MB85RS64
FRAM Test
Using STM32L4xx_HAL_Driver
HAL_SPI

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Contents

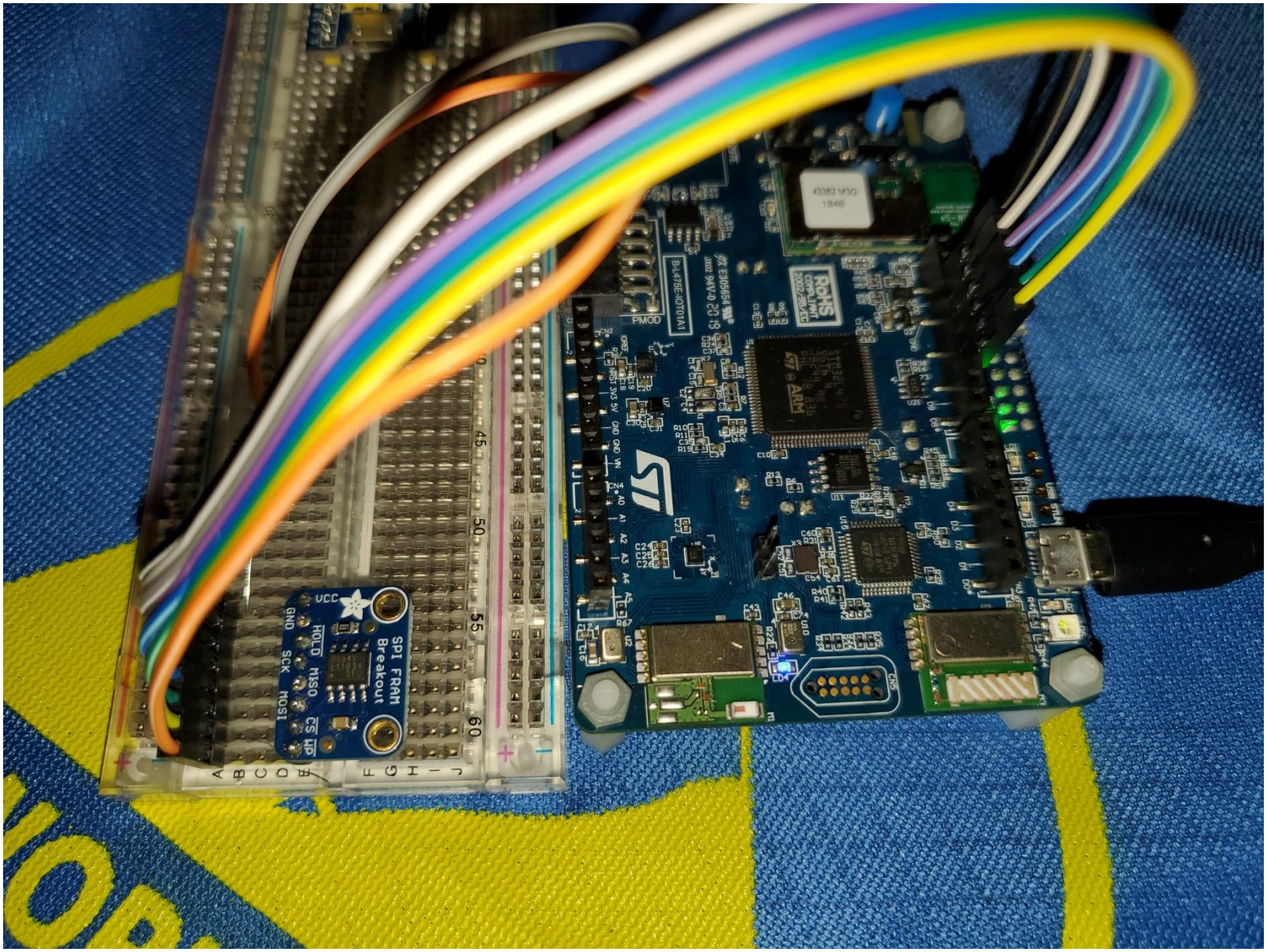
Abstract

- Adapted a Adafruit SPI FRAM Breakout board for use with SPI1 on the STM IOT Discovery board B-L475-IOT01A.
- FRAM device is an MB85RS64V 64K (8Kx8) bit SPI FRAM device
- Test and driver code ported from the MBED project:
  - https://os.mbed.com/users/stillChris/code/ESHD_L475VG_IOT01-Sensors-BSP/
- Enabled SPI1 using STMCubeMX
- Changed the following from their defaults:
  - `hspi1.Init.DataSize = SPI_DATASIZE_8BIT;`
  - `hspi1.Init.BaudRatePrescaler = SPI_BAUDRATEPRESCALER_16;`
- Selected the 16 bit clock prescaler based on observing SCLK on an O'Scope. SCLK is ~5.0MHz.
- Driver code is for hardware testing only:
  - Reduced SCK clock rate.
  - FRAM requires a refresh following write for normal operation.
  - Driver not optimized for performance.

I/O planning

ADA Fruit Daughter Card			Functional Description	Design & Implementation Specifics	Arduino Connector Option			
Pin No	Pin Name	Breadboard jumper wire color			CN1 PIN	Arduino PIN	Board Signal	STM32L475 pin
1	nWP	Orange	Write Protect	Not used on this design. Tie to 3.3VDC through a pull-up resister. This sets the active low input, (nWP) high, which disables Write Protection.	N/A	N/A	N/A	N/A
2	nCS	Yellow	Chip Select	This is driver by STM32L475 GPIO bank D, port 5. This active low net is driven low when the SPI2 clock and data are targeted to the FRAM device.	3	D10	SPI1_SSN	PA2
3	MOSI	Green	Serial Data Input	This is serial data output form the STM32L475 to the FRAM slave device.	4	D11	SPI1_MOSI	PA7
