LP3906 Smart Power Reference Design - 4 outputs

National Semiconductor
RD-161
Novtech Engineering
December 2007

1.0 Design Description

The LP3906 Smart Power Board provides a complete, multi-rail solution for FPGAs, Microprocessors, or any other systems requiring multiple voltages, special power sequencing, and boot management. This solution utilizes the National Semiconductor LP3906 Power Management Unit and an 8 bit microcontroller to manage the features of the PMU. There are more than 400,000 combinations of initial voltage values for the output voltages, this solution can provide them all regardless of the chip hard-coded startup values.

An RS-232 port and Windows application are also provided to simplify evaluation of the solution using a PC; however, this is not required for a final system implementation.

LP3906 Key Specifications:

Two Buck Regulators

•Buck 1 0.80-2.0V
•Buck 2 1.0-3.5V
•Up to 96% efficiency
•Up to 1.5A output current

Two Low Dropout Linear Regulators

•Programmable V_{OUT} of 1.0V-3.5V
•±3% output voltage accuracy
•300mA output currents
•25mV (typ) dropout

2.0 Features

LP3906 Smart Power Board Key Features

- Utilizes the National Semiconductor LP3906 Power Management Unit and the low cost Freescale 8-bit microcontroller
- Solution provides user control over all default voltage startup values, boot control (reset lines, enable lines, etc), order and time sequencing of rails. Power down sequencing is also possible with modifications to the firmware.
- Utilizes LP3906 GPIOs and / or MCU GPIO for boot control.
  - Power-on Reset
  - Peripheral Reset
  - Control of reset polarity and drive type (“open drain” like, push-pull)
- Board also provides jumpers to allow insertion for current monitoring of loads or input.
- The control values stored in the MCU flash can be easily modified for FPGAs, DSPs, other processors, and any other multi-rail devices without changing the firmware which speeds time to market.

LP3906 Device Special Features

- Compatible with advanced applications processors and FPGAs
- 2 LDOs for powering Internal processor functions and I/Os
- High speed serial interface for independent control of device functions and settings
- Precision internal reference
- Thermal overload protection
- Current overload protection
- 24-lead 5 × 4 × 0.8 mm LLP package
- Software Programmable Regulators

