MP3375

Step-Up, 4 String, Max. 350mA/String
Analog and PWM Dimming, White LED Controller

The Future of Analog IC Technology

DESCRIPTION

The MP3375 is a step-up controller with 4 current channels, designed to drive WLED arrays for large-size LCD panel backlighting applications. It can expand the number of LED channels by two or more ICs in parallel sharing a single inductive power source.

The MP3375 uses peak current mode with a fixed switching frequency. The frequency is programmable by an external setting resistor. The MP3375 drives an external MOSFET to boost up the output voltage from a 5V to 28V input supply. It regulates the current in each LED string to the value set by an external current-setting resistor.

The MP3375 applies 4 internal current sources for current balance. The current matching can achieve 2.5% regulation accuracy between strings. Its low regulation voltage on the LED current sources reduces power loss.

The MP3375 supports both analog and PWM dimming independently to meet the different dimming-mode requests. In addition, rich protection modes are integrated including OCP, OTP, UVP, OVP, LED short/open protection, and inductor/diode short protection.

The MP3375 is available in SOIC-16 and TSSOP16-EP packages.

FEATURES

- 4-String, Max 350mA/String WLED Driver
- 5V to 28V Input Voltage Range
- 2.5% Current Matching Accuracy
- Programmable Switching Frequency
- PWM and Analog Dimming Mode
- Cascading Capability with a Single Power Source
- LED Open and Short LED Protection
- Programmable Over-Voltage Protection
- Recoverable Thermal Shutdown Protection
- Over-Current Protection
- Inductor/Diode Short Protection
- Under-Voltage Lockout
- SOIC-16 and TSSOP16-EP Packages

APPLICATIONS

- Desktop LCD Flat Panel Displays
- Flat Panel Video Displays
- 2D/3D LCD TVs and Monitors

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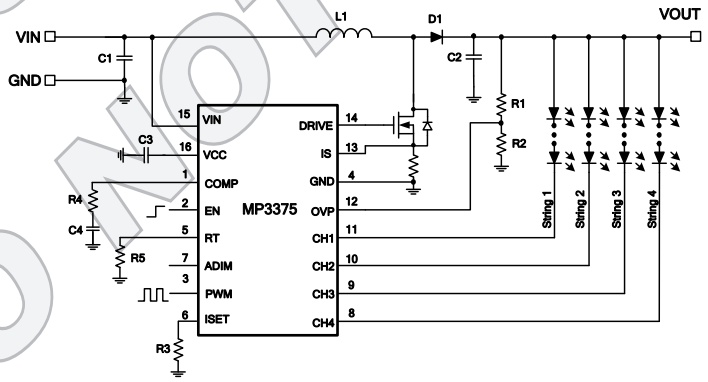
TYPICAL APPLICATION



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ORDERING INFORMATION

Part Number	Package	Top Marking
MP3375GS*	SOIC-16	*See Below*
MP3375GF**	TSSOP16-EP	*See Below*

* For Tape & Reel, add suffix –Z (e.g. MP3375GS–Z)
** For Tape & Reel, add suffix –Z (e.g. MP3375GF–Z)

TOP MARKING (MP3375GS)

MPSYYWW
MP3375
LLLLLLLLL

MPS: MPS prefix
YY: Year code
WW: Week code
MP3375: Part number
LLLLLLLLL: Lot number

TOP MARKING (MP3375GF)

MPSYYWW
MP3375
LLLLLL

MPS: MPS prefix
YY: Year code
WW: Week code
MP3375: Part number
LLLLLL: Lot number

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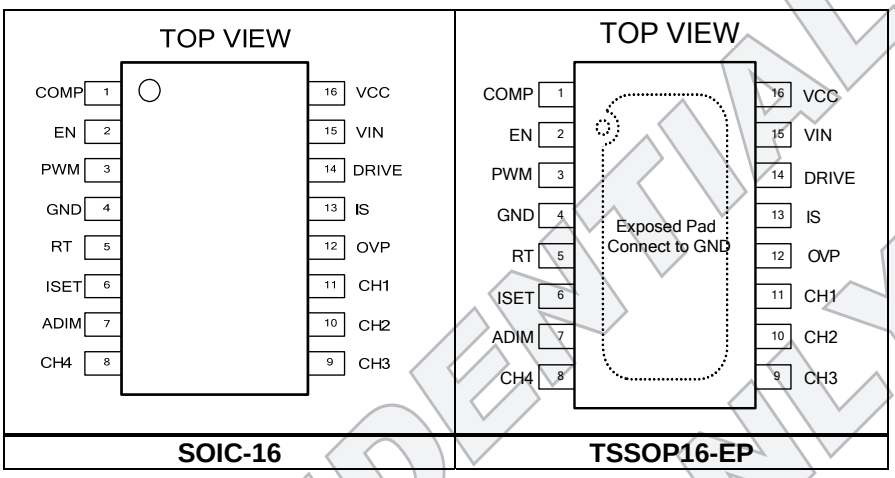
PACKAGE REFERENCE



ABSOLUTE MAXIMUM RATINGS (1)

VIN .....-0.3V to +30V
V_{DRIVE} .....-0.3V to +6.5V
VCC .....-0.3V to +6.5V
V_{CH1} to V_{CH4} .....-1V to +55V
V_{IS} .....-0.5V to +6.5V
All other pins .....–0.3V to VCC
Continuous power dissipation (T_A = 25°C) **(2)**
SOIC-16 .....1.56W
TSSOP16-EP 2.78W
Junction temperature .....150°C
Lead temperature .....260°C
ESD capability human body mode (all pins)
..... 3.5kV

Recommended Operating Conditions (3)

Supply voltage (V_{IN}) .....5V to 28V
LED current (backlight) .....10mA to 350mA
Operating junction temp. (T_J)... -40°C to +125°C

Thermal Resistance (4)

	θ_{JA}	θ_{JC}
SOIC-16	80	35 °C/W
TSSOP16-EP	45	10 °C/W

NOTES:

1) Exceeding these ratings may damage the device. The voltage is measured with a 20MHz bandwidth limited oscilloscope.
2) The maximum allowable power dissipation is a function of the maximum junction temperature T_J (MAX), the junction-to-ambient thermal resistance θ_{JA}, and the ambient temperature T_A. The maximum allowable continuous power dissipation at any ambient temperature is calculated by P_D (MAX) = (T_J (MAX)-T_A)/θ_{JA}. Exceeding the maximum allowable power dissipation will produce an excessive die temperature, causing the regulator to go into thermal shutdown. Internal thermal shutdown circuitry protects the device from permanent damage.
3) The device is not guaranteed to function outside of its operating conditions.
4) Measured on JESD51-7, 4-layer PCB.

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ELECTRICAL CHARACTERISTICS (5)

V_{IN} = 12V, V_{EN} = 5V, T_A = 25°C, unless otherwise noted.

