	Output	PC6 Expansion Port（SPI, other I/O can be assigned.）
26	EXP	Output	P64 Expansion Port (any signal can be assigned)

6.5. JTAG Port

The firmware of this PCB is rewritten from JTAG port or RS232C port.

The RS232C port is used for LFYIDE development environment.

* When using JTAG, set DIP switch 3 to OFF (disable RS232C).

Table 7 CN2 : JTAG Connector PIN Assignment

RES#	TDI	TMS	MD	TDO	TRST#	TCK
13	11	9	7	5	3	1
14	12	10	8	6	4	2
GND	GND	PC7	VCC	NC	EMLE	GND

6.6. Arduino Compatible Expansion Connector

An Arduino compatible connector can be mounted on this board for functionality expansion.

	PIN #	Description
P1	10	Arduino-Digital2 Connector（8 x digital I/O from PB0 to PB7, VCC, and GND）
P2	6	Arduino-Analog Connector（Analog input from AN002 to AN007）
P3	8	Arduino-Digital1 Connector（8 x digital I/O from PA0 to PA7）
P4	8	Arduino-Power Connector（+12V、+5V、VCC、GND and Reset Signal）

6.7. Expansion Connector for Communication

CN5 Expansion connector for communication can be mounted on this PCB. SCI 3, SCI 6, USB, and Ethernet signal lines are assigned to this 40-pin connector.

6.7.1. Ethernet port

Ethernet ports can be mounted on the expansion PCB.

Note: Physical layer and TCP / IP protocol stack are not installed.

6.7.2. USB-FUNCTION port

A USB-Function ports can be mounted on the expansion PCB for function expansion or F/W rewriting purpose.

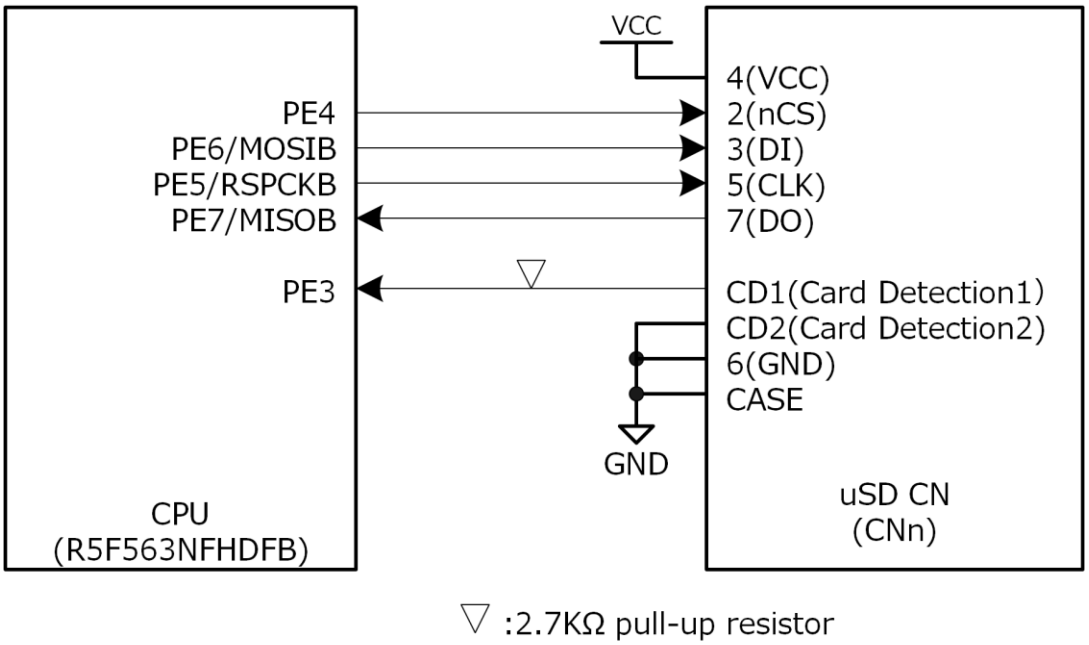
* USB function control program and USB connector are not installed.

