SII

Seiko Instruments

LIQUID CRYSTAL DISPLAY GRAPHIC MODULES

APPLICATION NOTES

Introduction

Seiko Instruments is a worldwide leader in advanced LCD technology. We have been manufacturing LCDs since 1973, and we were the first to offer supertwist technology on all of our catalog products. We are committed to incorporate our latest technical developments into our standard products to keep our customers on the leading edge of LCD performance.

Here are some examples of recent LCD technology developments that we have incorporated into the graphic LCD modules in this catalog:

- Built-in controller with graphics & text overlay capability
- Razor sharp black & white images with film supertwist
- Bright CFL edgelight for high contrast
- Wide operating temperature from - 20°C to + 70°C
- 0.3 mm dot pitch for high resolution in small packages
- LED edgelighting for industry's thinnest profile (8.9mm)
- Small size & low power consumption for portable applications

Typical Applications Include:

- Portable hand held products
- Instrumentation & test equipment
- Medical
- Industrial & process control
- Office automation
- Point of sale terminals
- Telecom

Our LCD products incorporate the latest technical features to keep your company on top in today's competitive market. For example, our built-in controller was carefully selected to offer you state-of-the-art information display capabilities:

- Eight bit parallel interface for fast updates of information
- Built-in character generator
- Improved resolution & custom fonts with external CG RAM
- Overlayed graphics & text planes
- Vertical scrolling, horizontal scrolling, & paging
- Underline, block & blink cursor
- Independent plane blinking

We are ready to provide the latest in technology and Seiko renowned quality for your LCD application!

Opto/Electrical Characteristics

Absolute Maximum Ratings (For all STN & FSTN Graphic Modules)

Item	Symbol	Min.	Max.	Unit
Power supply voltage	V_{DD}	-0.3	+7.0	V
	V_{LC}	V_{DD}-30.0	V_{DD}+0.3	V
	V_O	V_{DD}-30.0	V_{DD}+0.3	V
Input voltage	V_{IN}	0	V_{DD}+0.3	V
Operating temperature	T_{opr}	0	+50	°C
Storage temperature	T_{stg}	-20	+60	°C

Absolute Maximum Ratings (For WTSTN Graphic Modules)

Item	Symbol	Min.	Max.	Unit
Power supply voltage	V_{DD}	-0.3	+7.0	V
	V_{LC}	V_{DD}-19.0	V_{DD}+0.3	V
	V_O	-0.3	V_{DD}+0.3	V
Input voltage	V_{IN}	0	V_{DD}+0.3	V
Operating temperature	T_{opr}	-20	+70	°C
Storage temperature	T_{stg}	-30	+80	°C

Optical Characteristics (For all STN, FSTN & WTSTN Graphic Modules) T_a = 25°C ■ Frame Frequency = 70Hz

Item	Unit	F1016	G1213	G1216	G121C	G191C	G191D	G2436	G2446	G242C	G321D	G321E	G324E	G648D	G649D
Contrast (typ.)	—	8	6	6	6	6	6	6	6	6	6	8	6	5	10
Viewing angle (min.)	deg.	60	60	60	50	40	60	50	70	50	55	70	55	55	55
Response time (rise)	ms	160	80	40	150	180	75	180	250	250	250	230	250	130	250
Response time (fall)	ms	130	100	100	110	150	125	250	180	180	180	150	180	250	150

Product Selection Guide (H=Horizontal, V=Vertical, T=Thickness)

Reflective Modules

Part Number	Dot Format (H x V)	LCD Fluid Type	Module Size (H x V x T,mm)	Viewing Area (H x V,mm)	Dot Size (H x V,mm)	Dot Pitch (H x V,mm)	Duty Cycle, Bias
F10160A	100 x 64	STN	140 x 110 x 14.3	100 x 68	0.85 x 0.85	0.90 x 0.90	1/32, 1/6
G121300N000	128 x 32	WTSTN	75 x 42 x 6.8	60 x 21	0.40 x 0.48	0.43 x 0.51	1/64, 1/9
G121600N000	128 x 64	WTSTN	75 x 53 x 6.8	60 x 33	0.40 x 0.40	0.43 x 0.43	1/64, 1/9
G121C00P000	128 x 128	WTSTN	86 x 95 x 7.0	67 x 67	0.46 x 0.46	0.49 x 0.49	1/128, 1/10
G121C00P00C	128 x 128	WTSTN	86 x 95 x 7.0	67 x 67	0.46 x 0.46	0.49 x 0.49	1/128, 1/10
G191C00R0A0	192 x 128	FSTN	98 x 86 x 13.4	78 x 54	0.33 x 0.33	0.37 x 0.37	1/128, 1/12
G191D00P000	192 x 192	WTSTN	86 x 95 x 7.0	67 x 67	0.30 x 0.30	0.33 x 0.33	1/192, 1/12
G243600J000	240 x 64	STN	180 x 75 x 11.3	134 x 41	0.49 x 0.49	0.53 x 0.53	1/64, 1/9
G648D00R000	640 x 200	FSTN	270 x 150 x 12.0	239 x 104	0.32 x 0.46	0.35 x 0.49	1/200, 1/15

EL/LED Backlight Modules

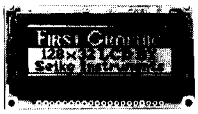
Part Number	Dot Format (H x V)	LCD Fluid Type	Module Size (H x V x T,mm)	Viewing Area (H x V,mm)	Dot Size (H x V,mm)	Dot Pitch (H x V,mm)	Duty Cycle, Bias
G1213B1N000** (LED)	128 x 32	WTSTN	75 x 42 x 8.9	60 x 21	0.40 x 0.48	0.43 x 0.51	1/64, 1/9
G1216B1N000** (LED)	128 x 64	WTSTN	75 x 53 x 8.9	60 x 33	0.40 x 0.40	0.43 x 0.43	1/64, 1/9
G121CB1P000** (LED)	128 x 128	WTSTN	86 x 95 x 9.0	67 x 67	0.46 x 0.46	0.49 x 0.49	1/128, 1/10
G121CB1P00C** (LED)	128 x 128	WTSTN	86 x 95 x 9.0	67 x 67	0.46 x 0.46	0.49 x 0.49	1/128, 1/10
G191C21R0A0** (EL)	192 x 128	FSTN	98 x 86 x 13.4	78 x 54	0.33 x 0.33	0.37 x 0.37	1/128, 1/12
G191DB1P000** (LED)	192 x 192	WTSTN	86 x 95 x 9.0	67 x 67	0.30 x 0.30	0.33 x 0.33	1/192, 1/12
G243621A000** (EL)	240 x 64	STN	180 x 75 x 11.3	134 x 41	0.49 x 0.49	0.53 x 0.53	1/64, 1/9
G648D21B000** (EL)	640 x 200	STN	270 x 150 x 12.0	239 x 104	0.32 x 0.46	0.35 x 0.49	1/200, 1/15

CFL Blacklight Modules

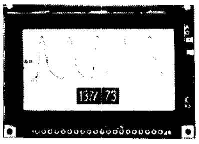
Part Number	Dot Format (H x V)	LCD Fluid Type	Module Size (H x V x T,mm)	Viewing Area (H x V,mm)	Dot Size (H x V,mm)	Dot Pitch (H x V,mm)	Duty Cycle, Bias
G2446X1R1AC**	240 x 64	FSTN	191 x 79 x 15.1	134 x 41	0.49 x 0.49	0.53 x 0.53	1/64, 1/9
G2446X5R1A0	240 x 64	FSTN	191 x 79 x 15.1	134 x 41	0.49 x 0.49	0.53 x 0.53	1/64, 1/9
G2446X5R1AC	240 x 64	FSTN	191 x 79 x 15.1	134 x 41	0.49 x 0.49	0.53 x 0.53	1/64, 1/9
G2446X5E1AC	240 x 64	WTSTN	191 x 79 x 15.1	134 x 41	0.49 x 0.49	0.53 x 0.53	1/64, 1/9
G242CX1R1AC**	240 x 128	FSTN	180 x 110 x 15.1	134 x 76	0.47 x 0.47	0.51 x 0.51	1/128, 1/12
G242CX5R1A0	240 x 128	FSTN	180 x 110 x 15.1	134 x 76	0.47 x 0.47	0.51 x 0.51	1/128, 1/12
G242CX5R1AC	240 x 128	FSTN	180 x 110 x 15.1	134 x 76	0.47 x 0.47	0.51 x 0.51	1/128, 1/12
G242CX5E1AC	240 x 128	WTSTN	180 x 110 x 15.1	134 x 76	0.47 x 0.47	0.51 x 0.51	1/128, 1/12
G321DX1R1AC**	320 x 200	FSTN	166 x 134 x 15.1	128 x 110	0.34 x 0.48	0.38 x 0.52	1/200, 1/15
G321DX5R1A0	320 x 200	FSTN	166 x 134 x 15.1	128 x 110	0.34 x 0.48	0.38 x 0.52	1/200, 1/15
G321DX5R1AC	320 x 200	FSTN	166 x 134 x 15.1	128 x 110	0.34 x 0.48	0.38 x 0.52	1/200, 1/15
G321EX1R000**	320 x 240	FSTN	150 x 96 x 14.0	103 x 80	0.27 x 0.27	0.30 x 0.30	1/240, 1/13
G321EX5R000	320 x 240	FSTN	150 x 96 x 14.0	103 x 80	0.27 x 0.27	0.30 x 0.30	1/240, 1/13
G324EX5R1A0	320 x 240	FSTN	166 x 134 x 15.1	128 x 110	0.32 x 0.39	0.36 x 0.43	1/240, 1/13
G324EX5R1AC	320 x 240	FSTN	166 x 134 x 15.1	128 x 110	0.32 x 0.39	0.36 x 0.43	1/240, 1/13
G694DX1R010**	640 x 200	FSTN	260 x 122 x 15.7	216 x 83	0.30 x 0.36	0.33 x 0.39	1/200, 1/15
G649DX5R010	640 x 200	FSTN	260 x 122 x 15.7	216 x 83	0.30 x 0.36	0.33 x 0.39	1/200, 1/15

(Unit: mm) *A built-in DC-DC converter eliminates the need for Vcc ** These models are transflective positive viewing mode for direct sunlight applications. All other EL and CFL versions are transmissive negative.
WTSTN = Wide temperature super twisted nematic fluid. STN = Super twisted nematic fluid. FSTN = Film super twisted nematic fluid.

G1213

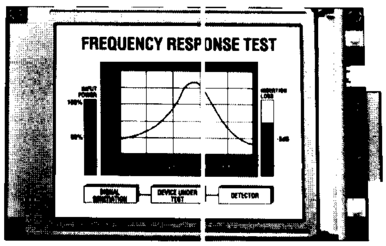


G1216



G191C

G321E



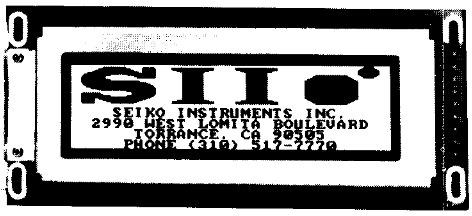
NOTE: Modules shown are approximately one-third of actual size, scale is 1mm = 3mm.

Power Requirements							
V_{DD} (V_{DD} x mA)	V_{LC} (V_{LC} x mA)	Backlight† (V_{DD} x mA)	Weight (g)	Suitable Controller	Controller Board	Inverter	Part Number
+5v @ 3.5	-5v @ 3.0	-	150	Built-in Data RAM	(Built-in RAM)	-	F10160A
+5v @ 2.0	-8v @ 1.5	-	40	Built-in Data RAM	(Built-in RAM)	-	G121300N000
+5v @ 2.0	-8v @ 1.5	-	40	Built-in Data RAM	(Built-in RAM)	-	G121600N000
+5v @ 4.3	-15v @ 4.1	-	75	MSM6255GS	LCDC-1330-32A	-	G121C00P000
+5v @ 6.5	-15v @ 4.1	-	75	Built-In SED1335	(Built-in)	-	G121C00P00C
+5v @ 3.1	-12.4v @ 2.9	-	100	MSM6255GS	LCDC-1330-32A	-	G191C00R0A0
+5v @ 6.5	-18v @ 6.0	-	75	MSM6255GS	LCDC-1330-32A	-	G191D00P000
+5v @ 8.0	*	-	140	MSM6255GS	LCDC-1330-32A	-	G243600J000
+5v @ 11.0	-24v @ 9.0	-	450	MSM6255GS	LCDC-1330-32A	-	G648D00R000
+5v @ 2.0	-8v @ 1.5	+4.1v @ 50	45	Built-in Data RAM	(Built-in RAM)	-	G1213B1N000 (LED)
+5v @ 2.0	-8v @ 1.5	+4.1v @ 100	45	Built-in Data RAM	(Built-in RAM)	-	G1216B1N000 (LED)
+5v @ 6.5	-18v @ 6.0	+4.1v @ 120	100	MSM625565	LCDC-1330-32A	-	G121CB1P000 (LED)
+5v @ 6.5	-18v @ 6.0	+4.1v @ 120	100	Built-in SED1335	(Built-in)	-	G121CB1P00C (LED)
+5v @ 3.1	-12.4v @ 2.9	+5v @ 120	100	MSM6255GS	LCDC-1330-32A	SKI-050-05H	G191C21R0A0** (EL)
+5v @ 6.5	-18v @ 6.0	+4.1v @ 120	100	MSM6255GS	LCDC-1330-32A	-	G191DB1P000 (LED)
+5v @ 8.0	*	+5v @ 75	140	MSM6255GS	LCDC-1330-32A	NEL-D32-49	G243621A000**(EL)
+5v @ 11.0	-24v @ 9.0	+12v @ 115	450	MSM6255GS	LCDC-1330-32A	NEL-D5-006	G648D21B000**(EL)
+5v @ 12.0	*	+5v @ 250	200	Built-in SED1330	(Built-in)	ILP-325-INV	G2446X1R1AC**
+5v @ 10.0	*	+5v @ 250	200	MSM6255GS	LCDC-1330-32A	ILP-325-INV	G2446X5R1A0
+5v @ 12.0	*	+5v @ 250	200	Built-in SED1330	(Built-in)	ILP-325-INV	G2446X5R1AC
+5v @ 12.0	*	+5v @ 250	200	Built-in SED1330	(Built-in)	ILP-325-INV	G2446X5E1AC
+5v @ 40.0	*	+5v @ 300	280	Built-in SED1330	(Built-in)	ILP-324-INV	G242CX1R1AC**
+5v @ 30.0	*	+5v @ 300	280	MSM6255GS	LCDC-1330-32A	ILP-324-INV	G242CX5R1A0
+5v @ 40.0	*	+5v @ 300	280	Built-in SED1330	(Built-in)	ILP-324-INV	G242CX5R1AC
+5v @ 40.0	*	+5v @ 300	200	Built-in SED1330	(Built-in)	ILP-324-INV	G242CX5E1AC
+5v @ 23.0	-24v @ 6	+5v @ 300	300	Built-in SED1330	(Built-in)	ILP-323-INV	G321DX1R1AC**
+5v @ 7.0	-24v @ 6	+5v @ 300	300	MSM6255GS	LCDC-1330-32A	ILP-323-INV	G321DX5R1A0
+5v @ 23.0	-24v @ 6	+5v @ 300	300	Built-in SED1330	(Built-in)	ILP-323-INV	G321DX5R1AC
+5v @ 6.4	-22v @ 5.7	+24v @ 80	195	MSM6255GS	LCDC-1330-32A	12902A	G321EX1R000**
+5v @ 6.4	-22v @ 5.7	+24v @ 80	195	MSM6255GS	LCDC-1330-32A	12902A	G321EX5R000
+5v @ 7.0	-24v @ 6	+5v @ 300	300	MSM6255GS	LCDC-1330-32A	ILP-323-INV	G324EX5R1A0
+5v @ 23.0	-24v @ 6	+5v @ 300	300	Built-in SED1330	(Built-in)	ILP-323-INV	G324EX5R1AC
+5v @ 11.0	-24v @ 9	+12v @ 350	420	MSM6255GS	LCDC-1330-32A	HIU-168	G649DX1R010**
+5v @ 11.0	-24v @ 9	+12v @ 350	420	MSM6255GS	LCDC-1330-32A	HIU-168	G649DX5R010

†Power consumption is typical and includes the backlight. For the EL and CFL versions it includes inverter losses.

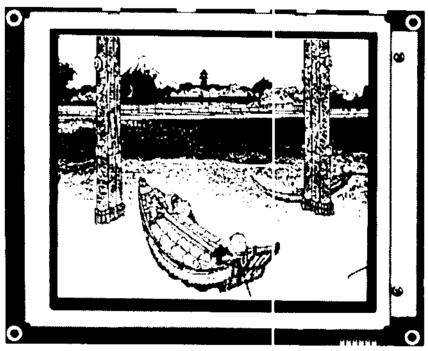
(Unit:mm)

G2446



G242C

G321D

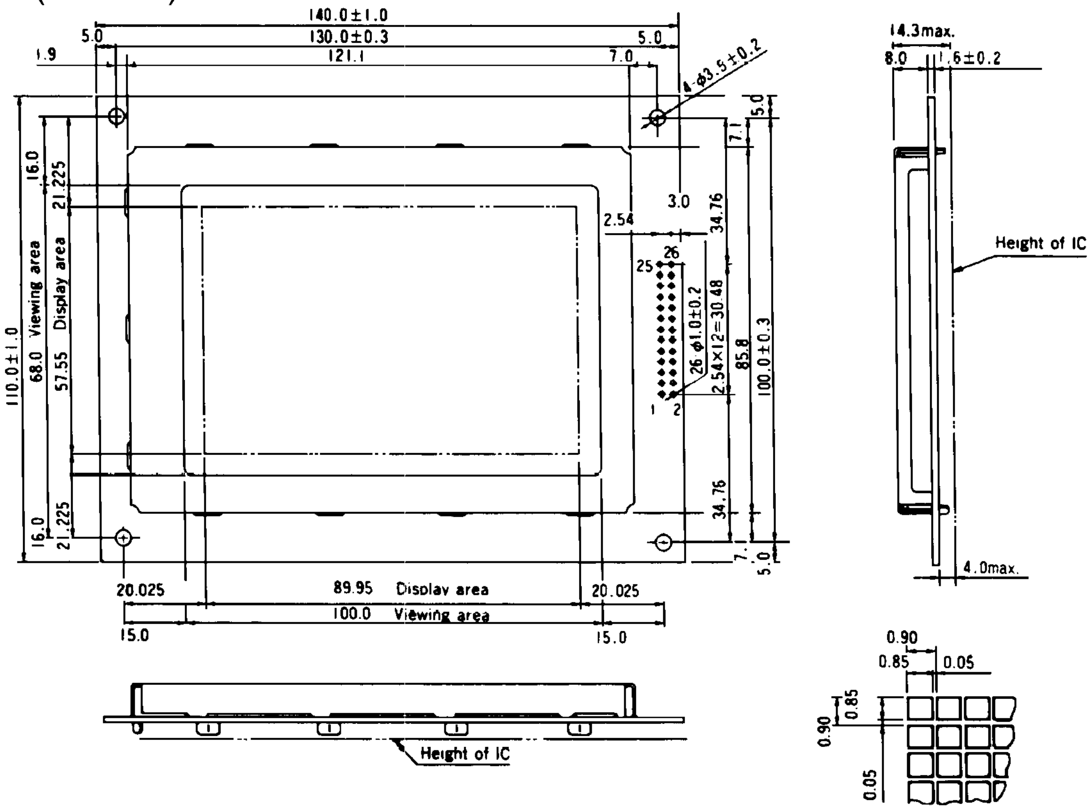


Since our policy is one of continuous improvements, we reserve the right to change the specifications of the products in the catalog without notice.

Module Outline Drawings

■ F1016 Unit: mm General tolerance: ± 0.5 mm

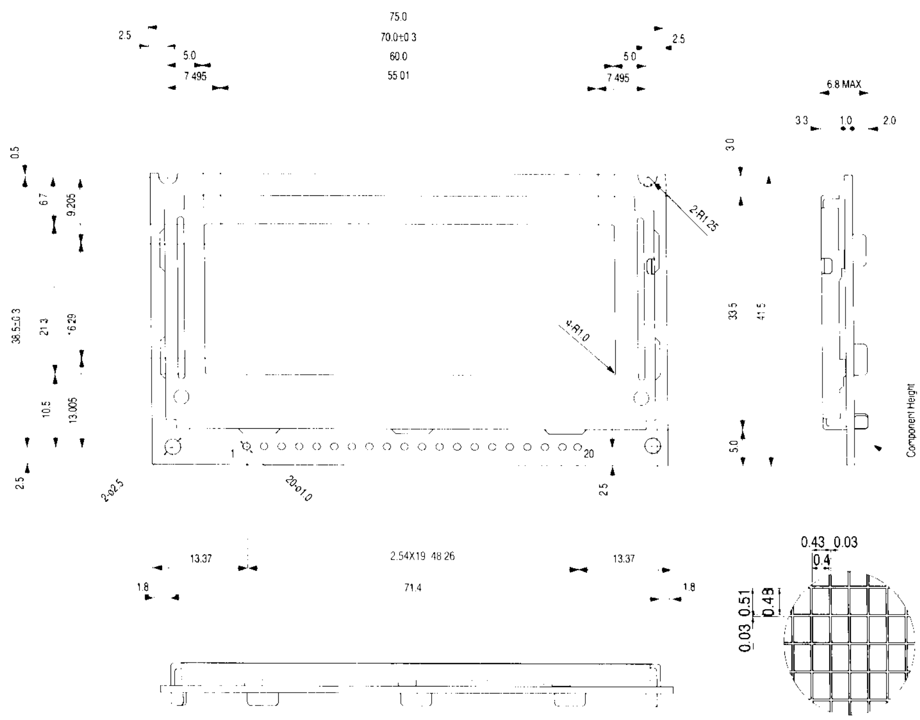
(100x64)



CN1 F1016			
No.	Symbol	No.	Symbol
1	DB_7	14	CS11
2	DB_6	15	CS21
3	DB_5	16	CS12
4	DB_4	17	CS22
5	DB_3	18	CS13
6	DB_2	19	CS23
7	DB_1	20	CS14
8	DB_0	21	CS24
9	E	22	NC
10	R/W	23	NC
11	D/I	24	V_{LC}
12	NC	25	V_{DD}
13	RST	26	V_{SS}

■ G1213 Unit: mm General tolerance: ± 0.5 mm

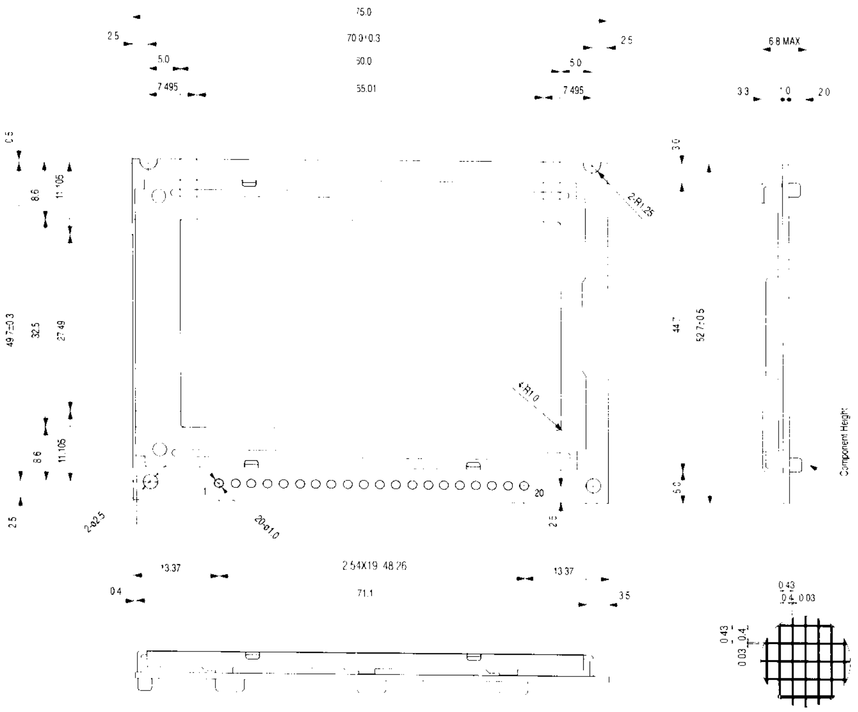
(128x32)



CN1 G1213			
No.	Symbol	No.	Symbol
1	V_{DD}	11	DB_7
2	V_{SS}	12	CS1
3	V_{LC}	13	RST
4	DB	14	R/W
5	DB	15	D/I
6	DB	16	E
7	DB	17	F_{GND}
8	DB	18	NC
9	DB	19*	LED (+)
10	DB	20*	LED (-)

* No connection to pins 19 & 20 for reflective part G121300N000).

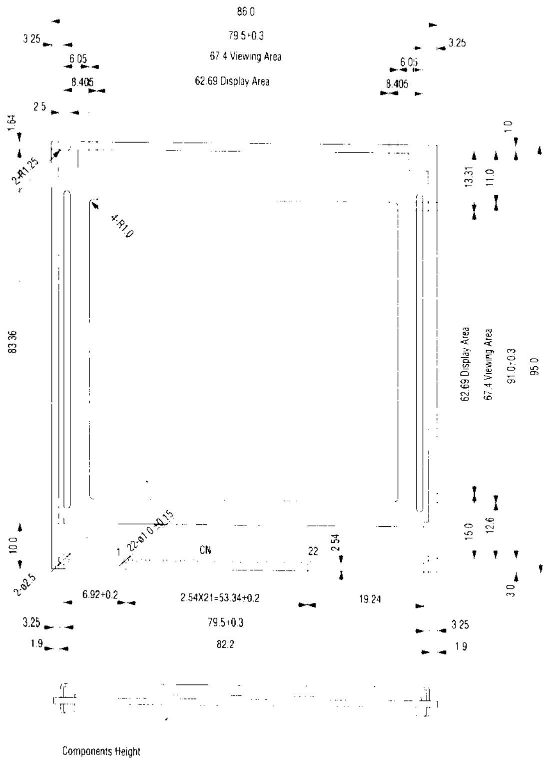
G1216 Unit: mm General tolerance: ± 0.5 mm (128x64)

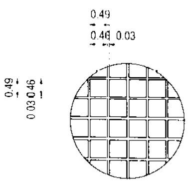


CN1 G1216			
No.	Symbol	No.	Symbol
1	V_{DD}	11	DB_7
2	V_{SS}	12	CS1
3	V_{LC}	13	CS2
4	DB_0	14	RST
5	DB_1	15	R/W
6	DB_2	16	D/I
7	DB_3	17	E
8	DB_4	18	F_{GND}
9	DB_5	19*	LED (+)
10	DB_6	20*	LED (-)

* No connection to pins 19 & 20 for reflective part (G121600N000).

G121C Unit: mm General tolerance: ± 0.5 mm (128x128)





CN1 With Controller G121C			
No.	Symbol	No.	Symbol
1	/RES	12	D_4
2	/RD	13	D_5
3	/WR	14	D_6
4	SEL2	15	D_7
5	SEL1	16	V_{DD}
6	/CS	17	V_{SS}
7	A0	18	V_U
8	D_0	19	V_{LC}
9	D_1	20	INH
10	D_2	21*	LED (+)
11	D_3	22*	LED (-)

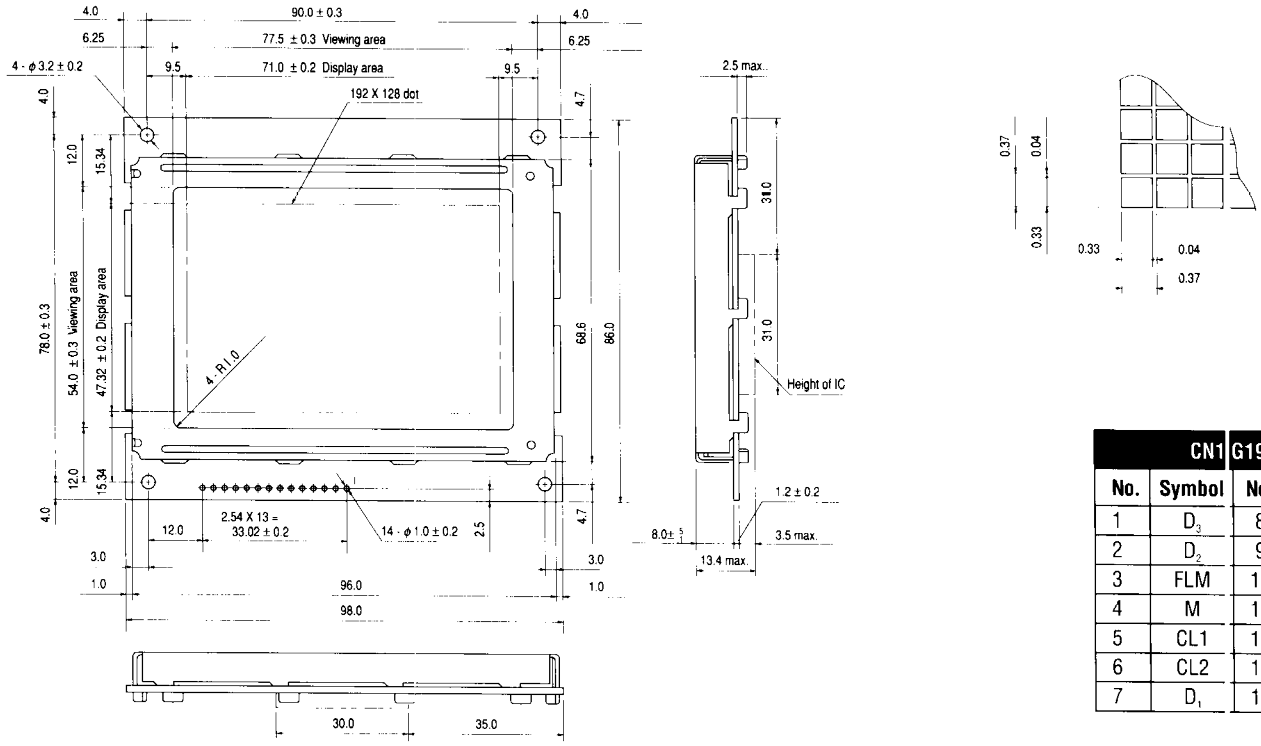
* No connection to pins 21 & 22 for reflective part (G121C00P00C).

CN1 Without Controller G121C			
No.	Symbol	No.	Symbol
1	V_{DD}	10	D_1
2	F_{GND}	11	D_2
3	CL2	12	D_3
4	INH	13	V_{LC}
5	FLM	14	V_0
6	CL1	15	V_{SS}
7	V_{SS}	16*	LED (+)
8	M	17*	LED (-)
9	D_0		

* No connection to pins 16 & 17 for reflective part (G121C00P000).

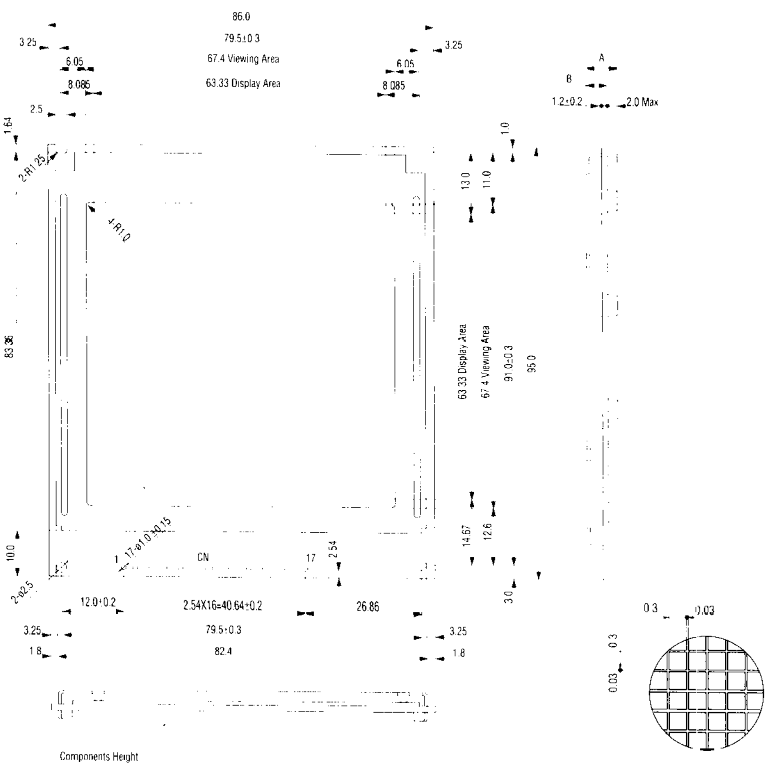
Module Outline Drawings (Continued)

■ G191C Unit: mm General tolerance: ± 0.5 mm
(192x128)



CN1	G191C		
No.	**Symbol**	**No.**	**Symbol**
1	D_3	8	D_0
2	D_2	9	V_{DD}
3	FLM	10	V_{SS}
4	M	11	V_{LC}
5	CL1	12	F_{GND}
6	CL2	13	V_{EL}
7	D_1	14	V_{ELG}

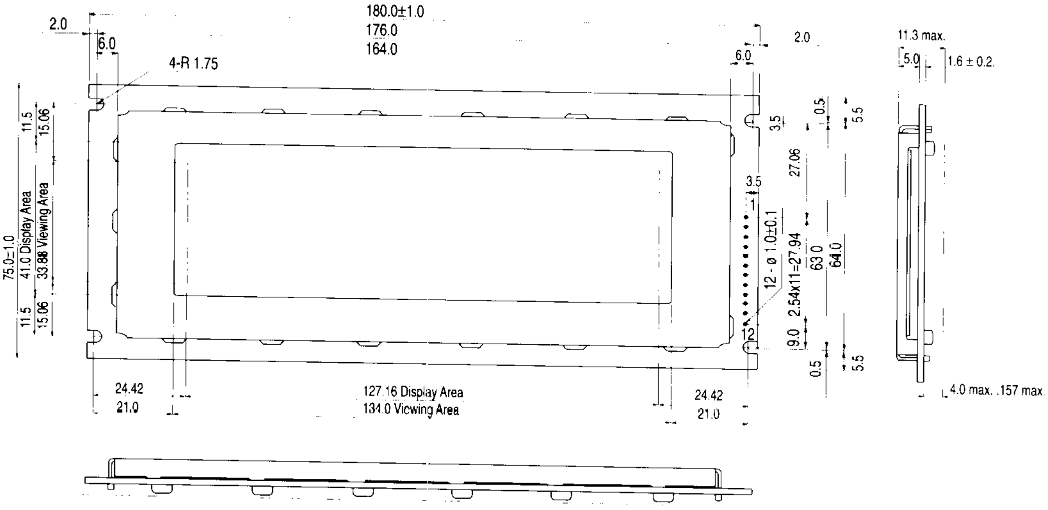
■ G191D Unit: mm General tolerance: ± 0.5 mm
(192x192)

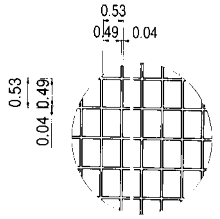


CN1	G191D		
No.	**Symbol**	**No.**	**Symbol**
1	V_{DD}	10	D_1
2	F_{GND}	11	D_2
3	CL2	12	D_3
4	INH	13	V_{LC}
5	FLM	14	V_0
6	CL1	15	V_{SS}
7	V_{SS}	16*	LED (+)
8	M	17*	LED (-)
9	D_0		

* No connection to pins 16 & 17 for reflective part (G191D00P000).

