

OPTICON

2D Scan Engine

MDI-4x00/N210 Image Capture



MDI-4x00

N-210

This document describes image capture procedures
for the imager scan engines MDI-4x00 and N-210

Image Capture Manual

All information subject to change without notice.

Document History

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1st	2022/10/20	-	-	Initial release
2nd	2022/11/23	front	-	Added MDI-4100 picture and corrected product name
		12	-	Removed reference to non existing SDK

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1. Abstract

This document describes image capture procedures for the imager scan engines MDI-4x00 and N-210.

2. Configuration Commands

2.1. Configuring with Commands

By sending the commands via the (USB) serial interface, you can configure the function settings for the scan engine. These commands are also use to control and enter image capture mode. The default command format is as shown below.

2.1.1. Command Format

The command format, from header to terminator, is defined as below, and the commands are executed in packets.

Command Header ^{*2}	Command ID ^{*1}		Command Terminator ^{*2}
<ESC> (1BH)	none	1 ~ 2 digits (ASCII)	<CR> (ODH)
	[(5BH)	3 digits (ASCII)	
	](5DH)	4 digits (ASCII)	

*1 It is possible to send multiple command IDs between a single header and terminator, except for a single command (1-digit) IDs.

*2 A combination of command header <STX>(02H) and terminator <ETX>(03H) is also possible.

Input examples:

1-digit command	: <Esc>△<CR>
2-digit command	: <Esc>△△<CR>
3-digit command	: <Esc>[△△△<CR>
4-digit command	: <Esc>]△△△△<CR>
2 and 3 digits command	: <Esc>△△[△△△<CR>

2.1.2. Command Usage Precautions

When sending multiple commands in a sequence, the subsequent command is not received while the previous command is still being executed. Since the RTS output will be in busy state while a command is executed when the Handshake is set to BUSY/READY or MODEM, it is recommended to refer to this signal for the right timing.

Any settings configured by commands are not retained in the non-volatile memory. Therefore, these will be lost when the scan engine power is turned off. When the power comes back on, the scan engine will be in the configuration state saved in the non-volatile memory. In order to save the settings with commands, send "Z2" to save all the parameters in non-volatile memory.

Command packet maximum buffer size is 1000 characters.

If more characters than maximum limit are sent, lack of a part of command, etc. occurs and the execution will not be performed correctly.

3. Image Capture Mode

This chapter describes the details of the image capture mode.

The scan engine has an image capture mode in which it can process and transmit the image.

3.1. Functional Overview

The following commands can be used for image capture mode. The transmission of the image is supported by serial (UART) and USB-COM interfaces only. Image processing settings contain settings of raw image cropping, subsampling and bit depth change.

Command	Description	Remark
DE6	Show image processing settings	
DE7	Change image processing settings	
DE8	Capture image	

3.1.1. Show Image Processing Settings

Use the "DE6" command to output the current image processing settings in the following format.

[Format]

1	T	r	i	m	(	2	,	3	,	4	,	5	)	S	u	b	(	6	,	7)
	B	p	8	J	q	9	F	f	10	T	r	11	r	R	e	12	13				

[Field]

No.	Field	Size [byte]	Effective range	Details
1	Start Character	1	0x3B	“;”
2	Trimming Left	4	0 ~ 639	The top left and bottom right coordinates of the image part that will be transmitted.
3	Trimming Top	4	0 ~ 479	
4	Trimming Right	4	0 ~ 639	
5	Trimming Bottom	4	0 ~ 479	
6	Sub Sampling Horizontal	1	1, 2, 4	Set subsampling horizontal
7	Sub Sampling Vertical	1	1, 2, 4	Set subsampling vertical
8	Bit per Pixel	2	1, 4, 8, 10	Bits per pixel (depth)
9	Jpeg Quality	3	5 ~ 100	Quality of JPEG compression
10	File Format	4	1, 3	Output format 1: JPEG , 3: BMP
11	Transfer Type	4		Transmission mode PART: Divided ALL: Batch
12	Color Reverse	1	0, 1, 2	Reverse black and white 0: Non-inverted 1: Inverted 2: In status quo
13	End Character	1	0x0D	CR

[Output example]

;Trim(0, 0, 639, 479) Sub(1,1) Bp 8 Jq 65 FfBMP TrPART Re2

3.1.2. Change Image Processing Settings

Use "DE7" command to change the various settings of image processing. Input Q0 ~ Q9 commands six times after the "DE7" command for various configurations.

