

KS0641

6 BIT 300 / 309 CHANNEL TFT-LCD SOURCE DRIVER

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Ver. 0.1

Prepared by:  Sangho Park

mrno1@samsung.co.kr

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CONTENTS

| | |
|---|----|
| INTRODUCTION | 4 |
| FEATURES | 4 |
| BLOCK DIAGRAM | 5 |
| PIN ASSIGNMENTS..... | 6 |
| PIN DESCRIPTIONS | 7 |
| OPERATION DESCRIPTION..... | 8 |
| DISPLAY DATA TRANSFER..... | 8 |
| EXTENSION OF OUTPUT | 8 |
| RELATIONSHIP BETWEEN INPUT DATA VALUE AND OUTPUT VOLTAGE | 9 |
| ABSOLUTE MAXIMUM RATINGS | 18 |
| RECOMMENDED OPERATION CONDITIONS..... | 18 |
| DC CHARACTERISTICS..... | 19 |
| AC CHARACTERISTICS..... | 20 |
| WAVEFORMS | 21 |
| RELATIONSHIPS BETWEEN CLK1, START PULSE (DIO1, DIO2) AND BLANKING PERIOD..... | 22 |

INTRODUCTION

The KS0641 is a 300 channel or 309 channel output, TFT-LCD source driver for 64 gray scale displays. Data input is based on digital input consisting of 6 bits by 3 dots, which can realize a full-color display of 260,000 colors by output of 64 values gamma-corrected.

This device has an internal D/A (Digital-to-Analog) converter for each output and 9 or 11 external power supplies.

KS0641 can be adopted to larger panel, and SHL (Shift Direction Selection) pin makes use of the LCD panel connection conveniently. Maximum operation clock frequency is 55 MHz at a 3.3 V logic operation. It can be applied to the TFT-LCD panel of SVGA, XGA standards.

FEATURES

- TFT active matrix LCD source driver LSI
- 64 gray scale is possible through 9 or 11 external power supply and D/A converter
- Line inversion display is possible
- CMOS level input
- Compatible with gamma-correction
- Logic supply voltage: 3.0 - 5.5 V
- LCD driver supply voltage: 3.0 - 5.5 V
- Output dynamic range: 2.6 - 5.1 Vp-p
- Maximum operating frequency: $f_{MAX} = 55$ MHz (internal data transmission rate at 3.3 V operation)
- Output: 300 / 309 outputs
- TCP

