TOSHIBA Bi-CMOS Integrated Circuit   Silicon Monolithic

TB62726AN,TB62726AF

16-bit Constant-Current LED Driver with Operating Voltage of 3.3-V and 5-V

The TB62726A series are comprised of constant-current drivers designed for LEDs and LED displays. The output current value can be set using an external resistor.

As a result, all outputs will have virtually the same current levels.

This driver incorporates 16-bit constant-current outputs, a 16-bit shift register, a 16-bit latch and a 16-bit AND-gate circuit.

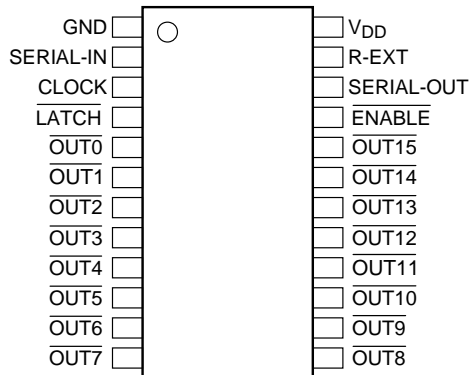These drivers have been designed using the Bi-CMOS process.

Features

- Output current capability and number of outputs:
  90 mA × 16 outputs
- Constant current range: 2 to 90 mA
- Application output voltage: 0.7 V (output current 2 to 80 mA)
  0.4 V (output current 2 to 40 mA)
- For anode-common LEDs
- Input signal voltage level: 3.3-V and 5-V CMOS level (Schmitt trigger input)
- Power supply voltage range V_{DD} = 3.0 to 5.5 V
- Maximum output terminal voltage: 17 V
- Serial and parallel data transfer rate: 20 MHz (max, cascade connection)
- Operating temperature range T_{opr} = −40 to 85°C
- Package: Type AN: SDIP24-P-300-1.78
  Type AF: SSOP24-P-300-1.00B
- Current accuracy (All output ON)

Output Voltage	Current Accuracy		Output Current
	Between Bits	Between ICs	
≧ 0.4 V	±4%	±15%	2 to 5 mA
≧ 0.7 V		±12%	5 to 80 mA

TB62726AN

SDIP24-P-300-1.78

TB62726AF
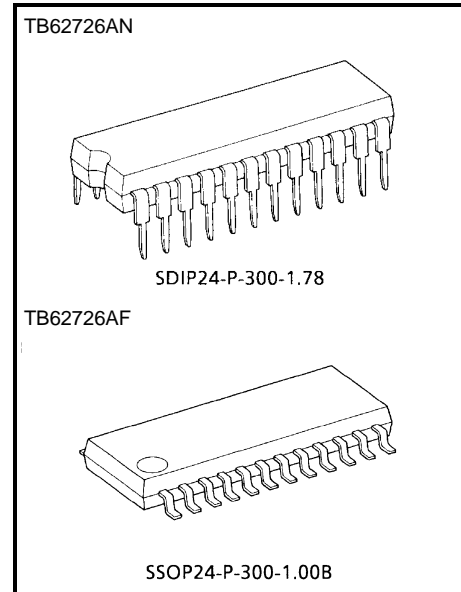
SSOP24-P-300-1.00B

Weight
SDIP24-P-300-1.78: 1.22 g (typ.)
SSOP24-P-300-1.00B: 0.32 g (typ.)

Pin Assignment (top view)

```
GND    [ ⊙        VDD
SERIAL-IN         R-EXT
CLOCK             SERIAL-OUT
LATCH             ENABLE
OUT0              OUT15
OUT1              OUT14
OUT2              OUT13
OUT3              OUT12
OUT4              OUT11
OUT5              OUT10
OUT6              OUT9
OUT7              OUT8
```

Warnings: Short-circuiting an output terminal toGND or to the power supply terminal may broken the device.
Please take care when wiring the output terminals, the power supply terminal and the GND terminals.

Block Diagram
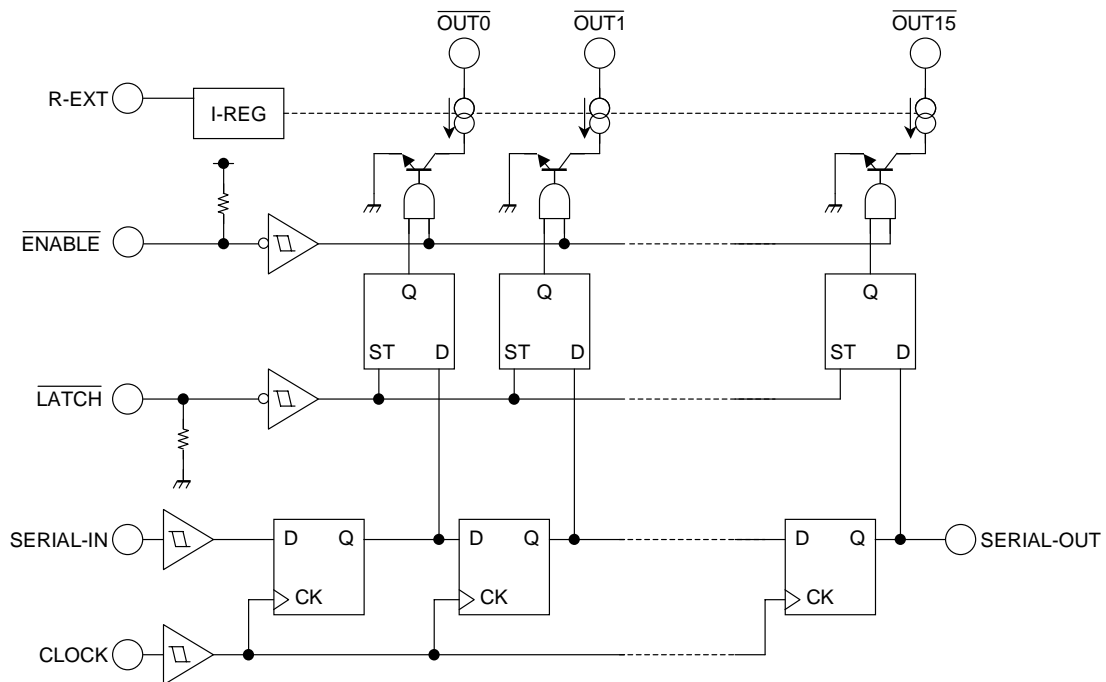
Truth Table

CLOCK	$\overline{\text{LATCH}}$	$\overline{\text{ENABLE}}$	SERIAL-IN	$\overline{\text{OUT0}}$ $\cdots$ $\overline{\text{OUT7}}$ $\cdots$ $\overline{\text{OUT15}}$	SERIAL-OUT
↑	H	L	Dn	Dn $\cdots$ Dn $-$ 7 $\cdots$ Dn $-$ 15	Dn $-$ 15
↑	L	L	Dn $+$ 1	No change	Dn $-$ 14
↑	H	L	Dn $+$ 2	Dn $+$ 2 $\cdots$ Dn $-$ 5 $\cdots$ Dn $-$ 13	Dn $-$ 13
↓	X	L	Dn $+$ 3	Dn $+$ 2 $\cdots$ Dn $-$ 5 $\cdots$ Dn $-$ 13	Dn $-$ 13
↓	X	H	Dn $+$ 3	OFF	Dn $-$ 13

Note 1: $\overline{\text{OUT0}}$ to $\overline{\text{OUT15}}$ = On when Dn = H; $\overline{\text{OUT0}}$ to $\overline{\text{OUT15}}$ = Off when Dn = L.
In order to ensure that the level of the power supply voltage is correct, an external resistor must be
connected between R-EXT and GND.

