HV9110/HV9112/HV9113

High-Voltage Current-Mode PWM Controller

Features

- Input Voltage Range of V_{DD} Regulator
  - HV9110: 10V to 120V
  - HV9112: 9V to 80V
  - HV9113: 10V to 120V
- Maximum Duty, Feedback Accuracy
  - HV9110: 49%, 1%
  - HV9112: 49%, 2%
  - HV9113: 99%, 1%
- Current Mode Control
- <1 mA Supply Current
- >1 MHz clock

Applications

- DC/DC Power Converters

General Description

HV9110/HV9112/HV9113 are Switch-Mode Power Supply (SMPS) controllers suitable for the control of a variety of converter topologies, including the flyback converter and the forward converter.

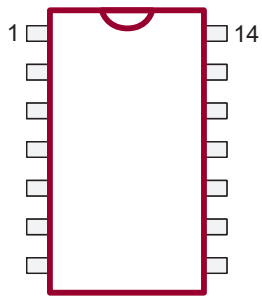
The V_{DD} regulator supports an input voltage as high as 80V or 120V.

HV9110/HV9112/HV9113 controllers include all essentials for a power converter design, such as a bandgap reference, an error amplifier, a ramp generator, a high-speed PWM comparator, and a gate driver. A shutdown latch provides on/off control.

The HV9110 and HV9113 feature an input voltage range of 10V to 120V, and the HV9112 has an input voltage range of 9V to 80V. The HV9110 and HV9112 have a maximum duty of 49%, while the HV9113 has a maximum duty of 99%.

