

DD313

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3-CHANNEL HIGH CONSTANT CURRENT LED DRIVER
with ERROR DETECTION



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DD313

3-CHANNEL HIGH CONSTANT CURRENT LED DRIVER with ERROR DETECTION

General Description

DD313 is a high constant current driver designed for LED lighting application and power LEDs. It incorporates three-channel constant current circuitry with current value set by three external resistors. The three enable pin is 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
- Maximum output current: 500mA determined by three external resistors
- Minimum output voltage: 1V ($I_{out} = 500mA$)
- Maximum output voltage: 18V
- Output enable terminal: 1MHz (max.)
- Supply voltage range: 5V ~ 18V
- Over current protection
- LED open detection
- Thermal alarm (junction temperature $> 110^{\circ}C$)
- Thermal shutdown (junction temperature $> 180^{\circ}C$)

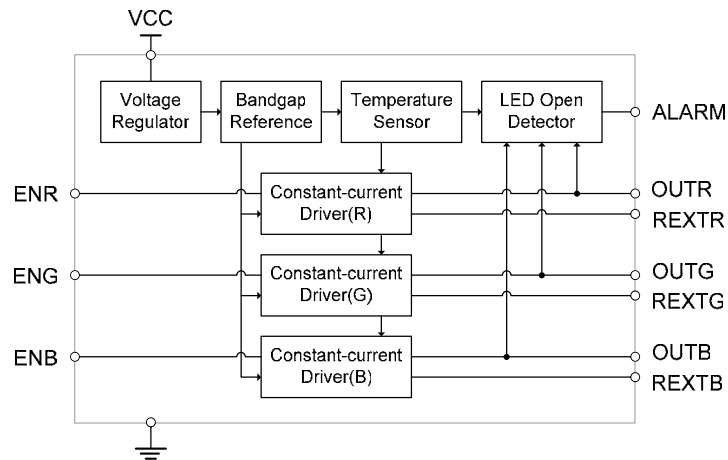
Applications

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

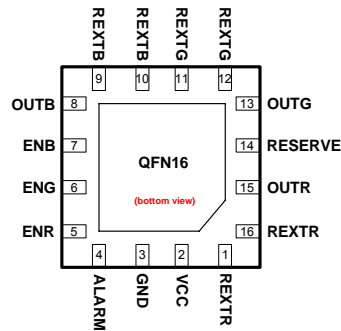
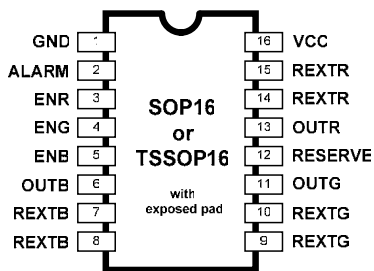
Package Types

- SOP16 (with thermal pad), TSSOP16 (with thermal pad), or QFN16 (with thermal pad)

Block Diagram



Pin Connection



Pin Description

PIN No.	PIN NAME	FUNCTION
SOP16/TSSOP16: 1 QFN16: 3	GND	Ground terminal.
SOP16/TSSOP16: 2,12 QFN16: 4	ALARM	Output open drain terminal: (connected to a pull-high resistor) 'H' for normal conditions, 'L' for LED open or chip overheated.
SOP16/TSSOP16: 3,4,5 QFN16: 5,6,7	ENR,G,B	Output current enable terminal.
SOP16/TSSOP16: 6,11,13 QFN16: 8,13,15	OUTB,G,R	Sink constant current outputs (open-drain).
SOP16/TSSOP16: 7,8,9,10,14,15 QFN16: 9,10,11,12,16,1	REXTB ^{*1} REXTG ^{*1} REXTB ^{*1}	External resistors connected between REXT and GND for driver current value setting.
SOP16/TSSOP16: 16 QFN16: 2	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+0.3	
Output Current	Iout	0.5	A
Output Voltage	Vout	-0.3 ~ 18	V
Enable Voltage	VEN	-0.3 ~ 18	
Output Enable Frequency	FEN	1.0	MHz
GND Terminal Current	IGND	1.5	A
Power Dissipation	Pd	3.0 (TSSOP16) 1.4 (SOP16) 0.8 (QFN16)	W
Thermal Resistance (Junction to Air)	Rth(j-a) *1	38 (TSSOP16) 81.2 (SOP16) 150 (QFN16)	°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	VIH	VCC = 5.0V ~ 18V	3.0	—	18	V
	VIL		-0.3	—	1.0	
Input Enable Frequency	FEN	Ven > 3.0V	DC	—	1	MHz

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

*2 Notice that 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).



