

## IRS21956S

### Floating Input, High and Low(Dual mode) Side Driver

#### Features

- Low side programmable ramp gate drive
- Low side generic gate drive integrated using the same low side output pin
- High side generic gate driver
- Under voltage lockout for VDD, VCC & VBS
- Floating 5V input logic compatible
- Tolerant to negative transient voltage on Vs
- Shoot through prevention
- RoHS compliant

#### Product Summary

Topology	PDP
$V_{\text{OFFSET}}$	$\leq 600 \text{ V}$
LO SR+	4.5V/us
$I_{\text{o+}}$ & $I_{\text{o-}}$ (typical)	0.5A & 0.5A
$t_{\text{ON}}$ & $t_{\text{OFF}}$ (typical)	300ns & 280ns

#### Package Options

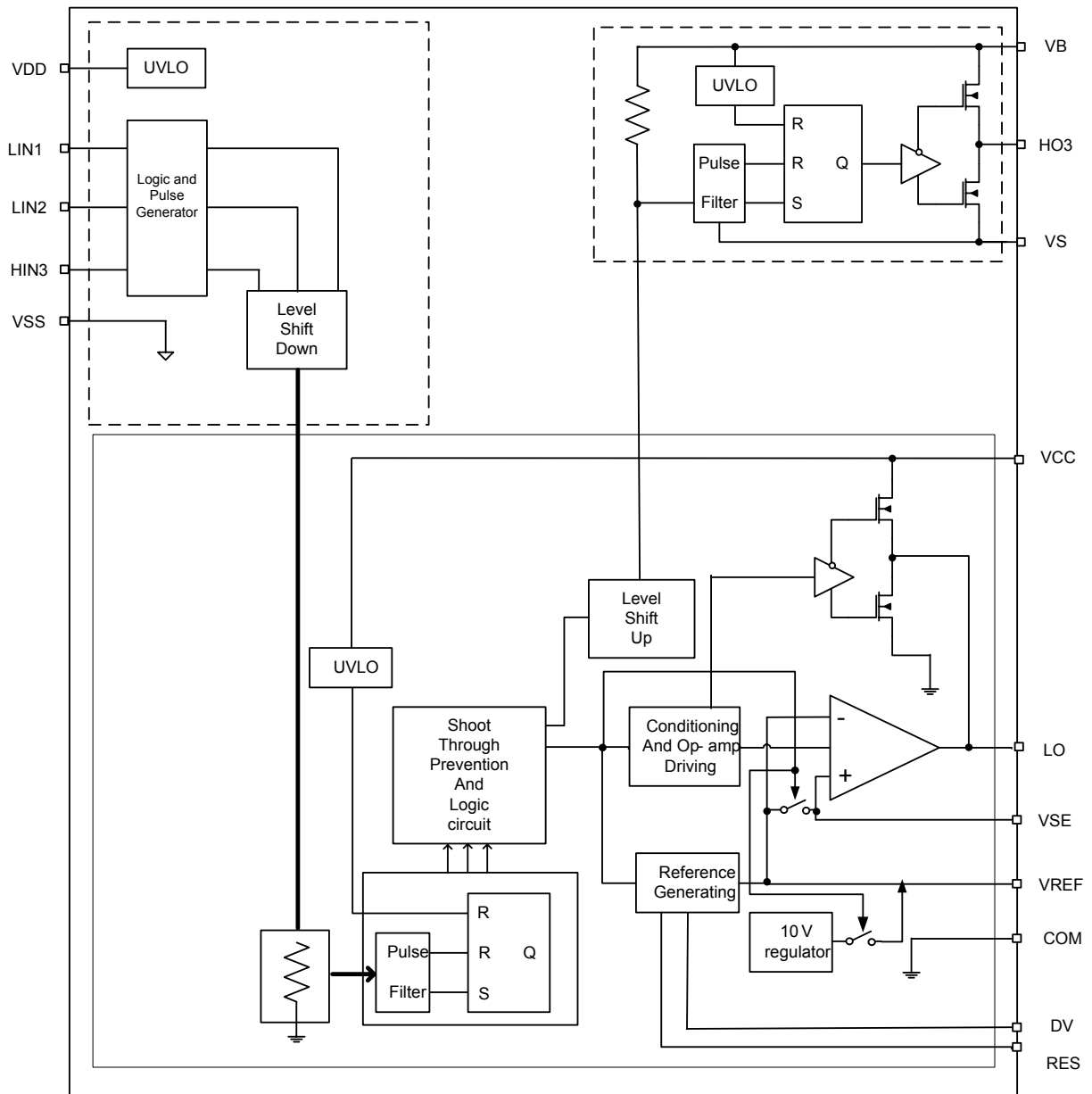


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### **Description**

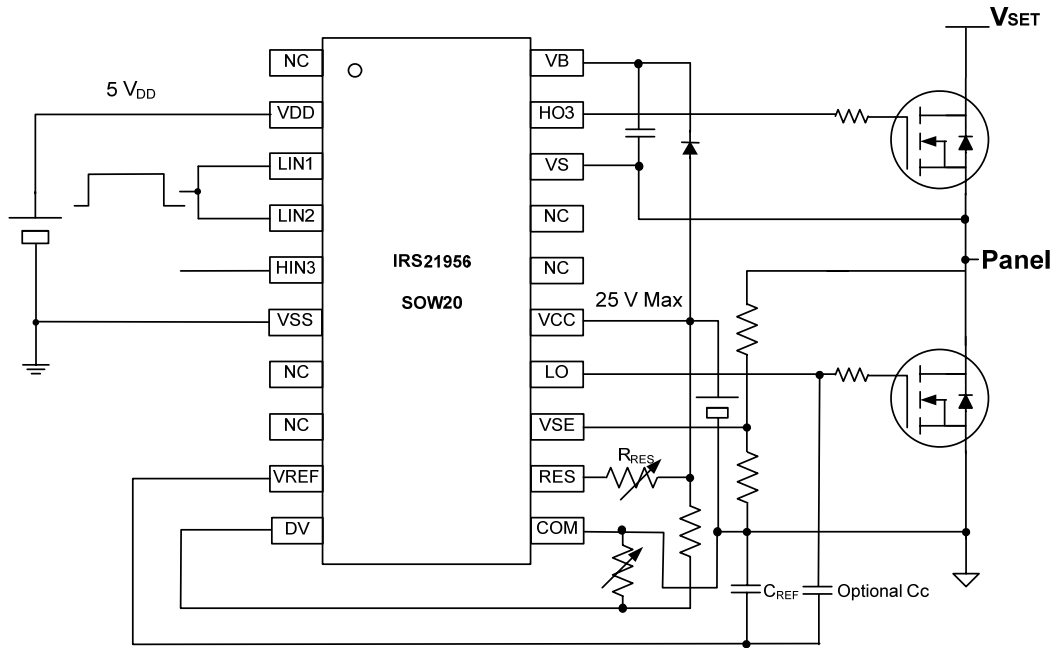
The IRS21956 is high voltage and programmable ramp slope control gate driver for MOSFET and IGBT with single low side dual mode driver, high side driver and floating 5V input. Proprietary HVIC and latch immune CMOS technologies enable ruggedized monolithic construction. The floating logic input is compatible with standard 5V CMOS or LSTTL output. The output driver features a programmable slope control by external R/C and input signals. The floating channels can be used to drive an N-channel power MOSFET or IGBT in the high side configuration, which operates up to 600 volts above the COM ground.

