

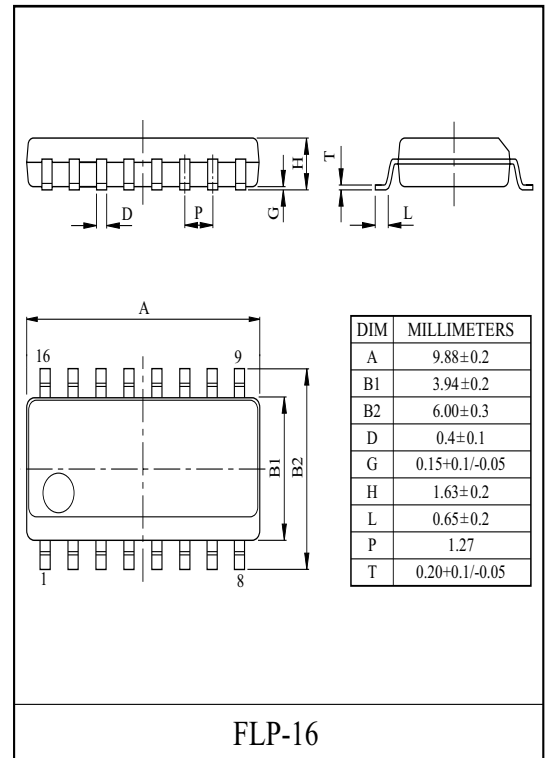
LCD BACKLIGHT INVERTER CONTROLLER

FEATURES

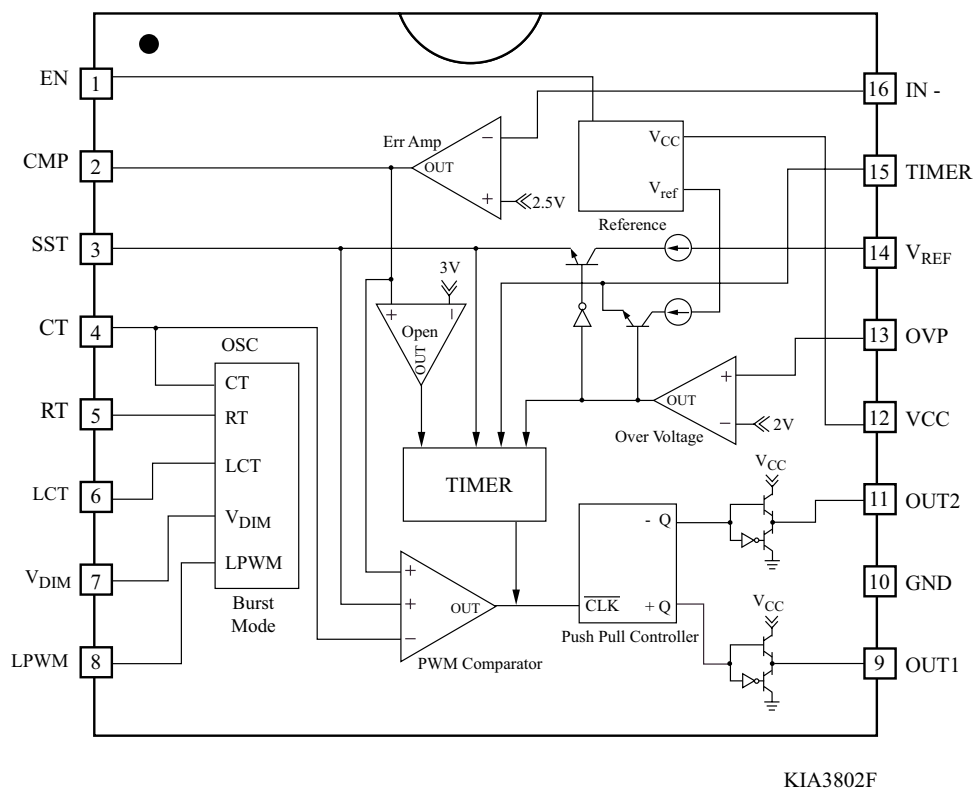
- Input voltage range of 7V to 20V
- Low cost, push-pull inverter topology
- Internal open lamp protection and over voltage detecting
- Built-in stand-by function
- Integrated with burst mode control, wide dimming range
- Soft-Start
- Timer function
- Reduces the number of components
- Supports multiple CCFLs

