

## Automotive Grade AUIRS20161S

High Side Driver with Internal Vs Recharge

### Features

- Leadfree, RoHS compliant
- Automotive qualified\*
- One high side output and internal low side Vs recharge.
- CMOS Schmitt trigger inverted input with pull up resistor
- CMOS Schmitt trigger inverted reset with pull down resistor
- 5V compatible logic level inputs
- Immune to -Vs spike and tolerant to dVs/dt

### Typical Applications

- Common Rail Injections
- Diesel/Gasoline Direct Injections
- Solenoid Drivers

### Product Summary

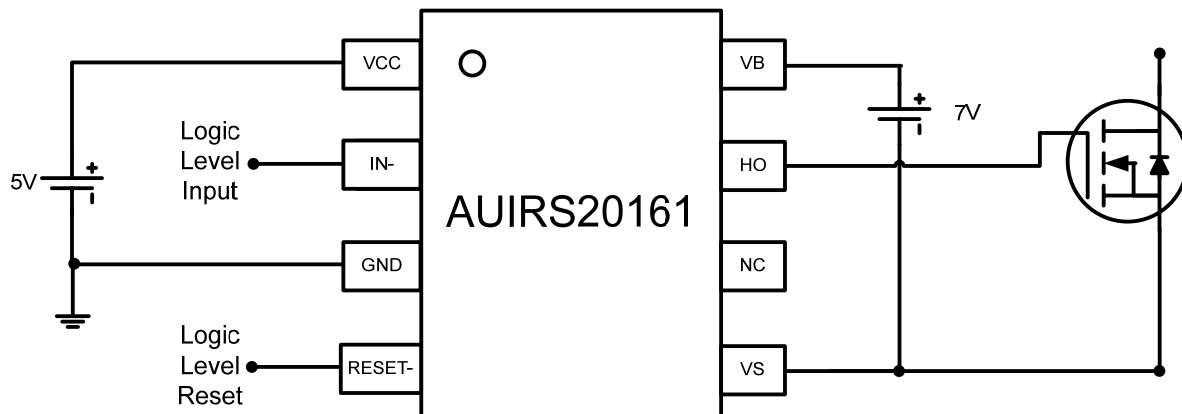
Topology	Low side input, high side driver with Vs recharge
$V_{\text{OFFSET}}$	150 V
$V_{\text{OUT}}$	4.4 V – 20 V
$I_{\text{O+}} & I_{\text{O-}}$ (typical)	0.25 A
$t_{\text{ON}} & t_{\text{OFF}}$ (typical)	150 ns
Deadtime $DT_{\text{ON}} / DT_{\text{OFF}}$ (typical)	70ns / 6 us

### Package Options



8 - Lead SOIC  
AUIRS20161S

### Typical Connection Diagram



<b>Table of Contents</b>	<b>Page</b>
Description	3
Qualification Information	4
Absolute Maximum Ratings	5
Recommended Operating Conditions	6
Electrical Characteristics	7
Functional Block Diagram	11
Input/Output Pin Equivalent Circuit Diagram	12
Lead Definitions	13
Lead Assignments	13
Application Information and Additional Details	14
Package Details	20
Tape and Reel Details	21
Part Marking Information	22
Ordering Information	23
Important Notice	24

## Description

The AUIRS20161 is a high voltage power MOSFET and IGBT high side driver with internal VS-to-GND recharge NMOS. Proprietary HVIC and latch immune CMOS technologies enable ruggedized monolithic construction. The logic input is compatible with standard 5V CMOS or LSTTL logic. The output driver features a 250mA high pulse current buffer stage. The channel can be used to drive an N-channel power MOSFET or IGBT in the high side configuration, which operates up to 150 volts above GND ground.

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

<b>Qualification Level</b>		Automotive (per AEC-Q100 <sup>††</sup> )	
		Comments: This family of ICs has passed an Automotive qualification. IR's Industrial and Consumer qualification level is granted by extension of the higher Automotive level.	
<b>Moisture Sensitivity Level</b>		SOIC8N	MSL3 <sup>†††</sup> 260°C (per IPC/JEDEC J-STD-020)
<b>ESD</b>	Machine Model	Class M1 (Pass +/-200 V) (per AEC-Q100-003)	
	Human Body Model	Class H1C (+/-2000V) (per AEC-Q100-002)	
	Charged Device Model	Class C4 (Pass +/-1000V) (per AEC-Q100-011)	
<b>IC Latch-Up Test</b>		Class II, Level A (per AEC-Q100-004)	
<b>RoHS Compliant</b>		Yes	

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

†† Exceptions to AEC-Q100 requirements are noted in the qualification report.

††† 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. These are stress ratings only, functional operation of the device at these or any other condition beyond those indicated in the “Recommended Operating Condition” is not implied. Exposure to absolute maximum-rated conditions for extended periods may affect device reliability. All voltage parameters are absolute voltages referenced to GND unless otherwise stated in the table. The thermal resistance and power dissipation ratings are measured under board mounted and still air conditions.

<b>Symbol</b>	<b>Definition</b>	<b>Min.</b>	<b>Max.</b>	<b>Units</b>
V <sub>BS</sub>	High Side Floating Supply Voltage	-0.3	20	V
V <sub>B</sub>	High Side Driver Output Stage Voltage, Neg. transient: 0.5 ms, external MOSFET off	-5.0	166	V
V <sub>S</sub>	High Side Floating Supply Offset Voltage Neg. transient 0.4 μs	-8.0	150	V
V <sub>HO</sub>	Output Voltage Gate Connection	V <sub>S</sub> – 0.3	V <sub>B</sub> + 0.3	V
V <sub>CC</sub>	Supply Voltage	-0.3	20	V
V <sub>IN</sub>	Input Voltage	-0.3	V <sub>CC</sub> + 0.3	V
I <sub>IN</sub>	Input Injection Current. Full function, no latch-up; (guaranteed by design). Test at 5V and 7V on Eng. Samples.	---	+1	mA
V <sub>RES</sub>	Reset Input Voltage	-0.3	V <sub>CC</sub> + 0.3	V
dV/dt	Allowable Offset Voltage Slew Rate	-50	50	V/nsec
R <sub>thJA</sub>	Thermal resistance, junction to ambient	-	200	°C/W
T <sub>J</sub>	Junction Temperature	-55	150	°C
T <sub>S</sub>	Storage Temperature	-55	150	°C

**Recommended Operating Conditions**

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

Symbol	Definition	Min.	Max.	Units
$V_B^{\dagger}$	High Side Driver Output Stage Voltage	$V_S+4.4$	$V_S+20$	V
$V_S$	High Side Floating Supply Offset Voltage	-3	150	V
$V_{HO}$	Output Voltage Gate	$V_S$	$V_B$	V
$V_{CC}$	Supply Voltage	4.4	6.5	V
$V_{IN}$	Input Voltage	0	$V_{CC}$	V
$V_{RES}$	Reset Input Voltage	0	$V_{CC}$	V
$T_a$	Ambient Temperature	-40	125	°C
$f_s$	Switching frequency <sup>††</sup> (load: 50 Ohm, 2.5nF into $V_S$ )	---	200	kHz
$t_{inlowmin}$	Minimum low input width <sup>†††</sup>	1000	---	ns
$t_{inhighmin}$	Minimum high input width <sup>†††</sup>	60	---	ns

<sup>†</sup> Reset-logic functional for  $V_{BS} > 2V$

<sup>††</sup> Duty cycle = 0.5,  $V_{BS} = 7 V$

<sup>†††</sup> Guaranteed by design. Pulse width below the specified values may be ignored. Output will either follow the input or will ignore it. No false output state is guaranteed when minimum input width is smaller than  $t_{in}$ .

