LP3971 Smart Power Reference Design - 8 outputs - RD-139

National Semiconductor
LP3971
Novtech Engineering
June 2007

1.0 Design Description

The LP3971 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 LP3971 Power Management Unit and an 8 bit microcontroller to manage the features of the PMU. There are more then billion combinations of initial voltage values for the output voltages, this solution can provide them all regardless 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.

LP3971 Key Specifications:

Three Buck Regulators

Programmable V_{OUT} from 0.8 to 3.3V
Up to 95% efficiency
Up to 1.6A output current

Six Accurate LDOs

Programmable V_{OUT} of 1.0V-3.3V
±3% output voltage accuracy
150/300/370mA output currents
100mV (typ) dropout

- LDO 1 300 mA
- LDO 2 150mA
- LDO 3 150mA
- LDO 4 150mA
- LDO 5 370mA
- LDO RTC 30mA

2.0 Features

LP3971 Smart Power Board Key Features

- Utilizes the National Semiconductor LP3971 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 LP3971 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.

LP3971 Device Special Features

- Compatible with advanced applications processors requiring DVM (Dynamic Voltage Management)
- Three buck regulators for powering high current processor functions or I/O’s
- 6 LDO’s for powering RTC, peripherals, and I/O’s
- Backup battery charger with automatic switch for lithium manganese coin cell batteries and Super capacitors
- I^2C compatible high speed serial interface
- Software control of regulator functions and settings
- Precision internal reference
- Thermal overload protection
- Current overload protection
- Tiny 40-pin 5 x 5 mm LLP package

