HARRIS SEMICONDUCTOR

HIP5015, HIP5016

7V, 7A SynchroFET™ Complementary Drive Synchronous Half-Bridge

June 1996

Features

- Complementary Drive, Half-Bridge Power NMOS
- Use With Low-Cost Single-Output PWM Controllers
- Improve Efficiency Over Conventional Buck Converter With Schottky Clamp
- Minimum Deadtime Provided by Adaptive Shoot-Through Protection Eliminates External Schottky
- Grounded Case for Low EMI and Simple Heatsinking
- Low Operating Current
- Frequency Exceeding 1MHz
- Dual Polarity Input Options
- All Pins Surge Protected

Applications

- 5V to ≤3.3V Synchronous Buck Converters
- 3.3V to ≤2.9V Synchronous Buck Converters
- Pentium™ Power Supplies
- Bus Terminations (BTL and GTL)
- Drive 5V Motors Directly from Microprocessor

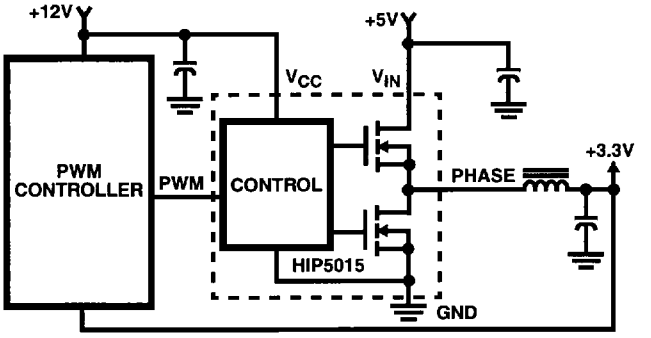
Ordering Information

PART NUMBER	TEMP. RANGE (°C)	PACKAGE	PKG. NO.
HIP5015IS	-40 to 85	7 Ld Gullwing SIP	Z7.05B
HIP5015IS1	-40 to 85	7 Ld Staggered Vertical SIP	Z7.05C
HIP5016IS	-40 to 85	7 Ld Gullwing SIP	Z7.05B
HIP5016IS1	-40 to 85	7 Ld Staggered Vertical SIP	Z7.05C

Description

Designed with the Pentium™ in mind, the Harris SynchroFET™ family provides a new approach for implementing a synchronous rectified buck switching regulator. The SynchroFET™ replaces two power DMOSs, a Schottky diode, two gate drivers and synchronous control circuitry. The complementary drive circuit turns the upper FET on and the lower FET off when the input from the PWM is high. When the input from the PWM goes low the upper FET turns off and the lower FET turns on. The HIP5016 has a $\overline{PWM}$ pin that inverts the relationship from the input to PHASE. This architecture allows the designer to utilize a low cost single-ended PWM controller in either a current or voltage mode configuration. The SynchroFET™ operates in continuous conduction mode reducing EMI constraints and enabling high bandwidth operation. Several features ensure easy start-up. First, the supply currents stay below specification as the supply voltages ramp up; no unexpected surges occur that might perturb a soft-start or deplete a charge-pump. Second, any power-up sequence of the V_{CC}, V_{IN}, or PWM pins can be used without causing large currents. Third, the chip operates when V_{CC} is greater than 2V so V_{CC} can be created from a charge pump powered from V_{IN}.

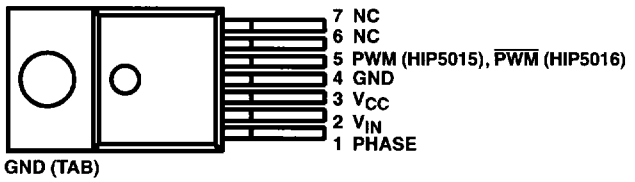
Typical Application Block Diagram



SYNCHRONOUS RECTIFIED BUCK CONVERTER

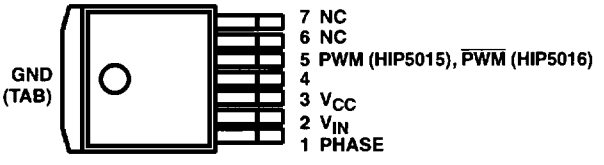
Pinouts

HIP5015IS1, HIP5016IS1 (SIP - VERTICAL)
TOP VIEW



FRONT ROWS = PINS 1,3,5,7
BACK ROWS = PINS 2,4,6

HIP5015IS, HIP5016IS (SIP - GULLWING)
TOP VIEW



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SynchroFET™ is a trademark of Harris Corporation.

