Introduction

This user manual describes the operation of STM32 based LED Matrix Display Demo board. This board demonstrates the capability of STP16DP05 LED driver to drive the matrix LED panel. The complete system includes one master board, one slave board and LED Matrix Display panels. Master and slave boards are STM32 microcontroller based control units which are used for configuring the display settings for STP16DP05 display driver.

This unit has a GPS module interfaced to it through an USART port. The GPS data can be displayed with information of latitude and longitude and also the real time clock. The display can be configured for any of the nine different display modes and nine different speeds using a PS2 keyboard. Display panels can also be configured through the HyperTerminal using the serial interface present on control units. System also consists of audio out for playing back the .wav file pre recorded in micro sd card.

Figure 1 LED Matrix Control Unit
Figure 2. LED Display Panel
# STM32 Based LED Matrix Display Demo-User Manual

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1 Getting Started

1.1 Package Contents

STM32 based led matrix display demo package consists of the hardware and supporting document.

- **Hardware:** One demonstration mother board + One LED Matrix Display Panel
- **Documentation:** User Manual for operating the demonstration board.

1.2 Hardware Description

This complete system has one control unit and a display unit. Control Unit is microcontroller based demo board and display unit is LED MATRIX board.

**Major Components on Control Unit are:**

- STM32F103VBT6, 32-bit Microcontroller
- ST485ABDR, RS485 Transceiver
- LD1086D2T33TR, Voltage Regulator
- ST3232BDR, RS232 Transceiver
- TS461CLT, Rail to rail operational amplifier
- TDA2822D, post amplifier
- STM1001RW6XF, Reset IC
- STPS1L30A, Schottky diode
- ESDALC6V1W5, ESD protection device
- 16 x 2 Alphanumeric LCD
- Mini USB connector
- External Power Supply Screw type Connector

**Major Components on Display Unit are:**

- STP16DP05MTR, Display Driver
- TIP105, Darlington pair
- 74VHC24MTR, Buffer
- 16 x 32 LED Matrix

1.3 Power Supply Unit

Power supply for control unit is 5Volt – 0.5Amps DC and for each Display board it is 3.5V -5Volt / 3Amps DC.

Both control unit and display unit are having one screw type connector each for power supply connection. Figure 3 shows the power supply connection for Control Unit and Figure 4 shows the power supply connection for display unit. In each display panel there are 2 screw type connectors for power connection. VCC+5V0 and GND are mentioned on each of these connectors. Power can be be
applied to any one of these two connectors to power the LED panel. Each panel is to be powered externally and individually.

Figure 3. Power Supply Connection On Control Unit

Figure 4. Power Supply Connection for LED Display Panel
2 Description Of System

This STM32 based display demo system is having a microcontroller based control unit and a LED driver based display unit. Control unit is used for configuring the display driver and display unit is used for controlling the LED display in accordance to the configuration received from control unit.

2.1 Description of Microcontroller based Control Unit

Control unit is STM32 microcontroller based board. This board has interfaces for:

- PS2 keyboard
- DB9 (Female) connector for PC serial port (UART) connection
- DB9 (Male) connector for serial (UART) connection to GPS module
- Onboard Numeric Keypad
- Audio Jack and also 2 pin connector for external speaker
- Screw type connector for RS485 communication between master and slave control units.
- 10 x 2 header (Ext.Con) for flat ribbon cable connection to display unit.
- Slot for micro SD card
- Screw type connector for 5V DC power connection

This microcontroller based unit is used to control the display board. This unit can be configured to operate as master (responsible for sending the commands for display control) or as slave unit (responsible for receiving the commands and executing it on display unit). In every system one control unit acts as a master.

2.1.1 Address Configuration Of Control Unit

Each control unit is having 8 dip switches (SW2). These switches are used to configure the address for the control unit.

Address configuration for control unit is done by moving the switches either to high or to low positions. Eight I/O lines are used for address allocation to the control unit. Thus upto 255 addresses can be assigned to any control board. Board can have any address between 0 and 255.

