BIT MAP LCD DRIVER

■ GENERAL DESCRIPTION

The NJU6575A is a bit map LCD driver to display graphics or characters.

It contains 4,422 bits display data RAM, microprocessor interface circuits, instruction decoder, 134-segment and 33-common (1 out of 33-driver is prepared for icon display) drivers.

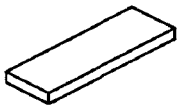
The bit image display data is transfer d to the display data RAM by serial or 8-bit parallel interface.

33 x 134 dots graphics or 8-character 2-line by 16 x 16 dot character with icon are displayed by NJU6575A itself.

The wide operating voltage from 2.4V t o 5.5V and low operateing current are useful for small size battery operating items.

The build-in Electrical Variable Resistance is very precision, furthermore the rectangle outlook is very applicable to COG or Slim TCP.

■ PACKAGE OUTLINE

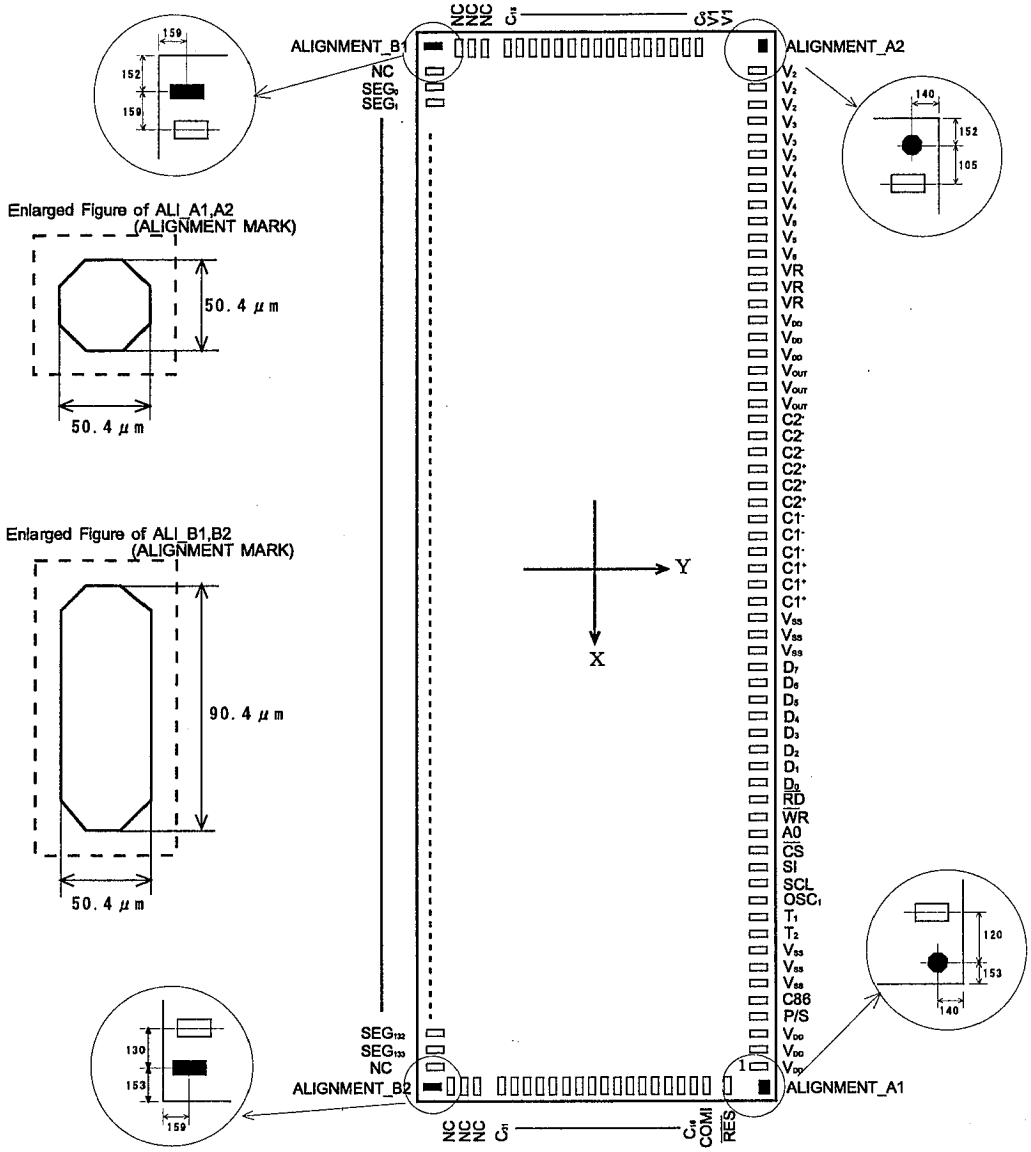


NJU6575ACH

■ FEATURES

- Direct Correspondence between Display Data RAM and LCD Pixel
- Display Data RAM - 4,422 bits
- 167 LCD Drivers - 33- common and 134-segment
- Direct micro processor Interface for both of 68 and 80 type MPU
- Serial Interface
- Programmable Duty Ratio ; 1/32 or 1/33 Duty
- Useful Instruction Set
  Display Data Read/Write, Display ON/OFF Cont, Inverse Display, Page Address Set, Column Address Set, Status Read, All On/Off, Icon Display, Read Modify Write, Common Driver order Assignment and Power Saving.
- Power Supply Circuits for LCD Incorporated
  Step up Circuits, Regulator, Voltage Follower x 4
- Precision Electrical Variable Resistance
- Low Power Consumption
- Operating Voltage — 2.4V to 5.5V
- LCD Driving Voltage — 6.0V to 13.5V
- Package Outline — TCP/Bumped Chip
- C-MOS Technology

■ PAD LOCATION



Chip	Center	X=0um, Y=0um
Chip	Size	X=11.49mm, Y=2.44mm
Chip	Thickness	400um ± 30um
PAD	Pitch	80um
Bump	Size	50um x 110um
Bump	Height	25um TYP.
Bump	Material	Au

■: Four PADs illustrated with this mark are the alignment marks for COG.

■ PAD COORDINATES

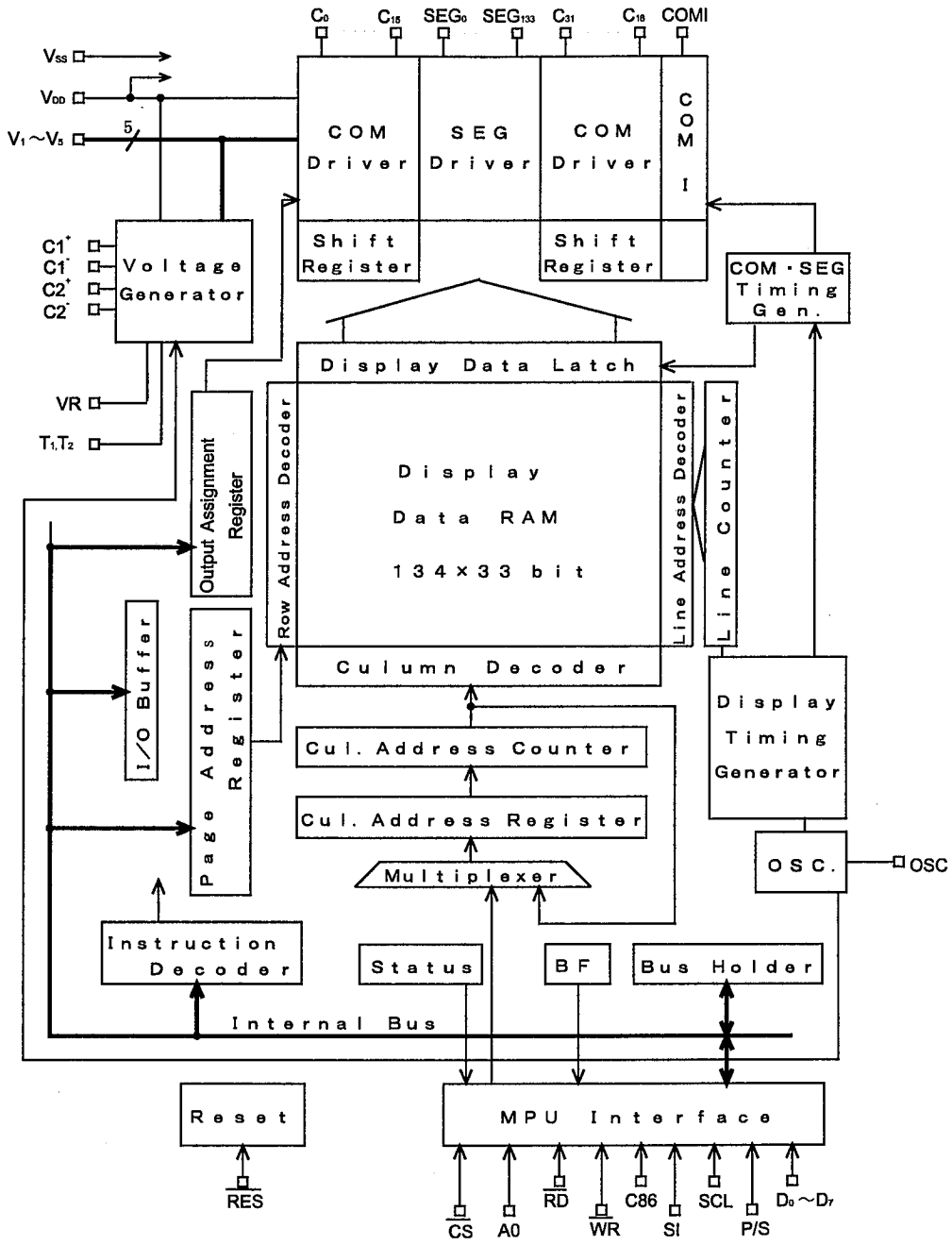
Chip Size 11.49mm x 2.44mm (Chip Center X=0um, Y=0um)

NO.	Termi.	X= μm	Y= μm
1	V_{DD}	5472	1054
2	V_{DD}	5392	1054
3	V_{DD}	5312	1054
4	P/S	5232	1054
5	C86	5152	1054
6	V_{SS}	5072	1054
7	V_{SS}	4992	1054
8	V_{SS}	4912	1054
9	T_2	4832	1054
10	T_1	4752	1054
11	OSC_1	4672	1054
12	SCL	4592	1054
13	SI	4192	1054
14	$\overline{CS}$	3792	1054
15	A0	3392	1054
16	$\overline{WR}$	2992	1054
17	$\overline{RD}$	2592	1054
18	D_0	2192	1054
19	D_1	1792	1054
20	D_2	1392	1054
21	D_3	992	1054
22	D_4	592	1054
23	D_5	192	1054
24	D_6	-208	1054
25	D_7	-608	1054
26	V_{SS}	-928	1054
27	V_{SS}	-1008	1054
28	V_{SS}	-1088	1054
29	$C1^+$	-1328	1054
30	$C1^+$	-1408	1054
31	$C1^+$	-1488	1054
32	$C1^-$	-1728	1054
33	$C1^-$	-1808	1054
34	$C1^-$	-1888	1054
35	$C2^+$	-2128	1054
36	$C2^+$	-2208	1054
37	$C2^+$	-2288	1054
38	$C2^-$	-2528	1054
39	$C2^-$	-2608	1054
40	$C2^-$	-2688	1054
41	V_{OUT}	-2928	1054
42	V_{OUT}	-3008	1054
43	V_{OUT}	-3088	1054
44	V_{DD}	-3328	1054
45	V_{DD}	-3408	1054
46	V_{DD}	-3488	1054
47	VR	-3728	1054
48	VR	-3808	1054
49	VR	-3888	1054
50	V_5	-4128	1054
51	V_5	-4208	1054
52	V_5	-4288	1054
53	V_4	-4528	1054
54	V_4	-4608	1054
55	V_4	-4688	1054
56	V_3	-4928	1054
57	V_3	-5008	1054
58	V_3	-5088	1054
59	V_2	-5328	1054
60	V_2	-5408	1054
61	V_2	-5488	1054
62	V_1	-5584	862
63	V_1	-5584	782
64	C_0	-5584	702
65	C_1	-5584	622
66	C_2	-5584	542
67	C_3	-5584	462
68	C_4	-5584	382
69	C_5	-5584	302
70	C_6	-5584	222
71	C_7	-5584	142
72	C_8	-5584	62
73	C_9	-5584	-18
74	C_{10}	-5584	-98
75	C_{11}	-5584	-178
76	C_{12}	-5584	-258
77	C_{13}	-5584	-338
78	C_{14}	-5584	-418
79	C_{15}	-5584	-498
80	NC	-5584	-634
81	NC	-5584	-770
82	NC	-5584	-906
83	NC	-5434	-1055
84	SEG_0	-5306	-1055
85	SEG_1	-5226	-1055
86	SEG_2	-5146	-1055
87	SEG_3	-5066	-1055
88	SEG_4	-4986	-1055
89	SEG_5	-4906	-1055
90	SEG_6	-4826	-1055
91	SEG_7	-4746	-1055
92	SEG_8	-4666	-1055
93	SEG_9	-4586	-1055
94	SEG_{10}	-4506	-1055
95	SEG_{11}	-4426	-1055
96	SEG_{12}	-4346	-1055
97	SEG_{13}	-4266	-1055
98	SEG_{14}	-4186	-1055
99	SEG_{15}	-4106	-1055
100	SEG_{16}	-4026	-1055
101	SEG_{17}	-3946	-1055
102	SEG_{18}	-3866	-1055
103	SEG_{19}	-3786	-1055
104	SEG_{20}	-3706	-1055
105	SEG_{21}	-3626	-1055
106	SEG_{22}	-3546	-1055
107	SEG_{23}	-3466	-1055
108	SEG_{24}	-3386	-1055
109	SEG_{25}	-3306	-1055
110	SEG_{26}	-3226	-1055
111	SEG_{27}	-3146	-1055
112	SEG_{28}	-3066	-1055
113	SEG_{29}	-2986	-1055
114	SEG_{30}	-2906	-1055
115	SEG_{31}	-2826	-1055
116	SEG_{32}	-2746	-1055
117	SEG_{33}	-2666	-1055
118	SEG_{34}	-2586	-1055
119	SEG_{35}	-2506	-1055
120	SEG_{36}	-2426	-1055
121	SEG_{37}	-2346	-1055
122	SEG_{38}	-2266	-1055
123	SEG_{39}	-2186	-1055
124	SEG_{40}	-2106	-1055
125	SEG_{41}	-2026	-1055
126	SEG_{42}	-1946	-1055
127	SEG_{43}	-1866	-1055
128	SEG_{44}	-1786	-1055
129	SEG_{45}	-1706	-1055
130	SEG_{46}	-1626	-1055
131	SEG_{47}	-1546	-1055
132	SEG_{48}	-1466	-1055
133	SEG_{49}	-1386	-1055
134	SEG_{50}	-1306	-1055
135	SEG_{51}	-1226	-1055
136	SEG_{52}	-1146	-1055
137	SEG_{53}	-1066	-1055
138	SEG_{54}	-986	-1055
139	SEG_{55}	-906	-1055
140	SEG_{56}	-826	-1055
141	SEG_{57}	-746	-1055
142	SEG_{58}	-666	-1055
143	SEG_{59}	-586	-1055
144	SEG_{60}	-506	-1055
145	SEG_{61}	-426	-1055
146	SEG_{62}	-346	-1055
147	SEG_{63}	-266	-1055
148	SEG_{64}	-186	-1055
149	SEG_{65}	-106	-1055
150	SEG_{66}	-26	-1055

