TIME DOMAIN

THE NEW WIRELESS MEDIUM

This application seeks approval for an ultra-wideband device that is the subject of a waiver request that was filed by Time Domain with the Commission on February 2, 1998. The waiver request submitted by Time Domain asked that section 15.205 be waived permitting emissions into the restricted bands, and that pulse desensitization not be applied because it is inappropriate for time-modulated ultra-wideband signals.

Ultra-wideband technology developed by Time Domain has been evaluated under a joint FCC-NTIA measurement program conducted in June and July of 1998. Because the intentional emissions from this device appear "noise-like" and, therefore, as if they were the emissions from an unintentional radiator, the test report in Exhibit 5 was prepared by DLS Electronic Systems at the request of Time Domain Corporation as if the equipment under test were subject to regulation as an unintentional radiator. This is consistent with the terms of the waiver request. The intentionally radiated signal is ultra-wideband in nature, having a bandwidth from 1 GHz to 3 GHz with a nominal center of 2 GHz.

See the product description located in this Exhibit for further details. Further, this application complies with the transition provision of section 15.37 of the FCC Rules.

CUMMINGS RESEARCH PARK • 6700 ODYSSEY DRIVE • HUNTSVILLE, AL 35806 · 256-922-9229 F:256-922-0387
WWW.TIME-DOMAIN.COM

Product Description

Overview
Description: The RadarVision radar system, designed and developed by Time Domain Corporation, is intended to be used to determine the presence of moving objects in situations where visual line-of-sight is obscured. For example, a law enforcement agency may wish to determine if people are in a room prior to attempting entry.

Figure 1. Representation of RadarVision application,
backpack not shown in picture

The system consists of a self-contained, battery-powered, man-portable electronics package, containing an ultra-wideband (UWB) transmitter, a compatible UWB receiver and associated antennas, displays, cables and batteries.

How it works: The RadarVision radar system works by transmitting a radio frequency (rf) electromagnetic wave, and receiving echoes created when this wave strikes an object and is reflected back to the receiver. By measuring the time between when the wave is transmitted and when the reflection is received, the distance to the reflecting object can be determined. The RadarVision system transmitted wave is a unique ultra-wideband (UWB) pulse. This UWB pulse is transmitted from the antenna toward a reflecting object at a rate very near 1 foot per nano-second (f/ns). The receiver monitors four time windows spaced

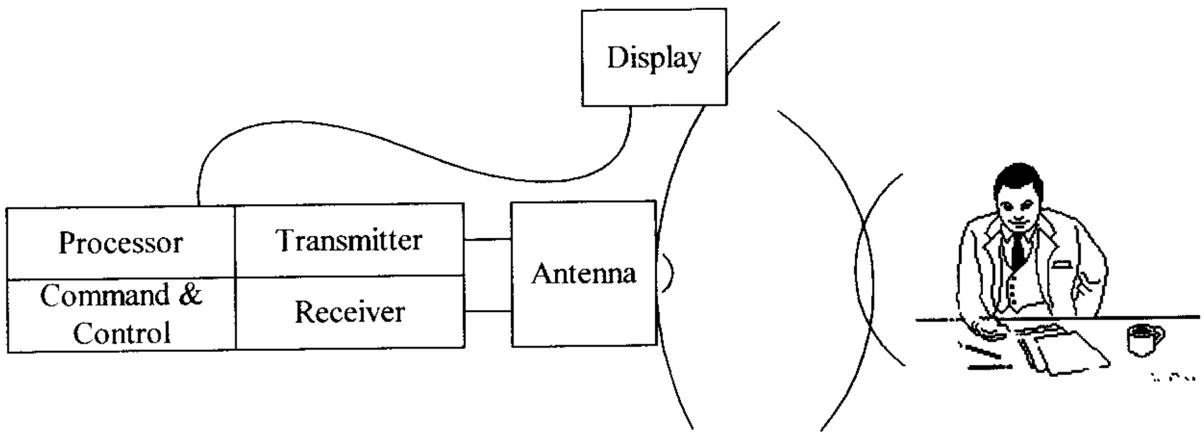


Figure 2. Representation of the RadarVision system in operation.

10 ns apart. This allows for reception of reflections at 5 foot increments. The current implementation of the RadarVision system is capable of receiving reflected waves from human sized objects at a range of 5, 10, 15 and 20 feet. The radar can be represented by Figure 2. The command control block represents the subsystems that synchronize the radar. Two important aspects of this are:

1) the random dither, and 2) the delay control between XMT (transmit) and REC (receive). This delay control defines the range being monitored. The transmitter consists of a pulser that generates a short duration pulse at a nominal PRF (pulse repetition frequency) of 5 MHz. These pulses have pseudo-randomly varying time spacing between them to make them noise-like. This randomization minimizes the potential for harmful interference. These pulses excite a UWB antenna.

The RadarVision Antenna:

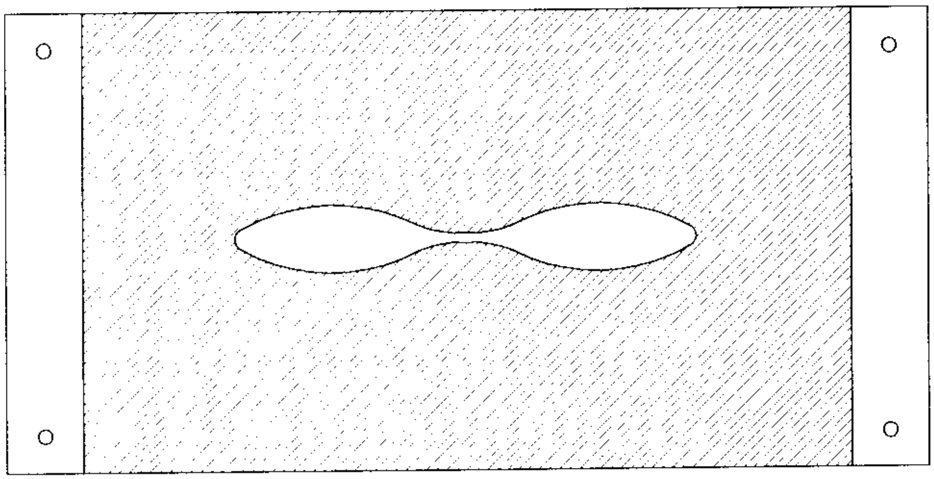


Figure 3: A diagram of the Time Domain Corporation RadarVision Antenna

The RadarVision antenna is a magnetic field antenna, in this case an antenna formed by making an aperture in a conductive ground plane. The conductive sheet is used so that current loops of varying sizes circulate, enabling the antenna to radiate over a bandwidth of from 1 GHz to 3 GHz. The antenna uses a reflector to direct the signal toward the desired direction. The transmit antenna radiates the UWB pulse that is reflected by the target, and in turn, received by a similar antenna. The received signals, at ranges determined by the command and control, are sampled by a UWB correlator receiver. This receiver is a coherent matched filter that is designed specifically to receive the desired signals. The data collected is processed, using various techniques to improve the signal-to-noise ratio and to determine if an alarm should be activated. The results of this processing are then displayed.

Description of the Detailed Block Diagram

A detailed block diagram illustrating the functional interconnects of the main radar components is presented. The radar is a completely self-contained apparatus.

The radar is powered from a nominal 12Vdc sealed lead-acid rechargeable battery pack. This battery pack is attached to the main radar enclosure by two captive screws. The power is routed from the battery pack to the main radar enclosure via a cable and screw on connector. This same cable provides the means for connecting the battery pact to a separate battery charger. The power is routed into the main radar enclosure and through an on-off switch before being connected to the power supply.

The main radar enclosure contains a power supply that is powered from the battery pack. This power supply consists of conventional switching dc-to-dc conversion circuits that are used to convert and regulate the battery pack power to various voltages required by the radar functional blocks.

The control processor is a COTS processor using a '486 level microprocessor associated with conventional support systems. Data, address and control buses are distributed to the radar subsystems by routing them through the standard PC/104 bus. Because this design required other digital and slow-speed, low-level linear board-to-board interconnects a second bus structure was defined which uses the same connectors as the PC/104 bus but has a non-standard pin assignment. This processor is clocked from a signal generated by a 33 MHz crystal oscillator.

The timing board generates precisely timed trigger pulses required by other functional blocks to route or generate signals that perform the radar motion detection. The nominal pulse repetition frequency (PRF) is 5 MHz.

One timer board trigger output is used to control the timing of a pulse generated by the pulser. Each trigger pulse results in the generation of a pulse approximately 1 nano-second long, with a power spectrum center frequency of nominally 2GHz. This pulse is routed through a fixed attenuator to the transmit antenna. The antenna radiates energy in the characteristic Time Domain Corporation ultra-wideband emission.

The emissions impinge on objects and structures in the environment. Portions of these emissions are re-radiated and in turn impinge on the radar receive antenna. The low-noise amplifier (LNA) amplifies the received signals. A low-noise amplifier is used to increase the level of the received signal and environmental noise while contributing negligible noise in the process. The signal is then passed through a correlator. This circuit is analogous to a heterodyne mixer in a conventional radar system. A trigger signal from the timer, that has been delayed a known amount, is used to time a template pulse. This template pulse is multiplied with the received signal, resulting in a base-band signal. Because the trigger to the correlator template generator is synchronous, howbeit delayed, with the trigger signal to the pulser, all pseudo-random time modulation is removed from this base-band signal.

The base-band processor block uses conventional analog-to-digital processing to generate a record of the amplitude of the sum of the received pulses. This record is stored and repeatedly compared with ensuing records. An indication of movement in the environment is generated when a difference in successive received records differs from stored records.

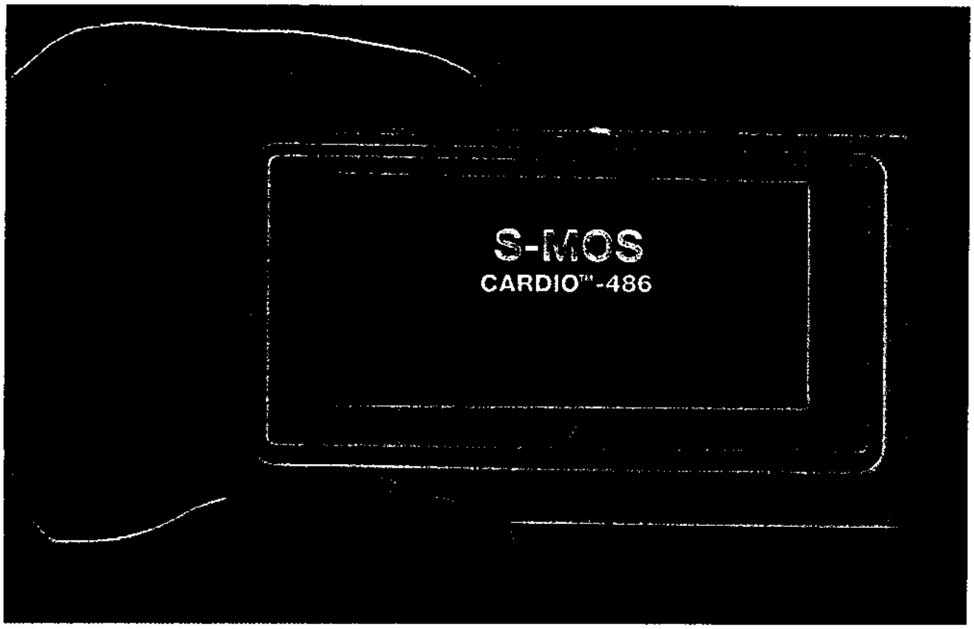
The control processor is used, at this point, to generate displays on the LCD screen, to generate a tone and direct signals to the DB-9 pin serial connector on the main radar enclosure side panel. This connector is included as part of the user I/O, to provide a link to a laptop computer that serves as an auxiliary display for demonstration and training.

S-MOS
SYSTEMS
A Seiko Epson Affiliate

S-MOS CARDIO™486

EATURES

- 486SL Super Set Core
- 8XC51SL Keyboard I/F
- Memory:
  - 4- or 8 MB RAM
  - (12 and 16MB)
  - 256KB ROM
- VGA:
  - Analog RGB
  - Mono-STN or color TFT
- SPC2052 FDC
- Power Supply:
- 3.3V ± 0.3V, 5.0V ± 5%
- IBM PC AT BIOS Compatible
  - Set-up functions
  - VGA support
  - Power management

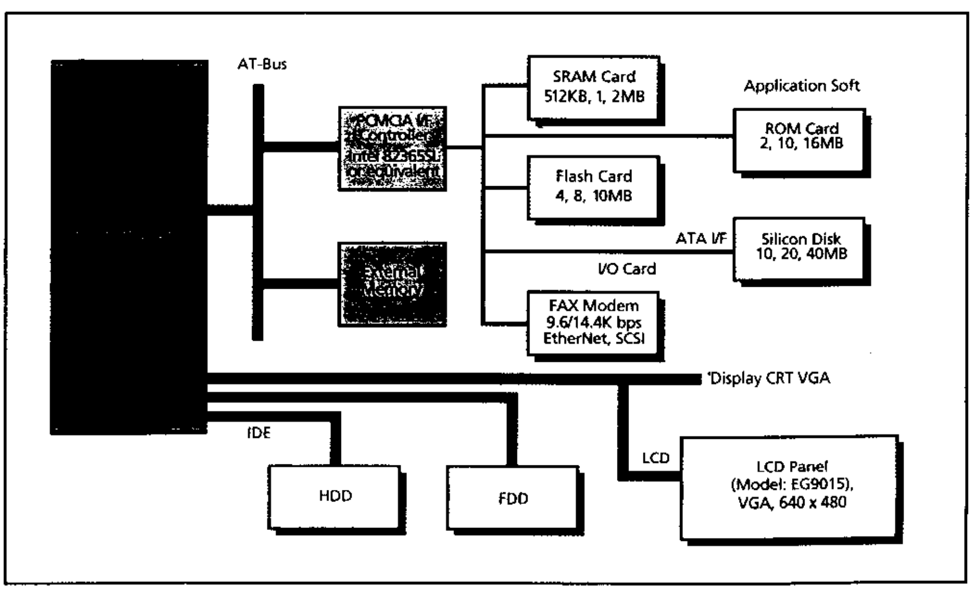


DESCRIPTION

The CARDIO™-486 is compatible with the IBM PC AT and condensed to a PCMCIA-sized card. The CARDIO™-486 consists of Intel486™ SL super set (with 8KB Cache and FPU), VGA, ROM, RAM, FDC and a keyboard controller. The CARDIO™-486 interfaces with peripherals through a standard ISA and the S-MOS ALL-IN-ONE SYSTEM INTERFACE.

