DESCRIPTION

The M66004 is a 16-digit 5×7-segment vacuum fluorescent display (VFD) controller using the silicon gate CMOS technology.

It contains 160 ROM characters and 16 user-defined RAM characters and receives display character codes and various commands from MCU to control VFD.

FEATURES

- Built in 5×7-dot segment character ROM
  (160 characters based on JIS-C-6220. Customization is possible.)
- Built in character RAM for user definition (16 characters)
- Display digit length can be changed. (from 9 to 16 digits)
- One-digit display cycle setting can be changed. (2 cycles)
- Dimmer is adjustable. (8 grades)
- Cursor display ON or OFF is selectable. (SEG35 output)
- Built in automatic display digit increment function
- Auto increment of display digit
- Built in simultaneous all-digit display ON/OFF command
- Connection to MCU by three signal lines, $\overline{CS}$, SCK and SDATA
- Instruction execution with one byte*
- 2 general purpose output ports
- Positive supply voltage   VCC=5V ± 10%
- Pull-down voltage VP=VCC-40V typ.
  VCC-45V   max. (peak)
  *: Except for character RAM setting

APPLICATION

AV equipments, vacuum fluorescent display controller for POS system, etc.

FUNCTION

The M66004 is a 16-digit 5×7-segment VFD (Vacuum Fluorescent Display) controller and contains 160 ROM characters based on JIS-C-6220 which can be customized and 16 RAM characters that user can define freely.

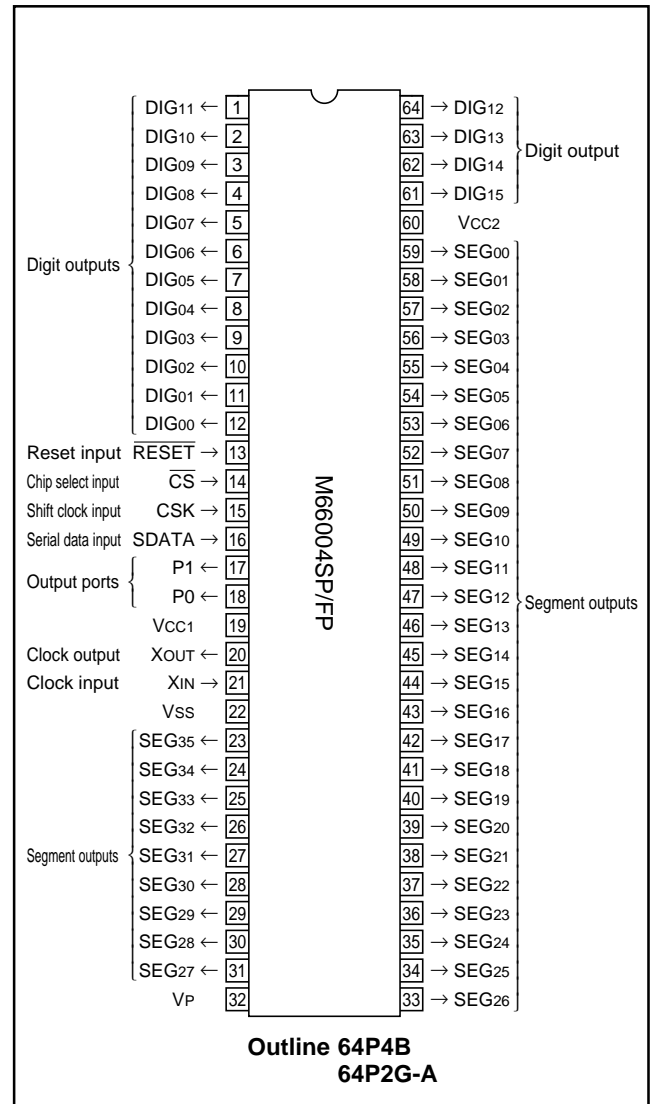Character display codes and various commands are received as 8-bit serial data from MCU.

Main functions of this IC are display digit length setting, one-digit display cycle setting and dimmer adjustment.

It has 36 segment output pins from SEG00 to SEG35 and uses 35 pins from SEG00 to SEG34 for character display.
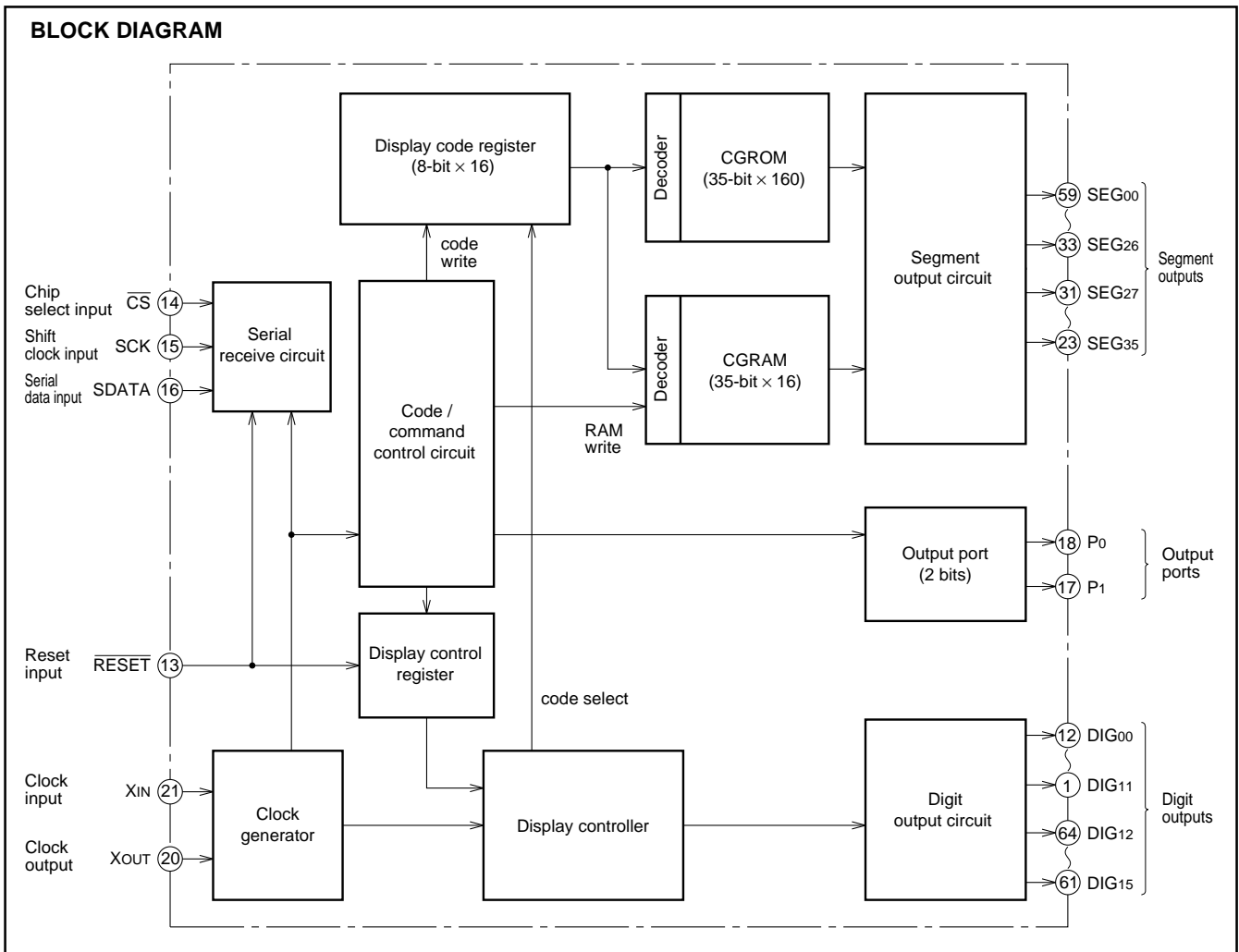
SEG35 output, which is independent of other segment, is used for cursor display by inputting either cursor ON or OFF command.

