

DD313

Version : A.003
Issue Date : 2008/09/26
File Name : SP-DD313-A.003.doc
Total Pages: 22

3-CHANNEL HIGH CONSTANT CURRENT LED DRIVER

with ERROR DETECTION



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3-CHANNEL HIGH CONSTANT CURRENT LED DRIVER with ERROR DETECTION

General Description

DD313 is a high constant current driver designed for power LED applications. It incorporates three-channel constant current circuitry with current value set by three external resistors. The three enable pins are specifically designed for independent control over each of the three output terminals. The fast response of the output current can adapt to high dimming resolution and high refresh rate applications. Built-in LED open detection, over temperature, and over current protection functions ensure the system reliability.

Features

- Three channel with independent dimming control and current adjustment
- Maximum output current: 500mA determined by three external resistors
- Minimum output voltage: 1V ($I_{out} = 500\text{mA}$)
- Maximum output voltage: 18V
- Fast output current response
- Supply voltage range: 5V ~ 18V
- Over current protection
- LED open detection
- Thermal alarm (junction temperature $> 110^{\circ}\text{C}$)
- Thermal shutdown (junction temperature $> 180^{\circ}\text{C}$)

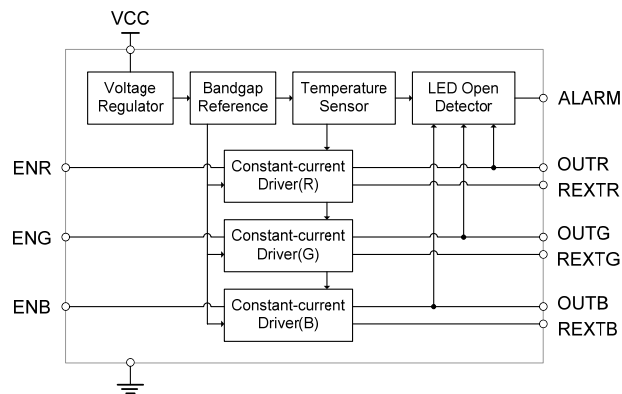
Applications

- LED architectural or entertainment lighting
- LED general or specialty illumination
- LED backlighting applications

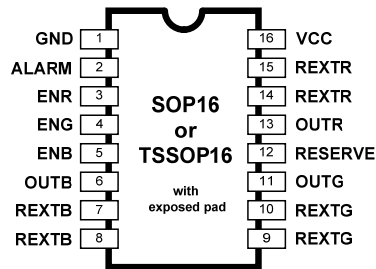
Package Types

- SOP16 (with exposed pad), TSSOP16 (with exposed pad)

Block Diagram



Pin Connection



Pin Description

PIN No.	PIN NAME	FUNCTION
SOP16/TSSOP16: 1	GND	Ground terminal.
SOP16/TSSOP16: 2	ALARM	Output open drain terminal: (connected to a pull-high resistor) ‘H’ means normal conditions, ‘L’ means LED open or chip overheated.
SOP16/TSSOP16: 3,4,5	ENR,G,B	Output current enable terminal.
SOP16/TSSOP16: 6,11,13	OUTB,G,R	Sink constant current outputs (open-drain).
SOP16/TSSOP16: 7,8,9,10,14,15	REXTB ^{*1} REXTG ^{*1} REXTR ^{*1}	External resistors connected between REXT and GND for driver current value setting.
SOP16/TSSOP16: 12	RESERVE	Terminal for testing, user should leave this pin open.
SOP16/TSSOP16: 16	VCC	Power supply terminal.

*1 Notice that both REXT pins (pin7 and 8, pin9 and 10, pin14 and 15) should be connected in PCB layout.



Maximum Ratings (Ta=25°C, Tj(max) = 140°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Supply Voltage	VCC	-0.3 ~ 18	V
Input Voltage	VIN	-0.3 ~ VCC	
Output Current	Iout	0.5	A
Output Voltage	Vout	-0.3 ~ 18	V
Enable Voltage	VEN	-0.3 ~ 18	
GND Terminal Current	IGND	1.5	A
Power Dissipation	Pd	3.3 (TSSOP16 with exposed pad) 2.7 (SOP16 with exposed pad)	W
Thermal Resistance (Junction to Air)	Rth(j-a) *1	38 (TSSOP16 with exposed pad) 46 (SOP16 with exposed pad)	°C/W
Operating Temperature	Top	-40 ~ 85	°C
Storage Temperature	Tstg	-55 ~ 150	

Recommended Operating Condition

CHARACTERISTIC	SYMBOL	CONDITION	MIN.	TYP.	MAX.	UNIT
Supply Voltage	VCC	—	5.0	—	18	V
Output Voltage	Vout	Driver On *2	0.8	—	—	V
		Driver Off *3	—	—	18	
Output Current	Iout	OUT(R, G, B)	—	—	0.5	A
Input Enable Voltage *4	VIH	VCC = 5V ~ 18V	3.0	—	18	V
	VIL		-0.3	—	0.7	
Input Enable Frequency	FEN	Ven > 3.0V	DC	—	1	MHz

*1 Base on JEDEC high conductivity test board (4-layer) simulation.

*2 The power dissipation is limited to its package and ambient temperature.

*3 The driver output voltage including any overshoot stress has to be compliant with the maximum voltage (18V).

*4 To avoid destroying the ESD protection circuit, the input enable voltage should be lower than the supply voltage.



Electrical Characteristics (Ta = 25°C unless otherwise noted)

CHARACTERISTIC	SYMBOL	CONDITION	MIN.	TYP.	MAX.	UNIT
Input Enable Voltage "H" Level	V _{EN(IH)}	VCC = 5.0 V ~ 18 V	3.0	—	18	V
Input Enable Voltage "L" Level	V _{EN(IL)}		-0.3	—	1.0	
Output Leakage Current	I _{OL}	V _{out} = 18 V V _{en (R,G,B)} = 0 V	—	—	1.0	uA
Output Current Skew (Channel-to-Channel) ^{*1}	I _{OL1}	V _{out} = 1.0 V I _{out} = 50mA ~ 0.5A	—	—	±3	%
Output Current Skew (Chip-to-Chip) ^{*2}	I _{OL2}		—	—	±6	
Output Voltage Regulation	% / V _{out}	V _{out} = 1 V ~ 3 V R _{EXT} = 1 Ω	—	0.1	—	% / V
Supply Voltage Regulation ^{*3}	% / VCC	R _{EXT} = 1 Ω	—	0.1	—	
LED Open Detection Threshold	V(od)	all outputs turn on	—	0.3	—	V
Alarm threshold temperature	T _{alm}	R _{EXT} = 1 KΩ all outputs turn on	—	110	—	°C
Shutdown threshold temperature	T _{std}		—	180	—	
Supply Current ^{*4}	I _{DD1}	VCC = 5 V R _{EXT} = 1 Ω all outputs turn on	—	1.2	—	mA
	I _{DD2}	VCC = 12 V R _{EXT} = 1 Ω all outputs turn on	—	2.4	—	
	I _{DD3}	VCC = 18 V R _{EXT} = 1 Ω all outputs turn on	—	3.3	—	

^{*1} Channel-to-channel skew is defined as the ratio between (any I_{out} – average I_{out}) and average I_{out}, where average I_{out} = (I_{max} + I_{min}) / 2.

