AN.No.G2436-920E

Preliminary

LIQUID CRYSTAL DISPLAY MODULE

G 2 4 3 6

USER'S MANUAL

Seiko Instruments Inc.

NOTICE

This manual describes the technical information, the function, and the operation of the G2436 Liquid Crystal Display Module of Seiko Instruments Inc. Please read this manual carefully to familiarize yourself with the functions and to make best use of them.
The descriptions here are subject to change without notice.

Revision Record

Edition	Revision	Date
1	Original	February 1989

Printed in Japan

CONTENTS

1. SPECIFICATIONS

1.1 General

The G2436 is a thin liquid crystal display (LCD) module that consists of a full dot-matrix LCD panel and CMOS LSIs. The panel features a wide viewing angle and high contrast. The full dot-matrix structure allows both graphics and character display. In addition, the display is clear and stable, with no image warping or position skew, because the display position is specified by the intersection of transparent electrodes in a matrix.

1.2 Features

- Full dot-matrix structure with 240 dots×64 dots
- 1 / 64 duty
- Four-bit parallel data input
- +5-V single power supply
- Built-in DC-DC converter
- Weight : 140 g

1.4 Absolute Maximum Ratings

V_{SS} = 0 V

Item	Symbol	Conditions	Min.	Max.	Unit
Power supply voltage	V_{DD}		−0.3	6.0	V
	V_{LC}*		V_{DD} − 20.0	V_{DD}	V
Input voltage	V_{IN}		−0.3	V_{DD} + 0.3	V
Operating temperature	T_{opr}		0	+ 50	°C
Storage temperature	T_{stg}		−20	+ 60	°C

* V_{LC} is used when the DC-DC converter is not used.

1.5 Electrical Characteristics

V_{SS} = 0 V, Ta = 0°C to 50°C

Item		Symbol	Conditions	Min.	Typ.	Max.	Unit
Power supply voltage		V_{DD}		4.75	5.00	5.25	V
Input voltage	High	V_{IH}	V_{DD} = 5 V ± 5%	0.8 V_{DD}	−	V_{DD}	V
	Low	V_{IL}	V_{DD} = 5 V ± 5%	0	−	0.2 V_{DD}	V
Current consumption		I_{DD}	V_{DD} = 5.0 V	−	8*	25	mA
Frame frequency		f_{FRM}	V_{DD} = 5 V ± 5%	65	70	75	Hz

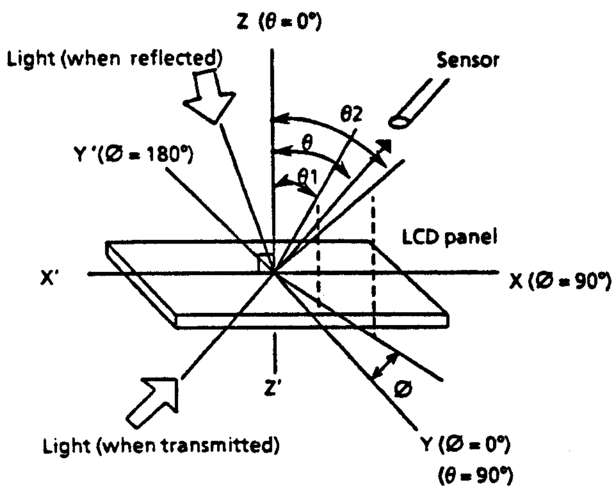
* Preliminary data

1.6 Optical Characteristics (Measured with Yellow-green Reflective Type Module)

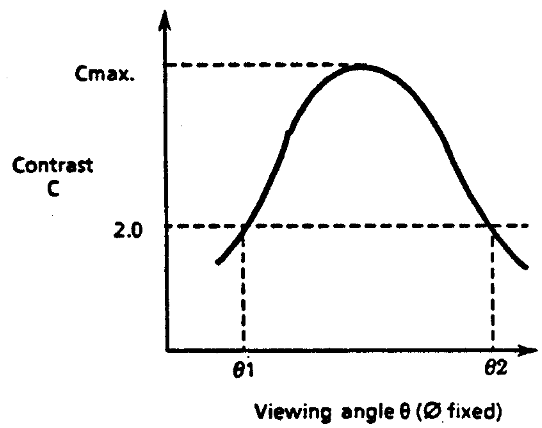
1 / 64 duty, 1 / 9 bias, Ta = 25°C

Item	Symbol	Conditions	Min.	Typ.	Max.	Reference
Viewing angle	$\theta_2 - \theta_1$	C ≧ 2.0, Ø = 0°	50°	–	–	Notes 1 & 2
Contrast	C	θ = 15°, Ø = 0°	4	6	–	Note 3
Response time (rise)	t_{on}	θ = 15°, Ø = 0°	–	180 ms	–	Note 4
Response time (fall)	t_{off}	θ = 15°, Ø = 0°	–	250 ms	–	Note 4

Note 1 : Definition of angles θ and Ø



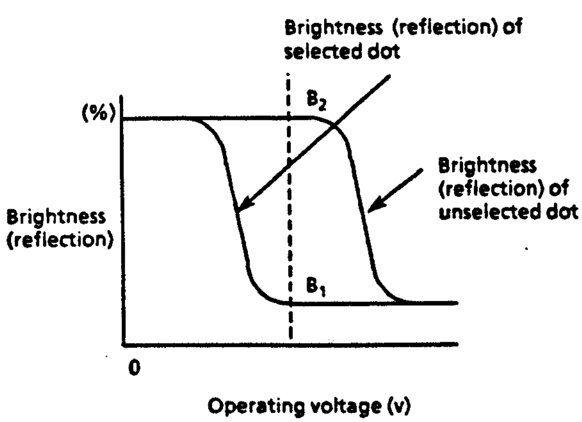
Note 2 : Definition of viewing angles θ1 and θ2



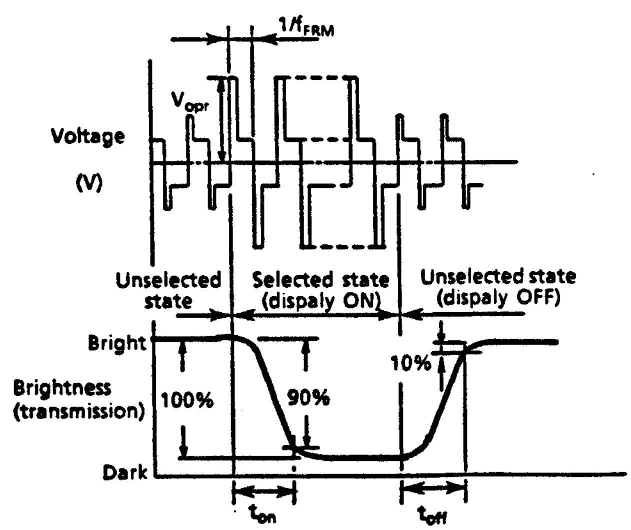
Note : Optimum viewing angle with the naked eye and viewing angle θ at Cmax. above are not always the same.

