TO FOREWORD

CONTROL SYSTEM

CAR-MOUNTED MULTIPLEX COMMUNICATION SYSTEM

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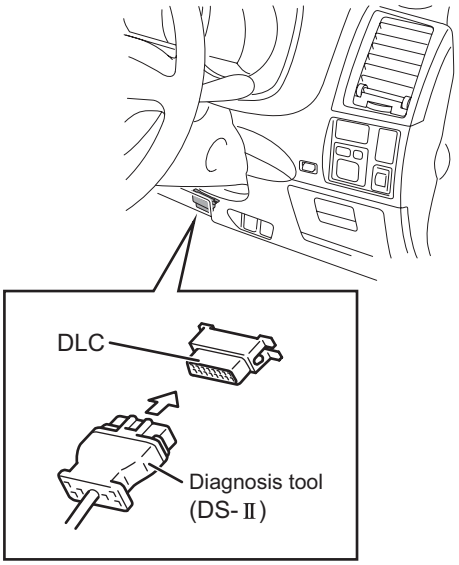
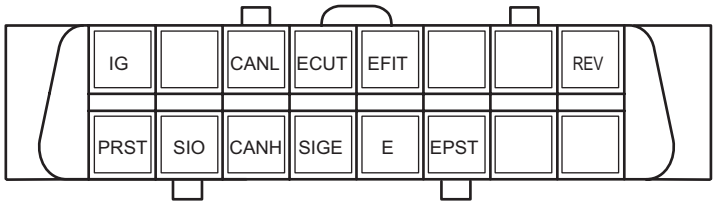
DLC (Data Link Connector)

● The DLC connector (DLC: Data Link Connector) is used to connect the diagnosis tool DS-II that provides access to each ECU. Using this connector along with a DS-II makes it possible to put out diagnosis codes, to monitor various kinds of data (including a check of ECU data), to conduct active tests (to operate actuators individually), and so on. For more information, refer to the service manual.





Terminal arrangement

A1270408B-D

CAN Communication System

● Every model employs a CAN* [ISO11898] communications system which converts multiple items of information and data into digital signals in its communications circuits and transmits them through a pair of communications cables (twisted-pair cables). Unlike systems which requires input devices (sensors, switches, etc.), control units, and output devices (motors, etc.) to be connected one to one, this system allows a reduction in the quantity of wire harness and the sliming down of the electronic control system.

