Using the LM3631EVM Evaluation Module

User's Guide

Literature Number: SNVU370
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The LM3631EVM Evaluation Module

This user's guide describes the characteristics, operation, and use of the LM3631 Complete LCD Backlight and Bias Power device evaluation module (EVM). This document includes descriptions of the device, as well as the evaluation hardware and software. It also includes a schematic of the EVM.

For related documents please check the LM3631 datasheet.

If you need assistance regarding this device or the EVM, please contact your local TI sales representative.

1 Overview

Texas Instruments' LM3631EVM helps designers evaluate the operation and performance of the LM3631 device. The LM3631EVM uses the LM3631 to create backlight power and LCD bias powers. Information about device characteristics and current ratings of LM3631 can be found in the datasheet. In order to facilitate ease of testing and evaluation of this circuit, the EVM contains a TI MSP430 microprocessor to provide easy communication via USB. The EVM also contains an external power supply connection for the VIN and VIO. Additionally, test points for signals can be found on the EVM. For evaluation purposes, the EVM has been tested over a 2.7V to 5.0V input range. This voltage range is within the absolute maximum input range of the LM3631. Users are cautioned to evaluate their specific operating conditions and choose components with the appropriate voltage ratings before designing this support circuitry into a final product.

2 LM3631 Device

The LM3631 provides a high-efficiency backlight and positive/negative bias supplies for LCD drivers to address the power requirements of high-definition LCDs. Capable of driving up to 16 LEDs, the LM3631 is ideal for small format displays. A high level of integration and programmability allows the LM3631 to address a variety of applications without the need for hardware changes.

2.1 Features

- Drives up to 2 Strings of Maximum of 8 LEDs in Series with up to 25 mA per String
- Backlight Up to 90% Efficient
- LCD Bias Efficiency >85%
- 11-Bit Exponential or Linear Dimming
- External PWM Brightness Control for CABC Backlight Operation
- Positive Programmable LCD bias, 100 mA
- Negative Programmable LCD bias, up to 80 mA
- Two Positive Programmable LDO Reference Outputs, 50 mA and 80 mA
- 2.7-V to 5-V Input Voltage Range

2.2 Applications

Mobile Device LCD Backlighting and Bias

2.3 Power Sequences

2.3.1 Start-up

After the nRST pin is set high and VBAT rises over the undervoltage lock-out (UVLO) limit, the LM3631 goes to Standby mode. Before entering Standby mode, references and bias currents are enabled (bias delay typically 200 µs), and registers are read from OTP (EPROM read delay typically 700 µs). In Standby mode references and bias currents are enabled, and I^2C writes are allowed. Oscillator, LCD powers, and backlight are disabled. During an I^2C write, the oscillator is enabled.

When LCD_EN is set to high (pin or bit), the start-up sequence is started. During the start-up sequence LDO_CONT, LCD Boost, and LCD bias powers are started. If the LDO_CONT is disabled, the start-up sequence goes directly to LCD Boost start-up.

LDO_CONT start-up: LDO_CONT is enabled. Programmable delay of 0 - 200 ms.

LCD Boost start-up: LCD Boost is enabled. Waits until Boost output voltage is reached 90% of target value.

LCD bias start-up: Enables sequentially LDO_VPOS, CP_VNEG, and LDO_OREF according to start-up delay settings. After the LCD bias start-up, the LM3631 enters backlight start-up mode if the BL_EN bit is set to ‘1’ and the PWM brightness value is different than 0. Even though backlight is not enabled, LCD remains active. If backlight is enabled and the BL_EN bit or PWM brightness value is set to '0', backlight is disabled; LCD remains active.

2.3.2 Shutdown

If LCD_EN is set to ‘0’, the device enters shutdown. In shutdown the backlight is shut down first (if it is enabled) . After backlight shutdown is completed, the device enters LCD Bias shutdown. In LCD bias shutdown LDO_VPOS, CP_VNEG, and LDO_OREF are shut down sequentially according to shutdown delay settings. After the LDO_VPOS, CP_VNEG, and LDO_OREF shutdown sequence is complete, the LCD Boost and LDO_CONT (if they are enabled) are shut down. LDO_CONT is shut down after adjustable delay (0 – 200 ms). Then the device enters Standby mode. If there is a fault situation (UVLO, Thermal, backlight boost short circuit, backlight overcurrent, LDO_OREF overcurrent, VPOS overcurrent, and CP short circuit), the device starts the shutdown sequence.

3 Evaluation Module

The LM3631 evaluation module consists of an evaluation board (hardware) and evaluation software.

3.1 Quick Setup

This section shortly describes how to connect and setup LM3631 EVM.

(A) Connect external power supply to VIN and GND of EVM. Set the voltage to, for example, 3.6 V.

(B) Connect USB cable to EVM.

(C) Start the Evaluation program from white arrow on left hand top corner.

(D) Check the nRST and LCD_EN boxes in General tab. Program reads the registers automatically.

(E) By now the LM3631 should be giving out VPOS and CP_VNEG voltages. Also LCD boost is on. Backlight is off.

(F) Setting backlight on:

- Switch to Backlight tab.
- Select "I2C Register" -control from Brightness Mode -pulldown menu.
- Set the brightness value from Brightness-slider.
- Push the Update Brightness -button

3.2 Setting Up

The LM3631EVM is connected via USB to the computer. The EVM is controlled with special evaluation software. An MSP430 microcontroller is used in the EVM to provide easy I^2C communication, nRST-pin, LCD_EN-pin, OTP_SEL-pin, and PWM control with the LM3631 via USB. The EVM is powered by default via USB. LM3631 device is powered from external power supply. The external power supply need to be connected to the green connector near USB connector.

LM3631 evaluation software (available at www.ti.com) uses the LabVIEW runtime engine which needs to be installed (if not installed previously). The LM3631 Evaluation Software Installer includes the setup.exe which installs the LM3631 evaluation software and LabVIEW runtime engine to Windows computer.

