General Description

IT1402 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.

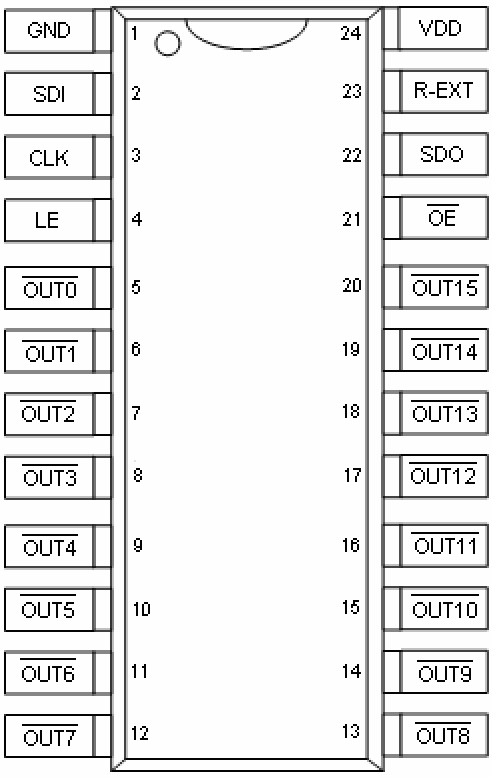
Features

- 16-bit constant current output channel.
- Excellent channel output current accuracy <±2%.
- Output current adjusted with an external resistor.
- Constant output current range:5~45mA.
- Data transfer rate: 25MHz.
- Maximum output terminal voltage: 17V
- 3V~5.5V Supply Voltage.
- Internal Power On Reset.

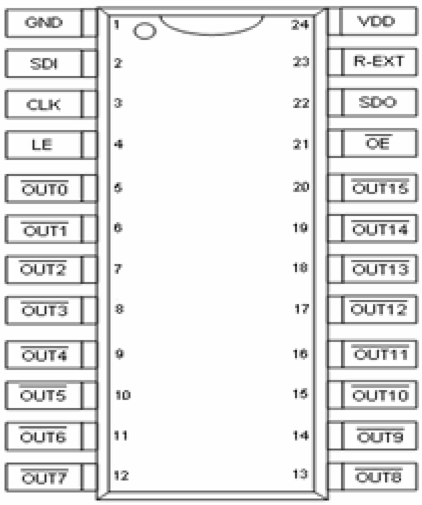
Current Accuracy		Output Current
Between Channels	Between ICs	
<±2%	<±5%	5mA~45mA

Pin Configurations

(TOP VIEW)

