

Serial-in / Parallel-out Driver Series

Serial / Parallel 2-input Drivers



BU2098F, BU2090F, BU2090FS

No.09051EAT04

●Description

Serial-in-parallel-out driver is a open drain output driver. It incorporates a built-in shift register and a latch circuit to turn on a maximum of 12 LED by a 2-line interface, linked to a microcontroller. A open drain output provides maximum of 25mA current.

●Features

- 1) LED can be driven directly. (Output current 25mA)
- 2) 8/12 Bit parallel output
- 3) This product can be operated on low voltage.
- 4) Compatible with I²C BUS. (BU2098)

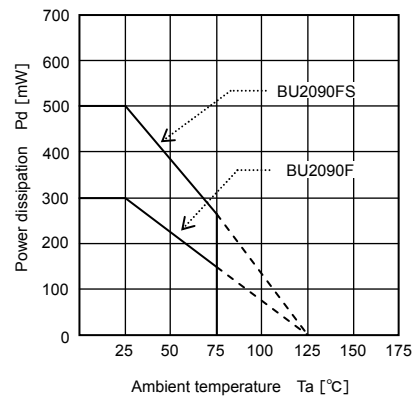
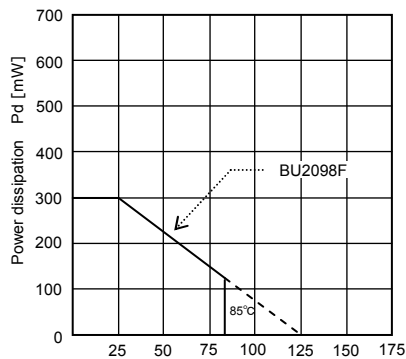
●Use

For AV equipment such as, audio stereo sets, videos and TV sets, PCs, control microcontroller mounted equipment.

●Line up

| Parameter | BU2098F | BU2090F | BU2090FS | Unit |
|----------------|---------|---------|----------|-------|
| Output current | 25 | 25 | | mA |
| Output line | 8 | 12 | | lines |
| Package | SOP16 | SOP16 | SSOP-A16 | — |

●Thermal derating curve



●Electrical characteristics

BU2098F (unless otherwise noted, $V_{DD}=5V$, $V_{SS}=0V$, $T_a=25^\circ C$)

| Parameter | Symbol | Min. | Typ. | Max. | Unit | Condition |
|----------------------------|----------|---------------------|------|---------------------|---------|---|
| Input High-level voltage | V_{IH} | $0.7 \times V_{DD}$ | - | - | V | |
| Input Low-level voltage | V_{IL} | - | - | $0.3 \times V_{DD}$ | V | |
| Output Low-level voltage | V_{OL} | - | - | 0.4 | V | $I_{OUT}=10mA$ |
| Input Low-level current | I_{IL} | - | - | 2.0 | μA | $V_{IN}=0$ |
| Input High-level current | I_{IH} | - | - | -2.0 | μA | $V_{IN}=V_{DD}$ |
| Output leakage current | I_{OZ} | - | - | ± 5.0 | μA | Output=High impedance $V_{OUT}=V_{DD}$ |
| Static dissipation current | I_{DD} | - | - | 2.0 | μA | |

BU2090F/BU2090FS (unless otherwise noted, $V_{DD}=5V/3V$, $V_{SS}=0V$, $T_a=25^\circ C$)

| Parameter | Symbol | Min. | Typ. | Max. | Unit | Condition |
|----------------------------|-----------|-------------|------|-------------|---------|---------------|
| Input High-level voltage | V_{IH} | $3.5/2.5^*$ | - | - | V | |
| Input Low-level voltage | V_{IL} | - | - | $1.5/0.4^*$ | V | |
| Output Low-level voltage | V_{OL} | - | - | $2.0/1.0^*$ | V | $I_{OL}=20mA$ |
| "H" output disable current | I_{OZH} | - | - | 10 | μA | $V_O=25V$ |
| "L" output disable current | I_{OZL} | - | - | -5.0 | μA | $V_O=0V$ |
| Static dissipation current | I_{DD} | - | - | $5.0/3.0^*$ | μA | |

(*the value at 5V /3V)

●Operating conditions ($T_a=25^\circ C$, $V_{SS}=0V$)

| Parameter | Symbol | Limits | | Unit |
|----------------------|----------|-------------|------------------|------|
| | | BU2098F | BU2090F/BU2090FS | |
| Power Supply Voltage | V_{DD} | +2.7 to 5.5 | | V |
| Output Voltage | V_O | 0 to +15 | 0 to +25 | V |