No.	Terminal	X= μm	Y= μm
151	SEG_{67}	54	-1055
152	SEG_{68}	134	-1055
153	SEG_{69}	214	-1055
154	SEG_{70}	294	-1055
155	SEG_{71}	374	-1055
156	SEG_{72}	454	-1055
157	SEG_{73}	534	-1055
158	SEG_{74}	614	-1055
159	SEG_{75}	694	-1055
160	SEG_{76}	774	-1055
161	SEG_{77}	854	-1055
162	SEG_{78}	934	-1055
163	SEG_{79}	1014	-1055
164	SEG_{80}	1094	-1055
165	SEG_{81}	1174	-1055
166	SEG_{82}	1254	-1055
167	SEG_{83}	1334	-1055
168	SEG_{84}	1414	-1055
169	SEG_{85}	1494	-1055
170	SEG_{86}	1574	-1055
171	SEG_{87}	1654	-1055
172	SEG_{88}	1734	-1055
173	SEG_{89}	1814	-1055
174	SEG_{90}	1894	-1055
175	SEG_{91}	1974	-1055
176	SEG_{92}	2054	-1055
177	SEG_{93}	2134	-1055
178	SEG_{94}	2214	-1055
179	SEG_{95}	2294	-1055
180	SEG_{96}	2374	-1055
181	SEG_{97}	2454	-1055
182	SEG_{98}	2534	-1055
183	SEG_{99}	2614	-1055
184	SEG_{100}	2694	-1055
185	SEG_{101}	2774	-1055
186	SEG_{102}	2854	-1055
187	SEG_{103}	2934	-1055
188	SEG_{104}	3014	-1055
189	SEG_{105}	3094	-1055
190	SEG_{106}	3174	-1055
191	SEG_{107}	3254	-1055
192	SEG_{108}	3334	-1055
193	SEG_{109}	3414	-1055
194	SEG_{110}	3494	-1055
195	SEG_{111}	3574	-1055
196	SEG_{112}	3654	-1055
197	SEG_{113}	3734	-1055
198	SEG_{114}	3814	-1055
199	SEG_{115}	3894	-1055

No.	Terminal	X= μm	Y= μm
200	SEG_{116}	3974	-1055
201	SEG_{117}	4054	-1055
202	SEG_{118}	4134	-1055
203	SEG_{119}	4214	-1055
204	SEG_{120}	4294	-1055
205	SEG_{121}	4374	-1055
206	SEG_{122}	4454	-1055
207	SEG_{123}	4534	-1055
208	SEG_{124}	4614	-1055
209	SEG_{125}	4694	-1055
210	SEG_{126}	4774	-1055
211	SEG_{127}	4854	-1055
212	SEG_{128}	4934	-1055
213	SEG_{129}	5014	-1055
214	SEG_{130}	5094	-1055
215	SEG_{131}	5174	-1055
216	SEG_{132}	5254	-1055
217	SEG_{133}	5334	-1055
218	NC	5462	-1055
219	NC	5583	-913
220	NC	5583	-777
221	NC	5583	-641
222	C_{31}	5583	-505
223	C_{30}	5583	-425
224	C_{29}	5583	-345
225	C_{28}	5583	-265
226	C_{27}	5583	-185
227	C_{26}	5583	-105
228	C_{25}	5583	-25
229	C_{24}	5583	56
230	C_{23}	5583	136
231	C_{22}	5583	216
232	C_{21}	5583	296
233	C_{20}	5583	376
234	C_{19}	5583	456
235	C_{18}	5583	536
236	C_{17}	5583	616
237	C_{16}	5583	696
238	COMI	5583	776
239	$\overline{RES}$	5583	856
ALIGNMENT	A1	5592	1080
ALIGNMENT	A2	-5593	1080
ALIGNMENT	B1	-5593	-1061
ALIGNMENT	B2	5592	-1061

■ BLOCK DIAGRAM



■ TERMINAL DESCRIPTION

No.	Symbol	I/O	Function
1,2,3, 44,45,46	V_{DD}	Power	V_{DD}=+5V. (Less than 4.5V should apply when voltage tripler using.)
6,7,8 26,27,28	V_{SS}	GND	V_{SS}=0V
62,63 59,60,61 56,57,58 53,54,55 50,51,52	V_1 V_2 V_3 V_4 V_5	Power	LCD Driving Voltage Supplying Terminal. When the internal voltage tripler is not used, supply each level of LCD driving voltage from outside with following relation. $V_{DD} \geqq V_1 \geqq V_2 \geqq V_3 \geqq V_4 \geqq V_5$ When the internal power supply is on, the internal circuits generate and supply following LCD bias voltage from V_1 to V_4 terminals. Term. / Volt.: V_1 = V_5+6/7V_{LCD}; V_2 = V_5+5/7V_{LCD}; V_3 = V_5+2/7V_{LCD}; V_4 = V_5+1/7V_{LCD} (V_{LCD}=V_{DD}-V_5)
29,30,31 32,33,34 35,36,37 38,39,40	C1 $^+$ C1 $^-$ C2 $^+$ C2 $^-$	O	Step up capacitor connecting terminals. In case of tripler operation, connect the capacitor between C1 $^+$ and C1 $^-$, C2 $^+$ and C2 $^-$. In case of doubler operation, connect the capacitor between C2 $^+$ and C2 $^-$, connect C2 $^+$ to C1 $^+$, and C1 $^-$ should be open.
41,42,43	V_{OUT}	O	Step up voltage output terminal. Connect the set up capacitor between this terminal and V_{SS}.
47,48,49	VR	I	Voltage adjust terminal. V_5 level is adjusted by external bleeder resistance connecting between V_{DD} and V5 terminal.
10 9	T_1 T_2	I	LCD bias voltage control terminals. ※ Don't Care T_1 / T_2 / Step up cir. / Voltage Adj. / V/F Cir.: L / ※ / Available / Available / Available H / L / Not Avail. / Available / Available H / H / Not Avail. / Not Avail. / Available
18 to 25	D_0 to D_7	I/O	Tri-state bi-directional Data I/O terminal in 8-bit parallel operation.
15	A0	I	Connect to the Address bus of MPU. The data on the D_0 to D_7 is distinguished between Display data and Instruction by status of A0. A0 / Dist.: H / Display Data; L / Instruction
239	$\overline{RES}$	I	Reset terminal. When the $\overline{RES}$ terminal goes to "L", the initialization is performed. Reset operation is executing during "L" state of $\overline{RES}$.
14	$\overline{CS}$	I	Chip select terminal. Data Input/Output are available during $\overline{CS}$ ="L".
17	$\overline{RD}$ (E)	I	<In case of interface with 80 type MPU> $\overline{RD}$ signal of 80 type MPU input terminal. Active "L". During this signal is "L", D_0 to D_7 terminals are output. <In case of 68 type MPU> Enable signal of 68 type MPU input terminal. Active "H".

<table>
<tr><th>No.</th><th>Symbol</th><th>I/O</th><th>F u n c t i o n</th></tr>
<tr><td>16</td><td>$\overline{WR}$
(R/W)</td><td>I</td><td><In case of with 80 type MPU>
Connect to the 80 type MPU $\overline{WR}$ signal. Active "L".
The data on the data bus input synchronizing the rise edge of this signal.
<In case of with 68 type MPU>
Read/write control signal of 68 type MPU input terminal.
<table>
<tr><td>R/W</td><td>H</td><td>L</td></tr>
<tr><td>State</td><td>Read</td><td>Write</td></tr>
</table></td></tr>
<tr><td>5</td><td>C86</td><td>I</td><td>MPU interface type terminal.
<table>
<tr><td>C86</td><td>H</td><td>L</td></tr>
<tr><td>Status</td><td>68 Type</td><td>80 Type</td></tr>
</table></td></tr>
<tr><td>13</td><td>SI</td><td>I</td><td>Serial data input terminal .</td></tr>
<tr><td>12</td><td>SCL</td><td>I</td><td>Serial data clock signal input terminal.
SI data input at the rise edge of SCL in successively. It convert to the parallel data at the 8th SCL clock rise edge.</td></tr>
<tr><td>4</td><td>P/S</td><td>I</td><td>Serial or parallel interface selection terminal.
<table>
<tr><th>P/S</th><th>Chip Select</th><th>Data/Command</th><th>Data</th><th>Read/Write</th><th>Serial CLK</th></tr>
<tr><td>"H"</td><td>$\overline{CS}$</td><td>A0</td><td>D_0 to D_7</td><td>$\overline{RD}$, $\overline{WR}$</td><td>–</td></tr>
<tr><td>"L"</td><td>$\overline{CS}$</td><td>A0</td><td>SI</td><td>Write only</td><td>SCL</td></tr>
</table>
*RAM data and status read operation do not work in mode of the serial interface.
・ In case of the parallel interface (P/S="H"), SI and SCL must be fixed "H" or "L".
・ In case of the serial interface (P/S="L"), $\overline{RD}$ and $\overline{WR}$ must be fixed. "H" or "L", and D_0 to D_7 are high impedance state.</td></tr>
<tr><td>11</td><td>OSC_1</td><td>I</td><td>System clock input terminal for Maker testing.
(This terminal should be open.)</td></tr>
</table>

<table>
<tr><th>No.</th><th>Symbol</th><th>I/O</th><th>F u n c t i o n</th></tr>
<tr><td>64 to 79</td><td>C_0 to C_{15}</td><td>O</td><td>LCD driving signal output terminals.
Segment output terminals : SEG_0 to SEG_{133}
Common output terminals :C_0 to C_{32}

・Segment output terminal
The following output voltage are selected by the combination of FR and data in the RAM.
<table><tr><th rowspan="2">RAM Data</th><th rowspan="2">FR</th><th colspan="2">Output Voltage</th></tr><tr><th>Normal</th><th>Reverse</th></tr><tr><td rowspan="2">H</td><td>H</td><td>V_{DD}</td><td>V_2</td></tr><tr><td>L</td><td>V_5</td><td>V_3</td></tr><tr><td rowspan="2">L</td><td>H</td><td>V_2</td><td>V_{DD}</td></tr><tr><td>L</td><td>V_3</td><td>V_5</td></tr></table>
・Common Output Terminal
The following output voltage are selected by the combination of FR and status of common.
<table><tr><th>Scan data</th><th>FR</th><th>Output Voltage</th></tr><tr><td rowspan="2">H</td><td>H</td><td>V_5</td></tr><tr><td>L</td><td>V_{DD}</td></tr><tr><td rowspan="2">L</td><td>H</td><td>V_1</td></tr><tr><td>L</td><td>V_4</td></tr></table></td></tr>
<tr><td>84 to 217</td><td>SEG_0 to SEG_{133}</td><td></td><td></td></tr>
<tr><td>222 to 237</td><td>C_{31} to C_{16}</td><td></td><td></td></tr>
<tr><td>238</td><td>COMI</td><td>O</td><td>Icon common output terminal.
Icon common output when Icon Display instruction execution.
<table><tr><th></th><th>Icon Display ON</th><th>Icon Display OFF</th></tr><tr><td>State</td><td>COM_{32}</td><td>V_1 or V_4</td></tr></table></td></tr>
</table>

(Terminals 80,81,82,83,218,219,220,221 are NC)

■ Functional Description

(1) Description for each blocks

(1-1) Busy Flag (BF)

While D_0 to D_7 the internal circuits are operating, the busy flag(BF) is "1", and any instruction except ing for the status read are inhibited .

The busy goes to "1" from D_7 terminal when status read instruction is executed.

When enough cycle time over than t_{CYC} indicated in "BUS TIMING CHARACTERISTICS" is ensured, no need to check the busy flag for reduction of the MPU loads.

(1-2) Line Counter

The Line Counter generates the line address of display data RAM by the count up operation synchronizing the common cycle after the reset operation at the status change of internal FR signal.

(1-3) Column Address Counter

The column address counter is 8-bit pre-settable counter addressing the column address of display data RAM as shown in Fig. 1. It is incremented (+1) up to $(A0)_H$ by the Display Data Read/Write instruction execution. It stops the count up operation at $(A0)_H$, and it does not count up non existing address area over than $(A0)_H$ by the count lock function. This count lock is released by new column address set.

The column address counter is independent of the Page Register.