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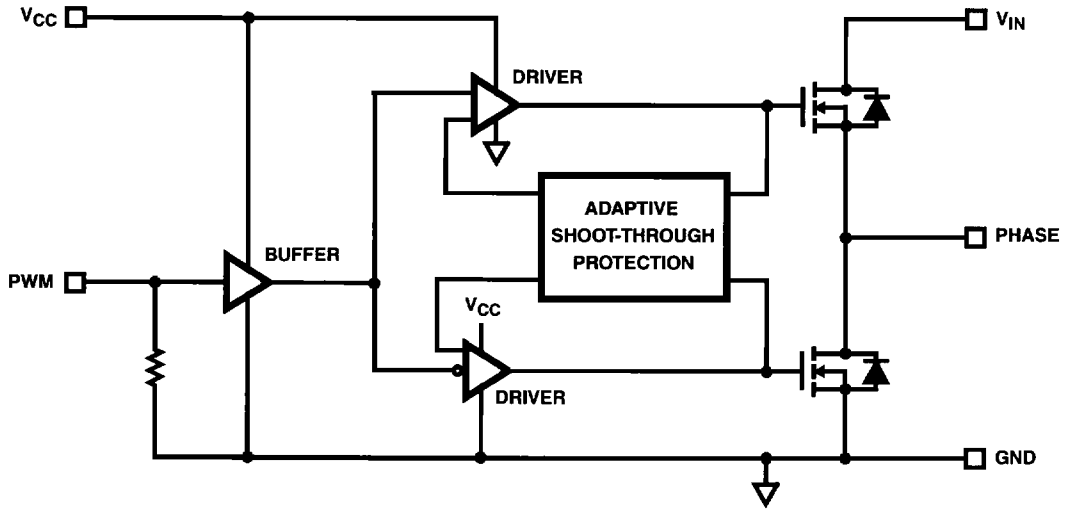
CAUTION: These devices are sensitive to electrostatic discharge. Users should follow proper IC Handling Procedures.

