NCL30000

Power Factor Corrected Dimmable LED Driver

The NCL30000 is a switch mode power supply controller intended for low to medium power single stage power factor (PF) corrected LED Drivers. The device is designed to operate in critical conduction mode (CrM) and is suitable for flyback as well as buck topologies. Constant on time CrM operation is particularly suited for isolated flyback LED applications as the control scheme is straightforward and very high efficiency can be achieved even at low power levels. These are important in LED lighting to comply with regulatory requirements and meet overall system luminous efficacy requirements. In CrM, the switching frequency will vary with line and load and switching losses are low as recovery losses in the output rectifier are negligible since the current goes to zero prior to reactivating the main MOSFET switch.

The device features a programmable on time limiter, zero current detect sense block, gate driver, trans−conductance error amplifier as well as all PWM control circuitry and protection functions required to implement a CrM switch mode power supply. Moreover, for high efficiency, the device features low startup current enabling fast, low loss charging of the V_{CC} capacitor. The current sense protection threshold has been set at 500 mV to minimize power dissipation in the external sense resistor. To support the environmental operation range of Solid State Lighting, the device is specified across a wide junction temperature range of −40°C to 125°C.

Features

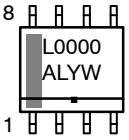
- Very Low 24 μA Typical Startup Current
- Constant On Time PWM Control
- Cycle−by−Cycle Current Protection
- Low Current Sense Threshold of 500 mV
- Low 2 mA Typical Operating Current
- Source 500 mA / Sink 800 mA Totem Pole Gate Driver
- Reference Design for TRIAC and Trailing Edge Line Dimmers
- Wide Operating Temperature Range
- No Input Voltage Sensing Requirement
- Enable Function and Overvoltage Protection
- These Devices are Pb−Free, Halogen Free/BFR Free and are RoHS Compliant

Typical Applications

- LED Driver Power Supplies
- LED Based Down Lights
- Commercial and Residential LED Fixtures
- TRIAC Dimmable LED Based PAR Lamps
- Power Factor Corrected Constant Voltage Supplies

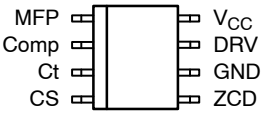
SOIC−8
D SUFFIX
CASE 751

MARKING DIAGRAM



A	= Assembly Location
L	= Wafer Lot
Y	= Year
W	= Work Week
▪	= Pb−Free Package

PIN CONNECTION



(Top View)

ORDERING INFORMATION

Device	Package	Shipping†
NCL30000DR2G	SOIC−8 (Pb−Free)	2500 / Tape & Reel

†For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D.

Table 2. MAXIMUM RATINGS

Rating	Symbol	Value	Unit
MFP Voltage	V_{MFP}	−0.3 to 10	V
MFP Current	I_{MFP}	±10	mA
COMP Voltage	$V_{Control}$	−0.3 to 6.5	V
COMP Current	$I_{Control}$	−2 to 10	mA
Ct Voltage	V_{Ct}	−0.3 to 6	V
Ct Current	I_{Ct}	±10	mA
CS Voltage	V_{CS}	−0.3 to 6	V
CS Current	I_{CS}	±10	mA
ZCD Voltage	V_{ZCD}	−0.3 to 10	V
ZCD Current	I_{ZCD}	±10	mA
DRV Voltage	V_{DRV}	−0.3 to V_{CC}	V
DRV Sink Current	$I_{DRV(sink)}$	800	mA
DRV Source Current	$I_{DRV(source)}$	500	mA
Supply Voltage	V_{CC}	−0.3 to 20	V
Supply Current	I_{CC}	±20	mA
Power Dissipation (T_A = 70°C, 2.0 Oz Cu, 55 mm^2 Printed Circuit Copper Clad)	P_D	450	mW
Thermal Resistance Junction−to−Ambient (2.0 Oz Cu, 55 mm^2 Printed Circuit Copper Clad) Junction−to−Air, Low conductivity PCB (Note 3) Junction−to−Air, High conductivity PCB (Note 4)	 $R_{\theta JA}$ $R_{\theta JA}$ $R_{\theta JA}$	 178 168 127	°C/W
Operating Junction Temperature Range	T_J	−40 to 125	°C
Maximum Junction Temperature	$T_{J(MAX)}$	150	°C
Storage Temperature Range	T_{STG}	−65 to 150	°C
Lead Temperature (Soldering, 10 s)	T_L	300	°C

Stresses exceeding Maximum Ratings may damage the device. Maximum Ratings are stress ratings only. Functional operation above the Recommended Operating Conditions is not implied. Extended exposure to stresses above the Recommended Operating Conditions may affect device reliability.

