POWERNAVIGATOR 5.4

DIGITAL MULTIPHASE USER GUIDE

MARCH 2018

BIG IDEAS
FOR EVERY SPACE

OVERVIEW

- **This guide walks a user through the steps to setup and configure the ISL691xx and ISL681xx Digital Multiphase products using the PowerNavigator GUI. For all other Renesas Digital Power devices, please see the Digital Point of Load user guide.**

- **This guide is intended for use with PowerNavigator Revision 5.4.62**

- **This presentation contains the following sections that can be referred to depending on the stage of the design:**
  - PowerNavigator Introduction
  - Running PowerNavigator
  - Creating a new project in offline mode
  - Connecting to Hardware and loading Project files
  - Creating HEX files for production programming

INSTALLING POWERNAVIGATOR

Installing PowerNavigator

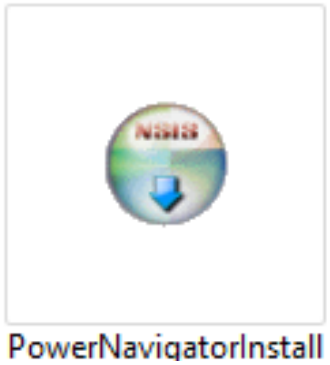
- Download the latest version of PowerNavigator from:

www.intersil.com/powernavigator

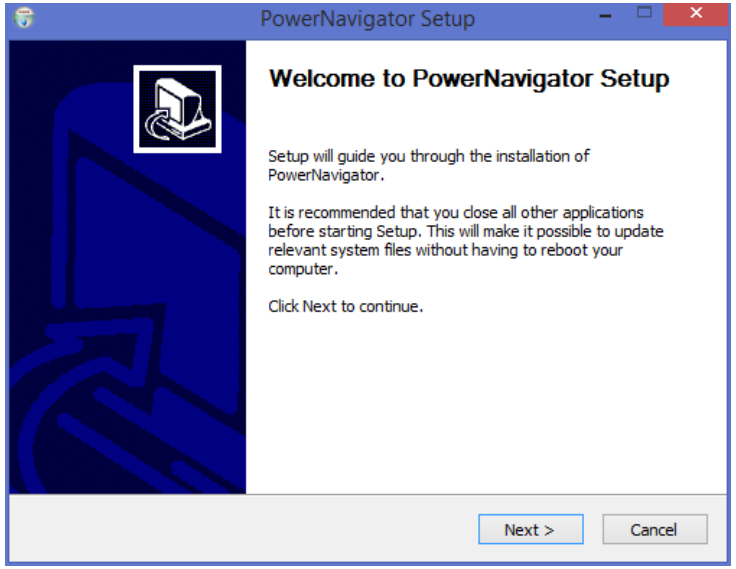
- PowerNavigator Requires a Windows PC with Windows Vista or greater
- A driver is NOT required for the USB to PMBus adapter – it uses the built-in Windows HID driver.

Installing PowerNavigator

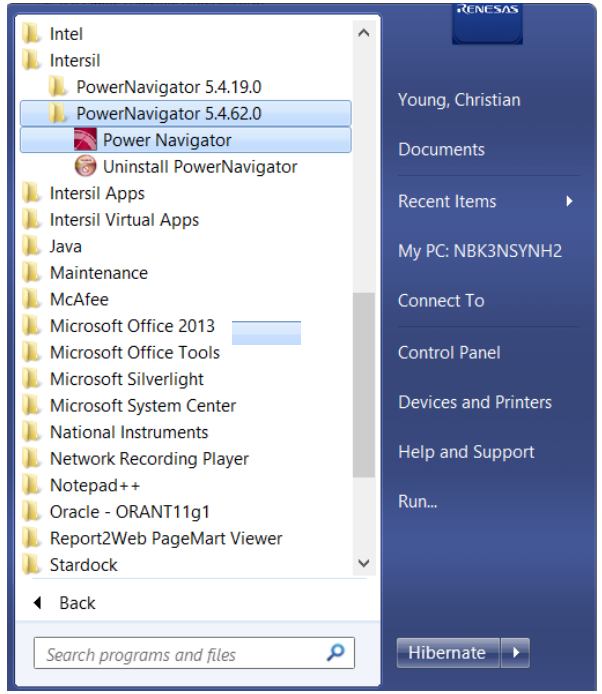
1 Double Click installer to begin install process.



2 Click through PowerNavigator Setup Wizard to install.

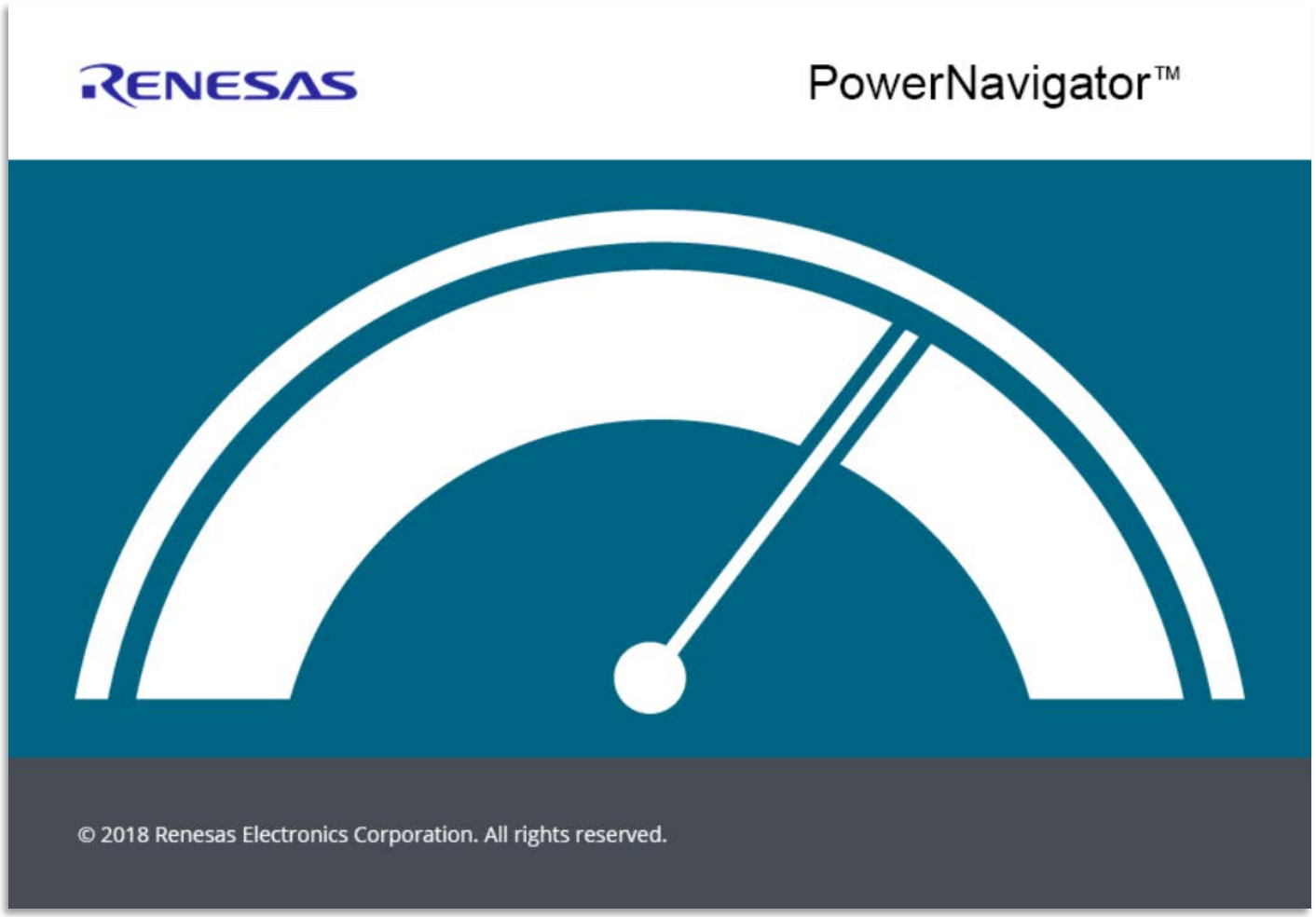


3 After installation is complete, PowerNavigator will be visible in Start Menu under “Intersil”



LAUNCHING POWERNAVIGATOR

PowerNavigator Launch Screen



PowerNavigator Launch Screen

Connected Devices:

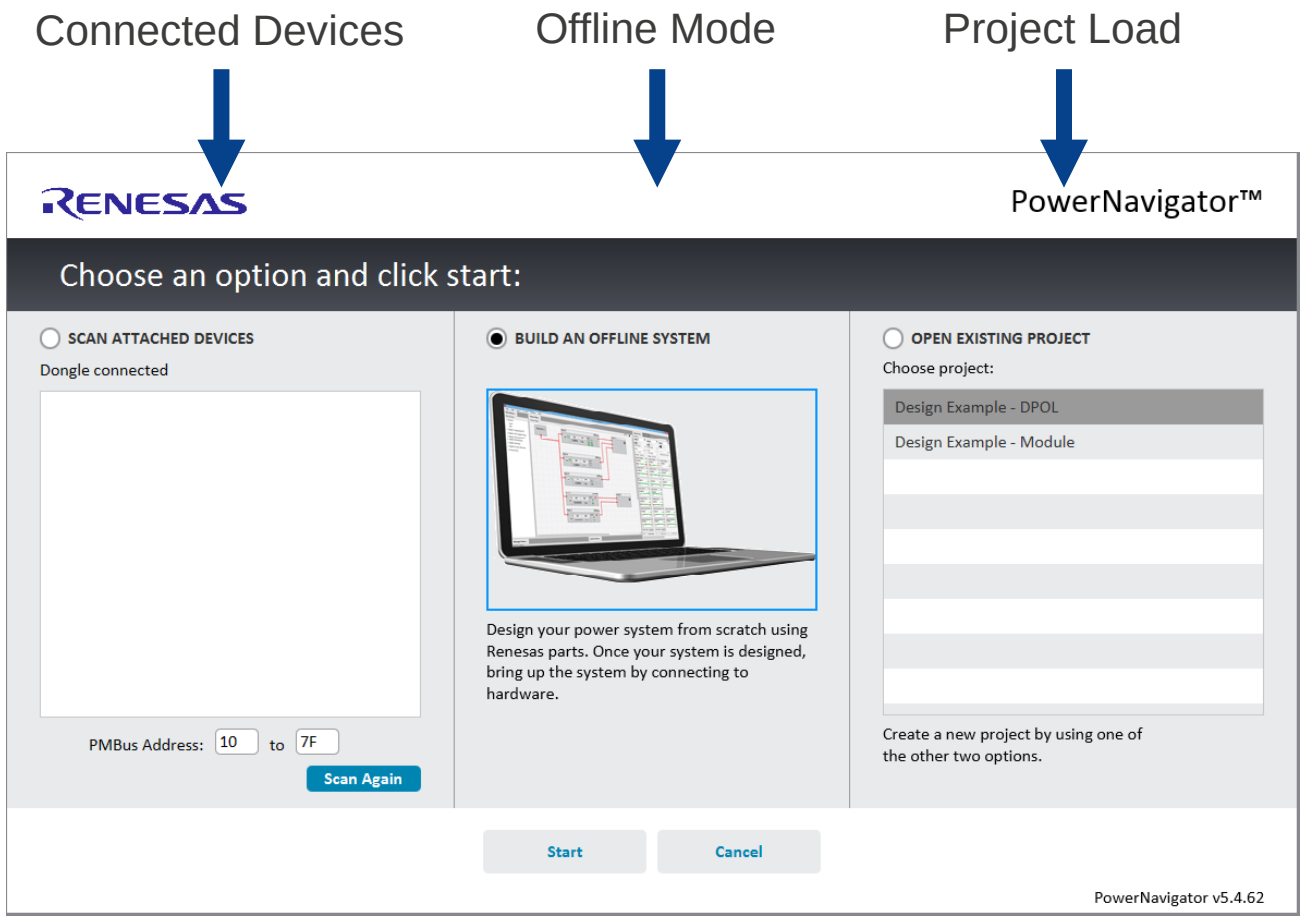
- Used for telemetry monitoring only. Device configuration changes cannot be made in this mode.

Offline Mode:

- Used to create new projects

Project Load:

- Used to load an existing project or connect to existing hardware. Allows device configuration changes to be made.



Project Files

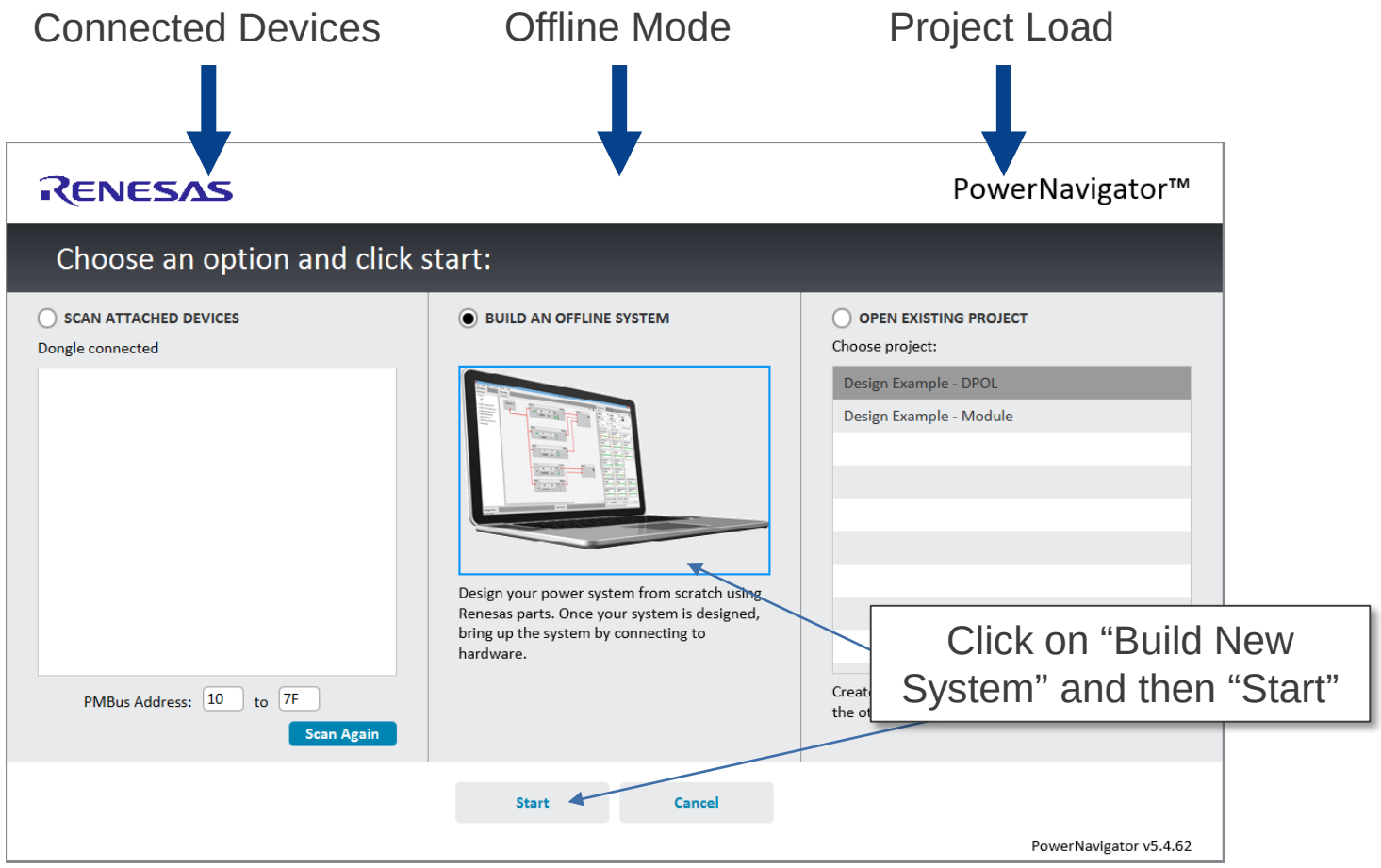
- Digital multiphase devices rely on **Project Files** for loading and editing configuration settings. ***It is not possible to read back the stored configuration settings from a multiphase controller***, so proper use and maintenance of project files is critical.

- **Definitions:**
  - **Project File**: System level file that contains all project information, including individual configuration files.
  - **Config File**: Unique file contained within the project file with the setup information for a single controller configuration

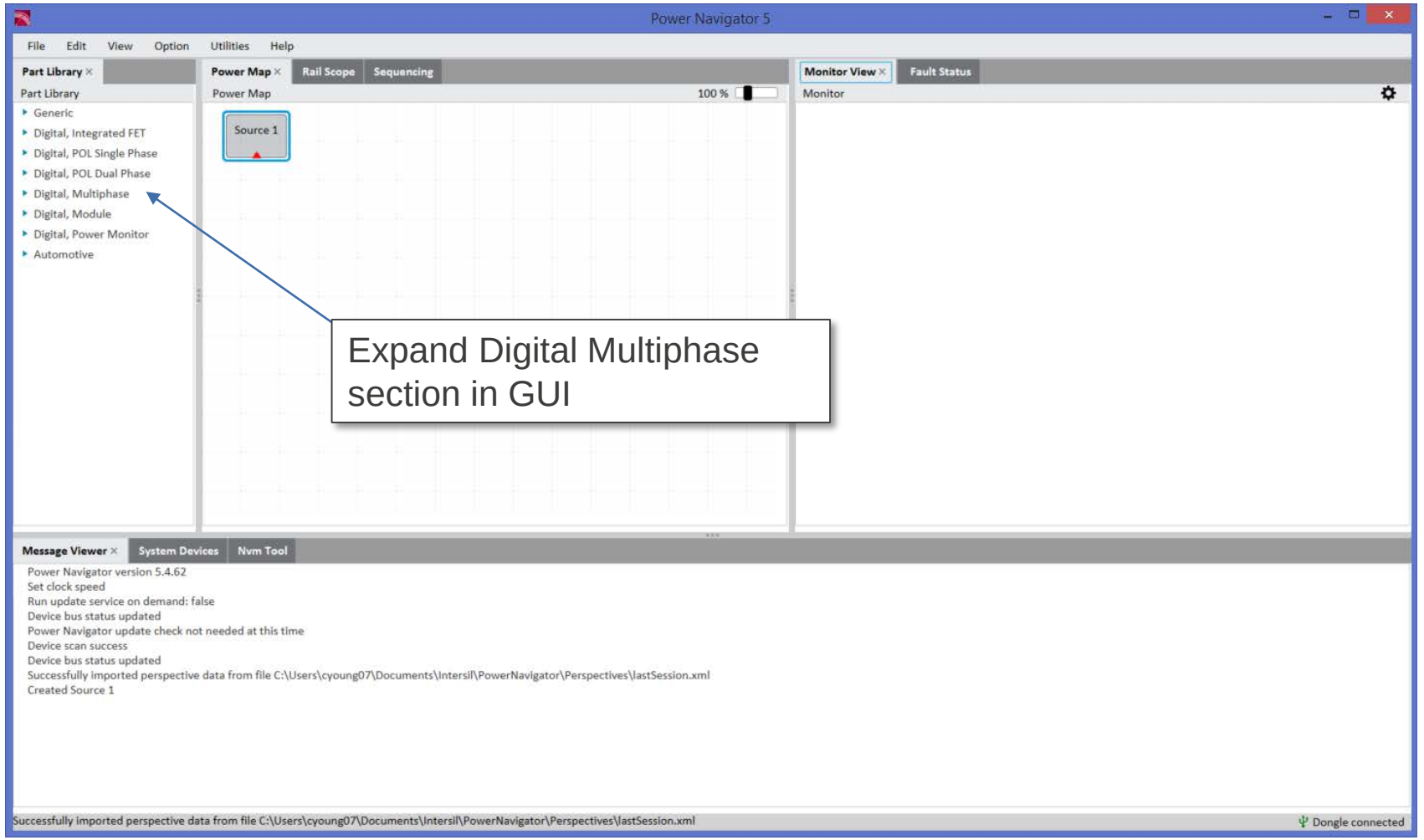
- **The project files can be found on your PC:**
  - C:\USERS***User Name***\Documents\Intersil\PowerNavigator\Projects
  - Project files for all Digital Multiphase demo boards are available from Renesas upon request

