



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



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

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2416 Monocolor LED 3mm/5mm Dot Matrix Display Information Board

NOTES:

Product Version : Ver 1.0

Document Version : Ver 2.0

Chapter 1. Overview

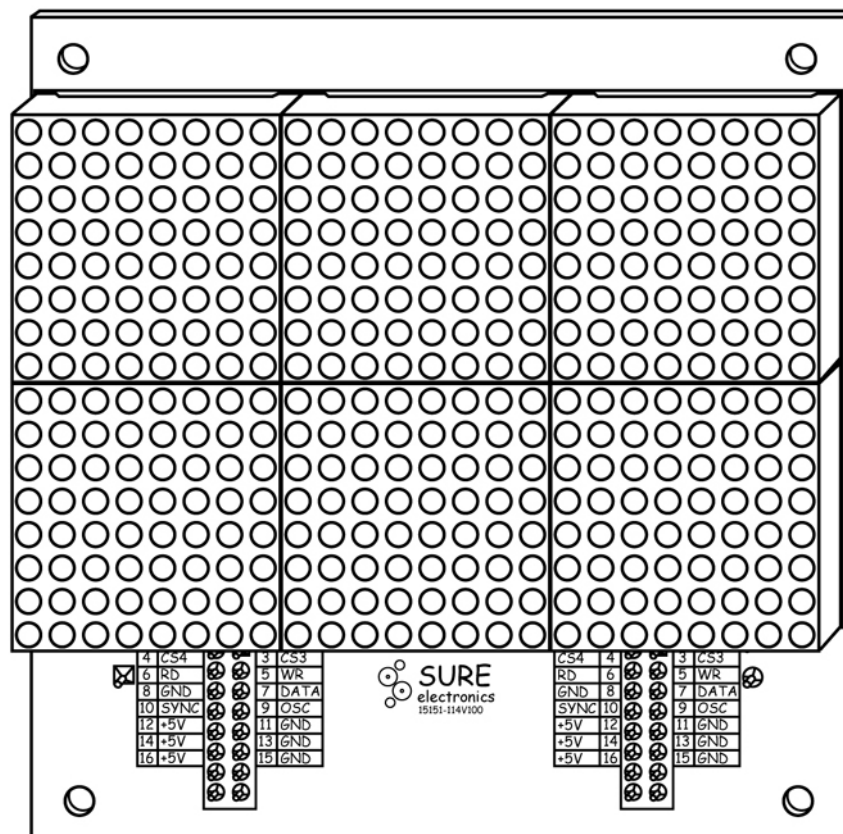
1.1 Overview

Thanks for using 2416 monochrome 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



