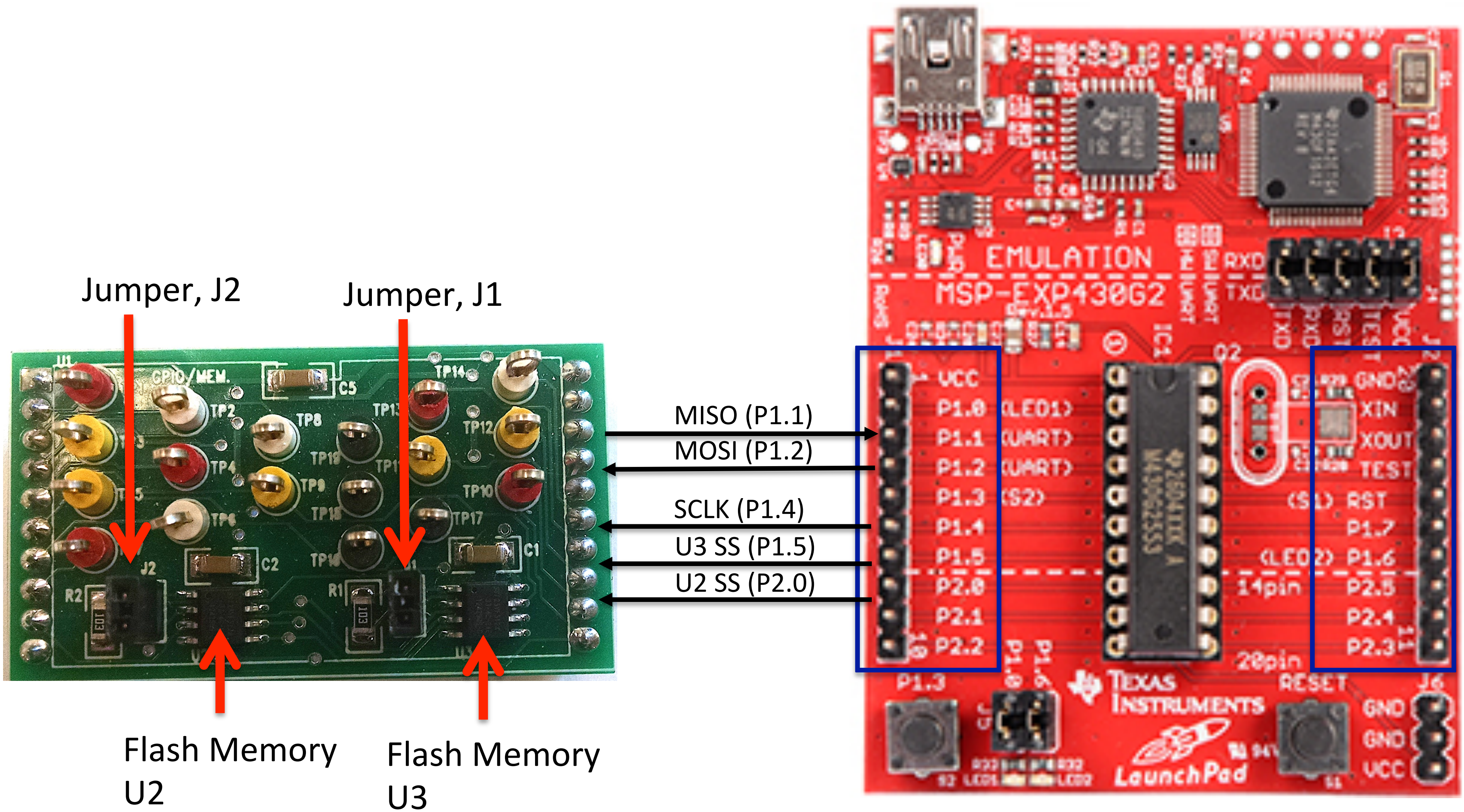
SPI Interfacing to Serial Flash Memory

GPIO/Serial Flash Header Board



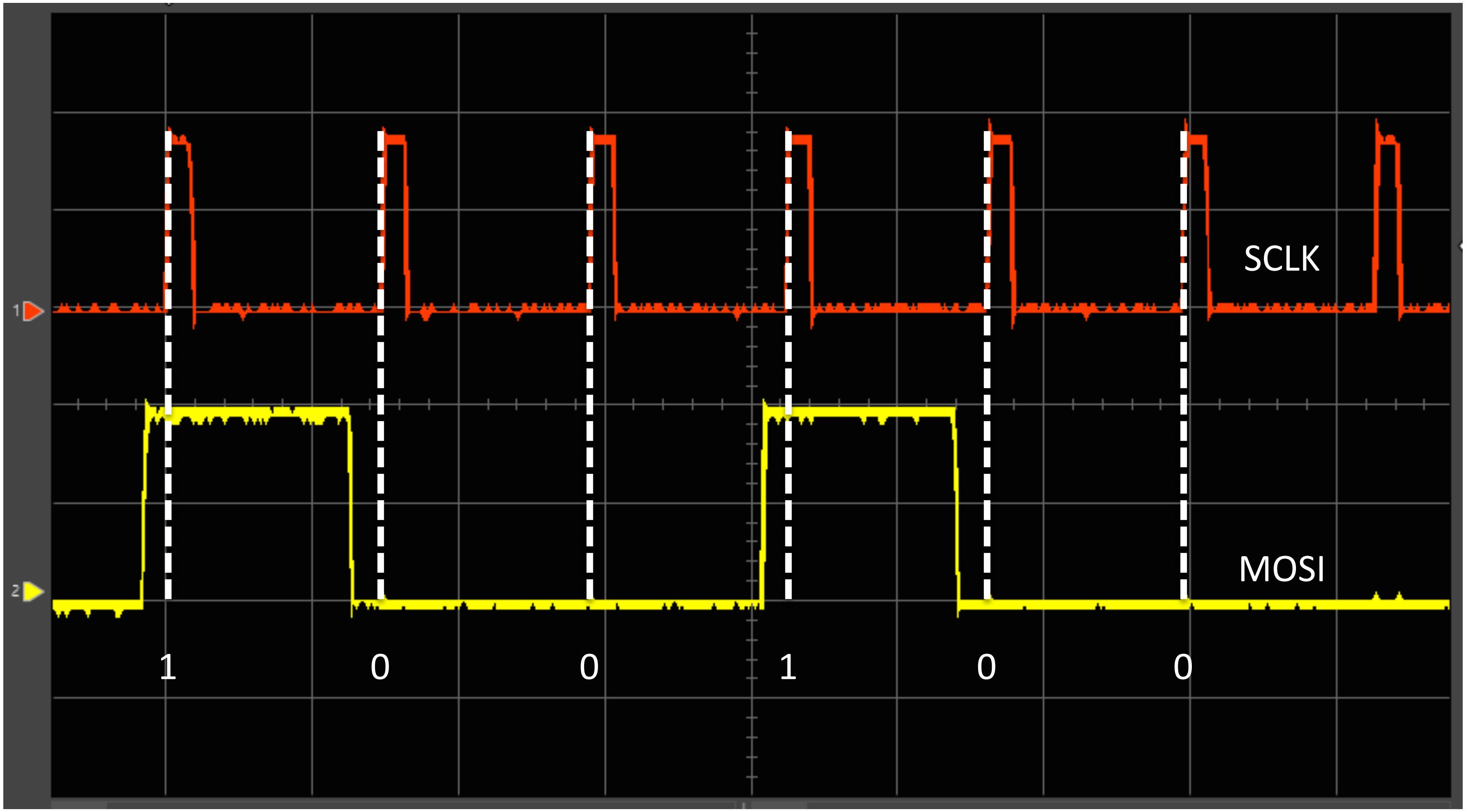
Sending Information Using SPI

```c
/*
 * This function initializes all hardware and port pins to support SPI.
 */
void InitializeSPI();

/*
 * This function sends the byte, SendValue, using SPI.
 */
void SPISendByte(unsigned char SendValue);

/*
 * This function receives a byte using SPI.
 *
 * Return Value: The byte that is received over SPI.
 */
unsigned char SPIReceiveByte();
```

