SED1520
CMOS Dot Matrix LCD Driver
Data Sheet and Design Guide
THIS PAGE INTENTIONALLY BLANK
# Table of Contents

Contents

## 1.0 Overview
- 1.1 Description ........................................................................................................ 7
- 1.2 Features ............................................................................................................... 7
  - 1.2.1 SED1520 family specifications .................................................................... 7
- 1.3 Block Diagram .................................................................................................. 8
- 1.4 Package ............................................................................................................. 9
  - 1.4.1 Pin Configuration Table .............................................................................. 9

## 2.0 Pin Description
- 2.1 Power Signals .................................................................................................. 13
- 2.2 System Bus Interface Signals .......................................................................... 13
- 2.3 LCD Drive Circuit Signals ............................................................................... 13

## 3.0 Description of Circuit Blocks
- 3.1 MPU Interface .................................................................................................. 17
  - 3.1.1 Selection of Interface Type ......................................................................... 17
  - 3.1.2 Identification of Data Bus Signals ............................................................... 17
  - 3.1.3 Access to Display Data RAM and Internal Register ............................... 17
- 3.2 Busy Flag ......................................................................................................... 17
- 3.3 Display Start Line Register ............................................................................... 17
- 3.4 Column Address Counter .................................................................................. 18
- 3.5 Page Register ................................................................................................... 18
- 3.6 Display Data RAM ............................................................................................ 19
- 3.7 Common Timing Generator .............................................................................. 19
- 3.8 Display Data Latch Circuit ............................................................................... 19
- 3.9 LCD Driver Circuit ............................................................................................ 19
- 3.10 Display Timing Generator ................................................................................ 19
- 3.11 Oscillation Circuit ........................................................................................... 19
- 3.12 Reset Circuit ................................................................................................... 22

## 4.0 Commands
- 4.1 Display ON/OFF ............................................................................................... 28
- 4.2 Display Start Line .............................................................................................. 28
- 4.3 Set Page Address ............................................................................................... 28
- 4.4 Column Address ................................................................................................. 28
- 4.5 Read Status ........................................................................................................ 28
- 4.6 Write Display Data ............................................................................................. 29
- 4.7 Read Display Data .............................................................................................. 29
- 4.8 Select ADC .......................................................................................................... 29
- 4.9 Static Drive ON/OFF ........................................................................................... 29
- 4.10 Select Duty ........................................................................................................ 29
- 4.11 Read Modify Write ........................................................................................... 29
- 4.12 End ...................................................................................................................... 30
- 4.13 Reset .................................................................................................................. 30
- 4.14 Save Power (Combined Command) ................................................................. 30

(continued)
## Table of Contents

5.0 Electrical Characteristics .................................................................................................................. 35
  5.1 Absolute Maximum Ratings .............................................................................................................. 35
  5.2 DC Characteristics ........................................................................................................................... 36
  5.3 Timing Characteristics ...................................................................................................................... 38
    5.3.1 System Bus Read/Write I (80 family MPU) ............................................................................ 38
    5.3.2 System Bus Read/Write II (68 family MPU) ........................................................................... 39
    5.3.3 Display Control Timing .............................................................................................................. 40

6.0 MPU Interface (Reference) .............................................................................................................. 43

7.0 LCD Driver Interconnections ......................................................................................................... 47

8.0 Typical Connections with LCD Panel ............................................................................................ 51

9.0 Package Dimensions (Reference) .................................................................................................. 55
1.0
Overview
1.0 Overview

1.1 Description

The SED1520 is a dot matrix LCD driver LSI intended for display of characters and graphics. It generates LCD driving signals based on bit image display data supplied from an 8-bit or 16-bit microcomputer and stored in the on-chip display data RAM.

The SED1520 incorporates innovative circuit design strategies to assure very low current dissipation and a wide range of operating voltages. With these features, the SED1520 permits the user to implement high-performance handy systems operating from a miniature battery.

In order for the user to adaptively configure his system, the SED1520 family offers two application forms. One form allows an LCD display of 12 characters × 2 lines with an indicator with a single chip. The other is dedicated to driving a total of 80 segments, enabling a medium-size display to be achieved by using a minimum number of drivers.

1.2 Features

- Direct display of data read from display data RAM
  - RAM bit data: ‘0’ — LCD off
  - ‘1’ — LCD on
- Fast 8-bit MPU interface; direct interface with 80- or 68-family microcomputer
- On-chip LCD driving circuits — 80 (segment + common) driver sets
- Duty ratios to choose from:
  - Command setup 1/16, 1/32 (SED1520F)
  - External input sync 1/8 to 1/32 (SED1521F)
- A variety of command functions, including:
  - Read/Write Display Data, Display ON/OFF, Set Address, Set Display Start Line, Set Column Address, Read Status, Static Drive ON/OFF, Select Duty, Read Modify Write, Select Segment Driving Selection, Save Power, etc.
- Very low power dissipation — 30 µW maximum (External clock operation: 2 kHz)
- Wide spectrum of supply voltages
  - $V_{DD} – V_{SS} – 2.4V$ to $–7.0V$
  - $V_{DD} – V_{5} – 3.5V$ to $–13.0V$
- CMOS process

1.2.1 SED1520 family specifications

<table>
<thead>
<tr>
<th>Product Name</th>
<th>Clock Frequency</th>
<th>Applicable Driver</th>
<th>No. of SEG Drivers</th>
<th>No. of COM Drivers</th>
</tr>
</thead>
<tbody>
<tr>
<td>SED1520F0A</td>
<td>18 kHz</td>
<td>SED1520F0A, SED1521F0A</td>
<td>61</td>
<td>16</td>
</tr>
<tr>
<td>SED1521F0A</td>
<td>—</td>
<td>SED1521F0A</td>
<td>80</td>
<td>0</td>
</tr>
<tr>
<td>SED1520FAA</td>
<td>—</td>
<td>SED1520F0A</td>
<td>61</td>
<td>16</td>
</tr>
<tr>
<td>SED1521F0A</td>
<td>—</td>
<td>SED1521F0A, HD44103CH</td>
<td>80</td>
<td>0</td>
</tr>
</tbody>
</table>
1.4 Package

* The pin configuration on the SED1520F is shown here.