●Absolute maximum ratings

BU2098F, BU2090F, BU2090FS

| Parameter | Symbol | Limits | | | Unit |
|-----------------------------|-----------|----------------------|-------------------------------|-------------------|------------|
| | | BU2098F | BU2090F | BU2090FS | |
| Power supply voltage | V_{DD} | -0.5 to +7.0 | -0.3 to +7.0V | | V |
| Power dissipation1 | P_{d1} | 300 ^{*1} | 300 ^{*1} | 500 ^{*2} | mW |
| Power dissipation2 | P_{d2} | - | 500 ^{*3} | 650 ^{*4} | |
| Operating temperature range | T_{opr} | -40 to +85 | | | $^\circ C$ |
| Storage temperature range | T_{stg} | -55 to +125 | | | $^\circ C$ |
| Output voltage | V_O | V_{SS} to +18.0 | $V_{SS}-0.3$ to +25V | | V |
| Input voltage | V_{IN} | -0.5 to $V_{DD}+0.5$ | $V_{SS}-0.3$ to $V_{DD}+0.3V$ | | V |

Allowable loss of single unit

* Reduced by 3mW/ $^\circ C$ over 25 $^\circ C$. (BU2098F)^{*1} Reduced by 3mW/ $^\circ C$ over 25 $^\circ C$.^{*2} Reduced by 5mW/ $^\circ C$ over 25 $^\circ C$.^{*3} Reduced by 5.0mW for each increase in T_a of 1 $^\circ C$ over 25 $^\circ C$.(When mounted on a board 70mm×70mm×1.6mm Glass-epoxy PCB)^{*4} Reduced by 6.5mW for each increase in T_a of 1 $^\circ C$ over 25 $^\circ C$.(When mounted on a board 70mm×70mm×1.6mm Glass-epoxy PCB)

●Pin descriptions

BU2098F

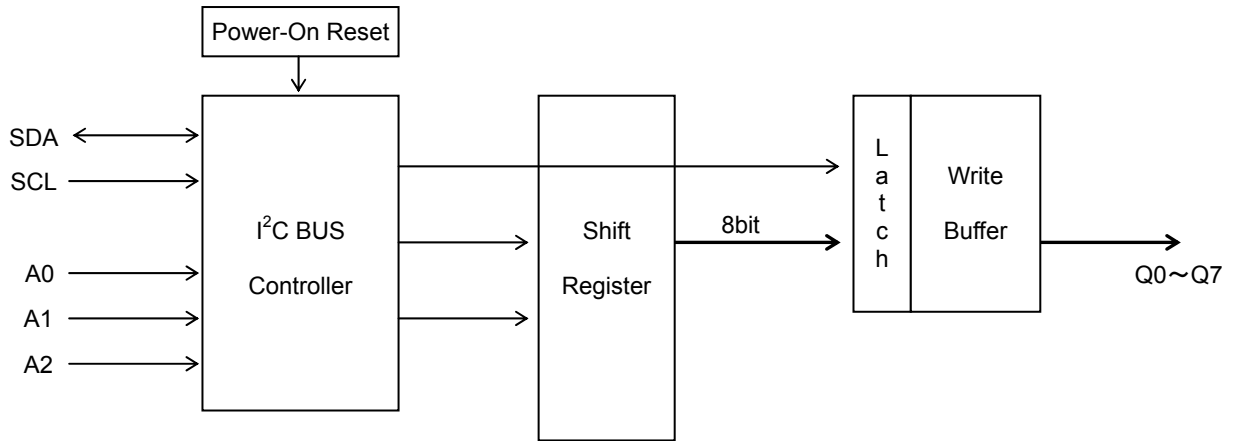
| PIN No. | Pin Name | I/O | Function |
|---------|----------|-----|-----------------------------------|
| 1 | A0 | I | Address input, internally pull-up |
| 2 | A1 | I | |
| 3 | A2 | I | |
| 4 | Q0 | O | Open drain output |
| 5 | Q1 | | |
| 6 | Q2 | | |
| 7 | Q3 | | |
| 8 | Vss | - | GND |
| 9 | Q4 | O | Open drain output |
| 10 | Q5 | | |
| 11 | Q6 | | |
| 12 | Q7 | | |
| 13 | N.C. | - | Non connected |
| 14 | SCL | I | Serial clock input |
| 15 | SDA | I/O | Serial data input/output |
| 16 | VDD | - | Power supply |

BU2090F/BU2090FS

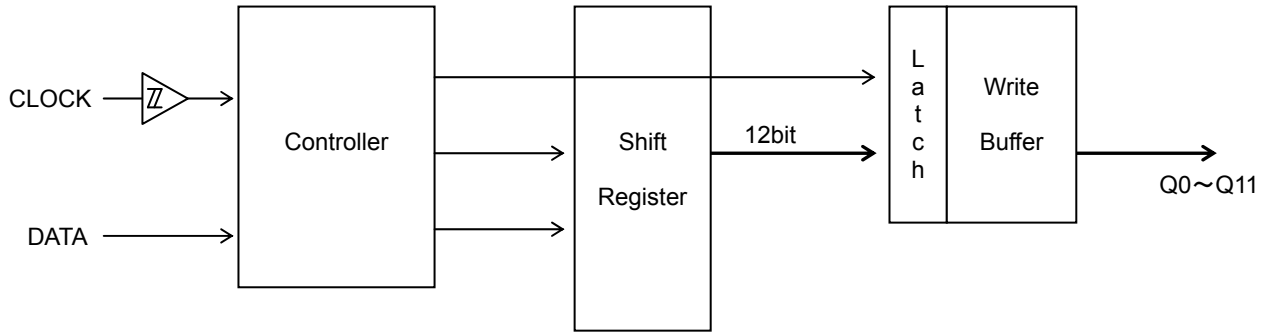
| PIN No. | Pin Name | I/O | Function |
|---------|----------|-----|---|
| 1 | Vss | - | GND |
| 2 | DATA | I | Serial data input |
| 3 | CLOCK | I | Data shift clock input (rising edge trigger) The shift data is transferred to the output when the input data logic level is high during the falling transition of the clock pulse. |
| 4 | Q0 | O | Parallel data output (Nch Open Drain FET) |
| 5 | Q1 | | |
| 6 | Q2 | | |
| 7 | Q3 | | |
| 8 | Q4 | | |
| 9 | Q5 | | |
| 10 | Q6 | | |
| 11 | Q7 | | |
| 12 | Q8 | | |
| 13 | Q9 | | |
| 14 | Q10 | | |
| 15 | Q11 | | |
| 16 | VDD | - | Power supply |

