Viewpro Viewlink Serial Command

Communication Protocol V3.3.3

Doc No.: Viewlink V3.3.3

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Update Records：

2021.06.07	V3.3.3	Add U, V packet protocol, add A1 packet manual relative angle control mode and manual RC control mode.
2022.03.25	V3.3.3	Add example commands

Content

1. Physical Layer

Baudrate range for console: 9600 bps, 19200 bps, 38400 bps, 57600 bps, 115200bps, 230400bps, 921600bps etc, default: 115200,

Re. 3. 1 U Communication Configuration Control, 3. 2 V Communication Configuration Status.

Standard: TTL 3.3V

Data bit: 8

Stop bit: 1

Parity bit: None

Flow control: None

2. Link Layer

2.1 Frame Structure (Big-Endian)

Byte	Name	Value	Note
0	Header	0x55	
1		0xaa	
2		0xdc	
3	body length and frame counter	bit 0~5: Body length: n = all bytes from byte3 to checksum. Min=4, max=63. bit 6~7: Frame counter	
4	CMD_ID_SET		
5~n+1	DATA N bytes data		Big-endian
N+2	CHECKSUM	CS =byte3 ~byte(1+n) XOR	

2.2 Data Flow for Entire System

Single frame application layer composition: The application layer of each frame may be composed of more than one data packet, and the combination relationship is as follows:

Direction	Data Packet Composition	Frame ID	Remark
Console to Payload	A1+C1+E1	0x30	14(9+2+3)
	A1+C1+E1+S1	0x32	28(9+2+3+14)
	A1	0x1A	9
	C1	0x1C	2
	E1	0x1E	3
	S1	0x16	14
	A2+C2+E2	0x31	10(2+3+5)
	A2+C2+E2+S2	0x33	15(2+3+5+5)
	A2	0x2A	2
	C2	0x2C	3
	E2	0x2E	5
	S2	0X26	5
	U	0x01	2
Payload to Console	T1+F1+B1+D1	0x40	41(22+1+6+12)
	T2+F2+B2+D2	0x41	49(18+15+11+5)
	V	0x02	2
AHRS(FC) to Payload	M	0xB1	42
Payload to Console	N	0xB2	60
Payload to Console Handshake	SH	0x00	1
Payload to Console Heartbeat	HB	0x10	1

2.3 Notes

a) Infrequently used frame request from the console: the payload normally responds to the T1+F1+B1+D1 frame. Only when a frame A2+C2+E2+S2 (and "infrequently used status feedback control bit" of A2 is set to 1)sent by the console is received, a frame of T2+F2+B2+D2 will be returned, and the infrequent frame request is valid only once, see byte1, bit5 of A2 packet for details.

b) For the control enumeration used in the internal communication of the system, if there is no special instructions, it should be used in accordance with the logic of "edge trigger", that is, it will be executed corresponding operation only when the received control enumeration **has change**. Correspondingly, for the received control parameter quantity, the most recent one shall prevail. For example, for the variable field of view operation of a continuous zoom lens, after receiving the first variable field of view instruction, the lens will continue to change the field of view until it receives the "no action" or "stop" instruction.

c) When sending a heartbeat packet or A1+C1+E1+(S1) packet, reply T1+F1+B1+D1. When sending A2+C2+E2+S2 and the "unusual state return control bit" in A2 is set to 1, it will reply one frame T2+F2+B2+D2.

3. Application Layer

3.1 U Communication Configuration Control 2 Bytes----Frame ID: 0x01

This packet is used to set configurations of payload.

Byte No.	Name	Range	Note
1	Control Command	00: Extract configuration 01: Reserved 02: Reserved 03: Reserved 04: Set #4 Time Zone 05: Set #5 OSD Hide ... Refer to Appendix 1 for more settings.	Refer to Appendix 1 for all settings.
2	Parameters	When the control command is 00 to query the configuration, the parameter is the specified configuration number. When it is less than 133, it is a number query, and when it is greater than 133, it is a group query. 0xFC: #04~#35 0xFD: #36~#67 0xFE: #68~ #99 0xFF: #100~ #131 When the control command is greater than 03, the parameter represents the setting value.	

3.2 V Communication Configuration Status 2 Bytes----Frame ID: 0x02

This packet is feedback of U packet.

Byte No.	Name	Range	Note
1	Control Command	00: Reserved 01: Reserved 02: Reserved 03: Reserved 04: Feedback #4 Time Zone 05: Feedback #5 OSD Hide ... Refer to groups FD, FE, FF in Appendix 1 for more meanings.	When the no. is ≥ 04, it represents setting no. Refer to Appendix 1 for details.
2	Parameters	When control command is 00, it's setting value When control command is 00, it's setting value	

3.3 A1 Servo Control Commonly Used 9 Bytes

Byte No.	Name	Range
1	Servo Control 4bits bit 0~3	Servo Control 0x00: Motor ON/OFF 0x01: Manual speed mode *0x02: Follow the current geographic location (not support yet)* 0x03: Follow yaw 0x04: Home position *0x05: Azimuth scan (not support yet)* 0x06: Tracking mode *0x07: Tilt scan (not support yet)* *0x08: Point to specified target (point to a specific latitude and longitude, not support yet)* 0x09: Manual relative angle mode(current position is 0) 0x0A: Follow yaw disable 0x0B: Manual absolute angle mode (Home position as 0) *0x0C: Follow-up space angle (not support yet)* 0x0D: Manual RC mode *0x0E: Reserved* 0x0F: Do not change the servo state, the parameter is meaningless
	4bits bit 4~7 reserved	
2~3	Parameter 1 2bytes	The meaning changes with the servo state, the default is 0
4~5	Parameter 2 2bytes	The meaning changes with the servo state, the default is 0
6~7	Parameter 3 2bytes	The meaning changes with the servo state, the default is 0
8~9	Parameter 4 2bytes	The meaning changes with the servo state, the default is 0