1.4.1 Pin Configuration Table

<table>
<thead>
<tr>
<th>Product Name</th>
<th>Pin Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>SED1520F0A</td>
<td>74, 75, 96 ~ 100, 1 ~ 1j</td>
</tr>
<tr>
<td></td>
<td>93, 94, 95</td>
</tr>
<tr>
<td>SED1521F0A</td>
<td>OSC1, OSC2</td>
</tr>
<tr>
<td></td>
<td>COM0 ~ COM15, M/S, V4, V1</td>
</tr>
<tr>
<td>SED1520FAa</td>
<td>CS, CL</td>
</tr>
<tr>
<td></td>
<td>SEG76 ~ SEG61, SEG79, SEG78, SEG77</td>
</tr>
<tr>
<td>SED1521FAa</td>
<td>CS, CL</td>
</tr>
<tr>
<td></td>
<td>COM0 ~ COM15, M/S, V4, V1</td>
</tr>
</tbody>
</table>

* Master LSI common outputs COM0 — COM15 correspond to slave LSI outputs COM31 — COM16.
2.0

Pin Description
2.0 Pin Description

2.1 Power Signals

- VDD
  Connected to +5V power. Common to MPU power pin VCC.

- Vss
  0V, connected to system GND.

- V1 – V5
  Multi-level power used to drive LCDs. Voltage specified to each LCD cell is divided by resistors or impedance-converted by an operational amplifier before being applied. Each voltage to be applied must be based on VDD, while fulfilling the following conditions:
  \[ V_{DD} \geq V_1 \geq V_2 \geq V_3 \geq V_4 \geq V_5 \]

2.2 System Bus Interface Signals

- D7 – D0
  8-bit, tri-state, bi-directional I/O bus. Normally, connected to the data bus of an 8-/16-bit standard microcomputer.

- A0
  Input pin. Normally, the LSB of the MPU address bus is connected to this input pin to provide data/command selection.
  \[ 0 : \text{Display control data on D0 — D7} \]
  \[ 1 : \text{Display data on D0 — D7} \]

- RES
  Input pin. The SED1520 can be reset or initialized by setting RES to low level (if it is interfaced with a 68-family MPU) or high level (if with an 80-family MPU). This reset operation occurs when an edge of the \( \overline{\text{RES}} \) signal is sensed. The level input selects the type of interface with the 68- or 80-family MPU:
  \[ \text{High level} : \text{Interface with 68-family MPU} \]
  \[ \text{Low level} : \text{Interface with 80-family MPU} \]

- CS
  Chip Select input signal which is normally obtained by decoding an address bus signal. Effective with “L” active and a chip operating with external clocks. For a chip containing an oscillator, CS works as an oscillation amplifier input pin to which an oscillation resistor (Ri) is connected. In this case, \( \overline{\text{RD}}, \overline{\text{WR}} \) and E must be a signal ANDed with CS.

- E (RD)
  - Chip interfaced with 68-family MPU:
    Enable Clock signal input for the 68-family MPU.
  - Chip interfaced with 80-family MPU:
    “L” active input pin to which the 80-family MPU RD signal is connected. With this signal held at “L”, the SED1520 data bus works as output.

- R/W (WR)
  - Chip interface with 68-family MPU:
    Read/write control signal input pin.
    \[ \overline{\text{R/W}} = \text{“H”} : \text{Read} \]
    \[ \overline{\text{R/W}} = \text{“L”} : \text{Write} \]
  - Chip interfaced with 80-family MPU:
    “L” active input pin to which the 80-family WR is connected. The signal on the data bus is fetched by the leading edge of \( \overline{\text{WR}} \).

2.3 LCD Drive Circuit Signals

- CL
  Input signal effective with a chip using external clocks. This display data latch signal increments the line counter (at the trailing edge) or the common counter (at the leading edge). CL is connected to CL2 of the common driver. For a chip containing an oscillator, this pin works as the oscillation amplifier output pin to which an oscillation resistor (Ri) is connected.
2.0 Pin Description

- **FR**
  LCD AC signal I/O pin. Connected to pin M of the common driver.

- **I/O selection:**
  Chip containing commons M/S = 1: Output
  M/S = 0: Input
  Chip containing segments alone : Input

- **SEG0 – SEG79**
  LCD column (segment) driving output. One of the VDD, V2, V3 and V5 levels is selected by a combination of the content of display RAM and the FR signal.

- **COM0 – COM15 (COM31 – COM16)**
  LCD common (row) driving output. One of the VDD, V1, V4 and V5 levels is selected by a combination of the output of the common counter and the FR signal. The common (row) scanning order for the slave LSI is reverse to that for the master LSI.

<table>
<thead>
<tr>
<th>M/S</th>
<th>FR</th>
<th>COM output</th>
<th>OSC1</th>
<th>OSC2</th>
</tr>
</thead>
<tbody>
<tr>
<td>VDD</td>
<td>Output</td>
<td>COM0 – COM15</td>
<td>Input</td>
<td>Output</td>
</tr>
<tr>
<td>VSS</td>
<td>Input</td>
<td>COM31 – COM16</td>
<td>NC</td>
<td>Input</td>
</tr>
</tbody>
</table>

* The common scanning order for the slave driver is reverse to that for master.
3.0

Description of Circuit Blocks
THIS PAGE INTENTIONALLY BLANK
3.0 Description of Circuit Blocks

3.1 MPU Interface

3.1.1 Selection of Interface Type

The SED1520 Series uses 8 bits of bi-directional data bus (D0 – D7) to transfer data. The reset pin is capable of selecting MPU interface; setting the polarity of RES to either “H” or “L” can provide direct interface of the SED1520 with a 68- or 80-family MPU (see Table 3.1 below).

With CS at high level, the SED1520 is independent from the MPU bus and stays in standby mode. In this mode, however, the reset signal is input independently of the internal status.

<table>
<thead>
<tr>
<th>Polarity of RES</th>
<th>Type</th>
<th>A0</th>
<th>R</th>
<th>R/W</th>
<th>CS</th>
<th>D0 – D7</th>
</tr>
</thead>
<tbody>
<tr>
<td>“L” active</td>
<td>68 MPU</td>
<td>↑</td>
<td>↑</td>
<td>↑</td>
<td>↑</td>
<td>↑</td>
</tr>
<tr>
<td>“H” active</td>
<td>80 MPU</td>
<td>↑</td>
<td>RD</td>
<td>WR</td>
<td>↑</td>
<td>↑</td>
</tr>
</tbody>
</table>

3.1.2 Identification of Data Bus Signals

The SED1520 uses a combination of A0, E, R/W, (RD, WR) to identify a data bus signal.