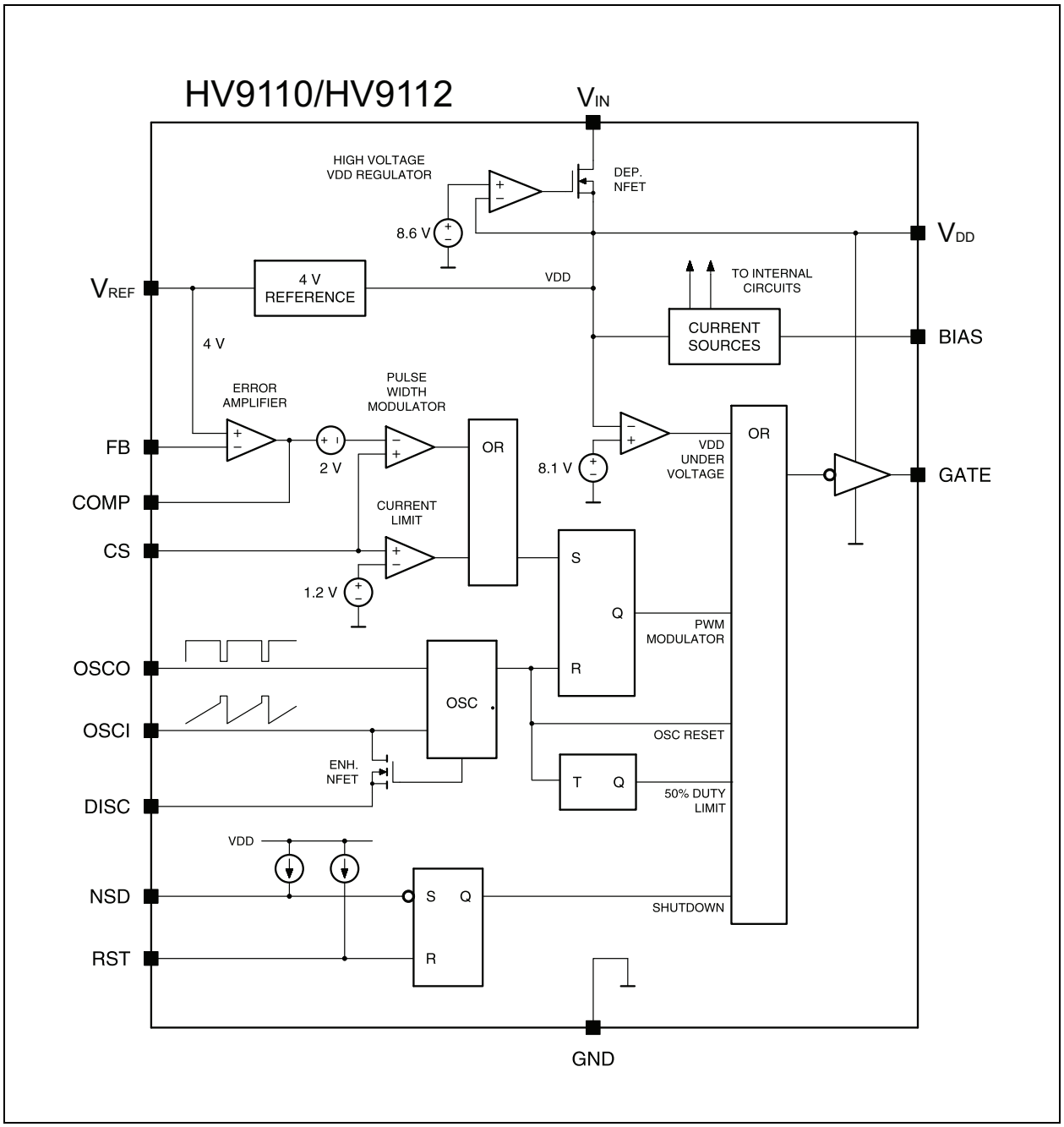
Package Type

14-lead SOIC

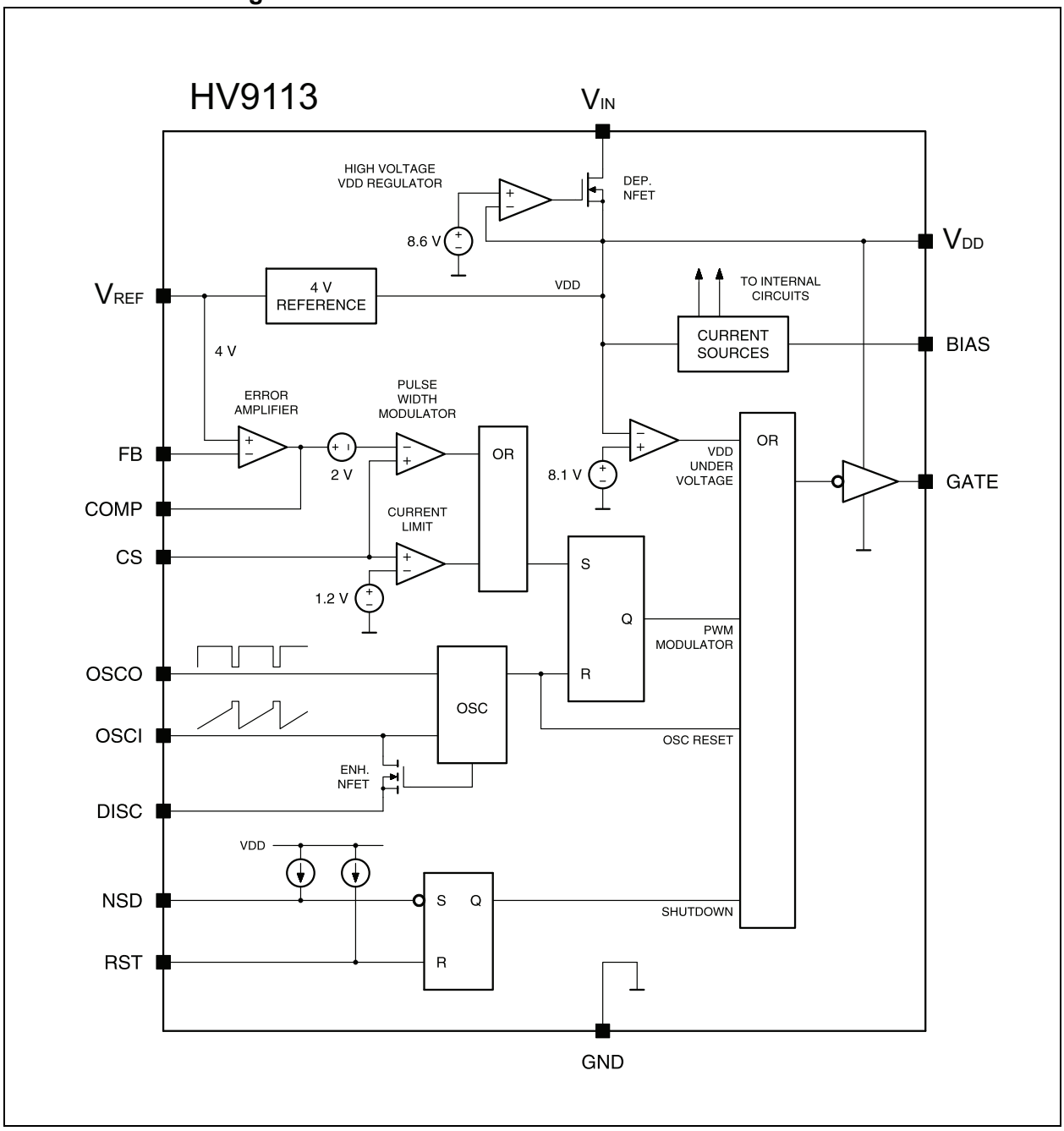


See Table 3-1 for pin information.

Functional Block Diagram



Functional Block Diagram



1.0 ELECTRICAL CHARACTERISTICS

ABSOLUTE MAXIMUM RATINGS†

Input Voltage, V_{IN}
- HV9110/HV9113 ..... 120V
- HV9112 ..... 80V

Device Supply Voltage, V_{DD} 15.5V
Logic Input Voltage Range ..... –0.3V to V_{DD} + 0.3V
Linear Input Voltage Range ..... –0.3V to V_{DD} + 0.3V
Storage Temperature Range ..... –65°C to +150°C
Operating Temperature Range ..... –55°C to +125°C
Power Dissipation: 14-lead SOIC ..... 750 mW

† Notice: Stresses above those listed under “Maximum Ratings” may cause permanent damage to the device. This is a stress rating only and functional operation of the device at those or any other conditions above those indicated in the operational listings of this specification is not implied. Exposure to maximum rating conditions for extended periods may affect device reliability.

ELECTRICAL CHARACTERISTICS

Electrical Specifications: V_{DD} = 10V, V_{IN} = 48V, V_{DISC} = 0V, R_{BIAS} = 390 kΩ, R_{OSC} = 330 kΩ, T_A= 25°C unless otherwise noted.

