# 2416 Monocolor LED 3mm/5mm Dot Matrix Display Information Board User's Guide

# 2416 MONOCOLOR LED 3MM/5MM DOT MATRIX DISPLAY INFOMATION BOARD USER'S GUIDE

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**NOTES:**

**Product Version : Ver 1.0**

**Document Version : Ver 2.0**

# 2416 MONOCOLOR LED 3MM/5MM DOT MATRIX DISPLAY INFORMATION BOARD USER'S GUIDE

# Chapter 1. Overview

## 1.1 Overview

Thanks for using 2416 monocolor LED dot matrix info board series by Sure Electronics. Each integrating HT1632C as the driver chip, these info boards support 16-level PWM brightness control and all LED dot matrixes displayed are mapped to the RAM of HT1632C. Peripheral circuits are required to light up LEDs via the ports on the boards. These info boards can be used to display digits, letters and even graphs. It is allowed to connect up to 4 boards of the same kind in series for wider applications such as info display in banks, stores, households and so on. You may refer to the following table for members of this series.

**TABLE 1-1 2416 MONOCOLOR LED DOT MATRIX DISPLAY INFO BOARD SERIES**

| Product Number | Product Name |
|---|---|
| DE-DP11111 | 2416 Green LED 3mm Dot Matrix Display Information Board |
| DE-DP11112 | 2416 Red LED 3mm Dot Matrix Display Information Board |
| DE-DP11211 | 2416 Green LED 5mm Dot Matrix Display Information Board |
| DE-DP11212 | 2416 Red LED 5mm Dot Matrix Display Information Board |

**FIGURE 1-1 FRONT VIEW OF 2416 3MM DOT MATRIX DISPLAY INFO BOARD**

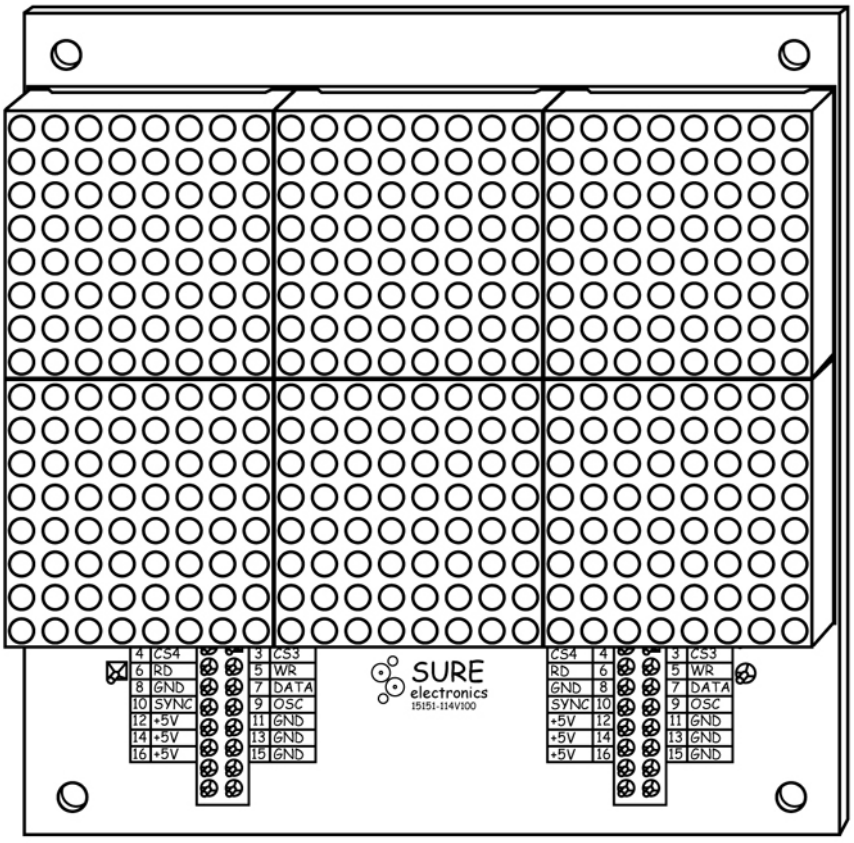


**FIGURE 1-2 FRONT VIEW OF 2416 5MM DOT MATRIX DISPLAY INFO BOARD**

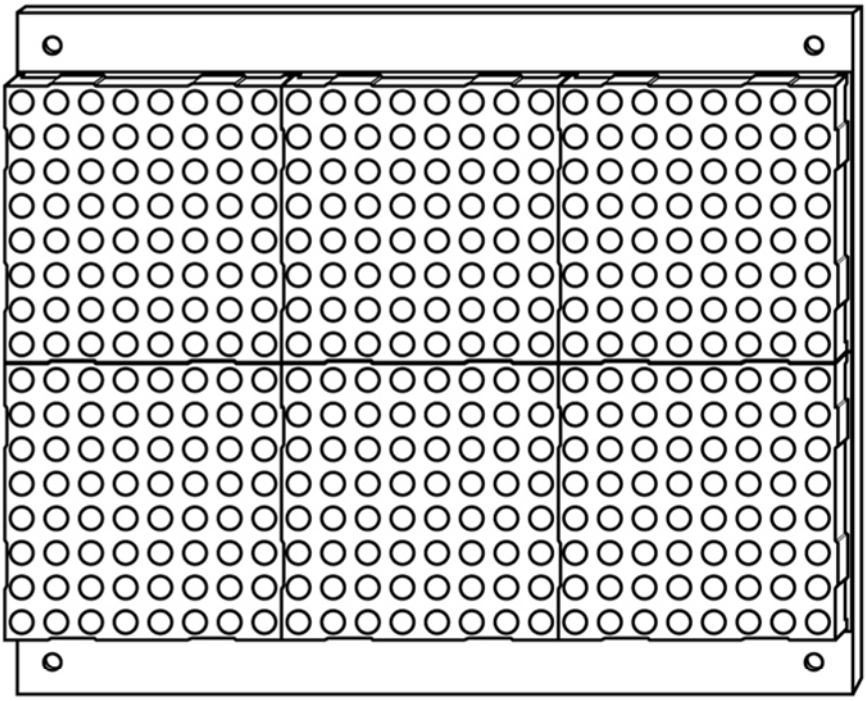


**FIGURE 1-3 BACK VIEW OF 2416 3MM DOT MATRIX DISPLAY INFO BOARD**

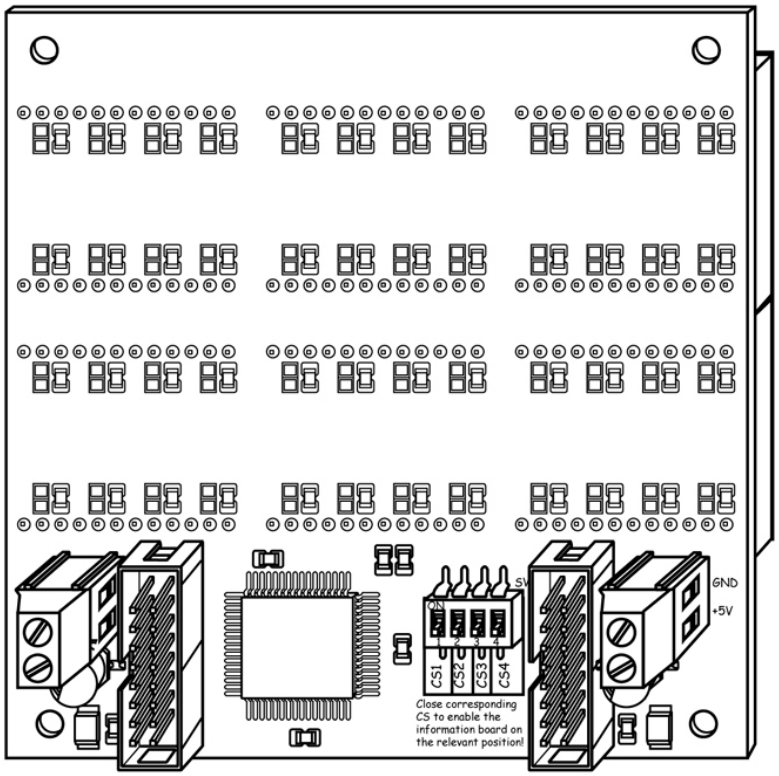
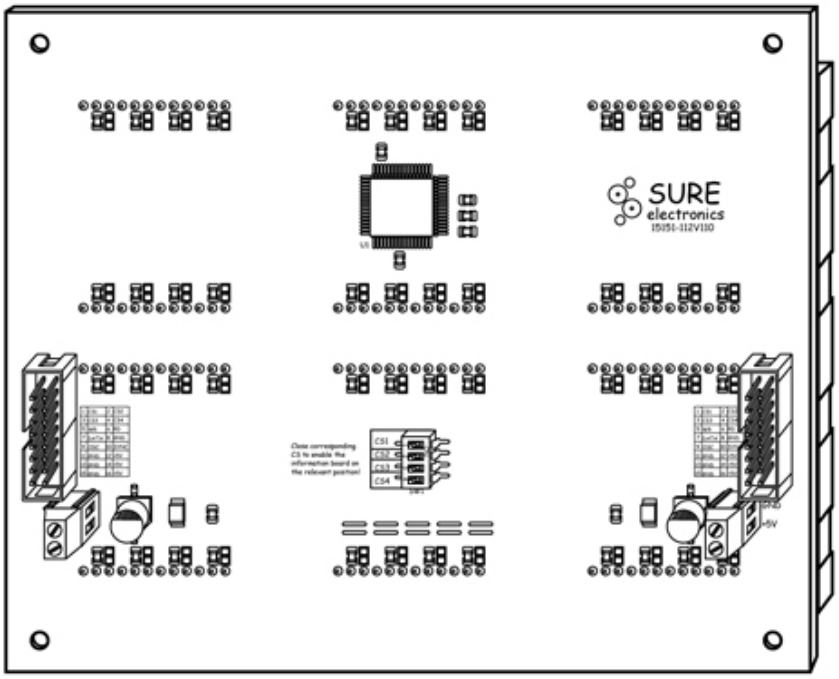