Once display data is fixed, display continues automatically until new data is input. Therefore, MCU can execute other jobs and is lightened of its load.

Additionally, the IC can control other I/O elements because it contains two static operation output ports.

	DIG11 ←	1	64	→ DIG12
	DIG10 ←	2	63	→ DIG13
	DIG09 ←	3	62	→ DIG14
	DIG08 ←	4	61	→ DIG15
	DIG07 ←	5	60	VCC2
Digit outputs	DIG06 ←	6	59	→ SEG00
	DIG05 ←	7	58	→ SEG01
	DIG04 ←	8	57	→ SEG02
	DIG03 ←	9	56	→ SEG03
	DIG02 ←	10	55	→ SEG04
	DIG01 ←	11	54	→ SEG05
	DIG00 ←	12	53	→ SEG06
Reset input	$\overline{RESET}$ →	13	52	→ SEG07
Chip select input	$\overline{CS}$ →	14	51	→ SEG08
Shift clock input	CSK →	15	50	→ SEG09
Serial data input	SDATA →	16	49	→ SEG10
Output ports	P1 ←	17	48	→ SEG11
	P0 ←	18	47	→ SEG12
	VCC1	19	46	→ SEG13
Clock output	XOUT ←	20	45	→ SEG14
Clock input	XIN →	21	44	→ SEG15
	VSS	22	43	→ SEG16
	SEG35 ←	23	42	→ SEG17
	SEG34 ←	24	41	→ SEG18
	SEG33 ←	25	40	→ SEG19
	SEG32 ←	26	39	→ SEG20
Segment outputs	SEG31 ←	27	38	→ SEG21
	SEG30 ←	28	37	→ SEG22
	SEG29 ←	29	36	→ SEG23
	SEG28 ←	30	35	→ SEG24
	SEG27 ←	31	34	→ SEG25
	VP	32	33	→ SEG26

Digit output (pins 64-61); Segment outputs (right side)

M66004SP/FP

Outline 64P4B
64P2G-A

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BLOCK DIAGRAM

Display code register (8-bit × 16)

Decoder

CGROM (35-bit × 160)

Decoder

CGRAM (35-bit × 16)

code write

Chip select input $\overline{CS}$ (14)

Shift clock input SCK (15)

Serial data input SDATA (16)

Serial receive circuit

Code / command control circuit

RAM write

Segment output circuit

(59) SEG00
(33) SEG26
(31) SEG27
(23) SEG35

Segment outputs

Output port (2 bits)

(18) P0
(17) P1

Output ports

Reset input $\overline{RESET}$ (13)

Display control register

code select

Clock input XIN (21)

Clock output XOUT (20)

Clock generator

Display controller

Digit output circuit

(12) DIG00
(1) DIG11
(64) DIG12
(61) DIG15

Digit outputs

OPERATION FLOW

The serial receive circuit receives 8-bit serial data, latches the data by an internal latch signal, and then masks inputs from the MCU.

When the code/command circuit receives a command, it sets the display control register to the fixed state, and when it receives a character code, it writes the code to one of 16 display code registers which corresponds to the digit to display. The display controller outputs digit ON/OFF timing pulse to the digit output circuit and selects one character code to display among display code registers. The selected character code is input to either CGROM decoder or CGRAM decoder and then converted into a 35-bit character pattern to input the segment output circuit.