3.3.1 The Meaning of A1 Parameters

3.3.1.1 For the Servo Control Command is Motor ON/OFF 0x00

Parameter 1 Byte 2~3	0x0100: Motor ON 0x0001: Motor OFF
Byte 6~9	Meaningless

3.3.1.2 For the Servo Control Command is Manual Speed Mode 0x01

Parameter 1 Byte 2~3	Azimuth velocity, signed integer 1bit=0.01° /S
Parameter 2 Byte 4~5	Tilt speed, signed integer 1bit=0.01° /S
Byte 6~9	Meaningless

3.3.1.3 For the Servo Control Command is Azimuth Scan 0x05

Parameter 1 Byte 2~3	When parameter 3 < 32768, it is azimuth speed, 1bit=0.01°/S. When parameter 3 ≥32768, it is azimuth speed, 1bit=0.1°/S, signed integer.
Parameter 2 Byte 4~5	When parameter 3 < 32768, it is tilt speed, 1bit=0.01° /S. When parameter 3 ≥32768, it is tilt speed, 1bit=0.1°/S, signed integer.
Parameter 3 Byte 6~7	When it is < 32768, it means that the scanning range is half width, 1bit=360/65536°. When ≥ 32768 it is a circle scan. At this time, the meaning of bit14-bit0 changes. Bit14 represents the reference frame of the scan angle: 0: relative to the vehicle, 1: relative to the earth. Bit0~7 represent the normalized gain of the tilt scan, 0x00 is the maximum, 0xFF No gain. The rest bits are reserved
Parameter 4 Byte 8~9	When parameter 4 < 32768, it scans center angle，1bit=360/65536°, signed integer. When parameter 4 ≥ 32768, it represents the follow-up angle in the direction orthogonal to the scan, 1bit=360/65536°, signed integer.

3.3.1.4 For the Servo Control Command is Relative Angle Mode 0x09 (Gimbal current position is 0)

Parameter 1 Byte 2~3	Azimuth velocity, 1bit=0.1°/S, signed integer When speed is 0, adopt system default speed.
Parameter 2 Byte 4~5	Azimuth angle, 1bit=360/65536°, signed integer
Parameter 3 Byte 6~7	Tilt speed, 1bit=0.1°/S, signed integer When speed is 0, adopt system default speed.
Parameter 4 Byte 8~9	Tilt angle, 1bit=360/65536°, signed integer

3.3.1.5 For the Servo Control Command is Absolute Angle Mode 0x0b (Gimbal home position as 0)

Parameter 1 Byte 2~3	Azimuth angle, signed integer 1bit=360/65536°
Parameter 2 Byte 4~5	Tilt angle, signed integer 1bit=360/65536°
Byte 6~9	Meaningless

3.3.1.6 For the Servo Control Command is Manual RC Control Mode 0x0d

Parameter 1 Byte 2~3	Azimuth velocity, 1bit=0.1°/S, unsigned integer When speed is 0, adopt system default speed.
Parameter 2 Byte 4~5	Azimuth RC value, 1100~1900, unsigned integer.
Parameter 3 Byte 6~7	Tilt speed, 1bit=0.1°/S, unsigned integer When speed is 0, adopt system default speed.
Parameter 4 Byte 8~9	Tilt RC value, 1100~1900, unsigned integer.

3.4 A2 Servo Control Infrequently Used 2 Bytes

Byte No.	Name	Range
1	Servo Action 5bits bit 0~4	0x00: No action *0x08: Azimuth zero drift adjustment (not support yet)* *0x09: Zero drift calibration (reserved)* The rest bits are reserved
	Infrequently used status feedback control 1bit bit5	0: Not feedback infrequently used frames 1: Feedback infrequently used frames
	Infrequently used frame counter 2bits bit 6~7	Determined by the console/radio to check for frame loss
2	Adjustment 1bytes	8bits signed integer

3.5 B1 Servo Status Commonly Used 6 Bytes

Byte No.	Name	Range
1	Roll angle 4bits bit0-3	Roll angle bit4~7, 1bit=180/4095°, unsigned integer
	Servo Status 4bits bit 4~7	Servo Status 0x00: Motor ON/OFF 0x01: Manual speed mode *0x02: Follow the current geographic location (not support yet)* 0x03: Follow yaw 0x04: Home position *0x05: Azimuth scan (not support yet)* 0x06: Tracking mode *0x07: Tilt scan (not support yet)* *0x08: Point to specified target (point to a specific latitude and longitude, not support yet)* 0x09: Manual relative angle mode(current position is 0) 0x0A: Follow yaw disable 0x0B: Manual absolute angle mode (Home position as 0) *0x0C: Follow-up space angle (not support yet)* 0x0D: Manual RC mode *0x0E: Reserved* 0x0F: Do not change the servo state, the parameter is meaningless
2	Roll angle Bit7~0	Roll angle bit7-0, 1bit=180/4095°, unsigned integer Value 0-90 correspond to 0~-90° Value 90-180 correspond to 0~+90° Roll angle is 12bit in total, bit 8~11 is at bit3~0 of byte 1
3~4	Azimuth angle	1bit=360/65536°, signed integer
5~6	Tilt angle	1bit=360/65536°, signed integer