**Simplified Block Diagram**

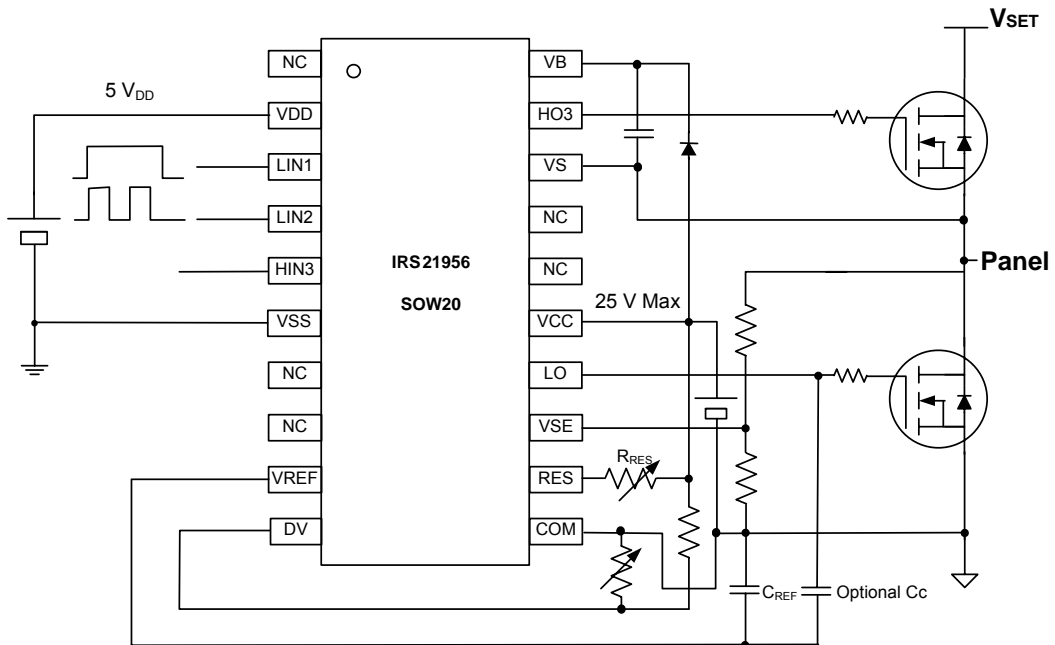


**Typical Connection Diagram**

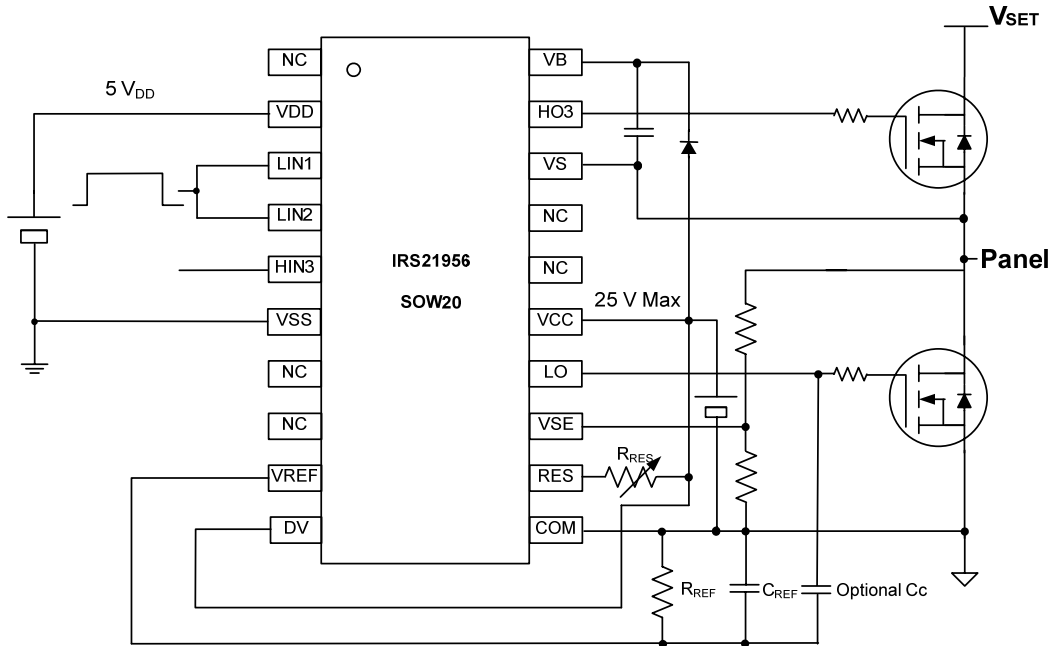
**A) Linear Ramp driver's connection diagram**



**B) Stepwise linear Ramp driver's connection diagram**



**C) Exponential Ramp driver's connection diagram**



**Qualification Information<sup>†</sup>**

<b>Qualification Level</b>		Industrial <sup>††</sup>	
		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.	
<b>Moisture Sensitivity Level</b>		SOIC20W	MSL3 <sup>†††</sup> 260°C (per IPC/JEDEC J-STD-020)
<b>ESD</b>	Machine Model	Class B (per JEDEC standard JESD22-A115)	
	Human Body Model	Class 2 (per EIA/JEDEC standard EIA/JESD22-A114)	
<b>IC Latch-Up Test</b>		Class I, Level A (per JESD78)	
<b>RoHS Compliant</b>		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 COM.

