Features

- 60 V_{DC} / 10 A Half-Bridge
- 14 mΩ (typ), integrated high side and low-side eGaN FETs
- Integrated GaN gate driver and level-shifter
- 12 V external bias supply
- 3.3 V or 5 V input logic levels
- Independent high side and low side control inputs
- Logic Input Shoot-Through Protection, commands both FETs off when control inputs are both high at the same time
- Internal Under-Voltage Lockout (UVLO) Circuitry
- Synchronous charging for high side bootstrap supply
- Flexible power-sequencing with active gate pull-down for HS and LS FET allows for V_{IN} before V_{BIAS} power-up
- High Switching Frequency Capability: up to 3 MHz
- Compact AlN Ceramic SMT Hermetic Package (L7)



EPC7011L7C

60 V_{DC} / 10 A GaN Power Stage

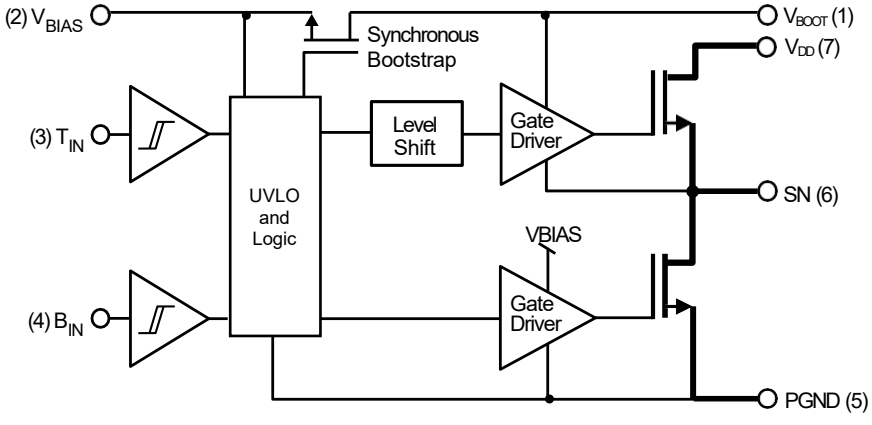
Description

The EPC Space EPC7011L7C, is a half-bridge GaN power stage. Input logic interface, level shifting, bootstrap charging and gate drive buffer circuits along with eGaN output FETs configured as a half-bridge are integrated within a monolithic chip in a custom 7-pin Aluminum Nitride SMT ceramic package. 60 V_{DC} maximum operating voltage, 100V capable internal power transistors and level shifter.

Applications

- Single and Multi-Phase Motor Drivers:
  - Reaction Wheel Assemblies (RWAs)
  - Motion Controls
  - Robotic Actuators
- Half-Bridge/POL Power Supplies:
  - Low Current Single Phase
  - High Current Multi-Phase
- Electrical Power System

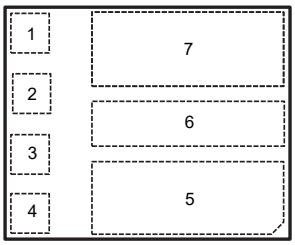
Functional Block Diagram



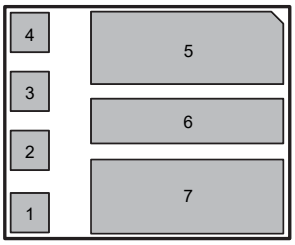
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7-Pin AlN Ceramic SMT Package

Top (X-Ray) View



Bottom (Pad) View



EPC7011L7C Configuration and Pin Assignment Table

Pin #	Pin Name	Type	Pin Function
1	V_{BOOT}	P/I	High-Side Driver Floating Power Supply
2	V_{BIAS}	P/I	+12V_{DC}, Nominal, Gate Driver Power Supply Bias Voltage
3	T_{IN}	L/I	High-Side Switch Logic Input
4	B_{IN}	L/I	Low-Side Switch Logic Input
5	PGND	P/L/H/GR	Power and Logic Supply Return (High Current)
6	SN	P/O/H	Switching Node (High dV/dt, High Current)
7	V_{DD}	P/I/H	Positive Power Supply Input (High Current)

KEY: P = Power, L= Logic, I= Input, O = Output, H = High Current Connection, GR = Ground Return

Pin Descriptions

V_{BOOT} (Pin 1)
High-Side Driver Floating Power Supply. The floating bootstrap high-side driver power supply referenced to the SN output (pin 6). For proper operation, connect a ceramic bootstrap capacitor (0.1 µF recommended) from V_{BOOT} to SN.

V_{BIAS} (Pin 2)
The raw DC bias power supply referenced to GND that supplies power to the low-and high-side gate drivers and to the internal logic in the EPC7011L7C. Connect two ceramic bypass capacitors (0.1 µF and 10 µF recommended) from V_{BIAS} to PGND (Pin 7).

T_{IN} (Pin 3)
The T_{IN} pin is the logic input for high-side power driver. When the T_{IN} input pin is logic low (“0”), the high-side output (V_{DD}-SN) pins (pins 5 and 6) are in the OFF (high impedance) state. When the T_{IN} input pin is logic high (“1”), the V_{DD}-SN pins are in the ON (low impedance) state.

B_{IN} (Pin 4)
The B_{IN} pin is the logic input for low-side power driver. When the B_{IN} input pin is logic low (“0”), the low-side output (SN-PGND) pins (pins 6 and 7) are in the OFF (high impedance) state. When the B_{IN} input pin is logic high (“1”), the SN-PGND pins are in the ON (low impedance) state.

PGND (Power Ground) (Pin 5)
The PGND pin (pin 5) is the ground return connection for the internal power output circuitry and high-speed gate driver circuitry associated with low-side power driver and for the power good and interface logic for the high-side driver. This pin should be connected directly to the system power return/ground plane to minimize common source inductance, and the voltage transients associated with this inductance. This is a high-current connection.

SN (Switching Node) (Pin 6)
The SN pin (pin 6) is the high-current power output for the half-bridge driver. This output alternates from high impedance (the low- and high-side power switches OFF when both logic inputs are “0” or “1” simultaneously) to low impedance from the SN pin to PGND (when BIN is logic “1”) to low impedance from the V_{DD} pin (pin 5) to SN (when T_{IN} is logic “1”). This is a high-current connection.

