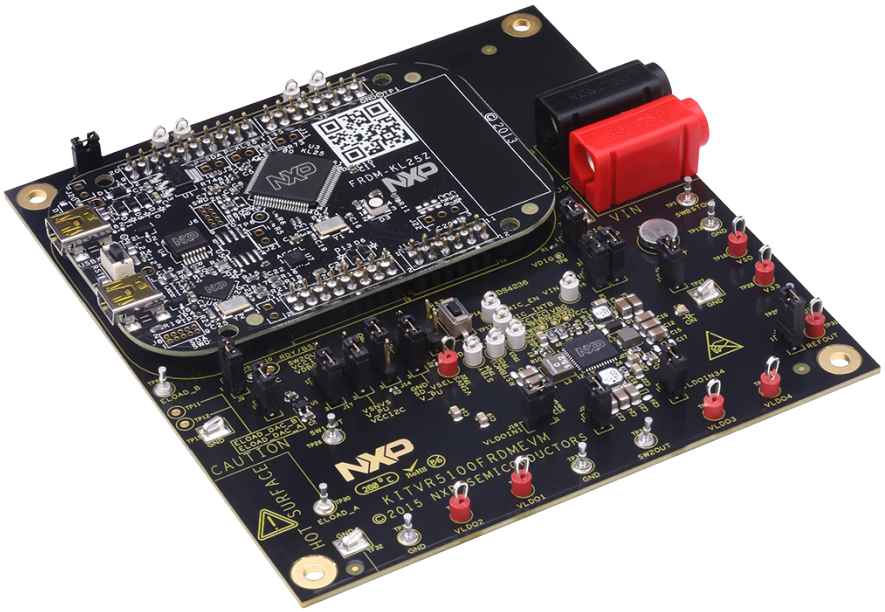
KTVR5100FRDMEVMUG

KITVR5100FRDMEVM evaluation board

Rev. 1.0 — 3 August 2016 User guide

1 KITVR5100FRDMEVM



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3 Overview of the VR5100 PMIC development environment

NXP offers a combination of boards that support the evaluation and programming of the VR5100 PMIC.

The KITVR5100FRDMEVM boards serves as an evaluation platform that allows designers to lab test and demo designs that incorporate the VR5100 PMIC. The evaluation board contains a preconfigured MC34VR5100 device and provides numerous jumpers and test points that allow designers to tailor the evaluation to their needs. The kit comes with a FRDM-KL25Z already mounted and loaded with compatible microcode. The FRDM-KL25Z's primary function is to control communication between the evaluation board and a PC.

The KITVR5100FRDMPGM board is designed to allow one-time programming of the VR5100’s configuration fuses. The board contains a socket that houses a single VR5100 device during the OTP (One Time Programming) process. This kit also comes with a mounted FRDM-KL25Z loaded with compatible microcode. The KL25Z controls communication between the evaluation board and a PC.

Alternatively, the designer may disconnect the KITVR5100FRDMPGM socket board from its dedicated KL25Z board and mount the socket board to the top of the KL25Z on the KITVR5100FRDMEVM board. This configuration is referred to as 'Combo' mode. Microcode on the KL25Z connected to the KITVR5100FRDMEVM board recognizes whether the evaluation board is in standalone mode or whether a socket board is mounted in Combo mode. In Combo mode the designer can exercise the functionality of the evaluation board with respect to the device in the socket and use the OTP feature to program the device fuses.

The user interface for all three of the above configurations is a software GUI that can be downloaded and installed on a PC from NXP’s website. The GUI provides direct access to the target VR5100 PMIC (either the device on the evaluation board or the device in the programming board socket). It allows the designer to load values for switches and regulators, read registers, clear interrupts and so forth. The GUI also provides a script editor that supports creating and executing a series of GUI commands. When the GUI is connected to a socket board, it serves as the interface for OTP programming of the VR5100 PMIC’s onboard configuration fuses.

When the GUI is activated on a PC connected to a KL25Z in one of the three configurations, it senses which configuration is connected and provides the corresponding functionality.

4 Getting started

4.1 Kit contents/packing list

The KITVR5100FRDMEVM contents includes:

- Assembled and tested KITVR5100FRDMEVM evaluation board
- Firmware loaded FRDM-KL25Z board (mounted to the evaluation board)
- USB to Mini-USB cable
- Quick start guide

4.2 Jump start

NXP's analog product development boards provide an easy-to-use platform for evaluating NXP products. The boards support a range of analog, mixed-signal and power solutions. They incorporate monolithic ICs and system-in-package devices that use proven high-volume SMARTMOS technology. NXP products offer longer battery life, a smaller form factor, reduced component counts, lower cost and improved performance in powering state of the art systems.

1. Go to www.nxp.com/KITVR5100FRDMEVM.
2. Review your Tools Summary Page.
3. Locate and click:

4. Download the documents, software and other information.

Once the files are downloaded, review the user guide in the bundle. The user guide includes setup instructions, BOM and schematics. Jump start bundles are available on each tool summary page with the most relevant and current information. The information includes everything needed for design.

4.3 Required equipment

This kit requires the following items:

- 4.2 V power supply wall adaptor or lab power supply with 3.0 V to 5.0 V at 3.0 A capability
- Two power supply cables with banana connectors
- KITVR5100GUI installed on a Windows PC
- Optional voltmeters to measure regulator outputs
- Optional oscilloscope

4.4 System requirements

The kit requires the following to function properly with the software:

- USB enabled computer running Windows XP, Vista, 7, 8, or 10 (32-bit or 64-bit)

5 Getting to know the hardware

5.1 Board overview

The KITVR5100FRDMEVM evaluation board (EVB) is an easy-to-use circuit board, allowing the user to exercise all the functions of the VR5100 power management IC.

An FRDM-KL25Z is mounted to the EVB as an integral component. The FRDM-KL25Z serves as an interface between the KITVR5100GUI and the VR5100 PMIC. The FRDM-KL25Z drives circuitry on the KITVR5100FRDMEVM, as well as provides an analog-to-digital convertor (ADC) to allow real-time monitoring of the VR5100 regulator voltages, and display their values in the GUI.

5.2 Board features

The board features are as follows:

- VR5100 Power Management IC
- Input supply using a wall adaptor or lab power supply through banana jacks
- Integrated FRDM-KL25Z as a communication link between the EVB and a PC
- Two 1.0 Amp E-loads with configurable current

5.3 Device features

This evaluation board features the following NXP product:

Table 1. Device features [1]

Device	Description	Features
VR5100	Power management integrated circuit (PMIC) for i.MX series and i.MX 6 SL/SX	• Three adjustable high efficiency buck regulators: 1.75 A, 1.5 A, 1.25 A, 1.0 A • 5.0 V, 600 mA boost regulator with PFM or auto mode • Six adjustable general purpose linear regulators • Input voltage range: 2.8 V to 4.5 V OTP (One Time Programmable) memory for device configuration

[1] Minimum start-up voltage is 3.1 V

5.4 Board description

Figure 1 describes the main elements on the KITVR5100FRDMEVM.

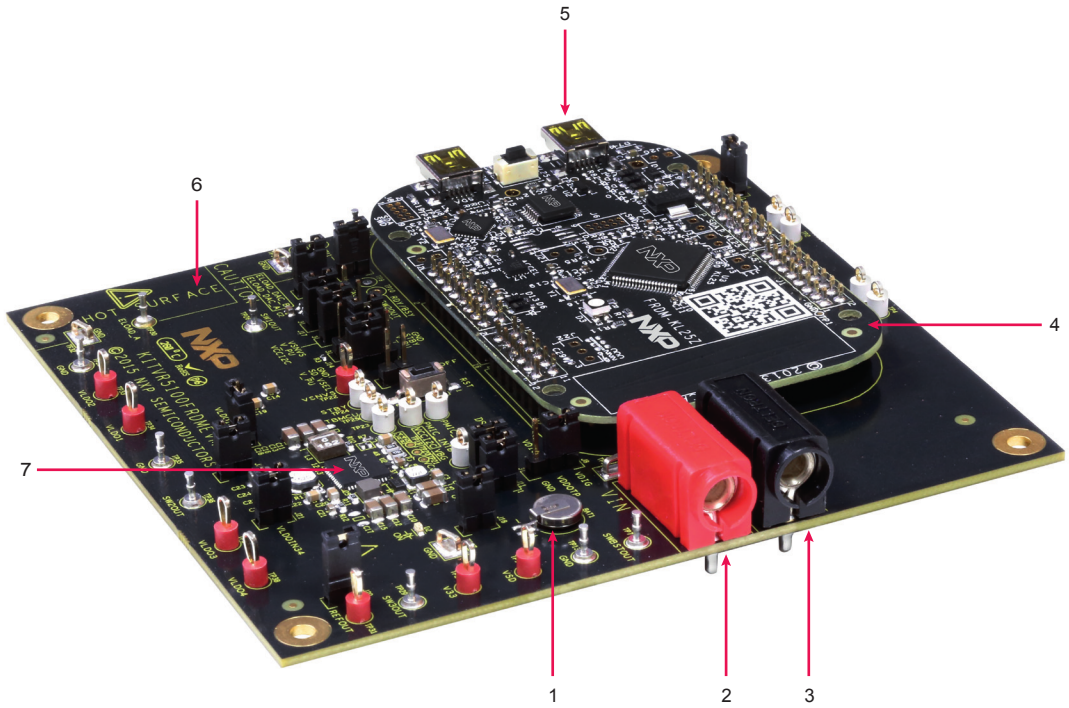


Figure 1. Board description

Table 2. Board description

Number	Name	Description
1	Coin cell battery	Backup power supply for VR5100 PMIC
2	Banana connector	Connection to power supply positive terminal
3	Banana connector	Connection to power supply negative terminal
4	FRDM-KL25Z	KL25Z board mounted via Arduino™ connectors. Controls communication with PC
5	USB KL25Z	USB port for connection to PC
6	KITVR5100FRDMEVM	VR5100 PMIC evaluation board
7	MC34VR5100A1EP	VR5100 PMIC (Power Management IC)

5.5 Device description

The VR5100 device populated on KITVR5100FRDMEVM features the A1 OTP. See Figure 4.

Table 3. Startup configuration [1]

Register name	Address	Data	Value
OTP PU CONFIG 1	0xE0	0x01	PWRON = level sensitive | DVS clock speed = 12.5 mV/µs | sequencer clock = 2.0 ms
OTP PGOOD ENABLE	0xE8	0x00	Power good = disabled
OTP I2C ADDR	0xFF	0x08	I^2C device address = 0x08
OTP SW1 VOLTS	0xA0	0x08	SW1 V_{OUT} = 0.900 Volts
OTP SW1 SEQUENCE	0xA1	0x02	SW1 power up sequence = 4.0 ms
OTP SW1 CONFIG	0xA2	0x05	SW1 switching frequency = 2.0 MHz
OTP SW2 VOLTS	0xAC	0x06	SW2 V_{OUT} = 3.200 Volts
OTP SW2 SEQUENCE	0xAD	0x01	SW2 power up sequence = 2.0 ms
OTP SW2 CONFIG	0xAE	0x01	SW2 switching frequency = 2.0 MHz
OTP SW3 VOLTS	0xB0	0x09	SW3 V_{OUT} = 1.350 Volts
OTP SW3 SEQUENCE	0xB1	0x01	SW3 power up sequence = 2.0 ms
OTP SW3 CONFIG	0xB2	0x01	SW3 switching frequency = 2.0 MHz
OTP SWBST VOLTS	0xBC	0x00	SWBST V_{OUT} = 5.000 Volts
OTP SWBST SEQUENCE	0xBD	0x00	SWBST power up sequence = OFF
OTP VSNVS VOLTS	0xC0	0x06	VSNVS V_{OUT} = 3.000 Volts
OTP LDO1 VOLTS	0xC8	0x00	LDO1 V_{OUT} = 1.800 Volts
OTP LDO1 SEQUENCE	0xC9	0x00	LDO1 power up sequence = OFF
OTP LDO2 VOLTS	0xCC	0x0F	LDO2 V_{OUT} = 1.550 Volts
OTP LDO2 SEQUENCE	0xCD	0x01	LDO2 power up sequence = 2.0 ms
OTP VSD VOLTS	0xD0	0x03	VSD V_{OUT} = 3.300 Volts
OTP VSD SEQUENCE	0xD1	0x01	VSD power up sequence = 2.0 ms
OTP V33 VOLTS	0xD4	0x03	V33 V_{OUT} = 3.300 Volts
OTP V33 SEQUENCE	0xD5	0x01	V33 power up sequence = 2.0 ms
OTP LDO3 VOLTS	0xD8	0x0F	LDO3 V_{OUT} = 3.300 Volts
OTP LDO3 SEQUENCE	0xD9	0x01	LDO3 power up sequence = 2.0 ms
OTP LDO4 VOLTS	0xDC	0x07	LDO4 V_{OUT} = 2.500 Volts
OTP LDO4 SEQUENCE	0xDD	0x09	LDO4 power up sequence = 18.0 ms

[1] This table specifies the default output voltage of the LDOs and SWx after start-up and/ or when the LDOs and SWx are enabled. VREFDDR_SEQ is internally fixed to be same as SW3_SEQ. VCC_SD voltage depends on the state of the SD_VSEL pin.

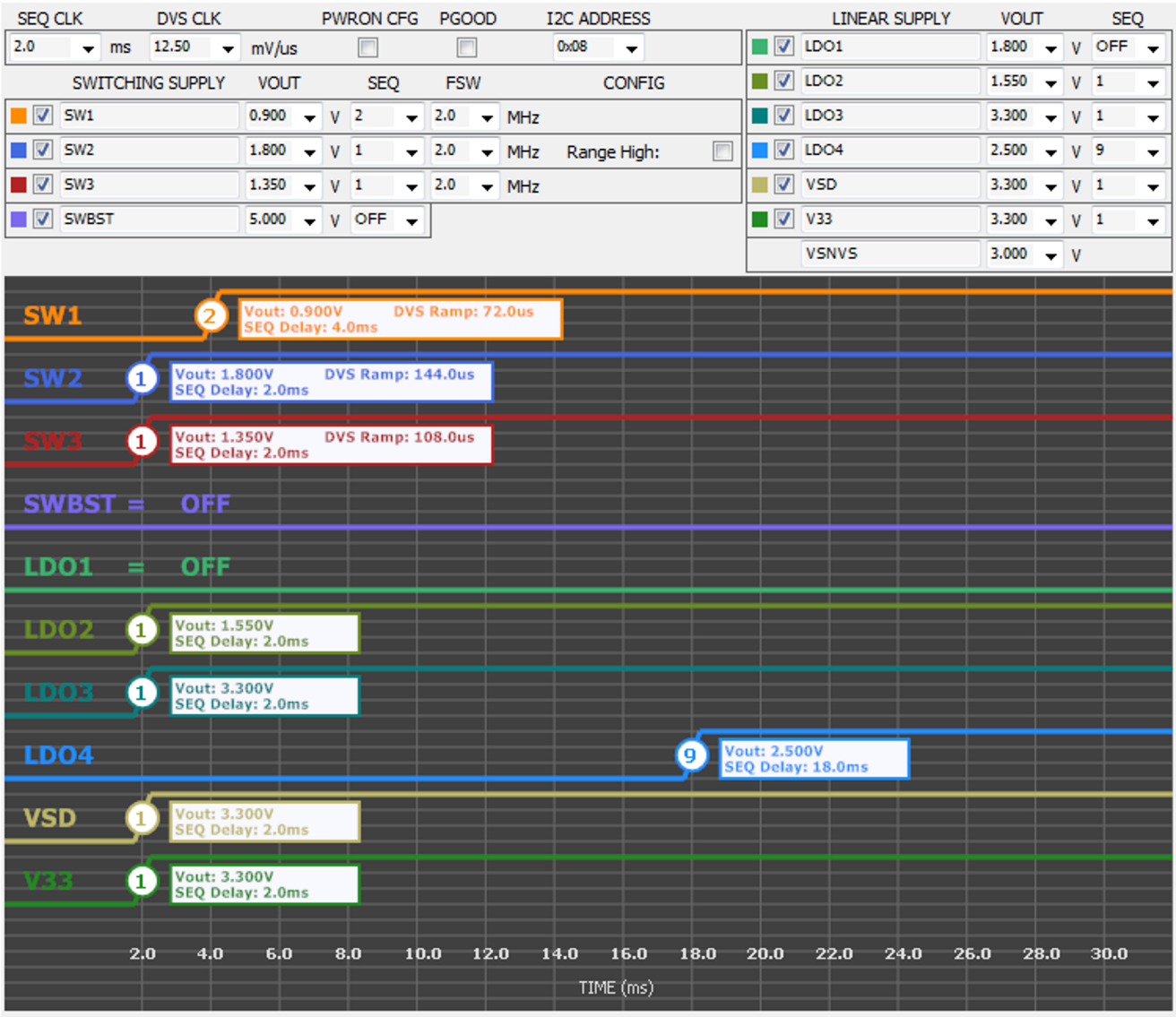


Figure 2. VR5100 GUI OTP Configuration panel showing onboard VR5100 startup configuration data

5.6 LED display

The board contains the following LED:

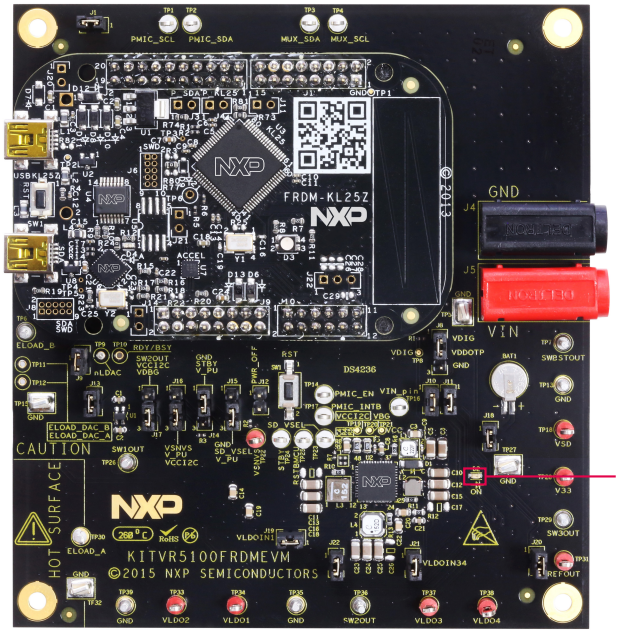


Figure 3. LED locations

Table 4. LED locations

LED ID	Description
D1	LED Green, V33 regulator output from VR5100 PMIC. Displays when the board is connected to a PC through the FRDM-KL25Z's USB port.