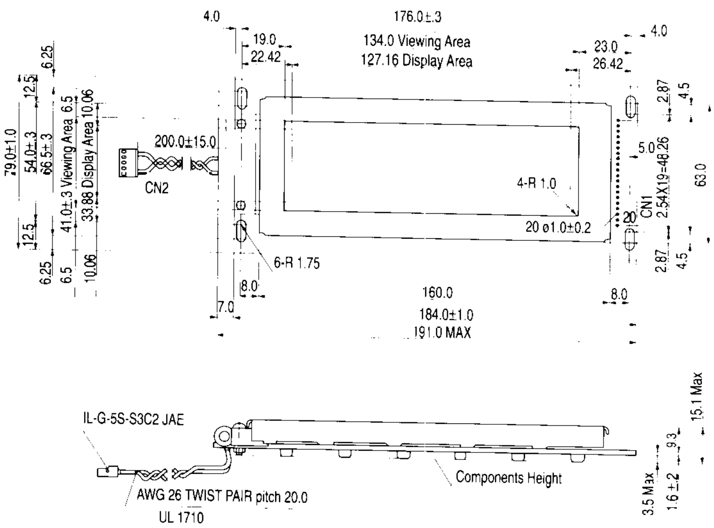
■ G2436 Unit: mm General tolerance: ± 0.5 mm
(240x64)

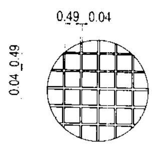




CN1 G2436			
No.	Symbol	No.	Symbol
1	D3	7	CL1
2	D2	8	CL2
3	D1	9	V_{DD}
4	D0	10	V_{SS}
5	FLM	11	V_0
6	M	12	V_{LC}

■ G2446 Unit: mm General tolerance: ± 0.5 mm
(240x64)





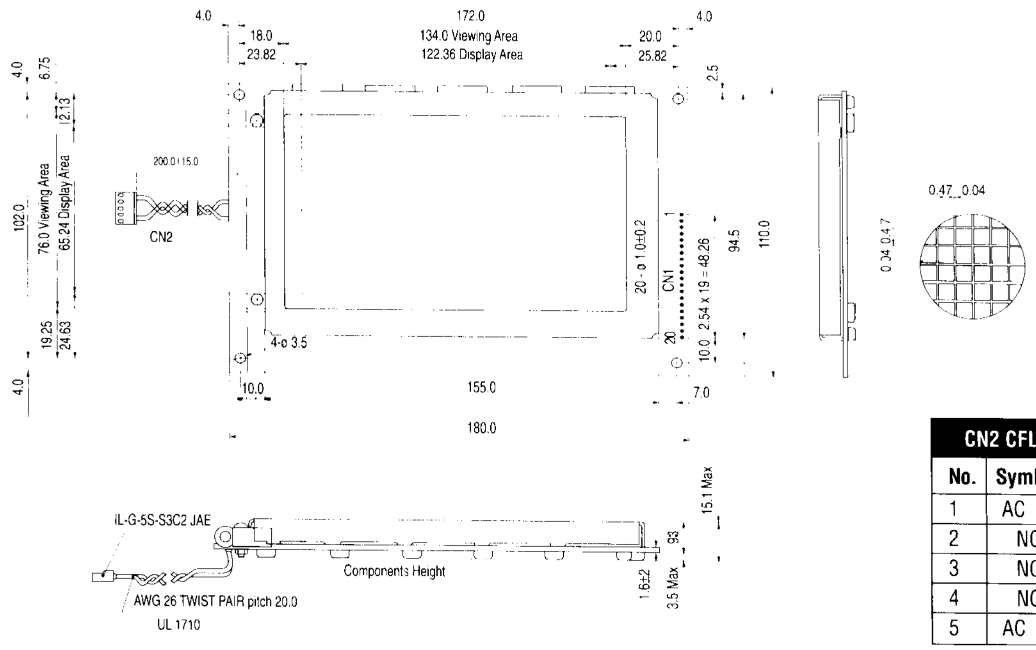
CN1 With Controller G2446			
No.	Symbol	No.	Symbol
1	/RES	11	D_3
2	/RD	12	D_4
3	/WR	13	D_5
4	SEL2	14	D_6
5	SEL1	15	D_7
6	/CS	16	V_{DD}
7	A0	17	V_{SS}
8	D_0	18	V_0
9	D_1	19	V_{LC}
10	D_2	20	F_{GND}

CN2 CFL	
No.	Symbol
1	AC IN
2	NC
3	NC
4	NC
5	AC IN

CN1 Without Controller G2446			
No.	Symbol	No.	Symbol
1	NC	11	D_3
2	NC	12	FLM
3	NC	13	M
4	NC	14	CL2
5	NC	15	CL1
6	NC	16	V_{DD}
7	INHX	17	V_{SS}
8	D_0	18	V_0
9	D_1	19	V_{LC}
10	D_2	20	F_{GND}

Module Outline Drawings (Continued)

■ G242C Unit: mm General tolerance: ± 0.5 mm
(240x128)

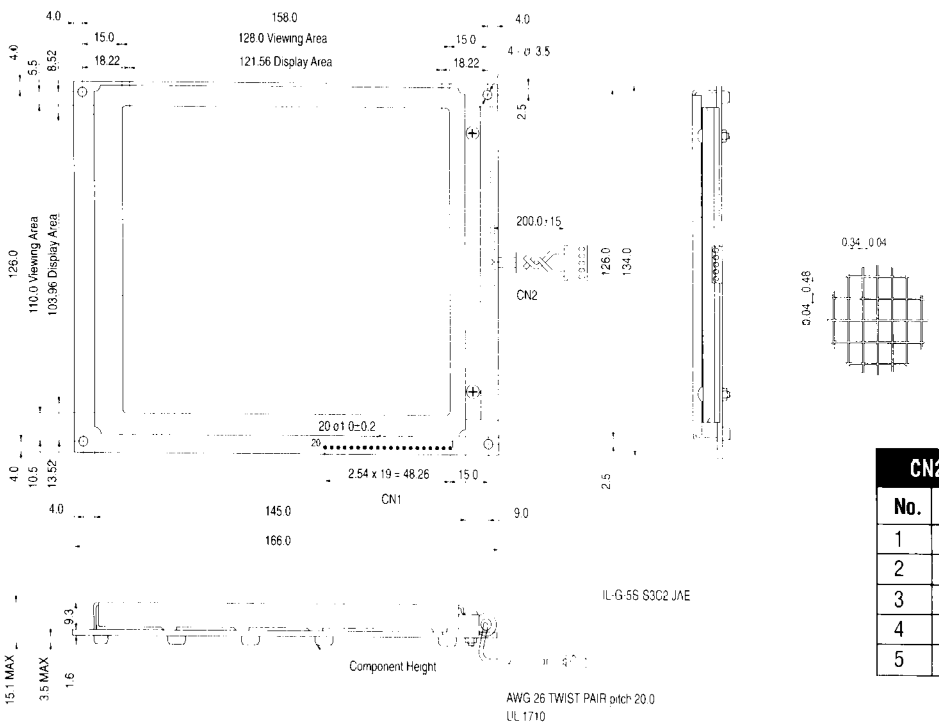


CN1 With Controller G242C			
No.	Symbol	No.	Symbol
1	/RES	11	D_3
2	/RD	12	D_4
3	/WR	13	D_5
4	SEL2	14	D_6
5	SEL1	15	D_7
6	/CS	16	V_{DD}
7	A0	17	V_{SS}
8	D_0	18	V_0
9	D_1	19	V_{LC}
10	D_2	20	F_{GND}

CN1 Without Controller G242C			
No.	Symbol	No.	Symbol
1	NC	11	D_3
2	NC	12	FLM
3	NC	13	M
4	NC	14	CL2
5	NC	15	CL1
6	NC	16	V_{DD}
7	INHX	17	V_{SS}
8	D_0	18	V_0
9	D_1	19	V_{LC}
10	D_2	20	F_{GND}

CN2 CFL	
No.	Symbol
1	AC IN
2	NC
3	NC
4	NC
5	AC IN

■ G321D Unit: mm General tolerance: ± 0.5 mm
(320x200)

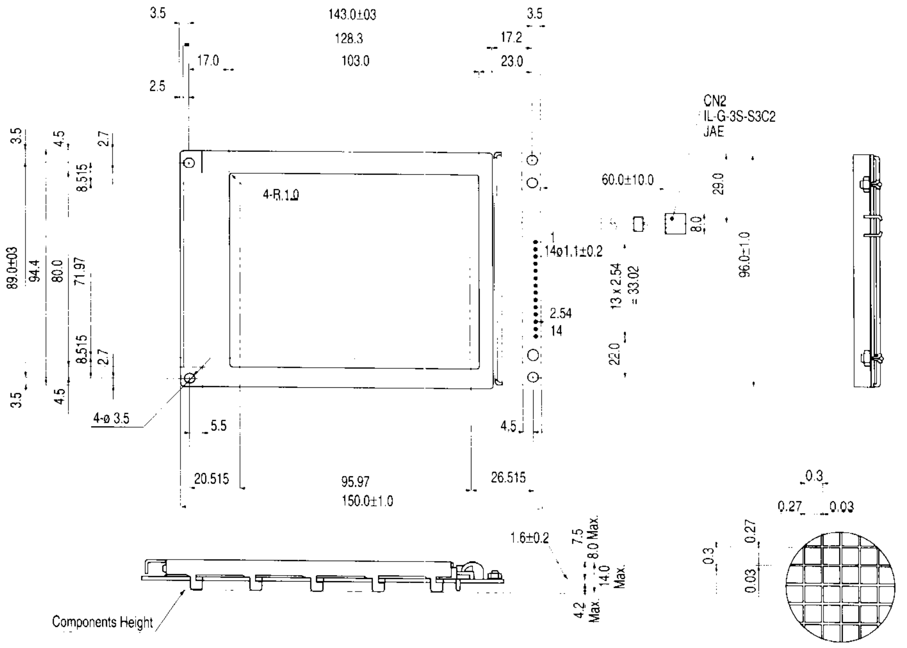


CN1 With Controller G321D			
No.	Symbol	No.	Symbol
1	/RES	11	D_3
2	/RD	12	D_4
3	/WR	13	D_5
4	SEL2	14	D_6
5	SEL1	15	D_7
6	/CS	16	V_{DD}
7	A0	17	V_{SS}
8	D_0	18	V_0
9	D_1	19	V_{LC}
10	D_2	20	F_{GND}

CN1 Without Controller G321D			
No.	Symbol	No.	Symbol
1	NC	11	D_3
2	NC	12	FLM
3	NC	13	M
4	NC	14	CL2
5	NC	15	CL1
6	NC	16	V_{DD}
7	INHX	17	V_{SS}
8	D_0	18	V_0
9	D_1	19	V_{LC}
10	D_2	20	F_{GND}

CN2 CFL	
No.	Symbol
1	AC IN
2	NC
3	NC
4	NC
5	AC IN

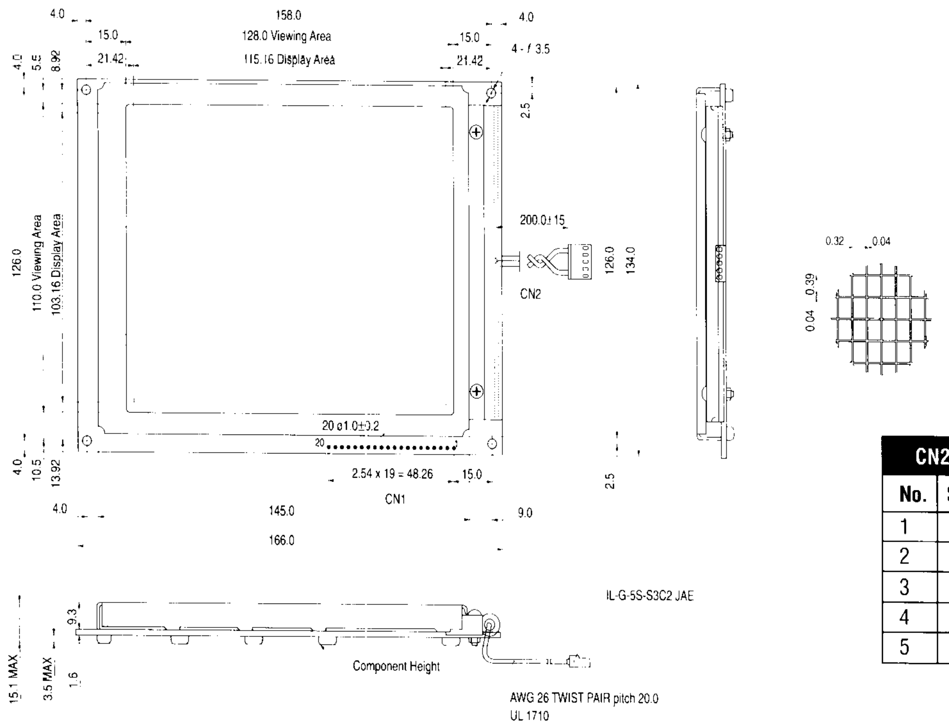
■ G321E Unit: mm General tolerance: ± 0.5 mm (320x240)



CN2 CFL	
No.	**Symbol**
1	AC IN
2	NC
3	AC IN

CN1 G321E			
No.	**Symbol**	**No.**	**Symbol**
1	FLM	14	D_2
2	M	15	D_3
3	CL1	16	V_{DD}
4	CL2	17	V_{SS}
5	INHX	18	V_{LC}
6	D_0	19	V_0
7	D_1	20	F_{GND}

■ G324E Unit: mm General tolerance: ± 0.5 mm (320x240)



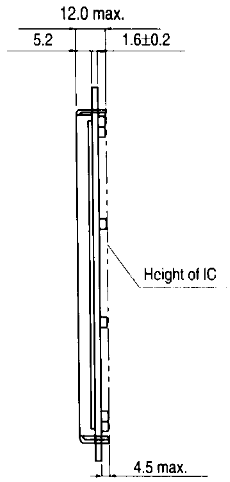
CN1 With Controller G324E			
No.	**Symbol**	**No.**	**Symbol**
1	/RES	11	D_3
2	/RD	12	D_4
3	/WR	13	D_5
4	NC	14	D_6
5	SEL1	15	D_7
6	/CS	16	V_{DD}
7	A0	17	V_{SS}
8	D_0	18	V_0
9	D_1	19	V_{LC}
10	D_2	20	F_{GND}

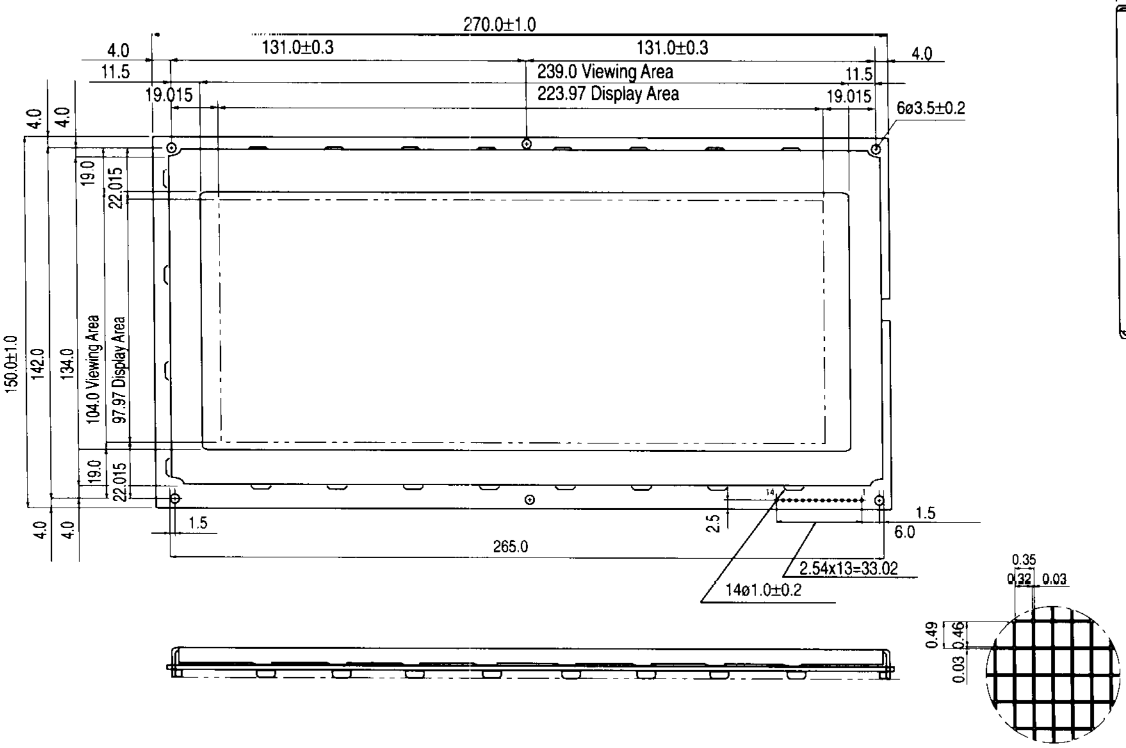
CN1 Without Controller G324E			
No.	**Symbol**	**No.**	**Symbol**
1	NC	11	D_3
2	NC	12	FLM
3	NC	13	M
4	NC	14	CL2
5	NC	15	CL1
6	NC	16	V_{DD}
7	INHX	17	V_{SS}
8	D_0	18	V_0
9	D_1	19	V_{LC}
10	D_2	20	F_{GND}

CN2 CFL	
No.	**Symbol**
1	AC IN
2	NC
3	NC
4	NC
5	AC IN

Module Outline Drawings (Continued)

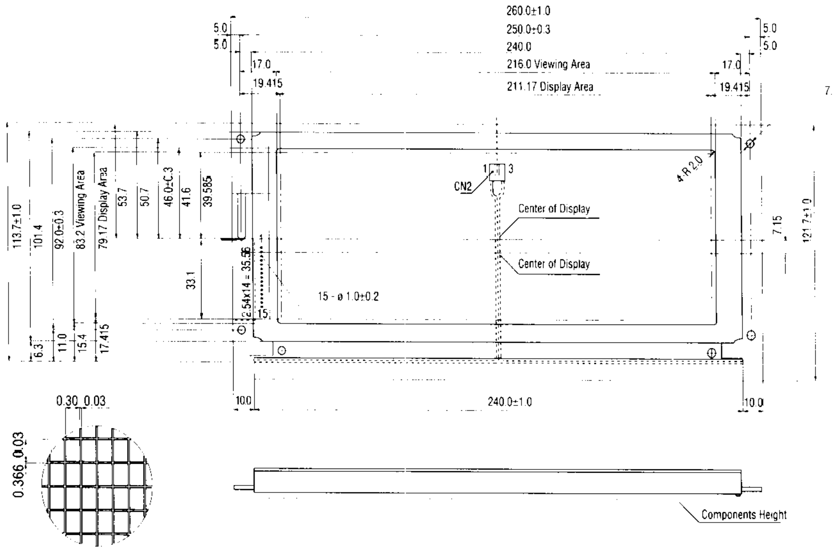
■ G648D Unit: mm General tolerance: ± 0.5 mm (640x200)

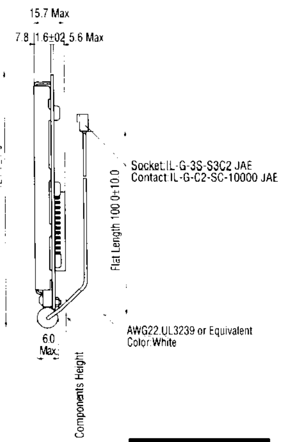




CN1 G648D			
No.	Symbol	No.	Symbol
1	D_3	8	D_0
2	D_2	9	V_{DD}
3	FLM	10	V_{SS}
4	M	11	V_{LC}
5	CL1	12	V_0
6	CL2	13	INHX
7	D_1	14	F_{GND}

■ G649D Unit: mm General tolerance: ± 0.5 mm (640x200)



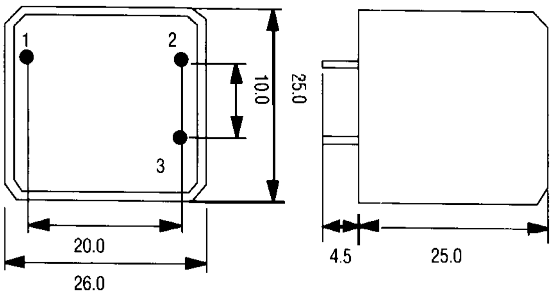


CN2 CFL	
No.	Symbol
1	AC IN
2	NC
3	AC IN

CN1 G649D			
No.	Symbol	No.	Symbol
1	V_{DD}	9	D_0
2	F_{GND}	10	D_1
3	CL2	11	D_2
4	INHX	12	D_3
5	FLM	13	V_{LC}
6	CL1	14	V_0
7	V_{SS}	15	V_{SS}
8	M		

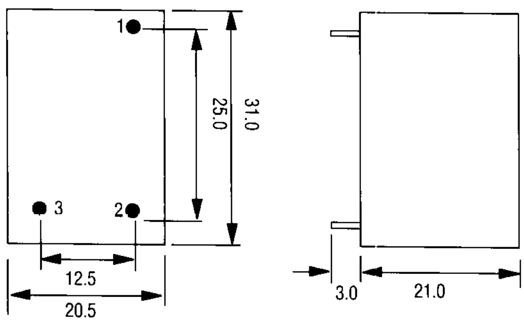
Inverter Outline Drawings

■ SKI-050-05H, G191C Unit: mm



Pin No.	Function
1	Input: 5V DC
2	Output
3	Common: GND

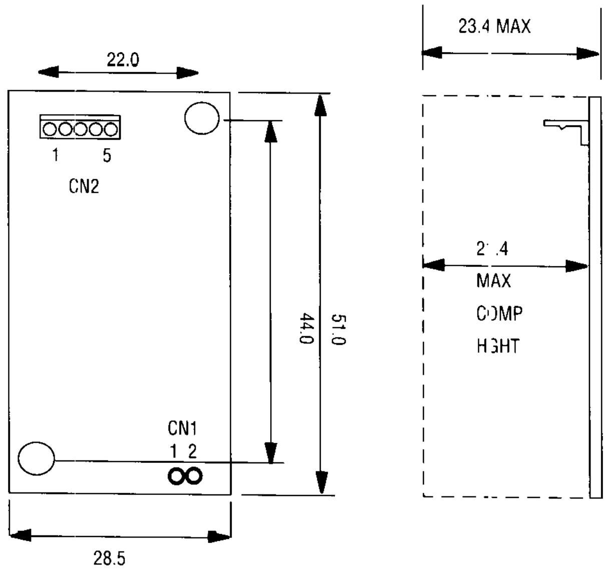
■ NEL-D32-49, G2436 Unit: mm



Pin No.	Function
1	Input: 5V DC
2	Common: GND
3	Output

■ ILP-32X-INV, G2446/G242C/G321D/G324E

Unit: mm



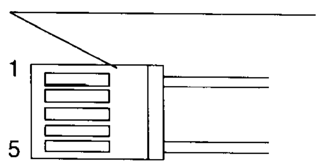
CN1 = INPUT

Pin No.	Function
1	Input: 5V DC
2	Ground

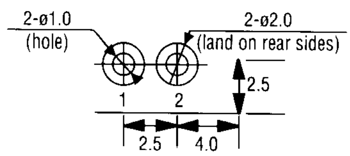
CN2 = OUTPUT

Pin No.	Function
1	AC output
2	no connection
3	no connection
4	no connection
5	AC output

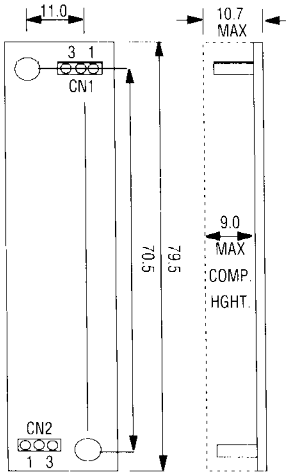
OUTPUT MATING CONNECTOR
JAE IL-G-5S-S3C2



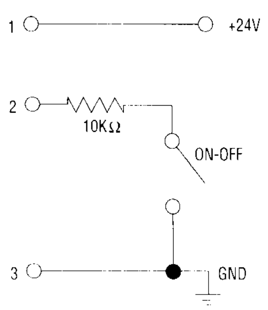
CN1 HOLE DETAIL



■ 12902A, G321E Unit: mm



CN1 CONNECTIONS



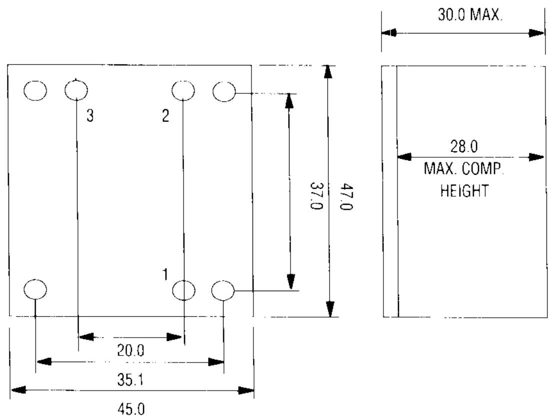
CN1 = INPUT
MATING CONNECTOR = AMP 175487-3

Pin No.	Function
1	Input: 24V DC
2	Switch: Gnd = ON, Open = OFF
3	Ground

CN2 = OUTPUT
MATING CONNECTOR = JAE IL-G-3P-S3L2

Pin No.	Function
1	AC output
2	no connection
3	AC output

■ NEL-D5-006, G648D Unit: mm

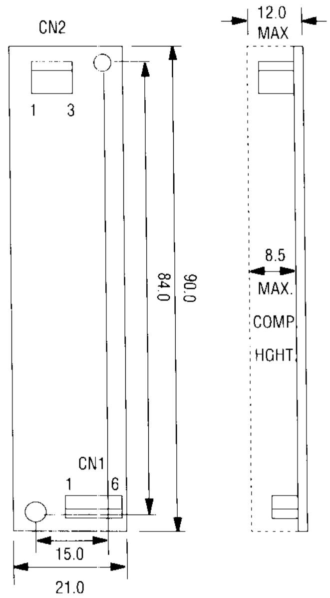


Pin No.	Function
1	Input: 12V DC
2	Common: GND
3	Output

■ HIU-168, G649D Unit: mm

CN2 = OUTPUT
MATING CONNECTOR = JAE IL-G-3P-S3L2-E

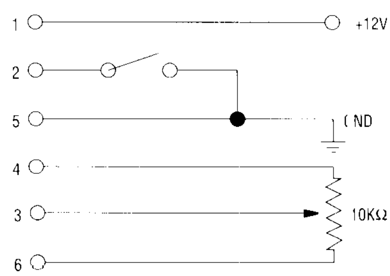
Pin No.	Function
1	AC output
2	no connection
3	AC output



CN1 = INPUT
MATING CONNECTOR = HIROSE DF 13-6P-1.25H

Pin No.	Function
1	Input: 12V DC
2	Switch: Gnd = OFF, Open = ON
3	10K ohm potentiometer (wiper)
4	10K ohm potentiometer (one end)
5	Ground
6	10K ohm potentiometer (one end)

CN1 CONNECTIONS



■ Basic Technology

Liquid crystal displays (LCDs) are a passive display technology. This means they do not emit light; instead, they use the ambient light in the environment. By manipulating this light, they display images using very little power. This has made LCDs the preferred technology whenever low power consumption and compact size are critical.

Liquid crystal (LC) is an organic substance that has both a liquid form and a crystal molecular structure. The rod-shaped molecules are normally in a parallel array, and an electric field can be used to control the molecules. Most LCDs today use a type of liquid crystal called twisted nematic (TN) (see Fig. 1).

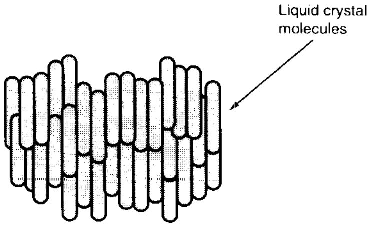


Figure 1
Structure of nematic liquid crystal

LCDs consist of two pieces of glass with electrodes printed on the inside. An alignment layer on each glass surface is used to twist the liquid crystal material in a helical or "twisted" pattern. Polarizers are used on the outside front and rear surfaces (see Figs. 2 & 3),

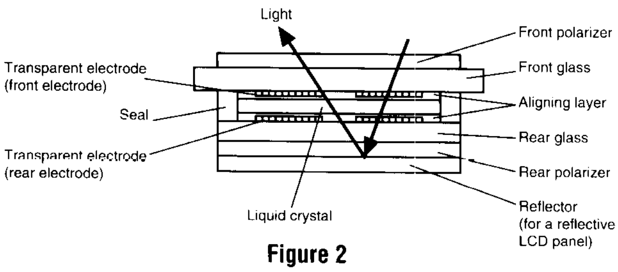


Figure 2
TN LCD panel

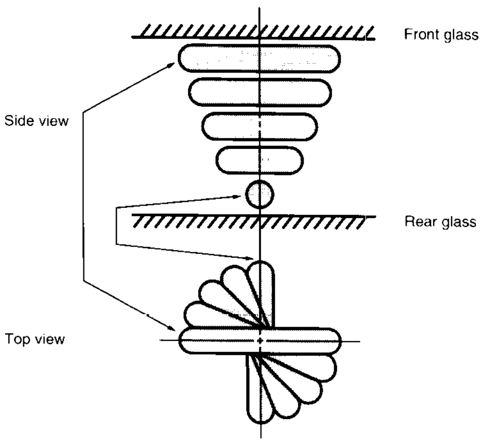


Figure 3
Orientation of nematic liquid crystal molecules (twist angle: 90°)

When the LCD is "off," no voltage is applied to the electrodes, and light passes through the LCD. When it is "on," voltage is applied and the LC molecules align themselves in the direction of the electric field. This causes the light to be out of phase with the polarizers and to be blocked, creating a dark area on the LCD. By selectively applying voltage to the electrodes, a variety of patterns can be achieved.

Many advances in TN LCDs have been produced. Super twisted nematic (STN) LC material offers a higher twist angle (≥ 200° vs. 90°) that provides higher contrast and a better viewing angle. However, one negative feature is the birefringence effect, which shifts the background color to yellow-green and the character color to blue. This background color can be changed to a gray by using a special filter.

The most recent advance has been the introduction of film super twisted nematic (FSTN) displays. This adds a retardation film to the STN display that compensates for the color added by the birefringence effect. This allows a black and white display to be produced. Because of the added filtering, FSTN displays look best when used with a backlight.

■ Backlighting

An LCD is basically a reflective part. It needs ambient light to reflect back to the eye. In uses where ambient light is low or non-existent, a light source must be placed behind the LCD. This is known as backlighting (see Fig. 4a). There are several technologies used:

■ **Electroluminescent** (EL):

EL backlights are very thin, light weight and provide a very even light. They are available in a variety of colors, with white being the most popular for use with LCDs. While their power consumption is fairly low, they require voltages of 80 to 100 VAC. This is supplied by an inverter that converts a 5, 12 or 24 VDC input to the AC output. ELs have a limited life of 2,000 to 3,000 hours to half brightness.

■ **Light Emitting Diode** (LED):

LED backlights offer a longer operating life — 50,000 hours minimum — and are brighter than ELs. They do consume more power than ELs. Being a solid state device, they operate directly off +5 VDC, so they do not require an inverter. However, a current limiting resistor is recommended for protection of the LEDs. LEDs are mounted in an array directly behind the display, which increases the thickness 2 to 5 mm. LEDs come in a variety of colors, with yellow-green being the most common.

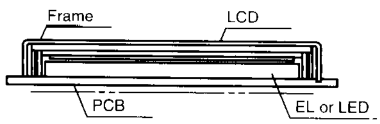
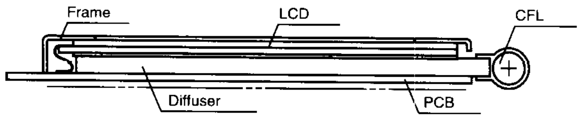


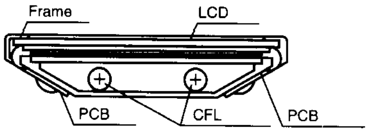
Figure 4a
EL and LED Backlight

■ Cold Cathode Fluorescent Lamp (CFL):

CFL backlight offers low power consumption and a very bright white light (see Fig. 4b). Two technologies are used: direct and edge lighting. In both types a cold cathode fluorescent tube is the light source. A diffuser distributes the light evenly across the viewing area. Edge lighting offers a thinner package and less power. CFLs require an inverter to supply the 270 to 300 VAC used by the CFL tube. They are used primarily in graphic LCDs and have a longer life – 10,000 to 15,000 hours – than ELs do.



Edge lighting type



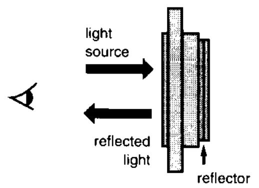
Backlight type

Figure 4b

■ Viewing Modes

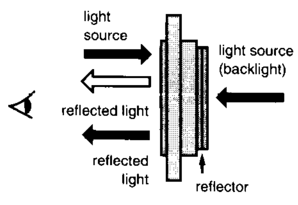
LCDs are offered in three basic light transmission modes: reflective, transmissive and transflective (see Fig. 5).

In a reflective mode, available light is used to illuminate the display. This is achieved by combining a reflector with the rear polarizer. It works best in an outdoor or well-lighted office environment.



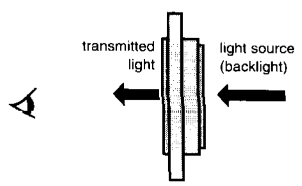
Reflective LCD

Reflector bonded to the rear polarizer reflects the incoming ambient light. Low power consumption.



Transflective LCD

Transflector bonded to the rear polarizer reflects light from front as well as enabling lights to pass through the back. Used with backlight off in bright light and with it on in low light to reduce power consumption.



Transmissive LCD

Without reflector or transflector bonded to the rear polarizer. Backlight required. Most common is transmissive negative image.

Figure 5

Transmissive LCDs have a transparent rear polarizer and do not reflect ambient light. They require a backlight to be visible. They work best in low light conditions with the backlight on continuously.

Transflective LCDs are a mixture of the reflective and transmissive types, with the rear polarizer having partial reflectivity. They are combined with a backlight for use in all types of lighting conditions. The backlight can be left off where there is sufficient light, conserving power. In darker environments, the backlight can provide a bright display. Transflective LCDs will not "wash out" when operated in direct sunlight.

Another feature of the viewing mode is whether the LCD is a positive or negative image (see Fig. 6). The standard image is positive, which means a light background with a dark character or dot. This works best in reflective or transflective mode. A negative image is usually combined with a transmissive mode. This provides a dark background with a light character. A strong backlight must be used to provide good illumination. In most graphic applications, the transmissive negative mode is inverted. This combination provides a light background with dark characters, which offers the user better readability.