3.0 Schematic

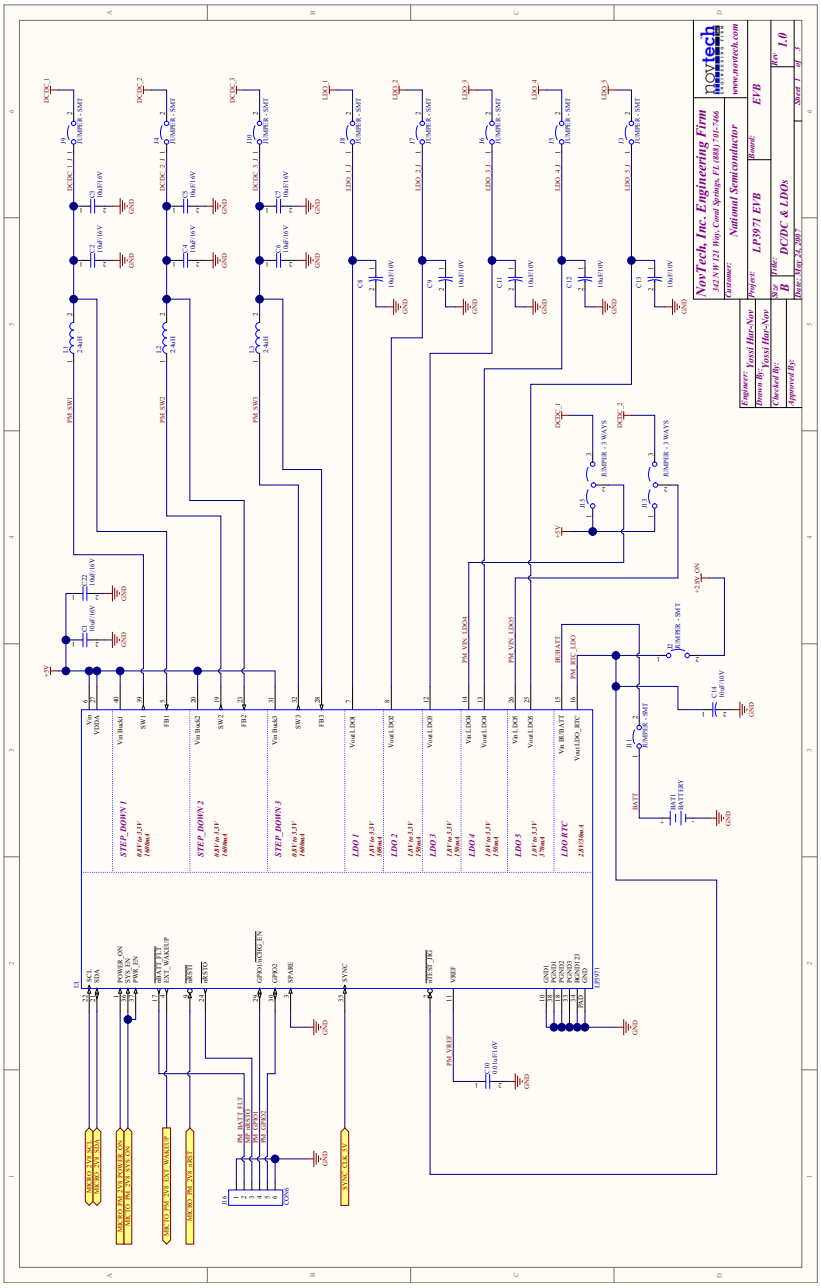
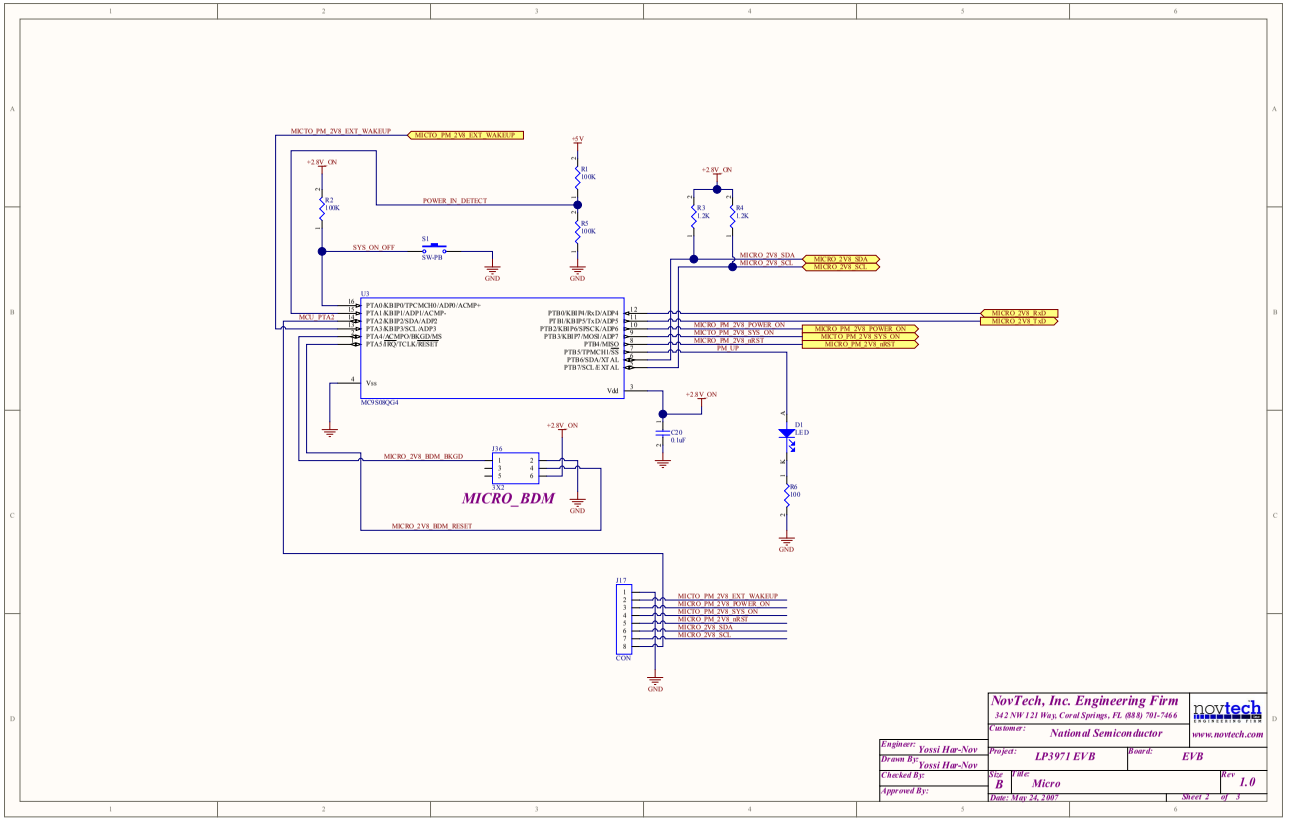
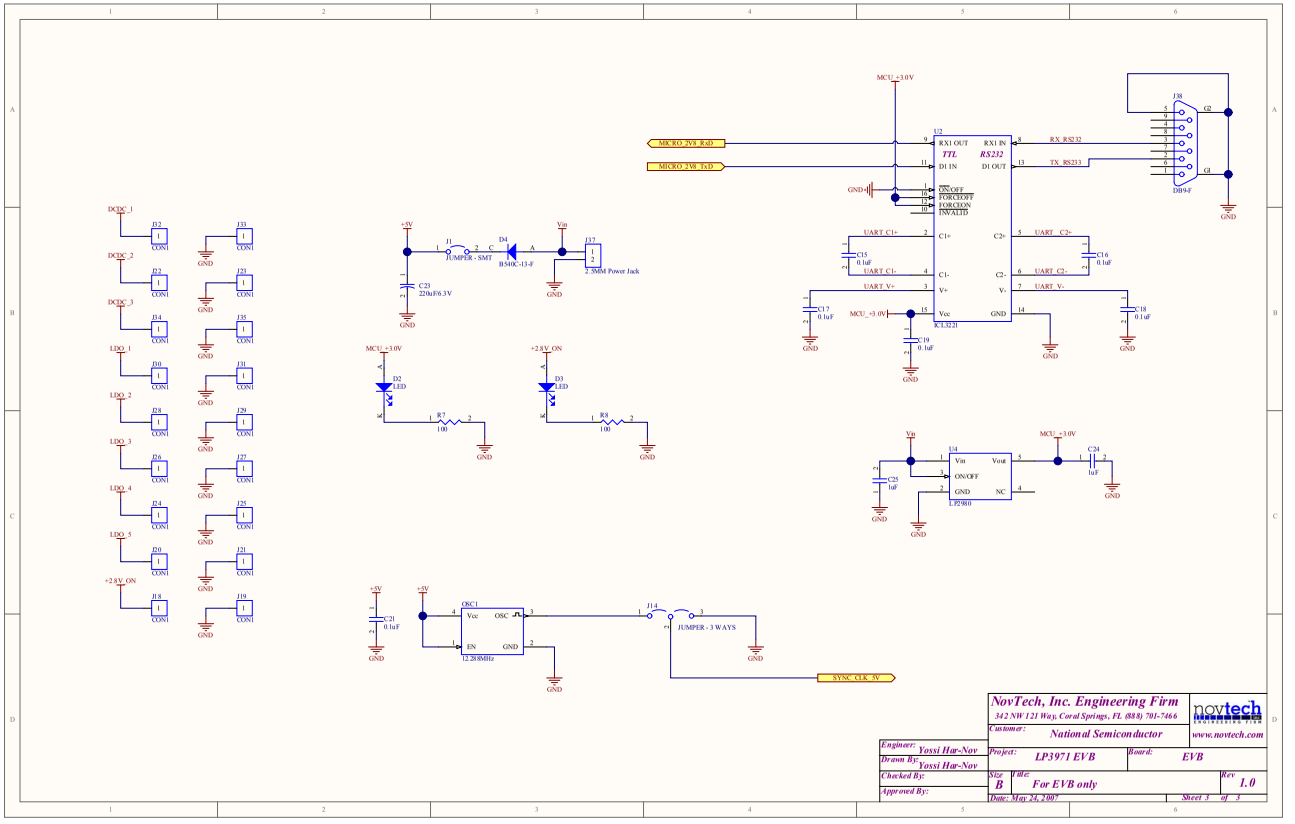


FIGURE 1. LP3971 Schematic



schematic1

FIGURE 2. Freescale Microcontroller



schematic2

FIGURE 3. Evaluation Board Related Circuits (not needed when used in embedded applications)

