



DESCRIPTION

PT6313-S is a Vacuum Fluorescent Display (VFD) Controller driven on a 1/4 to 1/8 duty factor. Eight segment output lines, 4 grid output lines, 4 segment/grid output drive lines, one display memory, control circuit, key scan circuit are all incorporated into a single chip to build a highly reliable peripheral device for a single chip micro computer. Serial data is fed to PT6313-S via a three-line serial interface. It is housed in a 28pins, SOP.

FEATURES

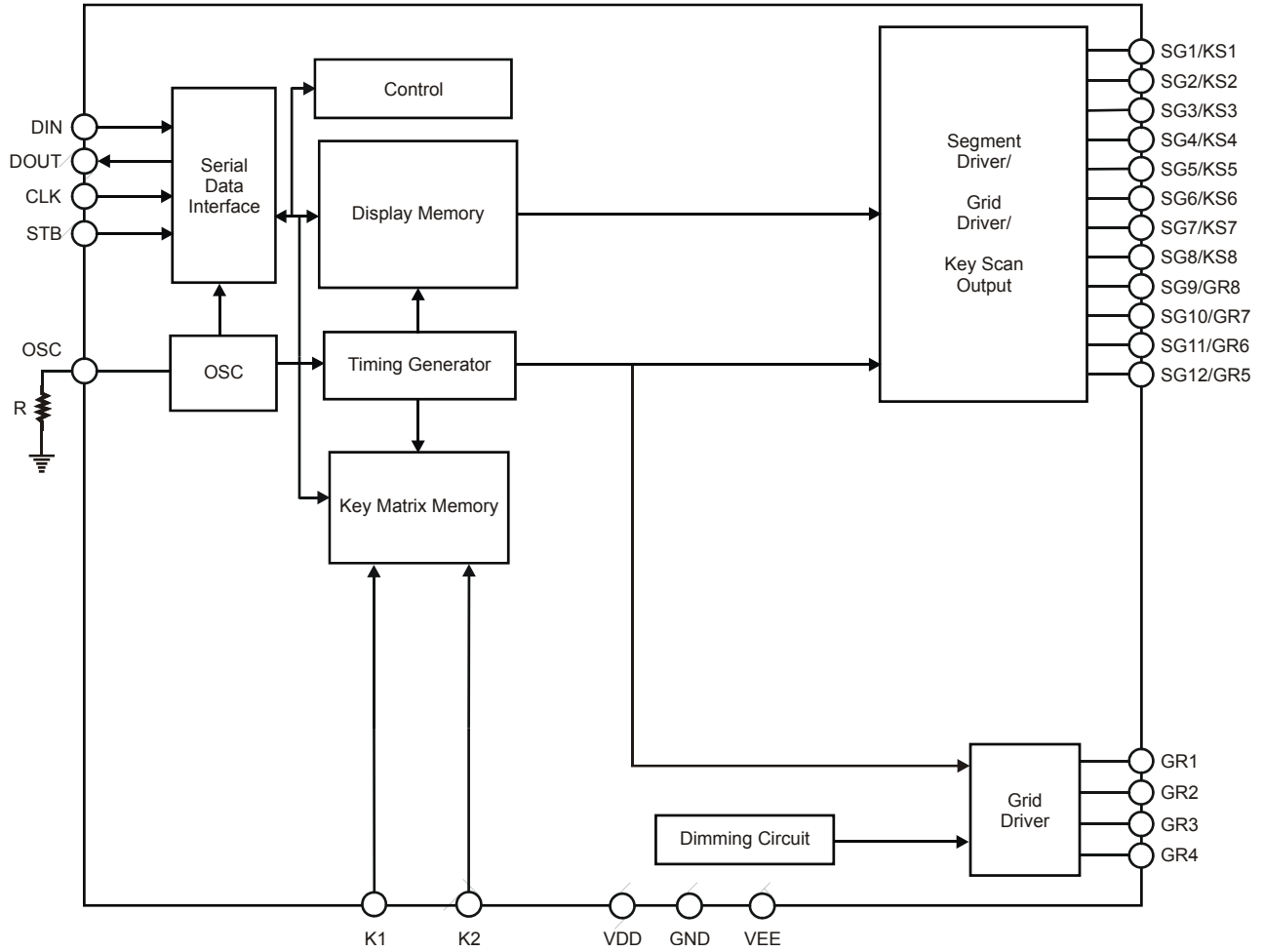
- CMOS Technology
- Low Power Consumption
- Key Scanning (8 x 2 matrix)
- Multiple Display Modes: (8 Segments, 8 Digits to 12 Segments, 4 Digits)
- 8-Step Dimming Circuitry
- Serial Interface for Clock, Data Input, Data Output, Strobe Pins
- No External Resistors Needed for Driver Outputs
- Available in 28pins, SOP