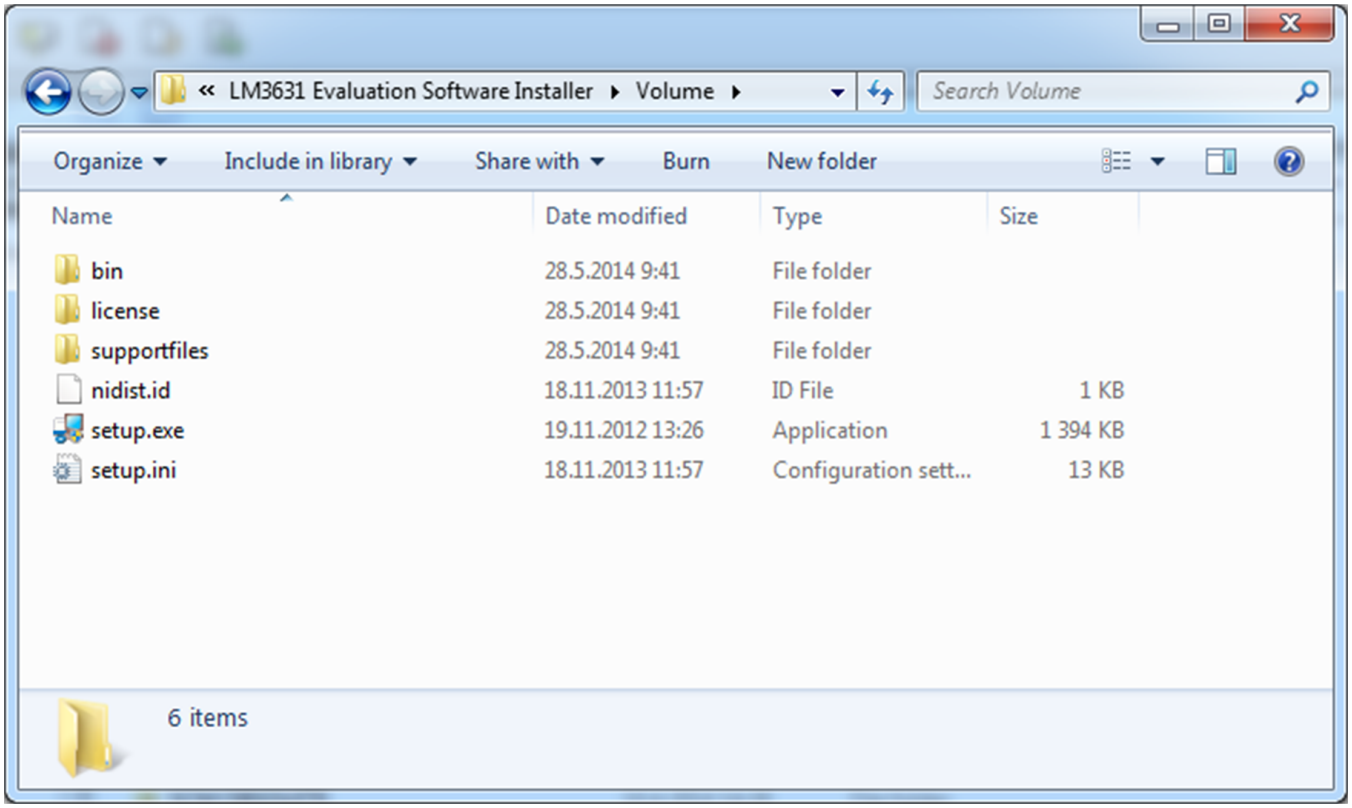

Figure 1. Evaluation Software Setup File

Running the setup opens up the installer, which prompts the Destination Directory where the program is to be installed. Note that user needs to have administrator rights to be able to install this program.

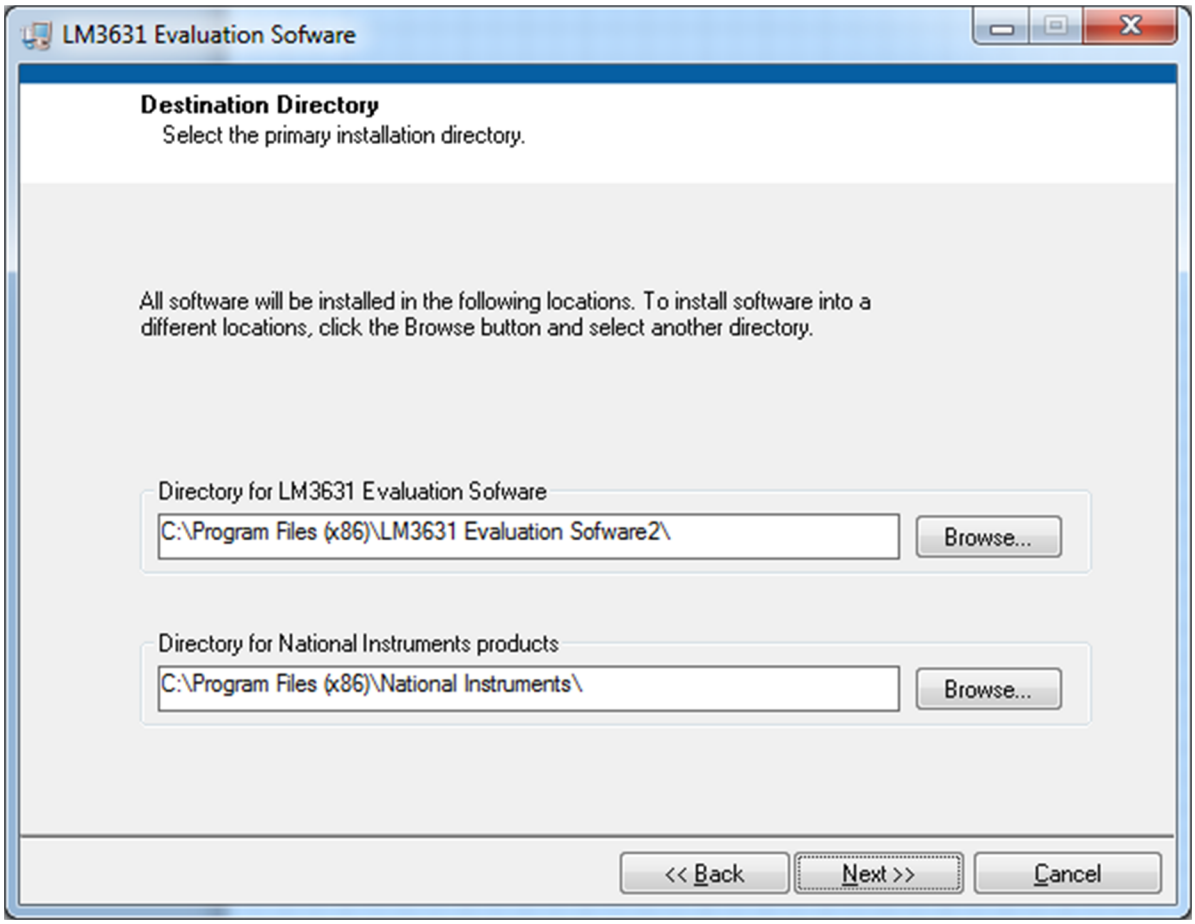

Figure 2. Software Installation

When the board is connected to a computer, Windows should recognize it automatically and start to install the driver. A “Found New Hardware” dialog box will prompt user to locate the missing driver. Select “No, not this time” and continue with “Next”. Select “Install from a list or specific location (Advanced)” to install the driver. Select the directory where the TI_CDC_Virtual_Port driver is. Windows should now install the driver, and the PC can communicate with the EVM using a virtual COM port. If Windows cannot find the driver, user needs to manually install the TI_CDC_Virtual_Port driver from the Device Manager.

