

## CPU Supervisor with 16Kbit SPI EEPROM

These devices combine three popular functions, Power-on Reset Control, Supply Voltage Supervision, and Block Lock Protect Serial EEPROM Memory in one package. This combination lowers system cost, reduces board space requirements, and increases reliability.

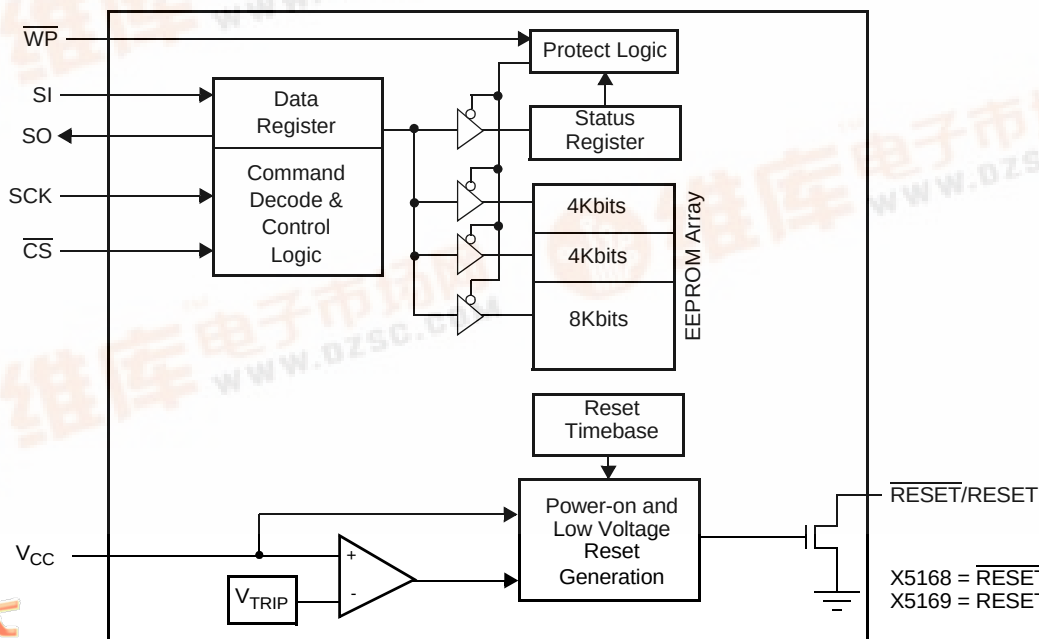
Applying power to the device activates the power-on reset circuit which holds  $\overline{\text{RESET}}$ /RESET active for a period of time. This allows the power supply and oscillator to stabilize before the processor can execute code.

The device's low  $V_{CC}$  detection circuitry protects the user's system from low voltage conditions by holding  $\overline{\text{RESET}}$ /RESET active when  $V_{CC}$  falls below a minimum  $V_{CC}$  trip point.  $\overline{\text{RESET}}$ /RESET remains asserted until  $V_{CC}$  returns to proper operating level and stabilizes. Five industry standard  $V_{TRIP}$  thresholds are available, however, Intersil's unique circuits allow the threshold to be reprogrammed to meet custom requirements or to fine-tune the threshold in applications requiring higher precision.

## Features

- Low  $V_{CC}$  Detection and Reset Assertion
  - Five standard reset threshold voltages
  - Re-program low  $V_{CC}$  reset threshold voltage using special programming sequence
  - Reset signal valid to  $V_{CC} = 1V$
- Long Battery Life with Low Power Consumption
  - $<50\mu A$  max standby current, watchdog on
  - $<1\mu A$  max standby current, watchdog off
  - $<400\mu A$  max active current during read
- 16Kbits of EEPROM
- Built-in Inadvertent Write Protection
  - Power-up/power-down protection circuitry
  - Protect 0, 1/4, 1/2 or all of EEPROM array with Block Lock™ protection
  - In circuit programmable ROM mode
- 2MHz SPI Interface Modes (0,0 & 1,1)
- Minimize EEPROM Programming Time
  - 32-byte page write mode
  - Self-timed write cycle
  - 5ms write cycle time (typical)
- 2.7V to 5.5V and 4.5V to 5.5V Power Supply Operation
- Available Packages
  - 14 Ld TSSOP, 8 Ld SOIC, 8 Ld PDIP
- Pb-Free Plus Anneal Available (RoHS Compliant)

## Block Diagram



## X5168, X5169

### Ordering Information

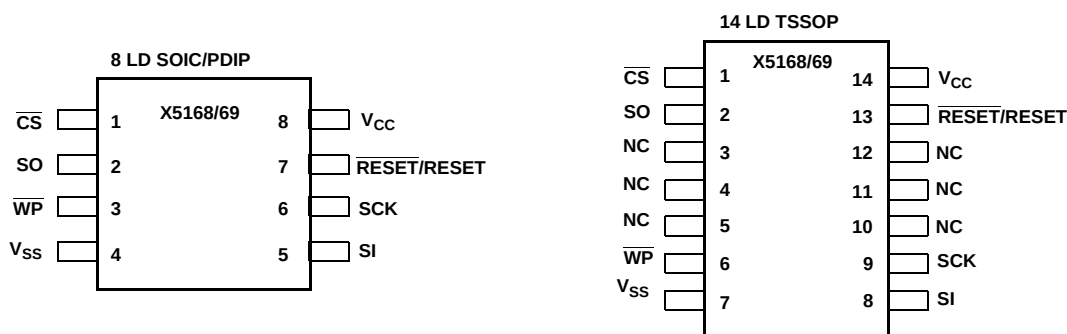
| PART NUMBER<br>RESET<br>(ACTIVE LOW) | PART<br>MARKING | PART NUMBER<br>RESET<br>(ACTIVE HIGH) | PART<br>MARKING | V <sub>CC</sub> RANGE<br>(V) | V <sub>TRIP</sub> RANGE<br>(V) | TEMP RANGE<br>(°C) | PACKAGE                                 |
|--------------------------------------|-----------------|---------------------------------------|-----------------|------------------------------|--------------------------------|--------------------|-----------------------------------------|
| X5168P-4.5A                          | X5168P AL       | X5169P-4.5A                           | X5169P AL       | 4.5-5.5                      | 4.5.4.75                       | 0 to 70            | 8 Ld PDIP                               |
| -                                    | -               | X5169PZ-4.5A                          |                 |                              |                                |                    | 8 Ld PDIP                               |
| X5168PI-4.5A                         |                 | X5169PI-4.5A                          |                 |                              |                                | -40 to 85          | 8 Ld PDIP                               |
| -                                    | -               | X5169PIZ-4.5A                         | X5169P Z AM     |                              |                                |                    | 8 Ld PDIP                               |
| X5168S8-4.5A                         | X5168 AL        | X5169S8-4.5A                          | X5169 AL        |                              |                                | 0 to 70            | 8 Ld SOIC                               |
| X5168S8Z-4.5A                        | X5168 Z AL      | X5169S8Z-4.5A                         | X5169 Z AL      |                              |                                |                    | 8 Ld SOIC                               |
| X5168S8I-4.5A*                       | X5168 AM        | X5169S8I-4.5A                         | X5169 AM        |                              |                                | -40 to 85          | 8 Ld SOIC                               |
| X5168S8IZ-4.5A*                      | X5168 Z AM      | X5169S8IZ-4.5A                        | X5169 Z AM      |                              |                                |                    | 8 Ld SOIC                               |
| X5168V14-4.5A                        |                 | X5169V14-4.5A                         |                 |                              |                                | 0 to 70            | 14 Ld TSSOP                             |
| X5168V14I-4.5A                       |                 | X5169V14I-4.5A                        |                 |                              |                                | -40 to 85          | 14 Ld TSSOP                             |
| X5168P                               | X5168P          | X5169P                                | X5169P          | 4.5-5.5                      | 4.25.4.5                       | 0 to 70            | 8 Ld PDIP                               |
| -                                    | -               | X5169PZ                               | X5169P Z        |                              |                                |                    | 8 Ld PDIP                               |
| X5168PI                              | X5168P I        | X5169PI                               | X5169P I        |                              |                                | -40 to 85          | 8 Ld PDIP                               |
| -                                    | -               | X5169PIZ                              | X5169P Z I      |                              |                                |                    | 8 Ld PDIP                               |
| X5168S8*                             | X5168           | X5169S8*                              | X5169           |                              |                                | 0 to 70            | 8 Ld SOIC                               |
| X5168S8Z*                            | X5168 Z         | X5169S8Z*                             | X5169 Z         |                              |                                |                    | 8 Ld SOIC                               |
| X5168S8I*                            | X5168 I         | X5169S8I*                             | X5169 I         |                              |                                | -40 to 85          | 8 Ld SOIC                               |
| X5168S8IZ*                           | X5168 Z I       | X5169S8IZ*                            | X5169 Z I       |                              |                                |                    | 8 Ld SOIC                               |
| X5168V14*                            | X5168V          | X5169V14*                             | X5169V          |                              |                                | 0 to 70            | 14 Ld TSSOP                             |
| X5168V14I*                           |                 | X5169V14I*                            |                 |                              |                                | -40 to 85          | 14 Ld TSSOP                             |
| X5168P-2.7A                          |                 | X5169P-2.7A                           |                 | 2.7-5.5                      | 2.85-3.0                       | 0 to 70            | 8 Ld PDIP                               |
| -                                    | -               | X5169PZ-2.7A                          | X5169P Z AN     |                              |                                |                    | 8 Ld PDIP                               |
| X5168PI-2.7A                         |                 | X5169PI-2.7A                          |                 |                              |                                | -40 to 85          | 8 Ld PDIP                               |
| -                                    | -               | X5169PIZ-2.7A                         | X5169P Z AP     |                              |                                |                    | 8 Ld PDIP                               |
| X5168S8-2.7A*                        | X5168 AN        | X5169S8-2.7A                          | X5169 AN        |                              |                                | 0 to 70            | 8 Ld SOIC                               |
| X5168S8Z-2.7A* (Note)                | X5168 Z AN      | X5169S8Z-2.7A                         | X5169 Z AN      |                              |                                |                    | 8 Ld SOIC<br>Tape and Reel<br>(Pb-free) |
| X5168S8I-2.7A                        |                 | X5169S8I-2.7A                         |                 |                              |                                | -40 to 85          | 8 Ld SOIC                               |
| X5168S8IZ-2.7A                       | X5168 Z AP      | X5169S8IZ-2.7A                        | X5169 Z AP      |                              |                                |                    | 8 Ld SOIC                               |
| X5168V14-2.7A                        |                 | X5169V14-2.7A                         |                 |                              |                                | 0 to 70            | 14 Ld TSSOP                             |
| X5168V14I-2.7A*                      |                 | X5169V14I-2.7A                        |                 |                              |                                | -40 to 85          | 14 Ld TSSOP                             |
| X5168P-2.7                           |                 | X5169P-2.7                            |                 | 2.7-5.5                      | 2.55-2.7                       | 0 to 70            | 8 Ld PDIP                               |
| -                                    | -               | X5169PZ-2.7                           | X5169P Z F      |                              |                                |                    | 8 Ld PDIP                               |
| X5168PI-2.7                          |                 | X5169PI-2.7                           |                 |                              |                                | -40 to 85          | 8 Ld PDIP                               |
| -                                    | -               | X5169PIZ-2.7                          | X5169P Z G      |                              |                                |                    | 8 Ld PDIP                               |
| X5168S8-2.7*                         | X5168 F         | X5169S8-2.7*                          | X5169 F         |                              |                                | 0 to 70            | 8 Ld SOIC                               |
| X5168S8Z-2.7*                        | X5168 Z F       | X5169S8Z-2.7*                         | X5169 Z F       |                              |                                |                    | 8 Ld SOIC                               |
| X5168S8I-2.7*                        | X5168 G         | X5169S8I-2.7*                         | X5169 G         |                              |                                | -40 to 85          | 8 Ld SOIC                               |
| X5168S8IZ-2.7*                       | X5168 Z G       | X5169S8IZ-2.7*                        | X5169 Z G       |                              |                                |                    | 8 Ld SOIC                               |
| X5168V14-2.7*                        |                 | X5169V14-2.7*                         |                 |                              |                                | 0 to 70            | 14 Ld TSSOP                             |
| X5168V14I-2.7                        |                 | X5169V14I-2.7*                        |                 |                              |                                | -40 to 85          | 14 Ld TSSOP                             |