Parameters	Symbol	Condition	Min	Typ	Max	Units
Operating input voltage	V_{IN}		5		28	V
Supply current (quiescent)	I_Q	V_{IN} = 12V, V_{EN} = 5V, no load without switching		1.2	1.35	1.5	mA
Supply current (operation)	I_{OP}	V_{IN} = 12V, V_{EN} = 5V, no load with switching		3	5.5	mA
Supply current (shutdown)	I_{ST}	V_{EN} = 0V, V_{IN} = 12V		0.01	0.5	μA
LDO output voltage	V_{CC}	V_{EN} = 5V, 7V < V_{IN} < 28V, 0 < I_{VCC} < 10mA	5.4	6	6.6	V
VCC UVLO threshold	V_{IN_UVLO}	Rising edge	3.6	4	4.4	V
VCC UVLO hysteresis				200		mV
EN high voltage	V_{EN_HIGH}	V_{EN} rising	1.8			V
EN low voltage	V_{EN_LOW}	V_{EN} falling			0.6	V
Step-Up Converter						
Gate driver impedance (sourcing)		V_{CC} = 6V, V_{DRIVE} = 6V		4.5	7	Ω
Gate driver impedance (Sinking)		V_{CC} = 6V, I_{DRIVE} = 10mA		2.5	5	Ω
Switching frequency	f_{SW}	R_{RT} = 115kΩ	459	540	621	kHz
		R_{RT} = 374kΩ	150	180	210	kHz
RT voltage	V_{RT}		1.20	1.23	1.26	V
Maximum duty cycle	D_{MAX}			93		%
Cycle-by-cycle IS current limit		Max duty cycle	145	180	215	mV
COMP source current limit	$I_{COMP\ SOLI}$	1V < COMP < 1.9V		70		μA
COMP sink current limit	$I_{COMP\ SILI}$	1V < COMP < 1.9V		17		μA
COMP trans-conductance	G_{COMP}	ΔI_{COMP} = ±10μA		400		μA/V
Current Dimming						
PWM input low threshold	V_{PWM_LO}	V_{PWM} falling	0.75			V
PWM input high threshold	V_{PWM_HI}	V_{PWM} rising			1.25	V
Analog dimming input-low threshold	Adim_L	R_{ISET} = 9.72k	0.38	0.41	0.44	V
Analog dimming input-high threshold	Adim_H		1.44	1.49	1.54	V
LED Current Regulation						
ILED voltage	V_{ISET}		1.195	1.22	1.245	V
CHX average current	I_{CH}	R_{ISET} = 30.5kΩ	31.3	32.3	33.3	mA
		R_{ISET} = 8.87kΩ, F_{ADIM}=20kHz, D_{ADIM}=5%	5.8	6.8	7.8	
Current matching (5)		I_{LED} = 33.2mA			2.5	%
		R_{ISET} = 8.87kΩ, F_{ADIM}=20kHz, D_{ADIM}=5%			2.5	

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ELECTRICAL CHARACTERISTICS *(continued)*

V_{IN} = 12V, V_{EN} = 5V, T_A = 25°C, unless otherwise noted.

Parameters	Symbol	Condition	Min	Typ	Max	Units
VCC max. current limit	Icc_Limit		50	75	100	mA
LED FET resistance	R_LED	I_{LED} = 10mA		1.7		Ω
CHX regulation voltage	V_{CHX}	I_{LED} = 330mA		800		mV
		I_{LED} = 60mA		285		mV
Protection						
OVP (over-voltage protection) threshold	V_{OVP_OV}	Rising edge	1.20	1.23	1.26	V
OVP (over-voltage protection) threshold HYS	V_{OVP_HYS}	HYS		80		mV
OVP UVLO threshold	V_{OVP_UV}	Step-up converter fails	30	75	120	mV
CHX UVLO threshold	V_{CHX_UV}		120	200	280	mV
CHX over-voltage threshold	V_{CHX_OV}		5.8	6.3	6.8	V
LED short fault cycles	T_LED_OV			4096		
Latch-off current limit	V_{LMT}		560	640	720	mV
Thermal protection threshold	T_{ST}			150		°C
Thermal protection hysteresis				25		°C

NOTES:

5) Matching is defined as the difference between the maximum to minimum current divided by 2 times the average currents.

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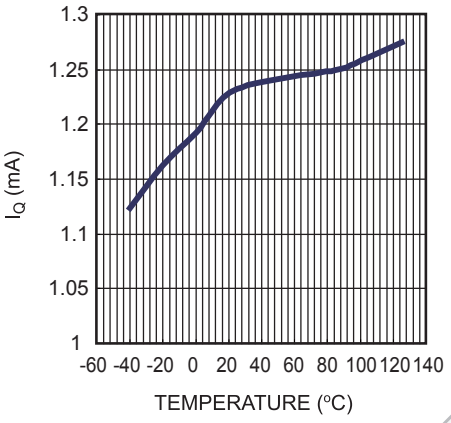
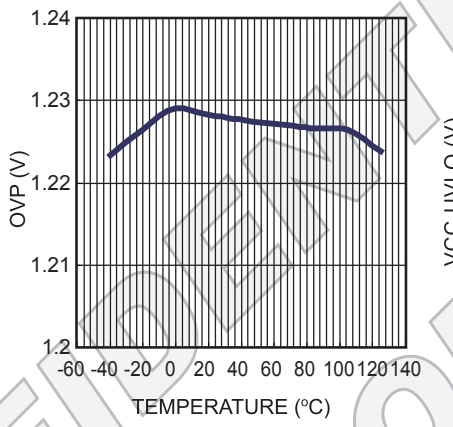
TYPICAL CHARACTERISTICS

V_{IN} = 12V, V_{OUT} = 30V, L = 33µH, I_{LED}=120mA/string, 4 strings, T_A = 25°C, unless otherwise noted.