6.8. µSD Card socket

µSD card socket is mounted for future expansion.

* The SPI driver, FAT system and µSD card are not installed.

Fig. 2 CN4 : µSD Card Interface – Connecting Diagram



▽ :2.7KΩ pull-up resistor

7. ECU Firmware

A 2 Mbyte program ROM, 256 Kbyte RAM, and 32 Kbyte E2 data memory are available for the CPU on the ECU. The firmware is installed in RAM since reprogramming is conducted through CAN bus. Note that the available capacity of RAM depends on the firmware code size. The E2 data area will be used as a storage area for setting information (parameter area).

Table 8 Software Requirements Specification

#	Description	Status
1	Researchers can update software on each ECUs	OK JTAG FWRITE2 YScope
2	Create reprogramming manuals	See Appendix
3	Define use cases of CAN-ID (Scenario pattern)	Constants in source code are changed
4	Offset of communication timing (transmit delay for each ID)	OK
5	Transmit MBOX x 3: 1. 0 to 200, 2. 201 to 400, 3. 401 to 7FF	OK
6	Manual of offset/MBOX	See Appendix
7	Visualization of vehicle behavior (Testbed →simulator)	OK Connect via RS-232C port
8	Dynamically change from simulator to testbed	OK Connect via RS-232C port
9	Keep the error of message transmission period within 20%	See Appendix
10	Arbitration delay in CGW bus is: the internal delay + 20% of period	See Appendix
11	Keep a routing MAP for standard mode and reprogramming mode	OK
12	Function to revert to the original MAP	OK

7.1. ECU number setting

To assign ECU-specific numbers, use DIP switches #4, 5, and 6.

The numbers can be 0 to 7. Up to seven ECUs and one CGW can be configured.

Table 9 ECU Number Setting with DIP Switch

No.	DIP Switch S1			ECU	Description
	6	5	4		
0	OFF	OFF	OFF	Power Train	Assigned to power-train ECU
1	OFF	OFF	ON	Chassis	Assigned to chassis EUC
2	OFF	ON	OFF	Body	Assigned to body ECU
3	OFF	ON	ON	—	Undefined
4	ON	OFF	OFF	—	Undefined
5	ON	OFF	ON	—	Undefined
6	ON	ON	OFF	—	Undefined
7	ON	ON	ON	CGW	Central Gateway（ECU）

CGW uses all four ports of CAN, and other ECUs use only one port each.

Ports can be restricted or expanded by changing the routing map.

7.2. Routing map

Each ECU (Electric Control Unit) and CGW (Central Gateway) have routing information individually and have a function to reduce congestion on each bus without processing unnecessary IDs. The routing map has two different modes: "normal mode" and "reprogramming mode". The routing map assigns 8 bits each to IDs from ID000 to ID7FF (total 2048). The CAN ports 0 to 3 and the map are defined as follows;

Table 10 Map and Bit Correspondence Table

Port	ECU	Bit Location	Function
CAN0	POWERTRAIN	Bit4,0	Engine speed, Vehicle speed, etc.
CAN1	CHASSIS	Bit5,1	Driver input, Status output, etc.
CAN2	BODY	Bit6,2	Vehicle Peripheral, Status output, etc.
CAN3	External CAN device	Bit7,3	Relay, Transfer

Upper 4 bits of the routing map are defined as the reprogramming routing, and the lower 4 bits are defined as the normal routing. Each message is processed when the bit corresponding to the ID in data is 1, and not processed when it is 0.
When multiple bits are 1, data is transferred to the corresponding multiple CAN buses. As for the CGW routing, for example when ID701 is transmitted from the chassis and the map value of ID701 is 0x06, the data is only transferred from the chassis CAN1 to the body CAN2. Similarly, when the map value is 0x0F, it is only transferred from CAN2 to CAN0, 1, 3, and is not sent back to the sender.