**Electrical Characteristics**

Unless otherwise specified,  $V_{CC} = 5V$ ,  $V_{BS} = 7V$ ,  $V_S = 0V$ ,  $I_N = 0V$ ,  $RES = 5V$ , load  $R = 50\Omega$ ,  $C = 2.5nF$ . Unless otherwise noted, these specifications apply for an operating junction temperature range of  $-40^{\circ}C \leq T_j \leq 125^{\circ}C$ .

Symbol	Definition	Min	Typ	Max	Units	Test Conditions
<b>V<sub>CC</sub> Supply Characteristics</b>						
$V_{CCUV+}$	$V_{CC}$ Supply Undervoltage Positive Going Threshold			4.3	V	$V_{CC}$ rising from 0V
$V_{CCUV-}$	$V_{CC}$ Supply Undervoltage Negative Going Threshold	2.8				$V_{CC}$ dropping from 5V
$V_{CCUVHYS}$	$V_{CC}$ Supply Undervoltage Lockout Hysteresis	0.02	0.3	0.60		
$t_{dUVCC}$	Undervoltage Lockout Response Time	0.5		20	$\mu\text{sec}$	$V_{CC}$ steps either from 6.5V to 2.7V or from 2.7V to 6.5V
$I_{QCC}$	$V_{CC}$ Supply Current			400	$\mu\text{A}$	$V_{CC} = 3.6V$ & $6.5V$
<b>V<sub>BS</sub> Supply Characteristics</b>						
$V_{BSUV+}$	$V_{BS}$ Supply Undervoltage Positive Going Threshold			4.3	V	$V_{BS}$ rising from 0V
$V_{BSUV-}$	$V_{BS}$ Supply Undervoltage Negative Going Threshold	2.8				$V_{BS}$ dropping from 5V
$V_{BSUVHYS}$	$V_{BS}$ Supply Undervoltage Lockout Hysteresis	0.02	0.3	0.60		
$t_{dUVBS}$	Undervoltage Lockout Response Time	0.5		20	$\mu\text{sec}$	$V_{BS}$ steps either from 6.5V to 2.7V or from 2.7V to 6.5V
$I_{QBS1}$	$V_{BS}$ Supply Current			130	$\mu\text{A}$	static mode, $V_{BS} = 7V$ , $I_N = 0V$ or 5V
$I_{QBS2}$	$V_{BS}$ Supply Current			300	$\mu\text{A}$	static mode, $V_{BS} = 16V$ , $I_N = 0V$ or 5V
$\Delta V_{BS}$	$V_{BS}$ Drop Due to Output Turn-On			210	mV	$V_{BS} = 7V$ , $C_{BS} = 1\mu\text{F}$ , $t_{dIG-IN} = 3\mu\text{sec}$ , $t_{TEST} = 100\mu\text{sec}$

**Electrical Characteristics**

Unless otherwise specified,  $V_{CC} = 5V$ ,  $V_{BS} = 7V$ ,  $V_S = 0V$ ,  $I_N = 0V$ ,  $R_{ES} = 5V$ , load  $R = 50\Omega$ ,  $C = 2.5nF$ . Unless otherwise noted, these specifications apply for an operating junction temperature range of  $-40^\circ C \leq T_j \leq 125^\circ C$ .

Symbol	Definition	Min	Typ	Max	Units	Test Conditions
<b>Gate Driver Characteristics</b>						
$I_{PKSo1}$	Peak Output Source Current	120	250		mA	$T_j = 25^\circ C, ^{††}$
$I_{PKSo2}$	Peak Output Source Current	70			mA	$^{††}$
$I_{PKSo3}$	Peak Output Source Current	250	500		mA	$V_{BS} = 16V, T_j = 25^\circ C^{††}$
$I_{PKSo4}$	Peak Output Source Current	150			mA	$V_{BS} = 16V^{††}$
$I_{HO,off}$	HO off-state leakage current			1	$\mu A$	HO forced at +100mV and -100mV with all other pins at 0V.
$t_{r1}$	Output Rise Time		0.2	0.4	$\mu sec$	$T_j = 25^\circ C$
$t_{r2}$	Output Rise Time			0.5	$\mu sec$	
$t_{r3}$	Output Rise Time		0.1	0.2	$\mu sec$	$V_{BS} = 16V, T_j = 25^\circ C$
$t_{r4}$	Output Rise Time			0.3	$\mu sec$	$V_{BS} = 16V$
$I_{PKSi1}$	Peak Output Sink Current	120	250		mA	$I_N = 5V, T_j = 25^\circ C^{††}$
$I_{PKSi2}$	Peak Output Sink Current	70			mA	$I_N = 5V, ^{††}$
$I_{PKSi3}$	Peak Output Sink Current	250	500		mA	$V_{BS} = 16V, I_N = 5V, T_j = 25^\circ C^{††}$
$I_{PKSi4}$	Peak Output Sink Current	150			mA	$V_{BS} = 16V, I_N = 5V^{††}$
$t_{f1}$	Output Fall Time		0.2	0.4	$\mu sec$	$I_N = 5V, T_j = 25^\circ C$
$t_{f2}$	Output Fall Time			0.5	$\mu sec$	$I_N = 5V$
$t_{f3}$	Output Fall Time		0.1	0.2	$\mu sec$	$V_{BS} = 16V, I_N = 5V, T_j = 25^\circ C$
$t_{f4}$	Output Fall Time			0.3	$\mu sec$	$V_{BS} = 16V, I_N = 5V$

$^{††}$  : Peak Output Sink and Source Current tests are performed with the output shorted and therefore highly dissipative. Therefore, it is not recommended that this test be performed for longer than 10usec at a time.



**Electrical Characteristics**

Unless otherwise specified,  $V_{CC} = 5V$ ,  $V_{BS} = 7V$ ,  $V_S = 0V$ ,  $I_N = 0V$ ,  $RES = 5V$ , load  $R = 50\Omega$ ,  $C = 2.5nF$ . Unless otherwise noted, these specifications apply for an operating junction temperature range of  $-40^{\circ}C \leq T_j \leq 125^{\circ}C$ .

