DM412

3-CHANNEL CONSTANT CURRENT LED DRIVERS

WITH LED OPEN DETECTION

SiTI

DM412

3-CHANNEL CONSTANT CURRENT LED DRIVERS
WITH LED OPEN DETECTION

General Description

DM412 is a PWM enabled LED driver specifically designed for LED video display or lighting applications. Each channel has linear adjustable 16-bits (65536 steps) grayscale PWM control current outputs. It incorporates shift registers, data latches, 3-channel constant current circuitry with current value set by 3 external resistors, and built-in oscillator for PWM functioning. Data, clock, and latch buffer outputs are designed for cascading another chip. Its built-in open detection function help users locate LED failures without additional circuits. The output polarity reverse function is designed for more high power LED applications.

Features

- Maximum constant current outputs: 200mA determined by three external resistors
- Maximum sinking output voltage: 17V
- Maximum serial-in clock frequency: 20 MHz
- 16-bit linear PWM control current outputs
- Built-in buffers for cascading clock, data, and strobe to next driver
- PWM free-running capability (refresh rate (~ 267 Hz) with internal oscillator (~ 17.5 MHz))
- Selectable auto/manual strobe (Patent pending)
- LED open detection
- Output polarity reverse function
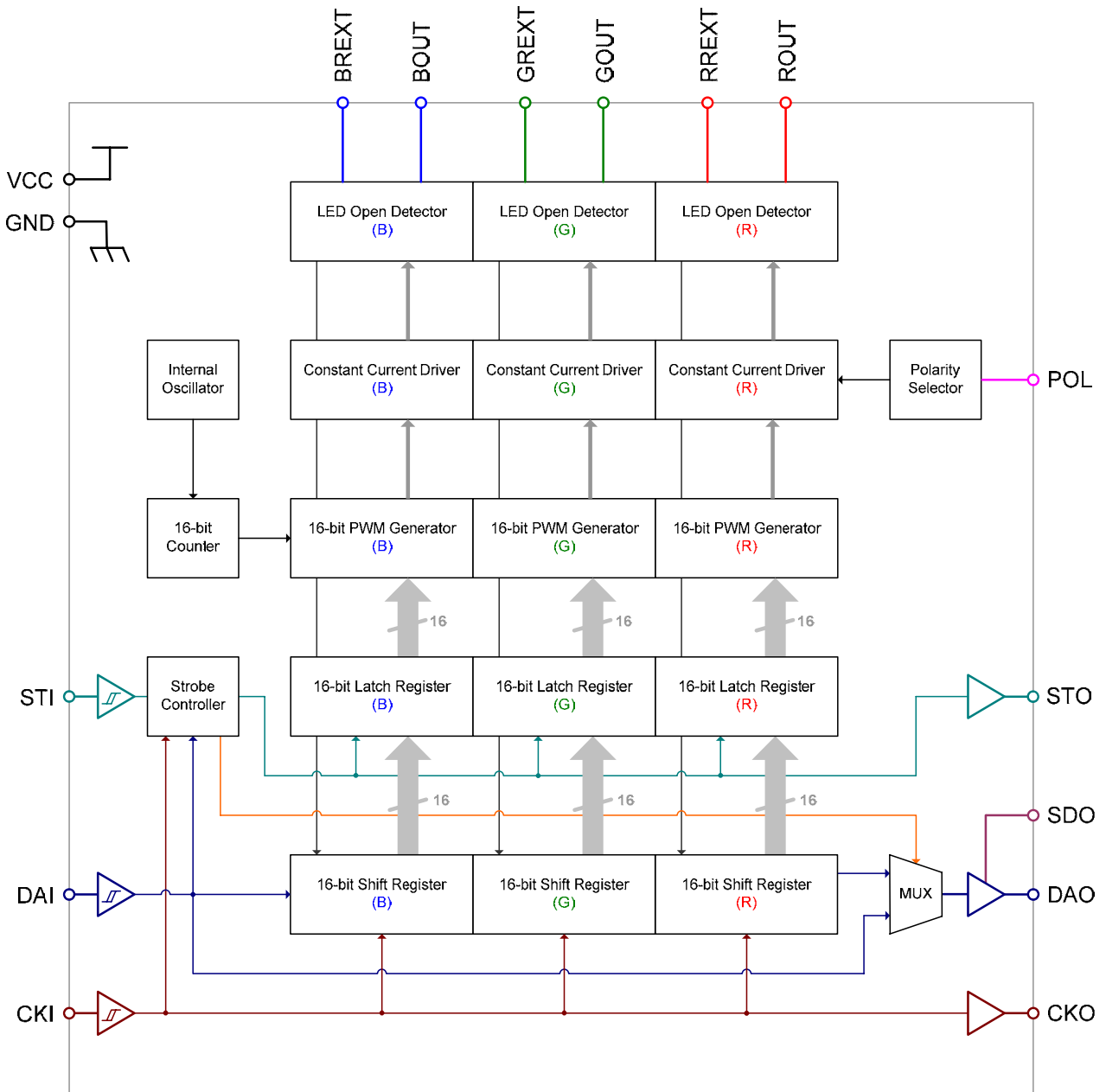- Power supply voltage: 4V ~ 5.5V

Applications

- LED Decorative Lighting
- Indoor/Outdoor LED Video or Message Display
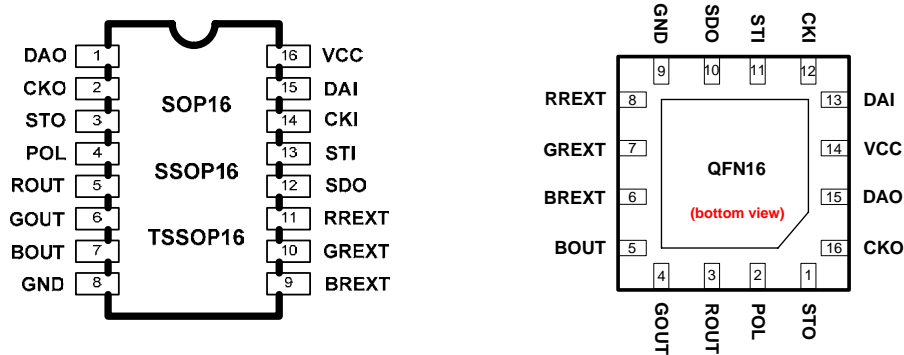- PWM Signal Generator

Package

- SSOP16, SOP16 (with exposed pad), TSSOP16 (with exposed pad), QFN16 (with exposed pad)
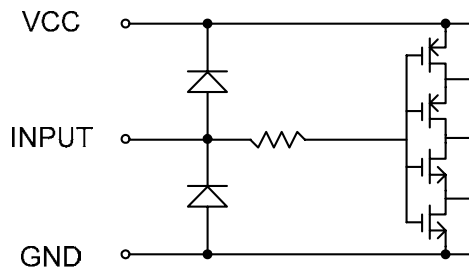
Block Diagram

Pin Connection

Pin Description

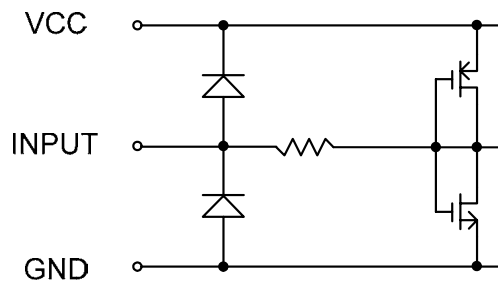| PIN No.	PIN NAME	FUNCTION
SOP16/SSOP16/TSSOP16: 1 QFN16: 15	DAO	Serial data output terminal.
SOP16/SSOP16/TSSOP16: 2 QFN16: 16	CKO	Clock output terminal.
SOP16/SSOP16/TSSOP16: 3 QFN16: 1	STO	Strobe output terminal.

SOP16/SSOP16/TSSOP16: 4
QFN16: 2
	POL	PWM current output polarity selection:
		  'H' means DM412 is to be LED driver,
		  'L' means DM412 is to be PWM generator.

SOP16/SSOP16/TSSOP16: 5~7 QFN16: 3~5	R(G、B)OUT	Sink constant current outputs (open-drain).
SOP16/SSOP16/TSSOP16: 8 QFN16: 9	GND	Ground terminal.
SOP16/SSOP16/TSSOP16: 9~11 QFN16: 6~8	R(G、B)REXT	External resistors connected between R(G、B)REXT and GND for driver current value setting.

SOP16/SSOP16/TSSOP16: 12
QFN16: 10
	SDO[*1]	Serial data output trigger mode selection:
		  'H' means data is shifted out on synchronization to falling edge of CKO,
		  'L' means data is shifted out on synchronization to rising edge of CKO.

SOP16/SSOP16/TSSOP16: 13
QFN16: 11
	STI	Input terminal of data strobe:
		  'H' means data is latched,
		  'L' means data on shift register goes through latch (level latch).

SOP16/SSOP16/TSSOP16: 14 QFN16: 12	CKI	Synchronous clock input terminal for serial data transfer. Data is sampled at the rising edge of CKI.
SOP16/SSOP16/TSSOP16: 15 QFN16: 13	DAI	Serial data input terminal.
SOP16/SSOP16/TSSOP16: 16 QFN16: 14	VCC	Power supply terminal.

[*1] It is recommended that SDO should be set to **high level** in cascading system applications.
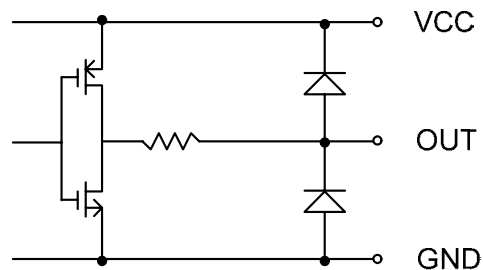
Equivalent Circuit of Inputs and Outputs

1. CKI, DAI, STI, SDO terminals

2. POL terminals

3. CKO, DAO, STO terminal

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

CHARACTERISTIC	SYMBOL	RATING	UNIT
Supply Voltage	VCC	-0.3 ~ 7.0	V
Input Voltage	VIN	-0.3 ~ VCC+0.3	V
Output Current	IOUT	200	mA
Output Voltage	VOUT	-0.3 ~ 17	V
Input Clock Frequency	FCKI	20	MHz
GND Terminal Current	IGND	610	mA
Power Dissipation	PD	0.77 (QFN16 exposed pad: Ta=25°C) 0.82 (SSOP16 : Ta=25°C) 1.4 (SOP16 exposed pad: Ta=25°C) 2.1 (TSSOP16 exposed pad: Ta=25°C)	W
Thermal Resistance	Rth(j-a)	150 (QFN16) 140.2 (SSOP16) 81.2 (SOP16 exposed pad) 55 (TSSOP16 exposed pad)	°C/W
Operating Temperature	Top	-40 ~ 85	°C
Storage Temperature	Tstg	-55 ~ 150	°C

Recommended Operating Condition

CHARACTERISTIC	SYMBOL	CONDITION	MIN.	TYP.	MAX.	UNIT
Supply Voltage	VCC	—	4	5.0	5.5	V
Output Voltage	VOUT	Driver On [*1]	1.0	—	10	V
Output Voltage	VOUT	Driver Off [*2]	—	—	17	
Output Current	IO	OUT (R, G , B)	5	—	200 [*3]	mA
	IOH	SERIAL-OUT	—	—	1.2	
	IOL		—	—	1.5	
Input Voltage	VIH	VCC = 4 V ~ 5.5V	0.8VCC	—	VCC	V
	VIL		0.0	—	0.2VCC	
Input Clock Frequency	FCKI	Single Chip Operation	DC	—	20M	Hz
		Cascade Operation (SDO='H', CL=13pF)			20M	
		Cascade Operation (SDO='L', CL=13pF)			10M	
STI Pulse Width	tw STI	VCC = 4 V ~ 5.5V	20	—	—	ns
CKI Pulse Width	tw CLK		20	—	—	
Set-up Time for DAI	tsetup(D)		15	—	—	
Hold Time for DAI	thold(D)		15	—	—	
Set-up Time for STI	tsetup(L)		15	—	—	
Set-up Time for Internal Strobe	tsetup(istb)		1	—	—	us
Internal Oscillator Frequency	FOSC		14	17.5	21	MHz

[*1] Notice that the power dissipation is limited to its package and ambient temperature.
[*2] The driver output voltage including any overshoot stress has to be compliant with the maximum voltage (17V).
[*3] It is recommended to choose good thermal dissipation package such as TSSOP16 (Iout = 100mA ~ 200mA).