Once the board is connected and the driver is installed, the red LED should blink on the evaluation board, indicating the board is recognized. The evaluation software scans the USB ports automatically. If the board is not found, the software should prompt regarding this issue. The USB address can be changed manually from the evaluation software; switching to another USB port also might solve the issue.

3.3 Evaluation Hardware

The LM3631 EVM consists basically of two sections:

- LM3631 and the application components; and
- MSP430 microcontroller and the support components.

By default the LM3631 is controlled by the MSP430 microcontroller via USB. VDD voltage come from USB, and the I^2C traffic is controlled with the microcontroller. The evaluation hardware also allows external control: the VDD can be fed externally via connector and with jumper selection. The I^2C traffic, nRST-pin, LCD_EN-pin, OTP_SEL-pin, PWM and FLAG-pin control can be changed from MSP430 control to external control using a pin header. The LED driver control can be changed from 4 to 8 WLEDs and from 1 to 2 strings. The pin header enables current measurement to the LED drivers. A test point (header) exists for some of the device pins.

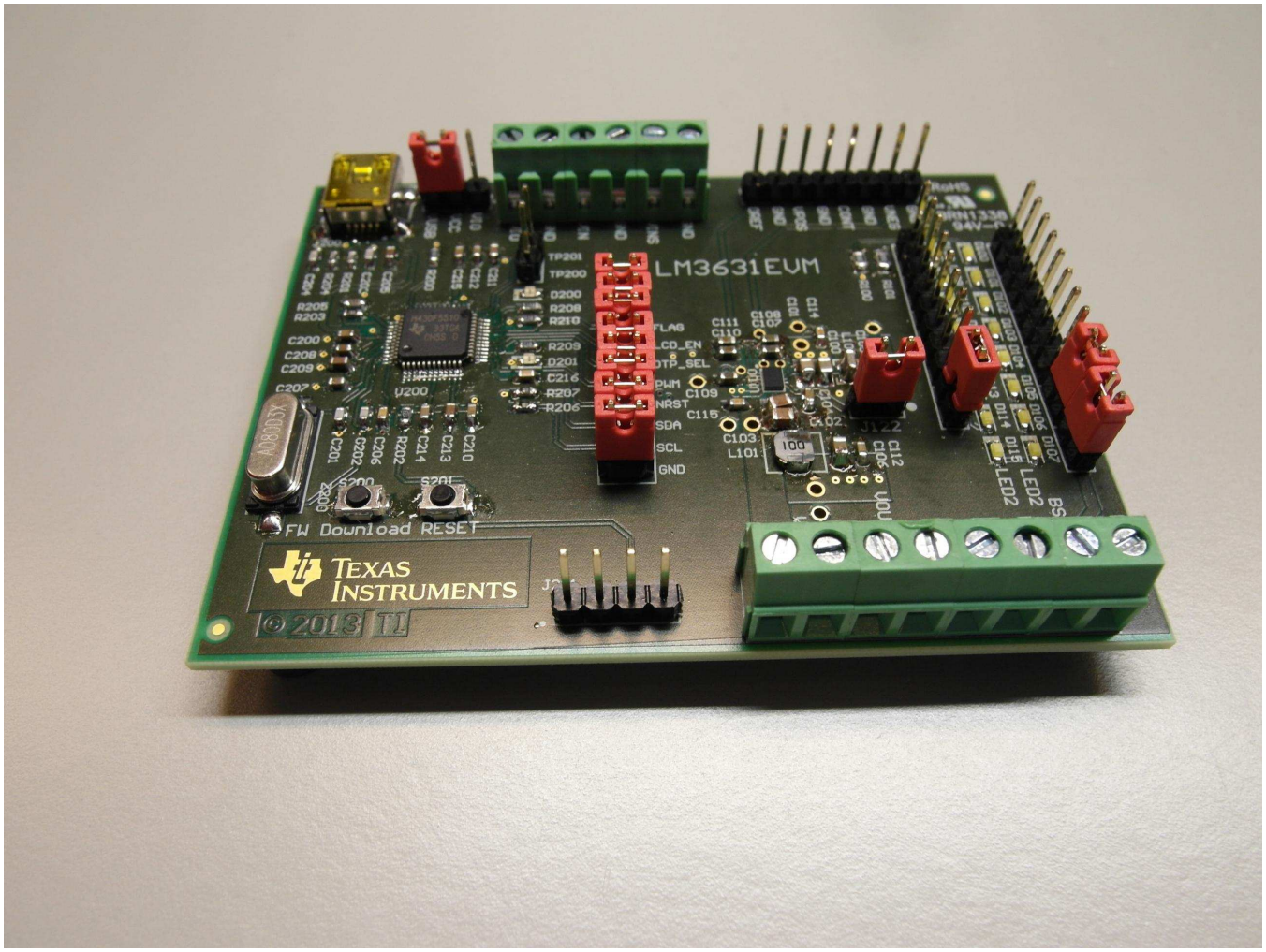

Figure 3. Evaluation Hardware

3.4 Evaluation Software

The LM3631 evaluation software helps user control the evaluation hardware connected to the computer. The evaluation software consists of four tabs: General tab, Backlight tab, LCD Bias tab, and History tab. When opened up, the program goes directly to RUN mode, so the EVM should be connected before opening the software. The program is stopped by pushing the STOP button or the red button on the upper left-hand corner. If stopped, and then user wants to run program again, simply push the white arrow on the upper left-hand corner.

A Help window, for showing control description, can be opened by pushing CTRL+H or from Help menu and selecting Show Context Help.

3.4.1 General Tab

From the General tab, user can control the following:

- USB Address: Evaluation software automatically polls the USB address and, if not found, prompts for error. The USB address is format ASRLx::INSTR, where x is the number of the USB port. The USB address can be changed by clicking the Address field, writing a new address value, and pushing the Init Communication button.
- Device I2C Address: This is the I^2C address of the LM3631 device. The address can be changed by clicking the field, writing a new value, and pushing the Change I2C address button.
- nRST checkbox: Setting nRST checkbox active will enable the MSP430 to set the nRST pin HIGH. Unchecking will set the nRST pin LOW.
- LCD_EN checkbox: Setting LCD_EN checkbox active will enable the MSP430 to set the LCD_EN pin HIGH. Unchecking will set the LCD_EN pin LOW
- OTP_SEL checkbox: Setting OTP_SEL checkbox active will enable the MSP430 to set the OTP_SEL pin HIGH. Unchecking will set the OTP_SEL pin LOW
- PWM frequency and PWM duty cycle: With the PWM frequency and duty cycle controls, the MSP430-generated PWM can be controlled. Frequency and duty cycle can be changed with the sliders or with the numerical control below sliders. Values are updated by pushing the Update PWM Frequency and Duty Cycle button.
- The Reset All Registers button performs a register reset for the LM3631.
- The Read All Registers button performs a read for all the registers.
- Device Revision can be read by pushing the Read button next to Device Revision indicator.
- OTP Revision can be read by pushing the Read button next to OTP Revision indicator.
- Single register read: User can read a single register by selecting the register from the Register pulldown menu and pushing the Read Register button. The register value will be updated to the Register Value indicator.
- Faults: Device faults can be checked by pushing the Check Faults button. Each fault has its own indicator. Faults can be cleared by pushing the Clear Faults button or by an individual Clear button. The Clear Faults button clears all the faults.
- PG FLAG: FLAG-pin status can be read by pushing the Read button under the PG_FLAG indicator. PG Flag polarity can be controlled with a switch and from two pulldown menus.