3.0 Schematic

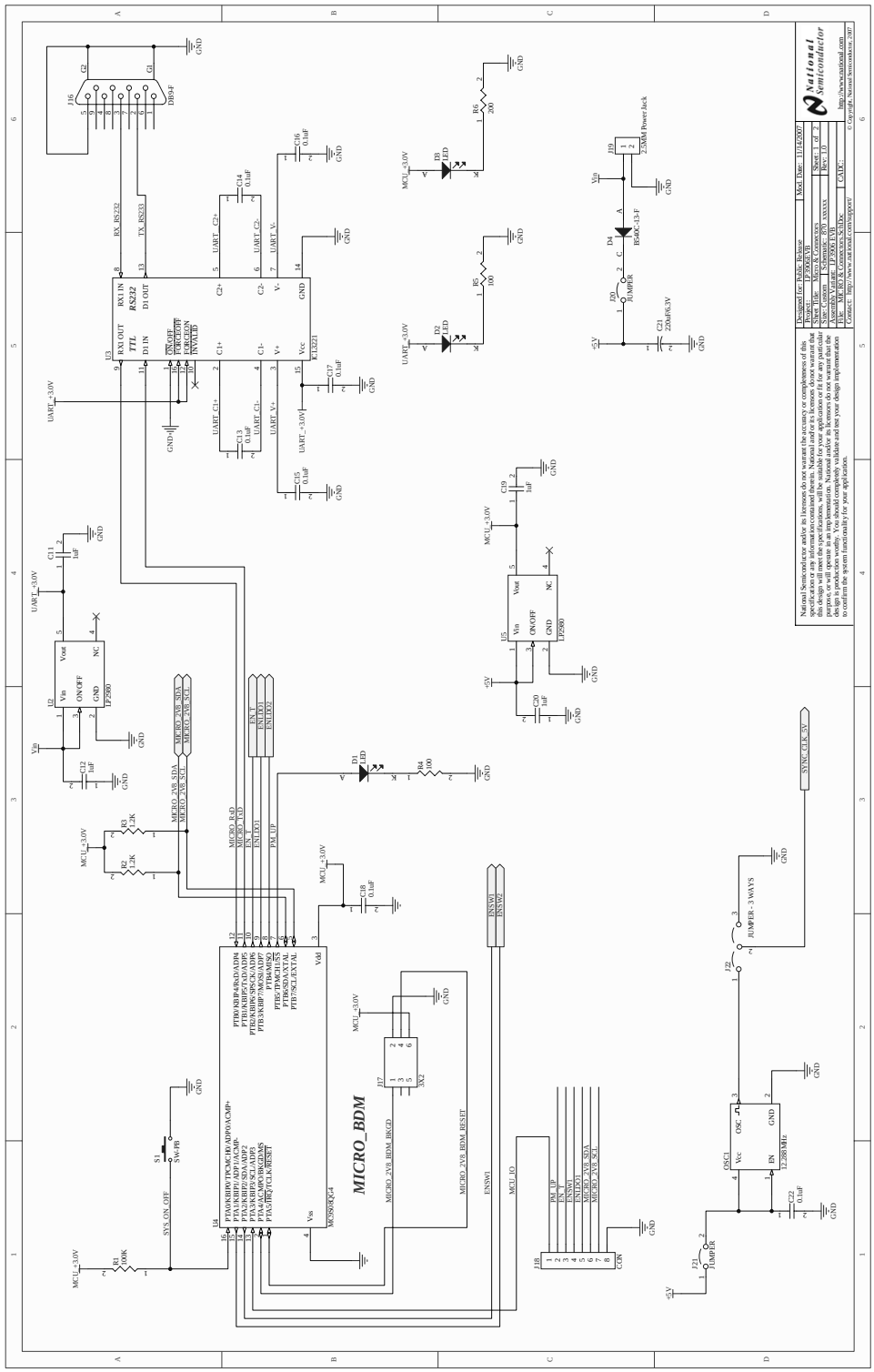


FIGURE 1. LP3906EVB_1

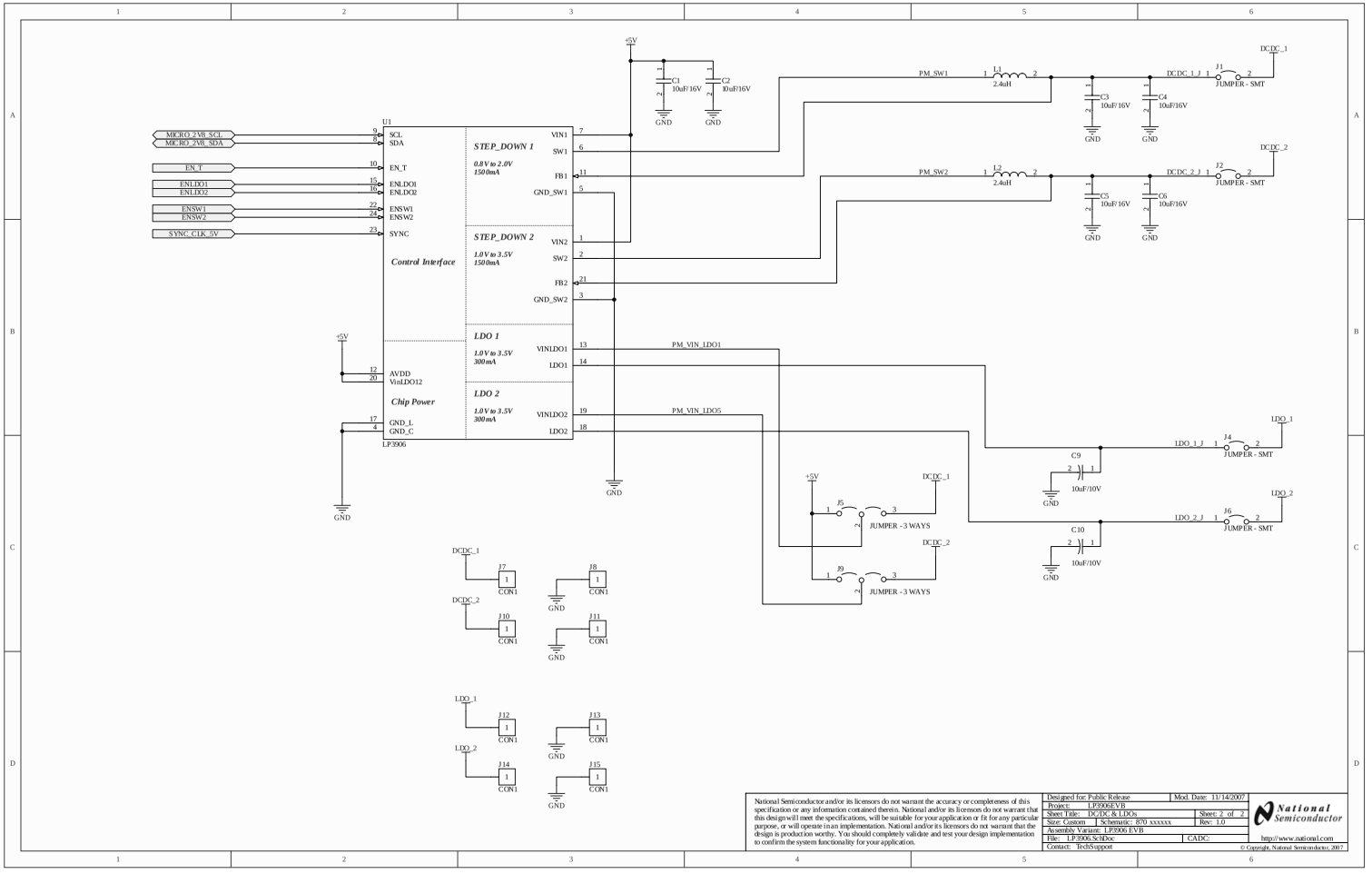


FIGURE 2. LP3906EVB_2

Component list

LP3906 EVB

Source Data From: LP3906_EVB.PrjPcb
Project: LP3906_EVB.PrjPcb
Variant: LP3906 EVB

