Low BOM Count, 450mA Non-Isolated Buck Converter Integrates High-Voltage Power BJT and Feedback Diode

1 Description

The iW1900 non-isolated buck converter integrates a high-voltage BJT power switch along with a unique control architecture to simplify the overall circuit design and reduce cost. The design uses Dialog's unique multi-mode DCM peak current control technology to provide high efficiency over a broad load range, ideal for home appliance applications and low-power consumption standby power supplies.

The iW1900's novel design approach enables a reduced BOM cost by integrating external components typically required for this type of non-isolated high voltage buck converter, including the internal low-voltage power supply circuit and high voltage start-up and feedback components.

Full protection features are integrated in the iW1900 to ensure safe operation even under fault conditions. These features include over-temperature protection (OTP), V_{CC} under-voltage lockout (UVLO) and over-current protection (OCP).

2 Features

- Universal input voltage range 85V_{AC}-264V_{AC}
- Output voltage 3.3V~24V configurable
- Output current up to 450mA
- Integrated 750V BJT
- EZ-EMI® - lowers EMI signature
- Standby power consumption: < 80mW
- Fast dynamic load response
- Proprietary start-up and V_{CC} generation circuit
  - Eliminates external high-voltage components
- Multi-mode technology for high efficiency (PFM/PWM/CDCM)
- Leading-edge blanking (LEB) to avoid the issues caused by the turn-on spike
  - Full protection features
  - Cycle-by-cycle over current protection (OCP)
  - V_{CC} under voltage lockout (UVLO)
  - Over temperature protection (OTP)
- SOIC 7-lead package

3 Applications

- Home appliances
- AC/DC power supplies
- Metering, home automation, infrastructure SMPS

Low BOM Count, 450mA Non-Isolated Buck Converter Integrates High-Voltage Power BJT and Feedback Diode

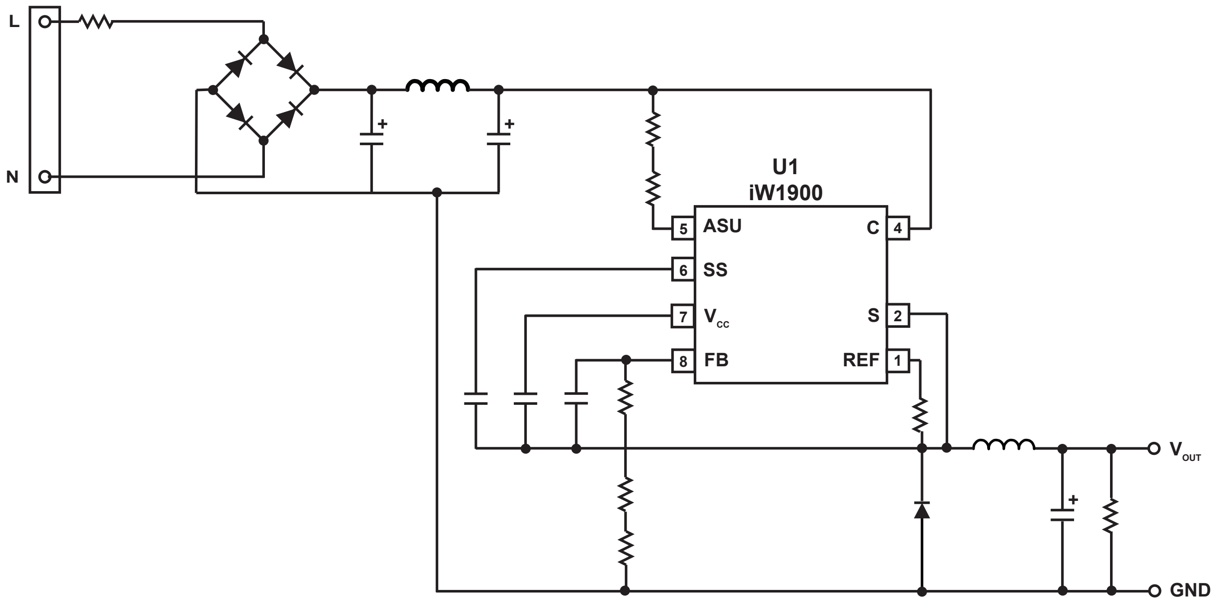


Figure 3.1 : iW1900 Typical Application Circuit Diagram

iW1900 Output Power Table at Universal Input ($90V_{AC}$–$264V_{AC}$)

Condition	Open Frame (Continuous)[1]	Open Frame (Peak)[3]
Output Power (W)[2]	5	Note 3

Notes:

Note 1. Maximum practical continuous output power measured at open frame ambient temperature of 50°C while minimum bulk capacitor voltage is kept above 90V (test unit is placed in a non-ventilated environment).

Note 2. The output power can vary depending on the power supply system designs and operating conditions.

Note 3. The peak output power is limited by I_{OCP} shown in table 10.2

Low BOM Count, 450mA Non-Isolated Buck Converter Integrates High-Voltage Power BJT and Feedback Diode

4 Pinout Description

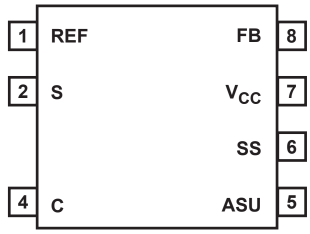


Figure 4.1 : SOIC-7 Package

Pin #	Name	Type	Pin Description
1	REF	Analog	Internal control logic reference voltage
2	S	Analog/GND	Internal power MOSFET source; ground pin for IC functions
4	C	Analog	Internal power BJT collector
5	ASU	Analog	Active start-up control and bias current source for V_{CC} during start-up
6	SS	Analog	Soft-start time, connect a capacitor to IC ground (S pin); soft-start time is 20ms without capacitor connected
7	V_{CC}	Analog	Power supply for internal control logic. A 4.7μF decoupling capacitor is recommended between V_{CC} and IC ground (S pin)
8	FB	Analog	Buck controller feedback input

5 Absolute Maximum Ratings

Absolute maximum ratings are the parameter values or ranges which can cause permanent damage if exceeded. For maximum safe operating conditions, refer to the Electrical Characteristics section.

Parameter	Symbol	Value	Units
C pin voltage	V_C	-1 to 750	V
FB, REF, V_{CC} and S pin voltage		-0.3 to 6.5	V
Maximum junction temperature		+150	°C
Operating junction temperature		-40 to +150	°C
Storage temperature		-65 to +150	°C
Lead temperature		260	°C
ESD rating per JEDEC JESD22-A114		±2000	V
Latch-up test per JESD78D		±100	mA
Collector current (DC)	I_C	2.5	A
Collector peak current (tp < 5ms)	I_{CM}	5	A
Base current (DC)	I_B	1.25	A
Base peak current (tp<5ms)	I_{BM}	2.5	A

6 Thermal Information

Parameter	Symbol	Value	Unit
Thermal Resistance Junction-to-Ambient[1]	θ_{JA}	102	°C/W
Thermal Resistance Junction-to-GND pin[2]	Ψ_{J_GND}	33.9	°C/W
Thermal Resistance Junction-to-C (Collector) pin[2]	$\Psi_{J-COLLECTOR}$	37.3	°C/W
Thermal Shutdown Threshold[3]	T_{SD}	145	°C
Thermal Shutdown Recovery[3]	T_{SD-R}	115	°C

Notes:

Note 1. Device is mounted on a JEDEC single-sided board with 67mm² of 70µm thick copper, in a one-cubic-foot natural convection chamber with 650mW dissipated power.

Note 2. Ψ_{J_GND} [Psi Junction to Ground] provides an estimation of the die junction temperature relative to the PCB [Board] surface temperature. $\Psi_{J-COLLECTOR}$ [Psi Junction to Collector pin] provides an estimation of the die junction temperature relative to the Collector pin [internal BJT Collector] surface temperature.

Note 3. These parameters are typical and they are guaranteed by design.

Low BOM Count, 450mA Non-Isolated Buck Converter Integrates High-Voltage Power BJT and Feedback Diode

7 Electrical Characteristics

V_{CC} = 5.2V, T_A = 25°C, unless otherwise specified.

Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit
V_{CC} SECTION (Pin 7)						
UVLO turn-on threshold	$V_{CC\text{-}ON}$			4.4	4.8	V
UVLO turn-off threshold	$V_{CC\text{-}OFF}$		3.6	4		V
Internal voltage supply	V_{CC}	No Load	4.9	5.2	5.5	V
Quiescent current	I_{CC}	Operating current, switching		0.7		mA
No-load current consumption	I_{CC_STD}	Non-switching standby mode		0.18		mA
Switch Controller (Pin 1, Pin 6, Pin 8)						
Maximum switching frequency (Note 3)	F_{MAX}			50		kHz
Soft-start time	T_{SST}	No connection to external C_{SS}		20		ms
Reference voltage	V_{REF}		1.98	2	2.02	V
Maximum operating peak current	I_{PK}	-00 option		950		mA
		-01 option		730		
		-10 option		527		
		-11 option		380		
Leading-edge blanking	T_{LEB}			240		ns
Internal BJT SECTION (Pin 4) (Note 1)						
Collector-base cut-off current	I_{CBO}	V_{CB} = 750V, I_E = 0A			0.01	mA
C-emitter cut-off current	I_{CES}	V_{BE} = 0, V_{CE} = 750V			0.01	mA
DC current gain (Note 2)	h_{FE}	V_{CE} = 5V, I_C = 0.5A	20		40	
C-B junction breakdown	V_{CBO}	I_C = 0.1mA	750			V
C-E breakdown voltage	V_{CES}	I_C = 0.1mA, R_{EB} = 0Ω (E-B)	750			V
C-E saturation voltage	$V_{CE(SAT)}$	I_C = 2A, I_B = 0.5A		0.3	1	V

Low BOM Count, 450mA Non-Isolated Buck Converter Integrates High-Voltage Power BJT and Feedback Diode

7 Electrical Characteristics (continued)

V_{CC} = 5.2V, T_A = 25°C, unless otherwise specified

Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit
Protection SECTION						
Protection junction temperature	T_{OTP}	Over temperature protection		145		°C
Restart junction temperature	$T_{RE\text{-}START}$	Over temperature protection		115		°C
Over-current value	I_{OCP}	-00 option		1.1		A
		-01 option		0.85		A
		-10 option		0.61		A
		-11 option		0.44		A
FB pin resistor open protection value	R_{FB_OPEN}			2000		kΩ
REF pin resistor short protection value	R_{REF_SHORT}			20		kΩ
MOSFET SECTION (Pin 2)						
Internal MOSFET switch on-resistance	$R_{DS(ON)}$	I_C = 250mA		0.4	1	Ω
Pull-down MOSFET on-resistance	R_{PULL_DOWN}	I_{ASU} = 100mA		0.8	2	Ω

Notes:

Note 1. These parameters are not 100% tested. They are guaranteed by design and characterization.

Note 2. Impulse $t_P \leq 300\mu s$, duty cycle ≤ 2%.

Note 3. Operating frequency varies based on the load conditions, see Section 10.4 for more details.

Low BOM Count, 450mA Non-Isolated Buck Converter Integrates High-Voltage Power BJT and Feedback Diode

