NEC

MOS INTEGRATED CIRCUIT

μPD16715A

384-OUTPUT TFT-LCD SOURCE DRIVER (COMPATIBLE WITH 64-GRAY SCALES)

DESCRIPTION

The μPD16715A is a source driver for TFT-LCDs capable of dealing with displays with 64-gray scales. Data input is based on digital input configured as 6 bits by 6 dots (2 pixels), which can realize a full-color display of 260,000 colors by output of 64 values γ-corrected by an internal D/A converter and 5-by-2 external power modules. Because the output dynamic range is as large as V_{SS2} + 0.1 V to V_{DD2} – 0.1 V, level inversion operation of the LCD's common electrode is rendered unnecessary. Also, to be able to deal with dot-line inversion when mounted on a single side, this source driver is equipped with a built-in 6-bit D/A converter circuit whose odd output pins and even output pins respectively output gray scale voltages of differing polarity. Assuring a maximum clock frequency of 55 MHz when driving at 3.0 V, this driver is applicable to XGA/SXGA-standard TFT-LCD panels.

FEATURES

- CMOS level input
- 384 outputs
- Input of 6 bits (gradation data) by 6 dots
- Capable of outputting 64 values by means of 5-by-2 external power modules (10 units) and a D/A converter
- Logic power supply (V_{DD1}): 3.3 V ± 0.3 V
- Driver power supply (V_{DD2}): 11.0 V $^{+2.5}_{-2.0}$ V
- High-speed data transfer: f_{CLK} = 55 MHz (internal data transfer speed when operating at 3.0 V)
- Output dynamic range V_{SS2} + 0.1 V to V_{DD2} – 0.1 V
- Apply for only dot-line inversion
- Single bank arrangement is possible (POL)
- Display data inversion function (POL2)
- Low power control function (LPC)
- ★ • Single-sided mounting (Slim TCP)

ORDERING INFORMATION

Part Number	Package
μPD16715AN- xxx	TCP (TAB package)

Remark The TCP's external shape is customized. To order your TCP's external shape, please contact an NEC salesperson.

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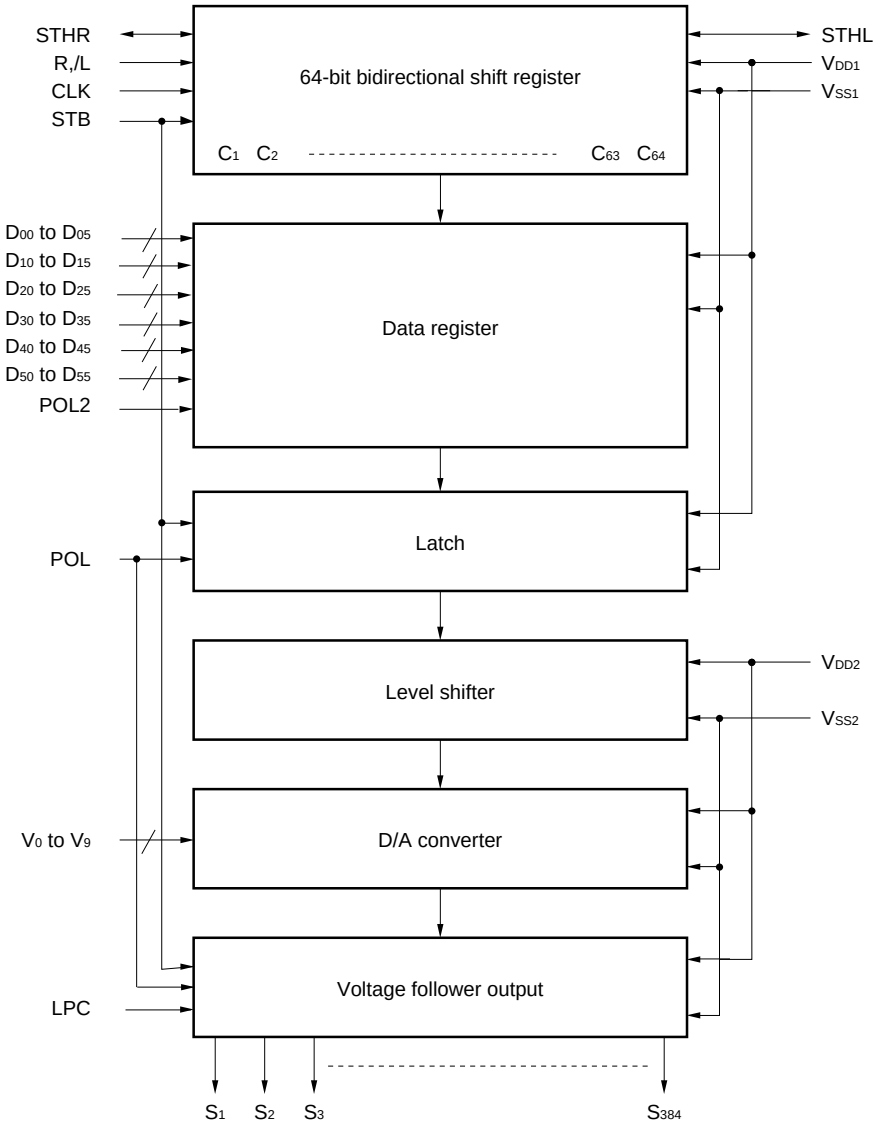
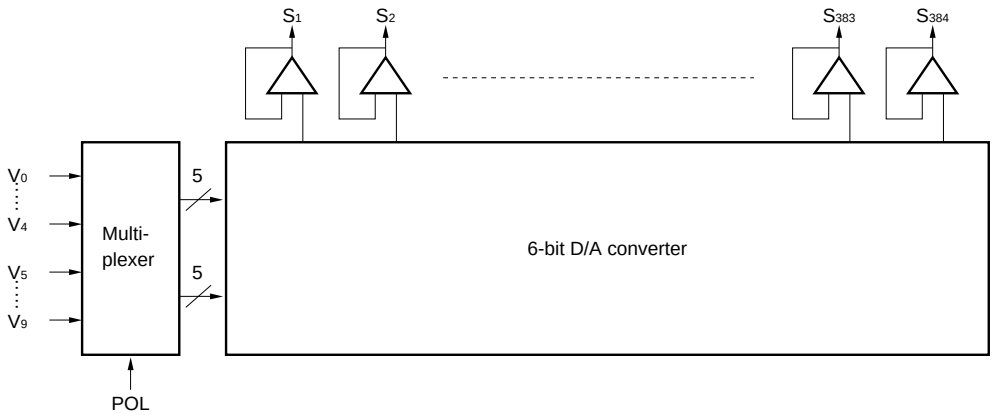
The mark ★ shows major revised points.