File Number **4142**

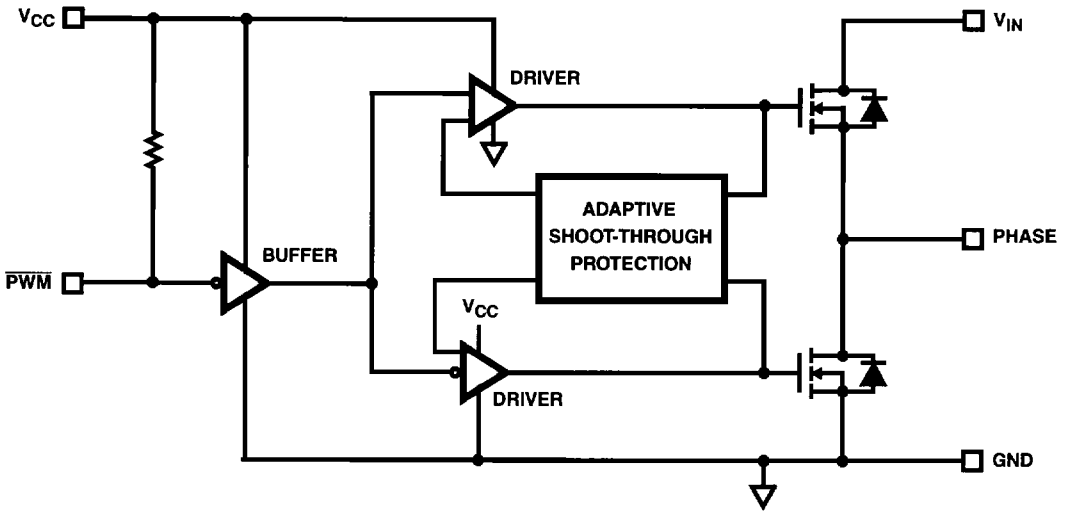
Non-Inverting SynchroFET™ Block Diagram

HIP5015



Inverting SynchroFET™ Block Diagram

HIP5016



Absolute Maximum Ratings

Supply Voltage, V_{CC} . . . . . +16V
Input Voltage V_{IN} . . . . . +7V
I_{PHASE}, I_{VIN}, I_{GND} . . . . . 7A (Repetitive Peak)
PWM Input . . . . . -4V to +16V
ESD Classification . . . . . Class 3 (4kV)
Lead Temperature (Soldering 10s) (Lead Tips Only) . . . . . +300°C
Storage Temperature Range . . . . . -65°C to +150°C
Junction Temperature Range . . . . . -40°C to +150°C

Thermal Information (Typical)

Package	θ_{JC}†† (°C/W)	θ_{JA} (°C/W)† 0	1	2	3	3†††
SIP (IS)	2	55	30	25	24	18
SIP (IS1)	2	55	-	-	-	-

† Versus additional square inches of 1 ounce copper on the printed circuit board.

†† θ_{JC} is typical with an infinite heatsink.

††† 200 linear feet per minute of air flow.

CAUTION: Stresses above those listed in "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress only rating and operation of the device at these or any other conditions above those indicated in the recommended operating conditions of this specification is not implied.

Recommended Operating Conditions

Supply Voltage, V_{CC} . . . . . +12V, ±20%
Input Voltage V_{IN} . . . . . 0V to 5.5V
Supply Voltage, V_{CC}, minimum for charge-pumped start-up . . +4.0V

I_{PHASE} 5A
I_{VIN} 4A
I_{GND} 3A

Electrical Specifications

PARAMETERS	SYMBOL	TEST CONDITIONS	T_J = 25°C MIN	TYP	MAX	T_J = -40°C, T_J = +150°C MIN	MAX	UNITS
$r_{DS(ON)}$ Upper MOSFET	R_{DSU}	V_{CC} = 12V, V_{IN} = 5V	-	68	78	-	130	mΩ
$r_{DS(ON)}$ Lower MOSFET	R_{DSL}	V_{CC} = 12V, V_{IN} = 5V	-	72	82	-	136	mΩ
V_{IN} Operating Current	I_{VINO}	V_{IN} = 5V, No Load, 500kHz	-	1.8	4	-	5	mA
V_{IN} Quiescent Current	I_{VIN}	PWM or $\overline{PWM}$ = V_{CC} or GND	-	0.1	10	-	100	µA
V_{CC} Operating Current	I_{CCO}	V_{CC} = 12V, 500kHz	-	4.3	7	-	9	mA
V_{CC} Quiescent Current (HIP5015)	I_{CCIH}	PWM = V_{CC}	-	40	-	-	300	µA
V_{CC} Quiescent Current (HIP5015)	I_{CCIL}	PWM = GND	-	0.1	10	-	100	µA
V_{CC} Quiescent Current (HIP5016)	I_{CCNIH}	$\overline{PWM}$ = V_{CC}	-	0.1	10	-	100	µA
V_{CC} Quiescent Current (HIP5016)	I_{CCNIL}	$\overline{PWM}$ = GND	-	100	-	-	300	µA
Low Level PWM Input Voltage	V_{IL}		-	1.8	-	1	-	V
High Level PWM Input Voltage	V_{IH}		-	2.1	-	-	3	V
PWM Input Voltage Hysteresis	V_{IHYS}		-	0.3	-	-	-	V
Input Pulldown Resistance (HIP5015)	R_{PWM}		-	220	-	100	400	kΩ
Input Pullup Resistance (HIP5016)	R_{PWM}		-	220	-	100	400	kΩ

