LED Displays and Signage Solutions
LED Displays & Signage Solutions

ST Position:
- #1 in Lighting Segment*
- #2 in Power Management**

ST Expertise:
- System Solutions
- Technology Integration and Innovation
- Excellent Technical Support

*STMicroelectronics, Datapoint and Darnell - 2008
**iSupply - 2010
Content

- LED Displays and Signage Solutions
  - LED Array Driver Features/Benefits
    - Constant Current
    - Error Detection/Diagnostics
    - Auto Power Savings/Shutdown
    - High Precision
    - High Current
    - Balanced Turn-on/off
  - System Evaluation Boards and Tools
    - HB LED driver solution with Diagnostics (32, 40 LEDs)
    - 16 x 32 LED Matrix Display Panel
    - RGB LED driver for Color Displays and Backlighting
    - Super HB RGB Color LED solution
    - High Brightness LED Array Dimmer Solution
    - RGB Moving Message Display System
LED array drivers

From Small to Very Large LED Displays and Signs
- Full color video
- Monochrome message boards
- Variable message signs
- Transportation
- Information
- Special Lighting
- LED Backlighting

STP04CM05, STP08*P05, STP16*05, and STP24*05 families

- Constant-current drivers, set by only one external resistor
- Serial data and clock resynchronization
- High current and high precision
- Thermal shutdown
- Error detection and auto power-saving
# LED Array Driver general portfolio

**STPXXYY05 Series Features**
- Absolute Output Voltage up to 20V
- Output Enable frequency up to 1MHz
- SDI and CLK re-synchronized device by device w/o use of CLK falling edge
- Analog Thermal Shutdown protection
- Clock frequency over 30MHz,
- TSSOP package with exposed pad

**C=** Constant current  
**P=** Precision  
**PP =** Precision and lower output current range (3-40mA output current)  
**M=** High current (80-400mA)  
**D=** Error Detection/Diagnostic  
**S =** Auto-Shutdown

**Extended Junction Temperature range of -40° to 125 °C**

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Description</th>
<th>Iout</th>
<th>Bit Prec.</th>
<th>Chip Prec.</th>
<th>Evaluation Board</th>
</tr>
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<tbody>
<tr>
<td>STP08CP05</td>
<td>8-bit C.C. LED driver</td>
<td>5–100mA</td>
<td>+/-1%</td>
<td>+/-3%</td>
<td>-</td>
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<tr>
<td>STP08DP05</td>
<td>8-bit C.C. LED driver w/Diagnostics</td>
<td>5–100mA</td>
<td>+/-1.5%</td>
<td>+/-5%</td>
<td>STEVAL-ILL002V3, STEVAL-ILL002V4</td>
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<tr>
<td>STP16CP(P)(S)05*</td>
<td>16-bit w/AutoPower-Saving</td>
<td>5–100mA</td>
<td>+/-1.5%</td>
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<td>STEVAL-ILL003V2</td>
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<tr>
<td>STP16DP(P)(S)05</td>
<td>16-bit with Diagnostics</td>
<td>5–100mA</td>
<td>+/-1.5%</td>
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<td>STEVAL-ILL025V1</td>
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<tr>
<td>STP1612PW05</td>
<td>16-bit w/12/16 bit e-PWM</td>
<td>3–80mA</td>
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<td>STP04CM05</td>
<td>4-bit C.C. Power LED Driver</td>
<td>80–400mA</td>
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<tr>
<td>STP24DP05</td>
<td>24-bit with Diagnostics</td>
<td>3–80mA</td>
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<td>+/-8%</td>
<td>STEVAL-ILL015V1</td>
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*Also available as STP16CPC05, STP16CPC26 with balanced turn-on/turn-off feature*
LED Array Driver Portfolio Features