1. BLOCK DIAGRAM

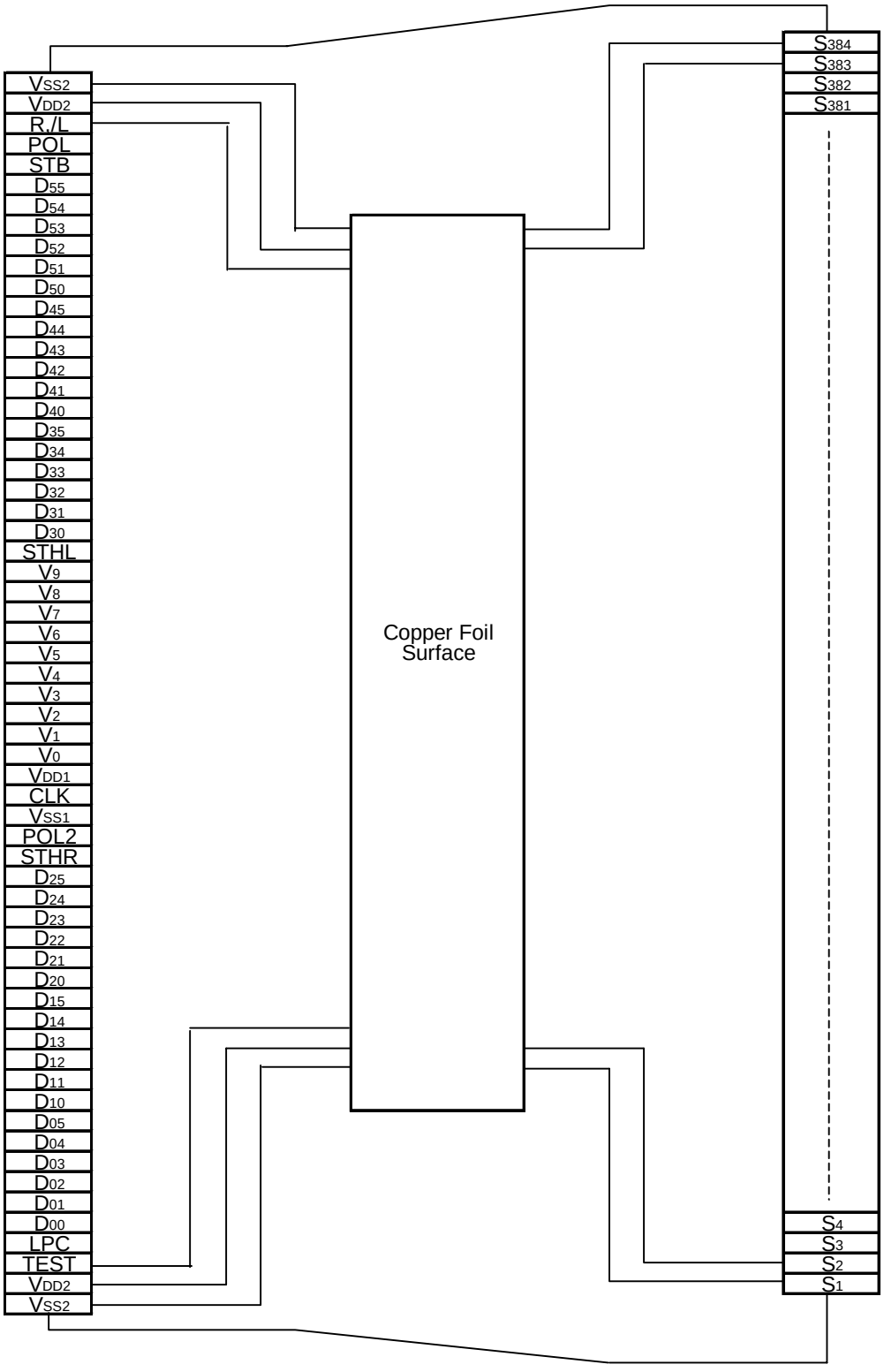


Remark /xxx indicates active low signal.

2. RELATIONSHIP BETWEEN OUTPUT CIRCUIT AND D/A CONVERTER



3. PIN CONFIGURATION (μPD16715AN-×××)



Remark This figure does not specify the TCP package.

4. PIN FUNCTIONS

(1/2)

Pin Symbol	Pin Name	Description
S_1 to S_{384}	Driver output	The D/A converted 64-gray scale analog voltage is output.
D_{00} to D_{05}	Display data input	The display data is input with a width of 36 bits, viz., the gray scale data (6 bits) by 6 dots (2 pixels). D_{X0} : LSB, D_{X5}: MSB
D_{10} to D_{15}		
D_{20} to D_{25}		
D_{30} to D_{35}		
D_{40} to D_{45}		
D_{50} to D_{55}		
R,/L	Shift direction control input	These refer to the start pulse input/output pins when driver ICs are connected in cascade. The shift directions of the shift registers are as follows. R,/L = H: STHR input, $S_1 \rightarrow S_{384}$, STHL output R,/L = L : STHL input, $S_{384} \rightarrow S_1$, STHR output
STHR	Right shift start pulse input/output	R,/L = H: Becomes the start pulse input pin. R,/L = L : Becomes the start pulse output pin.
STHL	Left shift start pulse input/output	R,/L = H: Becomes the start pulse output pin. R,/L = L : Becomes the start pulse input pin.
CLK	Shift clock input	Refers to the shift register's shift clock input. The display data is incorporated into the data register at the rising edge. At the rising edge of the 64th clock after the start pulse input, the start pulse output reaches the high level, thus becoming the start pulse of the next-level driver. The initial-level driver's 64th clock becomes valid as the next-level driver's start pulse is input. If 66 clock pulses are input after input of the start pulse, input of display data is halted automatically. The contents of the shift register are cleared at the STB's rising edge.
STB	Latch input	The contents of the data register are transferred to the latch circuit at the rising edge. And, at the falling edge, the gray scale voltage is supplied to the driver. It is necessary to ensure input of one pulse per horizontal period.
POL	Polarity input	POL = L: The S_{2n-1} output uses V_0 to V_4 as the reference supply ; The S_{2n} output uses V_5 to V_9 as the reference supply. POL = H : The S_{2n-1} output uses V_5 to V_9 as the reference supply ; The S_{2n} output uses V_0 to V_4 as the reference supply. S_{2n-1} indicates the odd output: and S_{2n} indicates the even output. Input of the POL signal is allowed the setup time ($t_{POL-STB}$) with respect to STB's rising edge.
POL2	Data inversion	POL2 = H : Display data is inverted. POL2 = L : Display data is not inverted
LPC	Driver voltage selection	The output buffer constant current source is blocked, reducing current consumption. Low power mode (LPC = 'H': DC-level input possible). The condition that low power mode can be used is that the load constant is at least 10 kΩ + 50 pF.
V_0 to V_9	γ-corrected power supplies	Input the γ-corrected power supplies from outside by using operational amplifier. Make sure to maintain the following relationships. During the gray scale voltage output, be sure to keep the gray scale level power supply at a constant level. $V_{DD2} - 0.1\ V > V_0 > V_1 > V_2 > V_3 > V_4 > V_5 > V_6 > V_7 > V_8 > V_9 > V_{SS2} + 0.1\ V$
TEST	Test pin	Test pin. Please input H or Open.
V_{DD1}	Logic power supply	3.3 V ± 0.3 V
V_{DD2}	Driver power supply	11.0 V $^{+2.5}_{-2.0}$ V
V_{SS1}	Logic ground	Grounding
V_{SS2}	Driver ground	Grounding

Cautions 1. The power start sequence must be V_{DD1}, logic input, and V_{DD2} & V_0 to V_9 in that order. Reverse this sequence to shut down. (Simultaneous power application to V_{DD2} and V_0 to V_9 is possible.)

2. To stabilize the supply voltage, please be sure to insert a 0.47 μF bypass capacitor between V_{DD1}-V_{SS1} and V_{DD2}-V_{SS2}. Furthermore, for increased precision of the D/A converter, insertion of a bypass capacitor of about 0.01 μF is also advised between the γ-corrected power supply terminals (V_0, V_1, V_2, ⋯, V_9) and V_{SS2}.