4.0 Bill of Materials

Component list — **LP3971 EVB BOM**

Source Data From: LP3971_EVB.PrjPcb
Project: LP3971_EVB.PrjPcb
Variant: None

Report Date: 5/25/2007 12:39:23 PM
Print Date: 07-Jun-07 10:13:41 AM

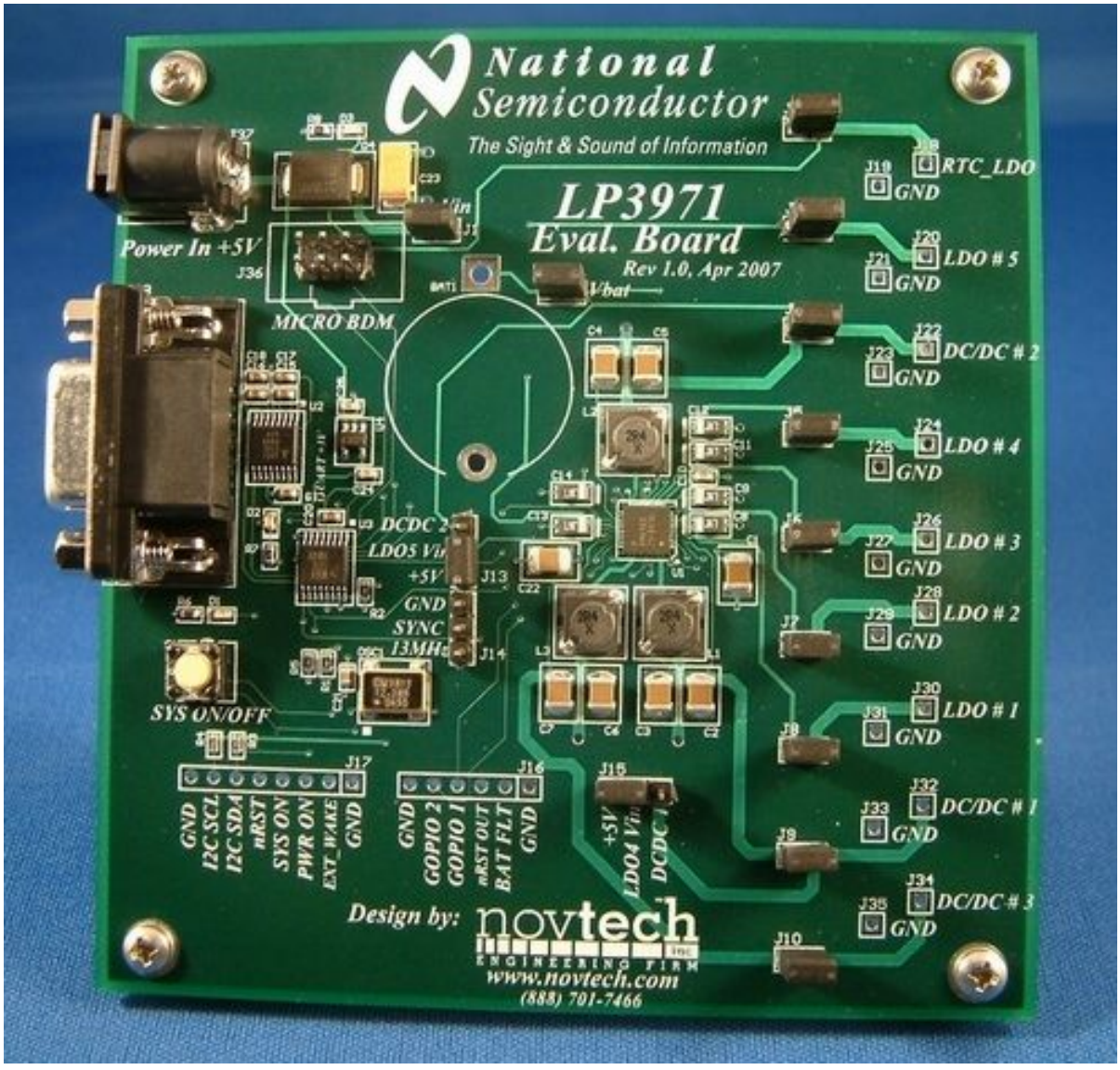
#	Comment	Description	Footprint	PART	MFG	RoHS	Designator	DigiKey	Quantity
	Required Parts in All Designs								
2	10uF/16V	Capasitor 0603footprint	1210_C	Choose a low ESR part	Any		C1, C2, C3, C4, C5, C6, C7, C22		8
3	10uF/10V	Tantalum Capacitor	A CASE (3216-18)	Choose a low ESR part	Any		C8, C9, C11, C12, C13, C14		6
4	0.01uF/16V	Capasitor 0603footprint	0603_C	Any	Any		C10		1
5	0.1uF	Capasitor 0603footprint	0603_C	Any	Any		C15, C16, C17, C18, C19, C20, C21		7
6	220uF/6.3V	Tantalum Capacitor	C CASE (6032-28)	T494C227M006AT	KEMET	Yes	C23	399-3848-1-ND	1
7	3X2	2 by 3 100mil Header	HEADER_BOX_3X2	Any	Any		J36		1
8	2.4uH	Power Inductor	ELL6PM	ELL-6PV2R4N	PANASONIC		L1, L2, L3	PCD1720CT-ND	3
9	1.2K	Resistor 0603 footprint	0603_R	Any	Any		R3, R4		2
10	LP3971	Power Management Unit for Advanced Application Processors	QFN40P500X500X80-40N	LP3971	NATIONAL		U1		1
11	MC9S08QG4	8 bit MCU from FreeScale	TSSOP_16	MC9S08QG4CDT	FreeScale		U3	MC9S08QG4CDTE-ND	1
								Sub Total:	**31**
	Optional Part in Some Designs								
	BATTERY	Recharchable Li-Ion battery	BATTERY ML2020	ML2020/H1C	Panasonic		BAT1	P047-ND	1
	LED		0603_LED	Any	Any		D1, D2, D3		3
	B540C-13-F		SMC	B540C-13-F	Diode Inc.	Yes	D4	B540C-FDICT-ND	1
	JUMPER - SMT	2 pin 100mil Header	BH2-NP				J1, J2, J3, J4, J5, J6, J7, J8, J9, J10, J11		11
	2.5MM Power Jack		PJ-002B (POWER JACK)	PJ-002B	CUI Inc	Yes	J37	CP-002B-ND	1
	12.288MHz		OSC_SMT_7.3X4.8	CWX815-12.288M	Connor-Winfield	Yes	OSC1	CW556CT-ND	1
	100K	Resistor 0603 footprint	0603_R	Any	Any		R1, R2, R5		3
	100	Resistor 0603 footprint	0603_R	Any	Any		R6, R7, R8		3
	SW-PB	Switch	B3F-602X	B3F6002BYOMZ		Yes	S1	SW797-ND	1
								Sub Total:	**25**
	Parts that are for EVB use								
	1uF	Capasitor 0603footprint	0603_C	Any	Any		C24, C25		2
	JUMPER - 3 WAYS	3 pin 100mil Header	BH3	Any	Any		J13, j14, J15		3
	CON6	6 pin 100mil Header	BH6-NP	Any	Any		J16		1
	CON8	8 pin 100mil Header	BH8-NP	Any	Any		J17		1
	CON1		BH1-NP - 46MIL	Any			J18, J19, J20, J21, J22, J23, J24, J25, J26, J27, J28, J29, J30, J31, J32, J33, J34, J35		18
	DB9-F	DB9 Female	DB9_F_318	Any	Any		J38		1
	ICL3221	IC TXRX SGL RS232 3-5.5V	TSSOP_16	ICL3221EIVZ	Intersil	Yes	U2	ICL3221EIVZ-ND	1
	LP2980	Micropowe 50mA LDO	SOT23-5	LP2980AIM5-3.0	NATIONAL	Yes	U4	LP2980AIM5-3.0CT-ND	1
								Sub Total:	**28**
								Total:	**84**