Table 11 CGW Routing Map Example

ID	Bit pattern	HEX	Description
000	00110011	33	Powertrain/chassis ID（CGW relays data between CAN0 and 1）
001	01100110	66	Chassis/body ID（CGW relays data between CAN1 and 2）
008	10011001	99	Powertrain/external device ID（CGW relays data between CAN0 and 3）
21F	00000111	07	Door lock related ID（CGW relays data between CAN0, 1, and 2）
7FF	11111111	FF	Forward to all CAN ports

7.3. Simulation Scenario

The ECUs exchange external input/output information with the simulator through RS-232C to operate. The simulator has an independent CPU board corresponding to the powertrain, chassis, and body. It has an LCD display and it displays the information on the CAN bus which depicts the status of the vehicle. Also, it performs simulated output responses according to the input information.

I/O numbers from 0 to 14 are chassis outputs, 15 to 41 are power tray outputs, and 42 to 63 are body outputs.

Note: The IDs can be changed by the ECU, however, the I/O numbers are fixed on the simulator side and cannot be changed.

Table 12 Simulated Scenario List

(DB＝1 Byte Info, DH/DL＝2 Byte Info, HH to LL＝4 Byte Info, XX＝indefinite)

I/O #	CAN-ID (HEX)	Data Location A B C D E F G H	Period (ms)	Description
0	01A	DH DL XX XX XX XX XX XX	10	Brake pedal depression input 0000 to 03FF（0 to 100%）
1	02F	DH DL XX XX XX XX XX XX	10	Accelerator pedal depression input 0000 to 03FF（0 to 100%）
2	058	DH DL XX XX XX XX XX XX	10	Steering wheel position input FE01 to 01FF（L : -100 to R : 100%）
3	06D	DB XX XX XX XX XX XX XX	10	Shift lever position switch input 00 : OFF 01 : UP 02 : DOWN * Logical OR value
4	083	DB XX XX XX XX XX XX XX	10	Status of turn signal / hazard switch input 00 : OFF 01 : Left 02 : Right 04 : Hazard * Logical OR value

I/O #	CAN-ID (HEX)	Data Location A B C D E F G H	Period (ms)	Description
5	098	DB XX XX XX XX XX XX XX	10	Horn switch input 00 : OFF 01 : ON
6	1A7	DB XX XX XX XX XX XX XX	50	Position / Low Beam / High Beam Switch input 00 : OFF 01 : Position 02 : Low Beam 04 : High Beam * Logical OR value
7	1B1	DB XX XX XX XX XX XX XX	50	Headlight flashing switch input 00 : OFF 01 : ON
8	1B8	DB XX XX XX XX XX XX XX	50	Engine start button input 00 : OFF 01 : ON
9	1C9	DB XX XX XX XX XX XX XX	50	Parking brake input 00 : OFF 01 : ON

I/O #	CAN-ID (HEX)	Data Location A B C D E F G H	Period (ms)	Description
10	25C	DH DL XX XX XX XX XX XX	100	Front Wiper/Intermittent/LOW/HIGH/Washer Switch, timer input 000X to 3FFX（0 to 100%）Timer 0000 : OFF 0001 : INT 0002 : LOW 0004 : HIGH 0008 : MIST * Logical OR value
11	271	DB XX XX XX XX XX XX XX	100	Rear Wiper/Washer switch input 00 : OFF 01 : LOW 08 : MIST * Logical OR value
12	286	DB XX XX XX XX XX XX XX	100	Doors Lock / Unlock switch input 00 : OFF 01 : ON
13	29C	DB XX XX XX XX XX XX XX	100	Right Door/Window Lifting switch input 00 : OFF 01 : UP 02 : DOWN * Logical OR value

