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The S-4562A is a 17 or 33 common, 60 segment output character LCD driver with built-in interfaces for serial and 8-bit CPUs. The S-4562A incorporates CGROM, making character display possible. It displays this independently of the CPU through the use of an internal oscillating circuit or clock input. It has a wide variety of command instructions which minimize the load of the CPU. It also features a wide voltage range, low power consumption, and a power save function, making the S-4562A a suitable display for system applications in portable electronics.

■ Features

- Display Area
 - 5-dot font
 - 12 columns 4 lines (+4 columns) ,
 - 24 columns 2 lines (+8 columns) ,
 - 12 columns 2 lines (+4 columns)
 - 6-dot font
 - 10 columns 4 lines (+6 columns) ,
 - 20 columns 2 lines (+12 columns) ,
 - 10 columns 2 lines (+6 columns)

Values in parentheses indicate the number of columns outside the display area.
- Icon Display
 - Max. 60 icons
 - Icons can be displayed upper and lower panel.
- Fonts; Both 5-dot font/6-dot font display are possible.
- Interface
 - 8-bit high-speed CPU interface
 - Serial interface
- Driver Output
 - 60 segments
 - 16 common+ Icon common: Command Setting
 - 32 common+ Icon common: Default
- Character Generator ROM (CGROM)
 - 9600 bits Character font 5×7 bits 240 characters
- Character Generator RAM (CGRAM)
 - 8 character×5×8=320 bits
- Display Data RAM (DDRAM)
 - 4 lines×16 characters=4×16×8=512 bits
 - (4 characters are outside the display area)
- Display Clock
 - Either internal CR oscillating circuit or external clock input is available:
 - CR oscillation: 1/17 duty cycle=31 kHz,
 - 1/33 duty cycle=60 kHz
- Duty Cycle
 - 1/17: Command Setting
 - 1/33: Default
- Internal LCD Bias Voltage Generator
 - Internal bias resistor: Command selection
 - for 1/6.7, 1/5, or 1/4 bias
 - External bias resistor: Free setting of 1/2 bias or more
- Interface Command
 - Display Clear, Cursor Home, Display ON/OFF,
 - Display Character Blink, Cursor Shift, Display Shift, Cursor ON/OFF
- Expanded Interface
 - Contrast Adjustment, Smooth Scrolling Control,
 - Icon Control, Icon Blinking, Bias Resistor Selection, Change of Number of Display Columns, Power Save, Only Icon Display, Boosting Frequency Selection
- Internal Booster Circuit: Dual/Triple Booster
- Power Supply voltage range
 - Logic Power: -2.4 V to -5.5 V
 - LCD Drive Power: -2.7 V to -11.0 V
- Low Current Consumption: T.B.D. max
- Approximately 0 μA (during power save operation)
- Shipment Form: Gold bump bare chip, TCP