Timing Diagram
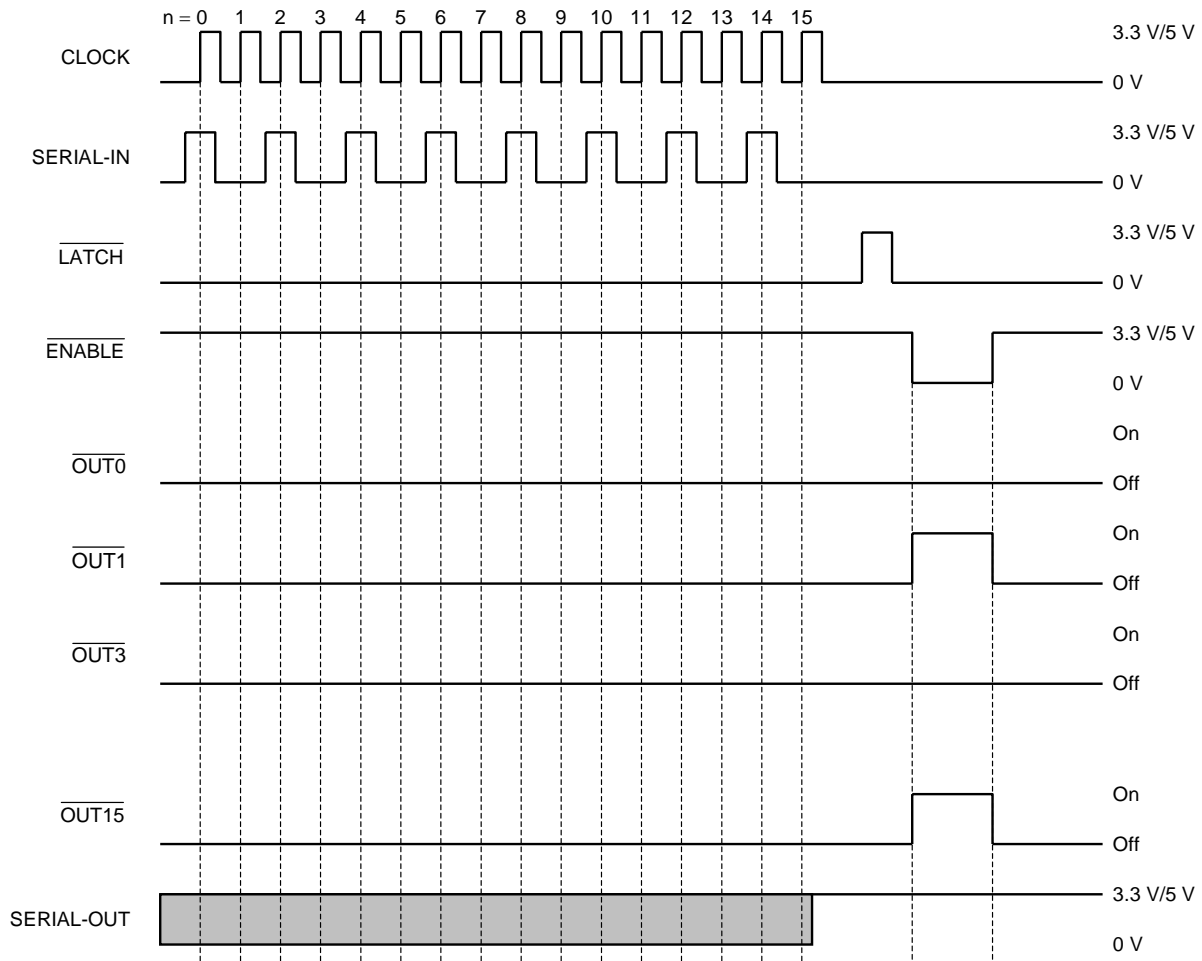
Warning: Latch circuit is leveled-latch circuit. Be careful because it is not triggered-latch circuit.

Note 2: The latches circuit holds data by pulling the $\overline{\text{LATCH}}$ terminal Low.
And, when $\overline{\text{LATCH}}$ terminal is a High level, latch circuit doesn't hold data, and it passes from the input to the output.
When $\overline{\text{ENABLE}}$ terminal is a Low level, output terminal $\overline{\text{OUT0}}$ to $\overline{\text{OUT15}}$ respond to the data, and on and off does.
And, when $\overline{\text{ENABLE}}$ terminal is a High level, it offs with the output terminal regardless of the data.

Terminal Description

| Pin No.	Pin Name	Function
1	GND	GND terminal for control logic
2	SERIAL-IN	Input terminal for serial data for data shift register
3	CLOCK	Input terminal for clock for data shift on rising edge
4	$\overline{\text{LATCH}}$	Input terminal for data strobe When the $\overline{\text{LATCH}}$ input is driven High, data is not latched. When it is pulled Low, data is latched.
5 to 20	$\overline{\text{OUT0}}$ to $\overline{\text{OUT15}}$	Constant-current output terminals
21	$\overline{\text{ENABLE}}$	Input terminal for output enable. All outputs ($\overline{\text{OUT0}}$ to $\overline{\text{OUT15}}$) are turned off, when the $\overline{\text{ENABLE}}$ terminal is driven High. And are turned on, when the terminal is driven Low.
22	SERIAL-OUT	Output terminal for serial data input on SERIAL-IN terminal
23	R-EXT	Input terminal used to connect an external resistor. This regulated the output current.
24	V_{DD}	3.3-V/5-V supply voltage terminal

Equivalent Circuits for Inputs and Outputs

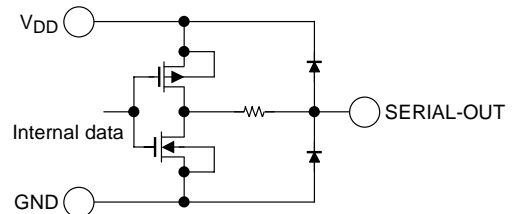### 1. $\overline{\text{ENABLE}}$ terminal
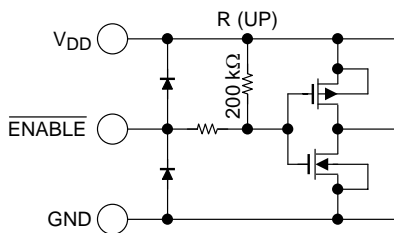
2. $\overline{\text{LATCH}}$ terminal
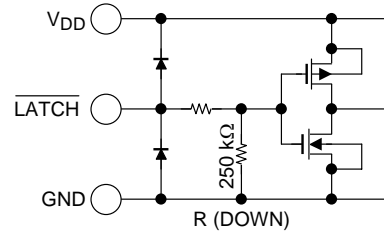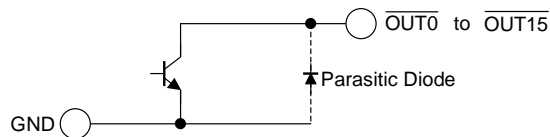