■ LCD Modules

The first LCDs were composed of only the LCD panel. This left the drive circuitry to the customer. More recent developments have combined the LCD panel with a PCB (printed circuit board) containing the drive LSI. This is known as an LCD module, which offers customers a more complete solution.

There are two types of LCD modules: character and graphic. The character module is composed of 1 to 4 lines of 16 to 40 character blocks having 5x8 dots. Each character block is addressed separately and can form alphanumeric characters and a limited number of symbols.

Graphic modules provide users with a greater degree of flexibility. They are composed of pixels arranged in rows and columns. Each pixel can be addressed individually for text, graphics or any combination of the two. An LCD controller IC (integrated circuit) is required to operate the graphic LCD. Some models feature the controller chip built into the module.

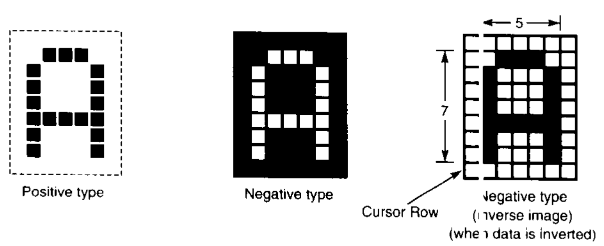
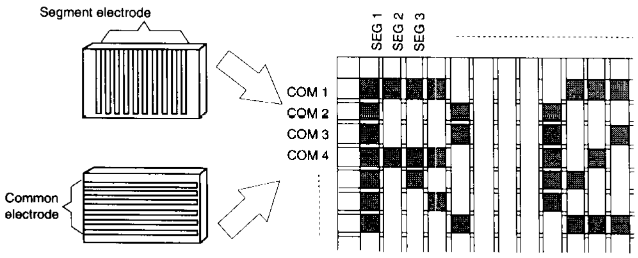


Figure 6

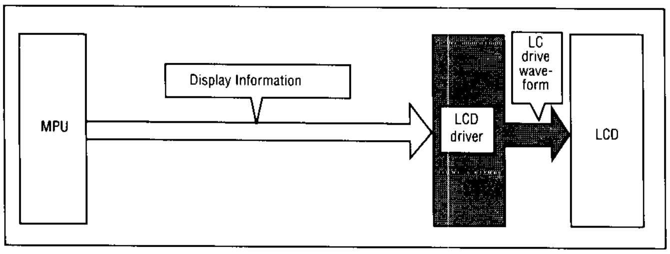
Graphic modules offer the greatest flexibility in formatting data on the display. They allow for text, graphics or any combination of the two. Since character size is defined by software, they allow any language or character font to be shown. The only limit is the resolution of the display.

Graphic modules are organized in rows (horizontal) and columns (vertical) of pixels. Each pixel is addressed individually, allowing any combination to be "on". This bitmapping provides the user with the ability to construct text of any size or shape, or true graphics, if that is desired.

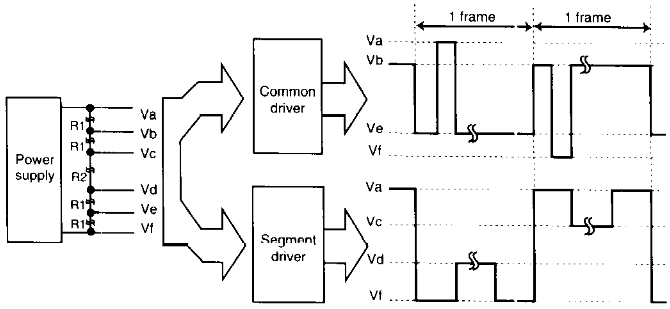


The above figure shows the structure of an LCD. Liquid crystals are placed between two types of glass substrates, one having segment electrodes (SEG1, SEG2, and so on), the other having common electrodes (COM1, COM2, and so on). Each cross point of the segment and common electrodes is a display pixel.

The LCD is driven as follows. The common electrodes are sequentially selected. The display pixels on the selected common electrode are turned on/off according to the select/non-select signals of the corresponding segment electrodes. This is called multiplex drive.



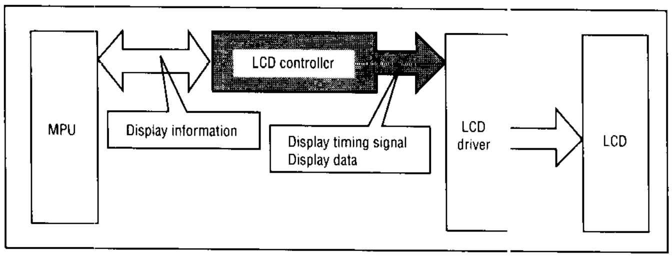
The LCD driver generates liquid crystal drive waveforms according to the display information sent from the MPU, and uses the waveforms to drive the LCD.



Liquid crystal drive waveform

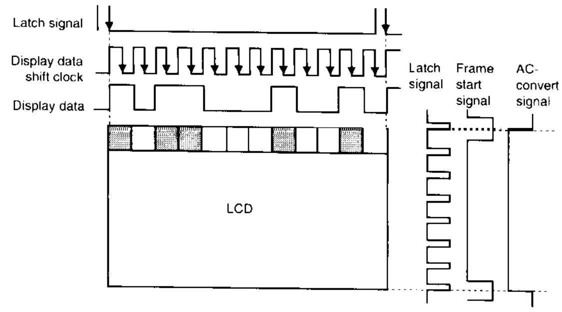
The LCD drivers are classified into the two types: the common driver and the segment driver. The common driver drives common electrodes and the segment driver drives segment electrodes. As shown in the figure above, these drivers select a proper voltage level sequentially from the six voltage levels (Va to Vf) to generate liquid crystal drive waveforms. The six voltage levels are generated by resistance division.

■ LCD Controller



The MPU cannot directly interface the LCD driver. So the LCD controller is placed between the MPU and the LCD drivers to handle the interface between them.

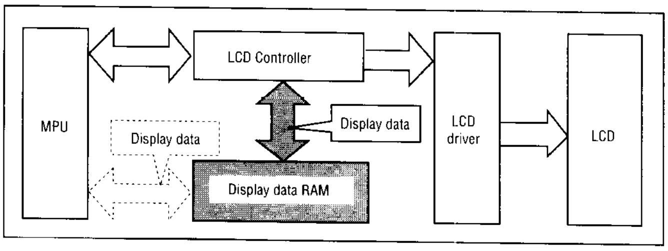
The LCD controller receives display information from the MPU, converts it into the display timing signals and display data required for the LCD drivers, and transfers them to the LCD drivers.



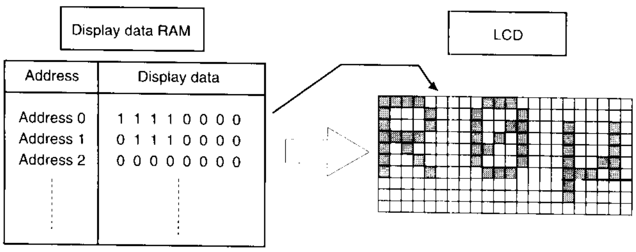
There are four display timing signals: display data shift clock, latch signal, frame start signal, and AC-convert signal.

There are two formats for the display data transfer: serial transfer and parallel transfer. In serial transfer, data is transferred bit by bit as shown in the figure above. In parallel transfer, four or eight bits are transferred at the same time. All Seiko Instruments graphic modules use parallel transfer.

■ Display Data RAM

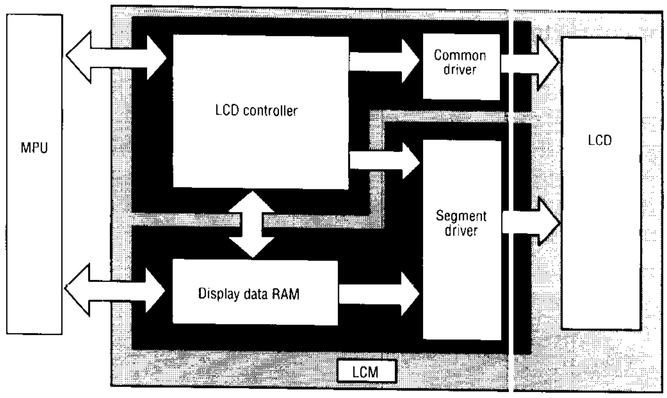


The display data RAM stores the display information sent from the MPU. The LCD controller reads data from the display data RAM, and transfers the data to the LCD drivers. Some LCD controllers let the MPU directly interface the display data RAM as shown by dotted lines in the figure above.



One of the methods to correspond display contents to display data is to assign a display data bit to a display pixel dot. In that case, if the MPU writes and stores data "11110000" at address 0 of the display data RAM, the LCD screen displays a pattern of "■■■■□□□□" according to the 0's and 1's in the data. This correspondence method is called the graphic display mode. The graphic display mode allows any pattern to be displayed, because each display pixel dot can be turned on and off independently.

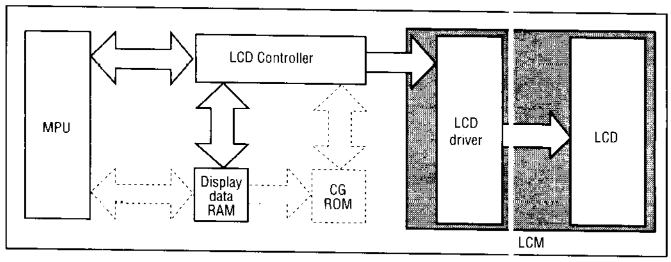
■ Graphic LCD Module With Built-in RAM
(F1016, G1213, G1216)



Built-in Data RAM = Direct Bit Mapping

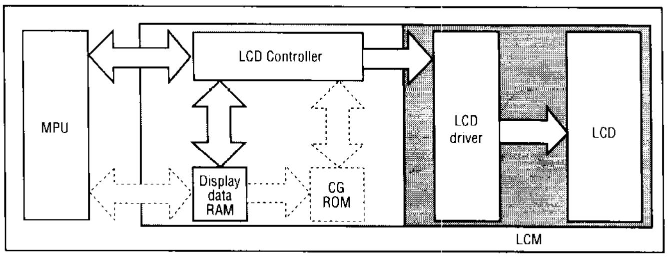
Graphic modules with built-in data RAM have two types of ICs: one integrating the controller and common driver, and one integrating the display data RAM and the segment driver. These modules use direct bit-mapping ... one bit in RAM corresponds to each pixel on the display. They communicate directly to the microprocessor through an 8-bit parallel interface. All the required controller timing functions are built-in to the module. There is no "CG ROM", or any way to store information.

■ Graphic LCD Modules With External Controller
(G191C, G191D, G2436, G321E, G648D, G649D)



Most graphic modules feature the segment and common drivers on the LCD Module, and use a four bit parallel interface to an external controller. The controller can be an external PC board (such as the LCDC-1330) or the controller IC can be located on the mother board with the microprocessor. In the larger graphic modules, all the board space is taken up with the driver ICs. Also for small graphic modules with high resolution, there may be no room to locate the controller on the module.

■ Graphic Modules With Built-in Controller
(G121C, G2446, G242C, G321D, G324E)

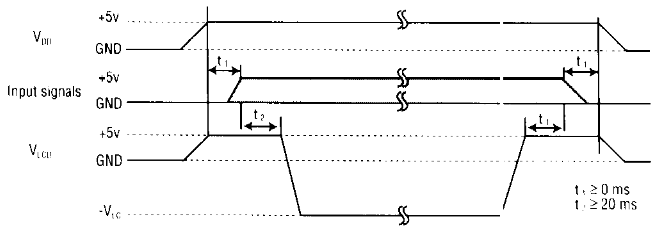


Seiko Instruments offers five graphic modules with the SED1330 controller built-in.* These modules interface directly to the microprocessor with an eight bit parallel interface. The 1330 was carefully chosen to offer our customers the most advanced features, including overlayed graphics & text, horizontal & vertical scrolling, built-in character generator with external RAM, etc.

* Model G121C features SED1335...see p. 31.

■ Power ON/OFF and Signal Input Timing

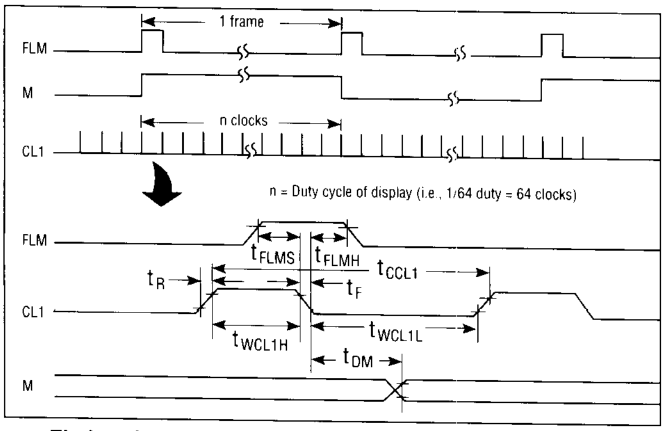
Power ON/OFF and signal input should be performed according to the timing shown below in order not to damage the LCD driving circuit and the LCD panel. See special requirements for G1213 & G1216 in the next section.



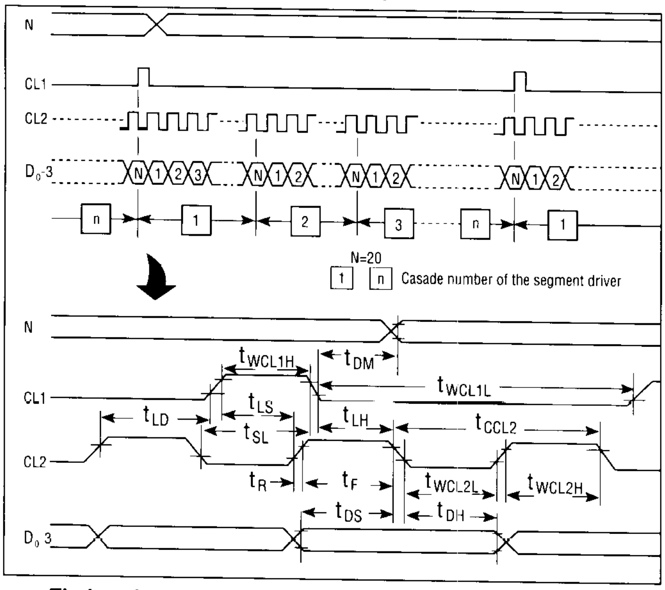
Interface Signal	Function
A0	Command mode set
CL1	Display data latch signal. Signal is used to latch data in each common line
CL2	Display data shift signal. Clock signal to shift data in four bit increments to the display
CS1, CS2	Chip select (read/write enable)
/CS	Chip select
CS11-CS24	Chip select (screen selection)
D_0-D_3	Display data signal; D_0-D_3 for single screen; UD0-UD3 & LD0-LD3 for dual screen display
DB_0-DB_7	Tri-state bidirectional data bus
D/I	Display data/display control data instruction
E	Enable
FLM	Frame start-up signal. Beginning signal that is sent at the start of each screen frame
INHX	Display on/off signal: H=on, L=off
M	Liquid crystal AC signal. This signal provides AC polarity in each display frame to prevent damage to the LCD from DC voltage
/RD	Read
/RES, RST	Reset
RS	Register select signal
R/W	Read/write select signal
SEL1, SEL2	MPU interface configuration; for Intel, SEL1=0, SEL2=0; for Motorola, SEL1=1, SEL2=0
V_{DD}	Power supply voltage for logic: +5v
V_{LC}	Power supply for LCD: -5v to -24v (see model)
V_O	LCD contrast adjustment voltage
V_{SS}	Ground
/WR	Write

■ Timing Characteristics

The following Timing diagrams apply to all the graphic modules without a built-in controller.



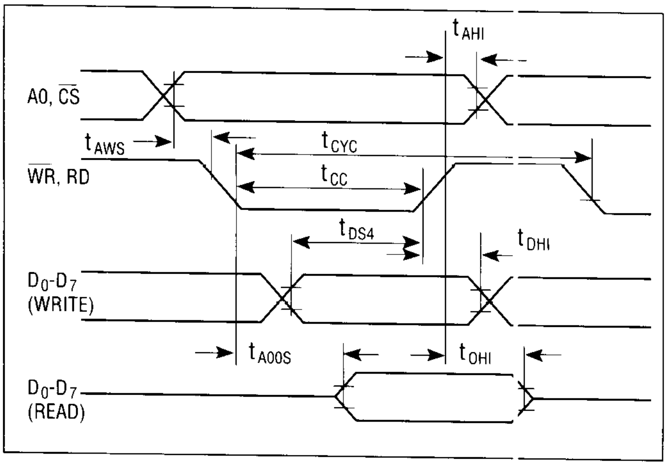
Timing characteristics of signal input into common driver.



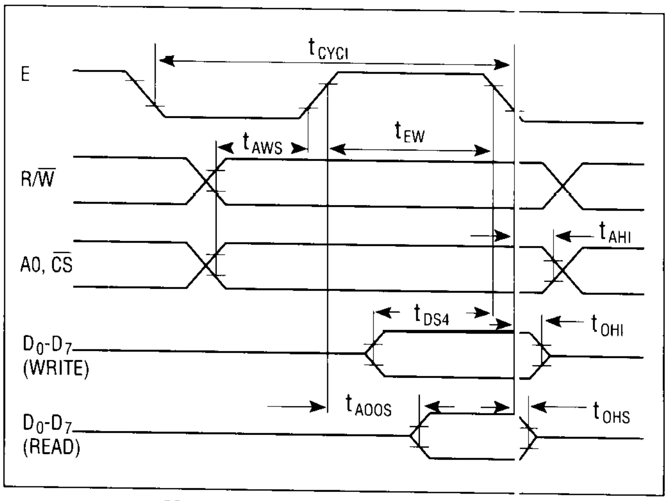
Timing characteristics of signal input into segment driver.

Timing Characteristics Temp. = 0 - 50°C, VDD = 5.0v ± 5%, VSS = 0v				
Item	**Symbol**	**Min.**	**Max.**	**Unit**
CL1 period	t_{CCL1}	1000		ns
CL1 "H" pulse width	t_{WCL1H}	125		ns
FLM setup time	t_{FLMS}	100		ns
FLM hold time	t_{FLMH}	100		ns
Input signal rise time	t_R		30	ns
Input signal fall time	t_F		30	ns
CL2 period	t_{CCL2}	330		ns
CL2 "H" pulse width	t_{WCL2H}	110		ns
CL2 "L" pulse width	t_{WCL2L}	110		ns
Data setup time	t_{DS}	100		ns
Data hold time	t_{DH}	100		ns
CL2 fall to CL1 fall time	t_{SL}	125		ns
CL1 fall to CL2 fall time	t_{LH}	80		ns

■ Timing Characteristics For Modules With Built-in 1330 Controller.



Intel 80 series timing diagram



Motorola 68 series timing diagram

Signal		Symbol	Item	Min.	Max	Unit
80 series timing	WR, RD	t_{CYC}	System cycle time	1000	-	ns
		t_{CC}	Control pulse width	220	-	ns
68 series timing	A0, CS, R/W, E	t_{CYC}	System cycle time	1000	-	ns
		t_{EW}	Enable pulse width	220	-	ns
80 and 68 series timing	A0, CS	t_{AH}	Address hold time	10	-	ns
		t_{AW}	Address setup time	30	-	ns
	D_0-D_7	t_{DS}	Data setup time	120	-	ns
		t_{DH}	Data hold time	10	-	ns
		t_{ACC}	RD access time	-	120	ns
		t_{OH}	Output disable time	10	50	ns

Note: See page 17 for microprocessor chip selection control (SEL).

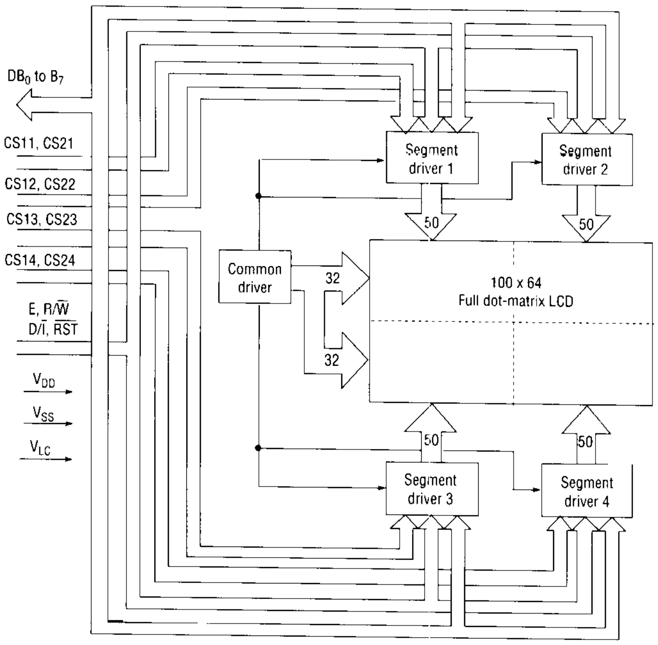
The Seiko Instruments liquid crystal display modules F1016, G1213 and G1216 are used to upgrade character-only modules in an easy and cost-effective way.

These compact graphic LCD modules can be used in personal translators, medical and scientific instrumentation, data collection, telephones, pagers, and devices that you can imagine. The new series of compact graphic LCD modules, G1213 and G1216, have the following features:

- 128 x 32 and 128 x 64
- Wide operating temperature range (-20°C to +70°C)
- High contrast for easy viewing
- STN reflective or optional LED backlight version
- Built-in RAM that eliminates external controllers
- Lower power consumption (+5V @ 2.0 mA and -8V @ 1.8 mA)

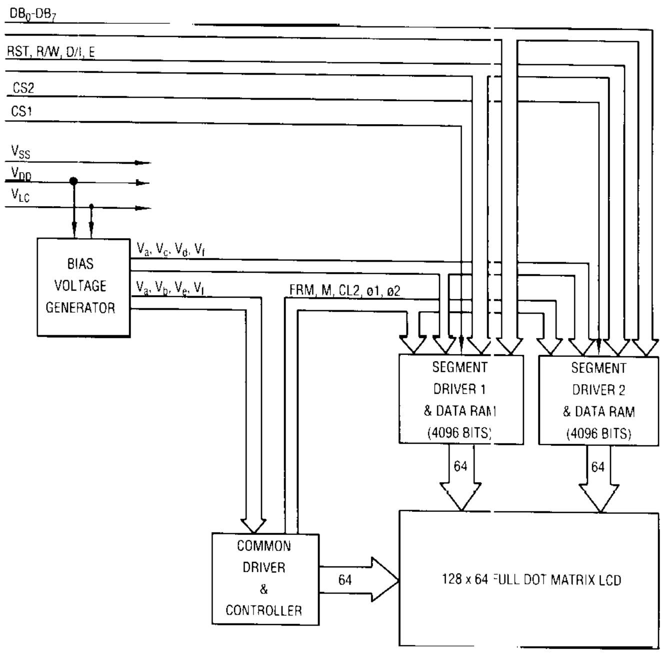
■ Circuit Block Diagram (F1016)

The F1016 is composed of a common driver and four segment drivers.

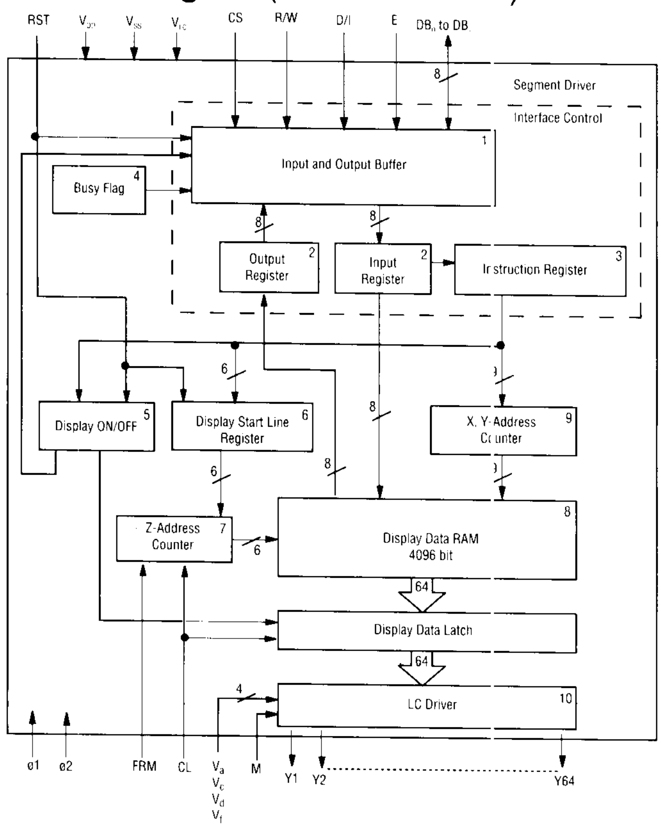


■ Circuit Block Diagram (G1213 & G1216)

The following block diagram shows the basic operation of the G1216. Model G1213 is similar with only one segment driver and 4096 bits of data RAM.



■ Segment Driver & Data RAM Detailed Block Diagram (G1213 & G1216)



■ Functions and Operations of Main Blocks. (G1213 & G1216)

■ Interface Control Unit

The interface control unit consists of the following blocks:

(1) Input and output buffer
(2) Input and output register
(3) Instruction register

The above blocks are selected according to the following combinations of R/W and D/I signals:

R/W	D/I	Functions
1	1	Output Register Read Internal Operation (Display Data RAM → Output Register)
0	1	Input Register Write Internal Operation (Input Register → Display Data RAM)
1	0	Busy Check and Status Read
0	0	Instruction

■ (1) Input and Output Buffer

The data is transmitted through eight data buses (DB_0 to DB_7).

DB_7 ..... MSB (most significant bit)
DB_0 ..... LSB (least significant bit)

The data can input and output only when the Chip Select is selected. Therefore, if the Chip Select is not selected, the internal condition remains unchanged and instruction will not be executed, even when changing the signal of the input terminals excluding the $\overline{RST}$ (reset) terminal.

Note that the $\overline{RST}$ operates regardless of CS1 and CS2.

■ (2) Input and Output Register

This product is provided with an input register and an output register so that the product can interface with MPUs having speed differing from the internal operation.

■ Input Register

The input register is a register that is used for temporarily storing the data to be written in the display data RAM. The data to be written from the MPU to the input register will be automatically written in the display data RAM through internal operation.

When the Chip Select is selected and R/$\overline{W}$ = 0, D/$\overline{I}$ = 0, the data is written in the register, synchronized with the fall of signal E.

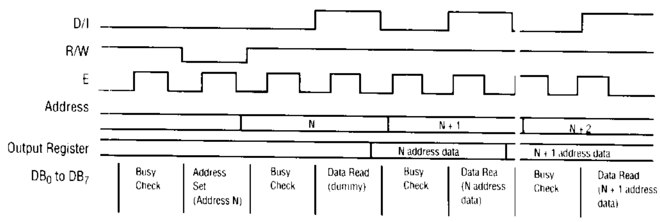
■ Output Register

The output register is a register that is used for temporarily storing the data to be read from the display data RAM.

■ (3) Instruction Register

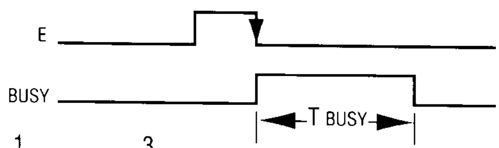
In order to read the content of the output register, the Chip Select must be selected, D/I must be 1, and R/W must be 1. When executing the "Read" instruction, the contents of the output register stored at that time are output during the time that "E" is 1. When "E" falls, display data of currently indicated address is written in the output register. After that, the address advances by one.

The contents of the output register are rewritten by the Read instruction. The data is retained by the address set or other instructions. Accordingly, when performing the address set, and next executing the Read instruction, the data of the specified address is not output and the data of the address which is specified is output at the second data read time. Therefore, when setting the address, a dummy read is needed once.



■ (4) Busy Flag

The status when busy flag is "1" means that the module is operating internally. Instructions other than The Status Read are not available at this time. The busy flag is output to DB_7 by the Status Read instruction. Ensure that the busy flag is "0" before executing the instruction.



$$\frac{1}{F\text{ø}} \geq T\ BUSY \geq \frac{3}{F\text{ø}}$$

Fø is frequency of ø1 or ø2
(1/2 the source oscillation frequency of HD61203): 215 KHz typ.

■ (5) Display ON/OFF Flip/Flop

The display ON/OFF Flip/Flop is a flip-flop function that determines whether the display data corresponding to the RAM data is output to the segment on the LCD (ON status) or goes to all nonlit status regardless of the RAM data (OFF status). This controlled by the display ON/OFF instruction. When the RST signal becomes "0", the display goes to OFF status. This flip-flop status is output to DB_5 by the Status Read instruction.

Even when performing display ON/OFF, the data inside the RAM is not affected.

■ (6) Display Start Line Register

The display start line register is a register which determines the line address for which data is displayed on the top line of the LCD screen when displaying the contents of the display data RAM on the LCD screen. It is also used to scroll the display. The 6 bit (0 to 63) display start line information is written in this register by the Display Start Line Set Instruction.

The contents of this register are transmitted to address counter Z at "H" level of the FRM signal (common driver output) which indicates the display start on the screen.

■ (7) Z-address Counter

The Z-address counter generates the address to output the display data synchronized with the common signal. This is a 6-bit counter which counts at the fall of the CL signal (common driver output). The contents of the display start line register are preset to the Z-address counter at "H" level of the FRM signal (common driver output).

■ (8) Display Data RAM

The display data RAM is a RAM that stores the display dot data. 1 bit of RAM data corresponds to lighting (data =1) or non-lighting (data = 0) of 1 dot of the display on the LCD screen.

■ (9) X,Y-address Counter

X,Y-address counter is a 9-bit counter which gives the address of the internal display data RAM. It is necessary to set the X-address counter of the three upper bits, and the Y-address counter of the six lower bits using differing instructions.

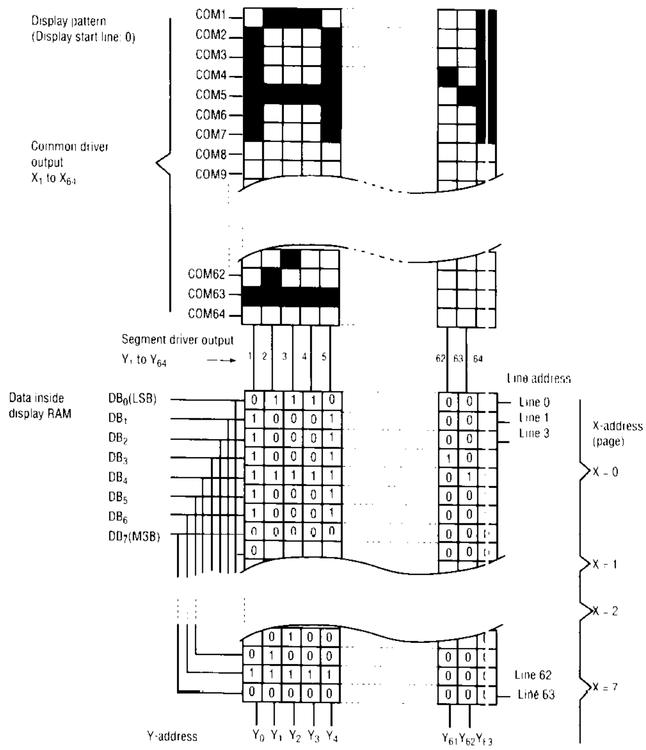
■ X-address Counter

Address counter X is a simple register that is not provided with a count function. The address is set by instruction.

■ Y-address Counter

This counter sets the address by instruction and is automatically advanced by the read/write operation. Counting is performed by looping the values 0 to 63.

■ Relationship Between Display and Data Inside Display RAM

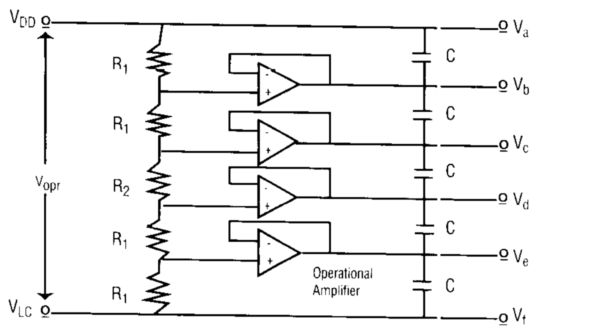


■ (10) Common Driver (HD61203)

The common driver is a 64 drive output CMOS IC. Incorporating an oscillation circuit, this driver generates the common signal and timing signals (LC AC drive control, and one-frame timing signal) necessary for the LC display, and controls the display by supplying the timing signals to the segment drivers.

■ (11) Bias Voltage Generator

Six levels of standard voltage V_a to V_f are applied to the drivers as a bias voltage. This voltage is generated by resistance division of Vopr and driven by a voltage follower through an operational amplifier.



1/9 bias: $R_2 = (9-4)\,R_1 = 5R_1$

■ Software Instructions (F1016)

Instruction	R/W̄	D/Ī	DB_7	DB_6	DB_5	DB_4	DB_3	DB_2	DB_1	DB_0	Note
(1) Address set	0	0	P	P	A	A	A	A	A	A	
(2) Address count mode set	0	0	0	0	1	1	1	0	1	AC	AC=1:Up mode AC=0:Down mode
(3) Display on/off set	0	0	0	0	1	1	1	0	0	Di	Di=1:Display on Di=0:Display off
(4) Write display data	0	1	D	D	D	D	D	D	D	D	
(5) Read display data	1	1	D	D	D	D	D	D	D	D	
(6) Display start page set	0	0	P	P	1	1	1	1	1	0	
(7) Status P: RAM page A: RAM address D: Display data	1	0	BF	AC	Di	R	0	0	0	0	BF=1:Instruction in progress BF=0:Instruction can be accepted AC=1:Up mode AC=0:Down mode Di=1:Display off Di=0:Display on R=1:Reset mode R=0:Operation mode

■ Address set (F1016)

	R/W̄	D/Ī	DB_7							DB_0
Code	0	0	0	0	A	A	A	A	A	A

P:RAM page
A:RAM address

Sets display RAM address from which display data is read or written. The upper two bits specify the display RAM page, and the lower six bits specify the address. The address specified with the lower six bit is incremented or decremented according to the address count mode set instruction when a read or write operation is executed. Addresses 0 to 49 are counted, but the RAM page is not counted. If data has been written to every address on a page, new data is overwritten into the first adress on the page. To write data in the next RAM page, the Address set instruction must be reexecuted.

■ Supplement 1:Display RAM (F1016)

The F1016 has four display RAMs. A display RAM has 50x8x4 (1600) bits, and controls one screen. It has the following constructon:

	0 1 ...... 48 49 Address
0 L / 7 M	Page 0: 00
L / M	Page 1: 01
L / M	Page 2: 10
L / M	Page 3: 11

Display RAM

■ Address count mode set (F1016)

		R/W̄	D/Ī	DB_7							DB_0
Code	Up mode	0	0	0	0	1	1	1	0	1	1
	Down mode	0	0	0	0	1	1	1	0	1	0

Sets adress count mode of the display RAM for reading or writing display data.

In up mode, the address is incremented. The value is looped from 49 to 0; After 49, the next address to be counted is 0.

