AN-1326 LM5068 Evaluation Board

1 Introduction

The LM5068 evaluation board is designed to provide the design engineer with a fully functional hot-swap controller board to evaluate the performance of LM5068 hot-swap controller IC, in a typical environment. The evaluation board is designed using the LM5068-2 (active high Power Good and Fault auto retry version). This application report explains the apparatus needed and method of operation to the user of the evaluation board. The *LM5068 Negative Voltage Hot Swap Controller* (SNVS254) should be consulted in conjunction with this user's guide.

The performance of the evaluation board is:

- Input range: -10V to -90V
- Transient voltage rating : -100V (absolute maximum)
- Maximum continuous load current: 1.0A
- Maximum short-circuit current : 2.4A
- Board Size: 58.5 mm × 31.8mm

2 Theory of Operation

The LM5068 features all of the functions needed to implement hot-swap capability and intelligent control of power supply connections during the insertion and removal of circuit cards powered by live system backplanes as shown in Figure 1.

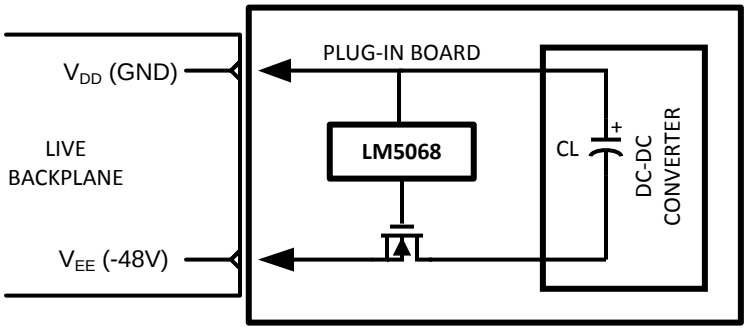


Figure 1. Live System Backplanes

The LM5068 provides both inrush current control and minimizes power supply transients in the backplane caused by the insertion of additional circuit cards. Once the turn-on sequence is completed, the LM5068 monitors the load current and provides overload protection. The LM5068 controls the external N-Channel MOSFET to provide programmable load current limiting and circuit breaker functions using a single external current sense resistor.

The LM5068 issues a power good (PWRGD) signal at the conclusion of a successful power-on sequence. Input over-voltage or under-voltage fault conditions will cancel the PWRGD indication. The LM5068-1 and -2 indicate power good as an open-drain active high PWRGD state. The LM5068-3 and -4 indicate power good as an open-drain active low PWRGD state. The LM5068 is available in MSOP-8 package.

The evaluation board schematic is shown in Figure 2.