Command							Description	Default
DE7	Qa	Qb	Qc	Qd	Qe	Qf	Set image processing	
	Q1	Q0	Qc	Qd	Qe	Qf	Set leftmost value for cropping $1000c + 100d + 10e + f = 0 \sim 751$	0
	Q1	Q1	Qc	Qd	Qe	Qf	Set top edge value for cropping $1000c + 100d + 10e + f = 0 \sim 479$	0
	Q1	Q2	Qc	Qd	Qe	Qf	Set rightmost value for cropping $1000c + 100d + 10e + f = 0 \sim 751$	639
	Q1	Q3	Qc	Qd	Qe	Qf	Set bottom edge value for cropping $1000c + 100d + 10e + f = 0 \sim 479$	479
	Q2	Q0	Q0	Q0	Q0	Qf	Set horizontal subsampling $f = 1, 2, 4$	1
	Q2	Q1	Q0	Q0	Q0	Qf	Set vertical subsampling $f = 1, 2, 4$	1
	Q3	Q0	Q0	Q0	Q0	Qf	Set bit depth (bits per pixel) $f = 0$: 8 bits (256 values) $f = 1$: 4 bits (16 values) $f = 2$: 1 bits (2 values) $f = 3$: 10 bits (1024 values, raw data)	0
	Q4	Q0	Q0	Qd	Qe	Qf	Set JPEG quality $100d + 10e + f = 5 \sim 100$	75
	Q5	Q0	Q0	Q0	Q0	Qf	Output format $f = 1$: JPEG $f = 3$: BMP	3
	Q6	Q0	Q0	Q0	Q0	Qf	Transmission mode $f = 0$: PART $f = 1$: ALL	0
	Q8	Q0	Q0	Q0	Q0	Qf	Reverse black and white $f = 0$: Non-inverted $f = 1$: Inverted $f = 2$: In status quo	2

Example of command transmission 1: Set coordinate (left 100, top 100, right 500, bottom 300) for image cropping.

```
<ESC>[DE7Q1Q0Q0Q1Q0Q0Q[DE7Q1Q1Q0Q1Q0Q0Q[DE7Q1Q2Q0Q5Q0Q0Q[DE7Q1Q3Q0Q3Q0Q0Q<CR>
```

Example of command transmission 2: Set horizontal subsampling 1/2, vertical subsampling 1/4.

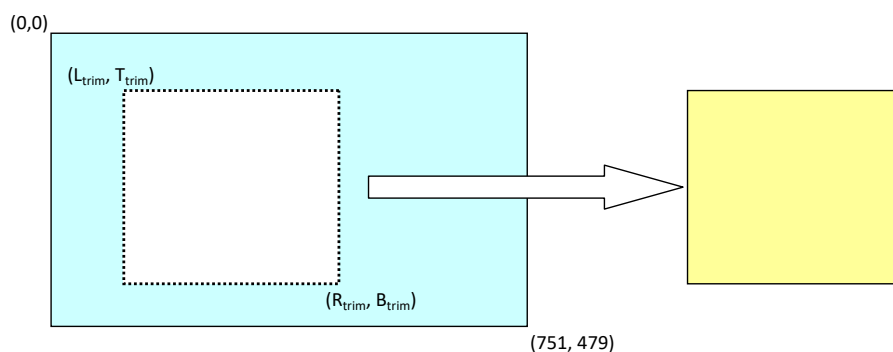
```
<ESC>[DE7Q2Q0Q0Q0Q0Q2Q[DE7Q2Q1Q0Q0Q0Q4Q<CR>
```

Example of command transmission 3: Set transmission mode to All and bit depth to 4 bits.

```
<ESC>[DE7Q6Q0Q0Q0Q0Q1Q[DE7Q3Q0Q0Q0Q0Q1Q<CR>
```

■ Cropping

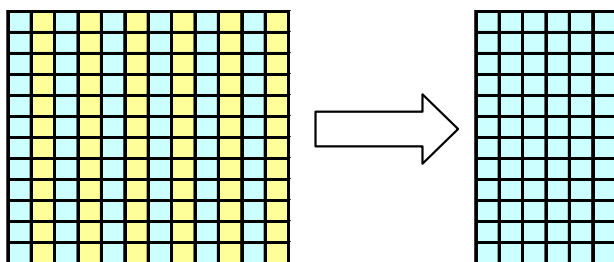
The removal of the outer parts of the original image (light-blue area) in order to retrieve only the necessary part (yellow area).