1. This device series contains ESD protection and exceeds the following tests:
   Pins 1− 8: Human Body Model 2000 V per JEDEC Standard JESD22−A114E.
   Machine Model Method 200 V per JEDEC Standard JESD22−A115−A.
2. This device contains Latch−Up protection and exceeds ± 100 mA per JEDEC Standard JESD78.
3. As mounted on a 40x40x1.5 mm FR4 substrate with a single layer of 80 mm^2 of 2 oz copper traces and heat spreading area. As specified for a JEDEC 51 low conductivity test PCB. Test conditions were under natural convection or zero air flow.
4. As mounted on a 40 x 40 x 1.5 mm FR4 substrate with a single layer of 650 mm^2 of 2 oz copper traces and heat spreading area. As specified for a JEDEC 51 high conductivity test PCB. Test conditions were under natural convection or zero air flow.

Table 3. ELECTRICAL CHARACTERISTICS

V_{MFP} = 2.4 V, $V_{Control}$ = 4 V, Ct = 1 nF, V_{CS} = 0 V, V_{ZCD} = 0 V, C_{DRV} = 1 nF, V_{CC} = 12 V, unless otherwise specified
(For typical values, T_J = 25°C. For min/max values, T_J = −40°C to 125°C, unless otherwise specified)

Characteristic	Test Conditions	Symbol	Min	Typ	Max	Unit
STARTUP AND SUPPLY CIRCUITS						
Startup Voltage Threshold	V_{CC} Increasing	$V_{CC(on)}$	11	12	12.5	V
Minimum Operating Voltage	V_{CC} Decreasing	$V_{CC(off)}$	8.8	9.5	10.2	V
Supply Voltage Hysteresis		H_{UVLO}	2.2	2.5	2.8	V
Startup Current Consumption	0 V < V_{CC} < $V_{CC(on)}$ − 200 mV	$I_{cc(startup)}$	−	24	35	μA
No Load Switching Current Consumption	C_{DRV} = open, 70 kHz Switching, V_{CS} = 2 V	I_{cc1}	−	1.4	1.7	mA
Switching Current Consumption	70 kHz Switching, V_{CS} = 2 V	I_{cc2}	−	2.1	2.6	mA
Fault Condition Current Consumption	No Switching, V_{MFP} = 0 V	$I_{cc(fault)}$	−	0.75	0.95	mA

Table 3. ELECTRICAL CHARACTERISTICS (Continued)
V_{MFP} = 2.4 V, $V_{Control}$ = 4 V, Ct = 1 nF, V_{CS} = 0 V, V_{ZCD} = 0 V, C_{DRV} = 1 nF, V_{CC} = 12 V, unless otherwise specified
(For typical values, T_J = 25°C. For min/max values, T_J = −40°C to 125°C, unless otherwise specified)

Characteristic	Test Conditions	Symbol	Min	Typ	Max	Unit
OVERVOLTAGE AND UNDERVOLTAGE PROTECTION						
Overvoltage Detect Threshold	V_{MFP} = Increasing	V_{OVP}/V_{REF}	105	106	108	%
Overvoltage Hysteresis		$V_{OVP(HYS)}$	20	60	100	mV
Overvoltage Detect Threshold Propagation Delay	V_{MFP} = 2 V to 3 V ramp, dV/dt = 1 V/μs V_{MFP} = V_{OVP} to V_{DRV} = 10%	t_{OVP}	–	500	800	ns
Undervoltage Detect Threshold	V_{MFP} = Decreasing	V_{UVP}	0.25	0.31	0.4	V
Undervoltage Detect Threshold Propagation Delay	V_{MFP} = 1 V to 0 V ramp, dV/dt = 10 V/μs V_{MFP} = V_{UVP} to V_{DRV} = 10%	t_{UVP}	100	200	300	ns
ERROR AMPLIFIER						
Voltage Reference	T_J = 25°C T_J = −40°C to 125°C	V_{REF}	2.475 2.460	2.500 2.500	2.525 2.540	V
Voltage Reference Line Regulation	$V_{CC(on)}$ + 200 mV < V_{CC} < 20 V	$V_{REF(line)}$	−10	–	10	mV
Error Amplifier Current Capability	V_{MFP} = 2.6 V V_{MFP} = 1.08*V_{REF} V_{MFP} = 0.5 V	$I_{EA(sink)}$ $I_{EA(sink)OVP}$ $I_{EA(source)}$	6 10 −110	10 20 −210	20 30 −250	μA
Transconductance	V_{MFP} = 2.4 V to 2.6 V T_J = 25°C T_J = −40°C to 125°C	gm	 90 70	 110 110	 120 135	μS
Feedback Pin Internal Pull−Down Resistor	V_{MFP} = V_{UVP} to V_{REF}	R_{MFP}	2	4.6	10	MΩ
Feedback Bias Current	V_{MFP} = 2.5 V	I_{MFP}	0.25	0.54	1.25	μA
Control Bias Current	V_{MFP} = 0 V	$I_{Control}$	−1	–	1	μA
Maximum Control Voltage	$I_{Control(pullup)}$ = 10 μA, V_{MFP} = V_{REF}	V_{EAH}	5	5.5	6	V
Minimum Control Voltage to Generate Drive Pulses	$V_{Control}$ = Decreasing until V_{DRV} is low, V_{Ct} = 0 V	$Ct_{(offset)}$	0.37	0.65	0.88	V
Control Voltage Range	V_{EAH} − $Ct_{(offset)}$	$V_{EA(DIFF)}$	4.5	4.9	5.3	V