**FIGURE 1-4 BACK VIEW OF 2416 5MM DOT MATRIX DISPLAY INFO BOARD**

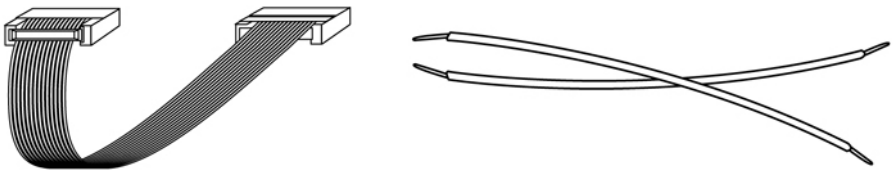



**Note:** All diagrams in this manual are for reference only.

## 1.2 Quick Start

A 16-pin IDC cable and two power cords are provided for free. DE-DD210 by Sure Electronics is used in this manual as a driver board. Program this driver board to control the display on the info board.

**FIGURE 1-5 ACCESSORIES**



16-pin IDC Cable　　Auxiliary Power Cord

**Note:**
1. Other driver board can be used. You may refer to **2.2 Port Definition** to do relative adjustments.
2. Sample codes are provided in this manual for reference.

### 1.2.1 Connection of One Info Board and The Driver Board

Connect BR1 of the info board and BR1 of the driver board with a 16-pin IDC cable and push CS1 of DIP switch on the info board to ON.

**FIGURE 1-6 CONNECTION OF THE DRIVER BOARD AND ONE 2416 3MM DOT MATRIX DISPLAY INFO BOARD**

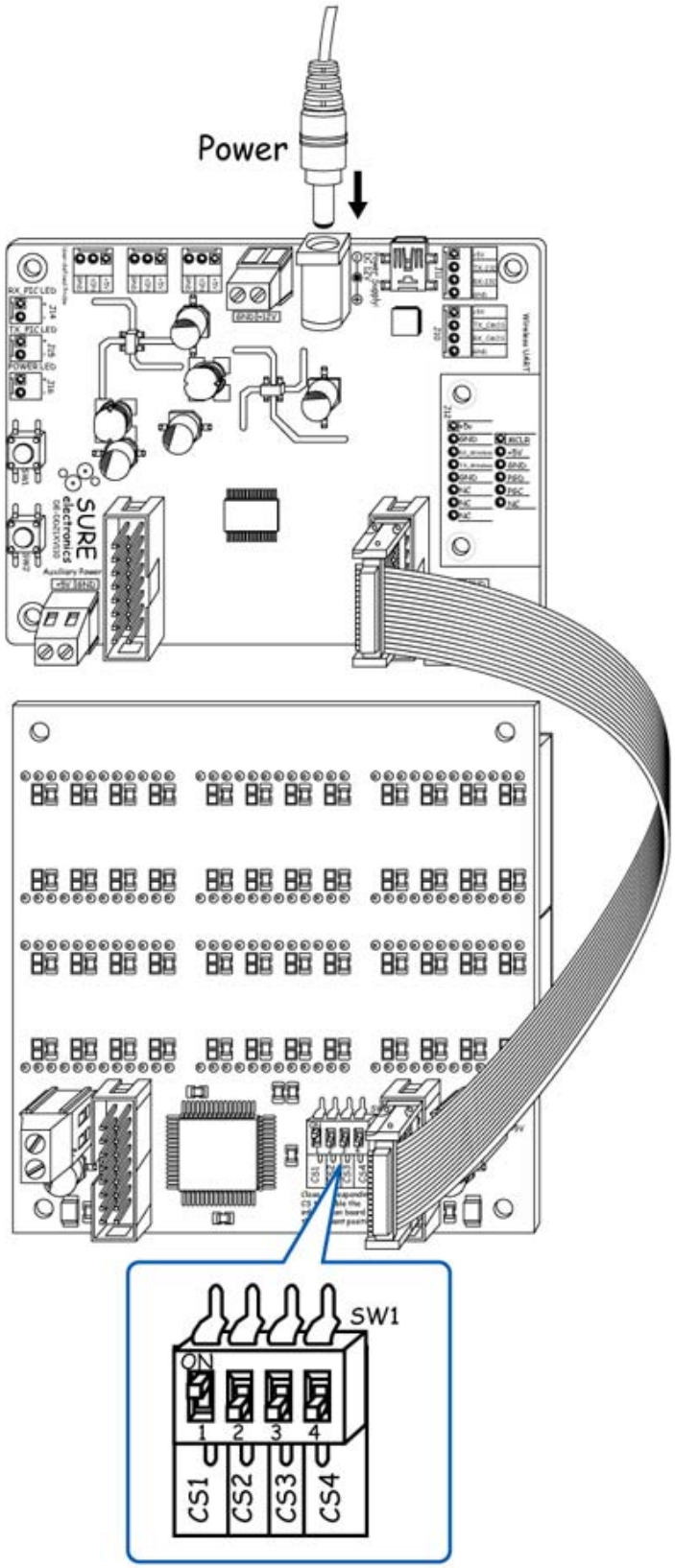
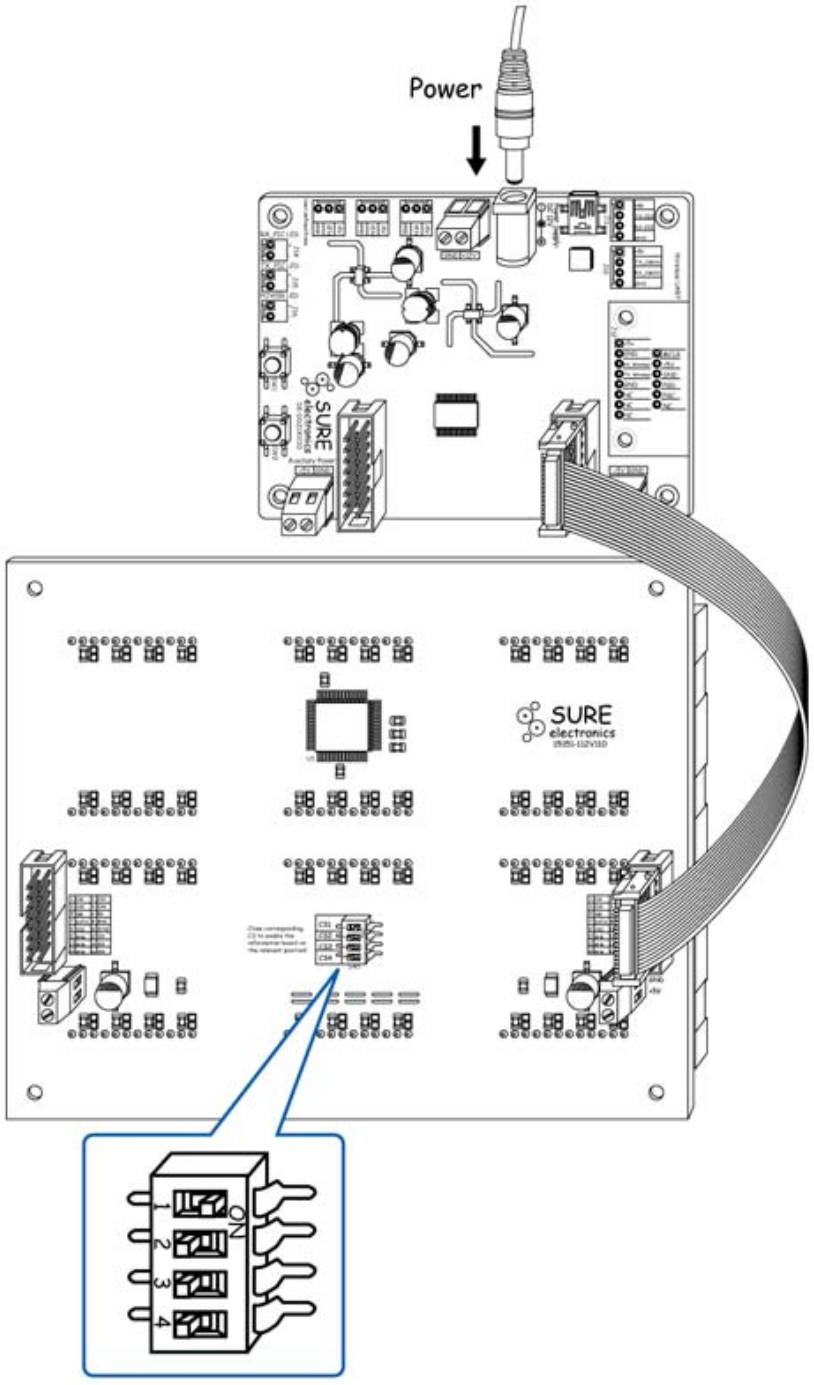