8 Typical Performance Characteristics

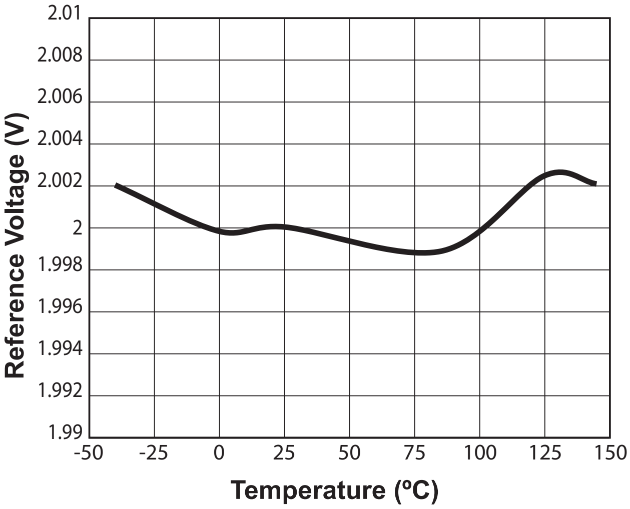


Figure 8.1 : Reference Voltage vs.Temperature

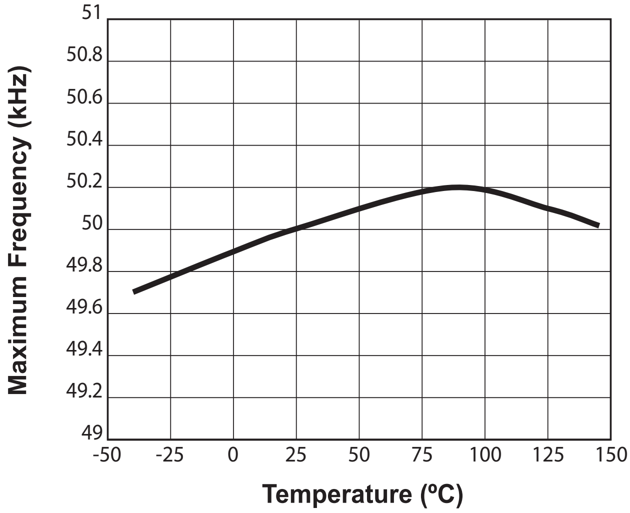


Figure 8.2 : Maximum Switching Frequency vs. Temperature

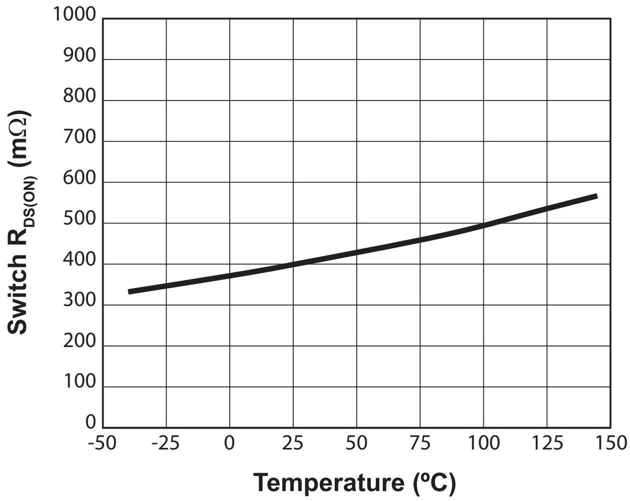


Figure 8.3 : MOSFET Switch $R_{DS(ON)}$ vs. Temperature

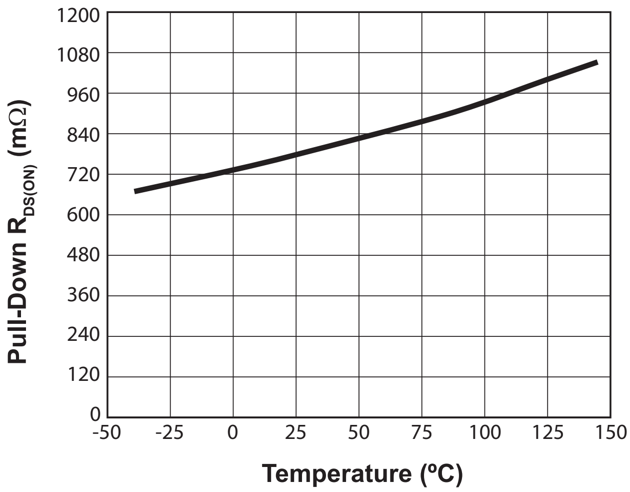


Figure 8.4 : MOSFET Pull-Down $R_{DS(ON)}$ vs. Temperature

9 Functional Block Diagram

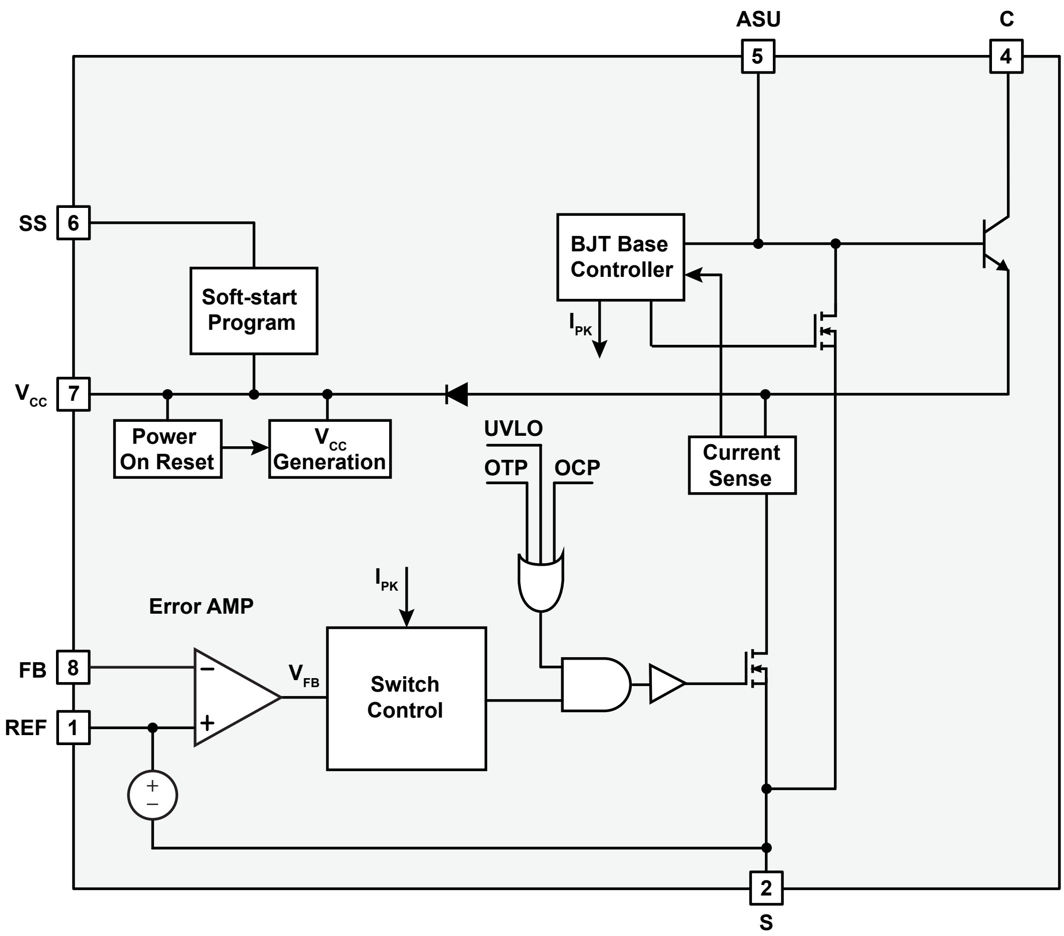


Figure 9.1 : iW1900 Functional Block Diagram

10 Theory of Operation

The iW1900 integrated power converter is optimized for configuration as a non-isolated high-side buck converter to step-down a high-voltage AC input voltage directly to low voltage DC with a minimum of external components. The device integrates a 750V power BJT and an intelligent base drive circuit to control the switching and reduce noise. The controller implements Dialog's unique multi-mode operation (PFM/PWM/CDCM) that enable high efficiency over a wide load range.

The iW1900 also integrates a unique emitter-charging topology that allows the control circuit to use the main power BJT to generate its own internal power supply. A direct current sense scheme is also implemented to provide continuous direct current monitoring to control the output and improve transient response without the need for highvoltage external feedback components.

The iW1900 is fully protected with over-current protection, over-voltage protection, under-voltage lockout and over-temperature protection to provide a very robust solution.

Low BOM Count, 450mA Non-Isolated Buck Converter Integrates High-Voltage Power BJT and Feedback Diode

10.1 Pin Detail

Pin 1 – REF

The REF pin provides a reference voltage point for the internal control logic and works with the FB pin to set the output voltage.

Pin 2 – S

The S pin is the source of the high-power internal MOSFET in series with the BJT emitter.

Pin 4 – C

The C pin is the collector of the internal high-voltage power BJT.

Pin 5 – ASU

The ASU pin and R_{ASU} provide a bias current to generate a V_{CC} voltage for the internal circuitry prior to switching.

Pin 6 – SS

The SS pin allows the user to set a soft-start time by connecting a single capacitor to ground. When left open, the soft-start time defaults to 20ms. See section 10.3 for details on selecting the SS capacitor.

Pin 7 – V_{CC}

The V_{CC} pin is the output of the internally-generated power supply and regulates to 5.2V. A small capacitor is required for proper operation. A minimum of 4.7µF is recommended.

Pin 8 – FB

The FB pin is the feedback pin for regulating the output voltage.

10.2 V_{CC} Generation

The iW1900 internally generates its own 5.2V V_{CC} power supply through a proprietary emitter-charging circuit. An external ceramic capacitor is used to filter that supply voltage and provide a clean power rail to the internal circuitry. The V_{CC} circuit schematic and charge path is shown in figure 10.1a and 10.1b. The peak current through the emitter is detected by the rectifying diode and used to charge the V_{CC} capacitor and regulate to 5.2V. This special high-side buck charge pump circuit eliminates external high voltage components typically required for this circuit.

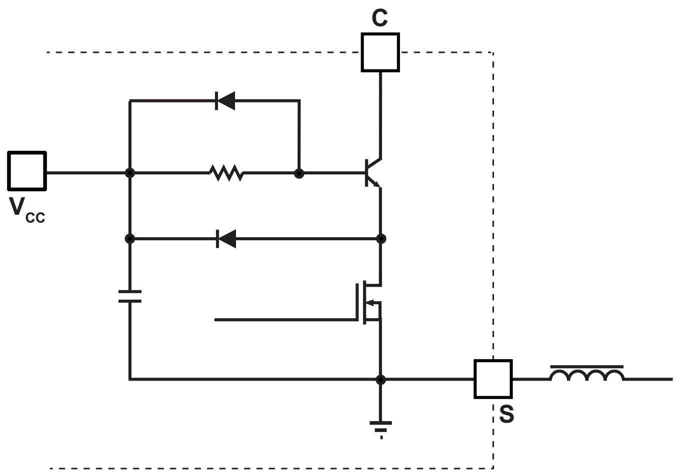


Figure 10.1a : Schematic of V_{CC} Generation Circuit

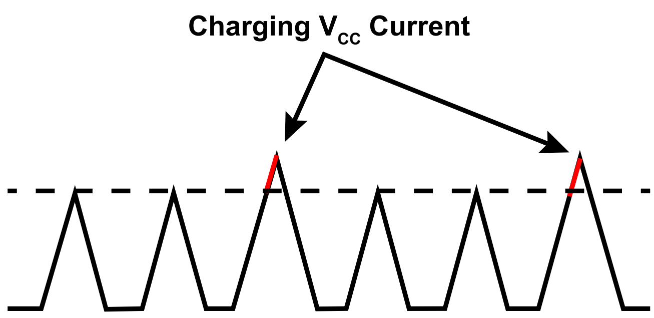


Figure 10.1b : Peak current waveform of V_{CC}

10.3 Start-Up

The power-on sequence for the iW1900 is as shown in figure 10.2. After V_{CC} reaches its regulated output voltage, the internal POR timer starts and after 65ms, the interal power good initiates the output soft-start sequence.

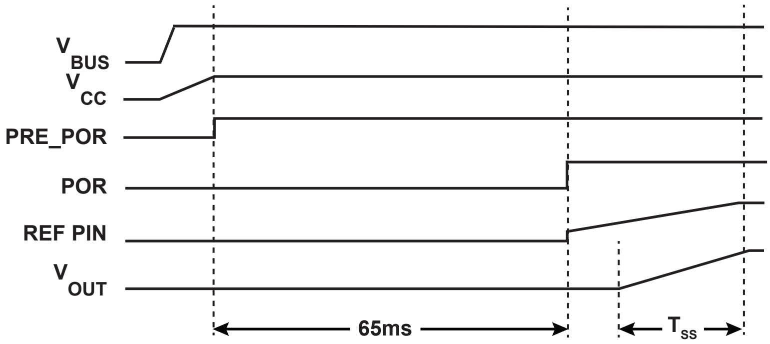


Figure 10.2 : iW1900 Start-up Timing Diagram

A capacitor is required from the SS pin to ground to ensure proper start-up under certain conditions. The output will start-up in a specific amount of time determined by the output capacitor value, output voltage, clamped peak current and max output current. The peak current is set by product option (see table 10.2) and the maximum output current is determined by the application. If the calculated soft-start time is less than 10ms, then an internal soft-start circuit forces the output to have a 20ms soft-start time and no external capacitor from SS to ground is required.

$$T_{SS} = \frac{C_{OUT} \times V_{OUT}}{\frac{I_{PK\_CLAMP}}{2} - I_{LOAD\_MAX}} \quad (10.1)$$

If the time calculated using equation 10.1 is greater than 10ms, then a capacitor from SS to ground is required to ensure proper start-up. The amount of capacitance required depends upon the output voltage setting. For a 12V output, each nF of output capacitance corresponds to 1ms of soft-start time. Table 10.1 shows the relationship between soft-start time and C_{SS}.

V_{OUT} (V)	SS_{GAIN} (ms/nF)
24	1.09
18	1.06
12	1.01
5	0.84
3.3	0.73

Table 10.1: Soft-Start Gain by Output Voltage

If a 12V, 450mA design using the iW1900-00 uses a 560µF output capacitor, the calculated soft-start time using equation 10.1 is 268.8ms. Therefore, a capacitance value greater than 266.1nF is required to ensure proper start-up, as calculated using equation 10.2:

$$C_{SS} = \frac{T_{SS}}{SS_{GAIN}} \quad (10.2)$$

The active start-up (ASU) also impacts start-up and a resistor is required for proper operation. The ASU pins requires a minimum of 600µA of current worst case. The resistor value can be calculated using equation 10.3:

$$R_{ASU} = < V_{BUS} \times \frac{(A_{BJT} + 1)}{600uA} \qquad (10.3)$$

Where the Gain (A_{BJT}) is 20 and V_{BUS} is the minimum DC input voltage.

