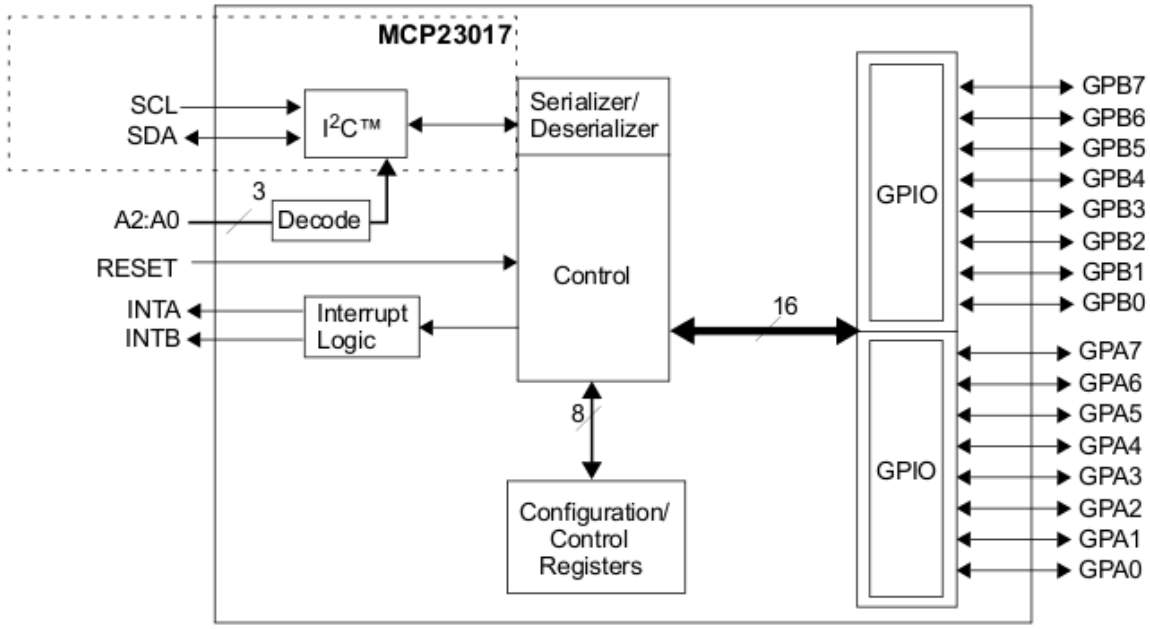
Expanding the ports of a Raspberry PI using a MCP23S17.

The MCP23S17 is a 16-Bit I/O Expander with Serial (SPI) Interface . The topology of the design is shown below.



To control the ports of the part various registers need to be addressed. The full Raspberry code for doing this is included in this document. The register address map is shown below.

TABLE 1-2: REGISTER ADDRESSES

Address IOCON.BANK = 1	Address IOCON.BANK = 0	Access to:
00h	00h	IODIRA
10h	01h	IODIRB
01h	02h	IPOLA
11h	03h	IPOLB
02h	04h	GPINTENA
12h	05h	GPINTENB
03h	06h	DEFVALA
13h	07h	DEFVALB
04h	08h	INTCONA
14h	09h	INTCONB
05h	0Ah	IOCON
15h	0Bh	IOCON
06h	0Ch	GPPUA
16h	0Dh	GPPUB
07h	0Eh	INTFA
17h	0Fh	INTFB
08h	10h	INTCAPA
18h	11h	INTCAPB
09h	12h	GPIOA
19h	13h	GPIOB
0Ah	14h	OLATA
1Ah	15h	OLATB

The basic registers are listed below:-

IODIR - I/O DIRECTION REGISTER

This controls the direction of the data I/O. When a bit is set, the corresponding pin becomes an input. When a bit is clear, the corresponding pin becomes an output.

For example to set all bits of portA to be outputs:-

```
  writeByte (IODIRA, 0x00) ;
```

and to set all bits of portB to be inputs:-

```
  writeByte (IODIRB, 0xFF) ;
```

Writing and reading data then becomes a simple matter of addressing the GPIO ports:-

```
  writeByte (GPIOA, <word>) ;
```
ie
```
  writeByte (GPIOA, 0xFF) ;
```

and reading the value of a port

```
  data = readByte (GPIOB) ;
```

IPOL - INPUT POLARITY REGISTER

This register allows the user to configure the polarity on the corresponding GPIO port bits.
If a bit is set, the corresponding GPIO register bit will reflect the inverted value on the pin.
For example to invert bit 1 of port A

```
  writeByte (IPOLB, 0x01) ;
```

GPPU - PULL-UP RESISTOR CONFIGURATION REGISTER

The GPPU register controls the pull-up resistors for the port pins. If a bit is set and the corresponding pin is configured as an input, the corresponding port pin is internally pulled up with a 100 kΩ resistor.