**FIGURE 1-7 CONNECTION OF THE DRIVER BOARD AND ONE 2416 5MM DOT MATRIX DISPLAY INFO BOARD**




Program codes to the chip of the driver board and repower the board.

**Note:** If you're not familiar with programming, try using the sample codes first.

### 1.2.2 Connection of Many Info Boards (Max 4 Boards)

First, auxiliary power cords are suggested to be used when four info boards are connected in series via the auxiliary power terminals: J1 and J2. Connect +5V, GND of J2 on one info board and the corresponding +5V, GND of J1 on the next info board with power cords. The auxiliary supply should be able to output DC5V 1.5A.

Connect BR1 of the driver board and BR1 of the info board with a 16-pin IDC cable.

Then, as shown in figure 1-8, connect four 2416 info boards and the driver board with 16-pin IDC cables and power cords. Set the CS1 of SW1 of the first info board, CS2 of the second info board, CS3 of the third info board and CS4 of the fourth info board ON.

**FIGURE 1-8 CONNECTION OF FOUR 2416 3MM DOT MATRIX DISPLAY INFO BOARDS CONNECTED IN SERIES**

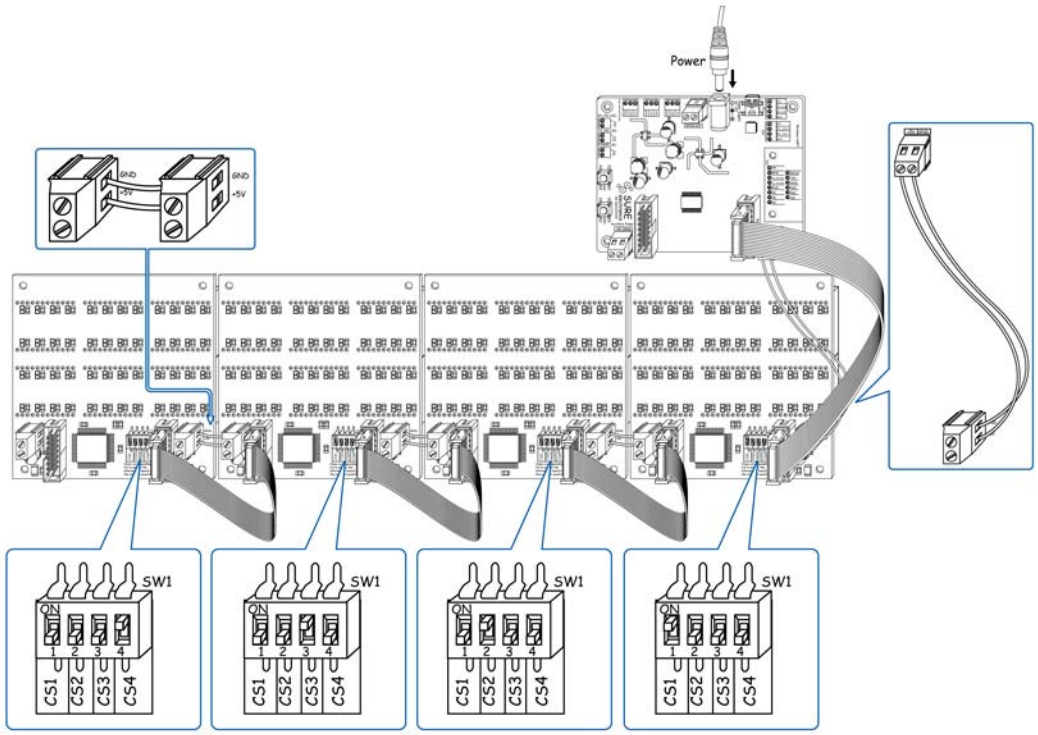
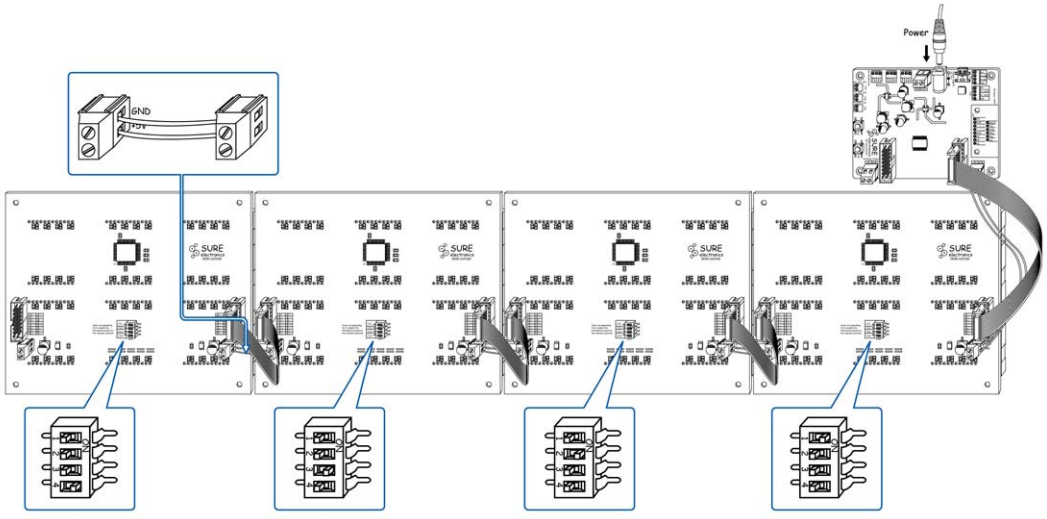



**FIGURE 1-9 CONNECTION OF FOUR 2416 5MM DOT MATRIX DISPLAY INFO BOARDS CONNECTED IN SERIES**




Program the chip on the driver board to control the LED display.

**Note:** If you use the sample codes, all the boards will display the same content.

# Chapter 2. Hardware Detail

## 2.1 Hardware

1. 6 pieces of 8*8 LED dot matrix display
   Light-emitting diameter of DE-DP11111 and DE-DP11112 is 3mm. Light-emitting diameter of DE-DP11211 and DE-DP11212 is 5mm
2. LED drive chip (U1): HT1632C, QFP packaging.
3. 16-pin male sockets (BR1 and BR2): used for data, clock, control signal and +5V supply input.
4. Auxiliary power supply terminals (+5V) (J1and J2): for external power input when more info boards are connected in series.

