Optimized Backlight Display Design with the MPQ3367

Introduction

A smart cockpit is essential for an intelligent, convenient, and safe automotive environment for drivers. Emerging energy companies and established car brands alike are increasing their investments to innovate cutting-edge smart cockpits. To meet this demand, MPS continues to introduce improved power management solutions in line with the future of automotive electronics.

Many automotive features — such as in-vehicle entertainment systems, LCD meters, head-up displays (HUDs), digital display rearview mirrors, and ambient lights — all require a reliable and stable backlight driver chip. In this article, we will discuss the MPQ3367, a step-up converter with 6 channel current sources, for backlight display design. The MPQ3367 is currently mass-produced and used by major automotive companies.

Figure 1 shows the MPQ3367's typical application circuit.

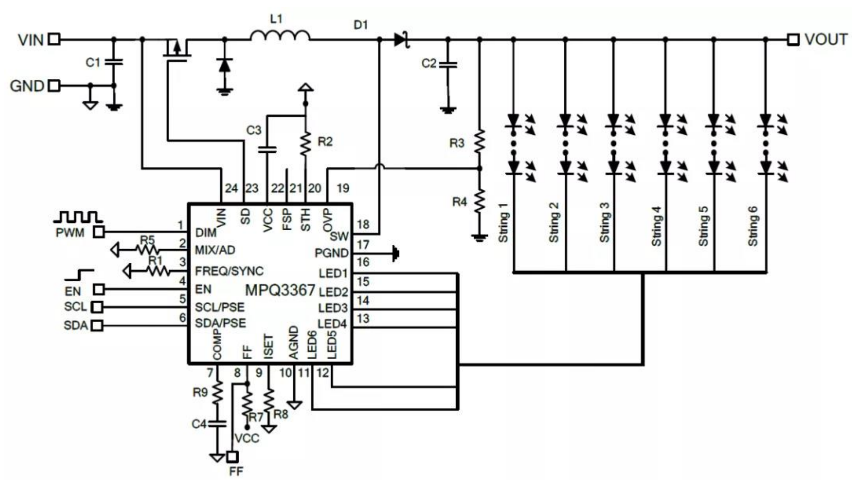

Figure 1: Typical Application Circuit of the MPQ3367

Available Dimming Modes

The MPQ3367 supports three dimming modes: analog dimming, pulse-width modulation (PWM) dimming, and mix dimming. To regulate the output current (I_{OUT}), the device uses PWM signal input control, which adjusts the backlight brightness.

Analog Dimming

Calculate the duty (D_{DIM}) of the external input PWM signal using a counter integrated inside the chip. The single output current can be calculated with I_{SET} x D_{DIM}, where I_{SET} represents the single maximum current configured for the ISET pin. In analog dimming mode, I_{OUT} is a continuous waveform, indicating enhanced EMI performance compared to PWM dimming mode.

PWM Dimming

Unlike analog dimming mode, the single output current amplitude of each channel is fixed in PWM dimming mode. I_{OUT} is split into waveforms with the same duty ratio as the input PWM. By adjusting the PWM duty-on ratio, the average I_{OUT} can be accurately controlled at a resolution of 1:15000.

Mix Dimming

Mix dimming uses PWM dimming when the PWM duty ratio is low, and analog dimming when the duty ratio is high. Figure 2 shows the mix dimming method.

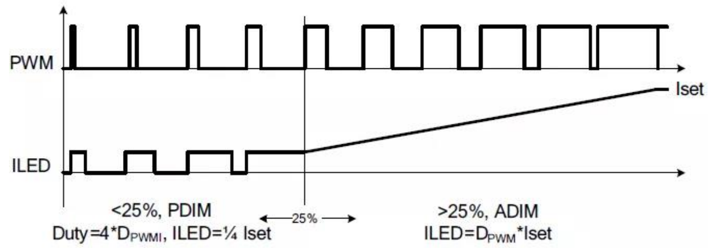

Figure 2: Hybrid Dimming for the MPQ3367

This mode ensures that the MPQ3367's dimming accuracy is high enough for low-current outputs with a lower brightness. In addition, mix dimming prevents abnormalities such as whistling during high-current outputs with higher brightness.

Optional Frequency Spread Spectrum

Faced with increasingly stringent EMC requirements, the power supply must have excellent EMC performance. The MPQ3367 includes an optional frequency spread spectrum function that disperses the switching pulse energy, making it easier to pass rigorous EMC testing. The MPQ3367 passes the Class 5 EMC test.

Figure 3 shows the MPQ3367's EMC conducted emission (CE) test results.

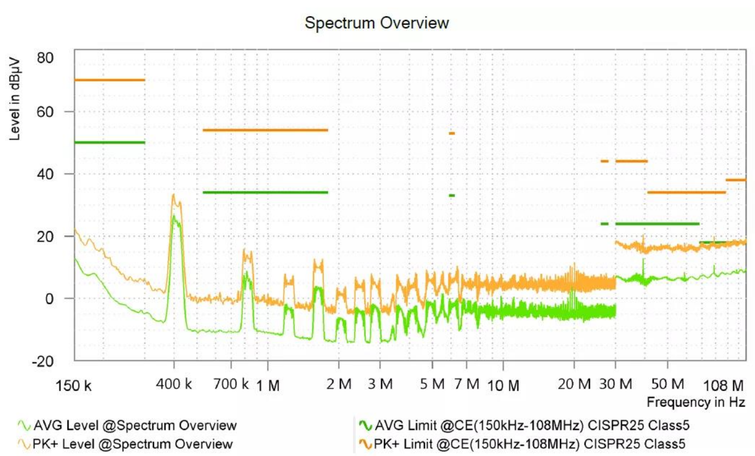

Figure 3: EMC Conducted Emission (CE) Test of the MPQ3367

Figure 4 shows the device's EMC radiated emission (RE) test results.