Approved **Notes**

bom1

FIGURE 4. Bill Of Materials

5.0 Board Photos



boardphoto4

FIGURE 5. Board Photo

6.0 Quick Start

LP3971 Smart Power Board Operation

Upon applying +5V input power to the board, the 2.8V LDO (which is always enabled in the LP3971) powers up 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 (PWR_ON) is set high which enables the LP3971 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 LP3971 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 LP3971 Power-on control pins (SYS_EN, PWR_EN). Please note, that without an MCU, these pins control the output sequence of the default values of the LP3971 (defined for the X-Scale processors – see data sheet). This solution allows ANY variant of the PMU to be used since the LP3971 manufacturing default values are over-ridden.
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 LP3971 with all necessary discrete components to support all of the voltage rails. The microcontroller is powered by the RTC_LDO output ('always on' rail).
The RS232 driver is powered by it's on discrete Low DropOut regulator to allow modifications of all the LP3971 output rails to any desire value. This allows the RS-232 transceiver to always have the required 3.3V power independent from the LP3971. This circuit can be removed from target implementations of this design.

Board jumpers:

J1 - Vin current shunt
J2 to J10 - LP3071 voltage rail current shunts
J11 - Bvat current shunt
J13 - LDO 5 Vin select between Vin (+5V) and DCDC2
J14 - SYNC select between ground and 13MHz clock
J15 - LDO 4 Vin select between Vin (+5V) and DCDC1
J16 - Header for monitor listed signals
J17 - Header for monitoring listed signals
J18-J19 - RTC_LDO power pins
J20-J21 - LDO 5 power pins
J22-J23 - DC/DC 2 power pins
J24-J25 - LDO 4 power pins
J26-J27 - LDO 3 power pins
J28-J29 - LDO 2 power pins
J30-J31 - LDO 1 power pins
J32-J33 - DC/DC 1 power pins
J34-J35 - DC/DC power pins

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

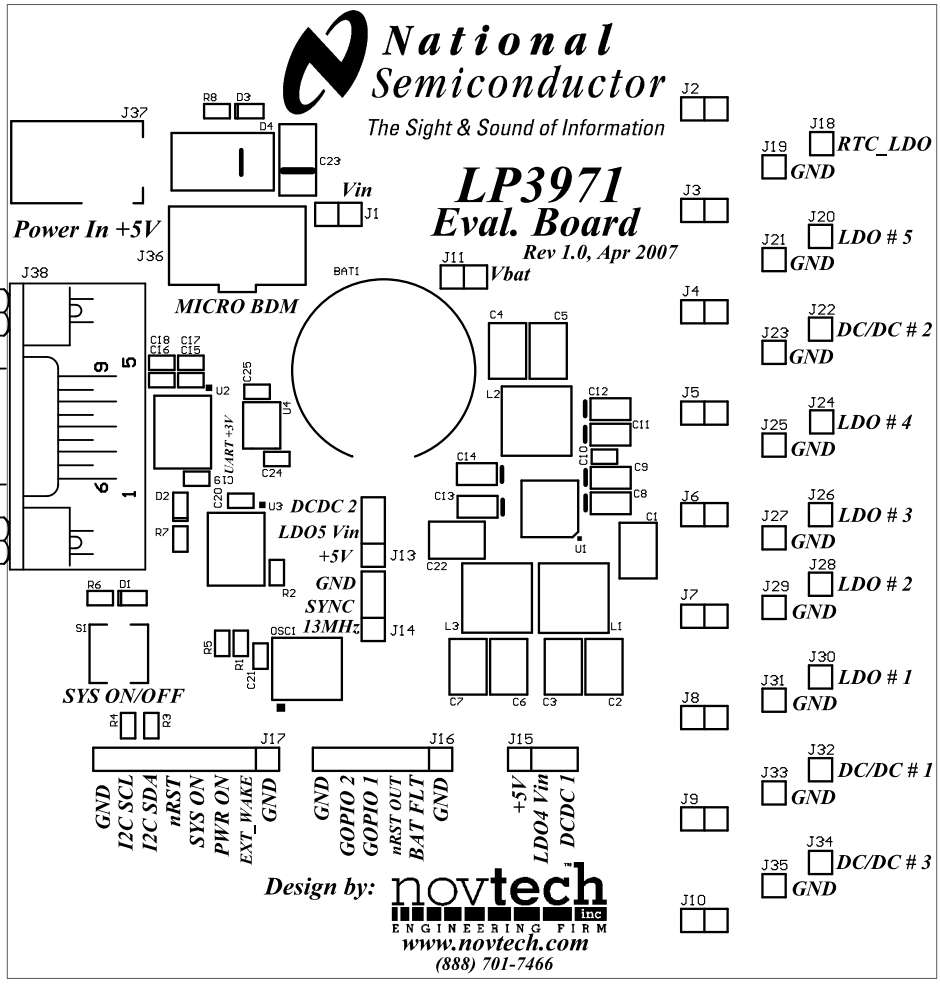
This reference design also has a Visual Basic application that will allow you to interact with the board via a serial port. This is an optional part of the design to aid in the initial development of your target application. It will allow you to change any of the setting of the LP3971. Included are several 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.

