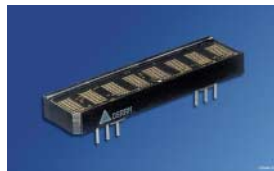


0.180" 8-Character 5 x 7 Dot Matrix Serial Input Dot Addressable Intelligent Display® Devices

Lead (Pb) Free Product - RoHS Compliant

| | |
|-----------------------|---------|
| Red | SCE5780 |
| Yellow | SCE5781 |
| Super-red | SCE5782 |
| Green | SCE5783 |
| High Efficiency Green | SCE5784 |
| Soft Orange | SCE5785 |
| InGaAIP Red | SCE5786 |



DESCRIPTION

The SCE5780 (red), SCE5781 (yellow), SCE5782 (HER), SCE5783 (green), SCE5784 (HEG), SCE5785 (orange), and SCE5786 (InGaAIP red) are eight digit, dot addressable 5 x 7 dot matrix, serial input, Intelligent Display devices. The eight 4.57 mm (0.180") high digits are packaged in a rugged, high quality, optically transparent, plastic 26 pin DIP with 7.62 mm (0.3") pin spacing.

The on-board CMOS has a 280 bit RAM, one bit associated with one LED, each to generate User Defined Characters.

The SCE578X is designed to work with the serial port of most common microprocessors. Data is transferred into the display through the Serial Data Input (DATA), clocked by the Serial Data Clock (SDCLK), and enabled by the Load Input (LOAD).

The Clock I/O (CLK I/O) and Clock Select ($\overline{\text{CLKSEL}}$) pins offer the user the capability to supply a high speed external multiplex clock. This feature can minimize audio in-band interference for portable communication equipment or eliminate the visual synchronization effects found in high vibration environments such as avionic equipment. The prescaler function allows for a higher speed external multiplex clock when set to divide by 16.

FEATURES

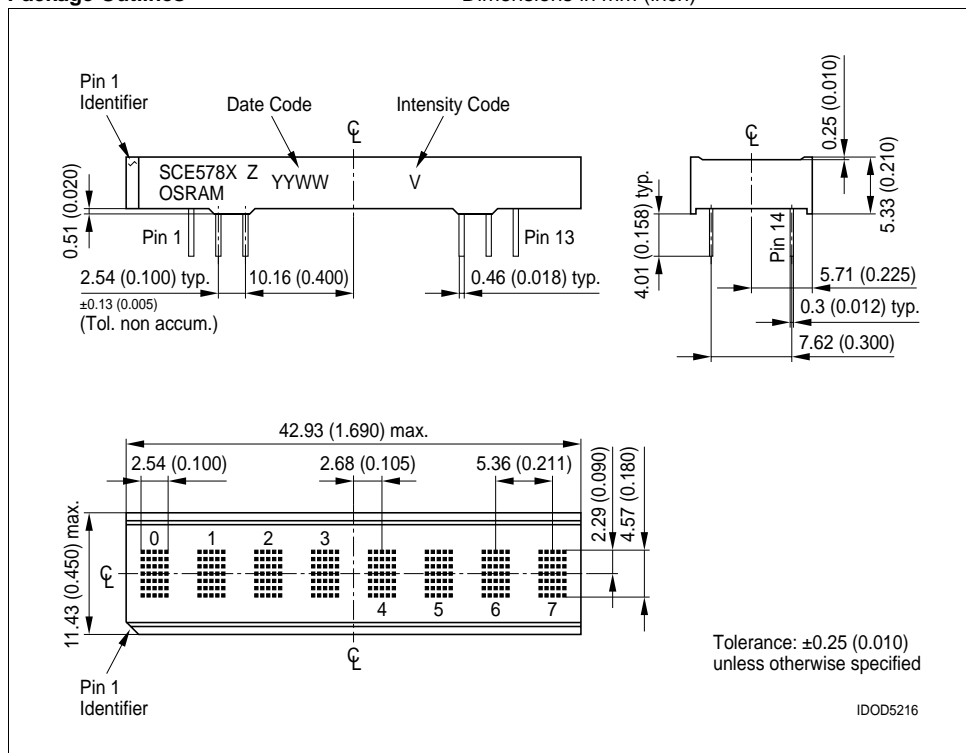
- Eight 4.57 mm (0.180") 5 x 7 Dot Matrix Characters in Red, Yellow, Super-red, Green, High Efficiency Green, Soft Orange, or InGaAIP Red
- ROMless Serial Input, Dot Addressable Display Ideal for User Defined Characters
- Built-in Decoders, Multiplexers and LED Drivers
- Readable from 2.5 meters (8 Feet)
- Programmable Features:
 - Clear Function
 - Eight Dimming Levels
 - Peak Current Select (12.5% or Full Peak Current)
 - Prescaler Function (External Oscillator Divided by 16 or 1)
 - Internal or External Clock

Ordering Information

| Type | Color of Emission | Character Height mm (inch) | Ordering Code |
|---------|-----------------------|-------------------------------|---------------|
| SCE5780 | red | 4.57 (0.180) | Q68000A9100 |
| SCE5781 | yellow | | Q68000A9101 |
| SCE5782 | super-red | | Q68000A9102 |
| SCE5783 | green | | Q68000A9103 |
| SCE5784 | high efficiency green | | Q68000A9104 |
| SCE5785 | soft orange | | on request |
| SCE5786 | InGaAlP Red | | Q68000A1435 |

Package Outlines

Dimensions in mm (inch)



Maximum Ratings

| Parameter | Symbol | Value | Unit |
|---|-----------|-----------------------|------|
| Operating temperature range ¹⁾ | T_{op} | - 40 ... + 85 | °C |
| Storage temperature range | T_{stg} | - 40 ... + 100 | °C |
| V_{CC} , Logic Supply Voltage (non-operating) | V_{CC} | -0.5 to + 7.0 | V |
| Input Voltage Levels Relative to GND | | -0.5 to V_{CC} +0.5 | V |
| V_{LL} , LED Supply Voltage (non-operating) | V_{COL} | -0.5 to + 5.5 | V |
| Solder temperature 1.59 mm (0.063") below seating plane, $t < 5.0$ s | T_S | 260 | °C |
| Relative Humidity at 85°C | | 85 | % |
| Power Dissipation at 70°C | | 1.7 | W |
| Power Dissipation at 85°C | | 1.25 | W |
| ESD (100 pF, 1.5 kΩ) | | 2.0 | kV |
| Input Current | | 100 | mA |

¹⁾ For operation at high temperature, see Thermal Considerations (page 10)

Optical Characteristics at 25°C

($V_{LL}=V_{CC}=5.0$ V at 100% brightness level, viewing angle: X axis $\pm 55^\circ$, Y axis $\pm 65^\circ$)

| Description | Symbol | Values | | | | | | | Unit |
|-------------------------------------|------------------|----------------|-------------------|----------------------|------------------|----------------------------------|------------------------|------------------------|--|
| | | Red SCE5780 | Yellow SCE5781 | Super-red SCE5782 | Green SCE5783 | High Efficiency Green SCE5784 | Soft Orange SCE5785 | InGaAlP Red SCE5786 | |
| Luminous Intensity (min.) (typ.) | I_V | 37.5 90.0 | 75 110 | 75 190 | 75 150 | 120 215 | 120 150 | 375 950 | $\mu\text{cd}/\text{dot}$ $\mu\text{cd}/\text{dot}$ |
| Peak Wavelength (typ.) | λ_{peak} | 660 | 585 | 630 | 565 | 568 | 610 | 645 | nm |
| Dominant Wavelength (typ.) | λ_{dom} | 639 | 583 | 626 | 570 | 574 | 605 | 632 | nm |

Notes:

1. Dot to dot intensity matching at 100% brightness is 1.8:1.
2. Display are binned for hue at 2.0 nm intervals for yellow, green, and high efficiency green.
3. Displays within a given intensity category have an intensity matching of 1.5:1 (max.)