Note 3 : Definition of contrast C

$$C = \frac{\text{Brightness (reflection) of unselected dot } (B_2)}{\text{Brightness (reflection) of selected dot } (B_1)}$$



Note 4 : Definition of response time



Note : Measured with a transmissive LCD panel which is displayed 1 cm²

V_{opr} : Operating voltage
t_{on} : Response time (rise)
f_{FRM} : Frame frequency
t_{off} : Response time (fall)

1.7 Dimensions

Unit : mm/inch

General tolerance : ± 0.5 mm

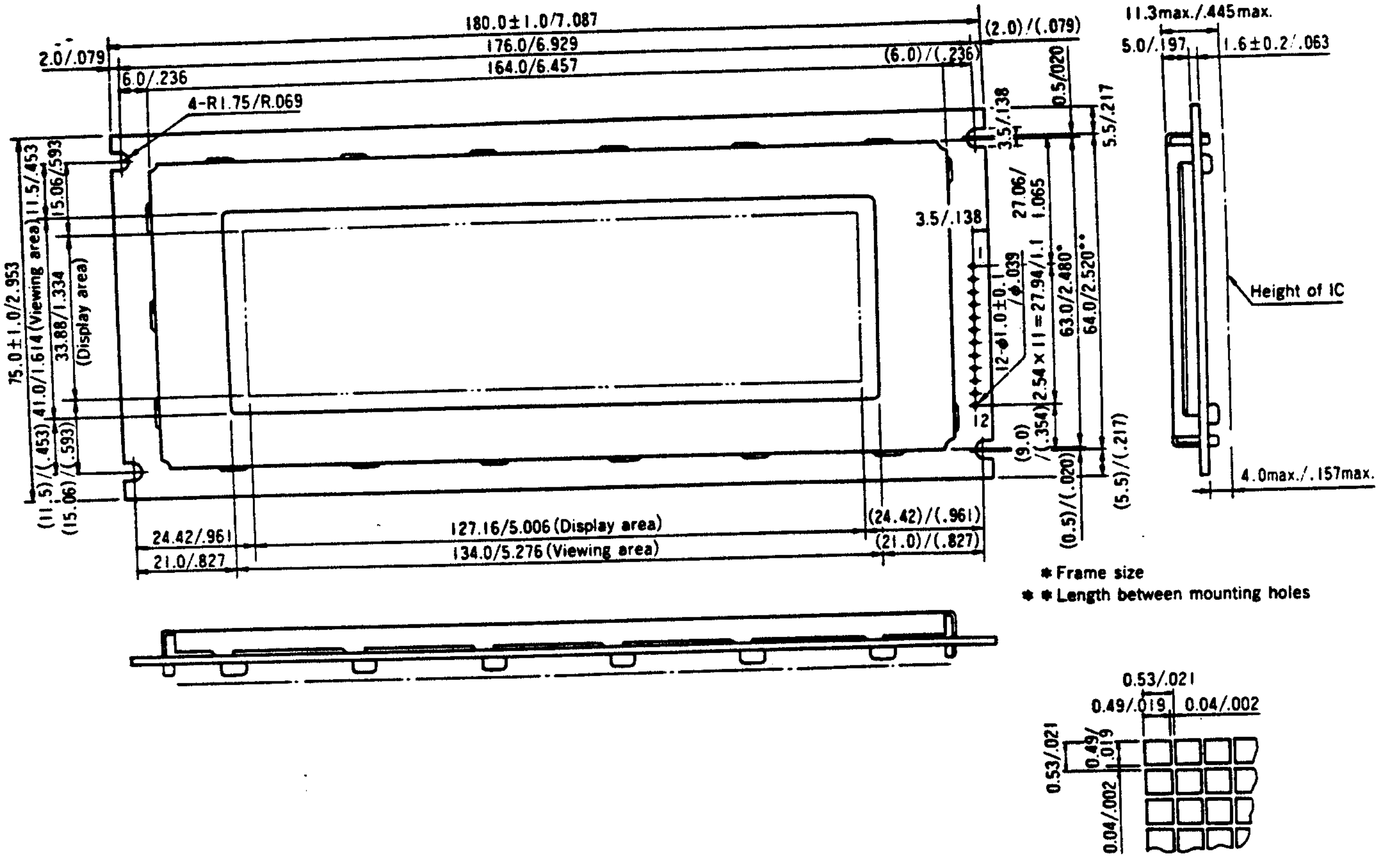


Figure 1 Dimensions

[I/O Terminal Functions]

No.	Symbol	Function
1	D_3	Display data input
2	D_2	Display data input
3	D_1	Display data input
4	D_0	Display data input
5	FLM	One-frame timing signal
6	M	Liquid crystal AC drive control signal

No.	Symbol	Function
7	CL1	One-common-line timing signal
8	CL2	Display data shift clock
9	V_{DD}	Power supply voltage (+5 V)
10	V_{SS}	GND (0 V)
11	V_O	NC (Liquid crystal drive voltage adjustment terminal) *
12	V_{LC}	NC (Power supply voltage: −10 V) *

* V_O and V_{LC} within parentheses are used as terminals when the DC-DC converter is not used.

CUST NEEDS TO SUPPLY 5V

2. CIRCUIT STRUCTURE

2.1 Liquid Crystal Driving Circuit

The drive waveform of the LCD panel is shown in Figure 2 on the next page. Since DC may damage the liquid crystal, the drive waveform polarity is reversed at alternate frames, and AC is applied between two frames. The signal controlling this is the liquid crystal AC drive control signal (M). The frame frequency is normally set to about 70±5 Hz to prevent screen flicker.

The G2436 has a 1/64 duty cycle, and the common electrodes are selected within a frame by time division from electrode 1 to electrode 64. This is called line sequential scanning. The voltage level of the segment electrodes determines whether the dots at the intersection of the segment electrodes are selected or not, when the common electrode is selected. As shown in Table 1, there are six drive waveform voltage levels, V_a to V_f. The voltage level is determined by the bias value. The voltage between the segment and common electrodes is thus applied to the liquid crystal. The selection waveform for SEG_0-COM_0 and the non-selection waveform for SEG_1-COM_1 are shown in Figure 2. The size of the effective voltage of the waveform determines whether the liquid crystal under the selected dots is in the selection or non-selection state.

