SILICON LABS

TS3310/12/14 Data Sheet

True 150 nA I_Q, Selectable 1.8 to 5 V_{OUT} Instant-On Boost Converter

The TS3310/12/14 is a low power boost switching regulator with an industry leading low quiescent current of 150 nA(typ). The 150 nA is the actual current consumed from the battery while the output is in regulation. The TS3310's extremely low power internal circuitry consumes 120 nA on average, with periodic switching cycles which service the load occurring at intervals of up to 25 seconds, together yielding the average 150 nA. The TS3310/12/14 steps up input voltages from 0.9 V (TS3312: 2 V) to 5 V to sixteen selectable output voltages ranging from 1.8 V to 5 V. The TS3310/12/14 includes two output options, one being an always-on storage output while the additional output is an output load switch that is designed to supply burst-on loads in a low duty cycle manner. The TS3310/12/14 operates in Discontinuous Conduction Mode with an on-time proportional to 1/VIN, thereby limiting the maximum input current by the selection of the inductor value, ensuring the input current does not drag down the input source.

The extremely low quiescent current combined with the output load switch make the TS3310/12/14 an ideal choice for applications where the load can be periodically powered from the output, while being disconnected from the output storage capacitor when the load is powered off to isolate the load's leakage current.

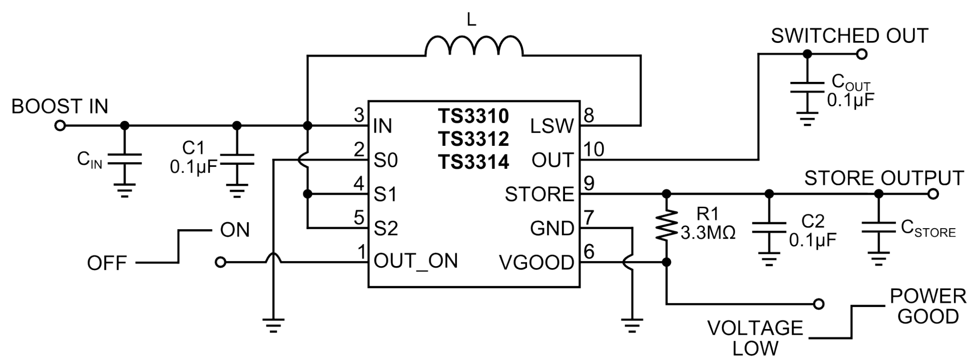
The TS3310/12/14 is fully specified over the –40 °C to +85 °C temperature range and is available in a low-profile, thermally-enhanced 10-pin 2x2 mm TDFN package with an exposed back-side paddle.

Applications

- Coin-Cell-Powered Portable Equipment
- Single-Cell Lithium-Ion or Alkaline Battery-Powered Equipment
- Solar or Mechanical Energy Harvesting
- Wireless Microphones
- Wireless Remote Sensors
- RFID Tags
- Personal Health-Monitoring Devices
- ZigBee Radio Enabled Devices
- Low-Energy Bluetooth Radio Enabled Devices

KEY FEATURES

- Market-Leading, Active-Mode, No-load Supply Current: I_Q = 150 nA
- Efficiency up to 92%
- Input Voltage Range: 0.9 to 5.0 V
- Delivers up to 35 mA at V_{STORE} from 1.2 V_{IN}
- Single Inductor, Discontinuous Conduction Mode Operation
- User-Enabled Secondary Output Load Switch to Isolate Leaky Burst Loads
- No External Schottky Diode Required
- UVLO Threshold
  - 0.9 V (TS3310/14)
  - 2.0 V (TS3312)
- Pin-Selectable Output Voltages:
  - 1.8 V, 2.1 V, 2.5 V, 2.85 V, 3 V, 3.3 V, 4.1 V, 5 V (TS3310)
  - 2.1 V, 2.5 V, 2.85 V, 3 V, 3.3 V, 4.1 V, 5 V (TS3312)
  - 4 V, 4.2 V, 4.35 V, 4.5 V, 4.6 V, 4.7 V, 4.8 V, 4.9 V (TS3314)
- 10-pin, 2 mm × 2 mm TDFN Package



1. Ordering Information

Ordering Part Number	Description	Output Voltage Options (V)
TS3310ITD1022	Boost regulator with 0.9 V UVLO	1.8, 2.1, 2.5, 2.85, 3, 3.3, 4.1, 5
TS3312ITD1022	Boost Regulator with 2 V UVLO	2.1, 2.5, 2.85, 3, 3.3, 4.1, 5
TS3314ITD1022	Boost Regulator with 0.9 V UVLO	4, 4.2, 4.35, 4.5, 4.6, 4.7, 4.8, 4.9

Note:

1. Adding the suffix “T” to the part number (e.g., TS3310ITD1022T) denotes tape and reel.

2. System Overview

2.1 Typical Application Circuit

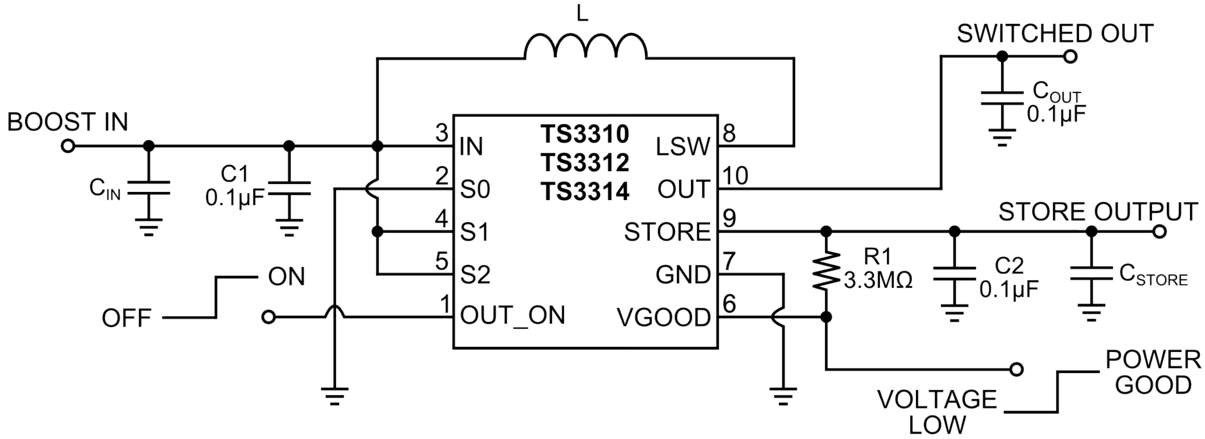


Table 2.1. Typical Application Circuit A and Circuit B Values

	Circuit A	Circuit B
L	10 µH PN: CBC3225T100KR	100 µH PN: CBC3225T101KR
$C_{IN} = C_{STORE}$	22 µF	2.2 µF

2.2 Functional Block Diagram

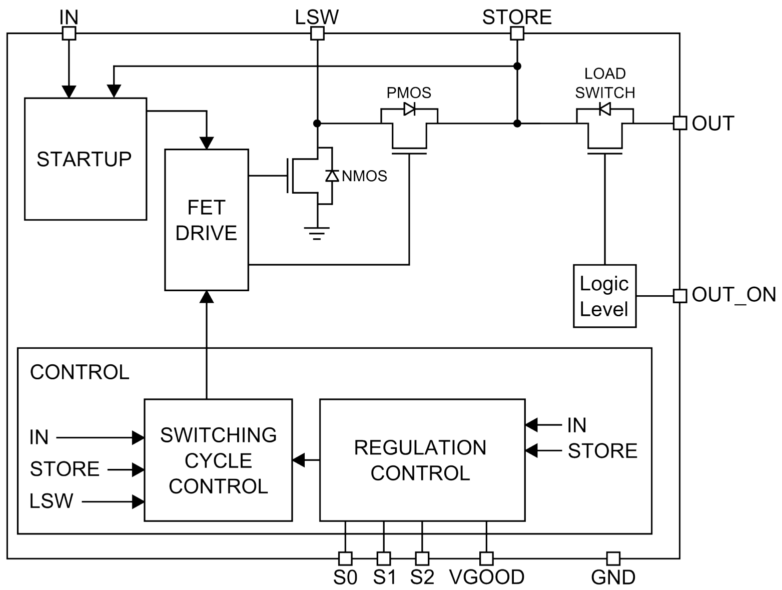


Figure 2.1. TS331x Functional Block Diagram

2.2.1 Theory of Operation

The TS3310/12/14 is a boost switching regulator with an industry leading low quiescent current of 150 nA.The 150 nA is the actual current consumed from the battery while the output is in regulation. The TS3310/12/14's extremely low power internal circuitry consumes 120 nA on average, with periodic switching cycles which service the load occurring at intervals of up to 25 seconds, as displayed in the scope captures titled "Input Quiescent Current : Circuit A with No-Load" in 3.1 Typical Performance Characteristics. The always-on output voltage at STORE is regulated by a comparator within the Regulation Control block. When a load discharges C_{STORE} and causes the output voltage to drop below the desired regulated voltage, switching periods are initiated. When the output voltage is at or above the desired regulated voltage, the comparator causes switching periods to stop.