3.6 B2 Servo Status Infrequently Used 11 Bytes

Byte No.	Name	Range
1	Timer	The cyclic timer with the servo local clock as the reference frame, unsigned integer 1bit=1ms (Reserved)

2	Servo Action Respond 6bits bit 0~4	0x00: No action *0x08: Azimuth zero drift adjustment (not support yet)* *0x09: Zero drift calibration (reserved)*
	Reserve Bit5	
	Not commonly used frame counter 2bits Bit6~7	Equal to the value of the infrequently used frame counter in the most recently received servo control infrequent packet (A2)
3	Fault Info 1bytes	
4~5	Tilt Angle 2bytes	1bit=360/65536°, signed integer
6~7	Tilt angular velocity 2bytes	1bit=0.01°/S, signed integer
8~9	Azimuth velocity 2bytes	1bit=0.01°/S, signed integer
10~11	Tilt angular velocity 2bytes	1bit=0.01°/S, signed integer

3.7 C1 Optical Control Commonly Used 2 Bytes

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
LRF			Operation Command No.							Zoom Speed			Sensor		

Byte No.	Name	Range
1~2	Image Sensor Choose 3bits bit 0~2	Video Choose (tracking infrequently used commands also can be used to switch videos) 0x00: No action 0x01: EO 1 0x02: IR thermal 0x03: EO 1+IR PIP 0x04: IR+EO 1 PIP 0x05: EO 2 **0x06: Fusion (For fixed lens dual sensor)**
	Operation Command 1 corresponding parameter 3bits bit 3~5	When the operation instruction 1 matches the parameter, the default is to indicate the change speed of operation instruction 1 without special instructions. For example: When operation command 1 is 0x08 or 0x09, this parameter means focus speed, 0X01 is slowest, 0X07 is fastest

	Operation Command 1 7bits bit 6~12 (0x00~ 0x7F)	0x00: No action 0x01: Stop focus, stop zoom 0x02: Brightness+ 0x03: Brightness- *0x04: Contrast ratio+ (not support yet)* *0x05: Contrast ratio- (not support yet)* *0x06: Aperture+ (not support yet)* *0x07: Aperture- (not support yet)* 0x08: FOV+ (For discrete field of view lenses, the rising edge is valid, and the digital zoom is included when it is enabled.) Zoom out 0x09: FOV- (For discrete field of view lenses, the rising edge is valid, and the digital zoom is included when it is enabled.) Zoom in 0x0A: Focus+ 0x0B: Focus- *0x0C: Internal non-uniformity correction (not support yet)* *0x0D: External non-uniformity correction(not support yet)* 0x0E: Polarity reversal (IR white hot) 0x0F: Polarity reversal (IR black hot) *0x10: Gain+ (not support yet)* *0x11: Gain- (not support yet)* 0x12: IR Rainbow 0x13: Take picture 0x14: Start record 0x15: Stop record 0x16: Switch to picture mode 0x17: Switch to record mode 0x18: Picture and Record Mode Switch 0x19: Auto focus mode 0x1a: Manual focus mode 0x1b: IR camera Dzoom+ 0x1c: IR camera Dzoom- 0x1d: Format SD card 0x1E: Query SD card status (T series) 0x1F: Query SD card total capacity (T series) 0X20: Query SD card left capacity (T series)

	Laser Rangefinder Command 3bits bit 13~15	0x00: No action 0x01: Laser Single Ranging 0x02: Laser continuous ranging start 0x03: Laser LPCL continuous ranging start (pro models) *0x04: External sync ranging (not support yet)* 0x05: Stop ranging

3.8 C2 Optical Control Infrequently Used 3 Bytes

Byte No.	Name	Range
1	Command 1 1byte	0x00: No action *0x04: Timing non-uniformity correction ON (Reserved)* *0x05: Timing non-uniformity correction OFF (Reserved)* 0x06: EO Dzoom ON 0x07: EO Dzoom OFF *0x10: Image enhance ON (not support yet)* *0x11: Image enhance OFF (not support yet)* 0x12: IR color bar ON (thermometry version) 0x13: IR color bar OFF (thermometry version) 0x14: EO image flip OFF 0x15: EO image flip ON 0x16: Defog OFF 0x17: Defog ON 0x18: Sensor build-in characters ON (OSD ON) 0x19: Sensor build-in characters OFF (OSD OFF) *0x1c: Brightness auto ON(Reserved)* *0x28: Focus auto (Reserved)* *0x2B: Stop focus(Reserved)* 0x4A: Near-infrared mode ON 0x4B: Near-infrared mode OFF *0x4E: Reboot / Auto-check (Reserved)* *0x50: Set brightness to the parameter value of this packet command (Reserved)* *0x51: Set contrast ratio to the parameter value of this packet command (Reserved)* *0x52: Set aperture to the parameter value of this packet command (Reserved)* 0x53: Set EO zoom times to the parameter value of this packet command

		0x54: Set focus to the parameter value of this packet command (Reserved)
		0x55: Set gain/ISO to the parameter value of this packet command (Reserved)
		0x74: Laser control command
		0x75: Optical power control command (Reserved)
2~3	Command 1 2bytes	Integer is non-dimensional, the definition changes according to command 1.

