

## SELF-OSCILLATING FULL-BRIDGE DRIVER IC

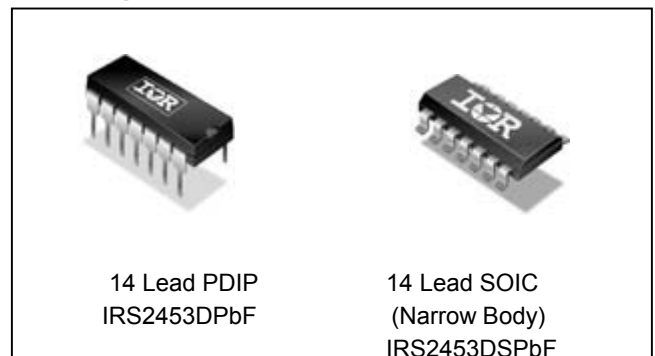
### Features

- Integrated 600V Full-Bridge Gate Driver
- CT, RT programmable oscillator
- 15.6V Zener Clamp on VCC
- Micropower Startup
- Logic Level Latched Shutdown Pin
- Non-latched shutdown on CT pin (1/6th VCC)
- Internal bootstrap FETs
- Excellent Latch Immunity on All Inputs & Outputs
- ESD Protection on All Pins
- 14-lead SOIC or PDIP package
- 1.0 usec (typ.) internal deadline