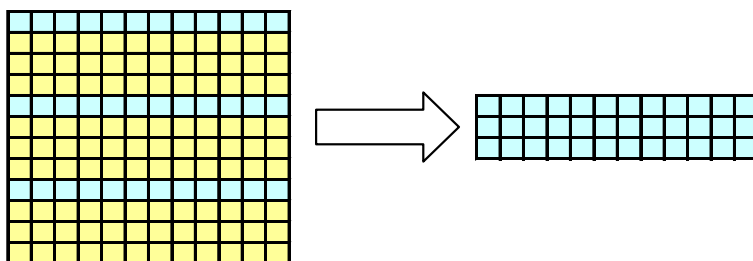
■ Subsampling

Thinning out pixel data in row and column directions to compress the data size.

In the setting of horizontal 2, the data is thinned out by removing one column from each two columns as shown in the figure below. The amount of information per line (in the horizontal direction) will then be 1/2.



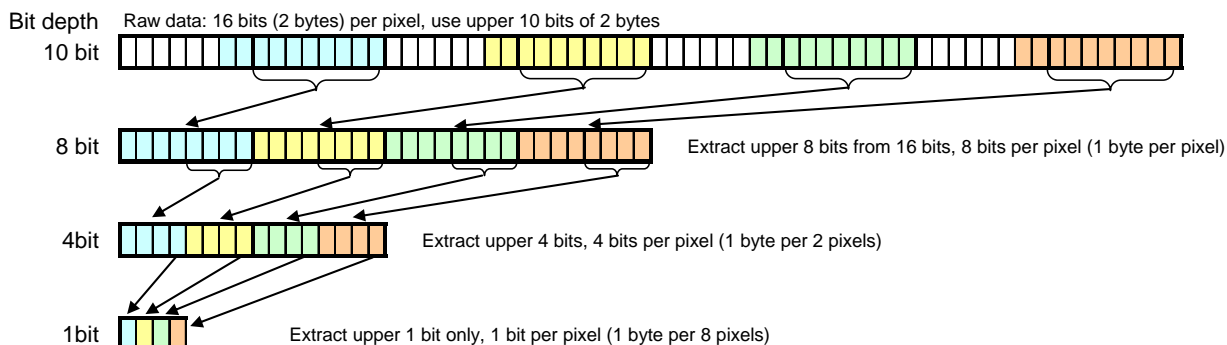
In the setting of vertical 4, the data is thinned out by removing three rows from each four rows as shown in the figure below. The amount of information per line (in the vertical direction) will then be 1/4.



■ Bit depth

Bit depth (bits per pixel) can be configured. When bit depth is set, the amount of information decreases, but the color gradation that can be displayed also decreases.

When the amount of information of 10 bits (raw data) is 1, that of 8 bits, 4 bits and 1 bit are 1/2, 1/4 and 1/16 respectively.



■ JPEG quality

Quality of JPEG conversion is configured. When lower quality is set, the amount of information decreases, but the image quality also decreases.

■ Output format

Output format of JPEG or BMP (bitmap). When JPEG is configured, lossy compression is used and the image is transmitted in standard JPEG format. In BMP mode, only the data (uncompressed color saturation values) is transmitted; the bitmap header is omitted.

3.1.3. Capture Image (DE8)

With the "DE8" command, the scan engine can go to Image Capture mode to take an image.

After capturing an image or the timeout expiration without capturing, Image Capture mode turns off and the scan engine then returns to normal operation.

When the scan engine receives this command, it starts to wait for a trigger. The next trigger then initiates the image capture (no decoding). Immediately after the image is captured, image data is output as described later in "Output protocol" .

There are two additional parameters, 'selecting capture mode' and 'timeout setting', and those are send in the following formats. Each parameter is specified with "Q0" ~ "Q9" and the data lengths are fixed. Timeout setting may not be required depending on the configured Capture mode.

