AL17150EV1 User Guide
High Voltage Step Down Converter

General Description

This demonstration board utilizes AL17150 to build a cost effective solution for high voltage Buck converter applications.

AL17150 integrates a 500V MOSFET and can works with a single winding inductor and very few external components to provide accurate constant voltage output and good dynamic performance.

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

- Universal 85 to 265 VAC Input Range;
- Constant Voltage (CV) Control;
- Internal MOSFET up to 500V
- Low Operation Current: 100μA (Static)
- Under Voltage Lock Out (UVLO)
- Output Short Protection
- Over Load Protection;
- Over Temperature Protection (OTP)

Applications

- Home Appliance Applications
- IoT Applications
- Industrial Controls
- Standby Power

Specifications

Parameter	Value
AC Input Voltage	85Vac ~ 265Vac
Output Power	0.99W
Output Current	300mA
Output Voltage	3.3V
Efficiency	>52%
Standby Power	<75mW
Dimension	50.93mm*19.05mm
RoHS Compliance	Yes

Evaluation Board

Figure 1: Top View

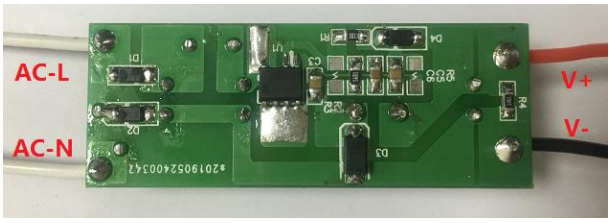

Figure 2: Bottom View

Connection Instructions:

AC Line Input: White L line

AC Neutral Input: White N line

Positive Output: Vout (Red)

Negative Output: Gnd (Black)