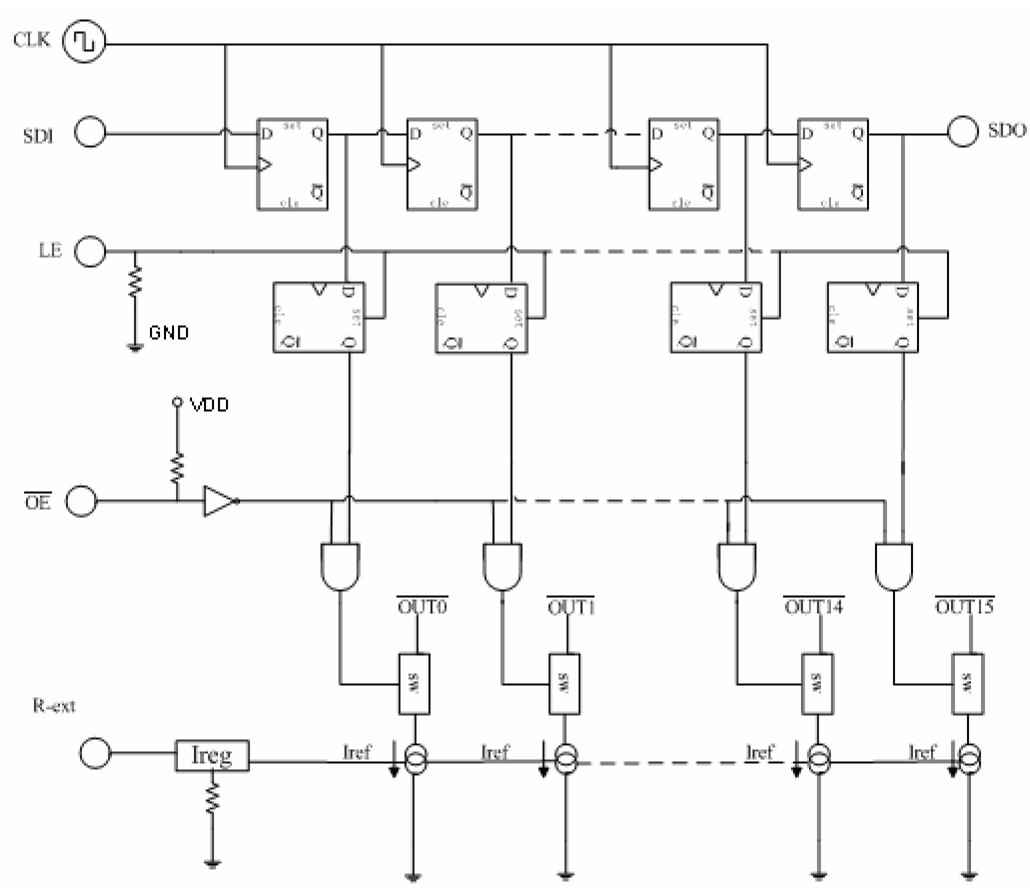


SOP24-300



SSOP24-150

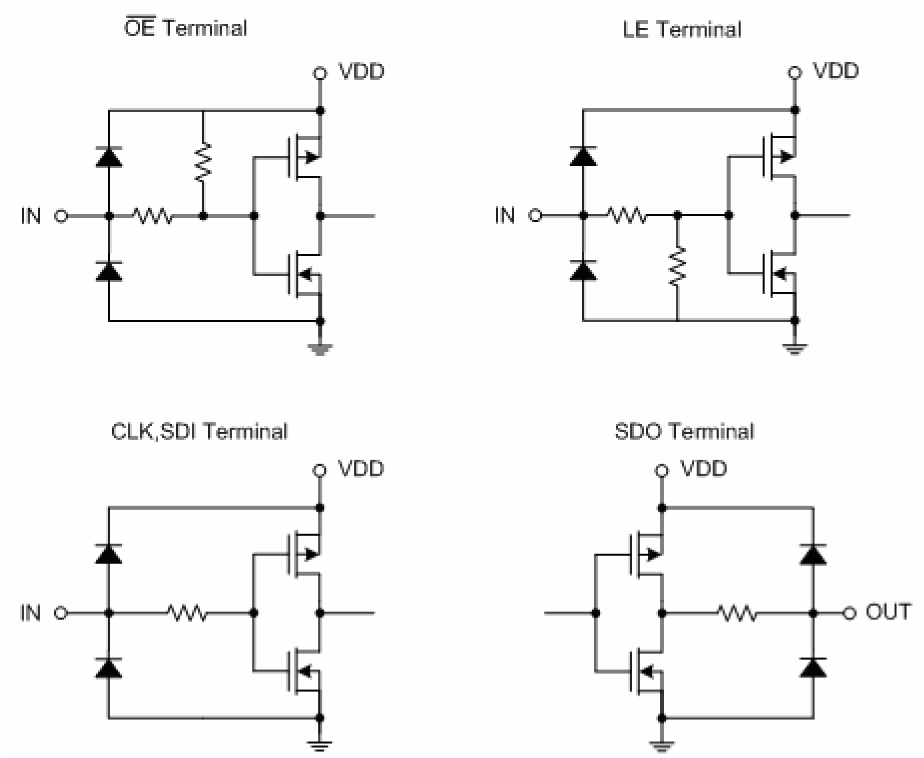
Block Diagram



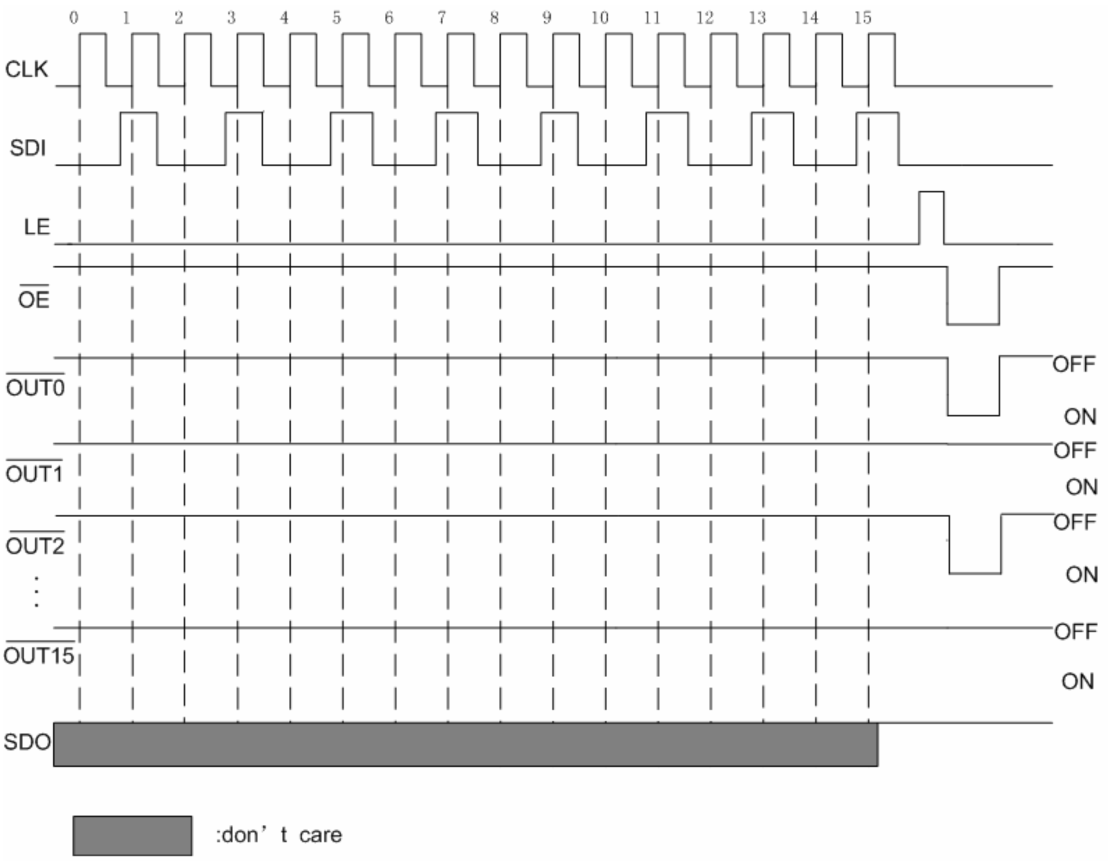
Pin Description

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	$\overline{OUT0}$~$\overline{OUT15}$	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	V_{DD}	I	Voltage supply input

Equivalent Circuits of Inputs and Outputs



Timing Diagram



Absolute Maximum Ratings

Parameter	Symbol	Rated Value		Unit
		Min.	Max.	
Supply Voltage	V_{DD}	-0.5	6.0	**V**
Input Voltage	V_{IN}	-0.2	V_{DD}+0.2	**V**
Output Current	I_{OUT}		45	**mA/ch**
Output Voltage	V_{OUT}	-0.2	17	**V**
Power Dissipation	Pd		1	**W**
Thermal Resistance	Rth(j-a)		75	**°C/W**
Operation Temperature	Topr	-40	85	**°C**
Junction Temperature	Tj		150	**°C**
Storage Temperature	Tstg	-55	150	**°C**
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 recommended. The Human Body model is a 100pF capacitor discharged through a 1.5kΩ resistor into each pin.

