Preliminary Data Sheet No.PD60180-B

International
IOR Rectifier

IR3220

FULLY PROTECTED H-BRIDGE FOR D.C. MOTOR

Features

- Over temperature shutdown
- Over current shutdown
- Inrush current limited by Soft-Start sequence
- E.S.D protection
- Status feedback
- Sleep mode for direct battery connection
- Braking/non-braking operation

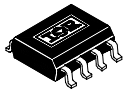
Description

The IR 3220 is a Fully Protected Dual High Side Switch I.C. With two additional Low Side switches (e.g. IRF7474 - available 01/01), the IR 3220 drives and controls the whole H bridge topology. It provides shoot-through protection for each leg, H bridge logic control, soft-start sequence and over-current /over-temp. protections. The signals IN1 and IN2 select the operation modes and the PWM Soft-Start sequence cycles the corresponding active low side switch in order to limit the motor inrush current. By using the recommended part number and the proper cooling, the inner High Side IPS protects the whole H bridge function. The Soft-Start sequence is programmed by an RC time constant and reset itself automatically.

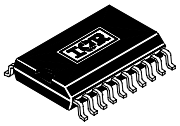
Product Summary

$R_{ds(on)}$	12mΩ max.
$V_{cc.op.}$	5.5 to 35V
$I_{cont.}$ (Ta = 85°C)	7.0A
$I_{shutdown}$	30A
Oper. Freq.	20 kHz

Packages

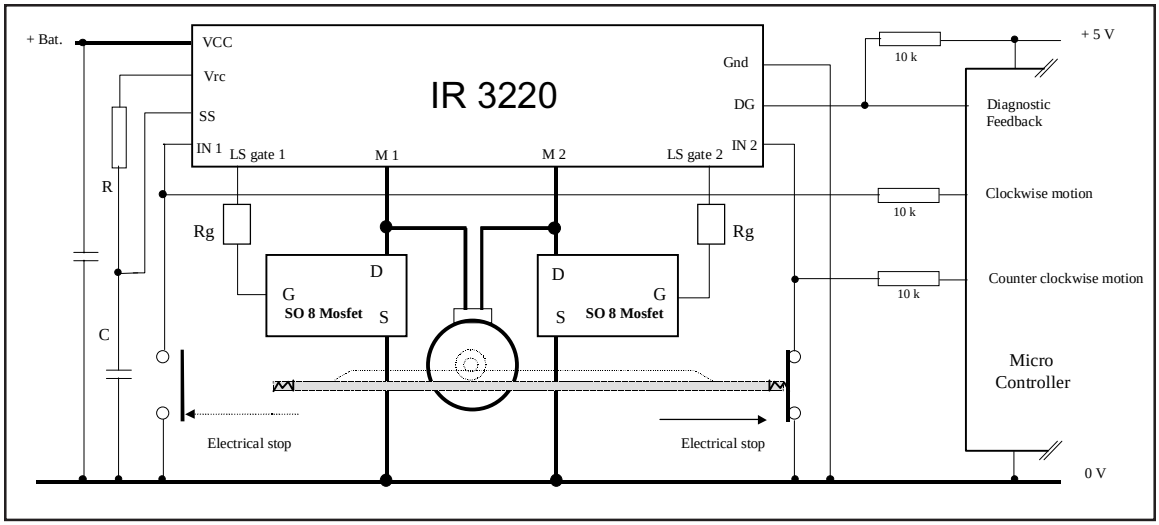


8 Lead SOIC
(e.g. IRF7474)



20 Lead SOIC (wide body)
(IR3220)

Typical Connection



Absolute Maximum Ratings

Absolute maximum ratings indicates sustained limits beyond which damage to the device may occur. All voltage parameters are referenced to Gnd lead. ($T_{Ambient}$ = 25°C unless otherwise specified). Symbols with (2) refer to M2 output.

