

High-Voltage Switchmode Regulator

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 W. It can either be operated from a low-voltage DC supply, or directly from a 10 to 120 V unregulated DC power source.

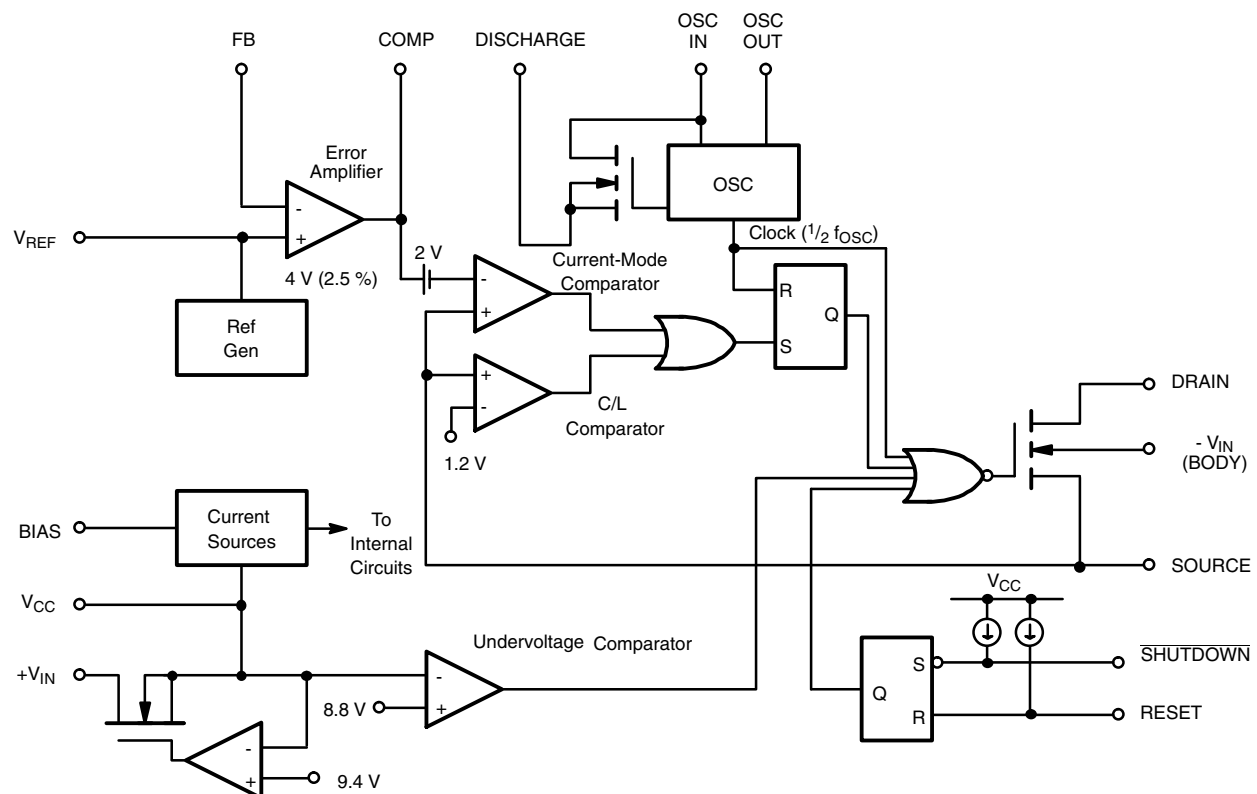
This device may be used with an appropriate transformer to implement most single-ended isolated power converter topologies (i.e., flyback and forward).

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

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)

FUNCTIONAL BLOCK DIAGRAM



ABSOLUTE MAXIMUM RATINGS

Parameter	Limit	Unit
Voltages Referenced to - V_{IN} ($V_{CC} < + V_{IN} + 0.3$ V)		
V_{CC}	15	V
$+V_{IN}$	120	
V_{DS}	200	
I_D (Peak) (Note: 300 μ s pulse, 2 % Duty Cycle)	2	A
I_D (rms)	250	mA
Logic Inputs (RESET, SHUTDOWN, OSC IN)	- 0.3 to $V_{CC} + 0.3$	V
Linear Inputs (FEEDBACK, SOURCE)	- 0.3 to 7	
HV Pre-Regulator Input Current (continuous)	3	mA
Storage Temperature	- 65 to 125	$^{\circ}$ C
Operating Temperature	- 40 to 85	
Junction Temperature (T_J)	150	
Power Dissipation (Package) ^a	16-Pin Plastic Wide-Body SOIC ^b	mW
Thermal Impedance (Θ_{JA})	16-Pin Plastic Wide-Body SOIC	$^{\circ}$ C/W

Notes:

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

b. Derate 7.2 mW/ $^{\circ}$ C above 25 $^{\circ}$ C.

Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

RECOMMENDED OPERATING RANGE

Parameter	Limit	Unit
Voltages Referenced to - V_{IN}		
V_{CC}	10 to 13.5	V
$+ V_{IN}$	10 to 120	
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 kΩ, R _{OSC} = 330 kΩ	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 MΩ	Room Full	3.92 3.85	4.0	4.08 4.15	V
Output Impedance ^e	Z _{OUT}		Room	15	30	45	kΩ
Short Circuit Current	I _{SREF}	V _{REF} = - V _{IN}	Room	70	100	130	μA
Temperature Stability ^e	T _{REF}		Full		0.25	1.0	mV/°C
Long Term Stability ^e		t = 1000 hrs., T _A = 125 °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 kΩ ^f	Room	80	100	120	kHz
		R _{OSC} = 150 kΩ ^f	Room	160	200	240	
Voltage Stability	Δf/f	Δf/f = f(13.5 V) - f(10 V)/f(10 V)	Room	4	10	15	%
Temperature Coefficient ^e	T _{OSC}		Full		200	500	ppm/°C

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			Temp ^b	Min ^d	Typ ^c	Max ^d	
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 V ≤ V _{CC} ≤ 13.5 V	Room	50	70		dB
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:

a. Refer to PROCESS OPTION FLOWCHART for additional information.

b. Room = 25 °C, Full = as determined by the operating temperature suffix.

c. Typical values are for DESIGN AID ONLY, not guaranteed nor subject to production testing.

d. The algebraic convention whereby the most negative value is a minimum and the most positive a maximum, is used in this data sheet.

e. Guaranteed by design, not subject to production test.

f. C_{STRAY} at OSC IN ≤ 5 pF.g. Temperature coefficient of $r_{DS(on)}$ is 0.75 % per °C, typical.

TIMING WAVEFORMS

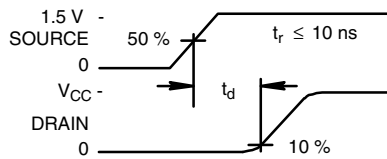


Figure 1.

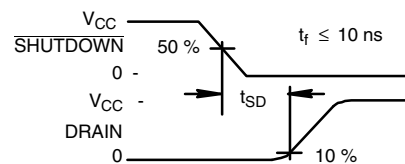


Figure 2.

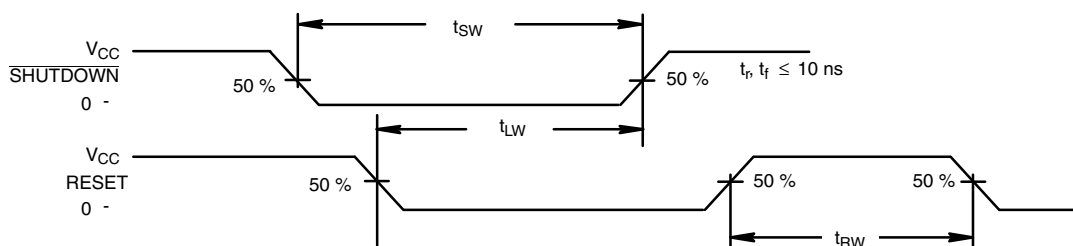


Figure 3.

TYPICAL CHARACTERISTICS

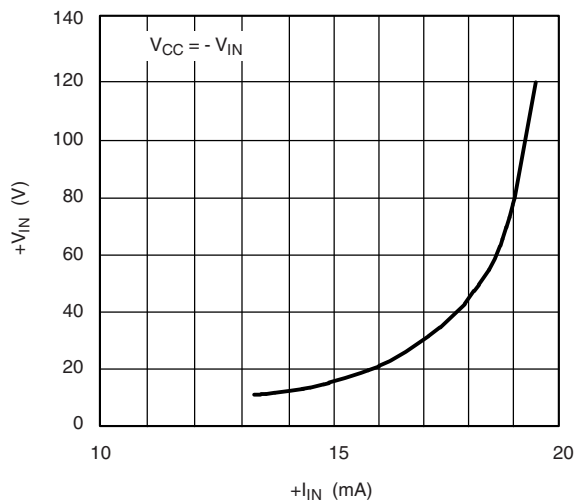
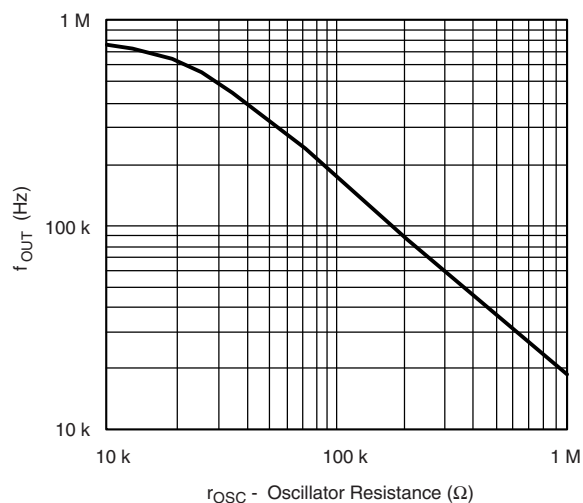
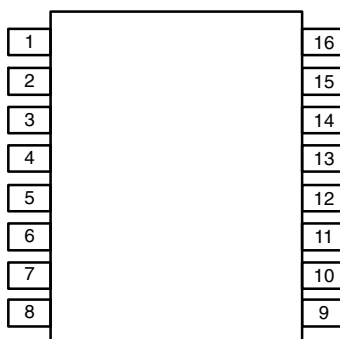
Figure 4. $+V_{IN}$ vs. $+I_{IN}$ at Start-Up