Electrical Characteristics (V_{DD}=5.0V)

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		45	**mA**
		SDO=high			-1	
		SDO=low			1	
Input Voltage	V_{iH}	T_a=-40°C ~85°C	0.7V_{DD}		V_{DD}	**V**
	V_{iL}	T_a=-40°C ~85°C	0		0.3V_{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}=40mA			±2	**%**
Output Current2	I_{OUT2}	V_{DS}=0.5V, R_{EXT}=3.3kΩ		20		**mA**
Current Skew	dI_{OUT2}	I_{OUT}=20mA			±2	**%**
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		5.4		**mA**
	I_{DD}(off)2	R_{EXT}=3.3kΩ, $\overline{OUT0}$~$\overline{OUT15}$ =OFF		9.8		
	I_{DD}(off)3	R_{EXT}=1.65kΩ, $\overline{OUT0}$~$\overline{OUT15}$ =OFF		10.5		
Supply Current (ON)	I_{DD}(on)1	R_{EXT}=3.3kΩ, $\overline{OUT0}$~$\overline{OUT15}$ =ON		9.8		
	I_{DD}(on)2	R_{EXT}=1.65kΩ, $\overline{OUT0}$~$\overline{OUT15}$ =ON		10.5		

Electrical Characteristics (V_{DD}=3.3V)

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
Supply Voltage Range	V_{DD}	-	3.0	3.3	3.6	V
Output Voltage	V_{OUT}	-	-	-	17	V
Output Current	I_{OUT}	DC Output Channel	5		45	mA
		SDO=high			-1	
		SDO=low			1	
Input Voltage	V_{iH}	T_a=-40°C ~85°C	0.7V_{DD}		V_{DD}	V
	V_{iL}	T_a=-40°C ~85°C	0		0.3V_{DD}	
Output Voltage(SDO)	V_{OH}	I_{OH}=-1.0mA	2.9			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}=40mA			±2	%
Output Current2	I_{OUT2}	V_{DS}=0.5V, R_{EXT}=3.3kΩ		20		mA
Current Skew	dI_{OUT2}	I_{OUT}=20mA			±2	%
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 3.0V and 3.6V			±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		4.8		mA
	I_{DD}(off)2	R_{EXT}=3.3kΩ, $\overline{OUT0}$~ $\overline{OUT15}$ =OFF		8.9		
	I_{DD}(off)3	R_{EXT}=1.65kΩ, $\overline{OUT0}$~ $\overline{OUT15}$ =OFF		9.4		
Supply Current (ON)	I_{DD}(on)1	R_{EXT}=3.3kΩ, $\overline{OUT0}$~ $\overline{OUT15}$ =ON		8.9		
	I_{DD}(on)2	R_{EXT}=1.65kΩ, $\overline{OUT0}$~ $\overline{OUT15}$ =ON		9.4		

Switching Characteristics (V_{DD}=5.0V)

Characteristic		Symbol	Condition	Values			Unit
				Min.	Typ.	Max.	
Propagation Delay ("L" to "H")	$CLK - \overline{OUTn}$	t_{pLH1}	V_{DD}=5.0V V_{IH}= V_{DD} V_{IL}=GND R_{ext}=3.3KΩ V_L=2.0V R_L=52Ω C_L=10pF	-	30	-	nS
	$LE - \overline{OUTn}$	t_{pLH2}		-	20	-	nS
	$\overline{OE} - \overline{OUTn}$	t_{pLH3}		-	20	-	nS
	$CLK - SDO$	t_{pLH}		-	15	-	nS
Propagation Delay ("H" to "L")	$CLK - \overline{OUTn}$	t_{pHL1}		-	50	-	nS
	$LE - \overline{OUTn}$	t_{pHL2}		-	35	-	nS
	$OEB - \overline{OUTn}$	t_{pHL3}		-	30	-	nS
	$CLK - SDO$	t_{pHL}		-	15	-	nS
Pulse Width	CLK	$t_{w(CLK)}$		20	-	-	nS
	LE	$t_{w(LE)}$		20	-	-	nS
	$\overline{OE}$	$t_{w(OE)}$		40	-	-	nS
Hold time for LE		$t_{h(LE)}$		5	-	-	nS
Setup time for LE		$t_{su(LE)}$		5	-	-	nS
Output Rise Time		t_{or}		-	25	-	nS
Output Fall Time		t_{of}		-	25	-	nS
Maximum CLK rise time		t_r^{**}		-	-	500	nS
Maximum CLK fall time		t_f^{**}		-	-	500	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.