<table>
<thead>
<tr>
<th>Common</th>
<th>68 MPU</th>
<th>80 MPU</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>A0</td>
<td>R/W</td>
<td>RD</td>
<td>WR</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>0</td>
<td>1</td>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>

3.1.3 Access to Display Data RAM and Internal Register

In order to make matching of operating frequencies between the MPU and the display data RAM or internal register, the SED1520 performs a sort of LSI-LSI pipelining via the bus holder attached to the internal data bus. Consider the case where the MPU reads the content of the display data RAM. In the first data read cycle (dummy), the data is stored on the bus holder. In the next data read cycle, the data is read from the bus holder to the system bus. Also consider the case where the MPU writes data to the display data RAM. In the first data write cycle, the data is held on the bus holder. The data is written to the display data RAM before the next data write cycle begins. Therefore, MPU’s access to the SED1520 is affected by data RAM access time (t ACC, t DS) but not by cycle time (t CYC). This leads to faster transfer of data to and from the MPU. If the cycle time requirement is not met, the MPU has only to execute the NOP instruction and this is apparently equivalent to execution of a waiting operation. However, there is a restriction on the read sequence of the display data RAM; when an address is set, its data is output not to the first read instruction (immediately following the address setting operation) but to the second read instruction. Thus, one dummy read cycle is necessary after an address set or write cycle. This relation is shown in Figure 3.1.

3.2 Busy Flag

Busy flag being “1” means that the SED1520 is performing its internal operation and any instruction other than Read Status is disabled. The busy flag is output to pin D7 by a Read Status instruction. As long as the cycle time (t CYC) requirement is met, the flag need not be checked before each command and this dramatically improves the MPU performance.

3.3 Display Start Line Register

This register is a pointer which determines the start line corresponding to COM0 (normally, the upper-most line of display) for display of data in the display data RAM. It is used for scrolling the display or changing the page from one to another.

Executing the Set Display Start Line command sets 5 bits of display start address in this register. Its content is preset in the line counter at each timing the FR signal changes. The line counter is incremented synchronously to a CL input, thus, generating a line address for sequential reading of 80 bits of data from the display data RAM to the LCD driver circuit.
3.0 Description of Circuit Blocks

3.4 Column Address Counter

The column address counter is a 7-bit presettable counter which gives column addresses of the display data RAM as shown in Figure 3.3. When a Read/Write Display Data command comes in, the counter is incremented by 1. For any nonexisting address over 50H, the counter is locked and not incremented.

The column address counter is independent from the page register.

3.5 Page Register

This register gives a page address of the display data RAM as shown in Figure 3.3. The Set Page Address command permits the MPU to access a new page of the display data RAM.
3.6 Display Data RAM

Dot data for display is stored in this RAM. Since the MPU and LCD driver circuit operate independently of each other, data can be changed asynchronously without adverse effect on the display.

One bit of the display data RAM is assigned to one bit of LCD:

- LCD on = “1”
- LCD off = “0”

The ADC command inverts the assignment relationship between a display data RAM column address and a segment output (see Figure 3.3).

3.7 Common Timing Generator

This circuit generates common timing and frame (FR) signals from the basic clock (CL). The Select Duty command selects a duty of 1/16 or 1/32. The 1/32 duty is achieved by a two-chip (master and slave) configuration (common multi-chip system).

3.8 Display Data Latch Circuit

The display data latch circuit temporarily stores the data which will be output from the display data RAM to the LCD driver circuit at one-common intervals. The Display ON/OFF and Static Driver ON/OFF commands control the latched data so that the data in the display data RAM remains unchanged.

3.9 LCD Driver Circuit

This circuit generates 80 sets of multiplexer that generate quartet levels for LCD driving. Display data in the display data latch, common timing generator output and FR signal are combined to output an LCD driving waveform.

3.10 Display Timing Generator

This circuit generates an internal display timing signal from the basic clock (CL) and frame signal (FR).

The frame signal FR makes the LCD driver circuit generate a dual frame AC driving waveform (type B) to drive LCD, while making both the line counter and common timing generator synchronized to the FR signal output LSI (dedicated common driver or the SED1520 master LSI). To achieve these functions, the FR signal must be a clock with a duty of 50% which is synchronized to the frame period. The clock CL is a clock used to operate the line counter. For a system in which both the SED1520 and SED1521F coexist, they should be of LSI types having the same clock frequency to be applied to pin CL.

3.11 Oscillation Circuit

This circuit is a low-power CR oscillator which uses an oscillation resistor Rf alone to adjust the oscillation frequency. It generates display timing signals. The SED1520 is available in two LSI types if classified by oscillation: one LSI type contains an oscillation circuit and the other uses an externally provided clock.

![Figure 3.2](image-url)
### 3.0 Description of Circuit Blocks

#### 3.6 – 3.11

#### Figure 3.3. Relationship between Display Data RAM Locations and Addresses (Display Start Line: 08)

<table>
<thead>
<tr>
<th>SEG Pin</th>
<th>Column Address</th>
<th>Page Address</th>
</tr>
</thead>
<tbody>
<tr>
<td>SEG0</td>
<td>4F 00H</td>
<td></td>
</tr>
<tr>
<td>SEG1</td>
<td>4E 01</td>
<td></td>
</tr>
<tr>
<td>SEG2</td>
<td>4D 02</td>
<td></td>
</tr>
<tr>
<td>SEG3</td>
<td>4C 03</td>
<td></td>
</tr>
<tr>
<td>SEG4</td>
<td>4B 04</td>
<td></td>
</tr>
<tr>
<td>SEG5</td>
<td>4A 05</td>
<td></td>
</tr>
<tr>
<td>SEG6</td>
<td>49 06</td>
<td></td>
</tr>
<tr>
<td>SEG7</td>
<td>48 07</td>
<td></td>
</tr>
<tr>
<td>SEG77</td>
<td>02 4D</td>
<td></td>
</tr>
<tr>
<td>SEG78</td>
<td>01 4E</td>
<td></td>
</tr>
<tr>
<td>SEG79</td>
<td>00 4F</td>
<td></td>
</tr>
</tbody>
</table>

(In this example, the display start line is set at address 08.)