Electrical Characteristics (VCC = 5.0 V, Ta = 25°C unless otherwise noted)

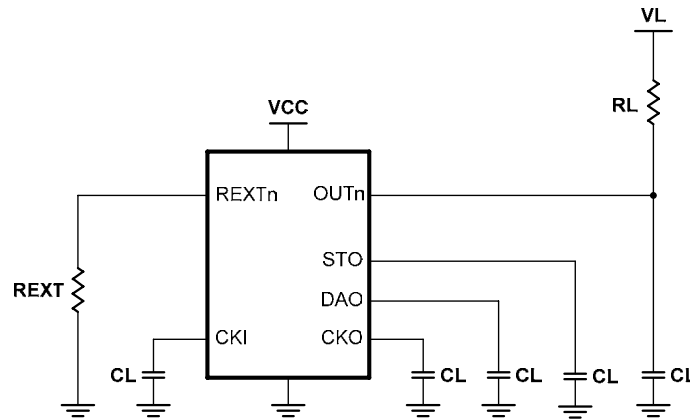| CHARACTERISTIC	SYMBOL	CONDITION	MIN.	TYP.	MAX.	UNIT
Input Voltage "H" Level	VIH	CMOS logic level	0.8VCC	—	VCC	V
Input Voltage "L" Level	VIL	CMOS logic level	GND	—	0.2VCC	
Input Leakage Current	IIH	VIH = VCC	—	—	1.0	uA
	IIL	VIL = GND	—	—	1.0	
Output Leakage Current	IOL	VOH = 17 V	—	—	1.0	uA
Output Voltage (S-OUT)	VOL	IOL = 1.5 mA	—	—	0.2	V
	VOH	IOH = 1.2 mA	VCC-0.2	—	—	
Output Current Skew (Channel-to-Channel) [1]	IOL1	VOUT = 1.0 V REXT = 120 Ω	—	—	±3	%
Output Current Skew (Chip-to-Chip) [2]	IOL2		4.62	4.92	5.22	mA
Output Voltage Regulation	% / VOUT	REXT = 120 Ω VOUT = 1 V ~ 3 V	—	0.1	0.5	% / V
Supply Voltage Regulation	% / VCC	REXT = 120 Ω	—	—	2	
Supply Current [3]	$I_{DD(off)}$	all pins are open unless VCC and GND	—	1.4	—	mA
	$I_{DD(off)}$	Vout = 1.0V Rext = 120Ω all outputs turn off	—	1.3	—	
	$I_{DD(on)}$	CKI = 20MHz Vout = 1.0V Rext = 120Ω all outputs turn on	—	1.8	—	
	$I_{DD(off)}$	Vout = 1.0V Rext = 2.9Ω all outputs turn off	—	1.3	—	
	$I_{DD(on)}$	CKI = 20MHz Vout = 1.0V Rext = 2.9Ω all outputs turn on	—	1.8	—	

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[1] Channel-to-channel skew is defined as the ratio between (any Iout – average Iout) and average Iout, where average Iout = (Imax + Imin) / 2.

[2] Chip-to-Chip skew is defined as the range into which any output current of any IC falls.

[3] IO excluded.

Switching Characteristics (VCC = 5.0V, Ta = 25°C unless otherwise noted)

CHARACTERISTIC		SYMBOL	CONDITION	MIN.	TYP.	MAX.	UNIT
Propagation Delay ('L' to 'H')	CKI-to-CKO	tpLH	VIH = VCC VIL = GND REXTs = 33 Ω VL = 5.0 V RL = 180 Ω CL = 13 pF	—	11.5	—	ns
	CKO-to-DAO (SDO = 'L')			—	8.4	—	
Propagation Delay ('H' to 'L')	CKI-to-CKO	tpHL		—	7.2	—	
	CKO-to-DAO (SDO = 'H')			—	4.0	—	
Output Current Rise Time		tor		—	18	—	
Output Current Fall Time		tof		—	12.5	—	
Output Current (Propagation Delay after STI low)		top [*1]		—	—	4.7	ms

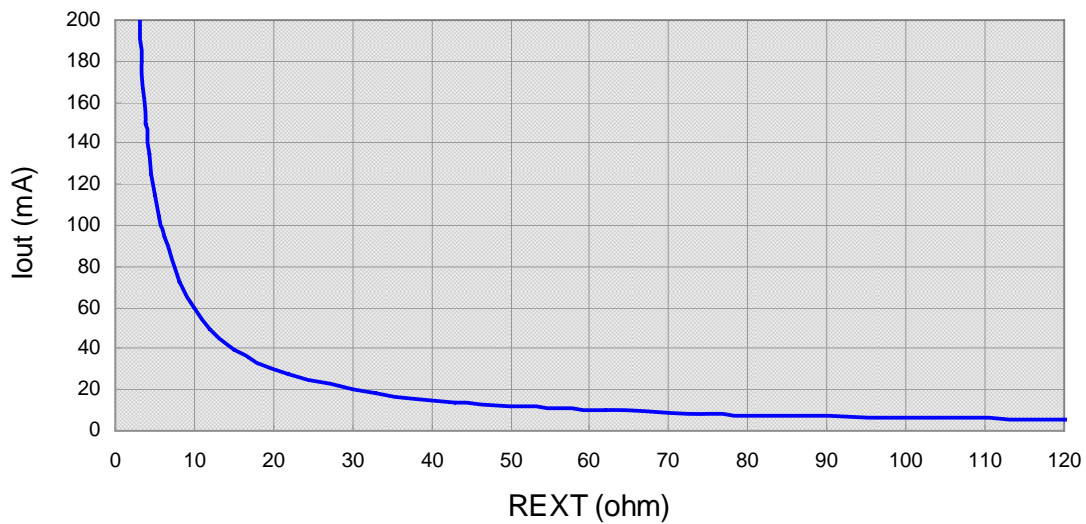Switching Characteristics Test Circuit

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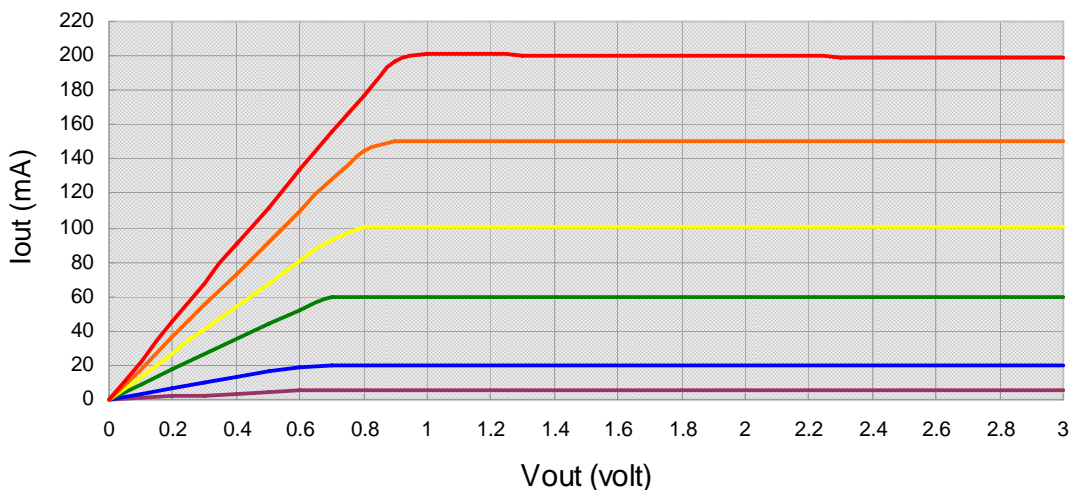[*1] Reload the new PWM data at the end of the last PWM frame.

Constant-Current Output

Constant-current value of each output channel is set by an external resistor connected between the R(G、B)REXT pin and GND individually. The current scale ranging can be adjusted from 5mA to 200mA by varying the resistor value. The output current value is calculated by the following equation:

$$\text{Iout(mA)} \simeq \frac{0.58 \text{ V}}{\text{REXT (ohm)}} \times 1000$$

Output Current as a Function of REXT value

Output Current as a Function of Output Voltage

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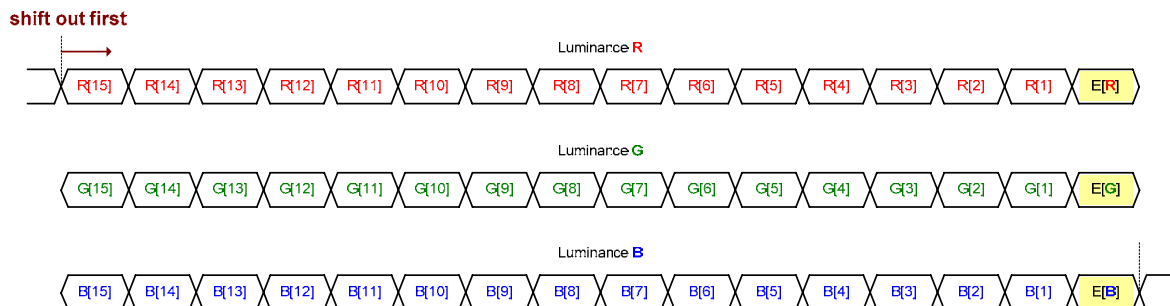**SILICON TOUCH TECHNOLOGY INC.**

Input Data Format

shift in first

$$\text{Active width per frame}(\%) = \frac{L^*[15]{\times}2^{15}+L[14]{\times}2^{14}+L[13]{\times}2^{13}+L[12]{\times}2^{12}+L[11]{\times}2^{11}+L[10]{\times}2^{10}+L[9]{\times}2^{9}+L[8]{\times}2^{8}+L[7]{\times}2^{7}+L[6]{\times}2^{6}+L[5]{\times}2^{5}+L[4]{\times}2^{4}+L[3]{\times}2^{3}+L[2]{\times}2^{2}+L[1]{\times}2^{1}+L[0]{\times}2^{0}}{65536}$$

*L[x] = 0 or 1 and it can be replaced by R[x], G[x], or B[x] , where x = 0, 1, 2.......15

LED Open Detection

DM412 provides a real time monitor of LED open detection function without extra components or circuit design. It will be identified as a LED open failure when the output is turned on but the output voltage is below 0.3V. The test result of each channel will write to its correspondent shift register which is in LSB position (R[0], G[0], B[0]) while strobe signal is active. User can refer to timing diagram on page12. Detecting report could be retrieved from serial-out (DAO) data. If the system reads '1' back, that indicates LED is in normal status. But if '0' was retrieved then LED open failure has occurred. In order to make sure LED open detection function is in well operating condition, it is recommended that all the luminance data are wrote to '1' then almost turning on the outputs during detection process.
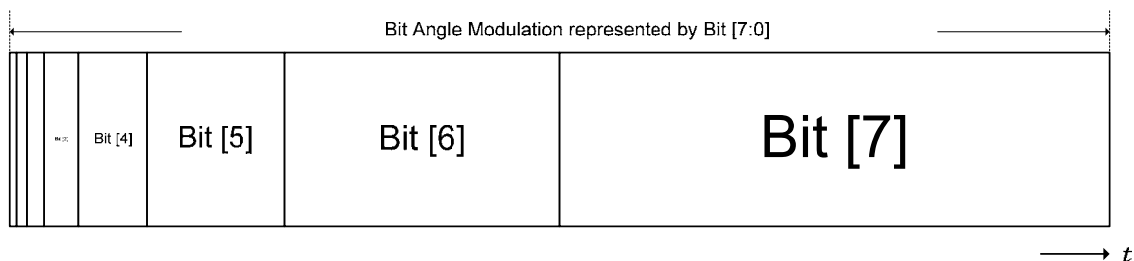
Serial-out Data Format

shift out first

＊E[R], E[G], E[B] are Error Message of LED Open Detection. '1' is normal, and '0' is abnormal.