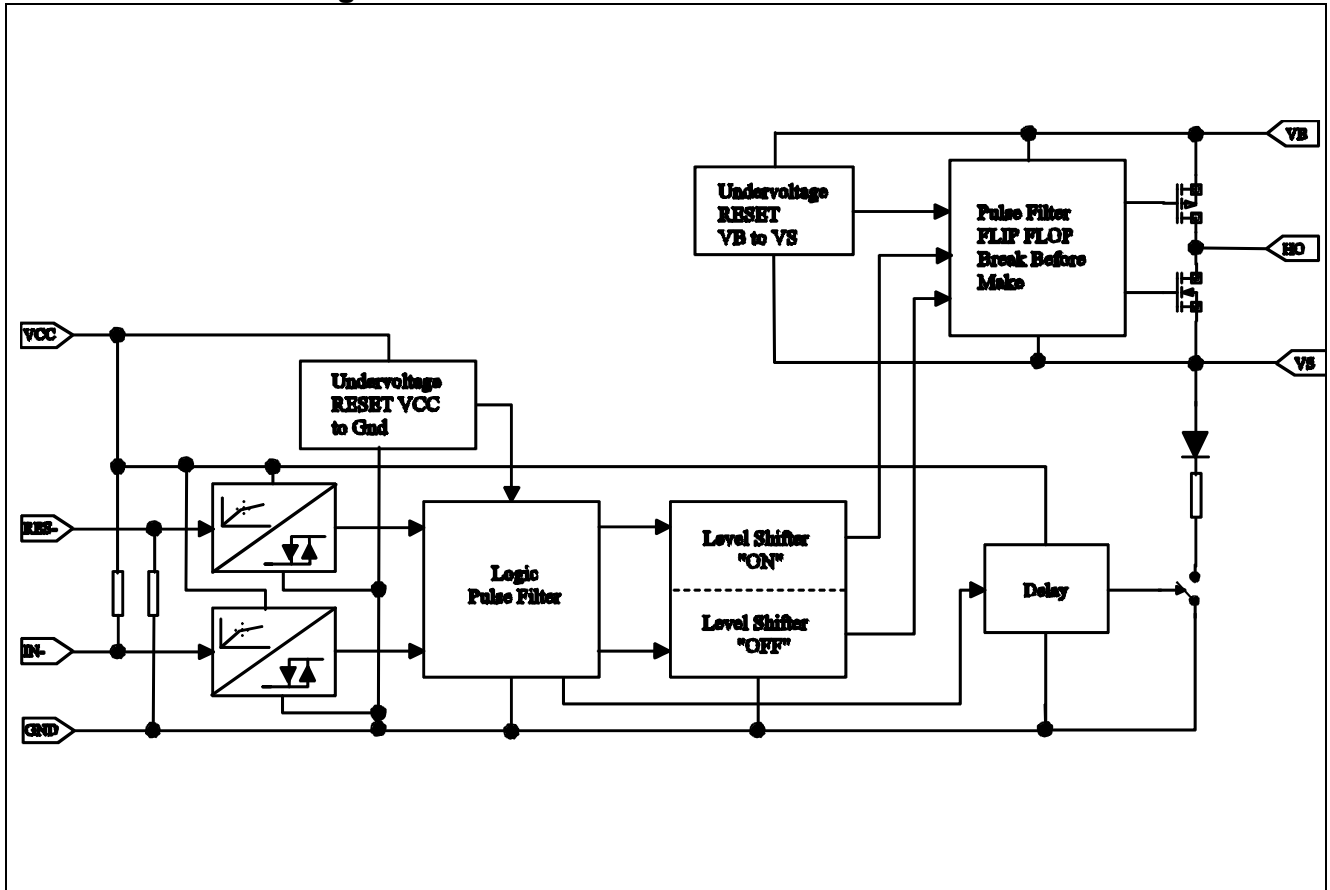
Symbol	Definition	Min	Typ	Max	Units	Test Conditions
$t_{plh}$	Input-to-Output Turn-On Propagation Delay (50% input level to 10% output level)		0.15	0.35	$\mu\text{sec}$	
$t_{phl}$	Input-to-Output Turn-Off Propagation Delay (50% input level to 90% output level)		0.15	0.35	$\mu\text{sec}$	
$t_{ph\_res}$	RES-to-Output Turn-Off Propagation Delay (50% input level to 90% [ $t_{phl}$ ] output levels)		0.15	0.35	$\mu\text{sec}$	
$t_{plh\_res}$	RES-to-Output Turn-On Propagation Delay (50% input level to 10% [ $t_{plh}$ ] output levels)		0.15	0.35	$\mu\text{sec}$	

**Electrical Characteristics**

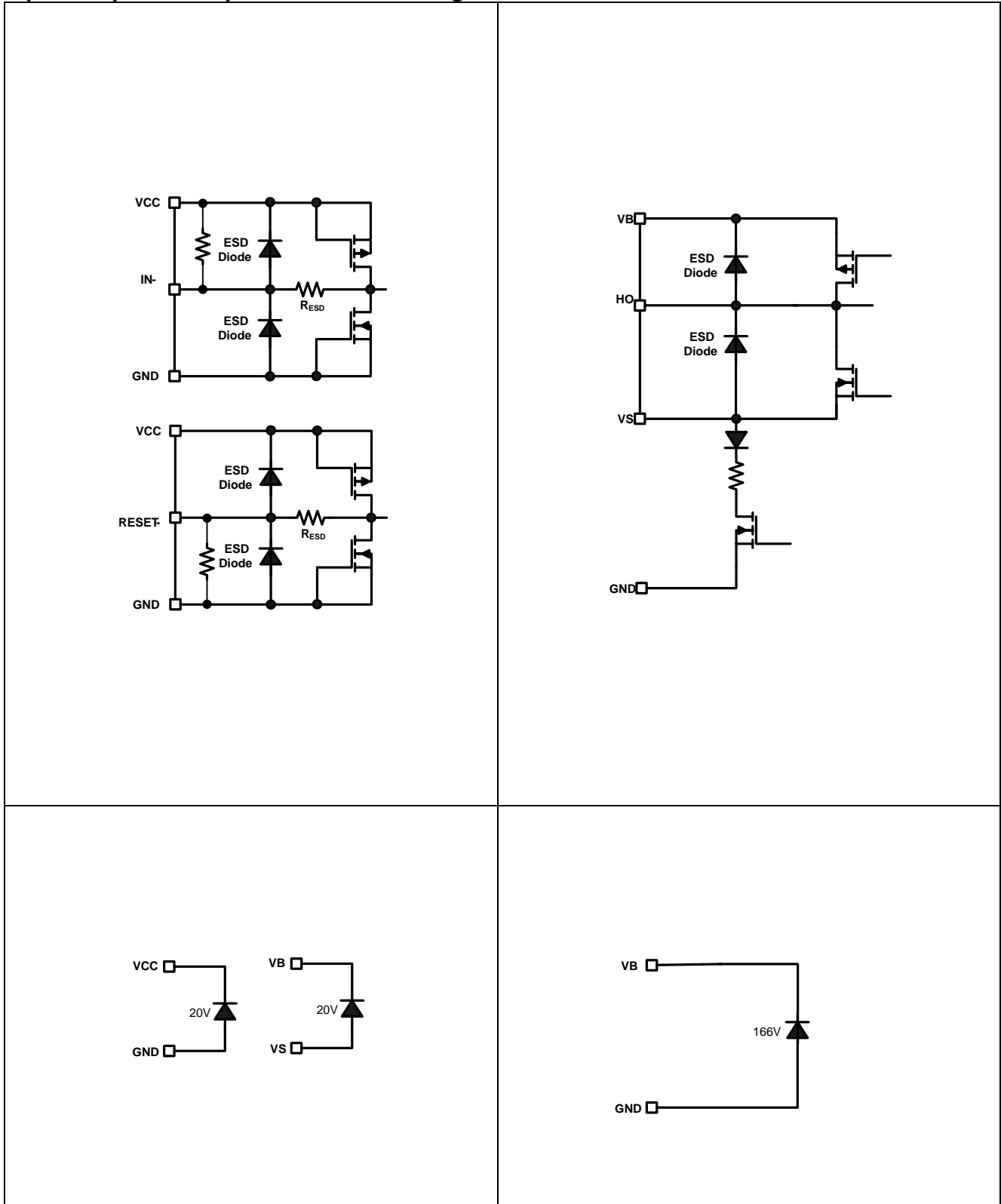
Unless otherwise specified,  $V_{CC} = 5V$ ,  $V_{BS} = 7V$ ,  $V_S = 0V$ ,  $I_N = 0V$ ,  $R_{ES} = 5V$ , load  $R = 50\Omega$ ,  $C = 2.5nF$ . Unless otherwise noted, these specifications apply for an operating junction temperature range of  $-40^{\circ}C \leq T_j \leq 125^{\circ}C$ .

