

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.

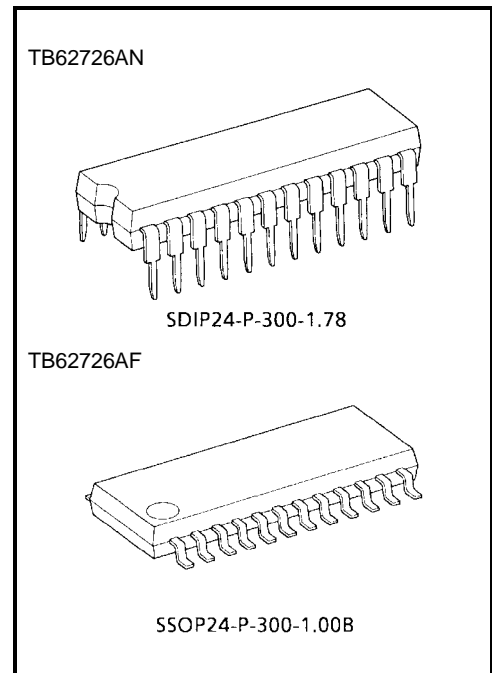
This driver incorporates 16-bit constant-current outputs, a 16-bit shift register, a 16-bit latch and a 16-bit AND-gate circuit.

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

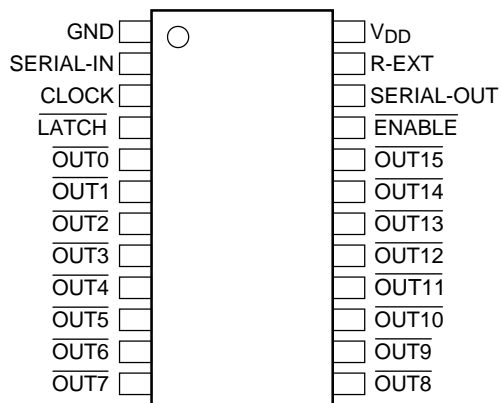


Weight

SDIP24-P-300-1.78: 1.22 g (Typ.)

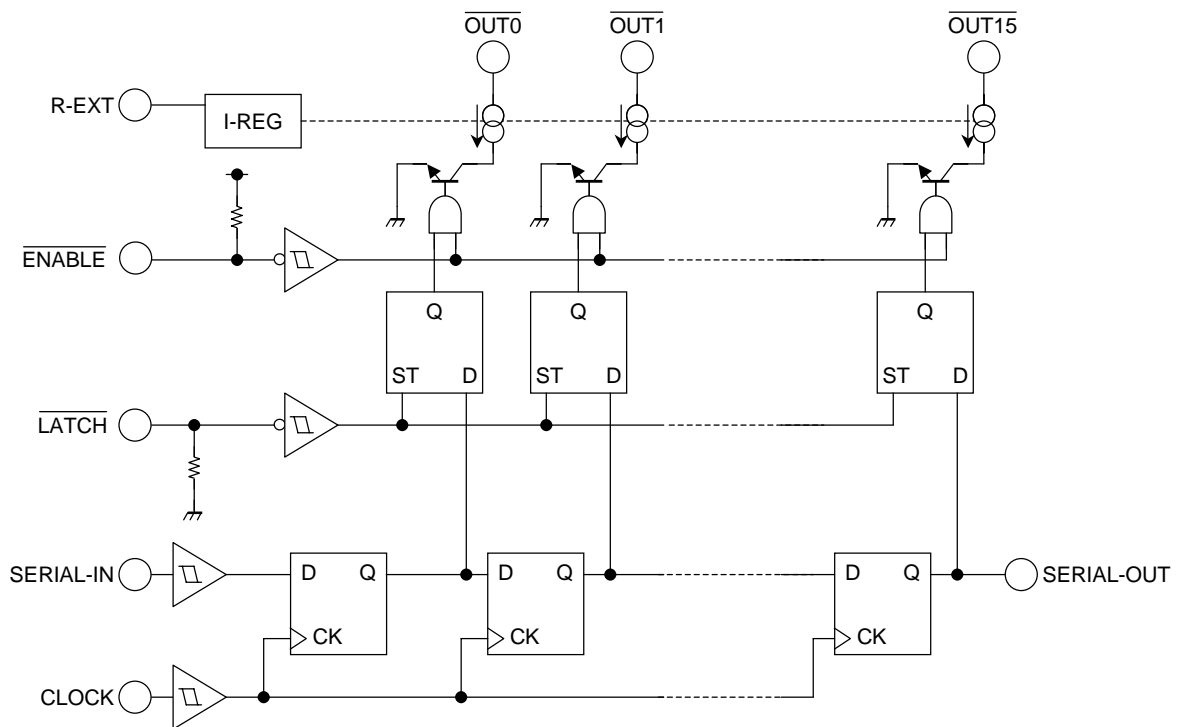
SSOP24-P-300-1.00B: 0.32 g (Typ.)