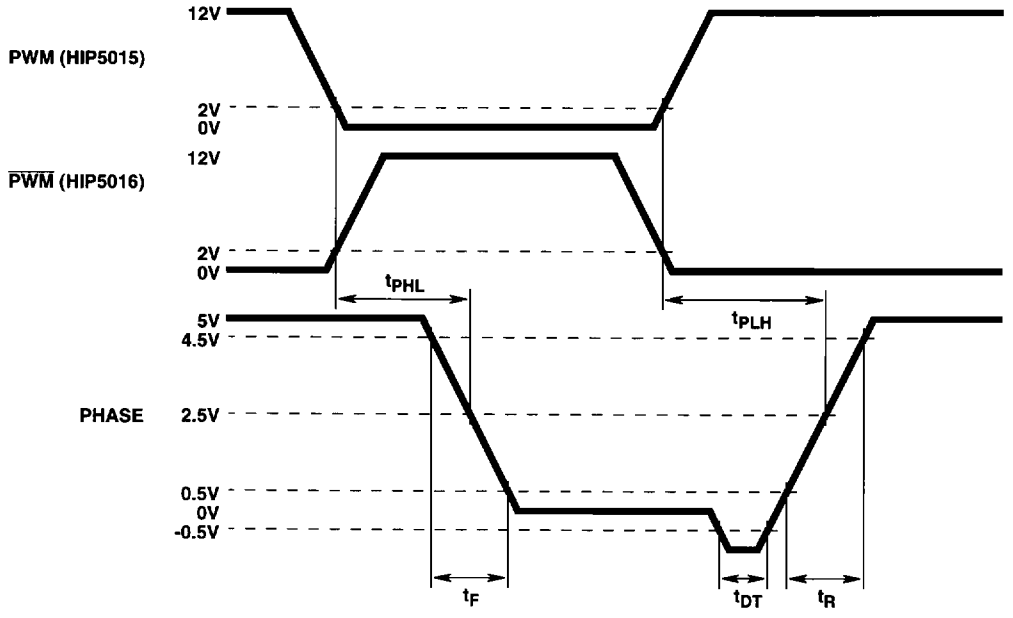
Switching Specifications

PARAMETERS	SYMBOL	TEST CONDITIONS	T_J = 25°C MIN	TYP	MAX	T_J = -40°C, T_J = +150°C MIN	MAX	UNITS
Upper Device Turn-Off Delay	t_{PHL}	V_{CC} = 12V, I_{PHASE} = -0.5A	-	30	50	-	80	ns
Lower Device Turn-Off Delay	t_{PLH}	V_{CC} = 12V, I_{PHASE} = +0.5A	-	30	50	-	80	ns
Dead Time	t_{DT}	V_{CC} = +12V, I_{PHASE} = -0.5A	-	10	-	-	-	ns
Phase Rise-Time	t_R	V_{CC} = 12V, I_{PHASE} = -0.5A	-	20	-	-	-	ns
Phase Fall-Time	t_F	V_{CC} = 12V, I_{PHASE} = +0.5A	-	20	-	-	-	ns

Pin Descriptions

SYMBOL	DESCRIPTION
V_{CC}	Positive supply to control logic and gate drivers. De-couple this pin to GND.
V_{IN}	FET Switch Input Voltage. De-couple this pin to GND.
PHASE	Output.
PWM (HIP5015) $\overline{PWM}$ (HIP5016)	Single Ended Control Input. This input connects to the PWM controller output.
GND	System Ground.

Timing Diagram



NOTE: I_{PHASE} = +0.5A for t_{PLH} and t_F, I_{PHASE} = -0.5A for t_{PHL}, t_{DT}, and t_R.

FIGURE 1.