5. RELATIONSHIP BETWEEN INPUT DATA AND OUTPUT VOLTAGE VALUE

The μPD16715A incorporates a 6-bit D/A converter whose odd output pins and even output pins output respectively gray scale voltages of differing polarity with respect to the LCD's counter electrode (common electrode) voltage. The D/A converter consists of ladder resistors and switches. The ladder resistors r_0 to r_{62} are so designed that the ratios between the LCD panel's γ - corrected voltages and $V_{0'}$ to $V_{63'}$ and $V_{0''}$ to $V_{63''}$ are roughly equal; and their respective resistance values are as shown on next page. Among the 5-by-2 γ -corrected voltages, input gray scale voltages of the same polarity with respect to the common voltage, for the respective five γ -corrected voltages of V_0 to V_4 and V_5 to V_9

Figure 5-1 shows the relationship between the driving voltages such as liquid-crystal driving voltages V_{DD2} and V_{SS2}, common electrode potential V_{COM}, and γ - corrected voltages V_0 to V_9 and the input data. Be sure to maintain the voltage relationships of

$$V_{DD2} - 0.1\ V > V_0 > V_1 > V_2 > V_3 > V_4 > V_5 > V_6 > V_7 > V_8 > V_9 > V_{SS2} + 0.1\ V.$$

Figures 5-2 and 5-3 show the relationship between the input data and the output voltage. Therefore, please do not use it for γ - corrected power supply level inversion in double-sided mounting.

Figure 5–1. Relationship Between Input Data and γ - corrected Power Supply

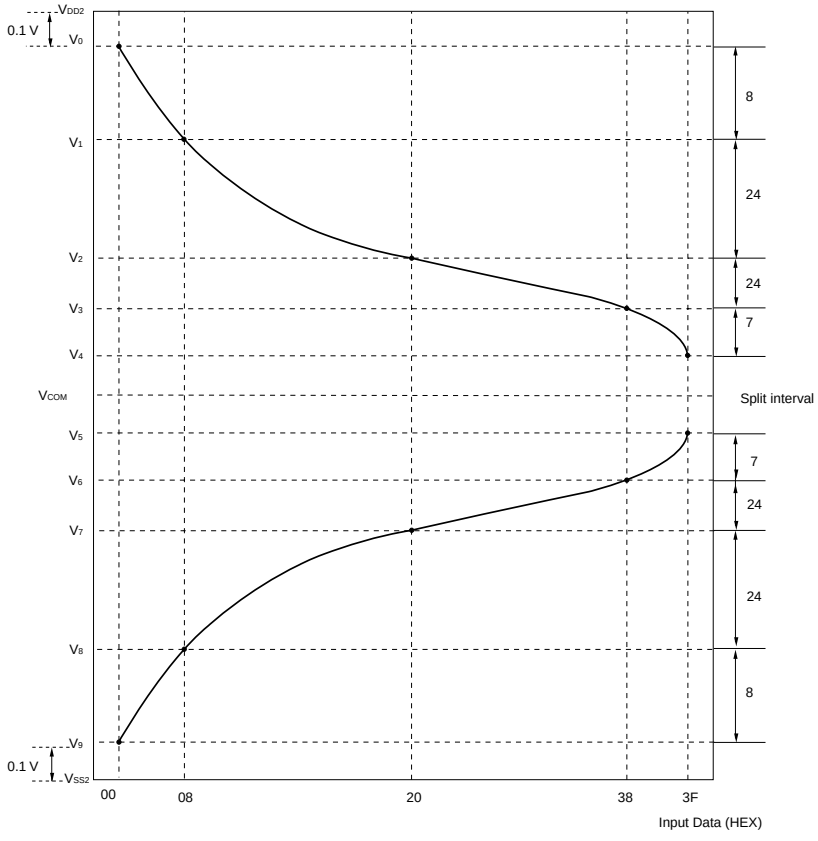
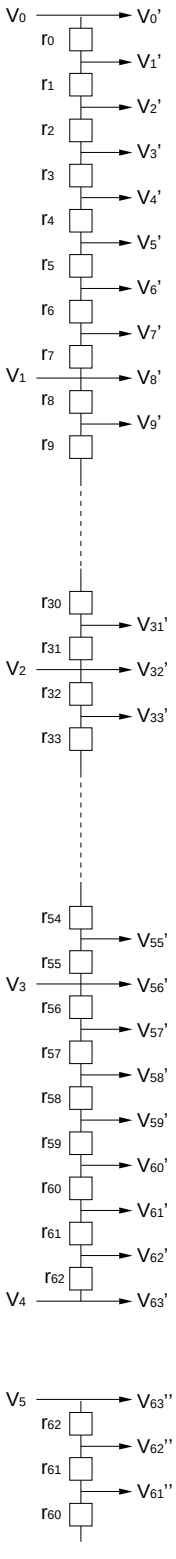


Figure 5–2. Relationship between Input Data and Output Voltage (1/2)

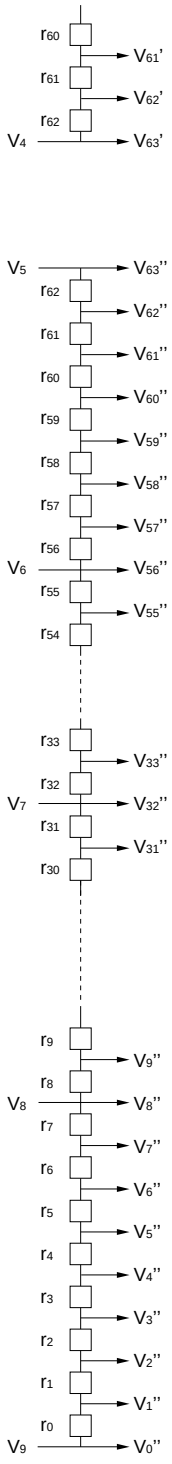
V_{DD2} – 0.1 V > V_0 > V_1 > V_2 > V_3 > V_4



