

## SPI Real-Time Clock Calendar with Enhanced Features and Battery Switchover

### Device Selection Table

| Part Number | 32 kHz Boot-up | SRAM (Bytes) | EEPROM (Kbits) | Unique ID |
|-------------|----------------|--------------|----------------|-----------|
| MCP795W20   | No             | 64           | 2              | Blank     |
| MCP795W10   | No             | 64           | 1              | Blank     |
| MCP795W21   | No             | 64           | 2              | EUI-48™   |
| MCP795W11   | No             | 64           | 1              | EUI-48™   |
| MCP795W22   | No             | 64           | 2              | EUI-64™   |
| MCP795W12   | No             | 64           | 1              | EUI-64™   |
| MCP795B20   | Yes            | 64           | 2              | Blank     |
| MCP795B10   | Yes            | 64           | 1              | Blank     |
| MCP795B21   | Yes            | 64           | 2              | EUI-48™   |
| MCP795B11   | Yes            | 64           | 1              | EUI-48™   |
| MCP795B22   | Yes            | 64           | 2              | EUI-64™   |
| MCP795B12   | Yes            | 64           | 1              | EUI-64™   |

**Note:** Watchdog Timer and Event Detects in all devices.

### Timekeeping Features:

- Real-Time Clock/Calendar:
  - Hours, Minutes, Seconds, Hundredth of Seconds, Day of Week, Month, Year, Leap Year
- Crystal Oscillator requires External 32,768 kHz Tuning Fork Crystal and Load Capacitors.
- Clock Out Function:
  - 1Hz, 4.096 kHz, 8.192 kHz, 32.768 kHz
- 32 kHz Boot-up Clock at Power-up (MCP795BXX)
- 2 Programmable Alarms – Supports  $\overline{\text{IRQ}}$  or  $\overline{\text{WDO}}$
- Programmable open drain output – Alarm or Interrupt
- On-Chip Digital Trimming/Calibration:
  - +/- 255 PPM range in 1 PPM steps
- Power-Fail Time-Stamp @ Battery Switchover:
  - Logs time when Vcc fails and Vcc is restored

### Low-Power Features:

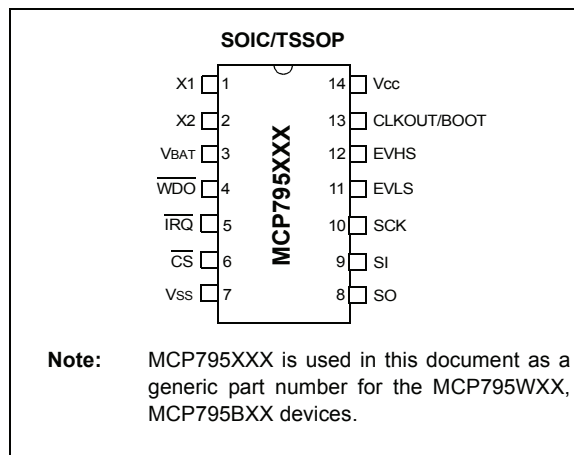
- Wide Operating Voltage:
  - Vcc: 1.8V to 5.5V
  - VBAT: 1.3V to 5.5V
- Low Operating Current:
  - Vcc Standby Current < 1uA @ 3V
  - VBAT Timekeeping Current: <700nA @ 1.8V
- Automatic Battery Switchover from Vcc to VBAT:
  - Backup power for timekeeping and SRAM retention

### User Memory:

- 64-Byte Battery-Backed SRAM
- 2 Kbit and 1 Kbit EEPROM Memory:
  - Software block write-protect (1/4, 1/2, or entire array)
  - Write Page mode (up to 8 bytes)
  - Endurance: 1M erase/write cycles
- 128-Bit Unique ID in Protected Area of EEPROM:
  - Available blank or preprogrammed
  - EUI-48™ or EUI-64™ MAC address
  - Unlock sequence for user programming

### Enhanced Features:

- SPI Clock Speed up to 10 MHz
- Programmable Watchdog Timer:
  - Dedicated watchdog output pin
  - Dual retrigger using SPI bus or EVHS digital input
- Dual Configurable Event Detect Inputs:
  - High-Speed Digital Event Detect (EVHS) with pulse count for 1<sup>st</sup>, 4<sup>th</sup>, 16<sup>th</sup> or 32<sup>nd</sup> event
  - Low-Speed Event Detect (EVLS) with programmable debounce delays of 31 msec and 500 msec
  - Edge triggered (rising or falling)
  - Operates from Vcc or VBAT
- Operating Temperature Ranges:
  - Industrial (I Temp): -40°C to +85°C.
- Packages include 14-Lead SOIC and TSSOP



# MCP795WXX/MCP795BXX

## Description:

The MCP795XXX is a low-power Real-Time Clock/Calendar (RTCC) that uses digital trimming compensation for an accurate clock/calendar, an interrupt output to support alarms and events, a power sense circuit that automatically switches to the backup supply, non-volatile memory for safe data storage and several enhanced features that support system requirements.

Along with a low-cost 32,768 kHz crystal, this RTCC tracks time using several internal registers and then communicates the data over a 10 MHz SPI bus that is fast enough to support a programmable millisecond alarm.

The device is fully accessible through the serial interface, while VCC is between 1.8V and 5.5V, but can operate down to 1.3V through the backup supply connected to the VBAT input for timekeeping and SRAM retention only.

As part of the power sense circuit, a time saver function is implemented to store the time when main power is lost and again, when power is restored to log the duration of a power failure.

Along with the onboard serial EEPROM and battery-backed SRAM, a 128-bit protected space is available for a unique ID. This space can be ordered preprogrammed with a MAC address, or blank for the user to program.

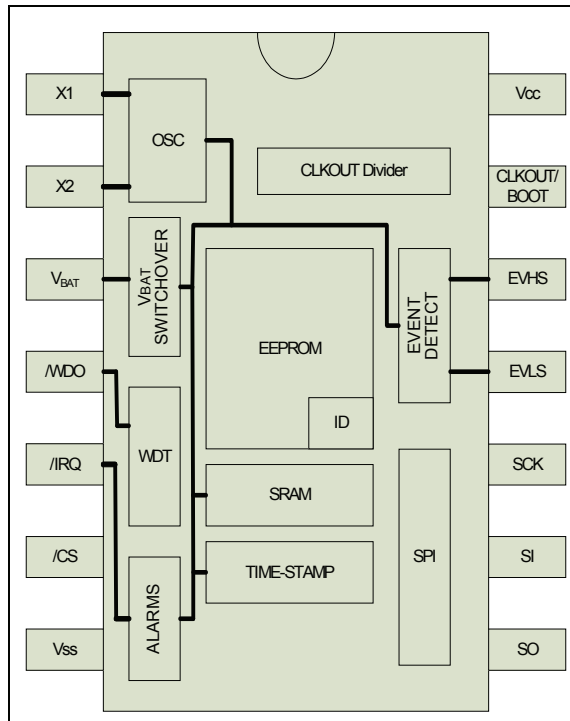
This clock/calendar automatically adjusts for months with fewer than 31 days including corrections for leap years. The clock operates in either 24-hour or 12-hour format with AM/PM indicator and settable alarm(s).

Using the external crystal, the CLKOUT pin can be set to generate a number of output frequencies. In addition, the MCP795BXX devices support a 32 kHz clock output at power-up on the CLKOUT/BOOT pin by using the same crystal driving the RTCC device.

For versatility, a digital event detect with a programmable pulse count can identify the 1<sup>st</sup>, 4<sup>th</sup>, 16<sup>th</sup> or 32<sup>nd</sup> pulse before sending an interrupt. A second event detect with built-in debounce input filter was also implemented to support noisy mechanical switches.

Since many microcontrollers do not have an integrated Watchdog Timer, this peripheral has been implemented in the RTCC. For many applications, this function must be performed outside the microcontroller for increased robustness.

FIGURE 1-1: BLOCK DIAGRAM



# MCP795WXX/MCP795BXX

## 1.0 ELECTRICAL CHARACTERISTICS

### Absolute Maximum Ratings (†)

|   |                 |
|---|-----------------|
| V <sub>CC</sub> .....                               | 6.5V            |
| All inputs and outputs w.r.t. V <sub>SS</sub> ..... | -0.6V to +6.5V  |
| Storage temperature .....                           | -65°C to +150°C |
| Ambient temperature under bias.....                 | -40°C to +85°C  |
| ESD protection on all pins.....                     | 4 kV            |

† NOTICE: Stresses above those listed under “Absolute Maximum Ratings” may cause permanent damage to the device. This is a stress rating only and functional operation of the device at those or any other conditions above those indicated in the operational listings of this specification is not implied. Exposure to maximum rating conditions for extended periods may affect device reliability.

**TABLE 1-1: DC CHARACTERISTICS**

| DC CHARACTERISTICS |                       |   | Industrial (I): T <sub>AMB</sub> = -40°C to +85°C V <sub>CC</sub> = 1.8V to 5.5V |                    |       |  |
|--------------------|-----------------------|---|--|--------------------|-------|--|
| Param. No.         | Sym.                  | Characteristic                                | Min.   | Max.               | Units | Test Conditions  |
| D001               | V <sub>IH1</sub>      | High-level input voltage                      | .7 V <sub>CC</sub>   | V <sub>CC</sub> +1 | V     |  |
| D002               | V <sub>IL1</sub>      | Low-level input voltage                       | -0.3   | 0.3V <sub>CC</sub> | V     | V <sub>CC</sub> ≥ 2.5V   |
| D003               | V <sub>IL2</sub>      |   | -0.3   | 0.2V <sub>CC</sub> | V     | V <sub>CC</sub> < 2.5V   |
| D004               | V <sub>OL</sub>       | Low-level output voltage                      | —  | 0.4                | V     | I <sub>OL</sub> = 2.1 mA   |
| D005               | V <sub>OL</sub>       |   | —  | 0.2                | V     | I <sub>OL</sub> = 1.0 mA, V <sub>CC</sub> < 2.5V                                   |
| D006               | V <sub>OH</sub>       | High-level output voltage                     | V <sub>CC</sub> -0.5   | —                  | V     | I <sub>OH</sub> = -400 μA  |
| D007               | I <sub>LI</sub>       | Input leakage current                         |  | ±1                 | μA    | $\overline{CS} = V_{CC}$ , V <sub>IN</sub> = V <sub>SS</sub> TO V <sub>CC</sub>    |
| D008               | I <sub>LO</sub>       | Output leakage current                        |  | ±1                 | μA    | $\overline{CS} = V_{CC}$ , V <sub>OUT</sub> = V <sub>SS</sub> TO V <sub>CC</sub>   |
| D009               | C <sub>INT</sub>      | Internal Capacitance (all inputs and outputs) | —  | 7                  | pF    | T <sub>AMB</sub> = 25°C, CLK = 1.0 MHz<br>V <sub>CC</sub> = 5.0V ( <b>Note 1</b> ) |
| D010               | I <sub>CC</sub> Read  | Operating Current                             | —  | 3                  | mA    | V <sub>CC</sub> = 5.5V; F <sub>CLK</sub> = 10.0 MHz<br>SO = Open                   |
| D011               | I <sub>DD</sub> write | Write Current                                 | —  | 5                  | mA    | V <sub>CC</sub> = 5.5V   |
| D012               | I <sub>BAT</sub>      | V <sub>BAT</sub> Current                      | —  | 700                | nA    | V <sub>BAT</sub> = 1.8V @ 25°C ( <b>Note 2</b> )                                   |
| D013               | V <sub>TRIP</sub>     | V <sub>BAT</sub> Change Over                  | 1.3  | 1.7                | V     | 1.5V typical at T <sub>AMB</sub> = 25°C  |
| D014               | V <sub>CCFT</sub>     | V <sub>CC</sub> Fall Time                     | 300  |                    | μs    | From V <sub>TRIP</sub> (max) to V <sub>TRIP</sub> (min)                            |
| D015               | V <sub>CCRT</sub>     | V <sub>CC</sub> Rise Time                     | 0  |                    | μs    | From V <sub>TRIP</sub> (min) to V <sub>TRIP</sub> (max)                            |
| D016               | V <sub>BAT</sub>      | V <sub>BAT</sub> Voltage Range                | 1.3  | 5.5                | V     | —  |
| D017               | I <sub>CCS</sub>      | Standby Current                               | —  | 1                  | μA    | —  |

**Note 1:** This parameter is periodically sampled and not 100% tested.

**2:** With oscillator running.

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**TABLE 1-2: AC CHARACTERISTICS**

| AC CHARACTERISTICS |                  |                             | Industrial (I): T <sub>AMB</sub> = -40°C to +85°C V <sub>CC</sub> = 1.8V to 5.5V |      |            |  |
|--------------------|------------------|-----------------------------|--|------|------------|--|
| Param. No.         | Sym.             | Characteristic              | Min.   | Max. | Units      | Test Conditions                        |
| 1                  | FCLK             | Clock Frequency             | —  | 10   | MHz        | 4.5V ≤ V <sub>CC</sub> ≤ 5.5V          |
|                    |                  |                             | —  | 5    | MHz        | 2.5V ≤ V <sub>CC</sub> < 4.5V          |
|                    |                  |                             | —  | 3    | MHz        | 1.8V ≤ V <sub>CC</sub> < 2.5V          |
| 2                  | T <sub>CSS</sub> | CS Setup Time               | 50   | —    | ns         | 4.5V ≤ V <sub>CC</sub> ≤ 5.5V          |
|                    |                  |                             | 100  | —    | ns         | 2.5V ≤ V <sub>CC</sub> < 4.5V          |
|                    |                  |                             | 150  | —    | ns         | 1.8V ≤ V <sub>CC</sub> < 2.5V          |
| 3                  | T <sub>CSH</sub> | CS Hold Time                | 50   | —    | ns         | 4.5V ≤ V <sub>CC</sub> ≤ 5.5V          |
|                    |                  |                             | 100  | —    | ns         | 2.5V ≤ V <sub>CC</sub> < 4.5V          |
|                    |                  |                             | 150  | —    | ns         | 1.8V ≤ V <sub>CC</sub> < 2.5V          |
| 4                  | T <sub>CSD</sub> | CS Disable Time             | 50   | —    | ns         | —                                      |
| 5                  | T <sub>SU</sub>  | Data Setup Time             | 10   | —    | ns         | 4.5V ≤ V <sub>CC</sub> ≤ 5.5V          |
|                    |                  |                             | 20   | —    | ns         | 2.5V ≤ V <sub>CC</sub> < 4.5V          |
|                    |                  |                             | 30   | —    | ns         | 1.8V ≤ V <sub>CC</sub> < 2.5V          |
| 6                  | T <sub>HD</sub>  | Data Hold Time              | 20   | —    | ns         | 4.5V ≤ V <sub>CC</sub> ≤ 5.5V          |
|                    |                  |                             | 40   | —    | ns         | 2.5V ≤ V <sub>CC</sub> < 4.5V          |
|                    |                  |                             | 50   | —    | ns         | 1.8V ≤ V <sub>CC</sub> < 2.5V          |
| 7                  | T <sub>R</sub>   | CLK Rise Time               | —  | 100  | ns         | (Note 1)                               |
| 8                  | T <sub>F</sub>   | CLK Fall Time               | —  | 100  | ns         | (Note 1)                               |
| 9                  | T <sub>HI</sub>  | Clock High Time             | 50   | —    | ns         | 4.5V ≤ V <sub>CC</sub> ≤ 5.5V          |
|                    |                  |                             | 100  | —    | ns         | 2.5V ≤ V <sub>CC</sub> < 4.5V          |
|                    |                  |                             | 150  | —    | ns         | 1.8V ≤ V <sub>CC</sub> < 2.5V          |
| 10                 | T <sub>LO</sub>  | Clock Low Time              | 50   | —    | ns         | 4.5V ≤ V <sub>CC</sub> ≤ 5.5V          |
|                    |                  |                             | 100  | —    | ns         | 2.5V ≤ V <sub>CC</sub> < 4.5V          |
|                    |                  |                             | 150  | —    | ns         | 1.8V ≤ V <sub>CC</sub> < 2.5V          |
| 11                 | T <sub>CLD</sub> | Clock Delay Time            | 50   | —    | ns         | —                                      |
| 12                 | T <sub>CLE</sub> | Clock Enable Time           | 50   | —    | ns         | —                                      |
| 13                 | T <sub>V</sub>   | Output Valid from Clock Low | —  | 50   | ns         | 4.5V ≤ V <sub>CC</sub> ≤ 5.5V          |
|                    |                  |                             | —  | 100  | ns         | 2.5V ≤ V <sub>CC</sub> < 4.5V          |
|                    |                  |                             | —  | 160  | ns         | 1.8V ≤ V <sub>CC</sub> < 2.5V          |
| 14                 | T <sub>HO</sub>  | Output Hold Time            | 0  | —    | ns         | (Note 1)                               |
| 15                 | T <sub>DIS</sub> | Output Disable Time         | —  | 40   | ns         | 4.5V ≤ V <sub>CC</sub> ≤ 5.5V (Note 1) |
|                    |                  |                             | —  | 80   | ns         | 2.5V ≤ V <sub>CC</sub> < 4.5V (Note 1) |
|                    |                  |                             | —  | 160  | ns         | 1.8V ≤ V <sub>CC</sub> < 2.5V (Note 1) |
| 16                 | T <sub>WC</sub>  | Internal Write Cycle Time   | —  | 5    | ms         | (Note 3)                               |
| 17                 | —                | Endurance                   | 1,000,000  | —    | E/W Cycles | (Note 2)                               |

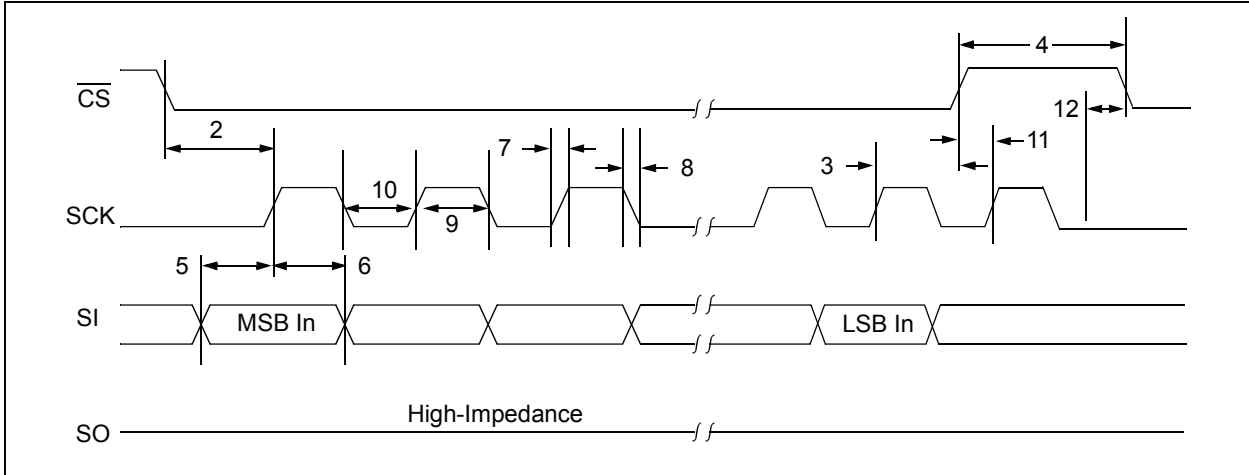
**Note 1:** This parameter is periodically sampled and not 100% tested.