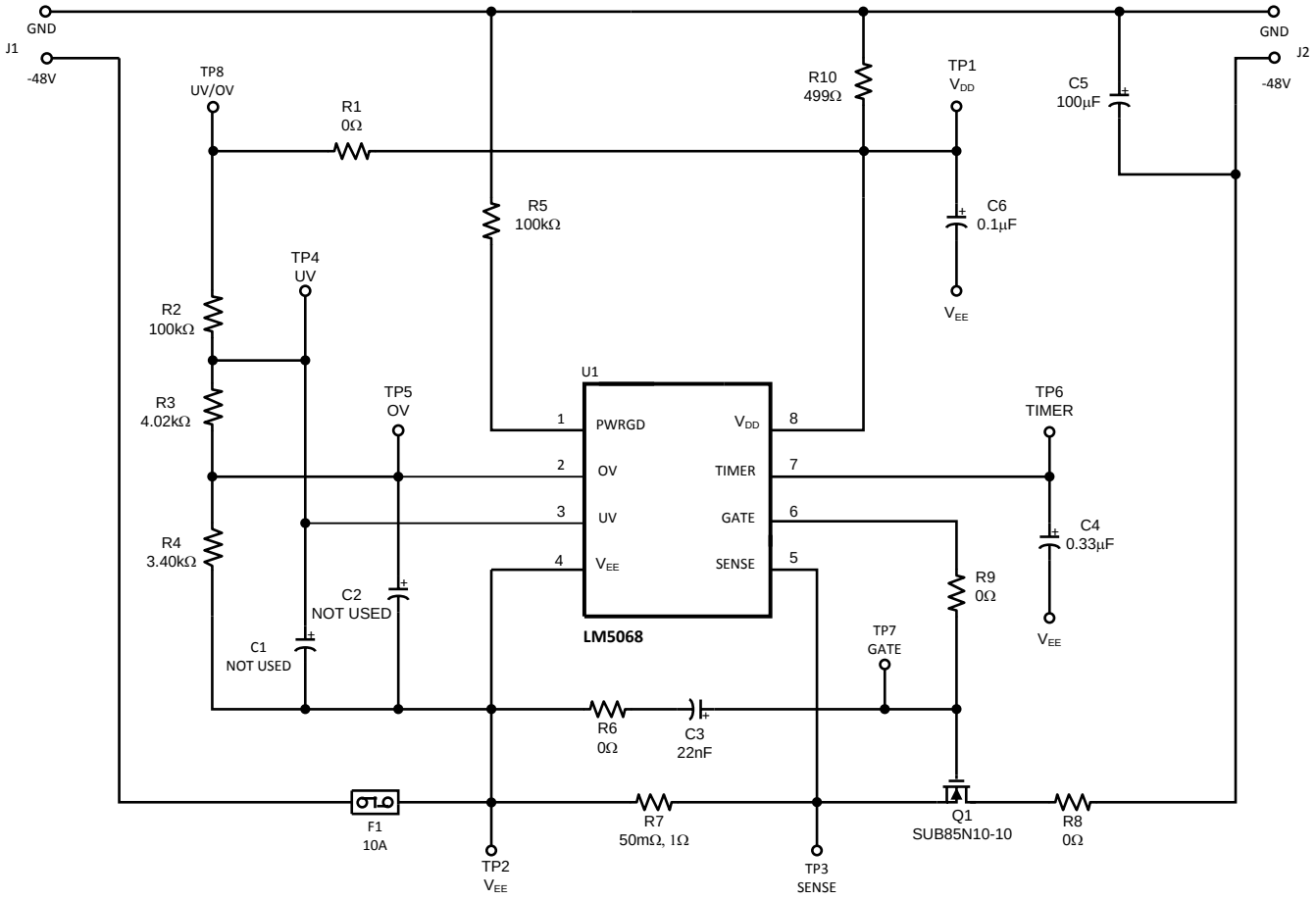


Figure 2. Evaluation Board Schematic

The apparatus required to test the evaluation board is:

- 100V/ 5A DC power supply
- 2 or 4 channel analog or digital storage oscilloscope
- Two RMS voltmeters (DVM) with floating inputs

Care must be exercised while operating at high input voltages.

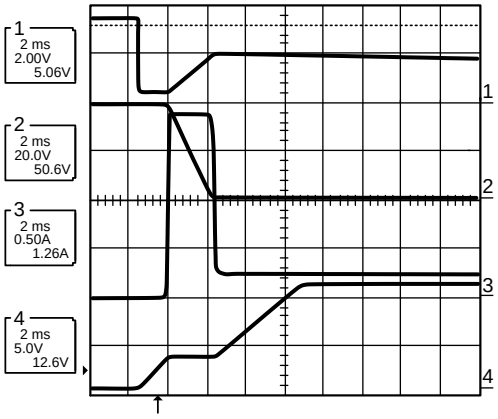
3 Operational Description of the Evaluation Board

The operation of LM5068 hot-swap controller embedded on a plug-in board can be categorized into three parts:

- Start-up and inrush current limiting
- Auto retry following the detection of a fault
- Load disconnect and power limiting during fault

3.1 Start-up and Inrush Current Limit

Whenever a circuit card with large electrolytic capacitors is inserted into a live backplane, large inrush currents will occur. These surge currents can cause the backplane voltage to drop, which can reset or otherwise interfere with adjacent boards. The current surges can also affect connector pins, burn out PCB traces and can interfere with data by generating EMI. The LM5068 actively limits inrush currents, which limits load voltage slew rate (ΔV/Δt). The LM5068 has active current limiting threshold of 100mV, and an R_{SENSE} equal to 50mΩ, therefore the maximum current is limited to 2.0A (see Figure 3).



CH1: Timer Pin Voltage
CH2: Voltage Across MOSFET Switch
CH3: Load Current
CH4: Gate Voltage

Figure 3. Start-Up Characteristics

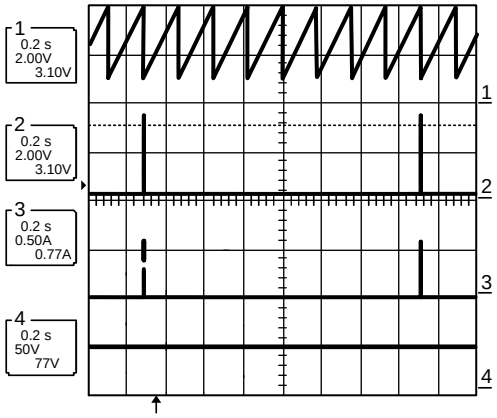
3.2 Auto Retry During Faults

If the fault conditions persist long enough for TIMER pin to charge CT to 4V, the LM5068 latches off (LM5068-1, -3) or switches off and initiates the re-try timer (LM5068-2, -4).

