CKESC UAVCAN Protocol 2.1

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catalogs

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1. Scope of application

1： This paper focuses on describing the protocols used by the ESCs to communicate with external devices.

2： Some functions are only available on ESCs configured with the appropriate hardware.

2. Nomenclature

Table 2-1 Document Terminology

nomenclature	explanation
ESC	electric speed controller 电子调速器
CAN	Controller Area Network 控制器局域网络同时是一种通讯协议。

3. Reference document

《CANBUS 规范 v2.0+中文版.pdf》

4. Protocol Definitions

4.1. UAVCAN protocols

UAVCAN Protocol based on standard CANBus 2.0B protocol, based on 29bit extended frame data frame,SamplePoint 87.5%.

4.1.1. Conceptual

1： Message frame - is a broadcast frame and all nodes are able to receive this message.

2： Service frame - is a non-broadcast frame that specifies the node ID and requires a service answer when the node sends a service request.

4.1.2. ID field

In the UAVCAN protocol, we only use the data frame defined in the CANBus, and all data is transmitted via the data frame; we define the data frame as follows We define the data frame in the following format：

Message frame

Field name	Priority					Message type ID												Service not message	Source node ID						
CAN ID bits	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Allowed values																						0	1...127						
CAN ID bytes	3					2								1								0							

Anonymous message frame

Field name	Priority					Discriminator								Lower bits of message type ID								Service not message	Source node ID						
CAN ID bits	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Allowed values																						0	0						
CAN ID bytes	3					2								1								0							

Service frame

Field name	Priority					Service type ID								Request not response	Destination node ID							Service not message	Source node ID						
CAN ID bits	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Allowed values															1...127							1	1...127						
CAN ID bytes	3					2								1								0							

Currently, only the Message frame and Service frame are used for the CAN bus communication application of the ESC, so the explanation of the Anonymous message frame will not be covered in the following.

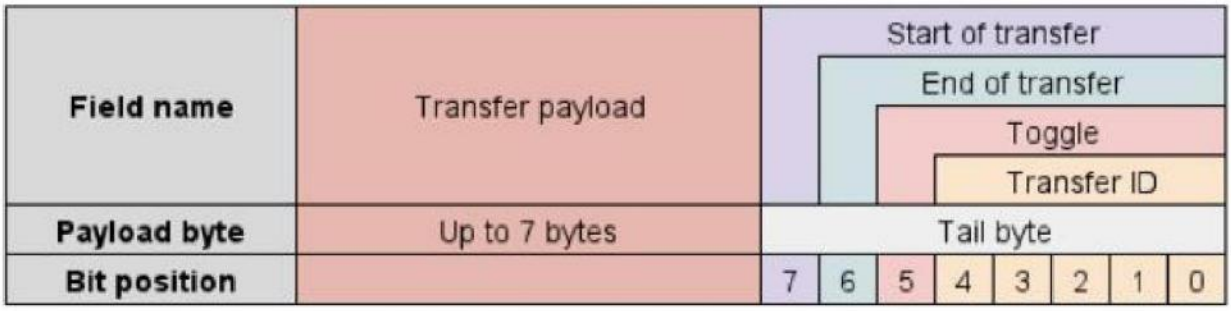
Bit Definition Terminology

<table>
<tr><th>bit definition</th><th colspan="4">explanation</th></tr>
<tr><td rowspan="6">Priority</td><td colspan="3" rowspan="6">1： Priority indicate CAN Data Frame Priority.
2： The range of priority values is 0~31.
3： The highest priority is 0， lower than 31.
4： HW-UAVCAN Define the priority as in the table on the right.</td><td>prioritization</td><td>numerical value</td></tr>
<tr><td>HIGHEST</td><td>0x00</td></tr>
<tr><td>HIGH</td><td>0x08</td></tr>
<tr><td>MEDIUM</td><td>0x10</td></tr>
<tr><td>LOW</td><td>0x18</td></tr>
<tr><td>LOWEST</td><td>0x1F</td></tr>
<tr><td>Message type ID</td><td colspan="4">The range of Message type ID is from 0 to 65535, including 0 and 65535.</td></tr>
<tr><td rowspan="2">Service not message</td><td rowspan="2">Indicates the type of this data frame</td><td>0</td><td colspan="2">Indicates that the data frame is a Message frame</td></tr>
<tr><td></td><td colspan="2">Indicates that the data frame is a Service frame</td></tr>
<tr><td rowspan="2">Request not response</td><td rowspan="2">Indicates whether the data frame is a request frame or an answer frame.</td><td>0</td><td colspan="2">Indicates that the frame is a Response frame</td></tr>
<tr><td></td><td colspan="2">Indicates that the frame is a Request frame</td></tr>
<tr><td>Node ID</td><td colspan="4">1： The Node ID consists of 7 bits, where 0 is the reserved ID, representing an unknown node.
2： Node ID takes values 1-127 and contains 1-127, where 126 and 127 are reserved IDs.
3： Node ID is divided into Source Node ID and Destination Node ID.
4： Source Node ID Indicates the node's own ID.
5： Destination Node ID Indicates the node ID of the other party.
6： Only Service frames will have a Destination Node ID and require an answer.</td></tr>
</table>

4.1.3. CAN Payload

CANBus2.0B specifies that the CAN bus transfers a maximum of 8 Bytes of data per frame. The UAVCAN protocol specifies that the 8 Byte Payload is divided into two parts, including the Transfer Payload and the Tail byte, as shown in the figure below:

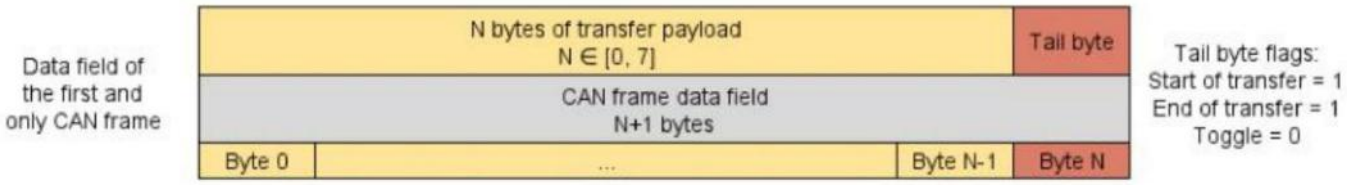
CAN payload



The valid data of some packets may exceed 7Byte, UAVCAN protocol stipulates that data frames not exceeding 7Byte should be transmitted in Single frame Transfer format, and data frames exceeding 7Byte should be transmitted in Multi frame Transfer format (this paper realizes all single frame, so it does not explain multi-frame in detail), the following is the definition of Single frame Transfer. The following is the definition of Single frame Transfer.

