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April 1st, 2010
Renesas Electronics Corporation

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DATA SHEET

RENESAS

MOS INTEGRATED CIRCUIT
μPD16754

384-OUTPUT TFT-LCD SOURCE DRIVER (COMPATIBLE WITH 256-GRAY SCALES)

DESCRIPTION

The μ PD16754 is a source driver for TFT-LCDs capable of dealing with displays with 256-gray scales. Data input is based on digital input configured as 8 bits by 6 dots (2 pixels), which can realize a full-color display of 16,777,216 colors by output of 256 values γ-corrected by an internal D/A converter and 8-by-2 external power modules.

Because the output dynamic range is as large as V_{DD2} – 0.2 V to V_{SS2} + 0.2 V, level inversion operation of the LCD's common electrode is rendered unnecessary. Also, to be able to deal with dot-line inversion, n-line inversion and column line inversion when mounted on a single side, this source driver is equipped with a built-in 8-bit D/A converter circuit whose odd output pins and even output pins respectively output gray scale voltages of differing polarity. Assuring a clock frequency of 40 MHz when driving at 3.0 V, this driver is applicable to XGA-standard TFT-LCD panels and SXGA TFT-LCD panels.

FEATURES

- CMOS level input
- 384 Outputs
- Input of 8 bits (gradation data) by 6 dots
- Capable of outputting 256 values by means of 8-by-2 external power modules (16 units) and a D/A converter
- Logic power supply voltage (V_{DD1}): 3.0 to 3.6 V
- Driver power supply voltage (V_{DD2}): 8.5 to 9.5 V
- Output dynamic range V_{DD2} – 0.2 V to V_{SS2} + 0.2 V
- High-speed data transfer: f_{CLK} = 40 MHz MAX. (internal data transfer speed when operating at V_{DD1} = 3.0 V)
- Apply for dot-line inversion, n-line inversion and column line inversion
- Output Voltage polarity inversion function (POL)
- Display data inversion function (POL21, POL22)

ORDERING INFORMATION

Part Number	Package
μ PD16754N - ×××	TCP (TAB package)

Remark The TCP's external shape is customized. To order the required shape, please contact one of our sales representatives.

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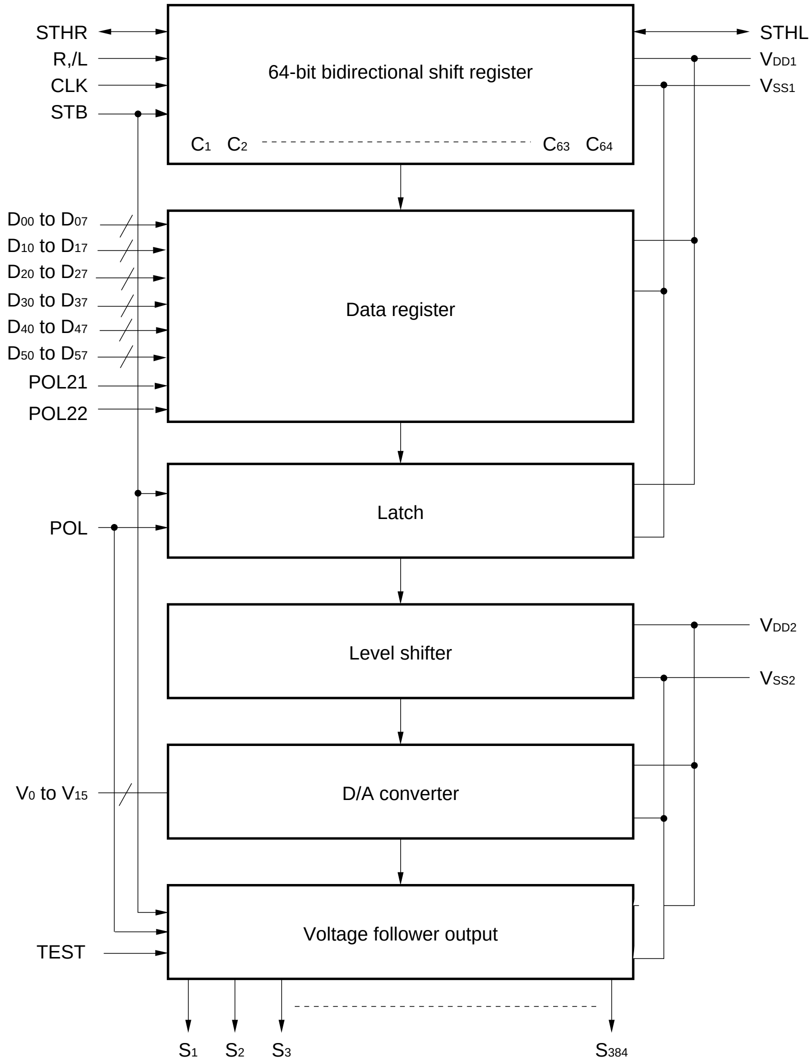
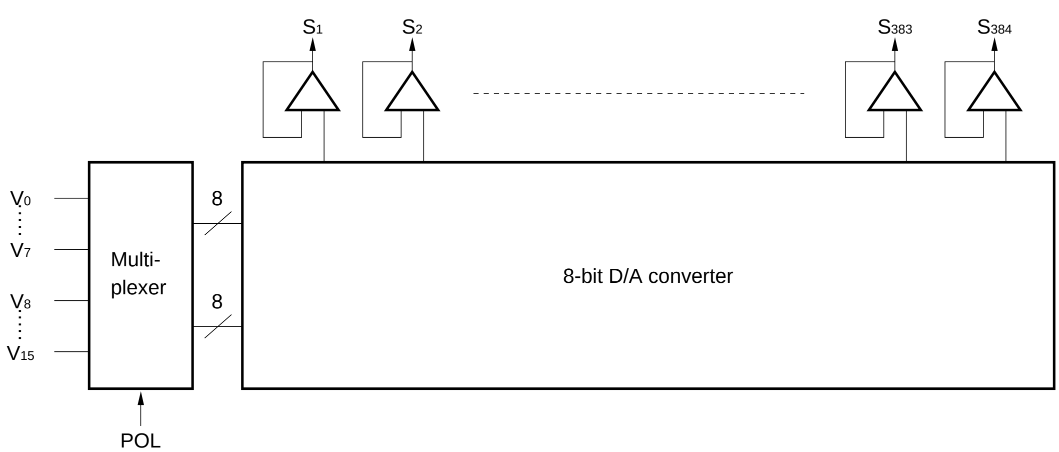
The mark ★ shows major revised points.

★ 1. BLOCK DIAGRAM

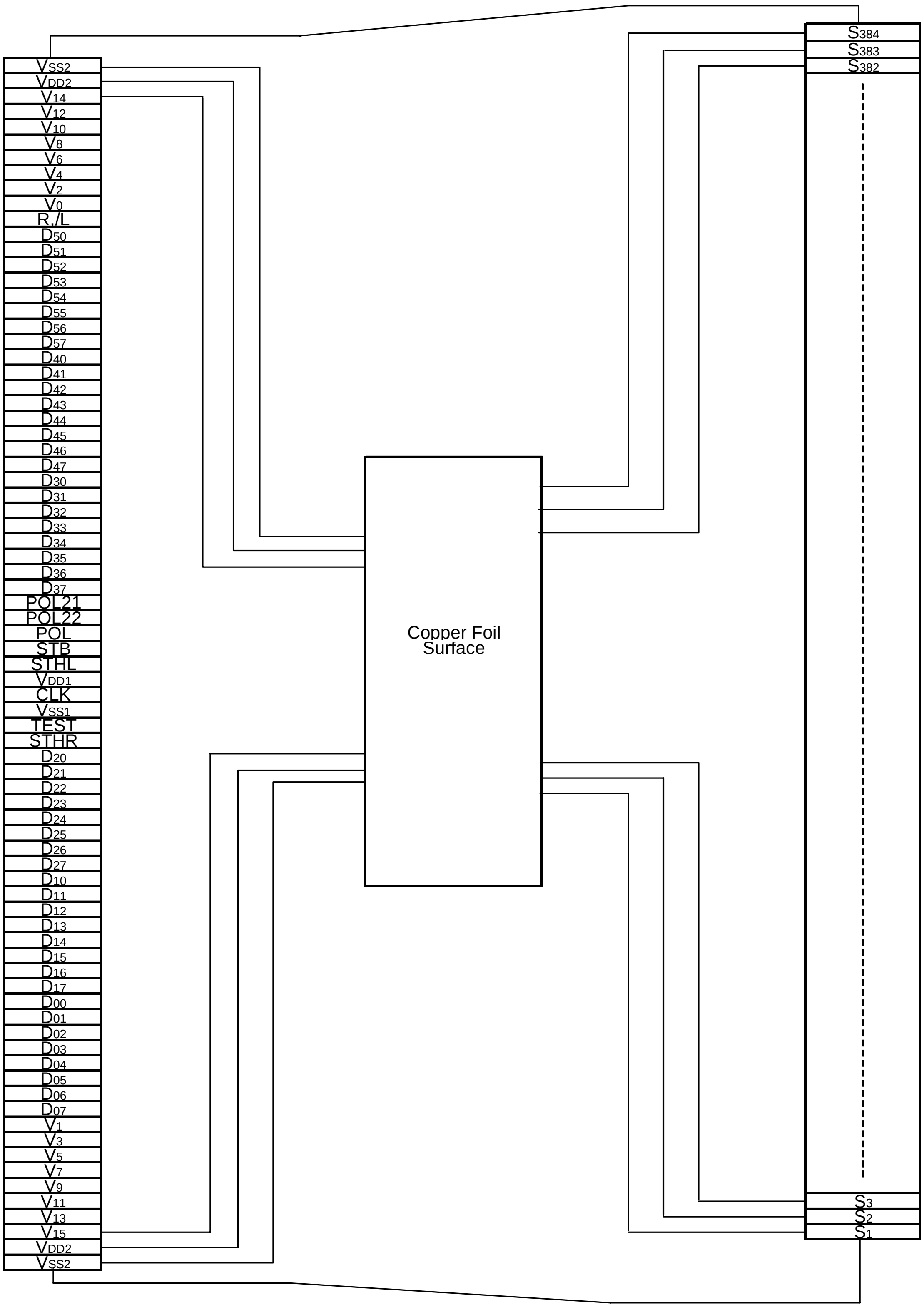


Remark /xxx indicates active low signal.

2. RELATIONSHIP BETWEEN OUTPUT CIRCUIT AND D/A CONVERTER



3. PIN CONFIGURATION (μPD16754N - xxx) (Copper Foil Surface, Face-up)



Remark This figure does not specify the TCP package.