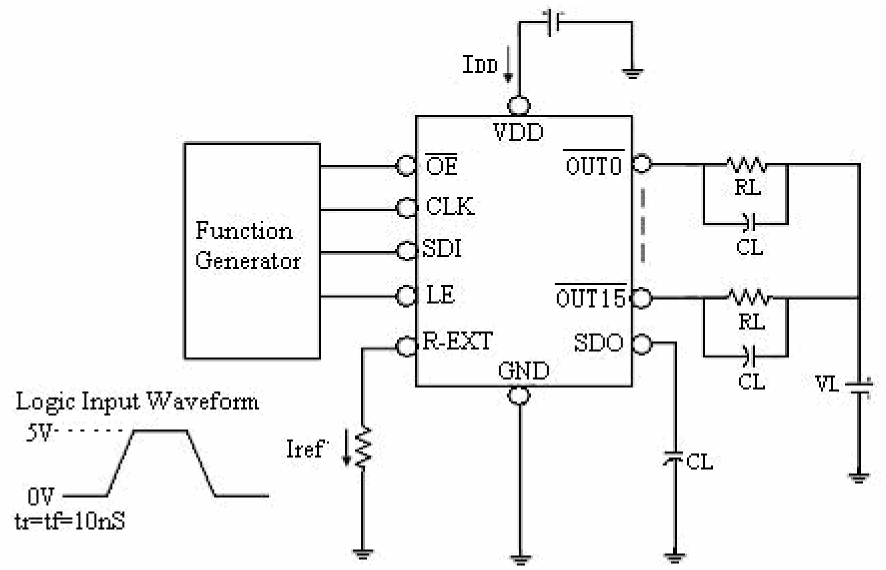
Switching Characteristics (V_{DD}=3.3V)

Characteristic		Symbol	Condition	Values			Unit
				Min.	Typ.	Max.	
Propagation Delay ("L" to "H")	$CLK - \overline{OUTn}$	t_{pLH1}	V_{DD}=3.3V V_{IH}= V_{DD} V_{IL}=GND R_{ext}=3.3KΩ V_L=2.0V R_L=52Ω C_L=10pF	-	40	-	nS
	$LE - \overline{OUTn}$	t_{pLH2}		-	30	-	nS
	$\overline{OE} - \overline{OUTn}$	t_{pLH3}		-	30	-	nS
	$CLK - SDO$	t_{pLH}		-	20	-	nS
Propagation Delay ("H" to "L")	$CLK - \overline{OUTn}$	t_{pHL1}		-	50	-	nS

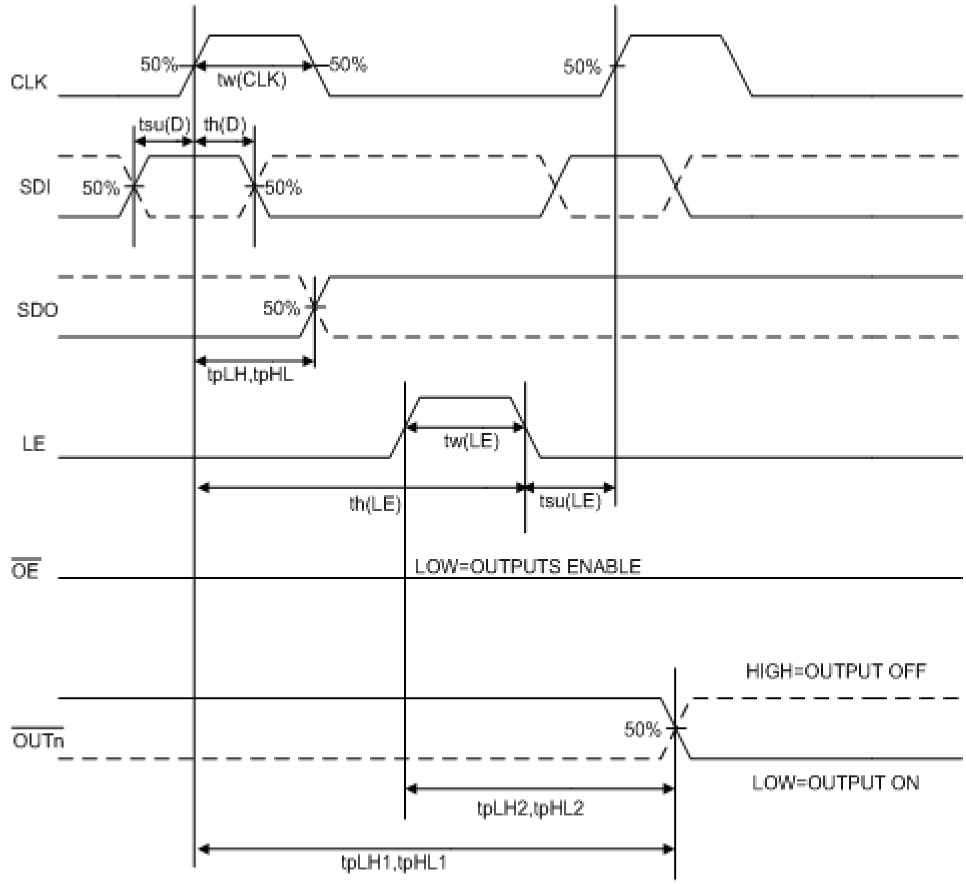
	$LE-\overline{OUTn}$	t_{pHL2}		-	35	-	**nS**
	$OEB-\overline{OUTn}$	t_{pHL3}		-	40	-	**nS**
	$CLK-SDO$	t_{pHL}		-	20	-	**nS**
Pulse Width	CLK	$t_{w(CLK)}$		20	-	-	**nS**
	LE	$t_{w(LE)}$		20	-	-	**nS**
	$\overline{OE}$	$t_{w(OE)}$		40	-	-	**nS**
Hold time for LE		$t_{h(LE)}$		5	-	-	**nS**
Setup time for LE		$t_{su(LE)}$		5	-	-	**nS**
Output Rise Time		t_{or}		-	35	-	**nS**
Output Fall Time		t_{of}		-	30	-	**nS**
Maximum CLK rise time		t_r^{**}		-	-	500	**nS**
Maximum CLK fall time		t_f^{**}		-	-	500	**nS**

