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## Integrated Navigation System X1

# CAN Protocol

Protocol


**INTRODUCTION**

This document introduces the commands and logs for CAN Bus configuration in Bynav X1 GNSS/INS integrated navigation system.

# Content

# 1 Introduction

## 1.1 Terminology

### 1.1.1 CAN

The Controller Area Network was developed by Robert Bosch GmbH for automotive applications in the early 1980s and publicly released in 1986. Typically, CAN interconnects a network of modules (or nodes) using two wire, twisted pair cable. Many companies implement CAN devices.

### 1.1.2 SAE J1939

SAE J1939 is the vehicle bus standard used for communication and diagnostics among vehicle components, originally by the car and heavy duty truck industry in the United States.

### 1.1.3 RTCM

The RTCM standard series describes messages and techniques for supporting Differential GNSS Service operation with one reference station or a network of reference stations.

## 1.2 List of Abbreviations

| | |
|---|---|
| CAN | Controller Area Network |
| GNSS | Global Navigation Satellite System |
| OSI | Open System Interconnection |
| PGN | Page Group Number |
| RTCM | Radio Technical Commission for Maritime Services |
| RTK | Real-Time Kinematic |
| SAE | Society of Automotive Engineers |

## 1.3 Open System Interconnection (OSI)

It should be obvious that if two or more microprocessors are to communicate, a standard protocol must exist defining how data are to be transmitted among cooperating devices. The most common protocol is TCP/IP (Transmission Control Protocol/Internet Protocol), which is used to connect hosts on the Internet.

The OSI protocol is sometimes referred to as the “7-layer” model because it consists of seven independent elements that describe the requirements forcommunication at different levels of abstraction. The seven layers are:

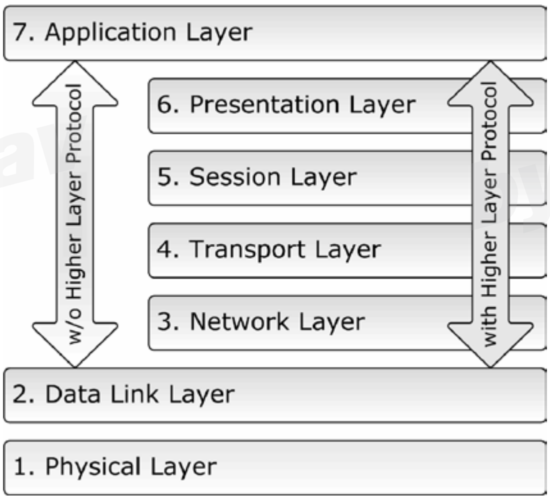


**Figure 1-1 ISO/OSI 7-Layer Reference Model**

**Application Layer:** The application layer specifies how application programs access the network. Examples include email, file transfer, remote terminal access and web browsers.

**Presentation Layer:** The presentation layer defines things like data compression and encryption.

**Session Layer:** The session layer establishes, manages and terminates the connections between cooperating applications.

**Transport Layer:** The transport layer provides transfer of data between users and addresses issues of error control and security.

**Network Layer:** The network layer performs network routing functions.

**Data Link Layer:** The data link layer provides synchronization and error control.

**Physical Layer:** The physical layer defines the physical specifications for devices on the network, including connectors, cables and electrical specifications like voltage levels.