■ Block Diagram

1. Block Overview

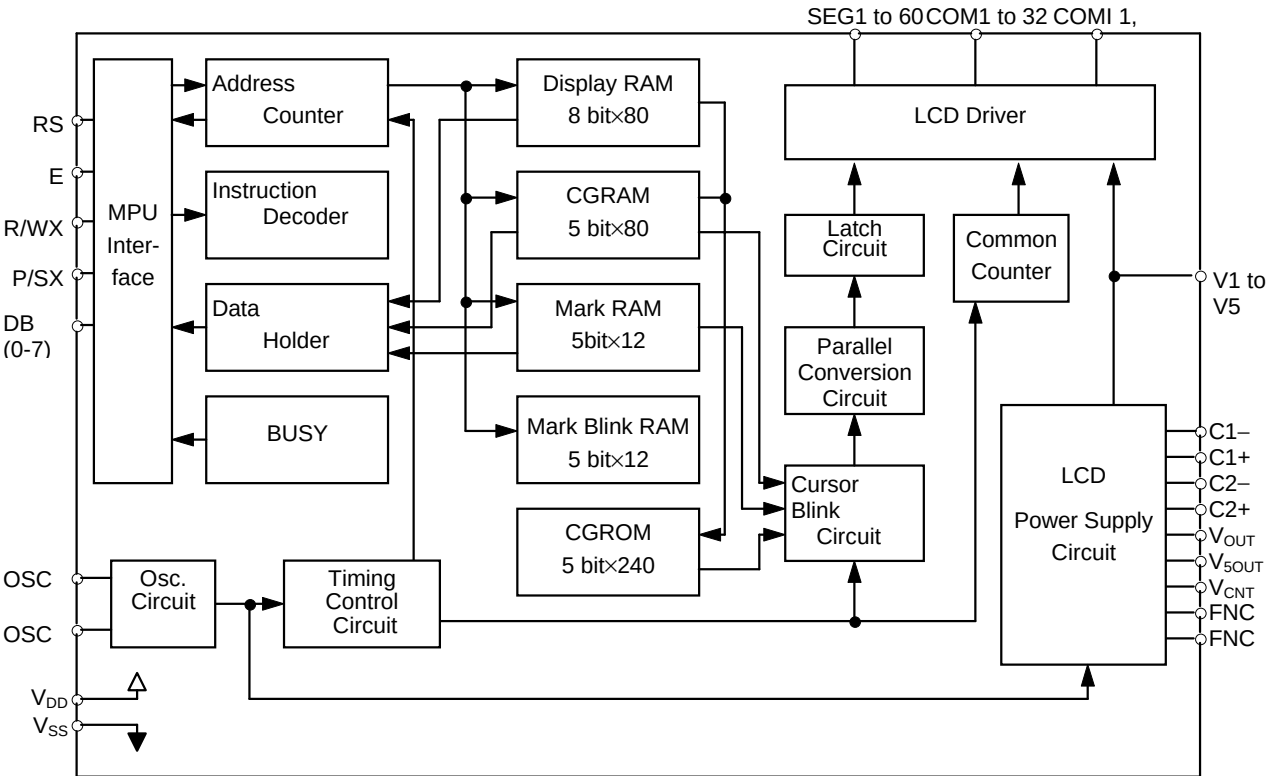


Figure 1

2. LCD Power Supply Circuit

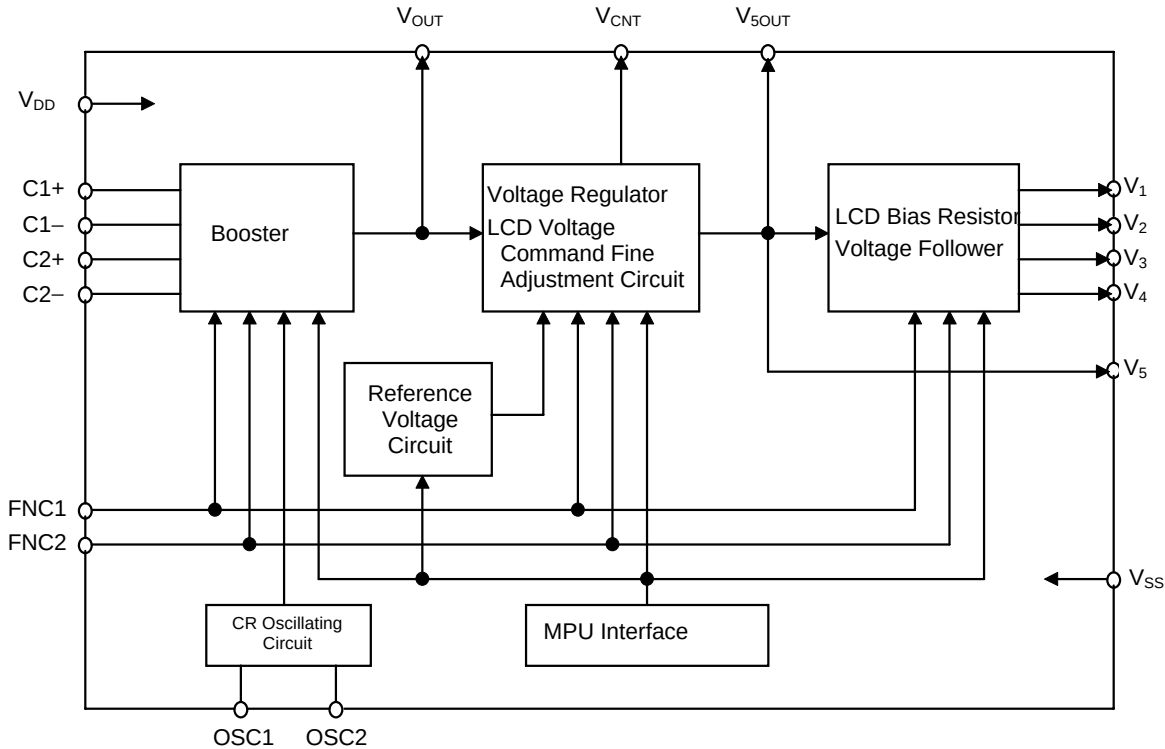


Figure 2

■ INSTRUCTION LIST

1. Normal Instructions

Table 1

Command	Code										Functions	Execution Time VDD=3V
	RS	R/WX	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0		
****	0	0	0	0	0	0	0	0	0	0		
Display Clear	0	0	0	0	0	0	0	0	0	0	Writes the space code in the entire DDRAM.	OSC 67 Clock
Cursor Home	0	0	0	0	0	0	0	0	1	CH	CH: 1/0= Cursor Return/Cursor Home	1μsec or less
Entry Mode	0	0	0	0	0	0	0	1	ID	S	ID: 1/0= Address Counter Increment/Decrement S: 1/0= Display Shift during DDRAM write	1μsec or less
Display ON/OFF	0	0	0	0	0	0	1	D	C	B	D: 1/0= Display ON/OFF C: 1/0= Cursor Display ON/OFF B: 1/0= Cursor Position Blink ON/OFF	1μsec or less
Cursor Display Shift	0	0	0	0	0	1	SC	RL	-	-	SC: 1/0= Whole Display Shift/Cursor Shift RL: 1/0= Cursor, Display Right /Left Shift	1μsec or less
Function Set	0	0	0	0	1	H	N	MS	DT	TC	H: 2 lines 12 columns select N: 2 lines 24 columns /4 lines 12 columns MS: 1/0= Expanded/Normal Interface DT: 1/0= 6-dot / 5-dot font TC: 1/0= Zig-Zag/Normal Common Output	1μsec or less
CGRAM Address	0	0	0	1	CGRAM Address						CGRAM Address Setting	1μsec or less
DDRAM Address	0	0	1	-	DDRAM Address						DDRAM Address Setting	1μsec or less
BUSY Address Read	0	1	BF	Address Counter							BF:BUSY Output Address Counter Setting	1μsec or less
Data Write	1	0	Write Data								Write Data	1μsec or less
Data Read	1	1	Data Read								Data Read	1μsec or less

-:don't care

2. Expanded Instruction list

Table 3

Command	Code										Functions	Execution Time VDD=3V
	RS	R/WX	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0		
Power Save Setting	0	0	0	0	0	0	-	-	-	PS	PS : 1/0= Power Save Operation/Normal Display	1μsec or less
Icon Only Display, Boosting Frequency Selection	0	0	0	0	0	1	-	MD	DC1	DC0	MD : 1/0= Icon Only Display/Normal Entire Display DC1, DC0: Boosting Frequency Selection	1μsec or less
