



High-Voltage Switchmode Regulator

FEATURES

- 10- to 120-V Input Range
- Current-Mode Control
- On-Chip 200-V, 5- Ω MOSFET Switch
- SHUTDOWN and RESET
- High Efficiency Operation (>80%)
- Internal Start-Up Circuit
- Internal Oscillator (1 MHz)

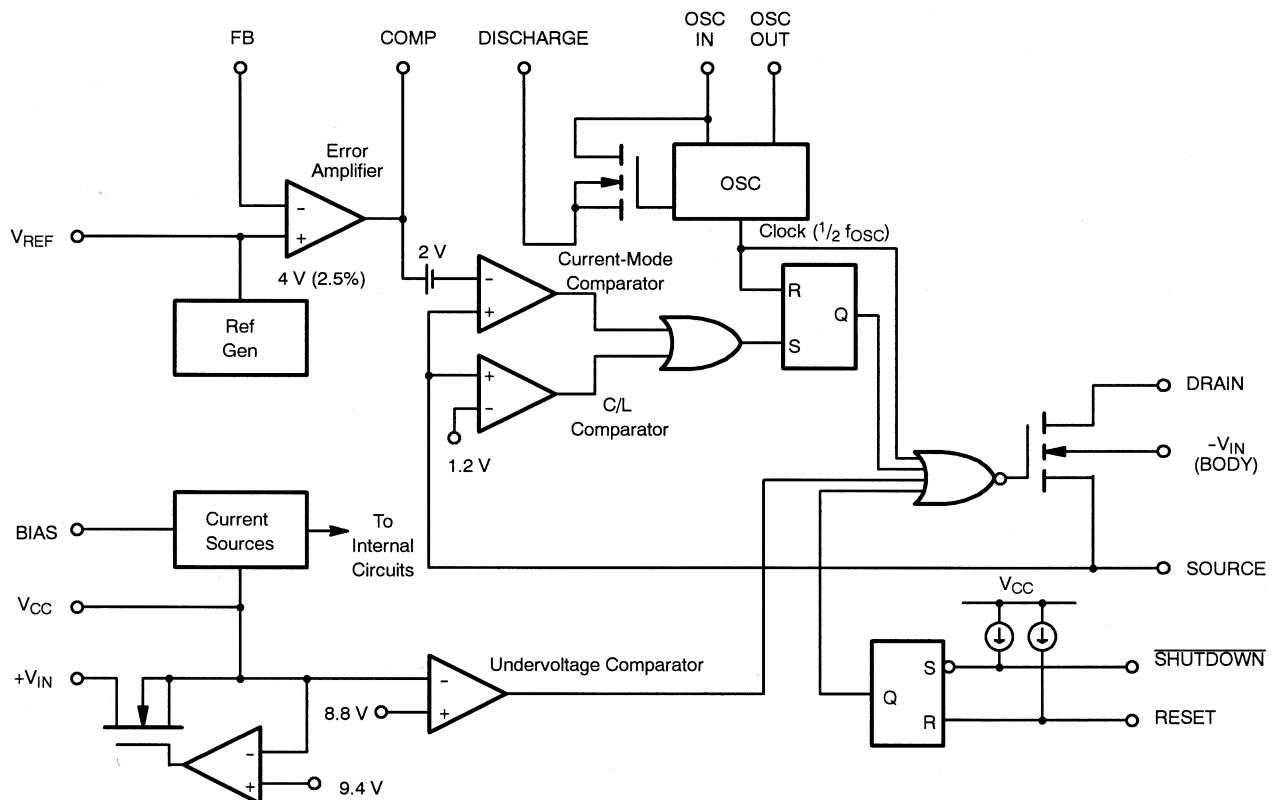
DESCRIPTION

The Si9104 high-voltage switchmode regulator is a monolithic BiC/DMOS integrated circuit which contains most of the components necessary to implement a high-efficiency dc-to-dc converter up to 3 watts. It can either be operated from a low-voltage dc supply, or directly from a 10- to 120-V unregulated dc power source.