2416 Monocolor LED 3mm/5mm Dot Matrix Display Information Board

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

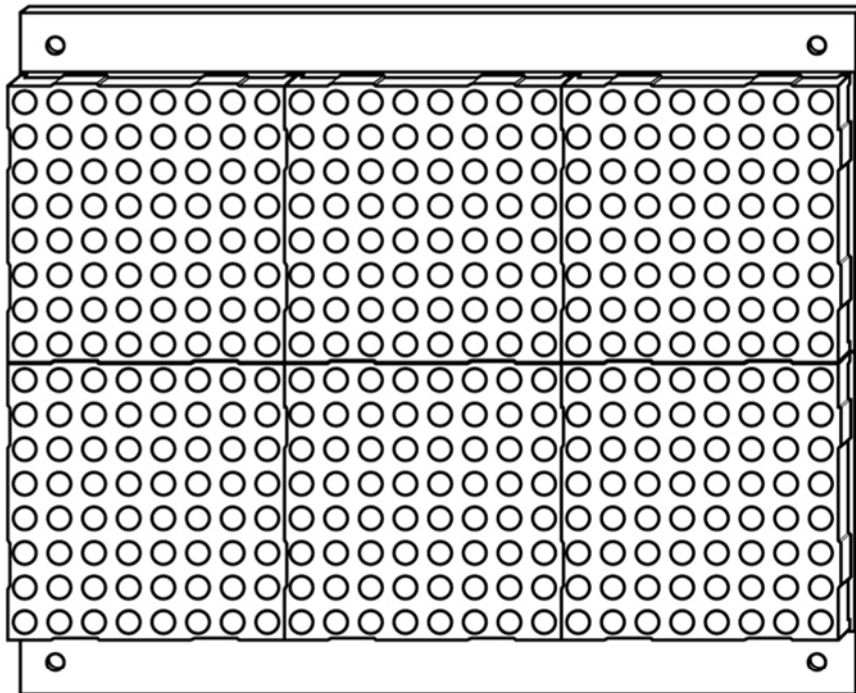


FIGURE 1-3 BACK VIEW OF 2416 3MM DOT MATRIX DISPLAY INFO BOARD

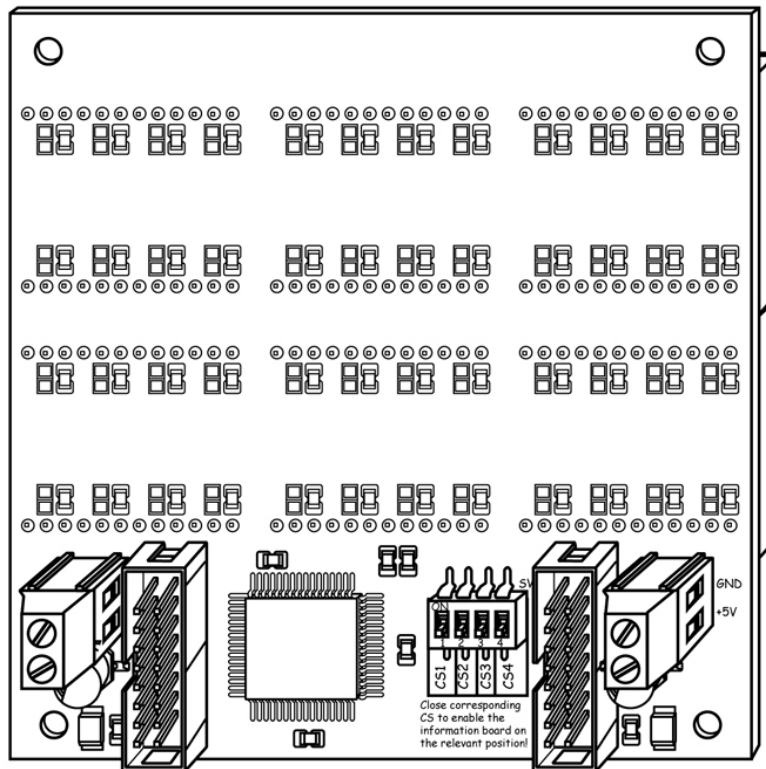
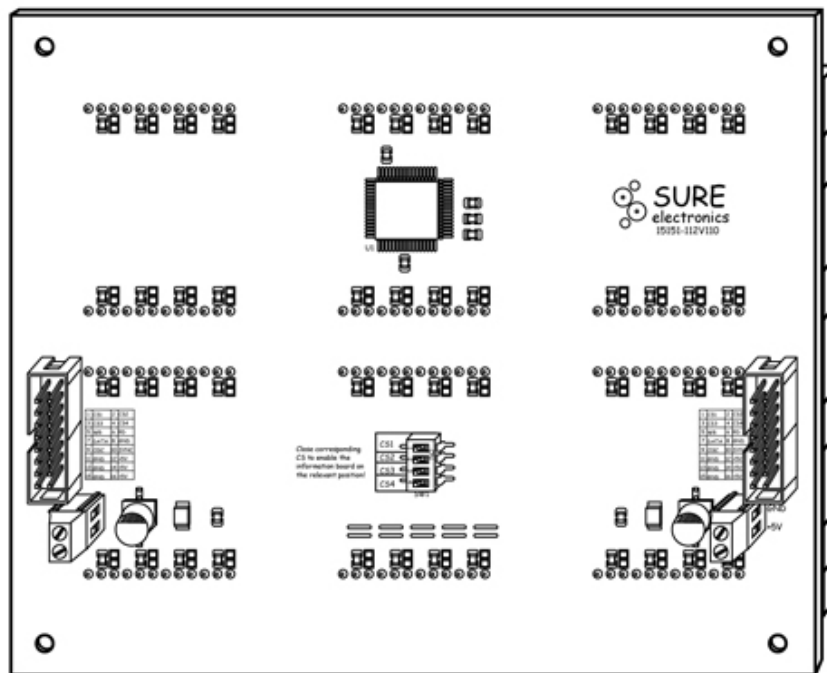


FIGURE 1-4 BACK VIEW OF 2416 5MM DOT MATRIX DISPLAY INFO BOARD

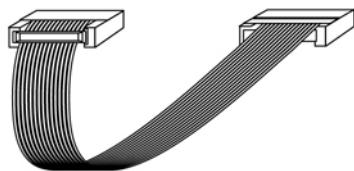


Note: All diagrams in this manual are for reference only.

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.