CREATING PROJECTS IN OFFLINE MODE

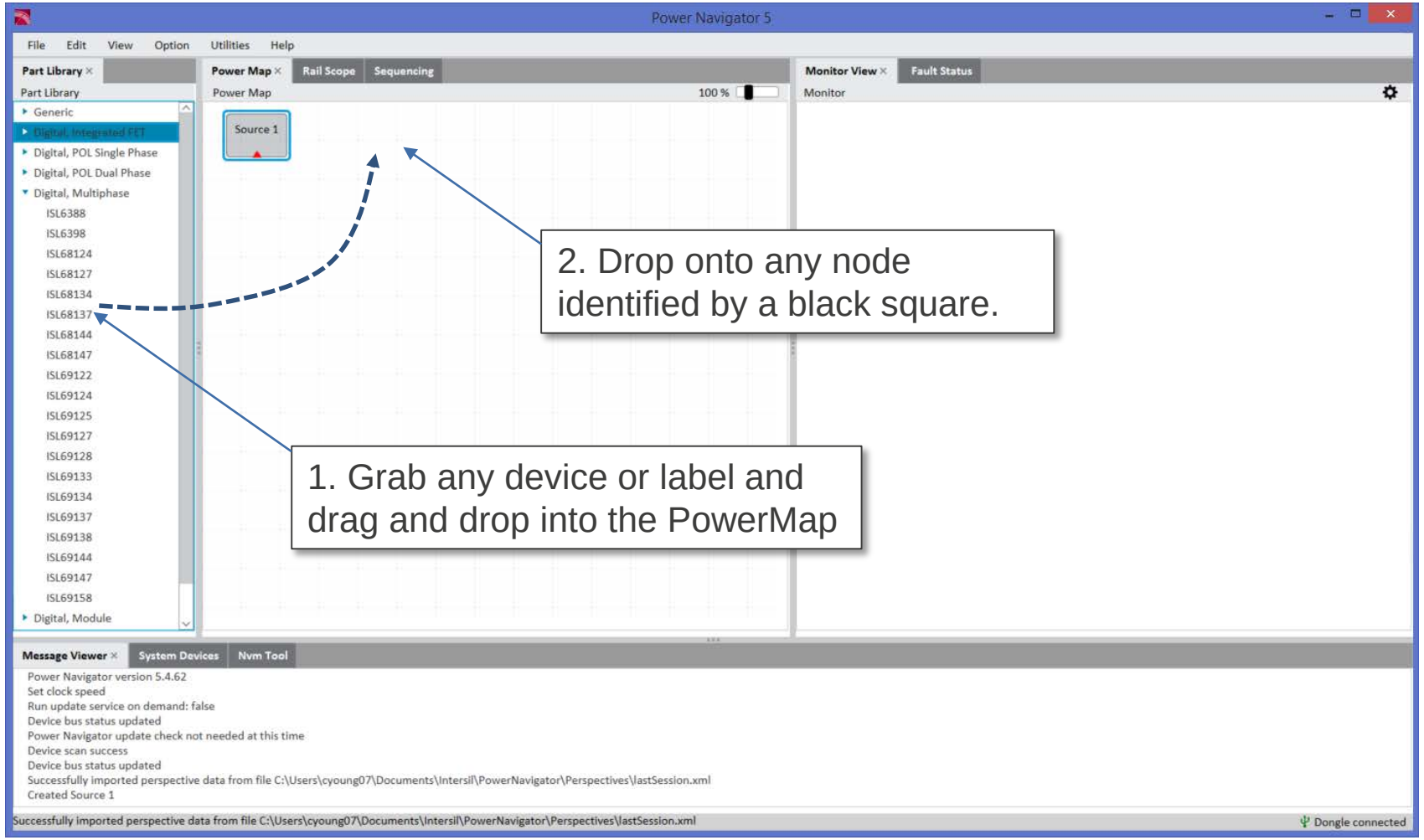
Digital Multiphase – Launch Screen



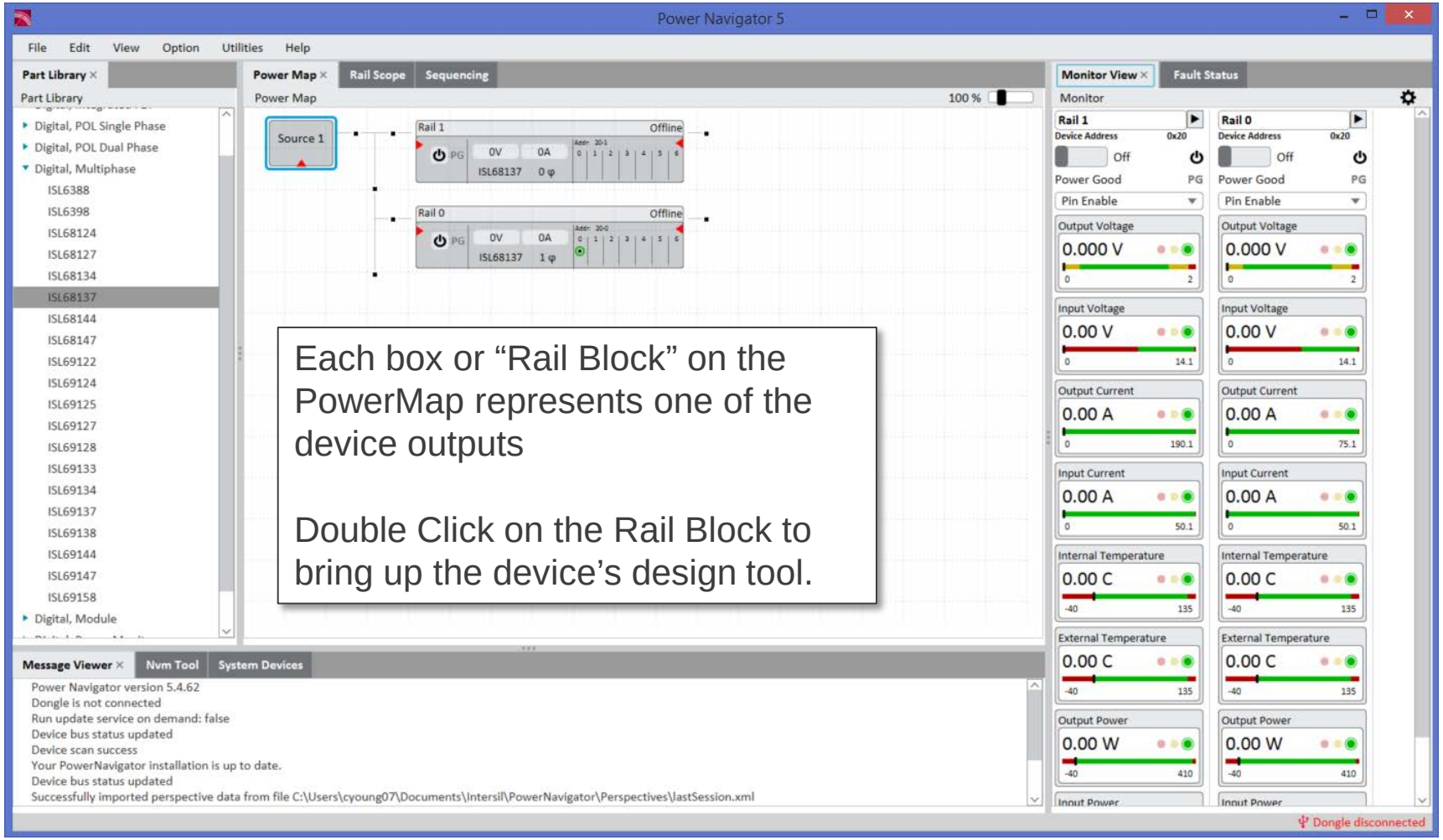
Digital Multiphase – Main Screen



Digital Multiphase – Main Screen

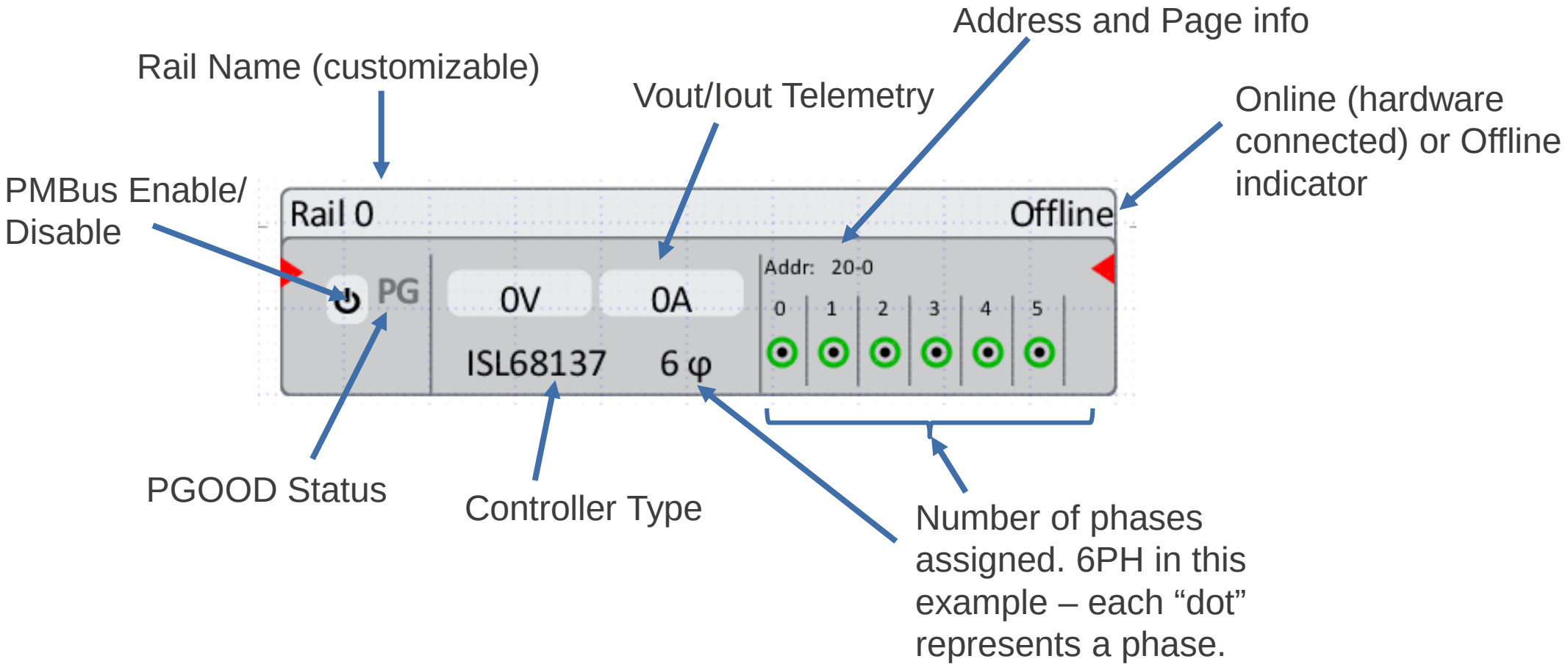


Digital Multiphase – PowerNavigator PowerMap

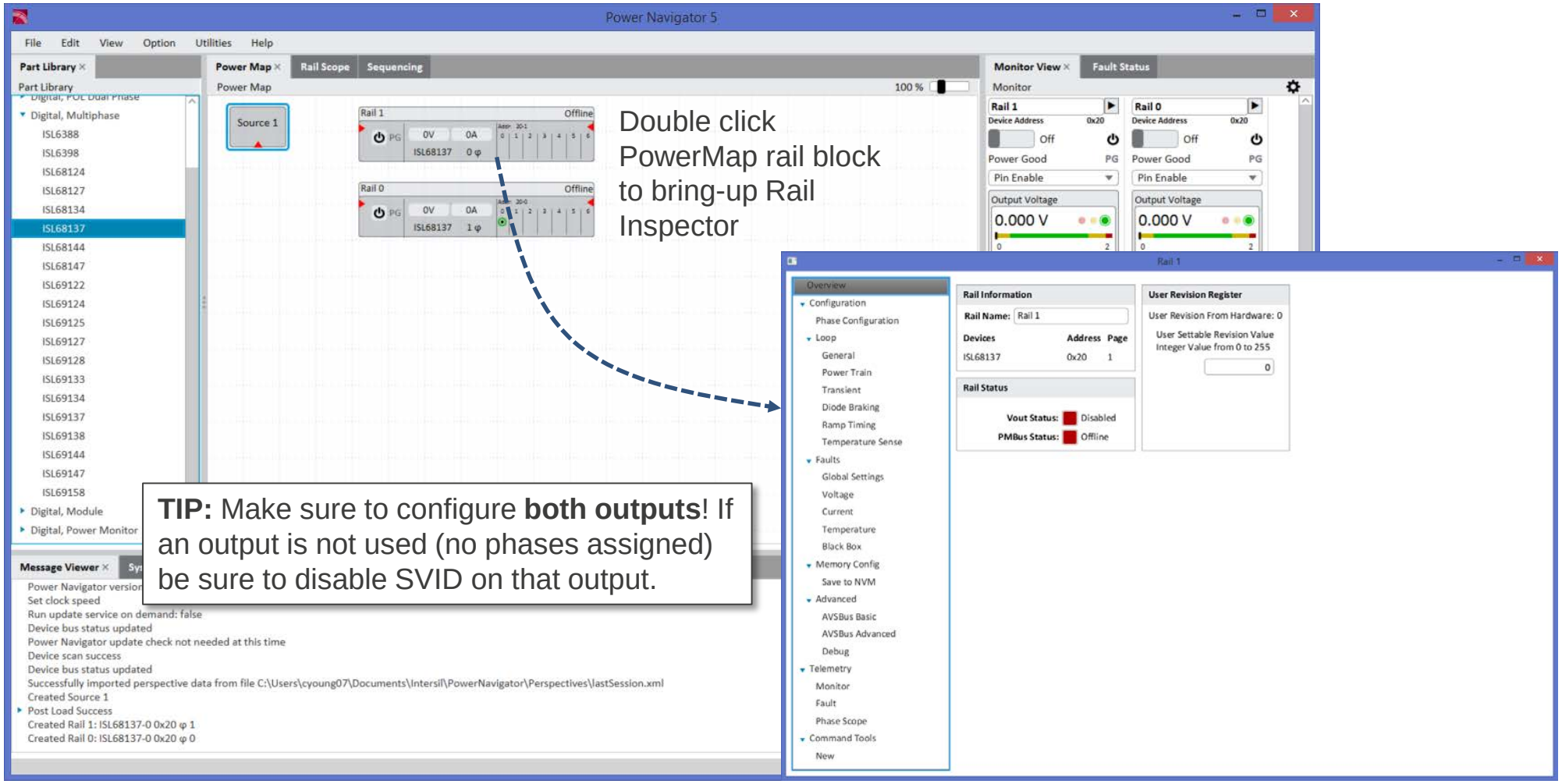


Digital Multiphase – PowerNavigator PowerMap

Example ISL68137 RailBlock (6-PH operation):



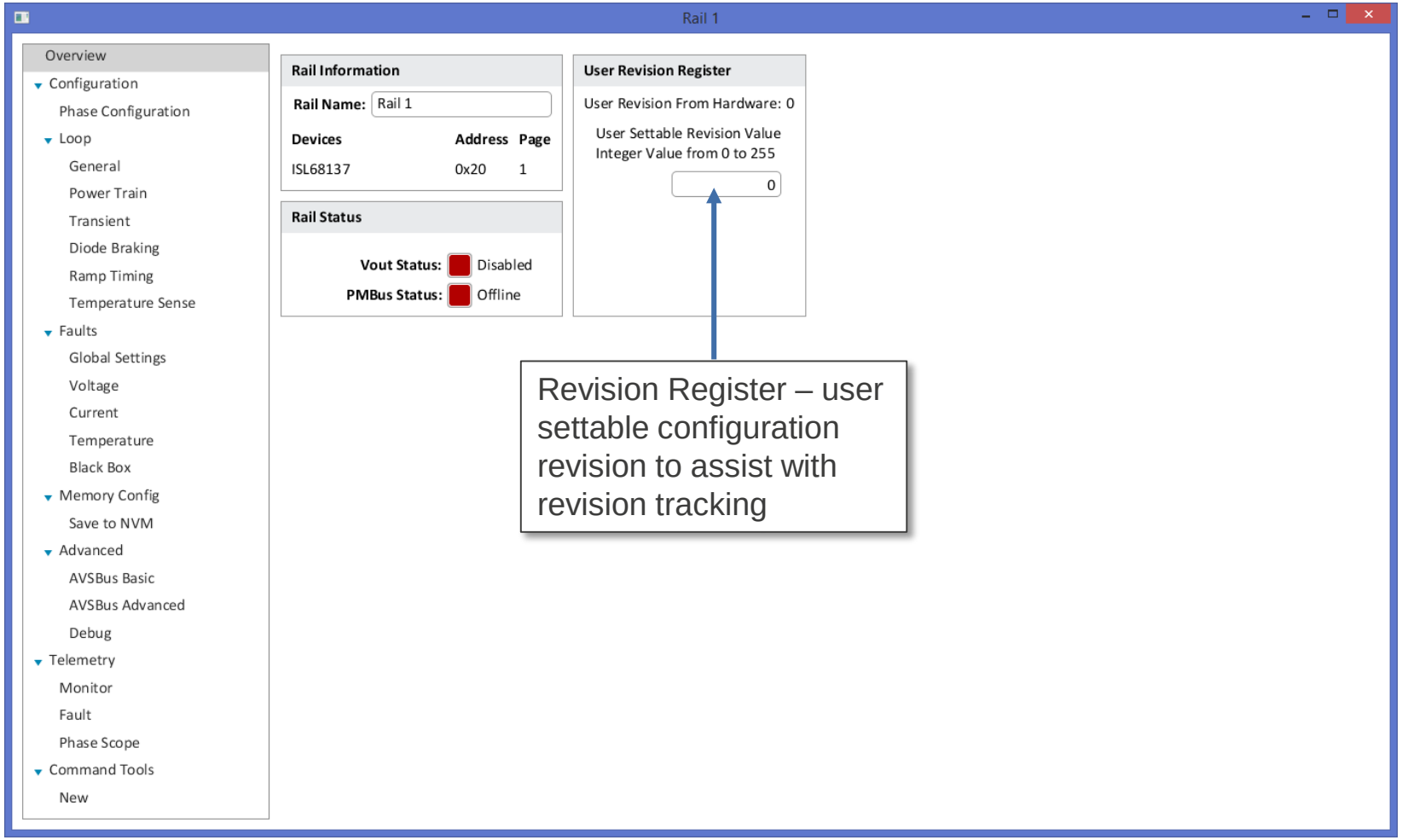
Digital Multiphase – PowerMap and Rail Inspector



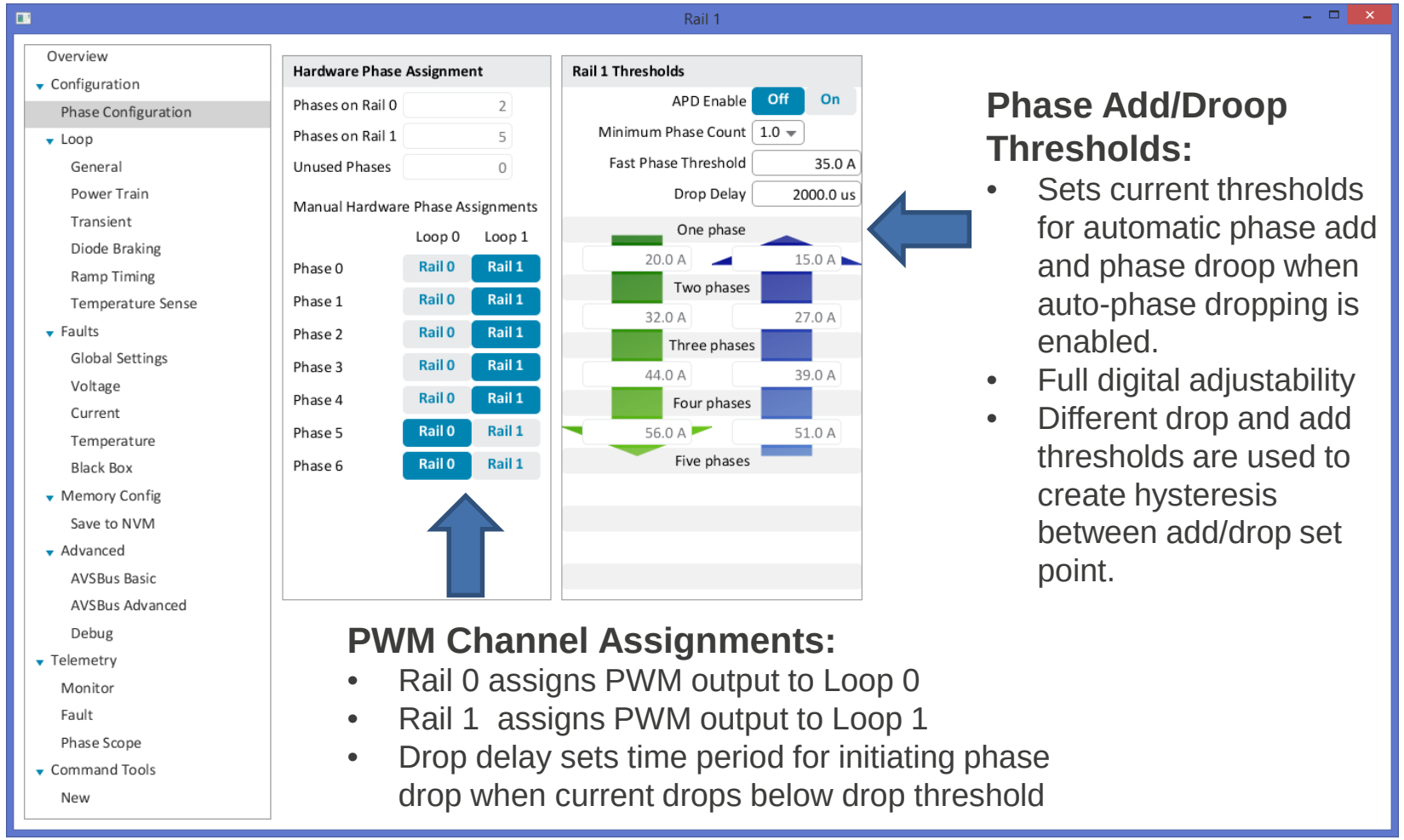
TIP: Make sure to configure **both outputs**! If an output is not used (no phases assigned) be sure to disable SVID on that output.

Digital Multiphase – Rail Inspector

Rail Inspector Navigation panel



Digital Multiphase – Phase Configuration



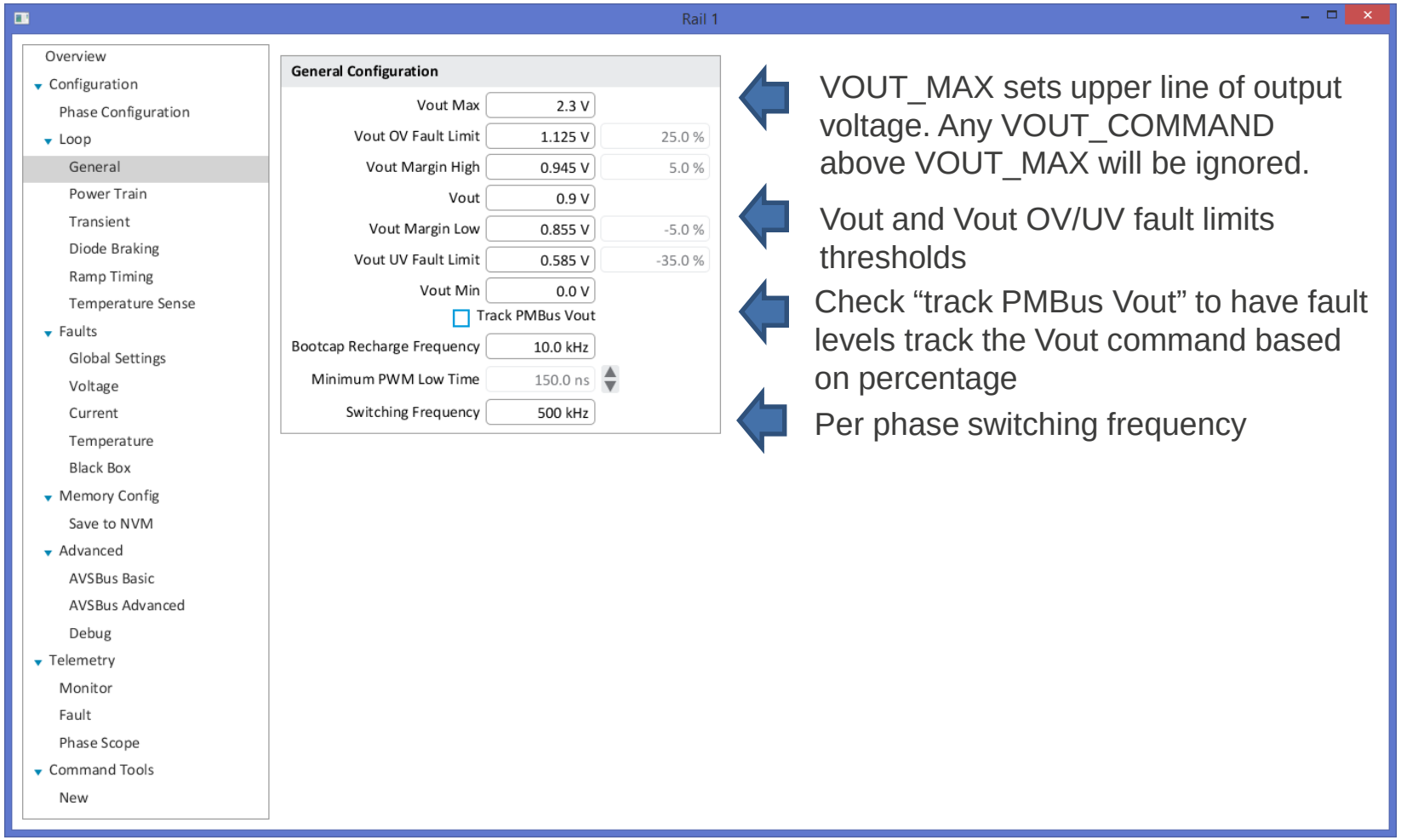
Phase Add/Droop Thresholds:

- Sets current thresholds for automatic phase add and phase droop when auto-phase dropping is enabled.
- Full digital adjustability
- Different drop and add thresholds are used to create hysteresis between add/drop set point.

