International
IOR Rectifier

January 26 2009

Automotive Grade AUIRS2016S(TR)

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

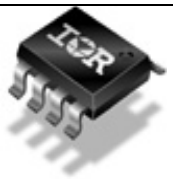
Typical Applications

- Common-rail magnetic valve application

Product Summary

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

Package Options



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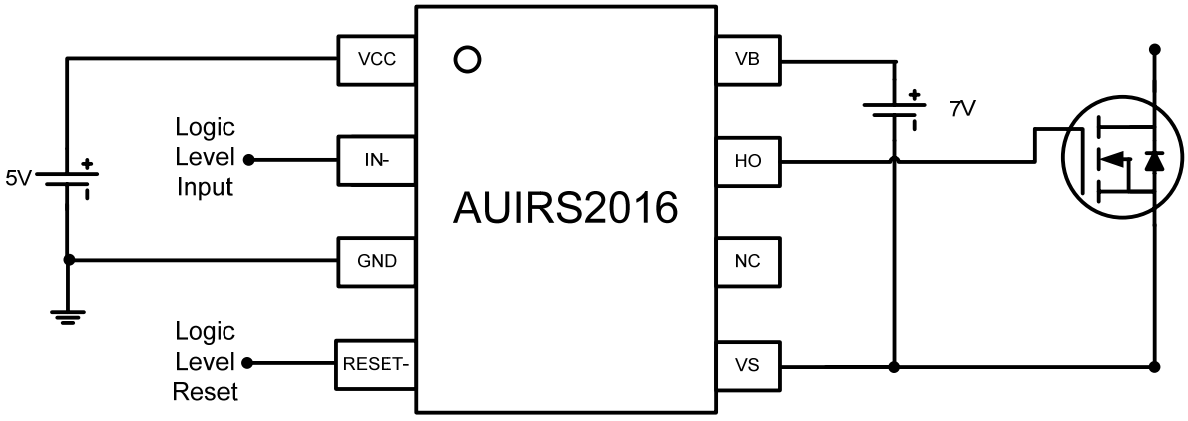
Typical Connection Diagram



* Qualification standards can be found on IR's web site ww.irf.com

Description

The AUIRS2016 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†

Qualification Level		Automotive (per AEC-Q100††)	
		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.	
Moisture Sensitivity Level		SOIC8	MSL3††† 260°C (per IPC/JEDEC J-STD-020)
ESD	Machine Model	Class M1 (per AEC-Q100-003)	
	Human Body Model	Class H2 (per AEC-Q100-002)	
	Charged Device Model	Class C5 (per AEC-Q100-011)	
IC Latch-Up Test		Class II, Level A (per AEC-Q100-004)	
RoHS Compliant		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. All voltage parameters are absolute voltages referenced to GND, all currents are defined positive into any lead. An operation above the absolute maximum limit is not implied and could damage the part.

Symbol	Definition	Min.	Max.	Units
V_{BS}	High Side Floating Supply Voltage	-0.3	20	V
V_B	High Side Driver Output Stage Voltage, Neg. transient: 0.5 ms, external MOSFET off	-5.0	166	V
V_S	High Side Floating Supply Offset Voltage Neg. transient 0.4 µs	-8.0	150	V
VH_O	Output Voltage Gate Connection	V_S – 0.3	V_B + 0.3	V
V_{CC}	Supply Voltage	-0.3	20	V
V_{IN}	Input Voltage	-0.3	V_{CC} + 0.3	V
I_{IN}	Input Injection Current. Full function, no latch-up; (guaranteed by design). Test at 5V and 7V on Eng. Samples.	---	+1	mA
V_{RES}	Reset Input Voltage	-0.3	V_{CC} + 0.3	V
V_{ESD}	Electrostatic Discharge Voltage(Human body model)	2k		V
V_{CDM}	Charge Device Model CDM, EOS/ESD Ass. Std 5.3. Number of discharges per pin: 6	2K		V
dV/dt	Allowable Offset Voltage Slew Rate	-50	50	V/nsec
T_J	Junction Temperature	-55	150	
T_S	Storage Temperature	-55	150	ºC

Recommended Operating Conditions

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

Symbol	Definition	Min.	Max.	Units
V_B 1)	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
Ta	Ambient Temperature (V_{BS} =14V¸load: 50 Ohm 2.5nF into V_S)	-40	125	ºC
f_s	Switching frequency 2)	---	200	kHz
$t_{inlowmin}$	Minimum low input width 3)	1000	---	ns
$t_{inlhighin}$	Minimum high input width 3)	60	---	ns

1) Reset-logic functional for VBS > 2V

2) Duty cycle = 0.5, V_{BS} = 7 V

3) 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, IN = 0V, RES = 5V, load R = 50Ω, C = 2.5nF. Unless otherwise noted, these specifications apply for an operating junction temperature range of -40°C ≤ Tj ≤ 125°C.

Symbol	Definition	Min	Typ	Max	Units	Test Conditions
VCC Supply Characteristics						
V_{CCUV+}	VCC Supply Undervoltage Positive Going Threshold			4.3	V	VCC rising from 0V
V_{CCUV-}	VCC Supply Undervoltage Negative Going Threshold	2.8				Vcc dropping from 5V
$V_{CCUVHYS}$	VCC Supply Undervoltage Lockout Hysteresis	0.02	0.3	0.60		
tdUVCC	Undervoltage Lockout Response Time	0.5		20	µsec	VCC steps either from 6.5V to 2.7V or from 2.7V to 6.5V
IQCC	VCC Supply Current			400	uA	VCC = 3.6V & 6.5V
VBS Supply Characteristics						
V_{BSUV+}	VBS Supply Undervoltage Positive Going Threshold			4.3	V	VBS rising from 0V
V_{BSUV-}	VBS Supply Undervoltage Negative Going Threshold	2.8				VBS dropping from 5V
$V_{BSUVHYS}$	VBS Supply Undervoltage Lockout Hysteresis	0.02	0.3	0.60		
tdUVBS	Undervoltage Lockout Response Time	0.5		20	µsec	VBS steps either from 6.5V to 2.7V or from 2.7V to 6.5V
IQBS1	VBS Supply Current			130	µA	static mode, VBS = 7V, IN = 0V or 5V
IQBS2	VBS Supply Current			200	µA	static mode, VBS = 16V, IN = 0V or 5V
ΔVBS	VBS Drop Due to Output Turn-On			210	mV	VBS = 7V, CBS = 1µF, tdIG-IN = 3µsec, t_{TEST} = 100µsec

