

The S-93L46A/56A/66A is a low voltage operation, high speed, low current consumption, 3-wire serial E²PROM with a wide operating voltage range. The S-93L46A/56A/66A has the capacity of 1 K-bit, 2 K-bit and 4 K-bit, and the organization is 64-word × 16-bit, 128-word × 16-bit, and 256-word × 16-bit. It is capable of sequential read, at which time addresses are automatically incremented in 16-bit blocks.

The communication method is by the Microwire bus.

■ Features

- Operating voltage range

| | |
|--------|-------------------------------|
| Read: | 1.6 V to 5.5 V |
| Write: | 1.8 V to 5.5 V (WRITE, ERASE) |
| | 2.7 V to 5.5 V (WRAL, ERAL) |
- Operation frequency: 2.0 MHz ($V_{CC} = 4.5 \text{ V to } 5.5 \text{ V}$)
- Write time: 8.0 ms max.
- Sequential read capable
- Write protect function during the low power supply voltage
- Function to protect against write due to erroneous instruction recognition
- Endurance: 10^6 cycles / word^{*1} ($T_a = +85^\circ\text{C}$)
- Data retention:

| |
|---|
| 100 years ($T_a = +25^\circ\text{C}$) |
| 20 years ($T_a = +85^\circ\text{C}$) |
- Memory capacity:

| | |
|-----------|---------|
| S-93L46A: | 1 K-bit |
| S-93L56A: | 2 K-bit |
| S-93L66A: | 4 K-bit |
- Initial shipment data: FFFFh
- Lead-free, Sn 100%, halogen-free^{*2}

*1. For each address (Word: 16-bit)

*2. Refer to "■ Product Name Structure" for details.

■ Packages

- 8-Pin SOP (JEDEC)
- 8-Pin TSSOP
- TMSOP-8
- SNT-8A
- WLP-7D

Caution This product is intended to use in general electronic devices such as consumer electronics, office equipment, and communications devices. Before using the product in medical equipment or automobile equipment including car audio, keyless entry and engine control unit, contact to SII is indispensable.

■ Pin Configurations

1. 8-Pin SOP (JEDEC)

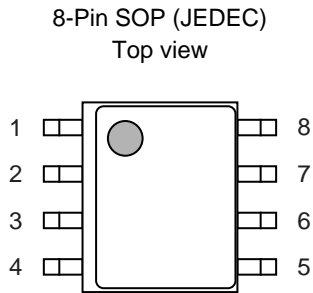


Figure 1

S-93L46AD0I-J8T1x
S-93L56AD0I-J8T1x
S-93L66AD0I-J8T1x

Table 1

| Pin No. | Symbol | Description |
|---------|--------------------|--------------------|
| 1 | CS | Chip select input |
| 2 | SK | Serial clock input |
| 3 | DI | Serial data input |
| 4 | DO | Serial data output |
| 5 | GND | Ground |
| 6 | TEST ^{*1} | Test |
| 7 | NC | No connection |
| 8 | VCC | Power supply |

*1. Connect to GND or V_{CC}.

Even if this pin is not connected, performance is not affected so long as the absolute maximum rating is not exceeded.

8-Pin SOP (JEDEC) (Rotated)
Top view

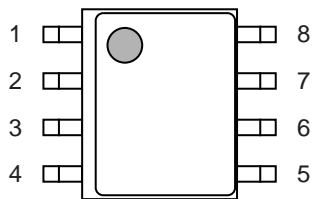


Figure 2

S-93L46AR0I-J8T1x
S-93L56AR0I-J8T1x
S-93L66AR0I-J8T1x

Table 2

| Pin No. | Symbol | Description |
|---------|--------------------|--------------------|
| 1 | NC | No connection |
| 2 | VCC | Power supply |
| 3 | CS | Chip select input |
| 4 | SK | Serial clock input |
| 5 | DI | Serial data input |
| 6 | DO | Serial data output |
| 7 | GND | Ground |
| 8 | TEST ^{*1} | Test |

*1. Connect to GND or V_{CC}.

Even if this pin is not connected, performance is not affected so long as the absolute maximum rating is not exceeded.

2. 8-Pin TSSOP

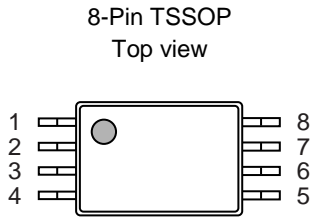


Figure 3

S-93L46AD0I-T8T1x
S-93L56AD0I-T8T1x
S-93L66AD0I-T8T1x

Table 3

| Pin No. | Symbol | Description |
|---------|--------------------|--------------------|
| 1 | CS | Chip select input |
| 2 | SK | Serial clock input |
| 3 | DI | Serial data input |
| 4 | DO | Serial data output |
| 5 | GND | Ground |
| 6 | TEST* ¹ | Test |
| 7 | NC | No connection |
| 8 | VCC | Power supply |

*1. Connect to GND or V_{CC}.
Even if this pin is not connected, performance is not affected so long as the absolute maximum rating is not exceeded.

3. TMSOP-8

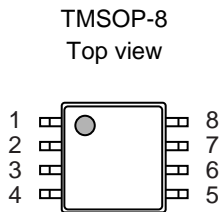


Figure 4

S-93L46AD0I-K8T3U
S-93L56AD0I-K8T3U
S-93L66AD0I-K8T3U

Table 4

| Pin No. | Symbol | Description |
|---------|--------------------|--------------------|
| 1 | CS | Chip select input |
| 2 | SK | Serial clock input |
| 3 | DI | Serial data input |
| 4 | DO | Serial data output |
| 5 | GND | Ground |
| 6 | TEST* ¹ | Test |
| 7 | NC | No connection |
| 8 | VCC | Power supply |

*1. Connect to GND or V_{CC}.
Even if this pin is not connected, performance is not affected so long as the absolute maximum rating is not exceeded.

4. SNT-8A

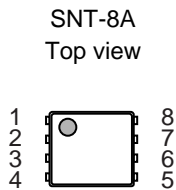


Figure 5

S-93L46AD01-I8T1x
S-93L56AD01-I8T1x
S-93L66AD01-I8T1x

Table 5

| Pin No. | Symbol | Description |
|---------|--------------------|--------------------|
| 1 | CS | Chip select input |
| 2 | SK | Serial clock input |
| 3 | DI | Serial data input |
| 4 | DO | Serial data output |
| 5 | GND | Ground |
| 6 | TEST ^{*1} | Test |
| 7 | NC | No connection |
| 8 | VCC | Power supply |

*1. Connect to GND or V_{CC}.

Even if this pin is not connected, performance is not affected so long as the absolute maximum rating is not exceeded.

5. WLP-7D

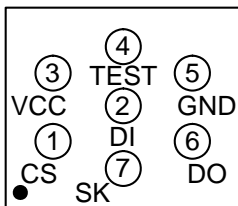
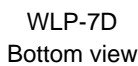


Figure 6

S-93L66AD01-H7T4S

Table 6

| Pin No. | Symbol | Description |
|---------|--------------------|--------------------|
| 1 | CS | Chip select input |
| 2 | DI | Serial data input |
| 3 | VCC | Power supply |
| 4 | TEST ^{*1} | Test |
| 5 | GND | Ground |
| 6 | DO | Serial data output |
| 7 | SK | Serial clock input |

*1. Connect to GND or V_{CC}.

Even if this pin is not connected, performance is not affected so long as the absolute maximum rating is not exceeded.

Remark 1. Refer to the "Package drawings" for the details.

2. x: G or U

3. Please select products of environmental code = U for Sn 100%, halogen-free products.

■ Block Diagram

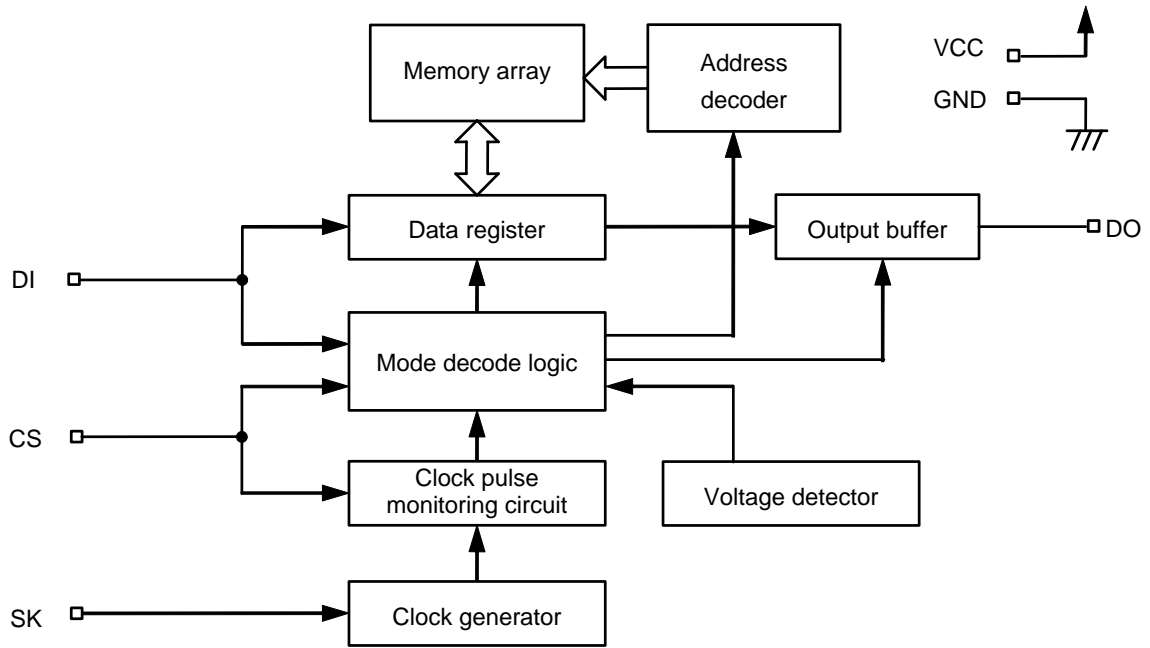


Figure 7

■ **Instruction Sets**

1. S-93L46A

Table 7

| Instruction SK input clock | Start Bit | Operation Code | | Address | | | | | | Data |
|-------------------------------|-----------|----------------|---|---------|----|----|----|----|----|--------------------------------|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 to 25 |
| READ (Read data) | 1 | 1 | 0 | A5 | A4 | A3 | A2 | A1 | A0 | D15 to D0 Output ^{*1} |
| WRITE (Write data) | 1 | 0 | 1 | A5 | A4 | A3 | A2 | A1 | A0 | D15 to D0 Input |
| ERASE (Erase data) | 1 | 1 | 1 | A5 | A4 | A3 | A2 | A1 | A0 | — |
| WRAL (Write all) | 1 | 0 | 0 | 0 | 1 | x | x | x | x | D15 to D0 Input |
| ERAL (Erase all) | 1 | 0 | 0 | 1 | 0 | x | x | x | x | — |
| EWEN (Write enable) | 1 | 0 | 0 | 1 | 1 | x | x | x | x | — |
| EWDS (Write disable) | 1 | 0 | 0 | 0 | 0 | x | x | x | x | — |

*1. When the 16-bit data in the specified address has been output, the data in the next address is output.

Remark x: Don't care

2. S-93L56A

Table 8

| Instruction SK input clock | Start Bit | Operation Code | | Address | | | | | | | Data | |
|-------------------------------|-----------|----------------|---|---------|----|----|----|----|----|----|------|--------------------------------|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 to 27 |
| READ (Read data) | 1 | 1 | 0 | x | A6 | A5 | A4 | A3 | A2 | A1 | A0 | D15 to D0 Output ^{*1} |
| WRITE (Write data) | 1 | 0 | 1 | x | A6 | A5 | A4 | A3 | A2 | A1 | A0 | D15 to D0 Input |
| ERASE (Erase data) | 1 | 1 | 1 | x | A6 | A5 | A4 | A3 | A2 | A1 | A0 | — |
| WRAL (Write all) | 1 | 0 | 0 | 0 | 1 | x | x | x | x | x | x | D15 to D0 Input |
| ERAL (Erase all) | 1 | 0 | 0 | 1 | 0 | x | x | x | x | x | x | — |
| EWEN (Write enable) | 1 | 0 | 0 | 1 | 1 | x | x | x | x | x | x | — |
| EWDS (Write disable) | 1 | 0 | 0 | 0 | 0 | x | x | x | x | x | x | — |

*1. When the 16-bit data in the specified address has been output, the data in the next address is output.

Remark x: Don't care

3. S-93L66A

Table 9

| Instruction SK input clock | Start Bit | Operation Code | | Address | | | | | | | Data | |
|-------------------------------|-----------|----------------|---|---------|----|----|----|----|----|----|------|--------------------------------|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 to 27 |
| READ (Read data) | 1 | 1 | 0 | A7 | A6 | A5 | A4 | A3 | A2 | A1 | A0 | D15 to D0 Output ^{*1} |
| WRITE (Write data) | 1 | 0 | 1 | A7 | A6 | A5 | A4 | A3 | A2 | A1 | A0 | D15 to D0 Input |
| ERASE (Erase data) | 1 | 1 | 1 | A7 | A6 | A5 | A4 | A3 | A2 | A1 | A0 | — |
| WRAL (Write all) | 1 | 0 | 0 | 0 | 1 | x | x | x | x | x | x | D15 to D0 Input |
| ERAL (Erase all) | 1 | 0 | 0 | 1 | 0 | x | x | x | x | x | x | — |
| EWEN (Write enable) | 1 | 0 | 0 | 1 | 1 | x | x | x | x | x | x | — |
| EWDS (Write disable) | 1 | 0 | 0 | 0 | 0 | x | x | x | x | x | x | — |

*1. When the 16-bit data in the specified address has been output, the data in the next address is output.

Remark x: Don't care

■ Absolute Maximum Ratings

Table 10

| Item | Symbol | Ratings | Unit |
|-------------------------------|-----------|------------------------|------|
| Power supply voltage | V_{CC} | -0.3 to +7.0 | V |
| Input voltage | V_{IN} | -0.3 to $V_{CC} + 0.3$ | V |
| Output voltage | V_{OUT} | -0.3 to V_{CC} | V |
| Operating ambient temperature | T_{opr} | -40 to +85 | °C |
| Storage temperature | T_{stg} | -65 to +150 | °C |

Caution The absolute maximum ratings are rated values exceeding which the product could suffer physical damage. These values must therefore not be exceeded under any conditions.

■ Recommended Operating Conditions

Table 11

| Item | Symbol | Conditions | $T_a = -40^\circ\text{C to } +85^\circ\text{C}$ | | Unit |
|--------------------------|----------|--|---|----------------------|------|
| | | | Min. | Max. | |
| Power supply voltage | V_{CC} | READ, EWDS | 1.6 | 5.5 | V |
| | | WRITE, ERASE, EWEN | 1.8 | 5.5 | V |
| | | WRAL, ERAL | 2.7 | 5.5 | V |
| High level input voltage | V_{IH} | $V_{CC} = 4.5\text{ V to } 5.5\text{ V}$ | 2.0 | V_{CC} | V |
| | | $V_{CC} = 2.7\text{ V to } 4.5\text{ V}$ | $0.8 \times V_{CC}$ | V_{CC} | V |
| | | $V_{CC} = 1.6\text{ V to } 2.7\text{ V}$ | $0.8 \times V_{CC}$ | V_{CC} | V |
| Low level input voltage | V_{IL} | $V_{CC} = 4.5\text{ V to } 5.5\text{ V}$ | 0.0 | 0.8 | V |
| | | $V_{CC} = 2.7\text{ V to } 4.5\text{ V}$ | 0.0 | $0.2 \times V_{CC}$ | V |
| | | $V_{CC} = 1.6\text{ V to } 2.7\text{ V}$ | 0.0 | $0.15 \times V_{CC}$ | V |

■ Pin Capacitance

Table 12

$T_a = +25^\circ\text{C}, f = 1.0\text{ MHz}, V_{CC} = 5.0\text{ V}$

| Item | Symbol | Conditions | Min. | Max. | Unit |
|--------------------|-----------|------------------------|------|------|------|
| Input Capacitance | C_{IN} | $V_{IN} = 0\text{ V}$ | — | 8 | pF |
| Output Capacitance | C_{OUT} | $V_{OUT} = 0\text{ V}$ | — | 10 | pF |

■ Endurance

Table 13

| Item | Symbol | Operating Ambient Temperature | Min. | Max. | Unit |
|-----------|--------|---|--------|------|-----------------|
| Endurance | NW | $T_a = -40^\circ\text{C to } +85^\circ\text{C}$ | 10^6 | — | Cycles / word*1 |

*1. For each address (Word: 16-bit)

■ Data Retention

Table 14

| Item | Symbol | Operating Ambient Temperature | Min. | Max. | Unit |
|----------------|--------|---|------|------|------|
| Data Retention | — | $T_a = +25^\circ\text{C}$ | 100 | — | year |
| | | $T_a = -40^\circ\text{C to } +85^\circ\text{C}$ | 20 | — | year |

■ DC Electrical Characteristics

Table 15

| Item | Symbol | Conditions | Ta = -40°C to +85°C | | | | | | Unit |
|----------------------------|------------------|------------|----------------------------------|------|----------------------------------|------|----------------------------------|------|------|
| | | | V _{CC} = 4.5 V to 5.5 V | | V _{CC} = 2.5 V to 4.5 V | | V _{CC} = 1.6 V to 2.5 V | | |
| | | | Min. | Max. | Min. | Max. | Min. | Max. | |
| Current consumption (READ) | I _{CC1} | DO no load | — | 0.8 | — | 0.5 | — | 0.4 | mA |

Table 16

| Item | Symbol | Conditions | Ta = -40°C to +85°C | | | | Unit |
|-----------------------------|------------------|------------|----------------------------------|------|----------------------------------|------|------|
| | | | V _{CC} = 4.5 V to 5.5 V | | V _{CC} = 1.8 V to 4.5 V | | |
| | | | Min. | Max. | Min. | Max. | |
| Current consumption (WRITE) | I _{CC2} | DO no load | — | 2.0 | — | 1.5 | mA |

Table 17

| Item | Symbol | Conditions | Ta = -40°C to +85°C | | | | | | Unit |
|--------------------------------------|-----------------|---|----------------------------------|------|----------------------------------|------|----------------------------------|------|------|
| | | | V _{CC} = 4.5 V to 5.5 V | | V _{CC} = 2.5 V to 4.5 V | | V _{CC} = 1.6 V to 2.5 V | | |
| | | | Min. | Max. | Min. | Max. | Min. | Max. | |
| Standby current consumption | I _{SB} | CS = GND, DO = Open, Other inputs to V _{CC} or GND | — | 1.5 | — | 1.5 | — | 1.5 | μA |
| Input leakage current | I _{LI} | V _{IN} = GND to V _{CC} | — | 1.0 | — | 1.0 | — | 1.0 | μA |
| Output leakage current | I _{LO} | V _{OUT} = GND to V _{CC} | — | 1.0 | — | 1.0 | — | 1.0 | μA |
| Low level output voltage | V _{OL} | I _{OL} = 2.1 mA | — | 0.4 | — | — | — | — | V |
| | | I _{OL} = 100 μA | — | 0.1 | — | 0.1 | — | 0.1 | V |
| High level output voltage | V _{OH} | I _{OH} = -400 μA | 2.4 | — | — | — | — | — | V |
| | | I _{OH} = -100 μA | V _{CC} - 0.3 | — | V _{CC} - 0.3 | — | — | — | V |
| | | I _{OH} = -10 μA | V _{CC} - 0.2 | — | V _{CC} - 0.2 | — | V _{CC} - 0.2 | — | V |
| Write enable latch data hold voltage | V _{DH} | Only when write disable mode | 1.5 | — | 1.5 | — | 1.5 | — | V |

