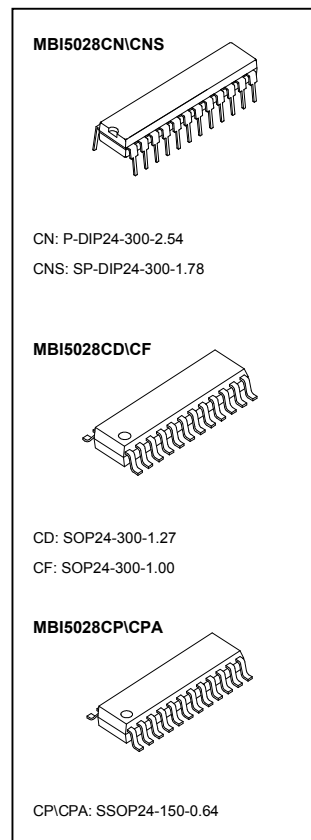**Macroblock**

# MBI5028

## 16-bit Constant Current LED Sink Driver with Gain Control

## Features

- 16 constant-current output channels
- Output current adjustable through an external resistor
- Programmable output current gain for White Balance
- Constant output current range: 5-90 mA
- Excellent output current accuracy:

  between channels: ±3% (max.), and

  between ICs: ±6% (max.)
- Constant output current invariant to load voltage change
- Fast response of output current, $\overline{\text{OE}}$ (min.): 200 ns
- 25MHz clock frequency
- Schmitt trigger input
- 5V supply voltage

**MBI5028CN\CNS**

CN: P-DIP24-300-2.54

CNS: SP-DIP24-300-1.78

**MBI5028CD\CF**

CD: SOP24-300-1.27

CF: SOP24-300-1.00

**MBI5028CP\CPA**

CP\CPA: SSOP24-150-0.64

| Current Accuracy | | Conditions |
|---|---|---|
| Between Channels | Between ICs | |
| < ±3% | < ±6% | $I_{OUT}$ = 10 ~ 60 mA |

# MBI5028      16-bit Constant Current LED Sink Driver with Gain Control

## Product Description

MBI5028 succeeds MBI5026 and is designed for LED displays with Gain Control extension. MBI5028 exploits PrecisionDrive™ technology to enhance its output characteristics. MBI5028 contains a 16-bit shift register and data latches, which convert serial input data into parallel output format. At MBI5028 output stage, sixteen regulated current ports are designed to provide constant current sinks for driving LEDs within a wide range of Vf variations.

MBI5028 provides users with great flexibility and device performance while using MBI5028 in their LED panel system design. Users may adjust the output current from 5 mA to 90 mA through an external resistor $R_{ext}$, which gives users flexibility in controlling the light intensity of LEDs. MBI5028 guarantees to endure maximum 17V at the output port. The high clock frequency, 25 MHz, also satisfies the system requirements of high volume data transmission.
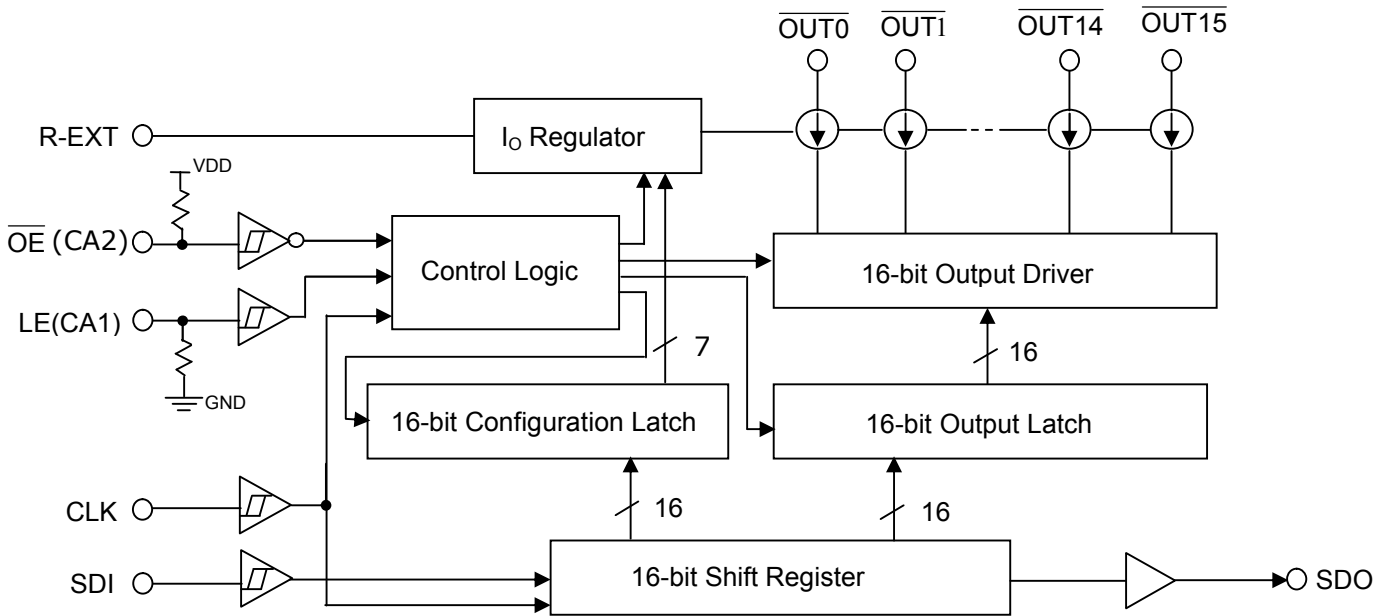
MBI5028 also exploits Share-I-O™ technology and is backward compatible with MBI5026 in both electrical characteristics and package aspect. To utilize the Current Adjust feature, users may not have to change the printed circuit board originally for MBI5026. To enter a special function mode--Current Adjust mode, users just need to set a specific sequence of signals on LE(CA1), $\overline{OE}$ (CA2) and CLK input pins. Normally, the output current can be regulated only through an external resistor. In addition, in the Current Adjust mode, the output current can be software-programmable by a system controller. The system controller adjusts the output current by sending a 7-bit Current Adjust code to 16-bit Configuration Latch through MBI5028 SDI pin. The code will be latched and effective to control the output current regulator. A fine adjustment of the output current could be achieved by a gain ranging from 0.5 to 1.984 with 128 fine steps. By setting another sequence of signals on LE(CA1), $\overline{OE}$ (CA2) and CLK input pins, MBI5028 may resume to a Normal mode and perform as MBI5026. The Shift Register, with SDI, SDO, and CLK, carries the image data as usual.

By means of the Share-I-O™ technique, an additionally effective function, Current Gain, can be added to LED drivers, MBI5028, without any extra pins. Thus, MBI5028 could be a drop-in replacement of MBI5026. The printed circuit board originally designed for MBI5026 may be also applicable for MBI5028.

For MBI5028, Pin LE and $\overline{OE}$ can respectively offer two functions:

| Device Type | Pin Name | Function description |
|---|---|---|
| CN\CNS\CD\CF\CP | Pin4 | LE+Current Adjust |
| CPA | Pin10 | LE+Current Adjust |
| CN\CNS\CD\CF\CP | Pin21 | $\overline{OE}$ +Current Adjust |
| CPA | Pin3 | $\overline{OE}$ +Current Adjust |

# MBI5028　　16-bit Constant Current LED Sink Driver with Gain Control

## Block Diagram



## Terminal Description

| Pin Name | Function |
|---|---|
| GND | Ground terminal for control logic and current sink |
| SDI | Serial-data input to the Shift Register |
| CLK | Clock input terminal for data shift on rising edge |
| LE(CA1) | Data strobe input terminal<br><br>Serial data is transferred to the respective latch when LE(CA1) is high. The data is latched when LE(CA1) goes low.<br><br>Also, a control signal input for Current Adjust mode (See **Timing Diagram**) |
| $\overline{OUT0} \sim \overline{OUT15}$ | Constant current output terminals |
| $\overline{OE}$ (CA2) | Output enable terminal<br><br>When $\overline{OE}$ (CA2)(active) low, the output drivers are enabled; when $\overline{OE}$ (CA2) high, all output drivers are turned OFF (blanked).<br><br>Also, a second control signal input for Current Adjust mode (See **Timing Diagram**) |
| SDO | Serial-data output to the following SDI of next driver IC |
| R-EXT | Input terminal used to connect an external resister for setting up all output current |
| VDD | 5V supply voltage terminal |

