

General Description

This demonstration board utilizes AL3353 to build a cost effective solution for boost LED driver.

AL3353 is a LED driver controller designed for boost converters in a constant frequency mode. It implements a peak current mode control scheme and an internal trans-conductance amplifier to accurately control the output current over a wide input and load conditions.

This user guide contains rich information for the users. A bill of materials is included that describes the parts used on this board. A schematic and PCB layout is also included along with measured system performance characteristics and test waveforms. These materials can be used as a reference design for your products to improve your product's time to market.

Key Features

1. Wide Input Voltage Range: 20V to 36V
2. Constant Current Mode PWM Controller
3. PWM to Analog Dimming Mode
4. Audio Noise Free
5. Built-in Comprehensive Protections
 - a) Under Voltage Lock Out (UVLO)
 - b) Over Voltage Protection(OVP)
 - c) Over Current Protection(OCP)
 - d) Over Temperature Protection (OTP)
 - e) LED Open Protection
 - f) Output Short Protection
 - g) Diode & Inductor Short Protection
 - h) LED Cathode Short to GND Protection
6. Low system BOM cost

Applications

- LCD TV
- LCD Monitor
- Flat Panel Display

Specifications

Parameter	Value
Input Voltage	20V ~ 36V
Output Power	48W
Output Current	800mA
Output Voltage	60V
Efficiency	>90 %
Dimension	70mm*50mm
RoHS Compliance	Yes

Evaluation Board

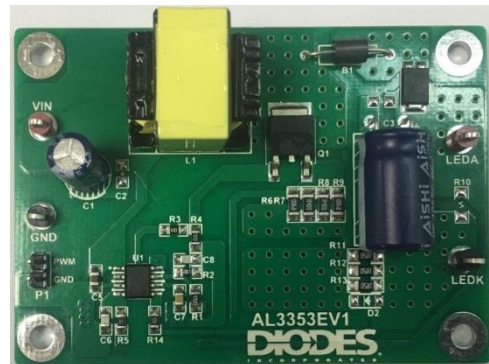


Figure 1: Top View

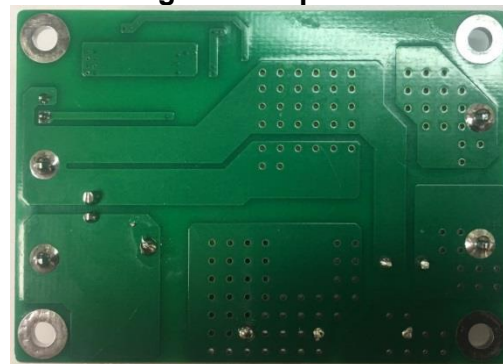


Figure 2: Bottom View

Connection Instructions:

DC Positive Input: White Test Point (VIN)
 DC Negative Input: Black Test Point (GND)
 PWM Signal Input: P1 (PWM)
 GND Signal Input: P1 (GND)
 Positive Output: Yellow Test Point (LEDA)
 Negative Output: Black Test Point (LEDK)