I/O #	CAN-ID (HEX)	Data Location A B C D E F G H	Period (ms)	Description
14	2B1	DB XX XX XX XX XX XX XX	100	Left Door/Window Lifting switch input 00 : OFF 01 : UP 02 : DOWN * Logical OR value
15	024	DH DL XX XX XX XX XX XX	10	Brake output indicator 0000 to 03FF（0 to 100%）
16	039	DH DL XX XX XX XX XX XX	10	Throttle position 0000 to 03FF（0 to 100%）
17	043	HH HL LH LL XX XX XX XX	10	Engine RPM/Speed (km/h) 0000XXXX to 7FFFXXXX（0 to 32767） XXXXFF38 to XXXX00C8（-200 to 200）
18	062	HH HL LH LL XX XX XX XX	10	Power steering output indicator（Left, Right %）/Torque FE01XXXX to 01FFXXXX（-100 to 100） XXXX0000 to XXXX0064（0 to 100%）
19	077	DB XX XX XX XX XX XX XX	10	Shift lever position 01 : P 02 : R 03 : N 04 : D 05 : L

I/O #	CAN-ID (HEX)	Data Location A B C D E F G H	Period (ms)	Description
20	146	DB XX XX XX XX XX XX XX	50	Brake oil indicator 00 to FF : Dummy Data
21	150	DB XX XX XX XX XX XX XX	50	Brake worn out warning, icy road warning 00 to FF : Dummy Data
22	15A	DB XX XX XX XX XX XX XX	50	Anti-lock brake operation 00 to FF : Dummy Data
23	164	DH DL XX XX XX XX XX XX	50	Brake pad temperature, Tire temperature 0000 to FFFF : Dummy Data
24	16F	DH DL XX XX XX XX XX XX	50	Throttle adjustment 0000 to 0064（0 to 100%）
25	179	DH DL XX XX XX XX XX XX	50	Fuel consumption rate, Air-fuel mixture ratio 0000 to FFFF : Dummy Data
26	183	DB XX XX XX XX XX XX XX	50	Engine cooling water temperature 00 to FF（-40 to 215℃）
27	18D	DB XX XX XX XX XX XX XX	50	Engine working status 00 : Working 01 : Not working
28	198	DB XX XX XX XX XX XX XX	50	Power steering status 00 to FF : Dummy Data
29	19A	DB XX XX XX XX XX XX XX	50	Engine status 00 : Engine is stopped 01 : Engine is working
30	1A2	DB XX XX XX XX XX XX XX	50	Anti skid brake system status 00 to FF : Dummy Data
31	1AD	DB XX XX XX XX XX XX XX	50	Transmission status 00 to FF : Dummy Data

I/O #	CAN-ID (HEX)	Data Location A B C D E F G H	Period (ms)	Description
32	1D3	DB XX XX XX XX XX XX XX	50	Parking brake status 00 : OFF 01 : ON
33	39E	DB XX XX XX XX XX XX XX	500	Electricity generated by Regenerative brake 00 to FF : Dummy Data
34	3A9	DH DL XX XX XX XX XX XX	500	Outdoor temperature, Exhaust temperature 0000 to FFFF : Dummy Data
35	3B3	DH DL XX XX XX XX XX XX	500	Toxic exhaust gas concentration, Particulates concentration 0000 to FFFF : Dummy Data
36	3BD	DB XX XX XX XX XX XX XX	500	Engine oil indicator 00 to FF : Dummy Data
37	3C7	DB XX XX XX XX XX XX XX	500	Ignition failure, Ignition timing abnormality 00 to FF : Dummy Data
38	3D4	DB XX XX XX XX XX XX XX	500	Fuel amount 00 to 2D（0 to 45ℓ）
39	3DE	DB XX XX XX XX XX XX XX	500	Battery warning 00 : Normal 01 : Abnormal
40	42B	DB XX XX XX XX XX XX XX	500	Parking brake warning 00 : Normal 01 : Abnormal
41	482	DB XX XX XX XX XX XX XX	500	Eco-driving judgement 00 : Not Eco-driving 01 : Eco-driving
42	08D	DB XX XX XX XX XX XX XX	10	Turn signal indicator 00 : OFF 01 : Left Signal ON 02 : Right Signal ON * Logical OR value

