International
IOR Rectifier

ADVANCED INFORMATION Data Sheet No. PD60169A

IR2159

DIMMING BALLAST CONTROLLER IC

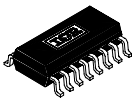
Features

- Ballast control and half-bridge driver in one IC
- Transformerless lamp power sensing
- Closed-loop lamp power control
- Closed loop preheat and ignition current control
- Programmable preheat time
- Programmable preheat current
- Programmable ignition-to-dim time
- 0.5 to 5VDC or 0 to 5VDC dimming control input
- Min and max lamp power adjustments
- Programmable deadtime
- Internal current sense blanking
- Full lamp fualt protection
- Automatic restart
- Micro-power startup
- Zener clamped Vcc
- Over-temperature protection
- 16-pin DIP and SOIC package types

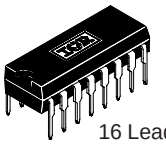
Description

The IR2159 is a complete dimming ballast controller and 600V half-bridge driver all in one IC. The architecture includes phase control for transformerless lamp power sensing and regulation which minimizes changes needed to adapt non-dimming ballast for dimming. Externally programmable features such as peheat time and curent, ignition-to-dim time, and a complete dimming interface with minimum and maximum settings provide a high degree of flexibility for the ballast design engineer. Protection from failure of a lamp to strike, filament failures, thermal overload, or lamp failure during normal operation, as well as an automatic restart function, have been included in a design. The heart of this control IC is a voltage controlled oscillator with externally programmable deadtime. The IR2159 is available in both 16 pin DIP and 16 pin narrow body SOIC packages.

Packages

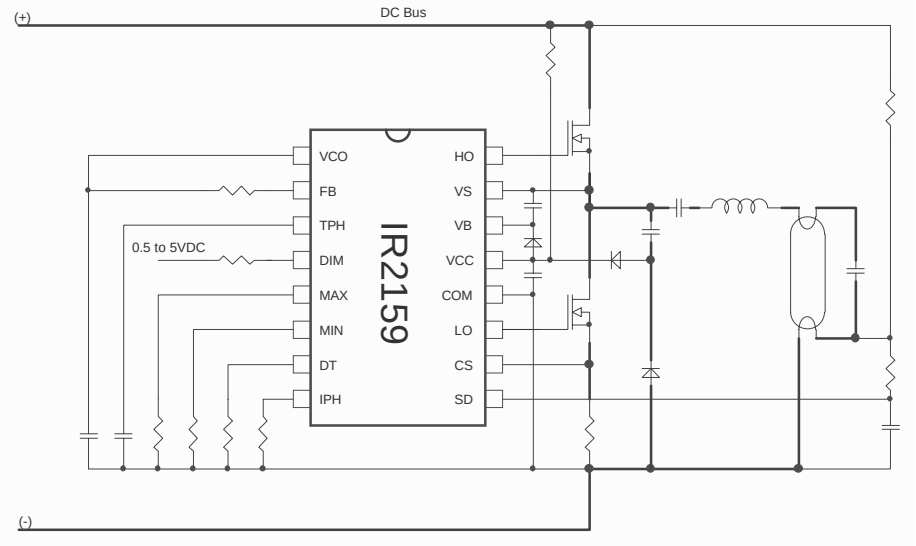


16 Lead SOIC
(narrow body)



16 Lead PDIP

Typical Connection



Absolute Maximum Ratings

Absolute maximum ratings indicate sustained limits beyond which damage to the device may occur. All voltage parameters are absolute voltages referenced to COM, all currents are defined positive into any lead. The thermal resistance and power dissipation ratings are measured under board mounted and still air conditions.