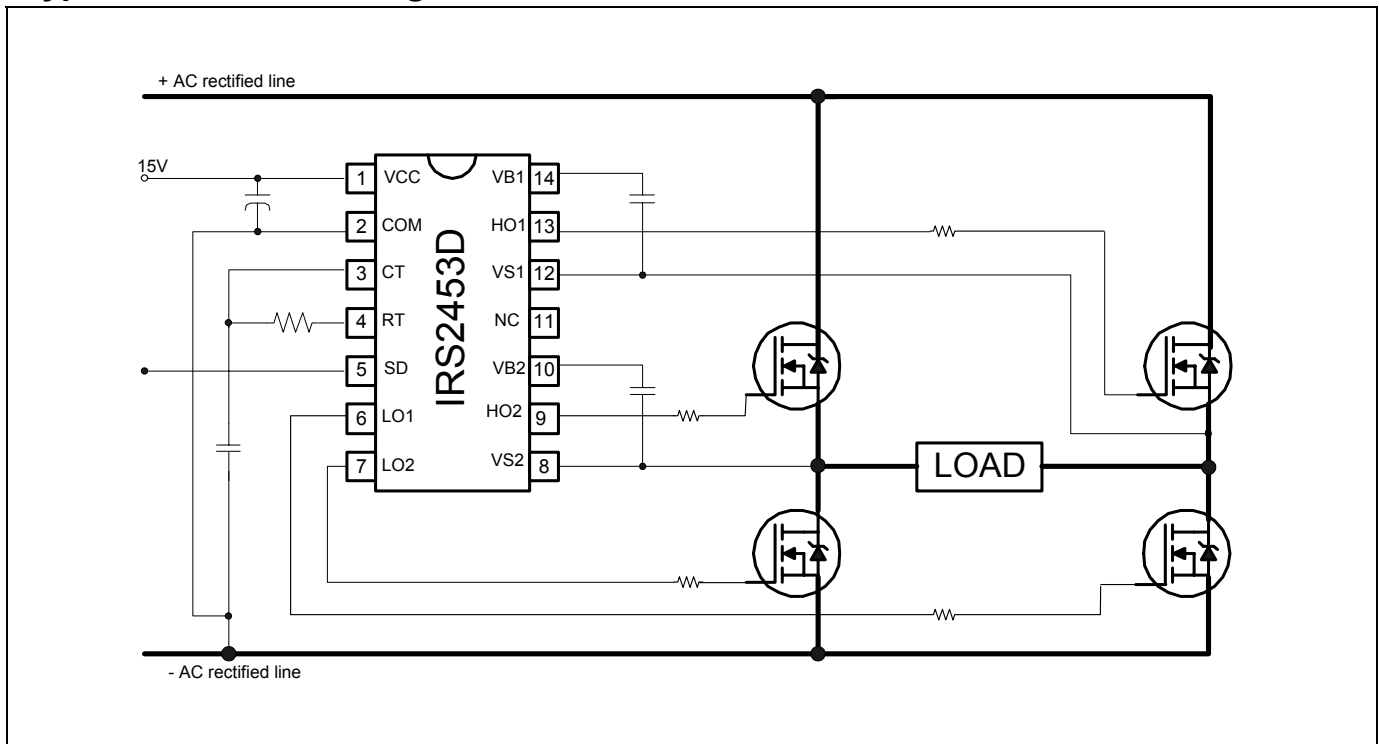
### Description

The IRS2453D is based on the popular IR2153 self-oscillating half-bridge gate driver IC, and incorporates a high voltage full-bridge gate driver with a front end oscillator similar to the industry standard CMOS 555 timer. HVIC and latch immune CMOS technologies enable ruggedized monolithic construction. The output driver features a high pulse current buffer stage designed for minimum driver cross-conduction. Noise immunity is achieved with low di/dt peak of the gate drivers, and with a undervoltage lockout hysteresis greater than 1.5V. The IRS2453D also includes latched and non-latched shutdown pins.

### Package



### Typical Connection Diagram



\* Please note that this datasheet contains advanced information which could change before the product is released to production.

**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.

Parameter		Min.	Max.	Units
Symbol	Definition			
$V_{B1}, V_{B2}$	High Side Floating Supply Voltage	-0.3	625	V
$V_{S1}, V_{S2}$	High Side Floating Supply Offset Voltage	$V_B - 25$	$V_B + 0.3$	V
$V_{HO1}, V_{HO2}$	High-Side Floating Output Voltage	$V_S - 0.3$	$V_B + 0.3$	V
$V_{LO1}, V_{LO2}$	Low-Side Output Voltage	-0.3	$V_{CC} + 0.3$	V
$V_{RT}$	$R_T$ Pin Voltage	-0.3	$V_{CC} + 0.3$	V
$V_{CT}$	$C_T$ Pin Voltage	-0.3	$V_{CC} + 0.3$	V
$V_{SD}$	SD Pin Voltage	-0.3	$V_{CC} + 0.3$	V
$I_{RT}$	$R_T$ Pin Current	-5	5	mA
$I_{CC}$	Supply Current (Note 1)	---	25	mA
$dV_S/dt$	Allowable Offset Voltage Slew Rate	-50	50	V/ns
$P_D$	Maximum Power Dissipation @ $T_A \leq +25^\circ\text{C}$ , 8-Pin DIP	---	1.0	W
$P_D$	Maximum Power Dissipation @ $T_A \leq +25^\circ\text{C}$ , 8-Pin SOIC	---	0.625	W
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient, 8-Pin DIP	---	125	$^\circ\text{C}/\text{W}$
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient, 8-Pin SOIC	---	200	$^\circ\text{C}/\text{W}$
$T_J$	Junction Temperature	-55	150	$^\circ\text{C}$
$T_S$	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  $V_{CLAMP}$  specified in the Electrical Characteristics section.

**Recommended Operating Conditions**

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

Parameter		Min.	Max.	Units
Symbol	Definition			
$V_{BS1}, V_{BS2}$	High Side Floating Supply Voltage	$V_{CC} - 0.7$	$V_{CLAMP}$	V
$V_{S1}, V_{S2}$	Steady State High Side Floating Supply Offset Voltage	-3.0 (Note 2)	600	V
$V_{CC}$	Supply Voltage	$V_{CCUV+}$	$V_{CLAMP}$	V
$I_{CC}$	Supply Current	(Note 3)	5	mA
$T_J$	Junction Temperature	-25	125	°C