**2:** This parameter is not tested but ensured by characterization. For endurance estimates in a specific application, please consult the Total Endurance™ Model which can be obtained from Microchip's web site: [www.microchip.com](http://www.microchip.com).

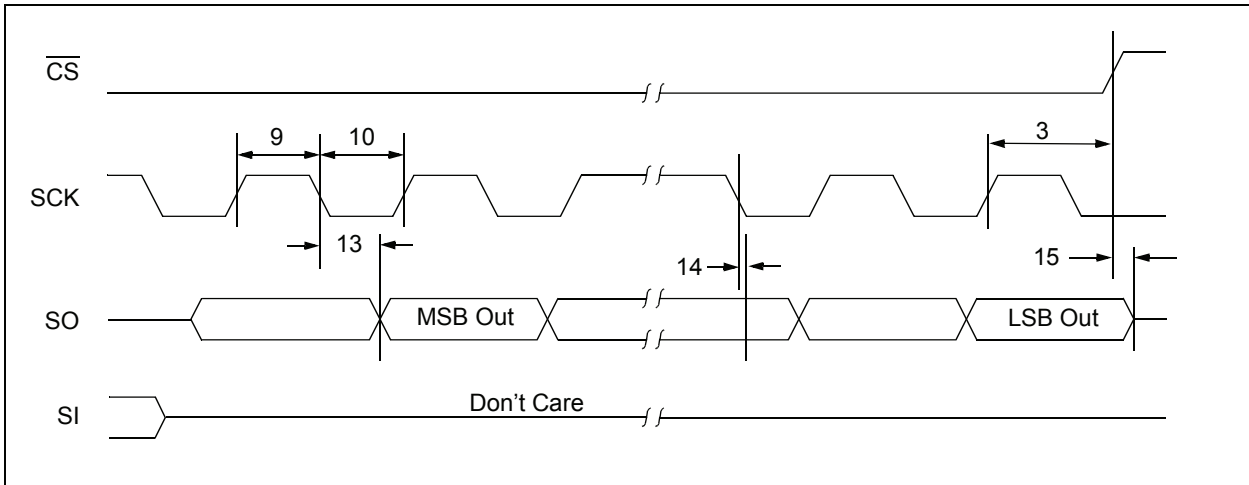
**3:** T<sub>WC</sub> begins on the rising edge of  $\overline{CS}$  after a valid write sequence and ends when the internal write cycle is complete.

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**FIGURE 1-1: SERIAL INPUT TIMING**



**FIGURE 1-2: SERIAL OUTPUT TIMING**

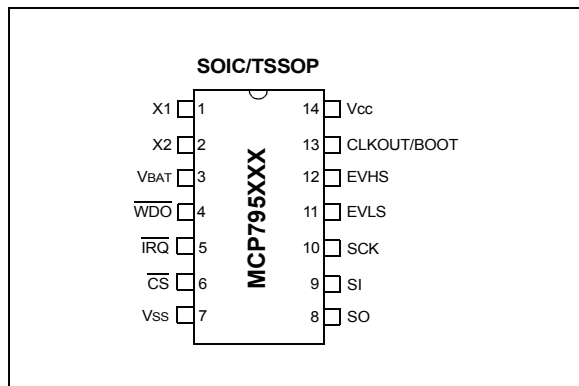


# MCP795WXX/MCP795BXX

## 2.0 PIN DESCRIPTION

The descriptions of the pins are listed in [Table 2-1](#).

**FIGURE 2-1: DEVICE PINOUTS**



### 2.1 Chip Select ( $\overline{CS}$ )

A low level on this pin selects the device. A high level deselects the device and forces it into Standby mode. However, a programming cycle which is already initiated or in progress will be completed, regardless of the  $\overline{CS}$  input signal. If  $\overline{CS}$  is brought high during a program cycle, the device will go in Standby mode as soon as the programming cycle is complete. When the device is deselected, SO goes into the high-impedance state, allowing multiple parts to share the same SPI bus. A low-to-high transition on  $\overline{CS}$  after a valid write sequence initiates an internal write cycle. After power-up, a low level on  $\overline{CS}$  is required prior to any sequence being initiated.

### 2.2 Serial Output (SO)

The SO pin is used to transfer data out of the MCP795XXX. During a read cycle, data is shifted out on this pin after the falling edge of the serial clock.

### 2.3 Watchdog Output ( $\overline{WDO}$ )

This pin is a hardware open drain from the internal watchdog circuit. This pin requires an external pull-up to Vcc. When a watchdog overflow occurs the onboard N-Channel will pulse this pin low. The pulse duration is user selectable (Address 0x0A:4). This pin has a maximum sink current of 10mA.

### 2.4 Serial Input (SI)

The SI pin is used to transfer data into the device. It receives instructions, addresses and data. Data is latched on the rising edge of the serial clock.

### 2.5 Serial Clock (SCK)

The SCK is used to synchronize the communication between a master and the MCP795XXX. Instructions, addresses or data present on the SI pin are latched on the rising edge of the clock input, while data on the SO pin is updated after the falling edge of the clock input.

### 2.6 Interrupt Output ( $\overline{IRQ}$ )

The  $\overline{IRQ}$  pin is shared with the onboard event detect and the Alarms. This pin requires an external pull-up to Vcc or VBAT. The onboard N-Channel will pull the pin low during an event detection or an alarm. The pin remains low until such time that the interrupt flag in the register is cleared by software. This pin has a maximum sink current of 10mA.

### 2.7 X1, X2

The X1 and X2 pins connect to the onboard oscillator block. X1 is the input to the module and X2 is the output of the module. The device can be run from an external CMOS signal by feeding into the X1 pin. If driving X1 the X2 pin should be a No Connect.

### 2.8 VBAT

The VBAT pin is a secondary supply input to maintain the Clock and SRAM contents when Vcc is removed.

### 2.9 CLKOUT/BOOT

The CLKOUT is a push-pull output that can be used to generate a squarewave or is used for the boot-up clock output at power-up. Please refer to [Section 9.1.2, Clockout Function](#) for more details.

### 2.10 EVHS and EVLS

The EVHS and EVLS are inputs for the High and Low Speed Event Detection circuit.

**TABLE 2-1: PIN DESCRIPTIONS**

| Pin Name         | Pin Function                          |
|------------------|---------------------------------------|
| Vss              | Ground                                |
| X1               | Xtal Input, External Oscillator Input |
| X2               | Xtal Output                           |
| VBAT             | Battery Backup Input (3V Typ)         |
| Vcc              | +1.8V to +5.5V Power Supply           |
| SI               | Serial Input                          |
| $\overline{WDO}$ | Watchdog Output                       |
| SCK              | Serial Clock                          |
| CLKOUT/BOOT      | Clock Out (Boot Clock on MCP795BXX)   |
| $\overline{CS}$  | Chip Select                           |
| $\overline{IRQ}$ | Interrupt Output                      |
| EVHS             | High-Speed Event Detect Input         |
| EVLS             | Low-Speed Event Detect Input          |
| SO               | Serial Output                         |

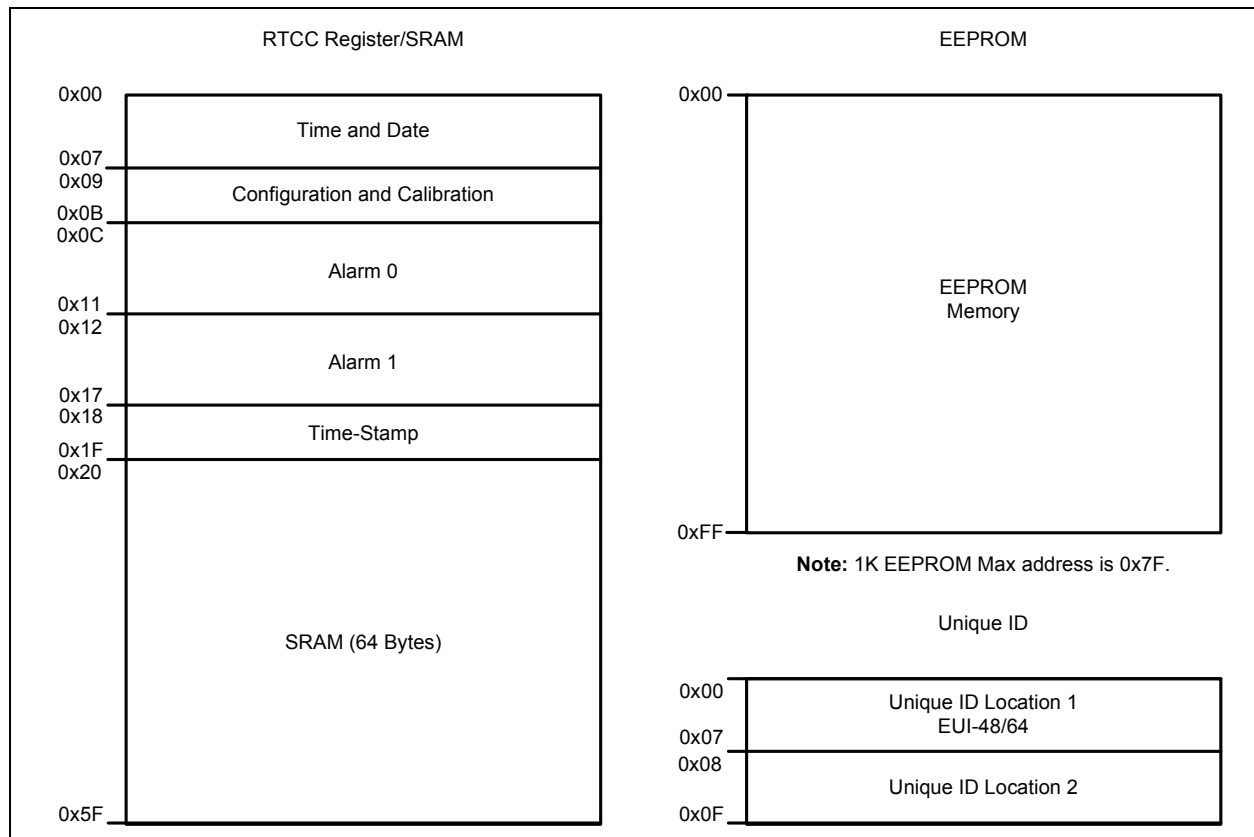
## 2.11 RTCC Memory Map

The RTCC registers are contained in addresses 0x00h-0x1fh. 64 bytes of user-accessable SRAM are located in the address range 0x20-0x5f. The SRAM memory is a separate block from the RTCC control and Configuration registers. All SRAM locations are battery-backed-up during a VCC power fail. Unused locations are not accessible.

- Addresses 0x00h-0x07h are the RTCC Time and Date registers. These are read/write registers. Care must be taken when writing to these registers with the oscillator running.
- Incorrect data can appear in the Time and Date registers if a write is attempted during the time frame where these internal registers are being incremented. The user can minimize the likelihood of data corruption by ensuring that any writes to the Time and Date registers occur before the contents of the second register reach a value of 0x59H.

- Addresses 0x08h-0x0Bh are the device Configuration, Calibration, Watchdog Configuration and Event Detect Configuration registers.
- Addresses 0x0ch-0x11h are the Alarm 0 registers. These are used to set up the Alarm 0, the interrupt pin and the Alarm 0 compare.
- Addresses 0x12h-0x17h are the Alarm 1 registers. These are used to set up the Alarm 1, the interrupt pin and the Alarm 1 compare, Alarm 1 offers a enhanced resolution of tenth and hundredths of seconds.
- Addresses 0x18h-0x1Fh are used for the Power-Down and Power-Up time-stamp feature. The detailed memory map is shown in [Table 4-1](#). No error checking is provided when loading Time and Date registers.

**FIGURE 2-2: MEMORY MAP**



# MCP795WXX/MCP795BXX

## 3.0 SPI BUS OPERATION

The MCP795XXX is designed to interface directly with the Serial Peripheral Interface (SPI) port of many of today's popular microcontroller families, including Microchip's PIC® microcontrollers. It may also interface with microcontrollers that do not have a built-in SPI port by using discrete I/O lines programmed properly in software to match the SPI protocol.

The MCP795XXX contains an 8-bit instruction register.

The device is accessed via the SI pin, with data being clocked in on the rising edge of SCK. The CS pin must be low for the entire operation.

Table 3-1 contains a list of the possible instruction bytes and format for device operation. All instructions, addresses, and data are transferred MSb first, LSb last.

Data (SI) is sampled on the first rising edge of SCK after CS goes low.

TABLE 3-1: INSTRUCTION SET SUMMARY

| Instruction Name | Instruction Format | Description  |
|------------------|--------------------|--|
| EEREAD           | 0000 0011          | Read data from EE memory array beginning at selected address       |
| EEWRITE          | 0000 0010          | Write data to EE memory array beginning at selected address        |
| EEWRDI           | 0000 0100          | Reset the write enable latch (disable write operations)            |
| EEWREN           | 0000 0110          | Set the write enable latch (enable write operations)               |
| SRREAD           | 0000 0101          | Read STATUS register   |
| SRWRITE          | 0000 0001          | Write STATUS register  |
| READ             | 0001 0011          | Read RTCC/SRAM array beginning at selected address                 |
| WRITE            | 0001 0010          | Write RTCC/SRAM data to memory array beginning at selected address |
| UNLOCK           | 0001 0100          | Unlock ID Locations  |
| IDWRITE          | 0011 0010          | Write to the ID Locations  |
| IDREAD           | 0011 0011          | Read the ID Locations  |
| CLRWDT           | 0100 0100          | Clear Watchdog Timer   |
| CLRDRAM          | 0101 0100          | Clear RAM Location to '0'  |

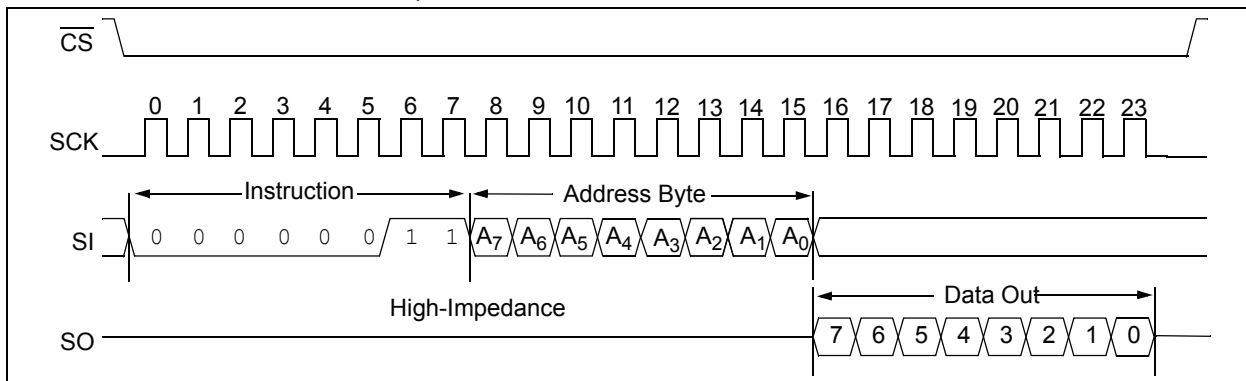
### 3.1 Read Sequence

The device is selected by pulling CS low. The various 8-bit read instructions are transmitted to the MCP795XXX followed by an 8-bit address. See Figure 3-1 for more details.

After the correct instruction and address are sent, the data stored in the memory at the selected address is shifted out on the SO pin. Data stored in the memory at

the next address can be read sequentially by continuing to provide clock pulses to the slave. The internal Address Pointer automatically increments 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 the first valid address allowing the read cycle to be continued indefinitely. The read operation is terminated by raising the CS pin (Figure 1-1).

FIGURE 3-1: EEREAD SEQUENCE





## 3.2 Nonvolatile Memory Write Sequence

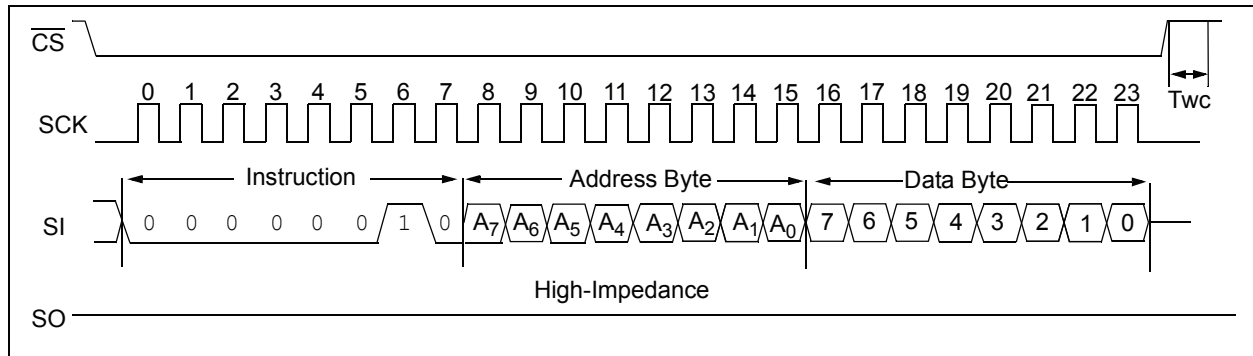
Prior to any attempt to write data to the nonvolatile memory (EEPROM, Unique ID and STATUS register) in the MCP795XXX, the write enable latch must be set by issuing the `EEWREN` instruction (Figure 3-4). This is done by setting  $\overline{CS}$  low and then clocking out the proper instruction into the MCP795XXX. After all eight bits of the instruction are transmitted,  $\overline{CS}$  must be driven high to set the write enable latch. If the write operation is initiated immediately after the `EEWREN` instruction without  $\overline{CS}$  driven high, data will not be written to the array since the write enable latch was not properly set.