Board Layout

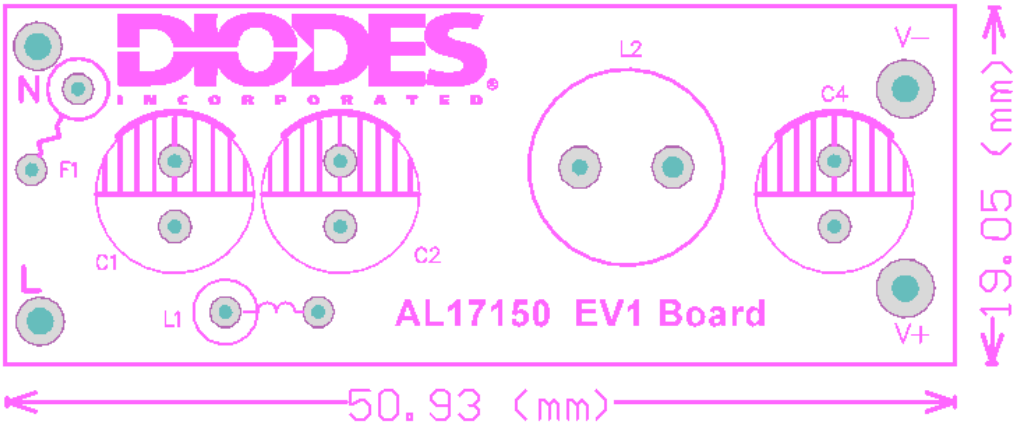

Figure 3: PCB Layout Top View

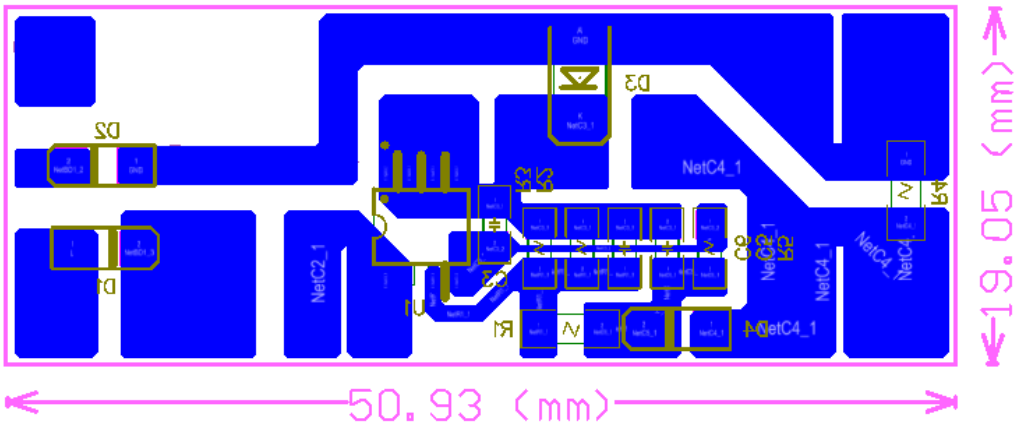

Figure 4: PCB Layout Bottom View

Quick Start Guide

1. Ensure that the AC source is switched OFF or disconnected.
2. Connect the AC line wires of power supply to “L” and “N” wires on the left side of the board.
3. Connect the red terminal of the electronic load to the “Vout” wire.
4. Connect the black terminal of the electronic load to the “Gnd” wire.
5. Turn on the main switch. The electronic load should show a 3.3V output.

