Software ICD

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Abbreviation list	
TCU	Turret Camera Unit
ECU	External Controller Unit
AZ	Azimuth
EL	Elevation
RO	Roll
IA	Inner Axis
OA	Outer Axis
HCU	Hand Control Unit
FOV	Field of View
INS	Inertial Navigation Solution
ECEF	Earth Centered Earth Fixed
LRF	Laser Range Finder
GPS	Global Positioning System
TOW	Time Of Week
UTC	Coordinated Universal Time
U8	Unsigned Integer 8-bit
U16	Unsigned Integer 16-bit
U32	Unsigned Integer 32-bit
S32	Signed Integer 32-bit
F32	IEEE 754 Floating point 32-bit
F64	IEEE 754 Floating point 64-bit

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1. System Description

1.1. Communication
This document is intended to define the communication protocol between the TCU and the ECU.

1.2. Interfaces
The communication protocol is available on any external serial port (RS422 or RS232) which is configured to utilize the 'TC Protocol'. External ports are configurable via the TC Menu System, under the 'Ext. Ports' page. By default, most external ports are setup to use this protocol.

In addition, this protocol is also available via TCP/IP or UDP connection on the Ethernet port. Multiple connections are allowed on the Ethernet port so that multiple devices can interact with the TCU. However, there are a few caveats:

- All Ethernet (TCP/IP and UDP) connections share streams (See Section 3)
- All Ethernet (TCP/IP and UDP) connections will receive any data transmitted from the TCU to any connection.
- If using version 10.9 or earlier, it is not possible to configure, start, stop or otherwise alter Stream Index #3 (See Section 3) when connected via Ethernet.

1.3. Serial communication
- Baud Rate: 115 200 (Default, configurable from 4800 to 115200)
- Data Bits: 8
- Parity: None
- Stop Bits: 1
- Handshaking/flow control: None

1.4. Ethernet Communication
- Ethernet Setup: Via Menu, Default is DHCP
- Fallback IP: 169.254.1.181/16
- TCP/IP Port: 51555
- UDP Port: 15555

Note: *To facilitate bidirectional communication, any IP/Port combination which transmits data to the gimbal's UDP connection on port 15555 will continue to receive data on the port used to establish the connection.*

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2. Protocol Information

2.1. Frame format

The commands and responses that are exchanged between the TCU and the ECU have variable size and follow the frame format shown below.

0	*1*	*2*	*3*	*4*	*5*	*6-…*	*6+SIZE*	*7+SIZE*
SYNC1	SYNC2	CLASS	CODE	SIZE	SIZE	DATA	CSUMA	CSUMB

SYNC1	U8	0xA7 – Fixed Synchronization Byte
SYNC2	U8	0x54 – Fixed Synchronization Byte
CLASS	U8	Message CLASS
CODE	U8	CODE that identifies type of message <u>within the CLASS</u>
SIZE	U16	Number of bytes in the 'Data' Section below. Format is Little-Endian
DATA		Data, all values shall be in Little-Endian format
CSUMA	U8	'A' byte of the Fletcher's Checksum
CSUMB	U8	'B' byte of the Fletcher's Checksum

2.2. Checksum

The checksum (CSUMA, CSUMB) consists of a Fletcher's Checksum computed starting at frame index 2 (CLASS), and continuing through the end of the data, both inclusive.

C-Code for computing the Fletcher's Checksum on a packet (pkt) with a data size of "size" is as follows:

```
U16 csuma = 0x00;
U16 csumb = 0x00;

for( int i = 2; i < 6+size; i++ )
{
      csuma = (csuma + pkt[i]) % 255;
      csumb = (csumb + csuma) % 255;
}
```

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2.3. Message CLASS & CODE

Each message CLASS has its own subset of message CODE's. The CODE is used to identify the type of message within each CLASS. See section 3 for more details. Please note that depending on the TCU configuration certain messages may not be available.

CLASS		CODE	
Streaming	0x05	Streaming Data Packet	0x01
		Streaming Start Packet	0x81
		Streaming Start Response Packet	0x82
		Streaming Stop Packet	0x89
		Streaming Stop Response Packet	0x8A
		Set Streaming Sample Time Packet	0x87
		Set Streaming Sample Time Response Packet	0x88
		Set Number of Stream Channels Packet	0x85
		Set Number of Stream Channels Response Packet	0x86
		Set Stream Channel Data Packet	0x83
		Set Stream Channel Data Response Packet	0x84
Database	0x01	Read Data Packet	0x03
		Read Data Response Packet	0x04
Gimbal	0x02	Set Rate AZ	0x02
		Set Rate EL	0x03
		Set Rate RO	0x04
		Set Mode	0x81
		Set Cage AZ	0x82
		Set Cage EL	0x83
		Set Cage RO	0x84
		Set Gyro Drift AZ	0x85
		Set Gyro Drift EL	0x86
		Set Gyro Drift RO	0x87
		Modify Rate Aid	0x91
		Toggle Stow Cage	0x93
		Adjust Cage	0x94
		Modify External Track	0x95
HCU	0x03	Set Joystick AZ	0x01
		Set Joystick EL	0x02
		Set Joystick RO	0x03
		Set Zoom	0x04
		Set Joystick Gain	0x05
		Set Focus	0x06
		Set Button Mask 1	0x08
		Set Button Mask 2	0x09
Geo	0x04	Set Ground Elevation (HAE)	0x01
		Setpoint ECEF	0x81
		Geo Track Command	0x8A
Sensor	0x81	Reserved	0x00
		Set Active Sensor	0x01
		Set Zoom	0x02
		Set Focus	0x03
		Set Image Exposure	0x04
		Set Image Enhancement	0x05
		Flat Field Correction Trigger	0x06
		Set Palette	0x07
		Set Filter	0x08
		Set Detector	0x09

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		Set Recording	0x0A
		Set LASER Mode	0x40
Video	0x82	Reserved	0x00
		Modify Tracking	0x01
		Modify Blending	0x02
		Modify MTI	0x03
		Video Recorder Control	0x04
		Video Streaming Control	0x05
		Modify CLAHE	0x06
		Video Track Data	0x07
		User Message	0x08
		Draw Calibration	0x83
Menu	0x83	Reserved	0x00
		Show	0x01
		Hide	0x02
		Navigate	0x03
External Device	0x84	Reserved	0x00
		Lamp Command	0x01
		Filter Command	0x02
		Lens Command	0x03
		Mode Command	0x04
		Rate Command	0x05
		Slave Position	0x06
		Request Status	0x07
		Status Response	0x80
Map	0x85	Video Window Command	0x01
		Draw Command	0x02
		Pin Command	0x03
		Display Command	0x04
		Capture Command	0x05
		Register Map Command	0x80
		Register Response	0x81
Error	0xFF	Unknown CLASS	0x01
		Unknown CODE	0x02

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2.4. Examples

2.4.1.1. Set Rate AZ

This example sets the gimbal azimuth rate to 0.5 radians per second. Send message to gimbal:

0	1	2	3	4	5	6	7	8	9	10	11
SYNC1	SYNC2	CLASS	CODE	SIZE	SIZE	DATA	DATA	DATA	DATA	CSUMA	CSUMB
0xA7	0x54	0x02	0x02	0x04	0x00	0x00	0x00	0x00	0x3F	0x47	0x75

2.4.1.2. Read Gimbal azimuth angle

This example reads the gimbals current azimuth angle by reading address ANGLE_AZ_OA from the database. Send message to gimbal:

0	1	2	3	4	5	6	7	8	9
SYNC1	SYNC2	CLASS	CODE	SIZE	SIZE	ADDR	ADDR	CSUMA	CSUMB
0xA7	0x54	0x01	0x03	0x02	0x00	0x09	0x18	0x27	0x47

Reply message from gimbal, azimuth angle is 0 radians in this example:

0	1	2	3	4	5	6	7	8	9	10	11	12	13
SYNC1	SYNC2	CLASS	CODE	SIZE	SIZE	ADDR	ADDR	DATA	DATA	DATA	DATA	CSUMA	CSUMB
0xA7	0x54	0x01	0x04	0x06	0x00	0x09	0x18	0x00	0x00	0x00	0x00	0x2C	0x0D

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3. TCU Communication

3.1. Streaming CLASS 0x05

The user may setup data streaming to periodically receive database values without having to poll for them. The user may create up to 4 streams with individual streaming frequencies. For example: Stream index 0 could be streamed with 10 Hz while stream index 1 is streamed with 1 Hz. Each stream may contain up to 32 channels of data. Max streaming frequency and amount of data is limited by the baud rate.

To configure a data stream, follow these steps (examples included).

1. Set streaming sample time (CLASS 0x05, CODE 0x87)

   Example: Configure Stream Index 0 for 1 Hz (Period = 5000)

0	1	2	3	4	5	6	7	8	9	10	11	12
SYNC1	SYNC2	CLASS	CODE	SIZE	SIZE	INDEX	TIME	TIME	TIME	TIME	CSUMA	CSUMB
0xA7	0x54	0x05	0x87	0x05	0x00	0x00	0x88	0x13	0x00	0x00	0x2D	0xE7

   Response (Echoes back new configuration):

0	1	2	3	4	5	6	7	8	9	10	11	12
SYNC1	SYNC2	CLASS	CODE	SIZE	SIZE	INDEX	TIME	TIME	TIME	TIME	CSUMA	CSUMB
0xA7	0x54	0x05	0x88	0x05	0x00	0x00	0x88	0x13	0x00	0x00	0x2E	0xEF

2. Set number of channels to be streamed (CLASS 0x05, CODE 0x85)

   Example: Configure Stream 0 to contain 2 channels

0	1	2	3	4	5	6	7	8	9	10	11	12
SYNC1	SYNC2	CLASS	CODE	SIZE	SIZE	INDEX	#CH	#CH	#CH	#CH	CSUMA	CSUMB
0xA7	0x54	0x05	0x85	0x05	0x00	0x00	0x02	0x00	0x00	0x00	0x91	0x84

   Response (Echoes back new configuration):

0	1	2	3	4	5	6	7	8	9	10	11	12
SYNC1	SYNC2	CLASS	CODE	SIZE	SIZE	INDEX	#CH	#CH	#CH	#CH	CSUMA	CSUMB
0xA7	0x54	0x05	0x86	0x05	0x00	0x00	0x02	0x00	0x00	0x00	0x92	0x8C