In down mode, the address is decremented. The value is looped from 0 to 49; After 0, the next address to be counted is 49.

■ Display on/off set (F1016)

		R/W̄	D/Ī	DB_7							DB_0
Code	Display on	0	0	0	0	1	1	1	0	0	1
	Display off	0	0	0	0	1	1	1	0	0	0

When the display set is on, display RAM data is displayed.

When the display is set to off, display RAM is not displayed. This has no effect on the data.

■ Write Display Data (F1016)

	R/W	D/I	DB_7							DB_0
Code	0	1	D	D	D	D	D	D	D	D

D: Display data

Write data at the display RAM Address specified with (1) Address set instruction from the CPU.

■ Read Display Data (F1016)

	R/W	D/I	DB_7							DB_0
Code	1	1	D	D	D	D	D	D	D	D

D: Display data

Reads data at the display RAM address specified with (1) Address set instruction to the CPU.

With a read operation, data read timing is as shown in Figure 7. After display data is read, the display data in the address that has been specified now is fetched into the internal register, and the address is incremented or decremented. If the Address set (Address N) instruction is executed, the first data becomes dummy data, and the data at Address N is output at the second data read.

■ Display Start Page Set (F1016)

	R/W	D/I	DB_7							DB_0
Code	0	0	P	P	1	1	1	1	1	0

P: RAM page

The upper two bits specify the display RAM page, which is displayed at the top of the screen.

■ Status Read (F1016)

	R/W	D/I	DB_7							DB_0
Code	0	1	BF	AC	Di	R	0	0	0	0

Outputs the status of the F1016

BF: Gives the status of the busy flag
- BF=1: Instruction is being executed. Only the Status read instruction can be received.
- BF=0: Instruction can be received.

AC: Gives the address count mode
- AC=1: Up mode
- AC=0: Down mode

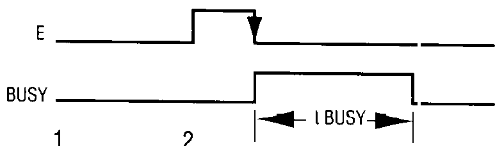
Di: The status of the display
- Di=1: Display off
- Di=0: Display on

R: Gives the internal status of the F1016
- R=1: Reset mode
- R=0: Operation mode

■ Supplement 2: Busy Flag (F1016)

When an instruction other than the Status read instruction is received, the busy flag is set during execution of the internal operation, and it is reset when the instruction is completed. The F1016 can only accept the Status read instruction in the busy state. Make sure the busy flag is reset before executing an nstruction.

■ Busy Flag Timing



$$\frac{1}{F\phi} \leq t_{BUSY} \leq \frac{2}{F\phi}$$

$F\phi = 215$ KHz typ.

■ Display Start Page (F1016)

When page 0 is specified (DB_7=0, DB_6=0)

Page 0
Page 1:
Page 2
Page 3

Screen 1 to 4 (50x32 dots)

When page 1 is specified (DB_7=0, DB_6=1)

Page 1
Page 2
Page 3
Page 0

Screen 1 to 4 (50x32 dots)

When page 2 is specified (DB_7=1, DB_6=0)

Page 2
Page 3
Page 0
Page 1

Screen 1 to 4 (50x32 dots)

When page 3 is specified (DB_7=1, DB_6=1)

Page 3
Page 0
Page 1
Page 2

Screen 1 to 4 (50x32 dots)

■ Software Instructions (G1213, G1216)

Instructions other than the Status Read instruction will not be executed if they are sent while another instruction is already being executed. The busy flag is "1" when executing the instruction. Check whether or not the flag is "1" before transmitting the instructions from the MPU.

	Instruction	Code										Function	
		R/W	D/I	DB_7	DB_6	DB_5	DB_4	DB_3	DB_2	DB_1	DB_0		
1	Display ON/OFF	0	0	0	0	1	1	1	1	1	1/0	Turns ON/OFF total display. Date and internal status in the display RAM remain unchanged. 1:ON 0:OFF	
2	Display start line	0	0	1	1	Display start lines (0 to 63)						Determines the RAM line to be displayed on the top line (COM1) on the display.	
3	X-address (page) set	0	0	1	0	1	1	1	x-address (page) (0 to 7)			Sets the x-address of the RAM (page) in the x-address (page) register.	
4	Y-address set	0	0	0	1	Y-address (0 to 63)						Set y-address of the RAM in the Y-address counter.	
5	Status read	1	0	BUSY	0	ON/OFF	RESET	0	0	0	0	Reads the status. RESET 1:Reset 0: Normal ON/OFF 1:Display OFF, 0: Display ON BUSY: 1:During internal operation 0:READY status	
6	Display data write	0	1	Write Data								Writes data to DB_0 (LSB) to DB_7 (MSB) on the data bus into the display RAM.	Accesses the RAM in which address has been specified beforehand. After that the Y-address advances by one.
7	Display data read	1	1	Read Data								Reads data DB_0 (LSB) to DB_7 (MSB) from the display RAM into the data bus.	

Note: The BUSY time varies depending upon the frequency Fø (:215 kHz (typ.)) of ø1, ø2 ($1/F_ø \leq T_{BUSY} \leq 3/F_ø$).

■ (1) Display ON/OFF (G1213, G1216)

	R/W	D/I	DB_7							DB_0
Code	0	0	0	0	1	1	1	1	1	D

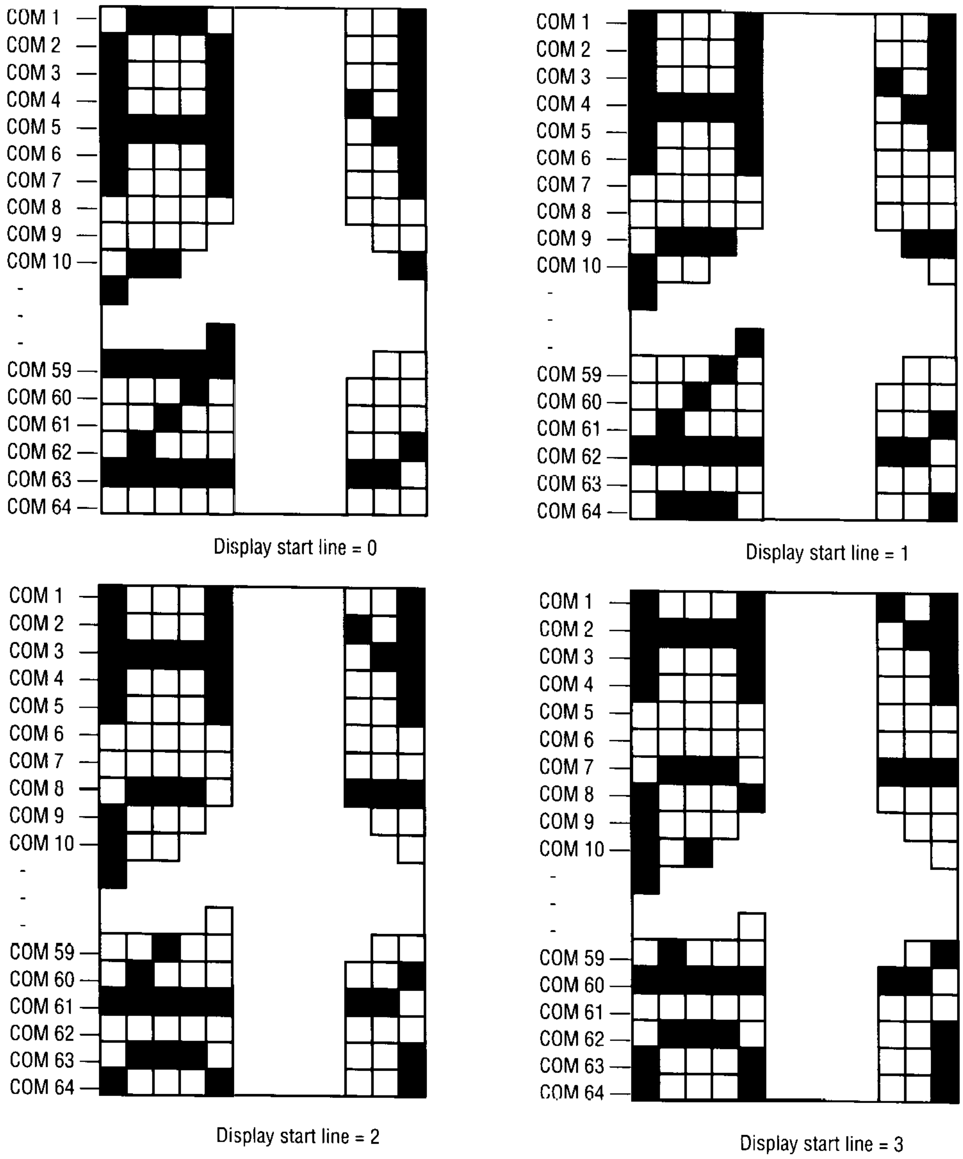
Turns the display ON when D = 1, and OFF when D = 0. When the display is turned OFF by D = 0, the original display appears if D is set to 1 because the display data is retained in the display data RAM.

■ (2) Display Start Line (G1213, G1216)

	R/W	D/I	DB_7							DB_0
Code	0	0	1	1	A	A	A	A	A	A

← Upper bits lower bits →

Sets the display data RAM line address expressed with binary AAAAAA in the display start line register. When displaying the content of the display data RAM, the display data on the line addresses which are set in the register is displayed on the top line on the LCD screen.



Relationship Between Display Start Lines and Displays

■ (3) X-address (page) Set (G1213, G1216)

	R/W	D/I	DB_7							DB_0
Code	0	0	1	0	1	1	1	A	A	A

← Upper bits
Lower bits →

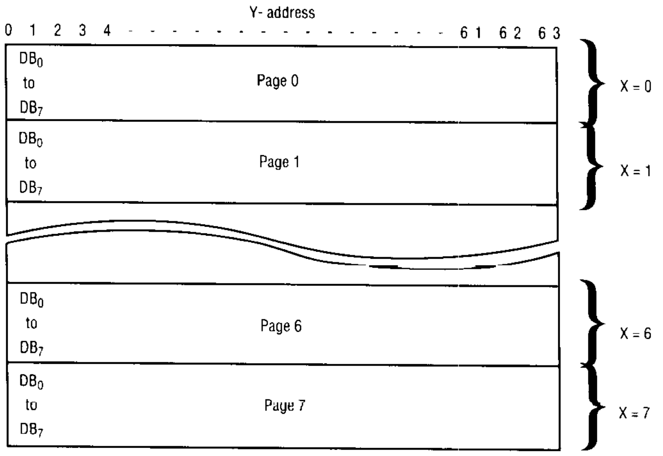
The display data RAM "X" address (page) which is expressed with binary AAA is set in the X-address register. Following write/read operations from the MPU are performed on the specified X-address (page) until the next X-address (page) set is performed.

■ (4) Y-address Set (G1213, G1216)

	R/W	D/I	DB_7							DB_0
Code	0	0	0	0	1	A	A	A	A	A

← Upper bits
Lower bits →

The display data RAM Y-address which is expressed with binary AAAAAA is set in the Y-address counter. After that the Y-address counter advances by one each time write/read is performed from the MPU.



Display Data RAM Address Configuration

■ (5) Status Read (G1213, G1216)

	R/W	D/I	DB_7							DB_0
Code	1	0	BUSY	0	ON/OFF	RESET	0	0	0	0

BUSY: When BUSY = 1, it means that the module is operating internally and the next instruction is not accepted until BUSY = 0. After confirming that BUSY = 0, it is necessary to perform the next write.

ON/OFF: Indicates that the display is OFF when ON/OFF = 1.

Indicates that the display is ON when ON/OFF = 0.

RESET: Indicates that initial setup is performed by the RST signal.

Indicates that the initialization is being performed when RESET = 1 and instructions other than the Status Read instruction are not accepted.

■ (6) Display Data Write (G1213, G1216)

	R/W	D/I	DB_7							DB_0
Code	0	1	D	D	D	D	D	D	D	D

← Upper bits Lower bits →

Writes 8-bit binary data DDDDDDDD in the display data RAM. After the write is completed, the Y-address is automatically advanced by one.

■ (7) Display Data Read (G1213, G1216)

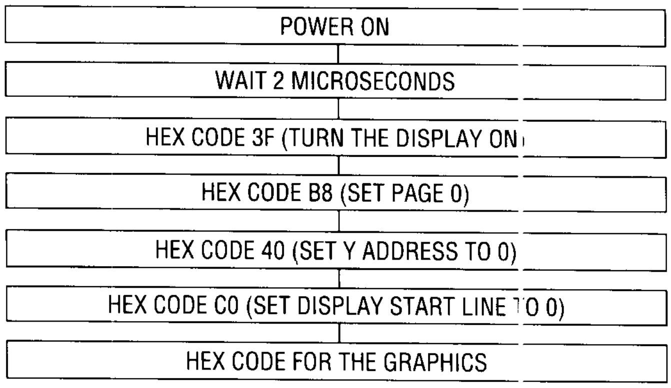
	R/W	D/I	DB_7							DB_0
Code	1	1	D	D	D	D	D	D	D	D

← Upper bits Lower bits →

Read 8-bit binary data DDDDDDDD from the display data RAM. After read is performed, the Y-address is automatically advanced by one. A dummy read is necessary once, immediately after the address set is completed.

■ Sample Software Instruction

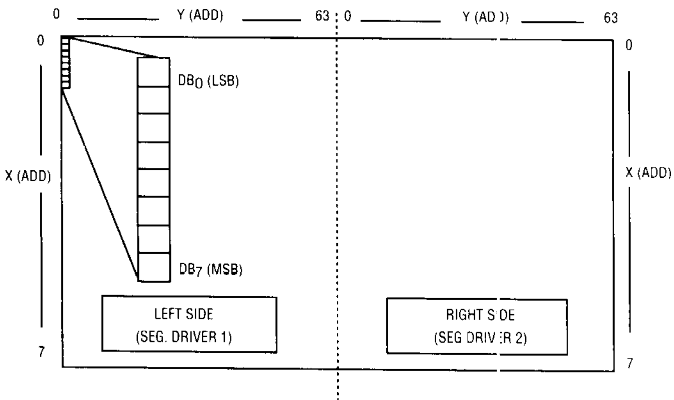
(G1213, G1216)



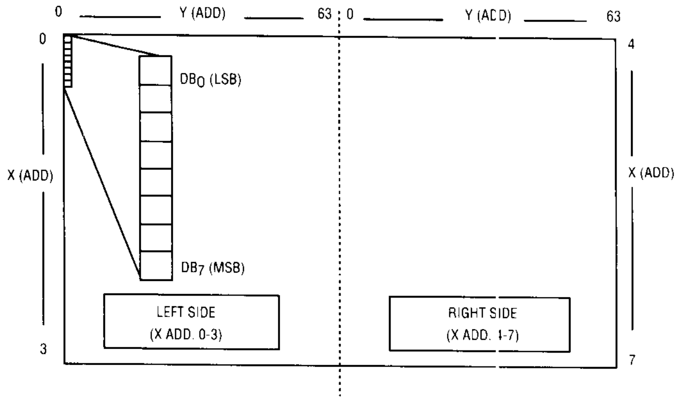
■ Hexadecimal Code for Characters
(8 Bytes per Character)

Text 0:	Byte	3EH, 7FH, 71H, 59H, 4DH, 7FH, 3EH, 00H
Text 1:	Byte	40H, 42H, 7FH, 7FH, 40H, 40H, 00H, 00H
Text 2:	Byte	62H, 73H, 59H, 49H, 6FH, 66H, 00H, 00H
Text 3:	Byte	22H, 63H, 49H, 49H, 7FH, 36H, 00H, 00H
Text 4:	Byte	18H, 1CH, 16H, 53H, 7FH, 7FH, 50H, 00H
Text 5:	Byte	27H, 67H, 45H, 45H, 7DH, 39H, 00H, 00H
Text 6:	Byte	3CH, 7EH, 4BH, 49H, 79H, 30H, 00H, 00H
Text 7:	Byte	03H, 03H, 71H, 79H, 0FH, 07H, 00H, 00H
Text 8:	Byte	36H, 7FH, 49H, 49H, 7FH, 36H, 00H, 00H
Text 9:	Byte	06H, 4FH, 49H, 69H, 3FH, 1EH, 00H, 00H
Text A:	Byte	7CH, 7EH, 13H, 13H, 7EH, 7CH, 00H, 00H
Text B:	Byte	41H, 7FH, 7FH, 49H, 49H, 7FH, 36H, 00H
Text C:	Byte	1CH, 3EH, 63H, 41H, 41H, 63H, 22H, 00H
Text D:	Byte	41H, 7FH, 7FH, 41H, 63H, 3EH, 1CH, 00H
Text E:	Byte	41H, 7FH, 7FH, 49H, 5DH, 41H, 63H, 00H
Text F:	Byte	41H, 7FH, 7FH, 49H, 1DH, 01H, 03H, 00H
Text G:	Byte	1CH, 3EH, 63H, 41H, 51H, 73H, 72H, 00H
Text H:	Byte	7FH, 7FH, 08H, 08H, 7FH, 7FH, 00H, 00H
Text I:	Byte	00H, 41H, 7FH, 7FH, 41H, 00H, 00H, 00H
Text J:	Byte	30H, 70H, 40H, 41H, 7FH, 3FH, 01H, 00H
Text K:	Byte	41H, 7FH, 7FH, 08H, 1CH, 77H, 63H, 00H
Text L:	Byte	41H, 7FH, 7FH, 41H, 40H, 60H, 70H, 00H
Text M:	Byte	7FH, 7FH, 0EH, 1CH, 0EH, 7FH, 7FH, 00H
Text N:	Byte	7FH, 7FH, 06H, 0CH, 18H, 7FH, 7FH, 00H
Text O:	Byte	1CH, 3EH, 63H, 41H, 63H, 3EH, 1CH, 00H
Text P:	Byte	41H, 7FH, 7FH, 49H, 09H, 0FH, 06H, 00H
Text Q:	Byte	1EH, 3FH, 21H, 71H, 7FH, 5EH, 00H, 00H
Text R:	Byte	41H, 7FH, 7FH, 09H, 19H, 7FH, 66H, 00H
Text S:	Byte	26H, 6FH, 4DH, 59H, 73H, 32H, 00H, 00H
Text T:	Byte	03H, 41H, 7FH, 7FH, 41H, 03H, 00H, 00H
Text U:	Byte	3FH, 7FH, 40H, 40H, 7FH, 3FH, 00H, 00H
Text V:	Byte	1FH, 3FH, 60H, 60H, 3FH, 1FH, 00H, 00H
Text W:	Byte	7FH, 7FH, 30H, 18H, 30H, 7FH, 7FH, 00H
Text X:	Byte	43H, 67H, 3CH, 18H, 3CH, 67H, 43H, 00H
Text Y:	Byte	07H, 4FH, 78H, 78H, 4FH, 07H, 00H, 00H
Text Z:	Byte	47H, 63H, 71H, 59H, 4DH, 67H, 73H, 00H

■ G1216 Addressing Layout (128 x 64)

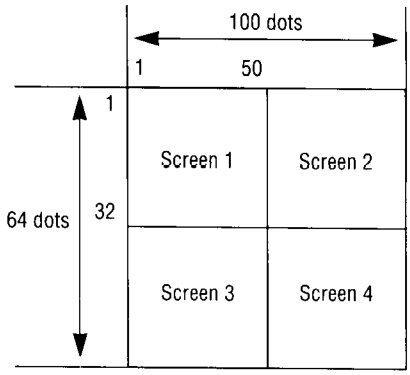


■ G1213 Addressing Layout (128 x 32)



■ F1016 Screen Selection (100 x 64)

The F1016 display is divided into four screens, each of which is controlled by a segment driver. Chip select signals select the screens and set their state. Then, a read or write operation is executed by an instruction.



CS1n	CS2n	State of chip selected
L	L	Unselected
L	H	Selected, read/write
H	L	Selected, write
H	H	Selected, read/write

n indicates screen No.

For example, Screen 1 is selected with CS11 (Pin No. 14) and CS21 (Pin No. 15).

Modules with Built-In Data RAM (Continued)

■ Terminal Functions

Signal	QTY	I/O	Destination	Functions
DB_0 to DB_7	8	I/O	MPU	Common terminal for tristate input and output, and data bus. DB_7 = MSB
E	1	Input	MPU	Enable Write (R/W = 0): Latches data of DB_0 to DB_7 at the fall of E. Read (R/$\overline{W}$ = 1): Outputs data to DB_0 to DB_7 while "E" keeps a high level.
R/W	1	Input	MPU	Read/Write selection R/W = 1: When E = 1 and CS1 = 0 or CS2 = 0, the data is output to DB_0 to DB_7 and read is available by MPU. R/W = 0: When CS1 = 0 or CS2 = 0, DB_0 to DB_7 are ready for receiving the input.
D/I	1	Input	MPU	Data/Instruction selection D/I = 1: Indicates that the data in DB_0 to DB_7 is the display data. D/I = 0: Indicates that the data in DB_0 to DB_7 is the instruction code.
CS1, CS2	2	Input	MPU	Chip select input. Data input and output is possible under the following status: Terminal No. / CS1 / CS2 — Status / 0 / 0 LCM display screen: CS1 ¦ CS2 CS1: Controls the LCM left half display screen (SEG1 to SEG64). CS2: Controls the LCM right half display screen (SEG65 to SEG128).
CSII-CS24	8	Input	MPU	F1016 only: see screen selection
RST	1	Input	MPU	Reset signal Setting the $\overline{RST}$ signal to a low level allows for initial setup. (1) ON/OFF register: 0 setup (display OFF) (2) Display start line register: 0 line setup (display starts from 0 line) The setup status is retained until the status is changed by an instruction after reset is released.
V_{DD}	1	-	Power	Power terminal for logic (+5V)
V_{SS}	1	-	Power	GND terminal (0V)
V_{LC}	1	-	Power	Power terminal for LC drive
LEDA	1	-	Power	LED backlight anode terminal (+)
LEDC	1	-	Power	LED backlight cathode terminal (-)
F_{GND}	1	-	–	Frame ground[1]

[1] F_{GND} terminal is connected to the metallic frame of the module. Use this terminal when grounding the frame.

■ Reset Function

Setting the $\overline{RST}$ terminal to a low level when the power is on allows for initial setup.

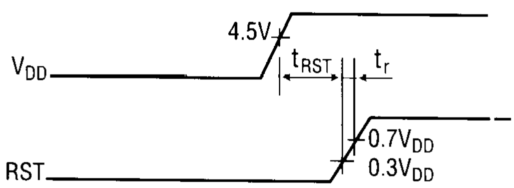
1 Display OFF
2 Display start line register:
  Set address 0. (G1213, G1216)
3. Address count mode: Up mode (F1016)

G1213, G1216: While the $\overline{RST}$ remains at a low level, instructions other than the status read cannot be accepted. Execute other instructions after confirming that DB_4 = 0 (reset release) and DB_7 = 0 (ready), using the status read instruction.

F1016: When $\overline{RST}$ turns to H, the F1016 can receive an instruction. With busy flag checked by status read instruction, display start page set, address count mode set, write/read display data instructions are executed.

The power conditions for power-on initial setup are as follows:

Item	Symbol	Min.	Typ.	Max.	unit
Reset time	t_{RST}	1.0	-	-	μs
Rise time	t_r	-	-	200	ns

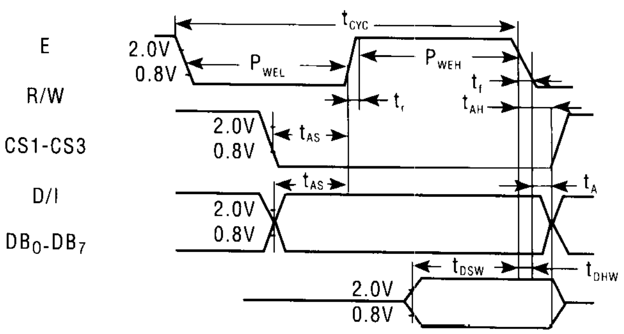


If the RESET is executed during operation, retention of the contents of all registers (excluding an ON/OFF register) and the RAM is not guaranteed. Always set them again.

■ Timing Characteristics

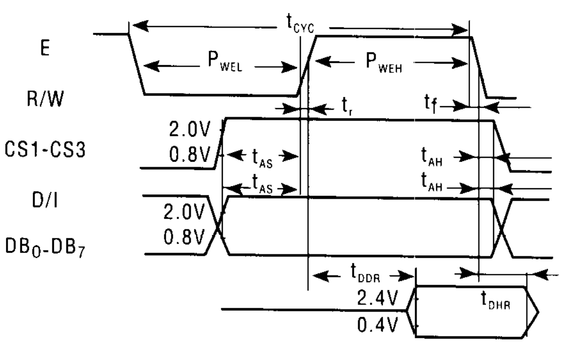
Item	Symbol	Min.	Typ.	Max.	Unit	Note
E cycle time	t_{CYC}	1000	-	-	ns	1, 2
E high level width	P_{WEH}	450	-	-	ns	1, 2
E low level width	P_{WEL}	450	-	-	ns	1, 2
E rise time	t_r	-	-	25	ns	1, 2
E fall time	t_f	-	-	25	ns	1, 2
Address setup time	t_{AS}	140	-	-	ns	1, 2
Address hold time	t_{AH}	10	-	-	ns	1, 2
Data setup time	t_{DSW}	200	-	-	ns	1
Data delay time	t_{DDR}	-	-	320	ns	2, 3
Data hold time (Write)	t_{DHW}	10	-	-	ns	1
Data hold time (Read)	t_{DHR}	20	-	-	ns	2

■ Data Write from MPU to Module



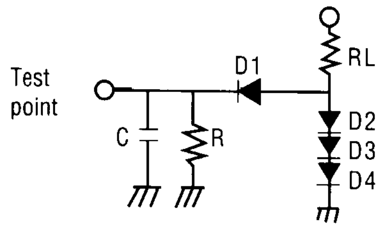
CPU Write Timing

■ Data Write from Module to MPU



CPU Read Timing

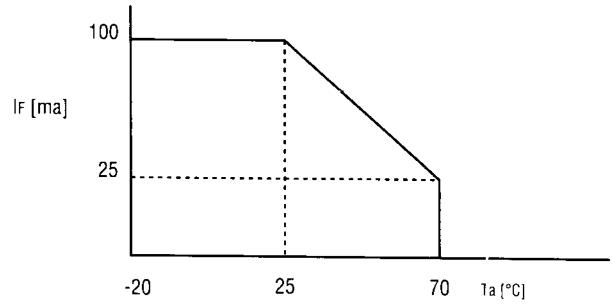
■ DB0-DB7: Load Circuit



RL=2.4KΩ
R=11KΩ
C=130pF (including jig capacity)
Diodes D1 to D4 are all 1S2074 (H).

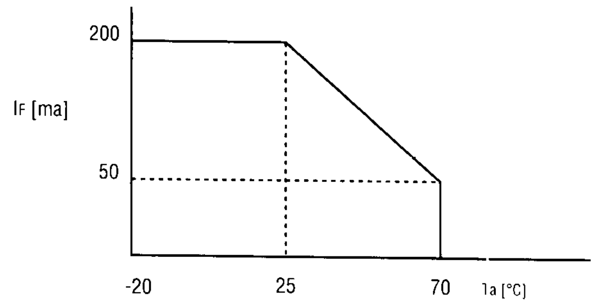
■ LED Backlight

■ G1213B1N000 Maximum Rating
(12 LEDs)



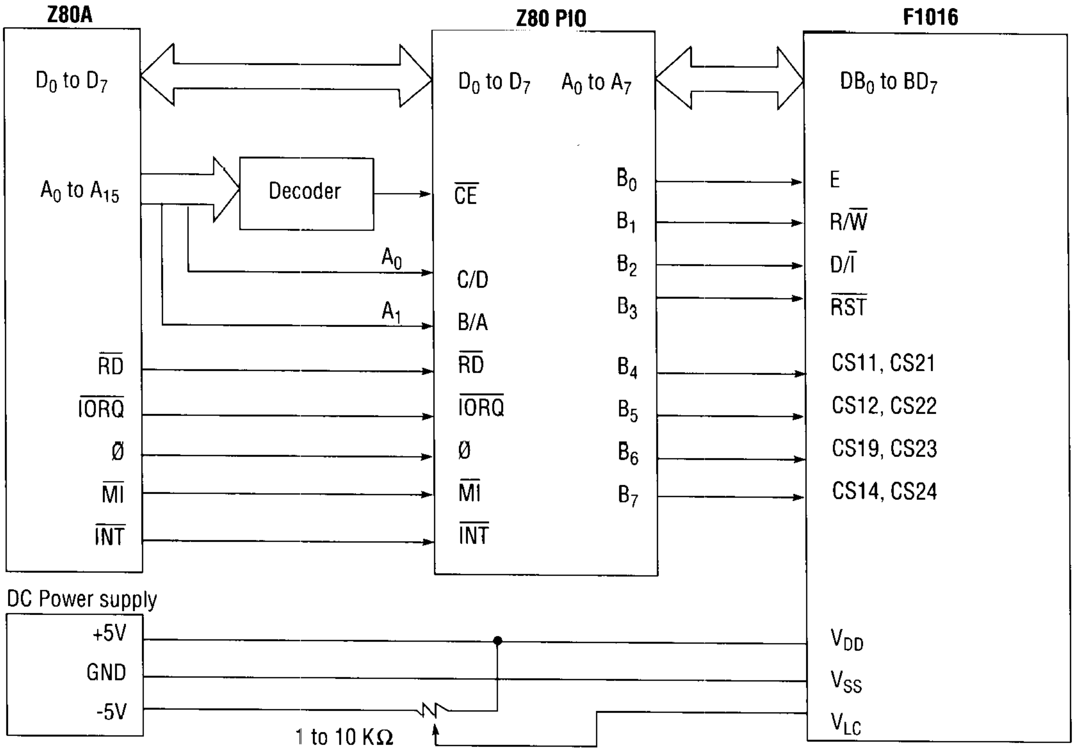
Recommended LED current = 50 mA @ 25°C
Typical forward voltage = 4.1 VDC
Use 18 OHM current limiting resistor to + 5 VDC supply (PIN 19)

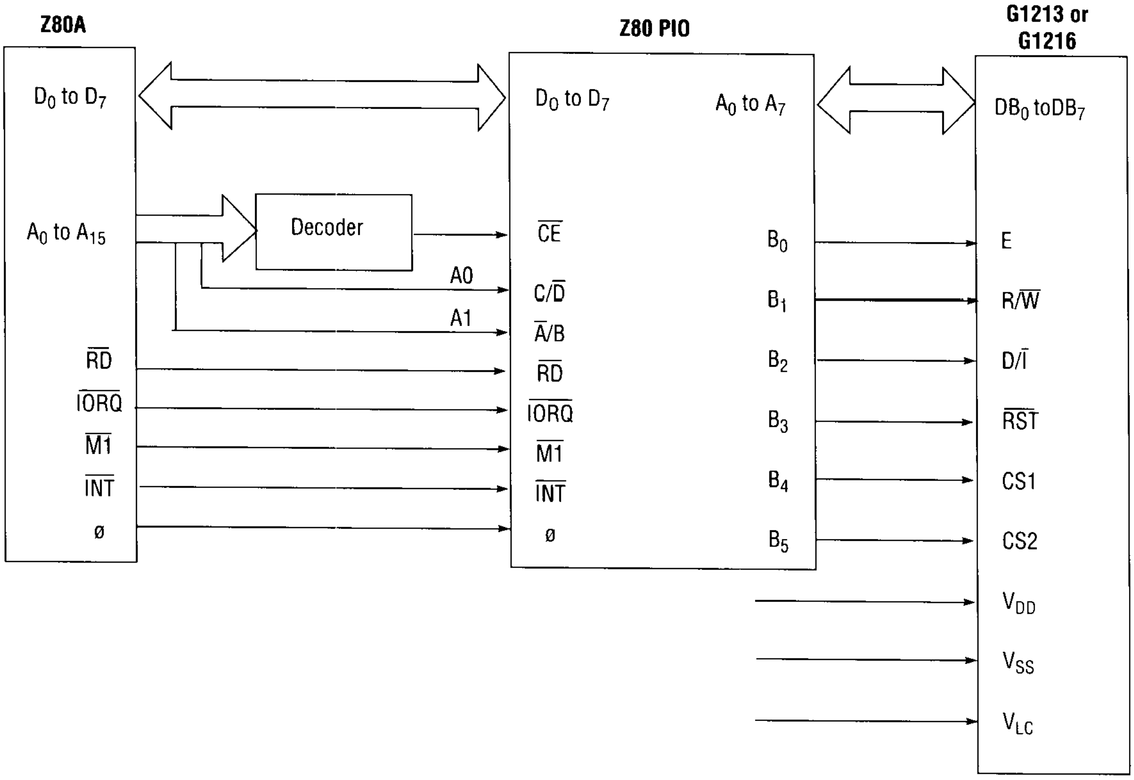
■ G1216B1N000 Maximum Rating
(20 LEDs)



Recommended LED current = 100 mA @ 25°C
Typical forward voltage = 4.1 VDC
Use 9.1 OHM current limiting resistor to + 5 VDC supply (PIN 19)

■ Example of Connection to Z80 Microprocessor





■ SED1330 Advanced LCD Display Controller

Seiko Instruments has selected the SED1330 to use as a built-in controller in our mid-size graphic modules. This CMOS LSI device generates all the signals required by the display memory and LCD drivers, and incorporates a character generator ROM. The command set within the SED1330 allows the user to create a layered display of characters and graphics, scroll the display, and assign display attributes to selected areas of the screen. The controller also functions as a pipeline buffer between the MPU and display memory so that low cost, medium speed SRAM can be used.

This advanced LCD controller IC features:

- 6800 and 8080 family compatibility
- Eight bit parallel buffered MPU interface (bi-directional)
- Control of 64 K bytes of memory
- Horizontal and vertical scrolling
- Reverse video and flashing
- Up to three layers of graphics
- Up to two layers of mixed character & graphics
- User defined characters & internal character generator
- Supports external character ROM & RAM
- Supports 8 x 8 or 8 x 16 pixel characters

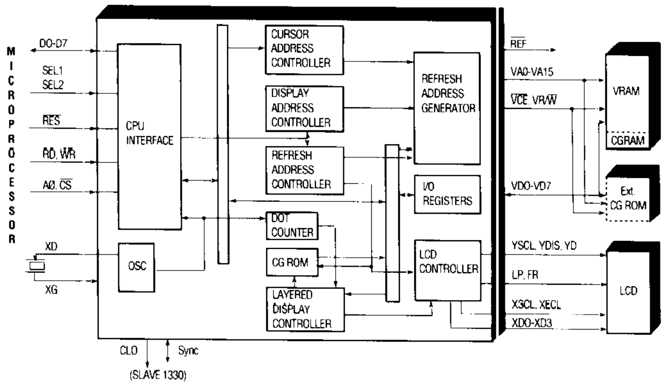
The new SED1335 controller, used in model G121C, has all of the same features as the SED1330. In addition, this new controller accommodates a +3.3 Volt input.

The SED1330, shown in the block diagram, is located between the MPU and the display memory. This permits the MPU to send and receive control commands and data for display. The SED1330 can control up to 64 K bytes of display memory.