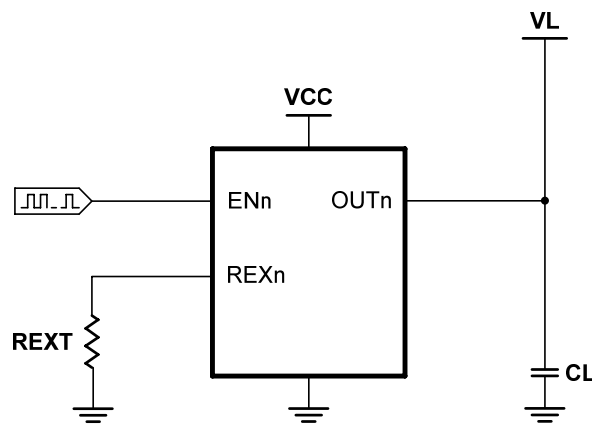
^{*2} Chip-to-Chip skew is defined as the range into which any output current of any IC falls.

^{*3} To operate driver within supply voltage 6.5V~8.5V may drop the output current due to semiconductor process variations.

^{*4} IO excluded.

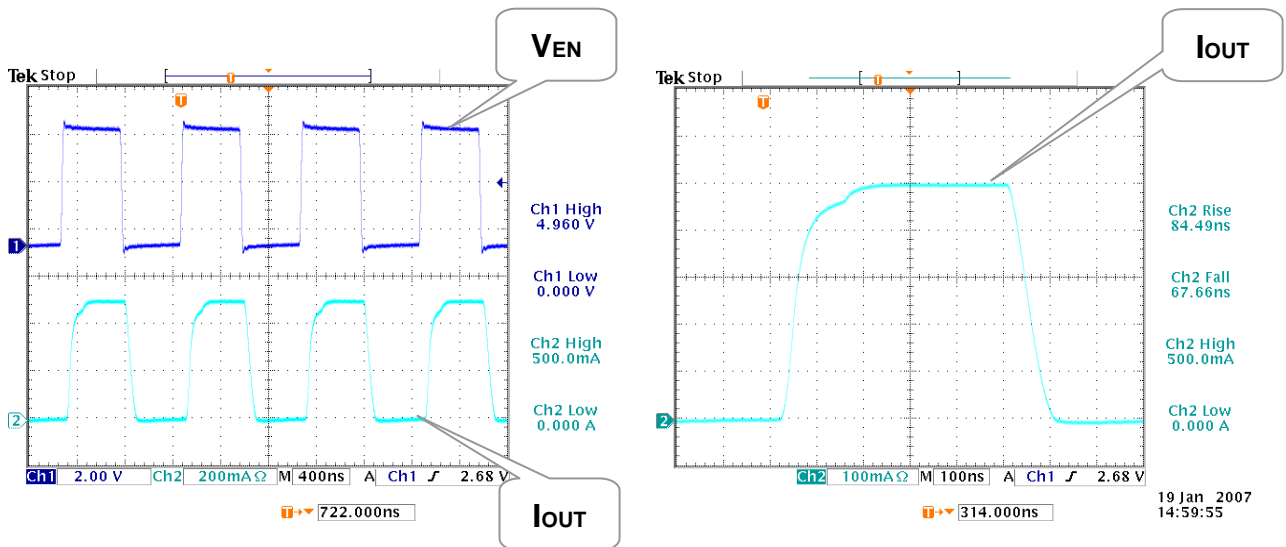
Switching Characteristics (Ta = 25°C unless otherwise noted)

CHARACTERISTIC		SYMBOL	CONDITION	MIN.	TYP.	MAX.	UNIT
Propagation Delay ('L' to 'H')	EN-to-OUT (Driver On)	tpLH	VIH = 5 V	—	65	—	ns
Propagation Delay ('H' to 'L')	EN-to-OUT (Driver Off)	tpHL	VIL = 0 V REXT = 1 Ω	—	65	—	
Output Current Rise Time		tor	VCC = 12 V VL = 5 V	—	50	—	
Output Current Fall Time		tof	CL = 13 pF	—	60	—	



Switching Characteristics Test Circuit

Transient Characteristics

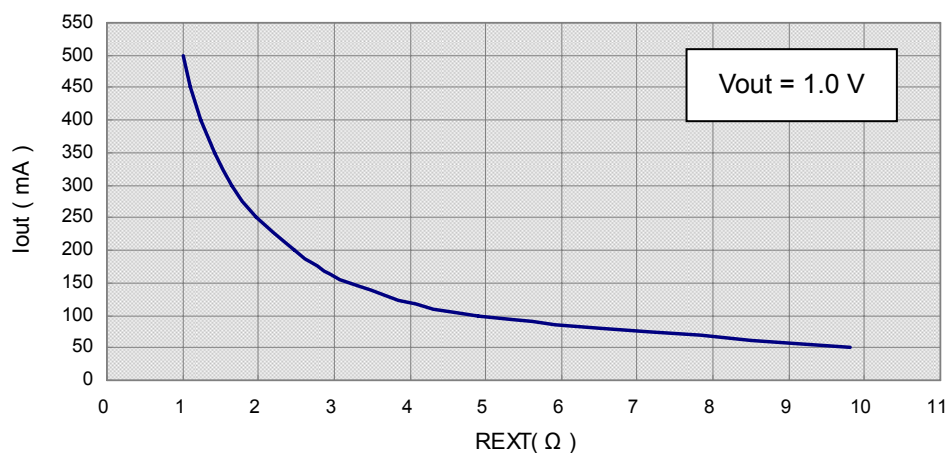


Constant-Current Output

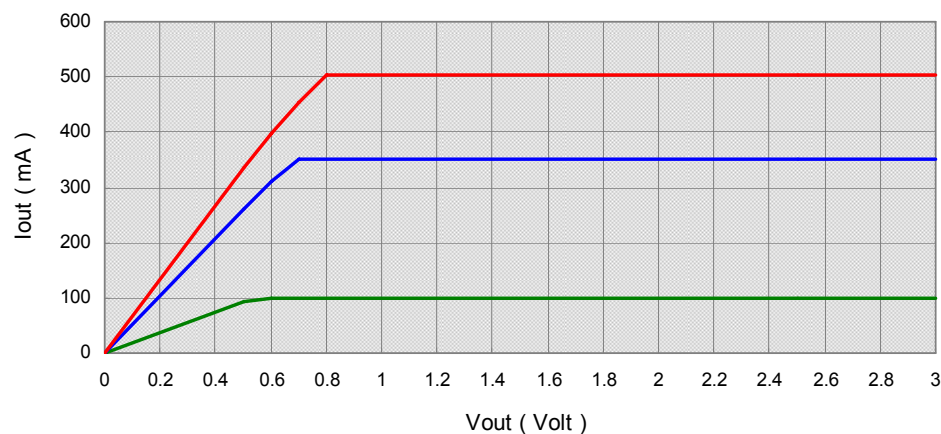
Constant-current value of each output channel is set by an external resistor connected between the REXT(R, G, B) pin and GND individually. Varying the resistor value can adjust the current up to 500mA. Notice that the output current is a little increasing or decreasing until the device temperature and ambient temperature are balanced. The maximum power dissipation of the determined external resistor should be large enough than the actual power consumption: $0.5(V) \times I_{out}(A)$ need to be considered. Approximate output current value can be calculated by following equation:

$$I_{OUT(R,G,B)} (A) \simeq 0.5 (V) / R_{EXT(R,G,B)} (\Omega)$$

Output Current as a Function of REXT value



Output Current as a Function of Output Voltage



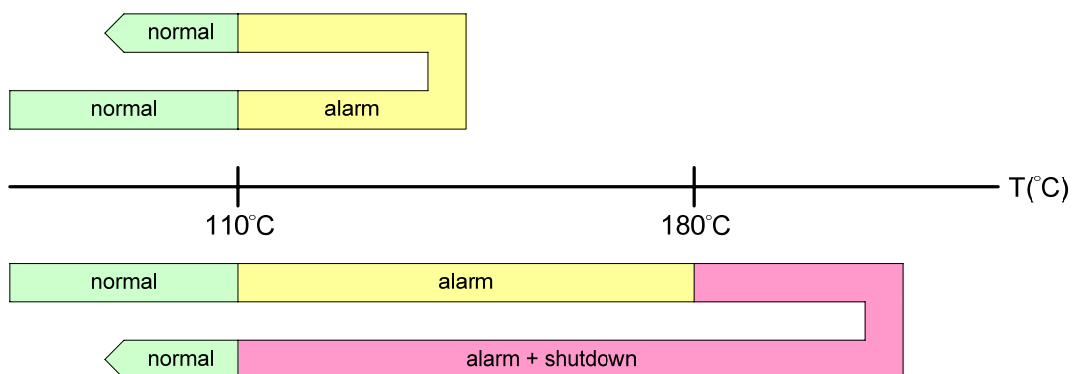
Alarm Function

It can detect the operating status by connecting a pull-high resistor to the open-drain ALARM pin. The ALARM pin is kept ‘H’ for normal conditions, and shifted to ‘L’ if there is any failure like LED open, overheating or both occurrence. User can determine the different status from the truth table below:

ALARM	ENR	ENG	ENB	Status
H	don't care	don't care	don't care	Normal Operation
H→L	H	L	L	OUTR LED Open or Thermal issue
H→L	L	H	L	OUTG LED Open or Thermal issue
H→L	L	L	H	OUTB LED Open or Thermal issue
H→L	L	L	L	Thermal Alarm or Shutdown

Thermal Alarm and Shutdown

During operation, when the junction temperature of the IC will reach about 110°C, the ALARM pin will shift to low level and produce a warning signal. Suggested cooling measures is to start the fan, lower the output currents and etc. If no cooling measures were activated, the junction temperature might continue to rise. Once it reaches approximately above 180°C, it will cause the driver to shutdown all the outputs. Basically, the IC will cool down and return to the safe operating temperature which is approximately below 110°C. The ALARM pin will reset to high level, disable the warning, and restart all the outputs at the same time. Operation in the thermal situation for a long time may cause chip damage permanently.



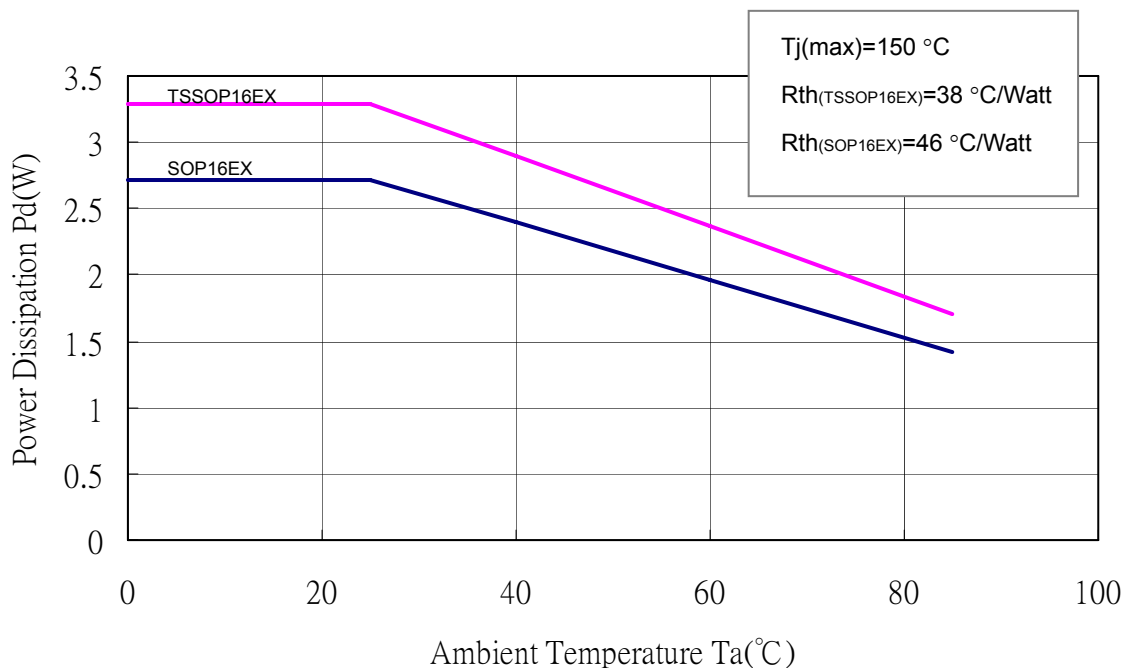
Relations between Alarm Function and Junction Temperature

Power Dissipation

The power dissipation of a semiconductor chip is limited to its package and ambient temperature, in which the device requires the maximum output current calculated for given operating conditions. The maximum allowable power consumption can be calculated by the following equation:

$$Pd(max)(Watt) = \frac{Tj(junction\ temperature)(max)(\text{ }^{\circ}C) - Ta(ambient\ temperature)(\text{ }^{\circ}C)}{Rth(junction\text{-to}\text{-air\ thermal\ resistance})(\text{ }^{\circ}C/Watt)}$$

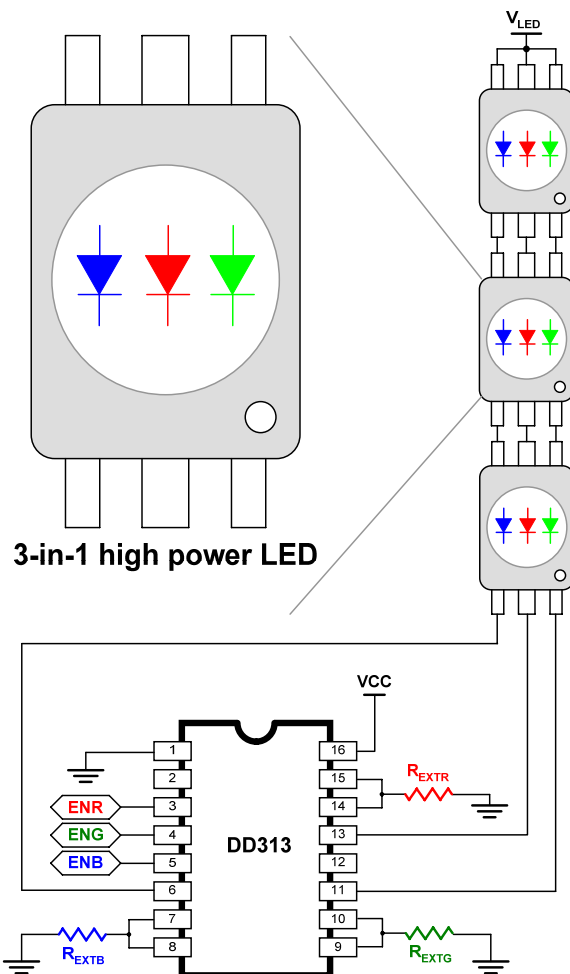
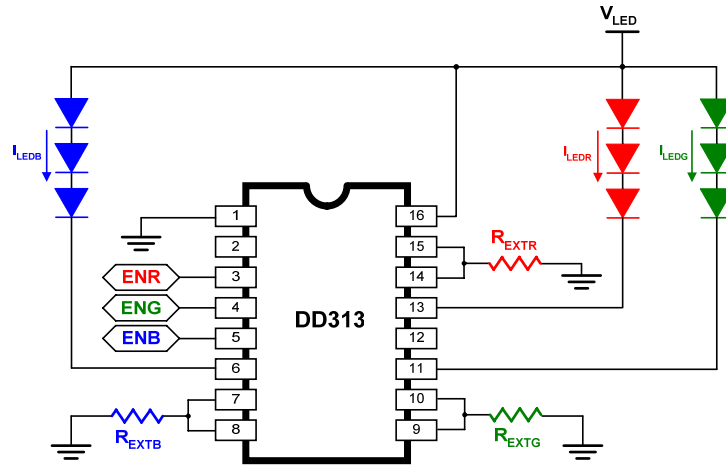
The relationship between power dissipation and operating temperature can be refer to the figure below:



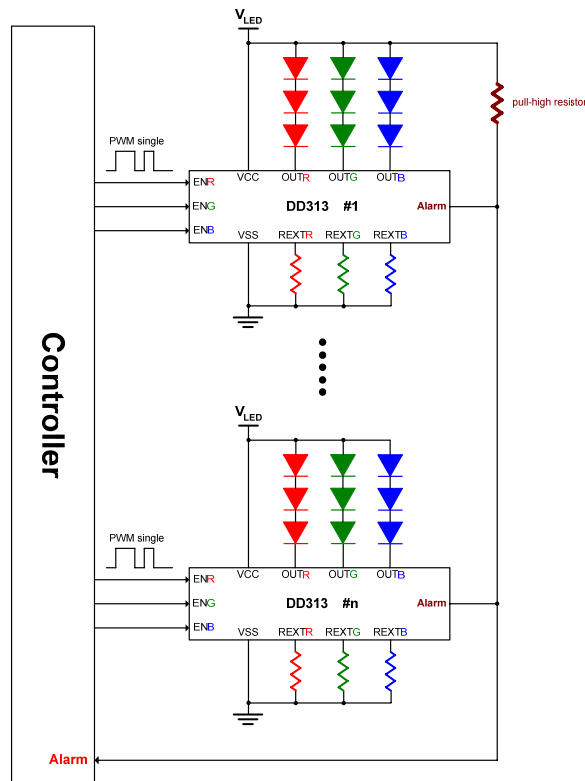
Based on the Pd(max), the maximum allowable voltage of output terminal can be determined by the following equation:

$$VoutR \times IoutR \times DutyR + VoutG \times IoutG \times DutyG + VoutB \times IoutB \times DutyB \leq Pd(max)(W) - Vcc(V) \times Idd(A)$$

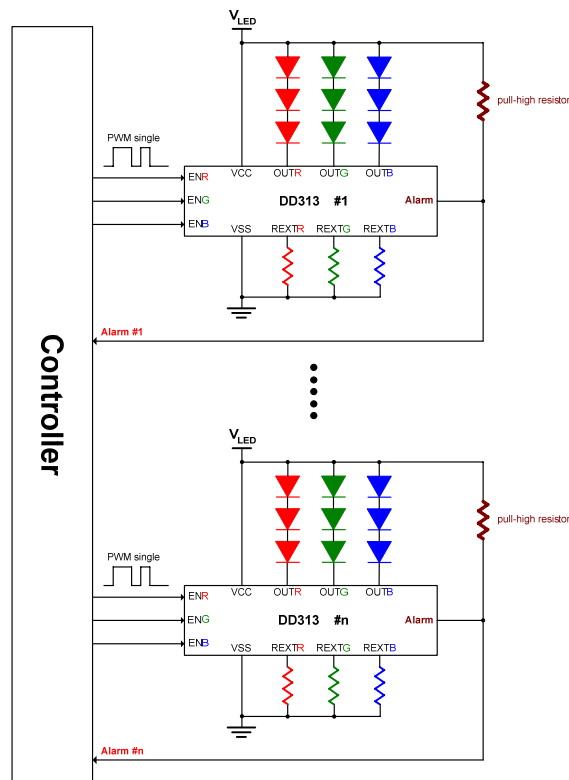
Typical Application



Typical Application

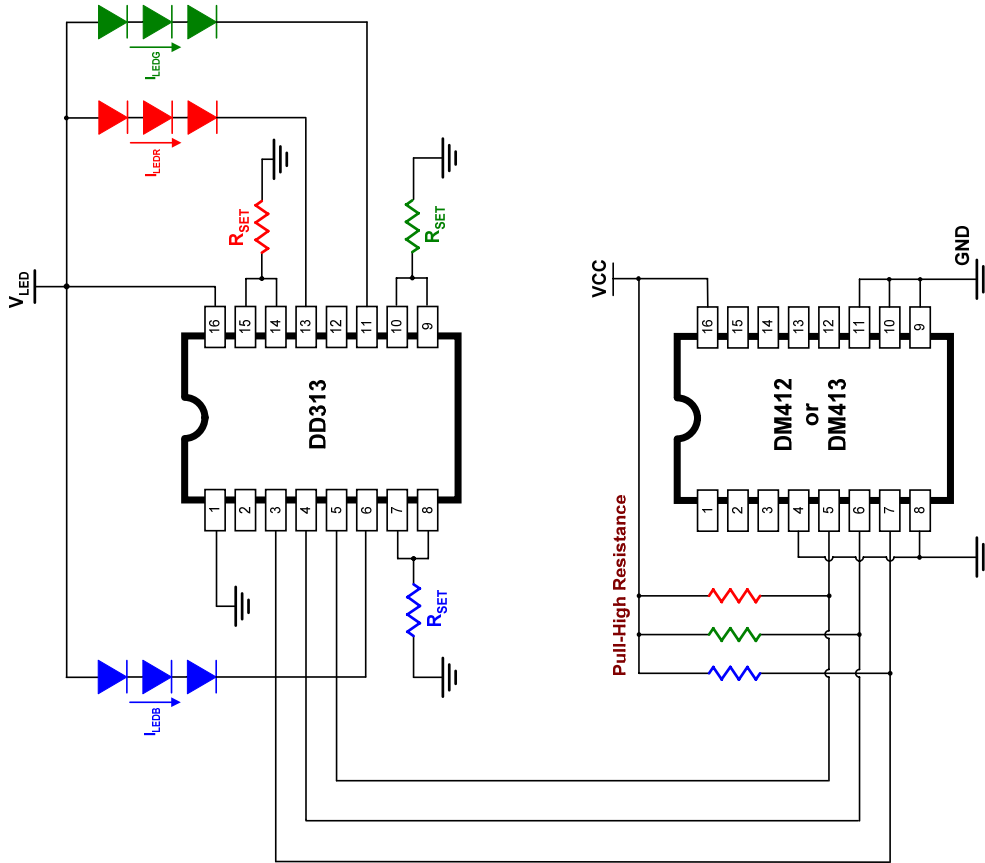


Feedback Alarm signal with only one pull-high resistor



Independent feedback Alarm signal

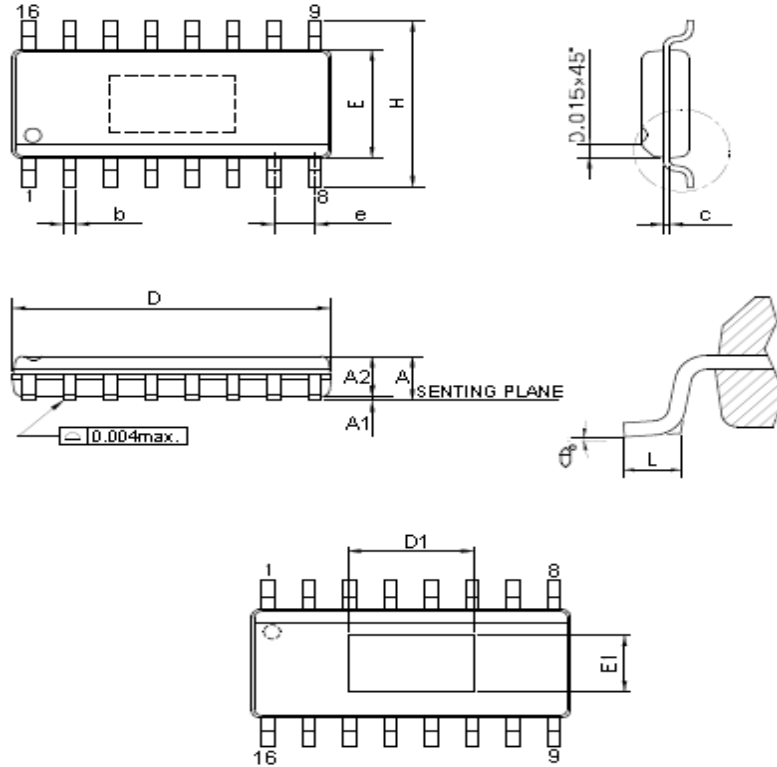
Typical Application



DD313 is specifically designed to withstand high frequency switching signal (1Mhz max) while providing high current driving capability. By connecting ENABLE pin to a PWM signal output, system will adapt to precise dimming control. In this display of a typical application, a PWM enabled RGB driver DM412/DM413 is configured to act as PWM signal generator. Through serial data input, DM412/DM413 can generate maximum of 16/14 bits RGB PWM grayscale signal to control the three channel of DD313. The combination of DD313 and DM412/DM413 offers an ideal solution for high end grayscale control and color manipulation.