Symbol	Parameter	Min.	Max.	Units
Vm1 (2)	Maximum M1 (M2) voltage (active clamp)	Vcc-37	Vcc+0.3	V
V_{in1} (2)	Maximum IN 1 (IN 2) voltage	-0.3	5.5	
Vcc/gnd	Maximum Vcc pin to GND pin voltage	0.3	50	
I in1 (2)	Maximum IN1 (IN 2) current	-1	10	mA
Vg1 (2)	Maximum Gate 1 (Gate 2) voltage	-0.3	7.5	V
Vss	Maximum SS voltage	-0.3	5.5	
Vrc	Maximum Vrc voltage	-0.3	5.5	
Irc	Maximum output current of the Vrc pin	—	1	mA
Vdg	Maximum diagnostic output voltage	-0.3	5.5	V
Idg	Maximum diagnostic output current	-1	10	mA
Isd cont.	Diode max. permanent current (Rth=60°C/W) (1)	—	3.0	A
	(Rth=45°C/W) (1)	—	4.0	
Isd pulsed	Diode max. pulsed current (1)	—	15	
ESD 1	Electrostatic discharge (human body model C=100pF, R=1500Ω)	—	tbd	V
ESD 2	Electrostatic discharge (machine model C=200pF, R=0Ω, L=10μH)	—	tbd	
PD	Maximum power dissipation (Rth = 60°C/W)	—	1.5	W
TJ max.	Max. storage & operating junction temperature	-40	+150	°C
T_L	Lead temperature (soldering 10 seconds)	—	300	
Vcc max.	Maximum Vcc voltage	—	37	V
Ig1 (2) max.	Maximum gate current (Ton < 5μS)	—	100	mA
Ig1 (2) avg.	Maximum average gate current	—	10	

(1) Limited by junction temperature (pulsed current limited also by internal wiring)

Thermal Characteristics

Symbol	Parameter	Typ.	Max.	Units
R_{th} 1	Thermal junction to amb. resistance (stnd footprint 1 MOS on)	60	—	°C/W
R_{th} 2	Thermal junction to ambient resistance (1" sq. footprint 1 MOS on)	45	—	

Recommended Operating Conditions

These values are given for a quick design. For operation outside these conditions, please consult the application notes.

Symbol	Parameter	Min.	Max.	Units
Vcc	Continuous Vcc voltage (2)	8	18	V
V_{in1} (2)	High level IN 1 (IN 2) input voltage	4	5.5	
V_{in1} (2)	Low level IN 1 (IN 2) input voltage	-0.3	0.9	
Iout Ta=85°C	Continuous output current (Rth/amb < 5 °C/W, Tj = 125°C)	—	7.0	A
Iout Ta=105°C	Continuous output current (Rth/amb < 5 °C/W, Tj = 125°C)	—	4.5	
R in	Recommended resistor in series with IN pin	10	20	kΩ
R dg	Recommended pull-up resistor on DG pin	1	20	
R	Soft-Start resistor	5.0	100	
C	Soft-Start capacitor	0.1	3.3	µF
R gate	Recommended gate resistor for Low Side Switch	0	50	Ω

Static Electrical Characteristics

(T_j = 25°C, V_{CC} = 14V unless otherwise specified.)

Symbol	Parameter	Min.	Typ.	Max.	Units	Test Conditions
Rds1 on	ON state resistance Tj = 25°C	—	9	12	mΩ	Vin1,2 = 5V,1m1,2 = 5A
Rds2 on	ON state resistance Tj = 150°C	—	16	22		
Vcc oper.	Functional voltage range	5.5	—	35	V	
Vclamp1 (2)	Vcc to M1 (M2) clamp voltage	37	40	48		Id =10mA see Figs.1,2
Vf1 (2)	Body diode 1 (2) forward voltage	—	0.9	—		Id = 5A, Vin1,2 = 0V
IM1 (2) leakage	M1 (M2) output leakage current	—	10	50	µA	Vm1, 2 = 0V; Tj = 25°C
Icc off	Supply current when off (sleep mode)	—	10	50		Vin1(2) = 0V
Icc on	Supply current when on	—	8	—	mA	Vin1 = 5V
Vdgl	Low level diagnostic output voltage	—	0.3	—	V	Idg = 1.6mA
Idg leakage	Diagnostic output leakage current	—	—	10	µA	Vdg = 5.5V
Vih1 (2) th.	IN1 (IN2) high threshold voltage	—	2.6	—	V	
Vil1 (2) th.	IN1 (IN2) low threshold voltage	—	2.0	—		
Iin1 (2)	ON state IN1 (IN2) positive current	—	25	—	µA	Vin1, 2 = 5V
Vccuv	Vcc UVLO positive going threshold	—	5	—	V	
Vccuv-	Vcc UVLO negative going threshold	—	4	—		
Vss+	SS high level threshold	—	4	—		
Vss-	SS low level threshold	—	1	—		
Iss leakage	SS pin leakage current	—	0.1	10	µA	