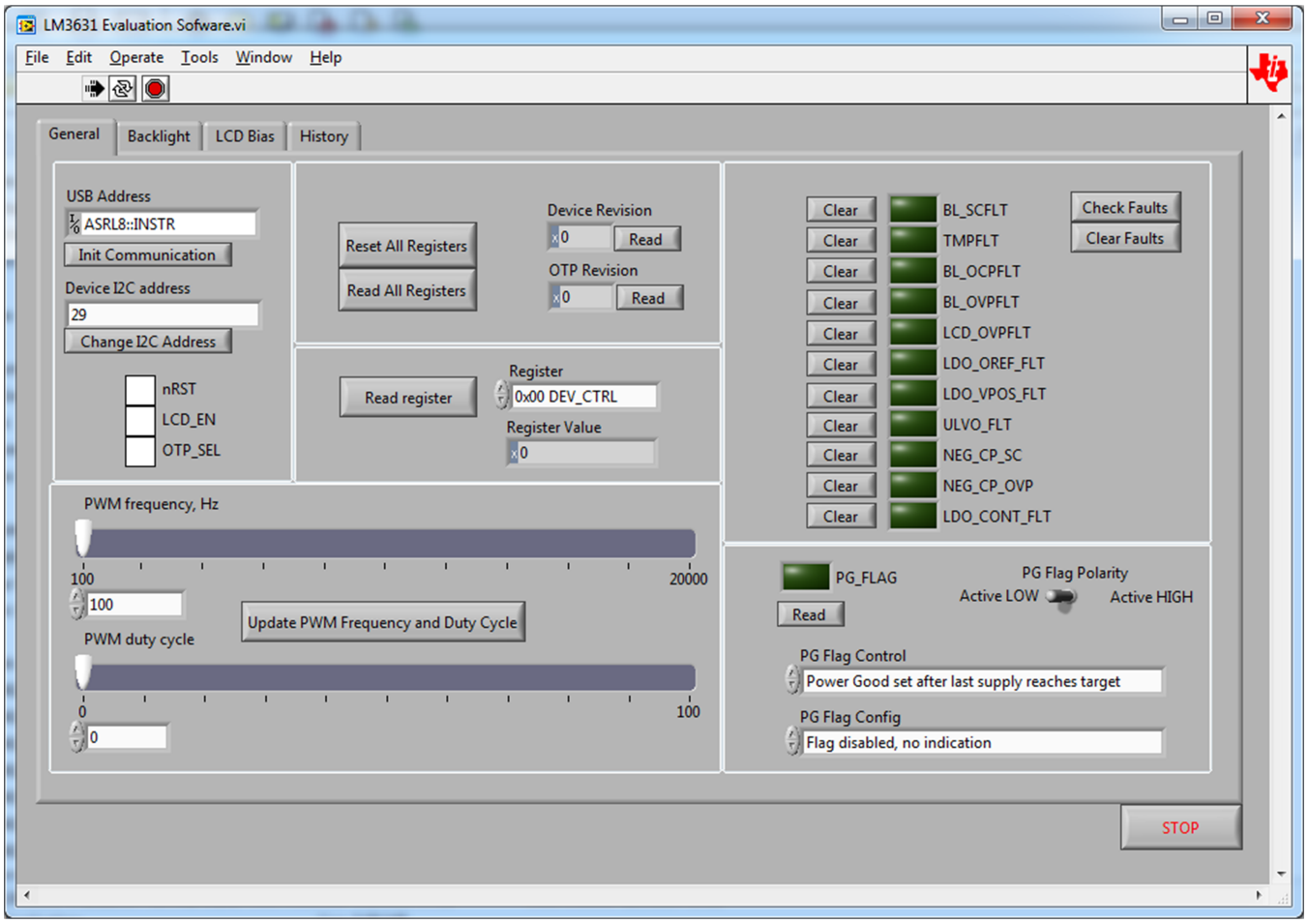

Figure 4. General Tab of Evaluation Software

3.4.2 Backlight Tab

From the Backlight tab user can control the bits related to backlight:

- Enable Backlight checkbox: by checking this, the BL_EN bit is set HIGH; unchecking will set the bit LOW.
- Enable Advanced Slope checkbox: by checking this, the EN_ADV_SLOPE bit is set HIGH; unchecking will set the bit LOW.
- Disable Dither checkbox: by checking this, the DISABLE_DITHER bit is set HIGH; unchecking will set the bit LOW.
- Mapper: With Mapper switch user can select the mapping mode.
- String Mode: With String Mode switch user can select LED string mode.
- Brightness Mode: With the Brightness Mode pulldown menu the brightness mode can be selected.
- Slope: With the Slope pulldown menu the brightness slope time can be selected.
- Dither Frequency: With the Dither Frequency pulldown menu the dithering frequency can be selected.
- Brightness: With Brightness control the 11-bit brightness is controlled. Brightness can be controlled with the slider or control below the slider. Brightness value is updated by pushing the Update brightness button.
- Auto Freq Threshold: With Auto Freq Threshold button the 8-bit auto frequency threshold can be controlled. Its value can be controlled with the slider or control below the slider. Value is updated by pushing the Update threshold button.

- Auto Freq mode can be selected with the Auto Freq switch.
- Backlight boost peak-current limit can be selected from Peak Current Limit pulldown menu control.
- Backlight boost over-voltage protection limit can be selected from BL Boost OVP pulldown menu control.
- Backlight boost Min Inductor switch controls the MIN_INDUCTOR bit.
- Backlight boost BL Boost Freq switch selects the backlight boost frequency.
- SEL_I term can be controlled with pulldown menu control.
- SEL_P term can be controlled with pulldown menu control.
- PWM input signal edge detection can be selected with Edge Detection switch.
- PWM input signal polarity selection can be done with PWM Polarity switch.
- PWM input hysteresis can be selected with PWM Hysteresis pulldown menu control.