V_{DD} (Pin 7)
The V_{DD} pin (pin 7) is the half-bridge power stage input. This pin should be connected directly to the system power (V_{DD}) bus via a low impedance connection, preferably through a low impedance power plane. This pin should be properly bypassed to the system power ground (PGND, pin 5) using the guidelines found in the “Recommended V_{DD}-to-PGND Power Supply Bypassing” section, following. This is a high-current connection.

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Absolute Maximum Rating *(-55°C ≤ T_C 125°C unless otherwise noted)*

Symbol	Parameter-Conditions	Value	Units
V_{DD}	Positive Power Supply Input Voltage (Note 1)	60	V
I_{DD}	Continuous Operating Current	10	A
V_{BIAS}	Continuous Gate Driver Bias Supply Voltage	14.0	V
V_{BOOT}	Continuous Bootstrap Supply Voltage	14.0	
B_{IN}, T_{IN}	B_{IN} or T_{IN} Logic Input Voltage	-0.3 to 5.5	
T_{STG}	Storage Junction Temperature Range	-55 to +150	°C
T_J	Operating Junction Temperature Range	-40 to +125	
T_C	Case Operating Temperature Range	-55 to +125	
T_{sol}	Package Mounting Surface Temperature	230	
ESD	ESD class level (HBM)	1B	
	Device Weight	0.226	g

Thermal Characteristics

Symbol	Parameter-Conditions	Value	Units
$R_{\theta JA}$	Thermal Resistance Junction to Ambient	55	°C/W
$R_{\theta JLid}$	Thermal Resistance Junction to Case: Lid/Top	5.1	
$R_{\theta JC}$	Thermal Resistance Junction to Case: Bottom of the Power Pads	2.5	

OUT Power Switch Static Electrical Characteristics *(T_C = 25°C unless otherwise noted)*

Symbol	Parameter	Test Conditions		MIN	TYP	MAX	Units
I_{DSS}	Drain – Source Leakage Current (V_{DD}-to-SN or SN-to-PGND) (Note 2)	V_{DS} = 40 V_{DC}, B_{IN} = T_{IN} = 0.5 V_{DC}	T_C = 25°C	-	2	200	µA
			T_C = 125°C	-	8	200	
		V_{DS} = 60 V_{DC}, B_{IN} = T_{IN} = 0.5 V_{DC}	T_C = 25°C	-	3	200	
			T_C = 125°C	-	9	200	
$R_{DS(on)}$	Drain – Source ON-State Resistance (V_{DD}-to-SN or SN-to-PGND) (Notes 3, 4, 5)	I_D = 6 A, B_{IN} = 2.4 V_{DC} or T_{IN} = 2.4 V_{DC}	T_C = 25°C	-	14	22	mΩ
			T_C = 125°C	-	20	40	
			T_C = -55°C	-	9	16	
		I_D = 10 A, B_{IN} = 2.4 V_{DC} or T_{IN} = 2.4 V_{DC}	T_C = 25°C	-	14	22	
			T_C = 125°C	-	20	40	
			T_C = -55°C	-	9	16	
V_{SD}	Source – Drain Clamping Voltage (SN-to-V_{DD} or PGND-to-SN) (Note 5, 6, 7)	I_D = -6 A, B_{IN} = T_{IN} = 0.5 V_{DC}	T_C = 25°C	-	2.4	3	V
			T_C = 125°C	-	2.4	4	
			T_C = -55°C	-	2.4	3	
		I_D = -10 A, B_{IN} = T_{IN} = 0.5 V_{DC}	T_C = 25°C	-	2.4	3	
			T_C = 125°C	-	2.4	4	
			T_C = -55°C	-	2.4	3	

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Recommended Operating Conditions *(-55°C ≤ T_C ≤ 125°C unless otherwise noted)*

Symbol	Parameter-Conditions	Value	Units
V_{DD}	Positive Power Supply Input Voltage (Note 1)	60	V
I_{DD}	Continuous Operating Current	10	A
V_{BIAS}	Continuous Bias Supply Voltage	11 - 13	V
V_{BOOT}	Continuous Bootstrap Supply Voltage	11 - 13	V

B_{IN}, T_{IN} Logic Input Static Electrical Characteristics *(-55°C ≤ T_C ≤ 125°C unless otherwise noted)*

Symbol	Parameter	Test Conditions	MIN	TYP	MAX	Units
V_{IL}	Low Logic Level Input Voltage	V_{BIAS} = 12 V_{DC} (Note 8)			0.5	V
V_{IH}	High Logic Level Input Voltage	V_{BIAS} = 12 V_{DC} (Notes 8, 9)	2.4			
V_{HYST}	Input Logic Threshold Hysteresis	V_{BIAS} = 12 V_{DC}	0.2	0.4		
R_{IL}	Logic Input Pull-Down Resistance	V_{BIAS} = 12 V_{DC}, V_I = 5.0 V_{DC}		10		kΩ
C_{IL}	Logic Input Capacitance	V_{BIAS} = 12 V_{DC}, V_I → 5.0 V_{DC} (Note 6)		6		pF

V_{BIAS} and V_{BOOT} Electrical Characteristics *(-55°C ≤ T_C ≤ 125°C unless otherwise noted)*

Symbol	Parameter	Test Conditions	MIN	TYP	MAX	Units
I_{BIAS}	V_{BIAS} Quiescent Operating Current	V_{BIAS} = 12 V_{DC}, B_{IN} = T_{IN} = 0.5 V_{DC}		22	25	mA
	V_{BIAS} Operating Current, f_s = 1 MHz	V_{BIAS} = 12 V_{DC}, D/C = 50% includes Iboot		32	45	
I_{BOOT}	V_{BOOT} Quiescent Operating Current	(V_{BOOT} - V_{SN}) = 12 V_{DC}, T_{IN} = 0.5 V_{DC}		8	11	
	V_{BOOT} Operating Current, f_s = 1 MHz	(V_{BOOT} - V_{SN}) = 12 V_{DC}, D/C = 50%		13	20	
V_{BOOT}	V_{BOOT} - to - V_{SN} Operating Voltage	(V_{BOOT} - V_{SN}) = 12 V_{DC}	9	11.5	13	V

Under-Voltage Lockout Static Electrical Characteristics *(-55°C ≤ T_C ≤ 125°C unless otherwise noted)*