■ AC Electrical Characteristics

Table 18 Measurement Conditions

| | |
|--------------------------|--|
| Input pulse voltage | $0.1 \times V_{CC}$ to $0.9 \times V_{CC}$ |
| Output reference voltage | $0.5 \times V_{CC}$ |
| Output load | 100 pF |

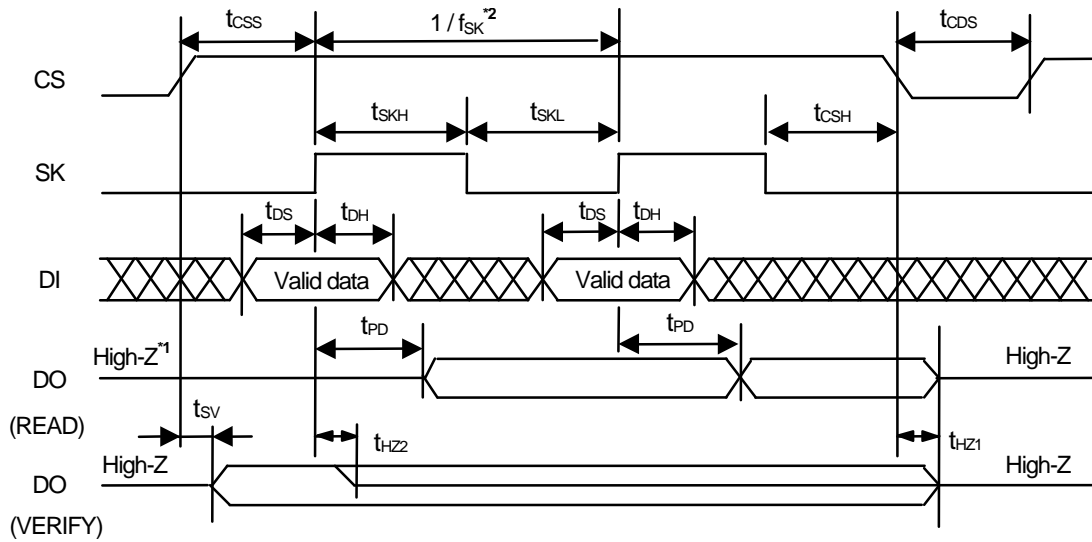
Table 19

| Item | Symbol | Ta = -40°C to +85°C | | | | | | Unit |
|---------------------------------|-------------------------------------|----------------------------------|------|----------------------------------|------|----------------------------------|------|------|
| | | V _{CC} = 4.5 V to 5.5 V | | V _{CC} = 2.5 V to 4.5 V | | V _{CC} = 1.6 V to 2.5 V | | |
| | | Min. | Max. | Min. | Max. | Min. | Max. | |
| CS setup time | t _{CSS} | 0.2 | — | 0.4 | — | 1.0 | — | μs |
| CS hold time | t _{CSH} | 0 | — | 0 | — | 0 | — | μs |
| CS deselect time | t _{CDS} | 0.2 | — | 0.2 | — | 0.4 | — | μs |
| Data setup time | t _{DS} | 0.1 | — | 0.2 | — | 0.4 | — | μs |
| Data hold time | t _{DH} | 0.1 | — | 0.2 | — | 0.4 | — | μs |
| Output delay time | t _{PD} | — | 0.4 | — | 0.8 | — | 2.0 | μs |
| Clock frequency ^{*1} | f _{SK} | 0 | 2.0 | 0 | 1.0 | 0 | 0.25 | MHz |
| SK clock time "L" ^{*1} | t _{SKL} | 0.1 | — | 0.25 | — | 1.0 | — | μs |
| SK clock time "H" ^{*1} | t _{SKH} | 0.1 | — | 0.25 | — | 1.0 | — | μs |
| Output disable time | t _{HZ1} , t _{HZ2} | 0 | 0.15 | 0 | 0.5 | 0 | 1.0 | μs |
| Output enable time | t _{SV} | 0 | 0.15 | 0 | 0.5 | 0 | 1.0 | μs |

*1. The clock cycle of the SK clock (frequency: f_{SK}) is 1 / f_{SK} μs. This clock cycle is determined by a combination of several AC characteristics, so be aware that even if the SK clock cycle time is minimized, the clock cycle (1 / f_{SK}) cannot be made equal to t_{SKL} (min.) + t_{SKH} (min.).

Table 20

| Item | Symbol | Ta = -40°C to +85°C | | | Unit |
|------------|-----------------|--------------------------------|------|------|------|
| | | V _{CC} = 1.8 to 5.5 V | | | |
| | | Min | Typ. | Max. | |
| Write time | t _{PR} | — | 4.0 | 8.0 | ms |



*1. Indicates high impedance.

*2. $1 / f_{SK}$ is the SK clock cycle. This clock cycle is determined by a combination of several AC characteristics, so be aware that even if the SK clock cycle time is minimized, the clock cycle ($1 / f_{SK}$) cannot be made equal to $t_{SKL} (\text{min.}) + t_{SKH} (\text{min.})$.

Figure 8 Timing Chart

■ Initial Shipment Data

Initial shipment data of all addresses is "FFFFh".

■ Operation

All instructions are executed by inputting DI in synchronization with the rising edge of SK after CS goes high. An instruction set is input in the order of start bit, instruction, address, and data.

Instruction input finishes when CS goes low. A low level must be input to CS between commands during t_{CDS} . While a low level is being input to CS, the S-93L46A/56A/66A is in standby mode, so the SK and DI inputs are invalid and no instructions are allowed.

■ Start Bit

A start bit is recognized when the DI pin goes high at the rise of SK after CS goes high. After CS goes high, a start bit is not recognized even if the SK pulse is input as long as the DI pin is low.

1. Dummy clock

SK clocks input while the DI pin is low before a start bit is input are called dummy clocks. Dummy clocks are effective when aligning the number of instruction sets (clocks) sent by the CPU with those required for serial memory operation. For example, when a CPU instruction set is 16 bits, the number of instruction set clocks can be adjusted by inserting a 7-bit dummy clock for the S-93L46A and a 5-bit dummy clock for the S-93L56A/66A.

2. Start bit input failure

- When the output status of the DO pin is high during the verify period after a write operation, if a high level is input to the DI pin at the rising edge of SK, the S-93L46A/56A/66A recognizes that a start bit has been input. To prevent this failure, input a low level to the DI pin during the verify operation period (refer to "4. 1 Verify operation").
- When a 3-wire interface is configured by connecting the DI input pin and DO output pin, a period in which the data output from the CPU and the serial memory collide may be generated, preventing successful input of the start bit. Take the measures described in "■ 3-Wire Interface (Direct Connection between DI and DO)".

3. Reading (READ)

The READ instruction reads data from a specified address.

After CS has gone high, input an instruction in the order of the start bit, read instruction, and address. Since the last input address (A_0) has been latched, the output status of the DO pin changes from high impedance (High-Z) to low, which is held until the next rise of SK. 16-bit data starts to be output in synchronization with the next rise of SK.

3.1 Sequential read

After the 16-bit data at the specified address has been output, inputting SK while CS is high automatically increments the address, and causes the 16-bit data at the next address to be output sequentially. The above method makes it possible to read the data in the whole memory space. The last address ($A_n \dots A_1 A_0 = 1 \dots 1$) rolls over to the top address ($A_n \dots A_1 A_0 = 0 \dots 0$).

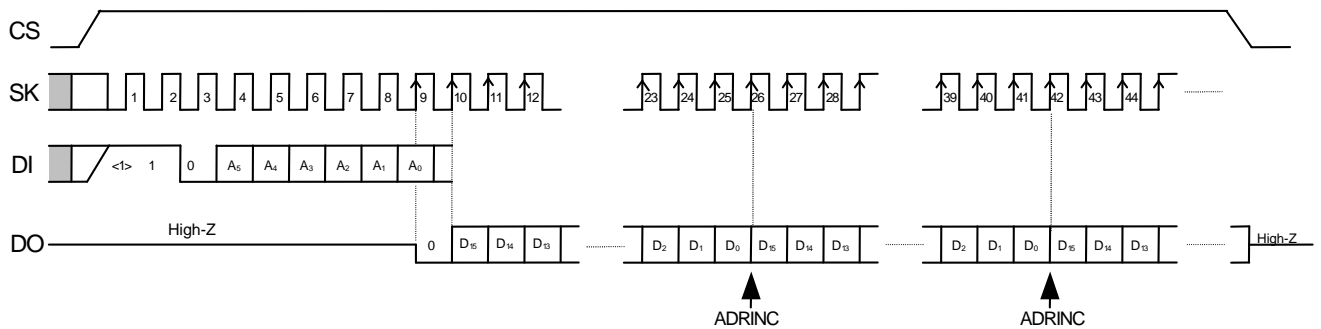


Figure 9 Read Timing (S-93L46A)

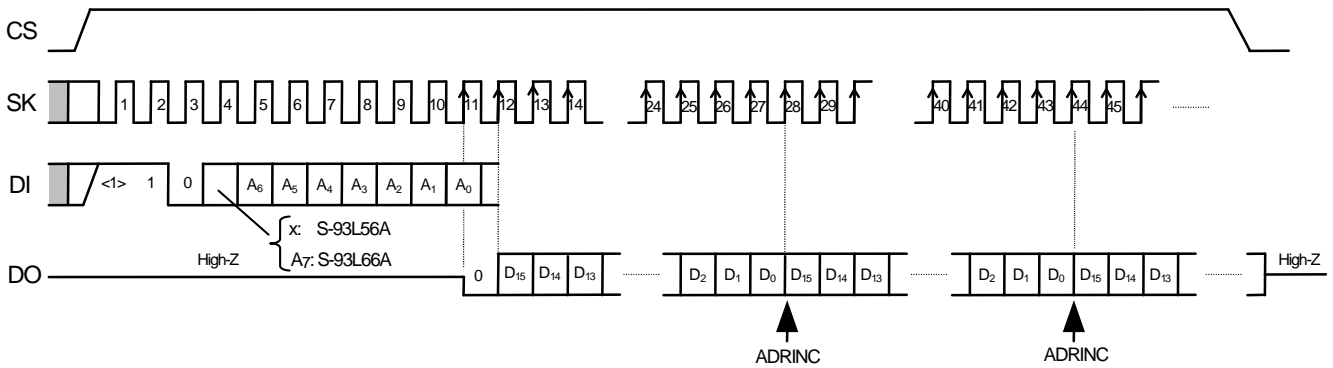


Figure 10 Read Timing (S-93L56A, S-93L66A)

4. Writing (WRITE, ERASE, WRAL, ERAL)

A write operation includes four write instructions: data write (WRITE), data erase (ERASE), chip write (WRAL), and chip erase (ERAL).

A write instruction (WRITE, ERASE, WRAL, ERAL) starts a write operation to the memory cell when a low level is input to CS after a specified number of clocks have been input. The SK and DI inputs are invalid during the write period, so do not input an instruction.

Input an instruction while the output status of the DO pin is high or high impedance (High-Z).

A write operation is valid only in program enable mode (refer to "5. Write enable (EWEN) and write disable (EWDS)").

4.1 Verify operation

A write operation executed by any instruction is completed within 8 ms (write time t_{PR} : typically 4 ms), so if the completion of the write operation is recognized, the write cycle can be minimized. A sequential operation to confirm the status of a write operation is called a verify operation.

4.1.1 Operation

After the write operation has started (CS = low), the status of the write operation can be verified by confirming the output status of the DO pin by inputting a high level to CS again. This sequence is called a verify operation, and the period that a high level is input to the CS pin after the write operation has started is called the verify operation period.

The relationship between the output status of the DO pin and the write operation during the verify operation period is as follows.

- DO pin = low: Writing in progress (busy)
- DO pin = high: Writing completed (ready)

4.1.2 Operation example

There are two methods to perform a verify operation: Waiting for a change in the output status of the DO pin while keeping CS high, or suspending the verify operation (CS = low) once and then performing it again to verify the output status of the DO pin. The latter method allows the CPU to perform other processing during the wait period, allowing an efficient system to be designed.

Caution 1. Input a low level to the DI pin during a verify operation.

2. **If a high level is input to the DI pin at the rise of SK when the output status of the DO pin is high, the S-93L46A/56A/66A latches the instruction assuming that a start bit has been input. In this case, note that the DO pin immediately enters a high-impedance (High-Z) state.**

4.2 Writing data (WRITE)

To write 16-bit data to a specified address, change CS to high and then input the WRITE instruction, address, and 16-bit data following the start bit. The write operation starts when CS goes low. There is no need to set the data to 1 before writing. If the clocks more than the specified number have been input, the clock pulse monitoring circuit cancels the WRITE instruction. For details of the clock pulse monitoring circuit, refer to “**Function to Protect Against Write due to Erroneous Instruction Recognition**”.

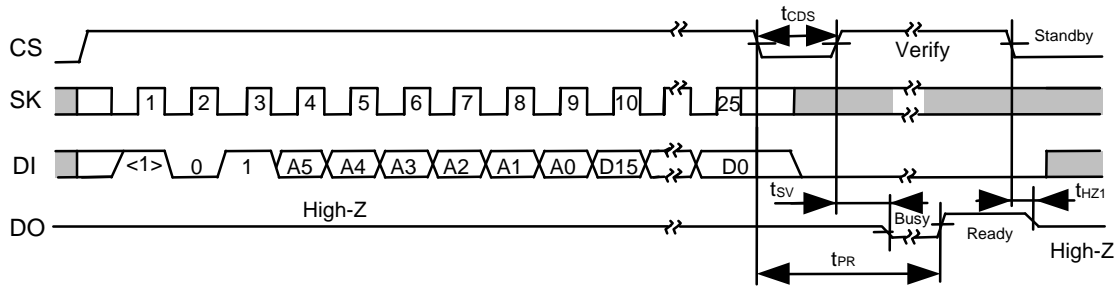


Figure 11 Data Write Timing (S-93L46A)

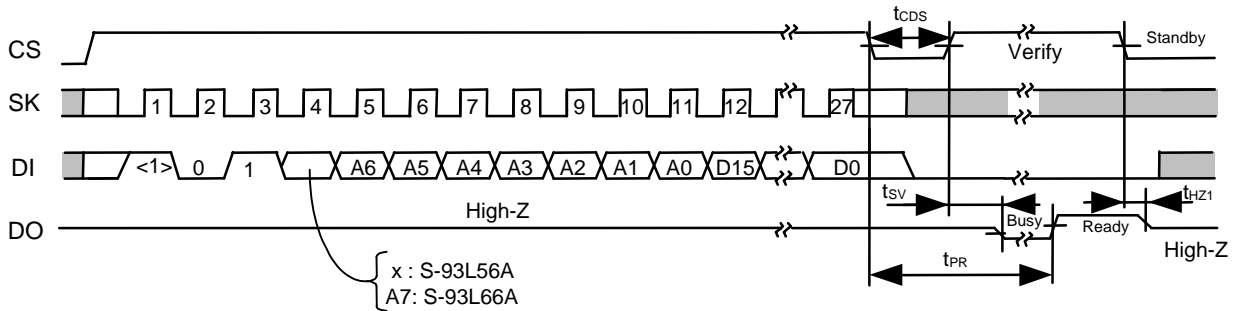


Figure 12 Data Write Timing (S-93L56A, S-93L66A)

4.3 Erasing data (ERASE)

To erase 16-bit data at a specified address, set all 16 bits of the data to 1, change CS to high, and then input the ERASE instruction and address following the start bit. There is no need to input data. The data erase operation starts when CS goes low. If the clocks have been input more than the specified number, the clock pulse monitoring circuit cancels the ERASE instruction. For details of the clock pulse monitoring circuit, refer to “**Function to Protect Against Write due to Erroneous Instruction Recognition**”.

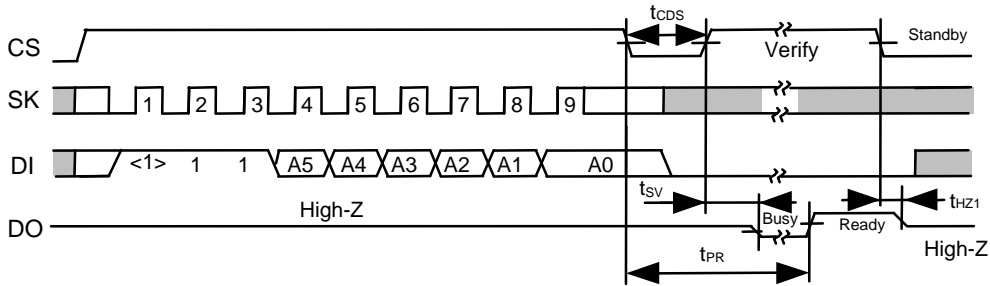


Figure 13 Data Erase Timing (S-93L46A)

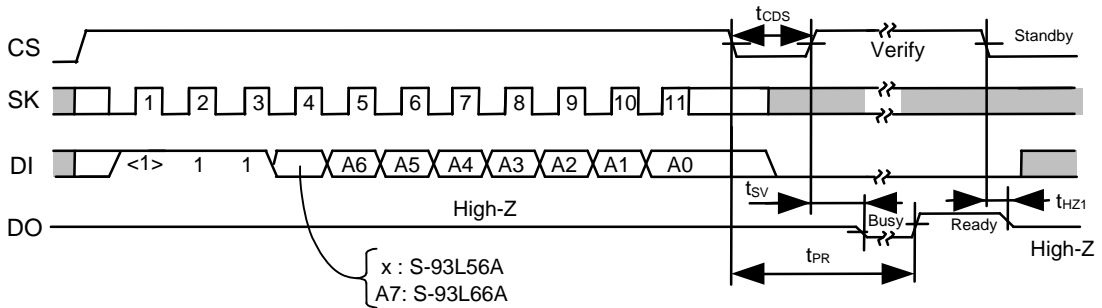


Figure 14 Data Erase Timing (S-93L56A, S-93L66A)

4.4 Writing to chip (WRAL)

To write the same 16-bit data to the entire memory address space, change CS to high, and then input the WRAL instruction, an address, and 16-bit data following the start bit. Any address can be input. The write operation starts when CS goes low. There is no need to set the data to 1 before writing. If the clocks more than the specified number have been input, the clock pulse monitoring circuit cancels the WRAL instruction. For details of the clock pulse monitoring circuit, refer to “**Function to Protect Against Write due to Erroneous Instruction Recognition**”.

