LX7178 EVALUATION BOARD USER GUIDE

LX7178 5 Amp Step Down Converter

Rev. 0.1, 2013-10-23

Microsemi
Analog Mixed Signal Group
One Enterprise Aliso Viejo, CA 92656 USA (800) 713-4113, (949) 380-6100

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Introduction to Product

The LX7178 is a digitally controlled step-down regulator IC with an integrated 40mΩ high-side P-channel MOSFET and a 14mΩ low-side N-channel MOSFET. It features Microsemi's proprietary constant-frequency hysteretic control engine for near-instantaneous correction to line/load transients. It does not require high-ESR output capacitors and incorporates energy-saving "PSM" (Power Save or Pulse Skip Mode) at light loads, to extend battery life in mobile applications.

The LX7178 has an I^2C serial interface port for output voltage margining and monitoring if required (it can also operate in default mode). In addition it includes robust fault monitoring functions.

The LX7178 will operate from 3V to 5.5V, and is available in a fixed output voltage option of 0.8V (no voltage divider is necessary). The output voltage can also be adjusted with an external voltage divider up to 3.3V.

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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
- I^2C Selectable 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
- Notebook/ Netbook
- Tablets/ Slates

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Part Specific Information

IC Part Number	Description
LX7178-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 0.8V, 2 is 0.9V, 3 is 0.975V)

Evaluation Board Part Number	Description
LX7178 EVAL BOARD	Evaluation PCB for LX7178