NOTE: Intersil Pb-free plus anneal products employ special Pb-free material sets; molding compounds/die attach materials and 100% matte tin plate termination finish, which are RoHS compliant and compatible with both SnPb and Pb-free soldering operations. Intersil Pb-free products are MSL classified at Pb-free peak reflow temperatures that meet or exceed the Pb-free requirements of IPC/JEDEC J STD-020.

\*Add "-T1" suffix for tape and reel.

## X5168, X5169

### Pin Configuration



### Pin Description

| PIN<br>(SOIC/PDIP) | PIN TSSOP | NAME            | FUNCTION                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|--------------------|-----------|-----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1                  | 1         | CS              | <b>Chip Select Input.</b> $\overline{CS}$ HIGH, deselects the device and the SO output pin is at a high impedance state. Unless a nonvolatile write cycle is underway, the device will be in the standby power mode. $\overline{CS}$ LOW enables the device, placing it in the active power mode. Prior to the start of any operation after power-up, a HIGH to LOW transition on $\overline{CS}$ is required.                                                                                                                                                                                         |
| 2                  | 2         | SO              | <b>Serial Output.</b> SO is a push/pull serial data output pin. A read cycle shifts data out on this pin. The falling edge of the serial clock (SCK) clocks the data out.                                                                                                                                                                                                                                                                                                                                                                                                                              |
| 5                  | 8         | SI              | <b>Serial Input.</b> SI is a serial data input pin. Input all opcodes, byte addresses, and memory data on this pin. The rising edge of the serial clock (SCK) latches the input data. Send all opcodes (Table 1), addresses and data MSB first.                                                                                                                                                                                                                                                                                                                                                        |
| 6                  | 9         | SCK             | <b>Serial Clock.</b> The serial clock controls the serial bus timing for data input and output. The rising edge of SCK latches in the opcode, address, or data bits present on the SI pin. The falling edge of SCK changes the data output on the SO pin.                                                                                                                                                                                                                                                                                                                                              |
| 3                  | 6         | WP              | <b>Write Protect.</b> The $\overline{WP}$ pin works in conjunction with a nonvolatile WPEN bit to "lock" the setting of the watchdog timer control and the memory write protect bits.                                                                                                                                                                                                                                                                                                                                                                                                                  |
| 4                  | 7         | $V_{SS}$        | Ground                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| 8                  | 14        | $V_{CC}$        | Supply Voltage                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| 7                  | 13        | RESET/<br>RESET | <b>Reset Output.</b> RESET/RESET is an active LOW/HIGH, open drain output which goes active whenever $V_{CC}$ falls below the minimum $V_{CC}$ sense level. It will remain active until $V_{CC}$ rises above the minimum $V_{CC}$ sense level for 200ms. RESET/RESET goes active if the watchdog timer is enabled and $\overline{CS}$ remains either HIGH or LOW longer than the selectable watchdog time out period. A falling edge of $\overline{CS}$ will reset the watchdog timer. RESET/RESET goes active on power-up at about 1V and remains active for 200ms after the power supply stabilizes. |
|                    | 3-5,10-12 | NC              | No internal connections                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |

## Principles of Operation

### Power-on Reset

Application of power to the X5168, X5169 activates a power-on reset circuit. This circuit goes active at about 1V and pulls the  $\overline{\text{RESET}}/\text{RESET}$  pin active. This signal prevents the system microprocessor from starting to operate with insufficient voltage or prior to stabilization of the oscillator. When  $V_{CC}$  exceeds the device  $V_{TRIP}$  value for 200ms (nominal) the circuit releases  $\overline{\text{RESET}}/\text{RESET}$ , allowing the processor to begin executing code.

### Low Voltage Monitoring

During operation, the X5168, X5169 monitors the  $V_{CC}$  level and asserts  $\overline{\text{RESET}}/\text{RESET}$  if supply voltage falls below a preset minimum  $V_{TRIP}$ . The  $\overline{\text{RESET}}/\text{RESET}$  signal prevents the microprocessor from operating in a power fail or brownout condition. The  $\overline{\text{RESET}}/\text{RESET}$  signal remains active until the voltage drops below 1V. It also remains active until  $V_{CC}$  returns and exceeds  $V_{TRIP}$  for 200ms.

### $V_{CC}$ Threshold Reset Procedure

The X5168, X5169 has a standard  $V_{CC}$  threshold ( $V_{TRIP}$ ) voltage. This value will not change over normal operating and storage conditions. However, in applications where the standard  $V_{TRIP}$  is not exactly right, or for higher precision in the  $V_{TRIP}$  value, the X5168, X5169 threshold may be adjusted.

### Setting the $V_{TRIP}$ Voltage

This procedure sets the  $V_{TRIP}$  to a higher voltage value. For example, if the current  $V_{TRIP}$  is 4.4V and the new  $V_{TRIP}$  is 4.6V, this procedure directly makes the change. If the new setting is lower than the current setting, then it is necessary to reset the trip point before setting the new value.

To set the new  $V_{TRIP}$  voltage, apply the desired  $V_{TRIP}$  threshold to the  $V_{CC}$  pin and tie the  $\overline{\text{CS}}$  pin and the  $\overline{\text{WP}}$  pin HIGH.  $\overline{\text{RESET}}/\text{RESET}$  and  $\text{SO}$  pins are left unconnected. Then apply the programming voltage  $V_P$  to both SCK and SI and pulse  $\overline{\text{CS}}$  LOW then HIGH. Remove  $V_P$  and the sequence is complete.