If switch is slided towards the side where numbers are written then logic ‘1’ is assigned to the port and if the switch is slided towards the side where “ON” is written then logic ‘0’ is assigned to the board.

Whenever the board is powered up and is connected as slave unit then its address will be displayed on the LCD mounted on board. Figure 5 shows on board switches.

Note: Address 255 is hardcoded to master unit and no slave unit is allowed to have this address. Thus one should never slide all the 8 switches to the side where numbers are written(opposite to side where “ON” is written)
Figure 5. Slave Unit Address Configuration Switches

Switch 2, 5 and 8 are at Low level and all other switches are at High level.
2.1.2 Selecting the Control Unit as Master or Slave

Any control unit can act as master or slave. On-board keypad is used to configure the control unit as Master or as Slave.

Below are the steps for configuring the control unit:
- Connect 5 volt power supply to control unit (as explained in section 1.3)
- LCD will display “Press # to enter Configuration Mod” for 4 seconds
- Press “#” on keypad present on board. LCD will show “Master Sel: Entr*1” and “Slave Sel: Entr *2”
- To configure the board as Master press “*1” or to configure the board as Slave press “*2” on keypad
- If “*1” was pressed then LCD will show “MASTER BOARD” for 2 seconds and then start the Master routine on board
- If “*2” was pressed then LCD will show “SLAVE BOARD” for 2 seconds and then start the Slave routine on board.
- On next power up of board LCD will again show the message “Press # to enter Configuration Mod” for 4 seconds but if “#” is not pressed in 4 seconds then board will enter in the mode which was configured last time.

2.2 Description of LED Driver based Display Unit

Display unit is STP16DP05MTR LED display driver based panel.

Each display panel is having four STP16DP05MTR LED display drivers, two buffers, eight darlington pair and a matrix of 16 x 32 LED’s. Each pannel can be connected in series to make a larger display. This series connection between the display panels is through 10 x 2 header. 20 pin flat ribbon cable is used to connect two display panels. Input to display panel is coming from the control unit through 20 pin Flat ribbon cable. Thus first display panel is connected to control unit to receive the data and also to next display panel to cascade the data further. Total 8 such panels can be cascaded in series.

Figure 6 shows the connection of Display panel. First panel is connected at both side, one to control unit using 20 pin cable between Ext Con header on control unit and INPUT header at display panel and other side to second display panel using OUTPUT header at first panel and INPUT header at second panel.

Note: Length of the flat ribbon cable (FRC) should not be exceeded 30 cm.
Figure 6. Connection of Display panels
3 Configuration of System

Whole system can be connected in one of the following configurations:

1. One control Unit and one display unit without a slave unit
2. Two control units (one acting as a master and other as slave) and one display unit
3. Multiple control units (one acting as a master and rest other as slaves) and multiple display units
   (each display unit connected to each slave. One display unit can have up to 8 cascaded panels that
   could be controlled by a single slave unit.)

3.1 One Control Unit and One Display Unit Configuration

In this configuration there is single control unit and a single display unit. Control unit will act as master.

Below are the steps to operate the system in this configuration:

Step 1: Connect PS2 keyboard to the control unit
Step 2: Connect the control unit with display panel using 20 pin flat ribbon cable. Insert the cable in
10 x 2 header (Ext.Con) present on master at one side and header J1 (INPUT) on display panel at
other side.

If needed display panels can be cascaded in series to make a longer display. To cascade display panels
connect 20 pin flat ribbon cable from jumper J3 (OUTPUT) of first panel to jumper J1 (INPUT) of second
panel. Figure 6 shows connections for cascading of display panels. Similarly connect frc cable from
jumper J3 (OUTPUT) of second panel to jumper J1 (INPUT) of third panel and so on to make a longer
display. Up to 8 such display panels can be cascaded in series.

