PROTEK DEVICES
ANALOG PRODUCTS DIVISION

# PA5026
## 16-Bit
## Constant Current LED Sink Driver

### FEATURES

- 16-channel constant–current output.
- Output constant current: 2 - 80mA
- Current accuracy (All output ON)
- Between BITS ±1%
- Between IC's ±1%
- Output Current 2~80mA adjustable
- Output current adjustable through an external resistor.
- Interleave time delay of output channel
- Fast response for output port (tr/td=50ns)
- 25MHz clock frequency

### DESCRIPTION

PA5026 contains a serial buffer and data latches which convert serial input data into parallel output format. At PA5026 output stage, sixteen regulated current ports are designed to provide uniform and constant current sinks for driving LED's within a large range of Vf variations.

PA5026 provides users with great flexibility and device performance in their system design for LED display applications, e.g. LED panels.

Users may adjust the output current from 2 mA to 80 mA through an external resistor, Rext, which gives them the flexibility in controlling the light intensity of LED's.

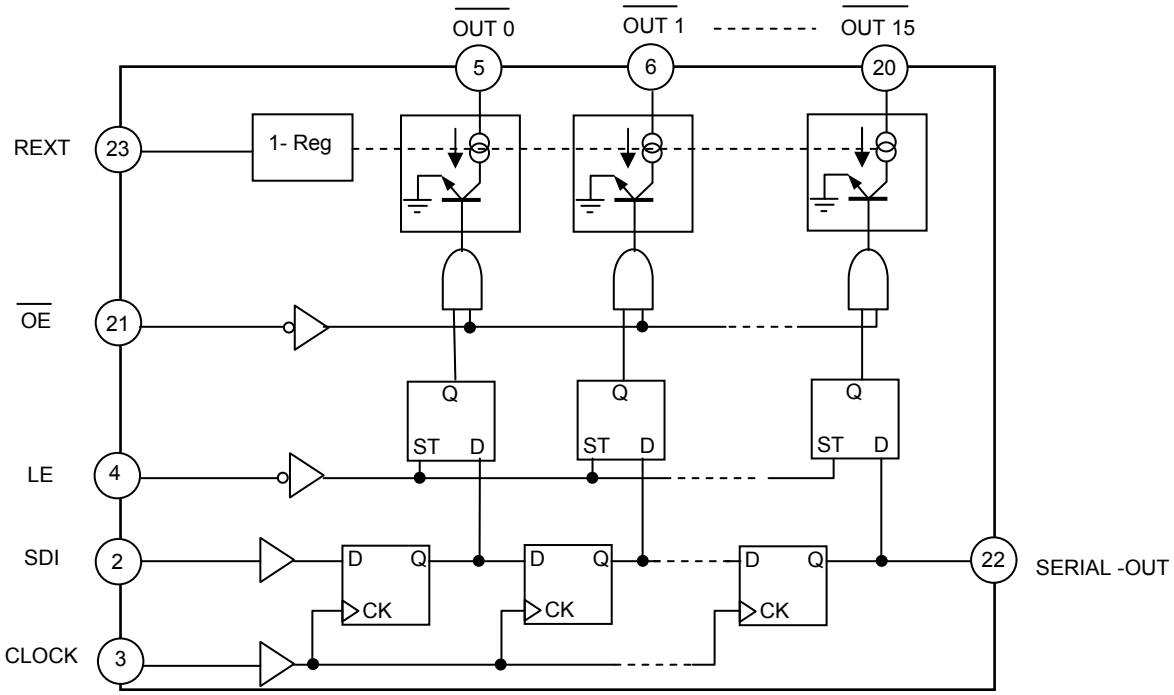
PA5026 guarantees a maximum of 17V at the output port.

The high clock frequency, 25 MHz, satisfies the system requirements of high volume data transmission.

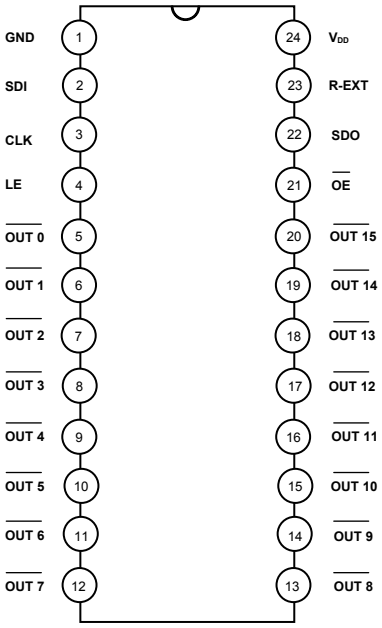
### ORDERING INFORMATION

| Device No. | Package |
|---|---|
| PA5026P | SSOP-24-300-1.0 |
| PA5026S<br>PA5026R | SSOP-24-150-0.635 |
| PA5026QN | QFN-24 |