## 2.2 Port Definition

**TABLE 2-1 PIN DEFINITION OF BR1 AND BR2**

| Pin Number | Pin Name | Function Description |
|---|---|---|
| 1 | CS1 | Chip Selection 1 |
| 2 | CS2 | Chip Selection 2 |
| 3 | CS3 | Chip Selection 3 |
| 4 | CS4 | Chip Selection 4 |
| 5 | WR | WRITE clock input with pull-high resistor Data on the DATA lines are latched into the HT1632C on the rising edge of the WR signal. |
| 6 | RD | READ clock input with pull-high resistor. The HT1632C RAM data is clocked out on the falling edge of the RD signal. The clocked out data will appear on the DATA line. The host controller can use the next rising edge to latch the clocked out data. |
| 7 | DATA | Serial data input or output with pull-high resistor |
| 9 | OSC | If the RC Master Mode command is programmed, the system clock source is from on-chip RC oscillator and system clock is output to OSC pin.<br>If the Slave Mode or EXT CLK Master Mode command is programmed, the system clock source is input from external clock via the OSC pin |
| 10 | SYNC | If the RC Master Mode or EXT CLK Master Mode command is programmed, the synchronous signal is output to SYN pin.<br>If the Slave Mode command is programmed, the synchronous signal is input from SYN pin. |
| 8, 11, 13, 15 | GND | GND |
| 12, 14, 16 | VCC | Power Supply |

## 2.3 Display Memory

Display is controlled by modifying the data stored in RAM of HT1632C. All LEDs on the board are controlled by only one HT1632C.

The distribution of HT1632C's corresponding address is shown as follows:

**TABLE 2-2 THE CORRESPONDING ADDRESS OF HT1632C**

| | COM15 | COM14 | COM13 | COM12 | Addr | … | COM3 | COM2 | COM1 | COM0 | Addr |
|---|---|---|---|---|---|---|---|---|---|---|---|
| OUT0 | | | | | 03H | | | | | | 00H |
| OUT1 | | | | | 07H | | | | | | 04H |
| OUT2 | | | | | 0BH | | | | | | 08H |
| OUT3 | | | | | 0FH | | | | | | 0CH |
| OUT4 | | | | | 13H | | | | | | 10H |
| OUT5 | | | | | 17H | | | | | | 14H |
| OUT6 | | | | | 1BH | | | | | | 18H |
| OUT7 | | | | | 1FH | | | | | | 1CH |
| OUT8 | | | | | 23H | | | | | | 20H |
| OUT9 | | | | | 27H | | | | | | 24H |
| OUT10 | | | | | 2BH | … | | | | | 28H |
| OUT11 | | | | | 2FH | | | | | | 2CH |
| OUT12 | | | | | 33H | | | | | | 30H |
| OUT13 | | | | | 37H | | | | | | 34H |
| OUT14 | | | | | 3BH | | | | | | 38H |
| OUT15 | | | | | 3FH | | | | | | 3CH |
| OUT16 | | | | | 43H | | | | | | 40H |
| OUT17 | | | | | 47H | … | | | | | 44H |
| OUT18 | | | | | 4BH | | | | | | 48H |
| OUT19 | | | | | 5FH | | | | | | 4CH |
| OUT20 | | | | | 53H | | | | | | 50H |
| OUT21 | | | | | 57H | | | | | | 54H |
| OUT22 | | | | | 5BH | | | | | | 58H |
| OUT23 | | | | | 5FH | … | | | | | 5CH |
| | D15 | D14 | D13 | D12 | Data | | D3 | D2 | D1 | D0 | Data |

**FIGURE 2-1 THE CORRESPONDING ADDRESS OF HT1632C ON 2416 3MM DOT MATRIX DISPLAY INFO BOARD**

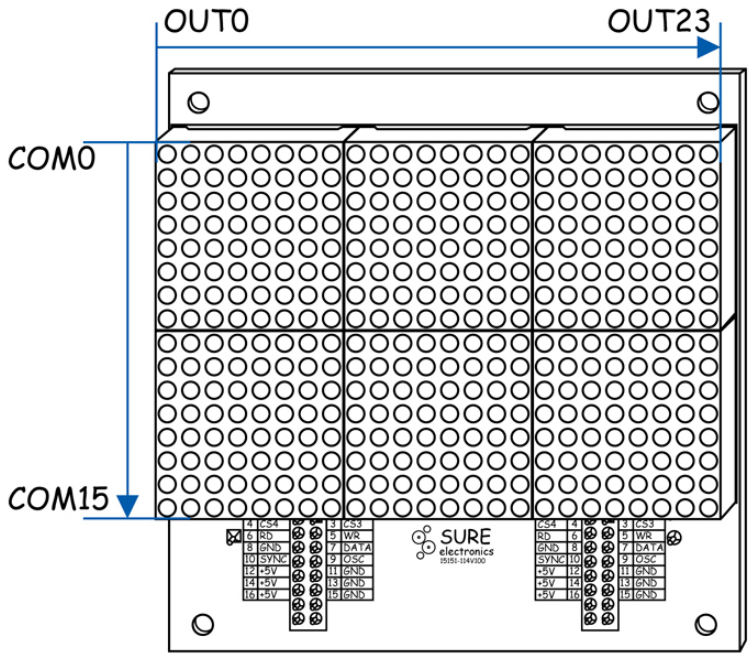
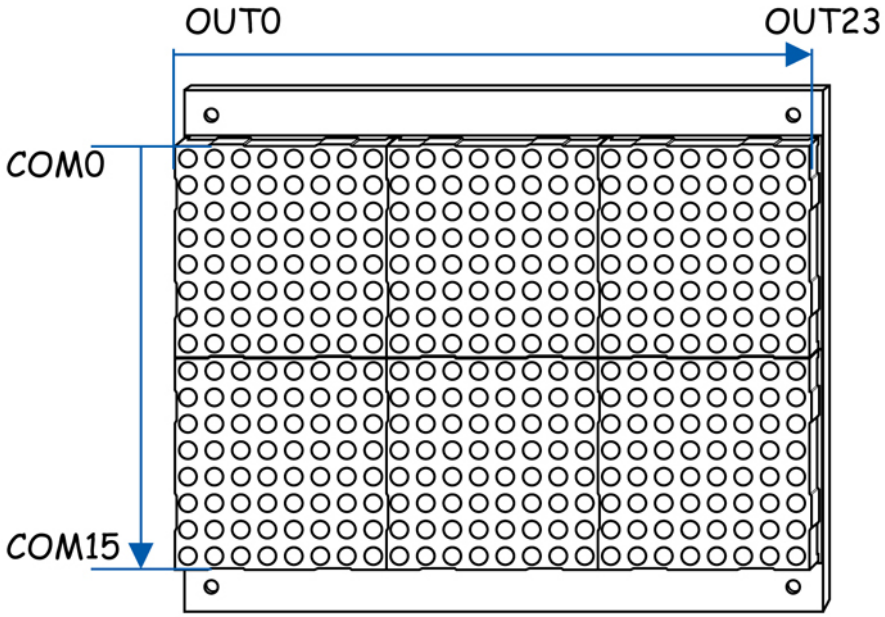



**FIGURE 2-2 THE CORRESPONDING ADDRESS OF HT1632C ON 2416 5MM DOT MATRIX DISPLAY INFO BOARD**




## 2.4 Command Format

CS (CS1、CS2、CS3、CS4) of HT1632C must be set to low before data or command is sent to this HT1632C. When the transmission is complete, CS must be reset to high. The timing diagram is as follows:

**FIGURE 2-3 SEND DATA**

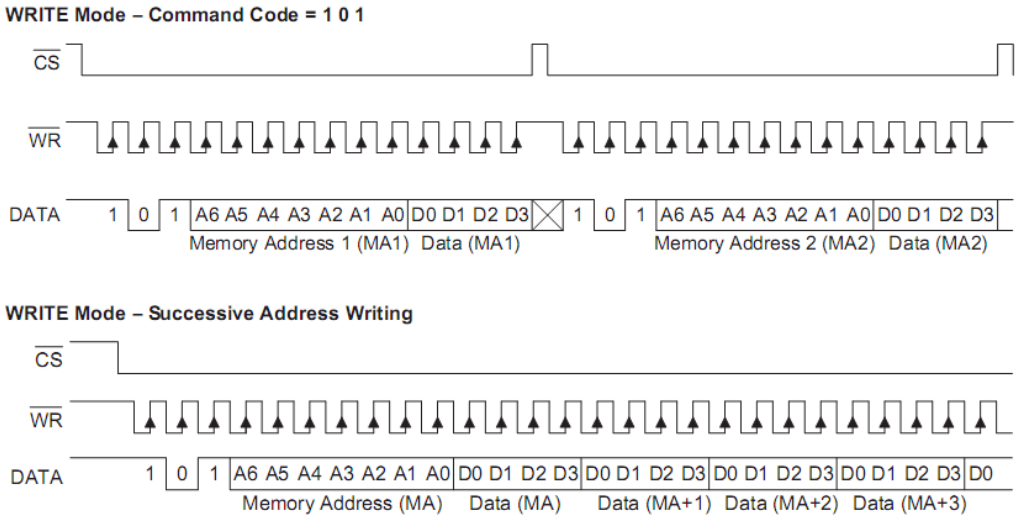
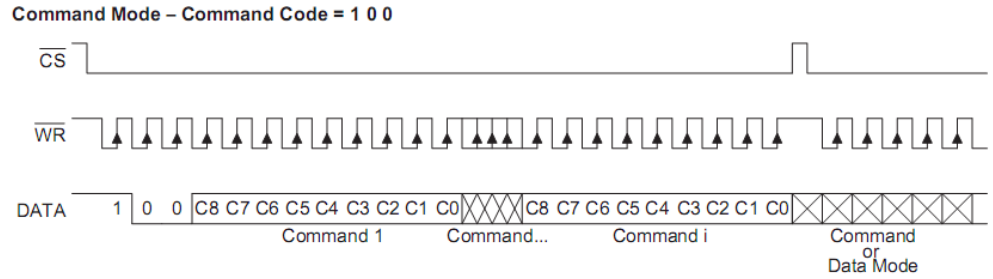



**FIGURE 2-4 SEND COMMAND**




**Note:** You may refer to HT1632C data sheet for details.

## 2.5 Command Summary

Command summary is shown as follows.

**FIGURE 2-5 COMMAND SUMMARY**

**Command Summary**

| Name | ID | Command Code | D/C | Function | Def. |
|---|---|---|---|---|---|
| READ | 1 1 0 | A6A5A4A3A2A1A0D0D1D2D3 | D | Read data from the RAM | |
| WRITE | 1 0 1 | A6A5A4A3A2A1A0D0D1D2D3 | D | Write data to the RAM | |
| READ-MODIFY-WRITE | 1 0 1 | A6A5A4A3A2A1A0D0D1D2D3 | D | Read and Write data to the RAM | |
| SYS DIS | 1 0 0 | 0000-0000-X | C | Turn off both system oscillator and LED duty cycle generator | Yes |
| SYS EN | 1 0 0 | 0000-0001-X | C | Turn on system oscillator | |
| LED Off | 1 0 0 | 0000-0010-X | C | Turn off LED duty cycle generator | Yes |
| LED On | 1 0 0 | 0000-0011-X | C | Turn on LED duty cycle generator | |
| BLINK Off | 1 0 0 | 0000-1000-X | C | Turn off blinking function | Yes |
| BLINK On | 1 0 0 | 0000-1001-X | C | Turn on blinking function | |
| SLAVE Mode | 1 0 0 | 0001-0XXX-X | C | Set slave mode and clock source from external clock, the system clock input from OSC pin and synchronous signal input from SYN pin | |
| RC Master Mode | 1 0 0 | 0001-10XX-X | C | Set master mode and clock source from on-chip RC oscillator, the system clock output to OSC pin and synchronous signal output to SYN pin | Yes |
| EXT CLK Master Mode | 1 0 0 | 0001-11XX-X | C | Set master mode and clock source from external clock, the system clock input from OSC pin and synchronous signal output to SYN pin | |
| COM Option | 1 0 0 | 0010-abXX-X | C | ab=00: N-MOS open drain output and 8 COM option<br>ab=01: N-MOS open drain output and 16 COM option<br>ab=10: P-MOS open drain output and 8 COM option<br>ab=11: P-MOS open drain output and 16 COM option | ab =00 |
| PWM Duty | 1 0 0 | 101X-0000-X | C | PWM 1/16 duty | |
| | 1 0 0 | 101X-0001-X | C | PWM 2/16 duty | |
| | 1 0 0 | 101X-0010-X | C | PWM 3/16 duty | |
| | 1 0 0 | 101X-0011-X | C | PWM 4/16 duty | |
| | 1 0 0 | 101X-0100-X | C | PWM 5/16 duty | |
| | 1 0 0 | 101X-0101-X | C | PWM 6/16 duty | |
| | 1 0 0 | 101X-0110-X | C | PWM 7/16 duty | |
| | 1 0 0 | 101X-0111-X | C | PWM 8/16 duty | |
| | 1 0 0 | 101X-1000-X | C | PWM 9/16 duty | |
| | 1 0 0 | 101X-1001-X | C | PWM 10/16 duty | |
| | 1 0 0 | 101X-1010-X | C | PWM 11/16 duty | |
| | 1 0 0 | 101X-1011-X | C | PWM 12/16 duty | |
| | 1 0 0 | 101X-1100-X | C | PWM 13/16 duty | |
| | 1 0 0 | 101X-1101-X | C | PWM 14/16 duty | |
| | 1 0 0 | 101X-1110-X | C | PWM 15/16 duty | |
| | 1 0 0 | 101X-1111-X | C | PWM 16/16 duty | |

# Chapter 3. Electrical Characteristics

**TABLE 3-1 ELECTRICAL CHARACTERISTICS**

| Parameter | | Symbol | Value | Unit |
|---|---|---|---|---|
| Operating Voltage | | $V_{in}$ | 5 | V |
| Storage Temperature | | $T_{stg}$ | -20 to 80 | ℃ |
| Average Operating Current | | $I_{avrg}$ | 0.20 | A |
| Maximum Operating Current (All LEDs on, 100% PWM duty cycle) | DE-DP11111 | $I_{max}$ | 0.35 | A |
| | DE-DP11112 | | 0.27 | |
| | DE-DP11211 | | 0.33 | |
| | DE-DP11212 | | 0.27 | |