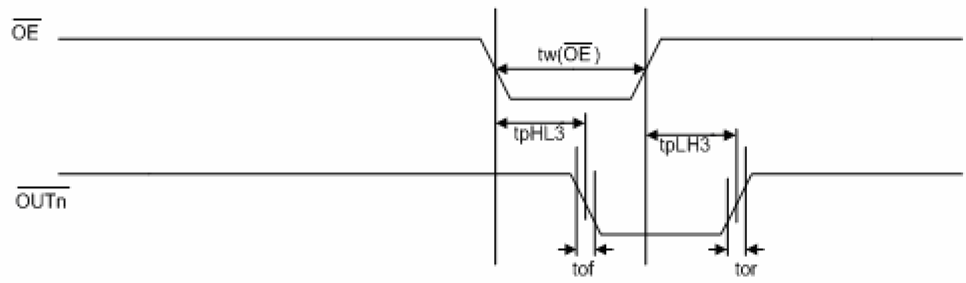
※If the devices are connected in cascade and t_r or t_f is large, it may be critical to achieve the timing required for data transfer between two cascaded devices.

Test Circuit for Switching Characteristics



Timing Waveform



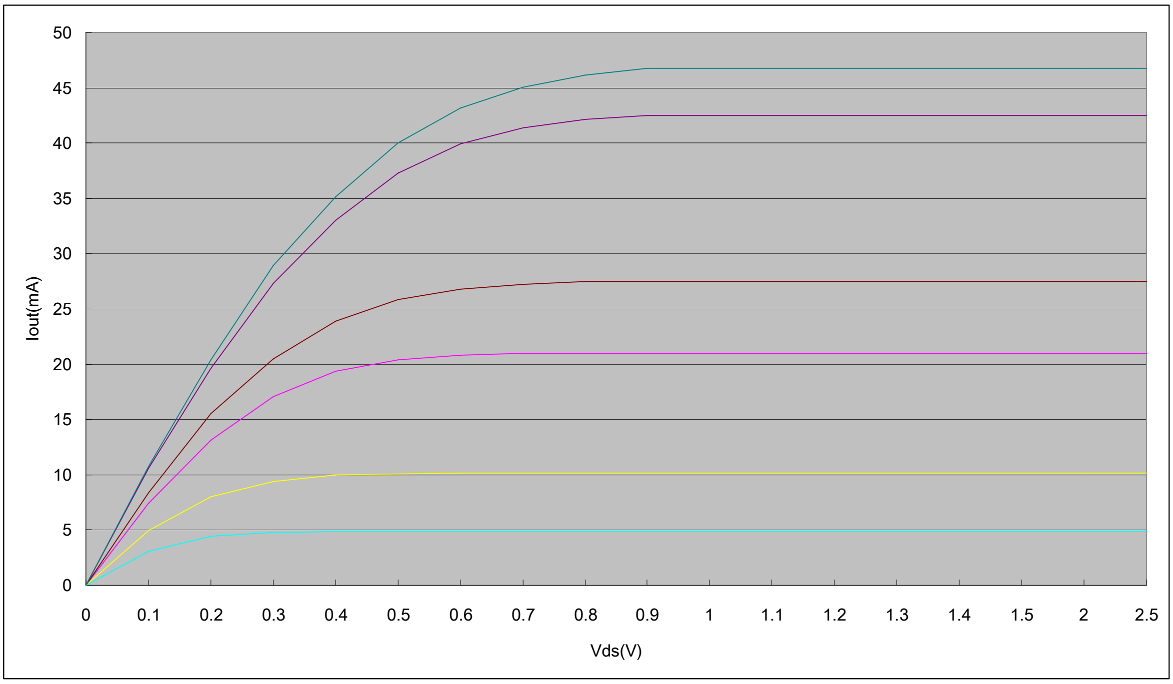


Application Information

Constant Current