APPLICATION

- Microcomputer Peripheral Devices

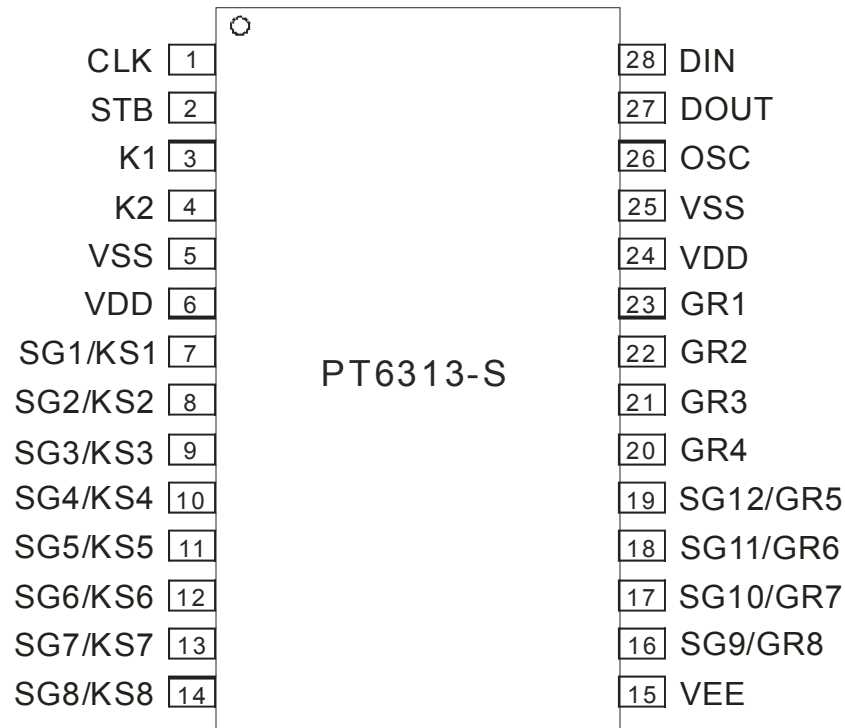


BLOCK DIAGRAM





PIN CONFIGURATION





PIN DESCRIPTION

| Pin Name | I/O | Description | Pin No. |
|---------------------|-----|---|----------|
| CLK | I | Clock Input Pin This pin reads serial data at the rising edge and outputs data at the falling edge. | 1 |
| STB | I | Serial Interface Strobe Pin The data input after the STB has fallen is processed as a command. When this in is "HIGH", CLK is ignored. | 2 |
| K1 to K2 | I | Key Data Input Pins The data inputted to these pins is latched at the end of the display cycle. | 3, 4 |
| VSS | - | Logic Ground Pin | 5, 25 |
| VDD | - | Logic Power Supply | 6, 24 |
| SG1/KS1 to SG8/KS8 | O | High-Voltage Segment Output Pins Also acts as the Key Source. | 7 to 14 |
| VEE | - | Pull-Down Level | 15 |
| SG9/GR8 to SG12/GR5 | O | High-Voltage Segment Output Pins | 16 to 19 |
| GR4 to GR1 | O | High-Voltage Grid Output Pins | 20 to 23 |
| OSC | I | Oscillator Input Pin A resistor is connected to this pin to determine the oscillation frequency. | 26 |
| DOUT | O | Data Output Pin (N-Channel, Open-Drain) This pin outputs serial data at the falling edge of the shift clock (starting from the lower bit). | 27 |
| DIN | I | Data Input Pin This pin inputs serial data at the rising edge of the shift clock (starting from the lower bit). | 28 |



FUNCTION DESCRIPTION

COMMANDS

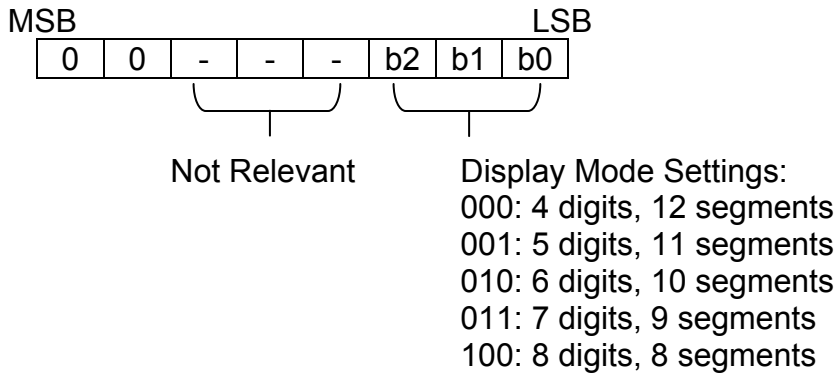
Commands determine the display mode and status of PT6313-S. A command is the first byte (b0 to b7) inputted to PT6313-S via the DIN Pin after STB Pin has changed from “HIGH” to “LOW” State. If for some reason the STB Pin is set to “HIGH” while data or commands are being transmitted, the serial communication is initialized, and the data/commands being transmitted are considered invalid.

COMMAND 1: DISPLAY MODE SETTING COMMANDS

PT6313-S provides 4 display mode settings as shown in the diagram below: As stated earlier a command is the first one byte (b0 to b7) transmitted to PT6313-S via the DIN Pin when STB is “LOW”. However, for these commands, the bits 4 to 6 (b3 to b5) are ignored, bits 7 & 8 (b6 to b7) are given a value of “0”.

The Display Mode Setting Commands determine the number of segments and grids to be used (1/4 to 1/8 duty, 12 to 8 segments).

When Power is turned “ON”, the 8-digit, 8-segment mode is selected.





VFD Driver/Controller IC

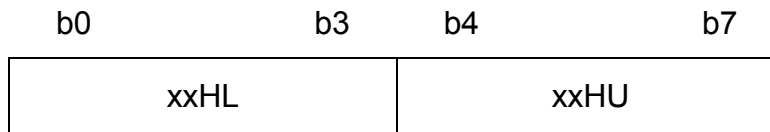
PT6313-S

Display Mode and RAM Address

Data transmitted from an external device to PT6313-S via the serial interface are stored in the Display RAM and are assigned addresses. The RAM Addresses of PT6313-S are given below in 8 bits unit.