The CARDIO™-486 can be tailored to any customer's specific embedded application such as POS, FA and CATV. System upgrading is fast and easy since all cards utilize a standard pin configuration.

CARDIO-486 APPLICATION EXAMPLE



S-MOS SYSTEMS
A Seiko Epson Affiliate

;-MOS CARDIO™-486

/AILABLE PRODUCTS

ırdio-86
ırdio-386
ırdio-386L
ırdio-486

/aluation Board
)IO5300

/aluation Board Peripherals
)IO5301 (FDD, Power Supply, HDD, LCD)
)IO5301R (FDD, Power Supply, HDD)
)IO5311 (6-inch LCD, 640x480 & Connector)

ʀAM Cards
VWB513ES4Y (512KB, w/2nd Battery)
VWB101ES4Y (1Meg, w/2nd Battery)
VWB201ES4Y (2Meg, w/2nd Battery)

ash Cards
IWB401S8YY (4MB)
IWB801S8YY (8MB)
IWB111S8YY(10MB)

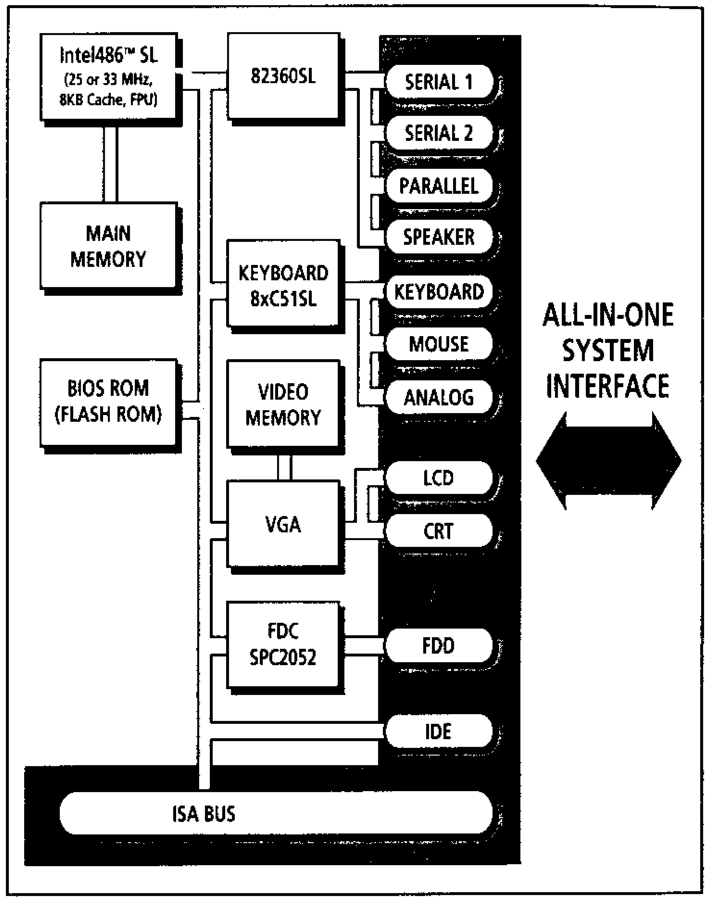
ırd Disk Card
HDD170

ıX/Modem Cards
FM144
FM96

'A Flash Cards
ιTA202NL11 (2.62MB)
ιTA502NL11 (5.24MB)
ιTA112NL11 (10.98MB)

:D Panel Module (640x480, STN Mono)
:G9015 (1/240 Duty)
:G9013 (1/480 Duty)

BLOCK DIAGRAM



:LECTION GUIDE

Part Number	Clock (MHz)	RAM (MB)	ROM (KB)	Dimensions (mm)
SCE8643509	25	4	256	85.6 x 54.0 x 5.5
SCE8643511	33	4	256	85.6 x 54.0 x 5.5
SCE8643513	25	8	256	85.6 x 54.0 x 5.5
SCE8643515	33	8	256	85.6 x 54.0 x 5.5

MOS Systems, Inc., 2460 North First Street, San Jose, California 95131 • Phone: (408) 922-0200, FAX: (408) 922-0238

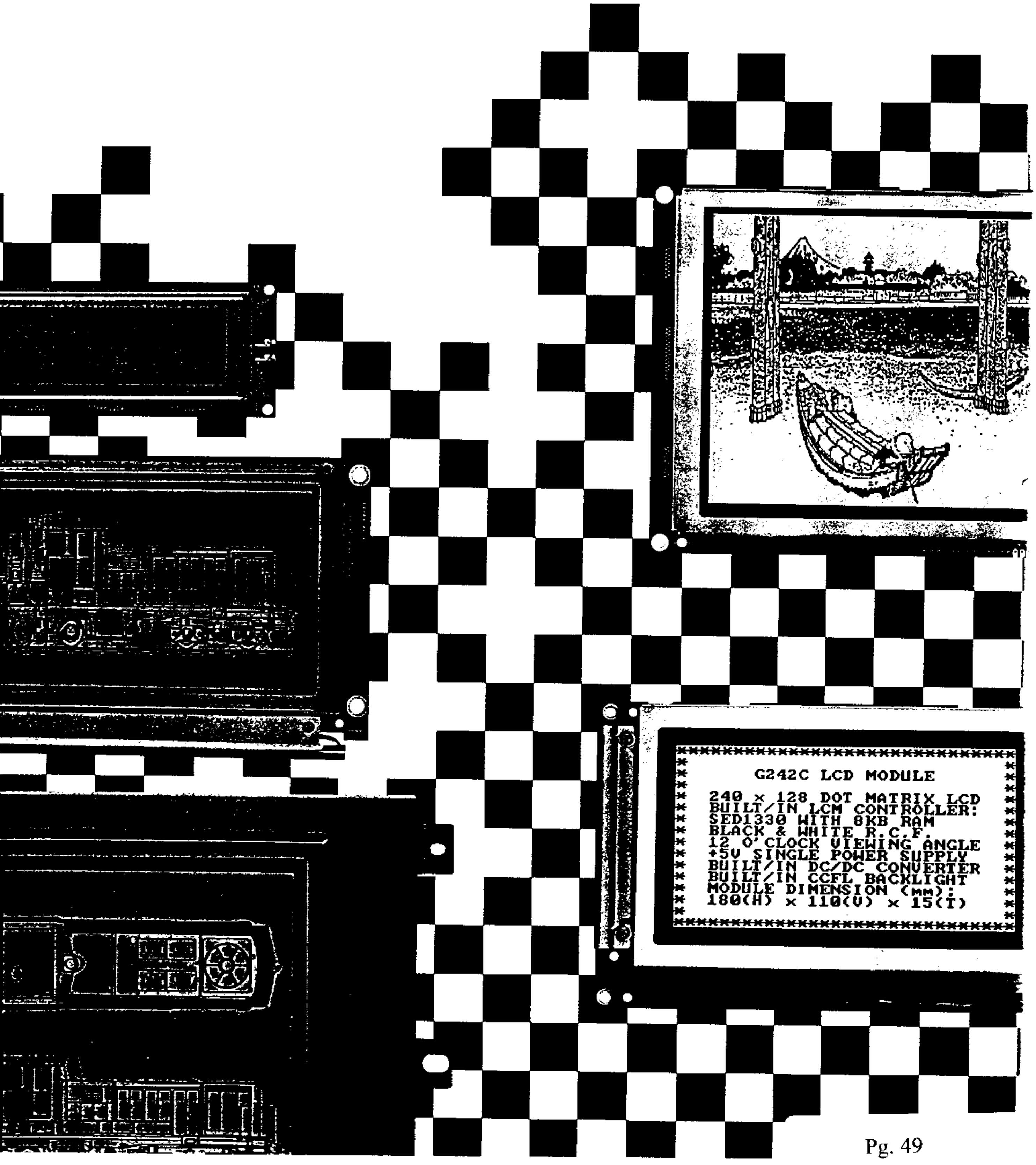
FCC ID: NUF - CW

SII

Seiko Instruments

Liquid Crystal Display Modules

Second Edition



Seiko Instruments is an industry leader in advanced liquid crystal display technology worldwide. Since 1973, Seiko Instruments has been manufacturing a full range of LCDs and LCD modules for medical, industrial, test and measurement, and office automation applications.

Seiko Instruments offers a wide range of LCD modules in both alphanumeric and graphic configurations. These products feature twisted nematic and super twisted nematic technology and are available with electroluminescent and LED backlighting. Seiko Instruments' graphic modules feature advanced cathode fluorescent edge light technology for sharper text and graphics.

Seiko Instruments is a well recognized leader in precision engineering, design and manufacturing of the highest quality industrial high technology and consumer products. The company's Electronic Components Division offers other products to meet your next-generation design needs such as micro thermal printers, quartz crystals and oscillators, fiberoptic components, batteries and application specific standard semiconductors.

Call Seiko Instruments today. We are ready to provide the LCD technology, engineering support and superior quality for your next design.

New Age Electronics, Inc.

P.O. Box 1887 · Huntsville, AL 35807
(205) 895-9400 · Fax: (205) 895-0063
4835 University Square Suite #9 · Huntsville, AL 35816

SII
iko Instruments

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Electronic Components Division
2990 West Lomita Blvd.
Torrance, CA 90505 U.S.A.
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LCD Technology

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 Figure 1).

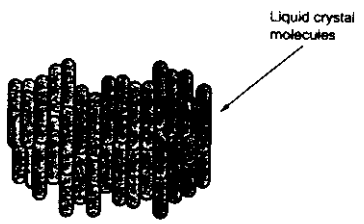


Figure 1 Structure of nematic liquid crystal

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 Figures 2 and 3).

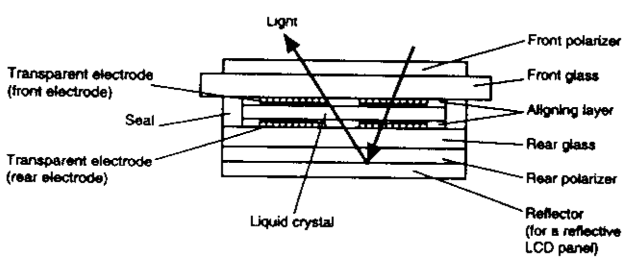


Figure 2 TN LCD panel

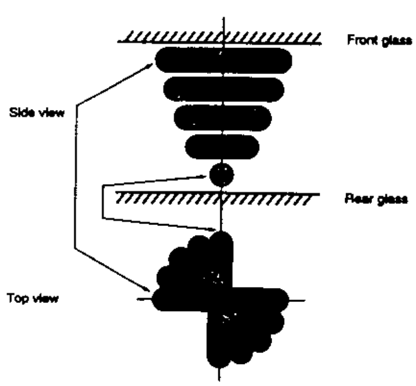


Figure 3 Orientation of nematic liquid crystal molecules (twist angle: 90°)

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 LC to be out of phase with the light, 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.

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 nonexistent, a light source must be placed behind the LCD. This is known as backlighting (see Figure 4a). There are several technologies used:

Electroluminescent (EL): EL backlights are very thin, lightweight and provide an 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 3,000 to 5,000 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. LEDs come in a variety of colors, with yellow-green being the most common.

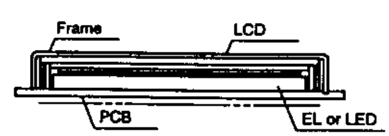


Figure 4a EL and LED Backlight

ɔld Cathode Fluorescent Lamp (CFL): CFL backlight ɔw power consumption and a very bright white light gure 4b). Two technologies are used: direct and edge ı. In both types a cold cathode fluorescent tube is the urce. A diffuser distributes the light evenly across the ı area. Edge lighting offers a thinner package and less CFLs require an inverter to supply the 270 to 300 VAC y the CFL tube. They are used primarily in graphic ınd have a longer life — 10,000 to 15,000 hours — .s do.

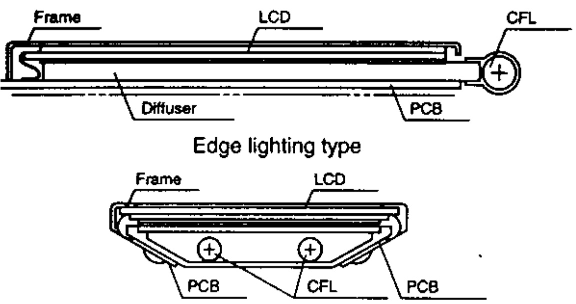


Figure 4b

ꞮING MODES

ƆDs are offered in three basic light transmission modes: ʼe, transflective and transmissive (see Figure 5).

the reflective mode, ambient light is used to illuminate ɔlay. This is achieved by combining a reflector with the larizer. It works best in an outdoor or well-lighted ·nvironment.

ansflective LCDs are a mixture of the reflective and ssive types, with the rear polarizer having partial ʼity. They are combined with a backlight for use in all f lighting conditions. The backlight can be left off here is sufficient outside lighting, conserving power. ɜr environments, the backlight is on to provide a bright display. ɜctive LCDs will not "wash out" when ɜd in direct sunlight.

ansmissive LCDs have a transparent larizer and do not reflect ambient ıey require a backlight to be visible. ɔrk best in low light conditions with ·klight on continuously.

ıother feature of the viewing mode is r the LCD is a positive or negative (see Figure 6). The standard image ive, which means a light back- with a dark character or dot. This ɔest in reflective or transflective mode. :ive image is usually combined with a transmissive mode. This provides a dark background with a light character. A 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.