| | | |
|------------|----|-----|
| Latch data | L | H |
| Output FET | ON | OFF |

●Block diagram
BU2098F



BU2090F/BU2090FS



●Interfaces

| BU2090F/BU2090FS | BU2090F/BU2090FS | BU2098F |
|------------------|------------------|---------|
| DATA, CLOCK | Q0~Q11 | Q0~Q7 |
| | | |
| BU2098F | BU2098F | BU2098F |
| A0~A2 | SDA | SCL |
| | | |

[BU2098F]

●AC characteristics (Unless otherwise noted, V_{DD}=5V, V_{SS}=0V, T_a=25°C)

| Parameter | Symbol | Fast mode I ² C BUS | | Standard mode I ² C BUS | | Unit |
|--|---------------------|--------------------------------|------|------------------------------------|------|------|
| | | Min. | Max. | Min. | Max. | |
| SCL clock frequency | f _{SCL} | 0 | 400 | 0 | 100 | kHz |
| Bus free time between start-stop condition | t _{BUS} | 1.3 | - | 4.7 | - | μs |
| Hold time start condition | t _{HD:STA} | 0.6 | - | 4.0 | - | μs |
| Low period of the SCL clock | t _{LOW} | 1.3 | - | 4.7 | - | μs |
| High period of the SCL clock | t _{HIGH} | 0.6 | - | 4.0 | - | μs |
| Set up time Re-start condition | t _{SU:STA} | 0.6 | - | 4.7 | - | μs |
| Data hold time | t _{HD:DAT} | 0 | 0.9 | 0 | - | μs |
| Data set up time | t _{SU:DAT} | 100 | - | 250 | - | ns |
| Rise time of SDA and SCL | t _r | 20+0.1Cb | 300 | - | 1000 | ns |
| Fall time of SDA and SCL | t _f | 20+0.1Cb | 300 | - | 300 | ns |
| Set up time stop condition | t _{SU:STO} | 0.6 | - | 4.0 | - | μs |
| Capacitive load for SDA line and SCL line | C _b | - | 400 | - | 400 | pF |

●Timing chart

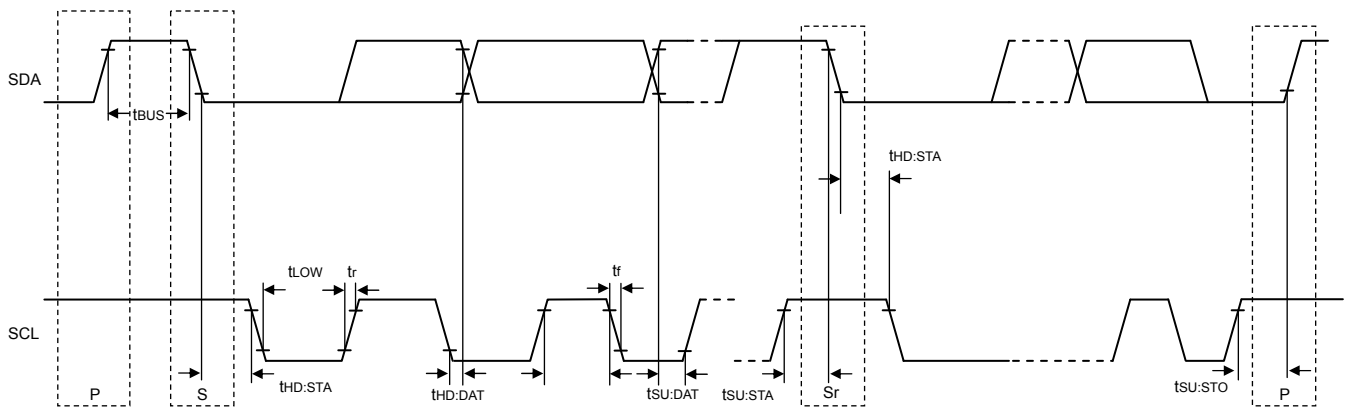


Fig.1 SDA, SCL timing chart

●Function

○Start condition

The start condition is a “HIGH” to “LOW” transition of the SDA line while SCL is “HIGH”.