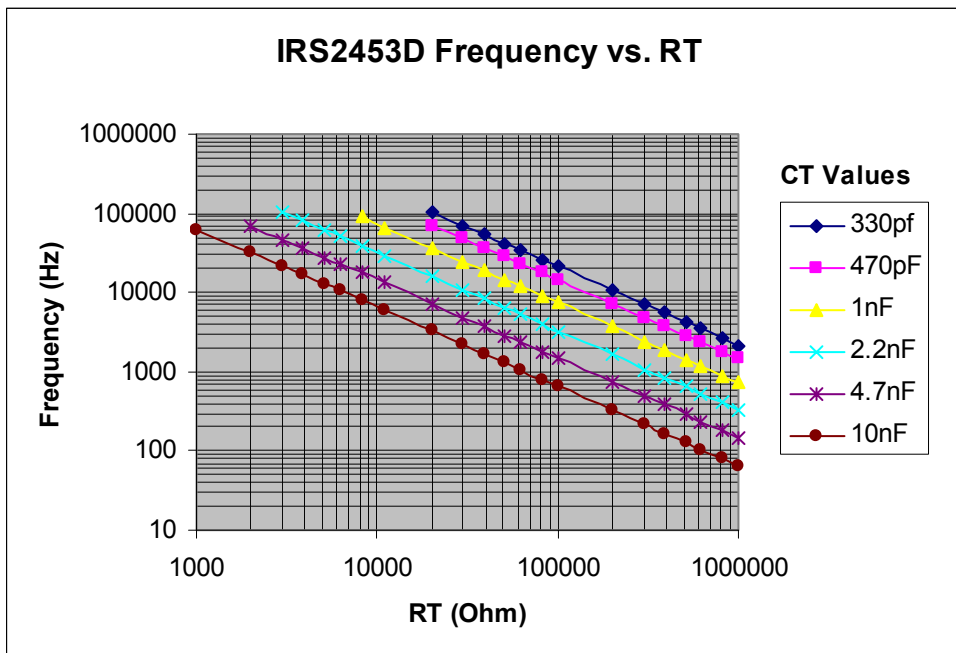
**Note 2:** Care should be taken to avoid output switching conditions where the  $V_S$  node flies inductively below ground by more than 5V.

**Note 3:** Enough current should be supplied to the  $V_{CC}$  pin of the IC to keep the internal 15.6V zener diode clamping the voltage at this pin.

**Recommended Component Values**

Parameter		Min.	Max.	Units
Symbol	Component			
$R_T$	Timing Resistor Value	1	---	k $\Omega$
$C_T$	$C_T$ Pin Capacitor Value	330	---	pF

$V_{BIAS} (V_{CC}, V_{BS}) = 14V, V_S = 0V$  and  $T_A = 25^\circ C, C_{LO1} = C_{LO2} = C_{HO1} = C_{HO2} = 1nF.$



### Electrical Characteristics

VBIAS (VCC, VBS) = 14V, CT = 1 nF and TA = 25°C unless otherwise specified. The VO and IO parameters are referenced to COM and are applicable to the respective output leads: HO or LO. CLO1=CLO2=CHO1=CHO2=1nF.

Symbol	Definition	Min	Typ	Max	Units	Test Conditions
<b>Low Voltage Supply Characteristics</b>						
V <sub>CCUV+</sub>	Rising V <sub>CC</sub> Undervoltage Lockout Threshold	10.0	11.0	12.0	V	
V <sub>CCUV-</sub>	Falling V <sub>CC</sub> Undervoltage Lockout Threshold	8.0	9.0	10.0		
V <sub>CCUVHYS</sub>	V <sub>CC</sub> Undervoltage Lockout Hysteresis	1.6	2.0	2.4		
I <sub>QCCUV</sub>	Micropower Startup V <sub>CC</sub> Supply Current	---	140	200	μA	V <sub>CC</sub> ≤ V <sub>CCUV-</sub>
I <sub>QCC</sub>	Quiescent V <sub>CC</sub> Supply Current	---	1.3	2.0	mA	
V <sub>CLAMP</sub>	V <sub>CC</sub> Zener Clamp Voltage	14.6	15.6	16.6	V	I <sub>CC</sub> = 5mA
<b>Floating Supply Characteristics</b>						
I <sub>QBS1UV</sub> , I <sub>QBS2UV</sub>	Micropower Startup V <sub>BS</sub> Supply Current	---	3	10	μA	V <sub>CC</sub> ≤ V <sub>CCUV-</sub> , V <sub>CC</sub> = V <sub>BS</sub>
I <sub>QBS1</sub> , I <sub>QBS2</sub>	Quiescent V <sub>BS</sub> Supply Current	---	60	100	μA	
V <sub>BS1UV+</sub> , V <sub>BS2UV+</sub>	V <sub>BS</sub> Supply Undervoltage Positive Going Threshold	8.0	9.0	10.0	V	
V <sub>BS1UV-</sub> , V <sub>BS2UV-</sub>	V <sub>BS</sub> Supply Undervoltage negative Going Threshold	7.0	8.0	9.0		
I <sub>LK1</sub> , I <sub>LK2</sub>	Offset Supply Leakage Current	---	---	50	μA	V <sub>B</sub> = V <sub>S</sub> = 600V
<b>Oscillator I/O Characteristics</b>						
f <sub>OSC</sub>	Oscillator Frequency	19.6	20.2	20.8	kHz	R <sub>T</sub> = 36.5kΩ
		89	95	101		R <sub>T</sub> = 7.15kΩ
d	R <sub>T</sub> Pin Duty Cycle	48	50	52	%	f <sub>o</sub> < 100kHz
I <sub>CT</sub>	C <sub>T</sub> Pin Current	---	0.05	1.0	μA	
I <sub>CTUV</sub>	UV-Mode C <sub>T</sub> Pin Pulldown Current	1	5	---	mA	V <sub>CC</sub> = 7V
V <sub>CT+</sub>	Upper C <sub>T</sub> Ramp Voltage Threshold	---	9.1	---	V	
V <sub>CT-</sub>	Lower C <sub>T</sub> Ramp Voltage Threshold	---	4.8	---		
V <sub>RT+</sub>	High-Level R <sub>T</sub> Output Voltage, V <sub>CC</sub> - V <sub>RT</sub>	---	10	50	mV	I <sub>RT</sub> = 100μA
		---	100	300	mV	I <sub>RT</sub> = 1mA
V <sub>RT-</sub>	Low-Level R <sub>T</sub> Output Voltage	---	10	50	mV	I <sub>RT</sub> = 100μA
		---	100	300	mV	I <sub>RT</sub> = 1mA
V <sub>RTUV</sub>	UV-Mode R <sub>T</sub> Output Voltage	---	0	100	mV	V <sub>CC</sub> ≤ V <sub>CCUV-</sub>

