Application Protocol of CAN

-for HAE UAV EFI

V1.0

http://www.uavenginesystem.com/

Note: If you are not sure about any specific details, please contact us at info@uavenginesystem.com.

Index	Page	Revision	Date	Note
1		**First Edition**	1.9.2019	V1.0

Chapter 1 Information of CAN

Two methods of data exchange are used by the nodes of the UAVCAN network to communicate:

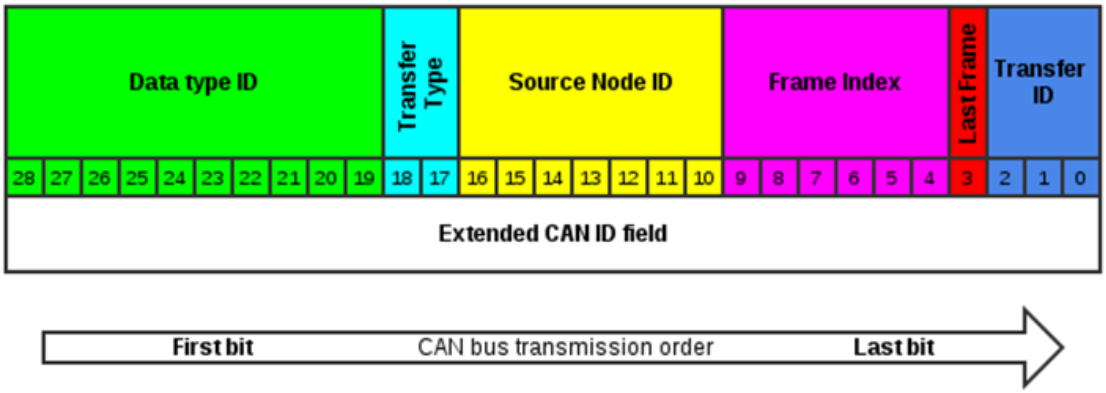
- Message publication
- Service invocation

Transfer is a single act of data transmission from source node to either single remote node (**unicast transfer**) or all other nodes (**broadcast transfer**), upon which all methods of data exchange are based.

- Message publication - one transfer, either unicast or broadcast.
- Service invocation - two subsequent unicast transfers:
    - From caller to server, i.e., request.
    - From server to caller, i.e., response.

CAN frame format - Only data frames of CAN 2.0B (29-bit ID field) are used.

Field	Bit length	Note
Data Type ID	10	Most significant bits; top priority during arbitration
Transfer Type	2	00_2 - Service response 01_2 - Service request 10_2 - Message broadcast 11_2 - Message unicast
Source Node ID	7	When multiple nodes are trying to publish data of the same type, the node with the lowest Node ID will transmit first
Frame Index	6	Starting from 0. Value 111111_2 is reserved. Frames with the lowest index win in the arbitration, so they will be transmitted in order.
Last Frame	1	0 - Expect more frames for this transfer 1 - Current frame is the last frame of this transfer
Transfer ID	3	Least significant bits; lowest priority during arbitration



Chapter 2 Application protocol of CAN

2.1 Additional Notes:

1) This document defines the CAN based parameters which are broadcasted from ECU
2) The ECU does not contain a 120 ohm termination resistor.

2.2 CAN Bus Details

• 250 kbps Rate
• Broadcast parameters are based on UAVCAN standard
• All 2 bytes data is stored with [LowByte, HighByte] group.

The data type is hexadecimal in default, so convert it to be decimal first by following two methods.
Convert HighByte and LowByte to be decimal first, marked as HighByte_D and LowByte_D
1) The data is **"unsigned"** type, so
Num = HighByte_D*256 + LowByte_D

2) If the data is **"signed"** type, so
Num = HighByte_D*256+LowByte_D
if (Num>32767) then
Num = Num - 65536

Note: Num is the decimal value.
You can see the data type in the following chats.