Pin Assignment (top view)



Warnings: Short-circuiting an output terminal to GND 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



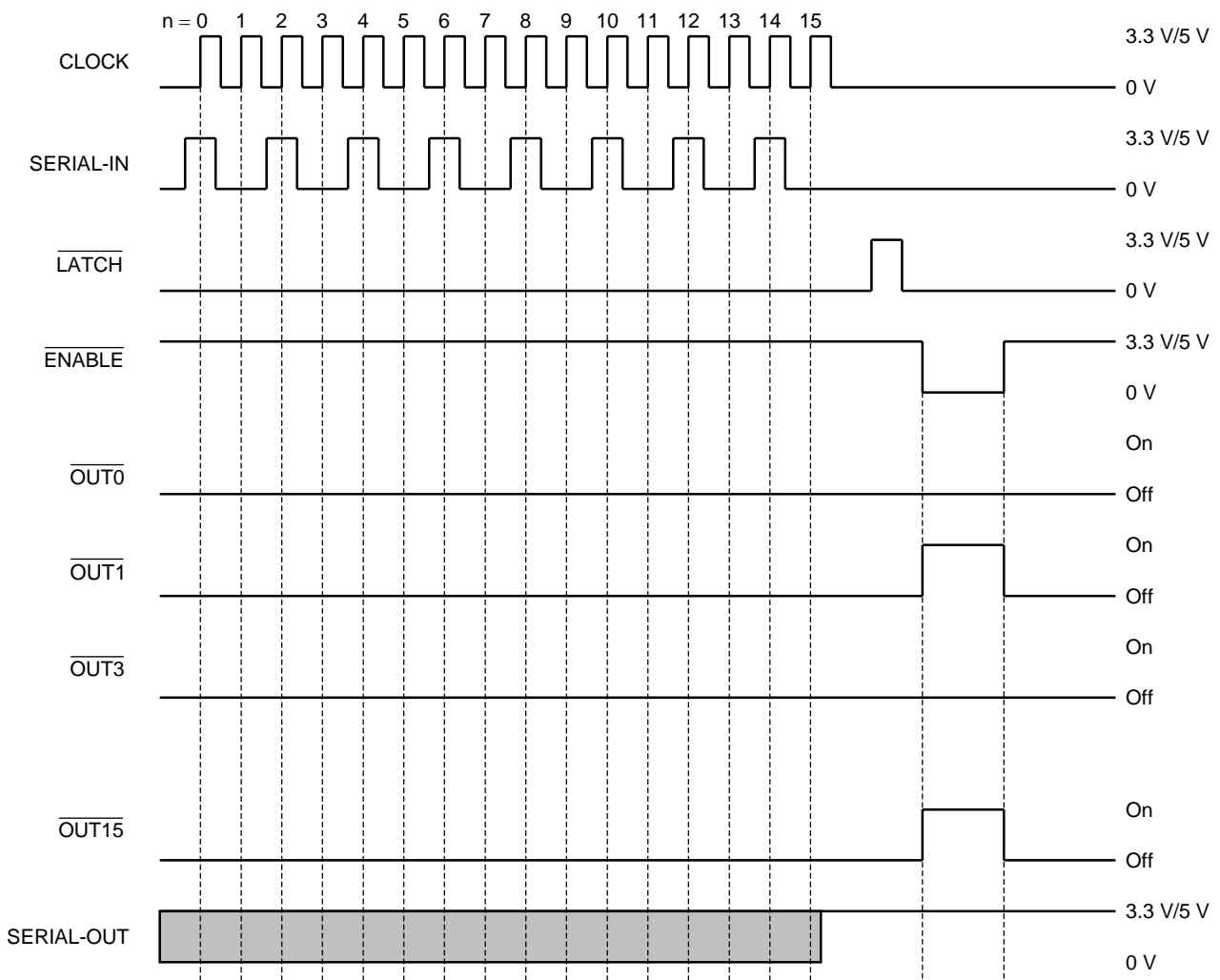
Truth Table

CLOCK	$\overline{\text{LATCH}}$	$\overline{\text{ENABLE}}$	SERIAL-IN	$\overline{\text{OUT0}} \dots \overline{\text{OUT7}} \dots \overline{\text{OUT15}}$	SERIAL-OUT
\uparrow	H	L	D_n	$D_n \dots D_{n-7} \dots D_{n-15}$	D_{n-15}
\uparrow	L	L	D_{n+1}	No change	D_{n-14}
\uparrow	H	L	D_{n+2}	$D_{n+2} \dots D_{n-5} \dots D_{n-13}$	D_{n-13}
\downarrow	X	L	D_{n+3}	$D_{n+2} \dots D_{n-5} \dots D_{n-13}$	D_{n-13}
\downarrow	X	H	D_{n+3}	OFF	D_{n-13}

Note 1: $\overline{\text{OUT0}}$ to $\overline{\text{OUT15}} = \text{On}$ when $D_n = \text{H}$; $\overline{\text{OUT0}}$ to $\overline{\text{OUT15}} = \text{Off}$ when $D_n = \text{L}$.

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.

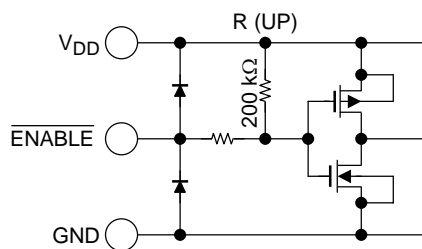
And, when $\overline{\text{ENABLE}}$ terminal is a High level, it offs with the output terminal regardless of the data.

Terminal Description

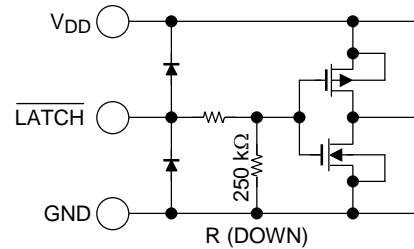
Pin No.	Pin Name	Function
1	GND	GND terminal for control logic
2	SERIAL-IN	Input terminal for serial data for data shift register
3	CLOCK	Input terminal for clock for data shift on rising edge
4	$\overline{\text{LATCH}}$	Input terminal for data strobe When the $\overline{\text{LATCH}}$ input is driven 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