Evaluation Board Schematic

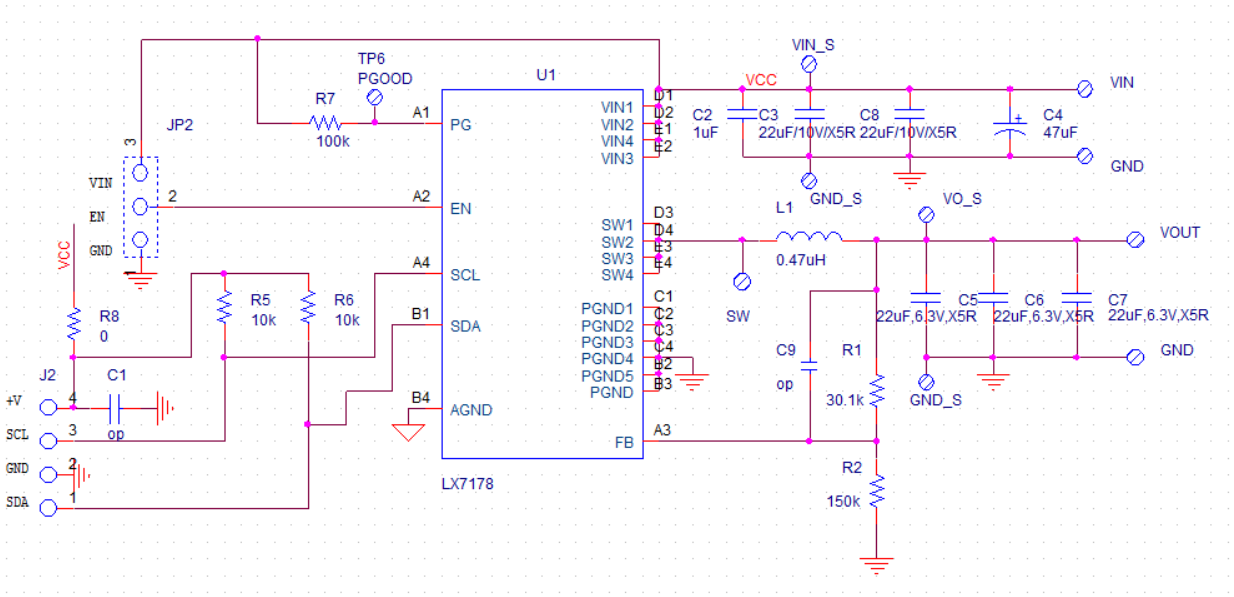

Figure 1: Schematic of Evaluation Board

Basic Connection Instruction

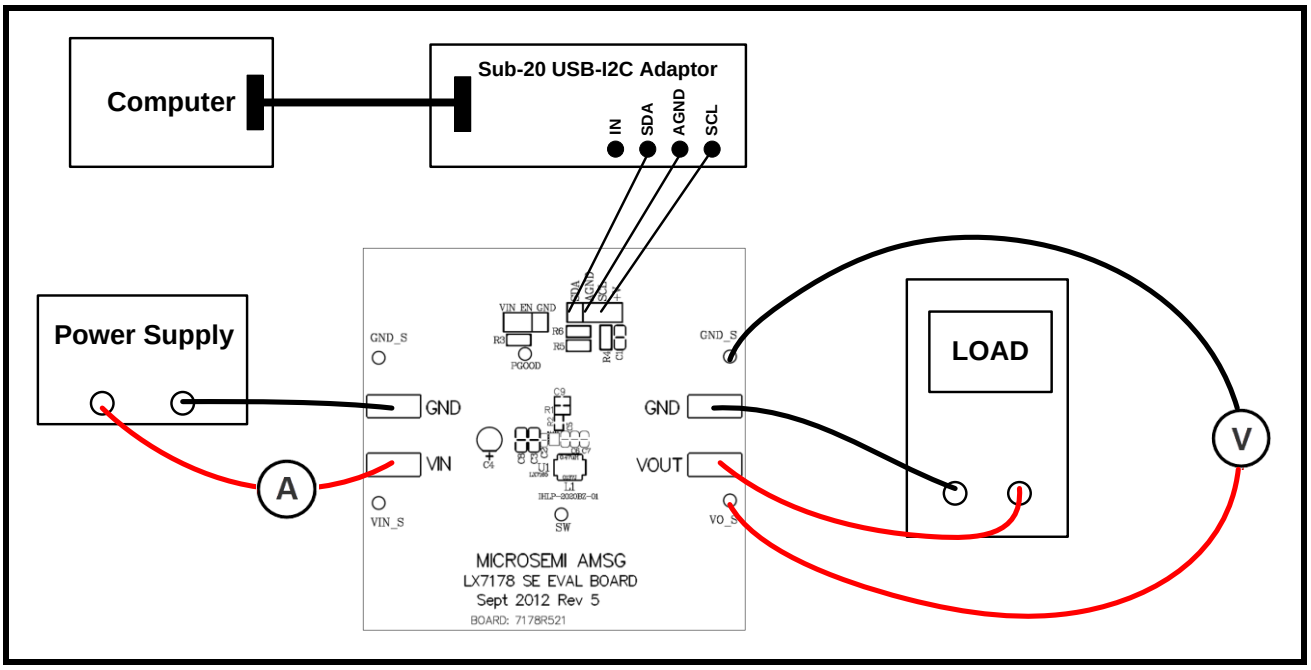

Figure 2: Power Supply and Load Connection with I^{2}C Implemented

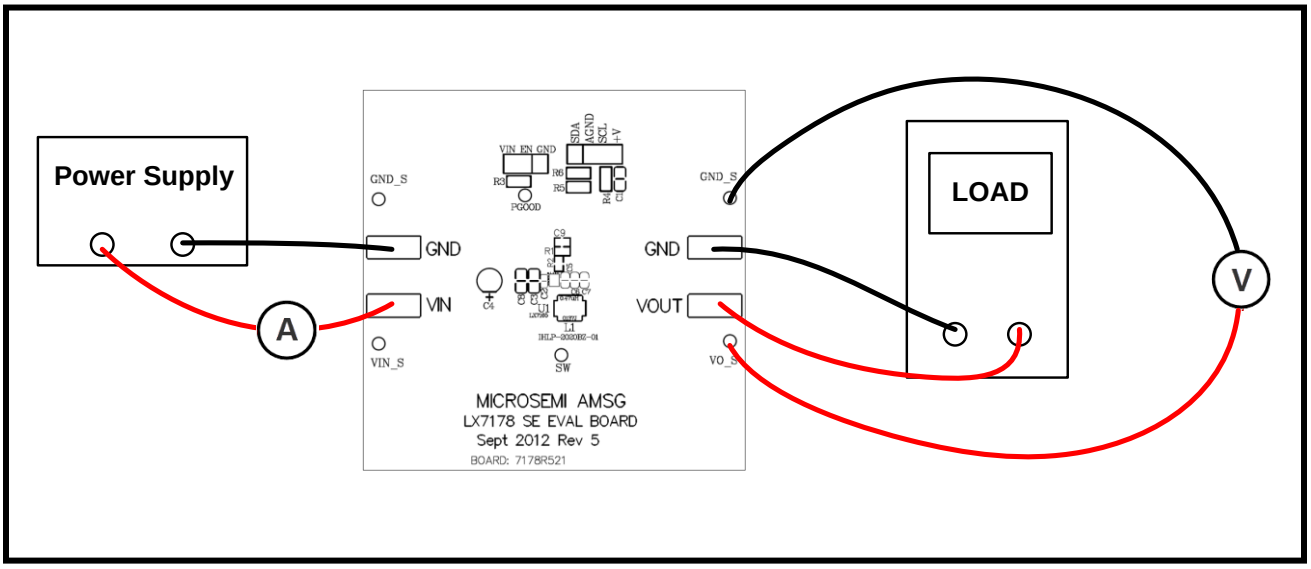

Figure 3: Power Supply and Load Connection without I^{2}C Implemented

LX7178 I²C GUI

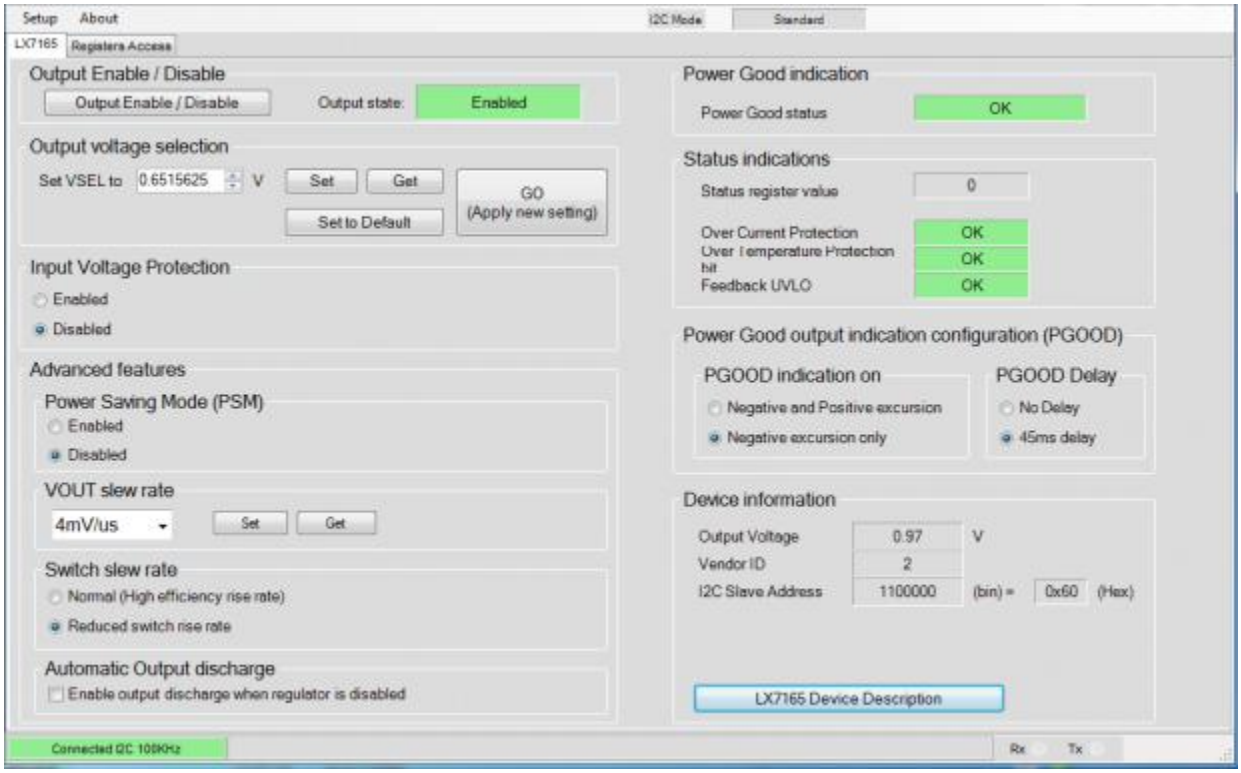

Figure 4: LX7178 I²C GUI

LX7178 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 LX7178 datasheet.

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

Recommended Operating Conditions

Description	Symbol	Min	Max	Unit
Input Voltage	V_{IN}	3	5.5	V
Output Current	I_{OUT}		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 EN 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

Using the I²C interface you 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 100kΩ. The formula below calculates the value of VOUT based on the resistor divider R1 & R2.

$$VOUT = V_{REF} \times \left(1 + \frac{R1}{R2}\right)$$

V_{REF} is determined by the chip, for example, to set the LX7178-01CSP to a VOUT = 0.96V, given V_{REF} = 0.8V. First pick the lower resistor R_2=150k, calculate the upper resistor R1=30.1k.

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PCB Layout of Evaluation Board

The LX7178 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. No microvias or blind vias are needed; each signal can leave the LX7178 directly without using any via under the device. The layout so implemented can lower the ESL with the bypass capacitors C2, C3 and C9, only C4 is located some distance from the controller.