Step 3: Connect the power to master control unit and to display panel as explained in section1.3
Step 4: LCD on master control unit will show “Press # to enter Configuration Mod” for 4 seconds
Step 5: Press “#” on keypad present on board. If 4 seconds has elapsed and the board was not
configured then it will enter in the mode which was last configured. To again configure it press reset
button.

Step 6: If “#” was pressed then LCD will show “Master Sel: Entr*1” and “Slave Sel: Entr *2”
Step 7: Press “*1” on keypad. LCD will show “MASTER BOARD”
Step 8: After 2 Seconds LCD will start the demo showing “Led Matrix Demo”
Step 9: Display will start showing 4 options:
   1) “Press F1 For PC – UART Comm”
   2) “Press F2 For GPS Data Display”
   3) “Press F3 For Typing Data”
   4) “Press F6 For Demo Mode”

Step 10: Press F1 or F2 or F3 or F6 on keyboard to select one of the above mentioned modes.

Step 11: Based on which of the above mentioned key is pressed, system will enter in one of the above
mentioned modes. Operation in each mode is explained in section 4

Step 12: Press ESC on keyboard to exit from the selected mode.

Step 13: Once exited from the selected mode, system will resume from step 9
3.2 Two Control Units and One Display Unit Configuration

In this configuration there are two control units and a single display unit. One Control unit should be master and other one should be slave. By default system comes with one master and one display panel. Below are the steps to operate the system in this configuration:

Step 1: Configure one control unit as Master and other control unit as Slave as explained in section 2.1.2

Step 2: Configure the address of Slave board using the onboard DIP switches as explained in section 2.1.1

Step 3: Connect PS2 keyboard to the master control unit

Step 4: Connect display panel to Slave control unit using 20 pin flat ribbon cable. Insert the cable in 10 x 2 header (Ext.Con) present on slave at one side and in header J1 (INPUT) on display panel at other side.

If needed display panels can be cascaded in series to make a longer display. To cascade display panels connect 20 pin flat ribbon cable from jumper J3 (OUTPUT) of first panel to jumper J1 (INPUT) of second panel. Figure 6 shows connections for cascading of display panels. Similarly connect frc cable from jumper J3 (OUTPUT) of second panel to jumper J1 (INPUT) of third panel and so on to make a longer display. Up to 8 such display panels can be cascaded in series.

Step 5: Connect Master and Slave control unit using twisted pair cable. Ensure that RS485+ at master is connected to RS485+ at slave and RS485- at master is connected to RS485- at slave. Connections are made at screw type connector (J18).

Figure 7 shows the RS485 connection

Step 6: Power up master control unit, slave control unit and Display panel using DC power supplies

Step 7: LCD on master and slave control unit will show “Press # to enter ConfigurationMod”. If master and slave boards are already configured (in step 1) then don’t press “#” and boards will resume its functionality in 4 seconds.

Step 8: Master control unit will start the demo showing “Led Matrix Demo” and slave control unit will start showing its own address.(Address is configured using on board switches).

Step 9: Display at master will start showing 4 options:

1) “Press F1 For PC – UART Comm”
2) “Press F2 For GPS Data Display”
3) “Press F3 For Typing Data”
4) “Press F6 For Demo Mode”

Step 10: Press F1 or F2 or F3 or F6 on keyboard (attached to master board) to select one of the above mentioned modes.

Step 11: Based on which of the above mentioned key is pressed, system will enter in one of the above mentioned modes. Operation in each mode is explained in section 4.

Step 12: Master control unit will send commands to slave control unit. Slave control unit will process these commands and configure the display panel for displaying entered data

Step 13: Press “ESC” on keyboard attached to master board to exit from present mode. After this system will resume from Step 9. If new address entered( for slave selection) matches with the slave address then slave display will be interrupted else display will continue will old data display.
3.3 Multiple Control and Display Unit Configuration

In this configuration there are multiple control units and multiple display panels. One Control unit should be master and rests other are slave. By default system comes with one master and one display panel.

