

# DRV110 120- and 230-V AC, 6- to 48-V DC Current Controller for Solenoids, Relays, and Valves

## 1 Features

- Internal Zener Diode on Supply Pin for High-Voltage Operation
  - 120- and 230-V AC Supply Through Rectifier and  $R_S$  Resistor
  - 24-V, 48-V, and Higher DC Supply Through  $R_S$  Resistor
- Drives an External MOSFET With PWM to Control Solenoid Current
  - External Sense Resistor for Regulating Solenoid Current
- Fast Ramp-Up of Solenoid Current to Ensure Activation
- Solenoid Current is Reduced in Hold Mode for Lower Power and Thermal Dissipation
- Ramp Peak Current, Keep Time at Peak Current, Hold Current, and PWM Clock Frequency Can Be Set Externally. They Can Also Be Operated at Nominal Values Without External Components.
- Protection
  - Thermal Shutdown
  - Undervoltage Lockout (UVLO)
  - Maximum Ramp Time
  - Optional STATUS Output
- Operating Temperature Range:  $-40^{\circ}\text{C}$  to  $+105^{\circ}\text{C}$
- 8-Pin and 14-Pin TSSOP Package Options

## 2 Applications

- Electromechanical Drivers: Solenoids, Valves, Relays, Contactors, Switchgear, Pneumatics
- White Goods, Solar, Transportation, Smart Grid, Power Distribution

## 3 Description

The DRV110 device is a PWM current controller for solenoids. The device is designed to regulate the current with a well-controlled waveform to reduce power dissipation. The solenoid current is ramped up fast to ensure opening of the valve or relay. After initial ramping, the solenoid current is kept at a peak value to ensure correct operation, after which the current is reduced to a lower hold level to avoid thermal problems and reduce power dissipation.

The peak current duration is set with an external capacitor. The peak and hold levels of the current ramp, as well as the PWM frequency, can independently be set with external resistors. External setting resistors can also be omitted if the default values for the corresponding parameters are suitable for the application.

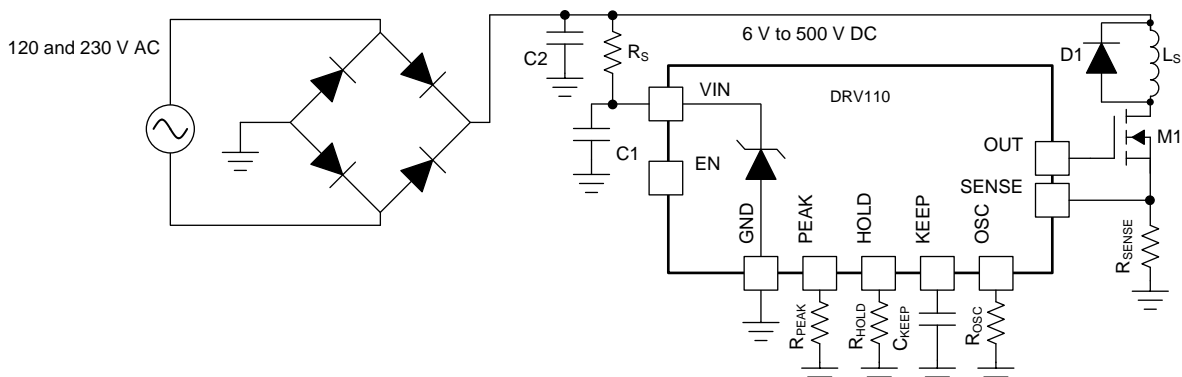
The DRV110 device has an internal Zener diode that limits the supply at VIN to 15 V for applications that require a higher supply voltage. Using the internal Zener, the DRV110 can be powered from 120-V and 230-V AC supplies through a rectifier and current-limiting resistor. High DC voltages such as 48-V can also be accommodated this way.

### Device Information<sup>(1)</sup>

PART NUMBER	PACKAGE	BODY SIZE (NOM)
DRV110	TSSOP (14)	5.00 mm x 4.40 mm
	TSSOP (8)	3.00 mm x 4.40 mm

(1) For all available packages, see the orderable addendum at the end of the data sheet.

### DRV110 Supplied by Power Line Voltage



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## 4 Revision History

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

<b>Changes from Revision D (June 2016) to Revision E</b>	<b>Page</b>
• Changed the title of the document to include V AC and V DC values .....	1
• Revised <i>Features</i> and <i>Applications</i> lists .....	1
• Changed first page graphic to schematic .....	1
• Revised table notes for <i>Recommended Operating Conditions</i> table .....	4

<b>Changes from Revision C (April 2016) to Revision D</b>	<b>Page</b>
• Changed the title of the document .....	1
• Changed 160 kΩ in the $f_{PWM}$ equation to 66.67 kΩ .....	9
• Added the <i>Receiving Notification of Documentation Updates</i> section .....	16

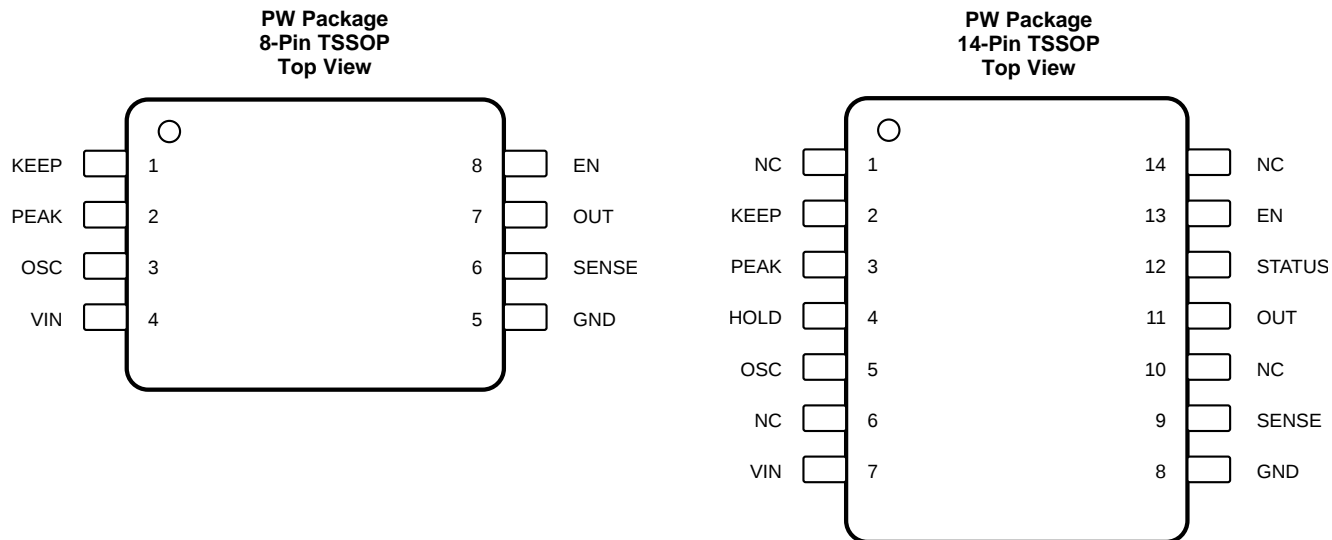
  

<b>Changes from Revision B (July 2015) to Revision C</b>	<b>Page</b>
• Changed one test condition ( $R_{OSC} = 50\text{ k}\Omega$ to 160 kΩ) and the maximum value for the Externally set PWM clock frequency (60 to 25) in the <i>Electrical Characteristics</i> table .....	5
• Changed the <i>PWM Clock Frequency Setting</i> graph.....	9