After setting the write enable latch, the user may proceed by driving  $\overline{CS}$  low, issuing either an `EEWRITE`, `IDWRITE` or a `SWRITE` instruction, followed by the remainder of the address, and then the data to be written. Up to 8 bytes of data can be sent to the device before a write cycle is necessary. The only restriction is that all of the bytes must reside in the same page. Addi-

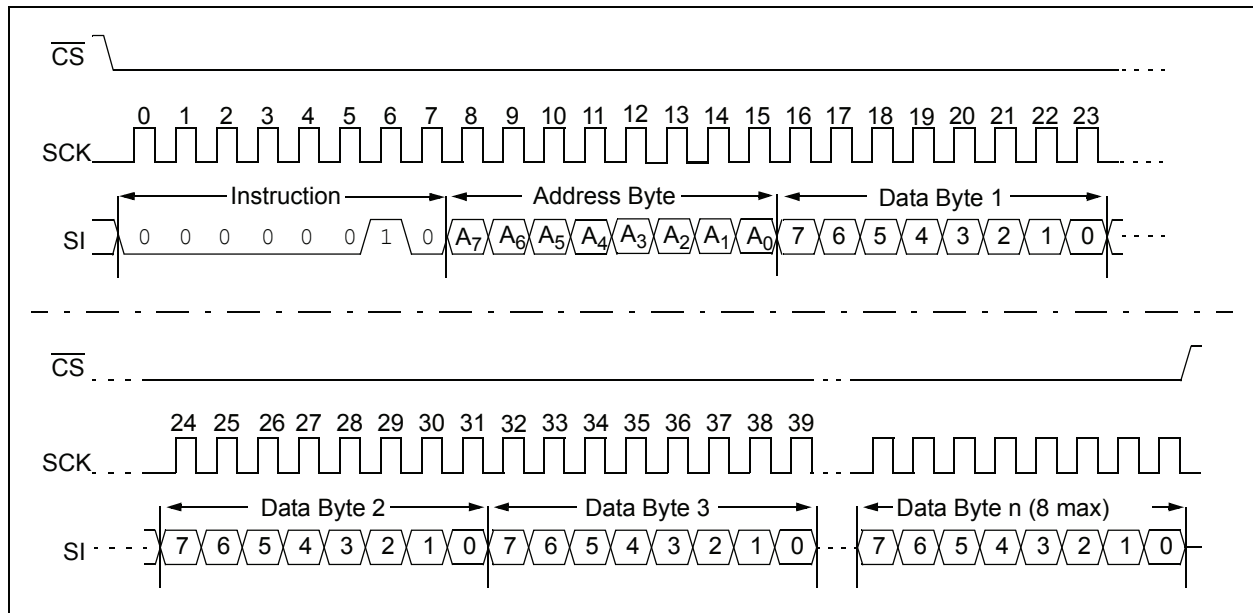
tionally, a page address begins with `XXXX 0000` and ends with `XXXX X111`. If the internal address counter reaches `XXXX X111` and clock signals continue to be applied to the chip, the address counter will roll back to the first address of the page and overwrite any data that previously existed in those locations.

For the data to be actually written to the array, the  $\overline{CS}$  must be brought high after the Least Significant bit (D0) of the *n*th data byte has been clocked in. If  $\overline{CS}$  is driven high at any other time, the write operation will not be completed. Refer to Figure 3-2 and Figure 3-3 for more detailed illustrations on the byte write sequence and the page write sequence, respectively. While the nonvolatile memory write is in progress, the STATUS register may be read to check the status of the WIP, WEL, BP1 and BP0 bits. Attempting to read a memory array location will not be possible during a write cycle. Polling the WIP bit in the STATUS register is recommended in order to determine if a write cycle is in progress. When the nonvolatile memory write cycle is completed, the write enable latch is reset.

**FIGURE 3-2: BYTE EEWRITE SEQUENCE**



**FIGURE 3-3: PAGE EEWRITE SEQUENCE**



# MCP795WXX/MCP795BXX

## 3.3 Write Enable (EEWREN) and Write Disable (EEWRDI)

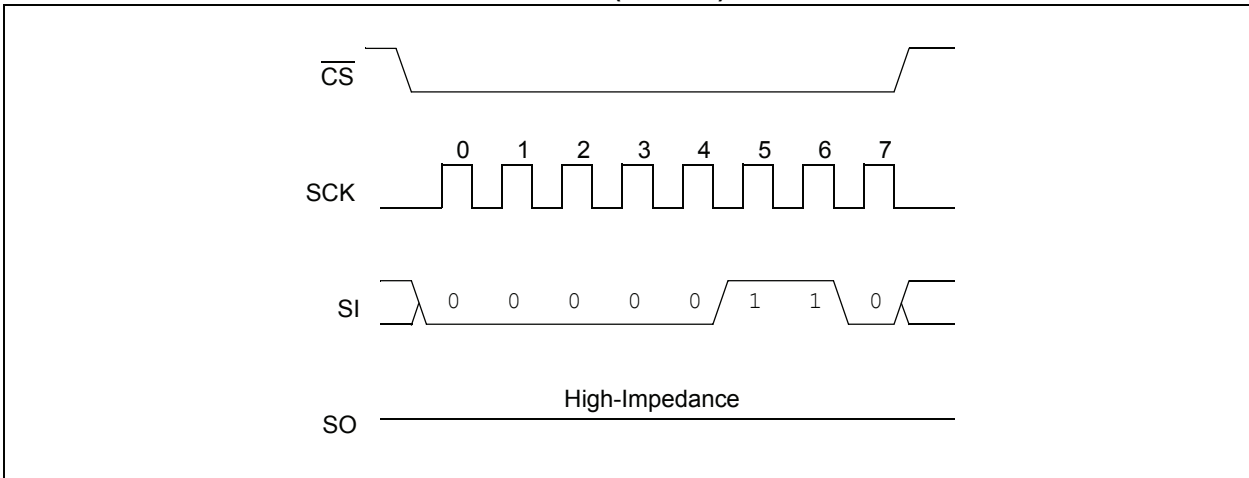
The MCP795XXX contains a write enable latch.

This latch must be set before any EEWRITE, SRWRITE and IDWRITE operation will be completed internally. The EEWREN instruction will set the latch, and the EEWRDI will reset the latch.

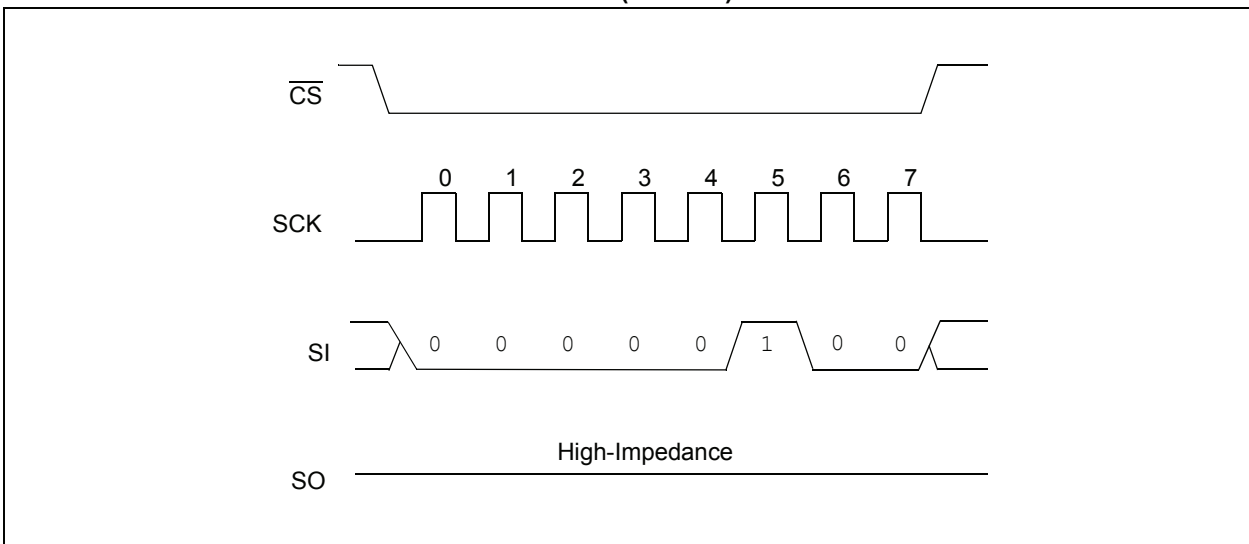
The following is a list of conditions under which the write enable latch will be reset:

- Power-up
- EEWRDI instruction successfully executed
- SRWRITE instruction successfully executed
- EEWRITE instruction successfully executed
- IDWRITE instruction successfully executed

**FIGURE 3-4: WRITE ENABLE SEQUENCE (EEWREN)**



**FIGURE 3-5: WRITE DISABLE SEQUENCE (EEWRDI)**



# MCP795WXX/MCP795BXX

## 4.0 RTCC FUNCTIONALITY

### 4.0.1 RTCC REGISTER MAP

The RTCC register space runs from 0x00 through to 0x1F. Any read or write that is started within the RTCC register address space will wrap to the beginning of the RTCC registers.

All of the RTCC registers are backed up from the VBAT supply when VCC is not available, provided that the VBATEN bit is set. Any unused bits or non implemented addresses read back as '0'. No error checking is provided for any of the RTCC, the user may load any value.

The RTCC register map is shown in [Table 4-1](#).

**TABLE 4-1: RTCC REGISTER MAP**

| Address                          | BIT 7         | BIT 6         | BIT 5         | BIT 4    | BIT 3                 | BIT 2                 | BIT 1 | BIT 0 | FUNCTION              | RANGE                 |       |
|----------------------------------|---------------|---------------|---------------|----------|-----------------------|-----------------------|-------|-------|-----------------------|-----------------------|-------|
| Time and Configuration Registers |               |               |               |          |                       |                       |       |       |                       |                       |       |
| 00h                              | Tenth Seconds |               |               |          | Hundredths of Seconds |                       |       |       | Hundredths of seconds | 00-99                 |       |
| 01h                              | ST (CT)       | 10 Seconds    |               |          |                       | Seconds               |       |       |                       | Seconds               | 00-59 |
| 02h                              |               | 10 Minutes    |               |          |                       | Minutes               |       |       |                       | Minutes               | 00-59 |
| 03h                              | CALSGN        | 12/24         | 10 Hour AM/PM | 10 Hour  | Hour                  |                       |       |       | Hours                 | 1-12 + AM/PM 00 - 23  |       |
| 04h                              |               |               | OSCON         | VBAT     | VBATEN                | Day                   |       |       | Day                   | 1-7                   |       |
| 05h                              |               |               | 10 Date       |          |                       | Date                  |       |       | Date                  | 01-31                 |       |
| 06h                              |               |               | LP            | 10 Month | Month                 |                       |       | Month | 01-12                 |                       |       |
| 07h                              | 10 Year       |               |               |          | Year                  |                       |       |       | Year                  | 00-99                 |       |
| 08h                              | OUT           | SQWE          | ALM1          | ALM0     | EXTOSC                | RS2                   | RS1   | RS0   | Control Reg.          |                       |       |
| 09h                              | CALIBRATION   |               |               |          |                       |                       |       |       | Calibration           |                       |       |
| 0Ah                              | WDTEN         | WDTIF         | WDDEL         | WDTPLS   | WD3                   | WD2                   | WD1   | WD0   | Watchdog              |                       |       |
| 0Bh                              | EVHIF         | EVLIF         | EVEN1         | EVEN0    | EVWDT                 | EVLDB                 | EVHS1 | EVHS0 | Event Detect          |                       |       |
| Alarm 0 Registers                |               |               |               |          |                       |                       |       |       |                       |                       |       |
| 0Ch                              |               | 10 Seconds    |               |          |                       | Seconds               |       |       |                       | Seconds               | 00-59 |
| 0Dh                              |               | 10 Minutes    |               |          |                       | Minutes               |       |       |                       | Minutes               | 00-59 |
| 0Eh                              |               | 12/24         | 10 Hour AM/PM | 10 Hours | Hour                  |                       |       |       | Hours                 | 1-12 + AM/PM 00-23    |       |
| 0Fh                              | ALM0PIN       | ALM0C2        | ALM0C1        | ALM0C0   | ALM0IF                | Day                   |       |       | Day                   | 1-7                   |       |
| 10h                              |               | 10 Date       |               |          |                       | Date                  |       |       |                       | Date                  | 01-31 |
| 11h                              |               | 10 Month      |               |          |                       | Month                 |       |       |                       | Month                 | 01-12 |
| Alarm 1 Registers                |               |               |               |          |                       |                       |       |       |                       |                       |       |
| 12h                              |               | Tenth Seconds |               |          |                       | Hundredths of seconds |       |       |                       | Hundredths of Seconds | 00-99 |
| 13h                              |               | 10 Seconds    |               |          |                       | Seconds               |       |       |                       | Seconds               | 00-59 |
| 14h                              |               | 10 Minutes    |               |          |                       | Minutes               |       |       |                       | Minutes               | 00-59 |
| 15h                              |               | 12/24         | 10 Hour AM/PM | 10 Hours | Hour                  |                       |       |       | Hours                 | 1-12 + AM/PM 00-23    |       |
| 16h                              | ALM1PIN       | ALM1C2        | ALM1C1        | ALM1C0   | ALM1IF                | Day                   |       |       | Day                   | 1-7                   |       |
| 17h                              |               | 10 Date       |               |          |                       | Date                  |       |       |                       | Date                  | 01-31 |
| Power-down Time-stamp Registers  |               |               |               |          |                       |                       |       |       |                       |                       |       |
| 18h                              |               | 10 Minutes    |               |          |                       | Minutes               |       |       |                       |                       |       |
| 19h                              |               | 12/24         | 10 Hour AM/PM | 10 Hours | Hour                  |                       |       |       |                       |                       |       |
| 1Ah                              |               | 10 Date       |               |          |                       | Date                  |       |       |                       |                       |       |
| 1Bh                              |               | Day           |               |          | 10 Month              | Month                 |       |       |                       |                       |       |
| Power-Up Time-stamp Registers    |               |               |               |          |                       |                       |       |       |                       |                       |       |
| 1Ch                              |               | 10 Minutes    |               |          |                       | Minutes               |       |       |                       |                       |       |
| 1Dh                              |               | 12/24         | 10 Hour AM/PM | 10 Hours | Hour                  |                       |       |       |                       |                       |       |
| 1Eh                              |               | 10 Date       |               |          |                       | Date                  |       |       |                       |                       |       |
| 1Fh                              |               | Day           |               |          | 10 Month              | Month                 |       |       |                       |                       |       |

# MCP795WXX/MCP795BXX

## 5.0 TIME AND CONFIGURATION REGISTERS

### REGISTER 5-1: HUNDREDTHS OF SECONDS 0x00

| RW            |       | RW                    |       |
|---------------|-------|-----------------------|-------|
| Tenth Seconds |       | Hundredths of Seconds |       |
| bit 7         | bit 4 | bit 3                 | bit 0 |

**Legend:** R = Readable Bit W = Writable Bit U = Unimplemented bit, Read as '0'

bit 7-4 Tenth Seconds

bit 3-0 Hundredths of Seconds

**Note:** Contains the BCD Tens and Hundredths of seconds

### REGISTER 5-2: SECONDS 0x01

| RW      | RW         |       | RW      |       |
|---------|------------|-------|---------|-------|
| ST (CT) | 10 Seconds |       | Seconds |       |
| bit 7   | bit 6      | bit 4 | bit 3   | bit 0 |

**Legend:** R = Readable Bit W = Writable Bit U = Unimplemented bit, Read as '0'

bit 7 ST (CT)

Setting this bit '1' starts the oscillator and clearing this bit '0' stops the on-board oscillator. For the MCP795BXX devices the ST bit is replaced by the CT bit. Setting this bit starts the timekeeping registers counting.

bit 6-4 10 Seconds

bit 3-0 Seconds

**Note:** Contains the BCD seconds and 10 seconds. The range is 00 to 59.

### REGISTER 5-3: MINUTES 0x02

| U     | RW         |       | RW      |       |
|-------|------------|-------|---------|-------|
|       | 10 Minutes |       | Minutes |       |
| bit 7 | bit 6      | bit 4 | bit 3   | bit 0 |

**Legend:** R = Readable Bit W = Writable Bit U = Unimplemented bit, Read as '0'

bit 7 Unimplemented

bit 6-4 10 Minutes

bit 3-0 Minutes

**Note:** Contains the BCD minutes and 10 minutes. The range is 00 to 59.

# MCP795WXX/MCP795BXX

## REGISTER 5-4: HOUR 0x03

|        |       |               |         |       |       |
|--------|-------|---------------|---------|-------|-------|
| RW     | RW    | RW            | RW      | RW    |       |
| CALSGN | 12/24 | 10 Hour AM/PM | 10 Hour | Hour  |       |
| bit 7  | bit 6 | bit 5         | bit 4   | bit 3 | bit 0 |

**Legend:** R = Readable Bit W = Writable Bit U = Unimplemented bit, Read as '0'

- bit 7 CALSGN  
Bit 7 is the sign bit (CALSGN) for the calibration. Clearing this bit produces a positive calibration, setting this bit produces a negative calibration.
- bit 6 12/24  
Clearing this bit to '0' enables 24-hour format, setting this bit '1' enables 12-hour format.
- bit 5 10 Hour (AM/PM bit for 12-hour time)
- bit 4 10 Hour
- bit 3-0 Hour
- Note:** Contains the BCD hour in bits <3:0>. Bits <5:4> contain either the 10-hour in BCD for 24-hour format or the AM/PM indicator and the 10-hour bit for 12-hour format. Bit 5 determines the hour format.