DM412/DM413 is a three-channel constant current LED driver specifically designed for LED lighting or display applications. It incorporates shift registers, data latches, and built-in oscillator for PWM functioning. Data and clock buffer outputs are designed for cascading another chip. Additionally the Output Polarity Reverse function make DM412/DM413 can be a PWM signal generator.

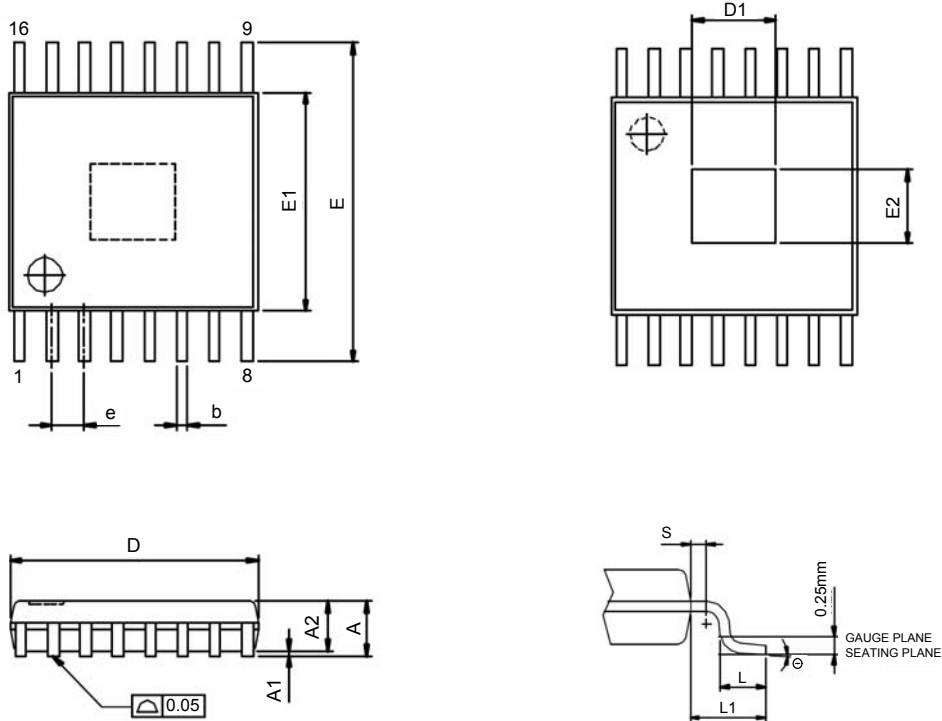
Package Outline Dimension SOP16 (exposed pad)



SOP16(EP)-150mil		mm	
SYMBOLS	MIN.	TYP.	MAX.
A	1.346	-	1.753
A1	0.051	-	0.152
A2	1.245	-	1.651
b	0.406 BSC		
c	0.203 BSC		
D	9.804	-	10.008
E	3.810	-	3.988
e	1.270 BSC		
H	5.791	-	6.198
L	0.406	-	1.270
θ°	0	-	8
PAD SIZE1 (95×18E)			
E1	1.930	-	2.413
D1	3.658	-	4.572

Package Outline Dimension

TSSOP16 (exposed pad)



TSSOP16(EP) mm			
SYMBOLS	MIN.	TYP.	MAX.
A	-	-	1.200
A1	0.000	-	0.150
A2	0.800	1.000	1.050
b	0.190	-	0.300
D	4.900	5.000	5.100
E1	4.300	4.400	4.500
E	6.400 TYP		
e	0.650 TYP		
L1	1.000 REF		
L	0.450	0.600	0.750
S	0.200	-	-
θ°	0	-	8
PAD SIZE (118×11E)			
E2	2.400	-	3.000
D1	2.400	-	3.000