<b>Changes from Revision A (January 2013) to Revision B</b>	<b>Page</b>
• Added <i>ESD Ratings</i> table, <i>Feature Description</i> section, <i>Device Functional Modes</i> , <i>Application and Implementation</i> section, <i>Power Supply Recommendations</i> section, <i>Layout</i> section, <i>Device and Documentation Support</i> section, and <i>Mechanical, Packaging, and Orderable Information</i> section .....	1

## 5 Pin Configuration and Functions



### Pin Functions

NAME	PIN NO.		I/O	DESCRIPTION
	8 PINS	14 PINS		
EN	8	13	I	Enable
GND	5	8	—	Ground
HOLD	—	4	I	Hold current set <sup>(1)</sup>
KEEP	1	2	I	Keep time set
NC	—	1	—	No connect
NC	—	6	—	No connect
NC	—	10	—	No connect
NC	—	14	—	No connect
OSC	3	5	I	PWM frequency set
OUT	7	11	O	Solenoid switch gate drive
PEAK	2	3	I	Peak current set
SENSE	6	9	I	Solenoid current sense
STATUS	—	12	O	Open drain fault indicator
VIN	4	7	I	6-V to 18-V supply

(1) In the 8-pin package, the HOLD pin is not bonded out. For this package, the HOLD mode is configured to default (internal) settings.

## 6 Specifications

### 6.1 Absolute Maximum Ratings

 See <sup>(1)</sup> and <sup>(2)</sup>

		MIN	MAX	UNIT
V <sub>IN</sub>	Input voltage	-0.3	20	V
	Voltage on EN, STATUS, PEAK, HOLD, OSC, SENSE, KEEP	-0.3	7	V
	Voltage on OUT	-0.3	20	V
T <sub>J</sub>	Operating virtual junction temperature	-40	125	°C
T <sub>stg</sub>	Storage temperature	-65	150	°C

- (1) 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 under *Recommended Operating Conditions* is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.
- (2) All voltage values are with respect to network ground terminal.

### 6.2 ESD Ratings

		VALUE	UNIT
V <sub>(ESD)</sub>	Electrostatic discharge		
	Human body model (HBM), per ANSI/ESDA/JEDEC JS-001 <sup>(1)</sup>	±2000	V
	Charged device model (CDM), per JEDEC specification JESD22-C101 <sup>(2)</sup>	±500	

- (1) JEDEC document JEP155 states that 500-V HBM allows safe manufacturing with a standard ESD control process.
- (2) JEDEC document JEP157 states that 250-V CDM allows safe manufacturing with a standard ESD control process.

### 6.3 Recommended Operating Conditions

over operating free-air temperature range (unless otherwise noted)

		MIN	NOM	MAX	UNIT
I <sub>Q</sub>	Supply current	1	1.5	3	mA
V <sub>IN</sub>	Device will start sinking current when V <sub>IN</sub> > 15 V to limit V <sub>IN</sub> <sup>(1)</sup>	6	15		V
C <sub>IN</sub>	Input capacitor between V <sub>IN</sub> and GND <sup>(2)</sup>	1	4.7		µF
L	Solenoid inductance		1		H
T <sub>A</sub>	Operating ambient temperature	-40		105	°C

- (1) The device regulates the supply with an internal Zener diode. The device sinks up to 3 mA with the added supply current. See [Equation 5](#) to find appropriate value for the R<sub>S</sub> resistor
- (2) 4.7-µF input capacitor and full wave rectified 230-Vrms AC supply results in approximately 500-mV supply ripple.

### 6.4 Thermal Information

THERMAL METRIC <sup>(1)</sup>	DRV110		UNIT	
	PW (TSSOP)			
	8 PINS	14 PINS		
R <sub>θJA</sub>	Junction-to-ambient thermal resistance	183.8	122.6	°C/W
R <sub>θJC(top)</sub>	Junction-to-case (top) thermal resistance	69.2	51.2	°C/W
R <sub>θJB</sub>	Junction-to-board thermal resistance	112.6	64.3	°C/W
ψ <sub>JT</sub>	Junction-to-top characterization parameter	10.4	6.5	°C/W
ψ <sub>JB</sub>	Junction-to-board characterization parameter	110.9	63.7	°C/W
R <sub>θJC(bot)</sub>	Junction-to-case (bottom) thermal resistance	N/A	N/A	°C/W

- (1) For more information about traditional and new thermal metrics, see the [Semiconductor and IC Package Thermal Metrics](#) application report (SPRA953).

## 6.5 Electrical Characteristics

 $V_{IN} = 14\text{ V}$ ,  $T_A = -40^\circ\text{C}$  to  $105^\circ\text{C}$ , over operating free-air temperature range (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
<b>SUPPLY</b>						
$I_Q$	Standby current	EN = 0, $V_{IN} = 14\text{ V}$ , bypass deactivated		200	250	$\mu\text{A}$
	Quiescent current	EN = 1, $V_{IN} = 14\text{ V}$ , bypass deactivated		360	570	
	Internally regulated supply	EN = 0, $I_{VIN} = 2\text{ mA}$ , bypass activated	10.5	15	19	V
		EN = 1, $I_{VIN} = 2\text{ mA}$ , bypass activated	14.5	15	15.5	
<b>GATE DRIVER</b>						
$V_{DRV}$	Gate drive voltage	Supply voltage in regulation ( $I_{VIN} > 1\text{ mA}$ )		$V_{IN}$		V
$I_{DRV\_SINK}$	Gate drive sink current	$V_{OUT} = 15\text{ V}$ ; $V_{IN} = 15\text{ V}$	8	15		mA
$I_{DRV\_SOURCE}$	Gate drive source current	$V_{OUT} = \text{GND}$ ; $V_{IN} = 15\text{ V}$		-15	-10	mA
$f_{PWM}$	PWM clock frequency	OSC = GND	15	20	27	kHz
$D_{MAX}$	Maximum PWM duty cycle			100%		
$D_{MIN}$	Minimum PWM duty cycle			7.5%		
$t_D$	Start-up delay	Delay between EN going high until gate driver starts switching, $f_{PWM} = 20\text{ kHz}$			50	$\mu\text{s}$
<b>CURRENT CONTROLLER, INTERNAL SETTINGS</b>						
$I_{PEAK}$	Peak current	$R_{SENSE} = 1\ \Omega$ , PEAK = GND	270	300	330	mA
$I_{HOLD}$	Hold current	$R_{SENSE} = 1\ \Omega$ , HOLD = GND	40	50	65	mA
<b>CURRENT CONTROLLER, EXTERNAL SETTINGS</b>						
$t_{KEEP}$	Externally set keep time at peak current	$C_{KEEP} = 1\ \mu\text{F}$		100		ms
$V_{PEAK}$	Externally set $V_{PEAK}$	$R_{PEAK} = 50\text{ k}\Omega$		900		mV
		$R_{PEAK} = 200\text{ k}\Omega$		300		
$V_{HOLD}$	Externally set $V_{HOLD}$	$R_{HOLD} = 50\text{ k}\Omega$		150		mV
		$R_{HOLD} = 200\text{ k}\Omega$		50		
$f_{PWM}$	Externally set PWM clock frequency	$R_{OSC} = 160\text{ k}\Omega$		25		kHz
		$R_{OSC} = 200\text{ k}\Omega$		20		
<b>LOGIC INPUT LEVELS (EN)</b>						
$V_{IL}$	Input low level				1.3	V
$V_{IH}$	Input high level		1.65			V
$R_{EN}$	Input pullup resistance		350	500		$\text{k}\Omega$
<b>LOGIC OUTPUT LEVELS (STATUS)</b>						
$V_{OL}$	Output low level	Pulldown activated, $I_{STATUS} = 2\text{ mA}$			0.3	V
$I_{IL}$	Output leakage current	Pulldown deactivated, $V(\text{STATUS}) = 5\text{ V}$			2	$\mu\text{A}$
<b>UNDERVOLTAGE LOCKOUT</b>						
$V_{UVLO}$	Undervoltage lockout threshold			4.6		V
<b>THERMAL SHUTDOWN</b>						
$T_{TSU}$	Junction temperature start-up threshold			140		$^\circ\text{C}$
$T_{TSD}$	Junction temperature shutdown threshold			160		$^\circ\text{C}$