5.7 Jumper and switch definitions

Figure 4 shows the location of jumpers and switches on the KITVR5100FRDMEVM evaluation board.

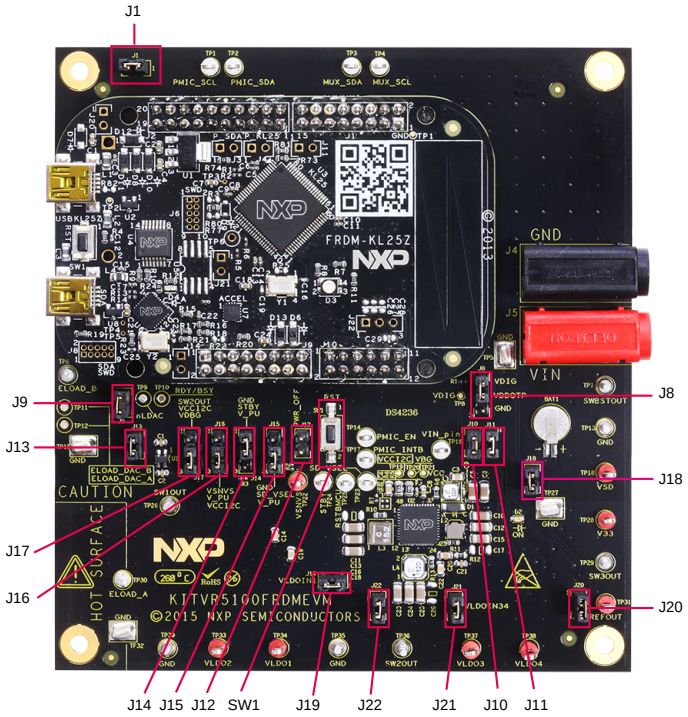


Figure 4. Jumper and switch locations

Table 5 describes the function and settings for each jumper and switch. Default jumper settings are shown in bold text.

Table 5. Jumper and switch definitions

Jumper/Switch	Description	Setting	Connection/Result
SW1	Reset	**Open**	**Connects EN pin to GND when pressed. Resets the PMIC device.**
J1	ELOAD B Drive	Open	ELOAD B has no drive (use for troubleshooting ELOAD only).
		[1-2]	**ELOAD B drive is connected. ELOAD functions properly.**
J8	VDDOTP Select	[1-2]	Connects VDDOTP pin to VDIG. PMIC in TBB mode.[1]
		[2-3]	**Connects VDDOTP pin to GND. PMIC in Normal Operation (RUN mode).**

Jumper/Switch	Description	Setting	Connection/Result
J9	ELOAD A Drive	Open	ELOAD A has no drive. (Use for troubleshooting ELOAD only)
		[1-2]	**ELOAD A drive is connected. ELOAD functions properly**.
J10	VIN Pin	Open	No connection to VIN pin. PMIC VIN is isolated
		[1-2]	VIN pin is connected to VIN bus. PMIC VIN is powered from banana plug J5.
J11	SWBST Out	**Open**	**SWBST output is not connected to Active Metering electronics**.
		[1-2]	SWBST output can be measured with Active Metering electronics.
J12	EN Select	**Open**	**EN pin is controlled by the state of SW1. PMIC in Normal Operation**.
		[1-2]	Connects EN pin to GND. PMIC held in Reset.
J13	VDBG Enable	Open	On board 3.3V LDO (U1) is disabled. VDBG = 0 V
		[1-2]	**On board 3.3V LDO (U1) is enabled. VDBG = 3.3 V**.
J14	STANDBY Select	**[1-2]**	**Connects STBY pin to GND. STANDBY is LOW (Not Enabled)**[2]
		[2-3]	STBY pin is pulled up to V_PU. STANDBY is HIGH (Enabled).
J15	SD Select	**[1-2]**	**Connects SD pin to GND. SD_VSEL is LOW (VSD = 3.3 V)** .[3]
		[2-3]	SD pin is pulled up to V_PU. SD_VSEL is HIGH (VSD = 1.8 V)
J16	V_PU Select	[1-2]	V_PU is connected to VSNVS.
		[2-3]	**V_PU is connected to VCCI2C**.
J17	VCCI2C Select	[1-2]	VCCI2C is connected to SW2 Vout.
		[2-3]	**VCCI2C is connected to VDBG (3.3V LDO)**.
J18	Coin Cell	Open	Coin Cell is isolated.

Jumper/Switch	Description	Setting	Connection/Result
		[1-2]	**Coin Cell is connected to LICELL pin**.
J19	VLDOIN1 Select	Open	VLDOIN1 disconnected from VIN bus. LDO1 has no input source.
		[1-2]	**VLDOIN1 connected to VIN bus. LDO1 is supplied from VIN**.
J20	MUX_IN Select	Open	Active Metering analog mux devices are unpowered. Active Metering OFF.
		[1-2]	**Active Metering analog mux devices powered from VDBG. Active Metering ON**.
J21	VLDOIN34 Select	Open	VLDOIN34 disconnected from VIN bus. LDO3 and LDO4 have no input source.
		[1-2]	**VLDOIN34 connected to VIN bus. LDO3 and LDO4 are supplied from VIN**.
J22	VLDOIN2 Select	Open	VLDOIN2 disconnected from VIN bus. LDO2 has no input source.
		[1-2]	**VLDOIN2 connected to VIN bus. LDO2 is supplied from VIN**.

[1] TBB Mode or “Try-Before-Burn” Mode is a special development mode that allows potential OTP configuration data to be previewed and tested before committing to permanently burning the OTP fuses.
[2] With this setting, STANDBY can be enabled/disabled within the GUI.
[3] With this setting, SD_SEL can be set high/low within the GUI.

5.8 Test point definitions

The following test points provide access to various signals to and from the board.

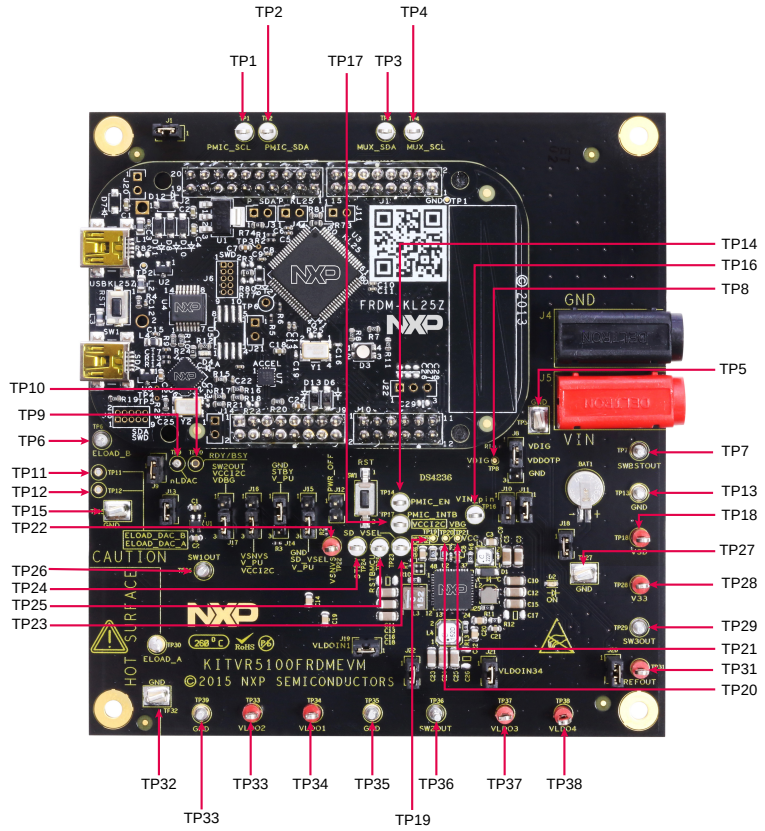


Figure 5. Test point locations

Table 6. Test point definitions

Test point name	Signal name	Description
TP1	PMIC_SCL	VR5100 PMIC I^2C clock signal via Arduino J3 (to KL25Z PTE1)
TP2	PMIC_SDA	VR5100 PMIC I^2C data line via Arduino J3 (to KL25Z PTE0)
TP3	MUX_SDA	Multiplex I^2C data line via Arduino J2 (to KL25Z PTC9)
TP4	MUX_SCL	Multiplex I^2C clock signal via Arduino J2 (to KL25Z PTC8)
TP5	NA	Ground loop
TP6	ELOAD_B	Si4156DY MOSFET (Q51) electronic load signal
TP7	SWBSTOUT	Output from SWBST boost regulator
TP8	VDIG	VR5100 PMIC VDIG (internal core supply) pin signal
TP9	nLDAC	MCP4728 DAC LDAC pin signal
TP10	RDY/BSY	MCP4728 DAC RDY/BSY pin signal
TP11	ELOAD_DAC_B	MCP4728 DAC VOUTB pin signal. When jumper J1 is set, positive input to MCP6V07 operational amplifier (U50A)
TP12	ELOAD_DAC_A	MCP4728 DAC VOUTA pin signal. When jumper J9 is set, positive input to MCP6V07 operational amplifier (U54A)
TP13	GND	Ground
TP14	PMIC_EN	VR5100 PMIC EN pin signal

Test point name	Signal name	Description
TP15	NA	Ground loop
TP16	VIN_pin	VR5100 PMIC VIN pin signal
TP17	PMIC_INTB	VR5100 PMIC INTB pin signal
TP18	VSD	ADG715 (U55) SPST switch VSD pin signal
TP19	VCCI2C	VR5100 PMIC VCCI2C pin signal
TP20	VBG	VR5100 PMIC VBG pin signal
TP21	VCC	VR5100 PMIC VBG pin signal
TP22	VSNVS	ADG715 (U55) SPST switch VSNVS pin signal
TP23	SD_VSEL	VR5100 PMIC SD_VSEL pin signal
TP24	PMIC_Standby	VR5100 PMIC STBY pin signal
TP25	RESETBMCU	VR5100 PMIC PORB pin signal
TP26	SW1OUT	ADG715 (U56) SPST switch SW1OUT pin signal
TP27	GND	Ground loop
TP28	V33	ADG715 (U55) SPST switch V33 pin signal
TP29	SW3OUT	ADG715 (U56) SPST switch SW3OUT pin signal
TP30	ELOAD_B	Si4156DY MOSFET (Q50) electronic load signal
TP31	REFOUT	ADG715 (U55) SPST switch REFOUT pin signal
TP32	GND	Ground loop
TP33	VLDO2	ADG715 (U56) SPST switch VLDO2 pin signal
TP34	VLDO1	ADG715 (U56) SPST switch VLDO2 pin signal
TP35	GND	Ground
TP36	SW2OUT	ADG715 (U56) SPST switch SW2OUT pin signal
TP37	VLDO3	ADG715 (U56) SPST switch VLDO3 pin signal
TP38	VLDO4	ADG715 (U56) SPST switch VLDO4 pin signal
TP39	GND	Ground

5.9 Banana connectors

The board has the following power supply banana connectors.

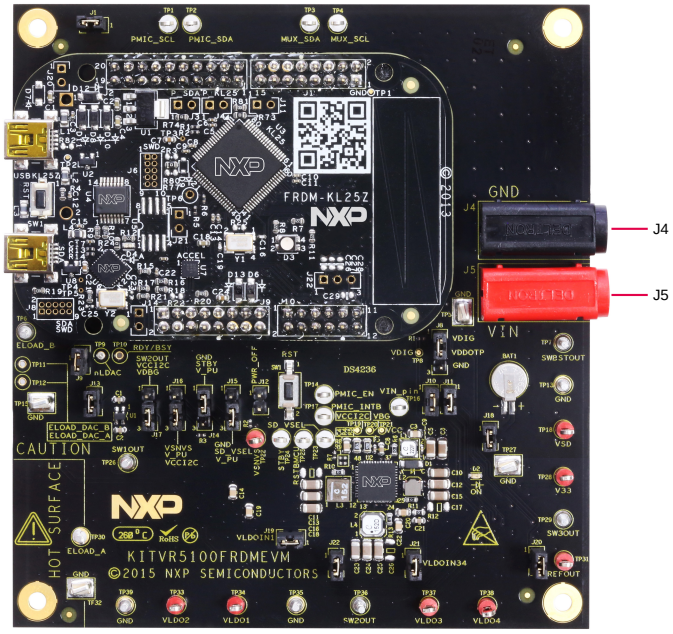


Figure 6. Screw terminal locations

Table 7. Banana connectors

Banana connector name	Description
J4	Board ground
J5	2.8 V to 4.5 V supply input. Use only when SW1 is in position 2 (VIN path).[1]

[1] Minimum startup voltage is 3.1 V

5.10 Coin cell battery

The KITVR5100FRDMEVM contains an on-board coin cell battery that supports the coin cell features of the VR5100 PMIC. The function of the coin cell is to retain data in the OTP registers when power is recycled during a TBB (Try Before Buy) session. The battery also becomes the power source for the device when the VSNVS pin on the VR5100 PMIC is connected directly to the VIN pin. See the VR5100 data sheet for additional information on the VR5100 PMIC's coin cell features.

The VR5100 PMIC contains on-chip circuitry to initiate recharging of the coin cell battery. This capability can be activated through the **Miscellaneous** panel of the VR5100 GUI.

To replace the coin cell battery, carefully lift the spring clip holding the coin cell in place. Slide out the old coin cell and slide in the new.

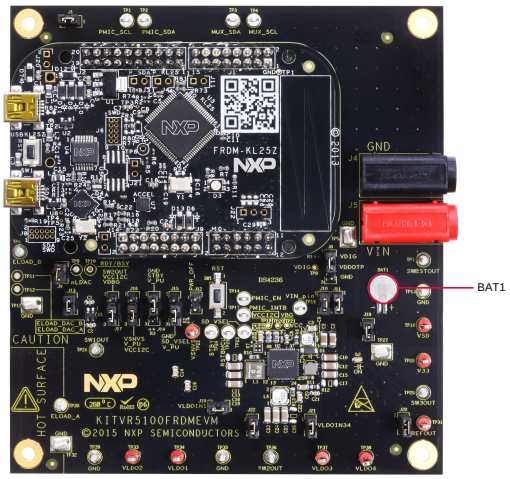


Figure 7. Coin cell battery

Table 8. Coin cell battery

LED ID	Description
BAT1	MS621 surface mount rechargeable backup battery. 3.0 V 5.5 mA lithium coin cell.

6 FRDM-KL25Z Freedom SPI dongle

The NXP Freedom development platform is a set of software and hardware tools supporting evaluation and development. It is ideal for rapid prototyping of microcontroller-based applications. The NXP Freedom KL25Z hardware, FRDM-KL25Z, is a simple, yet sophisticated design featuring a Kinetis L series microcontroller, the industry's first microcontroller built on the ARM® Cortex™-M0+ core.

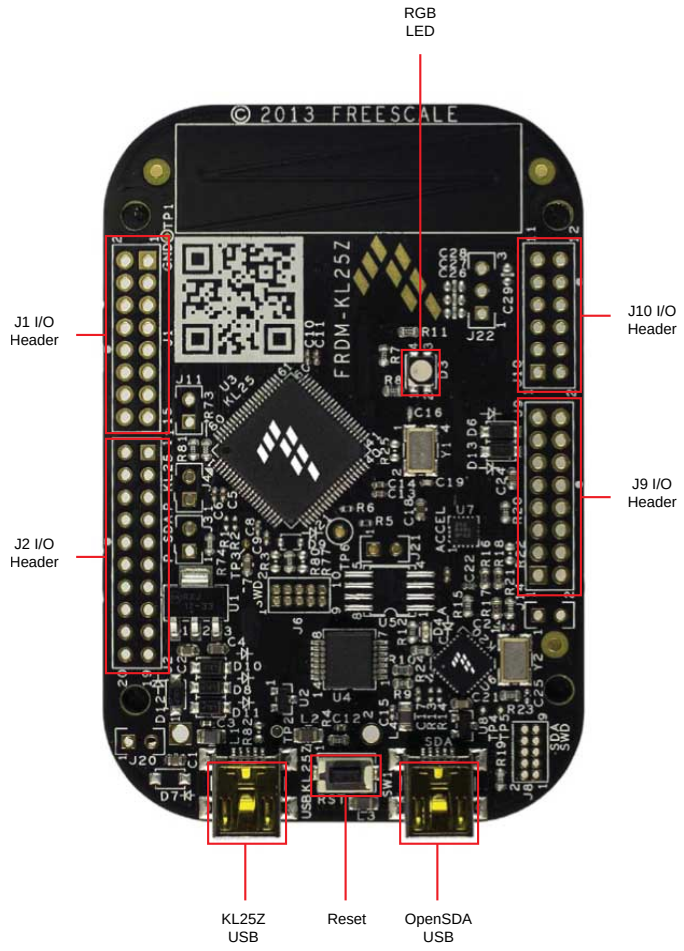


Figure 8. FRDM-KL25Z

6.1 Connecting the FRDM-KL25Z to the board

The FRDM-KL25Z evaluation board was chosen specifically to work with the KITVR5100FRDMEVM kit because of its low cost and features. The FRDM-KL25Z board makes use of the USB, built in LEDs and I/O ports available with NXP's Kinetis KL2x family of microcontrollers.

The KITVR5100FRDMEVM connects to the FRDM-KL25Z using the four dual row Arduino™ R3 connectors on the bottom of the board. Table 9 shows the signal connections between the FRDM-KL25Z and the KITVR5100FRDMEVM board.