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

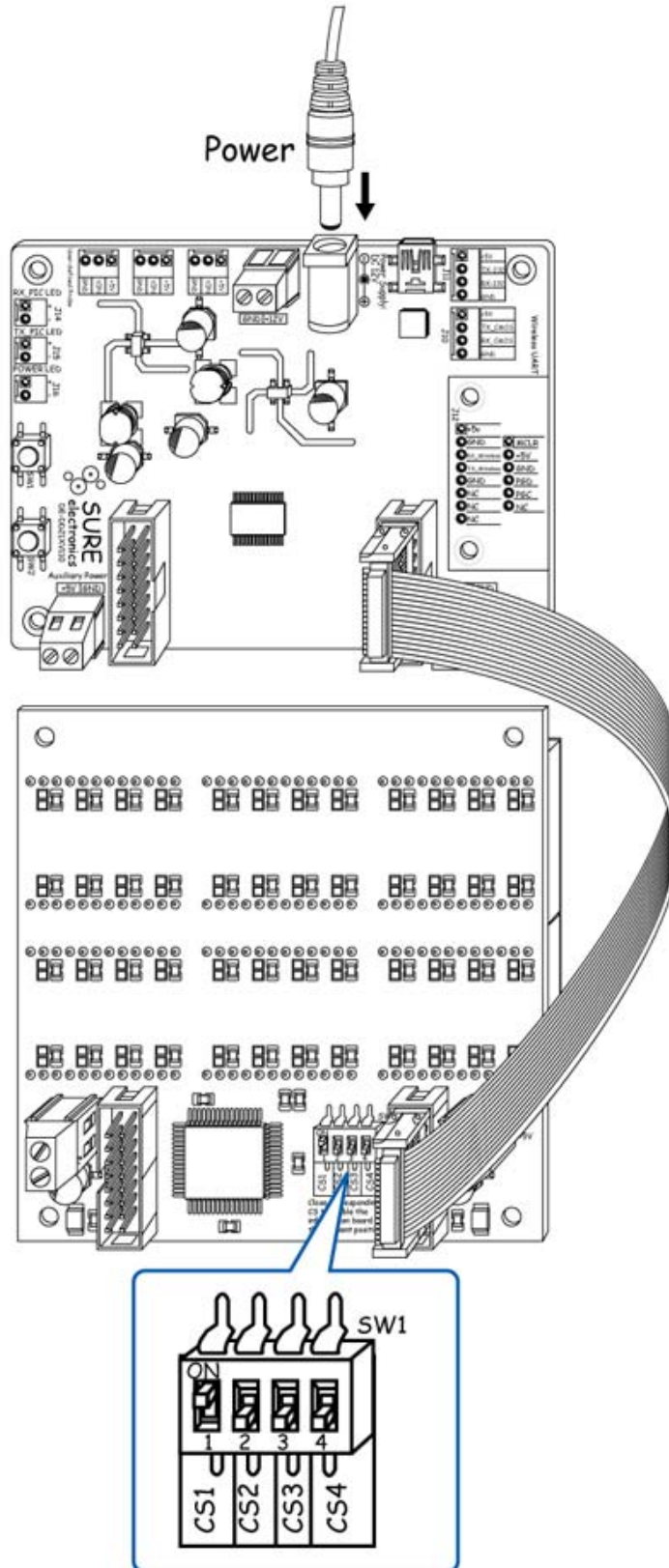
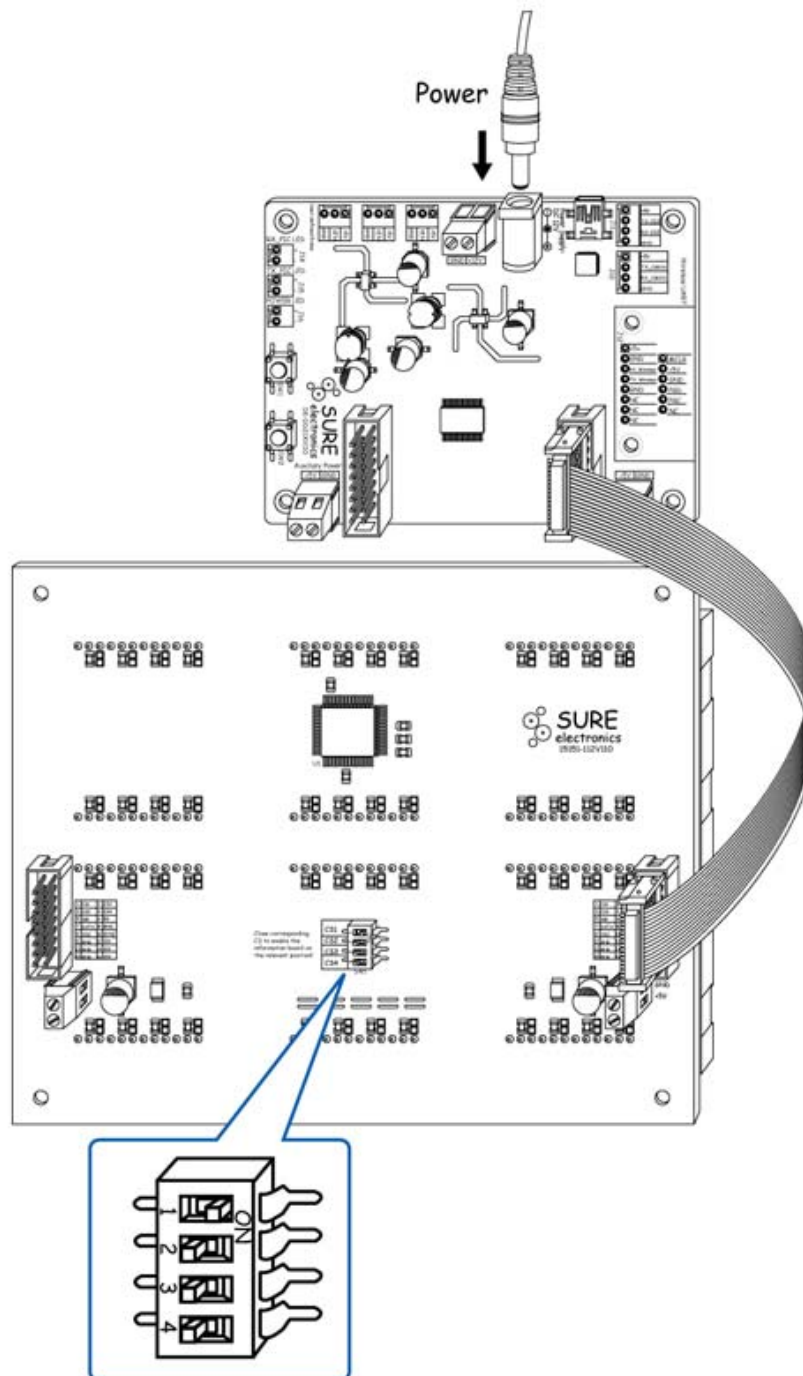


FIGURE 1-7 CONNECTION OF THE DRIVER BOARD AND ONE 2416 5MM DOT MATRIX DISPLAY INFO BOARD



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.