❖ REFERENCE ❖

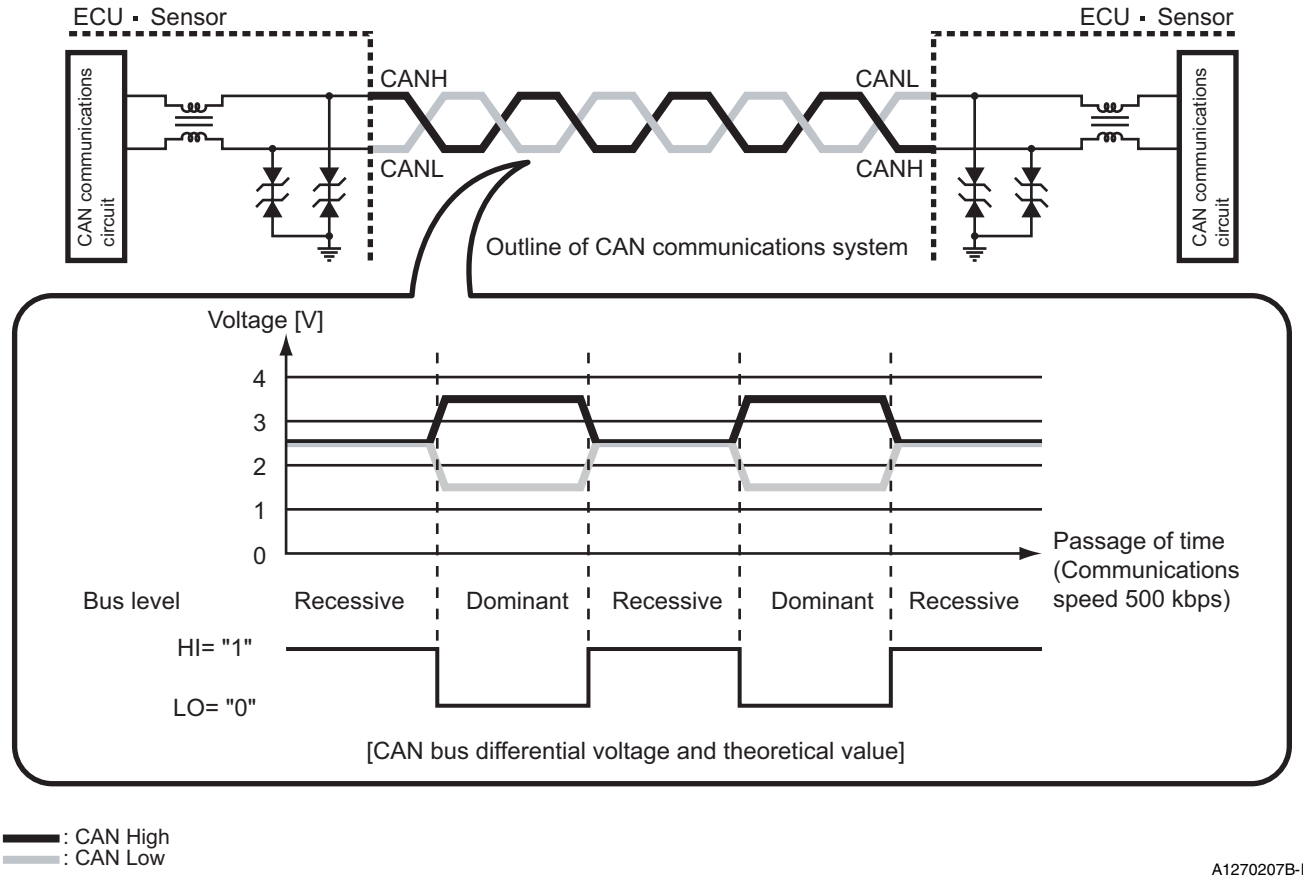
* : CAN, an acronym for Controller Area Network, is a serial communications network compliant with ISO (International Organization for Standardizations) standards.

● The CAN communications system determines the bus level*1 from the differential voltage between a pair of two communications cables (bus): CAN High and CAN Low, converts it into digital signals and transmits the digital signals at a rate of 500 kbps*2 in accordance with the dedicated communications protocol (communications rules).

❖ REFERENCE ❖

*1 : There are two bus levels: dominant level and recessive level. In the CAN communications system, a dominant lever is logically assumed to be a 0, and a recessive level to be a 1.

*2 : A unit of measurement for transmission speed of signals. 500 kbps means that 500,000 bits of data is transmitted per second.



CAN Communication Network

- The CAN communications system uses a bus network in which multiple computers are connected to each other through two shared communications cables, and the cables connecting the meter computer to the engine control computer are referred to as the bus (shared communications line).
- Two terminating resistors (120Ω) are installed on the bus. The terminating resistors enable the system to determine differential voltages in the network connected in a loop form.