## Pin Configuration
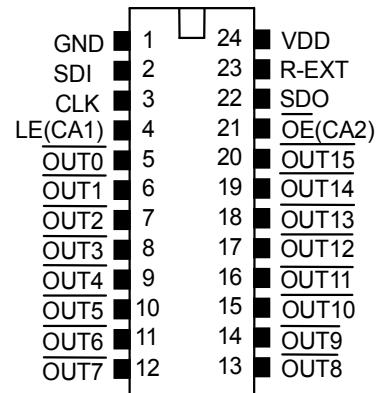


**MBI5028CN\CNS\CD\CF\CP**
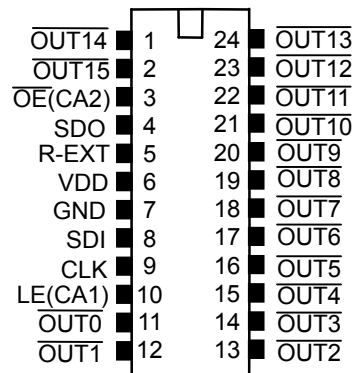


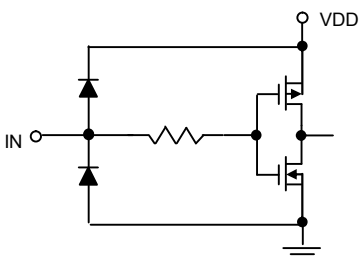**MBI5028CPA**

## Equivalent Circuits of Inputs and Outputs

**$\overline{\text{OE}}$ (CA2) terminal**
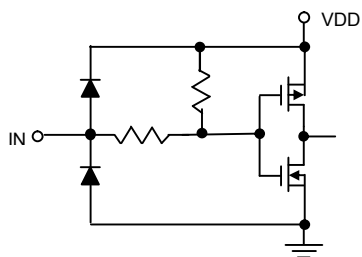
**LE(CA1) terminal**
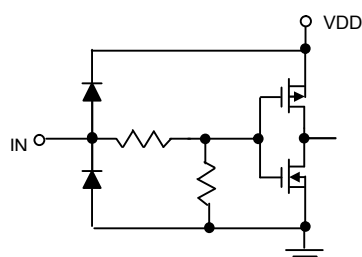
**CLK, SDI terminal**

**SDO terminal**
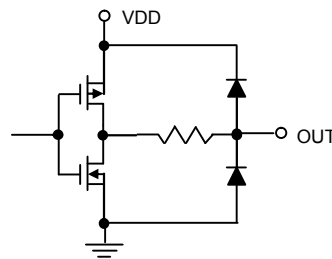
## Timing Diagram

### Normal Mode



: don't care
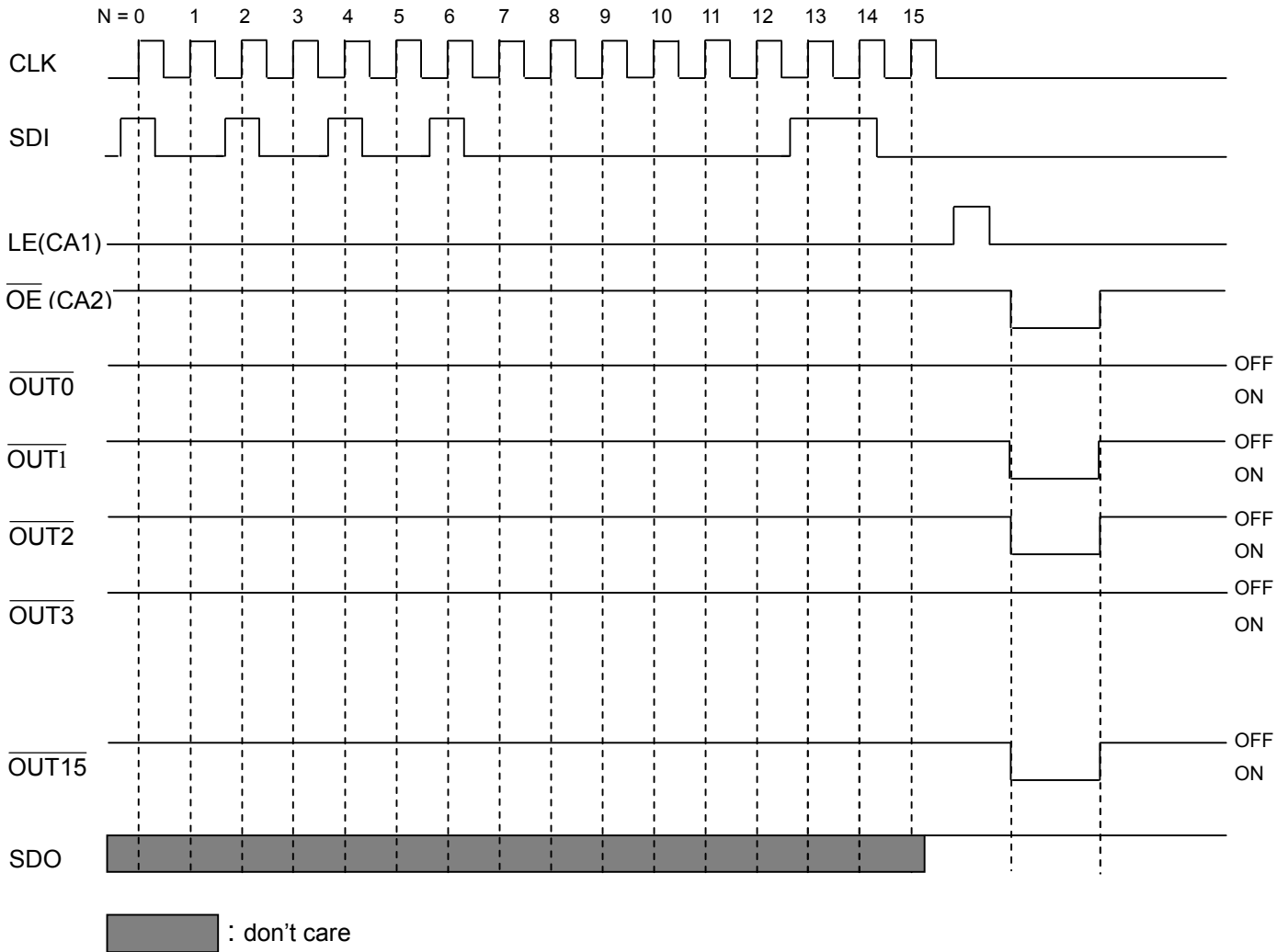
# Truth Table (In Normal Mode)

| CLK | LE | $\overline{OE}$ | 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 | $D_{n+2}$ | $\overline{D_{n+2}}$ .... $\overline{D_{n-5}}$ .... $\overline{D_{n-13}}$ | $D_{n-13}$ |
| ⤓ | X | L | $D_{n+3}$ | $\overline{D_{n+2}}$ .... $\overline{D_{n-5}}$ .... $\overline{D_{n-13}}$ | $D_{n-13}$ |
| ⤓ | X | H | $D_{n+3}$ | Off | $D_{n-13}$ |

## Switching to Current Adjust Mode
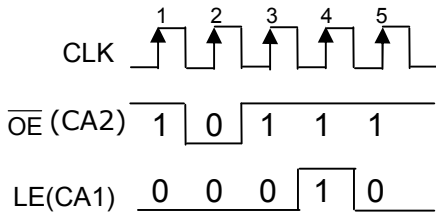


The signal sequence makes MBI5028 enter a **Current Adjust** mode. Here, the LE active pulse would not latch any data.
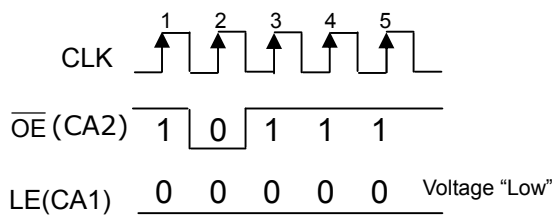
## Writing Configuration Code
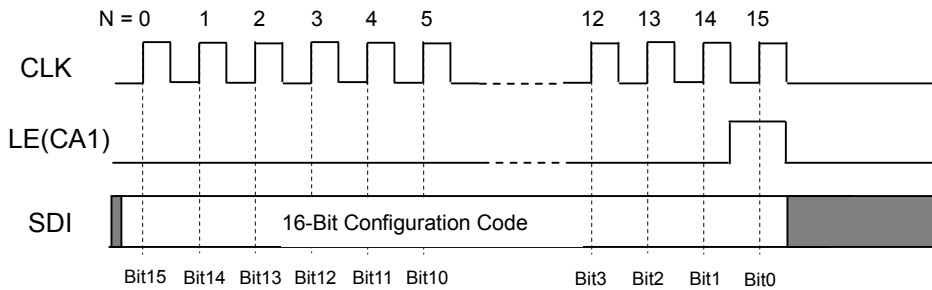


**Note:**

In the Current Adjust mode, by sending the positive pulse of LE(CA1), the content of the Shift Register, a Current Adjust code, will be written to the 16-Bit Configuration Latch.

## Switching to Normal Mode



The signal sequence makes MBI5028 resume to a Normal mode.

**Note:**

Pin $\overline{OE}$ (CA2) could always enable the output port no matter MBI5028 enters a Current Adjust mode or not. If users want to know the whole process, that is how to enter a Current Adjust mode, write Current Adjust codes and resume to a Normal mode, please refer to the contents in **Application Information**.