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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

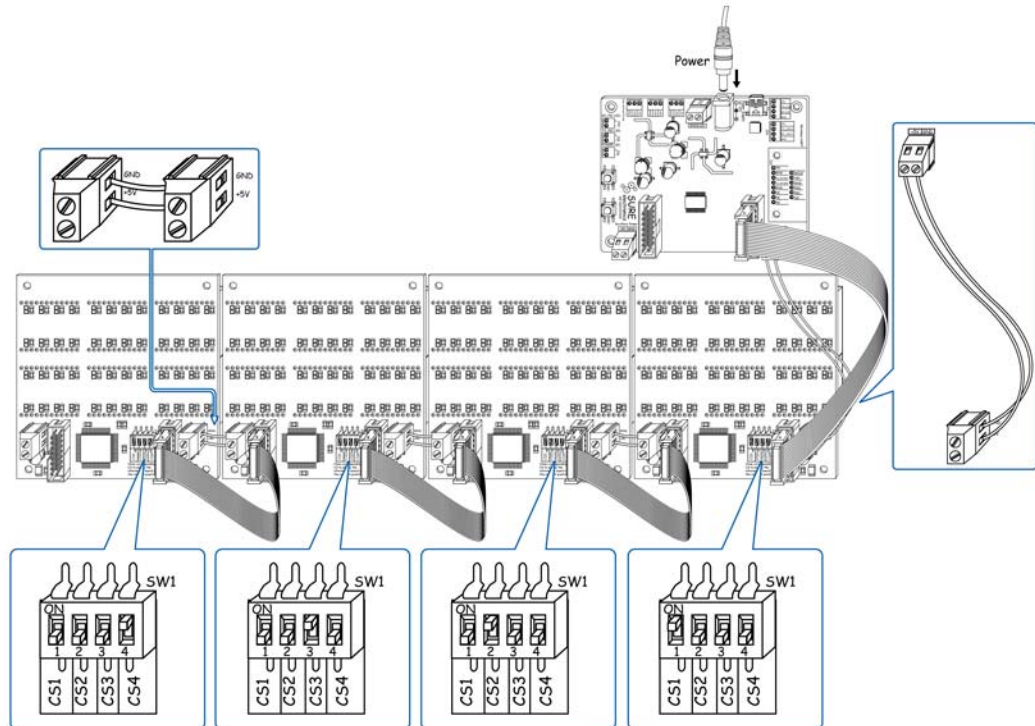
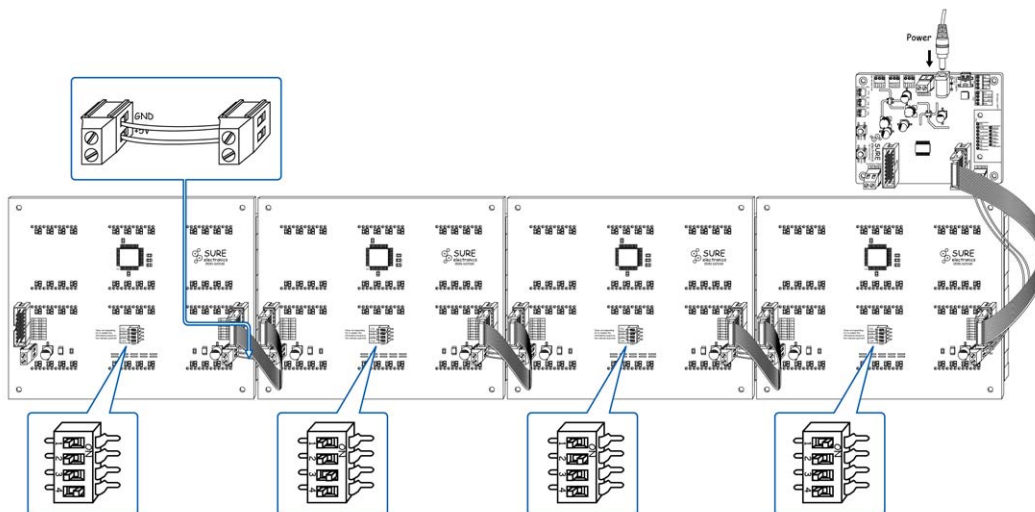


FIGURE 1-9 CONNECTION OF FOUR 2416 5MM DOT MATRIX DISPLAY INFO BOARDS CONNECTED IN SERIES



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) (J1 and 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. 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. 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

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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