Bias Select	0	0	0	1	0	0	-	-	BS1	BS0	BS1 BS0 0 0 1/6.7 Bias 0 1 1/5 Bias 1 0 1/4 Bias 1 1 Bias/External Setting	1μsec or less
Blink Select	0	0	0	1	0	1	-	-	BK1	BK0	BK1 BK0 0 0 Black Blinking 0 1 White Blinking 1 0 Cursor Blinking 1 1 Black/White Inverse Blinking	1μsec or less
Smooth Scroll Dot Shift	0	0	1	0	0	0	-	Dot Shift Amount			Dot Shift Amount : Setting and Operation of the Dot Shift Amount in the Smooth Scroll Select lines.	1μsec or less
Scroll Line Setting	0	0	1	0	0	1	L4	L3	L2	L1	L1: Selects the first line to Smooth Scroll line. L2: Select the second line to the Smooth Scroll line. L3: Select the third line to the Smooth Scroll line. L4: Select the forth line to the Smooth Scroll line.	1μsec or less
Smooth Scroll Character Shift	0	0	1	0	1	Character Shift Amount				Character Shift Amount: Setting and Operation of the Character Shift Amount in the Smooth Scroll Select lines.		1μsec or less
Icon RAM Address Setting	0	0	1	1	0	0	Icon RAM Address				Icon RAM Address Assignment	1μsec or less
Icon Blinking RAM Address Setting	0	0	1	1	0	1	Icon Blinking RAM Address				Icon Blinking RAM Address Assignment/ Sets the mark to blink.	1μsec or less
Contrast Adjustment	0	0	1	1	1	0	Contrast Amount				LCD Contrast Adjustment Data Setting	1μsec or less
Reference Volatage Temperature Coefficient Selection	0	0	1	1	1	1	-	-	-	DV0	DV0 0 -0.13%/ C, 1.6V 1 +0.01%/ C, 2.2V	1μsec or less
Function Set	0	0	0	0	1	H	N	MS	DT	TC	H: 1/0= 2 lines 12 columns Select/ N Valid N: 1/0= 2 lines 24 columns /4 lines 12 columns MS: 1/0= Expanded / Normal Instruction DT : 1/0=6-dot font/5-dot font TC : 1/0=Zig-Zag / Normal Common Output	1μsec or less
BUSY Address Read	0	1	BF	Address Counter						BF : BUSY Output Address Counter Setting		1μsec or less
Data Write	1	1	Write Data						Write Data			1μsec or less
Data Read	1	1	Read Data						Read Data			1μsec or less

--:don't care

IMPORTANT: Commands for the Function Set, BUSY Address Read, Data Write, and Data Read are common to Normal and Expanded Instructions.