4. PIN FUNCTIONS

(1/2)

Pin Symbol	Pin Name	I/O	Description
S_1 to S_{384}	Driver	Output	The D/A converted 256-gray-scale analog voltage is output.
D_{00} to D_{07} D_{10} to D_{17} D_{20} to D_{27} D_{30} to D_{37} D_{40} to D_{47} D_{50} to D_{57}	Display data	Input	The display data is input with a width of 48 bits, viz., the gray scale data (8 bits) by 6 dots (2 pixels). D_{X0}: LSB, D_{X7}: MSB
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	I/O	These refer to the start pulse I/O pins when driver ICs are connected in cascade. Fetching of display data starts when H is read at the rising edge of CLK. R,/L = H (right shift): STHR input, STHL output R,/L = L (left shift): STHL input, STHR output A high level should be input as the pulse of one cycle of the clock signal. If the start pulse input is more then 2CLK, the first 1CLK of the high-level input is valid.
STHL	Left shift start pulse	I/O	
CLK	Shift clock	Input	Refers to the shift register's shift clock input. At the rising edge of the 64th after the start pulse input, the start pulse output reaches the high level, thus becoming the start pulse of the next-level driver. If 66th 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_7 as the reference supply. The S_{2n} output uses V_8 to V_{15} as the reference supply. POL = H: The S_{2n-1} output uses V_8 to V_{15} as the reference supply. The S_{2n} output uses V_0 to V_7 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.
POL21, POL22	Data inversion	Input	Data inversion can invert when display data is loaded. POL21: Invert/not invert of display data D_{00} to D_{07}, D_{10} to D_{17}, D_{20} to D_{27}. POL22: Invert/not invert of display data D_{30} to D_{37}, D_{40} to D_{47}, D_{50} to D_{57}. POL21, POL22 = H: Data inversion loads display data after inverting it. POL21, POL22 = L: Data inversion does not invert input data.
TEST	TEST	Input	When this function is required, leave this pin = H or open. TEST is pulled up to the V_{DD1} power supply inside the IC.

(2/2)

Pin Symbol	Pin Name	I/O	Description
V_0 to V_{15}	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. $V_{DD2} - 0.2\ V \geq V_0 > V_1 > V_2 > V_3 > V_4 > V_5 > V_6 > V_7 \geq 0.5\ V_{DD2}$ $0.5\ V_{DD2} - 0.3 \geq V_8 > V_9 > V_{10} > V_{11} > V_{12} > V_{13} > V_{14} > V_{15} \geq V_{SS2} + 0.2\ V$
V_{DD1}	Logic power supply	–	3.0 to 3.6 V
V_{DD2}	Driver power supply	–	8.5 to 9.5 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_{15} in that order. Reverse this sequence to shut down (Simultaneous power application to V_{DD2} and V_0 to V_{15} is possible.).

2. To stabilize the supply voltage, please be sure to insert a 0.1 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_{15}) and V_{SS2}.

5. RELATIONSHIP BETWEEN INPUT DATA AND OUTPUT VOLTAGE VALUE

This product incorporates a 8-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.

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_{15} and the input data.

Be sure to maintain the voltage relationships as follows:

$V_{DD2} - 0.2\ V \geq V_0 > V_1 > V_2 > V_3 > V_4 > V_5 > V_6 > V_7 \geq 0.5\ V_{DD2}$

$0.5\ V_{DD2} - 0.3 \geq V_8 > V_9 > V_{10} > V_{11} > V_{12} > V_{13} > V_{14} > V_{15} \geq V_{SS2} + 0.2\ V.$

Figures 5–2 shows γ-corrected power supply voltage and ladder resistors ratio and Figures 5–3 shows the relationship between the input data and the output voltage and the resistance values of the resistor strings.

★ **Figure 5–1. Relationship between Input Data and γ- corrected Power Supplies**

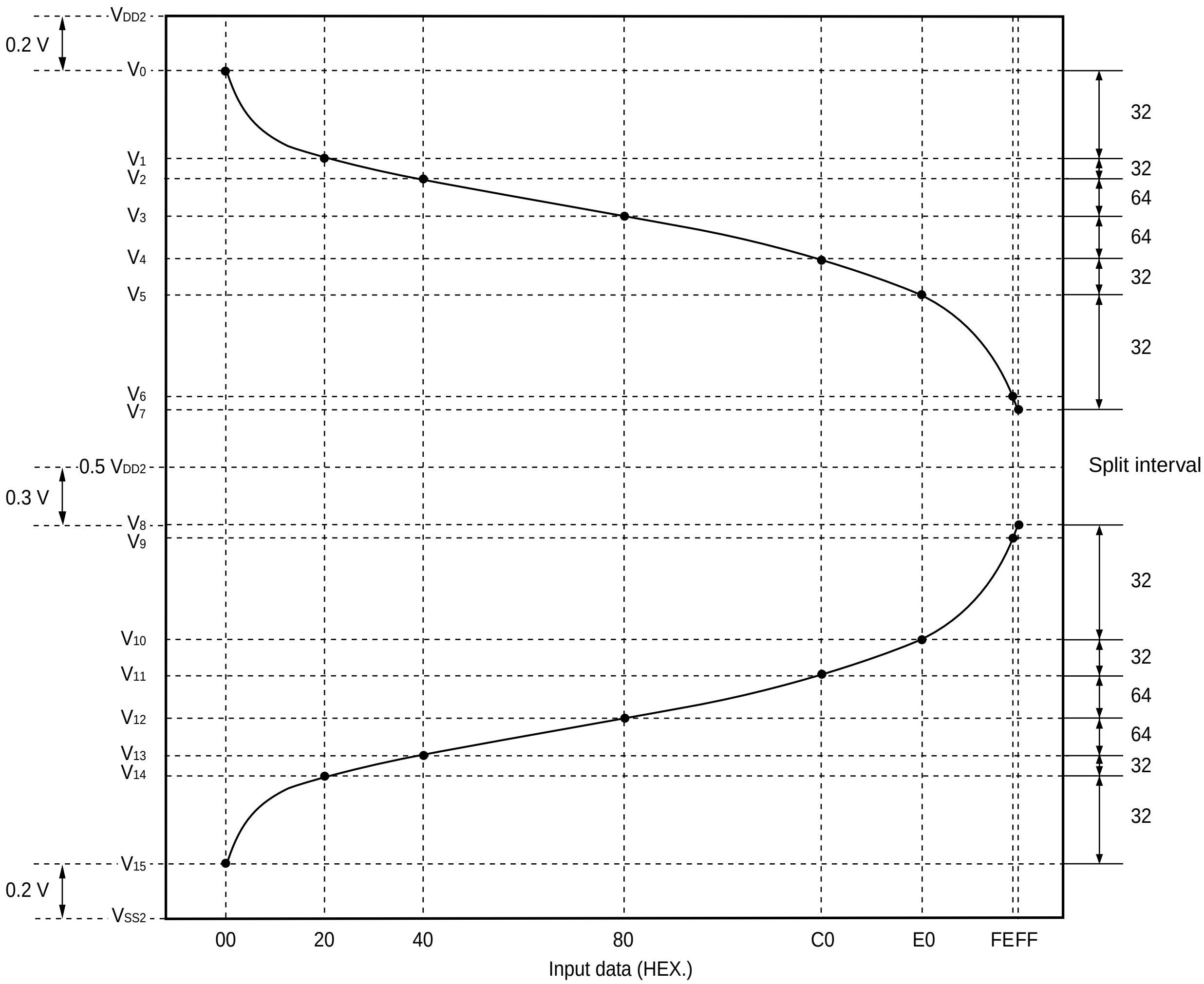


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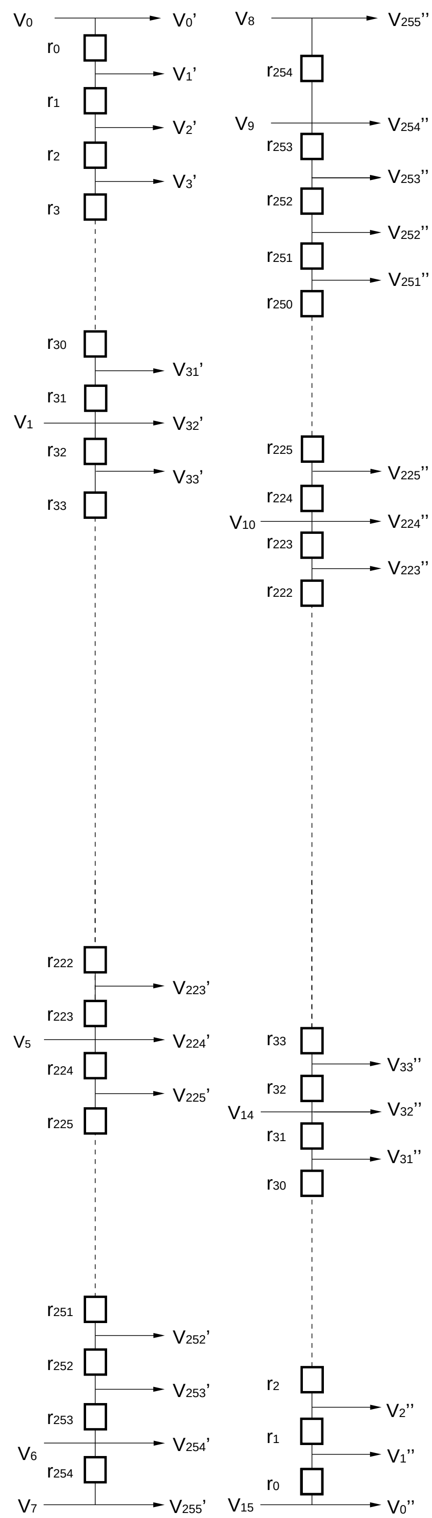
Figure 5–2. γ-corrected Voltages and Ladder Resistors Ratio



