

Color Video Camera

free-d Integration Manual
Software Version 1.0
BRC-AM7

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Overview

This document describes detailed technical information relating to the “tracking data (free-d) output function” required for system integration with virtual studios, etc.

This function allows a PTZ camera (hereinafter referred to as the camera), such as the BRC-AM7 that is primarily intended for remote shooting, to transmit the pan, tilt, zoom, and focus (hereinafter referred to as PTZF) positions of the camera in real-time. Using this function in conjunction with downstream VR/AR solutions makes possible the compositing of captured video with CG to create highly immersive images.

Target Models and Firmware Version

Model name	Supported firmware version
BRC-AM7	Version 1.0 and later

Supported Networking Protocol (free-d Protocol)

The 'free-d' protocol, which is widely used in virtual studio solutions, is used to transmit the tracking data comprising the PTZF position information from the camera.

For a description of the free-d protocol specification, refer to the publicly available "free-d Installation Manual."

Supported communication physical layer and transport layer

Although the original free-d protocol assumes its physical communication layer as RS422/RS485 serial communication, this camera adopts to use an Ethernet-based physical layer via the LAN (RJ-45) connector on the camera. One reason for adopting UDP/IP is that many virtual studio solution providers already have ample experience using UDP/IP.

The port number used for UDP data transmission can be any number in the range of 1024 to 65534.

Supported modes

The original free-d protocol specifies two modes of operation: stream mode and polled mode.

This camera only supports stream mode due to its lower overhead and higher efficiency. Accordingly, the mode switching function using D0 messages is not supported.

In stream mode, the "Start stream mode" command and "Stop stream mode" command of D0 messages are specified to control the transmission of tracking information.

Considering this message definition, this camera supports two types of stream mode ("always" and "on-demand") which are described in detail below.

'always' mode

In this mode, the camera keeps on transmitting tracking information to the destinations specified by the camera. Typically, UDP data transfers can use ICMP messages to check if the destination is valid, but this mode works regardless of whether there is a valid destination or not.

This mode requires that the destination IP address and port number be configured beforehand.

'on-demand' mode

In this mode, the camera waits for the "Start stream mode" D0 message, and then starts sending the tracking information to the sender of that message. Data transmission continues until the camera receives a "destination unreachable" ICMP error message or a "Stop stream mode" D0 message.

Supported free-d messages

According to the specification described above, the following free-d messages are supported.

- D0 message: Only supports two messages: "[00]: Stop stream mode" and "[01]: Start stream mode"
- D1 message: Values are set for the following metadata.
 - Camera pan angle
 - Camera tilt angle
 - Camera zoom
 - Camera focus
 - Iris F-number (using 16-bit user area)

Supported metadata description

This section describes the types of metadata included in the tracking information and their representation format.

Camera pan angle (bytes 2 to 4)

Bytes 2 to 4 of the tracking information (3 bytes, <PH><PM><PL> in the free-d protocol specification) contain the camera pan angle according to Appendix B.2 in the "free-d Installation Manual."

The value is expressed in degrees as a 24-bit twos-complement signed number. The most-significant bit (bit 23) is the sign bit, the next 8 bits (bits 22 to 15) are the integer part and the remaining bits (bits 14 to 0) are the fractional part. The pan angle range is specified as -90 degrees to +90 degrees in the free-d protocol, but a value exceeding this range can be set. Due to minute fluctuations in the position holding capability of the pan/tilt drive motor, the value of the angle that is returned may slightly exceed the pan and tilt angle range.

Camera tilt angle (bytes 5 to 7)

Bytes 5 to 7 of the tracking information (3 bytes, <TH><TM><TL> in the free-d protocol specification) contain the camera tilt angle according to Appendix B.3 in the "free-d Installation Manual." The format for the angle is expressed in the same format as the camera pan angle.

Note that the ceiling mount setting must be set appropriately to match the orientation of the

camera ([off] for desktop mounting, [on] for ceiling mounting), as this setting will change the tilt angle range. In addition, the tilt angle range is specified as -90 degrees to +90 degrees in the free-d protocol, but a value exceeding this range can be set.