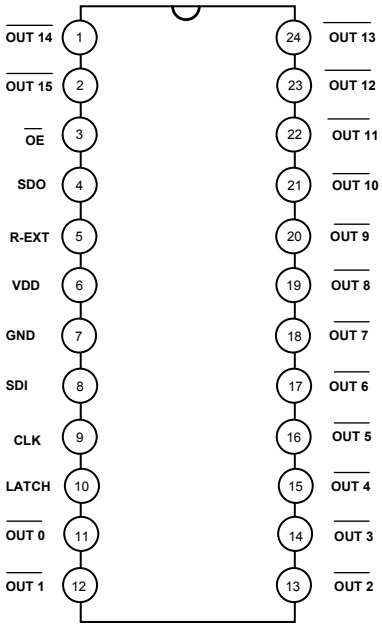
### BLOCK DIAGRAM



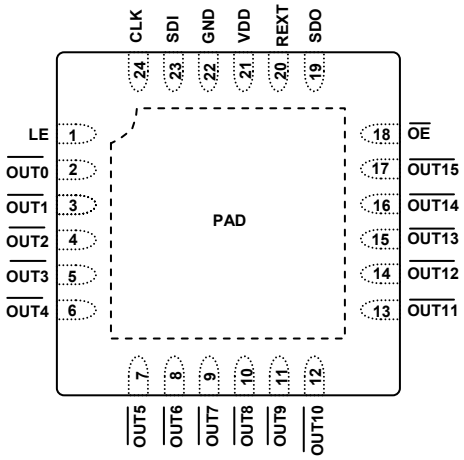
## PIN CONFIGURATIONS




**PA5026P (SSOP-24-300-1.0)**
**AND**
**PA5026R (SSOP-24-150-0.635)**




**PA5026S (SSOP-24-150-0.635)**

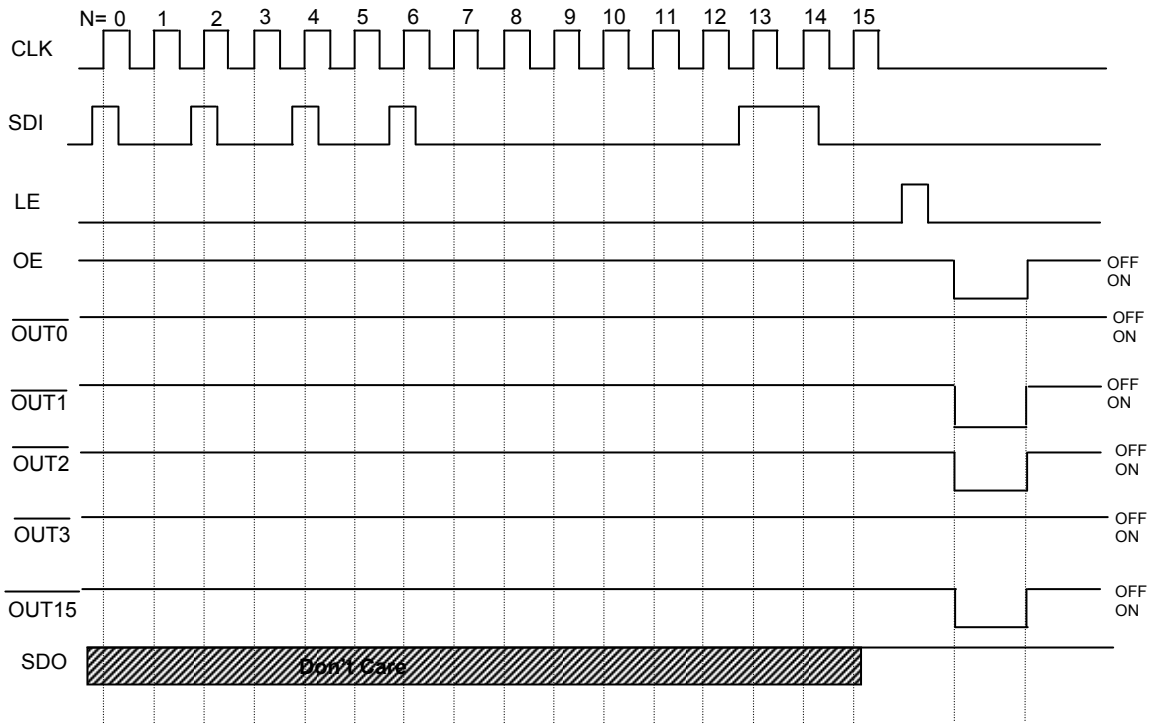



**PA5026QN (QFN-24)**

## PIN DESCRIPTIONS

| Pin Number | | | Pin Name | Description |
|---|---|---|---|---|
| **PA5026QN** | **PA5026P PA5026R** | **PA5026S** | | |
| 22 | 1 | 7 | GND | Ground |
| 23 | 2 | 8 | SDI | Shift register Data Input Pin |
| 24 | 3 | 9 | CLK | Shift Register Clock Input Pin, |
| 1 | 4 | 10 | LATCH ENABLE | Data Strobe Input Pin, |
| 2~9 | 5~12 | 11~18 | $\overline{OUT0}$~$\overline{OUT7}$ | Output Port |
| 10~15 | 13~18 | 19~24 | $\overline{OUT8}$~$\overline{OUT13}$ | |
| 16~17 | 19~20 | 1~2 | $\overline{OUT14}$~$\overline{OUT15}$ | |
| 18 | 21 | 3 | $\overline{OE}$ | Output Enable |
| 19 | 22 | 4 | SDO | Shift Register Data Output Pin |
| 20 | 23 | 5 | R-EXT | External Resistor Input Port |
| 21 | 24 | 6 | $V_{DD}$ | Power Supply |

## TIMING DIAGRAM




## TRUTH TABLE

| CLK | LE | OE | SDI | $\overline{OUT0}$…$\overline{OUT7}$…$\overline{OUT15}$ | SDO |
|---|---|---|---|---|---|
| ↑ | H | L | $D_N$ | $\overline{D_N}$..... $\overline{D_{N-7}}$..... $\overline{D_{N-15}}$ | $D_{N-15}$ |