PWM Channel Assignments:

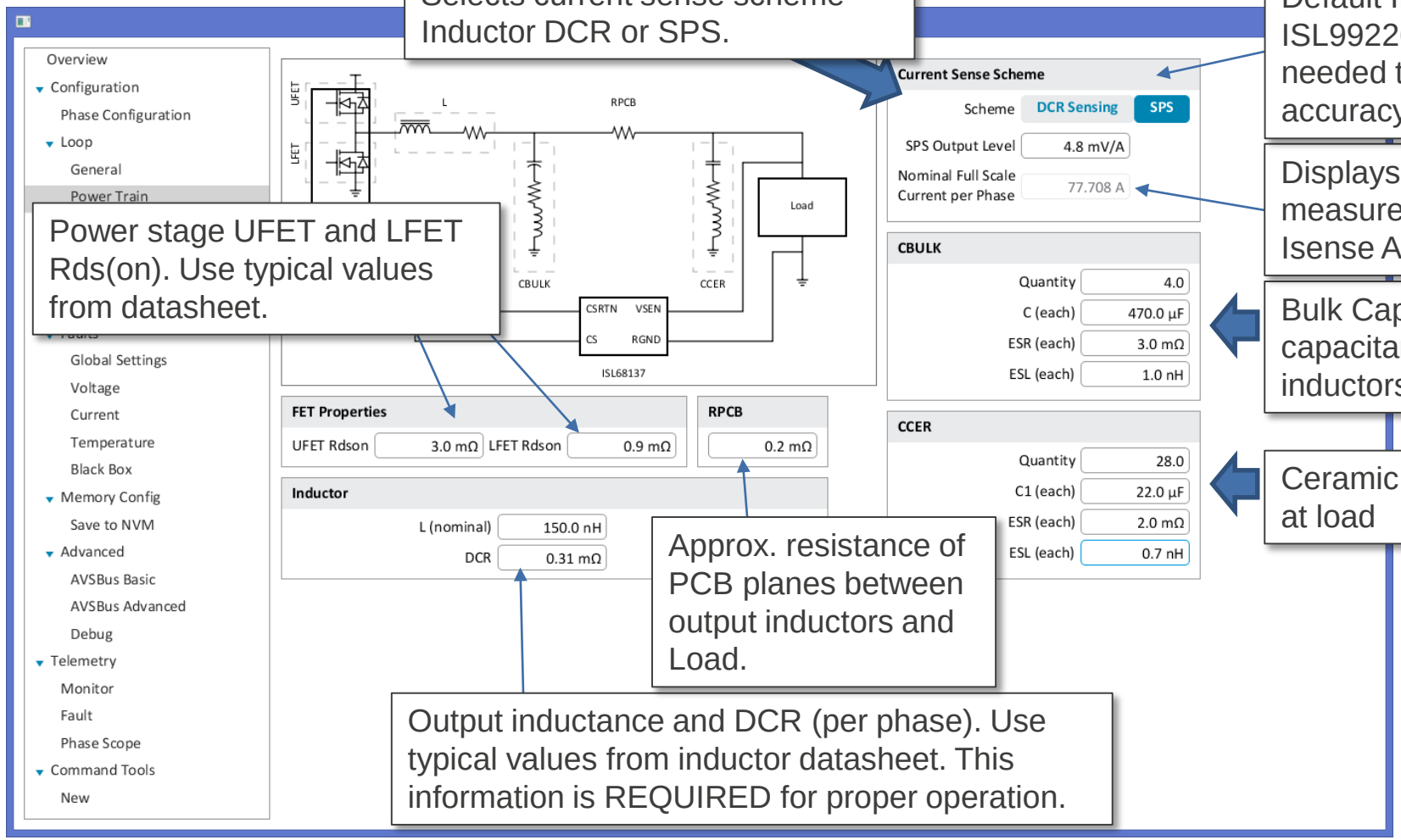
- Rail 0 assigns PWM output to Loop 0
- Rail 1 assigns PWM output to Loop 1
- Drop delay sets time period for initiating phase drop when current drops below drop threshold

Digital Multiphase – Device Setup



- VOUT_MAX sets upper line of output voltage. Any VOUT_COMMAND above VOUT_MAX will be ignored.
- Vout and Vout OV/UV fault limits thresholds
- Check “track PMBus Vout” to have fault levels track the Vout command based on percentage
- Per phase switching frequency

Digital Multiphase – Power Train Configuration



Selects current sense scheme – Inductor DCR or SPS.

Default IMON output for ISL99226/7 SPS. Adjust as needed to dial in load line accuracy

Displays max current measurement per phase before Isense ADC clips

Power stage UFET and LFET Rds(on). Use typical values from datasheet.

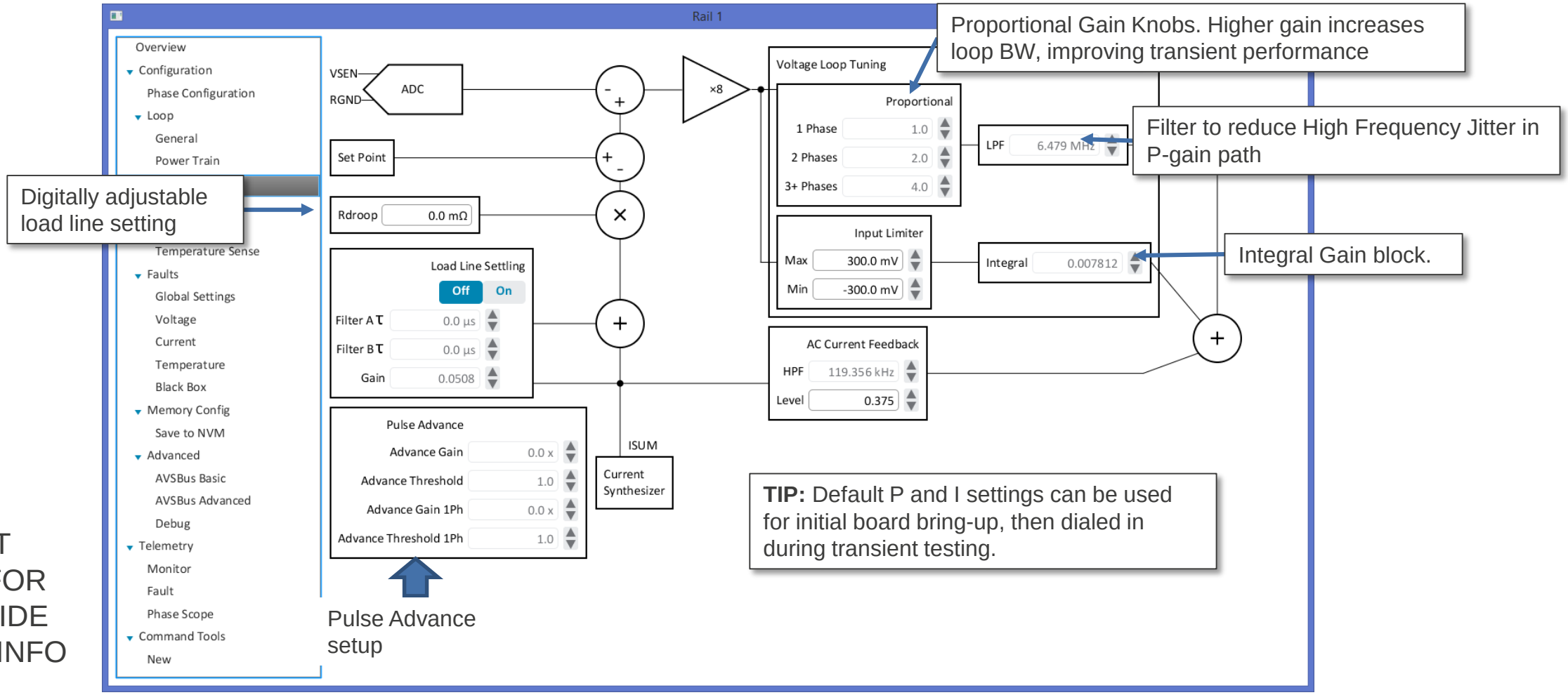
Bulk Capacitance or ceramic capacitance by output inductors

Ceramic Capacitance used at load

Approx. resistance of PCB planes between output inductors and Load.

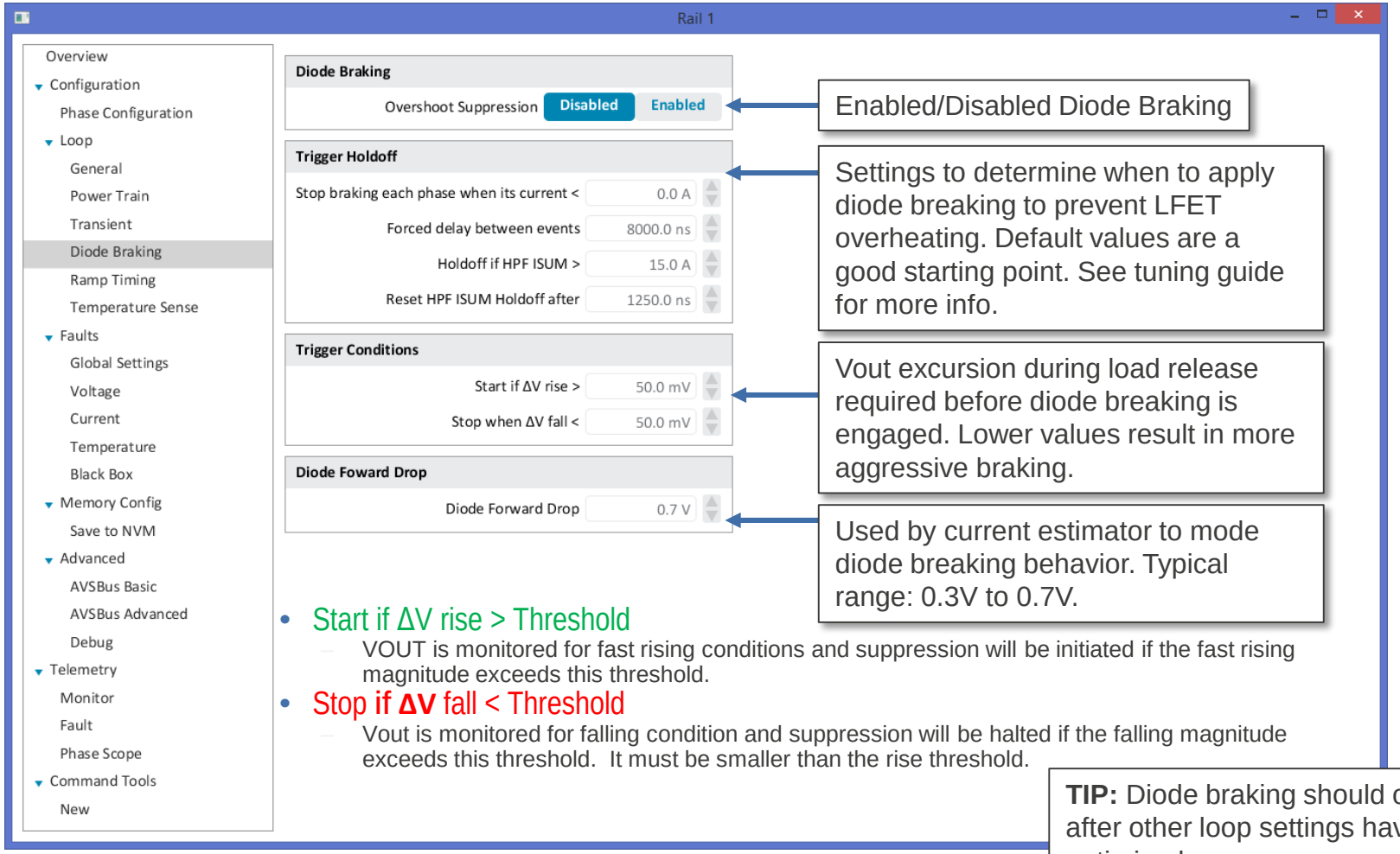
Output inductance and DCR (per phase). Use typical values from inductor datasheet. This information is REQUIRED for proper operation.

Digital Multiphase – Control Loop Configuration



CONTACT RENESAS FOR TUNING GUIDE WITH MORE INFO

Digital Multiphase – Diode braking



Enabled/Disabled Diode Braking

Settings to determine when to apply diode breaking to prevent LFET overheating. Default values are a good starting point. See tuning guide for more info.

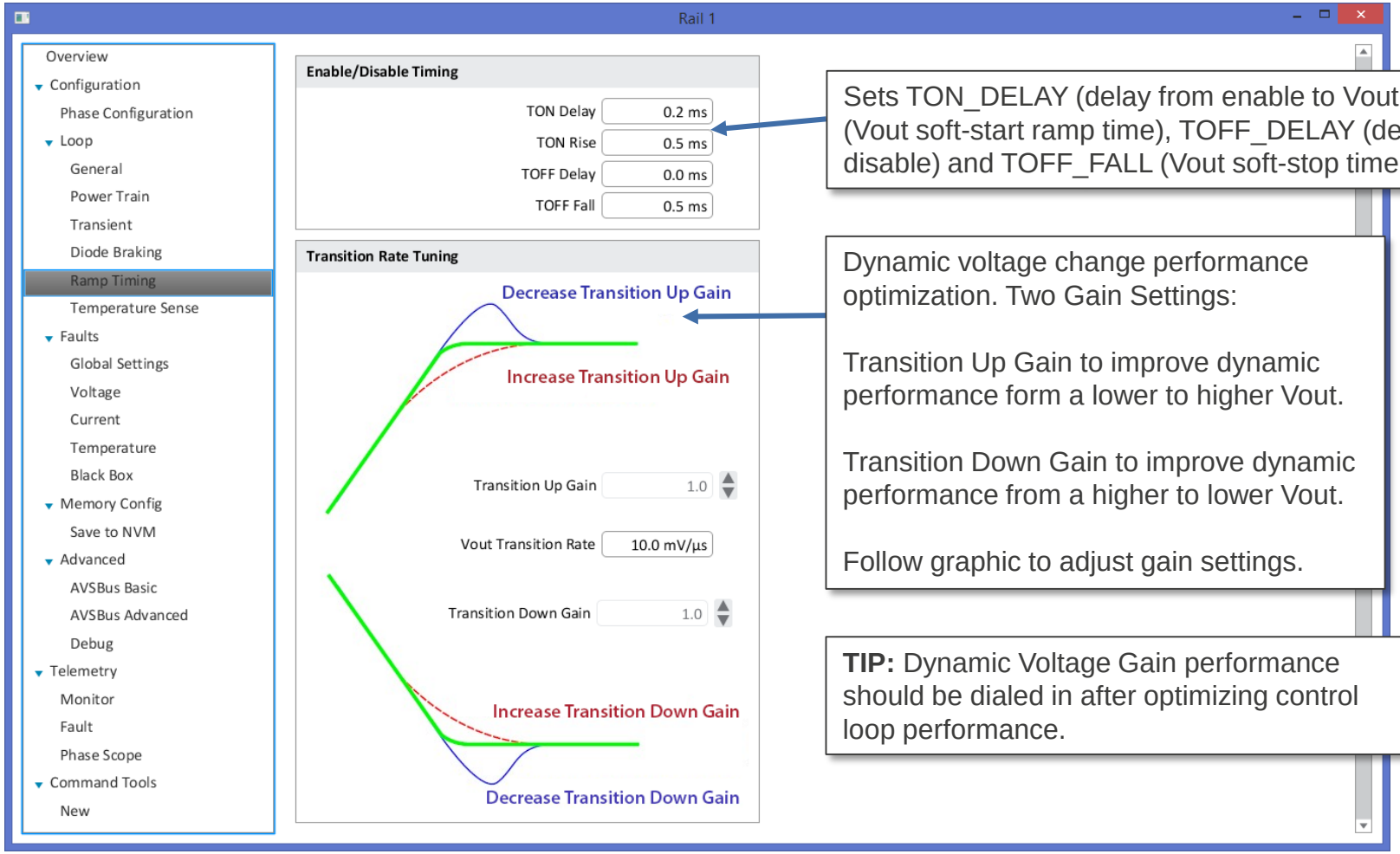
Vout excursion during load release required before diode breaking is engaged. Lower values result in more aggressive braking.

Used by current estimator to mode diode breaking behavior. Typical range: 0.3V to 0.7V.

- Start if ΔV rise > Threshold
  - VOUT is monitored for fast rising conditions and suppression will be initiated if the fast rising magnitude exceeds this threshold.
- Stop if **ΔV** fall < Threshold
  - Vout is monitored for falling condition and suppression will be halted if the falling magnitude exceeds this threshold. It must be smaller than the rise threshold.

TIP: Diode braking should only be enabled after other loop settings have been optimized.

Digital Multiphase – Dynamic Voltage Change Tuning



Sets TON_DELAY (delay from enable to Vout ramp), TON_RISE (Vout soft-start ramp time), TOFF_DELAY (delay from enable low to disable) and TOFF_FALL (Vout soft-stop time, if used)

Dynamic voltage change performance optimization. Two Gain Settings:

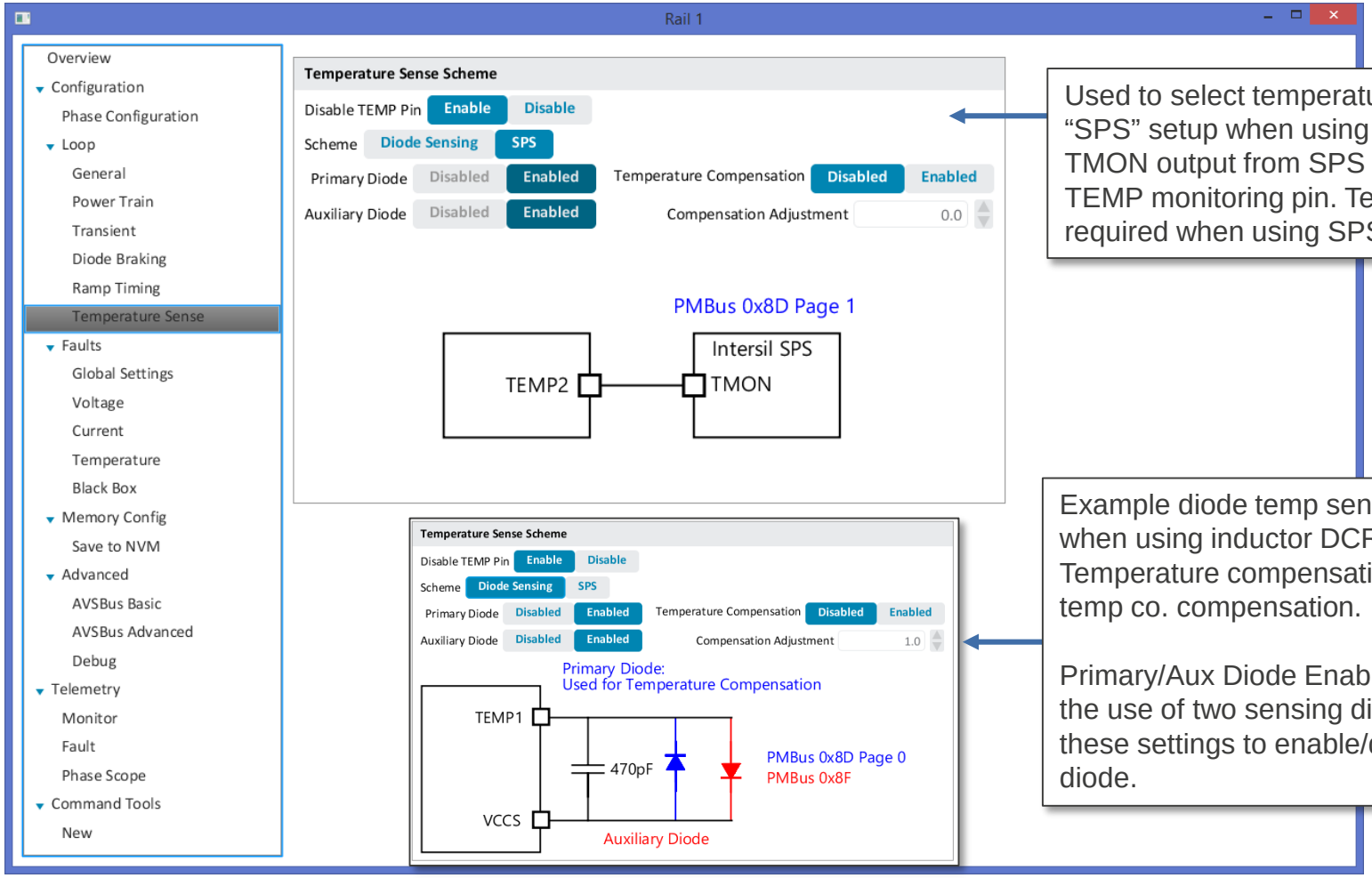
Transition Up Gain to improve dynamic performance form a lower to higher Vout.

Transition Down Gain to improve dynamic performance from a higher to lower Vout.

Follow graphic to adjust gain settings.

TIP: Dynamic Voltage Gain performance should be dialed in after optimizing control loop performance.

Digital Multiphase – Temp Sense Setup

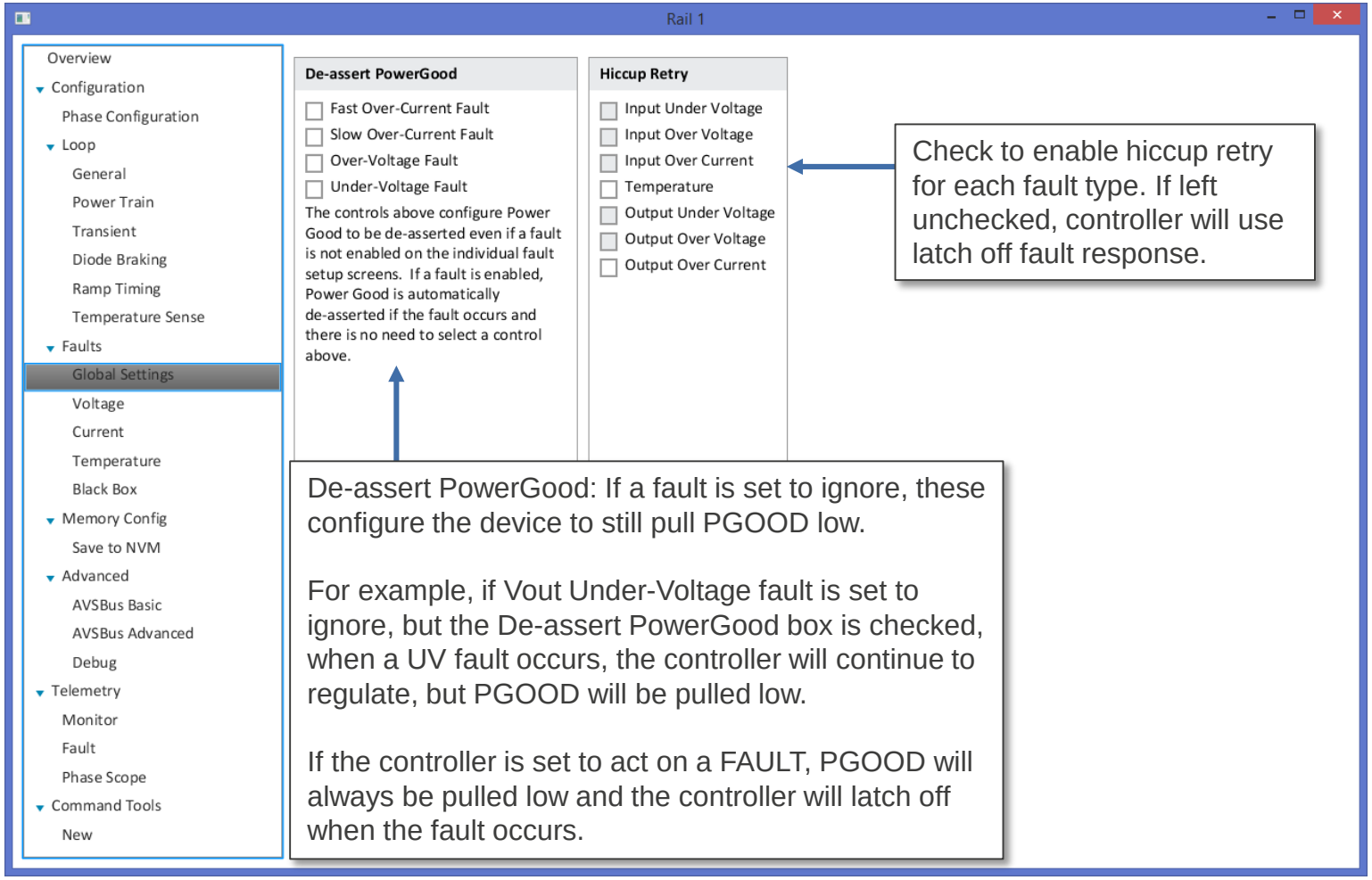


Used to select temperature sense scheme. Use “SPS” setup when using smart power stage – TMON output from SPS is directly connected to TEMP monitoring pin. Temp compensation is not required when using SPS.