SG1 SG4 SG5 SG8 SG9 SG12

| | | | |
|------|------|------|------|
| 00HL | 00HU | 01HL | DIG1 |
| 02HL | 02HU | 03HL | DIG2 |
| 04HL | 04HU | 05HL | DIG3 |
| 06HL | 06HU | 07HL | DIG4 |
| 08HL | 08HU | 09HL | DIG5 |
| 0AHL | 0AHU | 0BHL | DIG6 |
| 0CHL | 0CHU | 0DHL | DIG7 |
| 0EHL | 0EHU | 0FHL | DIG8 |



Lower 4 bits

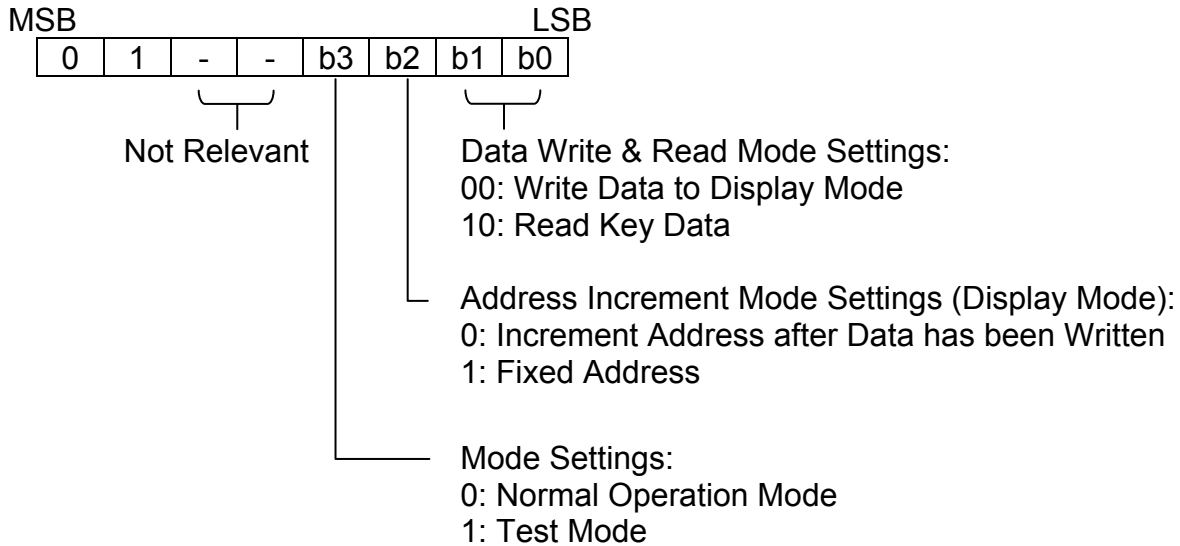
Higher 4 bits



COMMAND 2: DATA SETTING COMMANDS

The Data Setting Commands executes the Data Write or Data Read Modes for PT6313-S. The Data Setting Command, the bits 5 and 6 (b4, b5) are ignored, bit 7 (b6) is given the value of "1" while bit 8 (b7) is given the value of "0". Please refer to the diagram below.

When power is turned ON, the bit 4 to bit 1 (b3 to b0) are given the value of "0".



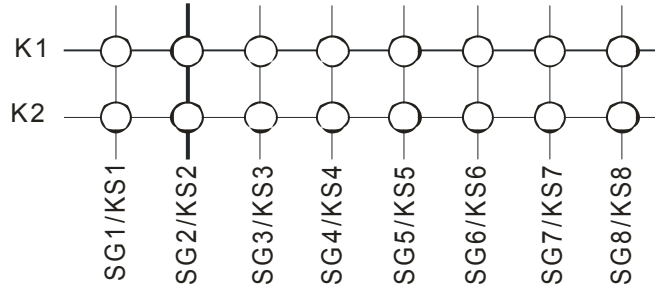


VFD Driver/Controller IC

PT6313-S

PT6313-S Key Matrix & Key Input Data Storage RAM

PT6313-S Key Matrix consists of 8 x 2 array as shown below:



Each data inputted by each key are stored as follows. They are read by a READ Command, starting from the last significant bit of the data (SG8, b7) has been read, the least significant bit of the next data (SG1, b0) is read.