Switching Specifications

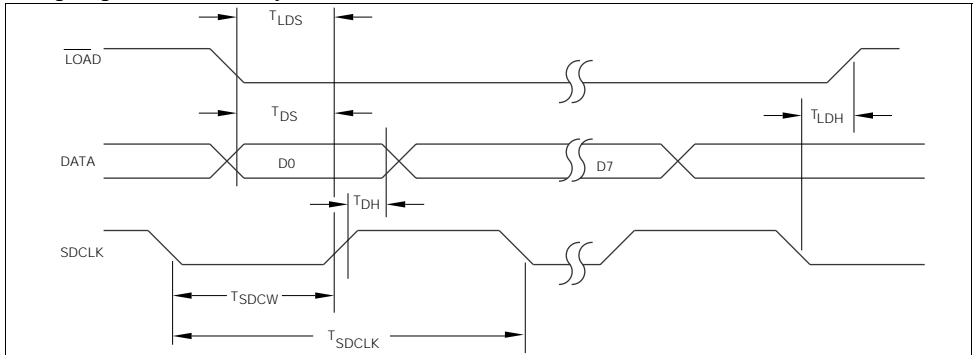
(over operating temperature range and $V_{CC}=4.5\text{ V to }5.5\text{ V}$)

| Symbol | Description | Min. | Units |
|-------------|--------------------|------|---------------|
| T_{RC} | Reset Active Time | 600 | ns |
| T_{LDS} | Load Setup Time | 50 | ns |
| T_{DS} | Data Setup Time | 50 | ns |
| T_{SDCLK} | Clock Period | 200 | ns |
| T_{SDCW} | Clock Width | 70 | ns |
| T_{LDH} | Load Hold Time | 0 | ns |
| T_{DH} | Data Hold Time | 25 | ns |
| T_{WR} | Total Write Time | 2.2 | μs |
| T_{BL} | Time Between Loads | 600 | ns |

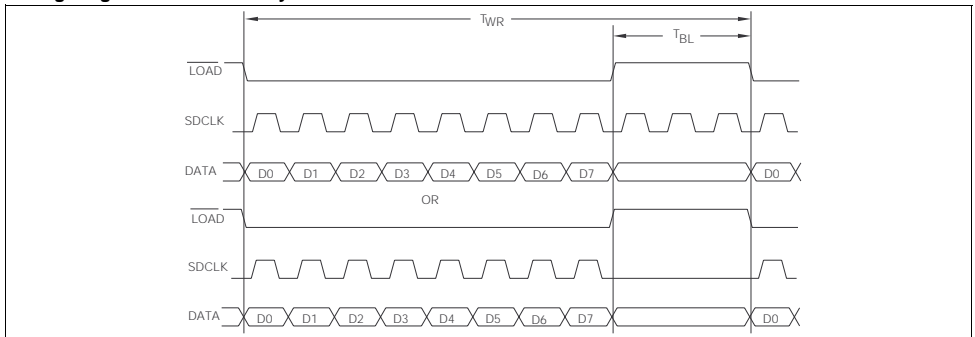
Note:

T_{SDCW} is the minimum time the SDCLK may be low or high.
The SDCLK period must be a minimum of 200 ns.

Timing Diagram—Data Write Cycle



Timing Diagram—Instruction Cycle



Electrical Characteristics (over operating temperature)

| Parameter | Min. | Typ. | Max. | Units | Conditions |
|--|------|------|------|----------------|--|
| V_{CC} | 4.5 | 5.0 | 5.5 | V | — |
| V_{LL} | 3.0 | — | 5.5 | V | — |
| I_{CC} (PWR DWN) ⁴⁾ | — | — | 100 | μ A | $V_{CC}=V_{LL}=5.0$ V, all inputs=0 V or V_{CC} |
| I_{LL} (PWR DWN) ⁴⁾ | — | — | 50 | μ A | — |
| I_{CC} | — | — | 2.0 | mA | $V_{CC}=5.0$ V |
| I_{LL} (20 dots/char) ^{1) 2)} | — | 240 | 345 | mA | $V_{CC}=V_{LL}=5.0$ V, “#” displayed in 8 digits, brightness=100%, $I_F=100\%$ at 25°C |
| I_{IL} | — | — | -10 | μ A | $V_{CC}=5.0$ V, all inputs=0 V |
| I_{IH} | — | — | 10 | μ A | $V_{CC}=V_{IN}=5.0$ V (all inputs) |
| V_{IH} | 3.5 | — | — | V | $V_{CC}=4.5$ V to 5.5 V |
| V_{IL} | — | — | 1.5 | V | $V_{CC}=4.5$ V to 5.5 V |
| I_{OH} (CLK I/O) | — | -8.9 | — | mA | $V_{CC}=4.5$ V, $V_{OH}=2.4$ V |
| I_{OL} (CLK I/O) | — | 1.6 | — | mA | $V_{CC}=4.5$ V, $V_{OH}=0.4$ V |
| θ_{JC-pin} | — | 34 | — | $^{\circ}$ C/W | — |
| Internal OSC Frequency | 120 | — | 347 | kHz | $V_{CC}=5.0$ V, CLKSEL=1, Prescale= \pm 1 |
| External OSC Frequency | 120 | — | 347 | kHz | $V_{CC}=5.0$ V, CLKSEL=0, Prescale= \pm 1 |
| External OSC Frequency with Prescale | 1.92 | — | 5.55 | MHz | $V_{CC}=5.0$ V, CLKSEL=0, Prescale= \pm 16 |
| Mux Frequency ³⁾ | 375 | 768 | 1086 | Hz | — |

Notes:

¹⁾ Peak current= $1.87 \times I_{LL} \times I_{LL}$ varies with V_{LL} Normalized curve, Figure „ I_{LL} Variance“ (page 11).

²⁾ Unused inputs must be tied high.

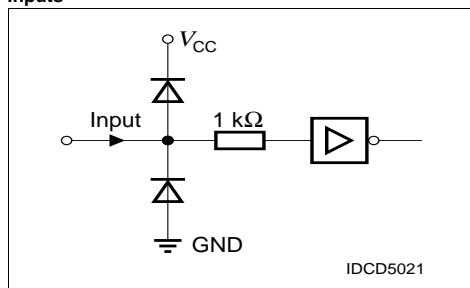
³⁾ Mux rate=[OSC Frequency]/(64 x 7)].

⁴⁾ External oscillator must be stopped during power down mode for minimum current.

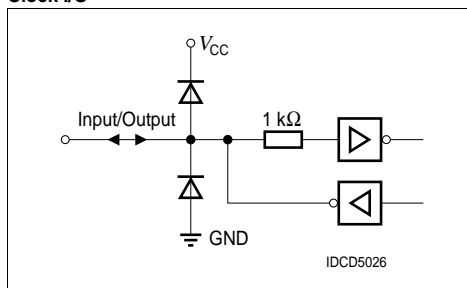
Input/Output Circuits

The following two figures show the input and output resistor/diode networks used for ESD protection and to eliminate substrate latch-up caused by input voltage over/under shoot.

