

CLASS D AUDIO DRIVER

Features

- Hi-side and Lo-side independent floating PWM input
- Programmable bidirectional over-current detection with self-reset function
- Over current sensing output
- Shoot-through prevention logic
- High noise immunity
- ± 100 V ratings deliver up to 500 W in output power
- 3.3 V / 5 V logic compatible input
- Operates up to 800 kHz

Product Summary

V _{OFFSET} (max)		± 100 V
Gate driver	Io+	2.0 A
	Io-	2.0 A
Propagation delay		120 ns
OC protection delay (max)		500 ns
Shutdown delay (max)		250 ns

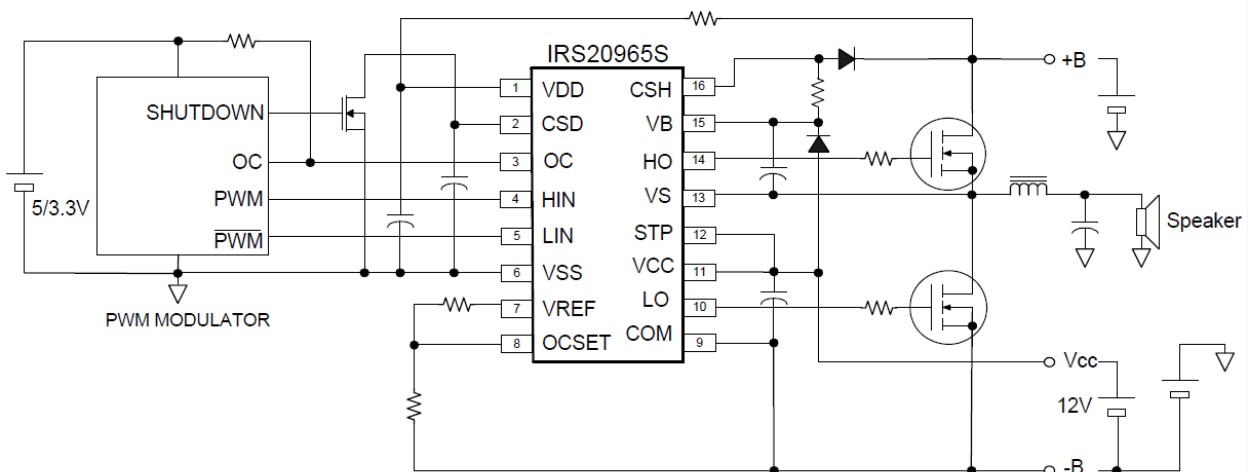
Typical Applications

- Class D audio amplifier
- Half bridge converter with digital controller

Package Options



Typical Connection Diagram



(Please refer to Lead Assignments for correct pin configuration. This diagram shows electrical connections only.)

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Description

The IRS20965S is a high voltage, high speed MOSFET driver with floating PWM inputs designed for Class D audio amplifier applications.

Bi-directional current sensing using $R_{DS(ON)}$ of the MOSFETs detects over current conditions during positive and negative load currents without any external shunt resistors. An over current flag output provides over current status without shutting down, enabling full external control over OCP protection sequences.

Independent HIN and LIN inputs offers independent control on HO and LO. Internal shoot-thru prevention logic provides safe operation by eliminating simultaneous ON state in the output MOSFET.

Qualification Information[†]

Qualification Level		Industrial ^{††}	
		Comments: This family of ICs has passed JEDEC's Industrial qualification. IR's Consumer qualification level is granted by extension of the higher Industrial level.	
Moisture Sensitivity Level		SOIC16N	MSL2 ^{†††} 260°C (per IPC/JEDEC J-STD-020)
ESD	Machine Model	Class B (per JEDEC standard EIA/JESD22-A115)	
	Human Body Model	Class 2 (per EIA/JEDEC standard JESD22-A114)	
IC Latch-Up Test		Class I, Level A (per JESD78D)	
RoHS Compliant		Yes	

† Qualification standards can be found at International Rectifier's web site <http://www.irf.com/>

†† Higher qualification ratings may be available should the user have such requirements. Please contact your International Rectifier sales representative for further information.

††† Higher MSL ratings may be available for the specific package types listed here. Please contact your International Rectifier sales representative for further information.