rn	Ratio 1	Ratio 2	Value	rn	Ratio 1	Ratio 2	Value	rn	Ratio 1	Ratio 2	Value	rn	Ratio 1	Ratio 2	Value
r0	16.0	0.0267	400.0	r64	1.0	0.0017	25.0	r128	1.0	0.0017	25.0	r192	1.7	0.0028	42.5
r1	14.5	0.0242	362.5	r65	1.0	0.0017	25.0	r129	1.0	0.0017	25.0	r193	1.7	0.0028	42.5
r2	13.0	0.0217	325.0	r66	1.0	0.0017	25.0	r130	1.0	0.0017	25.0	r194	1.7	0.0028	42.5
r3	11.5	0.0192	287.5	r67	1.0	0.0017	25.0	r131	1.0	0.0017	25.0	r195	1.7	0.0028	42.5
r4	10.0	0.0167	250.0	r68	1.0	0.0017	25.0	r132	1.0	0.0017	25.0	r196	1.7	0.0028	42.5
r5	8.9	0.0148	222.5	r69	1.0	0.0017	25.0	r133	1.0	0.0017	25.0	r197	1.7	0.0028	42.5
r6	7.8	0.0130	195.0	r70	1.0	0.0017	25.0	r134	1.0	0.0017	25.0	r198	1.7	0.0028	42.5
r7	6.8	0.0113	170.0	r71	1.0	0.0017	25.0	r135	1.0	0.0017	25.0	r199	1.7	0.0028	42.5
r8	5.8	0.0097	145.0	r72	1.0	0.0017	25.0	r136	1.0	0.0017	25.0	r200	1.9	0.0032	47.5
r9	4.8	0.0080	120.0	r73	1.0	0.0017	25.0	r137	1.0	0.0017	25.0	r201	1.9	0.0032	47.5
r10	4.8	0.0080	120.0	r74	1.0	0.0017	25.0	r138	1.0	0.0017	25.0	r202	1.9	0.0032	47.5
r11	4.8	0.0080	120.0	r75	1.0	0.0017	25.0	r139	1.0	0.0017	25.0	r203	1.9	0.0032	47.5
r12	3.8	0.0063	95.0	r76	1.0	0.0017	25.0	r140	1.0	0.0017	25.0	r204	1.9	0.0032	47.5
r13	3.8	0.0063	95.0	r77	1.0	0.0017	25.0	r141	1.0	0.0017	25.0	r205	1.9	0.0032	47.5
r14	3.8	0.0063	95.0	r78	1.0	0.0017	25.0	r142	1.0	0.0017	25.0	r206	1.9	0.0032	47.5
r15	3.0	0.0050	75.0	r79	1.0	0.0017	25.0	r143	1.0	0.0017	25.0	r207	1.9	0.0032	47.5
r16	3.0	0.0050	75.0	r80	1.0	0.0017	25.0	r144	1.0	0.0017	25.0	r208	2.1	0.0035	52.5
r17	3.0	0.0050	75.0	r81	1.0	0.0017	25.0	r145	1.0	0.0017	25.0	r209	2.1	0.0035	52.5
r18	2.5	0.0042	62.5	r82	1.0	0.0017	25.0	r146	1.0	0.0017	25.0	r210	2.1	0.0035	52.5
r19	2.5	0.0042	62.5	r83	1.0	0.0017	25.0	r147	1.0	0.0017	25.0	r211	2.1	0.0035	52.5
r20	2.5	0.0042	62.5	r84	1.0	0.0017	25.0	r148	1.0	0.0017	25.0	r212	2.1	0.0035	52.5
r21	2.0	0.0033	50.0	r85	1.0	0.0017	25.0	r149	1.0	0.0017	25.0	r213	2.1	0.0035	52.5
r22	2.0	0.0033	50.0	r86	1.0	0.0017	25.0	r150	1.0	0.0017	25.0	r214	2.1	0.0035	52.5
r23	2.0	0.0033	50.0	r87	1.0	0.0017	25.0	r151	1.0	0.0017	25.0	r215	2.1	0.0035	52.5
r24	1.5	0.0025	37.5	r88	1.0	0.0017	25.0	r152	1.1	0.0018	27.5	r216	2.3	0.0038	57.5
r25	1.5	0.0025	37.5	r89	1.0	0.0017	25.0	r153	1.1	0.0018	27.5	r217	2.3	0.0038	57.5
r26	1.5	0.0025	37.5	r90	1.0	0.0017	25.0	r154	1.1	0.0018	27.5	r218	2.3	0.0038	57.5
r27	1.5	0.0025	37.5	r91	1.0	0.0017	25.0	r155	1.1	0.0018	27.5	r219	2.3	0.0038	57.5
r28	1.5	0.0025	37.5	r92	1.0	0.0017	25.0	r156	1.1	0.0018	27.5	r220	2.3	0.0038	57.5
r29	1.5	0.0025	37.5	r93	1.0	0.0017	25.0	r157	1.1	0.0018	27.5	r221	2.3	0.0038	57.5
r30	1.5	0.0025	37.5	r94	1.0	0.0017	25.0	r158	1.1	0.0018	27.5	r222	2.3	0.0038	57.5
r31	1.5	0.0025	37.5	r95	1.0	0.0017	25.0	r159	1.1	0.0018	27.5	r223	2.3	0.0038	57.5
r32	1.4	0.0023	35.0	r96	1.0	0.0017	25.0	r160	1.2	0.0020	30.0	r224	2.3	0.0038	57.5
r33	1.4	0.0023	35.0	r97	1.0	0.0017	25.0	r161	1.2	0.0020	30.0	r225	2.8	0.0047	70.0
r34	1.4	0.0023	35.0	r98	1.0	0.0017	25.0	r162	1.2	0.0020	30.0	r226	2.8	0.0047	70.0
r35	1.4	0.0023	35.0	r99	1.0	0.0017	25.0	r163	1.2	0.0020	30.0	r227	2.8	0.0047	70.0
r36	1.4	0.0023	35.0	r100	1.0	0.0017	25.0	r164	1.2	0.0020	30.0	r228	3.3	0.0055	82.5
r37	1.4	0.0023	35.0	r101	1.0	0.0017	25.0	r165	1.2	0.0020	30.0	r229	3.3	0.0055	82.5
r38	1.4	0.0023	35.0	r102	1.0	0.0017	25.0	r166	1.2	0.0020	30.0	r230	3.3	0.0055	82.5
r39	1.4	0.0023	35.0	r103	1.0	0.0017	25.0	r167	1.2	0.0020	30.0	r231	3.8	0.0063	95.0
r40	1.3	0.0022	32.5	r104	1.0	0.0017	25.0	r168	1.3	0.0022	32.5	r232	3.8	0.0063	95.0
r41	1.3	0.0022	32.5	r105	1.0	0.0017	25.0	r169	1.3	0.0022	32.5	r233	3.8	0.0063	95.0
r42	1.3	0.0022	32.5	r106	1.0	0.0017	25.0	r170	1.3	0.0022	32.5	r234	4.5	0.0075	112.5
r43	1.3	0.0022	32.5	r107	1.0	0.0017	25.0	r171	1.3	0.0022	32.5	r235	4.5	0.0075	112.5
r44	1.3	0.0022	32.5	r108	1.0	0.0017	25.0	r172	1.3	0.0022	32.5	r236	4.5	0.0075	112.5
r45	1.3	0.0022	32.5	r109	1.0	0.0017	25.0	r173	1.3	0.0022	32.5	r237	5.2	0.0087	130.0
r46	1.3	0.0022	32.5	r110	1.0	0.0017	25.0	r174	1.3	0.0022	32.5	r238	5.2	0.0087	130.0
r47	1.3	0.0022	32.5	r111	1.0	0.0017	25.0	r175	1.3	0.0022	32.5	r239	5.9	0.0098	147.5
r48	1.2	0.0020	30.0	r112	1.0	0.0017	25.0	r176	1.4	0.0023	35.0	r240	5.9	0.0098	147.5
r49	1.2	0.0020	30.0	r113	1.0	0.0017	25.0	r177	1.4	0.0023	35.0	r241	6.6	0.0110	165.0
r50	1.2	0.0020	30.0	r114	1.0	0.0017	25.0	r178	1.4	0.0023	35.0	r242	6.6	0.0110	165.0
r51	1.2	0.0020	30.0	r115	1.0	0.0017	25.0	r179	1.4	0.0023	35.0	r243	7.3	0.0122	182.5
r52	1.2	0.0020	30.0	r116	1.0	0.0017	25.0	r180	1.4	0.0023	35.0	r244	7.3	0.0122	182.5
r53	1.2	0.0020	30.0	r117	1.0	0.0017	25.0	r181	1.4	0.0023	35.0	r245	8.0	0.0133	200.0
r54	1.2	0.0020	30.0	r118	1.0	0.0017	25.0	r182	1.4	0.0023	35.0	r246	8.0	0.0133	200.0
r55	1.2	0.0020	30.0	r119	1.0	0.0017	25.0	r183	1.4	0.0023	35.0	r247	9.0	0.0150	225.0
r56	1.1	0.0018	27.5	r120	1.0	0.0017	25.0	r184	1.5	0.0025	37.5	r248	9.0	0.0150	225.0
r57	1.1	0.0018	27.5	r121	1.0	0.0017	25.0	r185	1.5	0.0025	37.5	r249	10.0	0.0167	250.0
r58	1.1	0.0018	27.5	r122	1.0	0.0017	25.0	r186	1.5	0.0025	37.5	r250	10.0	0.0167	250.0
r59	1.1	0.0018	27.5	r123	1.0	0.0017	25.0	r187	1.5	0.0025	37.5	r251	12.0	0.0200	300.0
r60	1.1	0.0018	27.5	r124	1.0	0.0017	25.0	r188	1.5	0.0025	37.5	r252	12.0	0.0200	300.0
r61	1.1	0.0018	27.5	r125	1.0	0.0017	25.0	r189	1.5	0.0025	37.5	r253	14.0	0.0233	350.0
r62	1.1	0.0018	27.5	r126	1.0	0.0017	25.0	r190	1.5	0.0025	37.5	r254	14.0	0.0233	350.0
r63	1.1	0.0018	27.5	r127	1.0	0.0017	25.0	r191	1.5	0.0025	37.5	Total resistance			15003
												Minimum resistance value			25.0

Caution There is no connection between V_7 and V_8 in the chip.

★

Figure 5–3. Relationship between Input Data and Output Voltage (Output Voltage 1) (1/2)

$V_{DD2} - 0.2\ V \geq V_0 > V_1 > V_2 > V_3 > V_4 > V_5 > V_6 > V_7 \geq 0.5\ V_{DD2}$ (POL21, POL22 = L)

