Si9114

High-Frequency Switchmode Controller

Features

- 15- to 200-V Input Range
- Current-Mode Control
- Internal Start-Up Circuit
- Latched $\overline{\text{SHUTDOWN}}$
- Soft-Start
- 1.5-MHz Error Amp

Description

The Si9114 is a BiC/DMOS current-mode pulse width modulation (PWM) controller IC for high-frequency dc/dc converters. Single-ended topologies (forward and flyback) can be implemented at frequencies up to 1 MHz. The oscillator has an internal divide-by-two that limits the duty ratio to 50%. An oscillator sync output allows converters to be synchronized in phase as well as in frequency, in a master/slave configuration.

The output inverter can typically source 500 mA and sink 700 mA. Shoot-through current is all but eliminated to minimize supply current requirements.

The high-voltage DMOS transistor allows the IC to interface directly to bus voltages up to 200 V. Other features include a 1.5% accurate voltage reference, 1.5-MHz (min) bandwidth error amplifier, shutdown logic control, soft-start and undervoltage lockout circuits.

The Si9114 is available in 14-pin plastic DIP and SOIC packages, and is specified over the industrial, D suffix ($-40°$C to $85°$C) temperature range.

Functional Block Diagram

Preliminary

TEMIC
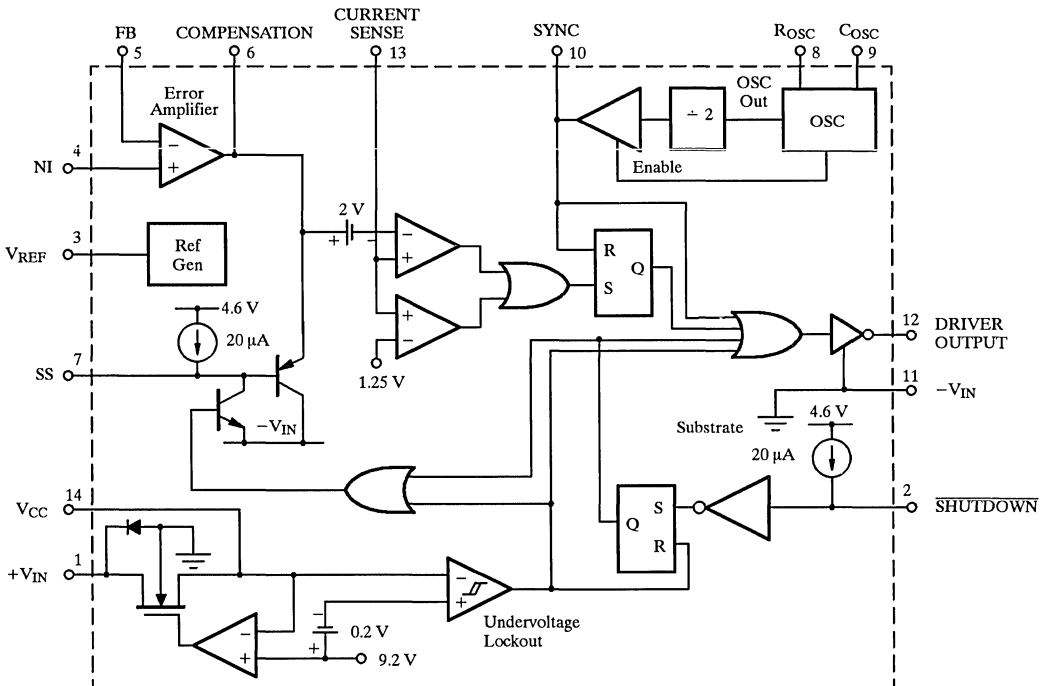
Absolute Maximum Ratings

Voltages Referenced to $-V_{IN}$

V_{CC} . . . . 18 V

$+V_{IN}$ (Note: $V_{CC} < +V_{IN} + 0.3$ V) . . . . 200 V

Logic Input ($\overline{SHUTDOWN}$, SYNC) . . . . -0.3 V to $V_{CC} + 0.3$ V

Linear Inputs (FEEDBACK, SENSE,
SOFT-START) . . . . -0.3 V to $V_{CC} + 0.3$ V

HV Pre-Regulator Input Current (continuous) . . . . 5 mA

Storage Temperature . . . . -65 to 150°C

Operating Temperature . . . . -40 to 85°C

Junction Temperature (T_J) . . . . 150°C
Power Dissipation (Package)[a]
14-Pin Plastic Dip (J Suffix)[b] . . . . 750 mW
14-Pin SOIC (Y Suffix)[c] . . . . 900 mW
Thermal Impedance (Θ_{JA})
14-Pin Plastic Dip . . . . 167°C/W
14-Pin SOIC . . . . 140°C/W
Notes
a. Device mounted with all leads soldered or welded to PC board.
b. Derate 6 mW/°C above 25°C.
c. Derate 7.2 mW/°C above 25°C.

