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SPECIFICATION

Rev. 1.0

***Application:*_____**

VACUUM FLUORESCENT DISPLAY MODULE

Model No.: 20T201DA2

Rev. No.	Issued Date	Revision Descriptions	Remark
Rev. 1.0	May 15, 2012	* First Edition	All Pages

Issued by	
Checked by	
Approved by	

Customer's Approval

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1. SCOPE

* This specification applies to VFD module (Model No.:20T201DA2) manufactured.

2. FEATURES

* The MCU can control this module by synchronous serial input interface.

* Since a DC/DC converter is used, only +5V power source is required to operate the module.

* One chip controller mounted on the module includes the character generator ROM (CG-ROM) of ASCII**,** European and Japanese Katakana characters.

* Continuous brightness level can be selected by dimming function.

* Characters are provided with a 5x7 dot matrix.

* The module has up to 8 user definable characters.(CG-RAM function)

3. PRECAUTIONS

* Avoid applying excessive shock or vibration beyond the specification for the VFD module.

* Since VFDs are made of glass material, careful handling is required. i.e. Direct impact with hard material to the glass surface (especially exhaust tip) may crack the glass.

* When mounting the VFD module to your system, leave a slight gap between the VFD glass and your front panel. The module should be mounted without stress to avoid flexing of the PCB.

* Avoid plugging or unplugging the interface connection with the power on, otherwise it may cause the severe damage to input circuitry.

* Slow starting power supply may cause non-operation because one chip MCU won't be reset.

* Exceeding any of maximum ratings may cause the permanent damage.

* Since the VFD modules contain high voltage source, careful handling is required during powered on.

* When the power is turned off, the capacitor does not discharge immediately. The high voltage applied to the VFD must not contact to the ICs. And the short-circuit of mounted components on PCB within 30 seconds after power-off may cause damage to those.

* The power supply must be capable of providing at least 5 times the rated current, because the surge current can be more than 5 times the specified current consumption when the power is turned on.

* Avoid using the module where excessive noise interference is expected. Noise may affects the interface signal and causes improper operation. And it is important to keep the length of the interface cable less than 50cm.

* Since all VFD modules contain C-MOS ICs, anti-static handling procedures are always required.

4. PRODUCT SPECIFICATIONS

4.1 Type

Type (Module Name)	20T201DA2
Character Format	5 * 7 Dot Matrix with Cursor
Number of Digits	40 (20 Digits * 2 Lines)

4.2 Outer Dimensions, Weight

* Please refer to Fig.-8 for details.)

Parameter	Symbol	Specification	Unit
Outer Dimensions	W * H * t	115.0 * 48.0 * 22.5	mm
Panel Size	W * H	76.0 * 23.0	mm
Display Size	W * H	78.55 * 14.25	mm
Character Size	CW * CH	2.55 * 4.65	mm
Character Pitch	CP(*x*) * CP(*y*)	4.0 * 9.6	mm
Dot Size	DW * DH	0.35 * 0.45	mm
Display Color	-	*x*= 0.250, *y* = 0.439 (Green)	-
Weight	-	Approx 80	g

4.3 Environment Conditions

Parameter	Symbol	Min.	Max.	Unit
Operating Temperature	Topr	0	+70	°C
Storage Temperature	Tstg	-50	+80	°C
Humidity (Operating)	Hopr	0	95	%
Humidity (Non-operating)	Hstg	0	95	%
Vibration (10 ~ 55 Hz)	-	-	4	G
Shock	-	-	40	G

4.4 Absolute Maximum Ratings

Parameter	Symbol	Min.	Max.	Unit
Supply Voltage	V_{CC}	-0.3	7.0	V_{DC}
Input Signal Voltage	V_{IS}	-0.4	7.0	V_{DC}

4.5 Recommend Operating Conditions

Parameter	Symbol	Min.	Typ.	Max.	Unit
Supply Voltage	V_{CC}	4.5	5.0	5.5	V_{DC}
H-Level Input Voltage	V_{IH}	2.0	-	V_{CC}+0.3	V_{DC}
L-Level Input Voltage	V_{IL}	-0.3	-	0.8	V_{DC}