This device may be used with an appropriate transformer to implement most single-ended isolated power converter topologies (i.e., flyback and forward).

The Si9104 is available in a 16-pin wide-body SOIC and is specified over the D suffix (-40 to 85°C) temperature range.

FUNCTIONAL BLOCK DIAGRAM



ABSOLUTE MAXIMUM RATINGS

Voltages Referenced to $-V_{IN}$ ($V_{CC} < +V_{IN} + 0.3$ V)

V_{CC}	15 V
$+V_{IN}$	120 V
V_{DS}	200 V
I_D (Peak) (300 μ s pulse, 2% duty cycle)	2 A
I_D (rms)	250 mA
Logic Inputs (RESET, SHUTDOWN, OSC IN) ..	-0.3 V to $V_{CC} + 0.3$ V
Linear Inputs (FEEDBACK, SOURCE)	-0.3 V to 7 V
HV Pre-Regulator Input Current (continuous)	3 mA
Storage Temperature	-65 to 125°C

Operating Temperature -40 to 85°C |Junction Temperature (T_J) 150°C |Power Dissipation (Package)^a16-Pin Plastic Wide-Body SOIC^b 900 mW |

Thermal Impedance (θ_{JA})

16-Pin Plastic Wide-Body SOIC 140°C/W |

Notes

a. Device mounted with all leads soldered or welded to PC board.

b. Derate 7.2 mW/°C above 25°C.

RECOMMENDED OPERATING RANGE

Voltages Referenced to $-V_{IN}$

V_{CC}	10 V to 13.5 V
$+V_{IN}$	10 V to 120 V
f_{OSC}	40 kHz to 1 MHz

R_{OSC} 25 k Ω to 1 M Ω |

Linear Inputs 0 to 7 V |

Digital Inputs 0 to V_{CC} |

SPECIFICATIONS ^a							
Parameter	Symbol	Test Conditions Unless Otherwise Specified DISCHARGE = $-V_{IN} = 0$ V, $V_{CC} = 10$ V $+V_{IN} = 48$ V, $R_{BIAS} = 390$ k Ω $R_{OSC} = 330$ k Ω	Limits D Suffix -40 to 85°C				Unit
			Temp ^b	Min ^d	Typ ^c	Max ^d	
Reference							
Output Voltage	V_R	OSC IN = $-V_{IN}$ (OSC Disabled) $R_L = 10$ M Ω	Room Full	3.92 3.85	4.0	4.08 4.15	V
Output Impedance ^e	Z_{OUT}		Room	15	30	45	k Ω
Short Circuit Current	I_{SREF}	$V_{REF} = -V_{IN}$	Room	70	100	130	μ A
Temperature Stability ^e	T_{REF}		Full		0.25	1.0	mV/°C
Long Term Stability ^e		t = 1000 hrs., $T_A = 125^\circ\text{C}$	Room		5	25	mV
Oscillator							
Maximum Frequency ^e	f_{MAX}	$R_{OSC} = 0$	Room	1	3		MHz
Initial Accuracy	f_{OSC}	$R_{OSC} = 330$ k Ω ^f	Room	80	100	120	kHz
		$R_{OSC} = 150$ k Ω ^f	Room	160	200	240	
Voltage Stability	$\Delta f/f$	$\Delta f/f = f(13.5 \text{ V}) - f(10 \text{ V}) / f(10 \text{ V})$	Room	4	10	15	%
Temperature Coefficient ^e	T_{OSC}		Full		200	500	ppm/°C
Error Amplifier							
Feedback Input Voltage	V_{FB}	FB Tied to COMP OSC IN = $-V_{IN}$ (OSC Disabled)	Room	3.96	4.00	4.04	V
Input BIAS Current	I_{FB}	OSC IN = $-V_{IN}$, $V_{FB} = 4$ V	Room		25	500	nA
Input OFFSET Voltage	V_{OS}	OSC IN = $-V_{IN}$ (OSC Disabled)	Room		± 15	± 40	mV
Open Loop Voltage Gain ^e	A_{VOL}		Room	60	80		dB
Unity Gain Bandwidth ^e	BW		Room	0.7	1		MHz
Dynamic Output Impedance ^e	Z_{OUT}		Room		1000	2000	Ω
Output Current	I_{OUT}	Source ($V_{FB} = 3.4$ V)	Room		-2.0	-1.4	mA
		Sink ($V_{FB} = 4.5$ V)	Room	0.12	0.15		
Power Supply Rejection	PSRR	$10 \text{ V} \leq V_{CC} \leq 13.5 \text{ V}$	Room	50	70		dB