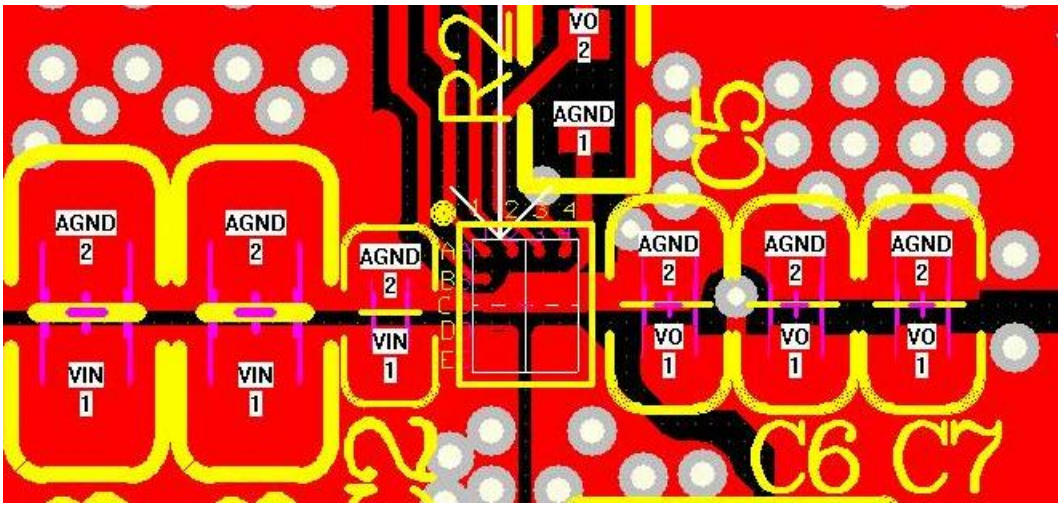

Figure 5: Layout Recommendation

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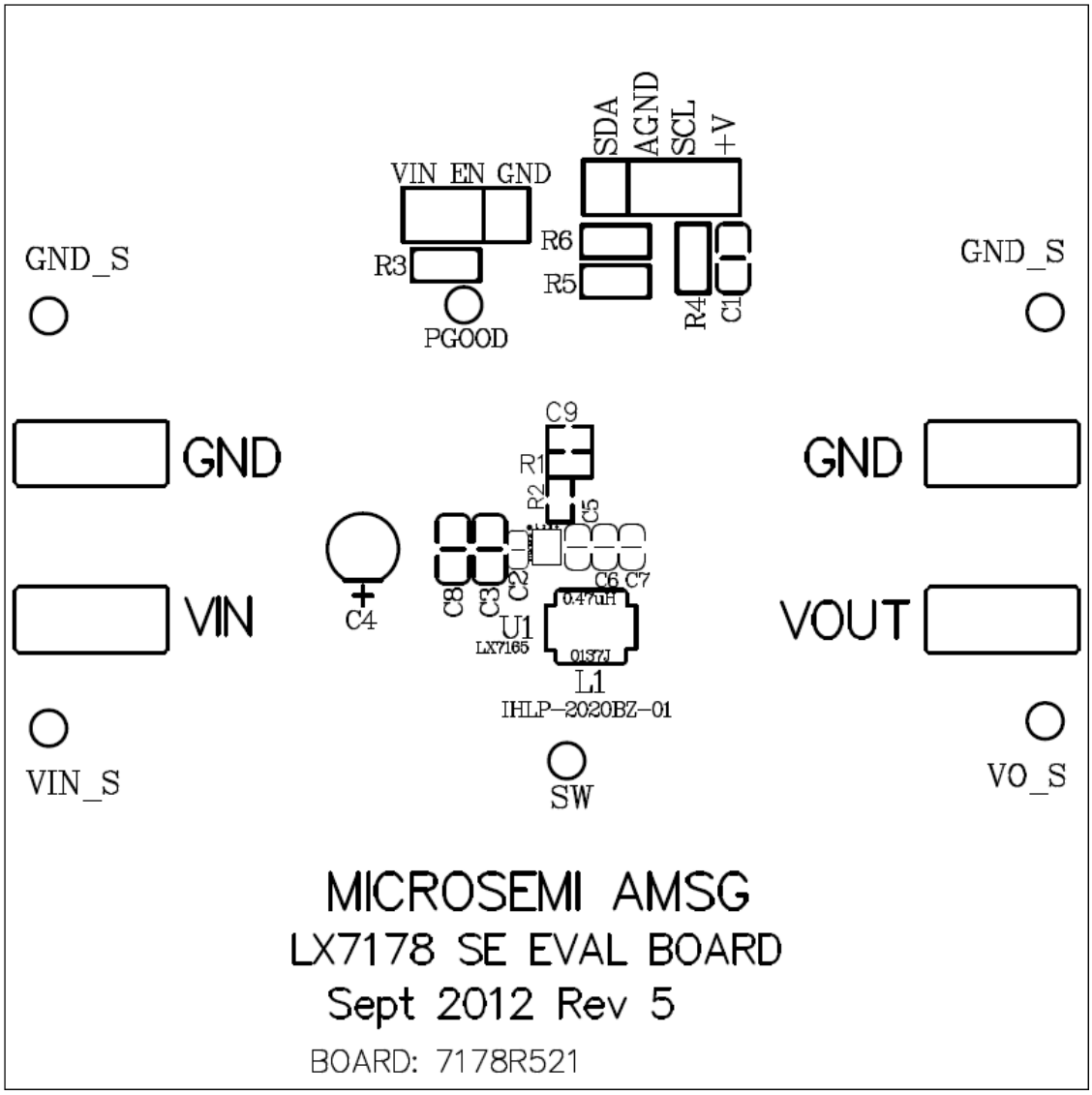