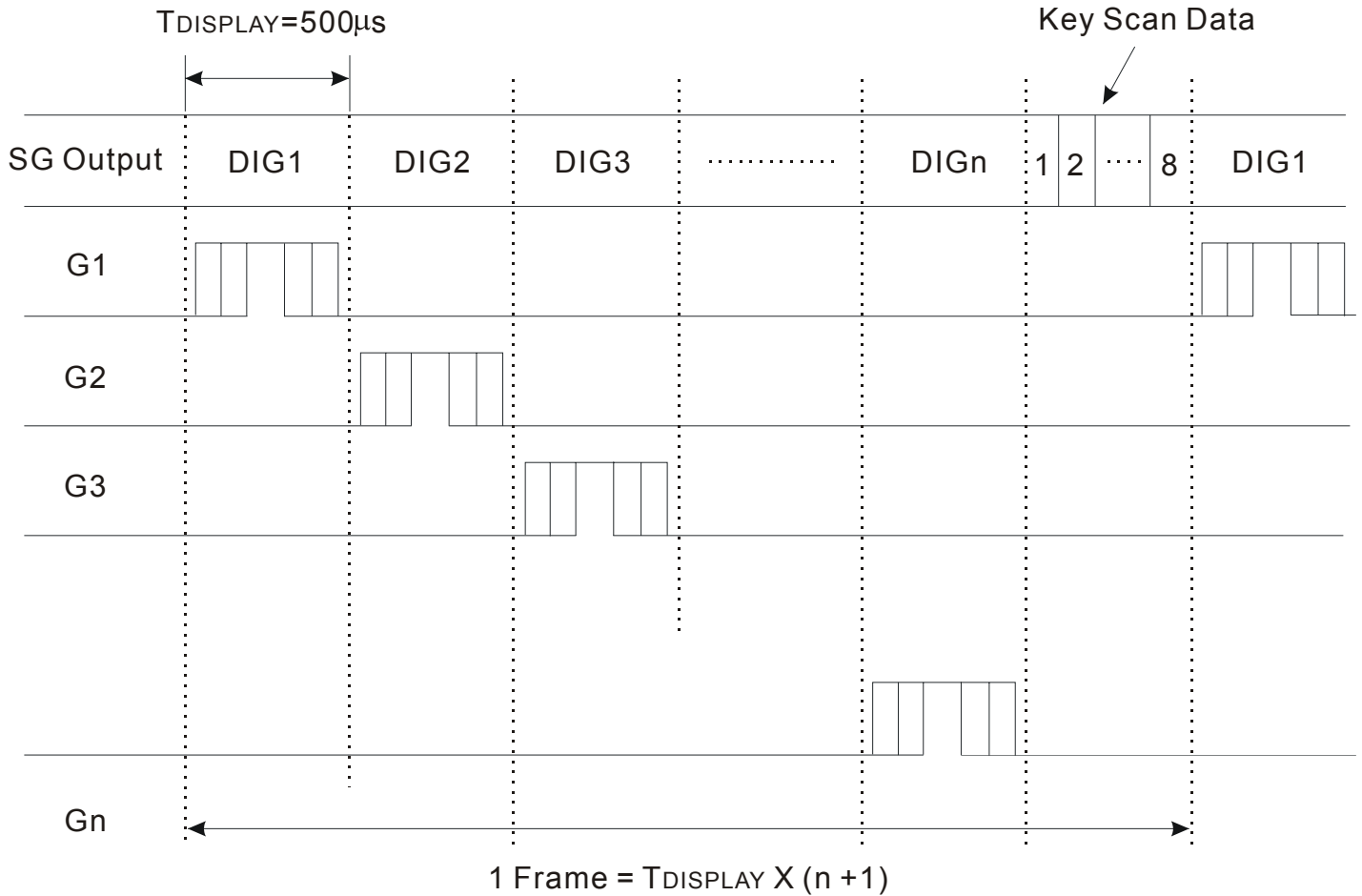
| | | | | |
|-----------|-----------|-----------|-----------|--------------------------|
| K1.....K1 | K2.....K3 | K4.....K5 | K6.....K7 | ↓ Reading Sequence |
| SG1/KS1 | SG2/KS2 | SG3/KS3 | SG4/KS4 | |
| SG5/KS5 | SG6/KS6 | SG7/KS7 | SG8/KS8 | |
| b0.....b1 | b2.....b3 | b4.....b5 | b6.....b7 | |



VFD Driver/Controller IC PT6313-S

SCANNING AND DISPLAY TIMING

The Key Scanning and display timing diagram is given below. The data of the 8 x 2 matrix is stored in the RAM.

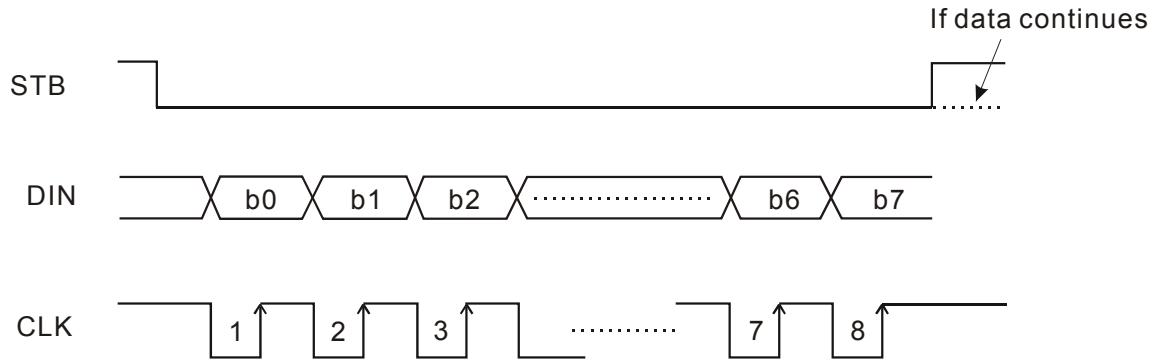




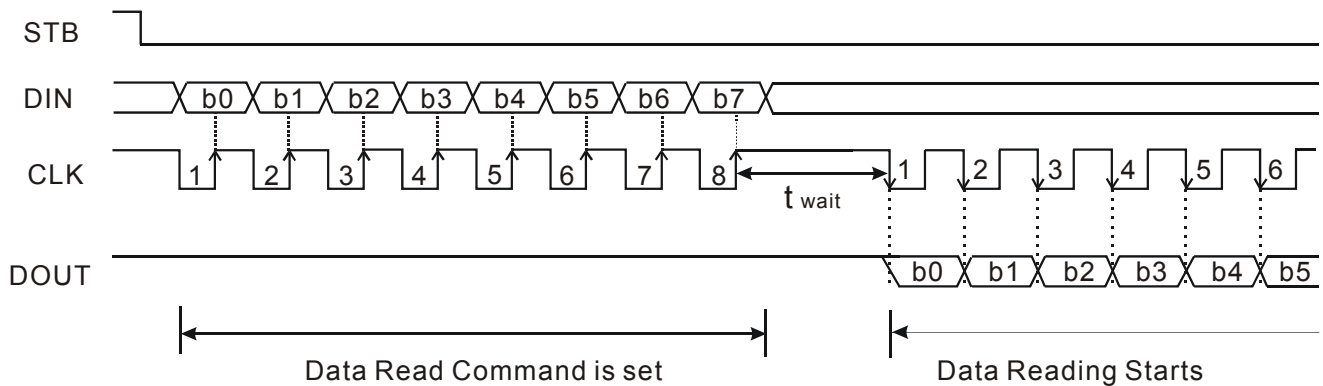
SERIAL COMMUNICATION FORMAT

The following diagram shows the PT6313-S serial communication format. The DOUT Pin is an N-channel, open-drain output pin; therefore, it is highly recommended that an external pull-up resistor (1KΩ to 10KΩ) must be connected to DOUT.