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 V_{SS} ; 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	215	V
V_S	High side floating supply voltage †	$V_B - 20$	$V_B + 0.3$	
V_{HO}	High side floating output voltage	$V_S - 0.3$	$V_B + 0.3$	
V_{CSH}	CSH pin input voltage	$V_S - 0.3$	$V_B + 0.3$	
V_{CC}	Low side fixed supply voltage †	-0.3	20	
V_{LO}	Low side output voltage	-0.3	$V_{CC} + 0.3$	
V_{DD}	Floating input supply voltage	-0.3	210	
V_{SS}	Floating input supply voltage †	(See I_{DDZ})	$V_{DD} + 0.3$	
V_{HIN}	PWM input voltage	$V_{SS} - 0.3$	$V_{DD} + 0.3$	
V_{LIN}	PWM input voltage	$V_{SS} - 0.3$	$V_{DD} + 0.3$	
V_{CSD}	CSD pin input voltage	$V_{SS} - 0.3$	$V_{DD} + 0.3$	
V_{OC}	OC pin input voltage	$V_{SS} - 0.3$	$V_{DD} + 0.3$	
V_{OCSET}	OCSET pin input voltage	-0.3	$V_{CC} + 0.3$	
V_{REF}	VREF pin voltage	-0.3	$V_{CC} + 0.3$	
I_{DDZ}	Floating input supply zener clamp current †	-	10	mA
I_{CCZ}	Low side supply zener clamp current †	-	10	
I_{BSZ}	Floating supply zener clamp current †	-	10	
I_{OREF}	Reference output current	-	5	V/ns
dVs/dt	Allowable Vs voltage slew rate	-	50	
dVss/dt	Allowable Vss voltage slew rate ††	-	50	
dVss/dt	Allowable Vss voltage slew rate upon power-up †††	-	50	V/ms
Pd	Maximum power dissipation	-	1.0	W
RthJA	Thermal resistance, Junction to ambient	-	115	°C/W
TJ	Junction Temperature	-	150	°C
TS	Storage Temperature	-55	150	
TL	Lead temperature (Soldering, 10 seconds)	-	300	

† $V_{DD} - V_{SS}$, $V_{CC} - COM$, and $V_B - V_S$ contain internal shunt zener diodes. Please note that the voltage ratings of these can be limited by the clamping current.

†† For the rising and falling edges of step signal of 10V. $V_{SS} = 15V$ to 200V.

††† V_{SS} ramps up from 0V to 200V.

Recommended Operating Conditions

For proper operation, the device should be used within the recommended conditions below. The V_S and COM offset ratings are tested with supplies biased at $I_{DD} = 3\text{mA}$, $V_{CC} = 12\text{V}$ and $V_B - V_S = 12\text{V}$.

Symbol	Definition	Min.	Max.	Units
V_B	High side floating supply absolute voltage	V_S+10	V_S+14	V
V_S	High side floating supply offset voltage	†	200	
I_{DDZ}	Floating input supply zener clamp current	1	5	mA
V_{OC}	OC pin input voltage	V_{SS}	V_{DD}	V
V_{SS}	Floating input supply absolute voltage	0	100	
V_{HO}	High side floating output voltage	V_S	V_B	
V_{CC}	Low side fixed supply voltage	10	15	
V_{LO}	Low side output voltage	0	V_{CC}	
V_{HIN}	HIN PWM input voltage	V_{SS}	V_{DD}	
V_{LIN}	LIN PWM input voltage	V_{SS}	V_{DD}	
V_{CSD}	CSD pin input voltage	V_{SS}	V_{DD}	
I_{OREF}	Reference output current to COM ††	0.3	0.8	
V_{OCSET}	OCSET pin input voltage	0.5	5	V
T_A	Ambient Temperature	-40	125	°C

† Logic operational for V_S equal to -5V to +200V. Logic state held for V_S equal to -5V to $-V_{BS}$.

†† Nominal voltage for V_{REF} is 5V. I_{OREF} of 0.3 – 0.8 mA dictates total external resistor value on V_{REF} to be 6.3k to 16.7k Ω .

Electrical Characteristics
 $V_{CC}, V_{BS} = 12\text{ V}, I_{DD} = 3\text{ mA}, V_{SS} = 20\text{ V}, C_L = 1\text{ nF}, STP = V_{CC}$ and $T_A = 25^\circ\text{C}$ unless otherwise specified.