Switching Electrical Characteristics

V_{CC} = 14V, Resistive Load = 3.0Ω, T_j = 25°C, (unless otherwise specified).

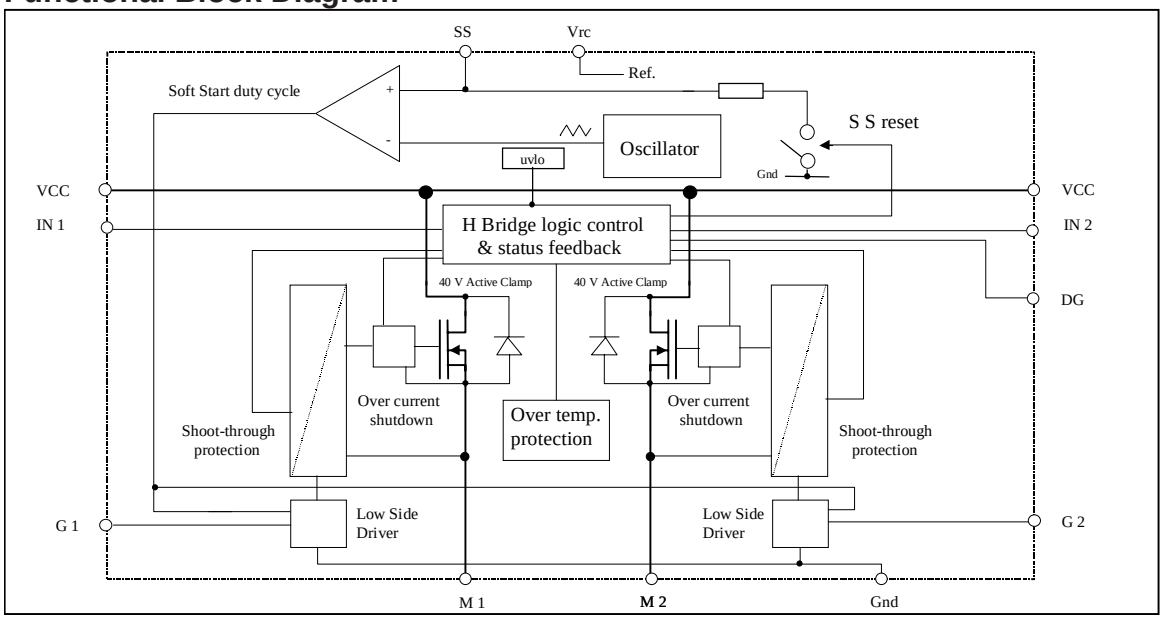
Symbol	Parameter	Min.	Typ.	Max.	Units	Test Conditions
Td_{on}	Turn-on delay time	—	5	—	µs	see figure 3
T_{r1}	Rise time to Vout = Vcc -5V	—	4	—		
Tr2	Rise time from the end of Tr1 to V_{out} = 90% of V_{cc}	—	65	—		
$d_{V/dt\ (on)}$	Turn ON $d_{V/dt}$	—	3	—	V/µs	
Tdoff	Turn-off delay time	—	65	—	µs	see figure 4
Tf	Fall time to Vout = 10% of Vcc	—	8	—		
dV/dt (off)	Turn OFF dV/dt	—	5	—	V/µs	
IN1 (2) max. freq.	Max. frequency on IN1 (IN2)	—	500	—	Hz	
Soft-Start freq.	Soft-Start oscillator frequency	15	20	30	kHz	
Ig1 (2) min.	Min. Gate 1 (Gate 2) current	50	—	—	mA	low side driver
Trd	Min. IN1 (2) OFF time to reset SS	2.0	—	—	ms	C=3.0µF, IN1 = IN2
Vg1	Gate 1 (gate 2) voltage	—	7	—	V	