Table 9. KITVR5100FRDMEVM to FRDM-KL25Z connections

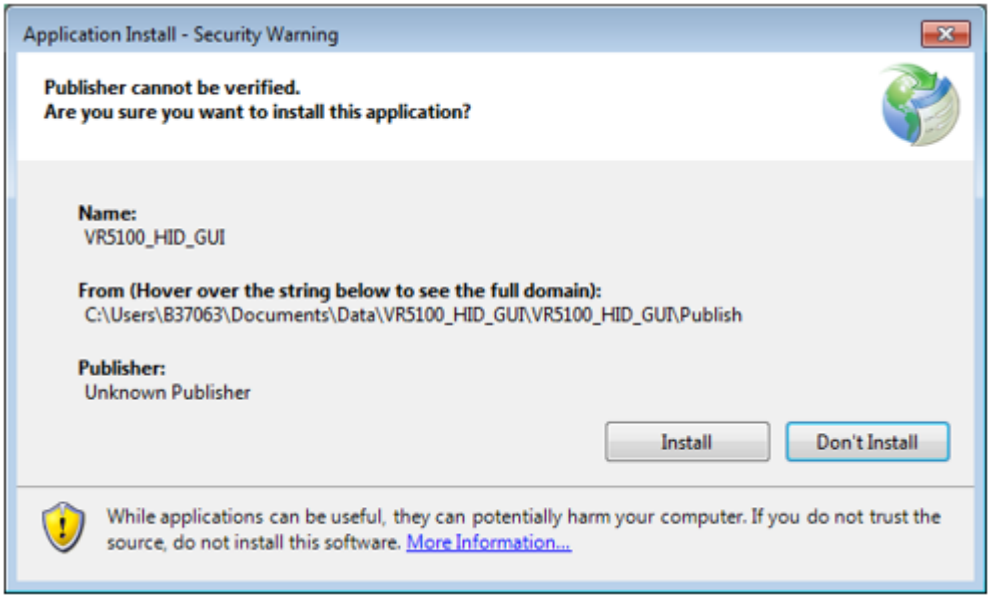
KITVR5100FRDMEVM		FRDM-KL25Z		Pin hardware name		Description
Header	Pin	Header	Pin	KITVR5100 FRDMEVM	FRDM-KL25Z	
J2	1	J1	1	Open	PTC7	Open
J2	2	J1	2	PMIC_INTB	PTA1	Interrupt signal from VR5100 PMIC
J2	3	J1	3	Open	PTC0	Open
J2	4	J1	4	N/C	PTA2	No connection
J2	5	J1	5	Open	PTC3	Open
J2	6	J1	6	RDY/BSY	PTD4	MCP4728 DAC RDY/ BSY pin signal
J2	7	J1	7	Open	PTC4	Open
J2	8	J1	8	nLDAC	PTA12	MCP4728 DAC LDAC pin signal
J2	9	J1	9	Open	PTC5	Open
J2	10	J1	10	N/C	PTA4	No connection
J2	11	J1	11	Open	PTC6	Open
J2	12	J1	12	N/C	PTA5	No connection
J2	13	J1	13	Open	PTC10	Open
J2	14	J1	14	MUX_SCL	PTC8	Multiplex I^2C clock
J2	15	J1	15	Open	PTC11	Open
J2	16	J1	16	MUX_SDA	PTC9	Multiplex I^2C data line
J3	1	J2	1	Open	PTC12	Open
J3	2	J2	2	PMIC_EN	PTA13	Power ON/OFF input to VR5100 PMIC
J3	3	J2	3	Open	PTC13	Open
J3	4	J2	4	PMIC_STANDBY	PTD5	VR5100 PMIC STBY pin signal
J3	5	J2	5	Open	PTC16	Open
J3	6	J2	6	SD_VSEL	PTD0	VR5100 PMIC SD regulator voltage selection
J3	7	J2	7	Open	PTC17	Open
J3	8	J2	8	MUX_RESETB	PTD2	NA
J3	9	J2	9	Open	PTA16	Open
J3	10	J2	10	RESETBMCU	PTD3	VR5100 PMIC PORB pin signal
J3	11	J2	11	Open	PTA17	Open
J3	12	J2	12	N/C	PTD1	No connection
J3	13	J2	13	Open	PTE31	Open
J3	14	J2	14	GND	GND	Ground
J3	15	J2	15	Open	N/C	Open
J3	16	J2	16	N/C	VREFH	No connection
J3	17	J2	17	Open	PTD6	Open
J3	18	J2	18	PMIC_SDA	PTE0	VR5100 PMIC I^2C data line
J3	19	J2	19	Open	PTD7	Open
J3	20	J2	20	PMIC_SCL	PTE1	VR5100 PMIC I^2C clock line
J6	1	J10	1	Open	PTE20	Open

KITVR5100FRDMEVM		FRDM-KL25Z		Pin hardware name		Description
Header	Pin	Header	Pin	KITVR5100 FRDMEVM	FRDM-KL25Z	
J6	2	J10	2	N/C	PTB0	Not connected
J6	3	J10	3	Open	PTE21	Open
J6	4	J10	4	N/C	PTB1	No connection
J6	5	J10	5	Open	PTE22	Open
J6	6	J10	6	VOUT_SNS	PTB2	NA
J6	7	J10	7	Open	PTE23	Open
J6	8	J10	8	ADC_1	PTB3	NA
J6	9	J10	9	Open	PTE29	Open
J6	10	J10	10	ADC_0	PTC2	No connection
J6	11	J10	11	Open	PTE30	Open
J6	12	J10	12	N/C	PTC1	No connection
J7	1	J9	1	Open	PTB8	Open
J7	2	J9	2	N/C	SDA_PTD5	No connection
J7	3	J9	3	Open	PTB9	Open
J7	4	J9	4	3V3_FRDM	P3V3	NA
J7	5	J9	5	Open	PTB10	Open
J7	6	J9	6	N/C	RESET/PTA20	No connection
J7	7	J9	7	Open	PTB11	Open
J7	8	J9	8	N/C	P3V3	No connection
J7	9	J9	9	Open	PTE2	Open
J7	10	J9	10	N/C	P5V_USB	No connection
J7	11	J9	11	Open	PTE3	Open
J7	12	J9	12	GND	GND	Ground
J7	13	J9	13	Open	PTE4	Open
J7	14	J9	14	GND	GND	Ground
J7	15	J9	15	Open	PTE5	Open
J7	16	J9	16	NC	P5-9V_VIN	No connection

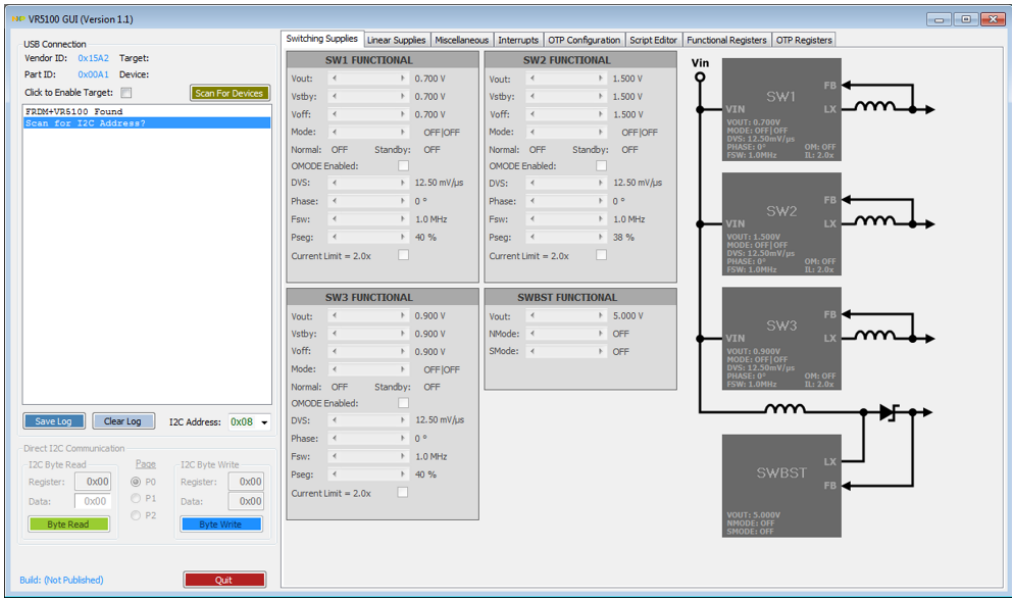
7 Installing the software and setting up the hardware

7.1 Installing VR5100GUI on your computer

1. Download VR5100GUI.zip from http://www.nxp.com/KITVR5100FRDMEVM.
2. Extract all the files to C:/NXP/VR5100GUI or any other desired folder on your PC.
3. Run setup.exe and click **Install** in the dialog box.

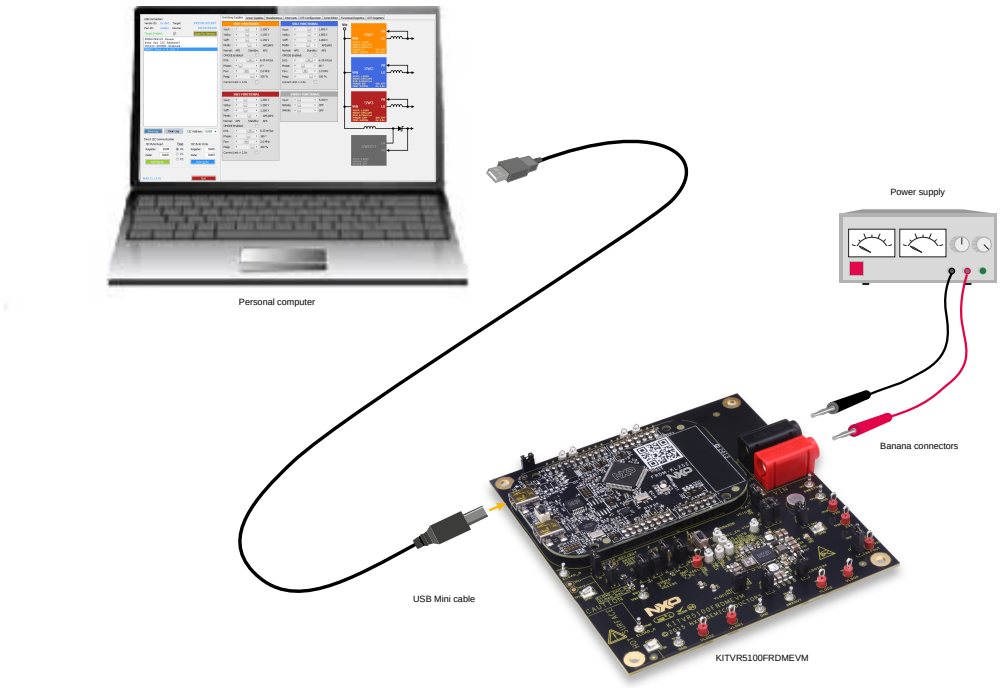


4. The GUI installation is complete and Installation Confirmation window appears. Do not click on anything until the board is plugged in.

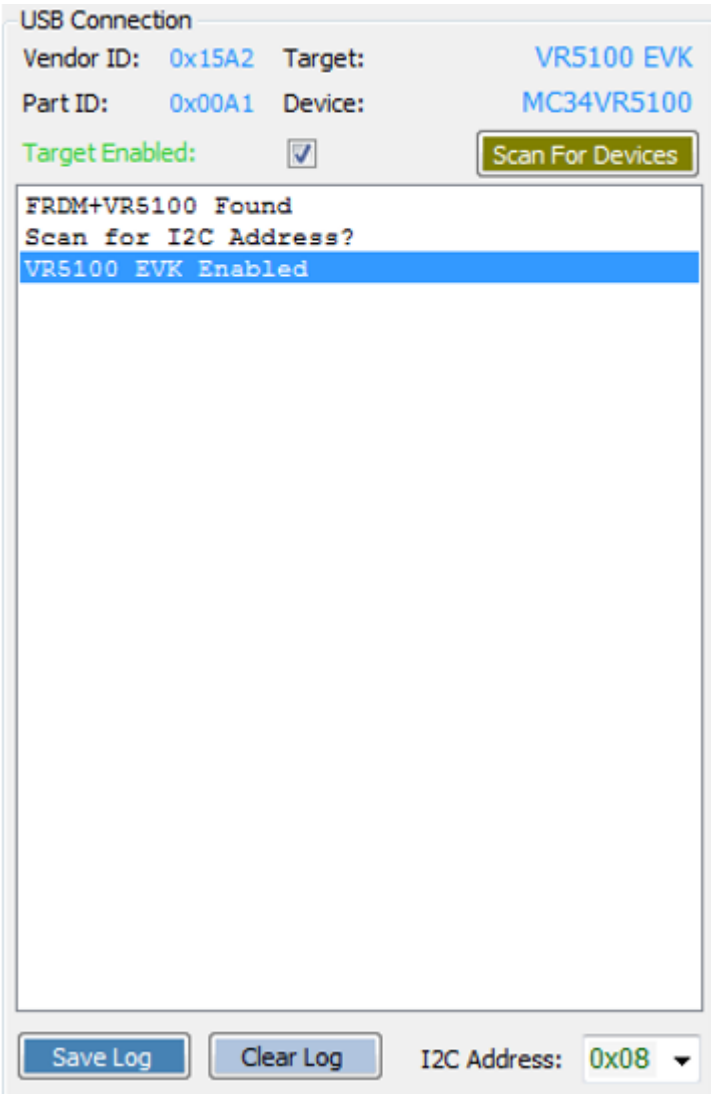


7.2 Configuring the hardware and using the GUI for control and monitoring

1. Apply input voltage to the board: use a 4.2 V supply connected to J5 (+) and J4 (−).
2. Plug the mini-USB side of the mini-USB to USB cable into the KL25Z USB port on the FRDM-KL25Z board and the other end to an available USB port on the PC.



3. Windows automatically installs the necessary drivers. Wait for this to complete.
4. Launch the VR5100 GUI.
5. In the VR5100 GUI window, click **Scan For Devices** button in the top-left portion. A confirmation message that a valid device is available is logged.



6. Enable the communication by clicking the **Target Enabled:** check box. The window turns from grey to color. The green LED on the FRDM-KL25Z also turns on.
7. The GUI installation and hardware setup is now complete.

7.3 Configuring the KITVR5100FRDMEVM and the KITVR5100FRDMPGM in Combo mode

The KITVR5100FRDMEVM and the KITVR5100FRDMPGM can be connected to function as a unit in Combo mode. In Combo mode, the functionality of both the evaluation board and the programming board can be utilized through the VR5100 GUI.

To configure the boards in Combo mode:

1. Disconnect any power being supplied to the KITVR5100FRDMEVM board connectors. Also disconnect any USB cables connecting either of the FRDM-KL25Z boards to a PC.
2. Carefully detach the KITVR5100FRDMPGM programming board from the Arduino™ connectors on the FRDM-KL25Z board.

3. Pull the Arduino connectors off the programming board's FRDM-KL25Z board and attach them to the top of the evaluation board's FRDM-KL25Z.
4. Mount the KITVR5100FRDMPGM programming board to the evaluation board's FRDM-KL25Z. Note that the evaluation board FRDM-KL25Z must be used because it contains the microcode to recognize and support Combo mode. Make sure that the programming board is firmly attached to the FRDM-KL25.
5. Connect the power supply to the KITVR5100FRDMEVM evaluation board. Then connect a USB cable from the USB KL25Z port on the FRDM-KL25Z to a USB port on the PC with the GUI installed. Green LEDS should light up on both the evaluation board and on the programming board.
6. Activate the GUI and click in the **Target Enabled** check box in the upper left corner of the panel. The log section displays the message **VR5100 COMBO Enabled**.

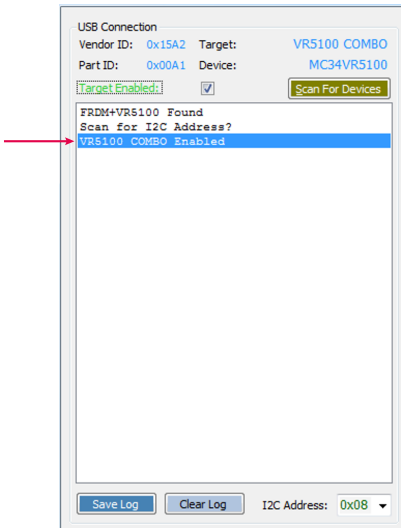


Figure 9. VR5100 GUI log with Combo mode target enabled

If the log section displays the message **VR5100EVK Enabled**, the programming board is not firmly connected to the FRDM-KL25Z. This may be the case even when the green LEDs are lit on both boards.

7.4 Using on-board ELOADs

Two on-board electronic loads (ELOADs) provide adjustable load currents from 0 to 1000 mA in 50 mA steps. The ELOADs are useful for testing supply performance or evaluating a particular PMIC supply rail at a specified load current.

To use the ELOADS, connect a suitable jumper wire (short length with proper gauge) between ELOAD A or ELOAD B and the desired supply VOUT.

Note that up to 2000 mA of load current can be achieved by using ELOAD A and ELOAD B connected in parallel. Each ELOAD's current must be set separately in the VR5100 GUI **Miscellaneous** panel. Be aware that continuous operation under full load current heats up the EVB.

Set each ELOAD back to 0 mA when finished.

Below is an example of a script that demonstrates the use of the ELOAD to test the LDO1 current limit of 150 mA. The KITVR5100FRDMEVM jump start package also contains this script.

```
//-------------------------------------------------------------------------
// LDO1 CURRENT LIMIT (150mA) TEST USING ELOAD A
// (Jumper ELOAD A to LDO1)
//-------------------------------------------------------------------------
LDO1:VOUT:2.000       // SET LDO1 VOUT = 2.000V
LDO1:ENABLE:ON        // ENABLE LDO1
DELAY:100             // ALLOW 100ms FOR VOUT TO RAMP UP
LOG:LDO1:VSENSE       // MEASURE LDO1 VOUT
ELOAD_A_ISET:50       // APPLY 50mA LOAD CURRENT
DELAY:100             // ALLOW 100ms TO STABILIZE
LOG:LDO1:VSENSE       // MEASURE LDO1 VOUT
ELOAD_A_ISET:100      // APPLY 100mA LOAD CURRENT
DELAY:100             // ALLOW 100ms TO STABILIZE
LOG:LDO1:VSENSE       // MEASURE LDO1 VOUT
ELOAD_A_ISET:150      // APPLY 150mA LOAD CURRENT
DELAY:100             // ALLOW 100ms TO STABILIZE
LOG:LDO1:VSENSE       // MEASURE LDO1 VOUT
ELOAD_A_ISET:200      // APPLY 200mA LOAD CURRENT
DELAY:100             // ALLOW 100ms TO STABILIZE
LOG:LDO1:VSENSE       // MEASURE LDO1 VOUT (SHOULD BE less than 200mV)
ELOAD_A_ISET:250      // APPLY 250mA LOAD CURRENT
DELAY:100             // ALLOW 100ms TO STABILIZE
LOG:LDO1:VSENSE       // MEASURE LDO1 VOUT (SHOULD BE less than 200mV)
ELOAD_A_ISET:300      // APPLY 300mA LOAD CURRENT
DELAY:100             // ALLOW 100ms TO STABIIZE
LOG:LDO1:VSENSE       // MEASURE LDO1 VOUT (SHOULD BE less than 200mV)
//-------------------------------------------------------------------------
ELOAD_A_ISET:0        // REMOVE THE LOAD CURRENT (0mA)
DELAY:100             // ALLOW 100ms FOR SUPPLY TO RECOVER
LOG:LDO1:VSENSE       // MEASURE LDO1 VOUT (SHOULD BE ~2.000V)
LDO1:ENABLE:OFF       // DISABLE SUPPLY
```

7.5 Measuring switching supply efficiency

Switching supply conversion efficiency is an important system performance parameter effecting the overall runtime of battery powered equipment. Efficiency is calculated as follows:

$$Efficiency = \eta = \frac{P_{OUT}}{P_{IN}} = \frac{V_{OUT} \times I_{OUT}}{V_{IN} \times I_{IN}}$$

The diagram below illustrates how to make an efficiency measurement for the SW1 supply.