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} = 0 V	—	—	1.0	uA
Output Current Skew (Channel-to-Channel) *1	I _{OL1}	V _{out} = 1.0 V R _{EXT} = 1 Ω	—	TBD	±3	%
Output Current Skew (Chip-to-Chip) *2	I _{OL2}		—	TBD	TBD	
Output Voltage Regulation	% / V _{out}	R _{EXT} = 1 Ω V _{out} = 0.8 V ~ 3 V	—	0.1	1	% / V
Supply Voltage Regulation	% / VCC	R _{EXT} = 1 Ω	—	—	2	
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 *3	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	—	

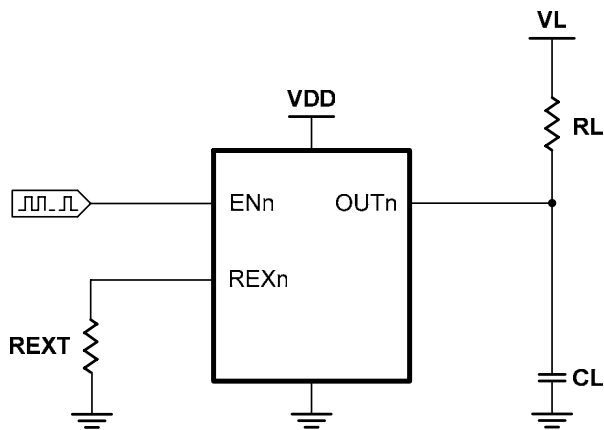
*1 Channel-to-channel skew is defined as the ratio between (any I_{out} – average I_{out}) and average I_{out}, where average I_{out} = (I_{max} + I_{min}) / 2.

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

*3 IO excluded.

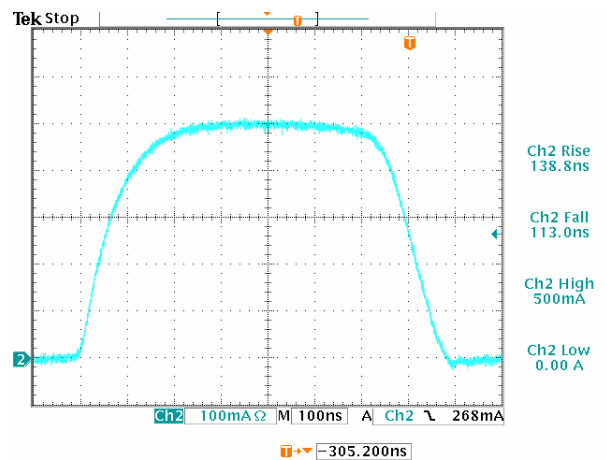
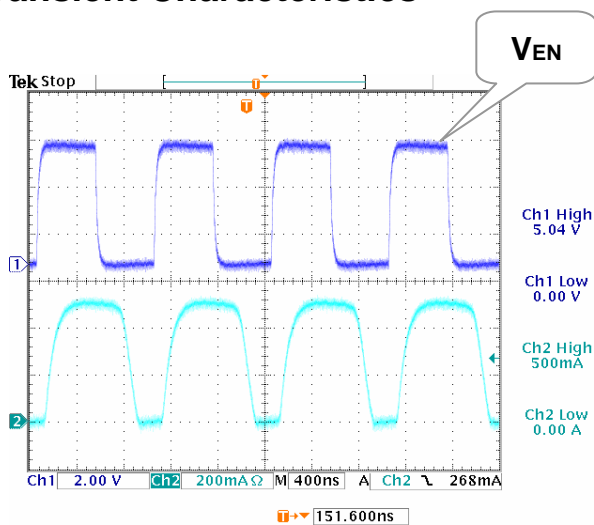
Switching Characteristics (Ta = 25°C unless otherwise noted)