4.6 DC Characteristics

* Test Condition: Ta=+25°C, V_{CC}=5.0V_{DC})

Parameter	Symbol	Min.	Typ.	Max.	Unit
Supply Current *(* Note-1)*	I_{CC}	-	320	420	mA
H-Level Input Current (@V_{IH} = V_{CC})	I_{IH}	-	-	1.0	mA
L-Level Input Current (@V_{IL} = GND)	I_{IL}	-	-	-0.8	mA
H-Level Output Voltage (@I_{OH}=-0.1mA)	V_{OH}	2.4	-	-	V_{DC}
L-Level Output Voltage (@IOL=0.1mA)	V_{OL}	-	-	0.45	V_{DC}
Brightness	L	102 (350)	204 (700)	-	ft-L(cd/m^2)
Brightness Difference between Characters	L_{MAX}/L_{MIN}	-	-	2	-
Brightness Difference adjacent Characters	$L_{(H)}/L_{(L)}$	-	-	1.5	-

*(*Note-1) The in-rush current can be approx. 5 times the specified supply current at power on.*

4.7 Timing Chart and AC Characteristics

4.7.1 Data Bit Write-in Timing

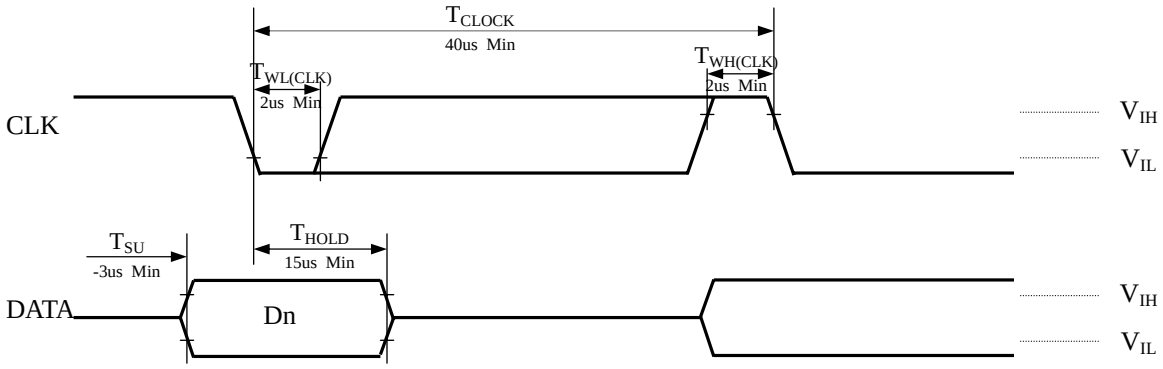