Command					Description	Effective value
DE8	Qa	Qb	Qc	Qd	Enter image capture mode	
	m				Select capture mode m = a	0, 1, 2, 3
			n		Set timeout [seconds] n = 100b + 10c + d	0 ~ 999

Example of command transmission: Commands in conjunction mode

<ESC>[DE8Q0<CR>

Example of command transmission: Trigger Capture (2) timeout 15 seconds

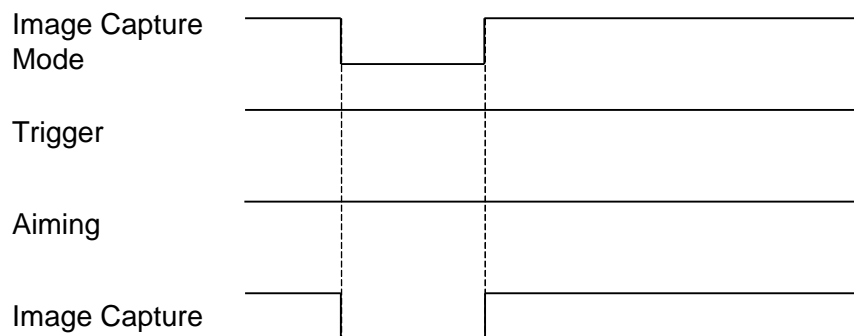
<ESC>[DE8Q2Q0Q1Q5<CR>

[m: Select capture mode]

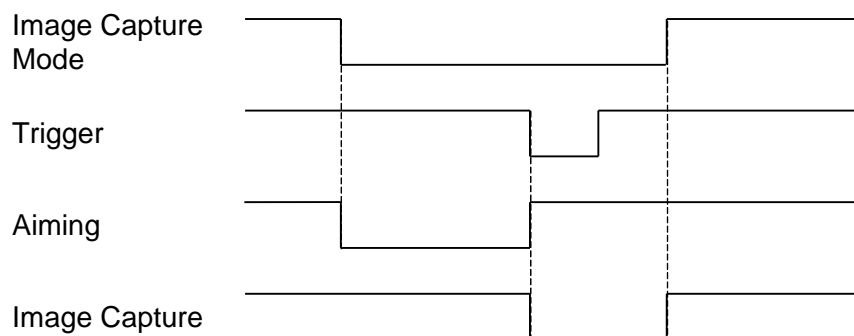
m	Capture mode	Description	Remark
0	Commands in conjunction	Capture image immediately after receiving command.	n (timeout setting is not needed)
1	Trigger capture (1)	Emit aiming immediately after receiving command. Capture image when the trigger is pressed.	
2	Trigger capture (2)	Wait for trigger press after receiving command. Emit aiming as long as the trigger is kept pressed. Capture image when the trigger is released.	
3	Trigger capture (3)	Wait for trigger after receiving command. Emit aiming LED after 1st trigger. Capture image after 2nd trigger.	

Timing chart for each capture mode are described below.
All signals in the following figures are Active Low, and Capture includes Output.