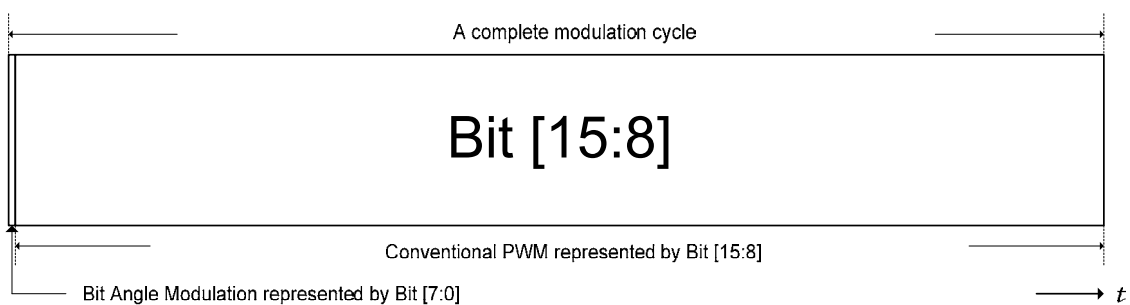**SILICON TOUCH TECHNOLOGY INC.**

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Output Modulation Technique

In order to minimize the harmonic noise and increasing current accuracy, DM412 provides a new LED drive technique of output modulation. It mixes traditional Pulse Width Modulation (PWM) represented by MSB 8 bit (Bit[15:8]) with Bit Angle Modulation (BAM) represented by LSB 8 bit (Bit[7:0]). The main benefit of BAM is to drive LED with an equivalent multiple frequencies in the lower intensity of LED light output. Each bit of BAM binary code is effectively allocated a fixed width of phase angles within a modulation cycle. The reference table shows the ratio defined by the binary significance of each bit:

bit	weighted width
7	256
6	128
5	64
4	32
3	16
2	8
1	4
0	1

Bit Angle Modulation represented by Bit [7:0]

Bit [4] | Bit [5] | Bit [6] | Bit [7]

→ *t*

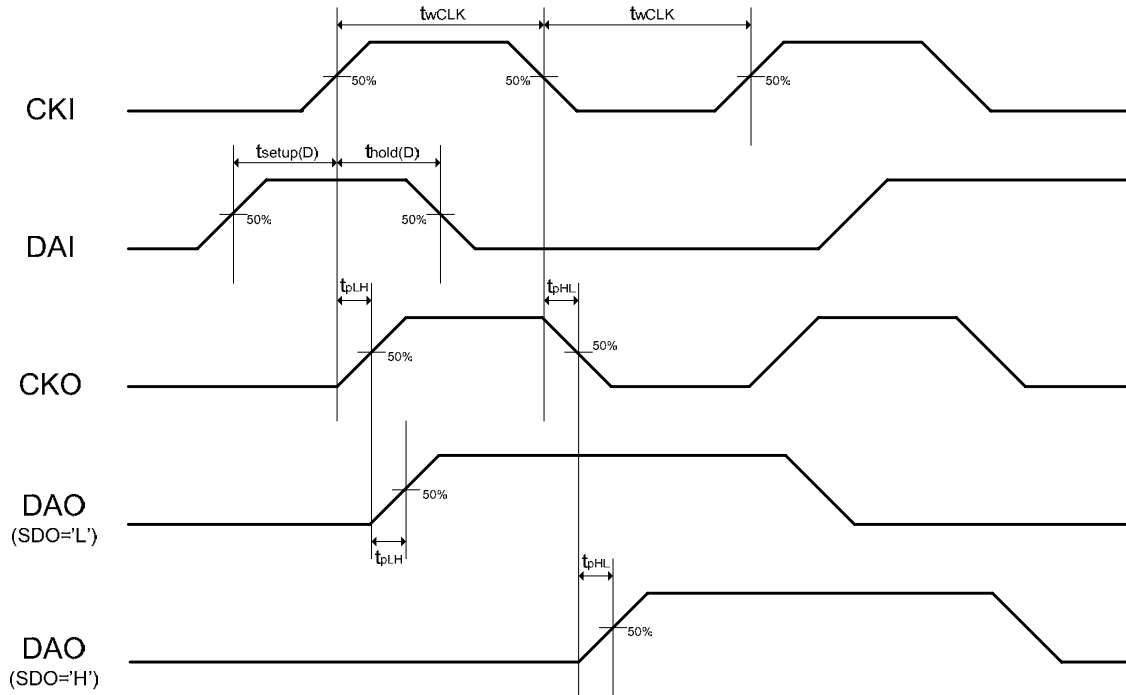The relationships between BAM and PWM in the time domain can be refer to the diagram (not to scale) below:

A complete modulation cycle

Bit [15:8]

Conventional PWM represented by Bit [15:8]

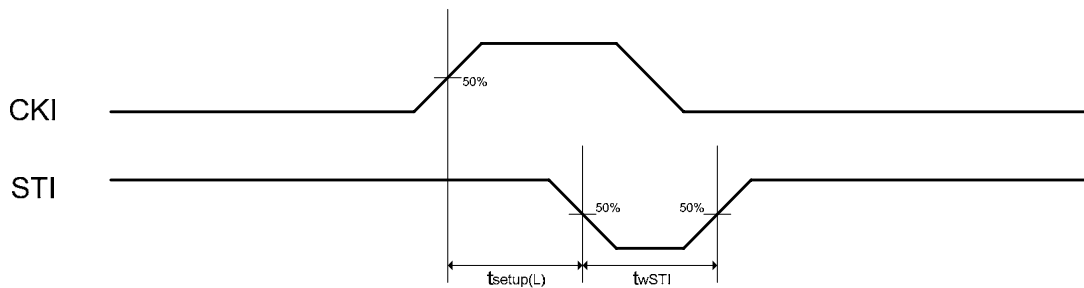Bit Angle Modulation represented by Bit [7:0]

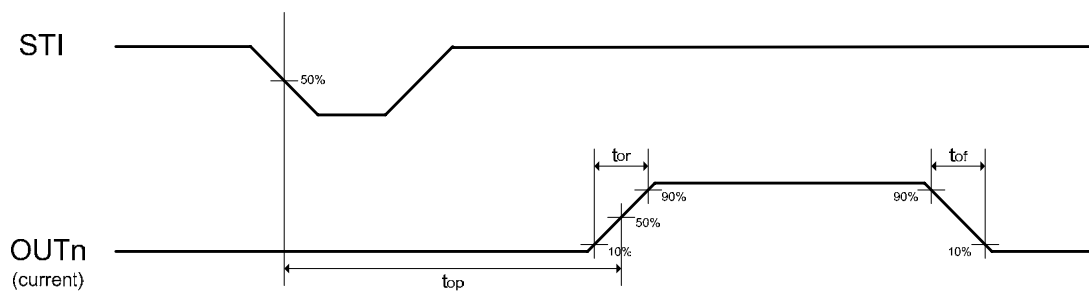→ *t*

Timing Diagram

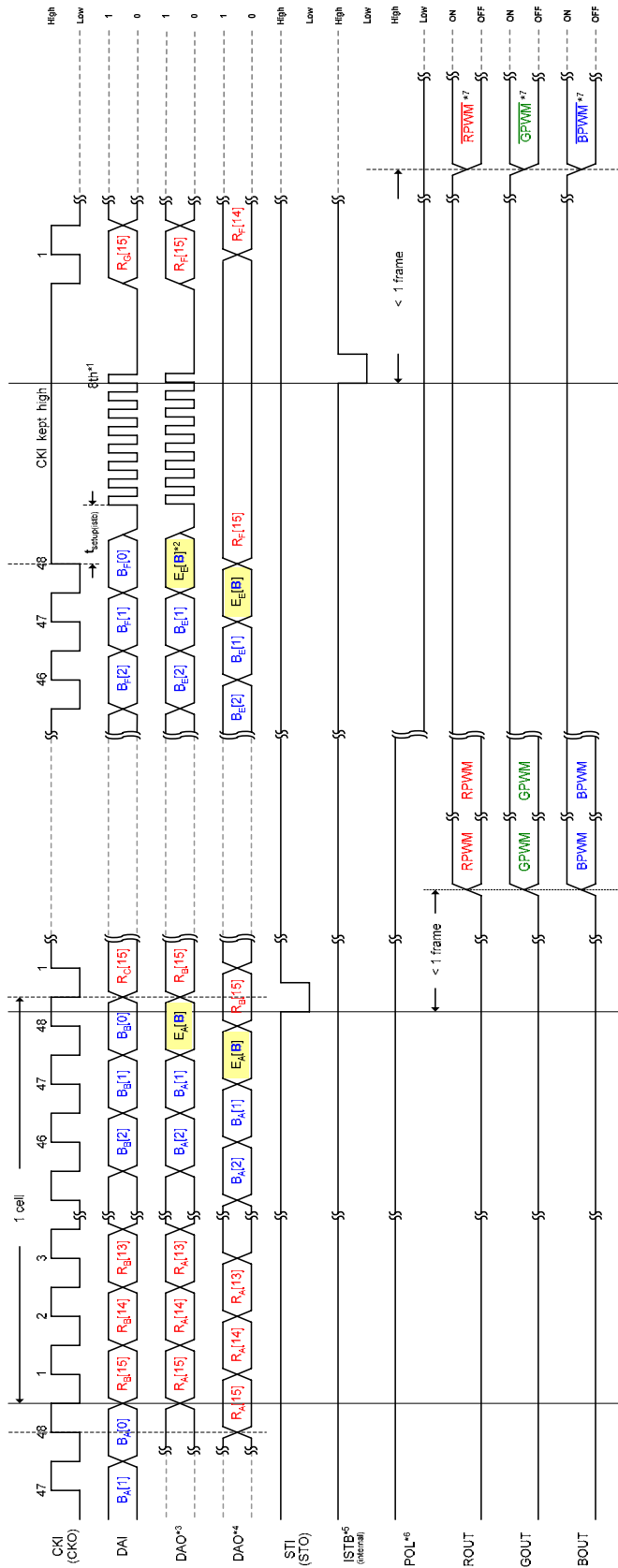## 1. CKI-DAI, CKO, DAO

2. CKI-STI

3. STI-OUTn

Timing Diagram

*1 Keeping CKI in high level and sending into eight DAI pulses successively will trigger internal strobe automatically.