○Stop condition

The stop condition is a “LOW” to “HIGH” transition of the SDA line while SCL is “HIGH”.

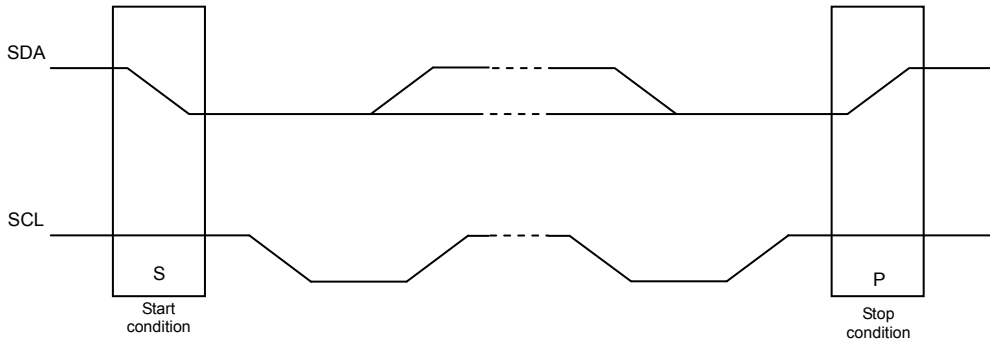


Fig.2 Start / Stop condition

○Acknowledge

The master (μ p) puts a resistive “HIGH” level on the SDA line during the acknowledge clock pulse. The peripheral (audio processor) that acknowledge has to pull-down (“LOW”) the SDA line during the acknowledge clock pulse, so that the SDA line is stable “LOW” during this clock pulse.

The slave which has been addressed has to generate an acknowledgement after the reception of each byte, otherwise the SDA line remains at the “HIGH” level during the ninth clock pulse time. In this case the master transmitter can generate the STOP information in order to abort the transfer.

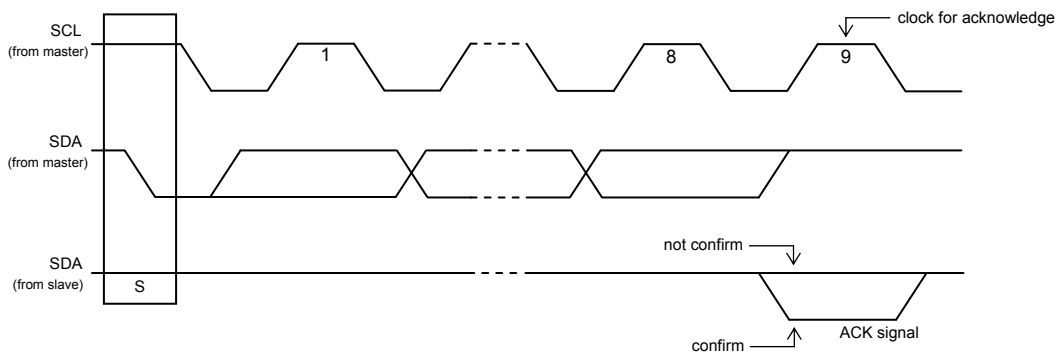


Fig.3 Acknowledge

○Write DATA

Send the slave address from master following the start condition (S). This address consists of 7 bits. The left 1 bit (the foot bit) is fixed "0". The stop condition (P) is needed to finish the data transferred. But the re-send starting condition (Sr) enables to transfer the data without STOP (P).

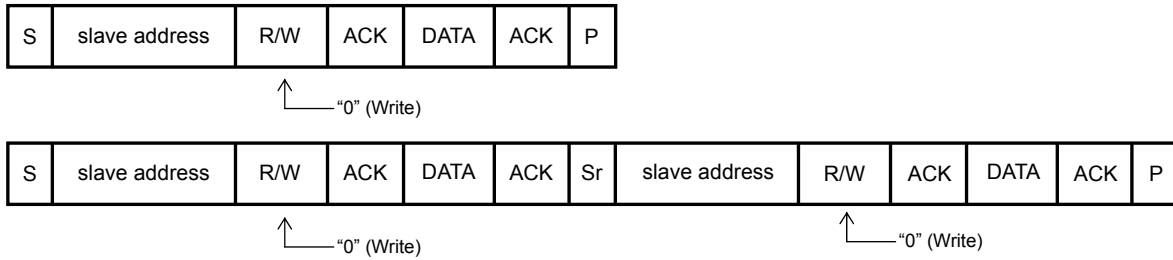


Fig.4 DATA transmit

○Data format

The format is following.