Electrical Characteristics

Unless otherwise specified, V_{CC} = 5V, V_{BS} = 7V, V_S = 0V, IN = 0V, RES = 5V, load R = 50Ω, C = 2.5nF. Unless otherwise noted, these specifications apply for an operating junction temperature range of -40°C ≤ Tj ≤ 125°C.

Symbol	Definition	Min	Typ	Max	Units	Test Conditions
Gate Driver Characteristics						
I_{PKSo1}	Peak Output Source Current	120	250		mA	Tj = 25°C, (Note 2)
I_{PKSo2}	Peak Output Source Current	70	150		mA	(Note 2)
I_{PKSo3}	Peak Output Source Current	250	500		mA	V_{BS} = 16V, Tj = 25°C††
I_{PKSo4}	Peak Output Source Current	150	300		mA	V_{BS} = 16V††
$I_{HO,off}$	HO off-state leakage current (guaranteed by design)			1	uA	
t_{r1}	Output Rise Time		0.2	0.4	µsec	Tj = 25°C
t_{r2}	Output Rise Time		0.3	0.5	µsec	
t_{r3}	Output Rise Time		0.1	0.2	µsec	V_{BS} = 16V, Tj = 25°C
t_{r4}	Output Rise Time		0.15	0.3	µsec	V_{BS} = 16V
I_{PKSi1}	Peak Output Sink Current	120	250		mA	IN = 5V, Tj = 25°C††
I_{PKSi2}	Peak Output Sink Current	70	150		mA	IN = 5V, (Note 2)
I_{PKSi3}	Peak Output Sink Current	250	500		mA	V_{BS} = 16V, IN = 5V, Tj = 25°C, (Note 2)
I_{PKSi4}	Peak Output Sink Current	150	300		mA	V_{BS} = 16V, IN = 5V††
t_{f1}	Output Fall Time		0.2	0.4	µsec	IN = 5V, Tj = 25°C
t_{f2}	Output Fall Time		0.3	0.5	µsec	IN = 5V
t_{f3}	Output Fall Time		0.1	0.2	µsec	V_{BS} = 16V, IN = 5V, Tj = 25°C
t_{f4}	Output Fall Time		0.15	0.3	µsec	V_{BS} = 16V, IN = 5V

†† PW<10us

Electrical Characteristics

Unless otherwise specified, V_{CC} = 5V, V_{BS} = 7V, V_S = 0V, IN = 0V, RES = 5V, load R = 50Ω, C = 2.5nF. Unless otherwise noted, these specifications apply for an operating junction temperature range of -40°C ≤ Tj ≤ 125°C.

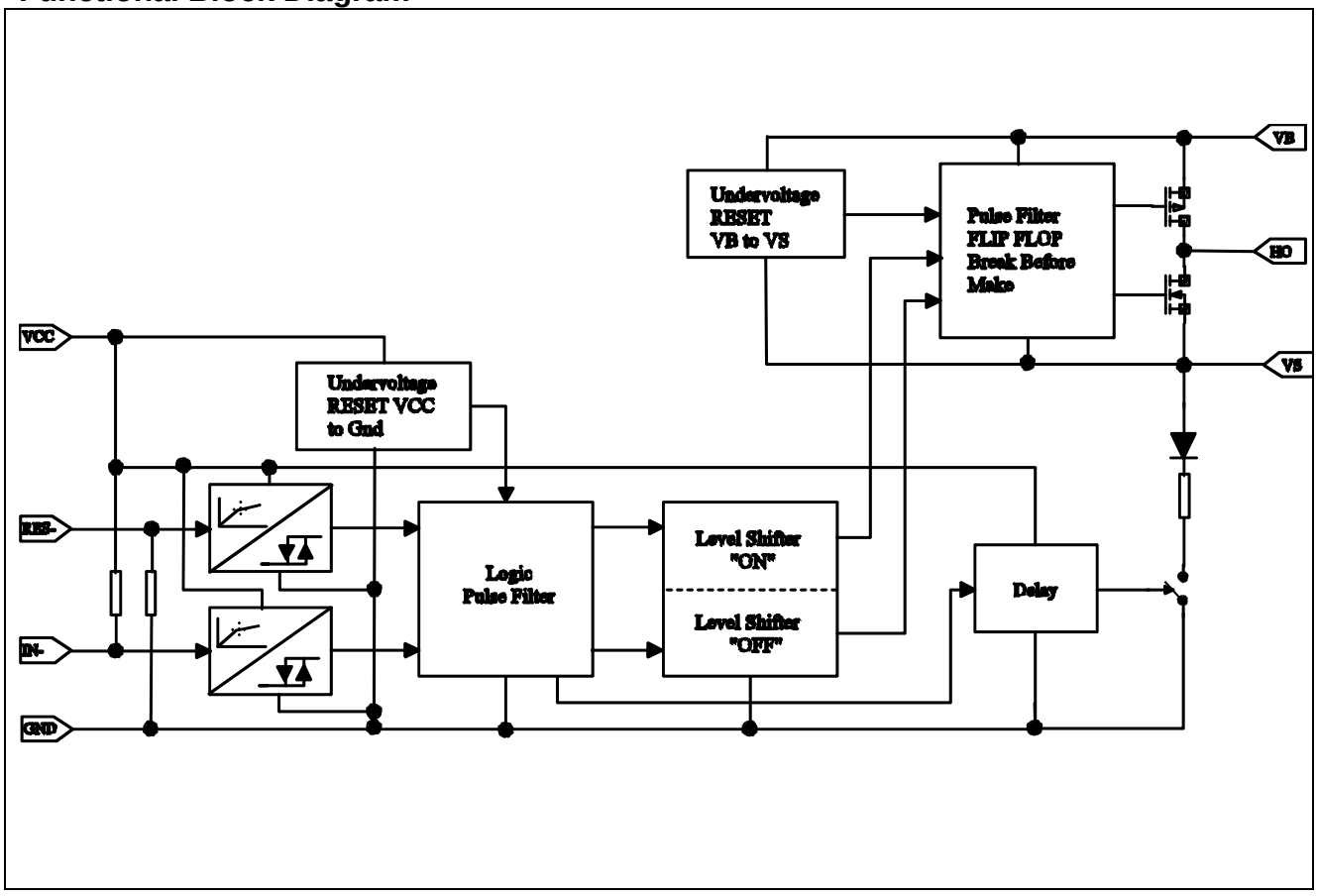
Symbol	Definition	Min	Typ	Max	Units	Test Conditions
t_{plh}	Input-to-Output Turn-On Propagation Delay (50% input level to 10% output level)		0.15	0.35	µsec	
t_{phl}	Input-to-Output Turn-Off Propagation Delay (50% input level to 90% output level)		0.15	0.35	µsec	
t_{phl_res}	RES-to-Output Turn-Off Propagation Delay (50% input level to 90% [t_{phl}] output levels)		0.15	0.35	µsec	
t_{plh_res}	RES-to-Output Turn-On Propagation Delay (50% input level to 10% [t_{plh}] output levels)		0.15	0.35	µsec	