<table>
<thead>
<tr>
<th>Segment</th>
<th>Column Address</th>
<th>Page Address</th>
</tr>
</thead>
<tbody>
<tr>
<td>SEG0</td>
<td>00H</td>
<td></td>
</tr>
<tr>
<td>SEG1</td>
<td>01</td>
<td></td>
</tr>
<tr>
<td>SEG2</td>
<td>02</td>
<td></td>
</tr>
<tr>
<td>SEG3</td>
<td>03</td>
<td></td>
</tr>
<tr>
<td>SEG4</td>
<td>04</td>
<td></td>
</tr>
<tr>
<td>SEG5</td>
<td>05</td>
<td></td>
</tr>
<tr>
<td>SEG6</td>
<td>06</td>
<td></td>
</tr>
<tr>
<td>SEG7</td>
<td>07</td>
<td></td>
</tr>
<tr>
<td>SEG77</td>
<td>4D</td>
<td></td>
</tr>
<tr>
<td>SEG78</td>
<td>4E</td>
<td></td>
</tr>
<tr>
<td>SEG79</td>
<td>4F</td>
<td></td>
</tr>
</tbody>
</table>

(The display area is shown in the diagram.)

---

S-MOS SYSTEMS, INC.
3.6 – 3.11 3.0 Description of Circuit Blocks

*1 As the parasitic capacitance in this portion increases, the oscillation frequency will shift to a lower level. The Rf must have a smaller value than the specification.

*2 For a system having two or more slave LSIs, a CMOS buffer is necessary.

Figure 3.4. LSI containing oscillator

Figure 3.5. LSI operating with external clock
3.0 Description of Circuit Blocks

The oscillation resistor $R_f$ is connected as shown below. Where an LSI containing an oscillation circuit is operated with an external clock, it is necessary to input the clock with the same phase as OSC2 of the master LSI to OSC2 of the slave LSI.

3.12 Reset Circuit

This circuit senses the leading edge or trailing edge of RES and initializes the system when its power is switched on.

**Initialization:**

(a) Display off
(b) Display start line register: First line
(c) Static drive off
(d) Column address counter: Address 0
(e) Page address register: Page 0
(f) Select duty: 1/32
(g) Select ADC: Forward (ADC command $D_0 = “0”, ADC status flag = “1”)
(h) Read modify write off

The input at pin RES is level-sensed to select an MPU interface mode as shown in Table 3.1. For interfacing with an 80-family MPU, an “H” active reset signal is input to pin RES. For interfacing with a 68-family MPU, an “L” active reset signal is input to the pin (see Figure 6.1).

As exemplified in chapter 6.0, “Interface with MPU,” pin RES is connected to the MPU reset pin. Thus, the SED1520 and the MPU are initialized at the same time. If system is initialized by pin RES at power-on, it may no longer be reset.

The Reset command causes initialization (b), (d) and (e).
3.11 – 3.12

3.0 Description of Circuit Blocks

Figure 3.6. Examples of LCD Driving Waveform
4.0

Commands
### 4.0 Commands

Table 4.1 lists the commands used with the SED1520. This LSI uses a combination of A0, R/W, (RD, WR) to identify a data bus signal. Interpretation and execution of a command depends not on external clock but on internal timing alone. Therefore, a command can be executed so fast that no busy check is needed.

#### Table 4.1. Commands

<table>
<thead>
<tr>
<th>Command</th>
<th>Code</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>A0 RD WR D7 D6 D5 D4 D3 D2 D1 D0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(1) Display ON/OFF</td>
<td>0 1 0 1 0 1 0 1 0 1 1 1 0/1</td>
<td>Turns all display on or off, independently of display RAM data or internal status. 1: ON 0: OFF (Power-saving mode with static drive on)*</td>
</tr>
<tr>
<td>(2) Display Start Line</td>
<td>0 1 0 1 1 0</td>
<td>Specifies RAM line corresponding to uppermost line (COM0) of display.</td>
</tr>
<tr>
<td>(3) Set Page Address</td>
<td>0 1 0 1 0 1 1 1 0</td>
<td>Sets display RAM page in page address register.</td>
</tr>
<tr>
<td>(4) Set Column (Segment) Address</td>
<td>0 1 0 0</td>
<td>Sets display RAM column address in column address register.</td>
</tr>
<tr>
<td>(5) Read Status</td>
<td>0 0 1</td>
<td>Reads the following status: BUSY: Internal operation 0: Ready ADC: 1: CW output (forward) 0: CCW output (reverse) ON/OFF: 1: Display off 0: Display on RESET: 1: Being reset 0: Normal</td>
</tr>
<tr>
<td>(6) Write Display Data</td>
<td>1 1 0</td>
<td>Writes data from data bus into display RAM.</td>
</tr>
<tr>
<td>(7) Read Display Data</td>
<td>1 0 1</td>
<td>Reads data from display RAM onto data bus.</td>
</tr>
<tr>
<td>(8) Select ADC</td>
<td>0 1 0 1 0 1 0 0 0 0 0 0 0/1</td>
<td>Used to invert relationship of assignment between display RAM column addresses and segment driver outputs. 0: CW output (forward) 1: CCW output (reverse)</td>
</tr>
<tr>
<td>(9) Static Drive ON/OFF</td>
<td>0 1 0 1 0 1 0 1 0 0 1 0 0/1</td>
<td>Selects normal display or static driving operation. 1: Static drive (power-saving mode) 0: Normal driving</td>
</tr>
<tr>
<td>(10) Select Duty</td>
<td>0 1 0 1 0 1 0 1 0 0 0 0 0/1</td>
<td>Selects LCD cell driving duty 1: 1/32 0: 1/16</td>
</tr>
<tr>
<td>(11) Read Modify Write</td>
<td>0 1 0 1 1 1 0 0 0 0 0</td>
<td>Increments column address counter by 1 when display data is written. (This is not done when data is read.)</td>
</tr>
<tr>
<td>(12) End</td>
<td>0 1 0 1 1 1 0 1 1 1 0</td>
<td>Clears read modify write mode.</td>
</tr>
<tr>
<td>(13) Reset</td>
<td>0 1 0 1 1 1 0 0 0 1 0</td>
<td>Sets display start line register on the first line. Also sets column address counter and page address counter to 0.</td>
</tr>
</tbody>
</table>

* With display off (command (1)), static drive going on (9) invokes power-saving mode.

