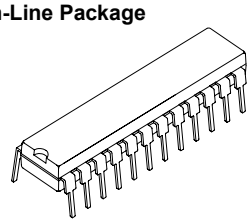
16-bit Constant Current LED Sink Driver

Features

- 16 constant-current output channels
- Constant output current invariant to load voltage change
- Excellent output current accuracy:
  between channels: <±3% (max.), and
  between ICs: <±6% (max.)
- Output current adjusted through an external resistor
- Constant output current range: 5-90 mA
- Fast response of output current, $\overline{OE}$ (min.): 200 ns
- 25MHz clock frequency
- Schmitt trigger input
- 5V supply voltage
- Optional for RoHS-Compliant Packages

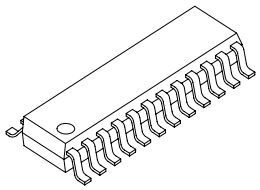
Dual In-Line Package



GN: P-DIP24-300-2.54

GNS: SP-DIP24-300-1.78

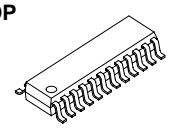
Small Outline Package



GD: SOP24-300-1.27

GF: SOP24-236-1.00

Shrink SOP



GP: SSOP24-150-0.64

GPA: SSOP24-150-0.64

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

Product Description

MBI5026 is designed for LED displays. As an enhancement of its predecessor, MBI5016, MBI5026 exploits PrecisionDrive™ technology to enhance its output characteristics. MBI5026 contains a serial buffer and data latches which convert serial input data into parallel output format. At MBI5026 output stage, sixteen regulated current ports are designed to provide uniform and constant current sinks for driving LEDs within a large range of V_F variations.

MBI5026 provides users with great flexibility and device performance while using MBI5026 in their system design for LED display applications, e.g. LED panels. 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. MBI5026 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.

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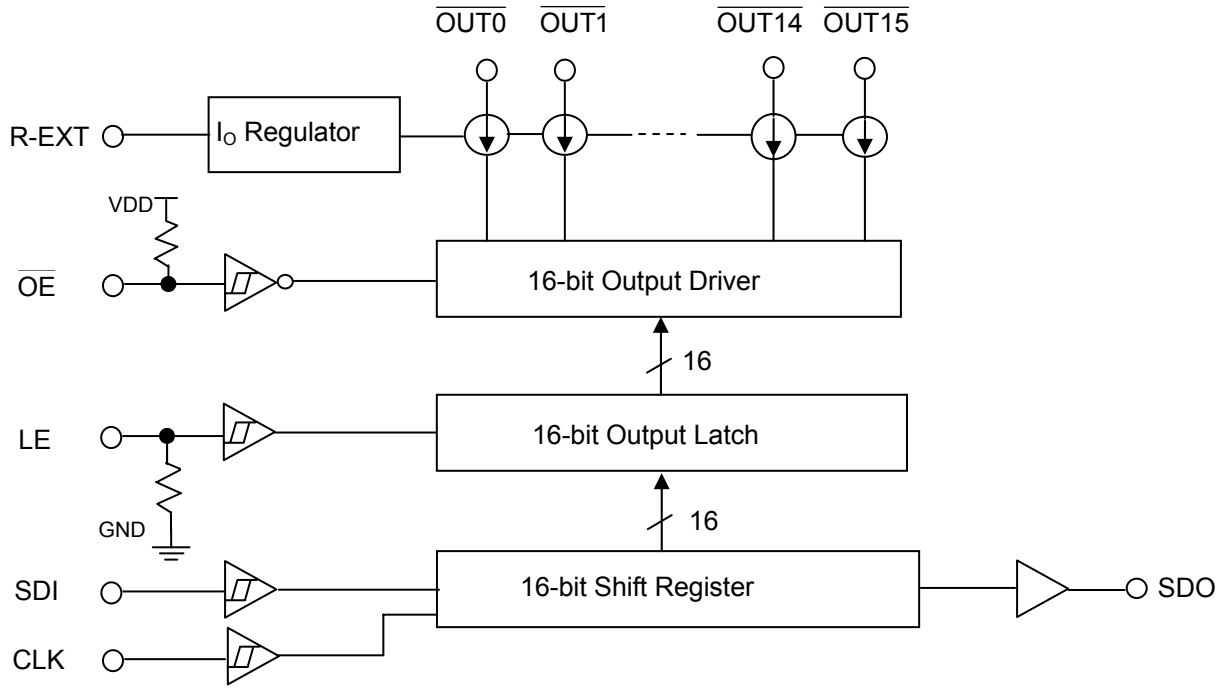
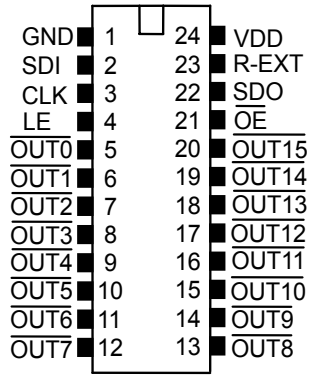
Block Diagram



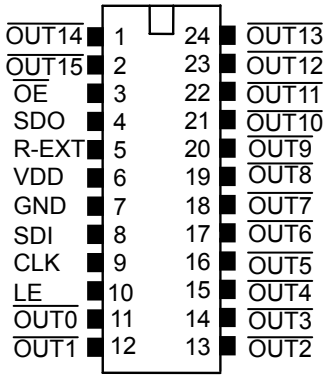
Terminal Description

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	Data strobe input terminal Serial data is transferred to the output latch when LE is high. The data is latched when LE goes low.
$\overline{OUT0}$ ~ $\overline{OUT15}$	Constant current output terminals
$\overline{OE}$	Output enable terminal When $\overline{OE}$ (active) low, the output drivers are enabled; when $\overline{OE}$ high, all output drivers are turned OFF (blanked).
SDO	Serial-data output to the following SDI of next driver IC
R-EXT	Input terminal used to connect an external resistor for setting up output current for all output channels
VDD	5V supply voltage terminal