- Standard constant current LED array drivers: STP08CP05, STP16CP05, STP16CPC26
- Low current/high accuracy LED array drivers: STP16CPP05, STP16DPP05, STP16CPPPS05, STP16DPPPS05
- LED array drivers with Error Detection: STP08DP05, STP16DP05, STP16DPP05, STP16DPS05, STP16DPPS05
- LED array drivers with Auto Shut-Down: STP16CPS05, STP16CPPPS05, STP16DPS05, STP16DPPS05
- LED array drivers with Balanced $T_{ON}/T_{OFF}$: STP16CPC05, STP16CPC26
- LED array drivers with PWM brightness control: STP1612PW05
- LED array drivers for RGB solutions: STP04CM05, STP24DP05,
STP08CP/DP05 – 8 ch, 5-100mA

LED Array Drivers

Key Features:
- Low-voltage power supply (3V – 5.5V)
- 8 constant-current output channels
- 8-bit shift register
- Serial data IN/parallel data OUT
- Output current: 5-100 mA
- Adjustable output current thru ext resistor
- Maximum clock frequency: 30 MHz
- 3.3V microcontroller driver-able
- Current accuracy: +/-1.5% between bits
  - STP08CP05: +/-3% between ICs
  - STP08DP05: +/-5% between ICs
- ESD protection: 2.5 kV HBM, 200V MM
- Extended thermal shut-down and protection features
- **Short and open output error detect:** STP08DP05
STP08DP05 w/Diagnostics

LED Driver Evaluation Board Solution

Key Features:
- 40 LED Matrix with
  - Error detection
  - Current regulation
  - Adjustable brightness
  - Animated text implemented
  - Adjustable blinking speed
  - GUI SW for LEDs diagnostic
  - Input voltage from 7V to 32V
  - DC/DC Converter for high efficiency
  - Standard supply connector

Key Products:
- STP08DP05 LED constant current driver
- ST7FLite39 8-bit microcontroller (10-bit ADC, SPI, SCI communication)
- LE50AB Linear voltage regulator
- ST3232C RS-232 Drivers and Receivers
- L5970D DC/DC Converter

Evaluation board | App note | Description
--- | --- | ---
STEVAL-ILL002V3 (Osram LEDs) | AN2478, AN2415 | High-brightness LED driver with diagnostics (40 LEDs) demonstration board
STEVAL-ILL002V4 (Vishay LEDs) | | |

STMicroelectronics
STP16CP(S)05 or STP16DP(S)05

16 channel, 5-100mA LED Array Drivers

Key Features:

- Low-voltage power supply: (3V to 5.5V)
- 16 constant-current output channels
- 16-bit shift register
- Output current:
  - 5 to 100mA for STP16*P05 series
- Adjustable output current - ext resistor
- 3.3 V microcontroller drivable
- Maximum clock frequency: 30 MHz
- Current accuracy:
  - +/-1.5% between bits
  - +/-3% between ICs
- ESD protection: 2.5 kV HBM, 200V MM
- Extended thermal range and protection features
- Short and open output ERROR DETECT:
  - STP16DP05 and STP16DPS05
- Auto Shut-Down:
  - STP16CPS05 and STP16DPS05
- Balanced output rise/fall time, typ 100ns:
  - STP16CPC05
STP16CP05 LED Driver Eval Board

Key Features:
- 32 LED Matrix with
  - Current regulation
  - Adjustable brightness
  - Animated text capability
  - Adjustable blinking speed
  - GUI SW for LEDs diagnostic
  - Input voltage from 5V to 35V
  - DC/DC Converter for high efficiency

Key Products:
- STP16CP05 LED constant current driver
- STP16CPS05 LED constant current driver w/auto power saving/shut down
- ST7FLite09 8-bit microcontroller
- L78L33AC Voltage regulator
- STPS340U Schottky diode
- L5970D DC/DC converter

<table>
<thead>
<tr>
<th>Evaluation board</th>
<th>Application note</th>
<th>Description</th>
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<tbody>
<tr>
<td>STEVAL-ILL003V2</td>
<td>AN2141</td>
<td>High-brightness 32-LED evaluation board without diagnostic based on the STP16CP05 LED driver</td>
</tr>
</tbody>
</table>
Key Features:
- 16 x 32 LED Matrix display with STP16DP05
- Mother/slave board for LED display based on STM32 uCtIr
- Supports up to 8 add’l display units in series
- Controlled by a single control unit supporting up to 254 display units
- Configurable through Windows HyperTerminal via serial interface and through a PS2 keyboard
- GPS Interface
- Audio Output - Playback of Pre-recorded .wav files