## REGISTER 5-5: DAY 0x04

|       |       |       |       |        |       |       |
|-------|-------|-------|-------|--------|-------|-------|
| U     | U     | R     | RW    | RW     | RW    |       |
|       |       | OSCON | VBAT  | VBATEN | Day   |       |
| bit 7 | bit 6 | bit 5 | bit 4 | bit 3  | bit 2 | bit 0 |

**Legend:** R = Readable Bit W = Writable Bit U = Unimplemented bit, Read as '0'

- bit 7-6 Unimplemented bit, read as '0'
- bit 5 Bit 5 is the OSCON bit. This is set and cleared by hardware. If this bit is set the oscillator is running, if clear, the oscillator is not running. This bit does not indicate that the oscillator is running at the correct frequency. The bit will wait 32 oscillator cycles before the bit is set.
- bit 4 Bit 4 is the VBAT bit. This bit is set by hardware when the VCC fails and the VBAT is used to power the oscillator and the RTCC registers. This bit is cleared by software.
- bit 3 Bit 3 is the VBATEN bit. If this bit is set the internal circuitry is connected to the VBAT pin. If this bit is '0' then the VBAT pin is disconnected and the only current drain on the external battery is the VBAT pin leakage.
- bit 2-0 Day
- Note:** Contains the BCD day. The range is 1-7. Also, additional bits are used for configuration and Status.

# MCP795WXX/MCP795BXX

## REGISTER 5-6: DATE 0x05

|       |       |         |       |       |       |
|-------|-------|---------|-------|-------|-------|
| U     | U     | RW      |       | RW    |       |
|       |       | 10 Date |       | Date  |       |
| bit 7 | bit 6 | bit 5   | bit 4 | bit 3 | bit 0 |

**Legend:** R = Readable Bit W = Writable Bit U = Unimplemented bit, Read as '0'

bit 7-6 Unimplemented bit, read as '0'

bit 5-4 10 Date

bit 3-0 Date

**Note:** Contains the BCD Date and 10 Date. The range is 01-31.

## REGISTER 5-7: MONTH 0x06

|       |       |       |          |       |       |
|-------|-------|-------|----------|-------|-------|
| U     | U     | R     | RW       | RW    |       |
|       |       | LP    | 10 Month | Month |       |
| bit 7 | bit 6 | bit 5 | bit 4    | bit 3 | bit 0 |

**Legend:** R = Readable Bit W = Writable Bit U = Unimplemented bit, Read as '0'

bit 7-6 Unimplemented bit, read as '0'

bit 5 Bit 5 is the Leap Year bit, this is set during a leap year and is read-only.

bit 4 10 Month

bit 3-0 Month

**Note:** Contains the BCD month. Bit 4 contains the 10 month.

## REGISTER 5-8: YEAR 0x07

|         |       |       |       |
|---------|-------|-------|-------|
| RW      |       | RW    |       |
| 10 Year |       | Year  |       |
| bit 7   | bit 4 | bit 3 | bit 0 |

**Legend:** R = Readable Bit W = Writable Bit U = Unimplemented bit, Read as '0'

bit 7-4 10 Year

bit 3-0 Year

**Note:** Contains the BCD Year and 10 Year. The Range is 00-99.

# MCP795WXX/MCP795BXX

## REGISTER 5-9: CONTROL REG 0x08

|       |       |       |       |        |       |       |       |
|-------|-------|-------|-------|--------|-------|-------|-------|
| RW    | RW    | RW    | RW    | RW     | RW    | RW    | RW    |
| OUT   | SQWE  | ALM1  | ALM0  | EXTOSC | RS2   | RS1   | RS0   |
| bit 7 | bit 6 | bit 5 | bit 4 | bit 3  | bit 2 | bit 1 | bit 0 |

**Legend:** R = Readable Bit W = Writable Bit U = Unimplemented bit, Read as '0'

- bit 7 Bit 7 is the OUT bit, this sets the logic level on the CLKOUT when not using this as a square wave output.
- bit 6 Bit 6 is the SQWE bit, setting this bit enables the divided output from the crystal oscillator.
- bit 5:4 ALM1 Bits <5:4> determine which alarms are active.
- 00 – No Alarms are active
  - 01 – Alarm 0 is active
  - 10 – Alarm 1 is active
  - 11 – Both Alarms are active
- bit 3 Bit 3 is the EXTOSC enable bit. Setting this bit will allow an external 32.768 kHz signal to drive the RTCC registers, eliminating the need for an external crystal.
- bit 2:0 RS2 Bits <2:0> set the internal divider for the 32.768 kHz oscillator to be driven to the CLKOUT. The following frequencies are available. The output is responsive to the Calibration register.
- 000 – 1 Hz
  - 001 – 4.096 kHz
  - 010 – 8.192 kHz
  - 011 – 32.768 kHz
  - 1XX enables the Cal Output function. Cal output appears on CLKOUT if SQWE is set (1 Hz nominal).
- Note:** When RS2 is set to enable the Cal Output function, the RTCC counters will continue to increment.

## REGISTER 5-10: CALIBRATION 0x09

|             |       |
|-------------|-------|
| RW          |       |
| CALIBRATION |       |
| bit 7       | bit 0 |

**Legend:** R = Readable Bit W = Writable Bit U = Unimplemented bit, Read as '0'

bit 7-0 Calibration Value

**Note:** This is an 8-bit register that is used to add or subtract clocks from the RTCC counter every minute. The CALSGN (0x03:7) is the sign bit and indicates if the count should be added or subtracted. The 8 bits in the Calibration register, with each bit adding or subtracting two clocks, gives the user the ability to add or subtract up to 510 clocks per minute.

# MCP795WXX/MCP795BXX

## REGISTER 5-11: WATCHDOG 0x0A

| RW    | RW    | RW    | RW     | RW    | RW    | RW    | RW    |
|-------|-------|-------|--------|-------|-------|-------|-------|
| WDTEN | WDTIF | WDDEL | WDTPLS | WD3   | WD2   | WD1   | WD0   |
| bit 7 | bit 6 | bit 5 | bit 4  | bit 3 | bit 2 | bit 1 | bit 0 |

**Legend:** R = Readable Bit W = Writable Bit U = Unimplemented bit, Read as '0'

- bit 7 Bit 7 is a read/write bit that is set by the user and can be cleared by the user of the hardware. This bit is set to enable the WDT function and cleared to disable the function. This bit is cleared by the hardware when the VCC supply is not present, it is not set again when VCC is present.
- bit 6 Bit 6 is a read/write bit that is set in hardware when the WDT times out and the WD pin is asserted. This bit must be cleared in software to restart the WDT.
- bit 5 Bit 5 is a read/write bit and is set to enable a 64-second delay before the WDT starts to count. If this bit is set and the WDTIF bit is cleared then there will be a 64 second delay before the WDT starts to count. This bit should be set before the WDTEN bit is set.
- bit 4 Bit 4 is a read/write bit that is used to select the pulse width on the WD pin when the WDT times out.  
- 0 – 122 us Pulse  
- 1 – 125 ms Pulse
- bit 3:0 Bits <3:0> are read/write bits that are used to set the WDT time-out period as below (all times are based off the uncalibrated crystal reference). Bit 3 should be cleared and is reserved for future use:  
- 000 – 977 us  
- 001 – 15.6 ms  
- 010 – 62.5 ms  
- 011 – 125 ms  
- 100 – 1s  
- 101 – 16s  
- 110 – 32s  
- 111 – 64s

**Note:** Please see [Section 9.1.3, Watchdog Timer](#) for more information.



# MCP795WXX/MCP795BXX

## REGISTER 5-12: EVENT DETECT 0x0B

| RW    | RW    | RW    | RW    | RW    | RW    | RW    | RW    |
|-------|-------|-------|-------|-------|-------|-------|-------|
| EVHIF | EVLIF | EVEN1 | EVEN0 | EVWDT | EVLDB | EVHS1 | EVHS0 |
| bit 7 | bit 6 | bit 5 | bit 4 | bit 3 | bit 2 | bit 1 | bit 0 |

**Legend:** R = Readable Bit W = Writable Bit U = Unimplemented bit, Read as '0'

- bit 7 When the configured number of high speed events has occurred the  $\overline{\text{IRQ}}$  pin is asserted and the EVHIF bit is set in hardware. The clear the IRQ pin and reset the EVHIF bit must be cleared in software.
- bit 6 When an event occurs on the low-speed pin this  $\overline{\text{IRQ}}$  pin is asserted and the EVLIF bit is set. This bit must be cleared by software to reset the module and clear the  $\overline{\text{IRQ}}$  pin.
- bit 5:4 <1:0> These two bits determine what combination of the high and low-speed modules are enabled.
- 00 – Both modules are Off
  - 01 – Low-speed module enabled, high speed disabled
  - 10 – Low-speed module disabled, high speed enabled
  - 11 – Both modules are enabled
- bit 3 Setting this bit overrides any setting for the High-Speed Event Detection and allows the EVHS pin to clear the Watchdog Timer. This is edge triggered. Either and H-L or L-H transition will clear the WDT.
- bit 2 This is the Low-Speed Event Debounce setting. Depending on the state of this bit the low-speed pin will have to remain at the same state for the following periods to be considered valid.
- 0 – 31.25 ms
  - 1 – 500 ms
- bit 1:0 EVHS <1:0> These bits determine how many high-speed events must occur before the EVHIF bit is set. All of these events must occur within 250 ms (based on the uncalibrated 32.768 kHz clock).
- 00 – 1st Event
  - 01 – 4th Event
  - 10 – 16th Event
  - 11 – 32nd Event

**Note:** Please see [Section 9.1.4, Event Detection](#) for more information.

# MCP795WXX/MCP795BXX

## 6.0 ALARM 0 REGISTERS

### REGISTER 6-1: SECONDS 0x0C

| RW    | RW         |       | RW      |       |
|-------|------------|-------|---------|-------|
|       | 10 Seconds |       | Seconds |       |
| bit 7 | bit 6      | bit 4 | bit 3   | bit 0 |

**Legend:** R = Readable Bit W = Writable Bit U = Unimplemented bit, Read as '0'

bit 7 Unimplemented

bit 6-4 10 Seconds

bit 3-0 Seconds

**Note:** This contains the seconds match for the Alarm 0.

### REGISTER 6-2: MINUTES 0x0D

| RW    | RW         |       | RW      |       |
|-------|------------|-------|---------|-------|
|       | 10 Minutes |       | Minutes |       |
| bit 7 | bit 6      | bit 4 | bit 3   | bit 0 |

**Legend:** R = Readable Bit W = Writable Bit U = Unimplemented bit, Read as '0'

bit 7 Unimplemented

bit 6-4 10 Minutes

bit 3-0 Minutes

**Note:** This contains the minutes match for the Alarm 0.

### REGISTER 6-3: HOURS 0x0E

| RW    | RW    |               |         | RW    |       |
|-------|-------|---------------|---------|-------|-------|
|       | 12/24 | 10 Hour AM/PM | 10 Hour | Hour  |       |
| bit 7 | bit 6 | bit 5         | bit 4   | bit 3 | bit 0 |

**Legend:** R = Readable Bit W = Writable Bit U = Unimplemented bit, Read as '0'

bit 7 Unimplemented

bit 6 12/24 (this is a copy of bit 6 in the Hours register (0x03))

bit 5 10 Hour AM/PM

bit 4 10 Hour

bit 3-0 Hour

# MCP795WXX/MCP795BXX

## REGISTER 6-4: DAY 0x0F

|         |        |        |        |        |             |
|---------|--------|--------|--------|--------|-------------|
| RW      | RW     |        |        | RW     | RW          |
| ALM0PIN | ALM0C2 | ALM0C1 | ALM0C0 | ALM0IF | Day         |
| bit 7   | bit 6  | bit 4  |        | bit 3  | bit 2 bit 0 |

**Legend:** R = Readable Bit W = Writable Bit U = Unimplemented bit, Read as '0'

- bit 7 Bit 7 configures the pin that is used for the Alarm 0 output. If this bit is clear the  $\overline{IRQ}$  pin is used. If set, the WDO pin is used. If the WDT is enabled then a valid Alarm will assert the WDO pin for 122 us.
- BIT 6:4 Bits <6:4> sets the condition on what the Alarm will trigger. The following options are available:
- 000 – Seconds match
  - 001 – Minutes match
  - 010 – Hours match (logic takes into account 12/24 operation)
  - 011 – Day match. Generates interrupt at 12:00:00 AM
  - 100 – Date match
  - 101 – Unimplemented, do not use
  - 110 – Unimplemented, do not use
  - 111 – Seconds, Minutes, Hour, Day, Date and Month
- bit 3 Bit 3 is the ALM0IF bit. This is set by hardware when an alarm condition has be generated. The bit must be cleared in software.
- bit 2-0 Day

## REGISTER 6-5: DATE 0x10

|       |       |         |       |       |       |
|-------|-------|---------|-------|-------|-------|
| U     | U     | RW      | RW    | RW    |       |
|       |       | 10 Date |       | Date  |       |
| bit 7 | bit 6 | bit 5   | bit 4 | bit 3 | bit 0 |

**Legend:** R = Readable Bit W = Writable Bit U = Unimplemented bit, Read as '0'

- bit 7-6 Unimplemented
- bit 5-4 10 Date
- bit 3-0 Date

# MCP795WXX/MCP795BXX

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## REGISTER 6-6: MONTH 0x11

|       |       |       |          |       |
|-------|-------|-------|----------|-------|
| U     | U     | U     | RW       | RW    |
|       |       |       | 10 Month | Month |
| bit 7 | bit 6 | bit 5 | bit 4    | bit 3 |
|       |       |       |          | bit 0 |

**Legend:** R = Readable Bit W = Writable Bit U = Unimplemented bit, Read as '0'

bit 7-5 Unimplemented

bit 4 10 Month

bit 3-0 Month

**Note:** Month match is only available on Alarm 0.

## 7.0 ALARM 1 REGISTERS

### REGISTER 7-1: HUNDREDTHS OF SECONDS 0x12

|               |       |                       |       |
|---------------|-------|-----------------------|-------|
| RW            |       | RW                    |       |
| Tenth Seconds |       | Hundredths of Seconds |       |
| bit 7         | bit 4 | bit 3                 | bit 0 |

**Legend:** R = Readable Bit W = Writable Bit U = Unimplemented bit, Read as '0'

bit 7-4 Tenth Seconds

bit 3-0 Hundredths of Seconds

**Note:** Hundredths and Tenth seconds only available on Alarm 1.

### REGISTER 7-2: SECONDS 0x13

|       |            |       |         |       |
|-------|------------|-------|---------|-------|
| U     | RW         |       | RW      |       |
|       | 10 Seconds |       | Seconds |       |
| bit 7 | bit 6      | bit 4 | bit 3   | bit 0 |

**Legend:** R = Readable Bit W = Writable Bit U = Unimplemented bit, Read as '0'

bit 7 Unimplemented

bit 6-4 10 Seconds

bit 3-0 Seconds

### REGISTER 7-3: MINUTES 0x14

|       |            |       |         |       |
|-------|------------|-------|---------|-------|
| U     | RW         |       | RW      |       |
|       | 10 Minutes |       | Minutes |       |
| bit 7 | bit 6      | bit 4 | bit 3   | bit 0 |

**Legend:** R = Readable Bit W = Writable Bit U = Unimplemented bit, Read as '0'

bit 7 Unimplemented

bit 6-4 10 Minutes

bit 3-0 Minutes

# MCP795WXX/MCP795BXX

## REGISTER 7-4: HOURS 0x15

|       |       |               |         |       |       |
|-------|-------|---------------|---------|-------|-------|
| U     | RW    | RW            | RW      | RW    |       |
|       | 12/24 | 10 Hour AM/PM | 10 Hour | Hour  |       |
| bit 7 | bit 6 | bit 5         | bit 4   | bit 3 | bit 0 |

**Legend:** R = Readable Bit W = Writable Bit U = Unimplemented bit, Read as '0'

bit 7 Unimplemented  
bit 6 12/24  
bit 5 10 Hour AM/PM  
bit 4 10 Hour  
bit 3-0 Hour

## REGISTER 7-5: DAY 0x16

|         |        |        |        |        |             |
|---------|--------|--------|--------|--------|-------------|
| RW      | RW     | RW     | RW     | RW     | RW          |
| ALM1PIN | ALM1C2 | ALM1C1 | ALM1C0 | ALM1IF | Day         |
| bit 7   | bit 6  | bit 5  | bit 4  | bit 3  | bit 2 bit 0 |

**Legend:** R = Readable Bit W = Writable Bit U = Unimplemented bit, Read as '0'

bit 7 Bit 7 configures the pin that is used for the Alarm 0 output. If this bit is clear the  $\overline{IRQ}$  pin is used. If set, the  $\overline{WDO}$  pin is used. If the WDT is enabled then a valid Alarm will assert the  $\overline{WDO}$  pin for 122 us.

BIT 6:4 Bits <6:4> sets the condition on what the Alarm will trigger. The following options are available:

- 000 – Seconds match
- 001 – Minutes match
- 010 – Hours match (logic takes into account 12/24 operation)
- 011 – Day match, generates interrupt at 12:00:00 am
- 100 – Date match
- 101 – Hundredths/Tenth of Seconds
- 110 – Unimplemented do not use
- 111 – Seconds, Minutes, Hour, Day and Date

bit 3 Bit 3 is the ALM1IF bit. This is set by hardware when an alarm condition has been generated. The bit must be cleared in software.

bit 2-0 Day

# MCP795WXX/MCP795BXX

## REGISTER 7-6: DATE 0x17

|       |       |         |       |       |  |       |
|-------|-------|---------|-------|-------|--|-------|
| U     | U     | RW      |       | RW    |  |       |
|       |       | 10 Date |       | Date  |  |       |
| bit 7 | bit 6 | bit 5   | bit 4 | bit 3 |  | bit 0 |

**Legend:** R = Readable Bit W = Writable Bit U = Unimplemented bit, Read as '0'

bit 7-6 Unimplemented  
bit 5-4 10 Date  
bit 3-0 Date

# MCP795WXX/MCP795BXX

## 8.0 POWER-DOWN TIME-STAMP REGISTERS

**Note:** It is strongly recommended that the timesaver function only be used when the oscillator is running. This will ensure accurate functionality.