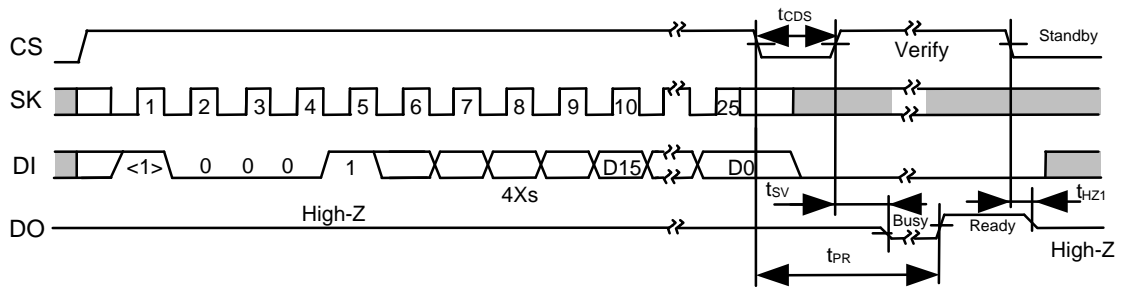


Figure 15 Chip Write Timing (S-93L46A)

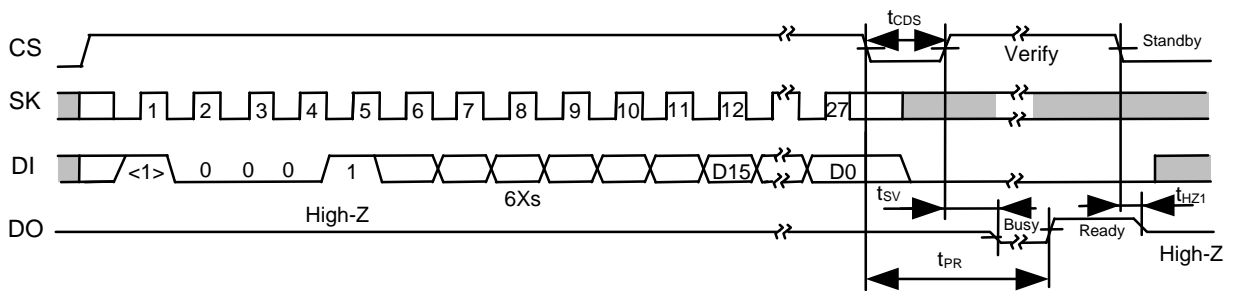


Figure 16 Chip Write Timing (S-93L56A, S-93L66A)

4.5 Erasing chip (ERAL)

To erase the data of the entire memory address space, set all the data to 1, change CS to high, and then input the ERAL instruction and an address following the start bit. Any address can be input. There is no need to input data. The chips erase operation starts when CS goes low. When the clocks more than the specified number have been input, the clock pulse monitoring circuit cancels the ERAL instruction. For details of the clock pulse monitoring circuit, refer to "■ Function to Protect Against Write due to Erroneous Instruction Recognition".

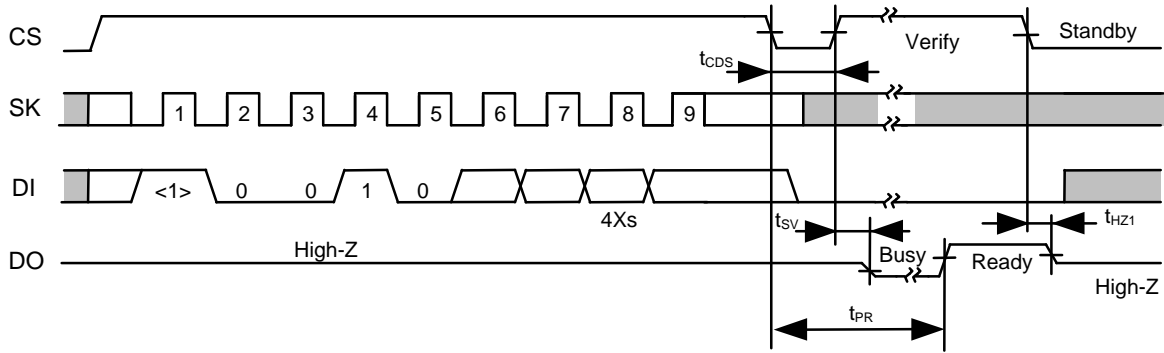


Figure 17 Chip Erase Timing (S-93L46A)

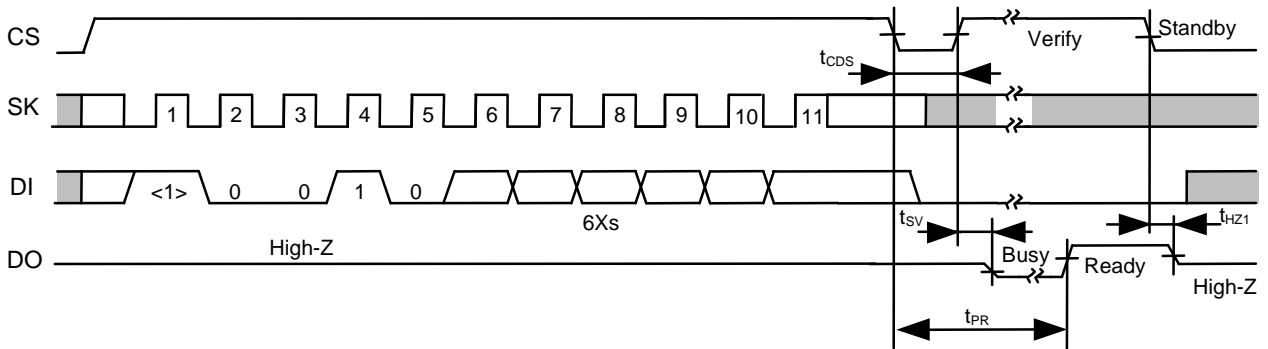


Figure 18 Chip Erase Timing (S-93L56A, S-93L66A)

5. Write enable (EWEN) and write disable (EWDS)

The EWEN instruction is an instruction that enables a write operation. The status in which a write operation is enabled is called the program enable mode.

The EWDS instruction is an instruction that disables a write operation. The status in which a write operation is disabled is called the program disable mode.

After CS goes high, input an instruction in the order of the start bit, EWEN or EWDS instruction, and address (optional). Each mode becomes valid by inputting a low level to CS after the last address (optional) has been input.

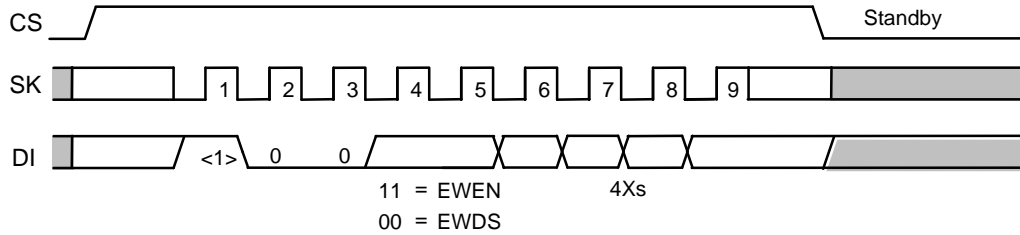


Figure 19 Write Enable / Disable Timing (S-93L46A)

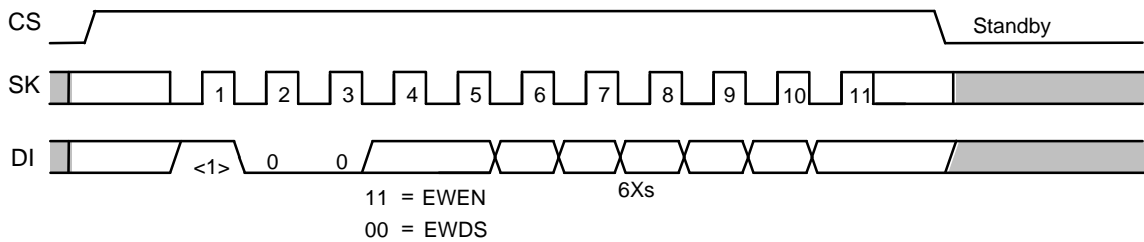


Figure 20 Write Enable / Disable Timing (S-93L56A, S-93L66A)

5.1 Recommendation for write operation disable instruction

It is recommended to implement a design that prevents an incorrect write operation when a write instruction is erroneously recognized by executing the write operation disable instruction when executing instructions other than write instruction, and immediately after power-on and before power off.

■ Write Protect Function during the Low Power Supply Voltage

The S-93L46A/56A/66A provides a built-in detector to detect a low power supply voltage and disable writing. When the power supply voltage is low or at power application, the write instructions (WRITE, ERASE, WRAL, and ERAL) are cancelled, and the write disable state (EWDS) is automatically set. The detection voltage and the release voltage are 1.4 V typ. (refer to **Figure 21**).

Therefore, when a write operation is performed after the power supply voltage has dropped and then risen again up to the level at which writing is possible, a write enable instruction (EWEN) must be sent before a write instruction (WRITE, ERASE, WRAL, or ERAL) is executed.

When the power supply voltage drops during a write operation, the data being written to an address at that time is not guaranteed.

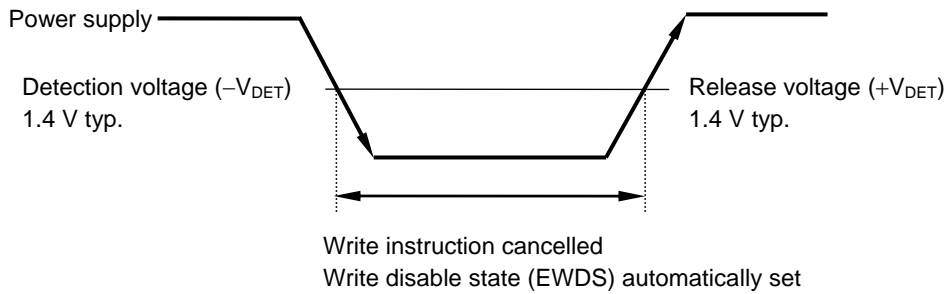


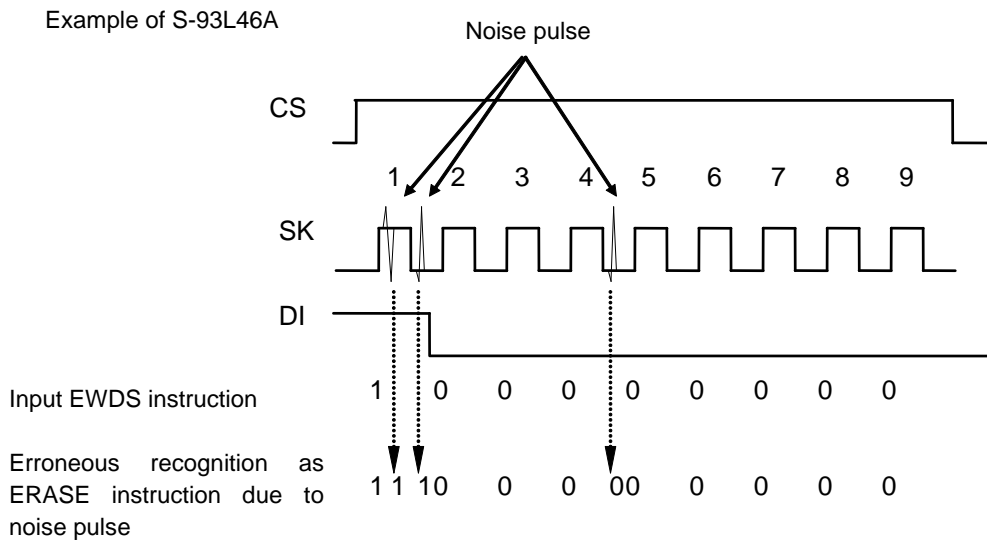
Figure 21 Operation during Low Power Supply Voltage

■ Function to Protect Against Write due to Erroneous Instruction Recognition

The S-93L46A/56A/66A provides a built-in clock pulse monitoring circuit which is used to prevent an erroneous write operation by canceling write instructions (WRITE, ERASE, WRAL, and ERAL) recognized erroneously due to an erroneous clock count caused by the application of noise pulses or double counting of clocks.

Instructions are cancelled if a clock pulse more or less than specified number decided by each write operation (WRITE, ERASE, WRAL, or ERAL) is detected.

<Example> Erroneous recognition of program disable instruction (EWDS) as erase instruction (ERASE)



In products that do not include a clock pulse monitoring circuit, FFFF is mistakenly written on address 00h. However the S-93L46A detects the overcount and cancels the instruction without performing a write operation.

Figure 22 Example of Clock Pulse Monitoring Circuit Operation

■ 3-Wire Interface (Direct Connection between DI and DO)

There are two types of serial interface configurations: a 4-wire interface configured using the CS, SK, DI, and DO pins, and a 3-wire interface that connects the DI input pin and DO output pin.

When the 3-wire interface is employed, a period in which the data output from the CPU and the data output from the serial memory collide may occur, causing a malfunction. To prevent such a malfunction, connect the DI and DO pins of the S-93L46A/56A/66A via a resistor (10 kΩ to 100 kΩ) so that the data output from the CPU takes precedence in being input to the DI pin (refer to **Figure 23**).

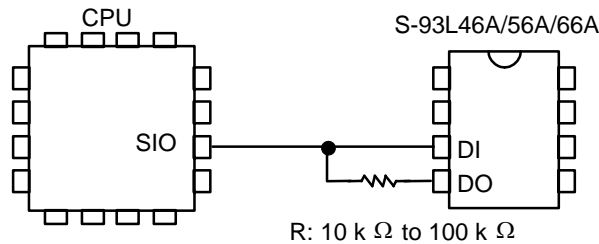


Figure 23 Connection of 3-Wire Interface

■ Input Pin and Output Pin

1. Connection of input pins

All the input pins of the S-93L46A/56A/66A employ a CMOS structure, so design the equipment so that high impedance will not be input while the S-93L46A/56A/66A is operating. Especially, deselect the CS input (a low level) when turning on / off power and during standby. When the CS pin is deselected (a low level), incorrect data writing will not occur. Connect the CS pin to GND via a resistor (10 kΩ to 100 kΩ pull-down resistor). To prevent malfunction, it is recommended to use equivalent pull-down resistors for pins other than the CS pin.

2. Equivalent circuit of input pin and output pin

The following shows the equivalent circuits of input pins of the S-93L46A/56A/66A. None of the input pins incorporate pull-up and pull-down elements, so special care must be taken when designing to prevent a floating status.

Output pins are high-level / low-level / high-impedance tri-state outputs. The TEST pin is disconnected from the internal circuit by a switching transistor during normal operation. As long as the absolute maximum rating is satisfied, the TEST pin and internal circuit will never be connected.

2.1 Input pin

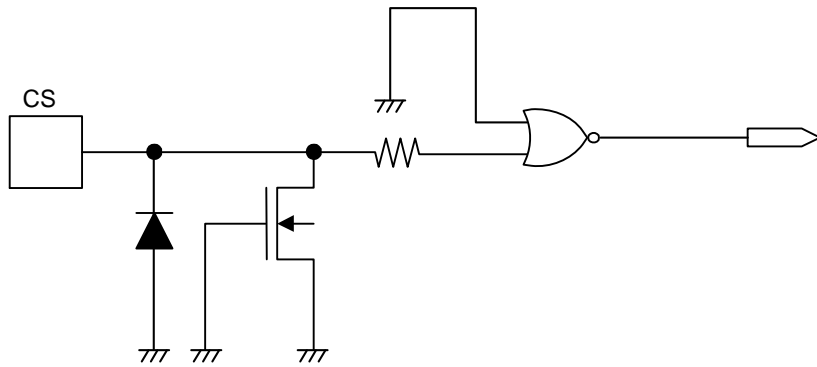


Figure 24 CS Pin

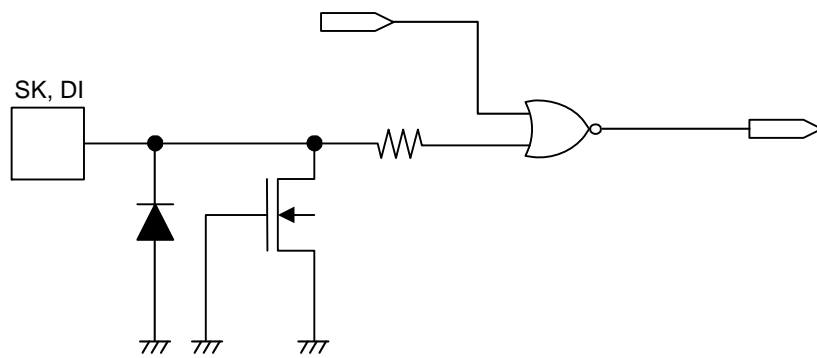


Figure 25 SK, DI Pin

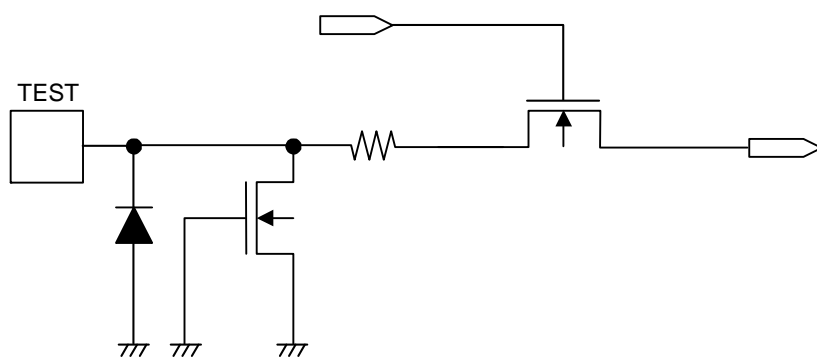


Figure 26 TEST Pin

2.2 Output pin

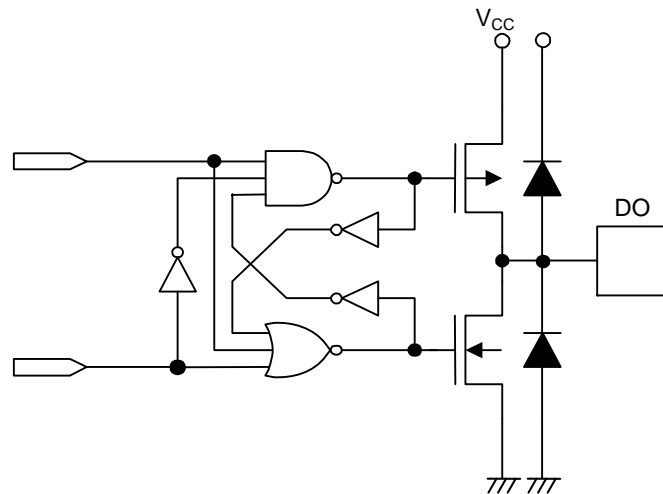


Figure 27 DO Pin

3. Input pin noise elimination time

The S-93L46A/56A/66A include a built-in low-pass filter to eliminate noise at the SK, DI, and CS pins. This means that if the supply voltage is 5.0 V (at room temperature), noise with a pulse width of 20 ns or less can be eliminated.

Note, therefore, the noise with a pulse width of more than 20 ns will be recognized as a pulse if the voltage exceeds V_{IH}/V_{IL} .