Symbol	Parameter	Test Conditions	MIN	TYP	MAX	Units
V_{BIAS} UVLO+	V_{BIAS} UVLO Rising Threshold	(Note 10)	5	9	10.9	V
V_{BIAS} (HYST)	V_{BIAS} UVLO Falling Hysteresis			0.4		
V_{BOOT} UVLO+	V_{BOOT} UVLO Rising Threshold	(Note 11)	5	9	10.9	
V_{BOOT} UVLO (HYST)	V_{BOOT} UVLO Falling Hysteresis			0.5		

Low- and High-Side Power Switch Dynamic Electrical Characteristics *(T_C = 25°C unless otherwise noted)*

Symbol	Parameter	Test Conditions	MIN	TYP	MAX	Units
$t_{d(on)}$	T_{IN}-to-SN or B_{IN}-to-SN Turn-ON Delay Time	V_{DS} = 25 V_{DC}; I_O = 10A (See Switching Figures)		20	45	ns
$t_{d(off)}$	T_{IN}-to-SN or B_{IN}-to-SN Turn-OFF Delay Time			20	45	
t_r/t_f	SN Rise/Fall Time			3		
t_{rl}/t_{fl}	Logic Input Rise/Fall Time	From V_{IL} to V_{IH} or V_{IH} to V_{IL} (Notes 6, 14)			25	
PW	Minimum B_{IN}/T_{IN} Pulse Width	(Notes 6, 12, 13)		20		
$T_{(delay)}$	B_{IN}-to-T_{IN} or T_{IN}-to-B_{IN} Dead (Delay) Time		20			
D/C	High-Side Power Switch Duty Cycle				95	%
t_{prg}	High-Side Bootstrap Capacitor Pre-Charge Time		5			µs
C_{OSS}	High Side Output Capacitance (VDD-SN)	V = 5 V (Note 6)		625		pF
	High Side Output Capacitance (VDD-SN)	V = 48 V (Note 6)		250		
	Low Side Output Capacitance (SN-PGND)	V = 5 V (Note 6)		625		
	Low Side Output Capacitance (SN-PGND)	V = 48 V (Note 6)		250		

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Notes

1.) DC value of V_{DD} plus any transient voltage spikes not to exceed this value.

2.) When either logic input (B_{IN} or T_{IN}) is at the low input voltage level, the associated output switch is guaranteed to be OFF (high impedance).

3.) When either logic input (B_{IN} or T_{IN}) is at the high input voltage level the associated output switch is guaranteed to be ON (low impedance) unless concurrent and therefore disabled by shoot-through protection.

4.) Measured using current pulse.

5.) Measured using 4-Wire (Kelvin) sensing techniques.

6.) Guaranteed by design. Not tested in production.

7.) Measured using 50 ns current pulse.

8.) Either B_{IN} or T_{IN} logic input.

9.) The input shoot-through protection is activated if both the B_{IN} and T_{IN} logic inputs are set to the logic high (“1”) condition simultaneously. In the case where the B_{IN} and T_{IN} inputs are set to logic high, both the low- and high-side power switches are set to their high impedance (OFF) state.

10.) Rising V_{BIAS} levels below the V_{BIAS} UVLO+ threshold and falling V_{BIAS} levels below the V_{BIAS} UVLO+ - V_{BIAS} UVLO (HYST) threshold result in the internal low-side gate drivers being disabled and the corresponding output being set to its high- impedance state, regardless of the state of the logic input.

11.) Rising V_{BOOT} levels below the V_{BOOT} UVLO+ threshold and falling V_{BOOT} levels below the V_{BOOT} UVLO+ - V_{BOOT} UVLO (HYST) threshold result in the internal high-side gate drivers being disabled and the corresponding output being set to its high- impedance state, regardless of the state of the logic input.

12.) The high-side power switch gate driver utilizes a bootstrap capacitor to provide the proper bias for this circuit. As such, this capacitor must be periodically re-charged from the V_{BIAS} supply. The time t_{prg} is the minimum time required to ensure that the bootstrap capacitor is properly charged when power is initially applied to the EPC7011L7C IC.

13.) The minimum frequency of operation is determined by the external bootstrap capacitance and the bias current required by the high-side power switch gate driver circuit, I_{BOOT}. In order to keep the high-side power switch gate driver bootstrap capacitor properly charged on a cycle-by-cycle basis, it is recommended that the maximum duty cycle of the high-side power switch is limited to the value shown.

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Typical power dissipation and thermal operating charts

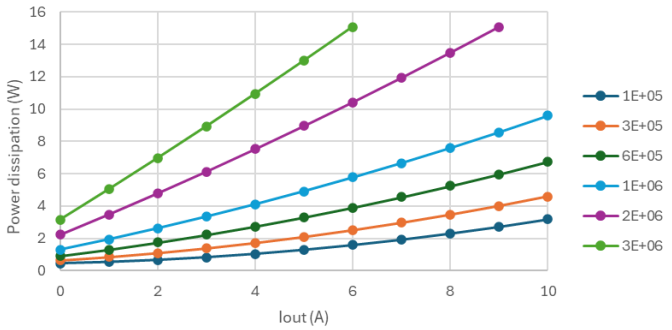


Figure 1: Typical power dissipation vs. output current, switching frequency; Tj=125C, Vdd=50V, deadtime=40ns

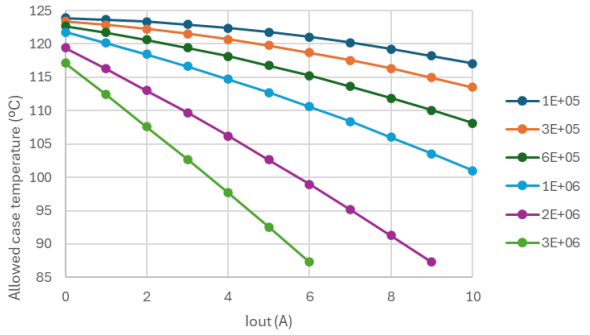


Figure 2: Typical allowed case (bottom pads) temperature vs. output current, switching frequency; Tj=125C, Vdd=50V, deadtime=40ns