Symbol	Definition	Min	Max	Units
V <sub>DD</sub>	Floating Input Supply Voltage	-0.3	625	V
V <sub>SS</sub>	Floating Input Supply Return Voltage	V <sub>DD</sub> -25	V <sub>DD</sub> +0.3	V
V <sub>IN</sub>	Logic input voltage (LIN1,LIN2,HIN3)	V <sub>SS</sub> -0.3	V <sub>DD</sub> +0.3	V
V <sub>CC</sub>	Low side supply voltage	-0.3	25	V
V <sub>DV</sub> , V <sub>VREF</sub>	Low side inputs voltage	COM-0.3	V <sub>CC</sub> +0.3	V
V <sub>VSE</sub> , V <sub>RES</sub>	Low side inputs voltage	COM-0.3	V <sub>CC</sub> +0.3	V
V <sub>LO</sub>	Low side gate drive output voltage	COM-0.3	V <sub>CC</sub> +0.3	V
V <sub>B</sub>	High side floating well supply voltage	-0.3	625	V
V <sub>S</sub>	High side floating well supply return voltage	V <sub>B</sub> -25	V <sub>B</sub> +0.3	V
V <sub>HO</sub>	Floating gate drive output voltage	V <sub>S</sub> -0.3	V <sub>B</sub> +0.3	V
dV <sub>SS</sub> /dt	Allowable V <sub>SS</sub> offset supply transient relative to COM	-	50	V/ns
dV <sub>S</sub> /dt	Allowable V <sub>S</sub> offset supply transient relative to COM	-	50	V/ns
P <sub>D</sub>	Package Power Dissipation @ T <sub>A</sub> ≤+25°C	-	1.0	W
R <sub>θJA</sub>	Thermal Resistance, Junction to Ambient	-	120	°C/W
T <sub>J</sub>	Junction Temperature	-55	150	°C
T <sub>S</sub>	Storage Temperature	-55	150	°C
T <sub>L</sub>	Lead temperature (Soldering, 10 seconds)	-	300	°C

### Recommended Operating Conditions

For proper operation, the device should be used within the recommended conditions. All voltage parameters are absolute voltages referenced to COM.

The offset rating are tested with supplies of (V<sub>CC</sub>-COM) = (V<sub>B</sub>-V<sub>S</sub>)=15V.

Symbol	Definition	Min	Max	Units
V <sub>DD</sub>	Floating Input Supply voltage	V <sub>SS</sub> +4.5	V <sub>SS</sub> +6	V
V <sub>SS</sub>	Floating Input Supply offset voltage	-0.3	600	V
V <sub>IN</sub>	LIN1, LIN2, HIN3 input voltage	V <sub>SS</sub>	V <sub>DD</sub>	V
V <sub>CC</sub>	Low side supply voltage	10	20	V
V <sub>LO</sub>	Low side gate drive output voltage	COM	V <sub>CC</sub>	V
V <sub>RES</sub>	RES input voltage	COM	V <sub>CC</sub>	V
V <sub>DV</sub>	DV input voltage	COM	V <sub>CC</sub>	V
V <sub>VREF</sub> , V <sub>VSE</sub>	VREF and VSE input voltage	COM	V <sub>CC</sub> -3	V
V <sub>B</sub>	High side floating well supply voltage	V <sub>S</sub> +10	V <sub>S</sub> +20	V
V <sub>S</sub>	High side floating well supply offset voltage	Note2††	600	V
V <sub>HO</sub>	Floating gate drive output voltage	V <sub>S</sub>	V <sub>B</sub>	V
T <sub>A</sub>	Ambient Temperature	-40	125	°C

† V<sub>S</sub> and V<sub>B</sub> voltages will be tolerant to short negative transient spikes. These will be defined and specified in the future.

†† Logic operation for V<sub>S</sub> of -5 to 600V. Logic state held for V<sub>S</sub> of -5V to -V<sub>BS</sub>. (Please refer to Design Tip DT97-3 for more details).



**Static Electrical Characteristics**

( $V_{CC}-COM$ ) = ( $V_B-V_S$ )=15V.  $T_A = 25^\circ C$ . The  $V_{IN}$ ,  $V_{IN TH}$  and  $I_{IN}$  parameters are referenced to  $V_{SS}$ . The  $V_O$  and  $I_O$  parameters are referenced to respective  $V_S$ ,  $COM$  and are applicable to the respective output leads  $HO3$ ,  $LO$ . The  $V_{CCUV}$  parameters are referenced to  $COM$ . The  $V_{BSUV}$  parameters are referenced to  $V_S$ . The  $V_{DDUV}$  parameters are referenced to  $V_{SS}$ .

Symbol	Definition	Min	Typ	Max	Units	Test Conditions
$V_{DDUV+}$	$V_{DD}$ supply undervoltage positive going threshold		4.0		V	
$V_{DDUV-}$	$V_{DD}$ supply undervoltage negative going threshold		3.9			
$V_{CCUV+}$	$V_{CC}$ supply undervoltage positive going threshold	7.8	8.7	9.6		
$V_{CCUV-}$	$V_{CC}$ supply undervoltage negative going threshold	7.2	8.0	8.8		
$V_{BSUV+}$	$V_{BS}$ supply undervoltage positive going threshold	7.8	8.7	9.6		
$V_{BSUV-}$	$V_{BS}$ supply undervoltage negative going threshold	7.2	8.0	8.8		
$I_{LK1}$	High side floating well offset supply leakage current	---	---	50	uA	$V_B = V_S = 600V$
$I_{LK2}$	High side floating well offset supply leakage current	---	---	50		$V_{DD} = V_{SS} = 300V$
$I_{QDD}$	Quiescent VDD supply current	---	145	250	uA	$IN1, 2, 3 = 0V \text{ or } 5V$
$I_{QBS}$	Quiescent VBS supply current	---	65	120	uA	$HIN3 = 5V \text{ or } 0V$
$I_{QCC}$	Quiescent VCC supply current	---	1	1.5	mA	$LIN1, 2 = 0V$ , $RES=130k\Omega$
		---	5	7	mA	$LIN1, 2 = 5V$ , $RES=130k\Omega$
$V_{IH}$	Logic "1" input voltage	3.5	---	---	V	
$V_{IL}$	Logic "0" input voltage	---	---	0.8		
$I_{IN+}$	Logic "1" input bias current	---	5	---	uA	$V_{IN} = 5V$
$I_{IN-}$	Logic "0" input bias current	---	0	---		$V_{IN} = 0V$
$I_{O+}$ $HO3, LO$	Output high short circuit pulsed current	---	0.5	---	A	$V_O=15V, V_{IN}=5V$ , $PW \leq 10\mu s$
$I_{O-}$ $HO3, LO$	Output low short circuit pulsed current	---	0.5	---		$V_O=0V, V_{IN}=0V$ , $PW \leq 10\mu s$
$V_{OL}$ $HO3, LO$	Low level output voltage	---	35	150	mV	$I_O=2mA$
$V_{OH}$ $HO3, LO$	High level output voltage, $V_{bias}-V_O$	---	15	80		$I_O=2mA$
$DV_{exp+}$	Positive DV input threshold for exponential ramp	---	10	---	V	$C_{REF} = 1nF, V_{SE} \text{ open } R_{RES} = 130K$