■ Precautions

- Do not apply an electrostatic discharge to this IC that exceeds the performance ratings of the built-in electrostatic protection circuit.
- SII claims no responsibility for any disputes arising out of or in connection with any infringement by products including this IC of patents owned by a third party.

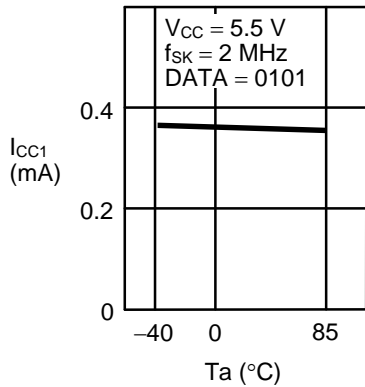
■ Precautions for WLP package

- The side of device silicon substrate is exposed to the marking side of device package. Since this portion has lower strength against the mechanical stress than the standard plastic package, chip, crack, etc should be careful of the handling of a package enough. Moreover, the exposed side of silicon has electrical potential of device substrate, and needs to be kept out of contact with the external potential.
- In this package, the overcoat of the resin of translucence is carried out on the side of device area. Keep it mind that it may affect the characteristic of a device when exposed a device in the bottom of a high light source.

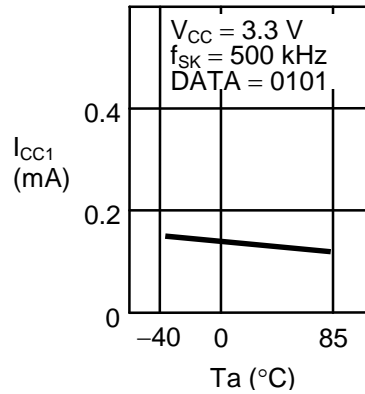
■ Characteristics (Typical Data)

1. DC Characteristics

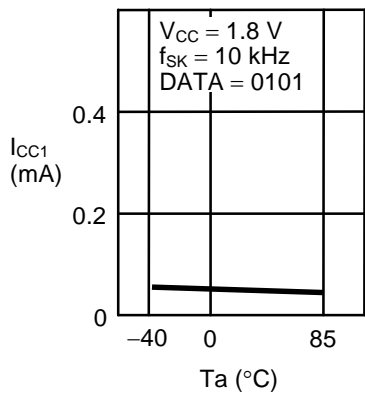
1.1 Current consumption (READ) I_{CC1} vs. ambient temperature T_a



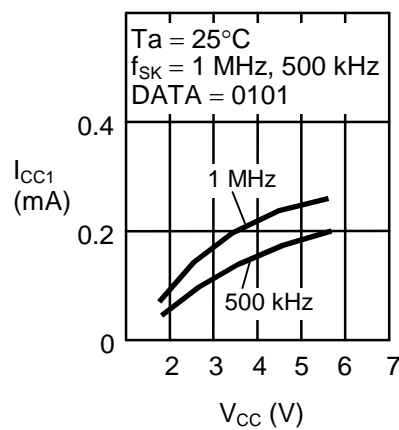
1.2 Current consumption (READ) I_{CC1} vs. ambient temperature T_a



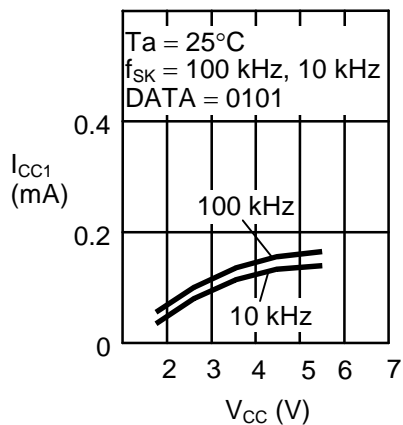
1.3 Current consumption (READ) I_{CC1} vs. ambient temperature T_a



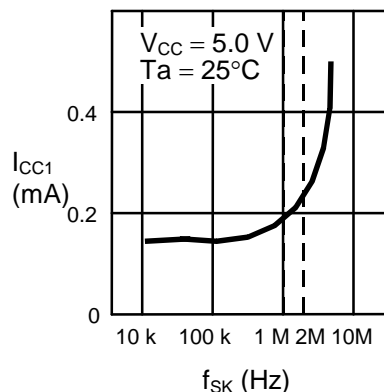
1.4 Current consumption (READ) I_{CC1} vs. power supply voltage V_{CC}



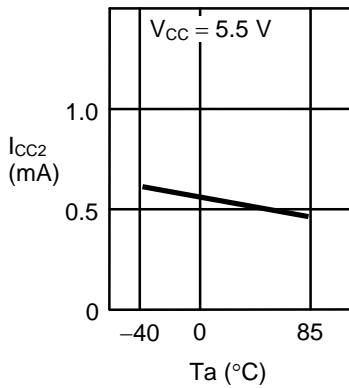
1.5 Current consumption (READ) I_{CC1} vs. power supply voltage V_{CC}



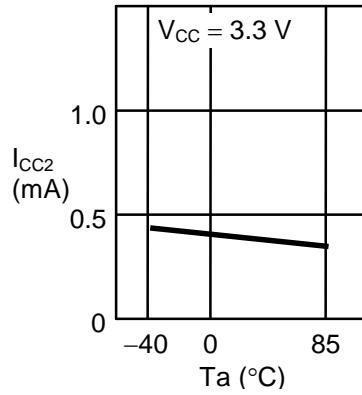
1.6 Current consumption (READ) I_{CC1} vs. Clock frequency f_{SK}



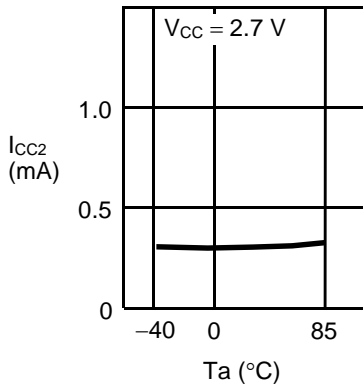
1.7 Current consumption (WRITE) I_{CC2} vs. ambient temperature T_a



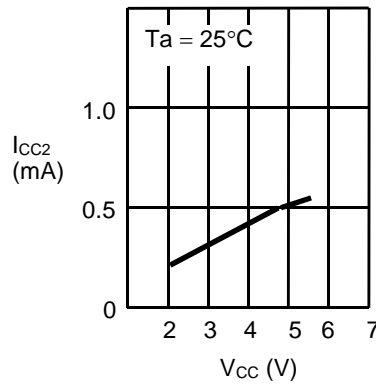
1.8 Current consumption (WRITE) I_{CC2} vs. ambient temperature T_a



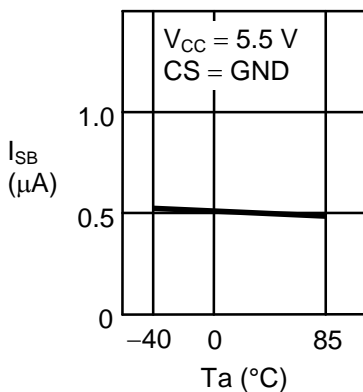
1.9 Current consumption (WRITE) I_{CC2} vs. ambient temperature T_a



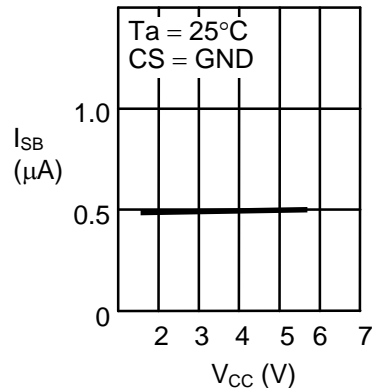
1.10 Current consumption (WRITE) I_{CC2} vs. power supply voltage V_{CC}



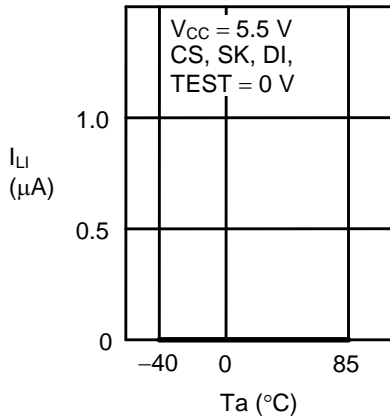
1.11 Current consumption in standby mode I_{SB} vs. ambient temperature T_a



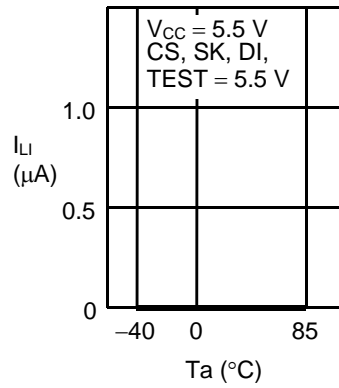
1.12 Current consumption in standby mode I_{SB} vs. power supply voltage V_{CC}



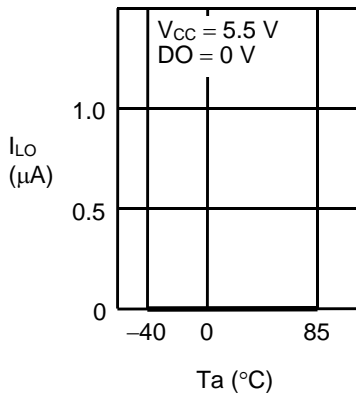
**1. 13 Input leakage current I_{LI}
vs. ambient temperature T_a**



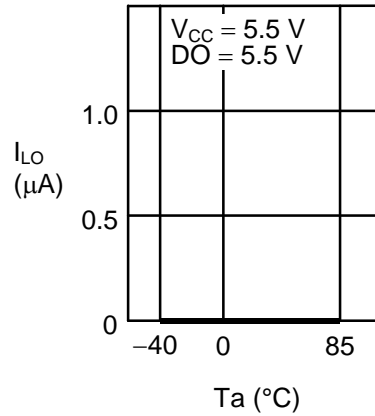
**1. 14 Input leakage current I_{LI}
vs. ambient temperature T_a**



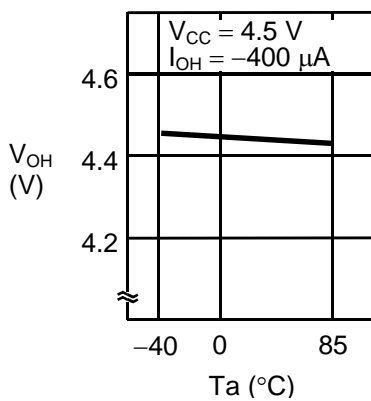
**1. 15 Output leakage current I_{LO}
vs. ambient temperature T_a**



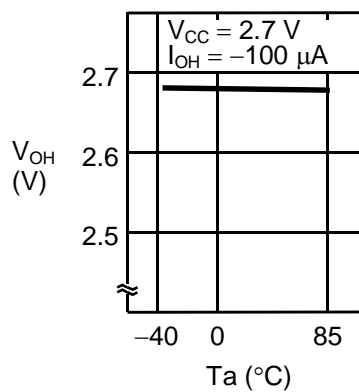
**1. 16 Output leakage current I_{LO}
vs. ambient temperature T_a**



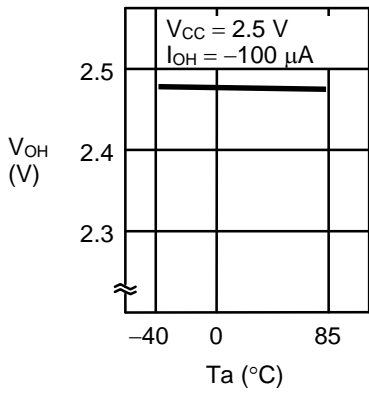
**1. 17 High-level output voltage V_{OH}
vs. ambient temperature T_a**



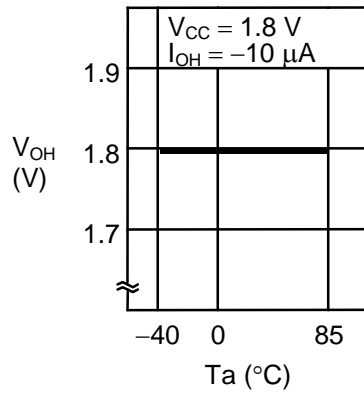
**1. 18 High-level output voltage V_{OH}
vs. ambient temperature T_a**



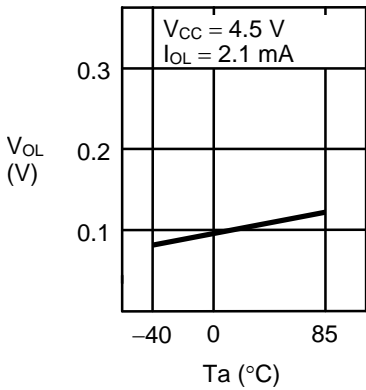
1. 19 High-level output voltage V_{OH} vs. ambient temperature T_a



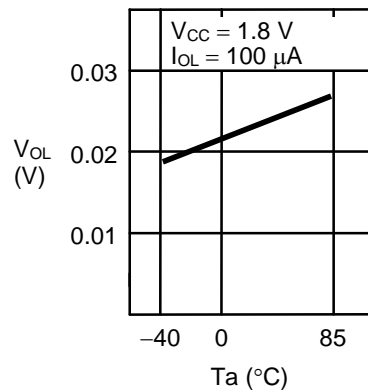
1. 20 High-level output voltage V_{OH} vs. ambient temperature T_a



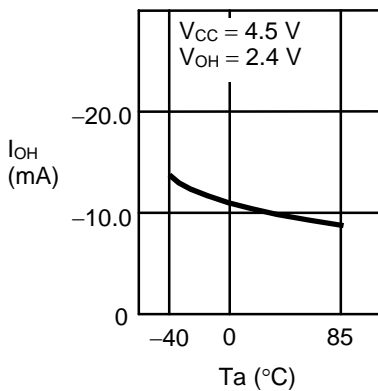
1. 21 Low-level output voltage V_{OL} vs. ambient temperature T_a



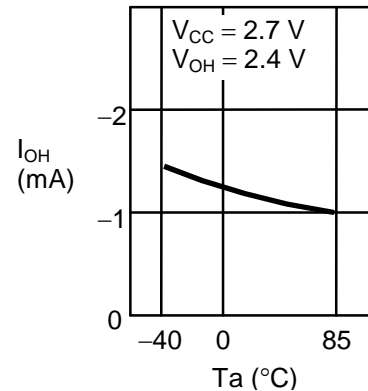
1. 22 Low-level output voltage V_{OL} vs. ambient temperature T_a



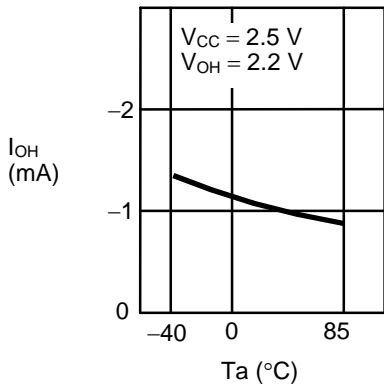
1. 23 High-level output current I_{OH} vs. ambient temperature T_a



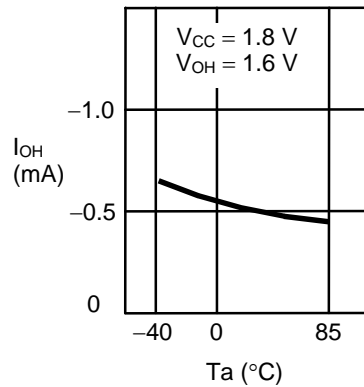
1. 24 High-level output current I_{OH} vs. ambient temperature T_a



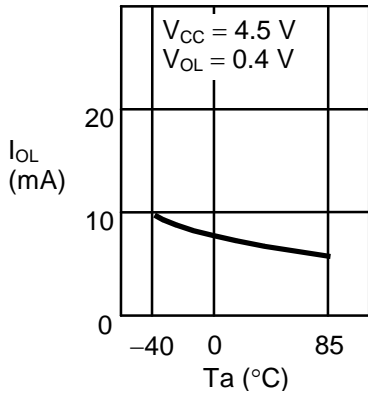
1. 25 High-level output current I_{OH} vs. ambient temperature T_a



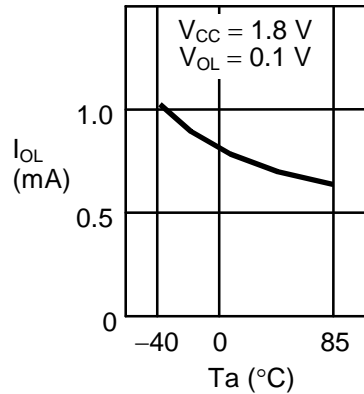
1. 26 High-level output current I_{OH} vs. ambient temperature T_a



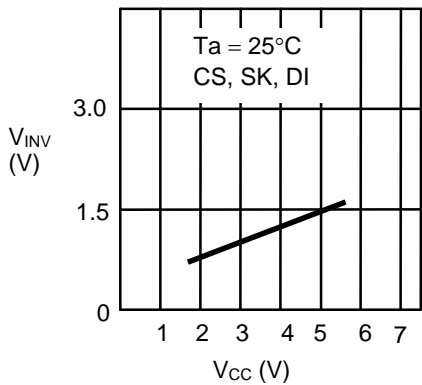
1. 27 Low-level output current I_{OL} vs. ambient temperature T_a



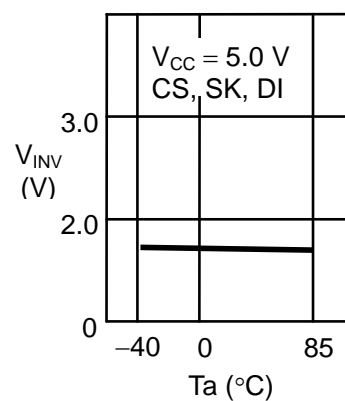
1. 28 Low-level output current I_{OL} vs. ambient temperature T_a



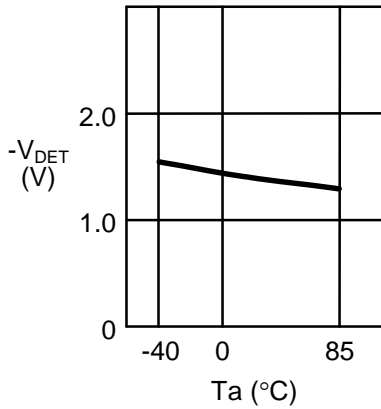
1. 29 Input inverted voltage V_{INV} vs. power supply voltage V_{CC}



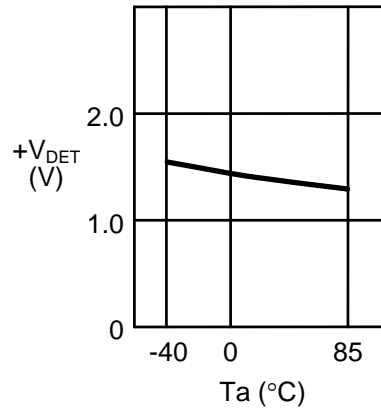
1. 30 Input inverted voltage V_{INV} vs. ambient temperature T_a



1. 31 Low supply voltage detection voltage $-V_{DET}$ vs. ambient temperature T_a