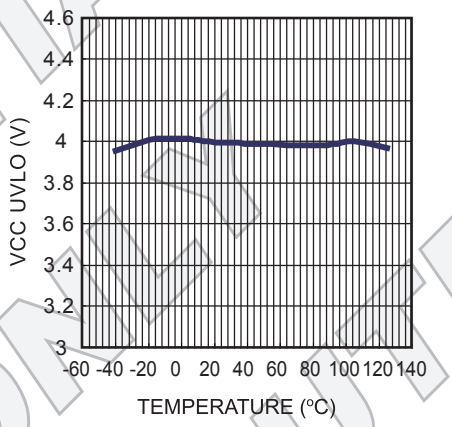
I_Q vs. Temperature



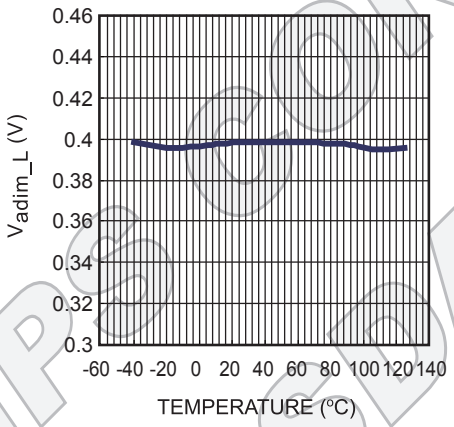
OVP Voltage vs. Temperature



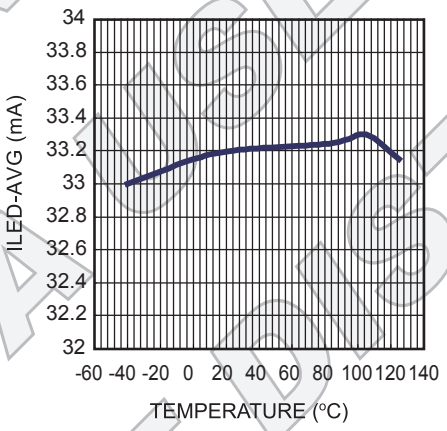
VCC UVLO vs. Temperature



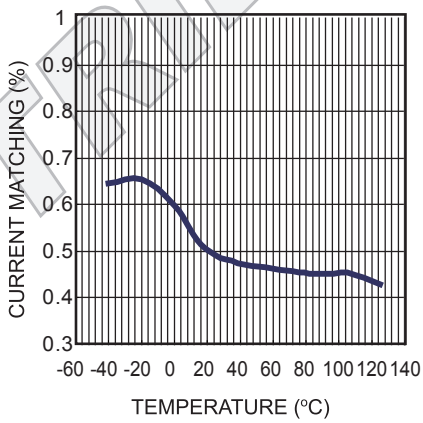
V_{adim_L} vs. Temperature



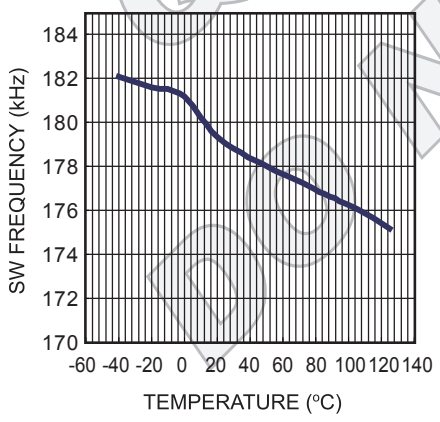
I_{LED_AVG} vs. Temperature



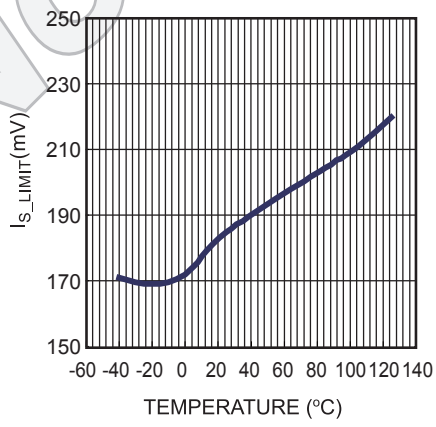
I_{LED} Matching vs. Temperatue



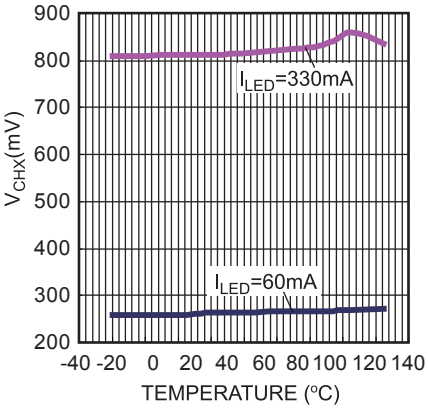
SW Frequency vs. Temperature (R_{RT}=374kΩ)



I_{S_LIMIT} vs. Temperature



V_{CHX} Regulation Voltage vs. Temperature



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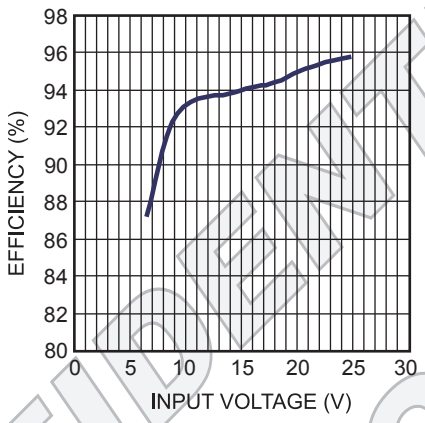
TYPICAL PERFORMANCE CHARACTERISTICS

V_{IN} = 12V, V_{OUT} = 30V, L = 33µH, I_{LED}=120mA/string, 4 strings, T_A = 25°C, unless otherwise noted.

Efficiency vs. Input Voltage



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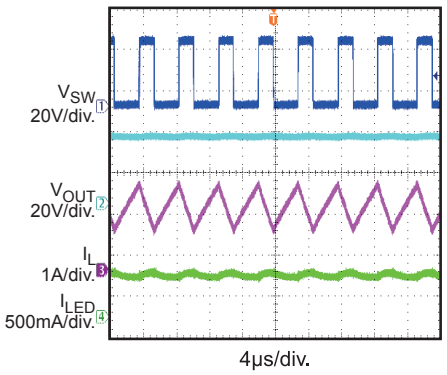
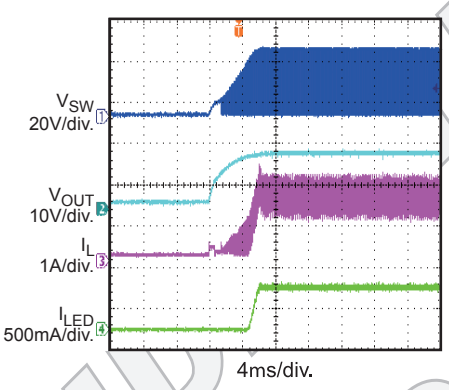
TYPICAL PERFORMANCE CHARACTERISTICS *(continued)*

V_{IN} = 12V, V_{OUT} = 30V, L = 33µH, T_A = 25°C, unless otherwise noted.