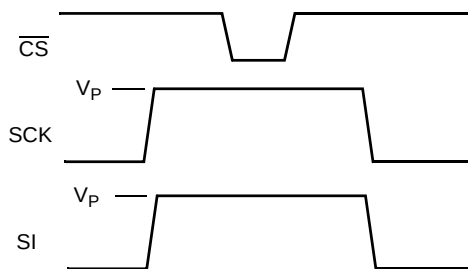


FIGURE 1. SET  $V_{TRIP}$  VOLTAGE

### Resetting the $V_{TRIP}$ Voltage

This procedure sets the  $V_{TRIP}$  to a "native" voltage level. For example, if the current  $V_{TRIP}$  is 4.4V and the  $V_{TRIP}$  is reset, the new  $V_{TRIP}$  is something less than 1.7V. This procedure must be used to set the voltage to a lower value.

To reset the  $V_{TRIP}$  voltage, apply a voltage between 2.7 and 5.5V to the  $V_{CC}$  pin. Tie the  $\overline{\text{CS}}$  pin, the  $\overline{\text{WP}}$  pin, and the SCK pin HIGH.  $\overline{\text{RESET}}/\text{RESET}$  and  $\text{SO}$  pins are left unconnected. Then apply the programming voltage  $V_P$  to the SI pin ONLY and pulse  $\overline{\text{CS}}$  LOW then HIGH. Remove  $V_P$  and the sequence is complete.

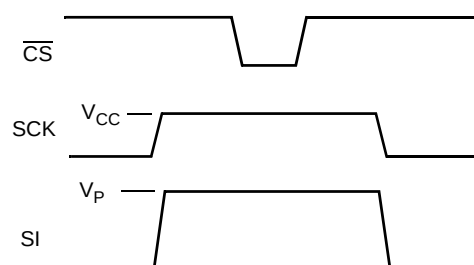
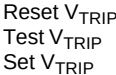
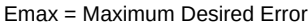


FIGURE 2. RESET  $V_{TRIP}$  VOLTAGE



#### FIGURE 4. SAMPLE $V_{TRIP}$ RESET CIRCUIT

## X5168, X5169

### SPI Serial Memory

The memory portion of the device is a CMOS serial EEPROM array with Intersil's block lock protection. The array is internally organized as x 8. The device features a Serial Peripheral Interface (SPI) and software protocol allowing operation on a simple four-wire bus.

The device utilizes Intersil's proprietary Direct Write™ cell, providing a minimum endurance of 100,000 cycles and a minimum data retention of 100 years.

The device is designed to interface directly with the synchronous Serial Peripheral Interface (SPI) of many popular microcontroller families. It contains an 8-bit instruction register that is accessed via the SI input, with data being clocked in on the rising edge of SCK. CS must be LOW during the entire operation.

All instructions (Table 1), addresses and data are transferred MSB first. Data input on the SI line is latched on the first rising edge of SCK after CS goes LOW. Data is output on the SO line by the falling edge of SCK. SCK is static, allowing the user to stop the clock and then start it again to resume operations where left off.

### Write Enable Latch

The device contains a write enable latch. This latch must be SET before a write operation is initiated. The WREN instruction will set the latch and the WRDI instruction will reset the latch (Figure 3). This latch is automatically reset upon a power-up condition and after the completion of a valid write cycle.

### Status Register

The RDSR instruction provides access to the status register. The status register may be read at any time, even during a write cycle. The status register is formatted as follows:

| 7    | 6   | 5 | 4 | 3   | 2   | 1   | 0   |
|------|-----|---|---|-----|-----|-----|-----|
| WPEN | FLB | 0 | 0 | BL1 | BL0 | WEL | WIP |

The Write-In-Progress (WIP) bit is a volatile, read only bit and indicates whether the device is busy with an internal nonvolatile write operation. The WIP bit is read using the RDSR instruction. When set to a "1", a nonvolatile write operation is in progress. When set to a "0", no write is in progress.

TABLE 1. INSTRUCTION SET

| INSTRUCTION NAME | INSTRUCTION FORMAT* | OPERATION                                                      |
|------------------|---------------------|----------------------------------------------------------------|
| WREN             | 0000 0110           | Set the write enable latch (enable write operations)           |
| SFLB             | 0000 0000           | Set flag bit                                                   |
| WRDI/RFLB        | 0000 0100           | Reset the write enable latch/reset flag bit                    |
| RSDR             | 0000 0101           | Read status register                                           |
| WRSR             | 0000 0001           | Write status register (watchdog, block lock, WPEN & flag bits) |
| READ             | 0000 0011           | Read data from memory array beginning at selected address      |
| WRITE            | 0000 0010           | Write data to memory array beginning at selected address       |

Note: \*Instructions are shown MSB in leftmost position. Instructions are transferred MSB first.

TABLE 2. BLOCK PROTECT MATRIX

| WREN CMD | STATUS REGISTER | DEVICE PIN | BLOCK           | BLOCK             | STATUS REGISTER         |
|----------|-----------------|------------|-----------------|-------------------|-------------------------|
| WEL      | WPEN            | WP#        | PROTECTED BLOCK | UNPROTECTED BLOCK | WPEN, BL0, BL1 WD0, WD1 |
| 0        | X               | X          | Protected       | Protected         | Protected               |
| 1        | 1               | 0          | Protected       | Writable          | Protected               |
| 1        | 0               | X          | Protected       | Writable          | Writable                |
| 1        | X               | 1          | Protected       | Writable          | Writable                |

## X5168, X5169

The Write Enable Latch (WEL) bit indicates the status of the write enable latch. When WEL = 1, the latch is set HIGH and when WEL = 0 the latch is reset LOW. The WEL bit is a volatile, read only bit. It can be set by the WREN instruction and can be reset by the WRDS instruction.

The block lock bits, BL0 and BL1, set the level of block lock protection. These nonvolatile bits are programmed using the WRSR instruction and allow the user to protect one quarter, one half, all or none of the EEPROM array. Any portion of the array that is block lock protected can be read but not written. It will remain protected until the BL bits are altered to disable block lock protection of that portion of memory.

| STATUS REGISTER BITS |     | ARRAY ADDRESSES PROTECTED |
|----------------------|-----|---------------------------|
| BL1                  | BL0 | X5168/X5169               |
| 0                    | 0   | None                      |
| 0                    | 1   | \$0600-\$07FF             |
| 1                    | 0   | \$0400-\$07FF             |
| 1                    | 1   | \$0000-\$07FF             |

The FLAG bit shows the status of a volatile latch that can be set and reset by the system using the SFLB and RFLB instructions. The flag bit is automatically reset upon power-up.

The nonvolatile WPEN bit is programmed using the WRSR instruction. This bit works in conjunction with the  $\overline{WP}$  pin to provide an in-circuit programmable ROM function (Table 2).

$\overline{WP}$  is LOW and WPEN bit programmed HIGH disables all status register write operations.

### In Circuit Programmable ROM Mode

This mechanism protects the block lock and watchdog bits from inadvertent corruption.

In the locked state (programmable ROM mode) the  $\overline{WP}$  pin is LOW and the nonvolatile bit WPEN is "1". This mode disables nonvolatile writes to the device's status register.

Setting the  $\overline{WP}$  pin LOW while WPEN is a "1" while an internal write cycle to the status register is in progress will not stop this write operation, but the operation disables subsequent write attempts to the status register.

When  $\overline{WP}$  is HIGH, all functions, including nonvolatile writes to the status register operate normally. Setting the WPEN bit in the status register to "0" blocks the  $\overline{WP}$  pin function, allowing writes to the status register when  $\overline{WP}$  is HIGH or LOW. Setting the WPEN bit to "1" while the  $\overline{WP}$  pin is LOW activates the programmable ROM mode, thus requiring a change in the  $\overline{WP}$  pin prior to subsequent status register changes. This allows manufacturing to install the device in a system with  $\overline{WP}$  pin grounded and still be able to program the status register. Manufacturing can then load configuration data, manufacturing time and other parameters into the EEPROM, then set the portion of memory to be protected by setting the block lock bits, and finally set the "OTP mode" by setting the WPEN bit. Data changes now require a hardware change.