The LM5068-1 and LM5068-3 remains off until the controller is reset by either temporarily pulling the UV pin low, pulling the TIMER pin below 1 volt, or decreasing the input voltage below the internal V_{DD} under-voltage lockout (UVLO) threshold.

The LM5068-2 and LM5068-4 respond to a fault condition by pulling the GATE and TIMER pins low and then initiating a timer sequence for automatic re-try. The re-try timer sequence begins with C_T capacitor being charged slowly to 4V with a 6µA current source and then discharged quickly to 1V with a 30mA discharge current. After eight charge/discharge cycles the GATE pin is released and charged with a 60µA current source. If the fault condition persists, the LM5068 will again turn off the MOSFET and another 8-cycle fault timer sequence will begin.

The Evaluation board is provided with a LM5068-2 , which features the auto retry following a fault detection (see Figure 4).



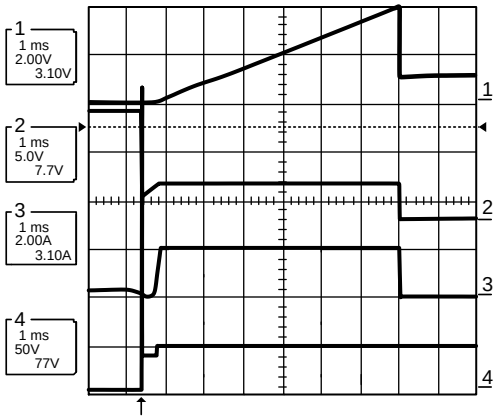
CH1: Timer Pin Voltage
CH2: Gate Pin Voltage
CH3: Current Through MOSFET
CH4: Voltage Across MOSFET

Figure 4. Auto Retry Feature after Fault Detection

3.3 Load Disconnect and Power Limit During Catastrophic Faults

During catastrophic faults like short-circuit on the output when the series MOSFET is fully enhanced, high inrush currents are still possible. To prevent these high surge currents, the LM5068 has a fast current limit threshold of 200mV. Fast Discharge Current (FDC) responds to fast rising over-loads such as short circuit faults. During a short circuit event the fast rising current may overshoot past the ACL (active current limit) threshold of 100mV due to the finite response time of the ACL loop. If the SENSE voltage reaches 200mV a fast discharge comparator quickly pulls GATE pin low. The rapid response of the FDC circuit assures a fast and safe transition to the ACL mode.

The LM5068 circuit breaker action filters low duty cycle over-load conditions to avoid declaring a fault during short duration load transients. The timer charges capacitor C_T with 240µA when the SENSE voltage is greater than 50mV. When the SENSE pin voltage falls below 50mV, a 6µA current discharges the TIMER capacitor. Repetitive over-current faults with duty cycle greater than 2.5% will eventually charge CT and trip the fault timer. This feature protects the pass MOSFET, which has a fast heating and slow cooling characteristic.



CH1: Timer Pin Voltage
CH2: Gate Pin Voltage
CH3: Current Through MOSFET
CH4: Voltage Across MOSFET

Figure 5. Fast Response Circuit Breaker during Output Short Circuit

4 Conclusion

This user's guide explains the apparatus and method needed to operate the LM5068 evaluation board in a typical environment. Typical operating modes have been explained with reference to the evaluation board.

5 Component List

Part	Value	Package	Description	Part Number
C1	NOT USED			
C2	NOT USED			
C3	0.022µF/ 50V	C0805	CAPACITOR, CERAMIC,KEMET	C0805C223K5RAC
C4	0.33µF / 50V	C0805	CAPACITOR,CERAMIC,KEMET	C0805C334K5RAC
C5	100µF / 100V		CAPACITOR, ALUMINIUM ELECTROLYTIC, SURFACE MOUNT,PANASONIC	EEV-FK2A101M
C6	0.1µF / 100V	C1206	CAPACITOR, CERAMIC, TDK	C3216X7R2A104KT
F1	10A FUSE	SMD_FUSE	COOPER BUSSMAN FAST ACTING FUSE TRON	TR/SFT-10 (Digikey # 283-2439-2-ND)
J1	PCB terminal Blocks/ 10A		MOUSER TERMINAL BLOCKS	651-1727010
J2	PCB terminal Blocks/ 10A		MOUSER TERMINAL BLOCKS	651-1727010
Q1	100V / 60A	N-Channel Power MOSFET,TO263	VISHAY	SUB85N10-10
R1	0	R1206	SMD RESISTOR, 1% TOL	CRCW12060000F
R2	100k	R1206	SMD RESISTOR, 1% TOL	CRCW12061003F
R3	4.02k	R0805	SMD RESISTOR, 1% TOL	CRCW08054020F
R4	3.40k	R0805	SMD RESISTOR, 1% TOL	CRCW08053401F
R5	100k	R0805	SMD RESISTOR, 1% TOL	CRCW08051003F
R6	0	R0805	SMD RESISTOR, 1% TOL	CRCW08050000F
R7	50m	R2512	SMD RESISTOR, 1% TOL	WSL-2512 .050F
R8	0	R1206	SMD RESISTOR, 1% TOL	CRCW12060000F
R9	0	R1206	SMD RESISTOR, 1% TOL	CRCW12060000F
R10	499	R1206	SMD RESISTOR, 1% TOL	CRCW1206499RF
U1	LM5068	VSSOP-8	Texas Instruments	LM5068-2