Sending Information Using SPI

```
Create local copy of SendValue;
for (each bit in SendValue) {
    if (MSB equals 1)
        set MOSI;
    else
        reset MOSI;
    Left-Shift local copy of SendValue by 1;

    // SCLK: 0->1->0
    Toggle SCLK twice;
}
```

Milestone 1 Verification



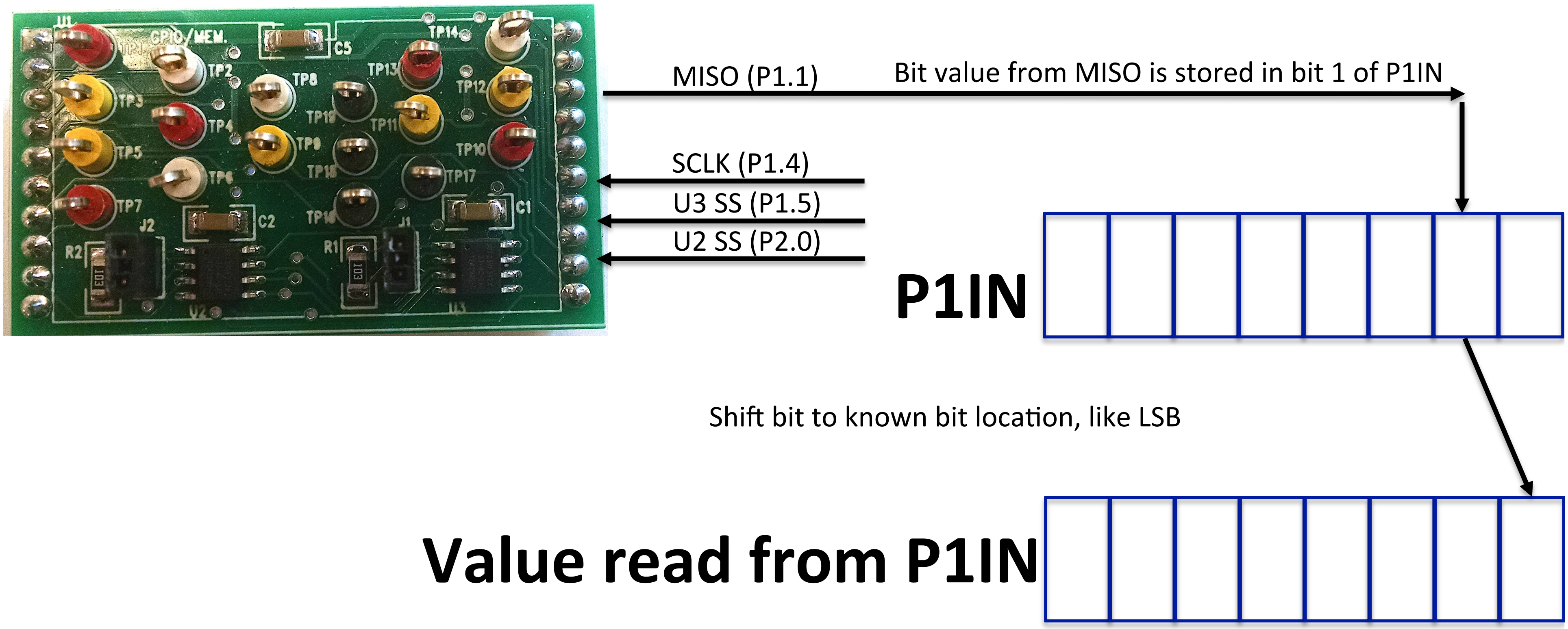
Receiving Information Using SPI

```c
/*
 * This function initializes all hardware and port pins to support SPI.
 */
void InitializeSPI();

/*
 * This function sends the byte, SendValue, using SPI.
 */
void SPISendByte(unsigned char SendValue);

/*
 * This function receives a byte using SPI.
 *
 * Return Value: The byte that is received over SPI.
 */
unsigned char SPIReceiveByte();
```