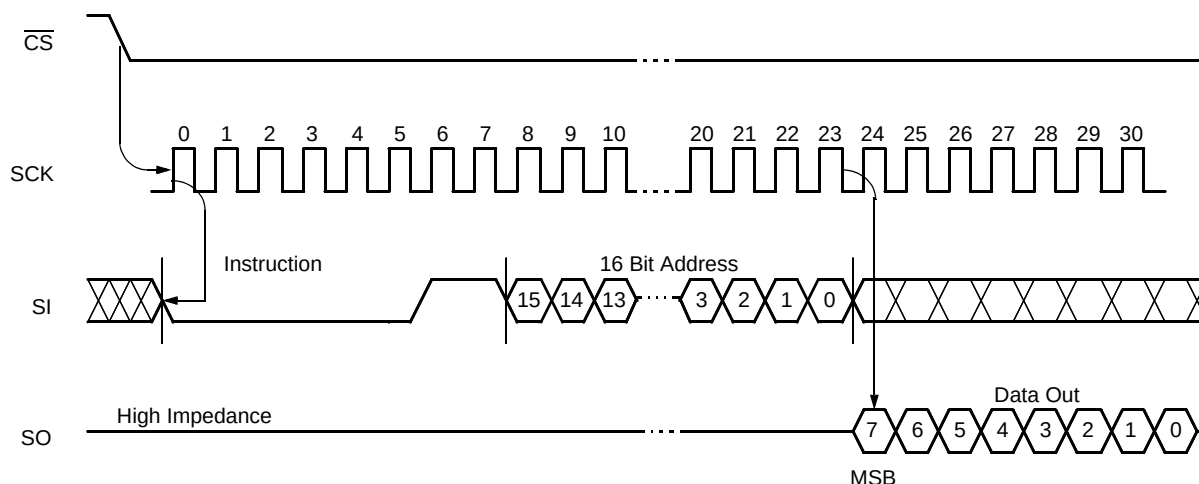


FIGURE 5. READ EEPROM ARRAY SEQUENCE

### Read Sequence

When reading from the EEPROM memory array,  $\overline{CS}$  is first pulled low to select the device. The 8-bit READ instruction is transmitted to the device, followed by the 16-bit address. After the READ opcode and address are sent, the data stored in the memory at the selected address is shifted out on the SO line. The data stored in memory at the next address can be read sequentially by continuing to provide clock pulses. The address is automatically incremented to the next higher address after each byte of data is shifted out. When the highest address is reached, the address counter rolls over to address \$0000 allowing the read cycle to be continued indefinitely. The read operation is terminated by taking  $\overline{CS}$  high. Refer to the read EEPROM array sequence (Figure 1).

To read the status register, the  $\overline{CS}$  line is first pulled low to select the device followed by the 8-bit RDSR instruction. After the RDSR opcode is sent, the contents of the status register are shifted out on the SO line. Refer to the read status register sequence (Figure 2).

### Write Sequence

Prior to any attempt to write data into the device, the "Write Enable" Latch (WEL) must first be set by issuing the WREN instruction (Figure 3).  $\overline{CS}$  is first taken LOW, then the WREN instruction is clocked into the device. After all eight bits of the instruction are transmitted,  $\overline{CS}$  must then be taken HIGH. If the user continues the write operation without taking  $\overline{CS}$  HIGH after issuing the WREN instruction, the write operation will be ignored.

To write data to the EEPROM memory array, the user then issues the WRITE instruction followed by the 16 bit address and then the data to be written. Any unused address bits are specified to be "0's". The WRITE operation minimally takes 32 clocks.  $\overline{CS}$  must go low and remain low for the duration of the operation. If the address counter reaches the end of a page and the clock continues, the counter will roll back to the first address of the page and overwrite any data that may have been previously written.

For the page write operation (byte or page write) to be completed,  $\overline{CS}$  can only be brought HIGH after bit 0 of the last data byte to be written is clocked in. If it is brought HIGH at any other time, the write operation will not be completed (Figure 4).

To write to the status register, the WRSR instruction is followed by the data to be written (Figure 5). Data bits 0 and 1 must be "0".

While the write is in progress following a status register or EEPROM sequence, the status register may be read to check the WIP bit. During this time the WIP bit will be high.

### Operational Notes

The device powers-up in the following state:

- The device is in the low power standby state.
- A HIGH to LOW transition on  $\overline{CS}$  is required to enter an active state and receive an instruction.
- SO pin is high impedance.
- The write enable latch is reset.
- The flag bit is reset.
- Reset signal is active for  $t_{PURST}$ .

### Data Protection

The following circuitry has been included to prevent inadvertent writes:

- A WREN instruction must be issued to set the write enable latch.
- $\overline{CS}$  must come HIGH at the proper clock count in order to start a nonvolatile write cycle.



## X5168, X5169

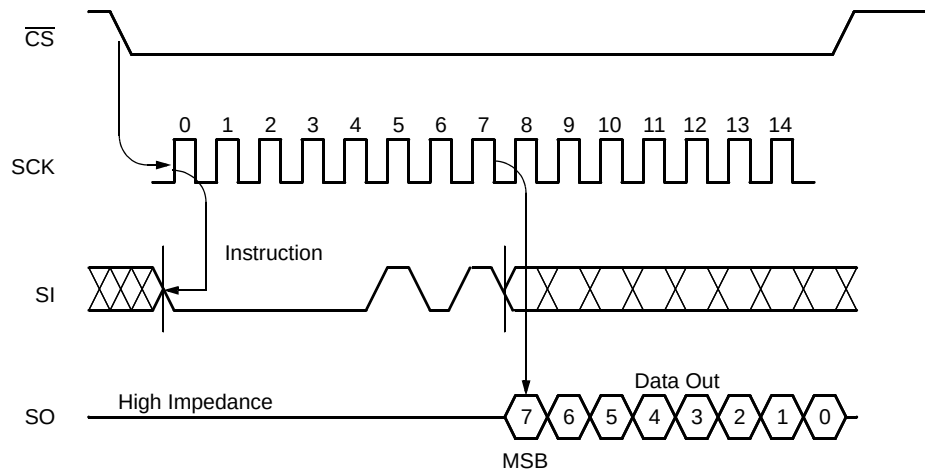


FIGURE 6. READ STATUS REGISTER SEQUENCE

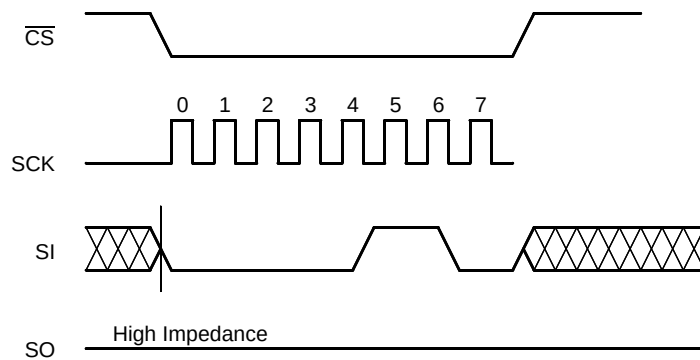


FIGURE 7. WRITE ENABLE LATCH SEQUENCE

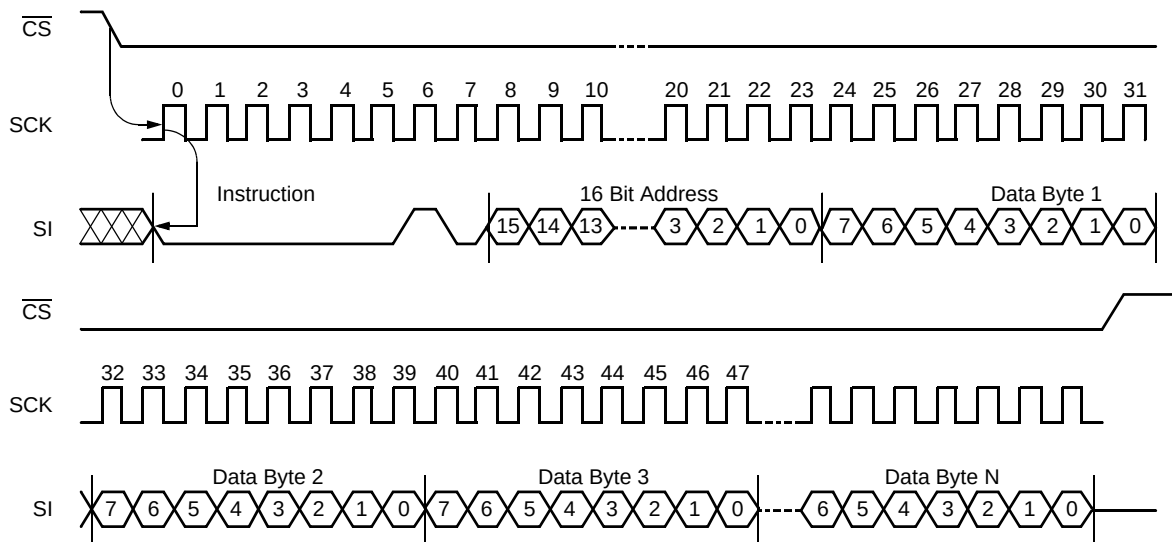


FIGURE 8. WRITE SEQUENCE

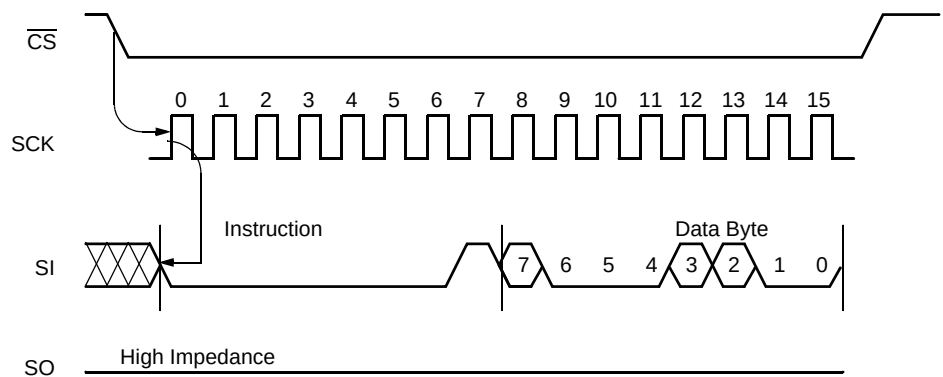


FIGURE 9. STATUS REGISTER WRITE SEQUENCE

Symbol Table

| WAVEFORM | INPUTS                      | OUTPUTS                       |
|----------|-----------------------------|-------------------------------|
|          | Must be steady              | Will be steady                |
|          | May change from LOW to HIGH | Will change from LOW to HIGH  |
|          | May change from HIGH to LOW | Will change from HIGH to LOW  |
|          | Don't Care: Changes Allowed | Changing: State Not Known     |
|          | N/A                         | Center Line is High Impedance |