Figure 5. Output Switching Frequency vs. Oscillator Resistance



PIN CONFIGURATIONS

SO-16
(Wide-Body)

Top View

Order Number: Si9104DW

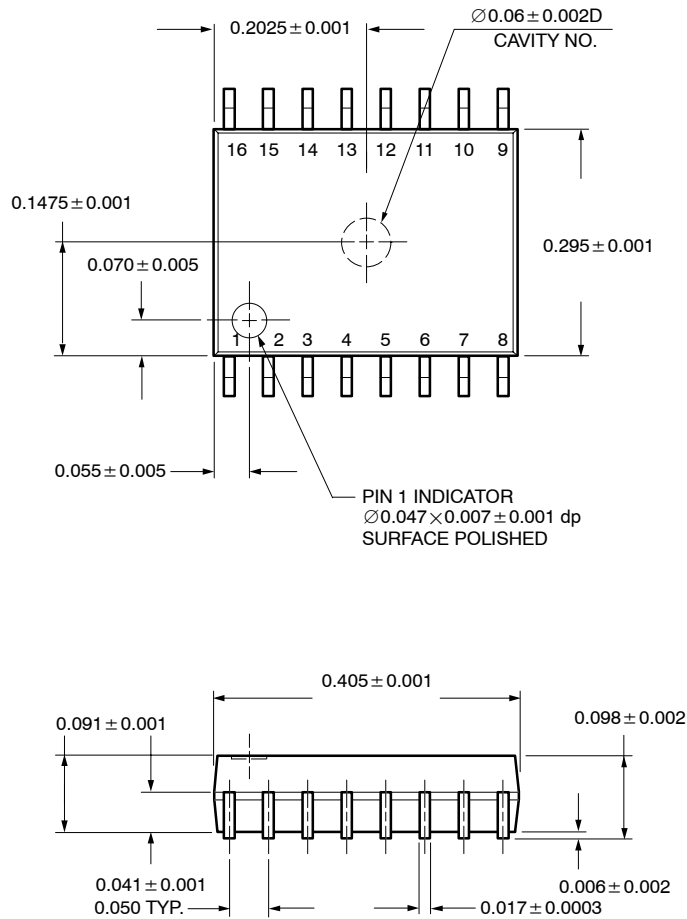
PIN DESCRIPTION

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
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

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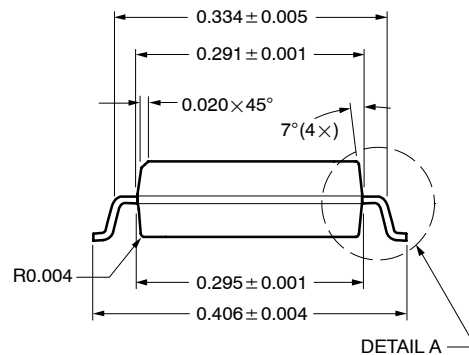
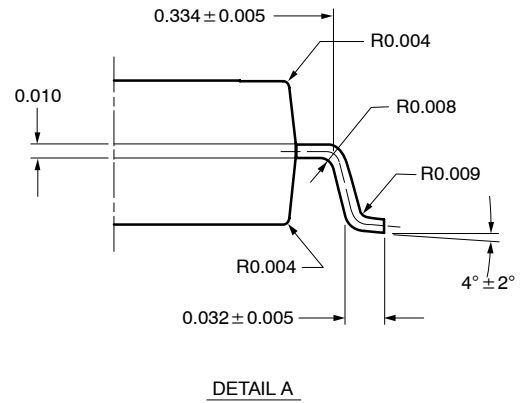


SOIC (WIDE-BODY): 16-LEAD (POWER IC ONLY)



All Dimensions In Inches

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





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