Receiving Information Using SPI

```
Initialize ReceiveValue = 0;
for (each bit in received byte) {

    Left-shift current value of ReceiveValue by 1;
    Then, OR ReceiveValue with MISO;

    // SCLK: 0->1->0
    Toggle SCLK twice;
}
```

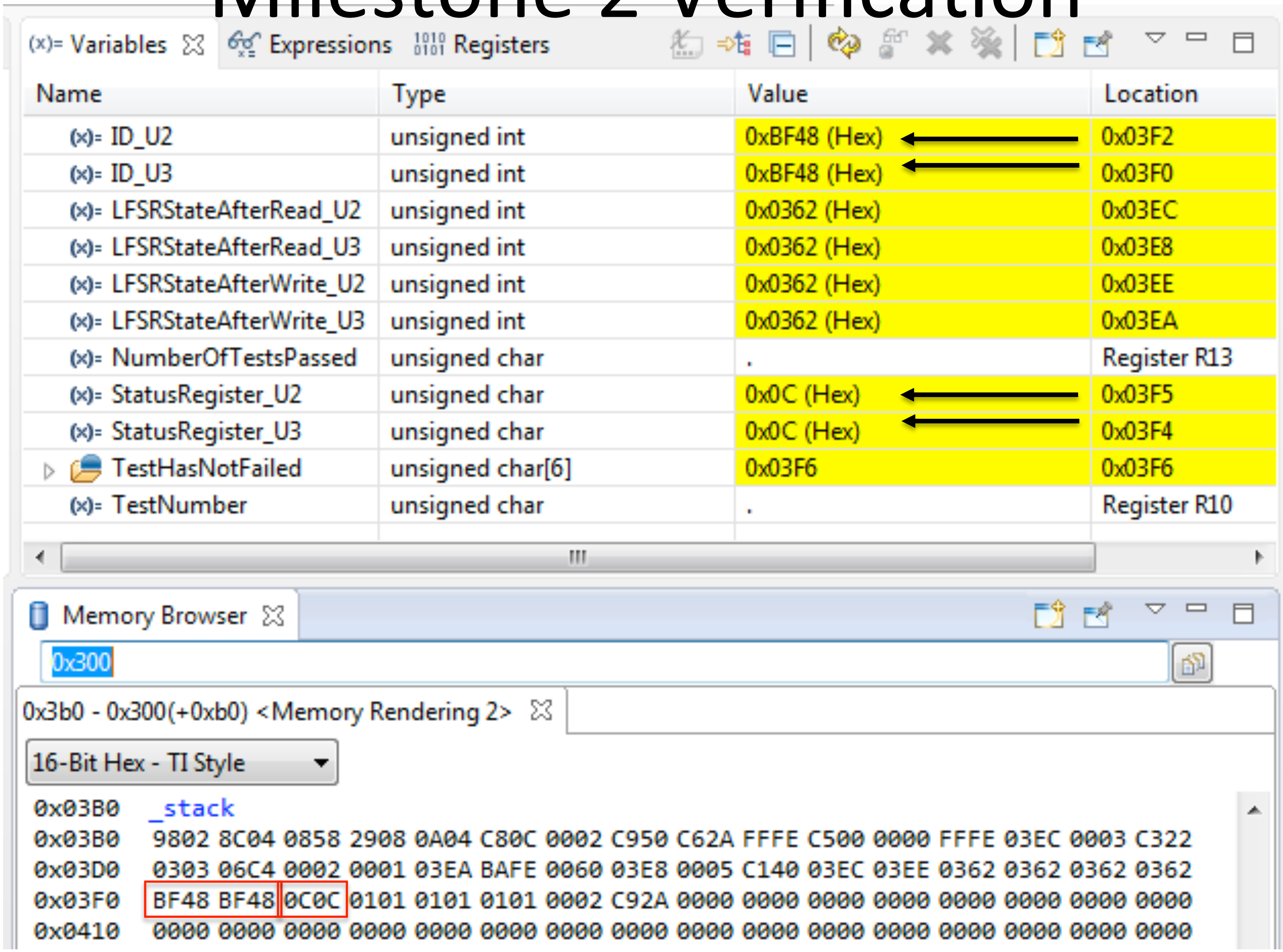
Reading MISO



Verification

```
// Begin by reading the ID for each flash memory. The value should be 0xBF48 for both.
ID_U3 = ReadFlashMemoryID(FLASH_MEMORY_U3);
if (ID_U3 != 0xBF48) {
    TestHasNotFailed[TestNumber] = FALSE;
    TestNumber++;
}
ID_U2 = ReadFlashMemoryID(FLASH_MEMORY_U2);
if (ID_U2 != 0xBF48) {
    TestHasNotFailed[TestNumber] = FALSE;
    TestNumber++;
}

// Next, turn on block protection, and then read status register for each flash memory.
// The value for each should be 0x0C.
SetBlockProtection(FULL, FLASH_MEMORY_U3);
SetBlockProtection(FULL, FLASH_MEMORY_U2);
StatusRegister_U3 = ReadFlashMemoryStatusRegister(FLASH_MEMORY_U3);
if (StatusRegister_U3 != 0x0C) {
    TestHasNotFailed[TestNumber] = FALSE;
    TestNumber++;
}
StatusRegister_U2 = ReadFlashMemoryStatusRegister(FLASH_MEMORY_U2);
if (StatusRegister_U2 != 0x0C) {
    TestHasNotFailed[TestNumber] = FALSE;
    TestNumber++;
}
```

Milestone 2 Verification



Final Verification

- The checksum test writes a pseudo-random test pattern to each memory location, and then reads the contents to confirm that every memory location can be correctly accessed