Schematic

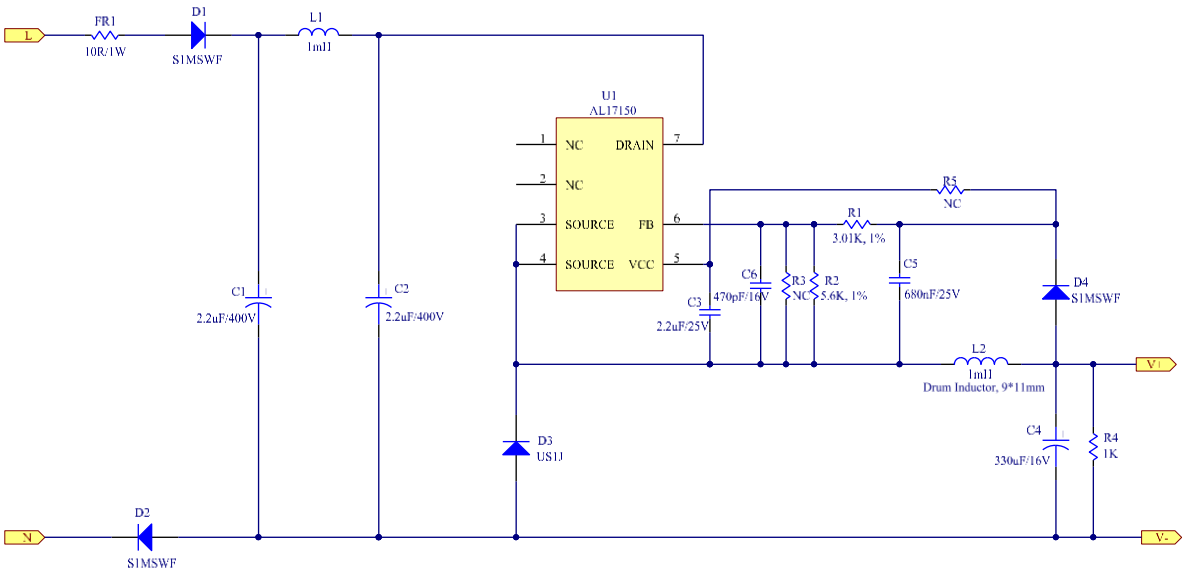

Figure 5: Schematic Circuit

Bill of Material

Item	Quantity	Package	Description
FR1	1	Thru-hole	10Ω, Fuse Resistor, 5%, 1W
D1,D2,D4	3	SOD123	S1MSWF, Diode,1000V,1A, Diodes Inc
D3	1	SMA	US1J, Ultra-fast Diode,600V,1A, Diodes Inc
C1,C2	2	Thru-hole	EGX2GM2R2E09OT, Electrolytic Capacitor, 2.2uF/400V,6.3*9mm, Aishi
C3	1	0805	2.2uF, Ceramic Capacitor,25V,X7R,20%
C4	1	Thru-hole	ERE1CM331F11OT, Electrolytic Capacitor, 330uF/16V,8*11mm, Aishi
C5	1	0805	680nF, Ceramic Capacitor,25V,X7R,10%
C6	1	0805	470pF, Ceramic Capacitor,16V,X7R,5%
L1	1	Thru-hole	77F102J-RC,1mH, Color-ring chock , 0510, Bourns
L2	1	Thru-hole	RLB0912,1mH, Drum Inductor, 9*11mm, Bourns
R1	1	0805	3.01kΩ, SMD Film Resistor, 1%
R2	1	0805	5.6kΩ, SMD Film Resistor, 1%
R4	1	0805	1kΩ, SMD Film Resistor, 5%
U1	1	SO7	AL17150-10BS7-13, HV Buck IC, Diodes Inc

System Performance

The AL17150EV1 board has excellent system performance. With very low BOM cost, the system can achieve high efficiency, low load regulation rate, low ripple and good load transient performance.

System efficiency

Figure 6 shows the measured efficiency versus load. The system efficiency at 300mA current load could reach 59% with 120Vac input and 56% with 230Vac input.

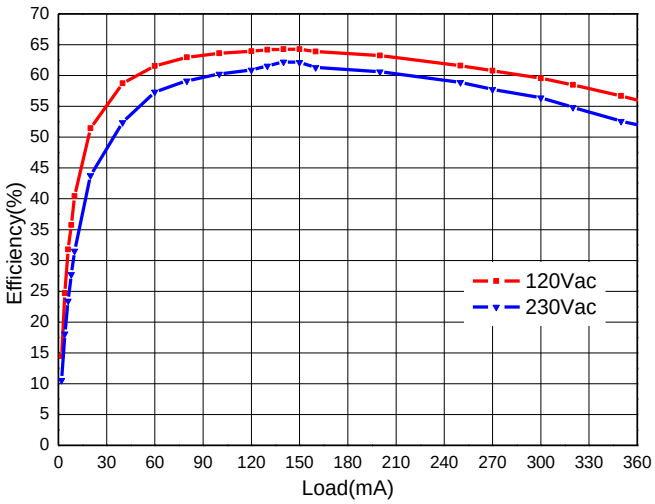

Figure 6: Efficiency vs load current

Load Regulation

The measured output voltage versus load is shown in Figure 7. With the load changing from 0~360mA, the output voltage ranges from 3.2V to 3.68V with 120Vac input and 3.19V to 3.66V with 230Vac input.

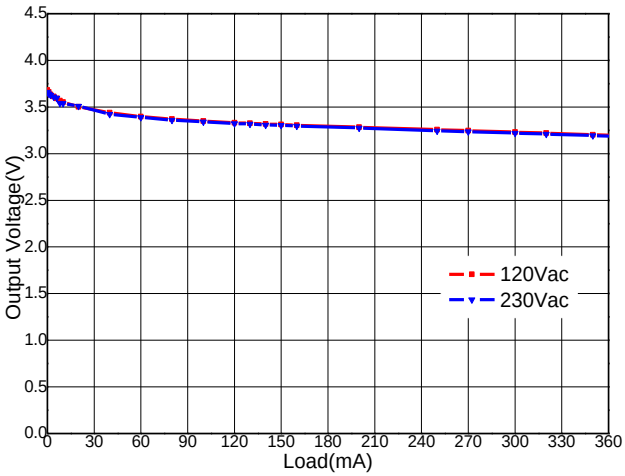

Figure 7: Output voltage vs load current

No load Power Consumption

AL17150 consumes very low input power with no load. Table 1 shows AL17150EV1's no load power consumptions with different input voltage.

Input Voltage(Vac)	Input power(mW)	VOUT(V)
90	33.7	3.663
120	38.0	3.678
132	41.1	3.675
180	48.7	3.665
230	62.5	3.657
264	71.1	3.649

Table 1: no load power with different input voltage

Output Ripple

The output voltage ripple is small in AL17150EV1. In Figure 8, channel 1 (yellow) shows the waveform of Vout. The output voltage ripple is measured at 300mA load at both 120Vac and 230Vac input.