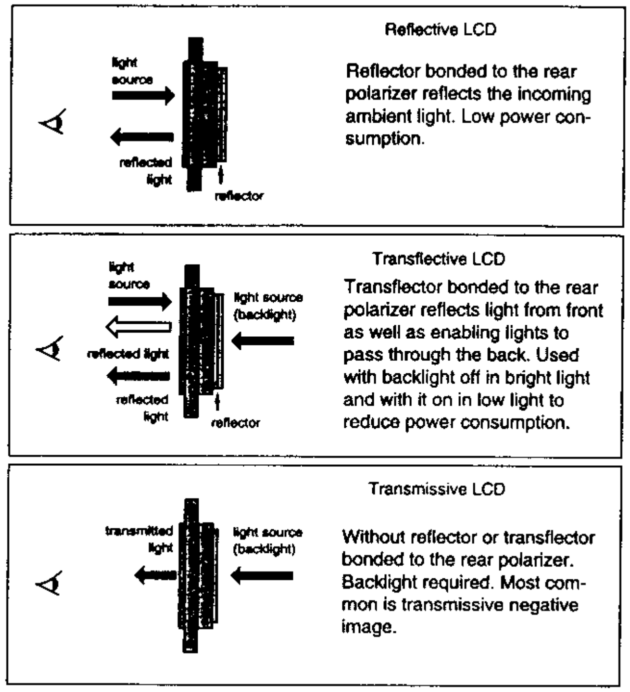


Figure 5

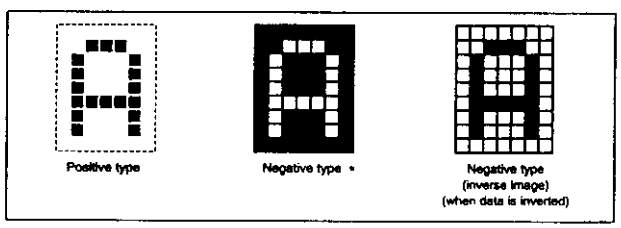


Figure 6

TABLE 1: LCD Viewing Modes

Viewing Mode	Display Description	Application Comments	Direct Sunlight	Office Light	Subdued Light	Very Low Light
Reflective Positive Image	Dark segments on light background	Not backlit. Provides best head-on contrast and environmental stability	Excellent	Very Good	Average	Poor
Transflective Positive Image	Dark segments on grey background	Can be viewed by reflected ambient light or with backlighting	Excellent (No backlight)	Good (No backlight)	Good (Backlit)	Very Good (Backlit)
Transflective Negative Image	Light grey segments on dark background	Needs high ambient light or backlighting. Frequently used with color and multicolor transflector	Good (No backlight)	Fair (No backlight)	Good (Backlit)	Very Good (Backlit)
Transmissive Negative Image	Backlit segments on dark background	Cannot be read by reflection	Poor (Backlit)	Good (Backlit)	Very Good (No backlight)	Excellent (Backlit)
Transmissive Positive Image	Dark segments on backlit background	Designed for very low light conditions, yet able to be read in bright ambient lights	Good (No backlight)	Good (Backlit)	Very Good (Backlit)	Excellent (Backlit)

raphic LCD Modules

atures

ΓN & FSTN technology offers excellent
ontrast and wide viewing angle
hin, light weight with low power consumption
FL backlight offers high brightness and long life
uilt-in controller on some models
bit parallel interface except for F1016, G1213
nd G1216 (8-bit)

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

Graphic modules are organized in rows (horizontal) columns (vertical) of pixels. Each pixel is addressed idually, allowing any combination to be "on". This ıpping provides the user with the ability to construct text y size or shape, or true graphics, if that is desired. Instruments offers resolutions of 100x64 to 640x480.

UIT BLOCK DIAGRAM

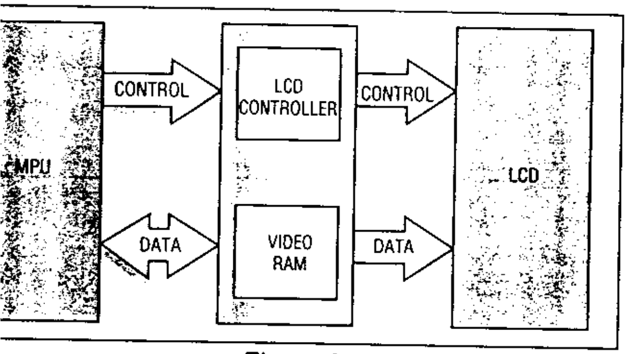


Figure 9

An LCD controller is required to send data to the graphic module (see Fig. 9). This specialized IC receives data from the MPU and sends the proper timing and data signals to the display. Data is sent to the display in 4-bit parallel mode. Each row of data is sent to a data register and then latched. This starts at the top of the display (line 1) and continues until the bottom is reached. For displays with more than 240 rows, the screen is split into upper and lower sections. In this case, 4 bits of data are sent to the upper and lower sections simultaneously.

CONTROLLER CHIPS

A recommended listing of controller chips for Seiko Instruments graphic modules is shown on page 16. Each controller offers a different mix of features, simplicity and cost. Several modules are offered with an S-MOS SED1330FBA controller and data RAM built in. This allows the display to interface directly with an MPU. The SED1330FBA contains a CG ROM with 160 characters (5x7 format). It also offers a variety of advanced features.

CONTROLLER BOARDS

Seiko Instruments offers two controller or interface boards for use with displays that do not have a built-in controller. The first is the LCDC-1330, which contains the SED1330FBA controller chip. This board comes in two versions, the only difference being the amount of RAM included. The LCDC-1330 interfaces directly with the MPU and the display. It can control displays up to 640x200 resolution.

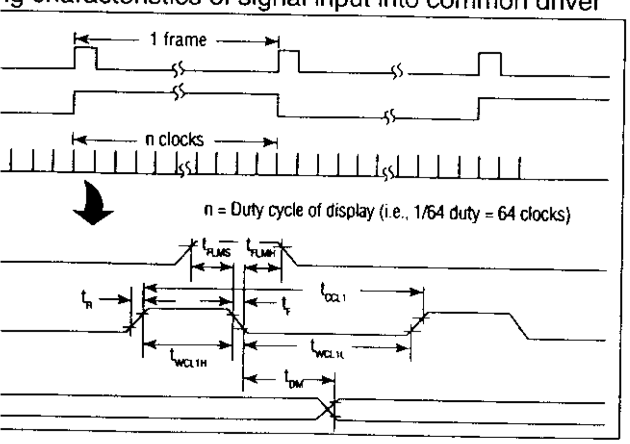
The UV-620 controller board is designed for VGA resolution displays. It contains the Cirrus Logic CL-GD610/620 chip set. This board is designed to be installed directly in a personal computer AT bus. It connects to the display and allows standard PC software to be run.

aphic LCD Specifications

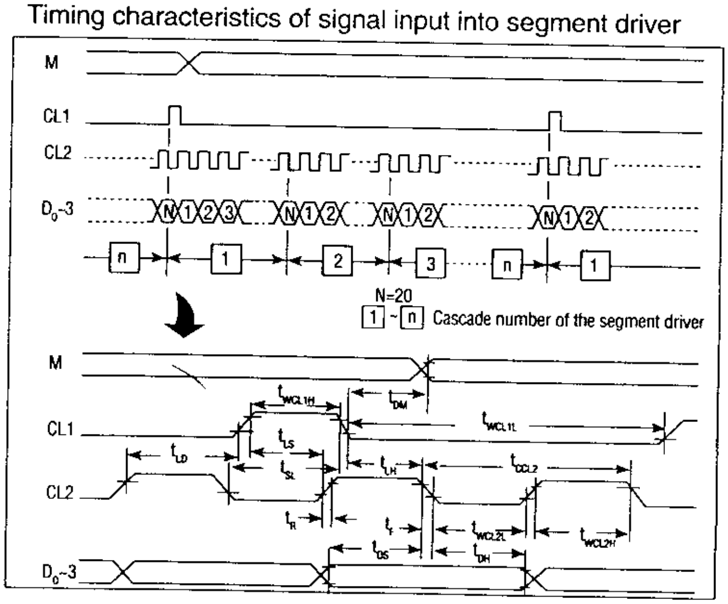
IG CHARACTERISTICS

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

ıg characteristics of signal input into common driver



Timing characteristics of signal input into segment driver



PRODUCT SELECTION GUIDE (H=HORIZONTAL, V=VERTICAL, T=THICKNESS)

GRAPHIC MODULES

COLOR 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
G121C0DX000	128 x 128	ECB	86 x 95 x 7	67 x 67	0.46 x 0.46	0.49 x 0.49	1/28, 1/10
G121C2EX000	128 x 128	ECB	86 x 95 x 7	67 x 67	0.46 x 0.46	0.49 x 0.49	1/28, 1/10

REFLECTIVE MODULES

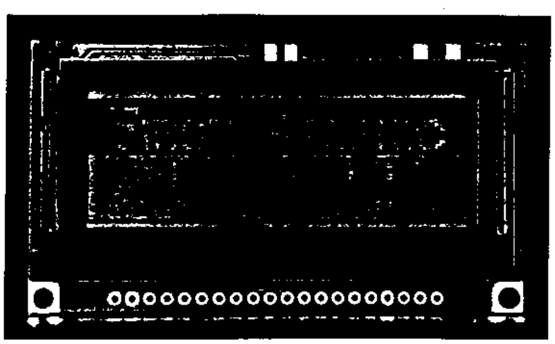
Part Number	Dot Format (H x V)	LCD Fluid Type	Module Size (H x V x T,mm)	Viewing Area (H x V,mm)	Dot Size (H x V,mm)	Dot Pitch (H x V,mm)	Duty Cycle, Bias
G121300N000	128 x 32	WTSTN	75 x 42 x 6.8	60 x 21	0.40 x 0.48	0.43 x 0.51	1/64,1/9
G121600N000	128 x 64	WTSTN	75 x 53 x 6.8	60 x 33	0.40 x 0.40	0.43 x 0.43	1/64,1/9
G122600N000	128 x 64	STN	93 x 70 x 11.4	70.7 x 38.8	0.52 x 0.52	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

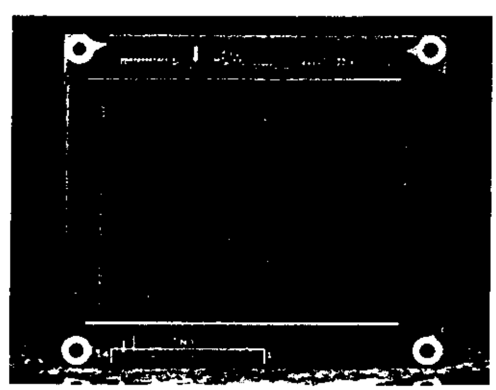
Part Number	Dot Format (H x V)	LCD Fluid Type	Module Size (H x V x T,mm)	Viewing Area (H x V,mm)	Dot Size (H x V,mm)	Dot Pitch (H x V,mm)	Duty Cycle, Bias
G1213B1N000** (LED)	128 x 32	WTSTN	75 x 42 x 8.9	60 x 21	0.40 x 0.48	0.43 x 0.51	1/64,1/9
G1216B1N000** (LED)	128 x 64	WTSTN	75 x 53 x 8.9	60 x 33	0.40 x 0.40	0.43 x 0.43	1/64,1/9
G1226B1J000**(LED)	128 x 64	STN	93 x 70 x 11.4	70.7 x 38.8	0.52 x 0.52	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
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
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

(Unit: mm) A built-in DC/DC converter eliminates the need for V_{LC} ** 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



RODUCT SELECTION GUIDE (H=HORIZONTAL, V=VERTICAL, T=THICKNESS)

APHIC MODULES

COLOR MODULES

Power Requirements VDD (VDD X mA)	VLC (VLC X mA)	Backlight + (VDD X mA)	Weight (g)	Suitable Controller	Controller Board	Inverter	Part Number
+5V @ 10.0	-15V @ 10.0	•	90	SED-1351*	•	•	G121C0DX000
+5V @ 10.0	-15V @ 10.0	+5V @ 110	90	SED-1351*	•	INV-50	G121C2EX000

ko Instruments will introduce the S-4581A controller designed for the ECB Color Graphic Modules in mid '96.

REFLECTIVE MODULES

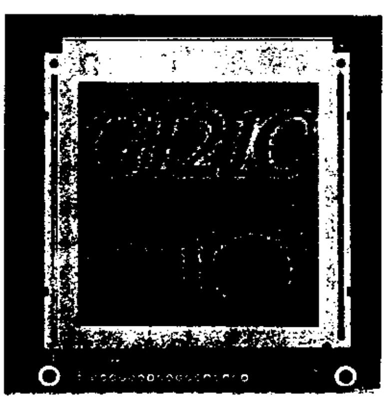
VDD	VLC	Backlight	Weight	Suitable Controller	Controller Board	Inverter	Part Number
+5V @ 2.0 -	8V @ 1.5	•	40	Built-in Data RAM	(Built-in RAM)	•	G121300N000
+5V @ 2.0 -	8V @ 1.5	•	40	Built-in Data RAM	(Built-in RAM)	•	G121600N000
+5V @ 4.3	-15V @ 4.1	•	75	MSM6255GS	LCDC-1330-32A	•	G121C00P000
+5V @ 6.5	-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

BLACKLIGHT MODULES

VDD	VLC	Backlight	Weight	Suitable Controller	Controller Board	Inverter	Part Number
+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)	•	G121681N000 (LED)
+5V @ 6.5	-18V @ 6.0	+4.1 V @ 120	100	MSM625565	LCDC-1330-32A	•	G121CB1P000 (LED)
+5V @ 6.5	-18V @ 6.0	+4.1 V @ 120	100	Built-in SED1335	(Built-in)	•	G121C81P00C (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)

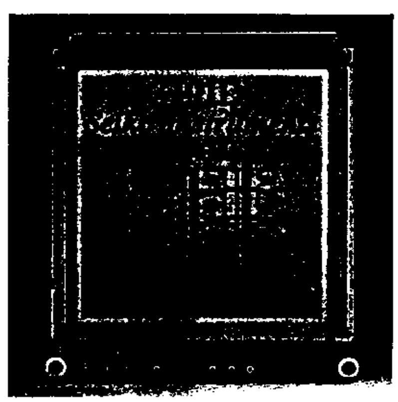
ver consumption is typical and includes the backlight. For the EL and CFL Versions it includes inverter losses. (Unit: mm)