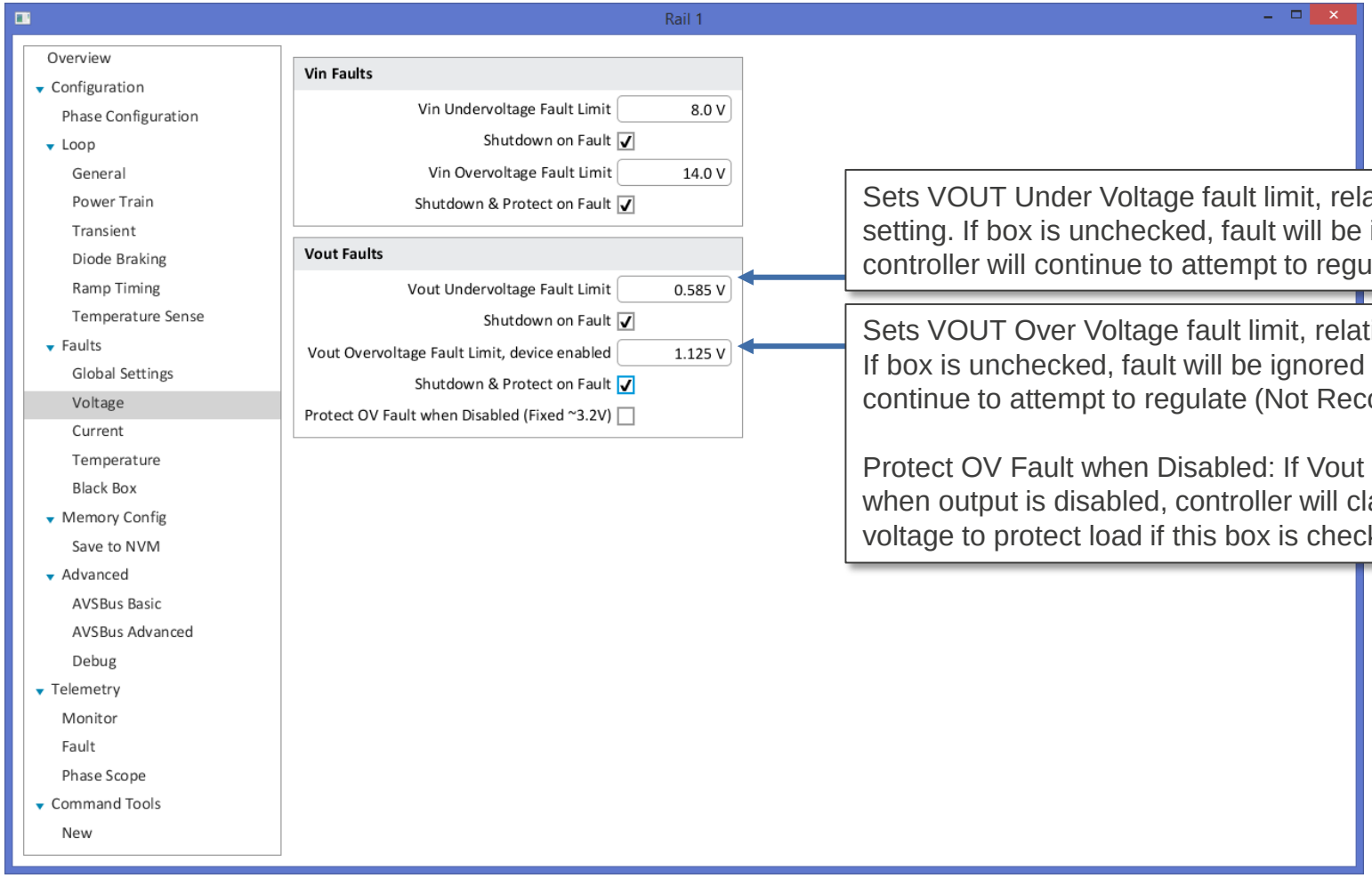
Example diode temp sense scheme. Use diode sense when using inductor DCR for current sense. Temperature compensation must be enabled for DCR temp co. compensation.

Primary/Aux Diode Enable: diode temp sense allows the use of two sensing diodes per TEMP pin. Use these settings to enable/disable Aux or Primary diode.

Digital Multiphase – Global Fault Setup



Digital Multiphase – Vout Fault Configuration

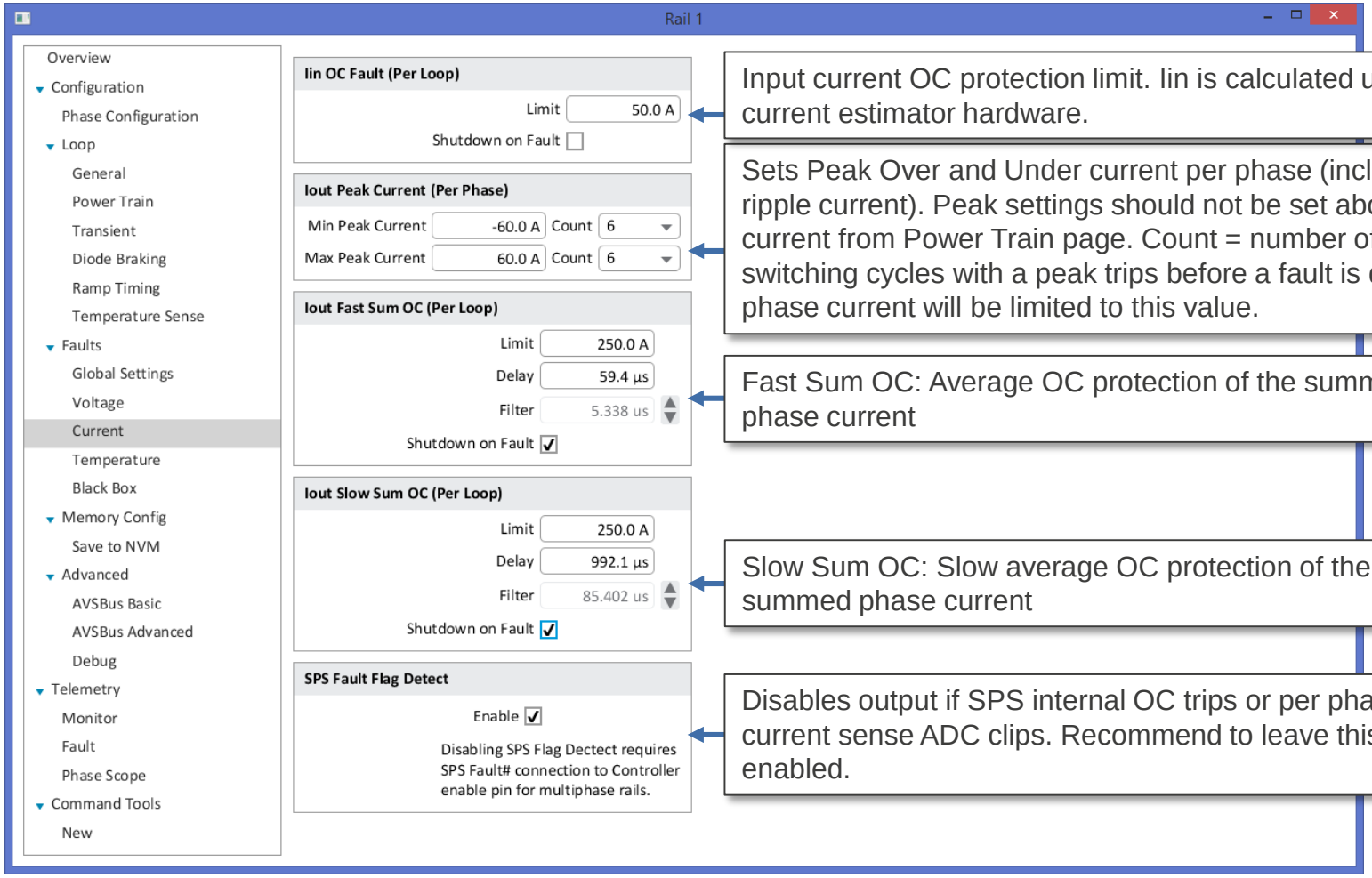


Sets VOUT Under Voltage fault limit, relative to VID setting. If box is unchecked, fault will be ignored and controller will continue to attempt to regulate.

Sets VOUT Over Voltage fault limit, relative to VID setting. If box is unchecked, fault will be ignored and controller will continue to attempt to regulate (Not Recommended).

Protect OV Fault when Disabled: If Vout exceeds 3.2V when output is disabled, controller will clamp output voltage to protect load if this box is checked.

Digital Multiphase – Current Fault Configuration



Input current OC protection limit. Iin is calculated using current estimator hardware.

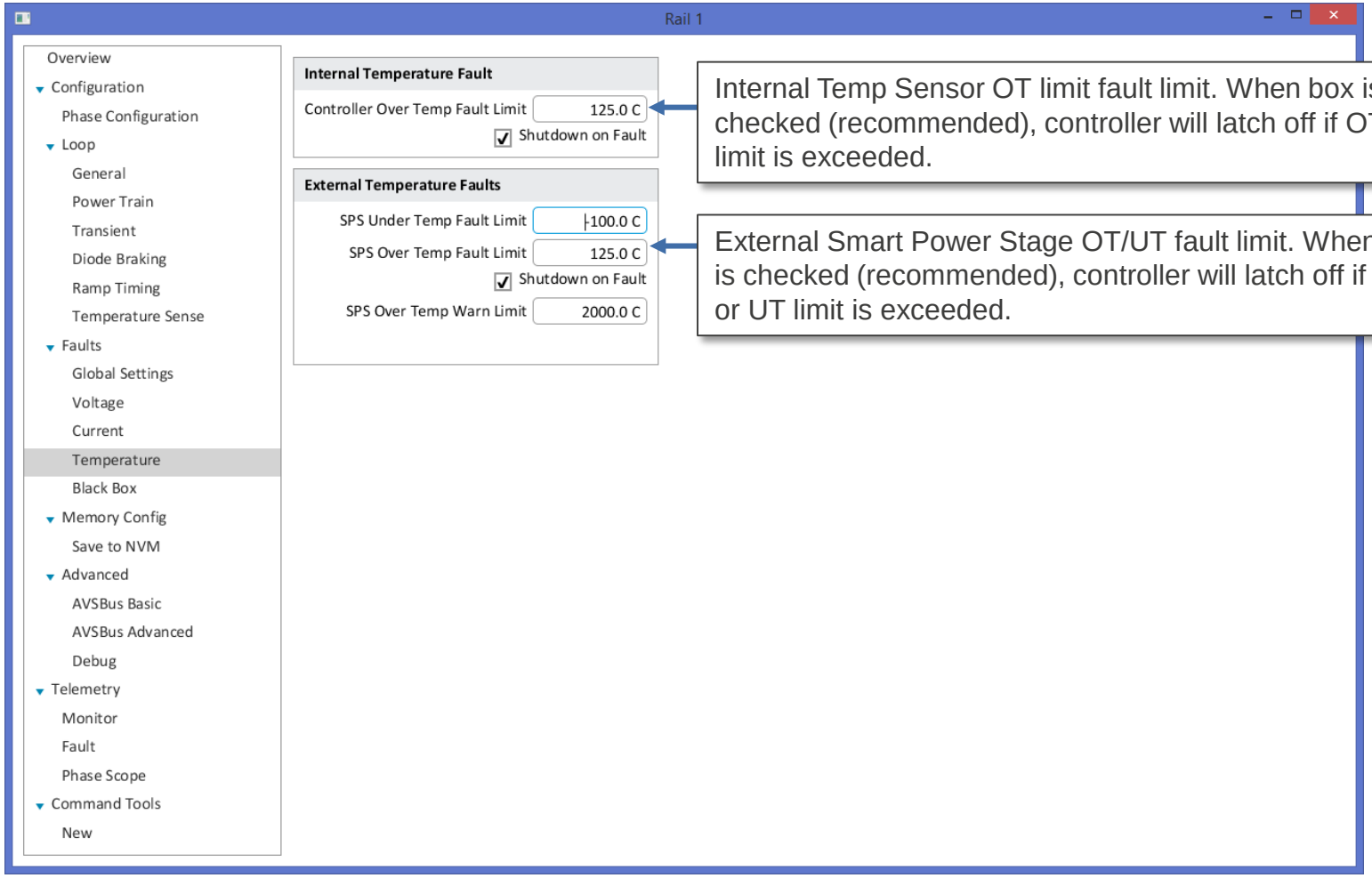
Sets Peak Over and Under current per phase (includes inductor ripple current). Peak settings should not be set above max measured current from Power Train page. Count = number of consecutive switching cycles with a peak trips before a fault is declared. Peak per phase current will be limited to this value.

Fast Sum OC: Average OC protection of the summed phase current

Slow Sum OC: Slow average OC protection of the summed phase current

Disables output if SPS internal OC trips or per phase current sense ADC clips. Recommend to leave this enabled.

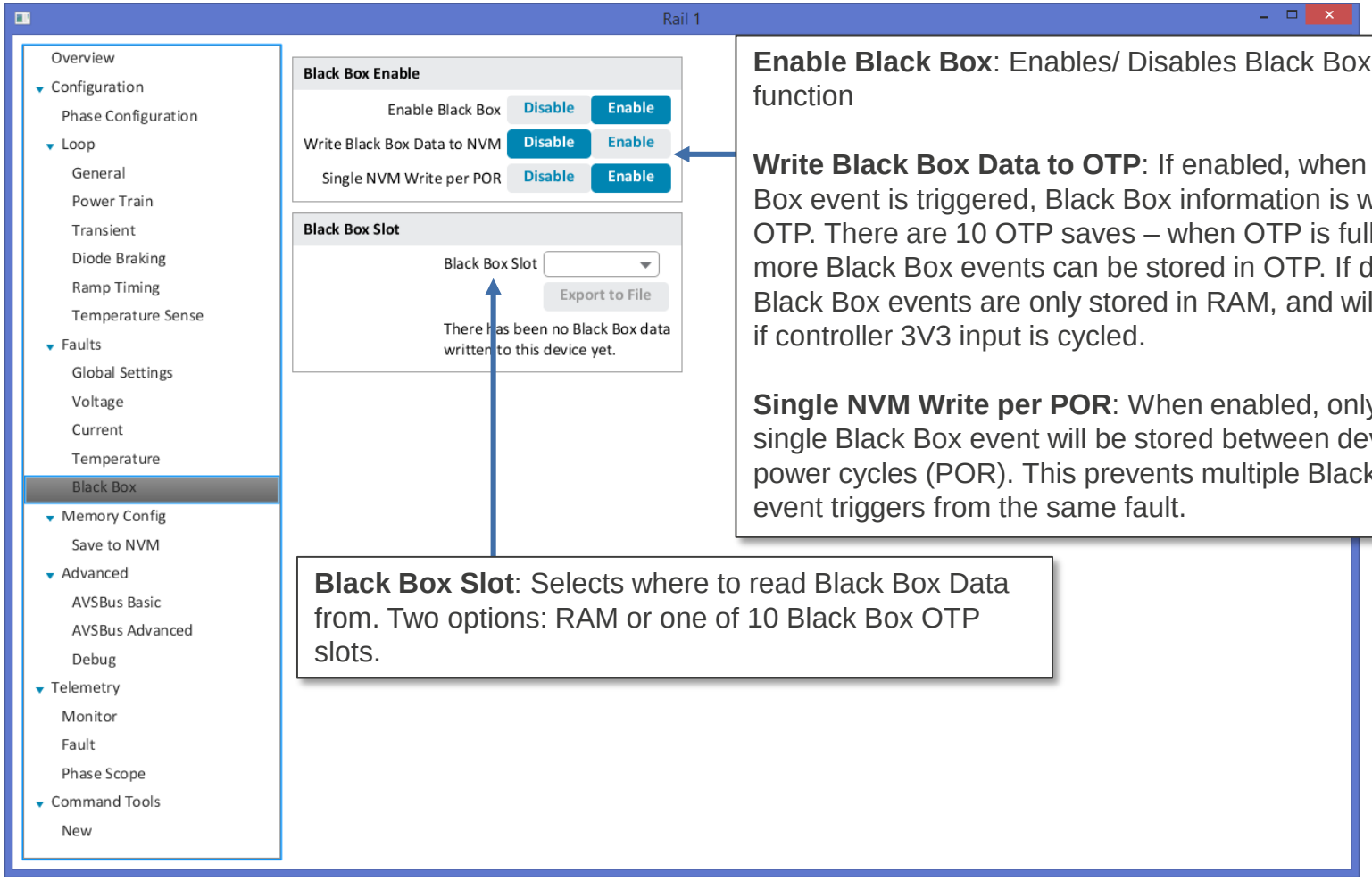
Digital Multiphase – Temp Fault Configuration



Internal Temp Sensor OT limit fault limit. When box is checked (recommended), controller will latch off if OT limit is exceeded.

External Smart Power Stage OT/UT fault limit. When box is checked (recommended), controller will latch off if OT or UT limit is exceeded.

Digital Multiphase – Black Box Setup



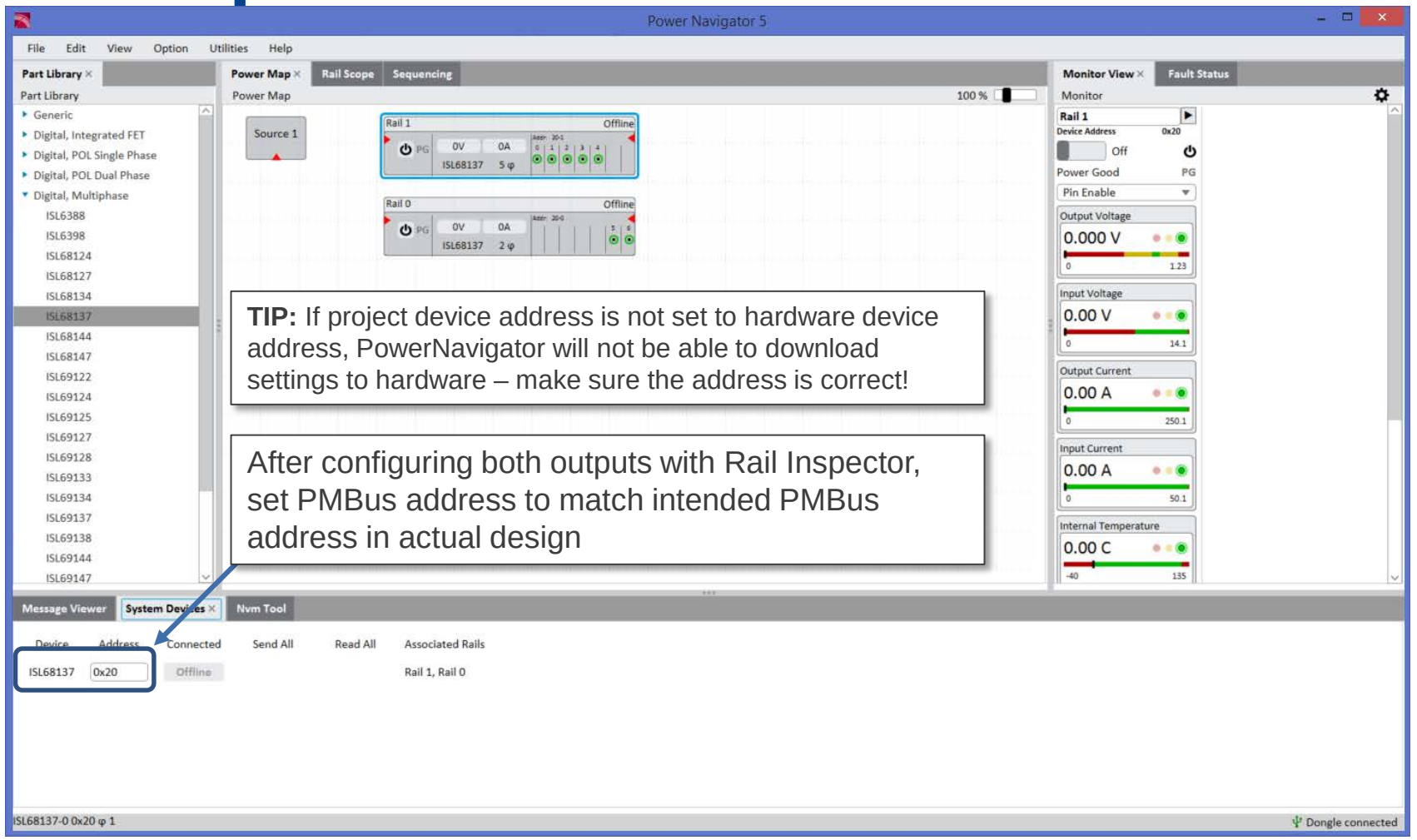
Enable Black Box: Enables/ Disables Black Box function

Write Black Box Data to OTP: If enabled, when a Black Box event is triggered, Black Box information is written to OTP. There are 10 OTP saves – when OTP is full, no more Black Box events can be stored in OTP. If disabled, Black Box events are only stored in RAM, and will be lost if controller 3V3 input is cycled.

Single NVM Write per POR: When enabled, only a single Black Box event will be stored between device power cycles (POR). This prevents multiple Black Box event triggers from the same fault.