By the Address Inverse Instruction, the column address decoder inverse the column address of Display Data RAM corresponding to the Segment Driver.

(1-4) Page Register

The page register gives a page address of Display Data RAM as shown in Fig. 1. When the MPU accesses the data with the page change, the page address set instruction is required.

Page address "4"(D_2="H" and D_1=D_0="L") is Icon RAM area, the data only for the D_0 is valid.

(1-5) Display Data RAM

Display Data RAM is the bit map RAM consisting of 4,422 bits to memorize the display data corresponding to each pixel of LCD panel. The each bit in the Display Data RAM corresponds to the each pixel of the LCD panel and controls the display by following bit data.

When Normal Display : On="1" , Off="0"

When Inverse Display : On="0" , Off="1"

The Display Data RAM outputs 134-bit parallel data in the area addressed by the line counter, and these data are set into the Display Data Latch.

The access operation from MPU to the display data RAM and the data output from the display data RAM are so controlled operate independently that the data rewriting does not influence with any malfunctions to the display.

The relation between column address and segment output can inverse by the Address Inverse Instruction ADC as shown in Fig. 1.

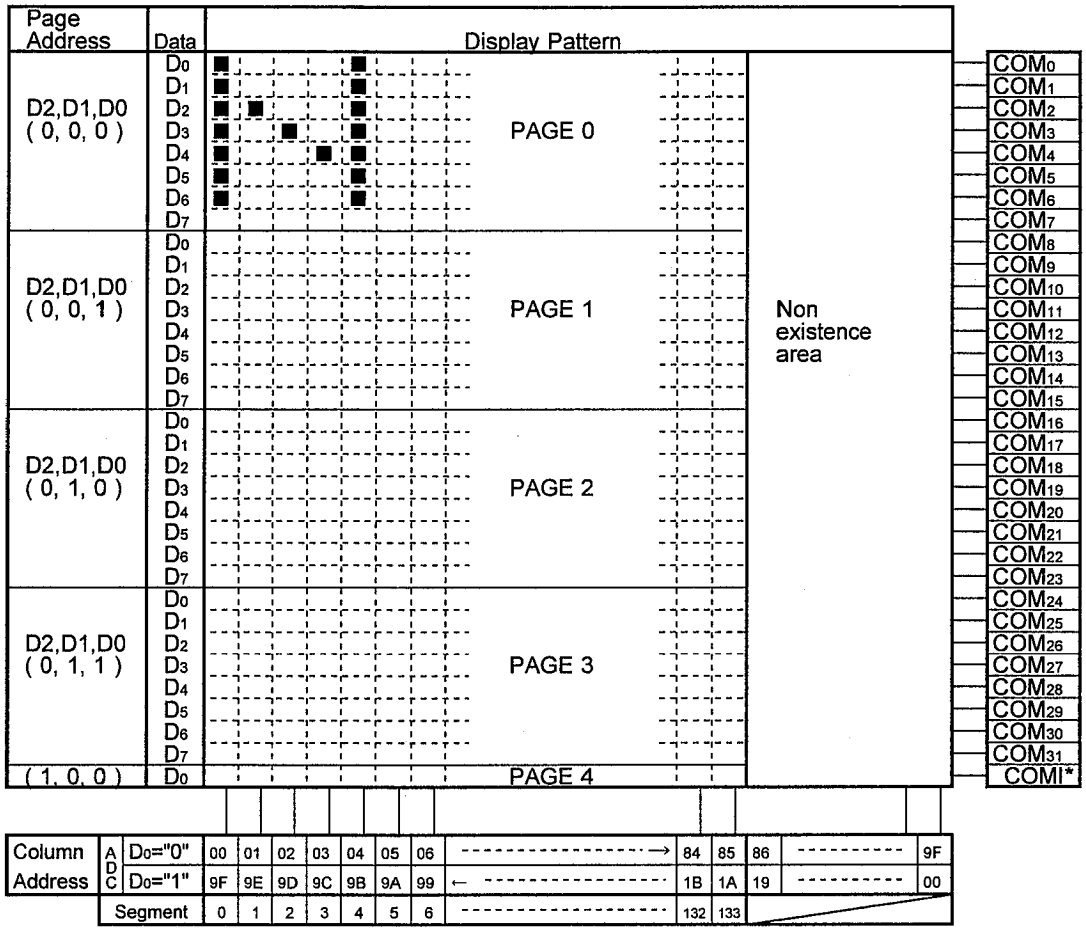


Fig.1 Correspondence with Display Data RAM and Address
(COMI can be used in case of 1/33 duty set.)

* When readout the Display Data RAM address 86H to 9FH in normal ADC or 00H to 19H in inverse ADC the data FFH is output as those address data.

(1-6) Common Driver Assignment

The scanning order can be assigned by setting A_3 of the Output Assignment Register as shown Table 1.

Table 1

Register	PAD No. / Pin name	COM Output Terminals			
A3		64 / 79		222 / 237	
		C_0	C_{15}	C_{31}	C_{16}
0	→	COM_{15} ←	COM_0	COM_{16} →	COM_{31}
1	→	COM_{16} →	COM_{31}	COM_{15} ←	COM_0

The Icon display is regardless with this function, therefore the Icon Display instruction must be executed when the Icon display is needed. In this time, the Icon display driver COMI is fixed to COM_{32} timing regardless the other Common Driver assignment.

(1-7) Reset Circuit

Reset circuit operates the following initializations when the condition of $\overline{RES}$ terminal goes to "L" level.

Initialization

① Display Off
② Normal Display(Non-inverse display)
③ Icon Display Reset
④ ADC Select : Normal (ADC Instruction D_0="0")
⑤ Read Modify Write Mode Off
⑥ Internal Power supply(Step up) circuits Off
⑦ Clear the serial interface register
⑧ Set the address $(00)_H$ to the Column Address Counter
⑨ Set the page "0" to the Page Address Register
⑩ Select the D_3 of the Output Assignment Register to "0"
⑪ Set the EVR register to $(00)_H$

The $\overline{RES}$ terminal should be connected to the Reset terminal of MPU for the initialization at the mean time with MPU as shown "MPU Interface Example". The period of reset signal requires over than 10us $\overline{RES}$="L" level input as shown in "Electrical Characteristics". After 1us from the rise edge of $\overline{RES}$ signal, the operation goes to normal.

When the internal LCD power supply is not used, the external LCD power supply into the NJU6575A must be turned on during $\overline{RES}$="L". Although the condition of $\overline{RES}$="L" clear each registers and initialize as above, the oscillation circuit and the output terminal conditions (D_0 to D_7) are not influenced. The initialization must be performed using $\overline{RES}$ terminal at the power on, to prevent hung up or any incorrect operations. The reset Instruction performs the initialization procedures from No.8 to No.11 as shown in above.

NOTE) The noise into the $\overline{RES}$ terminal should be eliminated to avoid the error on the application with the careful design.

(1-8) LCD Driving

(a) LCD Driving Circuits

LCD driving circuits are consisted of 167 multiplexers which operate as 134 Segment drivers and 32 Common drivers and 1 Icon common driver. 33 Common drivers with the shift register which the common display signal. The combination of the Display data, COM scan signal and FR signal forms the LCD driving output voltage. The output wave form is shown in the Fig. 7.

(b) Display Data Latch Circuits

Display Data Latch stores 134-bit display data temporarily which is output to LCD driver circuits at a common cycle from Display Data RAM addressed by Line Counter. The instructions of Display On/ Off, Display inverse ON/OFF and static Drive On/Off control only the data in Display Data Latch, therefore the data in the Display Data RAM is not changed.

(c) Line Counter and Latch signal of Latch Circuits

The clock to Line Counter and latch signal to the Latch Circuits are generated from the internal display clock(CL). The line address of Display Data RAM is renewed synchronizing with display clock(CL). 134 bits display data are latched in display latch circuits synchronizing with display clock, and then output to the LCD driving circuits. The display data transfer to the LCD driving circuits is executed independently with RAM access by the MPU.

(d) Display Timing Generator

Display timing Generator generates the timing signal for the display system by combination of the master clock CL and Driving Signal FR (refer to Fig.2). The Frame Signal FR and LCD alternative signal generate LCD driving waveform of the two frame alternative driving method.

(e) Common Timing Generation

The common timing is generated by display clock CL (refer to Fig.2).

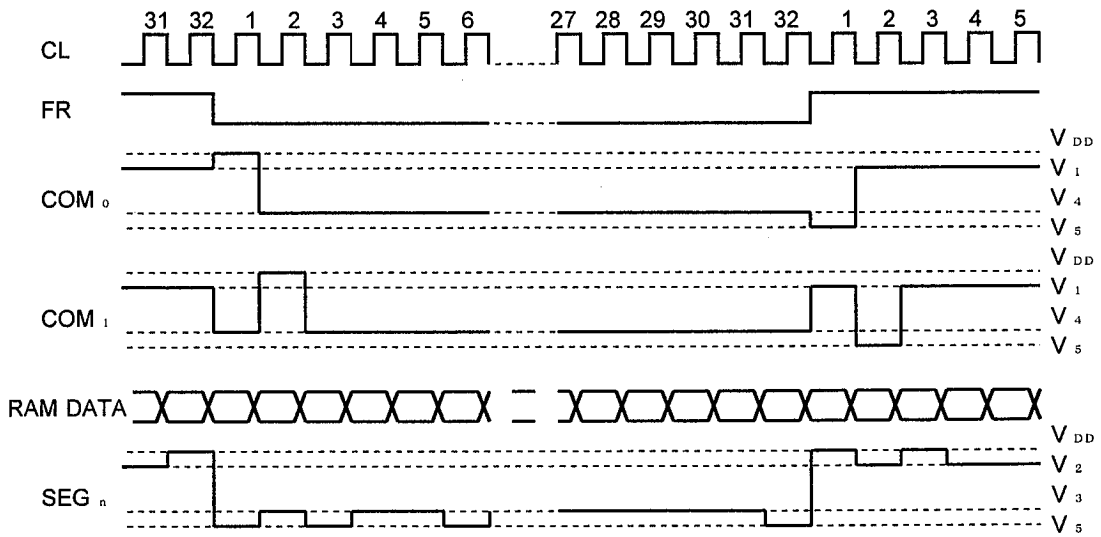


Fig. 2 Waveform of Display Timing

(f) Oscillation Circuit

The Oscillation Circuit is a low power CR oscillator incorporating with a Resistor and a Capacitor. It generates clocks for display timing signal source and voltage Step up circuits for LCD driving. The oscillation circuit output frequency is divided by 4 which is used as display clock CL.

(g) Power Supply Circuit

Internal Power Supply Circuit generate the High voltage and Bias voltage for the LCD. The power Supply Circuit consists of Step up(Tripler or Doubler) Circuits, Regulator Circuits, and Voltage Followers. The internal Power Supply is designed for small size LCD panel, therefore it is not suitable for the large size LCD panel application. If the contrast is not good in the large size LCD panel application, please supply the external.

The suitable values of the capacitors connecting to the V1 to V5 terminals and the step up circuit. And the feedback resistors for V5 operational amplifier depend on the LCD panel. And the power consumption with the LCD panel is depending on the display pattern. Please evaluate with actual LCD module.

The operation of internal Power Supply Circuits is controlled by the Internal Power Supply On/Off Instruction. When the Internal Power Supply Off Instruction is executed, all of the step up circuits, regulator circuits, voltage follower circuits are turned off. In this time, the bias voltage of V_1, V_2, V_3, V_4, and V_5 for the LCD should be supplied from outside, terminals $C1^+$, $C1^-$, $C2^+$, $C2^-$,and VR should be open. The status of internal power supply is selected by T_1 and T_2 terminal. Furthermore The external power supply operates with some of internal power supply function.

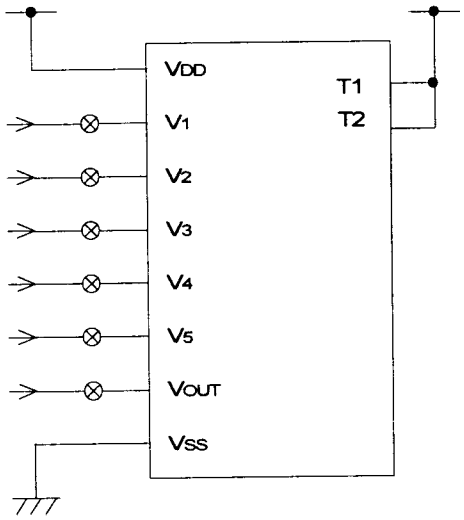
Table 3. (*:Don't Care)

T_1	T_2	Step up	Voltage Adj.	Buffer (V/F)	Ext. Pow Supply	C1+,C1-,C2+,C2-	VR Term.
L	*	○	○	○	-		
H	L	×	○	○	V_{OUT}	OPEN	
H	H	×	×	○	V_5, V_{OUT}	OPEN	OPEN

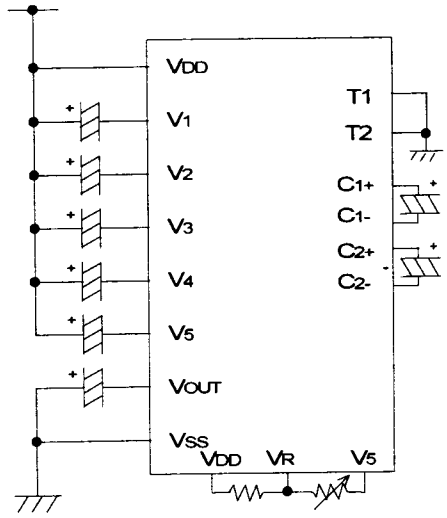
When (T_1, T_2)=(H, L), $C1^+$,$C1^-$ $C2^+$,$C2^-$ terminals for step up circuits are open because the step up circuits doesn't operate.Therefore LCD driving voltage to the V_{OUT} terminal should be supplied from outside. When(T_1, T_2)=(H, H), terminals for step up circuits and VR are open, because the step up circuits and Voltage adjust circuits do not operate.