BLOCK DIAGRAM

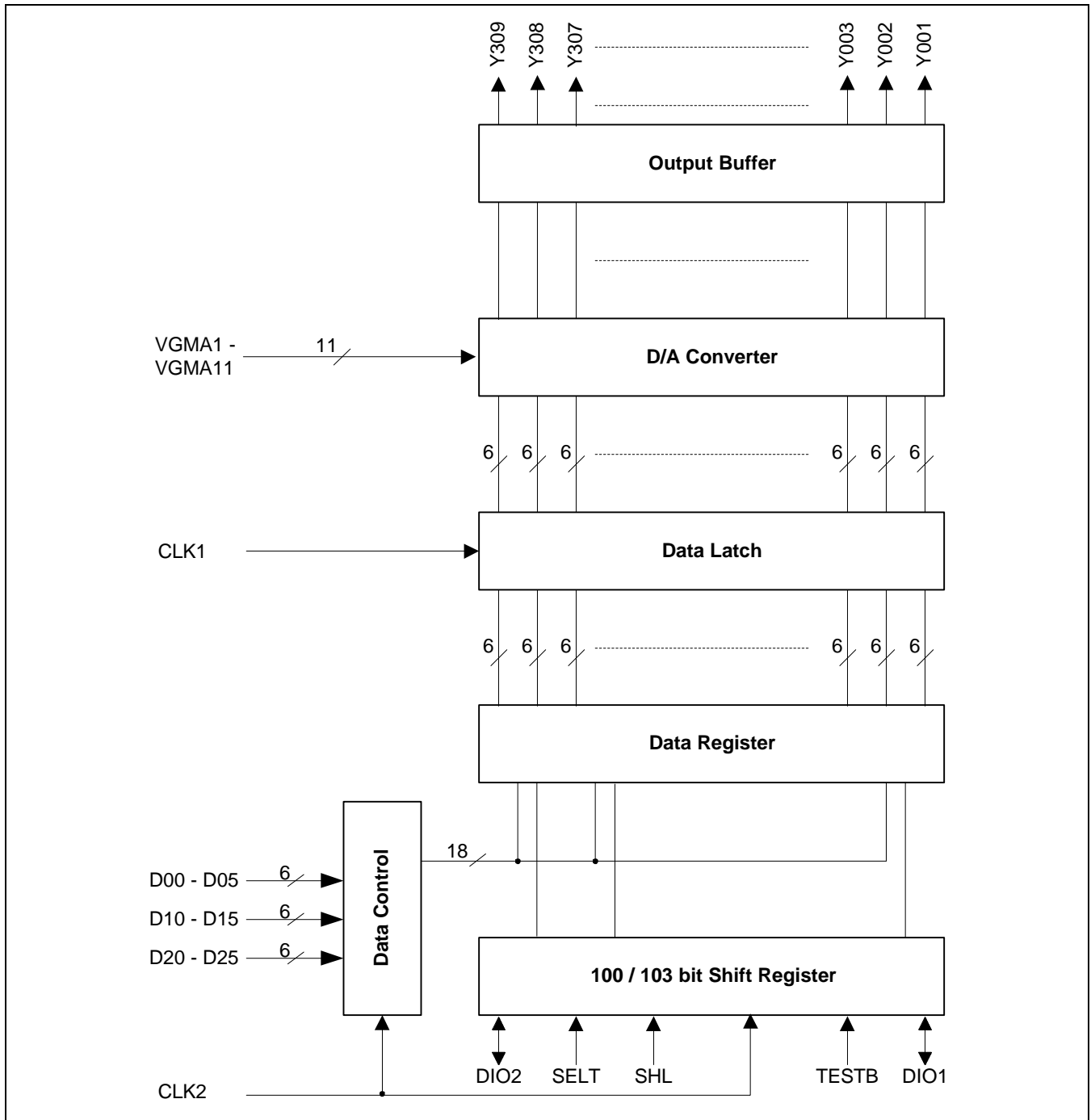


Figure 1. KS0641 Block Diagram

PIN ASSIGNMENTS

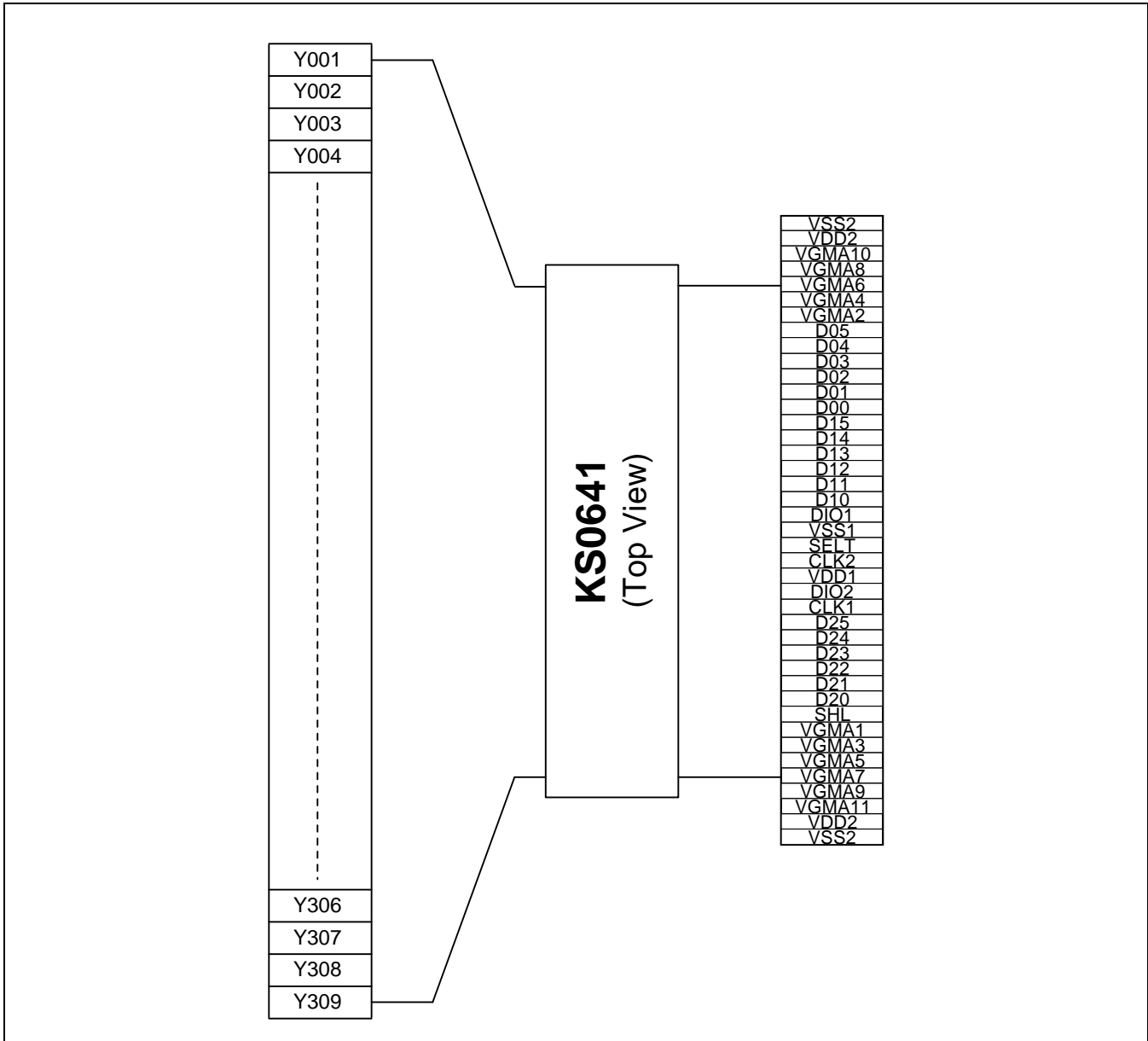


Figure 2. KS0641 Pin Assignments

PIN DESCRIPTIONS

| Symbol | Pin Name | Description |
|----------------------|----------------------------------|---|
| VDD1 | Logic power supply | 3.0- 5.5 V |
| VDD2 | Driver power supply | 3.0 - 5.5 V |
| VSS1 | Logic ground | Ground (0 V) |
| VSS2 | Driver ground | Ground (0 V) |
| Y1 – Y309 | Driver outputs | The D/A converted 64 gray scale analog voltage is output. |
| D0<0:5> - D2<0:5> | Display data input | The display data is input with a width of 18 bits, gray-scale data (6 bits) by 3 dots (R,G,B) DX0: LSB, DX5: MSB |
| SHL | Shift direction control input | This pin controls the direction of shift register in cascade connection. The shift direction of the shift registers is as follows. SHL = H: DIO1 input, Y1 → Y309, DIO2 output SHL = L: DIO2 input, Y309 → Y1, DIO1 output |
| DIO1 | Start pulse input / output | SHL = H: Used as the start pulse input pin. SHL = L: Used as the start pulse output pin. |
| DIO2 | Start pulse input / output | SHL = H: Used as the start pulse output pin. SHL = L: Used as the start pulse input pin. |
| CLK2 | Shift clock input | Refer to the shift register's shift clock input. the display data is loaded to the data register at the rising edge of CLK2. |
| CLK1 | Latch input | Latches the contents of the data register at rising edge and transfers them to the D/A converter. Also, after CLK1 input, clears the internal shift register contents. After 1 pulse input on start, operates normally. CLK1 input timing refers to the "Relationships between CLK1 start pulse (DIO1, DIO2) and blanking period" of the switching characteristic waveform. |
| SELT | 300 / 309CH output control input | This pin controls 300CH or 309CH output. SELT = H: 309CH output → Y151 to Y159 are useless. SELT = L: 300CH output. → Y151 to Y159 are useless. This pin is internally pulled-up.(Rpu = 30 kΩ) |
| VGMA1 – VGMA11 | Gamma corrected power supplies | Input the gamma corrected power supplies from external source. VDD2 ≥ VGMA1 > VGMA2 > > VGMA10 > VGMA11 ≥ VSS2 Keep gray-scale power supply unchanged during the gray-scale voltage output. |
| TESTB | Test input | TESTB = H: Normal operation mode TESTB = L: Test mode (OP AMP CUT-OFF) This pin is internally pulled-up.(Rpu = 30kΩ) |

OPERATION DESCRIPTION

DISPLAY DATA TRANSFER

When DIO1 (or DIO2) pulse is loaded into internal latch on the rising edge of CLK2, DIO1 (or DIO2) pulse enables the operation of data transfer, so display data is valid on the next rising edge of CLK2. Once all the data of 300 / 309 channels are loaded into internal latch, it goes into stand-by state automatically, and any new data is not accepted even though CLK2 is provided until next DIO1 (or DIO2) input. When next DIO1 (or DIO2) is provided, new display data is valid on the next rising edge of CLK2 after the falling edge of DIO1 (or DIO2).

EXTENSION OF OUTPUT

Output pin can be adjusted to an extended screen by cascade connection.

(1) SHL = "L"

Connect DIO1 pin of previous stage to the DIO2 pin of next stage and all the input pins except DIO1 and DIO2 are connected together in each device.

(2) SHL = "H"

Connect DIO2 pin of previous stage to the DIO1 pin of next stage and all the input pins except DIO2 and DIO1 are connected together in each device.

RELATIONSHIP BETWEEN INPUT DATA VALUE AND OUTPUT VOLTAGE

The LCD drive output voltages are determined by the input data and 11 gamma corrected power supplies (VGMA1 - VGMA11).

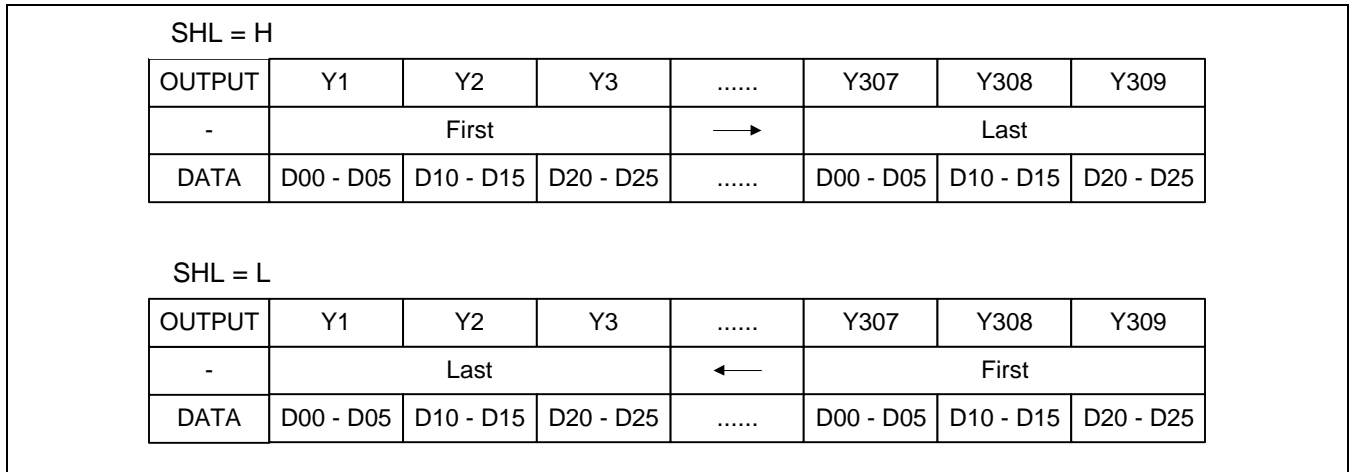


Figure 3. Relationship between Shift Direction and Output Data

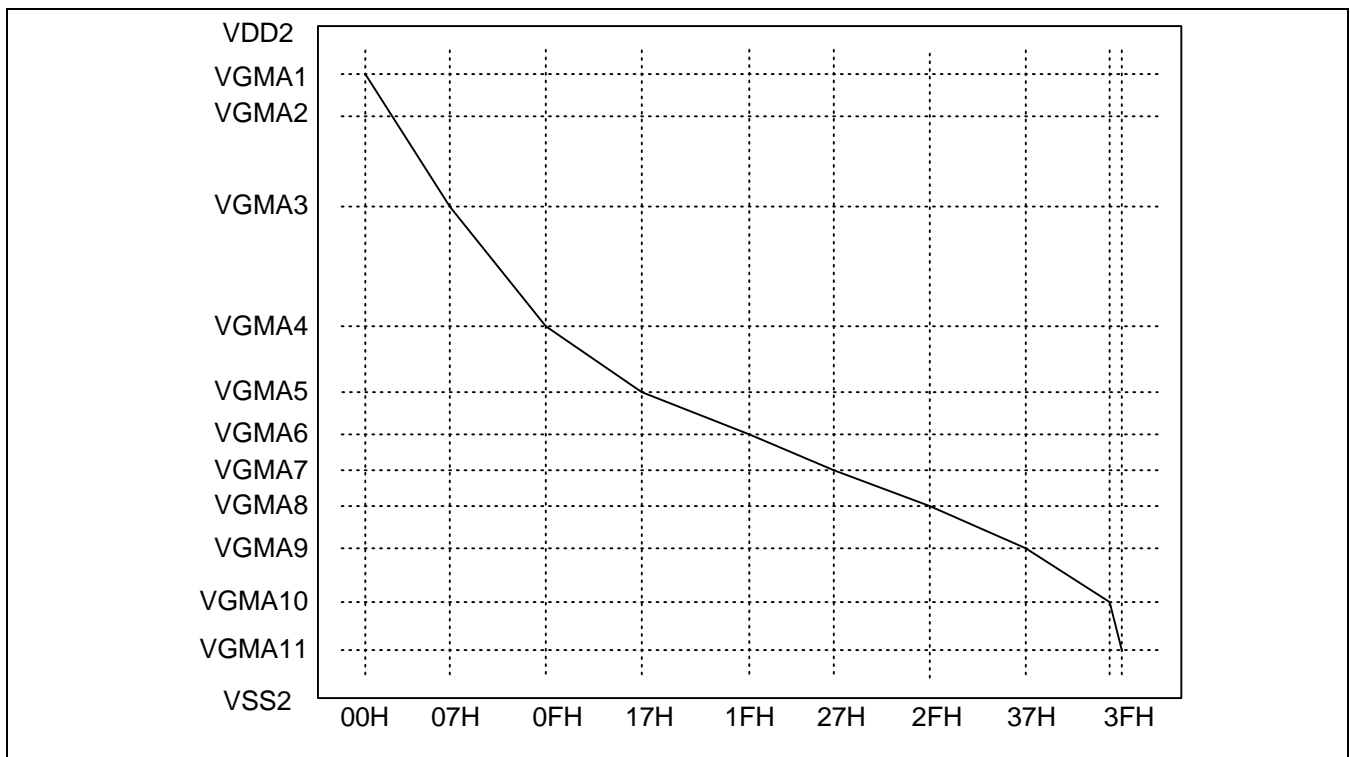


Figure 4. Gamma Correction Curve

**Table 2. Relationship between Input Data and Output Voltage Value:
In case of using 11 levels of Gamma-corrected power supplies (VGMA1 to VGMA11)**