Each switching cycle includes an ON period and an OFF period. During the ON period, the NMOS switch turns on to ramp current in the inductor, while during the OFF period, the NMOS switch turns off and the PMOS switch turns on to discharge inductor current into the C_{STORE} capacitor. When the ON and OFF cycles have completed, the PMOS switch turns off. The TS3310/12/14 operates in Discontinuous Conduction Mode (DCM); during any given switching cycle, the inductor current starts at and returns to zero. The switching cycle timing is governed by the Control block, which determines the ON and OFF periods according to the input and output voltages, regardless of the inductor current. The Control block sets the ON period according to the following equation:

$$t_{ON} = \frac{2.2\ \mu s}{V_{IN}}$$

Equation 1. ON Period Calculation

Then, the choice of inductor value determines the peak switching currents:

$$I_{pk} = \frac{V_{IN} \times t_{ON}}{L} = \frac{2.2\ \mu s}{L}$$

Equation 2. Peak Current Calculation

The average input current, $I_{IN(AVG)}$, will vary according to the load, since as the load is increased, the time between switching cycles is decreased. However, $I_{IN(AVG)}$ will never exceed $I_{IN(AVG,MAX)}$, the maximum averaged input current, which represents the case where switching periods are continuously initiated.

$$I_{IN(AVG,MAX)} = \frac{I_{pk}}{2} = \frac{1.1\ \mu s}{L}$$

Equation 3. Maximum Average Input Current Calculation

The above equation shows that an input current limit can be set by choice of inductor value, set appropriately for the capacity and output impedance of the input source.

Maximum available output current is also a function of inductor value for the case where switching cycles are continuously initiated, the expected maximum STORE output current is:

$$I_{STORE(MAX)} = \frac{V_{IN}}{V_{OUT}} \times I_{IN(AVG,MAX)} \times \text{Efficiency}$$

Equation 4. Expected Maximum STORE Current Calculation

2.2.2 Output Voltage Options

The Regulation Controls within the Control block monitor and control the regulation of the STORE output voltage. By strapping a combination of logic input pins (S0–S2) high or low, the STORE output voltage can be one of the selectable output voltages.

Table 2.2. STORE Output Value Options

S2	S2	S0	TS3310 STORE	TS3312 STORE	TS3314 STORE
0	0	0	1.8 V	—	4 V
0	0	1	2.5 V	2.5 V	4.2 V
0	1	0	3.3 V	3.3 V	4.35 V
0	1	1	5 V	5 V	4.5 V
1	0	0	2.1 V	2.1 V	4.6 V
1	0	1	2.85 V	2.85 V	4.7 V
1	1	0	3 V	3 V	4.8 V
1	1	1	4.1 V	4.1 V	4.9 V

The TS3310/12/14 provides an additional Instant-On switched OUT output that completely isolates loads from the storage capacitor at the STORE output. The OUT load switch is controlled by the logic input pin OUT_ON.

2.2.3 Output Load at Startup, VGOOD Output, and UVLO Feature

The TS3310/12/14 provides an Open-Drain VGOOD output that assumes a high impedance once the STORE output is greater than 90% of the target voltage.

At startup, the TS3310/12/14 can provide 5% of the maximum STORE output load current. Once the Open-Drain VGOOD output has assumed a high impedance, the TS3310/12/14 can be loaded with the expected maximum STORE current. The startup time varies depending upon the input voltage, output voltage selection, inductor, and input/output capacitor configuration.

The TS3310 and TS3314 come with an Under Voltage Lockout (UVLO) feature at 0.9 V, while the TS3312 comes with a UVLO feature at 2 V. TS3310 and TS3314 UVLO features have a 20 mV hysteresis. The TS3312 UVLO feature has a 100 mV hysteresis. The UVLO feature monitors the input voltage and inhibits the Switching Cycle Controls from initiating switching cycles if the VIN is too low. This ensures no switching currents are drawn from the input to collapse the voltage at the terminals of the battery when the internal resistance of the battery is high. The following figure displays the UVLO feature for the TS3310.

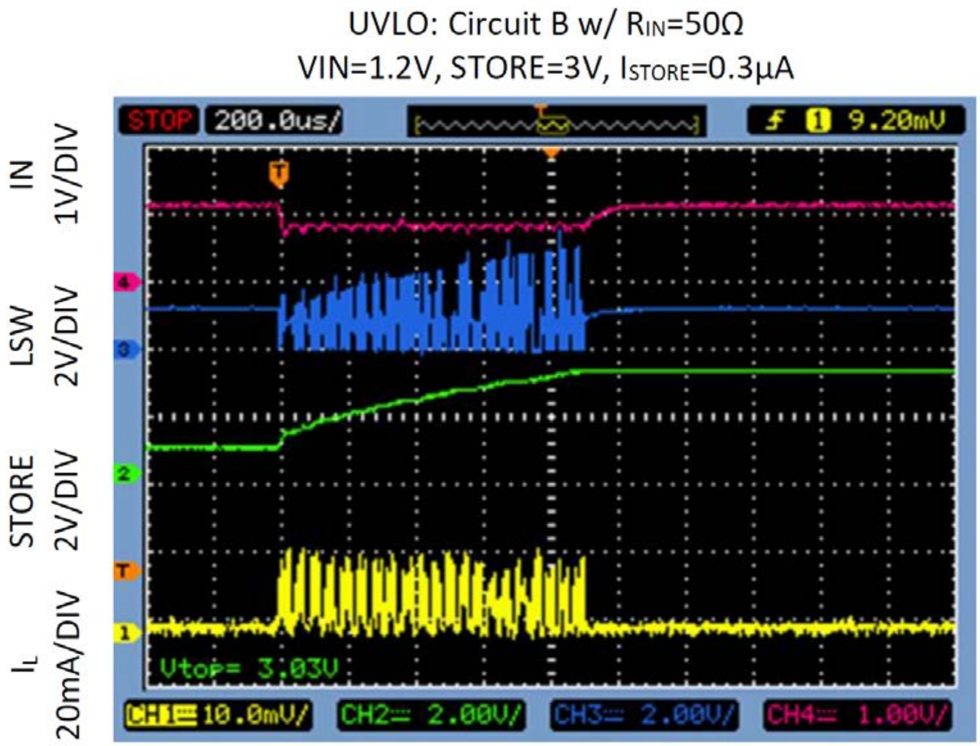


Figure 2.2. TS3310, UVLO = 0.9 V

2.2.4 Inductor Selection

When selecting an inductor value, the value should be chosen based on output current requirements. If the input source is a small battery, make sure the choice of the inductor value considers the maximum input current that the source battery can support (based on series resistance). For example, some small button cell batteries can exhibit 5Ω series resistance, therefore a 20 mA maximum input current may be appropriate (100 mV drop). Consider using a large STORE capacitor to support peak loads for small batteries (see 2.2.6 Bursted Load with Big STORE Buffer Capacitor).

Figure 2.3. Expected Maximum STORE Output Current with 85% Efficiency vs. Inductor Value

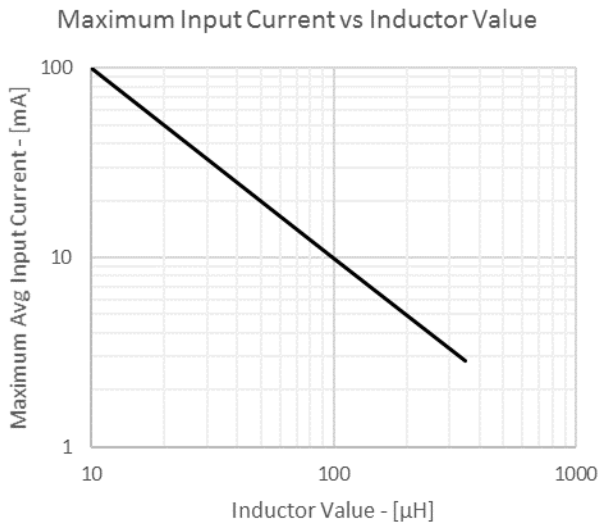


Figure 2.4. $I_{IN(AVG,MAX)}$ vs. Inductor Value

A low ESR, shielded inductor is recommended. Depending upon the application, the inductor value will vary. For applications with load currents less than a few milliamperes, a 100 µH inductor is recommended. As shown by the efficiency curves in 3.1 Typical Performance Characteristics, the efficiency is greater with a larger inductor value for smaller load currents. Please refer to the two "Maximum STORE Output Current vs. Input Voltage" graphs found in 3.1 Typical Performance Characteristics. Circuit A, which uses a 10 µH inductor, is able to source larger load currents than that of Circuit B with a 100 µH inductor due to the larger peak currents.

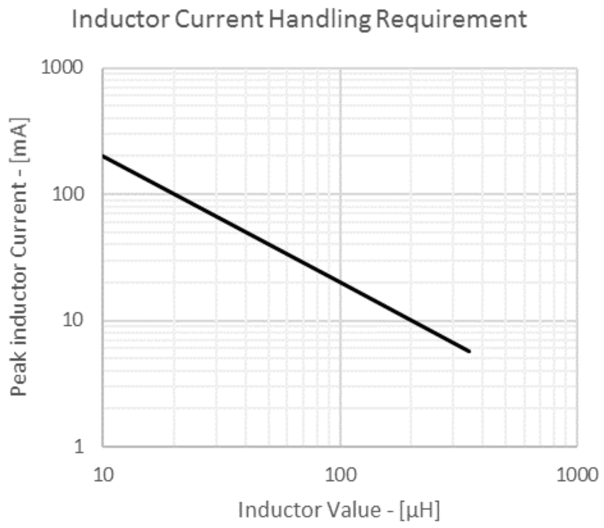


Figure 2.5. Inductor Peak Current vs. Inductor Value

The chosen inductor's saturation current for a specific inductor value should be at least 50% greater than the peak inductor current value displayed in the above figure. The following table provides a list of inductor manufacturers.