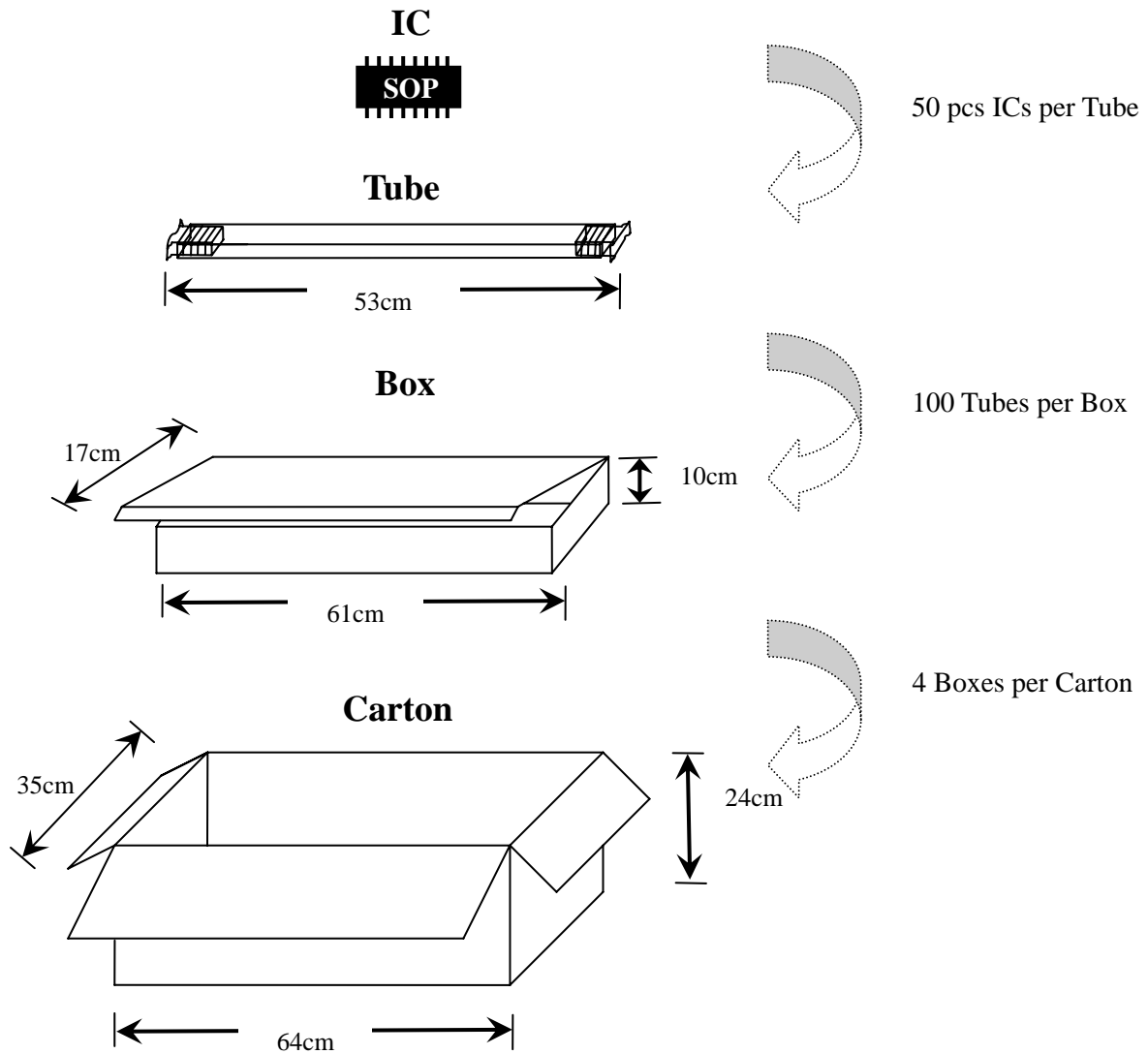


Product Ordering Information

Part Number	Package Type	Number / Weight (typ.)	
		Tube / Tray	Reel (Box included)
DD313-SOP	SOP16-150-0.05	50pcs / Tube 0.017kg \pm 5%	2,500pcs / Reel 0.97kg \pm 5%
DD313-TSSOP	TSSOP16-173-0.65	96pcs / Tube 0.014kg \pm 5%	2,500pcs / Reel 0.74kg \pm 5%

DD313-SOP Package and Weight (4 Boxes Set)

SOP16 - 150 - 0.05

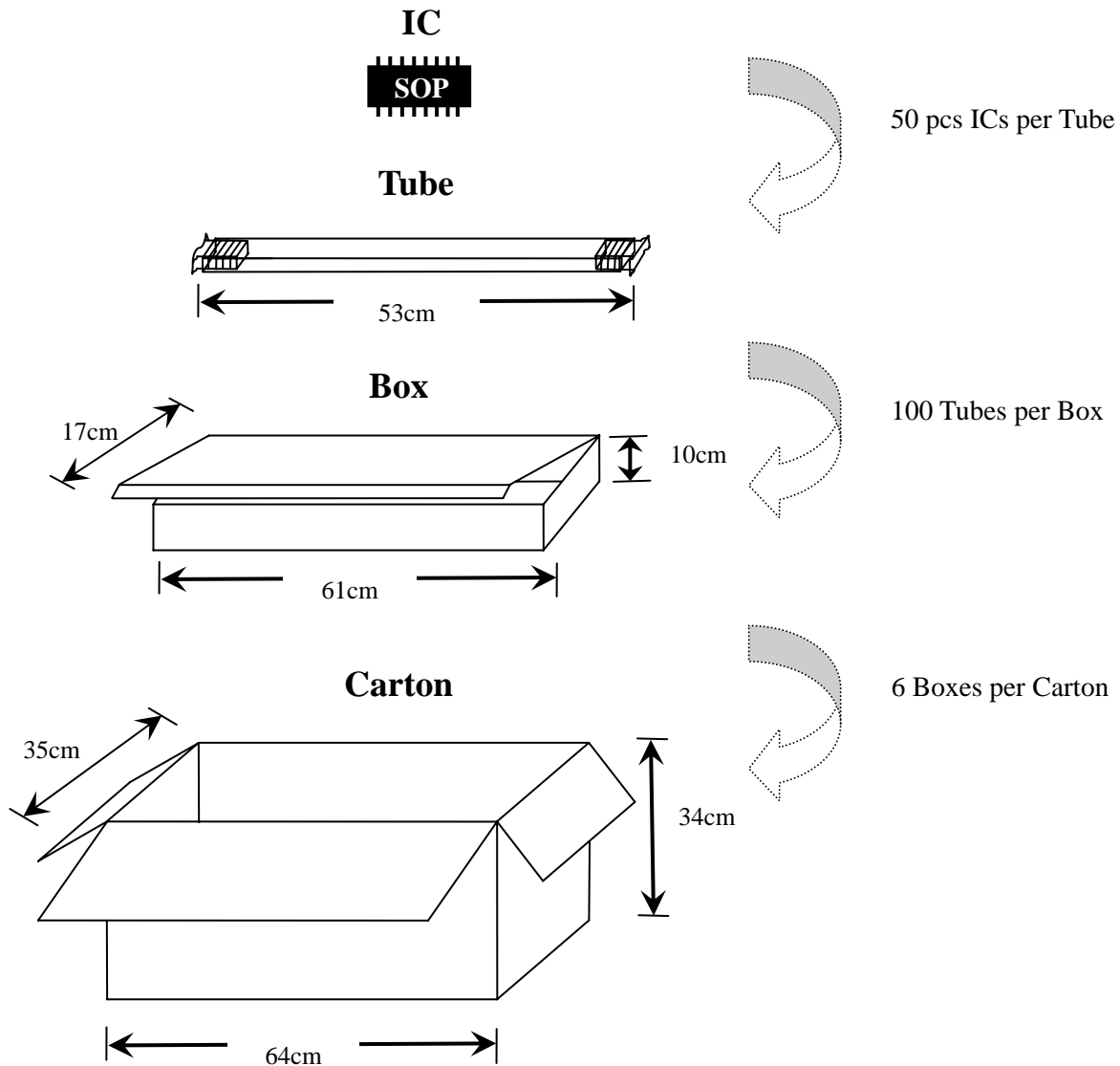


Weight

Item	Description	Weight (Kg)
1	50 pcs DD313-SOP per Tube	0.017±5%
2	Net Weight of one Box	0.40±5%
3	Net Weight of one Carton	1.24±5%
4	Per Carton Set (4 Boxes, 20,000 pcs)	9.64±5%

DD313-SOP Package and Weight (6 Boxes Set)

