LX7165 EVALUATION BOARD USER GUIDE

LX7165 5 Amp Step Down Converter

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Microsemi
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Introduction to Product

The LX7165 is a digitally controlled step-down regulator IC with an integrated 30mΩ high-side P-channel MOSFET and a 10mΩ low-side N-channel MOSFET. It features Microsemi's proprietary constant-frequency hysteretic control engine for near-instantaneous correction to sudden line/load transients. It does not require high-ESR output capacitors and incorporates energy-saving "PSM" (Power Saving or Pulse Skip Mode) at light loads, to extend battery life in mobile applications.

The LX7165 has an I^2C serial interface port for output voltage margining and monitoring if required (it can operate in default mode too). It includes robust fault monitoring functions.

The LX7165 will operate from 3V to 5.5V, and is available in several fixed output voltage options from 0.6V to 0.97V (no voltage divider is necessary). Each version's output voltage can also be made adjustable with use of an external voltage divider.

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Key Features

- Constant Frequency Hysteretic Control
- Extremely Fast Line/Load Transient Response
- I^2C for Output Adjustment (3.4Mbps)
- 1.875MHz Switching Frequency
- Extremely Low-R_{DSON} MOSFETS
- Input Voltage Rail 3.3V to 5V, Current 5A
- Programmable Power Save Mode for Light-Load Efficiency
- UVLO, OVP, OCP
- 0°C to +85°C Ambient Temperature
- Available in WLCSP-20 (0.4mm pitch)
- RoHS Compliant

Applications

- High Performance HDD
- LCD TV's
- Notebook/ Netbook
- Server and Workstations
- Video Cards
- PoE Powered Devices

Part Specific Information

IC Part Number	Description
LX7165-xyCSP	WLCSP 20Ball 0.4mm Pitch

Note: "x" is the 2 LSB bits of the binary I^2C slave address (0 to 3);
"y" is the set output voltage (0 is 0.6V, 1 is 0.9V, 2 is 0.95V, 3 is 0.97V)

Evaluation Board Part Number	Description
LX7165 EVAL BOARD	Evaluation PCB for LX7165