I/O #	CAN-ID (HEX)	Data Location A B C D E F G H	Period (ms)	Description
43	0A2	DB XX XX XX XX XX XX XX	10	Horn operation status 00 : OFF 01 : ON
44	0B4	DB XX XX XX XX XX XX XX	10	Airbag activation switch 00 : OFF 01 : ON
45	1BB	DB XX XX XX XX XX XX XX	50	Position/Headlights/High Beam Indicator 00 : OFF 01 : Position 02 : Low Beam 04 : High Beam * Logical OR value
46	266	DH DL XX XX XX XX XX XX	100	Front Wiper/Intermittent/LOW/HIGH/Washer switch and timer status 000X to 3FFX（0 to 10 sec.） 0000 : OFF 0001 : INT 0002 : LOW 0004 : HIGH 0008 : MIST * Logical OR value
47	27B	DB XX XX XX XX XX XX XX	100	Rear Wiper/Washer status 00 : OFF 01 : LOW 08 : MIST * Logical OR value

I/O #	CAN-ID (HEX)	Data Location A B C D E F G H	Period (ms)	Description
48	290	DB XX XX XX XX XX XX XX	100	Status of Door (Open/Close, Locked/Unlocked) 00 : Door Locked / Unlocked 01 : Left door unlocked 02 : Right Door Unlocked 04 : Door Open * Logical OR value
49	2A6	DH DL XX XX XX XX XX XX	100	Right Door/Window position, Limit switch status 00XX to 64XX（0 to 100%） 0000 : OFF 0001 : Lower limit LS-ON 0002 : Upper limit LS-ON * Logical OR value
50	2BB	DH DL XX XX XX XX XX XX	100	Left Door/Window position, limit switch status 00XX to 64XX（0 to 100%） 0000 : OFF 0001 : Lower limit LS-ON 0002 : Upper limit LS-ON * Logical OR value
51	3E9	DB XX XX XX XX XX XX XX	500	Light Bulb burned out warning (Turn Signal) 00 to FF : Dummy Data
52	3F4	DB XX XX XX XX XX XX XX	500	Horn malfunction 00 to FF : Dummy Data
53	3FF	DB XX XX XX XX XX XX XX	500	Light Bulb burned out warning (Position/Headlights/High Beam) 00 to FF : Dummy Data
54	40A	DB XX XX XX XX XX XX XX	500	Front Wiper/Intermittent/LOW/HIGH/Washer malfunction 00 to FF : Dummy Data

I/O #	CAN-ID (HEX)	Data Location A B C D E F G H	Period (ms)	Description
55	415	DB XX XX XX XX XX XX XX	500	Rear Wiper/Washer malfunction 00 to FF : Dummy Data
56	420	DB XX XX XX XX XX XX XX	500	Door lock drive unit malfunction 00 to FF : Dummy Data
57	436	DB XX XX XX XX XX XX XX	500	Right door window motor malfunction 00 to FF : Dummy Data
58	441	DB XX XX XX XX XX XX XX	500	Left door window motor malfunction 00 to FF : Dummy Data
59	44C	DB XX XX XX XX XX XX XX	500	Airbag malfunction 00 to FF : Dummy Data
60	457	DB XX XX XX XX XX XX XX	500	Seat belt sensor 00 to FF : Dummy Data
61	461	DB XX XX XX XX XX XX XX	500	Seat belt alarm 00 : Normal 01 : Alarm
62	46C	DB XX XX XX XX XX XX XX	500	Bonnet(Hood) Open/Close Switch 00 to FF : Dummy Data
63	477	DB XX XX XX XX XX XX XX	500	Trunk Open/Close Switch 00 to FF : Dummy Data

* Grayout items are not implemented since input information does not exist.

Revision History Revised parts have "☆" marks.

Edition	Reason of Revision	Revised Page/Part	Date of Rev.
1.0	First version		2019/03/20

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