Single frame Transfer： Single-frame transfers are used to handle data streams with no more than 7 bytes of transmitted data.

Single frame transfer



Interpretation of nouns

noun	explanation
data frame	1： CAN is capable of transmitting a data stream of up to 8 bytes at a time.
datagram	1： A packet of data may contain multiple data frames, the number of frames being determined by the amount of data being transmitted.
Transfer Payload	1： Valid data transmitted per data frame, 0 to 7 bytes.
Tail byte	1： Last byte of Payload in each data frame, additional protocol layer field information.
Start of transfer	1： For single-frame transmissions, the transmission start bit is always 1. 2: For Multi frame transfer, this bit is 1 if the current frame is the first frame of the packet, and 0 otherwise.
End of transfer	1： For Single frame transfer, the bit bit End of transfer is always 1. 2： For Multi frame transfer, this bit is 1 if the current frame is the last frame of the packet and 0 otherwise.
Toggle bit	1： For Single frame transfer, the Toggle bit is always zero. 2： For Multi frame transfer, this bit is 0 for the first frame of the packet and is flipped once for each subsequent frame.
Transfer ID	1： The value range is 0 to 31. 2： For data with the same Data Type ID, for each packet of data sent, the Transfer ID is increased by 1, and 0~31 is added cyclically. 3： For multiple data frames in the same packet data, the value remains unchanged.

4.2. CAN ESC working mechanism

All ESCs are connected by CAN bus, and the connection methods are commonly used as T-topology and star topology; the input throttle can use PWM analog throttle or CAN digital throttle, and it can be set which one of the PWM throttle and CAN throttle is used first, such as setting the priority of PWM throttle, the PWM throttle will be used first, and when the PWM throttle is abnormal but the CAN throttle is normal, it will be switched to the CAN throttle automatically.

4.2.1. Functionality

- The ESC automatically self-tests when it is powered on, and the self-test status can be queried by sending the self-test query command.
- Supports electrical regulation point ID settings.
- Supports CAN bus rate setting.
- The data reporting rate is adjustable.
- Other functions depend on the specific ESC model.
- Analog-Digital Dual Throttle Inputs.

4.2.2. Bus Bandwidth

UAVCAN supports a variety of bus rate settings, which can be set according to the actual number of devices and wires, up to 1MHz.

4.3. List of data frame types

4.3.1. ID domain assignment

The Broadcast Frame ID value uses the Vendor Usage ID area[20000,21000) defined in UAVCAN.

The Service Frame ID value uses the Provider Usage ID area[200,256) defined in UAVCAN.

4.3.2. Data Frame Type Table

List of broadcast frame types				
Domain type	Frame Type	frame ID	prioritization	Data Frame Description Description
test message [20000, 20010)	Can Test	0x4E20 (20000)	LOWEST	ESC Timing of the totalization count data frame sent to the CAN bus, off by default.
ESC Global Commands [20010, 20050)	MSG Control	0x4E2A (20010)	MEDIUM	ESC plenary adjustment order to temporarily disable/resume data reporting
	FRAME_MSG_ GET_ESC_ID	0x4E2D (20013)	MEDIUM	Query ESC ID and Throttle Channel
Brushless Power News [20050, 20100)	MSG1	0x4E52 (20050)	LOWEST	ESC Report current ESC RPM, throttle, status data (You can turn off this reported data and replace it with MSG_EXP data.)
	MSG2	0x4E53 (20051)	LOWEST	ESC Reports current ESC voltage, current, and temperature data. (You can turn off this report and replace it with MSG_EXP data.)

	MSG3	0x4E54 (20052)	LOWEST	ESC Report the current ESC additional data (temperature). (You can turn off this report and replace it with MSG_EXP data.)
	MSG_EXP1	20053	LOWEST	Motor Speed,Supply Voltage,Operating Current,MOS Temperature
	MSG_EXP2	20054	LOWEST	Debugging Information
	MSG_EXP3	20055	LOWEST	
	MSG_EXP4	20056	LOWEST	
	MSG_EXP5	20057	LOWEST	
	MSG_EXP6	20058	LOWEST	
	MSG_EXP7	20059	LOWEST	Setting parameter information
	MSG_EXP8	20060	LOWEST	ESC operation information, number of power-ups, number of startups, number of normal shutdowns
	MSG_EXP9	20061	LOWEST	ESC operation information, accumulated operating time, error code 1
	MSG_EXP10	20062	LOWEST	ESC operation information, current operating time, error code 2
	MSG_EXP11	20063	LOWEST	Mos Temp, MCU Temp, Capacitor Temp, Motor Temp (Reserved)
	MSG_EXP12	20064	LOWEST	Temperature logging (reported only once after sending the readback logging command)
Brushless Power Command [20100, 20150)	14bit Throttle Command	0x4E84 (20100)	HIGHEST	ESC CAN Digital Throttle Command, 4-axis single package (Not recommended)
	12bit Throttle Command	0x4E85 (20101)	HIGHEST	ESC CAN Digital Throttle Command, Multi-axis Single/Multi-Packs(Recommended)
	10bit Throttle Command	0x4E86 (20102)	HIGHEST	ESC CAN Digital Throttle Commands, 6 Axis Single Pack (Tail Byte Extension Protocol)