| Input data | DX5 | DX4 | DX3 | DX2 | DX1 | DX0 | G/S | Output voltage |
|------------|-----|-----|-----|-----|-----|-----|------|--------------------------------------|
| 00H | 0 | 0 | 0 | 0 | 0 | 0 | VH0 | VGMA1 |
| 01H | 0 | 0 | 0 | 0 | 0 | 1 | VH1 | $VGMA3 + (VGMA2 - VGMA3) \times 6/7$ |
| 02H | 0 | 0 | 0 | 0 | 1 | 0 | VH2 | $VGMA3 + (VGMA2 - VGMA3) \times 5/7$ |
| 03H | 0 | 0 | 0 | 0 | 1 | 1 | VH3 | $VGMA3 + (VGMA2 - VGMA3) \times 4/7$ |
| 04H | 0 | 0 | 0 | 1 | 0 | 0 | VH4 | $VGMA3 + (VGMA2 - VGMA3) \times 3/7$ |
| 05H | 0 | 0 | 0 | 1 | 0 | 1 | VH5 | $VGMA3 + (VGMA2 - VGMA3) \times 2/7$ |
| 06H | 0 | 0 | 0 | 1 | 1 | 0 | VH6 | $VGMA3 + (VGMA2 - VGMA3) \times 1/7$ |
| 07H | 0 | 0 | 0 | 1 | 1 | 1 | VH7 | VGMA3 |
| 08H | 0 | 0 | 1 | 0 | 0 | 0 | VH8 | $VGMA4 + (VGMA3 - VGMA4) \times 7/8$ |
| 09H | 0 | 0 | 1 | 0 | 0 | 1 | VH9 | $VGMA4 + (VGMA3 - VGMA4) \times 6/8$ |
| 0AH | 0 | 0 | 1 | 0 | 1 | 0 | VH10 | $VGMA4 + (VGMA3 - VGMA4) \times 5/8$ |
| 0BH | 0 | 0 | 1 | 0 | 1 | 1 | VH11 | $VGMA4 + (VGMA3 - VGMA4) \times 4/8$ |
| 0CH | 0 | 0 | 1 | 1 | 0 | 0 | VH12 | $VGMA4 + (VGMA3 - VGMA4) \times 3/8$ |
| 0DH | 0 | 0 | 1 | 1 | 0 | 1 | VH13 | $VGMA4 + (VGMA3 - VGMA4) \times 2/8$ |
| 0EH | 0 | 0 | 1 | 1 | 1 | 0 | VH14 | $VGMA4 + (VGMA3 - VGMA4) \times 1/8$ |
| 0FH | 0 | 0 | 1 | 1 | 1 | 1 | VH15 | VGMA4 |
| 10H | 0 | 1 | 0 | 0 | 0 | 0 | VH16 | $VGMA5 + (VGMA4 - VGMA5) \times 7/8$ |
| 11H | 0 | 1 | 0 | 0 | 0 | 1 | VH17 | $VGMA5 + (VGMA4 - VGMA5) \times 6/8$ |
| 12H | 0 | 1 | 0 | 0 | 1 | 0 | VH18 | $VGMA5 + (VGMA4 - VGMA5) \times 5/8$ |
| 13H | 0 | 1 | 0 | 0 | 1 | 1 | VH19 | $VGMA5 + (VGMA4 - VGMA5) \times 4/8$ |
| 14H | 0 | 1 | 0 | 1 | 0 | 0 | VH20 | $VGMA5 + (VGMA4 - VGMA5) \times 3/8$ |
| 15H | 0 | 1 | 0 | 1 | 0 | 1 | VH21 | $VGMA5 + (VGMA4 - VGMA5) \times 2/8$ |
| 16H | 0 | 1 | 0 | 1 | 1 | 0 | VH22 | $VGMA5 + (VGMA4 - VGMA5) \times 1/8$ |
| 17H | 0 | 1 | 0 | 1 | 1 | 1 | VH23 | VGMA5 |
| 18H | 0 | 1 | 1 | 0 | 0 | 0 | VH24 | $VGMA6 + (VGMA5 - VGMA6) \times 7/8$ |
| 19H | 0 | 1 | 1 | 0 | 0 | 1 | VH25 | $VGMA6 + (VGMA5 - VGMA6) \times 6/8$ |
| 1AH | 0 | 1 | 1 | 0 | 1 | 0 | VH26 | $VGMA6 + (VGMA5 - VGMA6) \times 5/8$ |
| 1BH | 0 | 1 | 1 | 0 | 1 | 1 | VH27 | $VGMA6 + (VGMA5 - VGMA6) \times 4/8$ |
| 1CH | 0 | 1 | 1 | 1 | 0 | 0 | VH28 | $VGMA6 + (VGMA5 - VGMA6) \times 3/8$ |
| 1DH | 0 | 1 | 1 | 1 | 0 | 1 | VH29 | $VGMA6 + (VGMA5 - VGMA6) \times 2/8$ |
| 1EH | 0 | 1 | 1 | 1 | 1 | 0 | VH30 | $VGMA6 + (VGMA5 - VGMA6) \times 1/8$ |
| 1FH | 0 | 1 | 1 | 1 | 1 | 1 | VH31 | VGMA6 |

NOTE: $VDD2 \geq VGMA1 > VGMA2 > VGMA3 > VGMA4 > VGMA5 > VGMA6 > VGMA7 > VGMA8 > VGMA9 > VGMA10 > VGMA11 \geq VSS2$

Table 2. Relationship between Input Data and Output Voltage Value (Continued)

| Input data | DX5 | DX4 | DX3 | DX2 | DX1 | DX0 | G/S | Output voltage |
|------------|-----|-----|-----|-----|-----|-----|------|--|
| 20H | 1 | 0 | 0 | 0 | 0 | 0 | VH32 | $VGMA7 + (VGMA6 - VGMA7) \times 7/8$ |
| 21H | 1 | 0 | 0 | 0 | 0 | 1 | VH33 | $VGMA7 + (VGMA6 - VGMA7) \times 7/8$ |
| 22H | 1 | 0 | 0 | 0 | 1 | 0 | VH34 | $VGMA7 + (VGMA6 - VGMA7) \times 7/8$ |
| 23H | 1 | 0 | 0 | 0 | 1 | 1 | VH35 | $VGMA7 + (VGMA6 - VGMA7) \times 7/8$ |
| 24H | 1 | 0 | 0 | 1 | 0 | 0 | VH36 | $VGMA7 + (VGMA6 - VGMA7) \times 7/8$ |
| 25H | 1 | 0 | 0 | 1 | 0 | 1 | VH37 | $VGMA7 + (VGMA6 - VGMA7) \times 7/8$ |
| 26H | 1 | 0 | 0 | 1 | 1 | 0 | VH38 | $VGMA7 + (VGMA6 - VGMA7) \times 7/8$ |
| 27H | 1 | 0 | 0 | 1 | 1 | 1 | VH39 | VGMA7 |
| 28H | 1 | 0 | 1 | 0 | 0 | 0 | VH40 | $VGMA8 + (VGMA7 - VGMA8) \times 7/8$ |
| 29H | 1 | 0 | 1 | 0 | 0 | 1 | VH41 | $VGMA8 + (VGMA7 - VGMA8) \times 6/8$ |
| 2AH | 1 | 0 | 1 | 0 | 1 | 0 | VH42 | $VGMA8 + (VGMA7 - VGMA8) \times 5/8$ |
| 2BH | 1 | 0 | 1 | 0 | 1 | 1 | VH43 | $VGMA8 + (VGMA7 - VGMA8) \times 4/8$ |
| 2CH | 1 | 0 | 1 | 1 | 0 | 0 | VH44 | $VGMA8 + (VGMA7 - VGMA8) \times 3/8$ |
| 2DH | 1 | 0 | 1 | 1 | 0 | 1 | VH45 | $VGMA8 + (VGMA7 - VGMA8) \times 2/8$ |
| 2EH | 1 | 0 | 1 | 1 | 1 | 0 | VH46 | $VGMA8 + (VGMA7 - VGMA8) \times 1/8$ |
| 2FH | 1 | 0 | 1 | 1 | 1 | 1 | VH47 | VGMA8 |
| 30H | 1 | 1 | 0 | 0 | 0 | 0 | VH48 | $VGMA9 + (VGMA8 - VGMA9) \times 7/8$ |
| 31H | 1 | 1 | 0 | 0 | 0 | 1 | VH49 | $VGMA9 + (VGMA8 - VGMA9) \times 6/8$ |
| 32H | 1 | 1 | 0 | 0 | 1 | 0 | VH50 | $VGMA9 + (VGMA8 - VGMA9) \times 5/8$ |
| 33H | 1 | 1 | 0 | 0 | 1 | 1 | VH51 | $VGMA9 + (VGMA8 - VGMA9) \times 4/8$ |
| 34H | 1 | 1 | 0 | 1 | 0 | 0 | VH52 | $VGMA9 + (VGMA8 - VGMA9) \times 3/8$ |
| 35H | 1 | 1 | 0 | 1 | 0 | 1 | VH53 | $VGMA9 + (VGMA8 - VGMA9) \times 2/8$ |
| 36H | 1 | 1 | 0 | 1 | 1 | 0 | VH54 | $VGMA9 + (VGMA8 - VGMA9) \times 1/8$ |
| 37H | 1 | 1 | 0 | 1 | 1 | 1 | VH55 | VGMA9 |
| 38H | 1 | 1 | 1 | 0 | 0 | 0 | VH56 | $VGMA10 + (VGMA9 - VGMA10) \times 6/7$ |
| 39H | 1 | 1 | 1 | 0 | 0 | 1 | VH57 | $VGMA10 + (VGMA9 - VGMA10) \times 5/7$ |
| 3AH | 1 | 1 | 1 | 0 | 1 | 0 | VH58 | $VGMA10 + (VGMA9 - VGMA10) \times 4/7$ |
| 3BH | 1 | 1 | 1 | 0 | 1 | 1 | VH59 | $VGMA10 + (VGMA9 - VGMA10) \times 3/7$ |
| 3CH | 1 | 1 | 1 | 1 | 0 | 0 | VH60 | $VGMA10 + (VGMA9 - VGMA10) \times 2/7$ |
| 3DH | 1 | 1 | 1 | 1 | 0 | 1 | VH61 | $VGMA10 + (VGMA9 - VGMA10) \times 1/7$ |
| 3EH | 1 | 1 | 1 | 1 | 1 | 0 | VH62 | VGMA10 |
| 3FH | 1 | 1 | 1 | 1 | 1 | 1 | VH63 | VGMA11 |