# MBI5028    16-bit Constant Current LED Sink Driver with Gain Control

## 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 ~ +20.0 | 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 |

## Recommended Operating Conditions

| Characteristic | Symbol | Condition | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| Supply Voltage | $V_{DD}$ | - | 4.5 | 5.0 | 5.5 | V |
| Output Voltage | $V_{DS}$ | $\overline{OUT0} \sim \overline{OUT15}$ | - | - | 17.0 | V |
| Output Current | $I_{OUT}$ | DC Test Circuit | 5 | - | 90 | mA |
|  | $I_{OH}$ | SDO | - | - | -1.0 | mA |
|  | $I_{OL}$ | SDO | - | - | 1.0 | mA |
| Input Voltage | $V_{IH}$ | CLK, $\overline{OE}$ (CA2), LE(CA1) and SDI | $0.8V_{DD}$ | - | $V_{DD}+0.3$ | V |
|  | $V_{IL}$ | CLK, $\overline{OE}$ (CA2), LE(CA1) and SDI | -0.3 | - | $0.3V_{DD}$ | V |
| LE(CA1) Pulse Width | $t_{w(L)}$ | Normal Mode $V_{DD}$=4.5~5.5V | 40 | - | - | ns |
| $\overline{OE}$ (CA2) Pulse Width | $t_{w(OE)}$ |  | 200 | - | - | ns |
| CLK Pulse Width | $t_{w(CLK)}$ |  | 20 | - | - | ns |
| Setup Time for SDI | $t_{su(D)}$ |  | 5 | - | - | ns |
| Hold Time for SDI | $t_{h(D)}$ |  | 10 | - | - | ns |
| Setup Time for LE(CA1) | $t_{su(L)}$ |  | 15 | - | - | ns |
| Hold Time for LE(CA1) | $t_{h(L)}$ |  | 15 | - | - | ns |
| CLK Pulse Width | $t_{w(CLK)}$ | Current Adjust Mode $V_{DD}$=4.5~5.5V | 20 | - | - | ns |
| Setup Time for LE(CA1) | $t_{su(CA1)}$ |  | 5 | - | - | ns |
| Hold Time for LE(CA1) | $t_{h(CA1)}$ |  | 10 | - | - | ns |
| Setup Time for $\overline{OE}$ (CA2) | $t_{su(CA2)}$ |  | 5 | - | - | ns |
| Hold Time for $\overline{OE}$ (CA2) | $t_{h(CA2)}$ |  | 10 | - | - | ns |
| Clock Frequency | $F_{CLK}$ | Cascade Operation | - | - | 25.0 | MHz |

## Electrical Characteristics

| Characteristic | | Symbol | Condition | | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|---|---|
| Supply Voltage | | $V_{DD}$ | - | | 4.5 | 5.0 | 5.5 | V |
| Output Voltage | | $V_{DS}$ | $\overline{OUT0} \sim \overline{OUT15}$ | | - | - | 17.0 | V |
| Output Current | | $I_{OUT}$ | DC Test Circuit | | 5 | - | 90 | mA |
| | | $I_{OH}$ | SDO | | - | - | -1.0 | mA |
| | | $I_{OL}$ | SDO | | - | - | 1.0 | mA |
| Input Voltage | "H" level | $V_{IH}$ | Ta = -40~85ºC | | $0.8V_{DD}$ | - | $V_{DD}$ | V |
| | "L" level | $V_{IL}$ | Ta = -40~85ºC | | GND | - | $0.3V_{DD}$ | 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 | $R_{ext}$=720 Ω | - | 26.0 | - | mA |
| Current Skew | | $dI_{OUT1}$ | $I_{OL}$=26mA $V_{DS}$=0.6V | $R_{ext}$=720 Ω | - | ±1 | ±3 | % |
| Output Current 2 | | $I_{OUT2}$ | $V_{DS}$=0.8V | $R_{ext}$=360 Ω | - | 52.1 | - | mA |
| Current Skew | | $dI_{OUT2}$ | $I_{OL}$=52.1mA $V_{DS}$=0.8V | $R_{ext}$=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 Resister | | $R_{IN}(up)$ | $\overline{OE}$ (CA2) | | 250 | 500 | 800 | KΩ |
| Pull-down Resister | | $R_{IN}(down)$ | LE(CA1) | | 250 | 500 | 800 | KΩ |
| Supply Current | "OFF" | $I_{DD}(off)$ 1 | $R_{ext}$=Open, $\overline{OUT0} \sim \overline{OUT15}$ =Off | | - | 7 | 12 | mA |
| | | $I_{DD}(off)$ 2 | $R_{ext}$=720 Ω, $\overline{OUT0} \sim \overline{OUT15}$ =Off | | - | 10 | 12 | |
| | | $I_{DD}(off)$ 3 | $R_{ext}$=360 Ω, $\overline{OUT0} \sim \overline{OUT15}$ =Off | | - | 12 | 15 | |
| | "ON" | $I_{DD}(on)$ 1 | $R_{ext}$=720 Ω, $\overline{OUT0} \sim \overline{OUT15}$ =On | | - | 10 | 18 | |
| | | $I_{DD}(on)$ 2 | $R_{ext}$=360 Ω, $\overline{OUT0} \sim \overline{OUT15}$ =On | | - | 12 | 20 | |

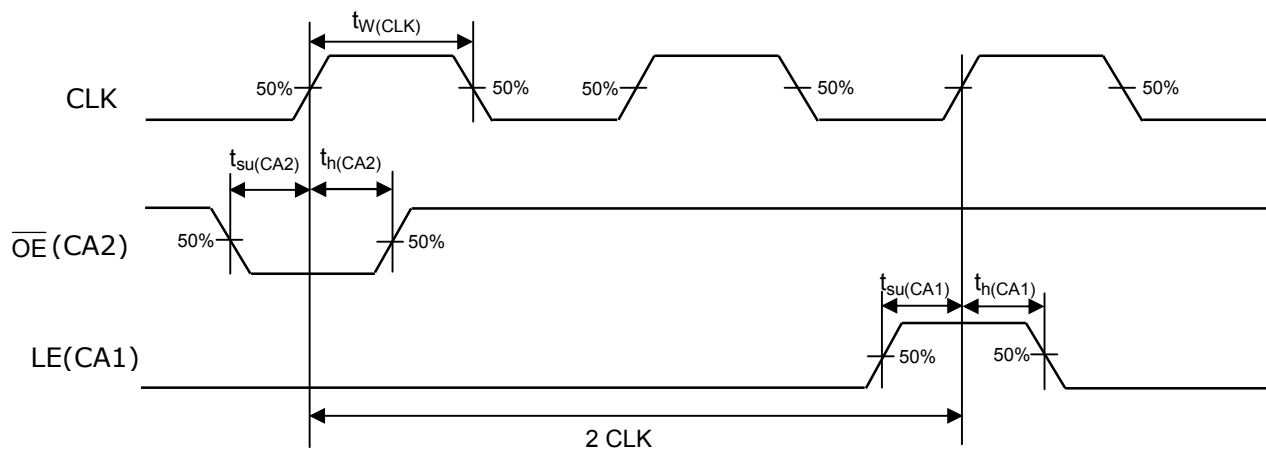## Test Circuit for Electrical Characteristics
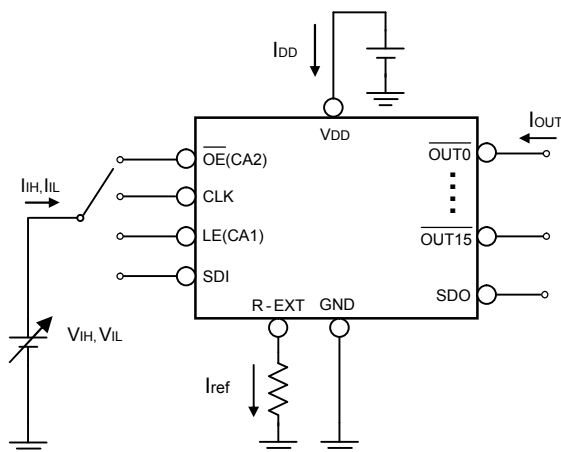
## Switching Characteristics

| Characteristic | | Symbol | Condition | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|---|
| Propagation Delay Time ("L" to "H") | CLK - $\overline{\text{OUTn}}$ | $t_{pLH1}$ | $V_{DD}$=5.0 V $V_{DS}$=0.8 V $V_{IH}$=$V_{DD}$ $V_{IL}$=GND $R_{ext}$=300 Ω $V_L$=4.0 V $R_L$=52 Ω $C_L$=10 pF | - | 50 | 100 | ns |
| | LE(CA1) - $\overline{\text{OUTn}}$ | $t_{pLH2}$ | | - | 50 | 100 | ns |
| | $\overline{\text{OE}}$ (CA2)- $\overline{\text{OUTn}}$ | $t_{pLH3}$ | | - | 20 | 100 | ns |
| | CLK - SDO | $t_{pLH}$ | | 15 | 20 | - | ns |
| Propagation Delay Time ("H" to "L") | CLK - $\overline{\text{OUTn}}$ | $t_{pHL1}$ | | - | 100 | 150 | ns |
| | LE(CA1) - $\overline{\text{OUTn}}$ | $t_{pHL2}$ | | - | 100 | 150 | ns |
| | $\overline{\text{OE}}$ (CA2)- $\overline{\text{OUTn}}$ | $t_{pHL3}$ | | - | 50 | 150 | ns |
| | CLK - SDO | $t_{pHL}$ | | 15 | 20 | - | ns |
| Pulse Width | CLK | $t_{w(CLK)}$ | | 20 | - | - | ns |
| | LE(CA1) | $t_{w(L)}$ | | 20 | - | - | ns |
| | $\overline{\text{OE}}$ (CA2) | $t_{w(OE)}$ | | 200 | - | - | ns |
| Hold Time for LE(CA1) | | $t_{h(L)}$ | | 5 | - | - | ns |
| Setup Time for LE(CA1) | | $t_{su(L)}$ | | 5 | - | - | ns |
| Maximum CLK Rise Time | | $t_r$** | | - | - | 500 | ns |
| Maximum CLK Fall Time | | $t_f$** | | - | - | 500 | ns |
| Output Rise Time of Vout (turn off) | | $t_{or}$ | | - | 40 | 120 | ns |
| Output Fall Time of Vout (turn on) | | $t_{of}$ | | - | 70 | 200 | ns |

**If the devices are connected in cascade and $t_r$ or $t_f$ is large, it may be critical to achieve the timing required for data transfer between two cascaded devices.