Figure 6: Top Silkscreen

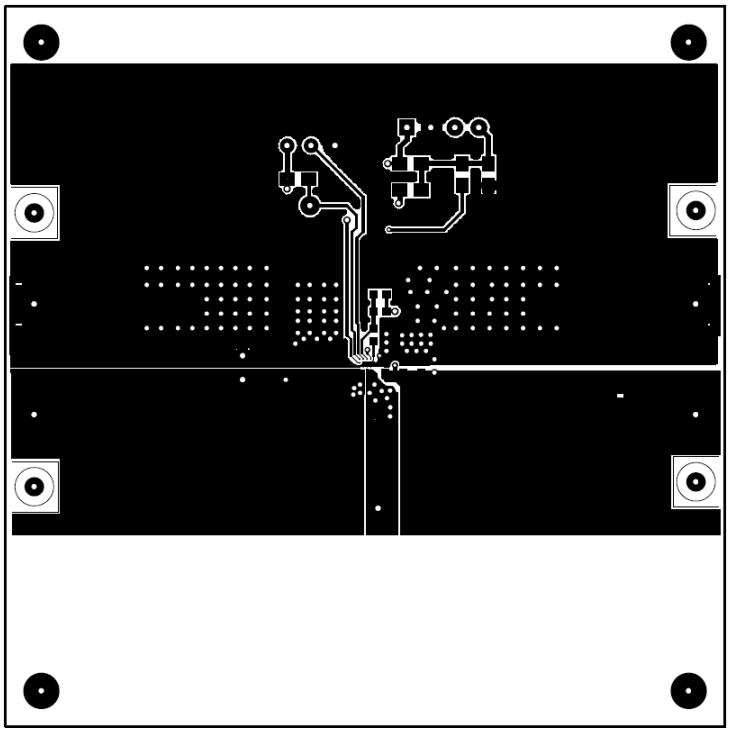

Figure 7: Layer 1: Top Layer

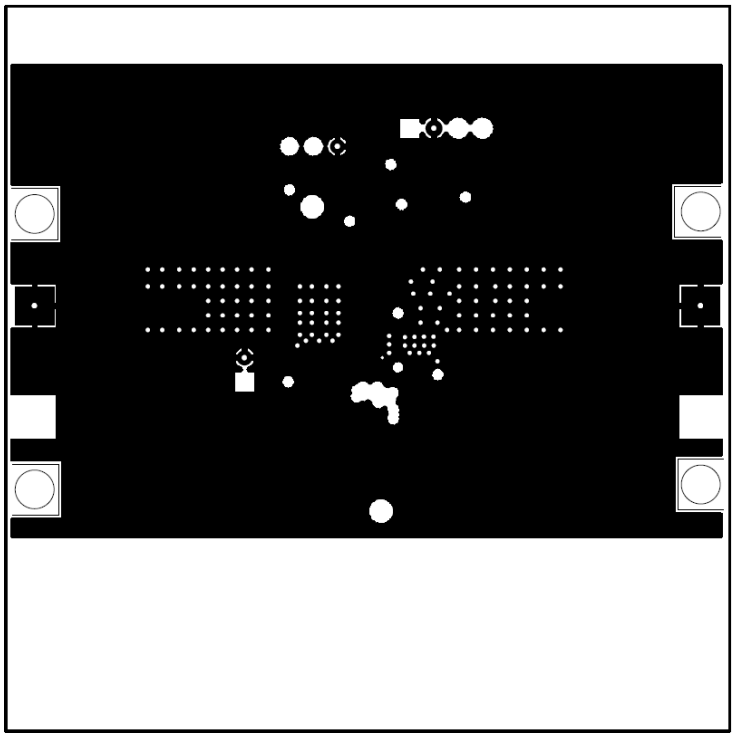

Figure 8: Layer 2: Ground Layer

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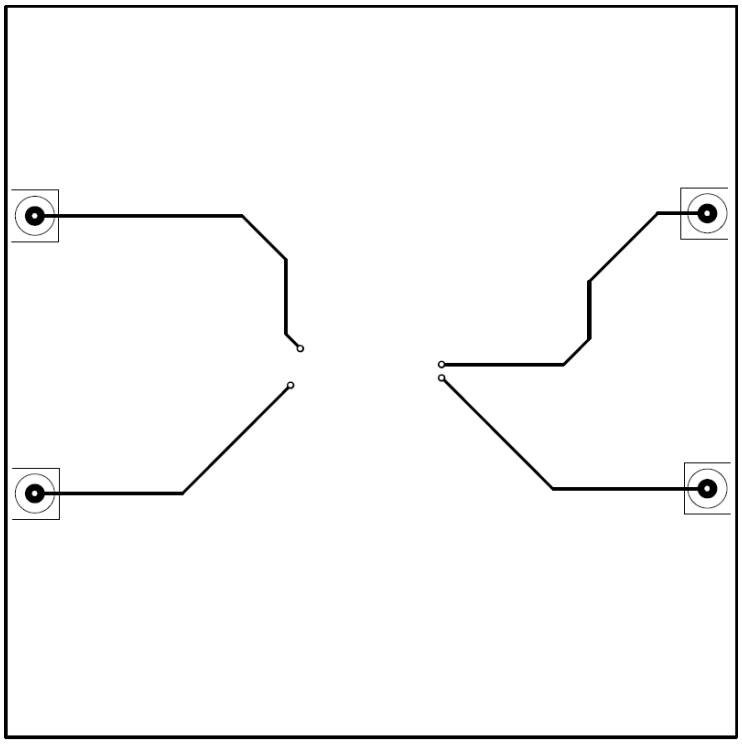

Figure 9: Layer 3: Sense Layer

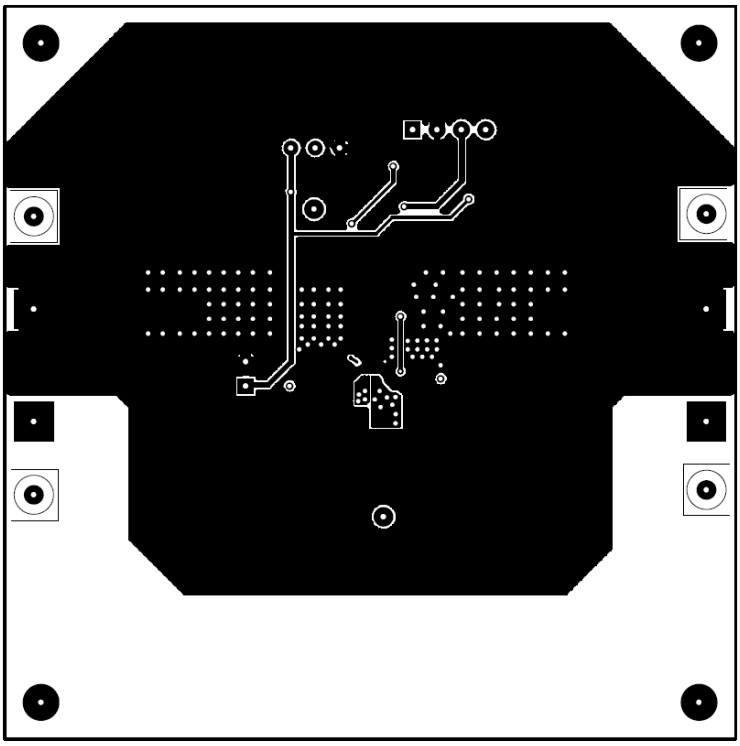

Figure 10: Layer 4: Bottom Layer

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Bill of Material

MISCELLANEOUS COMPONENTS			
Item	Part Description	Reference	Qty
1	Microsemi IC – LX7178-xy	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/10V/X5R	C2	1
7	22uF/10V/X5R	C3, C8	2
8	47uF Electronic/35V	C4	1
9	22uF/6.3V/X5R	C5, C6, C7	3

RESISTORS			
Item	Part Description	Reference	Qty
10	30.1kΩ	R1	1
11	150kΩ	R3	1
12	10kΩ	R5, R6	2
13	100kΩ	R7	1
14	0	R8	

INDUCTOR			
Item	Part Description	Reference	Qty
15	0.47uH -- IHLP-2020CZ-01series	L1	1