3. Configure channel data to be streamed (CLASS 0x05, CODE 0x83)

   Example: Configure Channel 0 = 0x1809, Channel 1 = 0x180A (AZ & EL Outer Angles)

0	1	2	3	4	5	6	7	8	9	10	11
SYNC1	SYNC2	CLASS	CODE	SIZE	SIZE	INDEX	CH	ADDR	ADDR	CSUMA	CSUMB
0xA7	0x54	0x05	0x83	0x04	0x00	0x00	0x00	0x09	0x18	0xAD	0x03

0	1	2	3	4	5	6	7	8	9	10	11
SYNC1	SYNC2	CLASS	CODE	SIZE	SIZE	INDEX	CH	ADDR	ADDR	CSUMA	CSUMB
0xA7	0x54	0x05	0x83	0x04	0x00	0x00	0x01	0x0A	0x18	0xAF	0x08

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Response (Echoes back new configuration):

0	1	2	3	4	5	6	7	8	9	10	11
SYNC1	*SYNC2*	*CLASS*	*CODE*	*SIZE*	*SIZE*	*INDEX*	*CH*	*ADDR*	*ADDR*	*CSUMA*	*CSUMB*
0xA7	0x54	0x05	0x84	0x04	0x00	0x00	0x00	0x09	0x18	0xAE	0x0A

0	1	2	3	4	5	6	7	8	9	10	11
SYNC1	*SYNC2*	*CLASS*	*CODE*	*SIZE*	*SIZE*	*INDEX*	*CH*	*ADDR*	*ADDR*	*CSUMA*	*CSUMB*
0xA7	0x54	0x05	0x84	0x04	0x00	0x00	0x01	0x0A	0x18	0xB0	0x0F

4. Start the streaming (CLASS 0x05, CODE 0x81)

   Example: Start Stream on Index 0

0	1	2	3	4	5	6	7	8
SYNC1	*SYNC2*	*CLASS*	*CODE*	*SIZE*	*SIZE*	*INDEX*	*CSUMA*	*CSUMB*
0xA7	0x54	0x05	0x81	0x01	0x00	0x00	0x87	0x22

   Response (Acknowledges start):

0	1	2	3	4	5	6	7	8
SYNC1	*SYNC2*	*CLASS*	*CODE*	*SIZE*	*SIZE*	*INDEX*	*CSUMA*	*CSUMB*
0xA7	0x54	0x05	0x82	0x01	0x00	0x00	0x88	0x26

The system will begin transmitting streaming data for both channels at 1 Hz.

Example:

0	1	2	3	4	5	6	7	8	9	10
SYNC1	*SYNC2*	*CLASS*	*CODE*	*SIZE*	*SIZE*	*INDEX*	*CH0*	*CH0*	*CH0*	*CH0*
0xA7	0x54	0x05	0x01	0x09	0x00	0x00	0xE0	0xBA	0x13	0x40

11	12	13	14	16	17
CH1	*CH1*	*CH1*	*CH1*	*CSUMA*	*CSUMB*
0x6D	0xF9	0x6B	0x3E	0x0F	0x3F

CH0 contains a floating-point value in radians of approximately 2.308. This represents the azimuth angle (132.3 degrees).

CH1 contains a floating-point value in radians of approximately 0.23. This represents the elevation angle (13.2 degrees).

To stop the streaming use CLASS 0x05, CODE 0x89.

The sections below detail the various streaming commands and responses.

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3.1.1. Streaming Data Packet

The streaming data package contains the stream data and index from the TCU. The size of the data payload will be 4 bytes for each channel configured for streaming. The data is placed into the packet from Channel Index 0 to the final channel.

CLASS: 0x05
CODE: 0x01
SIZE: Variable (1 + (Channels * 4))

Data	Data Index	Description	Comment
U8	0	Stream index	Range 0x00 to 0x03
U32/F32	1-4	Data channel 0	Data is depending on user setup.
…	…	…	…
U32/F32	4*N+1 to 4*N+4	Data channel "N"	Data is depending on user setup.

3.1.2. Streaming Start Packet

Sending this packet will initiate streaming, as configured, on the specified stream index. In addition, it will generate the 'Streaming Start Response' packet.

CLASS: 0x05
CODE: 0x81
SIZE: 0x01

Data	Data Index	Description	Comment
U8	0	Stream index	Range 0x00 to 0x03

3.1.3. Streaming Start Response Packet

This is packet sent in response to a 'Streaming Start' packet.

CLASS: 0x05
CODE: 0x82
SIZE: 0x01

Data	Data Index	Description	Comment
U8	0	Stream index	Range 0x00 to 0x03

3.1.4. Streaming Stop Packet

Sending this packet will stop streaming the specified stream index. In addition, it will generate a 'Streaming Stop Response' packet.

CLASS: 0x05
CODE: 0x89
SIZE: 0x01

Data	Data Index	Description	Comment
U8	0	Stream index	Range 0x00 to 0x03

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3.1.5. Streaming Stop Response Packet

This packet is sent by the TCU in response to a 'Streaming Stop' packet.

CLASS: 0x05
CODE: 0x8A
SIZE: 0x01

Data	Data Index	Description	Comment
U8	0	Stream index	Range 0x00 to 0x03

3.1.6. Set Streaming Sample Time Packet

Set the sample time on the specified stream index. Sending this packet will also generate a 'Set Streaming Sample Time Response' packet.

CLASS: 0x05
CODE: 0x87
SIZE: 0x05

Data	Data Index	Description	Comment
U8	0	Stream index	Range 0x00 to 0x03
U32	1-4	Sample Time	Sample Time = X * 0.2ms Example: 5000 * 0.2ms => 1Hz 500 * 0.2ms => 10Hz

3.1.7. Set Streaming Sample Time Response Packet

This packet is sent by the TCU in response to a Set Streaming Sample Time packet.

CLASS: 0x05
CODE: 0x88
SIZE: 0x05

Data	Data Index	Description	Comment
U8	0	Stream index	Range 0x00 to 0x03
U32	1-4	Sample Time	Sample Time = X * 0.2ms

3.1.8. Set Number of Stream Channels Packet

Set number of data channels to be streamed on the specified stream index. This packet will also generate the 'Set Number of Stream Channels Response' packet.

CLASS: 0x05
CODE: 0x85
SIZE: 0x05

Data	Data Index	Description	Comment
U8	0	Stream index	Range 0x00 to 0x03
U32	1-4	Number of Channels	Maximum Channels is 32

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3.1.9. Set Number of Stream Channels Response Packet

This packet is sent by the TCU in response to a Set Number of Stream Channels packet.

CLASS: 0x05
CODE: 0x86
SIZE: 0x05

Data	Data Index	Description	Comment
U8	0	Stream index	Range 0x00 to 0x03
U32	1-4	Number of Channels	The number of channels to stream

3.1.10. Set Stream Channel Data Packet

Set the data that shall be streamed on the specified stream and channel index. This packet should be sent for each channel to specify which data is placed in each channel. This packet will also generate the 'Set Stream Channel Data Response' packet.

CLASS: 0x05
CODE: 0x83
SIZE: 0x04

Data	Data Index	Description	Comment
U8	0	Stream index	Range 0 to 3
U8	1	Channel Index	The channel index is a stream position from 0x00 to 0x1F (31)
U16	2-3	Data Address	See TCU Data Address

3.1.11. Set Stream Channel Data Response Packet

This packet is sent by the TCU in response to a Set Stream Channel Data packet.

CLASS: 0x05
CODE: 0x84
SIZE: 0x04

Data	Data Index	Description	Comment
U8	0	Stream index	Range 0x00 to 0x03
U8	1	Channel Index	The channel index is a stream position from 0x00 to 0x1F (31)
U16	2-3	Data Address	See TCU Data Address

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3.2. Database CLASS 0x01

3.2.1. Read Data Packet

This packet should be sent to request a value of a given address in the database. The request will generate the 'Read Data Response' packet.

CLASS: 0x01
CODE: 0x03
SIZE: 0x02

Data	Data Index	Description	Comment
U16	0-1	Address	See TCU Data Address

3.2.2. Read Data Response Packet

This packet is generated as a response to the 'Read Data' packet. It contains the value for the requested address.

CLASS: 0x01
CODE: 0x04
SIZE: 0x06

Data	Data Index	Description	Comment
U16	0-1	Address	See TCU Data Address
U32/F32	2-5	Value	The value for the given address

3.2.3. TCU Database Addresses

Gimbal	Address	Description		Data type
Serial Number	0x07F9	The gimbal serial number		U32
Mode	0x0800	Rate	0	U32
		Cage	1	
		Stow	2	
		Geo Point	3	
LRF Shot Counter	0x0CB2	Total number of LRF shots (where available)		U32
System Temperature	0x1802	Temperature (C) inside the TCU		F32
Relative Humidity	0x1804	Relative Humidity level (%) inside the TCU		F32
Angle AZ OA	0x1809	Angle in radians		F32
Angle EL OA	0x180A			F32
Angle RO OA	0x180D			F32
Angular Rate AZ OA	0x180E	Angular rate in radians per second		F32
Angular Rate EL OA	0x180F			F32
Angular Rate RO OA	0x1812			F32

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Orientation W	0x183B	Gimbal IA orientation relative to the vehicle frame expressed as Quaternion	F32
Orientation X	0x183C		F32
Orientation Y	0x183D		F32
Orientation Z	0x183E		F32

INS	Address	Description			Data type
Status	0x0801	No GPS 0			U32
		Searching for Satellites 1			
		GPS Position 2			
		INS Solution Good 3			
Navigation Status	0x0824	BIT 0	0 = NO GPS		U32
		BIT 1	1 = Searching		
			2 = GPS Position OK		
			3 = INS Solution OK		
		BIT 8	Fixed Position Mode		
TCU Position ECEF X	0x1813	Gimbal IA position relative the ECEF-frame in meters			F32
TCU Position ECEF Y	0x1814				F32
TCU Position ECEF Z	0x1815				F32
TCU Velocity ECEF X	0x1819	Gimbal IA velocity relative the ECEF-frame in meters per second			F32
TCU Velocity ECEF Y	0x181A				F32
TCU Velocity ECEF Z	0x181B				F32
TCU Attitude ECEF W	0x1825	Gimbal IA attitude relative the ECEF-frame expressed as Quaternion			F32
TCU Attitude ECEF X	0x1826				F32
TCU Attitude ECEF Y	0x1827				F32
TCU Attitude ECEF Z	0x1828				F32