## Test Circuit for Switching Characteristics

## Timing Waveform

### Normal Mode
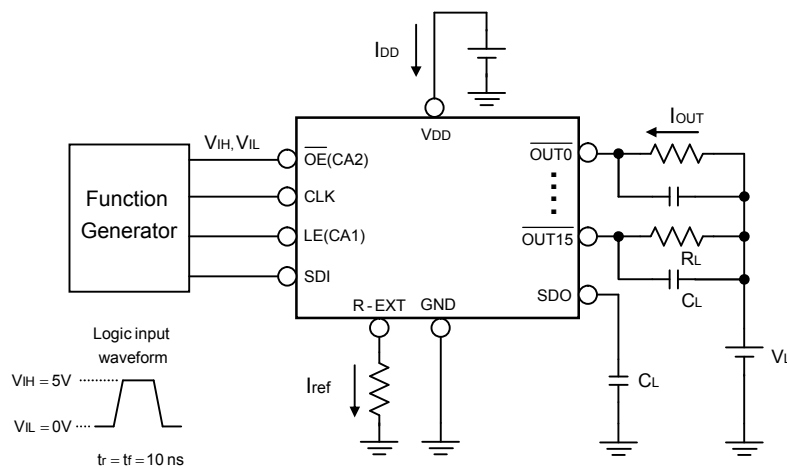
## Switching to Current Adjust Mode

# Application Information

## Constant Current

In LED display applications, MBI5028 provides nearly no variations in current from channel to channel and from IC to IC. This can be achieved by:

1) The maximum current variation between channels is less than ±3%, and that between ICs is less than ±6%.

2) In addition, the current characteristic of output stage is flat and users can refer to the figure as shown below. The output current can be kept constant regardless of the variations of LED forward voltages (Vf). This performs as a perfection of load regulation.
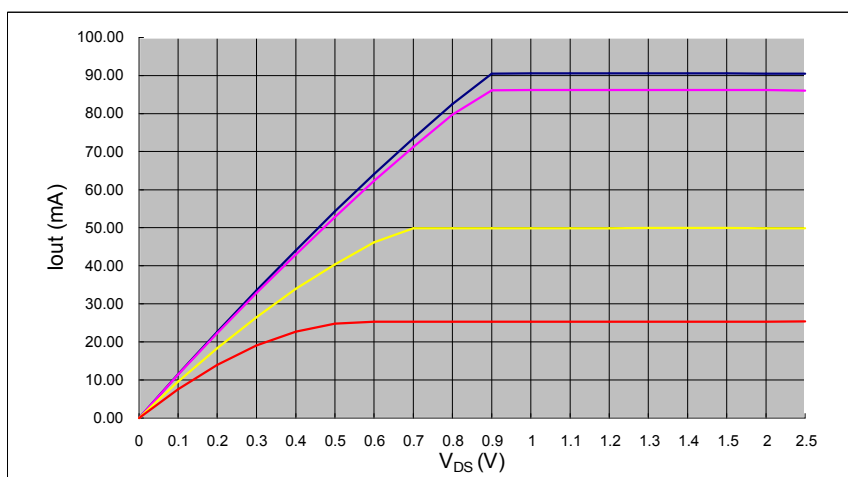
## Adjusting Output Current

The output current of each channel ($I_{OUT}$) is set by an external resistor, $R_{ext}$. After power-on, the default relationship between $I_{out}$ and $R_{ext}$ is shown in the following figure.
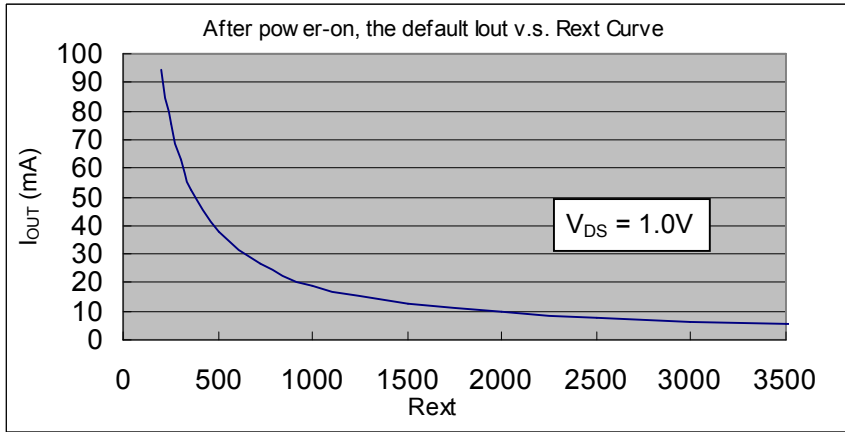


**Resistance of the external resistor, $R_{ext}$, in Ω**

Also, the output current can be calculated from the equations:

$V_{R-EXT}$ = 0.63Volt x G ; $I_{OUT}$ = ($V_{R-EXT}$ / $R_{ext}$ ) 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. Conceptually, G is the digital current gain, defined by the Current Adjust Code. After power-on, the default value of G is 1.984. Based on the default gain, $I_{OUT}$ = (0.63Volt x 1.984 / $R_{ext}$ ) x 15 = (1.25Volt/ $R_{ext}$) x 15, if another end of the resistor $R_{ext}$ is connected to the ground. The magnitude of current is around 52.1mA at 360Ω and 26.0mA at 720Ω. The section "16-bit Configuration Code" would describe how to set up the gain, G.

## Operation Mode Switching



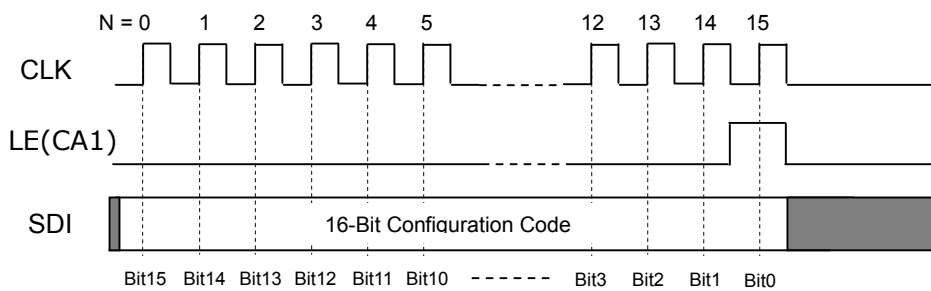**Switching to the Current Adjust Mode**

**Switching to the Normal Mode**
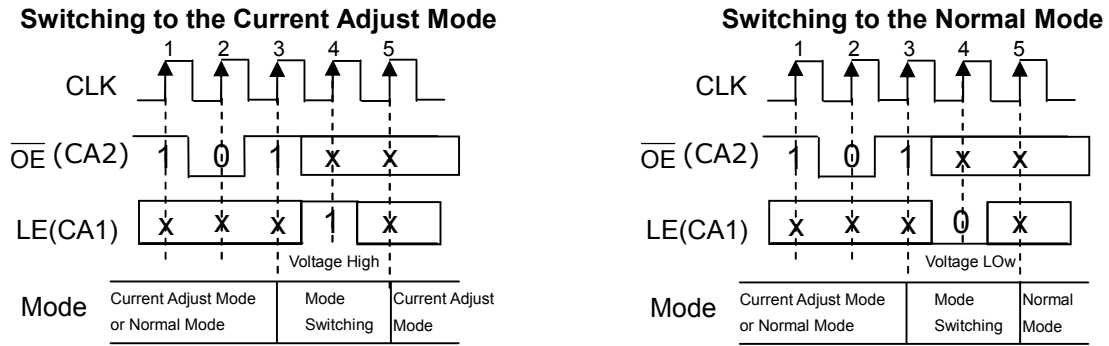
As shown in the above figures, once a short pulse "101" of $\overline{OE}$ (CA2) appears, MBI5028 would go through the mode switching. At the fourth rising edge of CLK, if LE(CA1) is sampled as " Voltage High", MBI5028 would switch to the Current Adjust mode; otherwise, it would switch to the Normal Mode. Worthwhile noticing, the signal LE(CA1) between the third and the fifth rising edges of CLK can not latch any data. Its level is just used for determining which mode to switch. However, the short pulse of $\overline{OE}$ (CA2) can still enable the output ports. During mode switching, the serial data can still be transferred through SDI pin and shifted out from SDO pin.