G121C

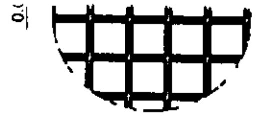


$130

G191D

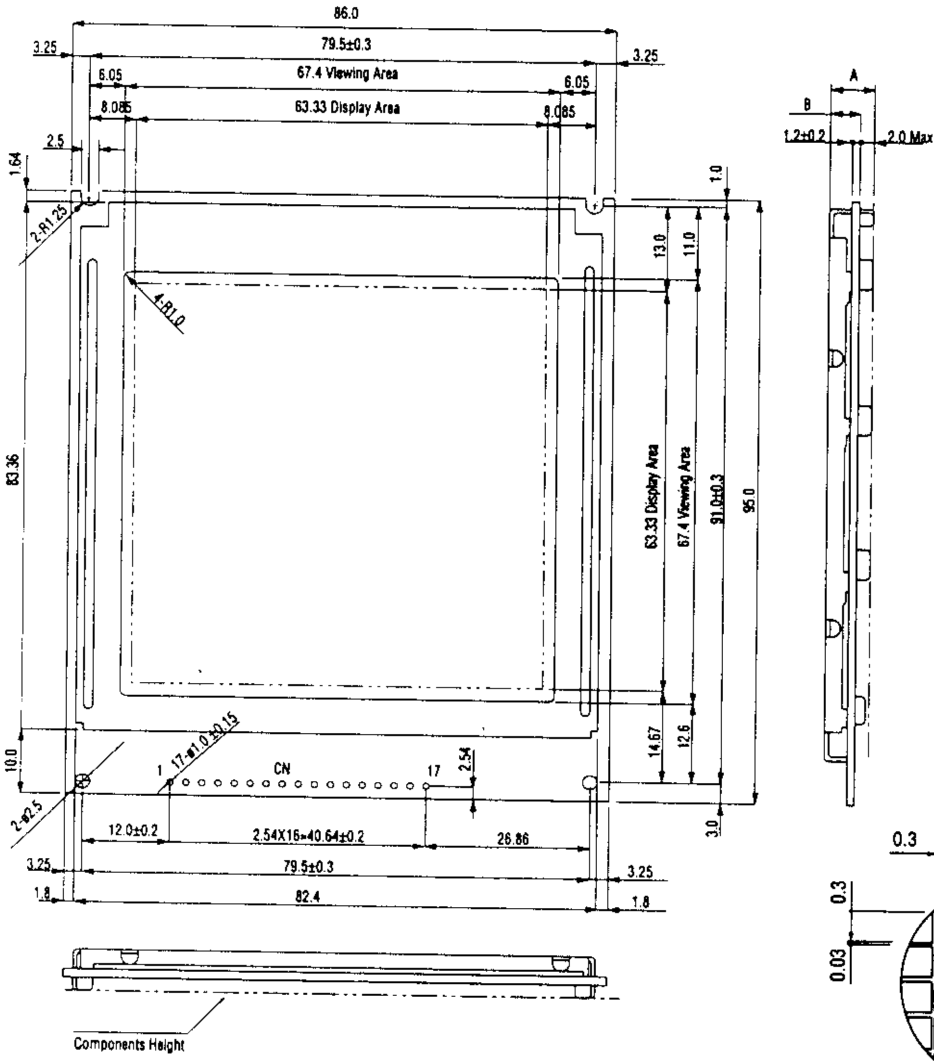


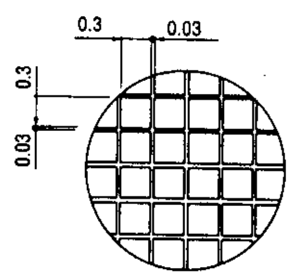
53



6	CL2	13	V_B
7	D1	14	V_{EE}

G191D (192 x 192) Unit: mm General Tolerance ±0.5





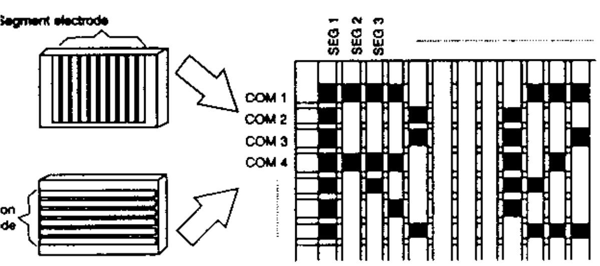
CN1 G191D			
No.	**Symbol**	**No.**	**Symbol**
1	V_{DD}	10	D1
2	F_{SEP}	11	D2
3	CL2	12	D3
4	INH	13	V_{LC}
5	FLM	14	V_{EE}
6	CL1	15	V_{SS}
7	V_{SS}	16*	LED (+)
8	M	17*	LED (-)
9	D0		

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

:INCIPLES OF OPERATION

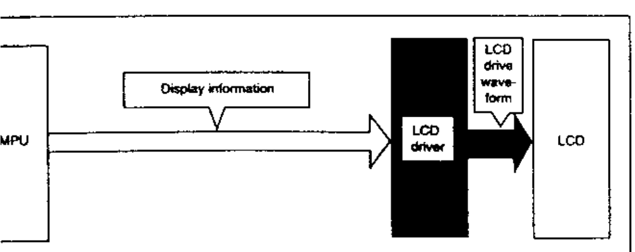
Graphic modules offer the greatest flexibility in format-
data on the display. They allow for text, graphics or any
bination of the two. Since character size is defined by
vare, they allow any language or character font to be
vn. The only limit is the resolution of the display.

Graphic modules are organized in rows (horizontal) and
mns (vertical) of pixels. Each pixel is addressed individu-
allowing any combination to be ON. This bitmapping
ides the user with the ability to construct text of any size
ape, or true graphics, if that is desired.

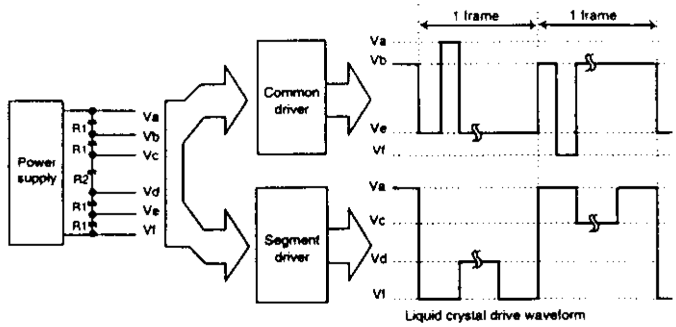


The above figure shows the structure of an LCD. Liquid
tals are placed between two types of glass substrates,
having segment electrodes (SEG1, SEG2, and so on),
other having common electrodes (COM1, COM2, and so
Each cross point of the segment and common elec-
es is a display pixel.

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

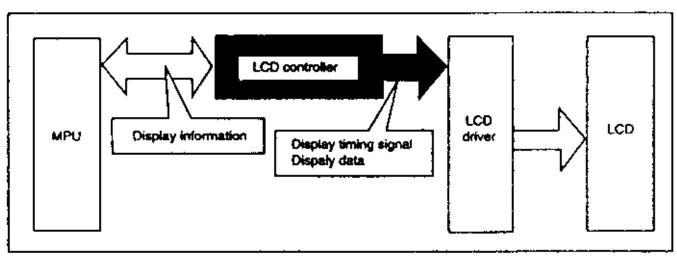


The LCD driver generates liquid crystal drive waveforms
ording to the display information sent from the MPU, and
the waveforms to drive the LCD.



The LCD drivers are classified into 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.

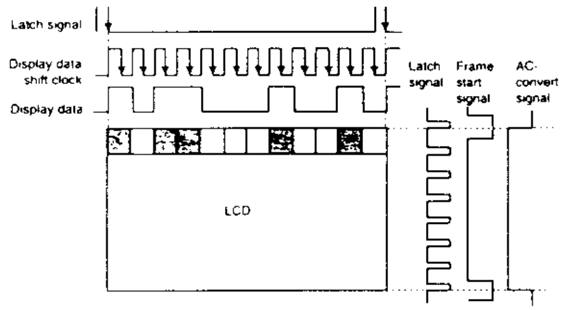
LCD CONTROLLER



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.

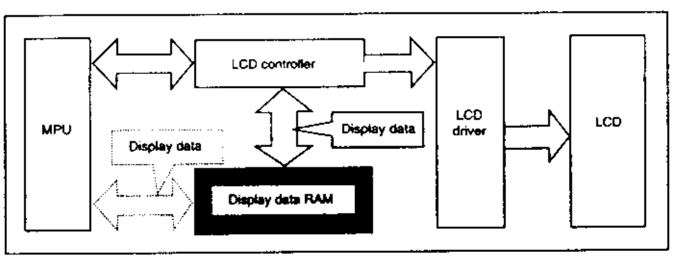
PRINCIPLES OF OPERATION (CONTINUED)



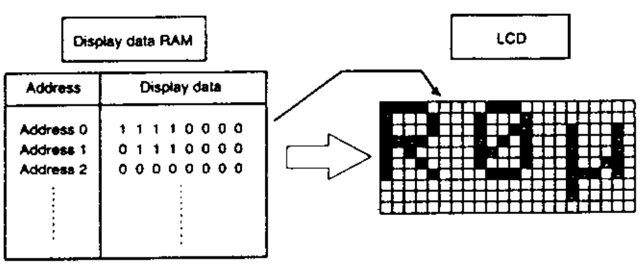
There are four display timing signals: display data shift clock, latch signal, frame start signal, and AC-convert signal.

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

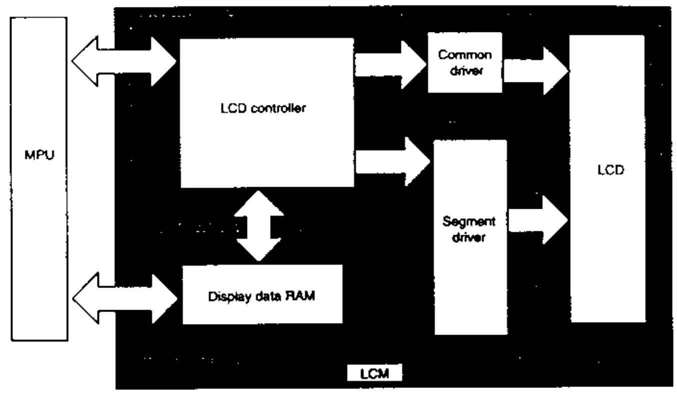


The display data RAM stores the display information sent from the MPU. The LCD controller reads data from the display data RAM, and transfers the data to the LCD drivers. Some LCD controllers let the MPU directly interface the display data RAM as shown by dotted lines in the figure above.



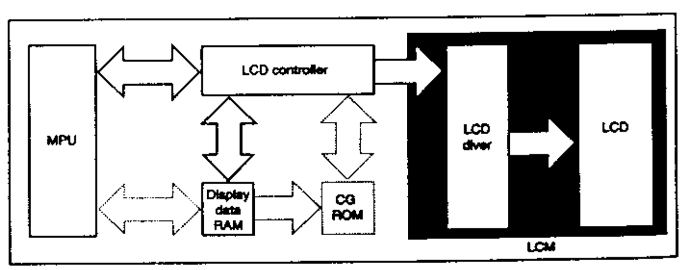
One of the methods to correspond display contents to display data is to assign a display data bit to a display pixel dot. In that case, if the MPU writes and stores data "11110000" at address 0 of the display data RAM, the LCD screen displays a pattern of "■■■■□□□□" according to the 0s and 1s in the 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 (G1213, G1216, G1226)



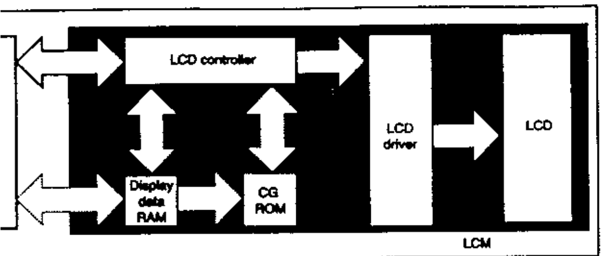
Graphic modules with built-in data RAM have two types of ICs: one integrating the controller and common driver, and one integrating the display data RAM and the segment driver. These modules use direct bitmapping; one bit in RAM corresponds to each pixel on the display. They communicate directly to the 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 4-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.

PHIC MODULES WITH BUILT-IN TROLLER (G121C, G2446, G242C, :1D, G324E)

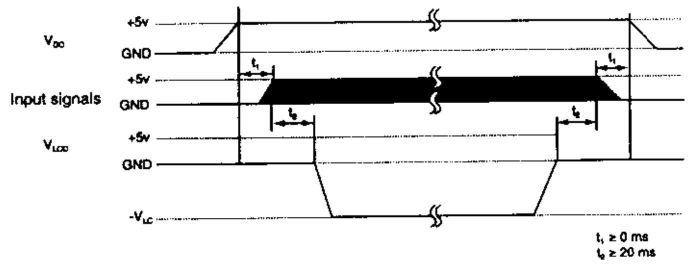


eiko Instruments offers five graphic modules with the 330 controller built-in.* These modules interface directly microprocessor with an 8-bit parallel interface. The was carefully chosen to offer our customers the most ced features, including overlayed graphics and text, ntal and vertical scrolling, built-in character generator xternal RAM, etc.

Model G121C features SED1335...see p. 65.

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 and G1226 in the next section.