Data	D_{X5}	D_{X4}	D_{X3}	D_{X2}	D_{X1}	D_{X0}	Output Voltage				r n(Ω)	
00H	0	0	0	0	0	0	V_0'	V_0			r0	800
01H	0	0	0	0	0	1	V_1'	$V_1+(V_0-V_1)\times$	4300 /	5100	r1	750
02H	0	0	0	0	1	0	V_2'	$V_1+(V_0-V_1)\times$	3550 /	5100	r2	700
03H	0	0	0	0	1	1	V_3'	$V_1+(V_0-V_1)\times$	2850 /	5100	r3	650
04H	0	0	0	1	0	0	V_4'	$V_1+(V_0-V_1)\times$	2200 /	5100	r4	600
05H	0	0	0	1	0	1	V_5'	$V_1+(V_0-V_1)\times$	1600 /	5100	r5	550
06H	0	0	0	1	1	0	V_6'	$V_1+(V_0-V_1)\times$	1050 /	5100	r6	550
07H	0	0	0	1	1	1	V_7'	$V_1+(V_0-V_1)\times$	500 /	5100	r7	500
08H	0	0	1	0	0	0	V_8'	V_1			r8	500
09H	0	0	1	0	0	1	V_9'	$V_1+(V_0-V_1)\times$	5200 /	5700	r9	400
0AH	0	0	1	0	1	0	V_{10}'	$V_1+(V_0-V_1)\times$	4800 /	5700	r10	400
0BH	0	0	1	0	1	1	V_{11}'	$V_1+(V_0-V_1)\times$	4400 /	5700	r11	350
0CH	0	0	1	1	0	0	V_{12}'	$V_1+(V_0-V_1)\times$	4050 /	5700	r12	350
0DH	0	0	1	1	0	1	V_{13}'	$V_1+(V_0-V_1)\times$	3700 /	5700	r13	350
0EH	0	0	1	1	1	0	V_{14}'	$V_1+(V_0-V_1)\times$	3350 /	5700	r14	300
0FH	0	0	1	1	1	1	V_{15}'	$V_1+(V_0-V_1)\times$	3050 /	5700	r15	300
10H	0	1	0	0	0	0	V_{16}'	$V_1+(V_0-V_1)\times$	2750 /	5700	r16	300
11H	0	1	0	0	0	1	V_{17}'	$V_2+(V_1-V_2)\times$	2450 /	5700	r17	250
12H	0	1	0	0	1	0	V_{18}'	$V_2+(V_1-V_2)\times$	2200 /	5700	r18	250
13H	0	1	0	0	1	1	V_{19}'	$V_2+(V_1-V_2)\times$	1950 /	5700	r19	250
14H	0	1	0	1	0	0	V_{20}'	$V_2+(V_1-V_2)\times$	1700 /	5700	r20	200
15H	0	1	0	1	0	1	V_{21}'	$V_2+(V_1-V_2)\times$	1500 /	5700	r21	200
16H	0	1	0	1	1	0	V_{22}'	$V_2+(V_1-V_2)\times$	1300 /	5700	r22	200
17H	0	1	0	1	1	1	V_{23}'	$V_2+(V_1-V_2)\times$	1100 /	5700	r23	150
18H	0	1	1	0	0	0	V_{24}'	$V_2+(V_1-V_2)\times$	950 /	5700	r24	150
19H	0	1	1	0	0	1	V_{25}'	$V_2+(V_1-V_2)\times$	800 /	5700	r25	150
1AH	0	1	1	0	1	0	V_{26}'	$V_2+(V_1-V_2)\times$	650 /	5700	r26	150
1BH	0	1	1	0	1	1	V_{27}'	$V_2+(V_1-V_2)\times$	500 /	5700	r27	100
1CH	0	1	1	1	0	0	V_{28}'	$V_2+(V_1-V_2)\times$	400 /	5700	r28	100
1DH	0	1	1	1	0	1	V_{29}'	$V_2+(V_1-V_2)\times$	300 /	5700	r29	100
1EH	0	1	1	1	1	0	V_{30}'	$V_2+(V_1-V_2)\times$	200 /	5700	r30	100
1FH	0	1	1	1	1	1	V_{31}'	$V_2+(V_1-V_2)\times$	100 /	5700	r31	100
20H	1	0	0	0	0	0	V_{32}'	V_2			r32	100
21H	1	0	0	0	0	1	V_{33}'	$V_3+(V_2-V_3)\times$	2450 /	2550	r33	100
22H	1	0	0	0	1	0	V_{34}'	$V_3+(V_2-V_3)\times$	2350 /	2550	r34	100
23H	1	0	0	0	1	1	V_{35}'	$V_3+(V_2-V_3)\times$	2250 /	2550	r35	100
24H	1	0	0	1	0	0	V_{36}'	$V_3+(V_2-V_3)\times$	2150 /	2550	r36	100
25H	1	0	0	1	0	1	V_{37}'	$V_3+(V_2-V_3)\times$	2050 /	2550	r37	100
26H	1	0	0	1	1	0	V_{38}'	$V_3+(V_2-V_3)\times$	1950 /	2550	r38	100
27H	1	0	0	1	1	1	V_{39}'	$V_3+(V_2-V_3)\times$	1850 /	2550	r39	100
28H	1	0	1	0	0	0	V_{40}'	$V_3+(V_2-V_3)\times$	1750 /	2550	r40	100
29H	1	0	1	0	0	1	V_{41}'	$V_3+(V_2-V_3)\times$	1650 /	2550	r41	100
2AH	1	0	1	0	1	0	V_{42}'	$V_3+(V_2-V_3)\times$	1550 /	2550	r42	100
2BH	1	0	1	0	1	1	V_{43}'	$V_3+(V_2-V_3)\times$	1450 /	2550	r43	100
2CH	1	0	1	1	0	0	V_{44}'	$V_3+(V_2-V_3)\times$	1350 /	2550	r44	100
2DH	1	0	1	1	0	1	V_{45}'	$V_3+(V_2-V_3)\times$	1250 /	2550	r45	100
2EH	1	0	1	1	1	0	V_{46}'	$V_3+(V_2-V_3)\times$	1150 /	2550	r46	100
2FH	1	0	1	1	1	1	V_{47}'	$V_3+(V_2-V_3)\times$	1050 /	2550	r47	100
30H	1	1	0	0	0	0	V_{48}'	$V_3+(V_2-V_3)\times$	950 /	2550	r48	100
31H	1	1	0	0	0	1	V_{49}'	$V_4+(V_3-V_4)\times$	850 /	2550	r49	100
32H	1	1	0	0	1	0	V_{50}'	$V_4+(V_3-V_4)\times$	750 /	2550	r50	100
33H	1	1	0	0	1	1	V_{51}'	$V_4+(V_3-V_4)\times$	650 /	2550	r51	100
34H	1	1	0	1	0	0	V_{52}'	$V_4+(V_3-V_4)\times$	550 /	2550	r52	100
35H	1	1	0	1	0	1	V_{53}'	$V_4+(V_3-V_4)\times$	450 /	2550	r53	150
36H	1	1	0	1	1	0	V_{54}'	$V_4+(V_3-V_4)\times$	300 /	2550	r54	150
37H	1	1	0	1	1	1	V_{55}'	$V_4+(V_3-V_4)\times$	150 /	2550	r55	150
38H	1	1	1	0	0	0	V_{56}'	V_3			r56	200
39H	1	1	1	0	0	1	V_{57}'	$V_4+(V_3-V_4)\times$	2300 /	2500	r57	200
3AH	1	1	1	0	1	0	V_{58}'	$V_4+(V_3-V_4)\times$	2100 /	2500	r58	250
3BH	1	1	1	0	1	1	V_{59}'	$V_4+(V_3-V_4)\times$	1850 /	2500	r59	250
3CH	1	1	1	1	0	0	V_{60}'	$V_4+(V_3-V_4)\times$	1600 /	2500	r60	300
3DH	1	1	1	1	0	1	V_{61}'	$V_4+(V_3-V_4)\times$	1300 /	2500	r61	500
3EH	1	1	1	1	1	0	V_{62}'	$V_4+(V_3-V_4)\times$	800 /	2500	r62	800
3FH	1	1	1	1	1	1	V_{63}'	V_4			rtotal	15850

Figure 5–3. Relationship between Input Data and Output Voltage (2/2)