S-60752—Rev. E, 05-Apr-99

2

FaxBack 408-970-5600, request 70002
www.siliconix.com



SPECIFICATIONS ^a							
Parameter	Symbol	Test Conditions Unless Otherwise Specified DISCHARGE = -V _{IN} = 0 V, V _{CC} = 10 V +V _{IN} = 48 V, R _{BIAS} = 390 kΩ R _{OSC} = 330 kΩ	Limits D Suffix -40 to 85°C				Unit
			Temp ^b	Min ^d	Typ ^c	Max ^d	
Current Limit							
Threshold Voltage	V _{SOURCE}	R _L = 100 Ω from DRAIN to V _{CC} , V _{FB} = 0 V	Room	1.0	1.2	1.4	V
Delay to Output	t _d	R _L = 100 Ω from DRAIN to V _{CC} V _{SOURCE} = 1.5 V, See Figure 1.	Room		100	200	ns
Pre-Regulator/Start-Up							
Input Voltage	+V _{IN}	I _{IN} = 10 μA	Room	120			V
Input Leakage Current	+I _{IN}	V _{CC} ≥ 10 V	Room			10	μA
Pre-Regulator Start-Up Current	I _{START}	Pulse Width ≤ 300 μs, V _{CC} = 7 V	Room	8	15		mA
V _{CC} Pre-Regulator Turn-Off Threshold Voltage	V _{REG}	I _{PRE-REGULATOR} = 10 μA	Room	7.8	9.4	9.8	V
Undervoltage Lockout	V _{UVLO}	R _L = 100 Ω from DRAIN to V _{CC} See Detailed Description	Room	7.0	8.8	9.3	
V _{REG} - V _{UVLO}	V _{DELTA}		Room	0.3	0.6		
Supply							
Supply Current	I _{CC}		Room	0.45	0.6	1.0	mA
Bias Current	I _{BIAS}		Room	10	15	20	μA
Logic							
SHUTDOWN Delay ^e	t _{SD}	V _{SOURCE} = -V _{IN} , See Figure 2.	Room		50	100	ns
SHUTDOWN Pulse Width ^e	t _{SW}	See Figure 3.	Room	50			
RESET Pulse Width ^e	t _{RW}		Room	50			
Latching Pulse Width ^e SHUTDOWN and RESET Low	t _{LW}		Room	25			
Input Low Voltage	V _{IL}		Room			2.0	V
Input High Voltage	V _{IH}		Room	8.0			
Input Current Input Voltage High	I _{IH}	V _{IN} = V _{CC}	Room		1	5	μA
Input Current Input Voltage Low	I _{IL}	V _{IN} = 0 V	Room	-35	-25		
MOSFET Switch							
Breakdown Voltage	V _{BR(DSS)}	I _{DRAIN} = 100 μA	Full	200	220		V
Drain-Source On-Resistance ^g	r _{DS(on)}	I _{DRAIN} = 100 mA	Room		3	5	Ω
Drain Off Leakage Current	I _{DSS}	V _{DRAIN} = 150 V	Room		5	10	μA
Drain Capacitance ^e	C _{DS}		Room		35		pF

Notes

- Refer to PROCESS OPTION FLOWCHART for additional information.
- Room = 25°C, Cold and Hot = as determined by the operating temperature suffix.
- Typical values are for DESIGN AID ONLY, not guaranteed nor subject to production testing.
- The algebraic convention whereby the most negative value is a minimum and the most positive a maximum, is used in this data sheet.
- Guaranteed by design, not subject to production test.
- C_{STRAY} @ OSC IN $\leq 5\text{ pF}$.
- Temperature coefficient of $r_{DS(on)}$ is 0.75% per °C, typical.