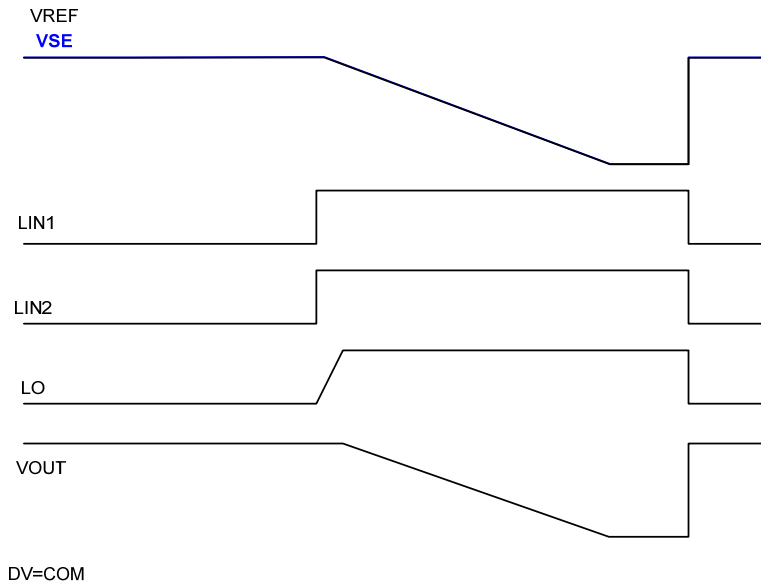
**DV / Linear (Stepwise) Mode**

Symbol	Definition	Min	Typ	Max	Units	Test Conditions
V <sub>REF, hold</sub>	DV reference voltage	0.4	0.5	0.6	V	DV=500mV, C <sub>REF</sub> =1nF, V <sub>SE</sub> open R <sub>RES</sub> =130K,
		2.82	3	3.18		DV=3V, C <sub>REF</sub> =1nF, V <sub>SE</sub> open R <sub>RES</sub> =130K,

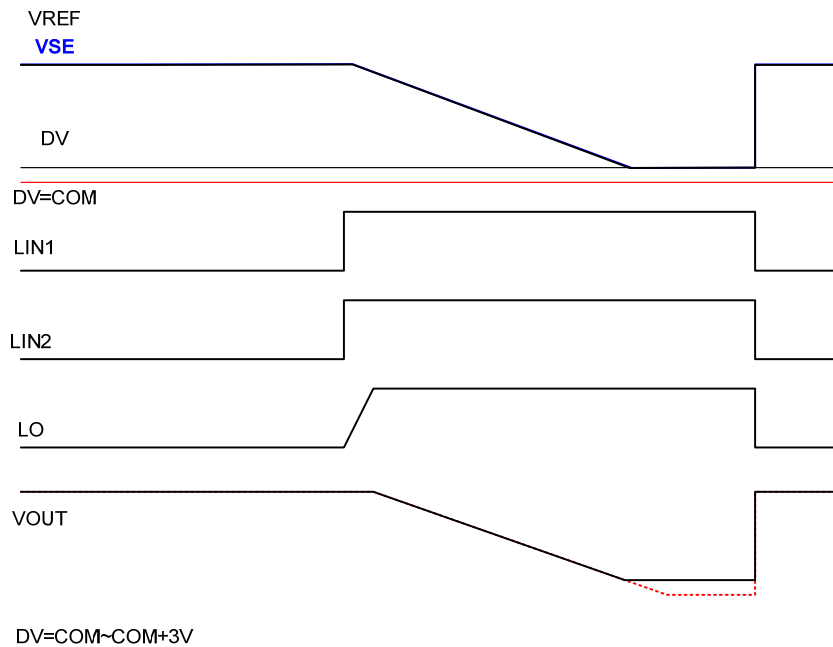
**Dynamic Electrical Characteristics**

(V<sub>CC</sub>-COM)= (V<sub>B</sub>-V<sub>S</sub>)=15V. TA = 25°C. C<sub>L</sub> = 1000pF unless otherwise specified. All parameters are reference to COM.

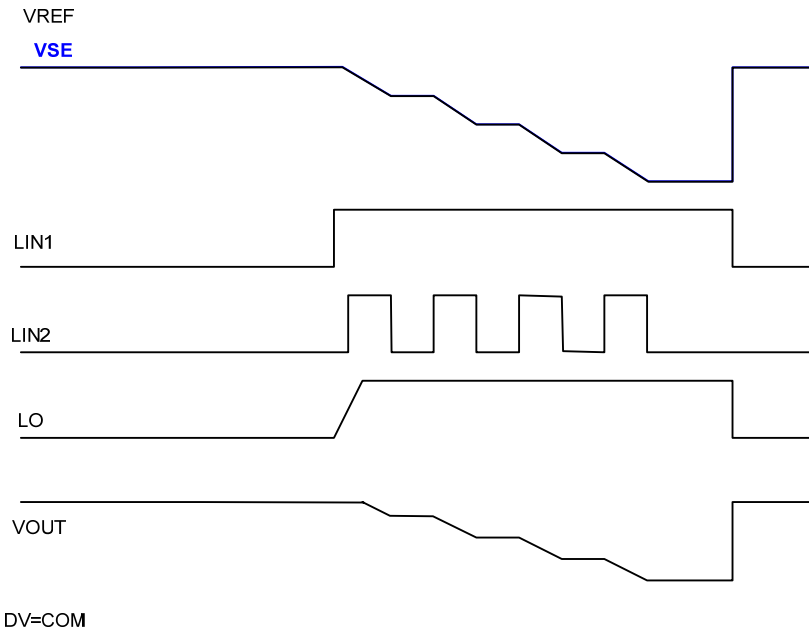
Symbol	Definition	Min	Typ	Max	Units	Test Conditions
<b>Internal Operational Amplifier Characteristics</b>						
t <sub>ref_in_ramp</sub>	Linear ramp reference 10% to 90%	130	190	250	μs	C <sub>REF</sub> =1nF, V <sub>SE</sub> open R <sub>RES</sub> =130K, V <sub>DV</sub> =COM
G <sub>m</sub>	OTA transconductance	---	12	---	mS	CL_LO=1nF, V <sub>DV</sub> =V <sub>CC</sub> , R <sub>RES</sub> =130K, dc bias 5V
G <sub>open loop</sub>	Open loop gain	45	60	---	dB	C <sub>c</sub> =1nF, V <sub>DV</sub> =V <sub>CC</sub> , R <sub>RES</sub> =130K
BW <sub>SS</sub>	Small signal bandwidth	---	3.5	---	MHz	C <sub>c</sub> =1nF V <sub>DV</sub> =V <sub>CC</sub> , R <sub>RES</sub> =130K
V <sub>OS</sub>	Input offset voltage	---	20	---	mV	V <sub>DV</sub> =V <sub>CC</sub> , R <sub>RES</sub> =130K
LO <sub>SR+</sub>	Output positive slew rate	---	4.5	---	V/μs	CL_LO=1nF, V <sub>DV</sub> =V <sub>CC</sub> , R <sub>RES</sub> =130K
CMRR	Common mode rejection ratio	55	65	---	dB	V <sub>DV</sub> =V <sub>CC</sub> , R <sub>RES</sub> =130K
PSRR	Power supply rejection ratio	55	65	---	dB	V <sub>DV</sub> =V <sub>CC</sub> , R <sub>RES</sub> =130K
<b>Propagation Delay Characteristics</b>						
t <sub>on</sub>	Turn-on delay (HO3, LO)	---	300	400	ns	Gate Drive Mode C <sub>L</sub> =1nF
t <sub>off</sub>	Turn-off delay (HO3, LO)	---	280	380		
t <sub>r</sub>	Turn-on rise from 10% to 90%	---	25	60		
t <sub>f</sub>	Turn-off fall from 90% to 10%	---	15	40		
MT	Delay matching, HO3 & LO turn-on/off			50		



