IT1411
16-bit Constant Current LED Sink Driver

INNOCHIP
Innochip Technology Inc.

General Description

IT1411 is a 16-bit constant current LED driver incorporating shift register and data latch designed for LEDs and LED displays. The output current can be set using an external resistor.

All outputs have virtually the same current levels. Sixteen regulated current ports are designed to provide uniform and constant current for driving LEDs within a large range of V_F variations.
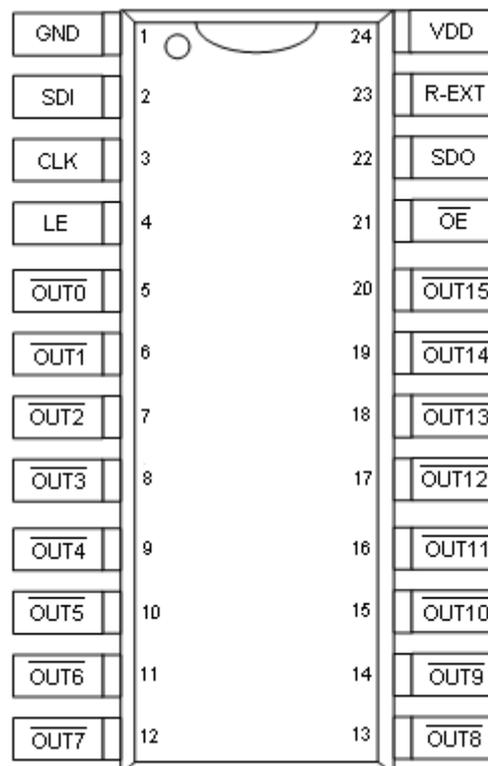
Features

- 16-bit constant current output channel.
- Excellent output current accuracy
  < ±2.5%(Channel to Channel), max.
  <±5%(IC to IC), max.
- Output current adjusted with an external resistor.
- Constant output current range:5~90mA.
- Data transfer rate: 25MHz.
- Maximum output terminal voltage: 17V
- 5V Supply Voltage.
- Internal Power On Reset.

Current Accuracy		Output Current
Between Channels	Between ICs	
<±2.5%	<±5%	5mA~60mA

Pin Configurations

(TOP VIEW)

GND — 1	24 — VDD
SDI — 2	23 — R-EXT
CLK — 3	22 — SDO
LE — 4	21 — $\overline{OE}$
$\overline{OUT0}$ — 5	20 — OUT15
$\overline{OUT1}$ — 6	19 — OUT14
$\overline{OUT2}$ — 7	18 — OUT13
$\overline{OUT3}$ — 8	17 — OUT12
$\overline{OUT4}$ — 9	16 — OUT11
$\overline{OUT5}$ — 10	15 — OUT10
$\overline{OUT6}$ — 11	14 — OUT9
$\overline{OUT7}$ — 12	13 — $\overline{OUT8}$