Recommended Operating Range

Voltages Referenced to $-V_{IN}$

V_{CC} . . . . 9.5 V to 16.5 V

$+V_{IN}$ . . . . 15 V to 200 V

f_{OSC} . . . . 20 kHz to 2 MHz

R_{OSC} . . . . 56 kΩ to 1 MΩ

C_{OSC} . . . . 47 pF to 200 pF

Linear Inputs . . . . 0 to $V_{CC} - 4$ V

Digital Inputs . . . . 0 to V_{CC}

Specifications

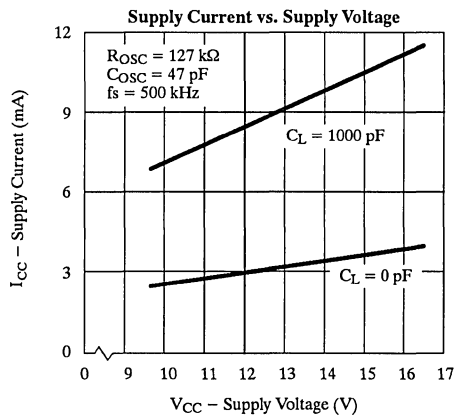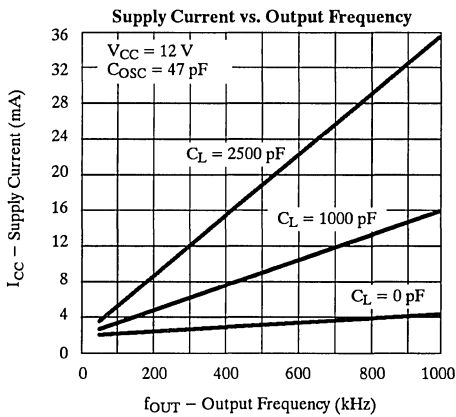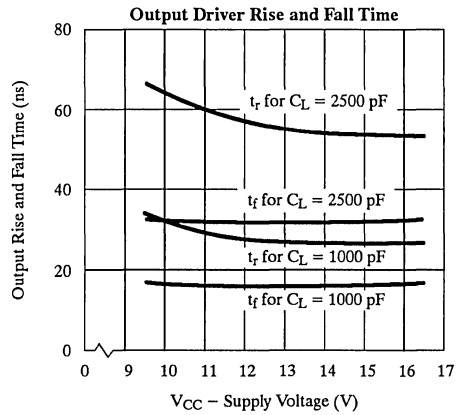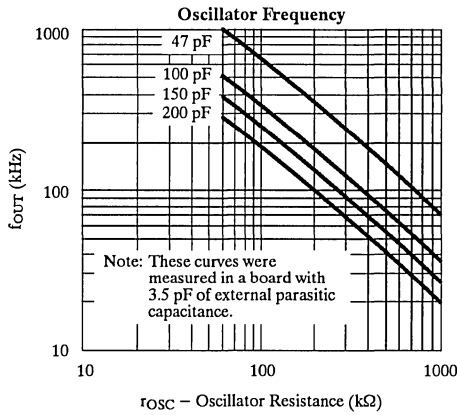| Parameter	Symbol	Test Conditions Unless Otherwise Specified Oscillator Disabled $-V_{IN} = 0$ V, $V_{CC} = 10$ V	Limits D Suffix -40 to 85°C Min[b]	Typ[a]	Max[b]	Unit
Reference						
Output Voltage	V_R	OSC Disabled, $T_A = 25$°C	3.94	4.0	4.06	V
		OSC Disabled Over Voltage and Temperature Ranges[c]	3.88	4.0	4.12	
Short Circuit Current	I_{SREF}	$V_{REF} = -V_{IN}$		-15	-5	mA
Load Regulation	$\Delta V_R/\Delta I_R$	$I_{REF} = 0$ to -3 mA		3	40	mV
Oscillator						
Initial Accuracy	f_{OSC}[d]	$R_{OSC} = 374$ kΩ, $C_{OSC} = 200$ pF	90	100	110	kHz
		$R_{OSC} = 133$ kΩ, $C_{OSC} = 100$ pF	450	500	550	
Voltage Stability[c]	$\Delta f/f$	$R_{OSC} = 133$ kΩ, $C_{OSC} = 100$ pF $\Delta f/f = [f(16.5$ V$) - f(9.5$ V$)] / f(9.5$ V$)$		1	2	%
Temperature Coefficient[c]	OSC TC	$-40 \le T_A \le 85$°C, $f_{OSC} = 100$ kHz		200	500	ppm/°C
Sync Output Current (Master Mode)	$I_{SYNC(M)}$	$V_{ROSC} \le 5$ V	± 1.0	± 3.0		mA
Sync Output Current (Slave Mode)	$I_{SYNC(S)}$	$V_{ROSC} = V_{CC}$		± 1	± 500	nA