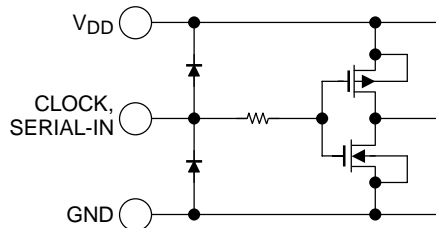
1. $\overline{\text{ENABLE}}$ terminal



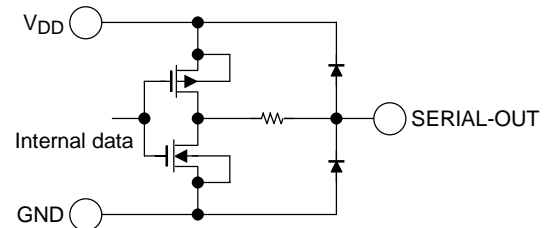
2. $\overline{\text{LATCH}}$ terminal



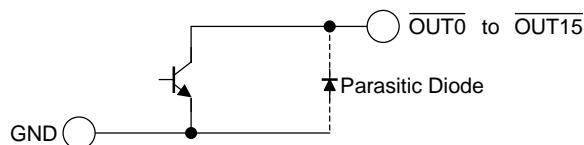
3. CLOCK, SERIAL-IN terminal



4. SERIAL-OUT terminal



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



Maximum Ratings (T_{opr} = 25°C)

Characteristics		Symbol	Rating	Unit
Supply voltage		V _{DD}	6	V
Input voltage		V _{IN}	-0.2~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 × V _{DD}	—	V _{DD} + 0.15	V
	V _{IL}		-0.15	—	0.3 × V _{DD}	
Clock frequency	f _{CLK}	Cascade connected	—	—	20	MHz
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 LATCH terminal	t _{SETUP2}		50	—	—	ns

Note 4: When the pulse of the Low level is inputted to the 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)

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} ≥ 0.4 V, All outputs ON	R _{EXT} = 490 Ω	—	±1	±4	%
	ΔI _{OUT2}	V _{OUT} ≥ 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)	ENABLE terminal		115	230	460	kΩ
Pull-down resistor	R (Down)	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	—	—	
	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 specified)

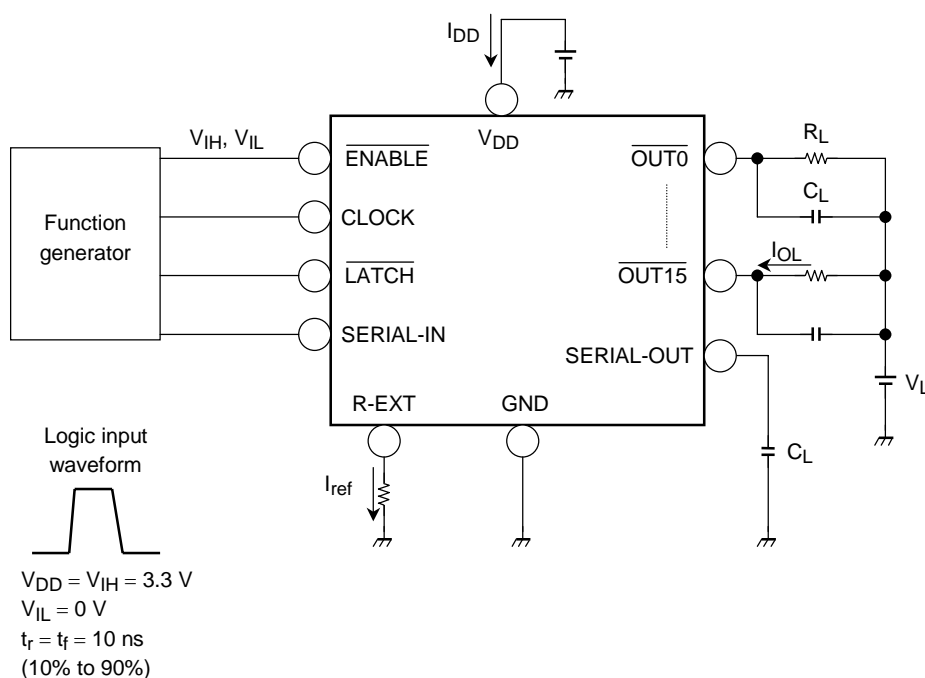
Characteristics	Symbol	Conditions	Min	Typ.	Max	Unit
Propagation delay	t _{pLH1}	CLK- $\overline{\text{OUTn}}$, $\overline{\text{LATCH}} = \text{"H"}$, $\overline{\text{ENABLE}} = \text{"L"}$	—	150	300	ns
	t _{pLH2}	$\overline{\text{LATCH}} - \overline{\text{OUTn}}$, $\overline{\text{ENABLE}} = \text{"L"}$	—	140	300	
	t _{pLH3}	$\overline{\text{ENABLE}} - \overline{\text{OUTn}}$, $\overline{\text{LATCH}} = \text{"H"}$	—	140	300	
	t _{pLH}	CLK-SERIAL OUT	3	6	—	
	t _{pHL1}	CLK- $\overline{\text{OUTn}}$, $\overline{\text{LATCH}} = \text{"H"}$, $\overline{\text{ENABLE}} = \text{"L"}$	—	170	340	
	t _{pHL2}	$\overline{\text{LATCH}} - \overline{\text{OUTn}}$, $\overline{\text{ENABLE}} = \text{"L"}$	—	170	340	
	t _{pHL3}	$\overline{\text{ENABLE}} - \overline{\text{OUTn}}$, $\overline{\text{LATCH}} = \text{"H"}$	—	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 (Note 5)	—	—	5	μs
Maximum CLOCK fall time	t _f		—	—	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

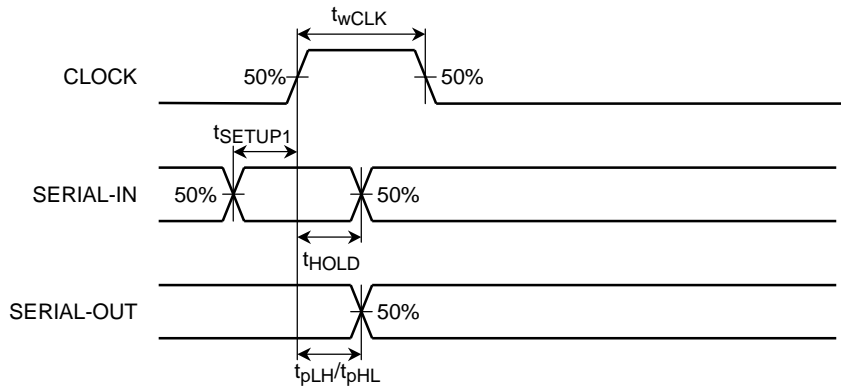
Note 5: If the device is connected in a cascade and t_r/t_f for the waveform is large, it may not be possible to achieve the timing required for data transfer. Please consider the timings carefully.