3. CLOCK, SERIAL-IN terminal
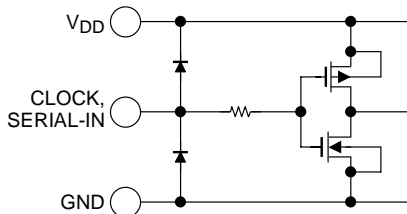
4. SERIAL-OUT terminal

5. $\overline{\text{OUT0}}$ to $\overline{\text{OUT15}}$ terminals

Absolute Maximum Ratings (T_{opr} = 25°C)

Characteristics		Symbol	Rating	Unit
Supply voltage		V_{DD}	6	V
Input voltage		V_{IN}	$-0.2 \sim V_{DD} + 0.2$	V
Output current		I_{OUT}	+90	mA/ch
Output voltage		V_{OUT}	−0.2 to 17	V
Power dissipation (Note 3)	AN-type (when not mounted)	P_{d1}	1.25	W
	AN-type (on PCB)		1.78	
	AF-type (when not mounted)	P_{d2}	0.83	
	AF-type (on PCB)		1.00	
Thermal resistance (Note 3)	AN-type (when not mounted)	$R_{th (j-a) 1}$	104	°C/W
	AN-type (on PCB)		70	
	AF-type (when not mounted)	$R_{th (j-a) 2}$	140	
	AF-type (on PCB)		120	
Operating temperature		T_{opr}	−40 to 85	°C
Storage temperature		T_{stg}	−55 to 150	°C

Note 3: AN-Type: Powers dissipation is derated by 14.28 mW/°C if device is mounted on PCB and ambient temperature is above 25°C.
AF-Type: Powers dissipation is derated by 6.67 mW/°C if device is mounted on PCB and ambient temperature is above 25°C.

With device mounted on glass-epoxy PCB of less than 40% Cu and of dimensions 50 mm × 50 mm × 1.6 mm.

Recommended Operating Conditions (T_{opr} = −40°C to 85°C unless otherwise specified)

Characteristics	Symbol	Conditions	Min	Typ.	Max	Unit
Supply voltage	V_{DD}	—	3	—	5.5	V
Output voltage	V_{OUT}	—	—	0.7	4	V
Output current	I_{OUT}	Each DC 1 circuit	2	—	80	mA/ch
	I_{OH}	SERIAL-OUT	—	—	−1	mA
	I_{OL}	SERIAL-OUT	—	—	1	
Input voltage	V_{IH}	—	$0.7 \times V_{DD}$	—	$V_{DD} + 0.15$	V
	V_{IL}		−0.15	—	$0.3 \times V_{DD}$	
Clock frequency	f_{CLK}	Cascade connected	—	—	20	MHz
$\overline{LATCH}$ pulse width	t_{wLAT}		50	—	—	ns
CLOCK pulse width	t_{wCLK}	—	25	—	—	ns
ENABLE pulse width (Note 4)	t_{wENA}	Upper I_{OUT} = 20 mA	2000	—	—	ns
		Lower I_{OUT} = 20 mA	3000	—	—	
Set-up time for CLOCK terminal	t_{SETUP1}		10	—	—	ns
Hold time for CLOCK terminal	t_{HOLD}	—	10	—	—	ns
Set-up time for $\overline{LATCH}$ terminal	t_{SETUP2}		50	—	—	ns

Note 4: When the pulse of the Low level is inputted to the $\overline{ENABLE}$ terminal held in the High level.

Electrical Characteristics (T_{opr} = 25°C, V_{DD} = 3.0 V to 5.5 V unless otherwise specified)

Electrical Characteristics (T_{opr} = 25°C, V_{DD} = 3.0 V to 5.5 V unless otherwise specified)

Characteristics	Symbol	Conditions		Min	Typ.	Max	Unit
Supply voltage	V_{DD}	Normal operation		3.0	—	5.5	V
Output current	I_{OUT1}	V_{OUT} = 0.4 V, V_{DD} = 3.3 V	R_{EXT} = 490 Ω	31.96	36.20	40.54	mA
	I_{OUT2}	V_{OUT} = 0.4 V, V_{DD} = 5 V		31. 59	35.90	40.20	
	I_{OUT3}	V_{OUT} = 0.7 V, V_{DD} = 3.3 V	R_{EXT} = 250 Ω	63.63	72.30	80.97	
	I_{OUT4}	V_{OUT} = 0.7 V, V_{DD} = 5 V		62.75	71.30	79.95	
Output current error between bits	ΔI_{OUT1}	$V_{OUT} \geqq$ 0.4 V, All outputs ON	R_{EXT} = 490 Ω	—	±1	±4	%
	ΔI_{OUT2}	$V_{OUT} \geqq$ 0.4 V, All outputs ON	R_{EXT} = 250 Ω				
Output leakage current input voltage	I_{OZ}	V_{OUT} = 15.0 V		—	—	1	μA
Input voltage	V_{IN}	—		0.7 V_{DD}	—	V_{DD}	V
		—		GND	—	0.3 V_{DD}	
SOUT terminal voltage	V_{OL}	I_{OL} = 1.0 mA, V_{DD} = 3.3 V		—	—	0.3	V
		I_{OL} = 1.0 mA, V_{DD} = 5 V		—	—	0.3	
	V_{OH}	I_{OH} = − 1.0 mA, V_{DD} = 3.3 V		3	—	—	
		I_{OH} = 1.0 mA, V_{DD} = 5 V		4.7	—	—	
Output current Supply voltage Regulation	%/V_{DD}	When V_{DD} is changed 3 V to 5.5 V		—	−1	−5	%
Pull-up resistor	R $_{(Up)}$	$\overline{ENABLE}$ terminal		115	230	460	kΩ
Pull-down resistor	R $_{(Down)}$	$\overline{LATCH}$ terminal					
Supply current	$I_{DD (OFF) 1}$	V_{OUT} = 15.0 V	R_{EXT} = OPEN	—	0.1	0.5	mA
	$I_{DD (OFF) 2}$	V_{OUT} = 15.0 V, All outputs OFF	R_{EXT} = 490 Ω	1	3.5	5	
	$I_{DD (OFF) 3}$	V_{OUT} = 15.0 V, All outputs OFF	R_{EXT} = 250 Ω	4	6	9	
	$I_{DD (ON) 1}$	V_{OUT} = 0.7 V, All outputs ON	R_{EXT} = 490 Ω	—	9	15	
		Same as the above, T_{opr} = −40°C		—	—	20	
	$I_{DD (ON) 2}$	V_{OUT} = 0.7 V, All outputs ON	R_{EXT} = 250 Ω	—	18	25	
		Same as the above, T_{opr} = −40°C		—	—	40	

Switching Characteristics (T$_{opr}$ = 25°C unless otherwise specifed)