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Specifications[a]

Parameter	Symbol	Test Conditions Unless Otherwise Specified Oscillator Disabled $-V_{IN} = 0$ V, $V_{CC} = 10$ V	Min[b]	Typ[a]	Max[b]	Unit
Error Amplifier ($C_{OSC} = -V_{IN}$ OSC Disabled)						
Input BIAS Current	I_{FB}	$V_{FB} = 5$ V, NI = V_{REF}		± 25	± 200	nA
Input OFFSET Voltage	V_{OS2}			± 5	± 25	mV
Open Loop Voltage Gain[c]	A_{VOL}		65	88		dB
Unity Gain Bandwidth[c]	BW		1.5	2.3		MHz
Output Current	I_{OUT}	Source ($V_{FB} = 3.5$ V, NI = V_{REF})		-2.0	-1.0	mA
		Sink ($V_{FB} = 4.5$ V, NI = V_{REF})	1.0	4.0		
Power Supply Rejection	PSRR	9.5 V $\leq V_{CC} \leq 16.5$ V	50	88		dB
Pre-Regulator/Start-Up						
Input Leakage Current	$+I_{IN}$	$+V_{IN} = 200$ V, $V_{CC} \geq 10$ V		<1	10	µA
Pre-Regulator Start-Up Current	I_{START}	$+V_{IN} = 48$ V, $t_{PW} \leq 300$ µs, $V_{CC} = V_{UVLO}$	8	20		mA
V_{CC} Pre-Regulator Voltage	V_{PR}	$+V_{IN} = 48$ V	8.8	9.1	9.4	
$V_{PR} - V_{UVLO}$ (Turn-On)	V_{DELTA}		0.1	0.2	0.7	V
Undervoltage Lockout Hysteresis	V_{HYST}		0.18	0.3	0.4	
Supply						
Supply Current	I_{CC}	$C_{LOAD} \leq 50$ pF $\quad f_{OSC} = 100$ kHz		1.3	2.5	mA
		$f_{OSC} = 500$ kHz		1.8	3.0	
Protection						
Current Limit Threshold Voltage	V_{SENSE}	$V_{FB} = 0$ V, NI = V_{REF}	1.15	1.23	1.30	V
Current Limit Delay to Output[c]	t_d	$V_{SENSE} = 1.5$ V, See Figure 1		70	100	ns
$\overline{SHUTDOWN}$ Logic Threshold	V_{SD}			2.5	0.5	V
$\overline{SHUTDOWN}$ Delay to Latched Output[c]	t_{SD}	See Figure 2		0.30	1.0	µs
$\overline{SHUTDOWN}$ Pull-Up Current	I_{SD}	$V_{SD} = 0$ V	12	17	30	µA
Soft-Start Current	I_{SS}		12	17	30	
Output Inhibit Voltage	$V_{SS(off)}$	Soft-Start Voltage to Disable Driver Output		1.7	0.5	V
MOSFET Driver						
Output High Voltage	V_{OH}	$I_{OUT} = -10$ mA	9.85	9.9		V
Output Low Voltage	V_{OL}	$I_{OUT} = 10$ mA		0.05	0.15	
Peak Output Current[c]	I_{SOURCE}	$V_{OUT} = 0$ V		-400	-200	mA
	I_{SINK}	$V_{OUT} = V_{CC}$	500	700		

Notes
a. Typical values are for DESIGN AID ONLY, not guaranteed nor subject to production testing.
b. The algebraic convention whereby the most negative value is a minimum and the most positive a maximum.
c. Guaranteed by design, not subject to production test.
d. $C_{STRAY} \leq 5$ pF on C_{OSC}.