3.8.1 C2 Command Parameter Meaning

3.8.1.1 For Reboot/Auto-check 0x4E

bit0~1	0 No action 1 Reboot 2 Auto-check
The rest bits are reserved	

3.8.1.2 For FOV to the Parameter Value of This Packet Command 0x53

2~3	Define zoom value 2bytes	Unsigned integer, 1bit = 0.1time

3.8.1.3 For Laser Control Command 0x74

0~4bit:	0x00: No action
	0x01: Laser on
	0x02: Laser off
	0x03: Laser system auto-check (not support yet)
	0x04: Laser zoom out
	0x05: Laser zoom in
	0x06: Laser zoom auto-sync EO mode
	0x07: Laser zoom manual control mode
	0x0E: Laser elevation protection OFF (not support yet)
	0x0F: Laser elevation protection ON (not support yet)
The rest bits are reserved	

3.8.1.4 For Power Control Command 0x75

0~1bit	EO 1 Power 0: No change 1: ON 2: OFF

2~3bit	IR Thermal Power 0: No change 1: ON 2: OFF
4~5bit	EO 2 Power 0: No change 1: ON 2: OFF
6~7bit	
8~13bit	Reserved
14~15bit	Laser Power 0: No change 1: ON 2: OFF

3.9 D1 Optical Status Commonly Used 12 Bytes

Byte No.	Name	Range
1	Optical sensor 3 bit bit 0~2	Current video stream 0x00: EO 1 only 0x01: IR only 0x02: EO 1+IR PIP 0x03: IR+EO 1 PIP 0x04: EO 2 only 0x05: Fusion mode Others: backup
	Current IR thermal camera Digital zoom times 4 bit bit 3~6	IR thermal camera digital zoom times: 0x0: X1 0x1: X2 0x2: X3 0x3: X4 ... 0xF: X16
	White hot/ black hot status 1bits Bit 7	To grayscale mode of IR thermal camera 0: White hot 1: Black hot
2	*Laser rangefinder counter* *1bit* *bit 0*	*Laser Rangefinder Counter* *Every time the ranging result is updated (may contain multiple echoes), the counter is inverted, and the value range is 0~1*
	Reserved Bit 1	

	LRF latency 6 bits bit 2~7	Relative to the delay of the servo command received by the optical packet, unsigned integer, 1bit=1ms
3~4	Bit 0~1: Optical Record Status 2bits	BIT0~1 Optical Record Status 0x0: Stop Rec 0x1: Recording 0x2: Pic mode
	Bit 2~5: IR Thermal Status Extension	BIT2~5: IR Thermal Status Extension 0x0: Grayscale mode 0x1: Rainbow
	Current EO camera Digital zoom times 4 bit bit 6~9	EO digital zoom (≥4 times) 0: X1 1: X2 .... 11: X12
	Bit10~15 6bits Reserved	
5~6	RLF feedback value 1 2bytes	RLF feedback value: 1bit = 1m, all 0 means invalid, unsigned integer
7~8	Current sensor vertical FOV 2bytes	Current sensor vertical FOV, unsigned integer 1bit=0.1°
8~9	Current sensor horizontal FOV 2bytes	Current sensor horizontal FOV, unsigned integer 1bit=0.1°
11~12	Current sensor optical zoom times 2bytes	Current sensor zoom times, unsigned integer 1bit=0.1 time

3.10 D2 Optical Status Infrequently Used 5 Bytes

Byte No.	Name	Range
1	Current sensor type 3bits bit 0~2	Current sensor type 0x00: EO 1 only 0x01: IR only 0x02: EO 1+IR PIP 0x03: IR+EO 1 PIP 0x04: EO 2 only
	Device failure Identification 5bits, bit 3~7	Device failure Identification pending. 0 is no failure, 1~3 is laser failure, After that, every 4 fault codes correspond to one sensor

2	Whether the current sensor is the main sensor (reserved) 1bit Bit7	0: Yes 1: No
	Optical sensor pixel quantity 7bit Bit0~6	1: 1080p 2: 2K 3: 4K 4: 960 5: 720 6: 640 The rest are reserved.
3~5	Reserved	

3.11 E2 Tracking Command Commonly Used 3 Bytes

Byte No.	Name	Range
1	Tracking source choose (Reserved) 3bits bit 0~2	0X00: No action 0x01~0x07 Tracking source choose: 0X01: EO 1 0X02: IR 0X03: EO 2
	Parameter 1 5bits Bit3~7	
2	Basic Command 1byte	0X00: No action 0X01: Stop 0X02: Search (Bring up the cross) 0X03: Turn on tracking 0X04: Switch tracking point to cross position(take placed by enable tracking) 0X05: AI ON/OFF 0X06: (Reserved) 0X07: (Reserved) 0X08: AI auto-track once recognized 0X20: 16×16 ultra small template (reserved) 0X21: 32×32 small template 0X22: 64×64 medium template 0X23: 128×128 big template 0X24: Self-adapt between small and medium template 0X25: Self-adapt between small and big template 0X26: Self-adapt between medium and big template