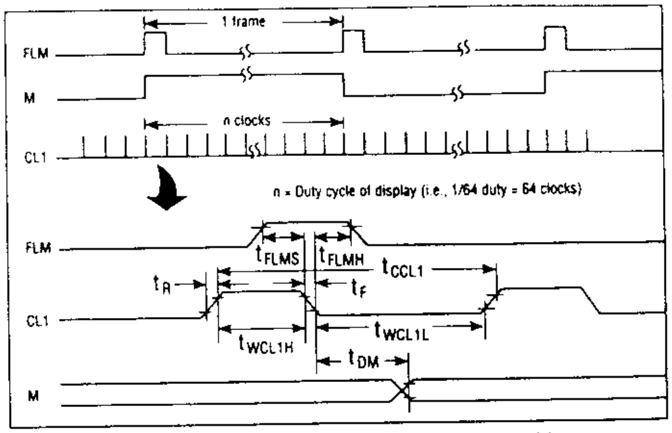


INTERFACE SIGNAL	FUNCTION
A0	Command mode set
CL1	Display data latch signal. Signal is used to latch data in each common line
CL2	Display data shift signal. Clock signal to shift data in 4-bit increments to the display
CS1, CS2	Chip select (read/write enable)
/CS	Chip select
CS11-CS24	Chip select (screen selection)
D_0-D_3	Display data signal; D0-D3 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, SEL 1=0, SEL 2=0; for Motorola, SEL 1=1, SEL 2=0
V_{DD}	Power supply voltage for logic: +5 V
V_{LC}	Power supply for LCD: -5 V to -24 V(see model)
V_o	LCD contrast adjustment voltage
V_{SS}	Ground
/WR	Write

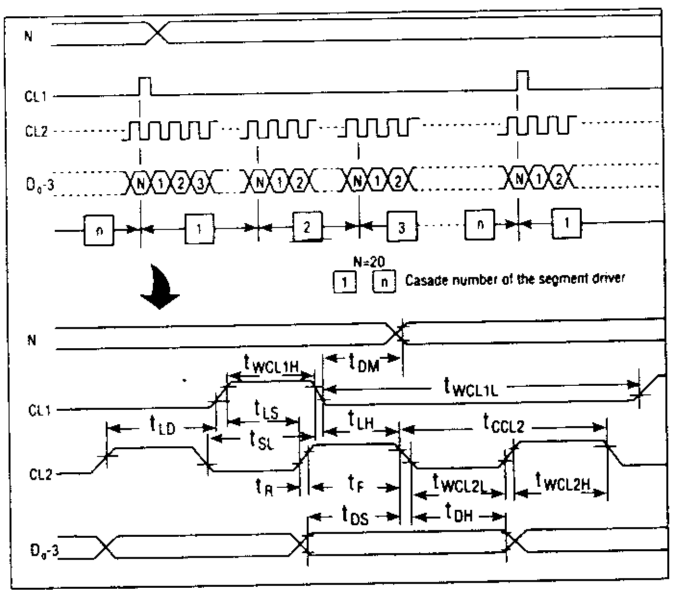
PRINCIPLES OF OPERATION (CONTINUED)

TIMING CHARACTERISTICS

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



Timing characteristics of signal input into segment driver.

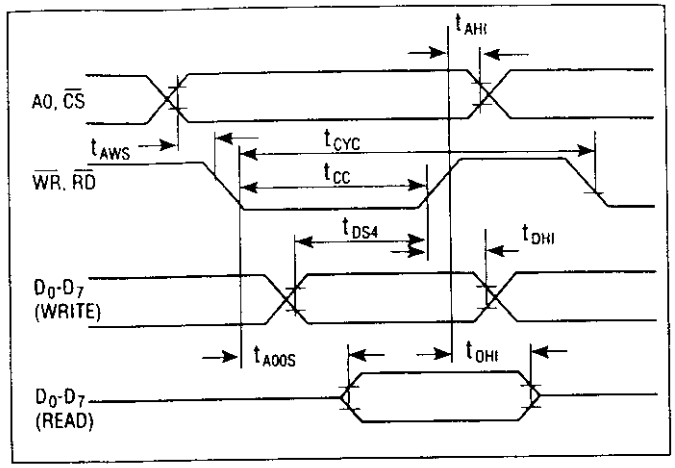


Timing characteristics of signal input into segment driver.

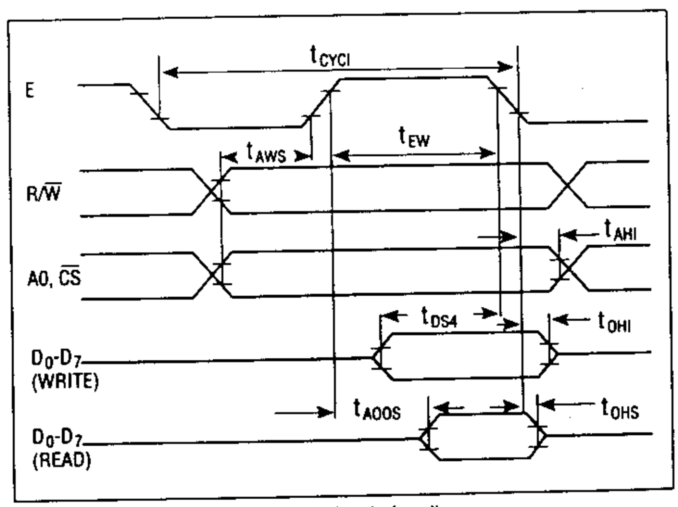
TIMING CHARACTERISTICS TEMP. = 0 - 50°C, V_{DD} = 5.0v ± 5%, V_{SS} = Ov

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

TIMINIG 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
	D0-D7	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 53 for microprocessor ch

;30 Controller Features

)1330 Advanced LCD Display
ıTROLLER

Seiko Instruments has selected the SED1330 to use as t-in controller in our mid-size graphic modules. This S LSI device generates all the signals required by the ay memory and LCD drivers, and incorporates a charac- enerator ROM. The command set within the SED1330 s the user to create a layered display of characters and iics, scroll the display, and assign display attributes to ted areas of the screen. The controller also functions as eline buffer between the MPU and display memory so ow cost, medium speed SRAM can be used.

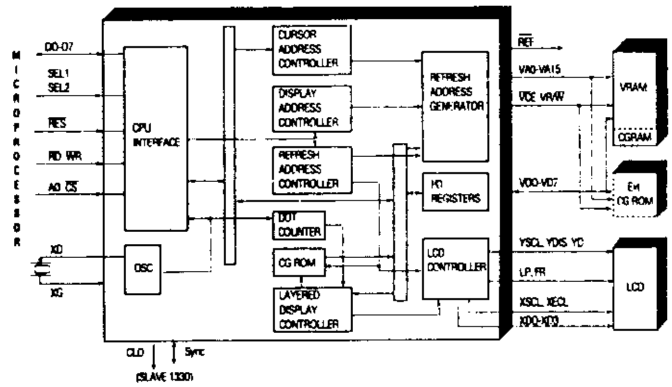
This advanced LCD controller IC features:
5800 and 8080 family compatibility
3-bit parallel buffered MPU interface (bi-directional)
Control of 64 K bytes of memory
Horizontal and vertical scrolling
Reverse video and flashing
Up to three layers of graphics
Up to two layers of mixed character & graphics
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 the same features as the SED1330. In addition, this new oller accommodates a +3.3 volt input.

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

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

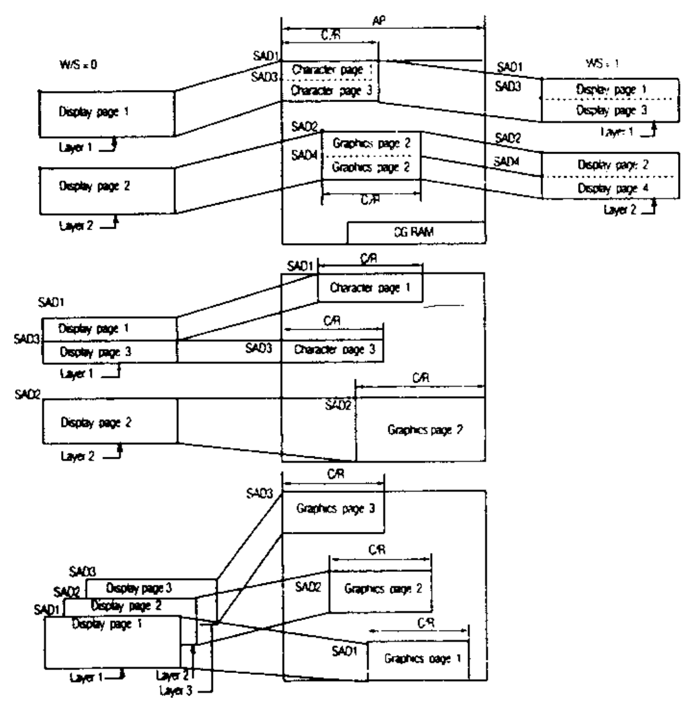
The SED1330 divides its memory space into four areas:
1. Character data table
2. Graphics data table
3. CG RAM table
4. External CG ROM table



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

›LAY ATTRIBUTES

'o improve the display legibility when using a mono-
ıatic LCD, the SED1330 can generate "reverse video"
cters, half-tone displays, and local flashing by combin-
yers in different ways.

	MX1 MX0	Screen	1st Layer Single Screen	2nd Layer Single Screen
verse	0 1 1 1	IV SEIKO	IV SEIKO	
ne Display	0 0 · 1 1	ME YES, NO	ME YES, NO	
Flashing splay	0 0 1 1	BL Error	BL	Error

Possible Display Attributes

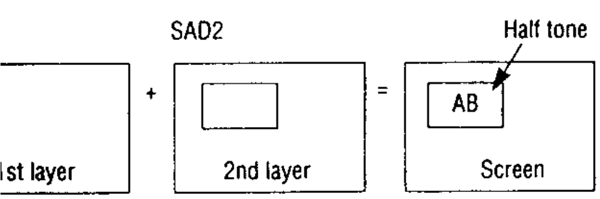
Only one style of attribute can be used per screen.

ERSE VIDEO

≀everse video effects can be generated by taking the
ısive-OR" of the 1st layer (character) and the 2nd layer
ıics).
;SRW, CSRDIR, and MWRITE commands: Data "1"
re written into the graphics area corresponding to
ıe intended "reversed" area of the display.
)VLAY command: The OVLAY command selects "exclu-
ive-OR" superposition of the first and second layers.
1X1 = 0, MX = 1
ISP ON/OFF command: This command turns on the
rst and second layers, resulting in reversed characters.
=P1, FP0) = (0,1) (FP3, FPZ) = (0,1)

F-TONE DISPLAY

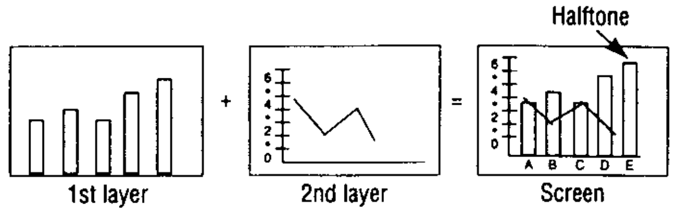
ʇalf-tone displays can be generated by rapidly flashing
ıyer of the display. Care should be taken using this dis-
ıode since it may cause certain LCDs to flicker.
)isplay of menu pad (using "OR-ed" layers)
, menu choice can be highlighted by displaying full-
ɔne characters against a half tone "pad."



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

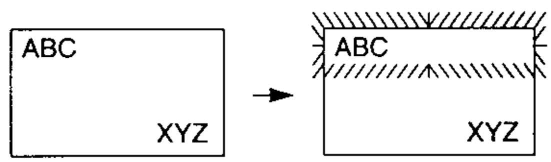
LOCALIZED FLASHING

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 "XORtied", and flashed slowly.



Localized Flashing

CHARACTER GENERATOR

INTERNAL CHARACTER GENERATOR

The internal character generator is recommended for minimum system configurations containing an 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

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 cursor's home layer by adjusting the parameters of the SCROLL command.

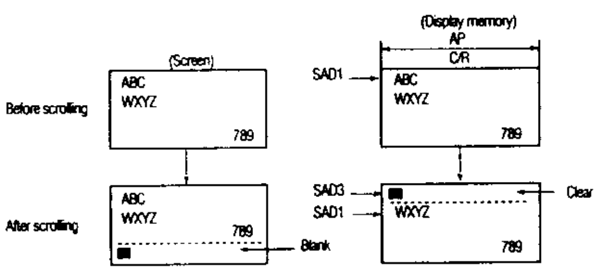
Scrolling

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.

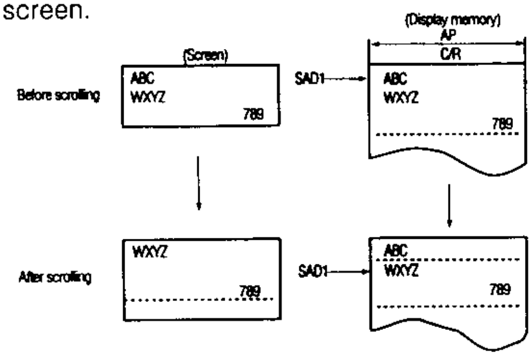
1. Set the start address of screen 3 to the current start address of screen 1 (SAD3 = SAD1).
2. Move screen 1 down one line (SAD1 = SAD1 + AP).
3. Clear the last line of screen 3.



On-page Scrolling

Inter-page Scrolling and Page Switch-over

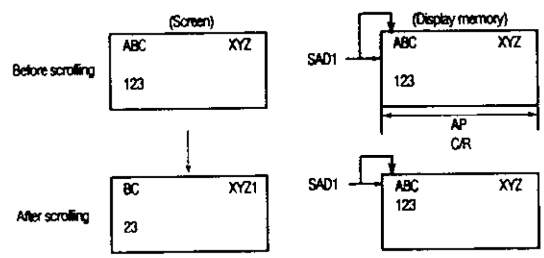
Inter-page scrolling and page switchover are available when using display memory with a capacity of more than one screen.



Inter-page Scrolling

Horizontal Wraparound Scrolling

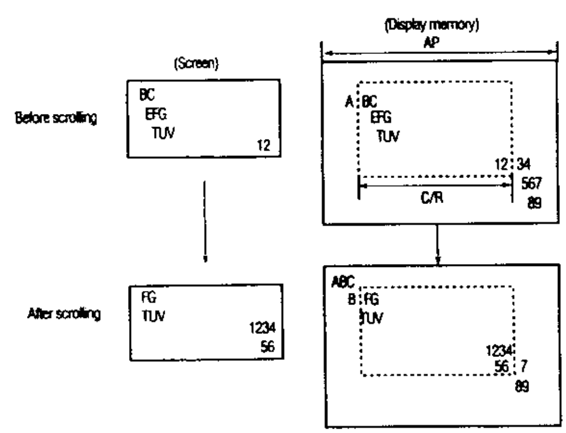
This scrolling style is available when C/R = AP.