List of service frame types				
Domain type	Frame Type	Frame ID	prioritization	Data Frame Description Description
Supplier orders [200, 210)				reservations
ESC Configuration [210, 240)	Set ID	0xD2 (210)	MEDIUM	Setting the ESC ID (pseudo-service frame, ESC power-up is valid for 120 seconds)
	Set Baud	0xD3 (211)	MEDIUM	Setting the CAN Bus Rate (ESC power-up valid for 120 seconds)
	Set Led	0xD4 (212)	LOW	Setting the LED color
	Set Rotor Direction	0xD5 (213)	LOW	Setting the motor steering
	Set Freq	0xD6 (214)	MEDIUM	Setting the MSG1 / MSG2 / MSG3 data reporting frequency
	Throttle	0xD7	MEDIUM	Throttle source selection: PWM throttle or PWM + CAN throttle

	Select	(215)		
	Self Test	0xD8 (216)	LOWEST	self-test command
	Expand Set cmd	222	MEDIUM	Extended Settings
	Get Rec cmd	223	MEDIUM	Getting Temperature Records
	Clear Rec cmd	224	MEDIUM	Clearing the temperature record (retention function)
ESC Information [240, 250)	ESC Information	0xF0 (240)		Get ESC version information
	Maintance Information	0xF1 (241)		Getting the runtime log
	Get Major Configuration	0xF2 (242)		Read the main configuration information
other than [250, 256)				reservations

4.4. Data frame type description

4.4.1. CAN Test(20000)

CAN Test transmitter frame

CAN frame	Option	Count	Tail byte
29bit message frame	payload[0]	payload[1~4]	payload[5]

CAN Test response frame

CAN frame	Option	Count	Tail byte
29bit message frame	payload[0]	payload[1~4]	payload[5]

Data Frame Parameter Interpretation

parameters	data type	descriptive
Option	uint8	0x00：Node ESC Use this value for timed reporting after bus test mode is turned on
		0xAA：Enable node ESC bus test mode
		0x55：Turn off node ESC bus test mode
Count	uint32	transmitter frame：0x00000000~0xFFFFFFFF arbitrary value
		response frame：Starting from the current internal count of ESC, add 1 for each frame sent.

clarification：

1：CAN Test is a bus communication quality test command, broadcast frame, user can test the actual CAN bus communication quality in this mode.

2：When the CAN Test mode is on, the ESC disables the active reporting of other data and sends a CAN Test data frame containing a 32-bit cumulative count from 0 to 0xFFFFFFFF, which is accumulated cyclically.

3：After CAN Test mode is turned on, send to turn CAN Test mode off and ESC returns to the state before CAN Test mode was turned on.

4：When CAN Test mode is turned on, it is only valid for this time, and is lost when power is dropped, and is turned off by default when ESC is re-powered;

4.4.2. MSG Control(20010)

MSG Control transmitter frame

CAN frame	Option	Count	Tail byte
29bit message frame	payload[0]	payload[1~4]	payload[5]

MSG Control response frame

CAN frame	Option	Count	Tail byte
29bit message frame	payload[0]	payload[1~4]	payload[5]

Data Frame Parameter Interpretation

parameters	data type	descriptive
Command **(Option=0)**	uint32	0x00000000： Answer packet after the ESC receives the command
		0x55555555： Temporary closure of active data reporting
		0xAAAAAAAA： Immediate recovery of active data reporting(MSG1,MSG2,MSG3)
		0xEEEEEEEE： Immediate recovery of active data reporting(MSGEXP1~MSGEXP12)

clarification：

1： MSG Control is a pause/resume active data upload command that broadcasts frames.

2： All ESCs on the bus respond to this command.

3： The Set Led color command, Set Rotation command, and parameter changes do not take effect when the active data reporting command is suspended! Settings can be made only after the active data reporting command is resumed!

4： When the ESC receives the command, it will answer, the answer time is related to the current ESC ID (ID%32), the maximum answer delay is 64ms.

4.4.3. FRAME_MSG_GET_ESC_ID (20013)

FRAME_MSG_GET_ESC_ID transmitter frame

CAN frame	Option	Tail byte
29bit message frame	payload[0]	payload[1]

MSG Control response frame

CAN frame	ESC node id	Throttle channel	Tail byte
29bit message frame	payload[0]	payload[1]	payload[2]

Data Frame Parameter Interpretation

Command **(Option=0)**	uint8	0x00： Query ESC ID and Throttle Channel

clarification：

1： FRAME_MSG_GET_ESC_ID The Query ESC ID and Throttle Channel commands are broadcast frames.

2： All ESCs on the bus respond to this command, and all ESCs send their own ESC IDs and throttle channels up when they receive the frame.

3： The Answer Data Frame Option is the same as the Send Data Frame Option.

4： When the ESC receives the command, it will answer, the answer time is related to the current ESC ID (ID%32), the maximum answer delay is 64ms.

4.4.4. MSG1(20050)

MSG1 Data reporting format

CAN frame	Speed_L	Speed_H	PWM_L	PWM_H	Status_L	Status_H	Tail byte
29bit message frame	payload[0]	payload[1]	payload[2]	payload[3]	payload[4]	payload[5]	payload[6]

Data Frame Parameter Interpretation

parameters	data type	descriptive
Speed	uint16	Motor speed(RPM)
PWM	uint16	0-2000(Throttle output PWM)
Status	uint16	ESC operation status

Status bitfield interpretation

Status							
Bit15	Bit14	Bit13	Bit12	Bit11	Bit10	Bit9	Bit8
directional symbol 0：CW 1：CCW	Throttle Signal Source 0 :CAN gas pedal 1 :PWM gas pedal	communication status 0:Communication is normal 1：Communication anomalies	1=phase sequence	1 = overvoltage	1 = overcurrent	1 = over-temperature	Run/Stop 0= Stop 1= Run
Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
1= Self-diagnostic COM port input low error	1 = self-test C phase Output low error	1 = self-test B phase Output low error	1 = self-test A phase Output low error	1= Self-test COM Port Input High Error	1 = self-test C phase Output high error	1 = self-test phase C Output high level error	1 = self-test A phase Output high error

clarification：

1 ： MSG1 data is the data that the ESC actively reports to the master node, and the valid data length is 6Byte.