2.3 Data Type ID:

768-800 (HAE specific message)
Transfer Type: 2
Source Node ID: 1
Frame Index: 1
Last Frame: 1
Transfer ID: 0

2.4 Variables of broadcast list:

All of the variables of ECU broadcasting are in the flowing sheet, please read it for details

UAVCAN ID(HEX)	Data Type ID	Name	Rate (ms)	Start Position	Length	Units	Resolution	Value Range	Type	Is It in J1939	PGN	SPN
0x18040418	768	End of Start	syn	1	1 byte		2 states/1 bit, 0 offset	0 to 1	unsigned char Measured	NO		
0x18040418	768	Error condition for crank sensor	syn	2	1 byte		2 states/1 bit, 0 offset	0 to 1	unsigned char Measured	NO		
0x18040418	768	Engine Percent Load At Current Speed	syn	3	1 byte	%	1 %/bit, 0 offset	0 to 250 %	unsigned char Measured	YES	61443	92
0x18040418	768	Engine Speed	syn	4-5	2 bytes	rpm	0.125 rpm/bit, 0 offset	0 to 8031.875 rpm	unsigned word Measured	YES	61444	190
0x180C0418	769	Engine Throttle Position	100	7	1 byte	%	0.4 %/bit, 0 offset	0 to 100%	unsigned char Measured	YES	65266	51
0x18140418	770	Barometric Pressure	1000	1	1 byte	kPa	0.5 kPa/bit, 0 offset	0 to 125kPa	unsigned char	YES	65269	108

									Measured			
0x181C0418	771	Engine Cylinder #1 Ignition Timing	syn	1-2	2 bytes	deg	1/128 deg/bit, -200 deg offset	-200 to 301.99 deg C	unsigned word Measured	YES	65154	1413
0x181C0418	771	IGBT Spark Dwell Time	syn	3	1 byte	ms	0.1 ms/bit, 0 offset	0 to 25.5 ms	unsigned char Measured	NO		
0x181C0418	771	Injection Time for Injector #0	syn	5-6	2 bytes	ms	0.001 ms/bit, 0 offset	0 to 65.535 ms	unsigned word Measured	N0		
0x181C0418	771	Injection Time for Injector #1	syn	7-8	2 bytes	ms	0.001 ms/bit, 0 offset	0 to 65.535 ms	unsigned word Measured	N0		
0x18240418	772	Engine Intake Manifold #1 Pressure	500	2	1 byte	kPa	2 kPa/bit, 0 offset	0 to 500 kPa	unsigned char Measured	YES	65270	102

0x18240418	772	Engine Intake Manifold 1 Temperature	500	3	1 byte	deg C	1 deg C/bit, -40 deg C offset	-40 to 210 deg C	unsigned char Measured	YES	65270	105
0x182C0418	773	Engine Coolant Temperature	1000	1	1 byte	deg C	1 deg C/bit, -40 deg C offset	-40 to 210 deg C	unsigned char Measured	YES	65262	110
0x18340418	774	Aftertreatment 1 Outlet %O2	50	3-4	2 bytes	%	0.000514 %/bit, -12 % offset	-12% to 21%	unsigned word Measured	YES	61455	3227
0x18340418	774	Battery Potential / Power Input 1	50	5-6	2 bytes	V	0.05 V/bit, 0 offset	0 to 3212.75 V	unsigned word Measured	YES	65271	168
0x183C0418	775	Fuel Level 1	1000	2	1 byte	%	0.4 %/bit, 0 offset	0 to 100%	unsigned char Measured	YES	65276	96
0x183C0418	775	Fuel Consumption Rate	1000	5-6	2 bytes	g/min	0.011594 g/min/bit, 0 offset	0 to 760 g/min	unsigned word Measured	NO		

Chapter 3 Message Publication

One transfer, either unicast or broadcast.

Data Type ID = 768-800 (HAE specific message)
Transfer Type = 2（Message broadcast）
Source Node ID = 1
Frame Index = 1
Last Frame = 1（Current frame is the last frame）
Transfer ID = 0

Data Type ID ： 768

Transmission Repetition Rate: syn
Data Length: 8

Start Position	Length	Parameter Name	Data Type ID	SPN
1	1 byte	End of Start	768	1
2	1 byte	Error condition for crank sensor	768	2
3	1 byte	Engine Percent Load At Current Speed	768	3
4-5	2 bytes	Engine Speed	768	4