○ Power Supply applications

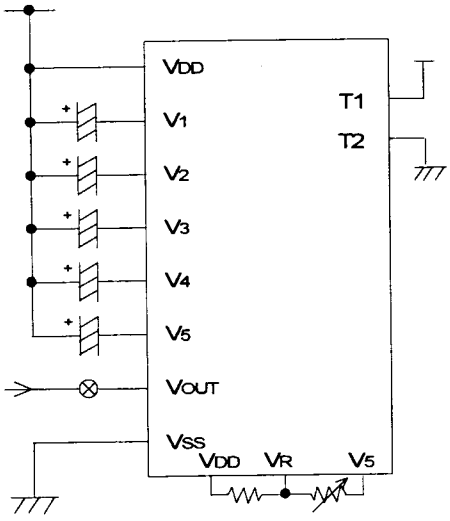
(1) External power supply operation.



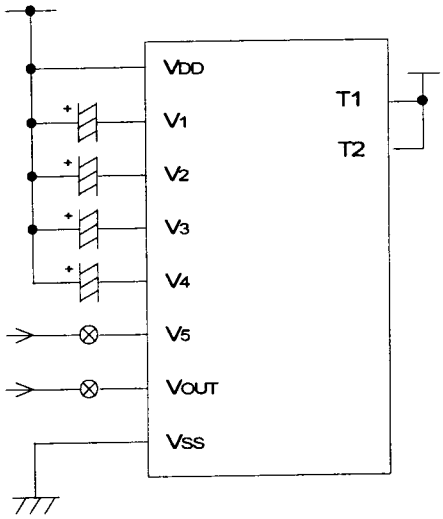
(2)Internal power supply operation.
(Voltage Booster, Voltage Adj., Buffer(V/F))
Internal power supply ON (instruction) (T1,T2)=(L,L)



(3)External power supply operation with
Voltage Adjustment, Buffer(V/F)
Internal power supply ON (Instruction) (T1,T2) = (H,L)



(4)External power supply operation adjusted
Voltage to V5.
Internal power supply ON (Instruction) (T1,T2) =(H,H)



* ⊗ : These switches should be open during the power save mode.

(2) Instruction

The NJU6575A distinguishes the signal on the data bus by combination of A0, $\overline{RD}$ and $\overline{WR}$. The decode of the instruction and execution performs only depend on the internal timing only neither the external clock. In case of serial interface, the data input as MSB first serially.

The Table. 4 shows the instruction codes of the NJU6575A.

Table 4. Instruction Code

	Instruction	Code A0	$\overline{RD}$	$\overline{WR}$	D_7	D_6	D_5	D_4	D_3	D_2	D_1	D_0	Description
(1)	Display ON/OFF	0	1	0	1	0	1	0	1	1	1	0 1	LCD Display ON/OFF 0:OFF 1:ON
(2)	Page Address Set	0	1	0	1	0	1	1	*	Page Address			Set the page of DD RAM to the Page Add. Register
(3)	Column Address Set High Order 4bit	0	1	0	0	0	0	1	High Order Column Add.				Set the Higher order 4 bits Column Address to the Reg.
(4)	Column Address Set Lower Order 4bit	0	1	0	0	0	0	0	Lower order Column Add.				Set the Lower order 4 bits Column Address to the Reg.
(5)	Status Read	0	0	1	Status				0	0	0	0	Read out the internal Status
(6)	Write Display Data	1	1	0	Write Data								Write the data into the Display Data RAM
(7)	Read Display Data	1	0	1	Read Data								Read the Data from the Display Data RAM
(8)	ADC Select	0	1	0	1	0	1	0	0	0	0	0 1	Set the DD RAM vs Segment 0:Normal 1:Inverse
(9)	Normal or Inverse of On/Off Set	0	1	0	1	0	1	0	0	1	1	0 1	Inverse the On and Off Display 0:Normal 1:Inverse
(10)	Whole Display On /Normal Display	0	1	0	1	0	1	0	0	1	0	0 1	Whole Display Turns On 0:Normal 1:Whole Disp. On
(11)	Icon Display	0	1	0	1	0	1	0	1	0	1	0 1	Set the Duty Ratio 0:No Icon 1:With Icon
(12)	Read Modify Write	0	1	0	1	1	1	0	0	0	0	0	Increment the Column Add. Register when writing but no-change when reading
(13)	End	0	1	0	1	1	1	0	1	1	1	0	Release from the Read Modify Write Mode
(14)	Reset	0	1	0	1	1	1	0	0	0	1	0	Initialize the internal Circuits
(15)	Output Assignment Register Set	0	1	0	1	1	0	0	A_3	*	*	*	Set the scanning order of common drivers to the Register
(16)	Internal Power Supply On/Off	0	1	0	0	0	1	0	0	1	0	0 1	0:Int. Power Supply Off 1:Int. Power Supply On
(17)	LCD Driving Voltage Set	0	1	0	1	1	1	0	1	1	0	1	Set LCD Driving Voltage after the internal(external) power supply is turned on
(18)	EVR Register Set	0	1	0	1	0	0	0	Setting Data				Set the V_5 output level to the EVR register
(19)	Power Save (Dual Command)	0 0	1 1	0 0	1 1	0 0	1 1	0 0	1 0	1 1	1 0	0 1	Set the Power save Mode

(*:Don't Care)

(3) Explanation of Instruction Code

(a) Display On/Off

This instruction executes whole display On/Off no relation with the data in the Display Data RAM and internal conditions.

A0	$\overline{RD}$	R/$\overline{W}$	D_7							D_0
0	1	0	1	0	1	0	1	1	1	D

D 0: Display Off
1: Display On

(b) Page Address Set

When MPU accesses the Display Data RAM, the page address must be selected before the data writing. The access to the Display Data RAM is available by the page and column address set(Refer the Fig. 1.). The page address change does not influence with the display. Page 4 is a Icon display data area which available only for the D_0.

A0	$\overline{RD}$	R/$\overline{W}$	D_7							D_0
0	1	0	1	0	1	1	*	A_2	A_1	A_0

(*:Don't Care)

A_2	A_1	A_0	Page
0	0	0	0
0	0	1	1
0	1	0	2
0	1	1	3
1	0	0	4

(c) Column Address

When MPU accesses the Display Data RAM, the page address (refer(b)) and column address set are required before the data writing. The column address set requires twice address set which are higher order 4 bits address set and lower order 4 bits. When the MPU accesses the Display Data RAM sequentially, the column address is increase one by one automatically, therefore, the MPU can access only the data sequentially without address set.

After writing 1page data ,page address setting is required due to page address doesn't increase automatically the increment of the column address is stopped at the address of $(A0)_H$ automatically, and the page address is not changed even if the column address increase to $(A0)_H$ and stop. In this time the page address is not changed.

	A0	$\overline{RD}$	R/$\overline{W}$	D_7							D_0
Higher Order	0	1	0	0	0	0	1	A7	A6	A5	A4
Lower Order	0	1	0	0	0	0	0	A3	A2	A1	A0

A7	A6	A5	A4	A3	A2	A1	A0	Column Address
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	1	1
				.				.
				.				.
1	0	1	0	0	0	0	0	A0

(d) Status Read

This instruction reads out the internal status of "BUSY", "ADC", "ON/OFF" and "RESET".

A0	$\overline{RD}$	R/$\overline{W}$	D_7							D_0
0	0	1	BUSY	ADC	ON/OFF	RESET	0	0	0	0

BUSY : BUSY=1 indicate the operating or the Reset cycle.
The instruction can be input after the BUSY status change to "0".

ADC : Indicate the output correspondence of column(segment) address and segment driver.
0 :Counterclockwise Output(Inverse) Column Address 133-n ⟷ Segment Driver n
1 :Clockwise Output (Normal) Column Address n ⟷ Segment Driver n
(Note) The data "0=Inverse" and "1=Normal" of ADC is inverted with the ADC select Instruction of "1=Inverse" and "0=Normal".

ON/OFF : Indicate the whole display On/Off status.
0 : Whole Display "On"
1 : Whole Display "Off"
(Note) The data "0=On" and "1=Off" of Display On/Off status read out is inverted with the Display On/Off instruction data of "1=On" and "0=Off".

RESET : Indicate the initializing by $\overline{RES}$ signal or reset instruction.
0 : —
1 : Initialization Period

(e) Write Display Data

This instruction writes the 8-bit data on the data bus into the Display Data RAM. The column address increases "1" automatically after data writing, therefore, the MPU can write the 8-bit data into the Display Data RAM continuously without any address setting after the start address setting.

A0	$\overline{RD}$	R/$\overline{WR}$	D_7 ——— D_0
1	1	0	WRITE DATA

(f) Read Display Data

This instruction reads out the 8-bit data from Display Data RAM addressed by the column and page address. The column address increase "1" automatically after data reading out, therefore, the MPU can read out the 8-bit data from the Display Data RAM without any address setting after the start address setting. One time of dummy read must operate after column address set as the explanation in "(5-5) Access to the Display Data RAM and Internal Register". In the serial interface mode, the display data is not read out.

A0	$\overline{RD}$	R/$\overline{WR}$	D_7 ——— D_0
1	0	1	READ DATA

(g) ADC Select

This instruction set the correspondence of column address in the Display Data RAM and segment driver output. (See Fig. 1.) By this instruction, the order of segment output can be changed by the software, and no restriction of the LSI placement against the LCD panel.

A0	$\overline{RD}$	R/$\overline{WR}$	D_7						D_0
0	1	0	1	0	1	0	0	0	0	D

D 0: Clockwise Output (Normal)
1: Counterclockwise Output (Inverse)

(h) Normal or Inverse On/Off Set

This instruction changes the condition of display turn on and off as normal or inverse. The contents of Display Data RAM is not changed by this instruction execution.

A0	$\overline{RD}$	R/$\overline{WR}$	D_7						D_0
0	1	0	1	0	1	0	0	1	1	D

D 0: Normal RAM data "1" correspond to "On"
1: Inverse RAM data "0" correspond to "On"

(i) Whole Display On

This instruction turns on the all pixels independent of the contents of the Display Data RAM. In this time, the contents of Display Data RAM is not changed and kept. This instruction takes precedence over the "Normal or Inverse On/Off Set Instruction".

A0	$\overline{RD}$	R/$\overline{WR}$	D_7						D_0
0	1	0	1	0	1	0	0	1	0	D

D 0: Normal Display
1: Whole Display turns on

When Whole Display On Instruction is executed in the Display Off status, the internal circuits go to the power save mode(refer to the (s) Power Save) .

(j) Icon Display

This instruction set the 1/33 duty for the Icon Display. The COMI terminal operate as COM $_{32}$ and output the icon display data stored in D $_0$ of Display Data RAM page 4 (refer to the Fig. 1).

A0	$\overline{RD}$	R/$\overline{W}$	D $_7$						D $_0$
0	1	0	1	0	1	0	1	0	1	D

D 0: 1/32 Duty
1: 1/33 Duty

(k) Read Modify Write

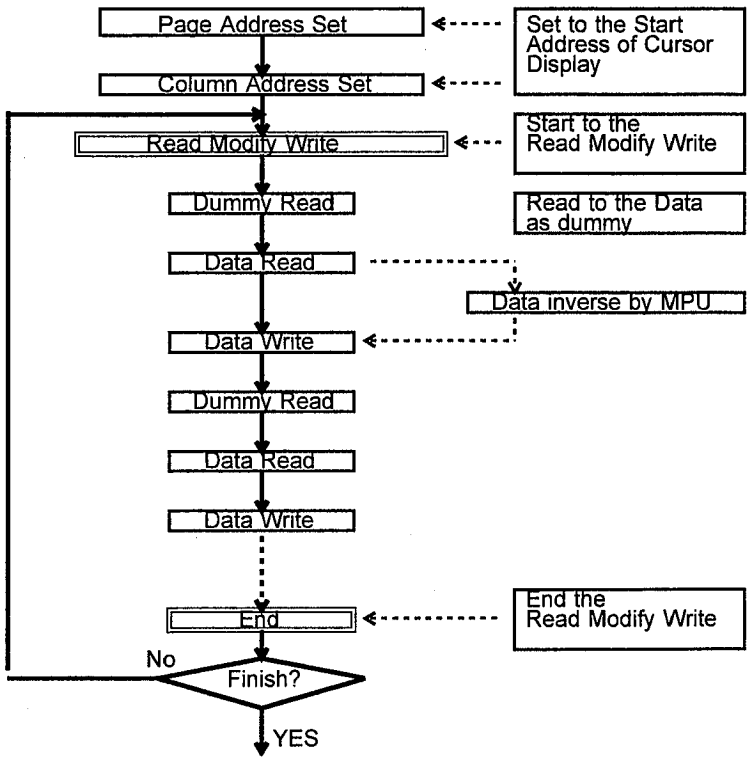
This instruction sets the Read Modify Write Mode for the column address increment control. In mode of the Read Modify, Write the column address increases "1" automatically when the Display Data Write Instruction is executed, but the address does not change when the Display Data Read Instruction is executed. This status is continued until End instruction execution. When the End instruction is input, the column address goes back to the start address before the Read Modify Write instruction input. This function reduces the load of MPU for repeating the display data change in the fixed area(ex. cursor blink).

the read modify write mode setting.

A0	$\overline{RD}$	R/$\overline{W}$	D $_7$						D $_0$
0	1	0	1	1	1	0	0	0	0	0

Note) In mode of the Read Modify Write mode, any instructions except for Column Address Set can be execute.

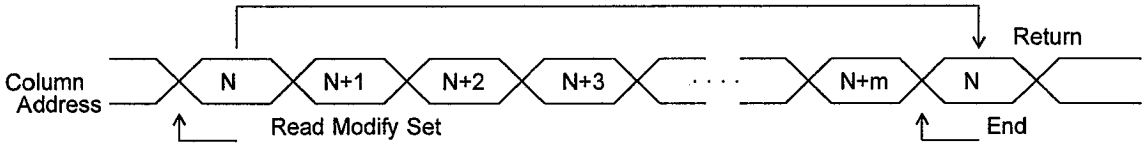
(l)Sequence of cursor blink display



(m) End

This instruction release the Read Modify Write mode and the column address back to the address where the read modify write mode setting.