Parameters		Sym.	Min.	Typ.	Max.	Units	Conditions
REFERENCE							
Output Voltage	HV9110/13	V_{REF}	3.92	4	4.08	V	R_L = 10 MΩ
	HV9112		3.88	4	4.12		
	HV9110/13		3.82	4	4.16		R_L = 10 MΩ, T_A = –55°C to +125°C
Output Impedance		Z_{OUT}	15	30	45	kΩ	(**Note 1**)
Short Circuit Current		I_{SHORT}	—	125	250	µA	V_{REF} = GND
Change in V_{REF} with Temperature		ΔV_{REF}	—	0.25	—	mV/°C	T_A = –55°C to +125°C (**Note 1**)
OSCILLATOR							
Oscillator Frequency		f_{MAX}	1	3	—	MHz	R_{OSC} = 0Ω
Initial Accuracy		f_{OSC}	80	100	120	kHz	R_{OSC} = 330 kΩ (**Note**)
			160	200	240		R_{OSC} = 150 kΩ (**Note**)
V_{DD} Regulation		—	—	—	15	%	9.5V < V_{DD} < 13.5V
Temperature Coefficient		—	—	170	—	ppm/°C	T_A = –55°C to +125°C (**Note 1**)
PWM							
Maximum Duty Cycle	HV9110/HV9112	D_{MAX}	49	49.4	49.6	%	(**Note 1**)
	HV9113		95	97	99		
Dead Time	HV9113	D_{MIN}	—	225	—	ns	HV9113 only (**Note 1**)
Minimum Duty Cycle			—	—	0	%	
Pulse Width where Pulse drops out			—	80	125	ns	(**Note 1**)
CURRENT LIMIT							
Maximum Input Signal		V_{LIM}	1	1.2	1.4	V	V_{FB} = 0V
Delay to Output		t_D	—	80	120	ns	V_{CS} = 1.5V, V_{COMP} ≤ 2V (**Note 1**)

ELECTRICAL CHARACTERISTICS (CONTINUED)

Electrical Specifications: V_{DD} = 10V, V_{IN} = 48V, V_{DISC} = 0V, R_{BIAS} = 390 kΩ, R_{OSC} = 330 kΩ, T_A= 25°C unless otherwise noted.

Parameters		Sym.	Min.	Typ.	Max.	Units	Conditions
ERROR AMPLIFIER							
Feedback Voltage	HV9110/13	V_{FB}	3.96	4	4.04	V	V_{FB} shorted to COMP
	HV9112		3.92	4	4.08		
Input Bias Current		I_{IN}	—	25	500	nA	V_{FB} = 4V
Input Offset Voltage		V_{OS}	Nulled during trim			—	
Open-loop Voltage Gain		A_{VOL}	60	80	—	dB	(**Note 1**)
Unity Gain Bandwidth		GB	1	1.3	—	MHz	(**Note 1**)
Output Source Current		I_{SOURCE}	–1.4	–2	—	mA	V_{FB} = 3.4V
Output Sink Current		I_{SINK}	0.12	0.15	—	mA	V_{FB} = 4.5V
HIGH-VOLTAGE REGULATOR AND START-UP							
Input Voltage	HV9110/13	V_{IN}	—	—	120	V	I_{IN} < 10 µA; V_{CC} > 9.4V
	HV9112		—	—	80		
Input Leakage Current		I_{IN}	—	—	10	µA	V_{DD} > 9.4V
Regulator Turn-off Threshold Voltage		V_{TH}	8	8.7	9.4	V	I_{IN} = 10 µA
Undervoltage Lockout		V_{LOCK}	7	8.1	8.9	V	
SUPPLY							
Supply Current		I_{DD}	—	0.75	1	mA	C_L < 75 pF
Quiescent Supply Current		I_Q	—	0.55	—	mA	V_{NSD} = 0V
Nominal Bias Current		I_{BIAS}	—	20	—	µA	
Operating Range		V_{DD}	9	—	13.5	V	
SHUTDOWN LOGIC							
Shutdown Delay		t_{SD}	—	50	100	ns	C_L= 500 pF, V_{CS}= 0V (**Note 1**)
NSD Pulse Width		t_{SW}	50	—	—	ns	(**Note 1**)
RST Pulse Width		t_{RW}	50	—	—	ns	(**Note 1**)
Latching Pulse Width		t_{LW}	25	—	—	ns	V_{NSD}, V_{RST} = 0V(**Note 1**)
Input Low Voltage		V_{IL}	—	—	2	V	
Input High Voltage		V_{IH}	7	—	—	V	
Input Current, Input High Voltage		I_{IH}	—	1	5	µA	V_{IN} = V_{DD}
Input Current, Input Low Voltage		I_{IL}	—	–25	–35	µA	V_{IN} = 0V
OUTPUT							
Output High Voltage	HV9110/13	V_{OH}	V_{DD}–0.25	—	—	V	I_{OUT} = 10 mA
	HV9112		V_{DD}–0.3	—	—		
	HV9110/13		V_{DD}–0.3	—	—		I_{OUT} = 10 mA, T_A = –55°C to 125°C
Output Low Voltage	All	V_{OL}	—	—	0.2	V	I_{OUT} = –10 mA
	HV9110/13		—	—	0.3		I_{OUT} = –10 mA, T_A = –55°C to 125°C
Output Resistance	Pull up	R_{OUT}	—	15	25	Ω	I_{OUT} = ±10 mA
	Pull down		—	8	20		
	Pull up		—	20	30	Ω	I_{OUT} = ±10 mA, T_A = –55°C to 125°C
	Pull down		—	10	30		
Rise Time		t_R	—	30	75	ns	C_L = 500 pF (**Note 1**)
Fall Time		t_F	—	20	75	ns	C_L = 500 pF (**Note 1**)

Note 1: Design guidance only; Not 100% tested in production.
2: Stray capacitance on OSC input pin must be ≤5 pF.

TEMPERATURE SPECIFICATIONS

Parameters	Sym.	Min.	Typ.	Max.	Units	Conditions
TEMPERATURE RANGES						
Operating Temperature	—	–55	—	125	°C	
Storage Temperature	—	–65	—	150	°C	
PACKAGE THERMAL RESISTANCE						
14-lead SOIC	θ_{ja}	—	83	—	°C/W	

1.1 Truth Table

TRUTH TABLE

SHUTDOWN	RESET	OUTPUT
H	H	Normal operation
H	H → L	Normal operation, no change
L	H	Off, not latched
L	L	Off, latched
L → H	L	Off, latched, no change

2.0 TYPICAL PERFORMANCE CURVES

Note: The graphs and tables provided following this note are a statistical summary based on a limited number of samples and are provided for informational purposes only. The performance characteristics listed herein are not tested or guaranteed. In some graphs or tables, the data presented may be outside the specified operating range (e.g. outside specified power supply range) and therefore outside the warranted range.