Due to minute fluctuations in the position holding capability of the pan/tilt drive motor, the value of the angle that is returned may slightly exceed the pan and tilt angle range.

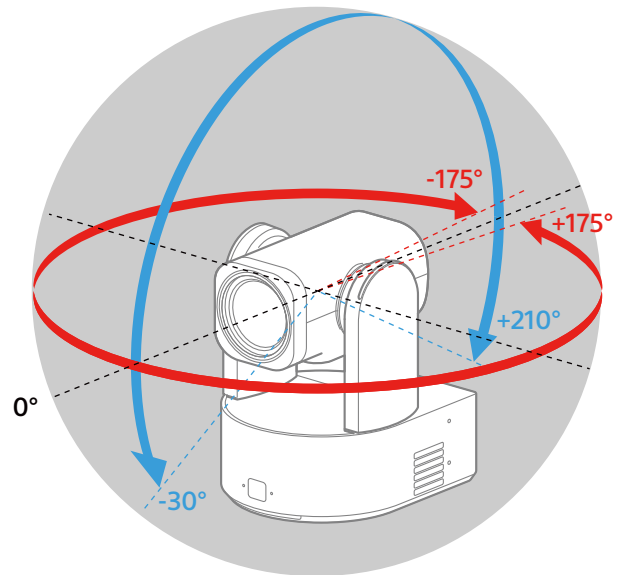


Figure 1. Pan/tilt angle ranges for desktop mounting

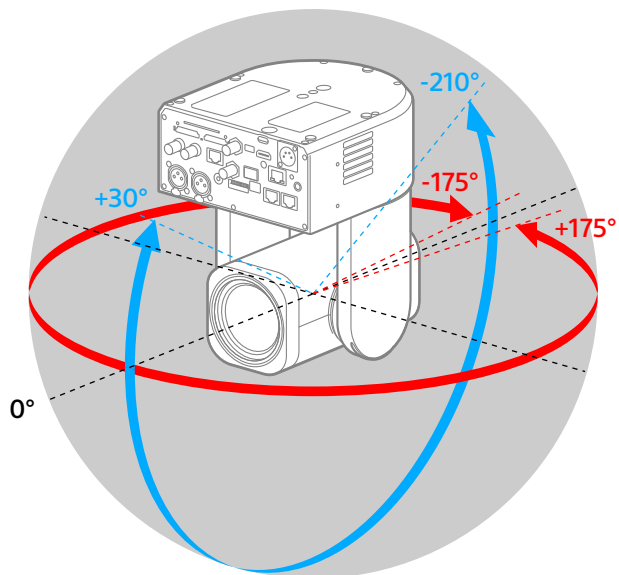


Figure 2. Pan/tilt angle ranges for ceiling mounting

Camera zoom (bits 20 to 22)

Bytes 20 to 22 of the tracking information (3 bytes, <ZH><ZM><ZL> in the free-d protocol specification) contain the camera zoom information according to Appendix B.8 in the “free-d Installation Manual.” The protocol

specification does not define how the information is represented. In this camera, the Wide end is represented as decimal 0 and the Tele end is represented as decimal 16384 as a 24-bit unsigned integer, as shown in Table 1.

Note

The angle of view may vary from camera to camera, even for the same free-d output value.

Table 1: Zoom information output value (reference value)

free-d output value (zoom position)	Remarks
0x0000	Wide end
0x4000	Tele end

Camera focus (bits 23 to 25)

Bytes 23 to 25 of the tracking information (3 bytes, <FH><FM><FL> in the free-d protocol specification) contain the camera focus information according to Appendix B.9 in the “free-d Installation Manual.” The protocol specification does not define how the information is represented. In this camera, the inverse of the focus distance is expressed as a 24-bit signed number with 16-bit fixed decimal point. An infinite focus distance is represented as 0x001000. Values lower than 0x001000 indicate the OverINF (over infinity) area. For details, see Table 2. If more detailed conversion of focus distance and focus information is required, it can be calculated using equation 1.

$$\text{Focus distance} = 2^{16} / (\text{Focus information} - 0x1000) \quad (1)$$

Notes

- The focus distance may vary from camera to camera, even for the same output value.
- Values lower than 001000 [hex] indicate a focus distance higher than ∞, so equation 1 cannot be applied.

