Command-driven
LCD Controller IC
Command Manual

April 2015, First Edition (Japanese version)

June 2015, First Edition (English version)

Kenic system

● Introduction ●

First of all, thank you for having purchased our command-driven LCD controller IC. (KS-350CT-I1, KS-430CT-I1, KS-570CT-I1) (the "Product").

This hardware manual (the "Manual") provides an overview of the Product. We hope that you will read the Manual carefully and make use of it for efficient development.

● Important Information ●

1. The Product and this Manual may change without notice.
   Before using the Product, obtain the newest catalog, manual,etc., from the company website.

2. The Product is not designed to be used in systems or devices that can cause death, injury, or serious physical or environmental damage directly due to any malfunction of the Product (life support device, nuclear facility equipment, aircraft, traffic control equipment, various safety devices, etc.). Danger and damage due to the Product being used in the foregoing systems or devices are the sole responsibility of the customer.

3. We assume no responsibility for any damages due to the use or the operation of the Product in a misguided or wrongful way.

4. The usage examples outlined herein are only an explanation of the Product functions. We assume no responsibility for any complaints, accidents, or any disadvantages which may be caused by the use on the basis of the examples outlined in this Manual.

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Table of Contents

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1. Command List

Table 1-1 is the list of commands.

Table 1-1 Command List

Category	Command	Function	Remarks
Drawing	D	Draws dots.	
	L	Draws lines.	
	B	Draws rectangles (fills or frames).	
	C	Draws circles or cylinders.	
	F	Draws characters.	
	S	Draws 7-segment characters.	
	W	Registers BMP image data (Note 1).	
	P	Draws image data (Note 1).	
Page	H	Sets display pages.	
	I	Sets write pages.	
Touch Panel	t	Returns touch panel data.	
	T	Sets the interval between continuous returns of touch panel data.	
Control	G	Controls LCD display directions.	This command is available to KS-570CT-I1 only.
	Y	Controls backlights.	
	Z	Controls a buzzer.	
	E	Moves to a low power consumption condition.	
Communication	U	Checks for the presence/absence of a checksum.	
	R	Checks for the presence/absence of ACK.	
Others	A	Checks for the presence/absence of the timeout of a serial flash memory.	

(Note 1) For more detail, these commands are described for Starter Kit users in the Starter Kit Manual.

2. Communication Specifications

The communication specifications are described below.

Baud Rate   :   115200bps, 38400bps, 19200bps, 9600bps

Data Length   :   8 bits

Stop Bit   :   1 bit

Parity   :   Not provided

Hardware Control :   RTS Control

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3. Data Format

3-1 Command Format

The command format consists of the command (1 byte), the data column (n bytes), and the delimiter CR (1 byte), as shown in Fig 3-1.

Command	Data Column	CR

Fig. 3-1 Command Format (Checksum: not provided)

The default format is without the checksum, as shown in Fig. 3-1. When the checksum is enabled by the 'U' command (for the presence/absence of a checksum), the checksum (2 bytes) will be required between the data column and the delimiter CR, as shown in Fig. 3-2.
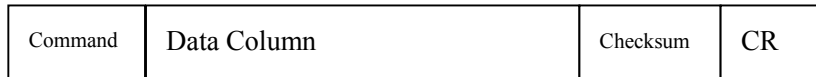
Command	Data Column	Checksum	CR

Fig. 3-2 Command Format (Checksum: provided)

3-1-1 Command

The command characters are shown in Table 1-1. The characters are ASCII codes.

3-1-2 Data Column

The data column includes necessary data for each command.

The number of bytes varies with each command.

Numerical values are represented hexadecimally with '0'(0x30) –'9'(0x39), 'A'(0x41) – 'F'(0x46).

For more detail of the data column, refer to "4. Description of Commands."

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3-1-3　Checksum

When the checksum is enabled by the 'U' command, a checksum (2 bytes) will be necessary.

The checksum (2 bytes) is produced by resolving the lower-order eight (8) bits of the total sum of the command and the data column by four (4) bits and then adding 0x30 to each of these four (4) bits.

First byte (0x30 + the high four (4) bits)　　Second byte (0x30 + the lower four (4) bits)

For example, when the command and the data are as shown in Fig. 3-3, the checksum is produced as follows (refer to Fig. 3-4):

D	0	1	3	0	1	F	1	2	2	F

Fig. 3-3 Example of Command and Data

D(0x44)+0(0x30)+1(0x31)+3(0x33)+0(0x30)+1(0x31)+F(0x46)+
1(0x31)+2(0x32)+2(0x32)+F(0x46)=0x25a

First byte (0x30+0x5)= '5'　Second byte (0x30+0xa)= ':'

5	:

Fig. 3-4 Checksum Data

3-1-4　Delimiter (CR)

The Delimiter CR (0x0d) is the end of a command.

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3-2 ACK (Return Data) Format

The ACK (Return Data) includes the following two types.

① ACK for each Command
② Touch Panel Data

3-2-1 ACK for each Command

When the ACK (disabled by default) is enabled by the 'R' Command (the presence/absence of the ACK), the LCD controller returns the ACK for each command. However, the LCD controller may not return the ACK dependently of the mode of 't' command (Touch Pane data returning command) in the case of the mode that returns Touch Panel data after receiving the 't' command. The ACK Format consists of the command (1 byte), the ACK data (1byte), and the delimiter CR (1 byte), as shown in Fig 3-5.
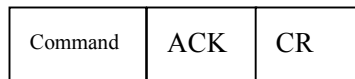
Command	ACK	CR

Fig. 3-5 ACK Format (Checksum not provided)

The default format is without a checksum, as shown in Fig. 3-5. When the checksum is enabled by the 'U' command (for the presence of a checksum), the checksum (2 bytes) will be added between the ACK and the delimiter CR, as shown in Fig. 3-6.
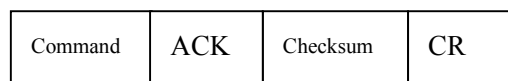
Command	ACK	Checksum	CR

Fig. 3-6 ACK Format (Checksum: provided)

(1) Command

The command characters are shown in Table 1-1. The characters are ASCII codes.

(2) ACK

The ACK is 'K' when each command is normally received and 'E' when each command is not received (Invalid.)

For the command error condition, refer to " 4. Description of Commands."

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(3) Checksum

The calculation that is explained in "3-1 Command Format", is performed and the result is added to the ACK.

3-2-2　Touch Panel Data

The ACK format of the touch panel data consists of the command (1 byte), the return data column (7 bytes), and delimiter CR (1 byte), as shown in Fig 3-7.

Command	Returning data column	CR

Fig. 3-7 Return Data Format of Touch Panel (Checksum: not provided)

The default format is without a checksum, as shown in Fig. 3-7. When the checksum is enabled by the 'U' command (for the presence/absence of a checksum), the checksum (2 bytes) will be added between the return data column and the delimiter CR, as shown in Fig. 3-8.

Command	Returning data column	Checksum	CR

Fig. 3-8 Return Data Format of Touch Panel (Checksum: provided)

For more detail, refer to "4-13 Return 't' command of the touch panel data."

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4. Description of Command

4-1　Data Column

The data columns of the command format are principally as follows:

   ① Type of data

   ② Coordinate data

   ③ Drawing color data

   ④ Character data

   ⑤ Other data

4-1-1　Type of Data

The type of data allows one to select command functions. There is one byte of data in ASCII code.

For example, when the type of data specified is 0, it will be '0'(0x30.)

4-1-2　Coordinate Data

The coordinate data allows one to specify the coordinates of a starting point and of an ending point. There are three (3) bytes of data in ASCII code.

The coordinate data are represented hexadecimally with '0'(0x30) - '9'(0x39), 'A'(0x41) - 'F'(0x46).

For example, 200 (decimal digit) is represented as C8 (hexadecimal digit), and then three (3) bytes as mentioned above.

    "0C8　h" -> **'**0'(0x31) 'C'(0x43) '8'(0x38)

4-1-3　Drawing Color Data

The drawing color data allows one to specify a drawing color. There are four (4) bytes of data in ASCII code.

The drawing color data is represented hexadecimally with '0'(0x30) - '9'(0x39), 'A'(0x41) - 'F'(0x46).

The drawing color is represented with the RGB565 format, as shown in Fig. 4-1.

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High order bytes

Bit	15	14	13	12	11	10	9	8
Name	R4	R3	R2	R1	R0	G5	G4	G3

Lower order bytes

Bit	7	6	5	4	3	2	1	0
Name	G2	G1	G0	B4	B3	B2	B1	B0

Fig. 4-1 RGB565 Format

When a drawing color is specified, as shown in Fig. 4-2, it will be hexadecimally 0x0843, which is 4 bytes.

"0843" -> '0'(0x31) '8'(0x38) '4'(0x34) '3'(0x33)

High order bytes

Bit	15	14	13	12	11	10	9	8
Name	0	0	0	0	1	0	0	0

Lower order bytes

Bit	7	6	5	4	3	2	1	0
Name	0	1	0	0	0	0	1	1

Fig. 4-2 Data Example: Drawing Color data

4-1-4   Character Data

The character drawing 'F' command and seven 7-segment character drawing 'S' command allow one to decide the characters that will be drawn.