SPN 1 End of Start
Transmission Repetition Rate: syn
Data Length: 1 byte
Type: unsigned (measured)
Variable Name: B_StaEnd
Resolution: 2 states/1 bit, 0 offset
Data Range: 0 to 1
Unit:
Data Type ID: 768
Conversion: Physical value = Convert “Hex type value” to be “Dec value”

SPN 2 Error condition for crank sensor
Transmission Repetition Rate: syn
Data Length: 1 byte

Type: unsigned (measured)
Variable Name: B_CrkErr
Resolution: 2 states/1 bit, 0 offset
Data Range: 0 to 1
Unit:
Data Type ID: 768
Conversion: Physical value = Convert “Hex type value” to be “Dec value”

SPN 3 Engine Percent Load At Current Speed
Transmission Repetition Rate: syn
Data Length: 1 byte
Type: unsigned (measured)
Variable Name: Ld
Resolution: 1% bit, 0 offset
Data Range: 0 to 250
Unit: %
Data Type ID: 768
Conversion: Physical value = Convert “Hex type value” to be “Dec value”

SPN 4 Engine Speed
Transmission Repetition Rate: syn
Data Length: 2 bytes
Type: unsigned (measured)
Variable Name: N
Resolution: 0.125 rpm/bit, 0 offset
Data Range: 0 to 8031.875
Unit: RPM
Data Type ID: 768
Conversion: Physical value = (Convert “Hex type value” to be “Dec value”) /8

Data Type ID ： 769

Transmission Repetition Rate: 100ms
Data Length: 8

Start Position	Length	Parameter Name	Data Type ID	SPN
7	1 byte	Engine Throttle Position	769	1

SPN 1 Engine Throttle Position
Transmission Repetition Rate: 100ms
Data Length: 1 byte
Type: unsigned (measured)
Variable Name: TPS
Resolution: 0.4% bit, 0 offset
Data Range: 0 to 100
Unit: %
Data Type ID: 769
Conversion: Physical value = (Convert “Hex type value” to be “Dec value”) /2.5

Data Type ID ： 770

Transmission Repetition Rate: 1000ms
Data Length: 8

Start Position	Length	Parameter Name	Data Type ID	SPN
1	1 byte	Barometric Pressure	770	1

SPN 1 Barometric Pressure
Transmission Repetition Rate: 1000ms
Data Length: 1 byte
Type: unsigned (measured)
Variable Name: Baro
Resolution: 0.5 kPa/bit, 0 offset
Data Range: 0 to 125
Unit: kPa
Data Type ID: 770
Conversion: Physical value = (Convert “Hex type value” to be “Dec value”) /2

Data Type ID ： 771

Transmission Repetition Rate: syn
Data Length: 8

Start Position	Length	Parameter Name	Data Type ID	SPN
1-2	2 bytes	Engine Cylinder #1 Ignition	771	1

		Timing		
3	1 byte	IGBT Spark Dwell Time	771	2
5-6	2 bytes	Injection Time for Injector #0	771	3
7-8	2 bytes	Injection Time for Injector #1	771	4

SPN 1 Engine Cylinder #1 Ignition Timing
Transmission Repetition Rate: syn
Data Length: 2 bytes
Type: unsigned (measured)
Variable Name: IgaOut
Resolution: 1/128 deg/bit,-200 deg offset
Data Range:-200 to 301.99
Unit: deg
Data Type ID: 771
Conversion: Physical value = (Convert “Hex type value” to be “Dec value”) /128 -200

SPN 2 IGBT Spark Dwell Time
Transmission Repetition Rate: syn
Data Length: 1 byte
Type: unsigned (measured)
Variable Name: tDwl
Resolution: 0.1 ms/bit, 0 offset
Data Range: 0 to 25.5
Unit: ms
Data Type ID: 771
Conversion: Physical value = (Convert “Hex type value” to be “Dec value”) /10

SPN 3 Injection Time for Injector #0
Transmission Repetition Rate: syn
Data Length: 2 bytes
Type: unsigned (measured)
Variable Name: tInj0
Resolution: 0.001 ms/bit, 0 offset
Data Range: 0 to 65.535
Unit: ms
Data Type ID: 771
Conversion: Physical value = (Convert “Hex type value” to be “Dec value”) /1000