SOP24-300-1.0 / SOP24

Block Diagram
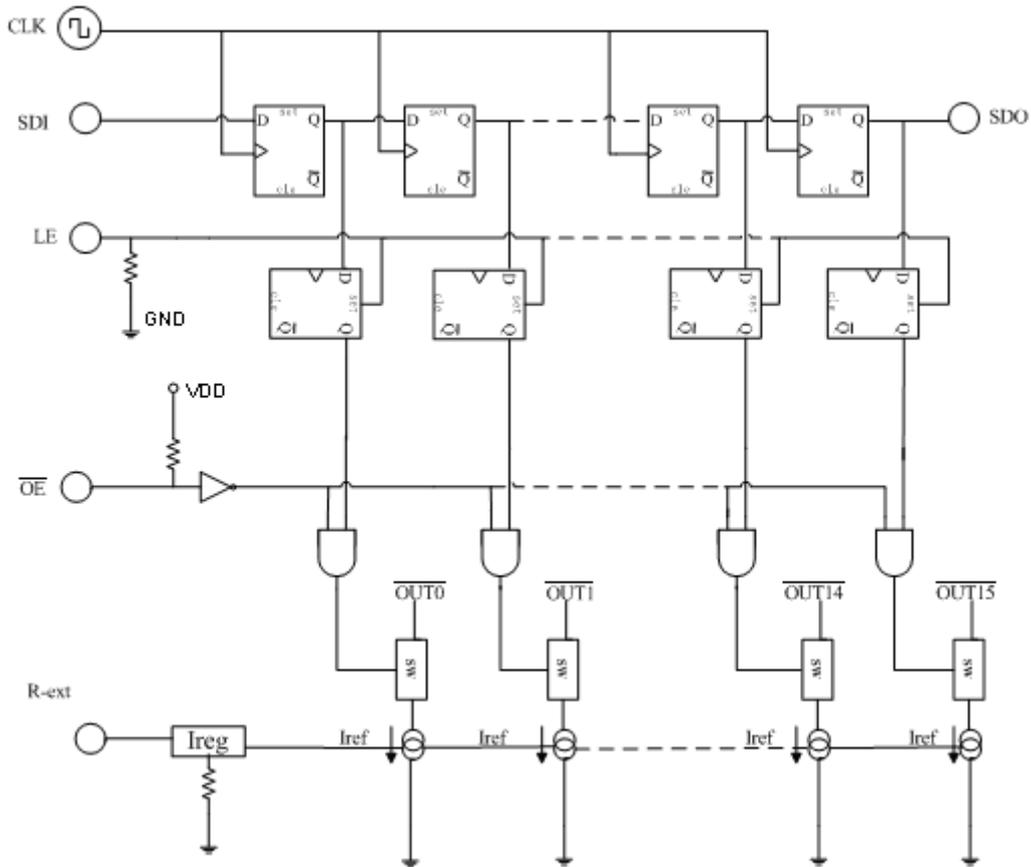
Pin Description

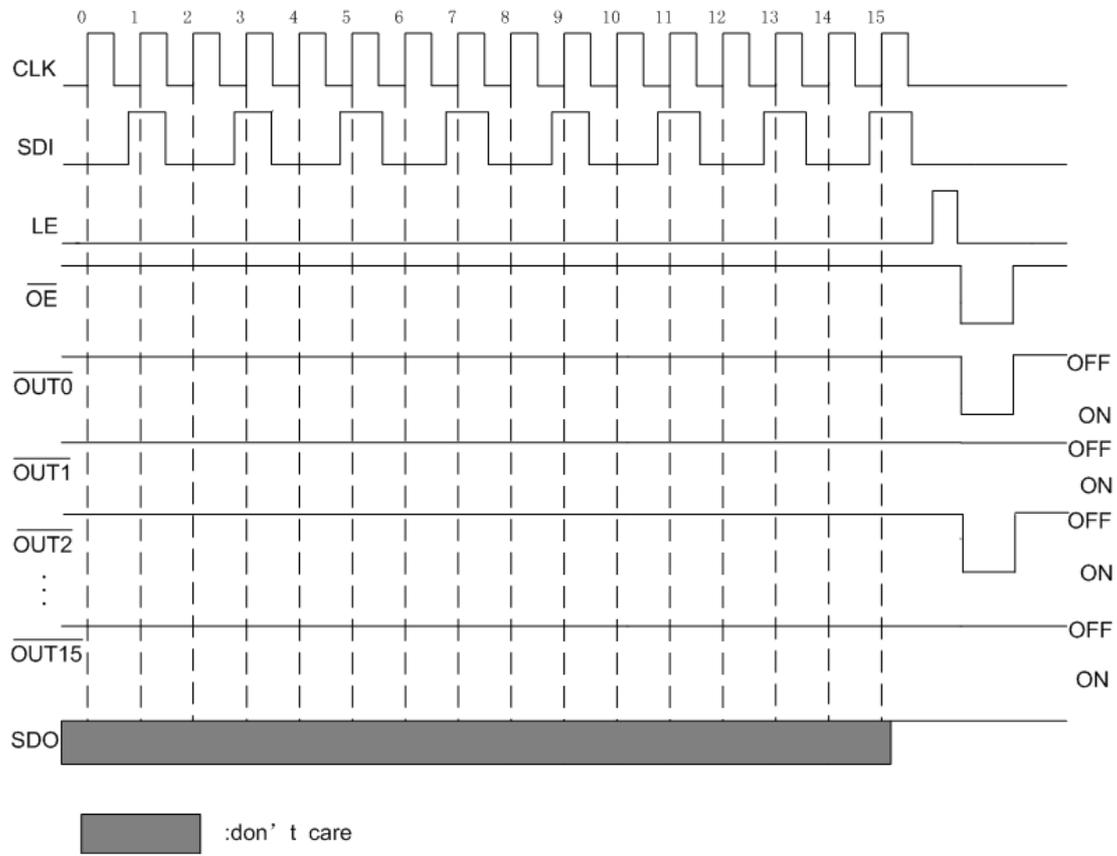| Pin		I/O	Description
NO.	Name		
1	GND		Ground pin
2	SDI	I	Serial input data for data shift register
3	CLK	I	Clock input for data shift on rising edge
4	LE	I	Serial data is transferred to output latch when LE is high. The data is latched when LE goes low.
5~20	$\overline{OUT0} \sim \overline{OUT15}$	O	Constant current output terminals
21	$\overline{OE}$	I	Output enable, low active
22	SDO	O	Serial data output to the following next driver IC
23	R-EXT	I	Input terminal used to connect an external resistor for setting output current for all channels
24	VDD	I	Voltage supply input

Equivalent Circuits of Inputs and Outputs

OE Terminal

LE Terminal

CLK,SDI Terminal

SDO Terminal

Timing Diagram

:don't care

Absolute Maximum Ratings

Characteristic		Symbol	Rating	Unit
Supply Voltage		V_{DD}	7	**V**
Input Voltage		V_{IN}	-0.2~VDD+0.2	**V**
Output Current		I_{OUT}	+90	**mA/ch**
Output Voltage		V_{OUT}	17	**V**
Clock Frequency		F_{CLK}	+25	**MHz**
GND Terminal Current		I_{GND}	1440	**mA**
Power Dissipation	SOP24-300	P_D	1.8	**W**
	SOP24		2.2	
Thermal Resistance	SOP24-300	$R_{th(j-a)}$	56	**ºC/W**
	SOP24		46	
Operation Temperature		Topr	-40~+85	**ºC**
Storage Temperature		Tstg	-55~+150	**ºC**
Minimum ESD Rating		HBM	2	**KV**
		MM	200	**V**

1.Stress beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

2. Device is ESD sensitive. Handling precaution is recommended. The Human Body model is a 100pF capacitor discharged through a 1.5kΩ resistor into each pin.

