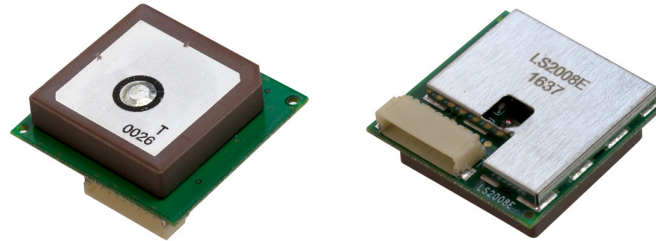


Product name	Description	Version
LS2008E	Standalone GPS smart antenna module	1.0



1 Introduction

LS2008E is a complete standalone GPS smart antenna module, including an embedded patch antenna and GPS receiver circuits. The module can simultaneously acquire and track multiple satellite constellations that include GPS, QZSS, and Galileo. It features low power and small form factor. Besides, it can provide you with superior sensitivity and performance even in urban canyon and dense foliage environment.

It is easy to install without both RF connector and coaxial cable that are needed in a separated GPS active antenna. In other words, reduce the cost and size. Also, speed up the time to market by eliminating R&D efforts on RF matching and stability between separated GPS antenna and module. Its far-reaching capability meets the sensitivity requirements of car navigation as well as other location-based applications.

2 Features

- HED high sensitivity solution
- Support GPS, QZSS, and Galileo (in future)
- Support up to 72-channel
- Fast TTFF at low signal level
- Built-in DC/DC converter to save power
- Built-in an independent power on/off switch
- Support 1PPS output
- Indoor and outdoor multi-path detection and compensation

3 Application

- Personal positioning and navigation
- Automotive navigation, model aircraft navigation
- Marine navigation