Reception (Data/Command Write)



Transmission (Data Read)



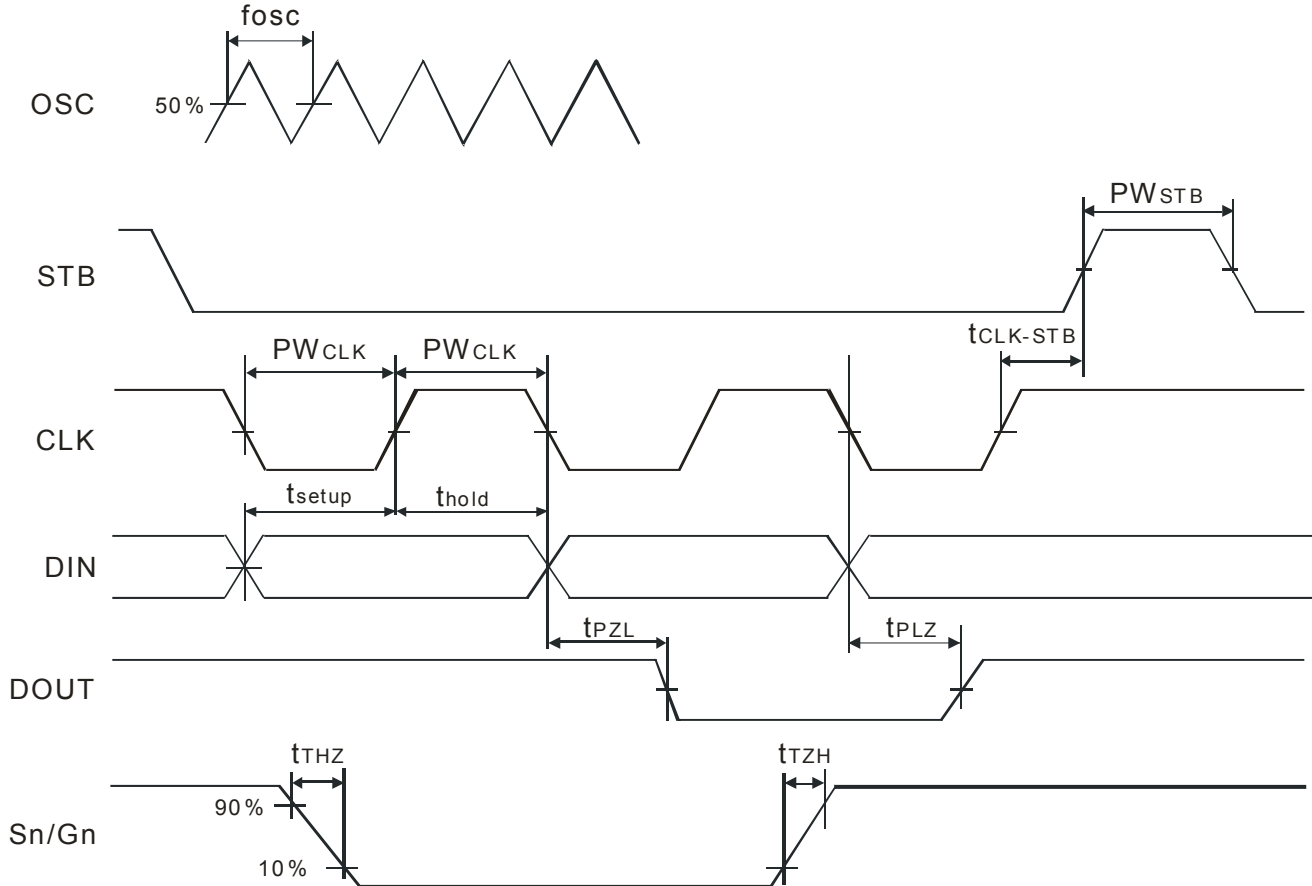
where: t_{wait} (waiting time) > $1\mu s$

It must be noted that when the data is read, the waiting time (t_{wait}) between the rising of the eighth clock that has set the command and the falling of the first clock that has read the data is greater or equal to $1\mu s$.



SWITCHING CHARACTERISTIC WAVEFORM

PT6313-S Switching Characteristics Waveform is given below.



where:

PW_{CLK} (Clock Pulse Width) $\geq 400ns$

t_{setup} (Data Setup Time) $\geq 100ns$

$t_{CLK-STB}$ (Clock - Strobe Time) $\geq 1\mu s$

t_{THZ} (Grid Rise Time) $\leq 0.5\mu s$ (VDD=5V)

t_{THZ} (Grid Rise Time) $\leq 1.0\mu s$ (VDD=3.3V)

t_{THZ} (Segment Rise Time) $\leq 2.0\mu s$ (VDD=5V)

t_{THZ} (Segment Rise Time) $\leq 3.0\mu s$ (VDD=3.3V)