*2 Error message of LED open detection will be sent out from DAO.

*3 SDO = '**H**'

*4 SDO = '**L**'

*5 Internal strobe signal. Auto latch function is only for SDO = '**H**'.

*6 POL is independent of STI or ISTB. Any level change of POL will set(POL=H→L) or reset(POL=L→H) PWM output.
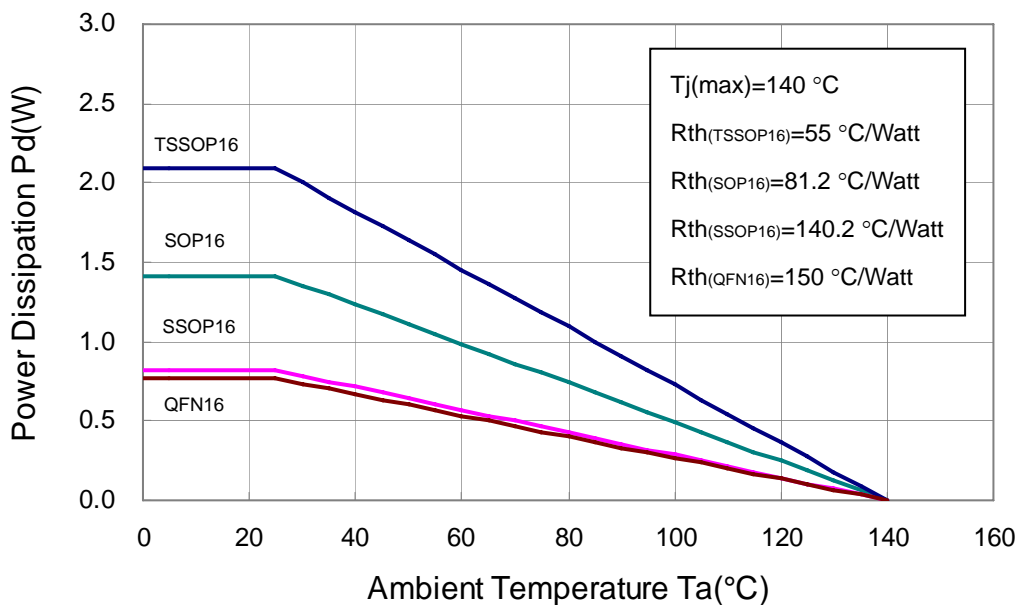
*7 $\overline{PWM}$ is inversion of PWM.

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:

$$Pd(max)(Watt) = \frac{Tj(junction\ temperature)(max)(℃) - Ta(ambient\ temperature)(℃)}{Rth(junction\text{-}to\text{-}air\ thermal\ resistance)(℃/Watt)}$$
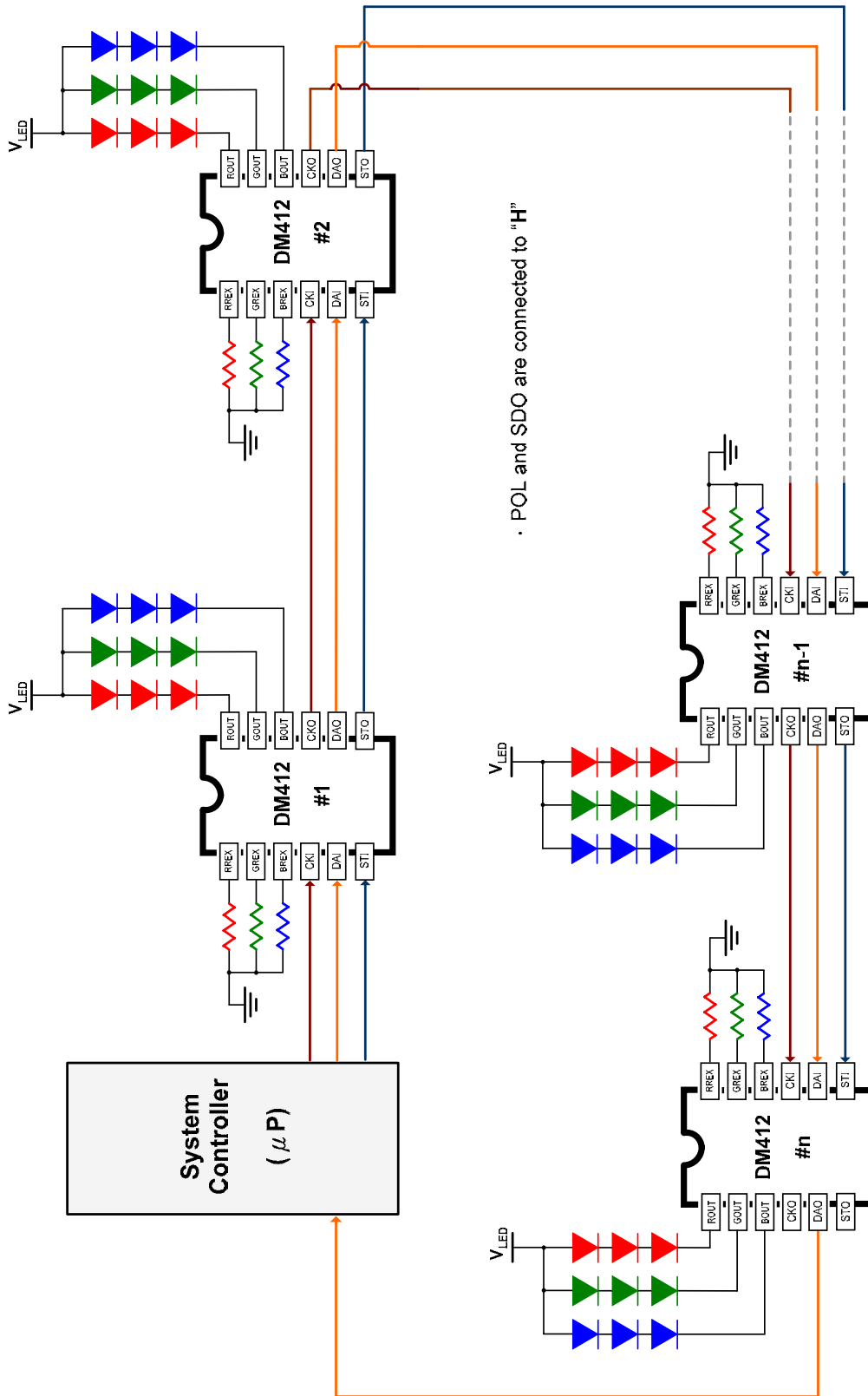
The relationship between power dissipation and operating temperature can be refer to the figure below:
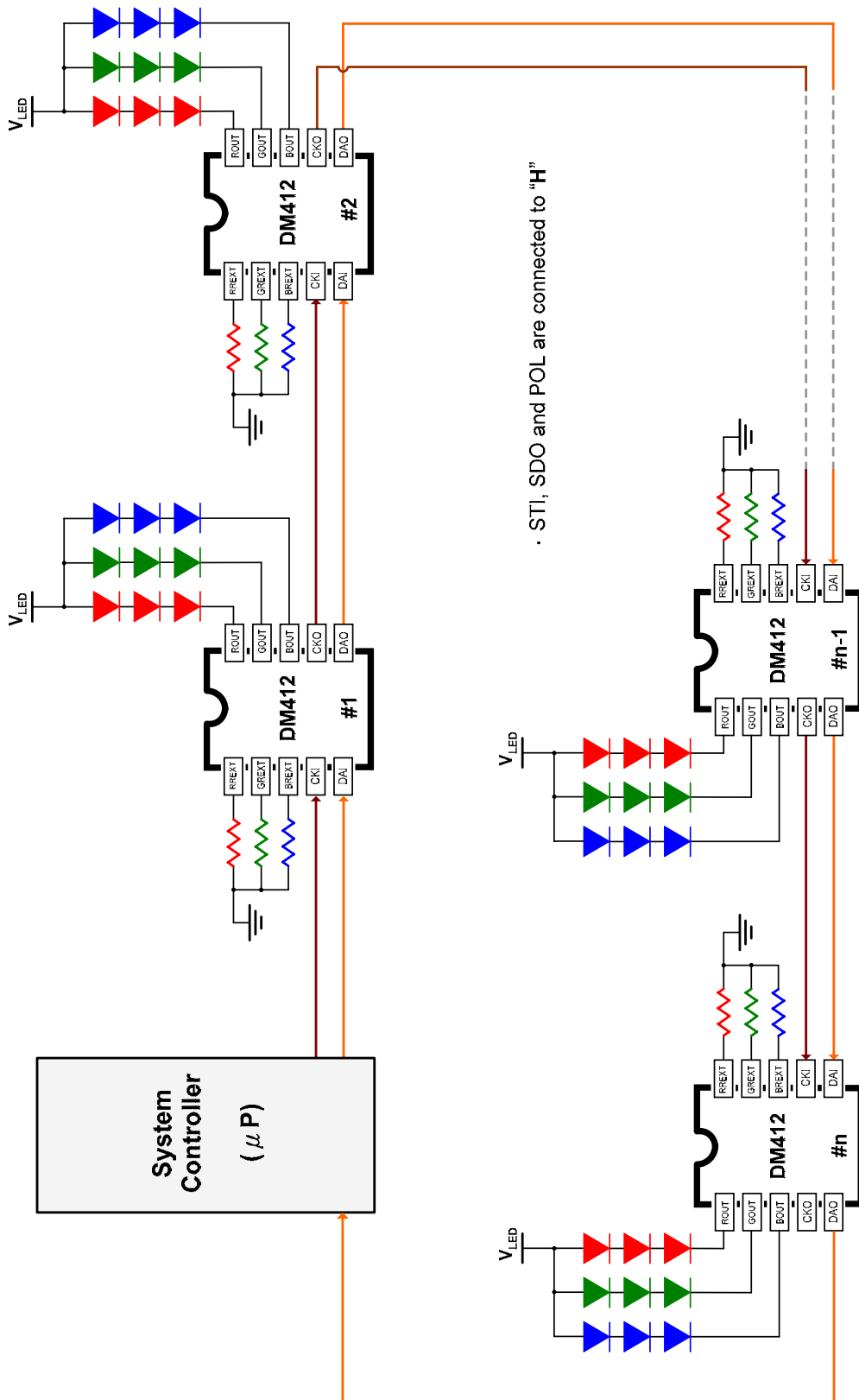