Pin Configuration



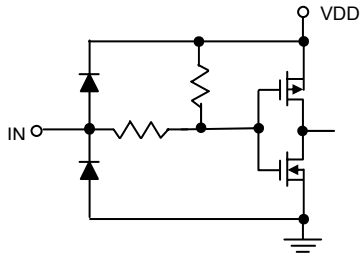
MBI5026GN\GNS\GD\GF\GP



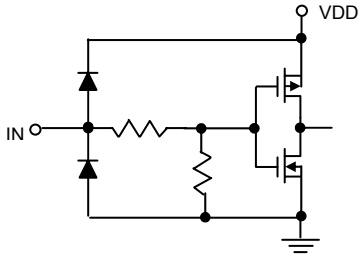
MBI5026GPA

Equivalent Circuits of Inputs and Outputs

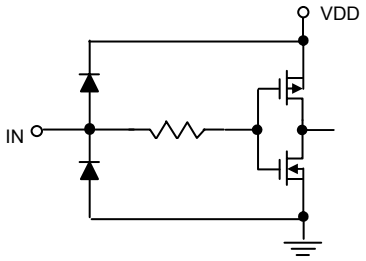
$\overline{OE}$ terminal



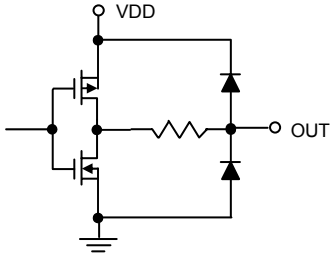
LE terminal



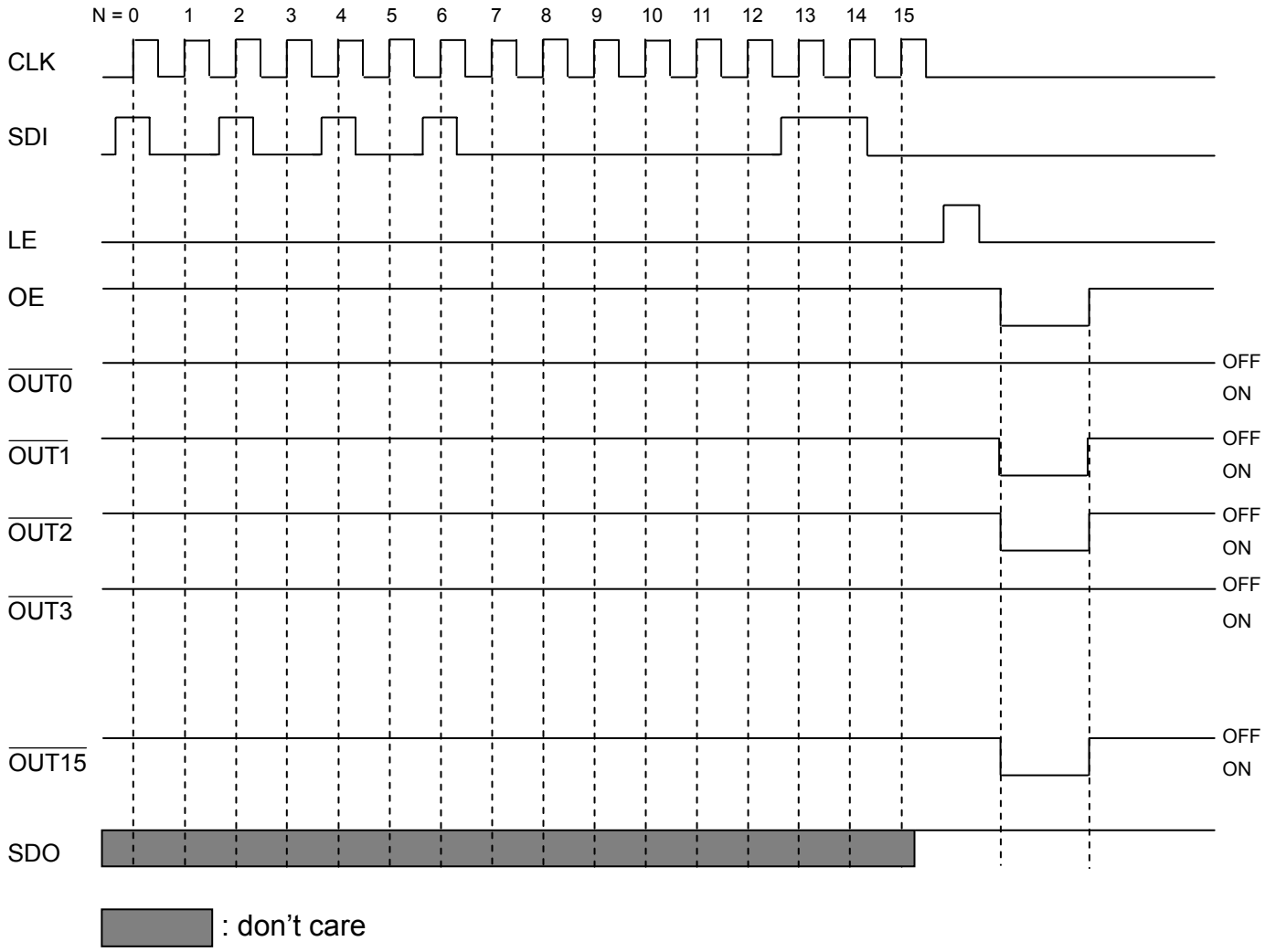
CLK, SDI terminal



SDO terminal



Timing Diagram



Truth Table

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}

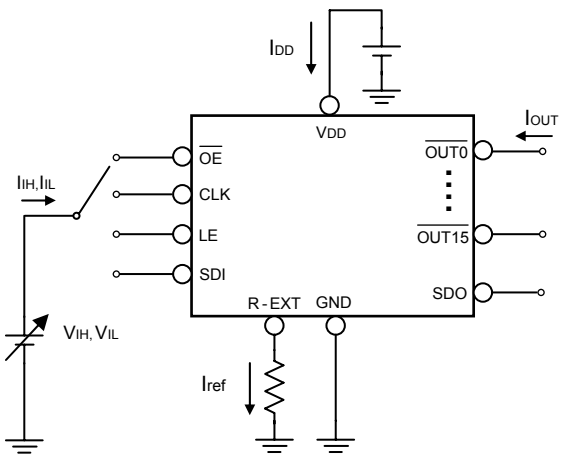
Maximum Ratings

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)	GN	P_D	2.00	W
	GNS		1.61	
	GD		2.19	
	GF		1.91	
	GP		1.46	
	GPA		1.46	
Thermal Resistance (On PCB, Ta=25°C)	GN	$R_{th(j-a)}$	49.9	°C/W
	GNS		62.28	
	GD		45.69	
	GF		52.38	
	GP		68.48	
	GPA		68.48	
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}	-		4.5	5.0	5.5	V
Output Voltage		V_{DS}	$\overline{OUT0}$ ~ $\overline{OUT15}$		-	-	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		0.8*V_{DD}	-	V_{DD}	V
	"L" level	V_{IL}	Ta = -40~85ºC		GND	-	0.3*V_{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	-	26.25	-	mA
Current Skew		dI_{OUT1}	I_{OL}=26.25mA V_{DS}=0.6V	R_{ext}=720 Ω	-	±1	±3	%
Output Current 2		I_{OUT2}	V_{DS}=0.8V	R_{ext}=360 Ω	-	52.5	-	mA
Current Skew		dI_{OUT2}	I_{OL}=52.5mA 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 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		-	6	6.8	mA
		I_{DD}(off) 2	R_{ext}=720 Ω, $\overline{OUT0}$ ~ $\overline{OUT15}$ =Off		-	8.8	9.6	
		I_{DD}(off) 3	R_{ext}=360 Ω, $\overline{OUT0}$ ~ $\overline{OUT15}$ =Off		-	12.4	13.2	
	"ON"	I_{DD}(on) 1	R_{ext}=720 Ω, $\overline{OUT0}$ ~ $\overline{OUT15}$ =On		-	8.8	10.8	
		I_{DD}(on) 2	R_{ext}=360 Ω, $\overline{OUT0}$ ~ $\overline{OUT15}$ =On		-	12.3	15.3	