4 Overview

4.1 Block Diagram

LS2008E Block Diagram

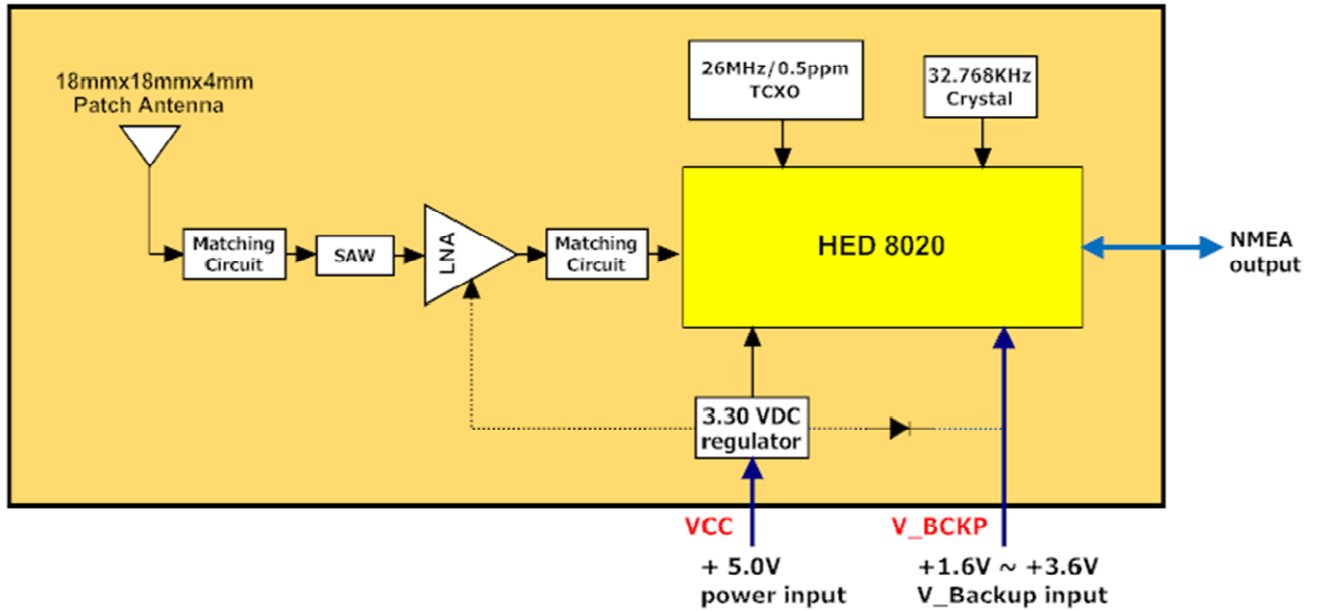


Fig 4-1 System block diagram of LS2008E

4.2 GPS Performance

Chip	HD8020	
Frequency	GPS, GALILEO, QZSS: L1 1575.42MHz, C/A code	
Channels	Up to 72 channels	
Update rate	1Hz default	
Acquisition Time	Hot start (Open Sky)	< 2s (typical)
	Cold Start (Open Sky)	29 s (typical)
Position Accuracy	Autonomous	2.5m CEP
Max. Altitude	< 18,000 m	
Max. Velocity	< 515 m/s	
Protocol Support	NMEA 0183 ver. 3.01	9600 ¹ bps, 8 data bits, no parity, 1 stop bits (default)
		1Hz: GGA, GLL,GSA, GSV, RMC, VTG

Note 1. Both baud rate and output message rate are configurable to be factory default.

4.3 Pin assignment and descriptions

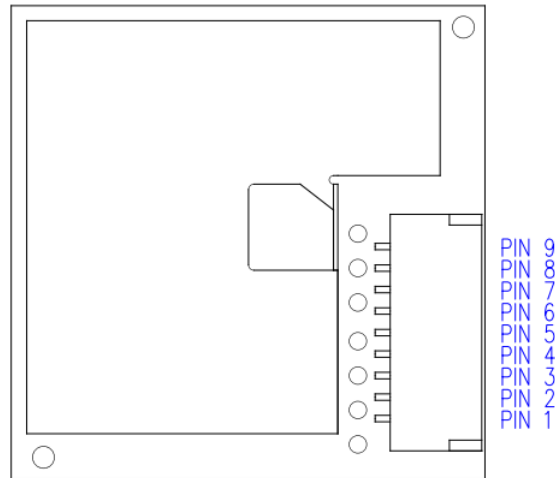


Fig 4-2 Pin assignment of LS2008E

Pin#	Name	Type	Description
1	NC		Not connect
2	1PPS	O	Pulse per second (default 100 ms pulse/sec when 3D fix is available)
3	TX	O	Serial data output
4	RX	I	Serial data input
5	NC		Not connect
6	SHUTDOWN	I	Power shutdown Input. Active low to shutdown device. If this pin is not used, leave it floating.
7	V_BCKP	P	Backup battery supply voltage
8	GND	P	Ground
9	VCC	P	DC supply voltage

5 DC & Temperature characteristics

5.1 Absolute maximum ratings

Parameter	Symbol	Ratings	Units
DC Supply Voltage	VCC	5.5	V
Input Backup Battery Voltage	V_BCKP	3.6	V
Operating Temperature Range	Topr	-25 ~ 85	°C
Storage Temperature Range	Tstg	-25 ~ 85	°C