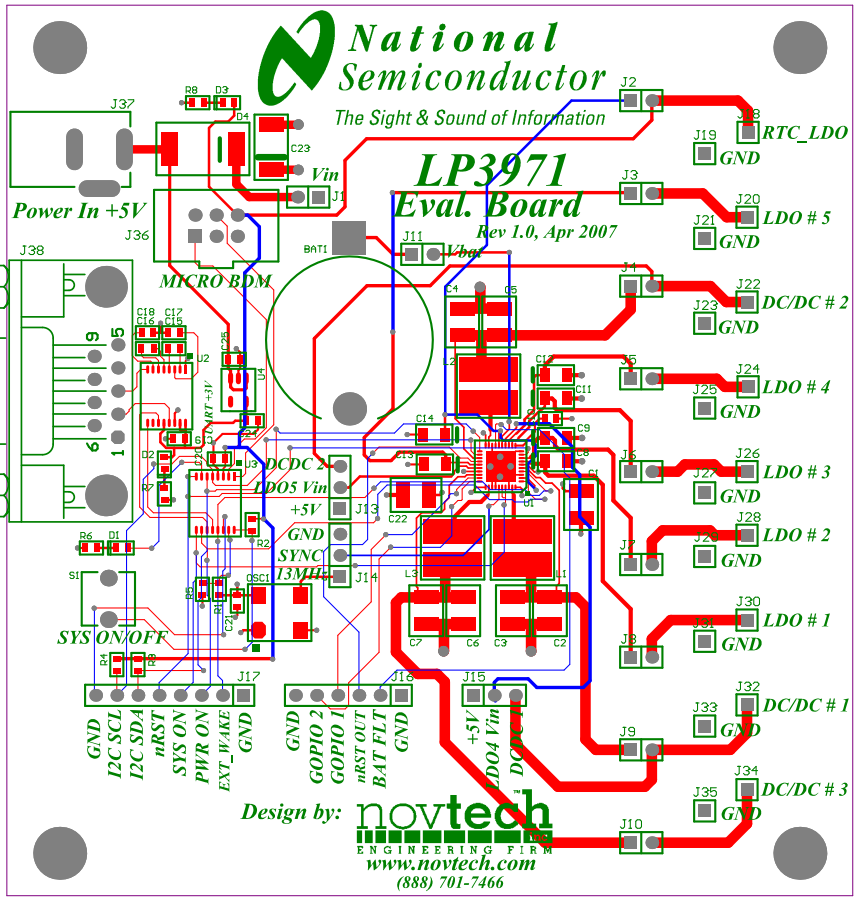
Once installed, you can access this application is via the **Start Menu - All Programs - NovTech Inc. - LP3971 EVB Control Application** link. This application has four panels which are used to control the application: **INFO, SETUP, VOLTAGE CONTROL, SEQUENCING.** Each panel is self explanatory and an image of each is shown in the appendix of this document.

9.0 Layouts



layout

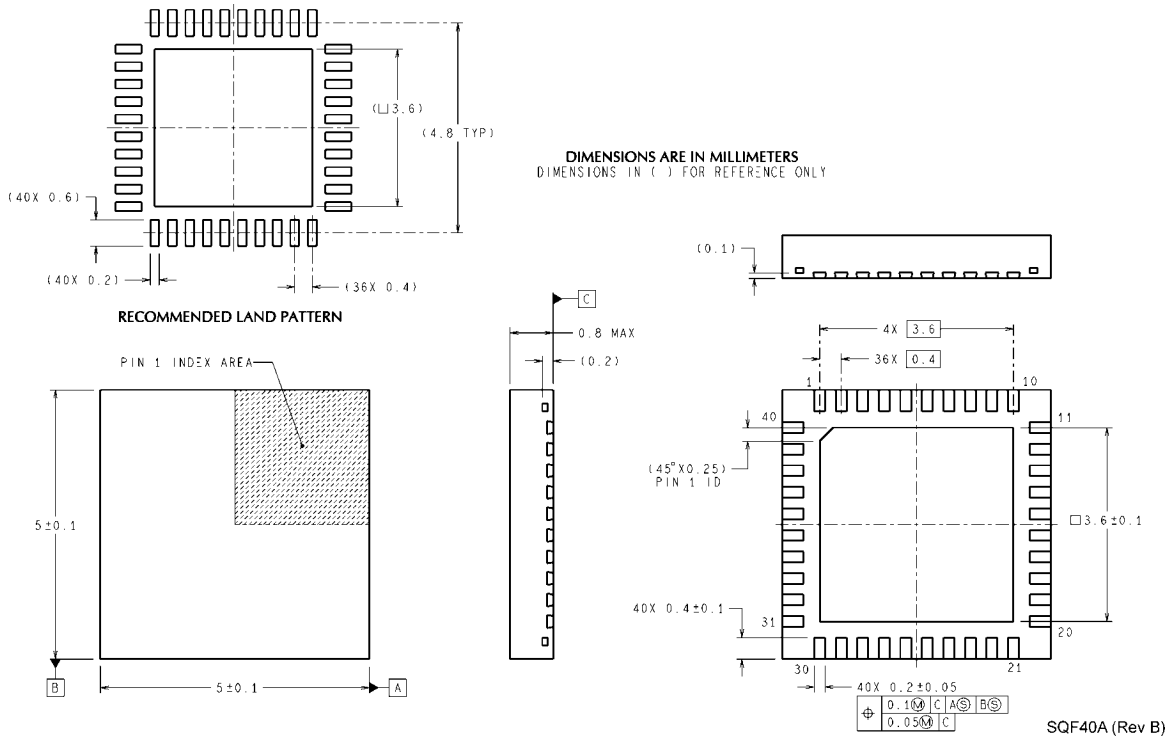
FIGURE 6. Board Layout (Assembly Diagram)