Fig.-1 Data Bit Write-in Timing

4.7.2 RESET Timing

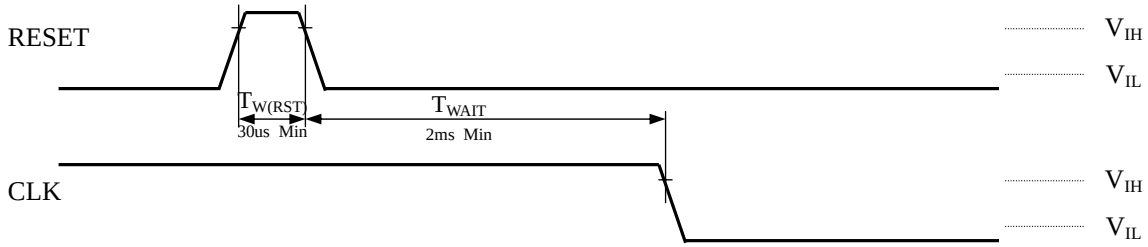


Fig.-2 RESET Timing

4.7.3 Data Write-in Timing (Mode 1)

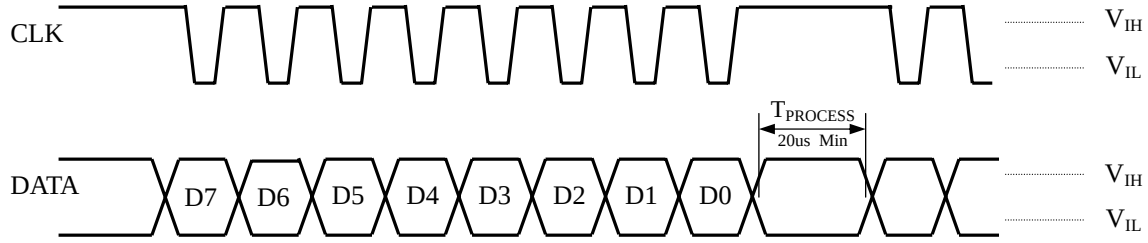


Fig.-3 Data Write-in Timing (Mode 1)

4.7.4 Hand Shake Timing before Data Byte (Mode 2)

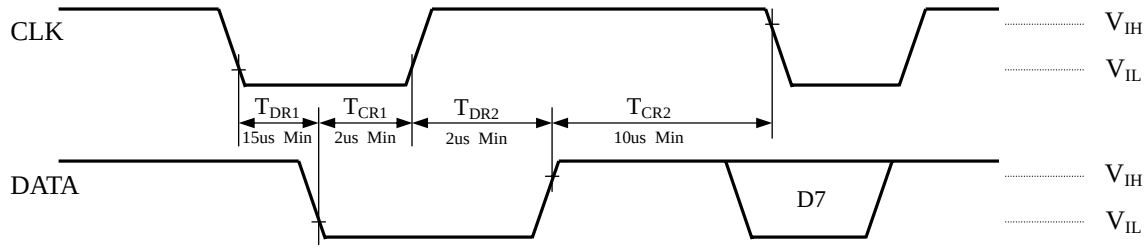


Fig.-4 Hand Shake Timing before Data Byte (Mode 2)

4.7.5 Hand Shake Timing after Data Byte (Mode 2)

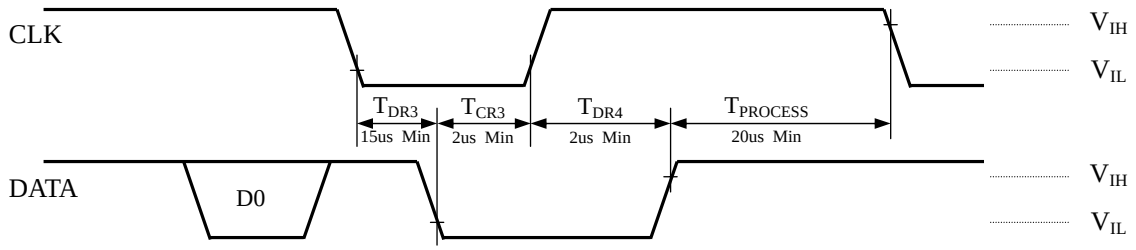


Fig.-5 Hand Shake Timing after Data Byte (Mode 2)

4.8 Connector Pin Assignment

Connector (Male): 104426-3(by AMP) or equivalent

→ See the below table for description of each pin.

Pin No.	Signal	Pin Description
1	VCC	Power Supply
2	CLK	Serial Clock Input Pin
3	GND	Ground Terminal
4	DATA	Serial Data Input Pin
5	RESET	Reset Input Pin