## X5168, X5169

### Absolute Maximum Ratings

|                                                    |                 |
|----------------------------------------------------|-----------------|
| Temperature Under Bias                             | -65°C to +135°C |
| Storage Temperature                                | -65°C to +150°C |
| Voltage on any Pin with Respect to V <sub>SS</sub> | -1.0V to +7V    |
| DC Output Current                                  | 5mA             |
| Lead Temperature (Soldering, 10s)                  | 300°C           |

### Recommended Operating Conditions

|                       |                |
|-----------------------|----------------|
| Temperature Range     |                |
| Commercial            | 0°C to +70°C   |
| Industrial            | -40°C to +85°C |
| Supply Voltage Limits |                |
| -2.7 or -2.7A         | 2.7V to 5.5V   |
| Blank or -4.5A        | 4.5V-5.5V      |

**CAUTION:** Stresses above those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress rating only; the functional operation of the device (at these or any other conditions above those listed in the operational sections of this specification) is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability

### DC Electrical Specifications Over the recommended operating conditions unless otherwise specified.

| SYMBOL                      | PARAMETER                                 | TEST CONDITIONS                                                                                             | LIMITS                |     |                       | UNIT |
|-----------------------------|-------------------------------------------|-------------------------------------------------------------------------------------------------------------|-----------------------|-----|-----------------------|------|
|                             |                                           |                                                                                                             | MIN                   | TYP | MAX                   |      |
| I <sub>CC1</sub>            | V <sub>CC</sub> write current (active)    | SCK = V <sub>CC</sub> x 0.1/V <sub>CC</sub> x 0.9 @ 2MHz,<br>SO = Open                                      |                       |     | 5                     | mA   |
| I <sub>CC2</sub>            | V <sub>CC</sub> read current (active)     | SCK = V <sub>CC</sub> x 0.1/V <sub>CC</sub> x 0.9 @ 2MHz,<br>SO = Open                                      |                       |     | 0.4                   | mA   |
| I <sub>SB</sub>             | V <sub>CC</sub> standby current WDT = OFF | $\overline{CS} = V_{CC}$ , V <sub>IN</sub> = V <sub>SS</sub> or V <sub>CC</sub> ,<br>V <sub>CC</sub> = 5.5V |                       |     | 1                     | μA   |
| I <sub>LI</sub>             | Input leakage current                     | V <sub>IN</sub> = V <sub>SS</sub> to V <sub>CC</sub>                                                        |                       | 0.1 | 10                    | μA   |
| I <sub>LO</sub>             | Output leakage current                    | V <sub>OUT</sub> = V <sub>SS</sub> to V <sub>CC</sub>                                                       |                       | 0.1 | 10                    | μA   |
| V <sub>IL</sub><br>(NOTE 1) | Input LOW voltage                         |                                                                                                             | -0.5                  |     | V <sub>CC</sub> x 0.3 | V    |
| V <sub>IH</sub><br>(NOTE 1) | Input HIGH voltage                        |                                                                                                             | V <sub>CC</sub> x 0.7 |     | V <sub>CC</sub> + 0.5 | V    |
| V <sub>OL1</sub>            | Output LOW voltage                        | V <sub>CC</sub> > 3.3V, I <sub>OL</sub> = 2.1mA                                                             |                       |     | 0.4                   | V    |
| V <sub>OL2</sub>            | Output LOW voltage                        | 2V < V <sub>CC</sub> ≤ 3.3V, I <sub>OL</sub> = 1mA                                                          |                       |     | 0.4                   | V    |
| V <sub>OL3</sub>            | Output LOW voltage                        | V <sub>CC</sub> ≤ 2V, I <sub>OL</sub> = 0.5mA                                                               |                       |     | 0.4                   | V    |
| V <sub>OH1</sub>            | Output HIGH voltage                       | V <sub>CC</sub> > 3.3V, I <sub>OH</sub> = -1.0mA                                                            | V <sub>CC</sub> - 0.8 |     |                       | V    |
| V <sub>OH2</sub>            | Output HIGH voltage                       | 2V < V <sub>CC</sub> ≤ 3.3V, I <sub>OH</sub> = -0.4mA                                                       | V <sub>CC</sub> - 0.4 |     |                       | V    |
| V <sub>OH3</sub>            | Output HIGH voltage                       | V <sub>CC</sub> ≤ 2V, I <sub>OH</sub> = -0.25mA                                                             | V <sub>CC</sub> - 0.2 |     |                       | V    |
| V <sub>OLS</sub>            | Reset output LOW voltage                  | I <sub>OL</sub> = 1mA                                                                                       |                       |     | 0.4                   | V    |

### Capacitance T<sub>A</sub> = +25°C, f = 1MHz, V<sub>CC</sub> = 5V.

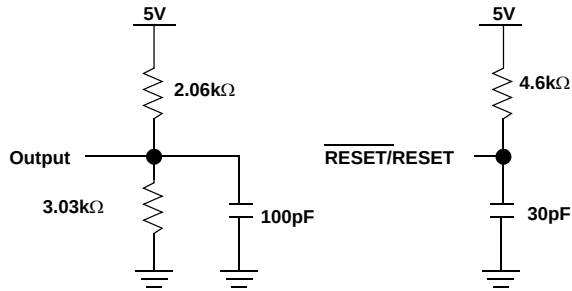
| SYMBOL                       | TEST                                                            | CONDITIONS            | MAX. | UNIT |
|------------------------------|-----------------------------------------------------------------|-----------------------|------|------|
| C <sub>OUT</sub><br>(NOTE 2) | Output capacitance (SO, $\overline{RESET}$ /RESET)              | V <sub>OUT</sub> = 0V | 8    | pF   |
| C <sub>IN</sub> (NOTE 2)     | Input capacitance (SCK, SI, $\overline{CS}$ , $\overline{WP}$ ) | V <sub>IN</sub> = 0V  | 6    | pF   |

#### NOTES:

- V<sub>IL</sub> min. and V<sub>IH</sub> max. are for reference only and are not tested.
- This parameter is periodically sampled and not 100% tested.

## X5168, X5169

### Equivalent A.C. Load Circuit at 5V $V_{CC}$



### A.C. Test Conditions

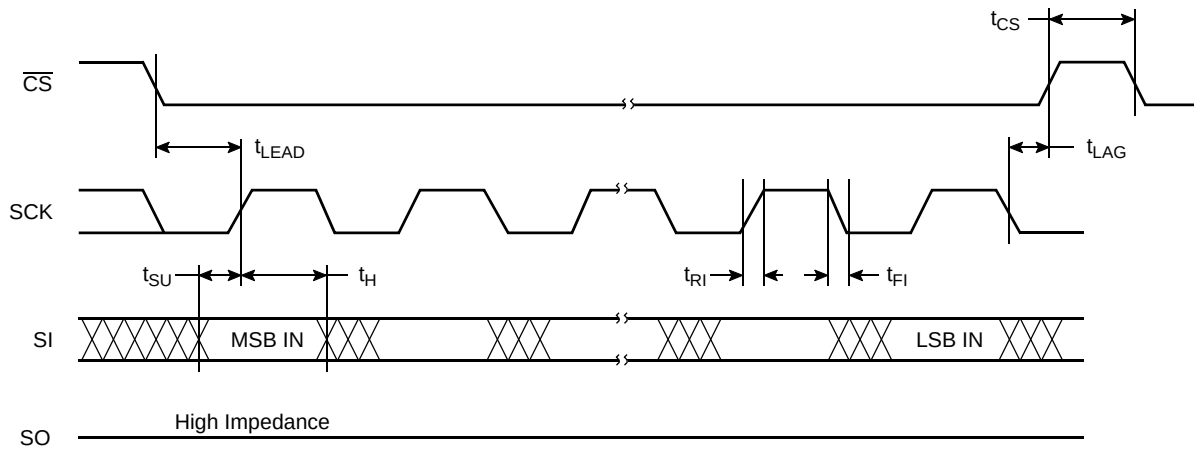
|                               |                                            |
|-------------------------------|--------------------------------------------|
| Input pulse levels            | $V_{CC} \times 0.1$ to $V_{CC} \times 0.9$ |
| Input rise and fall times     | 10ns                                       |
| Input and output timing level | $V_{CC} \times 0.5$                        |