4	MISO	Blue	Serial Data Output	This is serial data output form the FRAM slave device to the STM32L475 master.	5	D12	SPI1_MISO	PA6
5	SCK	Violet	Serial Clock	This is a clock output from the STM32L475 to the FRAM.	6	D13	SPI1_SCK	PA5
6	nHOLD	Grey	Hold	Not used on this design. Tie to 3.3VDC through a pull-up resister. This sets the active low input, (nHOLD) high, which disables Hold.	N/A		N/A	N/A
7	GND	White	Ground	Tied to system ground	7	D14	GND	N/A
8	VCC	Black	Supply Voltage	Tied to 3.3VDC	8	D15	3V3	N/A

Breadboard Photo



Code

github repo

https://github.com/stillChris/MB85RS64_FRAM_Test_STM32_HAL.git

Defines

```
/* USER CODE BEGIN PD */
#define FRAM_WREN    0x06
#define FRAM_WRDI    0x04
#define FRAM_RDSR    0x05
#define FRAM_WRSR    0x01
#define FRAM_READ    0x03
#define FRAM_WRITE   0x02
#define FRAM_RDID    0x9f
#define FRAM_SR_WPEN 0x80
#define FRAM_SR_BP0  0x08
#define FRAM_SR_BP1  0x04
#define FRAM_SR_WEL  0x02
#define FRAM_NULL    0x00

#define FRAM_NUM_BYTES (8 * 1024) //8KBytes
#define FRAM_TEST_DATA (((testAddr * 0x51)+0x17)&0xff)
#define FRAM_TEST_ERROR_INSERT 0 //set one bit in the ESHD_FRAM_TEST_ERROR_INSERT byte to intentionally induce write errors
#define FRAM_TEST_BLOCK_SIZE 512
#define FRAM_TEST_BLOCK_MASK ((FRAM_NUM_BYTES/FRAM_TEST_BLOCK_SIZE)-1)
//defines for FRAM Chip Select
#define FRAM_CS_Pin ARD_D10_Pin
#define FRAM_CS_Port ARD_D10_GPIO_Port
//Chip Select is active low.  So Enable drives the GPIO low (Reset)
#define FRAM_CS_ENABLE HAL_GPIO_WritePin(FRAM_CS_Port, FRAM_CS_Pin, 0);
#define FRAM_CS_DISABLE HAL_GPIO_WritePin(FRAM_CS_Port, FRAM_CS_Pin, 1);

/* USER CODE END PD *
```