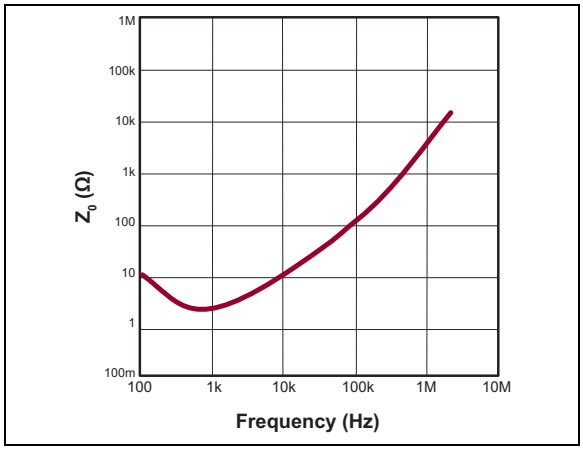


FIGURE 2-1: *Error Amplifier Output Impedance (Z_0).*

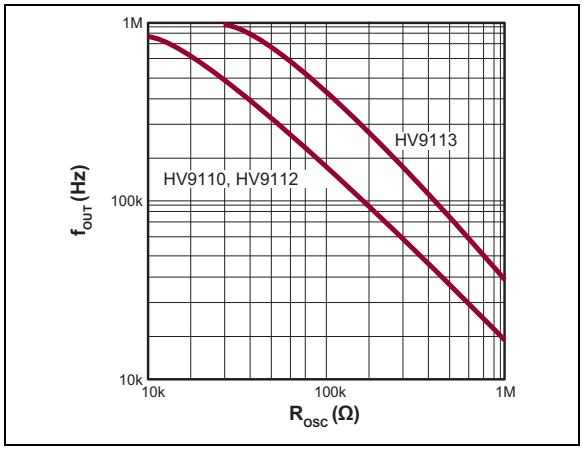


FIGURE 2-4: *Output Switching Frequency vs. Oscillator Resistance.*

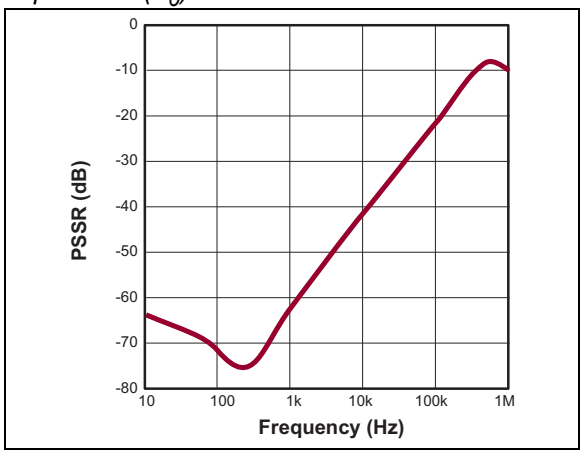


FIGURE 2-2: *PSRR –Error Amplifier and Reference.*

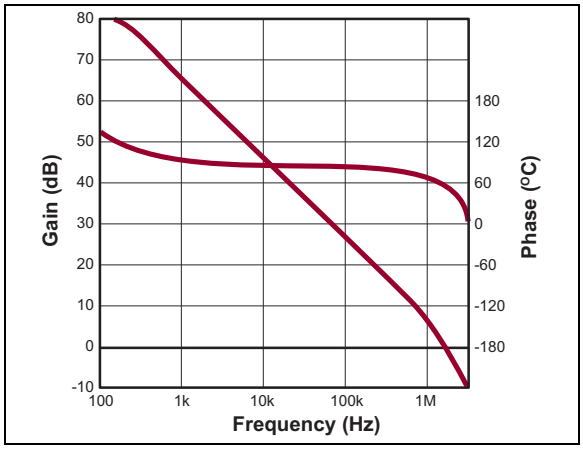


FIGURE 2-5: *Error Amplifier Open-loop Gain/Phase.*

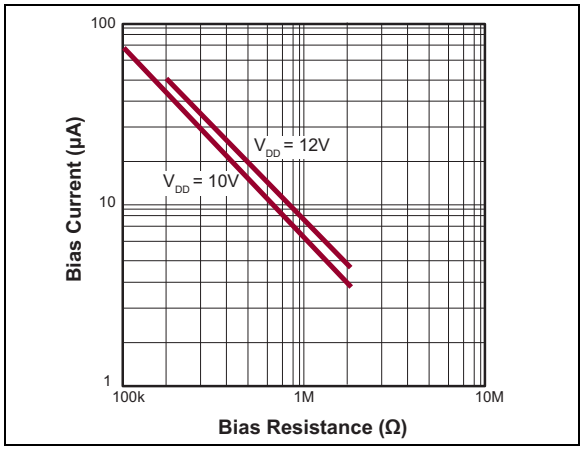


FIGURE 2-3: *Bias Current vs. Bias Resistance.*

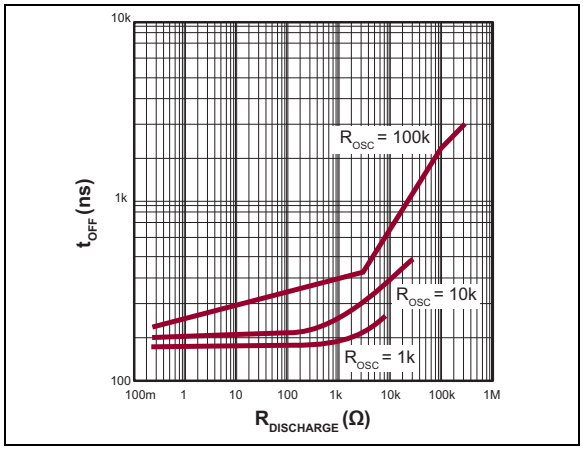


FIGURE 2-6: *$R_{DISCHARGE}$ vs. t_{OFF} (HV9113 only).*

3.0 PIN DESCRIPTION

Table 3-1 shows the pin description for HV9110/HV9112/HV9113. The locations of the pins are listed in Features.

