## LP3906 Smart Power Reference Design - 4 outputs

## 1.0 Design Description

The LP3906 Smart Power Board provides a complete, multirail 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 <sub>OUT</sub> of 1.0V-3.5V
±3% output voltage accuracy
300mA output currents
25mV (typ) dropout

National Semiconductor RD-161 Novtech Engineering December 2007



## 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)

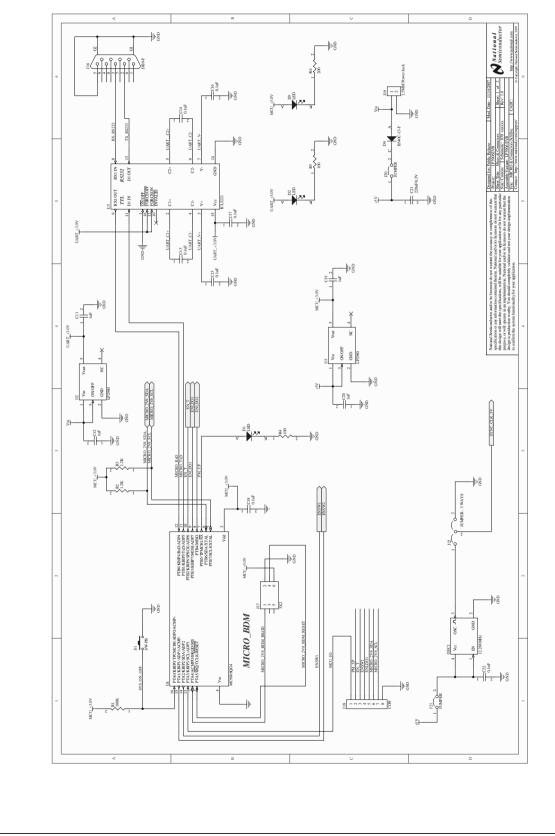
- Board also provides jumpers to allow insertion for current monitoring of loads or input.
- The control values stored in the MCU flash can be easily modified for FPGAs, DSPs, other processors, and any other multi-rail devices without changing the firmware which speeds time to market.

## 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

RD-161

# 3.0 Schematic



schematic7

schematic8 Semiconducto CC 10aP 16V -l+ŝ -li-8 240H - and FIGURE 2. LP3906EVB\_2 -li-ĝ -luĝ -l+g IBI CND\_SWI FB2 GND\_SW2 IOULI VIN2 SW2 ANLDO2 ININ STEP\_DOWN 1 0.8 Vie 2.0V 150 0mA STEP\_DOWN 2 1.0 V to 3.5V 1500md 1 DO 1 1.0 Vio 3.5V 300 mJ 1.0 Vio 3.5V 1.0 Vio 3.5V 1.0 Vio 3.5V Control Interf 12 AVDD 20 ViaLD012 Chip Power 4 GND\_L LP3005 SCL SDA ENLT ENLDOI ENLDOI ENSWI ENSWI -l+g š⊢ MICRO 2V8 SCL MICRO 2V8 SDA

# 4.0 Bill of Materials

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Page 1

bom5

FIGURE 3. LP3906\_EVB\_BOM

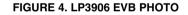
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## 5.0 Board Photos



boardphoto5



## 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:

- 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

•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 develop-

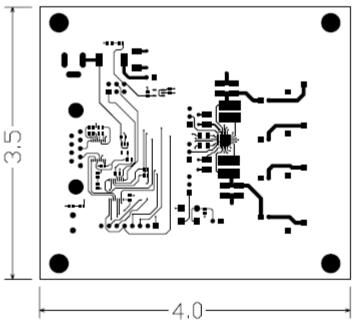
## 9.0 Layouts

ment 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

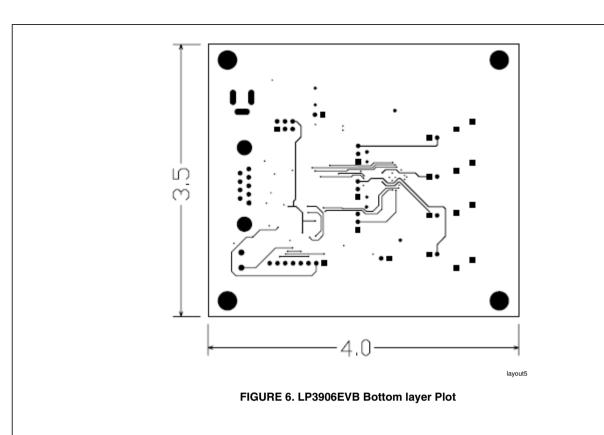
Copy the code that you find in the VB\_App\_Install folder to a folder of your choice. Click on the Setup.exe icon to start the installation. The first screen you will see is the Applications Install - Security Warning panel. An image of this panel is shown in the appendix of this document. Although 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.