Test Circuit for Electrical Characteristics

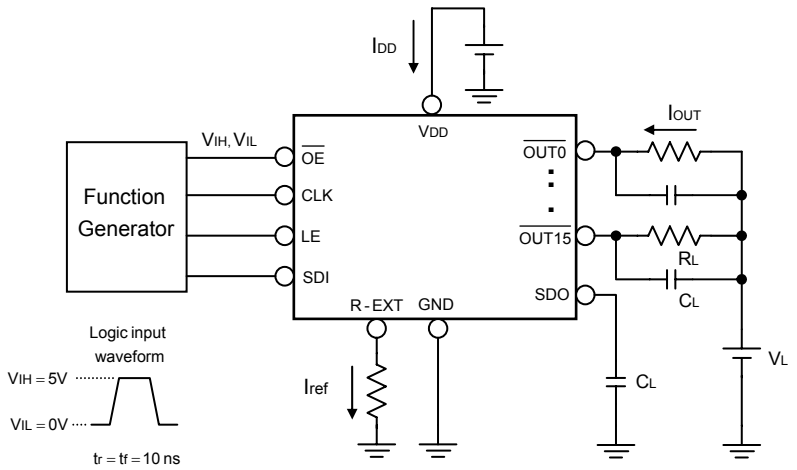


Switching Characteristics

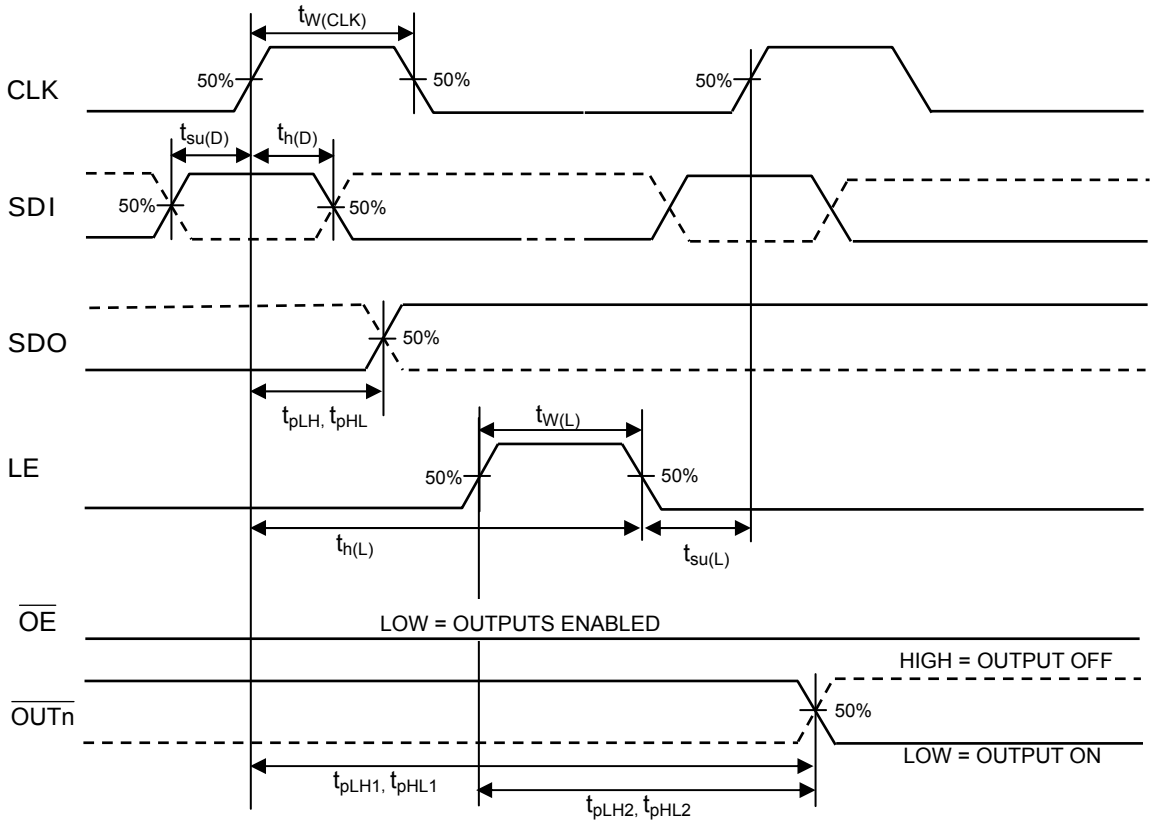
Characteristic		Symbol	Condition	Min.	Typ.	Max.	Unit
Propagation Delay Time ("L" to "H")	CLK - $\overline{OUTn}$	t_{pLH1}	V_{DD}=5.0 V V_{DS}=0.8 V V_{IH}=V_{DD} V_{IL}=GND R_{ext}=300 Ω V_L=4.0 V R_L=52 Ω C_L=10 pF	-	100	150	ns
	LE - $\overline{OUTn}$	t_{pLH2}		-	100	150	ns
	$\overline{OE}$ - $\overline{OUTn}$	t_{pLH3}		-	50	150	ns
	CLK - SDO	t_{pLH}		15	20	-	ns
Propagation Delay Time ("H" to "L")	CLK - $\overline{OUTn}$	t_{pHL1}		-	50	100	ns
	LE - $\overline{OUTn}$	t_{pHL2}		-	50	100	ns
	$\overline{OE}$ - $\overline{OUTn}$	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
	$\overline{OE}$	$t_{w(OE)}$		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		$t_{su(D)}$		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}		-	70	200	ns
Output Fall Time of Vout (turn on)		t_{of}		-	40	120	ns
Clock Frequency		F_{CLK}	Cascade Operation	-	-	25.0	MHz

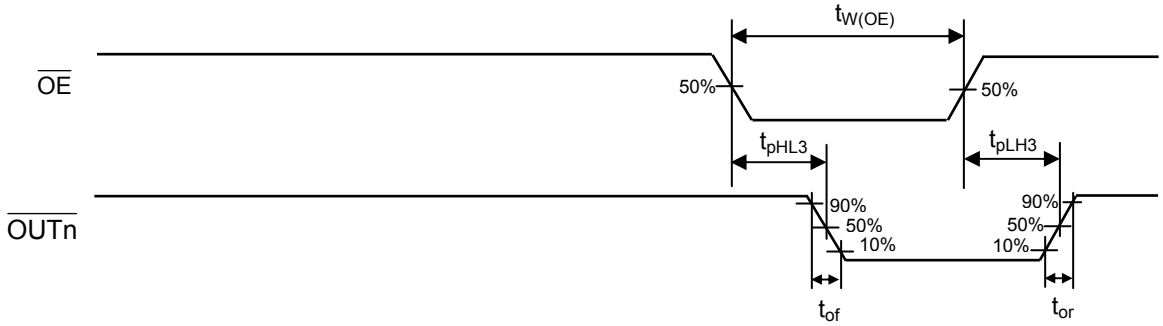
**If the devices are connected in cascade and t_r or t_f is large, it may be critical to achieve the timing required for data transfer between two cascaded devices.