Data	Output Voltage			Data	Output Voltage			Data	Output Voltage			Data	Output Voltage		
00H	V0'	V0		40H	V64'	V2		80H	V128'	V3		C0H	V192'	V4	
01H	V1'	V1+(V0-V1) X	3465.0 / 3865.0	41H	V65'	V3+(V2-V3) X	1575.0 / 1600.0	81H	V129'	V4+(V3-V4) X	1875.0 / 1900.0	C1H	V193'	V5+(V4-V5) X	1557.5 / 1600.0
02H	V2'	V1+(V0-V1) X	3102.5 / 3865.0	42H	V66'	V3+(V2-V3) X	1550.0 / 1600.0	82H	V130'	V4+(V3-V4) X	1850.0 / 1900.0	C2H	V194'	V5+(V4-V5) X	1515.0 / 1600.0
03H	V3'	V1+(V0-V1) X	2777.5 / 3865.0	43H	V67'	V3+(V2-V3) X	1525.0 / 1600.0	83H	V131'	V4+(V3-V4) X	1825.0 / 1900.0	C3H	V195'	V5+(V4-V5) X	1472.5 / 1600.0
04H	V4'	V1+(V0-V1) X	2490.0 / 3865.0	44H	V68'	V3+(V2-V3) X	1500.0 / 1600.0	84H	V132'	V4+(V3-V4) X	1800.0 / 1900.0	C4H	V196'	V5+(V4-V5) X	1430.0 / 1600.0
05H	V5'	V1+(V0-V1) X	2240.0 / 3865.0	45H	V69'	V3+(V2-V3) X	1475.0 / 1600.0	85H	V133'	V4+(V3-V4) X	1775.0 / 1900.0	C5H	V197'	V5+(V4-V5) X	1387.5 / 1600.0
06H	V6'	V1+(V0-V1) X	2017.5 / 3865.0	46H	V70'	V3+(V2-V3) X	1450.0 / 1600.0	86H	V134'	V4+(V3-V4) X	1750.0 / 1900.0	C6H	V198'	V5+(V4-V5) X	1345.0 / 1600.0
07H	V7'	V1+(V0-V1) X	1822.5 / 3865.0	47H	V71'	V3+(V2-V3) X	1425.0 / 1600.0	87H	V135'	V4+(V3-V4) X	1725.0 / 1900.0	C7H	V199'	V5+(V4-V5) X	1302.5 / 1600.0
08H	V8'	V1+(V0-V1) X	1652.5 / 3865.0	48H	V72'	V3+(V2-V3) X	1400.0 / 1600.0	88H	V136'	V4+(V3-V4) X	1700.0 / 1900.0	C8H	V200'	V5+(V4-V5) X	1260.0 / 1600.0
09H	V9'	V1+(V0-V1) X	1507.5 / 3865.0	49H	V73'	V3+(V2-V3) X	1375.0 / 1600.0	89H	V137'	V4+(V3-V4) X	1675.0 / 1900.0	C9H	V201'	V5+(V4-V5) X	1212.5 / 1600.0
0AH	V10'	V1+(V0-V1) X	1387.5 / 3865.0	4AH	V74'	V3+(V2-V3) X	1350.0 / 1600.0	8AH	V138'	V4+(V3-V4) X	1650.0 / 1900.0	CAH	V202'	V5+(V4-V5) X	1165.0 / 1600.0
0BH	V11'	V1+(V0-V1) X	1267.5 / 3865.0	4BH	V75'	V3+(V2-V3) X	1325.0 / 1600.0	8BH	V139'	V4+(V3-V4) X	1625.0 / 1900.0	CBH	V203'	V5+(V4-V5) X	1117.5 / 1600.0
0CH	V12'	V1+(V0-V1) X	1147.5 / 3865.0	4CH	V76'	V3+(V2-V3) X	1300.0 / 1600.0	8CH	V140'	V4+(V3-V4) X	1600.0 / 1900.0	CCH	V204'	V5+(V4-V5) X	1070.0 / 1600.0
0DH	V13'	V1+(V0-V1) X	1052.5 / 3865.0	4DH	V77'	V3+(V2-V3) X	1275.0 / 1600.0	8DH	V141'	V4+(V3-V4) X	1575.0 / 1900.0	CDH	V205'	V5+(V4-V5) X	1022.5 / 1600.0
0EH	V14'	V1+(V0-V1) X	957.5 / 3865.0	4EH	V78'	V3+(V2-V3) X	1250.0 / 1600.0	8EH	V142'	V4+(V3-V4) X	1550.0 / 1900.0	CEH	V206'	V5+(V4-V5) X	975.0 / 1600.0
0FH	V15'	V1+(V0-V1) X	862.5 / 3865.0	4FH	V79'	V3+(V2-V3) X	1225.0 / 1600.0	8FH	V143'	V4+(V3-V4) X	1525.0 / 1900.0	CFH	V207'	V5+(V4-V5) X	927.5 / 1600.0
10H	V16'	V1+(V0-V1) X	787.5 / 3865.0	50H	V80'	V3+(V2-V3) X	1200.0 / 1600.0	90H	V144'	V4+(V3-V4) X	1500.0 / 1900.0	D0H	V208'	V5+(V4-V5) X	880.0 / 1600.0
11H	V17'	V1+(V0-V1) X	712.5 / 3865.0	51H	V81'	V3+(V2-V3) X	1175.0 / 1600.0	91H	V145'	V4+(V3-V4) X	1475.0 / 1900.0	D1H	V209'	V5+(V4-V5) X	827.5 / 1600.0
12H	V18'	V1+(V0-V1) X	637.5 / 3865.0	52H	V82'	V3+(V2-V3) X	1150.0 / 1600.0	92H	V146'	V4+(V3-V4) X	1450.0 / 1900.0	D2H	V210'	V5+(V4-V5) X	775.0 / 1600.0
13H	V19'	V1+(V0-V1) X	575.0 / 3865.0	53H	V83'	V3+(V2-V3) X	1125.0 / 1600.0	93H	V147'	V4+(V3-V4) X	1425.0 / 1900.0	D3H	V211'	V5+(V4-V5) X	722.5 / 1600.0
14H	V20'	V1+(V0-V1) X	512.5 / 3865.0	54H	V84'	V3+(V2-V3) X	1100.0 / 1600.0	94H	V148'	V4+(V3-V4) X	1400.0 / 1900.0	D4H	V212'	V5+(V4-V5) X	670.0 / 1600.0
15H	V21'	V1+(V0-V1) X	450.0 / 3865.0	55H	V85'	V3+(V2-V3) X	1075.0 / 1600.0	95H	V149'	V4+(V3-V4) X	1375.0 / 1900.0	D5H	V213'	V5+(V4-V5) X	617.5 / 1600.0
16H	V22'	V1+(V0-V1) X	400.0 / 3865.0	56H	V86'	V3+(V2-V3) X	1050.0 / 1600.0	96H	V150'	V4+(V3-V4) X	1350.0 / 1900.0	D6H	V214'	V5+(V4-V5) X	565.0 / 1600.0
17H	V23'	V1+(V0-V1) X	350.0 / 3865.0	57H	V87'	V3+(V2-V3) X	1025.0 / 1600.0	97H	V151'	V4+(V3-V4) X	1325.0 / 1900.0	D7H	V215'	V5+(V4-V5) X	512.5 / 1600.0
18H	V24'	V1+(V0-V1) X	300.0 / 3865.0	58H	V88'	V3+(V2-V3) X	1000.0 / 1600.0	98H	V152'	V4+(V3-V4) X	1300.0 / 1900.0	D8H	V216'	V5+(V4-V5) X	460.0 / 1600.0
19H	V25'	V1+(V0-V1) X	262.5 / 3865.0	59H	V89'	V3+(V2-V3) X	975.0 / 1600.0	99H	V153'	V4+(V3-V4) X	1272.5 / 1900.0	D9H	V217'	V5+(V4-V5) X	402.5 / 1600.0
1AH	V26'	V1+(V0-V1) X	225.0 / 3865.0	5AH	V90'	V3+(V2-V3) X	950.0 / 1600.0	9AH	V154'	V4+(V3-V4) X	1245.0 / 1900.0	DAH	V218'	V5+(V4-V5) X	345.0 / 1600.0
1BH	V27'	V1+(V0-V1) X	187.5 / 3865.0	5BH	V91'	V3+(V2-V3) X	925.0 / 1600.0	9BH	V155'	V4+(V3-V4) X	1217.5 / 1900.0	DBH	V219'	V5+(V4-V5) X	287.5 / 1600.0
1CH	V28'	V1+(V0-V1) X	150.0 / 3865.0	5CH	V92'	V3+(V2-V3) X	900.0 / 1600.0	9CH	V156'	V4+(V3-V4) X	1190.0 / 1900.0	DCH	V220'	V5+(V4-V5) X	230.0 / 1600.0
1DH	V29'	V1+(V0-V1) X	112.5 / 3865.0	5DH	V93'	V3+(V2-V3) X	875.0 / 1600.0	9DH	V157'	V4+(V3-V4) X	1162.5 / 1900.0	DDH	V221'	V5+(V4-V5) X	172.5 / 1600.0
1EH	V30'	V1+(V0-V1) X	75.0 / 3865.0	5EH	V94'	V3+(V2-V3) X	850.0 / 1600.0	9EH	V158'	V4+(V3-V4) X	1135.0 / 1900.0	DEH	V222'	V5+(V4-V5) X	115.0 / 1600.0
1FH	V31'	V1+(V0-V1) X	37.5 / 3865.0	5FH	V95'	V3+(V2-V3) X	825.0 / 1600.0	9FH	V159'	V4+(V3-V4) X	1107.5 / 1900.0	DFH	V223'	V5+(V4-V5) X	57.5 / 1600.0
20H	V32'	V1		60H	V96'	V3+(V2-V3) X	800.0 / 1600.0	A0H	V160'	V4+(V3-V4) X	1080.0 1900.0	E0H	V224'	V5	
21H	V33'	V2+(V1-V2) X	965.0 / 1000.0	61H	V97'	V3+(V2-V3) X	775.0 / 1600.0	A1H	V161'	V4+(V3-V4) X	1050.0 / 1900.0	E1H	V225'	V6+(V5-V6) X	4630.0 / 4687.5
22H	V34'	V2+(V1-V2) X	930.0 / 1000.0	62H	V98'	V3+(V2-V3) X	750.0 / 1600.0	A2H	V162'	V4+(V3-V4) X	1020.0 / 1900.0	E2H	V226'	V6+(V5-V6) X	4560.0 / 4687.5
23H	V35'	V2+(V1-V2) X	895.0 / 1000.0	63H	V99'	V3+(V2-V3) X	725.0 / 1600.0	A3H	V163'	V4+(V3-V4) X	990.0 / 1900.0	E3H	V227'	V6+(V5-V6) X	4490.0 / 4687.5
24H	V36'	V2+(V1-V2) X	860.0 / 1000.0	64H	V100'	V3+(V2-V3) X	700.0 / 1600.0	A4H	V164'	V4+(V3-V4) X	960.0 / 1900.0	E4H	V228'	V6+(V5-V6) X	4420.0 / 4687.5
25H	V37'	V2+(V1-V2) X	825.0 / 1000.0	65H	V101'	V3+(V2-V3) X	675.0 / 1600.0	A5H	V165'	V4+(V3-V4) X	930.0 / 1900.0	E5H	V229'	V6+(V5-V6) X	4337.5 / 4687.5
26H	V38'	V2+(V1-V2) X	790.0 / 1000.0	66H	V102'	V3+(V2-V3) X	650.0 / 1600.0	A6H	V166'	V4+(V3-V4) X	900.0 / 1900.0	E6H	V230'	V6+(V5-V6) X	4255.0 / 4687.5
27H	V39'	V2+(V1-V2) X	755.0 / 1000.0	67H	V103'	V3+(V2-V3) X	625.0 / 1600.0	A7H	V167'	V4+(V3-V4) X	870.0 / 1900.0	E7H	V231'	V6+(V5-V6) X	4172.5 / 4687.5
28H	V40'	V2+(V1-V2) X	720.0 / 1000.0	68H	V104'	V3+(V2-V3) X	600.0 / 1600.0	A8H	V168'	V4+(V3-V4) X	840.0 / 1900.0	E8H	V232'	V6+(V5-V6) X	4077.5 / 4687.5
29H	V41'	V2+(V1-V2) X	687.5 / 1000.0	69H	V105'	V3+(V2-V3) X	575.0 / 1600.0	A9H	V169'	V4+(V3-V4) X	807.5 / 1900.0	E9H	V233'	V6+(V5-V6) X	3982.5 / 4687.5
2AH	V42'	V2+(V1-V2) X	655.0 / 1000.0	6AH	V106'	V3+(V2-V3) X	550.0 / 1600.0	AAH	V170'	V4+(V3-V4) X	775.0 / 1900.0	EAH	V234'	V6+(V5-V6) X	3887.5 / 4687.5
2BH	V43'	V2+(V1-V2) X	622.5 / 1000.0	6BH	V107'	V3+(V2-V3) X	525.0 / 1600.0	ABH	V171'	V4+(V3-V4) X	742.5 / 1900.0	EBH	V235'	V6+(V5-V6) X	3775.0 / 4687.5
2CH	V44'	V2+(V1-V2) X	590.0 / 1000.0	6CH	V108'	V3+(V2-V3) X	500.0 / 1600.0	ACH	V172'	V4+(V3-V4) X	710.0 / 1900.0	ECH	V236'	V6+(V5-V6) X	3662.5 / 4687.5
2DH	V45'	V2+(V1-V2) X	557.5 / 1000.0	6DH	V109'	V3+(V2-V3) X	475.0 / 1600.0	ADH	V173'	V4+(V3-V4) X	677.5 / 1900.0	EDH	V237'	V6+(V5-V6) X	3550.0 / 4687.5
2EH	V46'	V2+(V1-V2) X	525.0 / 1000.0	6EH	V110'	V3+(V2-V3) X	450.0 / 1600.0	AEH	V174'	V4+(V3-V4) X	645.0 / 1900.0	EEH	V238'	V6+(V5-V6) X	3420.0 / 4687.5
2FH	V47'	V2+(V1-V2) X	492.5 / 1000.0	6FH	V111'	V3+(V2-V3) X	425.0 / 1600.0	AFH	V175'	V4+(V3-V4) X	612.5 / 1900.0	EFH	V239'	V6+(V5-V6) X	3290.0 / 4687.5
30H	V48'	V2+(V1-V2) X	460.0 / 1000.0	70H	V112'	V3+(V2-V3) X	400.0 / 1600.0	B0H	V176'	V4+(V3-V4) X	580.0 / 1900.0	F0H	V240'	V6+(V5-V6) X	3142.5 4687.5
31H	V49'	V2+(V1-V2) X	430.0 / 1000.0	71H	V113'	V3+(V2-V3) X	375.0 / 1600.0	B1H	V177'	V4+(V3-V4) X	545.0 / 1900.0	F1H	V241'	V6+(V5-V6) X	2995.0 / 4687.5
32H	V50'	V2+(V1-V2) X	400.0 / 1000.0	72H	V114'	V3+(V2-V3) X	350.0 / 1600.0	B2H	V178'	V4+(V3-V4) X	510.0 / 1900.0	F2H	V242'	V6+(V5-V6) X	2830.0 / 4687.5
33H	V51'	V2+(V1-V2) X	370.0 / 1000.0	73H	V115'	V3+(V2-V3) X	325.0 / 1600.0	B3H	V179'	V4+(V3-V4) X	475.0 / 1900.0	F3H	V243'	V6+(V5-V6) X	2665.0 / 4687.5
34H	V52'	V2+(V1-V2) X	340.0 / 1000.0	74H	V116'	V3+(V2-V3) X	300.0 / 1600.0	B4H	V180'	V4+(V3-V4) X	440.0 / 1900.0	F4H	V244'	V6+(V5-V6) X	2482.5 / 4687.5
35H	V53'	V2+(V1-V2) X	310.0 / 1000.0	75H	V117'	V3+(V2-V3) X	275.0 / 1600.0	B5H	V181'	V4+(V3-V4) X	405.0 / 1900.0	F5H	V245'	V6+(V5-V6) X	2300.0 / 4687.5
36H	V54'	V2+(V1-V2) X	280.0 / 1000.0	76H	V118'	V3+(V2-V3) X	250.0 / 1600.0	B6H	V182'	V4+(V3-V4) X	370.0 / 1900.0	F6H	V246'	V6+(V5-V6) X	2100.0 / 4687.5
37H	V55'	V2+(V1-V2) X	250.0 / 1000.0	77H	V119'	V3+(V2-V3) X	225.0 / 1600.0	B7H	V183'	V4+(V3-V4) X	335.0 / 1900.0	F7H	V247'	V6+(V5-V6) X	1900.0 / 4687.5
38H	V56'	V2+(V1-V2) X	220.0 / 1000.0	78H	V120'	V3+(V2-V3) X	200.0 / 1600.0	B8H	V184'	V4+(V3-V4) X	300.0 / 1900.0	F8H	V248'	V6+(V5-V6) X	1675.0 / 4687.5
39H	V57'	V2+(V1-V2) X	192.5 / 1000.0	79H	V121'	V3+(V2-V3) X	175.0 / 1600.0	B9H	V185'	V4+(V3-V4) X	262.5 / 1900.0	F9H	V249'	V6+(V5-V6) X	1450.0 / 4687.5
3AH	V58'	V2+(V1-V2) X	165.0 / 1000.0	7AH	V122'	V3+(V2-V3) X	150.0 / 1600.0	BAH	V186'	V4+(V3-V4) X	225.0 / 1900.0	FAH	V250'	V6+(V5-V6) X	1200.0 / 4687.5
3BH	V59'	V2+(V1-V2) X	137.5 / 1000.0	7BH	V123'	V3+(V2-V3) X	125.0 / 1600.0	BBH	V187'	V4+(V3-V4) X	187.5 / 1900.0	FBH	V251'	V6+(V5-V6) X	950.0 / 4687.5
3CH	V60'	V2+(V1-V2) X	110.0 / 1000.0	7CH	V124'	V3+(V2-V3) X	100.0 / 1600.0	BCH	V188'	V4+(V3-V4) X	150.0 / 1900.0	FCH	V252'	V6+(V5-V6) X	650.0 / 4687.5
3DH	V61'	V2+(V1-V2) X	82.5 / 1000.0	7DH	V125'	V3+(V2-V3) X	75.0 / 1600.0	BDH	V189'	V4+(V3-V4) X	112.5 / 1900.0	FDH	V253'	V6+(V5-V6) X	350.0 / 4687.5
3EH	V62'	V2+(V1-V2) X	55.0 / 1000.0	7EH	V126'	V3+(V2-V3) X	50.0 / 1600.0	BEH	V190'	V4+(V3-V4) X	75.0 / 1900.0	FEH	V254'	V6	
3FH	V63'	V2+(V1-V2) X	27.5 / 1000.0	7FH	V127'	V3+(V2-V3) X	25.0 / 1600.0	BFH	V191'	V4+(V3-V4) X	37.5 / 1900.0	FFH	V255'	V7	