		0X28: Self-adaption between small, medium and big template
3	Parameter 2 1byte	

3.11.1 The Meaning of E1 Command Parameter

3.11.1.1 For Search Command 0x02

Parameter 1	1-15 move right 16-31 move left	To control azimuth velocity of the small cross, unsigned integer, non-dimensional
Parameter 2	1-15 move down 16-31 move up	To control tilt velocity of the small cross, unsigned integer, non-dimensional

3.11.1.2 For AI ON/OFF Command 0x05

Parameter 2	1byte	0: OFF 1: ON

3.11.1.3 For Adjust Tracking Velocity Coefficient 0x07

Parameter 2	1byte	Tracking velocity coefficient. 0 adopt system default tracking velocity. Unit: 0.1 time. Actual tracking velocity = Coefficient * system default tracking velocity.

3.11.1.4 For Adjust Tracking Velocity 0x06

Parameter 2	1byte	Tracking velocity. 0 adopt system default tracking speed. Unit: 0.2 degree/sec.

3.12 E2 Tracking Command Infrequently Used 5 Bytes

Byte No.	Name	Range
1	Extended Command1 1byte	0x01~0x0F: Control display content 0X02: Character display ON 0X03: Character display OFF 0X04: Display center cross 0X05: Hide center cross 0X06: GPS data display ON 0X07: GPS data display OFF 0X08: Gimbal angle display ON 0X09: Gimbal angle display OFF 0X0A: The tracking point moves to the command

		position
		0X0B: Specified rectangular area point 1
		0X0C: Specified rectangular area point 2
		0x10：Normal display sensor 00 (Reserved)
		0x11：Normal display sensor 01 (Reserved)
		0x12：Normal display sensor 02 (Reserved)
		0x20：PIP display 1 (00, 01) (Reserved)
		0x21：PIP display 2 (01, 00) (Reserved)
2~3	Parameter 1 2bytes	
4~5	Parameter 2 2bytes	

3.12.1 The Meaning of E2 Command Parameter 1 and 2

3.12.1.1 For The Tracking Point Moves to the Command Position 0X0A

Parameter 1	Tracking point azimuth command position, signed integer, 1bit=1pixel
Parameter 2	Tracking point tilt command position, signed integer, 1bit=1pixel

3.12.1.2 For Specified Rectangular Area Point 1&2 Command 0X0C

Parameter 1	X coordinate, signed integer (Left negative, right positive), 1bit=1pixel
Parameter 2	Y coordinate, signed integer (up negative, down positive), 1bit=1pixel

3.13 F1 Tracking Status Commonly Used 1 Byte

Byte No.	Name	Range
1	Sensor for tracking 3bits bit 0~2	Sensor for tracking 0x0：EO 1 0x1：IR thermal camera 0x2：EO 2
	2bits bit 3~4	Tracker current status 0x00: Stop 0x01: Search 0x02: Tracking 0x03: Lost
	3bits bit 5~7	Reserved

3.14 F2 Tracking Status Infrequently Used 15 Bytes

Byte No.	Name	Range
1~11	Reserved	Reserved
12~13	Azimuth target Pixel difference	Signed integer 1bit=1pixel
14~15	Tilt target Pixel difference	Signed integer 1bit=1pixel

3.15 S1 TGCC Control Commonly Used 14 Bytes

Byte No.	Name	Range
1	Calculation Command	0x00 No action 0x01 Gimbal to target with specified coordinate *0x02 Manual (air-to-ground) (Not support yet)* *0x03 Follow the current geographic location (Not support yet)* 0x04 Follow-up space angle. The rest are reserved.
2	Reserved	
3~14	Parameter	

3.15.1 The Meaning of Parameter

3.15.1.1 For Fixed-point Follow-up Command 0x01

Byte No.	Meaning
3~6	Point to specified target latitude 32bits signed integer Positive is north latitude Negative is south latitude 1bit=10^-7°, WGS-84
7~10	Point to specified target longitude 32bits signed integer Positive is east longitude Negative is west longitude 1bit=10^-7°, WGS-84
11~14	Point to specified target height 1bit=0.001m 0 corresponds to altitude 0m Int32

3.15.1.2 For Follow-up Space Angle Command 0x04

Byte No.	Meaning
3~6	The angle between the azimuth angle that the optical axis follows and the true north direction, 0 is true north, and positive is north east. Int32, 1bit=360/2^32degree
7~10	The angle between the tilt angle of the optical axis and the horizontal plane, 0 is horizontal, and positive is horizontal upwards. Int32, 1bit=360/2^32degree
11~14	Reserved

3.16 S2 TGCC Control Infrequently Used 5 Bytes

Byte No.	Name	Range
1	Configuration Command	0x00 No action *0x01 Set the current altitude as the takeoff altitude (Reserved)* *0x02 Give the current target coordinate altitude (Reserved)* *0x03 Save the current target altitude (Reserved)* The rest are reserved.
2~5	Configuration Parameter	

3.17 T1 TGCC Control Commonly Used 22 Bytes

Byte No.	Name	Range
1	Target distance source type 3bits Bit0~2	0x0 No Target 0x1 Laser Rangefinder value 0x2 Height estimate value *0x3 Radio frequency (Reserved)* The rest are reserved
	GPS signal capture stage 2bits Bit3~4	0x0 No signal *0x1 Time lock* *0x2 2D Lock in* *0x3 3D Lock in*
	GPS Horizontal signal quality 3bits Bit5~7	Reserved