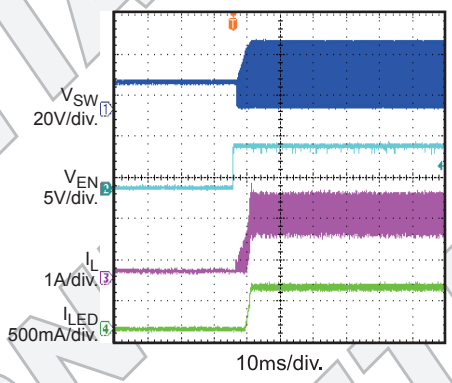
Steady State



V_{IN} Power On

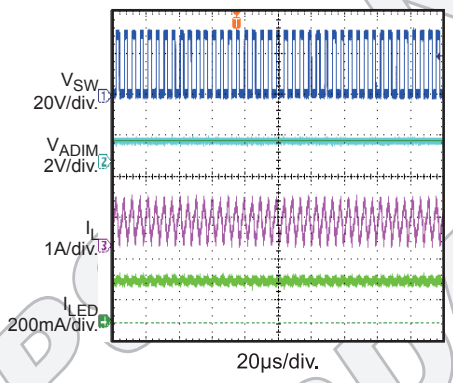


EN Power On



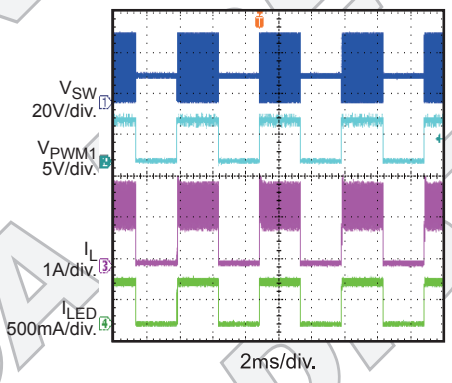
Analog Dimming

V_{DIM} = 0.9V



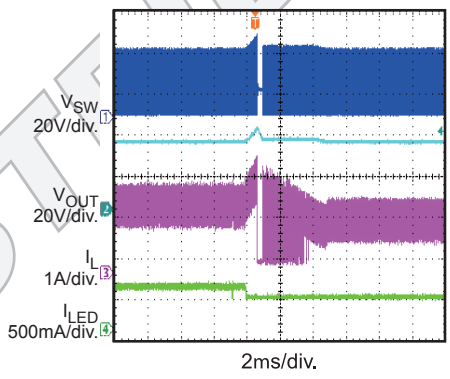
PWM Dimming

f_{PWM} = 200Hz, D_{PWM} = 50%



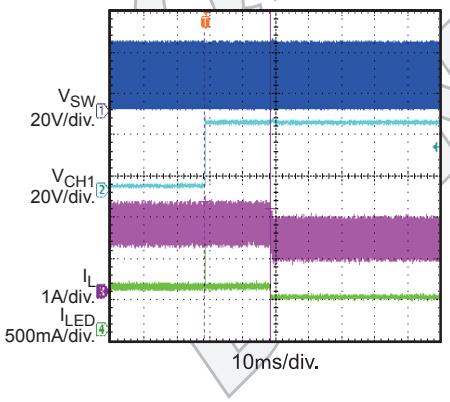
Open LED Protection

Open One LED String at Working

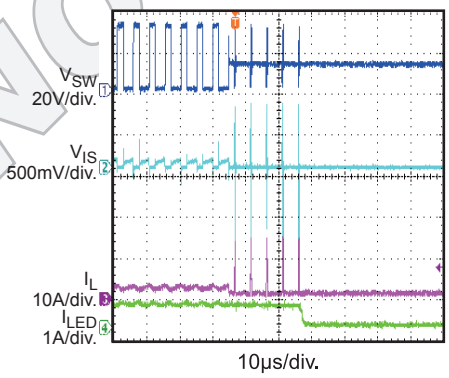


Short LED Protection

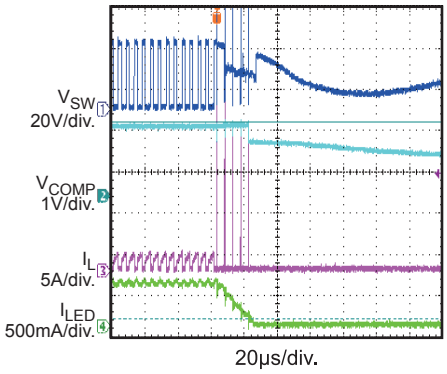
Short V_{OUT} to CH1 at Working



Short Inductor Protection



Short Diode Protection



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PIN FUNCTIONS

Pin #	Name	Description
1	COMP	**Step-up converter compensation**. COMP compensates the regulation control loop. Connect a ceramic capacitor from COMP to GND.
2	EN	**Enable control input.** A voltage greater than 1.8V turns the part on. A voltage less than 0.6 V turns the part off. Do NOT float EN.
3	PWM	**Input signal for PWM brightness control.** By applying a PWM signal on PWM, the LED current is chopped, and the average current is equal to Iset*D_dim (I_set is the LED current value set by a resistor connected to ISET; D_dim is the duty cycle of the PWM dimming duty cycle). Make sure the PWM amplitude voltage level > $V_{PWM_HI,}$ and the low-level voltage < V_{PWM_HI}. The input PWM signal frequency determines the LED current dimming ratio. The lower the dimming frequency is, the smaller the dimming current will be. In general, 200Hz to 2kHz covers most customers' LED current dimming requests. If PWM is floated, internally pull PWM to GND weakly. If PWM dimming is not required, pull PWM to a high voltage (1.25V < Vpwm).
4	GND	**Ground.**
5	RT	**Switching frequency set.** Connect a resistor between RT and GND to set the step-up converter switching frequency. The voltage at RT is regulated to 1.23V. The clock frequency is proportional to the current sourced from RT.
6	ISET	**LED current set.** Tie a current-setting resistor from ISET to ground to program the current in each LED string. ISET voltage is regulated to 1.225V. The LED current is proportional to the current through the ISET resistor.
7	ADIM	**Signal input for analog brightness control.** The LED current amplitude is determined by ADIM, and the input signal is either a PWM signal or a DC voltage signal. An internal RC filter (10MΩ resistor and 100pF capacitor) is integrated to ADIM. If a PWM signal is applied to ADIM, a >20kHz frequency is recommended to achieve improved PWM signal filtering performance (make sure the amplitude voltage is higher than 1.5V, and the low-level voltage is less than 0.4V). For DC signal input, please apply a DC input signal range from 0.4V to 1.5V to set linearly the LED current from 0% to 100%. If ADIM is floated, internally pull PWM to GND weakly. If Analog dimming is not required, pull ADIM to a high voltage (1.54V<Vpwm).
8	CH4	**LED channel 4 current input.** CH4 is the open-drain output of an internal dimming control switch. Connect the LED string 4 cathode to CH4.
9	CH3	**LED channel 3 current input.** CH3 is the open-drain output of an internal dimming control switch. Connect the LED string 3 cathode to CH3.
10	CH2	**LED channel 2 current input**. CH2 is the open-drain output of an internal dimming control switch. Connect the LED string 2 cathode to CH2.
11	CH1	**LED channel 1 current input.** CH1 is the open-drain output of an internal dimming control switch. Connect the LED string 1 cathode to CH1.
12	OVP	**Over-voltage protection input.** Connect a resistor divider from the output to OVP to program the OVP threshold. When the OVP voltage reaches 1.23V, the MP3375 triggers over-voltage protection mode.

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PIN FUNCTIONS *(continued)*

Pin #	Name	Description
13	IS	**Current sense input.** During normal operation, IS senses the voltage across the external inductor current-sensing resistor (R_{IS}) for peak-current–mode control and to limit the inductor current during every switching cycle. If IS is not used for cascading applications, tie IS to GND; do NOT float IS.
14	DRIVE	**Step-up converter power switch gate drive output**. DRIVE drives the external power N-MOSFET device.
15	VIN	**Supply input.** VIN supplies the power to the chip as well as the step-up converter switch. Drive VIN with a 5V to 28V power source. VIN must be bypassed locally.
16	VCC	**Internal 6V linear regulator output.** VCC provides a power supply for the external MOSFET switch gate driver and the internal control circuitry. Bypass VCC to GND with a ceramic capacitor.
	EP	**Exposed pad**.