Electrical Characteristics

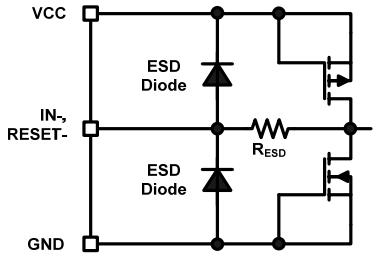
Unless otherwise specified, V_{CC} = 5V, V_{BS} = 7V, V_S = 0V, IN = 0V, RES = 5V, load R = 50Ω, C = 2.5nF. Unless otherwise noted, these specifications apply for an operating junction temperature range of -40°C ≤ Tj ≤ 125°C.

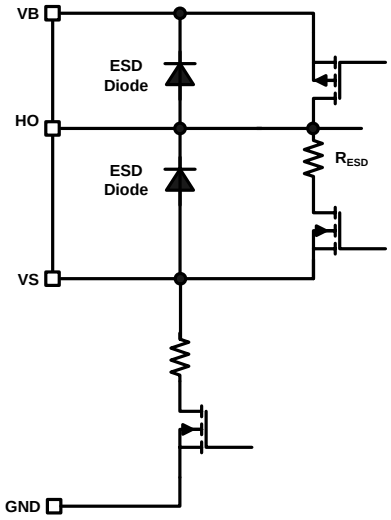
Symbol	Definition	Min	Typ	Max	Units	Test Conditions
Input Characteristics						
V_{INH}	High Logic Level Input Threshold	0.6* Vcc			V	VCC=5V
V_{INL}	Low Logic Level Input Threshold			0.28* Vcc	V	VCC=5V
R_{IN}	High Logic Level Input Resistance	60	100	220	kΩ	
I_{IN}	High Logic Level Input Current			5	µA	V_{IN}=VCC
V_{H_RES}	High Logic Level RES Input Threshold	3			V	VCC=5V
V_{L_RES}	Low Logic Level RES Input Threshold			1.4	V	VCC=5V
R_{RES}	High Logic Level RES Input Resistance	60	100	220	kΩ	
I_{RES}	Low Logic Level Input Current			5	µA	V_{RES}=0
Recharge Characteristics						
ton_rech	Recharge Transistor Turn-On Propagation Delay	3	6	9	µsec	V_S = 5V
toff_rech	Recharge Transistor Turn-Off Propagation Delay		0.08	0.2	µsec	
V_{RECH}	Recharge Output Transistor On-State Voltage Drop			1.2	V	I_S = 1mA, IN = 5V.
Deadtime Characteristics						
DT_{HOFF}	High Side Turn-Off to Recharge gate Turn-On	3	6	9	µsec	V_{CC} = 5V, V_{BS} = 7V
DT_{HON}	Recharge gate Turn-Off to High Side Turn-On	0.01	0.07	0.4	µsec	V_{CC} = 5V, V_{BS} = 7V

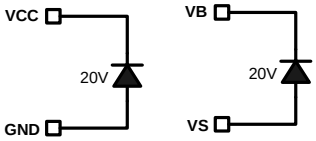
Functional Block Diagram

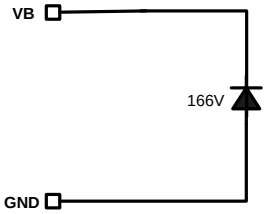


Input/Output Pin Equivalent Circuit Diagrams





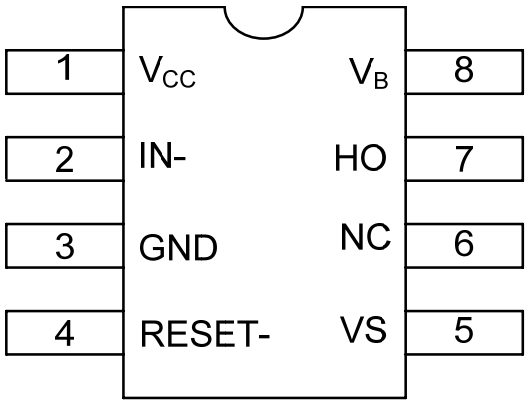




Lead Definitions

Pin Number	Symbol	Pin description
1	VCC	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	VS	MOSFET Source Connection
6	NC	No Connection (no Bondwire)
7	HO	MOSFET Gate Connection
8	VB	Driver Output Stage Supply