Below are the steps to operate the system in this configuration:

**Step 1:** Configure one control unit as Master and other control units as Slave as explained in section 2.1.2

**Step 2:** Configure the address of Slave boards using the onboard DIP switches as explained in section 2.1.1

**Step 3:** Connect PS2 keyboard to the master control unit

**Step 4:** Connect display panels to each Slave control unit using 20 pin flat ribbon cable. Insert the cable in 10 x 2 header (Ext.Con) present on slave at one side and in header J1 (INPUT) on display panel at other side.

If needed display panels can be cascaded in series to make a longer display. To cascade display panels connect 20 pin flat ribbon cable from jumper J3 (OUTPUT) of first panel to jumper J1 (INPUT) of second panel. Figure 6 shows connections for cascading of display panels. Similarly connect frc cable from jumper J3 (OUTPUT) of second panel to jumper J1 (INPUT) of third panel and so on to make a longer display. Up to 8 such display panels can be cascaded in series.

**Step 5:** Connect Master and Slave control units using twisted pair cable. Ensure that RS485+ at master is connected to RS485+ at slave and RS485- at master is connected to RS485- at slave. Connections are made at screw type connector (J18). Figure 8 shows the RS485 connection topology.
Step 6: Power up master control unit, slave control units and Display panels using DC power supplies. Please ensure in the case of cascading of display panels, power should be individually supplied at J5 screw type connector on each display panel.

Step 7: LCD on master and slave units will show “Press # to enter ConfigurationMode”. This will be displayed for 4 seconds. If master and slave boards are configured in Step 1 then don’t press “#” and boards will resume the functionality in 4 seconds.

Step 8: Master control unit will start the demo showing “Led Matrix Demo” and slave control unit will start showing its own address. (Address is configured using on board switches).

Step 9: Display at master will start showing 4 options:
1) “Press F1 For PC – UART Comm”
2) “Press F2 For GPS Data Display”
3) “Press F3 For Typing Data”
4) “Press F6 For Demo Mode”

Step 10: Press F1 or F2 or F3 or F6 on keyboard to select one of the above mentioned modes.

Step 11: Based on which of the above mentioned key is pressed, system will enter in one of the above mentioned modes. Operation in each mode is explained in section 4.

Step 12: Master board LCD will ask for address of slave control unit in order to configure the display unit. If the address entered at master unit matches with the slave unit then the selected slave unit can be configured for display else “Address Mismatch” is displayed over LCD and new address entry is requested.

Step 13: When address is matched then Master control unit will send commands to selected slave control unit. Slave control unit will process these commands and configure the display panel for displaying entered data. Rest other slave units will continue to display old data.

Step 14: Press “ESC” to exit from present mode. After this system will resume from Step 9. If new address entered (for slave selection) matches with the slave address then slave display will be interrupted else display will continue with old data.

Figure 8. RS485 Multi Drop Topology
Note: R is the termination resistance used for impedance matching
4 Modes Of System Operation

LED Display demo board has 4 different modes of operation. These are:

1. PC-UART Communication Mode
2. GPS Module Communication Mode
3. Key Board Typing Mode
4. Demo Mode

As soon as master control unit is powered up, LCD on master board will show “MASTER BOARD” for first 2 seconds and then a menu will be started which ask for pressing F1/F2/F3/F6 for selecting one of the above mentioned modes.

4.1 PC-UART Communication Mode

Master control unit communicates with computer using UART communication protocol. Female DB9 connector on control unit is used to connect to a computer using serial connection cable.