Board Layout

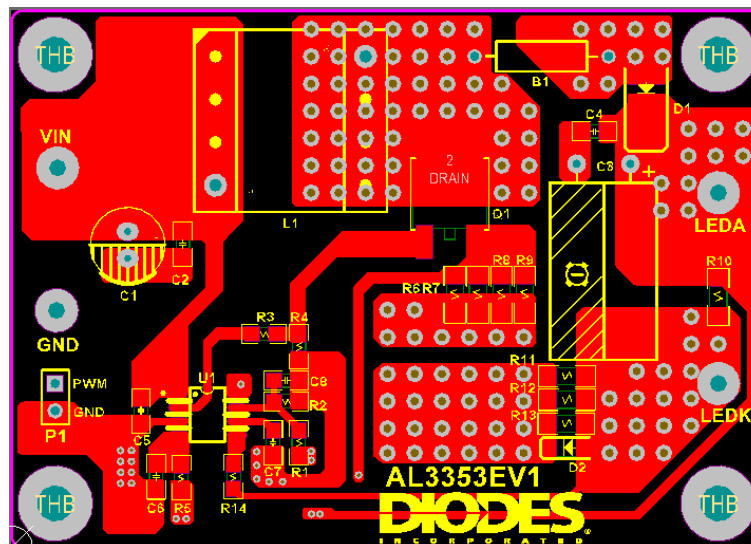


Figure 3: PCB Layout Top View

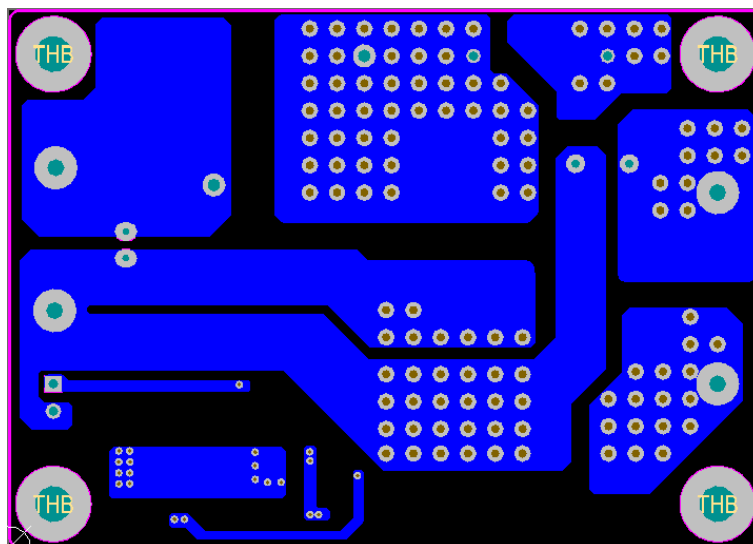


Figure 4: PCB Layout Bottom View

Quick Start Guide

1. Ensure that the power supply and the PWM signal are switched OFF or disconnected.
2. Connect the LED power supply to the test point “VIN” and “GND”.
3. Connect the LED PWM signal to the test point “PWM” and “GND”.
4. Connect the LED string anode to the test point “LEDA”.
5. Connect the LED string cathode to the test point “LEDK”.
6. Set the PWM signal and turn on the LED power supply. The LED string will light on and output the preset current.