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FUNCTIONAL BLOCK DIAGRAM

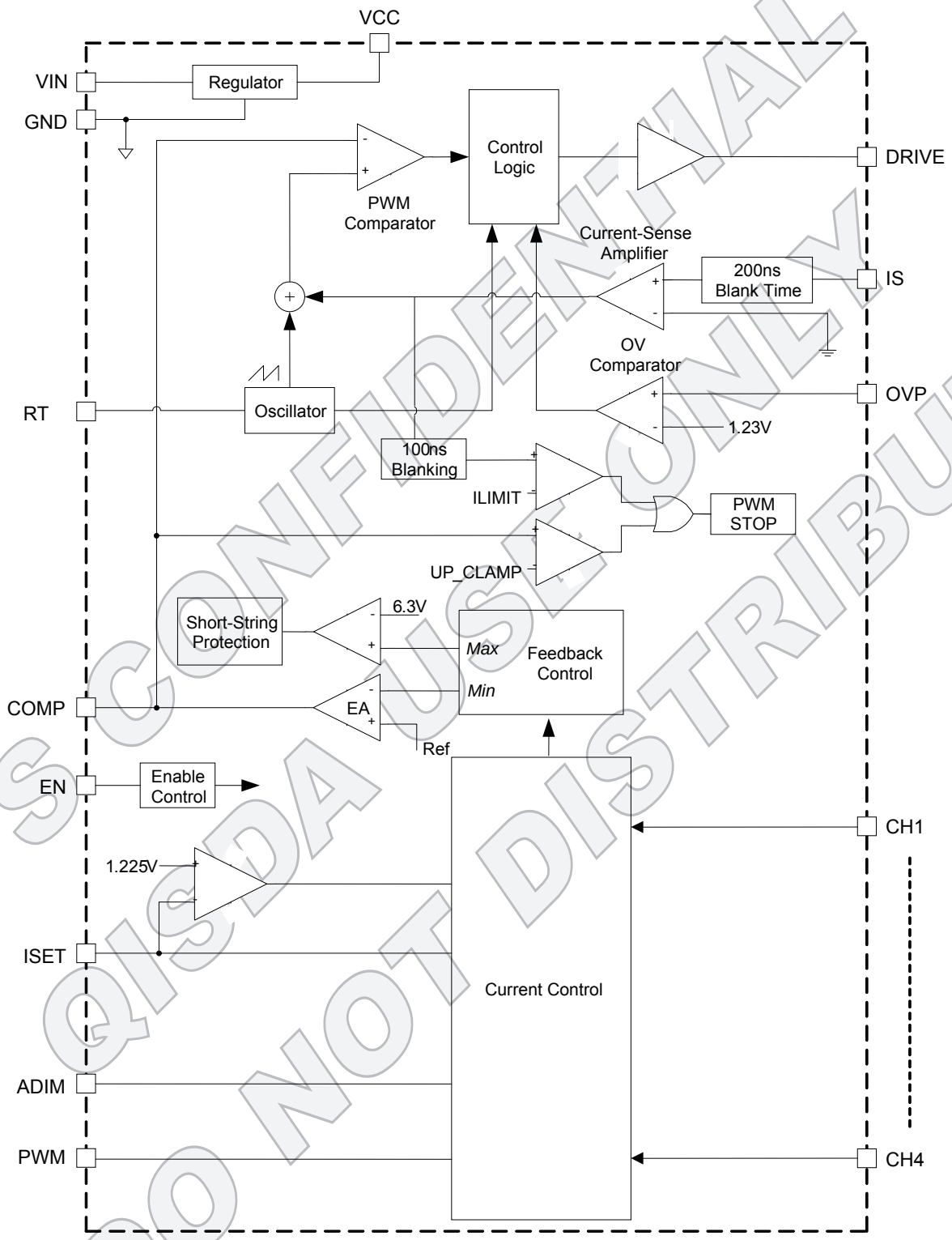

Figure 1: Functional Block Diagram

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OPERATION

The MP3375 is a step-up converter with peak current mode. It employs 4 channels of current sources to drive up to 4 strings of white LEDs.

Internal 6V Regulator

The MP3375 includes an internal linear regulator (VCC). When VIN is greater than 6.5V, this regulator outputs a 6V power supply to the external MOSFET switch gate driver and the internal control circuitry. The VCC voltage drops to 0V when the chip shuts down. The MP3375 features under-voltage lockout (UVLO). The chip is disabled until VCC exceeds the UVLO threshold. The UVLO hysteresis is approximately 200mV.

System Start-Up

When enabled, the MP3375 checks the topology connection first. The chip monitors the over-voltage protection (OVP) to see if the Schottky diode is not connected or if the boost output is shorted to GND. An OVP voltage of less than 75mV disables the chip. Also, the MP3375 checks additional safety limits including UVLO, over-temperature protection (OTP), and over-current protection after passing the OVP test. If all the protection tests pass, the chip then starts boosting the step-up converter with an internal soft-start.

It is recommended that the enable signal occurs after the establishment of the input voltage and PWM dimming signal during the start-up sequence to avoid large inrush current.

Step-Up Converter

The converter operating frequency is programmable (from 100kHz to 800kHz) with a external resistor connected to RT. This helps to optimize efficiency and the size of external components.

At the beginning of each switching cycle, the internal clock turns on the external MOSFET. (In normal operation, the minimum turn-on time is 200ns.) A stabilizing ramp added to the output of the current-sense amplifier prevents sub-harmonic oscillations for duty cycles greater than 50%. This result is fed into the PWM comparator. When this resulting voltage reaches the output voltage of the error amplifier (V_{COMP}), the external MOSFET turns off.

The output voltage of the internal error amplifier is an amplified signal of the difference between the reference voltage and the feedback voltage. The converter chooses automatically the lowest active CHX voltage to provide a high enough bus voltage to power all the LED arrays.

If the feedback voltage drops below the reference, the output of the error amplifier increases. This results in more current flowing through the MOSFET, thus increasing the power delivered to the output. This forms a closed loop that regulates the output voltage.

Under light-load operation, especially in the case of $V_{OUT} \approx$ VIN, the converter runs in pulse-skipping mode where the MOSFET turns on for a minimum on time of approximately 200ns, and then the converter discharges the power to the output for the remaining period. The external MOSFET remains off until the output voltage needs to be boosted again.

Dimming Control

The MP3375 provides two dimming methods: PWM or analog dimming mode.

For PWM dimming, apply a PWM signal to PWM. The LED current is chopped by this PWM signal, and the average LED current is equal to Iset*D_dim where D_dim is the duty cycle of the PWM dimming signal, and Iset is the LED current amplitude.

For analog dimming, either a PWM signal or a DC signal can be applied to ADIM.

When a PWM signal is applied to ADIM, this signal is filtered by the internal RC filter. The LED current amplitude is equal to Iset*D_Dim where D_dim is the duty cycle of the PWM dimming signal, and Iset is the LED current amplitude. A 20kHz or higher PWM signal is recommended to achieve improved filtering performance.

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When a DC signal is applied to ADIM, the voltage range (0.4V to 1.5V) sets directly the LED current linearly from 0% to 100%.

Open-String Protection

Open-string protection is achieved through the OVP pin and the CH(1 to 4) pins. If one or more strings are open, the respective CHX pins are pulled to ground, and the IC keeps charging the output voltage until it reaches the over-voltage protection (OVP) threshold. If the OVP point has been triggered for >4μs, the chip stops switching and marks the strings which have a CHX pin voltage lower than 196mV. Once marked, the remaining LED strings force the output voltage back into tight regulation. The string with the largest voltage drop determines the output regulation.