4.9 System Block Diagram

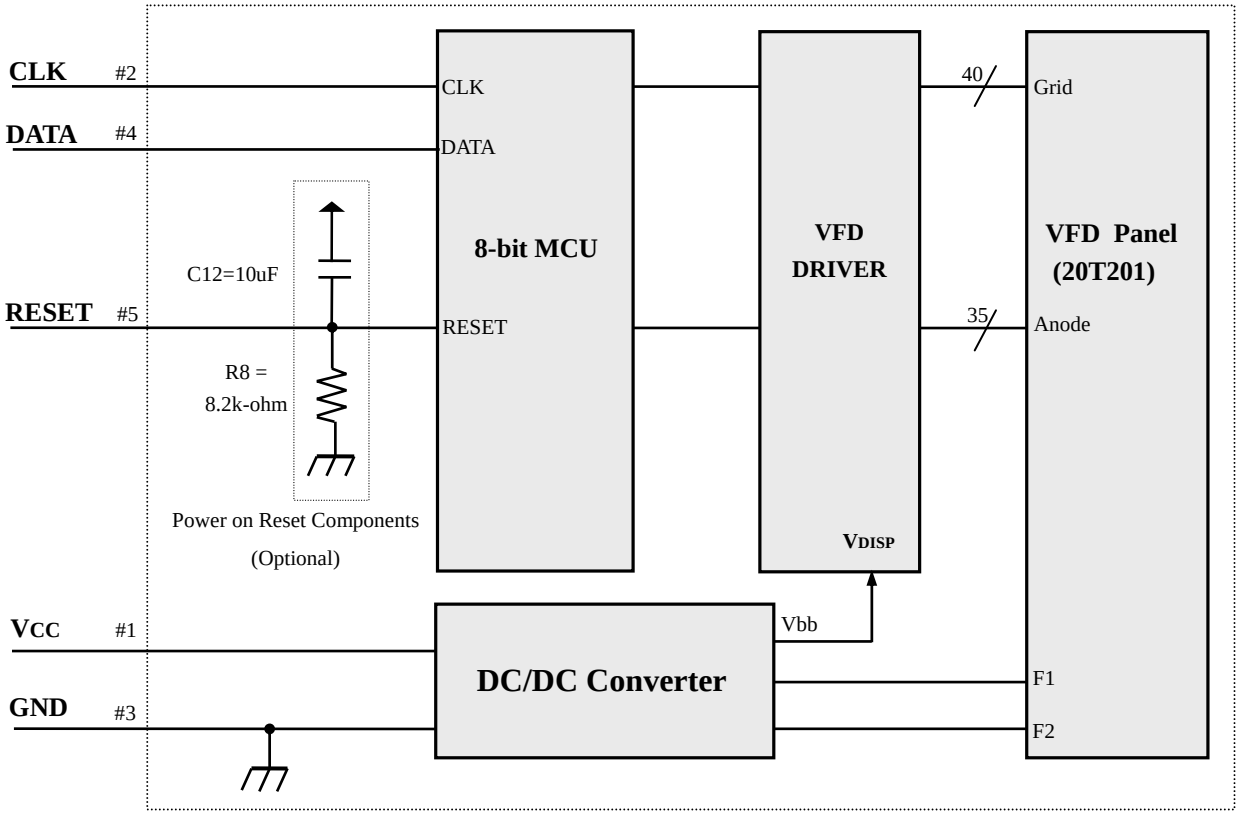


Fig.-6 System Block Diagram

4.10 Outer Dimensions

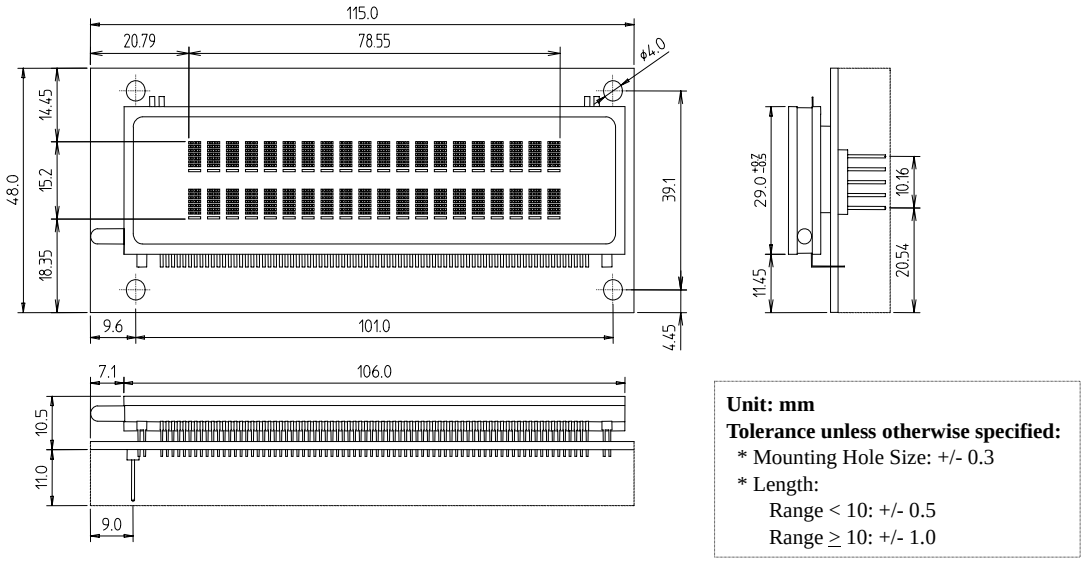


Fig.-7 Outer Dimensions

4.11 Pattern Details

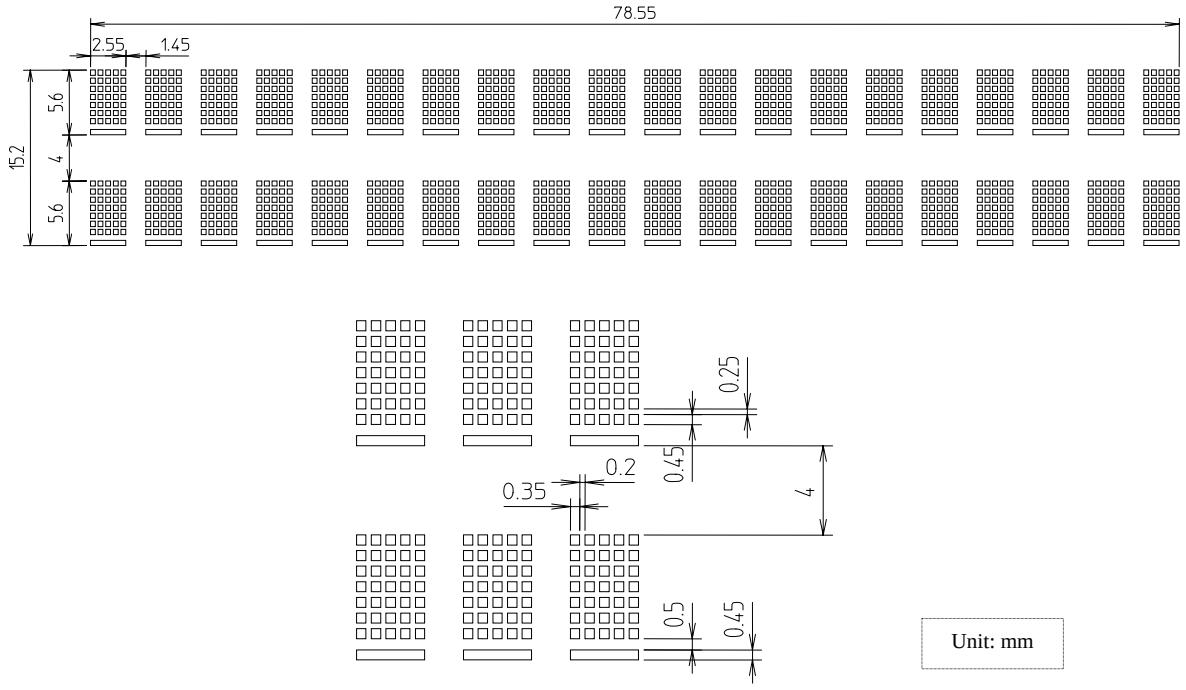


Fig.-8 Pattern Details

5. FUNCTION DESCRIPTIONS

The module accepts character data and control codes, and has a host controlled reset function.

5.1 RESET

The reset input to the microcontroller is accessible at pin #5 of the connector.
If equipped with component C12 and R8 a power up reset signal is automatically generated. Fig-6 shows the value of these components. Module reset timing is shown in Fig-2. At reset, the following commands are performed.