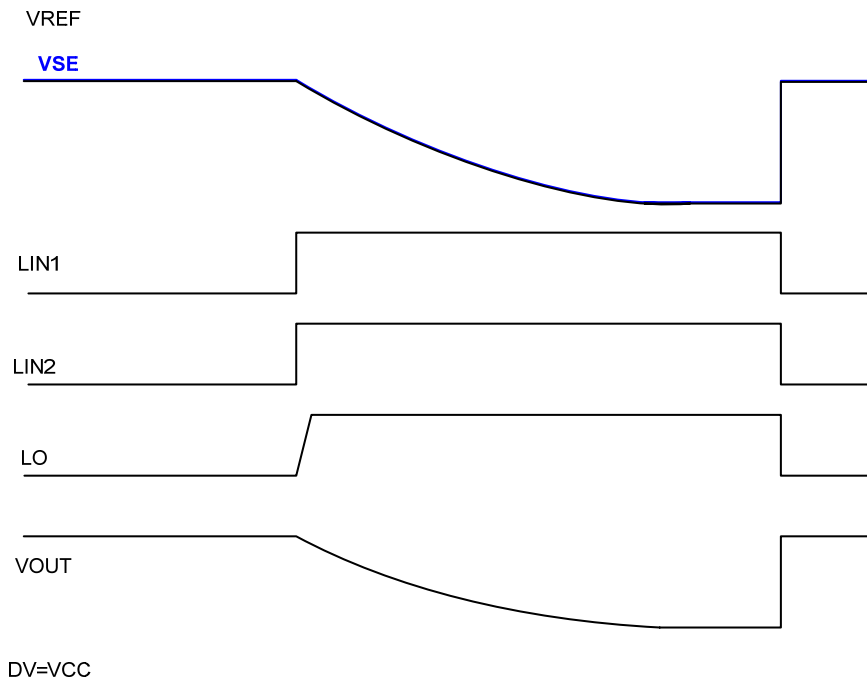
**Figure 1A1 Input/Output Timing Diagram: Linear Ramp**



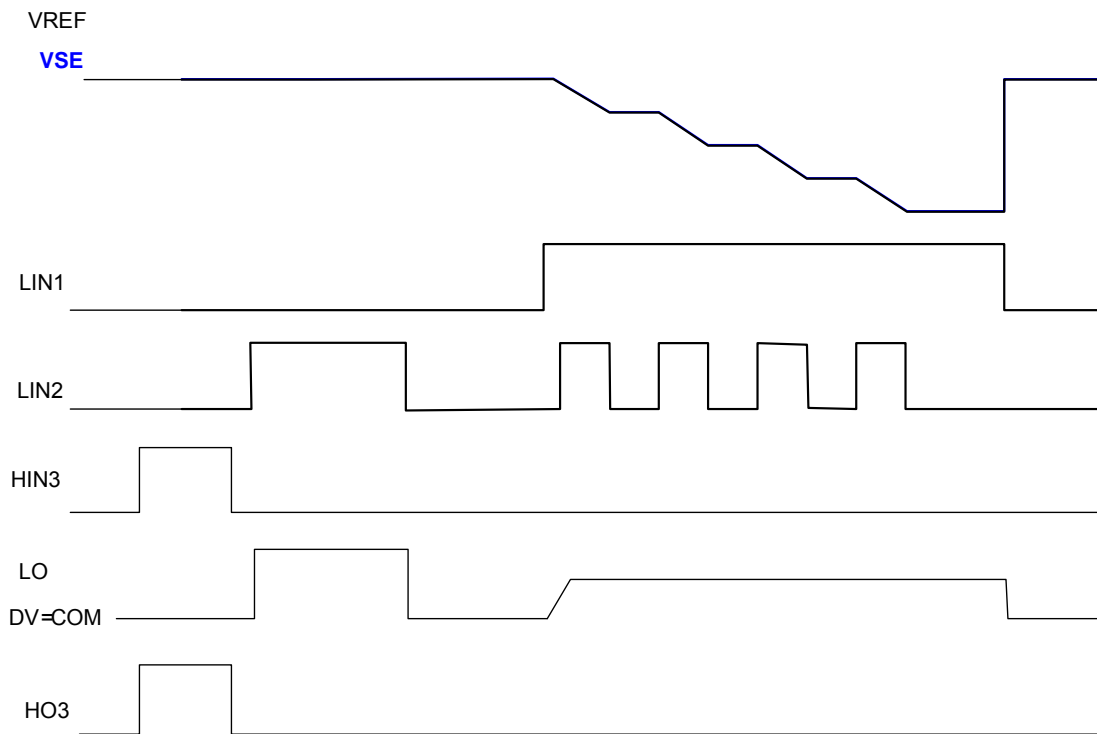
**Figure 1A2 Input/Output Timing Diagram: Linear Ramp with voltage difference**