layout1

FIGURE 7. Board Layout - Top and Bottom Layers

10.0 Physical Dimensions inches (millimeters) unless otherwise noted



11.0 Appendix

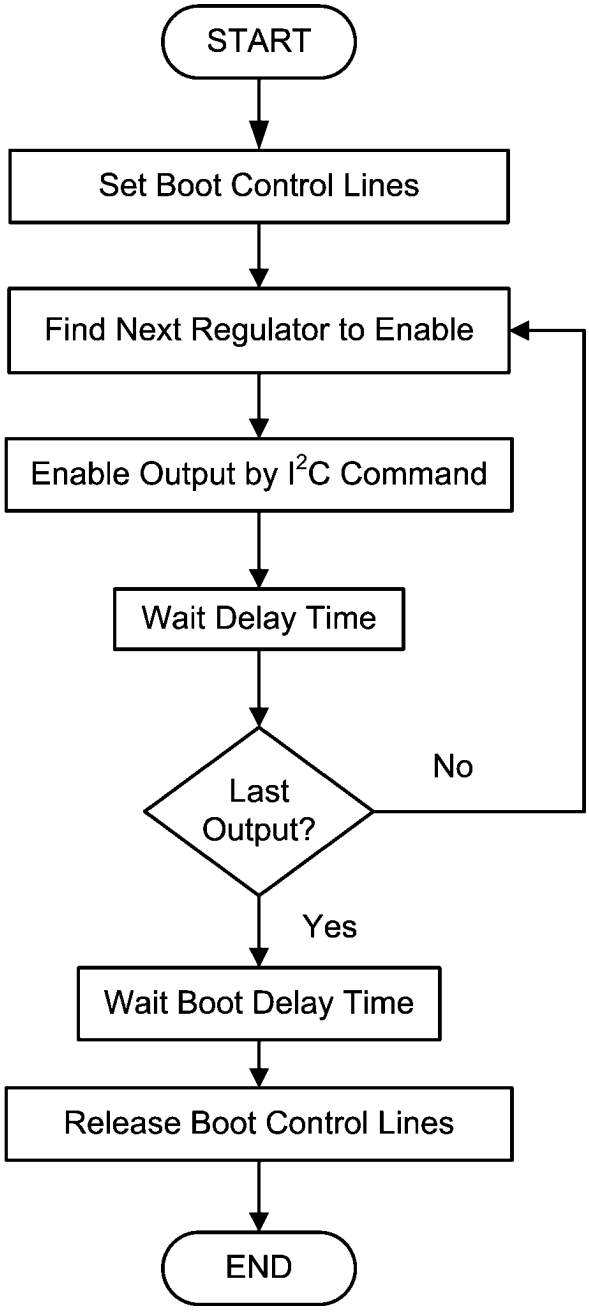


FIGURE 8. MCU Output Enable Routine Flow Chart

image2

FIGURE 9. LP3971 Advanced Application Board PC Control Software - Install Panel

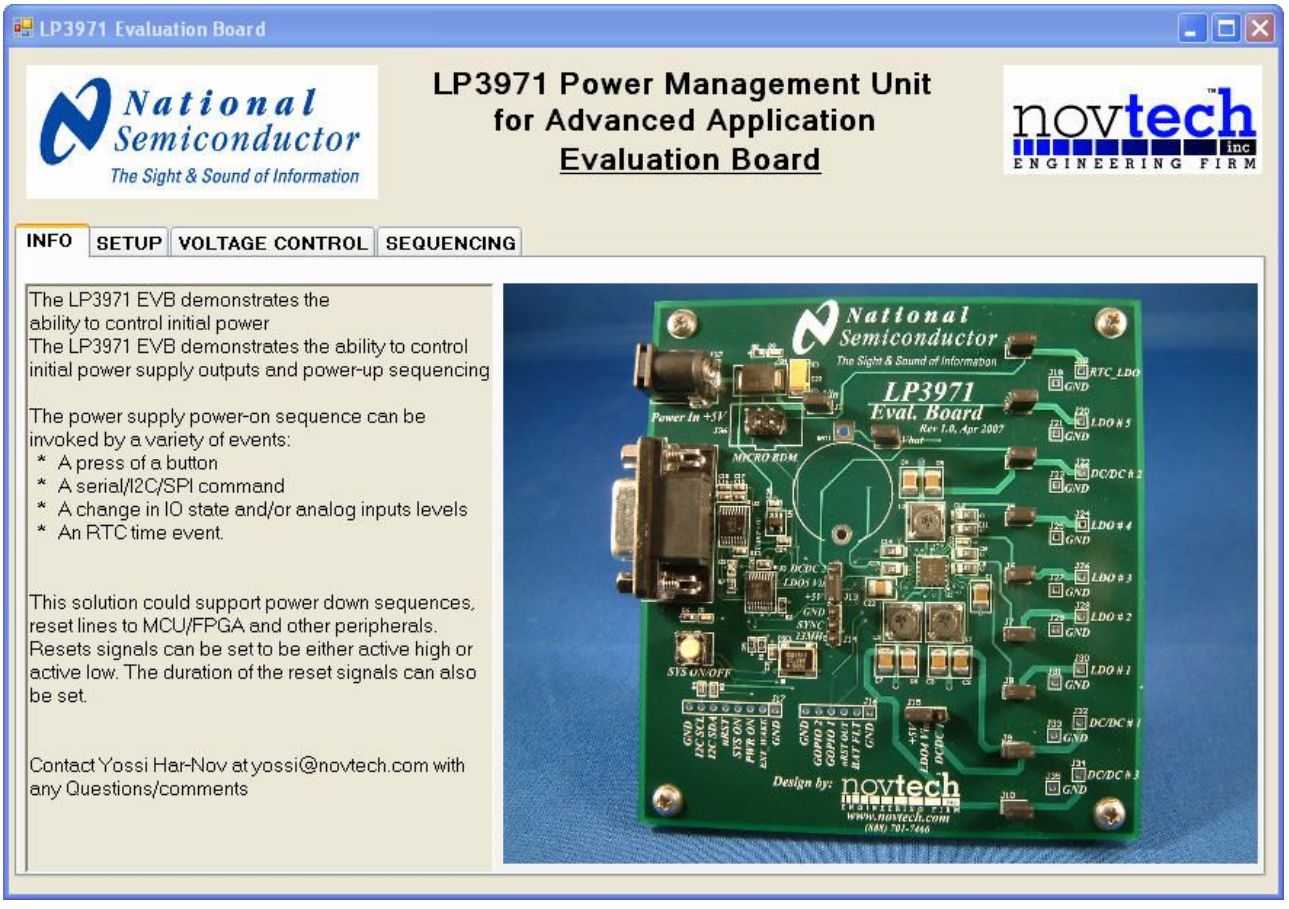