### REGISTER 8-1: MINUTES 0x18

|       |            |       |         |       |
|-------|------------|-------|---------|-------|
| U     | RW         |       | RW      |       |
|       | 10 Minutes |       | Minutes |       |
| bit 7 | bit 6      | bit 4 | bit 3   | bit 0 |

**Legend:** R = Readable Bit W = Writable Bit U = Unimplemented bit, Read as '0'

bit 7 Unimplemented  
 bit 6-4 10 Minutes  
 bit 3-0 Minutes

### REGISTER 8-2: HOUR 0x19

|       |       |               |          |       |       |
|-------|-------|---------------|----------|-------|-------|
| U     | RW    | RW            | RW       | RW    |       |
|       | 12/24 | 10 Hour AM/PM | 10 Hours | Hour  |       |
| bit 7 | bit 6 | bit 5         | bit 4    | bit 3 | bit 0 |

**Legend:** R = Readable Bit W = Writable Bit U = Unimplemented bit, Read as '0'

bit 7 Unimplemented  
 bit 6 12/24 (this is a copy of the status of the bit in register 0x03:6 at the time of the event)  
 bit 5 10 Hour AM/PM  
 bit 4 10 Hour  
 bit 3-0 Hour

### REGISTER 8-3: DATE 0x1A

|       |       |         |       |       |       |
|-------|-------|---------|-------|-------|-------|
| U     | U     | RW      | RW    | RW    |       |
|       |       | 10 Date |       | Date  |       |
| bit 7 | bit 6 | bit 5   | bit 4 | bit 3 | bit 0 |

**Legend:** R = Readable Bit W = Writable Bit U = Unimplemented bit, Read as '0'

bit 7-6 Unimplemented  
 bit 5-4 10 Date  
 bit 3-0 Date



# MCP795WXX/MCP795BXX

## REGISTER 8-4: MONTH 0x1B

|       |       |       |          |       |
|-------|-------|-------|----------|-------|
| RW    | RW    | RW    | RW       | RW    |
| Day   |       |       | 10 Month | Month |
| bit 7 | bit 6 | bit 5 | bit 4    | bit 3 |
|       |       |       |          | bit 0 |

**Legend:** R = Readable Bit W = Writable Bit U = Unimplemented bit, Read as '0'

bit 7-5 Day  
bit 4 10 Month  
bit 3-0 Month

# MCP795WXX/MCP795BXX

## 9.0 POWER-UP TIME REGISTERS

**Note:** It is strongly recommended that the timesaver function only be used when the oscillator is running. This will ensure accurate functionality.

### REGISTER 9-1: MINUTES 0x1C

| U     | RW         |       | RW      |       |
|-------|------------|-------|---------|-------|
|       | 10 Minutes |       | Minutes |       |
| bit 7 | bit 6      | bit 4 | bit 3   | bit 0 |

**Legend:** R = Readable Bit W = Writable Bit U = Unimplemented bit, Read as '0'

bit 7 Unimplemented  
bit 6-4 10 Minutes  
bit 3-0 Minutes

### REGISTER 9-2: HOUR 0x1D

| U     | RW    | RW            | RW       | RW    |       |
|-------|-------|---------------|----------|-------|-------|
|       | 12/24 | 10 Hour AM/PM | 10 Hours | Hour  |       |
| bit 7 | bit 6 | bit 5         | bit 4    | bit 3 | bit 0 |

**Legend:** R = Readable Bit W = Writable Bit U = Unimplemented bit, Read as '0'

bit 7 Unimplemented  
bit 6 12/24 (this is a copy of the status of the bit in register 0x03:6 at the time of the event)  
bit 5 10 Hour AM/PM  
bit 4 10 Hour  
bit 3-0 Hour

# MCP795WXX/MCP795BXX

## REGISTER 9-3: DATE 0x1E

|       |       |         |       |       |       |
|-------|-------|---------|-------|-------|-------|
| U     | U     | RW      | RW    | RW    |       |
|       |       | 10 Date |       | Date  |       |
| bit 7 | bit 6 | bit 5   | bit 4 | bit 3 | bit 0 |

**Legend:** R = Readable Bit W = Writable Bit U = Unimplemented bit, Read as '0'

bit 7-6 Unimplemented

bit 5-4 10 Date

bit 3-0 Date

## REGISTER 9-4: MONTH 0x1F

|       |       |       |          |       |       |
|-------|-------|-------|----------|-------|-------|
| RW    | RW    | RW    | RW       | RW    |       |
| Day   |       |       | 10 Month | Month |       |
| bit 7 | bit 6 | bit 5 | bit 4    | bit 3 | bit 0 |

**Legend:** R = Readable Bit W = Writable Bit U = Unimplemented bit, Read as '0'

bit 7-5 Day

bit 4 10 Month

bit 3-0 Month

# MCP795WXX/MCP795BXX

## 9.1 Features

### 9.1.1 CALIBRATION

The Calibration register (0x09h) allows a number of RTCC counts to be added or subtracted (Cal Sign bit located at 0x03:7) each minute. This allows for calibration to reduce the PPM error due to oscillator shift. This register is volatile.

The CALSIGN determines if calibration is positive or negative.

A value of 0x00 in the Calibration register will result in no calibration.

The calibration is linear, with one bit representing two RTC clocks.

The MCP795XXX utilizes digital calibration to correct for the inaccuracies of the input clock source (either external or crystal). Calibration is enabled by setting the value of the Calibration register at address 08H. Calibration is achieved by adding or subtracting a number of input clock cycles per minute in order to achieve ppm level adjustments in the internal timing function of the MCP795XXX.

The CALSGN bit is the sign bit, with a '1' indicating subtraction and a '0' indicating addition. The eight bits in the calibration register indicate the number of input clock cycles (multiplied by two) that are subtracted or added per minute to the internal timing function.

The internal timing function can be monitored using the CLKOUT output pin by setting bit 6 (SQWE) and bits <2:0> (RS2, RS1, RS0) of the Control register at address 07H. Note that the CLKOUT output waveform is disabled when the MCP795XXX is running in VBAT mode. With the SQWE bit set to '1', there are two methods that can be used to observe the internal timing function of the MCP795XXX:

#### A. RS2 bit set to '0'

With the RS2 bit set to '0', the RS1 and RS0 bits enable the following internal timing signals to be output on the CLKOUT pin:

| RS2 | RS1 | RS0 | Output Signal |
|-----|-----|-----|---------------|
| 0   | 0   | 0   | 1 Hz          |
| 0   | 0   | 1   | 4.096 kHz     |
| 0   | 1   | 0   | 8.192 kHz     |
| 0   | 1   | 1   | 32.768 kHz    |

The frequencies listed in the table presume an input clock source of exactly 32.768 kHz. In terms of the equivalent number of input clock cycles, the table becomes:

| RS2 | RS1 | RS0 | Output Signal |
|-----|-----|-----|---------------|
| 0   | 0   | 0   | 32768         |
| 0   | 0   | 1   | 8             |
| 0   | 1   | 0   | 4             |
| 0   | 1   | 1   | 1             |

With regards to the calibration function, the Calibration register setting has no impact upon the CLKOUT output clock signal when bits RS1 and RS0 are set to '11'. The setting of the calibration register to a non-zero value enables the calibration function which can be observed on the CLKOUT output pin. The calibration function can be expressed in terms of the number of input clock cycles added/subtracted from the internal timing function.

With bits RS1 and RS0 set to '00', the calibration function can be expressed as:

$$T_{\text{output}} = (32768 \pm (2 * \text{CALREG})) T_{\text{input}}$$

where:

$$T_{\text{output}} = \text{clock period of CLKOUT output signal}$$

$$T_{\text{input}} = \text{clock period of input signal}$$

$$\text{CALREG} = \text{decimal value of calibration register setting and the sign is determined by the CALSGN bit.}$$

Since the calibration is done once per minute (i.e. when the internal minute counter is incremented), only one cycle in sixty of the CLKOUT output waveform is affected by the calibration setting. Also note that the duty cycle of the CLKOUT output waveform will not necessarily be at 50% when the calibration setting is applied.

With bits RS1 and RS0 set to '01' or '10', the calibration function can not be expressed in terms of the input clock period. In the case where the MSB of the Calibration register is set to '0', the waveform appearing at the CLKOUT output pin will be "delayed", once per minute, by twice the number of input clock cycles defined in the Calibration register. The CLKOUT waveform will appear as shown in [Figure 9-1](#).

# MCP795WXX/MCP795BXX

In the case where the MSB of the Calibration register is set to '1', the CLKOUT output waveforms that appear when bits RS1 and RS0 are set to '01' or '10' are not as responsive to the setting of the Calibration register. For example, when outputting the 4.096 kHz waveform (RS1, RS0 set to '01'), the output waveform is generated using only eight input clock cycles. Consequently, attempting to subtract more than eight input clock cycles from this output does not have a meaningful affect on the resulting waveform. Any affect on the output will appear as a modification in both the frequency and duty cycle of the waveform appearing on the CLKOUT output pin.

B.RS2 bit set to '1'

With the RS2 bit set to '1', the following internal timing signal is output on the CLKOUT pin:

| RS2 | RS1 | RS0 | Output Signal |
|-----|-----|-----|---------------|
| 1   | x   | x   | 1.0 Hz        |

The frequency listed in the table presumes an input clock source of exactly 32.768 kHz. In terms of the equivalent number of input clock cycles, the table becomes:

| RS2 | RS1 | RS0 | Output Signal |
|-----|-----|-----|---------------|
| 1   | x   | x   | 32768         |

Unlike the method previously described, the calibration setting is continuously applied and affects every cycle of the output waveform. This results in the modulation of the frequency of the output waveform based upon the setting of the Calibration register.

Using this setting, the calibration function can be expressed as:

$$T_{\text{output}} = (32768 \pm (2 * \text{CALREG})) T_{\text{input}}$$

where:

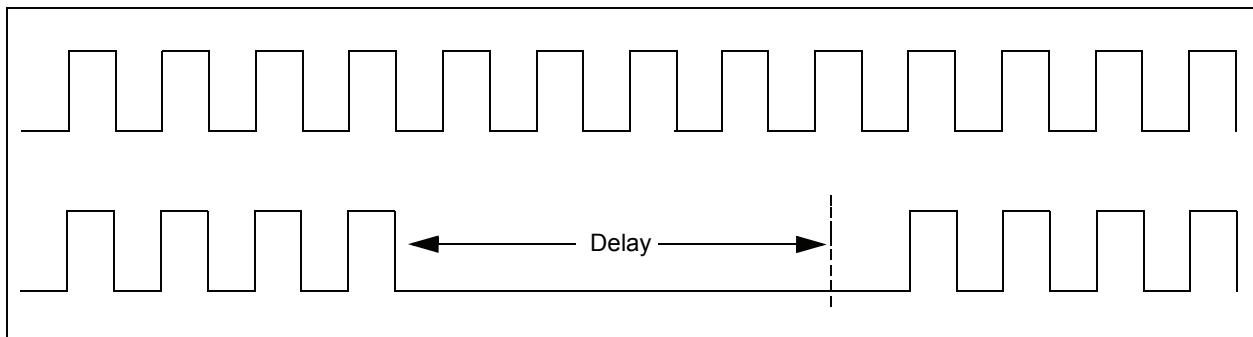
$$T_{\text{output}} = \text{clock period of CLKOUT output signal}$$

$$T_{\text{input}} = \text{clock period of input signal}$$

$$\text{CALREG} = \text{decimal value of calibration register setting and the sign is determined by the CALSGN bit.}$$

Since the calibration is done every cycle, the frequency of the output CLKOUT waveform is constant.

**FIGURE 9-1: CLKOUT WAVEFORM**



# MCP795WXX/MCP795BXX

## 9.1.2 CLOCKOUT FUNCTION

The MCP795W20 features a push-pull pin CLKOUT that can supply a digital signal based on a division of the main 32.768 kHz clock. If this function is not used the pin may be directly controlled using the OUT bit in the Control register (0x08). In VBAT mode, CLKOUT is logic low. In VDD POR condition, the CLKOUT is tri-stated. For the MCP795BXX devices, this pin functions as a Power-up Boot clock. A 32.768 kHz clock is enabled upon application of VCC.

## 9.1.3 WATCHDOG TIMER

The on-board Watchdog Timer is configured by loading the register at address 0x0A. The WDT is not available when the MCP795XXX is operating from the VBAT supply. When in this condition, the WDT is disabled by the hardware and must be re-enabled when VCC is restored. The output of the WDT is based on the uncalibrated 32.768 kHz oscillator.

Description of WDT Bits:

- Bit 7 is a read/write bit that is set and cleared by software. This bit is set to enable the WDT function and cleared to disable the function. A VCC power fail will cause this bit to be cleared and not re-enabled when VCC is restored.
- Bit 6 is a read/write bit that is set in hardware when the WDT times out and the  $\overline{WDO}$  pin is asserted. This bit must be cleared in software to restart the WDT.
- Bit 5 is a read/write bit and is set to enable a 64-second delay before the WDT starts to count. If this bit is set and the WDTIF bit is cleared then there will be a 64-second delay before the WDT starts to count. This bit should be set before the WDTEN bit is set.
- Bit 4 is a read/write bit that is used to select the pulse width on the  $\overline{WDO}$  pin when the WDT times out.
  - 0 – 122 us Pulse
  - 1 – 125 ms Pulse
- Bits <3:0> are read/write bits that are used to set the WDT time-out period as below (all times are based off the uncalibrated crystal reference). Bit 3 should be cleared and is reserved for future use:
  - 000 – 977 us
  - 001 – 15.6 ms
  - 010 – 62.5 ms
  - 011 – 125 ms
  - 100 – 1s
  - 101 – 16s
  - 110 – 32s
  - 111 – 64s

To reset the WDT the CLRWDT instruction must be issued over the SPI interface, as shown in Figure 9-7. If the WDT is not cleared with the CLRWDT command before time-out then the  $\overline{WDO}$  pin will assert and the WDTIF bit will be set. The WDTIF bit must be cleared by software to restart the WDT.

## 9.1.4 EVENT DETECTION

The on-chip event detection consists of two separate detection circuits.

The high-speed circuit is designed to operate with a digital signal from the output of an external signal conditioning circuit. The input is edge triggered, and will generate an interrupt when the correct number of events has occurred.

The low-speed circuit is designed to operate directly with mechanical switches and support built-in switch debounce.

Registers associated with the event detection module:

- EVHIF – When the configured number of high speed events has occurred the  $\overline{IRQ}$  pin is asserted and the EVHIF bit is set. This bit must be cleared by software to reset the module and clear the  $\overline{IRQ}$  pin.
- EVLIF – When an event occurs on the low-speed pin this  $\overline{IRQ}$  pin is asserted and the EVLIF bit is set. This bit must be cleared by software to reset the module and clear the  $\overline{IRQ}$  pin.
- EVEN<1:0> – These two bits determine what combination of the high and low-speed modules are enabled.
  - 00 – Both modules are off
  - 01 – Only low-speed module enabled
  - 10 – Only high-speed module disabled
  - 11 – Both modules are enabled
- EVWDT – setting this bit overrides any setting for the High-Speed Event Detection and allows the EVHS pin to clear the Watchdog Timer. This is edge triggered. Either H-L or L-H transition will clear the WDT.
- EVLDB – This is the low-speed event debounce setting. Depending on the state of this bit the low-speed pin will have to remain at the same state for the following periods to be considered valid.
  - 0 – 31.25 ms
  - 1 – 500 ms

# MCP795WXX/MCP795BXX

The debounce will only operate if the clock is running and these timings are based on the uncalibrated 32.768 kHz clock.

- EVHS<1:0> – These bits determine how many high-speed events must occur before the EVHIF bit is set. All of these events must occur within 250 ms.
  - 00 – 1st Event
  - 01 – 4th Event
  - 10 – 16th Event
  - 11 – 32nd Event

## 9.1.5 VBAT SWITCHOVER

If the VBAT feature is not used, the VBAT pin should be connected to GND. A low value series resistor and Schottky diode are recommended between the external battery and the VBAT pin to reduce inrush current and also to prevent any leakage current reaching the external VBAT source.

The VTRIP point is defined as 1.5V typical. When VDD falls below 1.5V the system will continue to operate the RTCC and SRAM using the VBAT supply. There is ~50mV hyst in the trip point changeover. The following conditions apply:

**TABLE 9-1: VBAT CHANGOVER CONDITIONS**

| Supply Condition          | Read/Write Access | Powered By |
|---------------------------|-------------------|------------|
| $VCC < VTRIP, VCC < VBAT$ | No                | VBAT       |
| $VCC > VTRIP, VCC < VBAT$ | Yes               | VCC        |
| $VCC > VTRIP, VCC > VBAT$ | Yes               | VCC        |

For more information on VBAT conditions see the RTCC Best Practices Application Note, AN1365 (DS01365).

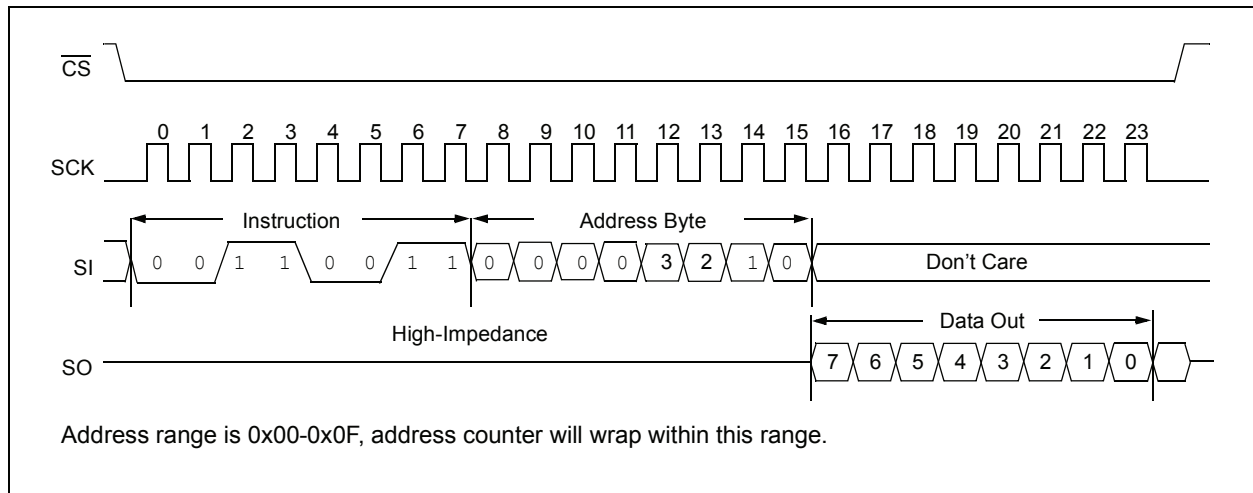
## 9.1.6 UNIQUE ID LOCATIONS

When the unique ID locations are preprogrammed from the factory with either an EUI-48 or EUI-64, the EUI code is programmed into location 0x00-0x07. Locations 0x08-0x0F are blank (0xFF).

**Note:** For EUI-64, the data is located in address 0x00-0x07. For EUI-48 locations, 0x02-0x07 contain the data. 0x00/01 contain 0xFF.

To read the unique ID location the IDREAD command is given with the starting address. Valid addresses are 0x00 through 0x0F. All 16 bytes can be read out in a single command by clocking the device. Trying to access locations past 0x0F will result in the address wrapping within these 16 bytes.