Test Circuit

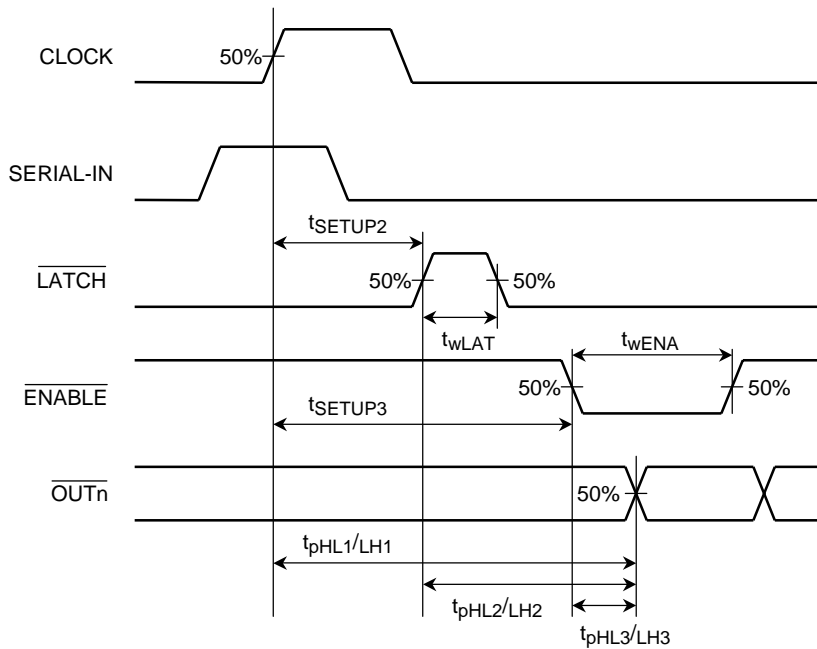


Timing Waveforms

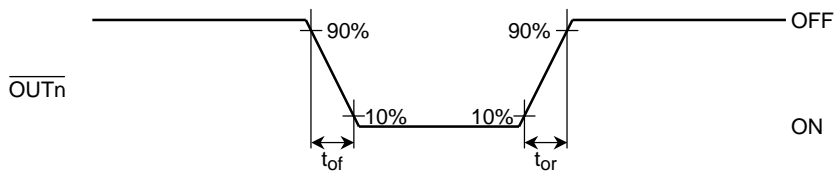
1. CLOCK, SERIAL-IN, SERIAL-OUT



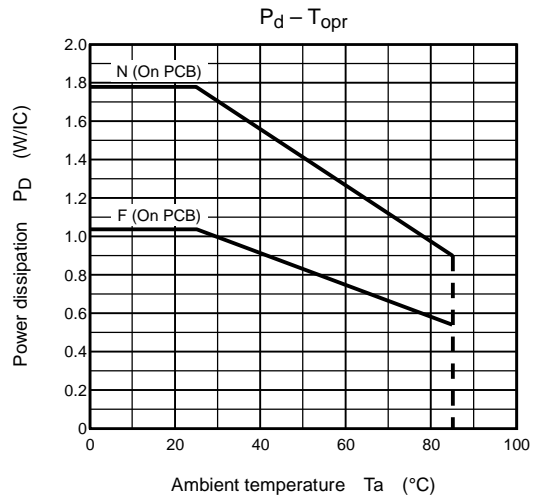
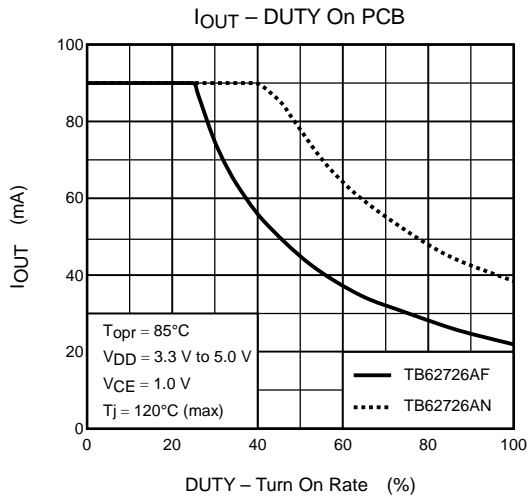
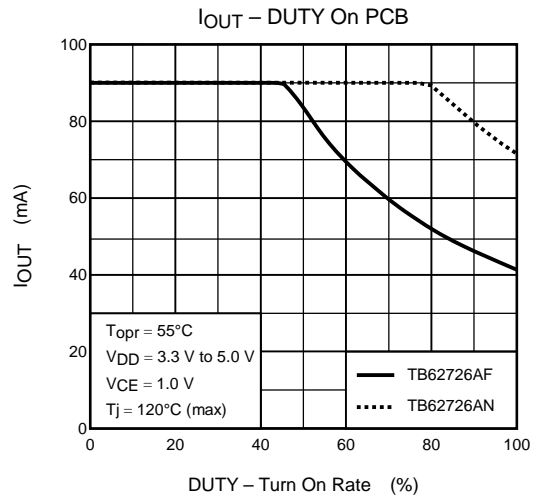
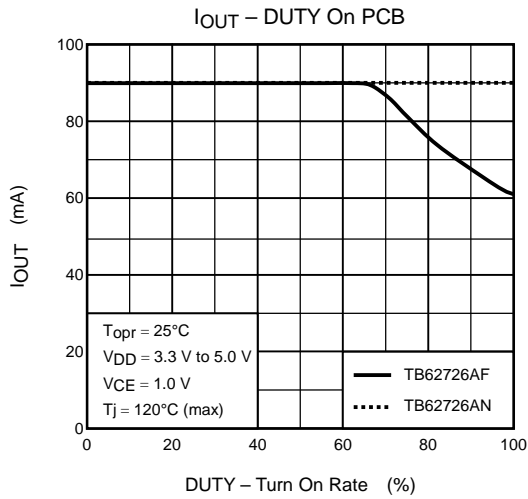
2. CLOCK, SERIAL-IN, $\overline{\text{LATCH}}$, $\overline{\text{ENABLE}}$, $\overline{\text{OUTn}}$