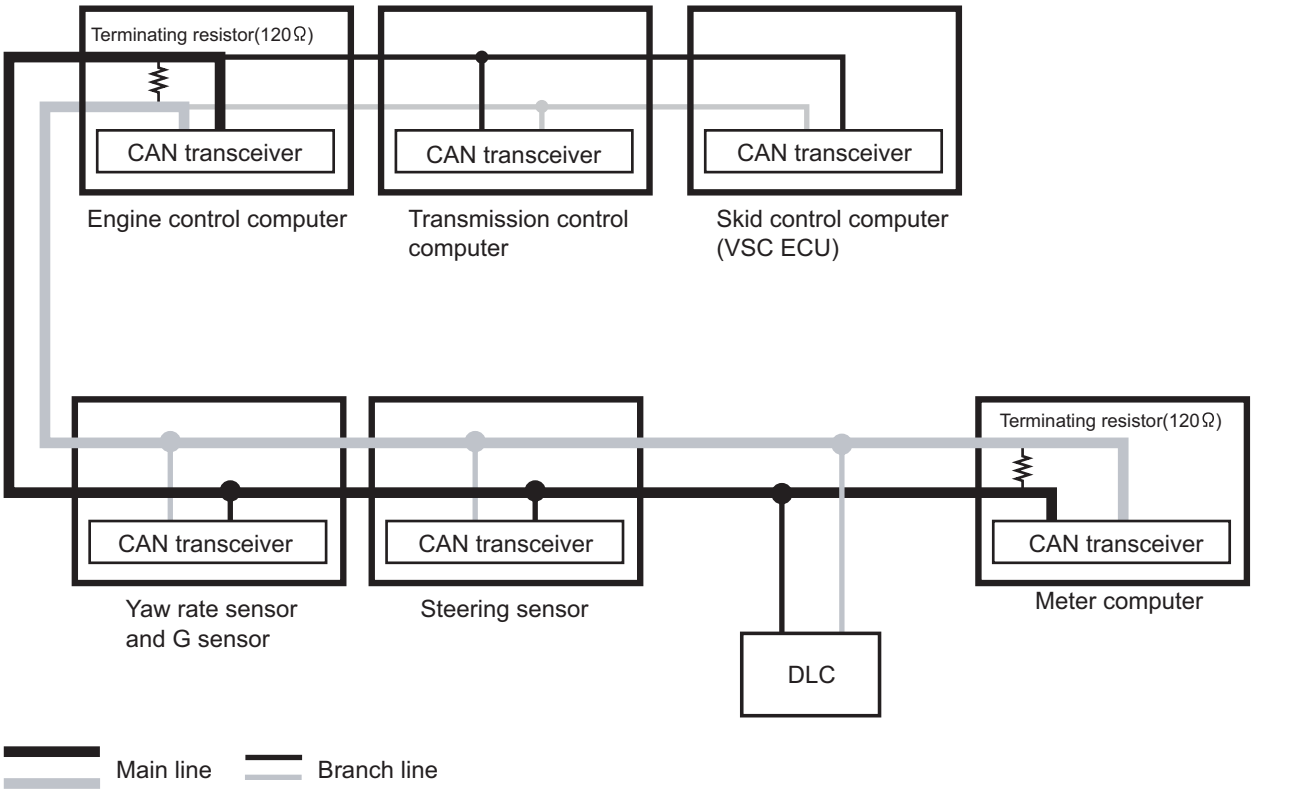


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Table of computers (ECU) and sensors incorporated in CAN communications system

No.	Computers and sensors	Principal functions
A	Engine control computer	• Provides engine speed data etc.
B	Transmission control computer	• Controls the automatic transmission.
C	Skid control computer(VSC ECU)	• Controls the ABS, the brake assist system, etc.
D	Meter computer	• Provides vehicle speed data, switch data, etc.
E	Steering sensor	• Senses the steering angle and the direction of wheel heading.
F	Yaw rate sensor and G sensor	• Sense the decelerations in the longitudinal and lateral directions of the vehicle.
G	DLC (Data Link Connector)	• Used to connect a diagnosis tool for inspections through CAN communications network. • Used to connect an electrical tester for continuity tests of the CAN communications bus.

Table of CAN communications control signals (A, B, C ... at the top correspond to A, B, C ... in the above table.)