SPI Initialization Code

```
static void MX_SPI1_Init(void)
{

  /* USER CODE BEGIN SPI1_Init 0 */

  /* USER CODE END SPI1_Init 0 */

  /* USER CODE BEGIN SPI1_Init 1 */

  /* USER CODE END SPI1_Init 1 */
  /* SPI1 parameter configuration*/
  hspi1.Instance = SPI1;
  hspi1.Init.Mode = SPI_MODE_MASTER;
  hspi1.Init.Direction = SPI_DIRECTION_2LINES;
  hspi1.Init.DataSize = SPI_DATASIZE_8BIT;
  hspi1.Init.CLKPolarity = SPI_POLARITY_LOW;
  hspi1.Init.CLKPhase = SPI_PHASE_1EDGE;
  hspi1.Init.NSS = SPI_NSS_SOFT;
  hspi1.Init.BaudRatePrescaler = SPI_BAUDRATEPRESCALER_16;
  hspi1.Init.FirstBit = SPI_FIRSTBIT_MSB;
  hspi1.Init.TIMode = SPI_TIMODE_DISABLE;
  hspi1.Init.CRCCalculation = SPI_CRCCALCULATION_DISABLE;
  hspi1.Init.CRCPolynomial = 7;
  hspi1.Init.CRCLength = SPI_CRC_LENGTH_DATASIZE;
  hspi1.Init.NSSPMode = SPI_NSS_PULSE_ENABLE;
  if (HAL_SPI_Init(&hspi1) != HAL_OK)
  {
    Error_Handler();
  }
  /* USER CODE BEGIN SPI1_Init 2 */

  /* USER CODE END SPI1_Init 2 */

}
```