2： Direction mark: The ESC will report the saved motor steering when it is powered on, please make sure that the three-phase motor wiring is consistent with the direction mark, because the three-phase motor wiring will change the motor steering 0: forward 1: reverse.

3 ： Communication status: If ESC does not receive any command from the host for more than 200ms under CAN throttle condition, it will set the communication exception; if the data is received and correct under the communication exception status, the communication will be resumed and this flag bit will be cleared.

4.4.5. MSG2(20051)

MSG2 Data reporting format

CAN frame	Voltage_L	Voltage_H	Current_L	Current_H	Temperature	Tail byte
29bit message frame	payload[0]	payload[1]	payload[2]	payload[3]	payload[4]	payload[5]

Data Frame Parameter Interpretation

parameters	data type	descriptive
Voltage	uint16	ESC input voltage, two decimal places (unit: V)

Current	uint16	Busbar current, two decimal places (unit: A)
Temperature	Uint8	Power MOS Temperature (Unit: ℃)

clarification：

1: MSG2 data is the data that the ESC actively reports to the master node, and the valid data length is 5 Byte.

2：The user adjusts the active reporting rate through **Set/Get Freq** according to specific usage requirements.

4.4.6. MSG3(20052)

MSG3 Data reporting format

CAN frame	MOS_T	CAP_T	Motor_T	MCU_T	Reserved	Tail byte
29bit message frame	payload[0]	payload[1]	payload[2]	payload[3]	payload[4,5,6]	payload[7]

Data Frame Parameter Interpretation

parameters	data type	descriptive
MOS_T	Uint8	ESC MOS Temperature (Unit: ℃)
CAP_T	Uint8	ESC Capacitor Temperature (Unit: ℃)
Motor_T	Uint8	Motor temperature (unit: ℃, need to configure motor temperature sensor)
MCU_T	Uint8	MCU Temperature (unit: ℃)

clarification：

1： MSG3 data is additional data that the ESC actively reports to the master node.

2： The user adjusts the active reporting rate through **Set/Get Freq** according to specific usage requirements.

4.4.7. MSG_EXP1(20053)

Data reporting format

CAN frame	Speed_L	Speed_H	Voltage_L	Voltage_H	Current_L	Current_H	Tail byte
29bit message frame	payload[0]	payload[1]	payload[2]	payload[3]	payload[4]	payload[5]	payload[6]

Data Frame Parameter Interpretation

Parameter	Data Type	Descripción
Speed	Uint16	Motor speed(RPM)
Voltage	Uint16	ESC input voltage, two decimal places (unit: V)
Current	Uint16	Busbar current, two decimal places (unit: A)

4.4.8. MSG_EXP2-6(20054-20058)

Data reporting format

CAN frame	Test_1	Test_2	Test_3	Test_4	Test_5	Test_6	Tail byte
29bit message frame	payload[0]	payload[1]	payload[2]	payload[3]	payload[4]	payload[5]	payload[6]

Data Frame Parameter Interpretation

Parameter	Data Type	Descripcion
Test_1-7	Uint16	Debugging data

4.4.9. MSG_EXP7(20059)

Data reporting format

CAN frame	Set_0	Set_1	Set_2	Set_3	Set_4	Set_5	Tail byte
29bit message frame	payload[0]	payload[1]	payload[2]	payload[3]	payload[4]	payload[5]	payload[6]

Data Frame Parameter Interpretation

Parameter	Data Type	Description
Set_0	Uint8	Bit3..0 Motor running direction : 1=Forward 2=Reverse
		Bit7..4 LED Setting 0=No light at all 1=Red light 2=Green light 3=Blue light
Set_1	Uint8	BIT3..0 communications interface 2=PWM_CAN 3=CAN
		BIT7..4 reservations留
Set_2	Uint8	BIT3..0 Active Continuity Control 0=off 1=on
		BIT4..4 Reserved (angle of approach setting 1)
Set_3	Uint8	BIT3..0 Reserved (angle of approach setting 2)
		BIT4..4 Reserved (load type setting)
Set_4	Uint8	BIT3..0 Pulp lock setting 0=No opening 1=Weak pulp lock 2=Medium pulp lock 3=Strong pulp lock
		BIT4..4 Startup acceleration setting 1-15 (the higher the value the shorter the startup time)
Set_5	Uint8	BIT3..0 Lost Signal Protection Setting 1-15 (the larger the value, the faster the lost signal throttle is reduced)
		BIT4..4 reservations

4.4.10. MSG_EXP8(20060)

Data reporting format

CAN frame	Times1_L	Times1_H	Times2_L	Times2_H	Times3_L	Times3_H	Tail byte
29bit message frame	payload[0]	payload[1]	payload[2]	payload[3]	payload[4]	payload[5]	payload[6]

Data Frame Parameter Interpretation

Parameter	Data Type	Descripcion
Times1	Uint16	ESC Number of power-ups
Times2	Uint16	ESC Number of activations
Times3	Uint16	ESC Number of shutdowns

4.4.11. MSG_EXP9(20061)

Data reporting format

CAN frame	Time_1	Time_2	Time_3	Time_4	Test_1	Test_2	Tail byte
29bit message frame	payload[0]	payload[1]	payload[2]	payload[3]	payload[4]	payload[5]	payload[6]

Data Frame Parameter Interpretation

Parameter	Data Type	Description
Time4..1	Uint32	ESC Cumulative running time

Test_2..1	Uint16	ESC Self-test fault code 1 (0 = power-up self-test normal)