Electrical Characteristics

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
Supply Voltage Range	V_{DD}	-	4.5	5	5.5	**V**
Output Voltage	V_{OUT}	-	-	-	17	**V**
Output Current	I_{OUT}	DC Output Channel	5		60	**mA**
		SDO=high			-1	
		SDO=low			1	
Input Voltage	V_{iH}	T_a=-40 ^{o}C ~85°C	$0.7V_{DD}$		V_{DD}	**V**
	V_{iL}	T_a=-40 ^{o}C ~85°C	0		$0.3^* V_{DD}$	
Output Voltage(SDO)	V_{OH}	I_{OH}=-1.0mA	4.6			**V**
	V_{OL}	I_{OL}=1.0mA			0.4	
Output Leakage Current	I_{OH}	V_{OUT}=17.0V			1	**µA**
Output Current1	I_{OUT1}	V_{DS}=0.8V, R_{EXT}=1.65kΩ		40		**mA**
Current Skew	dI_{OUT1}	I_{OUT}=42mA			±2.5	**%**
Output Current2	I_{OUT2}	V_{DS}=0.5V, R_{EXT}=3.3kΩ		20		**mA**
Current Skew	dI_{OUT2}	I_{OUT}=20mA			±2.5	**%**
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			±0.1	**%/V**
Pull-up Resistor	R_{IN}(up)	$\overline{OE}$		500		**KΩ**
Pull-down Resistor	R_{IN}(dn)	LE		500		**KΩ**
Supply Current (OFF)	I_{DD}(off)1	R_{EXT}=OPEN, $\overline{OUT0}$~$\overline{OUT15}$ =OFF		8.1		**mA**
	I_{DD}(off)2	R_{EXT}=3.3kΩ, $\overline{OUT0}$~$\overline{OUT15}$ =OFF		8.4		
	I_{DD}(off)3	R_{EXT}=1.65kΩ, $\overline{OUT0}$~$\overline{OUT15}$ =OFF		8.9		
Supply Current (ON)	I_{DD}(on)1	R_{EXT}=3.3kΩ, $\overline{OUT0}$~$\overline{OUT15}$ =ON		8.4		
	I_{DD}(on)2	R_{EXT}=1.65kΩ, $\overline{OUT0}$~$\overline{OUT15}$ =ON		8.9		

Switching Characteristics

Characteristic		Symbol	Condition	Values			Unit
				Min.	Typ.	Max.	
Propagation Delay ("L" to "H")	$CLK - \overline{OUTn}$	t_{pLH1}			60	100	**nS**
	$LE - \overline{OUTn}$	t_{pLH2}			50	100	**nS**
	$\overline{OE} - \overline{OUTn}$	t_{pLH3}			50	100	**nS**
	$CLK - SDO$	t_{pLH}	V_{DD}=5.0V		20		**nS**
Propagation Delay ("H" to "L")	$CLK - \overline{OUTn}$	t_{pHL1}	V_{DS}=0.8V V_{IH}= V_{DD}		60	150	**nS**
	$LE - \overline{OUTn}$	t_{pHL2}	V_{IL}=GND R_{ext}=1.2KΩ		50	150	**nS**
	$OEB - \overline{OUTn}$	t_{pHL3}	V_L=4.0V R_L=52Ω		50	150	**nS**
	$CLK - SDO$	t_{pHL}	C_L=10pF		20		**nS**
Pulse Width	CLK	$t_{w(CLK)}$		20			**nS**
	LE	$t_{w(LE)}$		20			**nS**
	$\overline{OE}$	$t_{w(OE)}$		45			**nS**
Hold time for LE		$t_{h(LE)}$		5			**nS**
Setup time for LE		$t_{su(LE)}$		5			**nS**
Output Rise Time		t_{or}			70	200	**nS**
Output Fall Time		t_{of}			40	120	**nS**
Maximum CLK rise time		t_r				500	**nS**
Maximum CLK fall time		t_f				500	**nS**