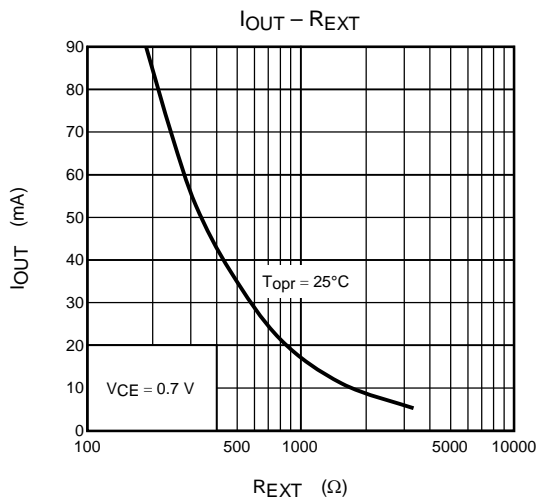
3. $\overline{\text{OUTn}}$



Output Current – Duty (LEDS turn-on rate)



Output Current – R_{EXT} Resistor

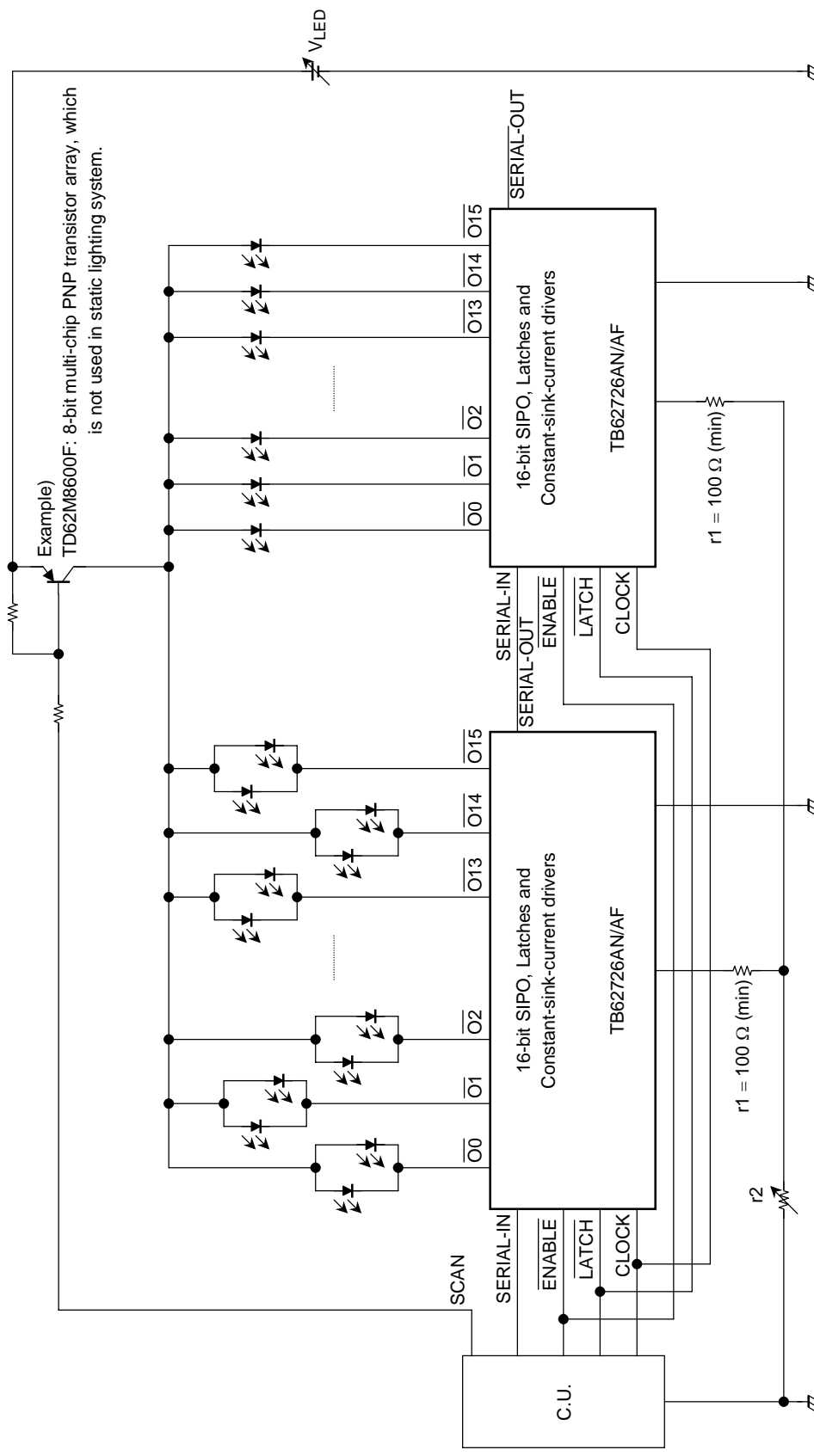


Application Circuit (example 1): The general composition in static lighting of LED.