Typical Performance Curves

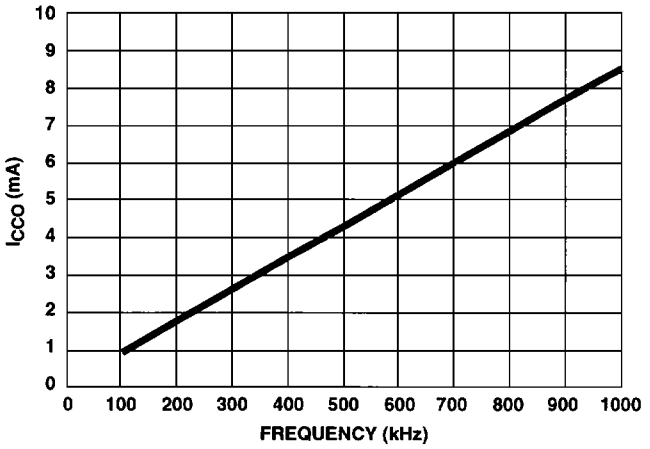


FIGURE 2. I_{CCO} vs FREQUENCY

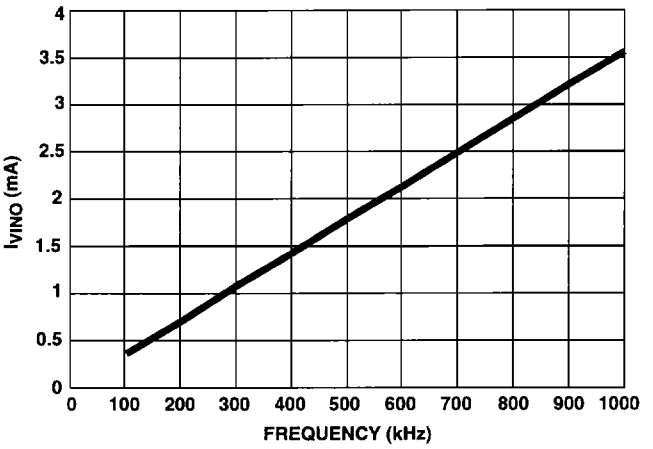


FIGURE 3. I_{VINO} vs FREQUENCY

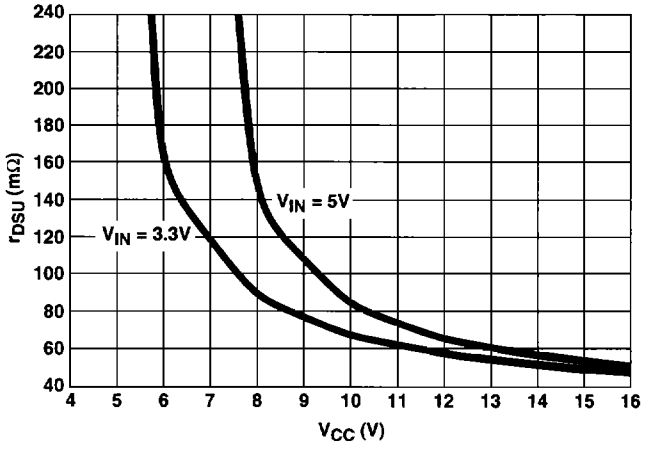


FIGURE 4. R_{DSU} vs V_{CC}

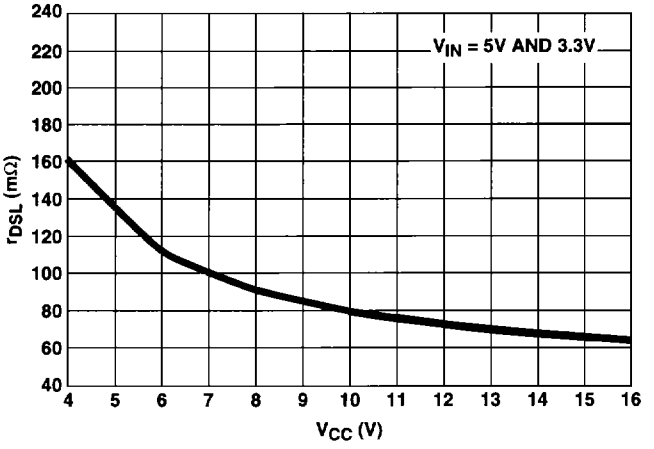


FIGURE 5. R_{DSL} vs V_{CC}

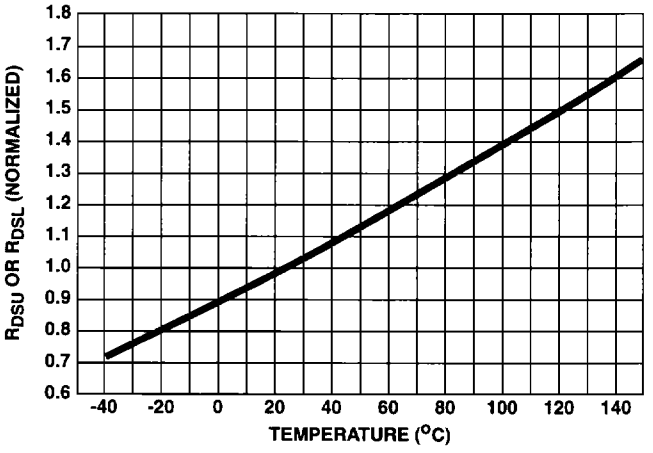
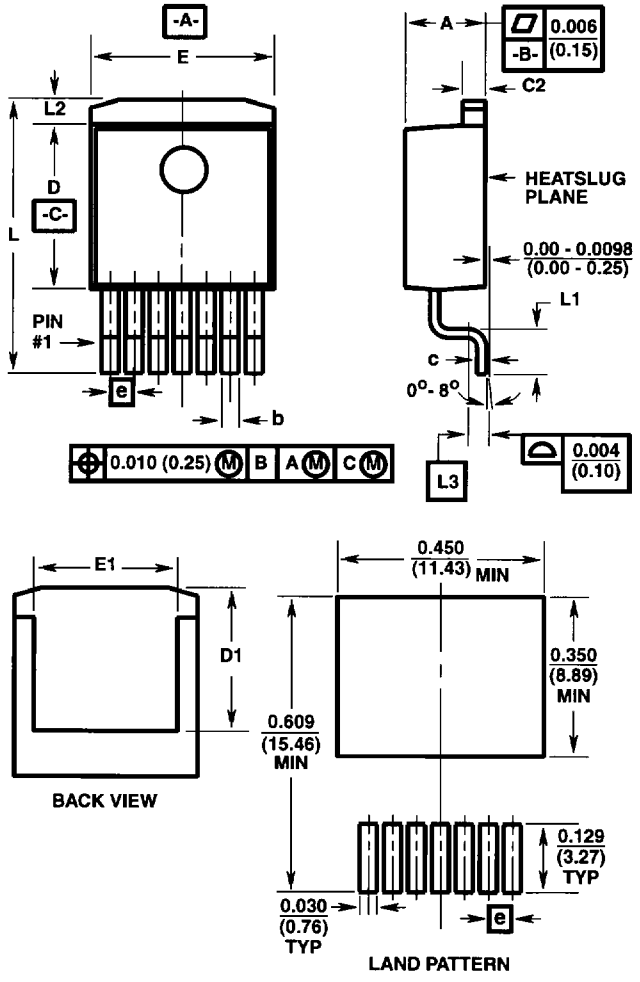


FIGURE 6. R_{DSU} OR R_{DSL} vs TEMPERATURE

Single-In-Line Plastic Packages (SIP)



Z7.05B

7 LEAD PLASTIC SINGLE-IN-LINE PACKAGE SURFACE MOUNT "GULLWING" LEAD FORM

SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN	MAX	MIN	MAX	
A	0.170	0.180	4.32	4.57	-
C2	0.048	0.055	1.22	1.39	5
D	0.350	0.370	8.89	9.39	-
E	0.395	0.405	10.04	10.28	-
D1	0.310	-	7.88	-	-
E1	0.310	-	7.88	-	-
L	0.549	0.569	13.95	14.45	-
L1	0.068	0.088	1.72	2.24	-
L2	0.045	0.055	1.15	1.40	-
L3	0.030 BSC		0.76 BSC		4
b	0.028	0.034	0.71	0.86	5, 6, 7
c	0.018	0.024	0.46	0.60	5
e	0.050 BSC		1.27 BSC		-