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## 1.4 CAN 2.0B

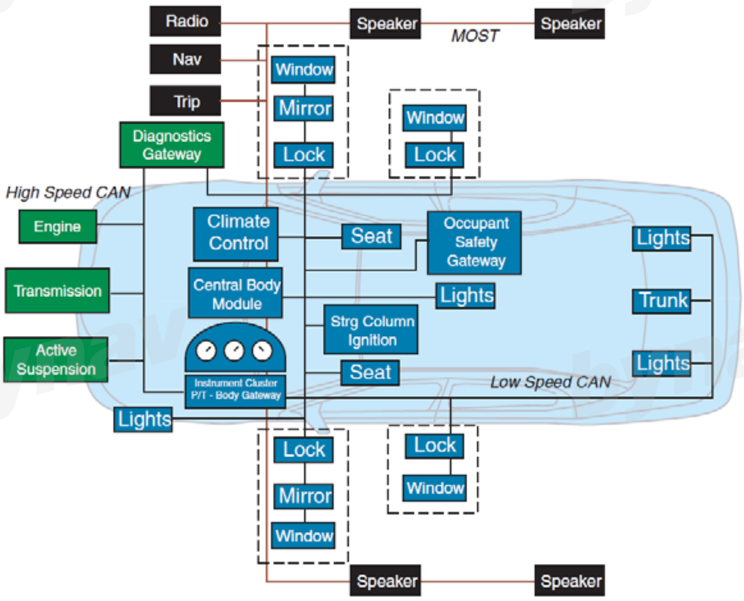


**Figure 1-2 Typical Automotive Networks**

The most commonly used network for control in automotive and manufacturing applications is the Controller Area Network, or CAN. The CAN protocol(here refers to **CAN 2.0B**) specifies rules for implementing the physical and data link layers of the OSI model in silicon to effect serial transfer of information between two or more devices. The layers above the Data Link Layer are covered by additional software, which represents per definition a higher layer protocol (here refers to **J1939**).

Bynav X1 supports CAN 2.0B message format. CAN 2.0B specifies rules for implementing the physical and data link layers of the OSI model.

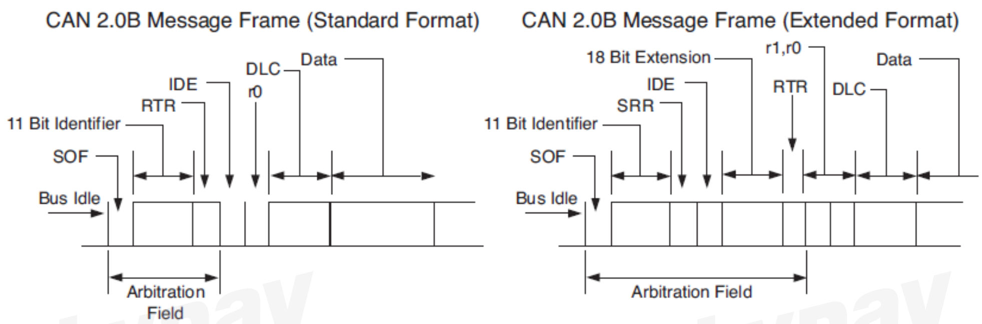


**Figure 1-3 CAN Message Formats**

The CAN data frame is composed of seven fields: Start of frame (SOF), arbitration, control, data, and cyclical redundancy check (CRC), acknowledge (ACK) and end of frame (EOF). CAN message bits are referred to as "dominant" (0) or "recessive" (1). The SOF field consists of one dominant bit. All network nodes waiting to transmit synchronize with the SOF and begin transmitting at the same time. An arbitration scheme determines which of the nodes attempting to transmit will actually control the bus.

| Field | Length | Description |
|---|---|---|
| Start of Frame (SOF) | 1 | Must be dominant |
| Identifier – Standard and Extended Formats | 11 | Unique identifier corresponds to Base ID in Extended Format |
| Identifier – Extended Format | 29 | Comprised of 11 bit Base ID and 18 bit Extended ID |
| Remote Transmission Request (RTR) – Standard and Extended Formats | 1 | Dominant in data frames; recessive in remote frames. In Standard Format, the 11 bit identifier is followed by the RTR bit. |
| Substitute Remote Request (SRR) – Extended Format | 1 | Must be recessive. SRR is transmitted in Extended Frames at the position of the RTR bit in Standard Frames. In arbitration between standard and extended frames, recessive SRR guarantees the standard message frame prevails. |
| IDE – Standard and Extended Frames | 1 | Must be recessive for Extended Format; dominant for Standard Format. |
| Reserved r0 – Standard For- | 1 | Must be dominant |
| Reserved r1, r0 – Extended Format | 2 | Must be recessive |
| Data Length Code (DLC) | 4 | Number of data bytes (0–8) |
| Data Field | 0–8 | Length determined by DLC field |
| Cyclic Redundancy Check | 15 | |
| CRC Delimiter | 1 | Must be recessive |
| Acknowledge (ACK) | 1 | Transmitter sends recessive; receiver asserts dominant |
| ACK Delimiter | 1 | Must be recessive |
| End of Frame (EOF) | 7 | Must be recessive |

