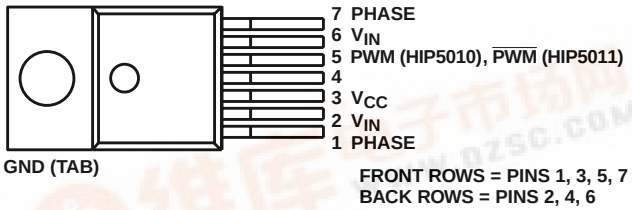
Data Sheet March 1996 File Number 4029.5

7V, 17A SynchroFET™ Complementary Drive Synchronous Half-Bridge

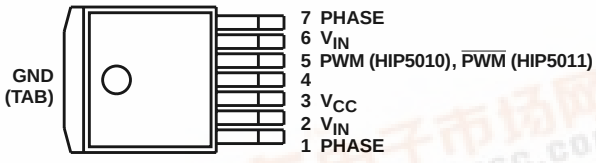
Designed with the P6 and Pentium® in mind, the Intersil SynchroFET™ family provides a new approach for implementing a synchronous rectified buck switching regulator. The SynchroFET replaces two power DMOSs, a Schottky diode, two gate drivers and synchronous control circuitry. The complementary drive 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 HIP5011 has a 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}.

Pinouts

HIP5010IS1, HIP5011IS1 (SIP - VERTICAL)
TOP VIEW



HIP5010IS, HIP5011IS (SIP - GULLWING)
TOP VIEW



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

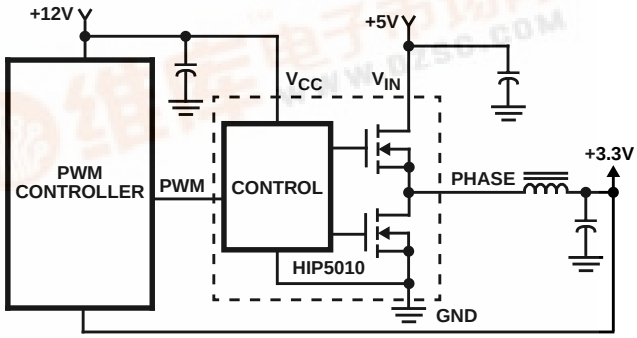
Applications

- 5V to ≤3.3V Synchronous Buck Converters
- Pentium and P6 Power Supplies
- PowerPC™ Power Supplies
- Bus Terminations (BTL and GTL)
- Drive 5V Motors Directly from Microprocessor

Ordering Information

PART NUMBER	TEMP. RANGE (^{o}C)	PACKAGE	PKG. NO.
HIP5010IS	-40 to 85	7 Ld Gullwing SIP	Z7.05B
HIP5010IS1	-40 to 85	7 Ld Staggered Vertical SIP	Z7.05C
HIP5011IS	-40 to 85	7 Ld Gullwing SIP	Z7.05B
HIP5011IS1	-40 to 85	7 Ld Staggered Vertical SIP	Z7.05C