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PIN DESCRIPTIONS

Symbol	Pin name	Function
$\overline{\text{RESET}}$	Reset input	This pin is used to initialize the internal state of the M66004.
$\overline{\text{CS}}$	Chip select input	In "L" state, communication with the MCU is possible. In "H" state, any instruction from the MCU is neglected.
SCK	Shift clock input	At the rising edge from "L" to "H", input data is shifted.
SDATA	Serial data input	Character code or command data to display is input from MSB.
X_{IN}, X_{OUT}	Clock input Clock output	This pin is used to connect a resistor and a capacitor externally to set oscillation frequency. (maximum oscillation frequency fosc(max)=1MHz) An external clock can be also connected. In this case, an external clock is connected to pin X_{IN}, and pin X_{OUT} is set to be in open state.
DIG_{00}~ DIG_{15}	Digit output	These pins are used to connect to digit pins of VFD. Pins from DIG_{00} to DIG_{15} correspond to digits of VFD from the first digit to the 16th digit.
SEG_{00}~ SEG_{35}	Segment output	These pins are used to connect to segment pins of VFD. Pins from SEG_{00} to SEG_{35} correspond to segment pins of VFD as shown in the table below.
P0, P1		Output port (static operation)
V_{CC1}		Positive power supply for internal logic
V_{CC2}		Positive power supply for high-pressure-resistant output port
V_{SS}		GND
V_P		Negative power supply for VFD drive

(Connection of segment output pins)
Each □ in the table shows one-dot segment and each figure in □ shows the output segment pin number (from 00 to 35) to connect.

|				
00	01	02	03	04
05	06	07	08	09
10	11	12	13	14
15	16	17	18	19
20	21	22	23	24
25	26	27	28	29
30	31	32	33	34

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DATA TRANSMISSION FORMAT

The MCU transmits 8-bit serial data (MSB-first) to the M66004. In either case of command data or character code data, the M66004 operates by transmitting only one-byte data.
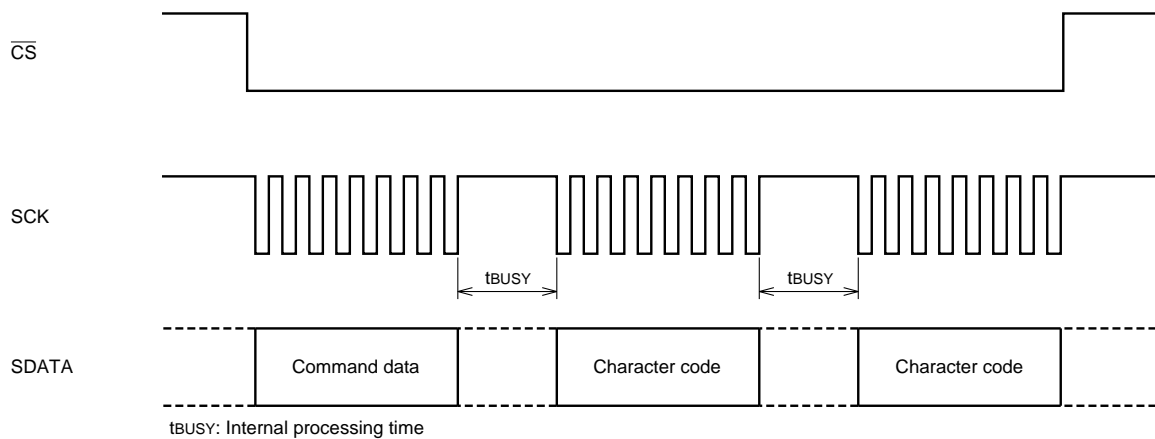
However, in case of character RAM data setting, it is necessary to send 7-byte data continuously.

(Transmission timing)

Standard timing
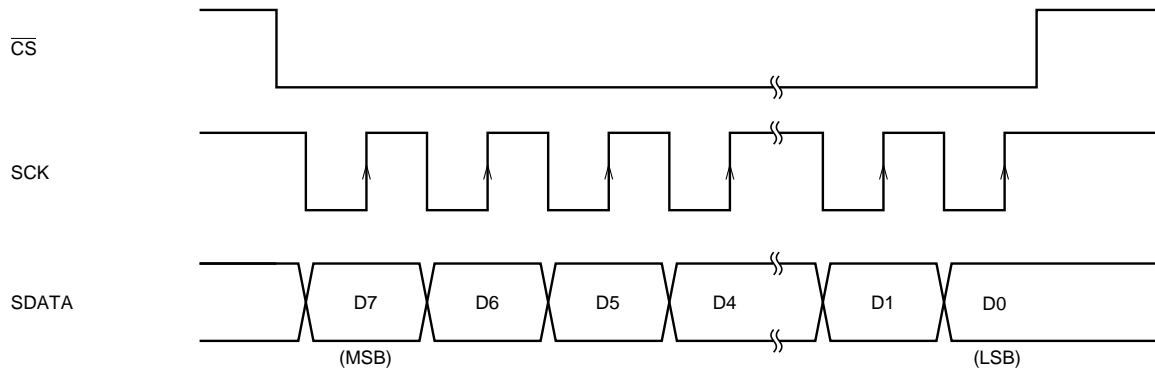
Continuous data transmission timing (In the following example, command data is transmitted and then character codes are transmitted continuously.)

tBUSY: Internal processing time

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COMMAND LIST

Function	Command code								Contents
	D7	D6	D5	D4	D3	D2	D1	D0	
Display digit length setting	0	0	0	0	0	*	*	*	The number of digits to display is fixed. Eight types of setting (from 9 digits to 16 digits) are possible.
Dimmer value setting	0	0	0	0	1	*	*	*	Eight types of setting (from 1/16 to 14/16) are possible for dimmer value.
One-digit display frequency setting	1	1	1	1	0	1	1	*	Either 128/f_{OSC} or 256/f_{OSC} is selected as one-digit display frequency.
Display digit setting	1	1	1	0	*	*	*	*	The first character code received after executing this command is displayed as designated by this command.
Auto increment setting	1	1	1	1	0	1	0	*	This command is executed to set or cancel the automatic display digit increment function.
Cursor ON	0	0	0	1	*	*	*	*	This command is executed to make SEG35 ON.
Cursor OFF	1	0	0	0	*	*	*	*	This command is executed to make SEG35 OFF.
All digit display ON/OFF	1	1	1	1	0	0	*	*	This command is executed to make all-digit display OFF or all-digit/segment display ON.
Write to user RAM	1	1	1	1	1	1	×	×	Character data is written into RAM for user definition.
Output port state setting	1	1	1	1	1	0	*	*	Output ports P0 and P1 are set or reset.

×: Optional
* : Refer to the description of command.