APPLICATION

- LCD Monitor
- Notebook Computer



BLOCK DIAGRAM



PIN DESCRIPTION

NO.	Symbol	I/O	Description
1	ENABLE	I	Enable input.
2	CMP	I	Compensation output of the error amplifier.
3	SST	I	Soft-start Capacitor.
4	CT	I	Timing capacitor.
5	RT	I	Timing resistor set operating frequency.
6	LCT	I	Triangular wave for burst-mode dimming; frequency.
7	V _{DIM}	I	Input analog signal for burst-mode dimming control.
8	LPWM	O	Low-frequency PWM signal for burst-mode dimming control.
9	OUT1	O	Output 1.
10	GND	I	Ground.
11	OUT2	O	Output 2.
12	V _{CC}	I	Voltage source for the IC.
13	OVP	I	Output voltage sense; V _{th} =2V.
14	V _{REF}	O	Reference voltage output ; 5V typical.
15	Timer	I	Capacitor for CCFL ignition duration.
16	IN-	I	Inverting input.

MAXIMUM RATING (Ta = 25 °C, unless otherwise noted.)

Rating	Symbol	Limits	Unit
Power Supply Voltage	V _{CC}	20	V
Power Dissipation(Ta=25 °C)	P _D	400	mW
Output Current	I _{O(MAX)}	50	mA
Operating Temp.	T _{opr}	-20 ~ 85	°C
Storage Temp.	T _{stg}	-55 ~ 150	°C

RECOMMENDED OPERATING CONDITIONS

Rating	Symbol	Limits	Unit
Power Supply Voltage	V _{CC}	7 ~ 20	V
Oscillation Frequency	f _{osc}	30 ~ 200	KHz
Timing Resister	RT	3 ~ 30	kΩ

ELECTRICAL CHARACTERISTICS

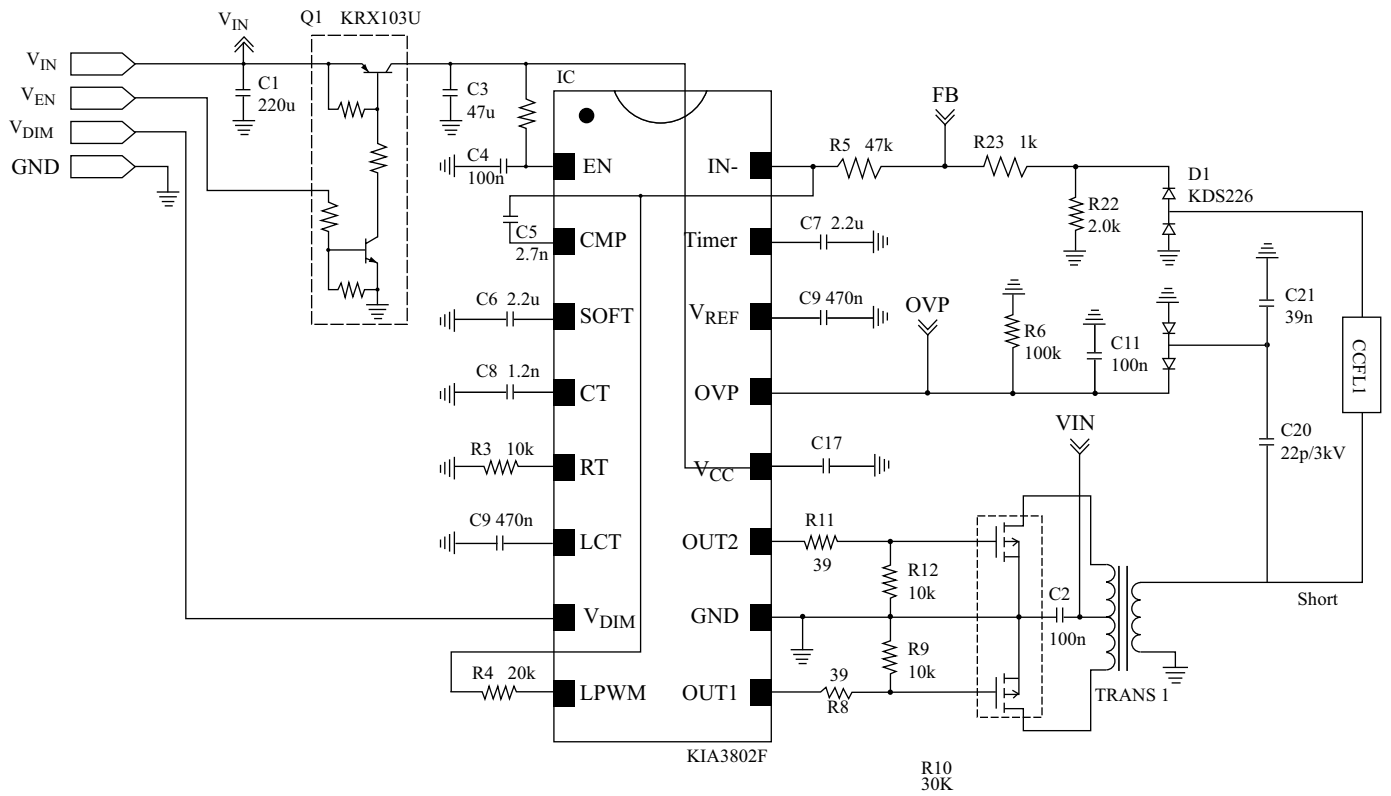
(V_{CC}=12V; V_{EN}=2.0V, Ta=25 °C, Unless otherwise noted.)

Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit
Reference Voltage						
Nominal Voltage	V _{REF}	I _{REF} = 1 mA	4.75	5.0	5.25	V
Line Regulation		V _{CC} =7V to 20V	-	2.0	25	mV
Load Regulation		I _{REF} = 1.0mA ~ 5mA	-	3.0	15	mV
High Frequency Oscillator⁽¹⁾						
Initial accuracy	f _{HOSC}	CT=1.2 nF, RT=10 kΩ	106	116	126	KHz
Ramp Peak			-	2.5	-	V
Ramp Vally			-	0	-	V
Low Frequency Oscillator						
Initial accuracy	f _{LOSC}	LCT = 470 nF	-	210	-	Hz
Ramp Peak			-	2.5	-	V
Ramp Vally			-	0.7	-	V
Low Frequency PWM						
Duty Cycle range	V _{DIML}		-	0.6	-	V
	V _{DIMH}		-	2.5	-	V
Error Amplifier⁽²⁾						
Input Voltage range			0	-	4.0	V
Open Loop Voltage Gain			-	80	-	dB
Unity gain Bandwidth		R _{CMP} =2 kΩ	-	1	-	MHz
Power Supply Rejection			-	60	-	dB
Threshold						
Enable	Output Off	V _{EN(OFF)}	0	-	0.5	V
	Output On	V _{EN(ON)}	2.0	-	5	
Open Lamp Protection	V _{CMP}	Output On -> Off	-	3	-	V
Over Voltage Protection	V _{OVP}	Output On -> Off	-	2	-	V
Supply						
Supply current	I _{CC(OFF)}	V _{EN} =0V	-	-	100	μA
Supply current	I _{CC(ON)}	V _{DIM} =0V	-	8	10	mA
Output						
Low State Output Voltage	V _{OL}	I _{O(SINK)} =1 mA	-	0.5	1.6	V
		I _{O(SINK)} =50mA	-	0.5	1.6	
High State Output Voltage	V _{OH}	I _{O(SOURCE)} =1mA	10	10.5	-	V
		I _{O(SOURCE)} =50mA	10	10.5	-	
Rise Time	t _r	C _{OUT} =2 nF	-	50	200	ns
Fall Time	t _f	C _{OUT} =2 nF	-	50	200	ns

Note 1 : The Lamp Oscillator Frequency is the half of the ramp wave Frequency.