1) Display buffer cleared
2) Message buffer cleared
3) Cursor position set to 1(Left-end digit of upper row)
4) Cursor mode set to auto-increment mode
5) Brightness level set to 100%
6) I/O mode set to mode 1(Unidirectional Data Interface).
7) Flashing off
8) Flash rate = 1 Hz
9) Character Font is set to Appendix-1 (Western European Font)
10) Default User Definable Characters
11) Buffered Mode 1(Non-buffered mode)

5.2 Data Write-in

Data is written to the module synchronously using the clock input and data signal,
There are two mode of operation, Mode 1 and Mode 2. See Fig-1 for a detailed data write in timing diagram.

5.2.1 Mode 1

In Mode 1, 8 bit data and control codes are written to the module with the MSB first on the high to low transition of the clock. After all 8 bits have been written, the clock must be returned to a high level for a minimum of 20us for the controller to process the received data.
Detailed timing diagram is shown in Fig-3.

5.2.2 Mode 2

In Mode 2, data is written to the display as in Mode 1 with the exception that a handshake is performed before and after the data is sent to the module.
The process is performed as follows. Before data is sent, the host must pull the clock line low.
The module responds by pulling the data line low. The host then returns the clock line high and the module returns the data line high.
Eight bits of data are then sent as in Mode 1. After the LSB is received, the host pulls the clock line low. The module responds by pulling the data line low. Finally the host sets the clock line high. And the module returns the data line high.
Detailed timing diagrams are shown in Fig-3,4 and 5.

5.3 Character Code

The character codes are shown in appendix. Appendix-1 shows the Western-European character table and Appendix-2 shows Japanese Katakana. Either table can be selected by suing the select character font command. See section 5.4 for a detailed description of commands.

5.4 Control Code

The command codes are as follows.
The details of each command are explained on the following pages.
Hex code represents the hexadecimal number which must be written to execute the command.

(00 Hex) NP : No Operation
(01 Hex) CD : Clear Entire Display
(02 Hex) SC : Set Cursor Position
(03 Hex) CM : Set Cursor Mode
(04 Hex) SB : Set Display Brightness Level
(05 Hex) IO : Set Input/Output Mode
(06 Hex) FP : Set Flash Position
(07 Hex) FM : Flash Mode
(08 Hex) FR : Set lash Rate
(09 Hex) FO : Select Character Font
(0A Hex) DC : Load User Definable Character
(0B Hex) BM : Set Buffered Mode
(0C Hex) PB : Print Message Buffer
(0D Hex~17 Hex) R : Reserved Code

(18 Hex) C1 : Print UDF #1
(19 Hex) C2 : Print UDF #2
(1A Hex) C3 : Print UDF #3
(1B Hex) C4 : Print UDF #4
(1C Hex) C5 : Print UDF #5
(1D Hex) C6 : Print UDF #6
(1E Hex) C7 : Print UDF #7
(1F Hex) C8 : Print UDF #8

* abbr.) UDF = User Definable Font

5.4.1 NP (00 Hex) : No Operation

Reception of this character will result in a no operation. If the module is looking for a command parameter, the command is set to its default value.

5.4.2 CD (01 Hex) : Clear Entire Display

The display and message buffer are cleared of all characters and the cursor position is set to position 1. Also flashing mode and flashing positions are set to their respective default values.

5.4.3 SC (02 Hex) : Set Cursor Position

The cursor position is set to one of the 40 positions of the display.
The position is chosen by sending a parameter byte within the following ranges:

(01 Hex)	Top row left most character (default)
(14 Hex)	Top row right most character
(15 Hex)	Bottom row left most character
(28 Hex)	Bottom row right most character

5.4.4 CM (03 Hex) : Set cursor Mode

The cursor mode determines the cursor position of the next character.
Auto increment moves the cursor position to the right after each character write.
Auto-decrement moves the cursor left after each character write and non increment keeps the cursor position statinary.
The cursor position wraps between the 1st and 40th positions.
The mode is chosen by one of the following parameter bytes :

(01 Hex)	Auto-increment (default)
(02 Hex)	Auto-decrement
(03 Hex)	Non-increment

Note that the cursor position is represented by the space next to the last character entered.
Changing between modes does not happen immediately. The next character will be written in the present cursor location before the new mode takes effect.