TABLE 3-1: PIN DESCRIPTION

Pin Number	HV9110/HV9112/HV9113 Pin Name	Description
1	BIAS	Internal bias, current set
2	V_{IN}	High-voltage V_{DD} regulator input
3	CS	Current sense input
4	GATE	Gate drive output
5	GND	Ground
6	V_{DD}	High-voltage V_{DD} regulator output
7	OSCO	Oscillator output
8	OSCI	Oscillator input
9	DISC	Oscillator discharge, current set
10	V_{REF}	4V reference output Reference voltage level can be overridden by an externally applied voltage source.
11	NSD	Active low input to set shutdown latch
12	RST	Active high input to reset shutdown latch
13	COMP	Error amplifier output
14	FB	Feedback voltage input

4.0 TEST CIRCUITS

The test circuits for characterizing error amplifier output impedance, Z_{OUT}, and error amplifier, power supply rejection ratio, PSRR, are shown in Figure 4-1 and Figure 4-2.

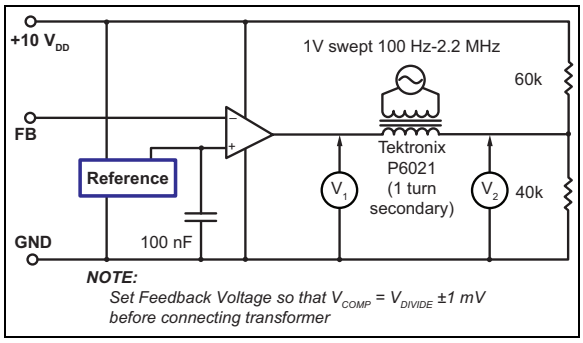


FIGURE 4-1: *Error Amp Z_{OUT}.*

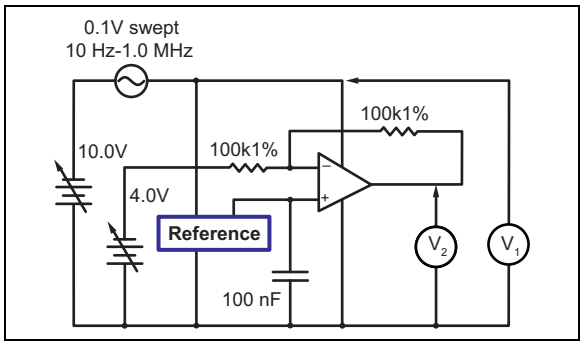


FIGURE 4-2: *PSRR.*

5.0 DETAILED DESCRIPTION

5.1 High-Voltage Regulator

The high-voltage regulator included in HV9110/HV9112/HV9113 consists of a high-voltage N-channel Depletion-mode DMOS transistor driven by an error amplifier, providing a current path between the V_{IN} terminal and the V_{DD} terminal. The maximum current, about 20 mA, occurs when V_{DD} = 0, with current reducing as V_{DD} rises. This path shuts off when V_{DD} rises to somewhere between 8V and 9.4V. So, if V_{DD} is held at 10V or 12V by an external source, no current other than leakage is drawn through the high voltage transistor. This minimizes dissipation within the high-voltage regulator.

Use an external capacitor between V_{DD} and GND. This capacitor should have good high-frequency characteristics. Ceramic caps work well.

The device uses a compound resistor divider to monitor V_{DD} for both the undervoltage lockout circuit and the shutoff circuit of the high-voltage FET. Setting the undervoltage sense point about 0.6V lower on the string than the FET shutoff point guarantees that the undervoltage lockout releases before the FET shuts off.

5.2 Bias Circuit

HV9110/HV9112/HV9113 require an external bias resistor, connected between the Bias pin and GND, to set currents in a series of current mirrors used by the analog sections of the chip. The nominal external bias current requirement is 15 µA to 20 µA, which can be set by a 390 kΩ to 510 kΩ resistor if V_{DD} = 10V, or a 510 kΩ to 680 kΩ resistor if V_{DD} = 12V. A precision resistor is not required, ±5% meets device requirements.

5.3 Clock Oscillator

The clock oscillator of the HV9110/HV9112/HV9113 consists of a ring of CMOS inverters, timing capacitors, and a capacitor-discharge FET. A single external resistor between the OSCI and OSCO sets the oscillator frequency. (See Figure 2-4.)

The HV9110 and HV9112 include a frequency-dividing flip-flop that allows the part to operate with a 50% duty limit. Accordingly, the effective switching frequency of the power converter is half the oscillator frequency. (See Figure 2-4.)

An internal discharge FET resets the oscillator ramp at the end of the oscillator cycle. The discharge FET is externally connected to GND, by way of a resistor. The resistor programs the oscillator dead time at the end of the oscillator period.

The oscillator turns off during shutdown to reduce supply current by about 150 µA.

5.4 Reference

The reference of the HV9110/HV9112/HV9113 consists of a band-gap reference, followed by a buffer amplifier, which scales the voltage up to 4V. The scaling resistors of the buffer amplifier are trimmed during manufacture so that the output of the error amplifier, when connected in a gain of –1 configuration, is as close to 4V as possible. This nulls out the input offset of the error amplifier. As a consequence, even though the observed reference voltage of a specific part may not be exactly 4V, the feedback voltage required for proper regulation will be 4V.