Symbol	Definition	Min	Typ	Max	Units	Test Conditions
<b>Input Characteristics</b>						
$V_{INH}$	High Logic Level Input Threshold	0.6* $V_{CC}$			V	$V_{CC}=5V$
$V_{INL}$	Low Logic Level Input Threshold			0.28* $V_{CC}$	V	$V_{CC}=5V$
$R_{IN}$	IN pull up Input Resistance	60	100	220	$k\Omega$	
$I_{IN}$	High Logic Level Input Current			5	$\mu A$	$V_{IN}= V_{CC}$
$V_{H\_RES}$	High Logic Level RES Input Threshold	0.6* $V_{CC}$			V	$V_{CC} =5V$
$V_{L\_RES}$	Low Logic Level RES Input Threshold			0.28* $V_{CC}$	V	$V_{CC} =5V$
$R_{RES}$	RES pull down Input Resistance	60	100	220	$k\Omega$	
$I_{RES}$	Low Logic Level Input Current			5	$\mu A$	$V_{RES}=0$
<b>Recharge Characteristics</b>						
$t_{on\_rech}$	Recharge Transistor Turn-On Propagation Delay	3	6	9	$\mu sec$	$V_S = 5V$
$t_{off\_rech}$	Recharge Transistor Turn-Off Propagation Delay		0.08	0.2	$\mu sec$	
$V_{RECH}$	Recharge Output Transistor On-State Voltage Drop			1.2	V	$I_S = 1mA, I_N = 5V.$
<b>Deadtime Characteristics</b>						
$DT_{HOFF}$	High Side Turn-Off to Recharge gate Turn-On	3	6	9	$\mu sec$	$V_{CC} = 5V, V_{BS} = 7V$
$DT_{HON}$	Recharge gate Turn-Off to High Side Turn-On	0.01	0.07	0.4	$\mu sec$	$V_{CC} = 5V, V_{BS} = 7V$

**Functional Block Diagram**



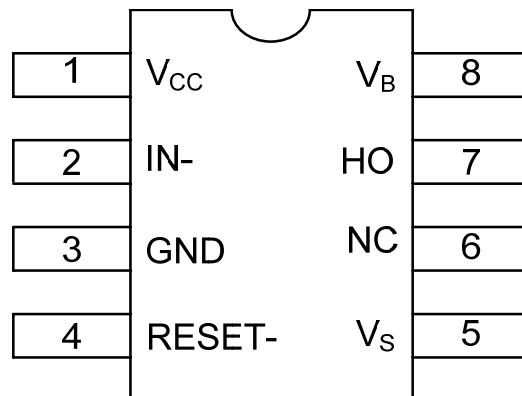
**Input/Output Pin Equivalent Circuit Diagrams**



**Lead Definitions**

Pin Number	Symbol	Pin description
1	V <sub>CC</sub>	Driver Supply, typically 5.0V
2	IN-	Driver Control Signal Input (negative logic)
3	GND	Ground
4	RESET-	Driver Enable Signal Input (negative logic)
5	V <sub>S</sub>	MOSFET Source Connection
6	NC	No Connection (no Bondwire)
7	HO	MOSFET Gate Connection
8	V <sub>B</sub>	Driver Output Stage Supply

**Lead Assignments**



8 Lead SOIC

**Application Information and Additional Details**

A Truth table for  $V_{CC}$ ,  $V_{BS}$ , RESET, IN,  $H_o$  and RechFET is shown as follows. This truth table is for ACTIVE LOW IN.

supply voltages and thresholds		Signals		Output $H_o$	Recharge Path
$V_{CC}$	$V_{BS}$	RESET-	IN-		
$< V_{CCUV-}$	X	X	X	OFF	ON
X	X	LOW	X	OFF	ON
X	X	X	HIGH	OFF	ON
$> V_{CCUV+}$	$> V_{BSUV+}$	HIGH	LOW	ON	OFF
$> V_{CCUV+}$	$< V_{BSUV-}$	HIGH	LOW	OFF	OFF

X means independent from signal

Recharge Path = ON indicates that the recharge MOSFET is on.  
 Recharge Path = OFF indicates that the recharge MOSFET is off.