More than $V_{LED} (V) \geq V_f$ (total max) +0.7 is recommended with the following application circuit with the LED power supply V_{LED} .

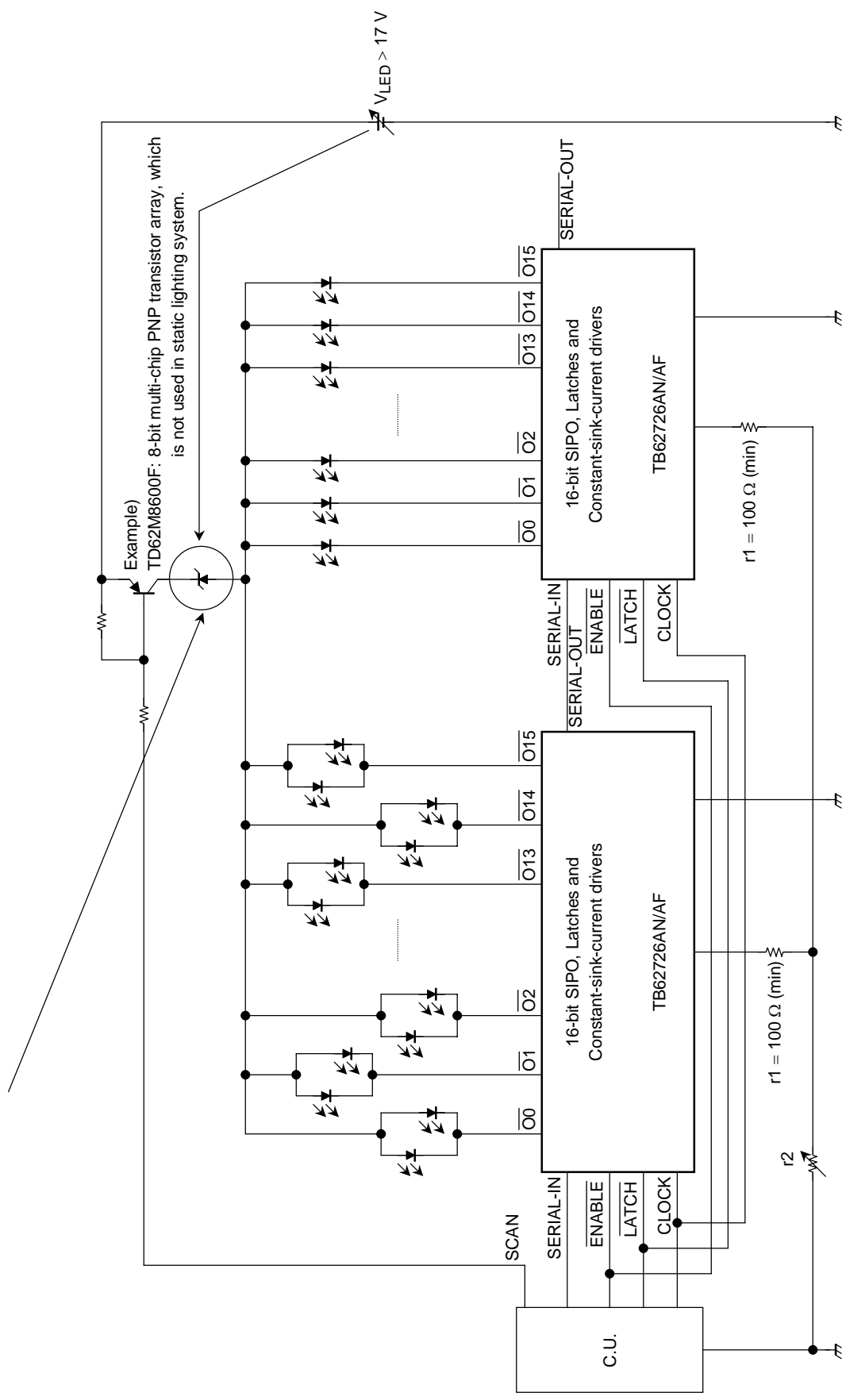
r1: The setup resistance for the setup of output current of every IC.

r2: The variable resistance for the brightness control of every LED module.