Protection Characteristics

Symbol	Parameter	Min.	Typ.	Max.	Units	Test Conditions
Tsd	Over-temperature threshold	—	165	—	°C	See figure 2
Isd	Over-current threshold	25	30	35	A	See figure 2
Treset	Minimum time to reset protections	—	100	—	µS	IN1 = IN2 = 0V

Note: The low side switches present sufficient cooling capability in order to have the whole H Bridge function protected by the IR3220 inner temperature sensor.

Functional Block Diagram



Truth Table

IN1	IN2	MODES	DG	HS1	LSS1	HS2	LSS2	SS reset
L	L	Stand-by with braking - sleep mode**	H	OFF	ON	OFF	ON	ON
L	H	Foward rotation (normal operation)	H	OFF	ON*	ON	OFF	OFF
L	H	Foward rotation (protection triiggered)	L	OFF	ON*	OFF	OFF	OFF
H	L	Reverse rotation (normal operation)	H	ON	OFF	OFF	ON*	OFF
H	L	Reverse rotation (protection triggered)	L	OFF	OFF	OFF	ON*	OFF
H	H	Stand-by without braking	H	OFF	OFF	OFF	OFF	ON

* During Soft-start sequence, the low side part is switching. ** Protections are reset in this mode

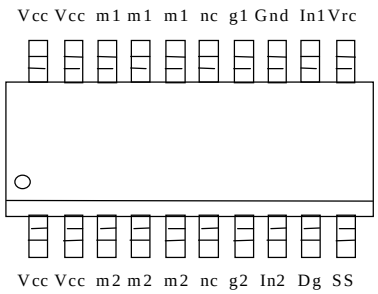
Lead Definitions

Vcc	Positive power supply	IN1	Logic input 1 (Leg 1 Cdt. / mode)
M1	Motor 1 output (high side source - leg 1)	IN2	Logic input 2 (Leg 2 Cdt. / mode)
M2	Motor 2 output (high side source - leg 2)	Dg	Diagnostic output (open drain)
G1	Gate 1 drive output (low side gate - leg 1)	Vrc	Voltage ref. output (soft-start RC)
G2	Gate 2 drive output (low side gate - leg 2)	SS	RC soft-start input (the voltage on this input drives the switching duty cycle)
Gnd	Power supply return		

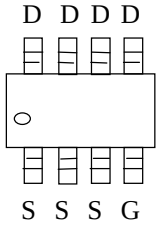
Recommended Low Side MOSFET

e.g. IRF7413 OR a 10mΩ /40V - SOIC 8 packaged Power Mosfet

Lead Assignments



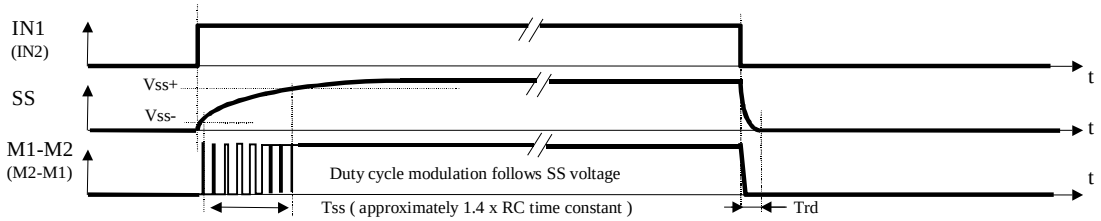
20 Lead - SOIC (wide body)