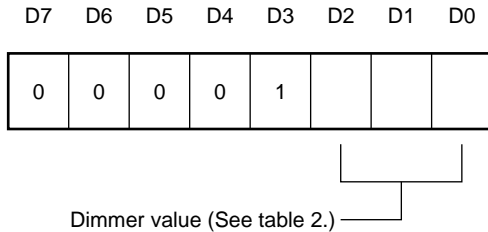## DESCRIPTION OF COMMAND

1. Display digit length setting

D7	D6	D5	D4	D3	D2	D1	D0
0	0	0	0	0			

Display digit length (See table 1.)

Table 1 Display digit length

D2	D1	D0	Display digit length
0	0	0	9
0	0	1	10
0	1	0	11
0	1	1	12
1	0	0	13
1	0	1	14
1	1	0	15
1	1	1	16

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2. Setting of dimmer value and one-digit display frequency(T_{dsp})

1) Dimmer value setting

D7	D6	D5	D4	D3	D2	D1	D0
0	0	0	0	1			

Dimmer value (See table 2.)

2) One-digit display frequency (T_{dsp}) setting

D7	D6	D5	D4	D3	D2	D1	D0
1	1	1	1	0	1	1	

One-digit display frequency (T_{dsp})
0: $T_{dsp}=128/f_{OSC}$
1: $T_{dsp}=256/f_{OSC}$
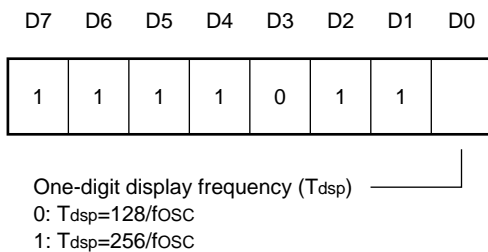
3. Display digit setting, setting and cancel of auto increment

1) Display digit setting

D7	D6	D5	D4	D3	D2	D1	D0
1	1	1	0				

Display digit (Note 1)

2) Setting and cancel of auto increment

D7	D6	D5	D4	D3	D2	D1	D0
1	1	1	1	0	1	0	

Setting and cancel of auto increment
1: Setting of auto increment
0: Cancel of auto increment
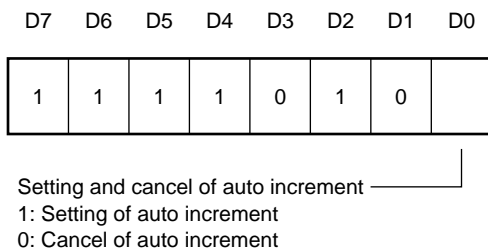
Note 1: When the display digit is defined as N, N equals [decimal values to which D3, D2, D1 and D0 are converted + 1]. In case of (D3, D2, D1, D0)=(1, 0, 0, 0), N is 9. The first character code received after executing this command is despoiled to the 9th digit.

Table 2 Dimmer value

D2	D1	D0	Dimmer value (T_{dig}/T_{dsp})
0	0	0	1/16
0	0	1	2/16
0	1	0	4/16
0	1	1	6/16
1	0	0	8/16
1	0	1	10/16
1	1	0	12/16
1	1	1	14/16

T_{dig} : One-digit-ON pulse width
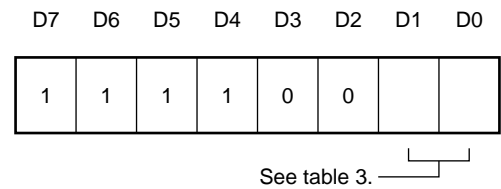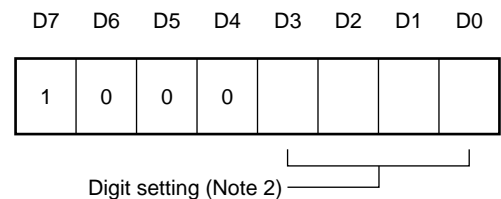T_{dsp}: One-digit display frequency

4. All-digit display ON/OFF

D7	D6	D5	D4	D3	D2	D1	D0
1	1	1	1	0	0		

See table 3.

Table 3 ON/OFF control

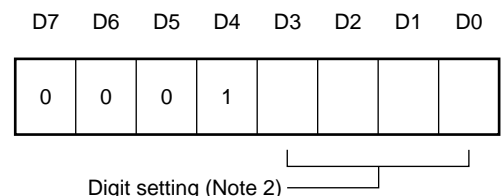| D1	D0	Operation
×	0	All-digit display OFF (All-OFF)
0	1	Normal operation mode setting
1	1	All-digit/segment display ON (All-ON)

×: Don't care

5. Cursor OFF (SEG35 output OFF)

D7	D6	D5	D4	D3	D2	D1	D0
1	0	0	0				

Digit setting (Note 2)

