



HTD-22-PAL VIDEO TRACKER

ELECTRONIC DEVICE FOR AUTOMATIC OBJECT TRACKING ON VIDEO
(Technical manual)

Device model: HTD-22-PAL-OEM
Software version: 1.0
Document version: 1.0
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DOCUMENT VERSIONS

Table 1 – Document versions.

Version	Description
1.0	Description of the HTD-22-PAL device.

SOFTWARE VERSIONS

Table 2 – SIRIUS HTD-22-PAL software versions.

Version	Description
1.0	Implemented: <ul style="list-style-type: none">• Video signal capture from three independent video sources.• Video compression and video transmission via Ethernet (up to three channels simultaneously).• Three independent tracking channels.• Control via the Rs485 interface.

DEVICE MODELS

Table 3 – HTD-22-PAL device models.

Model	Description
HTD-22-PAL-OEM	Device without housing.
HTD-22-PAL-BOX	Device with housing.

DESCRIPTION

The HTD-22-PAL device (device) is designed for automatic tracking of objects selected by the operator in video stream. In addition to automatic tracking, the device compresses the video and transfers it to the consumer. The device is a compact electronic module consisting of several electronic boards, and is intended to be used as a part of other equipment.

The device performs:

1. Capturing the analog video signal (PAL standard) from three independent video sources.
2. Compressing the video signal from three independent video sources and transferring it to the consumer.
3. Tracking calculation for selected objects.
4. Transferring the tracking data to the consumer.

BASIC CHARACTERISTICS

The basic characteristics of the device are given in Table 4.

Table 4 – Basic characteristics.

Parameter	Value and Note
Type and number of video inputs	Three independent video inputs of the PAL standard. The input resistance is 75 Ohm.
Control interface	RS-422, RS-485 (4-wire or 2-wire).
Video transmission interface	Two Ethernet 1000base-T interfaces.
Video compression	Simultaneous compression of three video channels. The compression format is JPEG.
Compressed video transmission protocol	RTP. It is compatible with any software that supports this protocol.
Number of tracking channels	Three independent tracking channels (one tracking channel per one video source).
Tracking algorithm	The modified correlation algorithm. To implement the tracking algorithm, the RF_VIDEO_TRACKER v2.3 software library is used. The

Parameter	Value and Note
	characteristics of automatic tracking correspond to the characteristics of the RF_VIDEO_TRACKER v2.3 software library.
Data transmission frequency	25 Hz (for video and tracking data).
Frame processing frequency	25 Hz (corresponds to the frequency of input video frames).
Duration of the frame processing cycle	No more than 10 ms between receiving the video frame and transmitting data to the consumer.
Device configuration	Device configuration is carried out via the WEB interface of the device.
Control protocol	This protocol is proprietary. The SDK is supplied for all types of operating systems. The control is performed via the RS-485 interface.
Connector types	Vibration-resistant.
Dimensions (h./w./l.)	85 mm / 55 mm / 25 mm (with connectors).
Weight	200 gram.
Power supply	from +6 V to +14 V DC.
Operating temperature	from -40 to +60°C.
Power consumption	Up to 15 W.

NOTE: device parameters can be changed by customer's request.

APPEARANCE AND INTERFACES

The appearance and interfaces of the device are shown in Figure 1.