8 Lead - SOIC

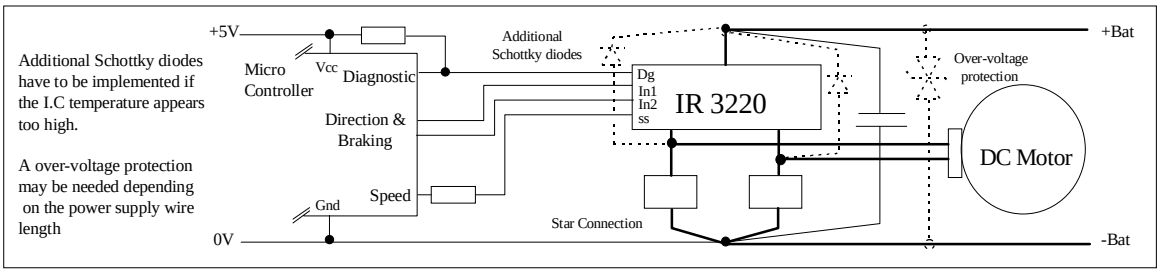
IR3220	e.g. IRF7474
Part Number	

Soft-start sequence



Permanent Switching Operation

(without external RC time constant)



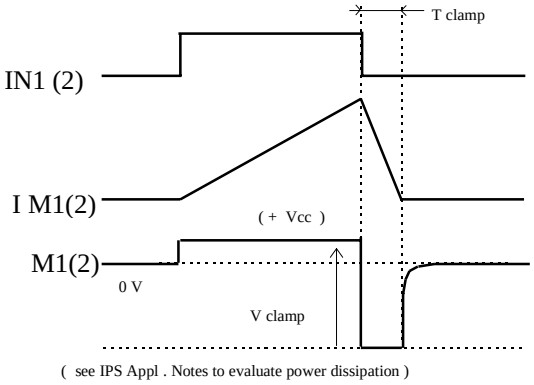


Figure 1 - Active clamp waveforms

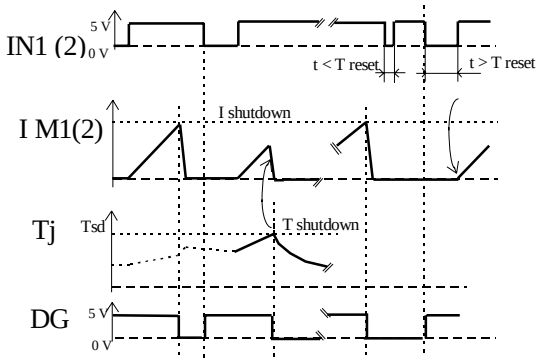


Figure 2 - Protection Timing diagram

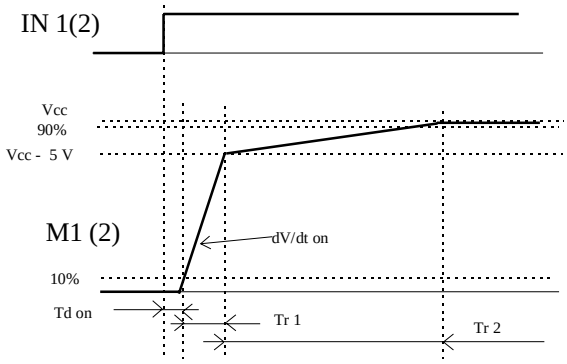


Figure 3 - Switching Time Definitions (turn-on)

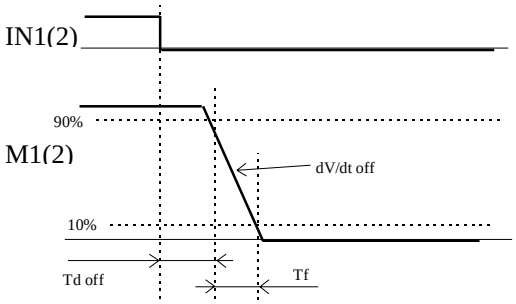


Figure 7 - Switching Time Definitions (turn-off)