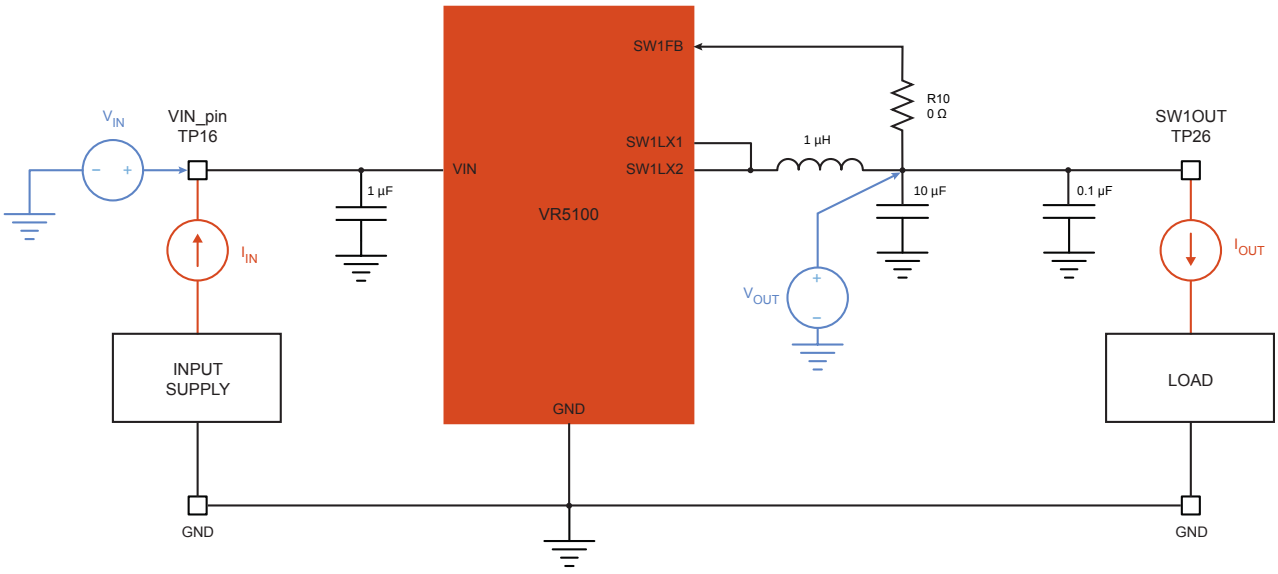


Figure 10. Efficiency measurement for SW1 supply

The V_{OUT} test points for most of the VR5100 PMIC supplies are placed for user convenience near the edges of the VR5100 EVB. The voltages measured at these test points, for light-load conditions, are extremely accurate. When making efficiency calculations for full-load currents, the Vout measurement should be taken at the switching supply feedback node. This is the 'regulation point' for the supply.

Under full-load conditions, there can be a significant voltage drop between the supply regulation point, and the output test point terminal. Each switching supply has a zero-ohm resistor in the feedback loop, and is a good place to measure the V_{OUT} voltage for the supply.

The figure below shows where to measure the V_{OUT} for each switching supply when calculating their efficiencies.

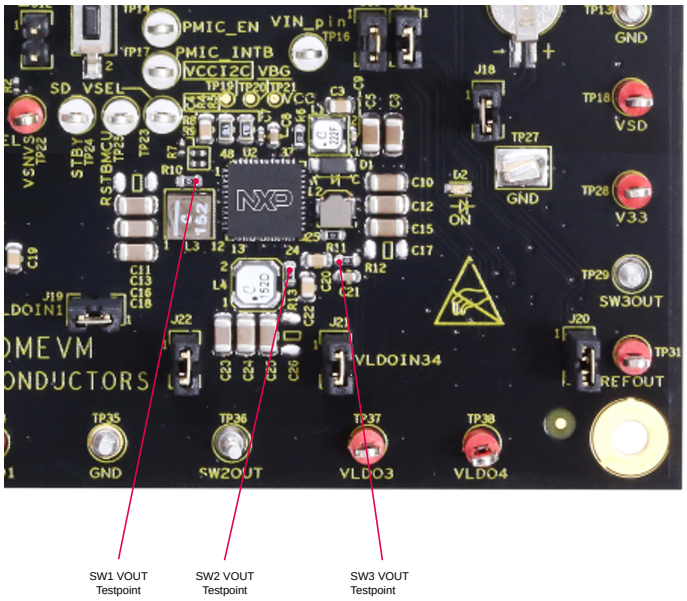


Figure 11. V_{OUT} measurement locations

7.6 Understanding and using the GUI

7.6.1 GUI structure for VR5100

Figure 12 shows the different components of the GUI.

To enable the volt meters on the board, click **Read Meters** button located in the bottom left of the window. The output of the meters is displayed in the right side of the window. Clicking the **Enable Live Meters** button enables continuous polling of the meters.

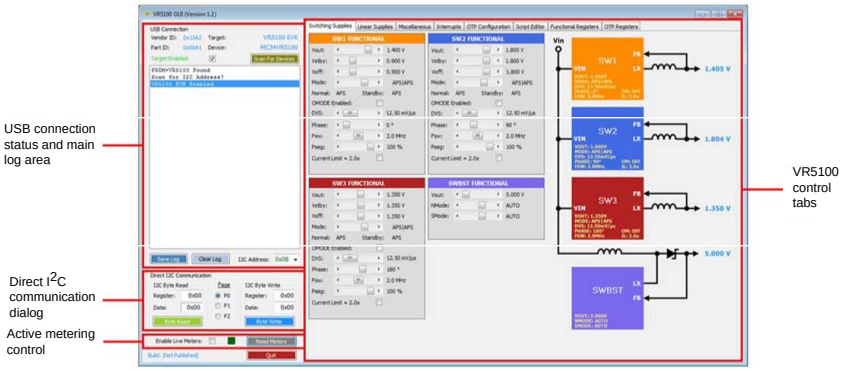


Figure 12. VR5100 GUI main window

7.6.2 GUI panels

When the GUI is launched, it looks for a VR5100 target board connected via the USB cable. If connected, the USB Connection panel displays the Vendor ID: 0x15A2, and Part ID: 0x00A1.

The Main Log window displays messages **FRDM+VR5100 Found**, and **Scan for I2C Address**.

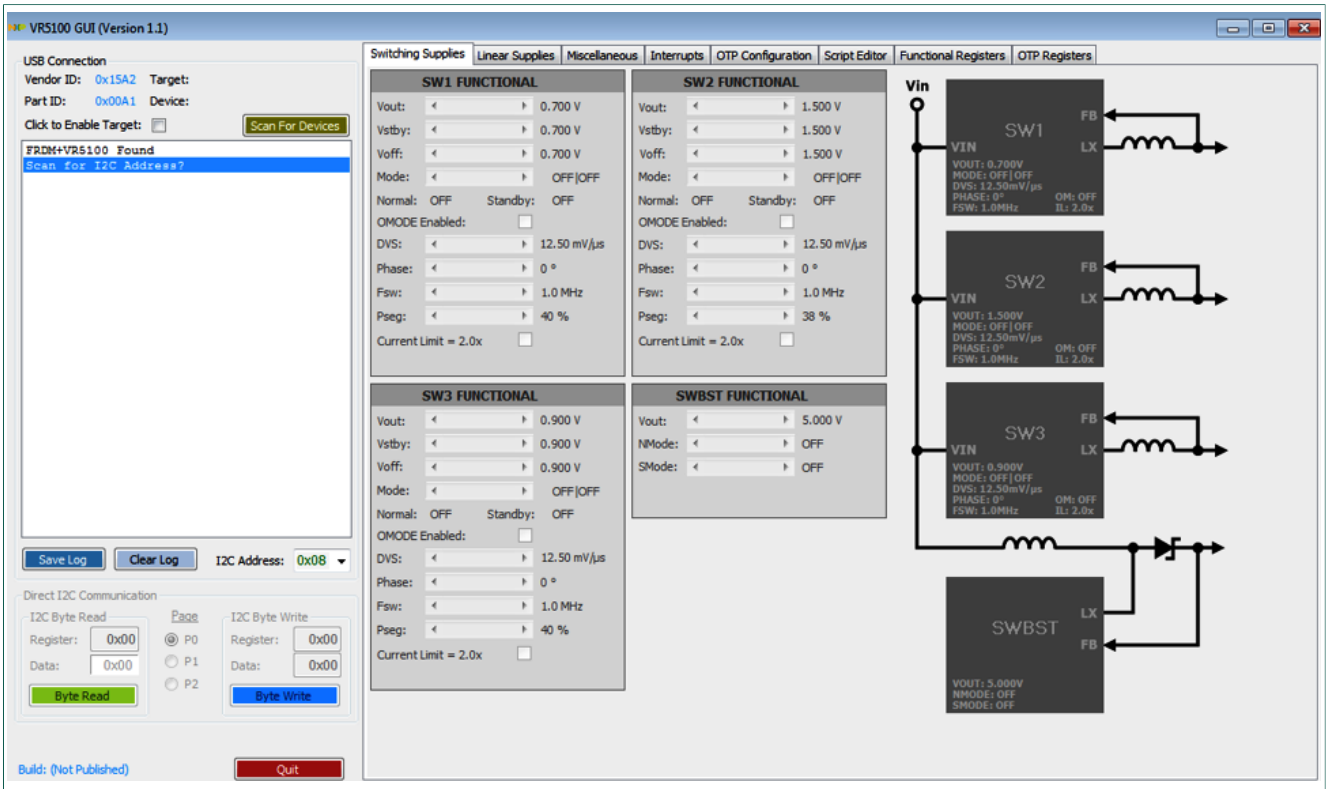


Figure 13. GUI startup

Pressing the **Scan For Devices** button attempts to read from each of the eight permissible I2C device addresses, and displays the results in the Main Log window. If multiple PMIC devices are detected, the GUI can be configured to communicate with a particular device by selecting the corresponding device address in the I2C Address list.

Note: *The GUI can communicate with only one PMIC device at a time.*

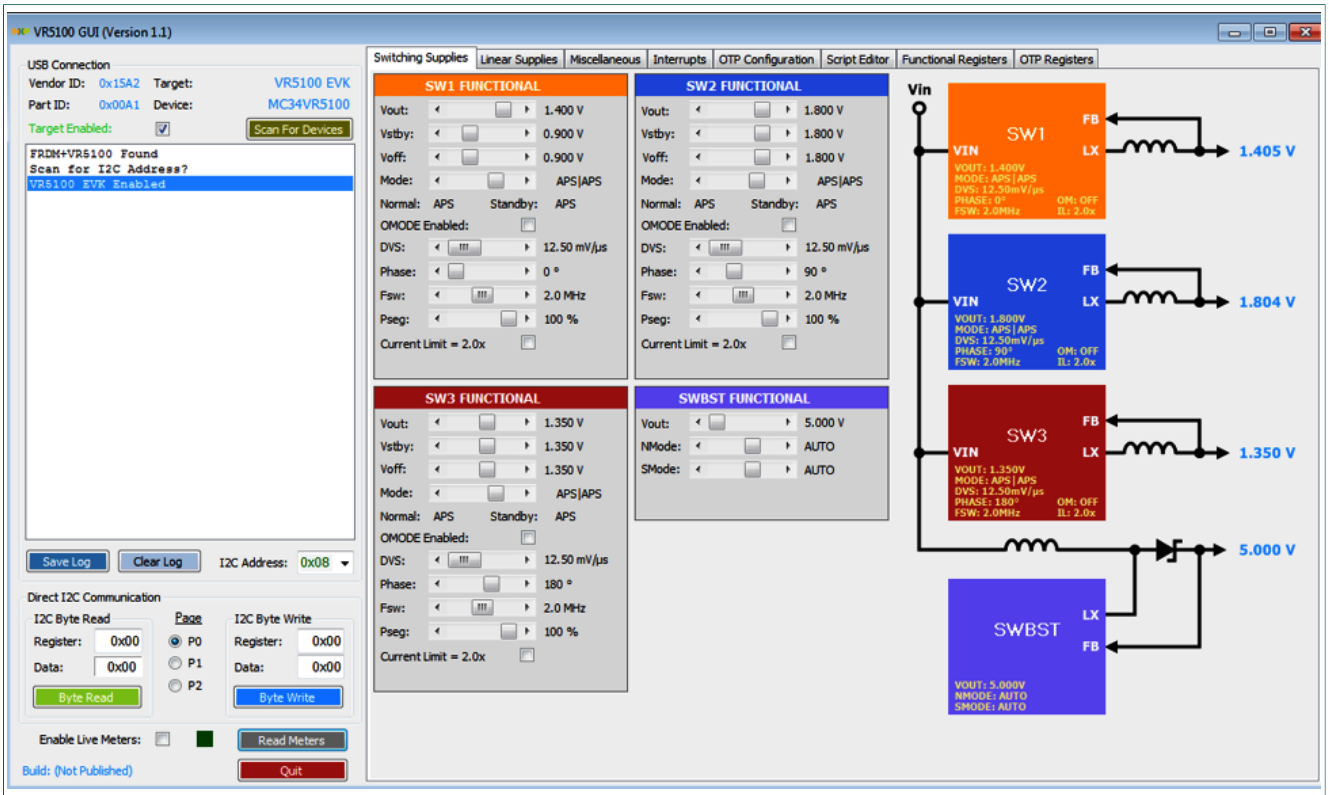


Figure 14. GUI connected to target board

7.6.2.1 Switching Supplies panel

The Switching Supplies panel allows users to adjust the functional parameters of each supply.

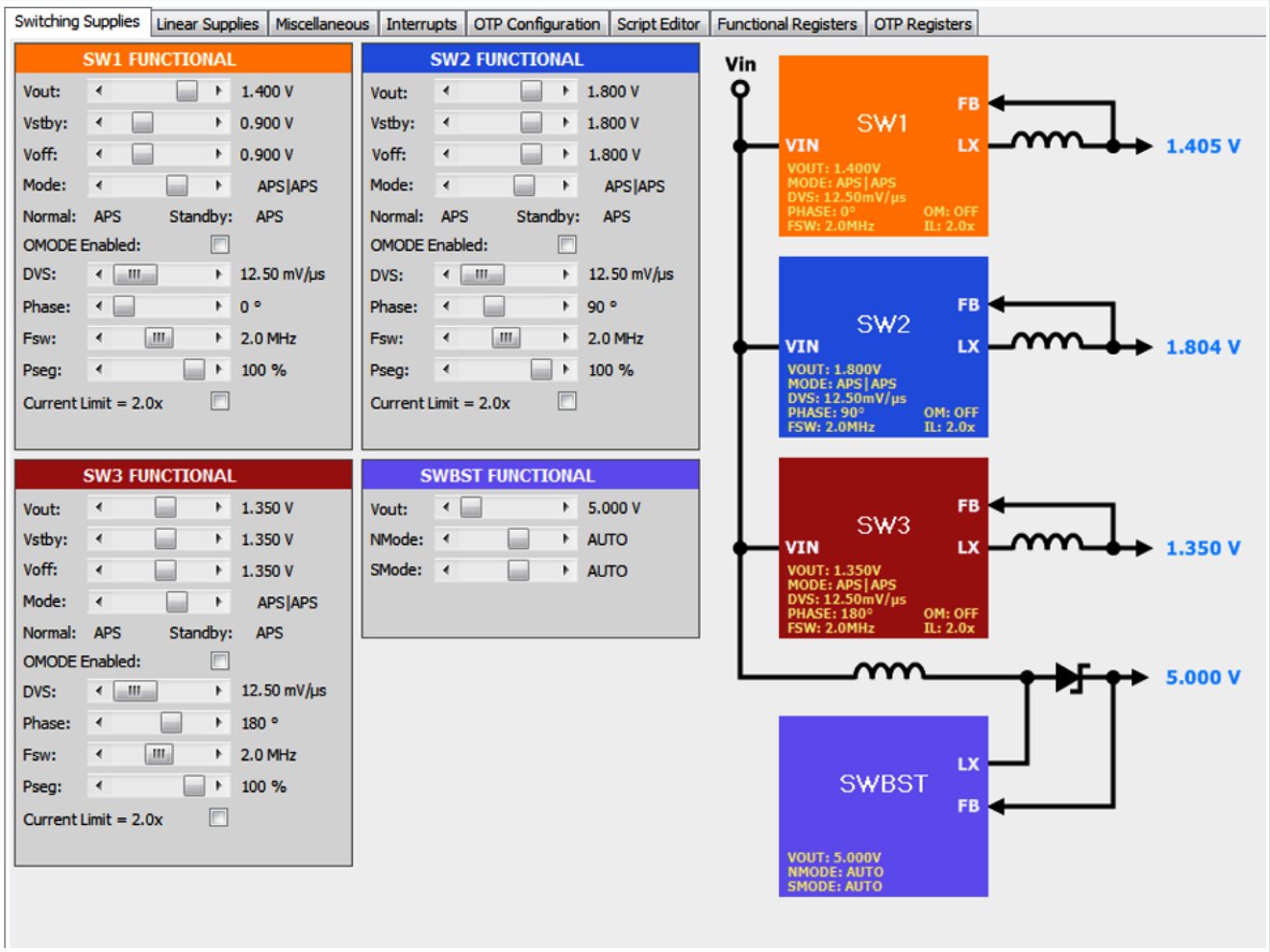


Figure 15. Switching Supplies panel

To change supply parameters, click and adjust the desired control. An **UPDATE** button appears whenever a change is made, and pressing the **UPDATE** button writes the change to the PMIC.

Note: *Multiple changes can be made at a time, and all changes are written when the* ***UPDATE*** *button is pressed.*

When the **Read Meters** button is pressed, or if the **Enable Live Meters** checkbox is selected, real-time output voltage measurements are displayed to the right of each supply block diagram.

7.6.2.2 Linear Supplies panel

The Linear Supplies panel allows users to adjust the functional parameters of each supply. To change supply parameters, click and adjust the desired control.