## 6.6 Typical Characteristics

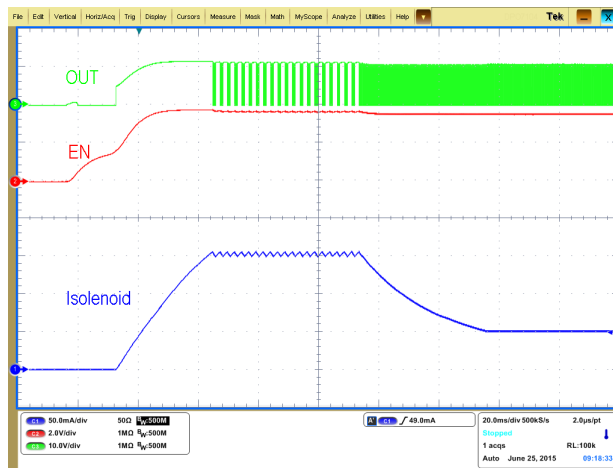


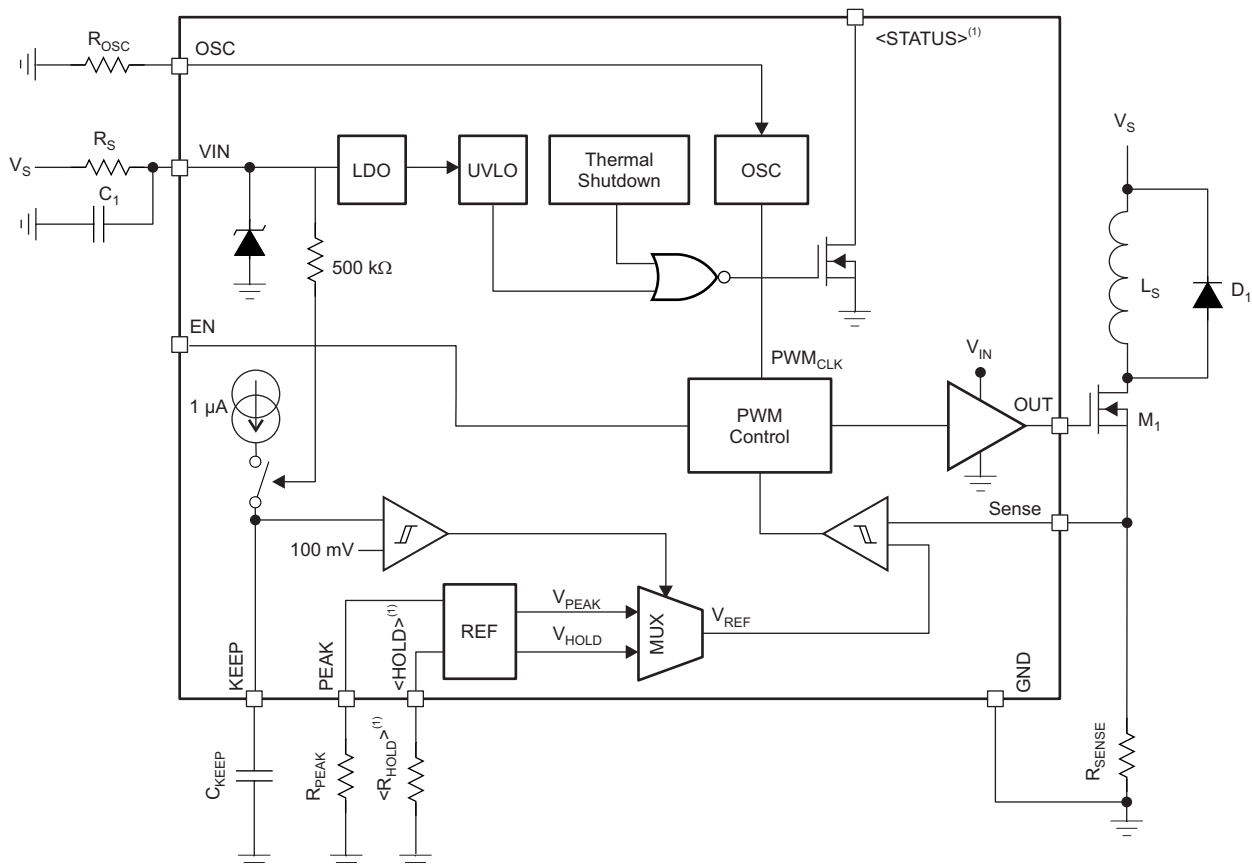
Figure 1. Solenoid Current, EN, and PWM vs Time

## 7 Detailed Description

### 7.1 Overview

The DRV110 device provides a PWM current controller for use with solenoids. The device provides a quick ramp to a high peak current value in order to ensure opening of the valve or relay. The peak current is held for a programmable time and then released to a lower value to maintain the open state of the valve or relay while reducing the total current consumption. Peak current duration, peak current amount, hold current amount (in the 14-pin package), and PWM frequency can all be controlled by external components or used at default levels by omitting these components (except peak current duration). Enable and disable of the switch is controlled by the EN pin. The DRV110 also features a wide VIN range with an internal bypass regulator to maintain VIN at an acceptable level. Finally, the 14-pin package features an open-drain pull-down path on the STATUS pin which is enabled as long as undervoltage lockout or thermal shutdown has not triggered.