Table 1

V_a	Common and segment selection level
V_b	Common non-selection level
V_c	Segment non-selection level
V_d	Segment non-selection level
V_e	Common non-selection level
V_f	Common and segment selection level

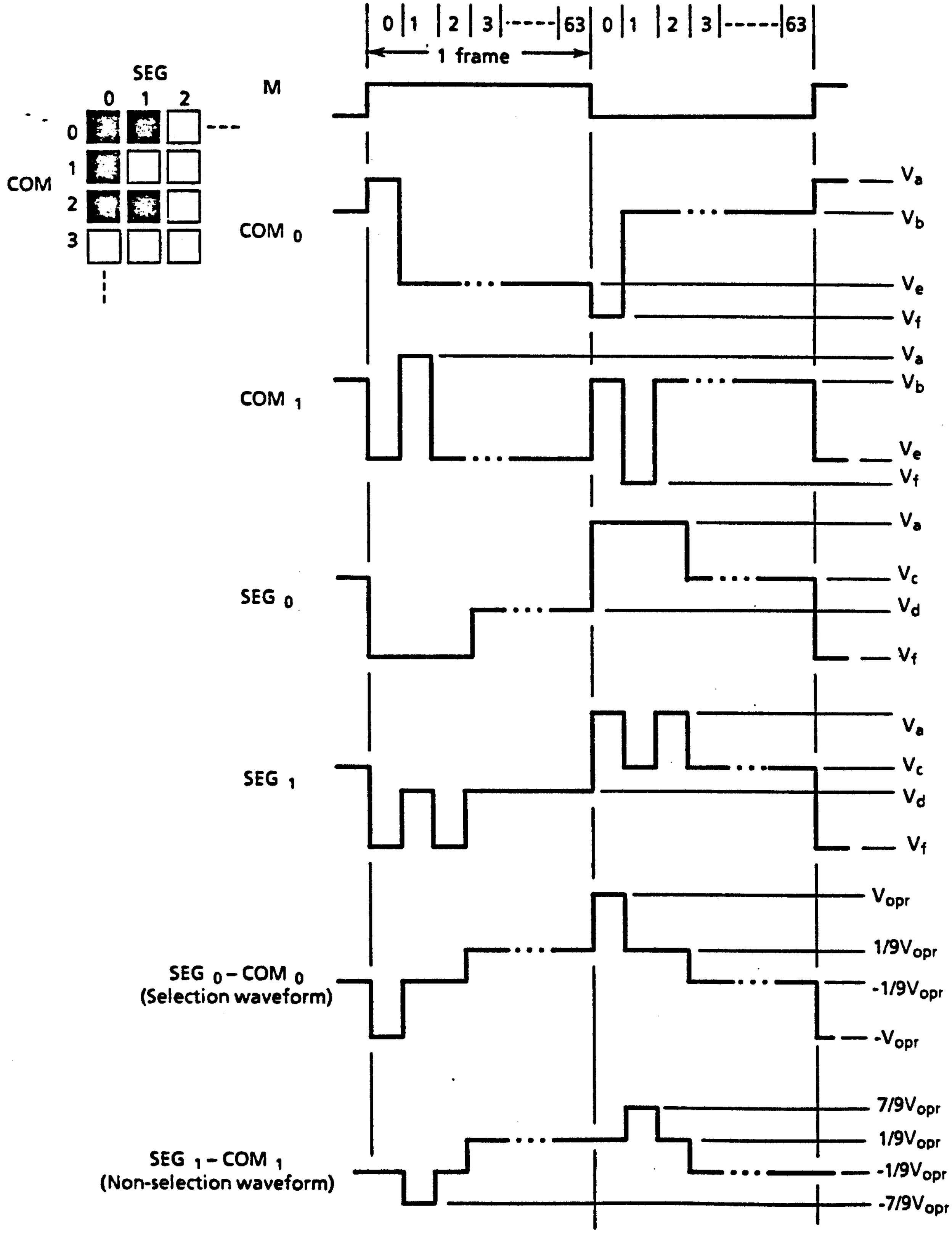


Figure 2 Drive waveform

2.2 Circuit Structure

The G2436 consists of a common driver, segment drivers, a DC-DC converter, and a bias voltage generation circuit. Figure 3 shows the block diagram.