6. Cursor ON (SEG35 output ON)

D7	D6	D5	D4	D3	D2	D1	D0
0	0	0	1				

Digit setting (Note 2)
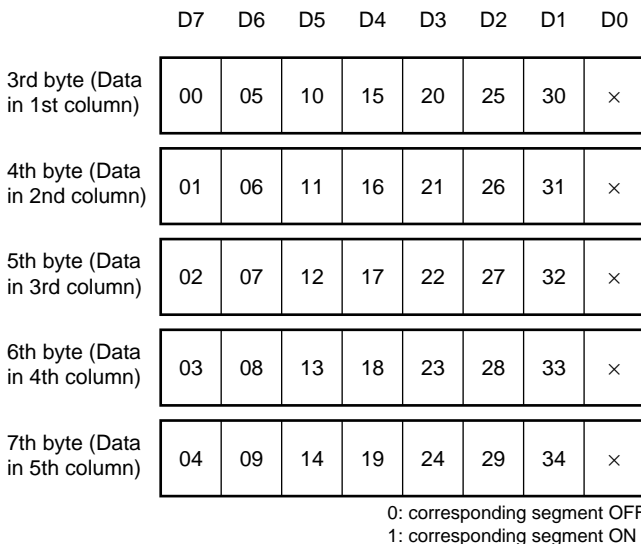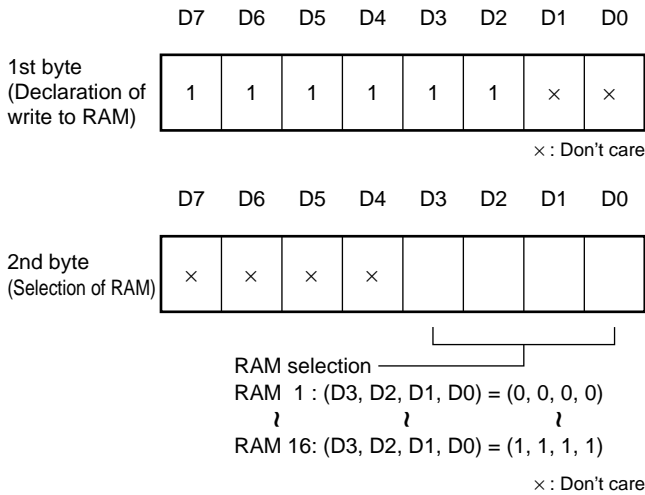
Note 2: The digit to which the cursor to make display ON or OFF belongs is designated. When digit is defined as N, N equals [decimal values to which D3, D2, D1 and D0 are converted + 1]. In case of (D3, D2, D1, D0)=(1, 0, 0, 0), N is 9. ON/OFF control of the cursor which belongs to the 9th digit is possible.

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7. Write to character RAM for user definition

Segment ON/OFF data is written into the character RAM for user definition (35 bits). After write to RAM is declared at the first byte, RAM is selected at the second byte and ON/OFF data is transmitted at the 3rd to 7th byte. Therefore, write to RAM is executed by a 7-byte command.

Character codes from RAM1 to RAM 16 are assigned to data from 90_{16} to $9F_{16}$ respectively.

	D7	D6	D5	D4	D3	D2	D1	D0
1st byte (Declaration of write to RAM)	1	1	1	1	1	1	×	×

× : Don't care

	D7	D6	D5	D4	D3	D2	D1	D0
2nd byte (Selection of RAM)	×	×	×	×				

RAM selection (D3, D2, D1, D0)

RAM 1 : (D3, D2, D1, D0) = (0, 0, 0, 0)
≀   ≀   ≀
RAM 16: (D3, D2, D1, D0) = (1, 1, 1, 1)

× : Don't care

	D7	D6	D5	D4	D3	D2	D1	D0
3rd byte (Data in 1st column)	00	05	10	15	20	25	30	×
4th byte (Data in 2nd column)	01	06	11	16	21	26	31	×
5th byte (Data in 3rd column)	02	07	12	17	22	27	32	×
6th byte (Data in 4th column)	03	08	13	18	23	28	33	×
7th byte (Data in 5th column)	04	09	14	19	24	29	34	×

0: corresponding segment OFF
1: corresponding segment ON

1st column   3rd column   5th column

00	01	02	03	04
05	06	07	08	09
10	11	12	13	14
15	16	17	18	19
20	21	22	23	24
25	26	27	28	29
30	31	32	33	34

2nd column   4th column
(Segment number)

Ex. In order to define "F" (see the figure) as character RAM 1, 7-byte data as shown in the following table should be transmitted in serial order.
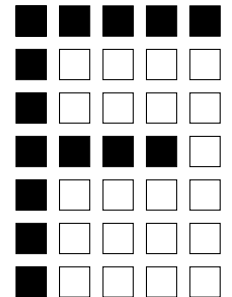
	Transmission data	Remarks
1	FC_{16}	Declaration of write to RAM 1
2	00_{16}	Selection of RAM 1
3	FE_{16}	Setting of 1st-column segment data
4	90_{16}	Setting of 2nd-column segment data
5	90_{16}	Setting of 3rd-column segment data
6	90_{16}	Setting of 4th-column segment data
7	80_{16}	Setting of 5th-column segment data

All optional bits are set to "0".

8. Output port setting

D7 D6 D5 D4 D3 D2 D1 D0

| 1 | 1 | 1 | 1 | 1 | 0 | | |

P0 set/reset
P1 set/reset

Set ("H"): 1
Reset ("L"): 0
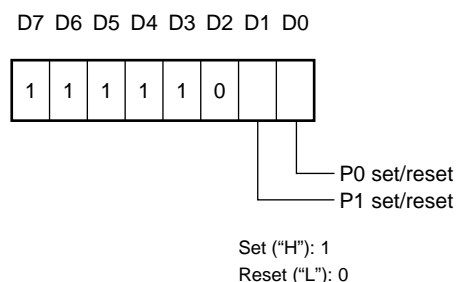
DESCRIPTION OF FUNCTION

1. Display digit length setting
The display digit length can be set within the range from 9-digit to 16-digit according to the number of digits of VFD.
In case that the display digit length is set to 12 when a 16-digit VFD is used, digits from 13 to 16 are displayed as blank.

2. Dimmer value and one-digit display frequency (T$_{dsp}$) setting
Regarding dimmer value, 8-stage setting is possible. One-digit display scan time (T$_{dsp}$) can be set to either T$_{dsp}$=128/f$_{OSC}$ or T$_{dsp}$=256/f$_{OSC}$.
Scan cycle time T is set to T=T$_{dsp}$ × N (N: display digit length).