Test Circuit for Switching Characteristics

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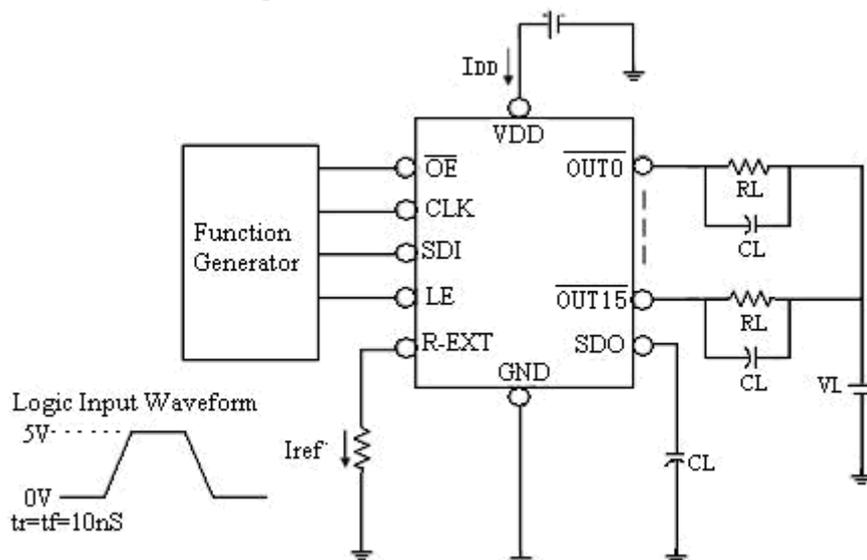
Timing Waveform
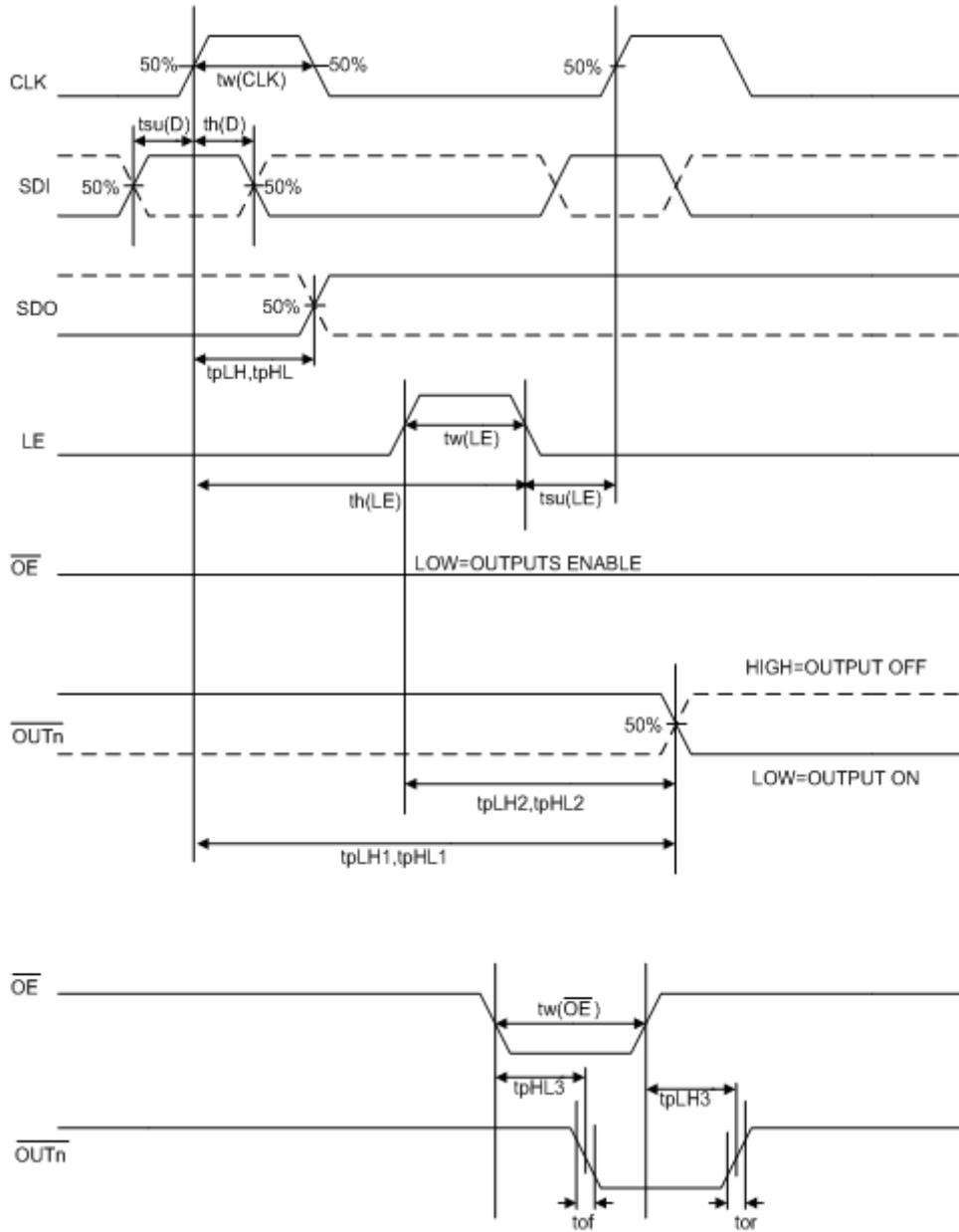
Application Information

Constant Current

To design LED displays, IT1411 provides very low variations in current from channel to channel and from IC to IC.

1) The maximum current variation between channels is less than ±2.5%, and between ICs is less than ±5%.