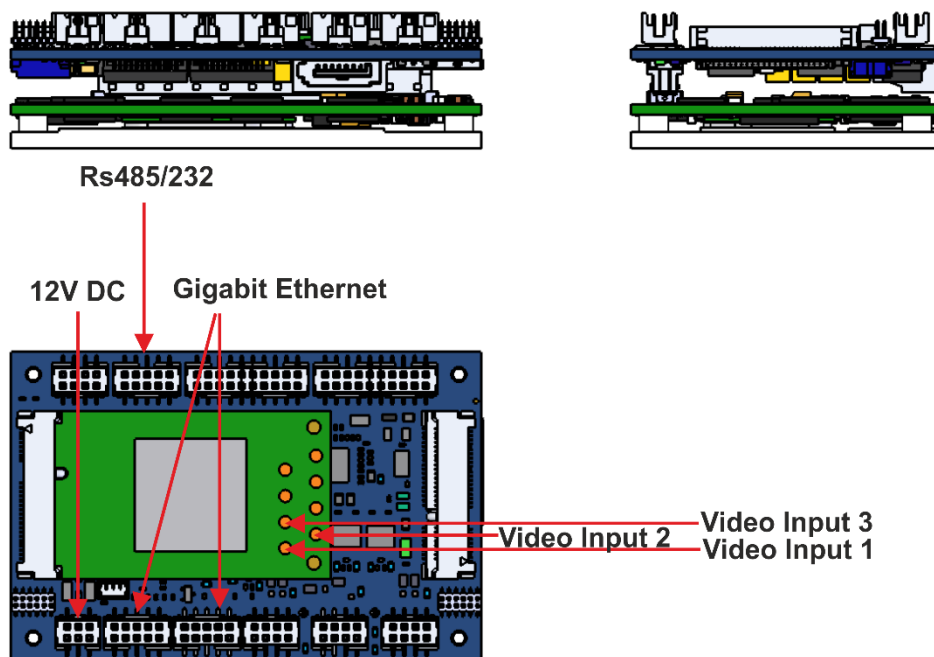


Figure 1 – Appearance and interfaces of the device.

Figure 2 shows the side with connectors. If necessary, they can be used to perform additional functions in accordance with the customer's requirements.

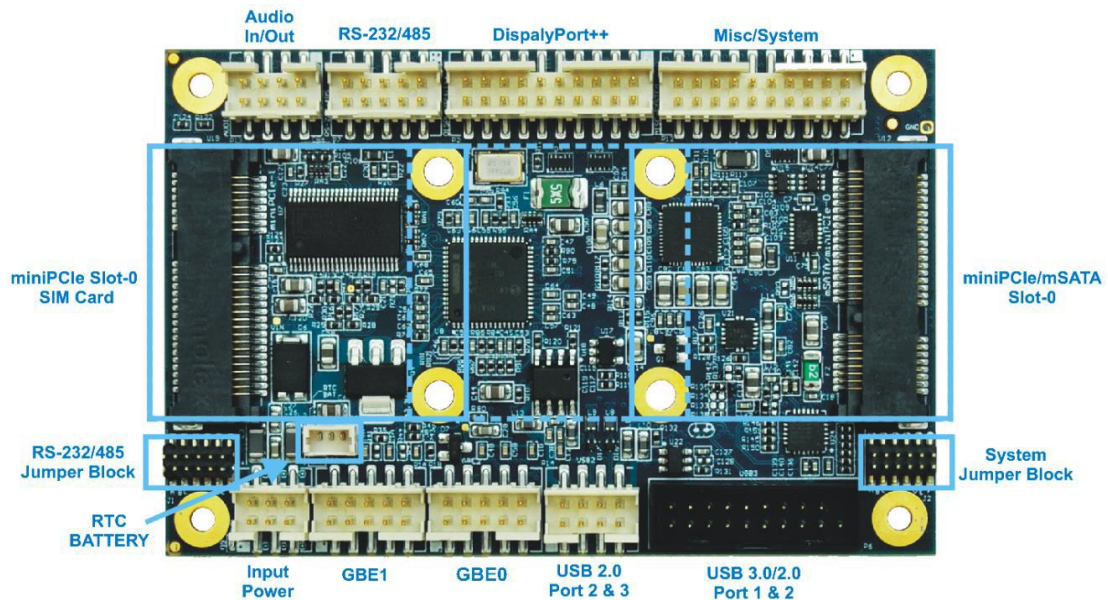
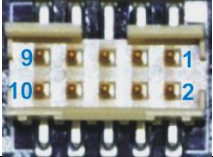
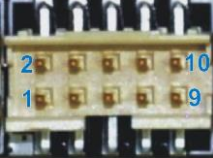


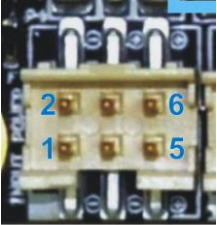

Figure 2 – Appearance of the side with connectors.