CHARACTERISTIC		SYMBOL	CONDITION	MIN.	TYP.	MAX.	UNIT
Propagation Delay ('L' to 'H')	EN-to-OUT (Driver On)	tpLH	VIH = VCC	—	110	—	ns
Propagation Delay ('H' to 'L')	EN-to-OUT (Driver Off)	tpHL	VIL = GND REXT = 1 Ω	—	280	—	
Output Current Rise Time		tor	VL = 5.0 V	—	135	—	
Output Current Fall Time		tof	RL = 8 Ω CL = 13 pF	—	115	—	



Switching Characteristics Test Circuit

Transient Characteristics

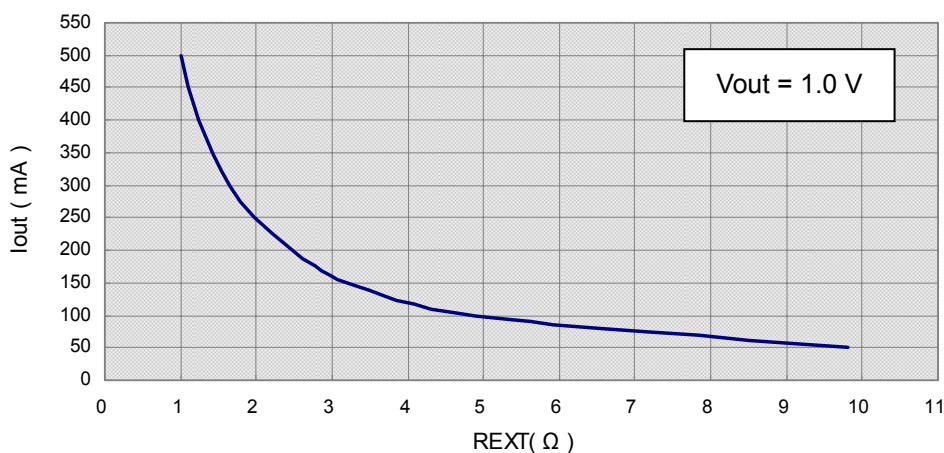


Constant-Current Output

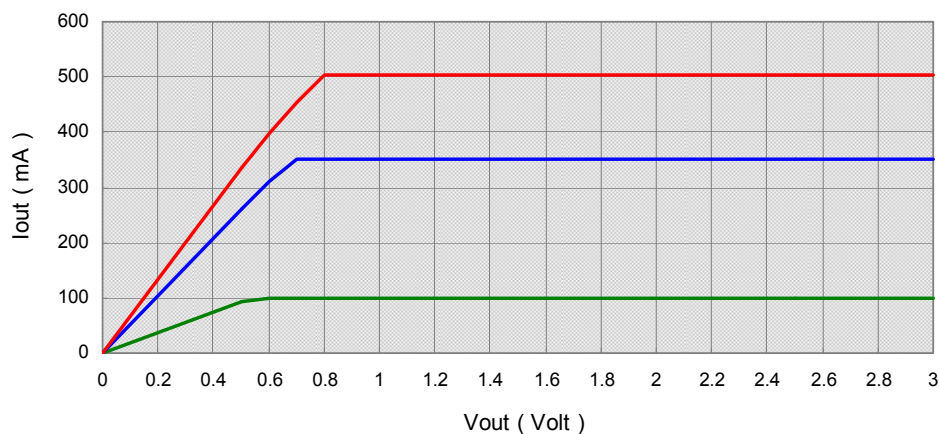
Constant-current value of each output channel is set by an external resistor connected between the REXT(R, G, B) pin and GND individually. Varying the resistor value can adjust the current up to 500mA. Notice that the output current is a little increasing or decreasing until the device temperature and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