6 PCB Layouts

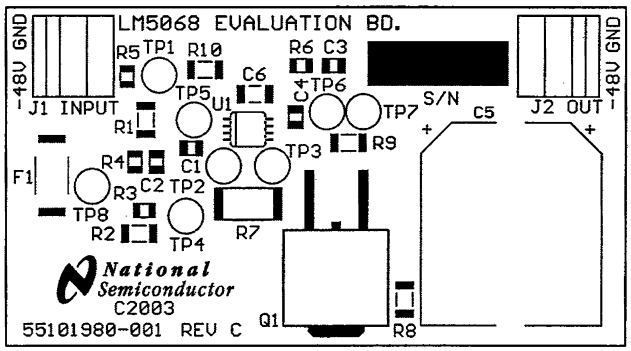


Figure 6. Silkscreen Layer as viewed from Top

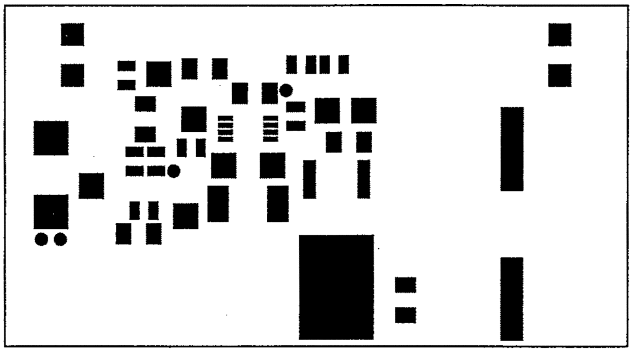


Figure 7. Top Side Soldermask as viewed from Top

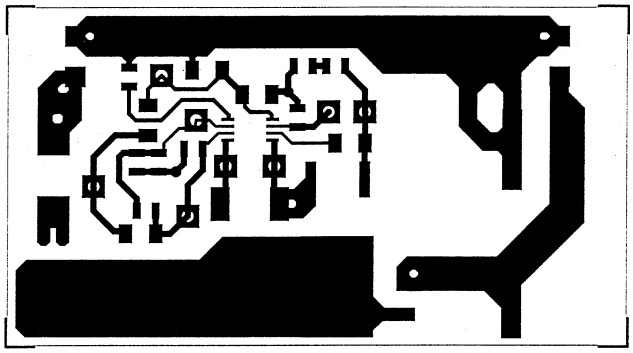


Figure 8. Top (Component) Layer as viewed from Top

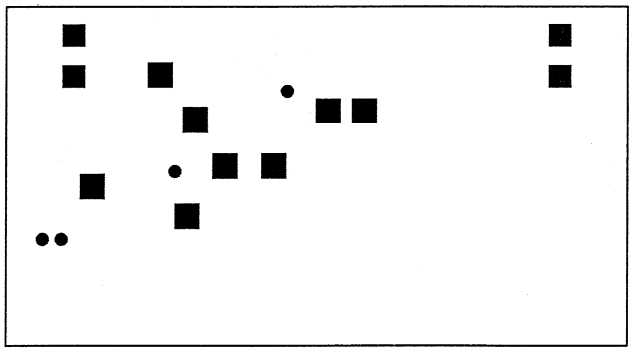


Figure 9. Bottom Side Soldermask as viewed from Top

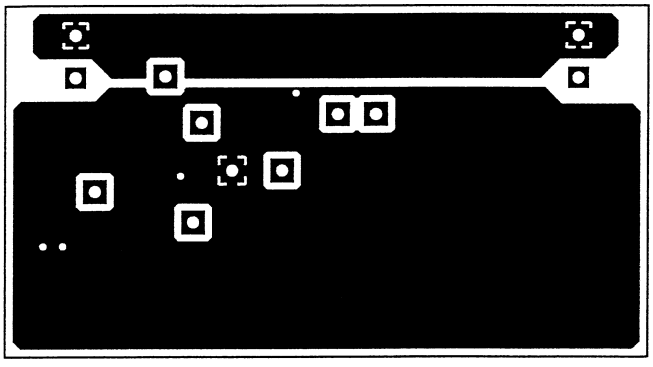


Figure 10. Bottom (Solder) Layer as viewed from Top

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