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Efficiency Plot

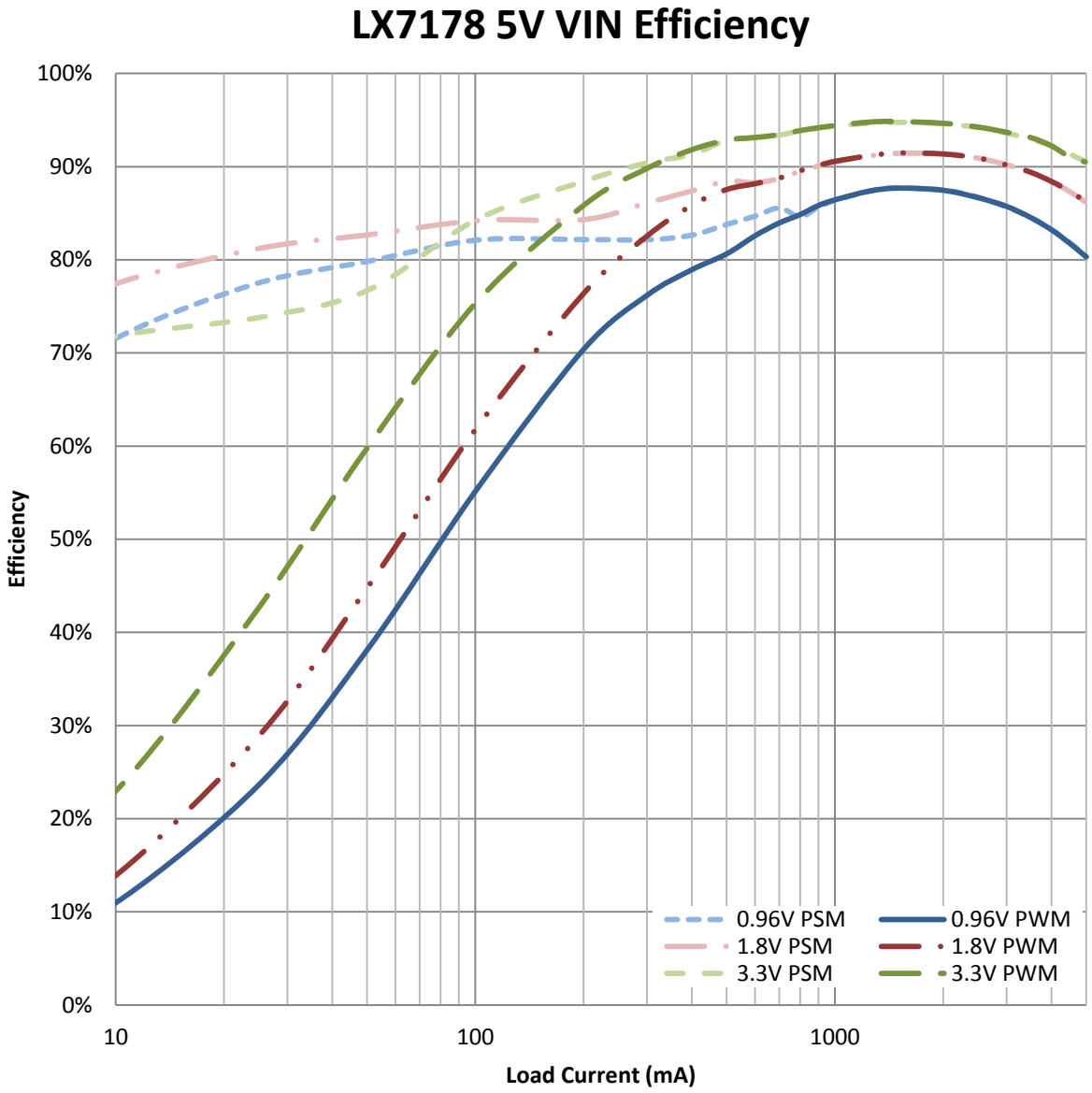

Figure 11: Efficiency Plot of LX7178-01CSP

Dynamic Load Response Scope Shots

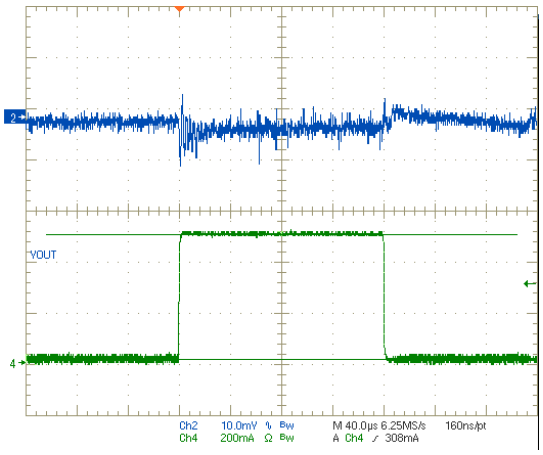

Figure 12: No load to 0.5A PWM
CH2: VOUT, CH4: I_{LOAD}

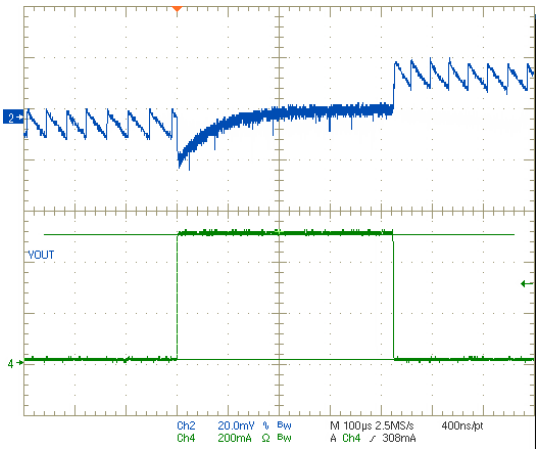

Figure 13: No load to 0.5A PSM
CH2: VOUT, CH4: I_{LOAD}

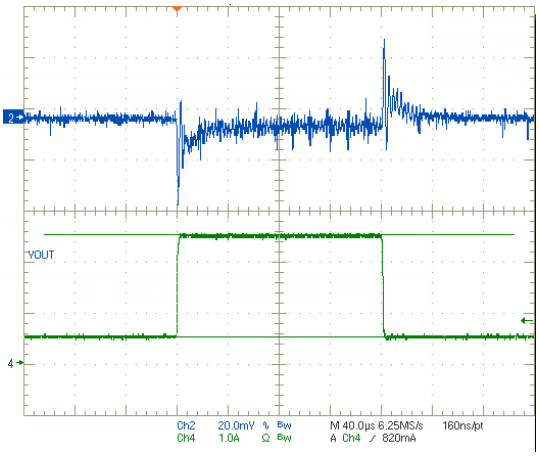

Figure 14: 0.5A to 2.5A PWM
CH2: VOUT, CH4: I_{LOAD}

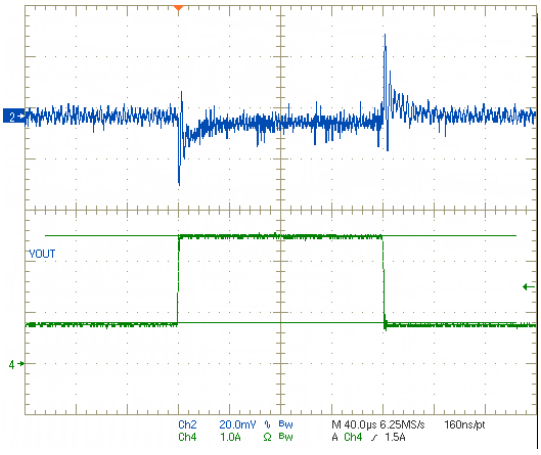

Figure 15: 0.8A to 2.5A PWM
CH2: VOUT, CH4: I_{LOAD}