Geo Pointing	Address	Description	Data type
Setpoint ECEF X	0x1851	Current setpoint relative the ECEF-frame	F32
Setpoint ECEF Y	0x1852		F32
Setpoint ECEF Z	0x1853		F32

Geo Location	Address	Description	Data type
Status	0x0819	Invalid 0	U32
		Valid 1	
ECEF X	0x1845	Current geo location (LOS intersect with ground) relative the ECEF-frame in meters.	F32
ECEF Y	0x1846		F32
ECEF Z	0x1847		F32

Time	Address	Description	Data type
GPS Week	0x081A		U32
GPS TOW millisecond	0x081B		U32
GPS TOW submilliseconds	0x081C		U32
GPS Leap seconds	0x081D	Offset from UTC	U32

HCU	Address	Description	Data type
Joystick AZ	0x080F	*Obsolete*	F32
Joystick EL	0x0810	*Obsolete*	F32

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Zoom	0x0811	Rate / *Obsolete*	F32
Joystick Gain	0x0812	*Obsolete*	F32
Joystick Roll	0x0813	*Obsolete*	F32
Focus	0x0815	*Obsolete*	S32
Button Mask 1	0x0817	Button Status on HCU / *Obsolete*	U32
Button Mask 2	0x0818	Button Status on HCU / *Obsolete*	U32

Video	Address	Description	Data type
Selected sensor index	0x1001	0xA1 = Sensor #1 (TV) 0xA2 = Sensor #2 (IR) 0xA3 = Sensor #3	U32
Number of Cameras	0x1000		U32

Sensor 1 (TV)	Address	Description	Data type
Horizontal FOV	0x1100	Degrees	F32
Digital Zoom Ratio	0x1101	Ratio from x1.0 up to sensor max ratio	F32
Max horizontal FOV	0x1102	Degrees	F32
Min horizontal FOV	0x1103	Degrees	F32
Horizontal Display Ratio	0x110B	Ratio of HFOV on processed video	F32
EX Digital Zoom Ratio	0x110E	Additional digital zoom applied prior to display. Values < 1.0 should be ignored.	F32

Sensor 2 (IR)	Address	Description	Data type
Horizontal FOV	0x1200	Degrees	F32
Digital Zoom Ratio	0x1201	Ratio from x1.0 up to sensor max ratio	F32
Max horizontal FOV	0x1202	Degrees	F32
Min horizontal FOV	0x1203	Degrees	F32
Horizontal Display Ratio	0x120B	Ratio of HFOV on processed video	F32
EX Digital Zoom Ratio	0x120E	Additional digital zoom applied prior to display. Values < 1.0 should be ignored.	F32

Sensor 3	Address	Description	Data type
Horizontal FOV	0x1400	Degrees	F32
Digital Zoom Ratio	0x1401	Ratio from x1.0 up to sensor max ratio	F32
Max horizontal FOV	0x1402	Degrees	F32
Min horizontal FOV	0x1403	Degrees	F32
Horizontal Display Ratio	0x140B	Ratio of HFOV on processed video	F32
EX Digital Zoom Ratio	0x140E	Additional digital zoom applied prior to display. Values < 1.0 should be ignored.	F32

Sensor LRF	Address	Description		Data type
Status Bitmask 1	0x1300	BIT0	1=Laser On, 0= Laser Off	U32
		BIT1	Toggles when Range is updated	
		BIT2	1=Error, 0=No error	
		BIT3	1=Last shot was a 'one-shot'	
		BIT4	1=Armed, 0=Not armed	
		BIT5	1=Valid, 0=Not valid	
		BIT6	1=Inhibit by fire zone, 0=No inhibit	
Range	0x1301	Last measured range in meters		U32
Range Correction	0x1302	Last measured range correction in millimeters [±999]		I32

Specifications and information are subject to change without notice.
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Video Tracker	Address	Description		Data type
Tracker Status Bitmask	0x0805	BIT0	1 = Track Active, 0 = Inactive	U32
		BIT1	1 = Coasting, 0 = Not Coasting	
Tracker Confidence	0x0827	0.0 – 100.0%, Track Quality		F32
Tracker Error (AZ)	0x0825	Tracker AZ error from center, Radians		F32
Tracker Error (EL)	0x0826	Tracker EL error from center, Radians		F32

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3.3. Gimbal CLASS 0x02

3.3.1. Set Rate AZ

Set Mode (CLASS 0x02, CODE 0x81) to Rate (0) for this command to have effect.

CLASS: 0x02
CODE: 0x02
SIZE: 0x04

Data	Data Index	Description	Comment
F32	0-3	Value	Angular rate in radians per second

3.3.2. Set Rate EL

Set Mode (CLASS 0x02, CODE 0x81) to Rate (0) for this command to have effect.

CLASS: 0x02
CODE: 0x03
SIZE: 0x04

Data	Data Index	Description	Comment
F32	0-3	Value	Angular rate in radians per second

3.3.3. Set Rate RO

Set Mode (CLASS 0x02, CODE 0x81) to Rate (0) for this command to have effect.

CLASS: 0x02
CODE: 0x04
SIZE: 0x04

Data	Data Index	Description	Comment
F32	0-3	Value	Angular rate in radians per second

3.3.4. Set Mode

CLASS: 0x02
CODE: 0x81
SIZE: 0x01

Data	Data Index	Description		Comment
U8	0	Rate	0x00	
		Cage	0x01	
		Stow	0x02	
		Geo Point	0x03	

3.3.5. Set Cage AZ

CLASS: 0x02
CODE: 0x82
SIZE: 0x04

Data	Data Index	Description	Comment
F32	0-3	Value	Cage angle in radians

Specifications and information are subject to change without notice.
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3.3.6. Set Cage EL

CLASS: 0x02
CODE: 0x83
SIZE: 0x04

Data	Data Index	Description	Comment
F32	0-3	Value	Cage angle in radians

3.3.7. Set Cage RO

CLASS: 0x02
CODE: 0x84
SIZE: 0x04

Data	Data Index	Description	Comment
F32	0-3	Value	Cage angle in radians

3.3.8. Set Gyro Drift AZ

CLASS: 0x02
CODE: 0x85
SIZE: 0x04

Data	Data Index	Description	Comment
F32	0-3	Value	Gyro bias value in radians per second

3.3.9. Set Gyro Drift EL

CLASS: 0x02
CODE: 0x86
SIZE: 0x04

Data	Data Index	Description	Comment
F32	0-3	Value	Gyro bias value in radians per second

3.3.10. Set Gyro Drift RO

CLASS: 0x02
CODE: 0x87
SIZE: 0x04

Data	Data Index	Description	Comment
F32	0-3	Value	Gyro bias value in radians per second

3.3.11. Set Gyro Drift (All)

CLASS: 0x02
CODE: 0x88
SIZE: 0x0C (12)

Data	Data Index	Description	Comment
F32	0-3	Azimuth Adjustment	AZ bias adjustment in radians/second
F32	4-7	Elevation Adjustment	EL bias adjustment in radians/second
F32	8-11	Roll Adjustment	RO bias adjustment in radians/second

Specifications and information are subject to change without notice.
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3.3.12. Modify Rate Aid

Rate-Aid is used to provide a constant angular rate to the gimbal's axes. With Rate Aid enabled, the zero-rate input (e.g. with joystick centred) is biased by some constant rate. This can be used in Gimbal Modes of 'Geo Point' or 'Rate'.

This mode is useful for tracking objects that are traveling at a relatively constant speed and direction, such as vehicles moving along straight roads.

CLASS: 0x02
CODE: 0x91
SIZE: 0x01

Data	Data Index	Description		Comment
U8	0	Reserved	0x00	No Action, reserved value
		Enable	0x01	Enables Rate Aid Mode, or resets bias to current rate if already enabled.
		Disable	0x02	Disables Rate Aid Mode
		Toggle Rate Aid	0x03	If in Rate Aid mode, then disable it, otherwise enter Rate Aid

3.3.13. Toggle Stow / Cage

CLASS: 0x02
CODE: 0x93
SIZE: 0x00

This is a zero-length command that will move the system between states using the following logic:
If the system is currently in the Stow mode, it will move to Cage. From any other mode, it will go to Stow.

3.3.14. Cage Adjust

CLASS: 0x02
CODE: 0x94
SIZE: 0x0D (13)

Data	Data Index	Description	Comment
U8	0	Mode	0x00 = RESERVED 0x01 = RADIANS 0x02 = FOV_RATIO
F32	1-4	Azimuth Adjustment	Units depend on mode
F32	5-8	Elevation Adjustment	Units depend on mode
F32	9-12	Roll Adjustment	Units depend on mode

This command will adjust the cage position by the given amount in all three axes. If the mode is specified as RADIANS, the adjustments will be an offset from the current cage position, in radians.

If the mode is specified as FOV_RATIO, the adjustments will be an offset in multiples of the active sensor's displayed field of view. Example a 0.1 FOV offset will result in nudging cage position by 1/10th of the active sensors current displayed FOV. This does not apply to the Roll axis adjustment; it will default to radians.

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3.3.15. Modify External Track

This command is used to modify the external track cursor, for example when using radar bearing handoff.

CLASS: 0x02
CODE: 0x95
SIZE: 0x01

Data	Data Index	Description	Comment
U8	0	Command	0x00 = RESERVED 0x01 = Start or Advance 0x02 = Stop

The 'Start or Advance' command will enable the external tracking if available and disabled. If already enabled, this command will instead cause the track cursor to be incremented to the next available source.
The stop command will exit external tracking mode, returning control to the user.

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3.4. HCU CLASS 0x03

Input from a HCU may be provided to TCU. The purpose is to give the user a possibility to connect their own custom HCU or simulate an HCU.

3.4.1. Set Joystick AZ

The joystick input range is -1.0 to +1.0. To stop gimbal set to 0. See Operators manual for more details.

Note: This message is obsolete. Support will be dropped in future versions.
Please use 'Set Joystick Rates' for new implementations.