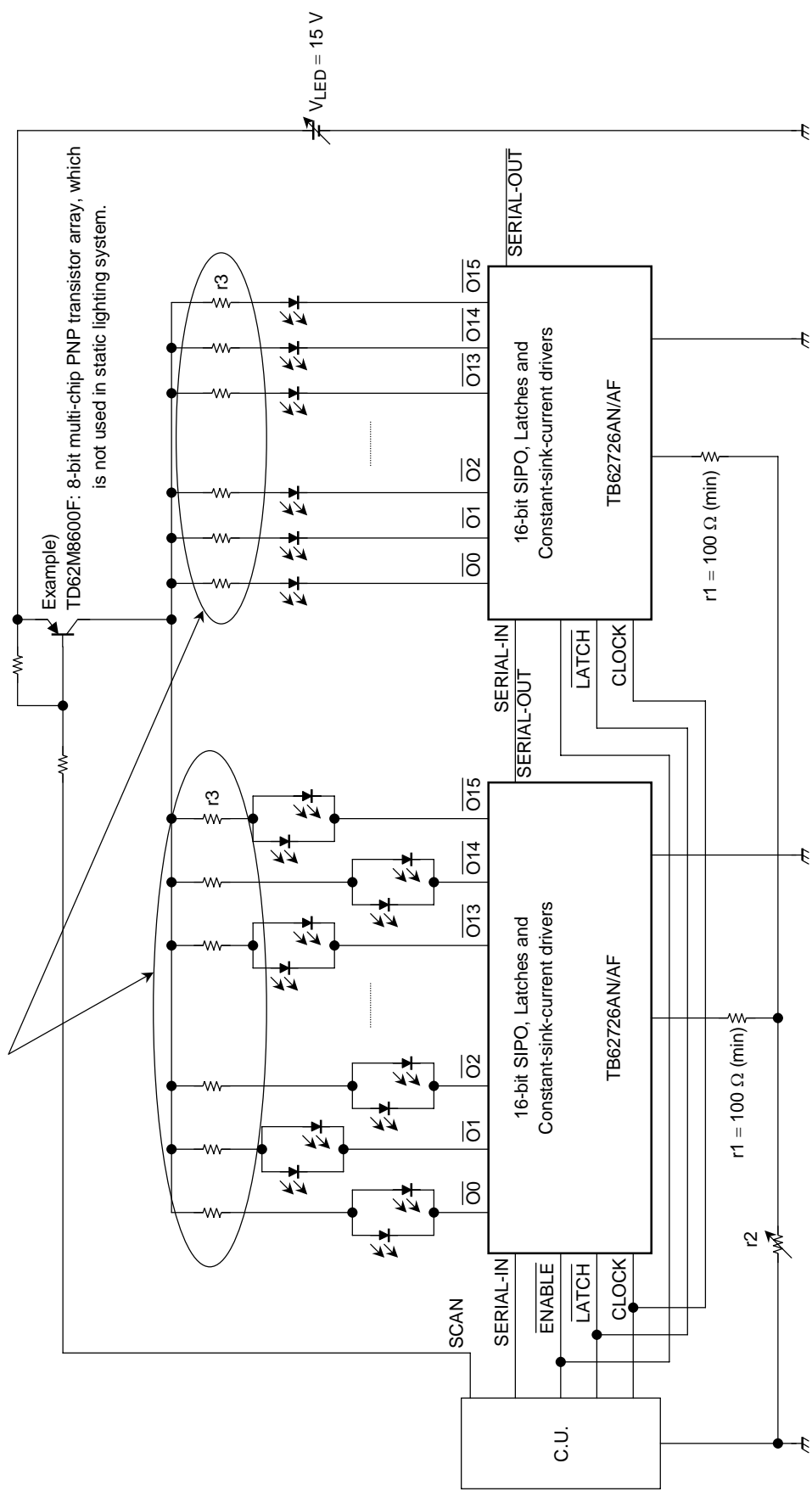
Application Circuit (example 2): When the condition of VLED is $V_{LED} > 17\text{ V}$

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



Application Circuit (example 3): When the condition of VLED is $V_f + 0.7 < V_{LED} < 17\text{ V}$

$V_{OUT} = V_{LED} - V_f = 0.7 \sim 1.0\text{ V}$ is the most suitable for V_{OUT} .
 Surplus V_{OUT} causes an IC fever and the useless consumption electric power.
 It is the one way of being effective to build in the r_3 in this problem.
 r_3 can make a calculation to the formula $r_3 \Omega = \text{surplus } V_{OUT}/I_{OUT}$.
 Though the resistance parts increase, the fixed constant current performance is kept