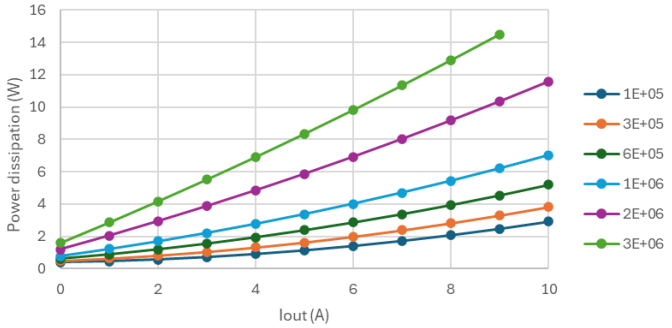


Figure 3: Typical power dissipation vs. output current, switching frequency; Tj=125C, Vdd=28V, deadtime=40ns

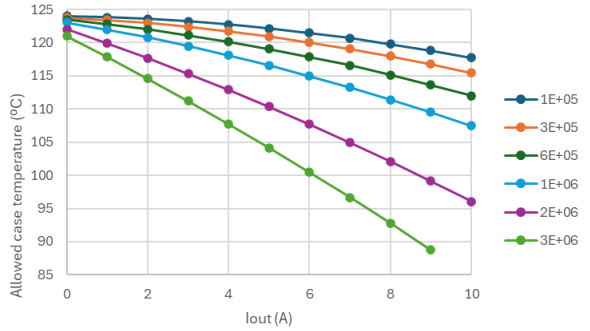


Figure 4: Typical allowed case (bottom pads) temperature vs. output current, switching frequency; Tj=125C, Vdd=28V, deadtime=40ns

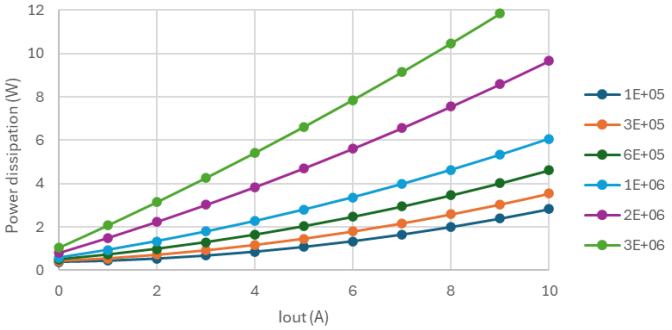


Figure 5: Typical power dissipation vs. output current, switching frequency; Tj=125C, Vdd=12V, deadtime=40ns

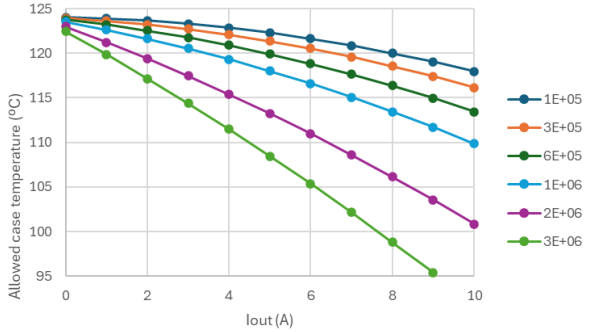
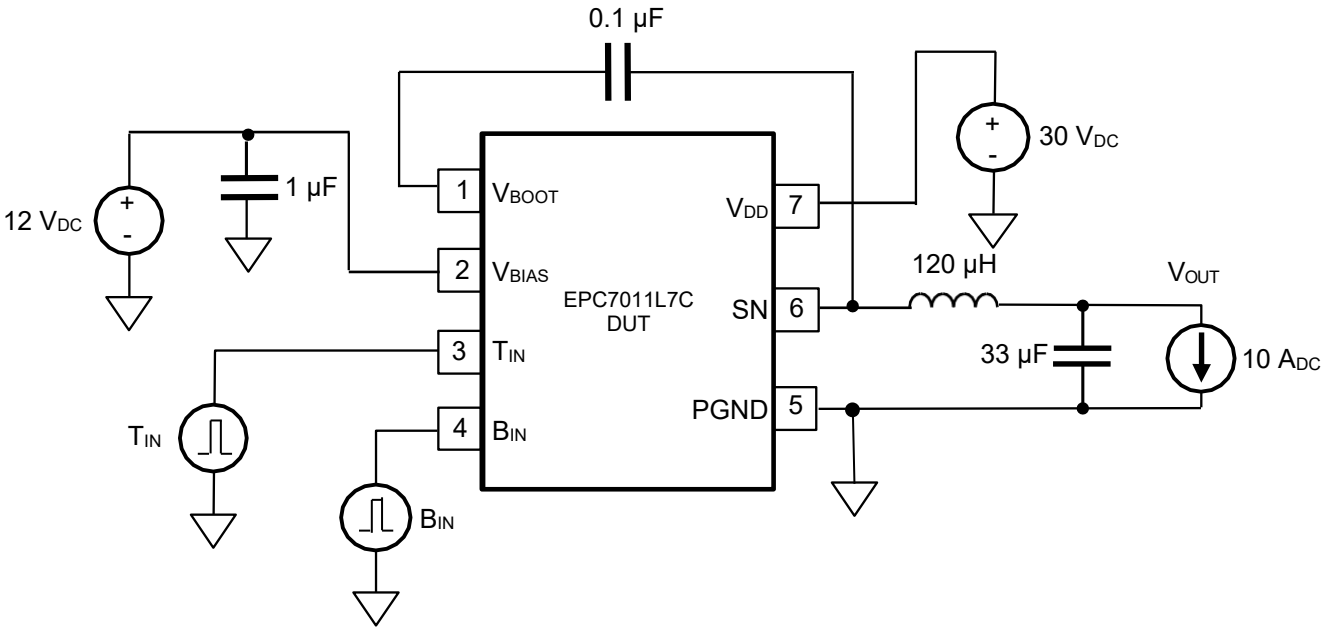
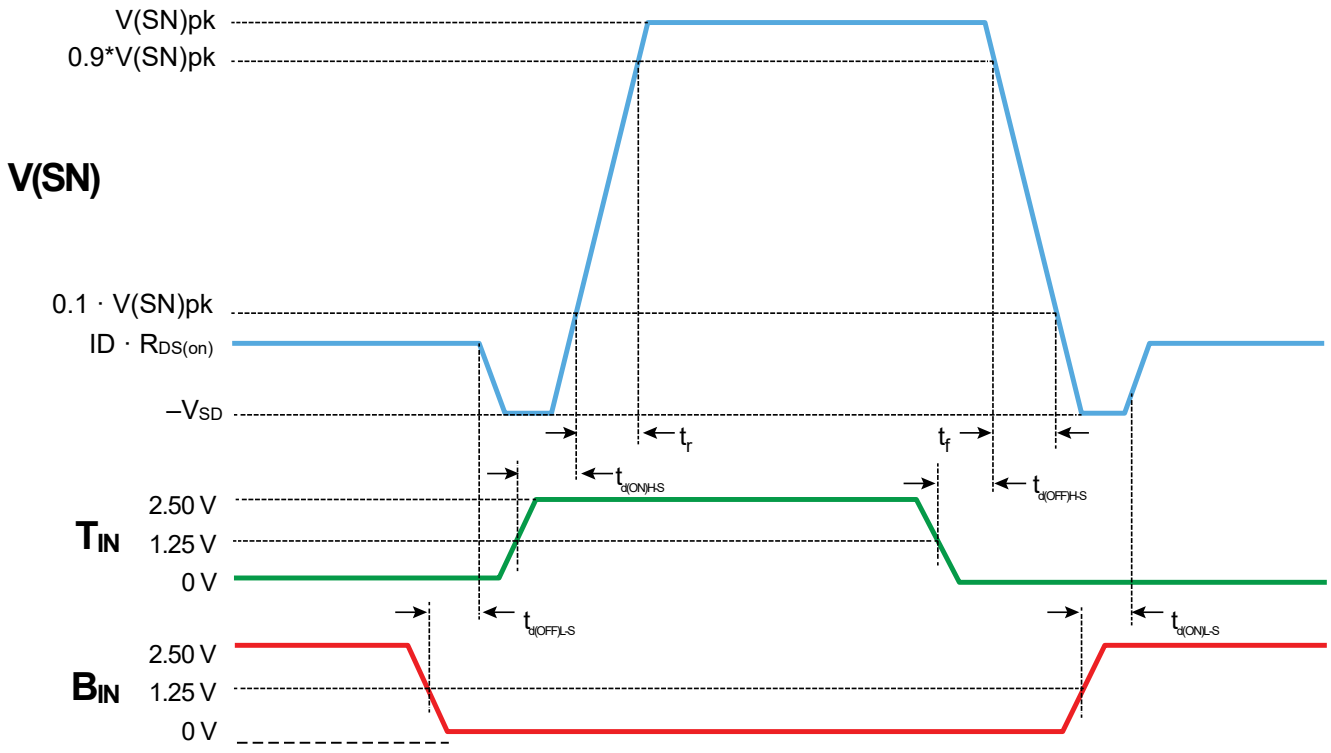