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.
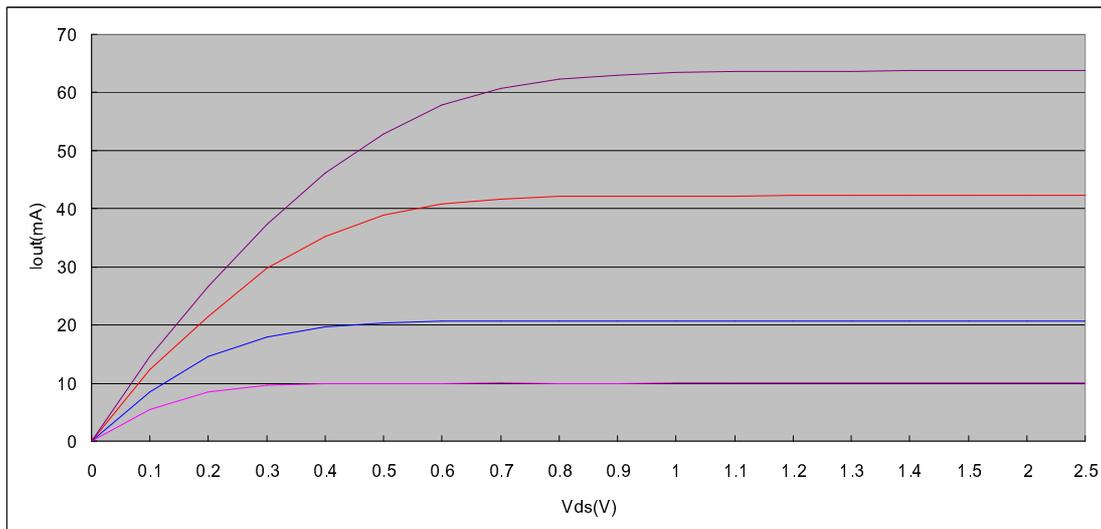
Adjusting Output Current

The output current of each channel (I_{OUT}) is set by an external resistor, R_{ext}. The relationship between I_{OUT} and R_{ext} is shown in the following figure.
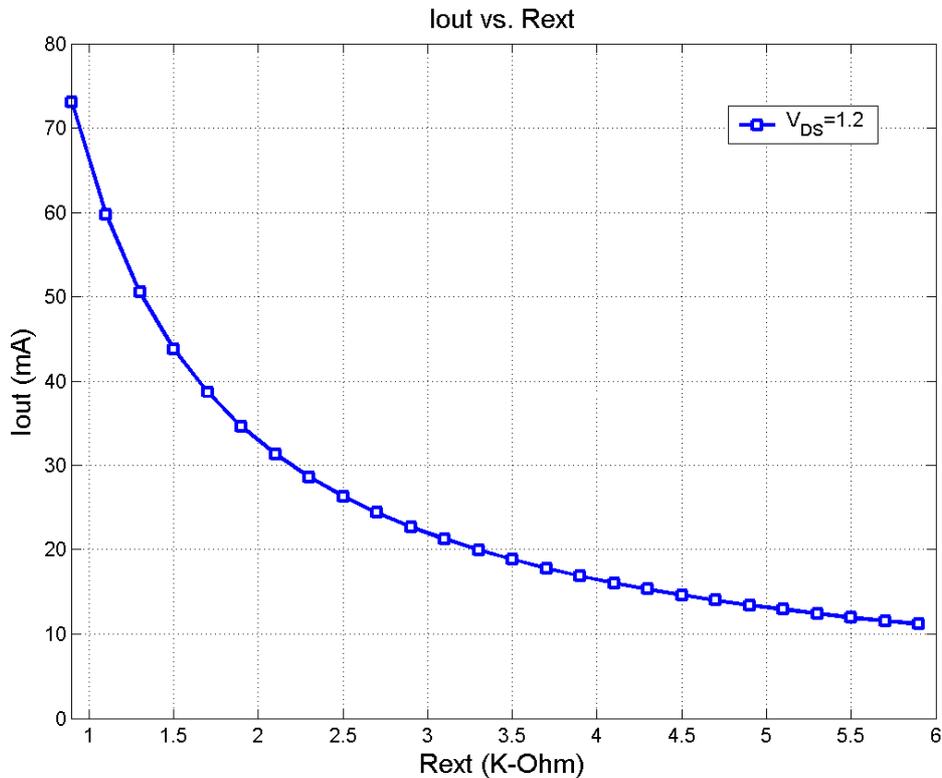
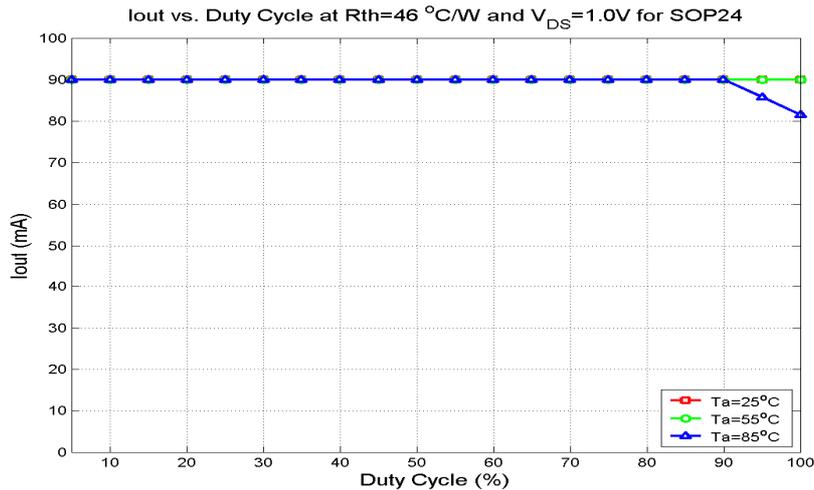The output current in milliamps can be calculated from the equation:

I_{OUT} is (1.24/R_{ext}) ⨉ 53, approximately,

Where R_{ext}, in Ω, is the resistance of the external resistor connected to R-EXT terminal.