Lead Assignments



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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 Ho	Recharge Path
Vcc	VBS	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

RESET = HIGH indicates that high side NMOS is allowed to be turned on.
RESET = LOW indicates that high side NMOS is OFF.
IN = LOW indicates that high side NMOS is on.
IN = HIGH indicates that high side NMOS is off.
RechFET = ON indicates that the recharge MOSFET is on.
RechFET = OFF indicates that the recharge MOSFET is off.

Timing Diagrams

Input / Output

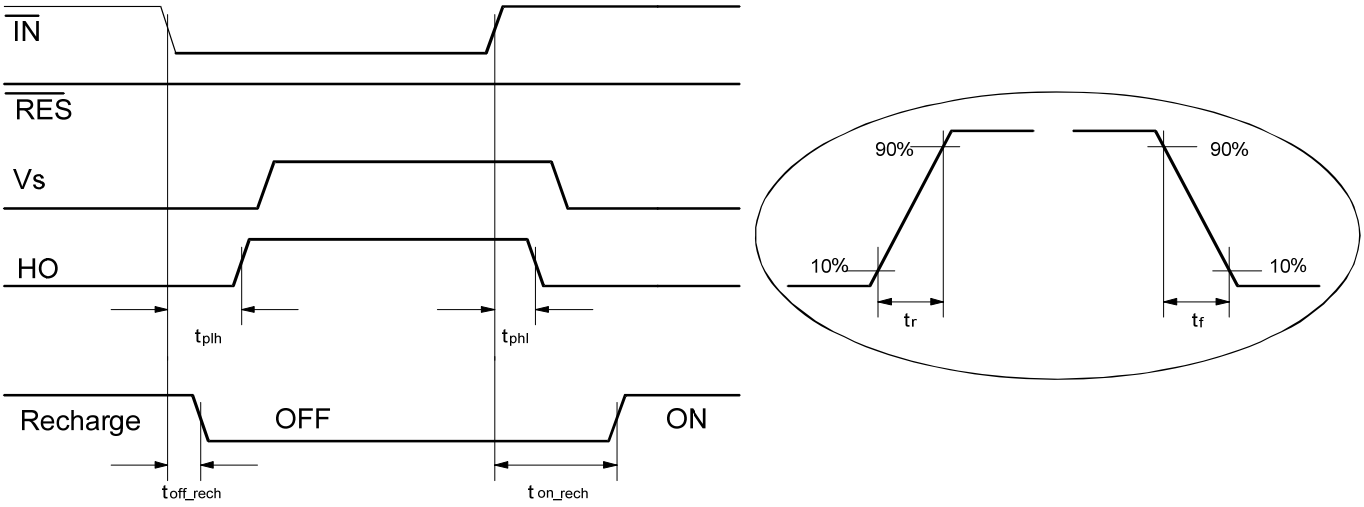


Figure 3: Input/Output Timing Diagram

Reset

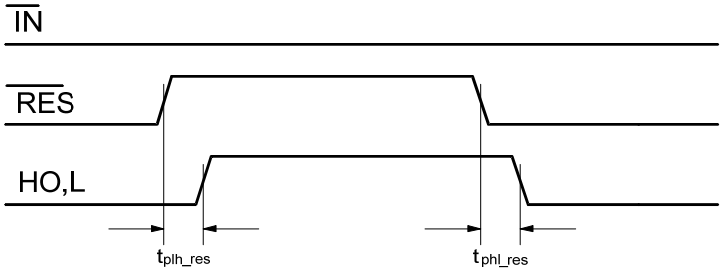


Figure 4: Reset Timing Diagram

Performance Graphs

RESET Functionality Graph:

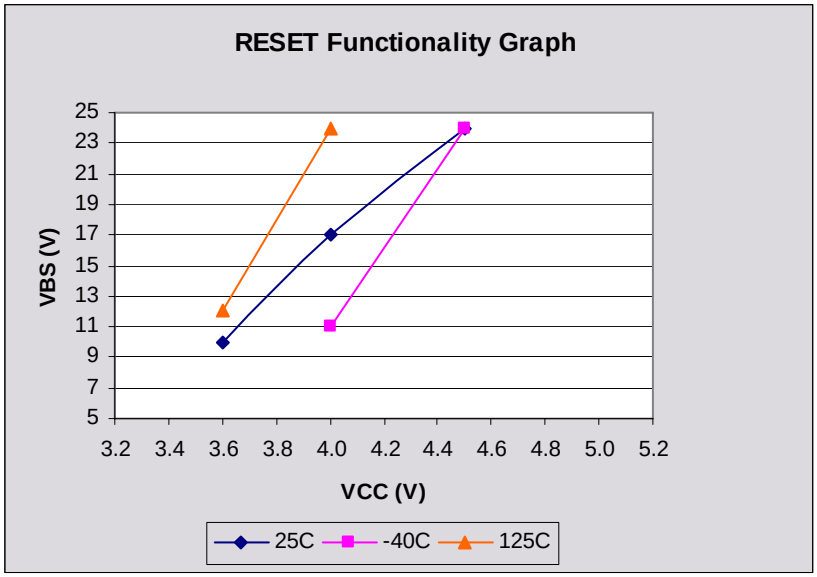
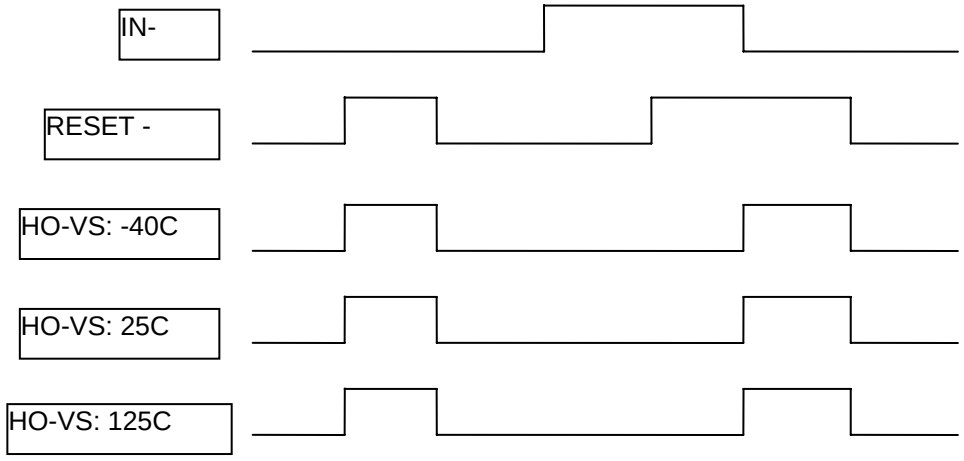


Figure 6. RESET Functionality:
This graph explains the functionality limitation as a function of VCC, VBS and temperature.
For each particular temperature and VCC, the output is non-functional for any value of VBS above the drawn curve. But for any value of VBS below the curve the functionality is fine.

RESET Functional Diagram:
The diagram is guaranteed for the following condition:
VCC=4.28V to 20V; VBS= 2V to 20V @ Tj= -40°C to +125°C (TBD)



Input and Reset Thresholds:

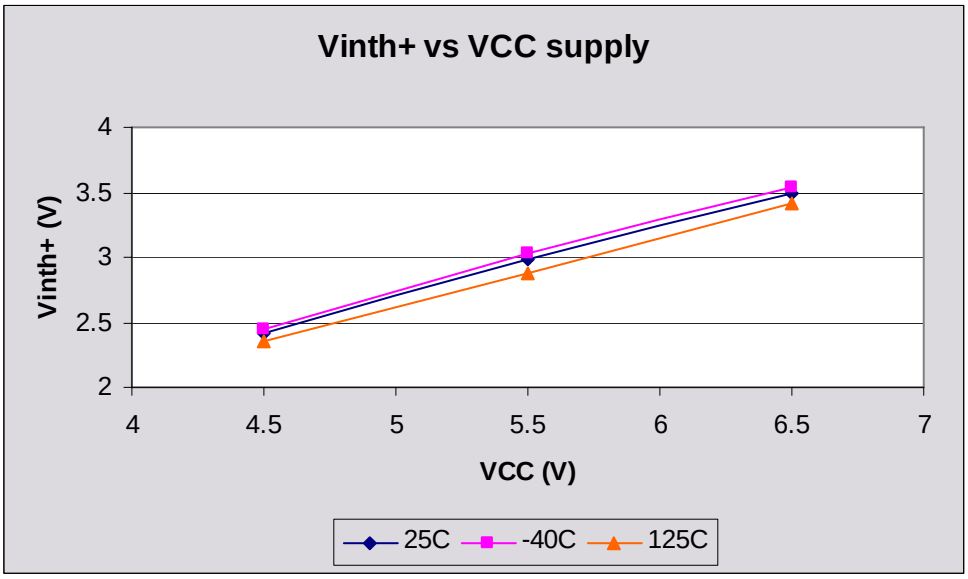


Figure 7-1: Positive Input and Reset Threshold Voltage Distribution Curves

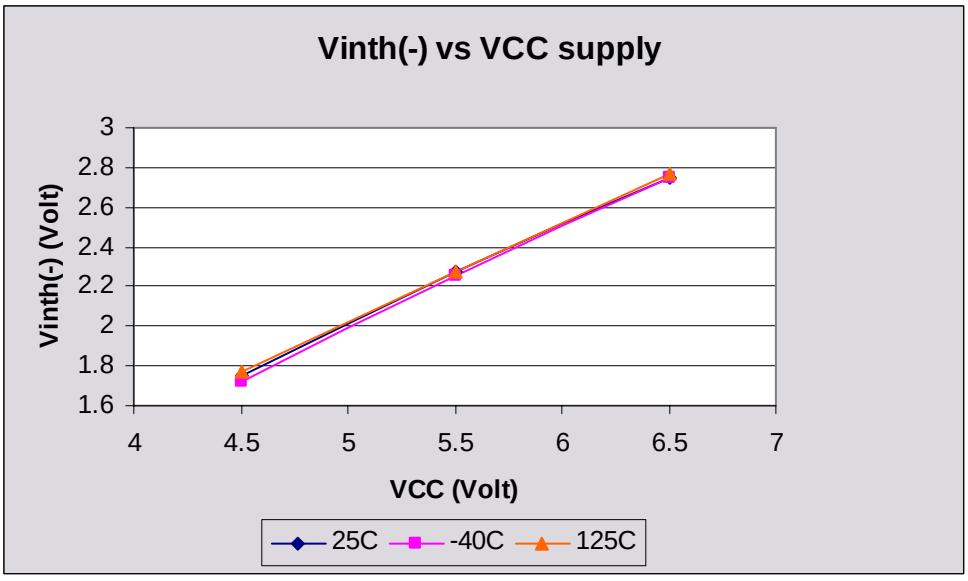


Figure 7-2: Negative Input and Reset Threshold Voltage Distribution Curves

VB_{UV} Undervoltage Shutdown Threshold VB: TBD

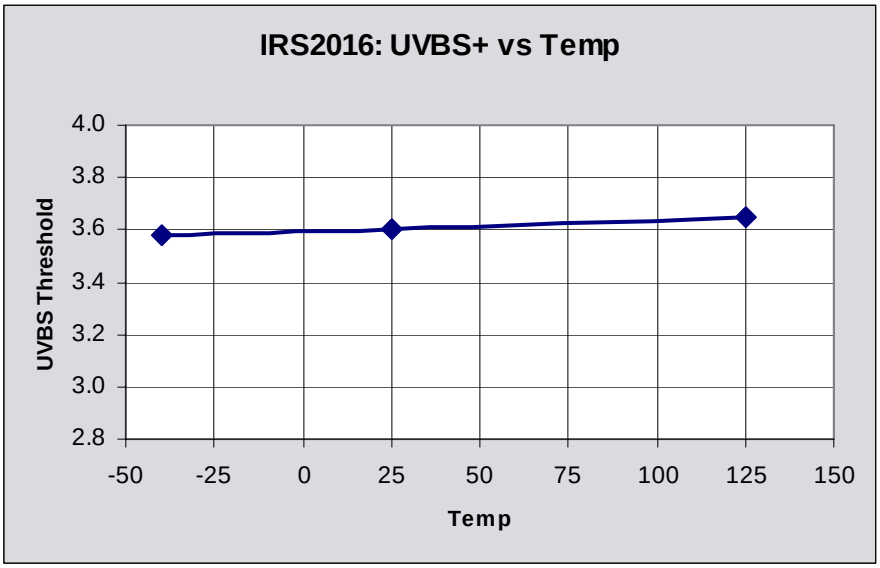


Figure 8-1: Positive going VB_{UV} value vs. Temperature: TBD

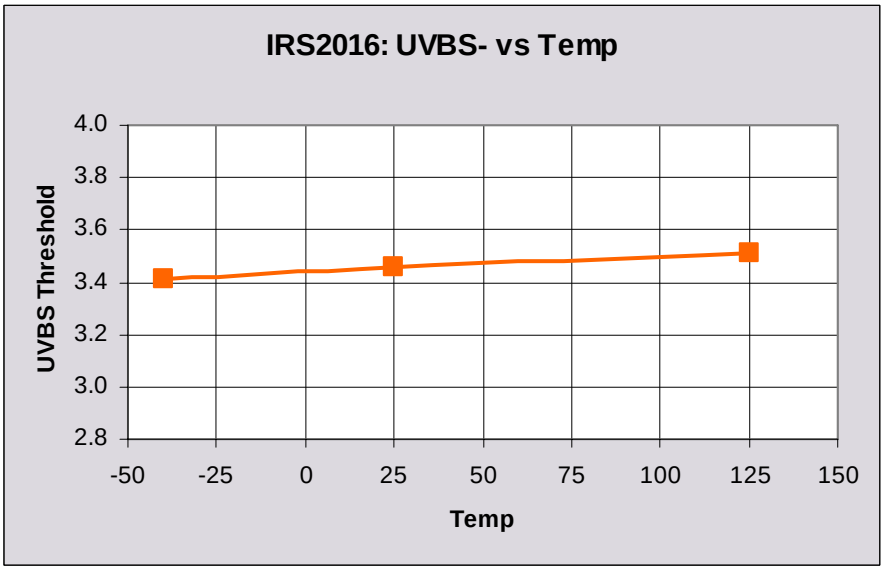


Figure 8-2: Negative going VB_{UV} Value vs. Temperature

Input and Reset Impedance

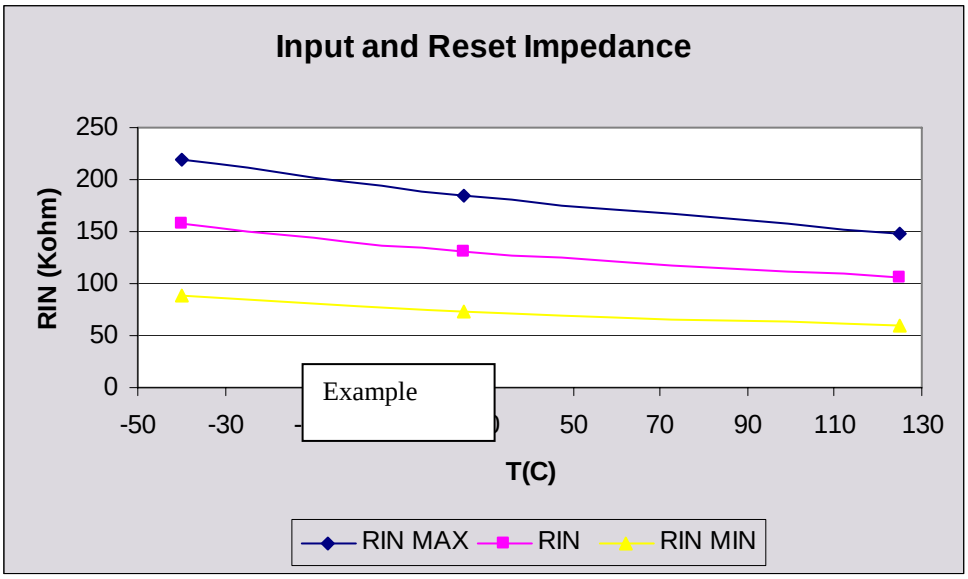


Figure 9: Input and Reset Impedance Distribution Curves