Driver Code

```
void FRAM_init(void)
{
       uint8_t spiCMD;

    //make sure FRAM chip select is disabled - Active low so disable drives GPIO high
    FRAM_CS_DISABLE;

       spiCMD = FRAM_RDID;
    FRAM_CS_ENABLE;
    HAL_SPI_Transmit(&hspi1, &spiCMD, sizeof(spiCMD), HAL_MAX_DELAY);
    FRAM_CS_DISABLE;

    spiCMD = FRAM_WRDI;
    FRAM_CS_ENABLE;
    HAL_SPI_Transmit(&hspi1, &spiCMD, sizeof(spiCMD), HAL_MAX_DELAY);
    FRAM_CS_DISABLE;

    spiCMD = FRAM_WREN;
    FRAM_CS_ENABLE;
    HAL_SPI_Transmit(&hspi1, &spiCMD, sizeof(spiCMD), HAL_MAX_DELAY);
    FRAM_CS_DISABLE;

    spiCMD = FRAM_WRSR;
    FRAM_CS_ENABLE;
    HAL_SPI_Transmit(&hspi1, &spiCMD, sizeof(spiCMD), HAL_MAX_DELAY);
    FRAM_CS_DISABLE;

    spiCMD = FRAM_SR_WEL;
    FRAM_CS_ENABLE;
    HAL_SPI_Transmit(&hspi1, &spiCMD, sizeof(spiCMD), HAL_MAX_DELAY);
    FRAM_CS_DISABLE;

    spiCMD = FRAM_RDSR;
    FRAM_CS_ENABLE;
    HAL_SPI_Transmit(&hspi1, &spiCMD, sizeof(spiCMD), HAL_MAX_DELAY);
    FRAM_CS_DISABLE;

    spiCMD = FRAM_NULL;
    FRAM_CS_ENABLE;
    HAL_SPI_Transmit(&hspi1, &spiCMD, sizeof(spiCMD), HAL_MAX_DELAY);
    FRAM_CS_DISABLE;
}
```

```c
void FRAM_write(uint16_t address, uint8_t byte)
{
       uint8_t spiCMD;
       uint8_t spiAddrByte;

       spiCMD = FRAM_WREN;
    FRAM_CS_ENABLE;
    HAL_SPI_Transmit(&hspi1, &spiCMD, sizeof(spiCMD), HAL_MAX_DELAY);
    FRAM_CS_DISABLE;

    spiCMD = FRAM_WRITE;
    //enable Chip Select
    FRAM_CS_ENABLE;
    //send WRITE command
    HAL_SPI_Transmit(&hspi1, &spiCMD, sizeof(spiCMD), HAL_MAX_DELAY);
    //send upper 8 bits of address
    spiAddrByte = ((address&0x3f00)>>8);
    HAL_SPI_Transmit(&hspi1, &spiAddrByte, sizeof(spiAddrByte), HAL_MAX_DELAY);
    //send lower 8 bits of address
    spiAddrByte = (address&0x00ff);
    HAL_SPI_Transmit(&hspi1, &spiAddrByte, sizeof(spiAddrByte), HAL_MAX_DELAY);
    //sent data byte
    HAL_SPI_Transmit(&hspi1, &byte, sizeof(byte), HAL_MAX_DELAY);
    //disable Chip Select
    FRAM_CS_DISABLE;
}
```

```
uint8_t FRAM_read(uint16_t address)
{
       uint8_t spiCMD;
       uint8_t spiAddrByte;
       uint8_t byte;

       spiCMD = FRAM_READ;
    //enable Chip Select
    FRAM_CS_ENABLE;
    //send WRITE command
    HAL_SPI_Transmit(&hspi1, &spiCMD, sizeof(spiCMD), HAL_MAX_DELAY);
    //send upper 8 bits of address
    spiAddrByte = ((address&0x3f00)>>8);
    HAL_SPI_Transmit(&hspi1, &spiAddrByte, sizeof(spiAddrByte), HAL_MAX_DELAY);
    //send lower 8 bits of address
    spiAddrByte = (address&0x00ff);
    HAL_SPI_Transmit(&hspi1, &spiAddrByte, sizeof(spiAddrByte), HAL_MAX_DELAY);
    //receive data byte
    HAL_SPI_Receive(&hspi1, &byte, sizeof(byte), HAL_MAX_DELAY);
    //disable Chip Select
    FRAM_CS_DISABLE;

    return(byte);
}
```

Test Code

```
int FRAM_test(uint16_t addrOffset, uint16_t addrRange)
{
    uint8_t testData=0;
    uint16_t testAddr=0;
    int rtnVal = 0;

    for(testAddr=0; testAddr<addrRange; testAddr++)
    {
        testData = FRAM_TEST_DATA | FRAM_TEST_ERROR_INSERT;
        FRAM_write(testAddr, testData);
    }

    for(testAddr=0; testAddr<addrRange; testAddr++)
    {
      testData = FRAM_read(testAddr);
        if(testData != FRAM_TEST_DATA)
        {
            printf(">>>FRAM test failure - memory = 0x%04x, expected value = 0x%02x, data read = 0x%02x\n",
               testAddr, FRAM_TEST_DATA, testData);
            rtnVal = -1;
        }
    }

    return (rtnVal);
}
```

Test Executive

```
/* Infinite loop */
/* USER CODE BEGIN WHILE */
while (1)
{
  /* USER CODE END WHILE */

  /* USER CODE BEGIN 3 */
     uint16_t FRAM_testAddr = FRAM_TEST_BLOCK_SIZE * (FRAM_testBlock & FRAM_TEST_BLOCK_MASK);
     printf("FRAM_test: addr=0x%08x, range=0x%08x\n", FRAM_testAddr, FRAM_TEST_BLOCK_SIZE);
     FRAM_test(FRAM_testAddr, FRAM_TEST_BLOCK_SIZE);
     ++FRAM_testBlock;
}
/* USER CODE END 3 */
```