	GPS vertical signal quality 3bits Bit0~2	Reserved
2	S2 packet command respond 1bit Bit3	0: Not received 1: Responded to S2 packet command, only continued 1 frame
	N packet command respond 4bits Bit4-7	1: Gyro offset auto adjusting 2: Gyro offset saving 3: Gyro offset recovered to factory default value 4: 0 angle position of AHRS adjusted 5: AHRS attitude offset Saving 6: AHRS attitude offset reset 7: Calibrating gyro temperature drift 8: Gyro temperature drift calibrated over
3~6	Vehicle position: Latitude 4bytes	32bits, signed integer Positive is north latitude Negative is south latitude 1bit=10^-7°, WGS-84
7~10	Vehicle position: Longitude 4bytes	32bits signed integer Positive is east longitude Negative is west longitude 1bit=10^-7°, WGS-84
11~12	Vehicle attitude: 2bytes	Int16, 1bit=1m
13~16	Target position: Latitude 4bytes	32bits, signed integer Positive is north latitude Negative is south latitude 1bit=10^-7°, WGS-84

17~20	Target position: Longitude 4bytes	32bits signed integer Positive is east longitude Negative is west longitude 1bit=10^-7°, WGS-84
21~22	Target attitude: 2bytes	Int16, 1bit=1m

3.18 T2 TGCC Control Infrequently Used 18 Bytes

Byte No.	Name	Range
1	Reserved	
2~3	Date 2bytes	Bit15~11: Day Bit10~7: Month Bit6~0: Year (+2000)
4~6	Time 3bytes	UTC time 1bit=0.01s
7~8	GPS Yaw 2bytes	1bit=360/65536°, signed integer
9~10	Vehicle attitude angle: Azimuth 2bytes	1bit=360/65536°, signed integer
11~12	Vehicle attitude angle: Tilt 2bytes	1bit=360/65536°, signed integer
13~14	Vehicle attitude angle: Tilt 2bytes	1bit=360/65536°, signed integer
15~18	Reserved	

3.19 M AHRS Sensor Output Data 1~42bytes

Note:

1) The data output organization of AHRS changes with the indication of byte 1 data type (bit0~4). The data output sequence is shown as follows. **When there is data lost in the middle, the following data is automatically aligned forward, so when the output data content is different, The length of the M packet is different.**

2) Definition of the attitude angle of the vehicle: **Look from the tail of the vehicle to the head**. Azimuth angle: 0 is the nose pointing to true north, positive is the nose pointing east by north, and negative for west by north. Tilt angle: The angle between nose and the horizontal. 0 is horizontal, positive is upwards, and negative is downwards. Tilt angle: 0 when the fuselage is level, positive is right tilt, and negative is left tilt.

Byte No.	Name	Range	Byte No.
1	Data type 5bits Bit0~4	Bit0: Attitude_DATA Bit1: GPS_DATA Bit2: Gyro_DATA	Set to 1 to includes this data group Default 0x07
	Bit5~7	Reserved	
2~8		Reserved	
9~10	Vehicle tilt angle 2bytes	1bit=360/65536°, signed integer	Attitude_DATA
11~12	Vehicle tilt angle 2bytes	1bit=360/65536°, signed integer	Attitude_DATA
13~14	Vehicle yaw angle 2bytes	1bit=360/65536°, signed integer	Attitude_DATA
15~16	Date 2bytes	Bit15~11: Day Bit10~7: Month Bit6~0: Year（+2000）	GPS_DATA
17~19	Time 3bytes	UTC time 1bit=0.01s	GPS_DATA
20~21	GPS yaw 2bytes	1bit=360/65536°, signed integer	GPS_DATA
22	Position mark (reserved) 1byte	bit 0 set: New Position bit 1 set: Clock fix calculated this position bit 2 set: Horizontal coordinates calculated this position bit 3 set: Height calculated this position	GPS_DATA
23~26	Latitude 4bytes	1bit=10^-7°, signed integer	GPS_DATA
27~30	Longitude 4bytes	1bit=10^-7°, signed integer	GPS_DATA
31~34	Height 4bytes	1bit=1mm, signed integer	GPS_DATA
35~36	Ground X Speed (Latitude, positive north) 2bytes	1bit=0.01m/s, signed integer	GPS_DATA
37~38	Ground Y Speed (Longitude, positive east) 2bytes	1bit=0.01m/s, signed integer	GPS_DATA
39~40	VDOP 2bytes	1bit=0.01	GPS_DATA
41~42	Ground Z Speed (Altitude, positive down) int16	1bit=0.01m/s, signed integer	GPS_DATA

Checksum:

```
uint8_t viewlink_protocol_checksum(uint8_t* viewlink_data_buf)
{
        uint8_t len = viewlink_data_buf[3];
        uint8_t  checksum = len;
        for(uint8_t i =0;i < len-2;i++)
        {
                checksum = checksum ^ viewlink_data_buf[4+i]);
        }
        return(checksum);
}
```