10.4 iW1900 Control Scheme

The iW1900 employs a PWM peak current control scheme to maintain discontinuous conduction (DCM) mode operation and uses Dialog's proprietary multi-mode topology to maximum efficiency over the full load range. The control circuit changes the specific mode of operation as the load varies, flattening out the efficiency curve. The three modes of operation are PWM, PFM and CDCM. The following describes the operation of this multi-mode operation.

PFM mode
For light loads, the controller will provide a narrow pulse and reduce the frequency as low as possible to maintain efficiency. During this mode, the frequency can fall into the audible noise range of frequencies, and if this occurs the peak current is minimized to avoid audible noise.

PWM mode
At medium-high loads, the converter moves to a low-frequency PWM mode and increases the operating frequency as the load current increases. This frequency is clamped at a maximum level of 50kHz. Once the maximum PWM frequency is reached, the peak current is increased in order to provide the necessary current to the load.

CDCM mode
When the peak current reaches a value that is twice the output current, the devices operates in critical conduction mode (CDCM) and the switching frequency can reduce to maintain regulation.

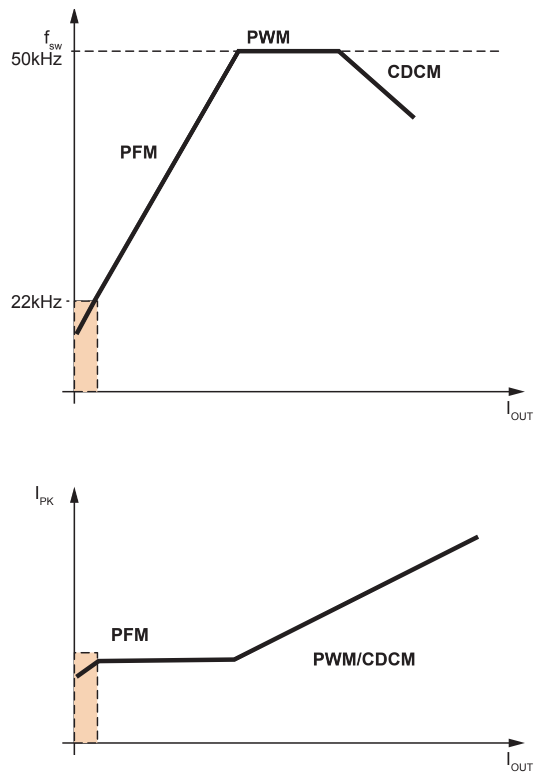


Figure 10.3 : Multi-Mode Control Scheme

10.5 Feedback

The proprietary feedback circuit of the iW1900 uses the internal digital control block to provide stability compensation without the need for complicated external compensation networks. The voltage feedback to regulate the output voltage (Figure 10.4) is comprised of an error amplifier and voltage reference. The feedback is low-side referenced in order to remove the need for the high-voltage feedback diode commonly used in these types of off-line buck converter applications. The FB resistor senses $V_{OUT(-)}$ with respect to the IC GND, S pin, therefore it is a negative voltage.

Therefore, the average current through R_{REF} and R_{FB} is also zero and the output voltage can be determined by the following equation:

$$V_{OUT} = 2 \times \left(\frac{R_{FB}}{R_{REF}} - 1 \right) \qquad (10.4)$$

It is important to maintain the resistor values in a specific range to maintain good stability and transient response. For the R_{FB} resistors, the total resistor value should be between 135kΩ and 900kΩ. For R_{REF}, the total resistance value should be between 51kΩ and 100kΩ.

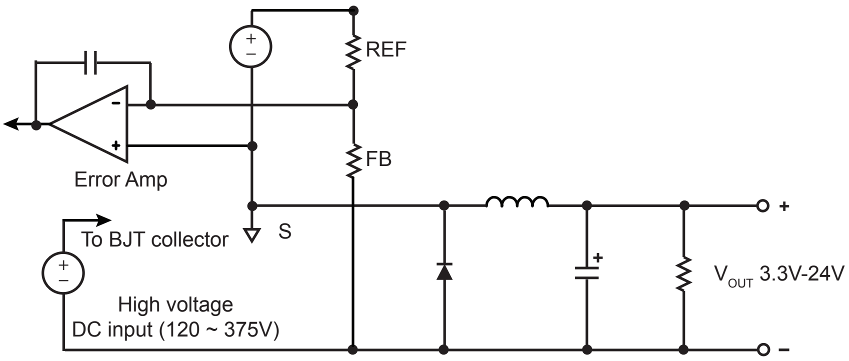


Figure 10.4 : Output Voltage Feedback Network

10.6 Under Voltage Lock Out (UVLO)

The iW1900 is fully protected with multiple voltage, current and temperature protection circuits to ensure robust operation.

Under-Voltage Lockout (UVLO)

During start up, if the voltage on the V_{CC} pin is lower than V_{CC_OFF}, the iW1900 will not start up. While in normal operation, if the voltage on the V_{CC} pin drops below the V_{CC_OFF} threshold, the system shuts down and stays shut down until the V_{CC} voltage rises above the V_{CC_ON} threshold.

Over Current Protection (OCP)

The iW1900 continuously monitors the peak drain current of the internal MOSFET during each pulse. If the OCP threshold is tripped, the iW1900 will continue to monitor the peak current for 32 cycles and if the fault is still present after 32 cycles, the device will turn-off the MOSFET gate and latch off the output completely.

iW1900	-00	-01	-10	-11
I_{OCP}	1.1A	0.85A	0.61A	0.44A
I_{PK}	0.95A	0.73A	0.53A	0.38A
I_{OUT_MAX}	0.45A	0.35A	0.25A	0.15A

Table 10.2: Over-current protection thresholds by product option

11 Application Information

11.1 Application Example

Figure 11.1 is a 12V_{DC}/450mA output application example for non-isolated power supply. The circuit is a high side buck convertor. It can be configured to support 3.3v~24v. The application can be used for a wide variety of home appliances or other applications that do not have input safety isolation requirements.

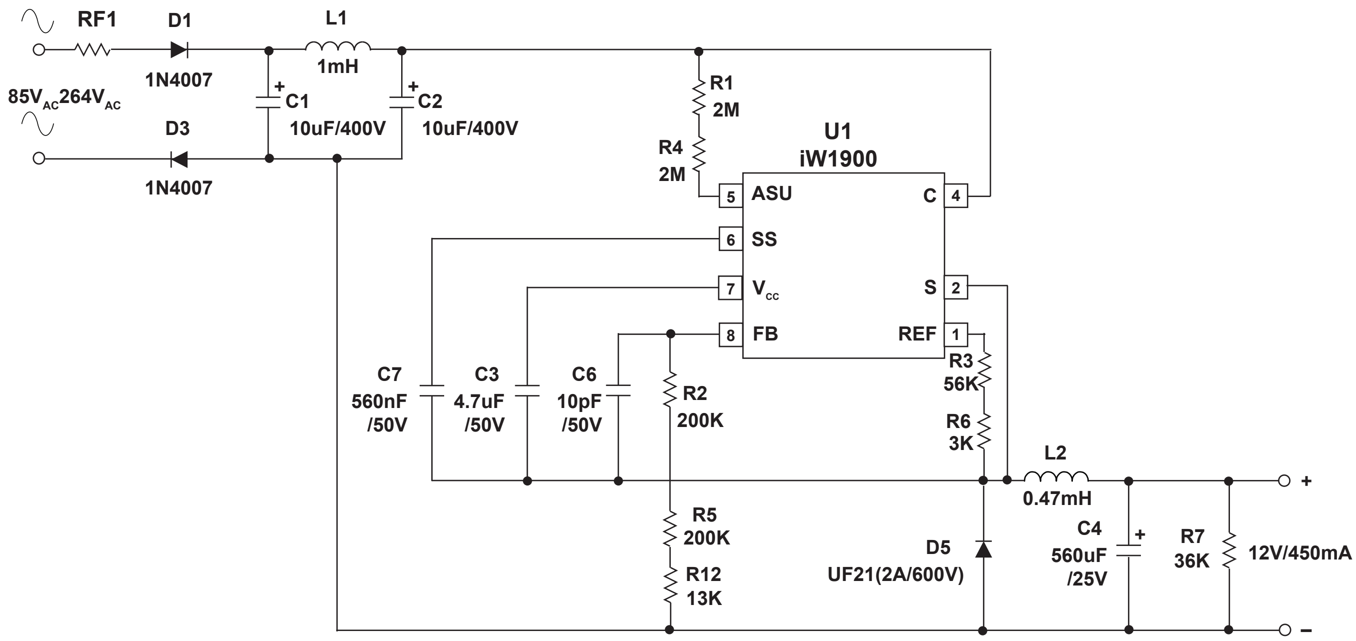


Figure 11.1 : iW1900 12V_{DC}/450mA Non-Isolated Buck Converter Design Example

11.2 Design Requirements

Symbol	Description	Condition	Min.	Typ.	Max.	Unit
V_{IN}	AC input Voltage		85		264	V_{RMS}
F_{LINE}	Line frequency		47	50/60	63	Hz
V_{OUT}	Output Voltage			12		V
I_{OUT}	Output Current			450		mA
ΔV_{OUT}	Output Voltage Ripple			240		mV
η	Converter Efficiency	$I_{OUT} \geq 60mA$	70			%
P_{NL}	No-load Input Power				80	mW
T_{AMB}	Ambient Temperature		-20		50	˚C
EMI	Environment Conducted		CISPR22B/EN55022B			Class B

Table 11.1: Design Requirements

11.3 Component Description and Selection Criteria

R_{FUSE} (RF1): R_{FUSE} is a non-flammable fusible resistor. It provides protection in case of an input component failure that causes a short circuit.