The MP3375 will always attempt to light at least one string. If all strings are open, the MP3375 shuts down the step-up converter. The strings will remain in this marked state until the chip is re-set.

Short-String Protection

The MP3375 monitors the CHX pin voltages to determine if a short-string fault has occurred. If one or more strings are shorted, the respective CHX pins tolerate high-voltage stress. If a CHX pin voltage is higher than 6.3V, this condition triggers the detection of a short string. When a short-string fault (CHX over-voltage fault) remains for 4096 switching clocks, the fault string is marked off and disabled. Once a string is marked off, it disconnects from the output voltage loop. The marked LED strings shut off completely until the part re-starts. The strings remain marked off until the chip re-sets. In order to prevent mis-triggering short LED protection when there is an open LED string, the short LED protection function is disabled when V_{CHX} of all used LED channels are higher than 1.5V.

Inductor/Diode Short Protection

To prevent damage to the IC and external MOSFET when the external inductor is shorted, the MP3375 offers the protection mode in the following ways:

1. When inductor is shorted, the output cannot maintain enough energy to load the LED, causing the output voltage to drop. Thus, the COMP (the error amplifier output) voltage tends to rise until it is clamped high. When it lasts longer than 512 switching cycles, the IC turns off and latches. In some cases, the COMP voltage cannot be clamped high when the inductor is shorted.
2. The IC detects the current flowing through the power MOSFET. When the current sense voltage across the sense resistor (connected between the MOSFET and GND) hits the V_{LMT} limit value and lasts for 4 switching cycles, the IC turns off and latches.

Thermal Shutdown Protection

To prevent the IC from operating at exceedingly high temperature, thermal shutdown is implemented in this chip by detecting the silicon die temperature. When the die temperature exceeds the upper threshold (T_{ST}), the IC shuts down. The IC recovers to normal operation when the die temperature drops below the lower threshold. Typically, the hysteresis value is 25°C.

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APPLICATION INFORMATION

Selecting the Switching Frequency

The switching frequency of the step-up converter is recommended from 100kHz to 500kHz for most applications. An oscillator resistor on RT sets the internal oscillator frequency for the step-up converter with Equation (1):

$$F_{SW}(kHz) = \frac{67320}{R_{RT}(k\Omega)} \quad (1)$$

For R_{RT} = 374kΩ, the switching frequency is set to 180kHz .

Setting the LED Current

Each LED string current can be set through the current-setting resistor on ISET using Equation (2):

$$I_{LED}(mA) = \frac{810 \times 1.22V}{R_{ISET}k\Omega} \quad (2)$$

For RSET = 8.2kΩ, the LED current is set to 120mA. Please do NOT leave ISET open.

Selecting the Input Capacitor

The input capacitor reduces the surge current drawn from the input supply and the switching noise from the device. The input capacitor impedance at the switching frequency should be less than the input source impedance to prevent the high-frequency switching current from passing through to the input. Use ceramic capacitors with X5R or X7R dielectrics for their low ESR and small temperature coefficients. For most applications, use a 4.7μF ceramic capacitor in parallel with a 220μF electrolytic capacitor.

Selecting the Inductor and Current-Sensing Resistor

The MP3375 requires an inductor to supply a higher output voltage while being driven by the input voltage. A larger value inductor results in less ripple current, resulting in lower peak inductor current and reducing stress on the N-channel MOSFET. However, the larger value inductor has a larger physical size, a higher series resistance, and a lower saturation current.

Choose an inductor that does not saturate under the worst-case load conditions. Select the minimum inductor value to ensure that the boost converter works in continuous conduction mode (CCM) with high efficiency and good EMI performance.

Calculate the required inductance value using Equation (3) and Equation (4):

$$L \geq \frac{\eta \times V_{OUT} \times D \times (1-D)^2}{2 \times f_{SW} \times I_{LOAD}} \quad (3)$$

$$D = 1 - \frac{V_{IN}}{V_{OUT}} \quad (4)$$

Where V_{IN} and V_{OUT} are the input and output voltages, f_{SW} is the switching frequency; I_{LOAD} is the LED load current, and η is the efficiency.

Usually, the switching current is used for the peak-current-mode control. In order to avoid hitting the current limit, the voltage across the sensing resistor (R_{IS}) must measure less than 80% of the worst case current-limit voltage (V_{IS}). See Equation (5) and Equation (6):

$$R_{IS} = \frac{0.8 \times V_{IS}}{I_{L(PEAK)}} \quad (5)$$

$$I_{L(PEAK)} = \frac{V_{OUT} \times I_{LOAD}}{\eta V_{IN}} + \frac{V_{IN} \times (V_{OUT} - V_{IN})}{2 \times L \times F_{SW} \times V_{OUT}} \quad (6)$$

Where $I_{L(PEAK)}$ is the peak value of the inductor current. V_{IS} is shown in Figure 2.

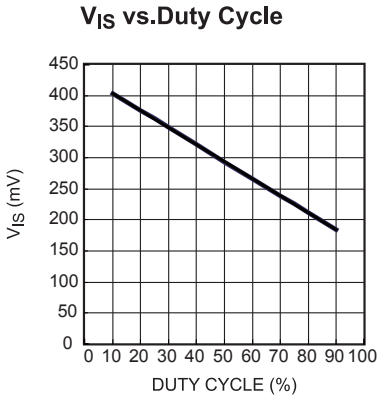

Figure 2: V_{IS} vs. Duty Cycle

Selecting the Power MOSFET

The MP3375 is capable of driving a wide variety of N-channel power MOSFETS. The critical

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parameters of selection of a MOSFET are:

1. maximum drain-to-source voltage, $V_{DS(MAX)}$,
2. maximum current, $I_{D(MAX)}$,
3. on resistance, $R_{DS(ON)}$,
4. gate-source charge (Q_{GS}) and gate-drain charge (Q_{GD}), and
5. total gate charge (Q_G).

Ideally, the off-state voltage across the MOSFET is equal to the output voltage. Considering the voltage spike when it turns off, $V_{DS(MAX)}$ should be greater than 1.5 times the output voltage.

The maximum current through the power MOSFET occurs at the minimum input voltage and the maximum output power. The maximum RMS current through the MOSFET is given using Equation (7) and Equation (8):

$$I_{RMS(MAX)} = I_{IN(MAX)} \times \sqrt{D_{MAX}} \quad (7)$$

$$D_{MAX} \approx \frac{V_{OUT} - V_{IN(MIN)}}{V_{OUT}} \quad (8)$$

The current rating of the MOSFET should be greater than 1.5 x I_{RMS}

The on resistance of the MOSFET determines the conduction loss, which is given with Equation (9):

$$P_{cond} = I_{RMS}{}^2 \times R_{DS(on)} \times k \quad (9)$$

Where, k is the temperature coefficient of the MOSFET.