The on-chip LCD control circuit enables the SED1330 to exploit all the graphic features of the Seiko Instruments LCD modules, using the on-chip register functions with no external circuits.

The SED1330 divides its memory space into four areas:

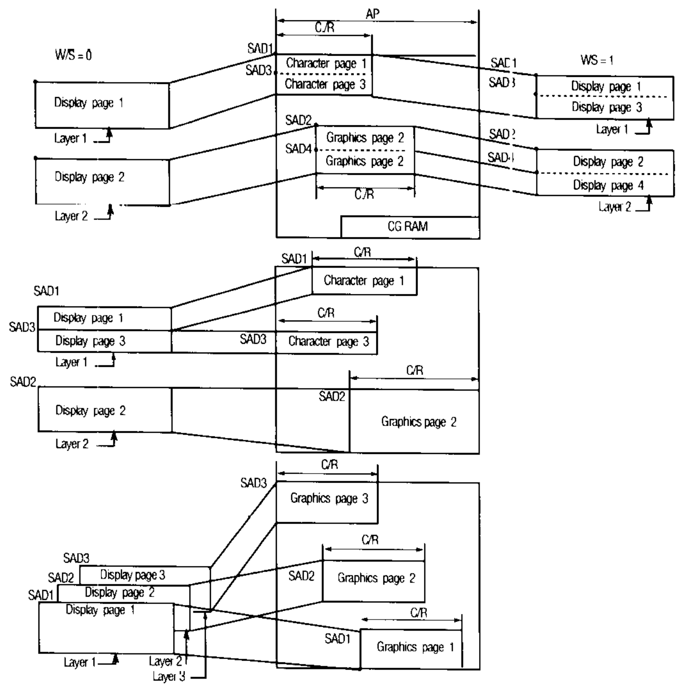
1. Character data table
2. Graphics data table
3. CG RAM table
4. External CG ROM table



Internal Block Diagram

The SED1330 supports virtual screens that are larger than the physical size of the LCD panel address range, C/R. A layer of the SED1330 can be considered as a window in the larger virtual screen held in display memory. This window can be divided into two blocks, with each block able to display a different portion of the virtual screen.

This enables, for example, one block to dynamically scroll through a data area while the other acts as a status message display area.



Display Layers and Memory

1330 Controller Features (Continued)

An SED1330 can provide a superimposed display of up to three layers of screens, but the cursor can be displayed on only one of the three. If more than one layer is used the cursor home layer is

- The 1st layer (L1) for a two-layer display.
- The 3rd layer (L3) for a three layer display.

The cursor is not displayed outside its home layer. Screens can be moved into the cursors home layer by adjusting the parameters of the SCROLL command.

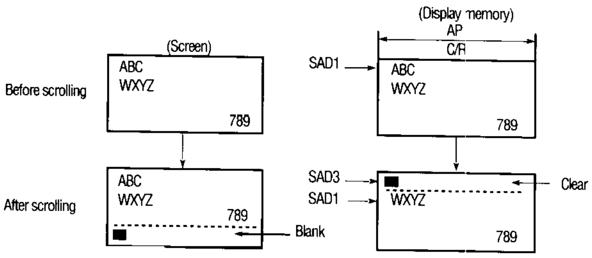
■ Scrolling

Scrolling of the screens is managed by the MPU, and affected by dynamically modifying the contents of the scroll address registers (SAD1 to SAD4). The MPU determines when scrolling should occur, selection of scroll mode, scroll rate, etc.

■ On-page Scrolling

Scrolling is executed in a display memory area the size of one screen. When the cursor is on the bottom line of the display, as shown below, execution of a line feed (LF) or the entry of the last character in the line should cause the whole screen to scroll up by one line width and the bottom line to be cleared. This is achieved by splitting the display between two screens, 1 and 3.

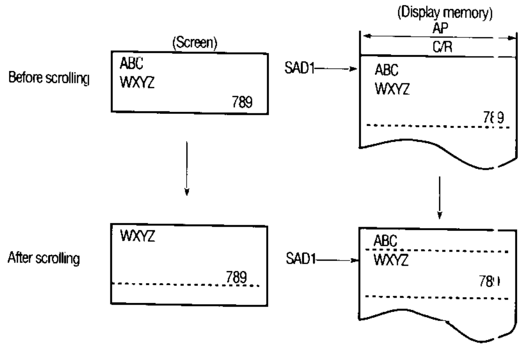
1. Set the start address of screen 3 to the current start address of screen 1 (SAD3 = SAD1).
2. Move screen 1 down one line (SAD1 = SAD1 + AP).
3. Clear the last line of screen 3.



On-page Scrolling

■ Inter-page Scrolling and Page Switch-over

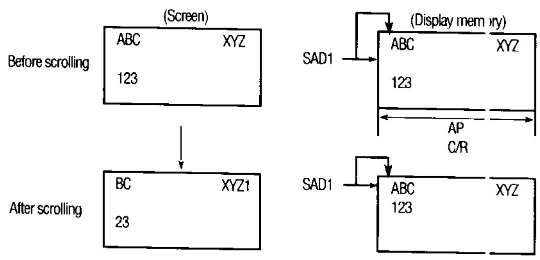
Inter-page scrolling and page switch-over are available when using display memory with a capacity of more than one screen.



Inter-page Scrolling

■ Horizontal Wraparound Scrolling

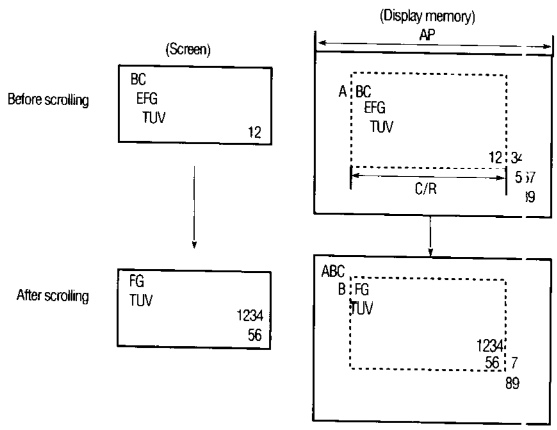
This scrolling style is available when C/R = AP.



Horizontal Wraparound Scrolling

■ Multi-directional Scrolling

This style of scrolling is available when the size of display memory is larger than the actual screen by at least one character in both the X and Y directions. Multi-directional scrolling is usually made in 1-character units, but by using the HDOT SCR command pixel by pixel horizontal scrolling is also possible.



Multidirectional Scrolling

■ Display Attributes

To improve the display legibility when using a monochromatic LCD, the SED1330 can generate "reverse video" characters, half tone displays, and local flashing by combining layers in different ways.

	MX1 MXO	Screen	1st Layer Single Screen	2nd Layer Single Screen
Reverse	0 1 1 1	IV [SEIKO]	IV SEIKO	[ ]
Half-Tone Display	0 0 - 1 1	ME [YES, NO]	ME YES, NO	[ ]
Locally Flashing Display	0 0 1 1	BL \///// Error /\\\\\	BL	\///// Error /\\\\\

Possible Display Attributes

* Only one style of attribute can be used per screen.

■ Reverse Video

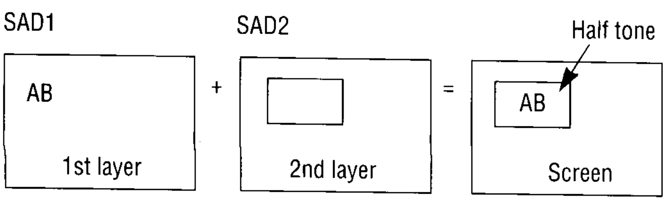
Reverse video effects can be generated by taking the "exclusive-OR" of the 1st layer (character) and the 2nd layer (graphics)

1. CSRW, CSRDIR, and MWRITE commands: Data "1" are written into the graphics area corresponding to the intended "reversed" area of the display.
2. OVLAY command: The OVLAY command selects "exclusive-OR" superposition of the first and second layers.
   MX1 = 0, MX = 1
3. DISP ON/OFF command: This command turns on the first and second layers, resulting in reversed characters.
   (FP1, FP0) = (0,1)
   (FP3, FPZ) = (0,1)

■ Half Tone Display

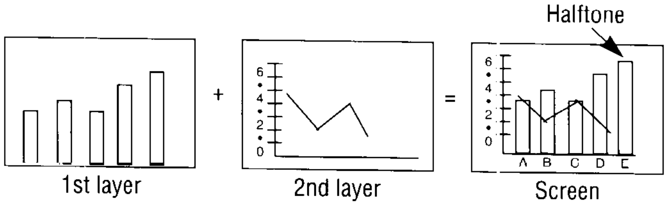
Half tone displays can be generated by rapidly flashing one layer of the display. Care should be taken using this display mode since it may cause certain LCD's to flicker.

1. Display of menu pad (using "OR-ed" layers)
   A menu choice can be highlighted by displaying full tone characters against a half tone "pad".



Halftone Menu

2. Graph display (using 'OR-ed" layers)
   If data is to be displayed in the form of graphs, two different graphs can be differentiated by creating a contrast difference between them.

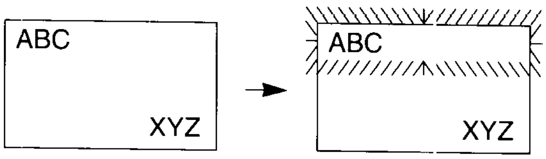


Halftone Display

■ Localized Flashing

1. When a few characters are to be flashed.
   A few characters can be flashed if the MPU alternately rewrites character codes and blank codes into display memory. The MPU should rewrite the data every 0.5 to 1.0 second.

2. When a large area is to be flashed.
   The first and second layers are divided into two screens each. Then the flashing sections are "XOR-tied", and flashed slowly.



Localized Flashing

■ Character Generator

■ Internal Character Generator

The internal character generator is recommended for minimum system configurations containing a SED1330, display RAM, LCD panel, single-chip microprocessor and power supply. Since the internal character generator uses a CMOS mask ROM, it is also recommended for low-power applications.

- ■ 5 x 7-pixel font
- ■ 160 JIS standard characters
- ■ Can be mixed with character generator RAM (maximum of 64 CG RAM characters)
- ■ Can be automatically spaced out up to 8 x 16 pixels

■ External Character Generator ROM

The external CG ROM can be used when fonts other than those in the internal ROM are needed. Data is stored in the external ROM in the same format used in the internal ROM.

- ■ Up to 8 x 8-pixel characters (M2 = 0) or 8 x 16-pixel characters (M2 = 1)
- ■ Up to 256 characters (192 if used together with the internal ROM)

- Mapped into the display memory address space at F000H to F7FFH (M2 = 0) or F000H to FFFFH (M2 = 1)
- Characters can be up to 8 x 16 pixels, however excess bits must be set to zero.

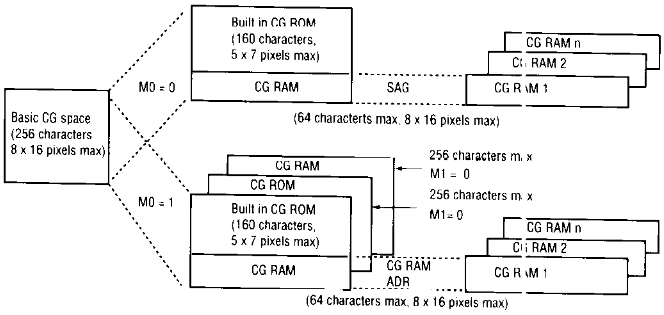
Character Generator RAM

The user can freely use the character generator RAM for storing graphics characters. The character generator RAM can be mapped by the microprocessor anywhere in display memory, allowing effective use of unused address space.

- Up to 8 x 8-pixel characters (M2 = 0) or 8 x 16 characters (M2 = 1)
- Up to 256 characters if mapped at F000H to FFFFH (64 if used together with character generator ROM)
- Can be mapped anywhere in display memory address space if used with the character generator ROM
- Mapped into the display memory address space at F000H to F7FFH if not used with the character generator ROM (more than 64 characters are in the CG RAM). Set SAG0 to F000H and M1 to zero when defining characters number 193 upwards.

CG Memory Allocation

Since the SED1330 uses 8-bit character codes, it can handle no more than 256 characters at a time. However, if a wider range of characters is required, character generator memory can be bank-switched using the CGRAM ADR command.



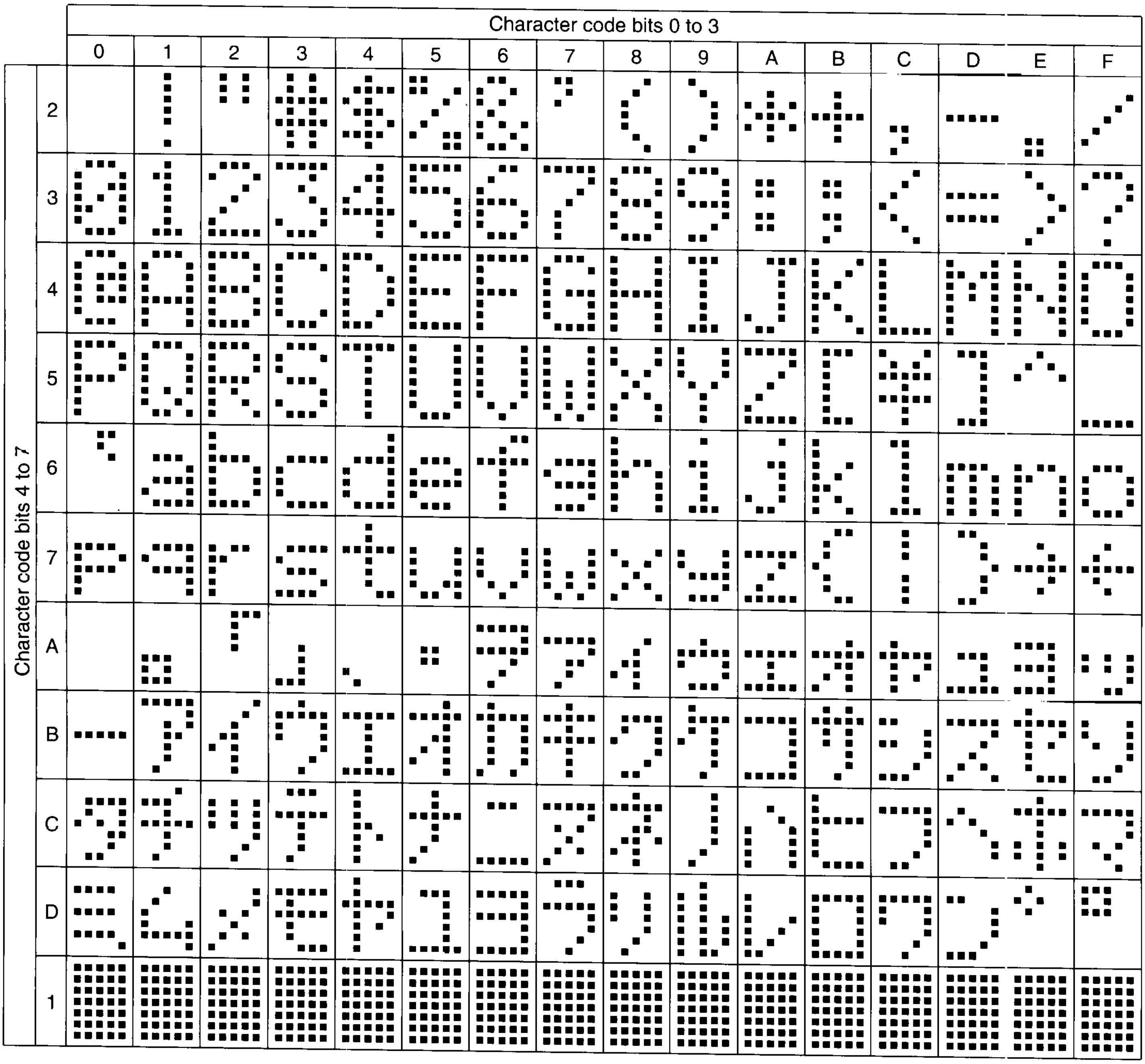
Internal and external character mapping

Note that there can be no more than 64 characters per bank.

Character Mapping

Item		Parameter	Remarks
Internal/external character generator selection			M0
Character field height	1 to 8 pixels	M2 = 0	
	9 to 16 pixels	M2 = 1	
	Greater than 16 pixels	Graphics mode (8 bits x 1 line)	
Internal CG ROM/RAM select External CG ROM/RAM select		Automatic	Determined by the character code
CG RAM bit 6 correction		M1	
CG RAM data storage address		Specified with CGRAM ADR command	Can be moved anywhere in the display memory address space
External CG ROM address	192 characters or less	Other than the area of figure 49	
	More than 192 characters	Set SAG to F000H and overlay SAG and the CG ROM table	

■ Internal Character Generator Font



Modules with Built-in 1330 Controller

■ Seiko Instruments Offers Five Mid-size Graphic Modules With a Built-in Controller.

- ■ G121C = 128 x 128 = SED1335
- ■ G2446 = 240 x 64 = SED1330
- ■ G242C = 240 x 128 = SED1330
- ■ G321D = 320 x 200 = SED1330
- ■ G324E = 320 x 240 = SED1330

The SED1330 LCD controller IC generates all the signals required by the display memory and by the common and segment drivers, and has a built-in character generator ROM. The MPU interface can be configured for both the 6800 family and 8080 family processors. Text, graphics, and overlayed text and graphics can be displayed.

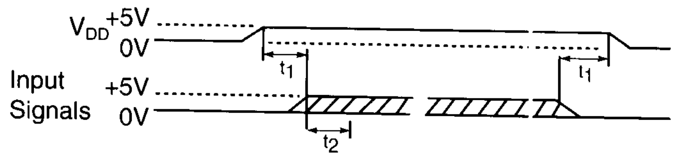
The new SED1335 controller, used in model G121C, has all of the same features as the SED1330. In addition, this new controller accommodates a +3.3 Volt input.

Command	Code (Hex)	Description
SYSTEM SET	40	System and display initialization
SLEEP IN	53	Enter standby mode
DISP ON/OFF	58,59	Display blinking and blanking
SCROLL	44	Set display starting address and display area
CSRFORM	5D	Set cursor type
CSRDIR	4C-4F	Set cursor movement direction
OVLAY	5B	Set overlay format
CGRAM ADR	5C	Set CGRAM start address
HDOT SCR	5A	Set horizontal scroll position
CSRW	46	Set cursor address
CSRR	47	Read cursor address
MWRITE	42	Write data to display memory
MREAD	43	Read data from memory

■ Timing Characteristics

Power ON/OFF and signal input timing should be performed according to the timing charts shown below.

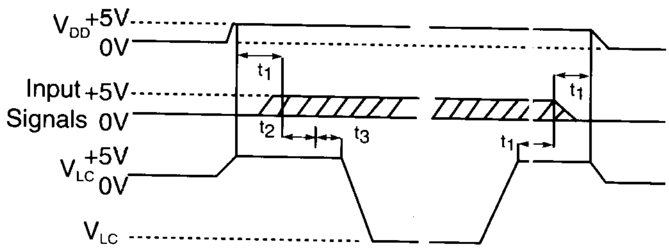
■ G2446 & G242C



$t_1 \geq 0$ ms
t_2: controller initialization time

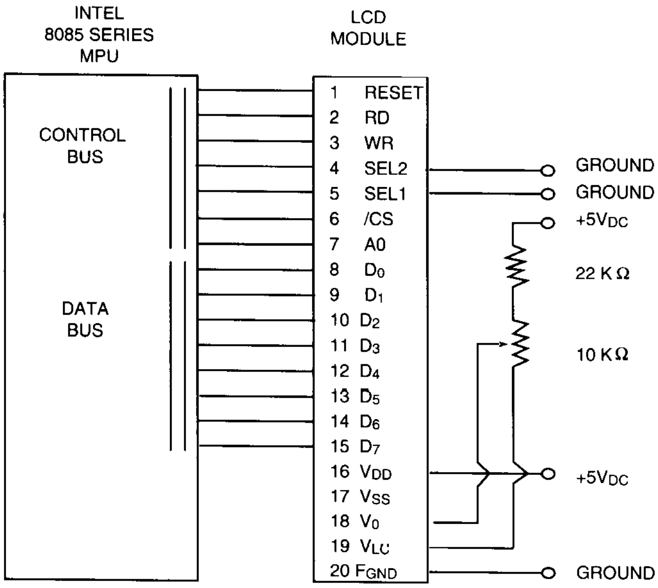
NOTE: The controller must be initialized immediately after the power supply goes to 5V

■ G121C, G321D, G324E

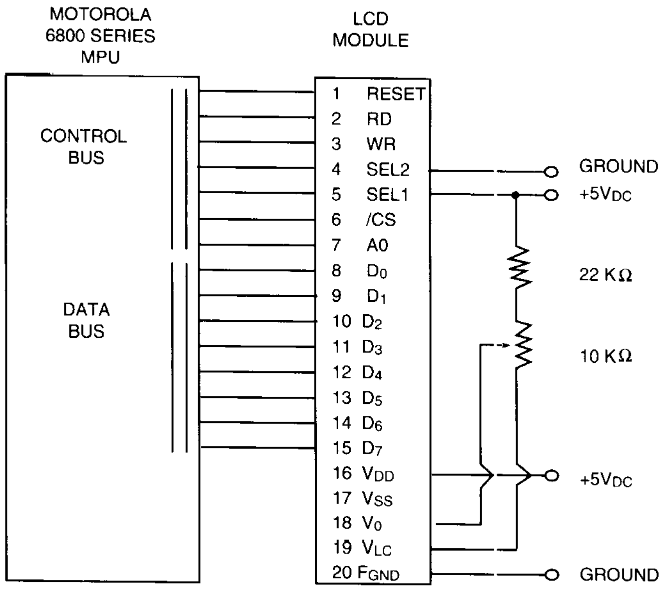


$t_1 \geq 0$ ms
$t_3 \geq 20$ ms
t_2: controller initialization time

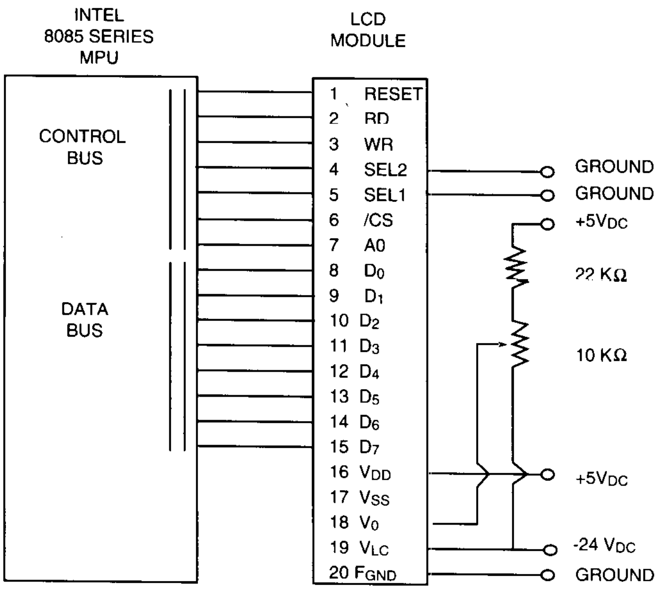
■ Connections for G2446 & G242C With Built-In Controller



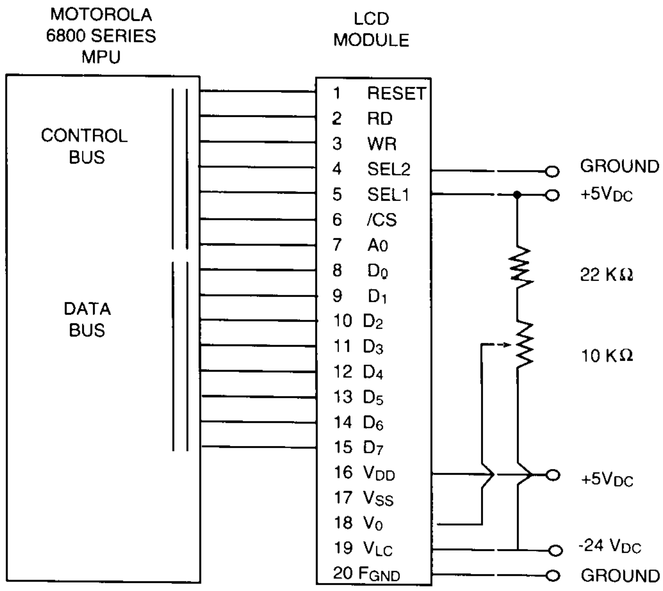
■ Connections for G2446 & G242C With Built-In Controller



■ Connections for G121C, G321D & G324E With Built-In Controller*



■ Connections for G121C, G321D & G324E With Built-In Controller*



* Note: Modify these two diagrams as follows:

G121C Pin 20 = INH. Pins 21 & 22 = LED backlight.

G324E: Pin 4 = no connection. SEL2 is internally grounded for G324E with built-in controller.

On the following pages you can find the initialization examples for the five display modules. Transferring the parameters to the display modules will set up a display system having:

- Single screen drive mode
- Layer 1, character display
- Layer 2, graphic display
- Character font, 8 x 8 pixels
- CGRAM, 32 characters max.

■ Initialization Example for G121C (128 x 128)

Command	Code (HEX)	D7	D6	D5	D4	D3	D2	D1	D0	Description
SYSTEM SET	40	0	1	0	0	0	0	0	0	System and display initialization command
Parameter 1	30	PKT	0	IV	1	W/S	M2	M1	M0	M0: 0 Internal CGROM M1: 0 CGRAM 32 characters Max M2: 0 Character height = 8 pixels W/S: 0 Single screen display I/V: 1 Character offset disabled PKT: 0
Parameter 2	87	WF	0	0	0	0	←	FX	→	FX: 7 Character field width = 8 WF: 1 Two frame AC Drive
Parameter 3	07	0	0	0	0	←		FY	→	FY: 7 Character field height = 8
Parameter 4	10	←			C/R				→	C/R: 29d Characters per row = 16
Parameter 5	4A	←			T C/R				→	T C/R: 148d Timing characters per row = 149d fOSC = 6 MHz: Frame Freq. = 70 Hz
Parameter 6	7F	←			L/F				→	L/F: 63 Number of lines per screen = 128
Parameter 7	1E	←			APL				→	APL: 30d Address pitch = C/R + 1
Parameter 8	00	←			APH				→	APH: 00H
SCROLL	44	0	1	0	0	0	1	0	0	Set display starting address and display area
Parameter 1	00	←			SAD1L				→	Screen1 start address (low) = 00H
Parameter 2	00	←			SAD1H				→	Screen1 start address (high) = 00H
Parameter 3	7F	←			SL1				→	SL1: 127d Number of lines in Screen 1 = 128d
Parameter 4	00	←			SAD2L				→	Screen2 start address (low) = 00H
Parameter 5	05	←			SAD2H				→	Screen2 start address (high) = 05H
Parameter 6	7F	←			SL2				→	SL2: 127d Number of lines in Screen 2 = 128d
CSRDIR	4C	0	1	0	0	1	1	CD1	CD2	Set cursor movement direction CD1, CD2: 0 0 Shift direction = Right
HDOT SCR	5A	0	1	0	1	1	0	1	0	Set horizontal scroll position
Parameter 1	00	0	0	0	0	0	←	CD1	→	CD1: 0d Don't scroll display horizontally
CSRW	46	0	1	0	0	0	1	1	0	Set cursor address
Parameter 1	00	←			CSRL				→	Cursor address (low) = 00
Parameter 2	00	←			CSRH				→	Cursor address (high) = 00
MWRITE	42	0	1	0	0	0	0	1	0	Write data to display memory
Parameter 1 - n	--	←			Character codes				→	Write n characters to the display memory
OVLAY	5B	0	1	0	1	1	0	1	1	Set overlay format
Parameter 1	01	0	0	0	OV	DM2	DM1	MX1	MX0	MX1, MX0: 01 L1 exOR L2 DM2, DM1: 00 1st and 3rd screens in character mode OV: 0 Two layer synthesis
DISP ON/OFF	59	0	1	0	1	1	0	0	D	Display blinking and blanking D: 1 Entire display active
Parameter 1	04	FP5	FP4	FP3	FP2	FP1	FP0	FC1	FC0	FC1, FC0: 00 Cursor display OFF FP1, FP0: 01 1st screen ON FP3, FP2: 00 2nd screen OFF FP5, FP4: 00 3rd screen OFF

Note: d: decimal notation, H: hex notation

■ Initialization Example for G2446 (240 x 64)

Command	Code (HEX)	D7	D6	D5	D4	D3	D2	D1	D0	Description
SYSTEM SET	40	0	1	0	0	0	0	0	0	System and display initialization command
Parameter 1	30	PKT	0	IV	1	W/S	M2	M1	M0	M0: 0 Internal CGROM M1: 0 CGRAM 32 characters Max M2: 0 Character height = 8 pixels W/S: 0 Single screen display I/V: 1 Character offset disabled PKT: 0
Parameter 2	87	WF	0	0	0	0	←	FX	→	FX: 7 Character field width = 8 WF: 1 Two frame AC Drive
Parameter 3	07	0	0	0	0	←		FY	→	FY: 7 Character field height = 8
Parameter 4	1D	←			C/R				→	C/R: 29d Characters per row = 30
Parameter 5	94	←			T C/R				→	T C/R: 148d Timing characters per row = 149d fOSC = 6 MHz: Frame Freq. = 70 Hz
Parameter 6	3F	←			L/F				→	L/F: 63 Number of lines per screen = 64
Parameter 7	1E	←			APL				→	APL: 30d Address pitch = C/R + 1
Parameter 8	00	←			APH				→	APH: 00H
SCROLL	44	0	1	0	0	0	1	0	0	Set display starting address and display area
Parameter 1	00	←			SAD1L				→	Screen1 start address (low) = 00H
Parameter 2	00	←			SAD1H				→	Screen1 start address (high) = 00H
Parameter 3	3F	←			SL1				→	SL1: 63d Number of lines in Screen 1 = 64d
Parameter 4	00	←			SAD2L				→	Screen2 start address (low) = 00H
Parameter 5	05	←			SAD2H				→	Screen2 start address (high) = 05H
Parameter 6	3F	←			SL2				→	SL2: 63d Number of lines in Screen 2 = 64d
CSRDIR	4C	0	1	0	0	1	1	CD1	CD2	Set cursor movement direction CD1, CD2: 0 0 Shift direction = Right
HDOT SCR	5A	0	1	0	1	1	0	1	0	Set horizontal scroll position
Parameter 1	00	0	0	0	0	0	←	CD1	→	CD1: 0d Don't scroll display horizontally
CSRW	46	0	1	0	0	0	1	1	0	Set cursor address
Parameter 1	00	←			CSRL				→	Cursor address (low) = 00
Parameter 2	00	←			CSRH				→	Cursor address (high) = 00
MWRITE	42	0	1	0	0	0	0	1	0	Write data to display memory
Parameter 1 - n	--	←			Character codes				→	Write n characters to the display memory
OVLAY	5B	0	1	0	1	1	0	1	1	Set overlay format
Parameter 1	01	0	0	0	OV	DM2	DM1	MX1	MX0	MX1, MX0: 01 L1 exOR L2 DM2, DM1: 00 1st and 3rd screens in character mode OV: 0 Two layer synthesis
DISP ON/OFF	59	0	1	0	1	1	0	0	D	Display blinking and blanking D: 1 Entire display active
Parameter 1	04	FP5	FP4	FP3	FP2	FP1	FP0	FC1	FC0	FC1, FC0: 00 Cursor display OFF FP1, FP0: 01 1st screen ON FP3, FP2: 00 2nd screen OFF FP5, FP4: 00 3rd screen OFF

Note: d: decimal notation, H: hex notation

■ Initialization Example for G242C (240 x 128)

Command	Code (HEX)	Function D7	D6	D5	D4	D3	D2	D1	D0	Description
SYSTEM SET	40	0	1	0	0	0	0	0	0	System and display initialization command
Parameter 1	30	PKT	0	IV	1	W/S	M2	M1	M0	M0: 0 Internal CGROM M1: 0 CGRAM 32 characters Max M2: 0 Character height = 8 pixels W/S: 0 Single screen display I/V: 1 Character offset disabled PKT: 0
Parameter 2	87	WF	0	0	0	0	←	FX	→	FX: 7 Character field width = 8 WF: 1 Two frame AC Drive
Parameter 3	07	0	0	0	0	←		FY	→	FY: 7 Character field height = 8
Parameter 4	1D	←			C/R				→	C/R: 29d Characters per row = 30
Parameter 5	4A	←			T C/R				→	T C/R: 74d Timing characters per row = 75d fOSC = 6 MHz: Frame Freq. = 70 Hz
Parameter 6	7F	←			L/F				→	L/F: 127 Number of lines per screen = 128
Parameter 7	1E	←			APL				→	APL: 30d Address pitch = C/R + 1
Parameter 8	00	←			APH				→	APH: 00H
SCROLL	44	0	1	0	0	0	1	0	0	Set display starting address and display area
Parameter 1	00	←			SAD1L				→	Screen1 start address (low) = 00H
Parameter 2	00	←			SAD1H				→	Screen1 start address (high) = 00H
Parameter 3	7F	←			SL1				→	SL1: 127d Number of lines in Screen 1 = 128d
Parameter 4	00	←			SAD2L				→	Screen2 start address (low) = 00H
Parameter 5	05	←			SAD2H				→	Screen2 start address (high) = 05H
Parameter 6	7F	←			SL2				→	SL2: 127d Number of lines in Screen 2 = 128d
CSRDIR	4C	0	1	0	0	1	1	CD1	CD2	Set cursor movement direction CD1, CD2: 0 0 Shift direction = Right
HDOT SCR	5A	0	1	0	1	1	0	1	0	Set horizontal scroll position
Parameter 1	00	0	0	0	0	0	←	CD1	→	CD1: 0d Don't scroll display horizontally
CSRW	46	0	1	0	0	0	1	1	0	Set cursor address
Parameter 1	00	←			CSRL				→	Cursor address (low) = 00
Parameter 2	00	←			CSRH				→	Cursor address (high) = 00
MWRITE	42	0	1	0	0	0	0	1	0	Write data to display memory
Parameter 1 - n	--	←			Character codes				→	Write n characters to the display memory
OVLAY	5B	0	1	0	1	1	0	1	1	Set overlay format
Parameter 1	01	0	0	0	OV	DM2	DM1	MX1	MX0	MX1, MX0: 01 L1 exOR L2 DM2, DM1: 00 1st and 3rd screens in character mode OV: 0 Two layer synthesis
DISP ON/OFF	59	0	1	0	1	1	0	0	D	Display blinking and blanking D: 1 Entire display active
Parameter 1	04	FP5	FP4	FP3	FP2	FP1	FP0	FC1	FC0	FC1, FC0: 00 Cursor display OFF FP1, FP0: 01 1st screen ON FP3, FP2: 00 2nd screen OFF FP5, FP4: 00 3rd screen OFF

Note: d: decimal notation, H: hex notation

■ Initialization Example for G321D (320 x 200)