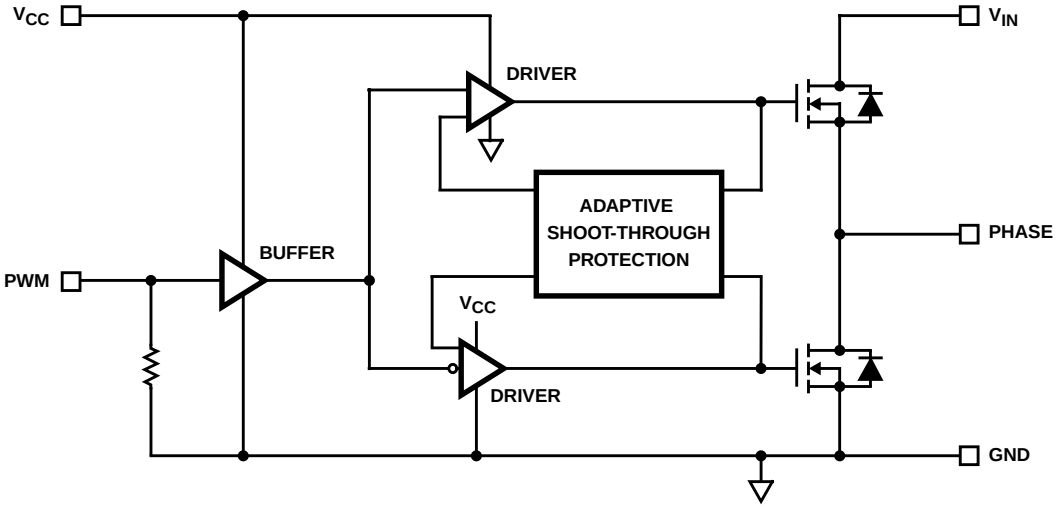
Typical Application Block Diagram



SYNCHRONOUS RECTIFIED BUCK CONVERTER

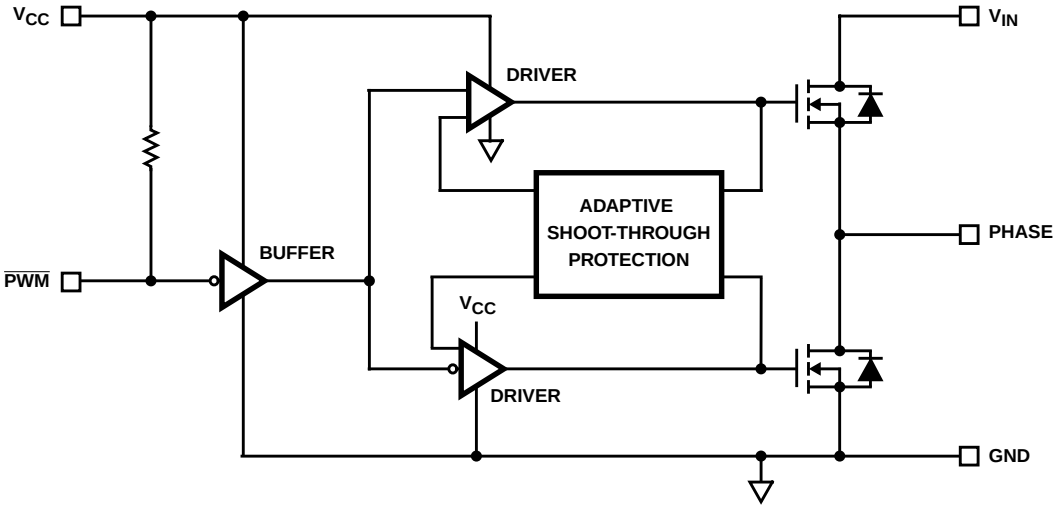
Non-Inverting SynchroFET Block Diagram

HIP5010



Inverting SynchroFET Block Diagram

HIP5011



Absolute Maximum Ratings

Supply Voltage, V_{CC} . . . . . +16V
Input Voltage V_{IN} . . . . . +7V
I_{PHASE}, I_{VIN}, I_{GND} (T_J = 25°C) . . . . . 17A (Repetitive Peak)
I_{PHASE}, I_{VIN}, I_{GND} (T_J = 150°C) . . . . . 15A (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

Operating Conditions

Supply Voltage, VCC . . . . . +12V, 20%
Input Voltage VIN . . . . . 0V to 5.5V
Supply Voltage, VCC, minimum for charge-pumped start-up . +4.0V

Thermal Information (Typical)

Package	θ_{JC}†† (°C/W)	θ_{JA} (°C/W)† 0	1	2	3	3†††
SOIC (IB) . . .	26	63	45	42	41	35
SIP (IS)	2	55	30	25	24	18
SIP (IS1)	2	-	-	-	-	-

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

†† θ_{JC} is measured to pin 12 for the SOIC. Printed circuit board had 1 square inch of copper. For SIP Packages value shown is typical with an infinite heat sink.

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

I_{PHASE} . SIPs:11.5A(RMS), 11.2A(DC); SOIC:7.4A(RMS), 7.4A(DC)
I_{VIN} . . . SIPs:10.0A(RMS), 8.5A(DC); SOIC:6.4A(RMS), 6.4A(DC)
I_{GND} . . . . SIPs:8.5A(RMS), 6.0A(DC); SOIC:5.4A(RMS), 5.4A(DC)

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.