A detailed description of all the commands follows.
4.0 Commands

4.1 Display ON/OFF
This command forces all display to turn on or off.

\[
\begin{array}{cccccccccc}
A0 & RD & WR & D7 & D6 & D5 & D4 & D3 & D2 & D1 & D0 \\
0 & 1 & 0 & 1 & 0 & 1 & 0 & 1 & 1 & 1 & D
\end{array}
\]

Note:
- D = 0 Display OFF
- D = 1 Display ON

4.2 Display Start Line
This command specifies a line address (shown in Figure 3.3) thus marking the display line that corresponds to COM0. Display begins with the specified line address and covers as many lines as match the display duty in address ascending order. Dynamic line address change with the Display Start Line command enables column-wise scrolling or page change.

\[
\begin{array}{cccccccccc}
A0 & RD & WR & D7 & D6 & D5 & D4 & D3 & D2 & D1 & D0 \\
0 & 1 & 0 & 0 & A4 & A3 & A2 & A1 & A0 & &
\end{array}
\]

4.3 Set Page Address
This command is used to specify a page address equivalent to a row address for MPU access to the display data RAM. A required bit of the display data RAM can be accessed by specifying its page address and column address. Changing the page address causes no change in display.

\[
\begin{array}{cccccccccc}
A4 & A3 & A2 & A1 & A0 & Line Address \\
0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 1 & 1 \\
1 & 1 & 1 & 1 & 1 & 31
\end{array}
\]

4.4 Column Address
This command specifies a display data RAM column address. The column address is incremented by 1 each time the MPU accesses from the set address to the display data RAM. Thus it is possible for the MPU to gain continuous access to only the data. This incrementing stops with address 80; the page address is not continuously changed.

\[
\begin{array}{cccccccccc}
A6 & A5 & A4 & A3 & A2 & A1 & A0 & Column Address \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 1 & 1 \\
1 & 0 & 0 & 1 & 1 & 1 & 1 & 79
\end{array}
\]

4.5 Read Status
This command checks the status of the system.

\[
\begin{array}{cccccccccc}
A0 & RD & WR & D7 & D6 & D5 & D4 & D3 & D2 & D1 & D0 \\
0 & 0 & 1 & BUSY & ADC & ON/OFF & RESET & 0 & 0 & 0 & 0
\end{array}
\]

Note:
- BUSY BUSY being “1” means that system is performing an internal operation or is reset. No command is accepted before BUSY = “0”. As long as the cycle time requirement is met, no BUSY check is needed.
- ADC Indicates assignment of column addresses to segment drivers.
  - 0: Inverted (column address 79 – n ↔ segment driver n)
  - 1: Forward (column address n ↔ segment driver n)
- ON/OFF Indicates display on or off.
  - 0: Display on
  - 1: Display off
- RESET Indicates that system is being initialized by the RES signal or the Reset command.
  - 0: Display mode
  - 1: Being reset
4.6 Write Display Data
This command allows the MPU to write 8 bits of data into the display data RAM. Once the data is written, the column address is automatically incremented by 1; this enables the MPU to write multi-word data continuously.

R/W

<table>
<thead>
<tr>
<th>A0</th>
<th>RD</th>
<th>WR</th>
<th>D7</th>
<th>D6</th>
<th>D5</th>
<th>D4</th>
<th>D3</th>
<th>D2</th>
<th>D1</th>
<th>D0</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note:
D = 0 Clockwise output (forward)
D = 1 Counterclockwise output (reverse)

4.7 Read Display Data
This command allows the MPU to read 8 bits of data from the display data RAM location specified by a column address and a page address. Once the data is read, the column address is automatically incremented by 1; this enables the MPU to read multi-word data continuously.

A dummy read is needed immediately after the column address is set. For details, see 3. (1) – (c).

R/W

<table>
<thead>
<tr>
<th>A0</th>
<th>RD</th>
<th>WR</th>
<th>D7</th>
<th>D6</th>
<th>D5</th>
<th>D4</th>
<th>D3</th>
<th>D2</th>
<th>D1</th>
<th>D0</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note:
D = 0 Static drive off
D = 1 Static drive on

4.8 Select ADC
This command inverts the relation of assignment between display data RAM column addresses and segment driver outputs. In other words, the Select ADC command can software-invert the order of segment driver output pins, reducing the restrictions on the configuration of ICs at LCD module assembly. For details, see Figure 3.3.

Incrementing the column address by 1, which takes place after the MPU writing or reading display data, follows the sequence of column addresses specified in Figure 3.3.

R/W

<table>
<thead>
<tr>
<th>A0</th>
<th>RD</th>
<th>WR</th>
<th>D7</th>
<th>D6</th>
<th>D5</th>
<th>D4</th>
<th>D3</th>
<th>D2</th>
<th>D1</th>
<th>D0</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

4.9 Static Drive ON/OFF
This command forces all display to be on and, at the same time, all common output to be selected.

R/W

<table>
<thead>
<tr>
<th>A0</th>
<th>RD</th>
<th>WR</th>
<th>D7</th>
<th>D6</th>
<th>D5</th>
<th>D4</th>
<th>D3</th>
<th>D2</th>
<th>D1</th>
<th>D0</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Note:
D = 0 Static drive off
D = 1 Static drive on

4.10 Select Duty
This command is used to select the duty (degree of multiplexity) of LCD driving. It is valid for the SED1520F (actively operating LSI) only, not valid for the SED1521F (passively operating LSI). The SED1521F operates with any duty determined by the FR signal.

R/W

<table>
<thead>
<tr>
<th>A0</th>
<th>RD</th>
<th>WR</th>
<th>D7</th>
<th>D6</th>
<th>D5</th>
<th>D4</th>
<th>D3</th>
<th>D2</th>
<th>D1</th>
<th>D0</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Note:
D = 0 Duty 1/16
D = 1 Duty 1/32

If the system contains both SED1520F0A (internal oscillation) and the SED1521F0A LSIs, they must have the same duty.