D_{IN1}, D_{IN2} (D1, D3): D_{IN1} and D_{IN2} are general purpose rectifier diodes (1A/1KV) which are suitable for input voltages < $265V_{AC}$.

C_{IN1}, C_{IN2} (C1, C2): C_{IN1} and C_{IN2} are high voltage filter capacitors. Combined with the input inductor L1, they form a single differential stage EMI filter. The filter also provides energy storage for the high voltage rectified DC input voltage (V_{BUS}).

Use of a half-wave rectifier requires a total input capacitor with 3µF/W rate for universal input voltage applications. The required minimum input capacitor value for the input voltage hold-up time can be calculated using equation 11.1:

$$C_{IN\_TOTAL} = 2\frac{P_{OUT} \times t_{HOLD\_UP}}{\eta \times (V^2_{DCIN\_MIN} - V^2_{MIN})} \qquad (11.1)$$

Where P_{OUT} is the maximum output power, $t_{hold\text{-}up}$ is the amount of time energy storage is required ($t_{hold\text{-}up} = (1/f_L) – 3ms$, where f_L is the AC frequency and 3ms is the approximate conduction time for a 60Hz input AC line frequency), η is the estimated efficiency, $V_{DCIN\_MIN} = \sqrt{2} * V_{ACMIN}$. Where V_{ACMIN} is the minimum AC input voltage and V_{MIN} is the minimum input voltage allowed for the application. The total required capacitance is then split between C_{IN1} and C_{IN2}. For example, an application with a 60Hz line frequency, 3ms hold-up time, estimated 70% efficiency, min AC voltage of 85V and minimum allowable DC voltage of 65V, the minimum required input capacitance is calculated to be 7.6µF. Setting C_{IN1} and C_{IN2} at 4.7µF each fulfills the minimum capacitance requirements for the system. A full-wave rectifier doubles the line frequency and allows smaller capacitance values for C_{IN1} and C_{IN2} at the expense of using two additional rectifier diodes.

R_{ASU} (R1, R4): R_{ASU} is the active start-up resistor to help decrease turn-on time by feeding current directly to the base of the main power BJT. The resistor needs to provide 600µA of current for the iW1900. Due to the high voltage across this resistor, two 1206-sized resistors in series are typically recommended instead of a single resistor. The resistor value can be calculated using equation 11.2:

$$R_{ASU} < V_{BUS} \times \frac{(A_{BJT} + 1)}{600uA} \qquad (11.2)$$

Where the Gain (A_{BJT}) is 20 and V_{BUS} is the minimum DC input voltage. For 85V, the maximum resistor value to set the minimum required ASU current is 4MΩ, which can be split into two, 2MΩ resistors.

C_{VCC} (C3): The C_{VCC} capacitor is the decoupling and storage capacitor for the internally generated V_{CC} power supply. A 4.7µF capacitor is recommended for best operation.

C_{SS} (C7): In section 10.3, the way to calculate the soft-start time is explained. For the design example, the soft-start time calculated based on the discrete components can be calculated to be 268.8ms. For a desired soft-start time of 500ms minimum, a 560nF capacitor is chosen to give a 560ms soft-start time.

Output Inductor (L2): The output inductor provides the energy storage required and the di/dt of the inductor current depends on its inductance value and input voltage (V_{IN} - V_{OUT}). Smaller value inductors and high input voltages will create high di/dt. To meet the iW1900's minimum on-time (T_{ON_MIN}) requirement for current limit detection, the inductor value cannot be too small. However, high value inductors of reasonable size have higher series resistance which causes lower current ratings. The recommended inductor value range for the iW1900 is from 330µH to 1500µH. An important selection criteria for determining the optimal inductor value for the application is the system switching frequency, with avoiding the audible noise range as a key factor. The easiest way to calculate the minimum inductor value to avoid the audible noise range in CDCM mode is to use equation 11.3:

$$L \geq \frac{V_{OUT}}{(I_{PK} \times F_{SW})} \qquad (11.3)$$

For example, if the desired output power is 12V/450mA and we select 470µH for the inductor, then minimum system switching frequency will be about $f_{SW} \approx 12V/(0.95A \times 0.47mH) = 26.9kHz$ in CDCM mode.

Low BOM Count, 450mA Non-Isolated Buck Converter Integrates High-Voltage Power BJT and Feedback Diode

D_{FW} (D5): D_{FW} is the freewheeling diode and needs to be high voltage rated (≥ 600V) with fast reverse recovery time (t_{rr} ≤ 500nS). In the application example in Figure 11.1 circuit, the diode is selected as 2A, 600V, t_{rr} = 200nS.

C_{OUT} (C4): The output capacitor provides the main energy storage to the output. The output capacitor value depends upon desired output voltage ripple, soft-start time and load transient response. Equation 11.4 shows how to calculate the ripple current and can be used for setting a minimum output capacitance for the application.

$$V_{DCM\_RIPPLE} = \frac{I_O}{f_S C_O} \times \left(\frac{I_{PK} - I_O}{I_{PK}} \right) + I_{PK} \times R_{ESR}, \text{ for } DCM \quad (11.4)$$

R_{PL} (R7): The pre-load resistor (R_{PL}) ensures the part works correctly under no-load conditions. The minimum current drawn by this resistor should be 300μA.

R_{FB}, R_{REF} (R2, R5, R12; R3, R6): The iW1900 regulates the output voltage using a resistor divider network connected to the FB and REF pins. Equation 11.5 shows how to calculate the output voltage using the resistors connected to those pins.

$$V_{OUT} = 2 \times \left(\frac{R_{FB}}{R_{REF}} - 1 \right) \quad (11.5)$$

The reference voltage (V_{REF}) is 2V and the recommended resistor value ranges for R_{FB} are 135kΩ to 900kΩ and for R_{REF} are 51kΩ to 100kΩ. The R_{FB} resistors see high voltage (> 300V) and the average 0805 resistor is rated to 150V, so three 0805 resistors are recommended to create the total R_{FB} resistance value required for the application.

11.4 BOM List

Item	Qty.	Reference	Part Description	Package	Manufacture	Part Number
1	2	C1, C2	Cap, ALUM 10uF, 400V, 20%	Radial (10mm)	Capxon	KM100M400G150
2	1	C3	Cap, CER 4.7uF, 50V, 10%, X5R	C0805	Yageo	CC0805KRX7R8475
3	1	C4	Cap, ALUM 560uF, 25V, 20%	Radial (8mm)	Capxon	F561M025E110
4	1	C6	Cap, 10pF, 50V, NPO	C0805	Yageo	CC0805JRNPO9100
5	1	C7	Cap, CER 560nF, 50V, 10%, X7R	C0805	Yageo	CC0805KRX7R9564
6	2	D1, D3	Diode, Rec 1000V, 1A	D041	PANJIT	1N4007
7	1	D5	Diode, U_Fast Rec 600V, 2A	SMB	PANJIT	UF2J
9	1	RF1	Fusible RES, 10Ω, 2W, 5%	Axial	Bourns	KNP2WST-52J10R
10	1	L1	IND, 1mH, 200mA, 2.3Ω	Axial	Bourns	5800-102-RC
11	1	L2	IND, 0.47mH, 1.8A, 0.43Ω	Radial	TDK	TSL1315RA-471K1R8-PF
12	1	R1	Chip RES 2M, 5%, 1/8W	C0805	Yageo	RC0805J-07205
13	1	R2	Chip RES 200K, 1%, 1/8W	C0805	Yageo	RC0805F-07204
14	1	R3	Chip RES 56K, 1%, 1/8W	C0805	Yageo	RC0805F-07563
15	1	R4	Chip RES 2M, 5%, 1/8W	C0805	Yageo	RC0805J-07205
16	2	R5	Chip RES 200K, 1%, 1/8W	C0805	Yageo	RC0805F-07204
17	1	R6	Chip RES 3K, 1%, 1/8W	C0805	Yageo	RC0805F-07302
18	1	R7	Chip RES 36K, 5%, 1/4W	C0805	Yageo	RC0805J-07363
20	1	R12	Chip RES 13K, 1%, 1/8W	C0805	Yageo	RC0805F-07133
21	1	U1	IC, Off-line Switcher	SOIC8	Dialog	iW1900-00