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	-	34	39	-	65	mΩ
$r_{DS(ON)}$ Lower MOSFET	R_{DSL}	V_{CC} = 12V, V_{IN} = 5V	-	36	42	-	68	mΩ
V_{IN} Operating Current	I_{VINO}	V_{IN} = 5V, No Load, 500kHz	-	5	8	-	10	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	-	8	12	-	15	mA
V_{CC} Quiescent Current (HIP5010)	I_{CCIH}	PWM = V_{CC}	-	80	-	-	400	µA
V_{CC} Quiescent Current (HIP5010)	I_{CCIL}	PWM = GND	-	0.1	10	-	100	µA
V_{CC} Quiescent Current (HIP5011)	I_{CCNIH}	$\overline{PWM}$ = V_{CC}	-	0.1	10	-	100	µA
V_{CC} Quiescent Current (HIP5011)	I_{CCNIL}	$\overline{PWM}$ = GND	-	140	-	-	400	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 (HIP5010)	R_{PWM}		-	220	-	100	400	kΩ
Input Pullup Resistance (HIP5011)	R_{PWM}		-	220	-	100	400	kΩ

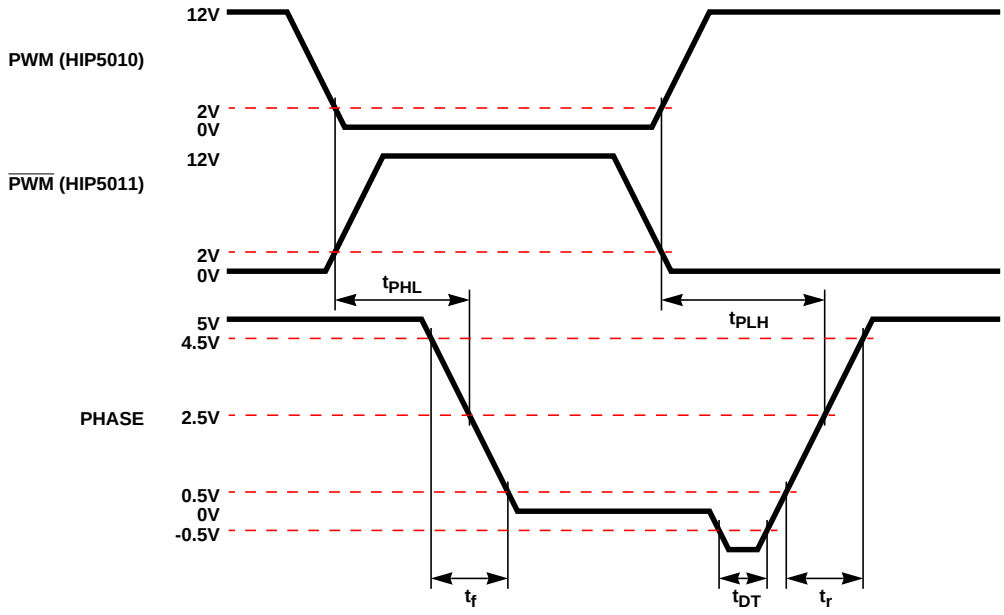
Switching Specifications

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} = -1A	-	30	50	-	80	ns
Lower Device Turn-Off Delay	t_{PLH}	V_{CC} = 12V, I_{PHASE} = +1A	-	30	50	-	80	ns
Dead Time	t_{DT}	V_{CC} = +12V, I_{PHASE} = -1A	-	10	-	-	-	ns
Phase Rise-Time	t_r	V_{CC} = 12V, I_{PHASE} = -1A	-	20	-	-	-	ns
Phase Fall-Time	t_f	V_{CC} = 12V, I_{PHASE} = +1A	-	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. Tie all V_{IN} terminals together.
PHASE	Output. Tie all phase terminals together.
PWM (HIP5010) $\overline{PWM}$ (HIP5011)	Single Ended Control Input. This input connects to the PWM controller output.
GND	System Ground.

Timing Diagram



NOTE: I_{PHASE} = +1A for t_{PLH} and t_f, I_{PHASE} = -1A for t_{PHL}, t_{DT}, and t_r.

FIGURE 1.