```
// Next, write pseudo-random data to each flash, and then read it to confirm flash read/write.
CheckSumFlashMemoryTest(FLASH_MEMORY_U3,BYTE_PROGRAM,CHIP_ERASE,INITIAL_LFSR_STATE,
        &LFSRStateAfterRead_U3,&LFSRStateAfterWrite_U3);
if (LFSRStateAfterRead_U3 != LFSRStateAfterWrite_U3) {
    TestHasNotFailed[TestNumber] = FALSE;
}
TestNumber++;
CheckSumFlashMemoryTest(FLASH_MEMORY_U2,AAI_PROGRAM,~CHIP_ERASE,INITIAL_LFSR_STATE,
        &LFSRStateAfterRead_U2,&LFSRStateAfterWrite_U2);
if (LFSRStateAfterRead_U2 != LFSRStateAfterWrite_U2) {
    TestHasNotFailed[TestNumber] = FALSE;
}
TestNumber++;
```

Final Verification

- The confirmation is accomplished by comparing the two variables passed to the function (using pointers)

```
// Next, write pseudo-random data to each flash, and then read it to confirm flash read/write.
CheckSumFlashMemoryTest(FLASH_MEMORY_U3,BYTE_PROGRAM,CHIP_ERASE,INITIAL_LFSR_STATE,
        &LFSRStateAfterRead_U3,&LFSRStateAfterWrite_U3);
if (LFSRStateAfterRead_U3 != LFSRStateAfterWrite_U3) {
    TestHasNotFailed[TestNumber] = FALSE;
}
TestNumber++;
CheckSumFlashMemoryTest(FLASH_MEMORY_U2,AAI_PROGRAM,~CHIP_ERASE,INITIAL_LFSR_STATE,
        &LFSRStateAfterRead_U2,&LFSRStateAfterWrite_U2);
if (LFSRStateAfterRead_U2 != LFSRStateAfterWrite_U2) {
    TestHasNotFailed[TestNumber] = FALSE;
}
TestNumber++;
```