4.11 Read Modify Write
This command is used with the End command in a pair. Once it has been entered, the column address will be incremented, not by the Read Display Data command, but by the Write Display Data command only. This mode will stay until the End command is entered.

Entry of the End command causes the column address to return to the address which was valid when the Read Modify Write command was entered. This function lessens the load of the MPU when the data in a specific display area are repeatedly updated (as blinking cursor).

R/W

<table>
<thead>
<tr>
<th>A0</th>
<th>RD</th>
<th>WR</th>
<th>D7</th>
<th>D6</th>
<th>D5</th>
<th>D4</th>
<th>D3</th>
<th>D2</th>
<th>D1</th>
<th>D0</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
**4.0 Commands**

* Even in the Read Modify Write mode, any command other than Read/Write Data and Set Column Address may be used.

![](image)

Figure 4.1. Cursor blinking sequence

**4.12 End**

This command cancels the Read Modify Write command, returning the column address to the initial mode address. See Figure 4.2.

<table>
<thead>
<tr>
<th>A0</th>
<th>RD</th>
<th>WR</th>
<th>D7</th>
<th>D6</th>
<th>D5</th>
<th>D4</th>
<th>D3</th>
<th>D2</th>
<th>D1</th>
<th>D0</th>
</tr>
</thead>
<tbody>
<tr>
<td>01011101110</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Initialization at power-on is performed, not by the Reset command, but by a reset signal applied to the RES pin.

**4.13 Reset**

This command initializes the display start line register, column address counter, and page address counter without any effect on the display data RAM. For details, see 6-(12).

The reset operation follows entry of the Reset command.

<table>
<thead>
<tr>
<th>A0</th>
<th>RD</th>
<th>WR</th>
<th>D7</th>
<th>D6</th>
<th>D5</th>
<th>D4</th>
<th>D3</th>
<th>D2</th>
<th>D1</th>
<th>D0</th>
</tr>
</thead>
<tbody>
<tr>
<td>01011100010</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**4.14 Save Power (Combined Command)**

Static drive going on with display off invokes power-saving mode, reducing current consumption to nearly static current level. During this mode, the SED1520 holds the following conditions:

- It stops driving the LCD; the segment and common driver outputs are at VDD level.
- Oscillation and external clock input are disabled; OSC2 is in floating condition.
- The display data and operational mode are held.

The power-saving mode is cancelled by display on or static drive off.

If an external resistor division circuit is used to give LCD driving voltage level, the current flowing into the resistors must be cut off by the power-save signal.
Figure 4.3
5.0

*Electrical Characteristics*
5.0 Electrical Characteristics

5.1 Absolute Maximum Ratings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Condition</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply voltage (1)</td>
<td>VSS</td>
<td>–8.0 ~ +0.3</td>
<td>V</td>
</tr>
<tr>
<td>Supply voltage (2)</td>
<td>V5</td>
<td>–16.5 ~ +0.3</td>
<td>V</td>
</tr>
<tr>
<td>Supply voltage (3)</td>
<td>V1, V4, V2, V3</td>
<td>V5 ~ +0.3</td>
<td>V</td>
</tr>
<tr>
<td>Input voltage</td>
<td>VIN</td>
<td>VSS – 0.3 ~ +0.3</td>
<td>V</td>
</tr>
<tr>
<td>Output voltage</td>
<td>V0</td>
<td>VSS – 0.3 ~ +0.3</td>
<td>V</td>
</tr>
<tr>
<td>Allowable loss</td>
<td>PD</td>
<td>250</td>
<td>mW</td>
</tr>
<tr>
<td>Operating temperature</td>
<td>Topr</td>
<td>–30 ~ +85</td>
<td>°C</td>
</tr>
<tr>
<td>Storage temperature</td>
<td>Tstg</td>
<td>–65 ~ +150</td>
<td>°C</td>
</tr>
<tr>
<td>Soldering temperature/time</td>
<td>Tsolder</td>
<td>260 / 10 (at lead)</td>
<td>°C / Sec</td>
</tr>
</tbody>
</table>

Notes:
1. All voltages are based on $V_{DD} = 0V$.
2. The following condition must always hold true with voltages V1, V2, V3, V4 and V5:
   $V_{DD} \geq V1 \geq V2 \geq V3 \geq V4 \geq V5$
3. The LSI may be permanently damaged if used with any value in excess of the absolute maximum ratings. During normal operation, the LSI should preferably be used within the specified electrical characteristics. Failure to meet them can cause the LSI to malfunction or lose its reliability.
4. Generally, flat package LSIs may have moisture resistance lowered when solder dipped. In mounting LSIs on a board, it is recommended to use a method which is least unlikely to give thermal stress on the package resin.
### 5.0 Electrical Characteristics

