DC354A-High Power Dual CCFL Demo Board

DESCRIPTION

Demonstration Board DC354 featuring the LT1768 is a complete solution for regulating current in high power dual CCFL displays. A single input source, either DC or PWM, controls CCFL current via a unique Multimode dimming scheme. Multimode dimming combines both linear and PWM control functions to maximize lamp life, efficiency and dimming range. Accurate maximum and minimum lamp currents can be easily set. The DC354 can detect and protect against lamp failures, which can shorten lamp life or produce hazardous voltages.

CONNECTIONS

Connect the input supply to the VIN (E1) and GND (E2) terminals. Connect the high side (the high side of the lamp is the shortest wire to the lamp and is usually pink in color) of each CCFL lamp to terminals E6 and E7 respectively. Connect the low side of each CCFL lamp to terminals E4 and E5 respectively. Connect a 0V to 5V DC or PWM voltage source to the PROG (E3) terminal. The SD (E8) terminal (Shutdown pin) can be left open, tied to VIN, or connected to an active low source. The FAULT(E9) terminal (Fault pin) is an open collector output that is active low when the LT1768 detects a fault condition.

CURRENT PROGRAMMING

Demonstration board DC354 operates from an input supply voltage of 8V to 24V. Below 8V the LT1768 is in undervoltage lockout preventing lamp operation. The DC354 can be placed in shutdown mode by taking the SD (E8) terminal below 1.25V, which results in a typical quiescent current of 65uA. Leaving the SD terminal open or tying it to the VIN (E1) terminal will result in normal operation.

Lamp current is controlled by the voltage source connected to the PROG (E3) terminal. The DC 354 takes a 0V to 5V DC or 1kHz PWM signal. The input is filtered by R1 and C4 and then sent to the PROG pin of the LT1768. Referring to Figure 1, the lamp current has five modes of operation depending on the value of the voltage on the LT1768 PROG pin.

When the LT1768 PROG pin voltage is less than 0.5V, DC354 will be in off mode and the lamp current will be zero.

When the LT1768 PROG pin voltage is between 0.5V and 1.0V, DC354 will be in minimum lamp current mode. The minimum lamp current is set to approximately 10 times the current flowing out 1.26V referenced RMIN pin on the LT1768. With jumper JP1 in the 1-2 position, R8 is connected to the 5V VREF pin and current flows into the RMIN pin, which results in zero lamp current. With jumper JP1 in the 2-3 position, R8 is connected to ground and 12.6uA flows out of the RMIN pin, which results in approximately 126uA of lamp current. The minimum current determines the dimming ratio of the display. Setting the minimum current to zero by connecting R8 to the VREF pin will produce the greatest dimming ratio but may violate lamp specifications Minimum lamp current can be set by putting the LT1768 in minimum current mode (VPROG=0.75V), and then adjusting R8 (jumper in 2-3 position) for the desired current.

When the LT1768 PROG pin voltage is between 1.0V and the LT1768 PWM pin voltage (3.0V set by the LT1768 5V VREF pin, and resistor divider R2 & R3) DC354 will be in PWM lamp current mode. In PWM mode, the lamp current will be pulse width modulated between the minimum lamp current and (VPROG-1V)/3V times the maximum lamp current. The PWM frequency is set to 220hz by the capacitor C3. The PWM frequency is defined by 22Hz/C3uF, with it's duty cycle equal to [1-(VPWM-VPROG)/(VPROG-1V)] *100%.