SPN 4 Injection Time for Injector #1
Transmission Repetition Rate: syn
Data Length: 2 bytes
Type: unsigned (measured)
Variable Name: tInj1
Resolution: 0.001 ms/bit, 0 offset
Data Range: 0 to 65.535
Unit: ms
Data Type ID: 771
Conversion: Physical value = (Convert “Hex type value” to be “Dec value”) /1000

Data Type ID ： 772

Transmission Repetition Rate: 500ms
Data Length: 8

Start Position	Length	Parameter Name	Data Type ID	SPN
2	1 byte	Engine Intake Manifold #1 Pressure	772	1
3	1 byte	Engine Intake Manifold 1 Temperature	772	2

SPN 1 Engine Intake Manifold #1 Pressure
Transmission Repetition Rate: 500ms
Data Length: 1 byte
Type: unsigned (measured)
Variable Name: Map
Resolution: 2 kPa/bit, 0 offset
Data Range: 0 to 500
Unit: kPa
Data Type ID: 772
Conversion: Physical value = (Convert “Hex type value” to be “Dec value”) *2

SPN 2 Engine Intake Manifold 1 Temperature
Transmission Repetition Rate: 500ms

Data Length: 1 byte
Type: unsigned (measured)
Variable Name: Ta
Resolution: 1 deg C/bit, -40 deg C offset
Data Range: -40 to 210
Unit: deg C
Data Type ID: 772
Conversion: Physical value = (Convert “Hex type value” to be “Dec value”) -40

Data Type ID ： 773

Transmission Repetition Rate: 1000ms
Data Length: 8

Start Position	Length	Parameter Name	Data Type ID	SPN
1	1 byte	Engine Coolant Temperature	773	1

SPN 1 Engine Coolant Temperature
Transmission Repetition Rate: 1000ms
Data Length: 1 byte
Type: unsigned (measured)
Variable Name: Tm
Resolution: 1 deg C/bit, -40 deg C offset
Data Range: -40 to 210
Unit: deg C
Data Type ID: 773
Conversion: Physical value = (Convert “Hex type value” to be “Dec value”) -40

Data Type ID ： 774

Transmission Repetition Rate: 50ms
Data Length: 8

Start Position	Length	Parameter Name	Data Type ID	SPN
3-4	2 bytes	Aftertreatment 1 Outlet %O2	774	1
5-6	2 bytes	Battery Potential / Power	774	2

		Input 1		

SPN 1 Aftertreatment 1 Outlet %O2

Transmission Repetition Rate: 50ms
Data Length: 2 bytes
Type: unsigned (measured)
Variable Name: ALM_lsuO2_FromCAN
Resolution: 0.000514 %/bit, -12 % offset
Data Range: -12 to 21
Unit: %
Data Type ID: 774
Conversion: Physical value = (Convert “Hex type value” to be “Dec value”) -0.000514 -12%

SPN 2 Battery Potential / Power Input 1

Transmission Repetition Rate: 50ms
Data Length: 2 bytes
Type: unsigned (measured)
Variable Name: UbAdc
Resolution: 0.05 V/bit, 0 offset
Data Range: 0 to 3212.75
Unit: V
Data Type ID: 774
Conversion: Physical value = (Convert “Hex type value” to be “Dec value”) /20

Data Type ID ： 775

Transmission Repetition Rate: 1000ms
Data Length: 8

Start Position	Length	Parameter Name	Data Type ID	SPN
2	1 byte	Fuel level	775	1
5-6	2 bytes	Fuel Consumption Rate	775	2

SPN 1 Fuel level (Ratio of volume of fuel to the total volume of fuel storage container)