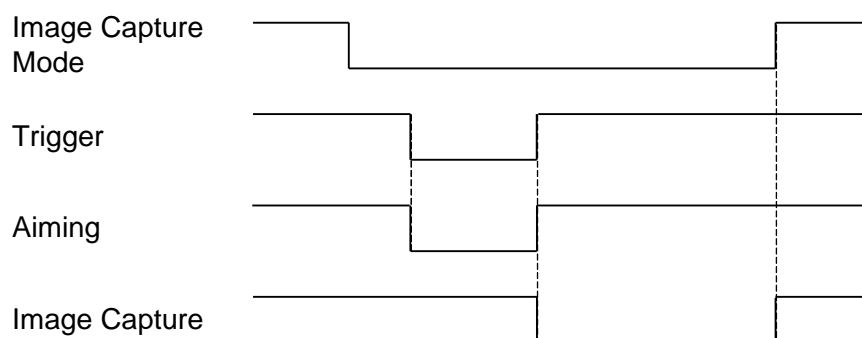
m=0 : Commands in conjunction mode



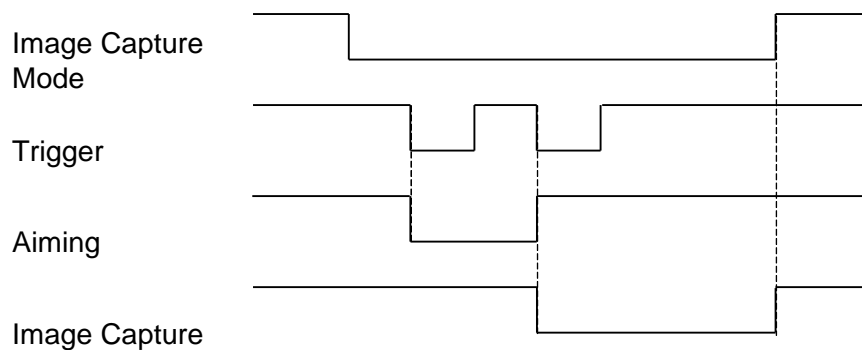
m=1 : Trigger Capture (1)



m=2 : Trigger Capture (2)



m=3 : Trigger Capture (3)



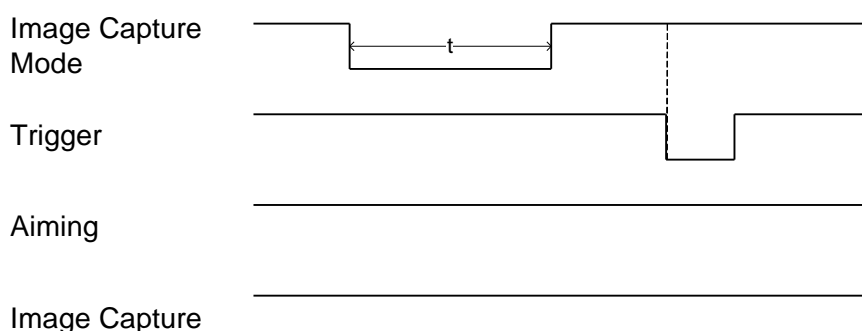
[n: Timeout setting]

Timeout of 'Image Capture mode' can be set in units of seconds. The effective values are 0 (000) ~ 999. For 'Commands in Conjunction mode ($m = 0$)', the timeout value is ignored. The timeout period is measured from command reception to capturing. When $n=0$, there is no timeout and the scan engine will wait indefinitely for a trigger input. When $n > 0$, this value specifies the timeout period in seconds.

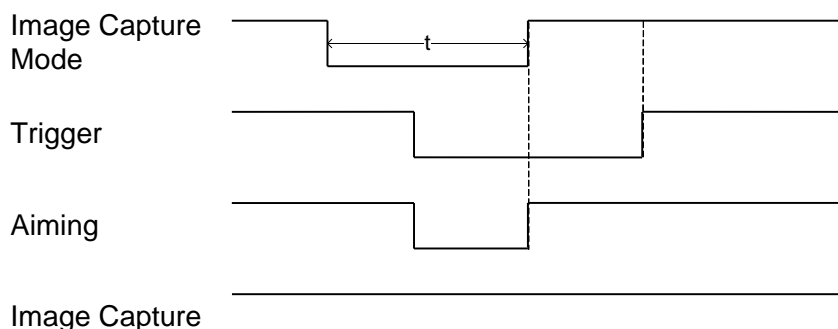
n	Timeout period	Remark
0	None	Wait indefinitely for a trigger
1 – 999	Specified periods [second]	

When there is no trigger input during timeout period 't', image capture mode is turned off after the 't' expires. Normal decoding will then be performed by subsequent trigger inputs.

In Trigger Capture (2) mode, the trigger needs to be released during the period of 't' to take a picture. If it is not released, the aiming stops after 't' expires and Image Capture mode is turned off. If the trigger is released, no operation is performed.