5.2 DC Electrical characteristics

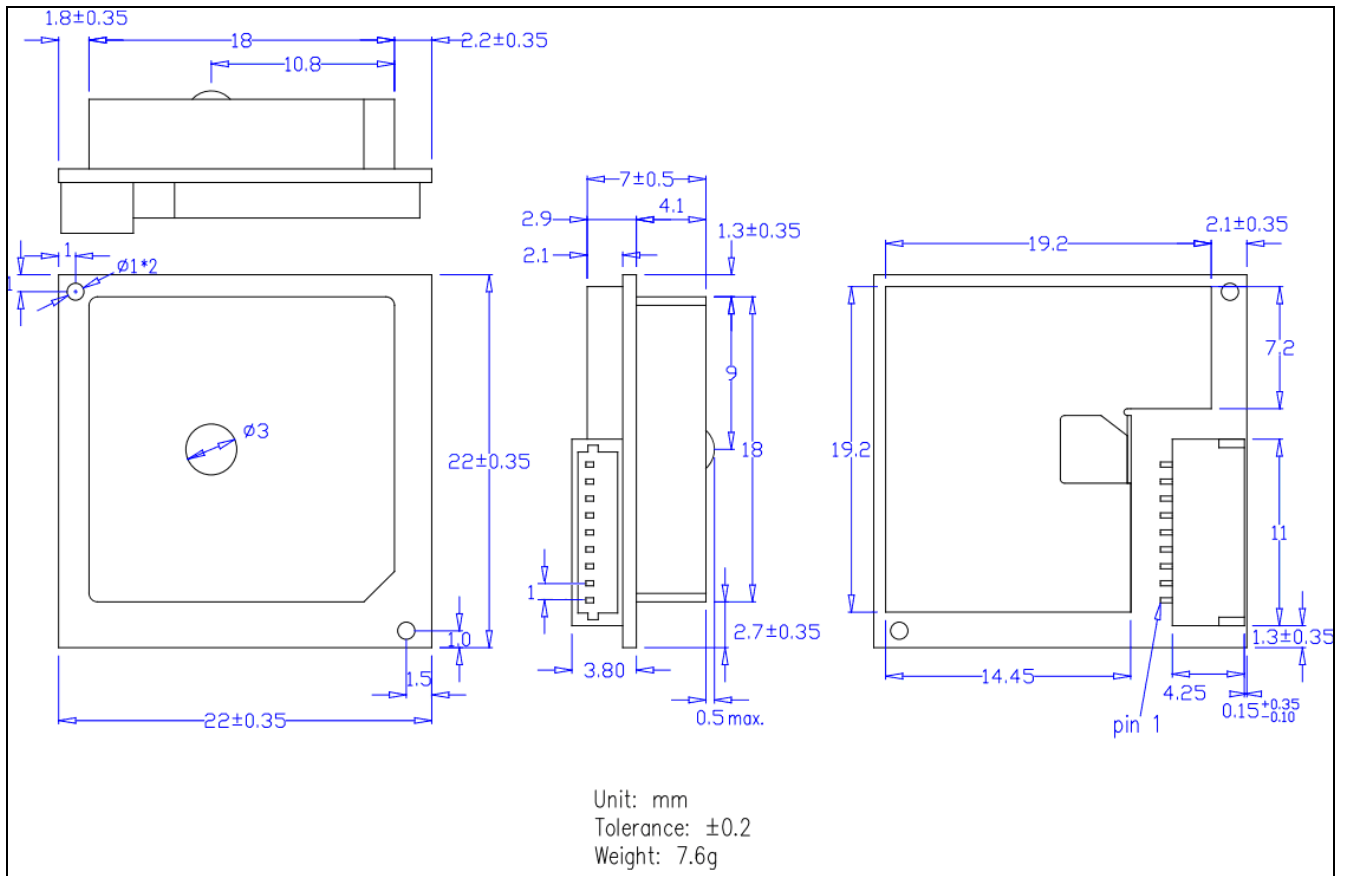
Parameter	Symbol	Conditions	Min.	Typ.	Max.	Units
Input Voltage	VCC		3.0	5.0	5.5	V
Input Backup Battery Voltage	V_BCKP		1.6		3.6	V
Supply Current	Ivcc	Acquisition Tracking		54 28		mA
Backup Battery Current	Ibat			12		uA
High Level Input Voltage	V _{IH}		2.21		3.3	V
Low Level Input Voltage	V _{IL}		0		0.9	V
High Level Output Voltage	V _{OH}		2.21		3.3	V
Low Level Output Voltage	V _{OL}				0.4	V
High Level Output Current	I _{OH}			2		mA
Low Level Output Current	I _{OL}			2		mA

5.3 Temperature characteristics

Parameter	Symbol	Min.	Typ.	Max.	Units
Operating Temperature	Topr	-25	-	85	°C
Storage Temperature	Tstg	-25	25	85	°C

6 Mechanical specification

6.1 Outline dimensions



The connector's part number is 1W1001WOR0-09NA from the company, TOKUTSU. It belongs to WAFER horizontal SMT single row connector, pitch 1.0mm

7 Software interface

7.1 NMEA output message

Table 7.1-1 NMEA output message

NMEA	Description
GGA	Global positioning system fixed data
GLL	Geographic position - latitude/longitude
GSA	GPS Overall satellite data
GSV	GPS Detailed satellite data
RMC	Recommended minimal data for GPS
VTG	Course over ground and ground speed
ZDA (optional)	Date and time