Final Verification

- One variable represents the final state of the LFSR used to generate the pseudo-random patterns after writing to each memory location

```
// Next, write pseudo-random data to each flash, and then read it to confirm flash read/write.
CheckSumFlashMemoryTest(FLASH_MEMORY_U3,BYTE_PROGRAM,CHIP_ERASE,INITIAL_LFSR_STATE,
        &LFSRStateAfterRead_U3,&LFSRStateAfterWrite_U3);
if (LFSRStateAfterRead_U3 != LFSRStateAfterWrite_U3) {
    TestHasNotFailed[TestNumber] = FALSE;
}
TestNumber++;
CheckSumFlashMemoryTest(FLASH_MEMORY_U2,AAI_PROGRAM,~CHIP_ERASE,INITIAL_LFSR_STATE,
        &LFSRStateAfterRead_U2,&LFSRStateAfterWrite_U2);
if (LFSRStateAfterRead_U2 != LFSRStateAfterWrite_U2) {
    TestHasNotFailed[TestNumber] = FALSE;
}
TestNumber++;
```

Final Verification

- The other variable represents the final state of the LFSR after the contents of each memory location is read

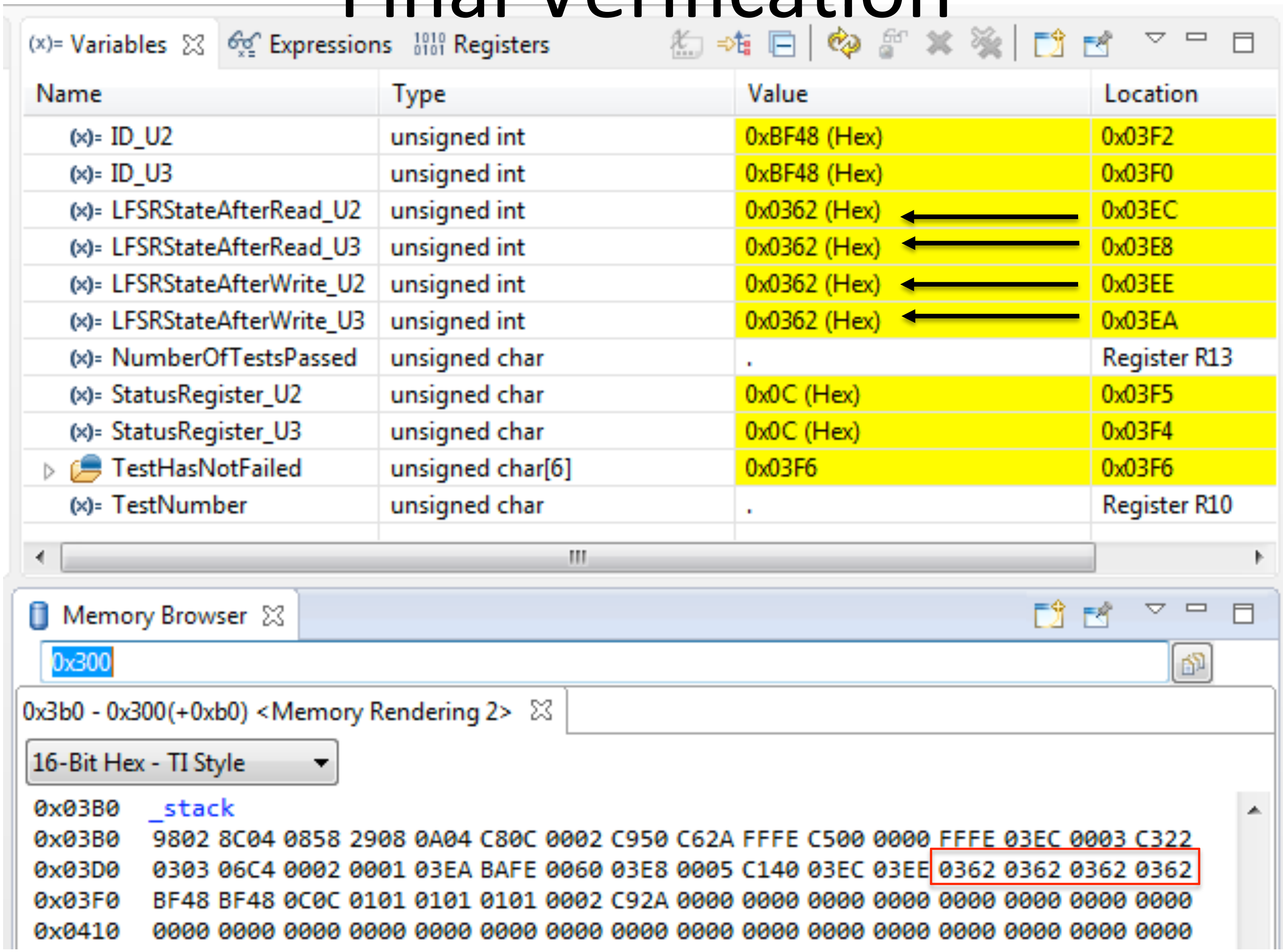
```
// Next, write pseudo-random data to each flash, and then read it to confirm flash read/write.
CheckSumFlashMemoryTest(FLASH_MEMORY_U3,BYTE_PROGRAM,CHIP_ERASE,INITIAL_LFSR_STATE,
        &LFSRStateAfterRead_U3,&LFSRStateAfterWrite_U3);
if (LFSRStateAfterRead_U3 != LFSRStateAfterWrite_U3) {
    TestHasNotFailed[TestNumber] = FALSE;
}
TestNumber++;
CheckSumFlashMemoryTest(FLASH_MEMORY_U2,AAI_PROGRAM,~CHIP_ERASE,INITIAL_LFSR_STATE,
        &LFSRStateAfterRead_U2,&LFSRStateAfterWrite_U2);
if (LFSRStateAfterRead_U2 != LFSRStateAfterWrite_U2) {
    TestHasNotFailed[TestNumber] = FALSE;
}
TestNumber++;
```