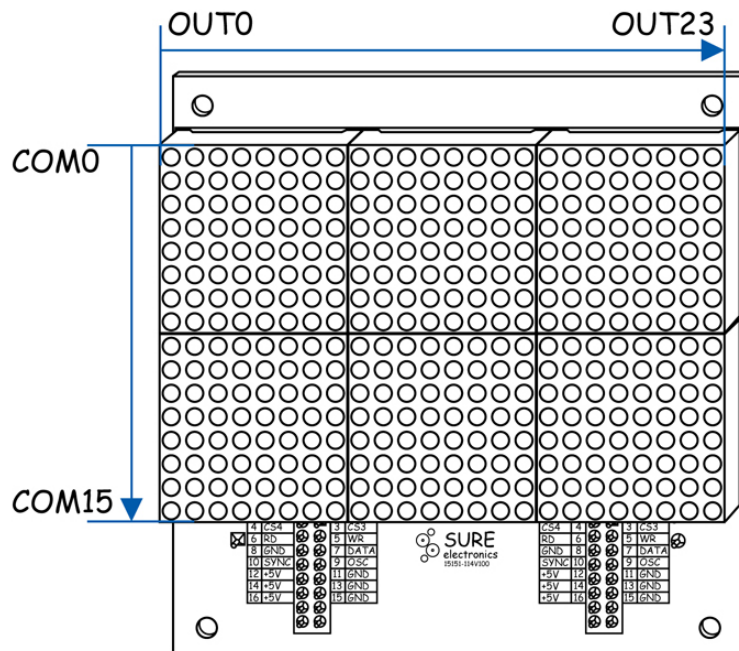
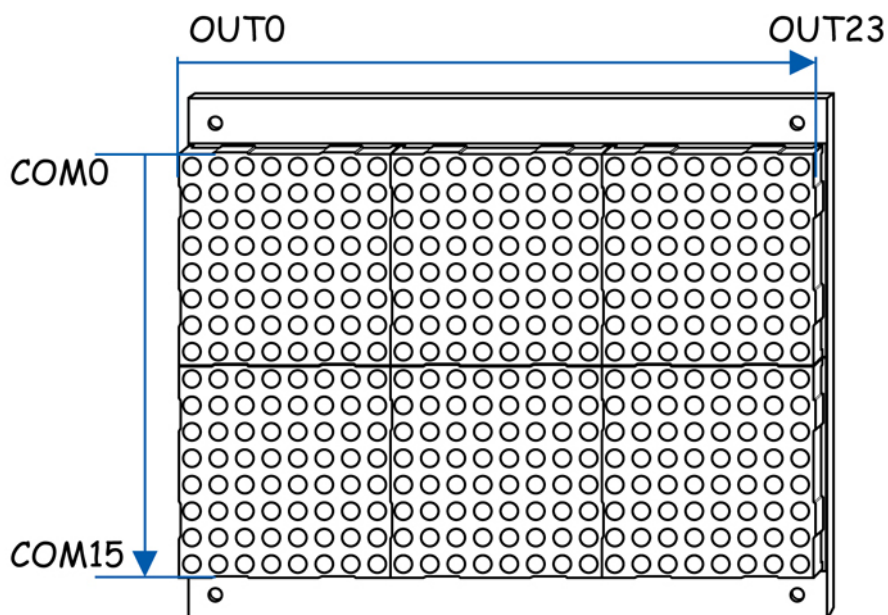


FIGURE 2-2 THE CORRESPONDING ADDRESS OF HT1632C ON 2416 5MM DOT MATRIX DISPLAY INFO BOARD



2.4 Command Format

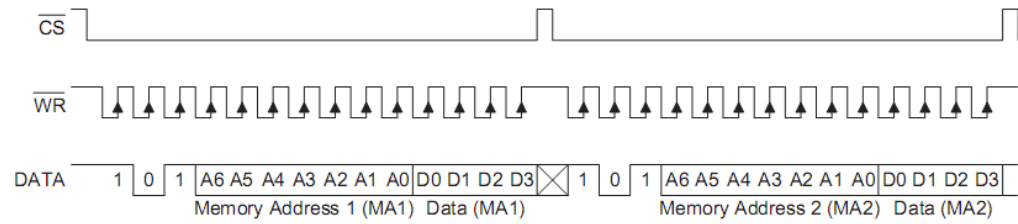
CS (CS1、CS2、CS3、CS4) of HT1632C must be set to low before data or command is sent to this HT1632C. When the transmission is complete, CS must be reset to high.

The timing diagram is as follows:

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FIGURE 2-3 SEND DATA

WRITE Mode – Command Code = 1 0 1



WRITE Mode – Successive Address Writing

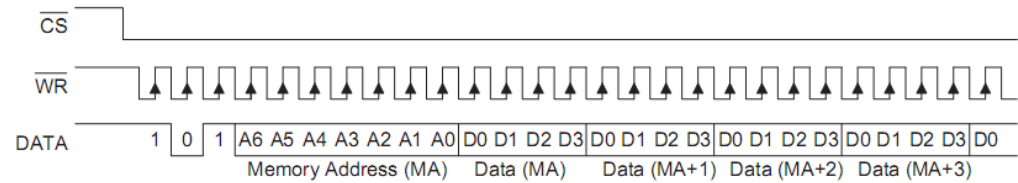
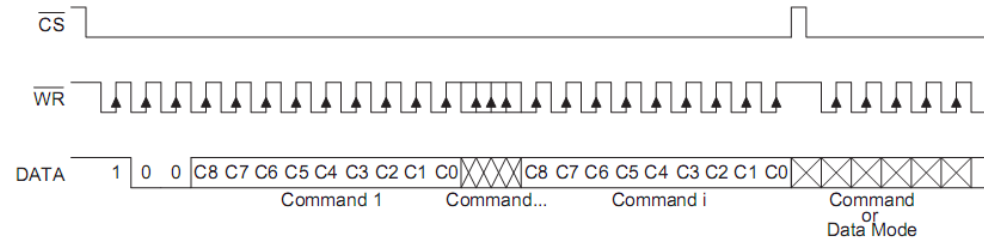


FIGURE 2-4 SEND COMMAND

Command Mode – Command Code = 1 0 0



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 ab=01: N-MOS open drain output and 16 COM option ab=10: P-MOS open drain output and 8 COM option 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	°C	
Average Operating Current	I_{avg}	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