- **GGA Global positioning system fixed data**

Table 7.1-2 contains the values for the following example:

\$GPGGA,073611.000,2503.71514,N,12138.74669,E,1,10,0.88,124.2,M,17.2,M,,*6F

Table 7.1-2 GGA Data Format

Name	Example	Units	Description
Message ID	\$GPGGA		GGA protocol header
UTC Time	073611.000		hhmmss.sss
Latitude	2503.71514		ddmm.mmmmm
N/S indicator	N		N=north or S=south
Longitude	12138.74669		dddmm.mmmmm
E/W Indicator	E		E=east or W=west
Position Fix Indicator	1		See Table 7.1-3
Satellites Used	10		Number of satellites in view, 00-24
HDOP	0.88		Horizontal Dilution of Precision (meters)
MSL Altitude	124.2	meters	Antenna Altitude above/below mean-sea-level (geoid) (in meters)
Units	M	meters	Units of antenna altitude, meters
Geoidal Separation	17.2	meters	
Units	M	meters	Units of geoidal separation, meters
Age of diff. GPS data		second	Null fields when DGPS is not used
Diff. Ref. Station ID			Differential reference station ID, 0000-1023
Checksum	*6F		Checksum
<CR> <LF>			End of message termination

Table 7.1-3 Position Fix Indicators

Value	Description
-------	-------------

0	Fix not available
1	GPS fix
2	Differential GPS fix

● GLL--- Geographic Position – Latitude/Longitude

Table 7.1-4 contains the values for the following example:

\$GPGLL,2503.71514,N,12138.74669,E,073611.000,A,A*5A

Table 7.1-4 GLL Data Format

Name	Example	Units	Description
Message ID	\$GPGLL		GLL protocol header
Latitude	2503.71514		ddmm.mmmmm
N/S indicator	N		N=north or S=south
Longitude	12138.74669		dddmm.mmmmm
E/W indicator	E		E=east or W=west
UTC Time	073611.000		hhmmss.sss
Status	A		A=data valid or V=data not valid
Mode	A		N =Invalid, A=Autonomous and D =Differential
Checksum	*5A		
<CR> <LF>			End of message termination

● GSA--GPS DOP and Active Satellites

Table 7.1-5 contains the values for the following example:

\$GPGSA,A,3,193,19,06,02,05,17,09,12,13,25,,,1.62,0.88,1.36*38

Table 7.1-5 GSA Data Format

Name	Example	Units	Description
Message ID	\$GPGSA		GSA protocol header
Mode 1	A		See Table 7.1-6
Mode 2	3		See Table 7.1-7
ID of satellite used	193		Sv on Channel 1
ID of satellite used	19		Sv on Channel 2
....		
ID of satellite used			Sv on Channel 12
PDOP	1.62		Position Dilution of Precision
HDOP	0.88		Horizontal Dilution of Precision
VDOP	1.36		Vertical Dilution of Precision
Checksum	*38		
<CR> <LF>			End of message termination

Table 7.1-6 Mode 1

Value	Description
M	Manual- forced to operate in 2D or 3D mode
A	Automatic-allowed to automatically switch 2D/3D

Table 7.1-7 Mode 2

Value	Description
1	Fix not available
2	2D ¹
3	3D

Note 1: 2D fix hint that the receiver position error meets the 2D level. Maybe under this condition the used satellite number is little more than 4

● GSV---GPS Satellites in View

Table 7.1-8 contains the values for the following example:

\$GPGSV,3,1,11,193,69,37,46,19,60,139,47,6,49,41,47,2,46,335,49*4A

\$GPGSV,3,2,11,5,44,260,44,17,37,143,45,9,28,52,45,12,24,279,41*45

\$GPGSV,3,3,11,13,11,191,44,25,6,311,39,23,4,38,41*71

Table 7.1-8 GSV Data Format

Name	Example	Units	Description
Message ID	\$GPGSV		GSV protocol header
Total number of messages ¹	3		Range 1 to 6
Message number ¹	1		Range 1 to 6
Satellites in view	11		
Satellite ID ²	193		Channel 1
Elevation	69	degrees	Channel 1 (Range 00 to 90)
Azimuth	37	degrees	Channel 1 (Range 000 to 359)
SNR (C/No)	46	dB-Hz	Channel 1 (Range 00 to 99, null when not tracking)
....		
Satellite ID	2		Channel 4 (Range 01 to 196)
Elevation	46	degrees	Channel 4 (Range 00 to 90)
Azimuth	335	degrees	Channel 4 (Range 000 to 359)
SNR (C/No)	49	dB-Hz	Channel 4 (Range 00 to 99, null when not tracking)
Checksum	*4A		
<CR> <LF>			End of message termination