| ↑ | L | L | $D_{N+1}$ | No Change | $D_{N-14}$ |
| ↑ | H | L | $D_{N+2}$ | $\overline{D_N}$..... $\overline{D_{N-5}}$..... $\overline{D_{N-13}}$ | $D_{N-13}$ |
| ↓ | X | L | $D_{N+3}$ | $\overline{D_N}$..... $\overline{D_{N-5}}$..... $\overline{D_{N-13}}$ | $D_{N-13}$ |
| ↓ | X | H | $D_{N+3}$ | Off | $D_{N-13}$ |

**MAXIMUM RATINGS**

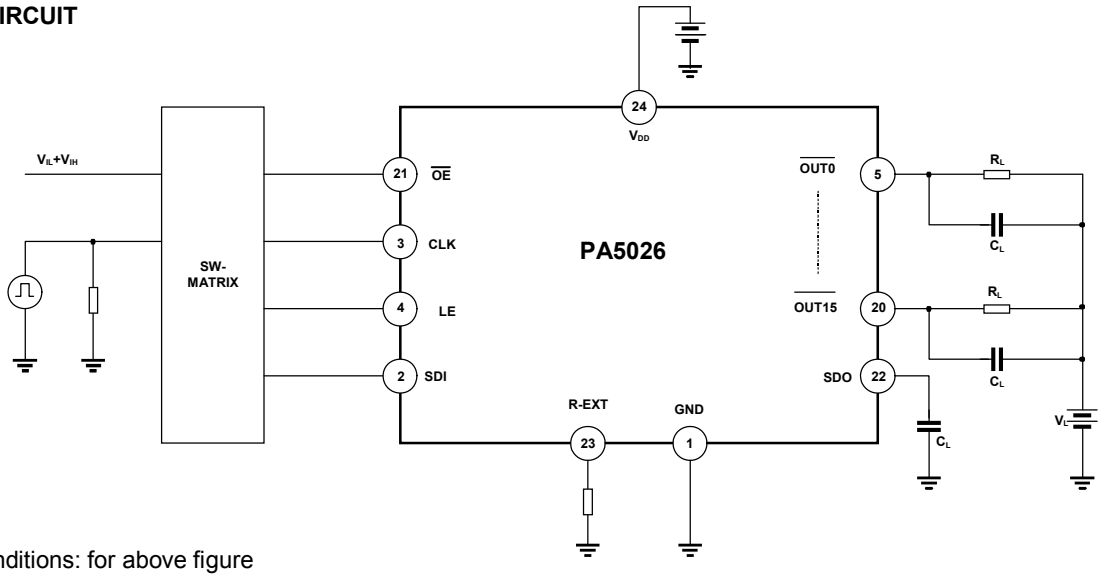
| Characteristic | | Symbol | Rating | Unit |
|---|---|---|---|---|
| Supply Voltage | | $V_{DD}$ | 0~7.0 | V |
| Input Voltage | | $V_{IN}$ | -0.4~$V_{DD}$ + 0.4 | V |
| Output Current | | $I_{OUT}$ | +90 | mA |
| Output Voltage | | $V_{DS}$ | -0.5~+17.0 | V |
| Clock Frequency | | $F_{CLK}$ | 25 | MHz |
| GND Terminal Current | | $I_{GND}$ | 1440 | mA |
| Power Dissipation (On PCB, Ta=25°C) | CN – type | $P_D$ | 2.32 | W |
| | CNS – type | | 1.87 | |
| | CD – type | | 2.51 | |
| | CF – type | | 2.12 | |
| | CP – type | | 1.73 | |
| | CPA – type | | 1.73 | |
| Thermal Resistance (On PCB, Ta=25°C) | CN – type | $R_{th(j-a)}$ | 53.82 | °C/W |
| | CNS – type | | 66.74 | |
| | CD– type | | 49.81 | |
| | CF – type | | 59.01 | |
| | CP – type | | 72.43 | |
| | CPA – type | | 72.43 | |
| Operating Temperature | | $T_{opr}$ | -40~+85 | °C |
| Storage Temperature | | $T_{stg}$ | -55~+150 | °C |