Evaluation Board Schematic

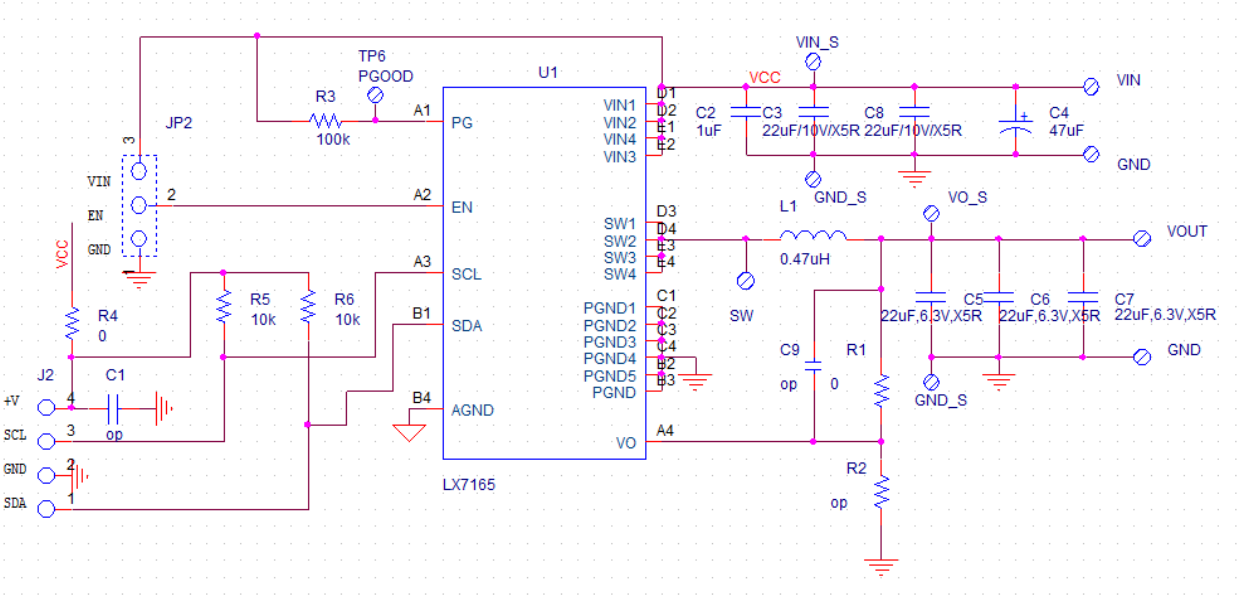

Figure 1 Schematic of Evaluation Board

Basic Connection Instructions

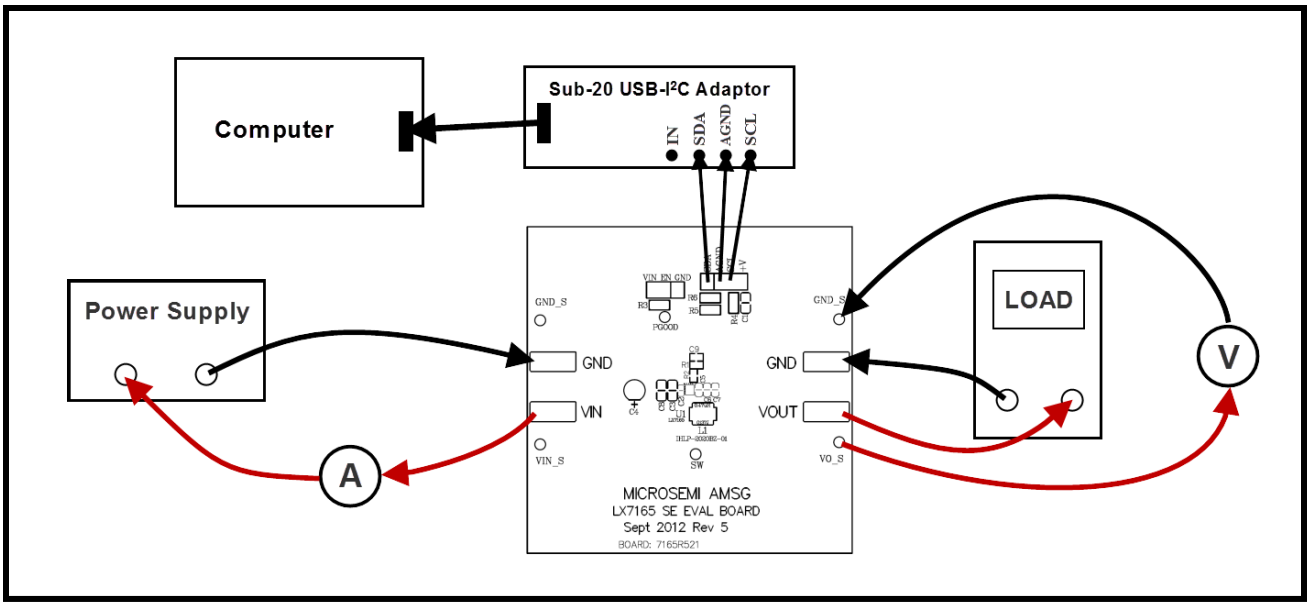

Figure 2 Power Supply and Load Connection with I²C Implemented

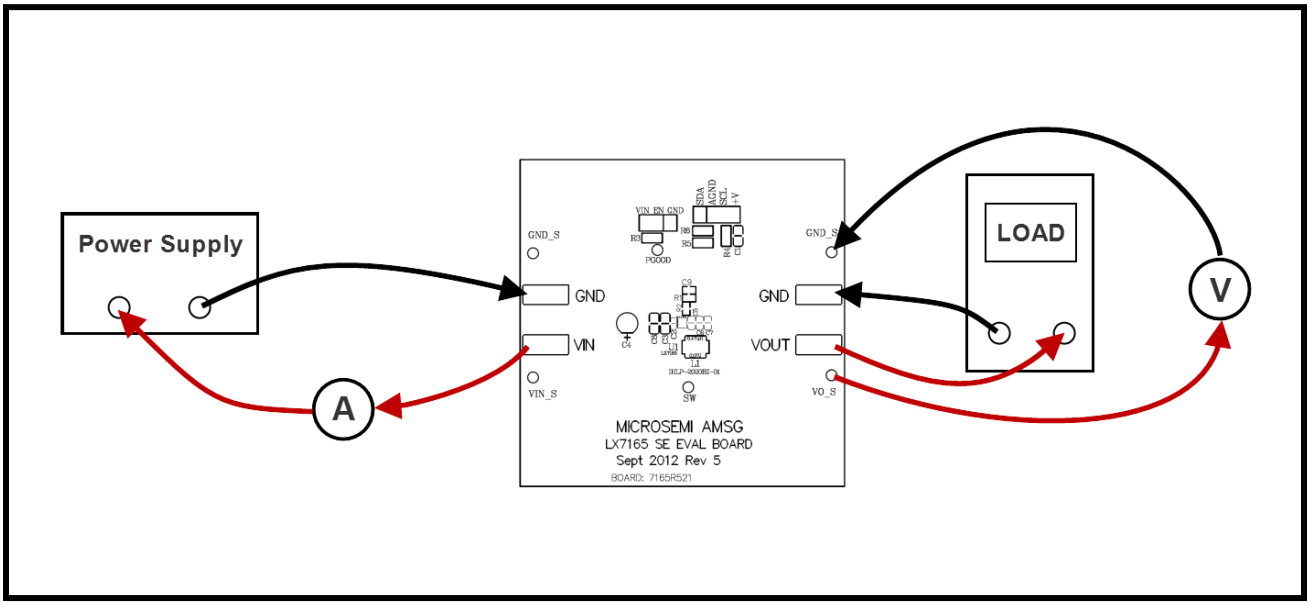

Figure 3 Power Supply and Load Connection without I²C Implemented

LX7165 I²C GUI

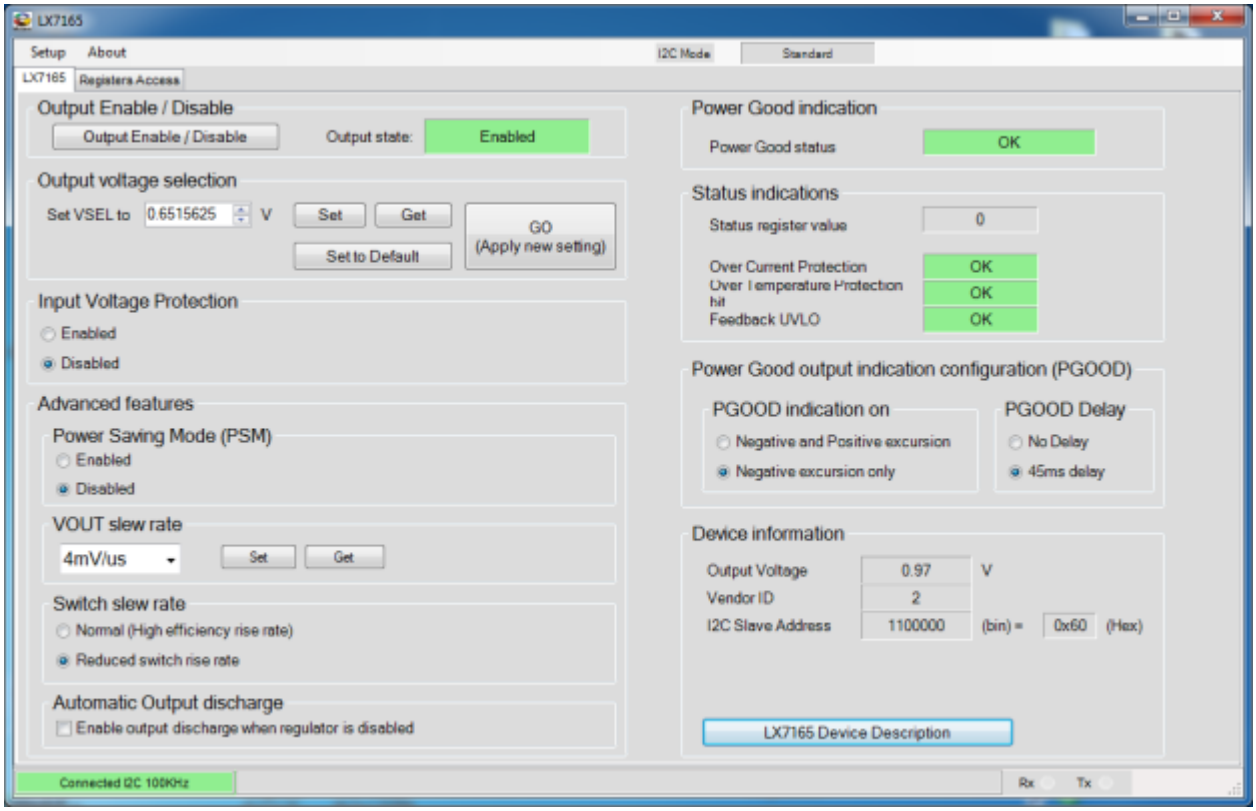

Figure 4 LX7165 GUI

LX7165 I²C GUI is a graphic user interface that can read/write IC status or change default settings via I²C serial portal. For example, it can used to enable/disable device, change output voltage, or enable power saving mode, etc.

More information about register map and I²C function can be found in LX7165 datasheet.

Note: To use this GUI, a SUB-20 USB-I²C adaptor is needed. See Dimax SUB-20 and LX7165 GUI Installation for details.