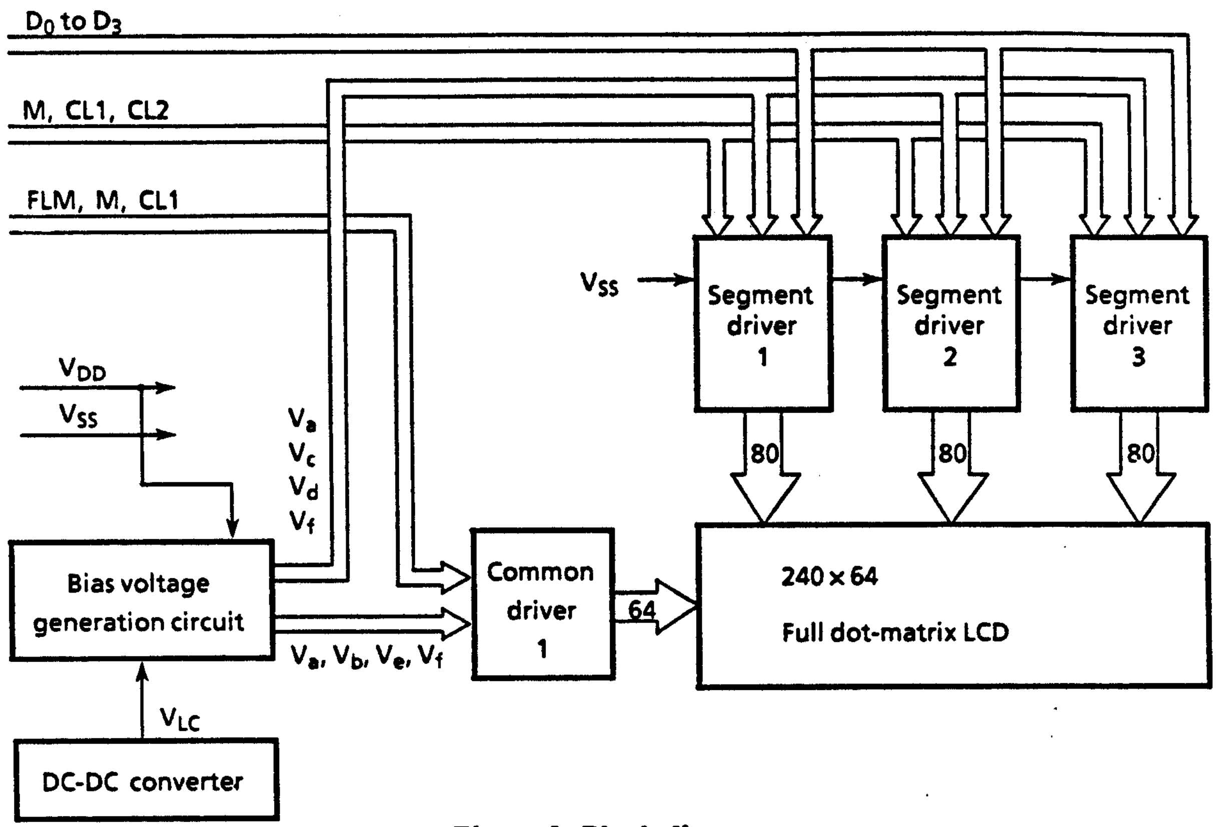


Figure 3 Block diagram

(1) Common driver (MSM5298GS)

A common driver (CD) is a CMOS IC with 86 drive outputs. The G2436 uses 64 of these and operates as follows.
Input one-frame timing signal (FLM) is taken into the internal shift register by the falling edge trigger of the one-common-line timing signal (CL1), and sequentially shifted. After 64-CL1 input, the next FLM is input and the same operation is repeated. As shown in Table 2, the common output is selected according to the shift register contents and the liquid crystal AC drive control signal (M) in the drive circuit, and the common drive waveform is formed.

Table 2

Shift register content	M	COM output
H	H	V_a
	L	V_f
L	H	V_e
	L	V_b

(2) Segment driver (MSM5299BGS)

A segment driver (SD) is a CMOS IC with 80 drive outputs. It operates as follows. Input four-bit data is sequentially taken into the internal register by the falling edge trigger of the display data shift clock (CL2). SD has a chip enable function. After 80 bits of data are taken into SD1, the next data is automatically taken into SD2. The G2436 has three SDs and 240 bits of data can be taken. The display data taken into internal register are latched by the falling edge trigger of CL1. As shown in the Table 3, the segment output is selected according to the display data and M in the drive circuit, and the segment drive waveform is formed.

Table 3

Display data	M	SEG output
H	H	V_f
	L	V_a
L	H	V_d
	L	V_c

The relationship between the display data and display screen is shown below.

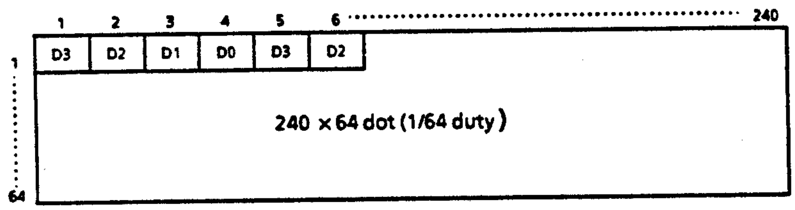


Figure 4

(3) Bias voltage generation circuit

Six levels of voltage, V_a to V_f, are applied to the common and segment drivers. The voltage is generated through operational amplifier by resistance-division from liquid crystal operating voltage (V_{opr}). Here, an operational amplifier is used as a voltage follower.

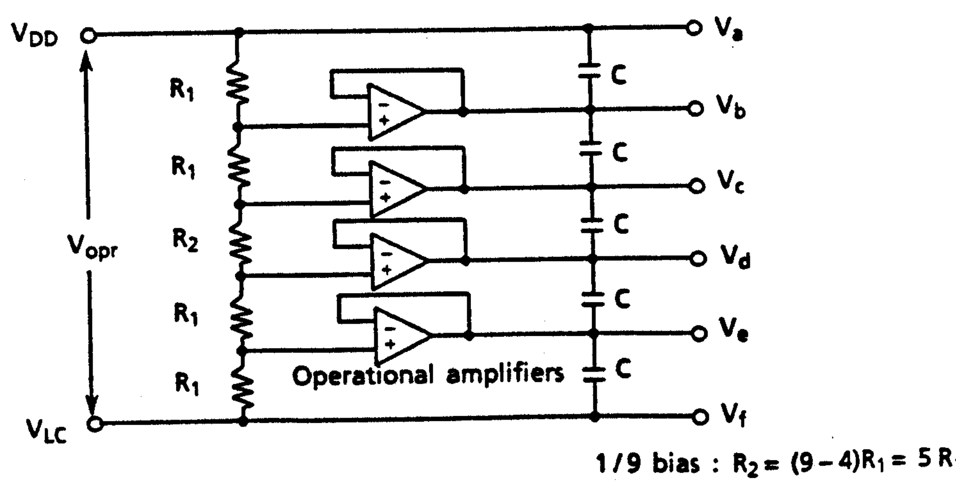


Figure 5 Bias voltage generation circuit

(4) DC-DC converter

The DC-DC converter internally generates the power supply voltage (V_{LC}). Also, the G2436 has a built-in variable resistor (VR) which controls V_{LC}. When V_{LC} is changed, the liquid crystal operating voltage (Vopr) changes. This changes the display screen contrast.
When the VR is supplied from external to the G2436, or when the DC-DC converter is not used, the circuit must be changed as follows.

[When the VR is supplied from external to the G2436]
Remove the VR, and supply 100kΩ of variable resistance between V_O and V_{LC}.

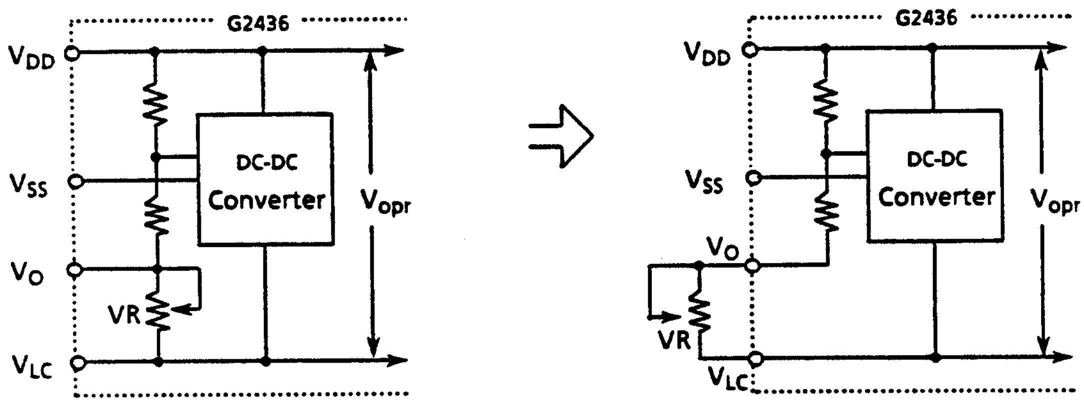


Figure 6

[When the DC-DC converter is not used]
Remove the DC-DC converter and the VR, and supply V_{opr} to the V_{LC} terminal. Set V_O to NC.