Figure 6: Typical allowed case (bottom pads) temperature vs. output current, switching frequency; Tj=125C, Vdd=12V, deadtime=40ns

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Switching Figures





BIN	TIN	LS	HS
0	0	Off	Off
1	0	On	Off
0	1	Off	On
1	1	Off	Off

Figure 7: Switching waveforms timing definitions and device inputs states

Logic Input Shoot- Through Protection

The EPC7011L7C is provided with input shoot-through (cross-conduction) protection such that if the B_{IN} and T_{IN} logic inputs are asserted as logic state high (“1”) simultaneously then the switching node (SN) assumes a high impedance (hi-Z) state until one of the logic inputs is asserted to a logic low (“0”) state. This feature prevents the EPC7011L7C IC from being destroyed by an unintentional logic condition at the logic inputs.

High-Side Bootstrap Capacitor Periodic Recharge

The high-side power switch gate driver utilizes a bootstrap capacitor to provide the proper bias for this circuit during switching operation. As such, this capacitor must be periodically recharged from the V_{BIAS} power supply. The time t_{prg} is the minimum time required for the low-side driver to be turned ON in order to ensure that the bootstrap capacitor is properly charged when power is initially applied to the EPC7011L7C IC.

Power-Up Sequencing

There are no power sequencing requirements for the V_{BIAS} and V_{DD} power supplies required by the EPC7011L7C. The two power supplies may be applied to the IC in any order/sequence required by the end-user.

Schottky “Freewheeling” Diodes

If third-quadrant operation of the internal output HEMTs in the EPC7011L7C is not desired, then it is recommended that two external Schottky “Freewheeling” diodes (Dext1 and Dext2) be added between VDD and SN and between SN and PGND as shown in Figure 8. The diodes should be properly de-rated for both voltage and current.

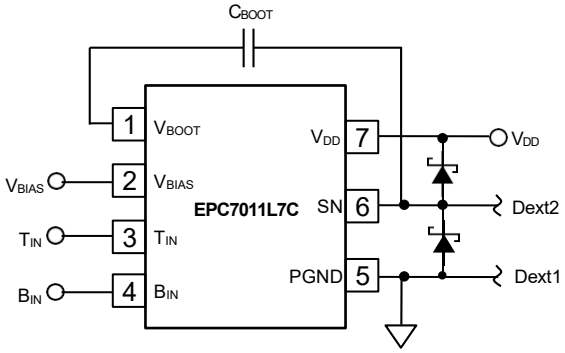


Figure 8: External Schottky Freewheeling Diode Connections

Place the diode packages as physically close to the EPC7011L7C package as possible, and keep the connections as short as possible, to eliminate parasitic loop inductances.

Resistors on Decoupling Capacitors

The EPC7011L7C is designed to be a high-speed power driver. As such it has extremely fast switching node (SN) rise and fall times by design. Fast rise and fall times can and will result in undesirable voltage spikes at the SN pin due to any parasitic layout inductance. If these spikes cannot be reduced to an acceptable level through PCB layout and decoupling optimization, two resistors may be added to increase the damping to the local supply loop. These resistors, R_{SD1} and R_{SD2} are shown in Figure 9.

R_{SD1} increases the fall time of the SN, as it affects the low side driver. Similarly, R_{SD2} increases the SN rise time. It is recommended to minimize the value of these resistors to the minimum necessary to obtain the desired loop damping, possibly not to exceed 5 ohms.