**FIGURE 9-2: IDREAD COMMAND SEQUENCE**

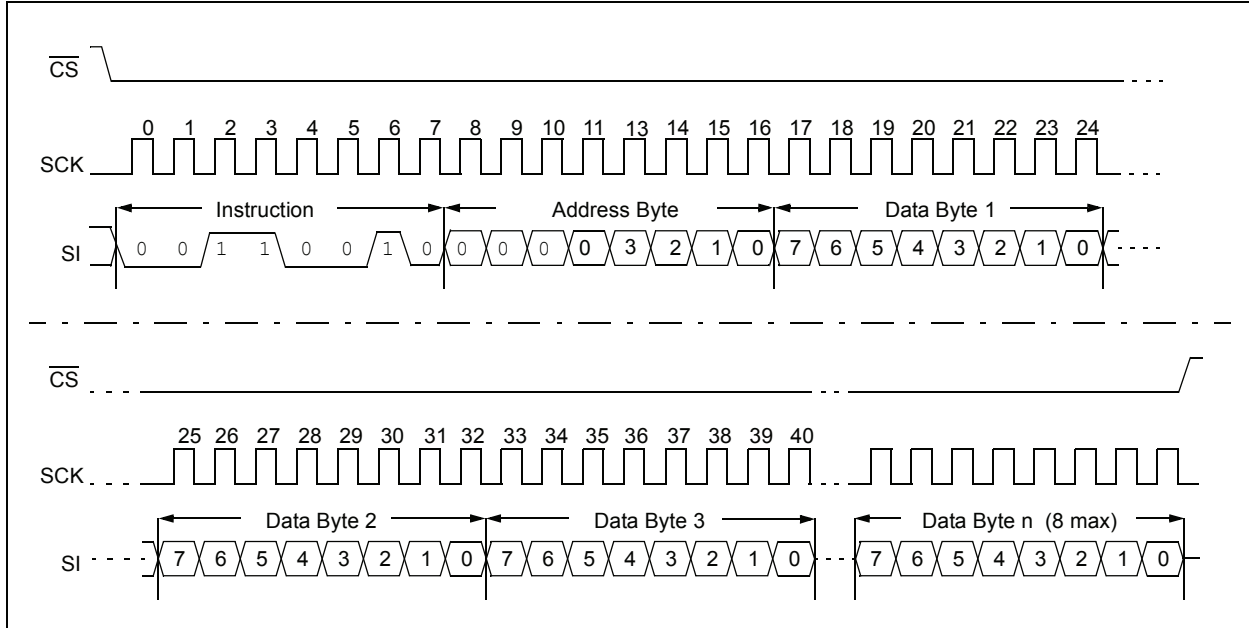


To write to the unique ID locations, the IDWRITE command is used. The device must be write enabled and the correct unlock sequence must have been performed. See [Section 10.1.4, Write to the Unlock Register](#) for more details.

The ID locations can be written to using the IDWRITE command. The valid address is between 0x00 and 0x0F. The entire 16 bytes must be written in two groups of 8 bytes. A maximum of 8 bytes can be written at once.

# MCP795WXX/MCP795BXX

FIGURE 9-3: IDWRITE COMMAND SEQUENCE





## 9.1.7 POWER-FAIL TIME-STAMP

The MCP795XXX family of RTCC devices feature a power-fail time-stamp feature. This feature will save the time at which VCC crosses the VTRIP voltage and is shown in Figure 9-4. To use this feature, a VBAT supply must be present and the oscillator must also be running. There are two separate sets of registers that are used to record this information:

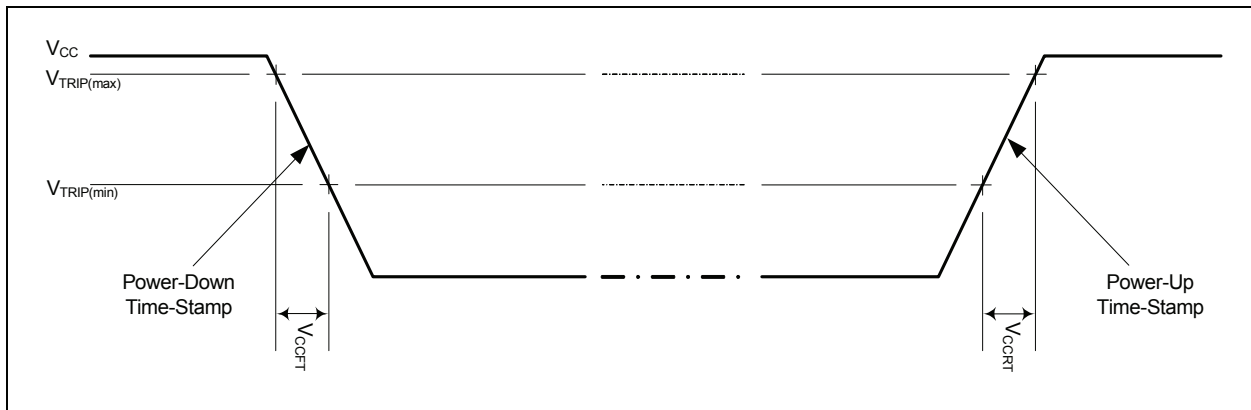
- The first set located at 0x18h through 0x1Bh are loaded at the time when VCC falls below VTRIP and the RTCC operates on the VBAT. The VBAT (register 0x03h bit 4) bit is also set at this time.

- The second set of registers, located at 0x1Ch through 0x1Fh, are loaded at the time when VCC is restored and the RTCC switches to VCC.

The power-fail time-stamp registers are cleared when the VBAT bit is cleared in software.

**Note:** It is strongly recommended that the time-saver function only be used when the oscillator is running. This will ensure accurate functionality

**FIGURE 9-4: POWER-FAIL GRAPH**



## 9.1.8 READ STATUS REGISTER (SRREAD)

The Read Status Register (SRREAD) 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   |
| — | — | — | — | R/W | R/W | R   | R   |
| X | X | X | X | BP1 | BP0 | WEL | WIP |

**Note:** Once a Write Status Register is initiated and a Read Status Register is attempted the new values for the nonvolatile bits will be read regardless of whether the values have been actually programmed into the device. (i.e., The values are moved to the latches prior to the write operation).

The **Write-In-Process (WIP)** bit indicates whether the MCP795XXX is busy with a nonvolatile memory write operation. When set to a '1', a write is in progress, when set to a '0', no write is in progress. This bit is read-only.

The **Write Enable Latch (WEL)** bit indicates the status of the write enable latch. When set to a '1', the latch allows writes to the nonvolatile memory, when set to a '0', the latch prohibits writes to the nonvolatile memory. The state of this bit can always be updated

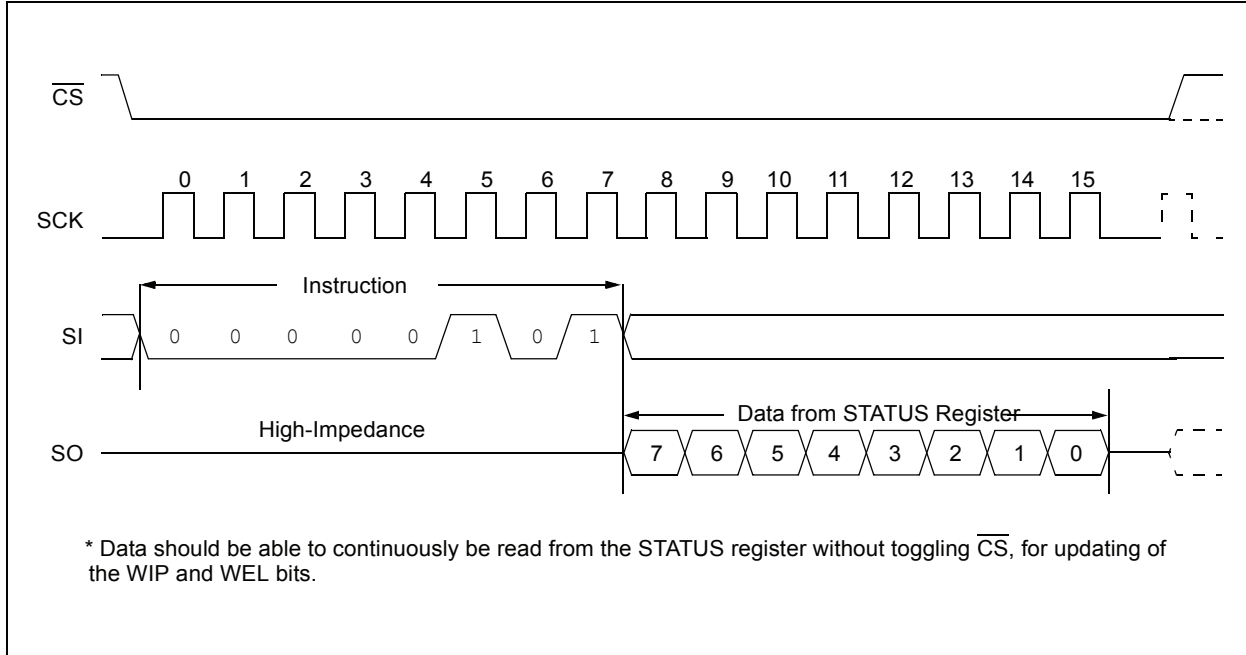
via the WREN or WRDI commands, regardless of the state of write protection on the STATUS register. This bit is read-only.

The **Block Protection (BP0 and BP1)** bits indicate which blocks are currently write-protected. These bits are set by the user issuing the WRSR instruction. These bits are nonvolatile.

See Figure 9-5 for the RDSR timing sequence.

# MCP795WXX/MCP795BXX

FIGURE 9-5: READ STATUS REGISTER TIMING SEQUENCE



## 9.1.9 WRITE STATUS REGISTER (SRWRITE)

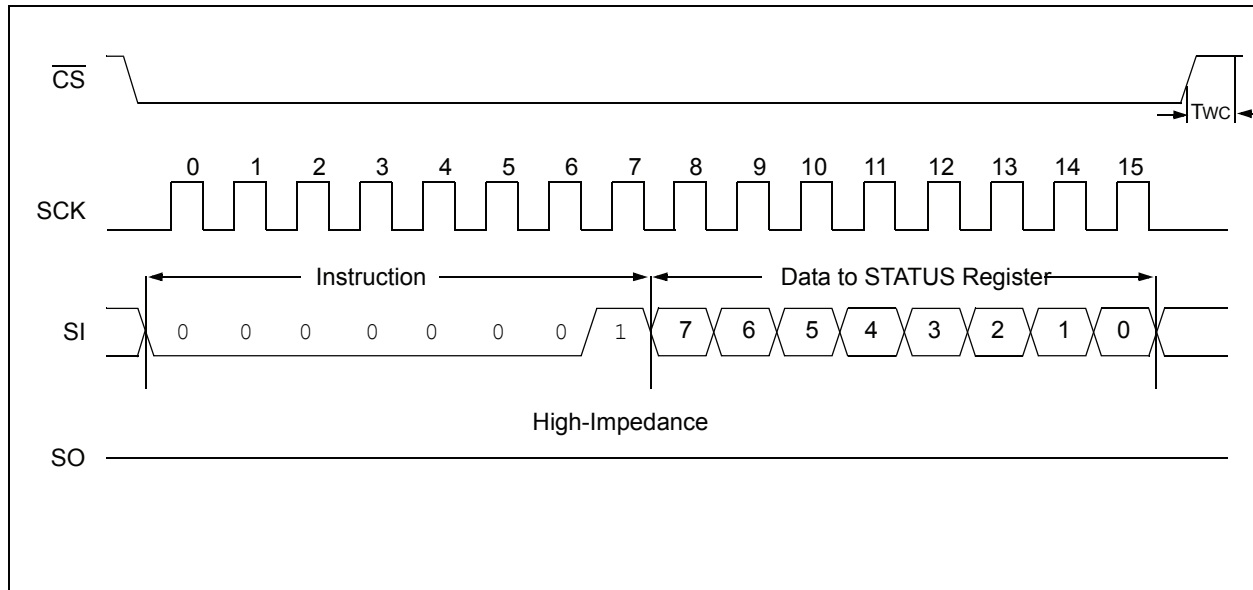
The Write Status Register (SRWRITE) instruction allows the user to select one of four levels of protection for the array by writing to the appropriate bits in the status register. The array is divided up into four segments. The user has the ability to write protect none, one, two, or all four of the segments of the array. The partitioning is controlled as shown in [Table 9-2](#).

See [Figure 9-6](#) for the SRWRITE timing sequence.

**TABLE 9-2: ARRAY PROTECTION**

| BP1 | BP0 | Array Addresses Write-Protected (2 kbit shown) |
|-----|-----|--|
| 0   | 0   | none   |
| 0   | 1   | upper 1/4 (C0h-FFh)                            |
| 1   | 0   | upper 1/2 (80h-FFh)                            |
| 1   | 1   | all (00h-FFh)                                  |

**FIGURE 9-6: WRITE STATUS REGISTER TIMING SEQUENCE**



# MCP795WXX/MCP795BXX

## 9.1.10 DATA PROTECTION

The following protection has been implemented to prevent inadvertent writes to the array:

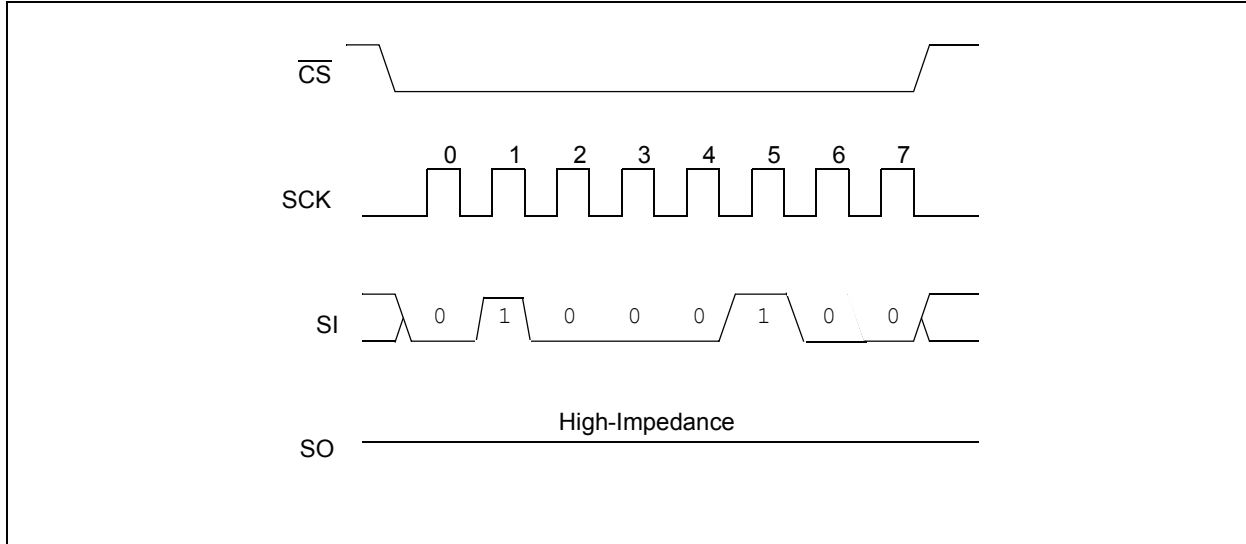
- The write enable latch is reset on power-up
- A Write Enable instruction must be issued to set the write enable latch
- After a byte write, page write, unique ID write, or STATUS register write, the write enable latch is reset

- $\overline{CS}$  must be set high after the proper number of clock cycles to start an internal write cycle
- Access to the array during an internal EEPROM write cycle is ignored and programming is continued
- Block protect bits are ignored for UID writes

## 9.1.11 CLEAR WATCHDOG INSTRUCTION

The Clear Watchdog command resets the internal Watchdog Timer.

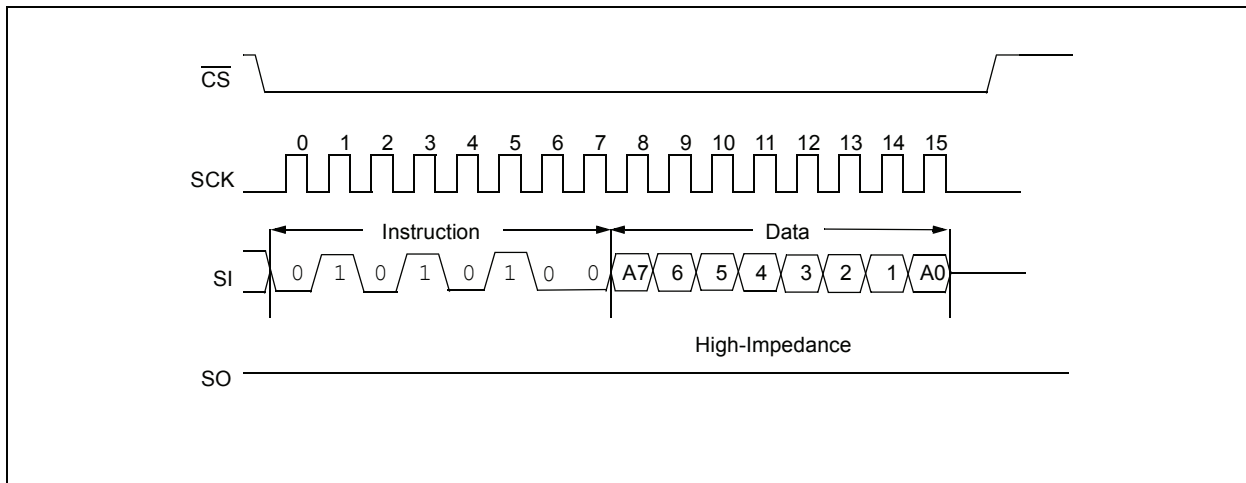
**FIGURE 9-7: CLRWDT**



## 9.1.12 CLEAR RAM INSTRUCTION

The Clear Ram instruction is a 2-byte command that will reset the internal SRAM to the known value. Using this command, all locations in the SRAM are set to 00h and the data value contained in the second byte of the command is ignored.

**FIGURE 9-8: CLRRAM**



## 9.2 Crystal Specification and Selection

The MCP795XXX has been designed to operate with a standard 32.768 kHz tuning fork crystal. The on-board oscillator has been characterized to operate with a crystal of maximum ESR of 70K Ohms.

Crystals with a comparable specification are also suitable for use with the MCP795XXX.