The output voltage ripple peak to peak value is 95.3mV for 120Vac input and 97.8mV for 230Vac input.

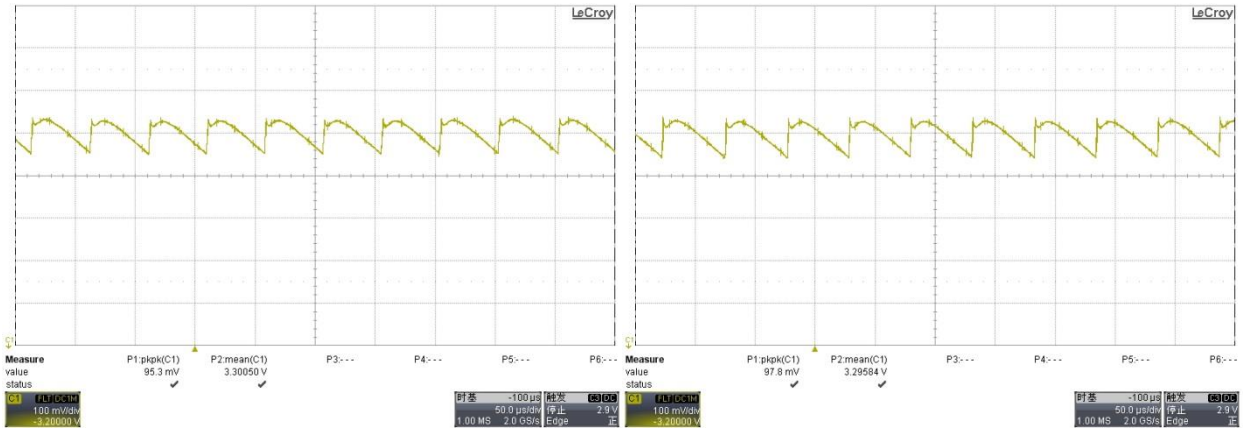

Figure 8: Output voltage ripple with 120Vac (Left) and 230Vac (Right)

Load Transient Response

The load transient response is tested with the load repeatedly switching from 0mA to 350mA in 1Hz frequency. The load switching slew rate for both rising and falling is 1A/us. In Figure 9, channel 1 (Yellow) shows the waveform of Vout and channel 4 (green) shows Iout.

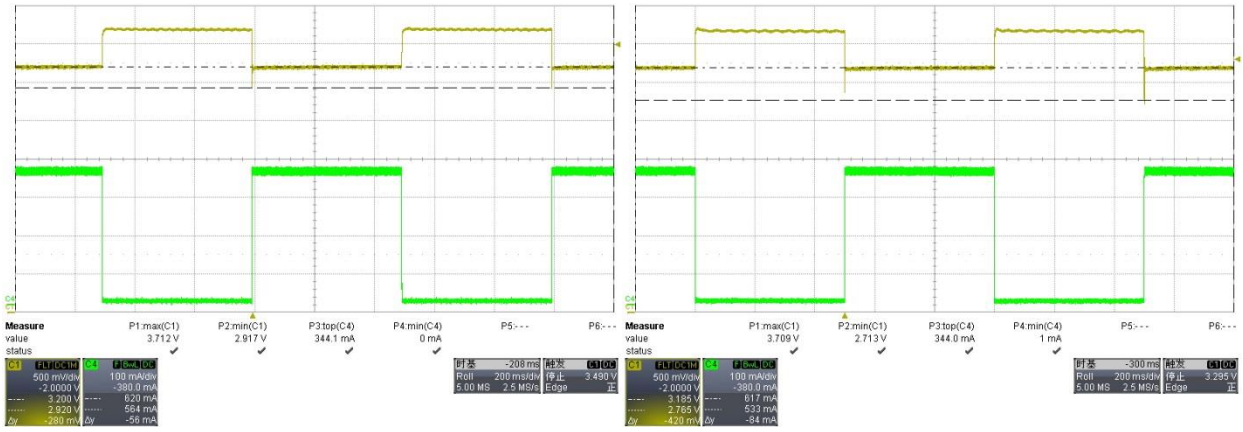

Figure 9: Load transient waveform with 120Vac (Left) and 230Vac (Right)

With 120Vac input, the overshoot and undershoot caused by the load transient is respectively 0mV and 280mV. With 230Vac input, the maximum overshoot and undershoot caused by the load transition are 0mV and 420mV, respectively.