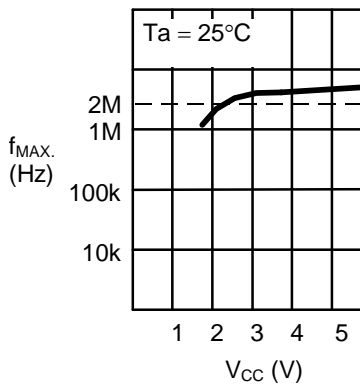


1. 32 Low supply voltage release voltage $+V_{DET}$ vs. ambient temperature T_a

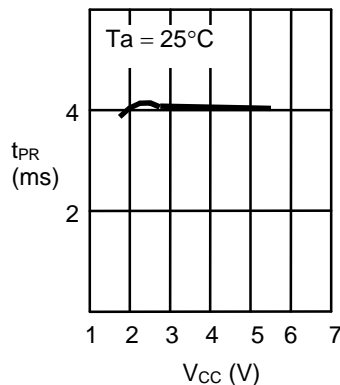


2. AC Characteristics

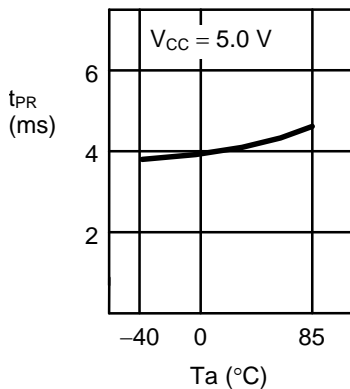
2. 1 Maximum operating frequency $f_{MAX.}$ vs. power supply voltage V_{CC}



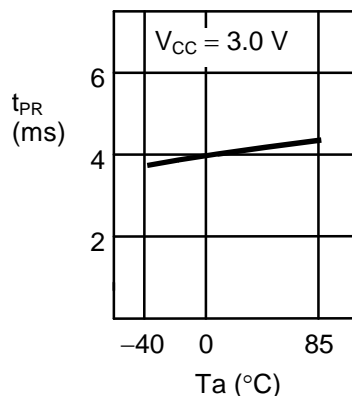
2. 2 Write time t_{PR} vs. power supply voltage V_{CC}



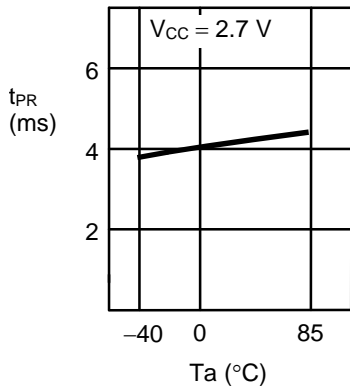
2. 3 Write time t_{PR} vs. ambient temperature T_a



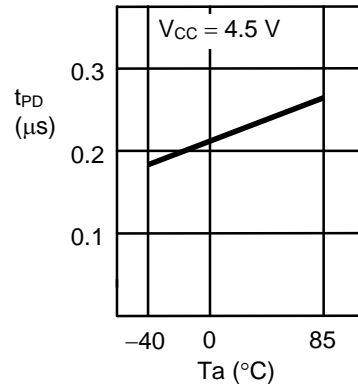
2. 4 Write time t_{PR} vs. ambient temperature T_a



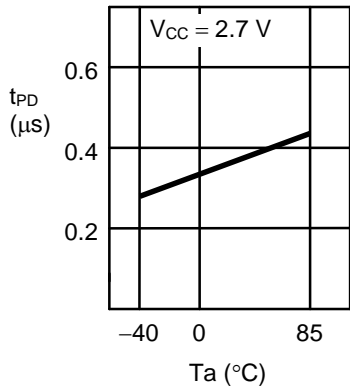
**2.5 Write time t_{PR}
vs. ambient temperature T_a**



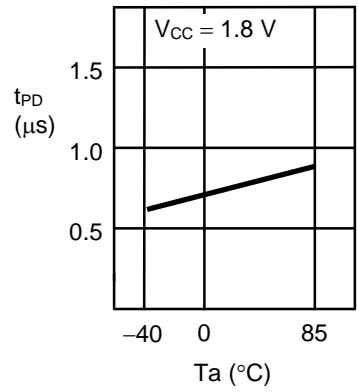
**2.6 Data output delay time t_{PD}
vs. ambient temperature T_a**



**2.7 Data output delay time t_{PD}
vs. ambient temperature T_a**



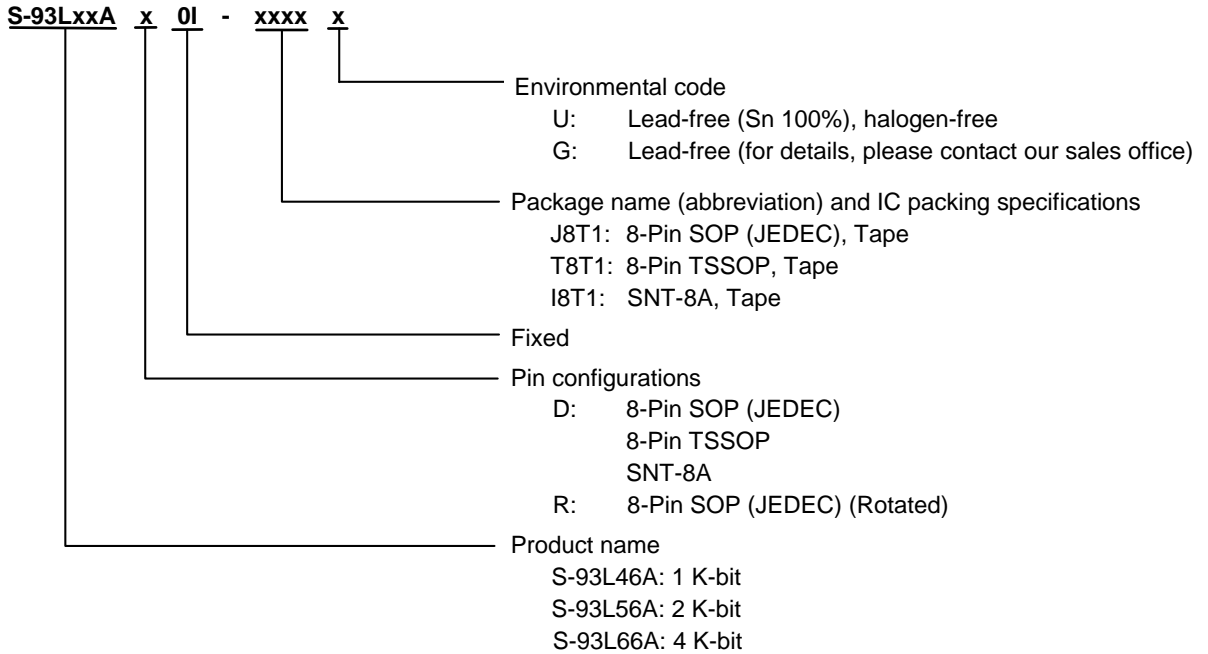
**2.8 Data output delay time t_{PD}
vs. ambient temperature T_a**



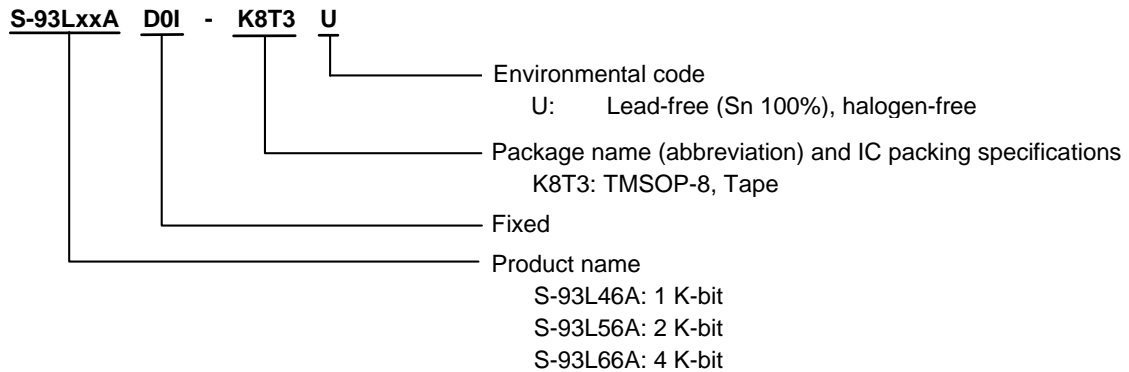
■ **Product Name Structure**

1. Product name

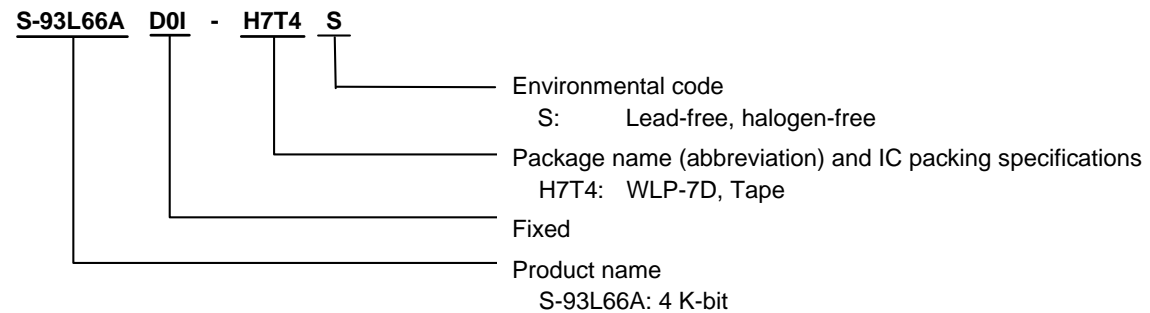
1.1 8-Pin SOP (JEDEC), 8-Pin TSSOP, SNT-8A



1.2 TMSOP-8

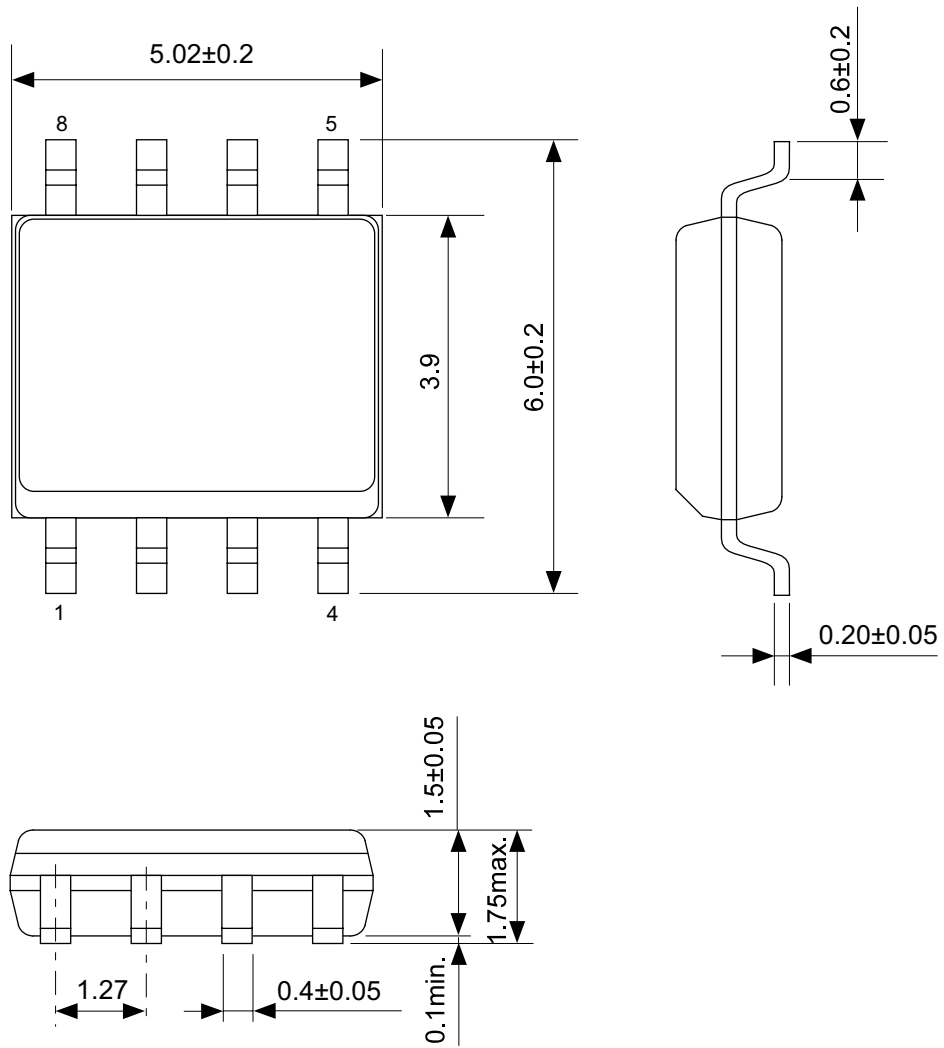


1.3 WLP-7D



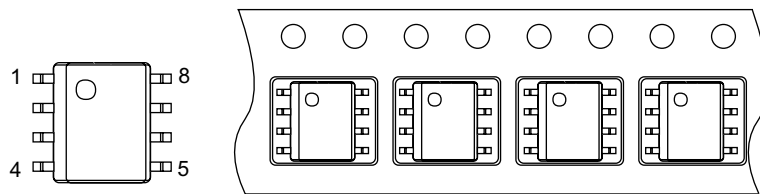
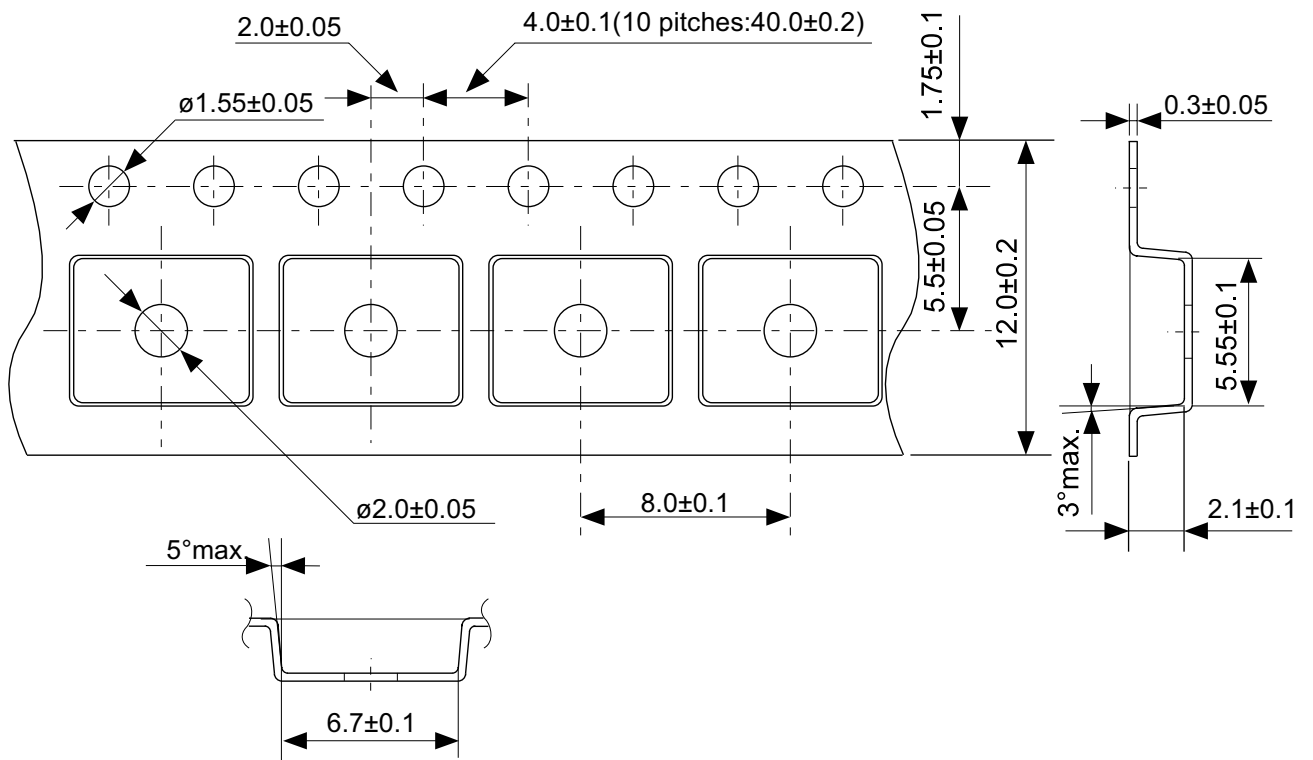
2. Packages

| Package name | | Drawing code | | | |
|----------------------|------------------------|--------------|--------------|--------------|--------------|
| | | Package | Tape | Reel | Land |
| 8-Pin SOP (JEDEC) | Environmental code = G | FJ008-A-P-SD | FJ008-D-C-SD | FJ008-D-R-SD | — |
| | Environmental code = U | FJ008-A-P-SD | FJ008-D-C-SD | FJ008-D-R-S1 | |
| 8-Pin TSSOP | Environmental code = G | FT008-A-P-SD | FT008-E-C-SD | FT008-E-R-SD | — |
| | Environmental code = U | FT008-A-P-SD | FT008-E-C-SD | FT008-E-R-S1 | |
| TMSOP-8 | | FM008-A-P-SD | FM008-A-C-SD | FM008-A-R-SD | — |
| SNT-8A | | PH008-A-P-SD | PH008-A-C-SD | PH008-A-R-SD | PH008-A-L-SD |
| WLP-7D | | HD007-C-P-SD | HD007-C-C-SD | HD007-A-R-SD | — |