**Table 1-1 CAN 2.0B Message Frame**

## 1.5 J1939 Message Format

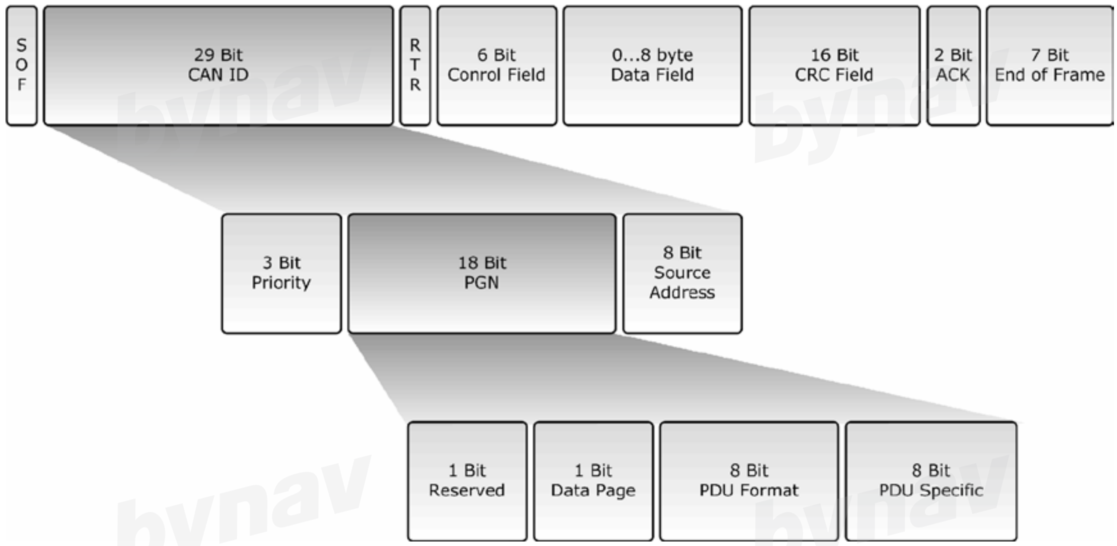


**Figure 1-4 J1939 Message Format**

With the definition of PDU Format (PF) and PDU Specific (PS) – as shown below - J1939 supports a total of 8672 Parameter Group numbers.

The Parameter Group Number range is divided into two sections:

1. Specific PGNs for peer-to-peer communication (PDU1 Format)

   Range: 00hex - EFhex (8bits, not including PDU Specific)

   PDU Specific: Destination Address

   Number of PGNs: 240

2. Generic PGNs for message broadcasting (PDU2 Format)

   Range: F000hex – FFFFhex (16bit, including PDU Specific)

   PDU Specific: used as Group Extension

   Number of PGNs: 4096

The DP bit works as a page selector for the following PDU (Protocol Data Unit) Format (PF) field. It is used to provide extended capacity, i.e. the total number of PGNs is doubled.

| DP | PGN Range (hex) | Number of PGNs | SAE or Manufacturer Assigned | Communication |
|---|---|---|---|---|
| 0 | 000000 – 00EE00 | 239 | SAE | PDU1 = Peer-to-Peer |
| 0 | 00EF00 | 1 | MF | PDU1 = Peer-to-Peer |
| 0 | 00F000 – 00FEFF | 3840 | SAE | PDU2 = Broadcast |
| 0 | 00FF00 – 00FFFF | 256 | MF | PDU2 = Broadcast |
| 1 | 010000 – 01EE00 | 239 | SAE | PDU1 = Peer-to-Peer |
| 1 | 01EF00 | 1 | MF | PDU1 = Peer-to-Peer |
| 1 | 01F000 – 01FEFF | 3840 | SAE | PDU2 = Broadcast |
| 1 | 01FF00 – 01FFFF | 256 | MF | PDU2 = Broadcast |

**Table 1-2 Parameter Group Number Range**

# 2 Commands and Logs

## 2.1 Commands

### 2.1.1 J1939CONFIG

Use this command to configure the CAN J1939 network-level parameters.