An approximately 50 kΩ resistor is located internally between the output of the reference buffer amplifier and the circuitry it feeds—reference output pin and non-inverting input to the error amplifier. This allows overriding the internal reference with a low impedance voltage source ≤ 6V. Using an external reference reinstates the input offset voltage of the error amplifier. Overriding the reference should seldom be necessary.

The reference of the HV9110/HV9112/HV9113 is a high-impedance node, and usually there will be significant electrical noise nearby. Therefore, a bypass capacitor between the reference pin and GND is strongly recommended. The reference buffer amplifier is compensated to be stable with a capacitive load of 0.01 µF to 0.1 µF.

5.5 Error Amplifier

The error amplifier on HV9110/HV9112/HV9113 is a low-power, differential-input, operational amplifier. A PMOS input stage is used, so the common mode range includes ground and the input impedance is high.

5.6 Current Sense Comparators

The HV9110/HV9112/HV9113 use a dual-comparator system with independent comparators for modulation and current limiting. This provides the designer greater latitude in compensation design, as there are no clamps, except ESD protection, on the compensation pin.

5.7 Remote Shutdown

The NSD and RST pins control the shutdown latch. These pins have internal current-source pull-ups so they can be driven from open drain logic. When not used they should be left open or connected to V_{DD}.

5.8 Output Buffer

The output buffer of HV9110/HV9112/HV9113 is of standard CMOS construction P-channel pull-up and N-channel pull-down. Thus, the body-drain diodes of the output stage can be used for spike clipping. External Schottky diode clamping of the output is not required.

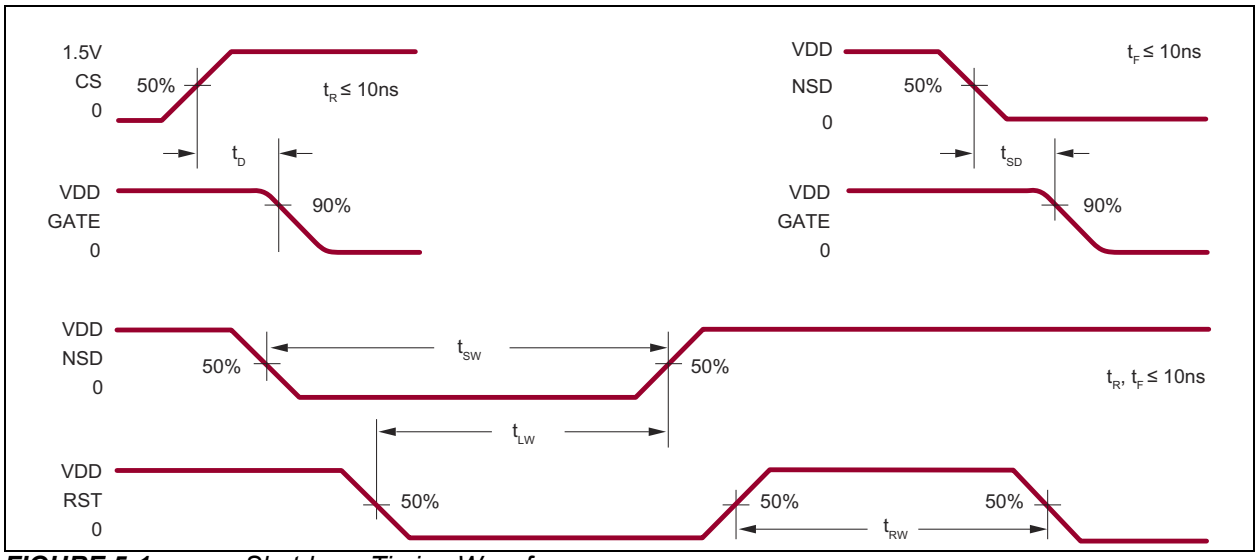
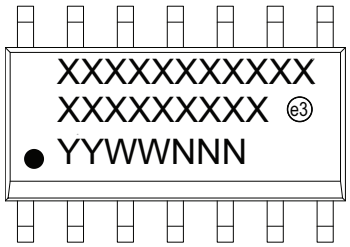