Key Products:
- STP16DP05         LED display driver
- STM32F103         32-bit ARM-based microcontroller
- STM1001            Reset IC
- ESDALC6V1W        Quad Transil
- STEVAL-ILL024V1    LED Matrix Control Unit
- STEVAL-ILL025V1    Shows Capability of STP16DP05 in driving Matrix LED Display panel

Evaluation boards | User Manual | Description
------------------|-------------|--------------------------------------------------
STEVAL-ILL024V1/STEVAL-ILL025V1 LED matrix control unit | UM0767 | Demonstration boards based on the STP16DP05 LED matrix driver and the STM32F103VB
## Error Detection/Diagnostic Mode

### Normal Mode
Device works like a Constant Current LED Driver

### Diagnostic Mode
The LED Driver enters the Diagnostic mode by using a Digital Key input to the SERIAL DATA IN

### Detection Conditions and Results

<table>
<thead>
<tr>
<th>Detection conditions</th>
<th>Detection results</th>
</tr>
</thead>
<tbody>
<tr>
<td>$I_{ODEC} \leq 0.5 \times I_o$</td>
<td>OPEN LINE (1) or OUTPUT SHORT TO GND (2) detected</td>
</tr>
<tr>
<td>$I_{ODEC} \geq 0.5 \times I_o$</td>
<td>NO ERROR DETECTED</td>
</tr>
<tr>
<td>$V_o \geq 2.4V$</td>
<td>SHORT ON LED (3) or SHORT TO $V_o$ (4)</td>
</tr>
<tr>
<td>$V_o \leq 2.2V$</td>
<td>NO ERROR DETECTED</td>
</tr>
</tbody>
</table>

Error Detection availability: STP08DP05, STP16DP05, STP16DPS05, STP16DPP05, STP16DPPS05, and STP24DP05, STP24GPL05, and STP1612PW05
AutoPower Saving/ShutDown Mode

NO Active Data Latched  ➔  Automatically Shuts Down
First Active Data Latched  ➔  Automatically Powers Up

At Io = 80mA,
• Active: $I_{DD(ON)} = 11.7mA$ (typ)
• Not Active: $I_{DD(Shut-down)} = 100uA$ (typ)

$I_{DD(SHUT-DOWN)}$ is 117 times less than $I_{DD(ON)}$

EXAMPLE

• LED panel size: 10m x 5m
• Estimated number of LED Drivers: 10,000 pcs
• LED drivers active at any one time : ~ 20%
  ❖ Using std LED driver ➔ All 10,000 will consume high current (approx 117 A)
  ❖ Using STP16DPS05 ➔ Only 2,000 will consumer high current (approx 23 A)

Power savings using STP16CPS05 is ~ 80 %

Auto Shut-Down available in **STP16CPS05, STP16DPS05, STP16CPPS05, STP16DPPS05**
STP16CPP/DPP05 - 16 ch, 3-40mA

High Accuracy LED drivers

Key Features:
- Low-voltage power supply: (3V to 5.5V)
- 16 constant-current output channels
- 16-bit shift register
- Serial data in/parallel data out
- 3.3V microcontroller driver-able
- Maximum clock frequency: 30 MHz
- Output current:
  - 3 to 40mA (adjustable through external resistor)
- Current accuracy:
  - +/-0.5% @ 20mA
  - +/-2% @ 3mA
- ESD protection: 2.5 kV HBM, 200 V MM
- Extended thermal range and protection features
- Auto Shut-Down available:
  - STP16CPPS05 and STP16DPPS05
STP16CPC26 – 16 channel, 5-90mA

w/Noise Immunity & Quasi-Balanced Current Turn On/Off

Key Features:

- 5V power supply
- 16 constant-current output channels
- Serial data in/parallel data out, cascadable
- 20V driving capability,
  - Allows users to connect more LEDs in series to each current source.
- Maximum clock frequency: 30 MHz
- Current range:
  - 5 to 90mA (adjustable through external resistor)
- Channel to Channel Current accuracy:
  - +/-1% @ 20mA
- Quasi-Balanced Current Turn On/Off at from 5mA
  - Excellent performance over full current range
  - Optimal Driver dynamic Response
  - Perfect Balanced Current Setting avoids flickering
  - No Image Distortions up to 4 MHz
- Better Noise Immunity due to higher hysteresis
  - ESD protection: 2.5 kV HBM
  - Thermal Shutdown for Over Temperature Protection
  - Power-on Reset, Undervoltage Lock-out Functions
  - Operating Temperature -40°C to 125°C

Applications:

- Full color/Monochrome Large Displays, Gaming
- LED Signage

STMicroelectronics
Balanced Turn ON/OFF

Balanced turn ON/OFF improves system performance by avoiding ringing or noise generation (EMI problems) due to parasitic inductance.

Current
Turn-ON/OFF
Voltage
Turn-ON/OFF

Turn-ON and Turn-OFF time typically around 100 ns.
Typical \(T_{ON}\) and \(T_{OFF}\) of other products -> tens of nanoseconds.

Balanced turn ON/OFF available in \textit{STP16CPC05, STP16CPC26}
STP1612PW05 –16 ch, 3-60mA

LED Driver w/Independent 12/16-bit PWM & Error Detection

Key Features:
- Low-voltage power supply: (3V to 5.5V)
- 16-channel, 3-to-60mA Constant Current Channels
- e-PWM enhanced algorithm to improve image fidelity
- Prog Controlled In-Rush Current to reduce flickering
- 12/16-bit Grayscale PWM resolution w/2 counters
- 8-bit current gain control by means of 256 steps in two selectable ranges
- Full Output Open and Short LED Error Detection
- Advanced Thermal management
- 20V output driving capability for more LEDs in series
- Maximum Clock Frequency: 30 MHz
- Excellent Current Accuracy +/- 1.5%
- PWM CLK – Time-out, Power-Off
- Timeout alert if clock signal is missing
- ESD protection 2.5kV HBM, 200V MM
- QFN 4x4 package tiny footprint solution
- Pin-out Compatible with STP16xP05 series

Applications:
- Full motion RGB video displays
- Monochrome LED display
- Signs, Billboards, and Scoreboards
- Gaming machine, Channel letter signs

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Data communication via SPI
Current gain adjustment through 8 bits of configuration register

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STP1612PW05 – Control Functions

Host Controller

Functions Available via Configuration Registers
- Data Latch
- Buffer latch
- Read Configuration
- Enable Error Detection
- Read Error Status
- Write Configuration
- Reset Register length

Functions Available via Serial Key
- Set 16 or 256 SR length
- Read Thermal Flag
- Enable Thermal Shutdown
- Set PWM Counter 16 or 12 bit
- Set PWM or Enhanced PWM mode
- Set Auto Sync or Manual Sync
- Set Current Gain
- Enable PWMCLK time out disconnection
STP1612PW05 Eval Board

LED Display w/PWM Generating Driver and STM32F103

Key Features:
- Three STP1612PW05 (16-channel LED driver w/16-bit PWM, 8-bit gain and full LED error detection)
  - 6 RGB LEDs with adjustable color (48 LEDs)
  - DC-DC power supply using the ST1S10
  - JTAG interface for microcontroller firmware change/update
  - 6 jumpers simulating LED failure for testing of the driver error detection mode
  - Mini USB connector for interconnection w/PC software
  - Stand-alone demonstration firmware w/animated menu

Key Products:
- STP1612PW05
- STM32F103
- ST1S10

Support:
- High level of low power LEDs, color or monochrome
- Open software architecture
- USB and JTAG programming connectivity for easy development with STM32 microcontroller

<table>
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<tr>
<th>Evaluation board</th>
<th>Documentation</th>
<th>Description</th>
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<tbody>
<tr>
<td>STEVAL-ILL028V1</td>
<td>UM0882, UM0885</td>
<td>RGB LED driver for color displays and backlighting based on the STP1612PW05 and STM32</td>
</tr>
</tbody>
</table>
High-Power LED Array Driver