Symbol	Definition	Min.	Max.	Units
V_B	High side floating supply voltage	-0.3	625	V
V_S	High side floating supply offset voltage	V_B - 25	V_B + 25	
V_{HO}	High side floating output voltage	V_S - 0.3	V_B + 0.3	
V_{LO}	Low side output voltage	-0.3	V_{CC} + 0.3	
I_{OMAX}	Maximum allowable output current (either output) due to external power transistor miller effect	-500	500	mA
V_{VCO}	Voltage controlled oscillator input voltage	-0.3	5.0	V
I_{TPH}	TPH current	-5	5	mA
V_{IPH}	IPH voltage	0.3	5.5	V
V_{DIM}	Dimming control pin input voltage	0.3	5.5	
V_{MAX}	Maximum lamp power setting pin input voltage	0.3	5.5	
V_{MIN}	Minimum lamp power setting pin input voltage	-0.3	5.5	
V_{CS}	Current sense input voltage	-0.3	5.5	
I_{SD}	Shutdown pin current	-5	5	mA
I_{CC}	Supply current (note 1)	—	25	
dV/dt	Allowable offset voltage slew rate	-50	50	V/ns
P_D	Package power dissipation @ $T_A \leq +25°C$	—	TBD	W
Rth_{JA}	Thermal resistance, junction to ambient	—	TBD	°C/W
T_J	Junction temperature	-55	150	°C
T_S	Storage temperature	-55	150	
T_L	Lead temperature (soldering, 10 seconds)	—	300	

Note 1: This IC contains a zener clamp structure between the chip V_{CC} and COM which has a nominal breakdown voltage of 15.6V. Please note that this supply pin should not be driven by a DC, low impedance power source greater than the diode clamp voltage (V_{CLAMP}) as specified in the Electrical Characteristics section.

Recommended Operating Conditions

For proper operation the device should be used within the recommended conditions.

Symbol	Definition	Min.	Max.	Units
V_{BS}	High side floating supply voltage	V_{CC} - 0.7	V_{CLAMP}	V
V_S	Steady state high side floating supply offset voltage	-1	600	
V_{CC}	Supply voltage	V_{CCUV+}	V_{CLAMP}	
I_{CC}	Supply current	note 2	10	mA
V_{VCO}	V_{CO} pin voltage	1	5	V
V_{DIM}	Dim pin voltage	0	5	
V_{MAX}	MAX pin current (note 3)	-750	0	µA
V_{MIN}	MIN pin current	1	3	V
R_{DT}	Deadtime resistance	20.0	40.0	kΩ
I_{SD}	Shutdown lead current	-1	1	mA
I_{CS}	Current sense lead current	-1	1	
T_J	Junction temperature	-40	125	°C

Electrical Characteristics

V_{CC} = V_{BS} = V_{BIAS} = 15V +/- 0.25V, V_{CS} = 0.5V, V_{SD} = 0.0V, R_{DT} = 40k, C_{VCO} = 10 nF, V_{DIM} = 0.0V, R_{MAX} = 33k, R_{MIN} = 56k, V_{TPH} = 0.0V, C_L = 1000pF, T_A = 25°C unless otherwise specified.

Supply Characteristics						
Symbol	**Definition**	**Min.**	**Typ.**	**Max.**	**Units**	**Test Conditions**
V_{CCUV+}	V_{CC} supply undervoltage positive going threshold	—	12.5	—	V	
V_{CCHYS}	V_{CC} supply undervoltage lockout hysteresis	—	1.6	—		
I_{QCCUV}	UVLO mode quiescent current	—	150	—	µA	$V_{CC} < V_{CCUV-}$
I_{QCCFLT}	Fault-mode quiescent current	—	200	—		SD=5V, CS=2V, or Tj > T_{SD}
I_{QCC}	Quiescent V_{CC} supply current	—	TBD	—	mA	
I_{QCC50K}	V_{CC} supply current, f= 50kHz	—	4.5	—		
V_{CLAMP}	V_{CC} zener clamp voltage	—	15.6	—	V	I_{CC} = 10mA

Note 2: Enough current should be supplied into the VCC lead to keep the internal 15.6V zener clamp diode on this lead regulating its voltage.

Note 3: The MAX lead is a voltage-controlled current source. For optimum dim interface current miror performance, this current should be kept between 0 and 750µA.

Electrical Characteristics (cont.)