RGMA (Gamma-Corrected Resistance) Ratio. (if the RGMA1 equals 1)

| | | | |
|-------|------|--------|------|
| RGMA1 | 1.00 | RGMA6 | 0.84 |
| RGMA2 | 2.00 | RGMA7 | 0.66 |
| RGMA3 | 2.77 | RGMA8 | 0.84 |
| RGMA4 | 1.50 | RGMA9 | 1.42 |
| RGMA5 | 0.90 | RGMA10 | 1.05 |

RGMA1 = 2.31 kΩ

**Table 3. Relationship between Input Data and Output Voltage Value:
In case of using 10 levels of Gamma-corrected power supplies (VGMA1 = OPEN)**

| Input data | DX5 | DX4 | DX3 | DX2 | DX1 | DX0 | G/S | Output voltage |
|------------|-----|-----|-----|-----|-----|-----|------|--------------------------------------|
| 00H | 0 | 0 | 0 | 0 | 0 | 0 | VH0 | VGMA2 |
| 01H | 0 | 0 | 0 | 0 | 0 | 1 | VH1 | $VGMA3 + (VGMA2 - VGMA3) \times 6/7$ |
| 02H | 0 | 0 | 0 | 0 | 1 | 0 | VH2 | $VGMA3 + (VGMA2 - VGMA3) \times 5/7$ |
| 03H | 0 | 0 | 0 | 0 | 1 | 1 | VH3 | $VGMA3 + (VGMA2 - VGMA3) \times 4/7$ |
| 04H | 0 | 0 | 0 | 1 | 0 | 0 | VH4 | $VGMA3 + (VGMA2 - VGMA3) \times 3/7$ |
| 05H | 0 | 0 | 0 | 1 | 0 | 1 | VH5 | $VGMA3 + (VGMA2 - VGMA3) \times 2/7$ |
| 06H | 0 | 0 | 0 | 1 | 1 | 0 | VH6 | $VGMA3 + (VGMA2 - VGMA3) \times 1/7$ |
| 07H | 0 | 0 | 0 | 1 | 1 | 1 | VH7 | VGMA3 |
| 08H | 0 | 0 | 1 | 0 | 0 | 0 | VH8 | $VGMA4 + (VGMA3 - VGMA4) \times 7/8$ |
| 09H | 0 | 0 | 1 | 0 | 0 | 1 | VH9 | $VGMA4 + (VGMA3 - VGMA4) \times 6/8$ |
| 0AH | 0 | 0 | 1 | 0 | 1 | 0 | VH10 | $VGMA4 + (VGMA3 - VGMA4) \times 5/8$ |
| 0BH | 0 | 0 | 1 | 0 | 1 | 1 | VH11 | $VGMA4 + (VGMA3 - VGMA4) \times 4/8$ |
| 0CH | 0 | 0 | 1 | 1 | 0 | 0 | VH12 | $VGMA4 + (VGMA3 - VGMA4) \times 3/8$ |
| 0DH | 0 | 0 | 1 | 1 | 0 | 1 | VH13 | $VGMA4 + (VGMA3 - VGMA4) \times 2/8$ |
| 0EH | 0 | 0 | 1 | 1 | 1 | 0 | VH14 | $VGMA4 + (VGMA3 - VGMA4) \times 1/8$ |
| 0FH | 0 | 0 | 1 | 1 | 1 | 1 | VH15 | VGMA4 |
| 10H | 0 | 1 | 0 | 0 | 0 | 0 | VH16 | $VGMA5 + (VGMA4 - VGMA5) \times 7/8$ |
| 11H | 0 | 1 | 0 | 0 | 0 | 1 | VH17 | $VGMA5 + (VGMA4 - VGMA5) \times 6/8$ |
| 12H | 0 | 1 | 0 | 0 | 1 | 0 | VH18 | $VGMA5 + (VGMA4 - VGMA5) \times 5/8$ |
| 13H | 0 | 1 | 0 | 0 | 1 | 1 | VH19 | $VGMA5 + (VGMA4 - VGMA5) \times 4/8$ |
| 14H | 0 | 1 | 0 | 1 | 0 | 0 | VH20 | $VGMA5 + (VGMA4 - VGMA5) \times 3/8$ |
| 15H | 0 | 1 | 0 | 1 | 0 | 1 | VH21 | $VGMA5 + (VGMA4 - VGMA5) \times 2/8$ |
| 16H | 0 | 1 | 0 | 1 | 1 | 0 | VH22 | $VGMA5 + (VGMA4 - VGMA5) \times 1/8$ |
| 17H | 0 | 1 | 0 | 1 | 1 | 1 | VH23 | VGMA5 |
| 18H | 0 | 1 | 1 | 0 | 0 | 0 | VH24 | $VGMA6 + (VGMA5 - VGMA6) \times 7/8$ |
| 19H | 0 | 1 | 1 | 0 | 0 | 1 | VH25 | $VGMA6 + (VGMA5 - VGMA6) \times 6/8$ |
| 1AH | 0 | 1 | 1 | 0 | 1 | 0 | VH26 | $VGMA6 + (VGMA5 - VGMA6) \times 5/8$ |
| 1BH | 0 | 1 | 1 | 0 | 1 | 1 | VH27 | $VGMA6 + (VGMA5 - VGMA6) \times 4/8$ |
| 1CH | 0 | 1 | 1 | 1 | 0 | 0 | VH28 | $VGMA6 + (VGMA5 - VGMA6) \times 3/8$ |
| 1DH | 0 | 1 | 1 | 1 | 0 | 1 | VH29 | $VGMA6 + (VGMA5 - VGMA6) \times 2/8$ |
| 1EH | 0 | 1 | 1 | 1 | 1 | 0 | VH30 | $VGMA6 + (VGMA5 - VGMA6) \times 1/8$ |
| 1FH | 0 | 1 | 1 | 1 | 1 | 1 | VH31 | VGMA6 |

NOTE: $VDD2 \geq VGMA1 > VGMA2 > VGMA3 > VGMA4 > VGMA5 > VGMA6 > VGMA7 > VGMA8 > VGMA9 > VGMA10 > VGMA11 \geq VSS2$

Table 3. Relationship between Input Data and Output Voltage Value (Continued)

| Input data | DX5 | DX4 | DX3 | DX2 | DX1 | DX0 | G/S | Output voltage |
|------------|-----|-----|-----|-----|-----|-----|------|--|
| 20H | 1 | 0 | 0 | 0 | 0 | 0 | VH32 | $VGMA7 + (VGMA6 - VGMA7) \times 7/8$ |
| 21H | 1 | 0 | 0 | 0 | 0 | 1 | VH33 | $VGMA7 + (VGMA6 - VGMA7) \times 7/8$ |
| 22H | 1 | 0 | 0 | 0 | 1 | 0 | VH34 | $VGMA7 + (VGMA6 - VGMA7) \times 7/8$ |
| 23H | 1 | 0 | 0 | 0 | 1 | 1 | VH35 | $VGMA7 + (VGMA6 - VGMA7) \times 7/8$ |
| 24H | 1 | 0 | 0 | 1 | 0 | 0 | VH36 | $VGMA7 + (VGMA6 - VGMA7) \times 7/8$ |
| 25H | 1 | 0 | 0 | 1 | 0 | 1 | VH37 | $VGMA7 + (VGMA6 - VGMA7) \times 7/8$ |
| 26H | 1 | 0 | 0 | 1 | 1 | 0 | VH38 | $VGMA7 + (VGMA6 - VGMA7) \times 7/8$ |
| 27H | 1 | 0 | 0 | 1 | 1 | 1 | VH39 | VGMA7 |
| 28H | 1 | 0 | 1 | 0 | 0 | 0 | VH40 | $VGMA8 + (VGMA7 - VGMA8) \times 7/8$ |
| 29H | 1 | 0 | 1 | 0 | 0 | 1 | VH41 | $VGMA8 + (VGMA7 - VGMA8) \times 6/8$ |
| 2AH | 1 | 0 | 1 | 0 | 1 | 0 | VH42 | $VGMA8 + (VGMA7 - VGMA8) \times 5/8$ |
| 2BH | 1 | 0 | 1 | 0 | 1 | 1 | VH43 | $VGMA8 + (VGMA7 - VGMA8) \times 4/8$ |
| 2CH | 1 | 0 | 1 | 1 | 0 | 0 | VH44 | $VGMA8 + (VGMA7 - VGMA8) \times 3/8$ |
| 2DH | 1 | 0 | 1 | 1 | 0 | 1 | VH45 | $VGMA8 + (VGMA7 - VGMA8) \times 2/8$ |
| 2EH | 1 | 0 | 1 | 1 | 1 | 0 | VH46 | $VGMA8 + (VGMA7 - VGMA8) \times 1/8$ |
| 2FH | 1 | 0 | 1 | 1 | 1 | 1 | VH47 | VGMA8 |
| 30H | 1 | 1 | 0 | 0 | 0 | 0 | VH48 | $VGMA9 + (VGMA8 - VGMA9) \times 7/8$ |
| 31H | 1 | 1 | 0 | 0 | 0 | 1 | VH49 | $VGMA9 + (VGMA8 - VGMA9) \times 6/8$ |
| 32H | 1 | 1 | 0 | 0 | 1 | 0 | VH50 | $VGMA9 + (VGMA8 - VGMA9) \times 5/8$ |
| 33H | 1 | 1 | 0 | 0 | 1 | 1 | VH51 | $VGMA9 + (VGMA8 - VGMA9) \times 4/8$ |
| 34H | 1 | 1 | 0 | 1 | 0 | 0 | VH52 | $VGMA9 + (VGMA8 - VGMA9) \times 3/8$ |
| 35H | 1 | 1 | 0 | 1 | 0 | 1 | VH53 | $VGMA9 + (VGMA8 - VGMA9) \times 2/8$ |
| 36H | 1 | 1 | 0 | 1 | 1 | 0 | VH54 | $VGMA9 + (VGMA8 - VGMA9) \times 1/8$ |
| 37H | 1 | 1 | 0 | 1 | 1 | 1 | VH55 | VGMA9 |
| 38H | 1 | 1 | 1 | 0 | 0 | 0 | VH56 | $VGMA10 + (VGMA9 - VGMA10) \times 6/7$ |
| 39H | 1 | 1 | 1 | 0 | 0 | 1 | VH57 | $VGMA10 + (VGMA9 - VGMA10) \times 5/7$ |
| 3AH | 1 | 1 | 1 | 0 | 1 | 0 | VH58 | $VGMA10 + (VGMA9 - VGMA10) \times 4/7$ |
| 3BH | 1 | 1 | 1 | 0 | 1 | 1 | VH59 | $VGMA10 + (VGMA9 - VGMA10) \times 3/7$ |
| 3CH | 1 | 1 | 1 | 1 | 0 | 0 | VH60 | $VGMA10 + (VGMA9 - VGMA10) \times 2/7$ |
| 3DH | 1 | 1 | 1 | 1 | 0 | 1 | VH61 | $VGMA10 + (VGMA9 - VGMA10) \times 1/7$ |
| 3EH | 1 | 1 | 1 | 1 | 1 | 0 | VH62 | VGMA10 |
| 3FH | 1 | 1 | 1 | 1 | 1 | 1 | VH63 | VGMA11 |