f_{osc} =Oscillation Frequency

PW_{STB} (Strobe Pulse Width) $\geq 1\mu s$

t_{hold} (Data Hold Time) $\geq 100ns$

t_{THZ} (Fall Time) $\leq 150\mu s$

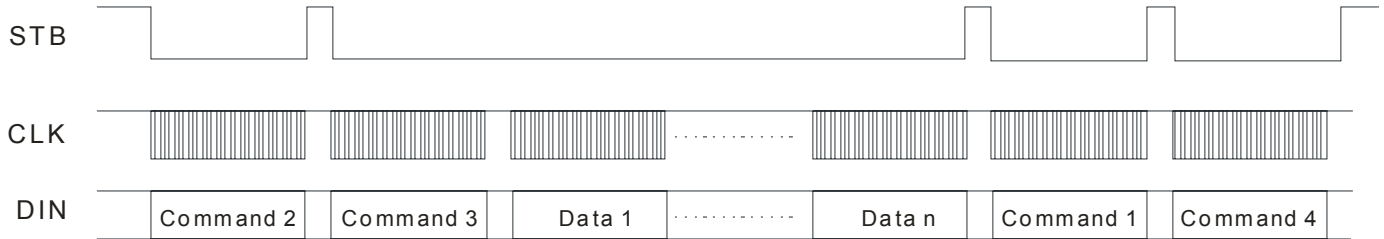
t_{PZL} (Propagation Delay Time) $\leq 100ns$

t_{PLZ} (Propagation Delay Time) $\leq 400ns$



APPLICATIONS

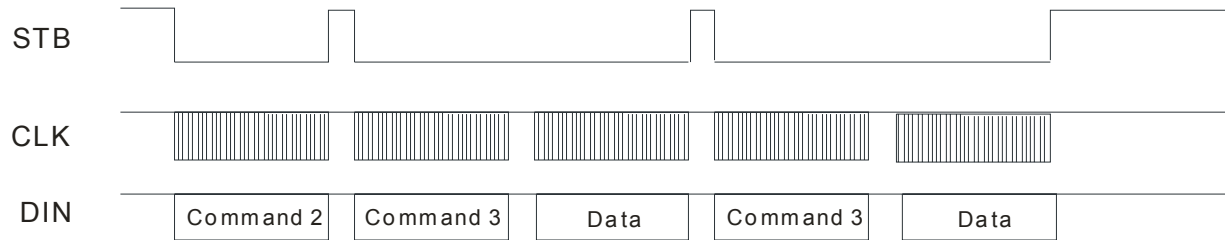
Display memory is updated by incrementing addresses. Please refer to the following diagram.



where:

- Command 1: Display Mode Setting Command
- Command 2: Data Setting Command
- Command 3: Address Setting Command
- Data 1 to n: Transfer Display Data (16 Bytes max.)
- Command 4: Display Control Command

The following diagram shows the waveforms when updating specific addresses.

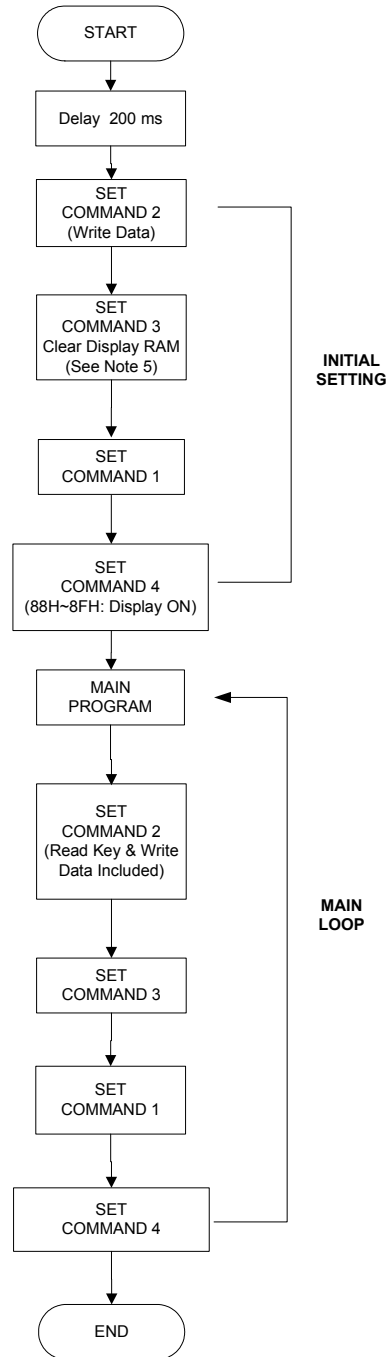


where:

- Command 2: Data Setting Command
- Command 3: Address Setting Command
- Data: Display Data



RECOMMENDED SOFTWARE FLOWCHART



Notes:

1. Command 1: Display Mode Commands
2. Command 2: Data Setting Commands
3. Command 3: Address Setting Commands
4. Command 4: Display Control Commands
5. When IC power is applied for the first time, the contents of the Display RAM are not defined; thus, it is strongly suggested that the contents of the Display RAM must be cleared during the initial setting.



ABSOLUTE MAXIMUM RATINGS

(Unless otherwise stated, Ta=25°C, GND=0V)

| Parameter | Symbol | Ratings | Unit |
|---------------------------|--------|-----------------------------|------|
| Logic Supply Voltage | VDD | -0.5 to +7 | V |
| Driver Supply Voltage | VEE | VDD +0.5 to VDD -40 | V |
| Logic Input Voltage | VI | -0.5 to VDD +0.5 | V |
| VFD Driver Output Voltage | VO | VEE -0.5 to VDD +0.5 | V |
| VFD Driver Output Current | IOVFD | -40 (Grid) -15 (Segment) | mA |
| Operating Temperature | Topr | -40 to +85 | °C |
| Storage Temperature | Tstg | -65 to +150 | °C |

RECOMMENDED OPERATING RANGE

(Unless otherwise stated, Ta=-25°C, GND=0V)

| Parameter | Symbol | Ratings | | | Unit |
|--------------------------|--------|---------|------|--------|------|
| | | Min. | Typ. | Max. | |
| Logic Supply Voltage | VDD | 3.0 | 5 | 5.5 | V |
| High-Level Input Voltage | VIH | 0.7VDD | - | VDD | V |
| Low-Level Input Voltage | VIL | 0 | - | 0.3VDD | V |
| Driver Supply Voltage | VEE | VDD -35 | - | 0 | V |