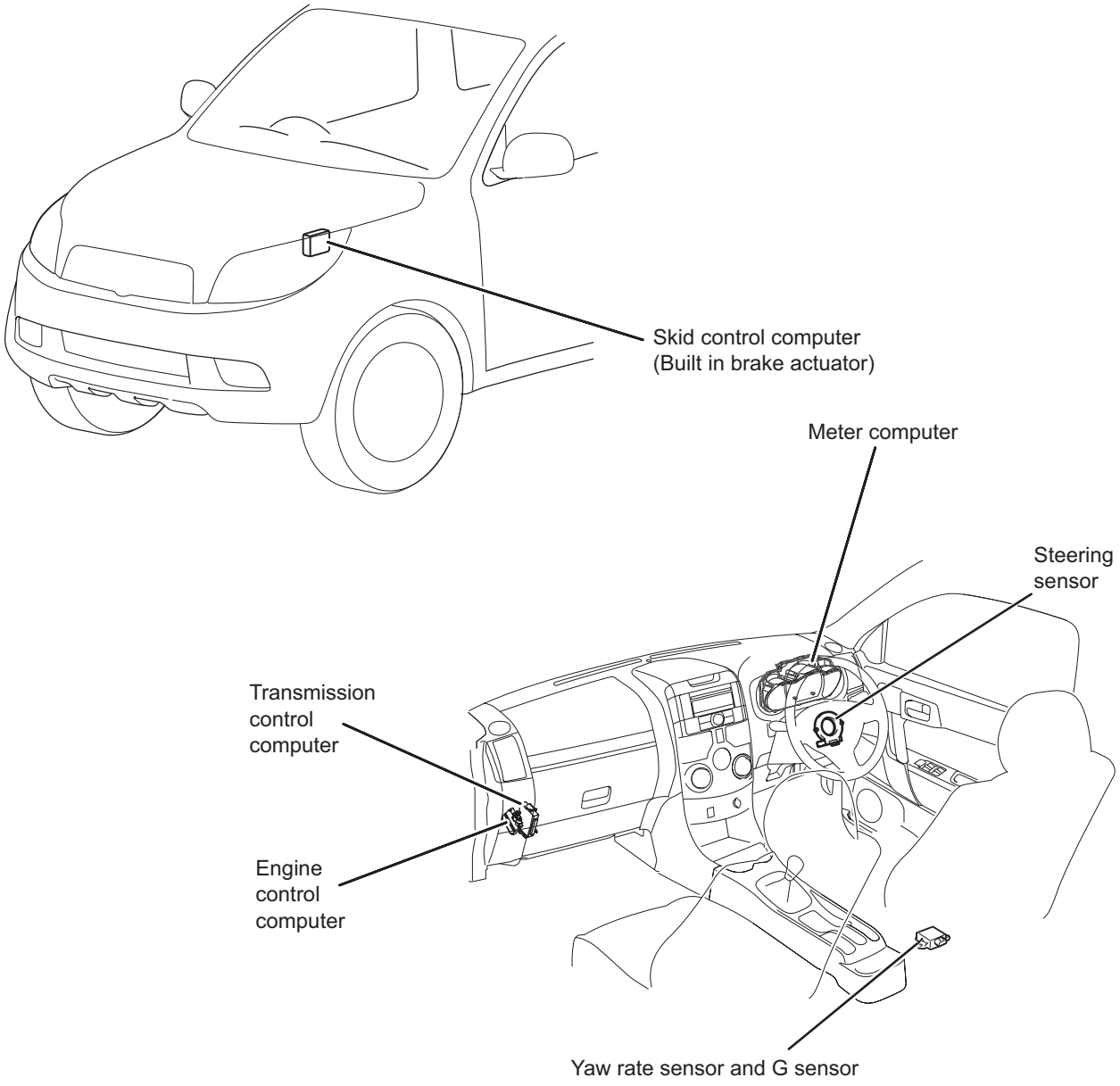
Signal names	A	B	C	D	E	F
Engine speed	●	❍	❍	❍		
Quantity of fuel injected	●			❍		
Throttle opening	●	❍	❍			