Schematic

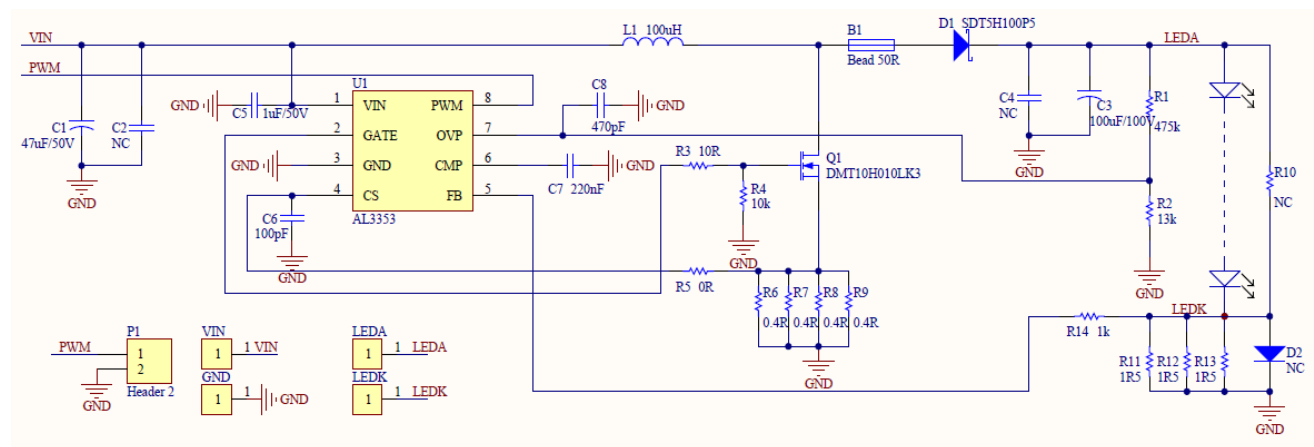


Figure 5: Schematic Circuit

Bill of Material

Item	Quantity	Package	Description
B1	1	DIP	Ferrite Bead, 50Ω@100MHz
C1	1	DIP	Electrolytic Capacitor, 47uF, 50V, 6.3*11
C3	1	DIP	Electrolytic Capacitor, 100uF, 100V, 10*16
C5	1	0805	Ceramic Capacitor, 1uF, 50V, X7R, ±10%
C6	1	0805	Ceramic Capacitor, 100pF, 16V, X7R, ±10%
C7	1	0805	Ceramic Capacitor, 220nF, 16V, X7R, ±10%
C8	1	0805	Ceramic Capacitor, 470pF, 16V, X7R, ±10%
D1	1	PowerDI5	Schottky Diode, SDT5H100P5, 100V,1A
L1	1	EE1610	Inductor, 100uH, EE1610, 36Ts
Q1	1	TO252	MOSFET, DMT10H010LK3, N Channel, 100V, 8.8mΩ
R1	1	0805	SMD Film Resistor, 475kΩ, ±1%
R2	1	0805	SMD Film Resistor, 13kΩ, ±1%
R3	1	0805	SMD Film Resistor, 10Ω, ±1%
R4	1	0805	SMD Film Resistor, 10kΩ, ±1%
R5	1	0805	SMD Film Resistor, 0Ω, ±1%
R6, R7, R8, R9	4	1206	SMD Film Resistor, 0.4Ω, ±1%
R11, R12, R13	3	1206	SMD Film Resistor, 1.5Ω, ±1%
U1	1	SO-8	IC, AL3353

System Performance

The AL3353 evaluation board has excellent system performance. With very low BOM cost, the system can achieve high efficiency and good dimming linearity. To enhance reliability, AL3353 also integrates comprehensive protections.

System Efficiency

Figure 6 shows the efficiency curve. The efficiency is measured with 32V DC input and 20*LED as load. The efficiency is 95% with 100% duty.

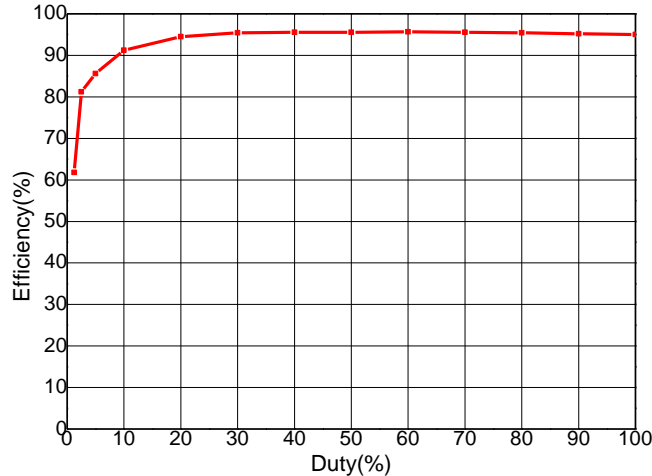


Figure 6: Efficiency vs PWM Duty

Dimming Performance

AL3353 can support PWM dimming with frequency ranging from 5 kHz to 50 kHz. Figure 7 shows the dimming curve with measured data. AL3353 dimming linearity is quite good with PWM duty from 1% to 100%.

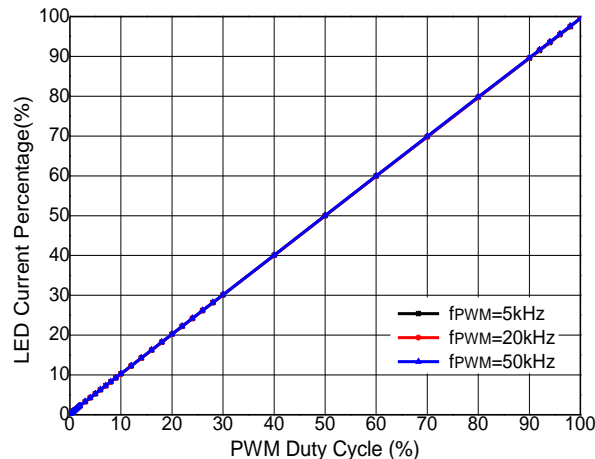


Figure 7: LED Current vs PWM Duty

LED Open Protection

AL3353 monitors the output voltage through the OVP pin. If the LED string is open, the output voltage will exceed the preset level and the converter will be shut down.