Final Verification

- If the read/write operations were successful, the values should be equal

```
// Next, write pseudo-random data to each flash, and then read it to confirm flash read/write.
CheckSumFlashMemoryTest(FLASH_MEMORY_U3,BYTE_PROGRAM,CHIP_ERASE,INITIAL_LFSR_STATE,
        &LFSRStateAfterRead_U3,&LFSRStateAfterWrite_U3);
if (LFSRStateAfterRead_U3 != LFSRStateAfterWrite_U3) {
    TestHasNotFailed[TestNumber] = FALSE;
}
TestNumber++;
CheckSumFlashMemoryTest(FLASH_MEMORY_U2,AAI_PROGRAM,~CHIP_ERASE,INITIAL_LFSR_STATE,
        &LFSRStateAfterRead_U2,&LFSRStateAfterWrite_U2);
if (LFSRStateAfterRead_U2 != LFSRStateAfterWrite_U2) {
    TestHasNotFailed[TestNumber] = FALSE;
}
TestNumber++;
```

Final Verification



Final Verification

```
// Next, write pseudo-random data to each flash, and then read it to confirm flash read/write.
CheckSumFlashMemoryTest(FLASH_MEMORY_U3,BYTE_PROGRAM,CHIP_ERASE,INITIAL_LFSR_STATE,
        &LFSRStateAfterRead_U3,&LFSRStateAfterWrite_U3);
if (LFSRStateAfterRead_U3 != LFSRStateAfterWrite_U3) {
    TestHasNotFailed[TestNumber] = FALSE;
}
TestNumber++;
CheckSumFlashMemoryTest(FLASH_MEMORY_U2,AAI_PROGRAM,~CHIP_ERASE,INITIAL_LFSR_STATE,
        &LFSRStateAfterRead_U2,&LFSRStateAfterWrite_U2);
if (LFSRStateAfterRead_U2 != LFSRStateAfterWrite_U2) {
    TestHasNotFailed[TestNumber] = FALSE;
}
TestNumber++;

// If all tests were successful, then indicate this by toggling the green LED.
// Otherwise, toggle the red LED.
for (NumberOfTestsPassed = 0, TestNumber = 0; TestNumber < NUMBER_OF_TESTS; TestNumber++)
    NumberOfTestsPassed += TestHasNotFailed[TestNumber];
while (TRUE) {
    if (NumberOfTestsPassed == NUMBER_OF_TESTS) {
        TOGGLE_LED2;
    }
    else {
        TOGGLE_LED1;
    }
    _delay_cycles(1000000);
}
```