### 7.2 Functional Block Diagram



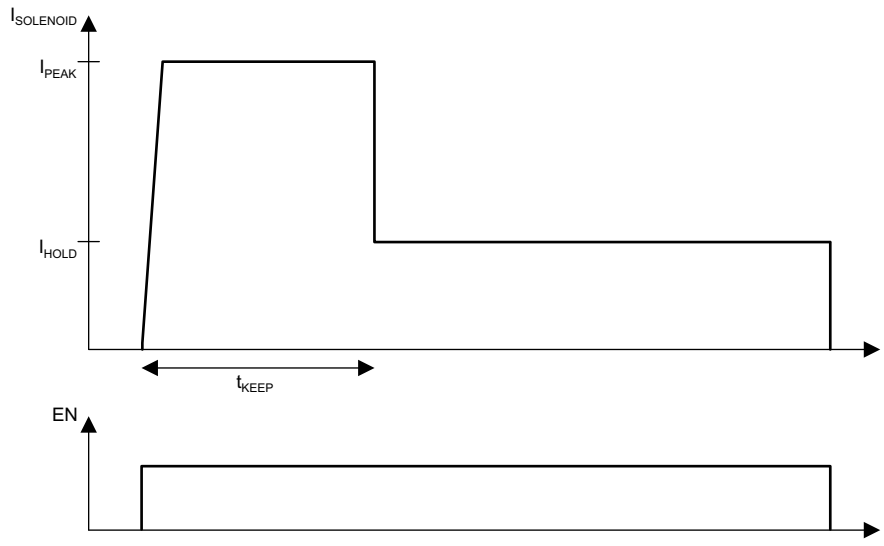
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(1) Available only in the 14-pin package.

### 7.3 Feature Description

The DRV110 controls the current through the solenoid as shown in Figure 2. Activation starts when EN pin voltage is pulled high either by an external driver or internal pullup. In the beginning of activation, DRV110 allows the load current to ramp up to the peak value  $I_{PEAK}$  and it regulates it at the peak value for the time,  $t_{KEEP}$ , before reducing it to  $I_{HOLD}$ . The load current is regulated at the hold value as long as the EN pin is kept high. The initial current ramp-up time depends on the inductance and resistance of the solenoid. Once EN pin is driven to GND, DRV110 allows the solenoid current to decay to zero.

**Feature Description (continued)**

**Figure 2. Typical Current Waveform Through the Solenoid**

$t_{KEEP}$  is set externally by connecting a capacitor to the KEEP pin. A constant current is sourced from the KEEP pin that is driven into an external capacitor resulting in a linear voltage ramp. When the KEEP pin voltage reaches 100 mV, the current regulation reference voltage,  $V_{REF}$ , is switched from  $V_{PEAK}$  to  $V_{HOLD}$ . Dependency of  $t_{KEEP}$  from the external capacitor size can be calculated by:

$$t_{KEEP} [s] = C_{KEEP} [F] \cdot 10^5 \left[ \frac{s}{F} \right] \quad (1)$$

The current control loop regulates, cycle-by-cycle, the solenoid current by sensing voltage at the SENSE pin and controlling the external switching device gate through the OUT pin. During the ON-cycle, the OUT pin voltage is driven and kept high (equal to  $V_{IN}$  voltage) allowing current to flow through the external switch as long as the voltage at the SENSE pin is less than  $V_{REF}$ . As soon as the voltage at the SENSE pin is above  $V_{REF}$ , the OUT pin voltage is immediately driven and kept low until the next ON-cycle is triggered by the internal PWM clock signal. In the beginning of each ON-cycle, the OUT pin voltage is driven and kept high for at least the time determined by the minimum PWM signal duty cycle,  $D_{MIN}$ .

$V_{PEAK}$  and  $V_{HOLD}$  depend on fixed resistance values  $R_{PEAK}$  and  $R_{HOLD}$  approximately as shown in [Figure 3](#). If the PEAK pin is connected to ground, the peak current reference voltage,  $V_{PEAK}$ , is at its default value (internal setting). The  $V_{PEAK}$  value can alternatively be set by connecting an external resistor to ground from the PEAK pin. For example, if a 50-k $\Omega$  ( $= R_{PEAK}$ ) resistor is connected between PEAK and GND, and  $R_{SENSE} = 1 \Omega$ , then the externally set  $I_{PEAK}$  level will be 900 mA. If  $R_{PEAK} = 200 \text{ k}\Omega$  and  $R_{SENSE} = 1 \Omega$ , then the externally set  $I_{PEAK}$  level will be 300 mA. In case  $R_{SENSE} = 2 \Omega$  instead of 1  $\Omega$ , then  $I_{PEAK} = 450 \text{ mA}$  (when  $R_{PEAK} = 50 \text{ k}\Omega$ ) and  $I_{PEAK} = 150 \text{ mA}$  (when  $R_{PEAK} = 200 \text{ k}\Omega$ ). In the 8-pin package, the HOLD reference uses the internal  $V_{REF}$  setting of 50 mV. In the 14-pin package, external setting of the HOLD current,  $I_{HOLD}$ , works in the way as the external setting for  $I_{PEAK}$  but the current levels are 1/6 of the  $I_{PEAK}$  levels. External settings for  $I_{PEAK}$  and  $I_{HOLD}$  are independent of each other. If  $R_{PEAK}$  or  $R_{HOLD}$  is decreased below 33.33 k $\Omega$  (typical value), then the reference is clamped to the internal setting of 300 mV for PEAK and 50 mV for HOLD. Approximate  $I_{PEAK}$  and  $I_{HOLD}$  values can be calculated by using [Equation 2](#) and [Equation 3](#).

$$I_{PEAK} = \frac{V_{REF}}{R_{SENSE}} = \frac{1 \Omega \times 900 \text{ mA} \times 66.67 \text{ k}\Omega}{R_{PEAK}} \times \frac{1}{R_{SENSE}}; 66.67 \text{ k}\Omega < R_{PEAK} < 2 \text{ M}\Omega \quad (2)$$

$$I_{HOLD} = \frac{V_{REF}}{R_{SENSE}} = \frac{1 \Omega \times 150 \text{ mA} \times 66.67 \text{ k}\Omega}{R_{HOLD}} \times \frac{1}{R_{SENSE}}; 66.67 \text{ k}\Omega < R_{HOLD} < 2 \text{ M}\Omega \quad (3)$$



Feature Description (continued)