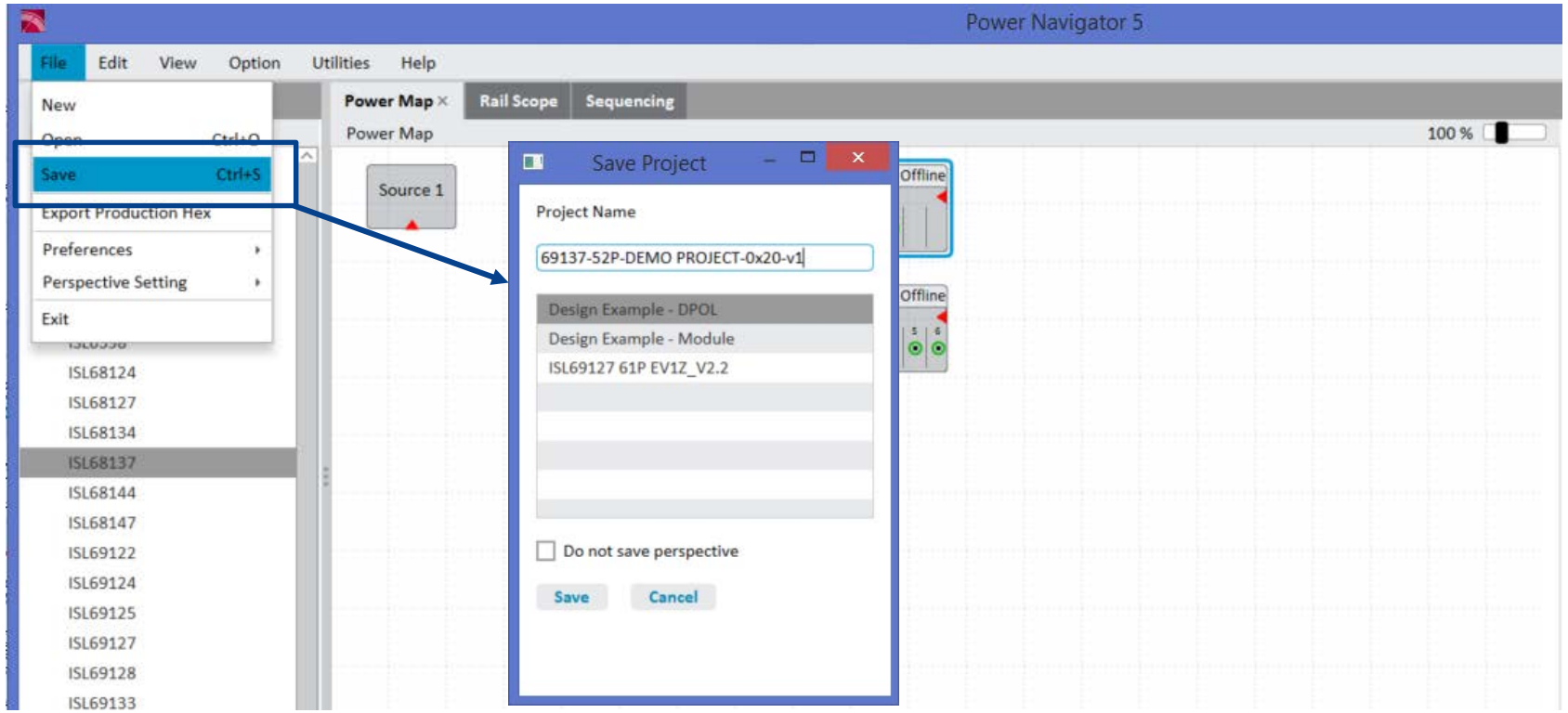
Black Box Slot: Selects where to read Black Box Data from. Two options: RAM or one of 10 Black Box OTP slots.

Digital Multiphase – Device PMBus Address Select



Offline Project Is Now Complete!

After reaching the NVM configuration screen on BOTH outputs, your offline project is now complete! Return to PowerNavigator main screen and save.

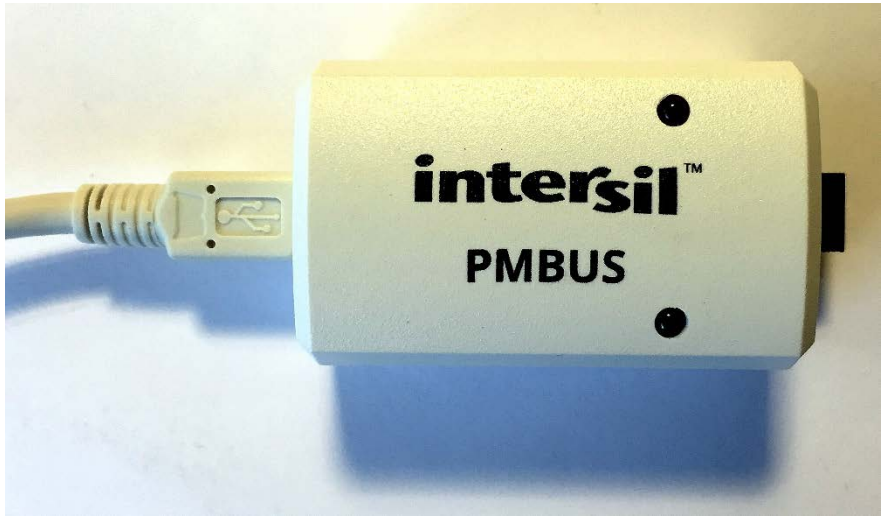


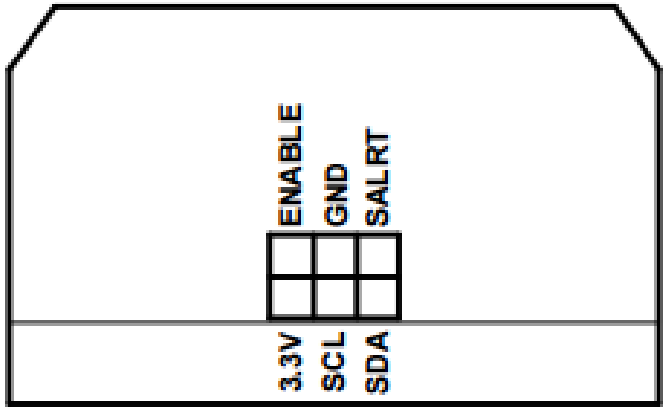
CONNECTING TO HARDWARE

Connecting to Hardware

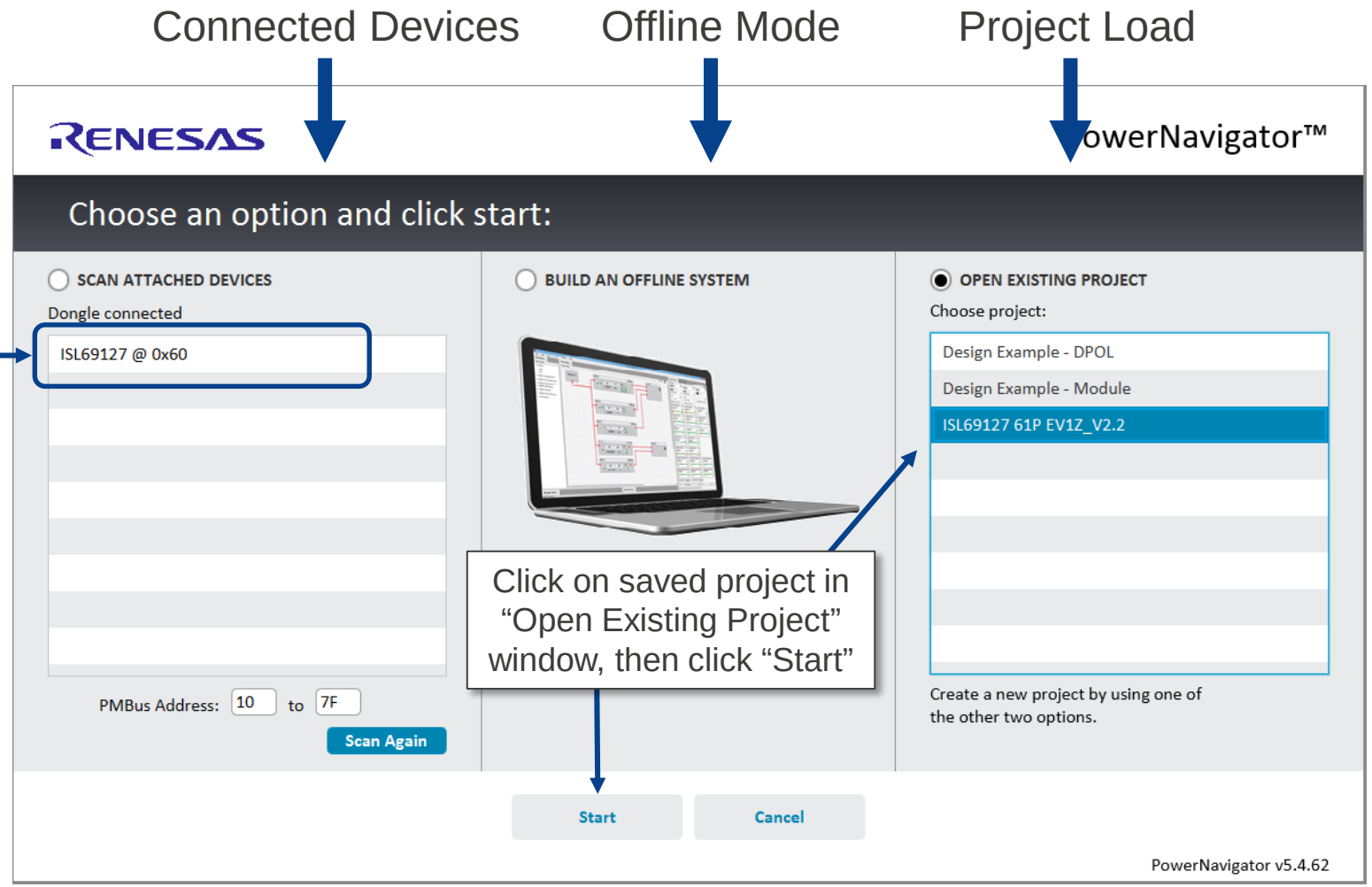
- Once the project file is complete, Renesas's USB to PMBus adapter (ZLUSBEVAL3Z) can be used to connect to hardware.

- To connect to the controller's PMBus interface, only SCL, SDA and GND connections from the adapter to the board are required.





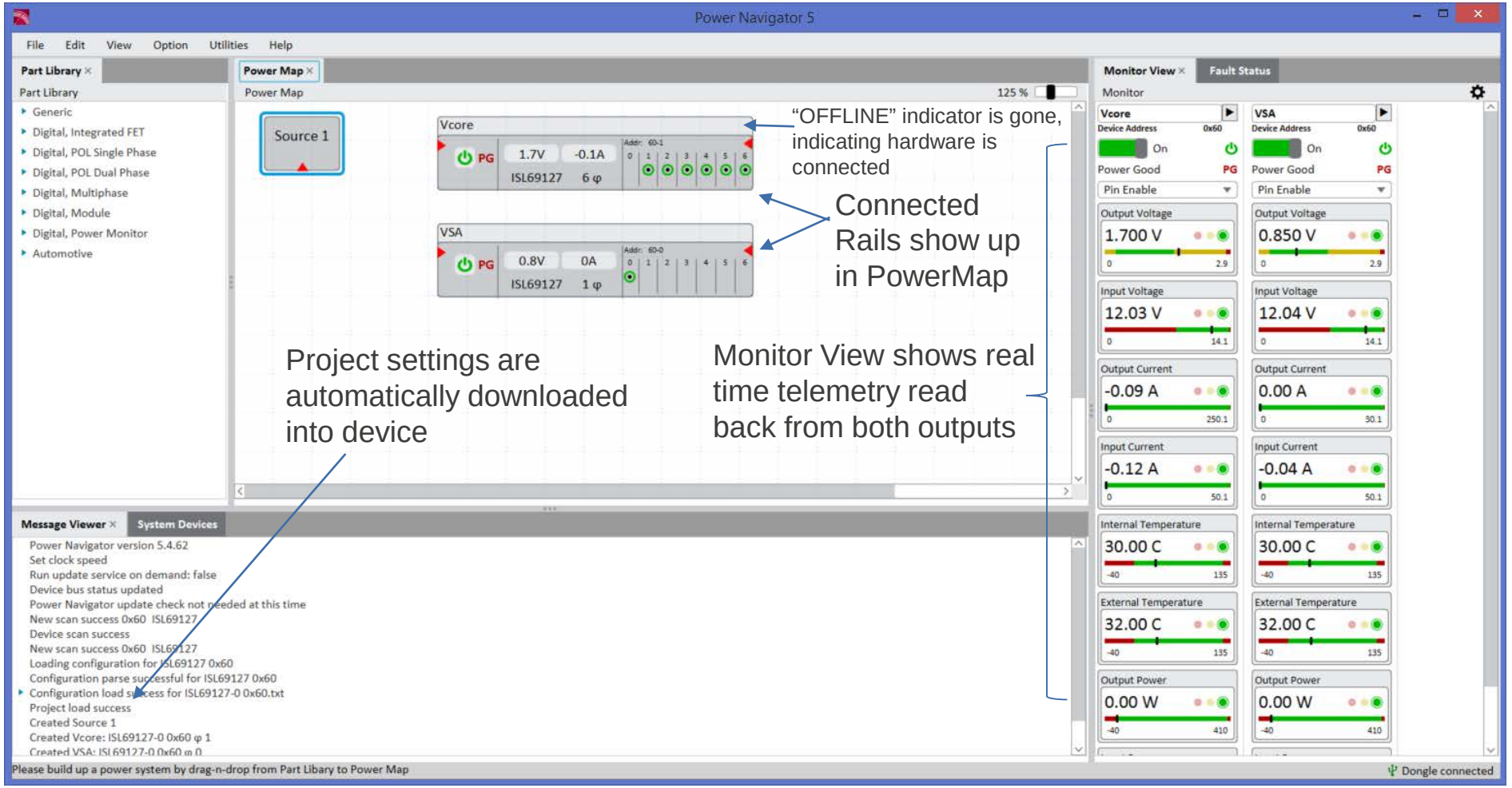
Digital Multiphase – Connecting to Hardware



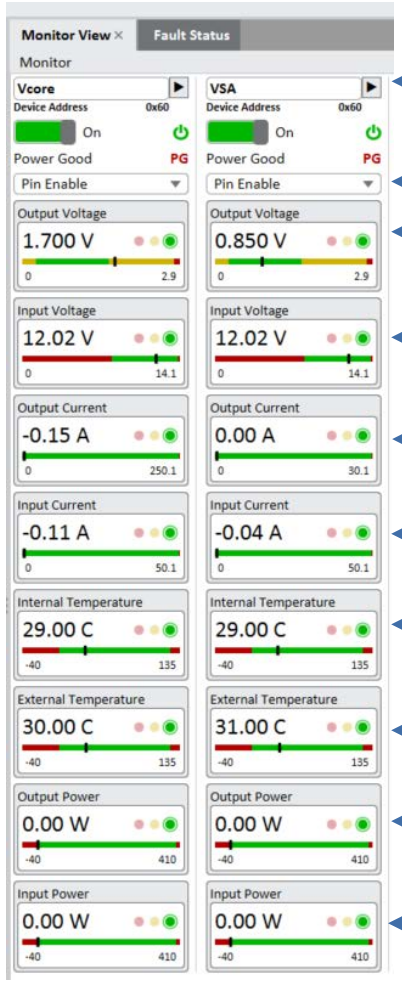
Connected devices show up in Device Scan.

Click on saved project in "Open Existing Project" window, then click "Start"

Digital Multiphase – Connected PowerMap



Digital Multiphase – Monitor View Screen



Rail Name(s)

Pin or PMBus Enable Selector

Vout Telemetry

Vin Telemetry

Iout Telemetry

Iin Telemetry

Internal Temp Telemetry

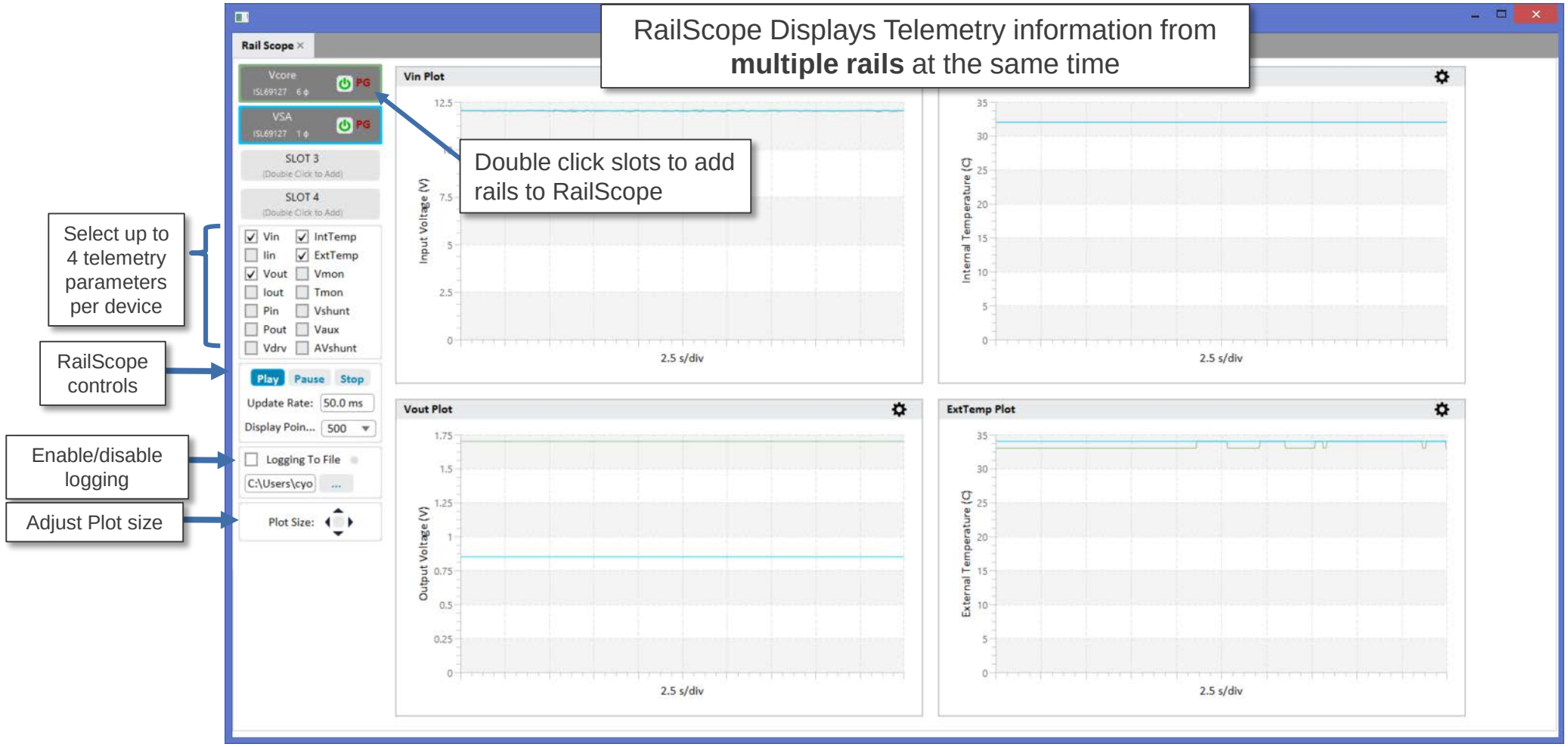
External Temp Telemetry

Pout Telemetry

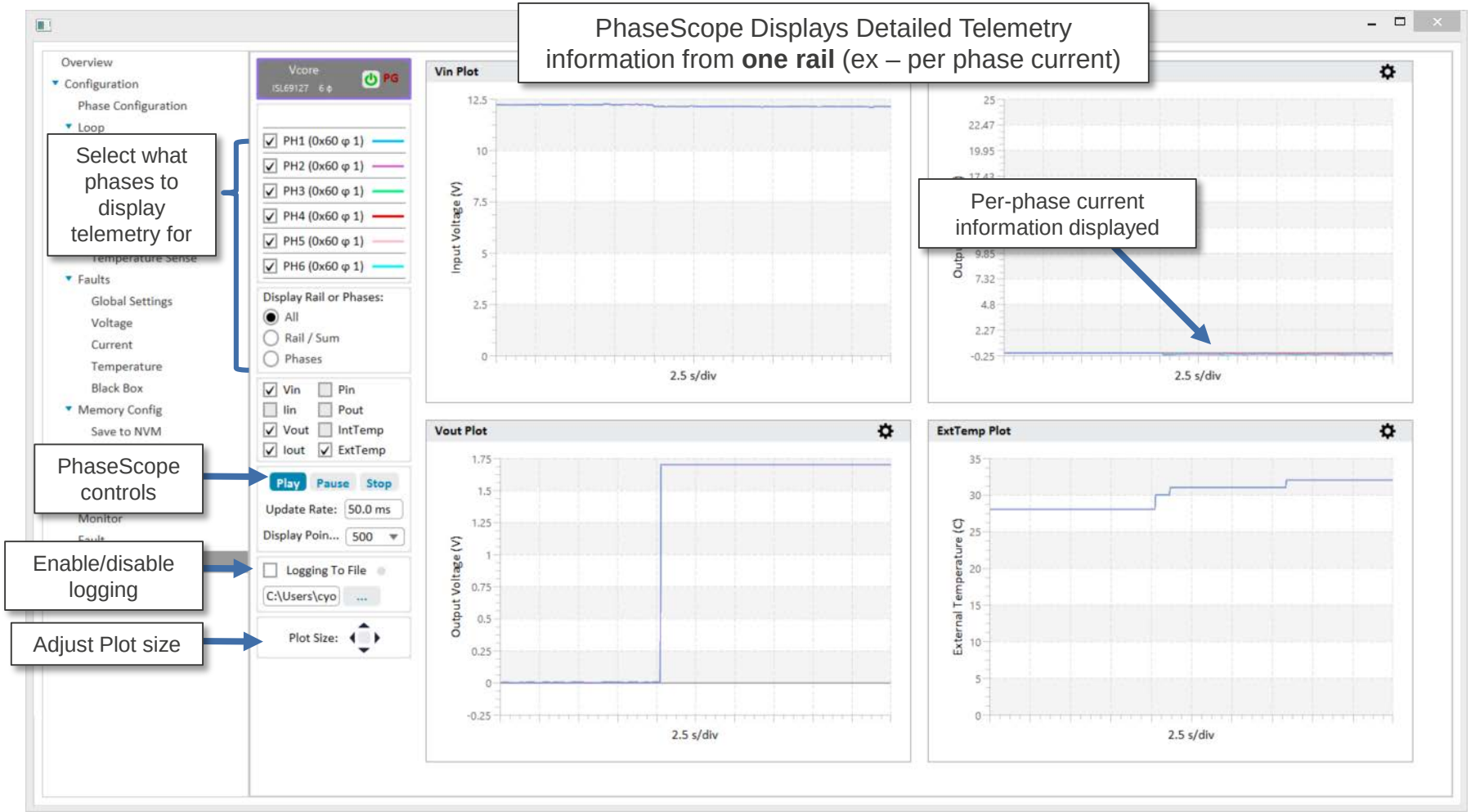
Pin Telemetry

Using the Monitor View screen, all device telemetry is automatically read back and displayed in real time.