**Timing Diagrams**

**Input / Output**

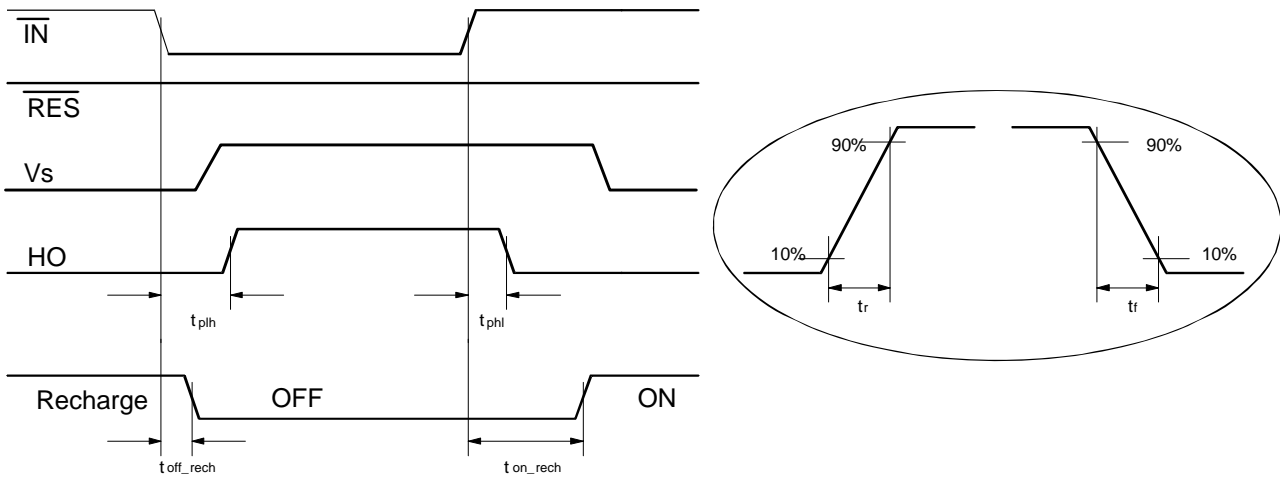


Figure 3: Input/Output Timing Diagram

**Reset**

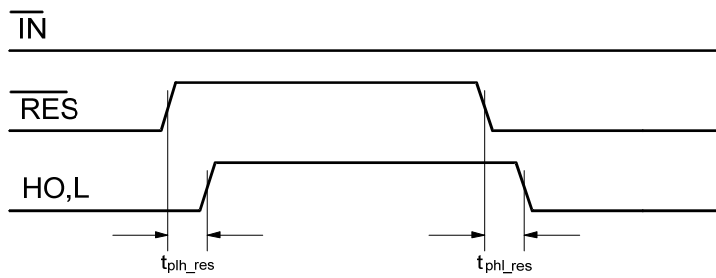
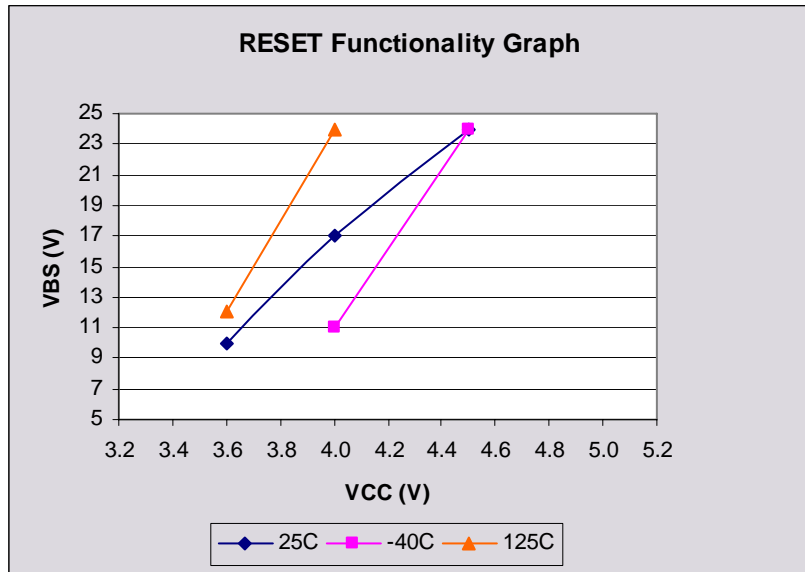


Figure 4: Reset Timing Diagram

Performance Graphs

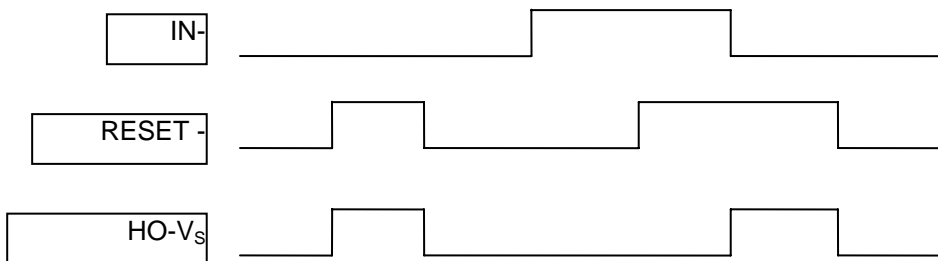
**RESET Functionality Graph:**



**Figure 6. RESET Functionality:**

This graph explains the functionality limitation as a function of  $V_{CC}$ ,  $V_{BS}$  and temperature. For each particular temperature and  $V_{CC}$ , the output is non-functional for any value of  $V_{BS}$  above the drawn curve. But for any value of  $V_{BS}$  below the curve the functionality is fine.

**RESET Functional Diagram:**





**Parameter Temperature Trends**

Figures illustrated in this chapter provide information on the experimental performance of the AUIRS20161S HVIC. The line plotted in each figure is generated from actual lab data. A large number of individual samples were tested at three temperatures (-40 °C, 25 °C, and 125 °C) in order to generate the experimental curve. The line consists of three data points (one data point at each of the tested temperatures) that have been connected together to illustrate the understood trend. The individual data points on the Typ. curve were determined by calculating the averaged experimental value of the parameter (for a given temperature).