For more detail, refer to items of these commands.

4-1-5   Other Data

For other data, refer to descriptions of each command.

The contents of the data columns vary with the commands.

For more detail, refer to descriptions of each command.

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4-2　Invalid

The following conditions are Invalid. When a condition is invalid, commands cannot be executed.
When the ACK is enabled by the 'R' command (for the presence/absence of ACK), the ACK will be 'E'.

① When the numbers of command bytes are not matched

② When the coordinates are not within the display range

③ When the characters of the data column are not '0' – '9' or 'A' – 'F' (except for character data)

④ When the type of data and other data are out of the range

⑤ When the checksums are not matched

4-2-1　When the numbers of command bytes are not matched

The numbers of the command bytes in each command (when the command, the data column, and the checksum are enabled, the checksum is included) are fixed byte numbers.

However, the drawing character 'F' command is a variable byte numbers.

The commands with fixed numbers of command bytes will cause a command error, when the command byte numbers are smaller or greater.

4-2-2　When the coordinates are not within the display range

When the coordinates are not within the display range, a command error will occur.

The display range varies with the LCD Controller as shown in Table 4-1.

Table 4-1　Display Format

LCD Controller Type	Display Format
KS-350CT-I1	(0,0)～(319,239)
KS-430CT-I1	(0,0)～(479,271)
KS-570CT-I1	(0,0)～(319,239)

4-2-3　When the characters of the data column are not '0'–'9' or 'A'–'F' (except for the character column data).

When the characters (except for character data) of the data column are not '0' – '9' or 'A' – 'F', a command error will occur.

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4-2-4　When the type of data and other data are not within the range

When the type of data and other data are not within the range, a command error will occur.

For more detail, refer to descriptions of each command.

4-2-5　When the checksums are not matched

When the checksums are not matched, a command error will occur.

The conditions of Invalid vary with the commands.

For more detail, refer to descriptions of each command.

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4-3   Dot Drawing 'D' command

4-3-1   Description of Command

The dot drawing 'D' command allows one to specify the coordinates (X, Y) and the dot drawing color and draw the dot on the screen, as shown in Fig. 4-3.
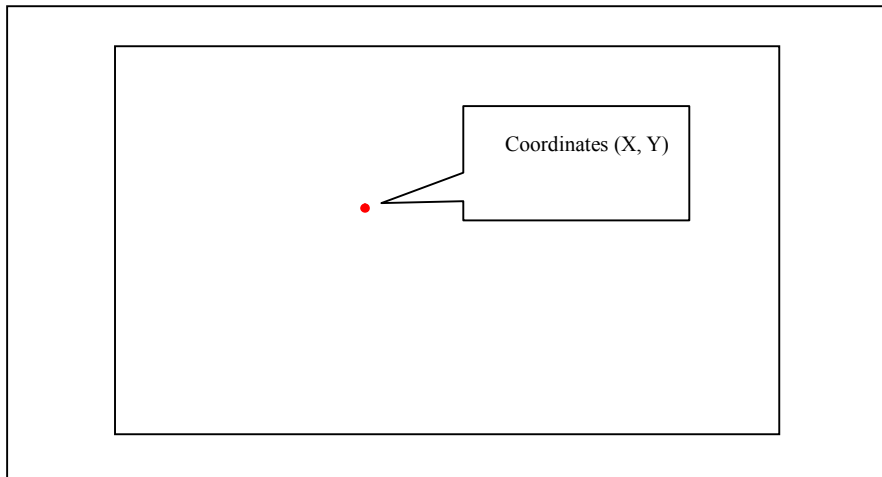

Fig. 4-3 Dot Drawing

The command and data column are represented with the following format, as shown in Table 4-2.

Table 4-2 Format of Dot Drawing 'D' Command

	Command	Data Column		
Contents	D	X coordinate	Y coordinate	Drawing Color
Number of Data	1 byte	3 bytes	3 bytes	4 bytes

4-3-2   Examples of Command and Character Drawing

When drawing the dot with the coordinates (100, 50) and the color 0xF800, these commands are represented, as shown in Table 4-3.

Also, the drawing result when this command is executed appears in Fig. 4-4.

Table 4-3 Example of Dot Drawing 'D' Command

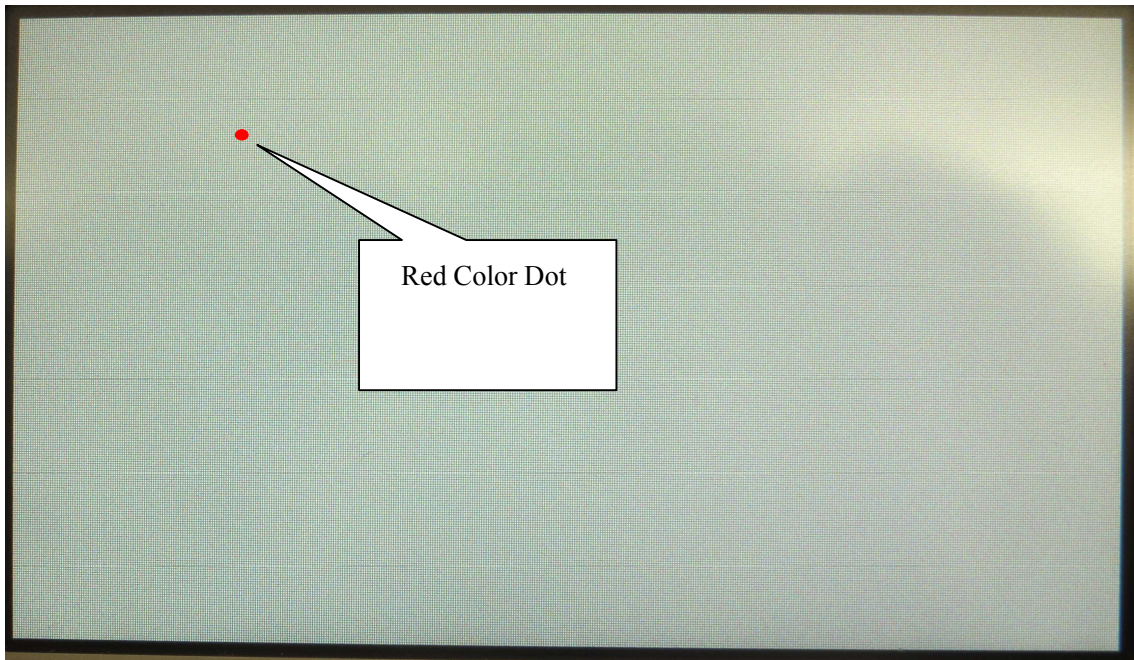|	Command	Data Column		
Contents	D	X coordinate	Y coordinate	Drawing Color
Data	'D'	"064"	"032"	"F800"

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Fig. 4-4 Condition when a dot was drawn on the screen

4-3-3　Command Error Condition

The following conditions will cause a command error.

- ・ When the numbers of command bytes are not matched
- ・ When the coordinates are not within the display range
- ・ When the characters of the data columns are not '0' – '9' or 'A' – 'F'
- ・ When the checksums are not matched (when checksums are enabled)

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4-4　Line Drawing 'L' Command

4-4-1　Description of Command

The line drawing 'L' command allows one to specify the coordinates of a starting point (X1, Y1) , coordinates of an ending point (X2, Y2), and the line drawing, as shown in Fig. 4-5. and then to draw a line.
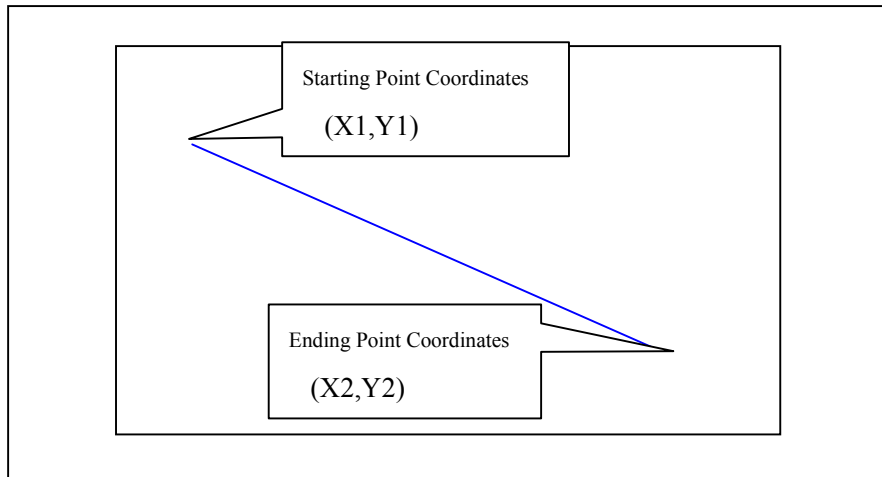

Fig. 4-5 Line Drawing

The command and data column are represented with the following format, as shown in Table 4-4.