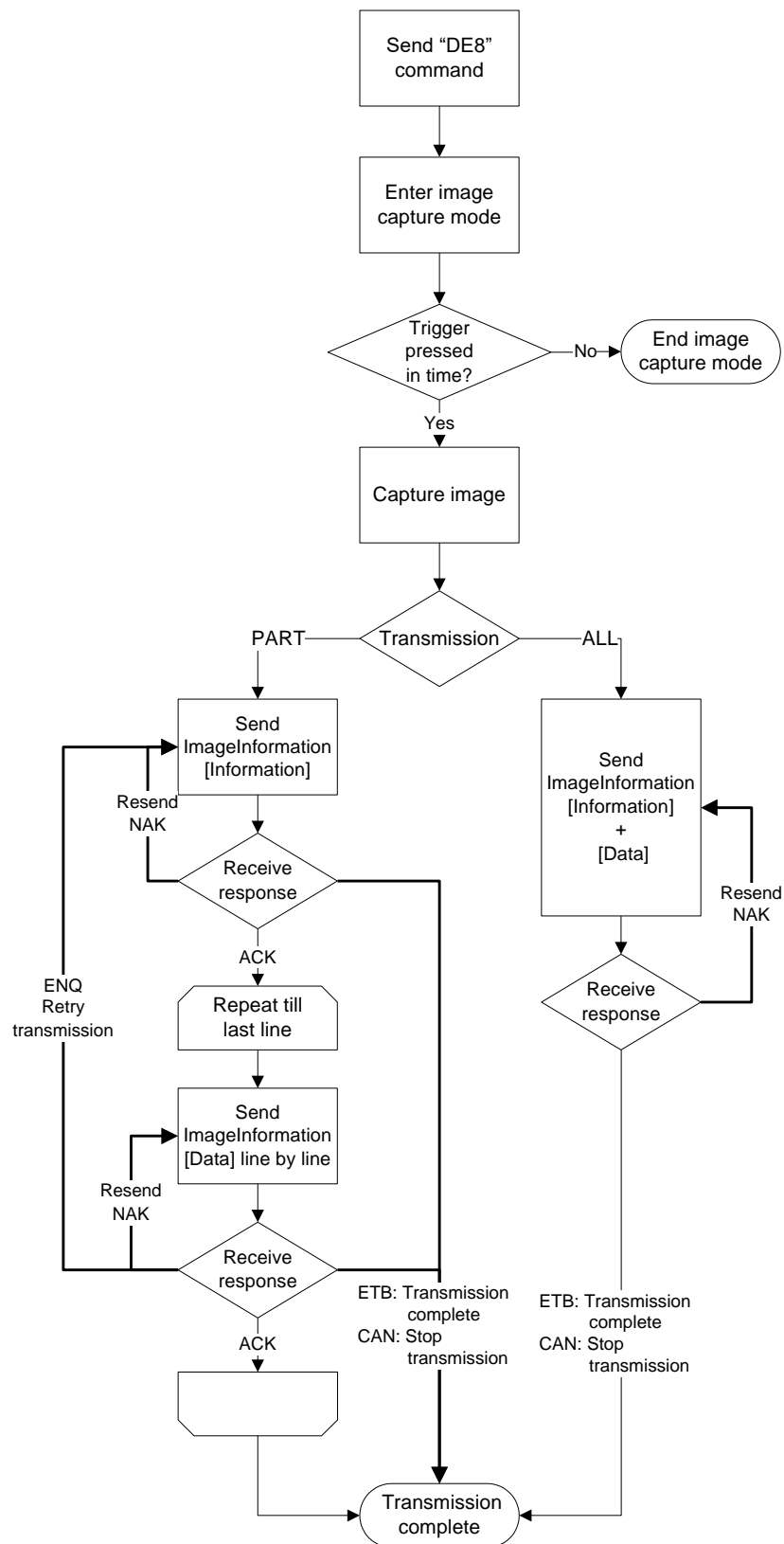


In Trigger Capture (3) mode, the trigger needs to be pressed twice during the period of 't' to take a picture. Aiming will turn on after the first trigger and it will be turned off after 't' expires. Normal decoding will be performed with the second trigger in that case.



3.2. Operation Flow

The following figure shows the flow of image capture operation.



3.3. Output Protocol

Protocol used for output is described below.

3.3.1. Image Information Format

[Function]

This is used for image output. The image information (Information) and the image itself (Data) may be contained in the image output.

[Format]

Start Char	rec No	Length	(A) Information, Data (*)	Check Sum	End Char
0x21					0x0D

* When Transmission mode is ALL, Information is transmitted, followed by Data (entire image).

[Field]

Field	Size [byte]	Details
Start Character	1	'!' (0x21)
rec No	2	Default value is 0. When packets in the same format are sent continuously, this field is incremented sequentially.
Length	4	The size of (A)
(A) *	Information	Information of image
	Data	Image itself PART transmission mode: send line by line ALL transmission mode: send an entire image
Check Sum	2	Calculated according to the method described below.
End Character	1	<CR> (0x0D)

* Refer to next page for each format.