#### 5.2 DC Characteristics

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Condition</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Unit</th>
<th>Applicable Pin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating voltage (1)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operating voltage (2)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High-level input voltage</td>
<td>VIHT</td>
<td>VSS + 2.0</td>
<td>—</td>
<td>VDD</td>
<td>—</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Low-level input voltage</td>
<td>VILT</td>
<td>VSS</td>
<td>—</td>
<td>VSS</td>
<td>+ 0.8</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>High-level output voltage</td>
<td>VOHT</td>
<td>IOH = –3.0 mA</td>
<td>VSS</td>
<td>—</td>
<td>—</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low-level output voltage</td>
<td>VOLC</td>
<td>IOL = 3.0 mA</td>
<td>—</td>
<td>VSS</td>
<td>+ 0.4</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Input leakage current</td>
<td>IIL</td>
<td>—1.0</td>
<td>—</td>
<td>1.0</td>
<td>µA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output leakage current</td>
<td>ILO</td>
<td>—3.0</td>
<td>—</td>
<td>3.0</td>
<td>µA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LCD driver ON resistor</td>
<td>RON</td>
<td>Ta = 25°C</td>
<td>5.0</td>
<td>7.5</td>
<td>kΩ</td>
<td></td>
<td>§SEG0-79 §COM0-15</td>
</tr>
<tr>
<td>Static current dissipation</td>
<td>IDDQ</td>
<td>—0.05</td>
<td>1.0</td>
<td></td>
<td>µA</td>
<td>VDD</td>
<td></td>
</tr>
<tr>
<td>Dynamic current dissipation</td>
<td>IDD (1)</td>
<td>V5 = –5.0V</td>
<td>2.0</td>
<td>5.0</td>
<td>µA</td>
<td>VDD *12</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>fCL = 2 kHz</td>
<td>—</td>
<td>5.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Rt = 1 MΩ</td>
<td>9.5</td>
<td>15.0</td>
<td>µA</td>
<td>VDD *13</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>fCL = 18 kHz</td>
<td>5.0</td>
<td>10.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>IDD (2)</td>
<td>During access tCYC = 200 kHz</td>
<td>300</td>
<td>500</td>
<td>µA</td>
<td>VDD *14</td>
<td></td>
</tr>
<tr>
<td>Input pin capacitance</td>
<td>CIN</td>
<td>Ta = 25°C</td>
<td>5.0</td>
<td>8.0</td>
<td>pF</td>
<td></td>
<td>All input pins</td>
</tr>
<tr>
<td>Oscillation frequency</td>
<td>fOSC</td>
<td>Ri = 1.0 MΩ ± 2%</td>
<td>VSS = –5.0V</td>
<td>15</td>
<td>18</td>
<td>21</td>
<td>kHz *9</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ri = 1.0 MΩ ± 2%</td>
<td>VSS = –3.0V</td>
<td>11</td>
<td>16</td>
<td>21</td>
<td></td>
</tr>
<tr>
<td>Reset time</td>
<td>tr</td>
<td>1.0</td>
<td>—</td>
<td>1000</td>
<td>µs</td>
<td>RES</td>
<td></td>
</tr>
</tbody>
</table>

**Notes:**

1. Operation over a wide range of voltages is guaranteed, except where a sudden voltage change occurs during access.
2. Pins A0, D0 – D7, E (RD), R/W (WR) and CS
3. Pins CL, FR, M/S and RES
4. Pins D0 – D7
5. Pin FR
6. Pins A0, E (RD), R/W (WR), CS, CL and RES
7. Applicable when pins D0 – D7 and FR are at high impedance.
8. This value is current consumption when a vertical stripe pattern is written at tCYC. Current consumption during access is nearly proportionate to access frequency (tCYC). Only TDD (1) is consumed while no access is made.
9. Relationship between the oscillation frequency, frame and Ri (see Figures 5.1 – 5.3).
10. Operating voltage ranges of VSS and V5 (see Figure 5.4).
11. Resistance with a voltage of 0.1V applied between the output pin (SEG, COM) and each power pin (V1, V2, V3, V4). It is specified within the operating voltage range.
12, 13, 14. Current consumed by each discrete IC, not including LCD panel and wiring capacitances.
12. Applicable to SED1520FA and SED1521FA
13. Applicable to SED1520FDA
14. Applicable to SED1521FDA

**S-MOS SYSTEMS, INC.**
5.2 5.0 Electrical Characteristics

*9 Relation between oscillation frequency, frame and \( R_f \) [SED1520F0A]

\[ f_{OSC} \text{ (KHz)} \]
\[ R_f \text{ (MΩ)} \]
\[ 0 \quad 0.5 \quad 1.0 \quad 1.5 \quad 2.0 \quad 2.5 \]
\[ 0 \quad 10 \quad 20 \quad 30 \quad 40 \]

\( Ta = 25°C \quad V_{SS} = -5V \)

Figure 5.1

Relationship between external clock \( f_{CL} \) and frame [SED1520FAA]

\[ \text{Frame (Hz)} \]
\[ f_{CL} \text{ (KHz)} \]
\[ 0 \quad 1 \quad 2 \quad 3 \]

\[ \text{Duty 1/32} \quad \text{Duty 1/16} \]

\( Ta = 25°C \quad V_{SS} = -5V \)

Duty 1/16, 1/32

Figure 5.2

*10 Operating voltage range of \( V_{SS} \) and \( V_5 \)

\[ V_5 \]
\[ V_{SS} \]
\[ 0 \quad -5 \quad -10 \quad -15 \]

Operating Voltage Range

\[ 0 \quad -2 \quad -4 \quad -6 \quad -8 \]

Figure 5.4
5.0 Electrical Characteristics

5.3 Timing Characteristics

5.3.1 System Bus Read/Write I (80-family MPU)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Signal</th>
<th>Condition</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Address hold time</td>
<td>tAH8</td>
<td>A0, CS</td>
<td></td>
<td>10</td>
<td>—</td>
<td>—</td>
<td>ns</td>
</tr>
<tr>
<td>Address setup time</td>
<td>tAW8</td>
<td></td>
<td></td>
<td>20</td>
<td>—</td>
<td>—</td>
<td>ns</td>
</tr>
<tr>
<td>System cycle time</td>
<td>tCYC8</td>
<td>WR, RD</td>
<td></td>
<td>1000</td>
<td>—</td>
<td>—</td>
<td>ns</td>
</tr>
<tr>
<td>Control pulse width</td>
<td>tCC</td>
<td></td>
<td></td>
<td>200</td>
<td>—</td>
<td>—</td>
<td>ns</td>
</tr>
<tr>
<td>Data setup time</td>
<td>tDS8</td>
<td></td>
<td></td>
<td>80</td>
<td>—</td>
<td>—</td>
<td>ns</td>
</tr>
<tr>
<td>Data hold time</td>
<td>tDH8</td>
<td>D0 – D7</td>
<td></td>
<td>10</td>
<td>—</td>
<td>—</td>
<td>ns</td>
</tr>
<tr>
<td>RD access time</td>
<td>tACC8</td>
<td></td>
<td>D0 – D7 (WRITE)</td>
<td>—</td>
<td>—</td>
<td>90</td>
<td>ns</td>
</tr>
<tr>
<td>Output disable time</td>
<td>tOH8</td>
<td></td>
<td>D0 – D7 (READ)</td>
<td>10</td>
<td>—</td>
<td>60</td>
<td>ns</td>
</tr>
</tbody>
</table>

*1 Each of the values where $V_{SS} = -3.0V$ is about 200% of that where $V_{SS} = -5.0V$ (i.e., the listed value).

*2 The rise or fall time of input signals should be less than 15 ns.