The magnitude of current (as a function of R_{ext}) is around 40mA at 1.65kΩ and 20mA at 3.3kΩ.

Package Power Dissipation(P_D)

This maximum allowable package power dissipation is determined as $P_D(max)=(T_j-T_a)/ R_{th(j-a)}$. When 16 output channels are turned on simultaneously, the actual package power dissipation is $P_D(act)=(I_{DD}×V_{DD})+(I_{OUT}×Duty×V_{Ds}×16)$. Therefore, to keep $P_D(act) \leqslant P_D(max)$, the allowable maximum output current as a function of duty cycle is:

$I_{OUT}=\{[(T_j-T_a)/ R_{th(j-a)}]-(I_{DD}×V_{DD})\}/ V_{Ds}/Duty/16$, where $T_j=150^oC$.

Iout vs. Duty Cycle at Rth=46 ^oC/W and V_{DS}=1.0V for SOP24

Iout vs. Duty Cycle at Rth=46 ^oC/W and V_{DS}=1.5V for SOP24
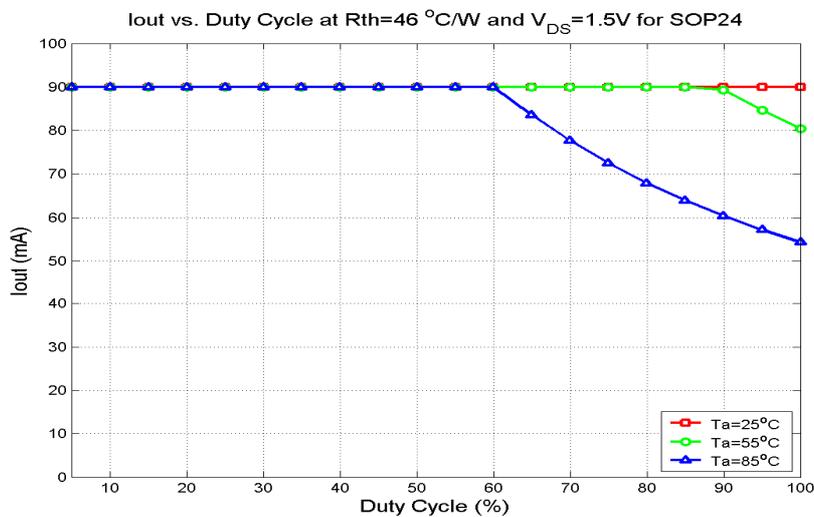
Condition: Iout=90mA, V_{DS}=1.2V, 16 output channels	
Device Type	$R_{th(j-a)}$(°C/W)
SOP24-300	56
SOP24	46

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

Maximum Power Dissipation at Various Ambient Temperature
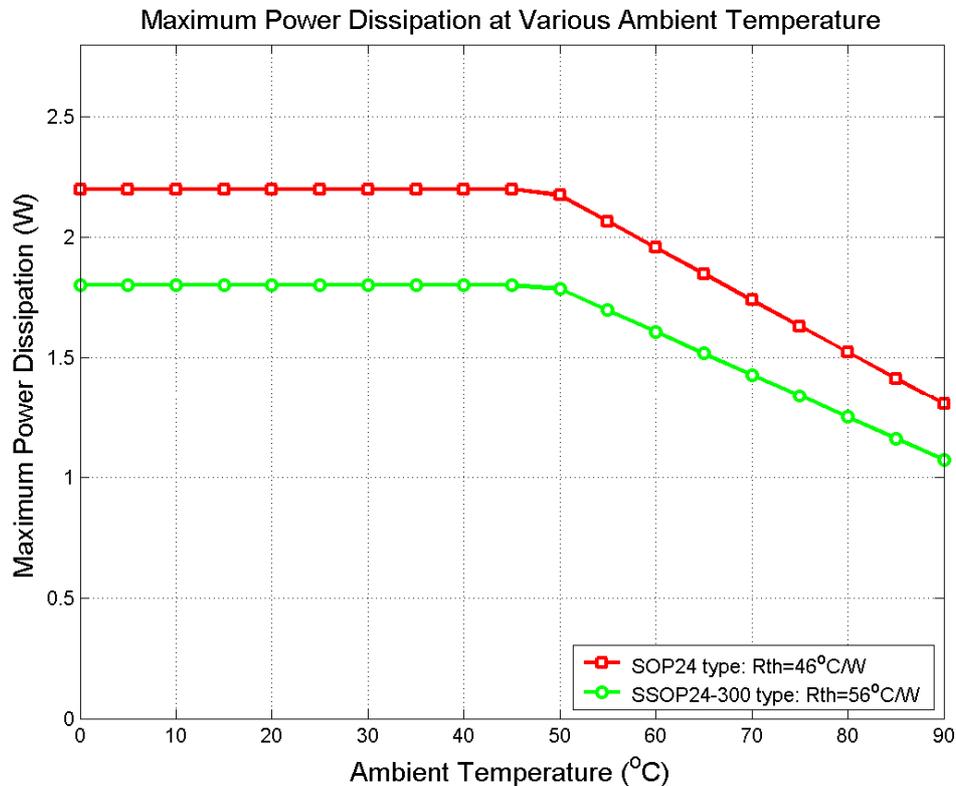
Load Supply Voltage(VLED)