Test Circuit for Switching Characteristics



Timing Waveform





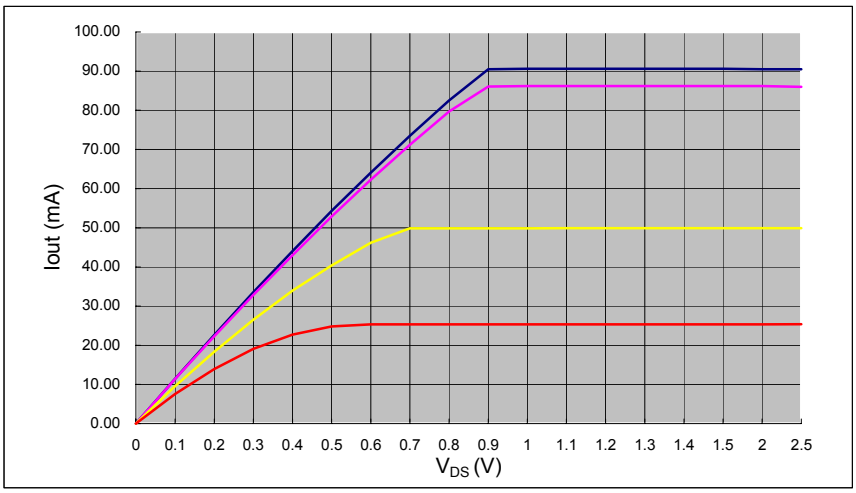
Application Information

Constant Current

In LED display application, MBI5026 provides nearly no variations in current from channel to channel and from IC to IC. This can be achieved by:

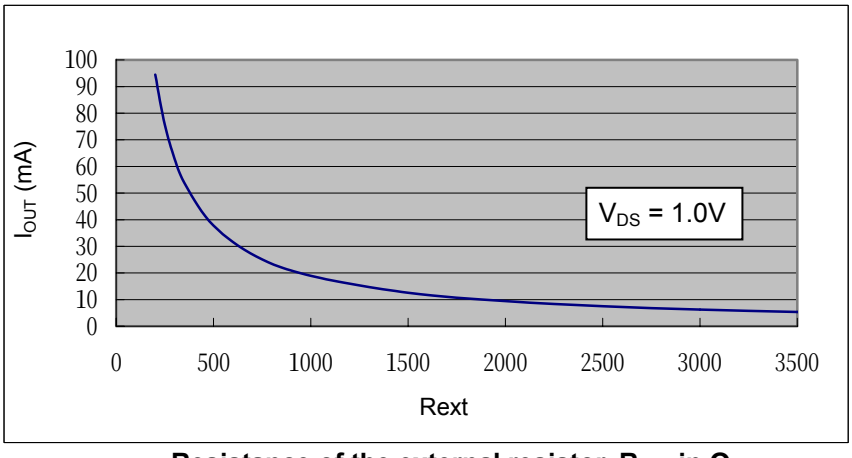
1) The maximum current variation between channels is less than ±3%, and that between ICs is less than ±6%.

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 (V_F). 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}. The relationship between I_{out} and R_{ext} is shown in the following figure.



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

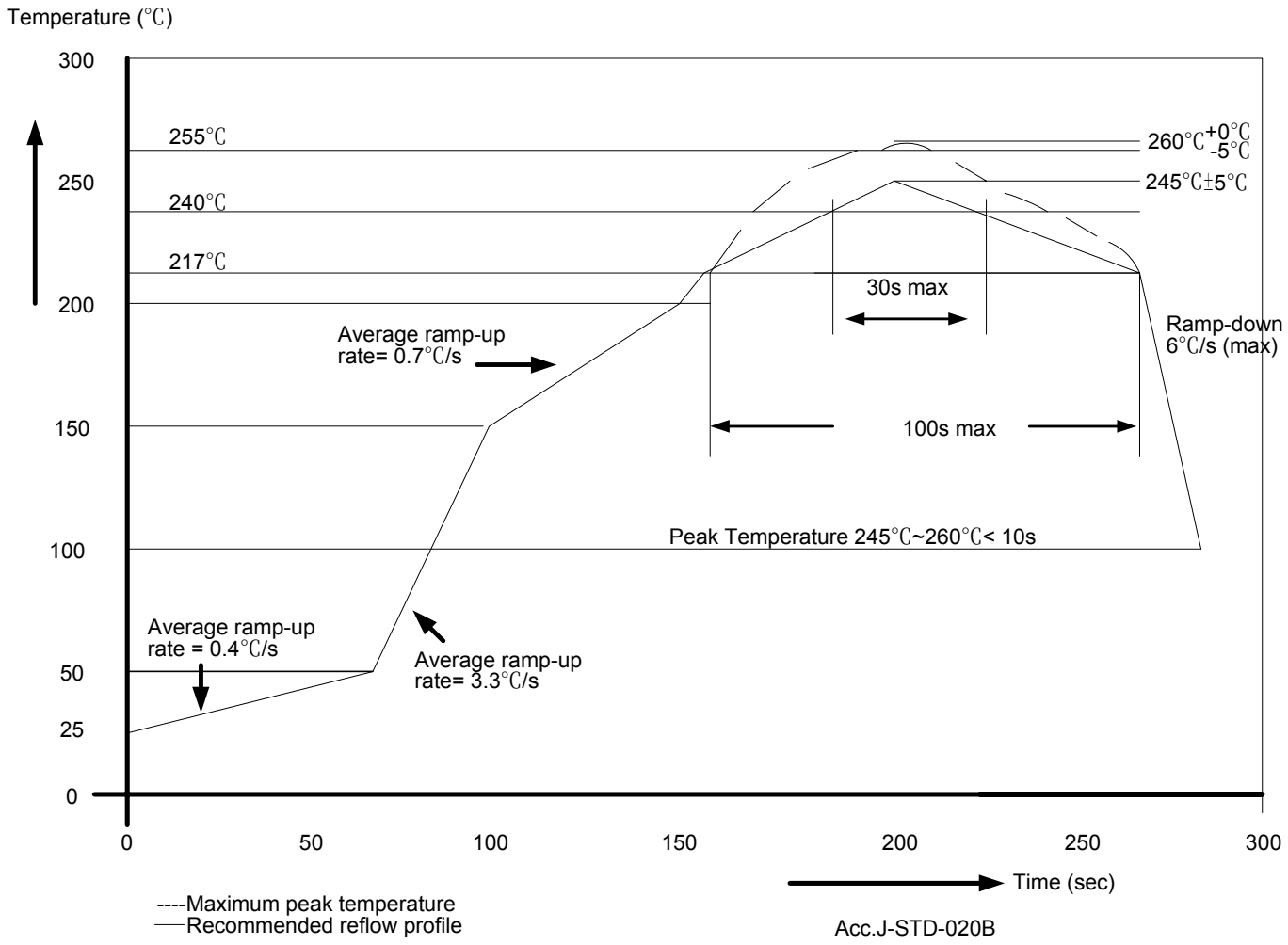
Also, the output current can be calculated from the equation:

$V_{R\text{-}EXT}$ = 1.26V ; I_{OUT} = ($V_{R\text{-}EXT}$ / R_{ext}) x 15

where R_{ext} is the resistance of the external resistor connected to R-EXT terminal and $V_{R\text{-}EXT}$ 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.