Symbol	Definition	Min	Typ	Max	Units	Test Conditions
Low Side Supply						
UV_{CC+}	Vcc supply UVLO positive threshold	8.4	8.9	9.4	V	
UV_{CC-}	Vcc supply UVLO negative threshold	8.2	8.7	9.2	V	
I_{QCC}	Low side quiescent current	-	-	1	mA	$V_{DT} = V_{CC}$
V_{CLAMPL}	Low side zener diode clamp voltage	19.6	20.4	21.6	V	$I_{CC} = 5\text{ mA}$
High Side Floating Supply						
UV_{BS+}	High side well UVLO positive threshold	8.0	8.5	9.0	V	
UV_{BS-}	High side well UVLO negative threshold	7.8	8.3	8.8	V	
I_{QBS}	High side quiescent current	-	-	1	mA	
I_{LKH}	High to Low side leakage current	-	-	50	μA	$V_B = V_S = 200\text{ V}$
V_{CLAMPH}	High side zener diode clamp voltage	14.7	15.3	16.2	V	$I_{BS} = 5\text{ mA}$
Floating Input Supply						
UV_{DD+}	V_{DD}, V_{SS} floating supply UVLO positive threshold	8.2	8.7	9.2	V	$V_{SS} = 0\text{ V}$
UV_{DD-}	V_{DD}, V_{SS} floating supply UVLO negative threshold	7.7	8.2	8.7	V	$V_{SS} = 0\text{ V}$
I_{QDD}	Floating Input quiescent current	-	-	1	mA	$V_{DD} = 9.5\text{ V} + V_{SS}$
V_{CLAMPM}	Floating Input zener diode clamp voltage	9.8	10.2	10.8	V	$I_{DD} = 5\text{ mA}$
I_{LKM}	Floating input side to Low side leakage current	-	-	50	μA	$V_{DD} = V_{SS} = 200\text{ V}$
Floating PWM Input						
V_{IH}	Logic "1" input threshold voltage	2.3	1.9	-	V	
V_{IL}	Logic "0" input threshold voltage	-	1.9	1.5	V	
I_{IN+}	Logic "1" input bias current	-	-	40	μA	$V_{IN} = 3.3\text{ V}$
I_{IN-}	Logic "0" input bias current	-	-	1	μA	$V_{IN} = V_{SS}$

Electrical Characteristics (cont'd)
 $V_{CC}, V_{BS} = 12\text{ V}$, $I_{DD} = 3\text{ mA}$, $V_{SS} = 20\text{ V}$, $C_L = 1\text{ nF}$, $STP = V_{CC}$ and $T_A = 25^\circ\text{C}$ unless otherwise specified.

Protection						
V_{REF}	Reference output voltage	4.8	5.1	5.4	V	$I_{OREF} = 0.5\text{ mA}$
$V_{th_{OCL}}$	Low side OC threshold in V_S	1.1	1.2	1.3	V	OCSET=1.2V
$V_{th_{OCH}}$	High side OC threshold in V_{CSH}	1.1+ V_S	1.2+ V_S	1.3+ V_S	V	
V_{th1}	CSD pin shutdown release threshold	$0.62 \times V_{DD}$	$0.70 \times V_{DD}$	$0.78 \times V_{DD}$	V	$V_{SS} = 0\text{ V}$
V_{th2}	CSD pin self reset threshold	$0.26 \times V_{DD}$	$0.30 \times V_{DD}$	$0.34 \times V_{DD}$	V	$V_{SS} = 0\text{ V}$
I_{CSD+}	CSD pin charge current	70	100	130	μA	$V_{SD} = V_{SS} + 5\text{ V}$
I_{CSD-}	CSD pin discharge current	70	100	130	μA	$V_{SD} = V_{SS} + 5\text{ V}$
I_{OCC}	OC output sink current	10	-	-	mA	$V_{oc} = 1\text{ V}$
		1	-	-	mA	$V_{oc} = 0.1\text{ V}$
t_{OCL}	Propagation delay time from $V_S > V_{th_{OCL}}$ to Shutdown	-	-	500	ns	
t_{OCH}	Propagation delay time from $V_{CSH} > V_{th_{OCH}}$ to Shutdown	-	-	500	ns	
PW_{OC}	OC output minimum pulse width	1	-	-	μs	
Gate Driver						
I_{o+}	Output high short circuit current (Source)		2.0	-	A	$V_o = 0\text{ V}$, $PW \leq 10\mu\text{S}$
I_{o-}	Output low short circuit current (Sink)		2.0	-	A	$V_o = 12\text{ V}$, $PW \leq 10\mu\text{S}$
V_{OL}	Low level output voltage LO – COM, HO - V_S	-	-	0.1	V	
V_{OH}	High level output voltage $V_{CC} - \text{LO}$, $V_B - \text{HO}$	-	-	1.4	V	$I_o = 0\text{ A}$
t_r	Turn-on rise time	-	15	-	ns	
t_f	Turn-off fall time	-	15	-	ns	
t_{on_1}	High and low side turn-on propagation delay, floating inputs	-	120	-	ns	$V_S = 100\text{ V}$, $V_{SS} = 100\text{ V}$
t_{off_1}	High and low side turn-off propagation delay, floating inputs	-	120	-	ns	
t_{on_2}	High and low side turn-on propagation delay, non-floating inputs	-	130	-	ns	
t_{off_2}	High and low side turn-off propagation delay, non-floating inputs	-	130	-	ns	
DT	Intrinsic dead-time: LO turn-off to HO turn-on (DT_{LO-HO}) & HO turn-off to LO turn-on (DT_{HO-LO})	0	10	20	ns	
PWmin	Minimum pulse width for outputs to respond. Positive or Negative.	-	25	-	ns	$V_S = \text{COM}$ $V_{SS} = \text{COM}$
OWmin	Allowable LO/HO over wrap	10	-	-	ns	