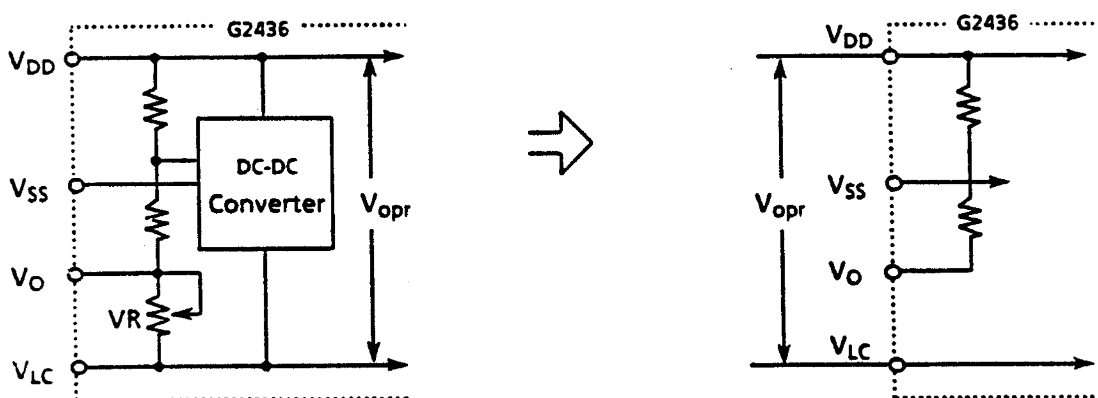


Figure 7

Note: Liquid crystal operating voltage when the DC-DC converter is not used
Display screen contrast and viewing angle are affected by changes in the liquid crystal operating voltage (V_{opr}), that is V_{LC}. Optical characteristics are influenced by the ambient temperature. The recommended V_{opr} level at different ambient temperatures is as follows.

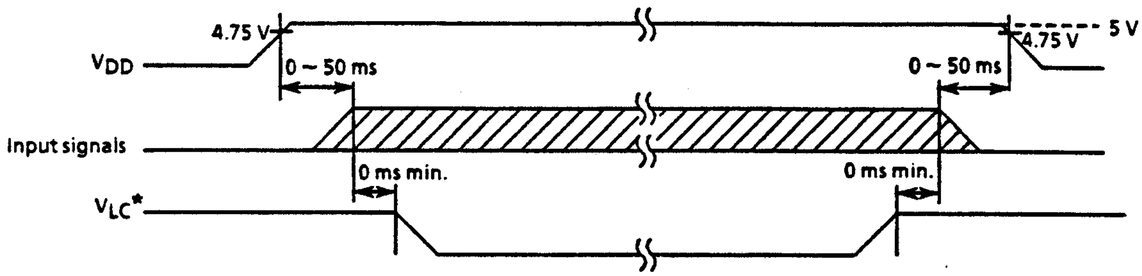
Temperature (°C)	0	25	50
V_{opr} (V)	13.6	12.5	11.0

$V_{opr} = V_{DD} - V_{LC}$

2.3 Timing Characteristics

2.3.1 Power ON/OFF and Signal Input Timing

Power ON/OFF and signal input should be performed according to the timing shown in the figure below in order not to damage the LCD driving circuit and the LCD panel.



* Power is applied to the V_{LC} terminal in the design where the DC-DC converter is removed. See page 9.

Figure 8 Power ON/OFF and signal input timing

2.3.2 Timing Characteristics

T_a = 0°C to 50°C, V_{DD} = 5.0 V ± 5%

Item	Symbol	Min.	Max.	Unit
CL1 period	tccl1	1000	—	ns
CL1 high pulse width	twcl1h	125	—	ns
CL1 low pulse width	twcl1l	—	—	ns
Data setup time 1	tds1	100	—	ns
Data hold time 1	tdh1	100	—	ns
Allowable M delay time	tdm	—	—	ns
Input signal rise time	t_r	—	50	ns
Input signal fall time	t_f	—	50	ns
CL2 period	tccl2	334	—	ns
CL2 high pulse width	twcl2h	125	—	ns
CL2 low pulse width	twcl2l	125	—	ns
Data setup time 2	tds2	100	—	ns
Data hold time 2	tdh2	100	—	ns
CL2 rise to CL1 rise	tld	63	—	ns
CL2 fall to CL1 fall	tsl	125	—	ns
CL1 rise to CL2 rise	tls	125	—	ns
CL1 fall to CL2 fall	tlh	63	—	ns