National Semiconductor
The Sight & Sound of Information

Report Date: 4/30/2007 6:32:37 PM
Print Date: 15-Nov-07 10:38:00 AM

#	Comment	Description	Footprint	PART	MFG	RoHS	Designator	DigiKey	Quantity
	Parts that should be included at target design								
1	10uF/16V	Capacitor 0603footprint	1210_C				C1, C2, C3, C4, C5, C6		6
2	10uF/10V		A CASE (3216-18)				C9, C10		2
3	1uF	Capacitor 0603footprint	0603_C				C19 , C20		2
4	0.1uF	Capacitor 0603footprint	0603_C				C18		1
5	220uF/6.3V		C CASE (6032- 28)	T494C227M006AT	KEMET	Yes	C21	399-3848-1-ND	1
6	3X2		HEADER_BOX_3X2				J17		1
8	2.4uH		ELL6PM	ELL-6PV2R4N	PANASONIC		L1, L2	PCD1720CT-ND	2
9	1.2K	Resistor 0603 footprint	0603_R				R2, R3		2
10	LP3906	Dual High-Current Step-Down DC/DC and Dual Linear Regulator with I2C	LLP-24PIN 5X4X0.8MM	LP3906SQ-DJXI/NOPB	NATIONAL SEMICONDUCTOR	Yes	U1	LP3906SQ-DJXICT-ND	1
11	LP2980	Micropowe 50mA LDO	SOT23-5	LP2980AIM5-3.0	NATIONAL SEMICONDUCTOR	Yes	U5	LP2980AIM5-3.0CT-ND	1
12	MC9S08QG4	8 bit MCU from FreeScale	TSSOP_16	MC9S08QG4CDT	FreeScale		U4	MC9S08QG4CDTE-ND	1
								sub total:	***20***
	Parts that can be included at target design								
13	0.1uF	Capacitor 0603footprint	0603_C				C22		1
14	B540C-13-F		SMC	B540C-13-F	Diode Inc.	Yes	D4	B540C-FDICT-ND	1
15	JUMPER - SMT	JUMPER - SMT	BH2-NP				J1, J2, J4, J6		4
16	JUMPER - 3 WAYS	JUMPER - SMT	BH3-NP				J5, J9, J22		3
17	2.5MM Power Jack		PJ-002B (POWER JACK)	PJ-002B	CUI Inc	Yes	J19	CP-002B-ND	1
18	12.288MHz		OSC_SMT_7.3X4.8	CWX815-12.288M	Connor-Winfield	Yes	OSC1	CW556CT-ND	1
19	100K	Resistor 0603 footprint	0603_R				R1		1
20	SW-PB	Switch	B3F-602X	B3F6002BYOMZ		Yes	S1	SW797-ND	1
								sub total:	***13***
	Parts that are for EVB use								
21	1uF	Capacitor 0603footprint	0603_C				C11 , C12		2
22	0.1uF	Capacitor 0603footprint	0603_C				C13 , C14, C15, C16, C17		5
23	LED		0603_LED				D1, D2, D3		3
24	CON1		BH1-NP - 46MIL				J7, J8, J10, J11, J12, J13, J14, J15		8
25	DB9-F		DB9_F_318				J16		1
26	JUMPER	JUMPER	BH2-NP				J20 , J21		2
27	CON		BH8-NP				J18		1
28	100	Resistor 0603 footprint	0603_R				R4, R5		2
29	200	Resistor 0603 footprint	0603_R				R6		1
30	LP2980	Micropowe 50mA LDO	SOT23-5	LP2980AIM5-3.0	NATIONAL SEMICONDUCTOR	Yes	U2	LP2980AIM5-3.0CT-ND	1
31	ICL3221	IC TXRX SGL RS232 3-5.5V	TSSOP_16	ICL3221EIVZ	Intersil	Yes	U3	ICL3221EIVZ-ND	1
								sub total:	***27***
								total:	**60**