Signal names	A	B	C	D	E	F
Engine torque	●	❍				
Water temperature	●	❍				
Engine cooling water temperature	●	❍		❍		
Outside air temperature	●	❍		❍		
Vehicle speed signal	❍	●		❍		
Torque reduction request	❍	●				
Shift position information	❍	●	❍	❍		
O/D OFF information		●		❍		
A/T warning request		●		❍		
A/T learned value clearing completion		●		❍		
ATF oil temperature	❍	●				
Vehicle speed signal	❍		●			❍
Torque down request	❍		●			
Brake warning request			●	❍		
ABS warning request			●	❍		
Slip indicator lamp request			●	❍		
VSC OFF warning request			●	❍		
VSC warning buzzer request			●	❍		
DAC (Downhill Assist Control System) warning request			●	❍		
DAC (Downhill Assist Control System) ON switch			❍	●		
TRC OFF switch			❍	●		
Parking brake switch			❍	●		
ECU-T terminal		❍	❍	●		
Tail switch	❍			●		
Meter vehicle speed output	❍			●		❍
Steering angle			❍		●	
Yaw rate			❍			●
Magnet clutch activation request	❍					

❖ REFERENCE ❖

●: Sender, ❍: Receiver

CAN Communication System Configuration



A1270399B-D

CAN Communication Protocol (Communication Rules)

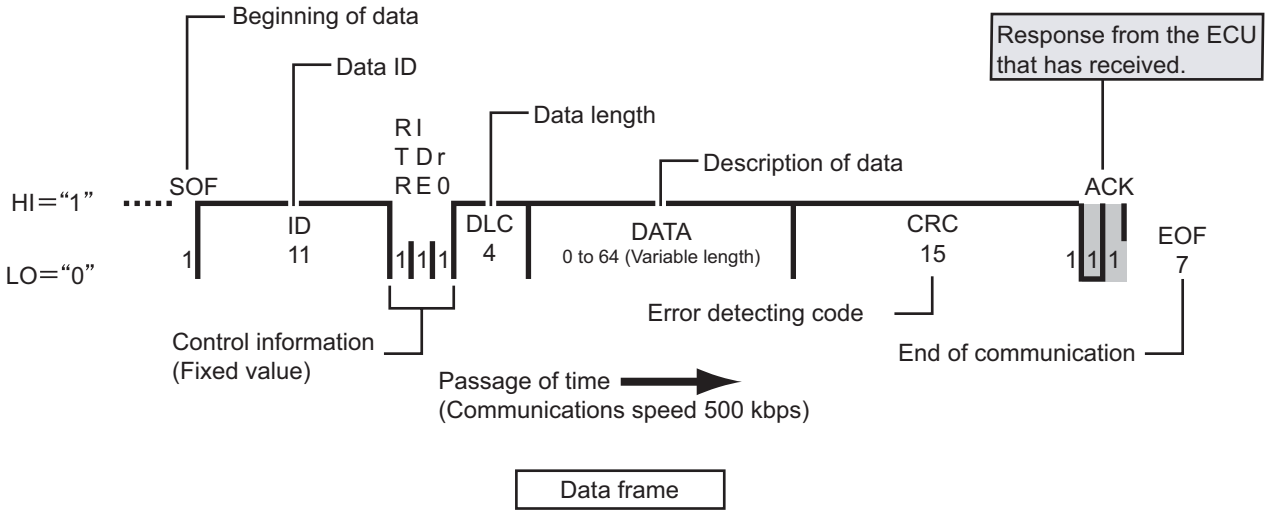
- The CAN communications system is a time-division multiplexing two-way communications system which allows every computer (ECU) and sensor constituting the network to send and receive data sequentially through a pair of communications cables (bus). To ensure smooth communications, therefore, every ECU and sensor needs to communicate in accordance with the common communications protocol (communications rules).
- The CAN communications protocol uses CSMA/CD (Carrier Sense Multiple Access with Collision Detection) scheme* as the technique for sending data to the communications line to allow every ECU and sensor to send and receive data, sharing a pair of communications cables.

❖ REFERENCE ❖

* : Carrier Sense Multiple Access with Collision Detection: A communications access control scheme in which each ECU is always placed in a state of readiness

to sense the condition (carrier waves) of the communication line as ECUs can send data only when the line is free. In addition, if a data collision occurs (two different ECUs sent data simultaneously), this control allows each ECU to send data again after a specified period of time.