O'Scope screen shots

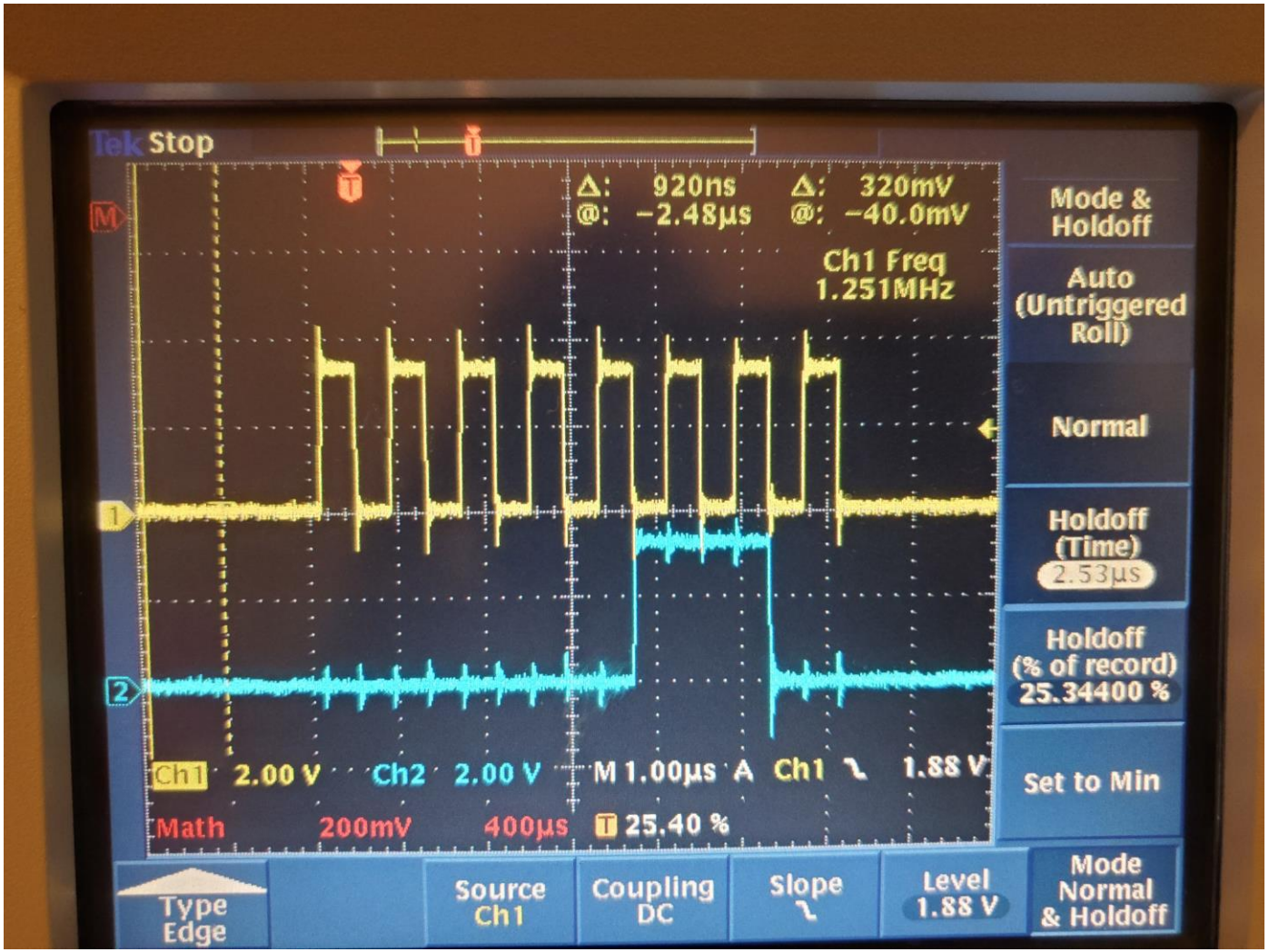
Breadboard jumpers induce significant noise with SCK = 5MHz. O'Scope screen shots taken with:

```
huart1.Init.OverSampling = UART_OVERSAMPLING_64;
```

for an SCK = 5MHz.