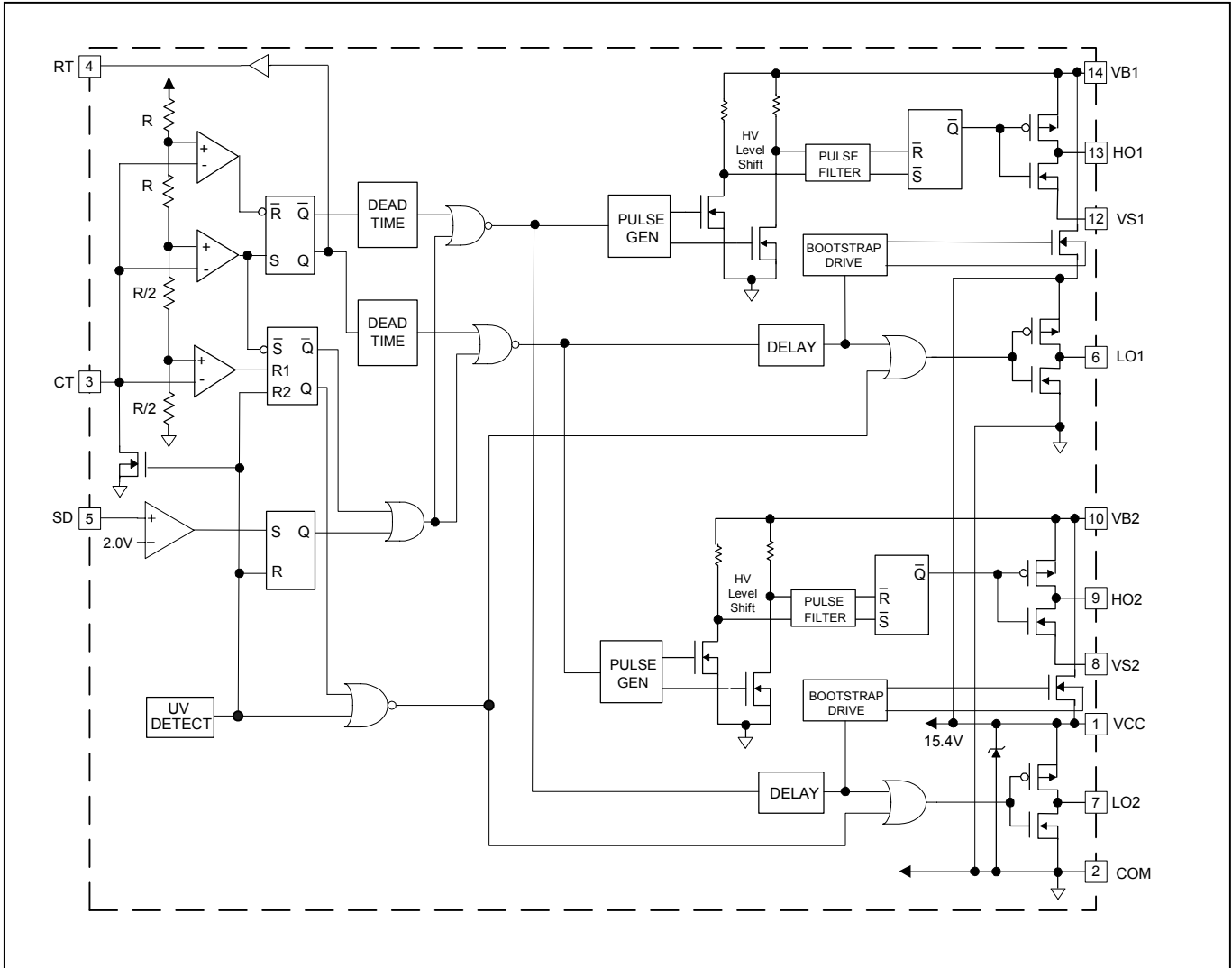
### Electrical Characteristics

VBIAS (VCC, VBS) = 14V, CT = 1 nF and TA = 25°C unless otherwise specified. The VO and IO parameters are referenced to COM and are applicable to the respective output leads: HO or LO. CLO1=CLO2=CHO1=CHO2=1nF.

Symbol	Definition	Min	Typ	Max	Units	Test Conditions
<b>Gate Driver Output Characteristics</b>						
VOH	High-Level Output Voltage, VBIAS - VO	---	VCC	---		IO = 0A
VOL	Low-Level Output Voltage, VO	---	COM	---		IO = 0A
VOL_UV	UV-Mode Output Voltage, VO	---	COM	---		IO = 0A, VCC ≤ VCCUV-
tr	Output Rise Time	---	120	220	nsec	
tf	Output Fall Time	---	50	100		
t <sub>sd</sub>	Shutdown Propagation Delay	---	275	---		
t <sub>d</sub>	Output Deadtime (HO or LO)	0.75	1.0	1.50	μsec	
IO+	Output source current	---	180	---	mA	
IO-	Output sink current	---	260	---		
<b>Shutdown</b>						
VSD	Shutdown Threshold at SD pin (latched)	---	2.0	---	V	
VCTSD	CT Voltage Shutdown Threshold (non latched)	---	2.3	---	V	
VRTSD	SD-Mode RT Output Voltage, VCC - VRT	---	10	50	mV	IRT = 100μA, VCT = 0V
		---	100	300	mV	IRT = 1mA, VCT = 0V
<b>Bootstrap FET Characteristics</b>						
VB1_ON VB2_ON	VB when the bootstrap FET is on	---	13.7	---	V	
IB1_CAP IB2_CAP	VB source current when FET is on	30	55	---	mA	CBS=0.1uF
IB1_10V IB2_10V	VB source current when FET is on	8	12	---		VB=10V