Table 11.2: Bill of Materials for the iW1900 Design Example

11.5 Test Data for 12V/450mA Design Example (T_A = 25˚C)

Input Voltage (V_{AC})	P_{IN} (W)	V_{OUT} (V)	Output Voltage Accuracy (%)	I_{OUT} (A)	P_{OUT} (W)	η(%)	Output Ripple (mV)
85	6.763	11.853	-1.23	0.45	5.33	78.87	89
90	6.703	11.854	-1.22	0.45	5.33	79.58	94
110	6.589	11.861	-1.16	0.45	5.34	81.01	84
130	6.532	11.865	-1.13	0.45	5.34	81.74	92
150	6.489	11.854	-1.22	0.45	5.33	82.21	86
170	6.472	11.851	-1.24	0.45	5.33	82.40	74
190	6.469	11.853	-1.23	0.45	5.33	82.45	74
220	6.438	11.861	-1.16	0.45	5.34	82.91	80
240	6.451	11.861	-1.16	0.45	5.34	82.74	94
264	6.481	11.866	-1.12	0.45	5.34	82.39	92

Table 11.3: Test results of the iW1900 design example, V_{AC} = 85V to 264V; V_{OUT} = 12V; I_{OUT} = 0.45A

Input Voltage (V_{AC})	P_{IN} (W)	V_{OUT} (V)	Output Voltage Accuracy (%)	I_{OUT} (A)	P_{OUT} (W)	η(%)	Output Ripple (mV)
110	0.033	12.064	0.53	0	0	0.00	32
110	0.726	12.047	0.39	0.05	0.60	82.97	52
110	1.414	12.024	0.20	0.1	1.20	85.04	56
110	2.123	12.001	0.01	0.15	1.80	84.79	56
110	2.819	11.977	-0.19	0.2	2.40	84.97	62
110	3.524	11.953	-0.39	0.25	2.99	84.80	66
110	4.239	11.925	-0.62	0.3	3.57	84.39	62
110	4.972	11.899	-0.84	0.35	4.17	83.76	68
110	5.722	11.862	-1.15	0.4	4.75	82.92	70
110	6.488	11.831	-1.41	0.45	5.32	82.06	84

Table 11.4: Test results of the iW1900 design example, V_{AC} = 110V; V_{OUT} = 12V; I_{OUT} = 0A to 0.45A

Input Voltage (V_{AC})	P_{IN} (W)	V_{OUT} (V)	Output Voltage Accuracy (%)	I_{OUT} (A)	P_{OUT} (W)	η(%)	Output Ripple (mV)
220	0.063	12.082	0.68	0	0	0.00	46
220	0.872	12.069	0.58	0.05	0.60	69.20	64
220	1.576	12.053	0.44	0.1	1.20	76.48	60
220	2.203	12.033	0.27	0.15	1.80	81.93	72
220	2.914	12.008	0.07	0.2	2.40	82.42	72
220	3.633	11.992	-0.07	0.25	3.00	82.52	78
220	4.328	11.983	-0.14	0.3	3.59	83.06	76
220	5.045	11.946	-0.45	0.35	4.18	82.88	86
220	5.762	11.931	-0.58	0.4	4.77	82.83	78
220	6.509	11.933	-0.56	0.45	5.37	82.50	80

Table 11.5: Test results of the iW1900 design example, V_{AC} = 220; V_{OUT} = 12V; I_{OUT} = 0A to 0.45A

Low BOM Count, 450mA Non-Isolated Buck Converter Integrates High-Voltage Power BJT and Feedback Diode

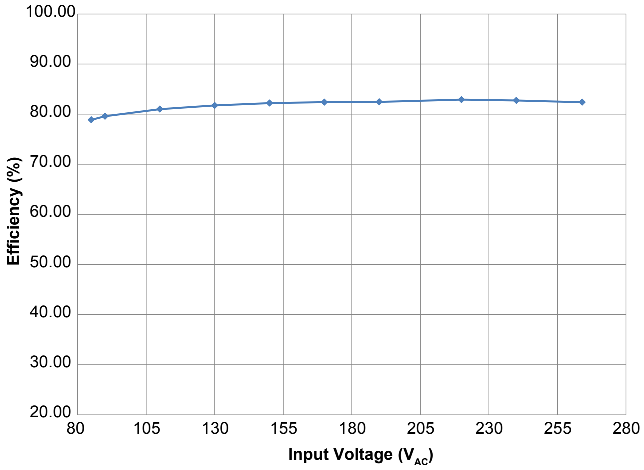


Figure 11.1 : Efficiency vs V_{AC} (I_{OUT} = 0.45A)

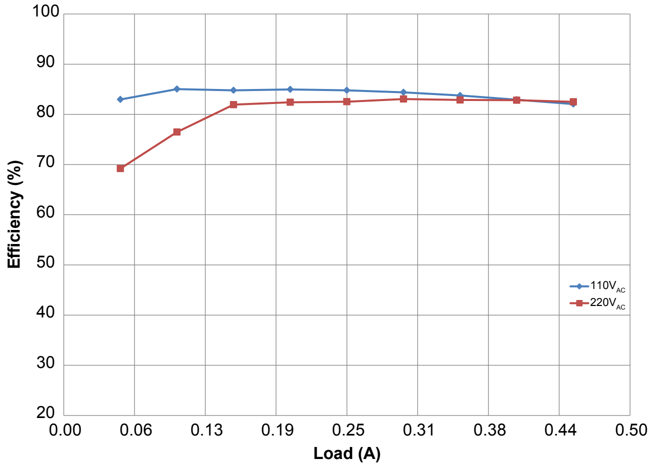


Figure 11.2 : Efficiency vs Output Current

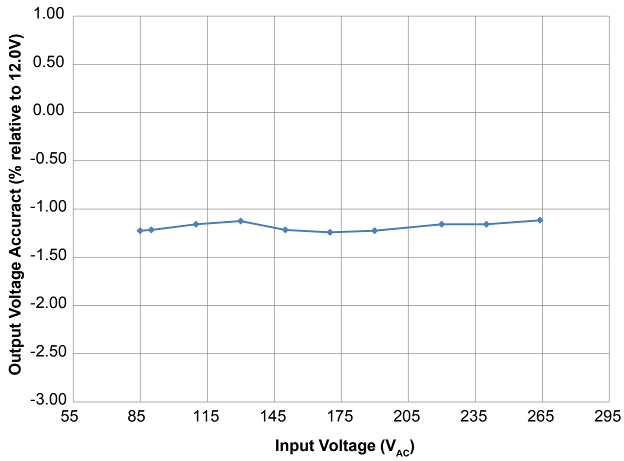


Figure 11.3 : Output Voltage Accuracy vs Input Voltage (I_{OUT} = 450mA)