Interface connectors

Table 5 lists the device interfaces and the corresponding connectors.

Table 5 – Device interfaces and connectors.

Interface	Connector	Pin assignment																																	
Rs485	<p>On the device: 98424-G52-10LF - Manufacturer: FCI</p> <p>Jack: 10073599-010LF - Manufacturer: FCI</p> <p>The device uses the first Rs-485 interface</p>	 <table border="1"> <thead> <tr> <th>Pin</th> <th>Signal</th> <th>Description</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>232TX0/485TX0+</td> <td>RS-232 0 Transmit / RS-485 0 Transmit +</td> </tr> <tr> <td>2</td> <td>232RX0/485RX0+</td> <td>RS-232 0 Transmit / RS-485 0 Transmit +</td> </tr> <tr> <td>3</td> <td>485TX0-</td> <td>RS-485 0 Transmit -</td> </tr> <tr> <td>4</td> <td>485RX0-</td> <td>RS-485 0 Transmit -</td> </tr> <tr> <td>5</td> <td>232/485-GND0</td> <td>Port 0 Ground</td> </tr> <tr> <td>6</td> <td>232/485-GND1</td> <td>Port 1 Ground</td> </tr> <tr> <td>7</td> <td>232TX1/485TX1+</td> <td>RS-232 1 Transmit / RS-485 1 Transmit +</td> </tr> <tr> <td>8</td> <td>232RX1/485RX+</td> <td>RS-232 1 Transmit / RS-485 1 Transmit +</td> </tr> <tr> <td>9</td> <td>485TX1-</td> <td>RS-485 1 Transmit -</td> </tr> <tr> <td>10</td> <td>485RX1+</td> <td>RS-485 1 Receive -</td> </tr> </tbody> </table>	Pin	Signal	Description	1	232TX0/485TX0+	RS-232 0 Transmit / RS-485 0 Transmit +	2	232RX0/485RX0+	RS-232 0 Transmit / RS-485 0 Transmit +	3	485TX0-	RS-485 0 Transmit -	4	485RX0-	RS-485 0 Transmit -	5	232/485-GND0	Port 0 Ground	6	232/485-GND1	Port 1 Ground	7	232TX1/485TX1+	RS-232 1 Transmit / RS-485 1 Transmit +	8	232RX1/485RX+	RS-232 1 Transmit / RS-485 1 Transmit +	9	485TX1-	RS-485 1 Transmit -	10	485RX1+	RS-485 1 Receive -
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Ethernet 1000base-T	<p>On the device: 98424-G52-10LF - Manufacturer: FCI</p> <p>Jack: 10073599-010LF - Manufacturer: FCI</p>	 <table border="1"> <thead> <tr> <th>Pin</th> <th>Signal</th> <th>Description</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>MX1-</td> <td>Ethernet Pair 1</td> </tr> <tr> <td>2</td> <td>MX1+</td> <td>Ethernet Pair 1</td> </tr> <tr> <td>3</td> <td>MX2-</td> <td>Ethernet Pair 2</td> </tr> <tr> <td>4</td> <td>MX2+</td> <td>Ethernet Pair 2</td> </tr> <tr> <td>5</td> <td>SHELL</td> <td>RJ Shell Connection</td> </tr> <tr> <td>6</td> <td>SHELL</td> <td>RJ Shell Connection</td> </tr> <tr> <td>7</td> <td>MX3-</td> <td>Ethernet Pair 3</td> </tr> <tr> <td>8</td> <td>MX3+</td> <td>Ethernet Pair 3</td> </tr> </tbody> </table>	Pin	Signal	Description	1	MX1-	Ethernet Pair 1	2	MX1+	Ethernet Pair 1	3	MX2-	Ethernet Pair 2	4	MX2+	Ethernet Pair 2	5	SHELL	RJ Shell Connection	6	SHELL	RJ Shell Connection	7	MX3-	Ethernet Pair 3	8	MX3+	Ethernet Pair 3						
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1	MX1-	Ethernet Pair 1																																	
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Interface	Connector	Pin assignment																							
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		9	MX4-	Ethernet Pair 4																					
		10	MX4+	Ethernet Pair 4																					
Power 12V DC	On the device: 98424-G52-06LF - Manufacturer: FCI Jack: 10073599-006LF - Manufacturer: FCI	 <table border="1"> <thead> <tr> <th>Pin</th> <th>Signal</th> <th>Description</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>GND</td> <td>Ground / Return</td> </tr> <tr> <td>2</td> <td>GND</td> <td>Ground / Return</td> </tr> <tr> <td>3</td> <td>GND</td> <td>Ground / Return</td> </tr> <tr> <td>4</td> <td>+VIN</td> <td>Power In</td> </tr> <tr> <td>5</td> <td>+VIN</td> <td>Power In</td> </tr> <tr> <td>6</td> <td>+VIN</td> <td>Power In</td> </tr> </tbody> </table>			Pin	Signal	Description	1	GND	Ground / Return	2	GND	Ground / Return	3	GND	Ground / Return	4	+VIN	Power In	5	+VIN	Power In	6	+VIN	Power In
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3	GND	Ground / Return																							
4	+VIN	Power In																							
5	+VIN	Power In																							
6	+VIN	Power In																							
Analog video inputs	Jack: U.FL-PR-SMT2.5-1(10) – Manufactured: Hirose Connector																								