Note:

1.  The signals for mode switching could be used for making sure under which mode MBI5028 is working.

2.  The aforementioned "1" and "0" are sampled at the rising edge of CLK. The "X" means its level would not affect the result of mode switching.
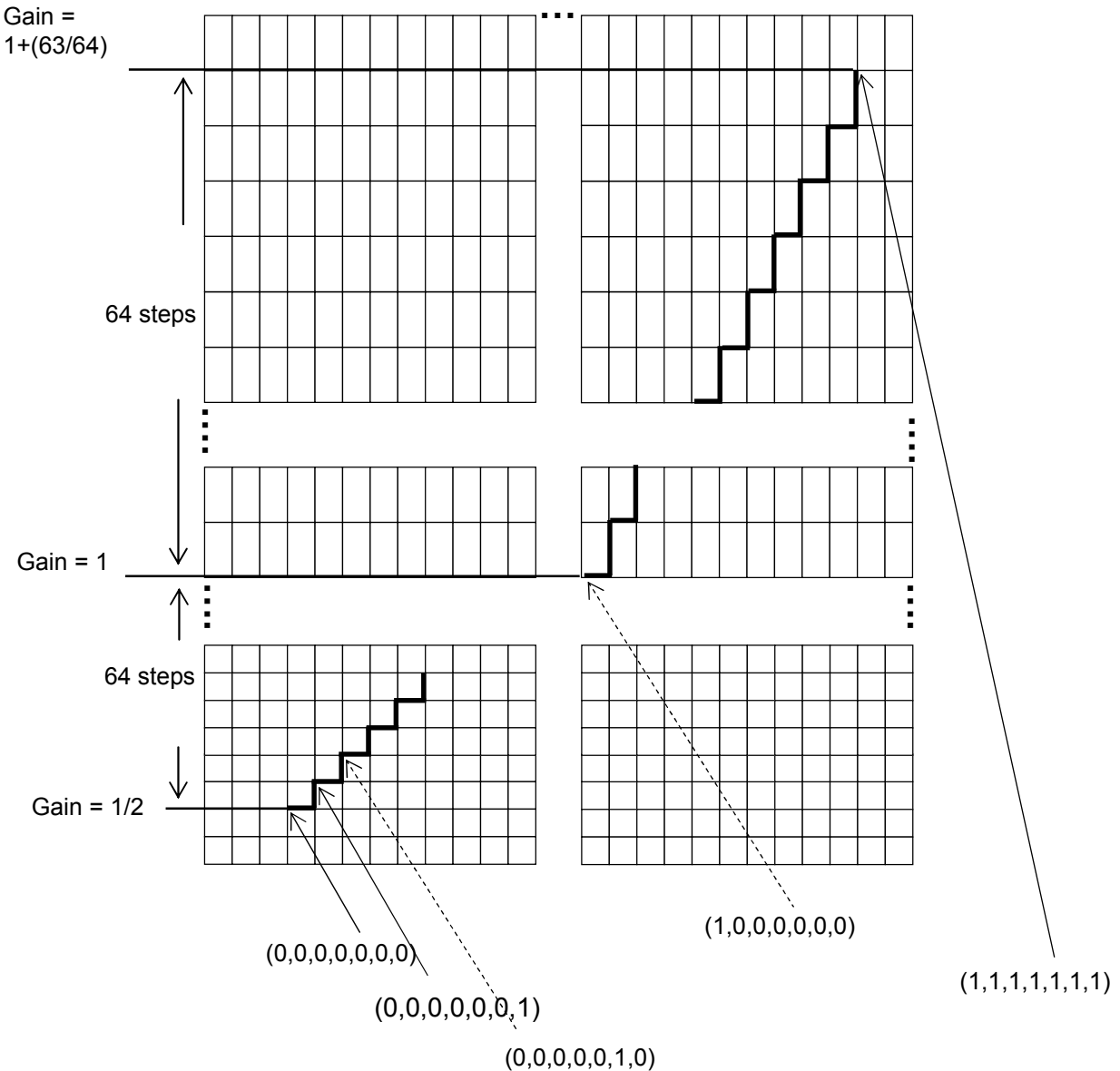
## Writing Configuration Code



: don't care

After entering the Current Adjust mode, the system controller sends a 7-bit Current Adjust code to 16-bit Shift Register through MBI5028 SDI pin. Then sending LE(CA1) active pulse will transfer the contents in the Shift Register to a 16-bit Configuration Latch rather than the 16-bit Output Latch in a Normal mode. The 7-bit Current Adjust code in the Configuration Latch will directly affect the voltage at R-EXT terminal and output current $I_{out}$ by the gain, G. The output current resulted by the gain values will be then defined as: (0.63Volt x G / $R_{ext}$ ) x 15. The gain will always be effective until power off or the Configuration Latch is re-written.

## Current Gain



Gain =
1+(63/64)

64 steps

Gain = 1

64 steps

Gain = 1/2

(0,0,0,0,0,0,0)

(0,0,0,0,0,0,1)

(0,0,0,0,0,1,0)

(1,0,0,0,0,0,0)

(1,1,1,1,1,1,1)

## 16-Bit Configuration Code

| | Bit 0 | Bit 1 | Bit 2 | Bit 3 | Bit 4 | Bit 5 | Bit 6 | Bit 7 | Bit 8 | Bit 9 | Bit 10 | Bit 11 | Bit 12 | Bit 13 | Bit 14 | Bit 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Meaning | - | HC | CC0 | CC1 | CC2 | CC3 | CC4 | CC5 | - | - | - | - | - | - | - | - |
| Default Value | - | 1 | 1 | 1 | 1 | 1 | 1 | 1 | - | - | - | - | - | - | - | - |

←————  7-bit Current Adjust Code  ————→        Note: "-" means "reserved and not used now"

The relationship between the Current Adjust Code HC, CC〔0:5〕and current gain G is shown below:

$G = (1 + HC) \times (1 + D/64)/2$

where HC is 1 or 0 (HC=0 : Low current band; HC=1 : High current band) and

$D = CC0 \times 2^5 + CC1 \times 2^4 + CC2 \times 2^3 + CC3 \times 2^2 + CC4 \times 2^1 + CC5 \times 2^0$;

So, the Current Adjust Code is a floating number with one bit exponent HC and 6-bit mantissa.

For example,
when the Current Adjust Code is (1,1,1,1,1,1,1)
Gain, G = (1+1) x (1+ 63/64)/2 = 1.984
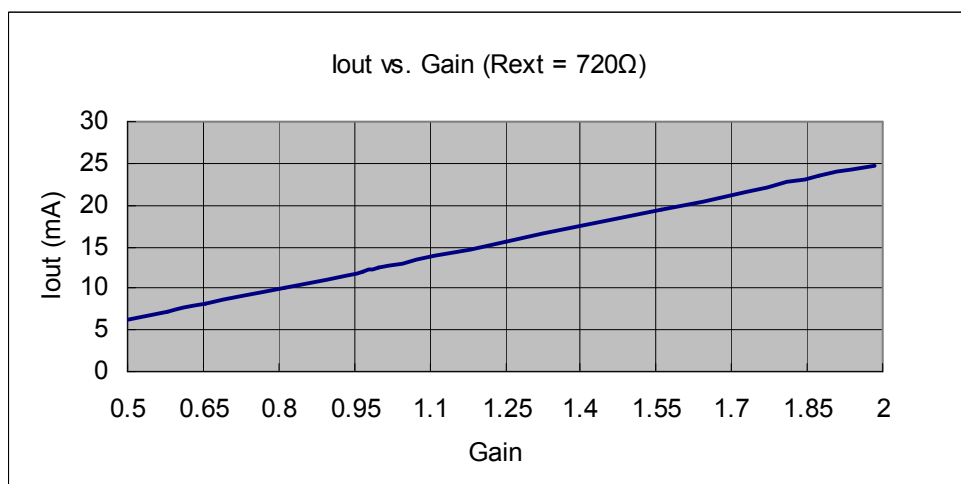
when the Current Adjust Code is (1,0,0,0,0,0,0)
Gain, G = (1+1) x (1+ 0/64)/2 = 1

when the Current Adjust Code is (0,0,0,0,0,0,0)
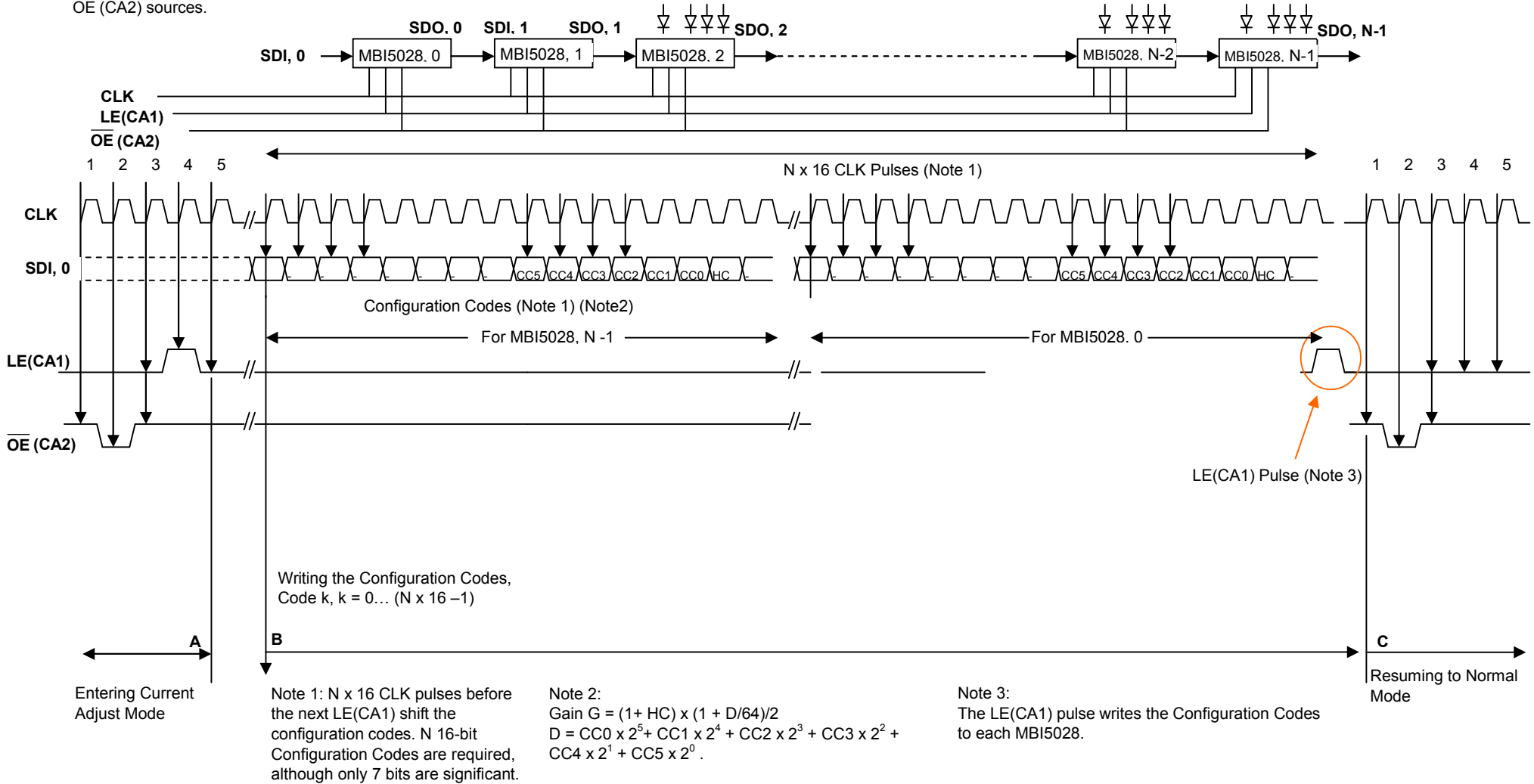Gain, G = (1+0) x (1+ 0/64)/2 = 0.5