$V_5 > V_6 > V_7 > V_8 > V_9 > V_{SS2}$ + 0.1 V



Data	D_{X5}	D_{X4}	D_{X3}	D_{X2}	D_{X1}	D_{X0}	Output Voltage				rn(Ω)	
00H	0	0	0	0	0	0	V_0"	V_9			r0	800
01H	0	0	0	0	0	1	V_1"	$V_9+(V_8-V_9)\times$	800 /	5100	r1	750
02H	0	0	0	0	1	0	V_2"	$V_9+(V_8-V_9)\times$	1550 /	5100	r2	700
03H	0	0	0	0	1	1	V_3"	$V_9+(V_8-V_9)\times$	2250 /	5100	r3	650
04H	0	0	0	1	0	0	V_4"	$V_9+(V_8-V_9)\times$	2900 /	5100	r4	600
05H	0	0	0	1	0	1	V_5"	$V_9+(V_8-V_9)\times$	3500 /	5100	r5	550
06H	0	0	0	1	1	0	V_6"	$V_9+(V_8-V_9)\times$	4050 /	5100	r6	550
07H	0	0	0	1	1	1	V_7"	$V_9+(V_8-V_9)\times$	4600 /	5100	r7	500
08H	0	0	1	0	0	0	V_8"	V_8			r8	500
09H	0	0	1	0	0	1	V_9"	$V_9+(V_8-V_9)\times$	500 /	5700	r9	400
0AH	0	0	1	0	1	0	V_{10}"	$V_9+(V_8-V_9)\times$	900 /	5700	r10	400
0BH	0	0	1	0	1	1	V_{11}"	$V_9+(V_8-V_9)\times$	1300 /	5700	r11	350
0CH	0	0	1	1	0	0	V_{12}"	$V_9+(V_8-V_9)\times$	1650 /	5700	r12	350
0DH	0	0	1	1	0	1	V_{13}"	$V_9+(V_8-V_9)\times$	2000 /	5700	r13	350
0EH	0	0	1	1	1	0	V_{14}"	$V_9+(V_8-V_9)\times$	2350 /	5700	r14	300
0FH	0	0	1	1	1	1	V_{15}"	$V_9+(V_8-V_9)\times$	2650 /	5700	r15	300
10H	0	1	0	0	0	0	V_{16}"	$V_9+(V_8-V_9)\times$	2950 /	5700	r16	300
11H	0	1	0	0	0	1	V_{17}"	$V_8+(V_7-V_8)\times$	3250 /	5700	r17	250
12H	0	1	0	0	1	0	V_{18}"	$V_8+(V_7-V_8)\times$	3500 /	5700	r18	250
13H	0	1	0	0	1	1	V_{19}"	$V_8+(V_7-V_8)\times$	3750 /	5700	r19	250
14H	0	1	0	1	0	0	V_{20}"	$V_8+(V_7-V_8)\times$	4000 /	5700	r20	200
15H	0	1	0	1	0	1	V_{21}"	$V_8+(V_7-V_8)\times$	4200 /	5700	r21	200
16H	0	1	0	1	1	0	V_{22}"	$V_8+(V_7-V_8)\times$	4400 /	5700	r22	200
17H	0	1	0	1	1	1	V_{23}"	$V_8+(V_7-V_8)\times$	4600 /	5700	r23	150
18H	0	1	1	0	0	0	V_{24}"	$V_8+(V_7-V_8)\times$	4750 /	5700	r24	150
19H	0	1	1	0	0	1	V_{25}"	$V_8+(V_7-V_8)\times$	4900 /	5700	r25	150
1AH	0	1	1	0	1	0	V_{26}"	$V_8+(V_7-V_8)\times$	5050 /	5700	r26	150
1BH	0	1	1	0	1	1	V_{27}"	$V_8+(V_7-V_8)\times$	5200 /	5700	r27	100
1CH	0	1	1	1	0	0	V_{28}"	$V_8+(V_7-V_8)\times$	5300 /	5700	r28	100
1DH	0	1	1	1	0	1	V_{29}"	$V_8+(V_7-V_8)\times$	5400 /	5700	r29	100
1EH	0	1	1	1	1	0	V_{30}"	$V_8+(V_7-V_8)\times$	5500 /	5700	r30	100
1FH	0	1	1	1	1	1	V_{31}"	$V_8+(V_7-V_8)\times$	5600 /	5700	r31	100
20H	1	0	0	0	0	0	V_{32}"	V_7			r32	100
21H	1	0	0	0	0	1	V_{33}"	$V_7+(V_6-V_7)\times$	100 /	2550	r33	100
22H	1	0	0	0	1	0	V_{34}"	$V_7+(V_6-V_7)\times$	200 /	2550	r34	100
23H	1	0	0	0	1	1	V_{35}"	$V_7+(V_6-V_7)\times$	300 /	2550	r35	100
24H	1	0	0	1	0	0	V_{36}"	$V_7+(V_6-V_7)\times$	400 /	2550	r36	100
25H	1	0	0	1	0	1	V_{37}"	$V_7+(V_6-V_7)\times$	500 /	2550	r37	100
26H	1	0	0	1	1	0	V_{38}"	$V_7+(V_6-V_7)\times$	600 /	2550	r38	100
27H	1	0	0	1	1	1	V_{39}"	$V_7+(V_6-V_7)\times$	700 /	2550	r39	100
28H	1	0	1	0	0	0	V_{40}"	$V_7+(V_6-V_7)\times$	800 /	2550	r40	100
29H	1	0	1	0	0	1	V_{41}"	$V_7+(V_6-V_7)\times$	900 /	2550	r41	100
2AH	1	0	1	0	1	0	V_{42}"	$V_7+(V_6-V_7)\times$	1000 /	2550	r42	100
2BH	1	0	1	0	1	1	V_{43}"	$V_7+(V_6-V_7)\times$	1100 /	2550	r43	100
2CH	1	0	1	1	0	0	V_{44}"	$V_7+(V_6-V_7)\times$	1200 /	2550	r44	100
2DH	1	0	1	1	0	1	V_{45}"	$V_7+(V_6-V_7)\times$	1300 /	2550	r45	100
2EH	1	0	1	1	1	0	V_{46}"	$V_7+(V_6-V_7)\times$	1400 /	2550	r46	100
2FH	1	0	1	1	1	1	V_{47}"	$V_7+(V_6-V_7)\times$	1500 /	2550	r47	100
30H	1	1	0	0	0	0	V_{48}"	$V_7+(V_6-V_7)\times$	1600 /	2550	r48	100
31H	1	1	0	0	0	1	V_{49}"	$V_6+(V_5-V_6)\times$	1700 /	2550	r49	100
32H	1	1	0	0	1	0	V_{50}"	$V_6+(V_5-V_6)\times$	1800 /	2550	r50	100
33H	1	1	0	0	1	1	V_{51}"	$V_6+(V_5-V_6)\times$	1900 /	2550	r51	100
34H	1	1	0	1	0	0	V_{52}"	$V_6+(V_5-V_6)\times$	2000 /	2550	r52	100
35H	1	1	0	1	0	1	V_{53}"	$V_6+(V_5-V_6)\times$	2100 /	2550	r53	150
36H	1	1	0	1	1	0	V_{54}"	$V_6+(V_5-V_6)\times$	2250 /	2550	r54	150
37H	1	1	0	1	1	1	V_{55}"	$V_6+(V_5-V_6)\times$	2400 /	2550	r55	150
38H	1	1	1	0	0	0	V_{56}"	V_6			r56	200
39H	1	1	1	0	0	1	V_{57}"	$V_6+(V_5-V_6)\times$	200 /	2500	r57	200
3AH	1	1	1	0	1	0	V_{58}"	$V_6+(V_5-V_6)\times$	400 /	2500	r58	250
3BH	1	1	1	0	1	1	V_{59}"	$V_6+(V_5-V_6)\times$	650 /	2500	r59	250
3CH	1	1	1	1	0	0	V_{60}"	$V_6+(V_5-V_6)\times$	900 /	2500	r60	300
3DH	1	1	1	1	0	1	V_{61}"	$V_6+(V_5-V_6)\times$	1200 /	2500	r61	500
3EH	1	1	1	1	1	0	V_{62}"	$V_6+(V_5-V_6)\times$	1700 /	2500	r62	800
3FH	1	1	1	1	1	1	V_{63}"	V_5			rtotal	15850