Horizontal Wraparound Scrolling

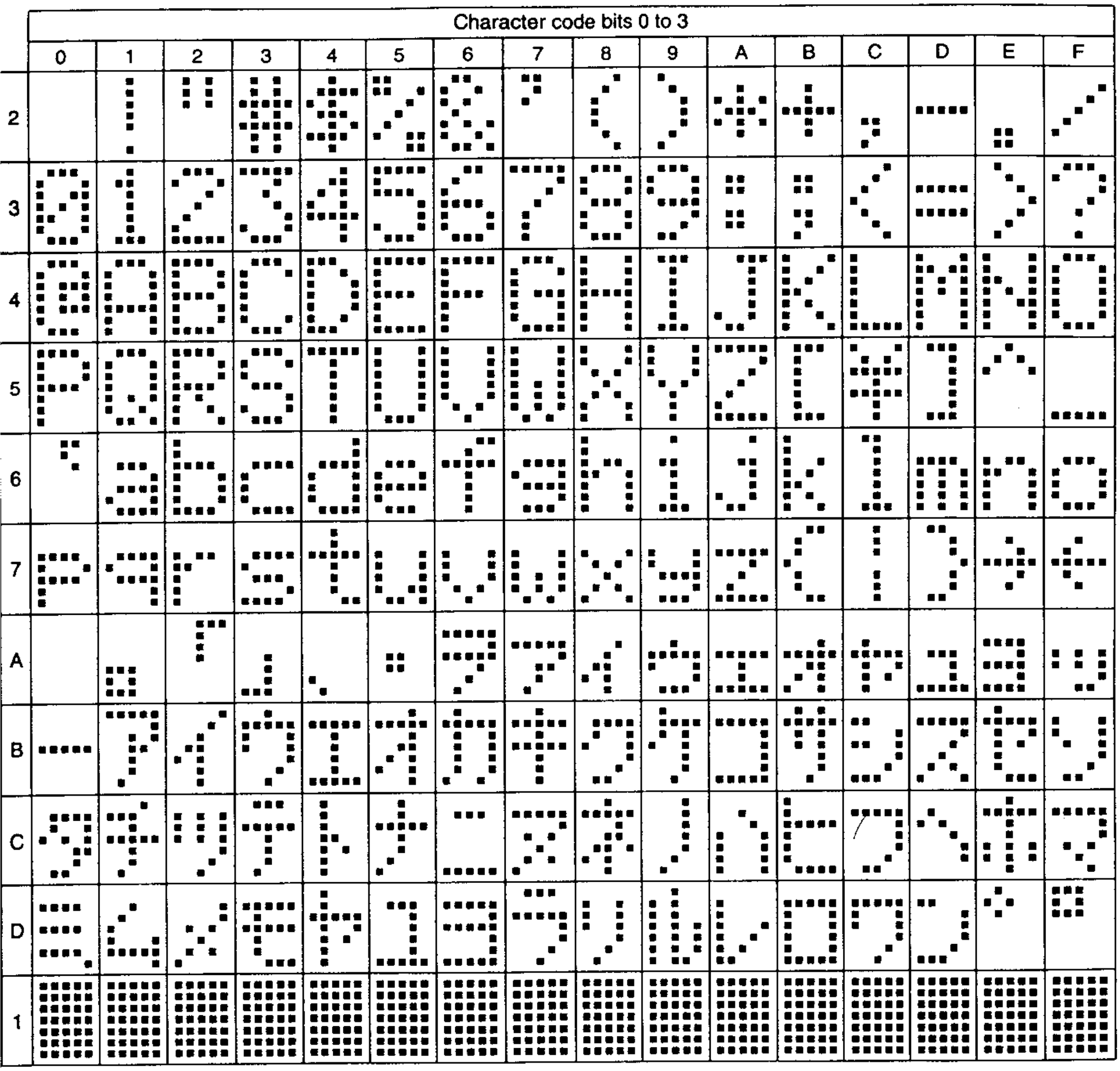
Multidirectional Scrolling

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. Multidirectional 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

ERNAL CHARACTER GENERATOR FONT



1330 Controller Features (continued)

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 FOOOH to F7FFH (M2 = O) or FOOOH to FFFFH (M2 = 1)
- Characters can be up to 8 x 16 pixels; however, excess bits must be set to zero.

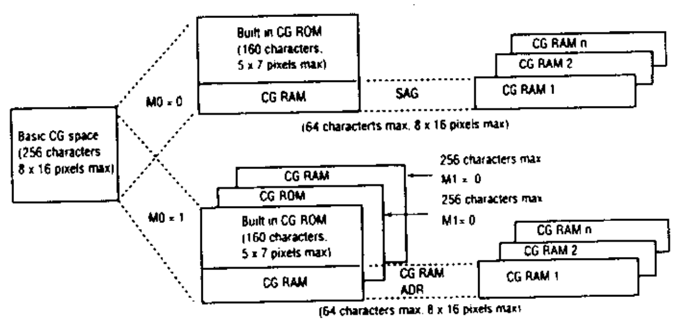
Character Generator RAM

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 = O) or 8 x 16 characters (M2 = 1)
- Up to 256 characters if mapped at FOOOH 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 FOOOH to F7FFH if not used with the character generator ROM (more than 64 characters are in the CG RAM). Set SAGO to FOOOH 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 CG RAM 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 CG RAM 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 FOOOH and overlay SAG and the CG ROM table	

)C-1330 CONTROLLER BOARD

e **Selko Instruments** family of LCDC-1330 controller
features the advanced SED1330 IC described in the
is section. These controller boards are designed to
ie user to quickly interface our graphic modules with
el 8085 or Motorola 6800 series microprocessors to
' text, graphics, and overlayed text and graphics. The
ler boards support 32K bytes of static RAM as display
y that can be defined as text space or graphics
These memory spaces may be overlayed to produce
graphics and text, inverse video, area blinking, and
' masking.

IORY SIZE SELECTION

ution LCD	Min. memory size for 1 screen	Model number
X 128	2K	LCDC-1300-32A
X 64	2K	LCDC-1330-32A
X 128	3K	LCDC-1330-32A
X 192	5K	LCDC-1330-32A
X 128	4K	LCDC-1330-32A
X 200	8K	LCDC-1330-32A
X 240	8K	LCDC-1330-32A
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

TRICAL CHARACTERISTICS (T_{OPR} = 0°C TO 50°C V_{DD} = 5V±5%; V_{SS} = OV)

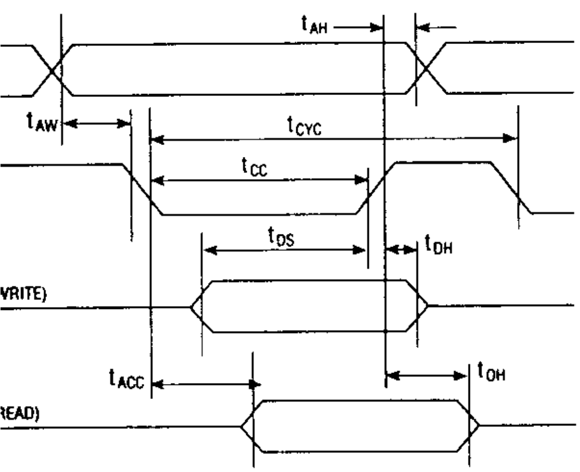
ol	Parameter	Min.	Typ.	Max.	Units	Conditions	Terminals
	Supply Voltage	4.0	5.0	6.0	V		V_{DD}
)	Power Down Supply Voltage	2.0		6.0	V		
	Input High Voltage (TTL)	2.2		V_{DD}=0.3	V		D_0 - D_7, A0 CS RD WR
	Input Low Voltage (TTL)	-0.3		0.8	V		
	Output High Voltage (TTL)	2.4			V	I_{OH}=-0.5mA	
	Output Low Voltage (TTL)			0.4	V	I_{OL}=5.0mA	
;	Input High Voltage (CMOS)	$0.8V_{DD}$			V		DB0-DB3, FLM, M CL1 CL2
	Input Low Voltage (CMOS)			$0.2V_{DD}$	V		
	Output High Voltage (CMOS)	V_{DD}-0.4			V	I_{OH}=1.6mA	
	Output Low Voltage (CMOS)	-		0.4	V	I_{OL}=1.6mA	
IITT	Positive-going Threshold Voltage	$0.5V_{DD}$ -	$0.7V_{DD}$	$0.8V_{DD}$	V		RES
	Negative-going Threshold Voltage	$0.2V_{DD}$ -	$0.3V_{DD}$	$0.5V_{DD}$	V		RES
	Input Leakage Current	-	0.05	2.0	μA		
	Output Leakage Current	-	0.10	5.0	μA		
	Average Dynamic Power Consumption	-	8.0	12	mA		
	Average Static Power Consumption	-	0.05	20	μA		

OPROCESSOR INTERFACE TIMING

C to 50°C V_{DD}=5.0V+ 10%)

al	Symbol	Parameter	Min.	Max.	Units
IES TIMING					
RD	t_{CYC}	System Cycle Time	1000		ns
	t_{cc}	Control Pulse Width	220		ns
IES TIMING					
S RW	t_{CYC}	System CycleTime	1000		ns
	t_{EW}	Enable Pulse Width	220		ns
FOR 80 AND 68 SERIES PROCESSORS					
CS	t_{AH}	Address Hold Time	10		ns
	t_{AW}	Address Setup Time	30		ns
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

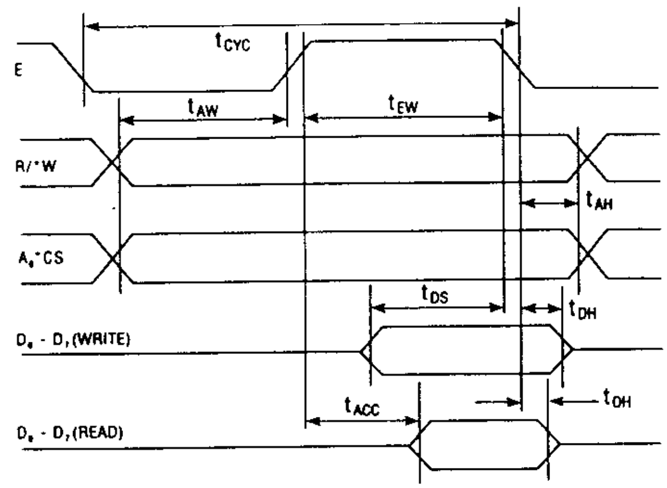
SERIES TIMING DIAGRAM)



RUCTION SET SUMMARY

ystem Set	01000000	40h
isplay On	01011001	59h
isplay Off	01011000	58h
verlay	01011011	5Bh
G RAM Address	01011100	5Ch
croll	01000100	44h
oriz. Dot Scroll	01011010	5Ah
ursor Format	01011101	5Dh
ursor Right	01001100	4Ch
ursor Left	01001101	4Dh
ursor Up	01001110	4Eh
ursor Down	01001111	4Fh
ursor Write	01000110	46h
ursor Read	01000111	47h
Memory Write	01000010	42h
Memory Read	01000011	43h
Erase	01010010	52h
Sleep	01010011	53h

68 (SERIES TIMING DIAGRAM)



CONTROL COMMAND DESCRIPTION

SYSTEM SET (C:40H)

Symbol	D7 D6 D5 D4 D3 D2 D1 D0	Description
P1	0 0 IV 1 0 M2 M1 M0 M0 0: Internal CG ROM 1: External CG ROM or CG RAM 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	T C/R TC/R x UF x FR x 9 = Fosc L/F: Lines per frame (vertical pixels/screen) FR: Frame frequency (from 60Hz to 80Hz) Fosc 10 MHz (107) for LCDC-1330 6MHz (6 x 106) 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 CR or C/R+1 is used	Virtual screen low byte
P8	APH APH: Normally 00h is used	Virtual screen high byte

LCDC-1330 Controller Board (continued)

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	R/W	FUNCTION
0	0	1	Status Register Read
1	0	1	Read Data
0	1	0	Write Data
1	1	0	Command Register Write

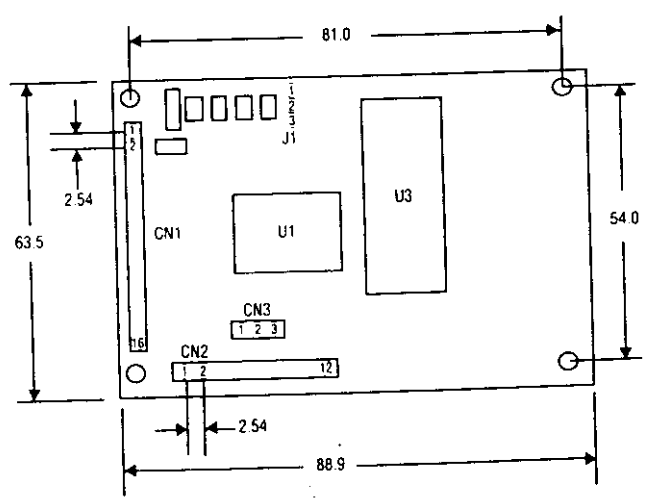
*Active low on the control signal

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}) Voltage on Any Pin Width	-0.3V to +7 0V
Respect to Ground (Vss)	-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)



ORY WRITE (42h)

his command sets the controller into the write mode. The
iat is passed to the parameter will be written to the mem-
ation specified by the current cursor address. After the
ry Write command, the controller automatically advances
rsor to the next sequential location defined by the cursor
on. This allows the users to write many bytes of data to
reen without issuing another write command.

. Continuous data writing

ORY READ (43h)

'his command sets the controller into the read mode.
ata that is read from the parameter will be from the
ory location specified by the current cursor address.
the Memory Read command, the controller automati-
advances the cursor to the next sequential location
ed by the cursor direction. This allows the users to
read many bytes of data to the screen without issuing another read command.

P1
P2
-
-
Pn

} Continuous data reading

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.

LIZATION SETTING FOR SEIKO INSTRUMENTS LCD MODULES

mmand	Symbol	G121C	G191C	G191D	G242C	G2436 G2446	G321D	G321E G324E	G648D G649D	Note
tem 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	1 Fh	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	1 Fh	1Fh	27h	27h	27h	27h	4Fh	
	P8	00h	00h	00h	00h	00h	00h	00h	00h	
play On	C	59h	59h	59h	59h	59h	59h	59h	59h	
	P1	05h	05h	05h	05h	05h	05h	05h	05h	
erlay	C	5Bh	5Bh	5Bh	5Bh	5Bh	5Bh	5Bh	5Bh	
	P1	00h	00h	00h	00h	00h	00h	00h	00h	
roll	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	
rsor 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	
rsor 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	
rsor Direction	C	4Ch	4Ch	4Ch	4Ch	4Ch	4Ch	4Ch	4Ch	
emory Write	C	42h	42h	42h	42h	42h	42h	42h	42h	
	P1	ASCII Code: 20h - 7Fh								
	-									
	Pn	ASCII Code: 20h - 7Fh								

LCDC-1330 Controller Board (continued)

Display On (C:59h)

Symbol	D7	D6	D5	D4	D3	D2	D1	D0	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	1	On with 2 Hz blink rate						
	1	1	On with 1 Hz blink rate						
	FP1	FP0	SAD1 (L1)						Layer1
	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	D7	D6	D5	D4	D3	D2	D1	D0	Note
P1	0	0	0	OV	DM1	DM0	MX1	MX0	
	MX1	MX0	Method of Overlay						
	0	0	L1 ∪ L2 ∪ L3		Simple Overlay				
	0	1	(L1 ⊕ L2) ∪ L3		Reverse Overlay				
	1	0	(L1 ∩ L2) ∪ L3		Selective Overlay				
	1	1	L1 > L2 > L3		Priority Overlay				
	DM0	0: SAD1 defined as character layer							The second
		1: SAD1 defined as graphic layer							layer can be
	DM1	0: SAD3 defined as character layer							used as
		1: SAD3 defined as graphic layer							graphic
	OV	0: Configured for 2 layers							layer only.
		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 FOOOh 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 1 operation, the cursor is automatically positioned to the next memory location.