After power on, the default value of Current Adjust Code is (1,1,1,1,1,1,1). Thus, G is 1.984.

Typically, the output current resulted by the digital current gain, G, is shown as the figure below.



Iout vs. Gain (Rext = 720Ω)

## Timing Chart for Current Adjust Mode (An Example)

N x MBI5028 are connected in cascade, ie, SDO, k --> SDI, k+1.
And, all MBI5028 ICs are connected to the same CLK, LE(CA1) and
$\overline{OE}$ (CA2) sources.



LE(CA1) Pulse (Note 3)

Writing the Configuration Codes,
Code k, k = 0… (N x 16 –1)

A

B

C

Resuming to Normal
Mode

Entering Current
Adjust Mode

Note 1: N x 16 CLK pulses before
the next LE(CA1) shift the
configuration codes. N 16-bit
Configuration Codes are required,
although only 7 bits are significant.

Note 2:
Gain $G = (1+ HC) \times (1 + D/64)/2$
$D = CC0 \times 2^5 + CC1 \times 2^4 + CC2 \times 2^3 + CC3 \times 2^2 + CC4 \times 2^1 + CC5 \times 2^0$.

Note 3:
The LE(CA1) pulse writes the Configuration Codes
to each MBI5028.

## Package Power Dissipation (P$_D$)

The maximum allowable package power dissipation is determined as P$_D$(max) = (Tj – Ta) / R$_{th(j-a)}$. When 16 output channels are turned on simultaneously, the actual package power dissipation is P$_D$(act) = (I$_{DD}$ x V$_{DD}$) + (I$_{OUT}$ x Duty x V$_{DS}$ x 16). Therefore, to keep P$_D$(act) ≤ P$_D$(max), the allowable maximum output current as a function of duty cycle is:

I$_{OUT}$ = { [ (Tj – Ta) / R$_{th(j-a)}$ ] – (I$_{DD}$ x V$_{DD}$) } / V$_{DS}$ / Duty / 16,

where Tj = 150°C.
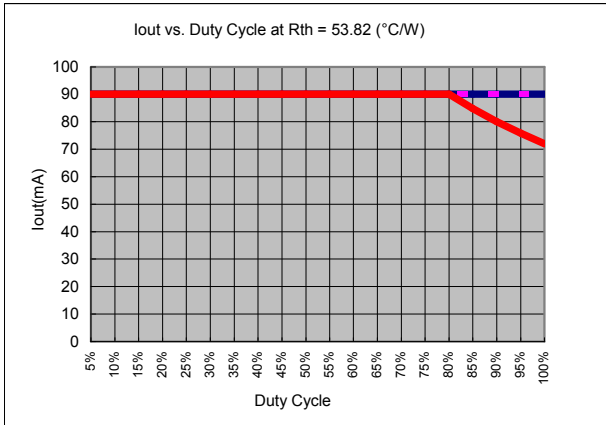


CN type package
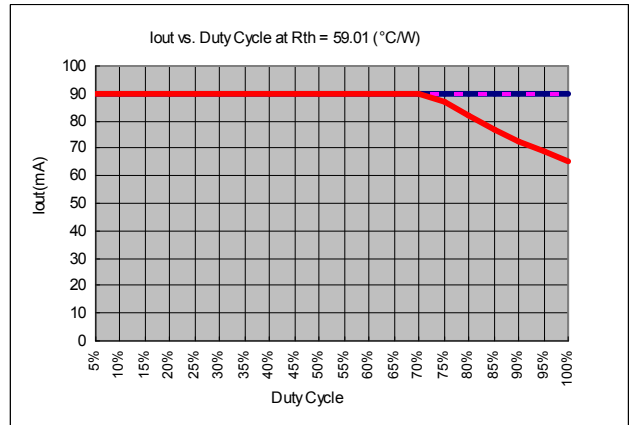


CF type package
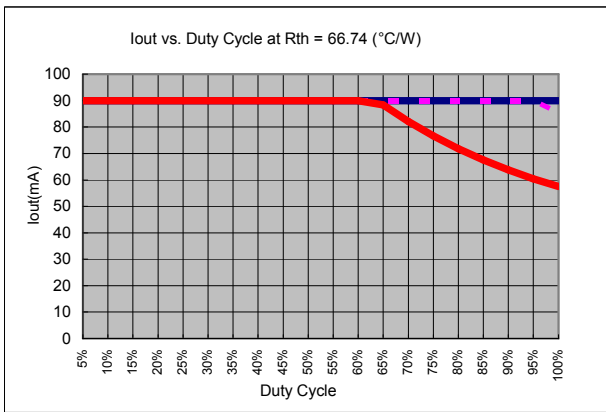


CNS type package
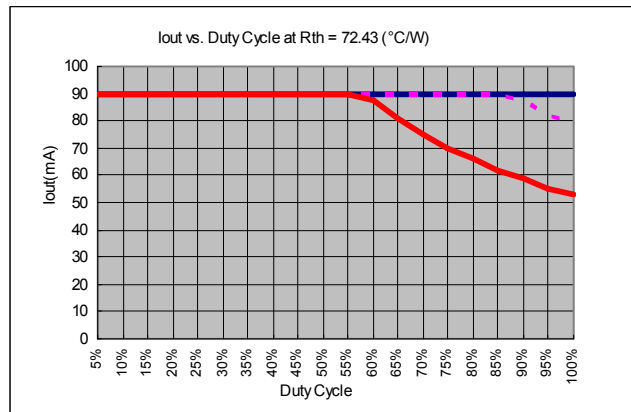


CP\CPA type package
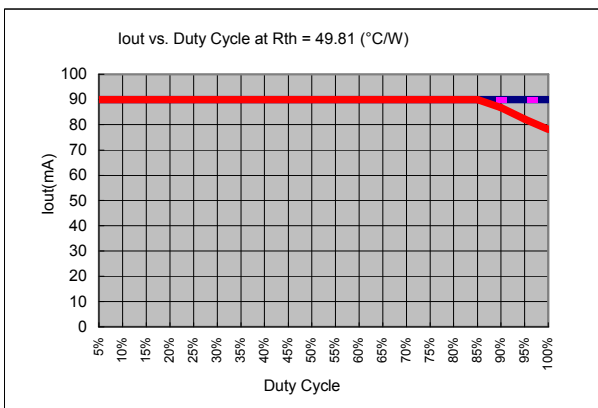


CD type package

| **Condition**：I$_{out}$ = 90mA，V$_{DS}$ = 1.0V，16 output channels active | | |
|---|---|---|
| Device Type | R$_{th(j-a)}$(°C/W) | Note |
| CN | 53.82 | |
| CNS | 66.74 | ———— Ta = 25℃ |
| CD | 49.81 | ·········· Ta = 55℃ |
| CF | 59.01 | ———— Ta = 85℃ |
| CP\CPA | 72.43 | |

The maximum power dissipation, $P_D(max) = (Tj - Ta) / R_{th(j-a)}$, decreases as the ambient temperature increases.