Table 2.3. Inductor Manufacturers

Inductors	
Coilcraft	www.coilcraft.com
Taiyo Yuden	www.t-yuden.com
Murata	www.murata.com
Sumida	www.sumida.com

The following tables show some example inductors for values of 10 µH and 100 µH that may be used for Circuit A or B. The tables include the inductors' Rdc (inductor series dc resistance or ESR) saturation current and dimensions. As mentioned previously, the inductor's saturation current should always be greater than 150% of the peak inductor current; therefore, the appropriate size and efficiency (dependent upon ESR) may be chosen based on application requirements.

Table 2.4. Taiyo-Yuden Example Inductors

Inductor Value P/N	Inductor Type	Rdc (Ω)	Saturation Current (mA)	(LxWxH) (mm)
10 µH CBC20166T100K	CBC 2016	0.82	380	2 x 1.6 x 1.6
10 µH CBC2518T100K	CBC 2518	0.36	480	2.5 x 1.8 x 1.8
10 µH CBC3225T100KR	CBC 3225	0.133	900	3.2 x 2.5 x 2.5
100 µH CB2016T101K	CB 2016	4.5	70	2 x 1.6 x 1.6

Inductor Value P/N	Inductor Type	Rdc (Ω)	Saturation Current (mA)	(LxWxH) (mm)
100 µH CB2518T101K	CB 2518	2.1	60	2.5 x 1.8 x 1.8
100 µH CBC2518T101K	CBC 2518	3.7	160	2.5 x 1.8 x 1.8
100 µH CBC3225T101KR	CBC 3225	1.4	270	3.2 x 2.5 x 2.5

Table 2.5. Murata Example Inductors

Inductor Value P/N	Inductor Type	Rdc (Ω)	Saturation Current (mA)	(LxWxH) (mm)
10 µH LQH32CN100K33	LQH 32C_33	0.3	450	3.2 x 2.5 x 2.0
10 µH LQH32CN100K53	LQH 32C_53	0.3	450	3.2 x 2.5 x 1.55
10 µH LQH43CN100K03	LQH 43C	0.24	650	4.5 x 3.6 x 2.6
100 µH LQH32CN101K23	LQH 32C_23	3.5	100	3.2 x 2.5 x 2.0
100 µH LQH32CN101K53	LQH 32C_53	3.5	100	3.2 x 2.5 x 1.55
100 µH LQH43CN101K03	LQH 43C	2.2	190	4.5 x 3.6 x 2.8

2.2.5 Input and STORE Capacitor Selection

Ceramic capacitors are recommended for C_{IN} and C_{STORE}, due to ceramics' extremely low leakage currents (generally limited by very high insulation resistance). Larger value ceramics (10 µF or greater) may use high constant dielectric materials, such as X5R and X7R. These materials exhibit a strong voltage coefficient and substantially lower capacitance than rated when operated near the maximum specified voltage. For these types of capacitors, use a 10 V or greater voltage rating.

The STORE voltage output ripple can be reduced by increasing the value of C_{STORE}. The figure below displays the STORE output voltage ripple for two different storage capacitor values. The output voltage ripple reaches a floor value when the internal voltage comparator hysteresis becomes the dominant source of ripple. Below this level, larger capacitance does not help reduce the ripple.

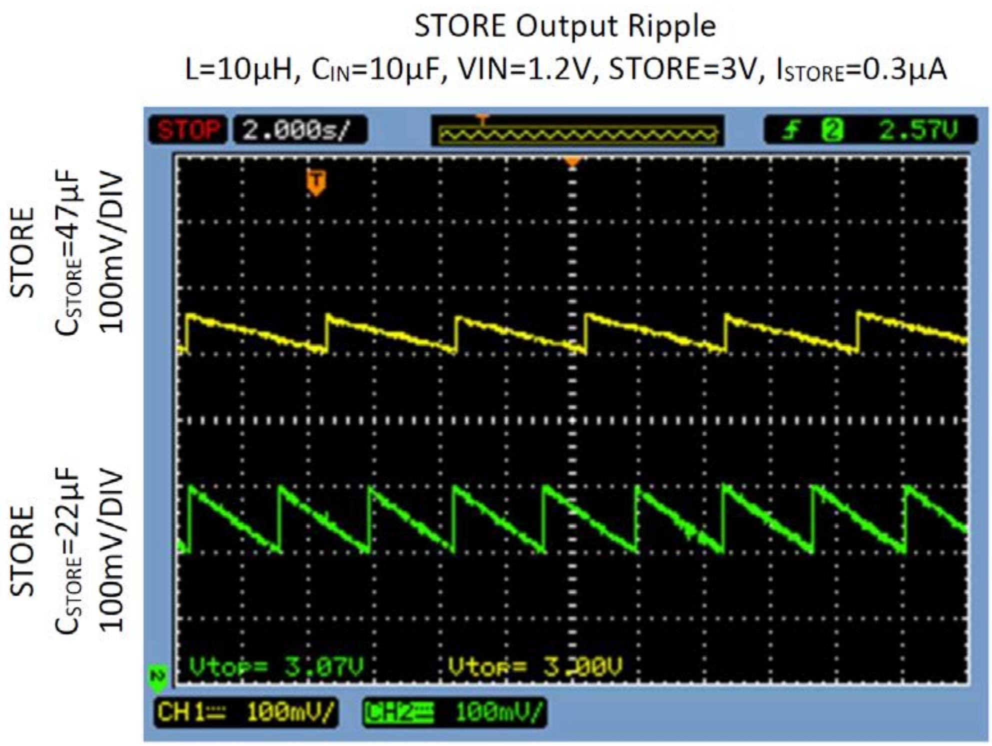


Figure 2.6. Output Voltage Ripple Comparison

2.2.6 Bursted Load with Big STORE Buffer Capacitor

The TS3310 provides a switched OUT output that is capable of sourcing short bursts of large output current by utilizing a large storage capacitor at the STORE output. The figure below displays an application circuit that utilizes this functionality.

The circuit is powered from a LR44 1.5 V Coin Cell Battery. In this example, the load needs to be powered on once every 20 seconds for 200 µs periods. The load requires a 3.3 V source and demands 100 mA current when it is powered on. Also in this example, the load continues to consume 10 µA of leakage current when off. By attaching the load to OUT when the load isn't used, the TS3310 isolates the 10 µA current so that overall quiescent current can be maintained. A 220 µF storage capacitor is used for C_{STORE} so that it can store the necessary charge to supply the 100 mA load current. The microcontroller brings the Instant-On Load Switch, OUT_ON, high when the load needs to be powered on. The TS3310 on average consumes 160 nA between load bursts.

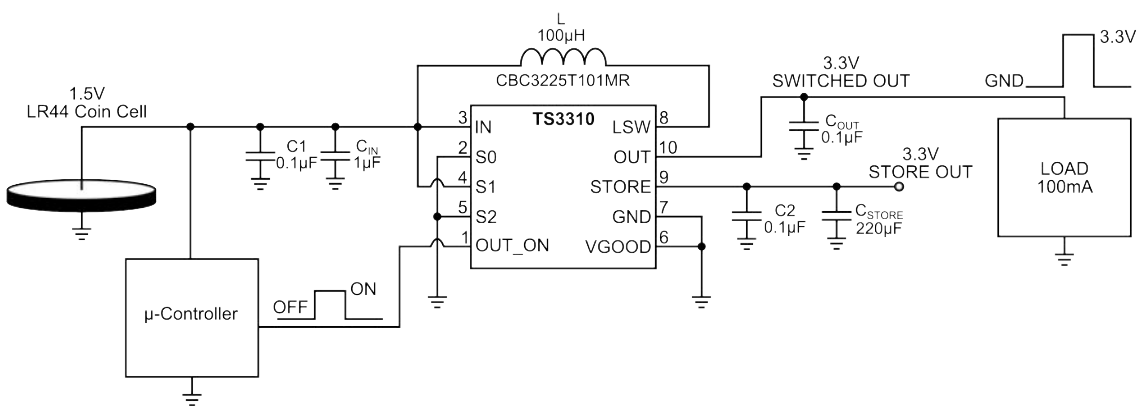


Figure 2.7. Bursted Load Application Circuit

To prevent the circuit from overloading the LR44 Coin Cell Battery, a 100 µH inductor is used to ensure the TS3310 only draws 10 mA of current on average while recharging C_{STORE} after the load is powered off. After the load has been powered off, the TS3310 recharges the 220 µF CSTORE capacitor within 6 ms and is ready for the next bursted cycle. The following figure displays the load being powered on for a 200 µs period and the recharge of the 220 µF C_{STORE} within 6 ms.