6. RELATIONSHIP BETWEEN OUTPUT DATA AND D/A CONVERTER

Data format : 6 bits × 2 RGBs (6 dots)
Input width : 36 bits (2-pixel data)

R,/L = H (Right shift)

Output	S_1	S_2	S_3	S_4	···	S_{383}	S_{384}
Data	D_{00} to D_{05}	D_{10} to D_{15}	D_{20} to D_{25}	D_{30} to D_{35}	···	D_{40} to D_{45}	D_{50} to D_{55}

R,/L = L (Left shift)

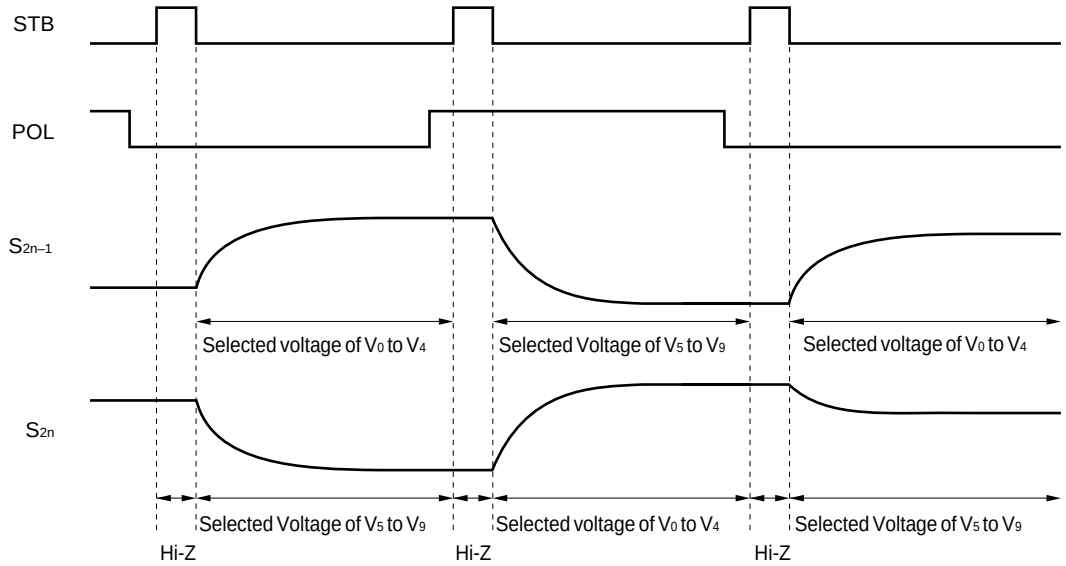
Output	S_1	S_2	S_3	S_4	···	S_{383}	S_{384}
Data	D_{00} to D_{05}	D_{10} to D_{15}	D_{20} to D_{25}	D_{30} to D_{35}	···	D_{40} to D_{45}	D_{50} to D_{55}

POL	S_{2n-1} Note	S_{2n} Note
L	V_0 to V_4	V_5 to V_9
H	V_5 to V_9	V_0 to V_4

Note S_{2n-1} (Odd output), S_{2n} (Even output), n = 1,2,···,192

7. RELATIONSHIP BETWEEN STB, POL, AND OUTPUT WAVEFORM

The output voltage is written to the LCD panel synchronized with the STB falling edge.



8. RELATIONSHIP BETWEEN OUTPUT DATA AND D/A CONVERTER

The μPD16715A is a dot inversion and inverts dots by alternately using a charging output buffer and a discharging output buffer. Therefore, the output voltage of the first line may not be correctly written because the last line's output polarity of frame n (n + 1) and the first line's output polarity are the same (refer to Figure 8-1).

Consequently, polarity inversion and write operation must be performed between frames (vertical blanking period) in order to invert (clear) the polarity of the wiring level of the liquid crystal panel by using the last line output of the previous frame (refer to Figure 8-2).

Figure 8-1. Incase of the output voltage may not be correctly written

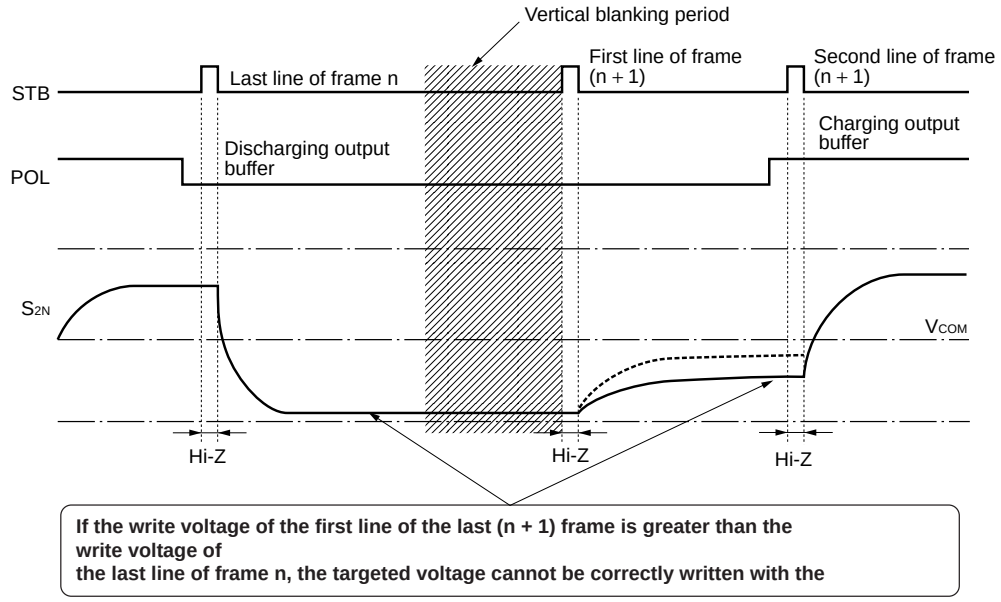
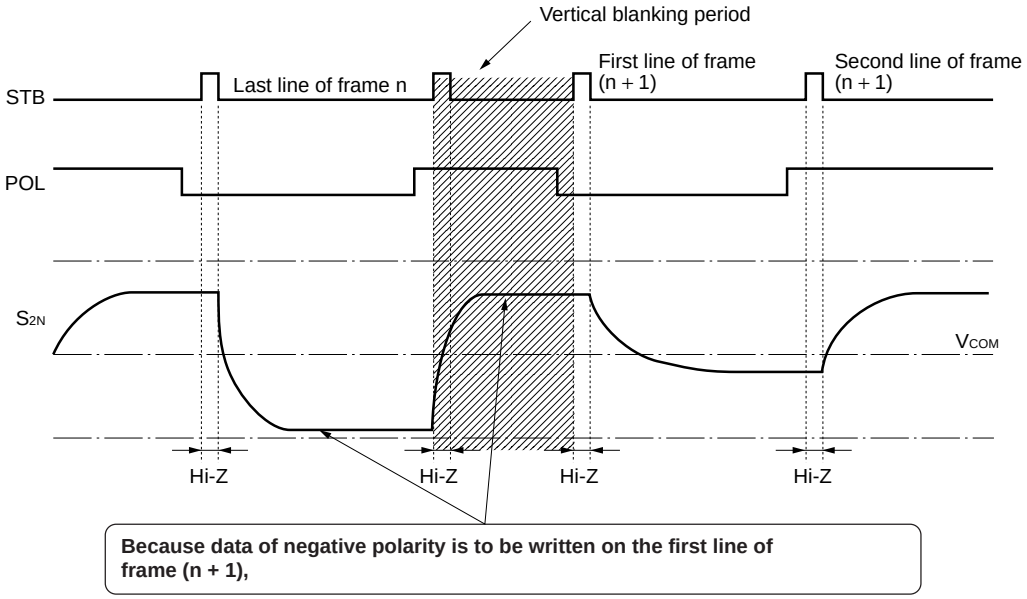