Transmission Repetition Rate: 1000ms
Data Length: 1 byte

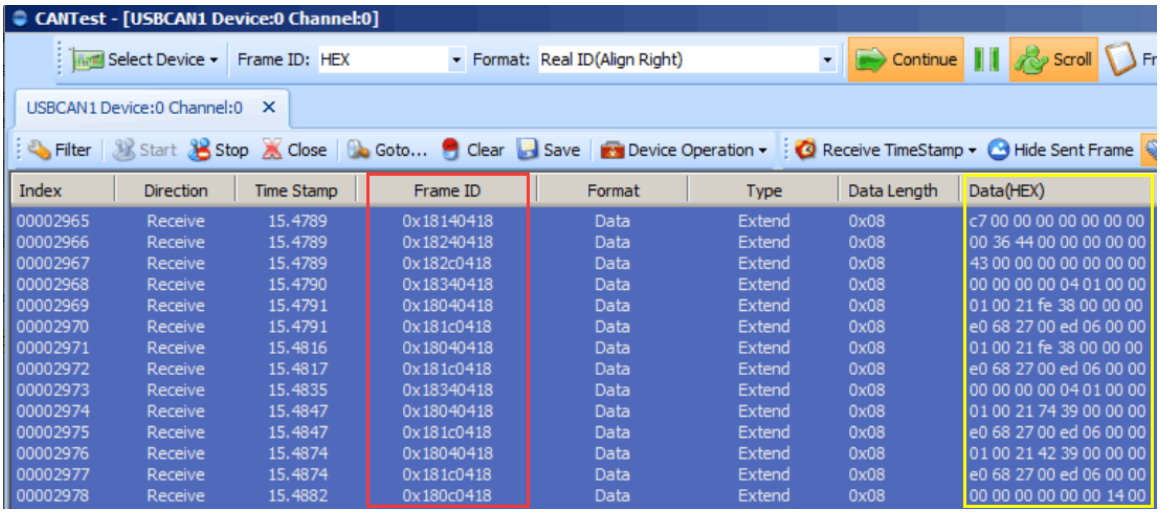
Type: unsigned (measured)
Variable Name: FuelLvl
Resolution: 0.4 %/bit, 0 offset
Data Range: 0 to 100%
Unit: %
Data Type ID: 775
Conversion: Physical value = (Convert “Hex type value” to be “Dec value”) /2.5

SPN 2 Fuel Consumption Rate, Averaged, gram per minute
Transmission Repetition Rate: 1000ms
Data Length: 2 bytes
Type: unsigned (measured)
Variable Name: dmFuel_A
Resolution: 0.011594 g/min/bit, 0 offset
Data Range: 0 to 760 g/min
Unit: g/min
Data Type ID: 775
Conversion: Physical value = (Convert “Hex type value” to be “Dec value”) / 86.253701

Chapter 4 How to read the message?

This is the example of how to read the message.

Note: We use the CAN test software to monitor the broadcast data from ECU. You also can use your own CAN test software, this example just let your know how to read the data from broadcasting.



Index	Direction	Time Stamp	Frame ID	Format	Type	Data Length	Data(HEX)
00002965	Receive	15.4789	0x18140418	Data	Extend	0x08	c7 00 00 00 00 00 00 00
00002966	Receive	15.4789	0x18240418	Data	Extend	0x08	00 36 44 00 00 00 00 00
00002967	Receive	15.4789	0x182c0418	Data	Extend	0x08	43 00 00 00 00 00 00 00
00002968	Receive	15.4790	0x18340418	Data	Extend	0x08	00 00 00 00 04 01 00 00
00002969	Receive	15.4791	0x18040418	Data	Extend	0x08	01 00 21 fe 38 00 00 00
00002970	Receive	15.4791	0x181c0418	Data	Extend	0x08	e0 68 27 00 ed 06 00 00
00002971	Receive	15.4816	0x18040418	Data	Extend	0x08	01 00 21 fe 38 00 00 00
00002972	Receive	15.4817	0x181c0418	Data	Extend	0x08	e0 68 27 00 ed 06 00 00
00002973	Receive	15.4835	0x18340418	Data	Extend	0x08	00 00 00 00 04 01 00 00
00002974	Receive	15.4847	0x18040418	Data	Extend	0x08	01 00 21 74 39 00 00 00
00002975	Receive	15.4847	0x181c0418	Data	Extend	0x08	e0 68 27 00 ed 06 00 00
00002976	Receive	15.4874	0x18040418	Data	Extend	0x08	01 00 21 42 39 00 00 00
00002977	Receive	15.4874	0x181c0418	Data	Extend	0x08	e0 68 27 00 ed 06 00 00
00002978	Receive	15.4882	0x180c0418	Data	Extend	0x08	00 00 00 00 00 00 14 00

First, find the Frame ID, it is the UAVCAN ID, then you can know which are the variable in the ID from the sheet.