Based on the Pd(max), the maximum allowable voltage of output terminal can be determined by the following equation:

$$VoutR \times IoutR \times DutyR + VoutG \times IoutG \times DutyG + VoutB \times IoutB \times DutyB \leq Pd(max)(W) - Vcc(V) \times I_{DD}(A)$$
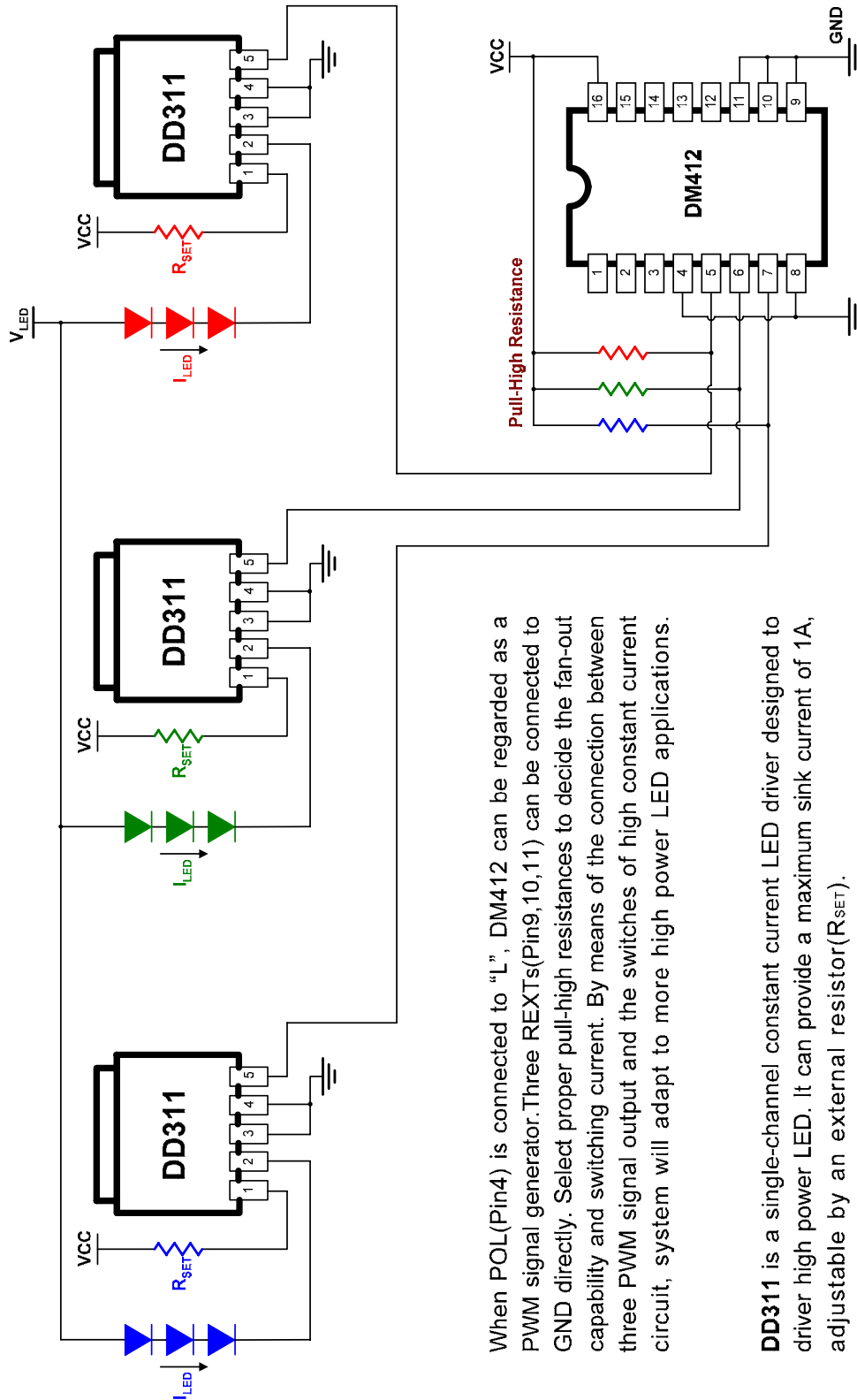
Typical Application

· POL and SDO are connected to "**H**"

Typical Application

· STI, SDO and POL are connected to "H"

Typical Application

When POL(Pin4) is connected to "L", DM412 can be regarded as a PWM signal generator.Three REXTs(Pin9,10,11) can be connected to GND directly. Select proper pull-high resistances to decide the fan-out capability and switching current. By means of the connection between three PWM signal output and the switches of high constant current circuit, system will adapt to more high power LED applications.

DD311 is a single-channel constant current LED driver designed to driver high power LED. It can provide a maximum sink current of 1A, adjustable by an external resistor(R_{SET}).
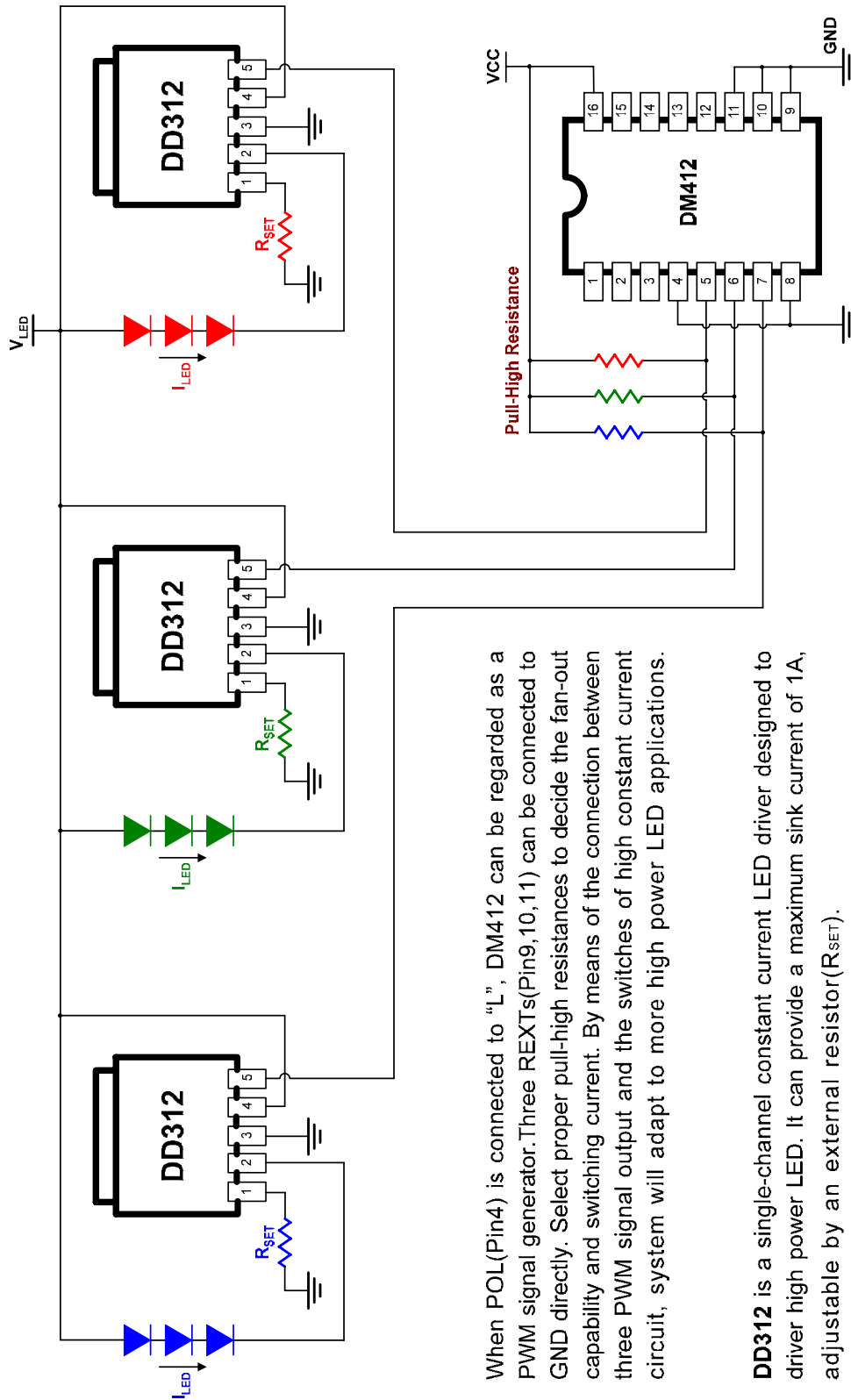
Typical Application

When POL(Pin4) is connected to "L", DM412 can be regarded as a PWM signal generator.Three REXTs(Pin9,10,11) can be connected to GND directly. Select proper pull-high resistances to decide the fan-out capability and switching current. By means of the connection between three PWM signal output and the switches of high constant current circuit, system will adapt to more high power LED applications.

DD312 is a single-channel constant current LED driver designed to driver high power LED. It can provide a maximum sink current of 1A, adjustable by an external resistor(R_{SET}).
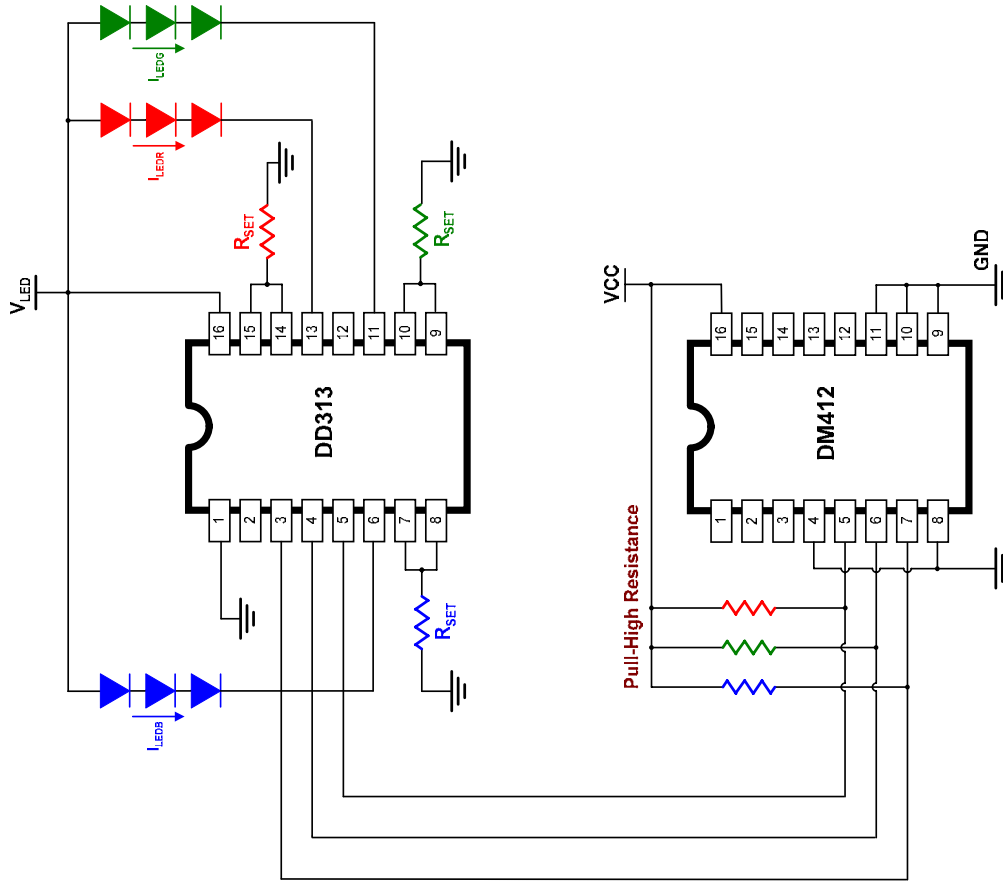
Typical Application

When POL(Pin4) is connected to "L", DM412 can be regarded as a PWM signal generator. Three REXTs(Pin9,10,11) can be connected to GND directly. Select proper pull-high resistances to decide the fan-out capability and switching current. By means of the connection between three PWM signal output and the switches of high constant current circuit, system will adapt to more high power LED applications.