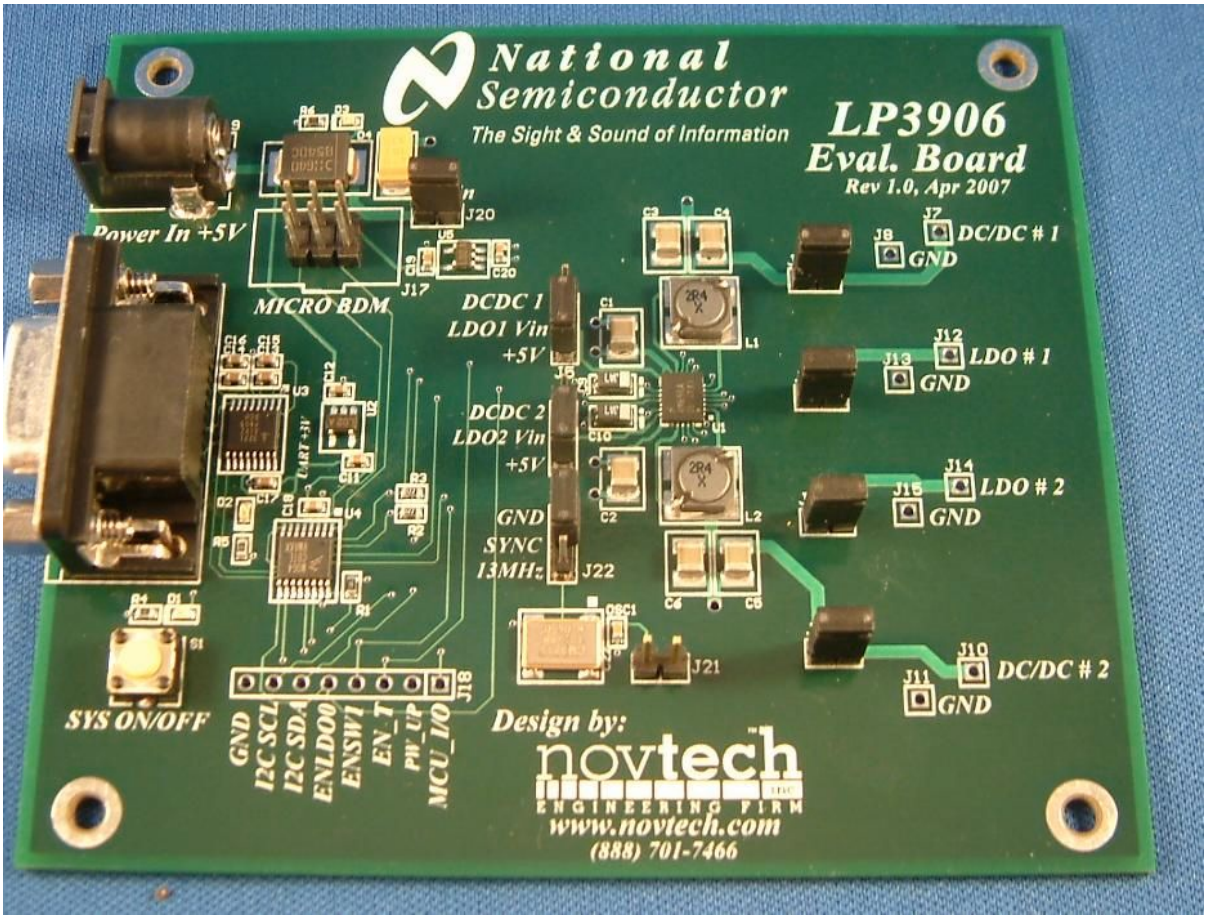
Approved

Notes

bom5

FIGURE 3. LP3906_EVB_BOM

5.0 Board Photos



boardphoto5

FIGURE 4. LP3906 EVB PHOTO

6.0 Quick Start

LP3906 Smart Power Board Operation

A dedicated 3V Micropower LDO (U5) powers the MCU. At this point the MCU can immediately start power sequencing the outputs or wait for an event to begin. In this implementation, the push-button will trigger power sequencing. Please note this feature can easily be changed by editing the firmware source code. Designers using this solution can utilize any event supported by the MCU to enable start-up. For example, communications events such as UART, I2C or SPI, changes in I/O state, MCU internal timers or external RTC events, etc. Until the power sequence start event, the MCU is held in stop mode consuming negligible current. Upon the startup event (push-button, etc.), the MCU will perform the following tasks:

1. The power-on control line (EN_T) is set high which enables the LP3906 interface (it does not enable any of the output voltages – it only allows access to the internal registers) and the device is reset.
2. By accessing the internal registers, all outputs are disabled and all voltage control registers in the LP3906 are updated from the values stored in the MCU flash.
3. The MCU then loads into RAM the sequence and delay tables.
4. The MCU enables the LP3906 Power-on control pins (ENLDO1, ENLDO2, ENSW1, ENSW2). Please note, that without an MCU, these pins control the output sequence of the default values of the LP3906. This solution allows ANY variant of the PMU to be used since the LP3906 manufacturing default values are overridden.
5. Now the MCU follows the **Flow Chart for Regulator Initialization** in the appendix to enable the outputs.

7.0 Hardware Description

The board has the LP3906 with all necessary discrete components to support all of the voltage rails. The microcontroller is powered by a Micropower LDO (U5).