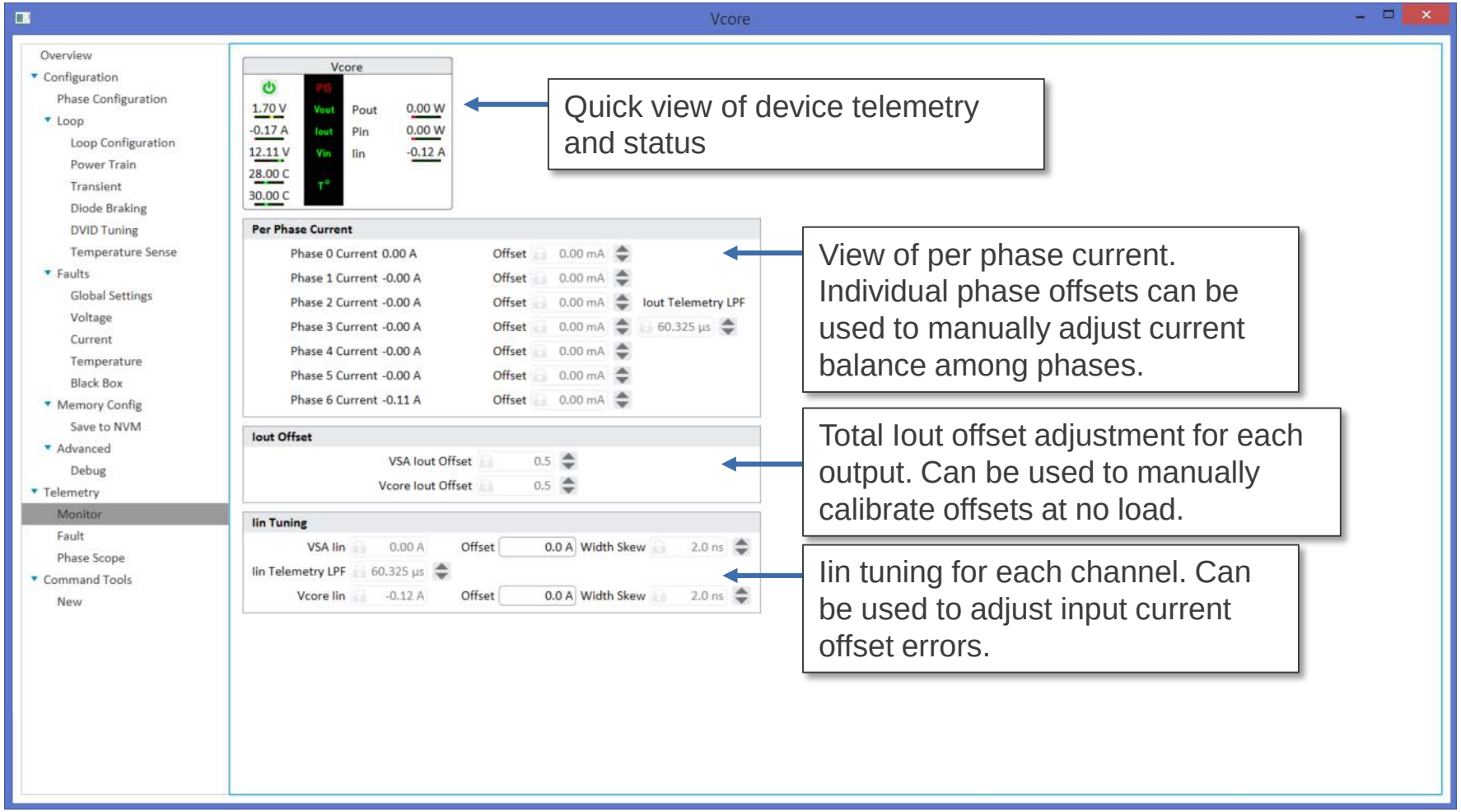
Digital Multiphase – Railscope



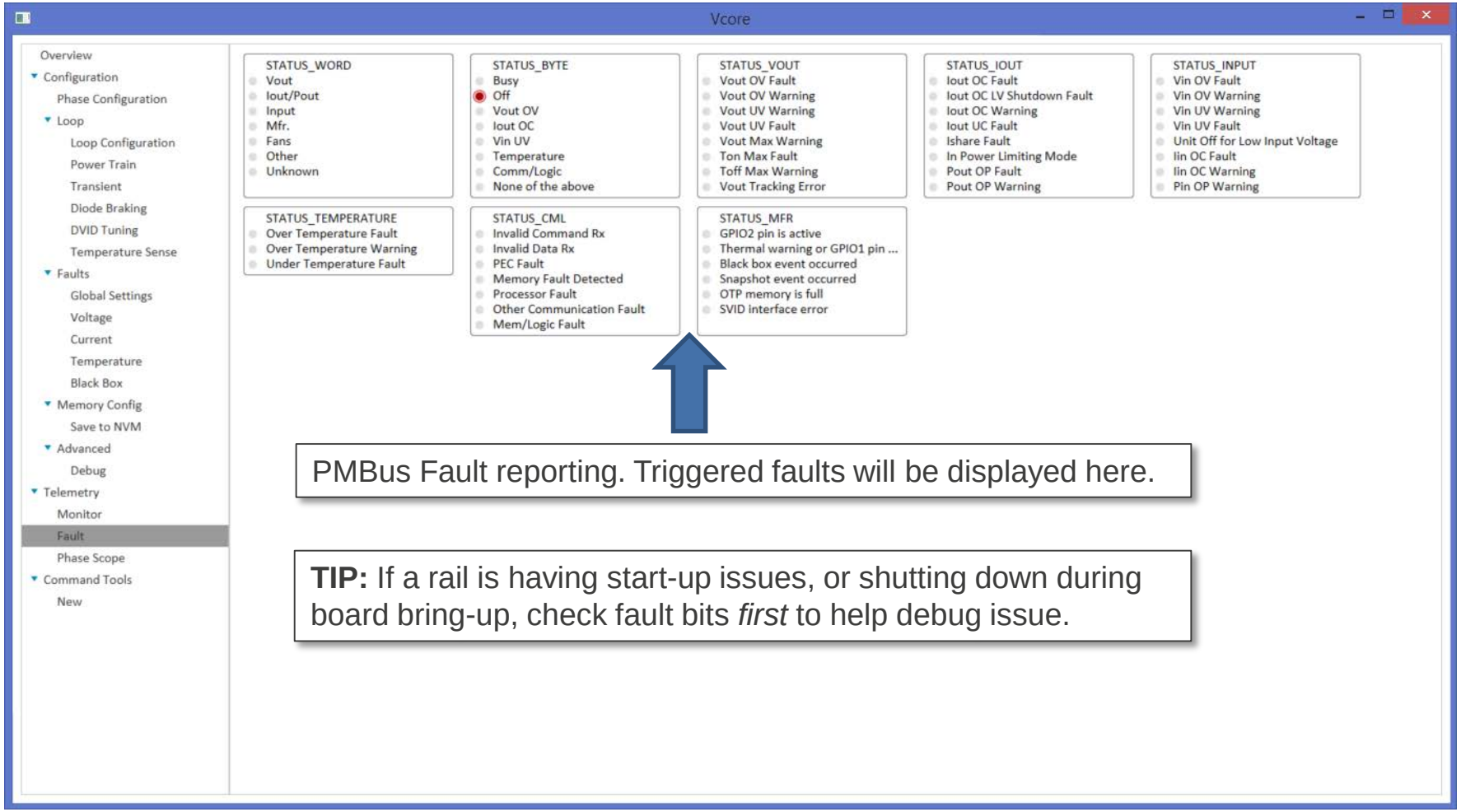
Digital Multiphase – PhaseScope



Digital Multiphase – Monitor/Current Balance



Digital Multiphase – Fault Reporting



PMBus Fault reporting. Triggered faults will be displayed here.

TIP: If a rail is having start-up issues, or shutting down during board bring-up, check fault bits *first* to help debug issue.

ADVANCED FEATURE SET: AVSBUS

AVSBus Overview

- AVSBus is an interface designed to facilitate and expedite point-to-point communication between an ASIC , FPGA, or other logic, memory, or processor devices and a POL control device on a system for the purpose of adaptive voltage scaling.

- This bus provides a focused set of functionality for the purpose of high speed rail control. All other configurations and settings must be done through the GUI or through PMBus.

- The AVSBus commands can always be read, but they cannot be written unless the device is configured to operate via AVSBUS in the PMBus command OPERATION.

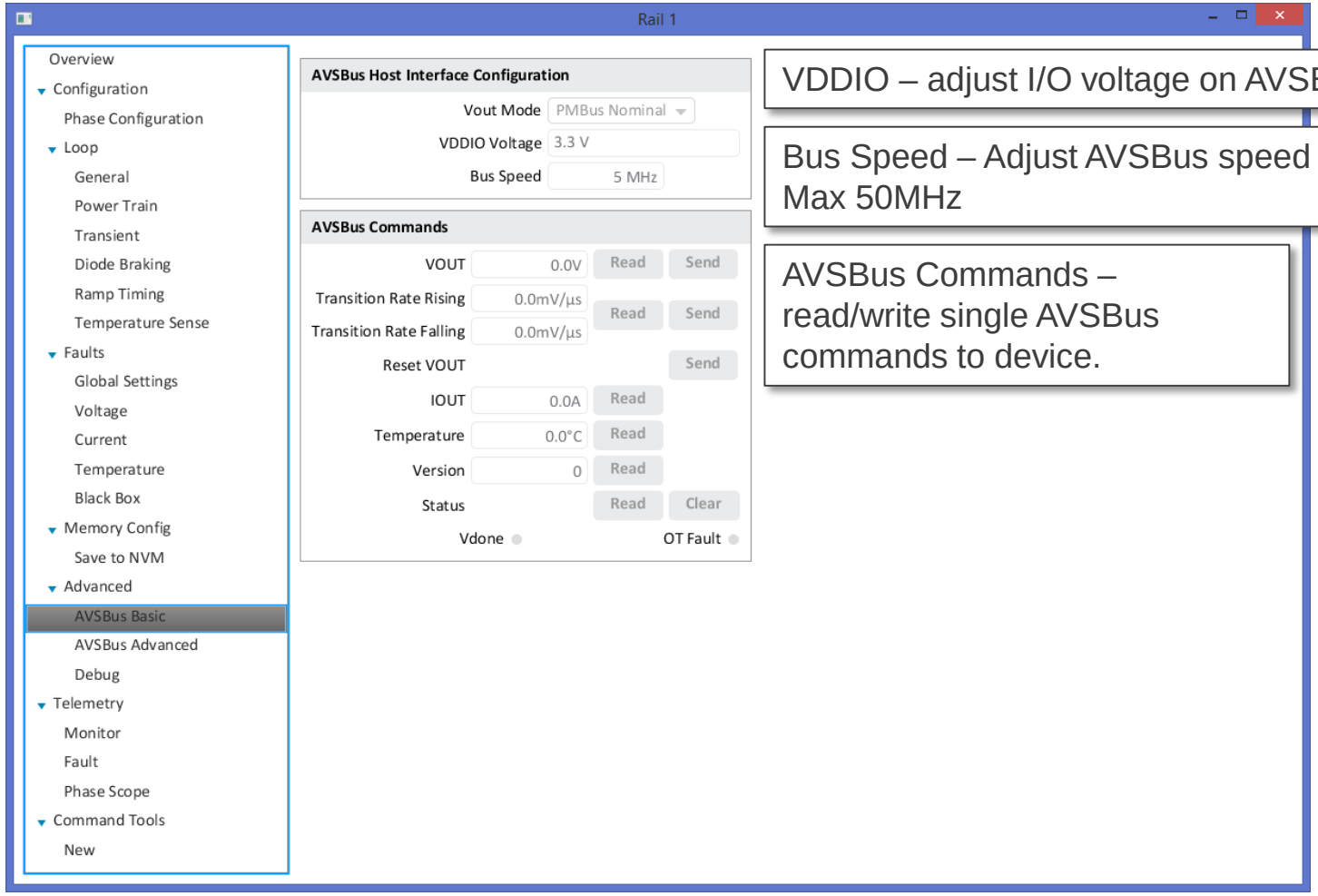
- 2 New Panels are visible using the PowerNavigator GUI to facilitate AVSBus testing
  - AVSBUS Basic
  - AVSBUS Advanced

- Require dedicated Renesas-developed AVSBus dongle to support device testing. Refer to the EVK users guide for details on dedicated hardware developed.

*Available only on ISL68137, ISL68134 devices

** Compliant to latest AVSBUS 1.3x04 Spec defined by System Management Interface Forum (PMBUS part III)

Digital Multiphase – AVSBus

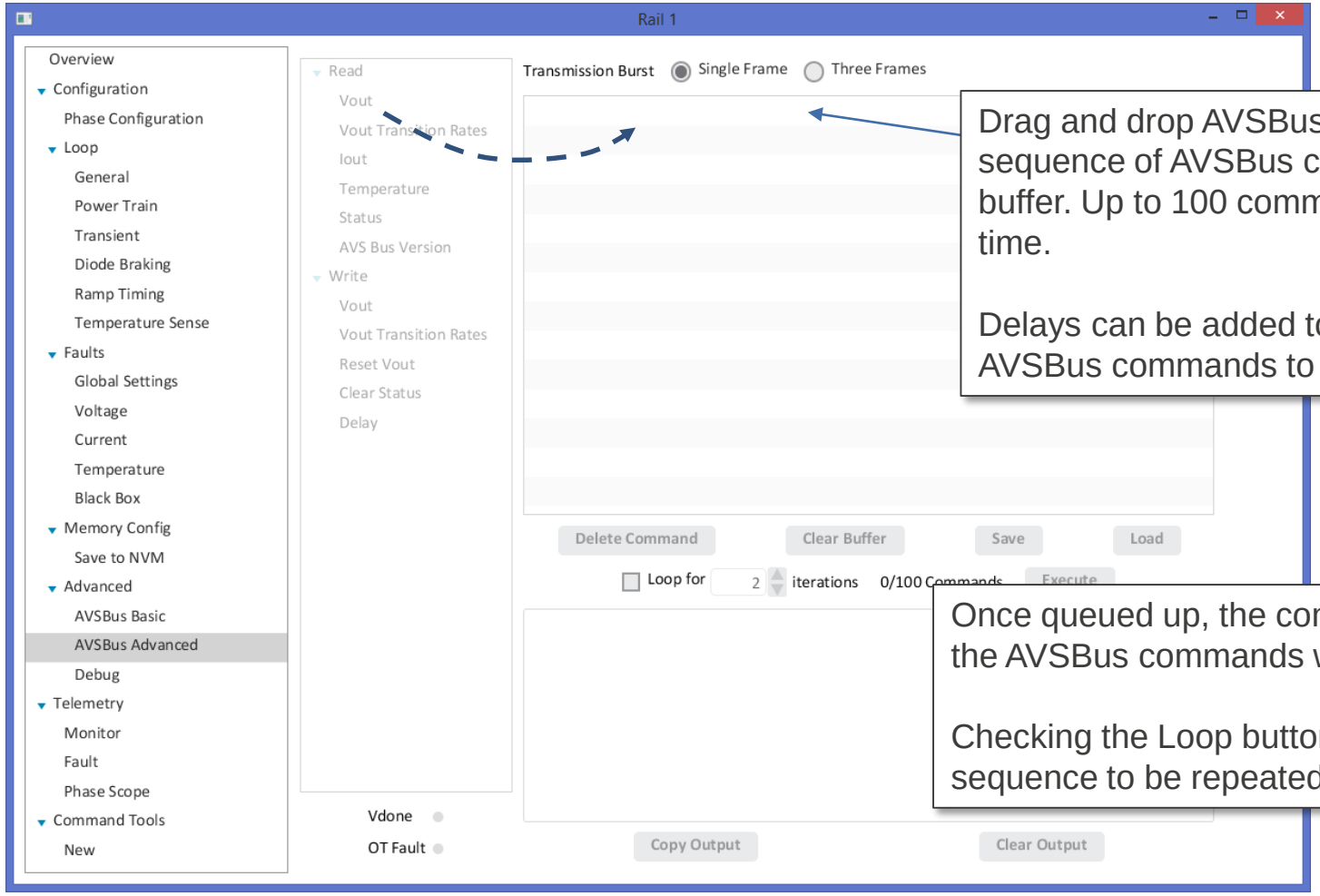


VDDIO – adjust I/O voltage on AVSBus adapter

Bus Speed – Adjust AVSBus speed on AVSBus adapter. Max 50MHz

AVSBus Commands – read/write single AVSBus commands to device.

Digital Multiphase – AVSBus



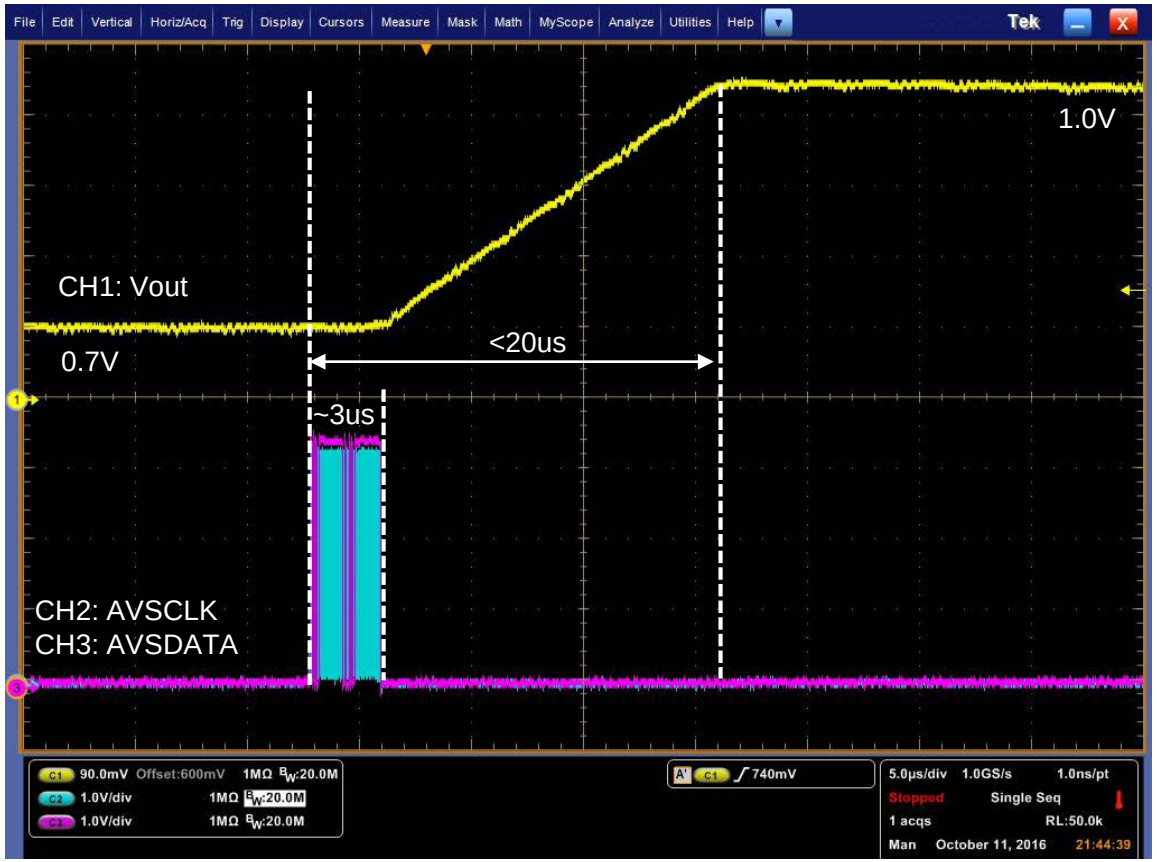
Drag and drop AVSBus commands to “queue” up a sequence of AVSBus commands to AVSBus dongle buffer. Up to 100 commands can be queued at a time.

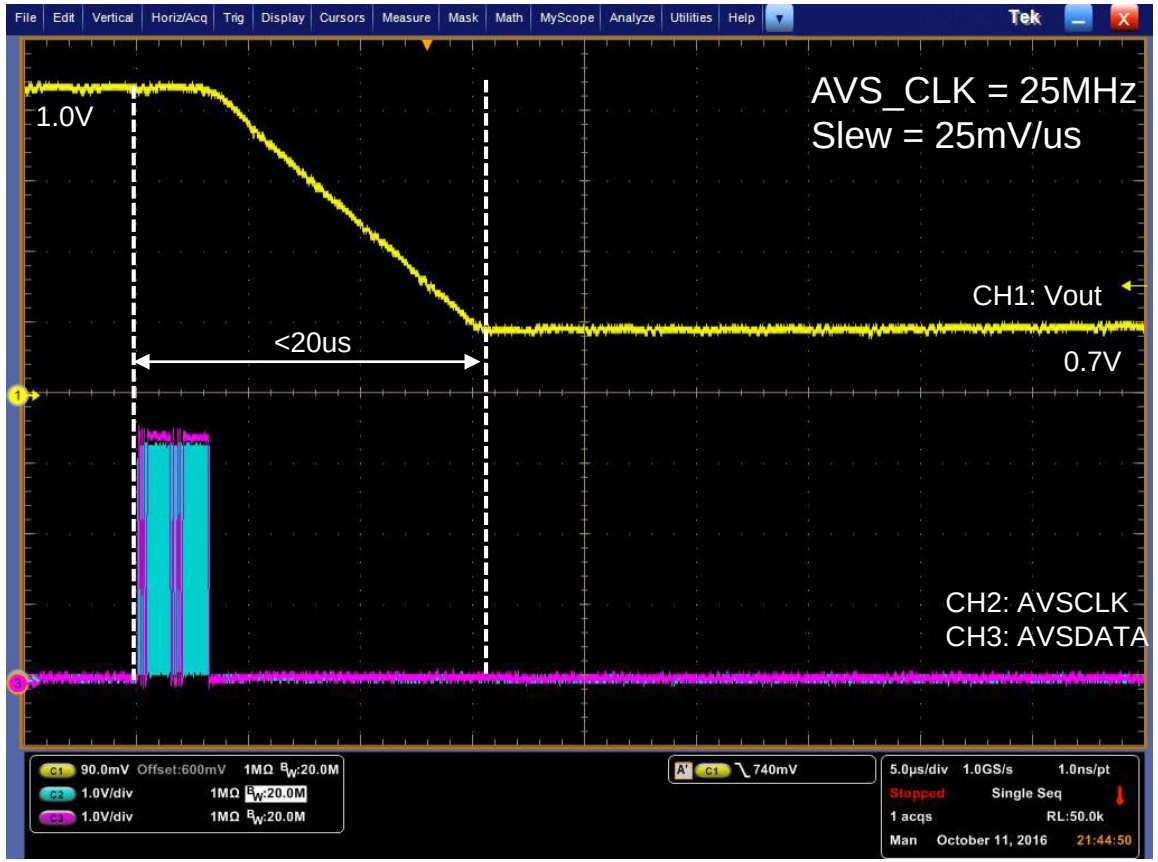
Delays can be added to the sequence, allowing the AVSBus commands to be precisely sequenced.

Once queued up, the command loop can be run and the AVSBus commands will be executed.

Checking the Loop button allows the command sequence to be repeated.

AVSBus – Example Vout Set Point Change





Using the AVSBus interface, 300mV change in Vout takes <20us, enabling rapid changes in CPU power states

SAVING SETTINGS TO NVM

Digital Multiphase NVM Stores

- Renesas Digital Multiphase controllers contain OTP (one time programmable) NVM memory for storing device configuration settings.

- Up to 8 different configurations (Configuration ID's) can be stored in the device, using 1 of 8 available NVM "slots"
  - Once a NVM slot is used, it cannot be erased or reprogrammed.
  - Multiple versions of the same Configuration ID can be stored in NVM – the controller will always use the most recent version.