Table 2: Focus information output value and focus distance (reference value)

free-d output value [hex]	Focus distance [m]	Remarks
000000 to 001000	OverINF	
1000	∞	
2000	16	
4000	5.33333333	
8000	2.28571429	
C000	1.45454545	

Table 2: Focus information output value and focus distance (reference value)

free-d output value [hex]	Focus distance [m]	Remarks
EDA5	1.0	Tele end minimum focusing distance*
40000	0.25396825	
61F83	0.165	Wide end minimum focusing distance*

* Design value which may vary from camera to camera.

Iris F-number and frame count (bytes 26 to 27)

After considering use cases in a virtual studio, it was decided that iris information would also be useful in addition to PTZF information, so it has been included as part of the tracking information. The addition of iris information makes it possible to appropriately correct the brightness of CG objects composited into the captured image.

The iris information (bits 26 to 27) of the tracking information (2 bytes, <SH><SL> in the free-d protocol specification) contains a value 100-times the F-number as a positive unsigned number in the lower 12 bits. For example, a value of 0x118 (<SH>=0x01, <SL>=0x18) represents a decimal value of 280, or an F-number of F2.8. The larger the value, the darker the lens iris. A closed iris is represented as 0x0FFF.

In addition, the upper 4 bits of the <SH> area are set successively to a number from 0 to 15 as the frame count. This is useful for determining which video frame the tracking information corresponds to when the UDP packet arrival time fluctuates due to the network environment, the processing load in the camera, or other reasons.

Configuring Tracking Data Output Items using CGI

This section describes the CGI parameters for configuring tracking data output items. The mechanism for configuring various settings makes use of the existing CGI mechanism of the camera to configure items using CGI from the Web App.

Basic configuration scheme

This section describes how to acquire and change various settings related to the tracking data output function using HTTP.

Acquiring the current configuration

You can acquire various settings related to the tracking data output function using the following HTTP URI. You can select either normal format or JavaScript parameter format as the acquisition method.

[Normal format]

```
http://<ip_address>/command/
inquiry.cgi?inq=freedconfig
```

[JavaScript parameter format]

```
http://<ip_address>/command/
inquiry.cgi?inqjs=freedconfig
```

GET is the only HTTP method supported when accessing information using these URIs. Authentication is performed using HTTP digest authentication (RFC 2167), and administrator privileges for the camera are required.

Changing the configuration

You can change various settings related to the tracking data output function using the following HTTP URI.

```
http://<ip_address>/command/
freedconfig.cgi?<parameter1>=<value1>[&<parameter2>=<value2>&...]
```

The "/command/freedconfig.cgi" URI path is a new path introduced for the tracking data output function. Multiple parameters can be changed simultaneously by concatenating "<parameter>=<value>" strings with an "&" character according to the HTTP query string specification.

Similarly, GET is the only HTTP method supported when accessing this URI. Authentication is performed using HTTP digest authentication,

and administrator privileges for the camera are required.

The main parameter is called "FreeDTransfer." Setting this parameter to "always" or "ondemand" enables the transmission of tracking information, but it is recommended that other required parameters be configured appropriately beforehand.

CGI parameters

This section describes the CGI parameters corresponding to the items related to the tracking data output function.

FreeDTransferMode

This parameter is used to control the transmission of tracking information. It is used to disable transmission or to set the transfer mode to "always" or "on-demand" mode. For details, see "'always' mode" (page 4) and "'on-demand' mode" (page 4).

Parameter	Value	Description
FreeDTransferMode	"always" / "ondemand" / "off" (Default value: "off")	Disables the transmission of tracking information or enables the transmission in "always" or "on-demand" mode

FreeDCameraID

This parameter is used to acquire/set the camera ID using the free-d protocol (<CA>, 1st byte in D1 message).

Parameter	Value	Description
FreeDCameraID	0 to 255 (Default value: "255")	Specifies the camera ID (<CA>) as a decimal value.

FreeDOutputNum

This parameter is used to acquire the number of destinations to which tracking information can be transmitted simultaneously in normal mode. This is a read-only parameter.