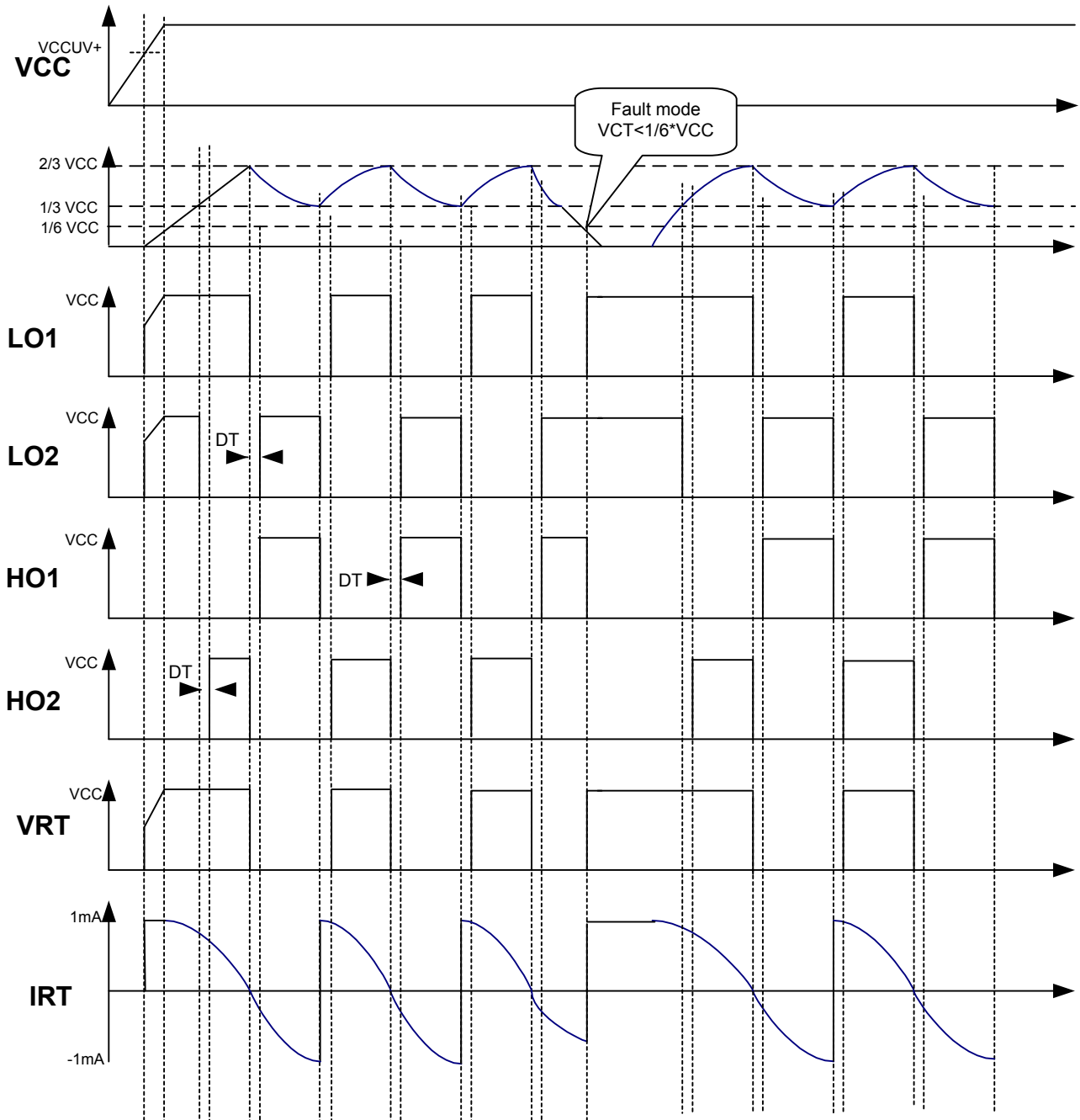


**Functional Block Diagram**



All values are typical.

**Timing Diagram**





## Functional Description

### Under-voltage Lock-Out Mode (UVLO)

The under-voltage lockout mode (UVLO) is defined as the state the IC is in when VCC is below the turn-on threshold of the IC. The IRS2453D under voltage lock-out is designed to maintain an ultra low supply current of less than 150uA, and to guarantee the IC is fully functional before the high and low side output drivers are activated. During under voltage lock-out mode, the high and low-side driver outputs LO1, LO2, HO1, HO2 are all low. With VCC above the VCCUV+ threshold, the IC turns on and the output begin to oscillate.

### Normal operating mode

Once VCC reaches the start-up threshold VCCUV+, the MOSFET M1 opens, RT increases to approximately VCC (VCC-VRT+) and the external CT capacitor starts charging. Once the CT voltage reaches VCT- (about 1/3 of VCC), established by an internal resistor ladder, LO1 and HO2 turn on with a delay equivalent to the deadtime td. Once the CT voltage reaches VCT+ (approximately 2/3 of VCC), LO1 and HO2 go low, RT goes down to approximately ground (VRT-), the CT capacitor starts discharging and the deadtime circuit is activated. At the end of the deadtime, LO2 and HO1 go high. Once the CT voltage reaches VCT-, LO2 and HO1 go low, RT goes to high again, the deadtime is activated. At the end of the deadtime, LO1 and HO2 go high and the cycle starts over again.

The frequency is best determined by the graph, Frequency vs. RT, Page 3, for different values of CT. A first order approximate of the oscillator frequency can also be calculated by the following formula::

$$f \approx \frac{1}{1.453 \times RT \times CT}$$

This equation can vary slightly from actual measurements due to internal comparator over- and under-shoot delays.