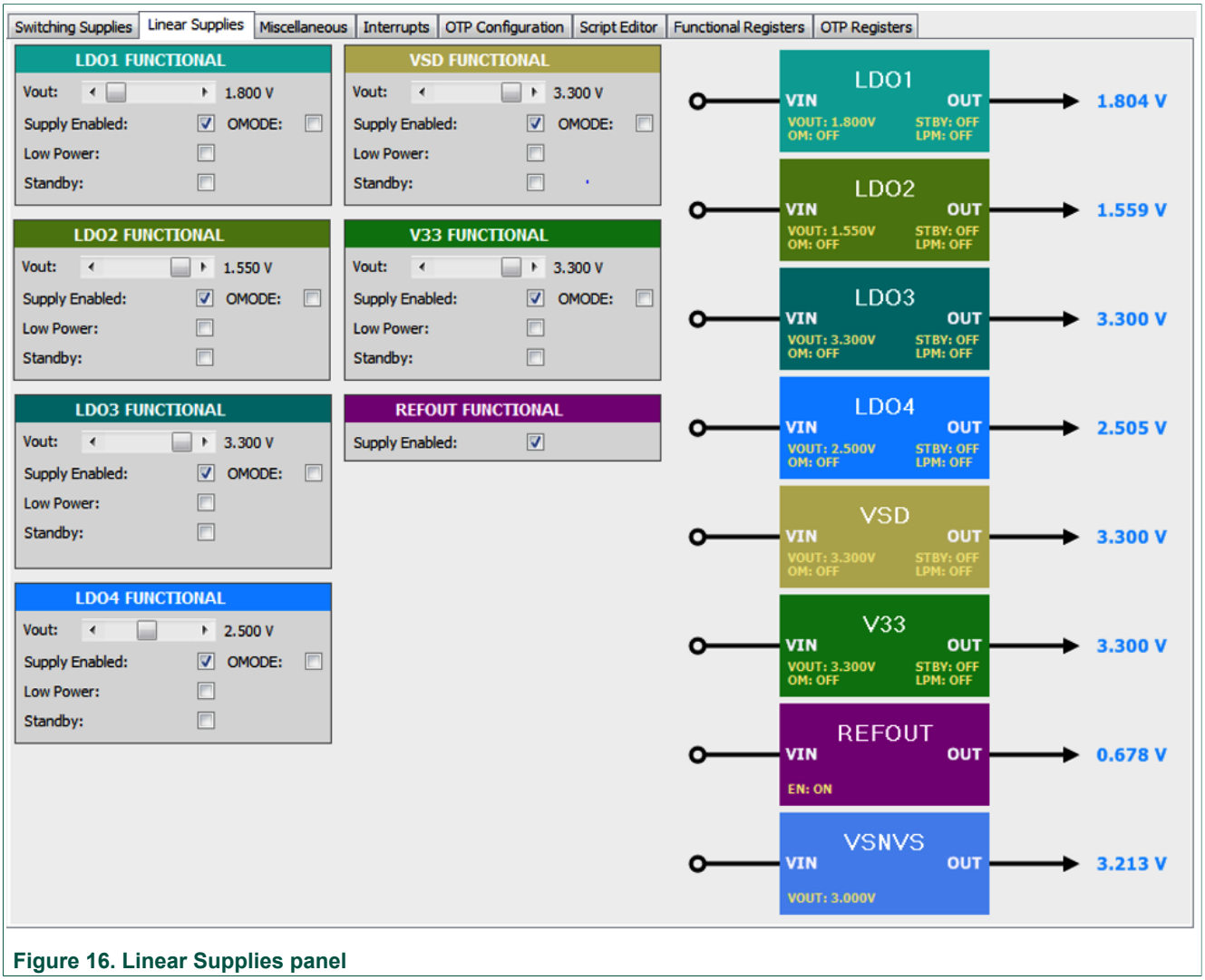


Figure 16. Linear Supplies panel

An **UPDATE** button appears whenever a change is made, and pressing the **UPDATE** button writes the change to the PMIC. Note that multiple changes can be made at a time, and all changes are written when the **UPDATE** button is pressed.

When the **Read Meters** button is pressed, or if the **Enable Live Meters** checkbox is selected, real-time output voltage measurements are displayed to the right of each supply block diagram.

7.6.2.3 Miscellaneous panel

The Miscellaneous panel contains an assortment of general purpose commands.

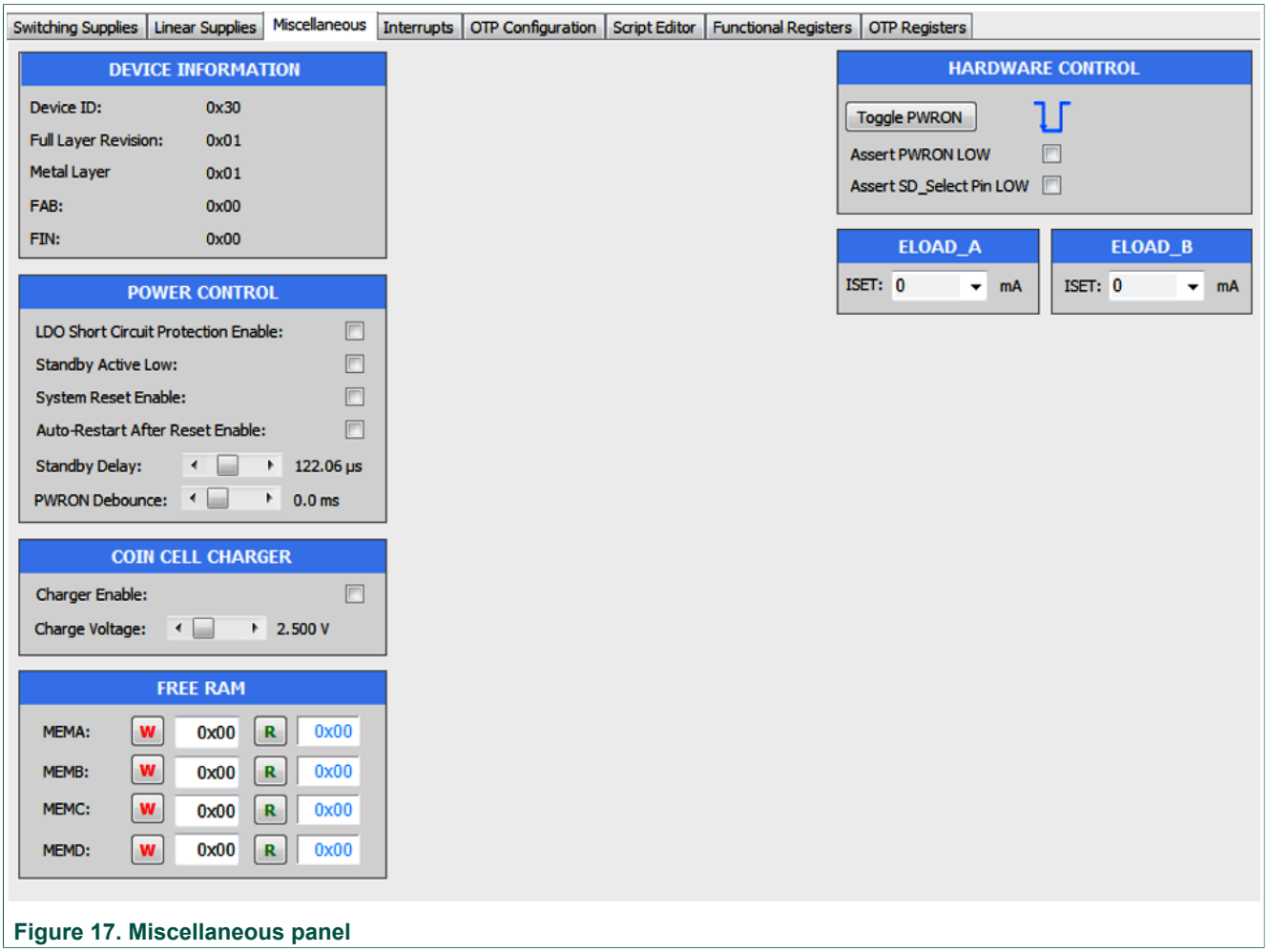


Figure 17. Miscellaneous panel

7.6.2.4 Interrupts panel

The Interrupts panel displays the state of all the VR5100 interrupts.

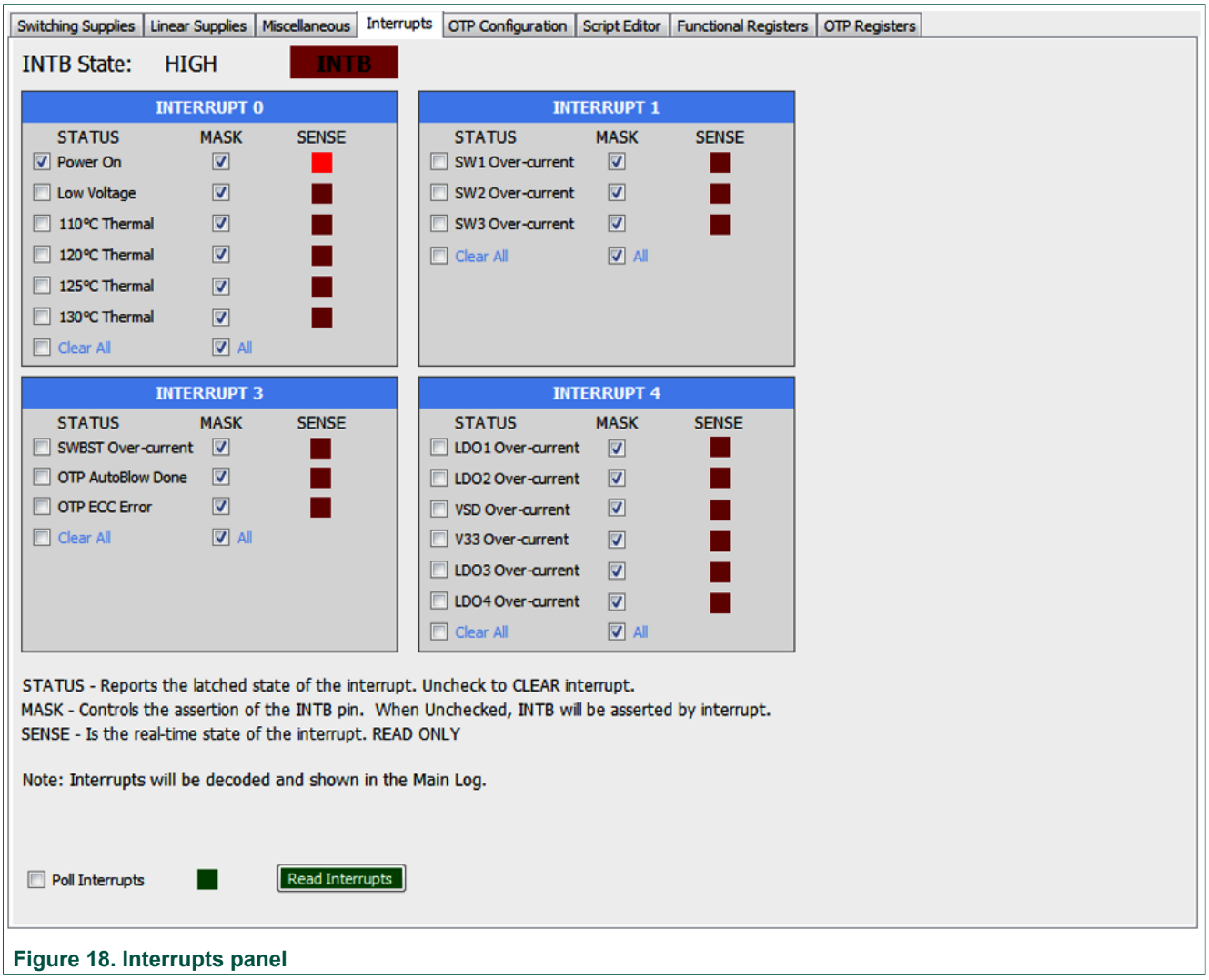


Figure 18. Interrupts panel

Pressing the **Read Interrupts** button reads and displays Status, Mask, and Sense registers for INT0, INT1, INT3, and INT4. Selecting the Poll Interrupts checkbox enables periodic update of this information.

The state of the VR5100 INTB pin is displayed, and updated asynchronously. Interrupts that are unmasked, causes the INTB pin go LOW while the interrupt condition exists. The VR5100 target hardware detects when the INTB pin goes LOW, and sends a message to the GUI to indicate that an interrupt has occurred. The INTB label on the panel flashes until the interrupt condition is cleared.

Figure 19 shows an example of a SW1 overcurrent fault condition.

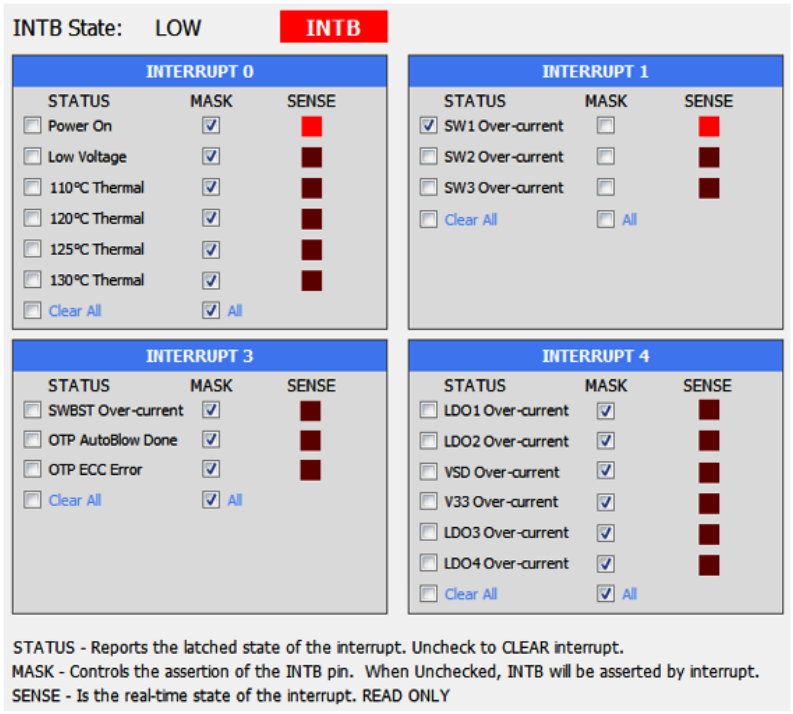


Figure 19. SW1 overcurrent fault condition

Figure 20 shows an example of an LDO1 overcurrent fault condition.

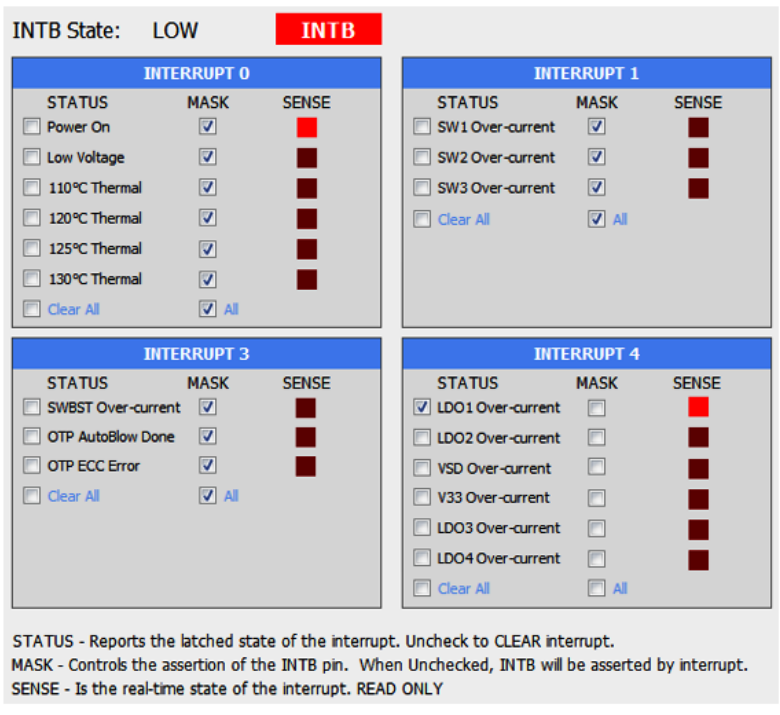


Figure 20. LDO1 overcurrent fault condition

7.6.2.5 OTP Configuration panel

The OTP Configuration panel allows access and editing of the VR5100 startup parameters.

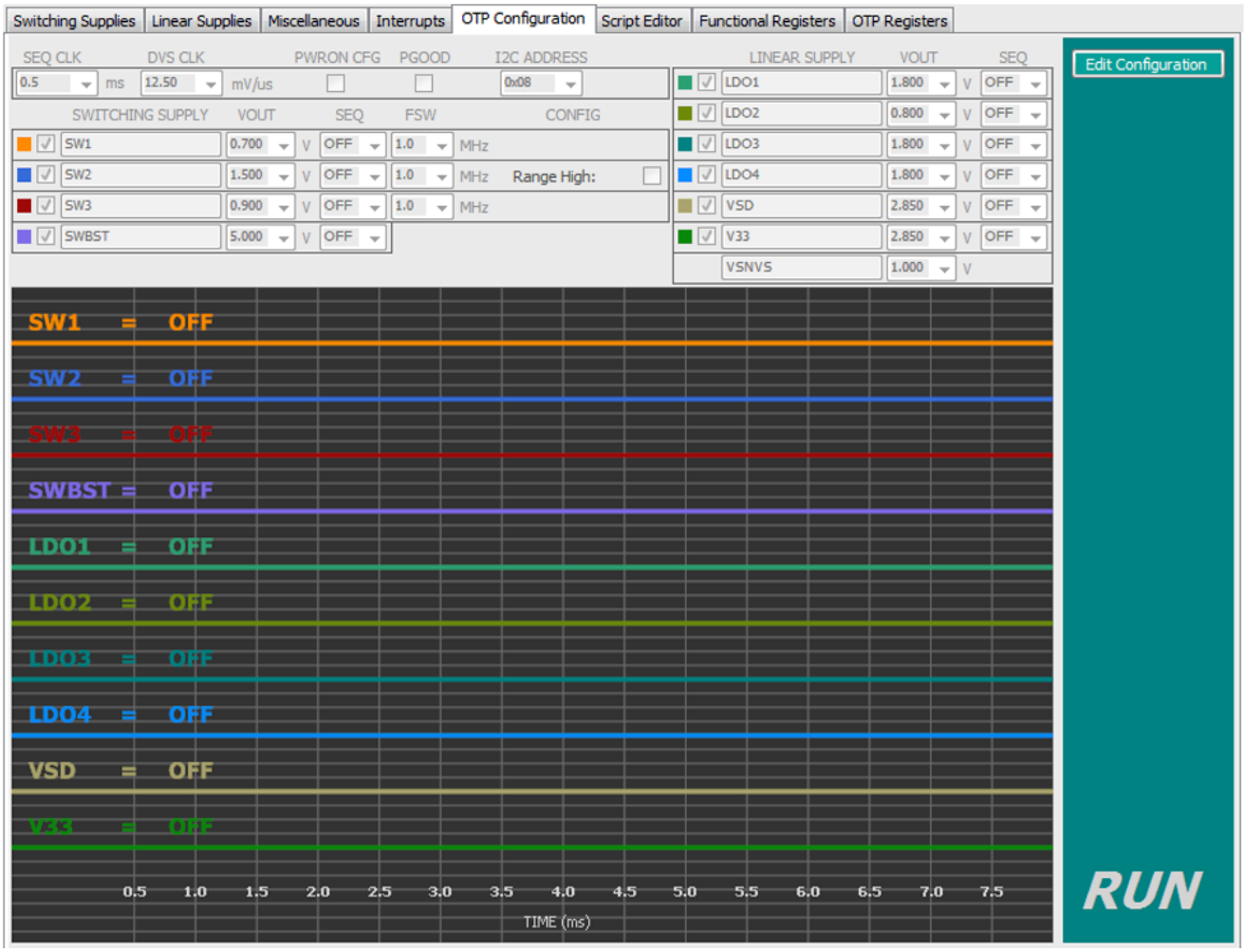


Figure 21. OTP Configuration panel

Initially, the panel display is greyed out. To populate the panel, press **Edit Configuration**, and select a data source to read from.