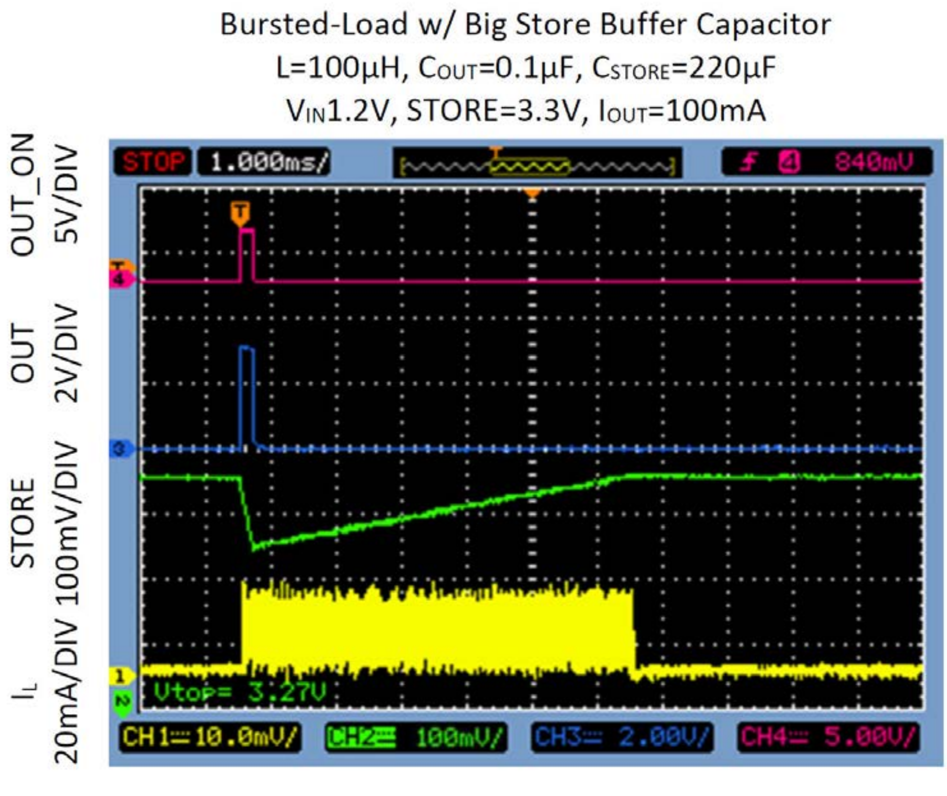


Figure 2.8. 220 µF C_{STORE} Recovery Scope Capture

3. Electrical Characteristics

Table 3.1. Recommended Operating Conditions[1]

Parameter		Symbol	Condition	Min	Typ	Max	Units
Input Voltage Range	TS3310 TS3314	V_{IN}		0.9		5	V
	TS3312			2.0		5	V
Undervoltage Lockout	TS3310 TS3314	UVLO			0.855	0.9	V
		Hysteresis			20		mV
	TS3312	UVLO			1.9	2.0	V
		Hysteresis			100		mV
STORE Voltage		V_{STORE}	L = 10 µH; I_{STORE} = 1% of $I_{STORE(MAX)}$ $V_{IN(MIN)} < V_{IN} < V_{IN(MAX)}$ at any $V_{PROG} > V_{IN}$; T_A = +25 °C [2]	0.97 x V_{PROG}	V_{PROG}	1.03 x V_{PROG}	V
VPROG Tempco					0.027		%/°C
Startup Output Impedance		R_{LOAD}	TS3310 V_{IN} = 1.2 V, V_{STORE} = 5 V	4.1 k			Ω
			TS3312 V_{IN} = 2 V, V_{STORE} = 5 V	2.5 k			Ω
			TS3314 V_{IN} = 1.2 V, V_{STORE} = 4.9 V	4.1 k			Ω
No-Load Input Current I_Q		I_{FLOOR}	@ IN[3]		120	230	nA
			@ STORE[3]		30		nA
		Active-Mode	TS3310 @ IN; V_{IN} = 1.2 V[4]		150		nA
			TS3312 @ IN; V_{IN} = 2.0 V[4]		165		nA
			TS3314 @ IN; V_{IN} = 1.2 V[4]		150		nA
Boost Switch On-Time		T_{ON}	For TS3310, V_{IN} = 1.8 V	0.75 x 2.2/V_{IN}	2.2/V_{IN}	1.25 x 2.2/V_{IN}	µs
			For TS3312, V_{IN} = 2.0 V				
			For TS3314, V_{IN} = 1.8 V				
On Resistance		R_{ON} NMOS	TS3310 V_{STORE} = 1.8 V		0.8	1.3	Ω
		R_{ON} PMOS			1.1		Ω
		R_{ON} Load Switch			1.1	1.65	Ω
		R_{ON} NMOS	TS3310 TS3312 V_{STORE} = 3 V		500		mΩ
		R_{ON} PMOS			650		mΩ
		R_{ON} Load Switch			650		mΩ
VSTORE GOOD		V_{VGOOD}	% of target STORE voltage	80	90	95	%
		Hysteresis			5		%

Parameter	Symbol	Condition	Min	Typ	Max	Units
V_{OUT_ON} Input Voltage	$V_{OUT\_ON\ L}$	Low CMOS Logic Level			0.2	V
	$V_{OUT\_ON\ H}$	High CMOS Logic Level	0.6			V
S0, S1, S2 Input Voltage	S0L, S1L, S2L	Low CMOS Logic Level			0.2	V
	S0H, S1H, S2H	High CMOS Logic Level	0.6			V
S0, S1, S2, OUT_ON Input Leakage Current				5		nA

Note:

1. For TS3310 and TS3314, V_{IN} = 1.2 V. For TS3312, V_{IN} = 2.0 V. V_{OUT_ON} = V_{IN}. V_{PROG} is the programmed voltage according to the S2, S1, and S0 pins. For TS3310 and TS3312, the STORE voltage is programmed for 3 V. For TS3314, the STORE voltage is programmed for 4.5 V unless otherwise specified. T_A= –40 °C to +85 °C. Typical values are at T_A = +25 °C unless otherwise specified.
2. $I_{STORE(MAX)}$ is provided as the Maximum Average STORE Current by Figure 2.3 Expected Maximum STORE Output Current with 85% Efficiency vs. Inductor Value on page 6 in 2.2.4 Inductor Selection.
3. V_{STORE} output is driven above regulation point. No switching is occurring. L = 10 µH. C_{STORE} = C_{IN} = 22 µF.
4. For TS3310 and TS3312, V_{STORE} = 3 V; L = 100 µH; C_{STORE} = C_{IN} = 2.2 µF; for TS3314, V_{STORE} = 4.35 V; L = 100 µH; C_{STORE} = C_{IN} = 2.2 µF

Table 3.2. Thermal Conditions

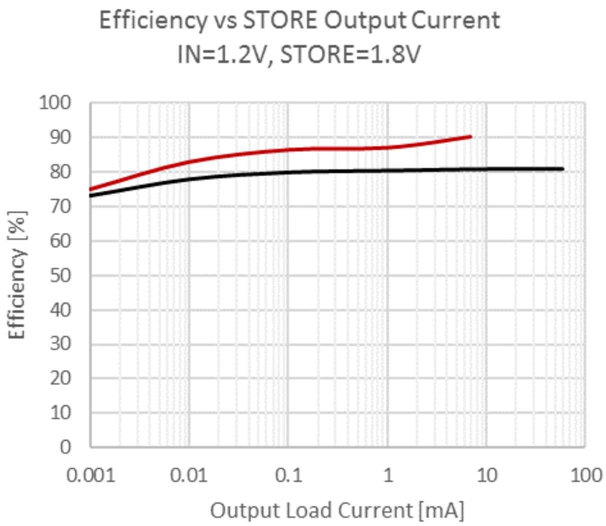
Parameter	Symbol	Conditions	Min	Typ	Max	Units
Operating Temperature Range	TOP		–40		+85	°C

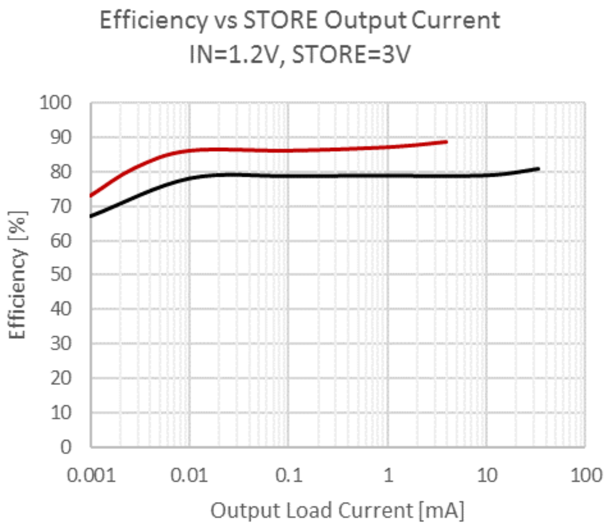
Table 3.3. Absolute Maximum Limits

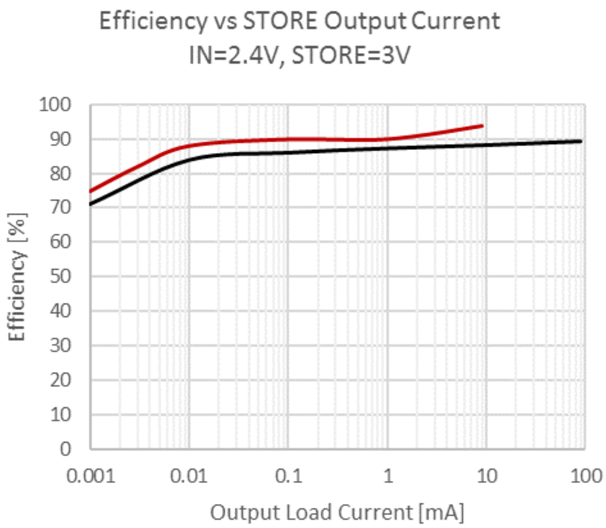
Parameter	Symbol	Conditions	Min	Typ	Max	Units
IN Voltage	V_{IN}		–0.3		+6.0	V
STORE Voltage	V_{STORE}		–0.3		+6.0	V
OUT Voltage	V_{OUT}		–0.3		+6.0	V
LSW Voltage	V_{LSW}		–0.3		+6.0	V
OUT_ON Voltage	V_{OUT_ON}		–0.3		+6.0	V
S0 Voltage	V_{S0}		–0.3		+6.0	V
S1 Voltage	V_{S1}		–0.3		+6.0	V
S2 Voltage	V_{S2}		–0.3		+6.0	V
Junction Temperature					150	°C
Storage Temperature Range			–65		150	°C
Lead Temperature (Soldering, 10 s)					300	°C
Soldering Temperature (Reflow)					260	°C
ESD Tolerance						
Human Body Model					2000	V
Machine Model					200	V