### Bootstrap MOSFET

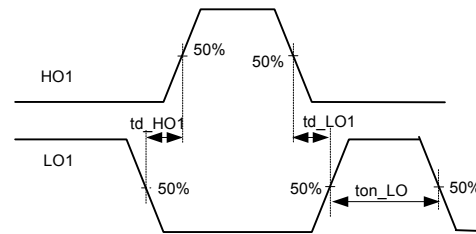
The internal bootstrap FET and supply capacitor (C<sub>BOOT</sub>) comprise the supply voltage for the high side driver circuitry. The internal bootstrap FET only turns on when the corresponding LO is high. To guarantee that the high-side supply is charged up before the first pulse on HO1 and HO2, LO1 and LO2 are both on when CT ramps between zero and 1/3\*VCC. LO1 and LO2 are also on when CT is grounded below 1/6\*VCC to ensure that the bootstrap capacitor is charged when CT is brought back over 1/3\*VCC.

### Non-latched Shutdown

If CT is pulled down below V<sub>CTSD</sub> (approximately 1/6 of VCC) by an external circuit, CT doesn't charge up and oscillation stops. All outputs are held low and the bootstrap FETs are off. Oscillation will resume once CT is able to charge up again to VCT-.

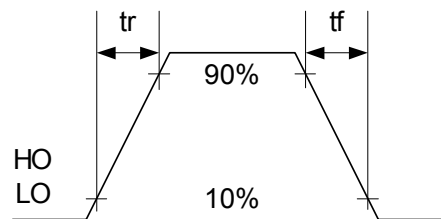
### Latched Shutdown

When the SD pin is brought above 2V, the IC goes into fault mode and all outputs are low. VCC has to be recycled below VCCUV- to restart the IC. The SD pin can be used for over-current or over-voltage protection using appropriate external circuitry.