Timing chart 1 Timing of signal input into common driver

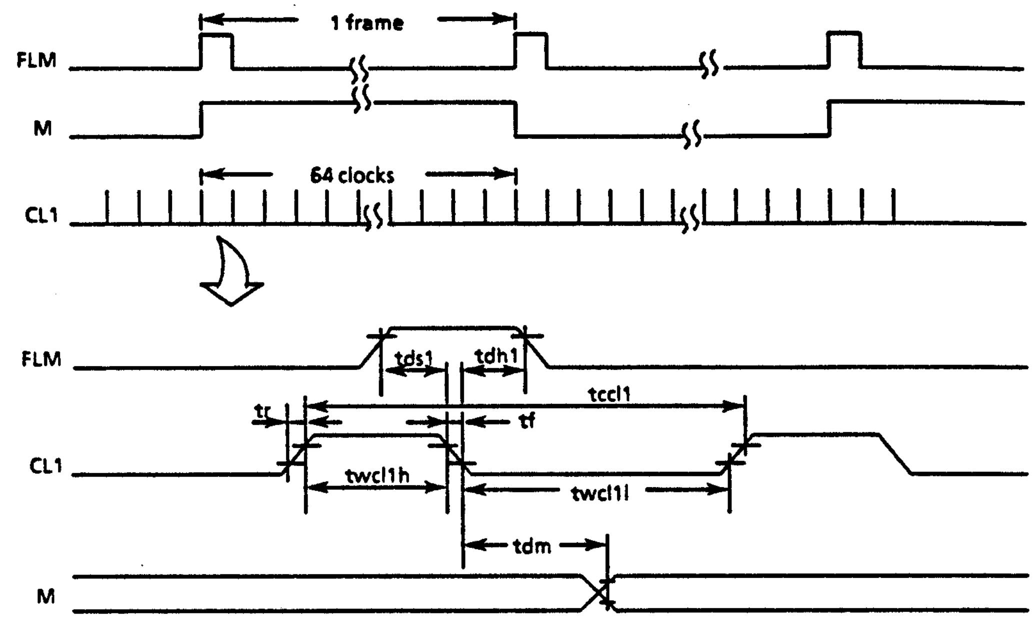


Figure 9

Timing chart 2 Timing of signal input into segment driver

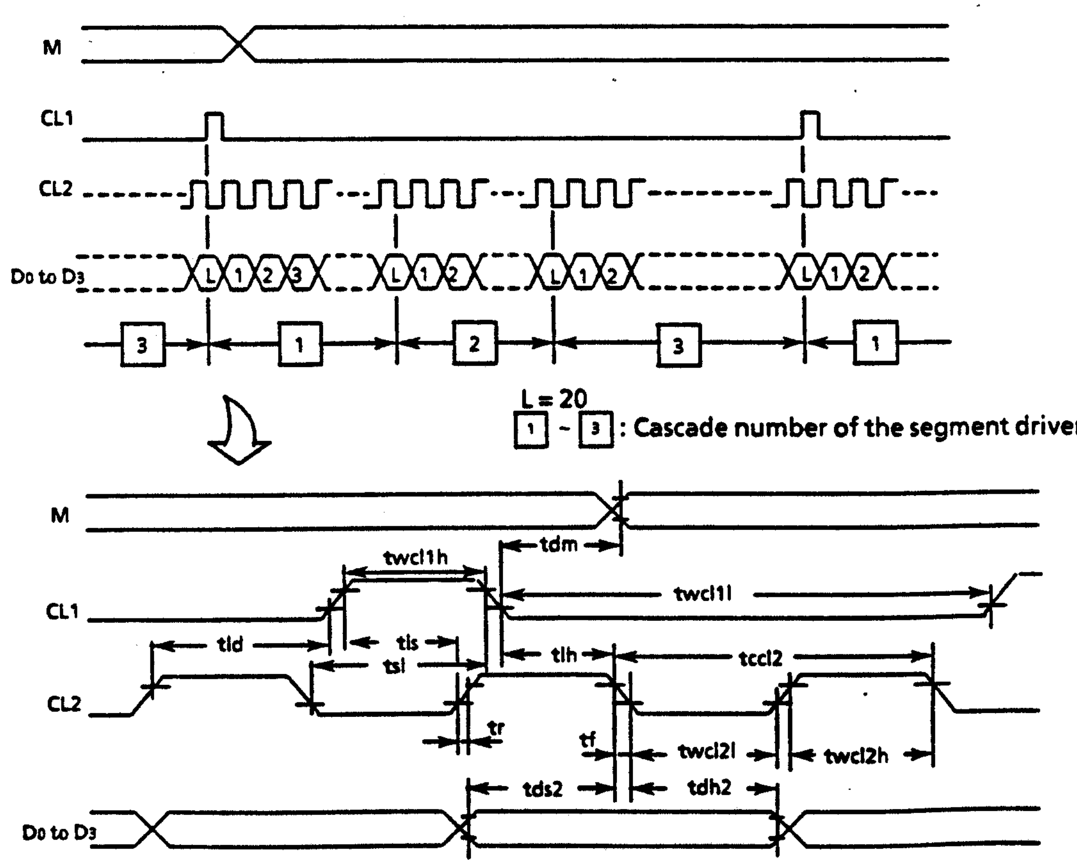


Figure 10

2.4 Interface Circuit

The G2436 is controlled by the MPU circuit, whose interface is easily set up when the LCD controller is used. The LCD controller has basic functions such as receiving information related to the display from the MPU circuit, and sending display timing signals and display data to the LCD module, and other functions such as cursor display.

The G2436 must use LCD controllers conforming to the following conditions.

- For a full dot-matrix LCD module
- Where data is transferred to the LCD module in four-bit parallel
- Where G2436 display screen has 1/64 duty

The following section gives examples of interfaces using the OKI MSM6255GSK, SEIKO EPSON SED1330FBA and HITACHI HD64646FS controllers.