V_{CC} = V_{BS} = V_{BIAS} = 15V +/- 0.25V, V_{CS} = 0.5V, V_{SD} = 0.0V, R_{DT} = 40k, C_{VCO} = 10 nF, V_{DIM} = 0.0V, R_{MAX} = 33k, R_{MIN} = 56k, V_{TPH} = 0.0V, C_L = 1000pF, T_A = 25°C unless otherwise specified.

Floating Supply Characteristics

Symbol	Definition	Min.	Typ.	Max.	Units	Test Conditions
I_{QBS0}	Quiescent V_{BS} supply current	—	0	—	µA	V_{HO} = V_S
I_{QBS1}	Quiescent V_{BS} supply current	—	30	—		V_{HO} = V_B
V_{BSMIN}	Minimum required VBS voltage for proper HO functionality	—	4	5	V	
I_{LK}	Offset supply leakage current	—	—	50	µA	V_B = V_S = 600V

Oscillator I/O Characteristics

Symbol	Definition	Min.	Typ.	Max.	Units	Test Conditions
f_{VCO}	Voltage controlled oscillator frequency	—	20	—	kHz	V_{VCO} = 1V
		—	100	—		V_{VCO} = 5V
df/dVcc	Oscillator frequency voltage stability	—	TBD	—	%	V_{VCO} = TBD V_{CCUV+} < V_{CC} < 15V
df/dT	Oscillator frequency temperature stability	—	TBD	—	%	V_{VCO} = TBD -40°C < Tj < 125°C
d	Gate drive outputs duty cycle	—	50	—	%	V_{VCO} = TBD
V_{VCOFLT}	Fault-mode VCO pin voltage (UVLO, shutdown, over-current/temp.)	—	5		V	
IVCOPH	Preheat mode VCO pin discharge current		1.0		µA	VTPH < 4V
IVCOIG	Ignition mode VCO pin discharge current		1.0		µA	4V < VTPH < 5V
IVCOPK	Peak current control VCO pin charging current		60.0		µA	VCS > VCSTH
IVCODIM	Dim mode VCO pin discharge current		16.0		µA	
tdlo	LO output deadtime	—	2.0	—	µs	R_{DT} = 40K
toho	HO output deadtime	—	2.0	—		
dtd/dVcc	Deadtime voltage stability	—	TBD	—	%	V_{CCUV+} < V_{CC} < 15V
dtd/dT	Deadtime temperature stability	—	TBD	—	%	-40°C < Tj < 125°C

Gate Driver Output Characteristics

Symbol	Definition	Min.	Typ.	Max.	Units	Test Conditions
VOL	Low-Level Output Voltage	—	—	100	mV	
VOH	High-Level Output Voltage	—	—	100	mV	VBIAS - VO
tr	Turn-On Rise Time	—	—	150	ns	
tf	Turn-Off Fall Time	—	—	100	ns	

Electrical Characteristics (cont.)

V_{CC} = V_{BS} = V_{BIAS} = 15V +/- 0.25V, V_{CS} = 0.5V, V_{SD} = 0.0V, R_{DT} = 40k, C_{VCO} = 10 nF, V_{DIM} = 0.0V, R_{MAX} = 33k, R_{MIN} = 56k, V_{TPH} = 0.0V, C_L = 1000pF, T_A = 25°C unless otherwise specified.

Preheat Characteristics

Symbol	Definition	Min.	Typ.	Max.	Units	Test Conditions
ITPH	TPH pin charging current	---	1.0	---	µA	ITPH = 0.04/RDT
VTPHIGN	TPH pin ignition mode threshold voltage		4.0		V	
VTPHCLMP	TPH pin clamp voltage		7.6		V	
IIPH	IPH pin DC source current		25.0		µA	IIPH = 1/RDT
VCSTH	Peak preheat current regulation threshold (Programmable)	0.7		V		VCSTH = (IIPH) x (RIPH)

Ignition Characteristics

Symbol	Definition	Min.	Typ.	Max.	Units	Test Conditions
V_{CSTH}	Peak ignition current regulation threshold	—	1.6	—	V	4V < V_{TPH} < 5V