DD313 is a three-channel constant current LED driver designed to driver high power LED. Each channel can provide a maximum sink current of 500mA, adjustable by an external resistor(R_{SET}).
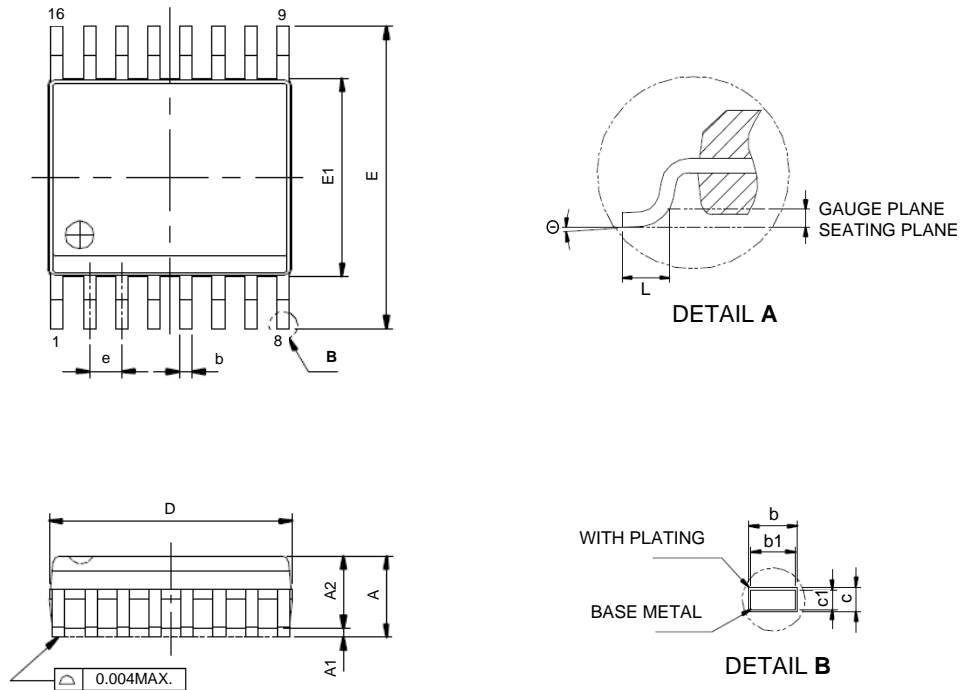
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Package Outline Dimension

DM412-SSOP

DETAIL **A**

DETAIL **B**

	DIMENSIONS IN INCH		DIMENSIONS IN MM	
SYMBOLS	MIN.	MAX.	MIN.	MAX.
A	0.053	0.069	1.346	1.753
A1	0.004	0.010	0.102	0.254
A2	-	0.059	-	1.499
b	0.008	0.012	0.203	0.305
b1	0.008	0.011	0.203	0.279
c	0.007	0.010	0.178	0.254
c1	0.007	0.009	0.178	0.229
D	0.189	0.197	4.801	5.004
E	0.228	0.244	5.791	6.198
E1	0.150	0.157	3.810	3.988
e	0.025TYP.		0.635TYP.	
L	0.016	0.050	0.406	1.270
Θ	0°	8°	0°	8°

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Package Outline Dimension

DM412-SOPEX

	DIMENSIONS IN INCH		DIMENSIONS IN MM	
SYMBOLS	MIN.	MAX.	MIN.	MAX.
A	0.053	0.069	1.346	1.753
A1	0.004	0.010	0.102	0.254
b	0.016TYP.		0.406TYP.	
D	0.386	0.394	9.804	10.008
D1	0.162TYP.		4.115TYP.	
E	0.150	0.157	3.810	3.988
E1	0.086TYP.		2.184TYP.	
e	0.050TYP.		1.270TYP.	
H	0.228	0.244	5.791	6.198
L	0.016	0.050	0.406	1.270
Θ	0°	8°	0°	8°

Package Outline Dimension

DM412-TSSOPEX

	DIMENSIONS IN INCH		DIMENSIONS IN MM	
SYMBOLS	MIN.	MAX.	MIN.	MAX.
A	-	0.047	-	1.20
A1	0.000	0.006	0.00	0.15
A2	0.031	0.041	0.80	1.05
b	0.007	0.012	0.19	0.30
D	0.193	0.201	4.90	5.10
D1	0.106	-	2.70	-
E	0.252TYP.		6.40TYP.	
E1	0.169	0.177	4.30	4.50
E2	0.106	-	2.70	-
e	0.026TYP.		0.65TYP.	
L	0.018	0.030	0.45	0.75
L1	0.039TYP.		1.00TYP.	
S	0.008	-	0.20	-
Θ	0°	8°	0°	8°

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Package Outline Dimension

DM412-QFN

SYMBOL	Dimensions (mm)			Dimensions (inch)		
	MIN	NOM	MAX	MIN	NOM	MAX
A	0.70	0.75	0.80	0.028	0.030	0.032
A_1	0.00	0.02	0.05	0.00	0.001	0.002
A_3	—	0.203	—	—	0.008	—
b	0.18	0.23	0.30	0.007	0.009	0.012
D	2.90	3.00	3.10	0.114	0.118	0.122
D_2	1.40	1.50	1.67	0.055	0.059	0.066
E	2.90	3.00	3.10	0.114	0.118	0.122
E_2	1.40	1.50	1.67	0.055	0.059	0.066
e	—	0.5	—	—	0.020	—
L	0.30	0.40	0.50	0.012	0.016	0.020
Y	—	0.08	—	—	0.003	—

DM412-SSOP Package and Weight（4 Boxes Set）

SSOP16 - 150 - 0.635

IC

SSOP

100 pcs ICs per Tube

Tube

53cm

100 Tubes per Box

Box

11cm

10cm

61cm

4 Boxes per Carton

Carton

24cm

24cm

64cm

Weight

Item	Description	Weight（Kg）
1	100 pcs DM412-SSOP per Tube	0.02±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, 40,000 pcs）	10.84±5%

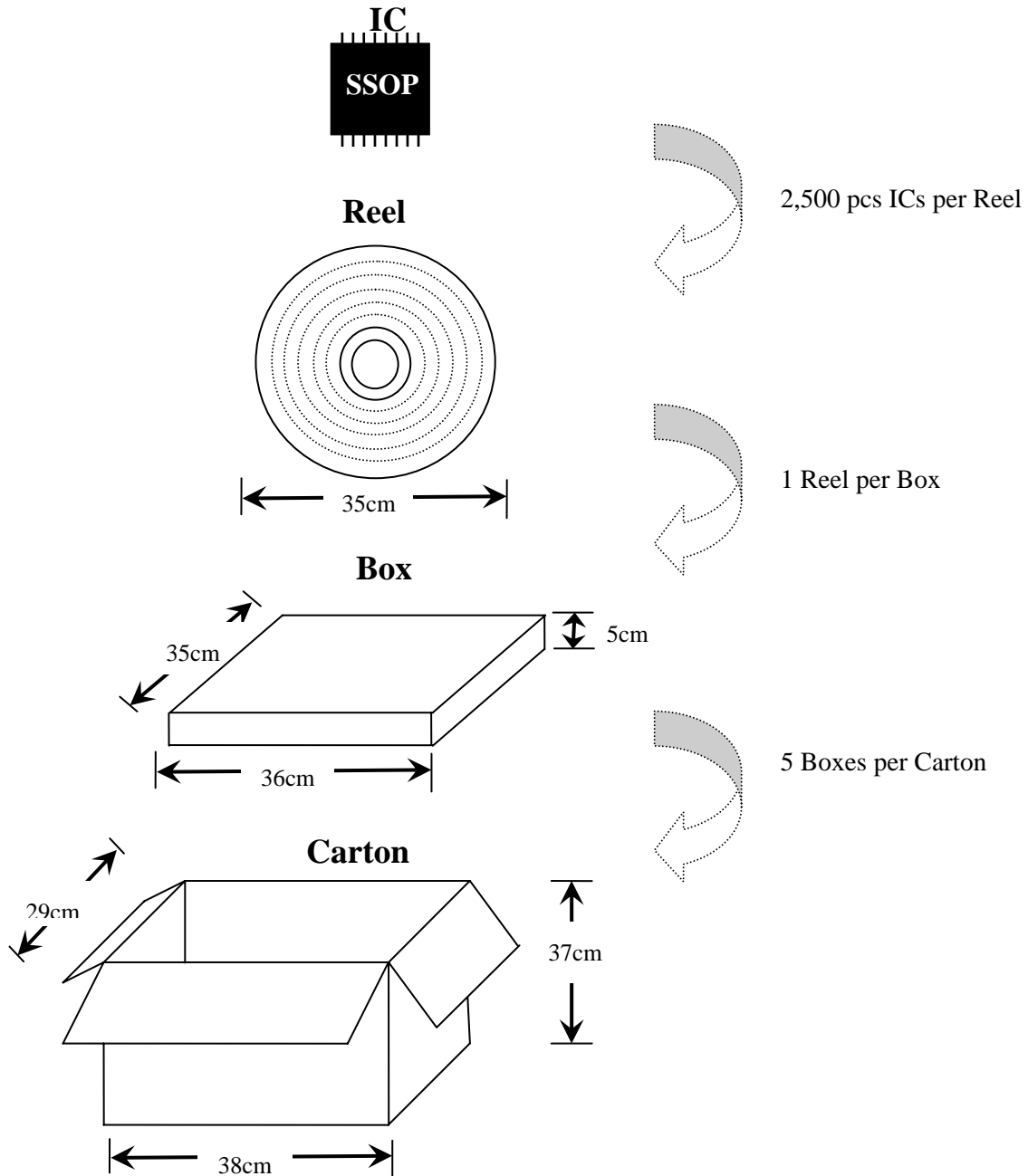# DM412-SSOP Package and Weight（6 Boxes Set）