- Each ECU and sensor can send data only when no data is being transmitted through the CAN bus. However, if two or more ECUs or sensors send data at the same time, the system sets priorities for data transmission based on the ID information contained in the data sent by each ECU.
- One frame of data used in the CAN communications system consists of ID, DLC, DATA, CRC and ACK, etc.



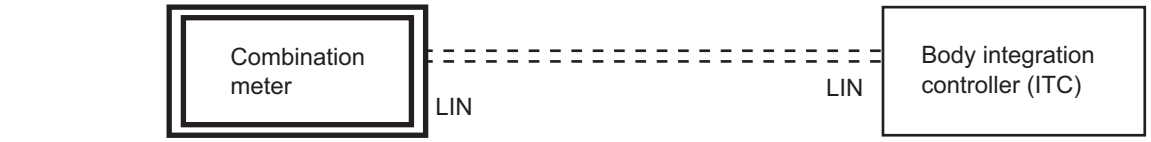
Note: Each figure in the frame represents the number of bits used to send information.

A1270210B-D

LIN Communication System

- Every model employs a LIN system which converts multiple items of information and data into digital signals and transmits them over a single communications line. Unlike systems which requires input devices (switches etc.) and output devices (motors etc.) to be connected one to one, this communications system allows a reduction in the quantity of wire harness and the slims down the electronic control system.
- A LIN communications circuit is composed of one computer (master node) which gives instructions to each control computer, and one or more computers (slave node) which performs control according to the instructions from the master node.
- The LIN communications system employs a single master scheme in which each slave node receives control instruction signals from the master node, sends signals according to the instructions, and controls the operation of the actuator(s) connected to it. Therefore, slave nodes do not send signals or operates actuators, unless they receive instructions from the master node.
- The master node keeps track of the state of connection of each ECU to communicate with, and if it finds that an ECU is incapable of communications, it instructs all other ECUs confirmed to be connected normally to perform control in disregard of the failed ECU. If the disabled ECU has recovered from an error and sends back a response again, then the master node sends normal control instruction signals to communicate with all ECUs.

LIN Communication Network



Master node

A1270400B-D

Table of computers (ECU) and sensors incorporated in LIN communications system

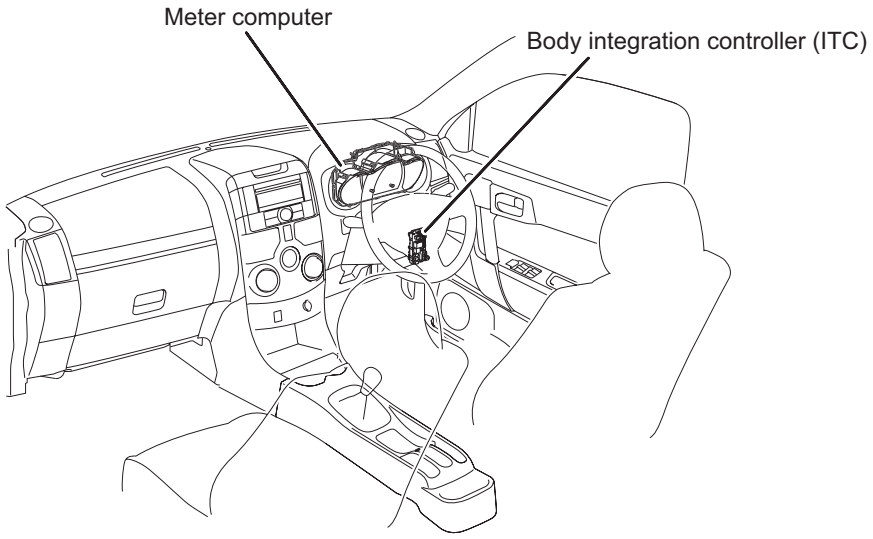
No.	Computers and sensors	Principal functions
A	Meter computer	• Provides vehicle speed data etc.
B	Body integration controller (ITC)	• Controls the door locks etc.