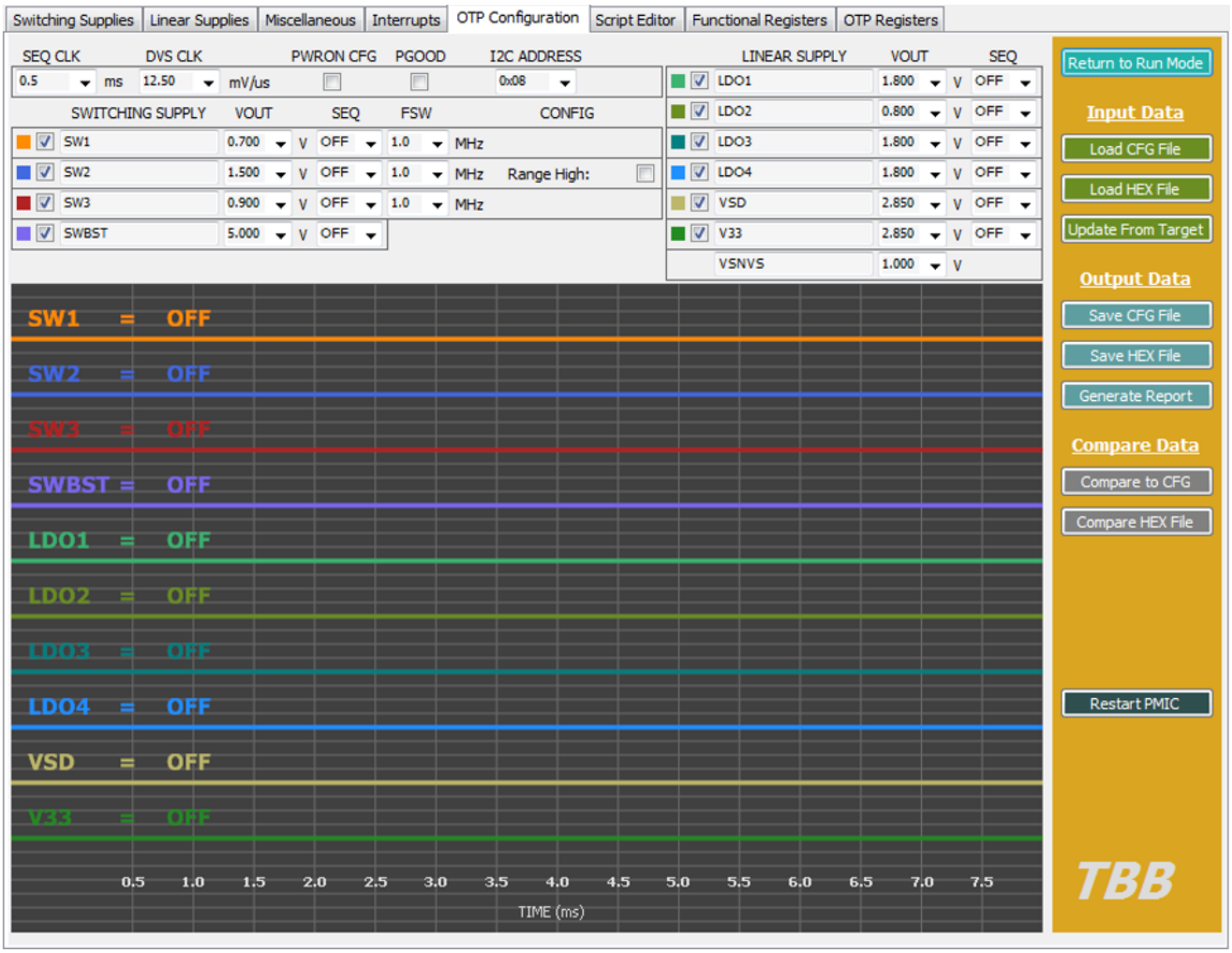


Figure 22. OTP Configuration Panel (TBB Mode on evaluation board)

The **Load CFG File** button opens the Configuration File Open dialog, and populates the panel with the parameters contained in this file.

The **Load HEX File** button opens the Hex File Open dialog, and populates the panel with the parameters contained in this file. Hex file format is an OTP data storage format used by most distributor programming services.

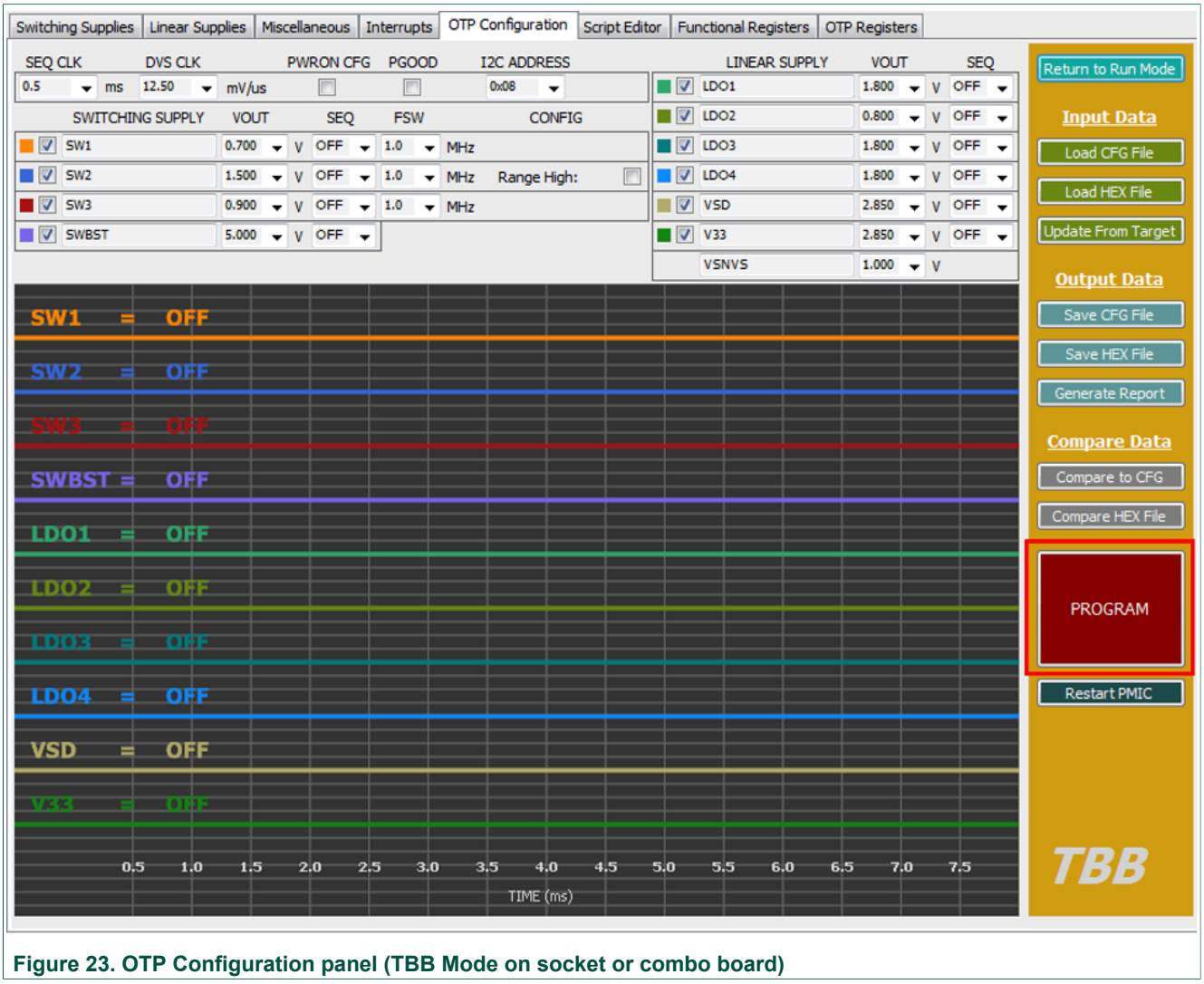


Figure 23. OTP Configuration panel (TBB Mode on socket or combo board)

If the target connected is a VR5100 socket board, or a VR5100 evaluation board with the VR5100 socket board mounted atop (COMBO), the GUI displays the **PROGRAM** button, and device programming is permitted.

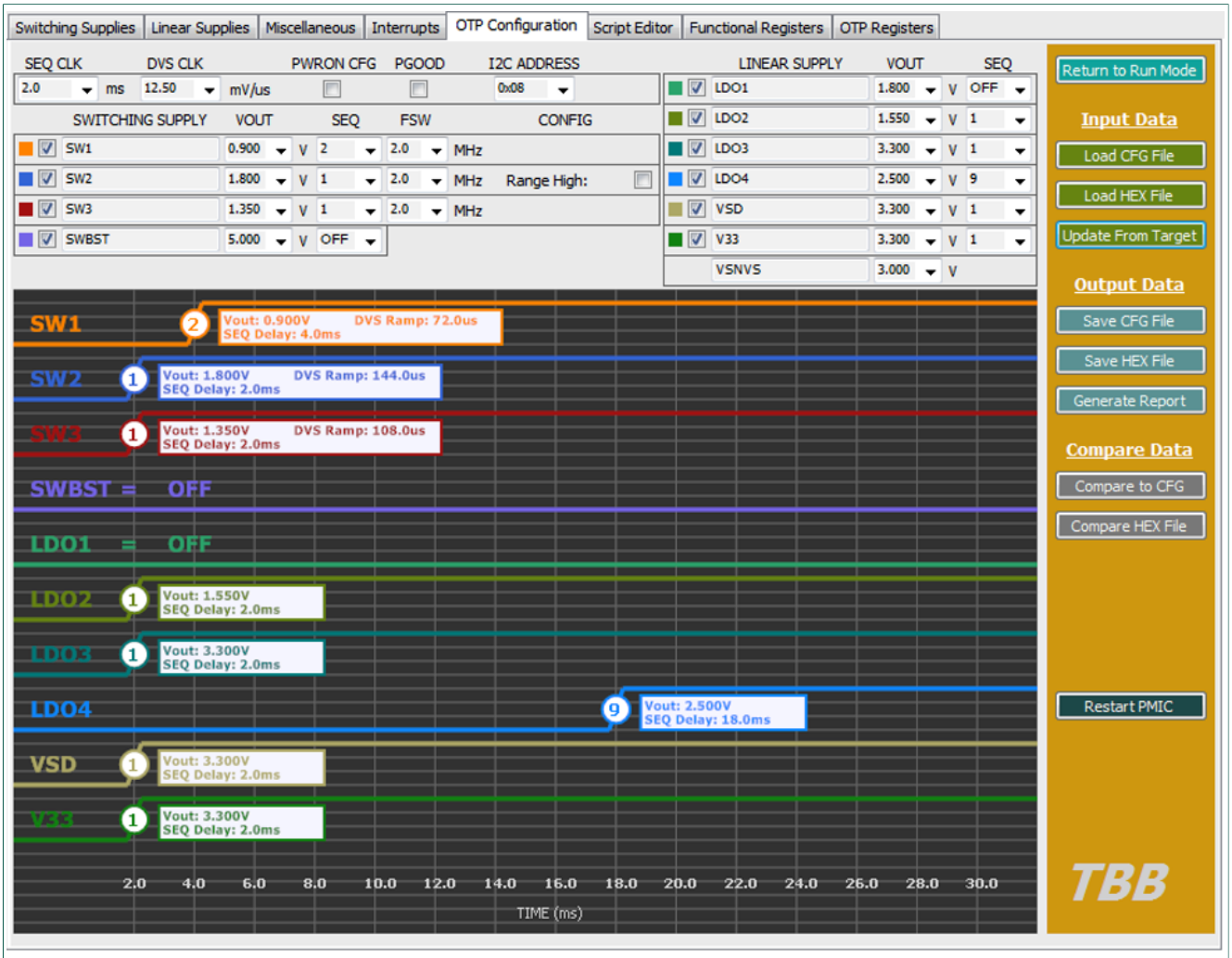


Figure 24. OTP Configuration panel (OTP data loaded from target EVB)

The **Update From Target** button loads the OTP configuration data from the target evaluation board.

7.6.2.6 Script Editor panel

The script editor allows the user to write and execute scripts that exercise various functions on the VR5100 PMIC, including setting voltages on the regulators, assigning values to free RAM , reading and writing I^2C addresses, and clearing interrupts. Script commands can be written directly in an editor window. Alternatively, the user can activate a scratch pad window and build the scripts by selecting commands from drop-down menus and entering the appropriate values. When the target is a KITVR5100FRDMPGM board or a KITVR5100FRDMEVM board mounted to a socket board (Combo mode), the Script Editor can also be used to initiate the programming of a device in the socket. See the *KITVR5100FRDMPGM programming socket board* user guide for details on OTP programming.

The scripts are executed within the **Files:** section of the panel and the results are displayed in the **Script Log** section.

Completed scripts can be saved as text files for later use.

The KITVR5100FRDMPGM board jump start package contains a number of example scripts. Go the tool summary page at http://www.nxp.com/KITVR5100FRDPGM to view and download the example scripts.

Figure 25 shows the main elements in the **Script Editor** panel.

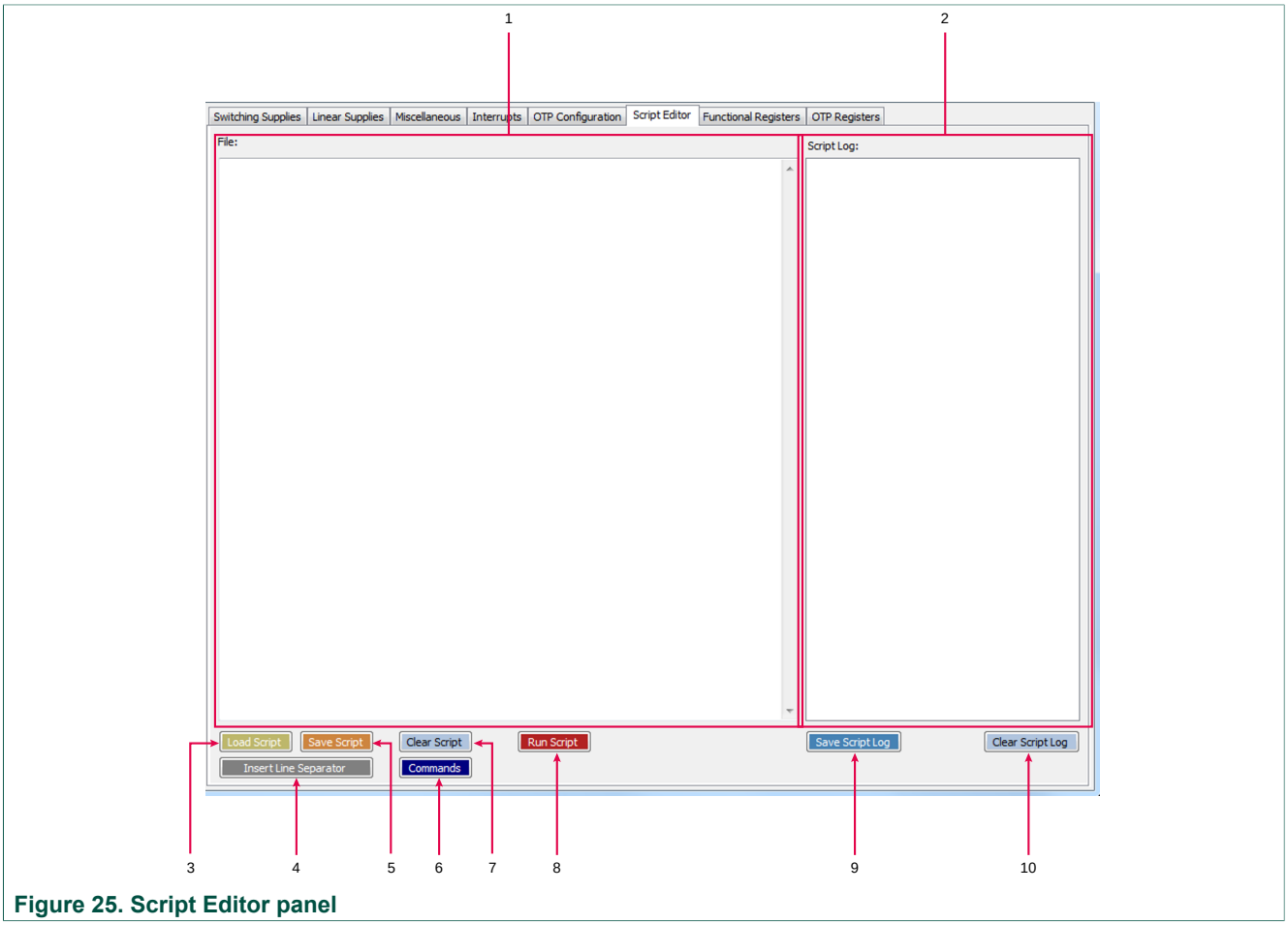


Figure 25. Script Editor panel

1. The **Files:** section allows scripts to be loaded, edited and executed.

2. The **Script Log** displays the results of an executed script.
3. **Load Script** loads a previously saved script into the **Files:** section.
4. **Insert Line Separator** inserts a dashed line after the last line of text in the **Files:** section. The separator is cosmetic and has no effect on the executed script.
5. **Save Script** saves the contents of the **Files:** section into a .txt file.
6. **Commands** opens the **Scripting Commands Scratch Pad** window. The window opens loaded with the script currently in the **Files:** section. See Section 7.6.2.6.1 "Scripting Command Scratchpad" for details on using the **Scripting Commands Scratch Pad** to build scripts.
7. **Clear Script** clears the contents of the **Files:** section.
8. **Run Script** executes the script currently in the **Files:** section. The results display in the **Script Log** section.
9. **Save Script Log** saves the contents of the **Script Log** section into a .txt file.
10. **Clear Script Log** clears the contents of the **Script Log**.