Waveform Definitions

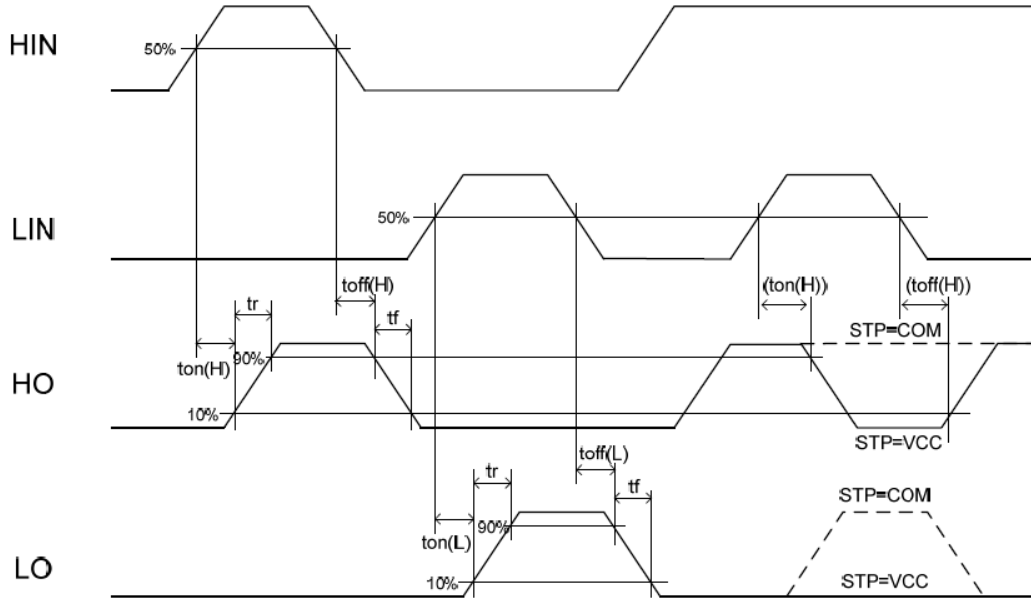


Figure 1: Timing Diagram

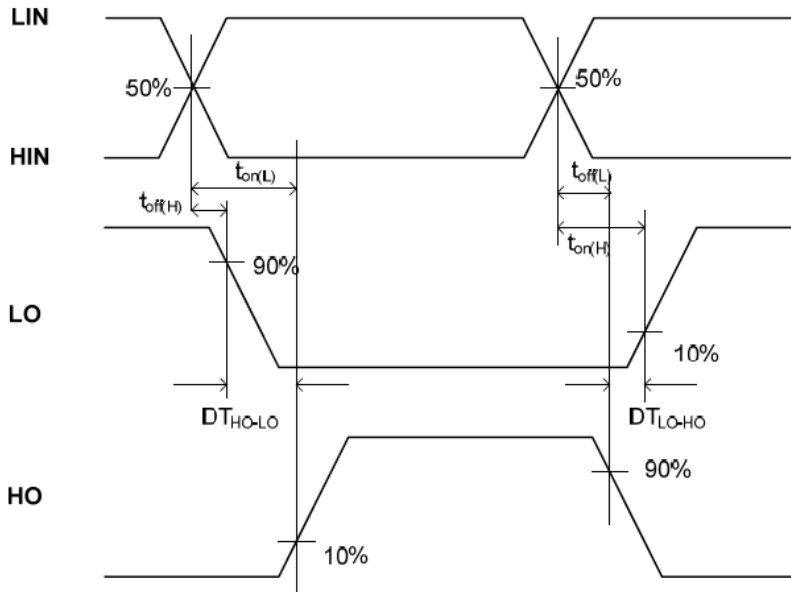


Figure 2: Deadtime Waveform Definitions

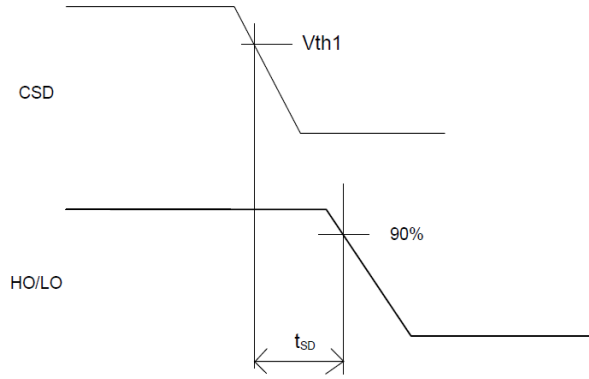


Figure 3: CSD to Shutdown Waveform Definitions