4.4.12. MSG_EXP10(20062)

Data reporting format

CAN frame	Time_1	Time_2	Time_3	Time_4	Test_1	Test_2	Tail byte
29bit message frame	payload[0]	payload[1]	payload[2]	payload[3]	payload[4]	payload[5]	payload[6]

Data Frame Parameter Interpretation

Parameter	Data Type	Description
Time4..1	Uint32	ESC Time of this run
Test_2..1	Uint16	ESC Self-test fault code 2 (0 = power-up self-test normal)

4.4.13. MSG_EXP11(20063)

Data reporting format

CAN frame	MOS_T	MCU_T	CAP_T	Motor_T	res	res	Tail byte
29bit message frame	payload[0]	payload[1]	payload[2]	payload[3]	payload[4]	payload[5]	payload[6]

Data Frame Parameter Interpretation

Parameter	Data Type	Description
MOS_T	Uint8	ESC MOS Temperature (Unit: ℃)
MCU_T	Uint8	MCU Temperature (unit: ℃)
CAP_T	Uint8	ESC Capacitor Temperature (Unit: ℃)
Motor_T	Uint8	Motor temperature (unit: ℃, need to configure motor temperature sensor)
res	Uint8	reservations

4.4.14. MSG_EXP12(20064)

Data reporting format

CAN frame	Byte_0	Byte_1	Byte_2	Byte_3	Byte_4	Byte_5	Byte_6	Byte_7
29bit message frame	T_MAX	TIMES_L	TIMES_H	TIME1	TIME2	TIME3	TIME4	Tail byte

Data Frame Parameter Interpretation

Parameter	Data Type	Description	
T_MAX	Uint8	Record temperature max.	
TIMES	Uint16	Record the number of runs at the temperature maximum	
TIME4..1	Uint32	Recording of the running time at the temperature maximum	
Tail byte	Uint8	Parameter	Description
		0XC1	The current frame is the highest temperature recorded by the MCU
		0XC2	The current frame is the highest MOS temperature recorded
		0XC3	The current frame is the CAP maximum temperature record
		0XC4	The current frame is the highest MOTOR temperature recorded

		0XC5	reservations

4.4.15. RawCommand_14b(20100)

RawCommand Send frame (4-axis single frame, 14*4=56bit=7Byte effective byte)

CAN frame	Throttle Data[0-6]	Tail byte
29bit message frame	payload[0-6]	payload[7]

clarification：

1： RawCommand_14b Command to send a throttle as a broadcast frame without an answer, all ESCs on the bus receive and parse at the same time.

2: Each throttle channel occupies 14 bits and the value range is 0-16383, but the actual throttle range is 0-2000.

3：RawCommand_14b Data Sending Format Analysis (4-axis example)：

payload[6]	payload[5]	payload[4]	payload[3]	payload[2]	payload[1]	payload[0]
XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX

XXXXXXXXXXXX :Channel 1, XXXXXXXXXXXX :Channel 2, XXXXXXXXXXXX :Channel 3, XXXXXXXXXXXX :Channel 4

a： Suppose we need to send a digital throttle with a value of 1000 (0x03E8) to four channels

Pending data(HEX)： {3E8, 3E8, 3E8, 3E8}

memory format(HEX)： [E8, 03, E8, 03, E8, 03, E8, 03]

memory format(BIN)： [11101000, 00000011, 11101000, 00000011, 11101000, 00000011, 11101000, 00000011]

b： Converts the original 16 bits to 14 bits of throttle data when sending the throttle (removes the highest 2 bits of the original 16 bits of data).Original 16bit data：

HEX：[0xE8 0x03 0xE8 0x03 0xE8 0x03 0xE8 0x03]

BIN：[1110_1000_0000_0011_1110_1000_0000_0011_1110_1000_0000_0011_1110_1000_0000_0011]

Converted to 14 bits of data (remove the highest 2 bits of the original data high byte, such as the part marked in red).：

HEX：[1110_1000_0000_1111_1010_0000_0011_1110_1000_0000_1111_1010_0000_0011]

BIN： [0xE8 0x0F 0xA0 0x3E 0x80 0xFA 0x03]

Send digital throttle data：

Throttle Data[0-6]={ 0xE8， 0x0F， 0xA0， 0x3E， 0x80， 0xFA， 0x03}

4.This frame is only for 4-axis, the throttle channels are fixed to 1-4, and it is not recommended to use it.

4.4.16. RawCommand_12b(20101)

Multi-axis Send frame (multi-axis multi-frame, 7 Byte active bytes, 6 bytes throttle data + 1 byte throttle channel group ID)

CAN frame	Throttle Data[0-5]	Throttle Channel group ID	Tail byte
29bit message frame	payload[0-5]	payload[6]	payload[7]

clarification：

1： RawCommand_12b Command to send a throttle as a broadcast frame without an answer, all ESCs on the bus receive and parse it at the same time.

2： Each throttle channel occupies 12 bits and has a value range of 0-4095, but the actual throttle range is 0-2000.

3： Select the actual throttle channel according to the throttle channel group ID. ID range 1-5, can control up to 20 ESC throttles, the corresponding throttle channels are ID*4-3, ID*4-2, ID*4-1, ID*4, e.g. if ID=1, then the output throttle channels are 1,2,3,4, ID=2, then the output throttle channels are 5,6,7,8.