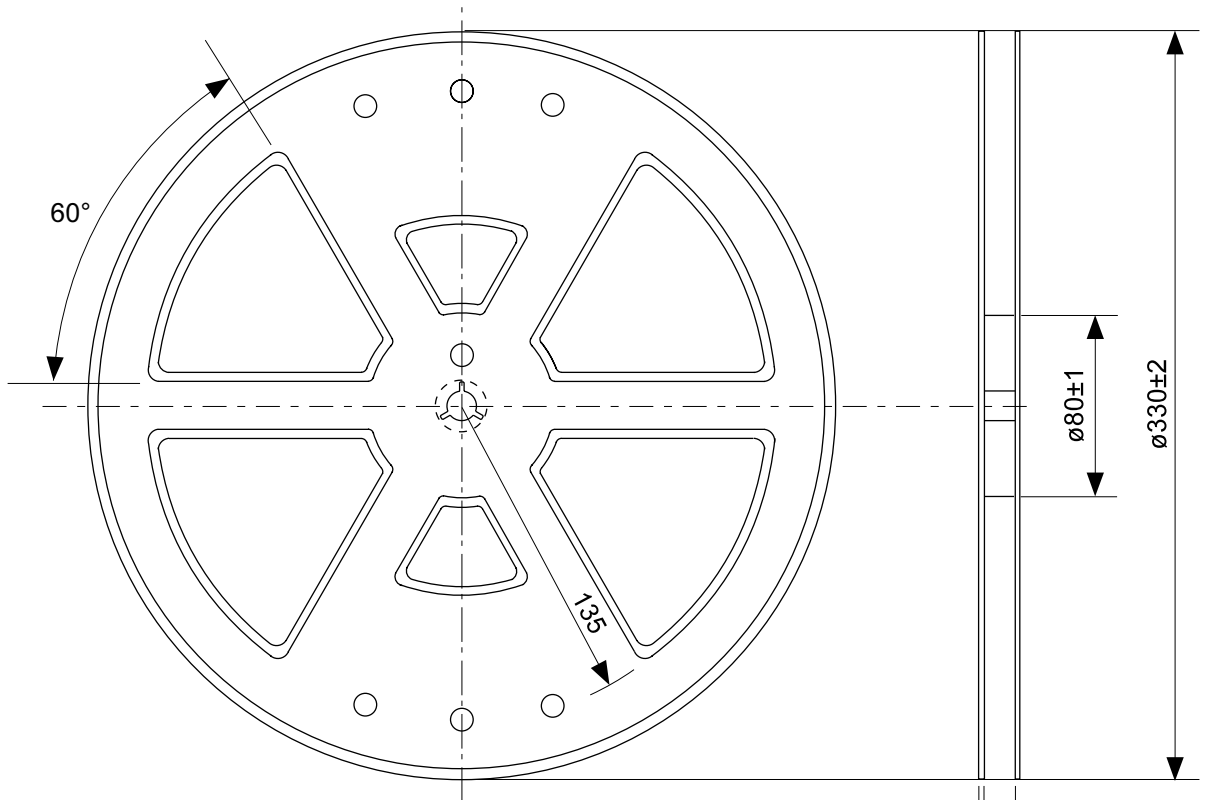
No. FJ008-A-P-SD-2.1

| | |
|------------------------|------------------------|
| TITLE | SOP8J-D-PKG Dimensions |
| No. | FJ008-A-P-SD-2.1 |
| SCALE | |
| UNIT | mm |
| | |
| Seiko Instruments Inc. | |

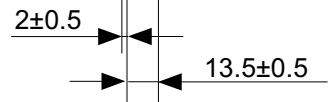
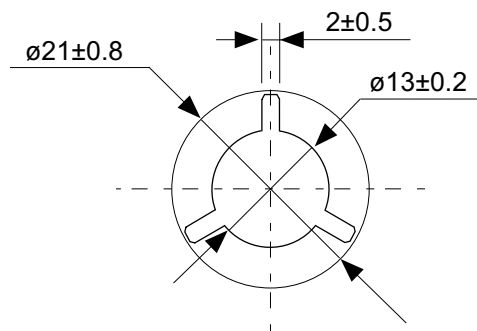


No. FJ008-D-C-SD-1.1

| | |
|------------------------|----------------------|
| TITLE | SOP8J-D-Carrier Tape |
| No. | FJ008-D-C-SD-1.1 |
| SCALE | |
| UNIT | mm |
| | |
| Seiko Instruments Inc. | |

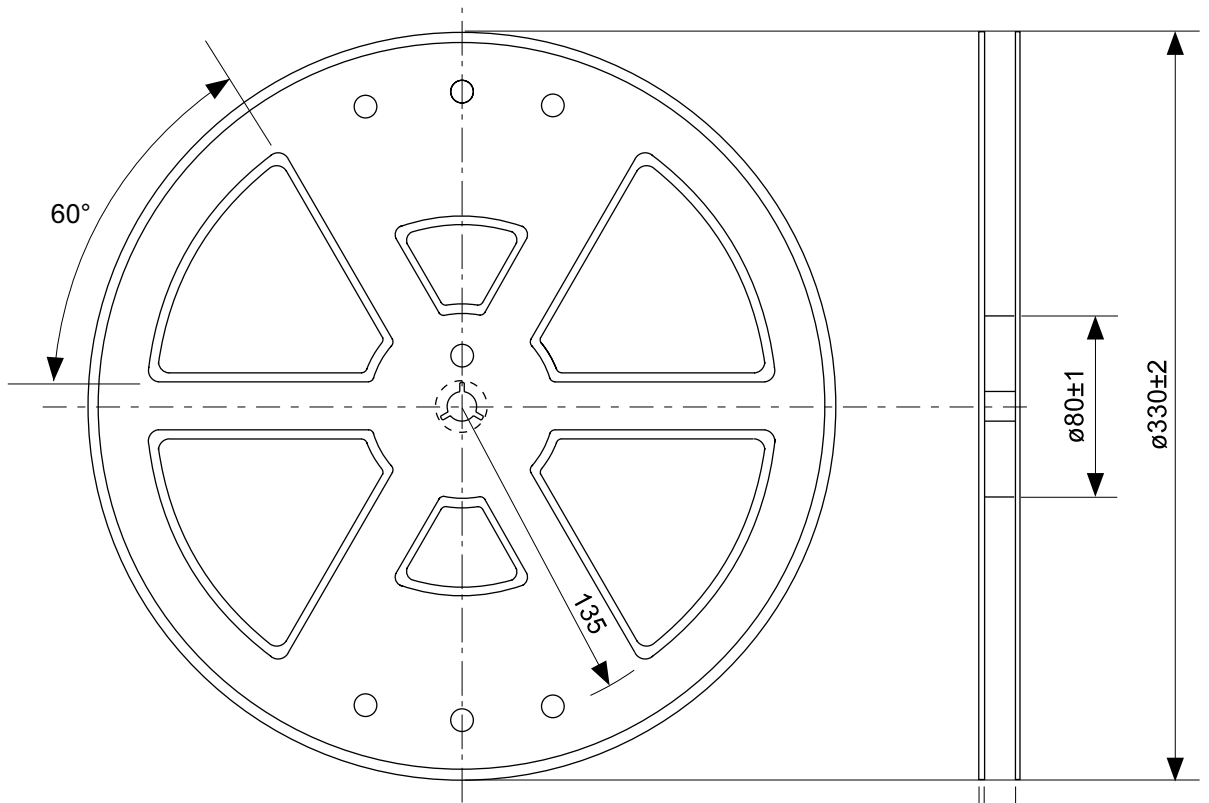


Enlarged drawing in the central part

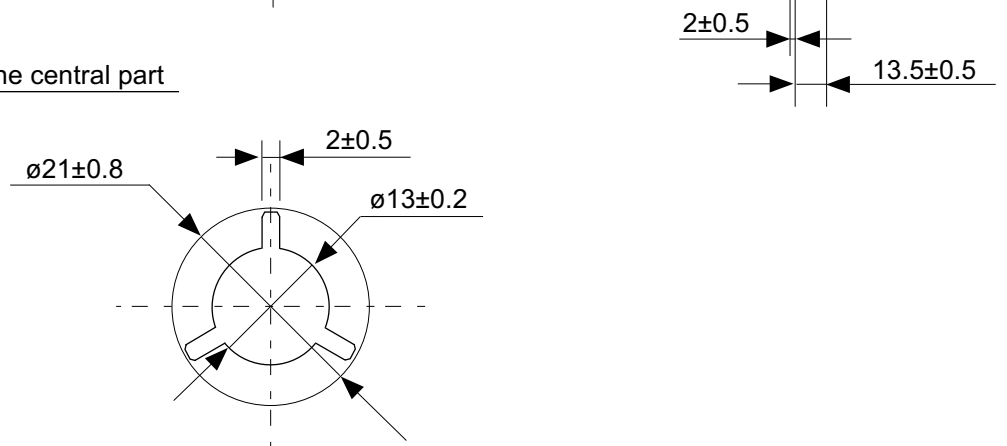


No. FJ008-D-R-SD-1.1

| | | | |
|------------------------|------------------|------|-------|
| TITLE | SOP8J-D-Reel | | |
| No. | FJ008-D-R-SD-1.1 | | |
| SCALE | | QTY. | 2,000 |
| UNIT | mm | | |
| | | | |
| Seiko Instruments Inc. | | | |



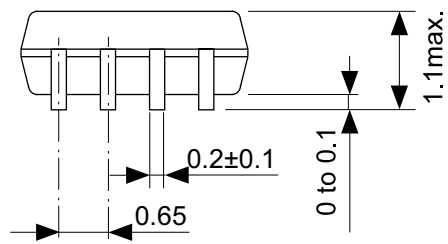
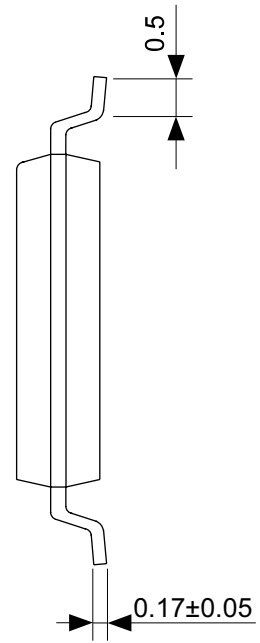
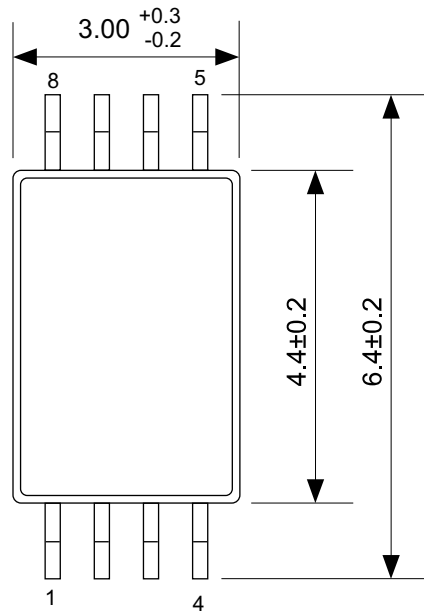
Enlarged drawing in the central part



No. FJ008-D-R-S1-1.0

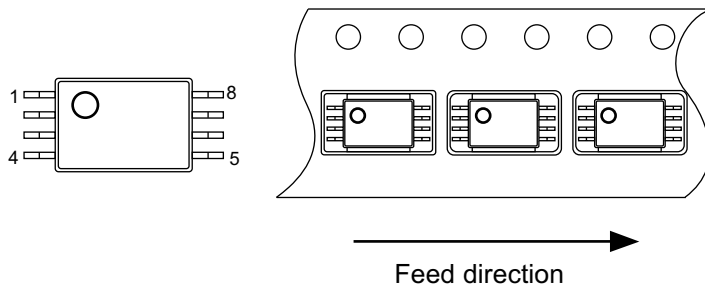
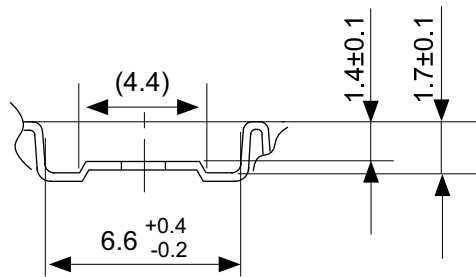
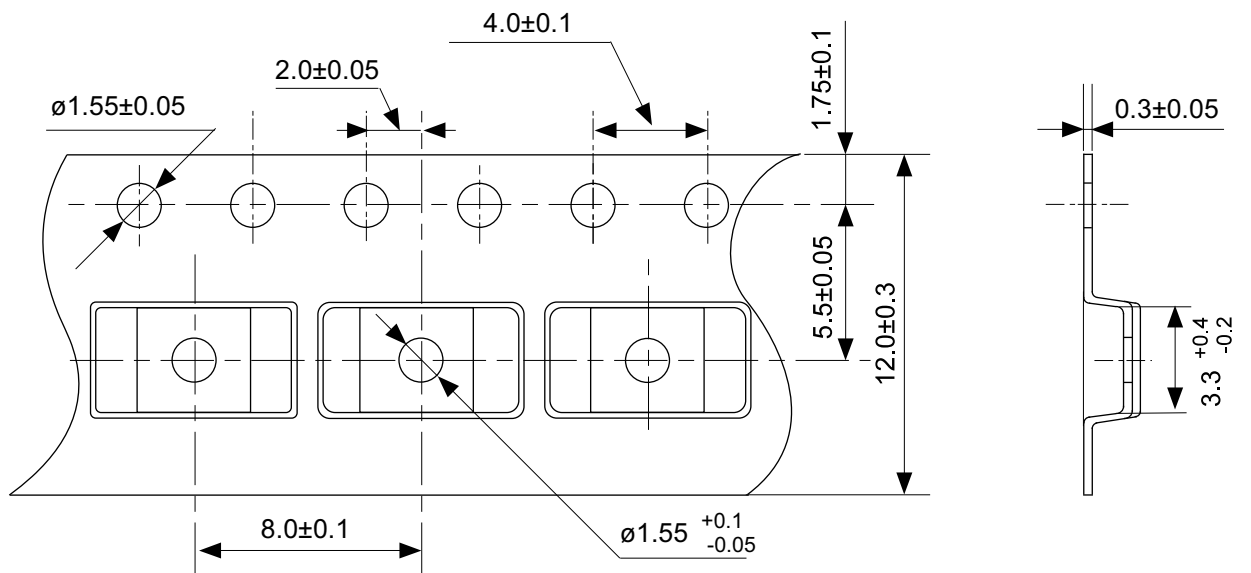
| | | | |
|-------|------------------|------|-------|
| TITLE | SOP8J-D-Reel | | |
| No. | FJ008-D-R-S1-1.0 | | |
| SCALE | | QTY. | 4,000 |
| UNIT | mm | | |
| | | | |

Seiko Instruments Inc.



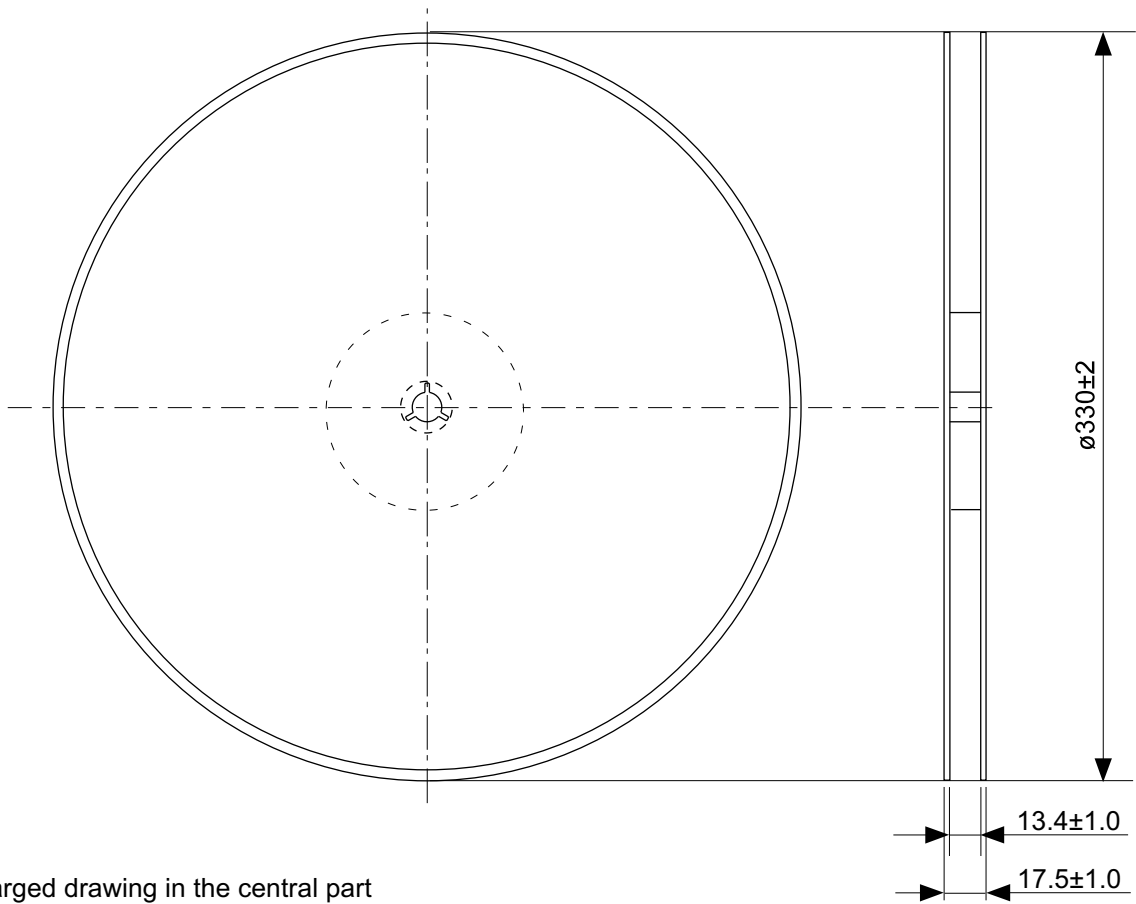
No. FT008-A-P-SD-1.1

| | |
|------------------------|-------------------------|
| TITLE | TSSOP8-E-PKG Dimensions |
| No. | FT008-A-P-SD-1.1 |
| SCALE | |
| UNIT | mm |
| Seiko Instruments Inc. | |

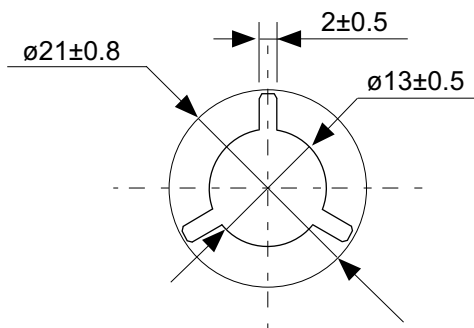


No. FT008-E-C-SD-1.0

| | |
|------------------------|-----------------------|
| TITLE | TSSOP8-E-Carrier Tape |
| No. | FT008-E-C-SD-1.0 |
| SCALE | |
| UNIT | mm |
| Seiko Instruments Inc. | |