## ELECTRICAL CHARACTERISTICS

| Characteristic | | Symbol | Condition | | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|---|---|
| Supply Voltage | | $V_{DD}$ | - | | 2.5* | 5.0 | 5.5 | V |
| Output Voltage | | $V_{DS}$ | $\overline{OUT0}$ ~ $\overline{OUT15}$ | | - | - | 17.0 | V |
| Output Current | | $I_{OUT}$ | DC Test Circuit | | 2 | - | 80 | mA |
| | | $I_{OH}$ | SDO | | - | - | -1.0 | mA |
| | | $I_{OL}$ | SDO | | - | - | 1.0 | mA |
| Input Voltage | "H" level | $V_{IH}$ | Ta = -40~85ºC | | 0.8VDD | - | VDD | V |
| | "L" level | $V_{IL}$ | Ta = -40~85ºC | | GND | - | 0.3VDD | V |
| Output Leakage Current | | $I_{OH}$ | $V_{OH}$=17.0V | | - | - | 0.5 | µA |
| Output Voltage | SDO | $V_{OL}$ | $I_{OL}$=+1.0mA | | - | - | 0.4 | V |
| | | $V_{OH}$ | $I_{OH}$=-1.0mA | | 4.6 | - | - | V |
| Output Current 1 | | $I_{OUT1}$ | $V_{DS}$=0.6V | Rext=720 Ω | - | 26.25 | - | mA |
| Current Skew | | $dI_{OUT1}$ | $I_{OL}$=26.25mA<br>$V_{DS}$=0.6V | Rext=720 Ω | - | ±1 | ±3 | % |
| Output Current 2 | | $I_{OUT2}$ | $V_{DS}$=0.8V | Rext=360 Ω | - | 52.5 | - | mA |
| Current Skew | | $dI_{OUT2}$ | $I_{OL}$=52.5mA<br>$V_{DS}$=0.8V | Rext=360 Ω | - | ±1 | ±3 | % |
| Output Current vs. Output Voltage Regulation | | $\%/dV_{DS}$ | $V_{DS}$ within 1.0V and 3.0V | | - | ±0.1 | - | % / V |
| Output Current vs. Supply Voltage Regulation | | $\%/dV_{DD}$ | $V_{DD}$ within 4.5V and 5.5V | | - | ±1 | - | % / V |
| Pull-up Resistor | | $R_{IN(up)}$ | $\overline{OE}$ | | 250 | 500 | 800 | KΩ |
| Pull-down Resistor | | $R_{IN(down)}$ | LE | | 250 | 500 | 800 | KΩ |
| Supply Current | "OFF" | $I_{DD(off)\ 1}$ | $R_{ext}$=Open, $\overline{OUT0}$ ~ $\overline{OUT15}$ =Off | | - | 7 | 12 | mA |
| | | $I_{DD(off)\ 2}$ | $R_{ext}$=720 Ω, $\overline{OUT0}$ ~ $\overline{OUT15}$ =Off | | - | 10 | 12 | |
| | | $I_{DD(off)\ 3}$ | $R_{ext}$=360 Ω, $\overline{OUT0}$ ~ $\overline{OUT15}$ =Off | | - | 12 | 15 | |
| | "ON" | $I_{DD(on)\ 1}$ | $R_{ext}$=720 Ω, $\overline{OUT0}$ ~ $\overline{OUT15}$ =On | | - | 10 | 18 | |
| | | $I_{DD(on)\ 2}$ | $R_{ext}$=360 Ω, $\overline{OUT0}$ ~ $\overline{OUT15}$ =On | | - | 12 | 20 | |