Table 4-4 Format of Line Drawing 'L' Command

	Command	Data Column				
Contents	L	Type of Data	X1 coordinate	Y1 coordinate	X2 coordinate	Y2 coordinate	Drawing Color
Data	1 byte	1 byte	3 bytes	3 bytes	3 bytes	3 bytes	4 bytes

Note)　Fix the type of data at 0.

4-4-2　Examples of Commands and Line Drawing

The commands when drawing the line with coordinates (10, 20) – (100, 200) and the color of 0xF800 are shown in Table 4-5.

Also, the drawing result when this command is executed appears in Fig. 4-6.

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Table 4-5 Example of Line Drawing 'L' Command

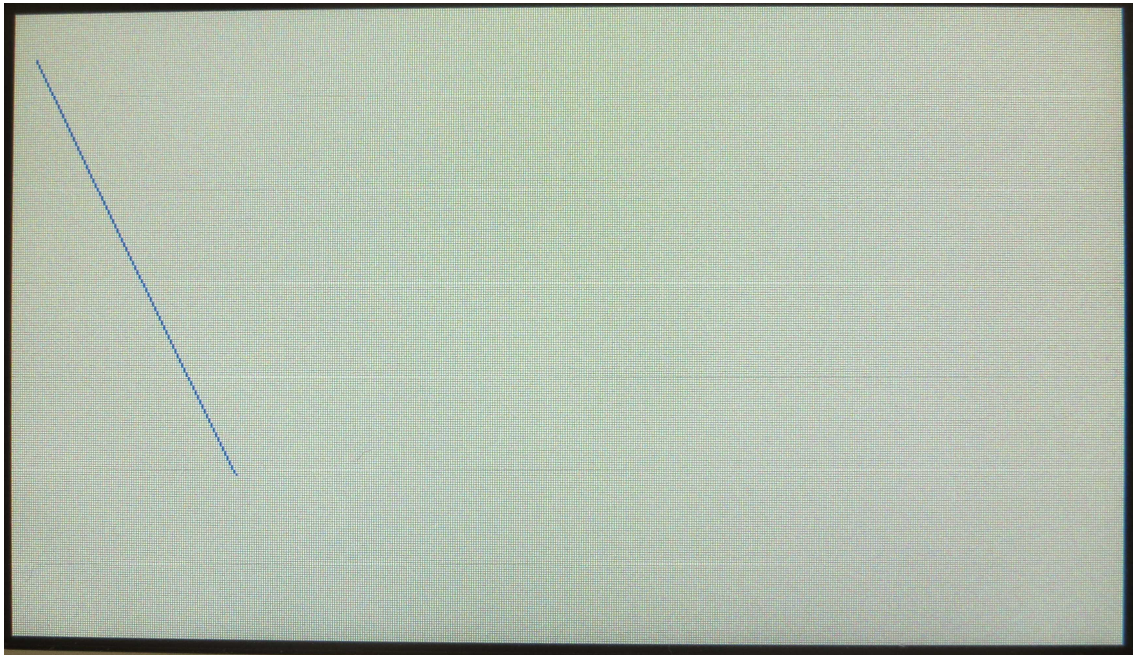|	Command	Data Column					
Contents	L	Type of Data	X1 coordinate	Y1 coordinate	X2 coordinate	Y2 coordinate	Drawing Color
Data	'L'	'0'	"00A"	"014"	"064"	"0C8"	"001F"

Fig. 4-6 Condition when the line was drawn on the screen

4-4-3　　Command Error Condition

The following conditions will cause a command error.

- ・ When the type of data is not '0'
- ・ When the numbers of the command bytes are not matched
- ・ When the coordinates are not within the display ranges
- ・ When the characters of the data column are not '0' – '9' or 'A' – 'F'
- ・ When the checksums are not matched (when checksums are enabled)

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4-5 Rectangle Drawing (fills and frames) 'B' Command

4-5-1 Description of Command

The Rectangle drawing 'B' command allows one to specify the coordinates of a starting point (X1, Y1), coordinates of an ending point (X2, Y2), and a rectangle drawing color, and then to draw a rectangle (a frame or a fill.)
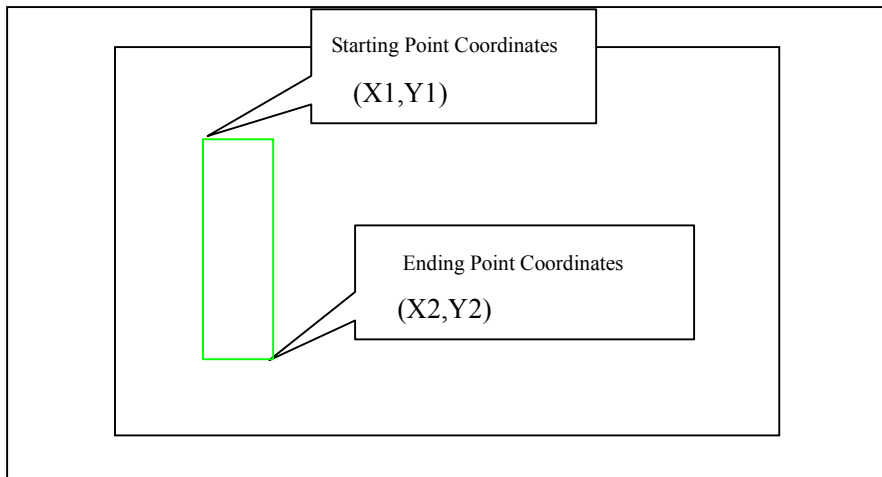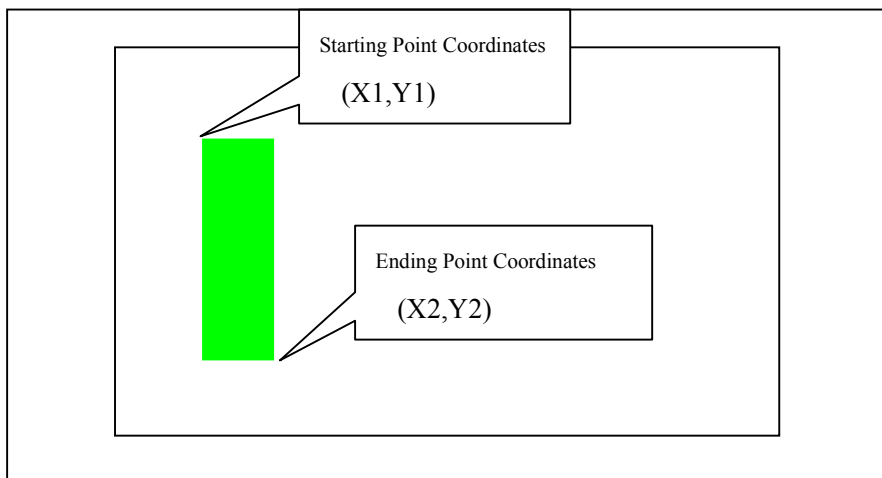

Fig. 4-7 Rectangle Frame Drawing

Fig. 4-8 Rectangle Fill Drawing

The command and data column are represented with the following format, as shown in Table 4-6.

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Table 4-6 Format of Rectangle Drawing (fills and frames) 'B' Command

	Command *	Data Column					
Contents	B	Type of Data	X1 coordinate	Y1 coordinate	X2 coordinate	Y2 coordinate	Drawing Color
Data	1 byte	1 byte	3 bytes	3 bytes	3 bytes	3 bytes	4 bytes

The type of data allows one to select the type of a rectangle drawing, as shown in Table 4-7.

Table 4-7 Type of Data

Type of Data	Type
'0'	Fill Drawing
'1'	Frame Drawing

4-5-2　Examples of Commands and Rectangle Drawing

When filling the frame enclosed with the coordinates (10, 20) – (100, 200) with the color 0x07E0, these commands are represented, as shown in Table 4-8.

Also, the drawing result when this command is executed appears in Fig. 4-9.