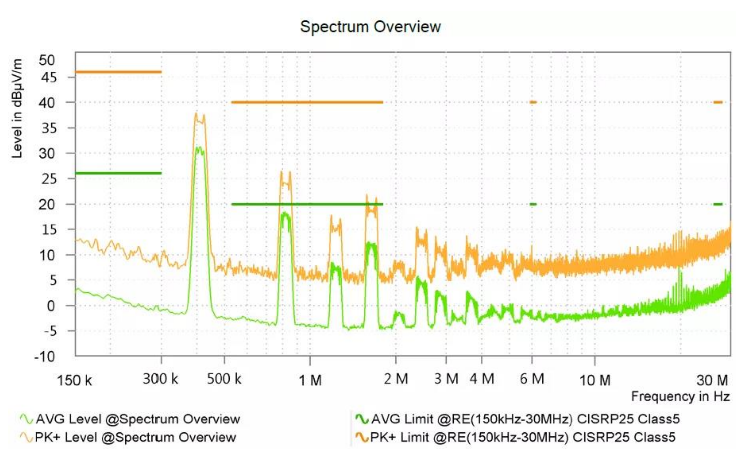

Figure 4: EMC Radiated Emission (RE) Test of the MPQ3367

High Efficiency

The MPQ3367 integrates a low on resistance MOSFET inside the chip, which requires a significantly high efficiency to reduce the chip's heat.

Figure 5 shows that efficiency can reach about 95% at input voltages of 8V, 12V, and 15V.

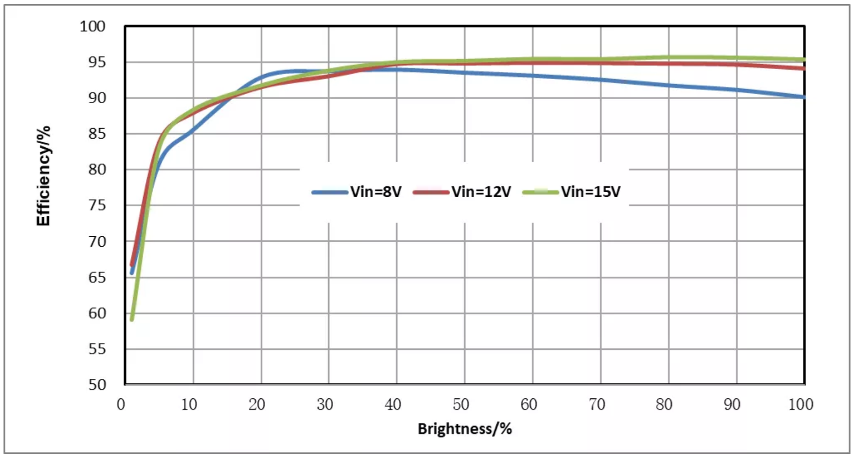

Figure 5: Efficiency Curve of the MPQ3367

Table 1 shows the efficiency test data for the MPQ3367. It reaches a peak efficiency boost when the input voltage (V_{IN}) is about 12V.

Table 1: Efficiency Test Data of the MPQ3367

Dpwm/%	Vin/V	Iin/mA	Vout/V	Iled/mA	E-Boost(%)	ΔT/℃
100	11.95	1478	27.13	613	94.16	45~50
90	12.06	1287	26.58	553	94.70	
80	12.1	1122	26.25	490.5	94.84	
70	11.99	980	25.94	430	94.93	
60	12.03	823	25.6	367.3	94.97	
50	12.06	677	25.27	306.5	94.86	
40	12.01	535	24.93	244.3	94.79	
30	11.99	401.2	24.59	182.1	93.09	
20	12.07	270.7	24.42	122.5	91.56	
10	12.03	141.8	24.43	61.4	87.93	
5	12.01	74.7	24.47	30.7	83.74	
1	12.1	18.83	24.51	6.2	66.70	

Other Key Features of the MPQ3367

The MPQ3367 offers additional features, described below:

- 3.5V to 36V V_{IN} range to meet a car battery's 12V direct power supply
- Supports 6 channels, with a maximum 150mA I_{OUT} per channel
- Integrated 100mΩ, 50V MOSFET that supports up to 45V of backlight output voltage
- Supports an adjustable switching frequency (f_{SW}) up to 2.2MHz
- High dimming resolution (the PWM dimming mode can reach a 15000:1 dimming ratio)
- Optional I^2C communication, fault indication, and operating mode selection
- Robust and reliable protection functions, including over-current protection (OCP), over-voltage protection (OVP), over-temperature protection (OTP), and LED short and open protection
- Available in QFN-24 (4mmx4mm) and TSSOP-28 packages
- Available in AEC-Q100 Grade 1

In terms of applications, the MPQ3367 is compatible with 8-inch to 15-inch screens for smart cockpits. It provides 6 output channels that can adapt to all mainstream screens.

Conclusion

Optimal backlight display design is crucial to power the various automotive features for smart cockpits. In this article, we reviewed the MPQ3367's available dimming modes to regulate the output current, frequency spread spectrum for EMC performance, and high efficiency due to the integrated low on resistance MOSFET. As one of MPS's leading backlight chips, the MPQ3367 effectively achieves a fully functional, integrated, and high-power solution.