Command ID	Command Name	Description
0x04	Time zone	Int8, -12 ~ 12
0x05	OSD hide	Uint8, detail ref: Table OSD on/hide control
0x06	magnetic_declination	Int8, unit 0.1degree
0x07	Osd type	Uint8, detail ref: Table OSD type control
0x08	Baud rate	Uint8,detail ref: table baud rate control
0x09	EO digital zoom	Uint8 0: disable 1: enable
0x0a	Temperature door 0xrs	Uint16,Temperature door for alarm (thermal camera).0xpqrs ,unit 1degree.
0x0b	Temperature door 0xpq	
0x0c	Tracking	0：disable， 1: enable
0x0d	LRF default mode	0: stop 1：continuous (with LRF model)
0x0e	Record resolution	0：1080p 1:4k (just for Z40K)
0x0f	Target pos calculation	Uint8, **Table: target position calculation byte**
0x10	RC channels map mode	1,(1~7) 2,(6~12) 3,(9~15) 4,custom definition
0x11	Yaw channel	0xRL : L =yaw left ch ,R = yaw right ch
0x12	Pitch channel	0xUD: U =pitch up ch, D =pitch down ch
0x13	Recenter/Speed channel	0xRS: R= recenter ch, S = speed control ch
0X14	Zoom channel	0xIO: I = Zoom in ch, O = zoom out ch
0X15	PiP /IR color channel	0xPC: P= Picture in picture ch C:color switch ch
0X16	record /shoot channel	0xRS: R= record ch S: shoot ch

0X17	Tracking channel	0xSE: S = start tracking ch E: Exit tracking ch
0x18	Focus hold mode	For Z5S, Z6KA7
0x19	reserved	
0x1a	YPMZ invert control	Table :YPMZ invert control
0x1b	PRM invert control	Table: PRM invert control
0x1c	reserved	
0x1d	reserved	
0x1e	reserved	
0x1f	reserved	
0x20	Output control	Bit0 = 1, reset ip to 192.168.2.119 Bit1 = 1, output tracking date from serial port Bit2 =1, output mavlink msg from tcp/udp port Bit3 =1, output mavlink msg from serial port
0x21	Z40k resolution OSD	0X10 , ON ; 0X20 OFF
0x22	Z40K date OSD	0X80 ,ON; 0X90, OFF
0x23	Z40K all OSD	0X40, ON; 0X30, OFF
0x24	Z40K SD remain OSD	0XB0, ON; 0XA0, OFF
0x25	Z40K record time OSD	0XC0, ON; 0XD0, OFF
0x26	Z40K record mode OSD	0X01, shoot mode; 0X00 record mode
0x27	Reserved	
0x28	Reserved	
0x29	Reserved	
0x2a	Reserved	
0x2b	Reserved	
0x2c	Reserved	
0x2d	Reserved	
0x2e	Flip control	Bit0 = 1, EO flip off Bit1 =1, EO flip on Bit4 - 1, IR flip off Bit5 =1, IR flip on
0x2f	IR raw data record	Bit0 = 0 off, bit0=1,on Bit1 =0 use IMU angle, bit1=1 use encoder angle
0x30	Interval time 0xrs	0xpqrs : Interval time for gimbal attitude output. Unit ms.
0x31	Interval time 0xpq	
0x32	Mavlink system ID	Default is 1
0x33	Interval time for shoot	Unit 100ms.

Table-A: OSD ON/hide control byte		
Bit0	0: all OSD on	1: all OSD hide
Bit1	0: cross frame on	1: cross frame hide
Bit2	0: pitch & yaw ON	1: pitch & yaw hide
Bit3	0: track point(X,Y) on	1: track point(X,Y) hide
Bit4	0: GPS on	1: GPS hide
Bit5	0: time on	1: time hide
Bit6	0: zoom/fov on	1: zoom/fov hide

Table-B: OSD type control byte		
Bit0	0: no save settings	1: save settings
Bit1	0: no time input	1: external input time,date,year
Bit2	0: no GPS input	1: external GPS input
Bit3	0: format is GPS	1: format is MGRS
Bit4	0: no pitch/yaw input	1: pitch/yaw input enable
Bit5	0: no zoom/fov input	1: zoom/fov input enable
Bit6	0: zoom times	1: fov
Bit7	0: Reserved	1: Reserved

Table-C: Target position calculation byte	
Bit0:	OSD GPS type 0: display UAV GPS information on OSD 1: display Object GPS information on OSD
Bit1~bit3:	reserved
Bit4:	serial data output enable/disable 0: serial port does not output data 1: serial port output data
Bit5~7:	data format of output from serial 0: v1 format 1: v2 format 2: v3 format

Table-D: Baud rate control byte	
0	Default 115200
1	4800
2	9600
3	19200
4	38400
5	57600
6	115200
7	S.bus

| 8 | 2400 |
| 9 | 500000 |

Table-E: YPMZ invert control	
Bit0	Zoom out control 0: 1900 zoom out , 1500 zoom stop 1: 1100 zoom out,1500 zoom stop
Bit1	Zoom in control 0: 1100 zoom in , 1500 zoom stop 1: 1900 zoom in , 1500 zoom stop
Bit2	Speed control 0: 1900 for slowest speed 1: 1100 for slowest speed
Bit3	Recenter 0: 1100 for recenter 1: 1900 for recenter
Bit4	pitch up control 0: 1900 for pitch up, 1500 for pitch stop 1: 1100 for pitch up, 1500 for pitch stop
Bit5	pitch down control 0: 1100 for pitch down, 1500 for pitch stop 1: 1900 for pitch down, 1500 for pitch stop
Bit6	Yaw left control 0: 1900 for yaw left, 1500 for yaw stop 1: 1100 for yaw left, 1500 for yaw stop
Bit7	Yaw right control 0: 1100 for yaw right, 1500 for yaw stop 1: 1900 for yaw right, 1500 for yaw stop