# Chapter 4. Mechanical Drawing

**FIGURE 4-1 MECHANICAL DRAWING OF ONE 2416 3MM DOT MATRIX DISPLAY INFO BOARD**

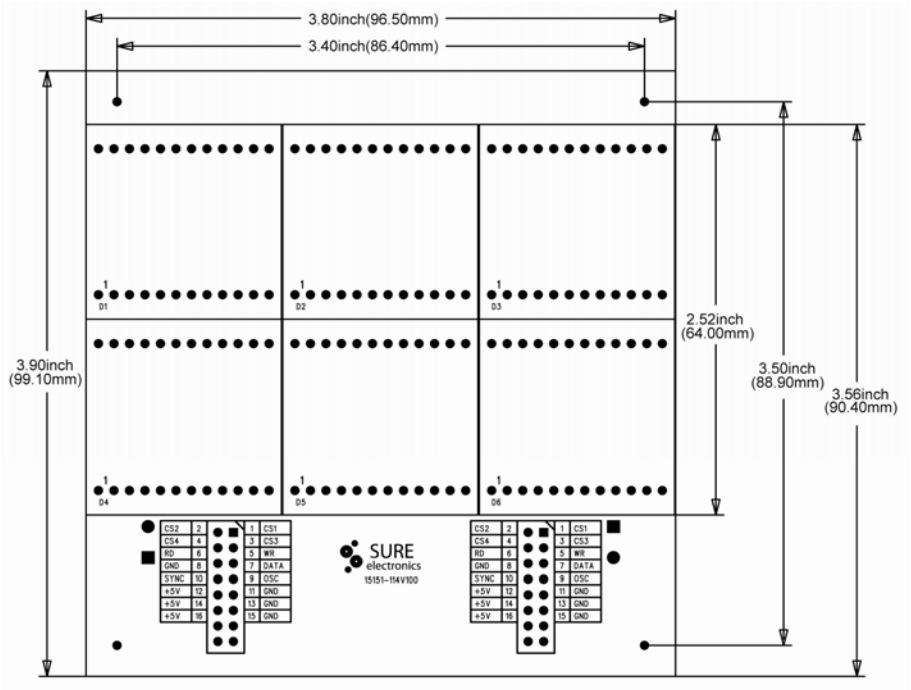
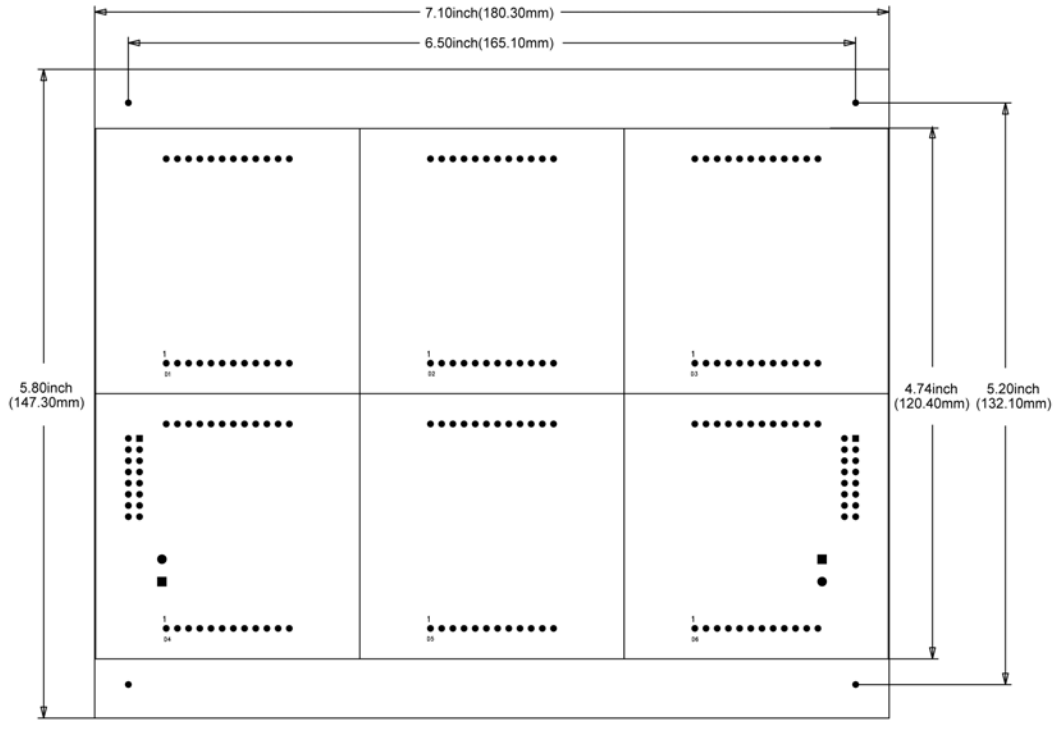


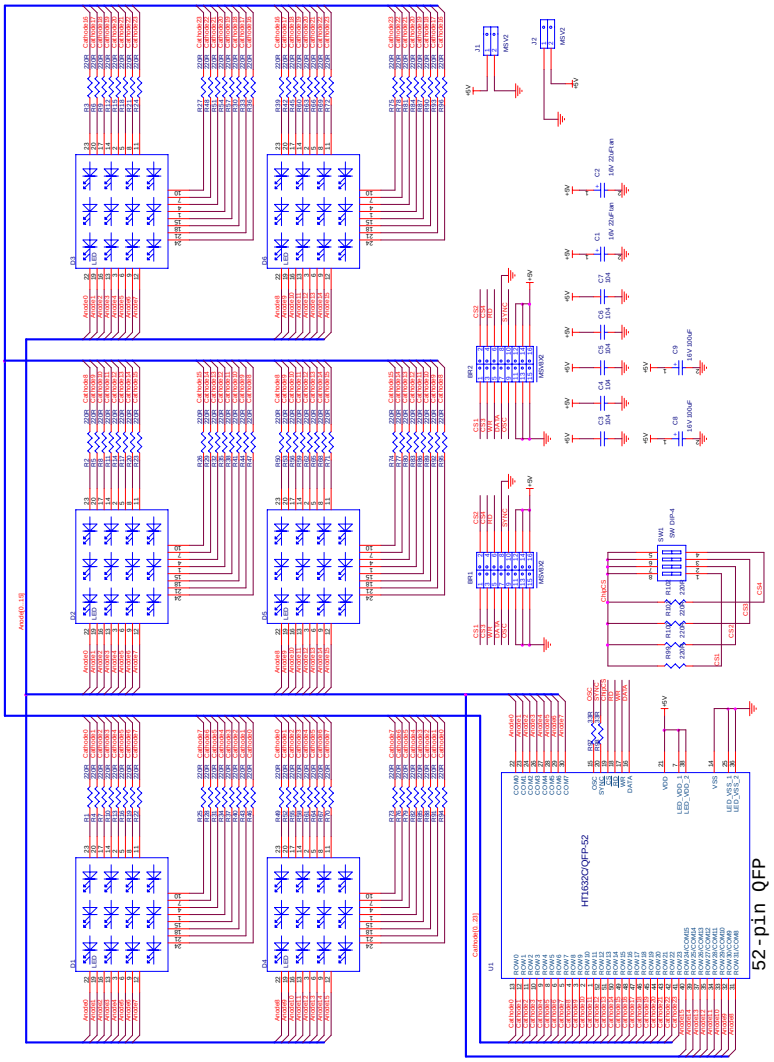

**FIGURE 4-2 MECHANICAL DRAWING OF ONE 2416 5MM DOT MATRIX DISPLAY INFO BOARD**



# Chapter 5. Appendix

## 5.1 Schematic

**FIGURE 5-1 SCHEMATIC**




## 5.2 Sample Code

The driver board DE-DD210, integrating PIC16F723 as its master chip, is used as an example. This sample code is used to illuminate the odd rows of LEDs.

Compilation environment: MPLAB IDE v8.40

Compiler: HI-TECH ANSI C Compiler PRO 9.65

File "Declare.h"

```
#ifndef    _DECLARE_
#define    _DECLARE_

//Macro definition of ports used
```

```
#define     CS1     RB0     //8 control ports
#define     CS2     RB1
#define     CS3     RB2
#define     CS4     RB3
#define     CS5     RB4
#define     CS6     RB5
#define     CS7     RB6
#define     CS8     RB7
#define     CS_OFF  CS1=1;CS2=1;CS3=1;CS4=1;CS5=1;CS6=1;CS7=1;CS8=1;
#define     CS_ON   CS1=0;CS2=0;CS3=0;CS4=0;CS5=0;CS6=0;CS7=0;CS8=0;

#define     CLK     RC3         //Clock line simulating SPI communication (this
                                //port is also the clock line of SPI communication
                                //integrated by MCU)
#define     DAT         RC5     //Data line simulating SPI communication (this
                                //port is also the data line of SPI communication
                                 //integrated by MCU)
#define     SW1         RC0     //Two switches
#define     SW2         RC1

//Following is the functions defined in a way of macro definition.
#define CLK_DELAY;   NOP()

//Following definition facilitates compilation of HT1632C control commands.
#define RC_MASTER_MODE   0b100000110000  //Set master mode and clock
                                         //source from on-chip RC oscillator
#define SYS_DIS          0b100000000000  //Turn off both system oscillator and
                                         //LED duty cycle generator
#define SYS_EN           0b100000000010  //Turn on system oscillator
#define LED_OFF          0b100000000100  //Turn off LED duty cycle generator
#define LED_ON           0b100000000110  //Turn on LED duty cycle generator
#define N_MOS_COM16      0b100001001000  //N-MOS open drain output and 16
                                         //common option
#define PWM_16           0b100101011110  //PWM 16/16 duty

#endif
```