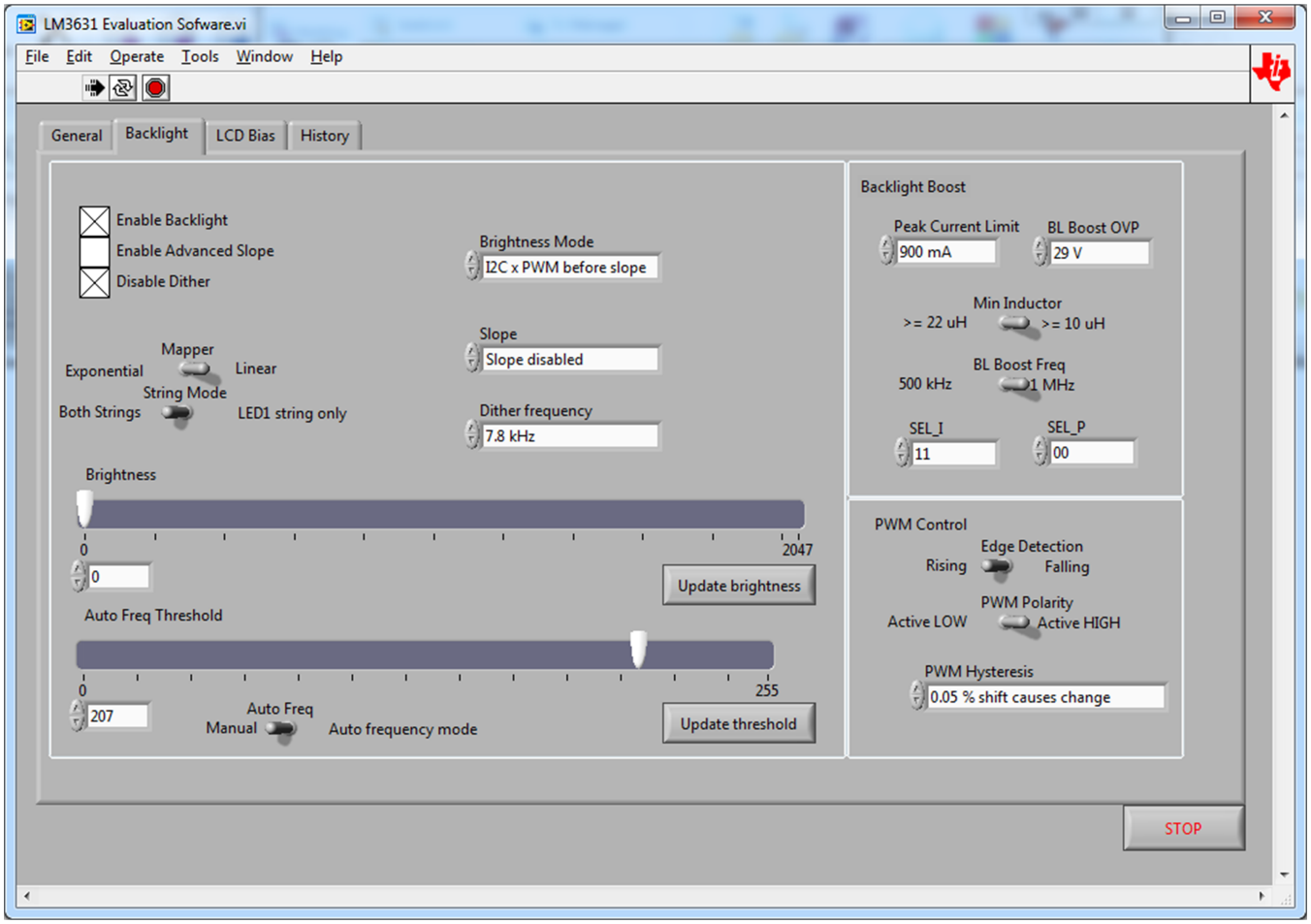

Figure 5. Backlight Tab of Evaluation Software

3.4.3 LCD Bias Tab

The LCD Bias tab contains the controls for bias powering:

- Enable LCD checkbox: by checking this the LCD_EN bit is set HIGH; unchecking sets the bit LOW.
- Enable LDO_VPOS checkbox: by checking this the LDO_VPOS_EN bit is set HIGH; unchecking sets the bit LOW.
- Enable CP_VNEG checkbox: by checking this the CP_VNEG_EN bit is set HIGH; unchecking sets the bit LOW.

- Enable LDO_OREF checkbox: by checking this the LDO_OREF_EN bit is set HIGH; unchecking sets the bit LOW.
- Enable LDO_CONT checkbox: by checking this the LDO_CONT_EN bit is set HIGH; unchecking sets the bit LOW.
- Enable LDO_CONT pulldown checkbox: by checking this the LDO_CONT_SD_PULLDN bit is set HIGH; unchecking sets the bit LOW.
- Enable LDO_OREF pulldown checkbox: by checking this the LDO_OREF_SD_PULLDN bit is set HIGH; unchecking sets the bit LOW.
- Enable CP_VNEG pullup checkbox: by checking this the CP_VNEG_SD_PULLUP bit is set HIGH; unchecking sets the bit LOW.
- Enable LDO_VPOS pulldown checkbox: by checking this the LDO_VPOS_SD_PULLDN bit is set HIGH; unchecking sets the bit LOW.
- LCD Boost output voltage is selected with the LCD Boost output voltage pulldown menu control.
- LDO_CONT start-up delay, shutdown delay, and output voltage are controlled with the LDO_CONT pulldown menu controls.
- LDO_VPOS start-up delay, shutdown delay, and output voltage are controlled with the LDO_VPOS pulldown menu controls.
- CP_VNEG start-up delay, shutdown delay, and output voltage are controlled with the CP_VNEG pullup menu controls.
- LDO_OREF start-up delay, shutdown delay, and output voltage are controlled with the LDO_OREF pulldown menu controls.