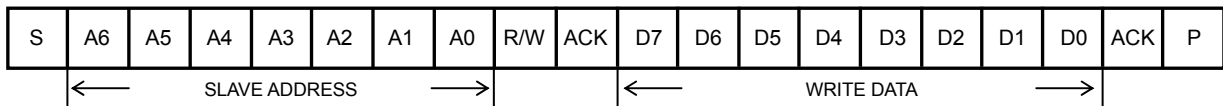


Table 1 for WRITE format

| | | |
|---------------|-------|---|
| Slave address | A0~A2 | Each bit can be defined by the input levels of pins A0~A3. |
| | A3~A6 | These 4 bits are fixed. |
| | R/W | "0" |
| Write Data | D0~D7 | Write "1" to D0 makes Q0 pin High-impedance. And write "0" makes Q0 pin LOW. D[1:7] and Q[1:7] are same as D0 and Q0. |

Table 2 for (A2, A1, A0) to SLAVE ADDRESS

| A6 | A5 | A4 | A3 | A2 | A1 | A0 | Slave address |
|----|----|----|----|----|----|----|---------------|
| 0 | 1 | 1 | 1 | 0 | 0 | 0 | 38H |
| 0 | 1 | 1 | 1 | 0 | 0 | 1 | 39H |
| 0 | 1 | 1 | 1 | 0 | 1 | 0 | 3AH |
| 0 | 1 | 1 | 1 | 0 | 1 | 1 | 3BH |
| 0 | 1 | 1 | 1 | 1 | 0 | 0 | 3CH |
| 0 | 1 | 1 | 1 | 1 | 0 | 1 | 3DH |
| 0 | 1 | 1 | 1 | 1 | 1 | 0 | 3EH |
| 0 | 1 | 1 | 1 | 1 | 1 | 1 | 3FH |

← Fixed for BU2098F →
← Defined by external pin A0~A2 →

OData transmission timing

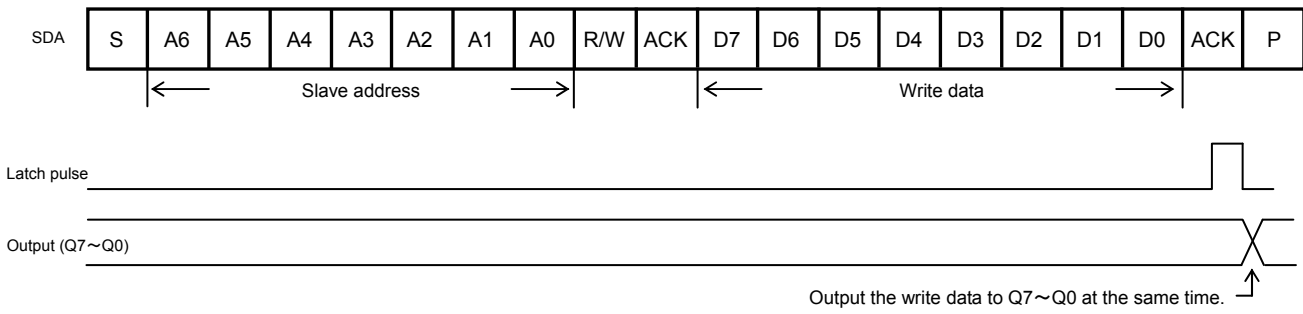
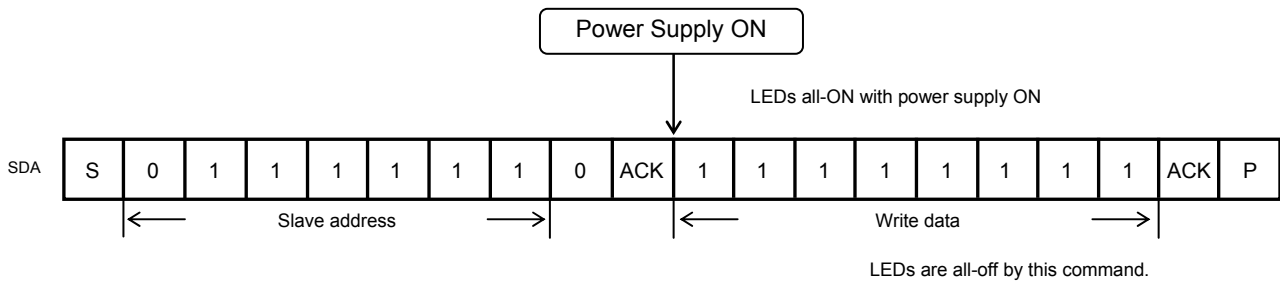


Fig.5 Timing chart for WRITE

Command sample for driving LEDs. These are all off. (terminal A0~A2 is open)



- RESET CONDITION
After reset, Q0~Q7 pins are ON. (LEDs are all ON.)
- RISING TIME OF POWER SUPPLY
VDD must rise within 10ms. If the rise time would exceed 10ms, it is afraid not to reset the BU2098F.