TIMING WAVEFORMS

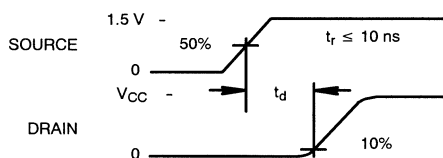


FIGURE 1.

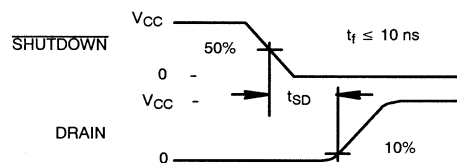


FIGURE 2.

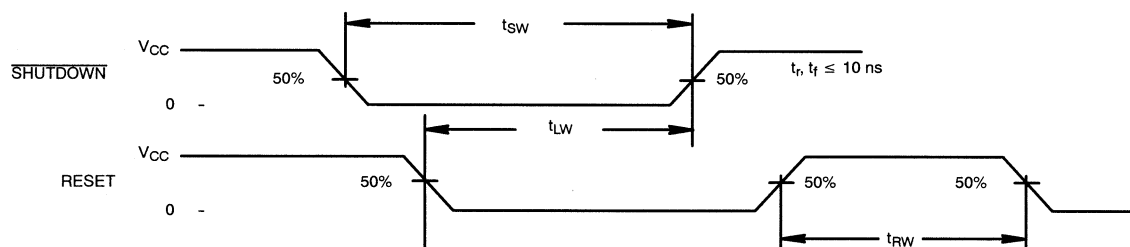


FIGURE 3.

TYPICAL CHARACTERISTICS

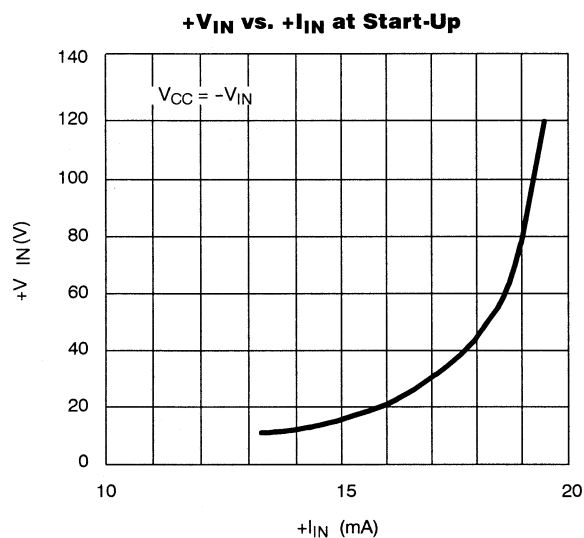


FIGURE 4.

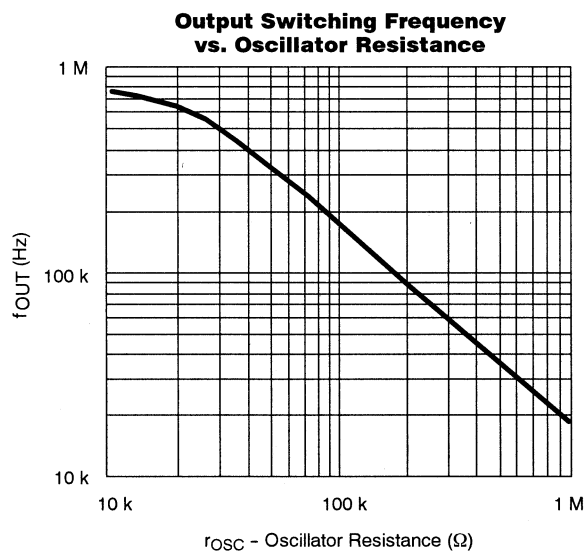
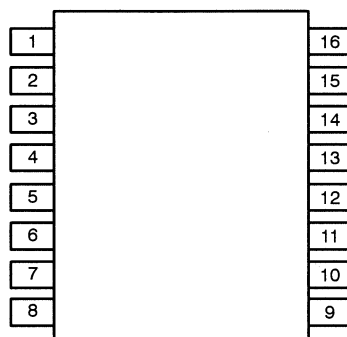


FIGURE 5.