The switching loss is related to Q_{GD} and Q_{GS1}, which determines the commutation time. Q_{GS1} is the charge between the threshold voltage and the plateau voltage when a driver charges the gate (which is in the V_{GS} vs. Q_G chart of the MOSFET datasheet). Q_{GD} is the charge during the plateau voltage. These two parameters are needed to estimate the turn-on and turn-off losses. See Equation (10)

$$P_{SW} = \frac{Q_{GS1} \times R_G}{V_{DR} - V_{TH}} \times V_{DS} \times I_{IN} \times f_{SW} + \frac{Q_{GD} \times R_G}{V_{DR} - V_{PLT}} \times V_{DS} \times I_{IN} \times f_{SW} \quad (10)$$

Where V_{TH} is the threshold voltage, V_{PLT} is the plateau voltage; R_G is the gate resistance, and V_{DS} is the drain-source voltage. Please note that calculating the switching loss is the most difficult part in the loss estimation. Equation (10) provides a simplified equation. For more accurate estimates, the equation becomes much more complex.

The total gate charge (Q_G) is used to calculate the gate drive loss. See Equation (11):

$$P_{DR} = Q_G \times V_{DR} \times f_{SW} \quad (11)$$

Where V_{DR} is the drive voltage.

Selecting the Output Capacitor

The output capacitor keeps the output voltage ripple small and ensures feedback loop stability. The output capacitor impedance must be low at the switching frequency. Ceramic capacitors with X7R dielectrics are recommended for their low ESR characteristics. For most applications, a 4.7μF ceramic capacitor in parallel with a 22μF electrolytic capacitor will suffice.

Setting the Over-Voltage Protection

Open-string protection is achieved through the detection of the voltage on OVP. In some cases, an LED string failure results in the feedback voltage always at zero. The part then keeps boosting the output voltage higher and higher. If the output voltage reaches the programmed OVP threshold, the protection is triggered.

To ensure the chip functions properly, select resistor values for the OVP resistor divider that provide an appropriate set voltage. The recommended OVP point is about 1.1 to 1.2 times higher than the output voltage for normal operation. See Equation (12):

$$V_{OVP} = 1.23 \times (1 + \frac{R_{HIGH}}{R_{LOW}}) \quad (12)$$

Selecting Dimming Control Mode

The MP3375 provides two different dimming methods:

1. Direct PWM dimming

An external PWM dimming signal is employed to achieve PWM dimming control. Apply a PWM dimming signal (in the range of 100Hz to 20kHz) to PWM. The minimum recommended amplitude of the PWM signal is 1.5V; the low level should be less than 0.4V (see Table 2).

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Table 1: PWM Dimming Duty Range

f_{PWM}(Hz)	D_{min}	D_{max}
100 < f ≤ 200	0.30%	100%
200 < f ≤ 500	0.75%	100%
500 < f ≤ 1k	1.50%	100%
1k < f ≤ 2k	3.00%	100%
2k < f ≤ 5k	7.50%	100%
5k < f ≤ 10k	15.00%	100%
10k < f ≤ 20k	30.00%	100%

2. Analog dimming

For analog dimming, apply a PWM signal or a DC voltage signal to ADIM. An internal RC filter (10MΩ resistor and 100pF capacitor) is integrated to ADIM. If a PWM signal is applied to ADIM, a >20kHz frequency is recommended to achieve improved PWM signal filtering performance (make sure the amplitude voltage is higher than 1.5V, and the low-level voltage is less than 0.4V with a >15mV/ns slope rate for the falling/rising edge). For a DC signal input, please apply a DC input signal range from 0.4V to 1.5V to set linearly the LED current from 0% to 100%.

Expanding LED Channels

The MP3375 can expand the number of LED channels by using two or three MP3375s in parallel. To connect two MP3375s for a total of 8 LED strings, tie the VCC pins of the master IC and the slave IC together to power the slave IC internal logic circuitry. Tie the COMP pins of the slave IC and the master IC together to regulate the voltage of all 8 LED strings. The slave IC MOSFET driving signals are not used; the boost converter can be driven only by the master IC. Do NOT leave IS of the slave IC floating; tie it to ground. Apply the EN and DIM signals to both ICs.

PCB Layout Guidelines

Efficient PCB layout is critical to reduce EMI noise. For best results, refer to Figure 3 and follow the guideline below:

1. Ensure the loop from the external MOSFET (M1) through the output diode (D1) and the output capacitor (C2 and C3) carries a high-frequency pulse current and must be as small and short as possible.

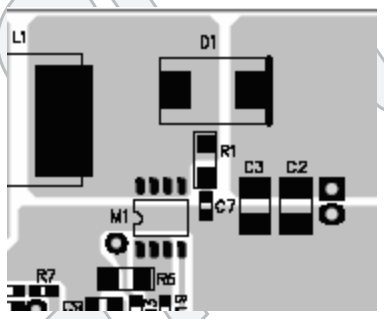

Figure 3: Recommended PCB Layout

All logic signals refer to the signal ground. In order to reduce the noise affection, it is recommend to separate the power ground (PGND) and the signal ground (GND), then connect PGND and GND together.

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TYPICAL APPLICATION CIRCUITS