Recommended Operating Conditions

Description	Symbol	Min	Max	Unit
Input Voltage	V_{IN}	3	5.5	V
Output Current	I_{OUT}	0	5	A
Operating Ambient Temperature	T_A	0	85	°C
Enable Chip	EN	V_{IN}		
Shut Down Chip	EN		Pull to GND	

Enabling Regulator from I²C Bus

In addition to the ENABLE pin, the regulator can be enabled and disabled via the I²C bus by programming the control register. During disable, the regulator and most of the support circuitry is turned off. However, the I²C bus circuitry is still active and maybe programmed.

Setting the Output Voltage

Only use I²C interface can adjust VOUT from 0.6V to 1.2V. When I²C interface is implemented, the reference voltage is programmed with the I²C bus VSEL register value.

$$V_{REF} = 0.6V + N_{SEL} \times 0.0046875V$$

Where N_{SEL} is the decimal value of the 7 VSEL bits.

In case a higher output voltage is needed, it must be programmed through an external resistor divider connected from SW to VOUT then to GND. For noise immunity, the lower resistor R2 from VOUT to GND should be greater than 100kOhm. A feed-forward capacitor C9 in parallel with upper resistor is needed to ensure loop stability. Recommend C9=33pF. The formula below gives the value of VOUT.

$$VOUT = V_{REF} \times \left(1 + \frac{R_1}{R_2}\right)$$

V_{REF} is determined by the chip, for example, to set LX7165-03CSP VOUT = 1.83V, given V_{REF} = 0.97V. First pick the lower resistor R_2=150k, calculate the upper resistor R1=133k, and C9=33pF.

PCB Layout of Evaluation Board

The LX7165 EVAL Board is a 4-layer board, the thickness of the board is 63mil in total. The second layer to top layer is 7mil, the third layer to the bottom layer is 7mil. There's no microvias or blind vias needed, each signal can leave the LX7165 directly without using any via under the device. And, it can lower the ESL with the bypass capacitors C2, C3 and C9 implemented. C4 is only needed when there's long wires connected.