PIN CONFIGURATIONS

SO-16
(Wide-Body)Top View
Order Number: Si9104DW

PIN DESCRIPTION			
Function	Pin Number		
	14-Pin Plastic DIP	16-Pin SOIC	20-Pin PLCC
SOURCE	4	1	7
$-V_{IN}$	5	2	8
V_{CC}	6	4	9
OSC_{OUT}	7	5	10
OSC_{IN}	8	6	11
DISCHARGE	9	7	12
V_{REF}	10	8	14
$\overline{SHUTDOWN}$	11	9	16
RESET	12	10	17
COMP	13	11	18
FB	14	12	20
BIAS	1	13	2
$+V_{IN}$	2	14	3
DRAIN	3	16	5
NC		3, 15	1, 4, 6, 13, 15, 19





Notice

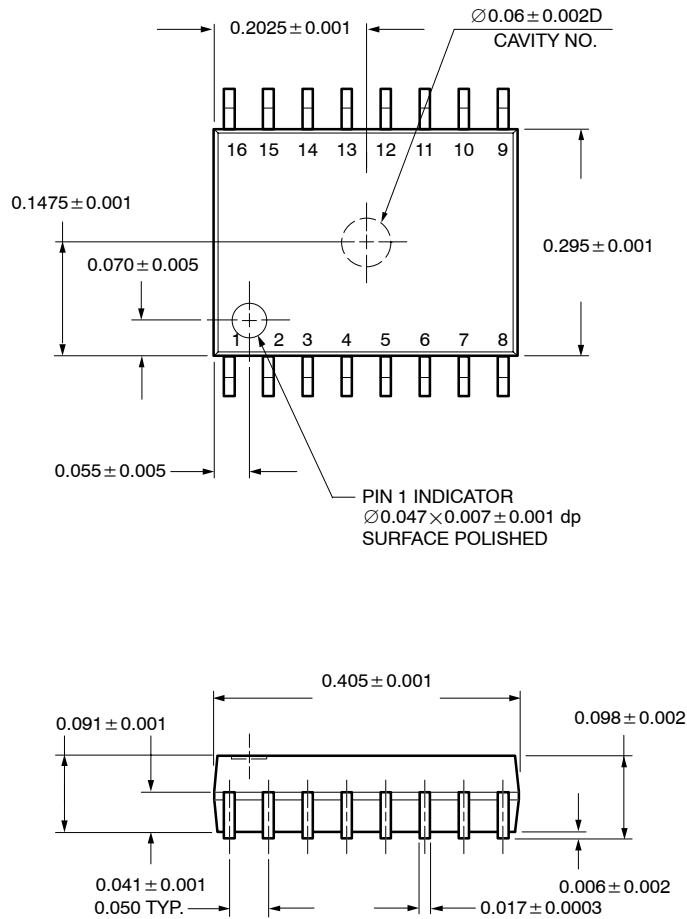
Specifications of the products displayed herein are subject to change without notice. Vishay Intertechnology, Inc., or anyone on its behalf, assumes no responsibility or liability for any errors or inaccuracies.

Information contained herein is intended to provide a product description only. No license, express or implied, by estoppel or otherwise, to any intellectual property rights is granted by this document. Except as provided in Vishay's terms and conditions of sale for such products, Vishay assumes no liability whatsoever, and disclaims any express or implied warranty, relating to sale and/or use of Vishay products including liability or warranties relating to fitness for a particular purpose, merchantability, or infringement of any patent, copyright, or other intellectual property right.

The products shown herein are not designed for use in medical, life-saving, or life-sustaining applications. Customers using or selling these products for use in such applications do so at their own risk and agree to fully indemnify Vishay for any damages resulting from such improper use or sale.