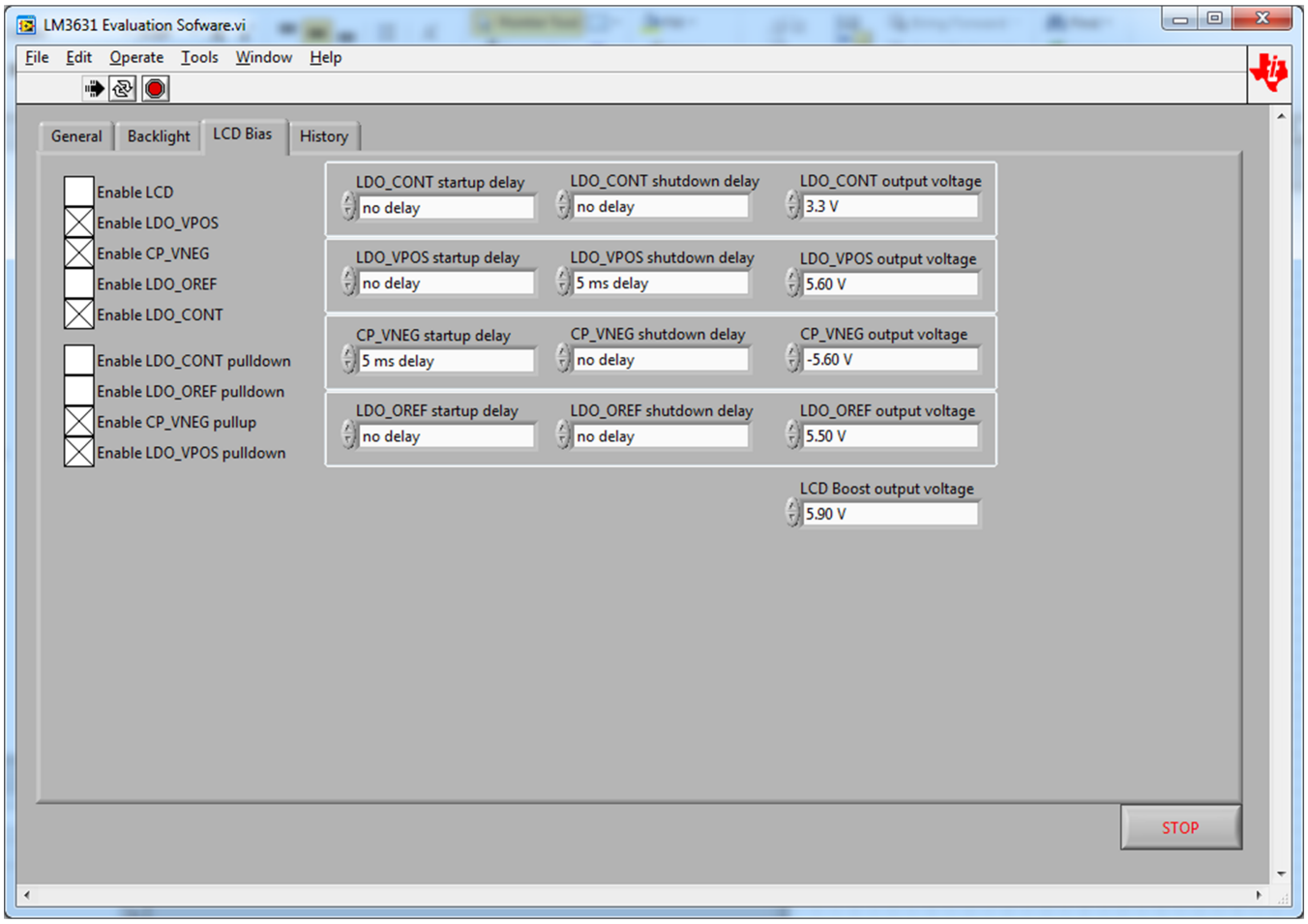

Figure 6. LCD Bias Tab of Evaluation Software

3.4.4 History Tab

From the History tab user can check all the instructions and I²C commands given to the LM3631 device. In this tab user can also create scripts for controlling the LM3631 device. Scripts are entered into Script control. Once script is ready its commands are run by pushing the Run Script button. User can also save, load, and clear scripts with the associated buttons.

The list below shows the available commands for the I²C register bits. After the '=' comes the wanted value. An underscore is needed, but text can be either lower case, upper case, or a mix. There can be spaces — they are ignored.

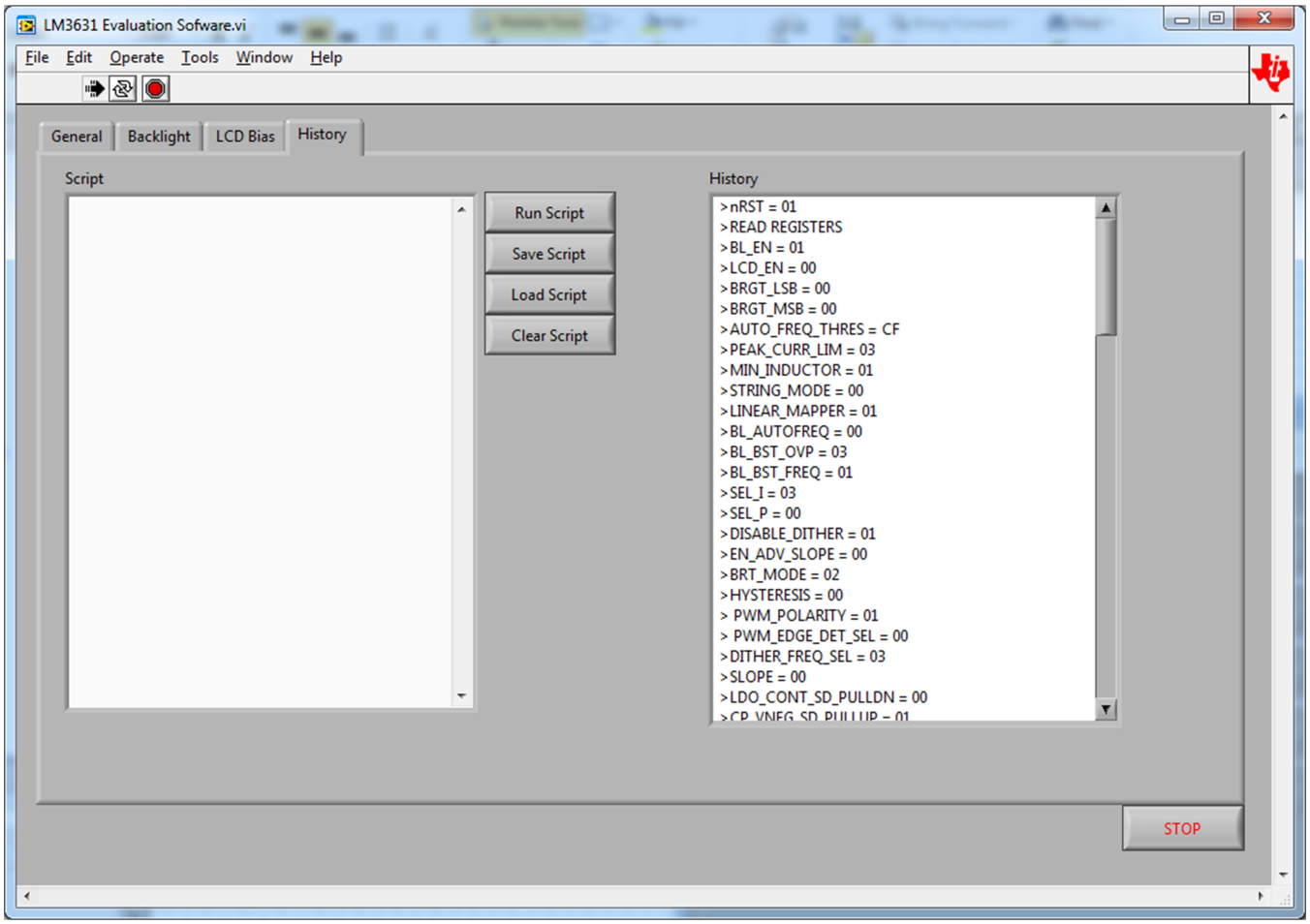

Figure 7. History Tab of Evaluation Software

- BL_EN=
- LCD_EN=
- BRGT_LSB=
- BRGT_MSB=
- AUTO_FREQ_THRES=
- PEAK_CURR_LIM=
- MIN_INDUCTOR=
- STRING_MODE=
- LINEAR_MAPPER=
- BL_BST_FREQ=
- BL_BST_OVP=