Note 1: Depending on the number of satellites tracked multiple messages of GSV data may be required.

2: GPS ID: 01~32, SBAS ID: 120~140, QZSS ID: 193~196

● **RMC---Recommended Minimum Specific GPS Data**

Table 7.1-9 contains the values for the following example:

\$GPRMC,073611.000,A,2503.71514,N,12138.74669,E,0.093,279.56,020916,,A*54

Table 7.1-9 RMC Data Format

Name	Example	Units	Description
Message ID	\$GPRMC		RMC protocol header
UTC Time	073611.000		hhmmss.sss
Status	A		A=data valid or V=data not valid
Latitude	2503.71514		ddmm.mmmmm
N/S Indicator	N		N=north or S=south
Longitude	12138.74669		dddmm.mmmmm
E/W Indicator	E		E=east or W=west
Speed over ground	0.093	knots	True
Course over ground	279.56	degrees	
Date	020916		ddmmyy
Magnetic variation		degrees	
Variation sense			E=east or W=west
Mode	A		N=Invalid, A=Autonomous, D=Differential.
Checksum	*54		
<CR> <LF>			End of message termination

● **VTG---Course Over Ground and Ground Speed**

Table 7.1-10 contains the values for the following example:

\$GPVTG,279.56,T,,M,0.058,N,0.107,K,A*39

Table 7.1-10 VTG Data Format

Name	Example	Units	Description
Message ID	\$GPVTG		VTG protocol header
Course over ground	279.56	degrees	Measured heading
Reference	T		True
Course over ground	0.00	degrees	Measured heading
Reference	M		Magnetic
Speed over ground	0.058	knots	Measured speed
Units	N		Knots
Speed over ground	0.107	km/hr	Measured speed
Units	K		Kilometer per hour
Mode	A		N=Invalid, A=Autonomous, D=Differential.
Checksum	*39		

<CR> <LF>			End of message termination
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● **ZDA--- Time & Date**

Table 7.1-11 contains the values for the following example:

\$GPZDA,075340.000,02,09,2016,*,*5D

Table 7.1-11 ZDA Data Format

Name	Example	Units	Description
Message ID	\$GPZDA		ZDA protocol header
UTC Time	075340.000		hhmmss.sss
Day	02		dd (01 to 31)
Month	09		mm (01 to 12)
Year	2016		yyyy (1980 to 2025)
Local zone hours		hour	
Local zone minutes		minute	
Checksum	*4C	4C	
<CR> <LF>			End of message termination

7.2 HED Proprietary Binary Packet Set

Please refer to CYNOSURE GPS Receiver Protocol. The following table shows the most common use proprietary command sets