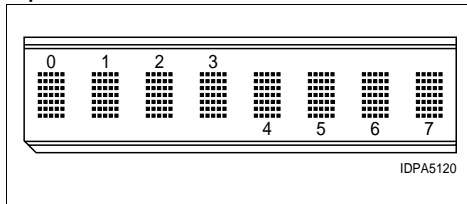
Inputs



Clock I/O



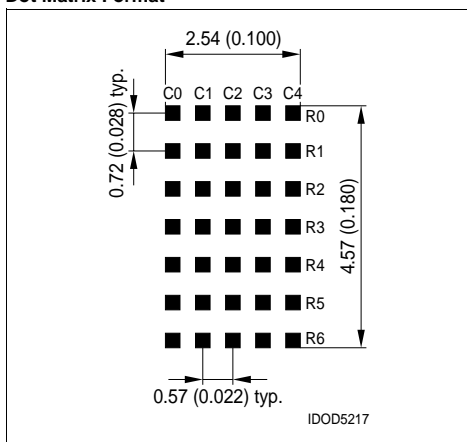
Top View



Pin Assignment

| Pin | Function | Pin | Function |
|-----|-------------------------|-----|-------------|
| 1 | CLKSEL | 14 | Serial Data |
| 2 | V _{CC} (Logic) | 15 | No connect |
| 3 | V _{LL} (LED) | 16 | Serial CLK |
| 4 | No pin | 17 | No pin |
| 5 | No pin | 18 | No pin |
| 6 | No pin | 19 | No pin |
| 7 | No pin | 20 | No pin |
| 8 | No pin | 21 | No pin |
| 9 | No pin | 22 | No pin |
| 10 | No pin | 23 | No pin |
| 11 | Load | 24 | Reset |
| 12 | GND | 25 | CLK I/O |
| 13 | GND | 26 | No connect |

Dot Matrix Format



Pin Definitions

| Pin | Function | Definitions |
|-------|-------------------------|--|
| 1 | CLKSEL | H=internal clock, L=external clock |
| 2 | V _{CC} (Logic) | Logic power supply |
| 3 | V _{LL} (LED) | LED power supply |
| 4–10 | No pin | No pins in these positions |
| 11 | Load | Low input enables data clocking into the 8-bit serial shift register. When Load goes high, the contents of the 8-bit serial shift register will be decoded. |
| 12,13 | GND | Power supply ground |
| 14 | Serial Data | Serial data input |
| 15 | No connect | Pin has no function |
| 16 | Serial CLK | For loading data into the 8-bit serial register on a low to high transition |
| 17–23 | No pin | No pins in these positions |
| 24 | Reset | Asynchronous input, when low will clear the Multiplex Counter, User RAM, and Data Register. Control Word Register is set to 100% brightness, maximum peak current, and oscillator divided by 1. The display blanked. |
| 25 | CLK I/O | Outputs master clock or input external clock for display multiplexing. |
| 26 | No connect | Pin has no function |

Display Column and Row Format

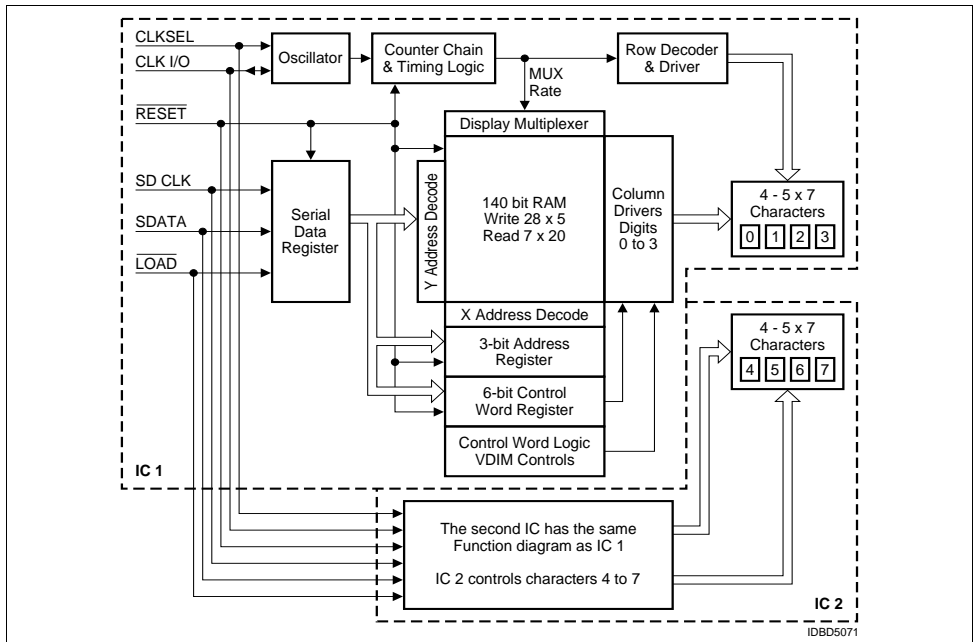
| | C0 | C1 | C2 | C3 | C4 |
|-------|----|----|----|----|----|
| Row 0 | 1 | 1 | 1 | 1 | 1 |
| Row 1 | 0 | 0 | 1 | 0 | 0 |
| Row 2 | 0 | 0 | 1 | 0 | 0 |
| Row 3 | 0 | 0 | 1 | 0 | 0 |
| Row 4 | 0 | 0 | 1 | 0 | 0 |
| Row 5 | 0 | 0 | 1 | 0 | 0 |
| Row 6 | 0 | 0 | 1 | 0 | 0 |

1=Display dot "On" // 0=Display dot "Off"

Column Data Ranges

| | |
|-------|------------|
| Row 0 | 00H to 1FH |
| Row 1 | 00H to 1FH |
| Row 2 | 00H to 1FH |
| Row 3 | 00H to 1FH |
| Row 4 | 00H to 1FH |
| Row 5 | 00H to 1FH |
| Row 6 | 00H to 1FH |

Block Diagram



Operation of the SCE578X

The SCE578X display consists of two CMOS ICs containing control logic and drivers for eight 5 x 7 characters. The first IC controls characters 0 through 3 and the second IC controls characters 4 through 7. These components are assembled in a compact plastic package.

Individual LED dot addressability allows the user great freedom in creating special characters or mini-icons.

The serial data interface provides a highly efficient interconnection between the display and the mother board. The SCE578X requires a minimum three input lines as compared to fourteen for an equivalent eight character parallel input part.

The on-board CMOS IC is the electronic heart of the display. Each IC accepts serially formatted data, which is stored in the internal RAM. The IC accepts data based on the character address selected. The first IC is selected when addressing characters 0 through 3, the second IC is selected when addressing characters 4 through 7, and both ICs are selected when the Control Word is addressed.

Asynchronously the RAM is read by the character multiplexer at a strobe rate that results in a flicker free display. The Block Diagram shows the three functional areas of the IC. These include: the input serial data register and control logic, a 140 bit two port RAM, and an internal multiplexer/display driver. The second IC is identical except characters 4 through 7 are driven.

The following explains how to format the serial data to be loaded into the display. The user supplies a string of bit mapped decoded

characters. The contents of this string is shown in Figure „Loading Serial Character Data“ a (page 8). Figure „Loading Serial Character Data“ b (page 8) shows that each character consist of eight 8 bit words. The first word encodes the display character location and the succeeding seven bytes are row data. The row data represents the status (On, Off) of individual column LEDs. Figure „Loading Serial Character Data“ c (page 8) shows that each 8 bit word is formatted to represent Character Address, or Column Data.