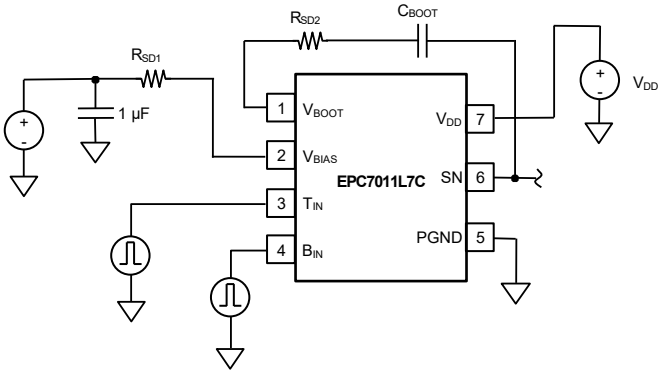


Figure 9: External Damping Resistor Connections

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Recommended VDD-to-PGND Power Supply Bypassing

The V_{DD} power supply pin and the return pin of the EPC7011L7C require proper high frequency bypassing.

Because of the extremely high slew-rate of voltage seen at the SN output it is recommended that a minimum of one (1) 3.3 microfarad ceramic capacitor, one (1) 1.0 microfarad ceramic capacitor, one (1) 0.1 microfarad ceramic capacitor and one (1) 0.01 microfarad ceramic capacitor, all with sufficient voltage de-rating, be connected from V_{DD} to PGND. All four of these capacitors should be low ESR types, if possible. It is strongly recommended that these capacitors have the smallest possible case sizes possible such that they inscribe the smallest possible loop area between V_{DD} and PGND so as to minimize the inductance related to this loop area. Also, to reduce the inductive loop between V_{DD} and PGND, it is strongly recommended that an induction loop cancellation layout of the high frequency power supply capacitors be employed. Figure 4 illustrates the recommended optimum layout and placement for the V_{DD}-PGND high-frequency bypass capacitors.

It should be noted that in Figure 10 that the light green copper etch area on the PCB's inner layer #1 is positioned directly beneath the copper etch clad on the top layer, as indicated by the dashed line.

The recommended component placement and etch layout capitalize upon the magnetic field cancellation between adjacent current carrying layers on the PCB. The high-frequency AC current (shown in **RED** in the side view) drawn from the V_{DD} power bus through the EPC7011L7C IC is then returned through the adjacent PCB copper etch layer with the same amplitude in the opposite direction, with the effect of mutually cancelling the induced field. The result is a very small residual parasitic loop inductance, and an associated lower spike voltage present on the switching node of the IC.

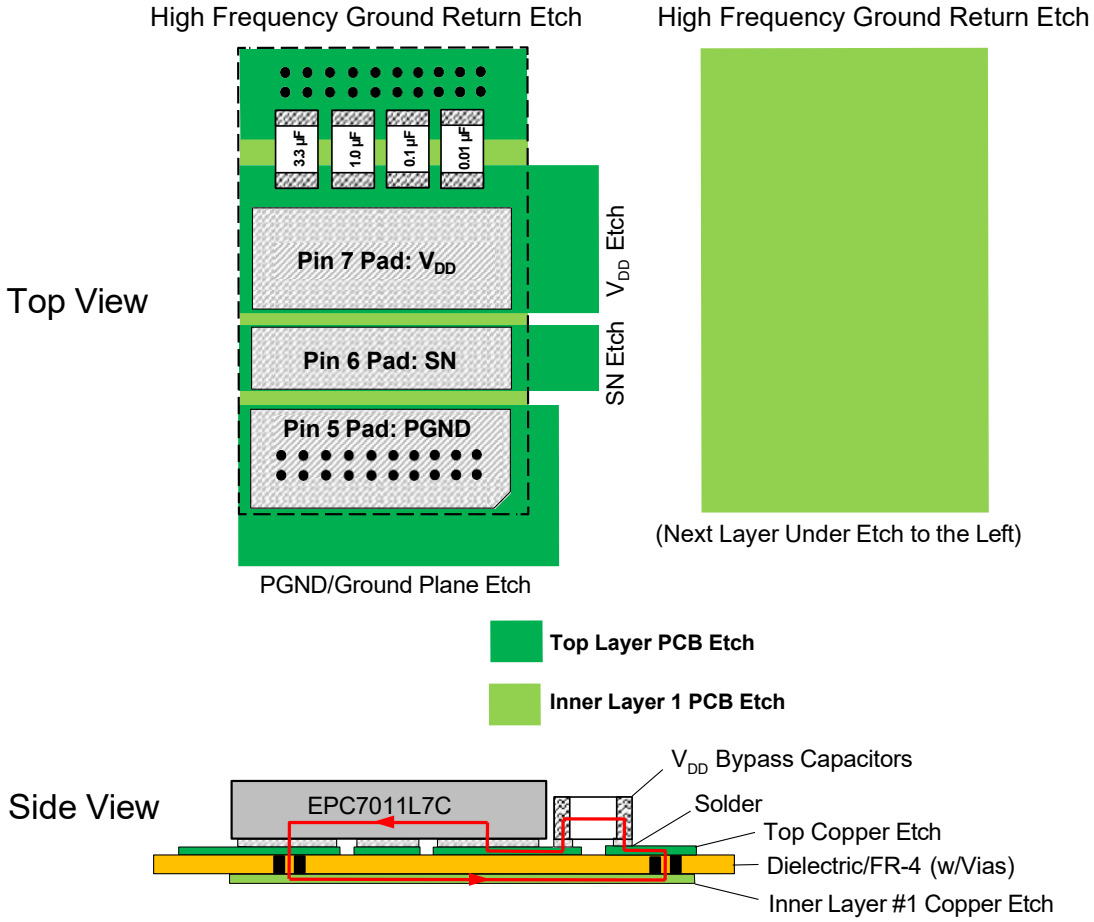


Figure10: Recommended Optimum V_{DD}-to-PGND Power Supply Bypass Capacitor Layout (Not to Scale)

Suggested Schematic Symbol

The suggested schematic symbol for the EPC7011L7C is shown in figure 11.

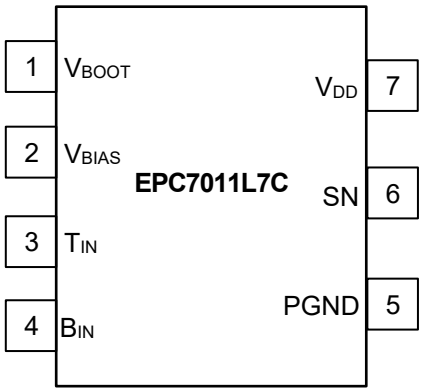


Figure 11: Suggested EPC7011L7C Integrated Circuit Schematic Symbol

Typical Application Information

In all the following figures only the pins that are considered or that require connection are identified.