File “SampleCode.c”

```
#include <pic.h>
#include "Declare.h"
//*****************************************************************************************
//Function Name: device file configuration
//Function Feature: configure MCU’s working modes and status
//Input Argument: INTIO: INTOSCIO- internal oscillator, OSC1 and OSC2 used as I/O
//ports
//              WDTDIS: Disable watchdog timer
```

```
//                PWRTDIS: Disable power-delay timer
//                MCLREN: Enable MCLR
//                UNPROTECT: Do NOT protect the code
//                BORDIS: Brown out reset disable
//                BORV25: Brown-out reset voltage set to 2.5V nominal
//                PLLEN:
//                DEBUGEN: In-circuit debugger enabled
//
//                VCAPDIS: Voltage regulator capacitor disable
//Output Argument: void
//*****************************************************************************************************
__CONFIG(INTIO & WDTDIS & PWRTEN & MCLREN & UNPROTECT & BORDIS &
BORV25 & PLLEN & DEBUGEN);
__CONFIG(VCAPDIS);

//Function Prototype Declaration
void SystemInit(void);                              //System Initialization
void SetHT1632As2416(void);                        //Set HT1632C to work in 24*16 mode
void CommandWrite(unsigned int command);     //Write commands to all HT1632Cs
void AddressWrite(unsigned char address);       //Write address
void SPI_ModelConfigure(void);                   //Configure data transfer mode as SPI
                                                          //mode
void SPI_DataSend(const unsigned char data);   //Send data in SPI mode
void Print(void);                                    //Function displayed on the board

void main()
{
      SystemInit();
      SetHT1632As2416();
      CS_ON;
      Print();
      while(1);
}
//*****************************************************************************************************
//Function Name: system initialization
//Function Feature: set corresponding data reading and writing of PORTB and PORTC
//Input Argument: void
//Output Argument: void
//*****************************************************************************************************
void SystemInit(void)
{
      IRCF1 = 1;          //Set the frequency of the internal oscillator as 8MHz
      IRCF0 = 0;
      BRGH=0;             //Select low baud rate mode, default status after power-on reset
      OSCTUNE = 0x1f;       //Oscillator at the maximum frequency
      ANSELB = 0x00;          //PORTB as a digital I/O port
```

```
    TRISB = 0x00;          //PORTB as an output port
    PORTB = 0x00;          //Clear PORTB output
    TRISC0 = 1;            //PORTC0 (SW1 port) as an input port
    TRISC1 = 1;            //PORTC1 (SW2 port) as an input port
    TRISC3 = 0;            //PORTC3 (CLK signal) as an output port
    TRISC5 = 0;            //PORTC5 (DATA signal) as an output port
    T0IE = 0;              //Turn off interruption of timer0
}

//*************************************************************************************************
//Function Name: SetHT1632C_As2416
//Function Feature: write basic configuration to HT1632C in command words
//Input Argument: void
//Output Argument: void
//*************************************************************************************************
void SetHT1632As2416(void)
{
    CommandWrite(SYS_EN);        //Enable system oscillator
    CommandWrite(LED_ON);        //Turn on LED
    CommandWrite(RC_MASTER_MODE);    // Select on-chip RC as the system clock
                                     //working in master mode
    CommandWrite(N_MOS_COM16);       //N-MOS open-drain output and 24
                                     //ROW * 16 COM
    CommandWrite(PWM_16);            //Set the grade of initial PWM brightness
                                     //as light_degree (16/16)
}

//*************************************************************************************************
//Function Name: CommandWrite
//Function Feature: Write control commands to all HT1632Cs
//Input Argument: command words written to “command”, specifically stated in “declare”
//function
//Output Argument: void
//Argument Description: compile control commands to all external HT1632Cs for the
//requirement of the project
//*************************************************************************************************
void CommandWrite(unsigned int command)
{
    unsigned char i;
    unsigned int j;
    command = command & 0x0fff;   //12-bit command word, upper four bits masked

    CS_OFF;                       //Disable all HT1632Cs
    CLK_DELAY;
    CS_ON                         //Enable all HT1632Cs
    CLK_DELAY;
```

```
    for(i=0; i<12; i++)              //Write command words in HI1632C register
    {
        CLK = 0;
        CLK_DELAY;
        j = command & 0x0800;        //Return the MSB
        command = command << 1;//Shift left once
        j = j >> 11;                 //Position the value at the LSB
        DAT = j;                     //Send the value to the data port
        CLK_DELAY;
        CLK = 1;                     //Data transmission (data valid on rising edge)
        CLK_DELAY;
    }
    CS_OFF;                          //Disable all HT1632Cs
}

//*************************************************************************************************
//Function Name: AddressWrite
//Function Feature: write start address of data to HT1632C
//Input Argument: address: address to be written
//Output Argument: void
//*************************************************************************************************
void AddressWrite(unsigned char address)
{
    unsigned char i,temp;
    SSPCON = 0x11;
    address = address & 0x7f;            //7-bit address, mask the MSB
    CLK = 0;                             //Clock line is 0
    CLK_DELAY;
    DAT = 1;                             //Send “1” to data port
    CLK_DELAY;
    CLK = 1;                             //Data transmission
    CLK_DELAY;
    CLK = 0;
    CLK_DELAY;
    DAT = 0;                             //Send “0” to data port
    CLK_DELAY;
    CLK = 1;                             //Data transmission
    CLK_DELAY;
    CLK = 0;
    CLK_DELAY;
    DAT = 1;                             //Send “1” to data port
    CLK_DELAY;
    CLK = 1;                             //Data transmission
    CLK_DELAY;
    for(i=0; i<7; i++)                   //Write “address” to HT1632C register
    {
```

```
            CLK = 0;                        //Clock line is 0
            CLK_DELAY;
            temp = address & 0x40;          //Return the MSB
            address = address << 1;         //Shift left once
            temp = temp >> 6;               //Position the value at the LSB
            DAT = temp;                     //Send the value to the data port
            CLK_DELAY;
            CLK = 1;                        //Data transmission
            CLK_DELAY;
        }
    }

    //*************************************************************************************************
    //Function Name: SPI_ModelConfigure
    //Function Feature: configure the corresponding data transfer port of PIC microcontroller
    //for SPI communication
    //Input Argument: void
    //Output Argument: void
    //*************************************************************************************************
    void SPI_ModelConfigure(void)
    {
        SSPIF = 0;          //Initial state: waiting to send data
        SSPCON = 0x31;  //Write in this register: SSPEN=1 (enable serial port); CKP=1
                            //(CLK high in an idle state); CLK is FOSC/16
        SSPSTAT = 0x80; // Write in this register: SMP=1(Input data sampled at end of
                            //data output time); CKE=0(data stable on rising edge of SCK)
    }

    //*************************************************************************************************
    //Function Name: SPI_DataSend
    //Function Feature: transmit data in SPI mode of PIC microcontroller
    //Input Argument: data: bytes of data to be transmitted
    //Output Argument: void
    //*************************************************************************************************
    void SPI_DataSend(const unsigned char data)
    {
        SSPBUF = data;              //Start sending
        while(!SSPIF);              //Wait for data being sent
        SSPIF = 0;                  //Clear flag
    }

    //*************************************************************************************************
    //Function Name: PrintString
    //Function Feature: up to 4 ASCII chars to be sent
    //Input Argument: string: strings to be sent
    //Output Argument: void
```

```
//*************************************************************************************************
void Print()
{
    unsigned char i = 0;
    unsigned char buff = 0x00;
    AddressWrite(0x00);
    SPI_ModelConfigure();
    for(i=0; i<48; i++)
    {
        buff = 0xaa;
        SPI_DataSend(buff);
    }
    SSPCON = 0x11;
}
```

## 5.3 Heat Dissipation

Following are pictures of heat dissipation gained by Fluke Ti20 Thermal Imager in the condition of info board working at full load, all LEDs on, 100% PWM duty cycle.