Table 4-8 Example of Format of Rectangle Drawing (fills and frames) 'B' Command

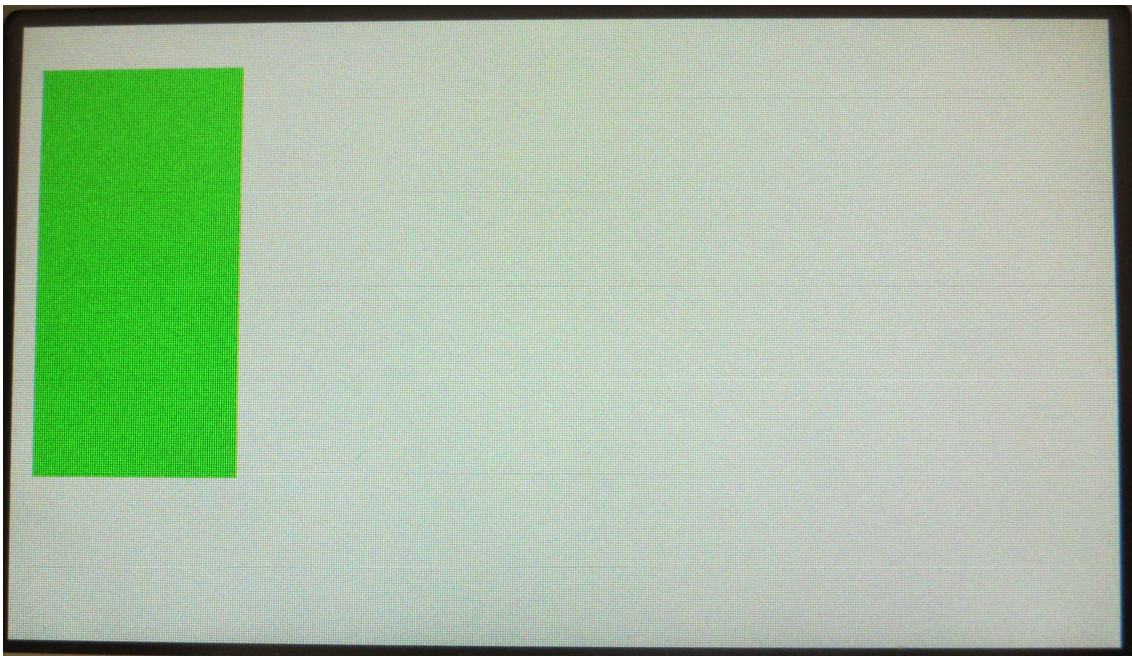|	Command	Data Column					
Contents	B	Type of Data	X1 coordinate	Y1 coordinate	X2 coordinate	Y2 coordinate	Drawing Color
Data	'B'	'0'	"00A"	"014"	"064"	"0C8"	"07E0"

Fig. 4-9 Condition when the rectangle (fills) was drawn on the screen

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4-5-3   Command Error Condition

The following conditions will cause a command error.

- When the type of data is not listed in Table 4-7
- When the numbers of the command bytes are not matched
- When the coordinates are not within the display range
- When the characters of the data column are not '0' – '9' or 'A' – 'F'
- When the checksums are not matched (when checksums are enabled)

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4-6   Circle or Cylinder Drawing 'C' Command

4-6-1   Description of Command

The Circle or Cylinder drawing 'C' command allows one to specify the central coordinate (X, Y), the X-radius, the Y-radius, the height of the cylinder, the frame color and the fill color, and then draw the circle or the cylinder (the vertical cylinder or the horizontal cylinder) on the screen, as shown in Fig.4-10, 11, and 12
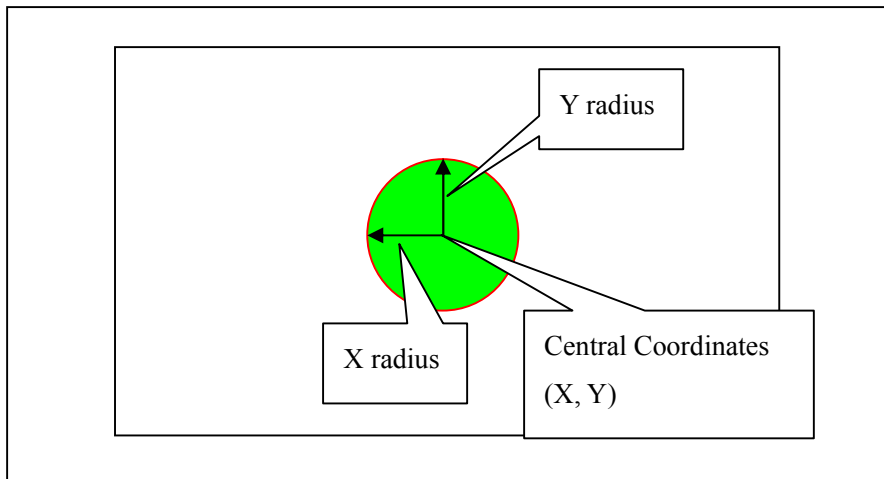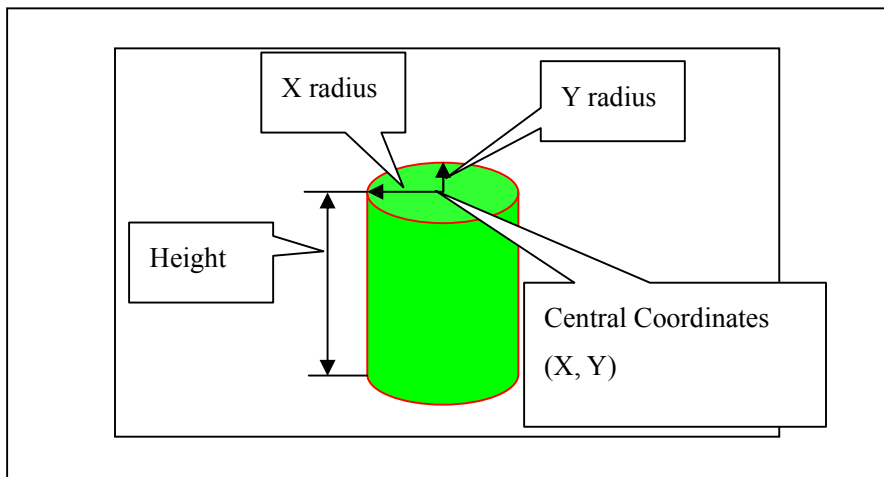

Fig. 4-10 Circle Drawing

Fig. 4-11 Vertical Cylinder Drawing

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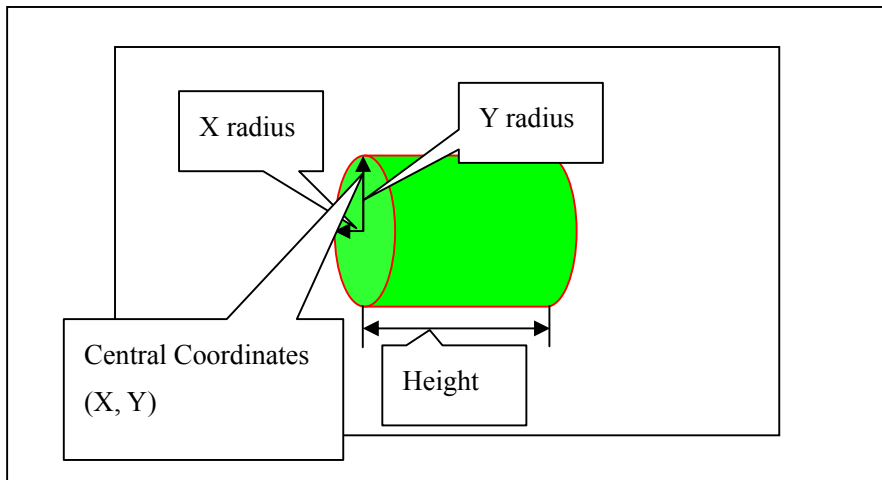
Fig. 4-12 Horizontal Cylinder Drawing

The command and data column are represented with the following format, as shown in Table 4-9.

Table 4-9 Format of Circle or Cylinder Drawing 'C' Command

	Command	Data Column							
Contents	C	Type of Data	X Central Coordinate	Y Central Coordinate	X Radius	Y Radius	Height	Frame Color	Fill-Color
Data	1 byte	1 byte	3 bytes	3 bytes	3 bytes	3 bytes	3 bytes	4 bytes	4 bytes

The type of data allows one to select the type of the circle drawing, as shown in Table 4-10.

Table 4-10 Type of Data

Type of Data	Type
'0'	Normal Circle Drawing
'1'	Vertical Cylinder Drawing
'2'	Horizontal Cylinder Drawing

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4-6-2　Examples of Command and Vertical Cylinder Drawing

The commands when drawing the vertical cylinder with the central coordinate (100, 40),

the X-radius of 20, the Y-radius of 10, and the cylinder height of 30, and drawing with the frame color

of 0xF800 and the fill color of 0x07E0 are shown in Table 4-11.

Also, the drawing result when this command is executed appears in Fig. 4-13.