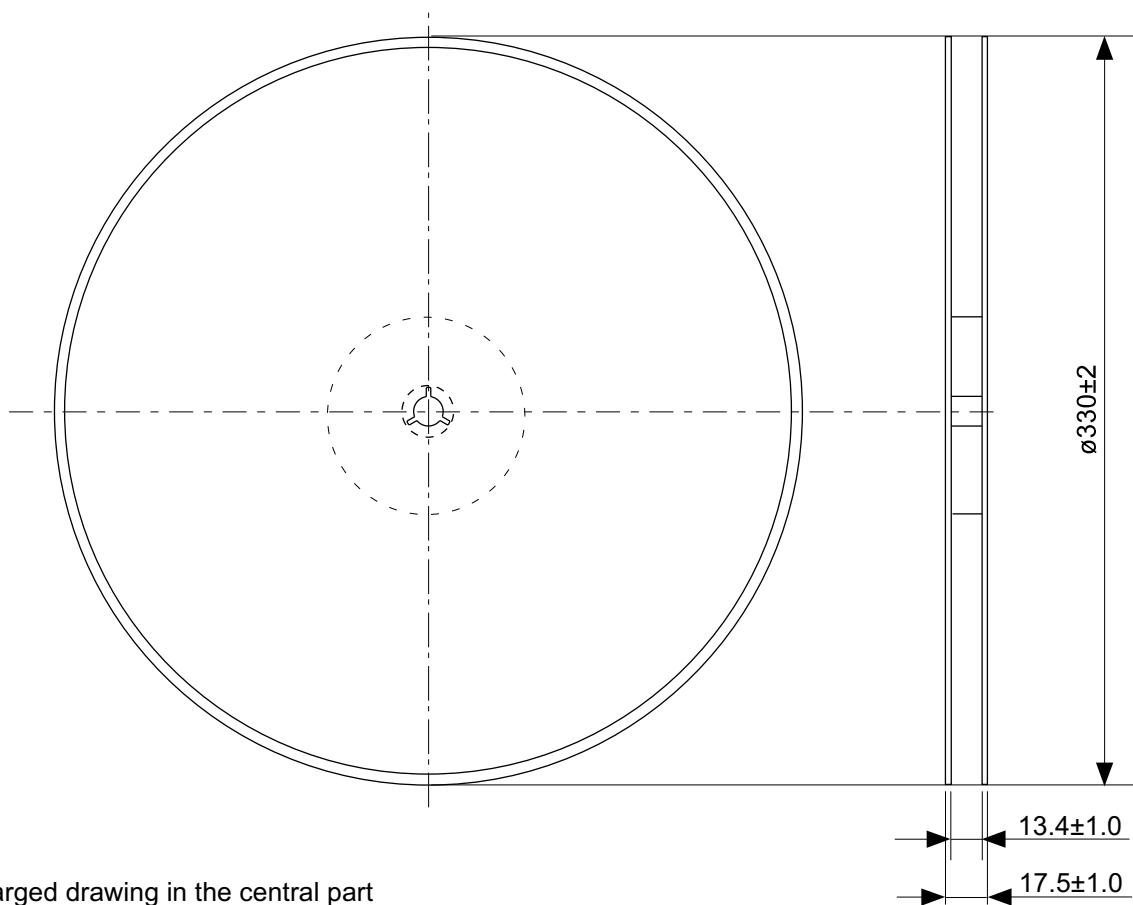


Enlarged drawing in the central part

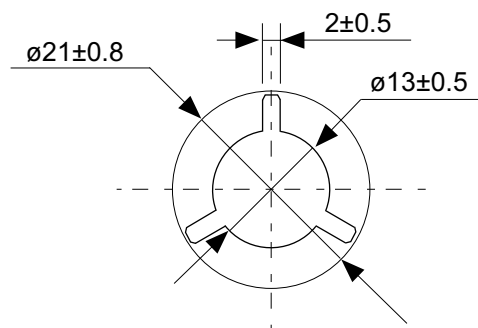


No. FT008-E-R-SD-1.0

| | | | |
|------------------------|------------------|------|-------|
| TITLE | TSSOP8-E-Reel | | |
| No. | FT008-E-R-SD-1.0 | | |
| SCALE | | QTY. | 3,000 |
| UNIT | mm | | |
| | | | |
| Seiko Instruments Inc. | | | |

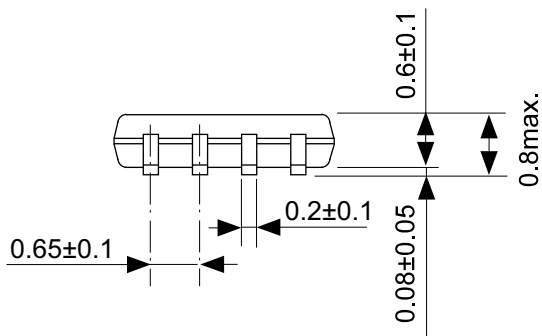
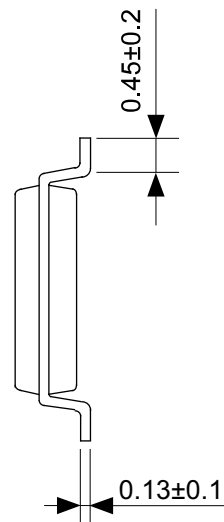
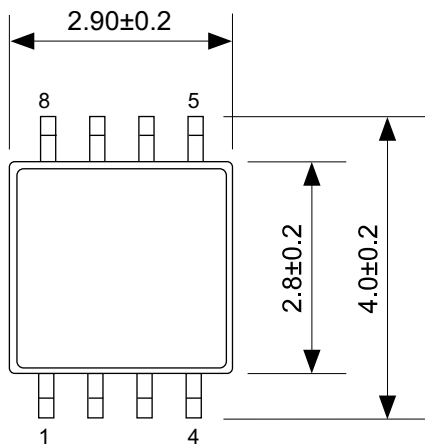


Enlarged drawing in the central part



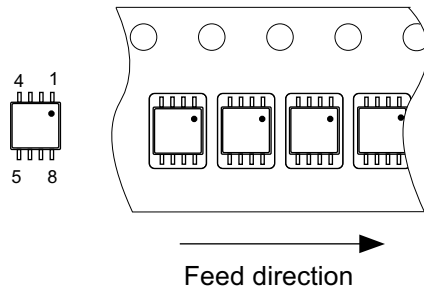
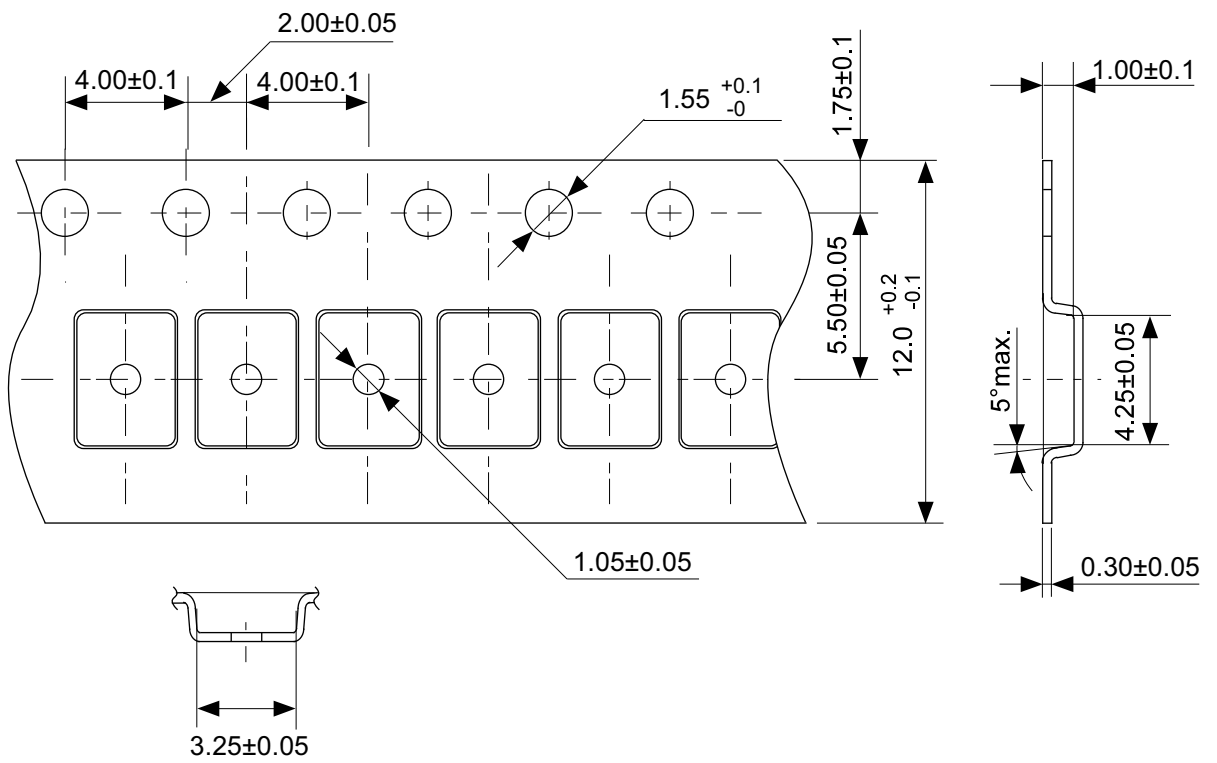
No. FT008-E-R-S1-1.0

| | | | |
|------------------------|------------------|------|-------|
| TITLE | TSSOP8-E-Reel | | |
| No. | FT008-E-R-S1-1.0 | | |
| SCALE | | QTY. | 4,000 |
| UNIT | mm | | |
| | | | |
| Seiko Instruments Inc. | | | |



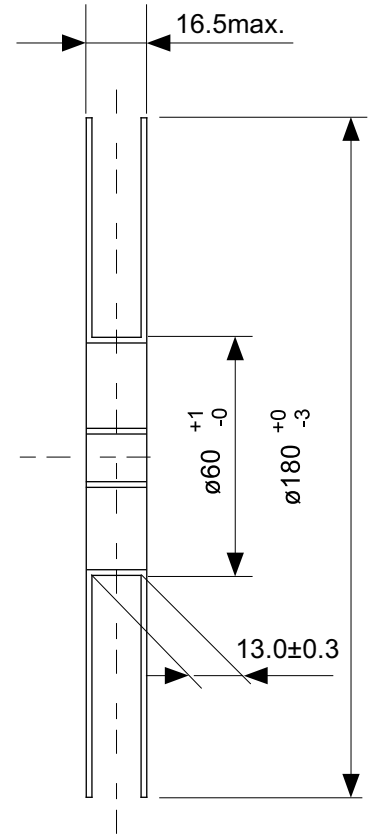
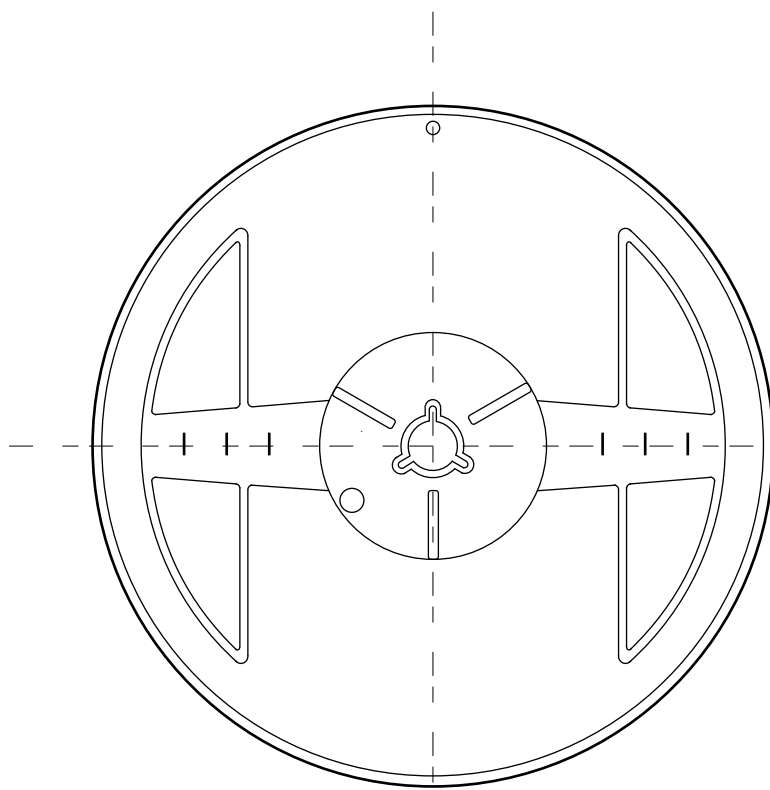
No. FM008-A-P-SD-1.1

| | |
|------------------------|-------------------------|
| TITLE | TMSOP8-A-PKG Dimensions |
| No. | FM008-A-P-SD-1.1 |
| SCALE | |
| UNIT | mm |
| | |
| Seiko Instruments Inc. | |

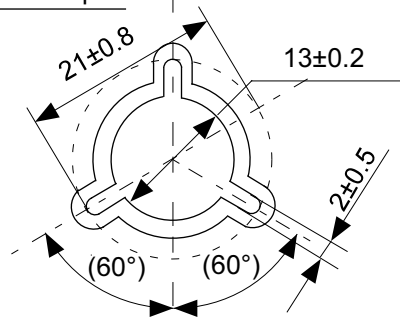


No. FM008-A-C-SD-1.0

| | |
|------------------------|-----------------------|
| TITLE | TMSOP8-A-Carrier Tape |
| No. | FM008-A-C-SD-1.0 |
| SCALE | |
| UNIT | mm |
| | |
| Seiko Instruments Inc. | |

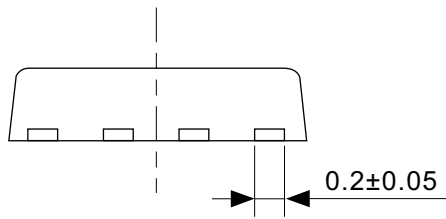
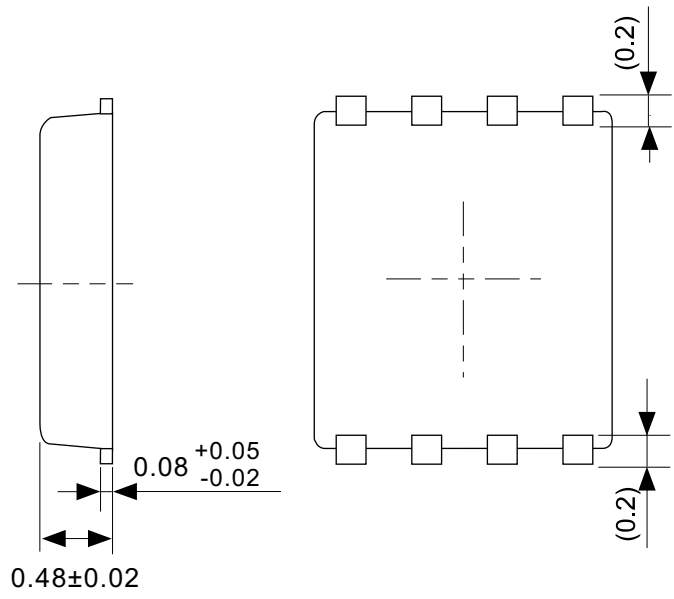
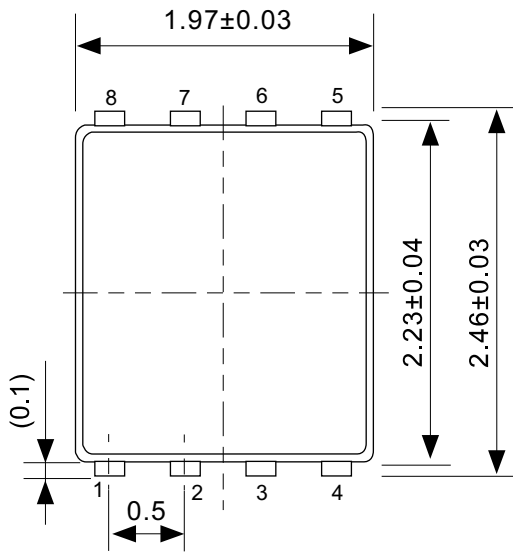


Enlarged drawing in the central part



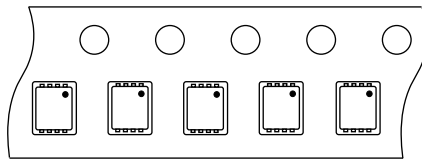
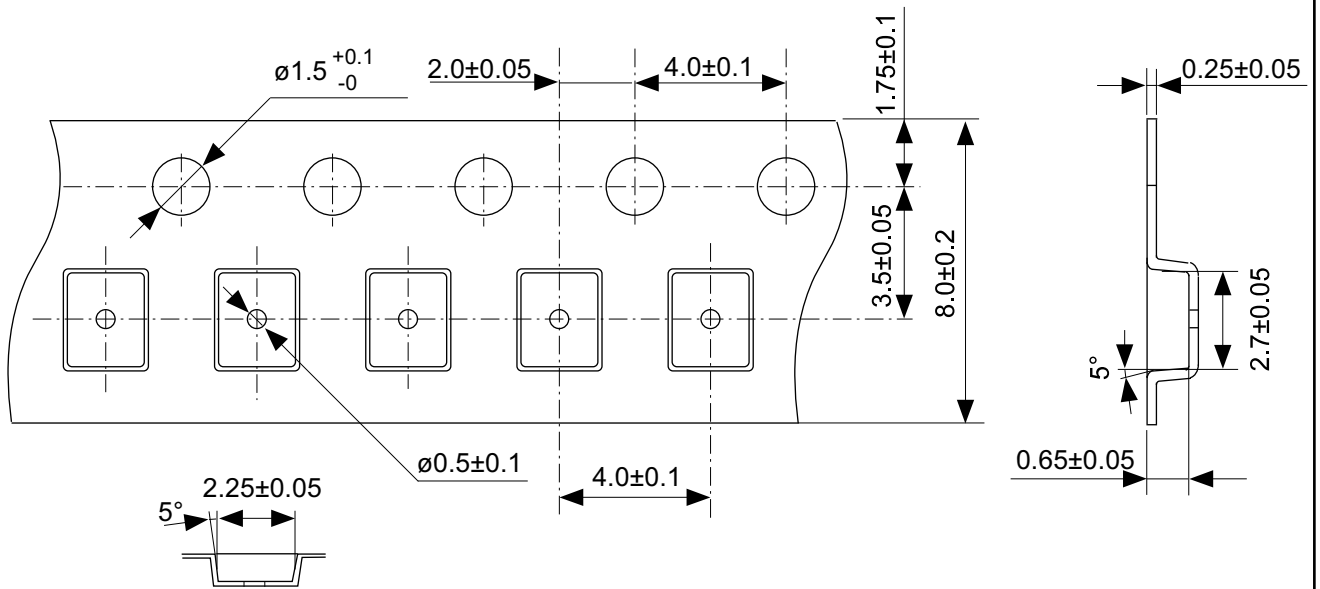
No. FM008-A-R-SD-1.0

| | | | |
|------------------------|------------------|------|-------|
| TITLE | TMSOP8-A-Reel | | |
| No. | FM008-A-R-SD-1.0 | | |
| SCALE | | QTY. | 4,000 |
| UNIT | mm | | |
| | | | |
| Seiko Instruments Inc. | | | |