A0	$\overline{RD}$	R/$\overline{W}$	D_7							D_0
0	1	0	1	1	1	0	1	1	1	0



(n) Reset

This instruction executes the following initialization.

Initialization

① Set the Address $(00)_H$ into the Column Address Counter.
② Set the page "0" into the Page Address Register.
③ Select the D3 of the Output Assignment Register to "0".
④ Set 0 to the EVR Register to $(00)_H$.

In this time, the Display Data RAM is not influenced.

A0	$\overline{RD}$	R/$\overline{W}$	D_7							D_0
0	1	0	1	1	1	0	0	0	1	0

The reset signal input to the $\overline{RES}$ terminal (hardware reset) must be input for the power on initialization. Reset instruction does not perform completely in stead of hardware reset using the $\overline{RES}$ terminal.

(o) Output Assignment Register

This instruction sets the common driver scanning order .

A0	$\overline{RD}$	R/$\overline{W}$	D_7							D_0
0	1	0	1	1	0	0	A3	*	*	*

(*:Don't Care)

A3: Set the scanning order .(Refer to 1-6)

(p) Internal Power Supply

This instruction set the condition 0f internal Power Supply On/Off. Voltage Booster circuits, Voltage Regulator and Voltage Follower operate at On. To operate the voltage booster circuits, the oscillation circuits must be operating.

A0	$\overline{RD}$	R/$\overline{W}$	D_7							D_0
0	1	0	0	0	1	0	0	1	0	D

D 0: Internal Power Supply Off
1: Internal Power Supply On

The internal Power Supply must be Off when external power supply using.

(q)LCD Driving Voltage Set

This instruction controls LCD driving waveform output through the COM/SEG terminals.

A0	$\overline{RD}$	R/$\overline{W}$	D_7							D_0
0	1	0	1	1	1	0	1	1	0	1

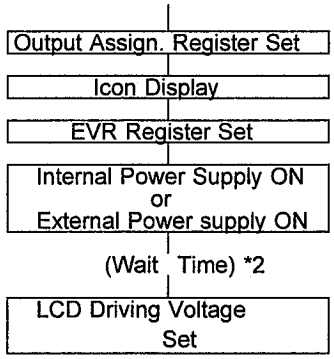
NJU6575A contains low power LCD driving voltage generator circuit reducing own operation current. Therefore, it requires the following sequence procedures at power on for the power source stabilized operation.

● LCD driving power supply ON/OFF sequences

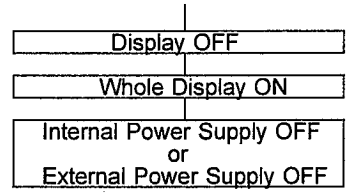
The following sequences are required when the power supply is tuned on/of.

When the power supply is tuned on again after the turn off (by the power save instruction), the power save release sequence (s) ((3-21)Power Save)is required.

Turn ON sequence

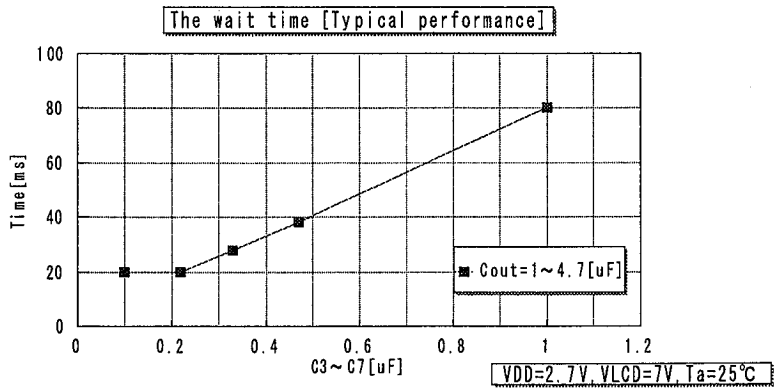


Turn OFF sequence



*1 This instruction is required in both cases of the internal and external power supply.
Until "LCD driving voltage Set" execution, NJU6575A operating current is higher than usual state and all COM/SEG terminals output V_{DD} level continuously.

*2 The wait time depends on the C_3 to C_7, C_{OUT} capacitors(refer(4) (d)Fig.4), V_{DD} and V_{LCD} voltage. Therefore it requires the actual evaluation using the LCD module to get the correct time. (Refer to the following graph.)



(r) EVR Register Set

This instruction controls voltage adjustment circuits of internal LCD power supply and changes LCD driving voltage "V_5". Finally, it adjusts the contrast of LCD display. By setting a data into EVR register. V5 output voltage selects one condition out of 16-voltage conditions. The range of V_5 voltage is adjusted by setting external resistors as mentioned in "(4) (b) Voltage Adjust Circuits".

A0	$\overline{RD}$	R/$\overline{W}$	D_7							D_0
0	1	0	1	0	0	0	A3	A2	A1	A0

A3	A2	A1	A0	V_{LCD}
0	0	0	0	Low
		:		:
		:		:
1	1	1	1	High

$V_{LCD}=V_{DD}-V_5$

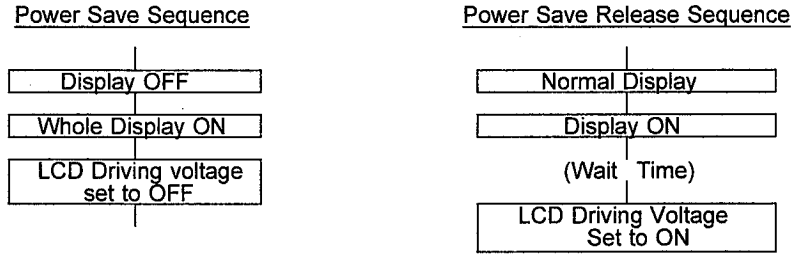
When EVR doesn't use, set the EVR register to (0,0,0,0).

(s) Power Save(Dual Command)

When both of Display Off and Whole Display On are executed, the internal circuits go to the power save mode and the operating current is reduced as same as the stand by current.
The internal status in the Power Save Mode is shown in follows;

① Stop the Oscillation Circuits and Internal Power Supply Circuits operation.
② Stop the LCD driving. Segment and Common drivers output V_{DD} level.
③ Keep the display data and operating mode just before the power save mode.
④ All of LCD driving bias voltage fix to the V_{DD} level.

The power save and its release perform according to the following sequences.



*1 In the power save sequence, the power save mode is started after the second instruction "whole Display ON".

*2 In the power save release sequence, the power save mode is released after the Normal Display instruction (Whole display OFF).
The instruction of display ON is input at any timing after the instruction of normal display in power save release sequence.

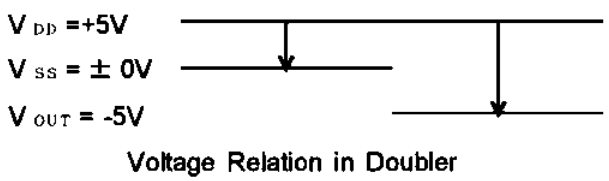
*3 Until "LCD driving voltage set to ON" execution, NJU6575A operating current is higher than usual state and all COM/SEG terminals output V_{DD} level continuously.

*4 In case of external power supply for LCD driving, it should be turned off and made condition like as disconnection or connected to V_{DD} before the power save mode or at the same time. In this time, V_{OUT} terminal should be made condition like as disconnection or connect to the lowest voltage of the system(V_5 level from the external power supply).

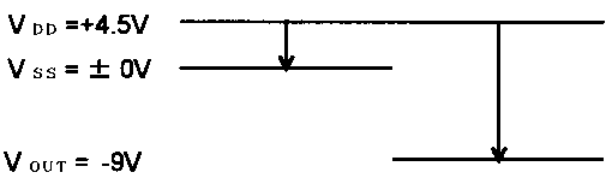
(4) Internal Power Supply

(a) Voltage tripler

Three times negative voltage(V_{DD} common) of the voltage V_{DD}-V_{SS} is output from V_{OUT} terminal when connecting three capacitor between $C1^+$ and $C1^-$, $C2^+$ and $C2^-$, V_{SS} and V_{OUT}. In case of the voltage doubler operation, connecting the two capacitors between $C2^+$ and $C2^-$, V_{SS} and V_{OUT}, then connect the $C1^+$ and $C2^+$ terminals. Step up circuits like as Voltage Tripler or Doubler using a oscillation circuits output as its clock signal, therefore, the oscillation circuits operation is required when step up operation. The voltage relation regarding the step up circuits is shown in below. When voltage tripler operation, the operation voltage V_{DD} should be less than 4.5V.



Voltage Relation in Doubler



Voltage relation in Tripler

(b) Voltage Adjust Circuits

The step up voltage of V_{OUT} output from V_5 through the voltage adjust circuits for LCD driving. The output voltage of V_5 is adjusted by changing the Ra and Rb within the range of $|V_5| < |V_{OUT}|$. The output voltage is calculated by the following formula.

$$V_{LCD} = V_{DD} - V_5 = (1+Rb/Ra)\cdot V_{REG} \cdots\cdots ①$$

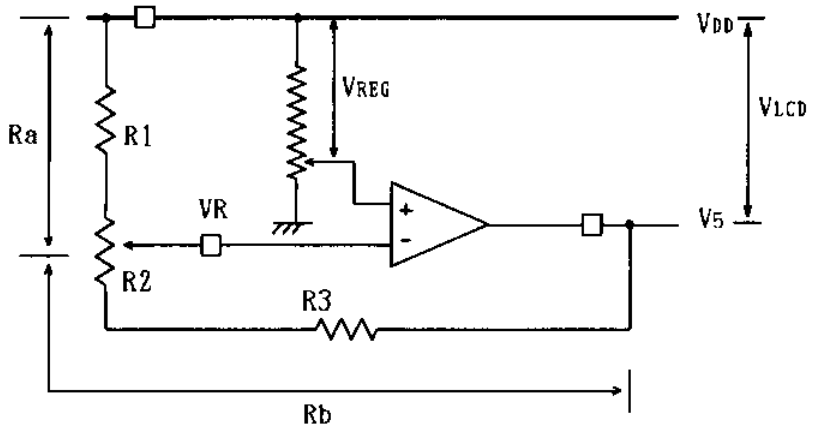


Fig. 3

The voltage of V_{REG} is a standard voltage produced from built-in bleeder resistance. And V_{REG} is possible to be fine-adjusted by EVR functions mentioned in (c).

For fine-adjustment of V_5, R2 as variable resistor, R1 and R3 as fixed constant should be connected to V_{DD} terminal, VR and V_5 as shown in Fig. 3.

[Design example for R1, R2 and R3 / Reference]

- R1+R2+R3=5M Ω (Determined by the current flown between V_{DD}-V_5)
- Variable voltage range by the R2. -3V ~ -4.5V (V_{LCD} =V_{DD} -V_5 → 6.0V ~ 7.5V)
  (Determined by the LCD electrical characteristics)
- $-V_{REG}$ =3V(In case of EVR=(0F)$_H$)
- R1, R2 and R3 are calculated by above conditions and the formula of ① to mentioned below;
  R1=2.0M Ω , R2=0.5M Ω , R3=2.5M Ω

* If the power supply voltage between V_{DD} and V_{SS} changes, V5 changes too. Therefore the power supply voltage should be stabilized for V5 stable operation.

(c) Contrast Adjustment by using the EVR function

The EVR controls voltage of V_{REG} by instruction and changes voltage of V_5.
As result, LCD display contrast is adjusted by V_5. The EVR selects a voltage of V_{REG} in the following 16 conditions by setting 4bits data in to the EVR register.
In case of EVR operation, T_1 terminal and T_2 require to set couples of value as (L,L),(L,H) and (H,L) excepting for (H,H) and the internal power supply must turn on by instruction.

EVR register		V_{REG}[V]	V_{LCD}
(00)$_H$	(0, 0, 0, 0)	(135/150)·(V_{DD} -V_{SS})	Low
(01)$_H$	(0, 0, 0, 1)	(136/150)·(V_{DD} -V_{SS})	
(02)$_H$	(0, 0, 1, 0)	(137/150)·(V_{DD} -V_{SS})	
⋮	⋮	⋮	⋮
(0D)$_H$	(1, 1, 0, 1)	(148/150)·(V_{DD} -V_{SS})	
(0E)$_H$	(1, 1, 1, 0)	(149/150)·(V_{DD} -V_{SS})	
(0F)$_H$	(1, 1, 1, 1)	(150/150)·(V_{DD} -V_{SS})	High

● Adjustable range of the LCD driving voltage by EVR function using

The adjustable range is decided by the power supply voltage V_{DD} and the ratio of external resistors Ra and Rb.

[Design example for the adjustable range / Reference]

- Condition V_{DD} =3.0V, V_{SS} =0V
  Ra=1M Ω , Rb=1M Ω (Ra:Rb=1:1)

The adjustable range and the step voltage are calculated as follows in the above condition.