Table 4-11 Example of Circle or Cylinder Drawing 'C' Command

	Command	Data Column							
Contents	C	Type of Data	X Central Coordinate	Y Central Coordinate	X Radius	Y Radius	Height	Frame Color	Fill-Color
Data	'C'	'1'	"064"	"028"	"014"	"00A"	"01E"	"F800"	"07E0"

Fig. 4-13 Condition when the vertical cylinder was drawn on the screen
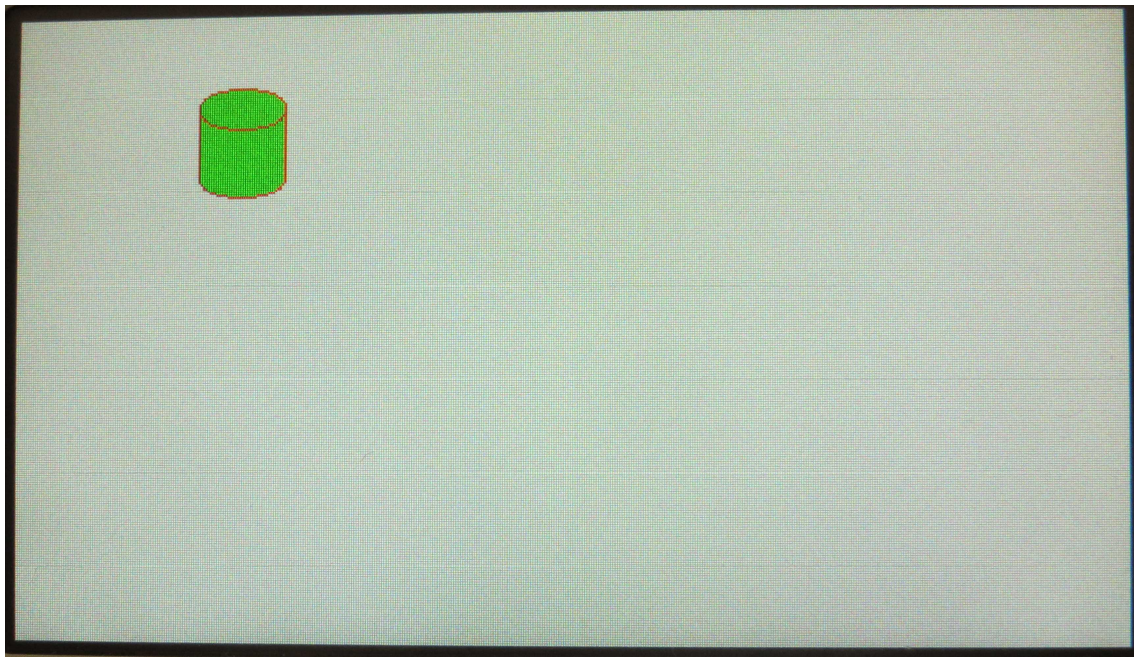
4-6-3　Command Error Condition

The following conditions will cause a command error.

- ・ When the type of data is not listed in Table 4-10
- ・ When the numbers of the command bytes are not matched
- ・ When the cylinder with the central coordinate, the radius, and the height that are specified are out of the display range or exceeds the range

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- When the characters of the data column are not '0' – '9' or 'A' – 'F'
- When the checksums are not matched (when checksums are enabled)

4-7   Character Drawing 'F' Command

4-7-1   Description of Command

The Character drawing 'F' command allows one to specify the font type, the font size, the coordinate (X, Y) of the starting point, the character color, and the character string and then to draw characters on the screen, as shown in Fig.4-14
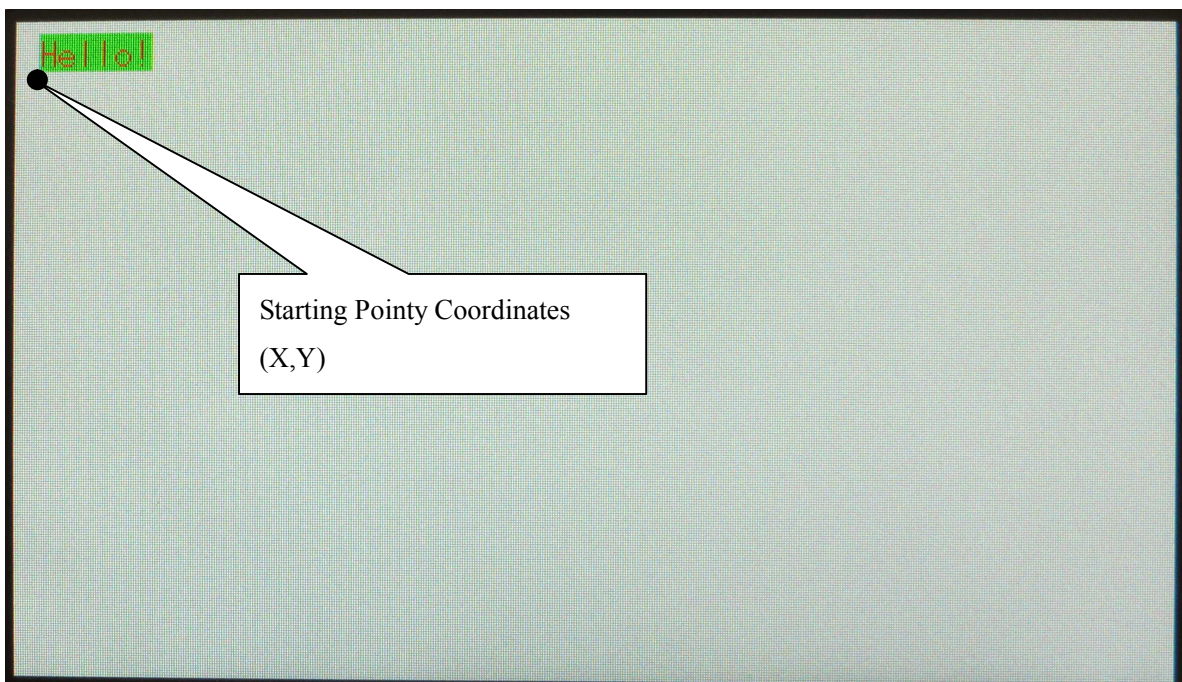
Fig. 4-14 Character Drawing

The command and data column are represented with the following format, as shown in Table 4-12.

Table 4-12 Format of Character Drawing 'F' Command

	Command	Data Column						
Contents	F	Font Type	Font Size	X Coordinate	Y Coordinate	Character Color	Background Color	Character String
Data	1 byte	1 byte	1 byte	3 bytes	3 bytes	4 bytes	4 bytes	Max. 40 bytes

The font type allows one to select a font type, as shown in Table 4-13.

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Table 4-13 Font Type

Font Type	Type
'0'	16-dot font (8×16 dot, 16×16 dot font)
'1'	24-dot font (12×24 dot, 24×24 dot font)

The 16-dot font data is included in the LCD Controller, but the 24-dot font data is not.

If the 24-dot font is necessary, please purchase our Starter Kit. Then, write the 24-dot font data in the serial flash memory connected to the LCD Controller that is attached to the Starter Kit. For more detail, refer to the Starter Kit Manual (This manual will be released to Starter Kit users only.)

The font size allows one to select the font size, as shown in Table 4-14.

Table 4-14 Font Size

Font Size	Type
'0'	Normal Size
'1'	Vertical Double Height Size
'2'	Spare (for expansion) Do not specify.
'3'	Vertical and Horizontal Double Height Size

The dot size types of each font size are described in Table 4-15.

Table 4-15 Dot Size Types of each Font

Normal Size	Vertical Double Height Size	Vertical and Horizontal Double Height Size
8×16 dot	8×32 dot	16×32 dot
16×16 dot	16×32 dot	32×32 dot
12×24 dot	12×48 dot	24×48 dot
24×24 dot	24×24 dot	48×48 dot

The Y coordinate begins from the lower side of the character, as shown in Fig. 4-14.

The maximum data size of the character string is 40 bytes. The data size of 40 bytes allows one to use a maximum of 40 characters for a one-byte character and a maximum of 20 characters for a double-byte character.

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4-7-2   Examples of Command and Drawing

The commands when drawing the characters "Tokyo" of the double height size of 16×32 dot from the starting point coordinate (10, 40) with the character color of 0x0000 and the background color of 0xFFFF are shown in Table 4-16.

Also, the drawing result when this command is executed appears in Fig. 4-15.