OPERATION PRINCIPLE

The device captures the video frames from three analog video inputs simultaneously. Then, the device compresses the captured video frames and transfers them to the consumer over the RTP protocol via the Ethernet interface. The compressed video is transferred only from the channels allowed by the operator (starting and stopping of the stream is performed by the operator's command). At the same time, the tracking calculation is performed simultaneously for three channels. To capture an object for tracking, it is necessary to send a command via the RS-485 interface. To control the tracking process (to reset or change settings, etc), the special commands must be formed and sent. For each processed video frame of all tracking channels, the device forms the tracking data regardless of the operation modes of the tracking channels. The tracking data formed for each video frame are transferred continuously (at the frequency of 25 Hz) to the consumer via the RS-485 interface.

DEVICE CONTROL

Device control principle

The device must be configured before using as a part of a system. The device configuration is carried out via the WEB interface of the device. The device configuration includes setting the IP address and UDP ports (for each video source). The device control is carried out via the RS-485 interface (2-wire or 4-wire) and consists in controlling the tracking channels, as well as in starting and stopping the video stream transmission over the RTP protocol. The device forms the tracking data for each processed video frame of each tracking channel, and transfers them via the RS-485 interface. Below is the format of the device control packet and tracking data packet.

Device configuration

To configure the device parameters, use the WEB interface of the device. By default, the device IP address is **192.168.0.3**. To access the WEB interface, it is necessary to input the device IP address in the WEB browser. Figure 3 shows the WEB interface of the device.