**Input and Reset Thresholds:**

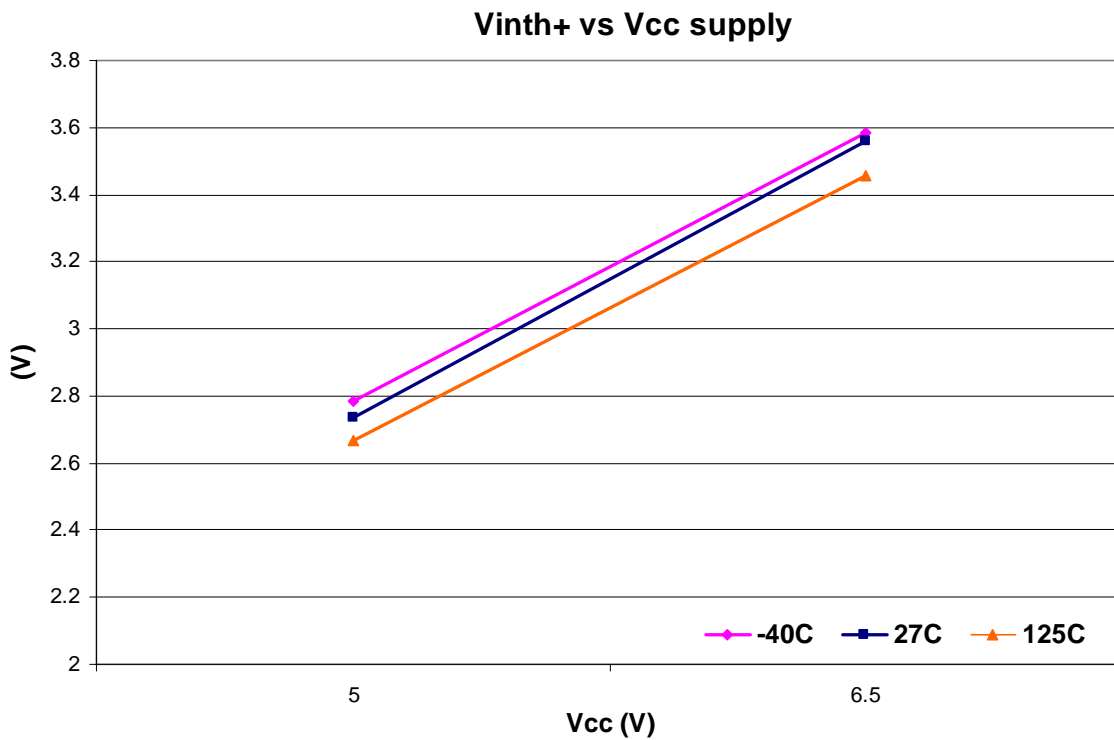


Figure 7-1: Positive Input and Reset Threshold Voltage Distribution Curves

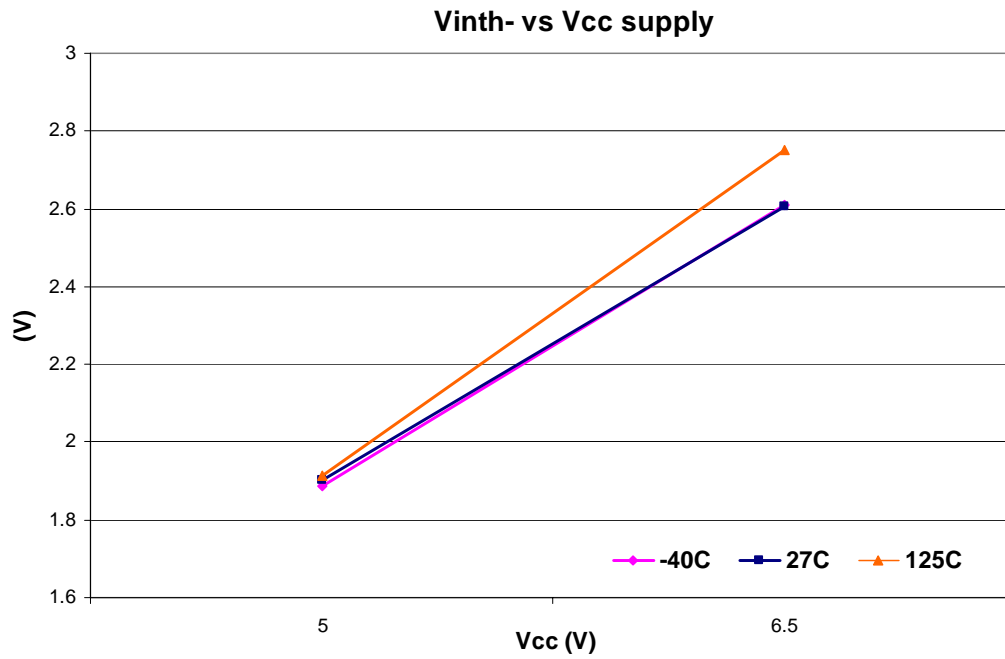


Figure 7-2: Negative Input and Reset Threshold Voltage Distribution Curves

**V<sub>BUV</sub> Undervoltage Shutdown Threshold V<sub>B</sub>:**

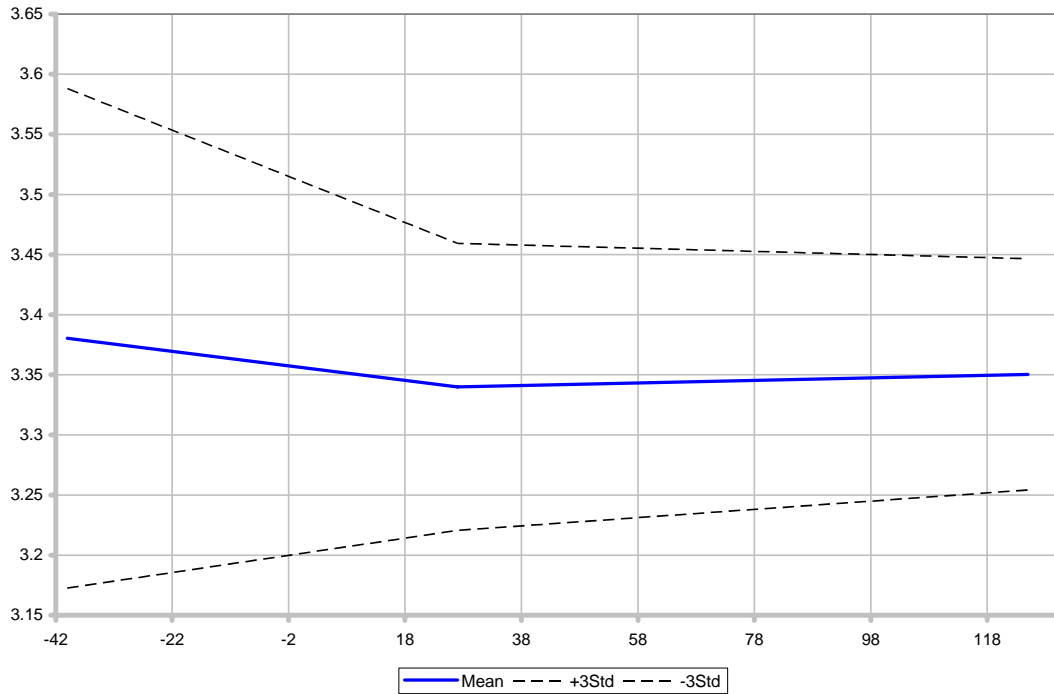


Figure 8-1: Negative going VBSUV- value vs. Temperature:

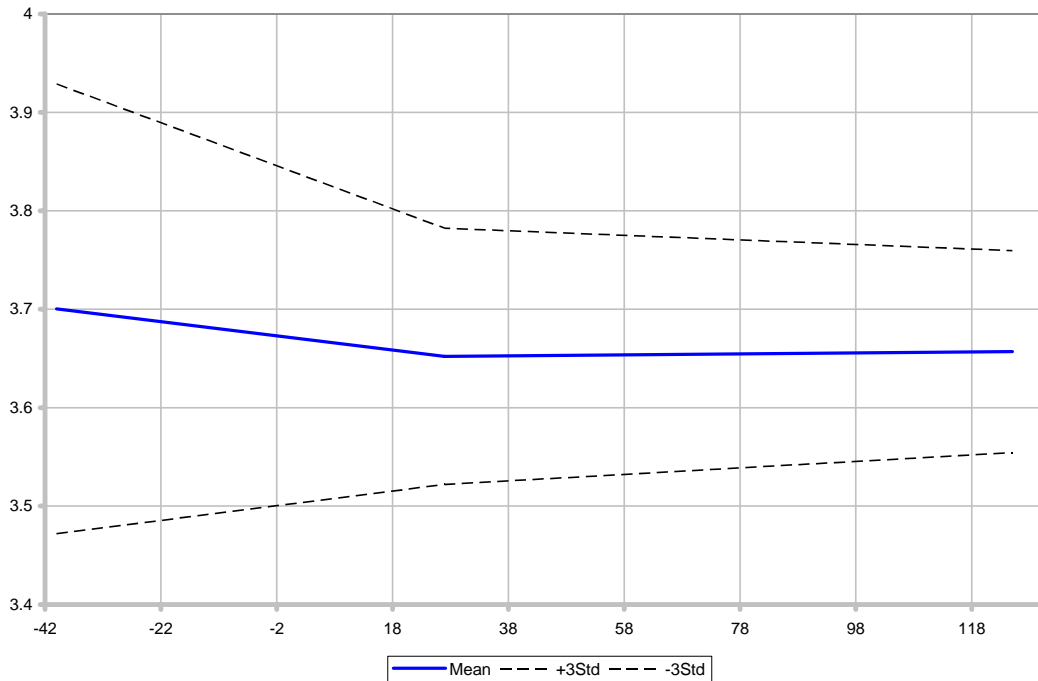


Figure 8-2: Positive going VBSUV+ Value vs. Temperature

**Input and Reset Impedance**

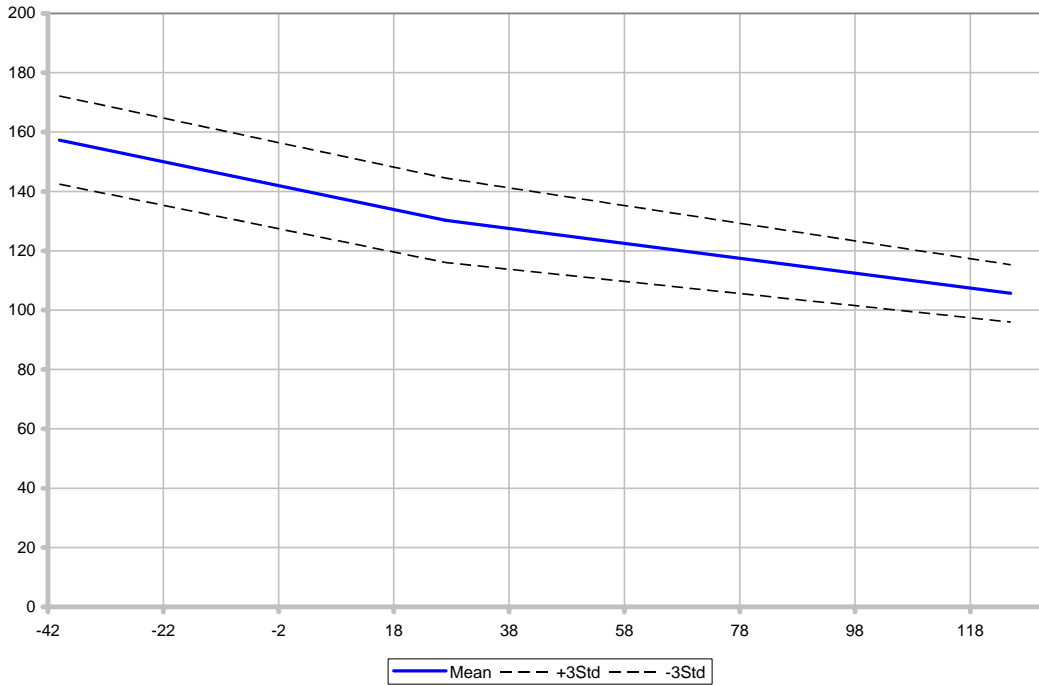


Figure 9: Input and Reset Impedance Distribution Curves vs. Temperature

**Recharge FET I-V Curve**

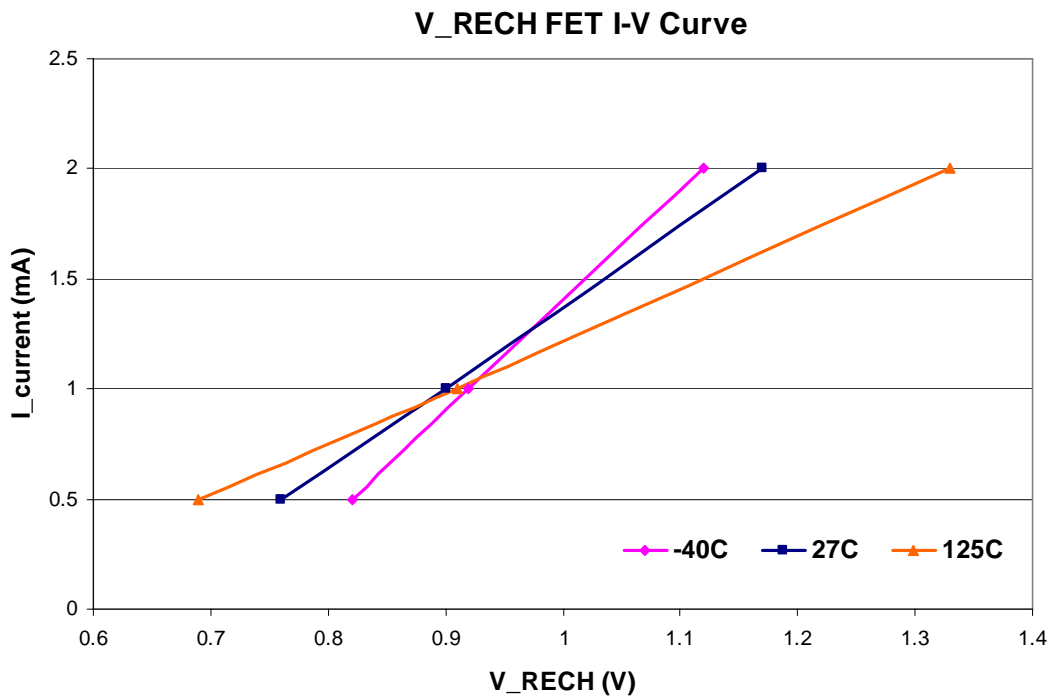
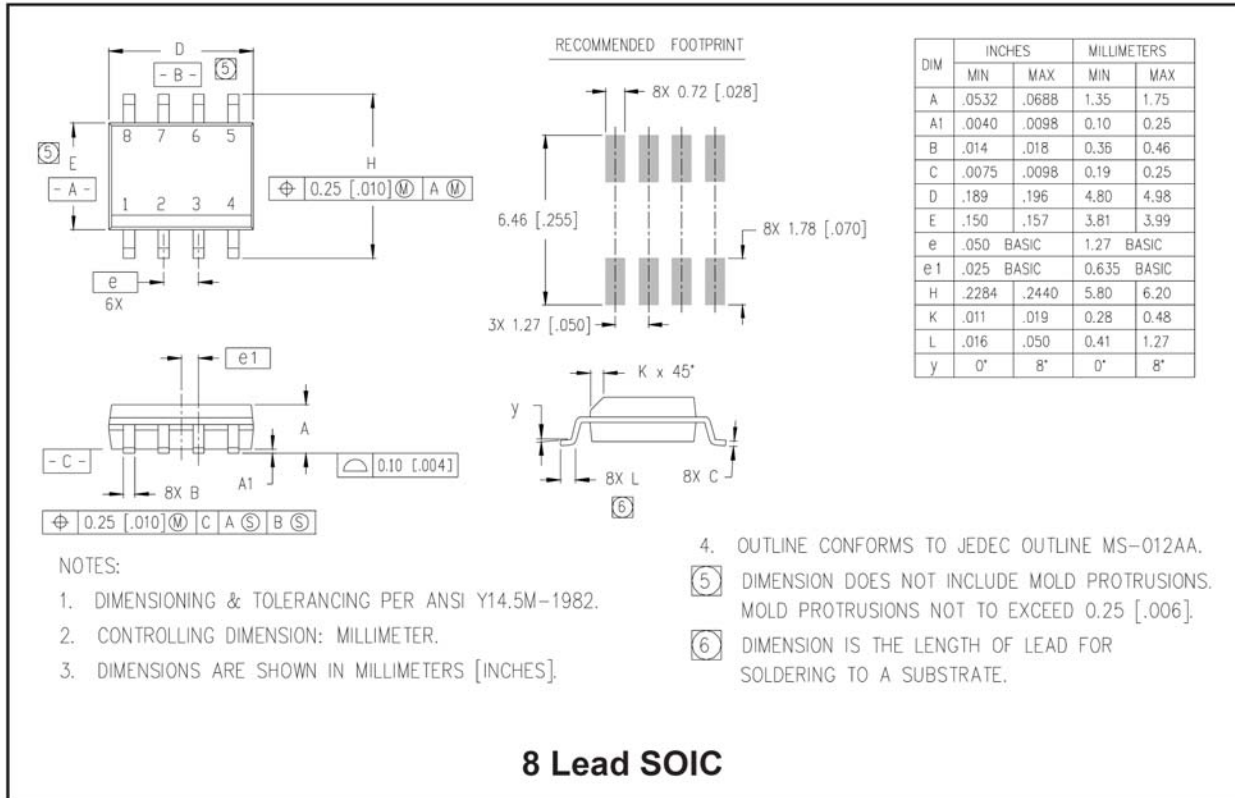
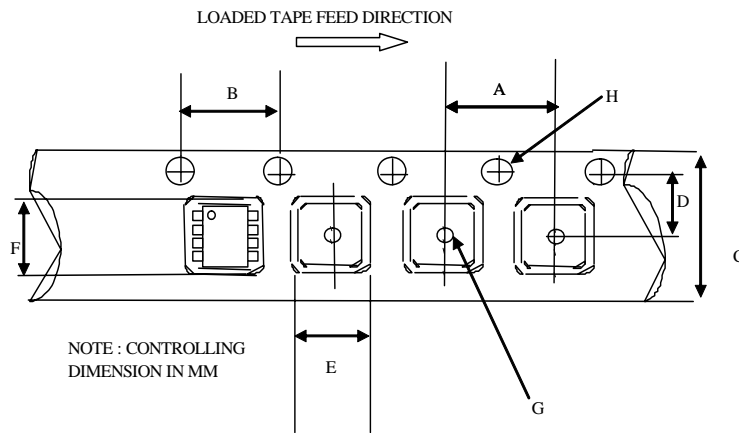