Figure „Loading Serial Character Data“ d (page 8) shows the sequence for loading the bytes of data. Bringing the LOAD line low enables the serial register to accept data. The shift action occurs on the low to high transition of the serial data clock (SDCLK). The least significant bit (D0) is loaded first. After eight clock pulses the LOAD line is brought high. With this transition the OPCODE is decoded. The decoded OPCODE directs D4–D0 to be latched in the Character Address register, stored in the RAM as Column data, or latched in the Control Word register. The control IC requires a minimum 600 ns delay between successive byte loads. As indicated in Figure „Loading Serial Character Data“ a (page 8), a total of 512 bits of data are required to load all eight characters into the display.

The Character Address Register selects the character address that the row and column data will be written to. See Table „Load Character Address“ (page 9) for opcode and character addressing. After loading the Character Address Register, the next seven bytes load the column data, one row at a time, starting with row 0 (top row) and ending with row 6 (bottom row). Each character address has a 7 x 5 bit User RAM formatted as seven rows, each containing five

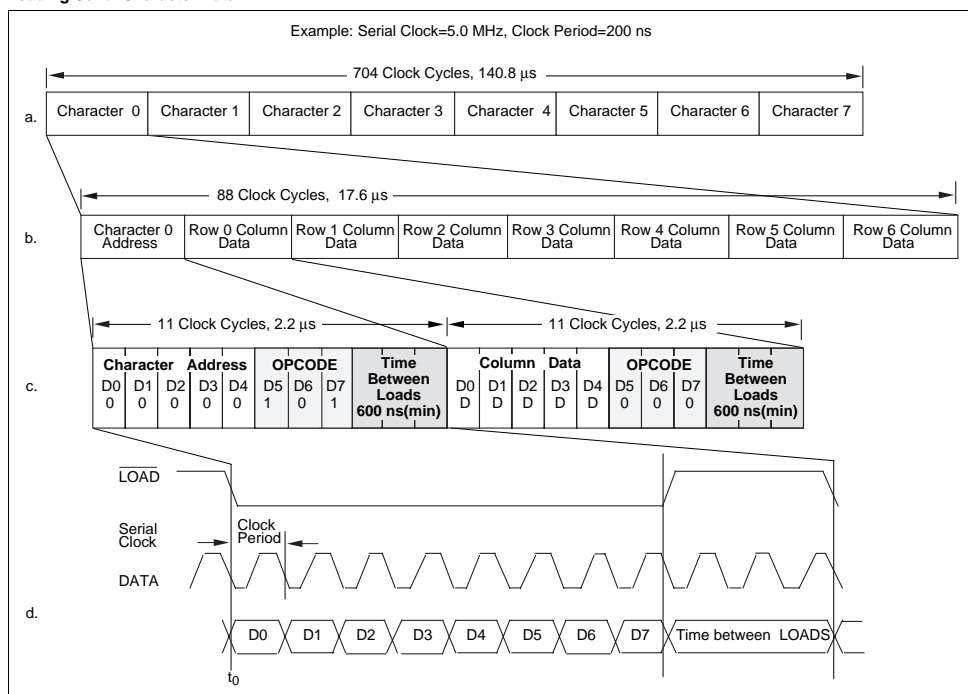
column data bits. The three most significant bits, D7–D5 represent the opcode for the row data and the least significant five bits, D4–D0 represent the column data. See Table „Load Column Data“ (page 9) for the column data format. If an address is loaded before all seven rows are written, the next column data will be loaded into Row 0 of the new address. The remaining rows of the old address are not changed.

Table Charcater „D“ (page 8) shows the Row Address for the example character, “D.” Column data is written and read asynchronously from the 280 bit RAM. Once loaded, the internal oscillator and character multiplexer reads the data from the RAM. These characters are row strobed with column data as shown in Figures „Row and Column Locations for a Character ‘D’“ (page 9) and „Row Strobing“ (page 10). The character strobe rate is determined by the internal or user supplied external MUX Clock and the ICs ÷ 320 counter.

Character „D“

| Row | Op code | | | Column Data | | | | Hex | |
|-----|---------|----|----|-------------|----------|----------|----------|-----|----------|
| | D7 | D6 | D5 | D4 C0 | D3 C1 | D2 C2 | D1 C3 | | D0 C4 |
| 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 1E |
| 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 11 |
| 2 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 11 |
| 3 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 11 |
| 4 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 11 |
| 5 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 11 |
| 6 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 1E |

Loading Serial Character Data



Load Character Address

| Op code D7 D6 D5 | Character Address D4 D3 D2 D1 D0 | | | Hex | Operation Load |
|---------------------|-------------------------------------|----|-------------|-----|----------------|
| 1 0 1 | 0 0 0 0 0 | A0 | Character 0 | | |
| 1 0 1 | 0 0 0 0 1 | A1 | Character 1 | | |
| 1 0 1 | 0 0 0 1 0 | A2 | Character 2 | | |
| 1 0 1 | 0 0 0 1 1 | A3 | Character 3 | | |
| 1 0 1 | 0 0 1 0 0 | A4 | Character 4 | | |
| 1 0 1 | 0 0 1 0 1 | A5 | Character 5 | | |
| 1 0 1 | 0 0 1 1 0 | A6 | Character 6 | | |
| 1 0 1 | 0 0 1 1 1 | A7 | Character 7 | | |

Load Column Data

| Op code D7 D6 D5 | Column Data D4 D3 D2 D1 D0 | | | | Operation Load |
|---------------------|-------------------------------|-------|--|--|----------------|
| 0 0 0 | C0 C1 C2 C3 C4 | Row 0 | | | |
| 0 0 0 | C0 C1 C2 C3 C4 | Row 1 | | | |
| 0 0 0 | C0 C1 C2 C3 C4 | Row 2 | | | |
| 0 0 0 | C0 C1 C2 C3 C4 | Row 3 | | | |
| 0 0 0 | C0 C1 C2 C3 C4 | Row 4 | | | |
| 0 0 0 | C0 C1 C2 C3 C4 | Row 5 | | | |
| 0 0 0 | C0 C1 C2 C3 C4 | Row 6 | | | |

The user can activate four Control functions. These include: LED Brightness Level, IC Power Down, Prescaler, or Display Clear. OPCODEs and six bit words are used to initiate these functions. The OPCODEs and Control Words for the Character Address and Loading Column Data are shown in Tables „Load Character Address“ and „Load Column Data“.

The user can select eight specific LED brightness levels, Tables „Display Brightness“. Depending on how D3 is selected either one (1) for maximum peak current or zero (0) for 12.5% of maximum peak current in the control word per Table „Display Brightness“, the user can select 16 specific LED brightness levels. These brightness levels (in percentages of full brightness of the display) depending on how the user selects D3 can be one (1) or zero (0) are as follows: 100% (E0_{HEX} or E8_{HEX}), 53% (E1_{HEX} or E9_{HEX}), 40% (E2_{HEX} or EA_{HEX}), 27% (E3_{HEX} or EB_{HEX}), 20% (E4_{HEX} or EC_{HEX}), 13% (E5_{HEX} or ED_{HEX}), and 6.6% (E6_{HEX} or EE_{HEX}), 0.0% (E7_{HEX} or EF_{HEX}). The brightness levels are controlled by changing the duty factor of the row strobe pulse.

The SCE578X offers a unique Display Power Down feature which reduces I_{CC} to less than 150 mA total. When EF_{HEX} is loaded (Table „Power Down“) the display is set to 0% brightness. When in the Power Down mode data may still be written into the RAM. The display is reactivated by loading a new brightness Level Control Word into the display.