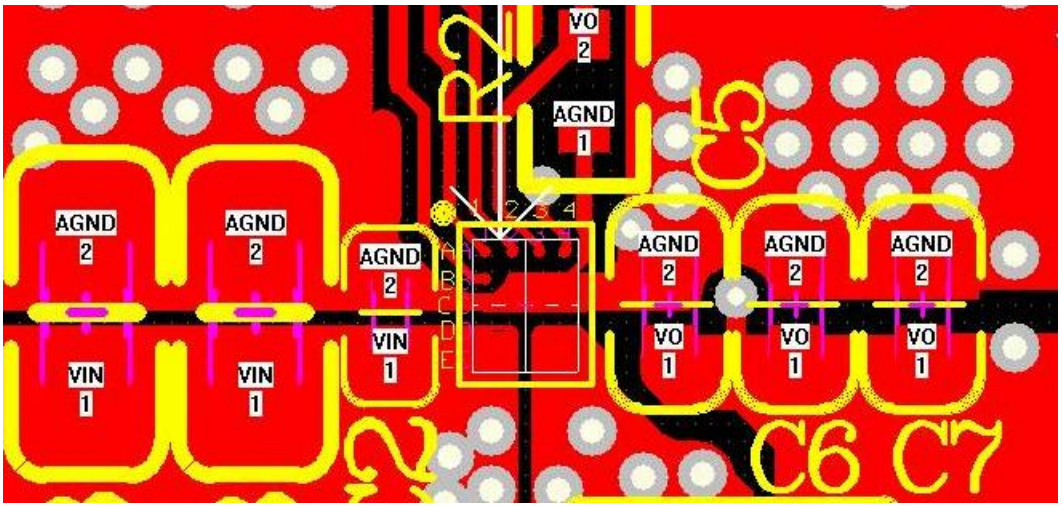

Figure 5 Layout Recommendation

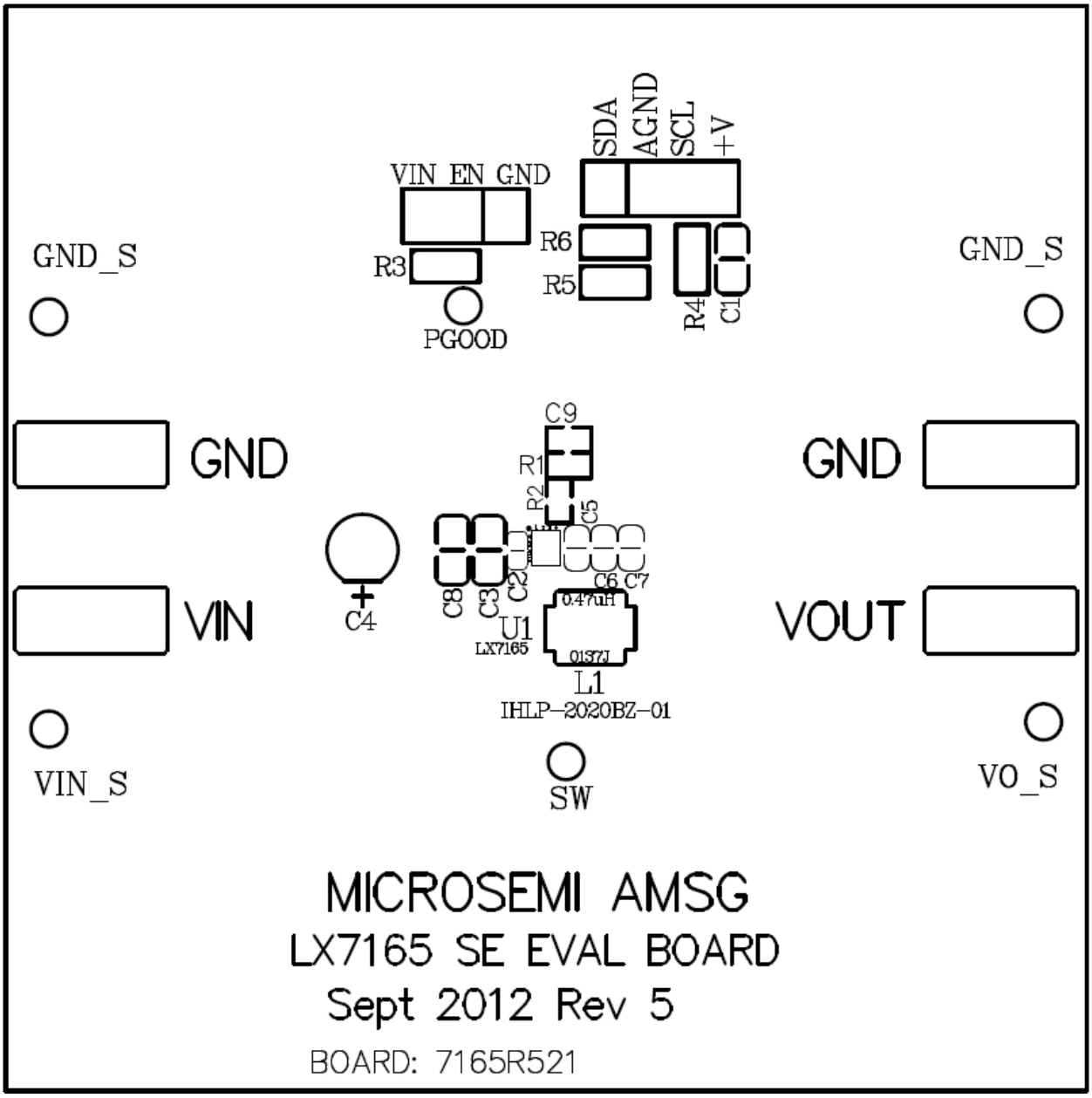

Figure 6 Top Silkscreen

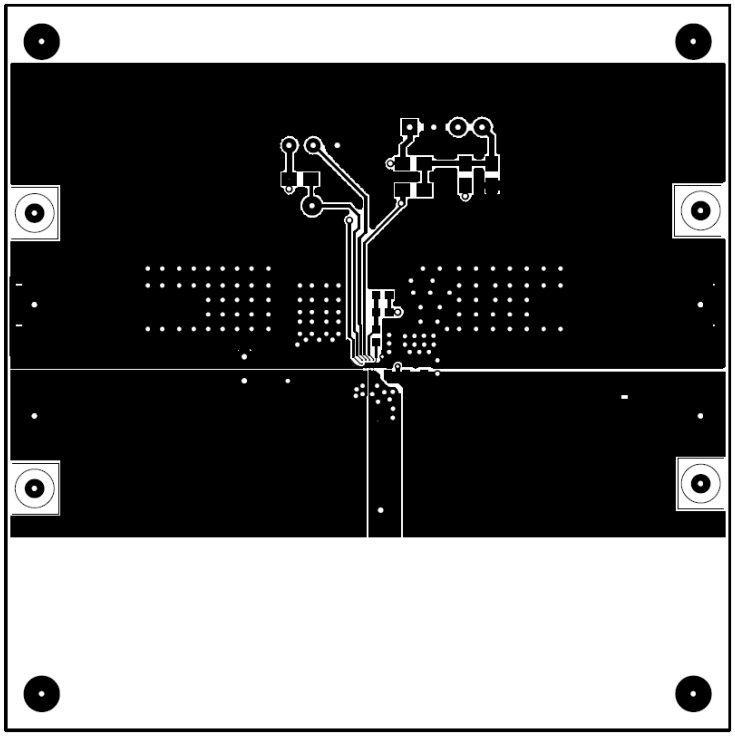

Figure 7 Layer 1: Top Layer

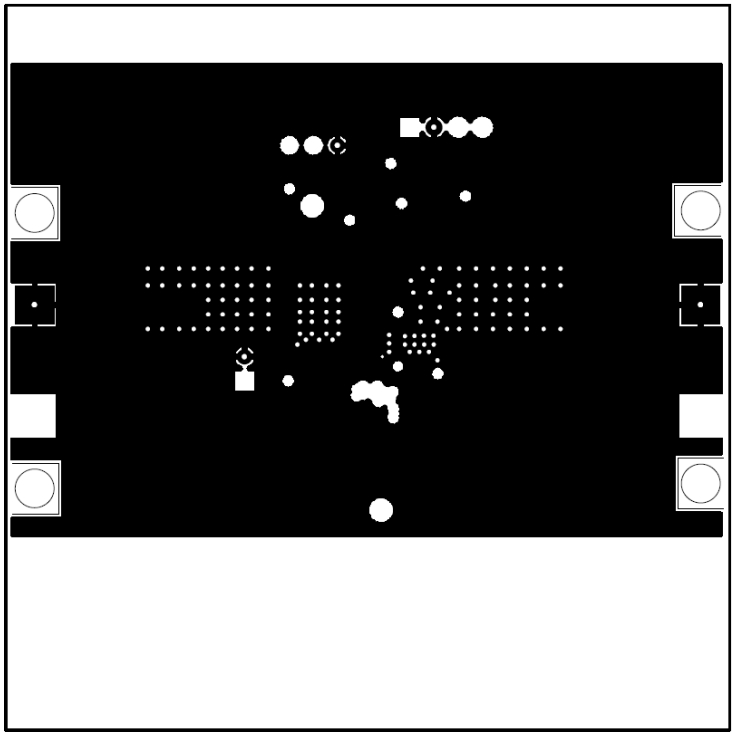

Figure 8 Layer 2: Ground Layer

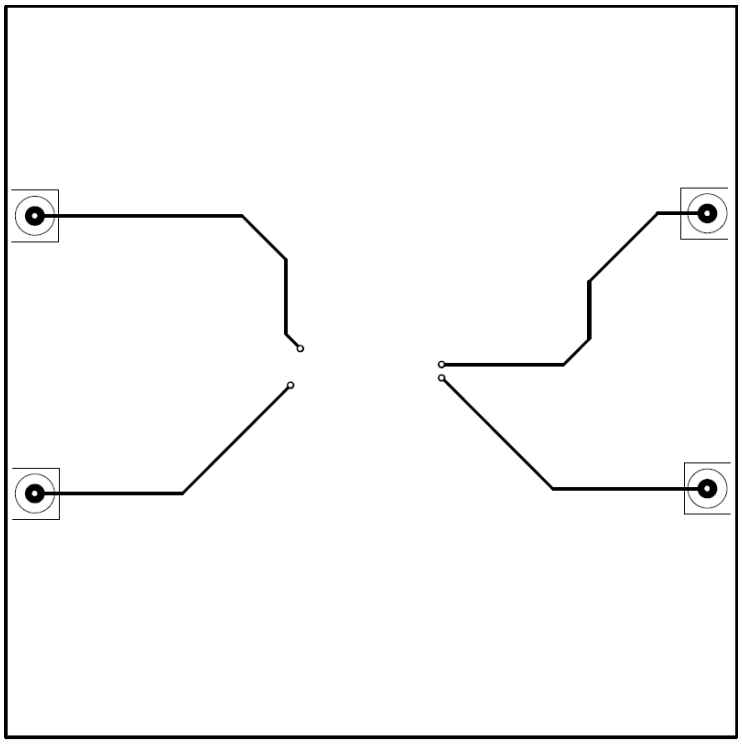

Figure 9 Layer 3: Sense Layer

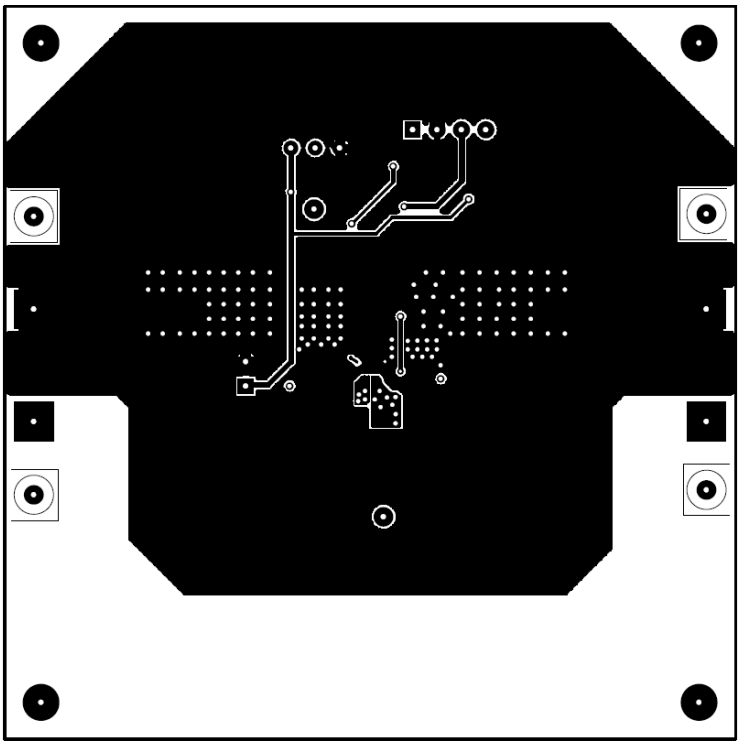

Figure 10 Layer 4: Bottom Layer

Bill of Material

MISCELLANEOUS COMPONENTS			
Item	Part Description	Reference	Qty
1	Microsemi IC – LX7165	U1	1
2	Test Point	SW, PGOOD, VIN_S, VO_S, GND_S, GND_S	6
3	Terminal	VIN, VOUT, GND, GND	4
4	Jumper/3pin	JP2	1
5	Jumper/4pin	J2	1

CAPACITORS			
Item	Part Description	Reference	Qty
6	1uF	C2	1
7	22uF/10V/X5R	C3, C8	2
8	47uF Electronic	C4	1
9	22uF/6.3V/X5R	C5, C6, C7	3

RESISTORS			
Item	Part Description	Reference	Qty
10	0	R1, R4	2
11	100kOhm	R3	1
12	10kOhm	R5, R6	2

INDUCTOR			
Item	Part Description	Reference	Qty
13	0.47uH -- IHLP-2020CZ-01series	L1	1