■ Function Explanation

1. Interface

Two interfaces for serial and 8-bit parallel connections, which can be changed by the P/SX terminal, are built in. The CPU interfaces with instruction code and several kinds of data via an instruction decoder and a data holder.

Data is read from memory via the Data Holder. Through the memory's Address Set Command, the contents of the memory are read at one time into the Data Holder, and output through the Read Instruction. Then, the next data is read into the Data Holder.

Parallel interface and serial interface execute all instructions within the ENABLE CYCLE or the CLOCK CYCLE specified according to timing characteristics. Because BUSY is cleared within the CYCLE, the execution of successive instructions is possible without having to confirm BUSY.

1.1 Parallel Interface

Parallel interface is engaged when the P/SX terminal is "H" Connect the P/SX terminal to VDD. The reading of instruction is carried out at the falling edge of ENABLE (E), and the reading of data and of addresses is carried out when ENABLE is "H"

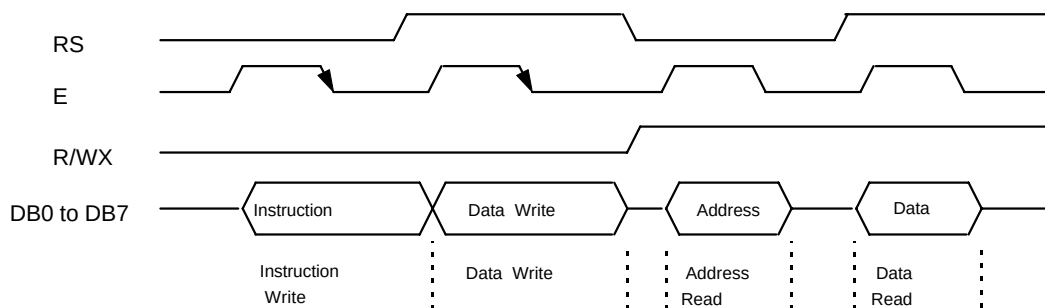


Figure 3

1.2 Serial Interface

Serial interface is engaged when the P/SX terminal is "L" The instruction code is read at the rising edge of Serial Lock (SCLK). Serial data is input in numeric order from DB0 through DB7. The instruction code is the same as that of the parallel data. Connect the P/SX terminal to VSS. Set the R/WX terminal to OPEN.

P/SX: "L" Serial Interface Operation/Connect it to VSS.
 RS: Write in the "L" Instruction Register
 Write in the "H" Data Register.
 E: "L" Active
 DB0: Serial Data Input Terminal (SDI)
 DB1: Serial Clock Input Terminal (SCLK)
 DB2 to DB7: OPEN
 R/WX: OPEN