Cursor Right: (C:4Ch - 01001100)
Cursor Left: (C:4Dh - 01001101)
Cursor Up: (C:4Eh - 01001110)
Cursor Down: (C:4Fh - 01001111)

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

LCDC-1330 Controller Board (continued)

Hardware Connection

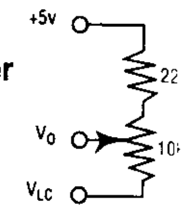
▶ **To Select MPU Interfaces on G121C, G2446, G242C, G321D, G324E With Built-in Controller:**
SEL1=0, SEL2=0 for 8085 Intel type MPU. SEL1=1, SEL2=0 for 6800 Motorola type MPU

▶ **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} (<VO) to pin 16 of CN1 (e.g., -15v for G191(
Use a 10KΩ potentiometer on CN3 to adjust Vo

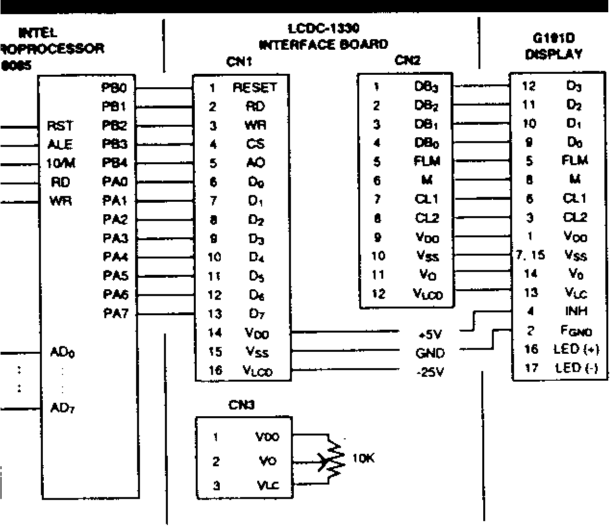
▶ **Contrast Control on the Modules With Built-in Controller**



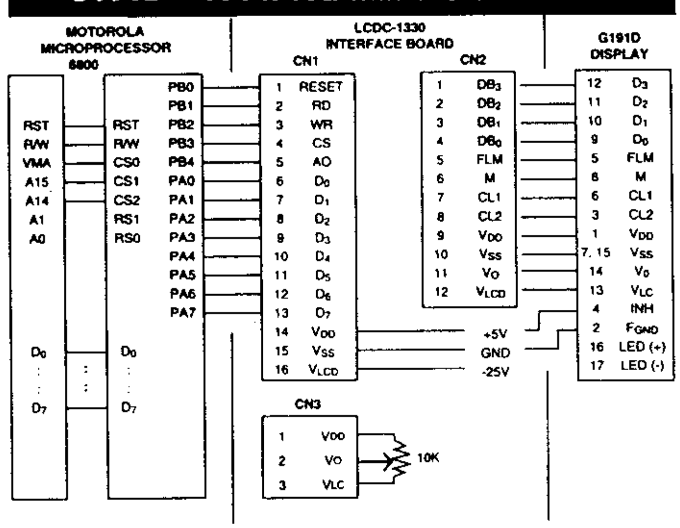
Optimum Contrast Control Voltage

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

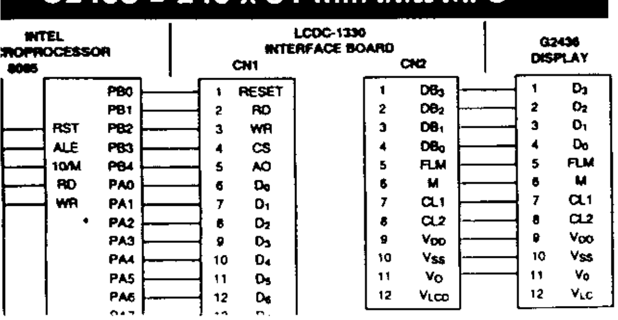
G191D = 191 x 192 with Intel MPU



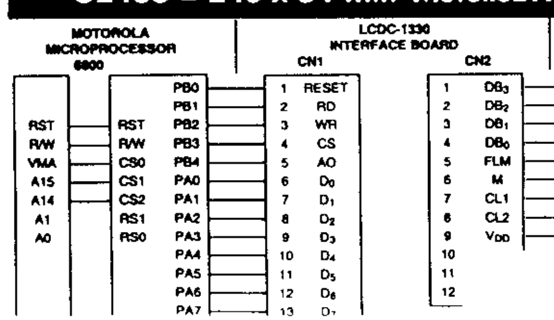
G191D = 191 x 192 with Motorola MPU



G2436 = 240 x 64 with Intel MPU



G2436 = 240 x 64 with Motorola MPU



ITERFACE HARDWARE

IKO INSTRUMENTS GRAPHIC LCD MODULES

el	Input mating Connector CN1	MFR	Backlight Type	Backlighting Connector CN2	MFR	Inverter	Inverter MFR	Inverter input Connector	MFR	Inverter output Connector	MFR
13 x 32	TSW-120-06-G-S	SAMTEC	LED	(Input Connector CN1)	N/A	None	N/A	N/A	N/A	N/A	N/A
16 x 64	TSW-120-06-G-S	SAMTEC	LED	(Input Connector CN1)	N/A	None	N/A	N/A	N/A	N/A	N/A
26 x 64	TSW-120-06-G-S	SAMTEC	LED	(Input Connector CN1)	N/A	None	N/A	N/A	N/A	N/A	N/A
IC x 128	TSW-122-06-G-S	SAMTEC	LED	(Input Connector CN1)	N/A	None	N/A		N/A	N/A	N/A
IC x 128	TSW-114-06-G-S	SAMTEC	EL	(Input Connector CN1)	N/A	SKI-050-OSH E-1546 (SV)	Seiko Instr. ERG	(None...Terminals) (None...Terminals)	N/A N/A	(None...Terminals) (None...Terminals)	N/A N/A
iD x 192	TSW-117-06-G-S	SAMTEC	LED	(Input Connector CN1)	N/A	None	N/A	N/A	N/A	N/A	N/A
6 x 64	TSW-112-06-G-S	SAMTEC	EL	(None...Pads)	N/A	NEL-D32-49 E-1535P (12V)	Seiko Instr. ERG	(None...Terminals) (None...Terminals)	N/A N/A	(None...Terminals) (None...Terminals)	N/A N/A
6 x 64	TSW-120-06-G-S	SAMTEC	CFL	IL-G-SS-S3C2	JAE	I LP-325-INV E-1401 (12V)	Seiko I nstr. ERG	(None...Thru Holes) (None...Terminals)	N/A N/A	IL-G-SP-S3T2-E (None...Terminals)	JAE N/A
C x 128	TSW-120-06-G-S	SAMTEC	CFL	IL-G-SS-S3C2	JAE	ILP-324-INV E-1402 (12V)	Seiko Instr. ERG	(None...Thru Holes) (None...Terminals)	N/A N/A	IL-G-SP-S3T2-E (None...Terminals)	JAE N/A
D x 200	TSW-120-06-G-S	SAMTEC	CFL	IL-G-SS-S3C2	JAE	ILP-323-INV E-1237 (SV) E-1238 (12V)	Seiko Instr. ERG ERG	(None...Thru Holes) (None...Terminals) (None...Terminals)	N/A N/A N/A	IL-G-SP-S3T2-E (None...Terminals) (None...Terminals)	JAE N/A N/A
E 240	XHP-14 TSW-114-4G-S	JST SAMTEC	CFL	IL-G-3S-S3C2	JAE	12902A E-1436 (SV) E-1437 (12V)	Seiko Instr. ERG ERG	175487-3 (None...Terminals) (None...Terminals)	AMP N/A N/A	IL-G-3P-S3L2-E (None...Terminals) (None...Terminals)	JAE N/A N/A
E 240	TSW-120-06-G-S	SAMTEC	CFL	IL-G-SS-S3C2	JAE	ILP-323-INV E-1237 (SV) E-1238 (12V)	Seiko Instr. ERG ERG	(None...Thru Holes) (None...Terminals) (None...Terminals)	N/A N/A N/A	IL-G-SP-S3T2-E (None...Terminals) (None...Terminals)	JAE N/A N/A
200	TSW-114-06-G-S	SAMTEC	EL	(None...Pads)	N/A	NEL-D5-006 E-1545H (SV) E-1 536H (12V)	Seiko Instr. ERG ERG	(None...Terminals) (None...Terminals) (None...Terminals)	N/A N/A N/A	(None...Terminals) (None...Terminals) (None...Terminals)	N/A N/A N/A
) 200	TSW-115-06-G-S	SAMTEC	CFL	IL-G-3S-S3C2	JAE	HIU-168 E-1380 (12V)	Seiko Instr. ERG	DF13-6P-1 .25H (None...Terminals)	HIROSE N/A	IL-G-3P-S3L2-E (None...Terminals)	JAE N/A

See page 102 for inverter manufacturer.

ᵓPPLICATION NOTES

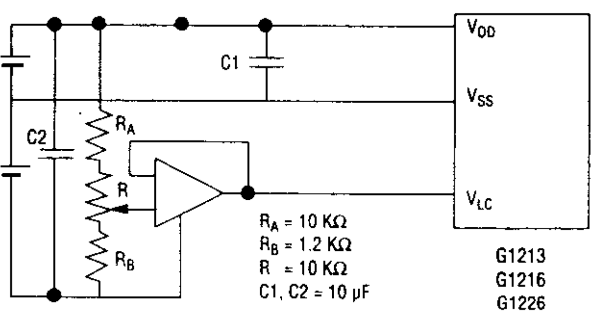
ERATING VOLTAGE (V_O) VS. TEMPERATURE

				V_O (VOLTS)					
	SIZE	DUTY	BIAS	-20°C	-1 0°C	0°C	+25°C	+50°C	+70°C
1213	128 x 32	1/64	1/9	-8.5	-8.3	-8.0	-7.5	-6.5	-5.5
1216	128 x 64	1/64	1/9	-8.5	-8.3	-8.0	-7.5	-6.5	-5.5
1226	128 x 64	1/64	1/9	-8.5	-8.3	-8.0	-7.5	-6.5	-5.5
121C	128 x 128	1/128	1/10	-17.0	-16.5	-16.4	-15.1	-13.7	-12.2
191C	192 x 128	1/128	1/12			-13.4	-12.4	-11.3	
191D	192 x 192	1/192	1/12	-24.0	-22.3	-21.1	-18.0	-16.5	-15.0
2436	240 x 64	1/64	1/9			-8.0	-7.0	-5.5	
2446	240 x 64	1/64	1/9			-8.8	-7.8	-6.5	
242C	240 x 128	1/128	1/12			-15.0	-12.0	-11.2	
321D	320 x 200	1/200	1/15			-18.0	-17.0	-15.2	
321E	320 x 240	1/240	1/13			-17.8	-16.2	-15.3	
324E	320 x 240	1/240	1/13			-19.0	-18.0	-17.1	
548D	640 x 200	1/200	1/15			-18.0	-17.5	-15.5	
549D	640 x 200	1/200	1/15			-18.0	-17.1	-15.3	

NTRAST ADJUSTMENT CIRCUITS

Display screen contrast and viewing angle are affected ıanges in the liquid crystal operating voltage (Vopr) and ımbient temperature. Here are some suggested circuits ıaintaining optimum contrast.

213, G1216, G1226

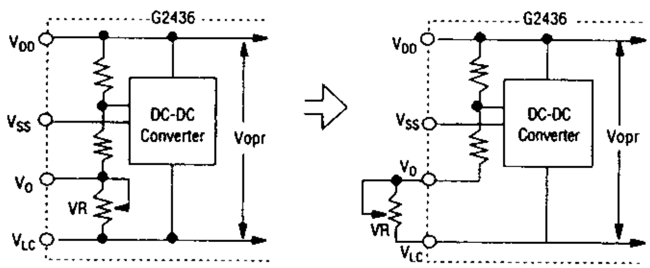


436

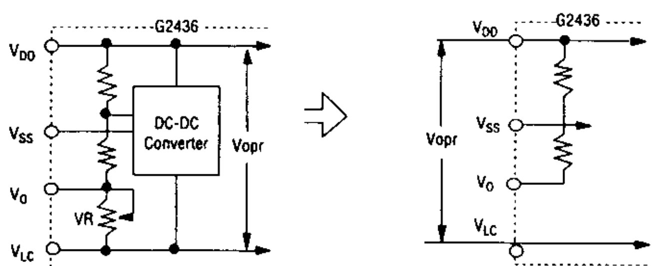
The DC/DC converter internally generates the power ıly voltage (V_{LC}). Also, the G2436 has a built-in variable tor (VR) which controls V_{LC}. When V_{LC} is changed, the li- crystal operating voltage (V_{opr}) changes. This changes lisplay screen contrast.

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.

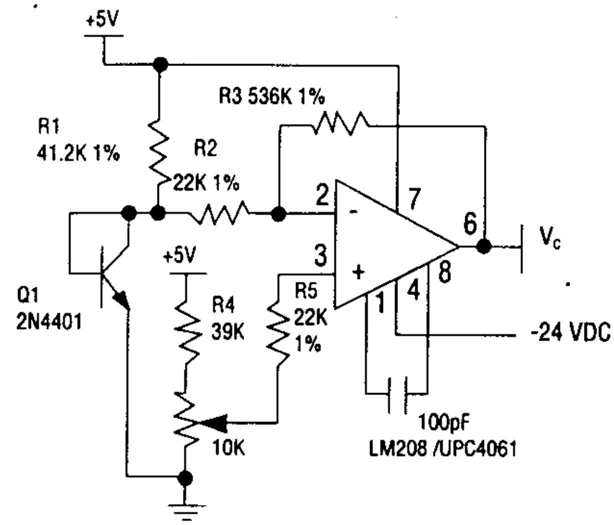
When the VR is supplied external to the G2436: remove the VR, and supply 100KΩ of variable resistance between V_O and V_{LC}.