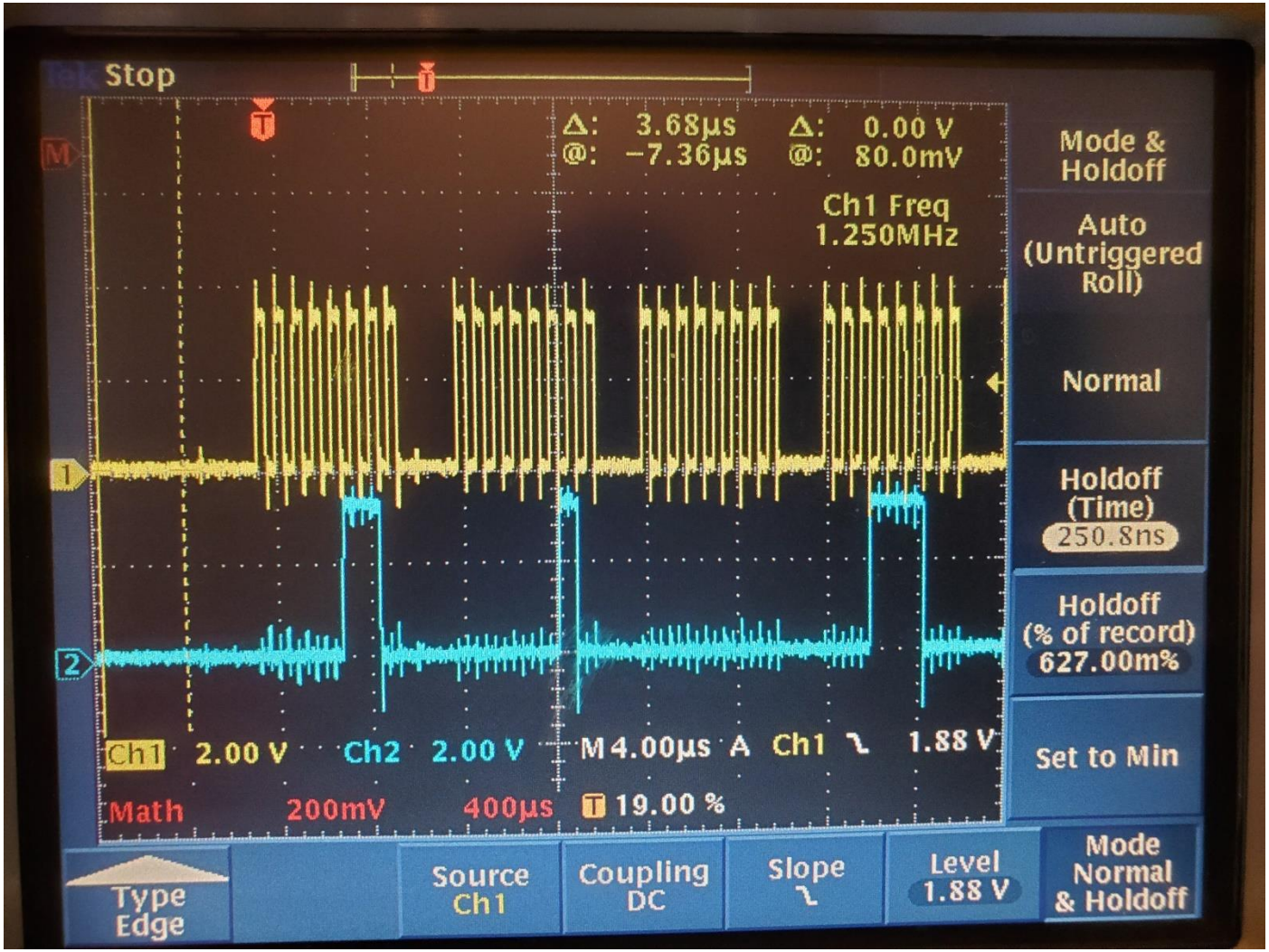
SPI Command Screen shot

To confirm proper SPI Polarity and Phase



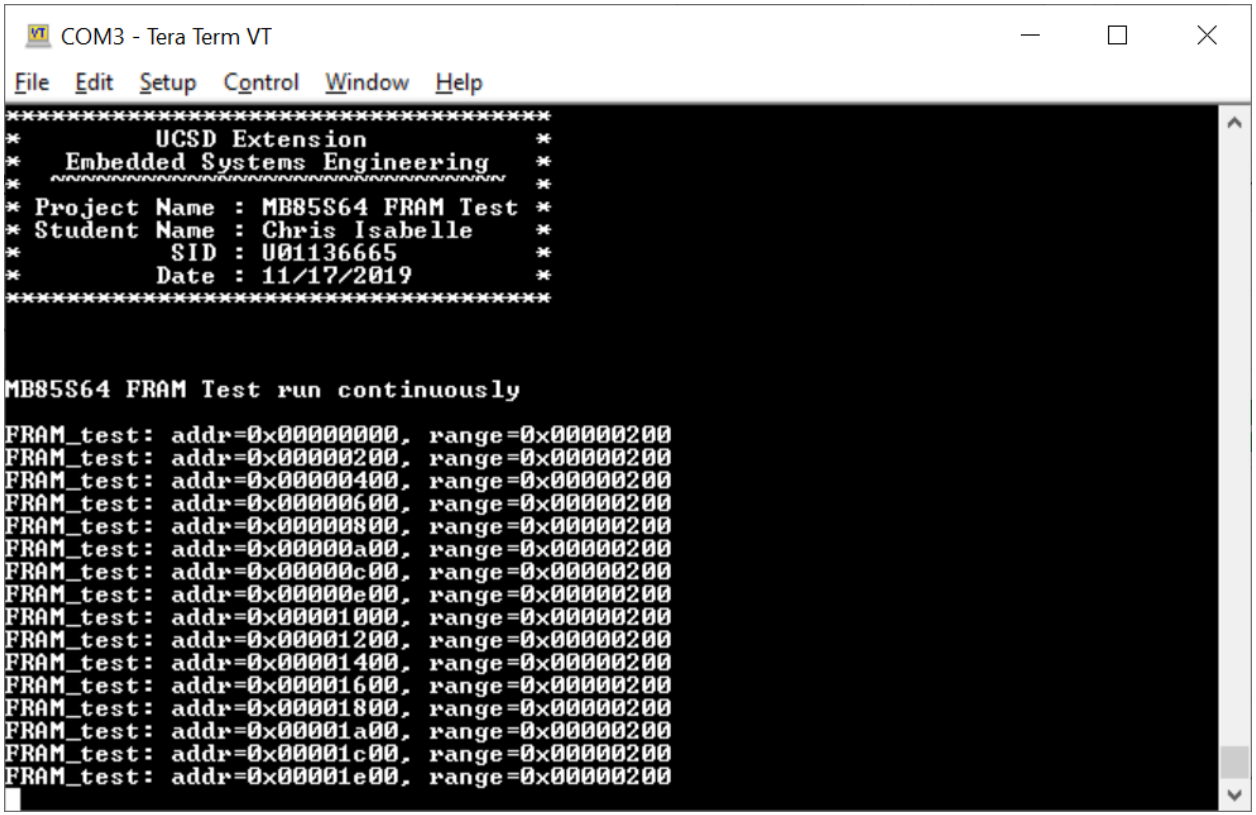
SPI Write Sequence

To confirm proper multi SPI sequence. Chip Select timing evaluated seperately



UART Terminal Screen Captures

Passing Test



Failing Test

Pulled MISO pin on breadboard