EMI

AL17150 could pass EMI standards with few filter inductors or capacitors. Figure 10 to 13 shows the conduction emission test result of AL17150EV1.

With 110Vac input, AL17150EV1 could pass EN55015 standard with -11.6dB margin. With 230Vac input, AL17150EV1 could pass EN55015 standard with -4.6dB margin. Therefore, AL17150EV1 can pass conduction emission test and is compliant with EN55015.

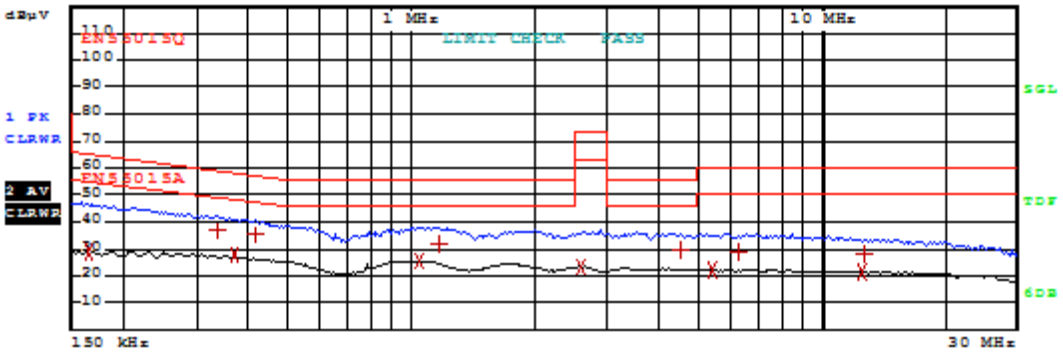

Figure 10: Conduction emission on Line with 110Vac input

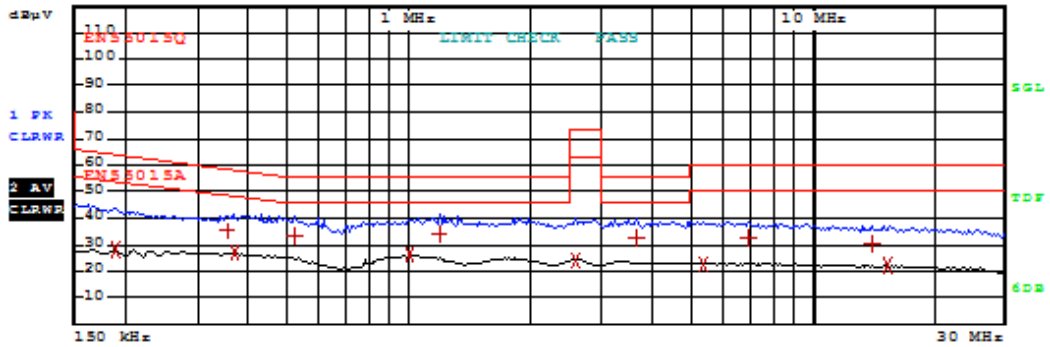

Figure 11: Conduction emission on Neutral with 110Vac input

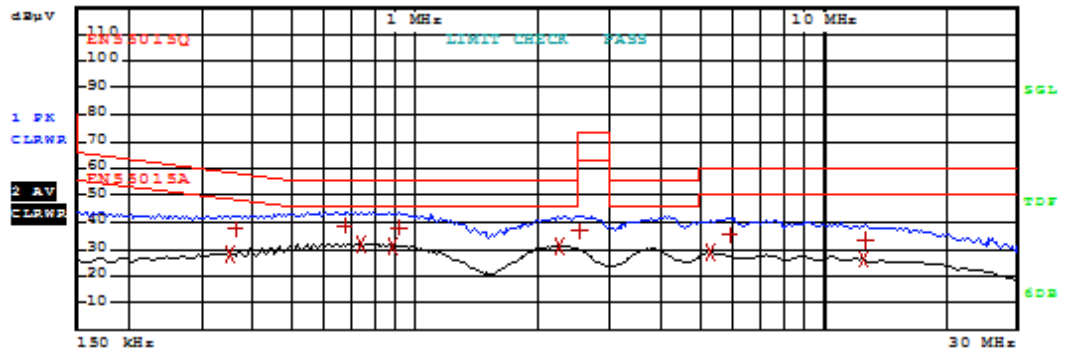

Figure 12: Conduction emission on Line with 230Vac input

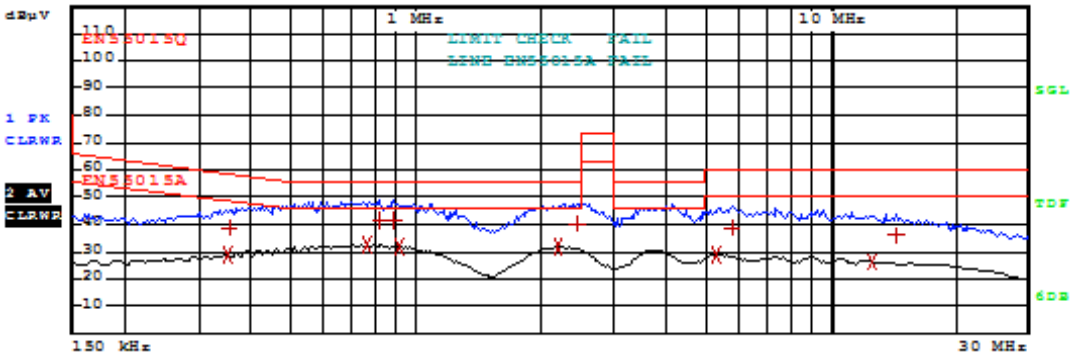