The RS232 driver is powered by it's on discrete Low DropOut regulator to allow modifications of all the LP3906 output rails to any desire value. This allows the RS-232 transceiver to always have the required 3.3V power independent from the LP3906. This circuit can be removed from target implementations of this design.

Board jumpers:

•J1,J2,J4,J6: LP3906 voltage rail current shunts
•J5: LDO 1 Vin select between Vin (+5V) and DCDC1
•J7-J8: DC/DC 1 power pins
•J9: LDO 2 Vin select between Vin (+5V) and DCDC2
•J10-J11: DC/DC 2 power pins
•J12-J13: LDO 1 power pins
•J14-J15: LDO 2 power pins
•J18: Header for monitoring listed signals
•J20: Vin current shunt
•J21: Power for 12.288MHz oscillator
•J22: SYNC select between GND and 12.288 MHz clock

8.0 Software Description

Freescale Processor Firmware

This reference design comes with the firmware source code for the Freescale processor. It is located in the Microcode folder. You will find both the binary image and the source files. The binary is for the code that exists as flashed into the Freescale part on the board. The source is also provided so that you can change the implementation to target your application. As well you can move the code to another Freescale processor as necessary.

Application Software

This reference design also has a Visual Basic application that will allow you to interact with the board via a serial port. This is an optional part of the design to aid in the initial development of your target application. It will allow you to change any of the setting of the LP3906. Included are several control panels that are accessed via a click of a tab in the interface. It is assumed that you have a Windows PC with the Visual Basic tool kit (a standard application that is part of Windows XP or later machines).

Installation

Copy the code that you find in the VB_App_Install folder to a folder of your choice. Click on the Setup.exe icon to start the installation. The first screen you will see is the Applications Install - Security Warning panel. An image of this panel is shown in the appendix of this document. Although the Publisher is shown unknown, the application is not a threat and you should click on the Install button to complete the installation process.

Once installed, you can access this application is via the Start Menu - All Programs - NovTech Inc. - LP3906 EVB Control Application link. This application has four panels which are used to control the application: INFO, SETUP, VOLTAGE CONTROL, SEQUENCING. Each panel is self explanatory and an image of each is shown in the appendix of this document.