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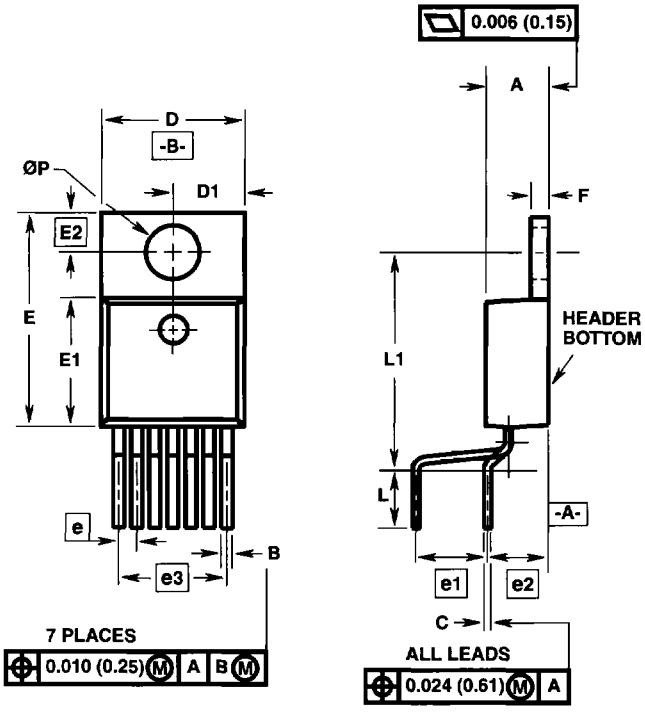
NOTES:

1. These package dimensions are within allowable dimensions of JEDEC MO-169AC, Issue A.
2. Controlling dimension: Inch.
3. Dimensioning and tolerance per ANSI Y14.5M-1982.
4. Gauge plane L3 is parallel to heatslug plane.
5. Dimensions include lead finish.
6. Leads are not allowed above the datum -B-.
7. Dimension "b" does not include dambar protrusion. Allowable dambar protrusion shall not cause the lead width to exceed the maximum "b" by more than 0.003" (0.08mm).

Single-In-Line Plastic Packages (SIP)



Z7.05C

7 LEAD PLASTIC SINGLE-IN-LINE PACKAGE
STAGGERED VERTICAL LEAD FORM

SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN	MAX	MIN	MAX	
A	0.170	0.180	4.32	4.57	-
B	0.028	0.034	0.71	0.86	3, 4
C	0.018	0.024	0.46	0.60	3
D	0.395	0.405	10.04	10.28	-
D1	0.198	0.202	5.03	5.13	-
E	0.595	0.605	15.11	15.37	-
E1	0.350	0.370	8.89	9.39	-
E2	0.110 BSC		2.79 BSC		
e	0.050 BSC		1.27 BSC		-
e1	0.200 BSC		5.08 BSC		-
e2	0.169 BSC		4.29 BSC		-
e3	0.300 BSC		7.62 BSC		-
F	0.048	0.055	1.22	1.39	3
L	0.150	0.176	3.81	4.47	-
L1	0.600	0.620	15.24	15.74	-
ØP	0.147	0.152	3.73	3.86	3

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NOTES:

1. Controlling dimension: INCH.
2. Dimensioning and tolerancing per ANSI Y14.5M-1982.
3. Dimensions include lead finish.
4. Dimension "B" does not include dambar protrusion. Allowable dambar protrusion shall not cause lead width to exceed maximum "B" by more than 0.003 inches (0.08mm).

All Harris Semiconductor products are manufactured, assembled and tested under **ISO9000** quality systems certification.

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