No. PH008-A-P-SD-2.0

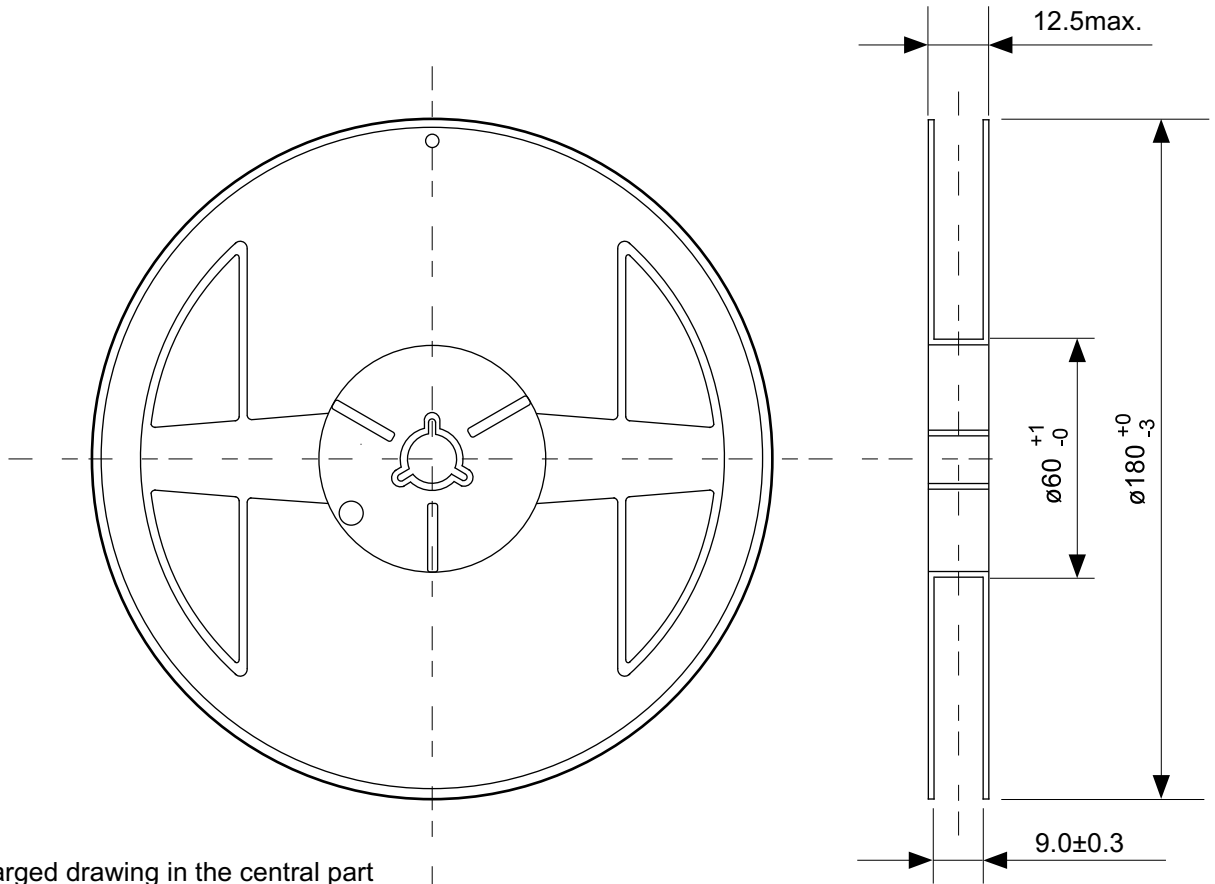
| | |
|------------------------|-------------------------|
| TITLE | SNT-8A-A-PKG Dimensions |
| No. | PH008-A-P-SD-2.0 |
| SCALE | |
| UNIT | mm |
| Seiko Instruments Inc. | |



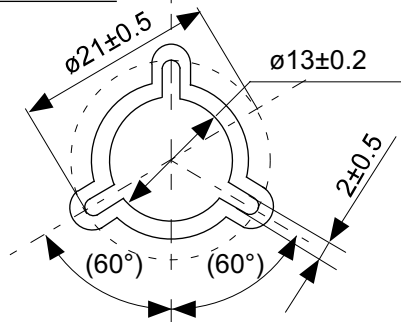
→
Feed direction

No. PH008-A-C-SD-1.0

| | |
|------------------------|-----------------------|
| TITLE | SNT-8A-A-Carrier Tape |
| No. | PH008-A-C-SD-1.0 |
| SCALE | |
| UNIT | mm |
| Seiko Instruments Inc. | |

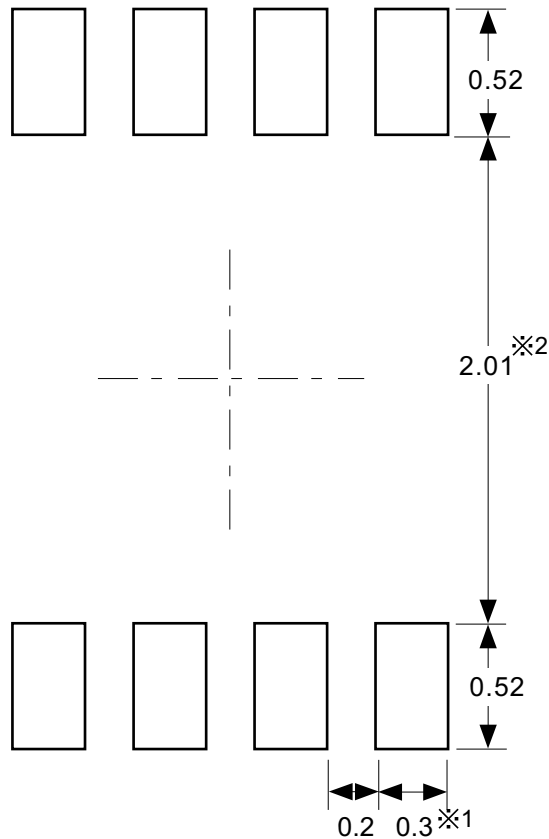


Enlarged drawing in the central part



No. PH008-A-R-SD-1.0

| | | | |
|------------------------|------------------|------|-------|
| TITLE | SNT-8A-A-Reel | | |
| No. | PH008-A-R-SD-1.0 | | |
| SCALE | | QTY. | 5,000 |
| UNIT | mm | | |
| | | | |
| Seiko Instruments Inc. | | | |



※1. ランドパターンの幅に注意してください (0.25 mm min. / 0.30 mm typ.).
 ※2. パッケージ中央にランドパターンを広げないでください (1.96 mm ~ 2.06 mm)。

- 注意
1. パッケージのモールド樹脂下にシルク印刷やハンダ印刷などしないでください。
 2. パッケージ下の配線上のソルダーレジストなどの厚みをランドパターン表面から0.03 mm以下にしてください。
 3. マスク開口サイズと開口位置はランドパターンと合わせてください。
 4. 詳細は "SNTパッケージ活用の手引き" を参照してください。

※1. Pay attention to the land pattern width (0.25 mm min. / 0.30 mm typ.).
 ※2. Do not widen the land pattern to the center of the package (1.96 mm to 2.06mm).

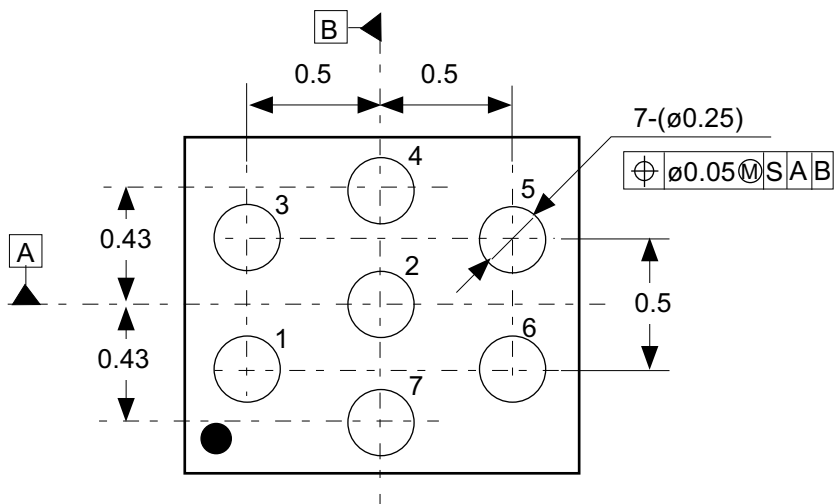
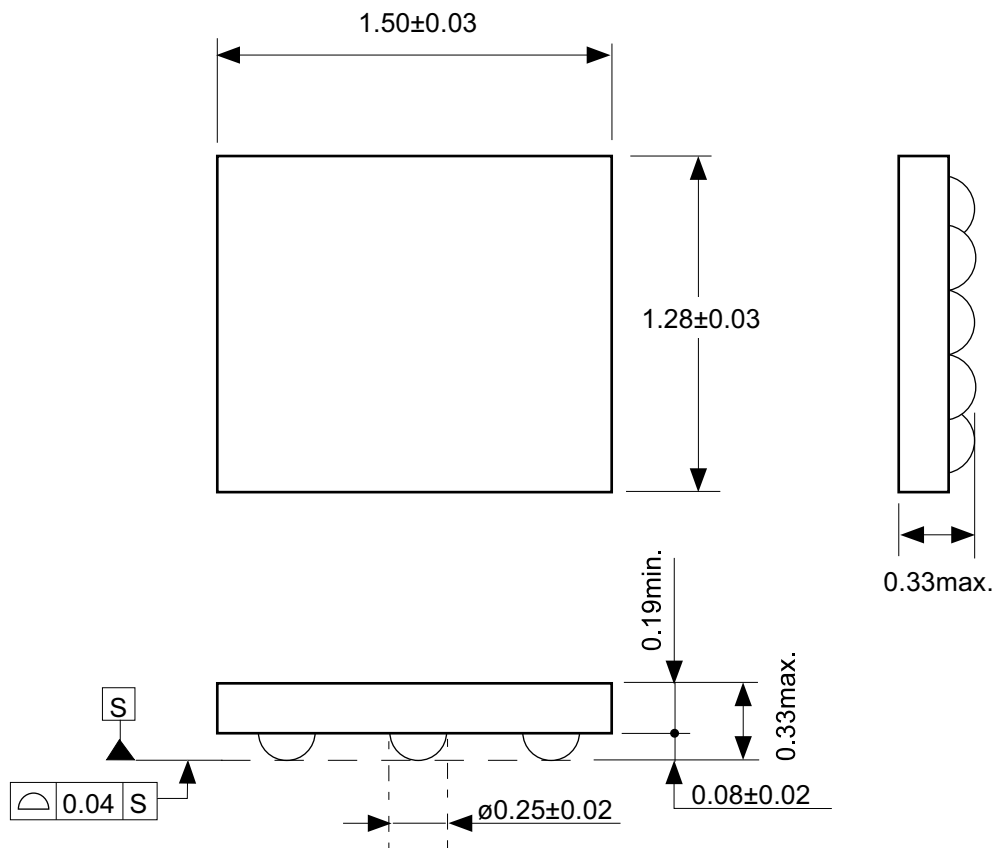
- Caution**
1. Do not do silkscreen printing and solder printing under the mold resin of the package.
 2. The thickness of the solder resist on the wire pattern under the package should be 0.03 mm or less from the land pattern surface.
 3. Match the mask aperture size and aperture position with the land pattern.
 4. Refer to "SNT Package User's Guide" for details.

※1. 请注意焊盘模式的宽度 (0.25 mm min. / 0.30 mm typ.).
 ※2. 请勿向封装中间扩展焊盘模式 (1.96 mm ~ 2.06 mm)。

- 注意
1. 请勿在树脂型封装的下面印刷丝网、焊锡。
 2. 在封装下、布线上的阻焊膜厚度 (从焊盘模式表面起) 请控制在0.03 mm以下。
 3. 掩膜的开口尺寸和开口位置请与焊盘模式对齐。
 4. 详细内容请参阅 "SNT封装的应用指南"。

No. PH008-A-L-SD-4.0

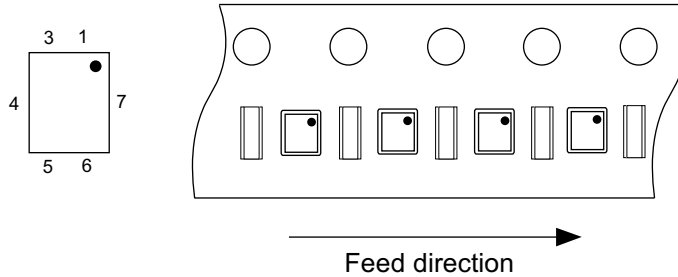
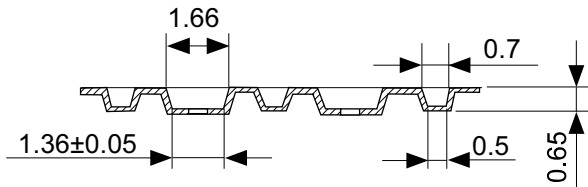
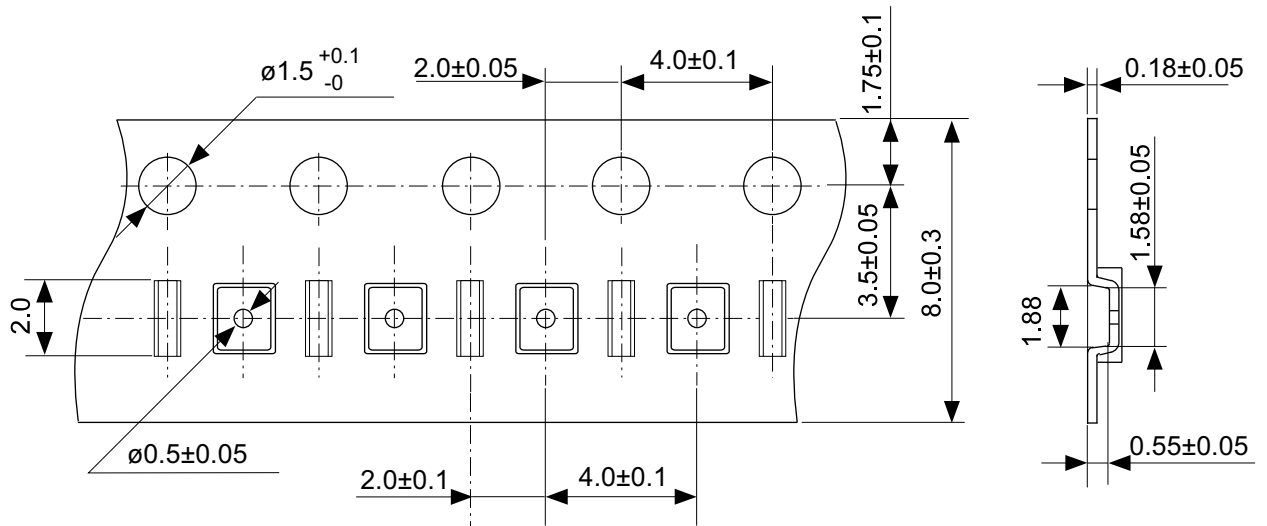
| | |
|------------------------|------------------------------|
| TITLE | SNT-8A-A-Land Recommendation |
| No. | PH008-A-L-SD-4.0 |
| SCALE | |
| UNIT | mm |
| Seiko Instruments Inc. | |



| Pin No. | Pin name |
|---------|----------|
| 1 | CS |
| 2 | DI |
| 3 | VCC |
| 4 | TEST |
| 5 | GND |
| 6 | DO |
| 7 | SK |

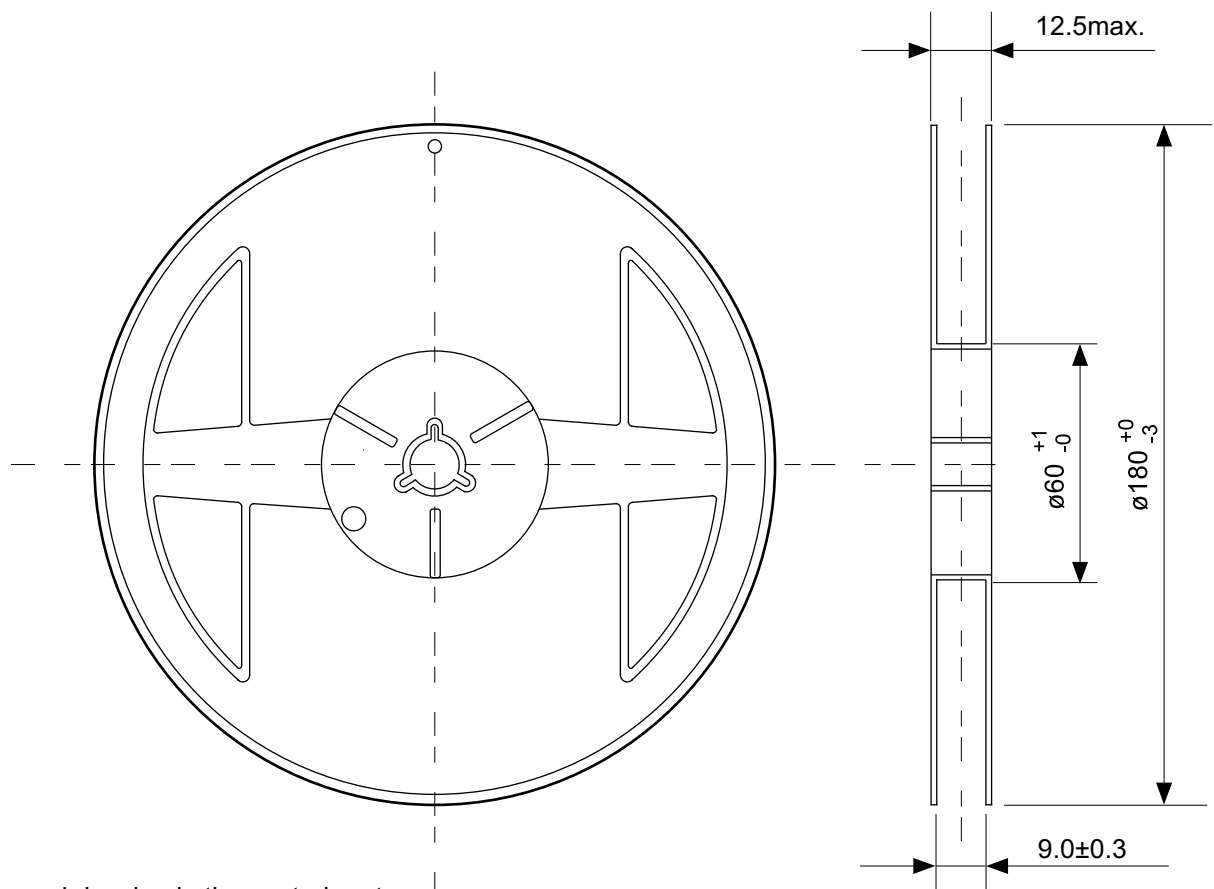
No. HD007-C-P-SD-2.0

| | |
|------------------------|-------------------------------------|
| TITLE | WLP-7D-C-PKG Dimensions (S-93L66AD) |
| No. | HD007-C-P-SD-2.0 |
| SCALE | |
| UNIT | mm |
| Seiko Instruments Inc. | |

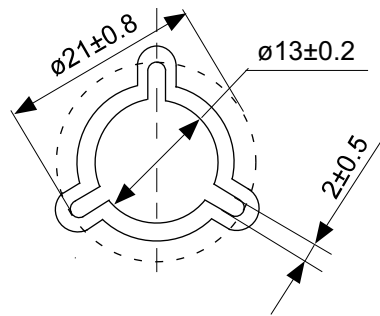


No. HD007-C-C-SD-1.0

| | |
|------------------------|--------------------------------------|
| TITLE | WLP-7D-C-Carrier Tape (S-93L66AD) |
| No. | HD007-C-C-SD-1.0 |
| SCALE | |
| UNIT | mm |
| Seiko Instruments Inc. | |



Enlarged drawing in the central part



No. HD007-A-R-SD-1.1

| | | | |
|------------------------|------------------------------|------|-------|
| TITLE | WLP-7D-C-Reel (S-93L66AD) | | |
| No. | HD007-A-R-SD-1.1 | | |
| SCALE | | QTY. | 3,000 |
| UNIT | mm | | |
| | | | |
| Seiko Instruments Inc. | | | |



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