Parameter	Value	Description
FreeDOutputNum	1 or higher (read-only)	Maximum number of simultaneous destinations

In BRC-AM7 version 1.0, this parameter always returns 1.

FreeDDestination

In "always" mode, this parameter is used to acquire or set whether to transmit tracking information to each destination.

Parameter	Value	Description
FreeDDestination<N>	"on" / "off" (Default value: "on")	Sets whether to transmit tracking information to the Nth client

<N> is a positive integer in the range 1 to FreeDOutputNum.

FreeDDestinationAddress

In "always" mode, this parameter is used to acquire or set the address of each destination.

Parameter	Value	Description
FreeDDestinationAddress<N>	IPv4 address format character string (Default value: blank)	Specifies the address of the Nth destination

<N> is a positive integer in the range 1 to FreeDOutputNum.

FreeDDestinationPort

In "always" mode, this parameter is used to acquire or set the UDP port number of each destination.

Parameter	Value	Description
FreeDDestinationPort<N>	1024 to 65534 (Default value: "40000")	Specifies the UDP port number of the Nth destination

<N> is a positive integer in the range 1 to FreeDOutputNum.

FreeDListenPort

In "always" mode, this parameter is used to acquire or set the UDP port number on which to listen for D0 "Start stream mode" requests.

Parameter	Value	Description
FreeDListenPort	1024 to 65534 (Default value: "0000")	Specifies the UDP port number on which the camera listens for requests

Tracking Information Transmission Interval

Table 3 shows the transmission interval for tracking information. The transmission interval varies depending on the configured system frequency and SDI1 output format.

Table 3: System frequency, SDI1 output format, and tracking information transmission interval

System frequency	SDI1 output format	Tracking information transmission interval [msec]
119.88Hz	(All)	16.68
100Hz	(All)	20.00
59.94Hz	(All)	16.68
50Hz	(All)	20.00
29.97Hz	1920×1080PsF	16.68
	Other than above	33.37
25Hz	1920×1080PsF	20.00
	Other than above	40.00
23.98Hz	1920×1080PsF	20.85
	Other than above	41.70

Recommended Settings for Lens Calibration in AR/VR Environments

This section describes the recommended settings for lens calibration in AR/VR environments. On this camera, auto distortion compensation is always enabled.

Zoom type

Set [Technical] > [Zoom] > [Zoom Type] to [Optical Zoom Only] in the camera menu.

Table 4: Zoom type setting

Item	Sub-item setting	Factory default	Description
[Zoom Type]	[Optical Zoom Only]	[Optical Zoom Only]	Sets the type of zoom

Known Limitations

This section describes some known limitations.

When the Slow & Quick Motion function is enabled

When the Slow & Quick Motion function is enabled, there may be a time lag between when tracking information changes occur and when the information is transmitted. As a result, in situations where the actual tracking information changes at a constant rate, the rate of change in the tracking information that is transmitted may not be constant but will fluctuate.

Number of destinations to which tracking information is transmitted simultaneously

Currently, only one tracking information destination is supported. In "on-demand" mode, if a DO "Start stream mode" request is received from a client while tracking information is being transmitted to another client, the destination switches to the client that sent the latest request, and tracking information is no longer transmitted to the first client.

Tracking information transmission when receiving an external sync signal

If the camera receives a sync signal on the GENLOCK connector, it cannot transmit tracking information while the camera is synchronizing to the reference signal. When synchronization is established, the transmission of tracking information will resume.

When streaming video and audio simultaneously

The camera supports video and audio streaming, which requires considerable network bandwidth and processing. When streaming, delays may occur in the transmission of tracking information causing fluctuations in the transmission interval.

Performance degradation due to user operations



The output of tracking information may be delayed or the output content may not be updated in the following cases.

- When displaying the setup menu of the camera
- When displaying the thumbnail list of recorded clips
- When playing recorded clips
- When changing various settings or executing some processes on the Web App settings screen

Output during auto framing operation

If the free-d output function is turned on during auto framing operation, free-d information may occasionally not be output under conditions of heavy processing load.

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