Table 4-16 Example of Character Drawing 'F' Command

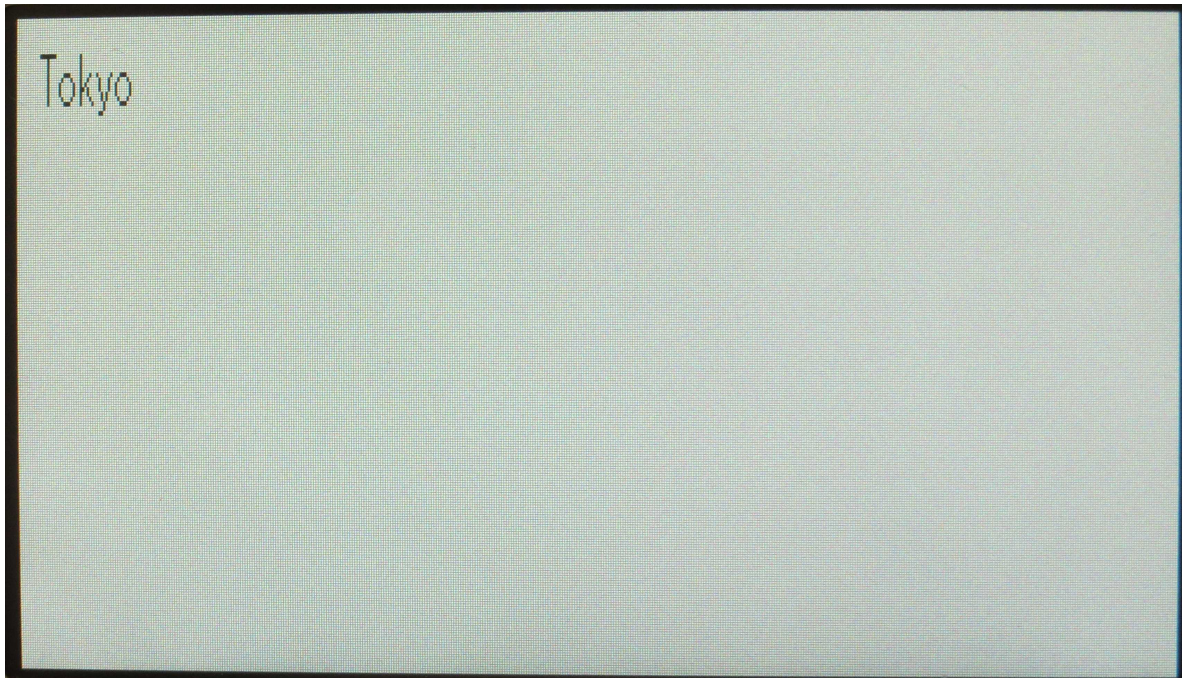|	Command	Data Column						
Contents	F	Font Type	Font Size	X Coordinate	Y Coordinate	Character Color	Background Color	Character String
Data	'F'	'0'	'1'	"00A"	"028"	"0000"	"FFFF"	"Tokyo"

Fig. 4-15 Condition when the characters were drawn on the screen

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4-7-3　Command Error Condition

The following conditions will cause a command error.

- ・ When the font type is not listed in Table 4-13
- ・ When the font size is not listed in Table 4-14 or is '2'
- ・ When the number of character strings is 0 byte
- ・ When the number of character strings is greater than 40 bytes
- ・ When the coordinates are not within the display range

  However, the Y-coordinate begins from the lower side of a character, as shown Fig. 4-16 and, thus, a command error value varies with the font type and font size, as shown in Table 4-17.

  When the Y coordinate is smaller than the lower limit of the Y coordinate, it will cause a command error.
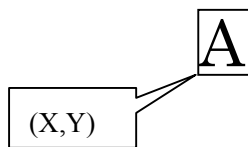
Fig. 4-16 Y Coordinate

Table 4-17 Y Coordinate Command Error Conditions

Font Type	Font Size	Y Coordinate Lower Limit
16 dot font	Normal Size	15
	Vertical Double Height Size	31
	Vertical and Horizontal Double Height Size	
24 dot Font	Normal Size	23
	Vertical Double Height Size	47
	Vertical and Horizontal Double Height Size	

When the starting point coordinate is in the display range and the characters exceed the display range due to the number of characters, it will not cause a command error. Accordingly, drawing will be done continuously. Be careful in this case, because it may be drawn in addition, on a separate page.

- ・ When characters of a data columns are not '0' – '9' or 'A' – 'F' (except for a character string).
- ・ When the checksums are not matched (when checksums are enabled)

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4-8   7-Segment Character Drawing 'S' Command

4-8-1   Description of Command

The 7-segment character drawing 'S' command allows one to specify the font type, the font size, the coordinate (X, Y) of the starting point, the character color, and the character string and then draw 7-segment characters on the screen, as shown in Fig.4-17

Starting Point Coordinates (X,Y)
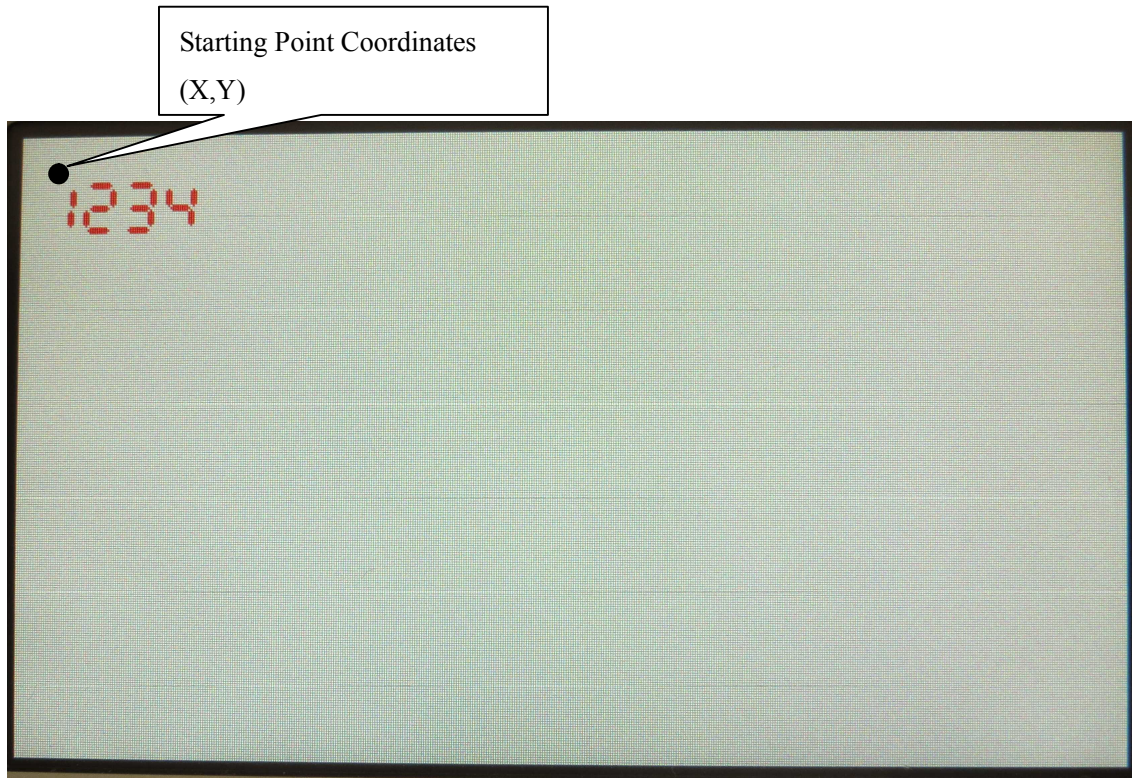
Fig.4-17 7-Segment Character Drawing 'S' Command

The command and data column are represented with the following format, as shown in Table 4-18.

Table 4-18 Format of 7-Segment Character Drawing 'S'

	Command	Data Column						
Contents	S	Size	Number of Display Digits	X Coordinate	Y Coordinate	Character Color	Background Color	Character String
Data	1 byte	1 byte	1 byte	3 bytes	3 bytes	4 bytes	4 bytes	(Number of Display Digits) bytes

Note)   Fix the size at 0.

The number of display digits allows one to specify the digit number of 7-segment characters. The number of display digits is set in the range of "1 - 5".

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4-8-2   Examples of Command and Drawing

The commands when drawing the 7-segment characters "1234" from the starting point coordinates (10, 20) with the character color of 0xF800 and the background color of 0xFFFF are shown in Table 4-19.

Also, the drawing result when this command is executed appears in Fig. 4-18.

Table 4-19 Example of 7-Segment Character Drawing 'S' Command

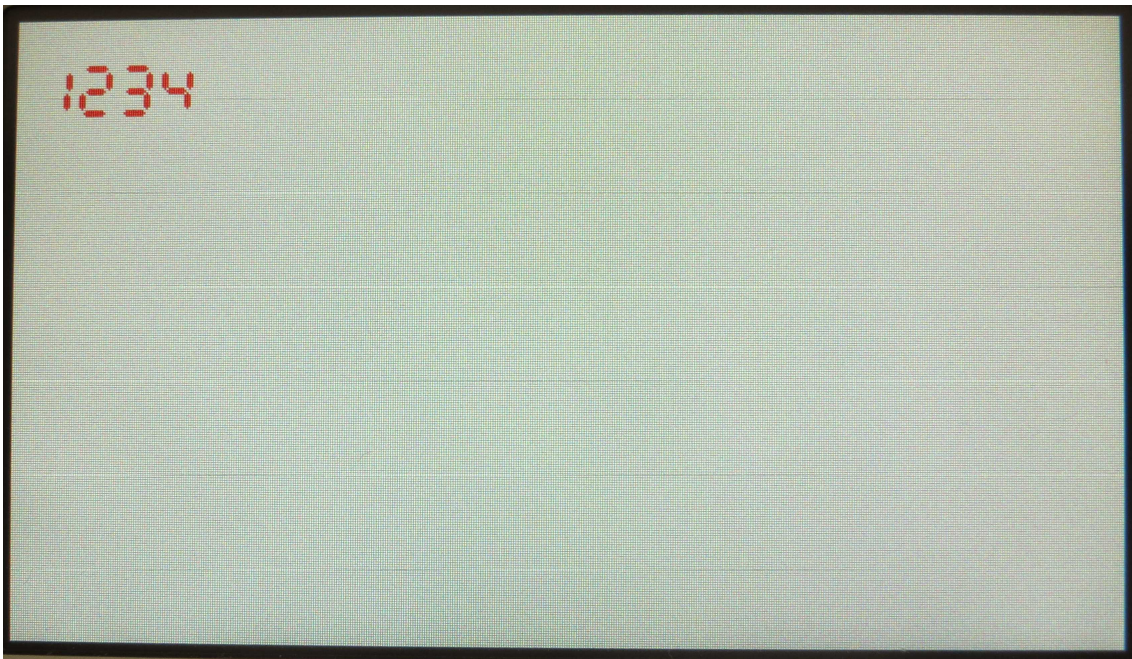| Contents	Command S	Data Column						
		Size	Number of Display Digits	X Coordinate	Y Coordinate	Character Color	Background Color	Character String
Data	'S'	'0'	'4'	"00A"	"014"	"F800"	"FFFF"	"1234"

Fig. 4-18 Condition when the 7-Segment characters were drawn on the screen

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4-8-3 Command Error Condition

The following conditions will cause a command error.