4：RawCommand_12b Explanation of data sending format

payload[6]	payload[5]	payload[4]	payload[3]	payload[2]	payload[1]	payload[0]
Group ID (1-5)	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX

XXXXXXXXXXXX :Channel 1,XXXXXXXXXXXX :Channel 2, XXXXXXXXXXXX :Channel 3, XXXXXXXXXXXX :Channel 4

payload[0] : The throttle output of the 1st throttle channel in the throttle channel group is 8 bits lower.

payload[1] : Throttle output of the 2nd throttle channel in the throttle channel group is 4 bits low + throttle output of the 1st throttle channel in the throttle channel group is 4 bits high..

payload[2] : The throttle output of the 2nd throttle channel in the throttle channel group is 8 bits higher.

payload[3] : The throttle output of the 3rd throttle channel in the throttle channel group is 8 bits lower.

payload[4] : Throttle output of the 4th throttle channel in the throttle channel group is 4 bits low + throttle output of the 3rd throttle channel in the throttle channel group is 4 bits high.

payload[5] : The throttle output of the 4th throttle channel in the throttle channel group is 8 bits higher.

payload[6] : Throttle Channel Group ID (1-5)

Six-axis demonstration frame :

payload[6]	payload[5]	payload[4]	payload[3]	payload[2]	payload[1]	payload[0]
1	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX

payload[6]	payload[5]	payload[4]	payload[3]	payload[2]	payload[1]	payload[0]
2	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX

XXXXXXXXXXXX :Channel 1, XXXXXXXXXXXX :Channel 2, XXXXXXXXXXXX :Channel 3, XXXXXXXXXXXX :Channel 4
XXXXXXXXXXXX :Channel 5, XXXXXXXXXXXX :Channel 6

5： This frame is suitable for multiple axes, and the throttle format is simple and recommended.

4.4.17. RawCommand_10b(20102)

6-axis Send frame (6-axis single frame, 8 Byte valid byte, Tail byte protocol extension)

CAN frame	Throttle Data[0-7]
29bit message frame	payload[0-7]

clarification：

1： RawCommand_10b Command to send a throttle as a broadcast frame without an answer, all ESCs on the bus receive and parse it at the same time.

2： Each throttle channel occupies 10bit, the value range is 0-1023, but the actual use of throttle range is 0-1000, ESC receives the oil X2, transformed to 0-2000 as the actual throttle output.

3： RawCommand_10b Data sending format analysis (the following table, the high 4 bits of payload[7] are invalid)

payload[7]	payload[6]	payload[5]	payload[4]	payload[3]	payload[2]	payload[1]	payload[0]
XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX

XXXXXXXXXXX :Channel 1, XXXXXXXXXXX :Channel 2, XXXXXXXXXXX :Channel 3, XXXXXXXXXXX :Channel 4, XXXXXXXXXXX :Channel 5, XXXXXXXXXXX :Channel 6

4： This frame is an extended protocol frame for 6-axis, which can reduce the amount of CAN bus data, and the throttle channels are fixed to 1-6, which can be used in different situations.

4.4.18. Set Id(210)

Set ID transmitter frame

CAN frame	ESC node id	Throttle channel	Tail byte
29bit message frame	payload[0]	payload[1]	payload[2]

Set ID response frame

CAN frame	ESC node id	Throttle channel	Tail byte
29bit message frame	payload[0]	payload[1]	payload[2]

Data Frame Parameter Interpretation

Parameter	Data Type	Description
ESC node id	uint8	Setting the node id of the CAN bus connected ESC (1~0x7D)
Throttle channel	uint8	Select the digital throttle channel used by the current node id

clarification：

1：Set Id is a command to set an ID for an ESC node, one ID for each ESC.

2： When this command is used to set the ESC ID, only one ESC can exist on the bus at the same time, and if more than one is connected, they will be uniformly set to the same ID.

3： When sending Set ID frame, since the ID of the ESC to be set is not clear, in order to avoid Destination Node Id polling for setting, the Set ID command is a pseudo-broadcast frame, and the Destination Node Id will be ignored when setting, and can be any value (0~0x7F).

4： The default ID is 0x7D. If the ID is set to 0x7D, data will not be reported actively, and if it is not 0x7D, data will be reported automatically on power-up.

5： ESC node id setting range is 1~0x7D (0, 0x7E, 0x7F are reserved ID, disabled).

6： Throttle channel Currently the protocol supports maximum 20 channels, this parameter indicates which throttle channel in Raw Command is used by the current node ESC (the digital throttle command Raw Command is a broadcast frame, all nodes in the CAN bus can receive the throttle data when it is sent. When node ESC receives the data, it selects the required throttle value according to the set Throttle channel value. e.g.: Throttle channel=0x01, it means that the current node ESC is using the throttle value of Raw Command channel 1.

7: This parameter will be saved in FLASH after setting and will not be lost when power is turned off, so the setting can be repeated.

8： Host ID is 0, source node id=0 for frames sent to ESC.

4.4.19. Set Baud(211)

Set Baud transmitter frame

CAN frame	Baud	Tail byte
29bit message frame	payload[0]	payload[1]

Set Baud response frame

CAN frame	Baud	Tail byte
29bit message frame	payload[0]	payload[1]

Data Frame Parameter Interpretation

Parameter	Data Type	Description

			Parameter	Description
Baud	uint8	CAN Bus Rate Setting	0	1Mbps
			1	**500kbps(default)**
			2	250kbps
			3	200kbps
			4	125kbps
			5	100kbps
			6	50kbps

clarification：

1： Sets the CAN bus rate, which takes effect after re-powering up.

2： Default bus rate is 500KHz, see the parameter table for other rates.

3： This parameter will be saved in FLASH after setting and will not be lost when power is turned off, so the setting can be repeated.

4.4.20. Set Led(212)

Set Led transmitter frame

CAN frame	Option	Color	Blink	Tail byte
29bit message frame	Payload[0]	Payload[1]	Payload[2]	Payload[3]

Set Led response frame

CAN frame	Option	Color	Blink	Tail byte
29bit message frame	Payload[0]	Payload[1]	Payload[2]	Payload[3]

Data Frame Parameter Interpretation

Parameter	Data Type	Description				
Option	uint8	Option bits, 0: do not save, 1: save				
Color	uint8	RGB LED Light Colors The lower three bits of Color are valid. bit [2]： R bit [1]： G bit [0]： B	R	G	B	descriptive
			0	**0**	**0**	RED+GREEN+BLUE OFF
			0	0	1	BLUE ON
			0	1	0	GREEN ON
			0	1	1	GREEN+BLUE ON
			1	0	0	RED ON
			1	0	1	RED+BLUE ON
			1	1	0	RED+GREEN ON
			1	1	1	RED+GREEN+BLUE ON
Blink	uint8	blinker control	parameters			描述
			0x00			non-flickering（default）
			0x01			1Hz flickers
			0x02			2Hz flickers
			0x05			5Hz flickers
			other			No operation is performed, no blinking.

clarification：

1： Set Led Color is a command that the master node sends to the ESC to set the color of the Led lamps.