SOP16 - 150 - 0.05

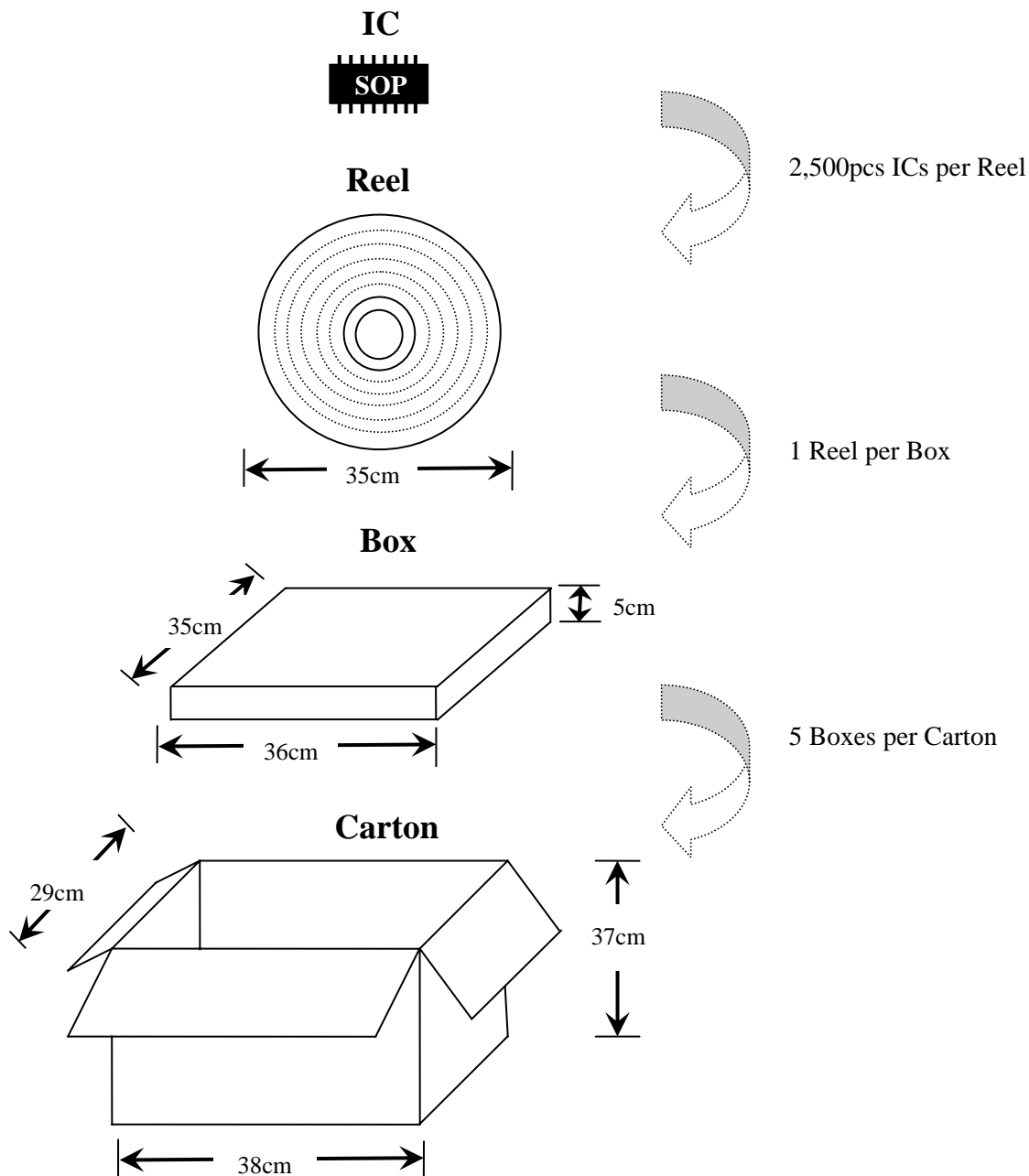


Weight

Item	Description	Weight (Kg)
1	50 pcs DD313-SOP per Tube	0.017±5%
2	Net Weight of one Box	0.40±5%
3	Net Weight of one Carton	1.44±5%
4	Per Carton Set (6 Boxes, 30,000 pcs)	14.04±5%

DD313-SOP Package and Weight

SOP16 - 150 - 0.05

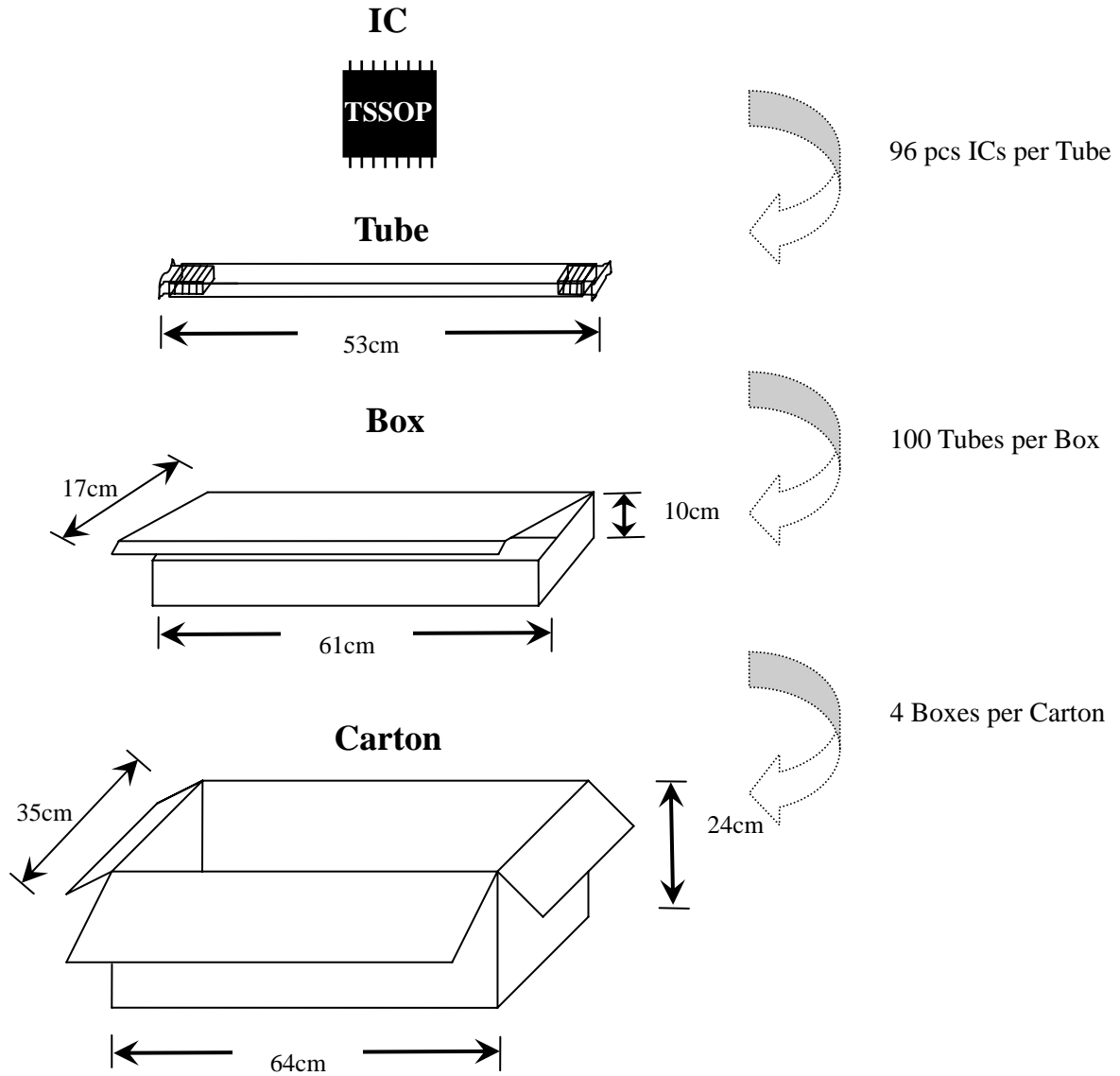


Weight

Item	Description	Weight (Kg)
1	2,500 pcs DD313-SOP per Reel	0.97±5%
2	Net Weight of one Box	0.24±5%
3	Net Weight of one Carton	0.90±5%
4	Per Carton Set (5 Boxes, 12,500 pcs)	6.95±5%

DD313-TSSOP Package and Weight (4 Boxes Set)