Characteristics	Symbol	Conditions	Min	Typ.	Max	Unit
Propagation delay	t$_{pLH1}$	CLK- $\overline{OUTn}$, $\overline{LATCH}$ = "H", $\overline{ENABLE}$ = "L"	—	150	300	ns
	t$_{pLH2}$	$\overline{LATCH}$ - $\overline{OUTn}$, $\overline{ENABLE}$ = "L"	—	140	300	
	t$_{pLH3}$	$\overline{ENABLE}$ - $\overline{OUTn}$, $\overline{LATCH}$ = "H"	—	140	300	
	t$_{pLH}$	CLK-SERIAL OUT	3	6	—	
	t$_{pHL1}$	CLK- $\overline{OUTn}$, $\overline{LATCH}$ = "H", $\overline{ENABLE}$ = "L"	—	170	340	
	t$_{pHL2}$	$\overline{LATCH}$ - $\overline{OUTn}$, $\overline{ENABLE}$ = "L"	—	170	340	
	t$_{pHL3}$	$\overline{ENABLE}$ - $\overline{OUTn}$, $\overline{LATCH}$ = "H"	—	170	340	
	t$_{pLH}$	CLK-SERIAL OUT	4	7	—	
Output rise time	t$_{or}$	10~90% of voltage waveform	40	85	150	ns
Output fall time	t$_{of}$	90~10% of voltage waveform	40	70	150	ns
Maximum CLOCK rise time	t$_r$	When not on PCB	—	—	5	μs
Maximum CLOCK fall time	t$_f$	(Note 5)	—	—	5	μs

Conditions: (Refer to test circuit.)

T$_{opr}$ = 25°C, V$_{DD}$ = V$_{IH}$ = 3.3 V and 5 V, V$_{OUT}$ = 0.7 V, V$_{IL}$ = 0 V, R$_{EXT}$ = 490 Ω,
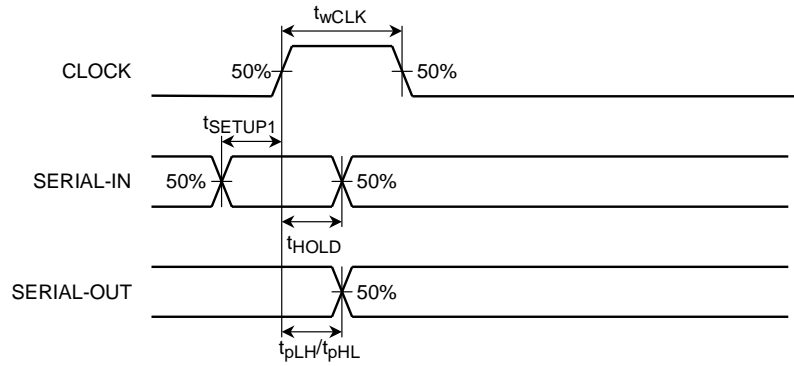V$_L$ = 3.0 V, R$_L$ = 60 Ω, C$_L$ = 10.5 pF

Note 5:   If the device is connected in a cascade and t$_r$/t$_f$ for the waveform is large, it may not be possible to achieve the timing required for data transfer. Please consider the timings carefully.
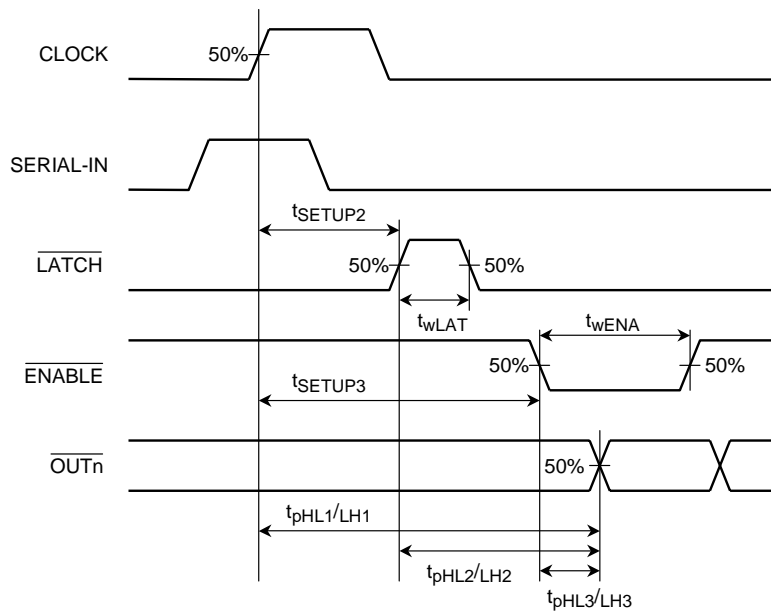

Test Circuit

V$_{DD}$ = V$_{IH}$ = 3.3 V
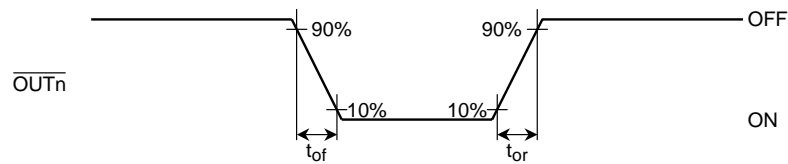V$_{IL}$ = 0 V
t$_r$ = t$_f$ = 10 ns
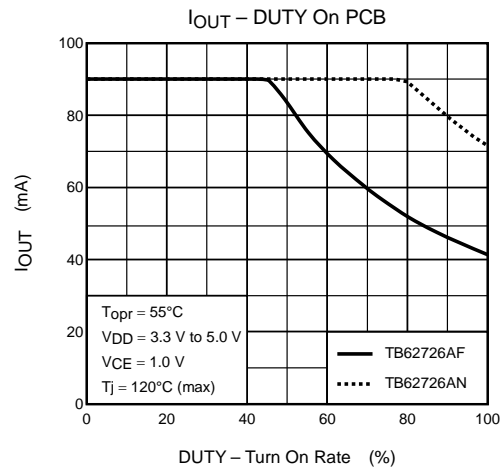(10% to 90%)

2006-06-14
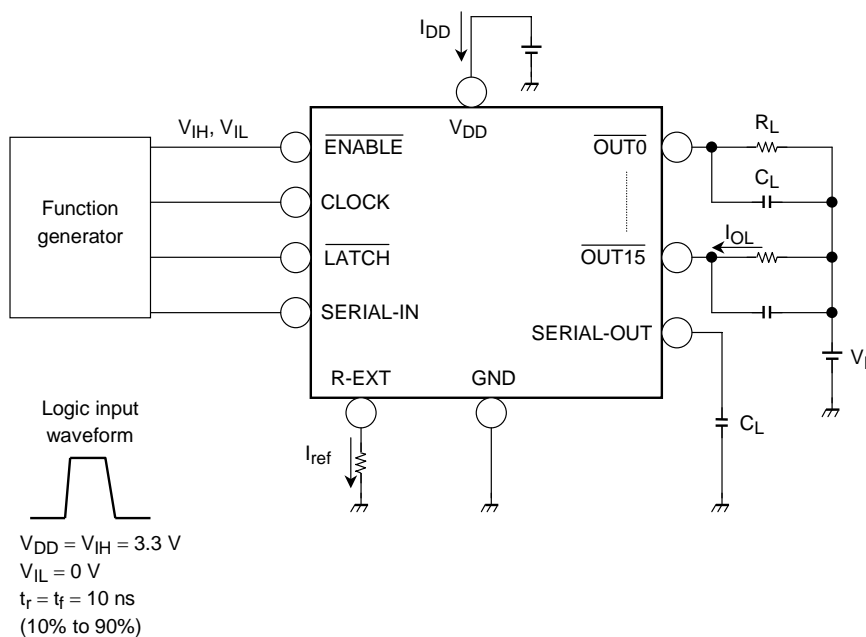
Timing Waveforms

1. CLOCK, SERIAL-IN, SERIAL-OUT

2. CLOCK, SERIAL-IN, $\overline{\text{LATCH}}$，$\overline{\text{ENABLE}}$，$\overline{\text{OUTn}}$

3. $\overline{\text{OUTn}}$

Output Current – Duty (LEDS turn-on rate)