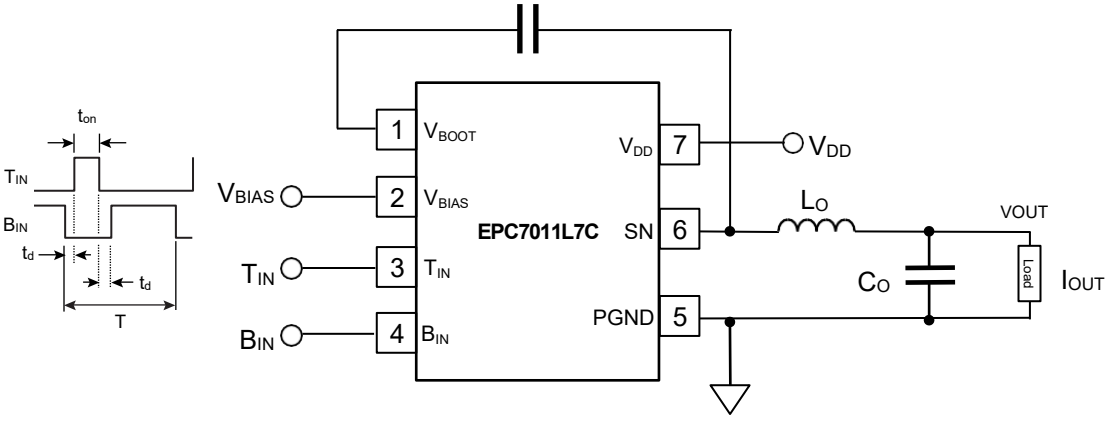


Figure 12: Low Parts-Count POL Converter Power Output Stage

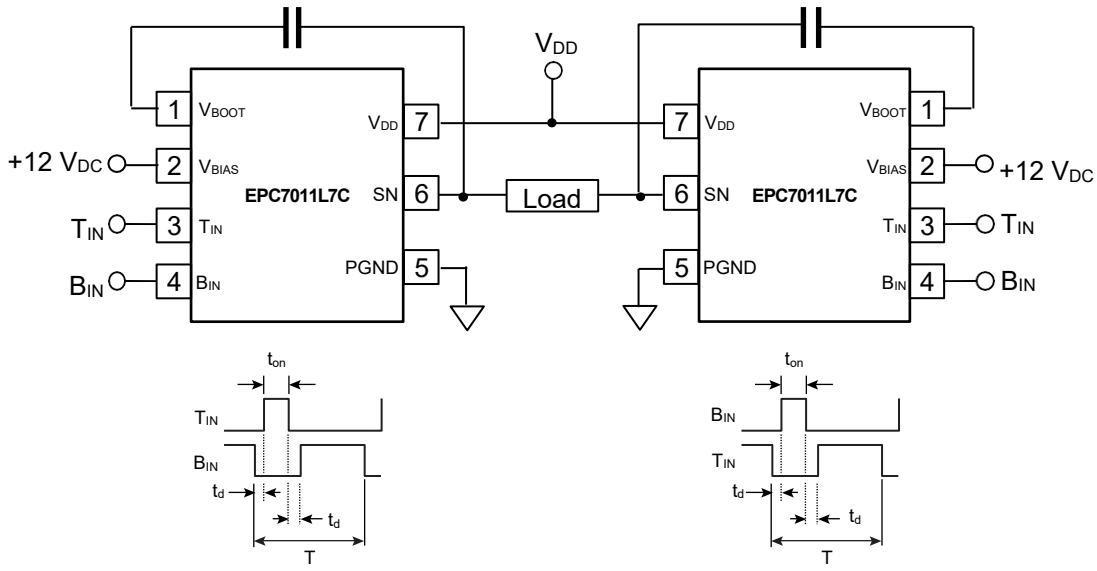
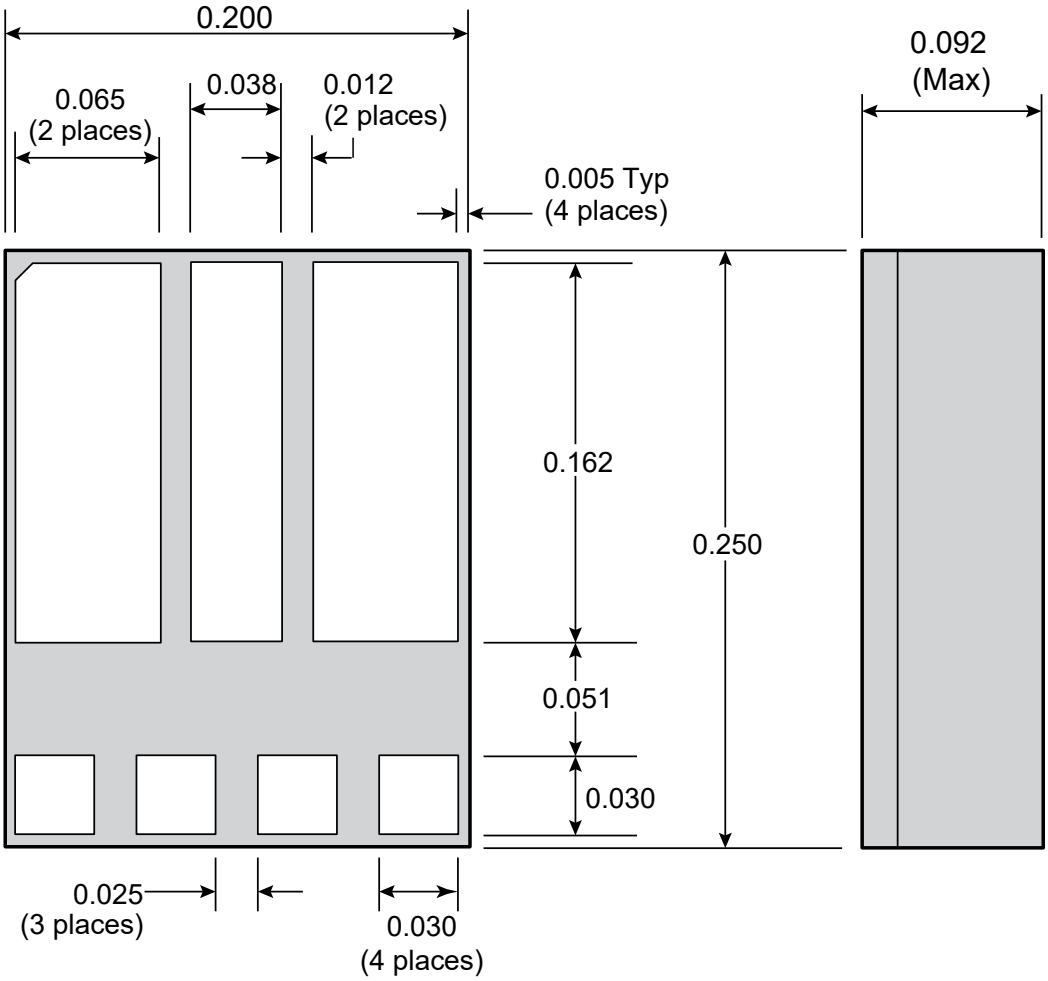


Figure 13: Full Bridge Power Output Stage.