Key Features:
- Low-voltage power supply: (3V to 5.5V)
- 4 constant-current output channels
- 4-bit shift register
- Adjustable output current (80 to 400 mA) using a single external resistor
- 20 V output driving capability
- Serial data in/parallel data out
- Output enable pin for dimming (PWM)
- Maximum clock frequency: 30 MHz
- ESD protection: 2.5 kV HBM, 200 V MM
- Extended thermal range and protection features

Applications:
- Very high brightness displays
- Special Lighting Applications.
- High-power LEDs
Key Features:
- Drives Super High Brightness Multicolor RGB LEDs
- 8 LEDs can be driven with 350mA or 4 LEDs with 700mA
- 6 lighting modes implemented
- 64 brightness levels for each LED
- 3A at 4V DC/DC converter using the ST1S10 for input voltage range (7-18V)
- LED drivers STP04CM05 and STP08CP05
- Input over voltage protection with Transil SMAJ15A
- Protection against input voltage reversion

Key Products:
- STP04CM05       LED driver
- STP08CP05       LED driver
- ST7FLITE09      8-bit microcontroller
- L78L05AC        Voltage regulator
- ST1S10          DC/DC converter
- STLM20          Temp Sensor
- SMAJ15A-TR      Transil

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<th>Evaluation board</th>
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<tbody>
<tr>
<td>STEVAL-ILL009V5</td>
<td>AN2531</td>
<td>RGB Color LED Demonstration Board based on the STP04CM05 and ST1S10</td>
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<td>(replaces STEVAL-ILL009V1)</td>
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<tr>
<td>STEVAL-ILL009V3</td>
<td>See above</td>
<td>OSTAR Projection Module load board</td>
</tr>
<tr>
<td>STEVAL-ILL009V4</td>
<td></td>
<td>Golden Dragon LEDs load board</td>
</tr>
</tbody>
</table>
STP24DP05 – 24 channel, 5-80mA

Key Features:
- Low-voltage power supply: from 3V-5.5V
- 24-bit shift registers
- Serial data in/parallel data out
- 3 groups (RGB) of 8 constant-current output channels from 5-80mA
- Short and Open output error detection
- Adjustable output current through external resistor for each group of 8-channel
- Gradual output delay (30ns for each group RGB)
- 3.3 V microcontroller driveable
- Maximum clock frequency: 25 MHz
- ESD protection: 2.5 kV HBM, 200 V MM
- Thermal Shutdown with flag pin

Applications:
- Full color high resolution LED panel displays
- Colored traffic signs
HB RGB Dimmer Evaluation Board

Based on STP24DP05 and STM32F103C6

Key Features:
- Two STP24DP05 (TQFP48) w/16 RGB high brightness LEDs connected (48 LEDs in total)
- STM32 with cost-effective internal HS osc
- High efficient switching power supply DC/DC
- ST1S10 with input voltage range of 7.5V - 18V, current 0.7A.
- Error Detection Feature/Over-Temp Flag
- Adjustable Brightness
- JTAG interface for C firmware updates
- Mini USB connector for PC GUI connection
- Imp signal test points for lab evaluation
- Buttons and a knob to control the board.
- 3 jumpers each for simulating disconnection and simulating shortage of 3 LEDs

Key Products:
- STP24DP05
- STM32F103
- ST1S10

Demo Kit Support:
- STEVAL-ILL015V1 with OSRAM LEDs
- CD with User Manual, Application Note, Datasheets
- C Library for dimming control of every single LED
- Demo Firmware and PC Software:
  - Stand alone: A game, color dimming effects, Error Detection
  - USB demo: Error Detection over USB

Evaluation board | App Notes /User Manuals | Description
--- | --- | ---
STEVAL-ILL015V1 | AN2841, UM0574, UM0588 | High Brightness RGB LED Array dimmer demo board based on the STP24DP05 and STM32
Multicolor LED Display Panel

Key Features:
- Control unit with PS2 keyboard interface for data entry
- LCD on control unit for showing the display text and background color options
- 4xSTP24DP05 for each display panel
- 8 panels can be cascaded in series through flat ribbon cable
- System configuration in typing data mode or in audio playback mode or in demo mode