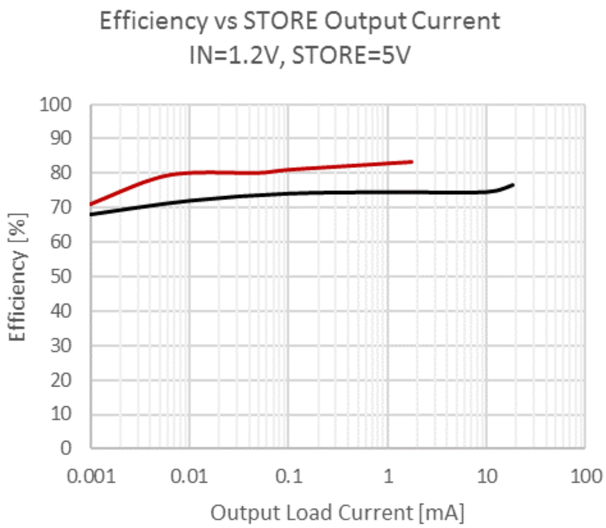
3.1 Typical Performance Characteristics

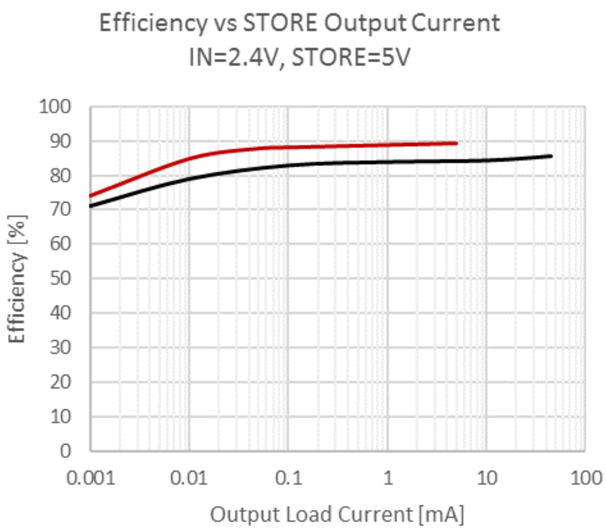
In the six efficiency charts on this page, the upper (red) curve applies to “Circuit B”, and the lower (black) curve applies to “Circuit A”.

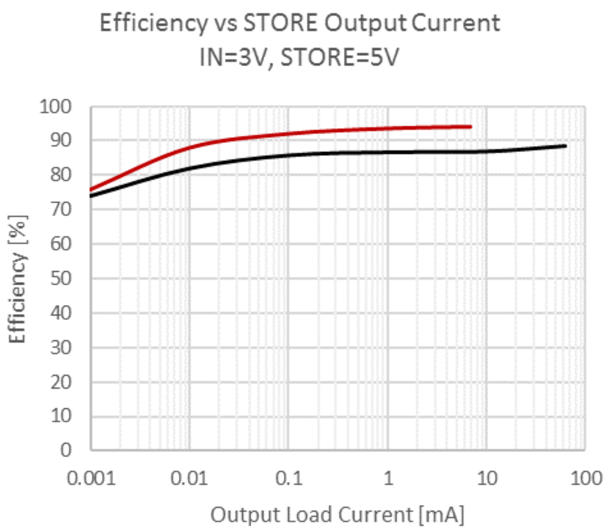


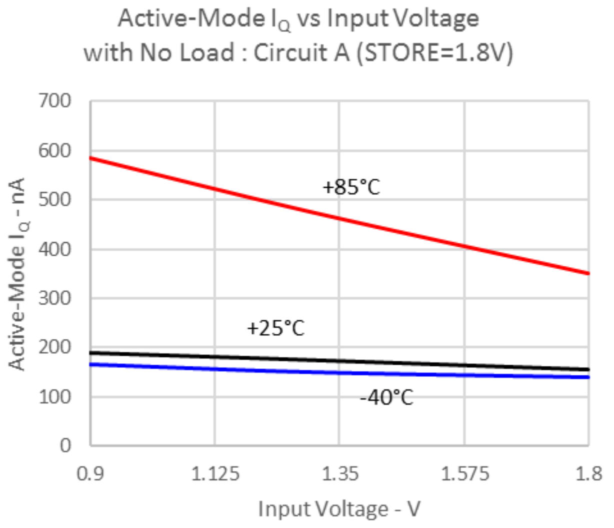


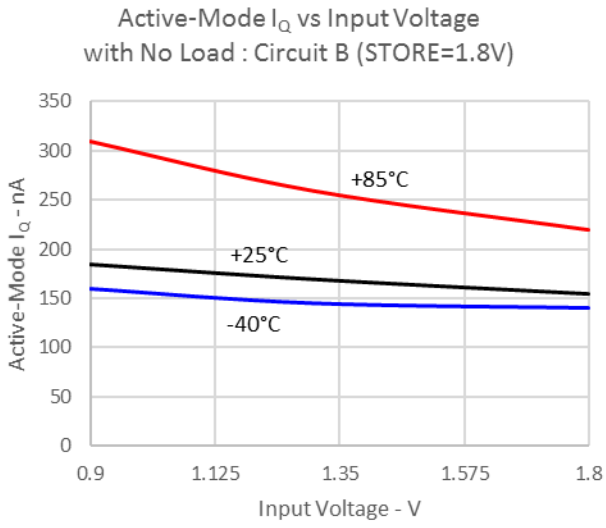


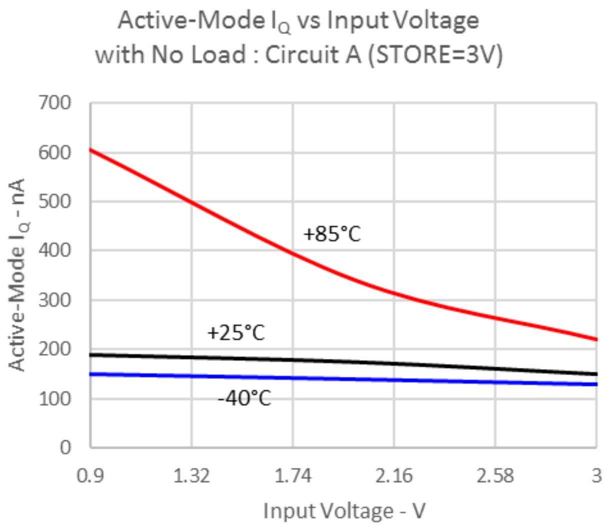


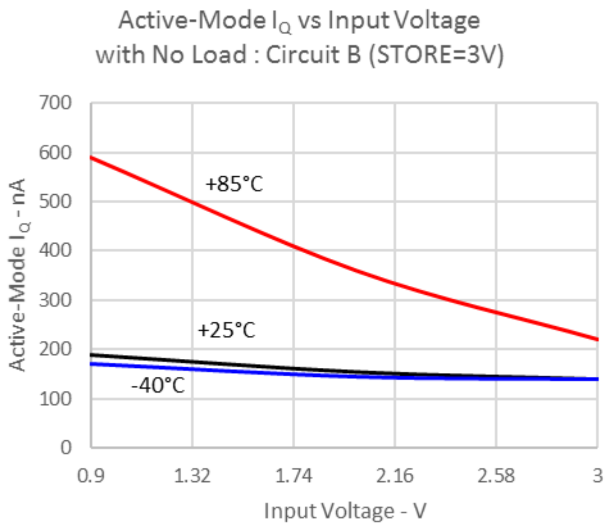


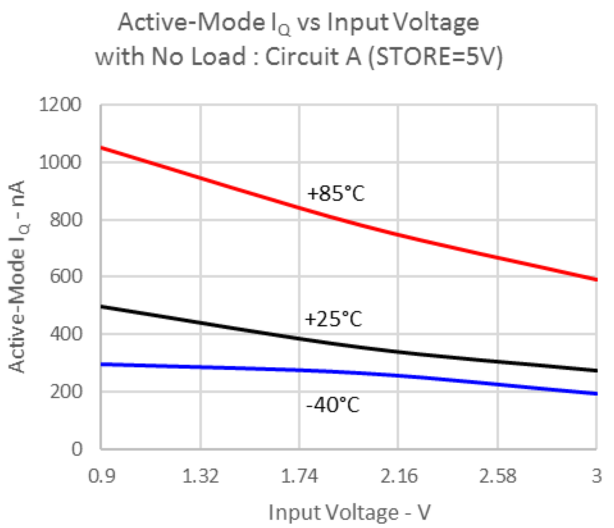


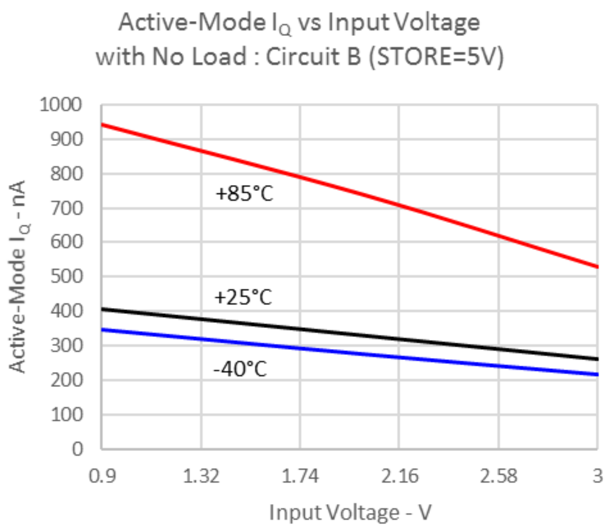

Active-Mode IQ vs Input Voltage with No Load : Circuit A (STORE=1.8V)
Active-Mode IQ - nA
Input Voltage - V
+85°C
+25°C
-40°C