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.



MPERATURE COMPENSATION



Temperature Compensation Circuit

The temperature sensitivity of the base to emitter voltage 2N4401 is used to provide automatic temperature com- sation to the drive voltage of the STN LCD.

Define V_{be} as the base to emitter voltage of the 2N4401 sistor and V2 as pin 3 of the OP AMP.

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

The gain is defined as:

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

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

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

$$= -\frac{R3}{R2}(V_{be} - V2)$$

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

= 23.9 x 22K ohms

= 536K ohms

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

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

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

$= -\ 7.9912V$

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

So, V_{be} = 0.6V + 2.3mV = 0.6023V

The output of the OP AMP at 24°C

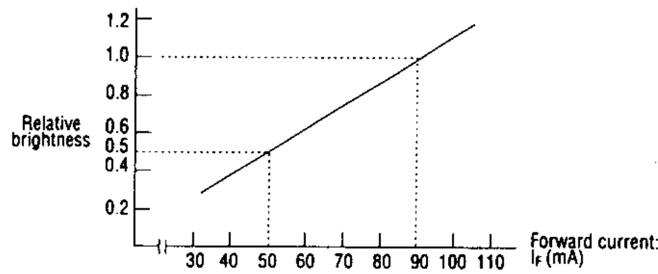
$V_{out} = -\frac{536K}{22K}(0.6023 - 0.272) = -8.47V$

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	50 mA	25 mA
G1226	100 mA	50 mA
G121C	120 mA	48 mA
G191D	120 mA	48 mA

In addition, the forward voltage will change with temperature. Here are examples for the G1213, G1216, G1226:

G1213 FORWARD VOLTAGE AT TEMPERATURES

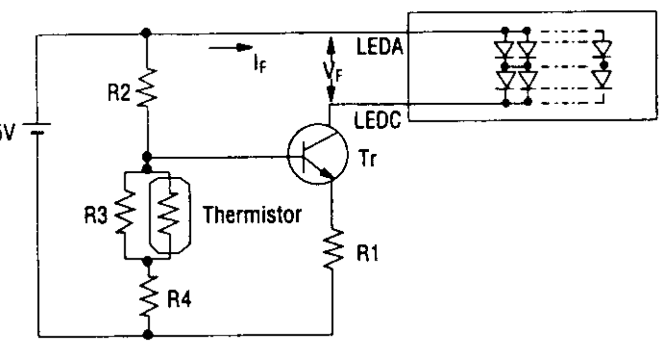
Temperature (Ta)	Conditions	$V_F$min.	$V_F$typ.	$V_F$max.
-20°C	IF = 40 mA	3.7V	3.9V	4.2V
+25°C	IF = 40 mA	3.6V	3.8V	4.1V
+70°C	IF = 25 mA	3.4V	3.6V	3.9V

G1216, G1226 FORWARD VOLTAGE AT TEMPERATURES

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

APPLICATION NOTES (CONTINUED)

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 IF 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 ~~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 15µsec.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 it should take about 90 msec.s to input a new frame of data.

Precautions to Seiko Instruments LCD Modules

1. Handling:

Electrostatic Discharge (ESD) precautions should be observed at all times when handling Seiko LCD module products. Static electricity can damage the CMOS LSI integrated circuits used on all Seiko LCD modules.

- 1a. Handling of the LCD modules should be performed at a grounded static-free workstation.
- 1b. The operator must be wearing a grounded wrist strap.
- 1c. The operator must be wearing powder-free antistatic gloves (Oak Technical # 96 series or equivalent).
- 1d. The LCD panel is plate glass. Take caution and do not hit or drop it.
- 1e. Do not remove the panel or frame from the module.

2. Cleaning:

- 2a. Do not wipe the polarizing plate with a dry cloth, as it may scratch the surface.
- 2b. Wipe the module gently with a soft cloth soaked with a petroleum benzine.
- 2c. Do not use ketonic solvents (ketone or acetone) or aromatic solvents (toluene and xylere). They may damage the polarizer.
- 2d. Keep away from extreme heat and humidity.

3. Safety:

- 3a. If the LCD panel breaks, be careful not to get the liquid crystal in your mouth.
- 3b. If liquid crystal touches your skin or clothes, wash it off immediately using soap and plenty of water.
- 3c. For all chemicals used, see manufacturer's individual Material Safety Data Sheets (MSDS).

For more information on ESD, contact the ESD association at

Electrostatic Discharge Association
200 Liberty Plaza
Rome, New York
(315) 339-6937
(315) 339-6793 Fax

ELIABILITY

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

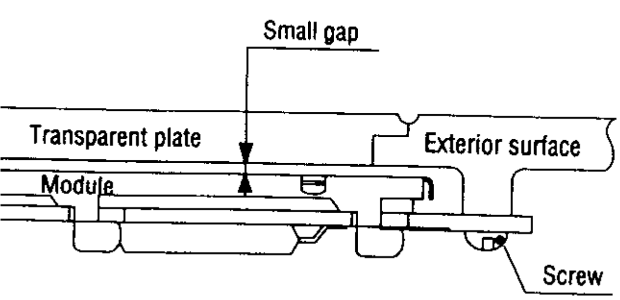
Here are the environmental specifications we would recommend for our LCD graphic modules. These test conditions are expanded for wide temperature WTSTN fluids. Contact the factory for details on a particular model.

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 hour 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 minute at 10 Hz, 55 Hz, 10 Hz, amplitude 1.5 mm 2 hours 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

UNTING AND DESIGN

ount the module by using the specified mounting part nd holes.

protect the module from external pressure, leave a small p by placing transparent plates (e.g., acrylic or glass) on e 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.

GLOSSARY

ACTIVE AREA/EFFECTIVE AREA - Perimeter dimensions of the conductive area, within the viewing area of the LCD glass.

ANNUNCIATOR - An active element, such as a symbol, word, or phrase.

BEZEL - A metal or plastic frame which fits over the LCD glass. The bezel acts as a pressure device, compressing the elastomer connector between the LCD glass and PCB.

CELL GAP - The spacing between the two pieces of glass. This space contains the liquid crystal fluid.

CHIP-ON-BOARD - The LCD driver is formatted into an area on the PCB. Electrical connections are made by micro diameter gold wires. The entire area is then covered with epoxy.

CHIP-ON-GLASS - A new technology being developed, where the LCD driver format is actually mounted on the surface of the LCD glass.

CHIP-ON-FLEX - The LCD driver is incorporated into a flex connector, which is attached to the contact edge of the LCD glass.

COMMON/BACKPLANE - The conductive surface on one of the two pieces of glass, which superimposes the pattern on the second piece of glass. The number of backplanes corresponds to the duty ratio.

COLD CATHODE BACKLIGHT (CCFT) - A type of fluorescent backlighting or edge lighting. Used in medium to large size graphic LCD modules.

CONTACT EDGE - The extended area of the LCD glass which contains the conductive leads/traces, to which electrical connection is made by a connector.

CONTRAST RATIO - The difference in luminance between the unselected area and the selected area.

CURSOR - A row or block of dots, used to indicate the location of the next character or symbol to be entered. Used in dot matrix character and graphic LCD modules.

DIL PINS - Individual metal pins, bonded by epoxy, to each conductive lead/trace on the contact edge.

DIRECT/STATIC DRIVE - Each conductive lead on the contact edge, connects to one segment or annunciator.

DOT/PIXEL - Typically a rectangular active element, when combined together in a matrix, forms a character or symbol.

DOT MATRIX - A group of dots/pixels forming a character or symbol. The most common dot matrix is a 5 x 7 matrix (5 dots across; 7 dots down).

DIL (Dual-In-Line) - Two parallel rows of connection holes on a PCB. Also refers to the type of connector needed with this array.

DUTY RATIO - 1/N, where N equals the number of energized or unenergized segments selected by one complete cycle.

EFFECTIVE AREA - See "ACTIVE AREA".

ELASTOMER CONNECTOR - A strip of silicone rubber made up of sequentially spaced conductive and non-conductive material. This is the most common connection method for LCD modules.

ELECTROPHORESIS - A phenomenon which occurs when excess DC voltage is applied to an LCD. Conductive particles from one piece of glass are transferred through the LC fluid and deposited on the conductive surface of the opposite piece of glass. A conductive spike is created thus causing a dead short.

ELECTROLUMINESCENT LAMP - Is a thin membrane consisting of two coated electrode plates with an aluminum reflector. When AC voltage is applied to the electrodes, the electrons collide with the light emission core. The energy given off is light.

FIBER OPTIC BACKLIGHT - Fiber optics are flattened and then sandwiched between two pieces of pliable plastic. The top piece is used as the diffuser. The opposite ends are tied into a coupler, which is connected to an LED or Halogen light source.

FILL HOLE - A space left between the epoxy seals, after assembly on one end of the LCD glass. This space is used to fill the glass with the LC fluid, which is noted by a mound of epoxy on one end of the glass.

FONT - The active pattern which has all information to be displayed in the LCD glass.

GHOSTING - A phenomenon which occurs when voltage from an energized element leaks to an adjacent OFF element and turns the adjacent element partially ON.

HEAT SEAL - A flat, flexible, adhesive connector which is bonded to the contact edge of the glass by heat. Typically used on large graphic modules.

INTERCONNECT DOT - Connects pattern piece of glass to each backplane. Consists of silver impregnated epoxy.

INVERTER (DC to AC) - Used to power electroluminescent lamps. Converts DC to AC voltage at a high frequency 300Hz ~1KHz.

INVERSE/REVERSE IMAGE - Used exclusively on negative image graphic displays (transmissive negative). With EL or cold cathode backlight where the background is energized and the information to be displayed remains static or the same color as the polarizer in the OFF state. This is achieved by inverting the signal of the data lines before going to the LCD module.

ROPIC STAGE - When the fluid heats up or cools down to oint where the fluid is no longer in the twisted nematic state. nolecules can no longer twist light and, therefore, all incom- ght is absorbed. In positive image displays, the viewing turns completely dark. The display will revert back to the ed nematic state when cooled below the isotropic tempera-

)(S) - The conductive trace(s) on the contact edge of the

BACKLIGHT - A form of backlighting for small to medium .CDs that use surface mount LEDs on a substrate with a diffuser over the top. In some cases LEDs are placed at end of the module and light is directed into the center.

ID CRYSTAL FLUID - Has properties of both a fluid and Consisting of rod shaped, bipolar molecules, which in the tate are capable of twisting polarized light.

JLE - Consists of an LCD (glass) connected to a PCB with s on board. Controllers, temperature compensation cir- etc., are optional.

IPLEX - Using multiple backplanes (commons) in order to e the number of connections between the drivers and

TIVE IMAGE - The viewing area is a dark color in the OFF This condition is achieved by having both front and rear zers in the same axis. In this mode, light passes through ergized areas. Some type of backlight must be used in to effectively view the information.

I - Is the center to center dimension of adjacent conduc- ces, dots, or connector holes.

. - See "DOT".

RIZERS - Are made of a polymer acetate with iodide mol- incorporated in the material. The molecules are arranged allow scattered light to enter in one plane/axis. Twisted ic LCDs require two polarizers, one on the front and one back.

IVE IMAGE - Active elements, when energized, appear color against a light background (non-energized); i.e., ive, transflective, transmissive, (positive) inverse image.

Retardation Control Film) - A thin (100 microns thick) of material laminated to the rear polarizer. Function is to e normal blue colored dots to black. Used on supertwist c modules with a CFL light source. Commonly referred to ck and white.

ECTIVE - Typically a smooth silver/gray piece of polished um foil bonded to the rear polarizer. Reflects the incoming nt light. Note: Backlighting cannot be used with a reflec- be LCD.

RESPONSE TIME (T OFF)- Total of delay time (Td off) and rise time Tr.

RESPONSE TIME (T ON) - Total of rise time Tr and delay time Td on: Time interval between 10%(on) to 90%(on).

SATURATION VOLTAGE - RMS voltage required to turn fluid to 90% on.

SEGMENT - An active element of a digit (i.e., typically numeric digits have 7 segments and alpha/numeric digits can have 14 or 16 segments).

SIL - Single-In-Line; An LCD module having a single row of con- nection holes, LCD glass having a single contact edge.

STATIC DRIVE - See "DIRECT DRIVE".

SUPERTWISTED NEMATIC (STN) - An improved twisted nematic fluid (200° twist or greater) which has better contrast and optimum viewing range than standard twisted nematic (90°). Acronyms - SBE, New TN; NTN; SNTN.

TAB (Tape Automated Bonding) - LCD driver/or controller elec- tronics are encapsulated in a thin, hard bubble package, of which the drive leads extend from the bubble package on a thin plastic substrate. The adhesive along the edges is used to attach the TAB to the LCD glass and/or PCB.

THRESHOLD VOLTAGE - RMS voltage required to turn fluid to 10% on.

TRANSFLECTIVE - A type of backing which is bonded to the rear polarizer. Enables light to pass through the back, as well as reflecting light from the front.

TRANSMISSIVE - A type of LCD which does not have a reflector or transflector laminated to the rear polarizer. A backlight must be used with this type of LCD configuration. Most common is transmissive negative image.

TWISTED NEMATIC (TN) - A type of liquid crystal whereas the alignment surface and therefore the LC molecules are oriented 90° from each surface of glass.

VIEWING ANGLE - A cone perpendicular to the LCD in which minimum contrast can be seen (see page 25).

VIEWING AREA - The dimensions measured from the inside perimeter of the LCD bezel or LCD glass epoxy seal.

ZEBRA CONNECTOR - See "ELASTOMER CONNECTOR".

Note on Power Supply / Battery

The power supply is internal to the radar. The battery is connected to the power supply, which in turn provides power to the boards inside the radar. The battery can not be charged using this internal power supply. A separate 12V charger is used to charge the battery. The battery can not be attached or used while it is charging. Further, the radar operates on battery power and not A/C.