Package Outline and Dimensions



Note: All dimensions are in inches

ALL tolerances +/- 0.005

Figure 14: EPC7011L7C Package Outline and Dimensions

Recommended PCB Solder Pad Configuration

It is important that the EPC7011L7C package be soldered to the PCB motherboard using SN63 (or equivalent) solder. Care should be taken during processing to ensure there is minimal solder voiding in the contacts to the V_{DD} (pin 7), SN (pin 6) and PGND (pin 5) pads on the package. The recommended pad dimensions and locations are shown in Figure 15. All dimensions are shown in inches.

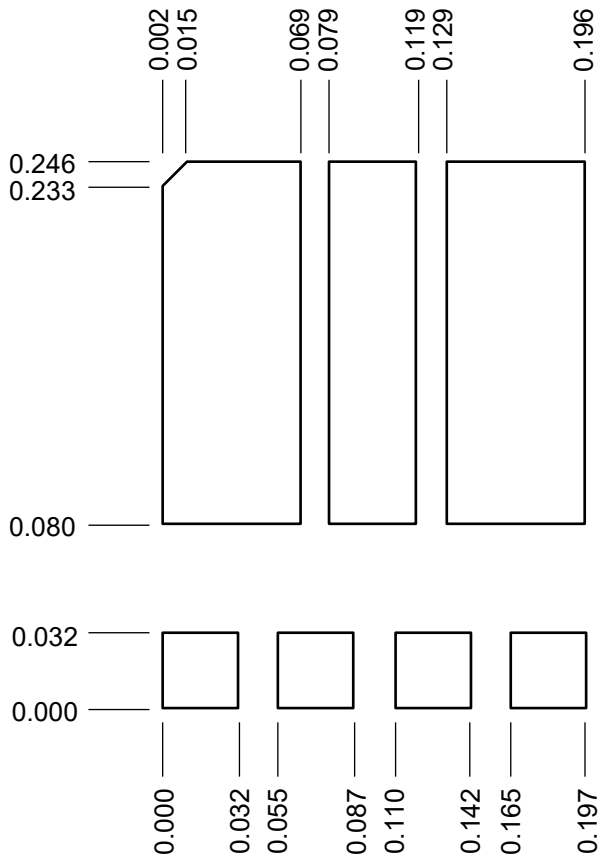


Figure 15: Recommended PCB Solder Pad Configuration (Bottom X-Ray View)

Example Typical Reflow Profile

The profile shown in Figure 16, below, is a typical reflow profile example. Optimize target reflow temperature profiling based on the actual solder paste used. The peak case temperature of the EPC7011L7C should never exceed 260°C.

If peak case temperature is not exceeded, reflow can be optimized following PCB assembly techniques and materials recommendations.

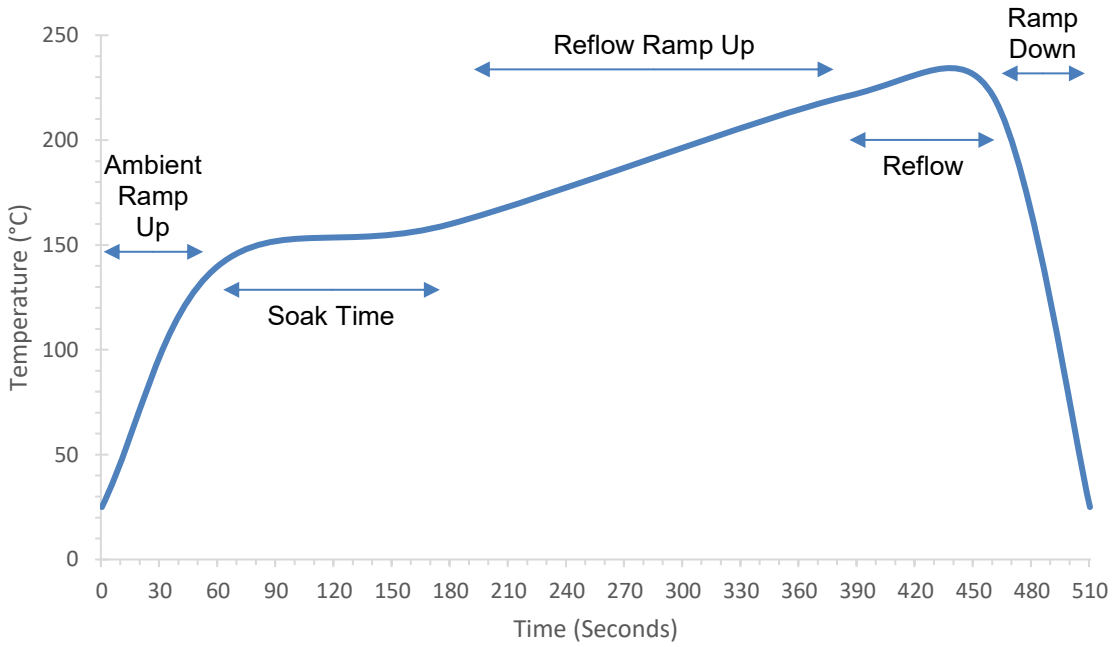


Figure 16. Typical Sn63/Pb37 Solder Attachment Reflow Profile

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Change Log

Revision	Version	Date	Remark
4	Final	30 April 2026	Current rating increased to 10A
5	Final	15 June 2026	I_{BOOT}, V_{BOOT} UVLO (HYST), V_{BIAS} (HYST) changes