- At start-up, an external pin-strap resistor tells the controller which of the stored *Configuration ID's* to use
  - The resistor does not point to a NVM slot, but rather to a *CONFIGURATION_ID*

Example Configuration Stores

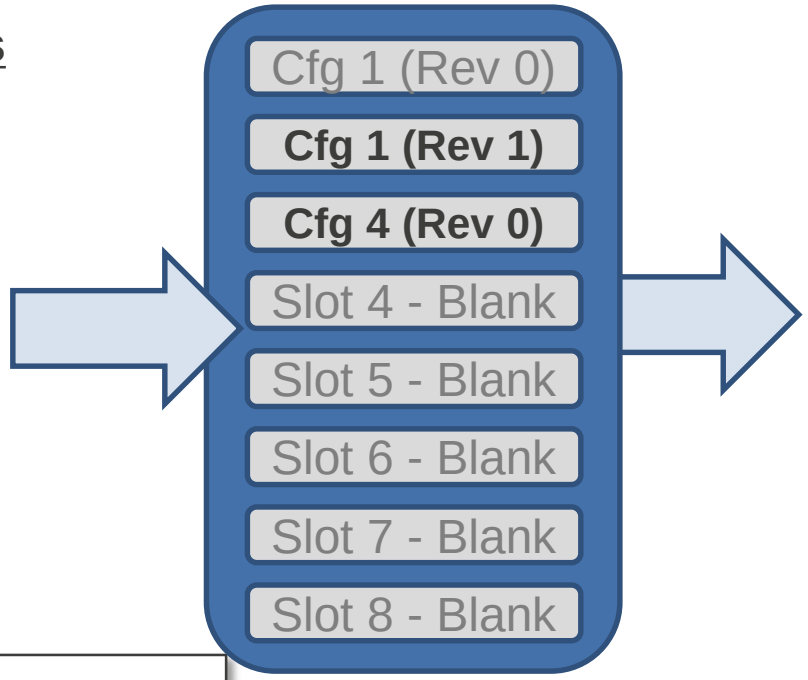
Example: Storing Configs

- A 4+0 design configuration is first stored as Config ID 1
- The 4+0 design is then updated due to design change (ex. Vboot change), resulting in a new Config ID 1 store.
- A 3+1 design configuration is stored as Config ID 4

In this example:

- **2** CONFIG IDs are stored in OTP
- **3** OTP slots are used, however. CFG1 (Rev 0) uses a slot, but is not accessible since it has been replaced by CFG1 (Rev 1)

Memory Allocation

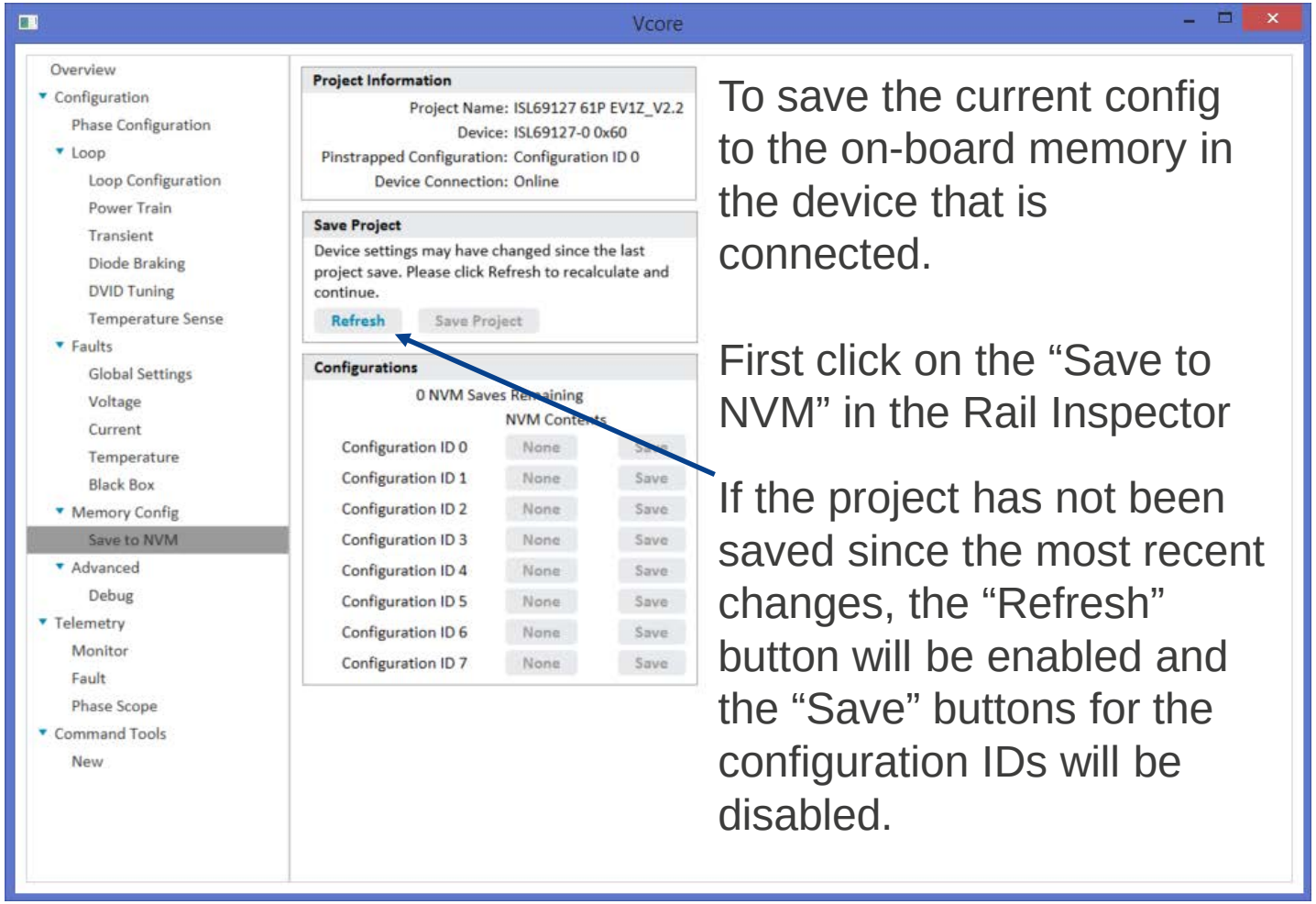


Upon Power Up

- A 1800 Ohm Rconfig will result in Cfg1 (Rev 1) to be used. Only the latest revision will ever be loaded
- A 3300 Ohm Rconfig will result in Cfg4 (Rev0) to be used

R CONFIG (Ω)	CONFIG ID
6800	0
1800	1
2200	2
2700	3
3300	4
3900	5
4700	6
5600	7

Saving Settings to NVM

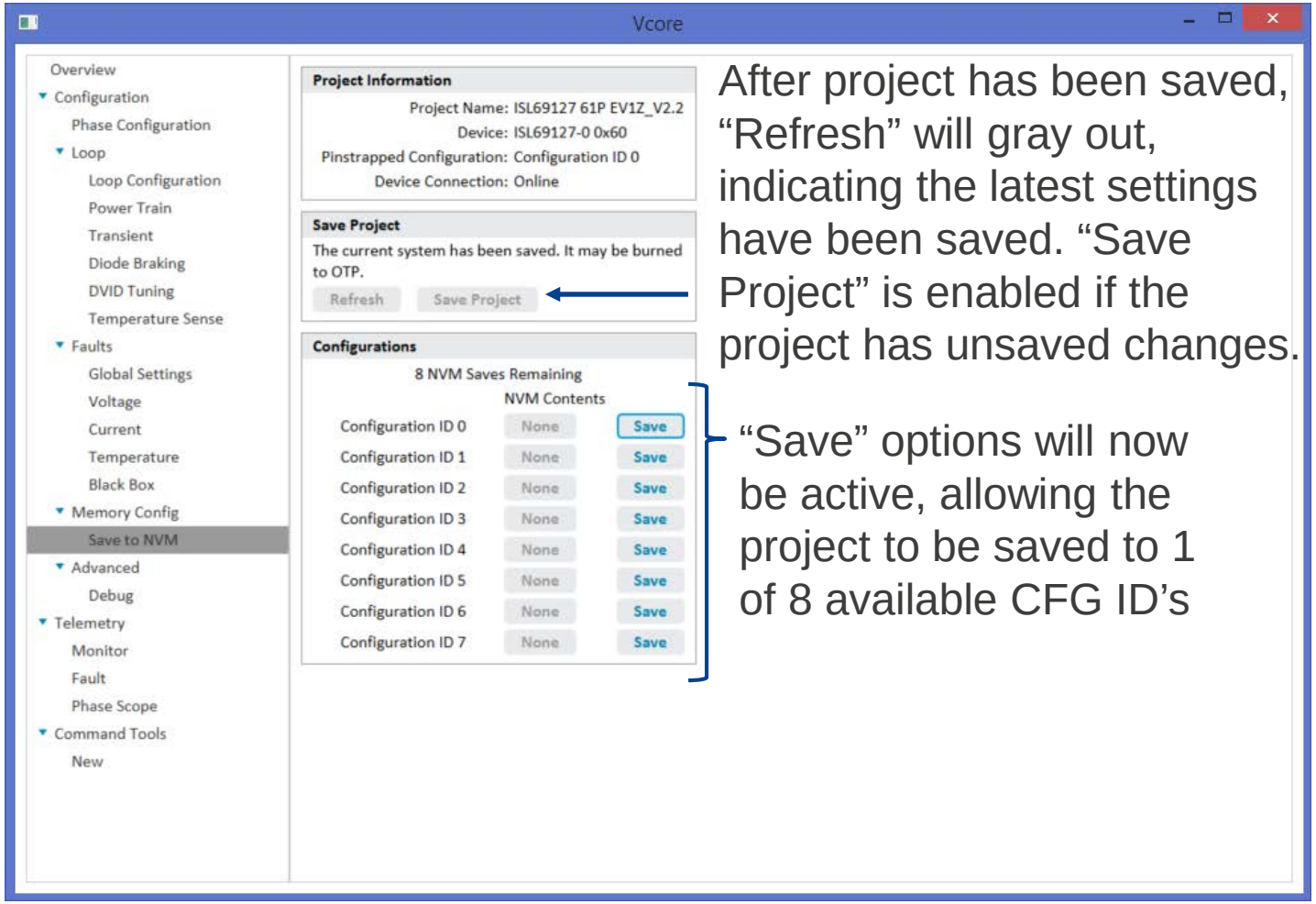


To save the current config to the on-board memory in the device that is connected.

First click on the “Save to NVM” in the Rail Inspector

If the project has not been saved since the most recent changes, the “Refresh” button will be enabled and the “Save” buttons for the configuration IDs will be disabled.

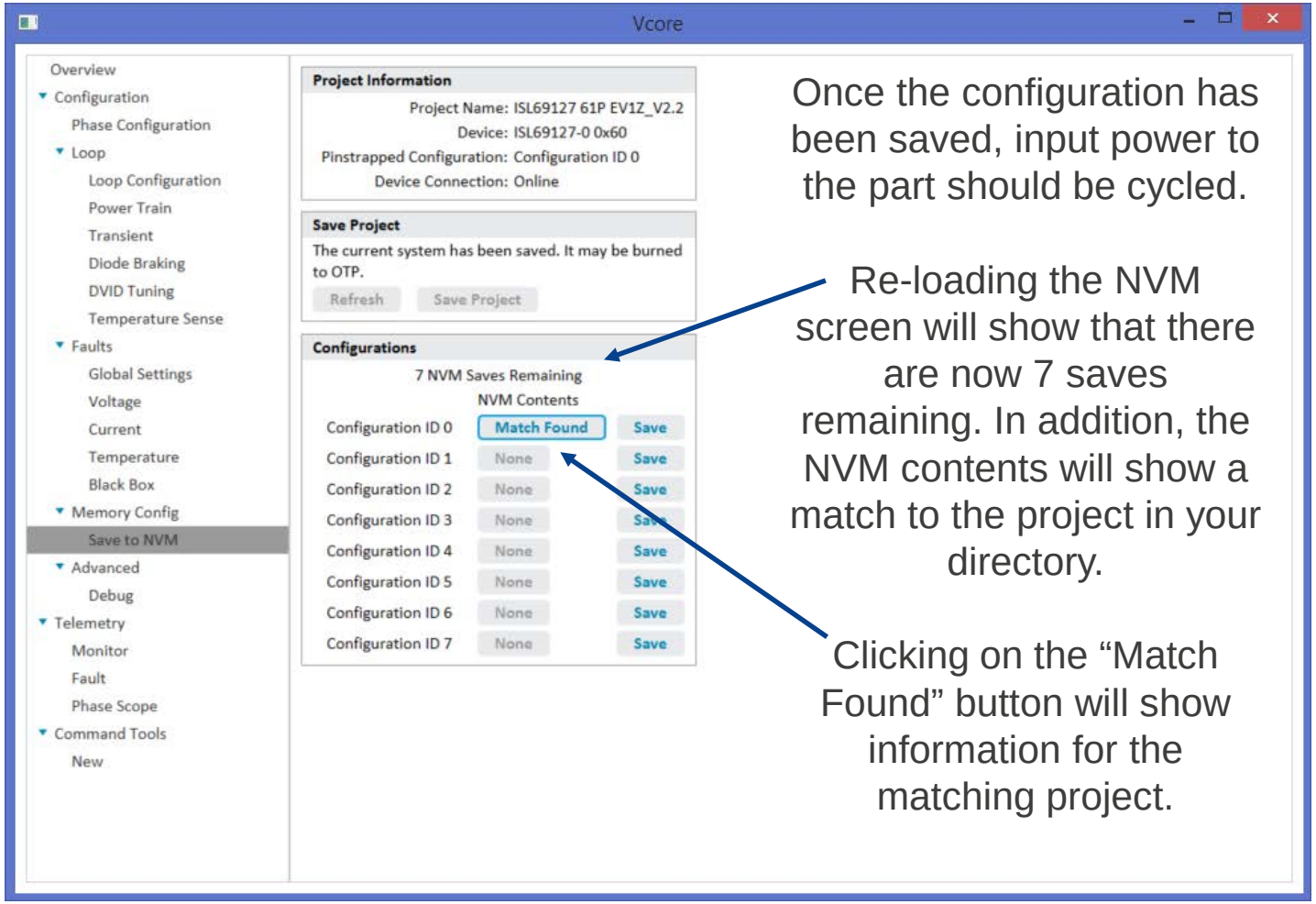
Saving Settings to NVM



After project has been saved, “Refresh” will gray out, indicating the latest settings have been saved. “Save Project” is enabled if the project has unsaved changes.

“Save” options will now be active, allowing the project to be saved to 1 of 8 available CFG ID’s

Saving Settings to NVM



Once the configuration has been saved, input power to the part should be cycled.

Re-loading the NVM screen will show that there are now 7 saves remaining. In addition, the NVM contents will show a match to the project in your directory.

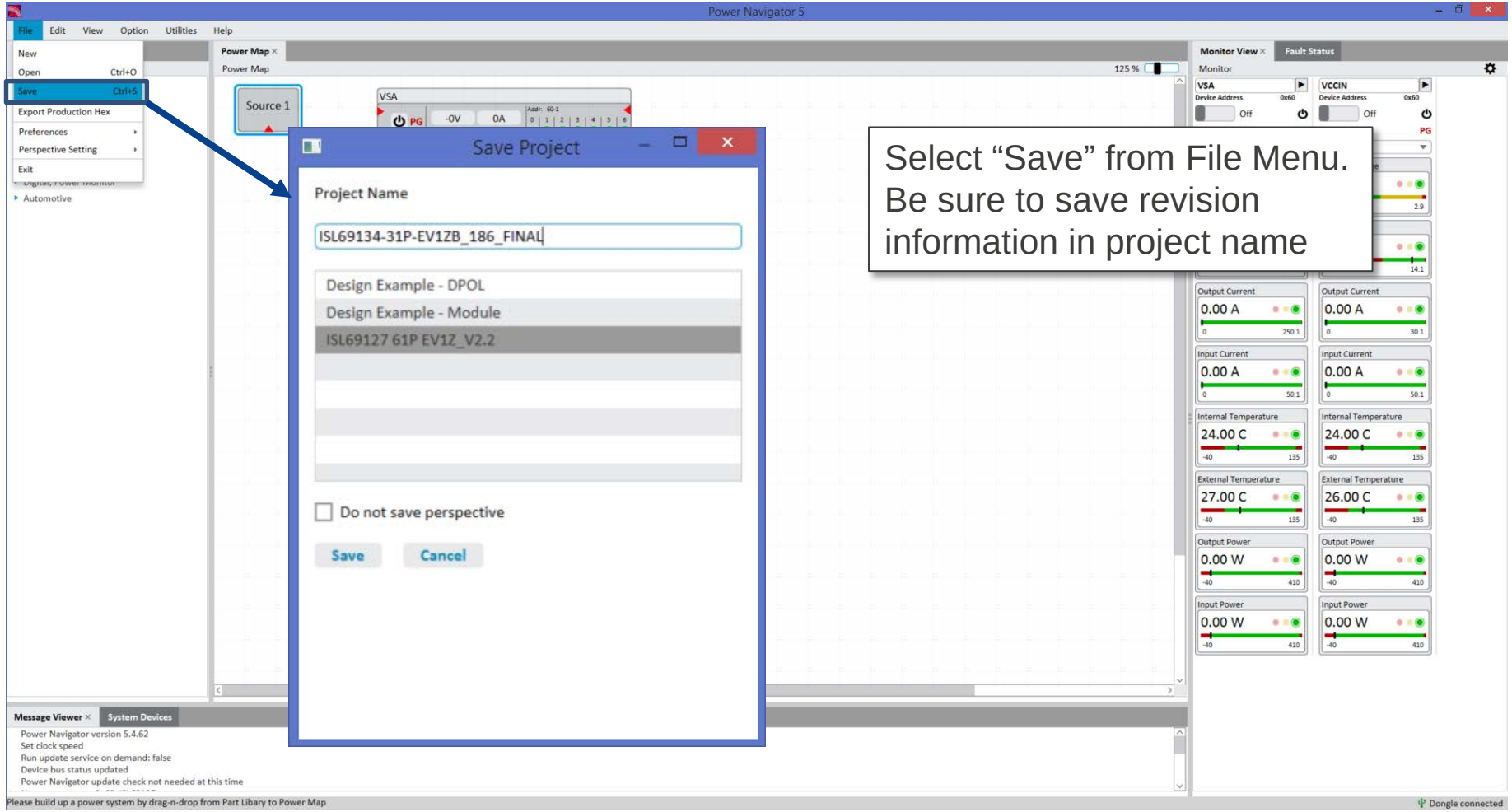
Clicking on the “Match Found” button will show information for the matching project.

HEX FILE EXPORT

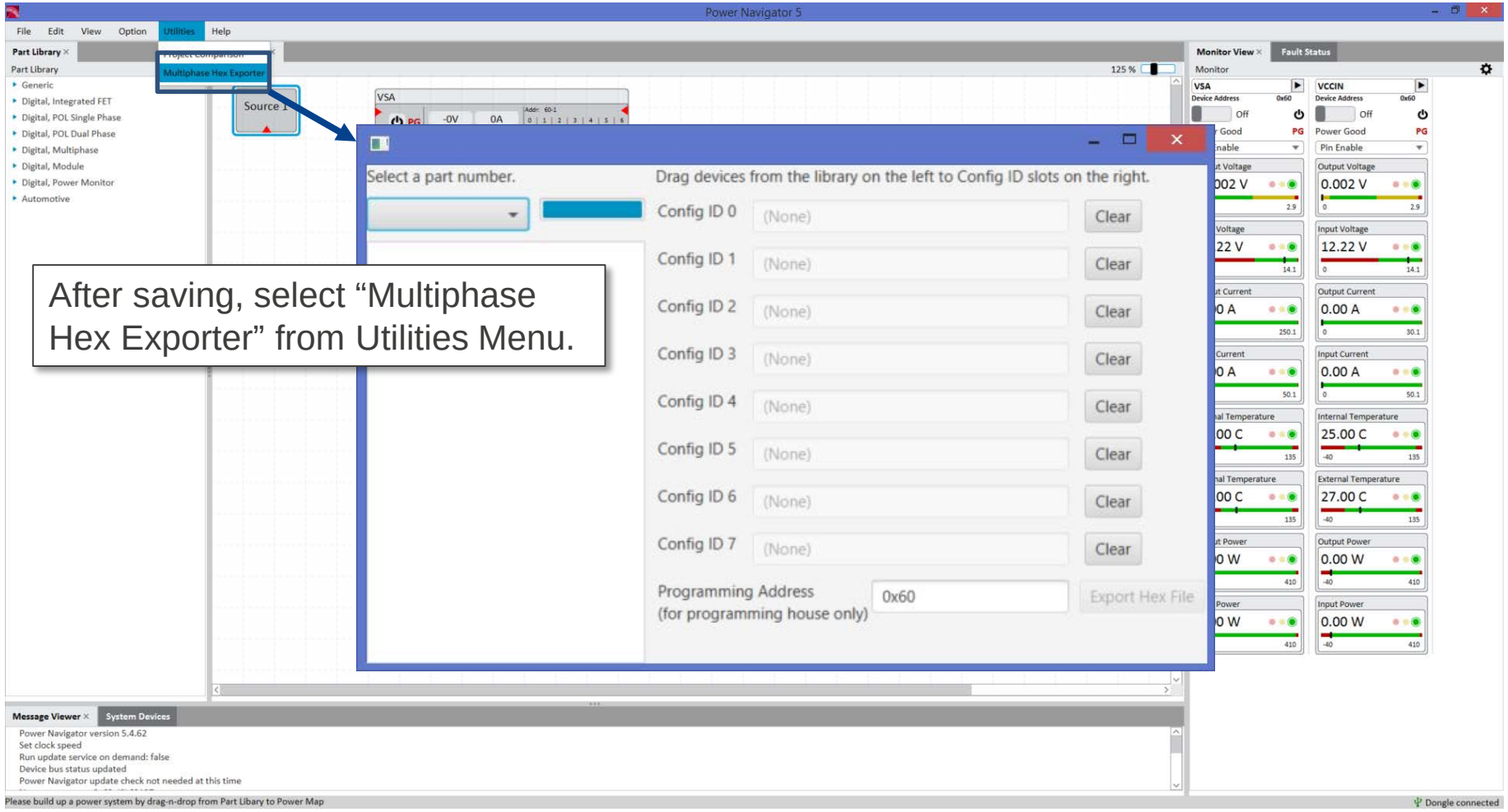
Digital Multiphase HEX File Export

- To support production programming, Digital Multiphase controllers support a HEX export utility.
  - Once a design has been finalized, the exported HEX file is used to program devices on high speed production programmers.
- The HEX export utility is available under the “Utilities” menu on the main PowerNavigator screen.
- Using this utility, multiple projects can be combined into a single HEX file
  - Each project is assigned one of 8 available CONFIG_IDs
  - An external resistor is then used to select the proper CONFIG_ID