Soldering Process of “Pb-free & Green” Package Plating*

Macroblock has defined "Pb-Free & Green" to mean semiconductor products that are compatible with the current RoHS requirements and selected **100% pure tin** (Sn) to provide forward and backward compatibility with both the current industry-standard SnPb-based soldering processes and higher-temperature Pb-free processes. Pure tin is widely accepted by customers and suppliers of electronic devices in Europe, Asia and the US as the lead-free surface finish of choice to replace tin-lead. Also, it is backward compatible to standard 215ºC to 240ºC reflow processes which adopt tin/lead (SnPb) solder paste. However, in the whole Pb-free soldering processes and materials, 100% pure tin (Sn), will all require up to 260°C for proper soldering on boards, referring to J-STD-020B as shown below.



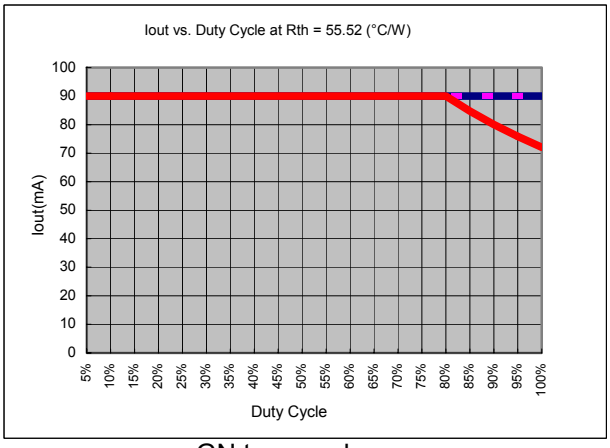
*Note1: For details, please refer to Macroblock’s “Policy on Pb-free & Green Package”.

Package Power Dissipation (P_D)

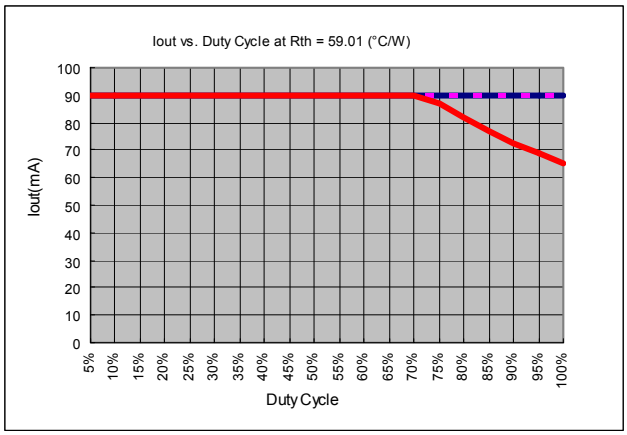
The maximum allowable package power dissipation is determined as $P_D(max) = (Tj – Ta) / R_{th(j-a)}$. When 16 output channels are turned on simultaneously, the actual package power dissipation is $P_D(act) = (I_{DD} \times V_{DD}) + (I_{OUT} \times Duty \times V_{DS} \times 16)$. Therefore, to keep $P_D(act) \leq P_D(max)$, the allowable maximum output current as a function of duty cycle is:

$I_{OUT} = \{ [(Tj – Ta) / R_{th(j-a)}] – (I_{DD} \times V_{DD}) \} / V_{DS} / Duty / 16,$

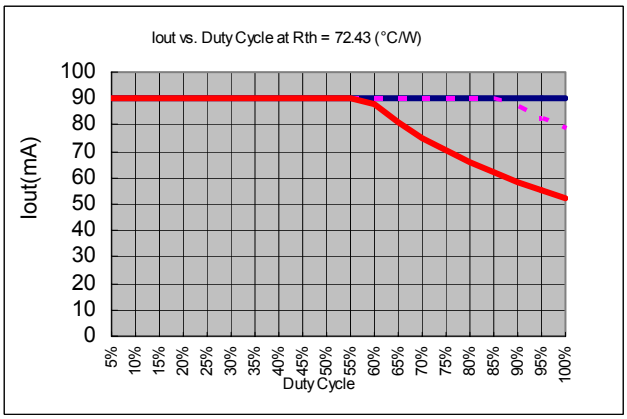
where Tj = 150°C.