For more advanced features and to use interrupts see the MCP23S17 datasheet.

References:-
The following is included for further reading.

https://projects.drogon.net/piface-mk2/

http://www.open.com.au/mikem/bcm2835/

http://www.cmdrkeen.net/tag/spi/

http://www.linuxjournal.com/article/6908

Using the information in the above links the following code was put together to test out the basic features of the MCP23S17 part. The code is intended as a starting point only. Credit and recognition for figuring out how to drive this part goes to the authors of the above links.

To compile save to a file and compile with

```
  > gcc <filename>.c -o <filename>
```

```
/****************************************
*    basic SPI demo for mcp23s17       *
****************************************/
#include <stdlib.h>
#include <stdio.h>
#include <string.h>
#include <fcntl.h>
#include <sys/ioctl.h>
#include <linux/spi/spidev.h>
#include <sys/mman.h>
#include <sys/types.h>
#include <sys/stat.h>
#include <unistd.h>

#include <stdint.h>

#define CMD_WRITE         0x40
#define CMD_READ 0x41

static char       *spiDevice = "/dev/spidev0.0" ;
static uint8_t     spiMode   = 0 ;
static uint8_t     spiBPW    = 8 ;
static uint32_t    spiSpeed  = 5000000 ;
static uint16_t    spiDelay  = 0;

// MCP23S17 Registers

#define         IOCON                   0x0A

#define         IODIRA                  0x00
#define         IPOLA           0x02
#define         GPINTENA        0x04
#define         DEFVALA                 0x06
#define         INTCONA                 0x08
#define         GPPUA                   0x0C
#define         INTFA           0x0E
#define         INTCAPA                 0x10
#define         GPIOA                   0x12
#define         OLATA                   0x14

#define         IODIRB                  0x01
#define         IPOLB           0x03
```

```
#define	GPINTENB	0x05
#define	DEFVALB		0x07
#define	INTCONB		0x09
#define	GPPUB		0x0D
#define	INTFB		0x0F
#define	INTCAPB		0x11
#define	GPIOB		0x13
#define	OLATB		0x15


int spi_fd;

static uint8_t readByte (uint8_t reg)
{
  uint8_t tx [4] ;
  uint8_t rx [4] ;
  struct spi_ioc_transfer spi ;

  tx [0] = CMD_READ ;
  tx [1] = reg ;
  tx [2] = 0 ;

  spi.tx_buf        = (unsigned long)tx ;
  spi.rx_buf        = (unsigned long)rx ;
  spi.len           = 3 ;
  spi.delay_usecs   = spiDelay ;
  spi.speed_hz      = spiSpeed ;
  spi.bits_per_word = spiBPW ;

  ioctl (spi_fd, SPI_IOC_MESSAGE(1), &spi) ;

  return rx [2] ;
}

static void writeByte (uint8_t reg, uint8_t data)
{
  uint8_t spiBufTx [3] ;
  uint8_t spiBufRx [3] ;
  struct spi_ioc_transfer spi ;

  spiBufTx [0] = CMD_WRITE ;
  spiBufTx [1] = reg ;
  spiBufTx [2] = data ;

  spi.tx_buf        = (unsigned long)spiBufTx ;
  spi.rx_buf        = (unsigned long)spiBufRx ;
  spi.len           = 3 ;
  spi.delay_usecs   = spiDelay ;
  spi.speed_hz      = spiSpeed ;
  spi.bits_per_word = spiBPW ;

  ioctl (spi_fd, SPI_IOC_MESSAGE(1), &spi) ;
```

```
}

/*spi_open
*      - Open the given SPI channel and configures it.
*      - there are normally two SPI devices on your PI:
*        /dev/spidev0.0: activates the CS0 pin during transfer
*        /dev/spidev0.1: activates the CS1 pin during transfer
*
*/
int spi_open(char* dev)
{
  if((spi_fd = open(dev, O_RDWR)) < 0){
    printf("error opening %s\n",dev);
    return -1;
  }
  return 0;
}

int main(int argc, char* argv[])
{
    unsigned char data = 0xAF;
    if(argc <= 1){
        printf("too few args, try %s /dev/spidev0.0\n",argv[0]);
        return -1;
    }
    // open and configure SPI channel. (/dev/spidev0.0 for example)
    if(spi_open(argv[1]) < 0){
        printf("spi_open failed\n");
        return -1;
    }

  writeByte (IODIRA, 0x00) ;            // Port A -> Outputs
  writeByte (GPIOA, 0xFF) ;
  //writeByte (IPOLB, 0x01) ; // invert lsb
  //writeByte (GPPUB, 0xFF) ; // enable pullups.
  writeByte (IODIRB, 0xFF) ;            // Port B -> Inputs
  data = readByte (GPIOB) ;

  printf("RECEIVED: %.2X\n",data);
  close(spi_fd);
  return 0;
}
```