2： Option is save, ESC will set Color and Blink as default color and save it, and update the color immediately; Option is no save, ESC will update the color immediately but not save the current setting parameters, and power down will restore the original setting.

3： Color is the color to be set, the lower 3Bit is valid, corresponds to the RGB light color, the default is green, see the parameter explanation Color.

4： Blink is a blink control, default is no blink, see parameter explanation Blink.

5: This parameter is saved in FLASH, not lost when power is turned off, and can be set repeatedly.

6: This command can only be set when data reporting is resumed (MSG Control command) and cannot be set when data reporting is suspended.

7: This command is only valid for ESC with LED.

4.4.21. Set Rotation(213)

Set Rotation transmitter frame

CAN frame	Baud	Tail byte
29bit message frame	payload[0]	payload[1]

Set Rotation response frame

CAN frame	Baud	Tail byte
29bit message frame	payload[0]	payload[1]

Data Frame Parameter Interpretation

Parameter	Data Type	Description		
			parameters	descriptive
Rotation	uint8	ESC Motor rotation direction setting	0x00	forward motion
			0x01	Inversions
			0xFF	Queries the current direction of rotation of the motor

clarification：

1： Set Rotation is a command sent from the master node to the ESC to set the direction of motor rotation.

2: This command can only be set when data reporting is on and the motor is stopped.

3: Default positive rotation, see parameter explanation for setting parameter commands.

4: This parameter will be saved in FLASH after setting and will not be lost when power is turned off, so the setting can be repeated.

4.4.22. Set/Get Freq(214)

Set/Get Freq transmitter frame

CAN frame	Option	MSG1_SET	MSG2_SET	MSG3_SET	Tail byte
29bit message frame	Payload[0]	Payload[1]	Payload[2]	Payload[3]	Payload[4]

Set/Get Freq response frame

CAN frame	Option	MSG1_SET	MSG2_SET	MSG3_SET	Tail byte
29bit message frame	Payload[0]	Payload[1]	Payload[2]	Payload[3]	Payload[4]

Data Frame Parameter Interpretation

Parameter	Data Type	Description
Option	uint8	Option bits, 0: read, 1: write
MSG1_SET	uint8	Data reporting type 1 Reporting interval (10-250)X2 ms
MSG2_SET	uint8	Data reporting type 2 Reporting interval (10-250)X2 ms
MSG3_SET	uint8	Data reporting type 3 Reporting interval (10-250)X2 ms

clarification：

1：Set Freq is a command that the master node sends to the ESC to set the data reporting frequency (time interval).

2：When Option is Read, ESC ignores the setting value in the transmit frame and the setting value in the answer frame is the current setting parameter of ESC.

3：When Option is Write, the setting value ranges from 10 to 250, and the setting is invalid if it is not legal.

4：MSG1_SET defaults to 10 , MSG2_SET defaults to 50 , and MSG1_SET defaults to 250 .

5：Setting the sending interval too small may cause the ESC throttle response to slow down, so try to set a larger sending interval if not necessary.

6：This parameter will be saved in FLASH after setting and will not be lost when power is turned off, so the setting can be repeated.

4.4.23. Throttle Select(215)

Throttle select transmitter frame

CAN frame	Throttle src	Tail byte
29bit message frame	payload[0]	payload[1]

Throttle select response frame

CAN frame	Throttle src	Tail byte
29bit message frame	payload[0]	payload[1]

Data Frame Parameter Interpretation

Parameter	Data type	Description		
Throttle src	uint8	Throttle mode selection	Parameter	Description
			0x00	CAN digital throttle
			0x01	PWM+CAN

clarification：

1：Throttle Select is a command sent by the flight control to select the throttle signal source and supports PWM +CAN and CAN digital throttles.

2：Default CAN digital throttle. The setup parameters are detailed in the parameter explanation.

3：To set this command, set it at zero throttle.

4：This parameter will be saved in FLASH after setting and will not be lost when power is turned off, so the setting can be repeated.

5：When the throttle control mode is set to CAN throttle, there are three kinds of control commands: 14bit, 12bti, and 10bit. The valid range of the 14bit and 12bit throttle commands is 0-2000, and the valid range of the 10bit throttle command is 0-1000 (the ESC receives the command and converts it to 0-2000 as the actual output).

6：PWM analog throttle input is 1ms-2ms (standard value, can be corrected), corresponding to 0-2000 CAN digital throttle, PWM analog throttle and CAN digital throttle input should be the same.When both PWM analog throttle and CAN digital throttle are input at the same time, the two throttle values should be the same.

4.4.24. Self Test(216)

Self Test transmitter frame

CAN frame	Tail byte

29bit message frame	payload[0]

Self Test response frame

CAN frame	Status	Tail byte
29bit message frame	payload[0]	payload[1]

Data Frame Parameter Interpretation

Parameter	Data Type	Description		
Status	uint8	autotest state	Parameter	Description
			0x00	Self-inspection passed
			0x01	Failed self-test

Description: 1 : Self Test is the command to query the self test status of ESC.