I_{OUT} – DUTY On PCB

(graph, y-axis: I_{OUT} (mA) 0 to 100, x-axis: DUTY – Turn On Rate (%) 0 to 100)

T_{opr} = 25°C
V_{DD} = 3.3 V to 5.0 V
V_{CE} = 1.0 V
T_j = 120°C (max)

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I_{OUT} – DUTY On PCB

(graph, y-axis: I_{OUT} (mA) 0 to 100, x-axis: DUTY – Turn On Rate (%) 0 to 100)

T_{opr} = 55°C
V_{DD} = 3.3 V to 5.0 V
V_{CE} = 1.0 V
T_j = 120°C (max)

— TB62726AF
···· TB62726AN

I_{OUT} – DUTY On PCB

(graph, y-axis: I_{OUT} (mA) 0 to 100, x-axis: DUTY – Turn On Rate (%) 0 to 100)

T_{opr} = 85°C
V_{DD} = 3.3 V to 5.0 V
V_{CE} = 1.0 V
T_j = 120°C (max)

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P_d – T_{opr}

(graph, y-axis: Power dissipation P_D (W/IC) 0 to 2.0, x-axis: Ambient temperature Ta (°C) 0 to 100)

N (On PCB)
F (On PCB)

Output Current – R_{EXT} Resistor

I_{OUT} – R_{EXT}

(graph, y-axis: I_{OUT} (mA) 0 to 90, x-axis: R_{EXT} (Ω) 100 to 10000)
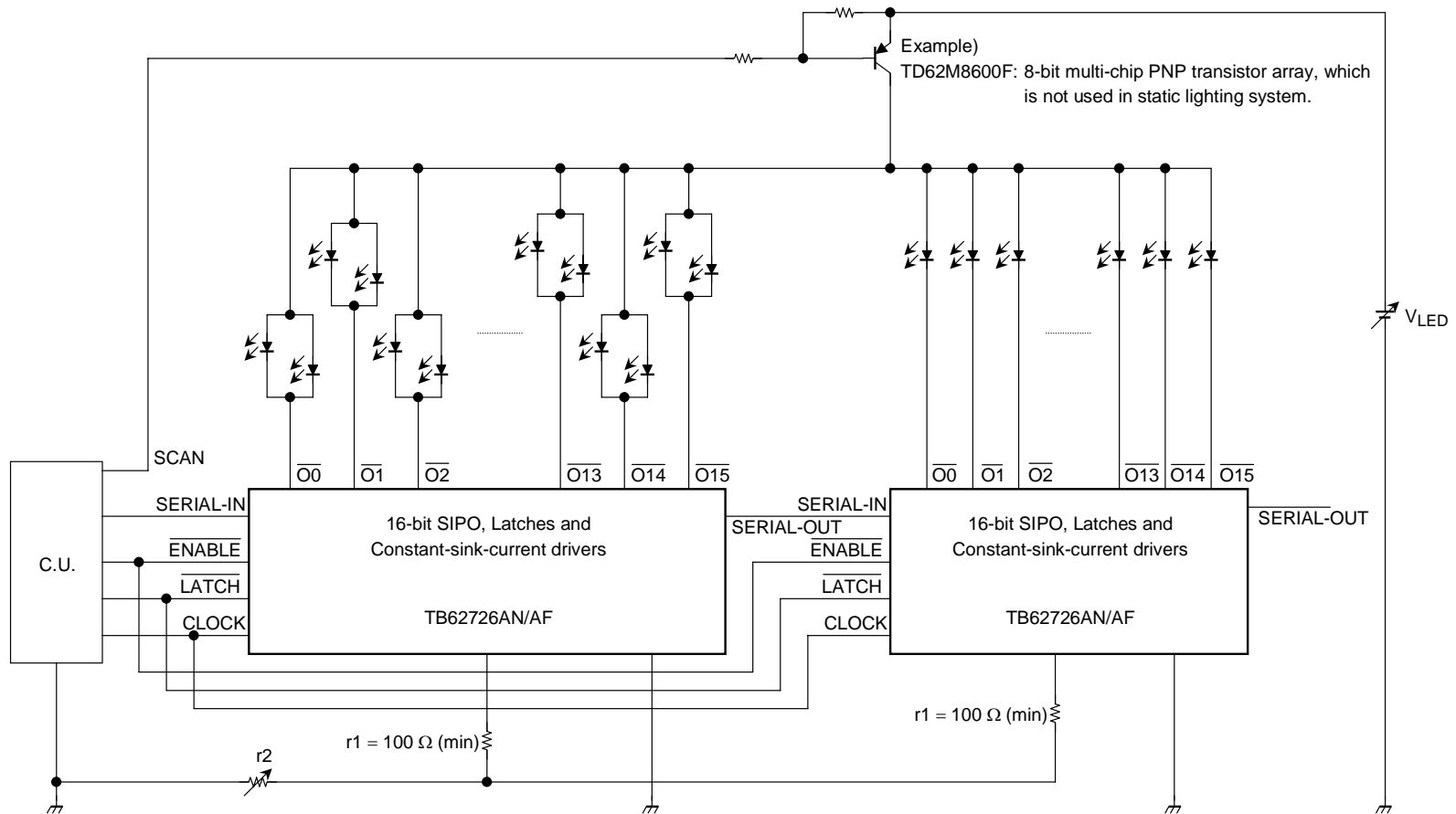
T_{opr} = 25°C

V_{CE} = 0.7 V

2006-06-14
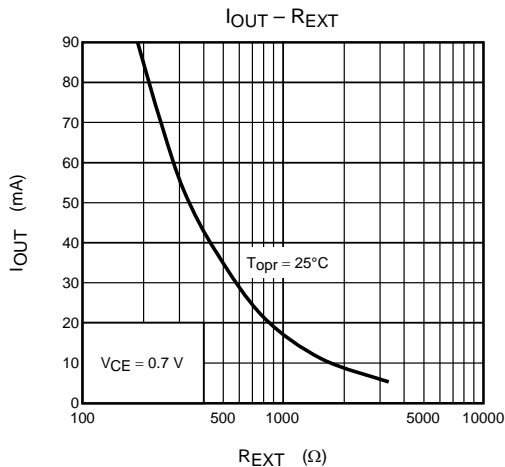
Application Circuit (example 1): The general composition in static lighting of LED.