**Format:** J1939CONFIG node port can_addr

**Example:** J1939CONFIG NODE1 CAN1 AA

| Field | Fiel Type | Description |
|---|---|---|
| 1 | J1939CONFIG header | Command header |
| 2 | node | Identifies the J1939 Node (i.e. CAN NAME) |
| 3 | port | Physical CAN port to use |
| 4 | can_addr | CAN address.<br>The receiver attempts to claim this address<br>(default = 0x0) |

### 2.1.2 CANCONFIG

Use the CANCONFIG command to configure the hardware parameters of the CAN ports.

**Format:** CANCONFIG port switch [speed]

**Example:** CANCONFIG CAN1 ON 250K

| Field | Fiel Type | Description |
|---|---|---|
| 1 | CANCONFIG header | Command header |
| 2 | port | Physical CAN port ID |
| 3 | switch | Sets the port to be On or Off the CAN bus |
| 4 | speed | Physical CAN port speed (bits per second)<br>(default = 250K) |

### 2.1.3 CCOMCONFIG

Bind a CAN communication port to a J1939 node and specify the CAN protocol, PGN, priority and address for messages transmitted and received over the CCOM port.

**Format:** CCOMCONFIG port node protocol [pgn [priority [address]]]

**Example:** CCOMCONFIG ccom1 node1 J1939 61184 7 FE

| Field | Field Type | Description |
|---|---|---|
| 1 | CCOMCONFIG Header | Command header |
| 2 | port | Name of CCOM port |
| 3 | node | The J1939 node to use.<br>This binds a CCOM port to the CAN NAME/address associated with the node. |
| 4 | protocol | CAN transport protocol to use (currently J1939 only) |
| 5 | pgn | Any valid PGN as defined by the J1939 protocol.<br>All messages transmitted over this CCOM port will contain this PGN value.<br>Only messages with this PGN will be received on<br>this CCOM port |
| 6 | priority | Default CAN message priority for transmitted messages.<br>(Priority 0 is the highest priority) |
| 7 | address | **00 – FD:**<br>Transmit and receive messages to/from this address only<br>**FE:**<br>Transmit and receive message to/from the<br>address of the first message received<br>**FF:**<br>Broadcast messages and receive messages from all addresses. |

## 2.2 Logs

### 2.2.1 BESTGNSSPOS

Best GNSS position (non INS).

**Recommand**

LOG [port] BESTGNSSPOS ontime 1

**Example**

#BESTGNSSPOSA,COM1,0,92.5,FINESTEER-ING,1692,332119.000,02000000,8505,43521;SOL_COMPUTED,SIN-GLE,51.11635530655,114.03819448382,1064.6283,16.9000,WGS84,1.2612,0.9535,2.7421," ",0.000,0.000,11,11,11,11,0,06,00,03*52d3f7c

**Description**

| Field | Field Type | Description |
|---|---|---|
| 1 | BESTGNSSPOS header | Log header |
| 2 | Sol Type | Solution status |
| 3 | Pos Type | Position type |
| 4 | Lat | Latitude (°) |
| 5 | Lon | Longitude (°) |
| 6 | Hgt | Height above mean sea level (m) |
| 7 | Undulation | Undulation |
| 8 | Datum ID | Datum ID |
| 9 | Lat σ | Latitude standard deviation |
| 10 | Lon σ | Longitude standard deviation |
| 11 | Hgt σ | Height standard deviation |
| 12 | Stn ID | Base station ID |
| 13 | Diff_age | Differential age (s) |
| 14 | Sol_age | Solution age (s) |
| 15 | #SVs | Number of satellites tracked |
| 16 | #solnL1SVs | L1/E1/B1 satellite number |
| 17 | #solnMultiSVs | Number of satellites with multi frequency signals |
| 18 | Reserved | |
| 19 | Ext sol stat | Extended solution status |
| 20 | Galileo and BeiDou sig mask | |
| 21 | GPS and GLONASS sig mask | |
| 22 | xxx | 32-bitCRC parity |
| 23 | [CR][LF] | Message terminator |