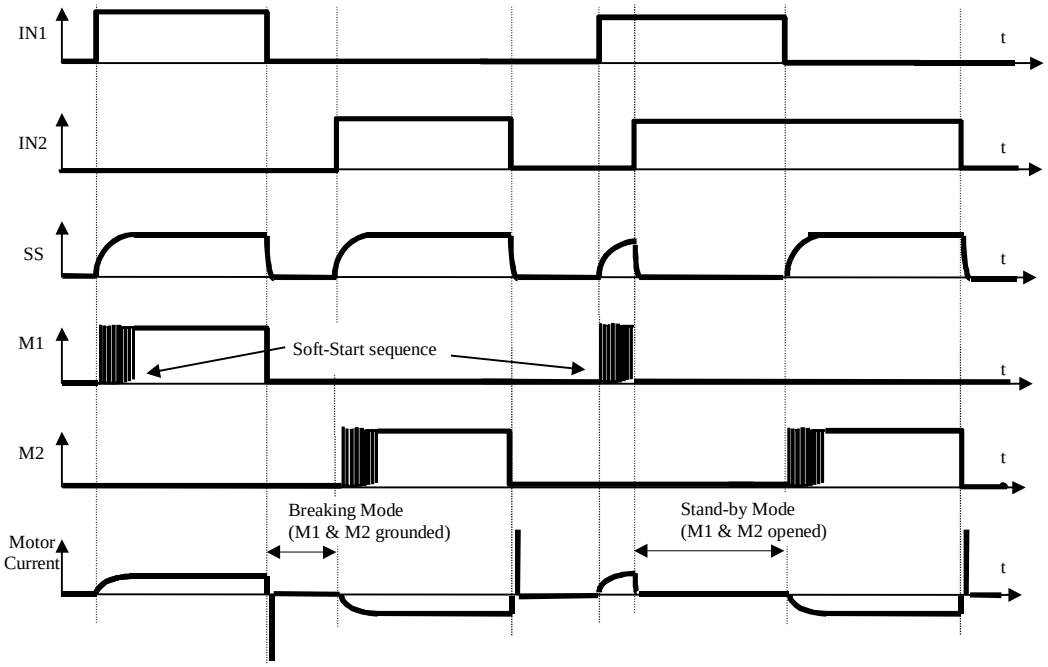


Figure 5 - IN1 (2) & M1 (2) Timing Diagrams

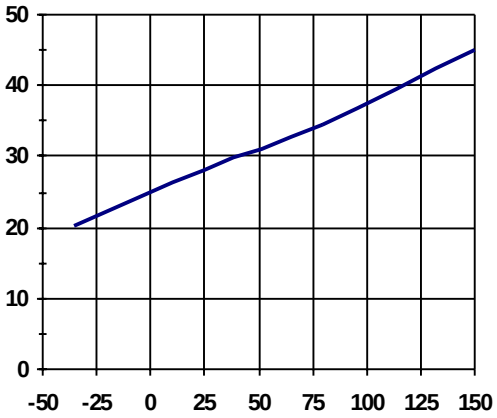


Figure 6 - IN1 (2) current (µA) vs Tj (°C)

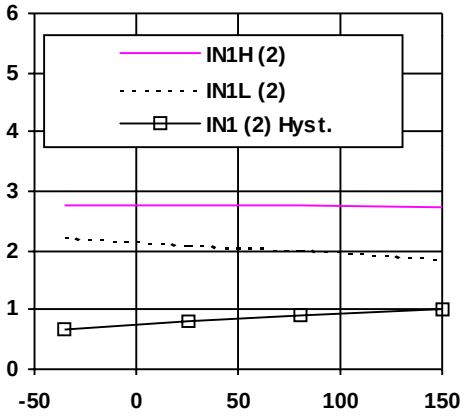


Figure 7 - IN1 (2) thresholds (V) vs Tj (°C)

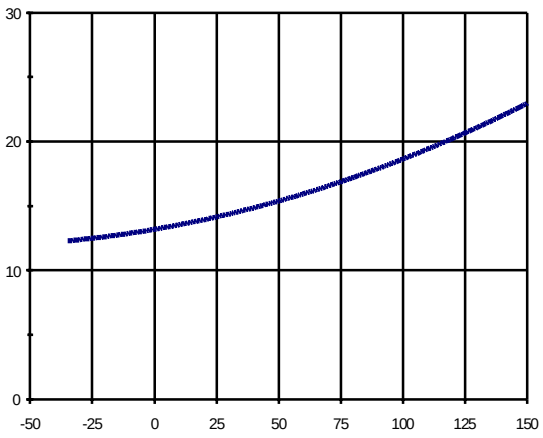


Figure 8 - Rdson (mΩ) vs Tj (°C)