Figure 10: Recharge FET IV-Curve

**Package Details: SOIC8**

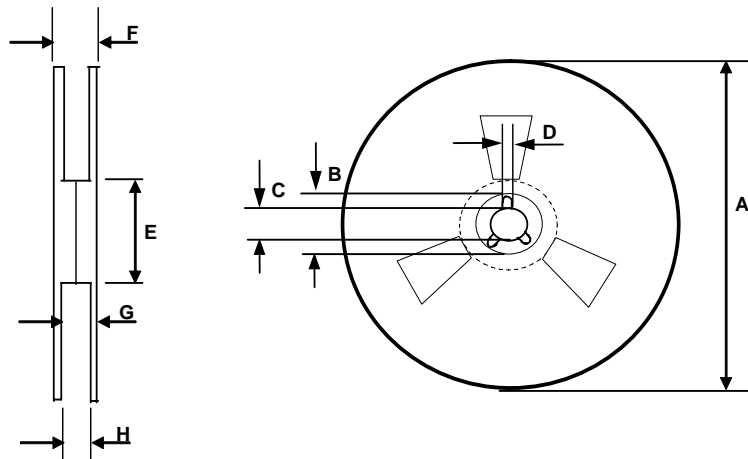


**Tape and Reel Details: SOIC8**



CARRIER TAPE DIMENSION FOR 8SOICN

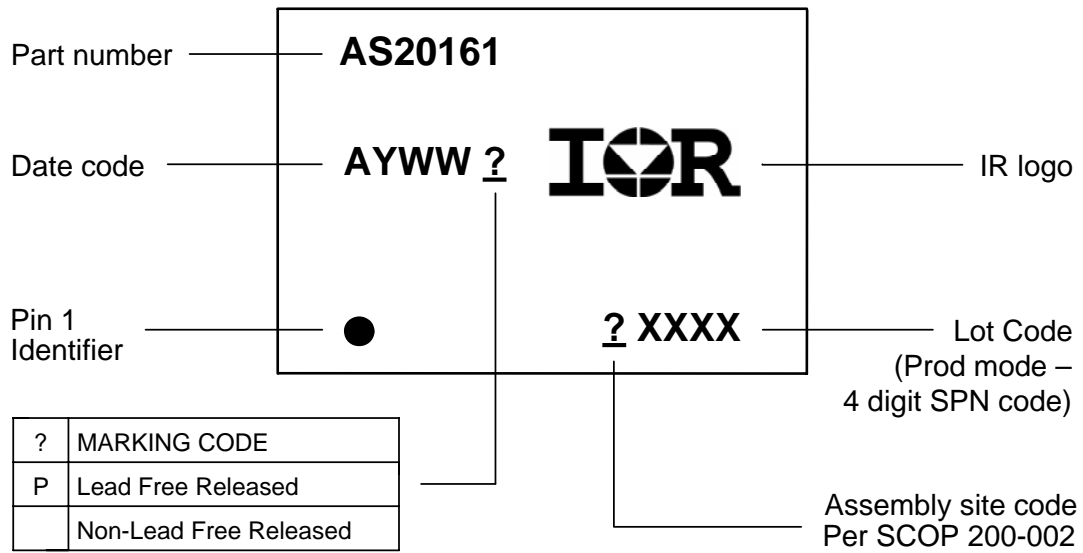
Code	Metric		Imperial	
	Min	Max	Min	Max
A	7.90	8.10	0.311	0.318
B	3.90	4.10	0.153	0.161
C	11.70	12.30	0.46	0.484
D	5.45	5.55	0.214	0.218
E	6.30	6.50	0.248	0.255
F	5.10	5.30	0.200	0.208
G	1.50	n/a	0.059	n/a
H	1.50	1.60	0.059	0.062



REEL DIMENSIONS FOR 8SOICN

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	18.40	n/a	0.724
G	14.50	17.10	0.570	0.673
H	12.40	14.40	0.488	0.566

**Part Marking Information**



**Ordering Information**

Base Part Number	Package Type	Standard Pack		Complete Part Number
		Form	Quantity	
AUIRS20161S(TR)	SOIC8	Tube/Bulk	95	AUIRS20161S
		Tape and Reel	2500	AUIRS20161STR



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