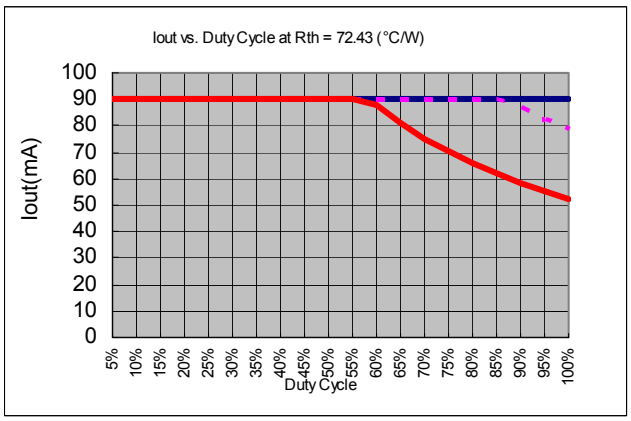
GN type package



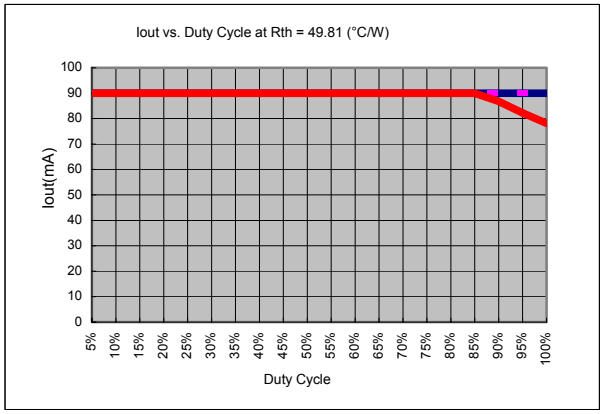
GF type package



GNS type package



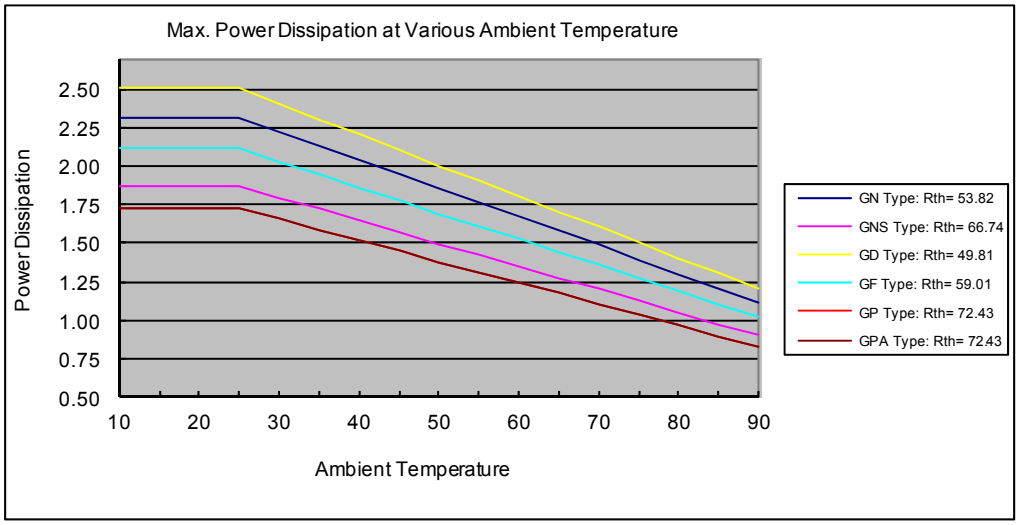
GP\GPA type package



GD type package

Condition : I_{out} = 90mA, V_{DS} = 1.0V, 16 output channels		
Device Type	$R_{th(j-a)}$(°C/W)	Note
GN	49.90	Ta = 25℃ Ta = 55℃ Ta = 85℃
GNS	62.28	
GD	45.69	
GF	52.38	
GP\GPA	68.48	

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

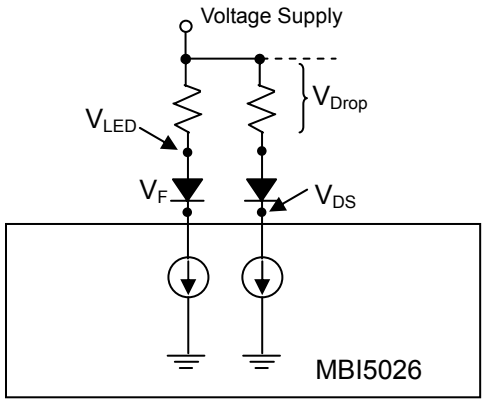


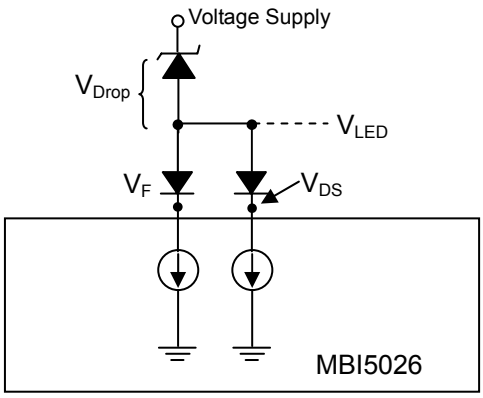
Load Supply Voltage (V_{LED})

MBI5026 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 $V_{DS} = V_{LED} – V_F$, 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 $V_{DS} = (V_{LED} – V_F) – V_{DROP}$.

Resistors or Zener diode can be used in the applications as shown in the following figures.