Figure 8 illustrates the LED open protection procedure. In the waveform, channel 1 (yellow) is the GATE signal, channel 2 (red) is the COMP signal, channel 3 (blue) is the OVP pin signal, and channel 4 (green) the LED current. From the waveforms, when V_{OVP} reaches 2.0V, AL3353 enters LED open protection and latches the system.

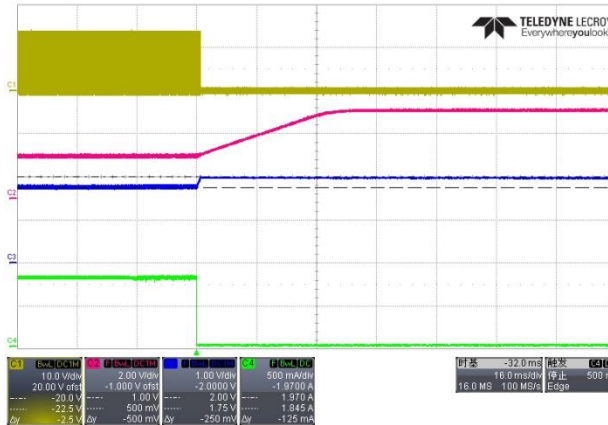


Figure 8: LED Open Protection with 100% Duty

LED Cathode Short to GND Protection

To prevent LED cathode short to ground, AL3353 monitors the COMP pin voltage. If V_{COMP} is continuously greater than 3.2V for 37ms, the converter will be shut down.

Figure 9 depicts the LED cathode short to ground protection procedure. In the waveforms, channel 1 (yellow) is the GATE signal, channel 2 (red) is the COMP signal, channel 3 (blue) is the CS signal, and channel 4 (green) the FB signal. From the waveforms, when LED cathode is short to GND, FB drops to $\sim 0V$ and V_{COMP} rises. When V_{COMP} reaches 3.2V and lasts for ~ 37 ms, AL3353 enters protection and latches the system.

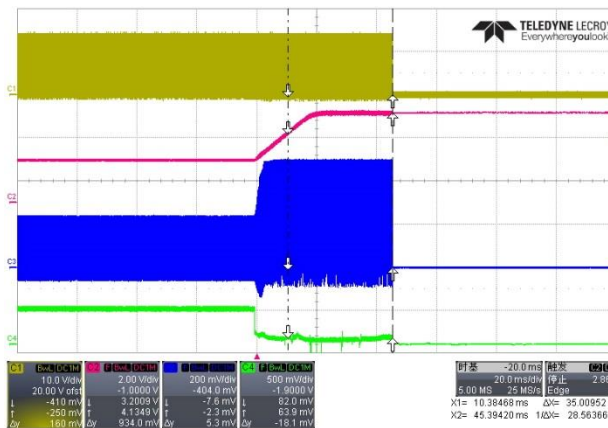


Figure 9: LED Cathode Short to GND Protection with 100% Duty

V_{OUT} Short Protection

AL3353 monitors the OVP pin voltage. If V_{OUT} is short, V_{OVP} will drop, and if V_{OVP} drops below 0.25V, the converter will be shut down.