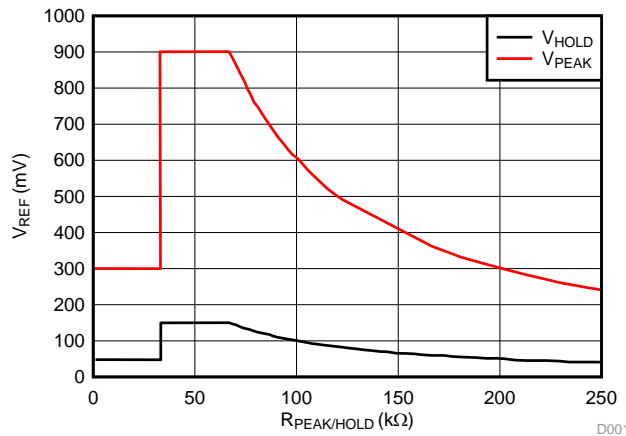


Figure 3. PEAK and HOLD Mode V<sub>REF</sub> Settings

Frequency of the internal PWM clock signal, PWM<sub>CLK</sub>, that triggers each OUT pin ON-cycle can be adjusted by external resistor, R<sub>OSC</sub>, connected between OSC and GND. Frequency as a function of resistor value is shown in Figure 4. Default frequency is used when OSC is connected to GND directly. Use Equation 4 to calculate the PWM frequency as a function of the external fixed adjustment resistor value (greater than 160 kΩ).

$$f_{\text{PWM}} = \frac{60 \text{ kHz}}{R_{\text{OSC}}} \times 66.67 \text{ k}\Omega; 160 \text{ k}\Omega < R_{\text{OSC}} < 2 \text{ M}\Omega \tag{4}$$

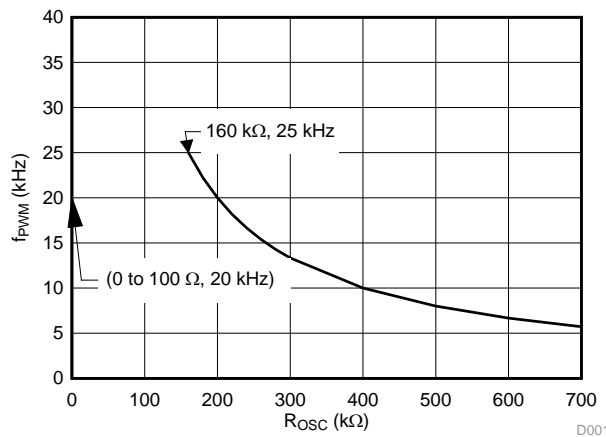


Figure 4. PWM Clock Frequency Setting

Voltage at the OUT pin, that is the gate voltage of an external switching device, is equal to VIN voltage during ON-cycle. The voltage is driven to ground during OFF-cycle. VIN voltages below 15 V can be supplied directly from an external voltage source. Supply voltages of at least 6 V are supported.

The DRV110 is able to regulate VIN voltage to 15 V from a higher external supply voltage, V<sub>S</sub>, by an internal bypass regulator that replicates the function of an ideal Zener diode. This requires that the supply current is sufficiently limited by an external resistor between V<sub>S</sub> and the VIN pin. An external capacitor connected to the VIN pin is used to store enough energy to charge the external switch gate capacitance at the OUT pin. Current limiting resistor size to keep quiescent current less than 1 mA can be calculated by Equation 5.

$$R_S = \frac{V_{S,\text{maxDC}} - 15\text{V}}{1\text{mA} + I_{\text{Gate,Ave}}} \tag{5}$$

Open-drain pulldown path at the STATUS pin is deactivated if either undervoltage lockout or thermal shutdown blocks have triggered.

## 7.4 Device Functional Modes

The DRV110 transitions through three different states. The first is the OFF state, where the EN pin is low and the PWM output is off. The second is the PEAK state, which begins when the EN pin is set high, and ends once  $t_{KEEP}$  has been reached. During this state, the PWM operates in order to reach the  $I_{PEAK}$  set by the  $R_{PEAK}$ . Finally, once  $t_{KEEP}$  has been reached, the PWM continues to operate, but at the  $I_{HOLD}$  level. This continues until the EN pin is set low again and the PWM turns off.

## 8 Application and Implementation

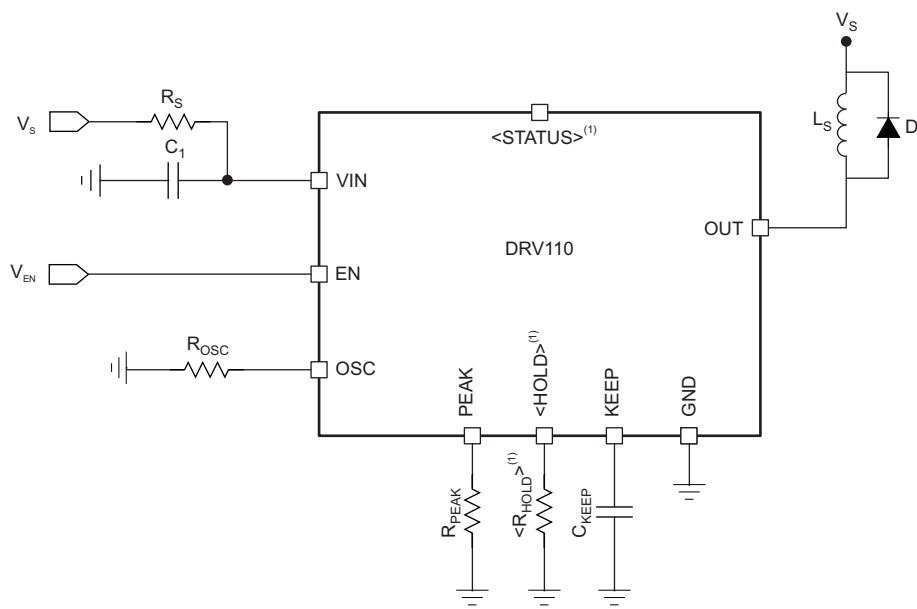
### NOTE

Information in the following applications sections is not part of the TI component specification, and TI does not warrant its accuracy or completeness. TI's customers are responsible for determining suitability of components for their purposes. Customers should validate and test their design implementation to confirm system functionality.

### 8.1 Application Information

The DRV110 device is designed to operate a solenoid valve or relay. For detailed information on using the DRV110 with 230 V AC solenoids, see [Current Controlled Driver for 230V AC Solenoids Reference Design](#). A typical DC input design will be outlined in [Typical Application](#). Approximate resistor and capacitor values for the peak current, hold current, sense, and keep time will be derived for a sample application.