Figure 13: Conduction emission on Neutral with 230Vac input

Protections

The AL17150 has rich protection features to enhance the system safety and reliability. It has Over Temperature Protection, VCC Under Voltage Lock function, Output Short Protection, Over Load Protection and Open Loop Protection.

When the load current is raised to 470mA, the over load protection is triggered and system will continuously restart. When the load is turned lower (360mA), IC recovers to normal operation. In Figure 14 the output voltage (channel 1, Yellow) and the inductor current (channel 4, green) waveforms prove that the protection works.

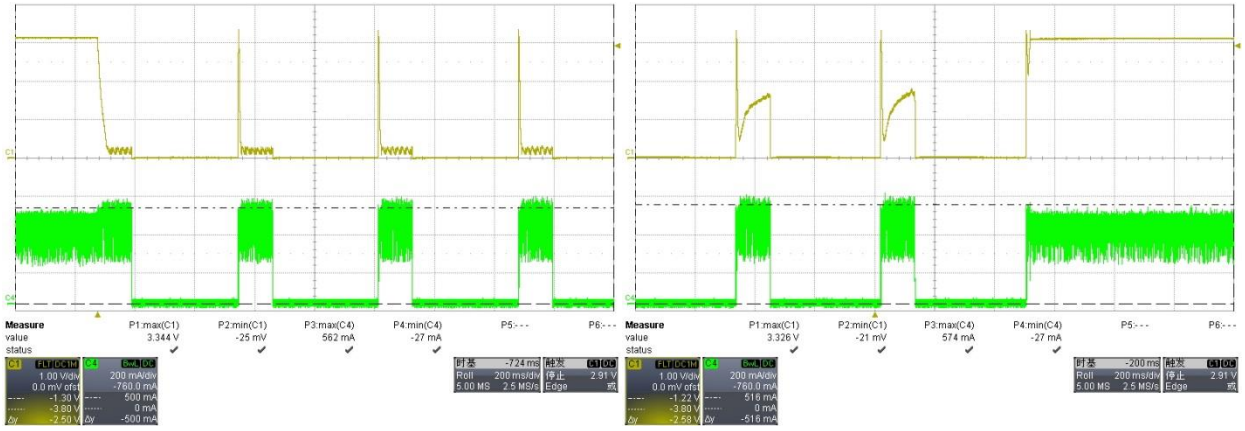

Figure 14: Over load protection entry (Left) and recovery (Right)