## Max. Power Dissipation at Various Ambient Temperature

CN Type: Rth= 53.82
CNS Type: Rth= 66.74
CD Type: Rth= 49.81
CF Type: Rth= 59.01
CP Type: Rth= 72.43
CPA Type: Rth= 72.43

Power Dissipation (y-axis)
Ambient Temperature (x-axis)
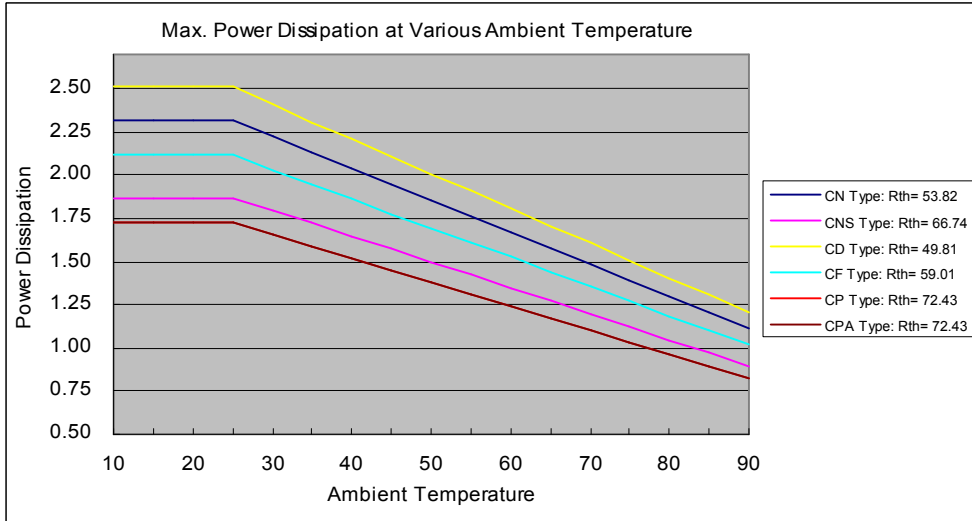
## Load Supply Voltage ($V_{LED}$)

MBI5028 are designed to operate with $V_{DS}$ ranging from 0.4V to 1.0V considering the package power dissipating limits. $V_{DS}$ may be higher enough to make $P_{D(act)} > P_{D(max)}$ when $V_{LED}$ = 5V and $V_{DS} = V_{LED} - Vf$, in which $V_{LED}$ is the load supply voltage. In this case, it is recommended to use the lowest possible supply voltage or to set an external voltage reducer ($V_{DROP}$).

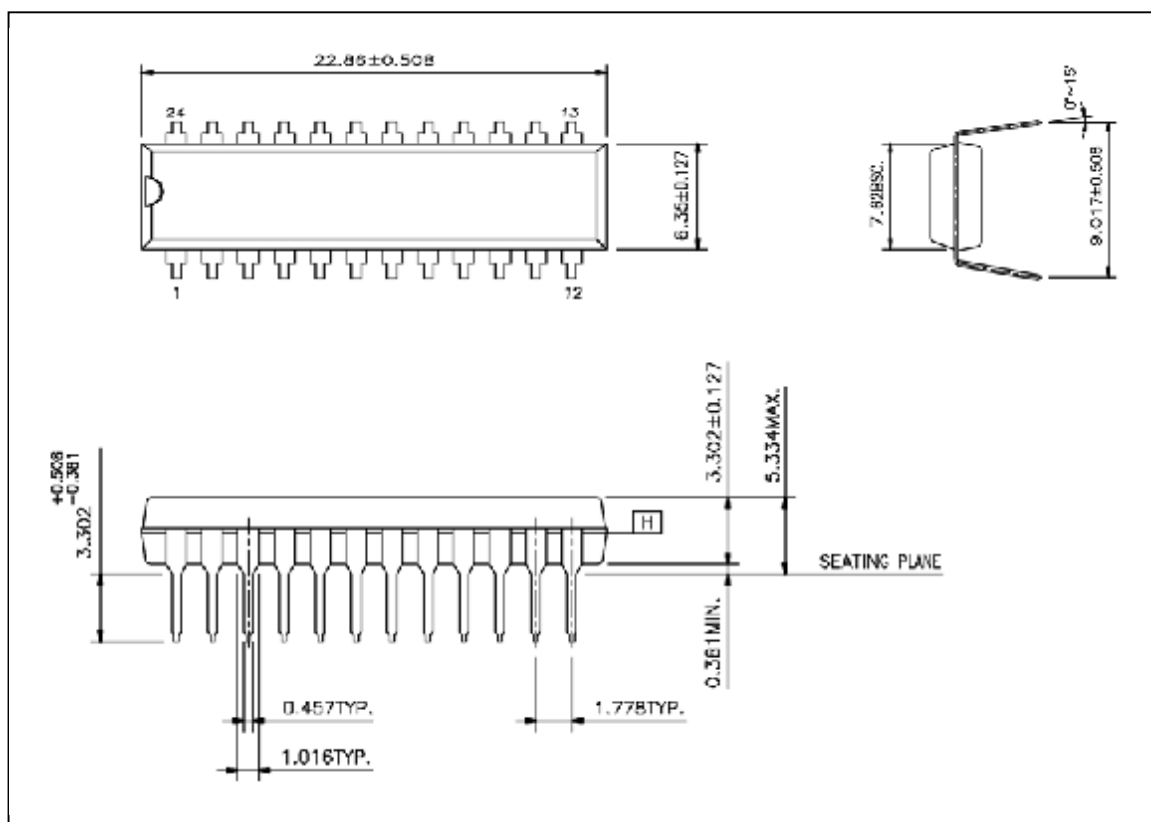A voltage reducer lets $V_{DS} = (V_{LED} - Vf) - V_{DROP}$.