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

$0.5\ V_{DD2} - 0.3\ V \geq V_8 > V_9 > V_{10} > V_{11} > V_{12} > V_{13} > V_{14} > V_{15} \geq V_{DD2} + 0.2\ V$ (POL21, POL22 = L)

Data	Output Voltage				
00H	V0"	V15			
01H	V1"	V15+(V14-V15) X	400.0	/	3865.0
02H	V2"	V15+(V14-V15) X	762.5	/	3865.0
03H	V3"	V15+(V14-V15) X	1087.5	/	3865.0
04H	V4"	V15+(V14-V15) X	1375.0	/	3865.0
05H	V5"	V15+(V14-V15) X	1625.0	/	3865.0
06H	V6"	V15+(V14-V15) X	1847.5	/	3865.0
07H	V7"	V15+(V14-V15) X	2042.5	/	3865.0
08H	V8"	V15+(V14-V15) X	2212.5	/	3865.0
09H	V9"	V15+(V14-V15) X	2357.5	/	3865.0
0AH	V10"	V15+(V14-V15) X	2477.5	/	3865.0
0BH	V11"	V15+(V14-V15) X	2597.5	/	3865.0
0CH	V12"	V15+(V14-V15) X	2717.5	/	3865.0
0DH	V13"	V15+(V14-V15) X	2812.5	/	3865.0
0EH	V14"	V15+(V14-V15) X	2907.5	/	3865.0
0FH	V15"	V15+(V14-V15) X	3002.5	/	3865.0
10H	V16"	V15+(V14-V15) X	3077.5	/	3865.0
11H	V17"	V15+(V14-V15) X	3152.5	/	3865.0
12H	V18"	V15+(V14-V15) X	3227.5	/	3865.0
13H	V19"	V15+(V14-V15) X	3290.0	/	3865.0
14H	V20"	V15+(V14-V15) X	3352.5	/	3865.0
15H	V21"	V15+(V14-V15) X	3415.0	/	3865.0
16H	V22"	V15+(V14-V15) X	3465.0	/	3865.0
17H	V23"	V15+(V14-V15) X	3515.0	/	3865.0
18H	V24"	V15+(V14-V15) X	3565.0	/	3865.0
19H	V25"	V15+(V14-V15) X	3602.5	/	3865.0
1AH	V26"	V15+(V14-V15) X	3640.0	/	3865.0
1BH	V27"	V15+(V14-V15) X	3677.5	/	3865.0
1CH	V28"	V15+(V14-V15) X	3715.0	/	3865.0
1DH	V29"	V15+(V14-V15) X	3752.5	/	3865.0
1EH	V30"	V15+(V14-V15) X	3790.0	/	3865.0
1FH	V31"	V15+(V14-V15) X	3827.5	/	3865.0
20H	V32"	V14			
21H	V33"	V14+(V13-V14) X	35.0	/	1000.0
22H	V34"	V14+(V13-V14) X	70.0	/	1000.0
23H	V35"	V14+(V13-V14) X	105.0	/	1000.0
24H	V36"	V14+(V13-V14) X	140.0	/	1000.0
25H	V37"	V14+(V13-V14) X	175.0	/	1000.0
26H	V38"	V14+(V13-V14) X	210.0	/	1000.0
27H	V39"	V14+(V13-V14) X	245.0	/	1000.0
28H	V40"	V14+(V13-V14) X	280.0	/	1000.0
29H	V41"	V14+(V13-V14) X	312.5	/	1000.0
2AH	V42"	V14+(V13-V14) X	345.0	/	1000.0
2BH	V43"	V14+(V13-V14) X	377.5	/	1000.0
2CH	V44"	V14+(V13-V14) X	410.0	/	1000.0
2DH	V45"	V14+(V13-V14) X	442.5	/	1000.0
2EH	V46"	V14+(V13-V14) X	475.0	/	1000.0
2FH	V47"	V14+(V13-V14) X	507.5	/	1000.0
30H	V48"	V14+(V13-V14) X	540.0	/	1000.0
31H	V49"	V14+(V13-V14) X	570.0	/	1000.0
32H	V50"	V14+(V13-V14) X	600.0	/	1000.0
33H	V51"	V14+(V13-V14) X	630.0	/	1000.0
34H	V52"	V14+(V13-V14) X	660.0	/	1000.0
35H	V53"	V14+(V13-V14) X	690.0	/	1000.0
36H	V54"	V14+(V13-V14) X	720.0	/	1000.0
37H	V55"	V14+(V13-V14) X	750.0	/	1000.0
38H	V56"	V14+(V13-V14) X	780.0	/	1000.0
39H	V57"	V14+(V13-V14) X	807.5	/	1000.0
3AH	V58"	V14+(V13-V14) X	835.0	/	1000.0
3BH	V59"	V14+(V13-V14) X	862.5	/	1000.0
3CH	V60"	V14+(V13-V14) X	890.0	/	1000.0
3DH	V61"	V14+(V13-V14) X	917.5	/	1000.0
3EH	V62"	V14+(V13-V14) X	945.0	/	1000.0
3FH	V63"	V14+(V13-V14) X	972.5		1000.0