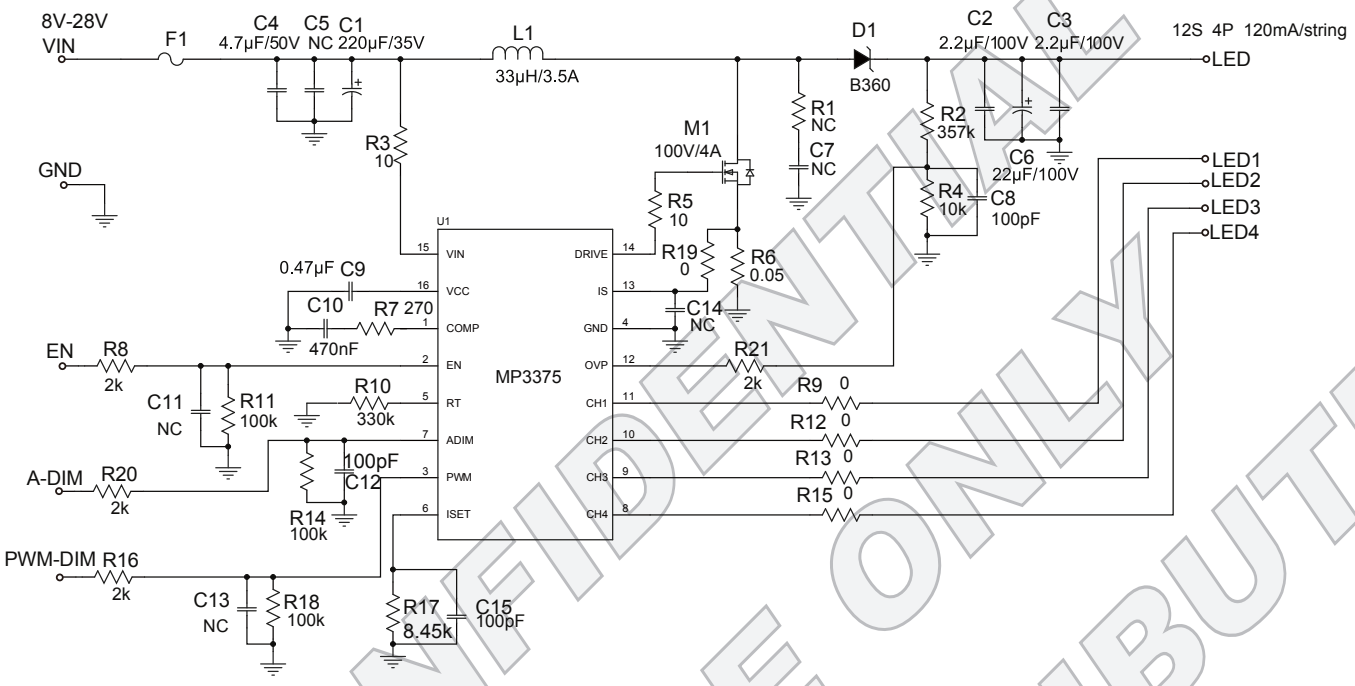

Figure 4: 4 String, 12 LED in Series, 120mA/String Application

(Some components are reasonably adjustable based on real case scenarios)

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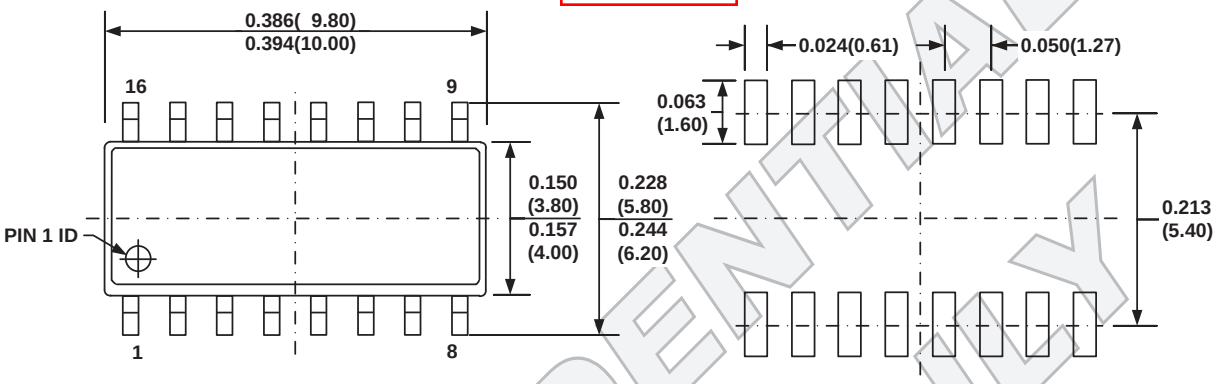
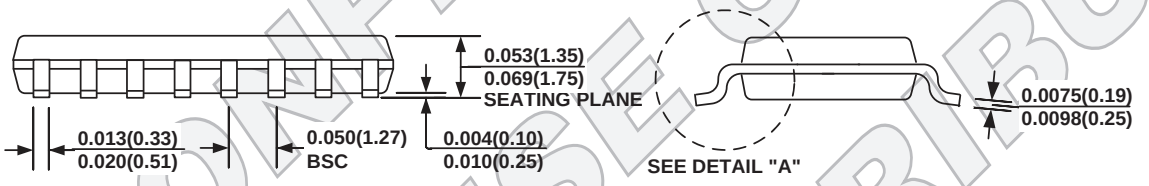
PACKAGE INFORMATION

SOIC16



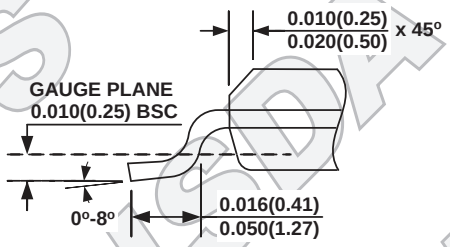
TOP VIEW

RECOMMENDED LAND PATTERN



FRONT VIEW

SIDE VIEW



DETAIL "A"

NOTE:

1) CONTROL DIMENSION IS IN INCHES. DIMENSION IN BRACKET IS IN MILLIMETERS.
2) PACKAGE LENGTH DOES NOT INCLUDE MOLD FLASH, PROTRUSIONS OR GATE BURRS.
3) PACKAGE WIDTH DOES NOT INCLUDE INTERLEAD FLASH OR PROTRUSIONS.
4) LEAD COPLANARITY (BOTTOM OF LEADS AFTER FORMING) SHALL BE 0.004" INCHES MAX.
5) DRAWING CONFORMS TO JEDEC MS-012, VARIATION AC.
6) DRAWING IS NOT TO SCALE.

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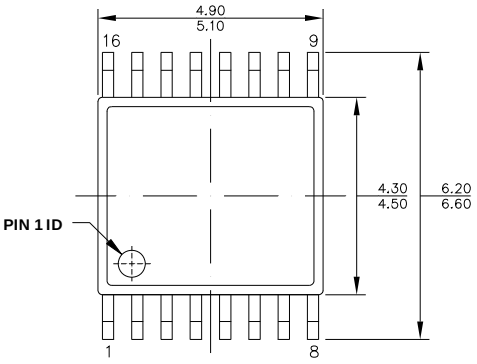
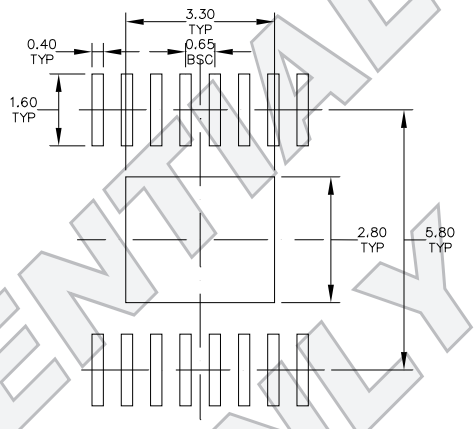
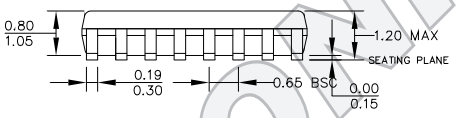
TSSOP16-EP（with external thermal pad）



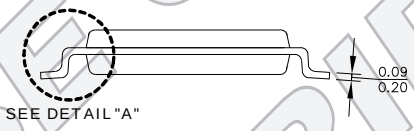
TOP VIEW



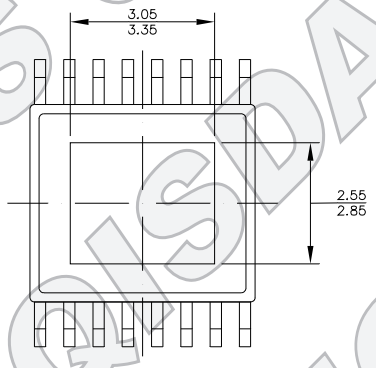
RECOMMENDED LAND PATTERN



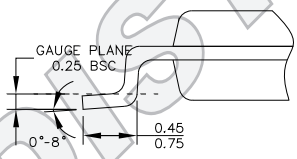
FRONT VIEW



SIDE VIEW



BOTTOM VIEW



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