Ex. f$_{OSC}$=455kHz, N=16
T$_{dsp}$=281μs, T=4.5ms (222Hz) or T$_{dsp}$=562μs, T=9.0ms (111Hz)

DISPLAY TIMING

T: Scan cycle time   T$_{dsp}$: One-digit scan time
T$_{dig}$: One-digit-ON pulse width   T$_{blk}$: Blanking time

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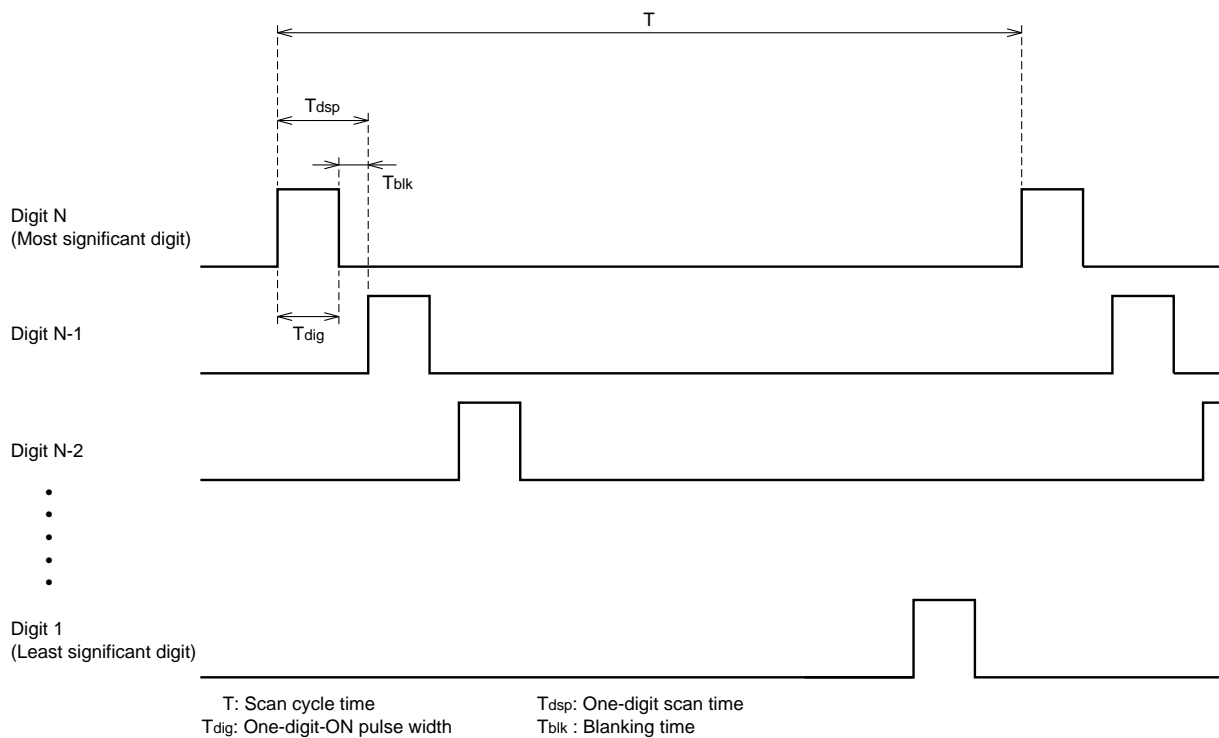
3. Character display

A character (refer to the character code table) which corresponds to the character code transmitted from the MCU is displayed as the designated digit.

The display digit is designated by the display digit setting command. In case that the display digit designated by this command is set to increase automatically, the display digit is automatically increased by 1. After a character is displayed to the most significant digit, it is displayed to the least significant digit.

When the auto increment setting is canceled, the display digit is fixed.

Ex. In order to display a character A to digits 14, 15, 16, 1 and 2 in this order and characters A, B and C to digit 8 successively, 12-byte data must be transmitted in the following order.

(Display digit length = 16)
A (code 41_{16})
B (code 42_{16})
C (code 43_{16})

	Transmission data	Display digit	Remarks
1	$F5_{16}$	–	Setting of auto increment
2	ED_{16}	–	Display digit is set to the 14th digit.
3	41_{16}	14	
4	41_{16}	15	Transmission of character code
5	41_{16}	16	
6	41_{16}	1	
7	41_{16}	2	
8	$F4_{16}$	–	Cancel of auto increment setting
9	$E7_{16}$	–	Display digit is set to the 8th digit.
10	41_{16}	8	
11	42_{16}	8	Transmission of character code
12	43_{16}	8	

4. All-digit display ON/OFF

All digits are simultaneously lighted or put off by inputting all-digit display ON command or all-digit display OFF command. When all-digit display ON command is transmitted, all digits including a cursor and all segments are lighted.

Therefore, this command can be used for the lamp test. When all-digit display ON setting is canceled (normal operation mode is selected), all digits are displayed according to the setting before all-digit display ON operation. It is also possible to set the next character to the designated digit during the all-digit display ON operation.

When all-digit display OFF command is transmitted, all digits including a cursor are put off. When all-digit display OFF setting is canceled (normal operation mode is selected), all digits are displayed according to the setting before all-digit display OFF operation. It is also possible to set the next character to the designated digit in the all-digit display OFF state.

OPERATION AT RESET

When a reset signal is input, the internal state is initialized as shown in Table 4.

Table 4 Initial state

Contents	Setting after reset
Display (characters and cursor)	All digits: OFF
Display digit length, dimmer value, display digit, one-digit display frequency, user character RAM state, auto increment setting	Values immediately before reset are held.
Serial receive circuit	Reset
Output port setting	Set

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ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter		Conditions	Ratings	Unit
V_{CC}	Supply voltage	V_{CC1}, V_{CC2}		$-0.3 \sim +7$	V
V_P	Pull-down voltage		(Note 3)	$V_{CC}-45 \sim V_{CC} + 0.3$	V
V_I	Input voltage			$-0.3 \sim V_{CC} + 0.3$	V
V_O	Output voltage	X_{OUT}, P0, P1		$-0.3 \sim V_{CC} + 0.3$	V
P_d	Maximum power dissipation	SP	Any external circuits are not connected to the IC. T_a=25°C (Note 4)	1.6	W
		FP	The IC is mounted on a board. T_a=25°C (Note 5)	1.4	
T_{stg}	Storage temperature			$-65 \sim 150$	°C

Notes 3: Frequency of pulse waveform exceeding V_{CC}-40V:450µs or above, pulse width: 30µs or below, output load: $C_L \leq 200$pF
　　　4: When T_a is 25°C or above, derating (12.8mW/°C) should be conducted.
　　　5: When T_a is 25°C or above, derating (11.2mW/°C) should be conducted.