Command	Code (HEX)	D7	D6	D5	D4	D3	D2	D1	D0	Description
SYSTEM SET	40	0	1	0	0	0	0	0	0	System and display initialization command
Parameter 1	30	PKT	0	IV	1	W/S	M2	M1	M0	M0: 0 Internal CGROM M1: 0 CGRAM 32 characters Max M2: 0 Character height = 8 pixels W/S: 0 Single screen display I/V: 1 Character offset disabled PKT: 0
Parameter 2	87	WF	0	0	0	0	←	FX	→	FX: 7 Character field width = 8 WF: 1 Two frame AC Drive
Parameter 3	07	0	0	0	0	←	FY		→	FY: 7 Character field height = 8
Parameter 4	27	←			C/R				→	C/R: 39d Characters per row = 40
Parameter 5	2F	←			T C/R				→	T C/R: 47d Timing characters per row = 48d fOSC = 6 MHz: Frame Freq. = 70 Hz
Parameter 6	C7	←			L/F				→	L/F: 199 Number of lines per screen = 200
Parameter 7	28	←			APL				→	APL: 40d Address pitch = C/R + 1
Parameter 8	00	←			APH				→	APH: 00H
SCROLL	44	0	1	0	0	0	1	0	0	Set display starting address and display area
Parameter 1	00	←			SAD1L				→	Screen1 start address (low) = 00H
Parameter 2	00	←			SAD1H				→	Screen1 start address (high) = 00H
Parameter 3	C7	←			SL1				→	SL1: 199d Number of lines in Screen 1 = 200d
Parameter 4	00	←			SAD2L				→	Screen2 start address (low) = 00H
Parameter 5	05	←			SAD2H				→	Screen2 start address (high) = 05H
Parameter 6	C7	←			SL2				→	SL2: 199d Number of lines in Screen 2 = 200d
CSRDIR	4C	0	1	0	0	1	1	CD1	CD2	Set cursor movement direction CD1, CD2: 0 0 Shift direction = Right
HDOT SCR	5A	0	1	0	1	1	0	1	0	Set horizontal scroll position
Parameter 1	00	0	0	0	0	0	←	CD1	→	CD1: 0d Don't scroll display horizontally
CSRW	46	0	1	0	0	0	1	1	0	Set cursor address
Parameter 1	00	←			CSRL				→	Cursor address (low) = 00
Parameter 2	00	←			CSRH				→	Cursor address (high) = 00
MWRITE	42	0	1	0	0	0	0	1	0	Write data to display memory
Parameter 1 - n	--	←			Character codes				→	Write n characters to the display memory
OVLAY	5B	0	1	0	1	1	0	1	1	Set overlay format
Parameter 1	01	0	0	0	0V	DM2	DM1	MX1	MX0	MX1, MX0: 01 L1 exOR L2 DM2, DM1: 00 1st and 3rd screens in character mode OV: 0 Two layer synthesis
DISP ON/OFF	59	0	1	0	1	1	0	0	D	Display blinking and blanking D: 1 Entire display active
Parameter 1	04	FP5	FP4	FP3	FP2	FP1	FP0	FC1	FC0	FC1, FC0: 00 Cursor display OFF FP1, FP0: 01 1st screen ON FP3, FP2: 00 2nd screen OFF FP5, FP4: 00 3rd screen OFF

Note: d: decimal notation, H: hex notation

■ Initialization Example for G324E (320 x 240)

Command	Code (HEX)	Function								Description
		D_7	D_6	D_5	D_4	D_3	D_2	D_1	D_0	
SYSTEM SET	40	0	1	0	0	0	0	0	0	System and display initialization command
Parameter 1	30	PKT	0	IV	1	W/S	M2	M1	M0	M0: 0 Internal CGROM M1: 0 CGRAM 32 characters Max M2: 0 Character height = 8 pixels W/S: 0 Single screen display I/V: 1 Character offset disabled PKT: 0
Parameter 2	87	WF	0	0	0	0	←	FX	→	FX: 7 Character field width = 8 WF: 1 Two frame AC Drive
Parameter 3	07	0	0	0	0	←	FY		→	FY: 7 Character field height = 8
Parameter 4	27	←			C/R				→	C/R: 39d Characters per row = 40
Parameter 5	2F	←			T C/R				→	T C/R: 47d Timing characters per row = 48d fOSC = 6 MHz: Frame Freq. = 70 Hz
Parameter 6	EF	←			L/F				→	L/F: 199D Number of lines per screen = 240
Parameter 7	28	←			APL				→	APL: 40d Address pitch = C/R + 1
Parameter 8	00	←			APH				→	APH: 00H
SCROLL	44	0	1	0	0	0	1	0	0	Set display starting address and display area
Parameter 1	00	←			SAD1L				→	Screen1 start address (low) = 00H
Parameter 2	00	←			SAD1H				→	Screen1 start address (high) = 00H
Parameter 3	EF	←			SL1				→	SL1: 239d Number of lines in Screen 1 = 240d
Parameter 4	00	←			SAD2L				→	Screen2 start address (low) = 00H
Parameter 5	05	←			SAD2H				→	Screen2 start address (high) = 05H
Parameter 6	EF	←			SL2				→	SL2: 239d Number of lines in Screen 2 = 240d
CSRDIR	4C	0	1	0	0	1	1	CD1	CD2	Set cursor movement direction CD1, CD2: 0 0 Shift direction = Right
HDOT SCR	5A	0	1	0	1	1	0	1	0	Set horizontal scroll position
Parameter 1	00	0	0	0	0	0	←	CD1	→	CD1: 0d Don't scroll display horizontally
CSRW	46	0	1	0	0	0	1	1	0	Set cursor address
Parameter 1	00	←			CSRL				→	Cursor address (low) = 00
Parameter 2	00	←			CSRH				→	Cursor address (high) = 00
MWRITE	42	0	1	0	0	0	0	1	0	Write data to display memory
Parameter 1 - n	--	←			Character codes				→	Write n characters to the display memory
OVLAY	5B	0	1	0	1	1	0	1	1	Set overlay format
Parameter 1	01	0	0	0	OV	DM2	DM1	MX1	MX0	MX1, MX0: 01 L1 exOR L2 DM2, DM1: 00 1st and 3rd screens in character mode OV: 0 Two layer synthesis
DISP ON/OFF	59	0	1	0	1	1	0	0	D	Display blinking and blanking D: 1 Entire display active
Parameter 1	04	FP5	FP4	FP3	FP2	FP1	FP0	FC1	FC0	FC1, FC0: 00 Cursor display OFF FP1, FP0: 01 1st screen ON FP3, FP2: 00 2nd screen OFF FP5, FP4: 00 3rd screen OFF

Note: d: decimal notation, H: hex notation

The Seiko instruments family of LCDC-1330 controller boards feature the advanced SED1330 IC described in the previous section. These controller boards are designed to allow the user to quickly interface our graphic modules with the intel 8085 or Motorola 6800 series microprocessors to display text, graphics, and overlayed text & graphics. The controller boards support 32K bytes of static RAM as display memory that can be defined as text space or graphics space. These memory spaces may be overlayed to produce mixed graphics and text, inverse video, area blinking, and overlay masking.

■ Memory Size Selection

Resolution of LCD	Min. memory size for 1 screen	Model number
128 x 128	2K	LCDC-1300-32A
240 x 64	2K	LCDC-1330-32A
192 x 128	3K	LCDC-1330-32A
192 x 192	5K	LCDC-1330-32A
240 x 128	4K	LCDC-1330-32A
320 x 200	8K	LCDC-1330-32A
320 x 240	8K	LCDC-1330-32A
640 x 200	16K	LCDC-1330-32A

■ LCDC-1330 Features

Character Display Mode

- Programmable or automatic cursor shift function
- Flexible scroll function
- Two or three screen layered function
- Block or underline cursor function
- Area flashing function
- Internal character generator: JIS 160 characters (5x7)
- External character generator: 256 characters (8x8 or 8x16)

Graphic Display Mode

- Maximum display size: 640 dots (H) x 256 dots (V)
- 2 or 3 screen overlayed function
- Independent block flashing and on/off control
- Graphic display mode can be mixed with character display mode

■ Electrical Characteristics (T_{opr} = 0°C to 50°C V_{DD} = 5V±5%; V_{SS} = 0V)

Symbol	Parameter	Min.	Typ.	Max.	Units	Test Conditions	Terminals
V_{DD}	Supply Voltage	4.0	5.0	6.0	V		V_{DD}
V_{DDPD}	Power Down Supply Voltage	2.0		6.0	V		
TTL							
V_{IHT}	Input High Voltage (TTL)	2.2	-	V_{DD}=0.3	V		D_0 - D_7, A0
V_{ILT}	Input Low Voltage (TTL)	-0.3	-	0.8	V		$\overline{CS}$, $\overline{RD}$, $\overline{WR}$
V_{OHT}	Output High Voltage (TTL)	2.4	-	-	V	I_{OH}=-0.5mA	
V_{OLT}	Output Low Voltage (TTL)	-	-	0.4	V	I_{OL}=5.0mA	
CMOS							
V_{IHC}	Input High Voltage (CMOS)	$0.8V_{DD}$	-	-	V		DB_0-DB_3, FLM, M
V_{ILC}	Input Low Voltage (CMOS)	-	-	$0.2V_{DD}$	V		CL1, CL2
V_{OHC}	Output High Voltage (CMOS)	V_{DD}-0.4	-	-	V	I_{OH}=1.6mA	
V_{OLC}	Output Low Voltage (CMOS)	-	-	0.4	V	I_{OL}=1.6mA	
SCHMITT							
V_{T+}	Positive-going Threshold Voltage	$0.5V_{DD}$	$0.7V_{DD}$	$0.8V_{DD}$	V		$\overline{RES}$
V_{T-}	Negative-going Threshold Voltage	$0.2V_{DD}$	$0.3V_{DD}$	$0.5V_{DD}$	V		$\overline{RES}$
I_{LI}	Input Leakage Current	-	0.05	2.0	µA		
I_{LO}	Output Leakage Current	-	0.10	5.0	µA		
I_{OPR}	Average Dynamic Power Consumption	-	8.0	12	mA		
I_Q	Average Static Power Consumption	-	0.05	20	µA		

■ Pin Assignment

CN1: Connection for Microprocessor Interface

PIN#	SIGNAL	PIN#	SIGNAL
1	*RESET	9	D_3
2	*RD (E)	10	D_4
3	*WR (R/*W)	11	D_5
4	*CS	12	D_6
5	A0	13	D_7
6	D_0	14	V_{DD} (+5V)
7	D_1	15	V_{SS} (GND)
8	D_2	16	V_{LCD}

*Active low on the control signal

CN2: Connection for LCD Interface

PIN#	SIGNAL	PIN#	SIGNAL
1	DB_3	7	CL1 (LP)
2	DB_2	8	CL2(XSCL)
3	DB_1	9	V_{DD} (+5V)
4	DB_0	10	V_{SS} (GND)
5	FLM (YD)	11	V_0
6	M (WF)	12	V_{LCD}

The microprocessor may access the command/status register or read/write data by changing the value of *RD, *WR, and A0.

CN3: Contrast Adjustment

PIN#	SIGNAL
1	V_{DD} (+5V)
2	V_0
3	V_{LCD}

J1: Jumper Settings for CPU

1-2: Select Intel 8085 or Z80 microprocessor
2-3: Select Motorola 6800 microprocessor

■ Control Signal Status

Intel 8080 Series

A0	*RD	*WR	FUNCTION
0	0	1	Status Register Read
1	0	1	Read Data
0	1	0	Write Data
1	1	0	Command Register Write

*Active low on the control signal

Motorola 6800 Series

A0	*RD	*WR	FUNCTION
0	1	1	Status Register Read
1	1	1	Read Data
0	0	1	Write Data
1	0	1	Command Register Write

*Active low on the control signal

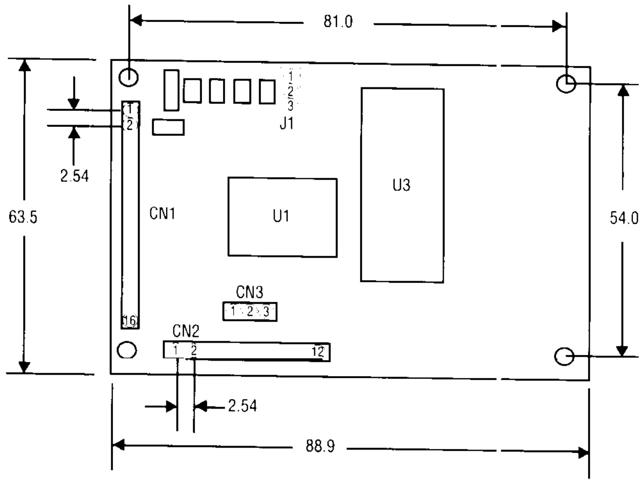
Except for the erase command, the LCDC-1330 does not require the CPU to check the ready status between passing commands or parameters. When issuing the erase command, the CPU must wait for at least two frame times before writing a new command to the LCDC-1330.

■ LCDC-1330 Characteristics

Absolute Maximum Ratings

ITEM	SPECIFICATION
Supply Voltage (V_{DD})	-0.3V to +7.0V
Voltage on Any Pin With Respect to Ground (V_{SS})	-0.5V to V_{DD} + 0.5
Operating Temperature	0°C to 50°C
Storage Temperature	-20°C to 60°C
Power Consumption	60mW

■ Dimensions of LCDC-1330 (mm)

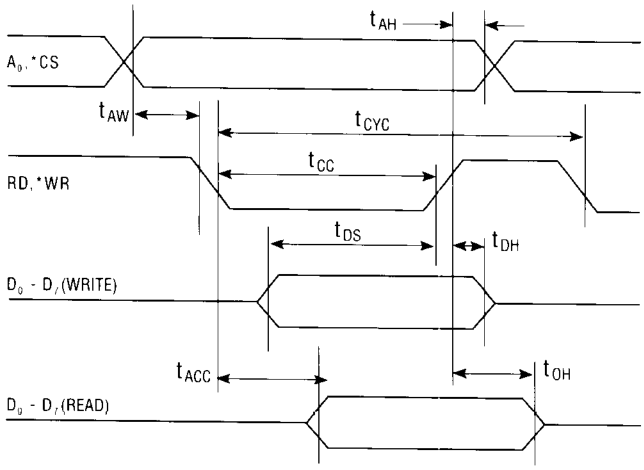


■ Microprocessor Interface Timing

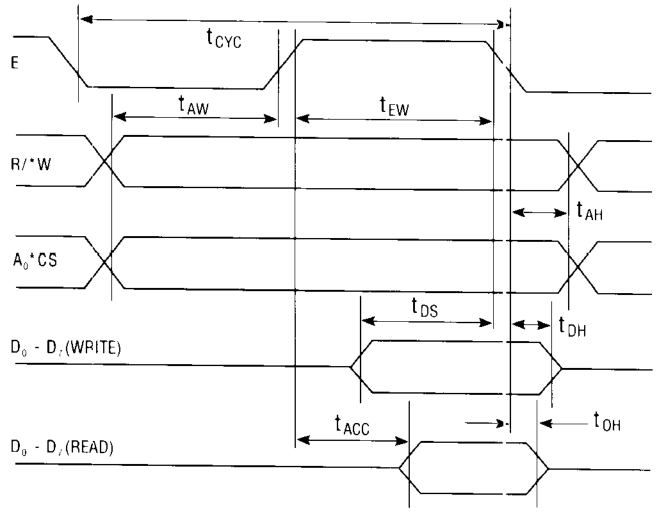
(T_{opr}=0°C to 50°C V_{DD}=5.0V±10%)

Signal	Symbol	Parameter	Min.	Max.	Units
80 Series Timing					
WR, RD	t_{CYC}	System Cycle Time	1000		ns
	t_{CC}	Control Pulse Width	220		ns
68 Series Timing					
A0, CS, $R\overline{W}$	t_{CYC}	System Cycle Time	1000		ns
E	t_{EW}	Enable Pulse Width	220		ns
Timing for 80 and 68 Series Processors					
A0, CS	t_{AH}	Address Hold Time	10		ns
	t_{AW}	Address Setup Time	30		ns
D_0-D_7	t_{DS}	Data Setup Time	120		ns
	t_{DH}	Data Hold Time	10		ns
	t_{ACC}	RD Access Time		120	ns
	t_{OH}	Output Disable Time	10	50	ns

■ 80 (Series Timing Diagram)



■ 68 (Series Timing Diagram)



■ Instruction Set Summary

System Set	0100 0000	40h
Display On	0101 1001	59h
Display Off	0101 1000	58h
Overlay	0101 1011	5Bh
CG RAM Address	0101 1100	5Ch
Scroll	0100 0100	44h
Horiz. Dot Scroll	0101 1010	5Ah
Cursor Format	0101 1101	5Dh
Cursor Right	0100 1100	4Ch
Cursor Left	0100 1101	4Dh
Cursor Up	0100 1110	4Eh
Cursor Down	0100 1111	4Fh
Cursor Write	0100 0110	46h
Cursor Read	0100 0111	47h
Memory Write	0100 0010	42h
Memory Read	0100 0011	43h
Erase	0101 0010	52h
Sleep	0101 0011	53h

■ Control Command Description

■ System Set (C:40h)

Symbol	D_7 D_6 D_5 D_4 D_3 D_2 D_1 D_0	Description
P1	0 0 IV 1 0 M2 M1 M0 M0 0: Internal CGROM 1: External CGROM or CGRAM M1: 0: 32 RAM based characters 1: 64 RAM based characters M2: 0: Character font = 8 rows/character 1: Character font = 16 rows/character IV: 0: First layer offset 1 row 1: No offset (normally used)	Mode of Operation
P2	WF 0 0 0 0 FX2 FX1 FX0 WF 0: Line reverse AC drive 1: Frame reverse AC drive (normally used) FXn 0/1: Define the width of the font (normally 111 is used for 8 pixels wide)	Width of a character field
P3	0 0 0 0 FY3 FY2 FY1 FY0 FYn 0/1: Define the height of the font (normally 0111 is used for 8 pixels high)	Height of a character field
P4 C/R:	C/R Total pixels in width divided by FX	Characters per row
P5	TC/R TC/R x L/F x FR x 9 = Fosc L/F: Lines per frame (vertical pixels/screen) FR: Frame frequency (from 60Hz to 80Hz) Fosc: 10 MHz (10^7) for LCDC-1330 6MHz (6×10^6) for built-in controller	Timing per character row (Adjust frame frequency)
P6	L/F L/F: Vertical pixels per screen	Lines per graphics screen
P7	APL APL: Normally C/R or C/R+1 is used	Virtual screen low byte
P8	APH APH: Normally 00h is used	Virtual screen high byte

■ Display On (C:59h)

Symbol	D_7	D_6	D_5	D_4	D_3	D_2	D_1	D_0	Note
P1	FP5	FP4	FP3	FP2	FP1	FP0	FC1	FC0	
	FC1	FC0	Cursor Control						
	0	0	Cursor off						
	0	1	Cursor on, no blink						
	1	0	On with 2 Hz blink rate						
	1	1	On with 1 Hz blink rate						
	FP1	FP0	SAD1 (L1)						Layer 1
	FP3	FP2	SAD2 (L2)						Layer 2
	FP5	FP4	SAD3 (L3)						Layer 3
	0	0	Layer off						
	0	1	Layer on, no blink						
	1	0	On with 2 Hz blink rate						
	1	1	On with 16 Hz blink rate						

■ Display OFF (C:58h)

This command causes the controller to inhibit the display of all enabled layers. The function of the parameter P1 that follows is the same as Display On.

■ Overlay (C:5Bh)

This command controls the plane interrelations defined by the following parameter byte. Options include or, xor, intersection, and priority overlay.

Symbol	D_7	D_6	D_5	D_4	D_3	D_2	D_1	D_0	Note
P1	0	0	0	OV	DM2	DM1	MX1	MX0	
	MX1	MX0	Method of Overlay						
	0	0	$L1 \cup L2 \cup L3$	Simple Overlay					
	0	1	$(L1 \oplus L2) \cup L3$	Reverse Overlay					
	1	0	$(L1 \cap L2) \cup L3$	Selective Overlay					
	1	1	$L1 > L2 > L3$	Priority Overlay					
	DM1	0: SAD1 defined as character layer 1: SAD1 defined as graphic layer							The second layer can be used as graphic layer only.
	DM0	0: SAD3 defined as character layer 1: SAD3 defined as graphic layer							
	OV	0: Configured for 2 layers 1: Configured for 3 layers							

■ CG RAM Address (C:5Ch)

The parameters of this command define the base address of a memory character generator table. (Normally F000h is used)

P1 (SAGL): Sets the lower byte of the CG RAM address
P2 (SAGH): Sets the higher byte of the CG RAM address

This command is not needed if the internal CG ROM is used. It is needed if an external CG RAM is used. A memory block of 2K or 4K bytes is required for vertical dot sizes of 8 or 16 respectively. (depends on M2 of System Set command)

■ Scroll (C:44h)

The scroll command is used to set the beginning display address of each layer and the number of lines in that layer. By modifying the beginning address of the layer, the screen may be made to scroll up or down.

P1 (SAD1L): Sets the lower byte of the first layer address
P2 (SAD1H): Sets the higher byte of the first layer address
P3 (SL1): Sets the line number per frame for the first layer
P4 (SAD2L): Sets the lower byte of the second layer address
P5 (SAD2H): Sets the higher byte of the second layer address
P6 (SL2): Sets the line number per frame for the second layer
P7 (SAD3L): Sets the lower byte of the third layer address
P8 (SAD3H): Sets the higher byte of the third layer address

■ Horiz. Dot Scroll (C:5Ah)

This command allows the screen to be scrolled by pixel increments. When used in conjunction with the Scroll command, smooth scrolling of the screen is possible. The number of pixels to offset by is passed in the parameter byte as follows:

P1: 0 0 0 0 0 D_2 D_1 D_0

■ Cursor Format (C:5Dh)

The variable size block and underline cursor can be set.

P1: 0 0 0 0 0 D_2 D_1 D_0 Cursor width
P2: CM 0 0 0 D_3 D_2 D_1 D_0 Cursor height
CM: 0 - Under line
1 - Block

■ Cursor Control

The cursor control commands are used to set the default cursor direction which points to the location to be modified. After every memory read or memory write operation, the cursor is automatically positioned to the next memory location.

Cursor Right: (C:4Ch - 0 1 0 0 1 1 0 0)
Cursor Left: (C:4Dh - 0 1 0 0 1 1 0 1)
Cursor Up: (C:4Eh - 0 1 0 0 1 1 1 0)
Cursor Down: (C:4Fh - 0 1 0 0 1 1 1 1)

■ Cursor Write (C:46h)

This command sets the current cursor address.

P1 (CSRL): Sets the lower byte of the cursor address
P2 (CSRH): Sets the higher byte of the cursor address

■ Cursor Read (C:47h)

This command returns the current cursor address.

P1 (CSRL): Reads the lower byte of the cursor address.
P2 (CSRH): Reads the higher byte of the cursor address

■ **Memory Write** (42h)

This command sets the controller into the write mode. The data that is passed to the parameter will be written to the memory location specified by the current cursor address. After the Memory Write command, the controller automatically advances the cursor to the next sequential location defined by the cursor direction. This allows the users to write many bytes of data to the screen without issuing another write command.

P1
P2 } Continuous data writing
-
-
Pn

■ **Memory Read** (43h)

This command sets the controller into the read mode. The data that is read from the parameter will be from the memory location specified by the current cursor address. After the Memory Read command, the controller automatically advances the cursor to the next sequential location defined by the cursor direction. This allows the users to read many bytes of data to the screen without issuing another read command.

P1
P2 } Continuous data reading
-
-
Pn

■ **Erase** (C:52h)

This command clears the screens that are enabled from the current cursor position to the end of the screens. After Erase command is issued, two frame time (min.) delay is needed before issuing the next command. (e.g. 34 ms is needed for 60 Hz frame frequency.)

■ **Sleep** (C:53h)

This command turns off the display, stops all internal operations, stops the oscillator, and enters the sleep mode. The controller may be brought out of the sleep mode by issuing the System Set command. The contents in the memory remain unchanged.

■ Initialization Setting for Seiko Instruments LCD Modules

Command	Symbol	G121C	G191C	G191D	G242C	G2436 G2446	G321D	G321E G324E	G648D G694D	Note
System Set	C	40h	40h	40h	40h	40h	40h	40h	40h	
	P1	30h	30h	30h	30h	30h	30h	30h	30h	P5 is based on 70 Hz frame rate with Fosc. = 10 MHz.
	P2	87h	85h	85h	85h	85h	87h	87h	87h	
	P3	07h	07h	07h	07h	07h	07h	07h	07h	
	P4	0Fh	1Fh	1Fh	27h	27h	27h	27h	4Fh	
	P5	7Ch	7Ch	53h	7Ch	F8h	4Fh	42h	4Fh	
	P6	7Fh	7Fh	BFh	7Fh	3Fh	C7h	EFh	C7h	
	P7	0Fh	1Fh	1Fh	27h	27h	27h	27h	4Fh	
	P8	00h	00h	00h	00h	00h	00h	00h	00h	
Display On	C	59h	59h	59h	59h	59h	59h	59h	59h	
	P1	05h	05h	05h	05h	05h	05h	05h	05h	
Overlay	C	5Bh	5Bh	5Bh	5Bh	5Bh	5Bh	5Bh	5Bh	
	P1	00h	00h	00h	00h	00h	00h	00h	00h	
Scroll	C	44h	44h	44h	44h	44h	44h	44h	44h	
	P1	00h	00h	00h	00h	00h	00h	00h	00h	
	P2	00h	00h	00h	00h	00h	00h	00h	00h	
	P3	7Fh	7Fh	BFh	7Fh	3Fh	C7h	EFh	C7h	
	P4	00h	00h	00h	00h	00h	00h	00h	00h	
	P5	04h	04h	06h	06h	04h	08h	10h	10h	
	P6	7Fh	7Fh	BFh	7Fh	3Fh	C7h	EFh	C7h	
Cursor Format	C	5Dh	5Dh	5Dh	5Dh	5Dh	5Dh	5Dh	5Dh	
	P1	07h	05h	05h	05h	05h	07h	07h	07h	
	P2	87h	87h	87h	87h	87h	87h	87h	87h	
Cursor Write	C	46h	46h	46h	46h	46h	46h	46h	46h	
	P1	00h	00h	00h	00h	00h	00h	00h	00h	
	P2	00h	00h	00h	00h	00h	00h	00h	00h	
Cursor Direction	C	4Ch	4Ch	4Ch	4Ch	4Ch	4Ch	4Ch	4Ch	
Memory Write	C	42h	42h	42h	42h	42h	42h	42h	42h	
	P1	ASCII Code: 20h - 7Fh								
	--									
	Pn	ASCII Code: 20h - 7Fh								

■ Hardware Connection

■ To Select MPU Interfaces On G121C, G2446, G242C, G321D, G324E With Built-in Controller:

SEL1=0, SEL2=0 for 8085 Intel type MPU
SEL1=1, SEL2=0 for 6800 Motorola type MPU

■ To Enable The Display On The Graphic Modules:

Connect INHX to +5V

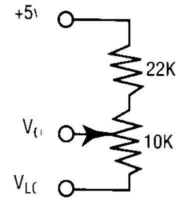
■ To Disable The Display On The Graphic Modules:

Connect INHX to Ground

■ Contrast Control On LCDC-1330

- Apply V_{LCD} (<V_0) to pin 16 of CN1 (e.g. -15v for G191C)
- Use a 10KΩ potentiometer on CN3 to adjust Vo

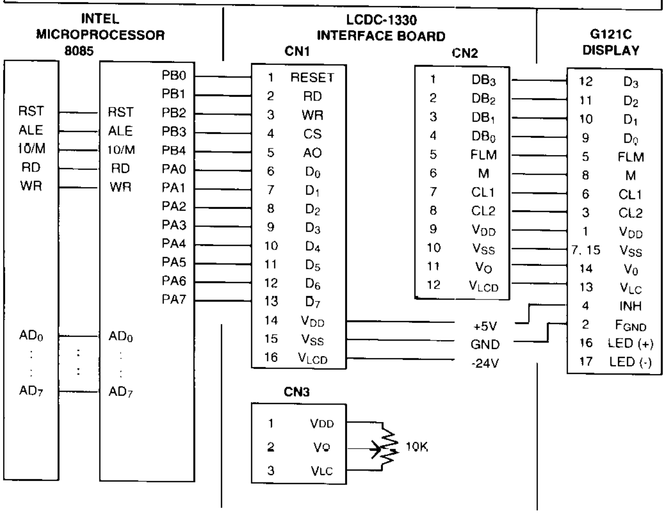
■ Contrast Control On The Modules With Built-in Controller



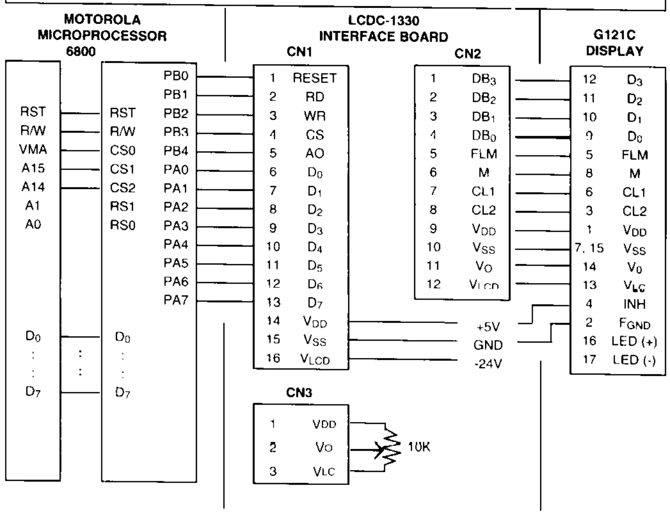
■ Optimum Contrast Control Voltage

Module	G121C	G191C	G191D	G2436	G2446	G242C	G321D	G321E	G324E	G648D	G649D
Vo	-15.1V	-12.5V	-17.9V	-7.8V	-7.8V	-13.0V	-17.0V	-16.5V	-16.5V	-17.5V	-17.5V