### AC Electrical Specifications (Over recommended operating conditions, unless otherwise specified.)

| SYMBOL                         | PARAMETER                     | 2.7-5.5V |     | UNIT |
|--------------------------------|-------------------------------|----------|-----|------|
|                                |                               | MIN      | MAX |      |
| SERIAL INPUT TIMING            |                               |          |     |      |
| f <sub>SCK</sub>               | Clock frequency               | 0        | 2   | MHz  |
| t <sub>CYC</sub>               | Cycle time                    | 500      |     | ns   |
| t <sub>LEAD</sub>              | $\overline{CS}$ lead time     | 250      |     | ns   |
| t <sub>LAG</sub>               | $\overline{CS}$ lag time      | 250      |     | ns   |
| t <sub>WH</sub>                | Clock HIGH time               | 200      |     | ns   |
| t <sub>WL</sub>                | Clock LOW time                | 200      |     | ns   |
| t <sub>SU</sub>                | Data setup time               | 50       |     | ns   |
| t <sub>H</sub>                 | Data hold time                | 50       |     | ns   |
| t <sub>RI</sub> <sup>(3)</sup> | Input rise time               |          | 100 | ns   |
| t <sub>FI</sub> <sup>(3)</sup> | Input fall time               |          | 100 | ns   |
| t <sub>CS</sub>                | $\overline{CS}$ deselect time | 500      |     | ns   |
| t <sub>WC</sub> <sup>(4)</sup> | Write cycle time              |          | 10  | ms   |

## X5168, X5169

### Serial Input Timing



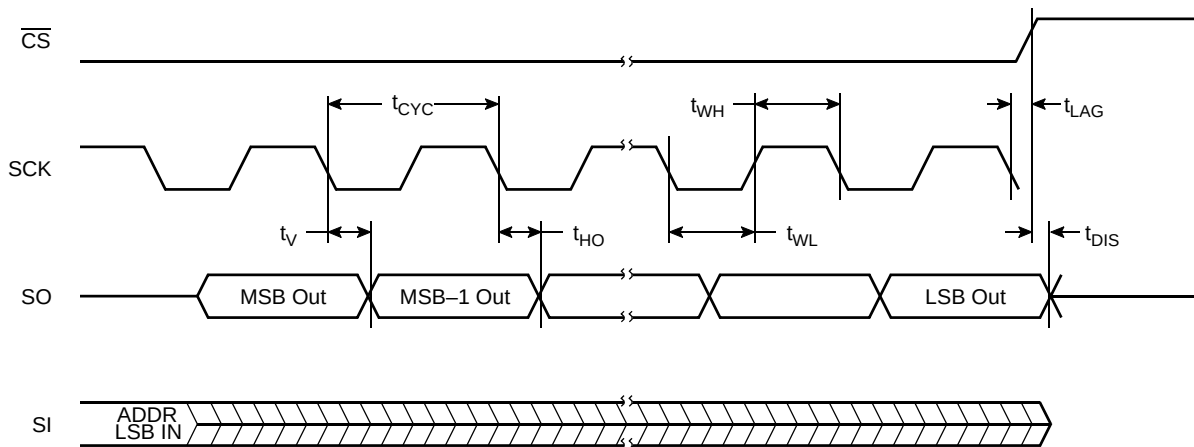
### Serial Output Timing

| SYMBOL         | PARAMETER                   | 2.7-5.5V |     | UNIT |
|----------------|-----------------------------|----------|-----|------|
|                |                             | MIN      | MAX |      |
| $f_{SCK}$      | Clock frequency             | 0        | 2   | MHz  |
| $t_{DIS}$      | Output disable time         |          | 250 | ns   |
| $t_V$          | Output valid from clock low |          | 200 | ns   |
| $t_{HO}$       | Output hold time            | 0        |     | ns   |
| $t_{RO}^{(3)}$ | Output rise time            |          | 100 | ns   |
| $t_{FO}^{(3)}$ | Output fall time            |          | 100 | ns   |

Notes: (3) This parameter is periodically sampled and not 100% tested.

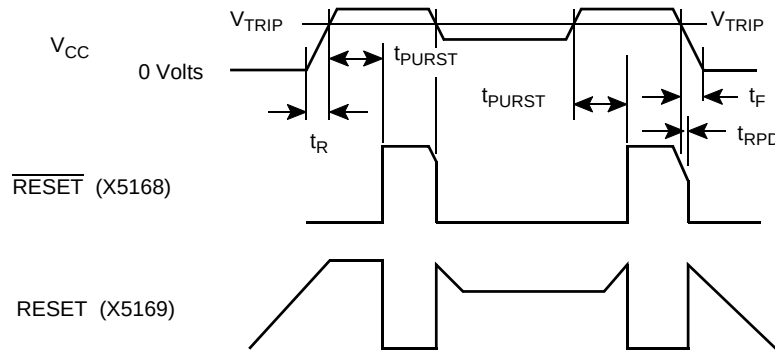
(4)  $t_{WC}$  is the time from the rising edge of CS after a valid write sequence has been sent to the end of the self-timed internal nonvolatile write cycle.

### Serial Output Timing



## X5168, X5169

### Power-Up and Power-Down Timing

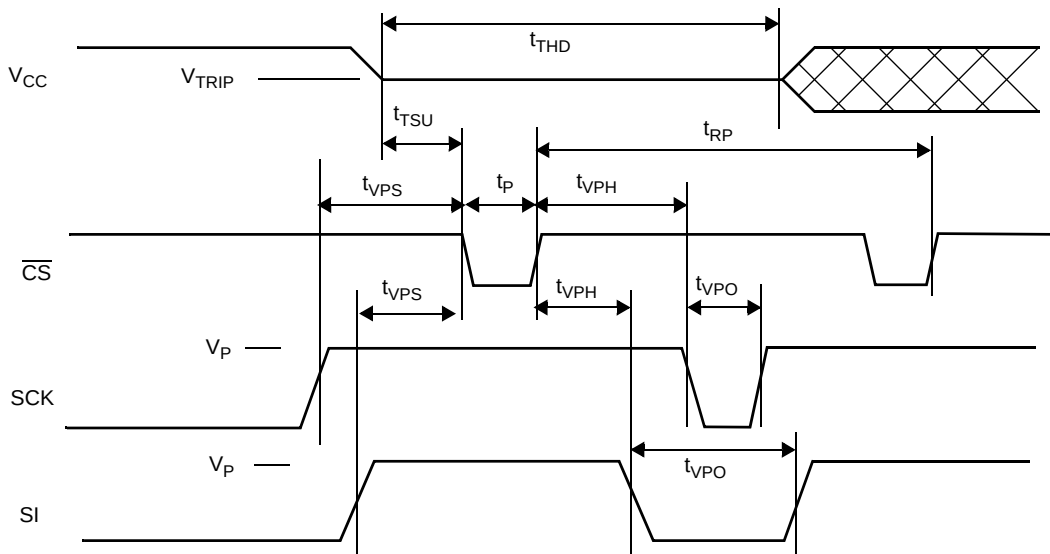


### RESET Output Timing

| SYMBOL          | PARAMETER                                                                                                                                                                                        | MIN                         | TYP                          | MAX                       | UNIT    |
|-----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------|------------------------------|---------------------------|---------|
| $V_{TRIP}$      | Reset trip point voltage, X5168-4.5A, X5168-4.5A<br>Reset trip point voltage, X5168, X5169<br>Reset trip point voltage, X5168-2.7A, X5169-2.7A<br>Reset trip point voltage, X5168-2.7, X5169-2.7 | 4.5<br>4.25<br>2.85<br>2.55 | 4.63<br>4.38<br>2.93<br>2.63 | 4.75<br>4.5<br>3.0<br>2.7 | V       |
| $V_{TH}$        | $V_{TRIP}$ hysteresis (HIGH to LOW vs. LOW to HIGH $V_{TRIP}$ voltage)                                                                                                                           |                             | 20                           |                           | mV      |
| $t_{PURST}$     | Power-up reset time out                                                                                                                                                                          | 100                         | 200                          | 280                       | ms      |
| $t_{RPD}^{(5)}$ | $V_{CC}$ detect to reset/output                                                                                                                                                                  |                             |                              | 500                       | ns      |
| $t_F^{(5)}$     | $V_{CC}$ fall time                                                                                                                                                                               | 100                         |                              |                           | $\mu$ s |
| $t_R^{(5)}$     | $V_{CC}$ rise time                                                                                                                                                                               | 100                         |                              |                           | $\mu$ s |
| $V_{RVALID}$    | Reset valid $V_{CC}$                                                                                                                                                                             | 1                           |                              |                           | V       |