RGMA (Gamma-Corrected Resistance) Ratio. (if the RGMA2 equals 1)

| | | | |
|-------|------|--------|------|
| RGMA1 | - | RGMA6 | 0.42 |
| RGMA2 | 1.00 | RGMA7 | 0.33 |
| RGMA3 | 1.39 | RGMA8 | 0.42 |
| RGMA4 | 0.75 | RGMA9 | 0.71 |
| RGMA5 | 0.45 | RGMA10 | 0.53 |

RGMA1 = 4.62 k Ω

**Table 4. Relationship between Input Data and Output Voltage Value:
In case of using 10 levels of Gamma-corrected power supplies (VGMA2 = OPEN)**

| Input data | DX5 | DX4 | DX3 | DX2 | DX1 | DX0 | G/S | Output voltage |
|------------|-----|-----|-----|-----|-----|-----|------|--------------------------------------|
| 00H | 0 | 0 | 0 | 0 | 0 | 0 | VH0 | $VGMA3 + (VGMA2 - VGMA3) \times 7/8$ |
| 01H | 0 | 0 | 0 | 0 | 0 | 1 | VH1 | $VGMA3 + (VGMA2 - VGMA3) \times 6/8$ |
| 02H | 0 | 0 | 0 | 0 | 1 | 0 | VH2 | $VGMA3 + (VGMA2 - VGMA3) \times 5/8$ |
| 03H | 0 | 0 | 0 | 0 | 1 | 1 | VH3 | $VGMA3 + (VGMA2 - VGMA3) \times 4/8$ |
| 04H | 0 | 0 | 0 | 1 | 0 | 0 | VH4 | $VGMA3 + (VGMA2 - VGMA3) \times 3/8$ |
| 05H | 0 | 0 | 0 | 1 | 0 | 1 | VH5 | $VGMA3 + (VGMA2 - VGMA3) \times 2/8$ |
| 06H | 0 | 0 | 0 | 1 | 1 | 0 | VH6 | $VGMA3 + (VGMA2 - VGMA3) \times 1/8$ |
| 07H | 0 | 0 | 0 | 1 | 1 | 1 | VH7 | VGMA3 |
| 08H | 0 | 0 | 1 | 0 | 0 | 0 | VH8 | $VGMA4 + (VGMA3 - VGMA4) \times 7/8$ |
| 09H | 0 | 0 | 1 | 0 | 0 | 1 | VH9 | $VGMA4 + (VGMA3 - VGMA4) \times 6/8$ |
| 0AH | 0 | 0 | 1 | 0 | 1 | 0 | VH10 | $VGMA4 + (VGMA3 - VGMA4) \times 5/8$ |
| 0BH | 0 | 0 | 1 | 0 | 1 | 1 | VH11 | $VGMA4 + (VGMA3 - VGMA4) \times 4/8$ |
| 0CH | 0 | 0 | 1 | 1 | 0 | 0 | VH12 | $VGMA4 + (VGMA3 - VGMA4) \times 3/8$ |
| 0DH | 0 | 0 | 1 | 1 | 0 | 1 | VH13 | $VGMA4 + (VGMA3 - VGMA4) \times 2/8$ |
| 0EH | 0 | 0 | 1 | 1 | 1 | 0 | VH14 | $VGMA4 + (VGMA3 - VGMA4) \times 1/8$ |
| 0FH | 0 | 0 | 1 | 1 | 1 | 1 | VH15 | VGMA4 |
| 10H | 0 | 1 | 0 | 0 | 0 | 0 | VH16 | $VGMA5 + (VGMA4 - VGMA5) \times 7/8$ |
| 11H | 0 | 1 | 0 | 0 | 0 | 1 | VH17 | $VGMA5 + (VGMA4 - VGMA5) \times 6/8$ |
| 12H | 0 | 1 | 0 | 0 | 1 | 0 | VH18 | $VGMA5 + (VGMA4 - VGMA5) \times 5/8$ |
| 13H | 0 | 1 | 0 | 0 | 1 | 1 | VH19 | $VGMA5 + (VGMA4 - VGMA5) \times 4/8$ |
| 14H | 0 | 1 | 0 | 1 | 0 | 0 | VH20 | $VGMA5 + (VGMA4 - VGMA5) \times 3/8$ |
| 15H | 0 | 1 | 0 | 1 | 0 | 1 | VH21 | $VGMA5 + (VGMA4 - VGMA5) \times 2/8$ |
| 16H | 0 | 1 | 0 | 1 | 1 | 0 | VH22 | $VGMA5 + (VGMA4 - VGMA5) \times 1/8$ |
| 17H | 0 | 1 | 0 | 1 | 1 | 1 | VH23 | VGMA5 |
| 18H | 0 | 1 | 1 | 0 | 0 | 0 | VH24 | $VGMA6 + (VGMA5 - VGMA6) \times 7/8$ |
| 19H | 0 | 1 | 1 | 0 | 0 | 1 | VH25 | $VGMA6 + (VGMA5 - VGMA6) \times 6/8$ |
| 1AH | 0 | 1 | 1 | 0 | 1 | 0 | VH26 | $VGMA6 + (VGMA5 - VGMA6) \times 5/8$ |
| 1BH | 0 | 1 | 1 | 0 | 1 | 1 | VH27 | $VGMA6 + (VGMA5 - VGMA6) \times 4/8$ |
| 1CH | 0 | 1 | 1 | 1 | 0 | 0 | VH28 | $VGMA6 + (VGMA5 - VGMA6) \times 3/8$ |
| 1DH | 0 | 1 | 1 | 1 | 0 | 1 | VH29 | $VGMA6 + (VGMA5 - VGMA6) \times 2/8$ |
| 1EH | 0 | 1 | 1 | 1 | 1 | 0 | VH30 | $VGMA6 + (VGMA5 - VGMA6) \times 1/8$ |
| 1FH | 0 | 1 | 1 | 1 | 1 | 1 | VH31 | VGMA6 |

NOTE: $VDD2 \geq VGMA1 > VGMA2 > VGMA3 > VGMA4 > VGMA5 > VGMA6 > VGMA7 > VGMA8 > VGMA9 > VGMA10 > VGMA11 \geq VSS2$

Table 4. Relationship between Input Data and Output Voltage Value (Continued)