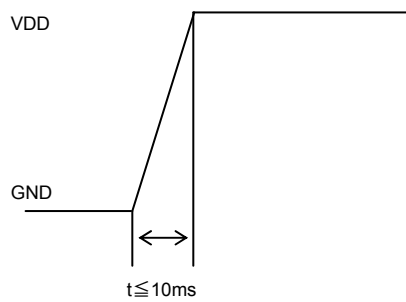


Fig.6 Rising time of power supply

[BU2090F/BU2090FS]

●AC characteristics (unless otherwise noted, VDD=5V, VSS=0V, Ta=25°C)

| Parameter | Symbol | Limit | | | Unit | Condition |
|----------------------------|--------|-------|------|------|------|-----------|
| | | Min. | Typ. | Max. | | |
| Minimum clock frequency | tw | 500 | - | - | ns | VDD=5V |
| | | 1000 | - | - | ns | VDD=3V |
| Data shift set up time | tsu | 200 | - | - | ns | VDD=5V |
| | | 300 | - | - | ns | VDD=3V |
| Data shift hold time | th | 200 | - | - | ns | VDD=5V |
| | | 400 | - | - | ns | VDD=3V |
| Data latch set up time | tLSUH | 50 | - | - | ns | VDD=5V |
| | | 100 | - | - | ns | VDD=3V |
| Data latch hold time | tLHH | 250 | - | - | ns | VDD=5V |
| | | 500 | - | - | ns | VDD=3V |
| Data latch "L" set up time | tLSUL | 200 | - | - | ns | VDD=5V |
| | | 400 | - | - | ns | VDD=3V |
| Data latch "L" hold time | tLHL | 250 | - | - | ns | VDD=5V |
| | | 500 | - | - | ns | VDD=3V |

●Switching time test circuit

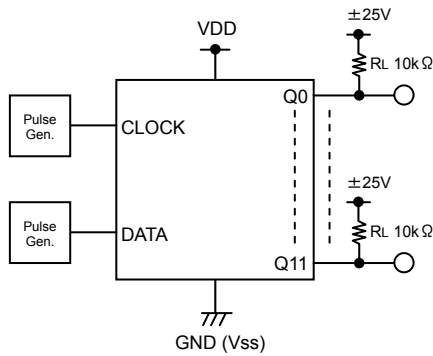


Fig.7

●Switching time test waveforms

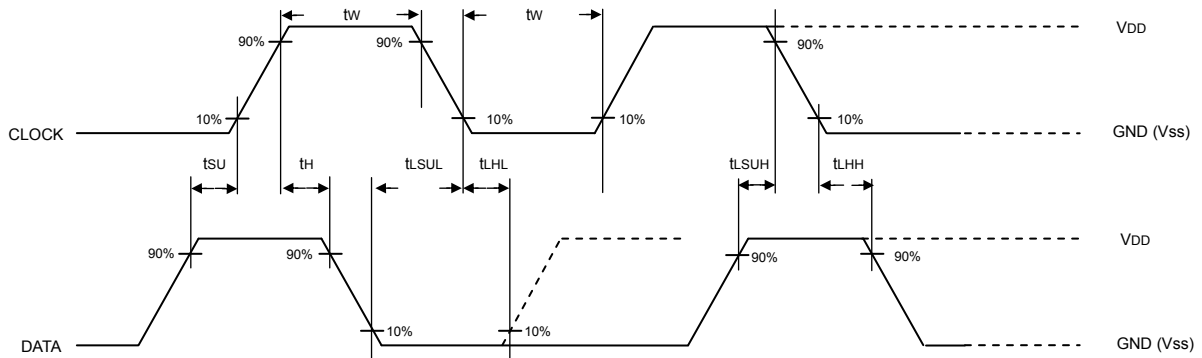
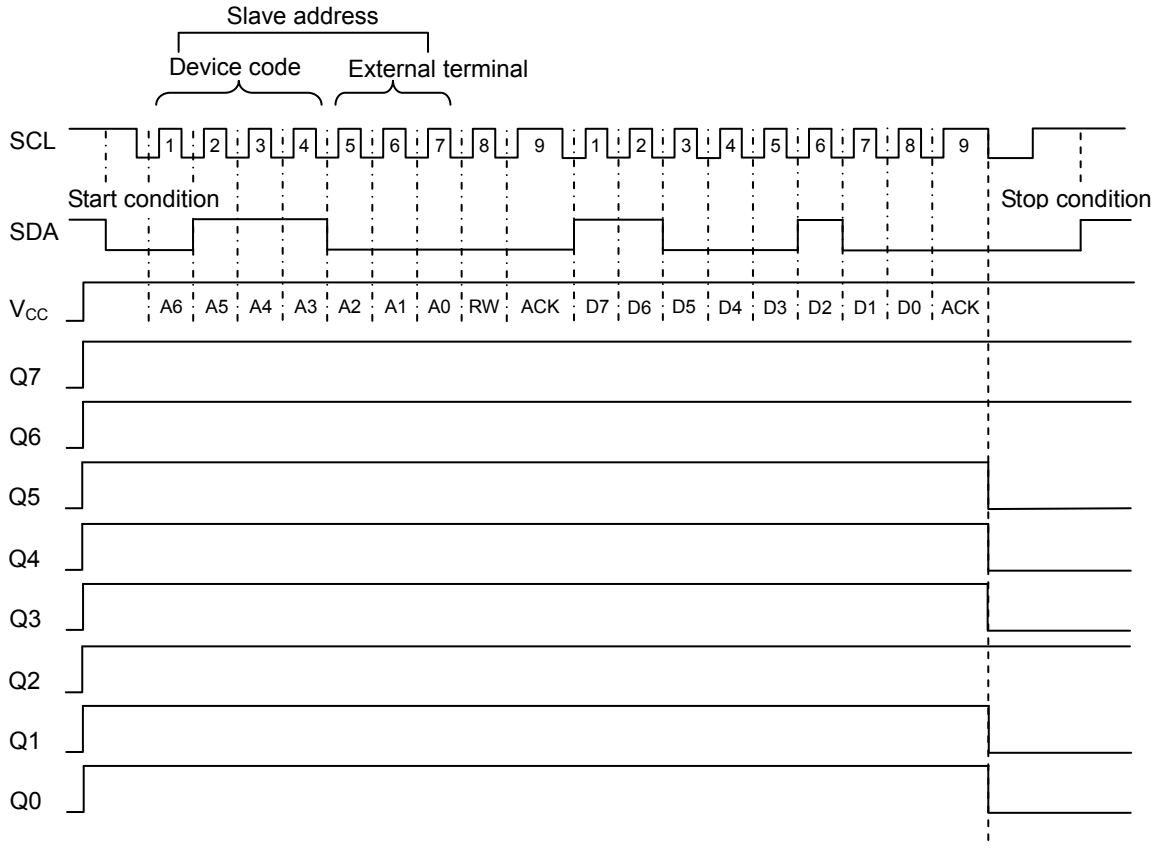