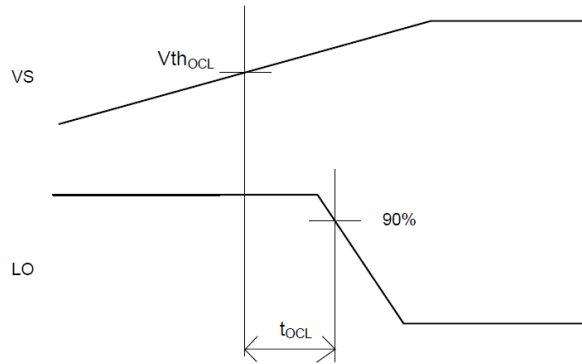


Figure 4: $V_S > V_{th_{OCL}}$ to Shutdown Waveform

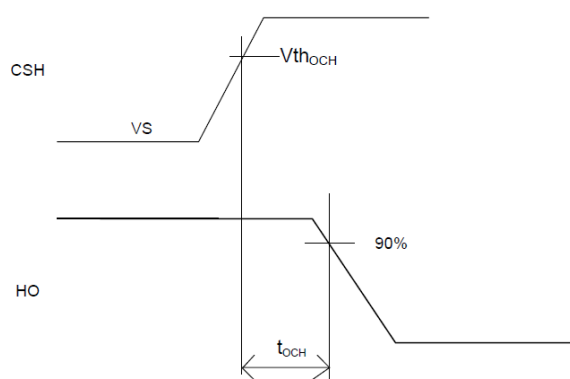
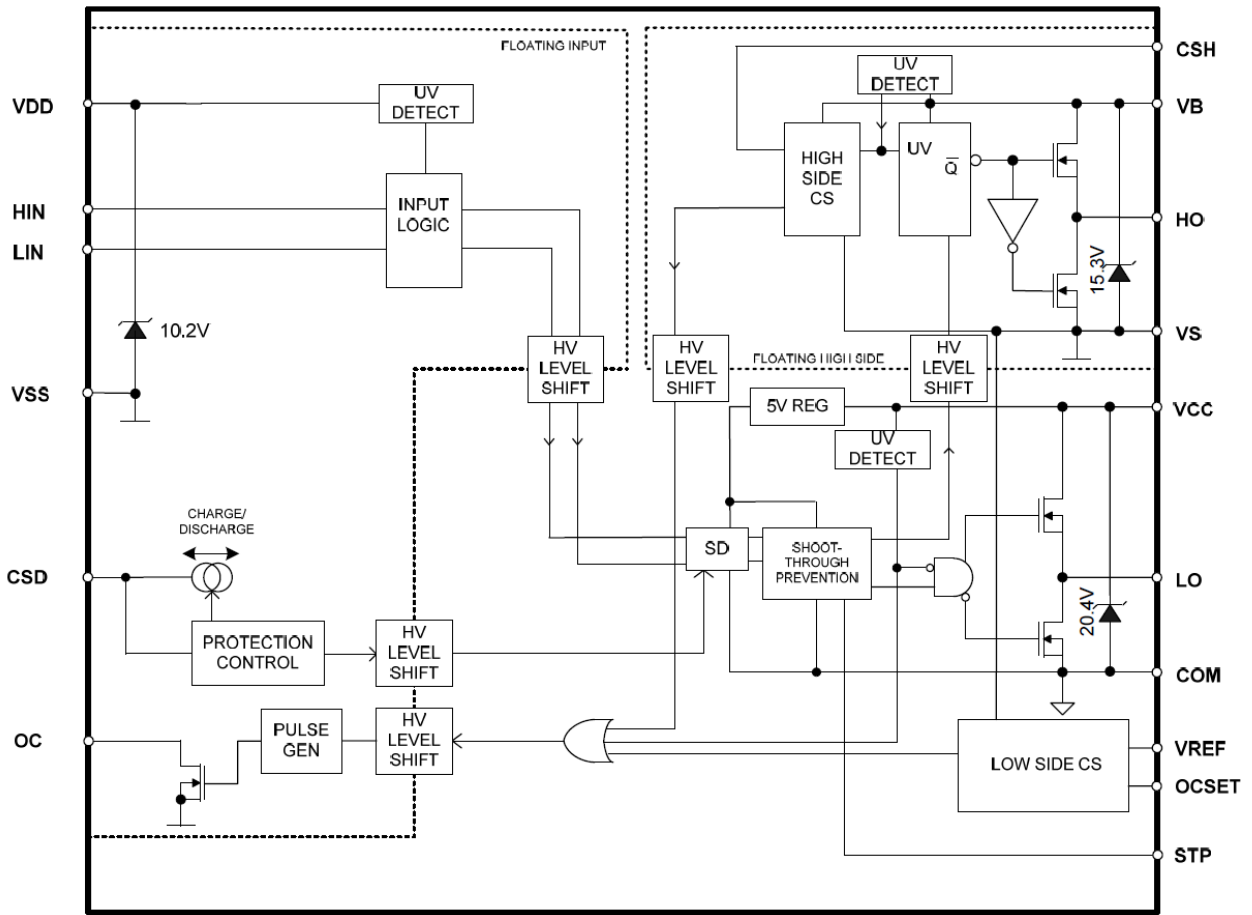
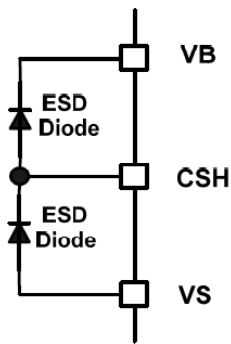
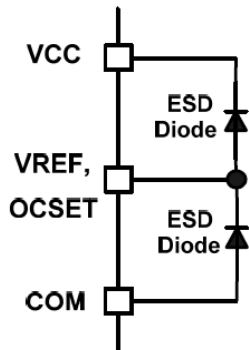