This device is operating with the VDS of 1.0V to 1.2V with LED forward voltage(VF) of 1.2V to 4.0V. If VDS be higher enough to make package power dissipation increased. It is recommended to use lowest load supply voltage or to set any serials dropping voltage as following figures.
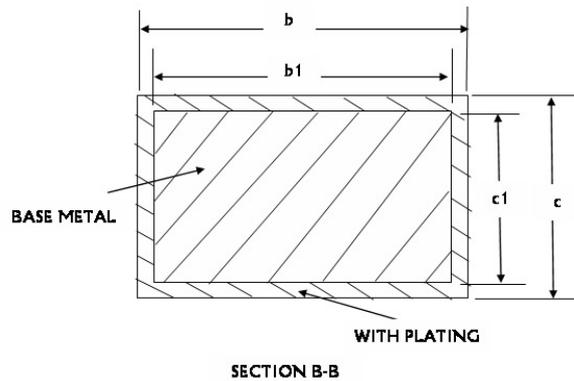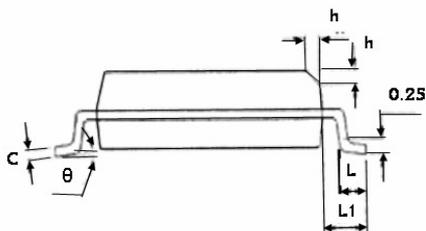
VDS=VLED-VF-VDROP

Safe Operation Area
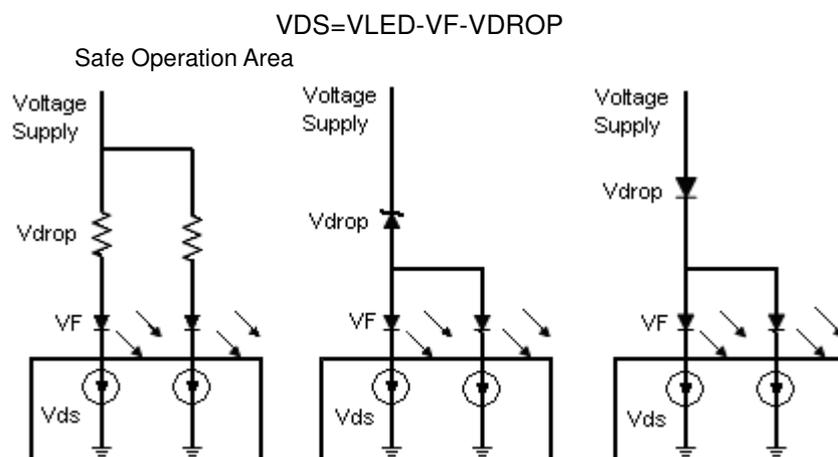
IT1411(SOP24-300-1.0) Outline Drawing
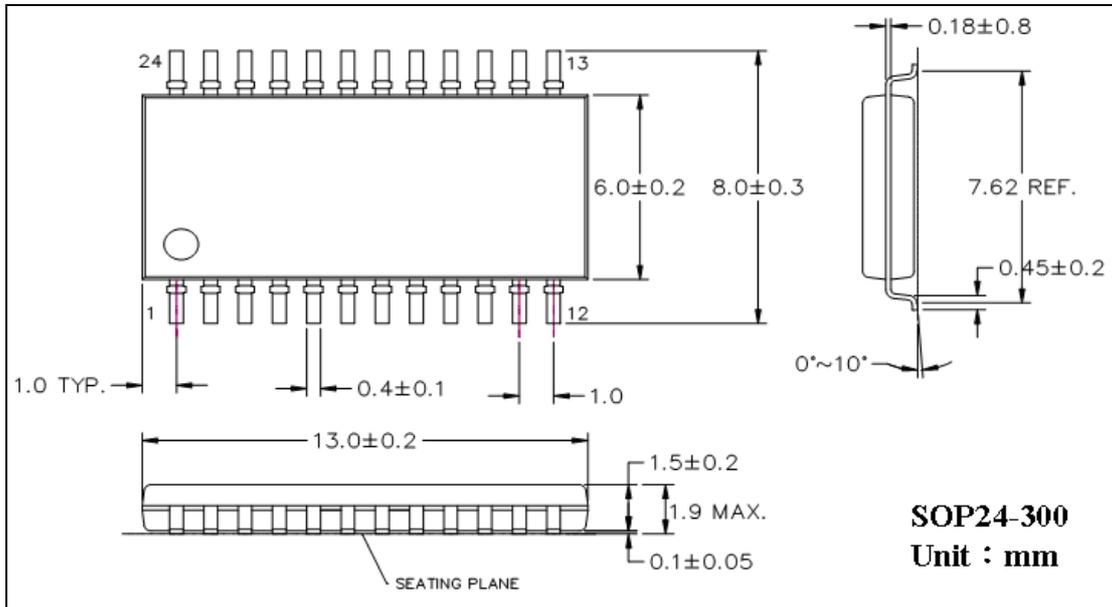
IT1411(SOP24) Outline Drawing
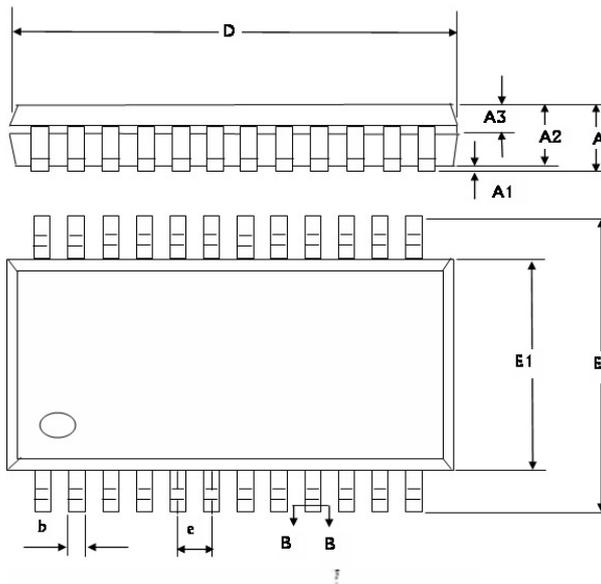
SYMBOL	MILLMETER		
	MIN	NOM	MAX
A	2.36	2.54	2.64
A1	0.1	0.2	0.3
A2	2.26	2.3	2.35
A3	0.97	1.02	1.07
b	0.39	-----	0.48
b1	0.38	0.41	0.43
c	0.25	-----	0.31
c1	0.24	0.25	0.26
D	15.2	15.4	15.6
E	10.1	10.3	10.5
E1	7.4	7.5	7.6
e	1.27 BSC		
L	0.7	-----	1
L1	1.40 BSC		
h	0.25	-----	0.75
θ	0	-----	8°
L/F載體尺寸 (mil)	80 * 110		190 * 220