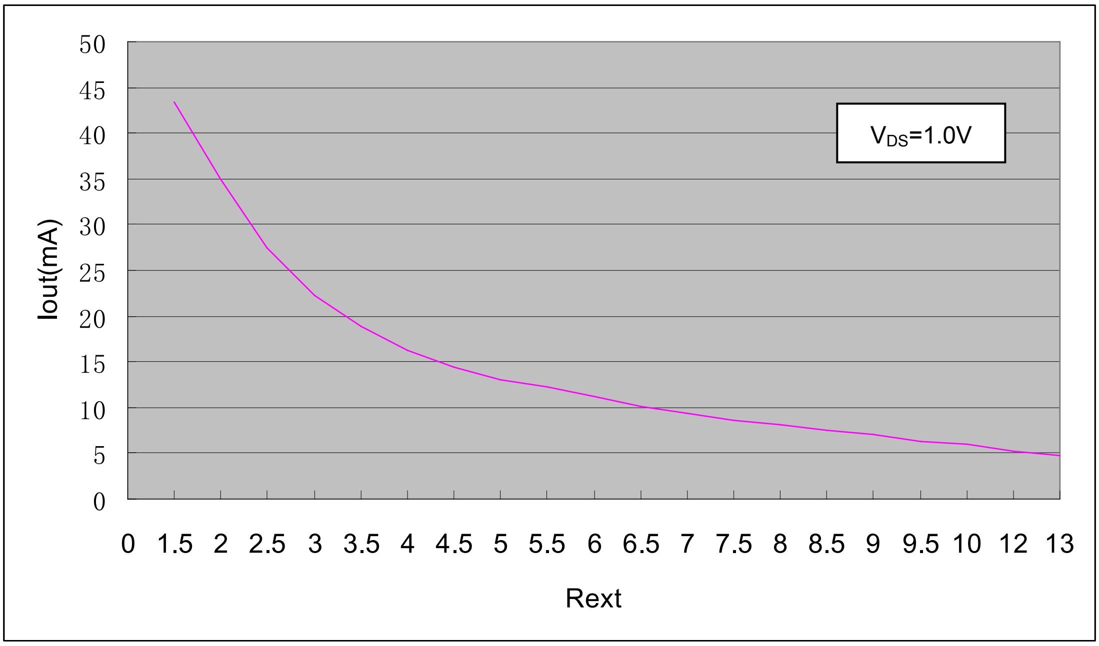
To design LED displays, IT1402 provides nearly no variations in current from channel to channel and from IC to IC. This can be achieved by:

1) The maximum current variation between channels is less than ±2%, and that 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 voltage(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.