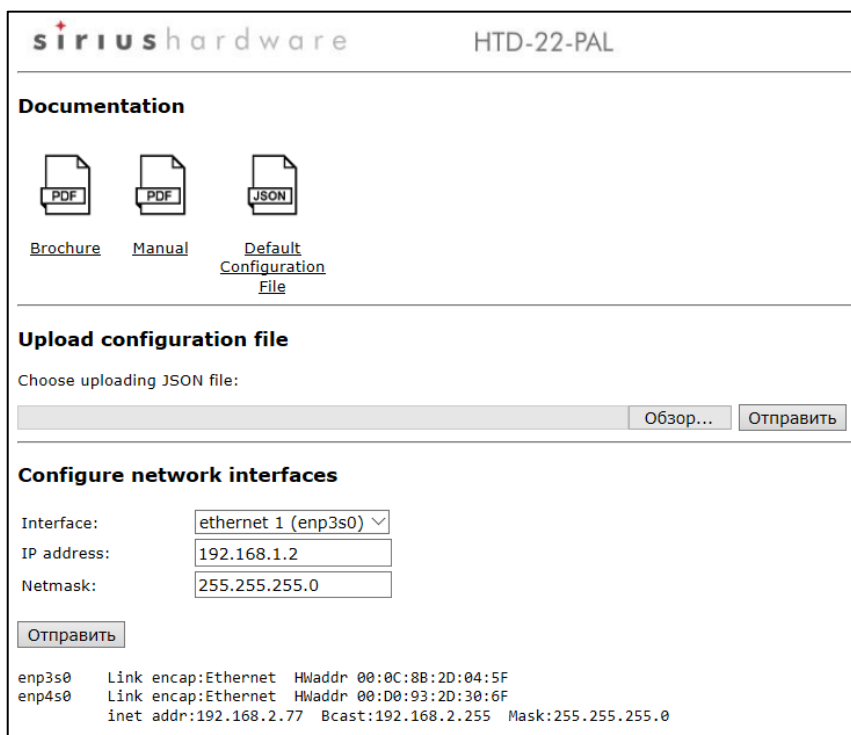


Figure 3 – WEB interface.

The WEB interface of the device includes three sections: “Documentation” section, “Upload configuration file” section, “Configure network interfaces” section.

The “Documentation” section allows to download the technical documentation and the default configuration file.

The “Upload configuration file” section allows to set the device parameters. The configuration file allows to set the following parameters:

1. The RS-485 (RS-422) interface number. The device has two RS-485 (RS-422) interfaces. The user can select one of them: “/dev/ttyS0” or “/dev/ttyS1”.
2. Video input numbers for each tracking channel. The device has three tracking channels (one per each video input).
3. IP addresses and destination port numbers for transmitting the video stream over RTP to the consumer.

To form the device configuration file, it is recommended to download the default configuration file in the “Documentation” section of the WEB interface, and then to edit it. Reboot the device (reconnect the power supply) in order for the changes to take effect.

To configure the device IP address, go to the “Configure network interfaces” section. The device has two network interfaces for video transmission. For each interface, the user can set the IP address and subnet mask. To apply the new IP address, click the «Отправить» button. The configuration data are displayed below.

The format of the tracking channel control packet

The operation modes and functionality of the tracking channel correspond to the operation modes of the RF_VIDEO_TRACKER v2.3. software library.

The format of the tracking channel control packet

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
170	2	command	channel	strobe_x				strobe_y				strobe_w				htrobe_h				substrobe_x			
24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47
substrobe_y				substrobe_w				substrobe_h				search_wind_dx				search_wind_dy				lost_frame_count			
48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71
frame_count				corr_w				corr_h				f_strobe_x				f_strobe_y				vel_x			
72	73	74	75	76	77	78				79													
vel_y				corr_p	mode	permanent_search_wind_dx				85													