**Figure 1B** Input/Output Timing Diagram: Stepwise linear Ramp



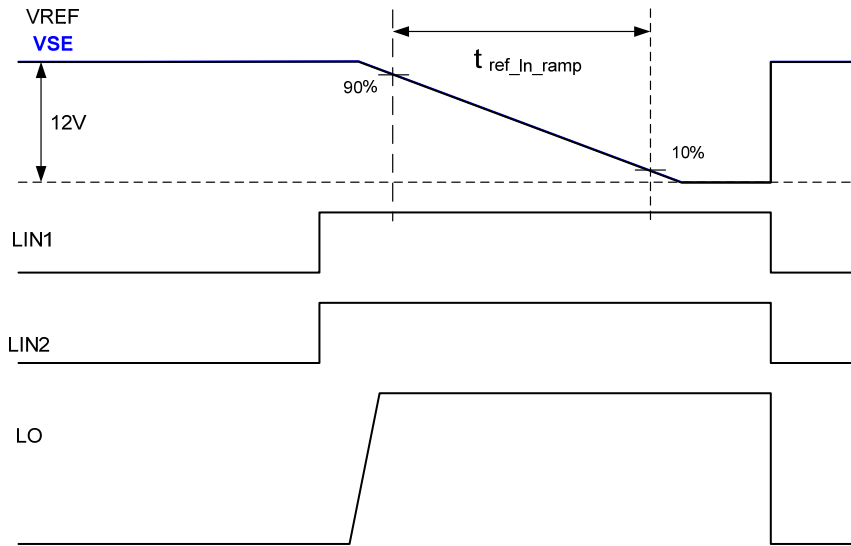
**Figure 1C** Input/Output Timing Diagram: Exponential Ramp



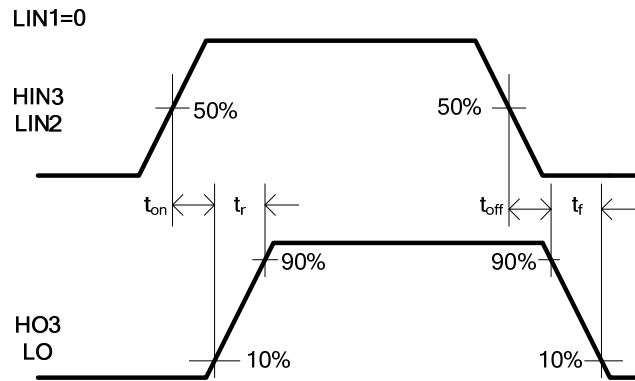
**Figure 1D Input/Output Timing Diagram : LO/HO3 outputs**

**Logic Truth Table**

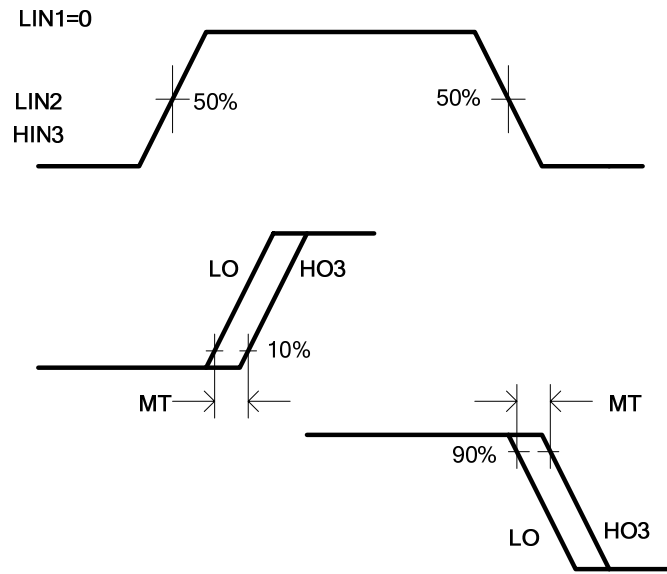
LIN1	LIN2	HIN3	HO3	OTA of LO	Gate driver of LO
0	0	0	0	High impedance (HIZ)	0
0	0	1	1	High impedance (HIZ)	0
0	1	0	0	High impedance (HIZ)	1
0	1	1	0	High impedance (HIZ)	0
1	1	0	0	Linear/Exp ramp depend on DV pin	High impedance (HIZ)
1	1	1	0	High impedance (HIZ)	0
1	Step(0/1)	0	0	Stepwise linear if DV pin is COM	High impedance (HIZ)
1	Step(0/1)	1	0	High impedance (HIZ)	0



**Figure 2 Timing Definitions of  $V_{REF}$**

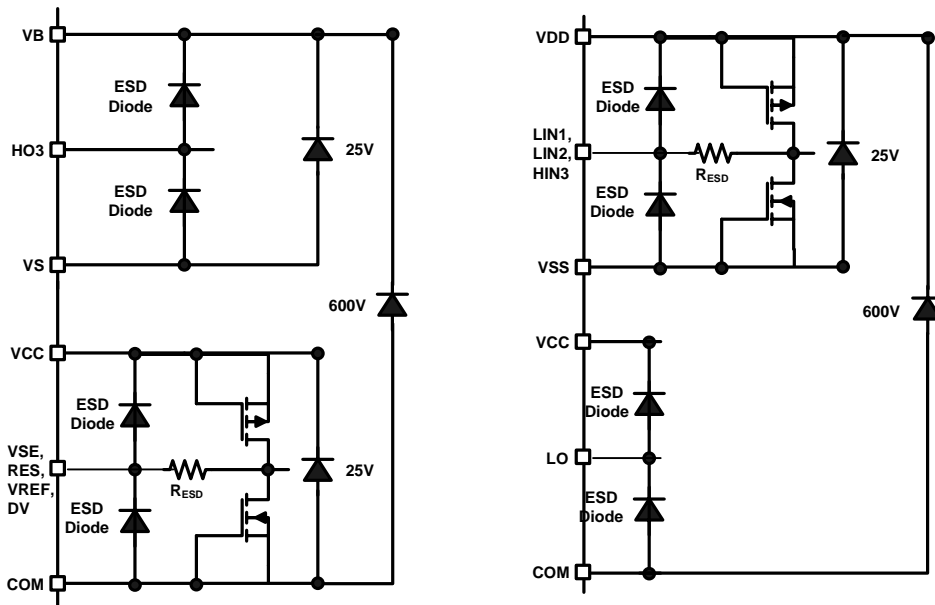
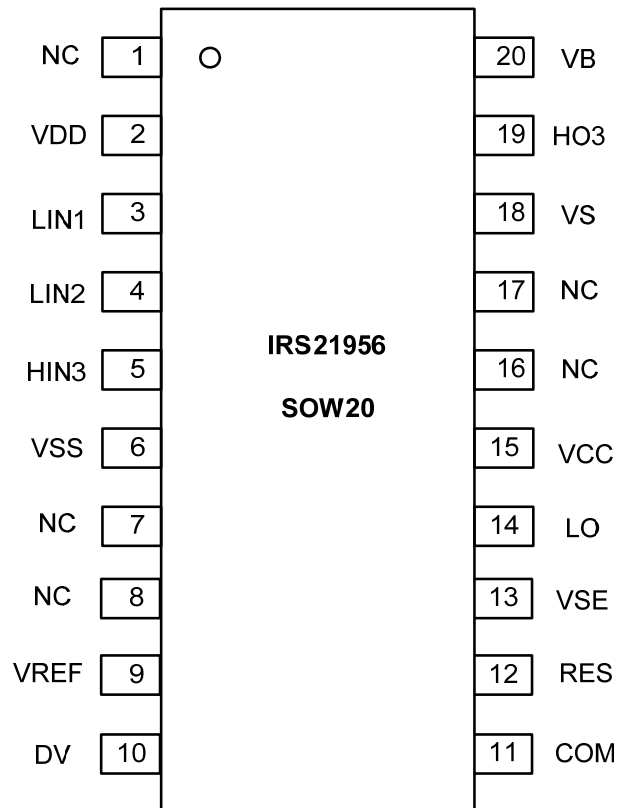