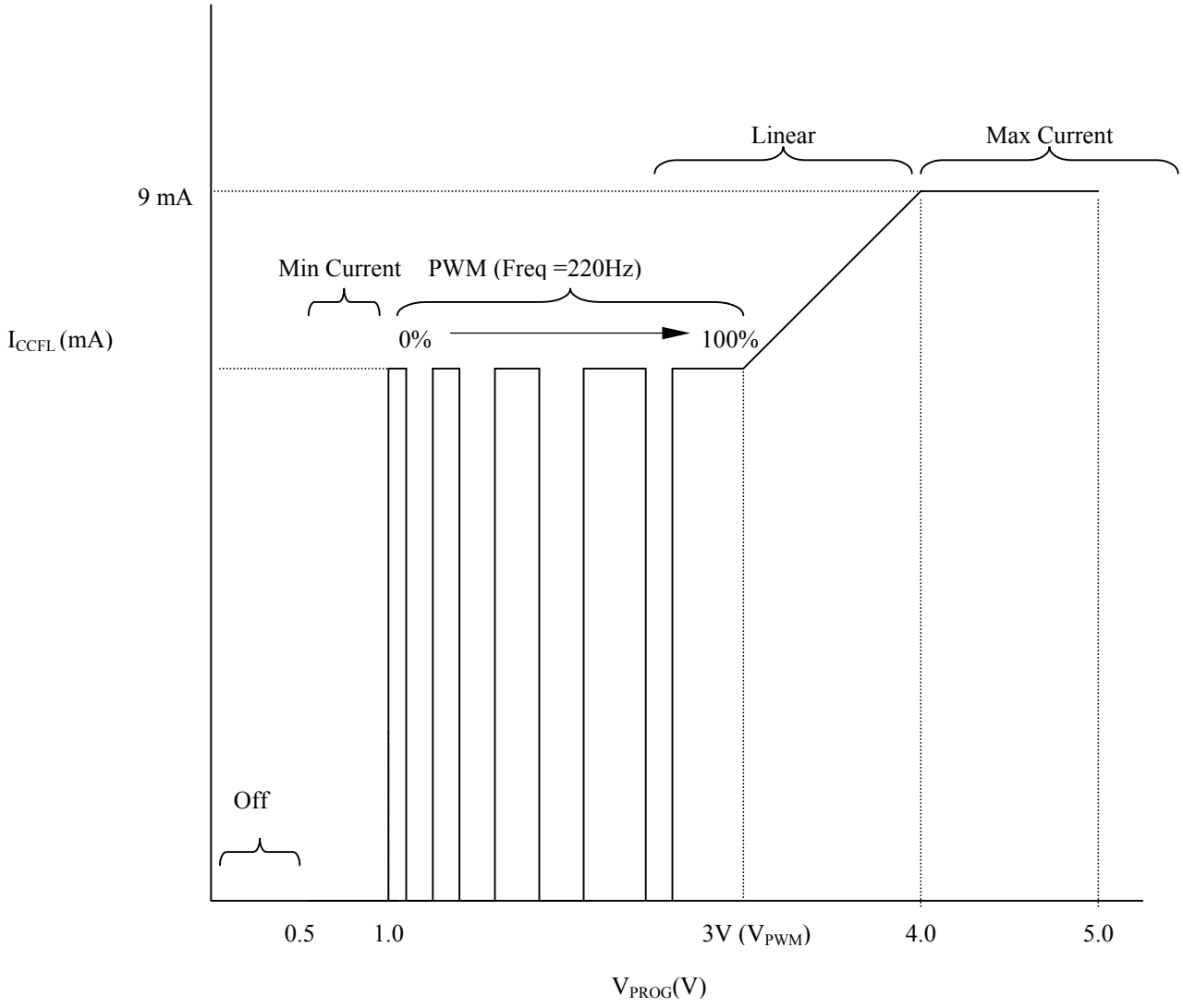


Figure 1. CCFL Current per Lamp vs PROG Voltage for the DC354

When the LT1768 PROG pin voltage is between the LT1768 PWM pin voltage and 4.0V, DC354 will be in linear lamp current mode. In linear mode, the lamp current increases linearly with the voltage on the LT1768 PROG pin and follows the equation, ILAMP = (VPROG-1V)/3V*(maximum lamp current). For optimum performance, the voltage on the LT1768 PWM pin should be set such that PWM mode starts just below the nominal lamp operating current.

When the LT1768 PROG pin voltage is between 4.0V and 5.0V, DC354 will be in maximum lamp current mode. The maximum lamp current is set to approximately 100 times the current flowing out 1.25V referenced RMAX pin on the LT1768. Maximum lamp current can be set by putting the LT1768 in maximum current mode (VPROG=4.5V), and then adjusting R4 for the desired current.

LAMP FAULTS

If the current in the low side of either lamp falls below 125uA for one complete PWM cycle (PWM frequency set by C3) the open collector FAULT (E9) terminal will be active low. When the FAULT pin is active current in the remaining lamp will stay constant. If the current in both lamps falls below 125uA for 1 complete PWM cycle and the voltage on the LT1768 VC pin hits its clamp value, indicating either an open circuit or lamp lowside short to ground, the LT1768 will latch itself off. The latch condition can be cleared by either setting the PROG voltage to zero, or placing the DC354 in shutdown mode.

At high VIN voltages, transformers with high turns ratios can produce high voltage AC waveforms during open lamp fault conditions. The fields associated with the high voltage waveforms can couple into the fault circuitry and fool open lamp detection. If this condition exists, a 1K resistor and BAT54 schottky diode can be added to the DIO pins on the LT1768 (optional components R9,R10,D2 & D3) to increase the open lamp threshold and restore open lamp fault detection.