9.0 Layouts

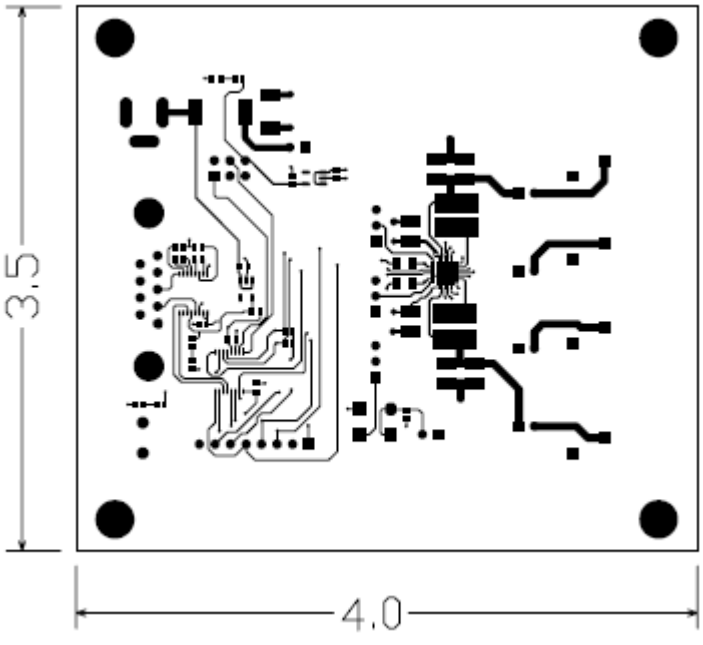


FIGURE 5. LP3906EVB Top layer Plot

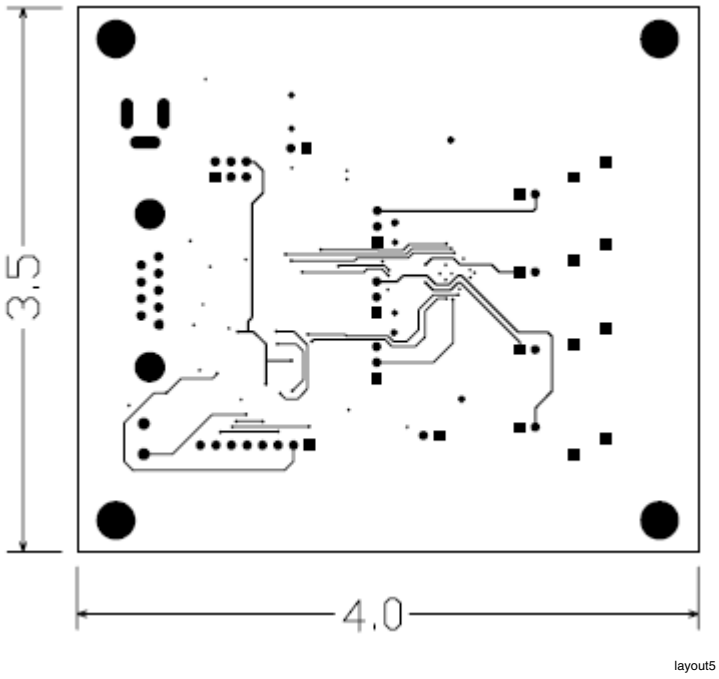


FIGURE 6. LP3906EVB Bottom layer Plot

10.0 Appendix

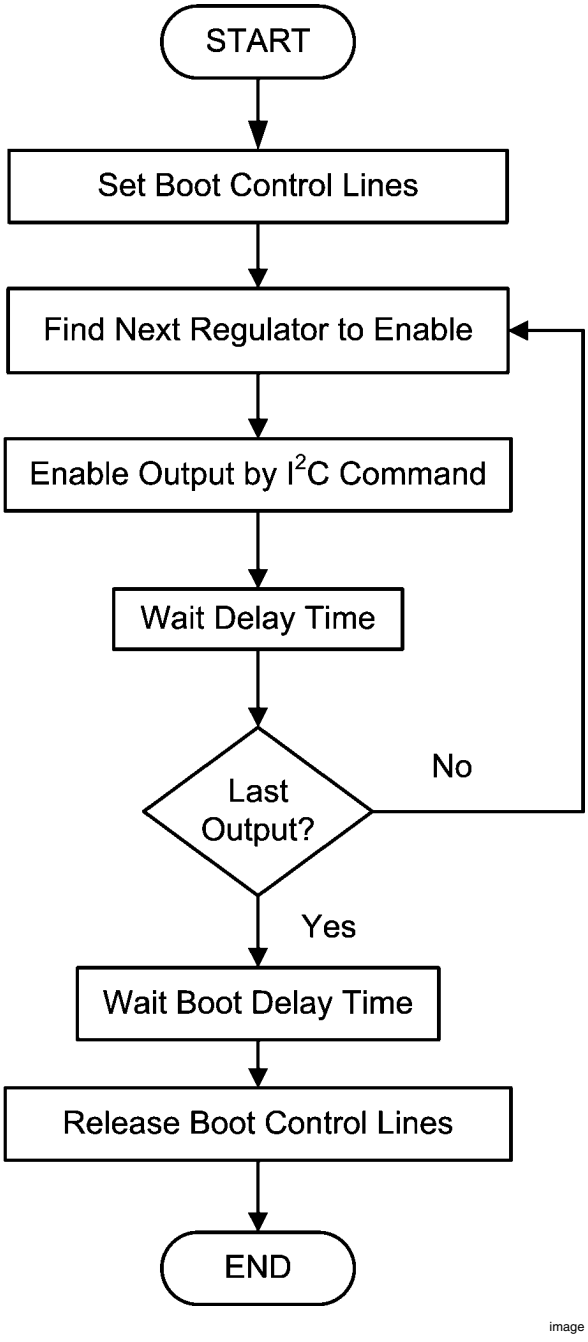


FIGURE 7. MCU Output Enable Routine Flow Chart

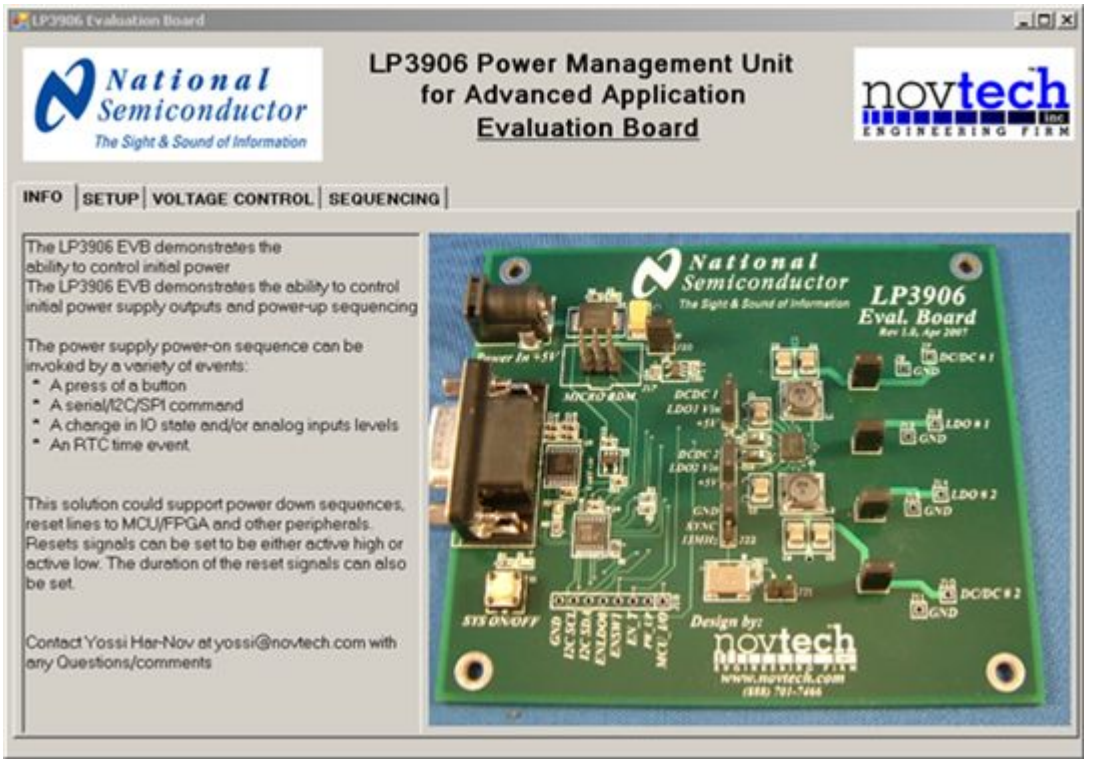