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Dynamic Load Response Scope Shots (Continue)

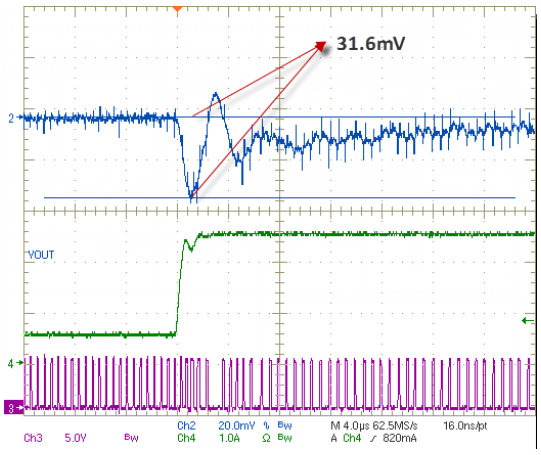

Figure 16: 0.5A to 2.5A PWM Rising Edge
CH2: VOUT, CH3: SW, CH4: I_{LOAD}

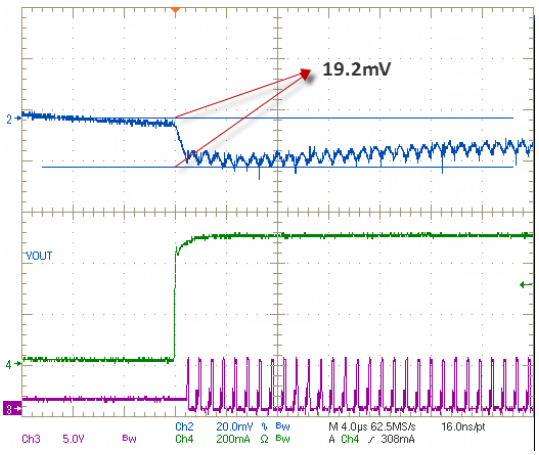

Figure 17: No load to 0.5A PSM Rising Edge
CH2: VOUT, CH3: SW, CH4: I_{LOAD}

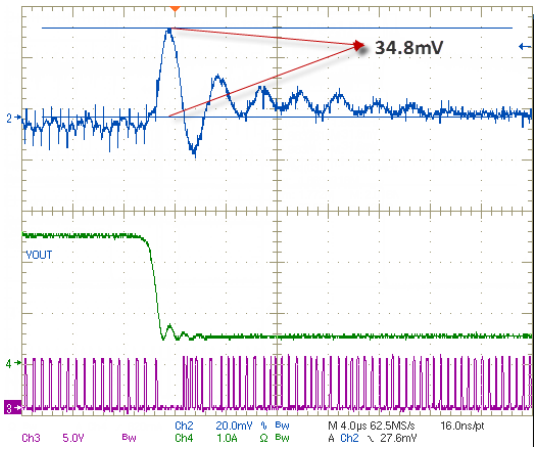

Figure 18: 0.5A to 2.5A PWM Falling Edge
CH2: VOUT, CH3: SW, CH4: I_{LOAD}

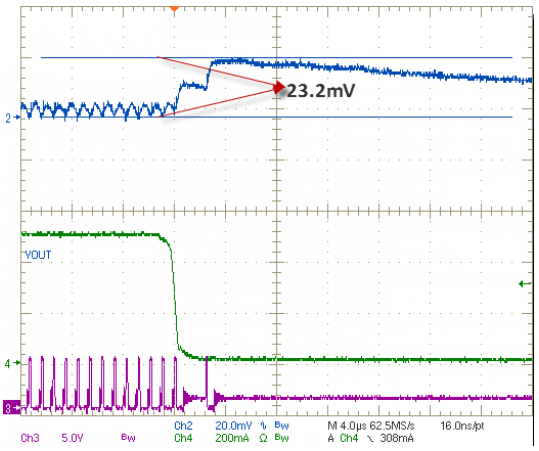

Figure 19: No load to 0.5A PSM Falling Edge
CH2: VOUT, CH3: SW, CH4: I_{LOAD}

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Start up and Short Condition Scope Shots