In case of setting (00)$_H$ in the EVR register,

V_{LCD} = ((Ra+Rb)/Ra)·V_{REG}
= (2/1)·[(135/150)·3.0]
= 5.4V

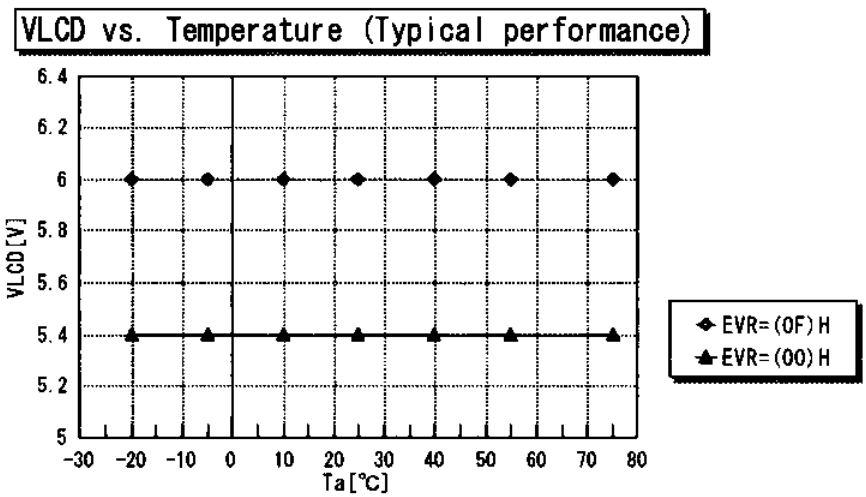
In case of setting (0F)$_H$ in the EVR register,

V_{LCD} = ((Ra+Rb)/Ra)·V_{REG}
= (2/1)·[(150/150)·3.0]
= 6.0V

	Min. (00)$_H$	Max. (0F)$_H$	
Adjustable Range	5.4 <----------	---------->6.0	[V]
Step Voltage	40		[mV]

*) The V_{LCD} operating temperature. Please refer to the following graphs.

(condition) V_{DD} = 3V
Ra=1M Ω , Rb=1M Ω (Ra:Rb = 1:1)
Voltage tripler

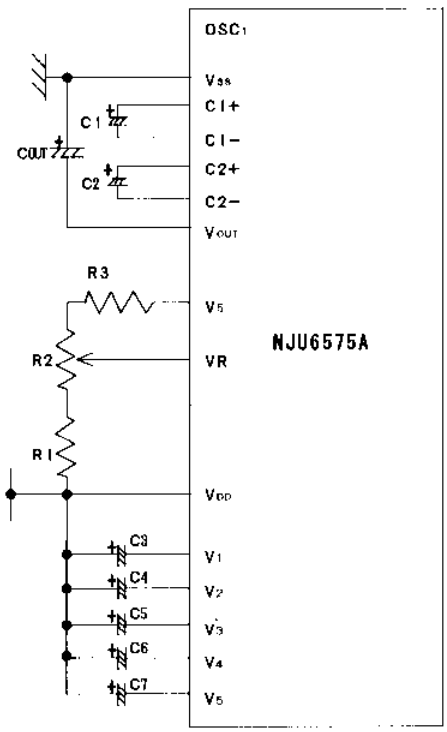


(d) LCD Driving Voltage Generation Circuits

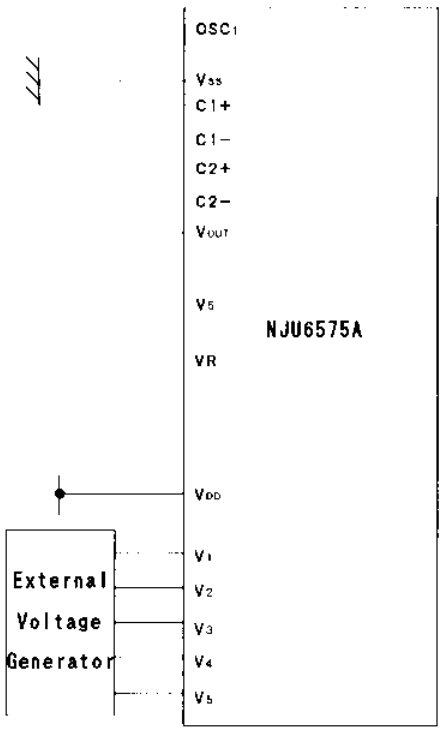
The LCD driving bias voltage of V_1, V_2, V_3, V_4 are generated internally by dividing the V_5 voltage with the internal bleeder resistance. And it is supplied to the LCD driving circuits after the impedance conversion with voltage follower circuit.

As shown in Fig. 4, Five capacitors are required to connect to each LCD driving voltage terminal for voltage stabilizing. And the value of capacitors C3, C4, C5, C6 and C7 determined depending on the actual LCD panel display evaluation.

Using the internal Power Supply



Using the external Power Supply



Reference set up value

VLCD = VDD-V5 ≒6 ~7.5V

Item	Value
C_{OUT}	4.7~10μF
C1,C2	4.7~10μF
C3 to C7	0.1~0.47μF
R1	2.0MΩ
R2	0.5MΩ
R3	2.5MΩ

Fig. 4

*1 Short wiring or sealed wiring to the VR terminal is required due to the high impedance of VR terminal.

*2 Following connection of VOUT is required when external power supply using.

When $V_{SS} > V_5$ -- $V_{OUT} = V_5$

When $V_{SS} \leqq V_5$ -- $V_{OUT} = V_{SS}$

(5) MPU Interface

(5-1) Interface type selection

NJU6575A interfaces with MPU by 8-bit bi-directional data bus (D_7 to D_0) or serial interface (SI). The 8 bit parallel or serial interface is determined by a condition of the P/S terminal connecting to "H" or "L" level as shown in Table 5. In case of the serial interface, status and RAM data read out operation is impossible.

Table 5

P/S	Type	$\overline{CS}$	A0	$\overline{RD}$	$\overline{WR}$	C86	SI	SCL	D_0~ D_7
H	Parallel	$\overline{CS}$	A0	$\overline{RD}$	$\overline{WR}$	C86	-	-	D_0~ D_7
L	Serial	$\overline{CS}$	A0	-	-	-	SI	SCL	OPEN

(5-2) Parallel Interface

The NJU6575A interfaces to 68 or 80 type MPU directly when the parallel interface (P/S="H") is selected. 68 type MPU or 80 is determined by the condition of C86 terminal connecting to "H" or "L" as shown in table 6.

Table 6

C86	Type	$\overline{CS}$	A0	$\overline{RD}$	$\overline{WR}$	D_0~ D_7
H	68 type MPU	$\overline{CS}$	A0	E	R/W	D_0~ D_7
L	80 type MPU	$\overline{CS}$	A0	$\overline{RD}$	$\overline{WR}$	D_0~ D_7

(5-3) Discrimination of Data Bus Signal

The NJU6575A discriminates the mean of signal on the data bus by the combination of A0, E, R/W, and (RD,WR) signals as shown in Table 7.

Table 7

Common	68 type	80 type		Function
A0	R/W	$\overline{RD}$	$\overline{WR}$	
1	1	0	1	Read Display Data
1	0	1	0	Write Display Data
0	1	0	1	Status Read
0	0	1	0	Write into the Register(Instruction)

(5–4) Serial Interface.(P/S="L")

Serial interface circuits consist of 8 bits shift register and 3 bits counter. SI and SCL input are activated when the chip select terminal $\overline{CS}$ set to "L" and P/S terminal set to "L". The 8 bits shift register and 3 bits counter are reset to the initial condition when chip is not selected. The data input from SI terminal is MSB first like as the order of D_7,D_6,····D_0. and the data are entered into the shift register synchronizing with the rise edge of the serial clock SCL. The data in the shift register are converted to parallel data at the 8th serial clock rise edge input. Discrimination of the display data or instruction of the serial input data is executed by the condition of A0 at the 8th serial clock rise edge. A0="H" is display data and A0="L" is instruction. When $\overline{RES}$ terminal becomes "L" or $\overline{CS}$ terminal becomes "H" before 8th serial clock rise edge, NJU6575A recognizes them as a instruction data incorrectly. Therefore a unit of serial data must be structured by 8-bits. The time chart for the serial interface is shown in Fig. 5. To avoid the noise trouble, the short wiring is required for the SCL input.

Note) The read out function, such as the status or RAM data read out, is not supported in this serial interface .

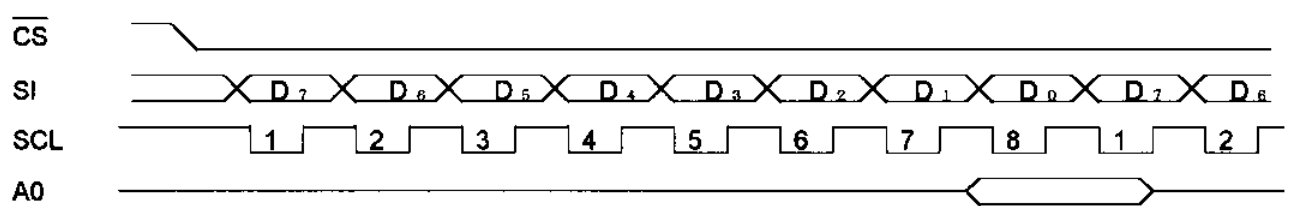


Fig. 5

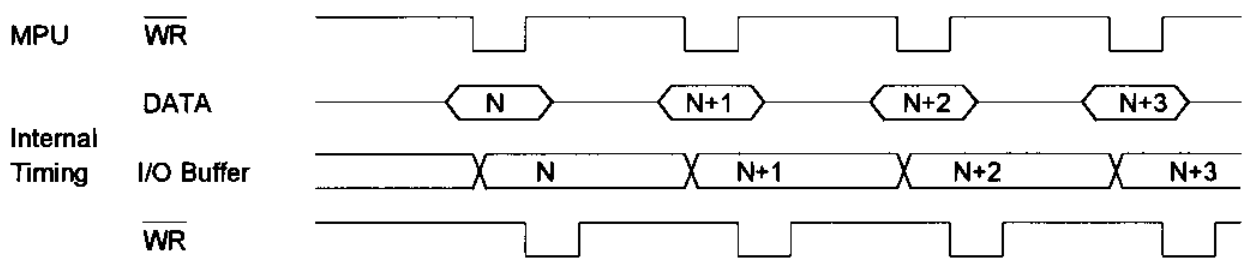
(5－5) Access to the Display Data RAM and Internal Register.

The NJU6575A is operating as one of pipe-line processor by the bus-holder connecting to the internal data bus to adjust the operation frequency between MPU and the Display Data RAM or Internal Register. For example, when the MPU reads out the data from the Display Data RAM, the read out data in the data read cycle(dummy read) is held in the bus-holder, then it is read out from the bus-holder to the system bus at the next data read cycle. When writes the data into the Display Data RAM, the data is held in the bus-holder, then it is written into the Display Data RAM by the next data write cycle.

Therefore high speed data transmission between MPU and NJU6575A is available because of it is not limited by the t_{ACC} and t_{DS} as display data RAM access time and limited by the system cycle time (R) or (W). If the cycle time is not be kept in the MPU operation, NOP should be inserted to the system instead of the waiting operation.

The read out operation does not read the data in the pointed address just after the address set operation, and second read out operation can read out the data correctly from the pointed address. Therefore, one dummy read is required after address setting or write cycle as shown in Fig. 6.

● Write Operation



● Read Operation

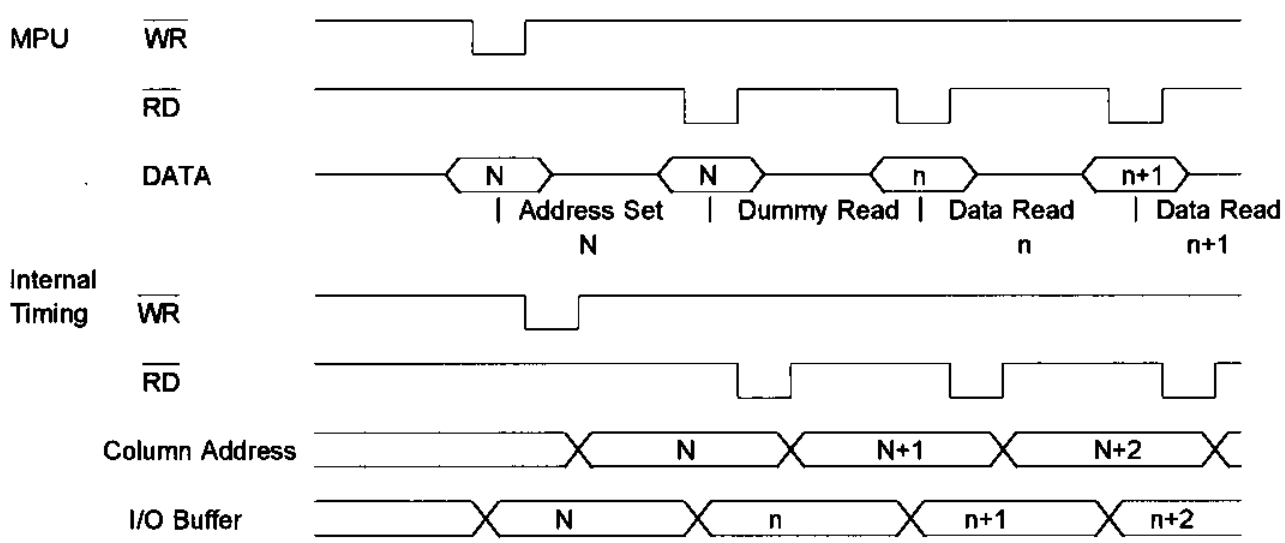


Fig.6

(5-6) Chip Select

CS is Chip Select terminal. In case of $\overline{CS}$="L", the interface with MPU is available. In case of $\overline{CS}$="H", the D_0 to D_7 are high impedance and A0, $\overline{RD}$, $\overline{WR}$, SI and SCL inputs are ignored. If the serial interface is selected when $\overline{CS}$="H", the shift register and counter are reset. However, the reset is always operated in any conditions of $\overline{CS}$.