More than VLED (V) ≧ Vf (total max) +0.7 is recommended with the following application circuit with the LED power supply VLED.
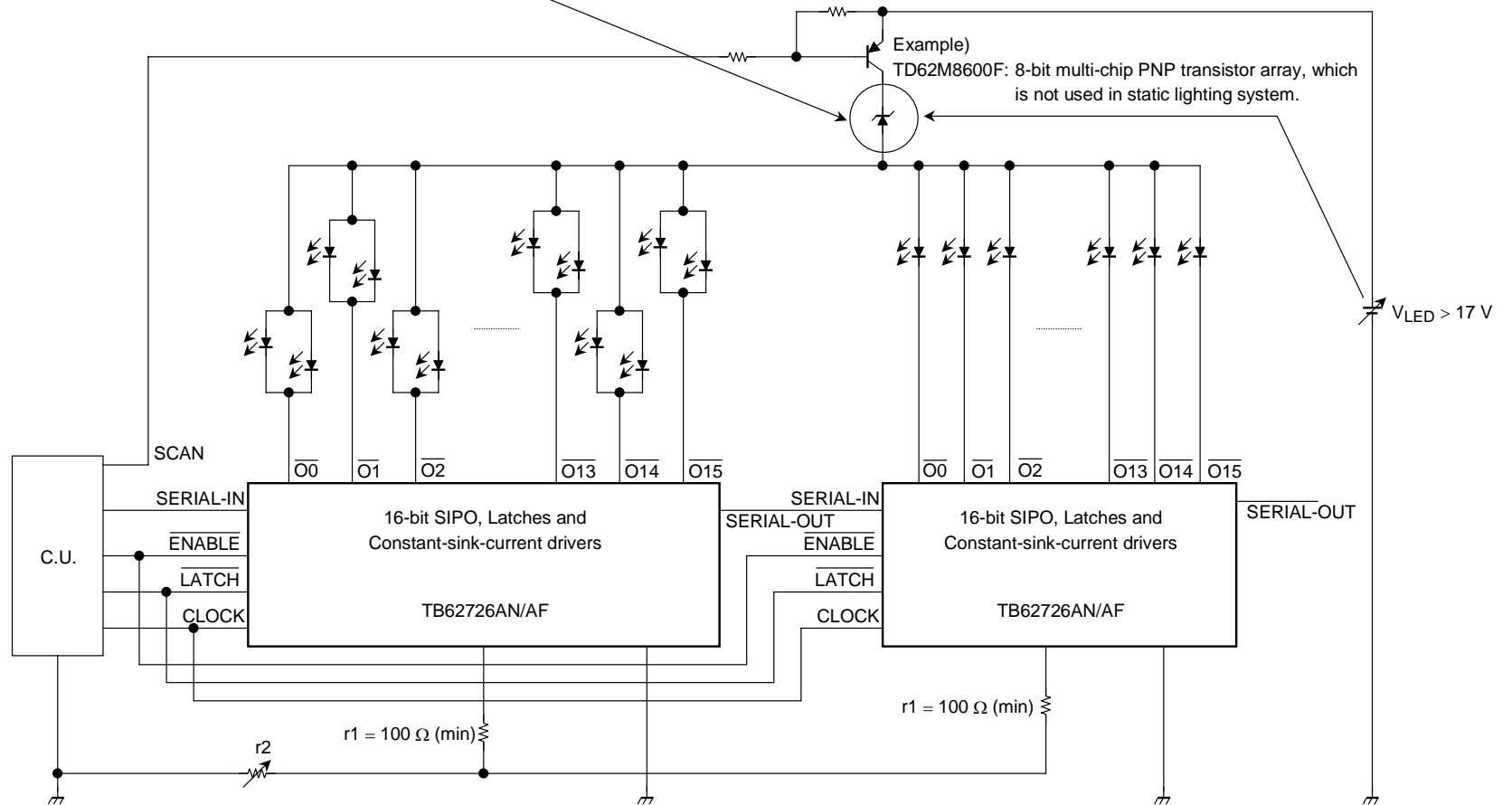
r1: The setup resistance for the setup of output current of every IC.
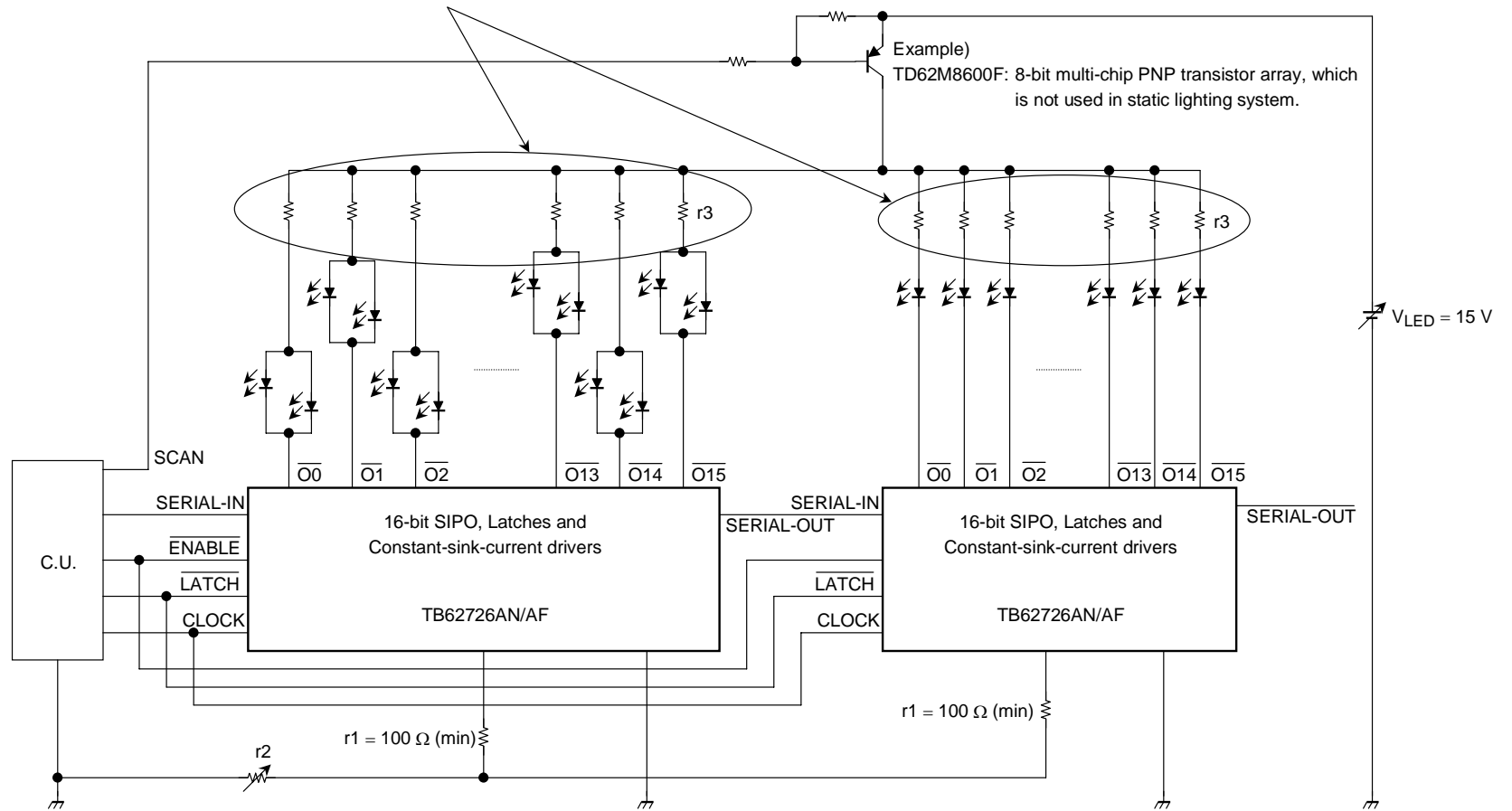r2: The variable resistance for the brightness control of every LED module.