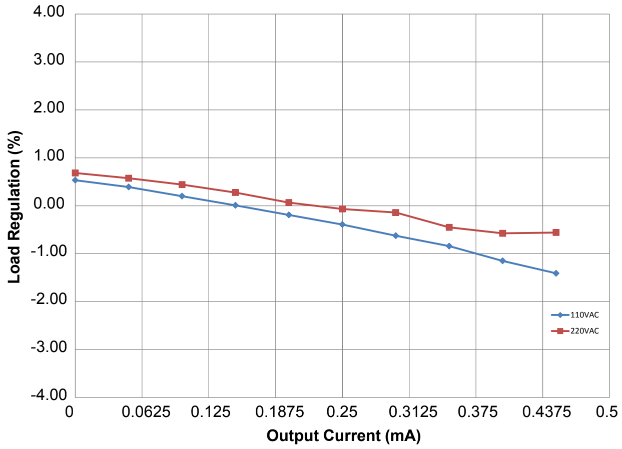


Figure 11.4 : Load Regulation

Output Voltage Ripple

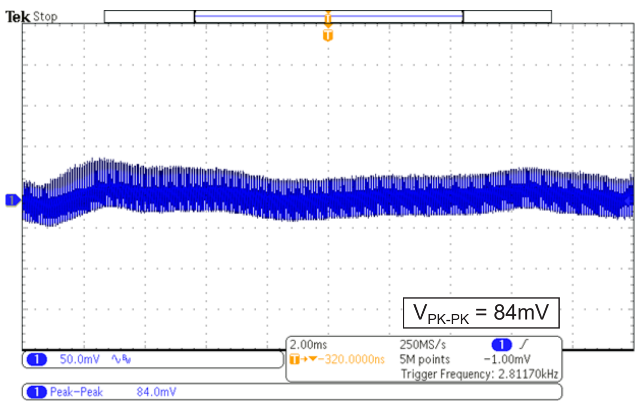


Figure 11.5 : Output Ripple Voltage – 110V_{AC}/450mA

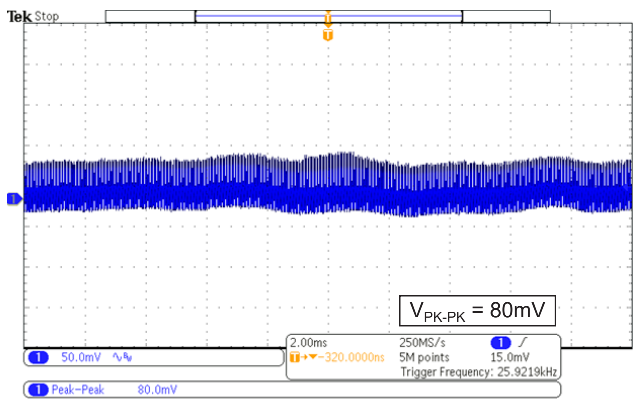


Figure 11.6 : Output Ripple Voltage – 220V_{AC}/450mA

Low BOM Count, 450mA Non-Isolated Buck Converter Integrates High-Voltage Power BJT and Feedback Diode

Dynamic Load Response

Channel 1: V_{OUT} Channel 2: I_{OUT}

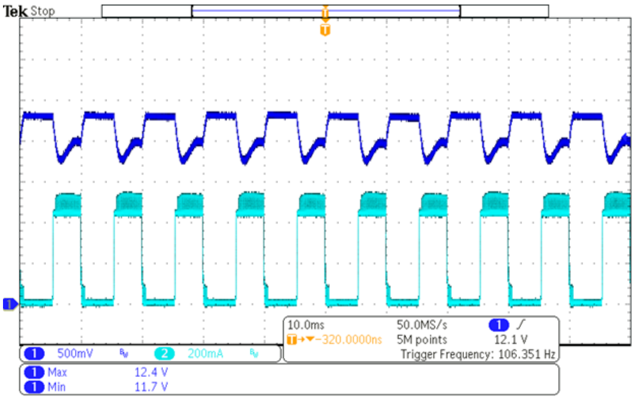


Figure 11.7 : Load Transient Response – $110V_{AC}$/0mA to 450mA, 100Hz

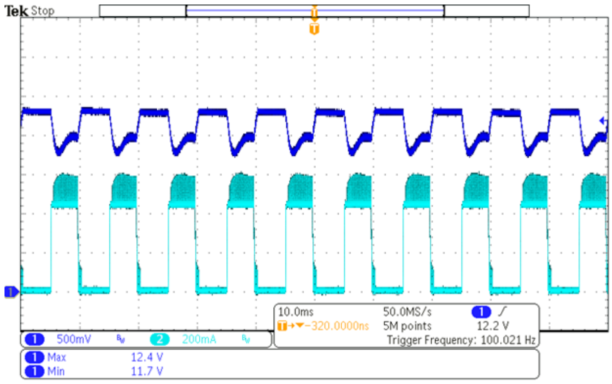


Figure 11.8 : Load Transient Response – $220V_{AC}$/0mA to 450mA, 100Hz

Start-up Characteristics

Channel 2: V_{IN} Channel 4: V_{OUT}

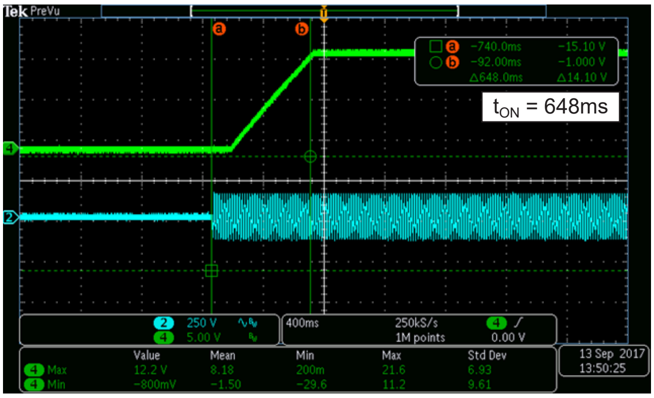


Figure 11.9 : Start-up Characteristics – $90V_{AC}$/0mA

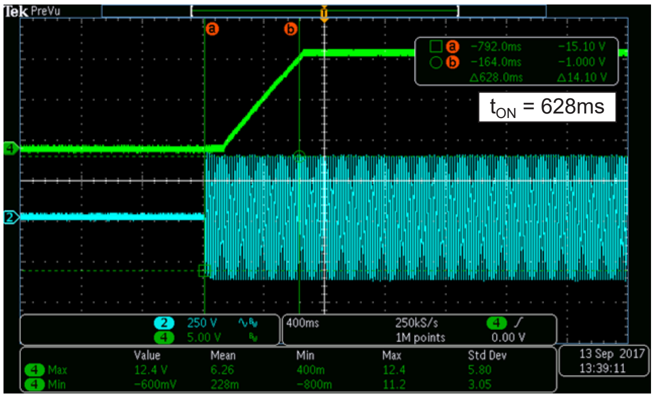


Figure 11.10 : Start-up Characteristics – $264V_{AC}$/0mA

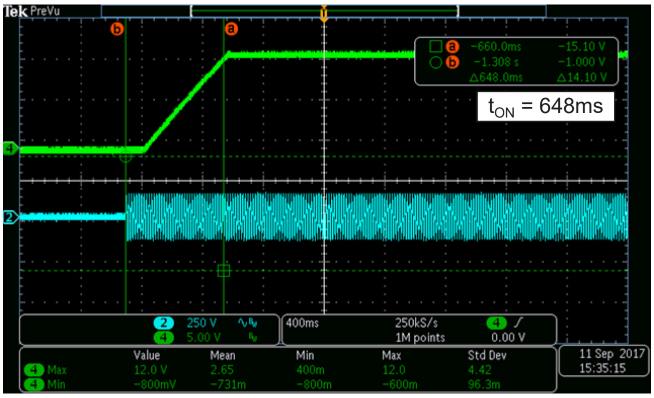


Figure 11.11 : Start-up Characteristics – $90V_{AC}$/450mA

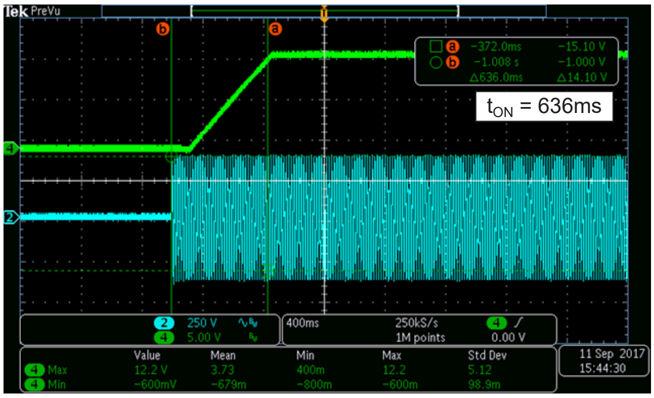


Figure 11.12 : Start-up Characteristics – $264V_{AC}$/450mA

Low BOM Count, 450mA Non-Isolated Buck Converter Integrates High-Voltage Power BJT and Feedback Diode