Active-Mode IQ vs Input Voltage with No Load : Circuit B (STORE=1.8V)
Active-Mode IQ - nA
Input Voltage - V
+85°C
+25°C
-40°C

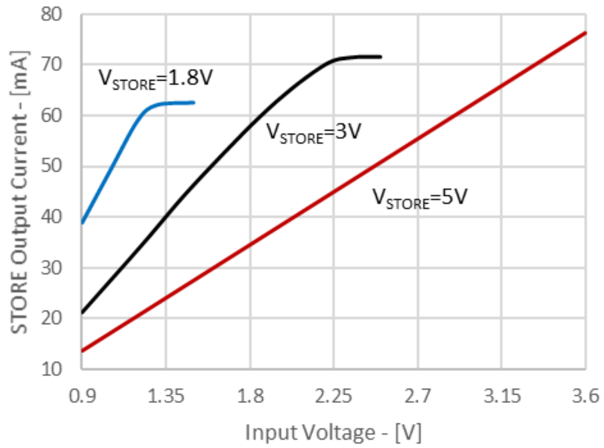

Active-Mode IQ vs Input Voltage with No Load : Circuit A (STORE=3V)
Active-Mode IQ - nA
Input Voltage - V
+85°C
+25°C
-40°C


Active-Mode IQ vs Input Voltage with No Load : Circuit B (STORE=3V)
Active-Mode IQ - nA
Input Voltage - V
+85°C
+25°C
-40°C

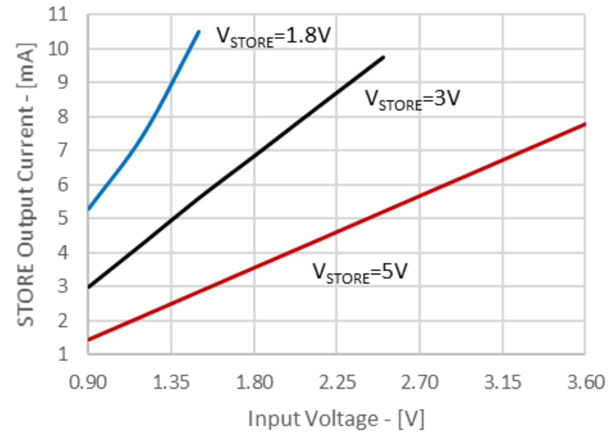

Active-Mode IQ vs Input Voltage with No Load : Circuit A (STORE=5V)
Active-Mode IQ - nA
Input Voltage - V
+85°C
+25°C
-40°C


Active-Mode IQ vs Input Voltage with No Load : Circuit B (STORE=5V)
Active-Mode IQ - nA
Input Voltage - V
+85°C
+25°C
-40°C

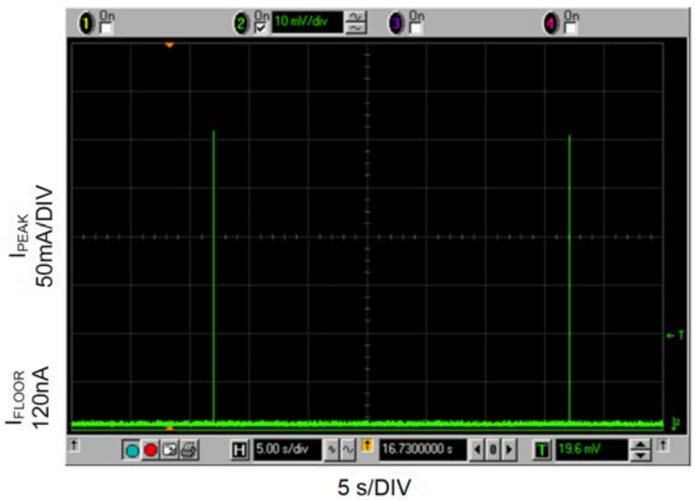
Maxmimum STORE Output Current vs Input Voltage w/ V_{STORE}≥96% of Target: Circuit A



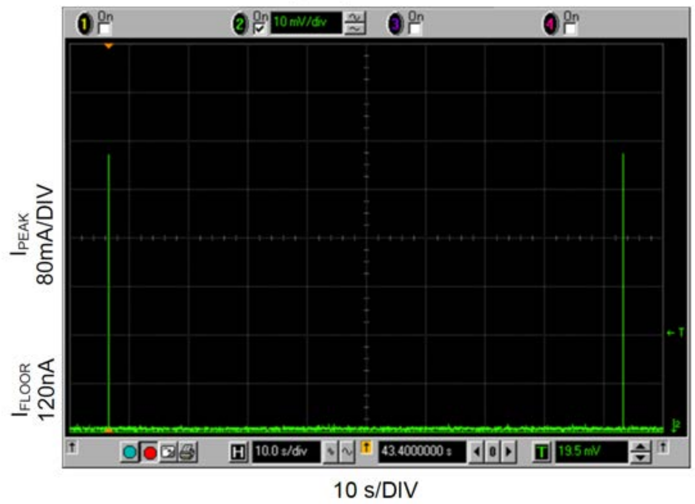
Maximum STORE Output Current vs Input Voltage w/ V_{STORE}≥96% of Target: Circuit B



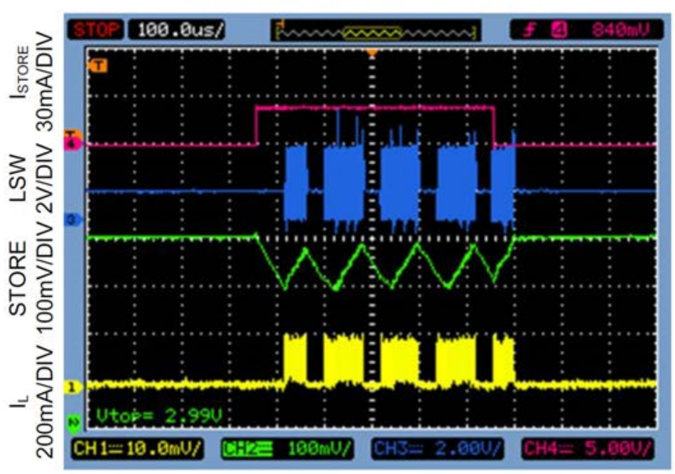
Input Quiescent Current : Circuit A with No-Load
V_{IN}=1.2V, STORE=3V



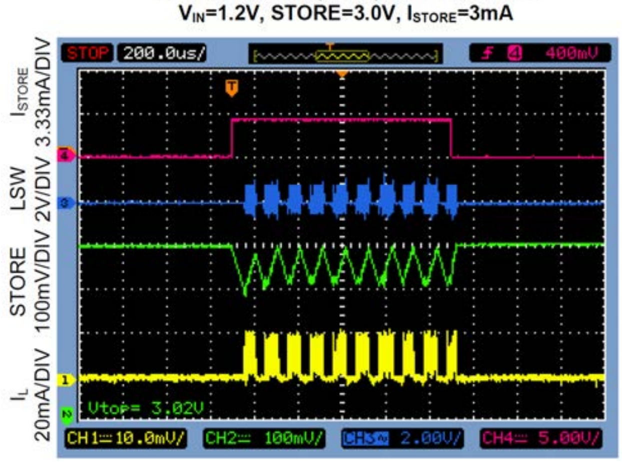
Input Quiescent Current : Circuit A with No-Load
V_{IN}=3V, STORE=3V



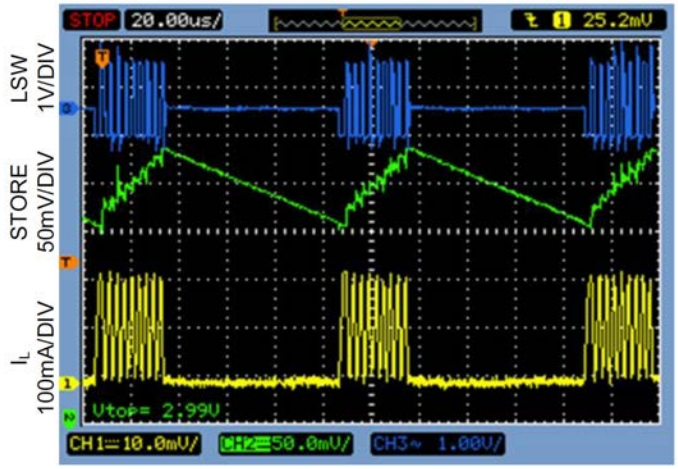
STORE Load Step Response : Circuit A
V_{IN}=1.2V, STORE=3V, I_{STORE}=24mA