When the higher feedback resistor (R2 in Figure 5) is open and AL17150 cannot detect correct feedback signal, it will enter open loop protection. AL17150 continuously restarts the inductor current (channel 4, green), DRAIN pin to SOURCE pin voltage (channel 1, Yellow) and output voltages (channel 3, blue) waveforms are shown in Figure 15.

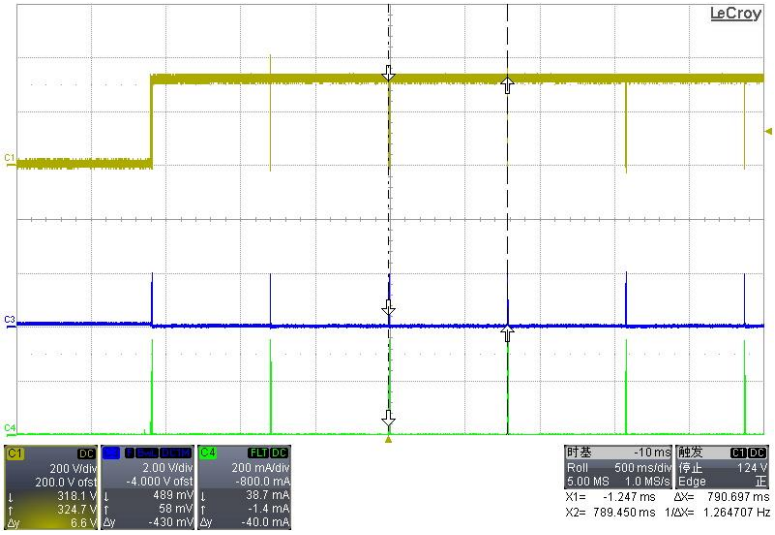

Figure 15: Open loop protection

When the ambient temperature rises up to 125℃, the over temperature protection would triggered. AL17150 will run into UVLO and periodically restarts until the temperature is lower. Figure 16 illustrates this protection feature. With 230Vac input and 350mA load, the protection is triggered at 125℃ and system can recover when the ambient temperature is lowered. In Figure 16, The VCC voltage (channel 3, blue), output voltages (channel 1, Yellow) and output current (channel 4, green) waveforms show this protection feature can correctly work.

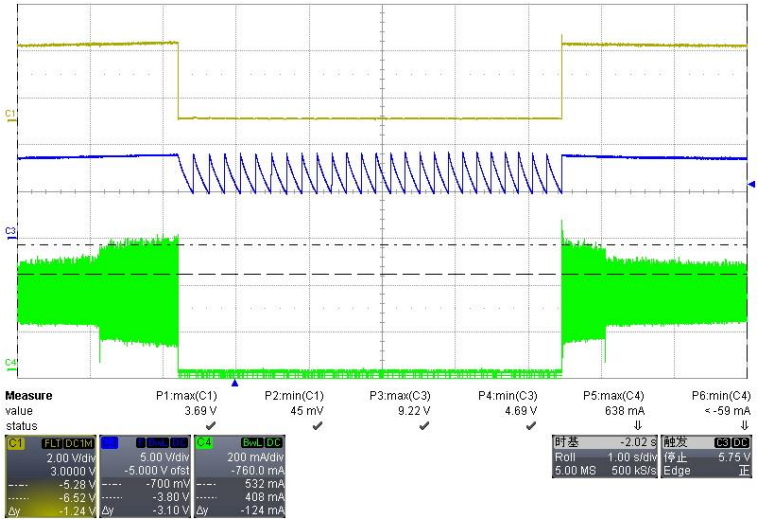

Figure 16: Over temperature protection entry and recovery

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