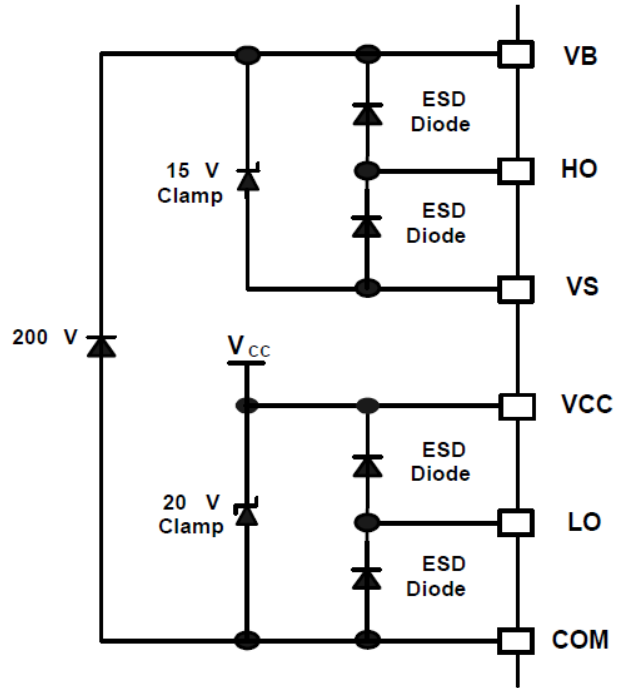
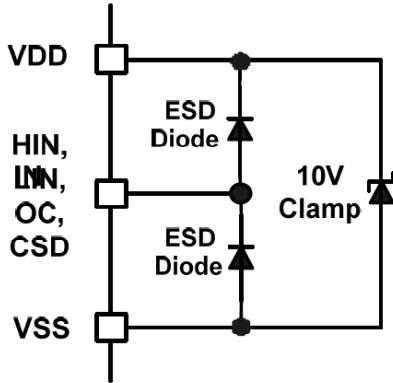


Figure 5: $V_{CSH} > V_{th_{OCH}}$ to Shutdown Waveform

Functional Block Diagram



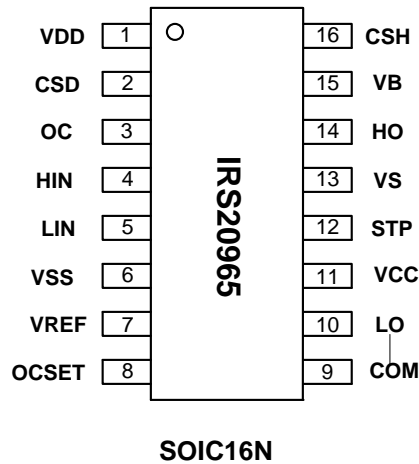
Input/Output Pin Equivalent Circuit Diagrams:



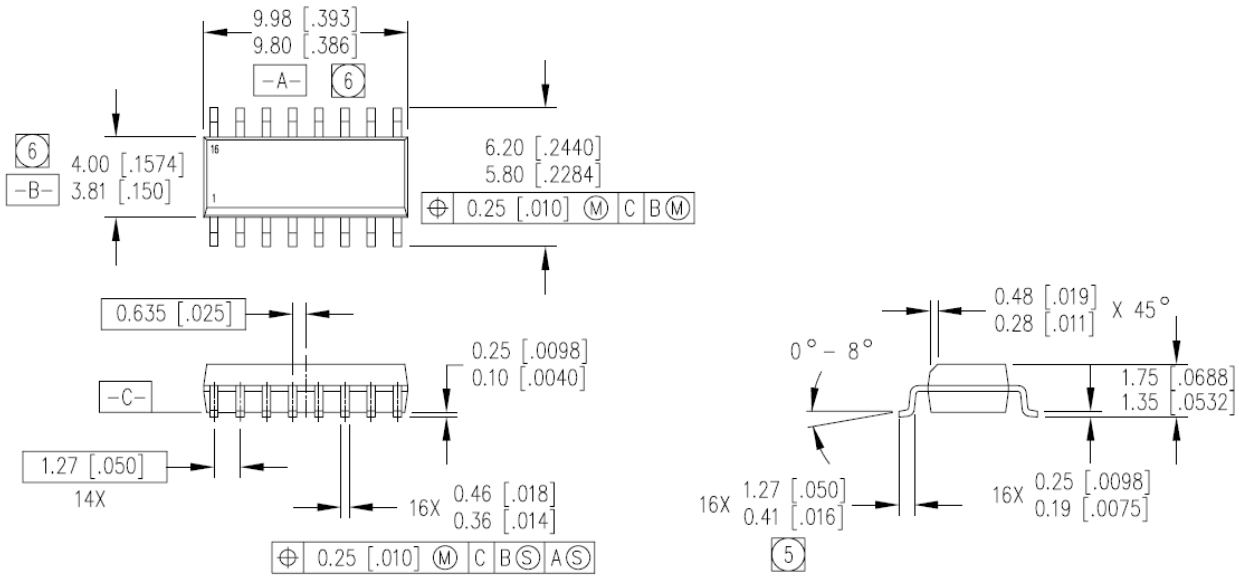
Lead Definitions

Pin #	Symbol	Description
1	VDD	Floating input positive supply
2	CSD	Shutdown timing capacitor, referenced to VSS
3	OC	Over current warning output, open drain referenced to VSS
4	HIN	PWM input, in phase with HO, referenced to VSS
5	LIN	PWM input, in phase with LO, referenced to VSS
6	VSS	Floating input supply return
7	VREF	5V reference output for setting OCSET, reference to COM
8	OCSET	Low side over current threshold setting, referenced to COM
9	COM	Low side supply return
10	LO	Low side output
11	VCC	Low side logic supply
12	STP	Shoot-thru prevention logic override (VCC: enabled, COM: disabled)
13	VS	High side floating supply return
14	HO	High side output
15	VB	High side floating supply
16	CSH	High side over current sensing input, referenced to VS

Lead Assignments



Package Details: SOIC16N

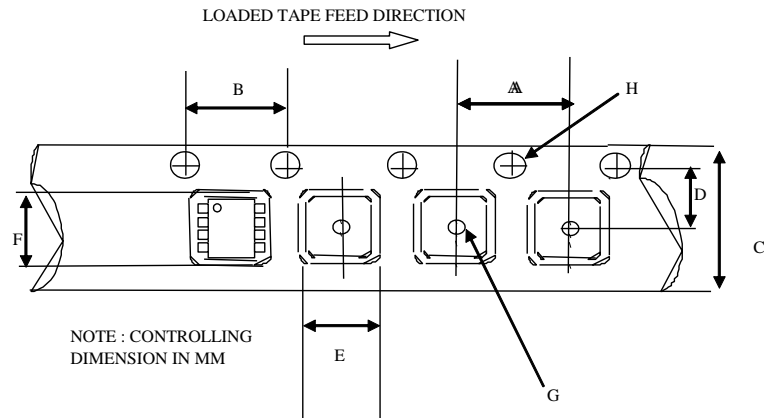


NOTES:

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.