3.3.2. Calculation of the checksum

Description

The checksum is the 16 bit sum of the data elements with index i (0,1,2,...) weighted by (i+1).

Calculation method

Start with a checksum of 0; then, for each data element with index 0, 1, 2, 3, and so on, multiply the value of the data element by its index+1, and add the result to the checksum, keeping only the 16 least significant bits.

As a formula

$$Checksum = \left(\sum_{i=0}^{length-1} x_i * (i+1) \right) \bmod 2^{16}$$

a) Details of Information Field

The Information field comprises the following subfields.

[Subfield]

No.	Subfield	Size [byte]	Effective range	Details
1	Identifier	1	00h ~ FFh	Shows field version
2	Image Size	4		Size of output image
3	Image Number	2	0 ~ 9	Image identification number in memory
4	Image Width	2	1 ~ 640	Width of processed image [pixel]
5	Image Height	2	1 ~ 480	Height of processed image [pixel]
6	Trimmed Left	2	0 ~ 639	Leftmost value of processed image
7	Trimmed Top	2	0 ~ 479	Top edge value of processed image
8	Trimmed Right	2	0 ~ 639	Rightmost value of processed image
9	Trimmed Bottom	2	0 ~ 479	Bottom edge value of processed image
10	Sub sampling Horizontal (SW)	1	1, 2, 4	Subsampling value in horizontal direction for output
11	Sub sampling Vertical (SW)	1	1, 2, 4	Subsampling value in vertical direction for output
12	Maximum Brightness	2	0 ~ 1023	Maximal brightness of processed image (1024-level)
13	Bit per Pixel (BPP)	1	1, 4, 8, 10	Bit depth per pixel
14	File format	1	1, 3	File format 1: JPEG, 3: BMP
15	Shot Left	2	0 ~ 751	Leftmost coordinate of raw image
16	Shot Top	2	0 ~ 479	Top edge coordinate of raw image
17	Shot Right	2	0 ~ 751	Rightmost coordinate of raw image
18	Shot Bottom	2	0 ~ 479	Bottom edge coordinate of raw image
19	Binning Horizontal (HW)	1	1	Subsampling value in horizontal direction for capture
20	Binning Vertical (HW)	1	1	Subsampling value in vertical direction for capture
21	Amplification	2	0 ~ 1500	Gain
22	Exposure Time	4	50 ~ 500000	Exposure time
23	Brightness Index Value	2	0 ~ 1023	Brightness index value (1024-level)
24	Total Transfer Count	2	0 ~ 65535	Number of image information transmissions, including this packet
25	Reserved	211 (*)	0	(For expansion)

* The total size used excluding Reserved is subtracted from 256.

b) Details of Data Field

The Data field comprises the following subfield.

[Subfield]

No.	Subfield	Size [byte]	Effective range	Details
1	Image Data	*	*	Output image data [Part transmission] line by line (horizontal width) [All transmission] entire image

* Those vary depending on the file format type and BPP setting. In the case of JPEG format, the horizontal width of the original image is transmitted (which is different from the real line information because of compression).

3.3.3. Output Image

The Image Information format is used for the image output. The way to output an image varies depending on the transmission modes. The output images in each transmission mode are as shown below.

1. PART transmission

The image information (information) is sent in the first packet, followed by the image itself (Data).

Packet 0

Start Char	rec No = 0	Length = 256	Information	Check Sum	End Char
------------	------------	--------------	-------------	-----------	----------

Packet 1

Start Char	rec No = 1	Length	Data	Check Sum	End Char
------------	------------	--------	------	-----------	----------

.

.

.

Packet n

Start Char	rec No = n	Length	Data	Check Sum	End Char
------------	------------	--------	------	-----------	----------

2. ALL transmission

The image information (information) and the image itself (Data) are all send in the first packet.

Packet 0

Start Char	rec No = 0	Length	Information	Data	Check Sum	End Char
------------	------------	--------	-------------	------	-----------	----------

3.4. Special Instruction

- Bar codes and 2D codes cannot be read during image capture mode.
- An image which was used for reading a bar code or 2D code is not output.