00002965	Receive	15.4789	0x18140418	Data	Extend	0x08	c7 00 00 00 00 00 00 00
00002966	Receive	15.4789	0x18240418	Data	Extend	0x08	00 36 44 00 00 00 00 00
00002967	Receive	15.4789	0x182c0418	Data	Extend	0x08	43 00 00 00 00 00 00 00
00002968	Receive	15.4790	0x18340418	Data	Extend	0x08	00 00 00 00 04 01 00 00
00002969	Receive	15.4791	0x18040418	Data	Extend	0x08	01 00 21 fe 38 00 00 00
00002970	Receive	15.4791	0x181c0418	Data	Extend	0x08	e0 68 27 00 ed 06 00 00
00002971	Receive	15.4816	0x18040418	Data	Extend	0x08	01 00 21 fe 38 00 00 00

Frame ID: 0x181c0418
Data (HEX): e0 68 27 00 ed 06 00 00
From the sheet we can see this, there are four variable in this ID, they are “Engine Cylinder #1 Ignition Timing”, “IGBT Spark Dwell Time”, “Injection Time for Injector #0”, “Injection Time for Injector #1”.

“Engine Cylinder #1 Ignition Timing”: start position is 1-2, has 2 bytes.
“IGBT Spark Dwell Time”: start position is 3, has 1 byte
“Injection Time for Injector #0”: start position is 5-6, has 2 byte
“Injection Time for Injector #0”: start position is 7-8, has 2 byte

So,
“Engine Cylinder #1 Ignition Timing”: Value is e0 68
“IGBT Spark Dwell Time”: Value is 27
“Injection Time for Injector #0”: Value is ed 06
“Injection Time for Injector #0”: Value is 00 00

From chapter 2.2, we can know:
All 2 bytes data is stored with **[LowByte, HighByte]** group.

First, we convert the Hex type value to be Dec value by using the method.

(The data type is hexadecimal in default, so convert it to be decimal first by

following two methods.

Convert HighByte and LowByte to be decimal first, marked as HighByte_D and LowByte_D

The data is **"unsigned"** type, so

Num = HighByte_D*256 + LowByte_D

)

Example, "Engine Cylinder #1 Ignition Timing": Value is e0 68

So, the LowByte is e0, the HighByte is 68

Convert e0 to be decimal value, it is 224; convert 68 to be decimal value, it is 104

Num=104*256+224=26848

So,

"Engine Cylinder #1 Ignition Timing": Value is 26848

"IGBT Spark Dwell Time": Value is 39

"Injection Time for Injector #0": Value is 1773

"Injection Time for Injector #0": Value is 0

From chapter 2, we can know the message Publication, and then convert the value to Physical value.

Note: Physical value is the real value of engine running conditions; you can see it in ProCAL or EcoCAL.

SPN 1 Engine Cylinder #1 Ignition Timing

Conversion: Physical value = (Convert "Hex type value" to be "Dec value") /128 +200

SPN 2 IGBT Spark Dwell Time

Conversion: Physical value = (Convert "Hex type value" to be "Dec value") /10

SPN 3 Injection Time for Injector #0

Conversion: Physical value = (Convert "Hex type value" to be "Dec value") /1000

SPN 4 Injection Time for Injector #1

Conversion: Physical value = (Convert "Hex type value" to be "Dec value") /1000

So,

SPN 1 Engine Cylinder #1 Ignition Timing

Conversion: Physical value = 26848 /128 -200=9.75

SPN 2 IGBT Spark Dwell Time

Conversion: Physical value = 39 /10=3.9

SPN 3 Injection Time for Injector #0

Conversion: Physical value = 1773 /1000=1.773

SPN 4 Injection Time for Injector #1

Conversion: Physical value 0 /1000=0

So,

You can know, the ignition timing is 9.75 CrA, the injection time of #1 injector is 1.773ms, and the IGBT spart dwell time is 3.9ms.

I think, you are very clear now, so you can to read the message of broadcast by your own equipment.