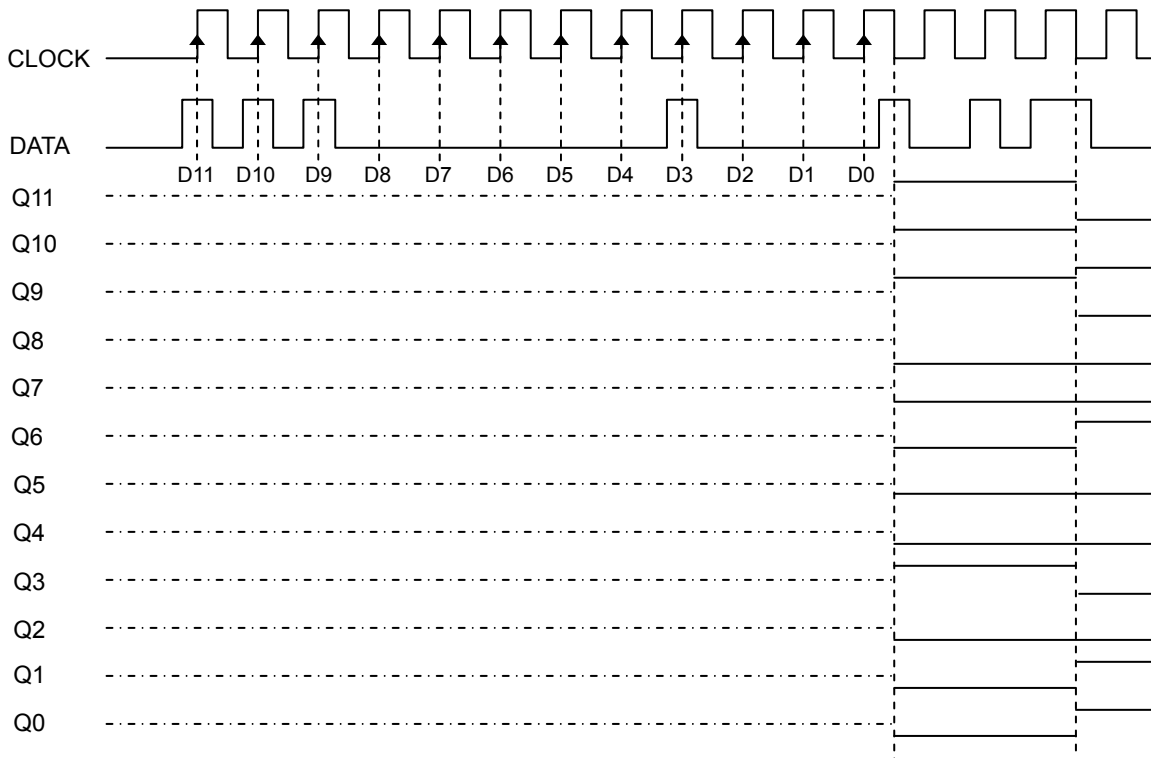
Fig.8

●Timing chart
【BU2098F】



Note) Diagram shows a status where a pull-up resistor is connected to output.

【BU2090F/BU2090FS】



Note1) ----- Indicates undefined output.

Note2) Output terminal is provided with a pull-up resistor.