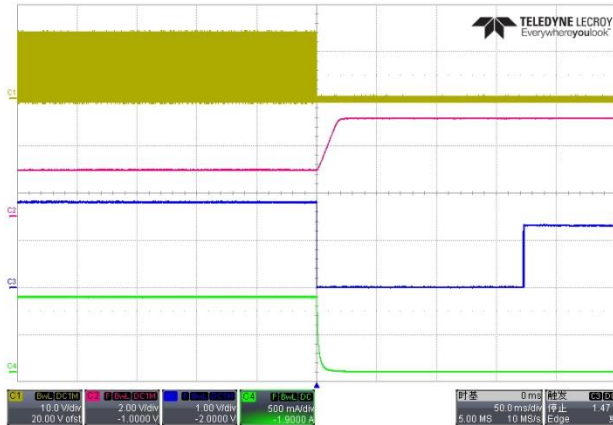


Figure 10: VOUT Short to GND Protection with 100% Duty

Figure 10 shows the V_{OUT} short to ground protection procedure. In the waveforms, channel 1 (yellow) is the GATE signal, channel 2 (red) is the COMP signal, channel 3 (blue) is the OVP signal, and channel 4 (green) the LED current. From the waveforms, when V_{OUT} is short to GND, OVP drops to $\sim 0V$, below $0.25V$, and then AL3353 enters protection and latches the system.

Over Temperature Protection

When the junction temperature exceeds $160^{\circ}C$, AL3353 latches and the converter shuts down.

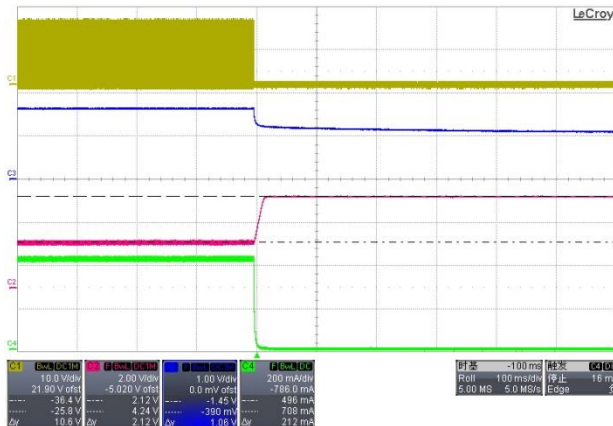


Figure 11: Over Temperature Protection with 50% Duty

Figure 11 illustrates the over temperature protection procedure. In the waveforms, channel 1 (yellow) is the GATE signal, channel 2 (red) is the OVP signal, channel 3 (blue) is the COMP signal, and channel 4 (green) the LED current. From the waveforms, when the IC junction temperature exceeds the threshold temperature, AL3353 latches the system.

If the LED anode short to LED cathode protection is required, the diode D2 is in need to prevent the FB pin from damaging. A diode should be placed to D2 whose peak repetitive reverse voltage should be no less than $100V$ and output current should be no less than $2A$.

Constant Voltage Mode

AL3353EV1 can also be configured to work in constant voltage mode. The PWM pin should be connected to a constant voltage (3.3V / 5V). For the 60V constant voltage output application, the below modifications should be implemented.

1. A 750k Ω , 1% precision, 0805 package resistor should be placed on R10.
2. R11, R12, R13 should be removed, and R11 be replaced by a 4.99k Ω , 1% precision, 0805 package resistor.
3. C7 should be replaced by a 10nF 0805 capacitor.

The constant output voltage can be measured between LEDA and GND.

System Efficiency

Figure 12 shows the efficiency curve. The efficiency is measured with different load current. The efficiency of AL3353EV1 constant voltage mode can reach 94% with 24V DC input and 95% with 32V DC input.