Soldering Temperature Suggestion for RoHS materials(JEDEC

J-STD-020C)

Temperature(°C)

Time(sec)
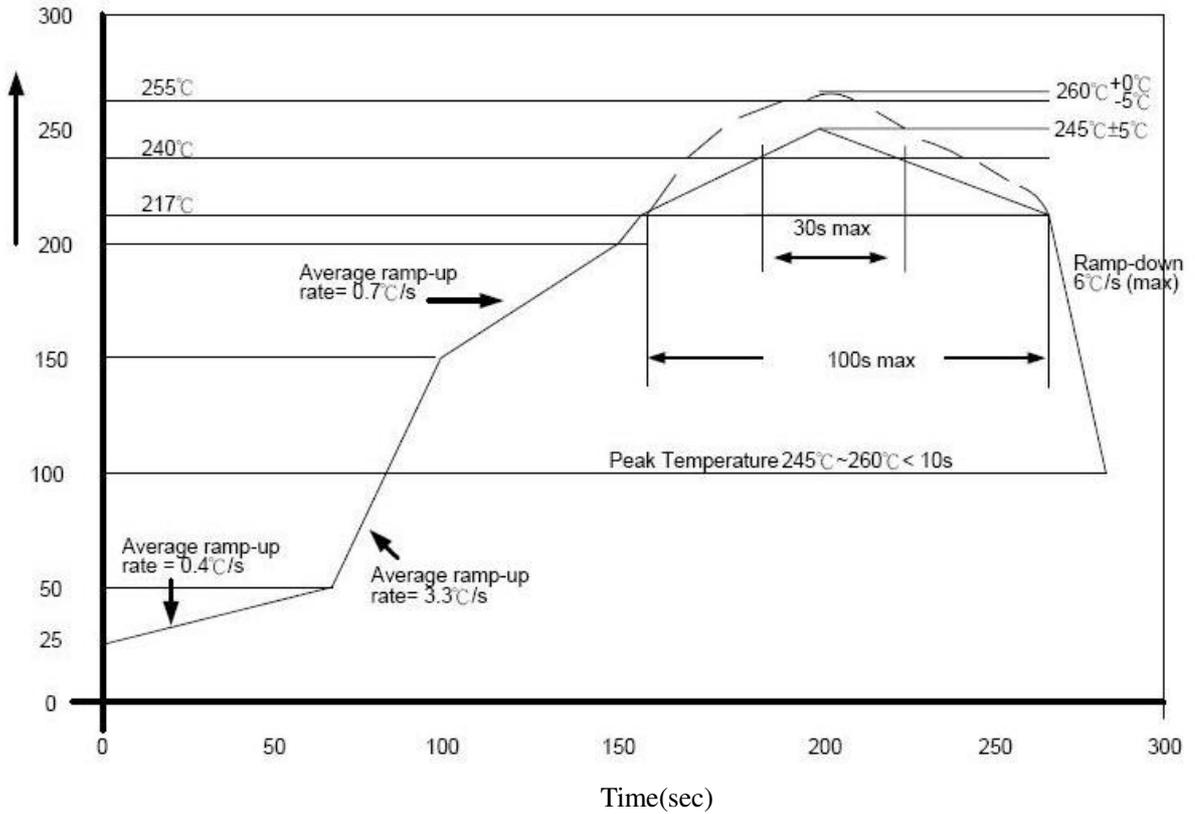
——: Recommended Reflow Profile

------: Maximum Peak Temperature