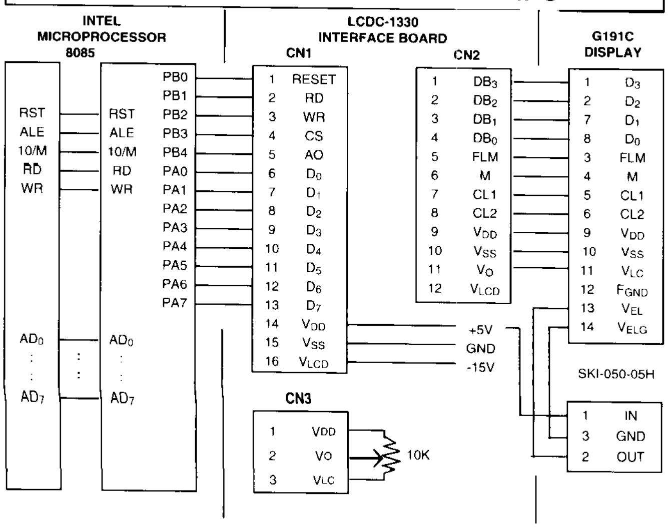
■ G121C = 128 x 128 with Intel MPU



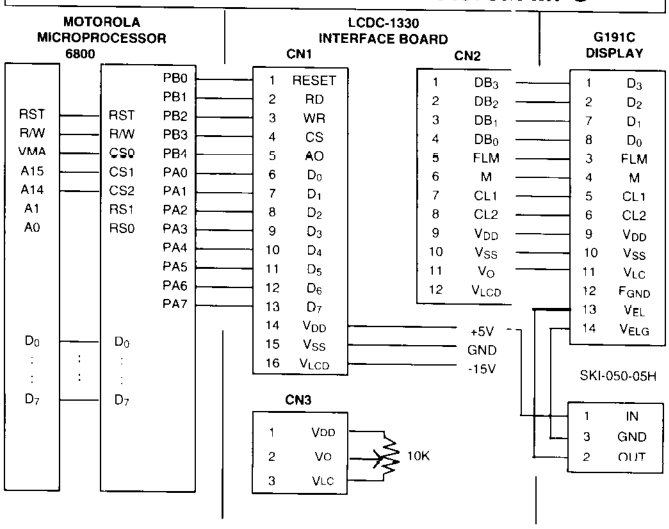
■ G121C = 128 x 128 with Motorola MPU



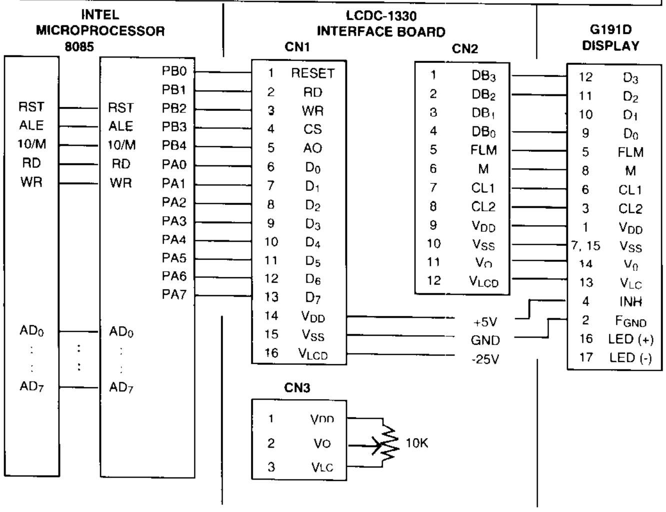
■ G191C = 192 x 128 with Intel MPU



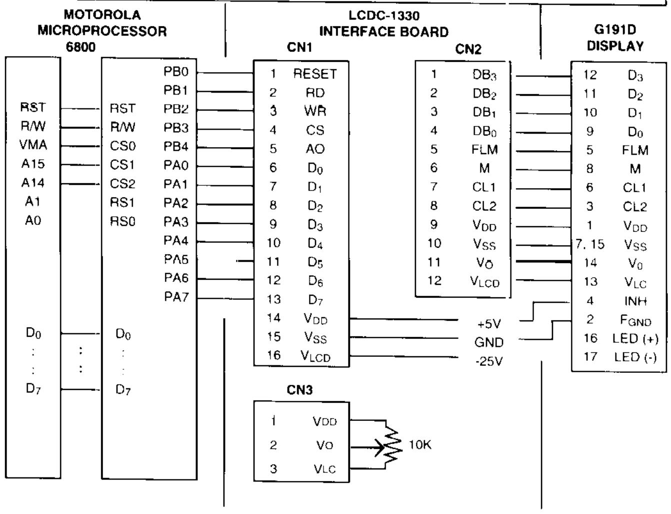
■ G191C = 192 x 128 with Motorola MPU



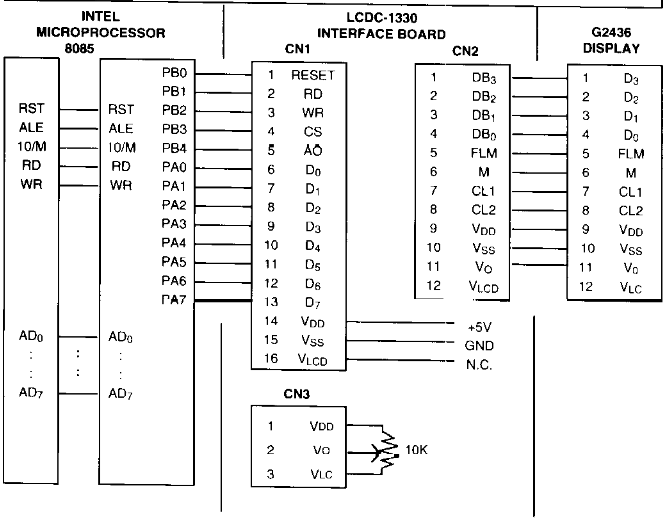
■ G191D = 192 x 192 with Intel MPU



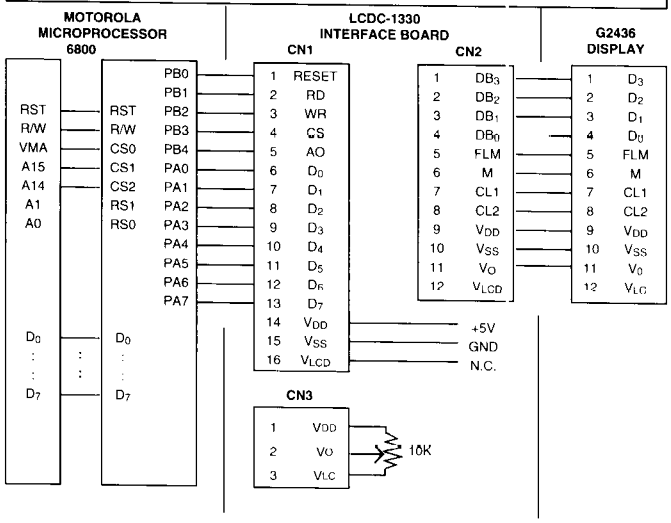
■ G191D = 192 x 192 with Motorola MPU



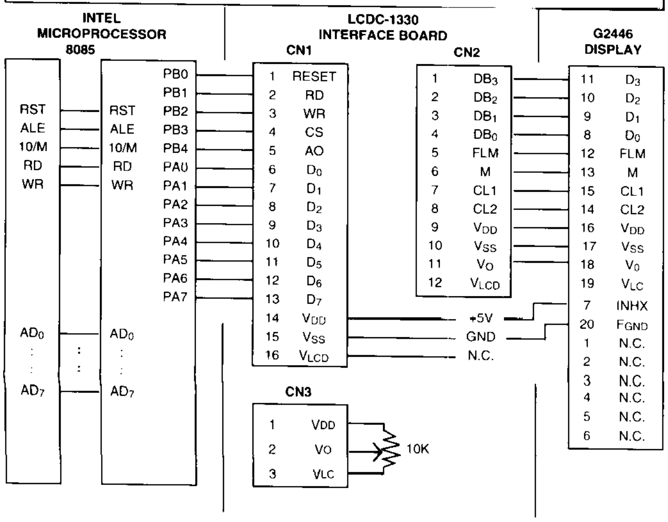
■ G2436 = 240 x 64 with Intel MPU



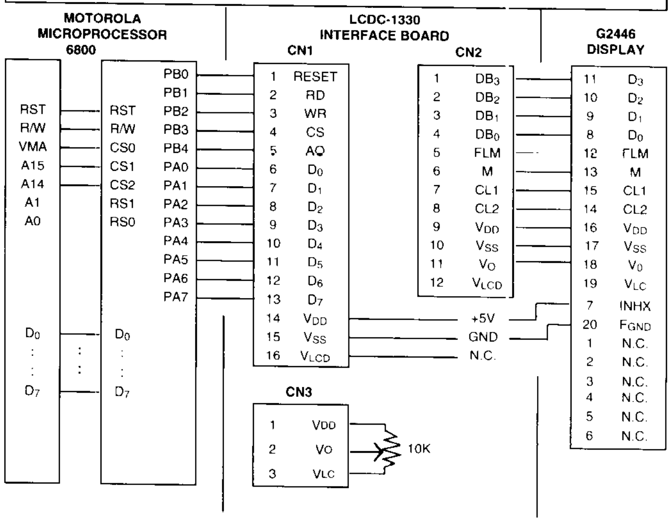
■ G2436= 240 x 64 with Motorola MPU



■ G2446X5R1A0 = 240 x 64 with Intel MPU

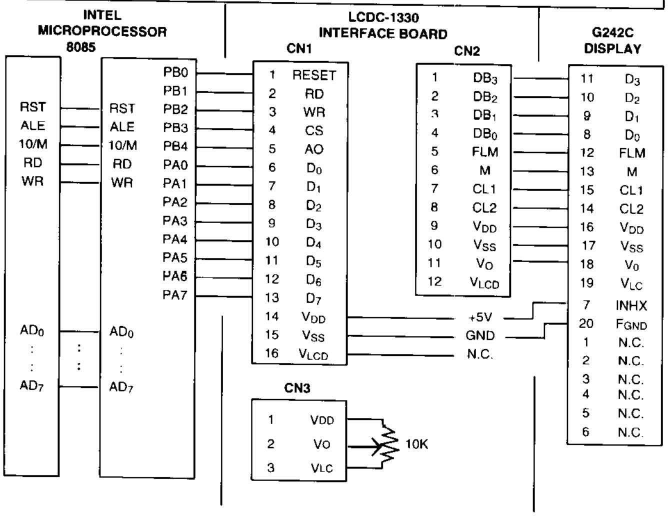


■ G2446X5R1A0 = 240 x 64 with Motorola MPU

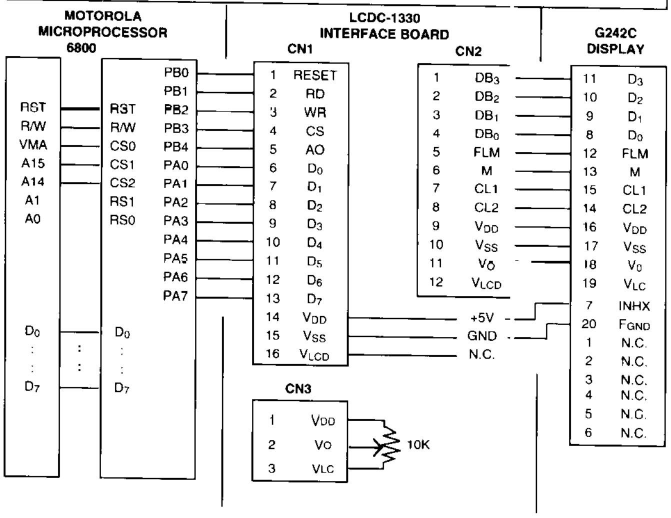


LCDC-1330 Controller Board (Continued)

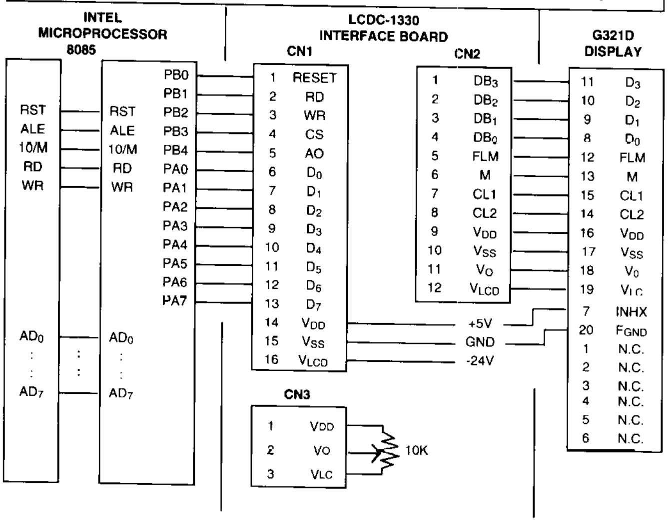
■ G242CX5R1A0 = 240 x 128 with Intel MPU



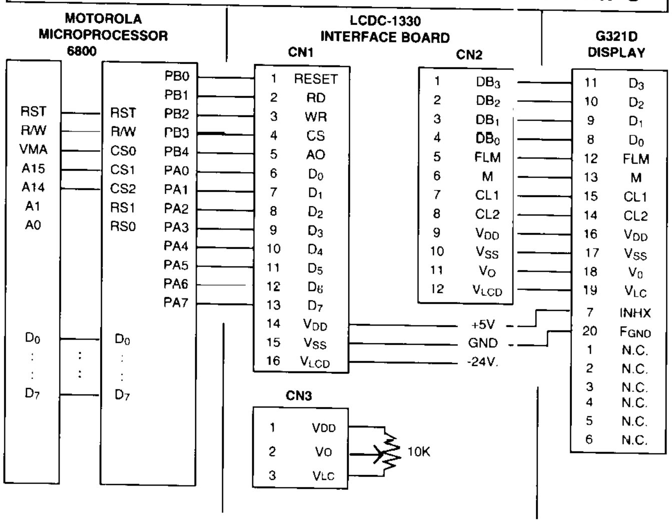
■ G242CX5R1A0 = 240 x 128 with Motorola MPU



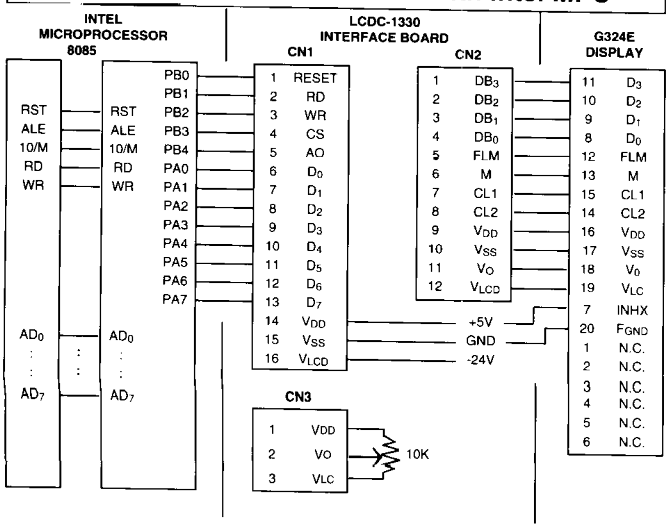
■ G321DX5R1A0 = 320 x 200 with Intel MPU



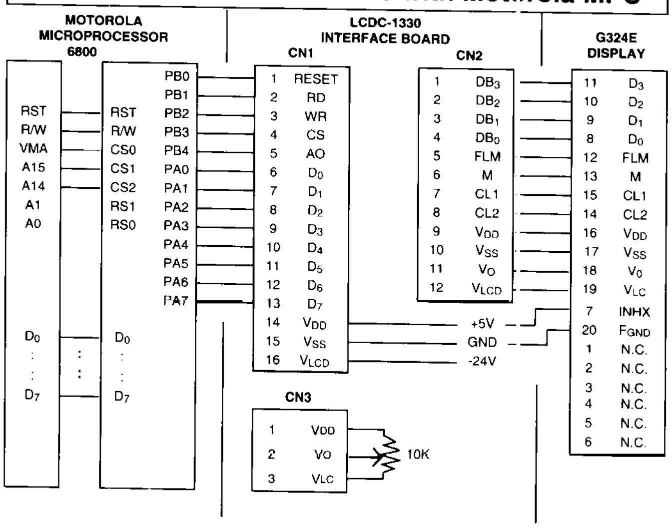
■ G321DX5R1A0 = 320 x 200 with Motorola MPU



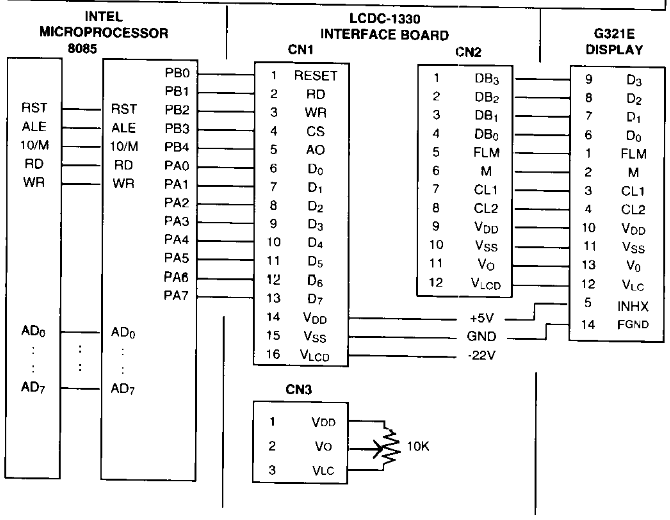
■ G324EX5R1A0 = 320 x 240 with Intel MPU



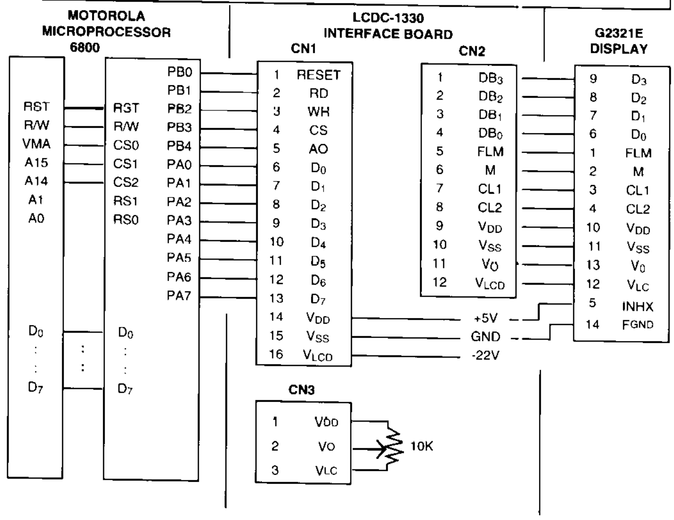
■ G324EX5R1A0 = 320 x 240 with Motorola MPU



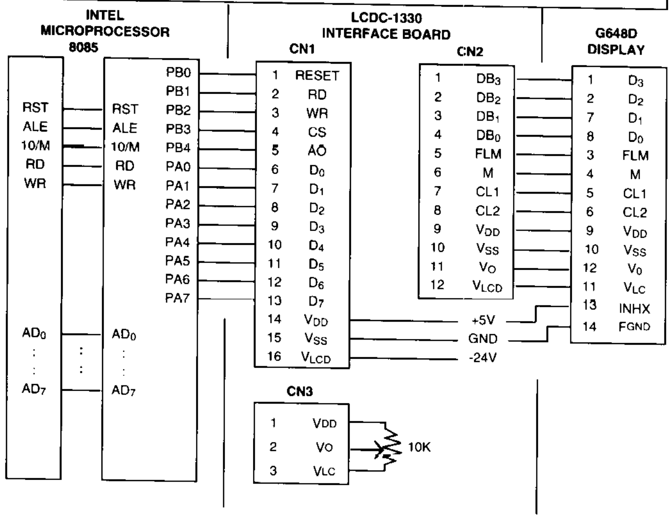
■ G321EX5R000 = 320 x 240 with Intel MPU



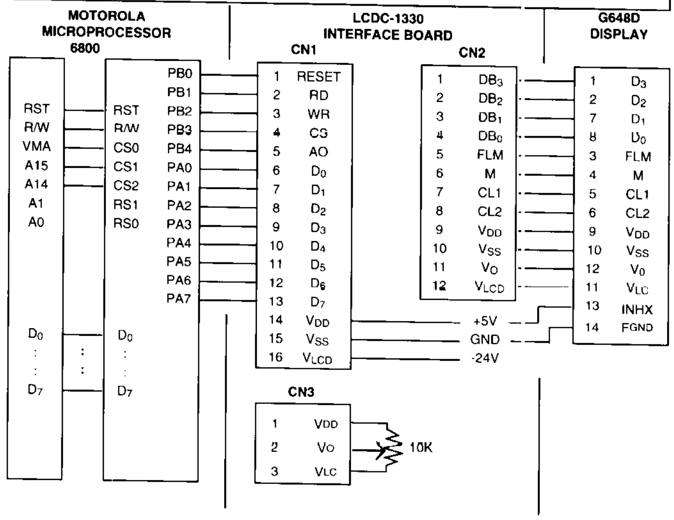
■ G321EX5R000 = 320 x 240 with Motorola MPU



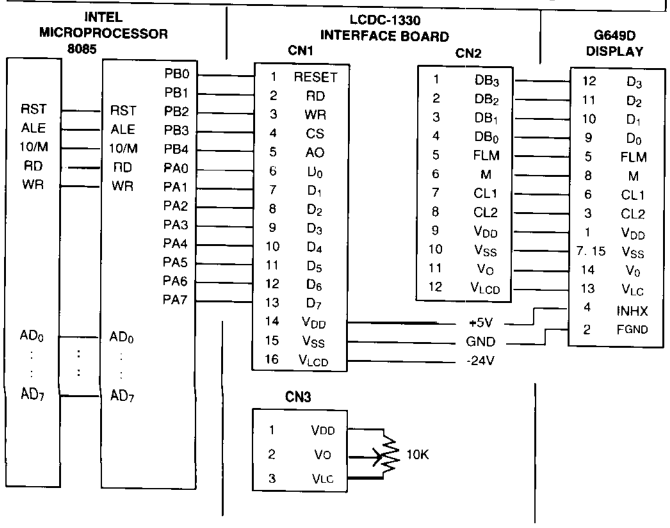
■ G648D = 640 x 200 with Intel MPU



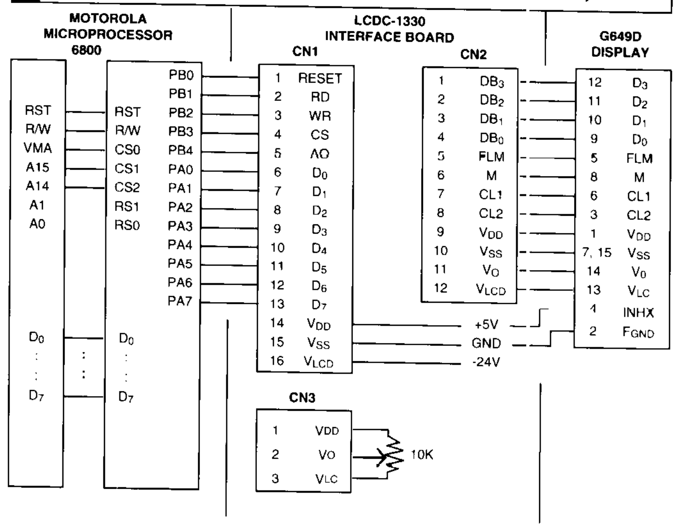
■ G648D = 640 x 200 with Motorola MPU



■ G649D = 640 x 200 with Intel MPU



■ G649D = 640 x 200 with Motorola MPU



Sample Programs

Here are sample programs to help get started with the following modules:

G1213 = t28 x 32
G1216 = 128 x 64
G191C = 192 x 128
G2446 = 240 x 64
G242C = 240 x 128
G321D = 320 x 200
G321E = 320 x 240
G324E = 320 x 240

For additional programming information, contact the LCD application engineering department at 310-517-7770, fax 310-517-7792.

Program For G1213 LCD Module

```
'SUBROUTINE FOR COMMAND CONTROL
DECLARE SUB FUNC1 ()
'SUBROUTINE FOR DATA CONTROL
DECLARE SUB FUNC2 ()

OUT PORT1,&3FH              'DISPLAY ON COMMAND
FUNC1
OUT PORT1,&B8H              'SET THE PAGE (X ADDRESS) TO 0
FUNC1
OUT PORT1,&40H              'SET Y ADDRESS TO 0
FUNC1
OUT PORT1,&COH              'SET Z ADDRESS TO 0
FUNC1

PAGE = &B8H
FOR I = 1 TO 4

FOR J = 1 TO 64             '64 BYTES OF DATA TO BE READ
READ CODE
OUT PORT1,CODE              'SHOW THE DATA ON THE SCREEN
FUNC2
NEXT J

PAGE = PAGE + 1
OUT PORT1,PAGE              'SET THE PAGE TO NEXT ONE
FUNC1
OUT PORT1,&40H              'SET Y ADDRESS TO 0
FUNC1
NEXT 1

SUB FUNC1                   'COMMAND CONTROL
OUT PORT2,2                 'WRITING TO COMMAND REGISTER
OUT PORT2,3
OUT PORT2,2
END SUB

SUB FUNC2                   'DATA CONTROL
OUT PORT2,0                 'WRITING TO DATA REGISTER
OUT PORT2,1
OUT PORT2,0
END SUB

DATA 3EH,7FH,71H,59H,4DH,7FH,3EH,OOH      'CHARACTER 0
DATA 40H,42H,7FH,7FH,40H,40H,OOH,OOH      'CHARACTER 1
DATA 62H,73H,59H,49H,6FH,66H,OOH,OOH      'CHARACTER 2
DATA 22H,63H,49H,49H,7FH,36H,OOH,OOH      'CHARACTER 3
DATA 18H,1CH,16H,53H,7FH,7FH,50H,OOH      'CHARACTER 4
DATA 27H,67H,45H,45H,7DH,39H,OOH,OOH      'CHARACTER 5
DATA 3CH,7EH,4BH,49H,79H,30H,OOH,OOH      'CHARACTER 6
DATA 03H,03H,71H,79H,OFH,07H,OOH,OOH      'CHARACTER 7
DATA 36H,7FH,49H,49H,7FH,36H,OOH,OOH      'CHARACTER 8
DATA 06H,4FH,49H,69H,3FH,1EH,OOH,OOH      'CHARACTER 9
DATA 7CH,7EH,13H,13H,7EH,7CH,OOH,OOH      'CHARACTER A
DATA 41H,7FH,7FH,49H,49H,7FH,36H,OOH      'CHARACTER B
DATA 1CH,3EH,63H,41H,41H,63H,22H,OOH      'CHARACTER C
DATA 41H,7FH,7FH,41H,63H,3EH,1CH,OOH      'CHARACTER D
DATA 41H,7FH,7FH,49H,5DH,41H,63H,OOH      'CHARACTER E
DATA 41H,7FH,7FH,49H,1DH,OIH,03H,OOH      'CHARACTER F
DATA 1CH,3EH,63H,41H,51H,73H,72H,OOH      'CHARACTER G
DATA 7FH,7FH,08H,08H,7FH,7FH,OOH,OOH      'CHARACTER H
DATA OOH,41H,7FH,7FH,41H,OOH,OOH,OOH      'CHARACTER I
DATA 30H,70H,40H,41H,7FH,3FH,01H,OOH      'CHARACTER J
DATA 41H,7FH,7FH,08H,1CH,77H,63H,OOH      'CHARACTER K
DATA 41H,7FH,7FH,41H,40H,60H,70H,OOH      'CHARACTER L
DATA 7FH,7FH,OEH,1CH,OEH,7FH,7FH,OOH      'CHARACTER M
DATA 7FH,7FH,06H,OCH,18H,7FH,7FH,OOH      'CHARACTER N
DATA 1CH,3EH,63H,41H,63H,3EH,1CH,OOH      'CHARACTER O
DATA 41H,7FH,7FH,49H,09H,OFH,06H,OOH      'CHARACTER P
DATA 1EH,3FH,21H,71H,7FH,5EH,OOH,OOH      'CHARACTER Q
DATA 41H,7FH,7FH,09H,19H,7FH,66H,OOH      'CHARACTER R
DATA 26H,6FH,4DH,59H,73H,32H,OOH,OOH      'CHARACTER S
DATA 03H,41H,7FH,7FH,41H,03H,OOH,OOH      'CHARACTER T
DATA 3FH,7FH,40H,40H,7FH,3FH,OOH,OOH      'CHARACTER U
DATA 1FH,3FH,60H,60H,3FH,1FH,OOH,OOH      'CHARACTER V
DATA 7FH,7FH,30H,18H,30H,7FH,7FH,OOH      CHARACTER W
DATA 43H,67H,3CH,18H,3CH,67H,43H,OOH      'CHARACTER X
DATA 07H,4FH,78H,78H,4FH,07H,OOH,OOH      'CHARACTER Y
DATA 47H,63H,71H,59H,4DH,67H,73H,OOH      'CHARACTER Z
```

■ Program For G1216 LCD Module

```
'SUBROUTINE FOR COMMAND CONTROL
DECLARE SUB FUNC11()
DECLARE SUB FUNC12()
'SUBROUTINE FOR DATA CONTROL
DECLARE SUB FUNC21()
DECLARE SUB FUNC22()


OUT PORT1,&3FH          'DISPLAY ON COMMAND
FUNC11
FUNC12
OUT PORT1,&B8H          'SET THE PAGE (X ADDRESS) TO 0
FUNC11
FUNC12
OUT PORT1,&40H          'SET Y ADDRESS TO 0
FUNC11
FUNC12
OUT PORT1,&C0H          'SET Z ADDRESS TO 0
FUNC11
FUNC12

PAGE = &B8H
FOR I = 1 TO 4

FOR J = 1 TO 64         '64 BYTES OF DATA TO BE READ
READ CODE
OUT PORT1,CODE          'SHOW THE DATA ON THE SCREEN
FUNC21
FUNC22
NEXT J

PAGE = PAGE + 1
OUT PORT1,PAGE          'SET THE PAGE TO NEXT ONE
FUNC11
FUNC12
OUT PORT1,&40H          'SET Y ADDRESS TO 0
FUNC11
FUNC12
NEXT I

SUB FUNC11              'COMMAND CONTROL FOR LEFT HALF
OUT PORT2,2             'WRITING TO COMMAND REGISTER
OUT PORT2,3
OUT PORT2,2
END SUB

SUB FUNC12              'COMMAND CONTROL FOR RIGHT HALF
OUT PORT2,6             'WRITING TO COMMAND REGISTER
OUT PORT2,7
OUT PORT2,6
END SUB
```

```
SUB FUNC21              'DATA CONTROL FOR LEFT HALF
OUT PORT2,0             'WRITING TO DATA REGISTER
OUT PORT2,1
OUT PORT2,0
END SUB

SUB FUNC22              'DATA CONTROL FOR RIGHT HALF
OUT PORT2,4             'WRITING TO DATA REGISTER
OUT PORT2,5
OUT PORT2,4
END SUB

DATA 3EH,7FH,71H,59H,4DH,7FH,3EH,00H     'CHARACTER 0
DATA 40H,42H,7FH,7FH,40H,40H,00H,00H     'CHARACTER 1
DATA 62H,73H,59H,49H,6FH,66H,00H,00H     'CHARACTER 2
DATA 22H,63H,49H,49H,7FH,36H,00H,00H     'CHARACTER 3
DATA 18H,1CH,16H,53H,7FH,7FH,50H,00H     'CHARACTER 4
DATA 27H,67H,45H,45H,7DH,39H,00H,00H     'CHARACTER 5
DATA 3CH,7EH,4BH,49H,79H,30H,00H,00H     'CHARACTER 6
DATA 03H,03H,71H,79H,0FH,07H,00H,00H     'CHARACTER 7
DATA 36H,7FH,49H,49H,7FH,36H,00H,00H     'CHARACTER 8
DATA 06H,4FH,49H,69H,3FH,1EH,00H,00H     'CHARACTER 9
DATA 7CH,7EH,13H,13H,7EH,7CH,00H,00H     'CHARACTER A
DATA 41H,7FH,7FH,49H,49H,7FH,36H,00H     'CHARACTER B
DATA 1CH,3EH,63H,41H,41H,63H,22H,00H     'CHARACTER C
DATA 41H,7FH,7FH,41H,63H,3EH,1CH,00H     'CHARACTER D
DATA 41H,7FH,7FH,49H,5DH,41H,63H,00H     'CHARACTER E
DATA 41H,7FH,7FH,49H,1DH,01H,03H,00H     CHARACTER F
DATA 1CH,3EH,63H,41H,51H,73H,72H,00H     'CHARACTER G
DATA 7FH,7FH,08H,08H,7FH,7FH,00H,00H     'CHARACTER H
DATA 00H,41H,7FH,7FH,41H,00H,00H,00H     'CHARACTER I
DATA 30H,70H,40H,41H,7FH,3FH,01H,00H     'CHARACTER J
DATA 41H,7FH,7FH,08H,1CH,77H,63H,00H     'CHARACTER K
DATA 41H,7FH,7FH,41H,40H,60H,70H,00H     'CHARACTER L
DATA 7FH,7FH,0EH,1CH,0EH,7FH,7FH,00H     'CHARACTER M
DATA 7FH,7FH,06H,0CH,18H,7FH,7FH,00H     'CHARACTER N
DATA 1CH,3EH,63H,41H,63H,3EH,1CH,00H     'CHARACTER O
DATA 41H,7FH,7FH,49H,09H,0FH,06H,00H     'CHARACTER P
DATA 1EH,3FH,21H,71H,7FH,5EH,00H,00H     'CHARACTER Q
DATA 41H,7FH,7FH,09H,19H,7FH,66H,00H     'CHARACTER R
DATA 26H,6FH,4DH,59H,73H,32H,00H,00H     'CHARACTER S
DATA 03H,41H,7FH,7FH,41H,03H,00H,00H     'CHARACTER T
DATA 3FH,7FH,40H,40H,7FH,3FH,00H,00H     'CHARACTER U
DATA 1FH,3FH,60H,60H,3FH,1FH,00H,00H     'CHARACTER V
DATA 7FH,7FH,30H,18H,30H,7FH,7FH,00H     'CHARACTER W
DATA 43H,67H,3CH,18H,3CH,67H,43H,00H     'CHARACTER X
DATA 07H,4FH,78H,78H,4FH,07H,00H,00H     'CHARACTER Y
DATA 47H,63H,71H,59H,4DH,67H,73H,00H     'CHARACTER Z
```

■ Program For G191C LCD Module

```
'SUBROUTINE FOR COMMAND CONTROL
DECLARE SUB FUNC1()
'SUBROUTINE FOR DATA CONTROL
DECLARE SUB FUNC2 ()

OUT PORT1,&40H          'SYSTEM SET COMMAND
FUNC1
OUT PORT1,&30H          'P1: MODE OF OPERATION
FUNC2
OUT PORT1,&85H          'P2: WIDTH OF A CHARACTER FIELD
FUNC2
OUT PORT1,&07H          'P3: HEIGHT OF A CHARACTER FIELD
FUNC2
OUT PORT1,&1FH          'P4: CHARACTERS PER ROW
FUNC2
OUT PORT1,&7CH          'P5: FRAME FREQUENCY CONTROL
FUNC2
OUT PORT1,&7FH          'P6: LINES PER GRAPHIC SCREEN
FUNC2
OUT PORT1,&20H          'P7: VIRTUAL SCREEN WIDTH LOW BYTE
FUNC2
OUT PORT1,&00H          'P8: VIRTUAL SCREEN WIDTH HIGH BYTE
FUNC2

OUT PORT1,&59H          'DISPLAY ON COMMAND
FUNC1
OUT PORT1,&05H          'LAYER 1 ON WITH CURSOR
FUNC2

OUT PORT1,&5BH          'OVERLAY COMMAND
FUNC1
OUT PORTI,&00H          'SIMPLE OVERLAY
FUNC2

OUT PORT1,&44H          'SCROLL COMMAND
FUNC1
OUT PORTI,&00H          'FIRST LAYER LOW BYTE
FUNC2
OUT PORTI,&00H          'FIRST LAYER HIGH BYTE
FUNC2
OUT PORT1,&7FH          'LINES OF THE LAYER
FUNC2
OUT PORTI,&00H          'SECOND LAYER LOW BYTE
FUNC2
OUT PORT1,&04H          'SECOND LAYER HIGH BYTE
FUNC2
OUT PORT1,&7FH          'LINES OF THE LAYER
FUNC2

OUT PORT1,&5DH          'CURSOR FORMAT COMMAND
FUNC1
OUT PORT1,&05H          'CURSOR WIDTH
FUNC2
OUT PORT1,&87H          'CURSOR HEIGHT
FUNC2

OUT PORT1,&4CH          'CURSOR DIRECTION COMMAND
FUNC1                   (SHIFT RIGHT)

OUT PORT1,&46H          'CURSOR WRITE COMMAND
FUNC1
OUT PORT1,&00H          'CURSOR POSITION LOW BYTE
FUNC2
OUT PORT1,&00H          'CURSOR POSITION HIGH BYTE
FUNC2

OUT PORT1,&42H          'MEMORY WRITE COMMAND
FUNC1
FOR I = 1 TO 16         '16 LINES OF DATA TO BE READ
READ ASCII$
FOR CHAR = 1 TO LEN(ASCII$)
ONE$ = MID$ (ASCII$,CHAR,1)
CODE = ASC (ONE$)
OUT PORT1,CODE
FUNC2
NEXT CHAR
NEXT I

SUB FUNC1               'COMMAND CONTROL
OUT PORT2,2             'WRITING TO COMMAND REGISTER
OUT PORT2,3
OUT PORT2,2
END SUB

SUB FUNC2               'DATA CONTROL
OUT PORT2,0             'WRITING TO DATA REGISTER
OUT PORT2,1
OUT PORT2,0
END SUB

DATA "********************************"
DATA "*                              *"
DATA "*   G191C LCD MODULE           *"
DATA "*   192x128 DOT MATRIX LCD     *"
DATA "*   EL BACK LIGHT              *"
DATA "*   FSTN FOR BLACK & WHITE     *"
DATA "*                              *"
DATA "*   DIMENSION:                 *"
DATA "*   98x86x13 (mm)              *"
DATA "*                              *"
DATA "*   VIEWING AREA:              *"
DATA "*   78x54 (mm)                 *"
DATA "*                              *"
DATA "*   SEIKO INSTRUMENTS INC.     *"
DATA "*                              *"
DATA "********************************"
```