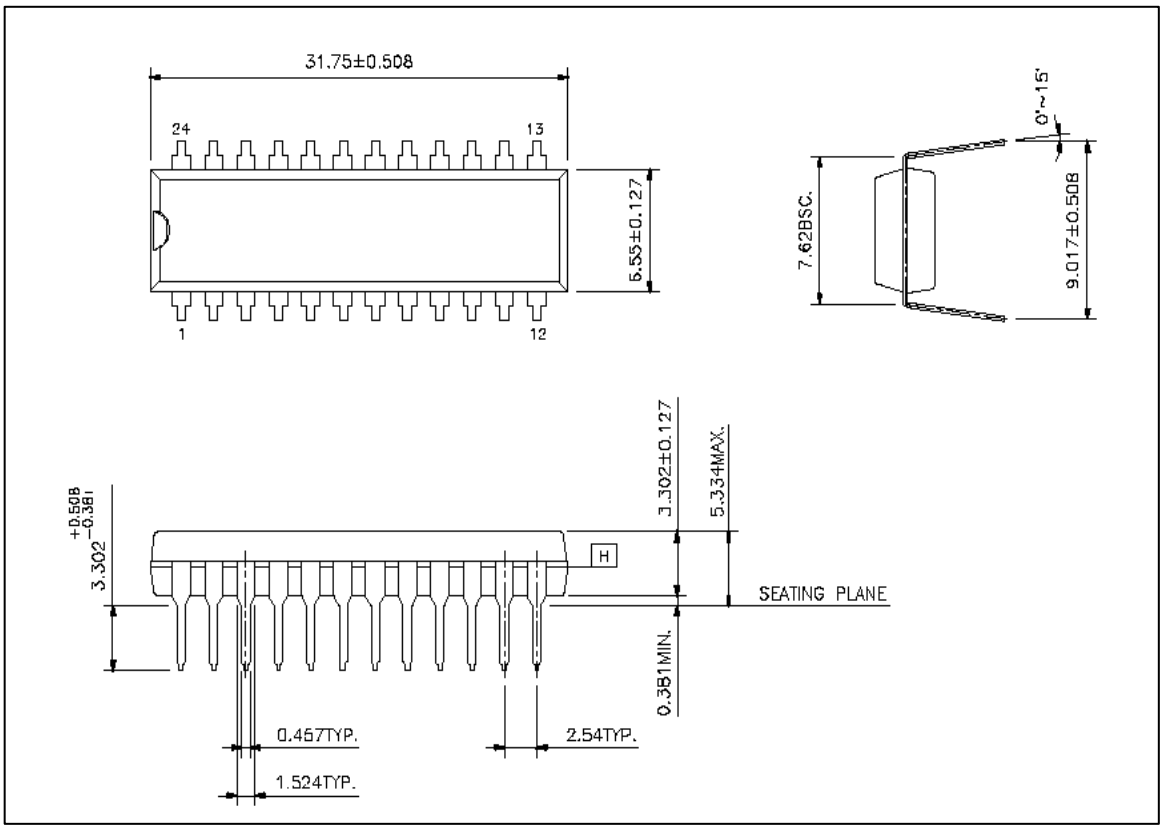




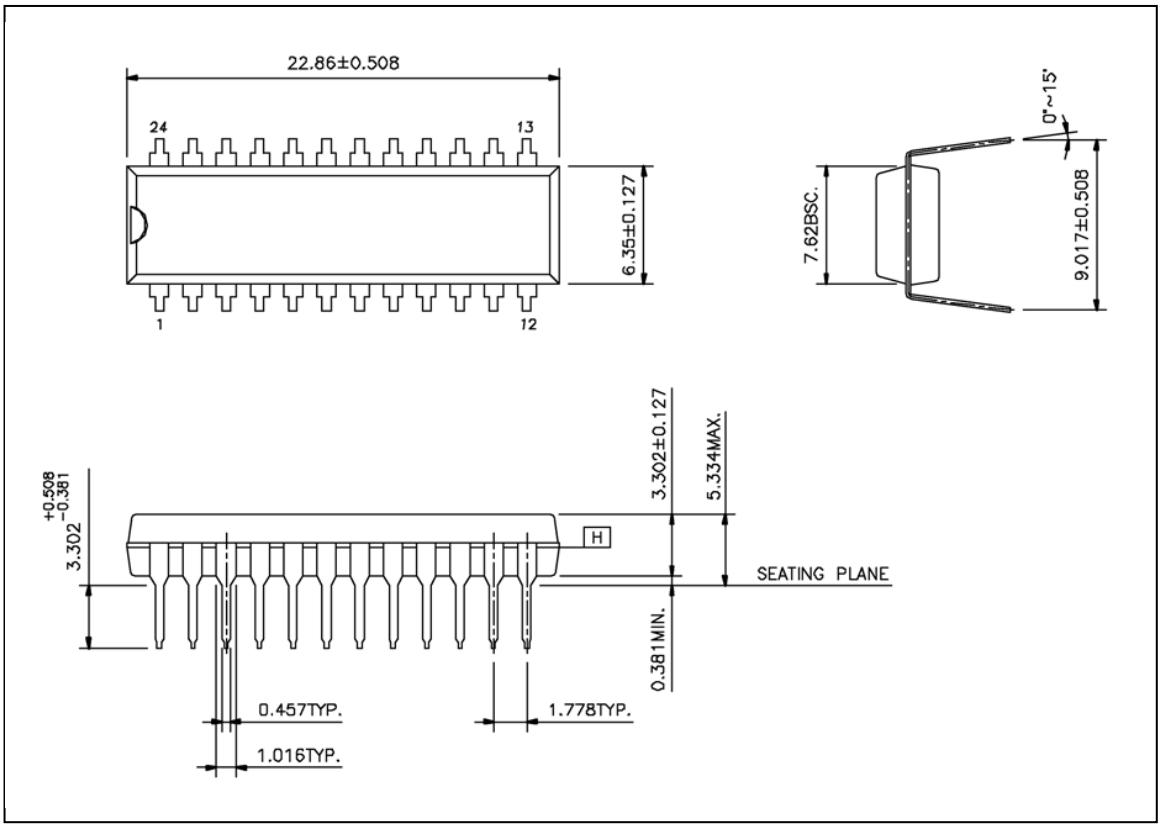
Switching Noise Reduction

LED driver ICs are frequently used in switch-mode applications which always behave with switching noise due to the parasitic inductance on PCB. To eliminate switching noise, refer to “Application Note for 8-bit and 16-bit LED Drivers- Overshoot”.