Resisters, or Zener diode can be used in the applications as the following figures.
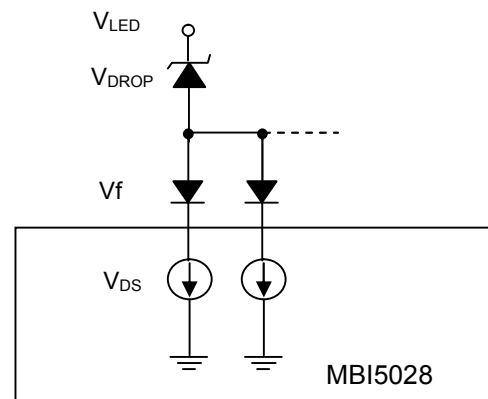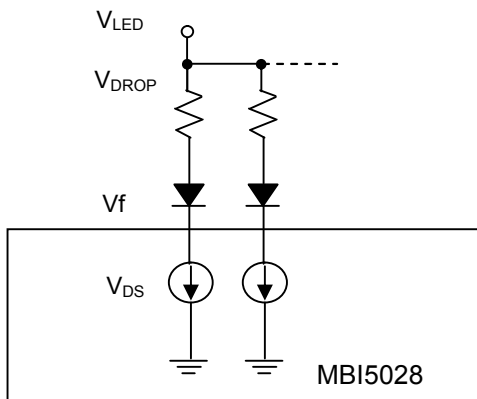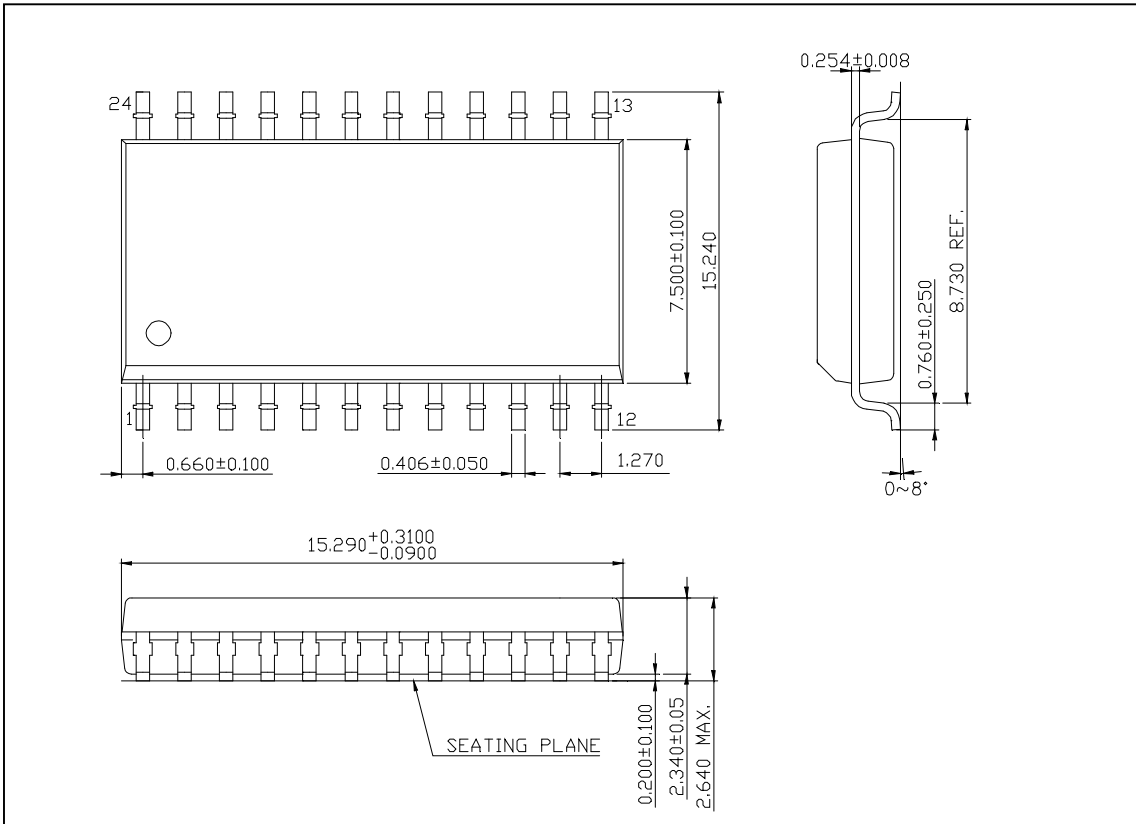
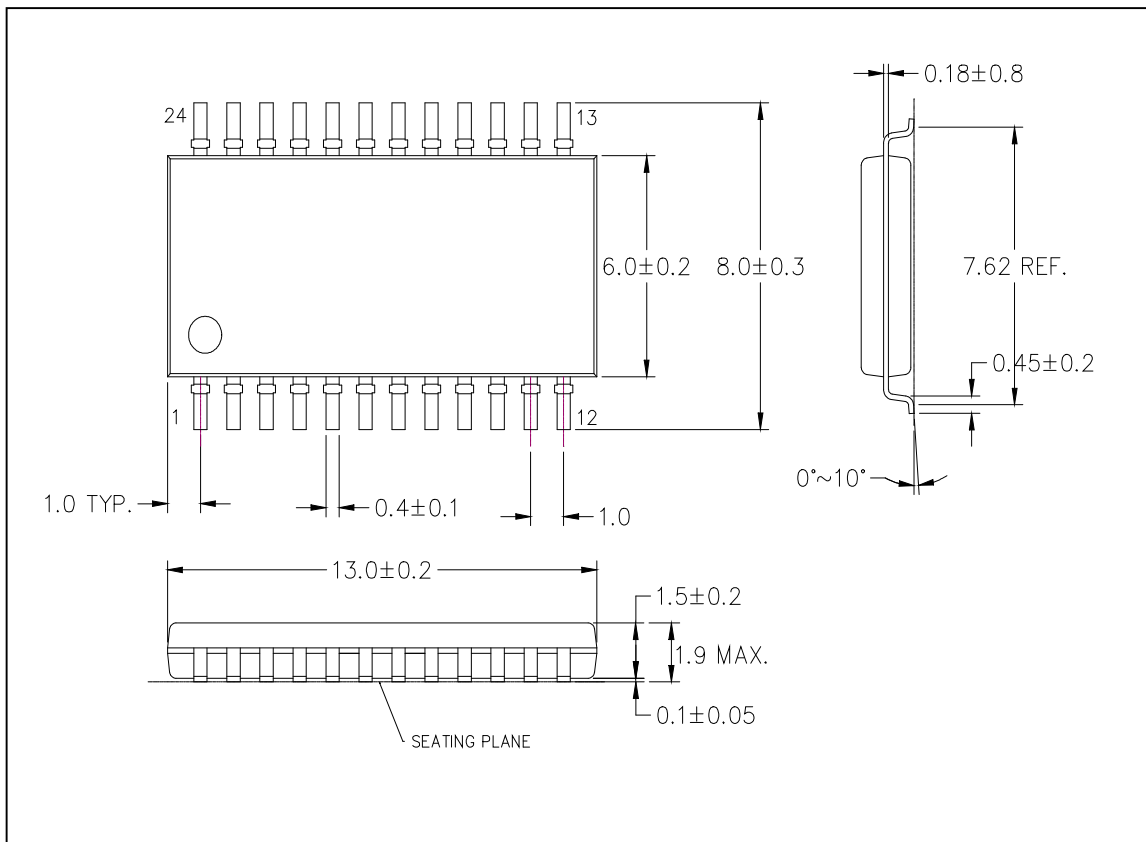## Package Outline
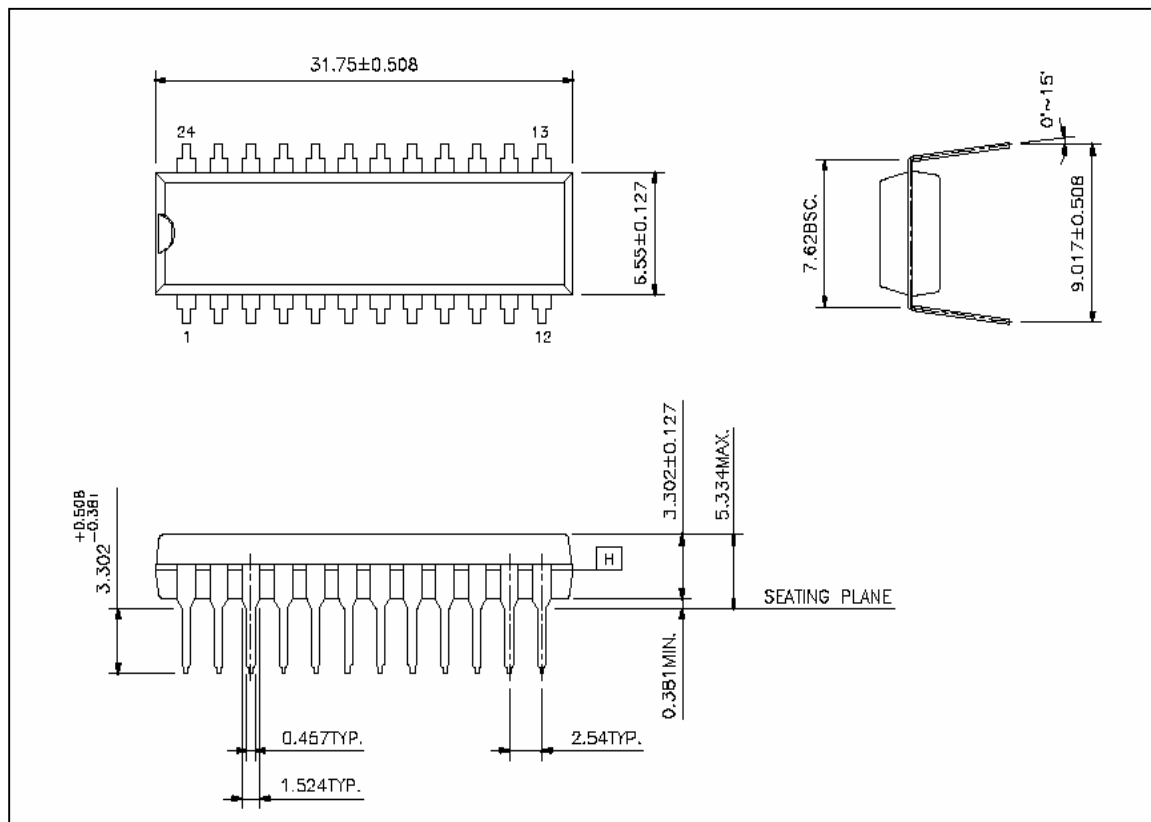


MBI5028CN Outline Drawing



MBI5028CNS Outline Drawing

MBI5028CD Outline Drawing



MBI5028CF Outline Drawing
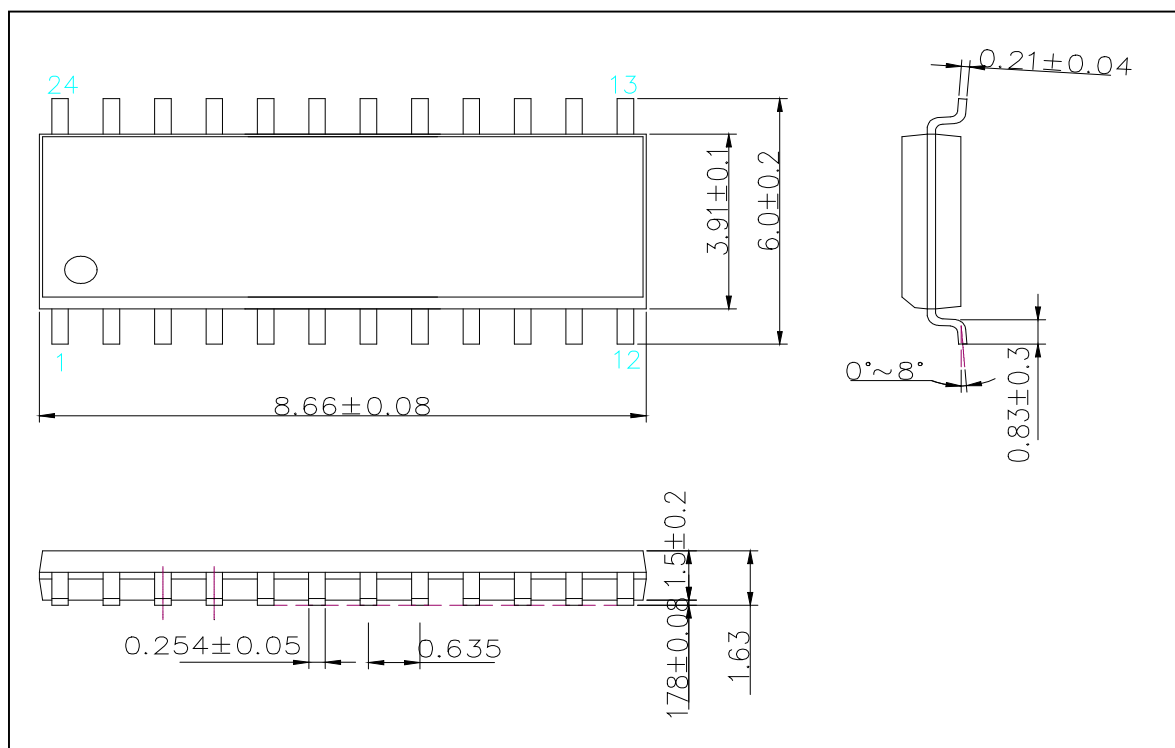
MBI5028CP\CPA Outline Drawing

## MBI5028 Package Information

| Device Type | Package Type | Weight(g) |
|---|---|---|
| CN | P-DIP24-300-2.54 | 1.628 |
| CNS | SP-DIP24-300-1.78 | 1.11 |
| CD | SOP24-300-1.27 | 0.617 |
| CF | SOP24-300-1.00 | 0.28 |
| CP\CPA | SSOP24-150-0.64 | 0.11 |

Note: The unit for the outline drawing is mm.

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