CLASS: 0x03
CODE: 0x01
SIZE: 0x04

Data	Data Index	Description	Comment
F32	0-3	Value	

3.4.2. Set Joystick EL

The joystick input range is -1.0 to +1.0. To stop gimbal set to 0. See Operators manual for more details.

Note: This message is obsolete. Support will be dropped in future versions. Please use 'Set Joystick Rates' for new implementations.

CLASS: 0x03
CODE: 0x02
SIZE: 0x04

Data	Data Index	Description	Comment
F32	0-3	Value	

3.4.3. Set Joystick RO

The joystick input range is -1.0 to +1.0. To stop gimbal set to 0. See Operators manual for more details.

Note: This message is obsolete. Support will be dropped in future versions. Please use 'Set Joystick Rates' for new implementations.

CLASS: 0x03
CODE: 0x03
SIZE: 0x04

Data	Data Index	Description	Comment
F32	0-3	Value	

Specifications and information are subject to change without notice.
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3.4.4. Set Zoom

The zoom input range is -1.0 to +1.0. To stop zooming set to 0. See Operators manual for more details.

Note: This message is obsolete. Support will be dropped in future versions. Please use Sensor, Set Zoom for new implementations.

CLASS: 0x03
CODE: 0x04
SIZE: 0x04

Data	Data Index	Description	Comment
F32	0-3	Value	

3.4.5. Set Joystick Gain

The joystick gain input range is -1.0 to +1.0. See Operators manual for more details.

Note: This message is obsolete. Support will be dropped in future versions.
Please use 'Set Joystick Rates' for new implementations.

CLASS: 0x03
CODE: 0x05
SIZE: 0x04

Data	Data Index	Description	Comment
F32	0-3	Value	

3.4.6. Set Focus

Focus absolute position. Set this to 0 as an initial value, then increase/decrease from it. See Operators manual for more details.

Note: This message is obsolete. Support will be dropped in future versions. Please use 'Sensor, Set Focus for new implementations.

CLASS: 0x03
CODE: 0x06
SIZE: 0x04

Data	Data Index	Description	Comment
S32	0-3	Value	

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3.4.7. BUTTON MASK's

Set to 0 as an initial value.
Bit = 1 the button is regarded as pressed.
Bit = 0 the button is regarded as released.
Only the 8 lower bits of the U32 bitmask is used.

To simulate a momentary button-press first write the bit to 1 and then to 0. The recommended interval between a button press and release is 100 milliseconds. For a description of what each button does see the Operators manual. For some functions a combination of several bits must be set to 1.

Note: This message is obsolete. Support will be dropped in future versions. Please use appropriate sensor or gimbal commands instead.

3.4.7.1. Set Button Mask 1
CLASS: 0x03
CODE: 0x08
SIZE: 0x04

Data	Data Index	Description		Comment
		BUTTON	**BIT**	
U32	0-3	V-TRK	0	
		VIDEO	1	
		CUST	2	
		FOCUS KNOB	3	
		F-TRK	4	
		MODE	5	
		F2	6	
		F1	7	
		RADAR	8	

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3.4.7.2. Set Button Mask 2

CLASS: 0x03
CODE: 0x09
SIZE: 0x04

Data	Data Index	Description		Comment
		BUTTON	**BIT**	
U32	0-3	RECORDER-CTRL	0	
		MENU	1	
		G-TRK	2	
		OK	3	
		RIGHT	4	
		LEFT	5	
		DOWN	6	
		UP	7	

Note: This message is obsolete. Support will be dropped in future versions.
Please use appropriate sensor or gimbal commands instead.

3.4.8. Set Joystick Rates

This packet is intended to replace the individual "Set Joystick" packets. It is variable length and uses a signed 16-bit value for each axis. Missing values can be omitted from the end of the packet or stuffed with the value -32768 to indicate invalid. In this case, a zero rate will be applied to that axis, if present.

Note that a first-in priority is assigned to these packets such that if multiple HCUs are sending non-zero values, the first in will take control and will only release control by sending zero rates, or no packets, for several seconds. At this point, a new first-in controller will be selected.

CLASS: 0x03
CODE: 0x84
SIZE: Variable

Data	Data Index	Description	Comment
S16	0	Azimuth Rate	+= Right
S16	2	Elevation Rate	+= Down
S16	4	Roll Rate	+= CW
S16	6	Gain	0 = Medium, -32768 = Use Menu
U16	8	Flags	Mask: 0x0001 – No Drift Adjust (Rate Aid) All other values reserved for future use

3.4.9. Example message

To set joystick azimuth to +0.5, elevation to 0.0, and use default Roll, Gain, and Flags

0	1	2	3	4	5	6	7	8	9	10	11
SYNC1	*SYNC2*	*CLASS*	*CODE*	*SIZE*	*SIZE*	*DATA*	*DATA*	*DATA*	*DATA*	*CSUMA*	*CSUMB*
0xA7	0x54	0x03	0x84	0x04	0x00	0xFF	0x7F	0x00	0x00	0x0B	0x4E

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3.5. Geo CLASS 0x04

3.5.1. Set Ground Altitude (HAE)

This message should be used to provide the ground altitude at the current sensor line of sight, when available. The most common use is to provide data from a terrain database to the gimbal so that it can display the geo-position in the absence of LRF data.

Ideally, this message should be transmitted at a rate of approximately 20Hz to provide continuous updates to the terrain engine. The message must be transmitted at a minimum of 1Hz to prevent the gimbal from invalidating the data due to timeout.

CLASS: 0x04
CODE: 0x01
SIZE: 0x04

Data	Data Index	Description	Comment
F32	0-3	Ground Altitude (m, HAE)	The elevation of the earth, in meters, relative to the WGS84 Ellipsoid where the sensor LOS intercepts the ground.

3.5.2. Setpoint ECEF

Set Mode to Geo Point for this command to have effect (CLASS 0x02, CODE 0x81, Mode 3).

CLASS: 0x04
CODE: 0x81
SIZE: 0x18 (24)

Data	Data Index	Description	Comment
F64	0-7	ECEF X Coordinate	
F64	8-15	ECEF Y Coordinate	Coordinate that the gimbal should point to
F64	16-23	ECEF Z Coordinate	

3.5.3. GeoPoint Command

Use this command to start Geo-Pointing from the current line of sight (overriding the Setpoint), when possible. Optionally, this can also be a 'Toggle' command which will switch between Rate and Geo Pointing modes.

CLASS: 0x04
CODE: 0x8A
SIZE: 0x01

Data	Data Index	Description		Comment
U8	0	Start	0x00	This command is optional and if omitted, 'Start' will be the assumed request.
		Toggle	0x01	

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3.6. Sensor CLASS 0x81

Each packet uses a 'Sensor Index' as the first byte. For values less than 0x20, the value is assumed to be a zero-based sensor index.

For convenience, there are also generic commands to allow transmitting messages to 'groups' of sensors without the need for knowing the exact sensor index. These message types are also necessary for accessing the special sensors (non-video producing) such as the Laser Range Finder, Laser Illuminator, or Laser Pointer.

Sensor Type	Meaning
Video/Photo Sensor Index Selections	
0x00	Specify Sensor By Index (First Sensor)
0x01	Specify Sensor By Index (Second Sensor)
0x02	Specify Sensor By Index (Third Sensor)
0x03	Specify Sensor By Index (Fourth Sensor)
0x04	Specify Sensor By Index (Final Sensor)
Video/Photo Sensor Type Selections	
0x20	Active Sensor (Shown on primary displays & controlled by HCU)
0x21	Any EO Sensors (Daylight Cameras)
0x22	Any Lowlight Sensors (Such as an EMCCD)
0x23	Any IR Sensors (includes LWIR, MWIR, and SWIR) sensors
0x24	Any LWIR Sensors (Long-Wave IR)
0x25	Any MWIR Sensors (Mid-Wave IR)
0x26	Any SWIR Sensors (Short-Wave IR)
0x27	Any UV Sensors
0x28	Any Near-IR Cameras (these are not included in true "IR" group)
0x29	Any Photo (Still) Cameras
0x3F	Broadcast the message to ALL Video/Photo sensors
Laser Index Selections	
0x40	Laser Range Finder
0x41	Laser Pointer / Illuminator By Index
0x42	Laser Pointer / Illuminator By Index
Laser Type Selections	
0x61	Visible Pointer (Any pointer operating in the visible light spectrum)
0x62	IR Pointer (Any pointer operating in the IR spectrum)
0x63	Illuminator (Any illuminator)
0x64	Selected Laser (Pointer or Illuminator as specified in Menu)
Other Groups	
0xFF	Broadcast the message to ALL sensors

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3.6.1. Set Active Sensor

Set the 'Active' sensor. To select a specific sensor, send the appropriate sensor index and use the ACTIVATE command. Other commands such as Next, Previous, and Toggle will ignore the sensor index and simply step through the available sensors. The TOGGLE_ACTIVE command will increment with rollover, providing a simple option for stepping through all enabled sensors.

Note that the 'Activate' command will be ignored for sensors that are not selectable in the system.

CLASS: 0x81
CODE: 0x01
SIZE: 0x02

Data	Data Index	Description	Comment
U8	0	Sensor Index	
U8	1	Command	0x00 = ACTIVATE 0x01 = ACTIVATE_NEXT 0x02 = ACTIVATE_PREVIOUS 0x03 = TOGGLE_ACTIVE 0x04 = SWAP_WITH_DISABLED

3.6.2. Set Zoom

Control the Zoom for the specified sensor. Note that for the digital zoom, the following rules generally apply:
An optical zoom 'wide' command will reset Digital Zoom to 1.0x.

Digital zoom is only available once the sensor reaches the optical narrow limit.

CLASS: 0x81
CODE: 0x02
SIZE: 0x06

Data	Data Index	Description	Comment
U8	0	Sensor Index	
U8	1	Zoom Command	0x00 = RATE 0x01 = HFOV 0x02 = DZ_RATE 0x03 = COMBINED
F32	2-5	Zoom Value	Depends on Command (see below)

Command	Valid Range	Description
RATE	-1.0 to +1.0	Sets zoom rate as a ratio of full speed (-) Narrow, (+) Wide, (0) Stop
HFOV	Positive Numbers	Request the lens to move to the specified Horizontal FOV (in Degrees)
DZ_RATE	-1.0 to +1.0	Sets the digital zoom rate. Interpreted the same as 'RATE' but for Digital Zoom.
COMBINED	-1.0 to +1.0	Works like RATE command but will automatically engage Digital Zoom when starting to zoom in at Narrow end

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3.6.3. Set Focus

Control the Focus for the specified sensor.