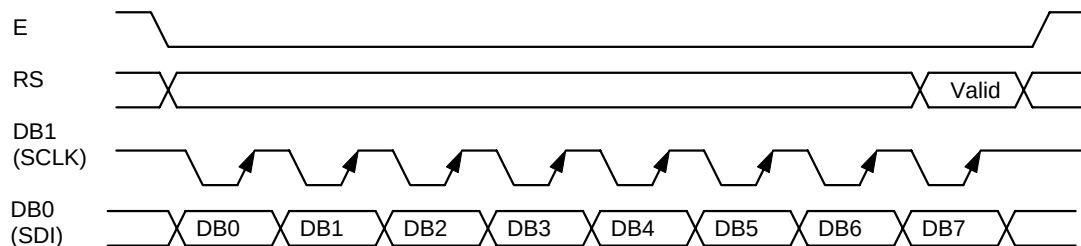
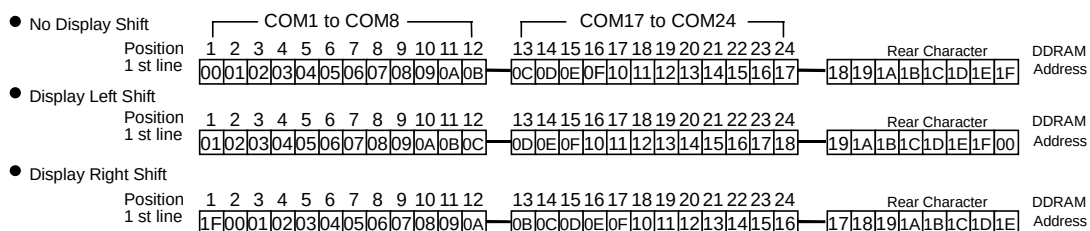
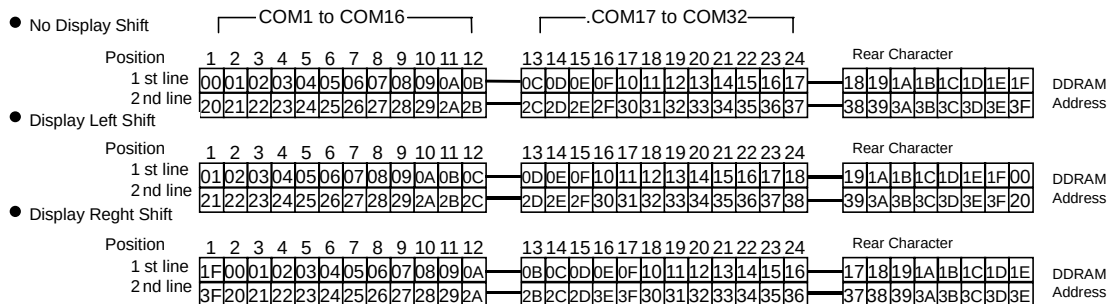


Figure 4

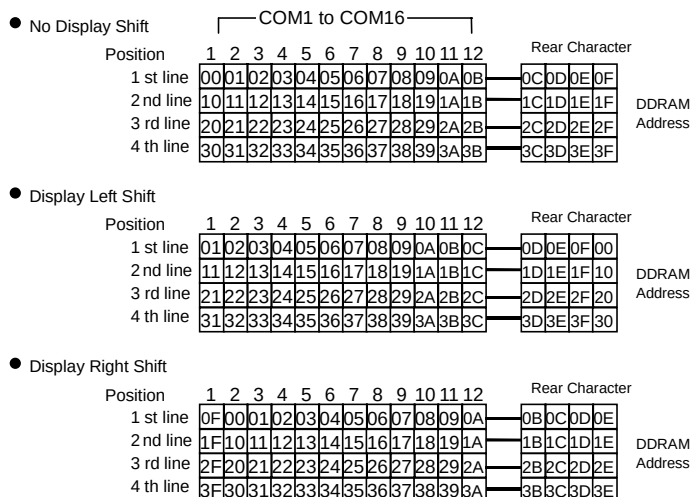
● 1 Line 24 Character Display



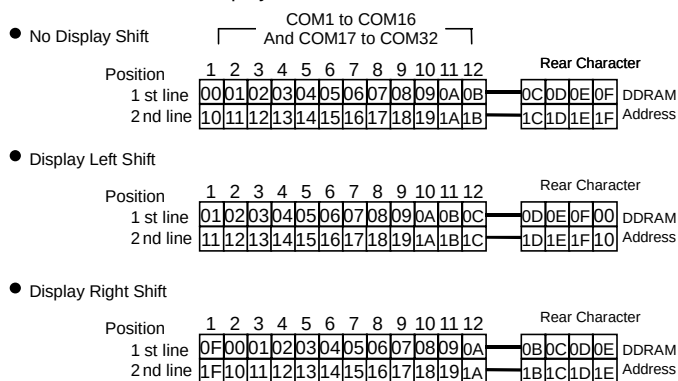
● 2 Line 24 Character Display



● 4 Line 12 Character Display



● 2 Line 12 Character Display



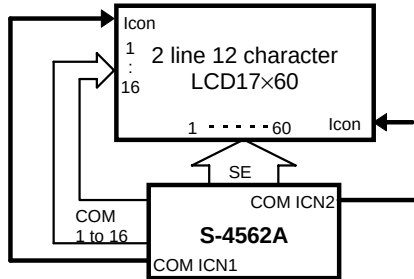
DDRAM Addresses and Positions

■ EXAMPLES OF CONNECTION TO LCD PANEL

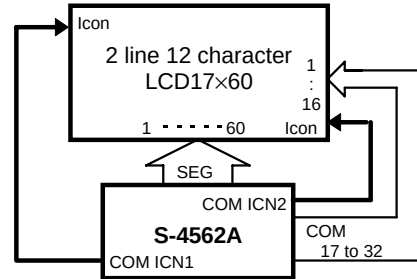
1. 2-line 12-character 1/17 duty cycle 17×60 panel

In case of the 2-line 12-character display, common output of chip's right and left side is the same phase.