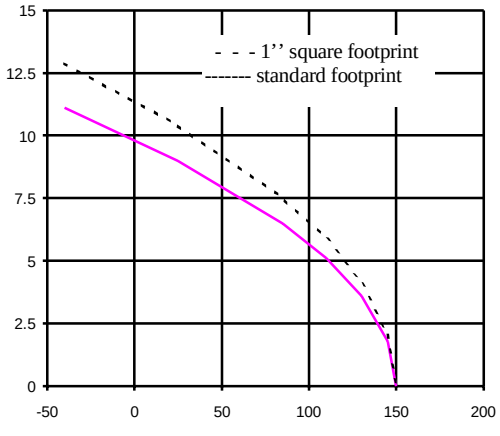


Figure 9 - Max. Cont. current (A) vs Amb. Temp. (°C)

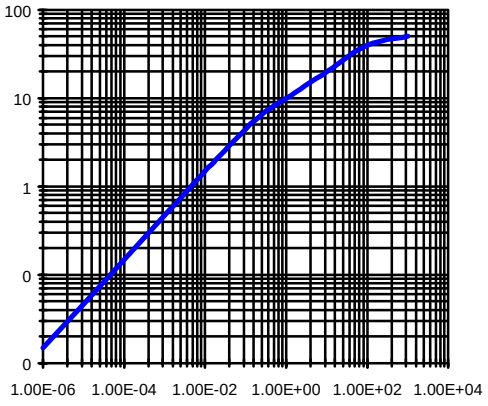


Figure 10 - Transient Thermal Imped. (°C/W) vs Time (s)

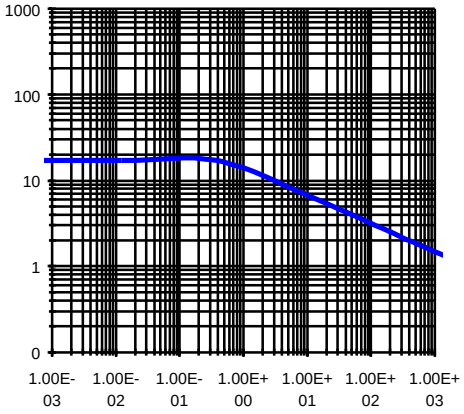
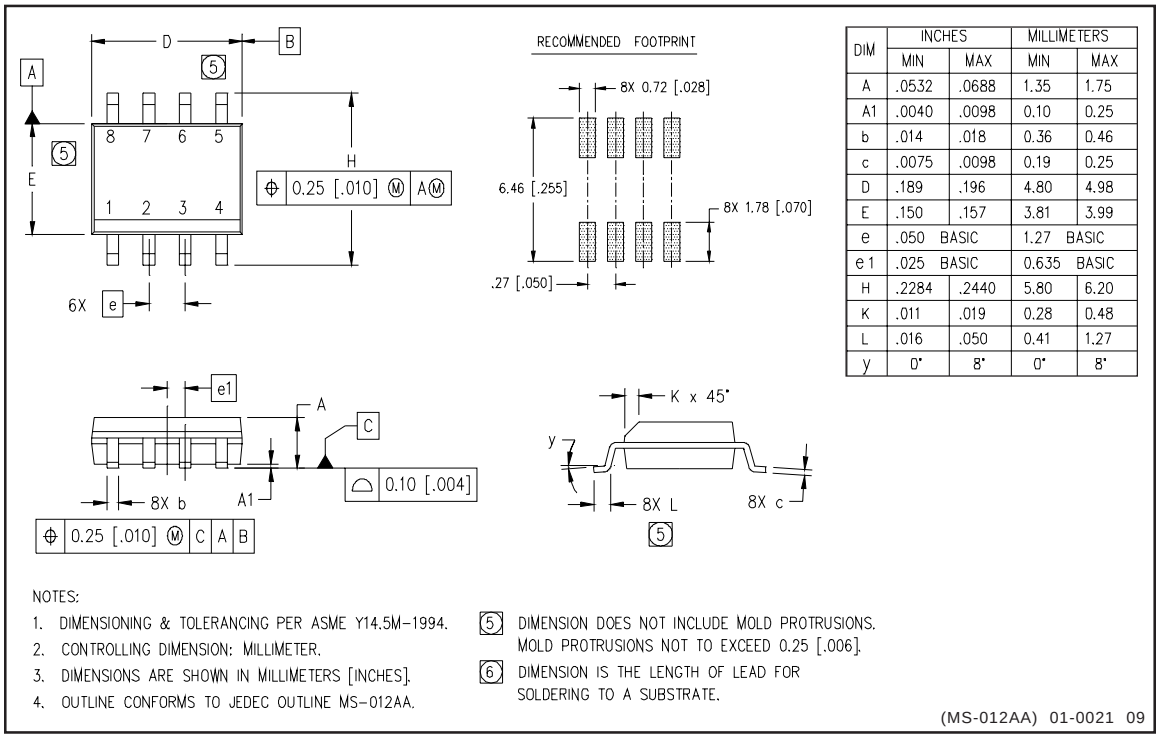