- BL_AUTOFREQ=
- SEL_P=
- SEL_I=
- DISABLE_DITHER=
- EN_ADV_SLOPE=
- BRT_MODE=
- HYSTERESIS=
- PWM_POLARITY=
- PWM_EDGE_DET_SEL=
- DITHER_FREQ_SEL=
- SLOPE=
- LDO_OREF_EN=
- CP_VNEG_EN=
- LDO_VPOS_EN=
- LDO_VPOS_SD_PULLDN=
- CP_VNEG_SD_PULLUP=
- LDO_OREF_SD_PULLDN=
- LDO_CONT_SD_PULLDN=
- LDO_CONT_EN=
- LDO_CONT_SD_DELAY=
- LDO_CONT_SU_DELAY=
- LCD_BST_VOUT=
- LDO_CONT_VOUT=
- LDO_VPOS_VOUT=
- LDO_VPOS_TARGET=
- CP_VNEG_VOUT=
- CP_VNEG_TARGET=
- LDO_OREF_VOUT=
- LDO_OREF_TARGET=
- LDO_VPOS_SD_DELAY=
- LDO_VPOS_SU_DELAY=
- CP_VNEG_SD_DELAY=
- CP_VNEG_SU_DELAY=
- LDO_OREF_SD_DELAY=
- LDO_OREF_SU_DELAY=
- PG_FLAG_CONFIG=
- PG_FLAG_CTRL=
- PG_FLAG_POLARITY=
- FLAG_PIN_POLARITY=

The following list shows other commands that are for reading, clearing, and booting (RESET, RST and BOOT). The PIN controls are also specified below.

- RESET "resets the device, register reset"
- RST "resets the device, register reset"
- BOOT "resets the device, register reset"
- DEV_REV "reads the device revision"
- OTP_REV "reads the OTP revision"
- CLEARFAULTS "clears all faults"
- READFAULTS "reads the faults"
- READFLAG "reads flag status"
- READPG "reads flag status"
- CLEARBL_SCFLT "clears fault"
- CLEARTMPFLT "clears fault"
- CLEARBL_OCPFLT "clears fault"
- CLEARBL_OVPFLT "clears fault"
- CLEARLCD_OVPFLT "clears fault"
- CLEARLDO_OREF_FLT "clears fault"
- CLEARLDO_VPOS_FLT "clears fault"
- CLEARUVLO_FLT "clears fault"
- CLEARNEG_CP_SC "clears fault"
- CLEARNEG_CP_OVP "clears fault"
- CLEARLDO_CONT_FLT "clears fault"
- NRST= "set nRST pin"
- LCD_EN_PIN= "set LCD_EN pin"
- OTP_SEL= "set OTP_SEL pin"
- FLAG_PIN_CONFIG= "flag pin configuration"
- FLAG_PIN_CONTROL= "flag pin control"
- FLAG_PIN_CTRL= "flag pin control"
- WAIT= "wait command"
- READREG "read register"
- READREGISTER "read register"
- RREG "read register"
- RREGISTER "read register"

4 Bill of Materials

Table 1 shows a bill of materials for LM3631 key components.

Table 1. LM3631 BOM

Designator	Qty	Description	Value	Part Number
U100	1	Complete LCD Backlight and Bias Power		LM3631
C100, C101, C105, C106	4	Ceramic Capacitor	10 µF, 16 V	GRM21BR61C106KE15L
C102, C103	2	Ceramic Capacitor	2.2 µF, 50 V	C2012X5R1H225K125AB
C104, C112, C113	3	Ceramic Capacitor	0.1 µF, 25 V	C1608X7R1E104K080AA
C107, C108, C109, C110, C111	5	Ceramic Capacitor	10 µF, 16 V	EMK107BBJ106MA-T
C114, C115	2	Ceramic Capacitor	100 pF, 50 V	06035A101JAT2A
D100, D101, C102, D103, D104, D105, D106, D107, D108, D109, D110, D111, D112, D113, D114, D115	16	White LED		SML312WBCW1
D116	1	Schottky Diode	40 V, 0.2 A	NSR0240P2T5G
L100	1	Inductor, Multilayer	1.5 µH, 1.2 A	MLP2016H1R5MT0S1
L101	1	Inductor, Wirewound	10 µH	NRS4012T100MDGJV
R100, R101	2	Resistor	10 Ω	CRCW080510R0FKEA