Example)
TD62M8600F: 8-bit multi-chip PNP transistor array, which
is not used in static lighting system.

V_{LED}

SCAN

O0 O1 O2 ... O13 O14 O15

O0 O1 O2 ... O13 O14 O15

SERIAL-IN

SERIAL-IN

SERIAL-OUT

16-bit SIPO, Latches and
Constant-sink-current drivers

16-bit SIPO, Latches and
Constant-sink-current drivers

SERIAL-OUT

ENABLE

ENABLE

C.U.

LATCH

LATCH

CLOCK

CLOCK

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r1 = 100 Ω (min)

r2

r1 = 100 Ω (min)

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Application Circuit (example 2): When the condition of VLED is VLED > 17 V

The unnecessary voltage is one effective technique as to making the voltage descend with the zenor diode.

Example)
TD62M8600F: 8-bit multi-chip PNP transistor array, which is not used in static lighting system.

$V_{LED} > 17$ V

SCAN

$\overline{O0}$ $\overline{O1}$ $\overline{O2}$ $\overline{O13}$ $\overline{O14}$ $\overline{O15}$ $\overline{O0}$ $\overline{O1}$ $\overline{O2}$ $\overline{O13}$ $\overline{O14}$ $\overline{O15}$

SERIAL-IN

SERIAL-IN

SERIAL-OUT

C.U.

$\overline{ENABLE}$

16-bit SIPO, Latches and
Constant-sink-current drivers

$\overline{ENABLE}$

16-bit SIPO, Latches and
Constant-sink-current drivers

SERIAL-OUT

$\overline{LATCH}$

$\overline{LATCH}$

CLOCK

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CLOCK

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r1 = 100 Ω (min)

r2

r1 = 100 Ω (min)

Application Circuit (example 3): When the condition of VLED is Vf +0.7 < VLED < 17 V

VOUT = VLED-Vf = 0.7~1.0 V is the most suitable for VOUT.

Surplus VOUT causes an IC fever and the useless consumption electric power.

It is the one way of being effective to build in the r3 in this problem.

r3 can make a calculation to the formula r3 Ω = surplus VOUT/IOUT.

Though the resistance parts increase, the fixed constant current performance is kept

Example)
TD62M8600F: 8-bit multi-chip PNP transistor array, which
is not used in static lighting system.

V_{LED} = 15 V

16-bit SIPO, Latches and
Constant-sink-current drivers

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16-bit SIPO, Latches and
Constant-sink-current drivers

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C.U.

SCAN
SERIAL-IN
ENABLE
LATCH
CLOCK

SERIAL-IN
SERIAL-OUT
LATCH
CLOCK

SERIAL-OUT

O0 O1 O2 O13 O14 O15

r1 = 100 Ω (min)

r1 = 100 Ω (min)

r2

Notes

- Operation may become unstable due to the electromagnetic interference caused by the wiring and other phenomena.
  To counter this, it is recommended that the IC be situated as close as possible to the LED module.
  If overvoltage is caused by inductance between the LED and the output terminals, both the LED and the terminals may suffer damage as a result.

- There is only one GND terminal on this device when the inductance in the GND line and the resistor are large, the device may malfunction due to the GND noise when output switchings by the circuit board pattern and wiring.
  To achieve stable operation, it is necessary to connect a resistor between the REXT terminal and the GND line.
  Fluctuation in the output waveform is likely to occur when the GND line is unstable or when a capacitor (of more than 50 pF) is used.
  Therefore, take care when designing the circuit board pattern layout and the wiring from the controller.

- This application circuit is a reference example and is not guaranteed to work in all conditions.
  Be sure to check the operation of your circuits.

- This device does not include protection circuits for overvoltage, overcurrent or overtemperature.
  If protection is necessary, it must be incorporated into the control circuitry.

- The device is likely to be destroyed if a short-circuit occurs between either of the power supply pins and any of the output terminals when designing circuits, pay special attention to the positions of the output terminals and the power supply terminals (V_{DD} and V_{LED}), and to the design of the GND line.

Package Dimensions

SDIP24-P-300-1.78   Unit : mm
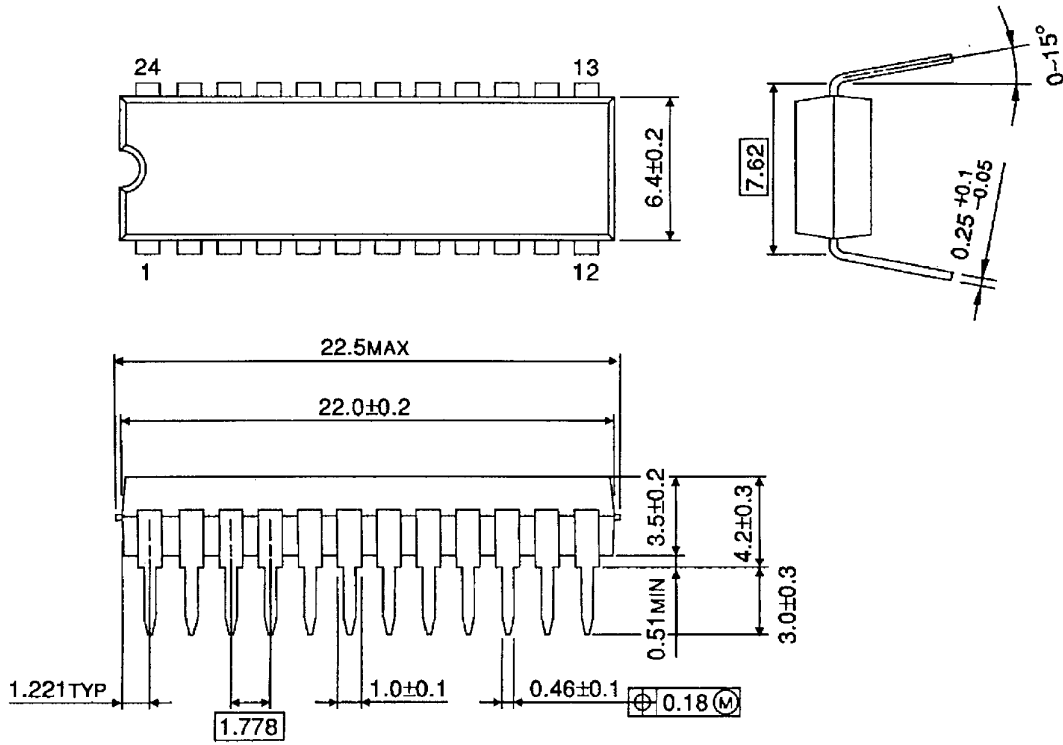
Weight: 1.22 g (typ.)