**Figure 3 Switching Time Waveform Definitions of LO and HO3**



**Figure 4 Delay Matching Waveform Definitions**

**Input/Output Pin Equivalent Circuit Diagram**

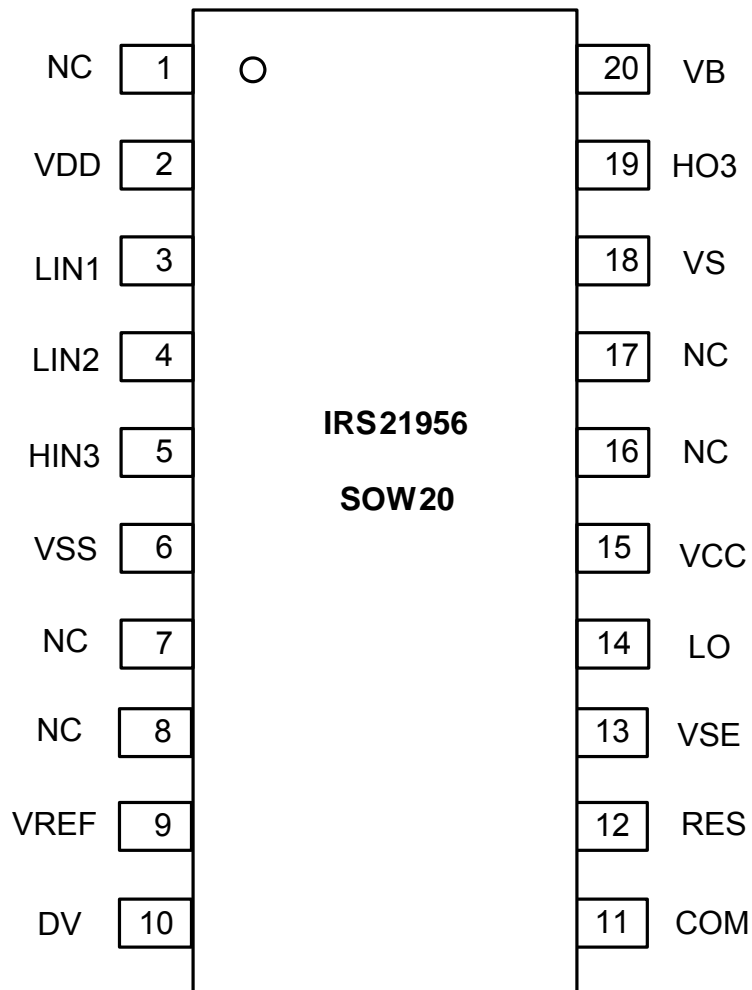




**Lead Definitions**

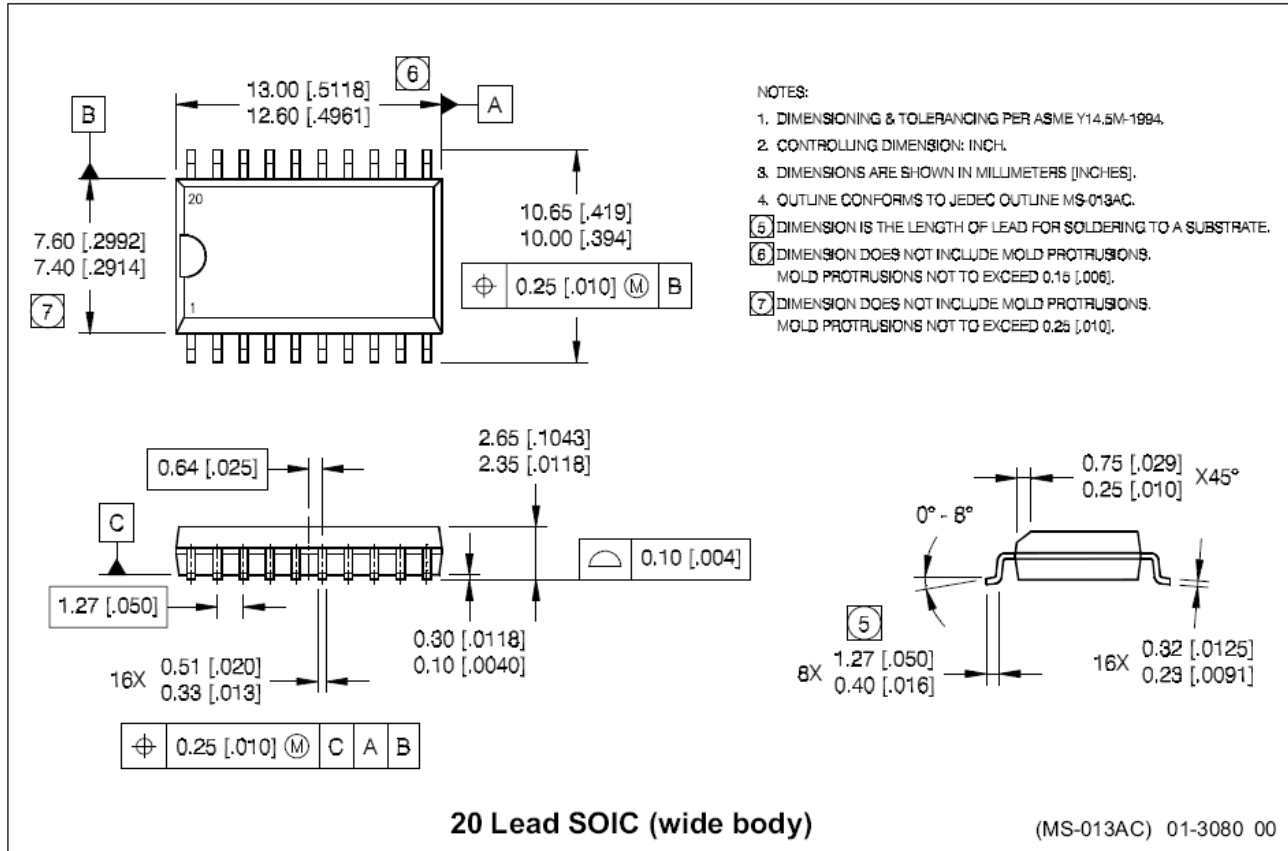
<b>PIN#</b>	<b>Symbol</b>	<b>Description</b>
1	NC	No Connection
2	VDD	Floating input supply voltage
3	LIN1	Logic input for LO ramp control
4	LIN2	Logic input for low side gate driver outputs, in phase
5	HIN3	Logic input for high side gate driver output
6	VSS	Floating input supply return
7	NC	No Connection
8	NC	No Connection
9	VREF	External programmable R/C input for ramp generation
10	DV	Ramp selection and programmable difference voltage (DV) input
11	COM	Low side supply return
12	RES	Adjustable current source resistor input
13	VSE	Voltage sense input
14	LO	Low side gate driver output
15	VCC	Low side supply voltage
16	NC	No Connection
17	NC	No Connection
18	VS	High side gate drive floating supply return
19	HO3	High side gate driver output
20	VB	High side gate drive floating supply