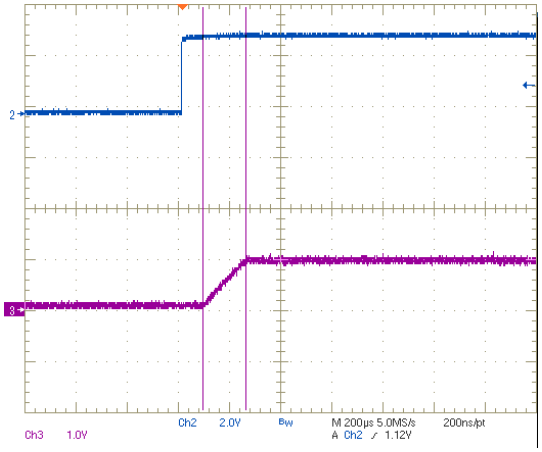

Figure 20: Startup with ENABLE toggled
CH2: EN, CH3: VOUT

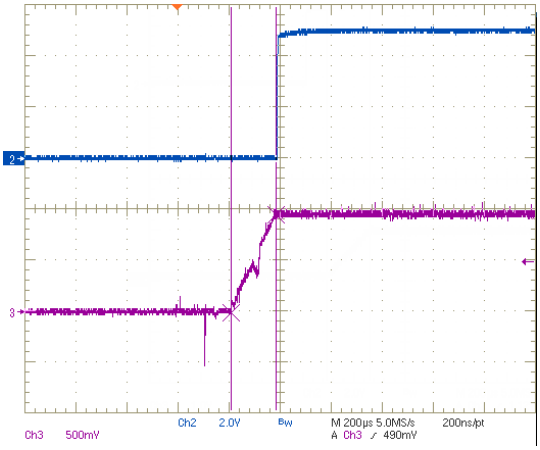

Figure 21: Soft start VIN tied to ENABLE
CH2: EN, CH3: VOUT

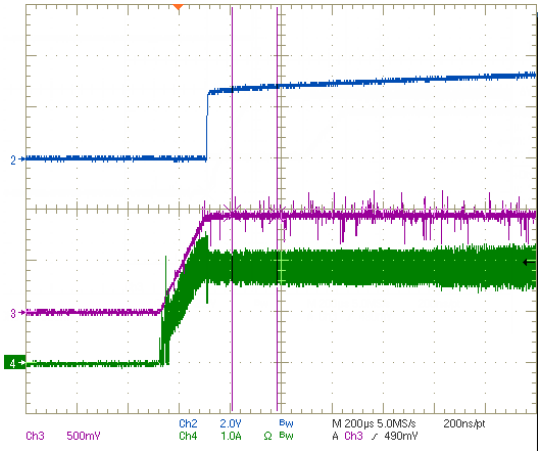

Figure 22: Start Up When Vin=4.5V Load=0.5ohm
CH2: PG, CH3: VOUT, CH4: Inductor Current

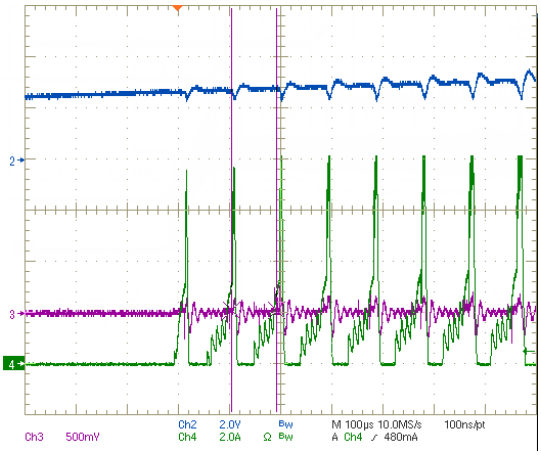

Figure 23: Power into Short
CH2: VIN, CH3: VOUT, CH4: Inductor Current

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Start up and Short Condition Scope Shots (Continue)

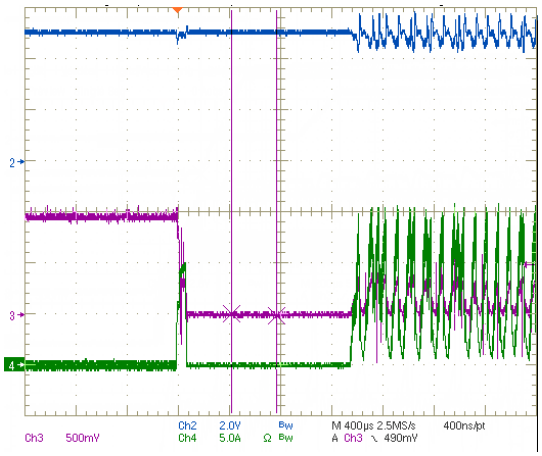

Figure 24: Power after Short
CH2: VIN, CH3: VOUT, CH4: Inductor Current

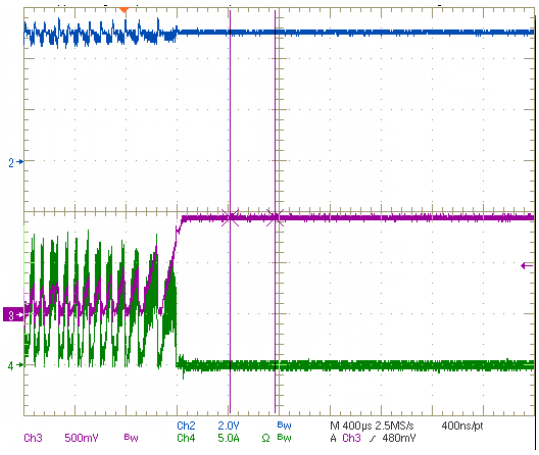

Figure 25: Recovery from Short
CH2: VIN, CH3: VOUT, CH4: Inductor Current

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Dimax Sub20 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 LX7178 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 LX7178 GUI
   Click CD:/LX7178 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. LX7178 GUI and SUB-20 driver could be found in the Support CD