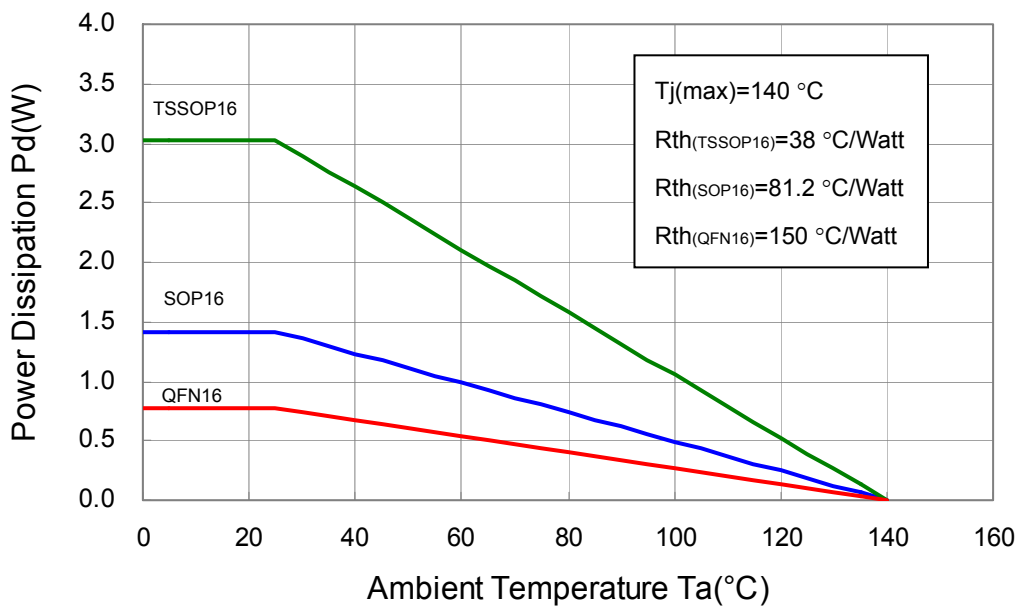


Power Dissipation

Notice that 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:

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

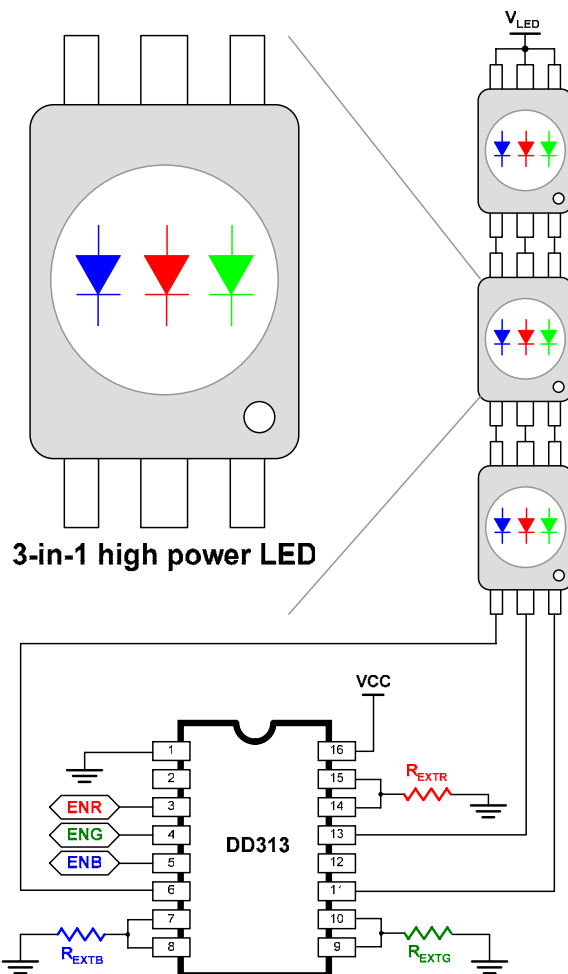
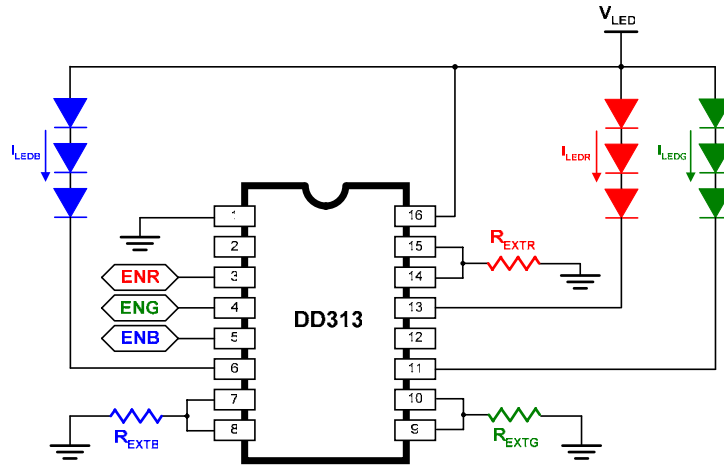
The relationship between power dissipation and operating temperature can be refer to the figure below:



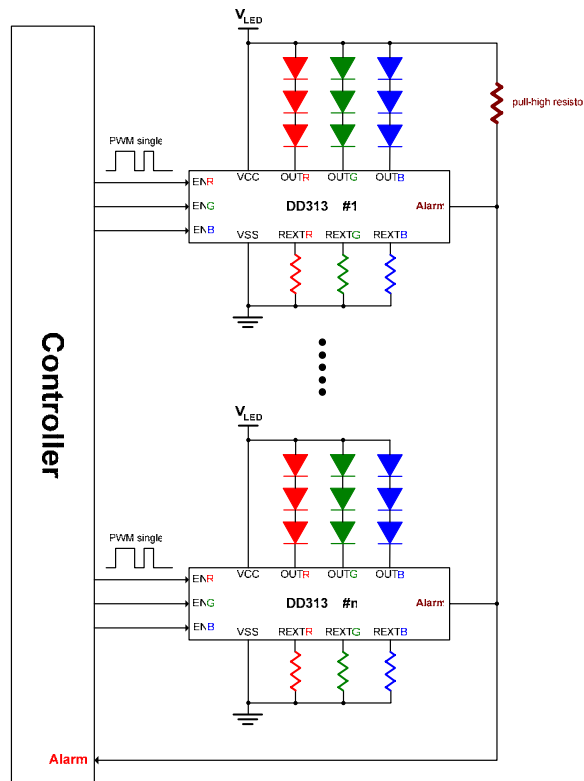
Based on the Pd(max), the maximum allowable voltage of output terminal can be determined by the following equation:

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

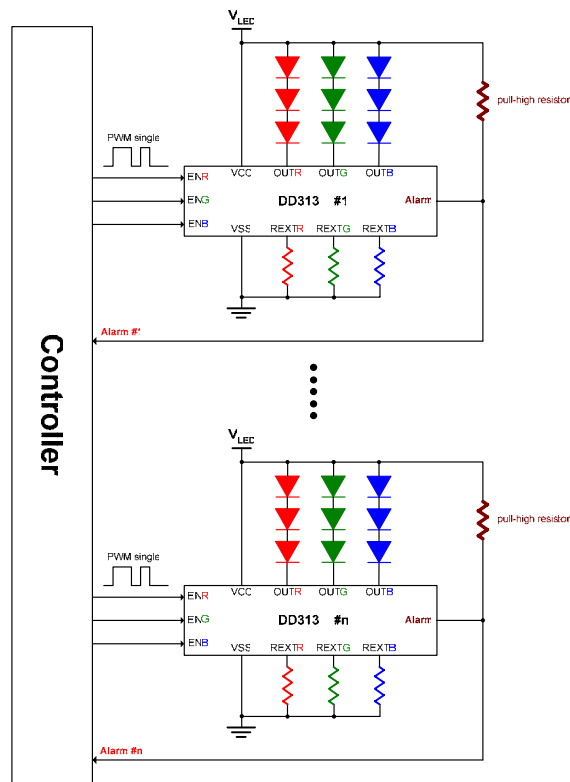
Typical Application



Typical Application

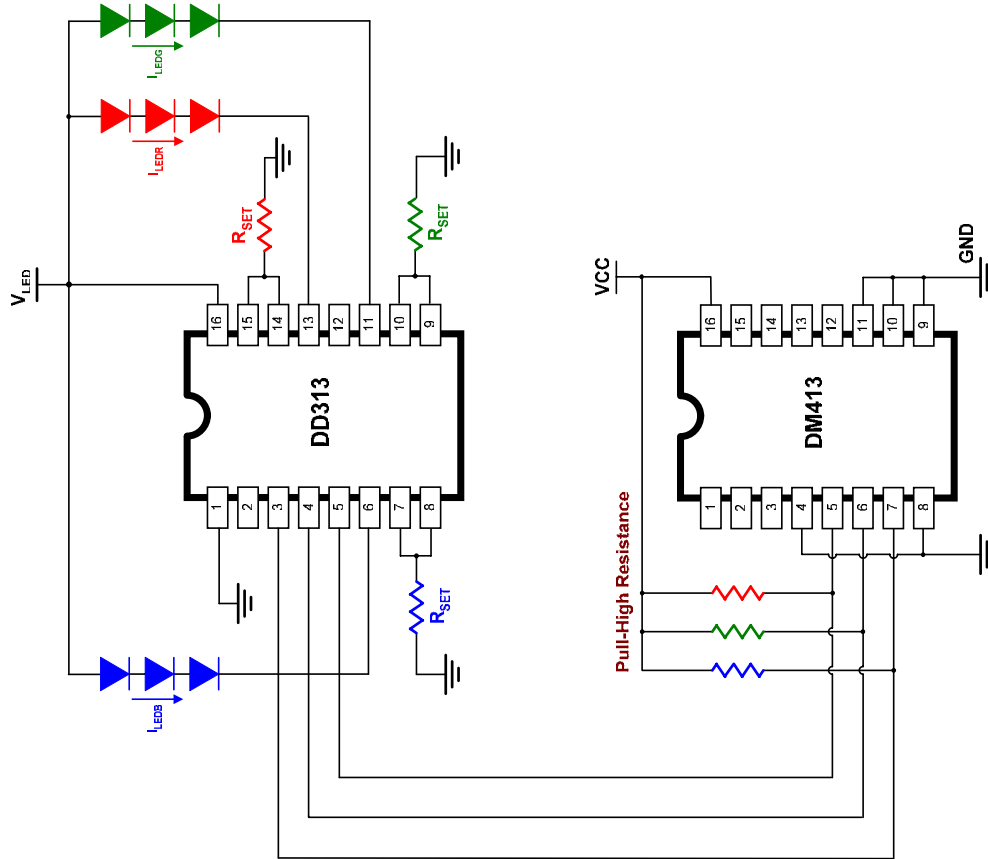


Feedback Alarm signal with only one pull-high resistor



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 DM413 is configured to act as PWM signal generator. Through serial data input, DM413 can generate maximum of 14 bits RGB PWM grayscale signal to control the three channel of DD313. The combination of DD313 and DM413 offers an ideal solution for high end grayscale control and color manipulation.

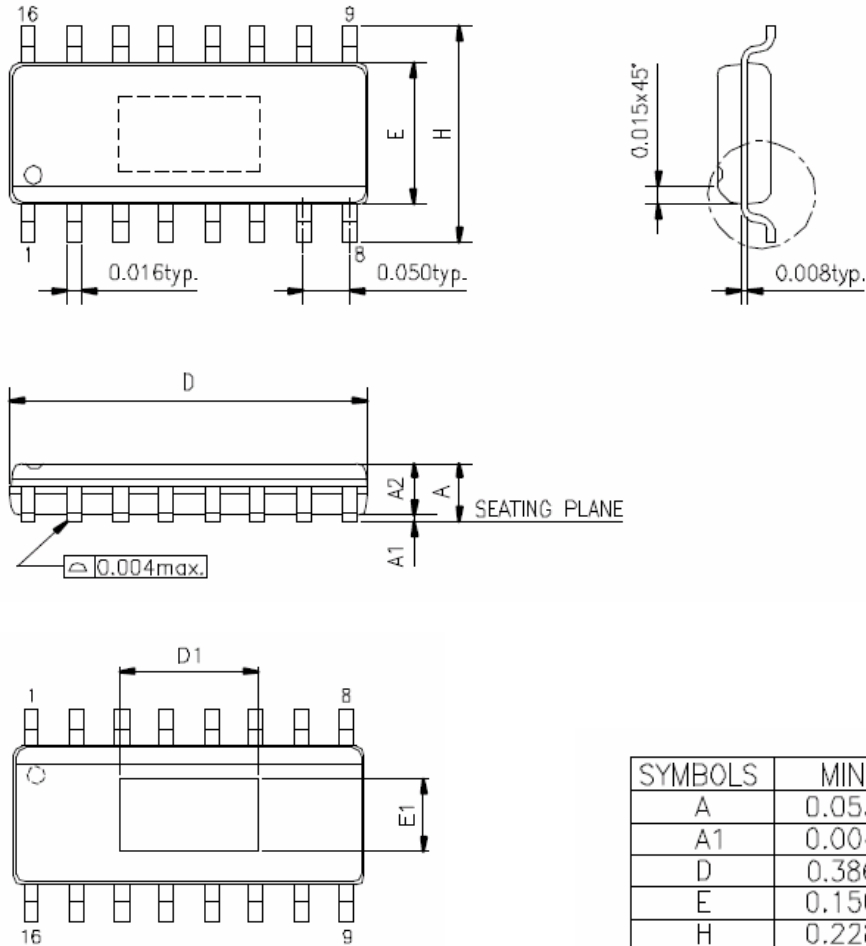
DM413 is a three-channel constant current LED driver specifically designed for LED lighting or display applications. It incorporates shift registers, data latches, and built-in oscillator for PWM functioning. Data and clock buffer outputs are designed for cascading another chip. Additionally the Output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