### 8.2 Typical Application

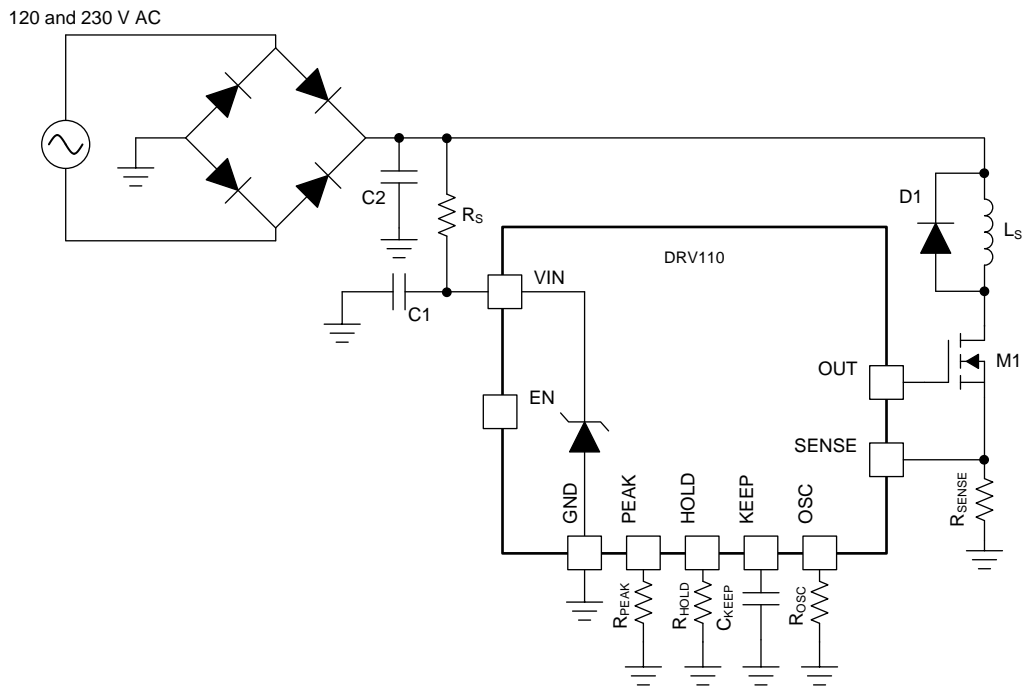


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(1) Available only in the 14-pin package.

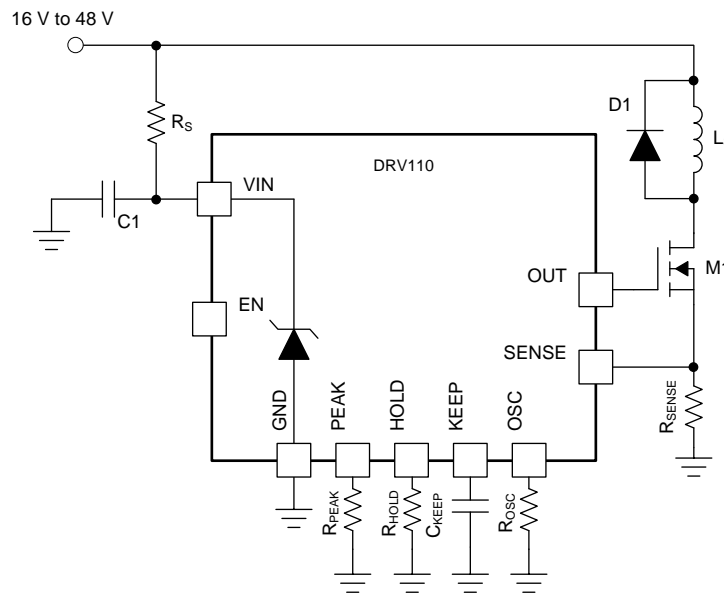
Figure 5. Default Configuration

Typical Application (continued)



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Figure 6. DRV110 Powered by a Rectified AC Power Source



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Figure 7. DRV110 Powered by a DC Power Source Greater than 15 V

## Typical Application (continued)

### 8.2.1 Design Requirements

The key elements to identify here are the system input voltage, peak current, hold current, and peak keep time values required for the solenoid or relay being used. With these values, approximate  $R_S$ ,  $R_{PEAK}$ ,  $R_{HOLD}$  (for 14-pin package),  $C_{KEEP}$ , and  $R_{SENSE}$  values can be determined and the proper FET and diode can be identified.  $R_{OSC}$  can be varied in order to tune the circuit to the chosen solenoid or relay.

### 8.2.2 Detailed Design Procedure

First, the input voltage to the DRV110 must be considered. If this is from 6 V to 15 V, then no current-limit resistor is required and only the input capacitor is necessary. If  $V_{IN}$  exceeds 15 V, then  $R_S$  must be calculated based on [Equation 5](#) and included to prevent excess power loss and potential damage.

Next, with the known peak current, hold current, and peak keep time values, the  $R_{PEAK}$ ,  $R_{HOLD}$  (for 14-pin package),  $C_{KEEP}$ , and  $R_{SENSE}$  values can be determined. Calculation will proceed based on example values shown in [Table 1](#).

**Table 1. Sample Application Values**

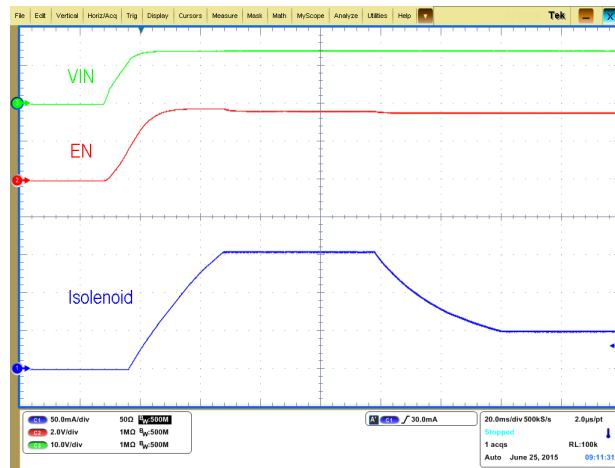
VARIABLE	VALUE
Peak current	150 mA
Hold current	50 mA
Keep time	100 ms

For  $I_{PEAK}$ , the  $V_{REF}$  range is 300 mV to 900 mV, so the  $I_{PEAK}$  range is defined by  $300 \text{ mV} / R_{SENSE}$  to  $900 \text{ mV} / R_{SENSE}$ . For  $I_{HOLD}$  with the 8-pin package,  $I_{HOLD}$  is set by  $50 \text{ mV} / R_{SENSE}$ . For  $I_{HOLD}$  with the 14-pin package, the  $V_{REF}$  range is 50 mV to 150 mV, so the  $I_{HOLD}$  range is defined by  $50 \text{ mV} / R_{SENSE}$  to  $150 \text{ mV} / R_{SENSE}$ . Based on these ranges, a suitable  $R_{SENSE}$  must be chosen. For the sample values,  $R_{SENSE}$  of  $1 \Omega$  works for both the 8-pin and 14-pin package. With  $R_{SENSE}$  chosen,  $R_{PEAK}$  and  $R_{HOLD}$  (if applicable) can be determined using [Equation 2](#) and [Equation 3](#). For the sample values,  $R_{PEAK}$  is set to  $400 \text{ k}\Omega$  and  $R_{HOLD}$  can be shorted to GND. TI recommends that a  $0\text{-}\Omega$  resistor is used for prototyping in case changes to this value are desired.

Next,  $C_{KEEP}$  can be set based on [Equation 1](#),  $1 \mu\text{F}$  for the sample values.  $R_{OSC}$  can initially be shorted to GND, but again a  $0\text{-}\Omega$  resistor is recommended for prototyping. Additionally, a filter on the SENSE line may be added if it will be in a high noise environment and is recommended for prototyping. Typical values for this are  $1 \text{ k}\Omega$  and  $100 \text{ pF}$ .