** 2.5V min for RED LED only Green and Blue LED require up to 4.0V*

## TEST CIRCUIT




Test conditions: for above figure

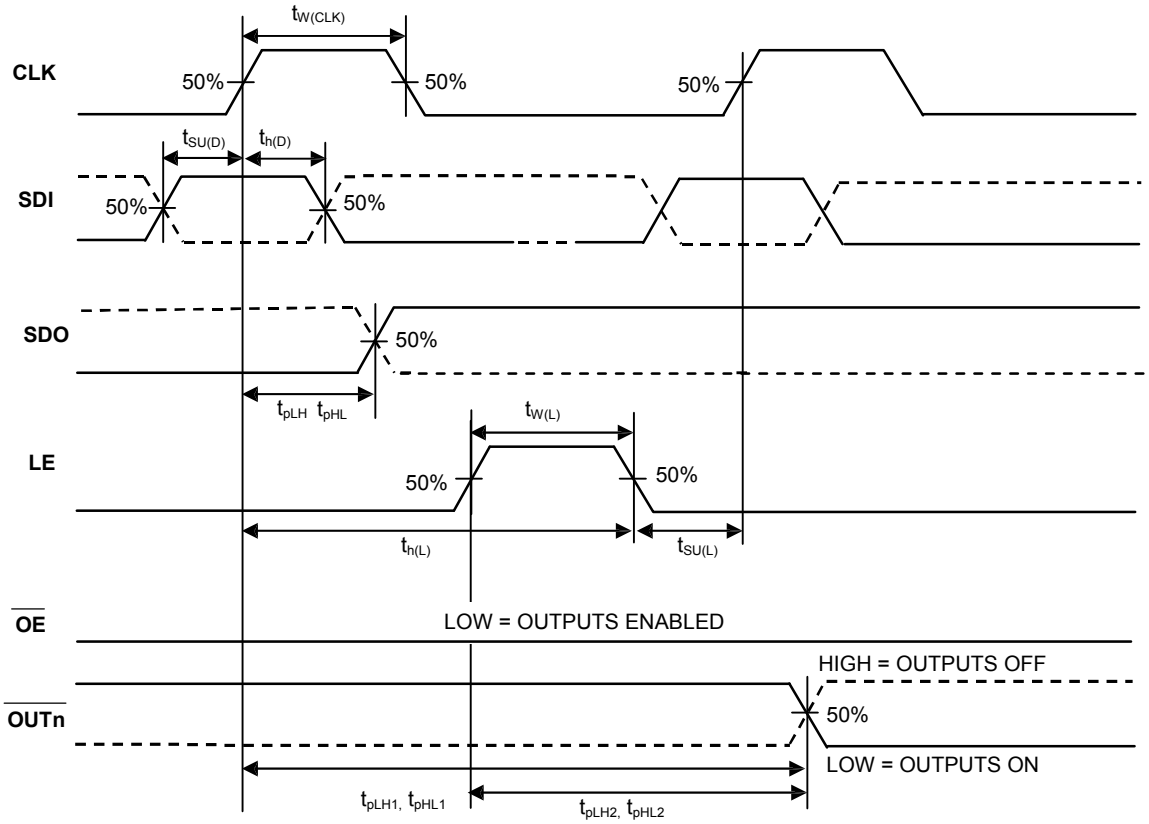
Tamb=25°C,VDD=VIH=3.3V and 5V,VOUT=0.7V,VIL=0V,REXT=490Ω,VL=3.0V,RL=60Ω,CL=IO.5pF