RECOMMENDED OPERATIONAL CONDITIONS (Ta=–10 ~ 70°C unless otherwise noted)

Symbol	Parameter		Conditions	Limits			Unit
				Min.	Typ.	Max.	
V_{CC}	Supply voltage	V_{CC1}, V_{CC2}		4.5	5	5.5	V
V_P	Pull-down voltage			$V_{CC}-40$		V_{CC}	V
V_{SS}	Supply voltage				0		V
V_I	Input voltage			0		V_{CC}	V
T_{opr}	Operating temperature			-10		70	°C

DC CHARACTERISTICS (Ta = –10 ~ 70°C, Vcc = 5V ± 10%, Vss = 0V)

Symbol	Parameter		Conditions	Limits			Unit
				Min.	Typ.	Max.	
V_{IH}	"H" input voltage	SDATA		$0.7V_{CC}$			V
V_{IL}	"L" input voltage					$0.3V_{CC}$	V
V_{T+}	Positive direction threshold voltage	$\overline{RESET}$ $\overline{CS}$ SCK, X_{IN}		$0.35V_{CC}$	2.8	$0.7V_{CC}$	V
V_{T-}	Negative direction threshold voltage			$0.2V_{CC}$	2	$0.55V_{CC}$	V
I_{IH}	"H" input current		$V_I=V_{CC}$			1	µA
I_{IL}	"L" input current		$V_I=0V$			-1	µA
V_{OH}	"H" output voltage	DIG output	$I_{OH}=-20$mA	$V_{CC}-2$			V
		SEG output	$I_{OH}=-5$mA	$V_{CC}-2$			
		P0, P1	$I_{OH}=-2$mA	$V_{CC}-0.8$			
V_{OL}	"L" output voltage	P0, P1	$I_{OL}=2$mA			0.55	V
I_O	Output pull-down current	DIG, SEG	$V_P=V_{CC}-40V$, $V_O=V_{CC}$	250	500	850	µA
I_{CC} (Note 6)	Positive supply current	V_{CC1}, V_{CC2}	$V_I=0V$, Output pin: open $V_P=V_{CC}-40V$			100	µA
			Output pin: open Output "H", clock stop $V_P=V_{CC}-40V$			40	mA
I_P	Negative supply current	V_P	Output pin: open Output "H", clock stop $V_P=V_{CC}-40V$			-40	mA

Note 6: Total of current at pin V_{CC1} and current at pin V_{CC2}.

16-DIGIT 5X7-SEGMENT VFD CONTROLLER

TIMING CONDITIONS (Ta = −10 ~ 70°C, VCC = 5V ± 10%, VSS = 0V)

Symbol	Parameter		Conditions	Limits			Unit
				Min.	Typ.	Max.	
tC	Clock cycle time	SCK		500			ns
		XIN		1000			
tWH	Clock cycle pulse width	SCK		230			ns
		XIN		460			
tWL	Clock low pulse width	SCK		230			ns
		XIN		460			
tsu(D)	SDATA setup time			130			ns
th(D)	SDATA hold time			100			ns
tsu(CS̄)	C̄S̄ setup time			0			ns
th(CS̄)	C̄S̄ hold time			130			ns
tBUSY (Note 7)	Internal processing time					6	1/fOSC

Note 7: This shows the internal operation time after receiving the serial data. Next data is prohibited in this period. Next data is available after 6T of the operation clock.

OSCILLATION CHARACTERISTICS (Ta = −10 ~ 70°C, VCC = 5V ± 10%, VSS = 0V)

Symbol	Parameter	Conditions	Limits			Unit
			Min.	Typ.	Max.	
fOSC	Oscillation frequency	C=100pF, R=27kΩ		500		kHz