image2

FIGURE 8. LP3906EBV Advanced Application Board PC Control Software - INFO Panel

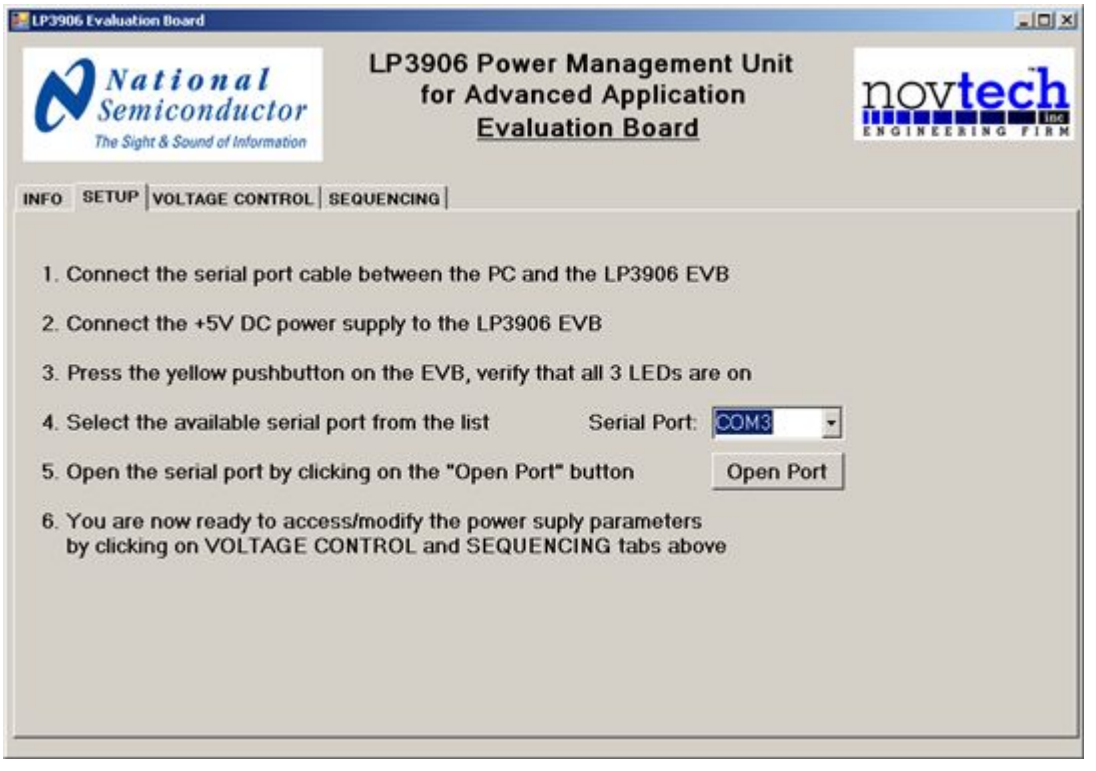


image3

FIGURE 9. LP3906EBV Advanced Application Board PC Control Software - SETUP Panel

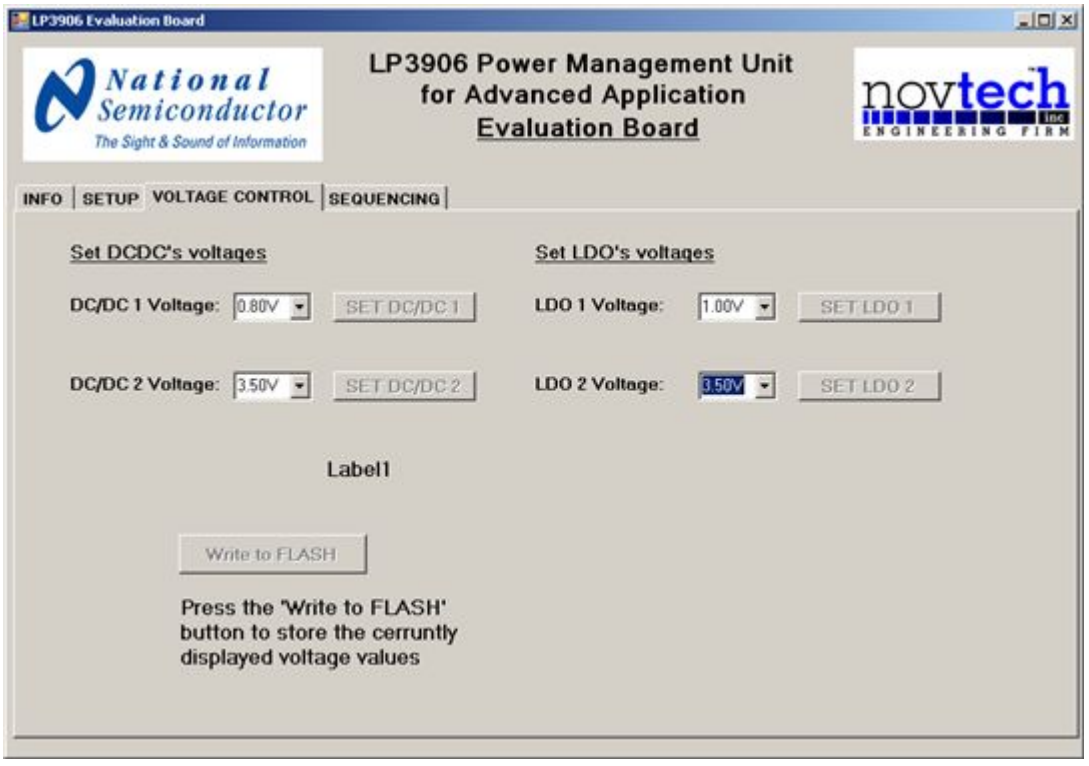


image4