**FIGURE 5-2 HEAT DISTRIBUTION OF THE BACK PANEL OF 2416 3MM DOT MATRIX DISPLAY INFO BOARD**

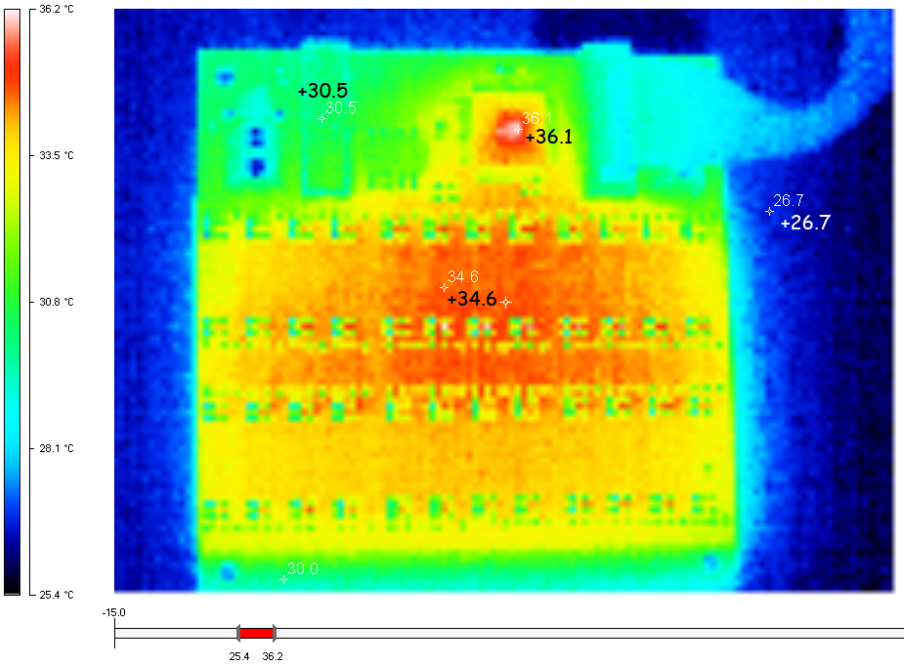


**FIGURE 5-3 HEAT DISTRIBUTION OF THE BACK PANEL OF 2416 5MM DOT MATRIX DISPLAY INFO BOARD ($T_A$=19℃)**

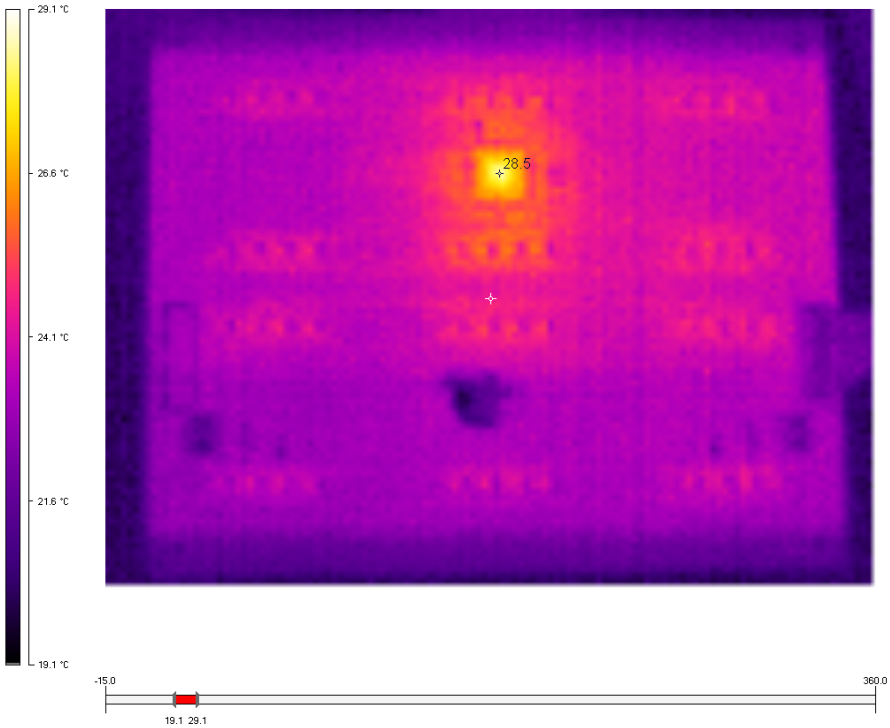



**FIGURE 5-4 HEAT DISTRIBUTION OF THE FRONT PANEL OF 2416 3MM DOT MATRIX DISPLAY INFO BOARD**

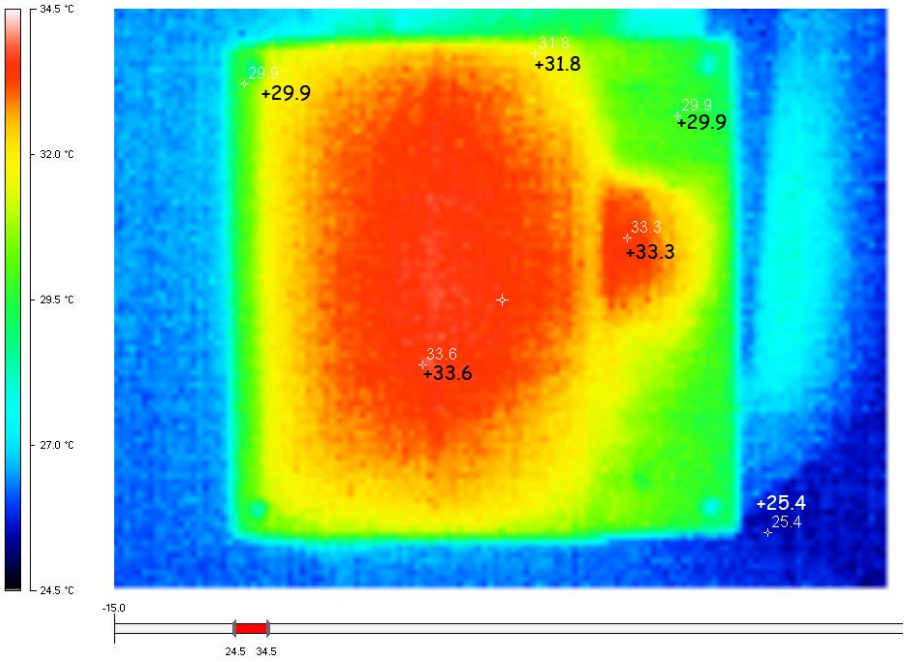
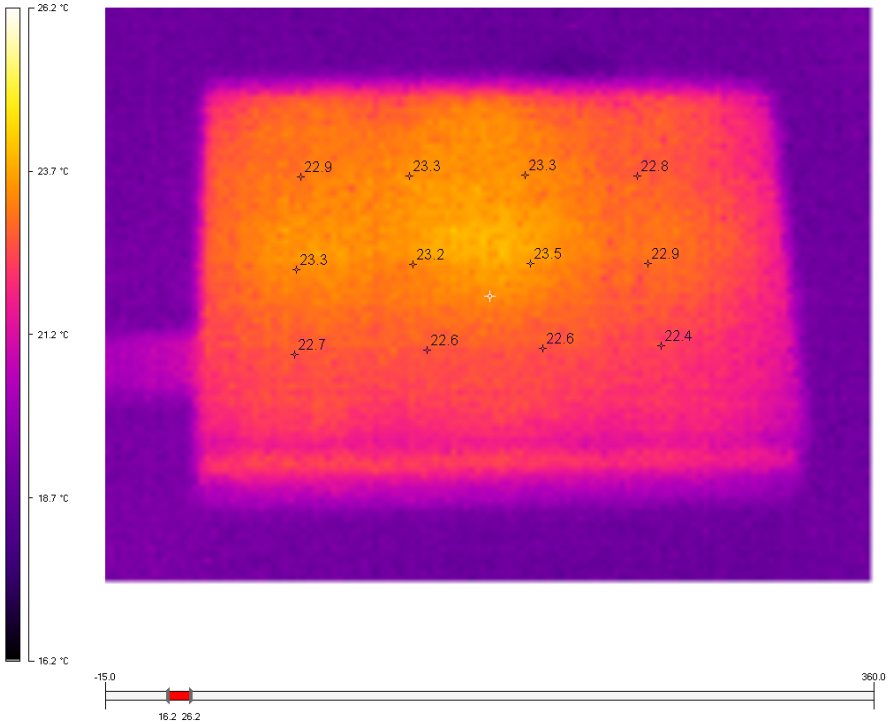


**FIGURE 5-5 HEAT DISTRIBUTION OF THE FRONT PANEL OF 2416 5MM DOT MATRIX DISPLAY INFO BOARD($T_A$=19℃)**



# Chapter 6. Contact Us

**Sure Electronics Co., Ltd.**
5F, Zone A,
Qinhuai Technology Innovation Center
105-2 DaMing Rd (ZIP:210022)
Nanjing
P.R.China
Tel: +86-13601408832 (For technical questions only)
+86-25-66606340 (English service, from GMT1-10AM)
Fax: +86-25- 66606341-866
Website: www.sure-electronics.com
www.sure-electronics.net