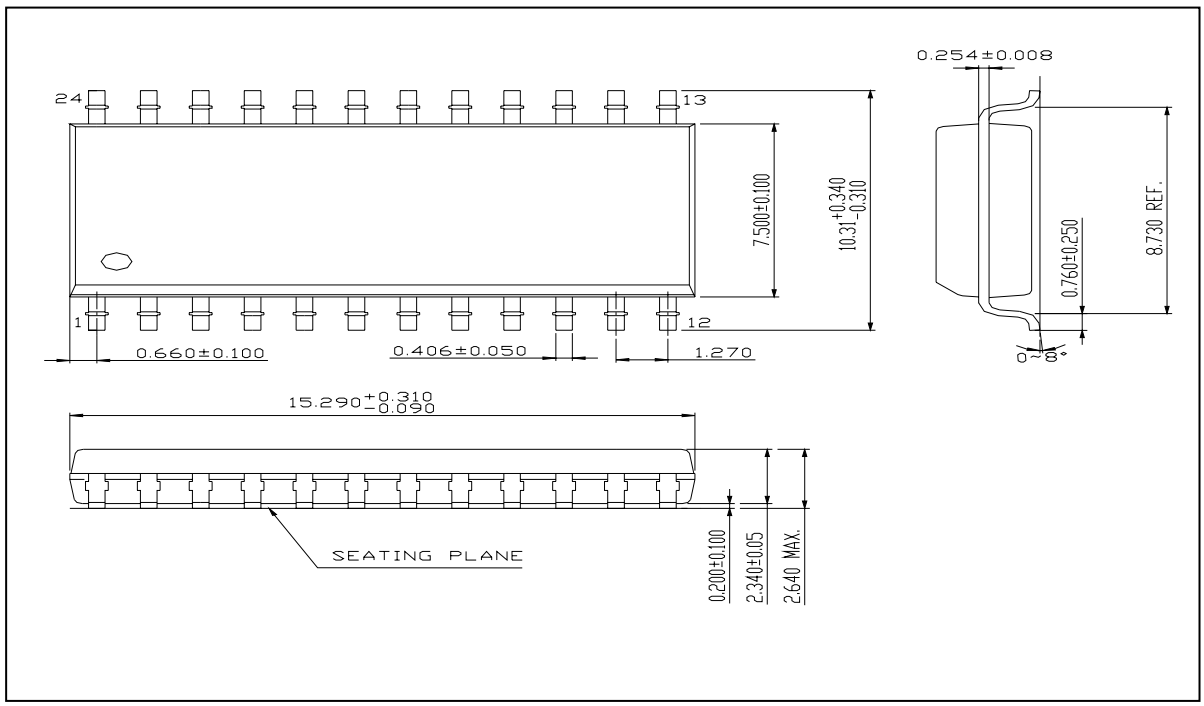
Package Outline



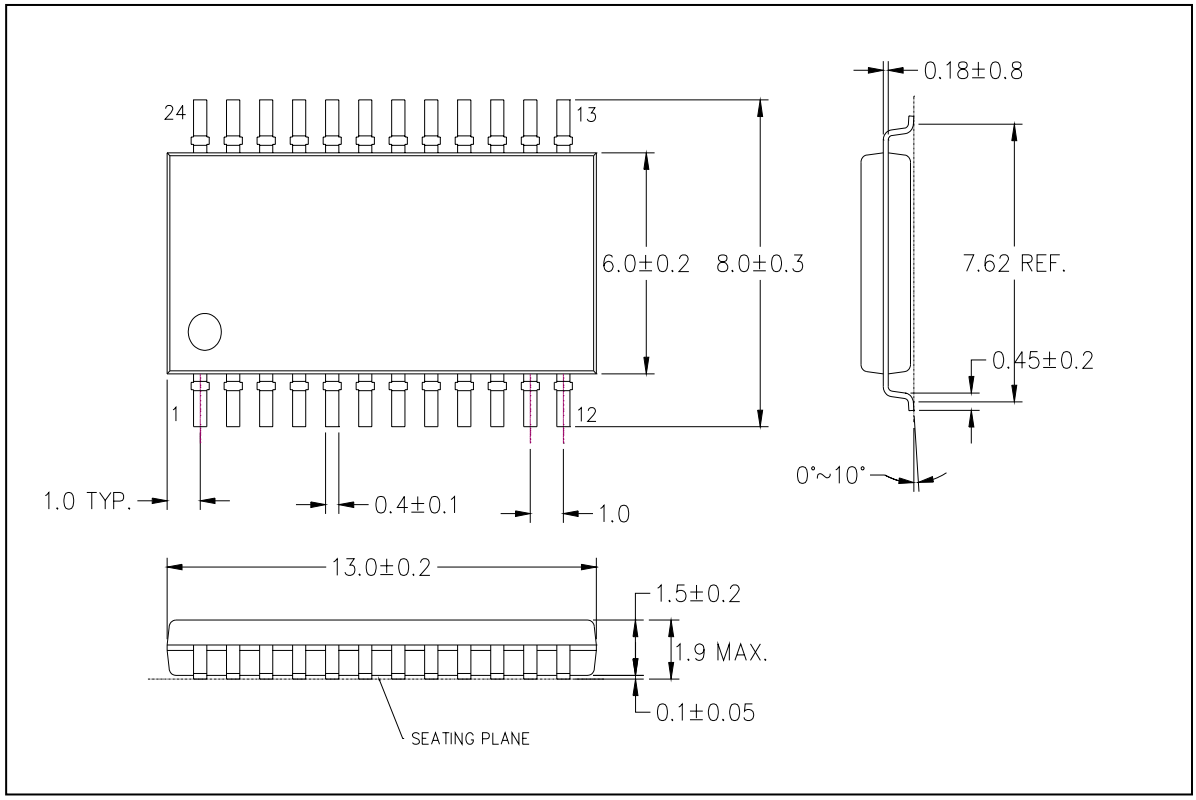
MBI5026GN Outline Drawing



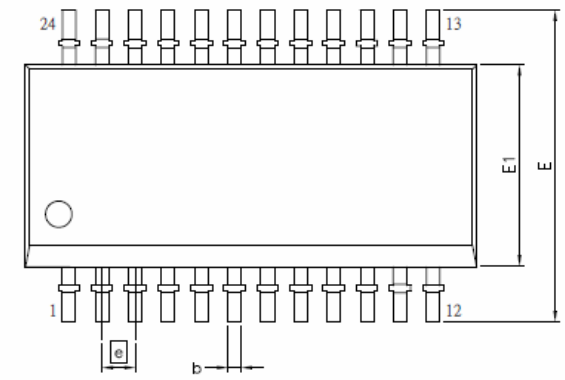
MBI5026GNS Outline Drawing

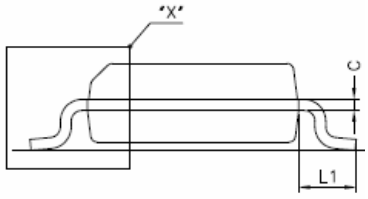


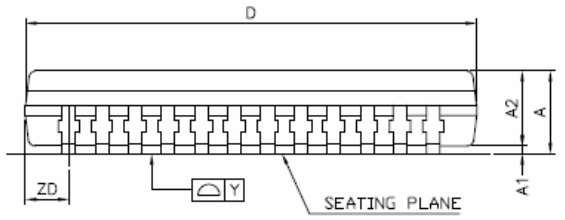
MBI5026GD Outline Drawing

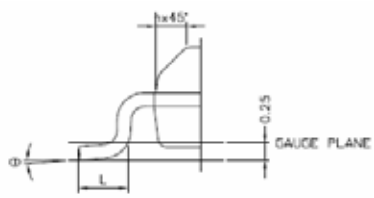


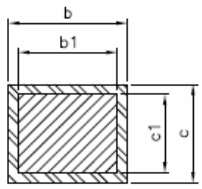
MBI5026GF Outline Drawing









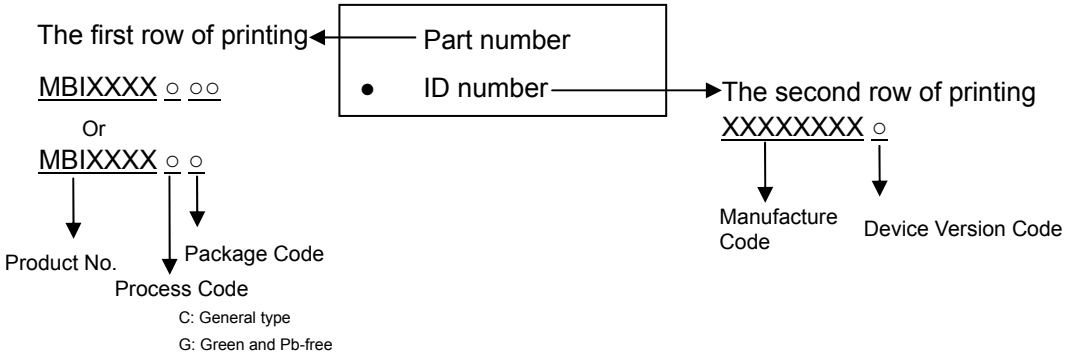


SYMBOL	DIMENSION (MM)			DIMENSION (MIL)		
	MIN.	NOM.	MAX.	MIN.	NOM.	MAX.
A	1.35	1.60	1.75	53	63	69
A1	0.10	0.15	0.25	4	6	10
A2			1.50			59
b	0.20		0.30	8		12
b1	0.20	0.254	0.28	8	10	11
c	0.18		0.25	7		10
c1	0.18	0.203	0.23	7	8	9
D	8.56	8.65	8.74	337	341	344
E	5.80	6.00	6.20	228	236	244
E1	3.80	3.90	4.00	150	154	157
e	0.635 BSC			25 BSC		
h	0.25	0.42	0.50	10	17	20
L	0.40	0.635	1.27	16	25	50
L1	1.00	1.05	1.10	39	41	43
ZD	0.838 REF			33 REF		
Y			0.10			4
θ	0°		8°	0°		8°

MBI5026GP\GPA Outline Drawing

Note: The unit for the outline drawing is mm.

Product Top-mark Information



Product Revision History

Datasheet version	Device version code
VA.00	*Not defined*
VA.01	A
VA.02	A
VA.03	A

Product Ordering Information

Part Number	**"Pb-free & Green" Package Type**	**Weight (g)**
MBI5026GN	P-DIP24-300-2.54	1.628
MBI5026GNS	SP-DIP24-300-1.78	1.11
MBI5026GD	SOP24-300-1.27	0.617
MBI5026GF	SOP24-300-1.00	0.28
MBI5026GP	SSOP24-150-0.64	0.11
MBI5026GPA	SSOP24-150-0.64	0.11

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