(1) OKI MSM6255GSK

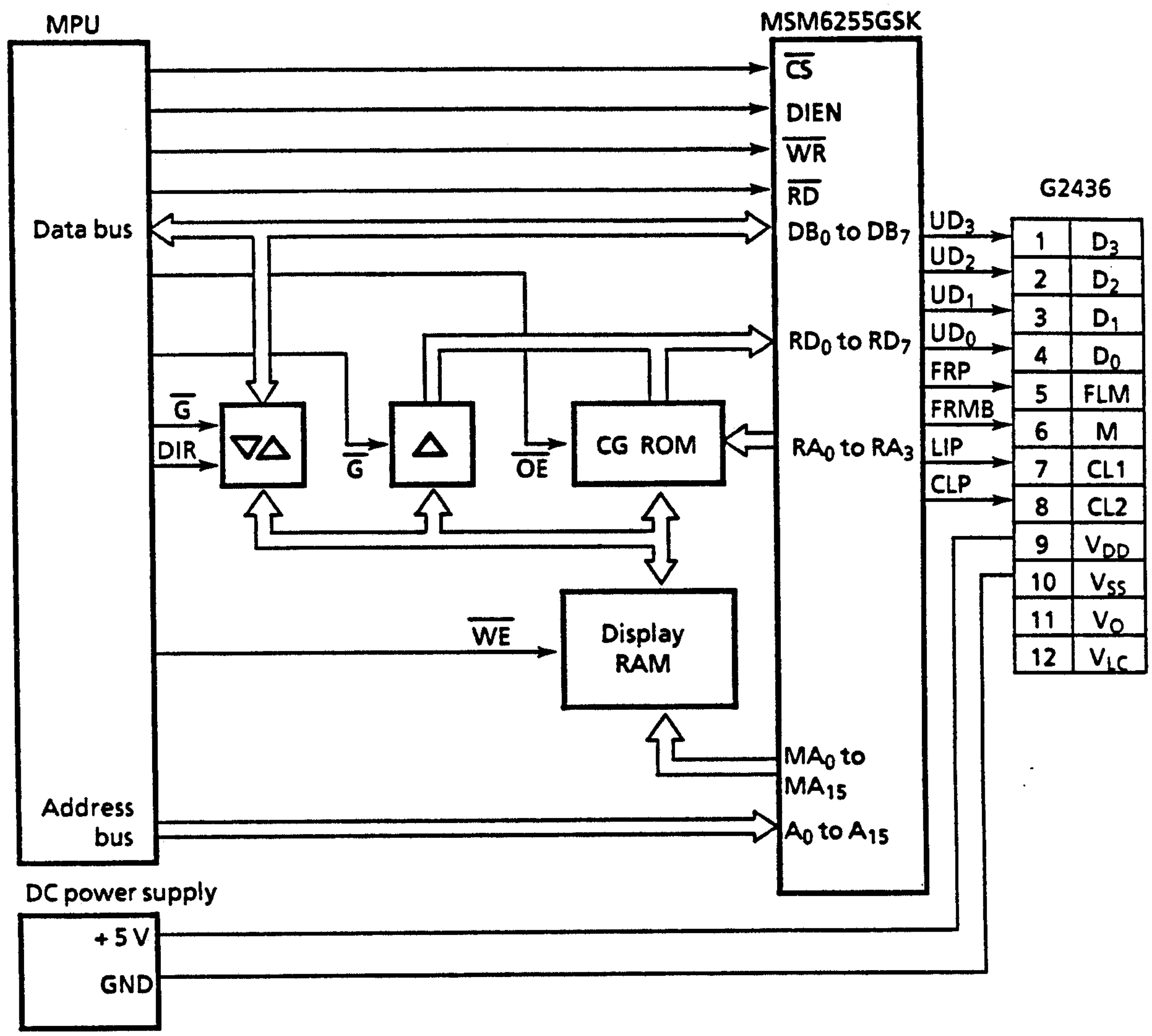


Figure 11 Interface circuit with MSM6255GSK

[Features of the MSM6255GSK]

- Interface with 80-series MPU possible
- Cursor
  - ·ON/OFF; blinking speed, form, and position are programmable
- Scrolling and paging
- CMOS process
- 5-V single power supply

(2) SEIKO EPSON SED1330FBA

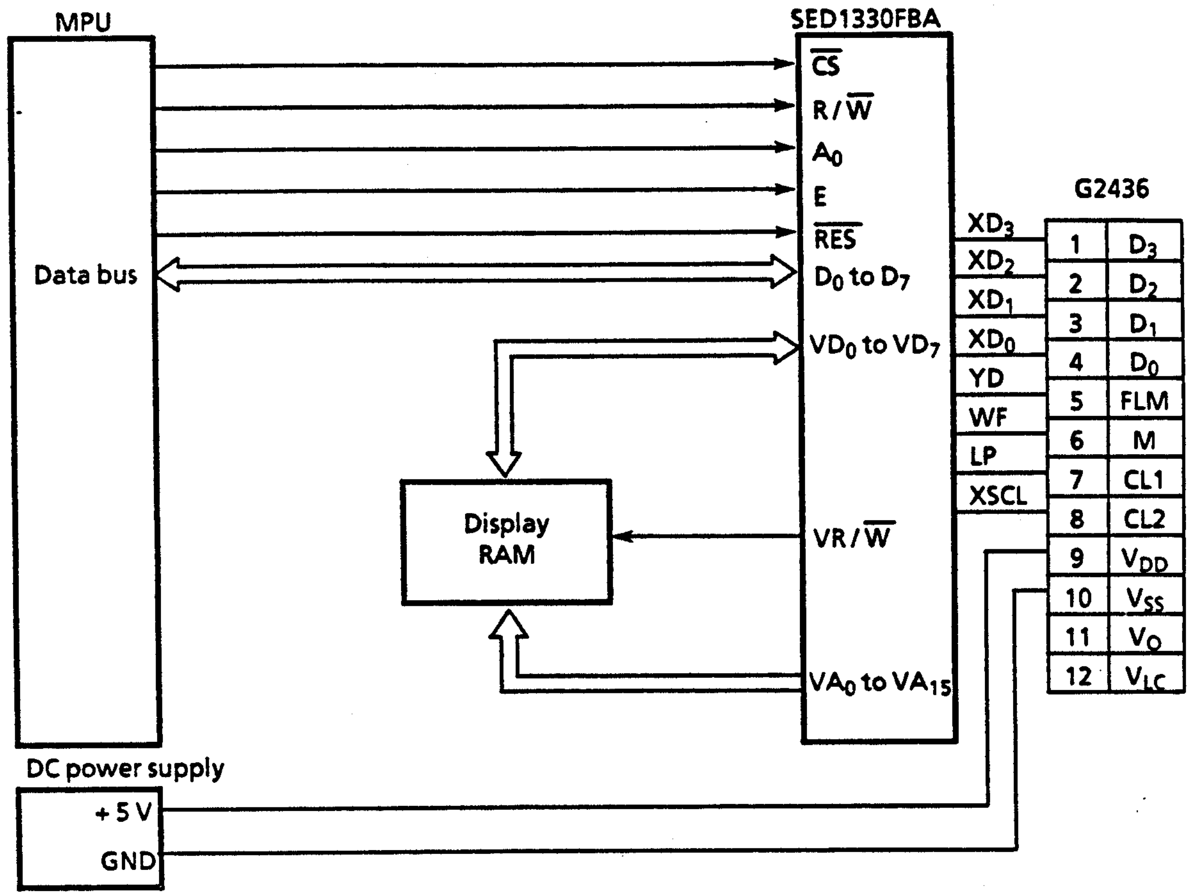


Figure 12 Interface circuit with SED1330FBA

[Features of the SED1330FBA]

- Interface with 80-series or 68-series MPU possible
- Built-in character generator ROM : 160 kinds
- External character generator
  - CG RAM : (8×16 dot-matrix)×64 kinds
  - CG ROM : (8×16 dot-matrix)×256 kinds
- Layered mode : AND, OR, XOR, "preferred" OR
- CMOS process
- Scrolling (vertical and horizontal)
- 5-V single power supply