EMI

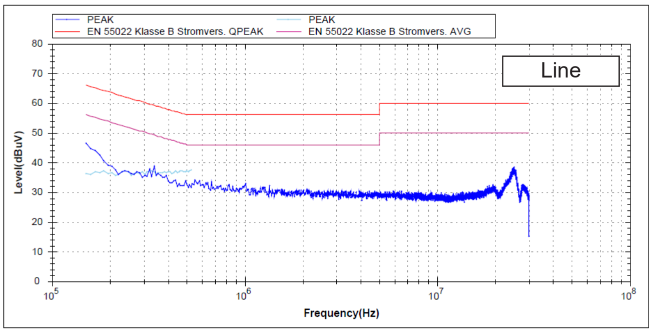


Figure 11.13 : EMI Characteristics – $110V_{AC}$/450mA

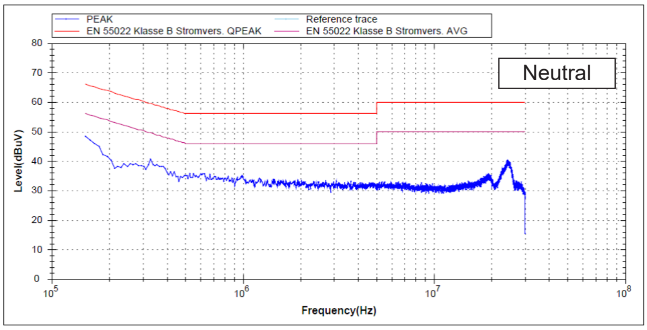


Figure 11.14 : EMI Characteristics – $110V_{AC}$/450mA

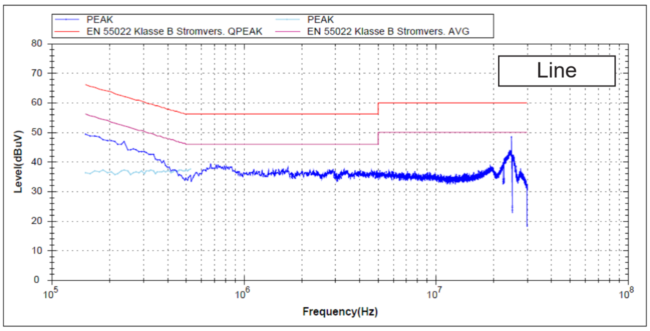


Figure 11.15 : EMI Characteristics – $230V_{AC}$/450mA

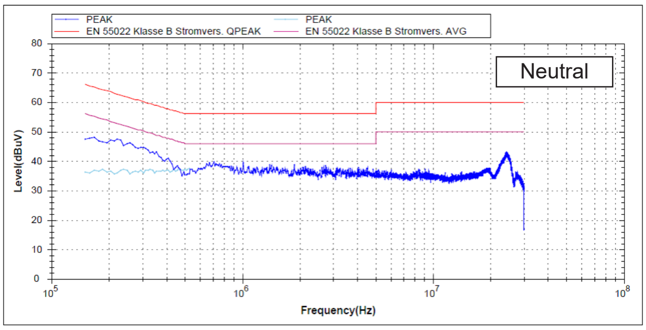


Figure 11.16 : EMI Characteristics – $230V_{AC}$/450mA

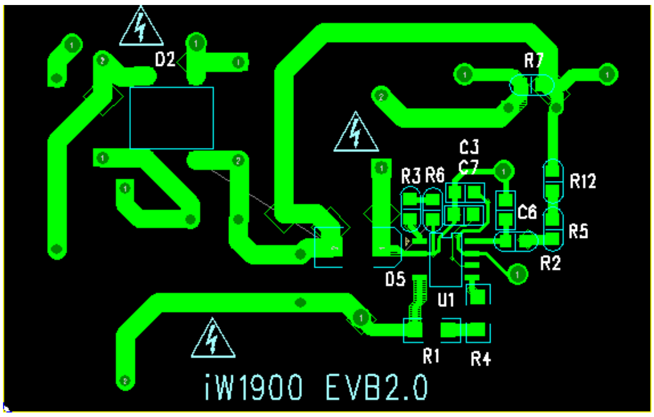


Figure 11.17 : PCB Layout - Top Assembly

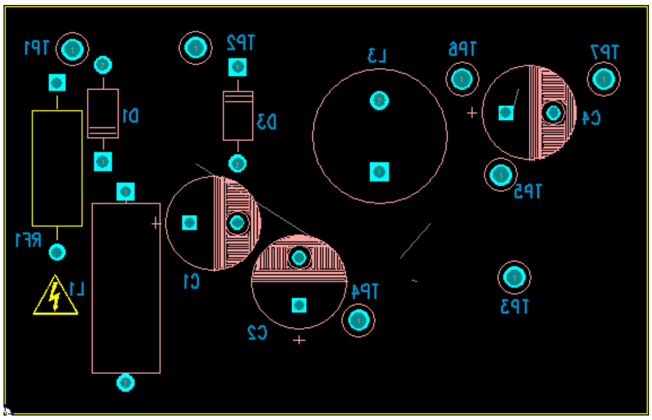
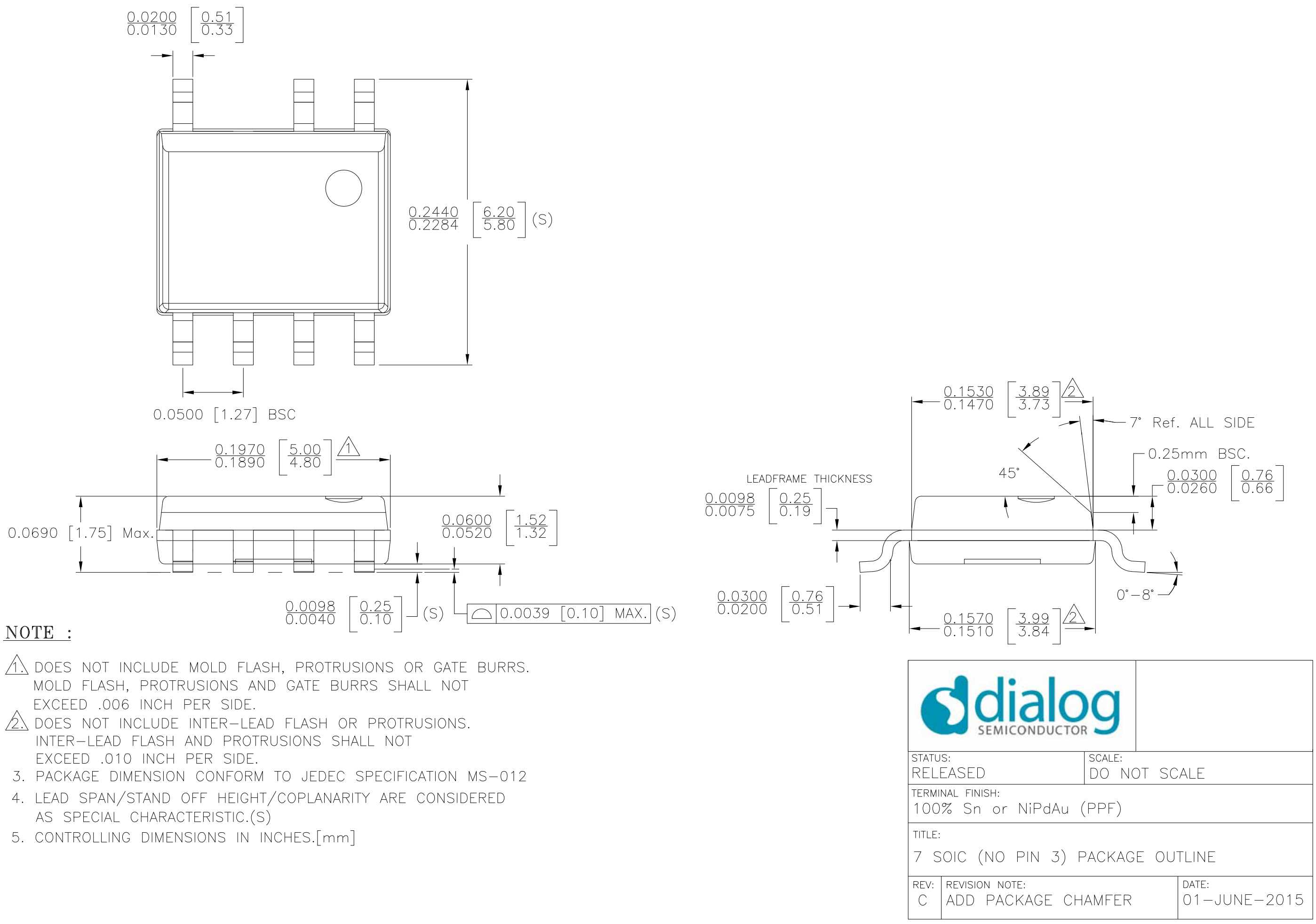


Figure 11.18 : PCB Layout - Bottom Assembly

12 Physical Dimensions



13 Ordering Information

Part no.	Options	Package	Description
iW1900-00	Maximum Output Current = 450mA	SOIC-7	Tape & Reel[1]
iW1900-01	Maximum Output Current = 350mA	SOIC-7	Tape & Reel[1]
iW1900-10	Maximum Output Current = 250mA	SOIC-7	Tape & Reel[1]
iW1900-11	Maximum Output Current = 150mA	SOIC-7	Tape & Reel[1]

Note 1: Tape and reel packing quantity is 2,500/reel. Minimum packing quantity is 2,500.

Low BOM Count, 450mA Non-Isolated Buck Converter Integrates High-Voltage Power BJT and Feedback Diode

Disclaimer

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Dialog Semiconductor's suppliers certify that its products are in compliance with the requirements of Directive 2011/65/EU of the European Parliament on the restriction of the use of certain hazardous substances in electrical and electronic equipment. RoHS certificates from our suppliers are available on request.

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