| Input data | DX5 | DX4 | DX3 | DX2 | DX1 | DX0 | G/S | Output voltage |
|------------|-----|-----|-----|-----|-----|-----|------|--|
| 20H | 1 | 0 | 0 | 0 | 0 | 0 | VH32 | $VGMA7 + (VGMA6 - VGMA7) \times 7/8$ |
| 21H | 1 | 0 | 0 | 0 | 0 | 1 | VH33 | $VGMA7 + (VGMA6 - VGMA7) \times 7/8$ |
| 22H | 1 | 0 | 0 | 0 | 1 | 0 | VH34 | $VGMA7 + (VGMA6 - VGMA7) \times 7/8$ |
| 23H | 1 | 0 | 0 | 0 | 1 | 1 | VH35 | $VGMA7 + (VGMA6 - VGMA7) \times 7/8$ |
| 24H | 1 | 0 | 0 | 1 | 0 | 0 | VH36 | $VGMA7 + (VGMA6 - VGMA7) \times 7/8$ |
| 25H | 1 | 0 | 0 | 1 | 0 | 1 | VH37 | $VGMA7 + (VGMA6 - VGMA7) \times 7/8$ |
| 26H | 1 | 0 | 0 | 1 | 1 | 0 | VH38 | $VGMA7 + (VGMA6 - VGMA7) \times 7/8$ |
| 27H | 1 | 0 | 0 | 1 | 1 | 1 | VH39 | VGMA7 |
| 28H | 1 | 0 | 1 | 0 | 0 | 0 | VH40 | $VGMA8 + (VGMA7 - VGMA8) \times 7/8$ |
| 29H | 1 | 0 | 1 | 0 | 0 | 1 | VH41 | $VGMA8 + (VGMA7 - VGMA8) \times 6/8$ |
| 2AH | 1 | 0 | 1 | 0 | 1 | 0 | VH42 | $VGMA8 + (VGMA7 - VGMA8) \times 5/8$ |
| 2BH | 1 | 0 | 1 | 0 | 1 | 1 | VH43 | $VGMA8 + (VGMA7 - VGMA8) \times 4/8$ |
| 2CH | 1 | 0 | 1 | 1 | 0 | 0 | VH44 | $VGMA8 + (VGMA7 - VGMA8) \times 3/8$ |
| 2DH | 1 | 0 | 1 | 1 | 0 | 1 | VH45 | $VGMA8 + (VGMA7 - VGMA8) \times 2/8$ |
| 2EH | 1 | 0 | 1 | 1 | 1 | 0 | VH46 | $VGMA8 + (VGMA7 - VGMA8) \times 1/8$ |
| 2FH | 1 | 0 | 1 | 1 | 1 | 1 | VH47 | VGMA8 |
| 30H | 1 | 1 | 0 | 0 | 0 | 0 | VH48 | $VGMA9 + (VGMA8 - VGMA9) \times 7/8$ |
| 31H | 1 | 1 | 0 | 0 | 0 | 1 | VH49 | $VGMA9 + (VGMA8 - VGMA9) \times 6/8$ |
| 32H | 1 | 1 | 0 | 0 | 1 | 0 | VH50 | $VGMA9 + (VGMA8 - VGMA9) \times 5/8$ |
| 33H | 1 | 1 | 0 | 0 | 1 | 1 | VH51 | $VGMA9 + (VGMA8 - VGMA9) \times 4/8$ |
| 34H | 1 | 1 | 0 | 1 | 0 | 0 | VH52 | $VGMA9 + (VGMA8 - VGMA9) \times 3/8$ |
| 35H | 1 | 1 | 0 | 1 | 0 | 1 | VH53 | $VGMA9 + (VGMA8 - VGMA9) \times 2/8$ |
| 36H | 1 | 1 | 0 | 1 | 1 | 0 | VH54 | $VGMA9 + (VGMA8 - VGMA9) \times 1/8$ |
| 37H | 1 | 1 | 0 | 1 | 1 | 1 | VH55 | VGMA9 |
| 38H | 1 | 1 | 1 | 0 | 0 | 0 | VH56 | $VGMA10 + (VGMA9 - VGMA10) \times 6/7$ |
| 39H | 1 | 1 | 1 | 0 | 0 | 1 | VH57 | $VGMA10 + (VGMA9 - VGMA10) \times 5/7$ |
| 3AH | 1 | 1 | 1 | 0 | 1 | 0 | VH58 | $VGMA10 + (VGMA9 - VGMA10) \times 4/7$ |
| 3BH | 1 | 1 | 1 | 0 | 1 | 1 | VH59 | $VGMA10 + (VGMA9 - VGMA10) \times 3/7$ |
| 3CH | 1 | 1 | 1 | 1 | 0 | 0 | VH60 | $VGMA10 + (VGMA9 - VGMA10) \times 2/7$ |
| 3DH | 1 | 1 | 1 | 1 | 0 | 1 | VH61 | $VGMA10 + (VGMA9 - VGMA10) \times 1/7$ |
| 3EH | 1 | 1 | 1 | 1 | 1 | 0 | VH62 | VGMA10 |
| 3FH | 1 | 1 | 1 | 1 | 1 | 1 | VH63 | VGMA11 |

RGMA (Gamma-Corrected Resistance) Ratio. (if the sum of RGMA1 and RGMA2 equals 1)

| | | | |
|-------|------|--------|------|
| RGMA1 | 1.00 | RGMA6 | 0.37 |
| RGMA2 | | RGMA7 | 0.29 |
| RGMA3 | 1.21 | RGMA8 | 0.37 |
| RGMA4 | 0.66 | RGMA9 | 0.62 |
| RGMA5 | 0.39 | RGMA10 | 0.46 |

RGMA1 + RGMA2 = 5.28 kΩ

Table 5. Relationship between Input Data and Output Voltage Value:
In case of using 9 levels of Gamma-corrected power supplies (VGMA2, VGMA10 = OPEN)

| Input data | DX5 | DX4 | DX3 | DX2 | DX1 | DX0 | G/S | Output voltage |
|------------|-----|-----|-----|-----|-----|-----|------|--------------------------------------|
| 00H | 0 | 0 | 0 | 0 | 0 | 0 | VH0 | $VGMA3 + (VGMA2 - VGMA3) \times 7/8$ |
| 01H | 0 | 0 | 0 | 0 | 0 | 1 | VH1 | $VGMA3 + (VGMA2 - VGMA3) \times 6/8$ |
| 02H | 0 | 0 | 0 | 0 | 1 | 0 | VH2 | $VGMA3 + (VGMA2 - VGMA3) \times 5/8$ |
| 03H | 0 | 0 | 0 | 0 | 1 | 1 | VH3 | $VGMA3 + (VGMA2 - VGMA3) \times 4/8$ |
| 04H | 0 | 0 | 0 | 1 | 0 | 0 | VH4 | $VGMA3 + (VGMA2 - VGMA3) \times 3/8$ |
| 05H | 0 | 0 | 0 | 1 | 0 | 1 | VH5 | $VGMA3 + (VGMA2 - VGMA3) \times 2/8$ |
| 06H | 0 | 0 | 0 | 1 | 1 | 0 | VH6 | $VGMA3 + (VGMA2 - VGMA3) \times 1/8$ |
| 07H | 0 | 0 | 0 | 1 | 1 | 1 | VH7 | VGMA3 |
| 08H | 0 | 0 | 1 | 0 | 0 | 0 | VH8 | $VGMA4 + (VGMA3 - VGMA4) \times 7/8$ |
| 09H | 0 | 0 | 1 | 0 | 0 | 1 | VH9 | $VGMA4 + (VGMA3 - VGMA4) \times 6/8$ |
| 0AH | 0 | 0 | 1 | 0 | 1 | 0 | VH10 | $VGMA4 + (VGMA3 - VGMA4) \times 5/8$ |
| 0BH | 0 | 0 | 1 | 0 | 1 | 1 | VH11 | $VGMA4 + (VGMA3 - VGMA4) \times 4/8$ |
| 0CH | 0 | 0 | 1 | 1 | 0 | 0 | VH12 | $VGMA4 + (VGMA3 - VGMA4) \times 3/8$ |
| 0DH | 0 | 0 | 1 | 1 | 0 | 1 | VH13 | $VGMA4 + (VGMA3 - VGMA4) \times 2/8$ |
| 0EH | 0 | 0 | 1 | 1 | 1 | 0 | VH14 | $VGMA4 + (VGMA3 - VGMA4) \times 1/8$ |
| 0FH | 0 | 0 | 1 | 1 | 1 | 1 | VH15 | VGMA4 |
| 10H | 0 | 1 | 0 | 0 | 0 | 0 | VH16 | $VGMA5 + (VGMA4 - VGMA5) \times 7/8$ |
| 11H | 0 | 1 | 0 | 0 | 0 | 1 | VH17 | $VGMA5 + (VGMA4 - VGMA5) \times 6/8$ |
| 12H | 0 | 1 | 0 | 0 | 1 | 0 | VH18 | $VGMA5 + (VGMA4 - VGMA5) \times 5/8$ |
| 13H | 0 | 1 | 0 | 0 | 1 | 1 | VH19 | $VGMA5 + (VGMA4 - VGMA5) \times 4/8$ |
| 14H | 0 | 1 | 0 | 1 | 0 | 0 | VH20 | $VGMA5 + (VGMA4 - VGMA5) \times 3/8$ |
| 15H | 0 | 1 | 0 | 1 | 0 | 1 | VH21 | $VGMA5 + (VGMA4 - VGMA5) \times 2/8$ |
| 16H | 0 | 1 | 0 | 1 | 1 | 0 | VH22 | $VGMA5 + (VGMA4 - VGMA5) \times 1/8$ |
| 17H | 0 | 1 | 0 | 1 | 1 | 1 | VH23 | VGMA5 |
| 18H | 0 | 1 | 1 | 0 | 0 | 0 | VH24 | $VGMA6 + (VGMA5 - VGMA6) \times 7/8$ |
| 19H | 0 | 1 | 1 | 0 | 0 | 1 | VH25 | $VGMA6 + (VGMA5 - VGMA6) \times 6/8$ |
| 1AH | 0 | 1 | 1 | 0 | 1 | 0 | VH26 | $VGMA6 + (VGMA5 - VGMA6) \times 5/8$ |
| 1BH | 0 | 1 | 1 | 0 | 1 | 1 | VH27 | $VGMA6 + (VGMA5 - VGMA6) \times 4/8$ |
| 1CH | 0 | 1 | 1 | 1 | 0 | 0 | VH28 | $VGMA6 + (VGMA5 - VGMA6) \times 3/8$ |
| 1DH | 0 | 1 | 1 | 1 | 0 | 1 | VH29 | $VGMA6 + (VGMA5 - VGMA6) \times 2/8$ |
| 1EH | 0 | 1 | 1 | 1 | 1 | 0 | VH30 | $VGMA6 + (VGMA5 - VGMA6) \times 1/8$ |
| 1FH | 0 | 1 | 1 | 1 | 1 | 1 | VH31 | VGMA6 |