(3) HITACHI HD64646FS

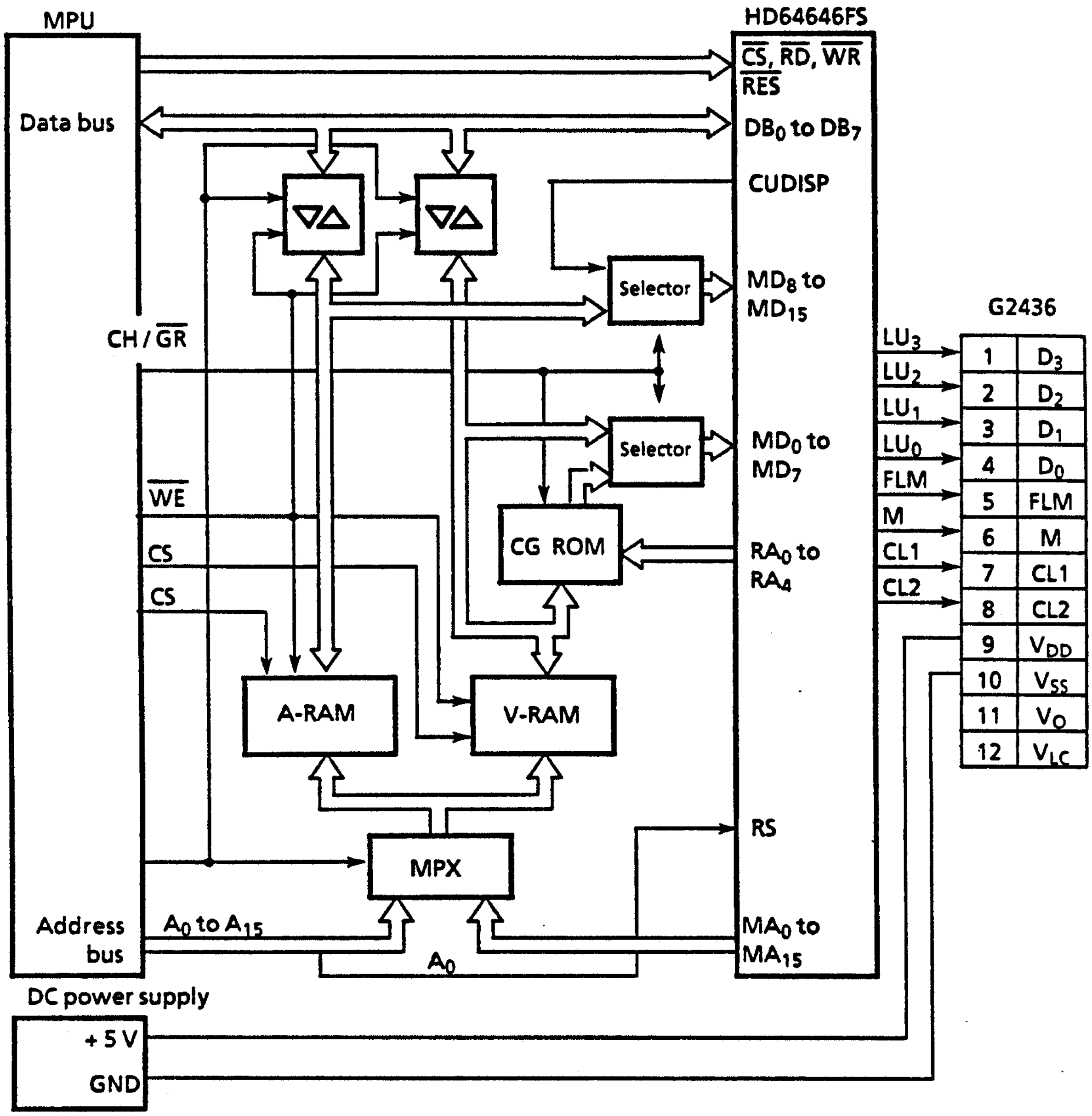


Figure 13 Interface circuit with HD64646FS

[Features of the MSM6255GSK]

- Interface with 80-series MPU possible
- Layered mode : OR (character and graphics)
- Character reverse, blinking, all black, all white
- Cursor
  - ON/OFF; blinking speed, form and position are programmable
- Character font
  - Vertical : 1 dot to 32 dots
  - Horizontal : 8 dots
- Scrolling
  - Vertical : smooth or character unit
  - Horizontal : character unit
- CMOS process
- 5-V single power supply

3. NOTES

Safety

- If the LCD panel breaks, be careful not to get the liquid crystal in your mouth. If the liquid crystal touches your skin or clothes, wash it off immediately using soap and plenty of water.

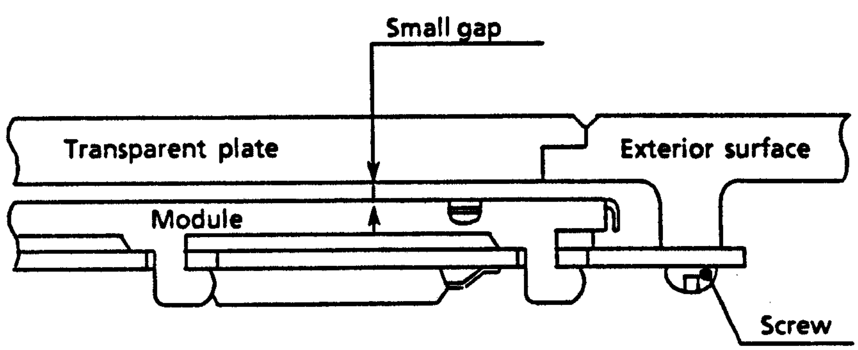
Handling

- Avoid static electricity as this can damage the CMOS LSI.
- The LCD panel is made of plate glass; do not hit or press aginst it.
- Do not remove the panel or frame from the module.
- The polarizer on the display is very fragile; handle it very carefully.

Mounting and Design

- Mount the module in the specified installation sections and holes.
- To protect the module from external pressure, put a plate of transparent material such as acrylic or glass over the display surface, frame, and polarizer. Leave a small gap between the transparent plate and the module.

☆Example



- Design the system so that no input signal is given unless the power-supply voltage is applied.
- Keep the module dry. Condensation can damage the transparent electrodes .

Storage

- Store the module in a dark place where the temperature is 25°C ±10°C and the humidity below 65% RH.
- Do not store the module near organic solvents or corrosive gases.
- Do not crush, shake, or jolt the module or its components.

Cleaning

- Do not wipe the polarizer with a dry cloth, as it may scratch the surface.
- Wipe the module gently with a soft cloth soaked with a petroleum benzine.
- Do not use ketonic solvents (ketone and acetone) or aromatic solvents (toluene and xylene), as they may damage the polarizer.

Index