Figure 8-2. Polarity inversion and write operation



5. ELECTRICAL SPECIFICATIONS

Absolute Maximum Ratings (T_A = 25 °C, V_{SS1} = V_{SS2} = 0 V)

Parameter	Symbol	Ratings	Unit
Logic Part Supply Voltage	V_{DD1}	–0.3 to + 6.5	V
Driver Part Supply Voltage	V_{DD2}	–0.5 to + 15.0	V
Logic Part Input Voltage	V_{I1}	–0.3 to V_{DD1} + 0.3	V
Driver Part Input Voltage	V_{I2}	–0.3 to V_{DD2} + 0.3	V
Logic Part Output Voltage	V_{O1}	–0.3 to V_{DD1} + 0.3	V
Driver Part Output Voltage	V_{O2}	–0.3 to V_{DD2} + 0.3	V
Operating Ambient Temperature	T_A	–10 to +75	°C
Storage Temperature	T_{stg}	–55 to +125	°C

Caution If the absolute maximum rating of even one of the above parameters is exceeded even momentarily, the quality of the product may be degraded. Absolute maximum ratings, therefore, specify the values exceeding which the product may be physically damaged. Be sure to use the product within the range of the absolute maximum ratings.

Recommended Operating Range (T_A = –10 to +75 °C, V_{SS1} = V_{SS2} = 0 V)

Parameter	Symbol	MIN.	TYP.	MAX.	Unit
Logic Supply Voltage	V_{DD1}	3.0	3.3	3.6	V
Driver Supply Voltage	V_{DD2}	9.0	11.0	13.5	V
High-Level Input Voltage	V_{IH}	0.7 V_{DD1}		V_{DD1}	V
Low-Level Input Voltage	V_{IL}	0		0.3 V_{DD1}	V
γ -Corrected Voltage	V_0 to V_9	V_{SS2} + 0.1		V_{DD2} – 0.1	V
Driver Part Output Voltage	V_O	V_{SS2} + 0.1		V_{DD2} – 0.1	V
Clock Frequency	f_{CLK}			55	MHz

Electrical Characteristics (T_A = –10 to +75 °C, V_{DD1} = 3.3 V ± 0.3 V, V_{DD2} = 11.0 V $^{+2.5}_{-2.0}$V, V_{SS1} = V_{SS2} = 0 V)

Parameter	Symbol	Condition		MIN.	TYP.	MAX.	Unit
Input Leak Current	I_{IL}					±1.0	μA
High-Level Output Voltage	V_{OH}	STHR (STHL), I_{OH} = 0 mA		V_{DD1} – 0.1		V_{DD1}	V
Low-Level Output Voltage	V_{OL}	STHR (STHL), I_{OL} = 0 mA				0.1	V
★ γ-Corrected Supply Current	I_γ	V_{DD2} = 13 V,	V_0 pin, V_5 pin		0.31	0.8	mA
		V_0 to V_4 = V_5 to V_9 = 6.0 V	V_4 pin, V_9 pin	–0.8	–0.31		mA
Driver Output Current	I_{VOH}	V_X = 8.0 V, V_{OUT} = 6.0 V				–0.25	mA
	I_{VOL}	V_X = 1.0 V, V_{OUT} = 3.0 V		0.25			mA
Output Voltage Deviation	ΔV_O	Input data				±20	mV
Average Output Voltage Variation	ΔV_{AV}	Input data			±10		mV
Output Voltage Range	V_O	Input data		V_{DD2} +0.1		V_{DD2} – 0.1	V
Logic Part Dynamic Current Consumption	I_{DD1}	V_{DD1} = 3.6 V, T_A = 25°C			1.5	8	mA
Driver Part Dynamic Current Consumption	I_{DD2}	V_{DD1} = 3.0 V, V_{DD2} = 13.5 V, No loads, T_A = 25°C			3.5	8	mA

Cautions 1. The output voltage deviation refers to the voltage difference between adjoining output pins when the display data is the same (within the chip).

2. The average output voltage variation refers to the average output voltage difference between chips. The average output voltage refers to the average voltage between chips when the display data is the same.

3. The STB cycle is defined to be 20 μs at f_{CLK} = 33 MHz.

4. The TYP. values refer to an all black or all white input pattern. The MAX. value refers to the measured values in the dot checkerboard input pattern.

5. Refers to the current consumption per driver when cascades are connected under the assumption of XGA single-sided mounting (8 units).

Switching Characteristics (T_A = –10 to +75 °C, V_{DD1} = 3.3 V ± 0.3 V, V_{DD2} = 11.0 V $^{+2.5}_{-2.0}$V, V_{SS1} = V_{SS2} = 0 V)