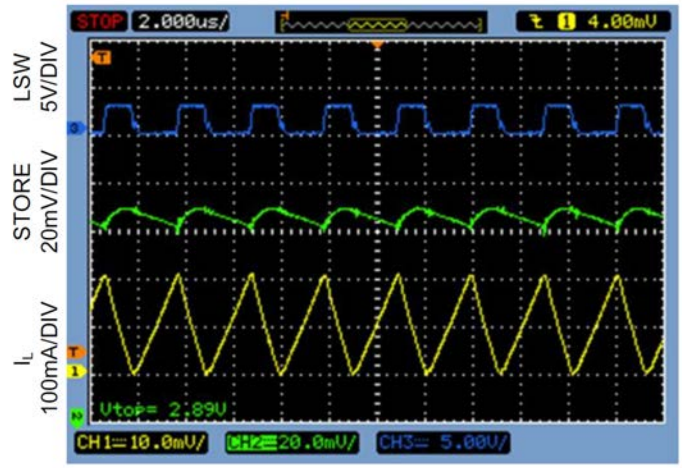
STORE Load Step Response : Circuit B
V_{IN}=1.2V, STORE=3.0V, I_{STORE}=3mA



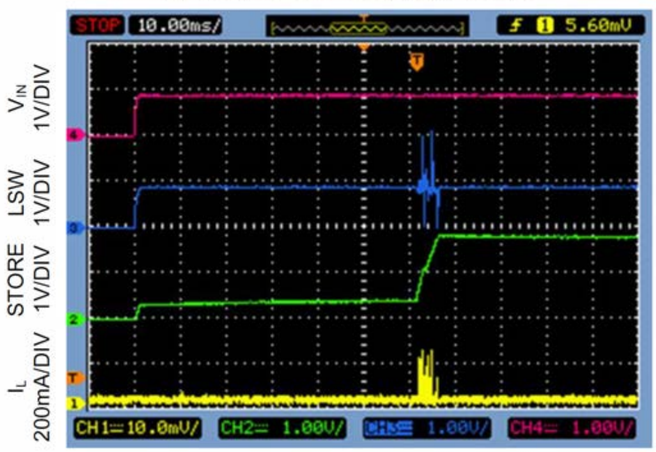
STORE Output Voltage Ripple, Inductor Current, and LSW Voltage : Circuit A
V_{IN}=1.2V, STORE=3V, I_{STORE}=10mA



STORE Output Voltage Ripple, Inductor Current, and LSW Voltage : Circuit A
V_{IN}=1.2V, STORE=3V, $I_{STORE(MAX)}$=35mA

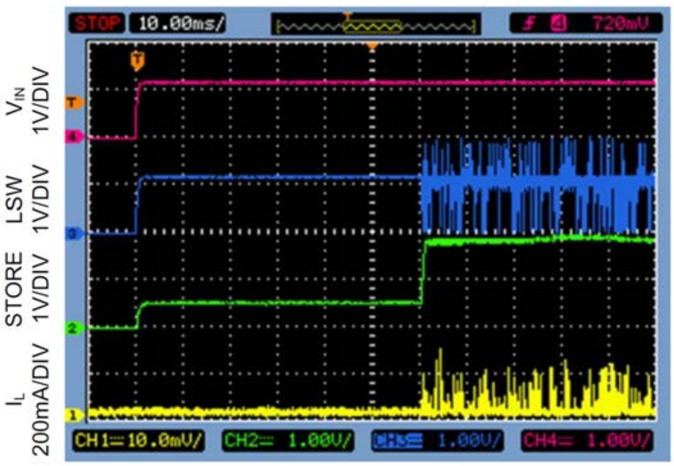


Startup : Circuit A with R_{IN}=10Ω
V_{IN}=0.9V, STORE=1.8V, I_{STORE}=0.18μA

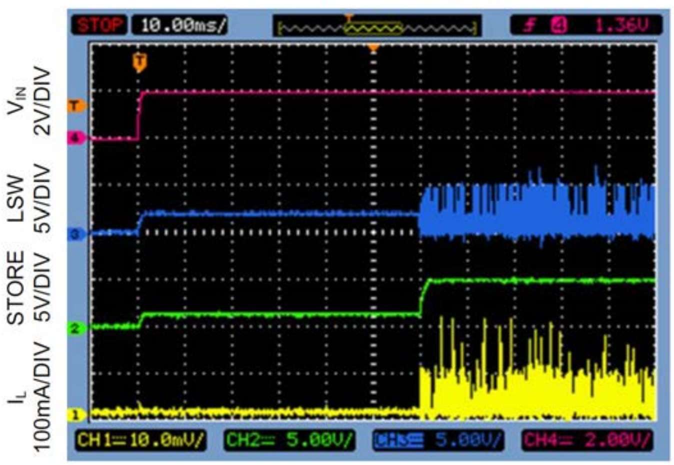


Startup : Circuit A with R_{IN}=10Ω
V_{IN}=2V, STORE=5V, I_{STORE}=0.5μA

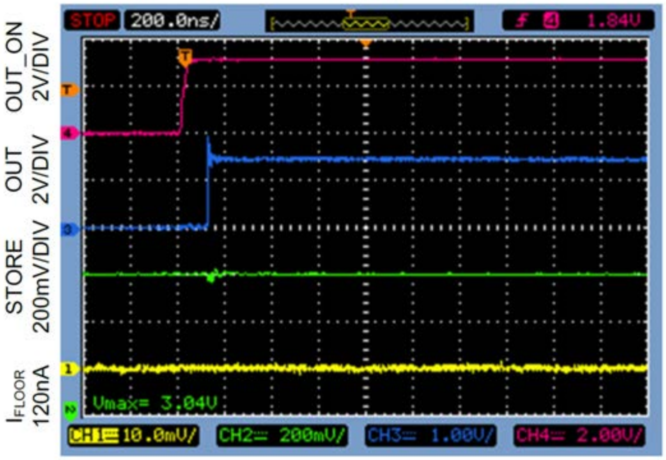
Startup : Circuit A with R_{IN}=10Ω
V_{IN}=1.2V, STORE=1.8V, I_{STORE}=3mA



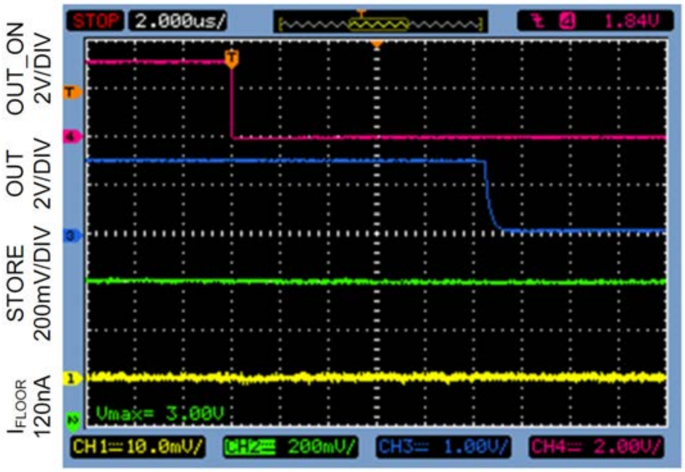
Startup : Circuit A with R_{IN}=10Ω
V_{IN}=2V, STORE=5V, I_{STORE}=3mA



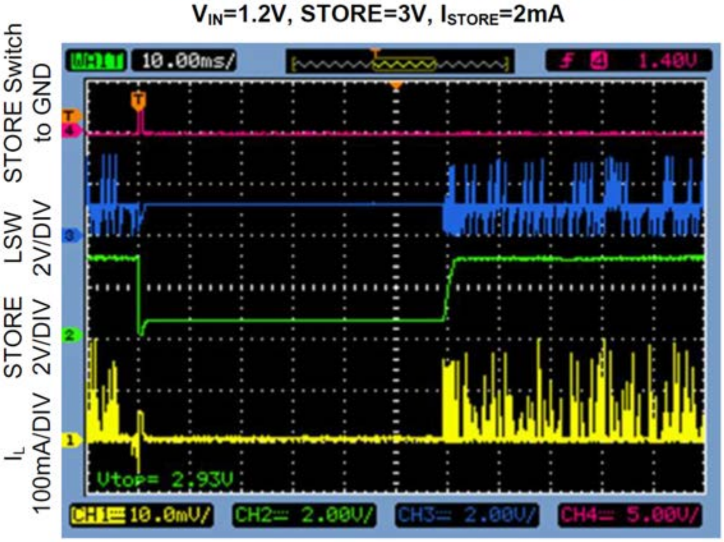
OUT_ON Switched ON : Circuit A with C_{OUT} Removed
V_{IN}=1.2V, STORE=3V, I_{STORE}=0.3μA, I_{OUT}=3mA



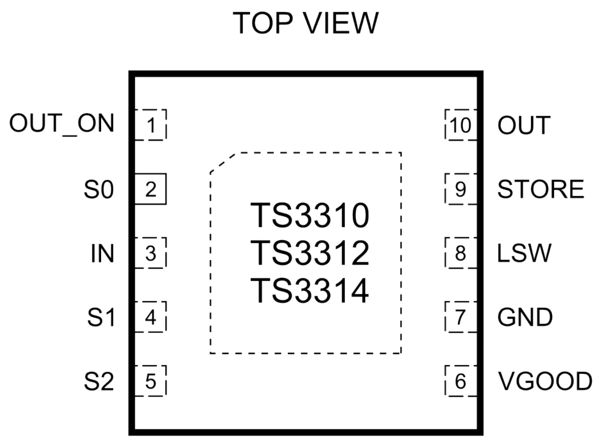
OUT_ON Switched OFF : Circuit A with C_{OUT} Removed
V_{IN}=1.2V, STORE=3V, I_{STORE}=0.3μA, I_{OUT}=3mA



Short STORE to GND for 1msec Recovery : Circuit A
V_{IN}=1.2V, STORE=3V, I_{STORE}=2mA



4. Pin Descriptions



2mm x 2mm x 0.75mm
TDFN-10 EP BD 10TSLP Package

Table 4.1. Pin Descriptions

Pin	Name	Function
1	OUT_ON	Logic Input. Turns on OUT switch.
2	IN	Boost Input. Connect to input source.
3	S0	Logic Input. Sets the regulated voltage at STORE.
4	S1	Logic Input. Sets the regulated voltage at STORE.
5	S2	Logic Input. Sets the regulated voltage at STORE.
6	VGOOD	Open Drain Output. High impedance when STORE>90% of regulation voltage.
7	GND	Ground. Connect this pin to the analog ground plane.
8	LSW	Inductor Connection.
9	STORE	Regulated output voltage set by S0, S1, S2 logic. Connect Storage capacitor.
10	OUT	Switched Output.
EPAD	EPAD	Exposed Paddle. Connect this pin to the analog ground plane.