Table-F: PRM invert control	
Bit0	RESERVED
Bit1	RESERVED
Bit2	Speed control 0: 1900 for slowest speed (from 1100 to 1900) 1: 1100 for slowest speed (from 1900 to 1100)
Bit3	Recenter 0: 1100 for recenter (from 1500 to 1100) 1: 1900 for recenter (from 1500 to 1900)
Bit4	shoot control 0: 1900 for shoot (from 1500 to 1900) 1: 1100 for shoot (from 1500 to 1100)

Bit5	record control
	0: 1100 for record start/stop (from 1500 to 1100)
	1: 1900 for record start/stop(from 1500 to 1900)
Bit6	Picture in picture control
	0: 1900 for picture in picture control (from 1500 to 1900)
	1: 1100 for picture in picture control (from 1500 to 1100)
Bit7	IR Color control
	0: 1100 for IR color (from 1500 to 1100)
	1: 1900 for IR color (from 1500 to 1900)

4. Example

4.1 Gimbal movement

Gimbal moves with speed 20°/s：

Left: 55 AA DC 11 30 01 F8 30 00 00 00 00 00 00 00 00 00 00 00 E8

Right: 55 AA DC 11 30 01 07 D0 00 00 00 00 00 00 00 00 00 00 00 F7

Up: 55 AA DC 11 30 01 00 00 07 D0 00 00 00 00 00 00 00 00 00 F7

Down: 55 AA DC 11 30 01 00 00 F8 30 00 00 00 00 00 00 00 00 00 E8

Stop: 55 AA DC 11 30 01 00 00 00 00 00 00 00 00 00 00 00 00 00 20

Angle control gimbal to yaw right to 90°, tilt down to 90°:

Angle control: 55 AA DC 11 30 0B 3F FC 3F FC 00 00 00 00 00 00 00 00 00 2A

Other controls:

Recenter: 55 AA DC 11 30 04 00 00 00 00 00 00 00 00 00 00 00 00 00 25

Enable follow yaw: 55 AA DC 11 30 03 00 00 00 00 00 00 00 00 00 00 00 00 00 22

Disable follow yaw: 55 AA DC 11 30 0A 00 00 00 00 00 00 00 00 00 00 00 00 00 2B

Motor ON: 55 AA DC 11 30 00 01 00 00 00 00 00 00 00 00 00 00 00 00 20

Motor OFF: 55 AA DC 11 30 00 00 01 00 00 00 00 00 00 00 00 00 00 00 20

4.2 Sensor Control

Zoom in: 55 AA DC 11 30 0F 00 00 00 00 00 00 00 00 02 78 00 00 00 54

Zoom out: 55 AA DC 11 30 0F 00 00 00 00 00 00 00 00 02 38 00 00 00 14

Stop zoom: 55 AA DC 11 30 0F 00 00 00 00 00 00 00 00 00 00 00 00 00 2E

Directly zoom to 20x times： 55 AA DC 0D 31 00 00 53 00 C8 00 00 00 00 00 00 A7

Switch pic and rec modes: 55 AA DC 11 30 0F 00 00 00 00 00 00 00 00 06 10 00 00 00 38

Take picture: 55 AA DC 11 30 0F 00 00 00 00 00 00 00 00 04 D0 00 00 00 FA

Start record: 55 AA DC 11 30 0F 00 00 00 00 00 00 00 00 05 10 00 00 00 3B

Stop record: 55 AA DC 11 30 0F 00 00 00 00 00 00 00 00 05 50 00 00 00 7B

4.3 With tracking function

Start tracking: 55 AA DC 11 30 06 00 00 00 00 00 00 00 00 00 00 00 03 00 24
Stop tracking: 55 AA DC 11 30 01 00 00 00 00 00 00 00 00 00 00 01 01 00 20
Point to track: 55 AA DC 0D 31 00 00 00 00 00 0A FF 88 01 18 58

4.4 With digital zoom (Dzoom)

IR Dzoom+ : 55 AA DC 11 30 0F 00 00 00 00 00 00 00 00 06 D0 00 00 00 F8
IR Dzoom- : 55 AA DC 11 30 0F 00 00 00 00 00 00 00 00 07 10 00 00 00 39
EO Dzoom ON : 55 AA DC 0D 31 00 00 06 00 00 00 00 00 00 00 3A
EO Dzoom OFF: 55 AA DC 0D 31 00 00 07 00 00 00 00 00 00 00 3B

4.5 IR thermal camera

EO + IR White hot : 55 AA DC 11 30 0F 00 00 00 00 00 00 00 00 03 83 00 00 00 AE
EO + IR Black hot : 55 AA DC 11 30 0F 00 00 00 00 00 00 00 00 03 C3 00 00 00 EE
EO + IR Pseudo color : 55 AA DC 11 30 0F 00 00 00 00 00 00 00 00 04 83 00 00 00 A9