Recharge FET I-V Curve at -40C, 25C and 125C

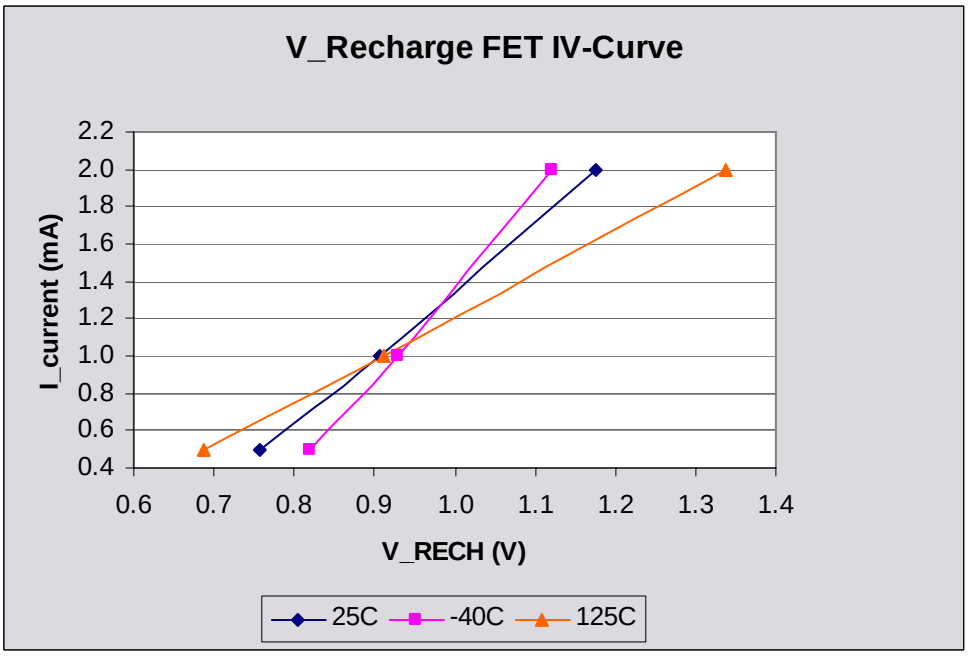
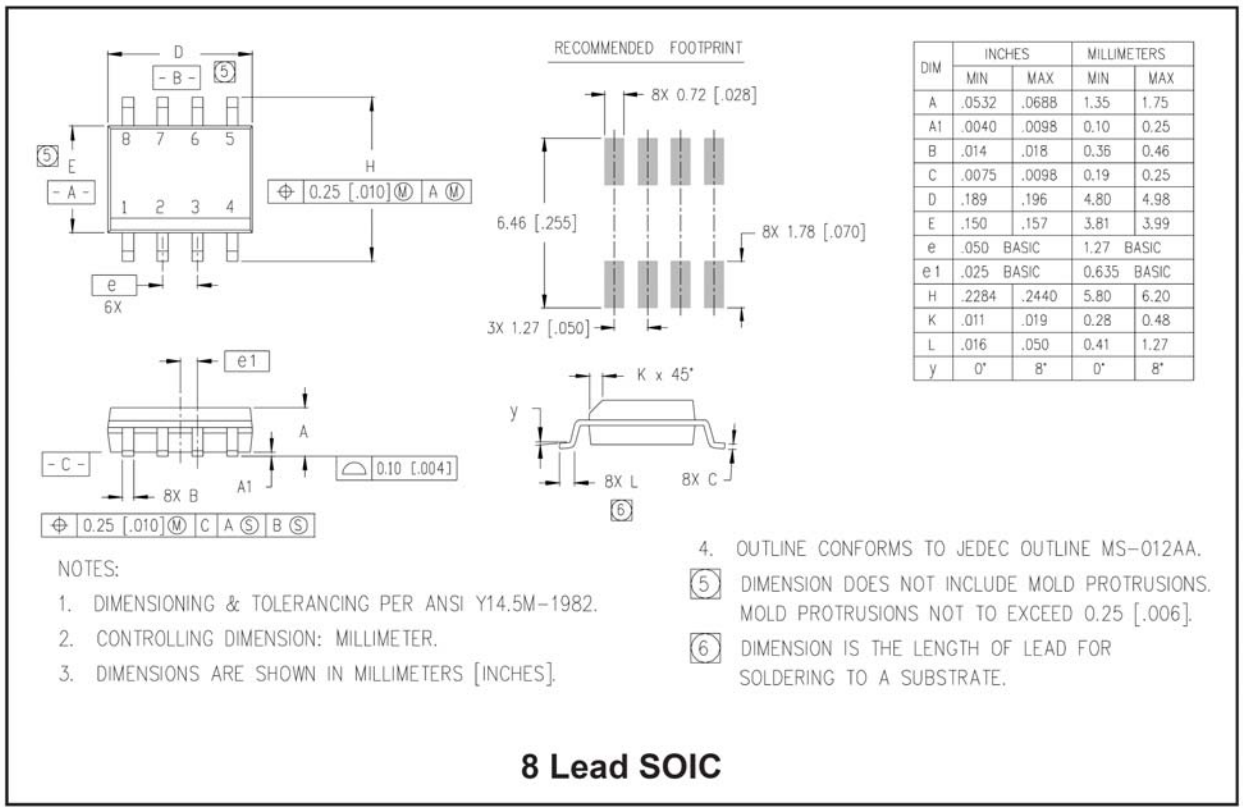


Figure 10: Recharge FET IV-Curve

Package Details: SOIC8



DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	.0532	.0688	1.35	1.75
A1	.0040	.0098	0.10	0.25
B	.014	.018	0.36	0.46
C	.0075	.0098	0.19	0.25
D	.189	.196	4.80	4.98
E	.150	.157	3.81	3.99
e	.050 BASIC		1.27 BASIC	
e1	.025 BASIC		0.635 BASIC	
H	.2284	.2440	5.80	6.20
K	.011	.019	0.28	0.48
L	.016	.050	0.41	1.27
y	0°	8°	0°	8°

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-012AA.