Package Dimensions

SSOP24-P-300-1.00B

Unit : mm
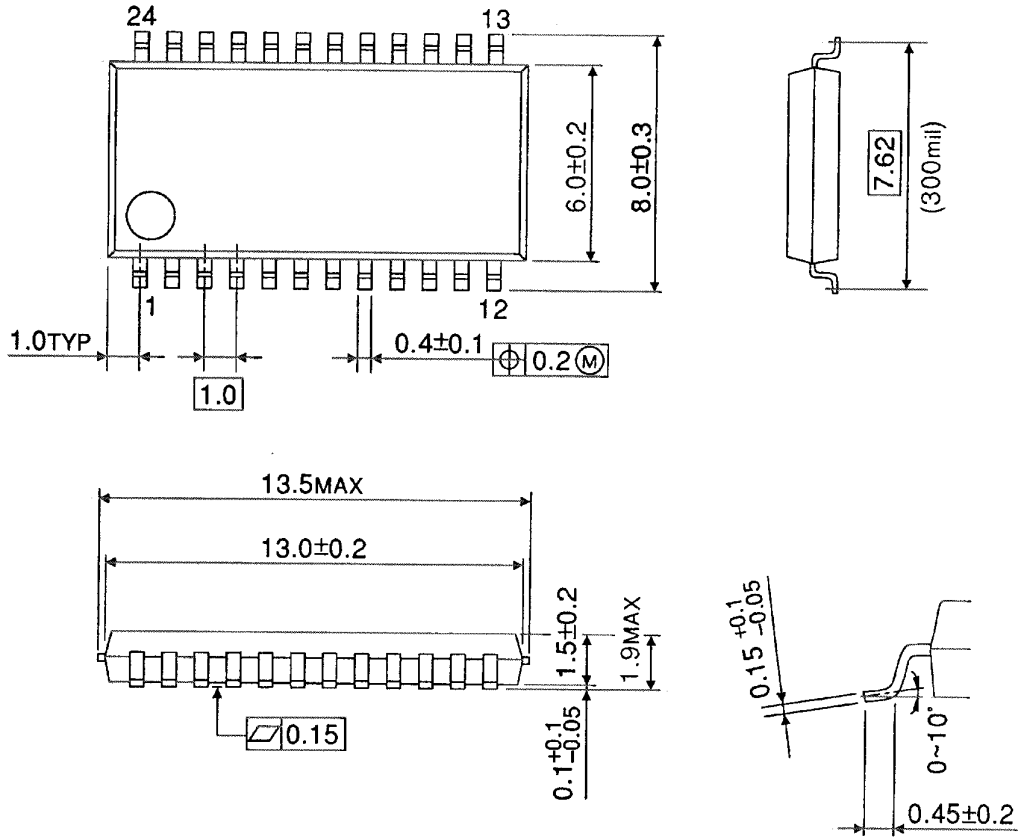
Weight: 0.32 g (typ.)

Notes on Contents

1. Block Diagrams

Some of the functional blocks, circuits, or constants in the block diagram may be omitted or simplified for explanatory purposes.

2. Equivalent Circuits

The equivalent circuit diagrams may be simplified or some parts of them may be omitted for explanatory purposes.

3. Timing Charts

Timing charts may be simplified for explanatory purposes.

4. Application Circuits

The application circuits shown in this document are provided for reference purposes only.
Thorough evaluation is required, especially at the mass production design stage.
Toshiba does not grant any license to any industrial property rights by providing these examples of application circuits.

5. Test Circuits

Components in the test circuits are used only to obtain and confirm the device characteristics. These components and circuits are not guaranteed to prevent malfunction or failure from occurring in the application equipment.

IC Usage Considerations

Notes on Handling of ICs

(1) The absolute maximum ratings of a semiconductor device are a set of ratings that must not be exceeded, even for a moment. Do not exceed any of these ratings.
Exceeding the rating(s) may cause the device breakdown, damage or deterioration, and may result injury by explosion or combustion.

(2) Use an appropriate power supply fuse to ensure that a large current does not continuously flow in case of over current and/or IC failure. The IC will fully break down when used under conditions that exceed its absolute maximum ratings, when the wiring is routed improperly or when an abnormal pulse noise occurs from the wiring or load, causing a large current to continuously flow and the breakdown can lead smoke or ignition. To minimize the effects of the flow of a large current in case of breakdown, appropriate settings, such as fuse capacity, fusing time and insertion circuit location, are required.

(3) If your design includes an inductive load such as a motor coil, incorporate a protection circuit into the design to prevent device malfunction or breakdown caused by the current resulting from the inrush current at power ON or the negative current resulting from the back electromotive force at power OFF. IC breakdown may cause injury, smoke or ignition.
Use a stable power supply with ICs with built-in protection functions. If the power supply is unstable, the protection function may not operate, causing IC breakdown. IC breakdown may cause injury, smoke or ignition.

(4) Do not insert devices in the wrong orientation or incorrectly.
Make sure that the positive and negative terminals of power supplies are connected properly. Otherwise, the current or power consumption may exceed the absolute maximum rating, and exceeding the rating(s) may cause the device breakdown, damage or deterioration, and may result injury by explosion or combustion.
In addition, do not use any device that is applied the current with inserting in the wrong orientation or incorrectly even just one time.

(5) Carefully select external components (such as inputs and negative feedback capacitors) and load components (such as speakers), for example, power amp and regulator.
If there is a large amount of leakage current such as input or negative feedback condenser, the IC output DC voltage will increase. If this output voltage is connected to a speaker with low input withstand voltage, overcurrent or IC failure can cause smoke or ignition. (The over current can cause smoke or ignition from the IC itself.) In particular, please pay attention when using a Bridge Tied Load (BTL) connection type IC that inputs output DC voltage to a speaker directly.

Points to Remember on Handling of ICs

(1) Heat Radiation Design
In using an IC with large current flow such as power amp, regulator or driver, please design the device so that heat is appropriately radiated, not to exceed the specified junction temperature (Tj) at any time and condition. These ICs generate heat even during normal use. An inadequate IC heat radiation design can lead to decrease in IC life, deterioration of IC characteristics or IC breakdown. In addition, please design the device taking into considerate the effect of IC heat radiation with peripheral components.

(2) Back-EMF
When a motor rotates in the reverse direction, stops or slows down abruptly, a current flow back to the motor's power supply due to the effect of back-EMF. If the current sink capability of the power supply is small, the device's motor power supply and output pins might be exposed to conditions beyond maximum ratings. To avoid this problem, take the effect of back-EMF into consideration in system design.

RESTRICTIONS ON PRODUCT USE

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