When testing U3, byte programming and full chip-erase are tested.

Final Verification

```
// Next, write pseudo-random data to each flash, and then read it to confirm flash read/write.
CheckSumFlashMemoryTest(FLASH_MEMORY_U3,BYTE_PROGRAM,CHIP_ERASE,INITIAL_LFSR_STATE,
        &LFSRStateAfterRead_U3,&LFSRStateAfterWrite_U3);
if (LFSRStateAfterRead_U3 != LFSRStateAfterWrite_U3) {
    TestHasNotFailed[TestNumber] = FALSE;
}
TestNumber++;
CheckSumFlashMemoryTest(FLASH_MEMORY_U2,AAI_PROGRAM,~CHIP_ERASE,INITIAL_LFSR_STATE,
        &LFSRStateAfterRead_U2,&LFSRStateAfterWrite_U2);
if (LFSRStateAfterRead_U2 != LFSRStateAfterWrite_U2) {
    TestHasNotFailed[TestNumber] = FALSE;
}
TestNumber++;

// If all tests were successful, then indicate this by toggling the green LED.
// Otherwise, toggle the red LED.
for (NumberOfTestsPassed = 0, TestNumber = 0; TestNumber < NUMBER_OF_TESTS; TestNumber++)
    NumberOfTestsPassed += TestHasNotFailed[TestNumber];
while (TRUE) {
    if (NumberOfTestsPassed == NUMBER_OF_TESTS) {
        TOGGLE_LED2;
    }
    else {
        TOGGLE_LED1;
    }
    _delay_cycles(1000000);
}
```

When testing U2, AAI programming and sector/block-erase are tested.

Final Verification

```c
// Next, write pseudo-random data to each flash, and then read it to confirm flash read/write.
CheckSumFlashMemoryTest(FLASH_MEMORY_U3,BYTE_PROGRAM,CHIP_ERASE,INITIAL_LFSR_STATE,
        &LFSRStateAfterRead_U3,&LFSRStateAfterWrite_U3);
if (LFSRStateAfterRead_U3 != LFSRStateAfterWrite_U3) {
    TestHasNotFailed[TestNumber] = FALSE;
}
TestNumber++;
CheckSumFlashMemoryTest(FLASH_MEMORY_U2,AAI_PROGRAM,~CHIP_ERASE,INITIAL_LFSR_STATE,
        &LFSRStateAfterRead_U2,&LFSRStateAfterWrite_U2);
if (LFSRStateAfterRead_U2 != LFSRStateAfterWrite_U2) {
    TestHasNotFailed[TestNumber] = FALSE;
}
TestNumber++;

// If all tests were successful, then indicate this by toggling the green LED.
// Otherwise, toggle the red LED.
for (NumberOfTestsPassed = 0, TestNumber = 0; TestNumber < NUMBER_OF_TESTS; TestNumber++)
    NumberOfTestsPassed += TestHasNotFailed[TestNumber];
while (TRUE) {
    if (NumberOfTestsPassed == NUMBER_OF_TESTS) {
        TOGGLE_LED2;
    }
    else {
        TOGGLE_LED1;
    }
    _delay_cycles(1000000);
}
```

Finally, if all of the tests are passed, the the green LED will flash to indicate as such.

Otherwise, the red LED will blink