Display Brightness

| Op code D7 D6 D5 | Control Word D4 D3 D2 D1 D0 | | | | Hex | Operation Level |
|---------------------|--------------------------------|----|------|--|-----|-----------------|
| 1 1 1 | 0 0 0 0 0 | E0 | 100% | | | |
| 1 1 1 | 0 0 0 0 1 | E1 | 53% | | | |
| 1 1 1 | 0 0 0 1 0 | E2 | 40% | | | |
| 1 1 1 | 0 0 0 1 1 | E3 | 27% | | | |
| 1 1 1 | 0 0 1 0 0 | E4 | 20% | | | |
| 1 1 1 | 0 0 1 0 1 | E5 | 13% | | | |
| 1 1 1 | 0 0 1 1 0 | E6 | 6.6% | | | |
| 1 1 1 | 0 0 1 1 1 | E7 | 0.0% | | | |

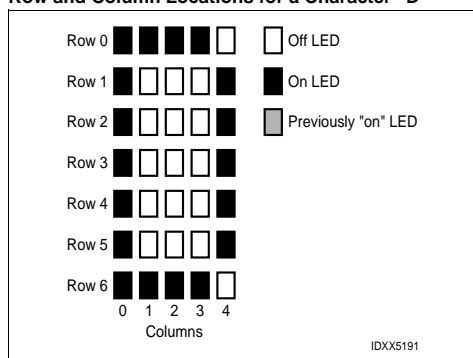
Display Brightness

| Op code D7 D6 D5 | Control Word D4 D3 D2 D1 D0 | | | | Hex | Operation Level |
|---------------------|--------------------------------|----|------|--|-----|-----------------|
| 1 1 1 | 0 1 0 0 0 | E8 | 100% | | | |
| 1 1 1 | 0 1 0 0 1 | E9 | 53% | | | |
| 1 1 1 | 0 1 0 1 0 | EA | 40% | | | |
| 1 1 1 | 0 1 0 1 1 | EB | 27% | | | |
| 1 1 1 | 0 1 1 0 0 | EC | 20% | | | |
| 1 1 1 | 0 1 1 0 1 | ED | 13% | | | |
| 1 1 1 | 0 1 1 1 0 | EE | 6.6% | | | |
| 1 1 1 | 0 1 1 1 1 | EF | 0.0% | | | |

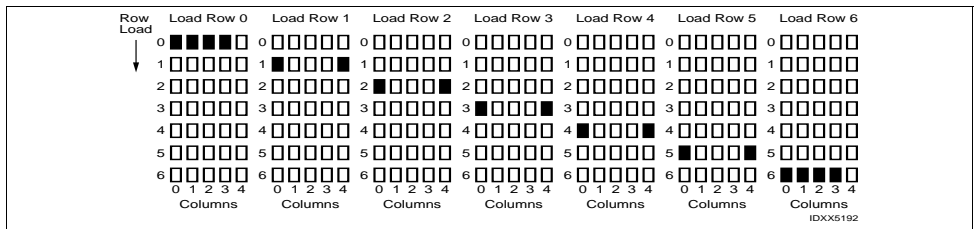
Power Down

| Op code D7 D6 D5 | Control Word D4 D3 D2 D1 D0 | | | | Hex | Operation Level |
|---------------------|--------------------------------|----|---------------|--|-----|-----------------|
| 1 1 1 | 0 1 1 1 1 | EF | 0% brightness | | | |

Row and Column Locations for a Character "D"



Row Strobing



The SCE578X allows a high frequency external oscillator source to drive the display. Data bit, D4, in the control word format controls the prescaler function. The prescaler allows the oscillator source to be divided by 16 by setting D4=1. However, the prescaler should not be used, i.e., when using the internal oscillator source.

The Software Clear (C0_{HEX}), given in Table „Software Clear“, clears the Address Register and the RAM. The display is blanked and the Character Address Register will be set to Character 0. The internal counter and the Control Word Register are unaffected. The Software Clear will remain active until the next data input cycle is initiated.

Software Clear

| Op code | Control Word | Hex | Operation |
|---------|-------------------|-----|-----------|
| D7 D6 | D5 D4 D3 D2 D1 D0 | | |
| 1 1 | 0 0 0 0 0 0 | C0 | CLEAR |

Multiplexer and Display Driver

The eight characters are row multiplexed with RAM resident column data. The strobe rate is established by the internal or external MUX Clock rate. The MUX Clock frequency is divided by a 320 counter chain. This results in a typical strobe rate of 768 Hz. By pulling the Clock SEL line low, the display can be operated from an external MUX Clock. The external clock is attached to the CLK I/O connection.

An asynchronous hardware Reset (pin 24) is also provided. Bringing this pin low will clear the Character Address Register, Control Word Register, RAM, and blanks the display. This action leaves the display set at Character Address 0, and the Brightness Level set at 100%, prescaler ÷1.

Electrical and Mechanical Considerations

Thermal Considerations

The display's power usage may need to be reduced to operate at high ambient temperatures. The power may be reduced by lowering the brightness level, reducing the total number of LEDs illuminated, or lowering V_{LED}. The V_{CC} supply, relative to the V_{LED} supply, has little effect on the power dissipation of the display and is not considered when determining the power dissipation.

To determine the power deration with a given ambient temperature, use the following formula:

$$T_{jmax} = T_A + P_D \cdot \theta_{ja}$$

where: T_{jmax}=maximum IC junction temperature
 P_D=power dissipated by the ICs
 θ_{ja}=thermal resistance, junction to ambient

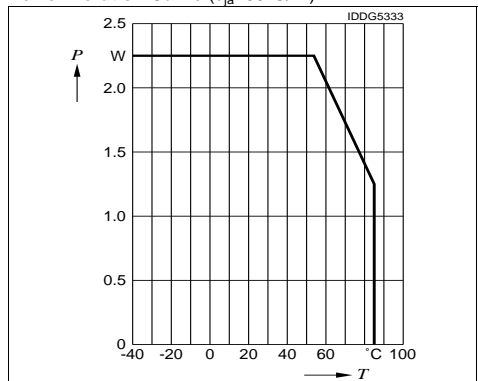
To determine the power dissipation of the display, use the following formula:

$$PD = N \cdot I_{LL} / 140 \cdot RB$$

where: N=number of LEDs on
 I_{LL}/140=average current for a single LED
 RB=relative brightness level

A typical thermal resistance value (θ_{ja}) for this display is 50°C/W when mounted in a socket soldered on a 1.57 mm (0.062") thick PCB with 0.5 mm (0.020"), 1 ounce copper traces and the display covered by a plastic filter. The display's maximum IC junction temperature is 125°C. Power Deration Curve is based on these typical values.

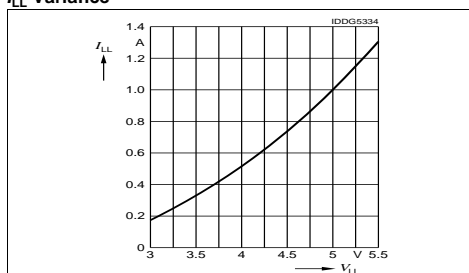
Power Deration Curve (θ_{ja}=50°C/W)



V_{CC} and V_{LL} are two separate power supplies sharing a common ground. V_{CC} supplies power for all the display logic. V_{LL} supplies the power for the LEDs. By separating the two supplies, V_{CC} and V_{LL} can be varied independently and keeps the logic supply clean.