Efficiency Plot

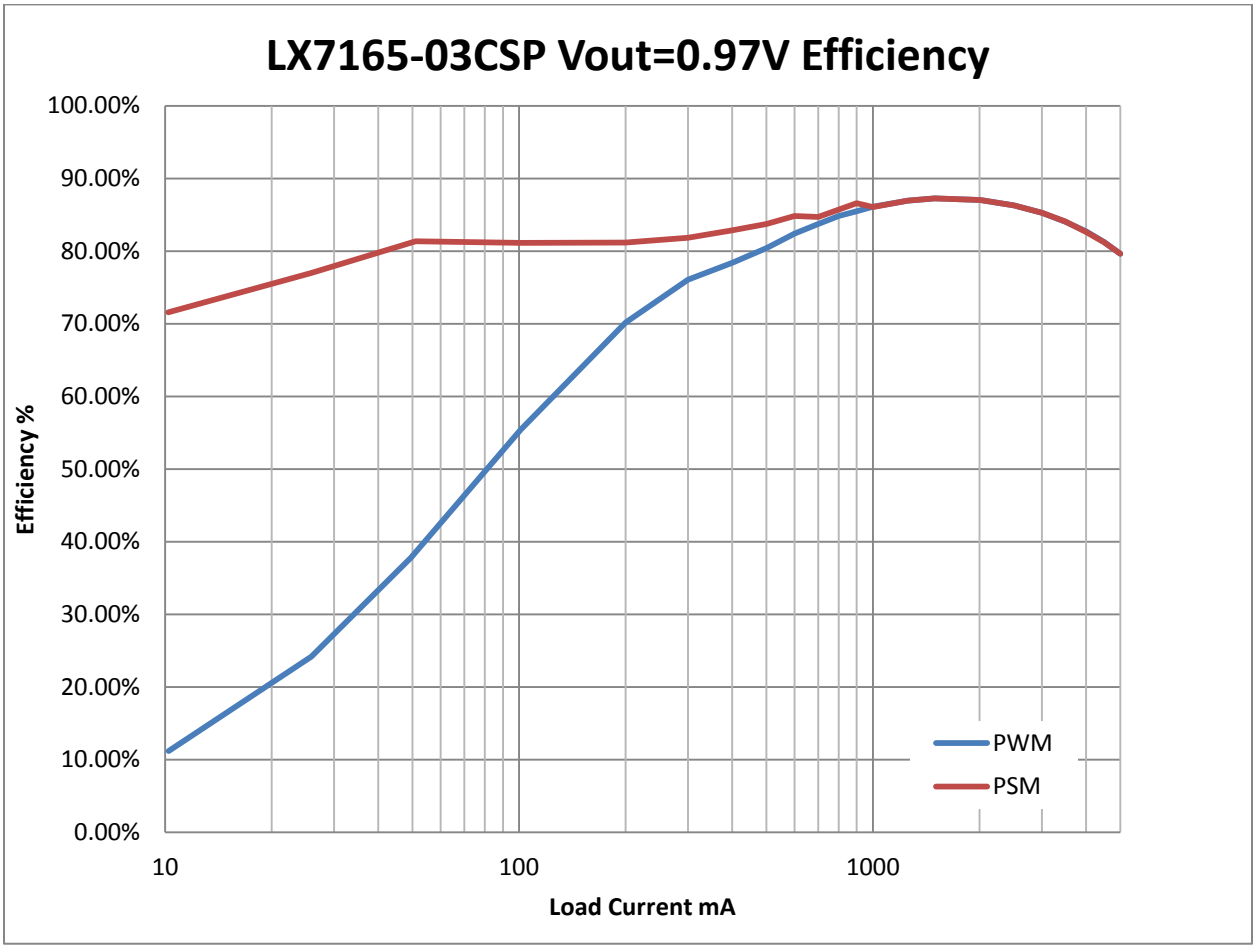

Figure 11 Efficiency Plot of LX7165-03CSP

Dynamic Load Response Scope Shots

Dynamic load response with 0.5↔2.5A load

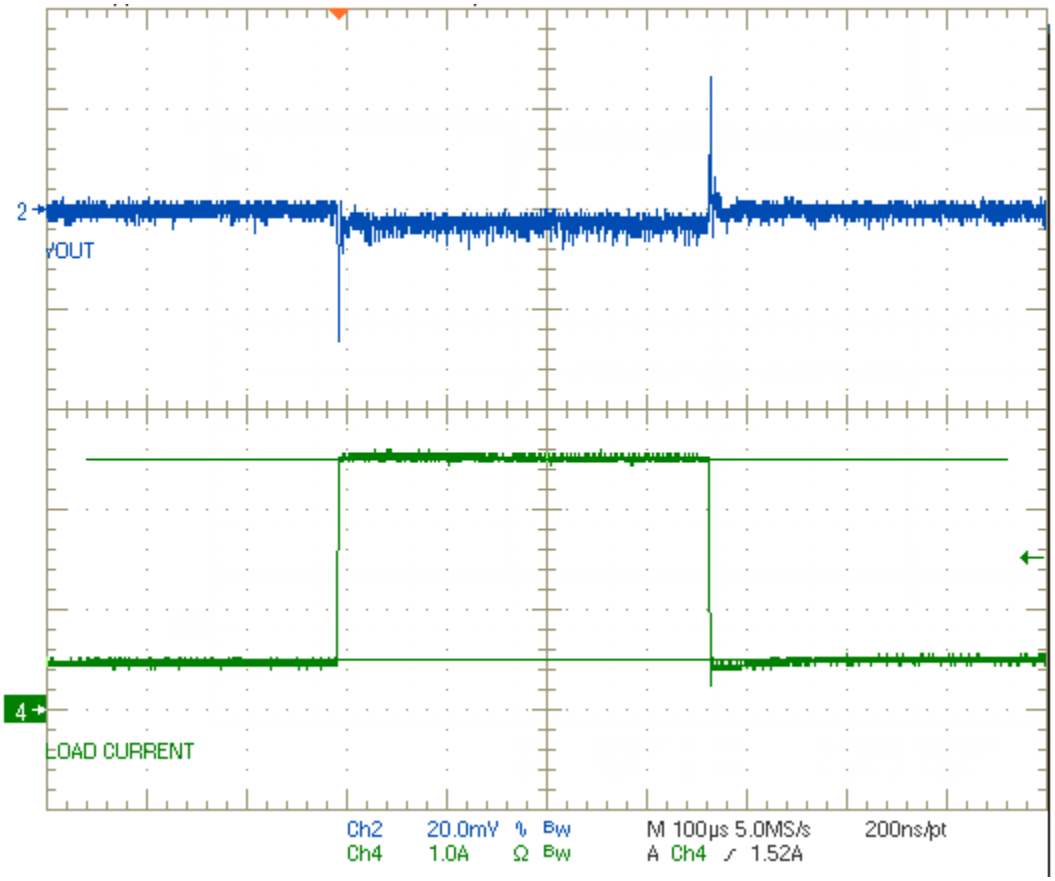

Figure 12 Dynamic Load Response with 0.5↔2.5A Load

CH2: VOUT, CH4: Load Current

Dynamic load response with 0.5↔2.5A load Rising Edge

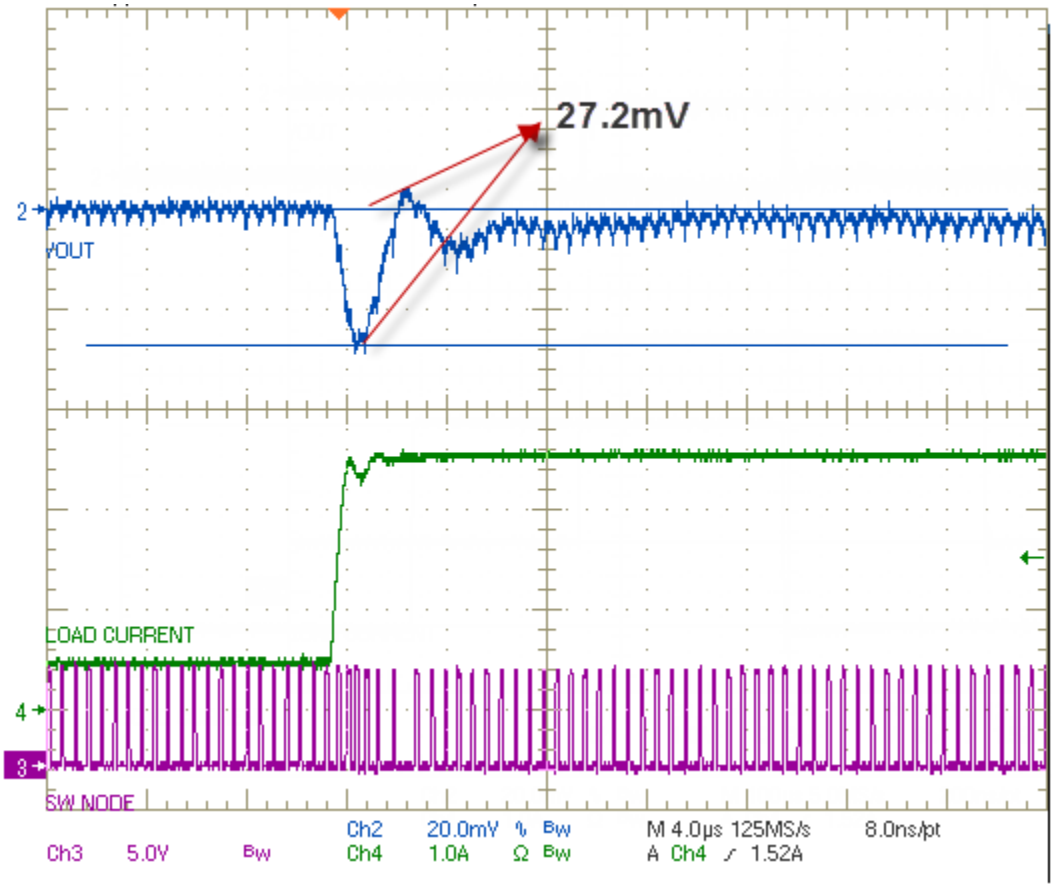

Figure 13 Dynamic Load Response Rising Edge with 0.5↔2.5A Load

CH2: VOUT, CH3: SW, CH4: Load Current

Dynamic load response with 0.5↔2.5A load Falling Edge

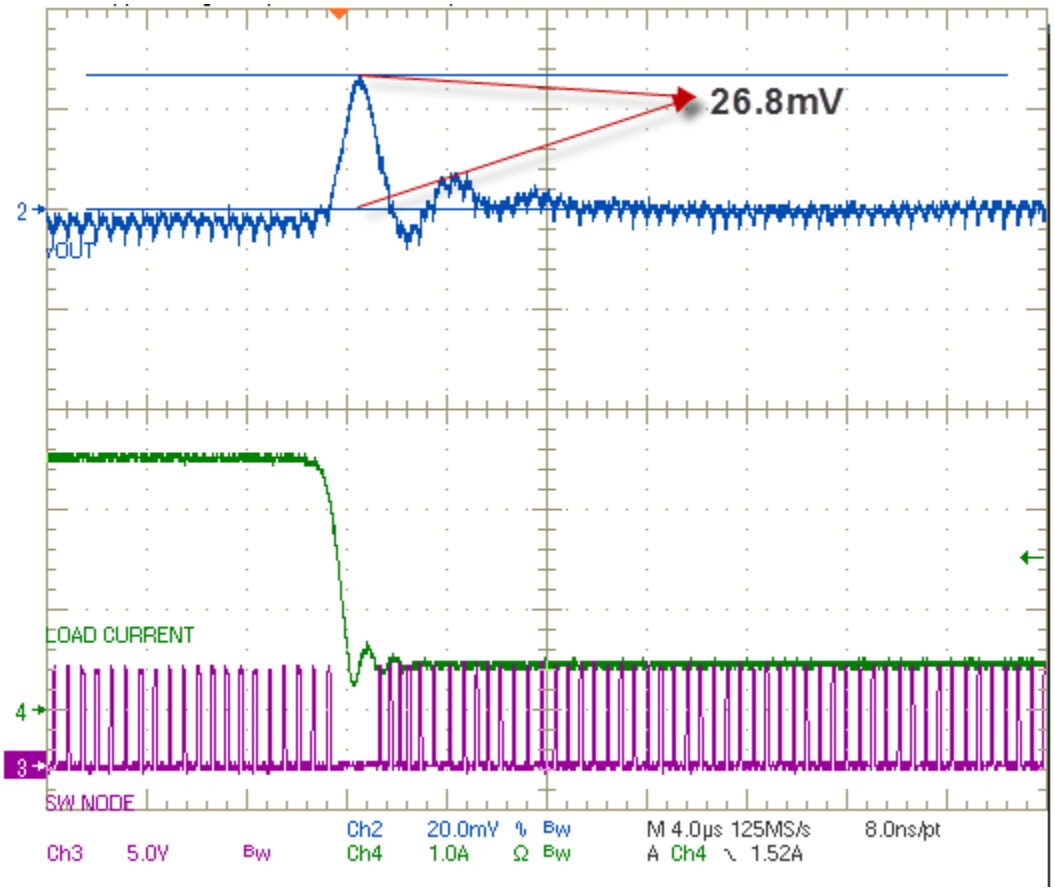

Figure 14 Dynamic Load Response Falling Edge with 0.5↔2.5A Load

CH2: VOUT, CH3: SW, CH4: Load Current

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Start up Scope Shots

Start up with ENABLE toggled

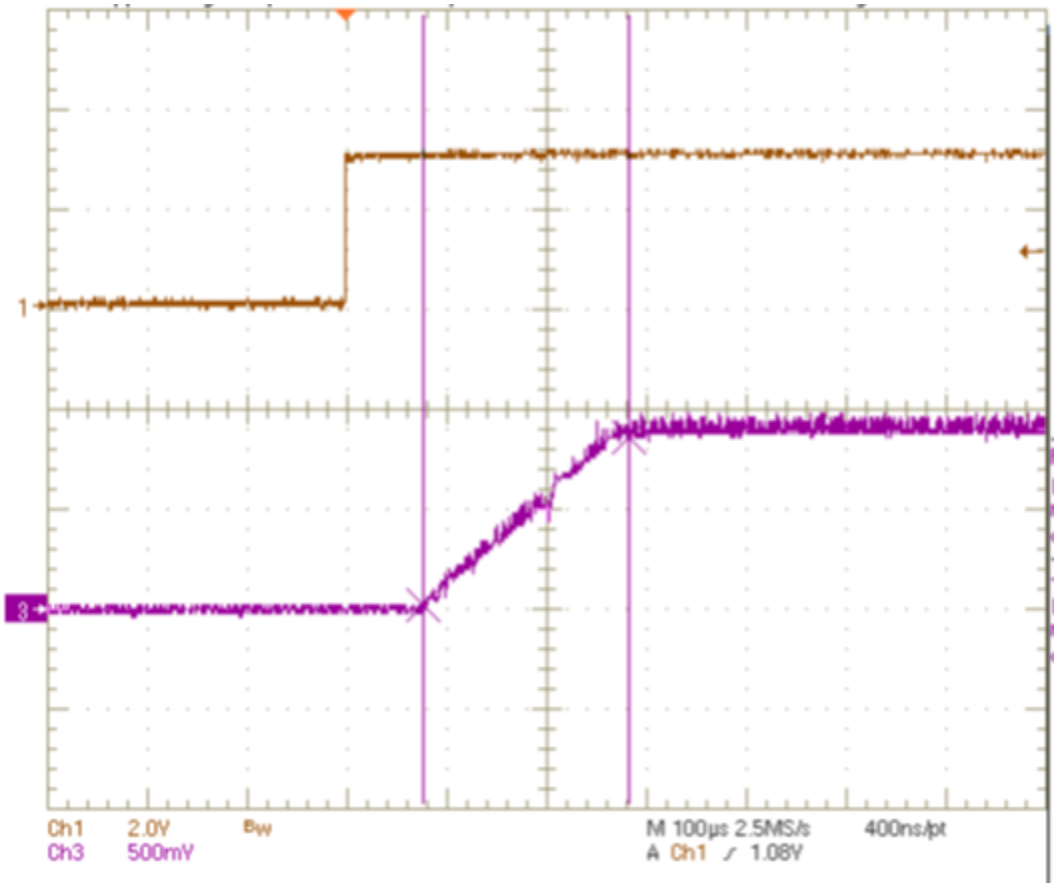

Figure 15 Startup with ENABLE toggled

CH2: EN, CH3, VOUT

Soft Start with VIN tied to EN

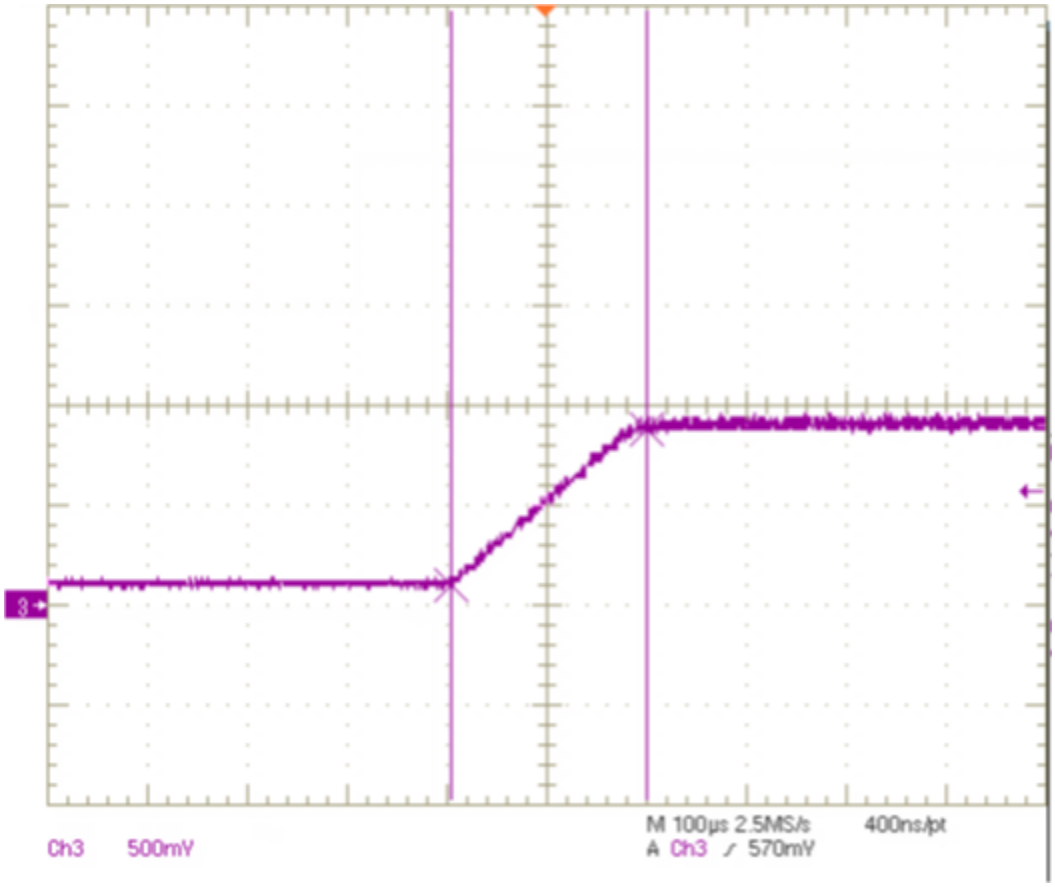