Finally, a FET and current recirculation diode must be chosen based on the current values defined in [Table 1](#). The current recirculation diode should be a fast recovery diode.

### 8.2.3 Application Curves



$R_{OSC} = 0 \Omega$	$R_{PEAK} = 303 \text{ k}\Omega$	$R_{HOLD} = 0 \Omega$
$R_{SENSE} = 1 \Omega$	$C_{KEEP} = 1 \mu\text{F}$	$L_{ind} = 1 \text{ H}$
$R_{ind} = 50 \Omega$	Measured on the EVM	

**Figure 8. I<sub>SOLENOID</sub>, EN, and V<sub>IN</sub> vs Time**

## 9 Power Supply Recommendations

The input supply range must be at least 6 V, and needs a current-limiting resistor above 15 V. An input capacitor of 4.7  $\mu$ F (typical) is required as well.  $I_Q$  max is 3 mA, but additional current will be required to operate the solenoid or relay.

## 10 Layout

### 10.1 Layout Guidelines

Routing for the SENSE pin should be careful to avoid noise sources. Routing for the output node and sense node should be minimized. The trace for the solenoid or relay current should be wide in order to prevent any unexpected voltage drop.

### 10.2 Layout Example

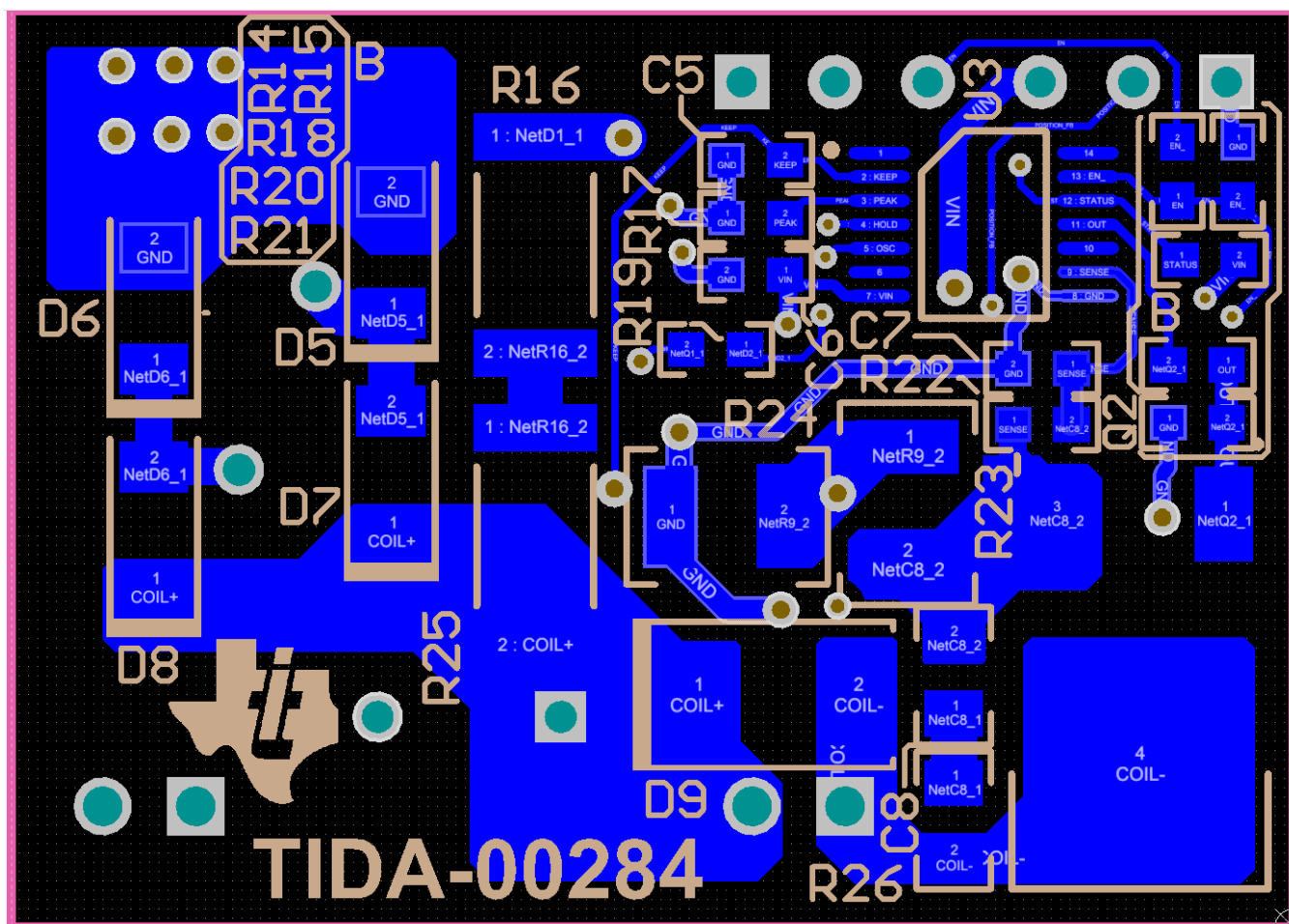


Figure 9. Layout Schematic

## 11 Device and Documentation Support

### 11.1 Documentation Support

#### 11.1.1 Related Documentation

For related documentation, see the following:

- [Current Controlled Driver for 230V AC Solenoids Reference Design](#)
- [DRV110 and DRV120 Evaluation Modules \(EVM\)](#)

#### 11.2 Receiving Notification of Documentation Updates

To receive notification of documentation updates, navigate to the device product folder on ti.com. In the upper right corner, click on *Alert me* to register and receive a weekly digest of any product information that has changed. For change details, review the revision history included in any revised document.

#### 11.3 Community Resources

The following links connect to TI community resources. Linked contents are provided "AS IS" by the respective contributors. They do not constitute TI specifications and do not necessarily reflect TI's views; see TI's [Terms of Use](#).

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**Design Support** *TI's Design Support* Quickly find helpful E2E forums along with design support tools and contact information for technical support.

#### 11.4 Trademarks

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#### 11.5 Electrostatic Discharge Caution



This integrated circuit can be damaged by ESD. Texas Instruments recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage.

ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because very small parametric changes could cause the device not to meet its published specifications.

#### 11.6 Glossary

[SLYZ022](#) — *TI Glossary*.

This glossary lists and explains terms, acronyms, and definitions.

## 12 Mechanical, Packaging, and Orderable Information

The following pages include mechanical, packaging, and orderable information. This information is the most current data available for the designated devices. This data is subject to change without notice and revision of this document. For browser-based versions of this data sheet, refer to the left-hand navigation.