CLASS: 0x81
CODE: 0x03
SIZE: 0x06

Data	Data Index	Description	Comment
U8	0	Sensor Index	
U8	1	Focus Command	0x00 = AF 0x01 = MF_BUMP 0x02 = AF_AFTER_ZOOM
S32	2-5	Focus Value	Depends on Command (see below)

Command	Valid Range	Description
AF	0	Requests Auto-Focus
MF_BUMP	Unrestricted	Enter manual focus mode and/or adjust manual focus (+) FAR, (-) NEAR, (0) No Adjustment
AF_AFTER_ZOOM	{0,1,2}	0 = Disable Auto-Focus after Zoom 1 = Enable Auto-Focus after Zoom 2 = Toggle Auto-Focus after Zoom from current setting

3.6.4. Set Image Exposure

Control the Exposure, Gain and related image functions. Gain and level are mapped to equivalent functions on all camera types, but specialized functions such as integration levels may not be available on all sensor types.

CLASS: 0x81
CODE: 0x04
SIZE: 0x06

Data	Data Index	Description	Comment
U8	0	Sensor Index	
U8	1	Command	0x00 = AUTO 0x10 = GAIN_BUMP 0x20 = LEVEL_BUMP 0x30 = INTEGRATION_BUMP 0x31 = INTEGRATION_TOGGLE 0x32 = INTEGRATION_SET 0x33 = INTEGRATION MAP 0x40 = PEDESTAL_BUMP 0x50 = MAXIMUM_EXPOSURE_TIME_BUMP 0x51 = MAXIMUM_EXPOSURE_TIME_SET
S32	2-5	Value	Depends on Command (see below)

Command	Valid Range	Description
AUTO	0	Enters Auto-Gain Control Mode
GAIN_BUMP	Unrestricted	Enter manual gain mode and/or adjust manual gain (+) Gain Up, (-) Gain Down, (0) No Adjustment
LEVEL_BUMP	Unrestricted	Enter manual exposure/level mode and/or adjust manual exposure / level (+) Increase Level (Brighter)

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		(-) Decrease Level (Darker) (0) No Adjustment
INTEGRATION_BUMP	Unrestricted	(+) Adjust integration for warmer scenes (-) Adjust integration for colder scenes
INTEGRATION_TOGGLE	0	Steps through available integration settings (increments by one with rollover)
INTEGRATION_SET	{0,1,2}	Choose integration level (0=Coldest, 2=Warmest)
INTEGRATION_MAP	0,1-6,14,15	0 = Default, selects camera's default setting 1-6 = Select a standard level 1=Coldest, 6=Hottest 14 = Fire Level (when supported) 15 = Automatic Mode (when supported)
PEDESTAL_BUMP	Unrestricted	(+) Increase black level (brighten) (-) Decrease black level (darken)
MAXIMUM_EXPOSURE_TIME_BUMP	Unrestricted	(+) Select the next available higher exposure time (-) Select the next available shorter exposure time
MAXIMUM_EXPOSURE_TIME_SET	Unrestricted	Exposure time in microseconds (µs), closest available will be selected. The maximum exposure time is a limit applied to the AUTO mode. Setting a short maximum exposure time reduces motion blur.

3.6.5. Set Image Enhancement

Control various Image Enhancement features such as Detail Level, etc.

CLASS: 0x81
CODE: 0x05
SIZE: 0x06

Data	Data Index	Description	Comment
U8	0	Sensor Index	
U8	1	Command	0x00 = DETAIL_BUMP 0x01 = DETAIL_TOGGLE 0x11 = DNR_TOGGLE 0x21 = HISTOGRAM_TOGGLE 0x22 = HISTOGRAM_SET 0x31 = HIGH_DYNAMIC_RANGE_TOGGLE 0x40 = DEFOG_BUMP 0x41 = DEFOG_TOGGLE
S32	2-5	Value	Depends on Command (see below)

Command	Valid Range	Description
DETAIL_BUMP	Unrestricted	Adjust detail level from the sensor. (+) Sharpen (Increase Enhancement Level) (-) Soften (Decrease Enhancement Level)
DETAIL_TOGGLE	0	Toggle through detail level options (increments by one with rollover)
DNR_TOGGLE	0	Toggle through Digital Noise Reduction options (increments by one with rollover)
HISTOGRAM_TOGGLE	0	Histogram modes are used to dynamically adjust pixel values to provide useful imagery throughout a scene with large variations. This command cycles through the various options on the sensor, with rollover.
HISTOGRAM_SET	{0-4}	0 = Use Default 1 = Histogram Off 2 = Histogram Low

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		3 = Histogram Medium 4 = Histogram High
HIGH_DYNAMIC_RANGE_TOGGLE	0	Toggle through dynamic range options (increments by one with rollover). High dynamic range settings are used to provide useful imagery from a scene with large variations. The sensor dynamically selects multiple exposure times to create several images that are then combined into one.
DEFOG_BUMP	Unrestricted	Adjust defog level. (+) Increase defog level (-) Decrease defog level
DEFOG_TOGGLE	0	Toggle through defog Level options (increments by one with rollover)

3.6.6. Flat Field Correction Trigger

Some sensors provide flat field correction modes such as Non-Uniformity (NUC) on IR sensors and triggered White Balance on some EO sensors. Send this command to initiate that process.
The actual FFC process depends on the sensor type and model.

CLASS: 0x81
CODE: 0x06
SIZE: 0x02

Data	Data Index	Description	Comment
U8	0	Sensor Index	
U8	1	Command	0x00 = Standard FFC 0x01 = Alternate FFC (Implementation is Sensor Dependent)

3.6.7. Set Palette

Control various aspects of the image palette. Primarily used by IR cameras to provide colorized IR imagery.

CLASS: 0x81
CODE: 0x07
SIZE: 0x06

Data	Data Index	Description	Comment
U8	0	Sensor Index	
U8	1	Command	0x00 = SET_POLARITY 0x01 = TOGGLE_POLARITY 0x10 = SET_PALETTE 0x11 = TOGGLE_PALETTE 0x20 = ADJUST_THRESHOLD
S32	2-5	Value	Depends on Command (see below)

Command	Valid Range	Description
SET_POLARITY	{0,1}	Change the polarity: 0 = White-Hot 1 = Black-Hot
TOGGLE_POLARITY	0	Toggle through polarity options
SET_PALETTE	0+	Set the palette to the given palette index
TOGGLE_PALETTE	0	Toggle through palette options (increments by one with rollover)
ADJUST_THRESHOLD	{-127,127}	Adjust the palette color threshold, where applicable

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3.6.8. Set Filter

Control any available sensor filters. This is generally used by EO sensors to remove IR filters to produce imagery suitable for low-light conditions.

CLASS: 0x81
CODE: 0x08
SIZE: 0x06

Data	Data Index	Description	Comment
U8	0	Sensor Index	
U8	1	Command	0x00 = SET_FILTER 0x01 = TOGGLE_FILTER
S32	2-5	Value	Depends on Command (see below)

Command	Valid Range	Description
SET_FILTER	{0,1}	Change the filter: 0 = No Filter (Low Light Mode) 1 = Visible Light (Standard IR Cut Filter)
TOGGLE_FILTER	0	Toggle through all filter options (increments by one with rollover).

3.6.9. Set Sensor Recorder

Used to trigger internal sensor recording devices such as photo capture on sensors that support it.

CLASS: 0x81
CODE: 0x0A
SIZE: 0x06

Data	Data Index	Description	Comment
U8	0	Sensor Index	
U8	1	Command	0x00 = None / Reserved 0x01 = Take Photo
S32	2-5	Value	Reserved for future use, set to 0x00000000

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3.6.10. Set LASER Mode

Set the Laser mode for the given sensor. If the 'TOGGLE' command is used, the laser state will be set to 'ON CONTINUOUS' if currently 'OFF'. Otherwise, it will be set to 'OFF'.

The 'ONE SHOT' command is used primarily for Laser Range Finders and will cause the LRF to fire one time and then switch to 'OFF' mode. For other lasers, this will enable the lasers for approximately two seconds unless the message is resent. This can be used to implement a 'safe' laser enable that will ensure the laser is disabled if communications are lost. In addition, there are special commands for LRF Alignment Pointers, which are pointers integrated into LRFs for alignment purposes.

CLASS:　　0x81
CODE:　　0x40
SIZE:　　0x02

Data	Data Index	Description	Comment
U8	0	Sensor Index	
U8	1	Command	0x00 = OFF 0x01 = ON CONTINUOUS 0x02 = ONE SHOT 0x03 = LRF POINTER ON 0x04 = LRF POINTER OFF 0x10 = TOGGLE 0x11 = LRF POINTER TOGGLE

3.6.11. Set Detector

The Detector Response options are only available on certain SWIR cameras and all options may not be supported. This support does not exist in early versions of 10.12 SW.
The High Gain option increases the sensitivity of the detector, useful in low light conditions It will also lower the maximum charge capacity, hence the detector could saturate, and the dynamic range will be less.
The Low Gain option is less sensitive but has a higher maximum charge capacity and a larger dynamic range, making it more all-**round** and can be used in both daylight and low light conditions.
The logarithmic option has the highest dynamic range but the lowest sensitivity and is mainly suitable in daylight conditions.

CLASS:　　0x81
CODE:　　0x09
SIZE:　　0x06

Data	Data Index	Description	Comment
U8	0	Sensor Index	
U8	1	Command	0x10 = SET_RESPONSE 0x11 = TOGGLE_RESPONSE
S32	2-5	Value	Depends on Command (see below)

Command	Valid Range	Description
SET_RESPONSE	{0,1,2,3,4}	Change the detectors response: 0 = Default (Sets the detectors response to default) 1 = Low Gain (analog gain) 2 = High Gain (analog gain) 3 = High Gain with CDS (analog gain) 4 = Logarithmic (logarithmic response mode)

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TOGGLE_RESPONSE	0	Toggle through all response options on the detector (increments by one with rollover).