Table of LIN communications control signals (A, B at the top correspond to A, B of the above table.)

Signal names	A	B
Keyless door lock/unlock signal	●	❍
ECU-T terminal signal	●	❍
Half-open door signal	●	❍
Key switch signal	●	❍
Tail switch signal	●	❍
Vehicle speed signal	●	❍
Driver's door lock position signal	❍	●
Unlock answer back ON signal	❍	●
Sleep prevention request signal	❍	●
Multi-purpose buzzer setting off request signal	❍	●

❖ REFERENCE ❖
●: Sender, ❍: Receiver

LIN Communication System Configuration



A1270401B-D

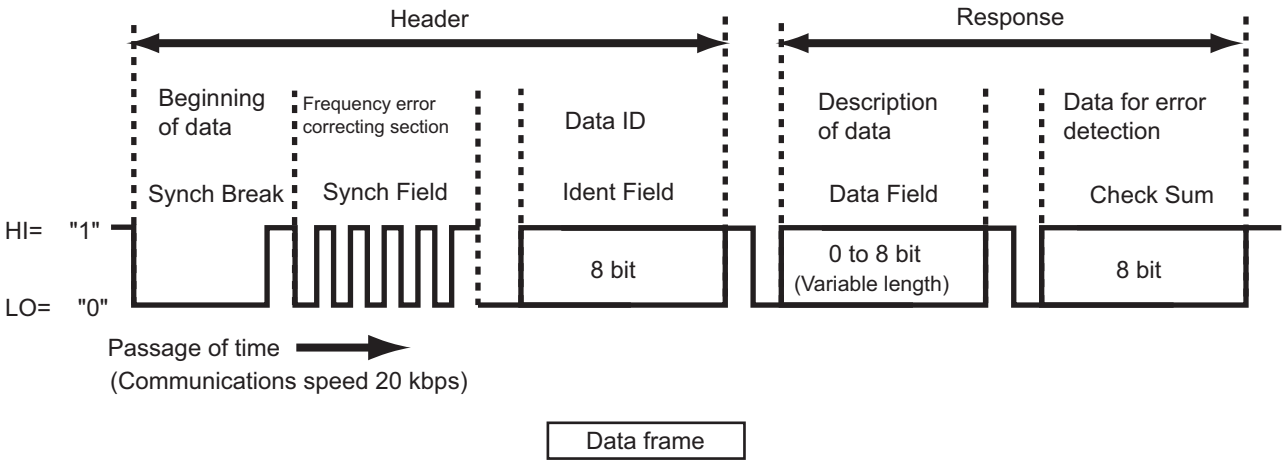
LIN Communication Protocol

- The LIN communications system is a time-division multiplexing one-way communications system in which each ECU sends multiple items of data one at a time over a single communications line.
- Each control computer connected to the bus (communications line) receives signals while sensing changes in bus level*1 caused by the transmission of signals.
- The LIN system handles two kinds of data: headers sent by the master node and responses sent by slave nodes, and it transmits these data types at a maximum rate of 20 kbps. *2
- A header is composed of three fields: Synch Break that indicates the start of a frame, Synch Field used to correct the frequency error between slave nodes, and Indent Field that specifies data.
- A response is composed of two fields: Data Field that contains control signals from a slave node, and Check Sum used to detect an error.

❖ REFERENCE ❖

*1 : There are two bus levels: a dominant level and a recessive level. In the LIN communications system, a dominant lever is logically assumed to be a 0, and a recessive level to be a 1.

*2 : A unit of measurement for transmission speed of signals. One kbps means that 1,000 bits of data are transmitted per second.



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Sleep and Wake-up Function

- When a specified period of time has elapsed after the IG (or ACC) switch was turned off or when all ECUs on the communications line have finished control, sleep control (switching to energy saving mode) is performed to reduce the amount of dark current.
- If an ECU determines during sleep control that the control start conditions set for it are satisfied, the ECU sends a wake-up signal to all other ECUs, restarting the whole LIN communications system.