Data	Output Voltage				
40H	V64"	V13			
41H	V65"	V13+(V12-V13) X	25.0	/	1600.0
42H	V66"	V13+(V12-V13) X	50.0	/	1600.0
43H	V67"	V13+(V12-V13) X	75.0	/	1600.0
44H	V68"	V13+(V12-V13) X	100.0	/	1600.0
45H	V69"	V13+(V12-V13) X	125.0	/	1600.0
46H	V70"	V13+(V12-V13) X	150.0	/	1600.0
47H	V71"	V13+(V12-V13) X	175.0	/	1600.0
48H	V72"	V13+(V12-V13) X	200.0	/	1600.0
49H	V73"	V13+(V12-V13) X	225.0	/	1600.0
4AH	V74"	V13+(V12-V13) X	250.0	/	1600.0
4BH	V75"	V13+(V12-V13) X	275.0	/	1600.0
4CH	V76"	V13+(V12-V13) X	300.0	/	1600.0
4DH	V77"	V13+(V12-V13) X	325.0	/	1600.0
4EH	V78"	V13+(V12-V13) X	350.0	/	1600.0
4FH	V79"	V13+(V12-V13) X	375.0	/	1600.0
50H	V80"	V13+(V12-V13) X	400.0	/	1600.0
51H	V81"	V13+(V12-V13) X	425.0	/	1600.0
52H	V82"	V13+(V12-V13) X	450.0	/	1600.0
53H	V83"	V13+(V12-V13) X	475.0	/	1600.0
54H	V84"	V13+(V12-V13) X	500.0	/	1600.0
55H	V85"	V13+(V12-V13) X	525.0	/	1600.0
56H	V86"	V13+(V12-V13) X	550.0	/	1600.0
57H	V87"	V13+(V12-V13) X	575.0	/	1600.0
58H	V88"	V13+(V12-V13) X	600.0	/	1600.0
59H	V89"	V13+(V12-V13) X	625.0	/	1600.0
5AH	V90"	V13+(V12-V13) X	650.0	/	1600.0
5BH	V91"	V13+(V12-V13) X	675.0	/	1600.0
5CH	V92"	V13+(V12-V13) X	700.0	/	1600.0
5DH	V93"	V13+(V12-V13) X	725.0	/	1600.0
5EH	V94"	V13+(V12-V13) X	750.0	/	1600.0
5FH	V95"	V13+(V12-V13) X	775.0	/	1600.0
60H	V96"	V13+(V12-V13) X	800.0	/	1600.0
61H	V97"	V13+(V12-V13) X	825.0	/	1600.0
62H	V98"	V13+(V12-V13) X	850.0	/	1600.0
63H	V99"	V13+(V12-V13) X	875.0	/	1600.0
64H	V100"	V13+(V12-V13) X	900.0	/	1600.0
65H	V101"	V13+(V12-V13) X	925.0	/	1600.0
66H	V102"	V13+(V12-V13) X	950.0	/	1600.0
67H	V103"	V13+(V12-V13) X	975.0	/	1600.0
68H	V104"	V13+(V12-V13) X	1000.0	/	1600.0
69H	V105"	V13+(V12-V13) X	1025.0	/	1600.0
6AH	V106"	V13+(V12-V13) X	1050.0	/	1600.0
6BH	V107"	V13+(V12-V13) X	1075.0	/	1600.0
6CH	V108"	V13+(V12-V13) X	1100.0	/	1600.0
6DH	V109"	V13+(V12-V13) X	1125.0	/	1600.0
6EH	V110"	V13+(V12-V13) X	1150.0	/	1600.0
6FH	V111"	V13+(V12-V13) X	1175.0	/	1600.0
70H	V112"	V13+(V12-V13) X	1200.0	/	1600.0
71H	V113"	V13+(V12-V13) X	1225.0	/	1600.0
72H	V114"	V13+(V12-V13) X	1250.0	/	1600.0
73H	V115"	V13+(V12-V13) X	1275.0	/	1600.0
74H	V116"	V13+(V12-V13) X	1300.0	/	1600.0
75H	V117"	V13+(V12-V13) X	1325.0	/	1600.0
76H	V118"	V13+(V12-V13) X	1350.0	/	1600.0
77H	V119"	V13+(V12-V13) X	1375.0	/	1600.0
78H	V120"	V13+(V12-V13) X	1400.0	/	1600.0
79H	V121"	V13+(V12-V13) X	1425.0	/	1600.0
7AH	V122"	V13+(V12-V13) X	1450.0	/	1600.0
7BH	V123"	V13+(V12-V13) X	1475.0	/	1600.0
7CH	V124"	V13+(V12-V13) X	1500.0	/	1600.0
7DH	V125"	V13+(V12-V13) X	1525.0	/	1600.0
7EH	V126"	V13+(V12-V13) X	1550.0	/	1600.0
7FH	V127"	V13+(V12-V13) X	1575.0		1600.0

Data	Output Voltage				
80H	V128"	V12			
81H	V129"	V12+(V11-V12) X	25.0	/	1900.0
82H	V130"	V12+(V11-V12) X	50.0	/	1900.0
83H	V131"	V12+(V11-V12) X	75.0	/	1900.0
84H	V132"	V12+(V11-V12) X	100.0	/	1900.0
85H	V133"	V12+(V11-V12) X	125.0	/	1900.0
86H	V134"	V12+(V11-V12) X	150.0	/	1900.0
87H	V135"	V12+(V11-V12) X	175.0	/	1900.0
88H	V136"	V12+(V11-V12) X	200.0	/	1900.0
89H	V137"	V12+(V11-V12) X	225.0	/	1900.0
8AH	V138"	V12+(V11-V12) X	250.0	/	1900.0
8BH	V139"	V12+(V11-V12) X	275.0	/	1900.0
8CH	V140"	V12+(V11-V12) X	300.0	/	1900.0
8DH	V141"	V12+(V11-V12) X	325.0	/	1900.0
8EH	V142"	V12+(V11-V12) X	350.0	/	1900.0
8FH	V143"	V12+(V11-V12) X	375.0	/	1900.0
90H	V144"	V12+(V11-V12) X	400.0	/	1900.0
91H	V145"	V12+(V11-V12) X	425.0	/	1900.0
92H	V146"	V12+(V11-V12) X	450.0	/	1900.0
93H	V147"	V12+(V11-V12) X	475.0	/	1900.0
94H	V148"	V12+(V11-V12) X	500.0	/	1900.0
95H	V149"	V12+(V11-V12) X	525.0	/	1900.0
96H	V150"	V12+(V11-V12) X	550.0	/	1900.0
97H	V151"	V12+(V11-V12) X	575.0	/	1900.0
98H	V152"	V12+(V11-V12) X	600.0	/	1900.0
99H	V153"	V12+(V11-V12) X	627.5	/	1900.0
9AH	V154"	V12+(V11-V12) X	655.0	/	1900.0
9BH	V155"	V12+(V11-V12) X	682.5	/	1900.0
9CH	V156"	V12+(V11-V12) X	710.0	/	1900.0
9DH	V157"	V12+(V11-V12) X	737.5	/	1900.0
9EH	V158"	V12+(V11-V12) X	765.0	/	1900.0
9FH	V159"	V12+(V11-V12) X	792.5	/	1900.0
A0H	V160"	V12+(V11-V12) X	820.0	/	1900.0
A1H	V161"	V12+(V11-V12) X	850.0	/	1900.0
A2H	V162"	V12+(V11-V12) X	880.0	/	1900.0
A3H	V163"	V12+(V11-V12) X	910.0	/	1900.0
A4H	V164"	V12+(V11-V12) X	940.0	/	1900.0
A5H	V165"	V12+(V11-V12) X	970.0	/	1900.0
A6H	V166"	V12+(V11-V12) X	1000.0	/	1900.0
A7H	V167"	V12+(V11-V12) X	1030.0	/	1900.0
A8H	V168"	V12+(V11-V12) X	1060.0	/	1900.0
A9H	V169"	V12+(V11-V12) X	1092.5	/	1900.0
AAH	V170"	V12+(V11-V12) X	1125.0	/	1900.0
ABH	V171"	V12+(V11-V12) X	1157.5	/	1900.0
ACH	V172"	V12+(V11-V12) X	1190.0	/	1900.0
ADH	V173"	V12+(V11-V12) X	1222.5	/	1900.0
AEH	V174"	V12+(V11-V12) X	1255.0	/	1900.0
AFH	V175"	V12+(V11-V12) X	1287.5	/	1900.0
B0H	V176"	V12+(V11-V12) X	1320.0	/	1900.0
B1H	V177"	V12+(V11-V12) X	1355.0	/	1900.0
B2H	V178"	V12+(V11-V12) X	1390.0	/	1900.0
B3H	V179"	V12+(V11-V12) X	1425.0	/	1900.0
B4H	V180"	V12+(V11-V12) X	1460.0	/	1900.0
B5H	V181"	V12+(V11-V12) X	1495.0	/	1900.0
B6H	V182"	V12+(V11-V12) X	1530.0	/	1900.0
B7H	V183"	V12+(V11-V12) X	1565.0	/	1900.0
B8H	V184"	V12+(V11-V12) X	1600.0	/	1900.0
B9H	V185"	V12+(V11-V12) X	1637.5	/	1900.0
BAH	V186"	V12+(V11-V12) X	1675.0	/	1900.0
BBH	V187"	V12+(V11-V12) X	1712.5	/	1900.0
BCH	V188"	V12+(V11-V12) X	1750.0	/	1900.0
BDH	V189"	V12+(V11-V12) X	1787.5	/	1900.0
BEH	V190"	V12+(V11-V12) X	1825.0	/	1900.0
BFH	V191"	V12+(V11-V12) X	1862.5		1900.0