Typical Performance Curves

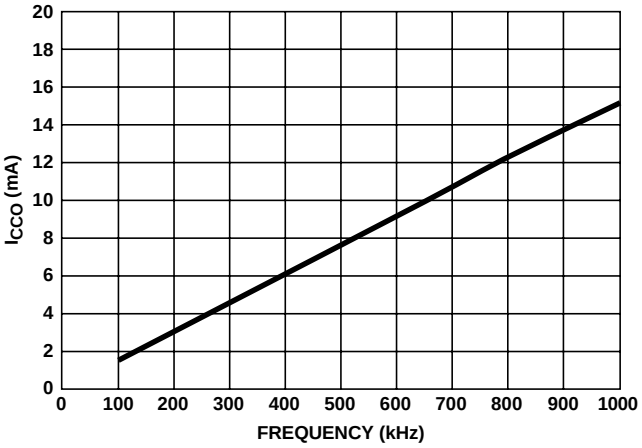


FIGURE 2. I_{CCO} vs FREQUENCY

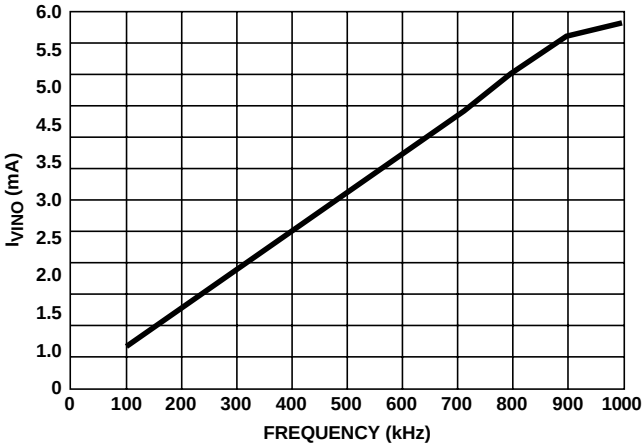


FIGURE 3. I_{VINO} vs FREQUENCY

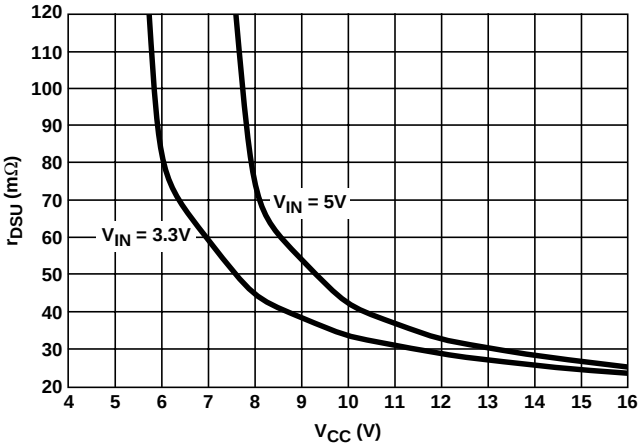


FIGURE 4. R_{DSU} vs V_{CC}

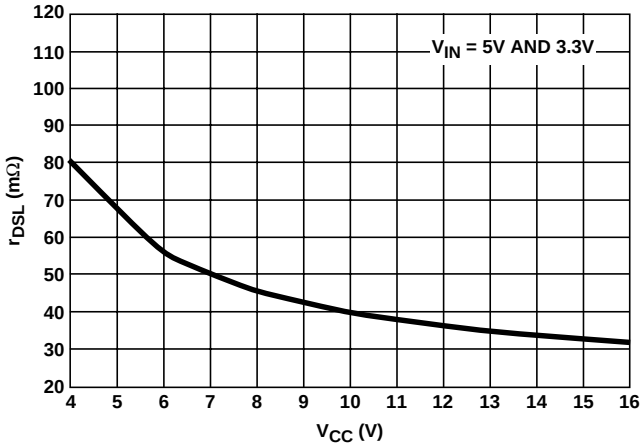


FIGURE 5. R_{DSL} vs V_{CC}

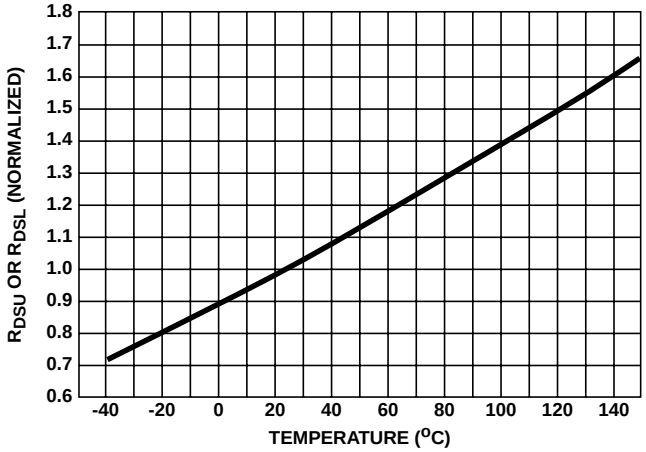


FIGURE 6. R_{DSU} OR R_{DSL} vs TEMPERATURE

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