- · When the size is not '0'.
- · When the number of display digits is not '1 - 5'
- · When the numbers of command bytes are not matched
- · When the byte number of the character string does not match the number of the display digit**s**
- · When the coordinates are not within the display range

  When drawing with the starting point coordinates within the display range

  and the 7-segment characters exceed the display range due to the number of characters, a command error will not occur. Accordingly, drawing will be done continuously.

  Be careful in this case, because it may be drawn in addition, on a separate page.
- · When the characters of the data columns are not '0' – '9' or 'A' – 'F' (except for the character string)
- · When the character string is not '0' – '9'
- · When the checksums are not matched (when checksums are enabled)

4-9 BMP Image Data Registering 'W' Command

Refer to the Starter Kit Manual (This manual will be released to Starter Kit users.)

4-10 Image Data Drawing 'P' Command

Refer to the Starter Kit Manual (This manual will be released to Starter Kit users.)

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4-11 Display Page Setting 'H' Command

4-11-1 Description of Command

This command allows one to specify the display page.

The command and data column are represented with the following format, as shown in Table 4-20.

Table 4-20 Format of Display Page Setting 'H' Command

	Command	Data Column
Contents	'H'	Page Number
Data	1 byte	1 byte

Each LCD controller has a page number range and a number of pages, as shown in Table 4-21.

Table 4-21 Range of Page Number and Number of Pages

LCD Controller Type	Range of Page Number	Number of Pages
KS-350CT-I1	'0' – '2' (Default 0)	3
KS-430CT-I1	'0' – '1' (Default 0)	2
KS-570CT-I1	'0' – '2' (Default 0)	3

After the LCD controller returns from the low power consumption condition to the normal mode, timeout will be the default condition.

4-11-2 Example of Command

The commands when setting a display page to Page 1 are shown in Table 4-22.

Table 4-22 Example of Display Page Setting 'H' Command

	Command	Data Column
Contents	H	Page Number
Data	'H'	'1'

4-11-3 Command Error Condition

The following conditions will cause a command error.

- ・ When the page number is not listed in Table 4-21
- ・ When the numbers of command bytes are not matched
- ・ When the checksums are not matched (when checksums are enabled)

Kenic system

4-12　Writing Page Setting 'I' Command

4-12-1　Description of Command

This command allows one to specify a writing page.

The command and data column are represented with the following format, as shown in Table 4-23.

Table 4-23 Format of Writing Page Setting 'I' Command

	Command	Data Column
Contents	I	Page Number
Data	1 byte	1 byte

Each LCD controller has a page number range and a number of pages, as shown in Table 4-21.

After the LCD controller returns from the low power consumption condition to the normal mode, timeout will be the default condition.

4-12-2　Example of Command

The commands when setting the writing page to Page 1 are shown in Table 4-24.

Table 4-24 Example of Writing Page Setting 'I' Command

	Command	Data Column
Contents	I	Page Number
Data	'I'	'1'

4-12-3　Command Error Condition

The following conditions will cause a command error.

・　When the page number is not listed in Table 4-21

・　When the numbers of command bytes are not matched

・　When the checksums are not matched (when checksums are enabled)

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4-13　Touch Panel Data Returning 't' Command

4-13-1　Description of Command

This command allows one to return the touch panel data.

The command and data column are represented with the following format, as shown in Table 4-25.

Table 4-25 Format of Touch Panel Data Returning 't' Command

	Command	Data Column
Contents	t	Type of Data
Data	1 byte	1 byte

The type of data allows one to select the returning mode, as shown in Table 4-26.

Table 4-26 Type of Data

Type of Data	Returning Mode
'0'	One (1) data returning (default)
'1'	Automatic, continuous returning
'2'	Continuous returning while pressing the touch panel
'3'	Returning only when pressing the touch panel
'4'	Returning only when releasing the touch panel
'5'	Returning both data when pressing and releasing the touch panel

For more detail of each returning mode, refer to Hardware Manual.

When the type of data is '0' or '1', the ACK will not be returned when it is enabled.

After the LCD controller returns from the low power consumption condition to the normal mode, timeout will be the default condition.

4-13-2　Example of Command

The commands when returning automatically and continuously are shown in Table 4-27.

Table 4-27 Example of Touch Panel Data Returning 't' Command

	Command	Data Column
Contents	t	Type of Data
Data	't'	'1'

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4-13-3　Returning Data

The format of touch panel returning data is represented, as shown in Table 4-28.

Table 4-28 Format of Touch Panel Returning Data

Contents	Command	Returning Data Column		
	t	Event	AD value in X direction	AD value in Y direction
Data	1 byte	1 byte	3 bytes	3 bytes

Event indicates the condition whether the touch panel is pressed or released.

Table 4-29 Event

Event	Type
'0'	Condition that the touch panel is released
'1'	Condition that the touch panel is pressed

Since the AD resolution is 10 bits, the AD values in the X direction and Y direction is in the range of 0x000 - 0x3FF.

The returning data when the position of X=0x3EF and Y=0x12B in AD values is pressed, is shown in Table 4-30.

Table 4-30 Example of Touch Panel Returning Data

Contents	Command	Returning Data Column		
	t	Event	AD value in X direction	AD value in Y direction
Data	't'	'1'	"3EF"	"12B"

4-13-4　Command Error Condition

The following conditions will cause a command error.

- ・ When the type of data is not listed in Table 4-26
- ・ When the numbers of command bytes are not matched
- ・ When the checksums are not matched (when checksums are enabled)

Kenic system

4-14　Setting 'T' Commands for Interval of Touch Panel Data Continuous Returning

4-14-1　Description of Command

This command allows one to set the interval of returning data

when the returning mode of the touch panel is continuous returning.

The command and data column are represented with the following format, as shown in Table 4-31.

Table 4-31 Format of Interval Setting 'T' Command in Touch

Panel Data Continuous Returning

	Command	Data Column
Contents	T	Interval of Returning
Data	1 byte	2 bytes

The interval of returning is in the range of 50 (0x32) msec to 200 (0xC8) msec.

The initial value is 50 msec.

After the LCD controller returns from the low power consumption condition to the normal

mode, timeout will be the default condition.

4-14-2　Example of Command

The commands when setting the interval of touch panel data continuous returning to 50 msec

are shown in Table 4-32.

Table 4-32 Example of Interval Setting 'T' Command in Touch

Panel Data Continuous Returning

	Command	Data Column
Contents	T	Interval of Returning
Data	'T'	"32"

4-14-3　Command Error Condition

The following conditions will cause a command error.

- ・ When the returning interval is out of the range
- ・ When the numbers of command bytes are not matched
- ・ When the characters of the data column are not '0' – '9' or 'A' – 'F'
- ・ When the checksums are not matched (when checksums are enabled)

Kenic system

4-15 LCD Display Direction Controlling 'G' Command

4-15-1 Description of Command

This command allows one to set the outputs of the U/D terminals and R/L terminals of the LCD controller (only KS-570CT-II.)

This command is used for only KS-570CT-II.

The command and data column are represented with the following format, as shown in Table 4-33.

Table 4-33 Format of LCD Display Direction Controlling 'G' Command

	Command	Data Column	
Contents	G	U/D	R/L
Data	1 byte	1 byte	1 byte

The U/D and R/L allows one to set the output condition of terminals, as shown in Table 4-34 and 4-35.

Table 4-34 U/D

U/D	U/D Terminal Output Status
'0'	LOW Output
'1'	HIGH Output (default)

Table 4-35 R/L

R/L	R/L Terminal Output Status
'0'	LOW Output (default)
'1'	HIGH Output

After the LCD controller returns from the low power consumption condition to the normal mode, timeout will be the default condition.

4-15-2 Example of Command

The commands when setting the U/D to the LOW Output and the R/L to the HIGH output are shown in Table 4-36.