![Figure 5.5. System bus read/write I (80-family MPU)](image-url)
5.3.2 5.0 Electrical Characteristics

5.3.2 System Bus Read/Write II (68-family MPU)

Ta = -210 to 75°C, VSS = -5.0V ±10%

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Signal</th>
<th>Condition</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>System cycle time</td>
<td>tCYC6</td>
<td>A0, CS</td>
<td></td>
<td>1000</td>
<td>—</td>
<td>—</td>
<td>ns</td>
</tr>
<tr>
<td>Address setup time</td>
<td>tAW6</td>
<td>R/W</td>
<td></td>
<td>20</td>
<td>—</td>
<td>—</td>
<td>ns</td>
</tr>
<tr>
<td>Address hold time</td>
<td>tAH6</td>
<td></td>
<td></td>
<td>10</td>
<td>—</td>
<td>—</td>
<td>ns</td>
</tr>
<tr>
<td>Data setup time</td>
<td>tDS6</td>
<td>D0 – D7</td>
<td>CL = 100 pF</td>
<td>80</td>
<td>—</td>
<td>—</td>
<td>ns</td>
</tr>
<tr>
<td>Data hold time</td>
<td>tDH6</td>
<td></td>
<td></td>
<td>10</td>
<td>—</td>
<td>—</td>
<td>ns</td>
</tr>
<tr>
<td>Output disable time</td>
<td>tOH6</td>
<td></td>
<td></td>
<td>10</td>
<td>—</td>
<td>60</td>
<td>ns</td>
</tr>
<tr>
<td>Access time</td>
<td>tACC6</td>
<td>E</td>
<td></td>
<td>—</td>
<td>—</td>
<td>90</td>
<td>ns</td>
</tr>
<tr>
<td>Enable pulse width: Read</td>
<td>tEW</td>
<td>E</td>
<td></td>
<td>100</td>
<td>—</td>
<td>—</td>
<td>ns</td>
</tr>
<tr>
<td>Enable pulse width: Write</td>
<td></td>
<td></td>
<td></td>
<td>80</td>
<td>—</td>
<td>—</td>
<td>ns</td>
</tr>
</tbody>
</table>

*1 tCYC6 indicates the cycle time during which CS•E = “H”. It does not mean the cycle time of signal E.

*2 Each of the values where VSS = -3.0V is about 200% of that where VSS = -5.0V (i.e., the listed value).

*3 The rise or fall time of input signals should be less than 15 ns.

Figure 5.6. System bus read/write II (68-family MPU)
5.0 Electrical Characteristics

5.3.3 Display Control Timing

Input Timing

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Signal</th>
<th>Condition</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low level pulse width</td>
<td>tWLCL</td>
<td>CL</td>
<td>—</td>
<td>35</td>
<td>—</td>
<td>—</td>
<td>µs</td>
</tr>
<tr>
<td>High level pulse width</td>
<td>tWHCL</td>
<td>CL</td>
<td>—</td>
<td>35</td>
<td>—</td>
<td>—</td>
<td>µs</td>
</tr>
<tr>
<td>Rise time</td>
<td>tr</td>
<td>CL</td>
<td>—</td>
<td>—</td>
<td>30</td>
<td>150</td>
<td>ns</td>
</tr>
<tr>
<td>Fall time</td>
<td>tr</td>
<td>CL</td>
<td>—</td>
<td>—</td>
<td>30</td>
<td>150</td>
<td>ns</td>
</tr>
<tr>
<td>FR delay time</td>
<td>tDFR</td>
<td>FR</td>
<td>—</td>
<td>−2.0</td>
<td>0.2</td>
<td>2.0</td>
<td>µs</td>
</tr>
</tbody>
</table>

Output Timing

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Signal</th>
<th>Condition</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>FR delay time</td>
<td>tDFR</td>
<td>FR</td>
<td>CL = 100 pF</td>
<td>—</td>
<td>0.2</td>
<td>0.4</td>
<td>µs</td>
</tr>
</tbody>
</table>

*1. The listed FR input delay time applies to the SED1521 and 1520 (slave).
   The listed FR output delay time applies to the SED1520 (master).

*2. Each of the values where Vss = −3.0V is about 200% of that where Vss = −5.0V (i.e., the listed value).

Figure 5.7. Display control timing
6.0

*MPU Interface (Reference)*
6.0 MPU Interface (Reference)

* These examples also apply to the SED1521F0A/SED1521FAA.

* The SED1520F0A (containing an oscillator) does not have pin CS. The output ORed with CS must be applied to pins A0, RD (E) and WR (R/W).
Figure 6.3
7.0

**LCD Driver Interconnections**
### 7.0 LCD Driver Interconnections

#### 7.0 LCD Driver Interconnections

![Figure 7.1. SED1520FoA – SED1520FoA](image1)

![Figure 7.2. SED1520FAA – SED1520FAA](image2)

![Figure 7.3. SED1520FoA – SED1521FoA *1](image3)

*1. In this connection, the duty of the SED1521FoA must be the same as that of the SED1520FoA.

*2. A CMOS buffer is needed for a system having two or more slave LSIs.
7.0 LCD Driver Interconnections

*1. In this connection, the duty of the SED1521F AA must be the same as that of the SED1520F AA.

*2. A CMOS buffer is needed for a system having two or more slave LSIs.
8.0
Typical Connections with LCD Panel
8.0 Typical Connections with LCD Panel

[Full dot LCD panel: 1 character = 6 × 8 dots]

Figure 8.1. Duty 1/16, 10 characters × 2 lines

Figure 8.2. Duty 1/16, 23 characters × 2 lines

Figure 8.3. Duty 1/32, 33 characters × 4 lines

* SED1521F may be omitted. If it is not used, the panel consists of 32 × 122 dots.

Note: Type AA (using external clock) and type 0A (containing an oscillator) cannot coexist for the same panel.
8.0 Typical Connections with LCD Panel

Figure 8.4. Duty 1/32, 20 kanji characters × 2 lines (kanji character 16 × 16 dots)

Figure 8.5. Duty 1/32, 2-screen display, 20 kanji characters × 4 lines
9.0

Package Dimensions
(Reference)
9.0 Package Dimensions (Reference)

Figure 9.1. Package Dimensions