FIGURE 10. LP3906EBV Advanced Application Board PC Control Software - VOLTAGE CONTROL Panel

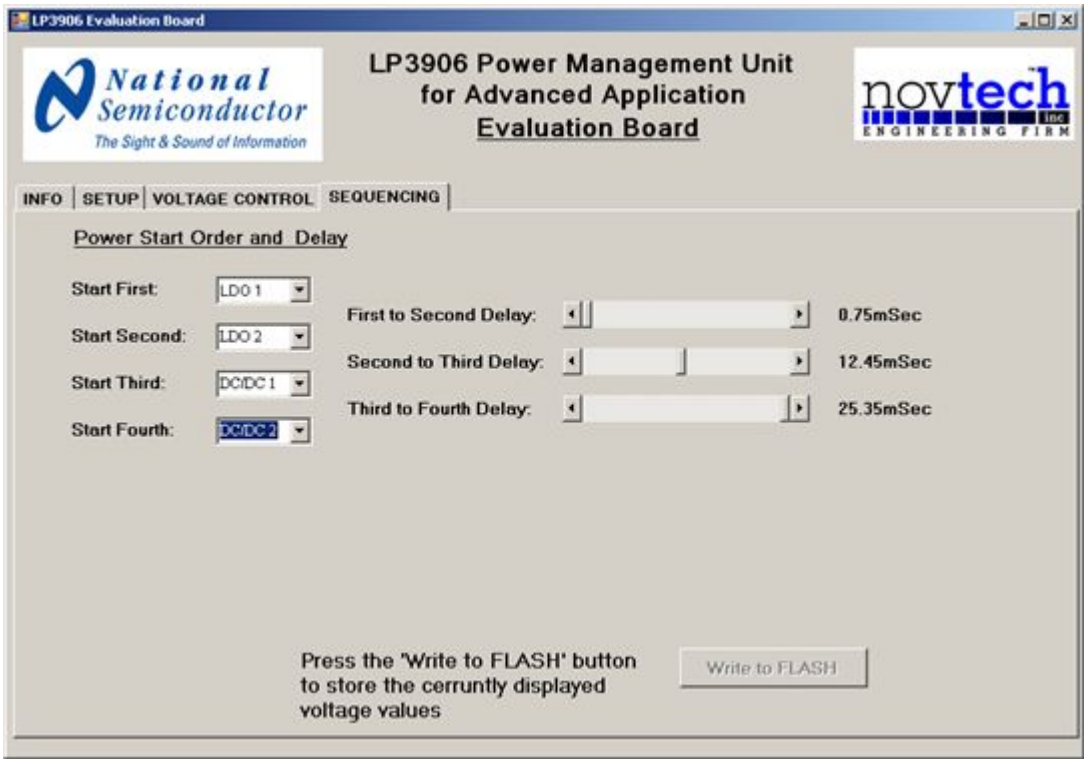


image5

FIGURE 11. LP3906EBV Advanced Application Board PC Control Software - SEQUENCING Panel

image

FIGURE 12. Novtech Inc. Contact Information

Notes

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