5.4.5 SB (04 Hex) : Set Brightness

The set brightness command sets the brightness of the entire display to one of 255 levels.
It is performed by sending the set brightness command and a parameter byte to determine the brightness level. Brightness ranges are shown below:

(01 Hex)	10%	: Minimum
(FF Hex)	100%	: Maximum (default)

5.4.6 IO (05 Hex) : Set Input/Output Mode

The input-output mode determines how the communication between the host and module is performed. Mode 1 is unidirectional from the host to the module. See section 5.2.1 for a detailed description of Mode 1.
Mode 2 is bi-directional, (a handshake is performed before and after data is sent). See section 5.2.2 for a details on Mode 2.
The mode is chosen by a parameter byte sent after the command byte. The values are shown below :

(01 Hex)	I/O mode 1 (default)
(02 Hex)	I/O mode 2

If the I/O mode is changed, the host must delay 1ms before its next data write.

5.4.7 FP (06 Hex) : Set flash Positions

The set flash positions command enables any range of characters to be flashed.
The positions are chosen by sending two parameter bytes, a start flash character position and an end flash character position. Different ranges can be chosen and can overlap. Default is all flash positions cleared.

5.4.8 FM (07 Hex) : Flash Mode

The flash mode is used to enable and disable display flashing. This is performed by sending the flash mode command followed by a parameter byte. The byte values are shown below.

(01 Hex)	Disable flashing (default)
(02 Hex)	Enable flashing

5.4.9 FR (08 Hex) : Set flash Rate

The rate of flash is determined by sending the set flash rate command followed by a parameter byte in the range of 01 Hex to 0FF Hex. The range of flash rate is shown below :

(01 Hex)	50 Hz
(30 Hex)	1 Hz (default)
(FF Hex)	1/10 Hz

5.4.10 FO (09 Hex) : Select Character Font

The character font is chosen by sending the select font command followed by the parameter byte.

(01 Hex)	Font #1 Western/European (default)
(02 Hex)	Font #2 Katakana

5.4.11 DC (0A Hex) : Load User Definable Character

The user definable characters are loaded by sending the load user definable character command followed by 6 bytes of parameter data.

Syntax: DC Command (0AH) + CHR (C1 ~ C8) + PT1 + PT2 + PT3 + PT4 + PT5

* byte 2: CHR (18H ~ 1FH).....Which character is to be loaded. (#1 ~ #8)
* byte 3 ~ 7: PT1 ~PT5..... 5 bytes of character data where bit zero of each byte is set.
Refer to the following table for loading user definable characters

	D7	D6	D5	D4	D3	D2	D1	D0	Description
PT1	A7	A6	A5	A4	A3	A2	A1	*	Specify ON or OFF of 35 dots position. Next example shows the relation between segment position and data formation. Next example shows the example of "Euro-currency" font design.
PT2	A14	A13	A12	A11	A10	A9	A8	*	
PT3	A21	A20	A19	A18	A17	A16	A15	*	
PT4	A28	A27	A26	A25	A24	A23	A22	*	
PT5	A35	A34	A33	A32	A31	A30	A29	*	

* : Don't Care

5x7 Dot Matrix Bit Map				
A1	A8	A15	A22	A29
A2	A9	A16	A23	A30
A3	A10	A17	A24	A31
A4	A11	A18	A25	A32
A5	A12	A19	A26	A33
A6	A13	A20	A27	A34
A7	A14	A21	A28	A35

Design Example of Euro Currency Symbol				
0	0	**1**	**1**	0
0	**1**	0	0	0
1	**1**	**1**	0	0
0	**1**	0	0	0
1	**1**	**1**	0	0
0	**1**	0	0	**1**
0	0	**1**	**1**	0

UDF Data Coding Example of Left Design

	D7	D6	D5	D4	D3	D2	D1	D0	Data
PT1	0	0	**1**	0	**1**	0	0	0	28 Hex
PT2	0	**1**	**1**	**1**	**1**	**1**	0	0	7C Hex
PT3	**1**	0	**1**	0	**1**	0	**1**	0	AA Hex
PT4	**1**	0	0	0	0	0	**1**	0	82 Hex
PT5	0	**1**	0	0	0	0	0	0	40 Hex

5.4.12 BM (0B Hex) : Set Buffered Mode

The module has a 40 character input message buffer which can be enabled or disabled through the use of the buffered mode command. When the non-buffered mode is enabled, (display buffer only) character data is transferred to the display as it is received.