image3

FIGURE 10. LP3971 Advanced Application Board PC Control Software - INFO Panel

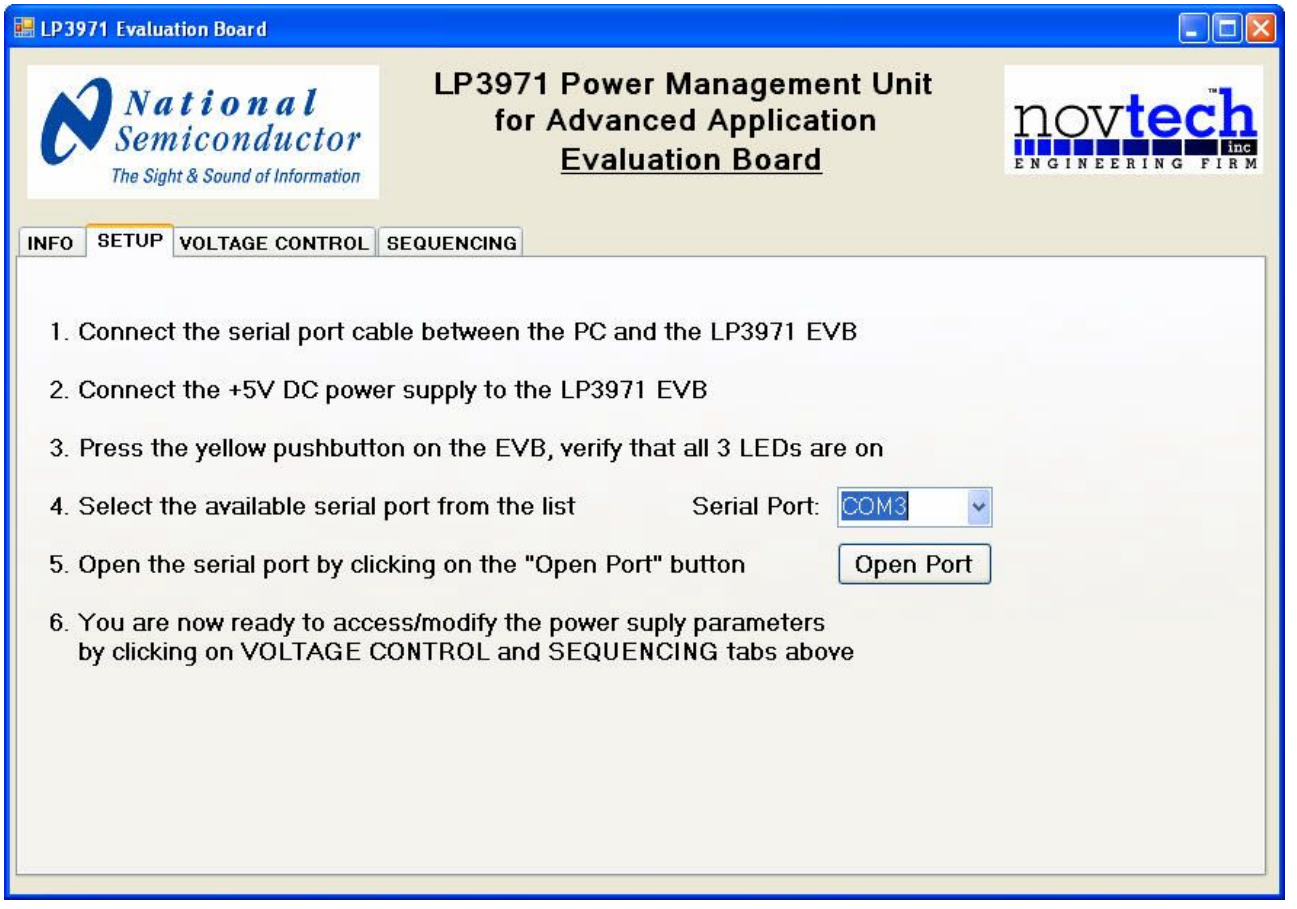


image4

FIGURE 11. LP3971 Advanced Application Board PC Control Software - SETUP Panel

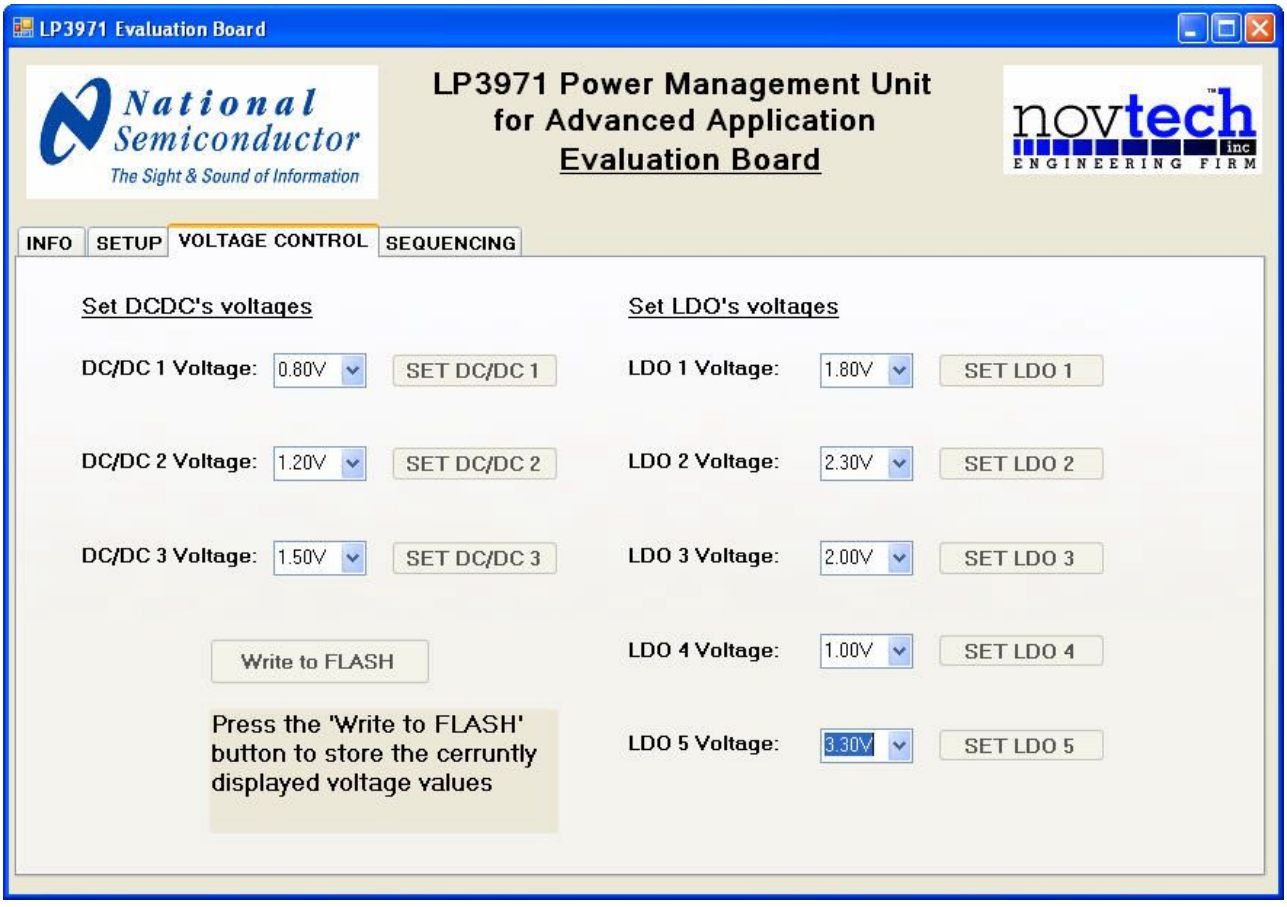


image5

FIGURE 12. LP3971 Advanced Application Board PC Control Software - VOLTAGE CONTROL Panel