●Notes for use

1. Absolute maximum ratings
An excess in the absolute maximum ratings, such as supply voltage, temperature range of operating conditions, etc., can break down the devices, thus making impossible to identify breaking mode, such as a short circuit or an open circuit. If any over rated values will expect to exceed the absolute maximum ratings, consider adding circuit protection devices, such as fuses.
2. Connecting the power supply connector backward
Connecting of the power supply in reverse polarity can damage IC. Take precautions when connecting the power supply lines. An external direction diode can be added.
3. Power supply lines
Design PCB layout pattern to provide low impedance GND and supply lines. To obtain a low noise ground and supply line, separate the ground section and supply lines of the digital and analog blocks. Furthermore, for all power supply terminals to ICs, connect a capacitor between the power supply and the GND terminal. When applying electrolytic capacitors in the circuit, not that capacitance characteristic values are reduced at low temperatures.
4. GND voltage
The potential of GND pin must be minimum potential in all operating conditions.
5. Thermal design
Use a thermal design that allows for a sufficient margin in light of the power dissipation (Pd) in actual operating conditions.
6. Inter-pin shorts and mounting errors
Use caution when positioning the IC for mounting on printed circuit boards. The IC may be damaged if there is any connection error or if pins are shorted together.
7. Actions in strong electromagnetic field
Use caution when using the IC in the presence of a strong electromagnetic field as doing so may cause the IC to malfunction.
8. Testing on application boards
When testing the IC on an application board, connecting a capacitor to a pin with low impedance subjects the IC to stress. Always discharge capacitors after each process or step. Always turn the IC's power supply off before connecting it to or removing it from a jig or fixture during the inspection process. Ground the IC during assembly steps as an antistatic measure. Use similar precaution when transporting or storing the IC.
9. Ground Wiring Pattern
When using both small signal and large current GND patterns, it is recommended to isolate the two ground patterns, placing a single ground point at the ground potential of application so that the pattern wiring resistance and voltage variations caused by large currents do not cause variations in the small signal ground voltage. Be careful not to change the GND wiring pattern of any external components, either.
10. Unused input terminals
Connect all unused input terminals to VDD or VSS in order to prevent excessive current or oscillation. Insertion of a resistor (100kΩ approx.) is also recommended.

●Ordering part number

| | |
|---|---|
| B | U |
|---|---|

Part No.

| | | | |
|---|---|---|---|
| 2 | 0 | 9 | 0 |
|---|---|---|---|

Part No.
2098
2090

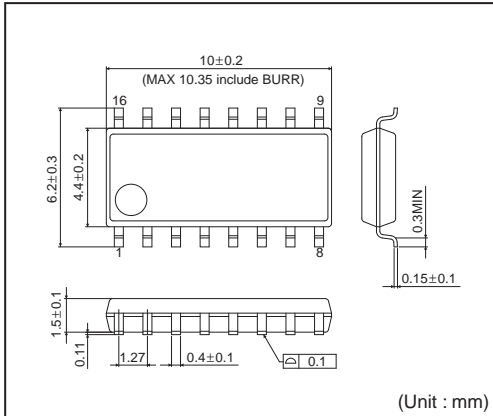
| | |
|---|---|
| F | S |
|---|---|

Package
F : SOP16
FS : SSOP-A16

| | |
|---|---|
| E | 2 |
|---|---|

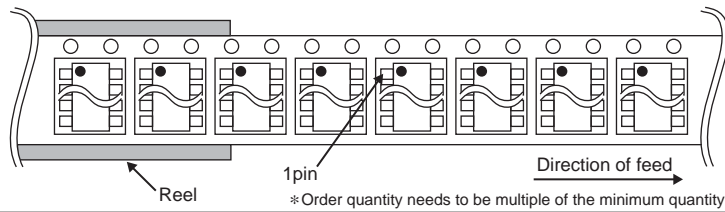
Packaging and forming specification
E2: Embossed tape and reel

SOP16

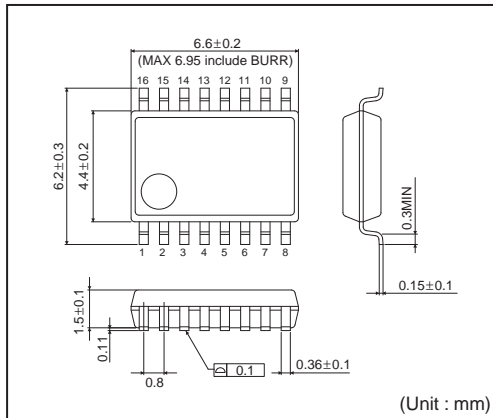


<Tape and Reel information>

| | |
|-------------------|---|
| Tape | Embossed carrier tape |
| Quantity | 2500pcs |
| Direction of feed | E2 (The direction is the 1pin of product is at the upper left when you hold reel on the left hand and you pull out the tape on the right hand) |

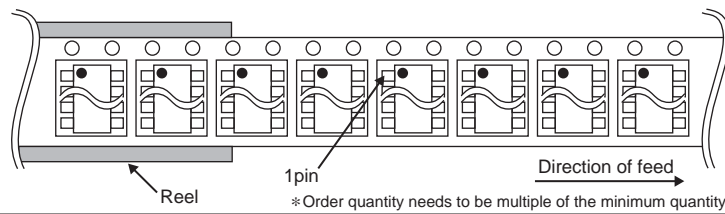


SSOP-A16



<Tape and Reel information>

| | |
|-------------------|---|
| Tape | Embossed carrier tape |
| Quantity | 2500pcs |
| Direction of feed | E2 (The direction is the 1pin of product is at the upper left when you hold reel on the left hand and you pull out the tape on the right hand) |



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