7.6.2.6.1 Scripting Command Scratchpad

The **Scripting Command Scratchpad** is a pop-up window that allows users to build a script by selecting commands and command parameters from drop-down menus. As commands are selected they appear in the script panel at the left of the window. Clicking **Done** loads the script into the **Files:** section of the **Script Editor** panel. The script is executed by click **Run Script** in the **Script Editor** panel.

The **Scripting Command Scratchpad** is activated by clicking the **Command** button in the **Script Editor** panel.

Figure 26 shows the types of commands available through the **Scripting Command Scratchpad** window.

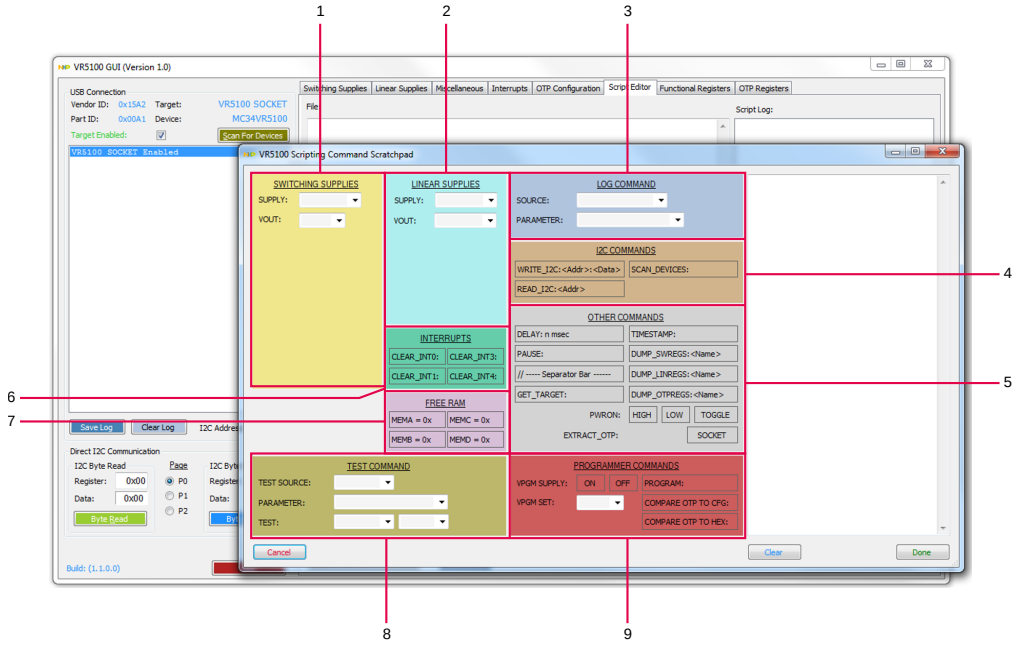


Figure 26. Scripting Command Scratchpad command types

1. The SWITCHING SUPPLIES section contains commands that set buck regulator and boost regulator parameters.

2. The LINEAR SUPPLIES section contains commands that set LDO regulator parameters.
3. The LOG COMMAND section contains commands that output the value of the selected supplies.
4. The I2C COMMANDS section contains commands related to connected I^2C devices.
5. The OTHER COMMANDS section contains miscellaneous commands that set delays, insert pauses, dump registers and so forth.
6. The INTERRUPTS section contains commands that clear interrupts.
7. The FREE RAM section contains commands that assign values to the embedded memory register banks.
8. The TEST COMMAND section contains commands that perform tests on the target device (for example, is VSENSE greater than some value) when the script is executed.
9. The PROGRAMMERS COMMANDS section contains commands that initiate the OTP programming of an unprogrammed device. This section is not visible unless the target is a KITVR5100FRDMPM socket board or a KITVR5100FRDMEVM with a mounted socket board (Combo mode).

7.6.2.6.1.1 Switching supply commands

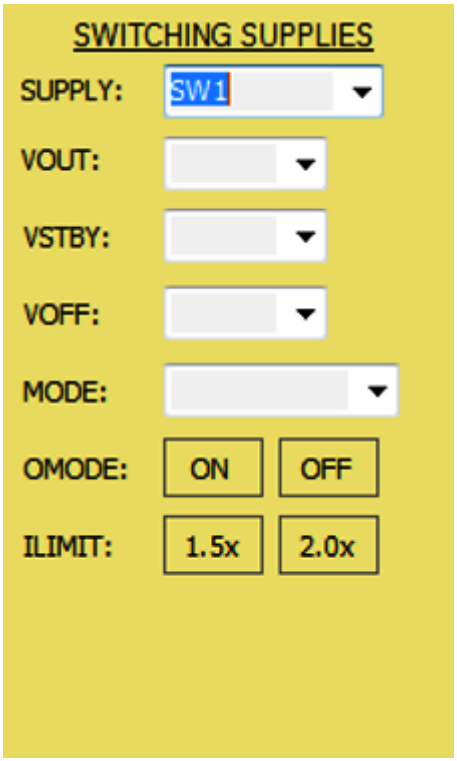


Figure 27. Switching supplies

Name	Description
SW1, SW2, SW3, or SWBST	Select supply from the list
VOUT	Select voltage from the list
VSTBY	Select voltage from the list
VOFF	Select voltage from the list

Name	Description
MODE	Select mode from the list
OMODE	ON or OFF
ILIMIT	1.5x or 2.0x

Examples:

SW1:VOUT:1.000

SW2:VSTBY:1.600

SW3:VOFF:1.050

SWBST:MODE_NORM:AUTO

SW1:OMODE:ON

SW2:MODE:PWM | PWM

SW3:ILIMIT:2.0x

7.6.2.6.1.2 Linear supply commands

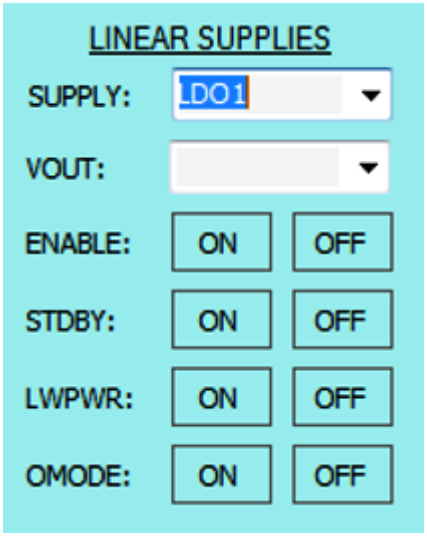


Figure 28. Linear supplies

Name	Description
LDO1, LDO2, VSD, V33, LDO3, LDO4, REFOUT	Select supply from the list
VOUT	Select voltage from the list
ENABLE	ON or OFF
STDBY	ON or OFF
LWPWR	ON or OFF
OMODE	ON or OFF

Examples:

LDO1:ENABLE:ON

LDO2:VOUT:1.300

VSD:STBY:ON

V33:LOWPWR:ON

LDO3:OMODE:ON

LDO4:VOUT:3.000

REFOUT:ENABLE:ON

7.6.2.6.1.3 Log commands

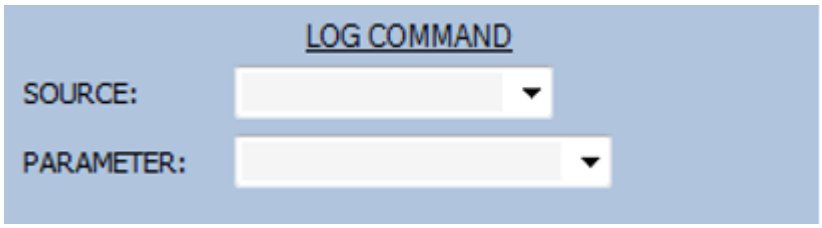


Figure 29. Log commands

Name	Description
SOURCE	Select source from the list
PARAMETER	Select parameter from the list

Examples:

LOG:SW1:VSENSE

LOG:LDO1:ENABLE

LOG:INT:SW3_FAULT

7.6.2.6.1.4 I2C commands

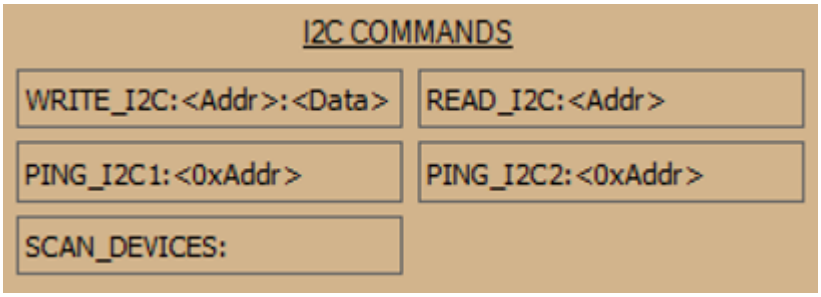


Figure 30. I2C commands

Name	Description
WRITE_I2C	Enter address and data
READ_I2C	Enter address
PING_I2C1	Enter 0xAddress
PING_I2C2	Enter 0xAddress
SCAN_DEVICES	

Examples:

WRITE_I2C:20:05

READ_I2C:1C

I2C1_PING:0x08

I2C2_PING:0xC0

SCAN_DEVICES:

7.6.2.6.1.5 Other commands

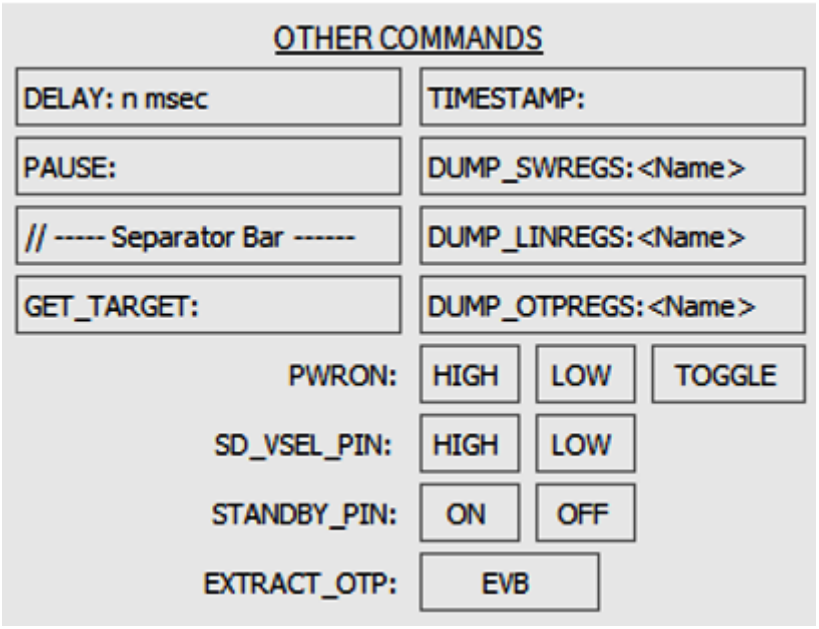


Figure 31. Other commands

Name	Description
DELAY	Enter delay time in milliseconds
PAUSE	Click on control
// ----- Separator Bar -----	Click on control
GET_TARGET	Click on control
TIMESTAMP	Click on control
DUMP_SWREGS	Enter switching supply
DUMP_LINREGS	Enter linear supply
DUMP_OTPREGS	Enter OTP supply register
PWRON	HIGH, LOW, or TOGGLE
SD_VSEL	HIGH or LOW
STANDBY	ON or OFF
EXTRACT_OTP	EVB or Socket

Examples:

DELAY:100

PAUSE:

GET_TARGET:

TIMESTAMP:

DUMP_SWREGS:SW2

DUMP_LINREGS:LDO1

DUMP_OTPREGS:SYS

DUMP_OTPREGS:SWBST

PWRON:HIGH

SD_VSEL:LOW

STANDBY:ON

EXTRACT_OTP:EVB

7.6.2.6.1.6 Interrupts commands

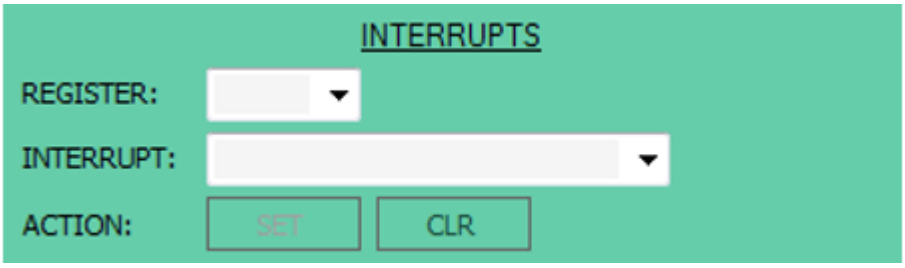


Figure 32. Interrupts commands

Name	Description
REGISTER	Select register from the list
INT0, INT1, INT3, INT4	Select interrupt event from the list
ACTION	SET or CLR

Examples:

INT0:STATUS_110C:CLR

INT0:STATUS_ALL:CLR

INT1:STATUS_SW1A_FAULT:CLR

INT1:MASK_SW2_FAULT:SET

INT1:MASK_ALL:CLR

INT3:STATUS_SWBST_FAULT:CLR

INT4:MASK_LDO2_FAULT:CLR

7.6.2.6.1.7 Free RAM commands

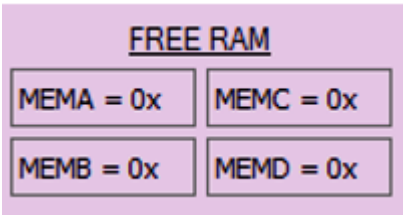


Figure 33. Free RAM commands

Name	Description
MEMA	Enter hex data
MEMB	Enter hex data
MEMC	Enter hex data
MEMD	Enter hex data

Examples:

MEMA:2C

MEMB:04

MEMC:55

MEMD:3F

7.6.2.6.1.8 Test commands

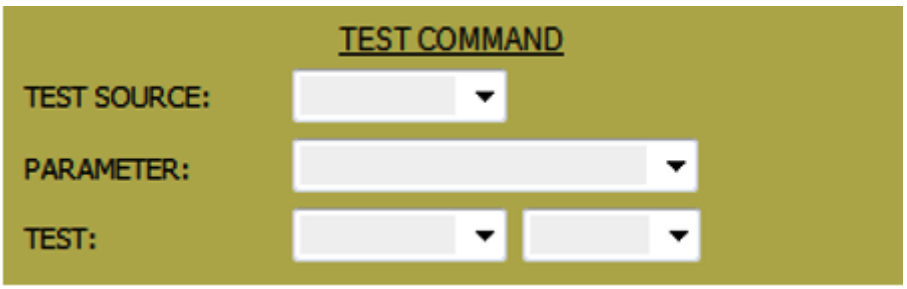


Figure 34. Test commands

Name	Description
TEST SOURCE	Select item
PARAMETER	Select item
TEST	Select item

7.6.2.6.1.9 Programmer commands

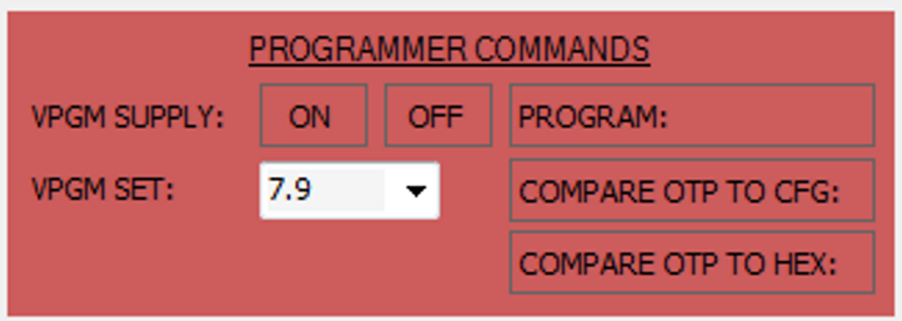


Figure 35. Programmer Commands

Name	Description
VPGM SUPPLY	Toggles VPGM supply on and off
VPGM SET	Sets the value of VPGM
PROGRAM	Initiates OTP programming
COMPARE OTP TO CFG	Compares the values in the OTP registers with the values in the CFG file used to program the device.
COMPARE OTP TO HEX	Compares the values in the OTP registers with the values in the HEX file used to program the device.

7.6.2.7 Functional Registers panel

The Functional Registers panel provides bit-level access to each register.