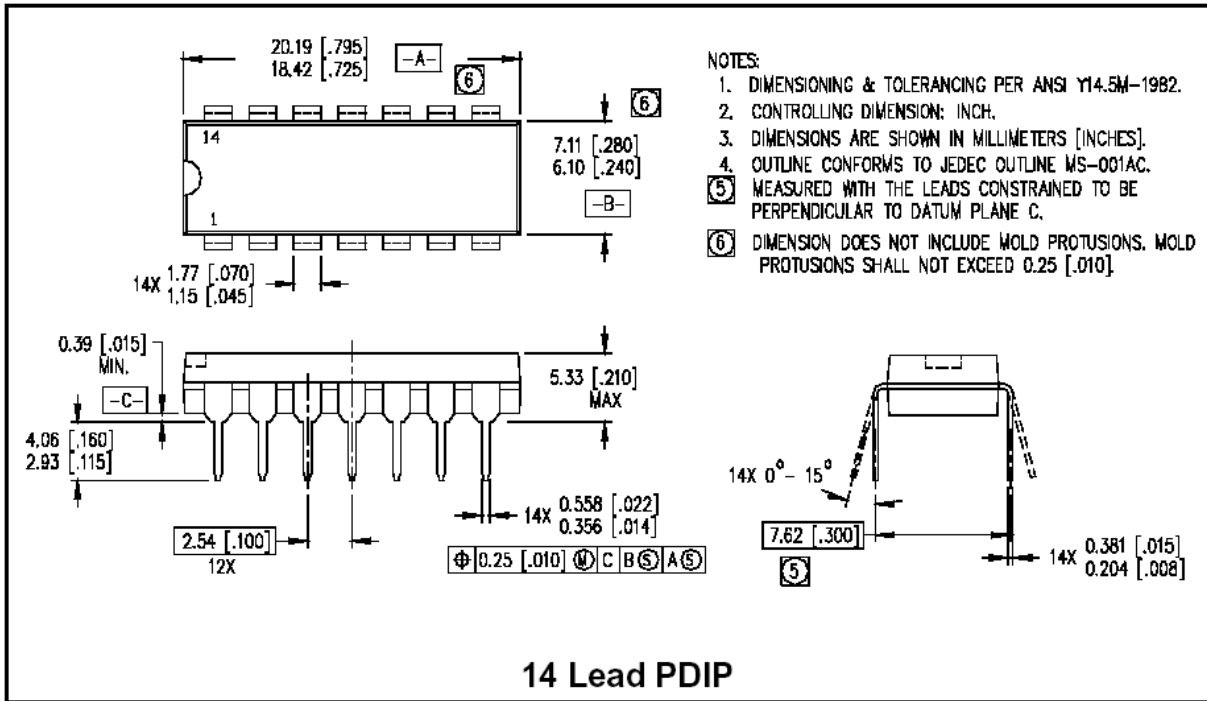
Deadtime Waveform Definitions

### Deadtime waveform

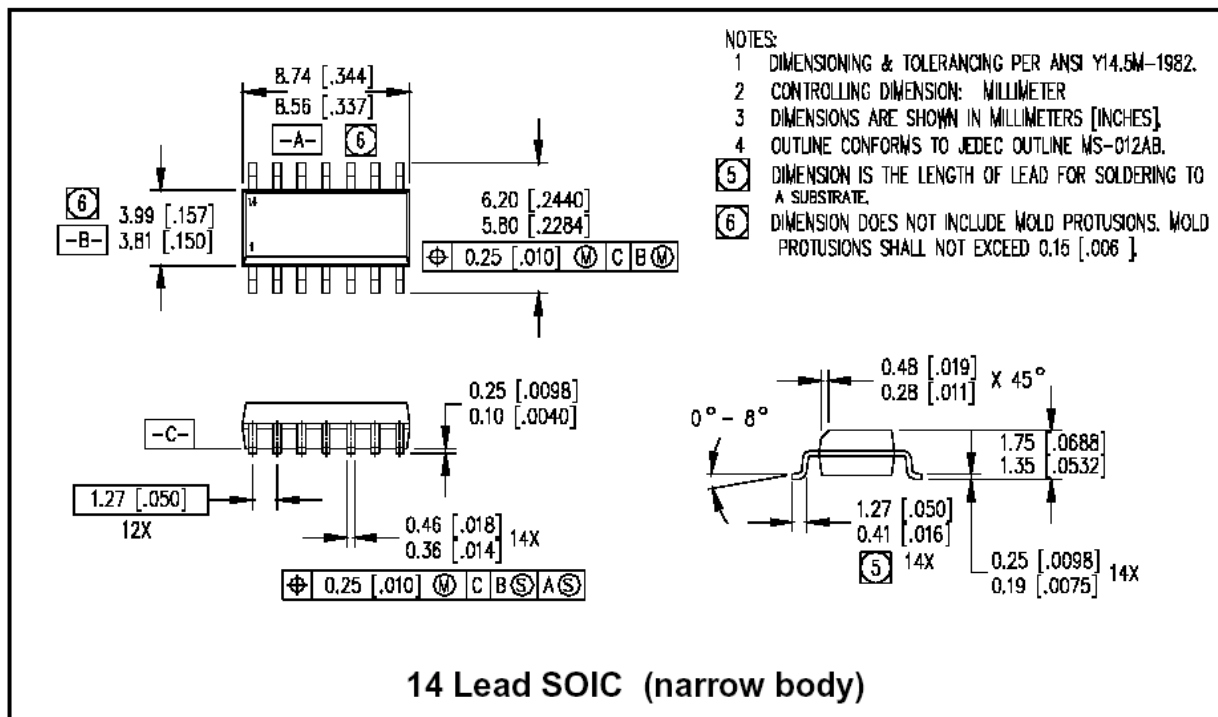


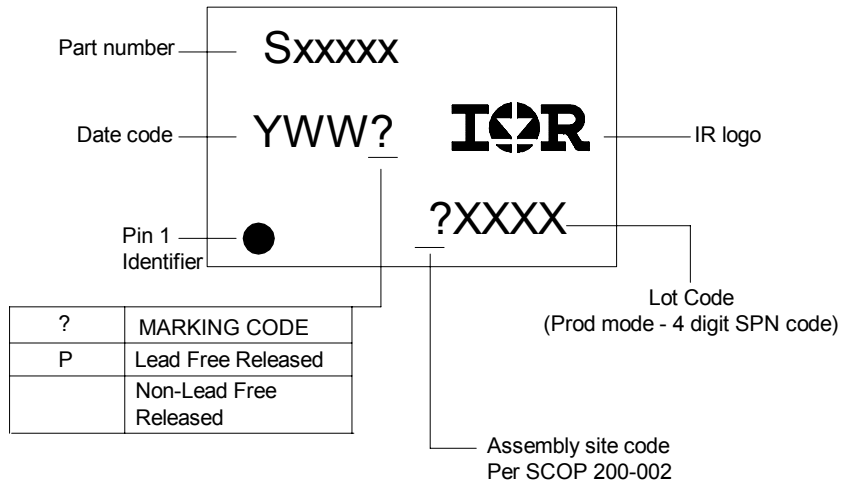
### Rise and fall time waveform

**IRS2453D**



**IRS2453DS**





**ORDER INFORMATION**

8-lead PDIP: order IRS2453DPbF  
 8-lead SOICN: order IRS2453DSPbF  
 8-lead SOICN tape & reel: order IRS2453DSTRPbF