3.7. Video CLASS 0x82

The video class is used for messages that relate to control of the video board. This includes command that control video tracking, moving target indication, blending, recording, etc.

3.7.1. Modify Tracking

The 'Modify Tracking' command is used to control the video tracker. The meaning of the command is controlled by the first byte, which is a tracker command such as start or stop tracking. The meaning of the remaining fields may change slightly depending on the command.

Note: *When tracking by target index, the OSD displays tracks with a 1-based index, whereas the command is zero based. For instance, to track the item labelled on the screen as "3", send request to START_INDEX with a value of "2".*

CLASS: 0x82
CODE: 0x01
SIZE: 0x06

Data	Data Index	Description	Comment
U8	0	Tracker Command	0x00 = RESERVED / NONE 0x01 = STOP_ALL 0x02 = START_RATIO 0x03 = TOGGLE_TRACKER 0x04 = TOGGLE_MODE 0x05 = START_INDEX 0x06 = START_SCENE 0x07 = START ALTERNATE 0x08 = ADJUST_GATE_SIZE
U8	1	Sensor	0-based sensor index. Ignored by the "STOP_ALL" and, "TOGGLE" commands. Use '0xFF' for 'Active'
S16	2-3	Parameter X	Depends on Command (see below)
S16	4-5	Parameter Y	Depends on Command (see below)

Command	Parameter X	Parameter Y
STOP_ALL	Parameters are Ignored. Command disables all trackers.	

START_RATIO	Desired track start 'X' position in display coordinates, scaled such that:
	    0 = Center Column
	    -32767 = Left Column
	    +32767 = Right Column
		Desired track start 'Y' position in display coordinates, scaled such that:
		    0 = Center Row
		    -32767 = Top Row
		    +32767 = Bottom Row

TOGGLE_TRACKER	Parameters are Ignored. Command toggles tracker on/off (TRK)	
TOGGLE_MODE	Obsolete. Avoid using this function for future development.	

START_INDEX	MTI Target Index:
	    • [-1] = Use Cursor
	    • [0+] = Index To Track
		Ignored

START_SCENE	Parameters ignored, starts "Scene Mode" tracking. Note that if you are actively object tracking, this command will not drop that track, but will enable the scene tracker as a fallback.	

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START ALTERNATE	Start Scene tracker if not tracking, otherwise Reset Track	
ADJUST_GATE_SIZE	Number of pixels to increase or decrease width	Number of pixels to increase or decrease height

3.7.2. Modify Blending

The 'Modify Blending' command is used to control the image blending functionality. Image blending utilizes both video inputs (e.g. IR and EO) and produces a combined image. The way the image is combined is controlled via these blending settings.

The type of the command is controlled by the first byte, which is a blending command to set levels, modes, etc. The meaning of the remaining fields may change slightly depending on the command.

CLASS: 0x82
CODE: 0x02
SIZE: 0x03

Data	Data Index	Description	Comment
U8	0	Blend Command	0x00 = RESERVED / NONE 0x01 = MODE_SET 0x02 = MODE_TOGGLE 0x03 = MODE_TOGGLE_PRESET 0x04 = BLEND_LEVEL_SET 0x05 = BLEND_LEVEL_BUMP
S16	1-2	Parameter	Depends on Command (see below)

Command	Valid Range	Description
MODE_SET	{0-4}	Change the blend mode: • **0 = Disabled / Off** • **1 = Monochrome Fader** • **2 = IR Highlight (EO with hot spots)** • **3 = EO Highlight (IR with bright spots)** • **4 = Color Fader**
MODE_TOGGLE	0	Toggle through all available blend modes
MODE_TOGGLE_PRESET	0	Toggle between Blending OFF and a Preset Mode
BLEND_LEVEL_SET	-100 to +100	Set the amount of blending, in modes that allow it: • **-100 = 100% Inactive Sensor** • **0 = 50-50 Blend** • **+100 = 100% Active Sensor**
BLEND_LEVEL_BUMP	-100 to +100	Bump the amount of blending by the specified amount.

3.7.3. Modify MTI

The 'Modify MTI' command is used to control the 'Moving Target Indicator' settings. This includes setting of the 'cursor' and other parameters. The track selected by the cursor is highlighted and can be designated via the Modify Track command (refer to 3.7.1), if desired.

CLASS: 0x82
CODE: 0x03
SIZE: 0x03

Data	Data Index	Description	Comment
U8	0	MTI Command	0x00 = RESERVED / NONE

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			0x01 = CURSOR_SET 0x02 = CURSOR_TOGGLE 0x03 = CURSOR SHOW 0x04 = REQUEST_TRACK_DATA
S16	1-2	Parameter	Depends on Command (see below)

Command	Valid Range	Description
CURSOR_SET	{0 to 128}	Explicitly change the MTI Cursor to the value specified. • Note: 0 indicates no cursor.
CURSOR_TOGGLE	{-1, +1}	Increment or Decrement (+1=INC, -1=DEC), ignoring inactive cursor positions. Will Roll-Over both directions.
CURSOR_SHOW	{0+}	Milliseconds until the cursor (line) should be hidden.
REQUEST_TRACK_DATA	{0+}	Milliseconds between Video Track Data packets, with 0 = OFF, see Section 0

3.7.4. Video Recorder Control

The 'Video Recorder Control' command is used to start, stop and otherwise configure the onboard video recording system (where equipped). In addition, this command may be used to request onboard video stills (photos). These settings are all configurable in the gimbal's menu system.

CLASS: 0x82
CODE: 0x04
SIZE: 0x03

Data	Data Index	Description	Comment
U8	0	Recorder Command	0x00 = RESERVED / NONE 0x01 = START_VIDEO_RECORDER 0x02 = STOP_VIDEO_RECORDER 0x03 = TOGGLE_VIDEO_RECORDER 0x04 = ACQUIRE_VIDEO_STILLS
S16	1-2	Parameter	Reserved for future use, set to 0x0000

3.7.5. Video Streaming Control

The 'Video Streaming Control' command is used to reconfigure the video stream settings on the video board. These settings are typically configured from the Menu, but by making them available here, the user can remotely control various aspects of the system's video streams.

CLASS: 0x82
CODE: 0x05
SIZE: 0x0E (14)

Data	Data Index	Description	Comment
U8	0	Stream Index	0-Based Stream index
U8	1	Source	0x00 = Sensor 0 0x01 = Sensor 1 0x02 = Sensor 2 0x80 = OFF 0x81 = Primary Sensor 0x82 = Alternate Sensor 0x83 = Best Visible Sensor 0x84 = Best IR Sensor

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U8	2	Flags	0x01 = Enable Broadcast
U8	3		IP Address, D
U8	4	Destination IP (A.B.C.D)	IP Address, C
U8	5		IP Address, B
U8	6		IP Address, A
U16	7,8	Destination Port	0-65535
U8	9	Video Protocol	0x00 = UDP/MPEGTS 0x01 = RTP/MPEGTS
U32	10-13	Bitrate in kbps	Stream data rate in kilobits per second Note: Currently limited to 10 Mbps

3.7.6. Modify CLAHE

The 'Modify CLAHE' command is used to control the level of enhancement performed on the video processing system. CLAHE is an abbreviation for "contrast limited adaptive histogram equalization" and is a way to improve contrast in images.

The type of the command is controlled by the first byte, which is subcommand allowing the configuration of further CLAHE parameters. The meaning of the remaining fields may change slightly depending on the command.

CLASS: 0x82
CODE: 0x06
SIZE: 0x02

Data	Data Index	Description	Comment
U8	0	Command	0x00 = RESERVED / NONE 0x01 = LEVEL_SET 0x02 = LEVEL_BUMP 0x03 = PRESET_TOGGLE
S8	1	Parameter	Depends on Command (see below)

Command	Valid Range	Description
LEVEL_SET	{0-100}	Adjust the level of CLAHE to the desired amount, where 0 is off, and 100 is the highest level possible
LEVEL_BUMP	-100 to +100	Bump the CLAHE level up/down by the given amount.
PRESET_TOGGLE	0	Toggles through common preset levels in a circular fashion

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3.7.7. Video Track Data

The 'Video Track Data' is used to transmit data about tracks being processed by the integrated video tracker. The 'Video Track Data' packets will only be sent to ethernet connections (UDP or TCP) due to the potential for large amounts of data. Additionally, this data will be transmitted to all active ethernet-based connections. To enable this data, refer to Section 3.7.3.

NOTE: *Tracks are labelled on the OSD with a 1-based index. To match track data with those displayed on the screen, the track index received in this packet needs to be incremented by 1. This only affects the display labels. All messages in this protocol use 0-based indexing and are consistent with each other.*

CLASS: 0x82
CODE: 0x07
SIZE: 0x0F (15)

Data	Data Index	Description	Comment
U8	0	Source	0x00 = Sensor 0 0x01 = Sensor 1 0x02 = Sensor 2 0x03 = Sensor 3 0x04 = Sensor 4
U16	1,2	Track Index	ID of the track, can be used to start tracking via the Modify Tracking command
U8	3	Tracker Status	BIT0 1= Active Track, 0 = Inactive BIT1 1=Coasting, 0 = Not Coasting
U8	4	Track Quality	0 – 100 %, Track Quality
F32	5-8	Track Error (AZ)	AZ angular error from center in Radians
F32	9-12	Track Error (EL)	EL angular error from center in Radians
U8	13	Track Type	0x00 = Unknown, Other 0x01 = Rotary Wing Aircraft/Drone 0x02 = Fixed Wing Aircraft/Drone 0x03 = Vehicle 0x04 = Person 0x05 = Boat
U8	14	Track Type Confidence	0 – 100 %, Track Confidence

3.7.8. User Message

Print a message to the On-Screen Display (OSD). The location of the message will be dependent on the type of message and the video board's implementation. Note that if a message of the same type arrives prior to the previous message being cleared, the old message will be cleared and the new one displayed instead.

CLASS: 0x82
CODE: 0x08
SIZE: 0x04 + Message Length

Data	Data Index	Description	Comment
U8	0	User Message Type	0x00 = Reserved/None 0x01 = Information
U16	1,2	Timeout	Duration in milliseconds to show the message, 0=Keep Indefinitely
U8	3	Message Length	Number of characters in the message. Up to 32 characters or supported.
STRING	4+	Message	The ASCII text message to display.