4.4.25. Expand Set Part(222)

Expand Set Part Send frame (no answer frame, the motor will beep when setting)

CAN frame	Set_cmd_L	Set_cmd_H	Part	Tail byte
29bit message frame	payload[0]	payload[1]	payload[2]	payload[3]

Data Frame Parameter Interpretation

Set_cmd	Part	functionality
0xfff0	01	forward motion
0xfff0	02	invert
0xfff1	00	turn off the light
0xfff1	01	red light
0xfff1	02	Green light on
0xfff1	03	blue light
0xfff2	01	PWM control (reserved)
0xfff2	02	PWM+TCAN control
0xfff2	03	TCAN control
0xfff2	04	DSHOT25 Control (reserved)
0xfff2	05	PWM+UAVCAN control
0xfff2	06	UAVCAN control
0xfff4	00	Synchronous Continuation Shutdown
0xfff4	01	Synchronized Continuous Flow On
0xfff5	01	Low to medium entry angle (reserved)
0xfff5	02	Center entry angle (reserved)
0xfff5	03	Medium-high angle of approach (reserved)
0xfff5	04	High angle of approach (reserved)
0xfff6	01	Low to medium entry angle 2 (reserved)
0xfff6	02	Center angle 2 (reserved)
0xfff6	03	03 Medium-high angle of approach 2 (reserved)

0xfff6	04	High angle of approach 2 (reserved)
0xfff7	01	Light load (reserved)
0xfff7	02	Standard load (reserved)
0xfff7	03	Overloading (reserved)
0xfff7	04	Overloading (reserved)
0xfff8	00	Slurry lock off
0xfff8	01	Locking slurry Weak
0xfff8	02	Locking slurry. - Medium.
0xfff8	03	Locking slurries Strong
0xfff9	0-15	Start-up acceleration (the larger the value the shorter the start-up time)
0xfffa	0-15	Lost Signal Throttle Reduction Speed (the larger the value, the faster the lost signal throttle reduction)
0xfffb	01	Read out high temperature records
0xfffc	0-6	Setting the CAN communication baud rate, 1M(0),500K,250K,200K,125K,100K,50K
0xfffe	00	Factory settings restored, not enabled
0xfffe	0x10	Turn off test mode
0xfffe	0x11	Turn on test mode for debugging

clarification：

1： Expand Set Part is required when the motor is stopped.

2： The ESC can be set using the General Setup Parameter command or this command.

4.4.26. ESC Information(240)

ESC Information transmitter frame

CAN frame	Option	Tail byte
29bit message frame	payload[0]=0	payload[1]

ESC Information response frame

CAN frame	Info_1	Info_2	Info_3	Info_4	Info_5	Info_6	Info_7	Tail byte
29bit message frame	Byte0	Byte1	Byte2	Byte3	Byte4	Byte5	Byte6	Byte7

Data Frame Parameter Interpretation：

Info_1 : esc Hardware information byte 1,esc Maximum voltage S number

Info_2 : esc Hardware information byte 2,esc Maximum current (X10A)

Info_3 : esc Hardware Information Byte 3,esc Hardware Version

Info_4 : esc The version of the protocol file used by the ESC

Info_5 : Firmware generation year

Info_6 : Month of firmware generation

Info_7 : Firmware generation date

4.4.27. Maintance Information(241)

Maintance Info transmitter frame

CAN frame	Option	Tail byte
29bit message frame	payload[0]	payload[1]

Get Maintance Info response frame

CAN frame	Info_1	Info_2	Info_3	Info_4	Info_5	Info_6	Info_7	Tail byte
29bit message frame	Byte0	Byte1	Byte2	Byte3	Byte4	Byte5	Byte6	Byte7

Data Frame Parameter Interpretation：

Option=0: Info_4 Info_3 Info_2 Info_1 = Accumulated Running Time(uint32 Unit:sec)
Info_5 = MOS Temperature Maximum (uint8)
Info_6 = Capacitor Temperature Maximum(uint8)

Option=1: Info_4 Info_3 Info_2 Info_1 = The current running time (uint32 unit: second)
Info_6 Info_5 = Number of runs (uint16)

Option=2: Info_2 Info_1 = Number of power-ups (uint16)
Info_4 Info_3 = Number of stops (uint16)
Info_6 Info_5 = Power-on self-test fault code (uint16 0 after normal power-on)
Info_7=Option

4.4.28. Get Major Configuration(242)

Get Major Configuration transmitter frame

CAN frame	Option	Tail byte
29bit message frame	payload[0]	payload[1]

Get Major Configuration response frame

CAN frame	Configuration	Tail byte
29bit message frame	payload[0-6]	payload[7]

Data Frame Parameter Interpretation

Parameter	Data Type		Description
Option	Payload[0]		Fixed to 0
Configuration **(Option=0)**	Payload[0]	Bit[7]	Motor rotation direction (0: forward, 1: reverse)
		Bit[6]	Throttle signal source (0: CAN digital throttle, 1: PWM + CAN throttle)
		Bit[5:0]	Set digital throttle channel
	Payload[1]	Bit[7:3]	LED flashing status
		Bit[2:0]	LED Static light color RGB
	Payload[2]	Bit[7:0]	MSG1 Data reporting interval (X2 ms)
	Payload[3]	Bit[7:0]	MSG2 Data reporting interval (X2 ms)
	Payload[4]	Bit[7:0]	MSG3 Data reporting interval (X2 ms)
	Payload[5]	Bit[7:0]	reservations
	Payload[6]	Bit[7:0]	reservations

Description:

1： Get Major Configuration is a data frame for the master node to quickly get the configuration information of the main parameters of the ESC.

2： Option Indicates the ESC type.

Attachment: Fault Code Definitions

Fault code 1:

0x01	Low com voltage during motor drive circuit test
0x02	High com voltage during motor drive circuit test
0x11	High A-phase test voltage during motor drive circuit test
0x12	High B-phase test voltage during motor drive circuit testing
0x13	High C-phase test voltage during motor drive circuit test
0x21	Motor Drive Circuit Test, Low Phase A Test Voltage
0x22	Motor Driver Circuit Test, Low Phase B Test Voltage
0x23	Motor Driver Circuit Test, Low Phase C Test Voltage

Error code 2: Not currently defined.