ELECTRICAL CHARACTERISTICS

(Unless otherwise stated, VDD=5V, GND=0V, VEE=VDD-35 V, Ta=25°C)

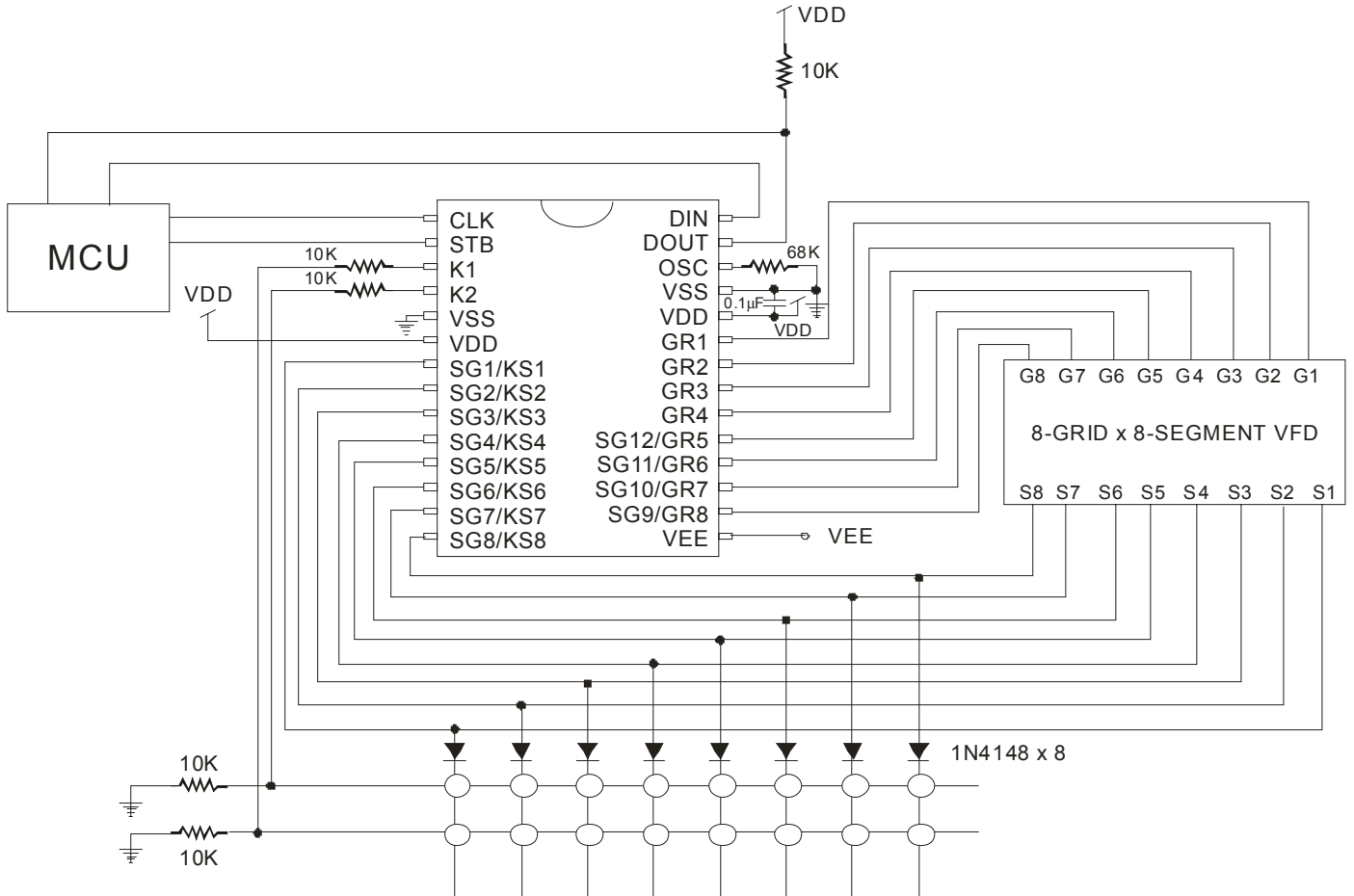
| Parameter | Symbol | Test Condition | Min. | Typ. | Max. | Unit |
|-----------------------------|---------|--|--------|------|--------|------|
| Low-Level Output Voltage | VOLDOUT | DOUT, IOLDOUT=4mA | - | - | 0.4 | V |
| High-Level Output Current | IOHSG | VO=VDD -2V SG1/KS1 to SG8/KS8 | -3 | - | - | mA |
| High-Level Output Current | IOHGR | VO=VDD -2V GR1 to GR4, SG9/GR8 to SG12/GR5 | -15 | - | - | mA |
| High-Level Input Voltage | VIH | - | 0.7VDD | - | VDD | V |
| Low-Level Input Voltage | VIL | - | - | - | 0.3VDD | V |
| Oscillation Frequency | fosc | R=68KΩ | 350 | 500 | 650 | KHz |
| Input Current | II | VI=VDD or VSS | - | - | ±1 | μA |
| Dynamic Current Consumption | IDDdyn | Under no load Display OFF | - | - | 5 | mA |

(Unless otherwise stated, VDD=3.3V, GND=0V, VEE=VDD-35 V, Ta=25°C)

| Parameter | Symbol | Test Condition | Min. | Typ. | Max. | Unit |
|-----------------------------|---------|--|--------|------|--------|------|
| Low-Level Output Voltage | VOLDOUT | DOUT, IOLDOUT=4mA | - | - | 0.4 | V |
| High-Level Output Current | IOHSG | VO=VDD -2V SG1/KS1 to SG8/KS8 | -1.5 | - | - | mA |
| High-Level Output Current | IOHGR | VO=VDD -2V GR1 to GR4, SG9/GR8 to SG12/GR5 | -6 | - | - | mA |
| High-Level Input Voltage | VIH | - | 0.7VDD | - | VDD | V |
| Low-Level Input Voltage | VIL | - | - | - | 0.3VDD | V |
| Oscillation Frequency | fosc | R=68KΩ | 350 | 500 | 650 | KHz |
| Input Current | II | VI=VDD or VSS | - | - | ±1 | μA |
| Dynamic Current Consumption | IDDdyn | Under no load Display OFF | - | - | 3 | mA |



APPLICATION CIRCUIT



Note: The capacitor (0.1µF) connected between the GND and the VDD pins must be located as close as possible to the PT6313-S chip.