The table below is given as design guidance and a starting point for crystal and capacitor selection.

| Manufacturer                          | Part Number          | Crystal Capacitance | CX1 Value | CX2 Value |
|---------------------------------------|----------------------|---------------------|-----------|-----------|
| Micro Crystal                         | CM7V-T1A             | 7pF                 | 10pF      | 12pF      |
| Citizen                               | CM200S-32.768KDZB-UT | 6pF                 | 10pF      | 8 pF      |
| Please work with your crystal vendor. |                      |                     |           |           |

### EQUATION 9-1:

$$C_{load} = \frac{CX2 \times CX1}{CX2 + CX1} + C_{stray}$$

The following must also be taken into consideration:

- Pin capacitance (to be included in Cx2 and Cx1)
- Stray Board Capacitance

The recommended board layout for the oscillator area is shown in [Figure 9-9](#). This actual board shows the crystal and the load capacitors. In this example, C2 is CX1, C1 is CX2 and the crystal is designated as Y1.

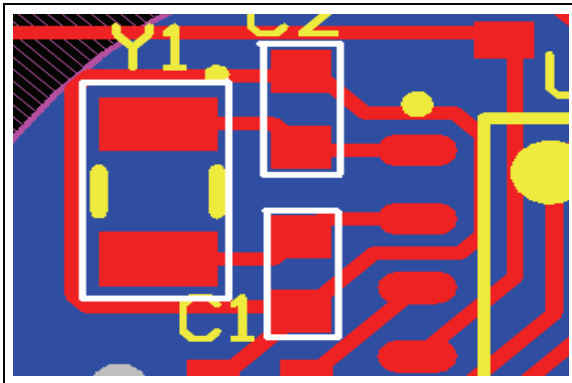
When calculating the effective load capacitance, [Equation 9-1](#) can be used.

Gerber files are available on request. Please contact your Microchip Sales representative.

It is required that the final application should be tested with the chosen crystal and capacitor combinations across all operating and environmental conditions. Please also consult with the crystal specification to observe correct handling and reflow conditions and for information on ideal capacitor values.

For more information please see the RTCC Best Practices AN1365 (DS01365).

**FIGURE 9-9: BOARD LAYOUT**



# MCP795WXX/MCP795BXX

## 10.0 ON-BOARD MEMORY

The MCP795XXX has both on-board EEPROM memory and battery-backed SRAM. The SRAM is arranged as 64 x 8 bytes and is retained when VCC supply is removed. The EEPROM is organized as 256/128 x 8 bytes. The EEPROM is nonvolatile and does not require VBAT supply for retention.

### 10.1 SRAM

The SRAM array is a battery-backed-up array of 64 bytes. The SRAM is accessed using the Read and Write commands, starting at address 0x20h.

Upon power-up the SRAM locations are in an undefined state but can be set to a known value using the CLR<sub>RAM</sub> instruction (Figure 9-8).

#### 10.1.1 SRAM/RTCC OPERATION

The MCP795XXX contains a Real-Time Clock and Calendar. The RTCC registers and SRAM array are accessed using the same commands. The RTCC registers and SRAM array are powered internally from the switched supply that is either connected to VCC or VBAT supply. No external read/write operations are permitted when the device is running from the VBAT supply.

Table 1-2 contains a list of the possible instruction bytes and format for device operation.

#### 10.1.2 READ SEQUENCE

The part is selected by pulling  $\overline{CS}$  low. The 8-bit READ instruction is transmitted to the MCP795W20 followed by the 8-bit address (A7 through A0). After the correct READ instruction and address are sent, the data stored in the memory at the selected address is shifted out on the SO pin. The data stored in the memory at the next address can be read sequentially by continuing to provide clock pulses. The internal Address Pointer is automatically incremented to the next higher address after each byte of data is shifted out.

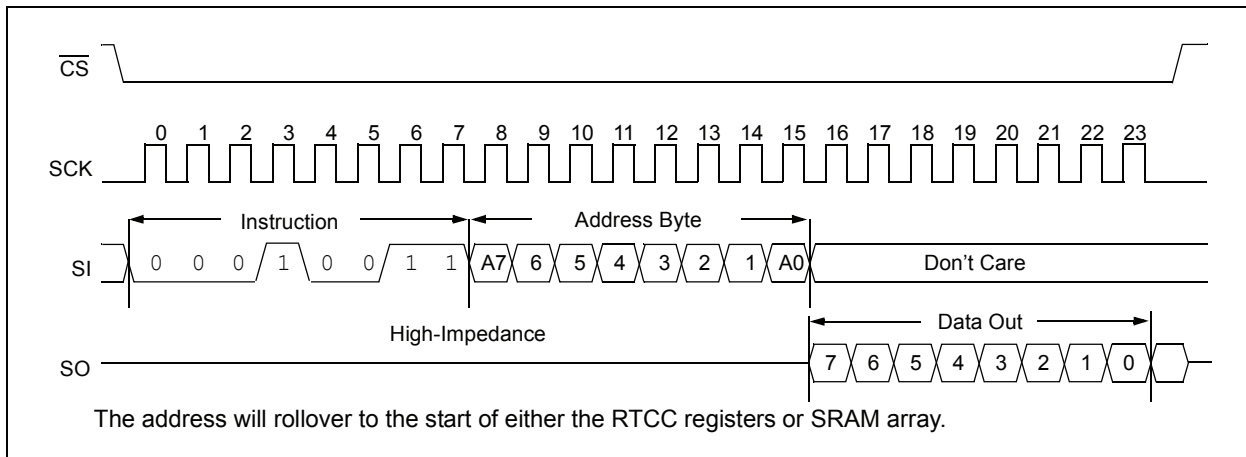
As the RTCC registers are separate from the SRAM array, when reading the RTCC registers set the address will wrap back to the start of the RTCC registers. Also when an address within the SRAM array is loaded the internal Address Pointer will wrap back to the start of the SRAM array. The READ instruction can be used to read the registers and array indefinitely by continuing to clock the device. The read operation is terminated by raising the  $\overline{CS}$  pin (Figure 10-1).

#### 10.1.3 WRITE SEQUENCE

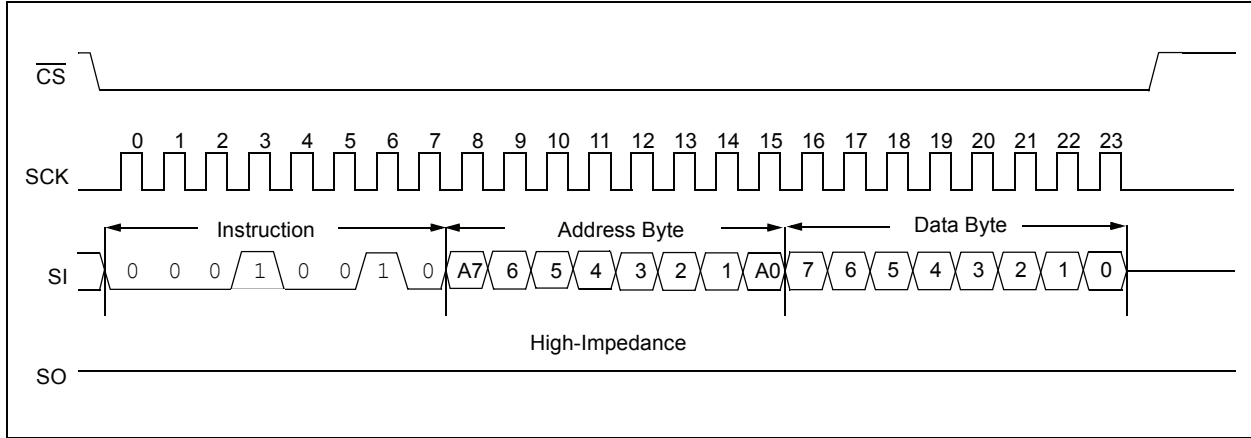
As the RTCC registers and SRAM array do not require the WREN sequence like the nonvolatile memory, the user may proceed by setting the  $\overline{CS}$  low, issuing the WRITE instruction, followed by the address, and then the data to be written. As no write cycle is required for the RTCC registers and SRAM array the entire contents can be written in a single command.

For the last data byte to be written to the RTCC registers and SRAM array, the  $\overline{CS}$  must be brought high after the last byte has been clocked in. If  $\overline{CS}$  is brought high at any other time, the last byte will not be written. Refer to Figure 10-2 for more detailed illustrations on the write sequence.

FIGURE 10-1: READ SEQUENCE



**FIGURE 10-2: WRITE SEQUENCE**



## 10.1.4 WRITE TO THE UNLOCK REGISTER

The MCP795XXX contains a protected area of 64 bits that can be used to hold a unique ID, such as a serial number or MAC address code. To gain write access to these locations, a specific sequence is required. Any deviation from this sequence will reset the lock on these locations. Once these locations have been unlocked they have to be written to in the next command by issuing the correct command. A write to a different location will lock the ID locations and clear the WEL bit.

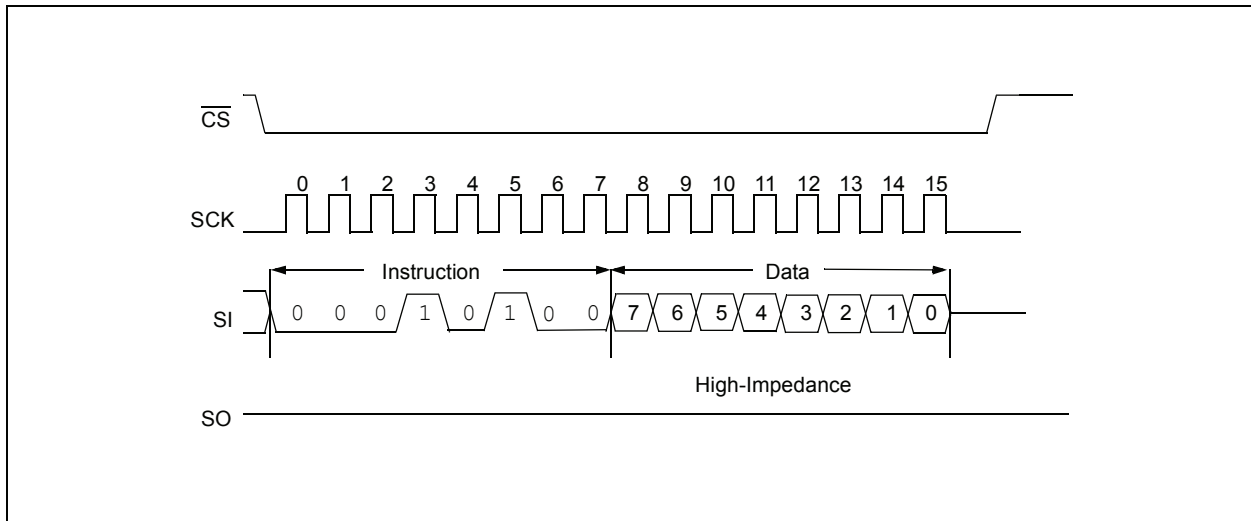
The following is a list of strict conditions which have to be followed before the unique locations can be written to:

- EEWREN instruction successfully executed
- UNLOCK 0x55 instruction successfully executed
- UNLOCK 0xAA instruction successfully executed

To issue each Unlock instruction the UNLOCK command is sent followed by 0x55. Then in a separate command the UNLOCK command is issued followed by 0xAA. It is a requirement that each command be separate, that is CS must toggle between each command.

Information on how to read and write the ID locations is detailed in [Section 9.1.6, Unique ID Locations](#).

**FIGURE 10-3: UNLOCK SEQUENCE**



# MCP795WXX/MCP795BXX

## 11.0 PACKAGING INFORMATION

### 11.1 Package Marking Information

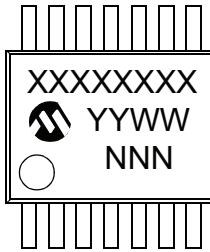
14-Lead SOIC (.150")



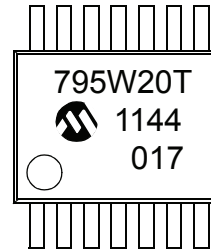
Example



14-Lead TSSOP



Example



| Part Number | 1st Line Marking Codes |         |
|-------------|------------------------|---------|
|             | SOIC                   | TSSOP   |
| MCP795W20   | MCP795W20              | 795W20T |
| MCP795W10   | MCP795W10              | 795W10T |
| MCP795W21   | MCP795W21              | 795W21T |
| MCP795W11   | MCP795W11              | 795W11T |
| MCP795W22   | MCP795W22              | 795W22T |
| MCP795W12   | MCP795W12              | 795W12T |
| MCP795B20   | MCP795B20              | 795B20T |
| MCP795B10   | MCP795B10              | 795B10T |
| MCP795B21   | MCP795B21              | 795B21T |
| MCP795B11   | MCP795B11              | 795B11T |
| MCP795B22   | MCP795B22              | 795B22T |
| MCP795B12   | MCP795B12              | 795B12T |

**Note:** T = Temperature grade  
 NN = Alphanumeric traceability code

**Legend:** XX...X Customer-specific information  
 Y Year code (last digit of calendar year)  
 YY Year code (last 2 digits of calendar year)  
 WW Week code (week of January 1 is week '01')  
 NNN Alphanumeric traceability code  
 (e3) Pb-free JEDEC designator for Matte Tin (Sn)  
 \* This package is Pb-free. The Pb-free JEDEC designator (e3) can be found on the outer packaging for this package.

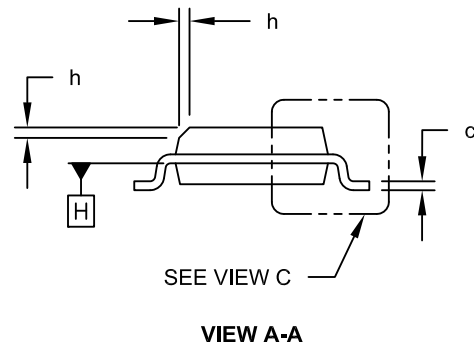
**Note:** In the event the full Microchip part number cannot be marked on one line, it will be carried over to the next line, thus limiting the number of available characters for customer-specific information.



# MCP795WXX/MCP795BXX

## 14-Lead Plastic Small Outline (SL) - Narrow, 3.90 mm Body [SOIC]

**Note:** For the most current package drawings, please see the Microchip Packaging Specification located at <http://www.microchip.com/packaging>

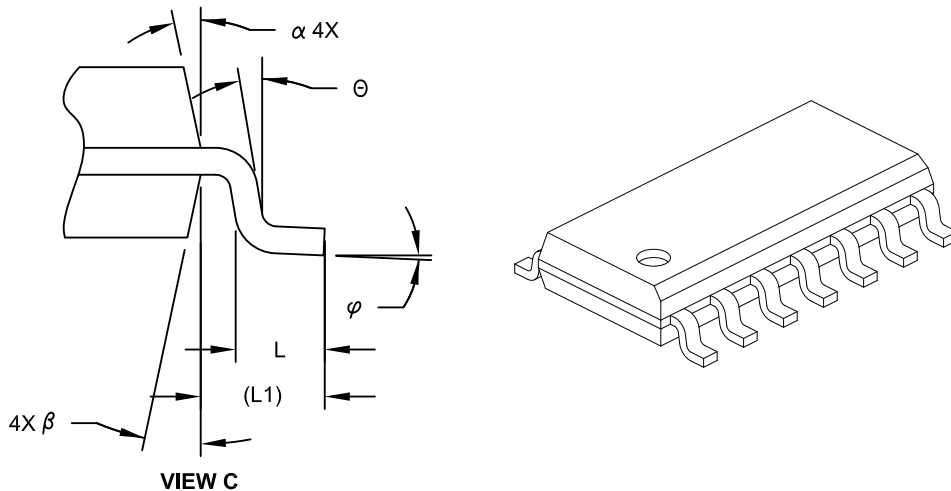


Microchip Technology Drawing No. C04-065C Sheet 1 of 2

# MCP795WXX/MCP795BXX

## 14-Lead Plastic Small Outline (SL) - Narrow, 3.90 mm Body [SOIC]

**Note:** For the most current package drawings, please see the Microchip Packaging Specification located at <http://www.microchip.com/packaging>



| Dimension Limits         | Units    | MILLIMETERS |     |      |
|--------------------------|----------|-------------|-----|------|
|                          |          | MIN         | NOM | MAX  |
| Number of Pins           | N        | 14          |     |      |
| Pitch                    | e        | 1.27 BSC    |     |      |
| Overall Height           | A        | -           | -   | 1.75 |
| Molded Package Thickness | A2       | 1.25        | -   | -    |
| Standoff §               | A1       | 0.10        | -   | 0.25 |
| Overall Width            | E        | 6.00 BSC    |     |      |
| Molded Package Width     | E1       | 3.90 BSC    |     |      |
| Overall Length           | D        | 8.65 BSC    |     |      |
| Chamfer (Optional)       | h        | 0.25        | -   | 0.50 |
| Foot Length              | L        | 0.40        | -   | 1.27 |
| Footprint                | L1       | 1.04 REF    |     |      |
| Lead Angle               | $\theta$ | 0°          | -   | -    |
| Foot Angle               | $\phi$   | 0°          | -   | 8°   |
| Lead Thickness           | c        | 0.10        | -   | 0.25 |
| Lead Width               | b        | 0.31        | -   | 0.51 |
| Mold Draft Angle Top     | $\alpha$ | 5°          | -   | 15°  |
| Mold Draft Angle Bottom  | $\beta$  | 5°          | -   | 15°  |

**Notes:**

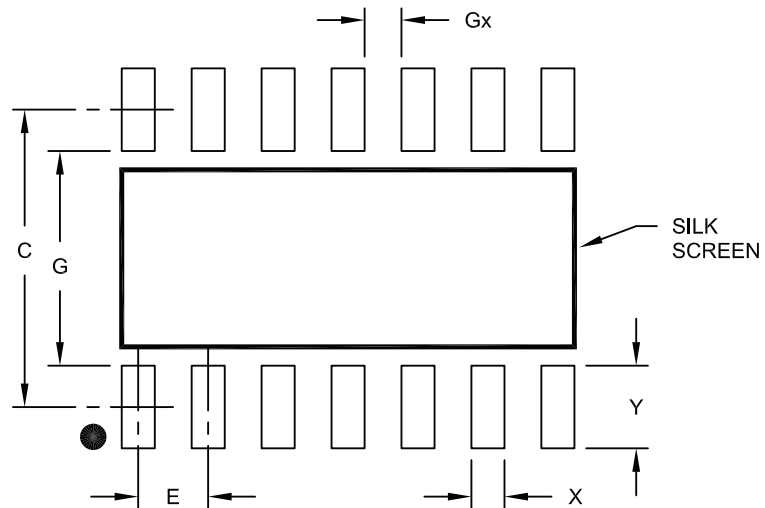
- Pin 1 visual index feature may vary, but must be located within the hatched area.
- § Significant Characteristic
- Dimension D does not include mold flash, protrusions or gate burrs, which shall not exceed 0.15 mm per end. Dimension E1 does not include interlead flash or protrusion, which shall not exceed 0.25 mm per side.
- Dimensioning and tolerancing per ASME Y14.5M  
BSC: Basic Dimension. Theoretically exact value shown without tolerances.  
REF: Reference Dimension, usually without tolerance, for information purposes only.
- Datums A & B to be determined at Datum H.