Protection Characteristics

Symbol	Definition	Min.	Typ.	Max.	Units	Test Conditions
V_{SDTH+}	Rising shutdown pin threshold voltage	—	3.0	—	V	
V_{SDHYS}	SD threshold hysteresis	—	150	—	mV	
$V_{SDCLAMP}$	SD pin clamp voltage	—	7.6	—	V	
V_{CSTH}	Peak over-current latch threshold voltage	—	1.6	—		
T_{SD} *	Thermal shutdown junction temperature	—	175	—	°C	

Phase Control

Symbol	Definition	Min.	Typ.	Max.	Units	Test Conditions
V_{CSTHZX}	Zero-crossing thresholdvoltage	—	0.0	—	V	
R_{DSFB}	FB pin on resistance (open drain)	—	125	—	Ω	

Dim Interface

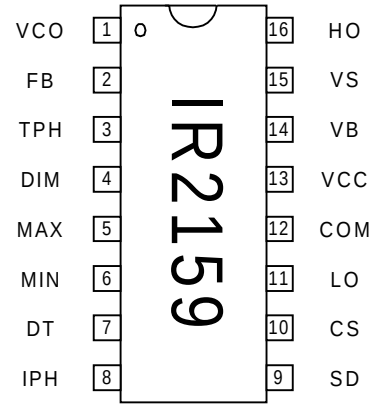
Symbol	Definition	Min.	Typ.	Max.	Units	Test Conditions
V_{DIMOFF}	DIM pin offset voltage	—	0.5	—		
V_{DIM}	DIM input voltage range	0.0	—	5.0		
V_{MIN}	DIM reference voltage range (MIN pin)	1.0	—	3.0		

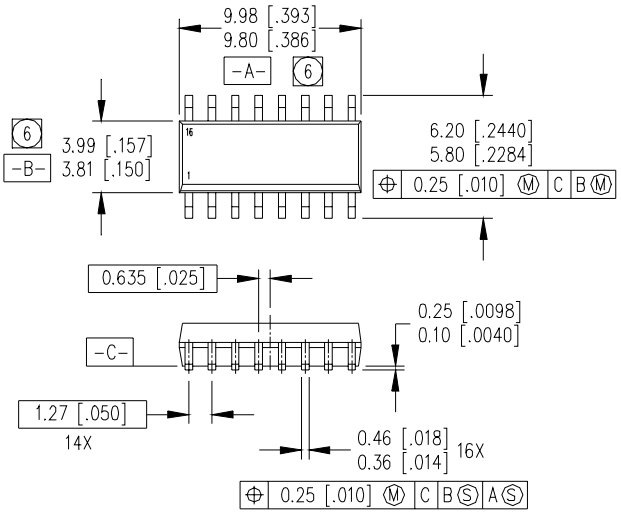
* When the IC senses an overtemperature condition (Tj > 125ºC), the chip is latched off. In order to reset this Latch, the supply to the IC must be cycled below the falling undervoltage lockout threshold, V_{CC-}, or the SD pin must be cycled.

Lead Assignments & Definitions

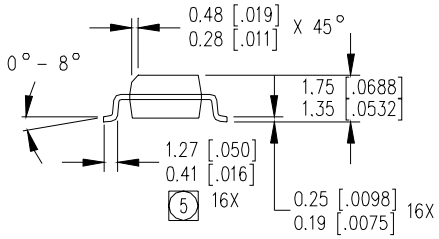
Lead #	Symbol	Description
1	V_{CO}	Voltage controlled oscillator input
2	FB	Feedback gain
3	T_{PH}	Preheat timing input
4	DIM	0.5 to 5VDC dimming control input
5	MAX	Maximum lamp power setting
6	MIN	Minimum lamp power setting
7	D_T	Deadtime programming
8	IPH	Peak preheat current reference
9	SD	Shutdown input
10	CS	Current sensing input
11	LO	Low-side gate driver output
12	COM	IC Power & signal ground
13	V_{CC}	Logic & low-side gate driver supply
14	V_B	High-side gate driver floating supply
15	V_S	High voltage floating return
16	HO	High-side gate driver output