V_{LL} can be varied between 3.0 V and 5.5 V. The LED drive current will vary with changes in V_{LL} . See Figure „ I_{LL} variance“:

I_{LL} Variance



V_{CC} can vary between 4.5 V and 5.5 V. Operation below 4.5 V will change the timing and switching levels of the inputs.

Interconnect Considerations

Optimum product performance can be had when the following electrical and mechanical recommendations are adopted. The SCE578X's IC is constructed in a high speed CMOS process; consequently high speed noise on the SERIAL DATA, SERIAL DATA CLOCK, LOAD and RESET lines may cause incorrect data to be written into the serial shift register. Adhere to transmission line termination procedures when using fast line drivers and long cables (> 10 cm).

Good ground and power supply decoupling will insure that I_{CC} (< 800 mA peak) switching currents do not generate localized ground bounce. Therefore it is recommended that each display package use a 0.1 μ F and 20 μ F tantalum capacitor between V_{CC} and ground.

When the internal MUX Clock is being used connect the CLKSEL pin to V_{CC} . In those applications where RESET will not be connected to the system's reset control, it is recommended that this pin be connected to the center node of a series 0.1 μ F and 100 k Ω RC network. Thus upon initial power up the RESET will be held low for 10 ms allowing adequate time for the system power supply to stabilize.

ESD Protection

The input protection structure of the SCE578X provides significant protection against ESD damage. It is capable of withstanding discharges greater than 2.0 kV. Take all the standard precautions, normal for CMOS components. These include properly grounding personnel, tools, tables, and transport carriers that come in contact with unshielded parts. If these conditions are not, or cannot be met, keep the leads of the device shorted together or the parts in antistatic packaging.

Soldering Considerations

The SCE578X can be hand soldered with SN63 solder using a grounded iron set to 260°C.

Wave soldering is also possible following these conditions: Pre-heat that does not exceed 93°C on the solder side of the PC board or a package surface temperature of 85°C. Water soluble organic acid flux (except carboxylic acid) or resin-based RMA flux without alcohol can be used.

Wave temperature of 245°C \pm 5°C with a dwell between 1.5 sec. to 3.0 sec. Exposure to the wave should not exceed temperatures above 260°C for five seconds at 1.59 mm (0.063") below the seating plane. The packages should not be immersed in the wave.

Post Solder Cleaning Procedures

The least offensive cleaning solution is hot D.I. water (60°C) for less than 15 minutes. Addition of mild saponifiers is acceptable. Do not use commercial dishwasher detergents.

For faster cleaning, solvents may be used. Exercise care in choosing solvents as some may chemically attack the nylon package. For further information refer to Appnotes 18 and 19.

An alternative to soldering and cleaning the display modules is to use sockets. Naturally, 14 pin DIP sockets 7.62 mm (0.300") wide with 2.54 mm (0.100") centers work well for single displays. Multiple display assemblies are best handled by longer SIP sockets or DIP sockets when available for uniform package alignment. Socket manufacturers are Aries Electronics, Inc., Frenchtown, NJ; Garry Manufacturing, New Brunswick, NJ; Robinson-Nugent, New Albany, IN; and Samtec Electronic Hardware, New Albany, IN.

For further information refer to Appnote 22.

Optical Considerations

The 4.57 mm (0.180") high character of the SCE578X gives readability up to five feet. Proper filter selection enhances readability over this distance.

Using filters emphasizes the contrast ratio between a lit LED and the character background. This will increase the discrimination of different characters. The only limitation is cost. Take into consideration the ambient lighting environment for the best cost/benefit ratio for filters.

Incandescent (with almost no green) or fluorescent (with almost no red) lights do not have the flat spectral response of sunlight. Plastic band-pass filters are an inexpensive and effective way to strengthen contrast ratios. The SCE5780 is a red display and should be used with long wavelength pass filter having a sharp cut-off in the 600 nm to 620 nm range. The SCE5782 is a super-red display and should be used with long wavelength pass filter having a sharp cut-off in the 570 nm to 600 nm range. The SCE5784 is a high efficiency green display and should be used with long wavelength pass filter that peaks at 565 nm. The SCE5785 is a soft orange display and should be used with long wavelength pass filter that peaks at 610 nm. The SCE5786 is an InGaAlP red display and should be used with long wavelength pass filter that peaks at 645 nm.

Additional contrast enhancement is gained by shading the displays. Plastic band-pass filters with built-in louvers offer the next step up in contrast improvement. Plastic filters can be improved further with anti-reflective coatings to reduce glare. The trade-off is fuzzy characters. Mounting the filters close to the display reduces this effect. Take care not to overheat the plastic filter by allowing for proper air flow.

Optimal filter enhancements are gained by using circular polar-

ized, anti-reflective, band-pass filters. The circular polarizing further enhances contrast by reducing the light that travels through the filter and reflects back off the display to less than 1.0%.

Several filter manufacturers supply quality filter materials. Some of them are: Panelgraphic Corporation, W. Caldwell, NJ; SGL Homalite, Wilmington, DE; 3M Company, Visual Products Division, St. Paul, MN; Polaroid Corporation, St. Paul, MN; Polaroid Corporation, Polarizer Division, Cambridge, MA; Marks Polarized Corporation, Deer Park, NY; Hoya Optics, Inc., Fremont, CA.

One last note on mounting filters: recessing displays and bezel assemblies is an inexpensive way to provide a shading effect in overhead lighting situations. Several Bezel manufacturers are: R.M.F. Products, Batavia, IL; Nobex Components, Griffith Plastic Corp., Burlingame, CA; Photo Chemical Products of California, Santa Monica, CA; I.E.E.-Atlas, Van Nuys, CA.

Microprocessor Interface

The microprocessor interface is through the serial port, SPI port or one out of eight data bits on the eight bit parallel port and also control lines \overline{SDCLK} and \overline{LOAD} .

Power Up Sequence

Upon power up display will come on at random. Thus the display should be reset at power-up. The reset will set the Address Register to Digit 0, User RAM is set to 0 (display blank) the Control Word is set to 0 (100% brightness) and the internal counters are reset.

Loading Data into the Display

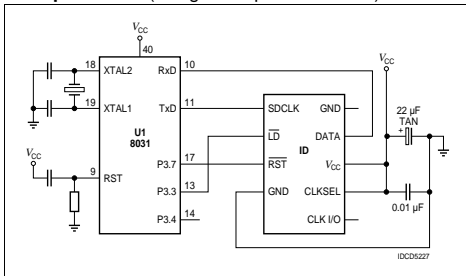
Use following procedure to load data into the display:

1. Power up the display.
2. Bring \overline{RST} low (600 ns duration minimum) to clear the Multiplex Counter, Address Register, Control Word Register, User Ram and Data Register. The display will be blank. Display brightness is set to 100%.
3. If a different brightness is desired, load the proper brightness opcode into the Control Word Register.
4. Load the Digit Address into the display.
5. Load display row and column data for the selected digit.
6. Repeat steps 4 and 5 for all digits.