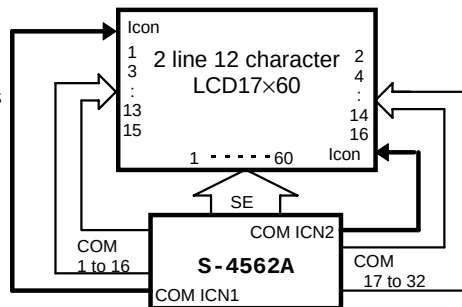
• Using COM1 to 16



• Using COM17 to 32



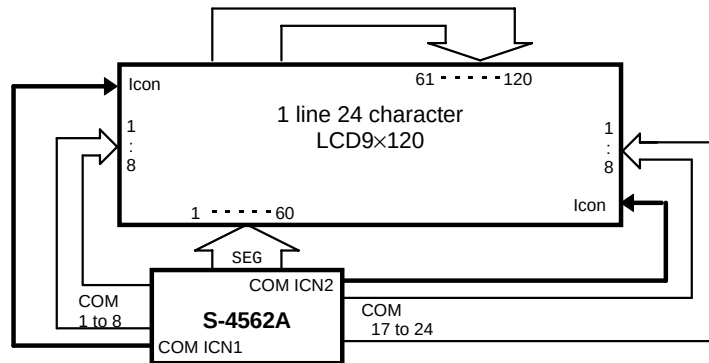
Odd numbered commons



Even numbered commons

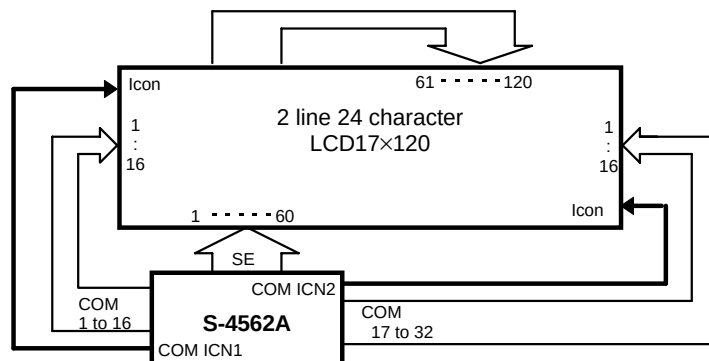
2. 1-line 24-character 1/33 duty cycle 9×120 panel

• Normal Common Output



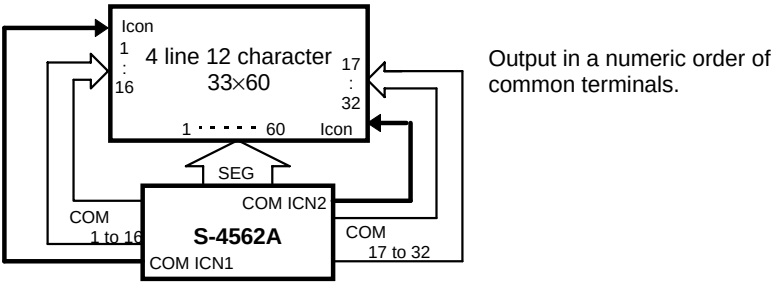
3. 2-line 24-character 1/33 duty cycle 17×120 panel

• Normal Common Output



4. 4- line 12- character 1/33 duty cycle 33×60 panel

- Normal Common Output



- Common Right and Left Alternate Output

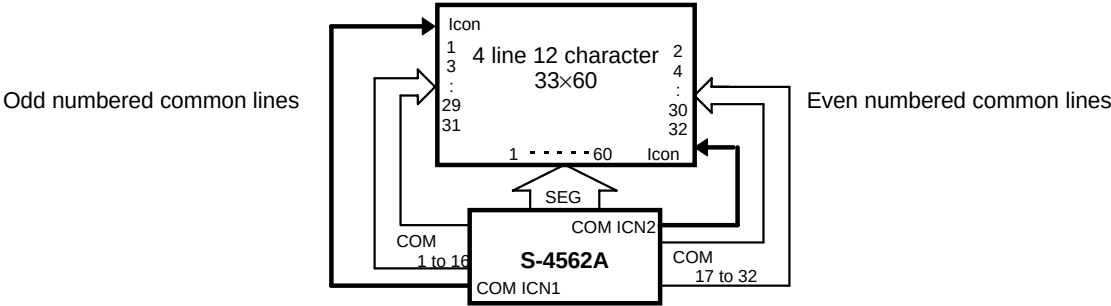


Figure 5 Connection to the LCD panel

■ DC Characteristics

1. ELECTRICAL CHARACTERISTICS

Table 3

(Unless otherwise specified: $V_{DD}=0\text{ V}$, $V_{SS}=-5.0\pm0.5\text{ V}$, $T_a=-30\text{ to }85\text{ }^\circ\text{C}$)