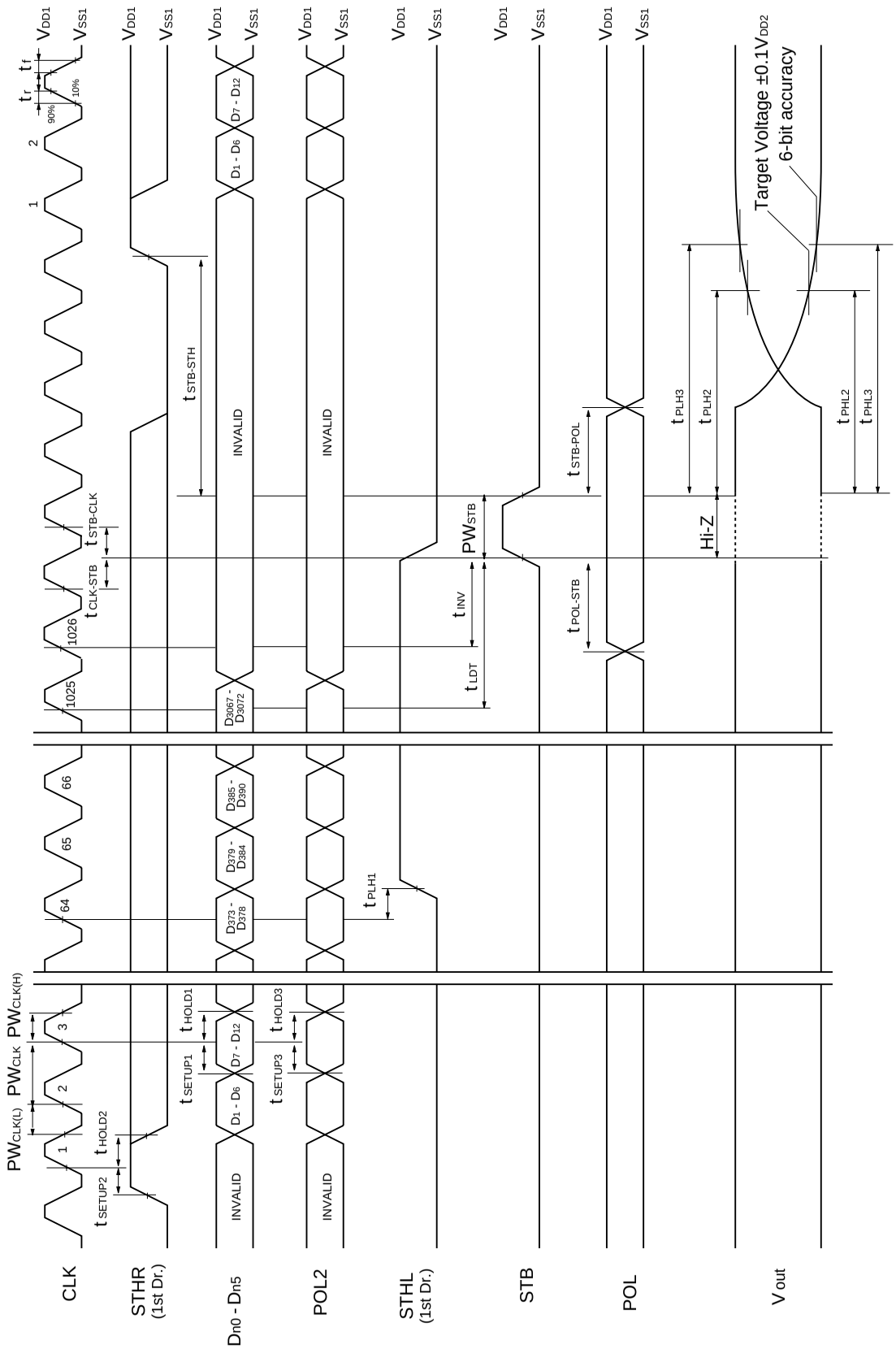
Parameter	Symbol	Condition	MIN.	TYP.	MAX.	Unit
Start Pulse Delay Time	t_{PLH1}	C_L = 25 pF		9.1	14	ns
Driver Output Delay Time	t_{PLH2}	C_L = 50 pF, R_L = 50 kΩ		5.2	11	μs
	t_{PLH3}			9.9	17	μs
	t_{PHL2}			5.3	11	μs
	t_{PHL3}			10.4	17	μs
Input Capacitance	C_{I1}	STHR (STHL) excluded, T_A = 25°C		5.8	15	pF
	C_{I2}	STHR (STHL), T_A = 25°C		5.7	15	pF

Timing Requirement (T_A = –10 to +75 °C, V_{DD1} = 3.3 V ± 0.3 V, V_{SS1} = V_{SS2} = 0 V, t_r = t_f = 8.0 ns)

Parameter	Symbol	Condition	MIN.	TYP.	MAX.	Unit
Clock Pulse Width	PW_{CLK}		18			ns
Clock Pulse High Period	$PW_{CLK(H)}$		5			ns
Clock Pulse Low Period	$PW_{CLK(L)}$		5			ns
Data Setup Time	t_{SETUP1}		0			ns
Data Hold Time	t_{HOLD1}		8			ns
Start Pulse Setup Time	t_{SETUP2}		4			ns
Start Pulse Hold Time	t_{HOLD2}		5			ns
POL2 Setup Time	t_{SETUP3}		0			ns
POL2 Hold Time	t_{HOLD3}		8			ns
STB Pulse Width	PW_{STB}		500			ns
Data Invalid Period	t_{INV}		1			CLK
Last Data Timing	t_{LDT}		2			CLK
CLK-STB Time	$t_{CLK-STB}$	CLK ↑ → STB ↑	5			ns
STB-CLK Time	$t_{STB-CLK}$	STB ↑ → CLK ↑	5			ns
Time Between STB and Start Pulse	$t_{STB-STH}$	STB ↑ → STHR(STHL) ↑	50			ns
POL-STB Time	$t_{POL-STB}$	POL ↑ or ↓ → STB ↑	–7			ns
STB-POL Time	$t_{STB-POL}$	STB ↓ → POL ↓ or ↑	9			ns

★ 9. SWITCHING CHARACTERISTICS WAVEFORM (R,/L = H)

(Unless otherwise specified, the input level is defined to be V_{IH} =0.5 V_{DD1}.)



7. RECOMMENDED SOLDERING CONDITIONS

The following conditions must be met for soldering conditions of the μPD16715A.

For more details, refer to the **Semiconductor Device Mounting Technology Manual (C10535E).**

Please consult with our sales offices in case other soldering process is used, or in case the soldering is done under different conditions.

Type of Surface Mount Device

μPD16715AN-×××: TCP (TAB package)

Mounting Condition	Mounting Method	Condition
Thermocompression	Soldering	Heating tool 300 to 350°C, heating for 2 to 3 seconds: pressure 100g (per solder)
	ACF (Adhesive Conductive Film)	Temporary bonding 70 to 100°C: pressure 3 to 8 kg/cm^2 : time 3 to 5 seconds. Real bonding 165 to 180°C: pressure 25 to 45 kg/cm^2 : time 30 to 40 seconds. (When using the anisotropy conductive film SUMIZAC1003 of Sumitomo Bakelite, Ltd.)

Caution To find out the detailed conditions for packaging the ACF part, please contact the ACF manufacturing company. Be sure to avoid using two or more packaging methods at a time.

NOTES FOR CMOS DEVICES

① PRECAUTION AGAINST ESD FOR SEMICONDUCTORS

Note:

Strong electric field, when exposed to a MOS device, can cause destruction of the gate oxide and ultimately degrade the device operation. Steps must be taken to stop generation of static electricity as much as possible, and quickly dissipate it once, when it has occurred. Environmental control must be adequate. When it is dry, humidifier should be used. It is recommended to avoid using insulators that easily build static electricity. Semiconductor devices must be stored and transported in an anti-static container, static shielding bag or conductive material. All test and measurement tools including work bench and floor should be grounded. The operator should be grounded using wrist strap. Semiconductor devices must not be touched with bare hands. Similar precautions need to be taken for PW boards with semiconductor devices on it.

② HANDLING OF UNUSED INPUT PINS FOR CMOS

Note:

No connection for CMOS device inputs can be cause of malfunction. If no connection is provided to the input pins, it is possible that an internal input level may be generated due to noise, etc., hence causing malfunction. CMOS devices behave differently than Bipolar or NMOS devices. Input levels of CMOS devices must be fixed high or low by using a pull-up or pull-down circuitry. Each unused pin should be connected to V_{DD} or GND with a resistor, if it is considered to have a possibility of being an output pin. All handling related to the unused pins must be judged device by device and related specifications governing the devices.

③ STATUS BEFORE INITIALIZATION OF MOS DEVICES

Note:

Power-on does not necessarily define initial status of MOS device. Production process of MOS does not define the initial operation status of the device. Immediately after the power source is turned ON, the devices with reset function have not yet been initialized. Hence, power-on does not guarantee out-pin levels, I/O settings or contents of registers. Device is not initialized until the reset signal is received. Reset operation must be executed immediately after power-on for devices having reset function.

Reference Documents

NEC Semiconductor Device Reliability / Quality Control System (C10983E)

Quality Grades to NEC's Semiconductor Devices (C11531E)

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  - Standard: Computers, office equipment, communications equipment, test and measurement equipment, audio and visual equipment, home electronic appliances, machine tools, personal electronic equipment and industrial robots
  - Special: Transportation equipment (automobiles, trains, ships, etc.), traffic control systems, anti-disaster systems, anti-crime systems, safety equipment and medical equipment (not specifically designed for life support)
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