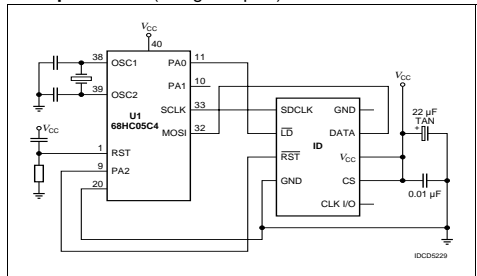
Data Contents for the Word „ABCDEFGH“

| Step | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 | Function |
|------|----|----|----|----|----|----|----|----|-----------------|
| A | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | CLEAR |
| B | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 100% BRIGHTNESS |
| 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | DIGIT D0 SELECT |
| 2 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | ROW 0 (A) |
| 3 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | ROW 1 (A) |
| 4 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | ROW 2 (A) |
| 5 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | ROW 3 (A) |
| 6 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | ROW 4 (A) |
| 7 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | ROW 5 (A) |
| 8 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | ROW 6 (A) |
| 9 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | DIGIT D1 SELECT |
| 10 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | ROW 0 (B) |
| 11 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | ROW 1 (B) |
| 12 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | ROW 2 (B) |
| 13 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | ROW 3 (B) |
| 14 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | ROW 4 (B) |
| 15 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | ROW 5 (B) |
| 16 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | ROW 6 (B) |
| 17 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | DIGIT D2 SELECT |
| 18 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | ROW 0 (C) |
| 19 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | ROW 1 (C) |
| 20 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | ROW 2 (C) |
| 21 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | ROW 3 (C) |
| 22 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | ROW 4 (C) |
| 23 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | ROW 5 (C) |
| 24 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | ROW 6 (C) |
| 25 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | DIGIT D3 SELECT |
| 26 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | ROW 0 (D) |
| 27 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | ROW 1 (D) |
| 28 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | ROW 2 (D) |
| 29 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | ROW 3 (D) |
| 30 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | ROW 4 (D) |
| 31 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | ROW 5 (D) |
| 32 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | ROW 6 (D) |
| 33 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | DIGIT D4 SELECT |
| 34 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | ROW 0 (E) |
| 35 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | ROW 1 (E) |
| 36 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | ROW 2 (E) |
| 37 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | ROW 3 (E) |
| 38 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | ROW 4 (E) |
| 39 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | ROW 5 (E) |
| 40 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | ROW 6 (E) |
| 41 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | DIGIT D5 SELECT |
| 42 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | ROW 0 (F) |
| 43 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | ROW 1 (F) |
| 44 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | ROW 2 (F) |
| 45 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | ROW 3 (F) |
| 46 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | ROW 4 (F) |
| 47 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | ROW 5 (F) |
| 48 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | ROW 6 (F) |
| 49 | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | DIGIT D6 SELECT |
| 50 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | ROW 0 (G) |
| 51 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | ROW 1 (G) |
| 52 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | ROW 2 (G) |
| 53 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | ROW 3 (G) |
| 54 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | ROW 4 (G) |
| 55 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | ROW 5 (G) |
| 56 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | ROW 6 (G) |
| 57 | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 1 | DIGIT D7 SELECT |
| 58 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | ROW 0 (H) |
| 59 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | ROW 1 (H) |
| 60 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | ROW 2 (H) |
| 61 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | ROW 3 (H) |
| 61 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | ROW 4 (H) |
| 62 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | ROW 5 (H) |
| 63 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | ROW 6 (H) |

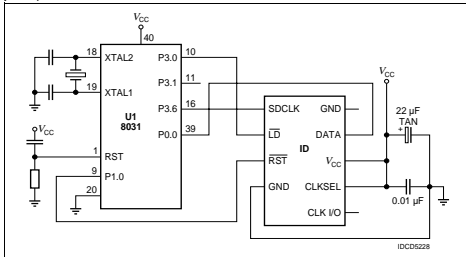
Display Interface to Siemens/Intel 8031 Microprocessor (using serial port in mode 0)



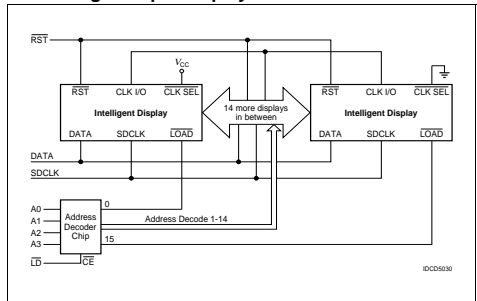
Display Interface with Motorola 68HC05C4 Microprocessor (using SPI port)



Display Interface to Siemens/Intel 8031 Microprocessor (using one bit of parallel port as serial port)



Cascading Multiple Displays



Multiple displays can be cascaded using the CLKSEL and CLK I/O pins (Figure „Cascading Multiple Display“). The display designated as the MasterClock source should have its CLKSEL pin tied high and the slaves should have their CLKSEL pins tied low. All CLK I/O pins should be tied together. One display CLK I/O can drive 15 slave CLK I/Os. Use RST to synchronize all display counters.