TIMING WAVEFORM (Reference voltage: 0.3VCC, 0.7VCC)
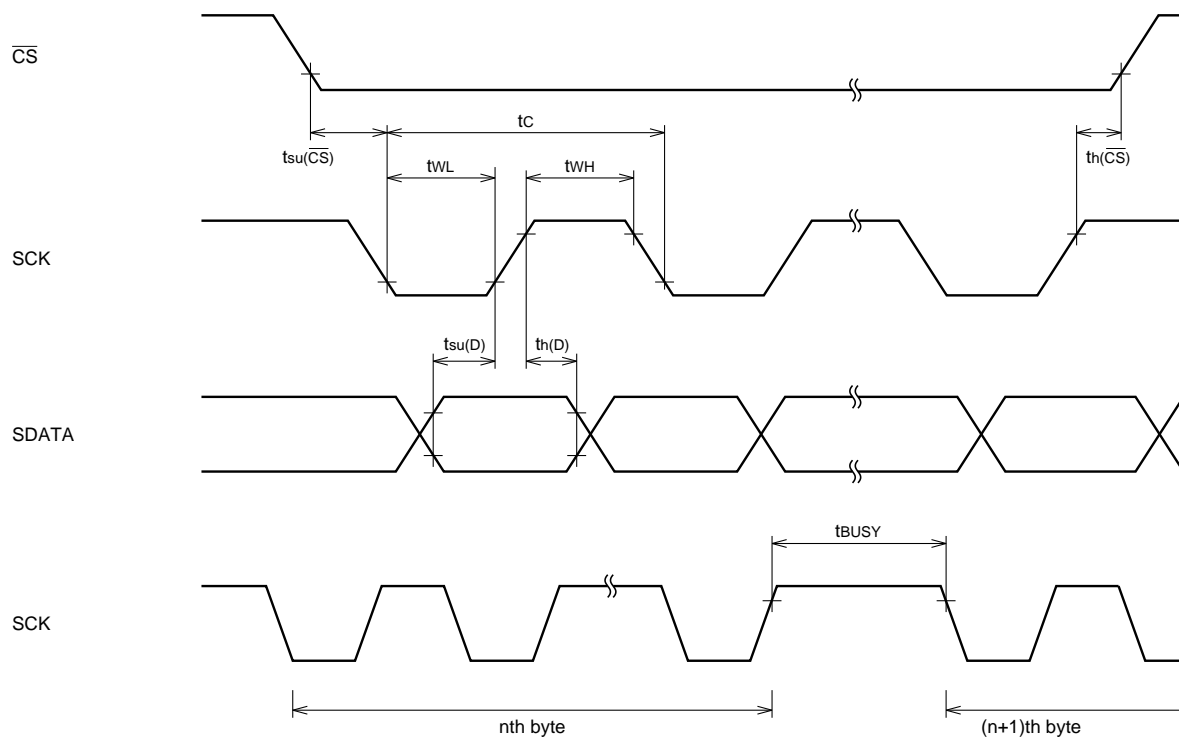
OPERATION FLOWCHART (Initial setting operation)

```
                          ( START )
                              │
                              ▼
                    ┌──────────────────┐
                    │ PUT OFF ALL-     │
                    │ DIGIT DISPLAY    │
                    └──────────────────┘
                              │
                              ▼
              ┌──────────────────────────────┐
              │  SET DISPLAY DIGIT LENGTH     │
              └──────────────────────────────┘
                              │
                              ▼
              ┌──────────────────────────────┐
              │  SET DIMMER VALUE AND         │
              │  ONE-DIGIT DISPLAY FREQUENCY  │
              └──────────────────────────────┘
                              │
                              ▼
              ┌──────────────────────────────┐
              │  TRANSMIT RAM WRITE COMMAND   │
              └──────────────────────────────┘
                              │
                              ▼
              ┌──────────────────────────────┐
              │  TRANSMIT RAM BIT DATA        │
              └──────────────────────────────┘
                              │
                              ▼
          NO  ◇ BIT DATA TRANSMISSION COMPLETED ◇
                              │ YES
                              ▼
          NO  ◇ WRITE TO RAM COMPLETED ◇
                              │ YES
                              ▼
              ┌──────────────────────────────┐
              │  SET AUTO INCREMENT,          │
              │  SET DISPLAY DIGIT            │
              └──────────────────────────────┘
                              │
                              ▼
              ┌──────────────────────────────┐
              │  TRANSMIT DISPLAY CHARACTER   │
              │  CODE                         │
              └──────────────────────────────┘
                              │
                              ▼
          NO  ◇ TRANSMISSION OF ALL DIGITS COMPLETED ◇
                              │ YES
                              ▼
              ┌──────────────────────────────┐
              │  SET TO NORMAL OPERATION MODE │
              └──────────────────────────────┘
                              │
                              ▼
                          ( END )
```
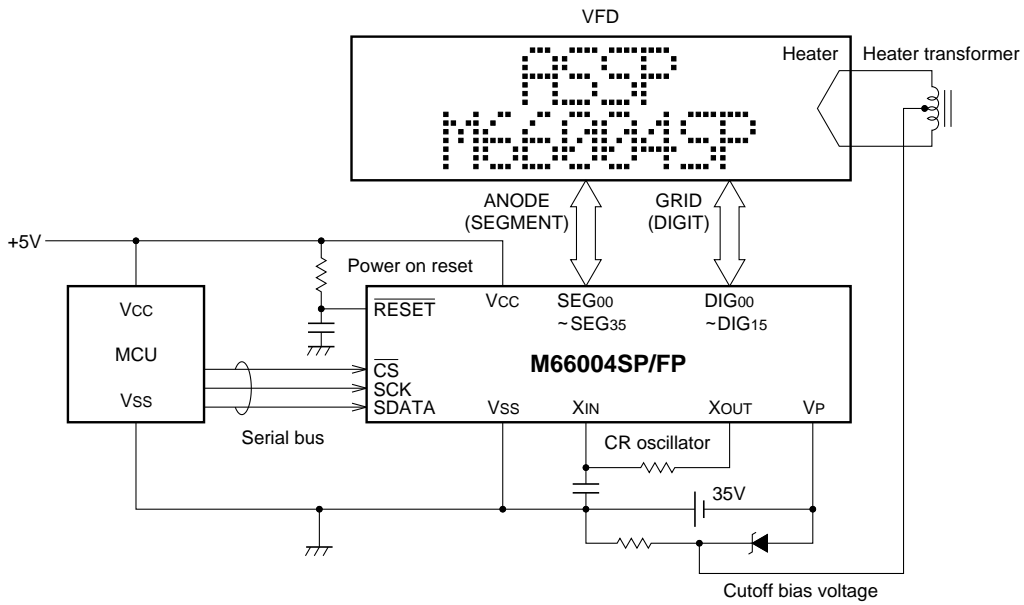
MITSUBISHI ELECTRIC

CHARACTER CODE LIST (conforming to JIS-C-6220)

Lower codes \ Upper codes	0000 (0₁₆)	0001 (1₁₆)	0010 (2₁₆)	0011 (3₁₆)	0100 (4₁₆)	0101 (5₁₆)	0110 (6₁₆)	0111 (7₁₆)	1000 (8₁₆)	1001 (9₁₆)	1010 (A₁₆)	1011 (B₁₆)	1100 (C₁₆)	1101 (D₁₆)	1110 (E₁₆)	1111 (F₁₆)
0000 (0₁₆)			SPASE							RAM1	SPASE					
0001 (1₁₆)										RAM2						
0010 (2₁₆)										RAM3						
0011 (3₁₆)										RAM4						
0100 (4₁₆)										RAM5						
0101 (5₁₆)										RAM6						
0110 (6₁₆)										RAM7						
0111 (7₁₆)										RAM8						
1000 (8₁₆)										RAM9						
1001 (9₁₆)										RAM10						
1010 (A₁₆)										RAM11						
1011 (B₁₆)										RAM12						
1100 (C₁₆)										RAM13						
1101 (D₁₆)										RAM14						
1110 (E₁₆)										RAM15						
1111 (F₁₆)										RAM16						

Note: Character codes which can be defined by users are 160 codes from 20₁₆ to 7F₁₆ and from A0₁₆ to DF₁₆.
Codes except those from 20₁₆ to 7F₁₆ and from 90₁₆ to DF₁₆ are command codes.

APPLICATION EXAMPLE