Note 2 : Only Verified by Simulation. Not 100% tested.

APPLICATION CIRCUIT



Functional Description

1) Main Frequency (Lamp Operation Frequency)

A resistor R_T and a capacitor C_T determine the main frequency of IC. The main frequency can be calculated as below equation:

$$\text{Main } f \text{ [kHz]} = \frac{6.8 \times 10^2}{C_T[\text{nF}] \times R_T[\text{k}\Omega]}$$

2) Open Lamp Protection

Open lamp protection in the ignition time is provided through both OVP and TIMER pin to ensure a rated voltage is achieved and a required timing is satisfied.

If time that TIMER capacitor charges to 3V is long than the CCFL ignition time, it can prevent over-operating by protection circuit.

3) Error Amplifier

The CCFL current is regulated through the error amplifier. Error amplifier output (CMP) voltage and ramp wave (CT) make the PWM pulses. The non-inverting reference is at 2.5V nominal.

4) OVP

When the output voltage reaches the threshold, it commands the PWM controller to maintain the current driving level. This ensures that output gets sufficient striking voltage while operating the power transformer safely. The OVP threshold is set at 2V nominal.

5) On/Off Function

The Enable pin provides the function to turn on and off the output without shut down the supply voltage. The threshold of the Enable is set at 2.0V.

6) Soft-start

The soft-start function is provided with a capacitor connected to SST pin. It provides a rate of rise for the pulse width where switches are turned on. A 2.2 μF capacitor connected on the SST pin can set a 0.4 second period for striking the lamp.

7) Burst-mode Dimming

The burst-mode frequency is determined by a capacitor connected to LCT pin.

The frequency can be calculated by:

$$f \text{ [Hz]} = \frac{1 \times 10^6}{LCT[\text{nF}] \times RT[\text{k}\Omega]}$$

To compare the input of V_{DIM} pin with the ramp wave(LCT) makes the PWM pulses for Burst-mode Dimming. The LPWM pin is pulled to V_{REF} to make the dark portion of the CCFL output burst and the floating state to make the bright portion. A less than 0.6V input on V_{DIM} pin will obtain 100% brightness.

Transformer Design

1. Transformer Turns Ratio

Calculation of the required turns ratio involves the estimation of two

critical factors.

1). Estimating Minimum Primary Voltage.

The minimum primary voltage is obtained from the value of the low supply voltage.

2). Estimating Maximum Secondary Voltage.

The secondary is composed of a ballast capacitor, a voltage divide capacitor and the lamp parasitic capacitor.

The voltage across the ballast capacitor can be calculated as below equation:

$$V_{\text{Ballast C}} = X_{\text{Ballast}} \times I_{\text{Lamp}}$$

The maximum secondary voltage can be calculated as below equation:

$$V_{\text{secondary}} = \sqrt{V_{\text{Lamp}}^2 + V_{\text{Ballast C}}^2}$$

Transformer turns ratio is:

$$N = \frac{V_{\text{secondary}}}{V_{\text{primary}}}$$

2. Required Number of Secondary Turns

From the core constant provided by the core manufacturer, you will need the effective core cross sectional area(A_e).

From the Faraday's law, the required number of secondary turns would be:

$$N_{\text{secondary}} = \frac{V_{\text{secondary}} \cdot \Delta t_{\text{max}} \cdot 10^8}{\Delta B \cdot A_e}$$

3. Required Number of Primary Turns

From the turns ratio and number of secondary turns

$$N_{\text{primary}} = \frac{N_{\text{secondary}}}{N}$$

4. Determination of Wire Gauge

Wire gauge can be done by an acceptable current density.

From the assumed current density (500cmil) and the current that flows through wires, the required Circular Mils is:

$$C_{\text{mils}} = C_{\text{DLim}} \cdot I_{\text{RMS}}$$

From the AWG table, pick a wire-gauge that would fit limit.

Using the selected wire diameter and bobbin information, determine if this wire gauge will fit in the space allotted. (when the space factor[SF] is accounted for)