Package Outline Dimension

SOP16 (exposed pad)

Unit: inch



SYMBOLS	MIN.	MAX.
A	0.053	0.069
A1	0.004	0.010
D	0.386	0.394
E	0.150	0.157
H	0.228	0.244
L	0.016	0.050
θ	0	8

UNIT : INCH

△ THERMALLY ENHANCED DIMENSIONS

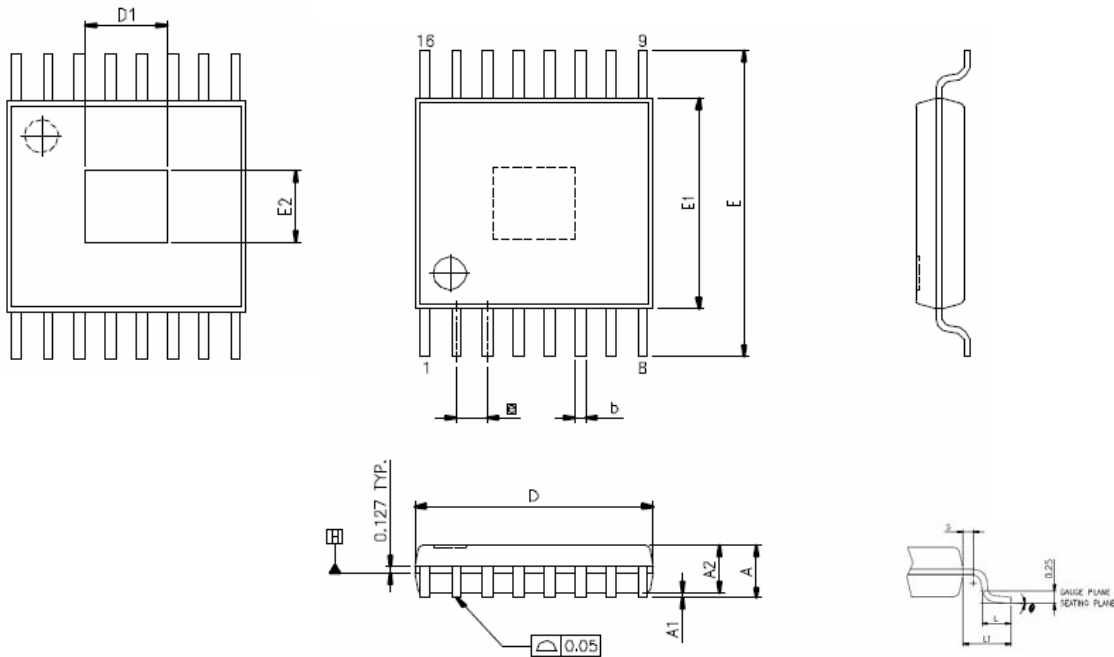
PAD DIZE	E1	D1
95X18E	0.086 REF	0.162 REF