5. Packaging

5.1 TS3310/12/14 Package Dimensions

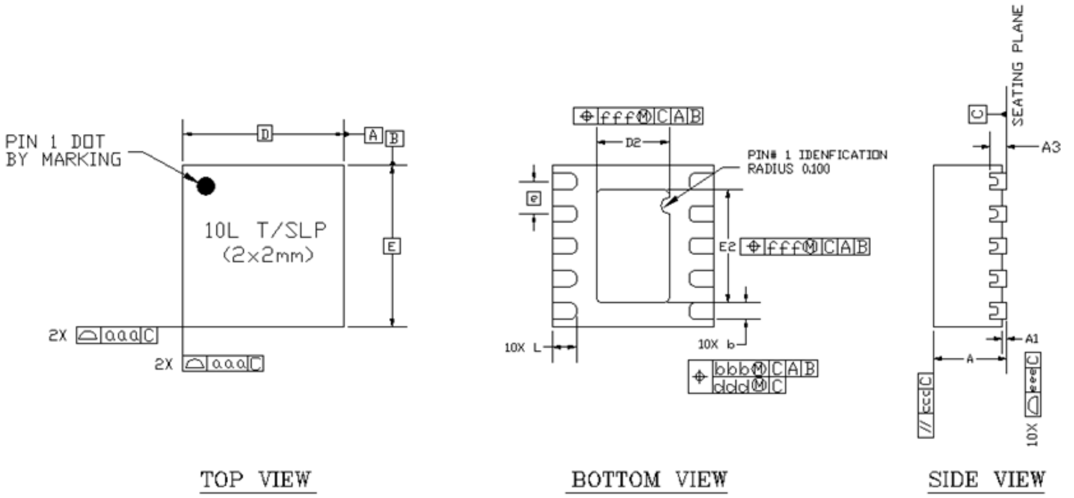


Figure 5.1. TS3310/12/14 2x2 mm 10-QFN Package Diagram

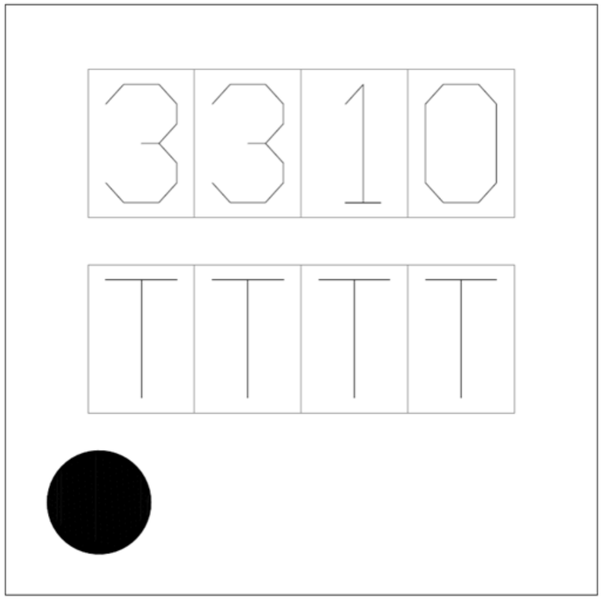
Table 5.1. Package Dimensions

Dimension	Min	Nom	Max
A	0.700	0.750	0.800
A1	0.000	---	0.050
b	0.150	0.200	0.250
A3	0.203 REF		
D	2.000 BSC		
e	0.400 BSC		
E	2.000 BSC		
D2	0.850	0.900	0.950
E2	1.350	1.400	1.450
L	0.250	0.300	0.350
aaa	0.500		
bbb	0.100		
ccc	0.050		
ddd	0.050		
eee	0.080		
fff	0.050		

Note:

1. All dimensions shown are in millimeters (mm) unless otherwise noted.
2. Dimensioning and Tolerancing per ANSI Y14.5M-1994.
3. Recommended card reflow profile is per the JEDEC/IPC J-STD-020 specification for Small Body Components.

5.2 TS3310 Top Marking



TS3310 Top Marking

Table 5.2. TS3310 Top Marking Explanation

Mark Method:	Laser	
Pin 1 Mark:	0.35 mm Diameter (Lower-Left Corner)	
Font Size:	0.40 mm (16 mils)	
Line 1 Mark Format:	Device Identifier	3310
Line 2 Mark Format:	TTTT = Mfg Code	Manufacturing Code from the Assembly Purchase Order Form

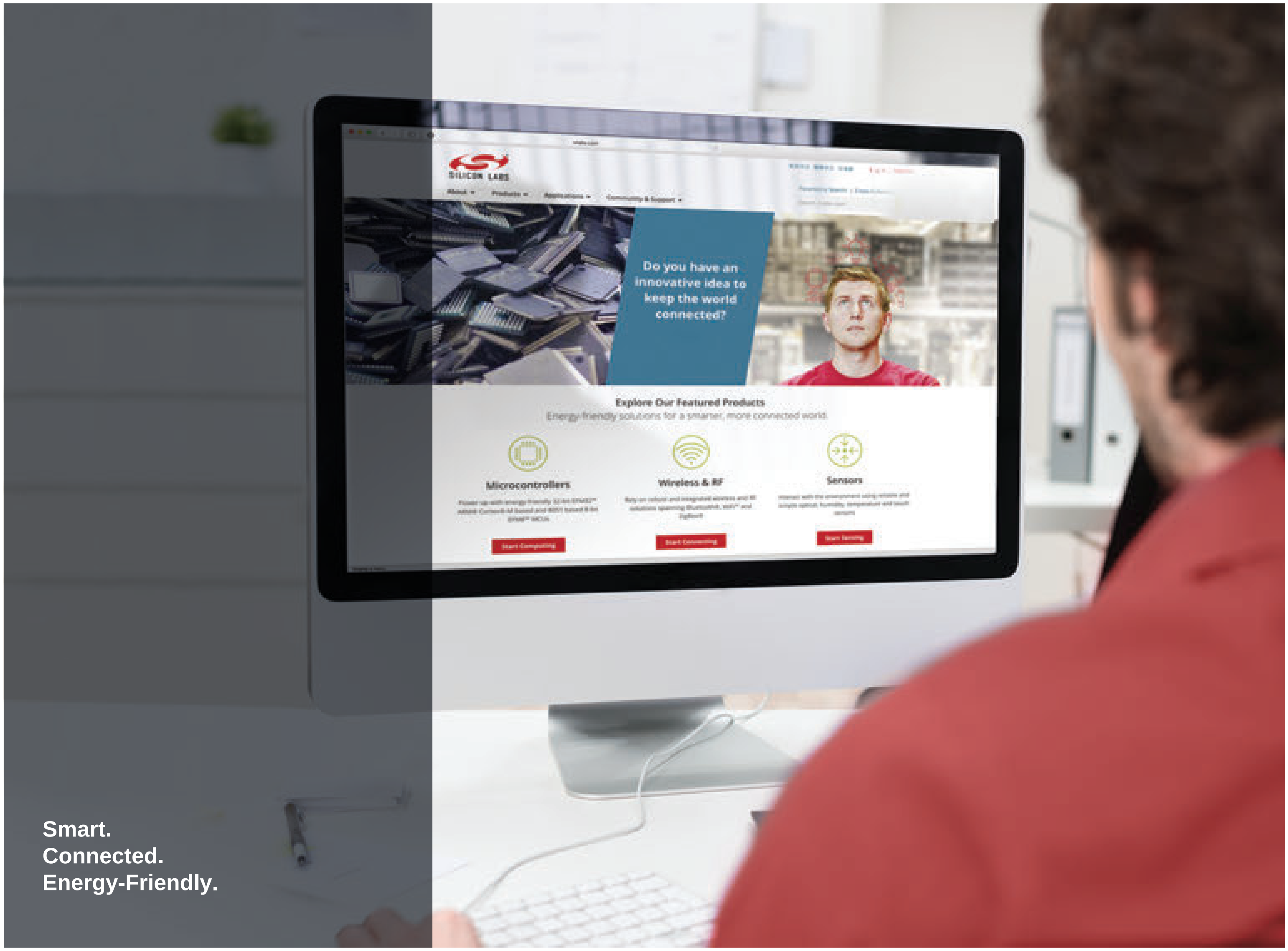
6. Revision History

Revision 1.0

February 24, 2016

- Initial external release.

Table of Contents



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