Pin Assignments





NOTES:
1. DIMENSIONING & TOLERANCING PER ANSI Y14.5M-1982.
2. CONTROLLING DIMENSION: MILLIMETER
3. DIMENSIONS ARE SHOWN IN MILLIMETERS [INCHES].
4. OUTLINE CONFORMS TO JEDEC OUTLINE MS-012AC.
5. DIMENSION IS THE LENGTH OF LEAD FOR SOLDERING TO A SUBSTRATE.
6. DIMENSION DOES NOT INCLUDE MOLD PROTUSIONS. MOLD PROTUSIONS SHALL NOT EXCEED 0.15 [.006].



16 Lead SOIC (narrow body)

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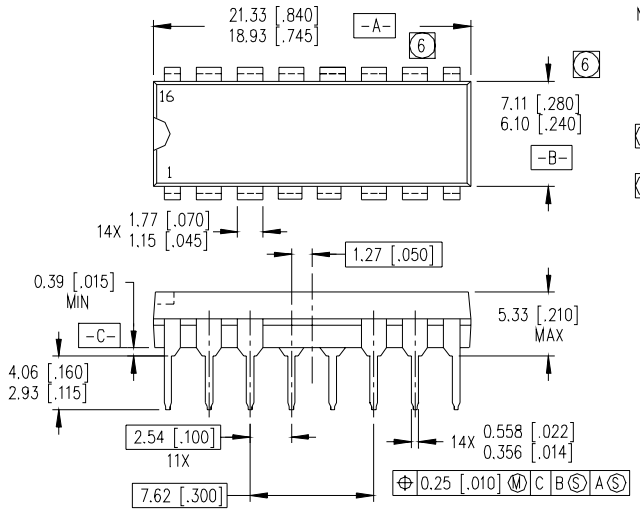
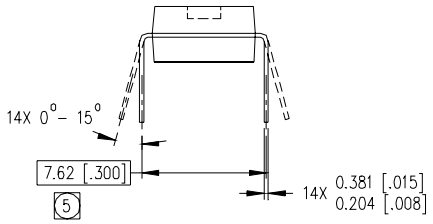
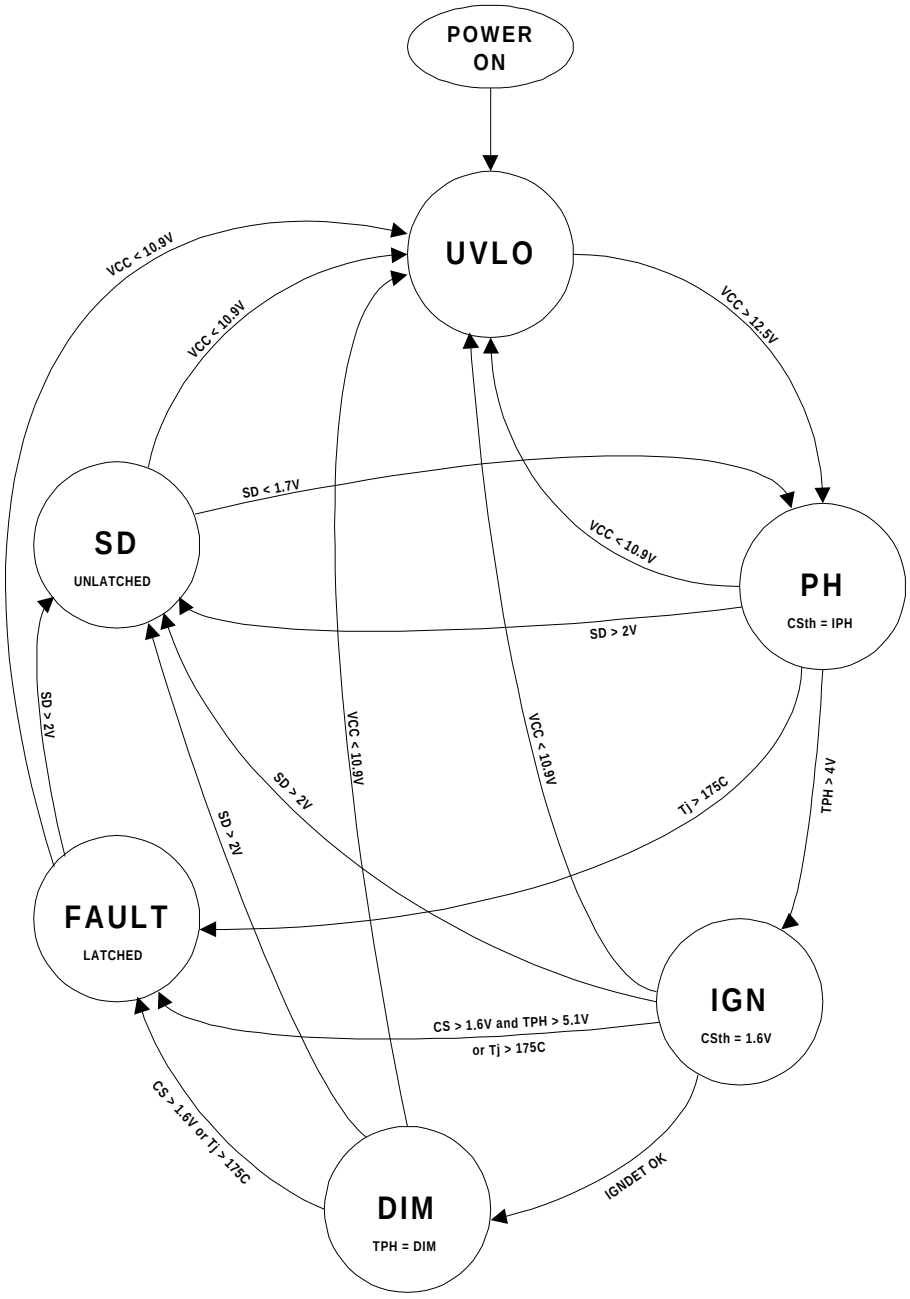