FIGURE 5-1: *Shutdown Timing Waveforms.*

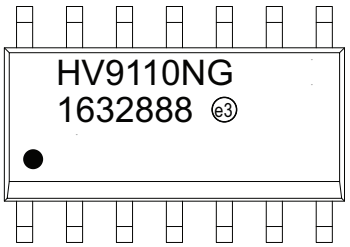
6.0 PACKAGING INFORMATION

6.1 Package Marking Information

14-lead SOIC



Example

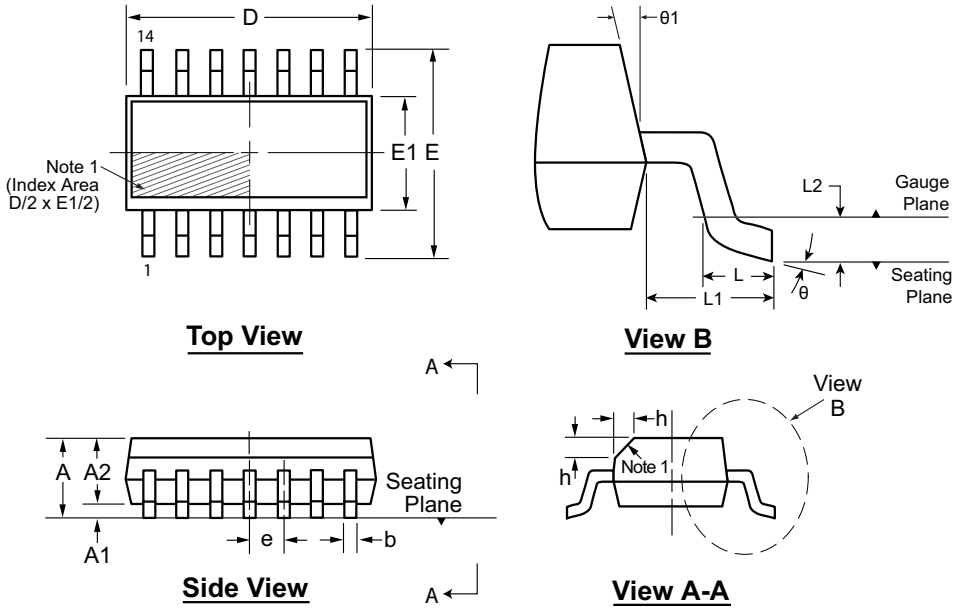


Legend:	XX...X	Product Code or Customer-specific information
	Y	Year code (last digit of calendar year)
	YY	Year code (last 2 digits of calendar year)
	WW	Week code (week of January 1 is week ‘01’)
	NNN	Alphanumeric traceability code
	(e3)	Pb-free JEDEC® designator for Matte Tin (Sn)
	*	This package is Pb-free. The Pb-free JEDEC designator ((e3)) can be found on the outer packaging for this package.

Note: In the event the full Microchip part number cannot be marked on one line, it will be carried over to the next line, thus limiting the number of available characters for product code or customer-specific information. Package may or not include the corporate logo.

14-Lead SOIC (Narrow Body) Package Outline (NG)

8.65x3.90mm body, 1.75mm height (max), 1.27mm pitch



Note: For the most current package drawings, see the Microchip Packaging Specification at www.microchip.com/packaging.

Note:

1. *This chamfer feature is optional. If it is not present, then a Pin 1 identifier must be located in the index area indicated. The Pin 1 identifier can be: a molded mark/identifier; an embedded metal marker; or a printed indicator.*

Symbol		A	A1	A2	b	D	E	E1	e	h	L	L1	L2	θ	θ1
Dimension (mm)	MIN	1.35*	0.10	1.25	0.31	8.55*	5.80*	3.80*	1.27 BSC	0.25	0.40	1.04 REF	0.25 BSC	0°	5°
	NOM	-	-	-	-	8.65	6.00	3.90		-	-			-	-
	MAX	1.75	0.25	1.65*	0.51	8.75*	6.20*	4.00*		0.50	1.27			8°	15°

JEDEC Registration MS-012, Variation AB, Issue E, Sept. 2005.
** This dimension is not specified in the JEDEC drawing.*
Drawings are not to scale.

NOTES:

APPENDIX A: REVISION HISTORY

Revision A (June 2016)

- Merged Supertex Doc #s DSFP-HV9110, DSFP-HV9112 and DSFP-DSFP-HV9113 to Microchip DS20005505A.
- Revised **Electrical Characteristics** to accommodate the merged products.
- Updated pin names to reflect new naming convention.
- Significant text changes to **Detailed Description**.
- Minor text changes throughout.

PRODUCT IDENTIFICATION SYSTEM

To order or obtain information, e.g., on pricing or delivery, refer to the factory or the listed sales office.

PART NO.	XX	-	X	-	X
Device	Package Options		Environmental		Media Type

Device:	HV9110 =	High-voltage Current-mode PWM Controller, 10V to 120V Input Voltage Range, 49% Duty Cycle
	HV9112 =	High-voltage Current-mode PWM Controller, 9V to 80V Input Voltage Range, 49% Duty Cycle
	HV9113 =	High-voltage Current-mode PWM Controller, 10V to 120V Input Voltage Range, 99% Duty Cycle
Package:	NG =	14-lead SOIC
Environmental	G =	Lead (Pb)-free/RoHS-compliant Package
Media Type:	(blank) =	53/Tube for an NG package

Examples:

a) HV9110NG-G: High-voltage Current-mode PWM Controller 10V to 120V Input Voltage Range, 49% Duty Cycle, 14-lead SOIC Package, 53/Tube

b) HV9112NG-G: High-voltage Current-mode PWM Controller, 9V to 80V Input Voltage Range, 49% Duty Cycle,14-lead SOIC Package, 53/Tube

c) HV9113NG-G: High-voltage Current-mode PWM Controller, 10V to 120V Input Voltage Range, 99% Duty Cycle, 14-lead SOIC Package, 53/Tube

Note the following details of the code protection feature on Microchip devices:

- Microchip products meet the specification contained in their particular Microchip Data Sheet.
- Microchip believes that its family of products is one of the most secure families of its kind on the market today, when used in the intended manner and under normal conditions.
- There are dishonest and possibly illegal methods used to breach the code protection feature. All of these methods, to our knowledge, require using the Microchip products in a manner outside the operating specifications contained in Microchip's Data Sheets. Most likely, the person doing so is engaged in theft of intellectual property.
- Microchip is willing to work with the customer who is concerned about the integrity of their code.
- Neither Microchip nor any other semiconductor manufacturer can guarantee the security of their code. Code protection does not mean that we are guaranteeing the product as "unbreakable."

Code protection is constantly evolving. We at Microchip are committed to continuously improving the code protection features of our products. Attempts to break Microchip's code protection feature may be a violation of the Digital Millennium Copyright Act. If such acts allow unauthorized access to your software or other copyrighted work, you may have a right to sue for relief under that Act.

Microchip received ISO/TS-16949:2009 certification for its worldwide headquarters, design and wafer fabrication facilities in Chandler and Tempe, Arizona; Gresham, Oregon and design centers in California and India. The Company's quality system processes and procedures are for its PIC® MCUs and dsPIC® DSCs, KEELOQ® code hopping devices, Serial EEPROMs, microperipherals, nonvolatile memory and analog products. In addition, Microchip's quality system for the design and manufacture of development systems is ISO 9001:2000 certified.