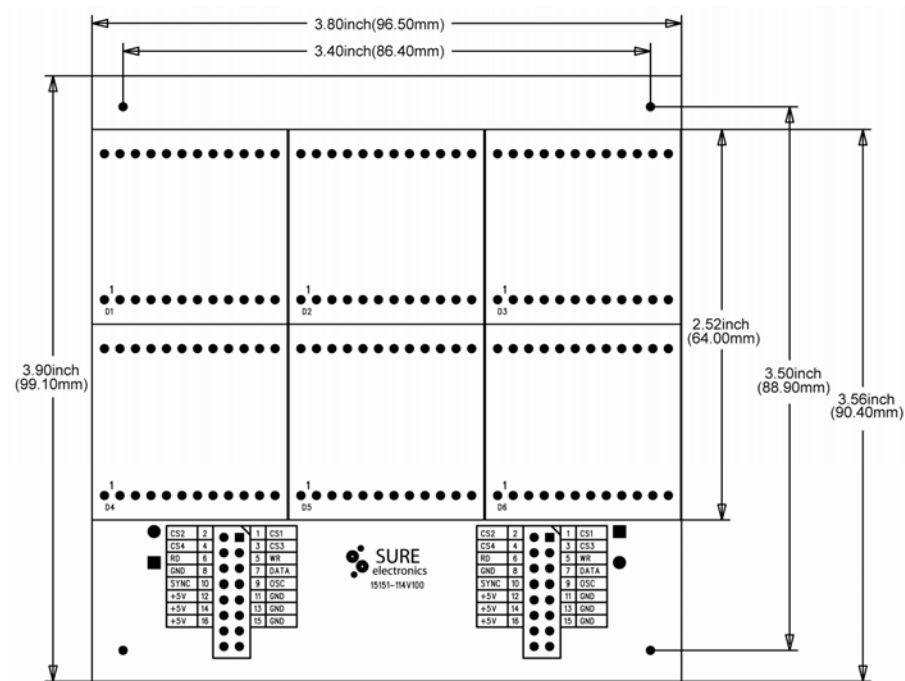
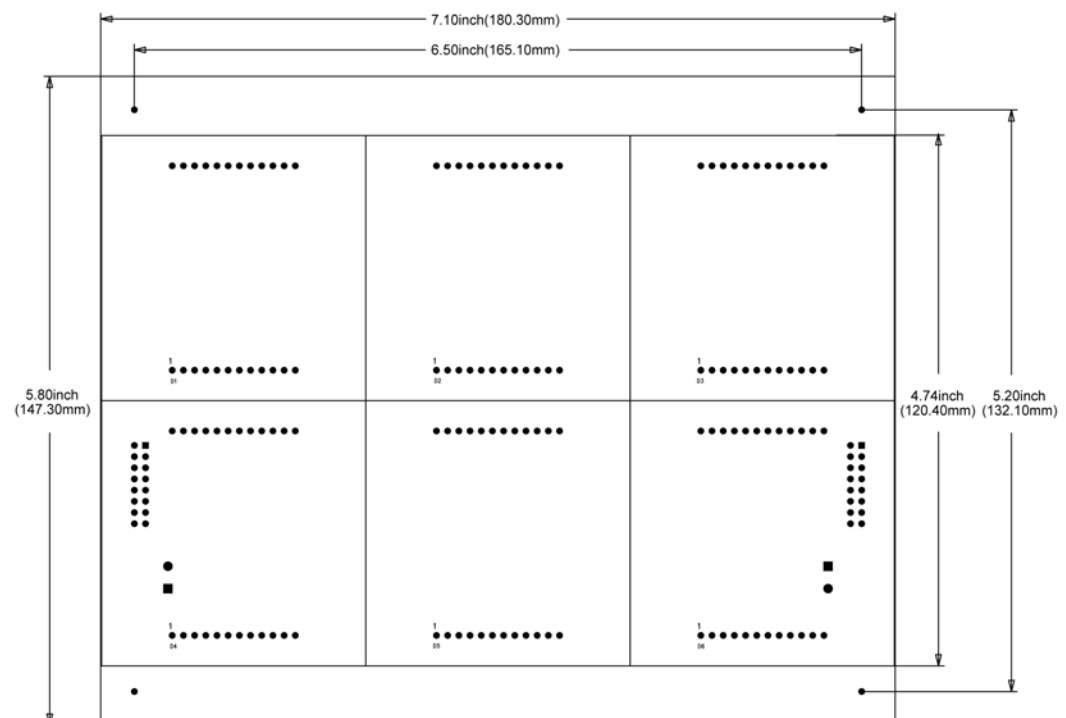