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3.7.9. Draw Calibration Marker

Draw special marker on the OSD. These are special indicators generally reserved for doing calibration or measurements based on data displayed in the video.

CLASS: 0x82
CODE: 0x83
SIZE: 0x09

Data	Data Index	Description	Comment
U8	0	Marker Type	0x00 = None (Disable/Clear) 0x01 = Source Ration 0x02 = Fixed FOV Box
F32	1-4	Horizontal	Depends on the Marker Type
F32	5-8	Vertical	Depends on the Marker Type

Source Ratio

This setting will draw small crosshairs at the given horizontal percentage of the sensor's available capture area. For instance, if you supply the value 50%, crosshairs will be drawn at the +/-25% from the center of the screen to the edge of the sensor's output. In this case the vertical value is ignored.

Fixed FOV Box

This setting will draw a FOV Box at the given horizontal and vertical FOVs, in degrees. Note that this may result in the boxes being drawn off-screen, depending on the sensor's zoom level.

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3.8. Menu CLASS 0x83

The menu class contains special commands that are used to present, hide, and navigate the built-in menu system.

3.8.1. Menu Show

The 'Menu Show' command is used to force the menu to be presented to the user. The command includes a timeout in milliseconds to ensure the current state of menu display is consistent with the controller status.

CLASS: 0x83
CODE: 0x01
SIZE: 0x02

Data	Data Index	Description	Comment
U16	0-1	Timeout (ms)	Milliseconds until the menu will be hidden automatically. • 0 = No Timeout

3.8.2. Menu Hide

The 'Menu Hide' command is used to close the menu. Upon closing the menu, the settings will either be saved or ignored, depending on the parameter supplied.

CLASS: 0x83
CODE: 0x02
SIZE: 0x01

Data	Data Index	Description	Comment
U8	0	Exit Command	0x00 = DISCARD_CHANGES 0x01 = APPLY_CHANGES 0x02 = STORE_CHANGES

When hiding the menu, the command will be applied as follows:
- Discard Changes: Any modifications made but not applied will be discarded.
- Apply Changes: Modifications will be applied but will not persist through a power cycle.
- Store Changes: Changes will be immediately applied and permanently stored.

3.8.3. Menu Navigate

The 'Menu Navigate' command is used to move through the menu. Note that these commands will be ignored if the menu is not currently visible.

CLASS: 0x83
CODE: 0x03
SIZE: 0x02

Data	Data Index	Description	Comment
U8	0	Command	0x00 = NONE 0x01 = ENTER 0x02 = UP 0x03 = DOWN 0x04 = LEFT 0x05 = RIGHT
U8	1	Repeat	Number of times to apply the command.

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3.9. External Device CLASS 0x84

The external device class is used to control specialized devices connected externally to the gimbal. For instance, these generic commands can be used to relay commands to a Trakka Searchlight connected via RS-232 or RS-422 to COM1-6.

Each packet uses a 'Device Index' as the first byte. For values less than 0x20, the value is assumed to be the COM port number. For convenience, there are also generic commands to allow transmitting messages to 'types' of devices without the need for knowing the exact COM port number.

Note that not all devices will support all commands.

Sensor Type	Meaning
COM Port Index Selections	
0x00	Reserved
0x01	Device on External COM Port #1
0x02	Device on External COM Port #2
0x03	Device on External COM Port #3
0x04	Device on External COM Port #4
0x05	Device on External COM Port #5
0x06	Device on External COM Port #6
Searchlight Devices	
0x20	Trakka Searchlight
0x2F	Broadcast the message to ALL Searchlight Devices
Other Groups	
0xFF	Broadcast the message to ALL external devices

3.9.1. Lamp Command

Control the Lamp for the specified device. This command is intended for use by external searchlights or other similar devices which can provide illumination with on/off capability.

CLASS: 0x84
CODE: 0x01
SIZE: 0x02

Data	Data Index	Description	Comment
U8	0	Device Index	
U8	1	Lamp Command	0x00 = RESERVED 0x01 = EXTINGUISH 0x02 = IGNITE 0x03 = TOGGLE 0x04 = DIM_ON 0x05 = DIM_OFF 0x06 = DIM_TOGGLE

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3.9.2. Filter Command

Control the Filters for the specified device. This command is intended for use by external searchlights or other similar devices which can provide selectable filter modes. Note that we have reserved indices 128+ for special commands such as increment and decrement.

CLASS: 0x84
CODE: 0x02
SIZE: 0x02

Data	Data Index	Description	Comment
U8	0	Device Index	
U8	1	Command Type	0x00 = NO CHANGE 0x01-0x7F = REQUESTED FILTER INDEX 0x80 = INCREMENT (CLAMPED) 0x81 = INCREMENT (W ROLLOVER) 0x82 = DECREMENT (CLAMPED) 0x83 = DECREMENT (W ROLLOVER)

3.9.3. Lens Command

Control the Zoom Lens for the specified device. This command is intended for use by external searchlights or other similar devices which have zoomable optics.

CLASS: 0x84
CODE: 0x03
SIZE: 0x03

Data	Data Index	Description	Comment
U8	0	Device Index	
U8	1	Command Type	0x00 = RESERVED 0x01 = RATE_COMMAND
S8	2	Command	Depends on Command Type

Command Type	Valid Range	Description
RESERVED	N/A	No Action
RATE_COMMAND	{-127,+127}	Proportional control with: • Zero Indicating Lens Stop • Negative indicating Zoom Narrow • Positive indicating Zoom Wide • +/-127 indicates full speed • -128 is treated like -127 for convenience

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3.9.4. Mode Command

Request the mode for the specified device. Common modes are provided, and the list may be expanded as needed in the future.

CLASS: 0x84
CODE: 0x04
SIZE: 0x02

Data	Data Index	Description	Comment
U8	0	Device Index	
U8	1	Mode Request	0x00 = RESERVED 0x01 = DEPLOY 0x02 = STOW 0x03 = ENABLE_SLAVING 0x04 = DISABLE_SLAVING 0x05 = ENABLE_SLAVE_CAL 0x80 = TOGGLE_SLAVING

3.9.5. Rate Command

Rate commands are used for steering an external device with standard Azimuth/Elevation controls

CLASS: 0x84
CODE: 0x05
SIZE: 0x06

Data	Data Index	Description	Comment
U8	0	Device Index	
U8	1	Rate Type	0x00 = RESERVED 0x01 = MAGNITUDE 0x02 = JOYSTICK 0x03 = ABSOLUTE
S16	2-3	Azimuth Rate	Depends on Rate Type
S16	4-5	Elevation Rate	Depends on Rate Type

Command Type	Description
RESERVED	No Action
MAGNITUDE	Proportional control relative to maximum rates
JOYSTICK	Joystick Deflection, rate determined by receiver
ABSOLUTE	Mapped proportionally to +/- 100 Deg/Second

3.9.5.1. Magnitude Commands

When the "Magnitude" rate type is used, the rates are interpreted as 16-bit signed values. The command speed is relative to the maximum that the gimbal can move, meaning the controller does not have to be aware of the available range of speeds.

Speeds are interpreted as a fixed-point ratio of full-scale speed, with a positive magnitude value representing movement in the positive direction (Right or Up), and a negative magnitude value representing movement in the negative direction (Down or Left)

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3.9.5.2. Joystick Commands

The joystick type is defined in the same terms as the 'Magnitude' commands. However, the GCM will apply a remapping of the input values such that a user-defined curve may be applied to remap the commands to provide different sensitivity levels for different regions of the joystick.

3.9.5.3. Absolute Commands

The absolute commands represent the angular rates of the attached device, remapped such that 32767 will result in 100 degrees/second. The sign and other aspects are treated similarly to the 'Magnitude' commands but remapped to absolute rates. Note that not all devices can support these commands, such as those with open-loop rate control.

3.9.6. Slave Position Command

Used to relay a slave position and override the slave mode, which typically follows the camera azimuth and elevation angles.

CLASS: 0x84
CODE: 0x06
SIZE: 0x06

Data	Data Index	Description	Comment
U8	0	Device Index	
U8	1	Mode Type	0x00 = RESERVED 0x01 = USE_GIMBAL_ANGLES 0x02 = USE_PROVIDED_ANGLES
S16	2-3	Azimuth Angle	Signed, Fixed Point Angle
S16	4-5	Elevation Angle	Signed, Fixed Point Angle

The provided Azimuth and Elevation angles are utilized only when the mode is set to "2" (Use Provided Angles). Those values should be set to Zero (0x0000) in any other mode. When angles are provided, they are mapped from -180 @ -32768, to +179.99 @ 32767, rolling over naturally to represent a 360-degree angle.

3.9.7. Request Status

Used to relay a slave position and override the slave mode, which typically follows the camera azimuth and elevation angles.

CLASS: 0x84
CODE: 0x07
SIZE: 0x01

Data	Data Index	Description	Comment
U8	0	Device Index	

When received, the device should respond with a Status Response Packet as defined by message code 0x80.

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3.9.8. Status Response

This packet is sent by the Gimbal in Response to a 'Request Status'. Drivers should be expected to populate any available data.

For the Azimuth and Elevation Angles, a signed, fixed-point representation is used such that -32768 is equivalent to -180 degrees, and +32767 is equivalent to +179.99 Degrees. This is a convenient format which rolls-over naturally.

This packet should be expected to be expanded in the future, so when processing this packet, you should accept longer packets and ignore bytes that are not defined today.

CLASS: 0x84
CODE: 0x80
SIZE: 0x0A (10)

Data	Data Index	Description	Comment
U8	0	Device Index	The device generating the response. This is the External COM Port.
S16	1-2	Azimuth Angle	Signed, Fixed Point Angle
S16	3-4	Elevation Angle	Signed, Fixed Point Angle
U8	5	Lamp Status	0x00 = UNKNOWN 0x01 = OFF 0x02 = STARTING 0x03 = ON (STANDARD) 0x04 = ON (DIM) 0x05 = COOLING
U8	6	Filter Status	0x00 = UNKNOWN 0x01+ = INDEX
U8	7	Lens Status	0x00 = UNKNOWN 0x01 = NARROW LIMIT 0xFF = WIDE LIMIT
U8	8	Mode Status	0x00 = UNKNOWN 0x01 = INITIALIZING 0x02 = STOWING 0x03 = STOWED 0x04 = DEPLOYING 0x05 = DEPLOYED 0x06 = DEPLOYED, SLAVING 0x07 = DEPLOYED, CALIBRATING 0x08 = DEPLOYED, STABILIZING
U8	9	Error Mask	0x00 = NONE/UNKNOWN 0x01 = E1 (Meaning is System Specific) 0x02 = E2 0x04 = E3 0x08 = E4 0x10 = E5 0x20 = E6 0x40 = E7 0x80 = E8

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3.10. Map Device CLASS 0x85

The map device class is meant to work with integrated or external mapping devices which register for to receive map messages. To register as a device that receives these commands, refer to section 3.10.6.
All devices registered as a 'Map' will receive the commands (Codes 0x00-0x7F) and can decide how to interpret the messages.