NOTE: VDD2 > VGMA1 > VGMA2 > VGMA3 > VGMA4 > VGMA5 > VGMA6 > VGMA7 > VGMA8 > VGMA9 > VGMA10 > VGMA11 > VSS2

Table 5. Relationship between Input Data and Output Voltage Value (Continued)

| Input data | DX5 | DX4 | DX3 | DX2 | DX1 | DX0 | G/S | Output voltage |
|------------|-----|-----|-----|-----|-----|-----|------|--|
| 20H | 1 | 0 | 0 | 0 | 0 | 0 | VH32 | $VGMA7 + (VGMA6 - VGMA7) \times 7/8$ |
| 21H | 1 | 0 | 0 | 0 | 0 | 1 | VH33 | $VGMA7 + (VGMA6 - VGMA7) \times 7/8$ |
| 22H | 1 | 0 | 0 | 0 | 1 | 0 | VH34 | $VGMA7 + (VGMA6 - VGMA7) \times 7/8$ |
| 23H | 1 | 0 | 0 | 0 | 1 | 1 | VH35 | $VGMA7 + (VGMA6 - VGMA7) \times 7/8$ |
| 24H | 1 | 0 | 0 | 1 | 0 | 0 | VH36 | $VGMA7 + (VGMA6 - VGMA7) \times 7/8$ |
| 25H | 1 | 0 | 0 | 1 | 0 | 1 | VH37 | $VGMA7 + (VGMA6 - VGMA7) \times 7/8$ |
| 26H | 1 | 0 | 0 | 1 | 1 | 0 | VH38 | $VGMA7 + (VGMA6 - VGMA7) \times 7/8$ |
| 27H | 1 | 0 | 0 | 1 | 1 | 1 | VH39 | $VGMA7$ |
| 28H | 1 | 0 | 1 | 0 | 0 | 0 | VH40 | $VGMA8 + (VGMA7 - VGMA8) \times 7/8$ |
| 29H | 1 | 0 | 1 | 0 | 0 | 1 | VH41 | $VGMA8 + (VGMA7 - VGMA8) \times 6/8$ |
| 2AH | 1 | 0 | 1 | 0 | 1 | 0 | VH42 | $VGMA8 + (VGMA7 - VGMA8) \times 5/8$ |
| 2BH | 1 | 0 | 1 | 0 | 1 | 1 | VH43 | $VGMA8 + (VGMA7 - VGMA8) \times 4/8$ |
| 2CH | 1 | 0 | 1 | 1 | 0 | 0 | VH44 | $VGMA8 + (VGMA7 - VGMA8) \times 3/8$ |
| 2DH | 1 | 0 | 1 | 1 | 0 | 1 | VH45 | $VGMA8 + (VGMA7 - VGMA8) \times 2/8$ |
| 2EH | 1 | 0 | 1 | 1 | 1 | 0 | VH46 | $VGMA8 + (VGMA7 - VGMA8) \times 1/8$ |
| 2FH | 1 | 0 | 1 | 1 | 1 | 1 | VH47 | $VGMA8$ |
| 30H | 1 | 1 | 0 | 0 | 0 | 0 | VH48 | $VGMA9 + (VGMA8 - VGMA9) \times 7/8$ |
| 31H | 1 | 1 | 0 | 0 | 0 | 1 | VH49 | $VGMA9 + (VGMA8 - VGMA9) \times 6/8$ |
| 32H | 1 | 1 | 0 | 0 | 1 | 0 | VH50 | $VGMA9 + (VGMA8 - VGMA9) \times 5/8$ |
| 33H | 1 | 1 | 0 | 0 | 1 | 1 | VH51 | $VGMA9 + (VGMA8 - VGMA9) \times 4/8$ |
| 34H | 1 | 1 | 0 | 1 | 0 | 0 | VH52 | $VGMA9 + (VGMA8 - VGMA9) \times 3/8$ |
| 35H | 1 | 1 | 0 | 1 | 0 | 1 | VH53 | $VGMA9 + (VGMA8 - VGMA9) \times 2/8$ |
| 36H | 1 | 1 | 0 | 1 | 1 | 0 | VH54 | $VGMA9 + (VGMA8 - VGMA9) \times 1/8$ |
| 37H | 1 | 1 | 0 | 1 | 1 | 1 | VH55 | $VGMA9$ |
| 38H | 1 | 1 | 1 | 0 | 0 | 0 | VH56 | $VGMA11 + (VGMA9 - VGMA11) \times 7/8$ |
| 39H | 1 | 1 | 1 | 0 | 0 | 1 | VH57 | $VGMA11 + (VGMA9 - VGMA11) \times 6/8$ |
| 3AH | 1 | 1 | 1 | 0 | 1 | 0 | VH58 | $VGMA11 + (VGMA9 - VGMA11) \times 5/8$ |
| 3BH | 1 | 1 | 1 | 0 | 1 | 1 | VH59 | $VGMA11 + (VGMA9 - VGMA11) \times 4/8$ |
| 3CH | 1 | 1 | 1 | 1 | 0 | 0 | VH60 | $VGMA11 + (VGMA9 - VGMA11) \times 3/8$ |
| 3DH | 1 | 1 | 1 | 1 | 0 | 1 | VH61 | $VGMA11 + (VGMA9 - VGMA11) \times 2/8$ |
| 3EH | 1 | 1 | 1 | 1 | 1 | 0 | VH62 | $VGMA11 + (VGMA9 - VGMA11) \times 1/8$ |
| 3FH | 1 | 1 | 1 | 1 | 1 | 1 | VH63 | $VGMA11$ |

RGMA (Gamma-Corrected Resistance) Ratio. (if the sum of RGMA1 and RGMA2 equals 1)

| | | | |
|-------|------|--------|------|
| RGMA1 | 1.00 | RGMA6 | 0.37 |
| RGMA2 | | RGMA7 | 0.29 |
| RGMA3 | 1.21 | RGMA8 | 0.37 |
| RGMA4 | 0.66 | RGMA9 | 0.71 |
| RGMA5 | 0.39 | RGMA10 | |

RGMA1 + RGMA2 = 5.28 kΩ

ABSOLUTE MAXIMUM RATINGS

Table 6. Absolute Maximum Ratings (VSS1 = VSS2 = 0 V)

| Parameter | Symbol | Ratings | Unit |
|-----------------------|------------|--------------------|------|
| Logic supply voltage | VDD1 | -0.3 to 6.5 | V |
| Driver supply voltage | VDD2 | -0.3 to 6.5 | |
| Input voltage | VGMA1 - 10 | -0.3 to VDD2 + 0.3 | |
| | Others | -0.3 to VDD1 + 0.3 | |
| Output voltage | DIO1, 2 | -0.3 to VDD1 + 0.3 | |
| | Y1 - Y309 | -0.3 to VDD2 + 0.3 | |
| Operation temperature | Topr | -20 to 75 | °C |
| Storage temperature | Tstg | -55 to 125 | |

CAUTIONS:

If LSIs are stressed beyond those listed above “absolute maximum ratings”, they may be permanently destroyed. These are stress ratings only, and functional operation of the device at these or any other condition beyond those indicated under “recommended operating conditions” is not implied. Exposure to absolute maximum rated conditions for extended periods may affect device reliability. Turn on power order: VDD1 → control signal input → VDD2 → VGMA1 - VGMA11
Turn off power order: VGMA1 - VGMA11 → VDD2 → control signal input → VDD1

RECOMMENDED OPERATION CONDITIONS

Table 7. Recommended Operation Conditions (Ta = -20 to 75 °C, VSS1 = VSS2 = 0 V)

| Parameter | Symbol | Min. | Typ. | Max. | Unit |
|-------------------------|----------------|--------------|------|------|----------|
| Logic supply voltage | VDD1 | 3.0 | 3.3 | 5.5 | V |
| Driver supply voltage | VDD2 | 3.0 | 5.0 | 5.5 | V |
| Gamma corrected voltage | VGMA1 – VGMA11 | VSS2 | - | VDD2 | V |
| Maximum clock frequency | fmax | VDD1 = 3.3 V | | 55 | MHz |
| Output load capacitance | CL | - | - | 150 | pF / PIN |

DC CHARACTERISTICS

Table 8. DC Characteristics (Ta = -20 to 75 °C, VDD1 = 3.0 to 5.5 V, VDD2 = 3.0 to 5.5 V, VSS1 = VSS2 = 0 V)

| Parameter | Symbol | Condition | Min. | Typ. | Max. | Unit |
|-----------------------------|------------------|--|------------|------|------------|------|
| High level input voltage | VIH | SHL, CLK2, D00 – D25, CLK1, DIO1 (DIO2) | 0.7 VDD1 | - | VDD1 | V |
| Low level input voltage | VIL | | 0 | - | 0.3 VDD1 | |
| Input leakage current | IL | | --0.5 | - | 0.5 | μA |
| High level output voltage | VOH | DIO1 (DIO2), VDD1=3.3V IO = -1.0 mA | VDD1 - 0.5 | - | - | V |
| Low level output voltage | VOL | DIO1 (DIO2), VDD1=3.3V IO = +1.0 mA | - | - | 0.5 | |
| Resistor | R0 - R62 | | Rn × 0.7 | | Rn × 1.3 | Ω |
| Driver output current | I _{VOH} | VDD2 = 5.0 V, V _x = 3.5 V, V _{yo} = 4.5 V | - | -1.5 | -0.5 | mA |
| | I _{VOL} | VDD2 = 5.0 V, V _x = 1.5 V, V _{yo} = 0.5 V | 0.5 | 0.5 | - | mA |
| Output voltage deviation | ΔVO | VSS2 + 0.2 V to VDD2 - 1.5 V | - | ±10 | ±20 | mV |
| Output voltage range | V _{yo} | Input data: 00H to 3FH | VSS2 + 0.2 | - | VDD2 - 0.2 | V |
| Logic part dynamic current | IDD1 | VDD1 = 3.0 V ⁽²⁾ | - | 3.5 | 5.5 | mA |
| Driver part dynamic current | IDD2 | VDD1 = 3.0 V, VDD2 = 5.0 V, VGMA1 = 4.5 V, VGMA11 = 0.5 V | - | 5.5 | 7.0 | |

NOTES:

- V_{yo} is the output voltage of analog output pins Y1 to Y309. V_x is the voltage applied to analog output pins Y1 to Y309.
- CLK1 period is defined to be 30 μs at f_{CLK2} = 30 MHz, data pattern = 101010 , (checkerboard pattern), Ta = 25 °C