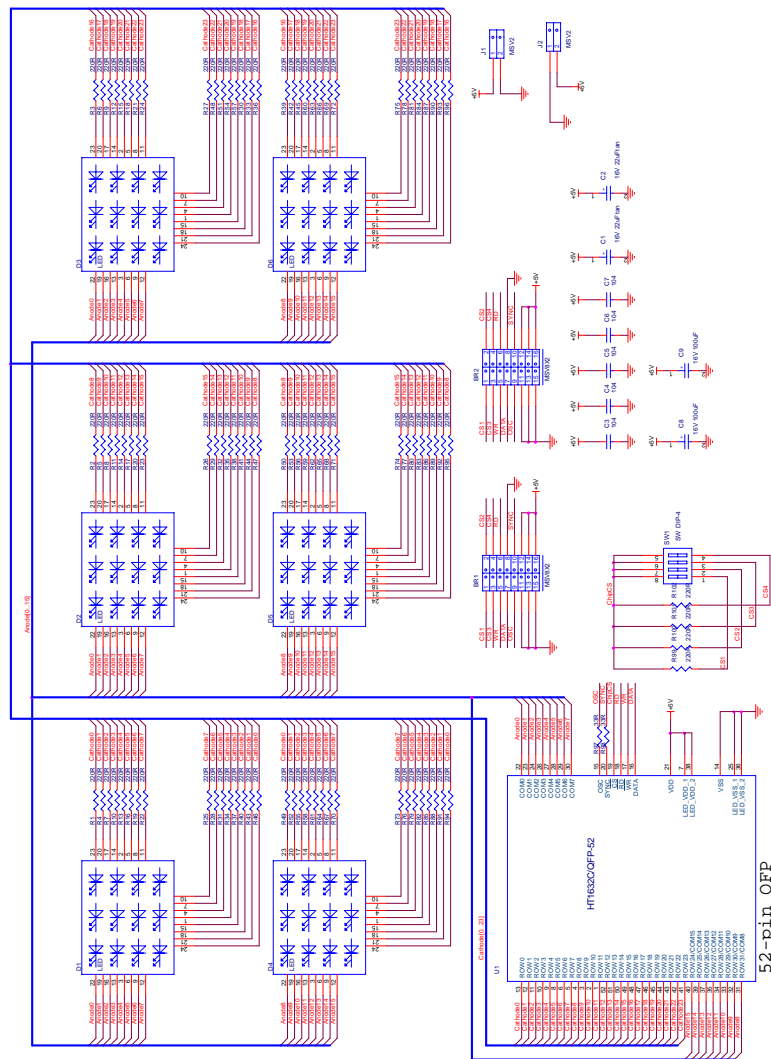
FIGURE 4-2 MECHANICAL DRAWING OF ONE 2416 5MM DOT MATRIX DISPLAY INFO BOARD



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
```

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```
#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
//          PLEN:
//          DEBUGEN: In-circuit debugger enabled
//
//          VCAPDIS: Voltage regulator capacitor disable
//Output Argument: void
//*****
__CONFIG(INTIO & WDTDIS & PWRTEN & MCLREN & UNPROTECT & BORDIS &
BORV25 & PLEN & 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
```

2416 Monocolor LED 3mm/5mm Dot Matrix Display Information Board

```
    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
    {
```

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```
        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
```