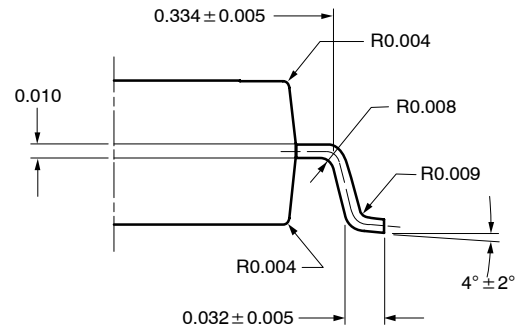


SOIC (WIDE-BODY): 16-LEAD (POWER IC ONLY)

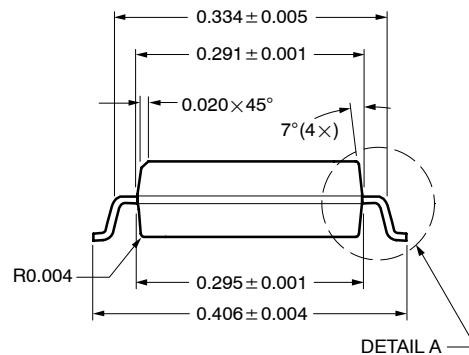


All Dimensions In Inches

ECN: S-40079—Rev. A, 02-Feb-04
DWG: 5910



DETAIL A



DETAIL A



Disclaimer

ALL PRODUCT, PRODUCT SPECIFICATIONS AND DATA ARE SUBJECT TO CHANGE WITHOUT NOTICE TO IMPROVE RELIABILITY, FUNCTION OR DESIGN OR OTHERWISE.

Vishay Intertechnology, Inc., its affiliates, agents, and employees, and all persons acting on its or their behalf (collectively, "Vishay"), disclaim any and all liability for any errors, inaccuracies or incompleteness contained in any datasheet or in any other disclosure relating to any product.

Vishay makes no warranty, representation or guarantee regarding the suitability of the products for any particular purpose or the continuing production of any product. To the maximum extent permitted by applicable law, Vishay disclaims (i) any and all liability arising out of the application or use of any product, (ii) any and all liability, including without limitation special, consequential or incidental damages, and (iii) any and all implied warranties, including warranties of fitness for particular purpose, non-infringement and merchantability.

Statements regarding the suitability of products for certain types of applications are based on Vishay's knowledge of typical requirements that are often placed on Vishay products in generic applications. Such statements are not binding statements about the suitability of products for a particular application. It is the customer's responsibility to validate that a particular product with the properties described in the product specification is suitable for use in a particular application. Parameters provided in datasheets and/or specifications may vary in different applications and performance may vary over time. All operating parameters, including typical parameters, must be validated for each customer application by the customer's technical experts. Product specifications do not expand or otherwise modify Vishay's terms and conditions of purchase, including but not limited to the warranty expressed therein.

Except as expressly indicated in writing, Vishay products are not designed for use in medical, life-saving, or life-sustaining applications or for any other application in which the failure of the Vishay product could result in personal injury or death. Customers using or selling Vishay products not expressly indicated for use in such applications do so at their own risk. Please contact authorized Vishay personnel to obtain written terms and conditions regarding products designed for such applications.

No license, express or implied, by estoppel or otherwise, to any intellectual property rights is granted by this document or by any conduct of Vishay. Product names and markings noted herein may be trademarks of their respective owners.

Material Category Policy

Vishay Intertechnology, Inc. hereby certifies that all its products that are identified as RoHS-Compliant fulfill the definitions and restrictions defined under Directive 2011/65/EU of The European Parliament and of the Council of June 8, 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment (EEE) - recast, unless otherwise specified as non-compliant.

Please note that some Vishay documentation may still make reference to RoHS Directive 2002/95/EC. We confirm that all the products identified as being compliant to Directive 2002/95/EC conform to Directive 2011/65/EU.

Vishay Intertechnology, Inc. hereby certifies that all its products that are identified as Halogen-Free follow Halogen-Free requirements as per JEDEC JS709A standards. Please note that some Vishay documentation may still make reference to the IEC 61249-2-21 definition. We confirm that all the products identified as being compliant to IEC 61249-2-21 conform to JEDEC JS709A standards.