Resistance of the external resistor, Rext, in KΩ

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

I_{OUT} is $(625/R_{ext})\times108$, 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)

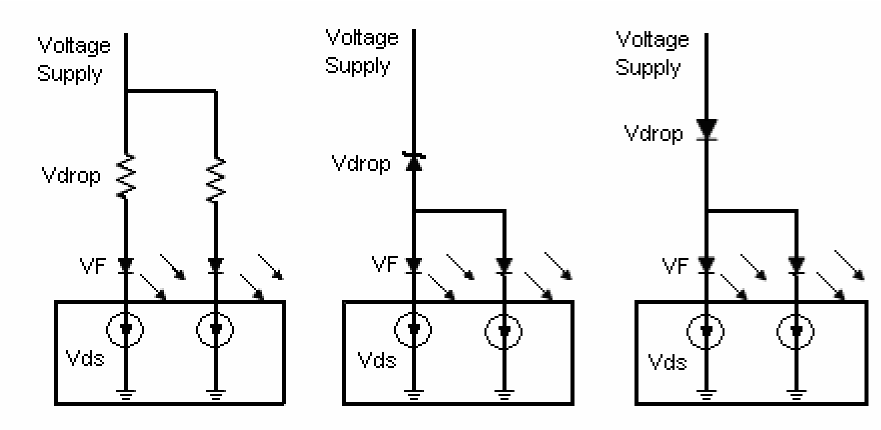
This maximum allowable package power dissipation is determined as $P_D(max)=(T_j-T_a)/R_{th(j-a)}$. When 16 output channels are turned on simultaneously, the actual package power dissipation is $P_D(act)=(I_{DD}\times V_{DD})+(I_{OUT}\times Duty\times V_{Ds}\times 16)$. Therefore, to keep $P_D(act) \leq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

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

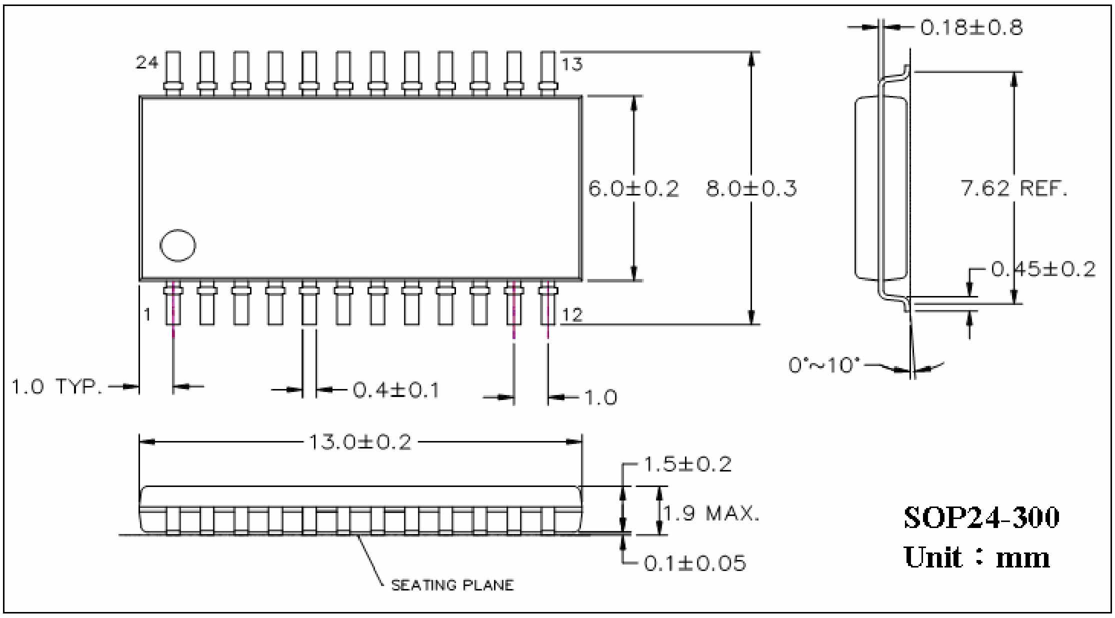
Load Supply Voltage(VLED)

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



IT1402(SOP24-300) Outline Drawing



IT1402(SSOP24-150) Outline Drawing