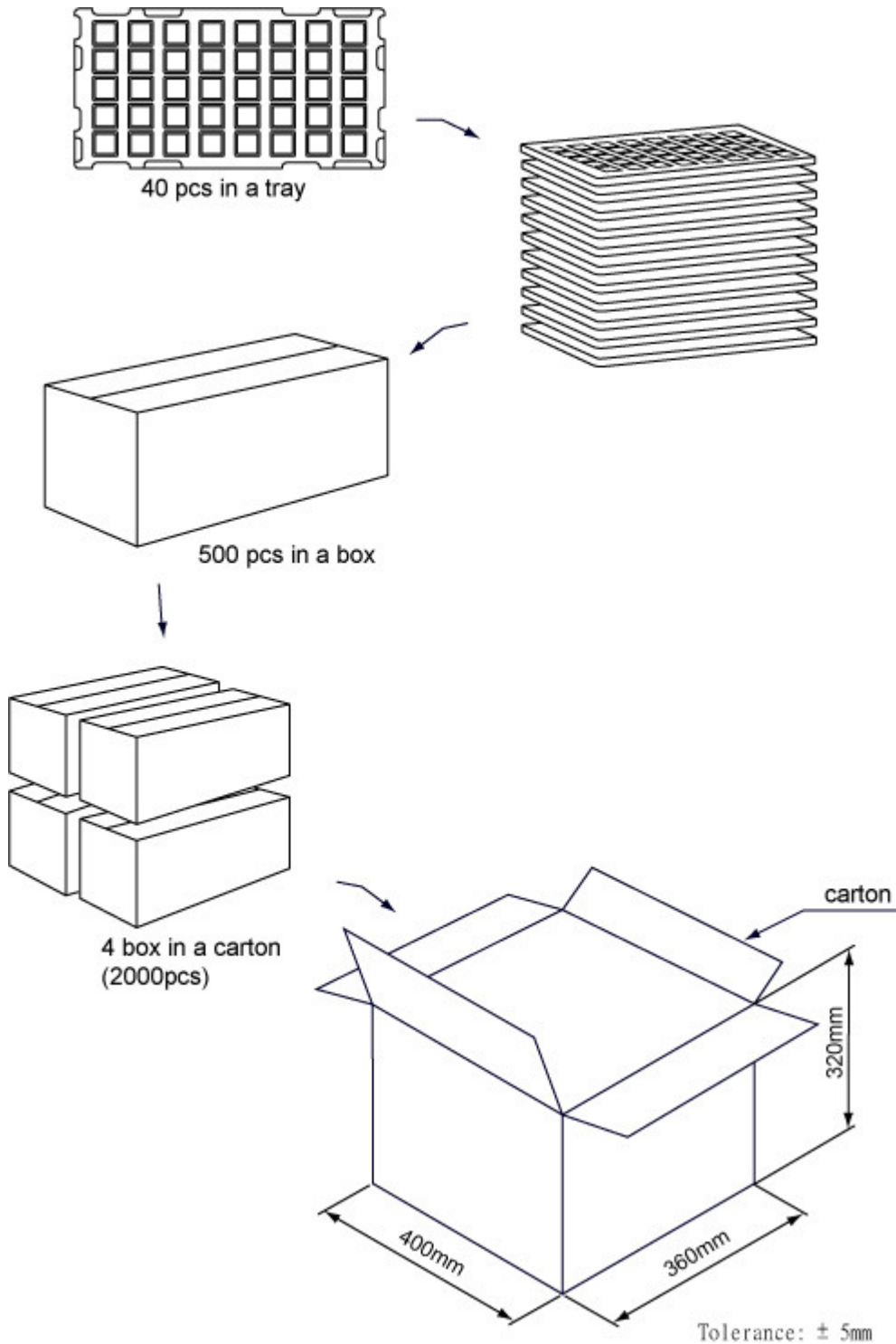
Table 7.2-1 The table below summarizes the set of proprietary command sets for the LS2008E

Command descriptions	Software command
Perform a Cold start	F1 D9 06 40 01 00 01 48 22
Perform a Warm start	F1 D9 06 40 01 00 02 49 23
Perform a Hot start	F1 D9 06 40 01 00 03 4A 24
Perform a Factory reset :	F1 D9 06 09 08 00 02 00 00 00 FF FF FF FF 15 01
UART configures as 115200bps	F1 D9 06 00 08 00 00 00 00 00 C2 01 00 D1 E0
UART configures as 9600bps	F1 D9 06 00 08 00 00 00 00 80 25 00 00 B3 07
Enable ZDA message	F1 D9 06 01 03 00 F0 07 01 02 1E
Disable ZDA message	F1 D9 06 01 03 00 F0 07 00 01 1D
Switch to Vehicle mode	F1 D9 06 0F 02 00 96 00 AD A3
Switch to Pedestrian mode	F1 D9 06 0F 02 00 00 00 17 77
Query firmware version ¹	F1 D9 0A 05 00 00 0F 37

Note 1: Firmware version will show as Hex mode too.

Note 2: Add **0D 0A** at the end of command.

8 Packing information



Document change list

Revision 1.0

- First release on October 27, 2016