```

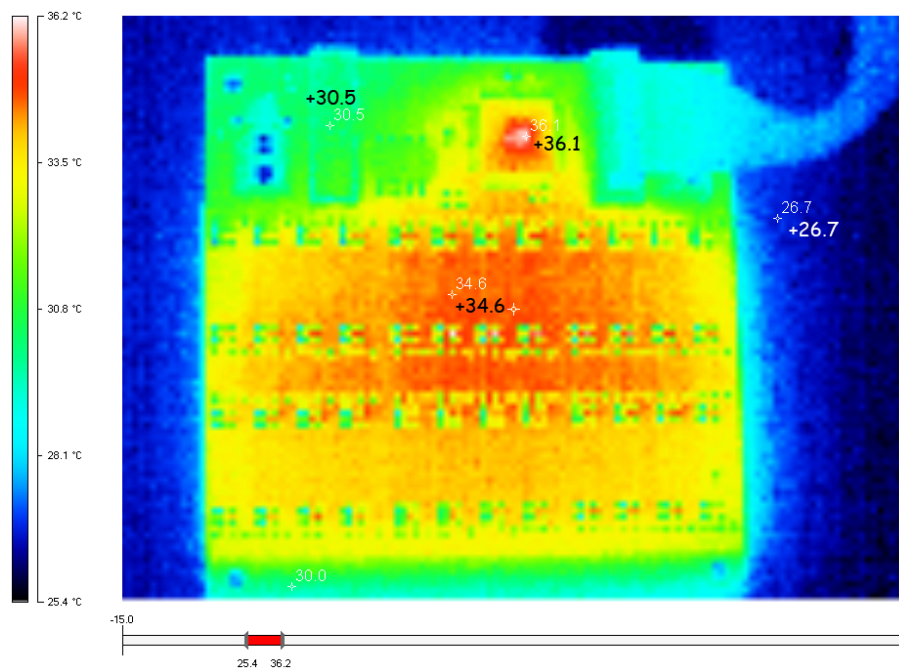
//*****
void Print()
{
    unsigned char i = 0;
    unsigned char buff = 0x00;
    AddressWrite(0x00);
    SPI_ModelConfigure();
    for(i=0; i<48; i++)
    {
        buff = 0xaa;
        SPI_DataSend(buff);
    }
    SSPCON = 0x11;
}

```

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



2416 Monocolor LED 3mm/5mm Dot Matrix Display Information Board

FIGURE 5-3 HEAT DISTRIBUTION OF THE BACK PANEL OF 2416 5MM DOT MATRIX DISPLAY INFO BOARD ($T_A=19^\circ\text{C}$)

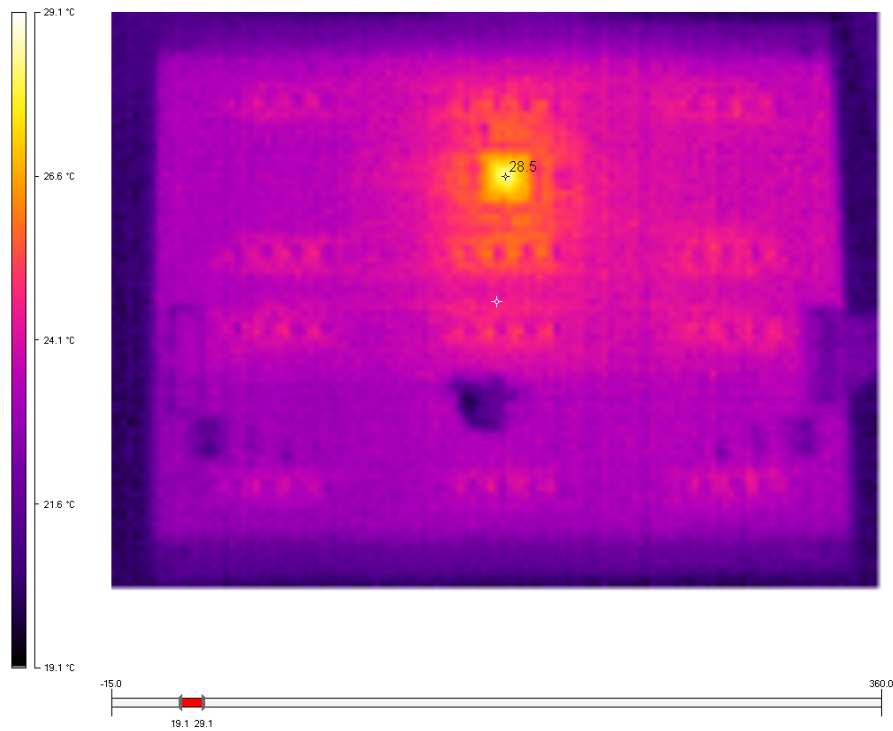


FIGURE 5-4 HEAT DISTRIBUTION OF THE FRONT PANEL OF 2416 3MM DOT MATRIX DISPLAY INFO BOARD

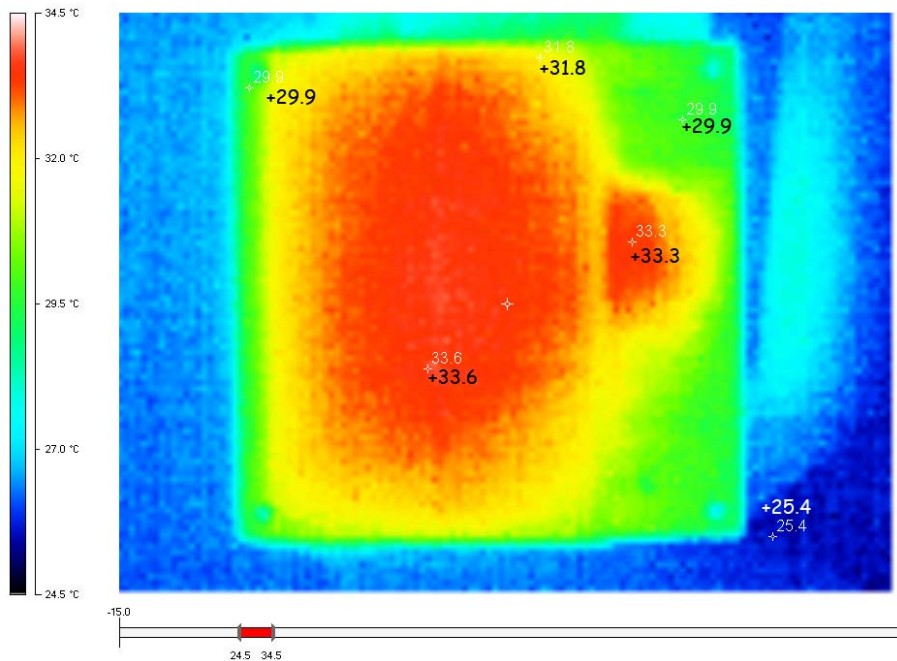
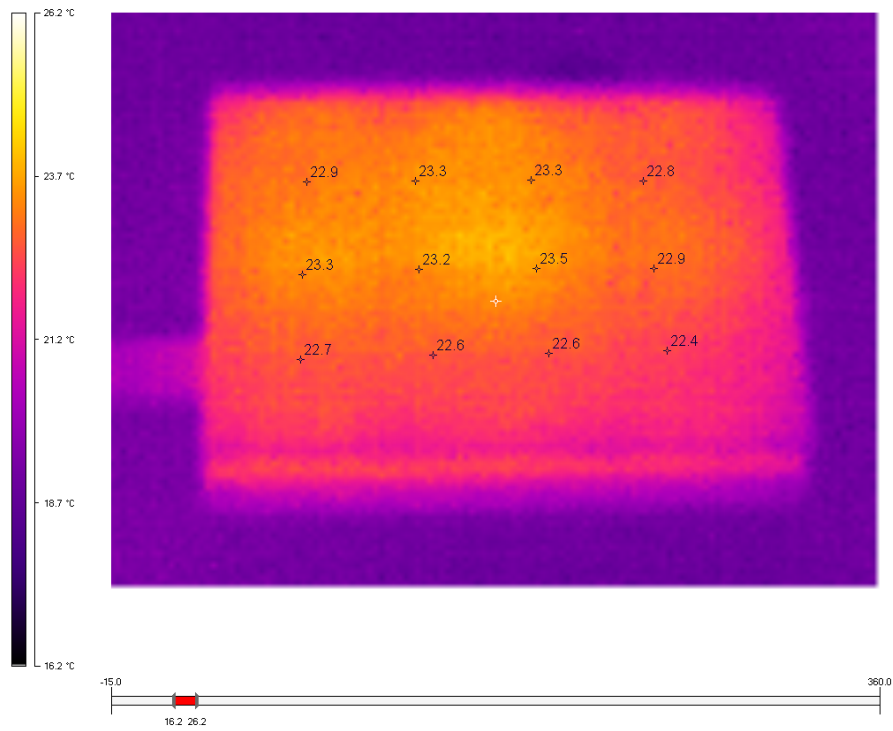


FIGURE 5-5 HEAT DISTRIBUTION OF THE FRONT PANEL OF 2416 5MM DOT MATRIX DISPLAY INFO BOARD($T_A=19^\circ\text{C}$)





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

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