Item	Symbol	Conditions	Min.	Typ.	Max.	Unit	Note
Op. Voltage	V _{SS}		-5.5	-	-2.4	V	Note1
LCD Drive Voltage	V ₅	When using an external LCD power supply	-11.0	-	-3.5	V	Note2
	V ₁ , V ₂		V ₅	-	V _{DD}	V	
	V ₃ , V ₄						
High Level Input Voltage	V _{IH}	V _{SS} =-2.4 to -4.5 V	0.2×V _{SS}	-	V _{DD}	V	Note3
		V _{SS} =-5.0±0.5 V	0.3×V _{SS}	-	V _{DD}		
Low Level Input Voltage	V _{IL}	V _{SS} =-2.4 to -4.5 V	V _{SS}	-	0.8×V _{SS}	V	Note3
		V _{SS} =-5.0±0.5 V	V _{SS}	-	0.7×V _{SS}		
High Level Output Voltage	V _{OH1}	I _{OH} =-0.5mA, V _{SS} =-2.4 to -4.5V	0.2×V _{SS}	-	-	V	Note4
		I _{OH} =-1.0 mA	0.2×V _{SS}	-	-		
	V _{OH2}	I _{OH} =-50μA, V _{SS} =-2.4 to -4.5 V	0.2×V _{SS}	-	-	V	OSC ₂
		I _{OH} =-120 μA	0.2×V _{SS}	-	-		
Low Level Output Voltage	V _{OL1}	I _{OL} =0.5mA, V _{SS} =-2.4 to -4.5 V	-	-	0.8×V _{SS}	V	Note4
		I _{OL} =1.0mA	-	-	0.8×V _{SS}		
	V _{OL2}	I _{OL} =50μA V _{SS} =-2.4 to -4.5 V	-	-	0.8×V _{SS}	V	OSC ₂
		I _{OL} =120μA	-	-	0.8×V _{SS}		
Input Leak Current	I _I LEAK	V _{SS} =-2.4 to -5.5 V	-1.0	-	1.0	μA	Note5
Output Leak Current	I _O LEAK	V _{SS} =-2.4 to -5.5 V	-3.0	-	3.0	μA	Note6
LCD Driver ON Resistance	R _{ON}	Ta=25 °C, V5=-8.0 V 1/5 Bias	-	3.0	5.0	kΩ	Note7
Current Consumption at Stationary Status	I _S		-	0.05	5.0	μA	Note8
Current Consumption During Operation	I _{SS}	When using an external LCD power During display V5=-8.0 V Rf=** Ω	-	T.B.D	T.B.D	μA	Note9
Oscillating Frequency	f _{OSC}	Rf=** MΩ V _{SS} =-3.0 V	T.B.D	T.B.D	T.B.D	kHz	Note10
		Rf=** MΩ V _{SS} =-5.0 V	T.B.D	60	T.B.D		
Wait Time	t _R	fosc=60KHz	T.B.D	-	-	μs	Note11

2. Electrical Characteristics of LCD Power Supply Circuit

Table 4

(Unless otherwise specified, VDD=0 V, VSS=-2.4 to -5.5V, Ta=-30 to 85 °C)

(Unless otherwise specified, V _{DD} =0 V, V _{SS} =2.4 to 3.5V, Ta=25 to 85 °C)								
Item	Symbol	Conditions		Min.	Typ.	Max.	Unit	Note
Op. Voltage	V _{SS}			-5.5	-	-2.4	V	Note12
Boosting Output Voltage	V ₅	Triple Boost: Up to V _{SS} =-3.6 V Dual Boost: Up to V _{SS} =-5.5V		-11.0	-		V	
LCD Power Supply Circuit Op. Voltage	V _{IH}	1/4 Bias		-11.0	-	-4.0		
		1/5 Bias		-11.0	-	-4.5	V	Note13
		1/6.7 Bias		-11.0	-	-5.5		
LCD Drive Circuit Op. Voltage	V _{LCD}			-11.0	-	-2.7	V	Note14
Internal LCD Power Supply Circuit Current Consumption	I _{SSL}	V _{OUT} =-10.0 V Double Boost V _{SS} =-5.0 V V5=-8.0 V 1/5 Bias Oscillating Frequency=60 kHz			T.B.D	T.B.D	μA	Note15
LCD Driver Current Consumption	I _{V5}	V5=-8.0 V 1/5 Bias			T.B.D	T.B.D	μA	Note16
Standard Voltage	V _{REF}	Ta=25 °C	+0.01%/ °C	-2.4	-2.2	-2.0	V	Note17
			-0.13%/ °C	-1.8	-1.6	-1.4		