Preliminary

TEMIC

Typical Characteristics (25°C Unless Otherwise Noted)

Oscillator Frequency

Note: These curves were measured in a board with 3.5 pF of external parasitic capacitance.

f_{OUT} (kHz) vs r_{OSC} − Oscillator Resistance (kΩ)

Curves: 47 pF, 100 pF, 150 pF, 200 pF

Output Driver Rise and Fall Time

Output Rise and Fall Time (ns) vs V_{CC} − Supply Voltage (V)

t_r for C_L = 2500 pF
t_f for C_L = 2500 pF
t_r for C_L = 1000 pF
t_f for C_L = 1000 pF

Supply Current vs. Output Frequency

V_{CC} = 12 V
C_{OSC} = 47 pF

C_L = 2500 pF
C_L = 1000 pF
C_L = 0 pF

I_{CC} − Supply Current (mA) vs f_{OUT} − Output Frequency (kHz)

Supply Current vs. Supply Voltage

R_{OSC} = 127 kΩ
C_{OSC} = 47 pF
fs = 500 kHz

C_L = 1000 pF
C_L = 0 pF

I_{CC} − Supply Current (mA) vs V_{CC} − Supply Voltage (V)

Switching Frequency vs. Supply Voltage

R_{OSC} = 56 kΩ
C_{OSC} = 47 pF

Switching Frequency (MHz) vs V_{CC} − Supply Voltage (V)

3

Power Conversion, PCMCIA Interface Battery Management

Preliminary

Timing Waveforms
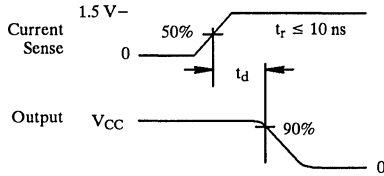
Figure 1.
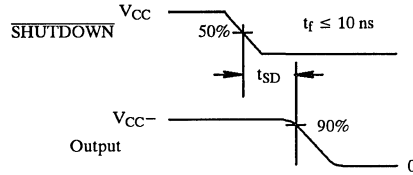
Figure 2.

Pin Configurations

Dual-In-Line and SOIC

$+V_{IN}$	1	14	V_{CC}
$\overline{SHUTDOWN}$	2	13	CURRENT SENSE
V_{REF}	3	12	DRIVER OUTPUT
NI	4	11	$-V_{IN}$
FB	5	10	SYNC
COMPENSATION	6	9	C_{OSC}
SS	7	8	R_{OSC}

Top View
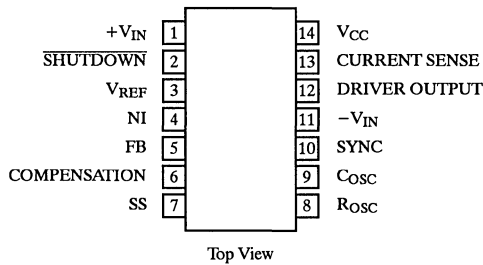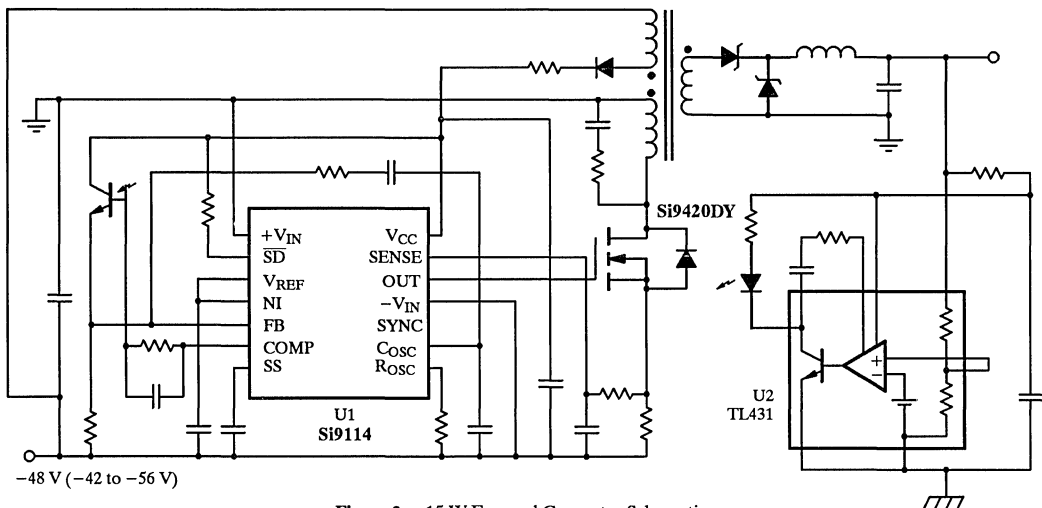
Order Numbers
Plastic DIP: Si9114DJ
SOIC: Si9114DY

Applications

Figure 3.   15-W Forward Converter Schematic

Preliminary
P-36732—Rev. B (05/30/94)