■ Program For G2446 LCD Module

```
'SUBROUTINE FOR COMMAND CONTROL
DECLARE SUB FUNC1()
'SUBROUTINE FOR DATA CONTROL
DECLARE SUB FUNC2()

OUT PORT1,&40H          'SYSTEM SET COMMAND
FUNC1
OUT PORT1,&30H          'P1: MODE OF OPERATION
FUNC2
OUT PORT1,&87H          'P2: WIDTH OF A CHARACTER FIELD
FUNC2
OUT PORT1,&07H          'P3: HEIGHT OF A CHARACTER FIELD
FUNC2
OUT PORT1,&1DH          'P4: CHARACTERS PER ROW
FUNC2
OUT PORT1,&F8H          'P5: FRAME FREQUENCY CONTROL
FUNC2
OUT PORT1,&3FH          'P6: LINES PER GRAPHIC SCREEN
FUNC2
OUT PORTI,&1DH          'P7: VIRTUAL SCREEN WIDTH LOW BYTE
FUNC2
OUT PORT1,&OOH          'P8: VIRTUAL SCREEN WIDTH HIGH BYTE
FUNC2

OUT PORT1,&59H          'DISPLAY ON COMMAND
FUNC1
OUT PORT1,&05H          'LAYER 1 ON WITH CURSOR
FUNC2

OUT PORT1,&5BH          'OVERLAY COMMAND
FUNC1
OUT PORT1,&OOH          'SIMPLE OVERLAY
FUNC2

OUT PORT1,&44H          'SCROLL COMMAND
FUNC1
OUT PORT1,&OOH          'FIRST LAYER LOW BYTE
FUNC2
OUT PORT1,&OOH          'FIRST LAYER HIGH BYTE
FUNC2
OUT PORT1,&3FH          'LINES OF THE LAYER
FUNC2
OUT PORT1,&OOH          'SECOND LAYER LOW BYTE
FUNC2
OUT PORT1,&04H          'SECOND LAYER HIGH BYTE
FUNC2
OUT PORT1,&3FH          'LINES OF THE LAYER
FUNC2

OUT PORT1,&5DH          'CURSOR FORMAT COMMAND
FUNC1
OUT PORT1,&07H          'CURSOR WIDTH
FUNC2
OUT PORT1,&87H          'CURSOR HEIGHT
FUNC2

OUT PORT1,&4CH          'CURSOR DIRECTION COMMAND
FUNC1                   (SHIFT RIGHT)

OUT PORT1,&46H          'CURSOR WRITE COMMAND
FUNC1
OUT PORT1,&OOH          'CURSOR POSITION LOW BYTE
FUNC2
OUT PORT1,&OOH          'CURSOR POSITION HIGH BYTE
FUNC2

OUT PORT1,&42H          'MEMORY WRITE COMMAND
FUNC1
FOR I = 1 TO 8          '8 LINES OF DATA TO BE READ
READ ASCII$
FOR CHAR = 1 TO LEN(ASCII$)
ONE$ = MID$(ASCII$,CHAR,1)
CODE = ASC(ONE$)
OUT PORT1,CODE
FUNC2
NEXT CHAR
NEXT I

SUB FUNC1               'COMMAND CONTROL
OUT PORT2,2             'WRITING TO COMMAND REGISTER
OUT PORT2,3
OUT PORT2,2
END SUB

SUB FUNC2               'DATA CONTROL
OUT PORT2,0             'WRITING TO DATA REGISTER
OUT PORT2,1
OUT PORT2,0
END SUB

DATA "******************************"
DATA "*                            *"
DATA "*    G2446 LCD MODULE        *"
DATA "*    240x64 DOT MATRIX LCD   *"
DATA "*    CCFL BACK LIGHT         *"
DATA "*    FSTN FOR BLACK & WHITE  *"
DATA "*                            *"
DATA "******************************"
```

■ **Program For G242C LCD Module**

```
'SUBROUTINE FOR COMMAND CONTROL
DECLARE SUB FUNC1()
'SUBROUTINE FOR DATA CONTROL
DECLARE SUB FUNC2()

OUT PORT1,&40H          'SYSTEM SET COMMAND
FUNC1
OUT PORT1,&30H          'P1: MODE OF OPERATION
FUNC2

OUT PORT1,&87H          'P2: WIDTH OF A CHARACTER FIELD
FUNC2
OUT PORT1,&07H          'P3: HEIGHT OF A CHARACTER FIELD
FUNC2
OUT PORT1,&1DH          'P4: CHARACTERS PER ROW
FUNC2
OUT PORT1,&7FH          'P5: FRAME FREQUENCY CONTROL
FUNC2
OUT PORT1,&7FH          'P6: LINES PER GRAPHIC SCREEN
FUNC2
OUT PORT1,&1EH          'P7: VIRTUAL SCREEN WIDTH LOW BYTE
FUNC2
OUT PORT1,&00H          'P8: VIRTUAL SCREEN WIDTH HIGH BYTE
FUNC2

OUT PORT1,&59H          'DISPLAY ON COMMAND
FUNC1
OUT PORT1,&05H          'LAYER 1 ON WITH CURSOR
FUNC2

OUT PORT1,&5BH          'OVERLAY COMMAND
FUNC1
OUT PORT1,&00H          'SIMPLE OVERLAY
FUNC2

OUT PORT1,&44H          'SCROLL COMMAND
FUNC1
OUT PORT1,&00H          'FIRST LAYER LOW BYTE
FUNC2
OUT PORT1,&00H          'FIRST LAYER HIGH BYTE
FUNC2
OUT PORT1,&3FH          'LINES OF THE LAYER
FUNC2
OUT PORT1,&00H          'SECOND LAYER LOW BYTE
FUNC2
OUT PORT1,&04H          'SECOND LAYER HIGH BYTE
FUNC2
OUT PORT1,&3FH          'LINES OF THE LAYER
FUNC2

OUT PORT1,&5DH          'CURSOR FORMAT COMMAND
FUNC1
OUT PORT1,&07H          'CURSOR WIDTH
FUNC2
OUT PORT1,&87H          'CURSOR HEIGHT
FUNC2

OUT PORT1,&4CH          'CURSOR DIRECTION COMMAND
FUNC1                   (SHIFT RIGHT)

OUT PORT1,&46H          'CURSOR WRITE COMMAND
FUNC1
OUT PORT1,&00H          'CURSOR POSITION LOW BYTE
FUNC2
OUT PORT1,&00H          'CURSOR POSITION HIGH BYTE
FUNC2

OUT PORT1,&42H          'MEMORY WRITE COMMAND
FUNC1
FOR I = 1 TO 16         '16 LINES OF DATA TO BE READ
READ ASCII$
FOR CHAR = 1 TO LEN(ASCII$)
ONE$ = MID$(ASCII$,CHAR,I)
CODE = ASC(ONE$)
OUT PORT1,CODE
FUNC2
NEXT CHAR
NEXT I

SUB FUNC1               'COMMAND CONTROL
OUT PORT2,2             'WRITING TO COMMAND REGISTER
OUT PORT2,3
OUT PORT2,2
END SUB

SUB FUNC2               'DATA CONTROL
OUT PORT2,0             'WRITING TO DATA REGISTER
OUT PORT2,1
OUT PORT2,0
END SUB

DATA "********************************"
DATA "*                              *"
DATA "*   G242C LCD MODULE           *"
DATA "*    240X128 DOT MATRIX LCD    *"
DATA "*   CCFL BACK LIGHT            *"
DATA "*   FSTN FOR BLACK & WHITE     *"
DATA "*                              *"
DATA "*   DIMENSION:                 *"
DATA "*   180x110x15 (mm)            *"
DATA " *                             *"
DATA "*   VIEWING AREA:              *"
DATA "*   134x76 (mm)                *"
DATA "*                              *"
DATA "*   SEIKO INSTRUMENTS INC.     *"
DATA "*                              *"
DATA "********************************"
```

■ Program For G321D LCD Module

```
'SUBROUTINE FOR COMMAND CONTROL
DECLARE SUB FUNC1()
'SUBROUTINE FOR DATA CONTROL
DECLARE SUB FUNC2()

OUT PORT1,&40H          'SYSTEM SET COMMAND
FUNC1
OUT PORT1,&30H          'P1: MODE OF OPERATION
FUNC2
OUT PORT1,&87H          'P2: WIDTH OF A CHARACTER FIELD
FUNC2
OUT PORT1,&07H          'P3: HEIGHT OF A CHARACTER FIELD
FUNC2
OUT PORT1,&27H          'P4: CHARACTERS PER ROW
FUNC2
OUT PORT1,&4FH          'P5: FRAME FREQUENCY CONTROL
FUNC2
OUT PORT1,&C7H          'P6: LINES PER GRAPHIC SCREEN
FUNC2
OUT PORT1,&28H          'P7: VIRTUAL SCREEN WIDTH LOW BYTE
FUNC2
OUT PORT1,&00H          'P8: VIRTUAL SCREEN WIDTH HIGH BYTE
FUNC2

OUT PORT1,&59H          'DISPLAY ON COMMAND
FUNC1
OUT PORT1,&05H          'LAYER 1 ON WITH CURSOR
FUNC2

OUT PORT1,&5BH          'OVERLAY COMMAND
FUNC1
OUT PORT1,&00H          'SIMPLE OVERLAY
FUNC2

OUT PORT1,&44H          'SCROLL COMMAND
FUNC1
OUT PORT1,&00H          'FIRST LAYER LOW BYTE
FUNC2
OUT PORT1,&00H          'FIRST LAYER HIGH BYTE
FUNC2
OUT PORT1,&C7H          'LINES OF THE LAYER
FUNC2
OUT PORT1,&00H          'SECOND LAYER LOW BYTE
FUNC2
OUT PORT1,&08H          'SECOND LAYER HIGH BYTE
FUNC2
OUT PORT1,&C7H          'LINES OF THE LAYER
FUNC2

OUT PORT1,&5DH          'CURSOR FORMAT COMMAND
FUNC1
OUT PORT1,&07H          'CURSOR WIDTH
FUNC2
OUT PORT1,&87H          'CURSOR HEIGHT
FUNC2
OUT PORT1,&4CH          'CURSOR DIRECTION COMMAND
FUNC1                   (SHIFT RIGHT)

OUT PORT1,&46H          'CURSOR WRITE COMMAND
FUNC1
OUT PORT1,&00H          'CURSOR POSITION LOW BYTE
FUNC2
OUT PORT1,&00H          'CURSOR POSITION HIGH BYTE
FUNC2

OUT PORT1,&42H          'MEMORY WRITE COMMAND
FUNC1
FOR I = 1 TO 25         '25 LINES OF DATA TO BE READ
READ ASCII$
FOR CHAR = 1 TO LEN(ASCII$)
ONE$ = MID$(ASCII$,CHAR,1)
CODE = ASC(ONE$)
OUT PORT1,CODE
FUNC2
NEXT CHAR
NEXT I

SUB FUNC1               'COMMAND CONTROL
OUT PORT2,2             'WRITING TO COMMAND REGISTER
OUT PORT2,3
OUT PORT2,2
END SUB

SUB FUNC2               'DATA CONTROL
OUT PORT2,0             'WRITING TO DATA REGISTER
OUT PORT2,1
OUT PORT2,0
END SUB

DATA "****************************************"
DATA "*                                      *"
DATA "*    G321D LCD MODULE                  *"
DATA "*    320x200 DOT MATRIX LCD            *"
DATA "*    CCFL BACK LIGHT                   *"
DATA "*    FSTN FOR BLACK & WHITE            *"
DATA "*                                      *"
DATA "*    DIMENSION:                        *"
DATA "*    166x134x15 (mm)                   *"
DATA "*                                      *"
DATA "*    VIEWING AREA:                     *"
DATA "*    128x110 (mm)                      *"
DATA "*                                      *"
DATA "*    SUITABLE CONTROLLER:              *"
DATA "*    SED1330FBA, MSM6255GS             *"
DATA "*                                      *"
DATA "*    SUITABLE CONTROLLER BOARD:        *"
DATA "*    LCDC-1330-32A                     *"
DATA "*                                      *"
DATA "*                                      *"
DATA "*    SEIKO INSTRUMENTS INC.            *"
DATA "*    2990 WEST LOMITA BLVD.            *"
DATA "*    TORRANCE, CA 90505                *"
DATA "*                                      *"
DATA "****************************************"
```

■ Program For G321E/G324E LCD Module

```
'SUBROUTINE FOR COMMAND CONTROL
DECLARE SUB FUNC1()
'SUBROUTINE FOR DATA CONTROL
DECLARE SUB FUNC2 ( )

OUT PORT1,&40H          'SYSTEM SET COMMAND
FUNC1
OUT PORT1,&30H          'P1: MODE OF OPERATION
FUNC2
OUT PORT1,&87H          'P2: WIDTH OF A CHARACTER FIELD
FUNC2
OUT PORT1,&07H          'P3: HEIGHT OF A CHARACTER FIELD
FUNC2
OUT PORT1,&27H          'P4: CHARACTERS PER ROW
FUNC2
OUT PORT1,&42H          'PS: FRAME FREQUENCY CONTROL
FUNC2
OUT PORT1,&EFH          'P6: LINES PER GRAPHIC SCREEN
FUNC2
OUT PORT1,&28H          'P7: VIRTUAL SCREEN WIDTH LOW BYTE
FUNC2
OUT PORT1,&00H          'P8: VIRTUAL SCREEN WIDTH HIGH BYTE
FUNC2

OUT PORT1,&59H          'DISPLAY ON COMMAND
FUNC1
OUT PORT1,&05H          'LAYER 1 ON WITH CURSOR
FUNC2

OUT PORT1,&5BH          'OVERLAY COMMAND
FUNC1
OUT PORT1,&00H          'SIMPLE OVERLAY
FUNC2

OUT PORT1,&44H          'SCROLL COMMAND
FUNC1
OUT PORT1,&00H          'FIRST LAYER LOW BYTE
FUNC2
OUT PORT1,&00H          'FIRST LAYER HIGH BYTE
FUNC2
OUT PORT1,&EFH          'LINES OF THE LAYER
FUNC2
OUT PORT1,&00H          'SECOND LAYER LOW BYTE
FUNC2
OUT PORT1,&08H          'SECOND LAYER HIGH BYTE
FUNC2
OUT PORT1,&EFH          'LINES OF THE LAYER
FUNC2

OUT PORT1,&5DH          'CURSOR FORMAT COMMAND
FUNC1
OUT PORT1,&07H          'CURSOR WIDTH
FUNC2
OUT PORT1,&87H          'CURSOR HEIGHT
FUNC2
OUT PORT1,&4CH          'CURSOR DIRECTION COMMAND
FUNC1                   (SHIFT RIGHT)

OUT PORT1,&46H          'CURSOR WRITE COMMAND
FUNC1
OUT PORT1,&00H          'CURSOR POSITION LOW BYTE
FUNC2
OUT PORT1,&00H          'CURSOR POSITION HIGH BYTE
FUNC2

OUT PORT1,&42H          'MEMORY WRITE COMMAND
FUNC1
FOR I = 1 TO 25         '25 LINES OF DATA TO BE READ
READ ASCII$
FOR CHAR = 1 TO LEN(ASCII$)
ONE$ = MID$(ASCII$,CHAR,1)
CODE = ASC(ONE$)
OUT PORT1,CODE
FUNC2
NEXT CHAR
NEXT I

SUB FUNC1               'COMMAND CONTROL
OUT PORT2,2             'WRITING TO COMMAND REGISTER
OUT PORT2,3
OUT PORT2,2
END SUB

SUB FUNC2               'DATA CONTROL
OUT PORT2,0             'WRITING TO DATA REGISTER
OUT PORT2,1
OUT PORT2,0
END SUB

DATA "****************************************"
DATA "*                                      *"
DATA "*     G321E LCD MODULE                 *"
DATA "*     320x240 DOT MATRIX LCD           *"
DATA "*     CCFL BACK LIGHT                  *"
DATA "*     FSTN FOR BLACK & WHITE           *"
DATA "*                                      *"
DATA "*     DIMENSION:                       *"
DATA "*     150x96x14 (mm)                   *"
DATA "*                                      *"
DATA "*     VIEWING AREA:                    *"
DATA "*     103x80 (mm)                      *"
DATA "*                                      *"
DATA "*     SUITABLE CONTROLLER:             *"
DATA "*     SED1330FBA, MSM6255GS            *"
DATA "*                                      *"
DATA "*     SUITABLE CONTROLLER BOARD:       *"
DATA "*     LCDC-1330-32A                    *"
DATA "*                                      *"
DATA "*                                      *"
DATA "*     SEIKO INSTRUMENTS INC.           *"
DATA "*     2990 WEST LOMITA BLVD.           *"
DATA "*     TORRANCE, CA 90505               *"
DATA "*                                      *"
DATA "****************************************"
```

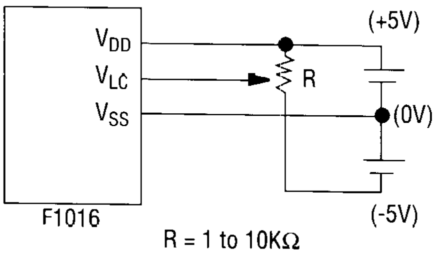
■ Operating Voltage vs Temperature

	SIZE	DUTY	BIAS	$V_{OPR} = V_{DD} - V_{LC}$ (VOLTS) -20°C	-10°C	0°C	+25°C	+50°C	+70°C
F1016	100 x 64	1/32	1/6	--	--	9.5	8.8	7.5	--
G1213	128 x 32	1/64	1/9	13.5	13.3	13.0	12.5	11.5	10.5
G1216	128 x 64	1/64	1/9	13.5	13.3	13.0	12.5	11.5	10.5
G121C	128 x 128	1/128	1/10	22.0	21.5	21.1	20.1	18.7	17.2
G191C	192 x 128	1/128	1/12	--	--	18.4	17.4	16.3	--
G191D	192 x 192	1/192	1/12	29.0	27.3	26.1	23.0	21.5	20.0
G2436	240 x 64	1/64	1/9	--	--	13.0	12.0	10.5	--
G2446	240 x 64	1/64	1/9	--	--	13.8	12.8	11.8	--
G242C	240 x 128	1/128	1/12	--	--	18.0	17.0	16.2	--
G321D	320 x 200	1/200	1/15	--	--	23.0	22.0	20.8	--
G321E	320 x 240	1/240	1/13	--	--	22.8	21.2	20.3	--
G324E	320 x 240	1/240	1/13	--	--	24.0	23.0	22.1	--
G648D	640 x 200	1/200	1/15	--	--	23.5	22.5	20.5	--
G649D	640 x 200	1/200	1/15	--	--	23.0	22.1	20.3	--

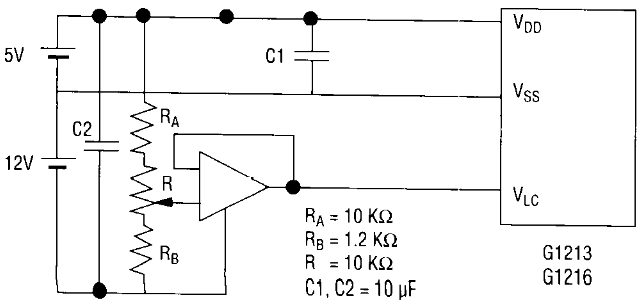
■ Contrast Adjustment Circuits

Display screen contrast and viewing angle are affected by changes in the liquid crystal operating voltage (V_{opr}) and the ambient temperature. Here are some suggested circuits for maintaining optimum contrast.

■ F1016:



■ G1213, G1216:

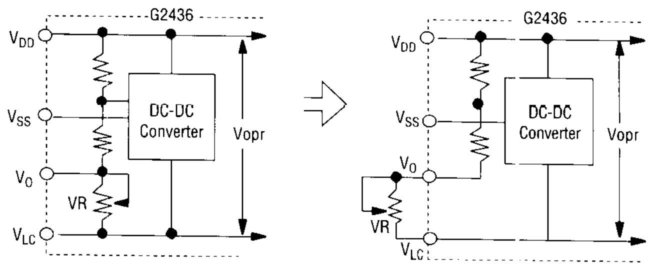


■ G2436:

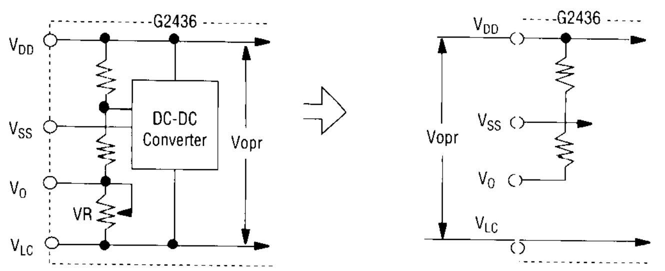
The DC-DC converter internally generates the power supply voltage (V_{LC}). Also, the G2436 has a built-in variable resistor (VR) which controls V_{LC}. When V_{LC} is changed, the liquid crystal operating voltage (V_{opr}) changes. This changes the display screen contrast.

When the VR is supplied external to the G2436, or when the DC-DC converter is not used, the circuit must be changed as follows.

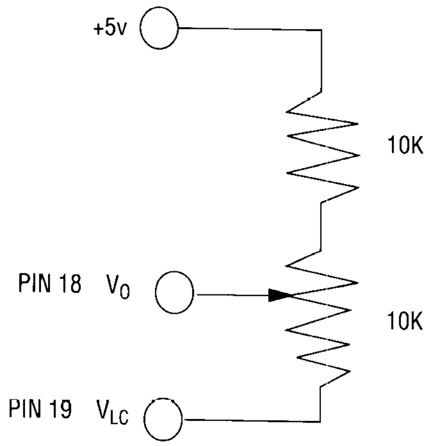
When the VR is supplied external to the G2436: remove the VR, and supply 100KΩ of variable resistance between V_O and V_{LC}.



When the DC-DC converter is not used: remove the DC-DC converter and the VR, and apply V_{opr} to the V_{LC} terminal. Set V_O to NC.

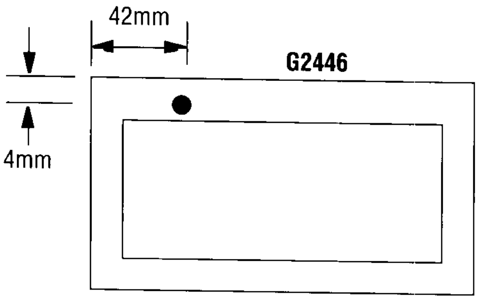


■ **G2446, G242C***

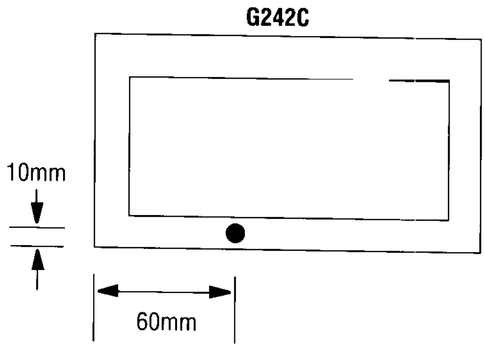


* Special Note: Both the G2446 and G242C have contrast adjustment holes accessible from the PC board. Here is their location (top view):

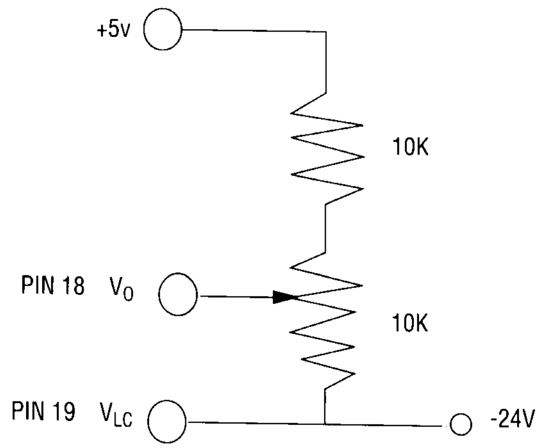
■ **G2446**



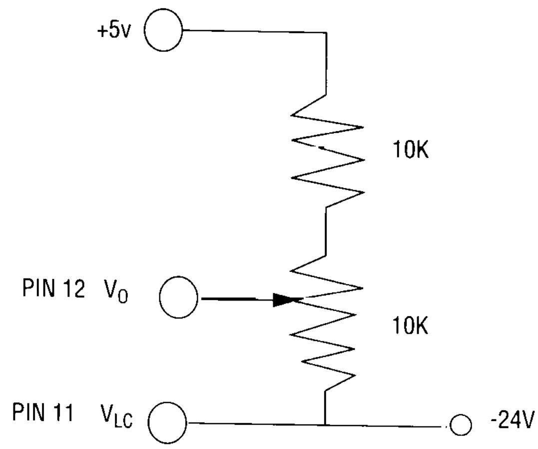
■ **G242C**



■ **G321D, G324E**



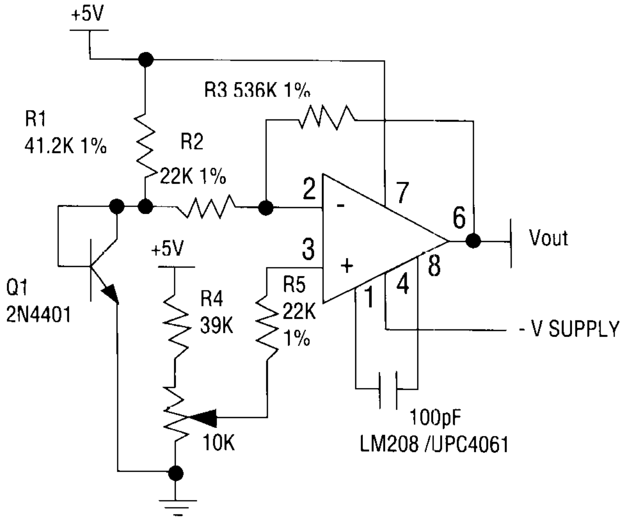
■ **G649D**



■ **LCDC-1330 Controller Board**

- ■ Apply V_{LCD} (<V_O) to pin 16 of CN1 (e.g. -15v for G191C)
- ■ Use a 10KΩ potentiometer on CN3 to adjust V_O

■ Temperature Compensation



Temperature Compensation Circuit

The temperature sensitivity of the base to emitter voltage of a 2N4401 is used to provide automatic temperature compensation to the drive voltage of the STN LCD.

Define Vbe as the base to emitter voltage of the 2N4401 transistor and V2 as pin 3 of the OP AMP.

Assuming a temperature coefficient of the STN LCD of -55mV/°C, and temperature coefficient of the transistor of -2.3 mV/°C.

The gain is defined as:

$$\text{Gain} = \frac{\text{Temp. coef. of STN LCD}}{\text{Temp. coef. of transistor}} = \frac{-55\text{mV}}{-2.3\text{mV}} = 23.9$$

From the OP AMP circuit, output of the OP AMP is:

$$\text{Vout} = -\frac{\text{feedback resistor}}{\text{input resistor}} (\text{Inverting I/P - non-inv. I/P})$$

$$= -\frac{R3}{R2} (\text{Vbe} - \text{V2})$$

If we choose R2 = 22K ohm, R3 = Gain X R2

= 23.9 X 22K ohms

= 536K ohms

$$\text{Therefore, Vout} = -\frac{536K}{22K} (0.6 - \text{V2})$$

The trimmer of the OP AMP is adjusted at room temperature (25°C) resulting in pin 3 of the OP AMP to be at V2 = 0.272 V.

$$\text{Then, Vout} = -\frac{536K}{22K} (0.6 - 0.272)$$

$$= -7.9912\text{V}$$

If the temperature is decreased 1°C, the temp. coef of the 2N4401 transistor is increased by 2.3mV

So, Vbe = 0.6V + 2.3mV = 0.6023V

The output of the OP AMP at 24°C

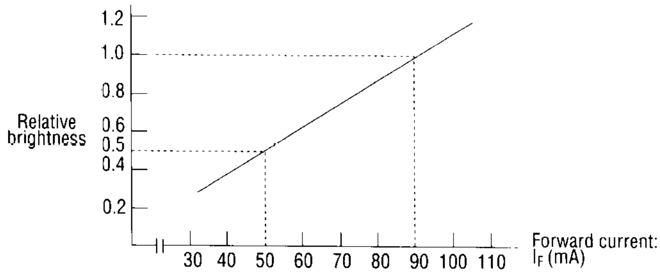
$$\text{Vout} = -\frac{536K}{22K} (0.6023 - 0.272) = -8.47\text{V}$$

Then the output of the OP AMP is increased by 55mV when the temperature drops by 1°C.

Adjust the gain of the OP AMP to match the temperature performance of the display you are using.

■ LED Brightness

The surface brightness of the LED backlight varies with the forward current.



G1216 Forward Current-Brightness Characteristics (Ta = 25°C)

The forward current must be reduced at high temperatures to maintain the LED within safe operating limits.

MODEL	I_F@ 25°C	I_F@ 70°C
G1213	50mA	25mA
G1216	100mA	50mA
G121C	120mA	48mA
G191D	120mA	48mA

In addition, the forward voltage will change with temperature. Here are examples for the G1213 and G1216:

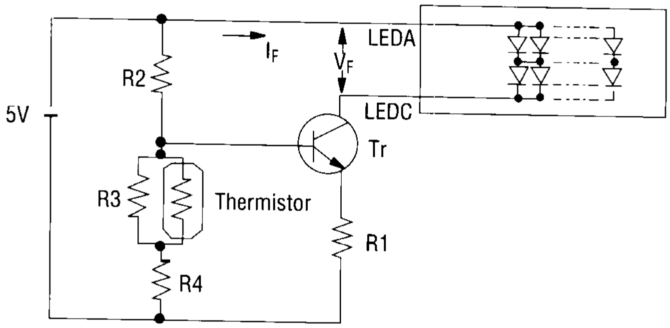
G1213 Forward Voltage At Temperatures

Temperature (Ta)	Conditions	V_F min.	V_F typ.	V_F max.
-20°C	I_F = 40 mA	3.7V	3.9V	4.2V
+25°C	I_F = 40 mA	3.6V	3.8V	4.1V
+70°C	I_F = 25mA	3.4V	3.6V	3.9V

G1216 Forward Voltage At Temperatures

Temperature (Ta)	Conditions	V_F min.	V_F typ.	V_F max.
-20°C	I_F = 90 mA	3.9V	4.3V	4.6V
+25°C	I_F = 90 mA	3.8V	4.1V	4.4V
+70°C	I_F = 50mA	3.5V	3.7V	3.9V

To keep the brightness at 25°C, use a thermosensitive element, like a thermistor, and a transistor as shown. Set the thermosensitive element to about I_F at 25°C and configure it so that "I_F and V_F" will be reduced as the temperature rises.



■ Reducing Screen Flicker

The 1330 controller chip is constantly reading the VRAM on board to refresh the screen, and when the user is also writing to the VRAM, interference may occur which will show up as scattered noise on the screen.

The only tool given to avoid this is the status register read. Bit 6 of this register goes "LOW" during the time interval within which it is safe to write to the VRAM without corrupting the screen image.

To utilize this, constantly read this register, and when bit 6 goes LOW, begin writing to VRAM. The register must still be intermittently read at this point, and when bit 6 goes HIGH, writing must stop.

The amount of time available is directly proportional to TC/R - CR, where these are the "System Set" instruction code parameters. C/R is defined by the number of lines in your display. TC/R must be > C/R + 4. To gain extra time in which to write to VRAM, make TC/R larger.

As TC/R increases, however, the overall frame time will decrease. It is normally around 70 Hz. If TC/R is made twice C/R, the frame time should roughly halve.

The formula relating TC/R and frame rate is

Fosc >= TC/R x 9 x L/F x fFR.

As an example, the G321D has a 6MHz clock cycle, and each memory byte takes approximately 9 oscillator cycles. You can calculate approximately how much time you have per line to write to VRAM, and how much the frame rate will be slowed down by increasing TC/R.

If you make TC/R = 50 decimal, with C/R = 40 decimal, then you should have approximately 15 µsec.s per line in which to write your graphics data. If you send your data at a cycle time of 0.5 MHz (one byte every 2 microseconds), you could send about 7 bytes per line. Thus it would take about 6 timing rows to input one new line, or about 6 frame times to input one entire new frame. At TC/R = 50, frame time is about 15 msec.s (above formula). Thus is should take about 90 msec.s to input a new frame of data.

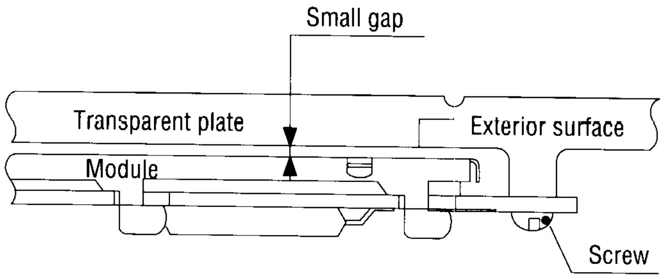
Seiko Instruments is a well recognized leader in precision engineering and manufacturing of the highest quality LCD products. Our LCD factories (in Japan and in Italy) have recently been certified to ISO-9001. Additionally, we are key suppliers to some of the industry's most demanding customers.

Here are the environmental specifications we would recommend for our LCD graphic modules. These test conditions are expanded for wide temperature WTSTN fluids. Contact the factory for details on a particular model.

Test	Test conditions	Evaluation and assessment
Operation at high temperature and humidity	40°C ± 2°C 90% RH for 500 hours	No abnormalities in functions and appearance
Operation at high temperature	60°C ± 2°C for 500 hours	No abnormalities in functions and appearance
Temperature cycle	-20°C + 60°C, 1 hr soak, 5 minute transition, 10 cycles	No abnormalities in functions and appearance
Low temperature storage	-20 + 2°C for 500 hours	No abnormalities in functions and appearance
Vibration	Sweep for 1 min at 10 Hz, 55 Hz, 10 Hz, amplitude 1.5 mm 2 hrs each in the X, Y, and Z directions	No abnormalities in functions and appearance
Drop shock	Dropped onto a board from a height of 10 cm	No abnormalities in functions and appearance

■ Mounting and Design

- Mount the module by using the specified mounting part and holes.
- To protect the module from external pressure, leave a small gap by placing transparent plates (e.g. acrylic or glass) on the display surface, frame, and polarizing plate.



- Design the system so that no input signal is given unless the power supply voltage is applied.
- Keep the module dry. Avoid condensation, otherwise the transparent electrodes may break.

■ Handling

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

■ Cleaning

- Do not wipe the polarizing plate 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 or acetone) or aromatic solvents (toluene and xylene). They may damage the polarizing plate.

■ 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.

■ Reference List For LCD Accessories

The following list of manufacturers is supplied as a time-saving guide to help engineers and buyers with their LCD program requirements It is not our intent to endorse or recommend any supplier listed in this section.

■ CONNECTORS

SAMTEC
P.O.Box1147
New Albany, IN 47150
Tel 812-944-6733
Fax 812-948-5047

■ DC / AC INVERTERS

ENDICOTT RESEARCH GROUP (ERG)
2601 Wayne Street
P.O Box 269
Endicott, NY 13760
Tel 607-754-9187
Fax 607-754-9255

TDK CORP
3102 Kashiwa Street
Torrance, CA 90505
Tel 310-539-6631
Fax 310-539-4066

■ DC / DC CONVERTERS

MAXIM
120 San Gabriel Drive
Sunnyvale, CA 94086-9892
Tel 408-737-7600
Fax 408-737-7194

TAMURA
43352 Business Park Drive
Temecula, CA 92590-6624
Tel 909-699-1270
Fax 909-676-9482

XENTEK
1770 La Costa Meadows Drive
San Marcos, CA 92069
Tel 619-471-4001
Fax 619-471-4021

■ LCD HEATERS

MINCO PRODUCTS
7300 Commerce Lane
Minneapolis, MN 55432-3177
Tel 612-571-3121
Fax 612-571-0927

■ PROTECTIVE OVERLAYS

3M INDUSTRIAL OPTICS
3M Center, Bldg 225-4N-14
St Paul, MN 55144-1000
Tel 612-736-2240
Fax 612-736-2298

HOMALITE
11 Brookside Drive
Wilmington, DE 19804
Tel 302-652-3686
Fax 302-652-4578

OPTICAL COATING LAB
2789 Northpoint Parkway
Santa Rosa, CA 95407-7397
Tel 707-545-6440
Fax 707-525-7410

PANELGRAPHIC
10 Henderson Drive
West Caldwell, NJ 07006
Tel 201-227-1500
Fax 201-227-7750

■ GRAPHIC CONTROLLER CHIPS

HITACHI SEMICONDUCTOR
2030 Main Street, Suite 450
Irvine, CA 92714
Tel 714-553-8500
Fax 714-553-8561

OKI SEMICONDUCTOR
785 North Mary Avenue
Sunnyvale, CA 94086-2909
Tel 408-720-1900
Fax 408-720-1918

S-MOS (SED1330 & SED1335)
2460 North First Street
San Jose, CA 95131
Tel 408-922-0200
Fax 408-922-0238