5 Schematic

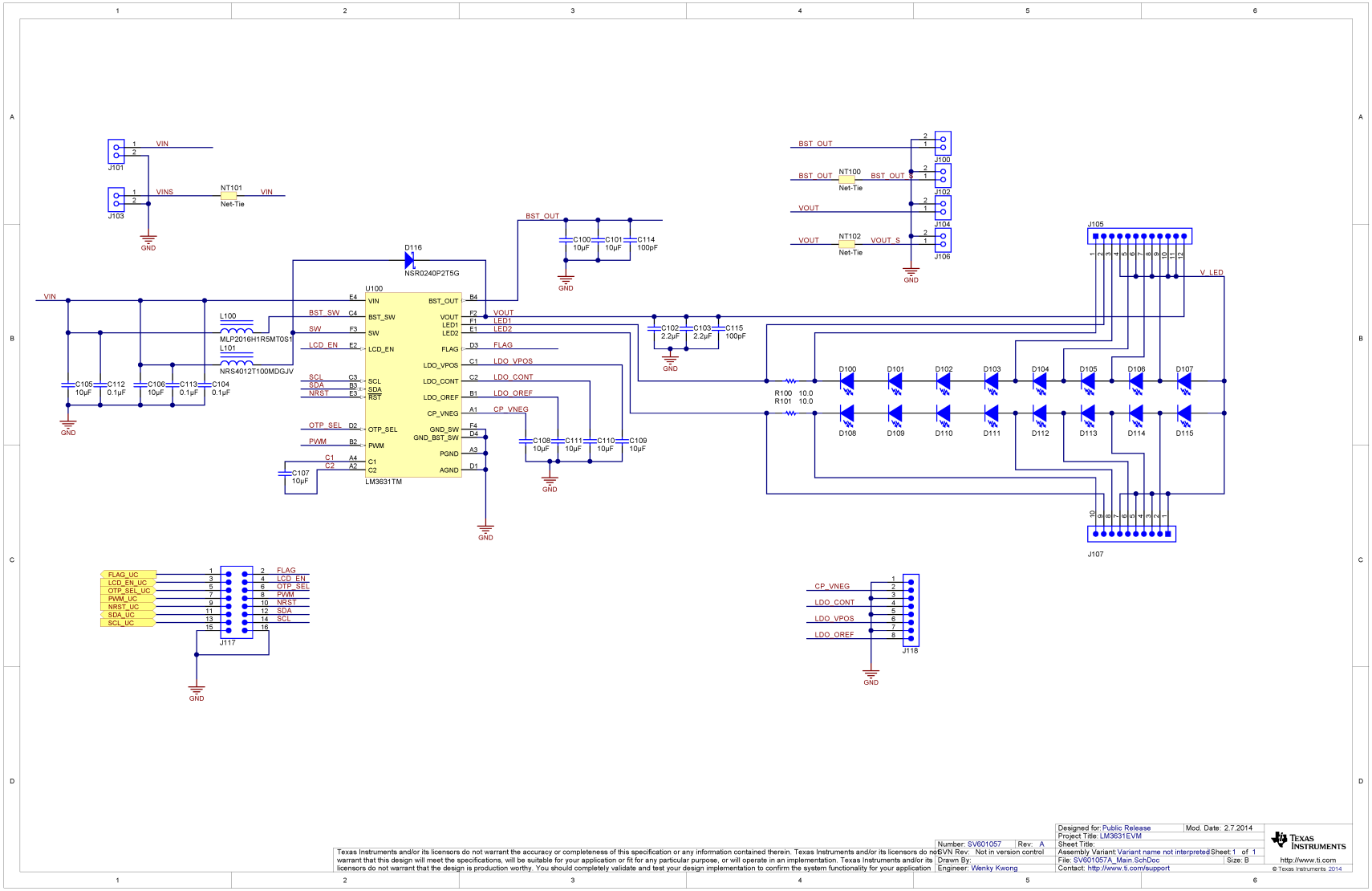

Figure 8. LM3631EVM Main Schematic

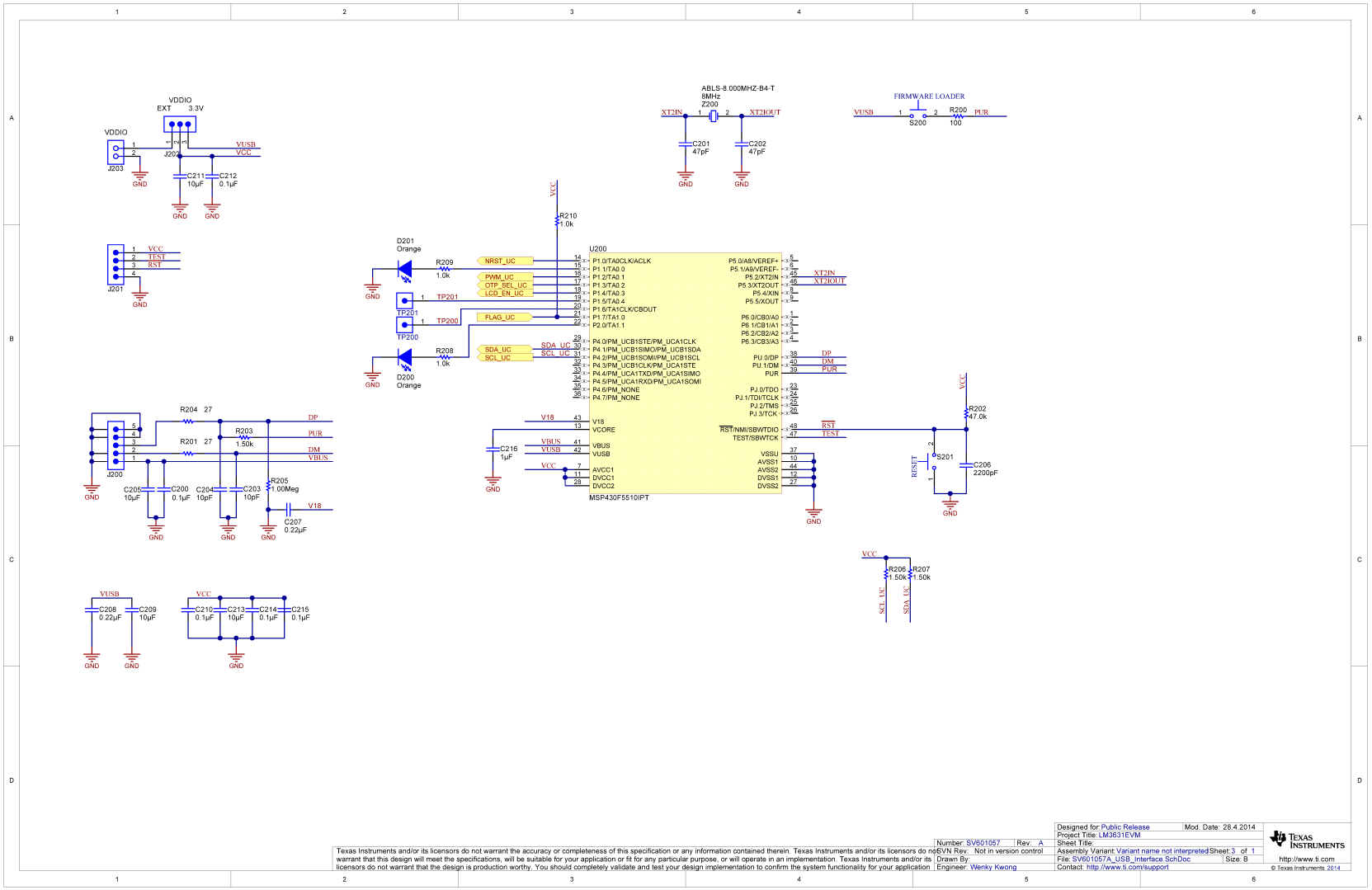

Figure 9. LM3631EVM USB Interface Schematic

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Logic	logic.ti.com	Security	www.ti.com/security
Power Mgmt	power.ti.com	Space, Avionics and Defense	www.ti.com/space-avionics-defense
Microcontrollers	microcontroller.ti.com	Video and Imaging	www.ti.com/video
RFID	www.ti-rfid.com		
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