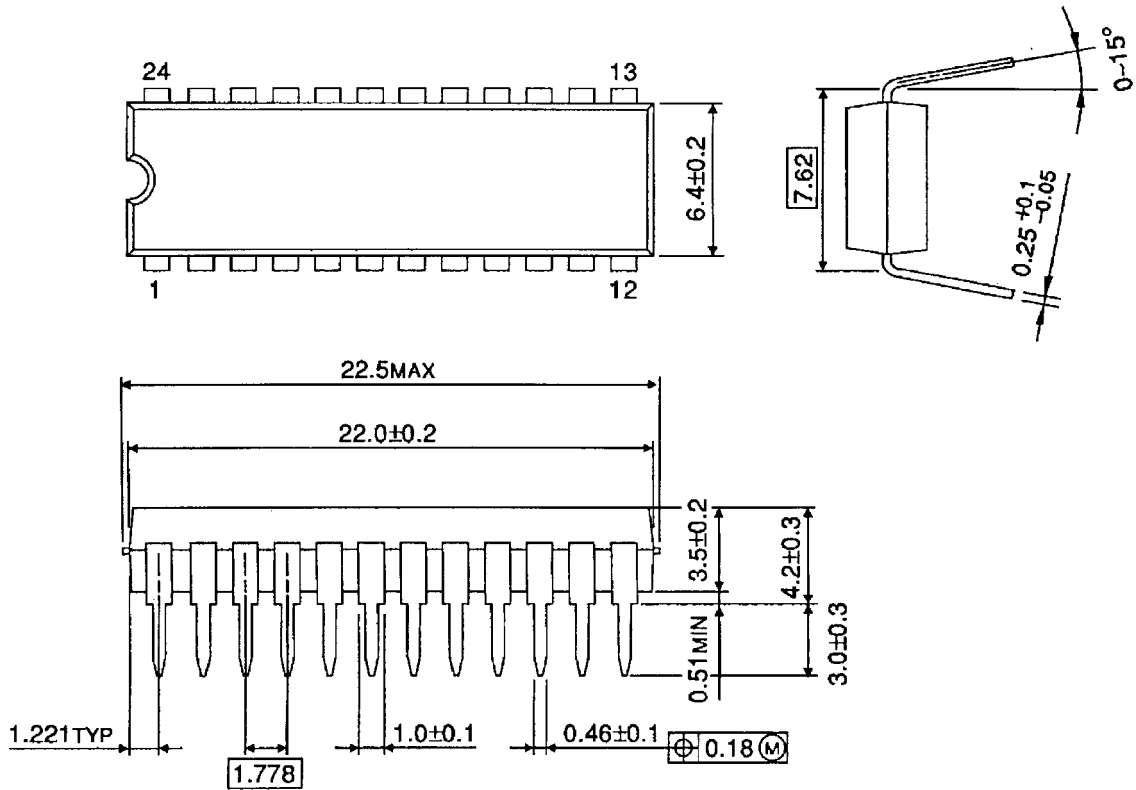
Notes

- 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

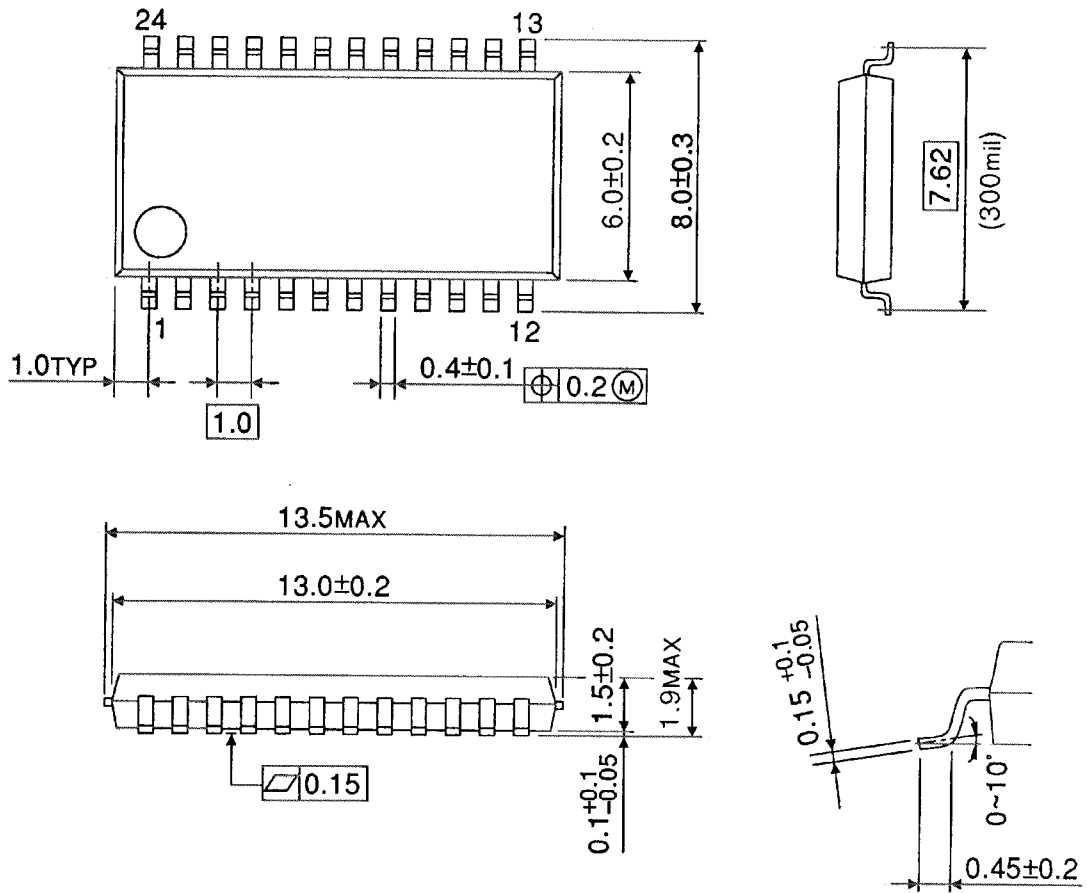


Weight: 1.22 g (typ.)

Package Dimensions

SSOP24-P-300-1.00B

Unit : mm



Weight: 0.32 g (typ.)

RESTRICTIONS ON PRODUCT USE

000707EBA

- TOSHIBA is continually working to improve the quality and reliability of its products. Nevertheless, semiconductor devices in general can malfunction or fail due to their inherent electrical sensitivity and vulnerability to physical stress. It is the responsibility of the buyer, when utilizing TOSHIBA products, to comply with the standards of safety in making a safe design for the entire system, and to avoid situations in which a malfunction or failure of such TOSHIBA products could cause loss of human life, bodily injury or damage to property.
In developing your designs, please ensure that TOSHIBA products are used within specified operating ranges as set forth in the most recent TOSHIBA products specifications. Also, please keep in mind the precautions and conditions set forth in the "Handling Guide for Semiconductor Devices," or "TOSHIBA Semiconductor Reliability Handbook" etc..
- The TOSHIBA products listed in this document are intended for usage in general electronics applications (computer, personal equipment, office equipment, measuring equipment, industrial robotics, domestic appliances, etc.). These TOSHIBA products are neither intended nor warranted for usage in equipment that requires extraordinarily high quality and/or reliability or a malfunction or failure of which may cause loss of human life or bodily injury ("Unintended Usage"). Unintended Usage include atomic energy control instruments, airplane or spaceship instruments, transportation instruments, traffic signal instruments, combustion control instruments, medical instruments, all types of safety devices, etc.. Unintended Usage of TOSHIBA products listed in this document shall be made at the customer's own risk.
- The products described in this document are subject to the foreign exchange and foreign trade laws.
- The information contained herein is presented only as a guide for the applications of our products. No responsibility is assumed by TOSHIBA CORPORATION for any infringements of intellectual property or other rights of the third parties which may result from its use. No license is granted by implication or otherwise under any intellectual property or other rights of TOSHIBA CORPORATION or others.
- The information contained herein is subject to change without notice.