### 2.2.2 INSPVA

Output position, velocity and attitude at the same time

**Recommend**

LOG [port] INSPVAA ontime 1

**Example**

#INSPVAA,COM1,0,31.0,FINESTEER-ING,1264,144088.000,02040000,5615,1541;1264,144088.002284950,51.116827527,114.037738908,401.191547167,354.846489850,108.429407241,10.837482850,1.116219952,3.476059035,7.372686190,INS_ALIGNMENT_COMPLETE*af719fd9

**Description**

| Field | Field Type | Description |
|---|---|---|
| 1 | INSPVA header | Log header |
| 2 | Week | GNSS week |
| 3 | Seconds into week | Seconds of Week |
| 4 | Lat | Latitude |
| 5 | Lon | Longitude |
| 6 | Hgt | Ellipsoid height |
| 7 | North Velocity | North Velocity |
| 8 | East Velocity | East Velocity |
| 9 | Up Velocity | Up Velocity |
| 10 | Roll | Roll |
| 11 | Pitch | Pitch |
| 12 | Azimuth | Azimuth |
| 13 | Status | IMU Status |
| 14 | xxx | 32-bitCRC parity |
| 15 | [CR][LF] | Message terminator |

# 3 Configuring CAN Bus

The Bynav X1 receiver can communicate with other devices in the system, such as computers and data loggers, using serial, CAN or Ethernet ports, the CAN Bus is available on the COMM2 interface of X1. First connect to the CAN Bus as below:

- Connect push-pull self-locking connector of Communication cable 2 included in the shipping box to COMM2 interface of X1
- Connect the other end Bare Wire of Communication cable 2 to the external CAN Bus

| J1 | | | J2 | | | Bare wire | |
|---|---|---|---|---|---|---|---|
| PIN1 | +5V | Output | PIN1 | NC | | CAN_H | Input / Output |
| PIN2 | GND_1 | | PIN2 | RS232_TXD2 | Output | CAN_L | Input / Output |
| PIN3 | RS232_TXD2 | Output | PIN3 | RS232_RXD2 | Input | | |
| PIN4 | RS232_RXD2 | Input | PIN4 | NC | | | |
| PIN5 | GND_2 | | PIN5 | GND_1 | | | |
| PIN6 | CAN_H | Input/ Output | PIN6 | NC | | | |
| PIN7 | CAN_L | Input/ Ouput | PIN7 | NC | | | |
| | | | PIN8 | NC | | | |
| | | | PIN9 | +5V | Output | | |

**Table 3-1 Pins of Communication Cable 2**

Then before CAN communication is available, it is recommended to use serial port to config the CAN port (Refer to *UG005 X1 User Manual* for serial port connection and configuration). The below configurations are needed:

- Use the **J1939CONFIG** command to specify J1939 NAME and desired address.
- Use the **CANCONFIG** command to place the receiver on bus
- Configure CAN Port to receive GNSS Corrections

**Note: refer to UG005 X1 User Manual for other configurations related to INS, such as installation and lever arm calibration etc. This document only introduces CAN communication.*

```
J1939CONFIG NODE1 CAN1 AA
CANCONFIG CAN1 ON 250K
CCOMCONFIG CCOM2 NODE1 J1939 61184 6 FF
INTERFACEMODE CCOM2 RTCM NONE OFF
CCOMCONFIG CCOM1 NODE1 J1939 126720 7 FE
```

```
INTERFACEMODE CCOM1 BYNAV BYNAV OFF
LOG CCOM1 INSPVAA ONTIME 0.05
SAVECONFIG
```

These commonds configure 2 virtual CAN Communication ports (CCOM) on physical CAN interface 1. CCOM2 is used to receive RTCM corrections (PGN 61184=0x0EF00), CCOM1 is used to send position, velocity and attitude information (PGN 126720=0x1EF00).

At last, configurations are saved in receiver.

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