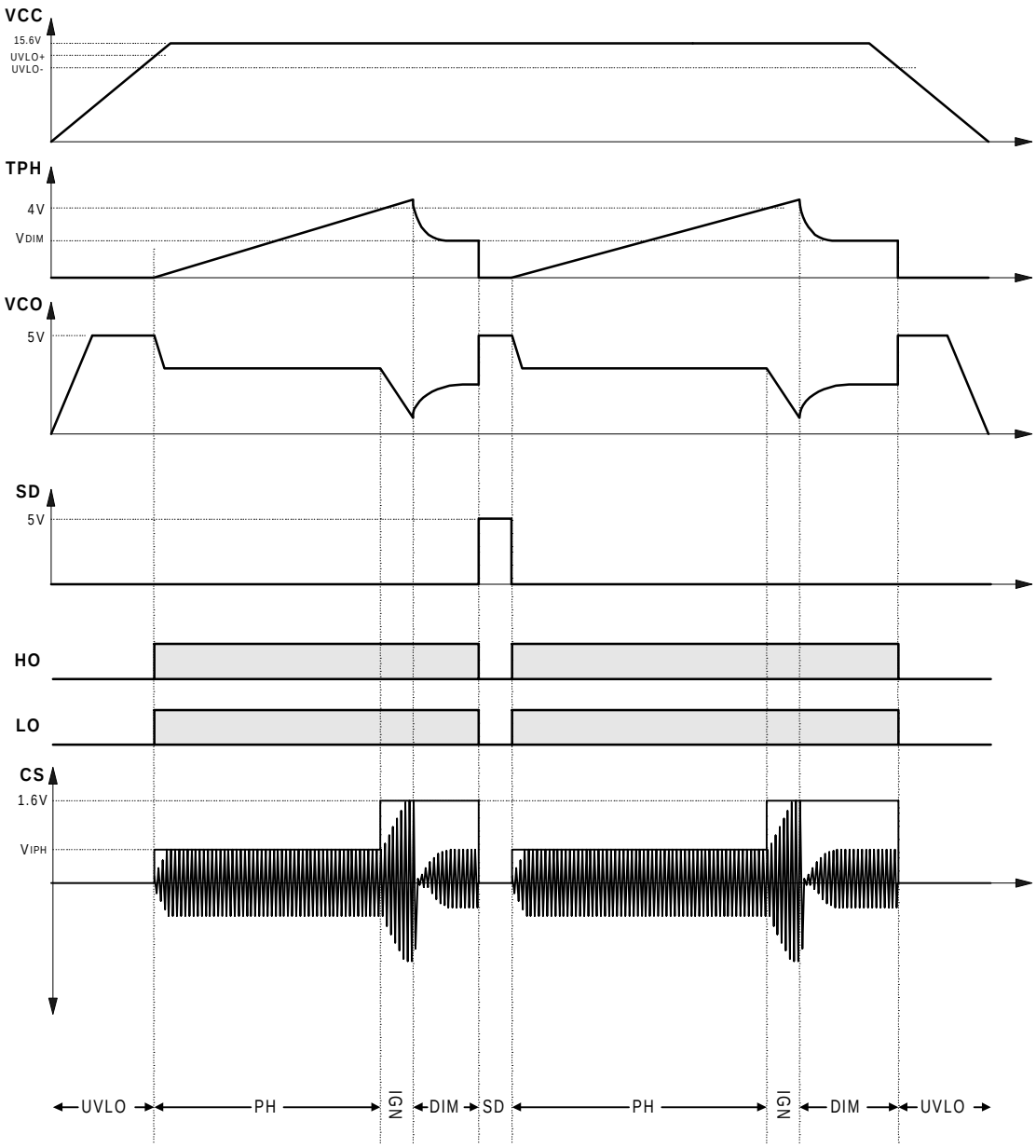
NOTES:

1. DIMENSIONING & TOLERANCING PER ANSI Y14.5M-1982.
2. CONTROLLING DIMENSION: INCH.
3. DIMENSIONS ARE SHOWN IN MILLIMETERS [INCHES].
4. OUTLINE CONFORMS TO JEDEC OUTLINE MS-001AA.
5. MEASURED WITH THE LEADS CONSTRAINED TO BE PERPENDICULAR TO DATUM PLANE C.
6. DIMENSION DOES NOT INCLUDE MOLD PROTUSIONS. MOLD PROTUSIONS SHALL NOT EXCEED 0.25 [.010].



16 Lead PDIP


POWER ON
UVLO
VCC < 10.9V
VCC < 10.9V
VCC > 12.5V
SD < 1.7V
SD
UNLATCHED
PH
CSth = IPH
VCC < 10.9V
SD > 2V
SD > 2V
VCC < 10.9V
VCC < 10.9V
SD > 2V
SD > 2V
Tj > 175C
TPH > 4V
FAULT
LATCHED
IGN
CSth = 1.6V
CS > 1.6V and TPH > 5.1V
or Tj > 175C
CS > 1.6V or Tj > 175C
IGNDET OK
DIM
TPH = DIM


VCC
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UVLO+
UVLO-
TPH
4V
VDIM
VCO
5V
SD
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UVLO
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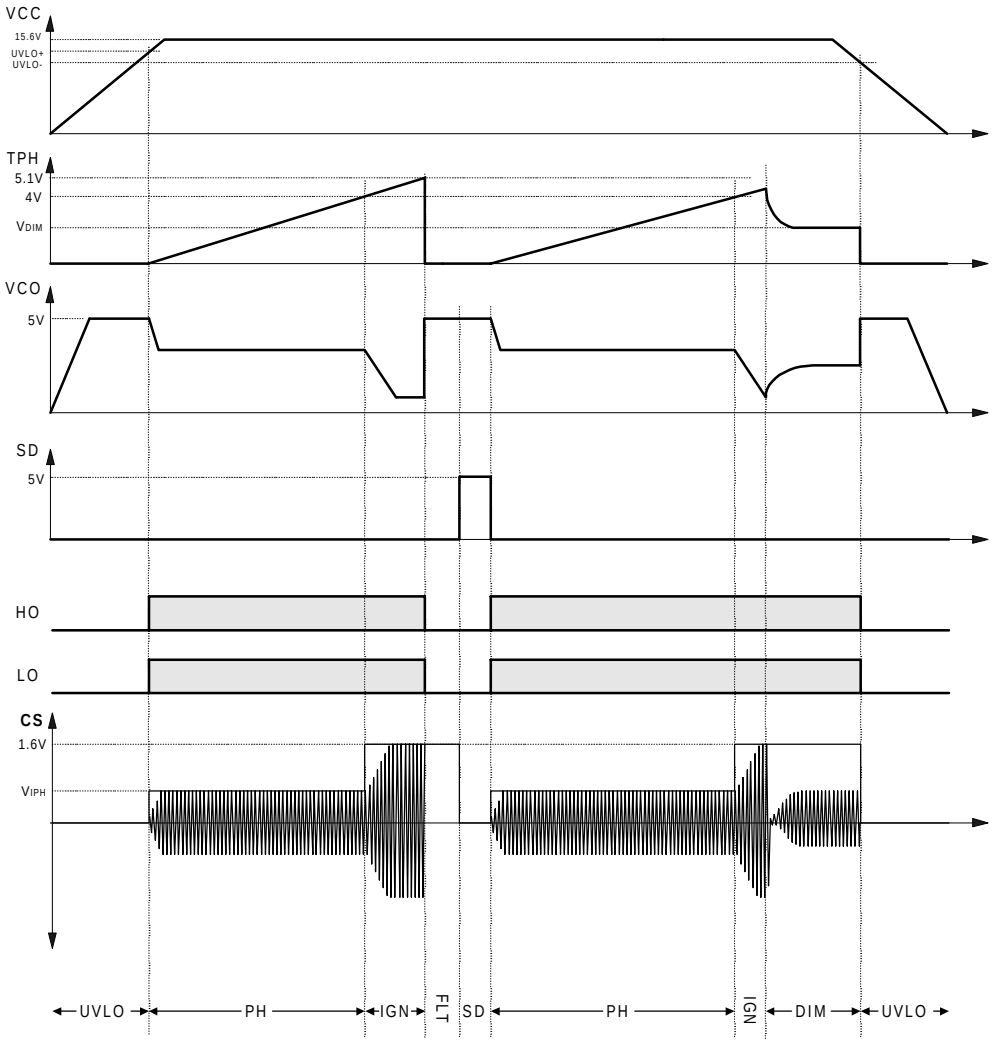
IGN
DIM
SD
PH
IGN
DIM
UVLO



WORLD HEADQUARTERS: 233 Kansas St., El Segundo, California 90245 Tel: (310) 322 3331
IR GREAT BRITAIN: Hurst Green, Oxted, Surrey RH8 9BB, UK Tel: ++ 44 1883 732020
IR CANADA: 15 Lincoln Court, Brampton, Ontario L6T 3Z2 Tel: (905) 453-2200
IR GERMANY: Saalburgstrasse 157, 61350 Bad Homburg Tel: ++ 49 6172 96590
IR ITALY: Via Liguria 49, 10071 Borgaro, Torino Tel: ++ 39 11 451 0111
IR FAR EAST: K&H Bldg., 2F, 30-4 Nishi-Ikebukuro 3-Chome, Toshima-Ku, Tokyo, Japan 171 Tel: 81 3 3983 0086
IR SOUTHEAST ASIA: 1 Kim Seng Promenade, Great World City West Tower, 13-11, Singapore 237994 Tel: 65 838 4630
IR TAIWAN: 16 Fl. Suite D..207, Sec.2, Tun Haw South Road, Taipei, 10673, Taiwan Tel: 886-2-2377-9936