Table 4-36 Example of LCD Display Direction Controlling 'G' Command

	Command	Data Column	
Contents	G	U/D	R/L
Data	'G'	'0'	'1'

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4-15-3　Command Error Condition

The following conditions will cause a command error.

- ・ When the U/D and R/L values are not listed in Table 4-34 and 4-35.
- ・ When the numbers of command bytes are not matched
- ・ When the checksums are not matched (when checksums are enabled)

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4-16   Backlight Controlling 'Y' Command

4-16-1   Description of Command

This command allows one to set the outputs of the BLEN terminals for the backlight ON/OFF signal, and the frequency and duty ratio of the PWM terminals for backlight dimming.

The command and data column are represented with the following format as shown in Table 4-37.

Table 4-37 Format of Backlight Controlling 'Y' Command

Contents	Command	Data Column		
	Y Coordinate	BLEN	FREQ	DUTY
Data	1 byte	1 byte	1 byte	2 bytes

The BLEN allows one to set the output condition of terminals, as shown in Table 4-38.

Table 4-38 BLEN

BLEN	BLEN Terminal Output Condition
'0'	LOW Output (KS-570CT-II default)
'1'	HIGH Output (KS-350CT-II, KS-430CT-II default)

FREQ allows one to select the frequency of the PWM signal, as shown in Table 4-39.

Table 4-39 FREQ

FREQ	PWM Frequency
'0'	100Hz
'1'	200Hz (default))
'2'	300Hz
'3'	400Hz
'4'	500Hz
'5'	600Hz
'6'	700Hz
'7'	800Hz
'8'	900Hz
'9'	1,000Hz
'A'	100kHz

The DUTY allows one to set the ON width of the PWM. The setting range is 0 (0x00) % to 100 (0x64) %. The initial value is 100 %.

After the LCD controller returns from the low power consumption condition to the normal mode, timeout will be the default condition.

Kenic system

4-16-2　Example of Command

　The commands when setting the BLEN to the HIGH output, the PWM frequency to 200Hz, and the DUTY to 50% are shown in Table 4-40.

Table 4-40 Example of Backlight Controlling 'Y' Command

	Command	Data Column		
Contents	Y	BLEN	FREQ	DUTY
Data	'Y'	'1'	'1'	"32"

4-16-3　Command Error Condition

　The following conditions will cause a command error.

- ・　When the BLEN setting is not listed in Table 4-38
- ・　When the FREQ setting is not listed in Table 4-39
- ・　When the DUTY is out of the setting range
- ・　When the numbers of command bytes are not matched
- ・　When characters of the data column are not '0' – '9' or 'A' – 'F'
- ・　When the checksums are not matched (when checksums are enabled)

Kenic system

4-17　Buzzer Controlling 'Z' Command

4-17-1　Description of Command

This command allows one to set the output of the BUZZ terminals and the HIGH time of the output.

The command and data column are represented with the following format, as shown in Table 4-41.

Table 4-41 Format of Buzzer Controlling 'Z' Command

	Command	Data Column	
		BUZZ	HIGH Time
Contents	Z	BUZZ	HIGH Time
Data	1 byte	1 byte	3 bytes

The BUZZ allows one to set the output condition of the BUZZ terminals, as shown in Table 4-42.

Table 4-42 BUZZ

BUZZ	BUZZ Terminal Output Condition
'0'	LOW Output (default)
'1'	HIGH Output

The HIGH time is in the range from 0 (0x000) to 4095 (xFFF) msec.

The BUZZ output is the HIGH condition until the BUZZ is set to LOW

when the HIGH time is set at 0 (0x00) msec and the BUZZ is set to the HIGH output.

4-17-2　Example of Command

The commands when setting the BUZZ terminal output condition to the HIGH output for a period of 200 msec are represented with the following format, as shown in Table 4-43.

Table 4-43 Example of Buzzer Controlling 'Z' Command

	Command	Data Column	
		BUZZ	HIGH Time
Contents	Z	BUZZ	HIGH Time
Data	'Z'	'1'	"0C8"

4-17-3　Command Error Condition

The following conditions will cause a command error.

- ・ When the BUZZ setting is not listed in Table 4-42
- ・ When the HIGH time is not within the setting range
- ・ When the numbers of command bytes are not matched
- ・ When the characters of the data column are not '0' – '9' or 'A' – 'F'

Kenic system

4-18   Low Power Consumption Moving 'E' Command

4-18-1   Description of Command

This command allows one to move the LCD Controller to the low power consumption condition.

The command is represented with the following format, as shown in Table 4-44.

Table 4-44 Format of Low Power Consumption Moving 'E' Command

	Command
Contents	E
Data	1 byte

4-18-2   Command Error Condition

The following conditions will cause a command error.

- ・ When the numbers of command bytes are not matched
- ・ When the checksums are not matched (when checksums are enabled)

Kenic system

4-19 Presence/absence of Checksum Checking 'U' Command

4-19-1 Description of Command

The command allows one to set the presence of the checksum.

The command and data column are represented with the following format, as shown in Table 4-45.

Table 4-45 Format of Presence of Checksum Checking 'U' Command

	Command	Data Column
Contents	U	Presence/Absence
Data	1 byte	1 byte

The presence/absence allows one to specify the enabling/disabling of the checksum.

Table 4-46 Presence/Absence

Presence/Absence	Type
'0'	Disabling of Checksum (default)
'1'	Enabling of Checksum

When the checksum is enabled from the disabled condition, the checksum (2 bytes) behind the data column is not required. When the checksum is disabled from the enabled condition, the checksum (2 bytes) is added behind the data column.

After the LCD controller returns from the low power consumption condition to the normal mode, timeout will be the default condition.

4-19-2 Example of Command

When enabling the checksum, the command is represented with the following format, as shown in Table 4-47.

Table 4-47 Format of Presence/Absence of Checksum Checking 'U' Command

	Command	Data Column
Contents	U	Presence/Absence
Data	'U'	'1'

4-19-3 Command Error Condition

The following conditions will cause a command error.

- ・ When the presence/absence setting is not listed in Table 44
- ・ When the numbers of command bytes are not matched
- ・ When the checksums are not matched (when checksums are enabled)

Kenic system

4-20   Presence/Absence of ACK Checking 'R' Command

4-20-1   Description of Command

The command allows one to set the presence/absence of the ACK.

The command and data column are represented with the following format, as shown in Table 4-48.

Table 4-48 Format of Presence/Absence of ACK Checking 'R' Command

	Command	Data Column
Contents	R	Presence/Absence
Data	1 byte	1 byte

The presence/absence of the ACK allows one to specify the enabling/disabling of the ACK.

Table 4-49 Presence/Absence

Presence/Absence	Type
'0'	Disabling of ACK (default)
'1'	Enabling of ACK

When enabling the ACK from the disabled condition, the ACK is returned. When disabling the ACK from the enabled condition, the ACK is not returned.

After the LCD controller returns from the low power consumption condition to the normal mode, the ACK will be the default condition.

4-20-2   Example of Command

When enabling the ACK, the command is represented with the following format, as shown in Table 4-50.

Table 4-50 Format of Presence/Absence of ACK Checking 'U' Command

	Command	Data Column
Contents	R	Presence/Absence
Data	'R'	'1'

4-20-3   Command Error Condition

The following conditions will cause a command error.

・ When the presence/absence setting is not listed in Table 44

・ When the numbers of command bytes are not matched

・ When the checksums are not matched (when checksums are enabled)

Kenic system

4-21 Presence/Absence of Timeout of Serial Flash Memory checking 'A' Command

4-21-1 Description of Command

This command allows one to set the presence/absence of timeout of the Serial Flash Memory.

The command and data column are represented with the following format, as shown in Table 4-51.

Table 4-51 Format of Presence/Absence of Timeout of Serial Flash Memory Checking 'A' Command

	Command	Data Column
Contents	A	Presence/Absence
Data	1 byte	1 byte

The presence/absence allows one to specify the enabling/disabling of timeout.

Table 4-52 Presence/Absence

Presence/Absence	Type
'0'	Enabling of Timeout
'1'	Disabling of Timeout (default)

When timeout is enabled, if the serial flash memory's action is not completed even

if the specified time passed, the processing will be interrupted. When timeout is disabled,

the serial flash memory's action will continue until the action is completed.

After the LCD controller returns from the low power consumption condition to the normal

mode, timeout will be the default condition.

4-21-2 Example of Command

When enabling timeout, the command is represented with the following format, as shown in Table 4-53.

Table 4-53 Example of Presence/Absence of Timeout of Serial Flash

Memory Checking 'A' Command

	Command	Data Column
Contents	A	Presence/Absence
Data	'A'	'0'

Kenic system

4-21-3　Command Error Condition

The following conditions will cause a command error.

- ・　When the presence/absence setting is not listed in Table 4-52
- ・　When the numbers of command bytes are not matched
- ・　When the checksums are not matched (when checksums are enabled)

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