Data	Output Voltage				
C0H	V192"	V11			
C1H	V193"	V11+(V10-V11) X	42.5	/	1600.0
C2H	V194"	V11+(V10-V11) X	85.0	/	1600.0
C3H	V195"	V11+(V10-V11) X	127.5	/	1600.0
C4H	V196"	V11+(V10-V11) X	170.0	/	1600.0
C5H	V197"	V11+(V10-V11) X	212.5	/	1600.0
C6H	V198"	V11+(V10-V11) X	255.0	/	1600.0
C7H	V199"	V11+(V10-V11) X	297.5	/	1600.0
C8H	V200"	V11+(V10-V11) X	340.0	/	1600.0
C9H	V201"	V11+(V10-V11) X	387.5	/	1600.0
CAH	V202"	V11+(V10-V11) X	435.0	/	1600.0
CBH	V203"	V11+(V10-V11) X	482.5	/	1600.0
CCH	V204"	V11+(V10-V11) X	530.0	/	1600.0
CDH	V205"	V11+(V10-V11) X	577.5	/	1600.0
CEH	V206"	V11+(V10-V11) X	625.0	/	1600.0
CFH	V207"	V11+(V10-V11) X	672.5	/	1600.0
D0H	V208"	V11+(V10-V11) X	720.0	/	1600.0
D1H	V209"	V11+(V10-V11) X	772.5	/	1600.0
D2H	V210"	V11+(V10-V11) X	825.0	/	1600.0
D3H	V211"	V11+(V10-V11) X	877.5	/	1600.0
D4H	V212"	V11+(V10-V11) X	930.0	/	1600.0
D5H	V213"	V11+(V10-V11) X	982.5	/	1600.0
D6H	V214"	V11+(V10-V11) X	1035.0	/	1600.0
D7H	V215"	V11+(V10-V11) X	1087.5	/	1600.0
D8H	V216"	V11+(V10-V11) X	1140.0	/	1600.0
D9H	V217"	V11+(V10-V11) X	1197.5	/	1600.0
DAH	V218"	V11+(V10-V11) X	1255.0	/	1600.0
DBH	V219"	V11+(V10-V11) X	1312.5	/	1600.0
DCH	V220"	V11+(V10-V11) X	1370.0	/	1600.0
DDH	V221"	V11+(V10-V11) X	1427.5	/	1600.0
DEH	V222"	V11+(V10-V11) X	1485.0	/	1600.0
DFH	V223"	V11+(V10-V11) X	1542.5	/	1600.0
E0H	V224"	V10			
E1H	V225"	V10+(V9-V10) X	57.5	/	4687.5
E2H	V226"	V10+(V9-V10) X	127.5	/	4687.5
E3H	V227"	V10+(V9-V10) X	197.5	/	4687.5
E4H	V228"	V10+(V9-V10) X	267.5	/	4687.5
E5H	V229"	V10+(V9-V10) X	350.0	/	4687.5
E6H	V230"	V10+(V9-V10) X	432.5	/	4687.5
E7H	V231"	V10+(V9-V10) X	515.0	/	4687.5
E8H	V232"	V10+(V9-V10) X	610.0	/	4687.5
E9H	V233"	V10+(V9-V10) X	705.0	/	4687.5
EAH	V234"	V10+(V9-V10) X	800.0	/	4687.5
EBH	V235"	V10+(V9-V10) X	912.5	/	4687.5
ECH	V236"	V10+(V9-V10) X	1025.0	/	4687.5
EDH	V237"	V10+(V9-V10) X	1137.5	/	4687.5
EEH	V238"	V10+(V9-V10) X	1267.5	/	4687.5
EFH	V239"	V10+(V9-V10) X	1397.5	/	4687.5
F0H	V240"	V10+(V9-V10) X	1545.0	/	4687.5
F1H	V241"	V10+(V9-V10) X	1692.5	/	4687.5
F2H	V242"	V10+(V9-V10) X	1857.5	/	4687.5
F3H	V243"	V10+(V9-V10) X	2022.5	/	4687.5
F4H	V244"	V10+(V9-V10) X	2205.0	/	4687.5
F5H	V245"	V10+(V9-V10) X	2387.5	/	4687.5
F6H	V246"	V10+(V9-V10) X	2587.5	/	4687.5
F7H	V247"	V10+(V9-V10) X	2787.5	/	4687.5
F8H	V248"	V10+(V9-V10) X	3012.5	/	4687.5
F9H	V249"	V10+(V9-V10) X	3237.5	/	4687.5
FAH	V250"	V10+(V9-V10) X	3487.5	/	4687.5
FBH	V251"	V10+(V9-V10) X	3737.5	/	4687.5
FCH	V252"	V10+(V9-V10) X	4037.5	/	4687.5
FDH	V253"	V10+(V9-V10) X	4337.5	/	4687.5
FEH	V254"	V9			
FFH	V255"	V8			

6. RELATIONSHIP BETWEEN INPUT DATA AND OUTPUT PIN

Data format: 8 bits × 2 RGBs (6 dots)
Input width: 48 bits (2-pixel data)

(1) R,/L = H (Right shift)

Output	S_1	S_2	S_3	S_4	···	S_{383}	S_{384}
Data	D_{00} to D_{07}	D_{10} to D_{17}	D_{20} to D_{27}	D_{30} to D_{37}	···	D_{40} to D_{47}	D_{50} to D_{57}

(2) R,/L = L (Left shift)

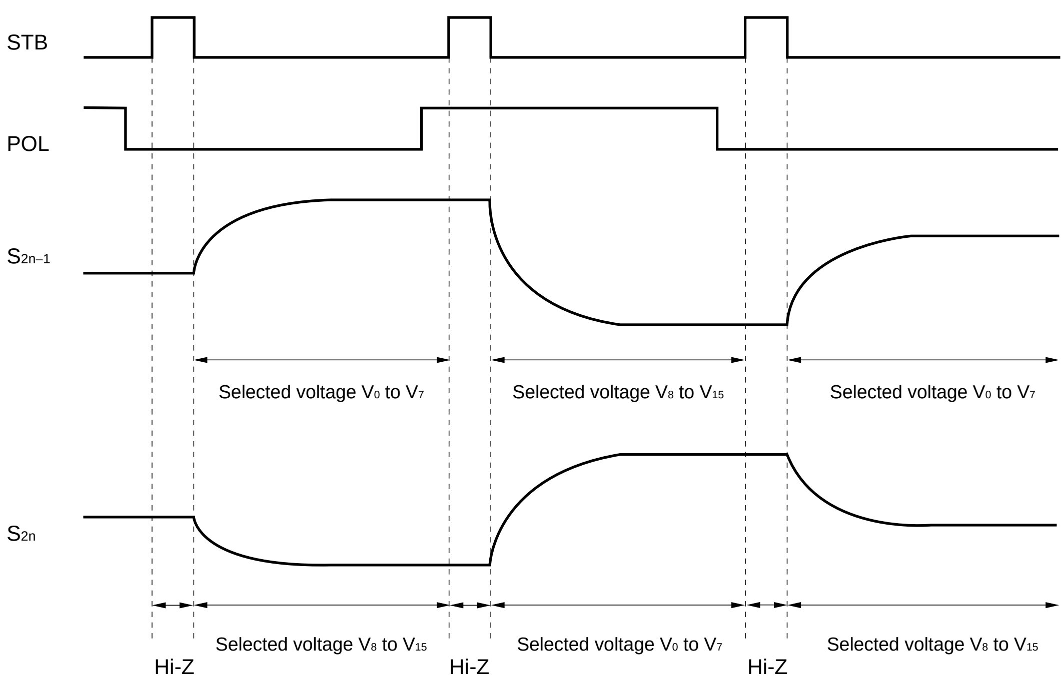
Output	S_1	S_2	S_3	S_4	···	S_{383}	S_{384}
Data	D_{00} to D_{07}	D_{10} to D_{17}	D_{20} to D_{27}	D_{30} to D_{37}	···	D_{40} to D_{47}	D_{50} to D_{57}

POL	S_{2n-1} Note	S_{2n} Note
L	V_0 to V_7	V_8 to V_{15}
H	V_8 to V_{15}	V_0 to V_7

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

7. RELATIONSHIP BETWEEN STB, POL AND OUTPUT WAVEFORM

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

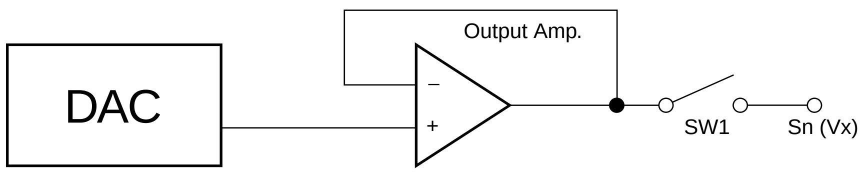


Remark Hi-Z: High impedance

8. RELATIONSHIP BETWEEN STB, CLK, AND OUTPUT WAVEFORM

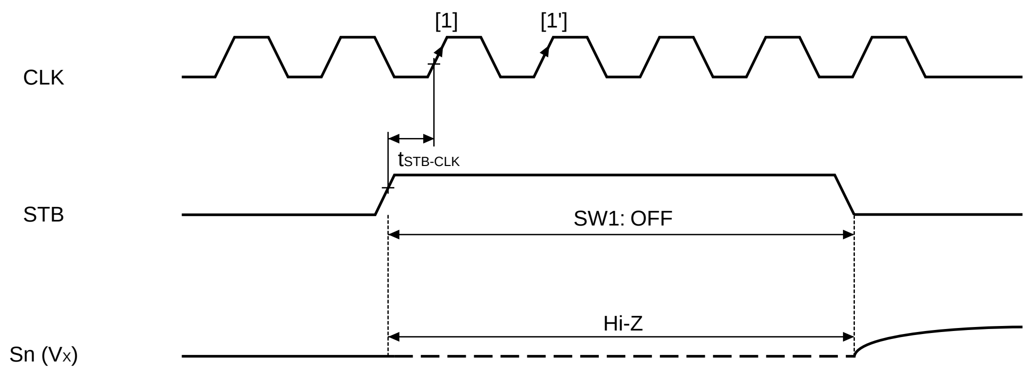
The output voltage is written to the LCD panel synchronized with the STB falling edge.

Figure 8–1. Output Circuit Block Diagram



SW1 switches according to the level of STB signal.
STB = L: SW = ON
STB = H: SW = OFF

Figure 8–2. Output Circuit Timing Chart



STB = H is loaded with the rising edge of CLK [1]. However, when not satisfying the specification of $t_{STB\text{-}CLK}$, STB = H is loaded with the rising edge of the next CLK [1’].

Latch operation of display data is completed with the falling edge of the next CLK which loaded STB = H.

Therefore, in order to complete latch operation of display data, it is necessary to input at least 2CLK in STB = H period.

9. ELECTRICAL SPECIFICATIONS

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

Parameter	Symbol	Rating	Unit
Logic Part Supply Voltage	V_{DD1}	–0.5 to +4.0	V
Driver Part Supply Voltage	V_{DD2}	–0.5 to +10.0	V
Logic Part Input Voltage	V_{I1}	–0.5 to V_{DD1} + 0.5	V
Driver Part Input Voltage	V_{I2}	–0.5 to V_{DD2} + 0.5	V
Logic Part Output Voltage	V_{O1}	–0.5 to V_{DD1} + 0.5	V
Driver Part Output Voltage	V_{O2}	–0.5 to V_{DD2} + 0.5	V
Operating Ambient Temperature	T_A	–10 to +75	°C
Storage Temperature	T_{stg}	–55 to +125	°C

Caution Product quality may suffer if the absolute maximum rating is exceeded even momentarily for any parameter. That is, the absolute maximum ratings are rated values at which the product is on the verge of suffering physical damage, and therefore the product must be used under conditions that ensure that the absolute maximum ratings are not exceeded.