TSSOP - 173 - 0.65

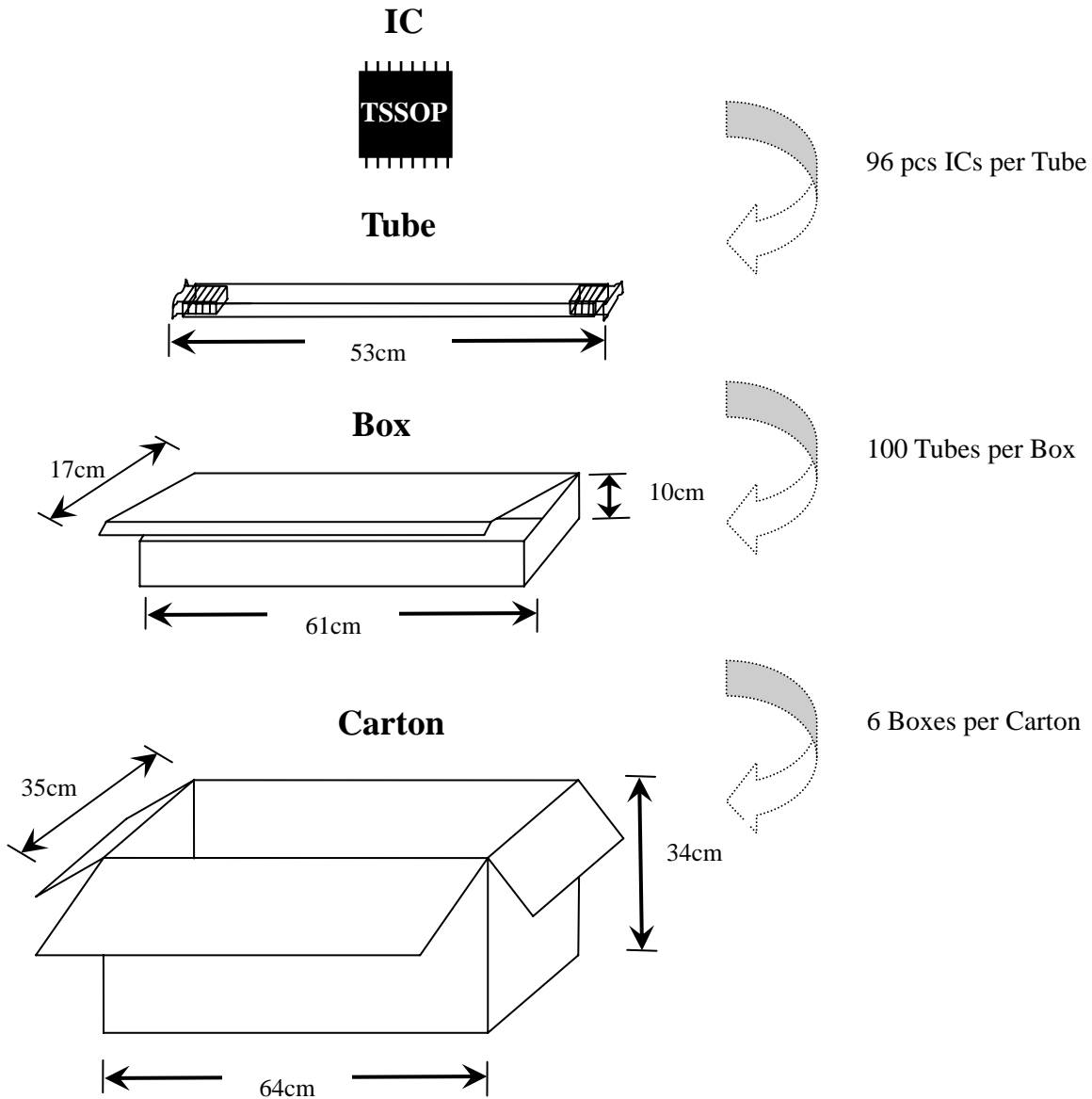


Weight

Item	Description	Weight (Kg)
1	96 pcs DD313-TSSOP per Tube	0.014±5%
2	Net Weight of one Box	0.40±5%
3	Net Weight of one Carton	1.24±5%
4	Per Carton Set (4 Boxes, 38,400 pcs)	8.44±5%

DD313-TSSOP Package and Weight (6 Boxes Set)

TSSOP - 173 - 0.65

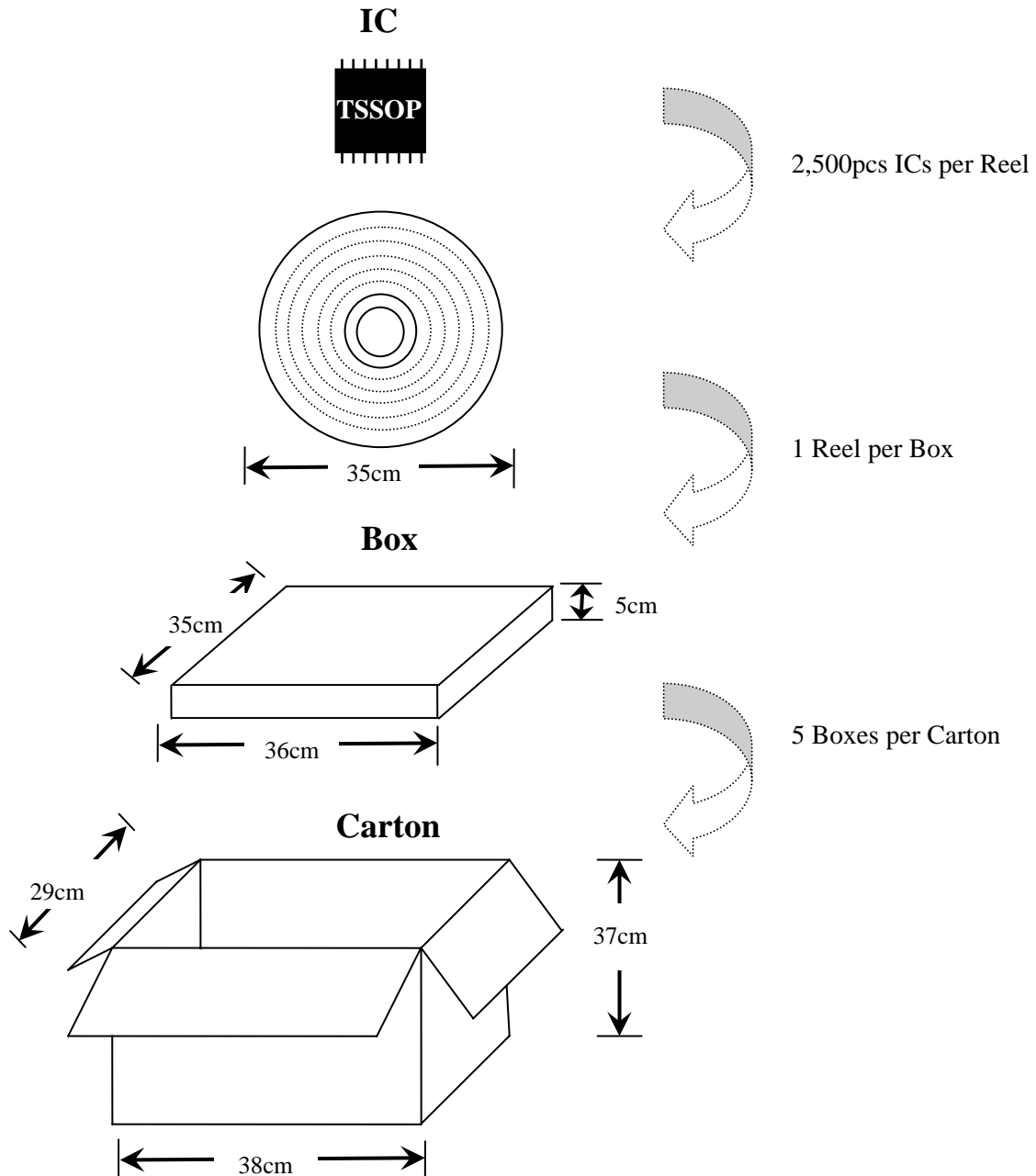


Weight

Item	Description	Weight (Kg)
1	96 pcs DD313-TSSOP per Tube	0.014±5%
2	Net Weight of one Box	0.40±5%
3	Net Weight of one Carton	1.44±5%
4	Per Carton Set (6 Boxes, 57,600 pcs)	12.24±5%

DD313-TSSOP Package and Weight

TSSOP16 - 173 - 0.65



Weight

Item	Description	Weight (Kg)
1	2,500 pcs DD313-TSSOP per Reel	0.74±5%
2	Net Weight of one Box	0.24±5%
3	Net Weight of one Carton	0.90±5%
4	Per Carton Set (5 Boxes, 12,500 pcs)	5.80±5%



The products listed herein are designed for ordinary electronic applications, such as electrical appliances, audio-visual equipment, communications devices and so on. Hence, it is advisable that the devices should not be used in medical instruments, surgical implants, aerospace machinery, nuclear power control systems, disaster/crime-prevention equipment and the like. Misusing those products may directly or indirectly endanger human life, or cause injury and property loss.

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