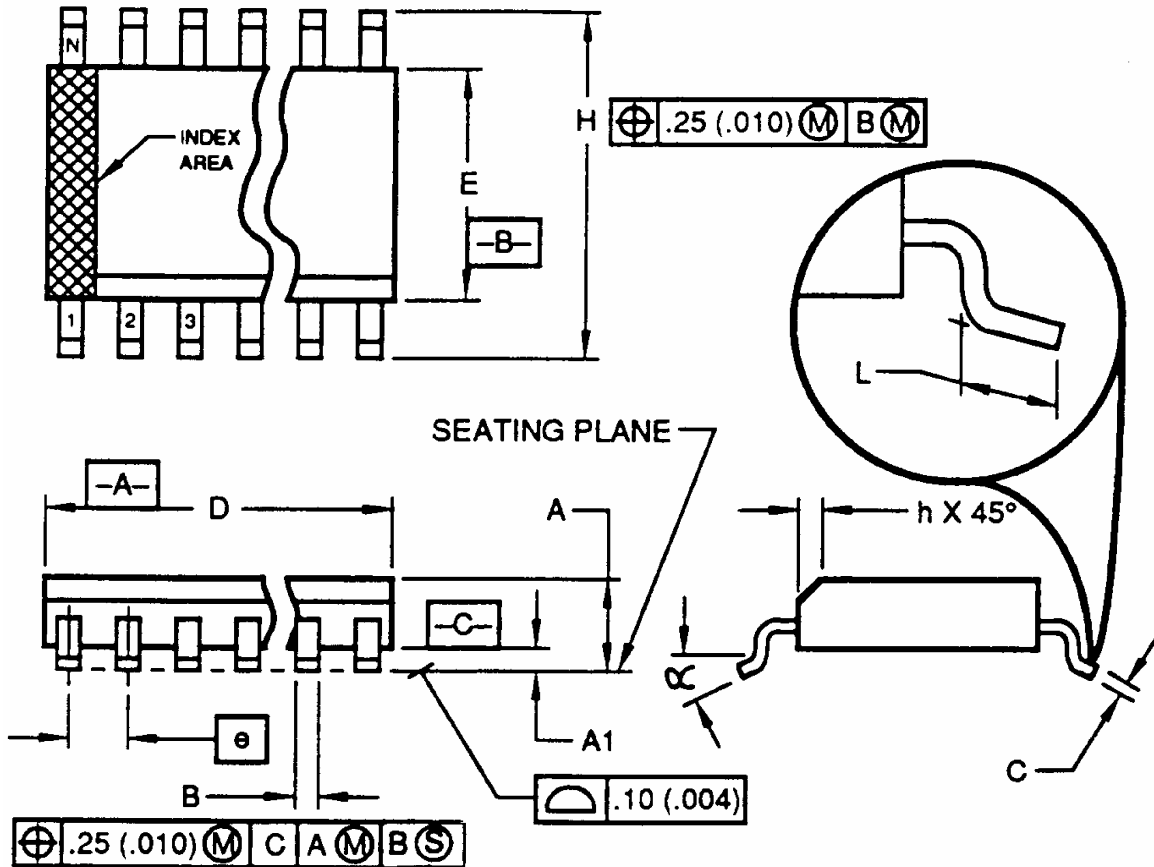
ORDER INFORMATION

| Valid Part Number | Package Type | Top Code |
|-------------------|---------------------|----------|
| PT6313-S | 28pins, SOP, 300mil | PT6313-S |



PACKAGE INFORMATION

28 PINS, SOP, 300 MIL



| Symbol | Min. | Max |
|--------|-----------|-------|
| A | 2.35 | 2.65 |
| A1 | 0.10 | 0.30 |
| B | 0.33 | 0.51 |
| C | 0.23 | 0.32 |
| D | 17.70 | 18.10 |
| E | 7.40 | 7.60 |
| e | 1.27 bsc. | |
| H | 10.00 | 10.65 |
| h | 0.25 | 0.75 |
| L | 0.40 | 1.27 |
| α | 0° | 8° |



VFD Driver/Controller IC

PT6313-S

Notes:

1. Dimensioning and tolerancing per ANSI Y14.5-1982.
2. Dimension D does not include mold flash, protrusions or gate burrs. Mold flash, protrusions and gate burrs shall not exceed 0.15mm (0.006 in) per side.
3. Dimension E does not include interlead flash or protrusions. Interlead flash and protrusion shall not exceed 0.15mm (0.016in) per side.
4. The chamfer on the body is optional. If it is not present, a visual index feature must be located within the crosshatched area.
5. L is the length of terminal for soldering to a substrate.
6. N is the number of terminal positions (N=28).
7. The lead width B as measured 0.36mm (0.014in) or greater above the seating plane, shall not exceed a maximum value of 0.61 mm (0.024 in).
8. Controlling dimension: MILLIMETER
9. Refer to JEDEC MS-013 Variation AE.

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