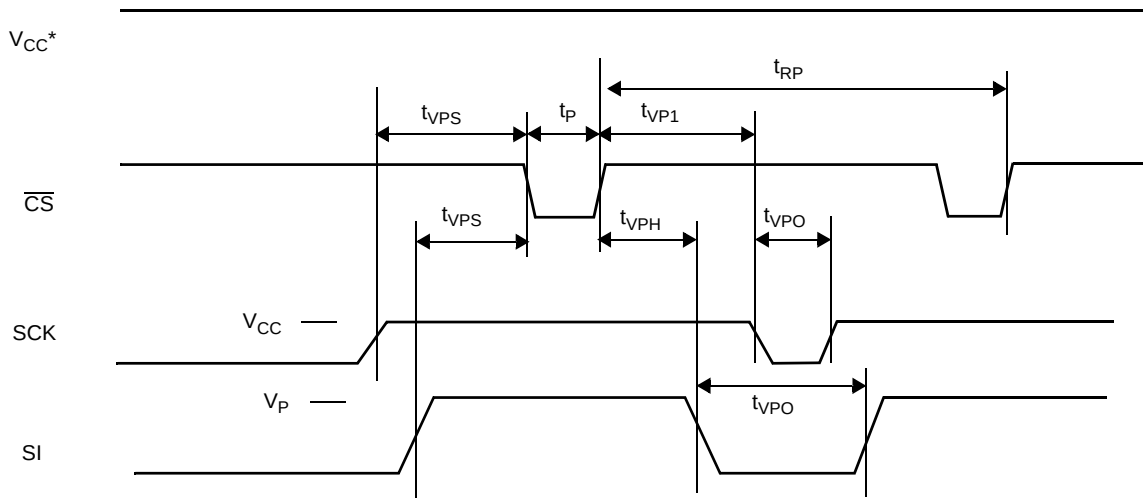
Note: (5) This parameter is periodically sampled and not 100% tested.

### $V_{TRIP}$ Set Conditions



## X5168, X5169

### $V_{TRIP}$ Reset Conditions



\* $V_{CC} > \text{Programmed } V_{TRIP}$

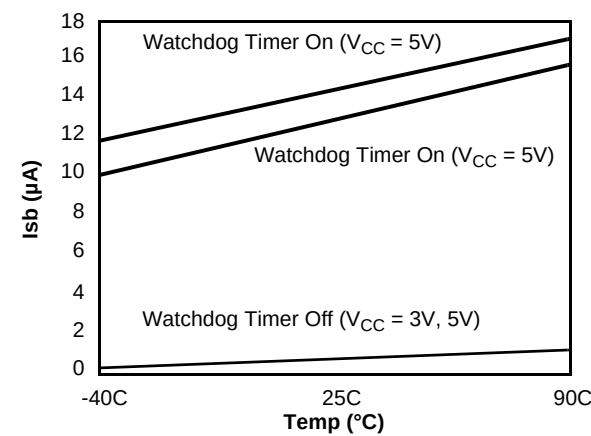
### $V_{TRIP}$ Programming Specifications $V_{CC} = 1.7\text{-}5.5\text{V}$ ; Temperature = $0^\circ\text{C}$ to $70^\circ\text{C}$

| PARAMETER  | DESCRIPTION                                                                                                                       | MIN  | MAX  | UNIT          |
|------------|-----------------------------------------------------------------------------------------------------------------------------------|------|------|---------------|
| $t_{VPS}$  | SCK $V_{TRIP}$ program voltage setup time                                                                                         | 1    |      | $\mu\text{s}$ |
| $t_{VPH}$  | SCK $V_{TRIP}$ program voltage hold time                                                                                          | 1    |      | $\mu\text{s}$ |
| $t_P$      | $V_{TRIP}$ program pulse width                                                                                                    | 1    |      | $\mu\text{s}$ |
| $t_{TSU}$  | $V_{TRIP}$ level setup time                                                                                                       | 10   |      | $\mu\text{s}$ |
| $t_{THD}$  | $V_{TRIP}$ level hold (stable) time                                                                                               | 10   |      | ms            |
| $t_{WC}$   | $V_{TRIP}$ write cycle time                                                                                                       |      | 10   | ms            |
| $t_{RP}$   | $V_{TRIP}$ program cycle recovery period (between successive programming cycles)                                                  | 10   |      | ms            |
| $t_{VPO}$  | SCK $V_{TRIP}$ program voltage off time before next cycle                                                                         | 0    |      | ms            |
| $V_P$      | Programming voltage                                                                                                               | 15   | 18   | V             |
| $V_{TRAN}$ | $V_{TRIP}$ programmed voltage range                                                                                               | 1.7  | 5.0  | V             |
| $V_{ta1}$  | Initial $V_{TRIP}$ program voltage accuracy ( $V_{CC}$ applied- $V_{TRIP}$ ) (programmed at $25^\circ\text{C}$ )                  | -0.1 | +0.4 | V             |
| $V_{ta2}$  | Subsequent $V_{TRIP}$ program voltage accuracy [ $(V_{CC}$ applied- $V_{ta1}$ )- $V_{TRIP}$ ] (programmed at $25^\circ\text{C}$ ) | -25  | +25  | mV            |
| $V_{tr}$   | $V_{TRIP}$ program voltage repeatability (successive program operations) (programmed at $25^\circ\text{C}$ )                      | -25  | +25  | mV            |
| $V_{tv}$   | $V_{TRIP}$ Program variation after programming ( $0\text{-}75^\circ\text{C}$ ). (programmed at $25^\circ\text{C}$ )               | -25  | +25  | mV            |

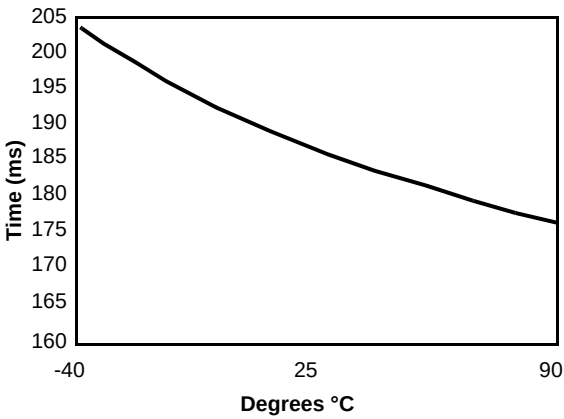
$V_{TRIP}$  programming parameters are periodically sampled and are not 100% tested.

Typical Performance

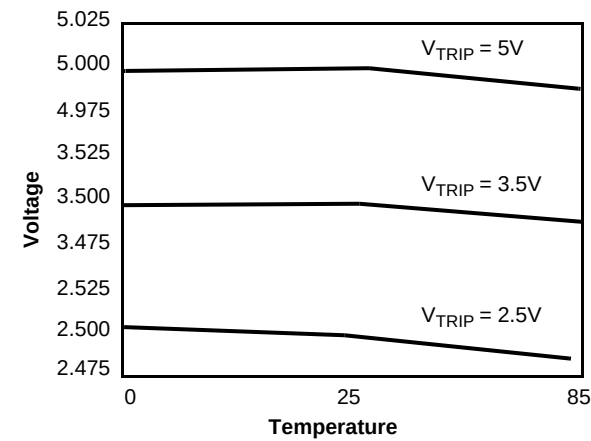
V<sub>CC</sub> Supply Current vs. Temperature (I<sub>SB</sub>)



t<sub>PURST</sub> vs. Temperature



V<sub>TRIP</sub> vs. Temperature (programmed at 25°C)