Figure 16 Soft start VIN tied to ENABLE

CH3, VOUT

Start up when VIN = 4.5V, Load = 0.5Ohm

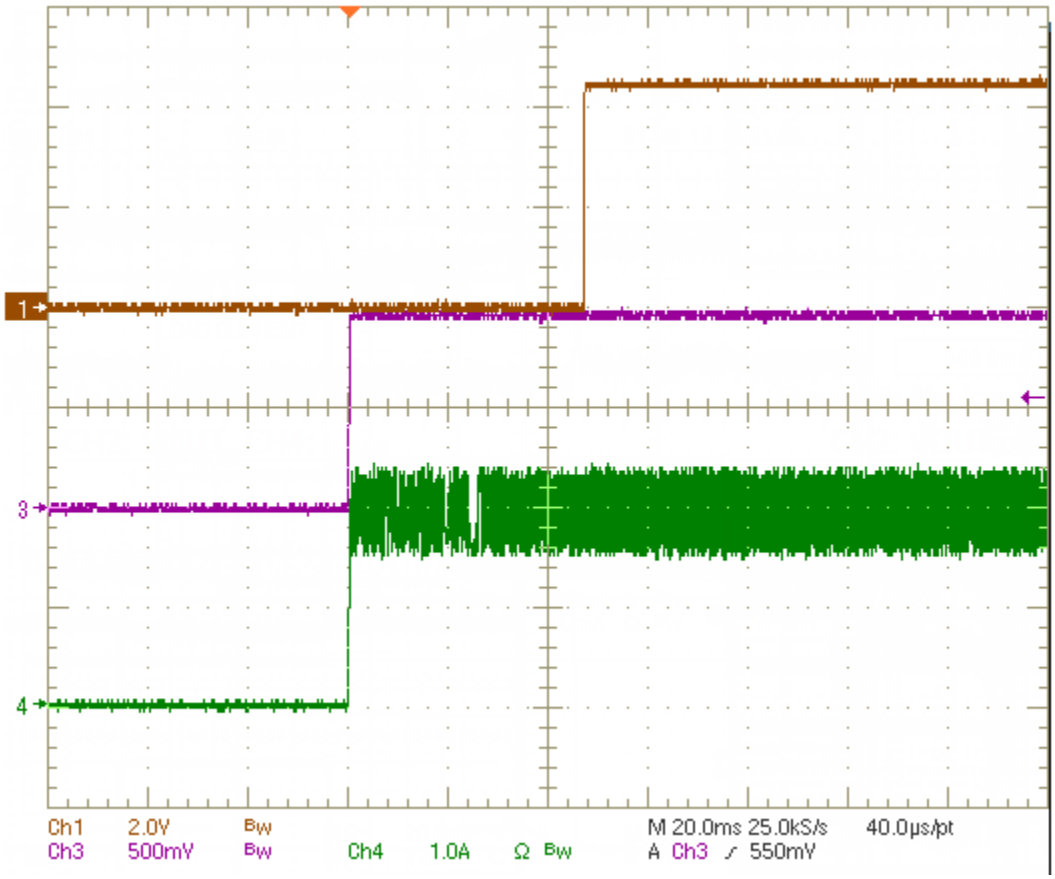

Figure 17 Start Up When Vin=4.5V Load=0.5ohm

CH1: PG, CH3: VOUT, CH4: Inductor Current

Start up when VIN = 4.5V, Load = 0.5Ohm, Rising Edge

Figure 18 Zoomed in Rising Edge of Start Up When VIN = 4.5V Load = 0.5ohm

CH3: VOUT, CH4: Inductor Current

Dimax SUB-20 and LX7165 GUI Installation

Figure 19 Dimax SUB-20 Adapter

1. Uninstall any previous version of the SUB-20 adapter if exist.
2. Download and install SUB-20 USB driver from
   http://www.xdimax.net/download/SUB-20-120121-x32.exe
   Note: Install the x64 driver file for 64-bit systems.
   More downloads available at http://www.xdimax.com/sub20/sub20.html#DLD
3. Connect SUB-20 device to computer's USB,
   If this is the first time you connect the specific device, wait for SUB-20 driver installation to finish - Found new hardware, let computer auto search for driver.
4. Firmware update:
   - The SUB-20 firmware version should be 0.3.5.
   - Open "Firmware updater" tool. The Firmware updater tool has a shortcut on the desktop. It may also be found at Start→ Programs → SUB-20 → Firmware updater.
5. Follow the instructions in the following link: SUB-20 Firmware Update
6. Connect the adaptor according to the following connection:
   - 4 PIN to 9PIN cable connects LX7165 EVB I^2C port and SUB-20 (Unused pin on 4 PIN connecter aligns with V+ pin on I^2C port)
   - USB to mini-USB cable connects SUB-20 and PC
   - SUB-20 DB-9 connector pin #5 = GND
   - SUB-20 DB-9 connector pin #6 = I2C_SDA
   - SUB-20 DB-9 connector pin #8 = I2C_SCL
7. Install LX7165 GUI
   Click CD:/LX7165 GUI/I2C Register Access_1_0_8_x.exe to start the installation,
   To open the GUI, go to Startup> All Programs> Microsemi> Register Access>
   Choose "LX7165" when "production selects window "pops out.
8. LX7165 GUI and SUB-20 driver could be found in the Support CD