Key Products:
- STP24DP05   LED Display Driver
- STM32F103   32-bit microcontroller on control board
- STM1001     Reset IC
- STPS3L60    Schottky Diode
- ST3232C     3V RS232 com interface

Support:
- Full color Display Panels
- Airport and Railway information system
- Bank currency conversion rate boards

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<th>Evaluation board</th>
<th>User Manuals</th>
<th>Description</th>
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<tbody>
<tr>
<td>STEVAL-ILL032V1, STEVAL-ILL033V1</td>
<td>UM1449</td>
<td>STM32-based RGB LED Matrix Display Demo</td>
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# LED Array Driver Feature Summary

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<th>Part Number</th>
<th>#ch</th>
<th>$I_{LED}$ (mA)</th>
<th>Channel to channel (MAX)</th>
<th>$\Delta I_{LED}$</th>
<th>IC to IC (MAX)</th>
<th>Error detect</th>
<th>Auto Power Saving</th>
<th>Balanced Turn ON/OFF</th>
<th>Gray-scale Brightness control</th>
<th>Current Gain Adjustment</th>
<th>Staggered output delay</th>
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<tbody>
<tr>
<td>STP04CM05</td>
<td>4</td>
<td>80 - 400</td>
<td>1.5% (80 - 400mA)</td>
<td>6%</td>
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<td>STP08CP05</td>
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<td>3% (20 - 100mA)</td>
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<td>3% (20 - 40mA)</td>
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<td>3% (20 - 100mA)</td>
<td>5%</td>
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<td>6% (5 - 15mA)</td>
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<td>3 - 60</td>
<td>1.5% (3 - 60mA)</td>
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## Evaluation Boards Summary

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<tr>
<th>Part Number</th>
<th>Order Code</th>
<th>Description</th>
<th>Feature</th>
<th>App Notes</th>
<th>Power Supply</th>
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<tr>
<td><strong>STP16CP05</strong></td>
<td><strong>STP16CP05</strong></td>
<td><strong>STEVAL-ILL03V2</strong></td>
<td>32 LEDs Array Reference Board</td>
<td>- Adjustable Brightness, Blinking Speed - Animated Text - GUI SW for LEDs diagnostics</td>
<td>AN2241</td>
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<td><strong>STP16DP05</strong></td>
<td><strong>STEVAL-ILL024V1</strong></td>
<td><strong>STEVAL-ILL025V1</strong></td>
<td>Mother/slave board for LED display based on STM32 16x32 LED matrix</td>
<td>- Animated Text - Adjustable Blinking Speed - GPS Interface</td>
<td>UM0767</td>
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<td><strong>STP1612PW05</strong></td>
<td><strong>STEVAL-ILL028V1</strong></td>
<td>RGB LED Driver w/Indep PWM for Color Display via STM32 SPI</td>
<td>-Adjustable Color - JTAG interface for C firmware update</td>
<td>UM0882 UM0885</td>
<td>Std Supply Connector</td>
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<td><strong>STP08DP05</strong></td>
<td><strong>STEVAL-ILL002V3</strong></td>
<td>40 LEDs Diagnostic Reference Board Using OSRAM Blue LEDs</td>
<td>- Adjustable Brightness, Blinking Speed - Animated Text - Error Detection Feature</td>
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<td><strong>STEVAL-ILL009V3</strong></td>
<td><strong>STEVAL-ILL009V4</strong></td>
<td><strong>STEVAL-ILL009V5</strong></td>
<td>RGB LED Reference Board OSTAR Proj Mod Golden Dragon LEDs</td>
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<td><strong>STP24DP05</strong></td>
<td><strong>STEVAL-ILL015V1</strong></td>
<td>16 RGB LED Array based on STP24DP05 and STM32F103C6</td>
<td>- Adjustable Brightness - JTAG interface for C firmware update - Mini USB connector for PC GUI - Error Detection Feature</td>
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<td><strong>STEVAL-ILL032V1</strong></td>
<td><strong>STEVAL-ILL033V1</strong></td>
<td>STM32-based RGB LED Matrix Display Demo</td>
<td>- Adjustable text color and speed - Adjustable background color - Audio Playback Mode</td>
<td>UM1449</td>
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</tbody>
</table>
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