Character Set

| HEX CODE | HEX CODE | HEX CODE | HEX CODE | HEX CODE | HEX CODE | HEX CODE | HEX CODE | HEX CODE | HEX CODE |
|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|
| 02 | 04 | 0E | 1F | 00 | 00 | 0C | 00 | 1F | 00 |
| 06 | 04 | 0E | 11 | 00 | 00 | 12 | 00 | 04 | 08 |
| 0E | 0A | 0E | 0A | 00 | 00 | 16 | 00 | 04 | 08 |
| 0E | 0A | 0E | 04 | 00 | 00 | 19 | 00 | 04 | 08 |
| 02 | 0E | 0E | 11 | 00 | 00 | 13 | 00 | 04 | 08 |
| | | | 11 | 00 | 00 | 10 | 00 | 04 | 08 |
| 00 | 00 | 0E | 00 | 00 | 00 | 00 | 00 | 04 | 08 |
| 00 | 10 | 11 | 00 | 00 | 00 | 00 | 00 | 04 | 08 |
| 0A | 1C | 12 | 1F | 00 | 00 | 0E | 0A | 04 | 02 |
| 11 | 12 | 12 | 11 | 00 | 00 | 1C | 0A | 04 | 02 |
| 0A | 02 | 0E | 0A | 00 | 00 | 0A | 0A | 04 | 02 |
| 11 | 02 | 0E | 11 | 00 | 00 | 0A | 0A | 04 | 02 |
| 00 | 00 | 0E | 04 | 00 | 00 | 0A | 0A | 04 | 0E |
| 00 | 04 | 0E | 00 | 00 | 00 | 0E | 0E | 04 | 0E |
| 0E | 15 | 11 | 11 | 00 | 00 | 11 | 1F | 04 | 11 |
| 14 | 15 | 11 | 11 | 00 | 00 | 12 | 12 | 04 | 11 |
| 04 | 0E | 0E | 0A | 00 | 00 | 11 | 11 | 04 | 11 |
| 04 | 04 | 1B | 0D | 00 | 00 | 11 | 11 | 04 | 0E |
| 0A | 0A | 00 | 00 | 00 | 00 | 0C | 06 | 06 | 11 |
| 02 | 00 | 0A | 00 | 00 | 00 | 04 | 08 | 0C | 04 |
| 0E | 11 | 00 | 02 | 08 | 08 | 08 | 08 | 0C | 04 |
| 11 | 11 | 00 | 1F | 0C | 08 | 0E | 0E | 0E | 0E |
| 0E | 11 | 00 | 04 | 04 | 18 | 00 | 0F | 04 | 0C |
| 0E | 11 | 00 | 04 | 04 | 00 | 00 | 08 | 08 | 04 |
| 00 | 04 | 0A | 0A | 04 | 0F | 19 | 14 | 08 | 0C |
| 00 | 04 | 0A | 0A | 0A | 0E | 14 | 14 | 0C | 0C |
| 00 | 04 | 0A | 0A | 0A | 0E | 15 | 15 | 0C | 0C |
| 00 | 04 | 0A | 0A | 0A | 0E | 1A | 1A | 0C | 0C |
| 00 | 04 | 0A | 0A | 0A | 0E | 1E | 1E | 0C | 0C |
| 00 | 04 | 0A | 0A | 0A | 0E | 13 | 12 | 0C | 00 |
| 02 | 08 | 00 | 00 | 00 | 00 | 03 | 0D | 00 | 00 |
| 04 | 04 | 0A | 00 | 00 | 00 | 00 | 00 | 02 | 01 |
| 04 | 04 | 0A | 04 | 00 | 00 | 00 | 00 | 0F | 08 |
| 04 | 04 | 0A | 04 | 00 | 00 | 00 | 00 | 00 | 08 |
| 04 | 04 | 0A | 04 | 00 | 00 | 00 | 00 | 0C | 08 |
| 02 | 08 | 00 | 00 | 00 | 00 | 00 | 00 | 0C | 00 |
| 0E | 04 | 0E | 0E | 0E | 02 | 1F | 06 | 0F | 1F |
| 13 | 04 | 01 | 01 | 0E | 0A | 1E | 10 | 02 | 0F |
| 15 | 04 | 08 | 08 | 12 | 12 | 1E | 1E | 04 | 08 |
| 19 | 04 | 0B | 0B | 10 | 10 | 01 | 01 | 08 | 08 |
| 0E | 04 | 0E | 1F | 0E | 02 | 01 | 01 | 0E | 0E |
| 0E | 0E | 0C | 0C | 01 | 02 | 00 | 10 | 0E | 11 |
| 11 | 11 | 0C | 0C | 02 | 02 | 00 | 08 | 04 | 11 |
| 0E | 0F | 0C | 0C | 04 | 04 | 00 | 0F | 04 | 02 |
| 11 | 01 | 0C | 0C | 04 | 04 | 00 | 0F | 04 | 02 |
| 11 | 02 | 0C | 0C | 04 | 04 | 00 | 0F | 04 | 02 |
| 0E | 0C | 0C | 0C | 08 | 08 | 00 | 10 | 04 | 04 |
| 0E | 11 | 1E | 1E | 0E | 1E | 1F | 1F | 00 | 04 |
| 11 | 11 | 11 | 11 | 10 | 11 | 10 | 10 | 11 | 11 |
| 17 | 1F | 11 | 11 | 10 | 11 | 10 | 10 | 10 | 15 |
| 17 | 1F | 11 | 11 | 10 | 11 | 10 | 10 | 10 | 13 |
| 10 | 11 | 11 | 11 | 10 | 11 | 10 | 10 | 10 | 11 |
| 0E | 11 | 11 | 11 | 10 | 11 | 10 | 10 | 10 | 0E |
| 11 | 07 | 01 | 11 | 10 | 10 | 11 | 11 | 0E | 11 |
| 11 | 04 | 01 | 12 | 10 | 10 | 11 | 11 | 11 | 11 |
| 11 | 04 | 01 | 14 | 10 | 10 | 11 | 11 | 11 | 11 |
| 1F | 04 | 01 | 18 | 10 | 10 | 11 | 11 | 11 | 11 |
| 11 | 04 | 01 | 14 | 10 | 10 | 11 | 11 | 11 | 11 |
| 11 | 07 | 0E | 12 | 10 | 10 | 11 | 11 | 11 | 11 |
| 1E | 0E | 1E | 0E | 11 | 04 | 11 | 11 | 11 | 11 |
| 11 | 11 | 11 | 11 | 11 | 04 | 11 | 11 | 11 | 11 |
| 1E | 11 | 11 | 11 | 11 | 0A | 11 | 11 | 11 | 11 |
| 10 | 15 | 14 | 01 | 04 | 11 | 11 | 11 | 15 | 15 |
| 10 | 12 | 12 | 11 | 04 | 11 | 11 | 11 | 1B | 1B |
| 10 | 0D | 11 | 0E | 04 | 11 | 11 | 11 | 04 | 11 |
| 11 | 11 | 1F | 07 | 00 | 1C | 04 | 00 | 00 | 00 |
| 0A | 0A | 04 | 04 | 08 | 04 | 04 | 04 | 00 | 00 |
| 0A | 04 | 04 | 04 | 04 | 04 | 04 | 04 | 00 | 00 |
| 0A | 04 | 04 | 04 | 04 | 04 | 04 | 04 | 00 | 00 |
| 11 | 04 | 04 | 04 | 07 | 04 | 04 | 04 | 00 | 00 |
| 11 | 04 | 04 | 04 | 07 | 04 | 04 | 04 | 00 | 00 |
| 0C | 00 | 10 | 00 | 01 | 00 | 04 | 04 | 00 | 00 |
| 08 | 10 | 0E | 0E | 01 | 0E | 0A | 0A | 00 | 00 |
| 04 | 12 | 16 | 10 | 0D | 11 | 1C | 1C | 0F | 0F |
| 00 | 12 | 1E | 10 | 13 | 1E | 10 | 10 | 11 | 11 |
| 00 | 12 | 1E | 10 | 13 | 1E | 10 | 10 | 11 | 11 |
| 10 | 00 | 02 | 10 | 0C | 00 | 00 | 00 | 00 | 00 |
| 10 | 04 | 04 | 04 | 04 | 0A | 16 | 16 | 0E | 0E |
| 16 | 00 | 06 | 12 | 04 | 14 | 19 | 19 | 04 | 11 |
| 19 | 0C | 0C | 02 | 04 | 11 | 11 | 11 | 0E | 11 |
| 11 | 04 | 04 | 12 | 04 | 11 | 11 | 11 | 0E | 11 |
| 11 | 04 | 04 | 12 | 04 | 11 | 11 | 11 | 0E | 11 |
| 00 | 00 | 00 | 00 | 00 | 08 | 00 | 00 | 00 | 00 |
| 00 | 00 | 00 | 00 | 00 | 08 | 00 | 00 | 00 | 00 |
| 00 | 0F | 08 | 00 | 08 | 08 | 00 | 11 | 11 | 11 |
| 11 | 00 | 0C | 00 | 08 | 08 | 11 | 11 | 08 | 11 |
| 19 | 13 | 08 | 0E | 08 | 08 | 11 | 11 | 08 | 11 |
| 16 | 0D | 08 | 0E | 0A | 0A | 13 | 13 | 08 | 15 |
| 10 | 01 | 08 | 01 | 0E | 04 | 0D | 0D | 04 | 0A |
| 00 | 00 | 04 | 02 | 00 | 04 | 00 | 00 | 08 | 04 |
| 00 | 00 | 04 | 04 | 04 | 04 | 04 | 04 | 15 | 15 |
| 01 | 11 | 0F | 02 | 04 | 08 | 00 | 00 | 0A | 15 |
| 0A | 04 | 04 | 04 | 04 | 04 | 04 | 04 | 02 | 0A |
| 0A | 04 | 04 | 04 | 04 | 04 | 04 | 04 | 02 | 0A |
| 11 | 04 | 04 | 04 | 04 | 04 | 04 | 04 | 02 | 0A |
| 11 | 04 | 04 | 04 | 04 | 04 | 04 | 04 | 02 | 0A |

IDCS5095

Revision History: 2006-01-23

Previous Version: 2005-01-10

| Page | Subjects (major changes since last revision) | Date of change |
|------|--|----------------|
| all | Lead free device | 2006-01-23 |
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