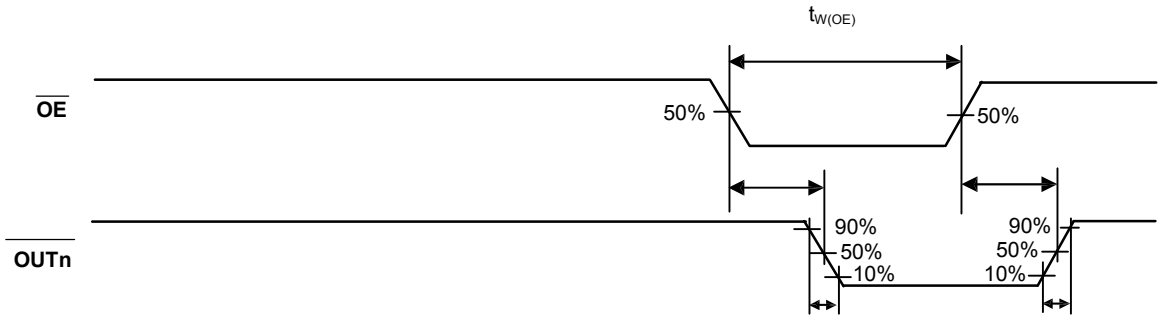
## SWITCHING CHARACTERISTICS

| Characteristic | | Symbol | Condition | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|---|
| Propagation Delay Time ("L" to "H") | CLK - OUTn | $t_{pLH1}$ | $V_{DD}$=5.0 V<br>$V_{DS}$=0.8 V<br>$V_{IH}$=$V_{DD}$<br>$V_{IL}$=GND<br>$R_{ext}$=300 Ω<br>$V_L$=4.0 V<br>$R_L$=52 Ω<br>$C_L$=10 pF | - | 100 | 150 | ns |
| | LE - OUTn | $t_{pLH2}$ | | - | 100 | 150 | ns |
| | OE - OUTn | $t_{pLH3}$ | | - | 50 | 150 | ns |
| | CLK - SDO | $t_{pL}$ | | 15 | 20 | - | ns |
| Propagation Delay Time ("H" to "L") | CLK - OUTn | $t_{pHL1}$ | | - | 50 | 100 | ns |
| | LE - OUTn | $t_{pHL2}$ | | - | 50 | 100 | ns |
| | OE - OUTn | $t_{pHL3}$ | | - | 20 | 100 | ns |
| | CLK - SDO | $t_{pHL}$ | | 15 | 20 | - | ns |
| Pulse Width | CLK | $t_{w(CLK)}$ | | 20 | - | - | ns |
| | LE | $t_{w(L)}$ | | 20 | - | - | ns |
| | OE | $t_{w(OE)}$ | | 200 | - | - | ns |
| Hold Time for LE | | $t_{h(L)}$ | | 5 | - | - | ns |
| Setup Time for LE | | $t_{su(L)}$ | | 5 | - | - | ns |
| Hold Time for SDI | | $t_{h(D)}$ | | 10 | - | - | ns |
| Setup Time for SDI | | $t_{su(}$ | | 5 | - | - | ns |
| Clock Frequency | | $F_{CLK}$ | Cascade Operation | - | - | 25.0 | MHz |
| Maximum CLK Rise Time | | $t_r$** | | - | - | 500 | ns |
| Maximum CLK Fall Time | | $t_f$** | | - | - | 500 | ns |
| Output Rise Time of Vout (turn off) | | $t_{or}$ | | - | 70 | 200 | ns |

| | | | | | | |
|---|---|---|---|---|---|---|
| Output Fall Time of Vout (turn on) | $t_{of}$ | | - | 40 | 120 | ns |

**TIMING WAVEFORM**



**APPLICATION NOTE**

In LED applications, the PA5026 can maintain the current with almost no variation, across different channels and chips. The maximum current accuracy between bits is ±3%, and between chips is ±6%.

There is only one ground pin for signal ground, constant current source ground and power ground.

We recommend adopting minimum inductance in layout to reduce the switch noise and chip faults. In order to prevent driver damage by over current, do not turn off the driver and scan the triode at the same time.

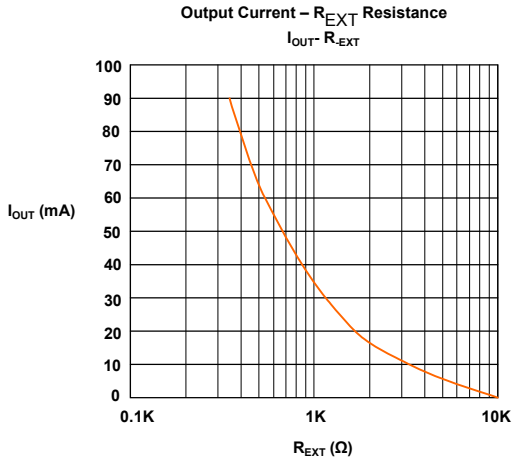
The resistor should be placed near the R-EXT pin.