SSOP16 - 150 - 0.635

IC
SSOP

100 pcs ICs per Tube

Tube

53cm

Box

11cm

10cm

61cm

100 Tubes per Box

Carton

24cm

34cm

64cm

6 Boxes per Carton

Weight

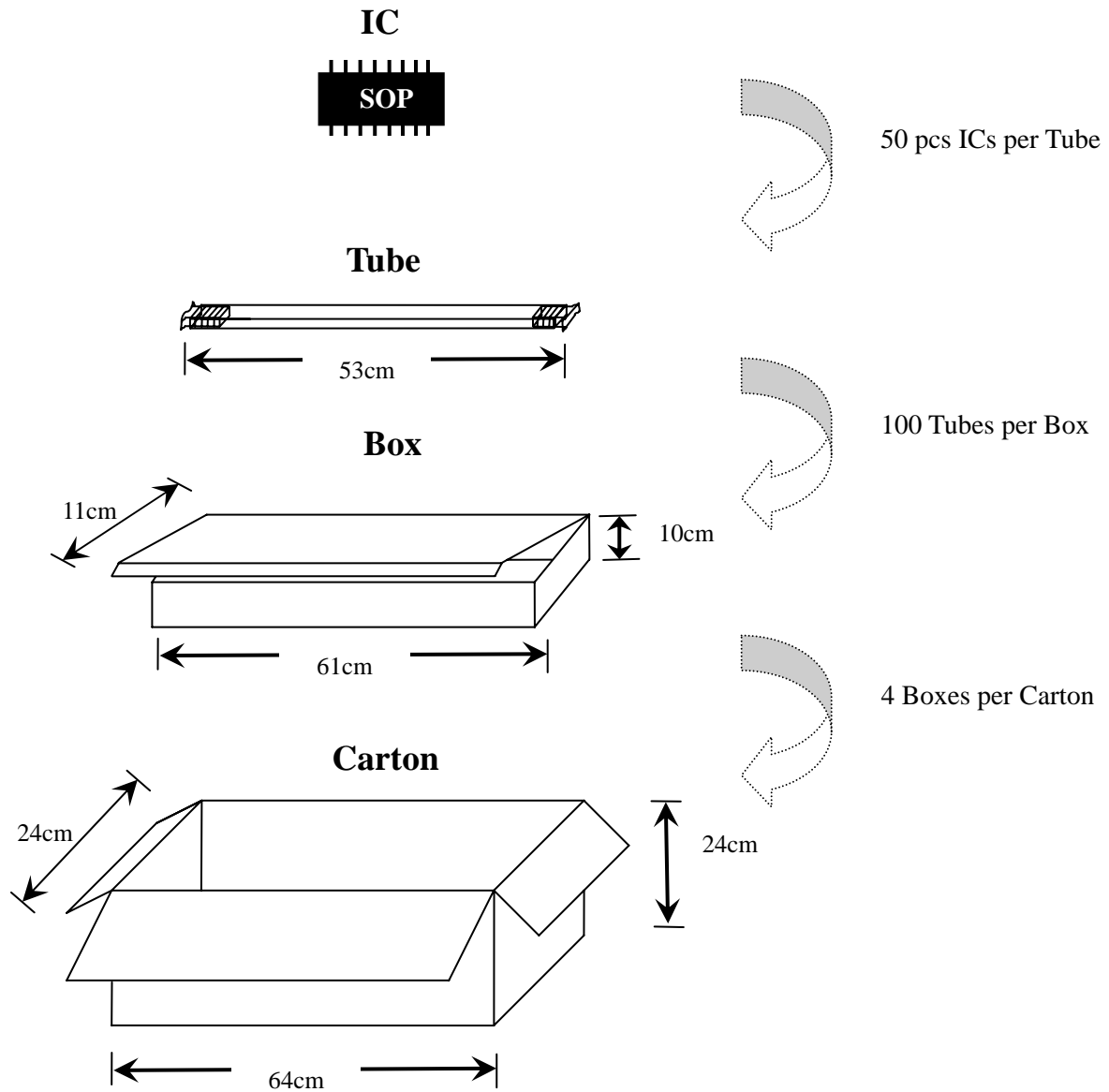| Item	Description	Weight（Kg）
1	100 pcs DM412-SSOP per Tube	0.02±5%
2	Net Weight of one Box	0.40±5%
3	Net Weight of one Carton（for 6 Boxes）	1.44±5%
4	Per Carton Set (6 Boxes, 60,000 pcs)	15.84±5%

DM412-SSOP Package and Weight

SSOP16 - 150 - 0.635

IC

SSOP

Reel

2,500 pcs ICs per Reel

35cm

1 Reel per Box

Box

35cm

5cm

36cm

5 Boxes per Carton

Carton

29cm

37cm

38cm

Weight

Item	Description	Weight (Kg)
1	2,500 pcs DM412-SSOP per Reel	0.71±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)	5.65±5%

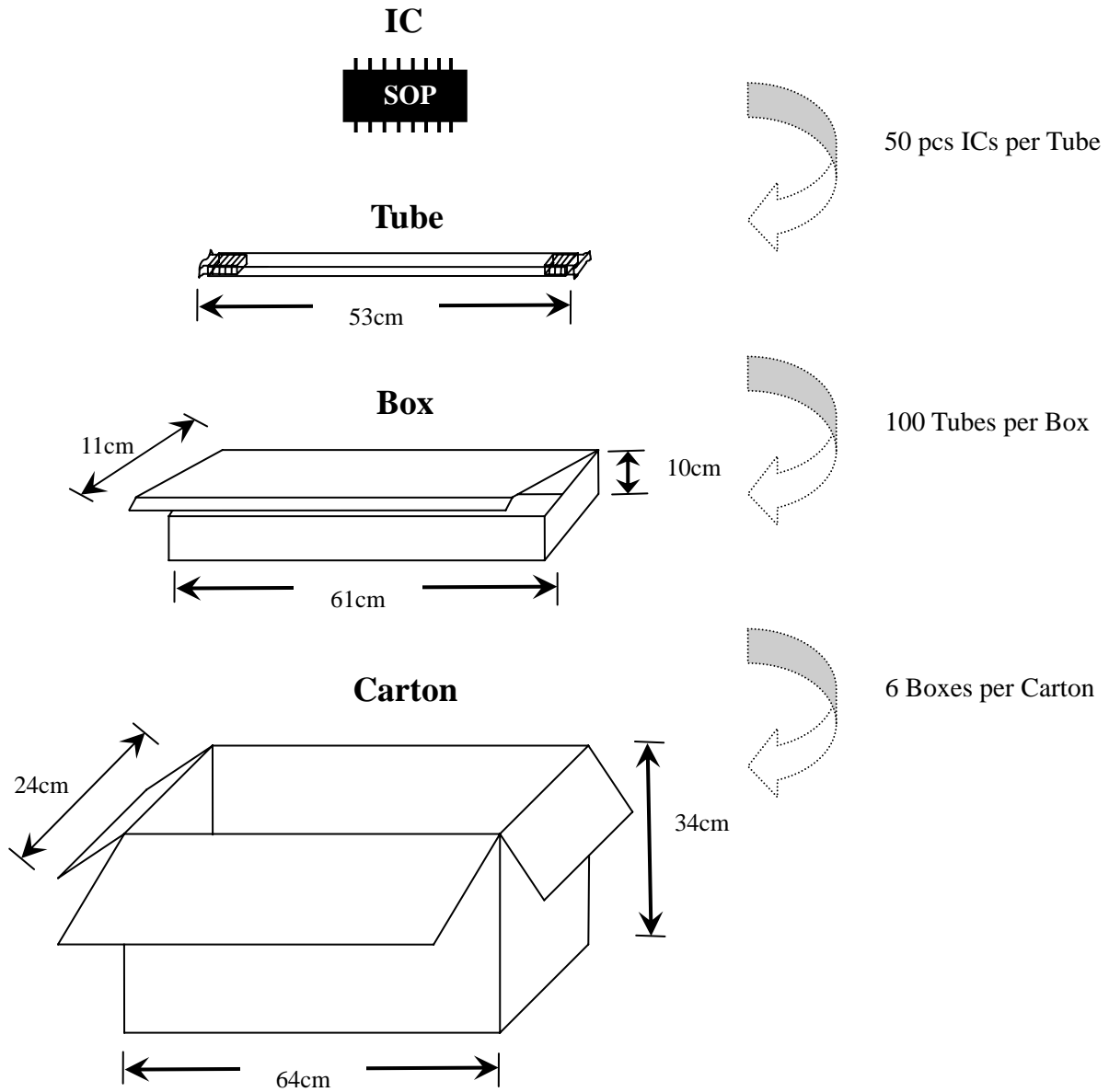# DM412-SOPEX Package and Weight（4 Boxes Set）

SOP16 – 150 - 1.27（Exposed Pad）

IC

SOP

50 pcs ICs per Tube

Tube

53cm

100 Tubes per Box

Box

11cm

10cm

61cm

4 Boxes per Carton

Carton

24cm

24cm

64cm

Weight

Item	Description	Weight（Kg）
1	50 pcs DM412-SOPEX per Tube	0.016±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）	9.24±5%

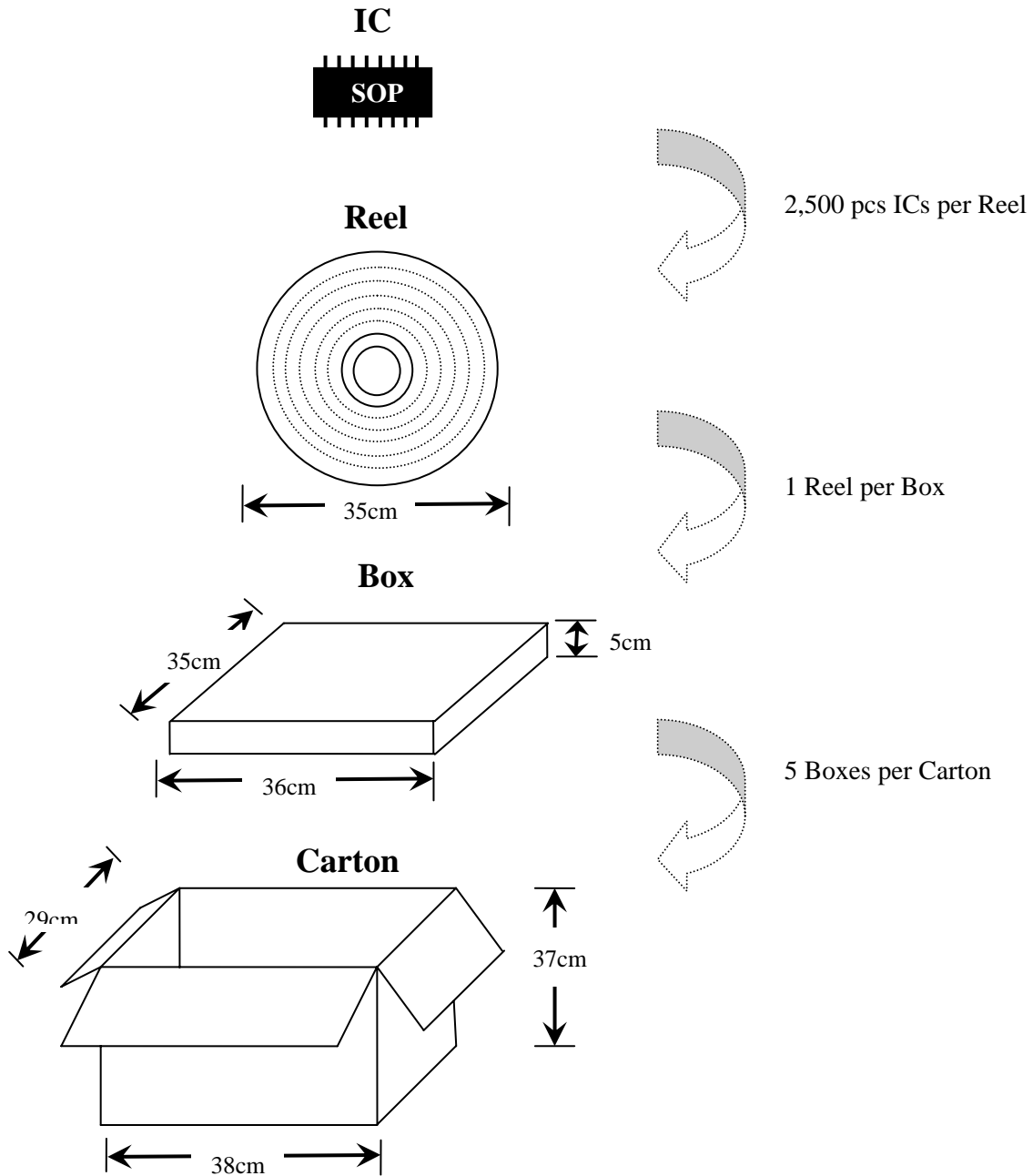# DM412-SOPEX Package and Weight（6 Boxes Set）