**Lead Assignments**

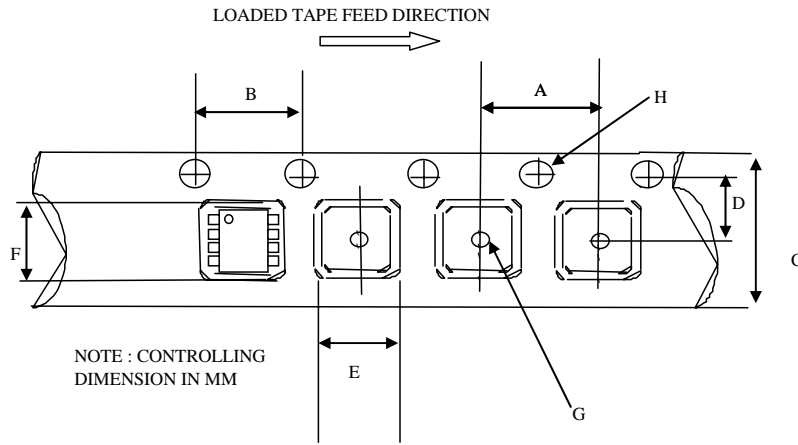


**Package 20 pin SOW**

**Package Information**

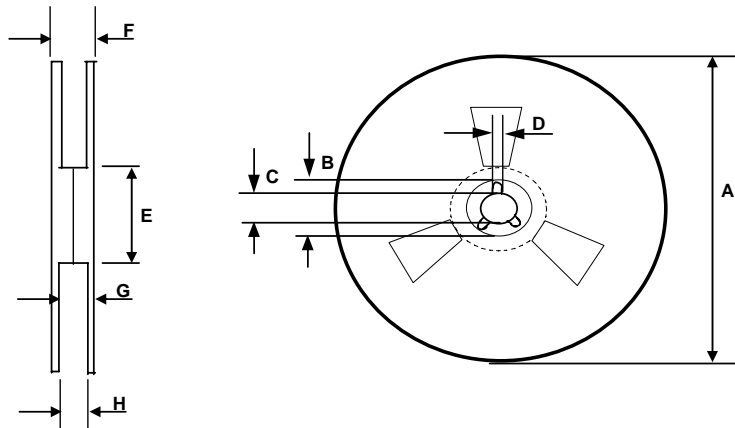


**Package Details:**



CARRIER TAPE DIMENSION FOR 20SOICW

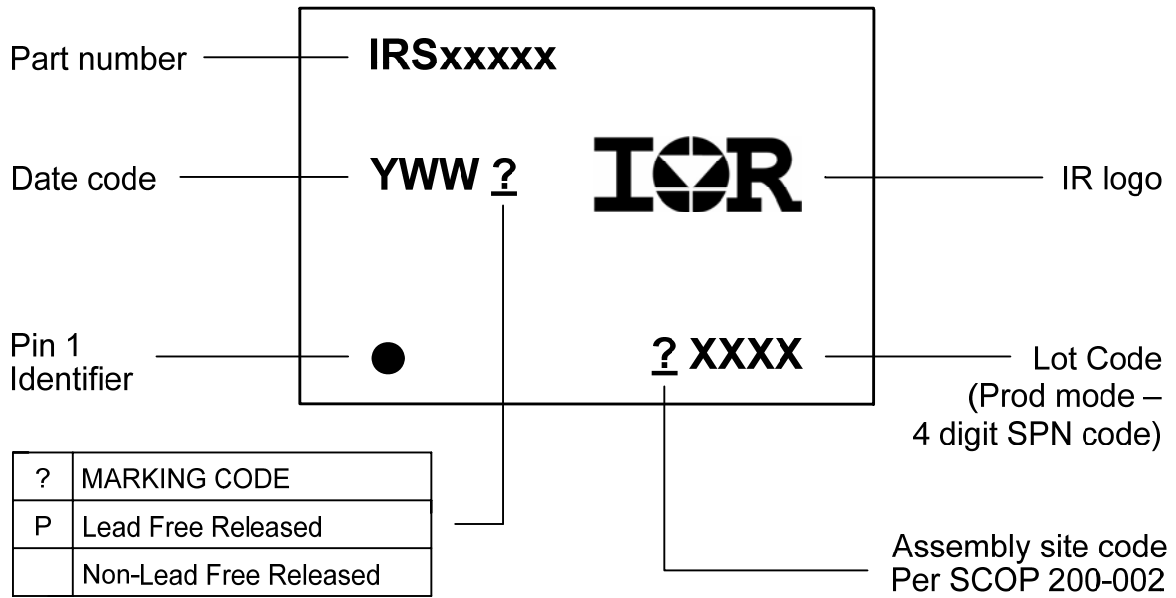
Code	Metric		Imperial	
	Min	Max	Min	Max
A	11.90	12.10	0.468	0.476
B	3.90	4.10	0.153	0.161
C	23.70	24.30	0.933	0.956
D	11.40	11.60	0.448	0.456
E	10.80	11.00	0.425	0.433
F	13.20	13.40	0.520	0.528
G	1.50	n/a	0.059	n/a
H	1.50	1.60	0.059	0.062



REEL DIMENSIONS FOR 20SOICW

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	30.40	n/a	1.196
G	26.50	29.10	1.04	1.145
H	24.40	26.40	0.96	1.039

**Part Marking Information**



**Ordering Information**

Base Part Number	Package Type	Standard Pack		Complete Part Number
		Form	Quantity	
IRS21956	SOIC20W	Tube/Bulk	38	IRS21956SPBF
		Tape and Reel	1000	IRS21956STRPBF

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