AC CHARACTERISTICS

Table 9. AC Characteristics (Ta = -20 to 75 °C, VDD2 = 3.0 to 5.5 V, VDD1 = 3.0 to 5.5 V, VSS1 = VSS2 = 0 V)

| Parameter | Symbol | Condition | Min. | Typ. | Max. | Unit |
|---------------------------|------------|----------------------------|------|------|------|-------------|
| Clock pulse width | PWCLK | - | 18 | - | - | ns |
| Clock pulse low period | PWCLK(L) | - | 4 | - | - | |
| Clock pulse high period | PWCLK(H) | - | 4 | - | - | |
| Data setup time | tSETUP1 | (1) | 4 | - | - | |
| Data hold time | tHOLD1 | (1) | 0 | - | - | |
| Start pulse setup time | tSETUP2 | (1) | 4 | - | - | |
| Start pulse hold time | tHOLD2 | (1) | 0 | - | - | |
| Start pulse delay time | tPLH1 | VDD1 = 3.3 V CL = 35 pF | - | - | 14 | |
| CLK1 setup time | tSETUP3 | - | 1 | - | - | CLK2 period |
| Driver output delay time1 | tPHL1 | (2) | - | - | 3 | μs |
| Driver output delay time2 | tPHL2 | (3) | - | - | 10 | |
| CLK1 pulse high period | PWCLK1 | - | 2 | - | - | CLK2 period |
| Data invalid period | tINV | DIO1 (2) ↑ → CLK2↑ | 1 | | | CLK2 period |
| Last data timing | tLDT | - | 0 | - | - | ns |
| CLK1-CLK2 time | tCLK1-CLK2 | CLK1↑ → CLK2↑ | 6 | - | - | ns |

NOTES:

1. Input condition (VIH = 0.7 VDD1, VIL = 0.3 VDD1)
2. The value is specified when the drive voltage value reaches the target output voltage level of 90%
3. The value is specified when the drive voltage value reaches the target output voltage level of 6-bit accuracy.

WAVEFORMS

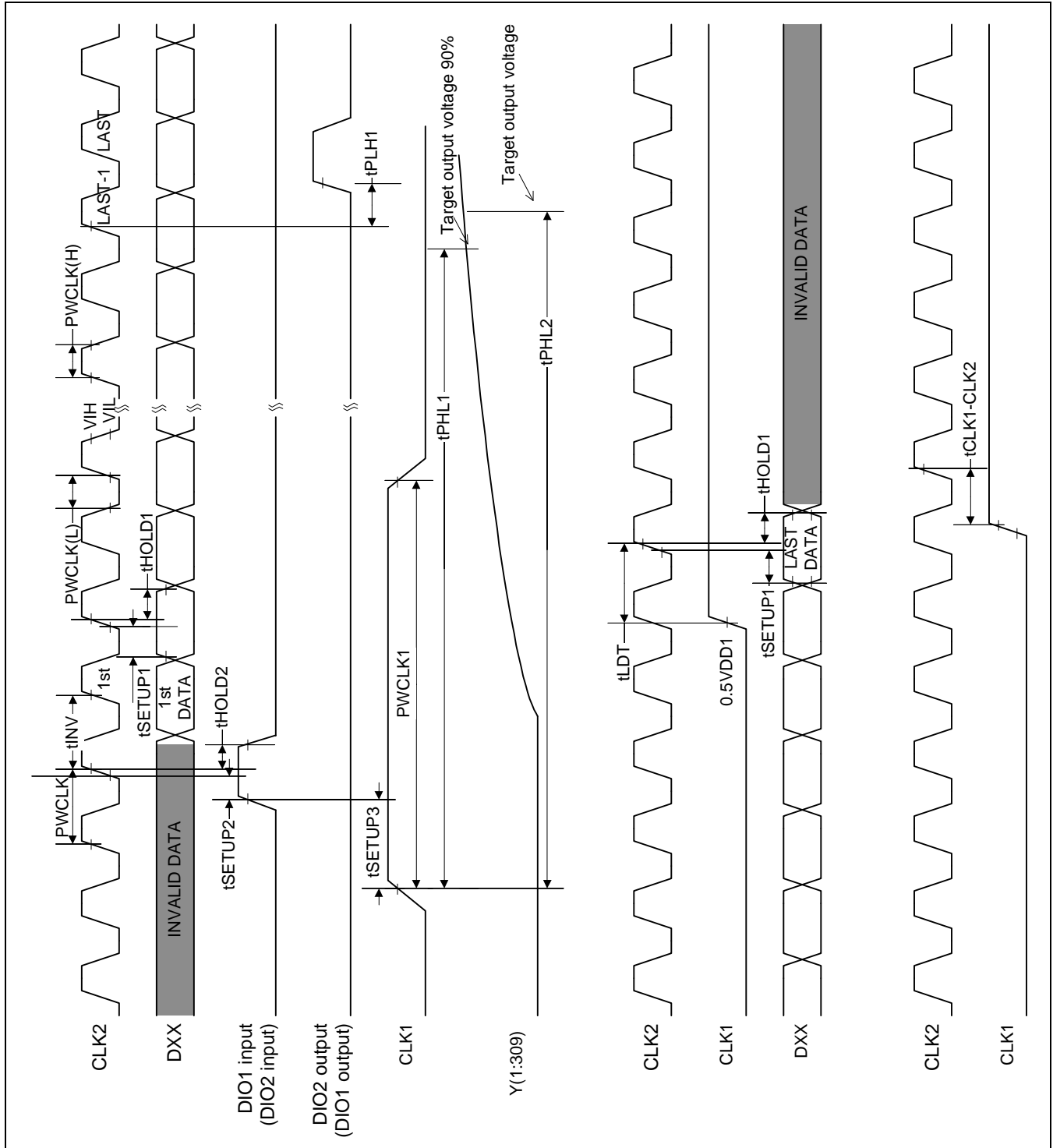


Figure 5. Waveforms

RELATIONSHIPS BETWEEN CLK1, START PULSE (DIO1, DIO2) AND BLANKING PERIOD

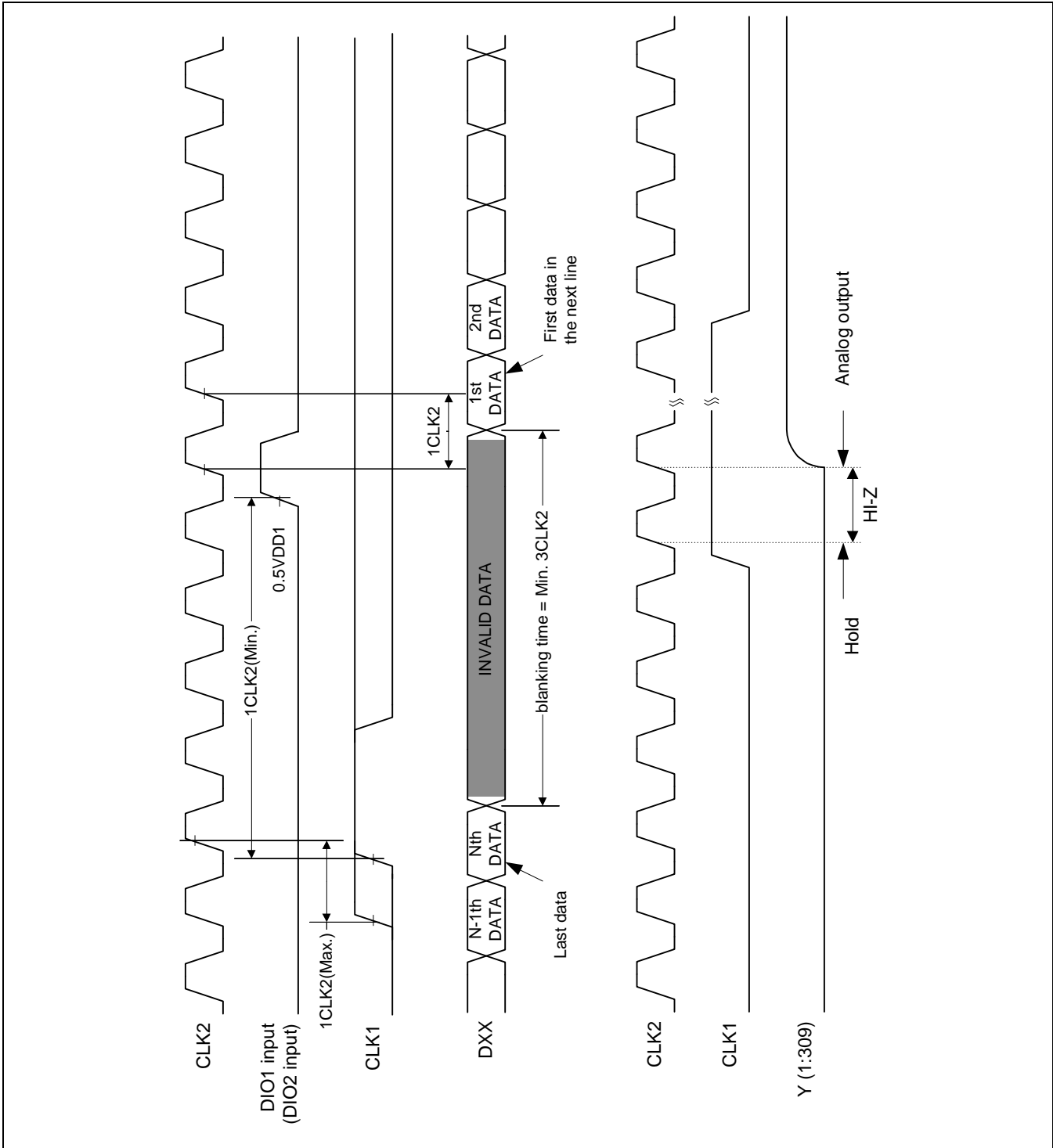


Figure 6. Waveforms