SOP16 – 150 - 1.27（Exposed Pad）

IC

SOP

50 pcs ICs per Tube

Tube

53cm

Box

11cm

10cm

61cm

100 Tubes per Box

Carton

24cm

34cm

64cm

6 Boxes per Carton

Weight

Item	Description	Weight（Kg）
1	50 pcs DM412-SOPEX per Tube	0.016±5%
2	Net Weight of one Box	0.40±5%
3	Net Weight of one Carton（for 6 Boxes）	1.44±5%
4	Per Carton Set (6 Boxes, 30,000 pcs)	13.44±5%

DM412-SOPEX Package and Weight
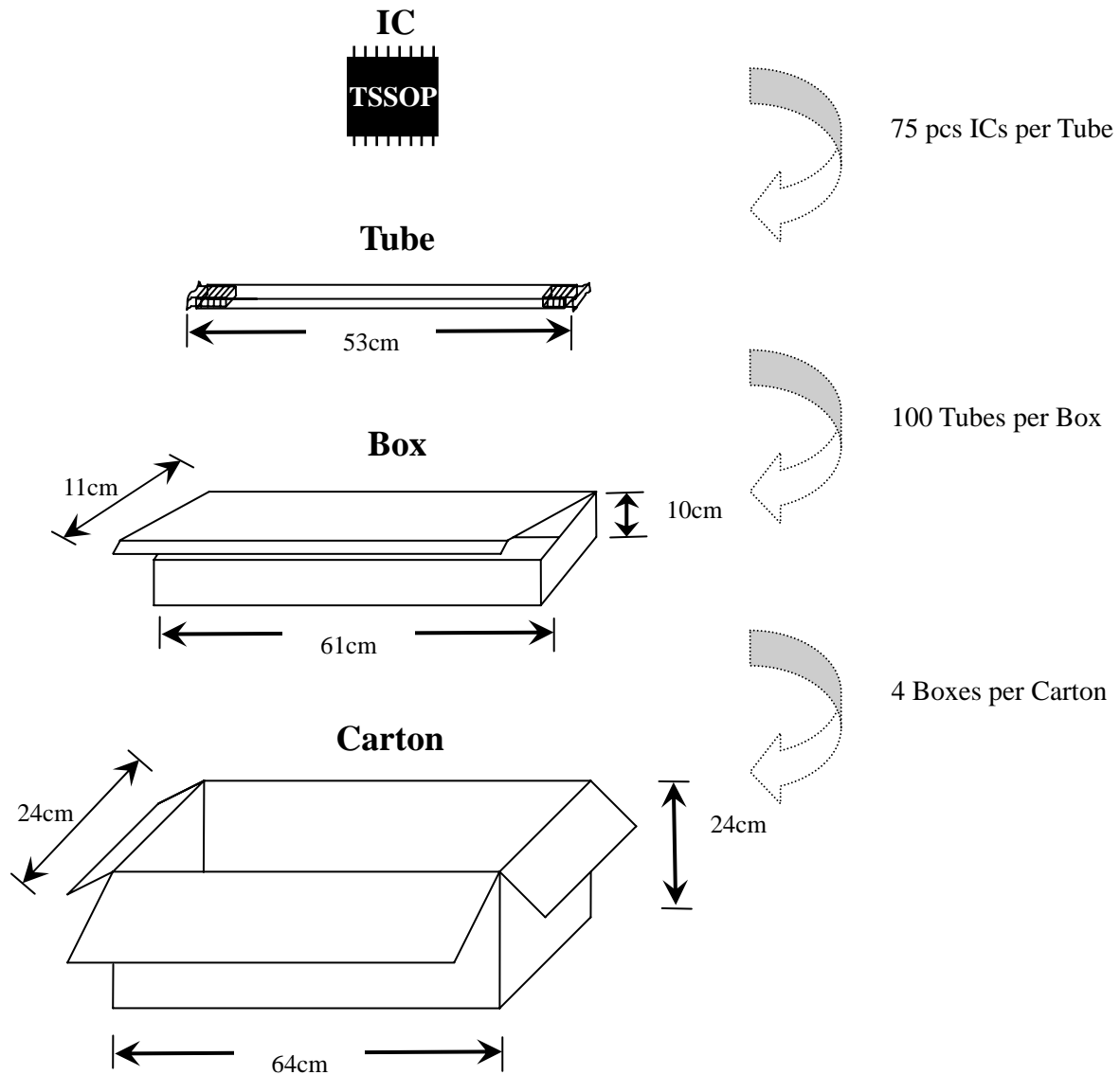
SOP16 – 150 - 1.27（Exposed Pad）

IC

SOP

2,500 pcs ICs per Reel

Reel

35cm

1 Reel per Box

Box

35cm

5cm

36cm

5 Boxes per Carton

Carton

29cm

37cm

38cm

Weight

Item	Description	Weight（Kg）
1	2,500 pcs DM412-SOPEX 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%

點晶科技股份有限公司
SILICON TOUCH TECHNOLOGY INC.

DM412-TSSOPEX Package and Weight（4 Boxes Set）

TSSOP16 - 173 - 0.65（Exposed Pad）

IC

TSSOP

75 pcs ICs per Tube

Tube

53cm

100 Tubes per Box

Box

11cm

10cm

61cm

4 Boxes per Carton

Carton

24cm

24cm

64cm

Weight

Item	Description	Weight（Kg）
1	75 pcs DM412-TSSOPEX per Tube	0.011±5%
2	Net Weight of one Box	0.40±5%
3	Net Weight of one Carton（for 4 Boxes）	1.24±5%
4	Per Carton Set（4 Boxes, 30,000 pcs）	7.24±5%

點晶科技股份有限公司
SILICON TOUCH TECHNOLOGY INC.

DM412-TSSOPEX Package and Weight（6 Boxes Set）

TSSOP16 - 173 - 0.65（Exposed Pad）

IC

TSSOP

75 pcs ICs per Tube

Tube

53cm

100 Tubes per Box

Box

11cm

10cm

61cm

6 Boxes per Carton

Carton

24cm

34cm

64cm

Weight

Item	Description	Weight（Kg）
1	75 pcs DM412-TSSOPEX per Tube	0.011±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, 45,000 pcs）	10.44±5%

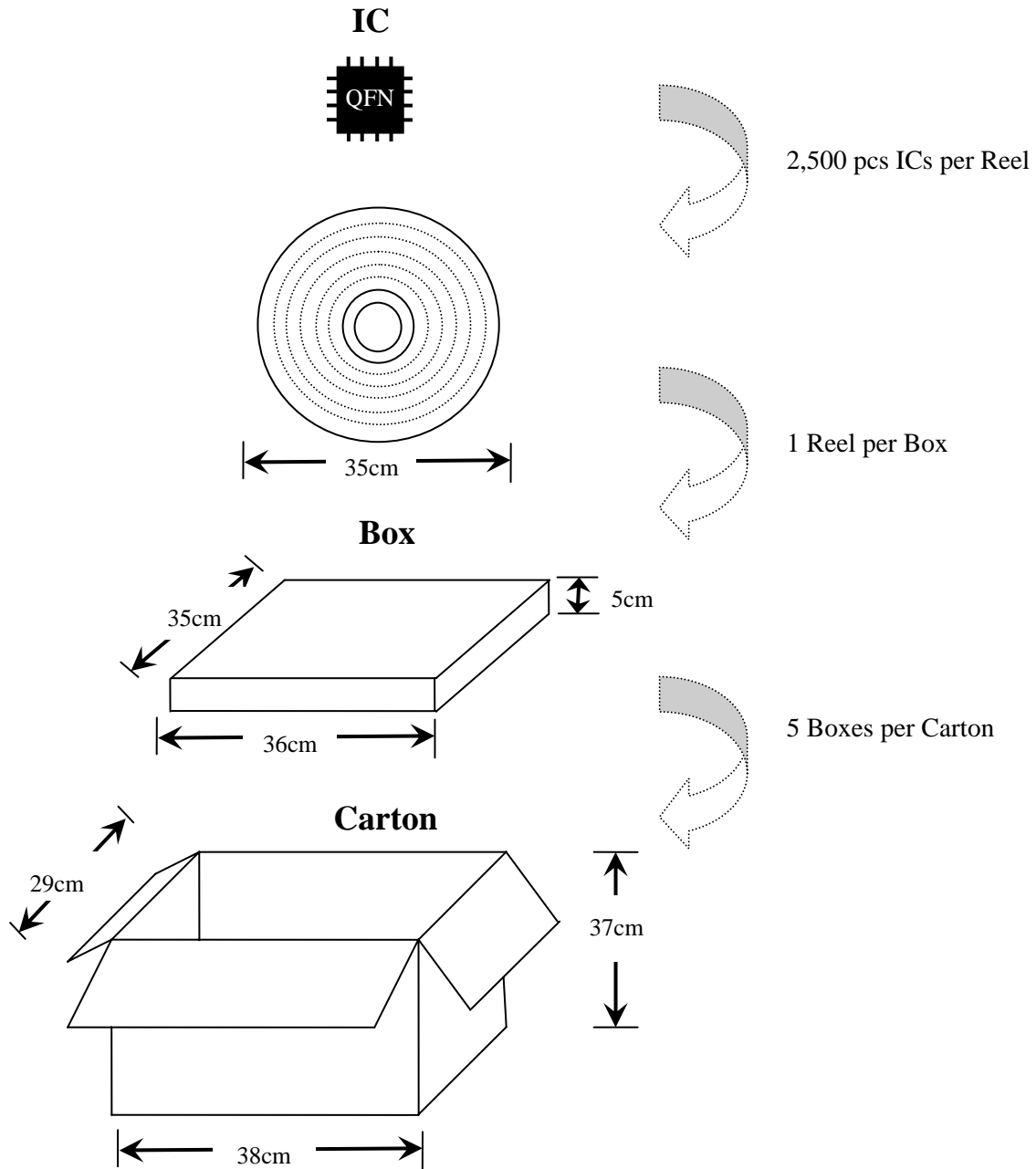# DM412-TSSOPEX Package and Weight

TSSOP16 - 173 - 0.65 (Exposed Pad)

IC

TSSOP

2,500 pcs ICs per Reel

35cm

1 Reel per Box

Box

35cm

5cm

36cm

37cm

Carton

29cm

37cm

38cm

Weight

Item	Description	Weight (Kg)
1	2,500 pcs DM412-TSSOPEX per Reel	0.73±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)	5.75±5%

DM412-QFN Package and Weight

SOP16 - 150 - 1.27（Exposed Pad）

IC

QFN

2,500 pcs ICs per Reel

35cm

1 Reel per Box

Box

35cm

5cm

36cm

5 Boxes per Carton

Carton

29cm

37cm

38cm

Weight

Item	Description	Weight（Kg）
1	2,500 pcs DM412-QFN per Reel	0.58±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±5%

Product Ordering Information

Part Number	Package Type	Number / Weight (typ.)	
		Tube / Tray	**Reel (Box included)**
DM412-SOPEX	SOP16-150-1.27 (Exposed Pad)	50 pcs / Tube 0.016kg ± 5%	2,500pcs / Reel 0.97kg ± 5%
DM412-SSOP	SSOP16-150-0.635	100pcs / Tube 0.02kg ± 5%	2,500pcs / Reel 0.71kg ± 5%
DM412-TSSOPEX	TSSOP16-173-0.65 (Exposed Pad)	75pcs / Tube 0.011kg ± 5%	2,500pcs / Reel 0.73kg ± 5%
DM412-QFN	QFN16-3×3	—	2,500pcs / Reel 0.58kg ± 5%