■ ABSOLUTE MAXIMUM RATINGS (Ta=25°C)

PARAMETER	SYMBOL	RATINGS	UNIT
Supply Voltage (1)	V_{DD}	− 0.3 ～ + 7.0 − 0.3 ～ + 4.5 (used Tripler)	V
Supply Voltage (2)	V_5	V_{DD}−13.5 ～ V_{DD}+0.3	V
Supply Voltage (3)	V_1～V_4	V_5 ～ V_{DD}+0.3	V
Input Voltage	V_{IN}	− 0.3 ～ V_{DD}+0.3	V
Operating Temperature	Topr	− 30 ～ + 80	°C
Storage Temperature	Tstg	− 55 ～ + 125 (Chip) − 55 ～ + 100 (TCP)	°C

Note 1) If the LSI are used on condition above the absolute maximum ratings, the LSI may be destroyed. Using the LSI within electrical characteristics is strongly recommended for normal operation. Use beyond the electric characteristics conditions will cause malfunction and poor reliability.

Note 2) All voltage values are specified as V_{SS} = 0 V.

Note 3) The relation : $V_{DD} \geqq V_1 \geqq V_2 \geqq V_3 \geqq V_4 \geqq V_5$; $V_{DD} > V_{SS} \geqq V_{OUT}$ must be maintained.

Note 4) Decoupling capacitor should be connected between V_{DD} and V_{SS} due to the stabilized operation for the voltage converter.

■ ELECTRICAL CHARACTERISTICS (1) (V_{DD}=5V±10%, V_{SS}=0V, Ta=−20～+75°C)

PARAMETER		SYMBOL	CONDITIONS		MIN	TYP	MAX	UNIT	Note
Operating Voltage (1)	Recommend	V_{DD}			4.5	5.0	5.5	V	5
	Available				2.4		5.5		
Operating Voltage (2)	Recommend	V_5			V_{DD}−13.5		V_{DD}−3.5	V	
	Available				V_{DD}−13.5				
	Available	V_1, V_2	V_{LCD}=V_{DD}−V_5		V_{DD}−0.6xV_{LCD}		V_{DD}		
	Available	V_3, V_4			V_5		V_{DD}−0.4xV_{LCD}		
Input Voltage	1	V_{IHC1}	D0, D1...D7, A0, $\overline{CS}$, $\overline{RES}$, $\overline{RD}$, $\overline{WR}$, C86, SI, SCL, P/$\overline{L}$ Terminals		0.7xV_{DD}		V_{DD}	V	
		V_{IHC2}		V_{DD}=2.7V	0.8xV_{DD}		V_{DD}		
	2	V_{ILC1}			V_{SS}		0.3xV_{DD}		
		V_{ILC2}		V_{DD}=2.7V	V_{SS}		0.2xV_{DD}		
Output Voltage	1	V_{OHC11}	D0, D1...D7, Terminals	I_{OH}=−1mA	0.8xV_{DD}		V_{DD}	V	
		V_{OHC12}		I_{OH}=−0.5mA V_{DD}=2.7V	0.8xV_{DD}		V_{DD}		
	2	V_{OLC11}	D0, D1...D7, Terminals	I_{OL}= 1mA	V_{SS}		0.2xV_{DD}		
		V_{OLC12}		I_{OL}= 0.5mA V_{DD}=2.7V	V_{SS}		0.2xV_{DD}		
Input Leakage Current		I_{LI}	All input terminals		−1.0		1.0	uA	
		I_{LO}	All I/O term. (D0...D7)		−3.0		3.0		6
Driver On-resistance		R_{ON1}	Ta=25°C	V_{LCD}=13.5V		2.0	3.0	kΩ	7
		R_{ON2}		V_{LCD}=8.0V		3.0	4.5		
Stand-by Current		I_{DDQ}	during Power save Mode			0.05	5.0	uA	8
Operating Current		I_{DD12}	Display			28	45	uA	
		I_{DD14}	V_{LCD}=8.0V	V_{DD}=2.7V		16	25		
		I_{DD21}	Accessing			350	500	uA	9
		I_{DD22}	fcyc=200kHz	V_{DD}=2.7V		170	240		

■ ELECTRICAL CHARACTERISTICS (2)

PARAMETER		SYMBOL	CONDITIONS		MIN	TYP	MAX	UNIT	Note
Input Terminal Capacitance		C_{IN}	A0, $\overline{CS}$, $\overline{RES}$, $\overline{RD}$, $\overline{WR}$, C86, SI, SCL, P/S, T1, T2, D0...D7 Ta=25°C			10		pF	
Oscillation Frequency		fosc	Ta=25°C	V_{DD}=5.0V	9	11	13	kHz	
				V_{DD}=2.7V	8	9.75	11.5		
Voltage Tripler	Input Voltage	V_{DD1}	V_{DD}-V_{SS}		2.4		5.5	V	
		V_{DD2}	V_{DD}-V_{SS}, used Tripler		2.4		4.5		10
	Output Volt.	V_{OUT}	V_{SS}-V_{LCD}, used Tripler		-9.0			V	
	On -resistance	R_{TRI}	V_{DD}=3V; C=4.7uF used Tripler			600	1000	Ω	
	Adjustment range of LCD Driving Volt	V_{OUT}	Tripler Circuit "OFF"		V_{DD}-13.5		V_{DD}-5.0	V	11
	Voltage Follower	V_5	Voltage Adjustment Circuit "OFF"		V_{DD}-13.5		V_{DD}-5.0	V	
	Operating Current	I_{OUT1}	V_{DD}=4.5V, V_{LCD}=8V COM/SEG Terminals Open No Access Display Checkered pattern			58	120	uA	12
		I_{OUT2}				22	45		
		I_{OUT3}				21	43		
	Voltage Reg.	V_{REG}	V_{DD}=3.0V, Ta=25°C				3	%	13

Note 5) NJU6575A can operate wide operating range, but it is not guarantee immediate voltage changing during the accessing of the MPU.

Note 6) Apply to the High-impedance state of the D_0 to D_7 terminals.

Note 7) R_{ON} is the resistance values between power supply terminals(V_1,V_2,V_3,V_4) and each output terminals of common and segment supplied by 0.1V. This is specified within the range of supply voltage (2).

Note 8,9,12)Apply to current after "LCD Driving Voltage Set".

Note 8) Apply to the external display clock operation in no access from the MPU and no use internal power supply circuits.

Note 9) Apply to the condition of cyclic (tcyc) inverted data input continuously in no use internal power supply circuits. The operating current during the accessing is proportionate to the access frequency. In the no accessing period, it is as same as I_{DD1X}.

Note 10) Supply voltage (V_{DD}) range for internal Voltage Tripler operation.

Note 11) LCD driving voltage V_5 can be adjusted within the voltage follower operating range.

Note 12) Each operating current of voltage supply circuits block is specified under below table conditions.

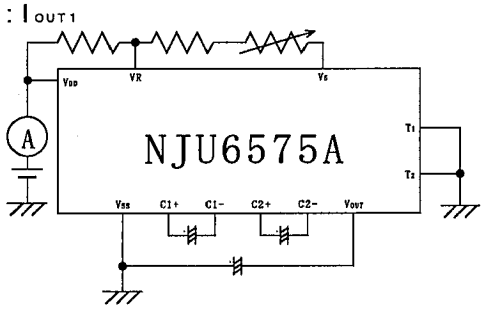
SYMBOL	Status		Operating Condition				External Voltage Supply (Input Terminal)
	T_1	T_2	Internal Oscillator	Voltage Tripler	Voltage Adjustment	Voltage Follower	
I_{OUT1}	L	*	Validity	Validity	Validity	Validity	Unuse
I_{OUT2}	H	L	Validity	Invalidity	Validity	Validity	Use(V_{OUT})
I_{OUT3}	H	H	Validity	Invalidity	Invalidity	Validity	Use(V_{OUT}, V_5)

* = Don't Care

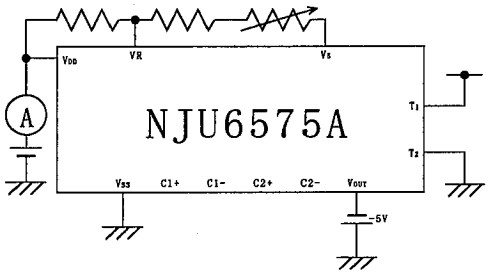
Note 13) Apply to the precision of the voltage between V_{DD} and V_5 with EVR function.

MEASUREMENT BLOCK DIAGRAM

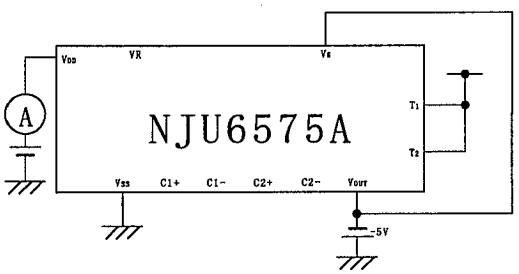
: I_{OUT1}



: I_{OUT2}



: I_{OUT3}



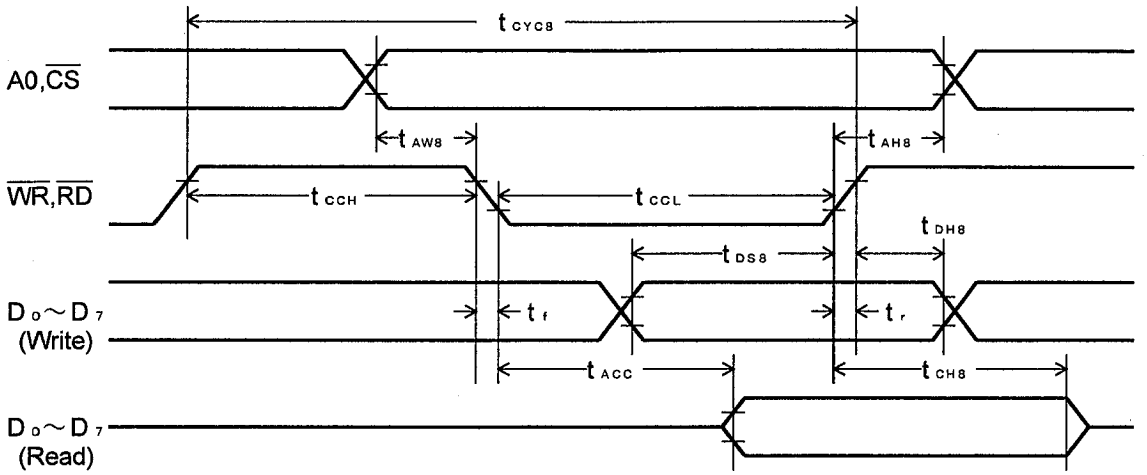
■ ELECTRICAL CHARACTERISTICS (3)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNIT	Note
Reset time	t_R	$\overline{RES}$ Terminal	1.0			us	14
Reset "L" Level Pulse Width	t_{RW}	$\overline{RES}$ Terminal	10			us	15

Note 14) Specified from the rising edge of $\overline{RES}$ to finish the internal circuit reset.
Note 15) Specified minimum pulse width of $\overline{RES}$ signal. Over than t_{RW} "L" input should be required for correct reset operation.

■ BUS TIMING CHARACTERISTICS

• Read/Write operation sequence (80 Type MPU)



(V_{DD}=5.0V±10%, Ta=-20～75°C)

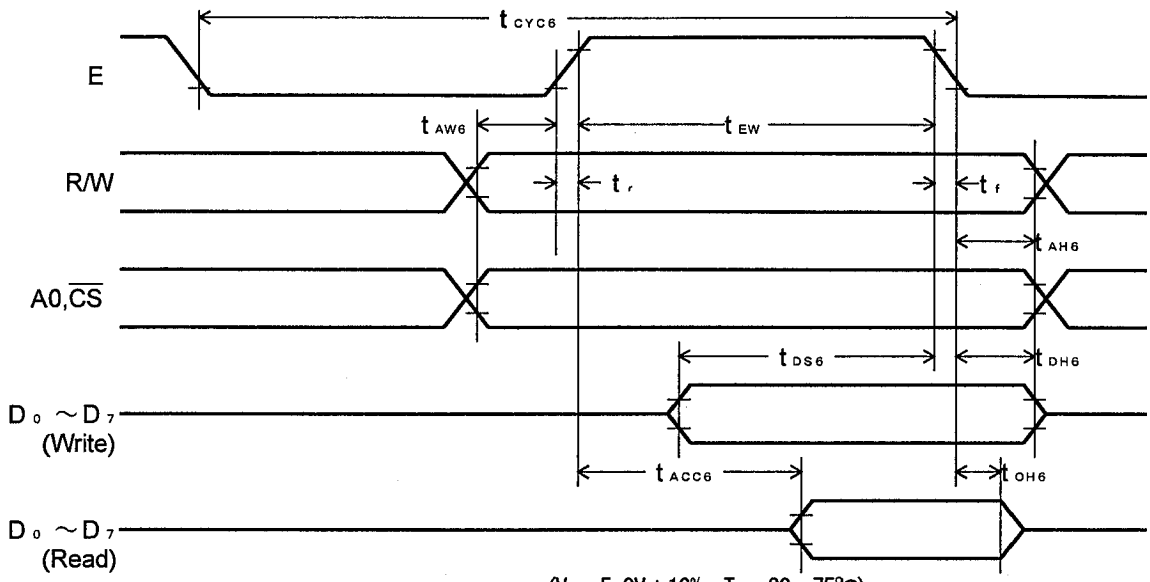
PARAMETER			SYMBOL	MIN	MAX	CONDITION	UNIT
Address Hold Time		A0, CS Terminals	t_{AH8}	10			ns
Address Set Up Time			t_{AW8}	10			
System Cycle Time		WR, RD Terminals	t_{CYC8}	180			
Control Pulse Width	WR,"L"		t_{CCL} (W)	25			
	RD,"L"		t_{CCL} (R)	80			
	"H"		t_{CCH}	70			
Data Set Up Time		D0～D7 Terminals	t_{DS8}	60			
Data Hold Time			t_{DH8}	10			
RD Access Time			t_{ACC8}		70	CL=100pF	
Output Disable Time			t_{OH8}	0	30		
Rise Time, Fall Time		CS, WR, RD, A0, D0～D7 Terminals	t_r, t_f		15		

(V_{DD}=2.7V～4.5V, Ta=-20～75°C)

PARAMETER			SYMBOL	MIN	MAX	CONDITION	UNIT
Address Hold Time		A0, CS Terminals	t_{AH8}	25			ns
Address Set Up Time			t_{AW8}	25			
System Cycle Time		WR, RD Terminals	t_{CYC8}	450			
Control Pulse Width	WR,"L"		t_{CCL} (W)	50			
	RD,"L"		t_{CCL} (R)	200			
	"H"		t_{CCH}	220			
Data Set Up Time		D0～D7 Terminals	t_{DS8}	120			
Data Hold Time			t_{DH8}	35			
RD Access Time			t_{ACC8}		140	CL=100pF	
Output Disable Time			t_{OH8}	0	35		
Rise Time, Fall Time		CS, WR, RD, A0, D0～D7 Terminals	t_r, t_f		15		

Note 16) Rise time(tr) and fall time(tf) of input signal should be less than 15ns.
Note 17) Each timing is specified based on 0.2xV_{DD} and 0.8xV_{DD}.