The output current of each channel ($I_{OUT}$) is set by an external resistor, Rext.

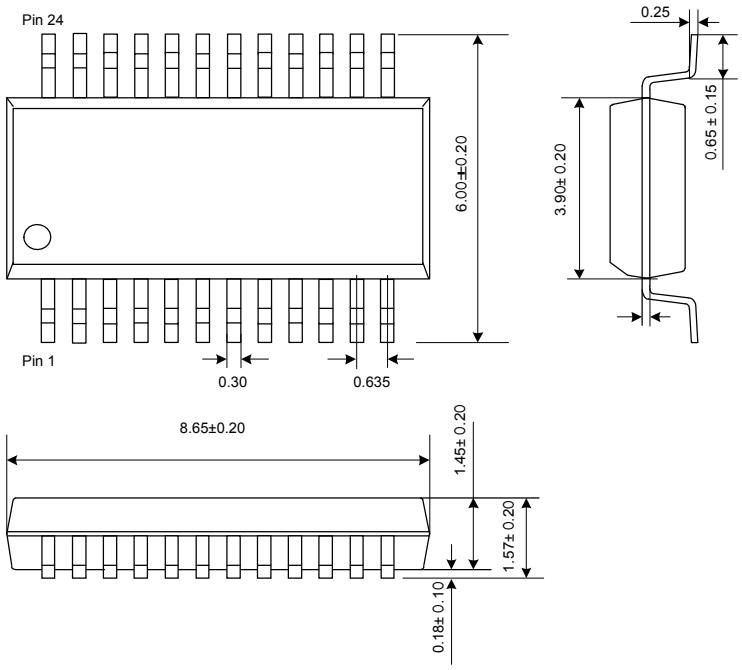
The output current can be calculated from the equation: $VR_{-EXT}$ = 1.26V ; $I_{OUT}$ = ($V_{R-EXT}$ / Rext ) x 15 where $R_{ext}$ is the resistance of the external resistor connected to $R_{EXT}$ terminal and $V_{R-EXT}$ is the voltage of $R_{-EXT}$ terminal.

The magnitude of current (as a function of $R_{ext}$) is around 52.5mA at 360Ω and 26.25mA at 720Ω.