3. References

Table 5 References

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit	Note
Input Pin Capacity	C _{IN}	Ta=25 °C	-	5	8	pF	Note 3

Note 1 Sharp variation in the supply voltage or input signal voltage due to strange noises may lead to a malfunction of the IC. Supply stable supply voltage and input signal voltage.

If you change the level of the supply voltage intentionally, a malfunction may occur. NEVER CHANGE the level of the supply voltage.

Note 2 V_{DD}≥V1, V2, V3, V4≥V5. There is no limitation for determining the voltage level of V1, V2, V3, and V4.

Note 3 Pins RS, E, R/WX, P/S, OSC1, FNC1 and FNC2.

Pins DB0 to DB7 during display data write and command input.

Fully swing the levels V_{IH} and V_{IL} of the input signal within the range of power supply voltage so that the state is V_{IH}=V_{DD}, V_{IL}=V_{SS}. When the level of V_{IH} and V_{IL} is the middle level of the supply voltage, the through current flowing through the input pin and the current consumption may be increased.

Note 4 Pin s DB0 to DB7 during read.

Note 5 Pins RS, E, R/WX, P/S, OSC1, FNC1 and FNC2.

Note 6 Pins D0 to D7 during write and high-impedance.

Note 7 ON resistance between LCD drive output pins (SEG1 to SEG60, COM1 to 31, COM1CN1, and 2) and LCD drive bias voltage pins (V1, V2, V3, V4). Using the external LCD power supply, measure the resistance at a 0.1-V difference from the LCD drive output pin after applying 1/2 voltage of V5 to the LCD drive bias voltage pin.

Note 8 Power save state.

Note 9 Shows the current consumption during display including CR oscillation.

It does not include the current consumed by the booster, LCD supply voltage adjustment circuit, voltage regulator, LCD bias resistor when using the external LCD power supply. The LCD drive output pin is no load. The current consumed by the LCD panel and wiring capacitor is not included. Measure it without access from the MPU. The current consumed by the external LCD power supply and external bias resistor and other is not included.

- Note 10 For a 2-line x 12-column display, set the oscillating frequency to 31 kHz when $R_f = \text{**k}\Omega$. Refer to the graph showing the oscillating frequency vs R_f dependency.
- Note 11 Shows the wait time from when the power voltage rises to 80% of the specified voltage to when the command input is available. This is applicable when $f_{osc} = 60 \text{ kHz}$ and is proportional to the reciprocal of f_{osc} .
- Note 12 The operating voltage range of the booster.
- Note 13 Shows the operating voltage range of the LCD voltage adjustment circuit, voltage follower, and LCD bias resistor. The operating voltage range differs depending upon each bias setting value. To adjust V_5 with the LCD voltage adjustment circuit, it is necessary to set the voltage within the bias voltage.
- Note 14 The operating voltage range of the LCD driver after the voltage follower functions. Also, it shows the voltage range of V_1 to V_5 supplied from the external LCD power supply circuit.
- Note 15 Shows the value of the current consumed by the booster, LCD voltage adjustment circuit, voltage follower, LCD bias resistor. It does not include the value $IRREG = V_5 / (R_1 + R_2 + R_3)$ of the current flowing through external resistors R_1 , R_2 , and R_3 . Current consumption of the IC during display is $ISSL + IDD1 + IRREG$.
- Note 16 Shows the value of the current consumed by the voltage follower and LCD driver.
The built-in circuit uses the external power supply to generate the bias voltage when the booster and LCD power supply voltage adjustment circuits stop.
Current consumption of the IC during display is $IVF + IDD1$.
When using the external power supply, stop the built-in LCD power supply circuit. Shorting of the internal and external power supply can damage the IC.
- Note 17 The reference voltage differs depending upon the reference voltage temperature coefficient selected with the corresponding command. $V_{DD} = 0V$