Table 3. ELECTRICAL CHARACTERISTICS (Continued)
V_{MFP} = 2.4 V, $V_{Control}$ = 4 V, Ct = 1 nF, V_{CS} = 0 V, V_{ZCD} = 0 V, C_{DRV} = 1 nF, V_{CC} = 12 V, unless otherwise specified
(For typical values, T_J = 25°C. For min/max values, T_J = −40°C to 125°C, unless otherwise specified)

Characteristic	Test Conditions	Symbol	Min	Typ	Max	Unit
RAMP CONTROL						
Ct Peak Voltage	V_{COMP} = open	$V_{Ct(MAX)}$	4.775	4.93	5.025	V
On Time Capacitor Charge Current	V_{COMP} = open V_{Ct} = 0 V to $V_{Ct(MAX)}$	I_{charge}	235	275	297	μA
Ct Capacitor Discharge Duration	V_{COMP} = open V_{Ct} = $V_{Ct(MAX)}$ −100 mV to 500 mV	$t_{Ct(discharge)}$	–	50	150	ns
PWM Propagation Delay	dV/dt = 30 V/μs V_{Ct} = $V_{Control}$ − $Ct_{(offset)}$ to V_{DRV} = 10%	t_{PWM}	–	130	220	ns
ZERO CURRENT DETECTION						
ZCD Arming Threshold	V_{ZCD} = Increasing	$V_{ZCD(ARM)}$	1.25	1.4	1.55	V
ZCD Triggering Threshold	V_{ZCD} = Decreasing	$V_{ZCD(TRIG)}$	0.6	0.7	0.83	V
ZCD Hysteresis		$V_{ZCD(HYS)}$	500	700	900	mV
ZCD Bias Current	V_{ZCD} = 5 V	I_{ZCD}	− 2	–	+ 2	μA
Positive Clamp Voltage	I_{ZCD} = 3 mA	$V_{CL(POS)}$	9.8	10	12	V
Negative Clamp Voltage	I_{ZCD} = −2 mA	$V_{CL(NEG)}$	−0.9	−0.7	−0.5	V
ZCD Propagation Delay	V_{ZCD} = 2 V to 0 V ramp, dV/dt = 20 V/μs V_{ZCD} = $V_{ZCD(TRIG)}$ to V_{DRV} = 90%	t_{ZCD}	–	100	170	ns
Minimum ZCD Pulse Width		t_{SYNC}	–	70	–	ns
Maximum Off Time in Absence of ZCD Transition	Falling V_{DRV} = 10% to Rising V_{DRV} = 90%	t_{start}	75	165	300	μs
DRIVE						
Drive Resistance	I_{source} = 100 mA I_{sink} = 100 mA	R_{OH} R_{OL}	– –	12 6	20 13	Ω
Rise Time	10% to 90%	t_{rise}	–	35	80	ns
Fall Time	90% to 10%	t_{fall}	–	25	70	ns
Drive Low Voltage	V_{CC} = $V_{CC(on)}$−200 mV, I_{sink} = 10 mA	$V_{out(start)}$	–	–	0.2	V
CURRENT SENSE						
Current Sense Voltage Threshold		V_{ILIM}	0.45	0.5	0.55	V
Leading Edge Blanking Duration	V_{CS} = 2 V, V_{DRV} = 90% to 10%	t_{LEB}	100	195	350	ns
Overcurrent Detection Propagation Delay	dV/dt = 10 V/μs V_{CS} = V_{ILIM} to V_{DRV} = 10%	t_{CS}	40	100	170	ns
Current Sense Bias Current	V_{CS} = 2 V	I_{CS}	−1	–	1	μA