(5) DIMENSION DOES NOT INCLUDE MOLD PROTRUSIONS. MOLD PROTRUSIONS NOT TO EXCEED 0.25 [.006].

(6) DIMENSION IS THE LENGTH OF LEAD FOR SOLDERING TO A SUBSTRATE.

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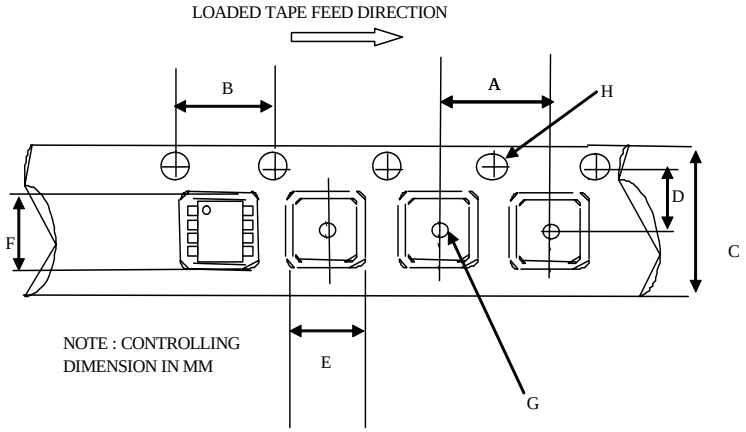
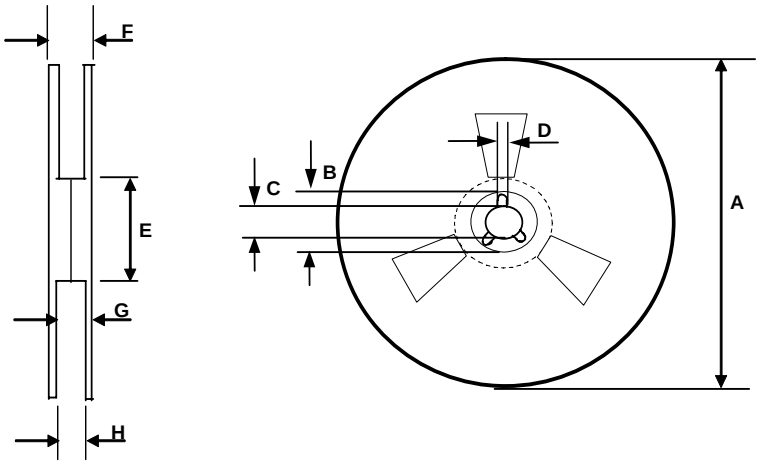
Tape and Reel Details: SOIC8



CARRIER TAPE DIMENSION FOR 8SOICN

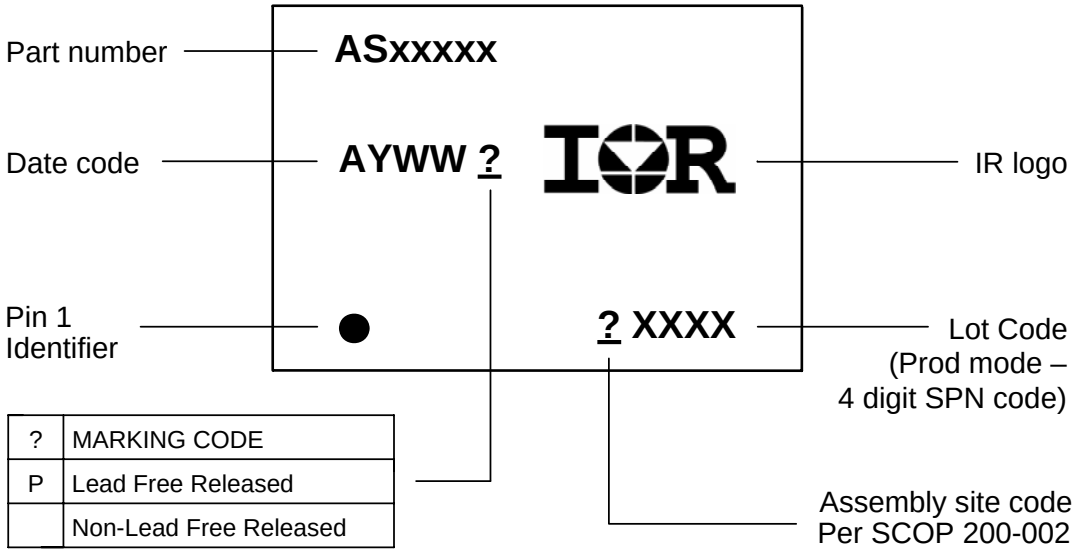
Code	Metric		Imperial	
	Min	Max	Min	Max
A	7.90	8.10	0.311	0.318
B	3.90	4.10	0.153	0.161
C	11.70	12.30	0.46	0.484
D	5.45	5.55	0.214	0.218
E	6.30	6.50	0.248	0.255
F	5.10	5.30	0.200	0.208
G	1.50	n/a	0.059	n/a
H	1.50	1.60	0.059	0.062



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



?	MARKING CODE
P	Lead Free Released
	Non-Lead Free Released

Ordering Information

Base Part Number	Package Type	Standard Pack		Complete Part Number
		Form	Quantity	
AUIRS2016S(TR)	SOIC8	Tube/Bulk	95	AUIRS2016S
		Tape and Reel	2500	AUIRS2016STR

For technical support, please contact IR's Technical Assistance Center
http://www.irf.com/technical-info/

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