Table 6 – The assignment of fields

Field name	Number of bytes, format	Assignment
command	1, uint8_t	Command identifier: 1 – capture an object for tracking; 2 – reset tracking; 3 – set the “INERTIAL” mode; 4 – set the “LOST” mode; 5 – set the “STATIC” mode; 6 – set a number of positions to be checked horizontally and vertically relative to the previous position of the object; 7 – set the dimensions of the tracked object; 8 – automatically set the dimensions of the tracking rectangle; 9 – edit the position of the tracking rectangle; 10 – set the search area shift. When forming a command, it is necessary to set the required fields.
channel	1, uint8_t	The tracking channel number to which the command is assigned. In the current software version only three channels are implemented (numbering starts from 0).
strobe_x	4, uint32_t	The horizontal coordinate of the tracking rectangle center. It is used when capturing the tracked object. It also has the tracking rectangle shift (signed) in the tracking mode.
strobe_y	4, uint32_t	The vertical coordinate of the tracking rectangle center. It is used when capturing the tracked object. It also has the tracking rectangle shift (signed) in the tracking mode.
strobe_w	4, uint32_t	The tracking rectangle width. It is used when capturing the tracked object and setting its new dimensions.
strobe_h	4, uint32_t	The tracking rectangle height. It is used when capturing the tracked object and setting its new dimensions.
substrobe_x	4, uint32_t	Not used in the command. The horizontal coordinate of the object rectangle center in the tracking rectangle. During the automatic tracking, the software library calculates the position and size of the object in the tracking strobe to ensure the subsequent editability. The center of the coordinate system for the position of the object rectangle center is in the upper left corner of the tracking rectangle.
substrobe_y	4, uint32_t	Not used in the command. The vertical coordinate of the object rectangle center in the tracking rectangle. During the automatic tracking, the software library calculates the position and size of the object in the tracking strobe to ensure the subsequent editability. The center of the coordinate system for the position of the object rectangle center is in the upper left corner of the tracking rectangle.
substrobe_w	4, uint32_t	Not used in the command. The width of the object rectangle in the tracking rectangle.
substrobe_h	4, uint32_t	Not used in the command. The height of the object rectangle in the tracking rectangle.
search_wind_dx	4, int32_t	The horizontal shift of the search window relative to the calculated position of the tracking rectangle center. It is used when setting the search area shift.
search_wind_dy	4, int32_t	The vertical shift of the search window relative to the calculated position of the tracking rectangle center. It is used when setting the search area shift.
lost_frame_count	4, uint32_t	Not used in the command. The counter of the processed frames in the “LOST” mode.
frame_count	4, uint32_t	Not used in the command. The counter of the processed frames from the moment of capturing an object for tracking.
corr_w	4, uint32_t	The number of positions to be checked horizontally. This parameter determines the width of the search area. The width of the search area is calculated as (strobe_w + corr_w - 1). It is used when setting the number of positions to be checked horizontally and vertically.
corr_h	4, uint32_t	The number of positions to be checked vertically. This parameter determines the height of the search area. The height of the search area is calculated as (strobe_h + corr_h - 1). It is used when setting the number of positions to be checked horizontally and vertically.
f_strobe_x	4, float	Not used in the command. The horizontal coordinate of the tracking rectangle center with sub-pixel accuracy.
f_strobe_y	4, float	Not used in the command. The vertical coordinate of the tracking rectangle center with sub-pixel accuracy.
vel_x	4, float	Not used in the command. The calculated estimation of the horizontal component of the object’s velocity on video frames (pixels per frame).

vel_y	4, float	Not used in the command. The calculated estimation of the vertical component of the object's velocity on video frames (pixels per frame).
corr_p	1, uint8_t	Not used in the command. Estimating the probability of finding the object on the processed frame. The value ranges from 0 (minimum probability) to 255 (maximum probability).
mode	1, uint8_t	Not used in the command. Identifier of the operation mode of the tracking algorithm in accordance with the value of macros.
permanent_search wind_dxy	1, uint8_t	The flag of the permanent shift of search area. When the user sets the search area shift, the permanent shift flag is set (0 - only one frame, 1 - permanent shift). If you set the shift by one frame, the values of shifts <i>search_wind_dx</i> and <i>search_wind_dy</i> will be set to 0 automatically after processing the frame. It is used when setting the search area shift.