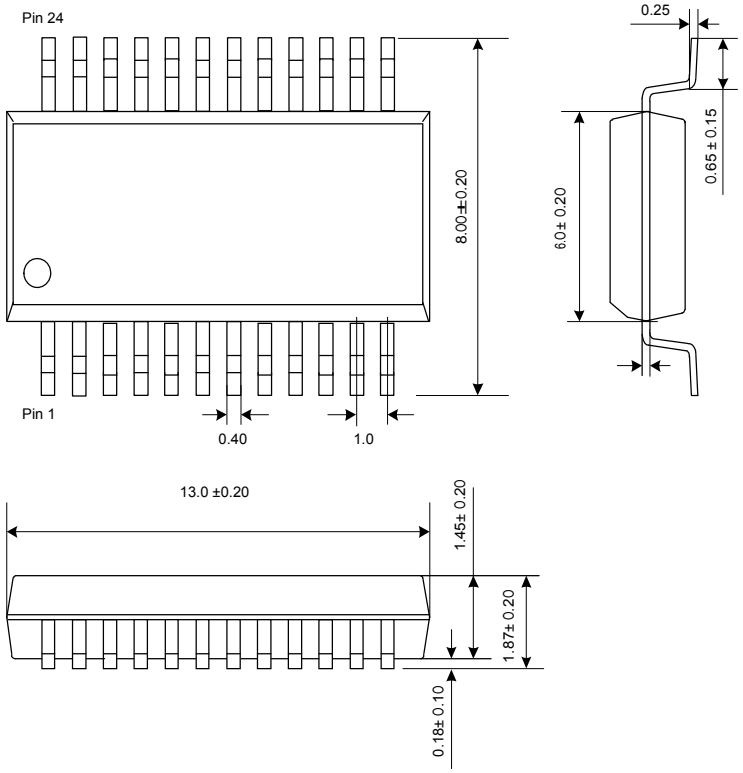
**ELECTRICAL CHARACTERISTIC CURVE**



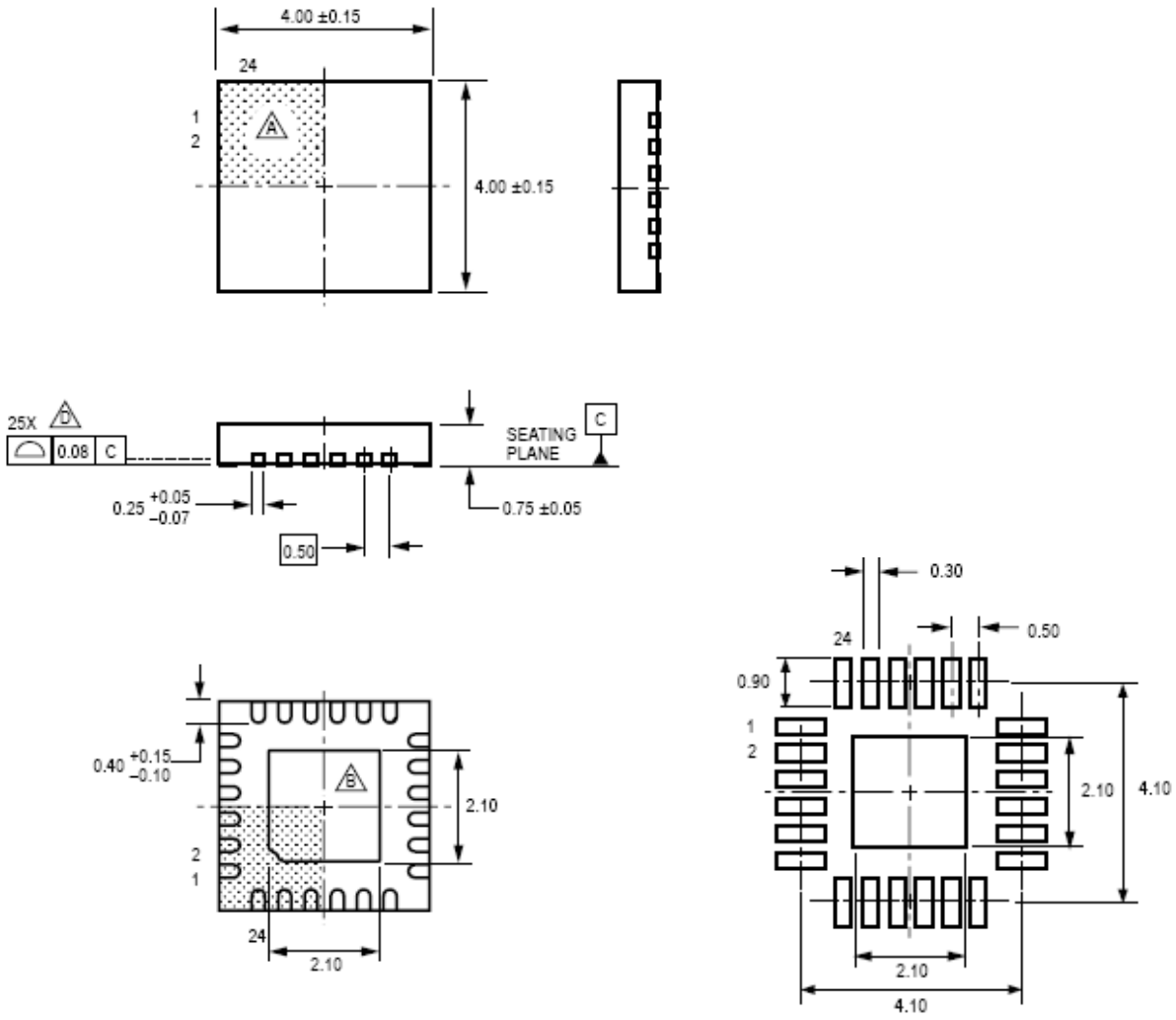
**PACKAGE OUTLINE AND DIMENSIONS** *(Measurements shown in mm)*
**SSOP-24-150-0.635 FOR PA5026S AND THE PA5026R**




**PACKAGE OUTLINE AND DIMENSIONS**
**SSOP-24-300- 1.00 FOR PA5026P**



## PACKAGE OUTLINE AND DIMENSIONS
## QFN-24 FOR PA5026QN




Recommended Pad Layout

### Tape and Reel Specifications

| Reel Dia | A0 | B0 | K0 | D | E | F | W | P0 | P2 | P | t-max |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 178 (7") | 4.10±0.10 | 4.10±0.10 | 0.85±0.10 | 1.50±0.10 | 1.75±0.10 | 3.50±0.05 | 12.00±0.30 | 4.00±0.10 | 2.00±0.05 | 4.00±0.10 | 0.25 |