Below are the steps to communicate using HyperTerminal of computer:

Steps:
1. Connect a serial cable between serial port of computer and female DB9 connector of master control unit (VB1)
2. Connect PS2 keyboard to master control unit.
3. Configure HyperTerminal on computer using following settings:
   - Bits per Second: 115200
   - DataBits: 8
   - Parity: None
   - Stop bits: 1
   - Flow Control: None
4. Make the ASCII settings as shown in Figure 9.
5. Power up master control unit, LED Panel and also slave control unit (if connected)
6. LCD on master will show the menu program asking for “Press F1 for PC-USART Comm”
7. Press “F1” key on the keyboard attached to PS2 connector of master control unit
8. HyperTerminal will show a message
   - “USART HyperTerminal Communication Demo Maximum Allowed String Length is 200 Words”.
   - “Enter Display Board Address, Enter 1-255”
9. Enter the slave control unit address (as seen on LCD of slave control unit) or address of master(255) and then press “Enter” key on PC keyboard. Addresses allowed are between 1 and 255.
10. If the entered address is not present then there will be an error message on Hyper terminal “Address Mismatch; Enter Display Board Address”. Check the address of slave board and then re enter on hyper terminal.
11. When address is matched then Message on hyper terminal is “Enter No. Of LED Boards”. Enter number of LED display panels connected in cascade to the selected control unit.
12. Next message will be “Enter Mode; Entr between 1-9”. This is for entering one of 9 display modes. These modes are as followings:
a. Mode 1 => Curtain Up  
b. Mode 2 => Curtain Down  
c. Mode 3 => Left To Right Scroll  
d. Mode 4 => Right To Left Scroll  
e. Mode 5 => Typing Data mode  
f. Mode 6 => Stable Display  
g. Mode 7 => Flashing mode  
h. Mode 8 => Curtain Right  
i. Mode 9 => Curtain Left  

If the mode entered is other than 1-9 then default mode will be selected and message will be seen on terminal: “Default Mode : Right To Left”

13. As soon as mode is entered, selected mode will be seen on hyper terminal and then the next message will be “Enter Speed; Entr between 1-9”. This speed is for seeing the display on LED Matrix. Speed 1 is fastest and 9 is slowest. If speed entered is other than 1-9 then default speed of 2 will be selected.

14. Next message will be “Enter String”

15. Enter the string (maximum allowed string length is of 200 letters). When required string is entered, hit ENTER key on keyboard.

16. Data will be sent to LED Matrix display and can be seen over there.

17. Next message on hyper terminal will be “Enter Y to Re-enter Display Mode Settings or any other key to Exit PC-UART mode:” Thus if Y is entered then system will start from step 8. If any other key is entered then system will exit from PC-UART mode and normal menu will be seen on LCD of master control unit.

Figure 9. ASCII settings of Hyper terminal in Computer
4.2 GPS Communication Mode

Global Positioning System mode is used for interacting with externally connected GPS module and display Time, Latitude, Longitude and Satellite fixture status.

Below are the steps for communicating with GPS module:

Steps:
1. Connect a serial cable between GPS module and DB9 male connector (VB2) of master control unit. GPS systems should follow the handshaking protocol for serial communication.
2. Connect PS2 keyboard to master control unit.
3. Power up master control unit, LED Panel and also slave control unit (if connected)
4. LCD on master will show the menu program asking for “Press F2 for GPS Data Display ”
5. Press “F2” key on the keyboard attached to PS2 connector of master control unit
6. LCD at master will show GPS mode selected and “Enter Display Board Address”. Enter the slave board address where data is to be displayed on LED Matrix panel. Addresses allowed are in between 1 and 255. 255 is fixed for master unit. If wrong data is entered then LCD will show “Address Mismatch” and will again ask for address
7. When address is matched then LCD will ask for entering the number of display panels connected in cascade at selected slave device.
8. As soon as number of display panels is entered, LED Matrix will start showing Time, Latitude, Longitude and Satellite fixture status on LED Matrix.
9. Press “ESC” on keyboard to exit from GPS mode and return to main menu.

4.3 Key Board Typing Mode

This mode is for user interaction using the key board attached at PS2 connector mother board.