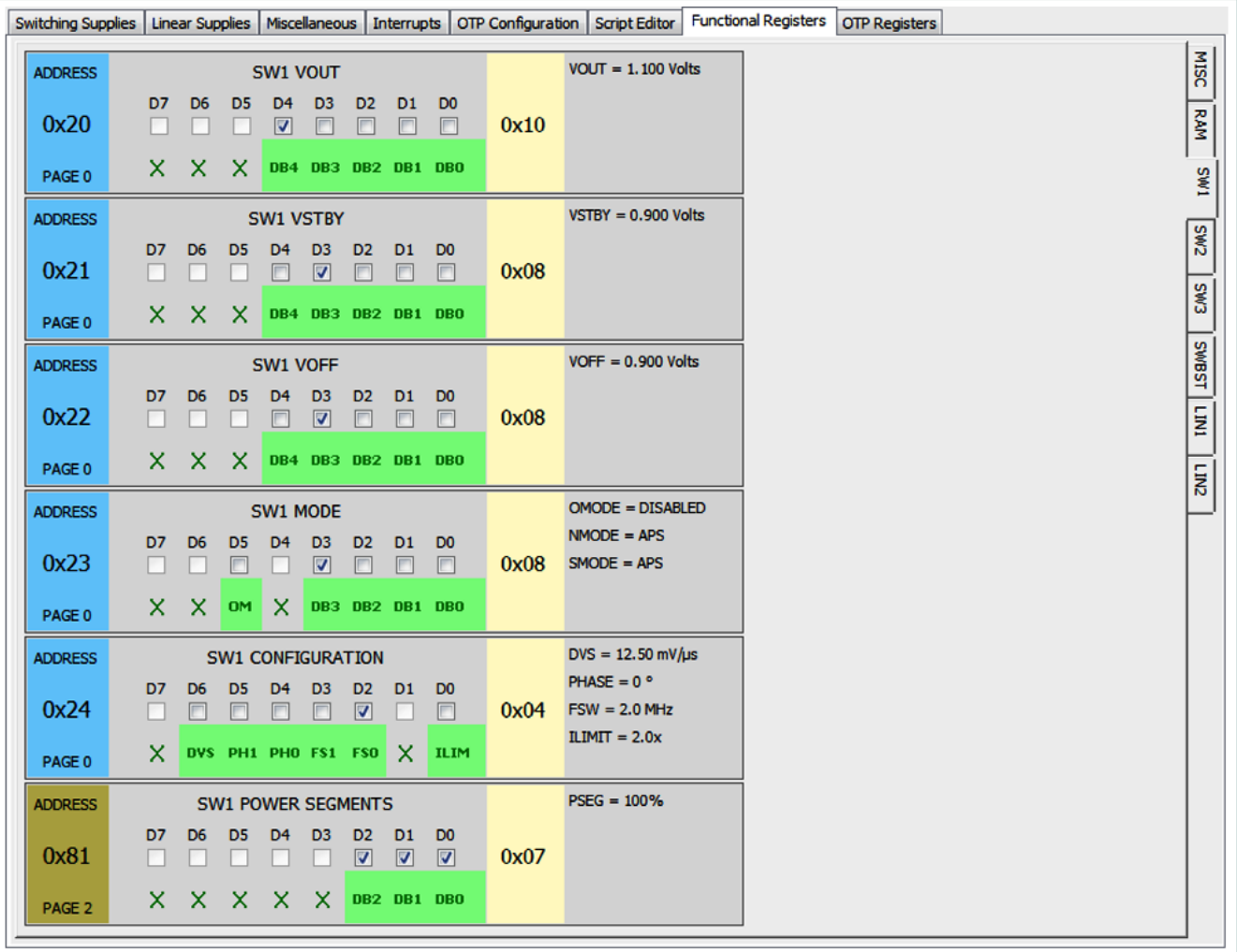


Figure 36. Functional Registers panel

Clicking on a checkbox immediately sets or clears the corresponding register bit. Key bit-fields in each register are decoded to assist in displaying the actual state of each parameter.

Registers are grouped within each tab by function.

7.6.2.8 OTP Registers panel

The OTP Registers panel provides bit-level access to each register.

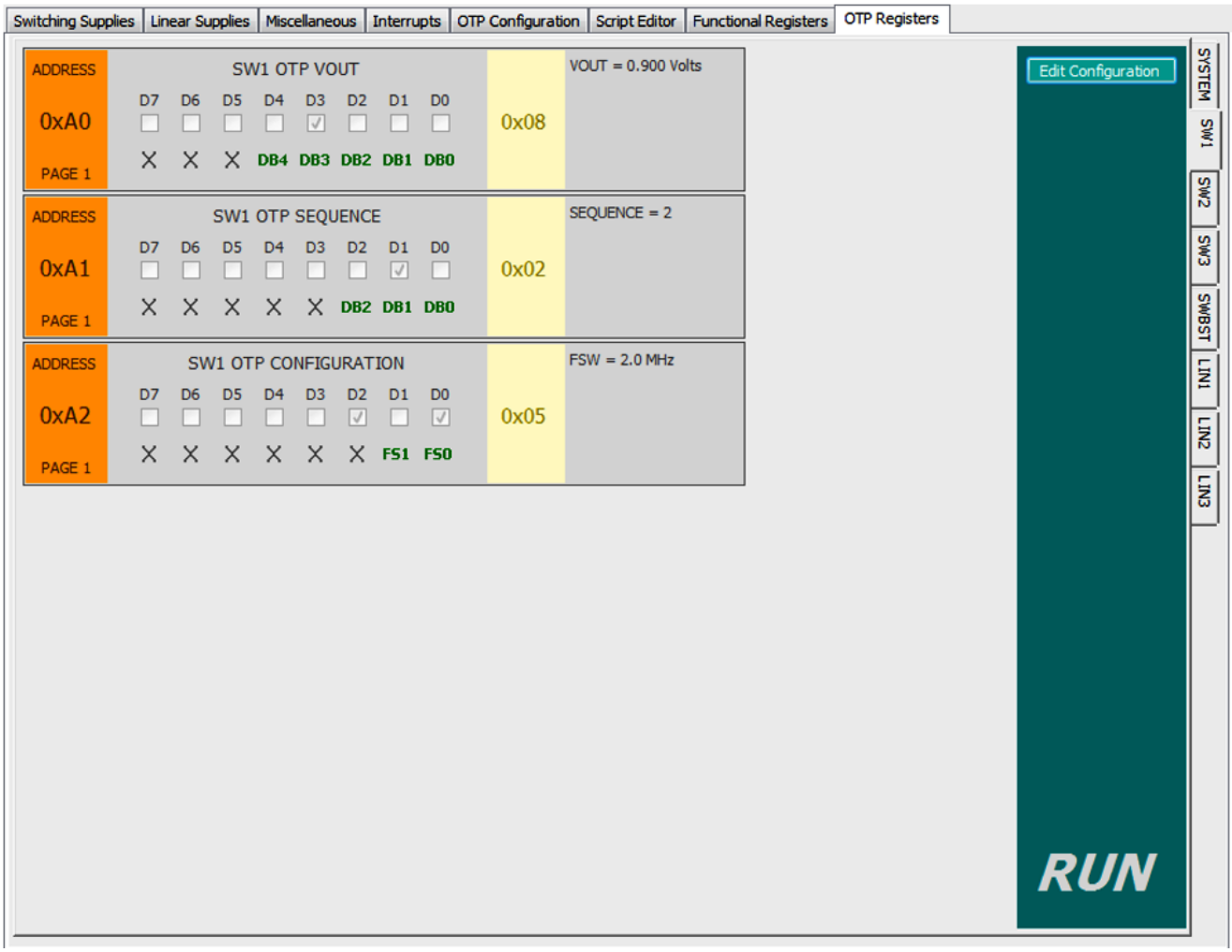


Figure 37. OTP Registers panel

Bits can only be changed after the **Edit Configuration** has been pressed.

Clicking on a checkbox immediately sets or clears the corresponding register bit. Key bit-fields in each register are decoded to assist in displaying the actual state of each parameter.

Registers are grouped within each tab by function.

While in Edit Configuration (TBB mode), the OTP data import, export, and compare buttons are visible. The buttons function the same as those on the OTP Configuration panel.

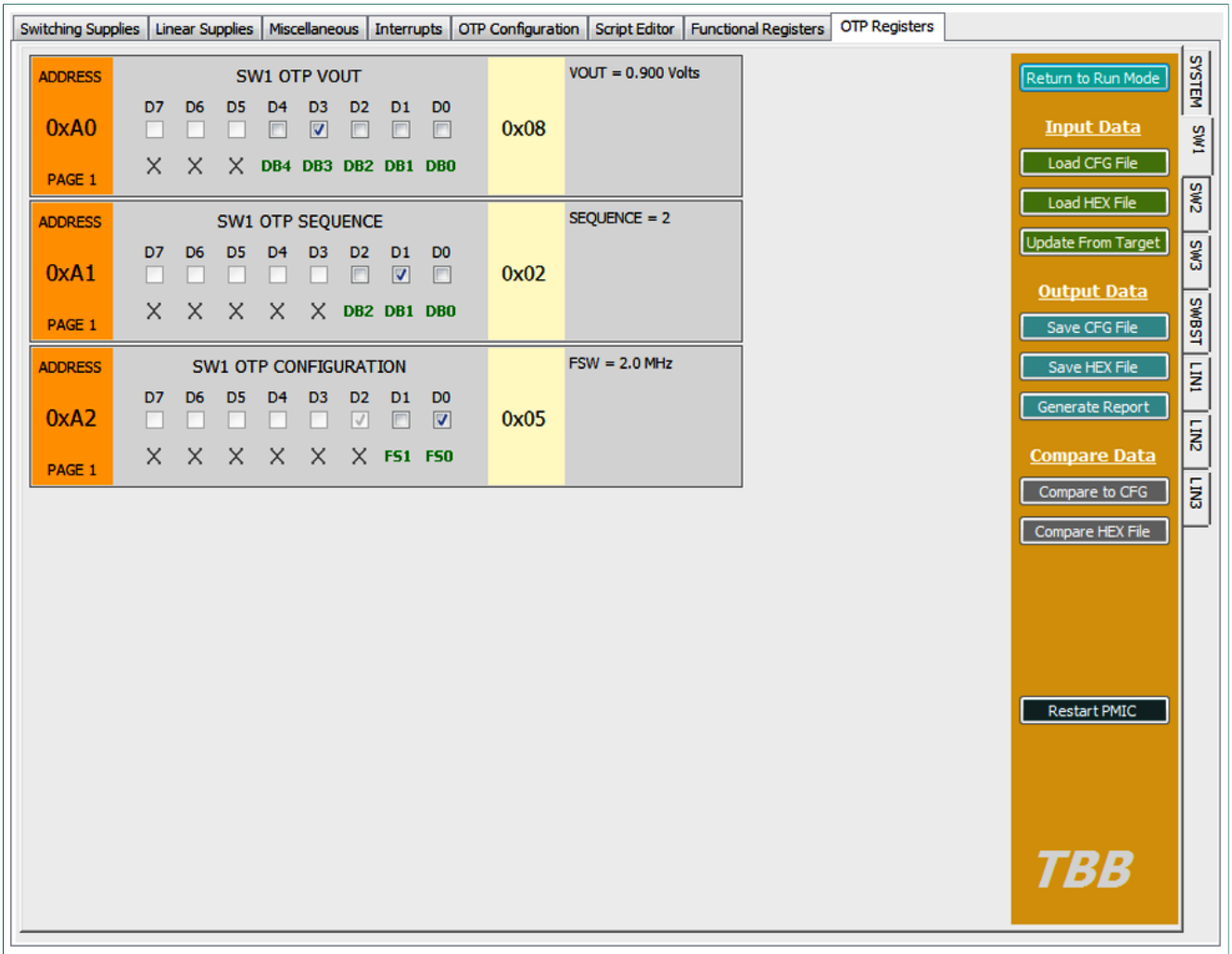


Figure 38. OTP Registers panel (TBB mode on evaluation board)

If the target connected is a VR5100 Socket board, or a VR5100 EVB with the VR5100 Socket board mounted atop (COMBO), the GUI displays the **PROGRAM** button, and device programming is permitted.

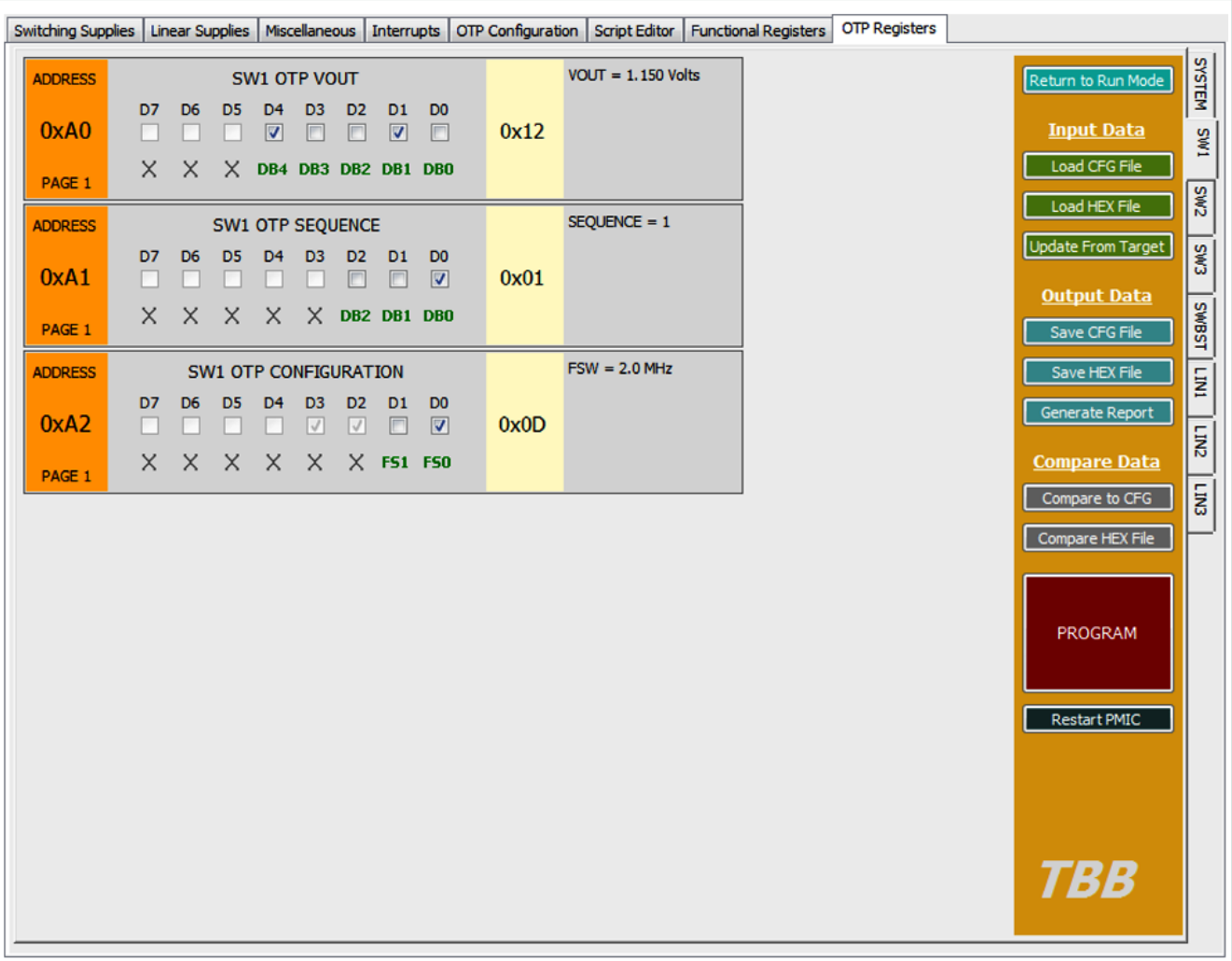


Figure 39. OTP Registers panel (TBB mode on socket or combo board)

7.6.2.9 Try-Before-Buy mode using the “Configuration” tab

The KITVR5100FRDMEVM comes with a VR5100 device whose OTP memory is pre-programmed. The VR5100 allows the user to override the OTP memory using the **Try-Before-Buy** mode.

To use this mode, go to the **OTP Configuration** tab and click **Edit Configuration** button in the top-right of the window. Use the drop down option to change the voltage, sequence and configuration of the regulators. Click the **Update** button after all the desired options are selected.

To restart the VR5100 using the selected configuration, click **Restart PMIC** button. Alternatively, you can toggle the PWRON button to initiate the startup. The startup sequence can be monitored on an oscilloscope and will match this selection in the **Configuration** tab. To measure voltages, use either a stand-alone meter or the on-board meters available in the GUI.

Use the **Save Configuration** and **Load Configuration** buttons to save the configuration for later use.

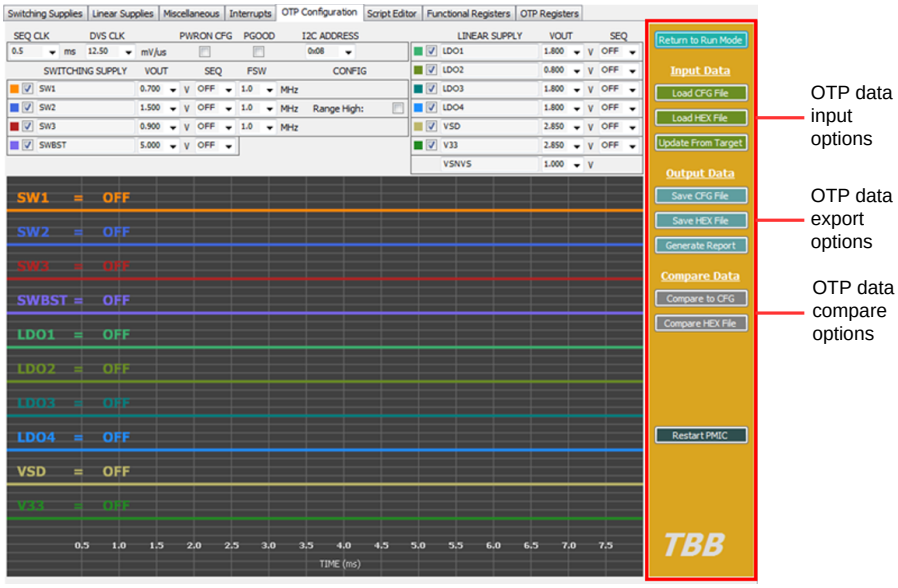


Figure 40. Try-Before-Buy window

8 Schematics, board layout and bill of materials

KITVR5100FRDMEVM board schematics, board layout and bill of materials are available in the download tab of the KITVR5100FRDMEVM Tool summary page at the following URL: http://www.nxp.com/KITVR5100FRDMEVM

9 References

Following are URLs where you can obtain information on related NXP products and application solutions:

NXP.com support pages	Description	URL
KITVR5100FRDMEVM	Tool summary page	http://www.nxp.com/KITVR5100FRDMEVM
	Schematic, BOM, board layout	https://www.nxp.com/KITVR5100FRDMEVM (Download section)
KITVR5100FRDPGM	Tool summary page	http://www.nxp.com/KITVR5100FRDPGM
VR5100	Product summary page	http://www.nxp.com/VR5100
FRDM-KL25Z	Freedom Development Platform	http://www.nxp.com/FRDM-KL25Z

10 Contact information

Visit http://www.nxp.com/support for a list of phone numbers within your region.
Visit http://www.nxp.com/warranty to submit a request for tool warranty.

11 Revision history

Revision	Date	Description of changes
1.0	8/2016	Initial release

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