When the buffered mode is enabled, incoming characters are stored in a message buffer.

The characters are moved to the display buffer by performing a data write with the cursor on the 40th position, or the host can perform PM command. (See Section 5.4.13)

Flash positions must be set for the message buffer before transferring to the display buffer.

After the transfer from the message buffer to the display buffer the message buffer is cleared and the cursor position is set to 1. The modes are chosen by the parameter byte:

(01 Hex)	Non-buffered mode (default)
(02 Hex)	Buffered mode

5.4.13 PM (0C Hex) : Print Message Buffer

The print message buffer command transfers the data from the message buffer to the display buffer. The message buffer is cleared and the cursor is then placed at position 1.

5.4.14 C1 (18 Hex) : Print UDF #1

User defined character 1 is printed at the present cursor position.

5.4.15 C2 (19 Hex) : Print UDF #2

User defined character 2 is printed at the present cursor position.

5.4.16 C3 (1A Hex) : Print UDF #3

User defined character 3 is printed at the present cursor position.

5.4.17 C4 (1B Hex) : Print UDF #4

User defined character 4 is printed at the present cursor position.

5.4.18 C5 (1C Hex) : Print UDF #5

User defined character 5 is printed at the present cursor position.

5.4.19 C6 (1D Hex) : Print UDF #6

User defined character 6 is printed at the present cursor position.

5.4.20 C7 (1E Hex) : Print UDF #7

User defined character 7 is printed at the present cursor position.

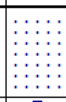
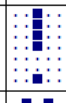
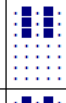
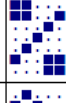
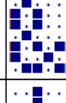
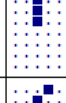
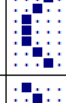
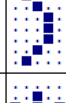
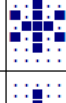
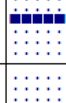
5.4.21 C7 (1F Hex) : Print UDF #8

User defined character 8 is printed at the present cursor position.

*** Appendix-1. Western/European Character Code Table**

Upper / Lower Nibble	D7	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1
	D6	0	0	0	0	1	1	1	1	0	0	0	0	1	1	1	1
	D5	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1
	D4	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1
D3 D2 D1 D0		0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
0 0 0 0	0	NP	R														
0 0 0 1	1	CD	R														
0 0 1 0	2	SC	R														
0 0 1 1	3	CM	R														
0 1 0 0	4	SB	R														
0 1 0 1	5	IO	R														
0 1 1 0	6	FP	R														
0 1 1 1	7	FM	R														
1 0 0 0	8	FR	C1														
1 0 0 1	9	FO	C2														
1 0 1 0	A	DC	C3														
1 0 1 1	B	BM	C4														
1 1 0 0	C	PB	C5														
1 1 0 1	D	R	C6														
1 1 1 0	E	R	C7														
1 1 1 1	F	R	C8														

*** Appendix-2. Japanese Katakana Code Table**

Upper / Lower Nibble	D7	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1
	D6	0	0	0	0	1	1	1	1	0	0	0	0	1	1	1	1
	D5	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1
	D4	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1
D3 D2 D1 D0		0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
0 0 0 0	0	NP	R														
0 0 0 1	1	CD	R														
0 0 1 0	2	SC	R														
0 0 1 1	3	CM	R														
0 1 0 0	4	SB	R														
0 1 0 1	5	IO	R														
0 1 1 0	6	FP	R														
0 1 1 1	7	FM	R														
1 0 0 0	8	FR	C1														
1 0 0 1	9	FO	C2														
1 0 1 0	A	DC	C3														
1 0 1 1	B	BM	C4														
1 1 0 0	C	PB	C5														
1 1 0 1	D	R	C6														
1 1 1 0	E	R	C7														
1 1 1 1	F	R	C8