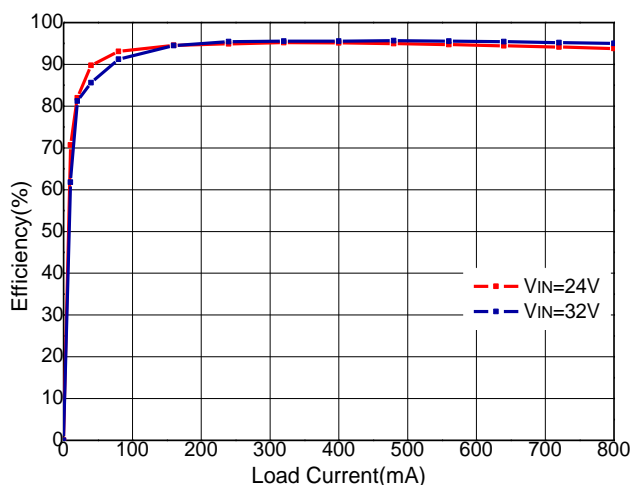


Figure 12: Efficiency vs Load Current

Load Regulation

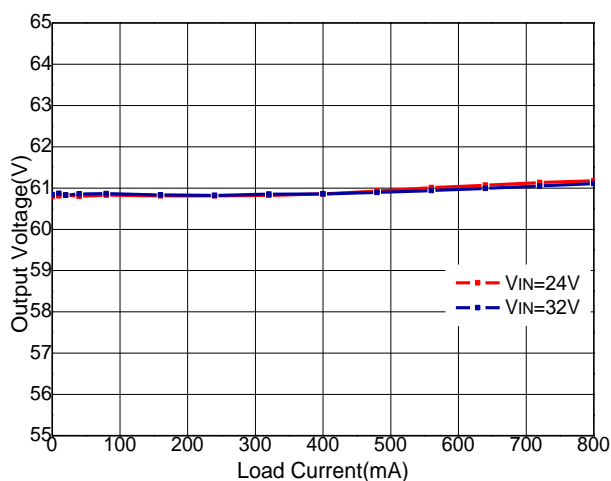


Figure 13: Output Voltage vs Load Current

Figure 13 shows the output voltage with different load current. The measured output voltage with 0~800mA load ranges 60.8V to 61.2V. The load regulation rate is 0.6%.

Line Regulation

Figure 14 shows the output voltage with different input voltage. With 20V ~ 36V DC input, the output voltage at 800mA load ranges from 61.24V to 61.10V. The line regulation rate is 0.2%.

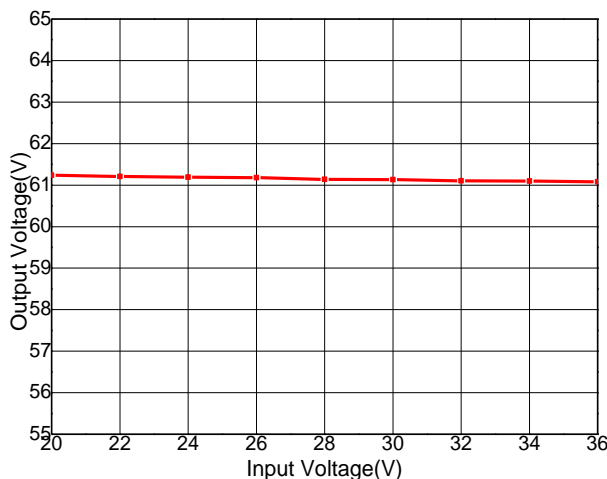


Figure 14: Output Voltage vs Input Voltage

Load Transient

The load transient waveform in Figure 15 is measured with the load current switching from 0mA to 800mA, rising slew rate 1A/μs, and from 800mA to 0mA, falling slew rate 1A/μs. When loading, the output voltage drops to 52.75V for a very short time. When unloading, the maximum output voltage is 65.10V.

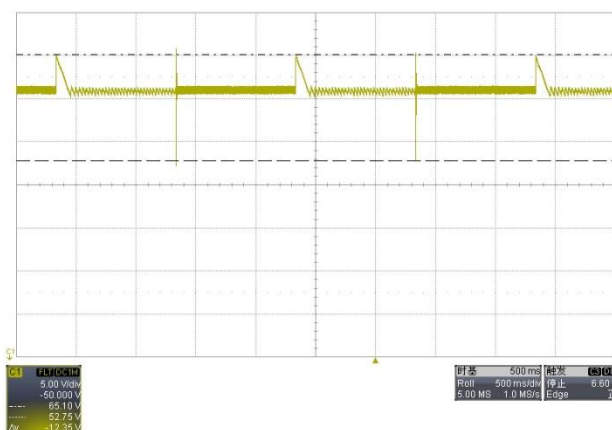


Figure 15: Load Transient with 32V Input

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