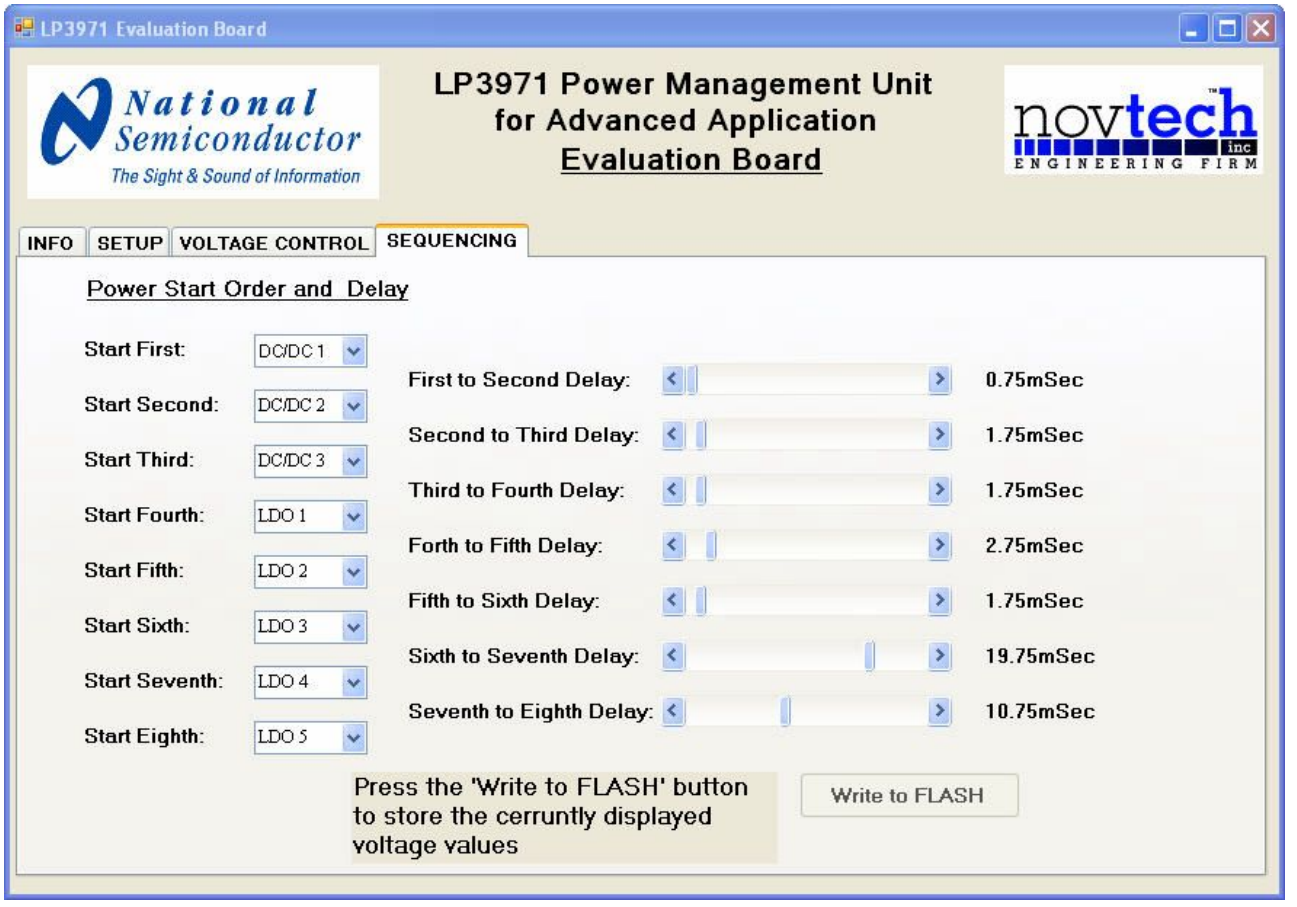


image6

FIGURE 13. LP3971 Advanced Application Board PC Control Software - SEQUENCING Panel

342 NW 121 Way
Coral Springs FL 33071
(954) 341-3320 FAX
(954) 341-3323
www.novtech.com

image9

FIGURE 14. Novtech Inc. Contact Information

Notes

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