Figure 11 - Iclamp (A) vs Power Supply Wire Inductance (mH - single pulse)

Case Outline - 8 Lead SOIC



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 ASME Y14.5M-1994.
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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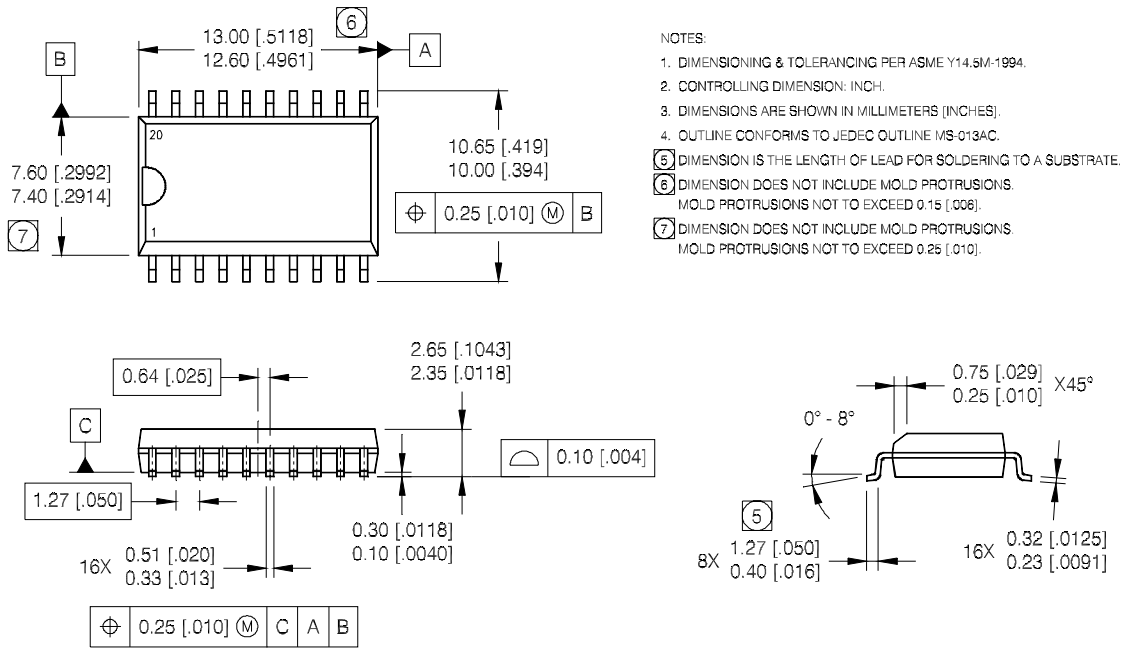
Case Outline



20 Lead SOIC (wide body) (MS-013AC) 01-3080 00