QUALITY MANAGEMENT SYSTEM
CERTIFIED BY DNV
═ ISO/TS 16949 ═

Trademarks

ISBN: 978-1-5224-0736-2

Worldwide Sales and Service

AMERICAS

Corporate Office
2355 West Chandler Blvd.
Chandler, AZ 85224-6199
Tel: 480-792-7200
Fax: 480-792-7277
Technical Support:
http://www.microchip.com/support
Web Address:
www.microchip.com

Atlanta
Duluth, GA
Tel: 678-957-9614
Fax: 678-957-1455

Austin, TX
Tel: 512-257-3370

Boston
Westborough, MA
Tel: 774-760-0087
Fax: 774-760-0088

Chicago
Itasca, IL
Tel: 630-285-0071
Fax: 630-285-0075

Cleveland
Independence, OH
Tel: 216-447-0464
Fax: 216-447-0643

Dallas
Addison, TX
Tel: 972-818-7423
Fax: 972-818-2924

Detroit
Novi, MI
Tel: 248-848-4000

Houston, TX
Tel: 281-894-5983

Indianapolis
Noblesville, IN
Tel: 317-773-8323
Fax: 317-773-5453

Los Angeles
Mission Viejo, CA
Tel: 949-462-9523
Fax: 949-462-9608

New York, NY
Tel: 631-435-6000

San Jose, CA
Tel: 408-735-9110

Canada - Toronto
Tel: 905-695-1980
Fax: 905-695-2078

ASIA/PACIFIC

Asia Pacific Office
Suites 3707-14, 37th Floor
Tower 6, The Gateway
Harbour City, Kowloon

Hong Kong
Tel: 852-2943-5100
Fax: 852-2401-3431

Australia - Sydney
Tel: 61-2-9868-6733
Fax: 61-2-9868-6755

China - Beijing
Tel: 86-10-8569-7000
Fax: 86-10-8528-2104

China - Chengdu
Tel: 86-28-8665-5511
Fax: 86-28-8665-7889

China - Chongqing
Tel: 86-23-8980-9588
Fax: 86-23-8980-9500

China - Dongguan
Tel: 86-769-8702-9880

China - Guangzhou
Tel: 86-20-8755-8029

China - Hangzhou
Tel: 86-571-8792-8115
Fax: 86-571-8792-8116

China - Hong Kong SAR
Tel: 852-2943-5100
Fax: 852-2401-3431

China - Nanjing
Tel: 86-25-8473-2460
Fax: 86-25-8473-2470

China - Qingdao
Tel: 86-532-8502-7355
Fax: 86-532-8502-7205

China - Shanghai
Tel: 86-21-5407-5533
Fax: 86-21-5407-5066

China - Shenyang
Tel: 86-24-2334-2829
Fax: 86-24-2334-2393

China - Shenzhen
Tel: 86-755-8864-2200
Fax: 86-755-8203-1760

China - Wuhan
Tel: 86-27-5980-5300
Fax: 86-27-5980-5118

China - Xian
Tel: 86-29-8833-7252
Fax: 86-29-8833-7256

ASIA/PACIFIC

China - Xiamen
Tel: 86-592-2388138
Fax: 86-592-2388130

China - Zhuhai
Tel: 86-756-3210040
Fax: 86-756-3210049

India - Bangalore
Tel: 91-80-3090-4444
Fax: 91-80-3090-4123

India - New Delhi
Tel: 91-11-4160-8631
Fax: 91-11-4160-8632

India - Pune
Tel: 91-20-3019-1500

Japan - Osaka
Tel: 81-6-6152-7160
Fax: 81-6-6152-9310

Japan - Tokyo
Tel: 81-3-6880- 3770
Fax: 81-3-6880-3771

Korea - Daegu
Tel: 82-53-744-4301
Fax: 82-53-744-4302

Korea - Seoul
Tel: 82-2-554-7200
Fax: 82-2-558-5932 or
82-2-558-5934

Malaysia - Kuala Lumpur
Tel: 60-3-6201-9857
Fax: 60-3-6201-9859

Malaysia - Penang
Tel: 60-4-227-8870
Fax: 60-4-227-4068

Philippines - Manila
Tel: 63-2-634-9065
Fax: 63-2-634-9069

Singapore
Tel: 65-6334-8870
Fax: 65-6334-8850

Taiwan - Hsin Chu
Tel: 886-3-5778-366
Fax: 886-3-5770-955

Taiwan - Kaohsiung
Tel: 886-7-213-7828

Taiwan - Taipei
Tel: 886-2-2508-8600
Fax: 886-2-2508-0102

Thailand - Bangkok
Tel: 66-2-694-1351
Fax: 66-2-694-1350

EUROPE

Austria - Wels
Tel: 43-7242-2244-39
Fax: 43-7242-2244-393

Denmark - Copenhagen
Tel: 45-4450-2828
Fax: 45-4485-2829

France - Paris
Tel: 33-1-69-53-63-20
Fax: 33-1-69-30-90-79

Germany - Dusseldorf
Tel: 49-2129-3766400

Germany - Karlsruhe
Tel: 49-721-625370

Germany - Munich
Tel: 49-89-627-144-0
Fax: 49-89-627-144-44

Italy - Milan
Tel: 39-0331-742611
Fax: 39-0331-466781

Italy - Venice
Tel: 39-049-7625286

Netherlands - Drunen
Tel: 31-416-690399
Fax: 31-416-690340

Poland - Warsaw
Tel: 48-22-3325737

Spain - Madrid
Tel: 34-91-708-08-90
Fax: 34-91-708-08-91

Sweden - Stockholm
Tel: 46-8-5090-4654

UK - Wokingham
Tel: 44-118-921-5800
Fax: 44-118-921-5820

06/23/16