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

Parameter	Symbol	MIN.	TYP.	MAX.	Unit
Logic Part Supply Voltage	V_{DD1}	3.0	3.3	3.6	V
Driver Part Supply Voltage	V_{DD2}	8.5	9.0	9.5	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_7	0.5 V_{DD2}		V_{DD2} – 0.2	V
	V_8 to V_{15}	0.2		0.5 V_{DD2} – 0.3	V
Driver Part Output Voltage	V_O	V_{SS2} + 0.2		V_{DD2} – 0.2	V
Clock Frequency	f_{CLK}			40	MHz

Electrical Characteristics (T_A = –10 to +75°C, V_{DD1} = 3.0 to 3.6 V, V_{DD2} = 8.5 to 9.5 V, V_{SS1} = V_{SS2} = 0 V)

Parameter	Symbol	Conditions	MIN.	TYP.	MAX.	Unit
Input Leak Current	I_{IL}			±0.1	±1.0	μA
High Level Output Voltage	V_{OH}	STHR (STHL), I_{OH} = 0 mA	V_{DD1} – 0.1			V
Low Level Output Voltage	V_{OL}	STHR (STHL), I_{OL} = 0 mA			0.1	V
γ-Corrected Supply Resistance	R_γ	V_0 to V_7 = V_8 to V_{15} = 4.0 V	4.4	8.9	17.8	kΩ
★ Driver Output Current	I_{VOH}	V_X = 7.0 V, V_{OUT} = 6.5 V Note		–0.185	–0.09	mA
	I_{VOL}	V_X = 1.0 V, V_{OUT} = 1.5 V Note	0.12	0.238		mA
Output Voltage Deviation	ΔV_O	V_O = 0.2 V to 1.2 V V_O = V_{DD2} –1.2 V to V_{DD2} – 0.2 V		±30	±50	mV
		V_O = 1.2 V to 0.5 V_{DD2} – 0.3 V V_O = 0.5 V_{DD2} to V_{DD2} –1.2 V		±10	±20	mV
Output Swing Difference Deviation	ΔV_{P-P}	V_O = 0.2 V to 0.8 V V_O = V_{DD2} – 0.8 V to V_{DD2} –0.2 V		±20	±40	mV
		V_O = 0.8 V to 1.2 V V_O = V_{DD2} – 1.2 V to V_{DD2} –0.8 V		±10	±20	mV
		V_O = 1.2 V to 0.5 V_{DD2} – 0.3 V V_O = 0.5 V_{DD2} to V_{DD2} – 1.2 V		±3	±10	mV
★ Output Swing Average Difference Deviation	AV_O	V_{DD2} = 8.5 V, V_O = 7.9 V, V_3 = 6.22 V, V_7 = 4.0 V, V_8 = 4.0 V, V_{12} = 1.78 V, V_{15} = 0.1 V, V_1, V_2, V_4 to V_6, V_9 to V_{11}, V_{13}, V_{14}: Open, T_A = 25°C, Input data: 80H	4.433		4.447	V
Logic Part Dynamic Current Consumption	I_{DD1}	V_{DD1}, with no load		0.8	6.0	mA
★ Driver Part Dynamic Current Consumption	I_{DD2}	V_{DD2}, with no load		4.5	11.0	mA

Note V_X refers to the output voltage of analog output pins S_1 to S_{384}. V_{OUT} refers to the voltage applied to analog output pins S_1 to S_{384}.

Cautions 1. The STB cycle is defined to be 20 μs at f_{CLK} = 40 MHz.

2. 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.

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

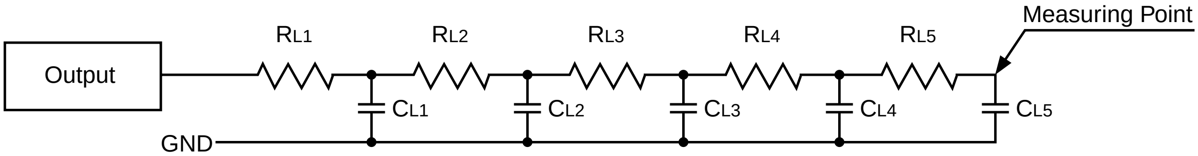
Switching Characteristics (T_A = –10 to +75°C, V_{DD1} = 3.0 to 3.6 V, V_{DD2} = 8.5 to 9.5 V, V_{SS1} = V_{SS2} = 0 V)

Parameter	Symbol	Conditions	MIN.	TYP.	MAX.	Unit
Start Pulse Delay Time	t_{PLH1}	C_L = 15 pF		8	20	ns
Driver Output Delay Time	t_{PLH2}	C_L = 75 pF, R_L = 5 kΩ		3	6	μs
	t_{PLH3}			4	8	μs
	t_{PHL2}			3	6	μs
	t_{PHL3}			4	8	μs
Input Capacitance	C_{I1}	STHR (STHL) excluded, T_A = 25°C		4.8	10	pF
	C_{I2}	STHR (STHL), T_A = 25°C		8.6	15	pF

<Measure Condition>

R_{Ln} = 1 kΩ

C_{Ln} = 15 pF



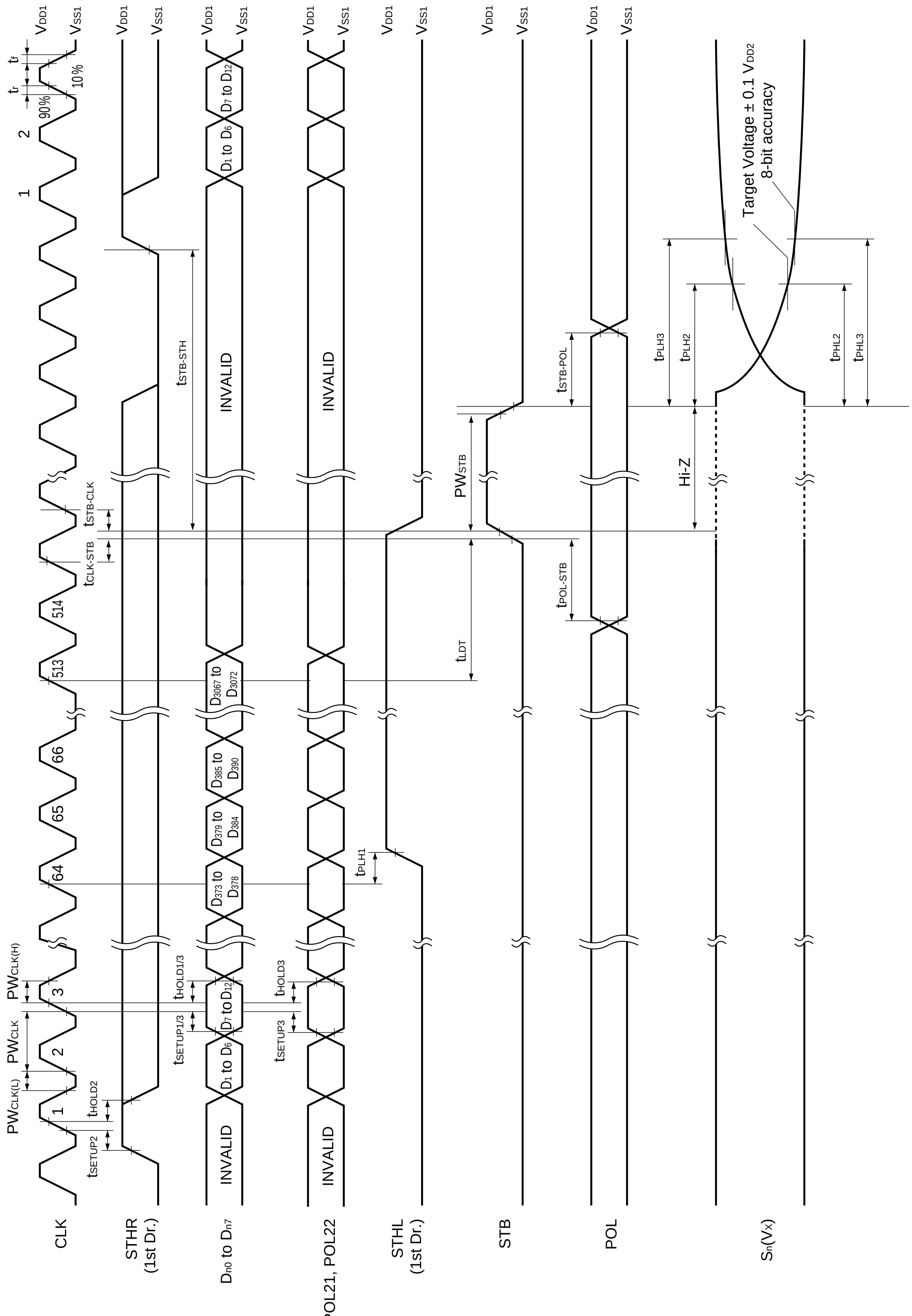
Timing Requirement (T_A = –10 to +75°C, V_{DD1} = 3.0 to 3.6 V, V_{SS1} = 0 V, t_r = t_f = 5.0 ns)

Parameter	Symbol	Conditions	MIN.	TYP.	MAX.	Unit
Clock Pulse Width	PW_{CLK}		25			ns
Clock Pulse High Period	$PW_{CLK(H)}$		4			ns
Clock Pulse Low Period	$PW_{CLK(L)}$		4			ns
Data Setup Time	t_{SETUP1}		2			ns
Data Hold Time	t_{HOLD1}		2			ns
Start Pulse Setup Time	t_{SETUP2}		2			ns
Start Pulse Hold Time	t_{HOLD2}		2			ns
POL21, POL22 Setup Time	t_{SETUP3}		2			ns
POL21, POL22 Hold Time	t_{HOLD3}		2			ns
STB Pulse Width	PW_{STB}		2			μs
Last Data Timing	t_{LDT}		2			CLK
CLK-STB Time	$t_{CLK-STB}$	CLK ↑ → STB ↑	6			ns
STB-CLK Time	$t_{STB-CLK}$	STB ↑ → CLK ↑	6			ns
Time Between STB and Start Pulse	$t_{STB-STH}$	STB ↑ → STHR (STHL) ↑	2			CLK
POL-STB Time	$t_{POL-STB}$	POL ↑ or ↓ → STB ↑	–5			ns
STB-POL Time	$t_{STB-POL}$	STB ↓ → POL ↓ or ↑	6			ns

Remark Unless otherwise specified, the input level is defined to be V_{IH} = 0.7 V_{DD1}, V_{IL} = 0.3 V_{DD1}.

★ **Switching Characteristics Waveform (R,/L = H)**

Unless otherwise specified, the input level is defined to be $V_{IH} = 0.7\ V_{DD1}$, $V_{IL} = 0.3\ V_{DD1}$.



★ 10. RECOMMENDED MOUNTING CONDITIONS

The following conditions must be met for mounting conditions of the μPD16754.

For more details, refer to the **Semiconductor Device Mount Manual (http://www.necel.com/pkg/en/mount/index.html).**

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

μPD16754N - ×××: TCP (TAB package)

Mounting Condition	Mounting Method	Condition
Thermocompression	Soldering	Heating tool 300 to 350°C, heating for 2 to 3 seconds, pressure 100 g (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 mounting the ACF part, please contact the ACF manufacturing company. Be sure to avoid using two or more mounting 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 On NEC Semiconductor Devices (C11531E)

★ **Semiconductor Device Mount Manual (http://www.necel.com/pkg/en/mount/index.html)**