Below are the steps for operating in Typing mode:

Steps:
1. Connect Key Board to PS2 connector on master control unit.
2. Power up master control unit, LED Panel and slave control unit (if present)
3. LCD on master will show the menu program asking for “Press F3 for Typing Data ”
4. Press “F3” key on the keyboard attached to PS2 connector of master control unit
5. LCD at master will show “Enter Display Board Address”. Enter the slave board address where data is to be displayed on LED Matrix panel. Addresses allowed are between 1 and 255. 255 is fixed for master unit. If wrong data is entered then LCD will show “Address Mismatch” and will again ask for address
6. When Address is matched, LCD will show message “Enter No. Of LED Boards”. Enter number of LED panels connected in cascade to the selected control unit
7. Next message will be “Enter Mode; Entr between 1-9”. This is for entering one of 9 display modes. Modes are explained in step 12 of section 4.1
8. As soon as mode is entered, selected mode will be seen on LCD and then will ask for “Enter Speed; Entr between 1-9”. This speed is for seeing the display on LED Matrix. Speed 1 is fastest and 9 is slowest. If speed entered is other than 1-9 then default speed of 2 will be selected
9. Next message will be “Enter String ; Pres ESC to exit”
10. Enter the data which is to be seen on LED Matrix display. If user does not want to enter data and wants to exit from this mode, then “ESC” key should be pressed
11. As soon as data is entered, it will be seen on LED Matrix and then LCD will show "Press ESC to exit; Enter to Proceed". Thus to continue with the Typing mode hit "ENTER" key on keyboard, system will switch to step 5 else hit "ESC" to exit from this mode and return to main menu.

Note: To check is Caps lock is ON or OFF see to the typed character on LCD. If Caps lock is ON then the alphabets will be seen in CAPITAL CASE on LCD else it will be in SMALL CASE.

4.4 Demo Mode

Demo mode will be executed with master control unit and display panel connected to "Master unit".

This mode is supported with audio output.

Below are the steps for demo mode:

Steps:

1. Save an audio file in .wav format in micro SD card. Save the audio file with name "STN2". Configuration for audio file should be: 8Bit, 8kHz mono. This is the audio which will be heard from board.
2. Insert micro SD card in memory card slot connected at back side of master as shown in Figure 10.
3. Connect a display panel to master control unit using 20 pin flat ribbon cable.
4. Connect PS2 keyboard to master unit
5. Connect external speaker to two pin audio connector (near audio jack) or to audio jack. Audio jack is having a mono output only.
6. Power up master control unit and also the display panel.
7. Menu will be started on LCD. It will display "Press F6 for Demo Mode". Press "F6" key to enter in Demo mode.
8. As soon as F6 is pressed, LCD will show message for entry of display panel number "Enter No. Of LED Boards". Enter number of display panel connected to master unit.
9. After number of led panels is entered audio file saved as STN2 in micro SD card will be played on speaker and LED panel will show a message "Wish You A Happy Journey".
10. Press "ESC" key on keyboard to exit from this mode and go back to menu.

Note: For DEMO mode, microSD card should be inserted in the card slot else no data display will occur. ESC key is used to exit from this mode at any point of time.

Note: At any point of system press twice the ESC key on key board attached to master unit to return back to main menu.

Note: Until we enter one of the Modes of system pressing of any key (other than F1/F2/F3/F6) will show a message of "Key Not Allowed".

Note: In PC USART mode key board attached to mother unit will not be active for data entry. Only ESC key will be functional in this mode.
Figure 10. Micro SD card Connection
5 Schematic

STM32 based display driver demo schematic is made in 2 parts. First one is for microcontroller based control unit and second is for LED display panel. Figure 11 shows the schematic for control unit and figure shows the schematic for display panel.

Figure 11 Schematic for Control Unit
Figure 12. LED Display Panel Schematic
## 6 BOM

Table 1. BOM Of Microcontroller based Control Unit

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<th>Component Description</th>
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**STM32 Based LED Matrix Display Demo-User Manual**

**STMicroelectronics Rev 1.0**

25/26
Table 2. BOM of LED Display Panel

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<td>December 2, 2008</td>
<td>Initial draft</td>
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