UNIT : INCH

Package Outline Dimension

TSSOP16 (exposed pad)

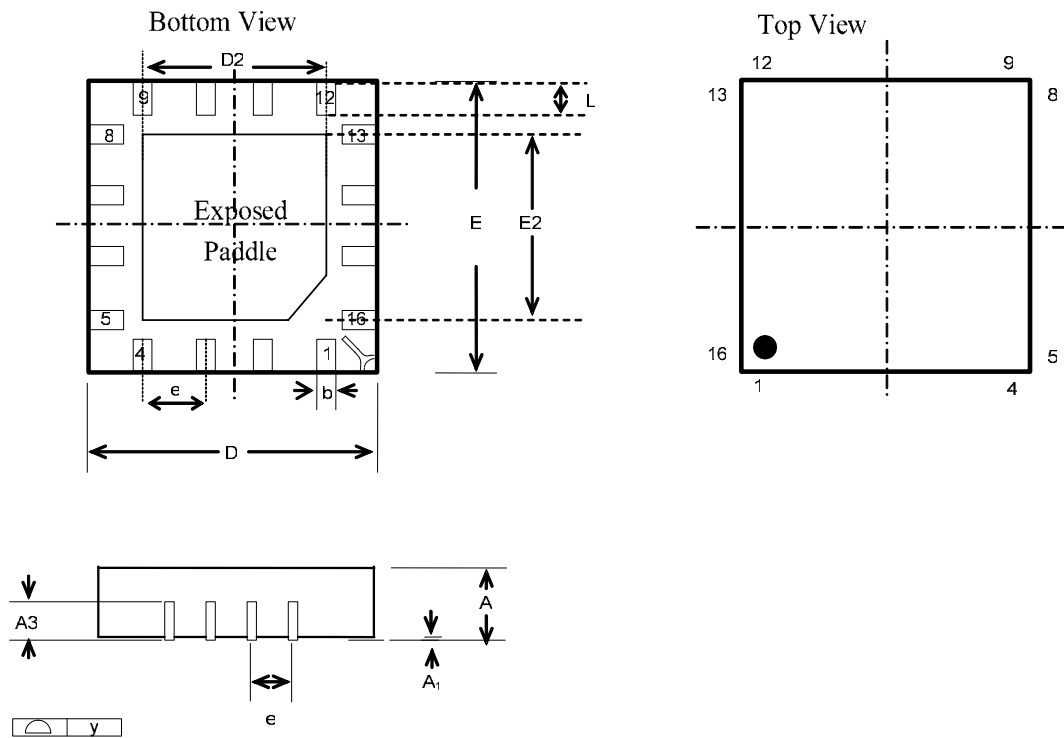
Unit: mm



SYMBOLS	MIN.	NOM.	MAX.
A	—	—	1.20
A1	0.00	—	0.15
A2	0.80	1.00	1.05
b	0.19	—	0.30
D	4.90	5.00	5.10
D1	1.70	—	—
E2	1.50	—	—
E1	4.30	4.40	4.50
E	6.40 BSC		
\square	0.65 BSC		
L1	1.00 REF		
L	0.45	0.60	0.75
S	0.20	—	—
\emptyset	0'	—	8'

Package Outline Dimension

QFN16 (exposed pad)



SYMBOL	Dimensions (mm)			Dimensions (mil)		
	MIN	NOM	MAX	MIN	NOM	MAX
A	0.70	0.75	0.80	27.6	29.5	31.5
A ₁	0.00	0.02	0.05	0.00	0.79	1.97
A ₃	—	0.203	—	—	8.00	—
b	0.18	0.23	0.30	7.09	9.06	11.81
D	2.90	3.00	3.10	114.17	118.11	122.05
D ₂	1.40	1.50	1.67	55.12	59.06	65.74
E	2.90	3.00	3.10	114.17	118.11	122.05
E ₂	1.40	1.50	1.67	55.12	59.06	65.74
e	—	0.5	—	—	19.69	—
L	0.30	0.40	0.50	11.81	15.75	19.69
Y	—	0.08	—	—	3.15	—



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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