**PACKAGING INFORMATION**

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
DRV110APWR	ACTIVE	TSSOP	PW	14	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR	-40 to +105	110A	<a href="#">Samples</a>
DRV110PWR	ACTIVE	TSSOP	PW	8	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR	-40 to +105	110	<a href="#">Samples</a>

(1) The marketing status values are defined as follows:

**ACTIVE:** Product device recommended for new designs.

**LIFEBUY:** TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

**NRND:** Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

**PREVIEW:** Device has been announced but is not in production. Samples may or may not be available.

**OBSOLETE:** TI has discontinued the production of the device.

(2) Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check <http://www.ti.com/productcontent> for the latest availability information and additional product content details.

**TBD:** The Pb-Free/Green conversion plan has not been defined.

**Pb-Free (RoHS):** TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.

**Pb-Free (RoHS Exempt):** This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.

**Green (RoHS & no Sb/Br):** TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

(3) MSL, Peak Temp. - The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

(5) Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

(6) Lead/Ball Finish - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead/Ball Finish values may wrap to two lines if the finish value exceeds the maximum column width.

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**TAPE AND REEL INFORMATION**

**QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE**


\*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
DRV110APWR	TSSOP	PW	14	2000	330.0	12.4	6.9	5.6	1.6	8.0	12.0	Q1
DRV110PWR	TSSOP	PW	8	2000	330.0	12.4	7.0	3.6	1.6	8.0	12.0	Q1

**TAPE AND REEL BOX DIMENSIONS**


\*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
DRV110APWR	TSSOP	PW	14	2000	367.0	367.0	35.0
DRV110PWR	TSSOP	PW	8	2000	367.0	367.0	35.0



PW (R-PDSO-G14)

PLASTIC SMALL OUTLINE



4211284-2/G 08/15

- NOTES:
- All linear dimensions are in millimeters.
  - This drawing is subject to change without notice.
  - Publication IPC-7351 is recommended for alternate designs.
  - Laser cutting apertures with trapezoidal walls and also rounding corners will offer better paste release. Customers should contact their board assembly site for stencil design recommendations. Refer to IPC-7525 for other stencil recommendations.
  - Customers should contact their board fabrication site for solder mask tolerances between and around signal pads.

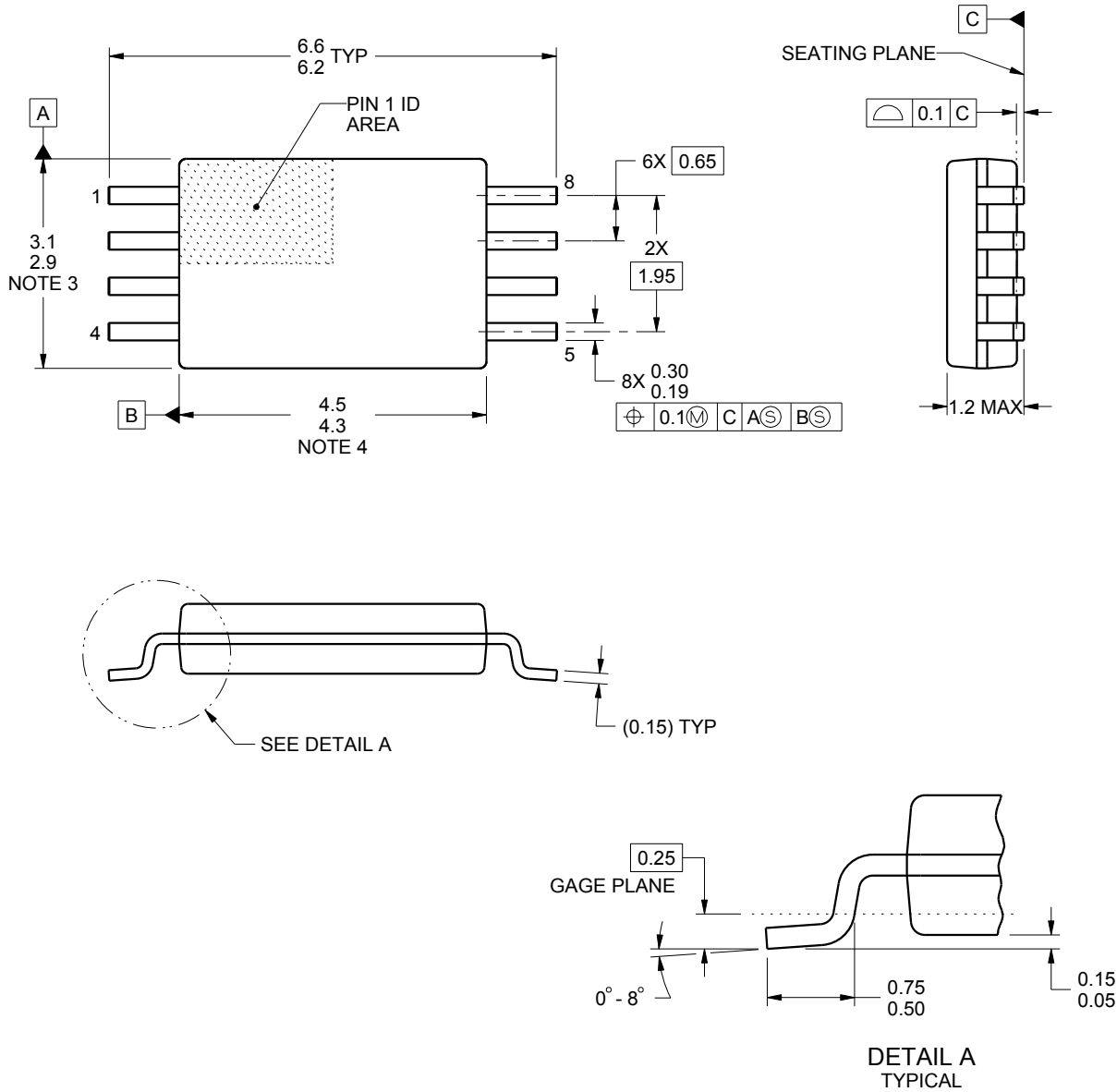
PW0008A



# PACKAGE OUTLINE

## TSSOP - 1.2 mm max height

SMALL OUTLINE PACKAGE



4221848/A 02/2015

### NOTES:

1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.15 mm per side.
4. This dimension does not include interlead flash. Interlead flash shall not exceed 0.25 mm per side.
5. Reference JEDEC registration MO-153, variation AA.

# EXAMPLE BOARD LAYOUT

PW0008A

TSSOP - 1.2 mm max height

SMALL OUTLINE PACKAGE



LAND PATTERN EXAMPLE  
SCALE:10X



SOLDER MASK DETAILS  
NOT TO SCALE

4221848/A 02/2015

NOTES: (continued)

- 6. Publication IPC-7351 may have alternate designs.
- 7. Solder mask tolerances between and around signal pads can vary based on board fabrication site.



# EXAMPLE STENCIL DESIGN

PW0008A

TSSOP - 1.2 mm max height

SMALL OUTLINE PACKAGE



SOLDER PASTE EXAMPLE  
BASED ON 0.125 mm THICK STENCIL  
SCALE:10X

4221848/A 02/2015

NOTES: (continued)

8. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.
9. Board assembly site may have different recommendations for stencil design.

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