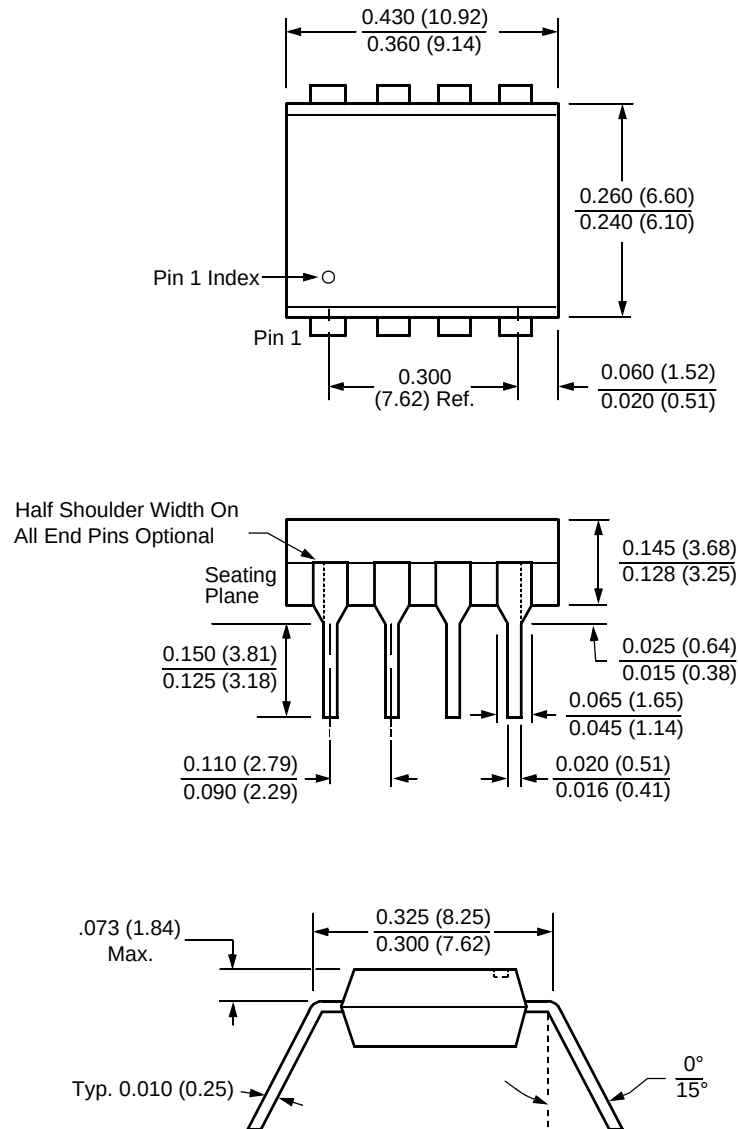




## X5168, X5169

### Packaging Information

#### 8-Lead Plastic Dual In-Line Package Type P

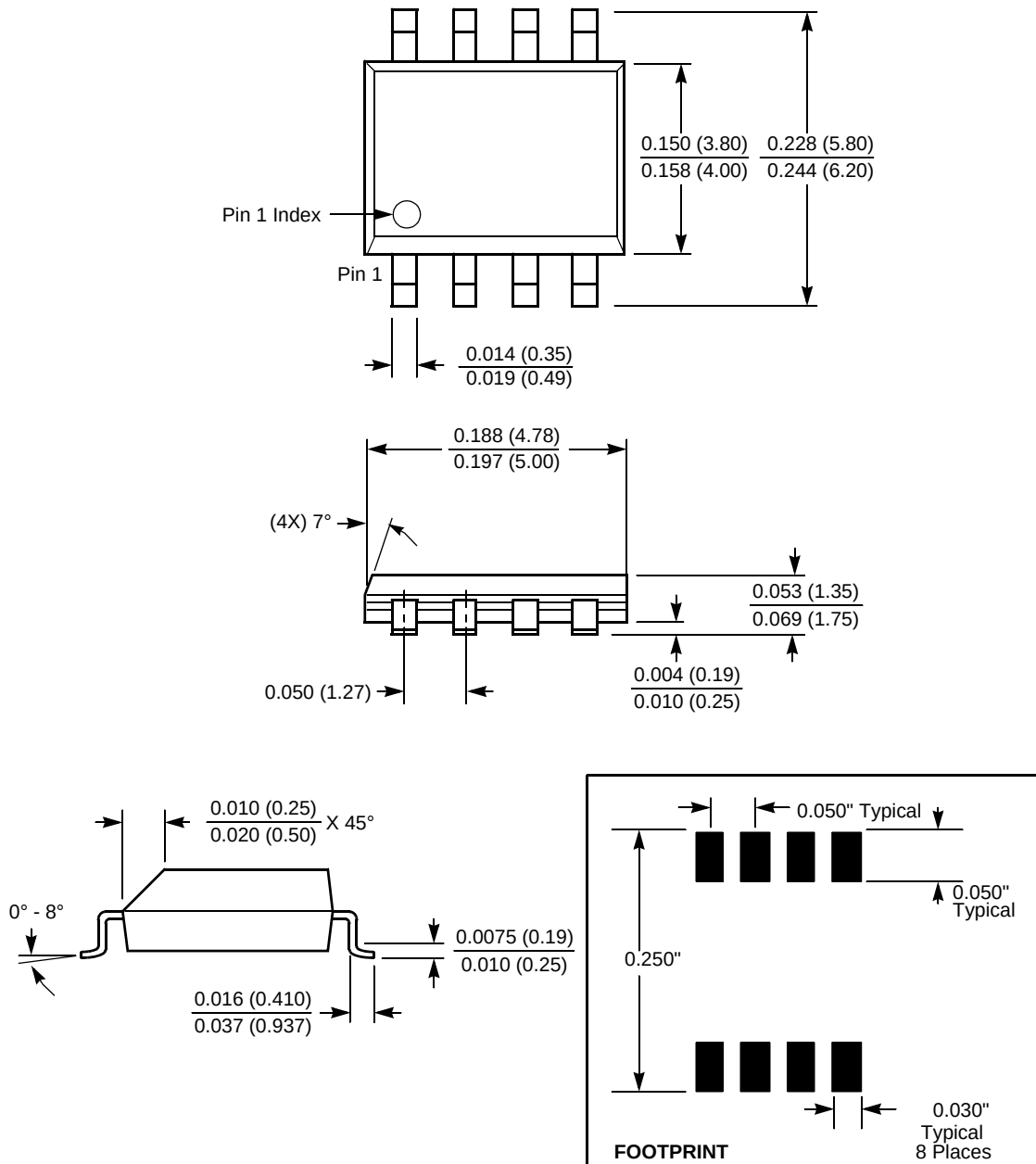


#### NOTE:

1. ALL DIMENSIONS IN INCHES (IN PARENTHESES IN MILLIMETERS)
2. PACKAGE DIMENSIONS EXCLUDE MOLDING FLASH

**Packaging Information**

**8-Lead Plastic Small Outline Gull Wing Package Type S**

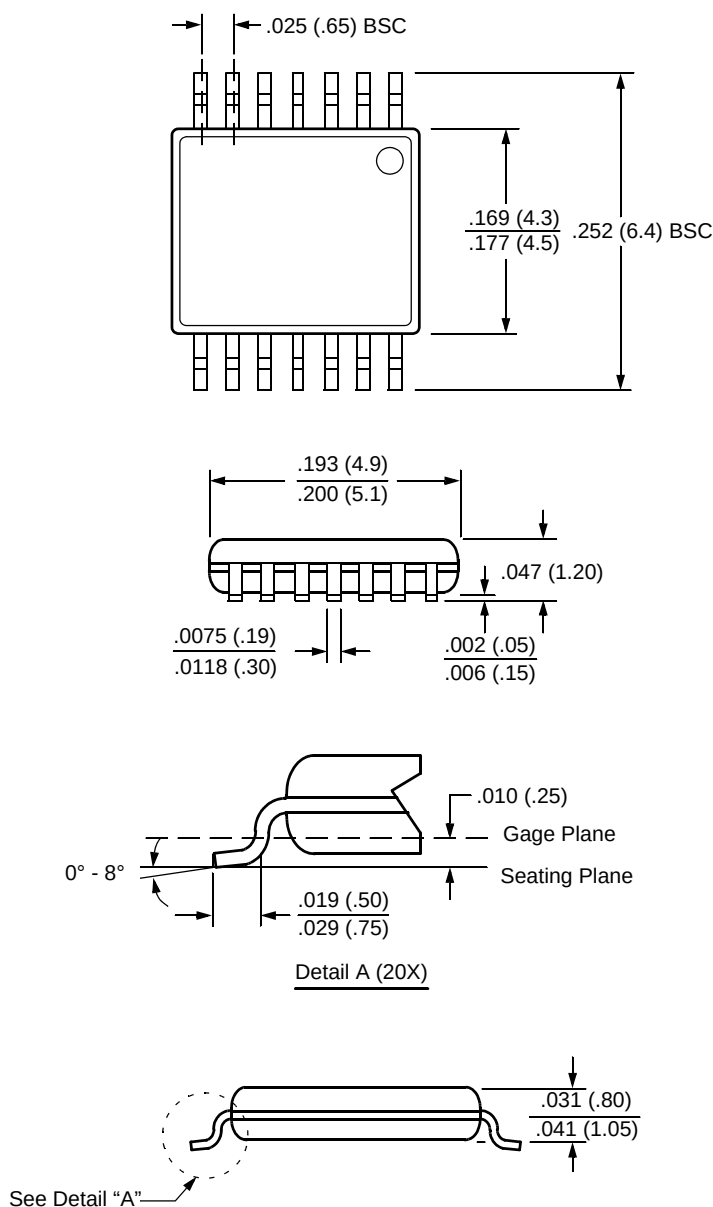


**NOTE: ALL DIMENSIONS IN INCHES (IN PARENTHESES IN MILLIMETERS)**

## X5168, X5169

### Packaging Information

#### 14-Lead Plastic, TSSOP, Package Type V



NOTE: ALL DIMENSIONS IN INCHES (IN PARENTHESES IN MILLIMETERS)

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