・Read/Write operation sequence (68 Type MPU)



(V_{DD}=5.0V±10%, Ta=-20~75°C)

PARAMETER		SYMBOL	MIN	MAX	CONDITION	UNIT
Address Hold Time	A0, $\overline{CS}$, R/W Terminals	t_{AH6}	10			ns
Address Set Up Time		t_{AW6}	10			
System Cycle Time		t_{CYC6}	180			
Enable Pulse Width	Read	t_{EW}	100			
	Write		25			
Data Set Up Time	D_0~D_7 Terminals	t_{DS6}	60			
Data Hold Time		t_{DH6}	20			
Access Time		t_{ACC6}		70	CL=100pF	
Output Disable Time		t_{OH6}	0	25		
Rise Time, Fall Time	A0, $\overline{CS}$, R/W, E, D_0~D_7 Terminals	t_r, t_f		15		

(V_{DD}=2.7V~4.5V, Ta=-20~75°C)

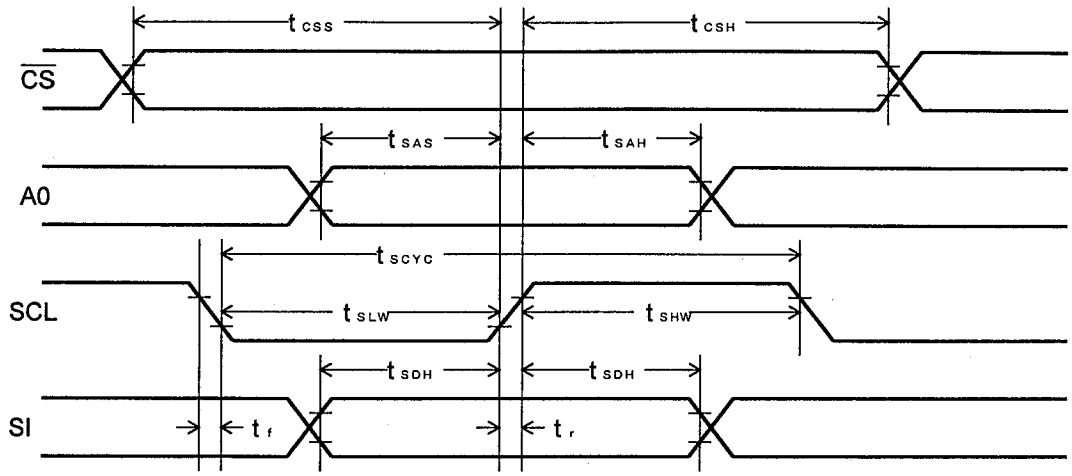
PARAMETER		SYMBOL	MIN	MAX	CONDITION	UNIT
Address Hold Time	A0, $\overline{CS}$, R/W Terminals	t_{AH6}	25			ns
Address Set Up Time		t_{AW6}	25			
System Cycle Time		t_{CYC6}	450			
Enable Pulse Width	Read	t_{EW}	200			
	Write		50			
Data Set Up Time	D_0~D_7 Terminals	t_{DS6}	120			
Data Hold Time		t_{DH6}	40			
Access Time		t_{ACC6}		140	CL=100pF	
Output Disable Time		t_{OH6}	0	45		
Rise Time, Fall Time	A0, $\overline{CS}$, R/W, E, D_0~D_7 Terminals	t_r, t_f		15		

Note 18) t_{CYC6} indicates the E signal cycle during the $\overline{CS}$ activation period. The System Cycle Time must be required after $\overline{CS}$ becomes active.

Note 19) Rise time(tr) and fall time(tf) of input signal should be less than 15ns.

Note 20) Each timing is specified based on 0.2xV_{DD} and 0.8xV_{DD}.

・Write operation sequence (Serial Interface)



(V_{DD}=5.0V±10%, Ta=-20~75°C)

PARAMETER		SYMBOL	MIN	MAX	CONDITION	UNIT
Serial Clock cycle	SCL Terminal	t_{SCYC}	500			ns
SCL "H" pulse width		t_{SHW}	150			
SCL "L" pulse width		t_{SLW}	150			
Address Set Up Time	A0 Terminal	t_{SAS}	120			
Address Hold Time		t_{SAH}	200			
Data Set Up Time	SI Terminal	t_{SDS}	120			
Data hold Time		t_{SDH}	50			
$\overline{CS}$-SCL Time	$\overline{CS}$ Terminal	t_{CSS}	30			
		t_{CSH}	400			
Rise Time, Fall Time	SCL, A0, $\overline{CS}$, SI Terminals	t_r, t_f		15		

(V_{DD}=2.7V~4.5V, Ta=-20~75°C)

PARAMETER		SYMBOL	MIN	MAX	CONDITION	UNIT
Serial Clock cycle	SCL Terminal	t_{SCYC}	1000			ns
SCL "H" pulse width		t_{SHW}	300			
SCL "L" pulse width		t_{SLW}	300			
Address Set Up Time	A0 Terminal	t_{SAS}	250			
Address Hold Time		t_{SAH}	400			
Data Set Up Time	SI Terminal	t_{SDS}	250			
Data hold Time		t_{SDH}	100			
$\overline{CS}$-SCL Time	$\overline{CS}$ Terminal	t_{CSS}	60			
		t_{CSH}	800			
Rise Time, Fall Time	SCL, A0, $\overline{CS}$, SI Terminals	t_r, t_f		15		

Note 21) Rise time(tr) and fall time(tf) of input signal should be less than 15ns.
Note 22) Each timing is specified based on 0.2xV_{DD} and 0.8xV_{DD}.

■ LCD DRIVING WAVEFORM

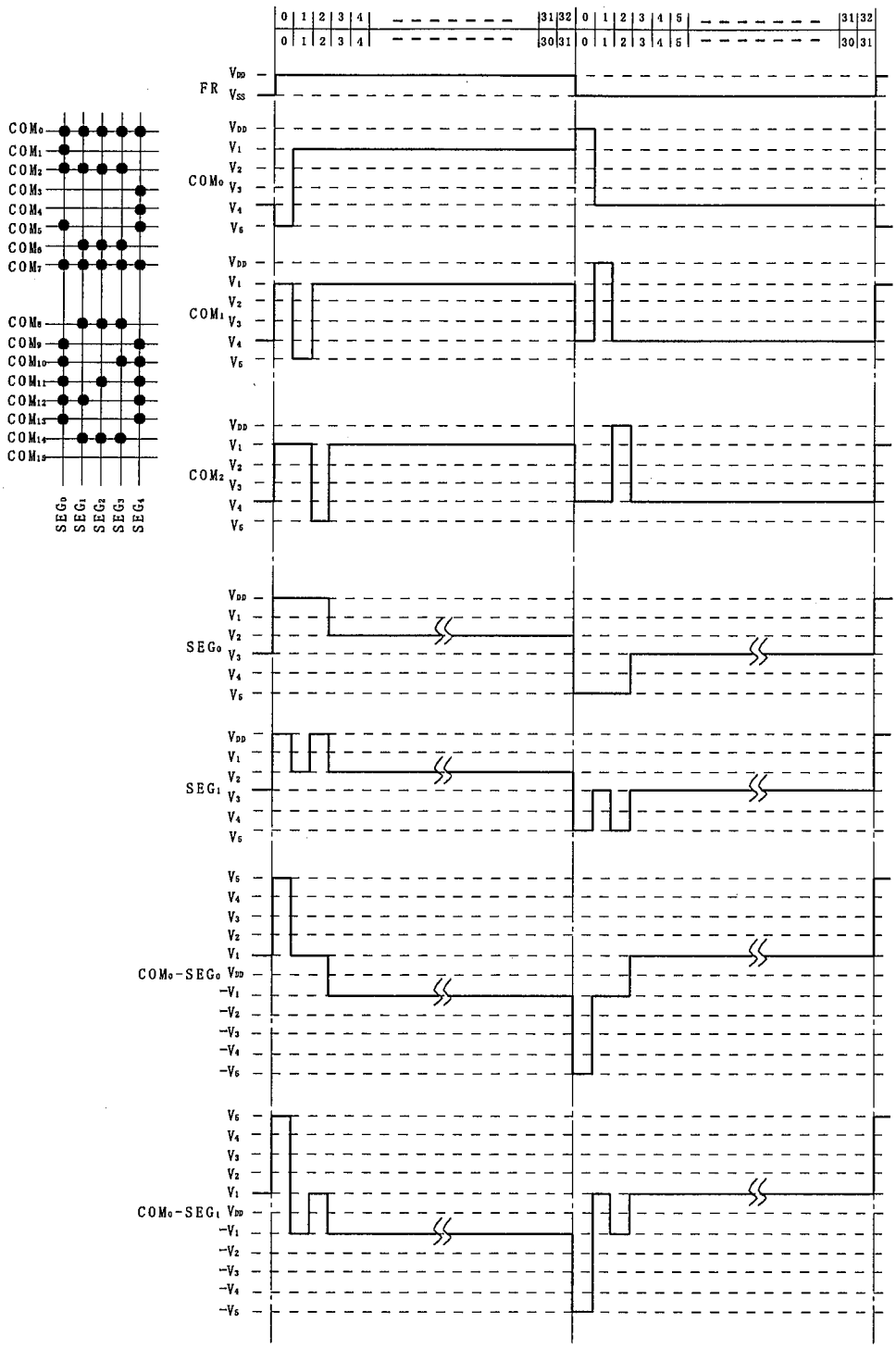


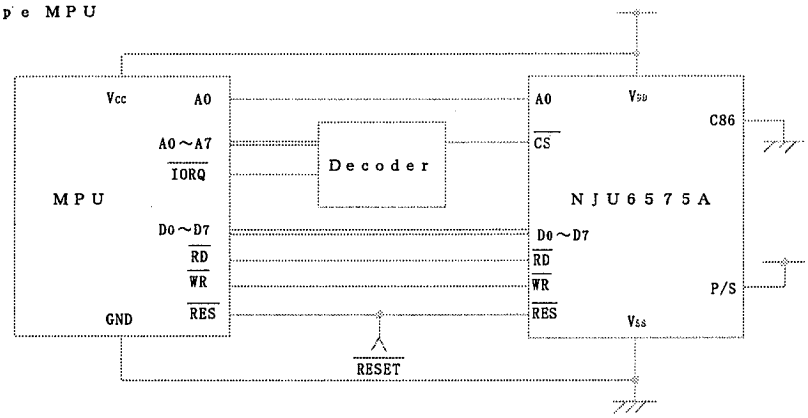
Fig. 7

■ APPLICATION CIRCUIT

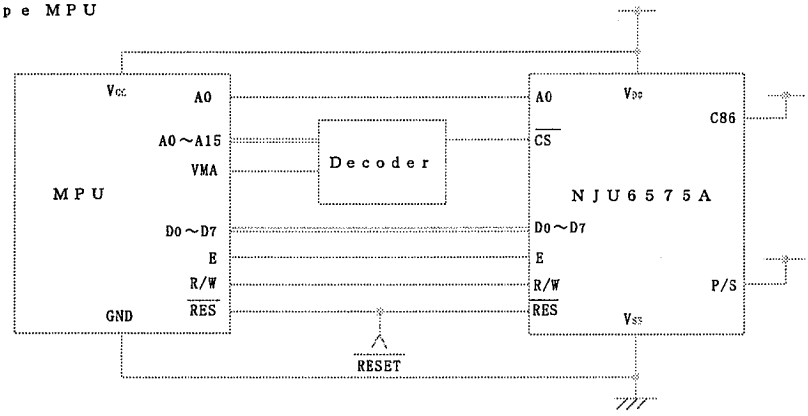
·Microprocessor Interface Example

The NJU6575A interfaces to 80 type or 68 type MPU directly.
And the serial interface also communicate with MPU.

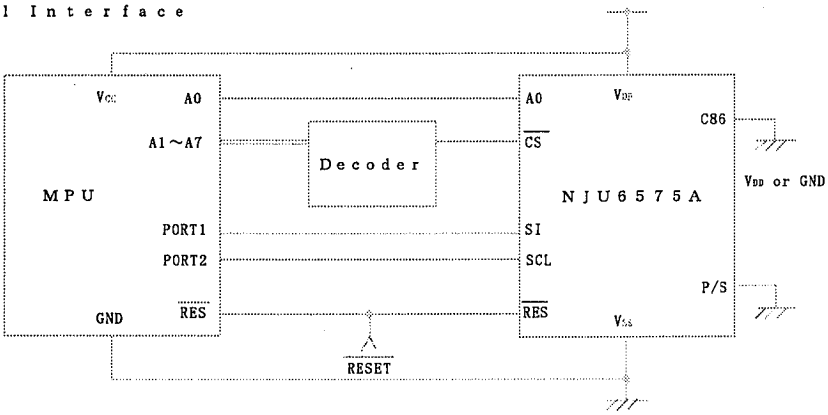
●80 Type MPU



●68 Type MPU



●Serial Interface



MEMO

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