The format of the tracking data packet

The operation modes of the tracking channel and the composition of transmitted data are fully correspond to the RF_VIDEO_TRACKER v2.3 software library.

The format of the tracking data packet

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
170	1	0	channel	strobe_x				strobe_y				strobe_w				htrobe_h				substrobe_x			
24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47
substrobe_y				substrobe_w				substrobe_h				search_wind_dx				search_wind_dy				lost_frame_count			
48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71
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72	73	74	75	76	77	78						79											
vel_y				corr_p	mode	permanent_search_wind_dx						85											

Table 7 – The assignment of fields

Field name	Number of bytes, format	Assignment
channel	1, uint8_t	The tracking channel number from which the data came.
strobe_x	4, uint32_t	The horizontal coordinate of the tracking rectangle center.
strobe_y	4, uint32_t	The vertical coordinate of the tracking rectangle center.
strobe_w	4, uint32_t	The tracking rectangle width.
strobe_h	4, uint32_t	The tracking rectangle height.
substrobe_x	4, uint32_t	The horizontal coordinate of the object rectangle center in the tracking rectangle. During the automatic tracking, the software library calculates the position and size of the object in the tracking strobe to ensure the subsequent editability. The center of the coordinate system for the position of the object rectangle center is in the upper left corner of the tracking rectangle.
substrobe_y	4, uint32_t	The vertical coordinate of the object rectangle center in the tracking rectangle. During the automatic tracking, the software library calculates the position and size of the object in the tracking strobe to ensure the subsequent editability. The center of the coordinate system for the position of the object rectangle center is in the upper left corner of the tracking rectangle.
substrobe_w	4, uint32_t	The width of the object rectangle in the tracking rectangle.
substrobe_h	4, uint32_t	The height of the object rectangle in the tracking rectangle.
search_wind_dx	4, int32_t	The horizontal shift of the search window relative to the calculated position of the tracking rectangle center.
search_wind_dy	4, int32_t	The vertical shift of the search window relative to the calculated position of the tracking rectangle center.
lost_frame_count	4, uint32_t	The counter of the processed frames in the "LOST" mode.
frame_count	4, uint32_t	The counter of the processed frames from the moment of capturing an object for tracking.
corr_w	4, uint32_t	The number of positions to be checked horizontally. This parameter determines the width of the search area. The width of the search area is calculated as $(strobe_w + corr_w - 1)$.
corr_h	4, uint32_t	The number of positions to be checked vertically. This parameter determines the height of the search area. The height of the search area is calculated as $(strobe_h + corr_h - 1)$.
f_strobe_x	4, float	The horizontal coordinate of the tracking rectangle center with sub-pixel accuracy.
f_strobe_y	4, float	The vertical coordinate of the tracking rectangle center with sub-pixel accuracy.

vel_x	4, float	The calculated estimation of the horizontal component of the object's velocity on video frames (pixels per frame).
vel_y	4, float	The calculated estimation of the vertical component of the object's velocity on video frames (pixels per frame).
corr_p	1, uint8_t	Estimating the probability of finding the object on the processed frame. The value ranges from 0 (minimum probability) to 255 (maximum probability).
mode	1, uint8_t	Identifier of the operation mode of the tracking algorithm in accordance with the value of macros.
permanent_search wind_dxy	1, uint8_t	The flag of the permanent shift of search area. When the user sets the search area shift, the permanent shift flag is set (0 - only one frame, 1 - permanent shift). If you set the shift by one frame, the values of shifts <i>search_wind_dx</i> and <i>search_wind_dy</i> will be set to 0 automatically after processing the frame.

The format of the video transmission start packet

The command is used to start the video stream transmission from the selected channel (the **channel** field) in accordance with the configuration parameters of the device. Below is the format of the command.

0	1	2	3
170	3	channel	85

The format of the video transmission stop packet

The command is used to stop the video stream transmission from the selected channel (the **channel** field). Below is the format of the command.

0	1	2	3
170	4	channel	85