Note that not all devices will support all commands.

3.10.1. Video Window Command

Control settings for the specified video window on the mapping device.

CLASS: 0x85
CODE: 0x01
SIZE: 0x06

Data	Data Index	Description	Comment
U8	0	Video Window	0x00 = All Video Windows 0x01 = Video Window 1 0x02 = Video Window 2 0x03 = Video Window 3
U8	1	Command	0x00 = RESERVED 0x01 = AR TOGGLE 0x02 = AR SET
S32	2-5	Parameter	Depends on Command (See Below)

Command	Valid Range	Description
RESERVED	0	Command is reserved for future use
AR TOGGLE	0	Toggles the Augmented Reality overlays On/Off
AR SET	{0,1}	0 = Disable AR Overlays 1 = Enable AR Overlays

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3.10.2. Draw Command

Controls the user drawing capabilities. Allows the user to start / stop a drawing entity, control the placement of points, etc.

CLASS: 0x85
CODE: 0x02
SIZE: 0x05

Data	Data Index	Description	Comment
U8	0	Command	0x00 = RESERVED 0x01 = CHANGE MODE 0x02 = ADD POINT 0x03 = TOOL VISIBILITY
S32	1-4	Parameter	Depends on Command (See Below)

Command	Valid Range	Description
RESERVED	0	Command is reserved for future use
CHANGE MODE	{0-3}	0 = Off 1 = Add Footprints 2 = Snap to Camera 3 = Add Points
ADD POINT	0	Add a point at the camera position, according to the current mode of operation
TOOL VISIBILITY	{0,1,2}	0 = Collapse Drawing Control 1 = Show Drawing Control 2 = Toggle Drawing Control Visibility

3.10.3. Pin Command

Controls the ability to drop a map pin.

CLASS: 0x85
CODE: 0x03
SIZE: 0x01

Data	Data Index	Description	Comment
U8	0	Pin Action	0x00 = Drop Pin 0x01 = Drop and Activate Pin

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3.10.4. Display Command

Controls the ability to modify the map screen layout.

CLASS: 0x85
CODE: 0x04
SIZE: 0x05

Data	Data Index	Description	Comment
U8	0	Command	0x00 = RESERVED 0x01 = TOGGLE LAYOUT 0x02 = SET LAYOUT 0x03 = PIP TOGGLE
S32	1-4	Parameter	Depends on Command (See Below)

Command	Valid Range	Description
RESERVED	0	Command is reserved for future use
TOGGLE LAYOUT	0	Step through available screen layouts, depends on mapping setup (Split, Map, Video, PiP)
SET LAYOUT	{0-4}	0 = Split screen view 1 = Map Only View 2 = Video Only View 3 = Picture in Picture (PiP) View, Map small 4 = Picture in Picture (PiP) View, Video small
PIP TOGGLE	0	Only valid when using PiP View, cycles through the windows presented as 'main'

3.10.5. Capture Command

Controls the capture (record and snapshot) functionality of the mapping system. This can be used to take screenshots/stills, start/stop the recorder, etc.

CLASS: 0x85
CODE: 0x05
SIZE: 0x05

Data	Data Index	Description	Comment
U8	0	Command	0x00 = RESERVED 0x01 = TAKE STILLS 0x02 = TOGGLE STILL 0x03 = TOGGLE RECORDER 0x04 = SET RECORDER
S32	1-4	Parameter	Depends on Command (See Below)

Command	Valid Range	Description
RESERVED	0	Command is reserved for future use
TAKE STILLS	{-1,0+}	Request that the mapping system capture stills and optionally show a preview of the primary capture. The parameter is the duration of the preview in ms, with -1 meaning indefinite.
TOGGLE STILL	{-1,0+}	Toggle the visibility of the most recent still. If the result is to display the preview, the parameter represents the duration, with -1 meaning indefinitely.
TOGGLE RECORDER	0	Toggle the video recorder on/off
SET RECORDER	{0,1}	0 = Stop the Recorder 1 = Start the Recorder

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3.10.6. Register Map Command

Register the sending device to receive map commands. This command should be sent by any devices that wish to receive the map commands. Map commands are codes in the Map Class with values 0x00 to 0x7f. By unregistering, you will stop receiving these commands.

CLASS: 0x85
CODE: 0x80
SIZE: 0x01

Data	Data Index	Description	Comment
U8	0	Command	0x00 = UNREGISTER 0x01 = REGISTER

3.10.7. Register Response

Sent to the device registering as a map device to confirm the request.

CLASS: 0x85
CODE: 0x81
SIZE: 0x01

Data	Data Index	Description	Comment
U8	0	Status	0x00 = UNREGISTERED 0x01 = REGISTERED

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3.11. Error CLASS 0xFF

3.11.1. Error Message Packet

Error message packets may be received because of invalid commands.

3.11.2. Unknown CLASS

The message CLASS was not recognized

CLASS: 0xFF
CODE: 0x01
SIZE: 0x01

Data	Data Index	Description	Comment
U8	0	The unknown CLASS	

3.11.3. Unknown CODE

The message CODE was not recognized

CLASS: 0xFF
CODE: 0x02
SIZE: 0x02

Data	Data Index	Description	Comment
U8	0	CLASS of the unknown CODE	
U8	1	The unknown CODE	

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4. Revision history

Revision	Date	By	Summary Change
A	19 DEC 2016	DG	First release
B	27 MAR 2017	SL	2.4.2 Correct Checksum
C	23 NOV 2017	DA	2.4.2 – Corrected AZ Address in Sample 3.6 – Added Sensor Class Messages
D	28 NOV 2017	DA	3.5 – Added Set Ground Altitude Message
E	18 JAN 2018	DA	1.2 – Define Ethernet Connection Parameters
F	13 FEB 2018	DA	3.4.7 – Recorder Control Button Mask 3.6.4 – Added Pedestal-Bump 3.6.9 – Added LRF Alignment Pointer Controls 3.3.11 – Add Gyro Drift 'Adjust' command'
G	02 AUG 2018	DA/DG	1.2 – Added UDP Connection Options 3.6 – Added 'All Video/Photo Sensor' Type +3.7 – Adding VIDEO class (Tracking) 3.6.4 – Added maximum exposure time set and bump commands 3.6.5 – Added High dynamic range command 3.2.3 – Added LRF status bits
H	19 SEP 2018	DA/DG	Changes for v10.7.x Fixed REV A Year in Record of Change (2016) 3.2.3 – Added LRF range correction 3.4.7 – Added radar button mask Messages to support GRIP: 3.7.1 – Add Tracker Toggle commands 3.7.2 – New section, Blend mode 3.7.3 – New section, Modify MTI 3.8 – New Section, Menu Commands 3.6.2 – Added Combined Zoom command 3.4.8 – Set Joystick Command
I	8 AUG 2019	DA	Changes for v10.9.x 3.6 – Adding "Selected Laser" Type 3.9 – Adding External Device Messages
J	31 JAN 2020 (SW v10.11+)	DA	Changes for v10.11.x 3.7 – Added Stills, Stream & Recorder Controls 3.3.12 – Added Rate Aid Control 3.7.1 – Added Start Scene/Secondary command 3.4.8 – Added optional flags to joystick message 1.2 – Added default Ethernet data 3.1 – Added Streaming Examples
K	18 MAR 2021 (SW v10.12+)	DA/DG	3.7.1 – Add Gate and Alternate Track Command 3.7.2 – Fixed Blend Level Bump/Set codes 3.7.6 – Modify CLAHE command added 3.6.7 – Added threshold adjust command 3.6.9 – New Recorder (Photo) control 3.9.2 – Added Extern Filter Bump codes 3.3 – Gimbal commands to support new HCU
L	13 APR 2021 (SW v10.12+)	DA/DG	3.7.5 – Fix IP Address byte ordering 3.1 – Fix Packet Class in Streaming Examples 3.7.1 – Obsolete TOGGLE_MODE in Tracker 3.2 – Added Video Tracker Addresses 2.3 New sensor command Set Detector 3.6.11 Set Detector command description 3.2.3 – Added "Sensor 3", changed labels

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M	25 MAR 2022 (SW v10.13+)	DA	3.6.5 – Add Histogram Set Command 3.7 – Added Video Track Data (MTI Tracks) 3.7 – Added User Message 3.10 – Added Map Commands
N	02 NOV 2022 (SW v10.13+)	JP	New template. TC-300 added.
P	12 JAN 2024 (SW v10.13+)	JP	First page generalized to TC-series.
Q	22 JAN 2024 (SW v10.13+)	JP	Added base part number 2-0602 to first page. 2.3 – Added Video Track Data, User Message, Draw Calibration Markers to Video class. New Map class. 3.6.4 - Added definition for INTEGRATION_MAP 3.7.9 – Added New Video Command (Draw Calibration Marker)
R	24 APR 2024 (SW v10.13+)	JP	3.3.11 – Fixed name (Gyro Drift All) 3.4.8 – Added reserved comment regarding other values 3.5.3 – Removed duplicate size label 3.4.9 – Changed example to use modern version of the packet Various – Modified all Command values to be displayed in HEX Various – All sizes are displayed as HEX with decimals in parentheses for values that are different (larger than 9)
S	03 OCT 2024 (SW v10.13+)	JP DA	1.3 – Changed typo "Polarity" to "Parity". Added "Flow control". 3.2.3 – Add Nav Status and EX Digital Zoom addresses 3.2.3 – Add diagnostic addresses (Temp/RH/SN/LRF Counter)

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