Microchip Technology Drawing No. C04-065C Sheet 2 of 2

# MCP795WXX/MCP795BXX

## 14-Lead Plastic Small Outline (SL) - Narrow, 3.90 mm Body [SOIC]

**Note:** For the most current package drawings, please see the Microchip Packaging Specification located at <http://www.microchip.com/packaging>



RECOMMENDED LAND PATTERN

| Dimension Limits      | Units | MILLIMETERS |      |      |
|-----------------------|-------|-------------|------|------|
|                       |       | MIN         | NOM  | MAX  |
| Contact Pitch         | E     | 1.27 BSC    |      |      |
| Contact Pad Spacing   | C     |             | 5.40 |      |
| Contact Pad Width     | X     |             |      | 0.60 |
| Contact Pad Length    | Y     |             |      | 1.50 |
| Distance Between Pads | Gx    | 0.67        |      |      |
| Distance Between Pads | G     | 3.90        |      |      |

**Notes:**

1. Dimensioning and tolerancing per ASME Y14.5M

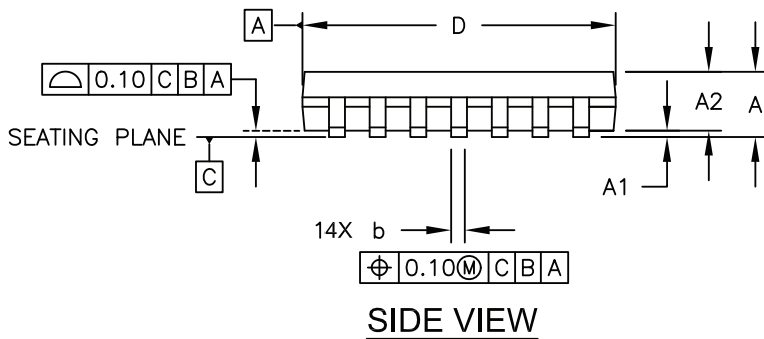
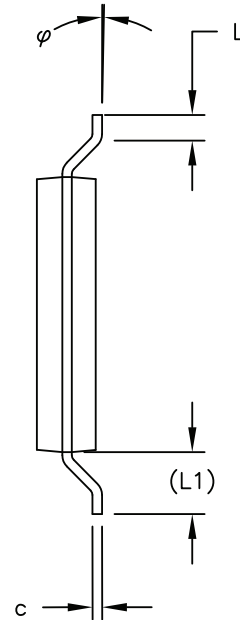
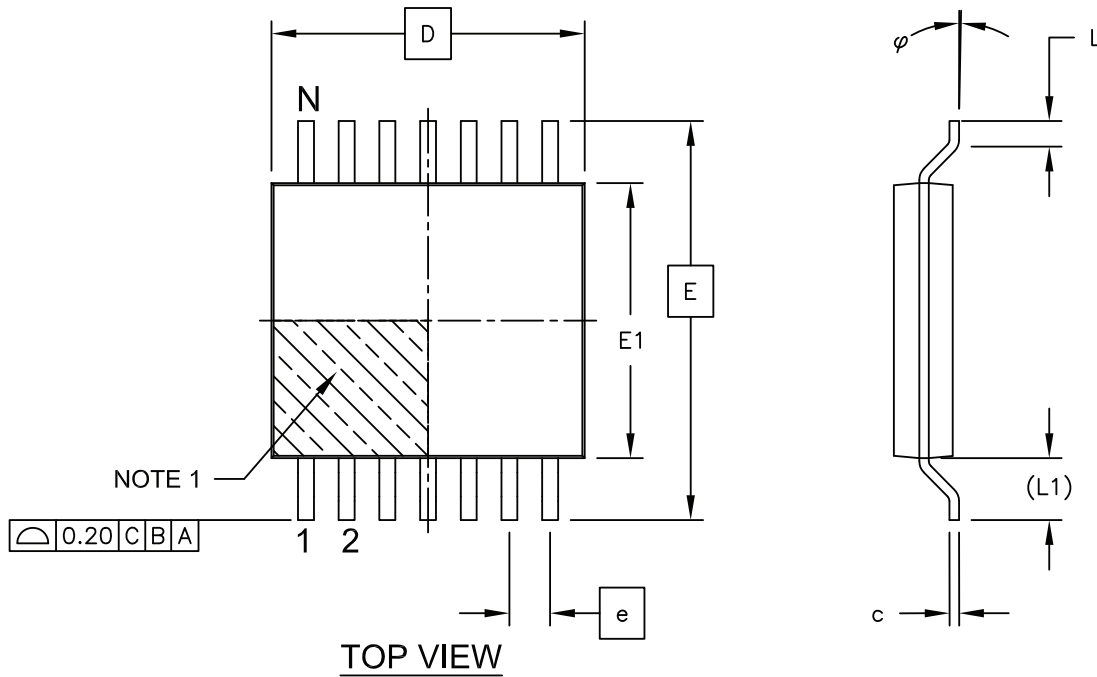
BSC: Basic Dimension. Theoretically exact value shown without tolerances.

Microchip Technology Drawing No. C04-2065A

# MCP795WXX/MCP795BXX

## 14-Lead Plastic Thin Shrink Small Outline (ST) - 4.4 mm Body [TSSOP]

**Note:** For the most current package drawings, please see the Microchip Packaging Specification located at <http://www.microchip.com/packaging>

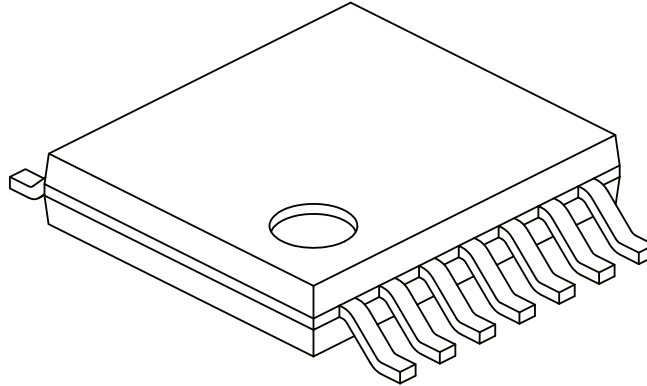


Microchip Technology Drawing C04-087C Sheet 1 of 2

# MCP795WXX/MCP795BXX

## 14-Lead Plastic Thin Shrink Small Outline (ST) - 4.4 mm Body [TSSOP]

**Note:** For the most current package drawings, please see the Microchip Packaging Specification located at <http://www.microchip.com/packaging>



| Dimension Limits         | Units     | MILLIMETERS |      |      |
|--------------------------|-----------|-------------|------|------|
|                          |           | MIN         | NOM  | MAX  |
| Number of Pins           | N         | 14          |      |      |
| Pitch                    | e         | 0.65 BSC    |      |      |
| Overall Height           | A         | -           | -    | 1.20 |
| Molded Package Thickness | A2        | 0.80        | 1.00 | 1.05 |
| Standoff                 | A1        | 0.05        | -    | 0.15 |
| Overall Width            | E         | 6.40 BSC    |      |      |
| Molded Package Width     | E1        | 4.30        | 4.40 | 4.50 |
| Molded Package Length    | D         | 4.90        | 5.00 | 5.10 |
| Foot Length              | L         | 0.45        | 0.60 | 0.75 |
| Footprint                | (L1)      | 1.00 REF    |      |      |
| Foot Angle               | $\varphi$ | 0°          | -    | 8°   |
| Lead Thickness           | c         | 0.09        | -    | 0.20 |
| Lead Width               | b         | 0.19        | -    | 0.30 |

**Notes:**

1. Pin 1 visual index feature may vary, but must be located within the hatched area.
2. Dimensions D and E1 do not include mold flash or protrusions. Mold flash or protrusions shall not exceed 0.15mm per side.
3. Dimensioning and tolerancing per ASME Y14.5M

BSC: Basic Dimension. Theoretically exact value shown without tolerances.

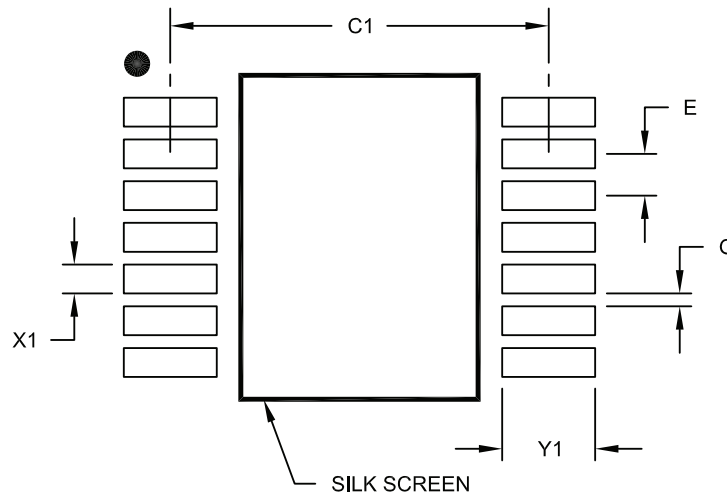
REF: Reference Dimension, usually without tolerance, for information purposes only.

Microchip Technology Drawing No. C04-087C Sheet 2 of 2

# MCP795WXX/MCP795BXX

## 14-Lead Plastic Thin Shrink Small Outline (ST) - 4.4 mm Body [TSSOP]

**Note:** For the most current package drawings, please see the Microchip Packaging Specification located at <http://www.microchip.com/packaging>



RECOMMENDED LAND PATTERN

| Dimension Limits         | Units | MILLIMETERS |      |      |
|--------------------------|-------|-------------|------|------|
|                          |       | MIN         | NOM  | MAX  |
| Contact Pitch            | E     | 0.65 BSC    |      |      |
| Contact Pad Spacing      | C1    |             | 5.90 |      |
| Contact Pad Width (X14)  | X1    |             |      | 0.45 |
| Contact Pad Length (X14) | Y1    |             |      | 1.45 |
| Distance Between Pads    | G     | 0.20        |      |      |

**Notes:**

1. Dimensioning and tolerancing per ASME Y14.5M

BSC: Basic Dimension. Theoretically exact value shown without tolerances.

Microchip Technology Drawing No. C04-2087A

## APPENDIX A: REVISION HISTORY

### Revision A (11/2011)

Initial Release.

# MCP795WXX/MCP795BXX

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NOTES:



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- Local Sales Office
- Field Application Engineer (FAE)
- Technical Support
- Development Systems Information Line

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**Technical support is available through the web site at: <http://microchip.com/support>**

# MCP795WXX/MCP795BXX

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Device: MCP795WXX/MCP795BXX

Literature Number: DS22280A

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1. What are the best features of this document?

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\_\_\_\_\_  
\_\_\_\_\_

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\_\_\_\_\_

4. What additions to the document do you think would enhance the structure and subject?

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\_\_\_\_\_

5. What deletions from the document could be made without affecting the overall usefulness?

\_\_\_\_\_  
\_\_\_\_\_

6. Is there any incorrect or misleading information (what and where)?

\_\_\_\_\_  
\_\_\_\_\_

7. How would you improve this document?

\_\_\_\_\_  
\_\_\_\_\_

# MCP795WXX/MCP795BXX

## PRODUCT IDENTIFICATION SYSTEM

To order or obtain information, e.g., on pricing or delivery, refer to the factory or the listed sales office. Not every possible ordering combination is listed below.

| <u>MCP795</u>   | <u>W</u>   | <u>1</u> | <u>0</u>  | <u>T</u> | <u>I</u>   | <u>/SN</u> |                       |  |                             |  |                |  |                        |   |             |                                   |                           |                    |                 |                                       |
|---|--|----------|-----------|----------|------------|------------|-----------------------|--|-----------------------------|--|----------------|--|------------------------|---|-------------|-----------------------------------|---------------------------|--------------------|-----------------|---------------------------------------|
| Base Part   | Additional Features  | Memory   | Unique ID | T/R      | Temp Range | Package    |                       |  |                             |  |                |  |                        |   |             |                                   |                           |                    |                 |                                       |
| <table border="1"> <tr> <td><b>Base Part No.:</b></td> <td>MCP794 = I<sup>2</sup>C™ RTCC<br/>MCP795 = SPI RTCC</td> </tr> <tr> <td><b>Additional Features:</b></td> <td>Blank = None<br/>W = Watchdog Timer, 2 Event Detects<br/>B = 32 kHz Boot-up Clock, Watchdog Timer, 2 Event Detects</td> </tr> <tr> <td><b>Memory:</b></td> <td>0 = 64 Bytes SRAM<br/>1 = 1 Kbit EE, 64 Bytes SRAM<br/>2 = 2 Kbits EE, 64 Bytes SRAM</td> </tr> <tr> <td><b>ID/MAC Address:</b></td> <td>0 = Blank<br/>1 = EUI-48™ MAC Address<br/>2 = EUI-64™ MAC Address</td> </tr> <tr> <td><b>T/R:</b></td> <td>Blank = Tube<br/>T = Tape and Reel</td> </tr> <tr> <td><b>Temperature Range:</b></td> <td>I = -40°C to +85°C</td> </tr> <tr> <td><b>Package:</b></td> <td>SL = 14-Pin SOIC<br/>ST = 14-Pin TSSOP</td> </tr> </table> |  |          |           |          |            |            | <b>Base Part No.:</b> | MCP794 = I <sup>2</sup> C™ RTCC<br>MCP795 = SPI RTCC | <b>Additional Features:</b> | Blank = None<br>W = Watchdog Timer, 2 Event Detects<br>B = 32 kHz Boot-up Clock, Watchdog Timer, 2 Event Detects | <b>Memory:</b> | 0 = 64 Bytes SRAM<br>1 = 1 Kbit EE, 64 Bytes SRAM<br>2 = 2 Kbits EE, 64 Bytes SRAM | <b>ID/MAC Address:</b> | 0 = Blank<br>1 = EUI-48™ MAC Address<br>2 = EUI-64™ MAC Address | <b>T/R:</b> | Blank = Tube<br>T = Tape and Reel | <b>Temperature Range:</b> | I = -40°C to +85°C | <b>Package:</b> | SL = 14-Pin SOIC<br>ST = 14-Pin TSSOP |
| <b>Base Part No.:</b>   | MCP794 = I <sup>2</sup> C™ RTCC<br>MCP795 = SPI RTCC   |          |           |          |            |            |                       |  |                             |  |                |  |                        |   |             |                                   |                           |                    |                 |                                       |
| <b>Additional Features:</b>   | Blank = None<br>W = Watchdog Timer, 2 Event Detects<br>B = 32 kHz Boot-up Clock, Watchdog Timer, 2 Event Detects |          |           |          |            |            |                       |  |                             |  |                |  |                        |   |             |                                   |                           |                    |                 |                                       |
| <b>Memory:</b>  | 0 = 64 Bytes SRAM<br>1 = 1 Kbit EE, 64 Bytes SRAM<br>2 = 2 Kbits EE, 64 Bytes SRAM                               |          |           |          |            |            |                       |  |                             |  |                |  |                        |   |             |                                   |                           |                    |                 |                                       |
| <b>ID/MAC Address:</b>  | 0 = Blank<br>1 = EUI-48™ MAC Address<br>2 = EUI-64™ MAC Address  |          |           |          |            |            |                       |  |                             |  |                |  |                        |   |             |                                   |                           |                    |                 |                                       |
| <b>T/R:</b>   | Blank = Tube<br>T = Tape and Reel  |          |           |          |            |            |                       |  |                             |  |                |  |                        |   |             |                                   |                           |                    |                 |                                       |
| <b>Temperature Range:</b>   | I = -40°C to +85°C   |          |           |          |            |            |                       |  |                             |  |                |  |                        |   |             |                                   |                           |                    |                 |                                       |
| <b>Package:</b>   | SL = 14-Pin SOIC<br>ST = 14-Pin TSSOP  |          |           |          |            |            |                       |  |                             |  |                |  |                        |   |             |                                   |                           |                    |                 |                                       |
| <p><b>Examples:</b></p> <ul style="list-style-type: none"> <li>a) MCP795W20-I/SL: 2K EEPROM, Blank ID, Industrial Temperature, SOIC Package</li> <li>b) MCP795W10-I/ST: 1K EEPROM, Blank ID, Industrial Temperature, TSSOP Package</li> <li>c) MCP795W21-I/SL: 2K EEPROM, EUI-48™, Industrial Temperature, SOIC Package</li> <li>d) MCP795W22-I/ST: 2K EEPROM, EUI-64™, Industrial Temperature, TSSOP Package</li> <li>e) MCP795B20-I/SL: Boot Clock, 2K EEPROM, Blank ID, Industrial Temperature, SOIC Package</li> <li>f) MCP795B10-I/ST: Boot Clock, 1K EEPROM, Blank ID, Industrial Temperature, TSSOP Package</li> </ul> <p><b>Note 1:</b> All devices include a Watchdog Timer and two Event Detects.</p>   |  |          |           |          |            |            |                       |  |                             |  |                |  |                        |   |             |                                   |                           |                    |                 |                                       |

# MCP795WXX/MCP795BXX

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NOTES:

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**Note the following details of the code protection feature on Microchip devices:**

- Microchip products meet the specification contained in their particular Microchip Data Sheet.
- Microchip believes that its family of products is one of the most secure families of its kind on the market today, when used in the intended manner and under normal conditions.
- There are dishonest and possibly illegal methods used to breach the code protection feature. All of these methods, to our knowledge, require using the Microchip products in a manner outside the operating specifications contained in Microchip's Data Sheets. Most likely, the person doing so is engaged in theft of intellectual property.
- Microchip is willing to work with the customer who is concerned about the integrity of their code.
- Neither Microchip nor any other semiconductor manufacturer can guarantee the security of their code. Code protection does not mean that we are guaranteeing the product as “unbreakable.”

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