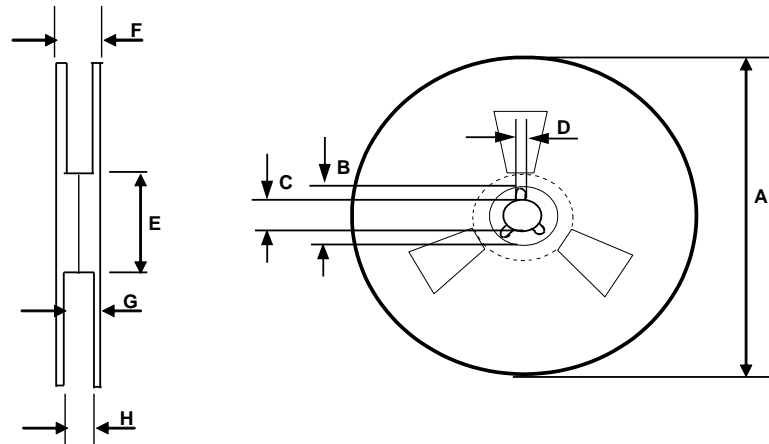
- 5. DIMENSION IS THE LENGTH OF LEAD FOR SOLDERING TO A SUBSTRATE.
- 6. DIMENSION DOES NOT INCLUDE MOLD PROTUSIONS. MOLD PROTUSIONS SHALL NOT EXCEED 0.15 [.006].

Tape and Reel Details: SOIC16N



CARRIER TAPE DIMENSION FOR 16SOICN

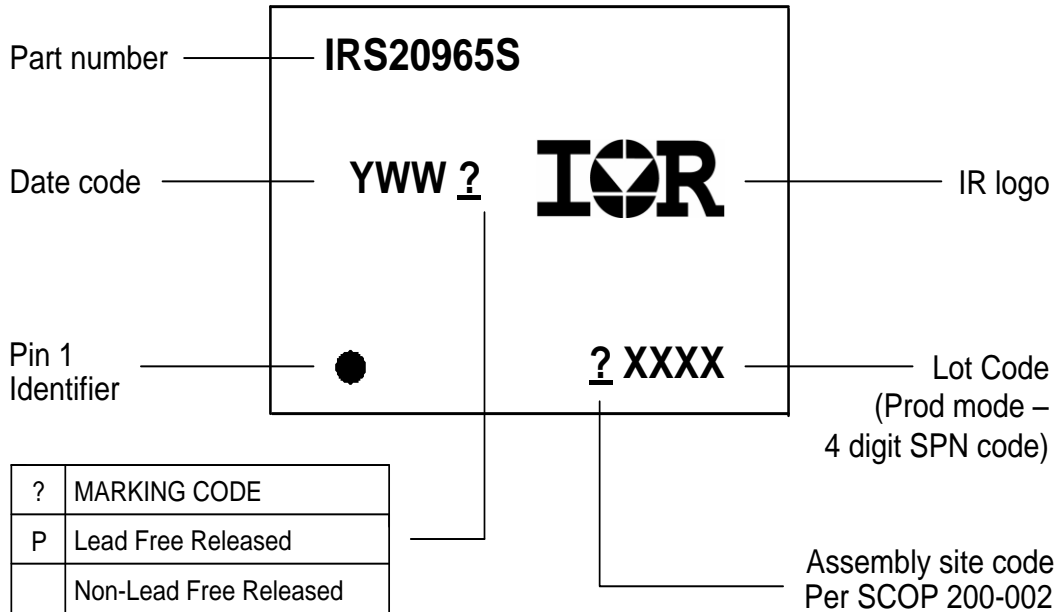
Code	Metric		Imperial	
	Min	Max	Min	Max
A	7.90	8.10	0.311	0.318
B	3.90	4.10	0.153	0.161
C	15.70	16.30	0.618	0.641
D	7.40	7.60	0.291	0.299
E	6.40	6.60	0.252	0.260
F	10.20	10.40	0.402	0.409
G	1.50	n/a	0.059	n/a
H	1.50	1.60	0.059	0.062



REEL DIMENSIONS FOR 16SOICN

Code	Metric		Imperial	
	Min	Max	Min	Max
A	329.60	330.25	12.976	13.001
B	20.95	21.45	0.824	0.844
C	12.80	13.20	0.503	0.519
D	1.95	2.45	0.767	0.096
E	98.00	102.00	3.858	4.015
F	n/a	22.40	n/a	0.881
G	18.50	21.10	0.728	0.830
H	16.40	18.40	0.645	0.724

Part Marking Information



Ordering Information

Base Part Number	Package Type	Standard Pack		Complete Part Number
		Form	Quantity	
IRS20965SPBF	SO16N	Tube/Bulk	45	IRS20965SPBF
		Tape and Reel	2500	IRS20965STRPBF

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