SINGLE LAMP OPERATION

For single lamp operation, the lowside of the lamp should be connected to both of the LT1768 DIO pins (E4 & E5), and the values for R4 and R6 increased to two times the values that would be used in a dual lamp configuration. In single lamp mode all fault detection will operate as in the dual lamp configuration but the open lamp threshold will double. If the increase in the open lamp threshold is unacceptable, a positive offset current can be added to reduce the open lamp threshold by placing a resistor between the LT1768 REF and DIO pins (a 33k resistor will decrease the open lamp threshold by approximately 100uA). When an offset current is added , the values for RMAX and RMIN max need to be increased from their nominal values to compensate for the offset current.

COMPENSATION

A single capacitor (C2) from the LT1768 VC pin to ground provides loop frequency compensation. Careful consideration should be given to the value of capacitance used. A large value (1uF) will give excellent stability at high lamp currents but will result in degraded line regulation in PWM mode. On the other hand, a small value (10nF) will give excellent PWM response but might result in overshoot and poor load regulation. The value chosen will depend on the maximum load current and dimming range. After these parameters are decided upon, the value of the VC capacitor should be increased until the line regulation becomes unacceptable. DC354 uses a typical value of 0.47uF for the VC capacitor.

COMPONENTS

SENSE RESISTOR

The SENSE resistor (R7) determines the maximum current supplied to the ROYER converter. The peak switch current is equivalent to Ipk = 0.1 / RSENSE. The SENSE resistor should be set such that the voltage on the LT1768 VC pin is approximately 2.5V when the LT1768 is in maximum current mode (VPROG > 4V). Typical values for the SENSE resistor range from 25mOhm to 50mOhm for large desktop displays.

Since the maximum threshold at the SENSE pin is only 100mV, switching transients and other noise can adversely affect LT1768 operation. A simple filter between the SENSE resistor and the LT1768 SENSE pin (components R6 and C7) insures correct operation.

EXTERNAL MOSFET

The external MOSFET Q2 should be rated for, VGS > 14V, ID > maximum switch current, and VDS > maximum supply voltage. The MOSFET RDSON should be as low as possible to achieve maximum efficiency.

CATCH DIODE

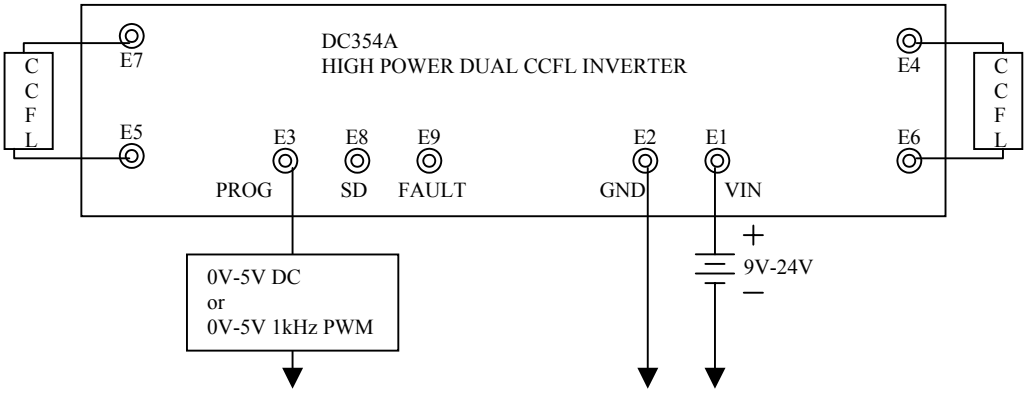
The catch diode D1 should be a schottky diode rated for the maximum switch current and supply voltage.

ROYER CONVERTER

The DC354 Royer converter is comprised of transformers T1 & T2, ballast capacitors C9 & C10, resonating capacitors C8 & C11, transistor Q1, resistor R5, and inductor L1. Transformers T1 & T2 must be rated for the maximum lamp current. The transformer turns ratio should be kept as low as possible to avoid high open lamp voltages, but high enough to provide maximum lamp current at the minimum input voltage. The remaining DC354 Royer component values have been set to typical values used in desktop displays. These component values affect both optical and electrical efficiency, and are highly interactive. For a complete discussion on Royer optimization, please refer to application note AN65.

PCB LAYOUT

In most cases, the circuit area traces of the demonstration board may be dropped directly into a PCB layout. If not, please refer to the LT1768 data sheet and application note AN65 for extensive discussions on high frequency switcher and high voltage layout techniques.


DC354A
HIGH POWER DUAL CCFL INVERTER
C
C
F
L
E7
E5
E3
E8
E9
E2
E1
E4
E6
C
C
F
L
PROG
SD
FAULT
GND
VIN
+
9V-24V
−
0V-5V DC
or
0V-5V 1kHz PWM

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