layout4

FIGURE 5. LP3906EVB Top layer Plot



10.0 Appendix

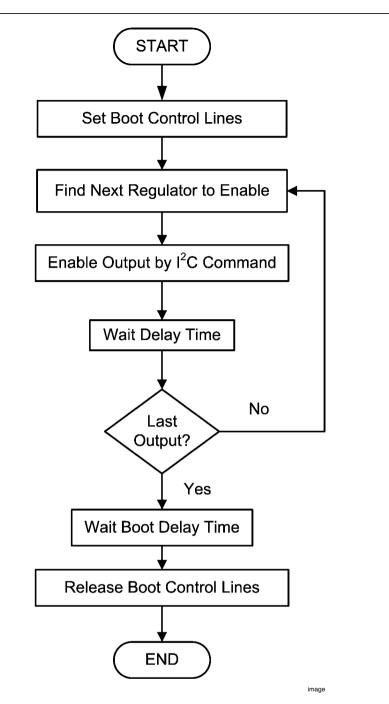


FIGURE 7. MCU Output Enable Routine Flow Chart

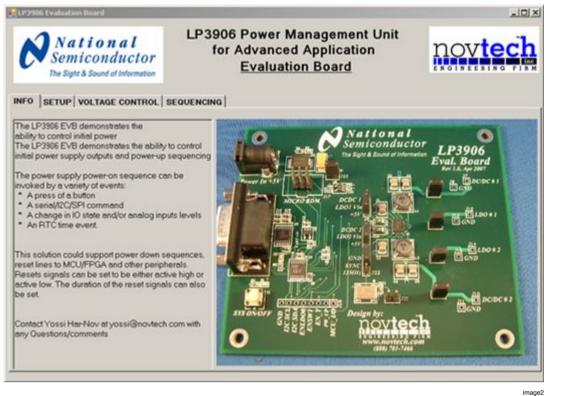


FIGURE 8. LP3906EBV Advanced Application Board PC Control Software - INFO Panel

LP3906 Evaluation Board			
National Semiconductor The Sight & Sound of Information	LP3906 Power Managem for Advanced Applica <u>Evaluation Board</u>	tion	novtech
NFO SETUP VOLTAGE CONTROL S	EQUENCING		
<ol> <li>Connect the +5V DC power</li> <li>Press the yellow pushbuttor</li> <li>Select the available serial p</li> <li>Open the serial port by click</li> <li>You are now ready to access</li> </ol>	n on the EVB, verify that all 3 LEDs a ort from the list Serial Port	are on COM3 - Open Port	

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

National Semiconductor The Sight & Sound of Information	P3906 Power Management Unit for Advanced Application <u>Evaluation Board</u>	novtech
NFO SETUP VOLTAGE CONTROL SEQUE	NCING	
Set DCDC's voltages	Set LDO's voltages	
DC/DC 1 Voltage: 0.80V SET	DC/DC1 LD01 Voltage: 1.00V T	SET LD0 1
DC/DC 2 Voltage: 350V 💌 SET	DC/DC 2. LDO 2 Voltage: 350V 🔹	SET LD0 2
Label1		
Write to FLASH		
Press the "Write to FI button to store the co displayed voltage value	erruntly	

image4

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

INFO SETUP VOLTAGE CONTROL SEQUENCING Power Start Order and Delay Start First: LD01  Start Second: LD02  Start Second: LD02  Start Third: DCDC1  Start Fourth: DCDC1  Third to Fourth Delay:  Start Fourth: DCDC2  Press the 'Write to FLASH' button  Write to FLASH' button	Nation Semicon The Sight & Sound	ductor for A	Power Managemen dvanced Applicati Evaluation Board	
Start First: D01 *   Start Second: D02 *   Start Second: D02 *   Start Third: D0D01 *   Start Fourth: D0001 *				
Start Second:       IDO2 •         Start Third:       DCDC1 •         Start Fourth:       IDDECE •         Third to Fourth Delay:       •         Start Fourth:       IDDECE •		LD01 ×		
Start Third: DCDC1 Third to Fourth Delay. 1 25.35mSec	Start Second:		Delay:	▶ 0.75mSec
Start Fourth:	Start Third:		i Delay: 🚺 🚽	12.45mSec
Press the "Write to FLASH" button		Third to Fourth	Delay: 🔟	25.35mSec
to store the cerruntly displayed		to store the cerru		Write to FLASH

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image

FIGURE 12. Novtech Inc. Contact Information

National Semiconductor's design tools attempt to recreate the performance of a substantially equivalent physical implementation of the design. Reference designs are created using National's published specifications as well as the published specifications of other device manufacturers. While National does update this information periodically, this information may not be current at the time the reference design is built. National and/or its licensors do not warrant the accuracy or completeness of the specifications or any information contained therein. National and/or its licensors do not warrant that any designs or recommended parts will meet the specifications you entered, will be suitable for your application or fit for any particular purpose, or will operate as shown in the simulation in a physical implementation. National and/or its licensors do not warrant that the designs are production worthy. You should completely validate and test your design implementation to confirm the system functionality for your application.

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- Life support devices or systems are devices or systems which, 2.

   (a) are intended for surgical implant into the body, or (b) support or sustain life, and whose failure to perform when properly used in accordance with instructions for use provided in the labeling, can be reasonably expected to result in a significant injury to the user.
- A critical component is any component of a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.

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National Semiconductor certifies that the products and packing materials meet the provisions of the Customer Products Stewardship Specification (CSP-9-111C2) and the Banned Substances and Materials of Interest Specification (CSP-9-111S2) and contain no "Banned Substances" as defined in CSP-9-111S2.

Leadfree products are RoHS compliant.



**RD-16**<sup>-</sup>

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