Digital Multiphase – Saving A Project

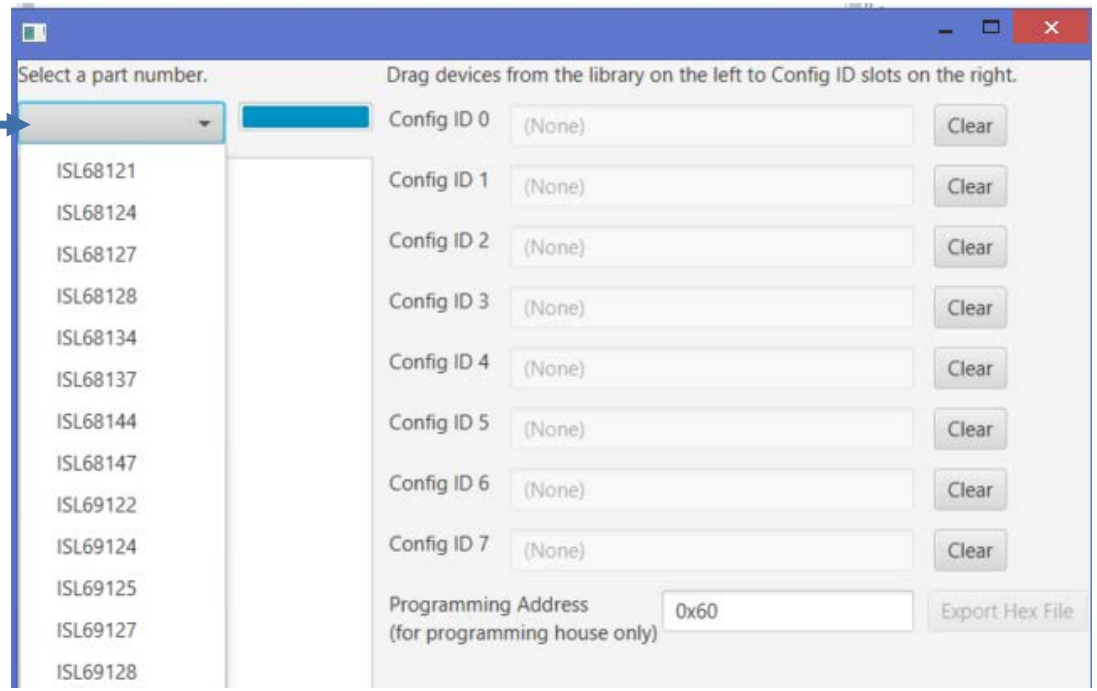


Digital Multiphase – Exporting HEX File



Digital Multiphase – Exporting HEX File

In Multiphase Hex Exporter, select controller part number from drop down box

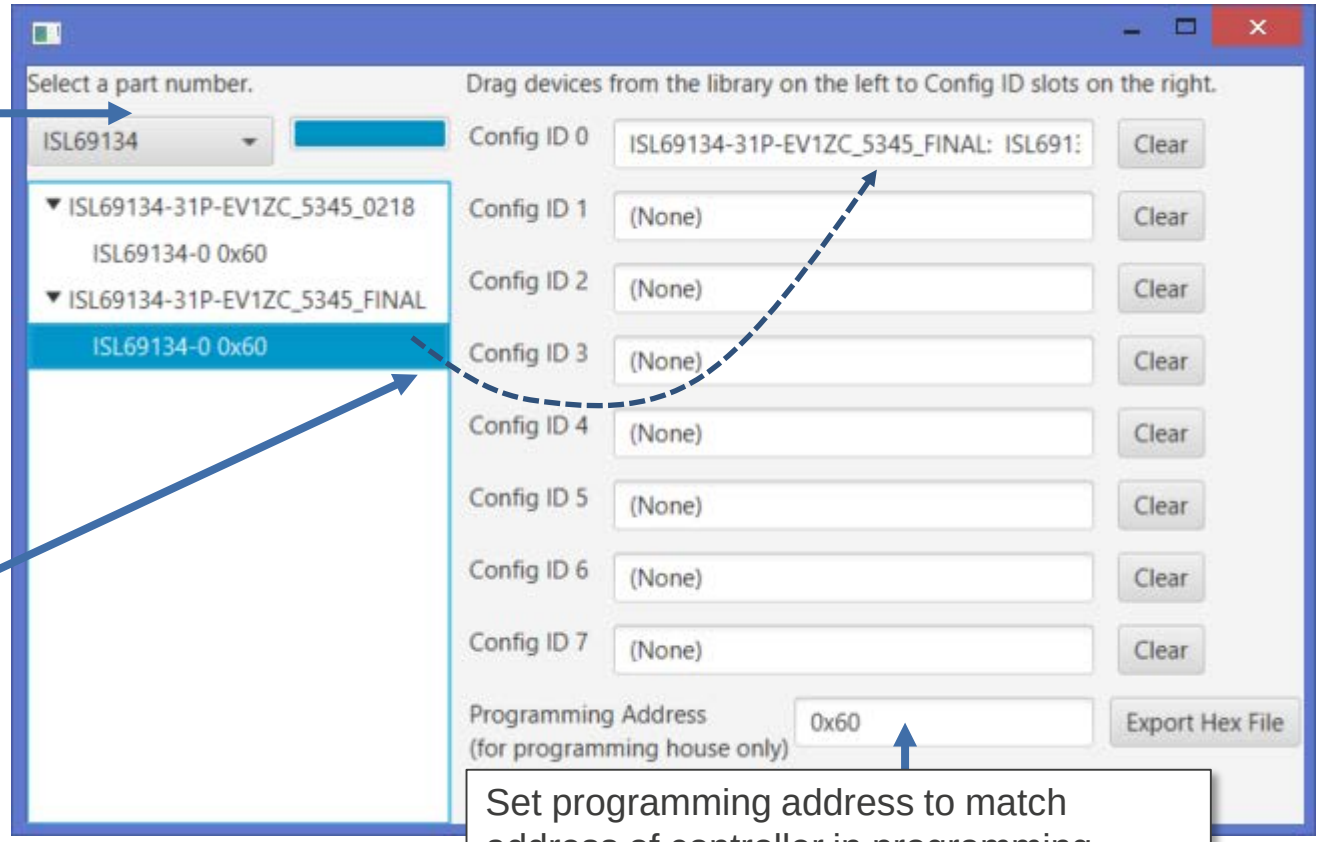


Digital Multiphase – Exporting HEX File

After part number is selected, the Hex Exporter tool will scan the PowerNavigator Projects folder for all project IDs with that part number.

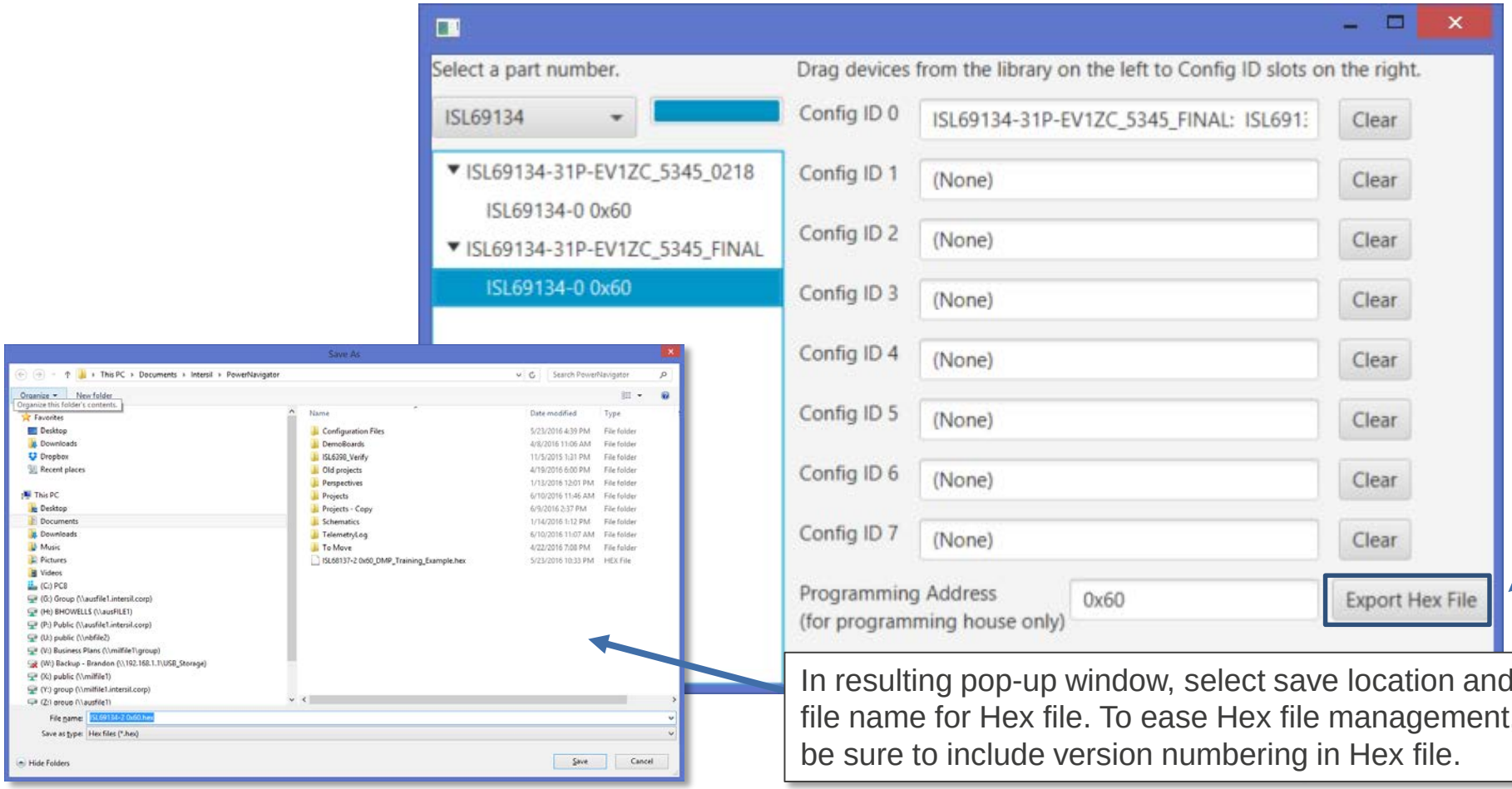
After scanning is complete, all projects using that part number will be displayed

Select project, then Click and drag project into desired Config ID.



Set programming address to match address of controller in programming environment.

Digital Multiphase – Exporting HEX File



After all projects have been loaded, click “Export Hex File”

In resulting pop-up window, select save location and file name for Hex file. To ease Hex file management, be sure to include version numbering in Hex file.

Digital Multiphase – Configuration Vs. HEX File

Configuration File

ISL69134-0 0x60.txt

```
# ISL69134-0 0x60
# connected: true
# IC_DEVICE_ID                    0x002DD249
# IC_DEVICE_REV                   0x00040000
# 5.3.24
# 2016/06/10 11:54:48

PAGE                              0x00              # 0x0
SFVRATETODAC                      0x00004444        # 0xE451
SFTELTEMPRANGE                    0x0000020D        # 0xE452
SFTELVINRANGEMV                   0x000051D1        # 0xE453
SFTELVOUTRANGEMV                  0x0000104C        # 0xE454
SFPINRANGEBY8                     0x00001062        # 0xE455
SFLPVOUTRANGEMV                   0x00001000        # 0xE456
SFLPIINRANGEBY64                  0x00000400        # 0xE457
SCALEDROOP                        0x031B031B        # 0xE458
TEMPCO0                           0x00000000        # 0xE459
TEMPCO1                           0x00000000        # 0xE45A
SCALEIOUT                         0x136D136D        # 0xE45B
SCALEPOWER                        0x09F209F2        # 0xE45C
TCTELCFG1                         0x41841C11        # 0xE45D
TCTELCFG2                         0x00000000        # 0xE45E
TCTELCFG3                         0x00000001        # 0xE45F
RAMUSR_TMONCALOFFSET              0x00000000        # 0x1090
RAMUSR_FILTERWAIT                 0x00000010        # 0x1091
RAMUSR_CH0UTLIMITS                0xFFCEFFCE        # 0x1092
RAMUSR_CH1UTLIMITS                0xFFCEFFCE        # 0x1093
RAMUSR_OTLIMITS                   0x107D7D7D        # 0x1094
RAMUSR_TEMPCONFIG                 0x25E2828C        # 0x1095
RAMUSR_PH01DCRFILTRES             0x000001EC        # 0x1096
RAMUSR_PH23DCRFILTRES             0x00000000        # 0x1097
RAMUSR_PH45DCRFILTRES             0x01EC01EC        # 0x1098
RAMUSR_PH6DCRFILTRES              0x800001EC        # 0x1099
RAMUSR_PH01ISENGAIN               0x80008000        # 0x109A
RAMUSR_PH23ISENGAIN               0x80008000        # 0x109B
RAMUSR_PH45ISENGAIN               0x80008000        # 0x109C
RAMUSR_PH6ISENGAIN                0x80008000        # 0x109D
RAMUSR_PH01ISENOFFSET             0x003A0000        # 0x109E
RAMUSR_PH23ISENOFFSET             0x00000000        # 0x109F
```

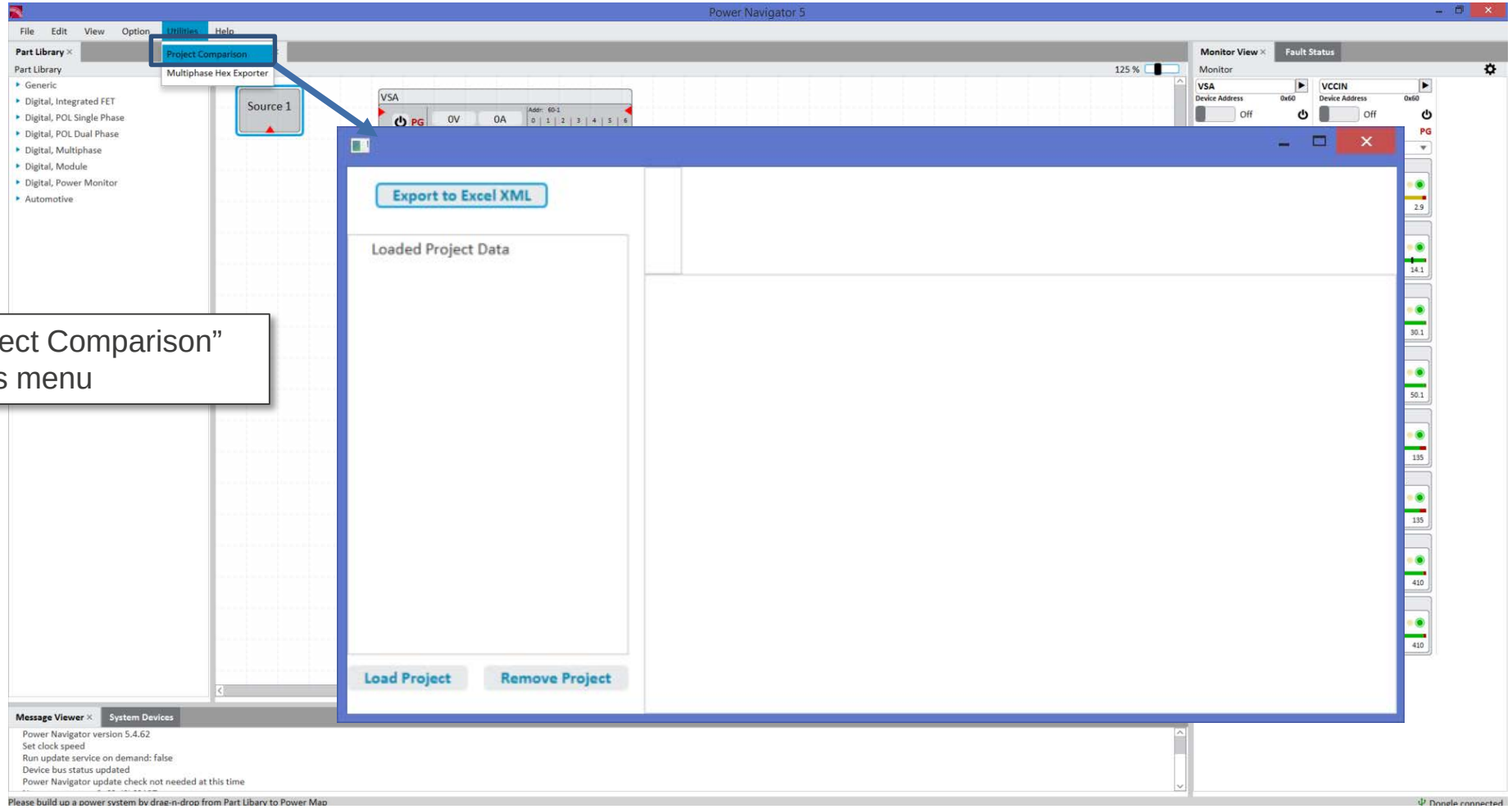
Hex File

ISL69134-10 0x60.hex RevE.hex

```
4907C0AD49D22D001E
4907C0AE000005007A
4907C000050400007F
4909C001352E332E323401
490BC002000001553B4928BDA5
0005C0E601000C
0005C0F70001D7
0007C0F6B3040000D1
0007C0F600000000D8
0007C0F600000000D8
0007C0F600000000D8
0007C0F600000000D8
0007C0F600000000D8
0007C0F600000000D8
0007C0F600000000D8
0007C0F600000000D8
0007C0F600000000D8
0007C0F600000000D8
0007C0F600000000D8
0007C0F600000000D8
0007C0F600000000D8
0007C0F600000000D8
0007C0F600000000D8
0007C0F601000000CE
0007C0F600000000D8
0007C0F6B3040000D1
0007C0F603B4014849
0007C0F6019001BD48
0007C0F60D27002093
0007C0F603B4014849
0007C0F6019001BD48
0007C0F62503002005
0007C0F670B5054654
0007C0F6002004461A
0007C0F62968FFF738
0007C0F6EDFFA10064
0007C0F64919496884
```

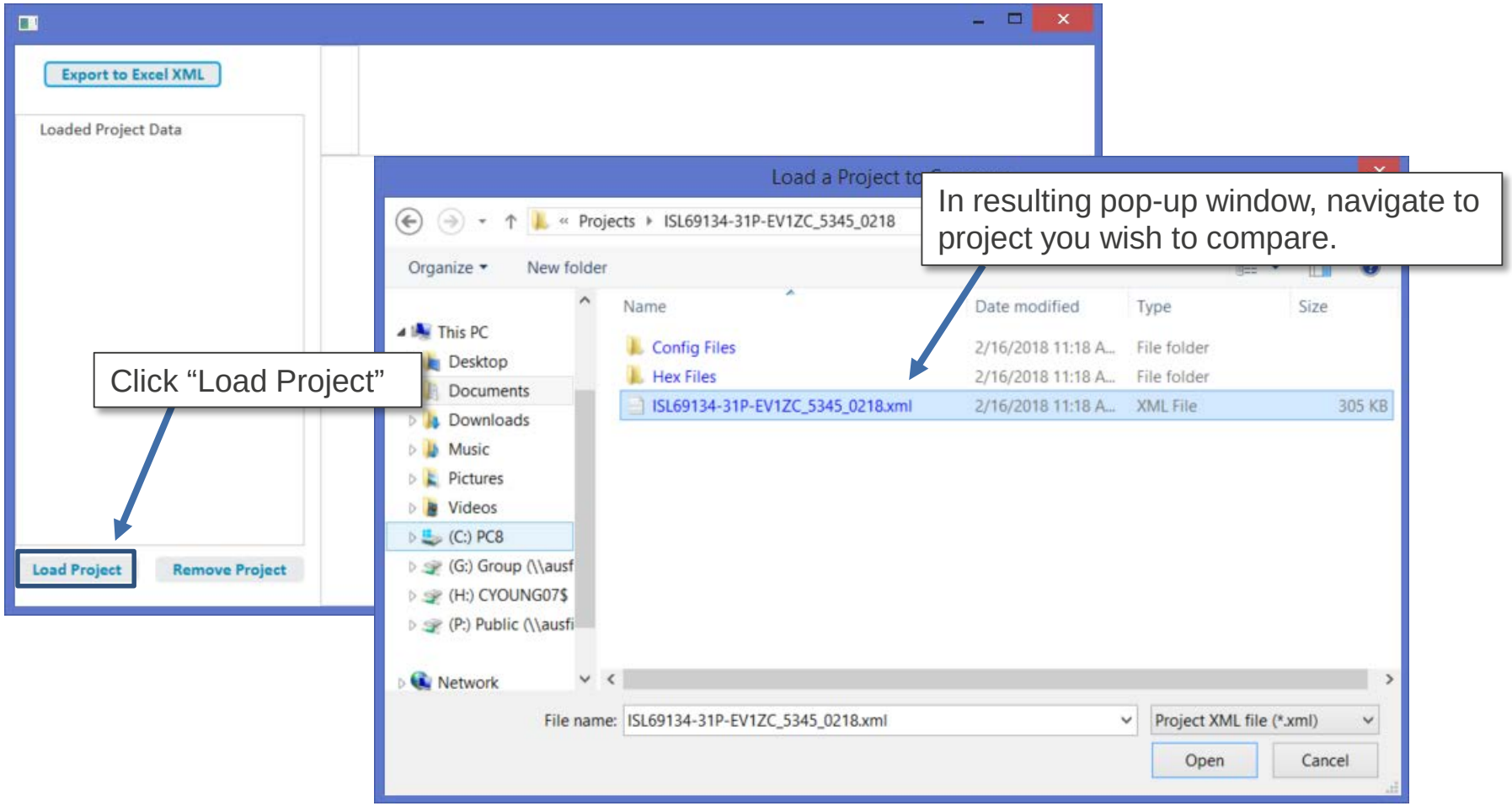
PROJECT COMPARE

Digital Multiphase – Project Compare



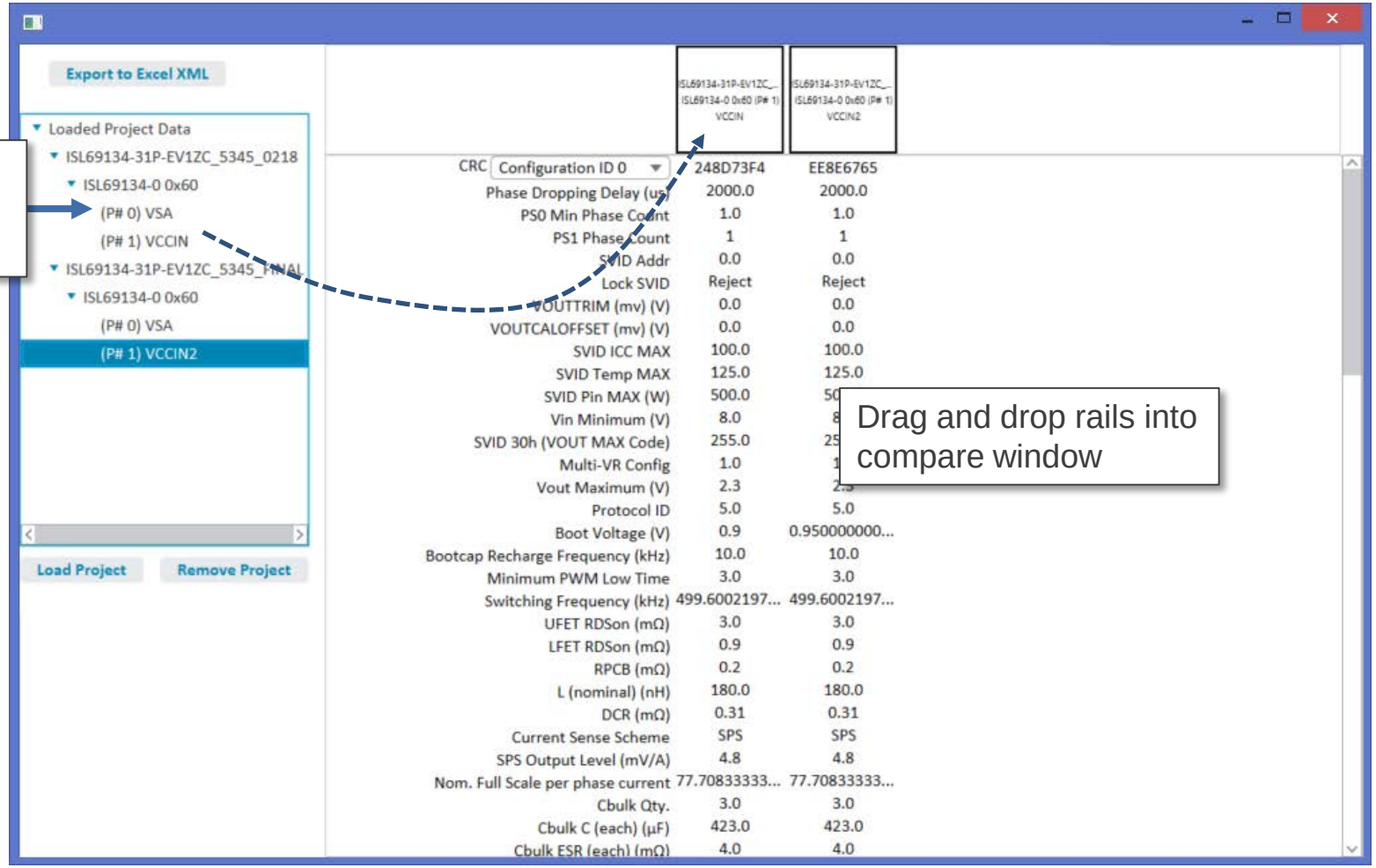
Select “Project Comparison” from Utilities menu

Digital Multiphase – Connecting to Hardware

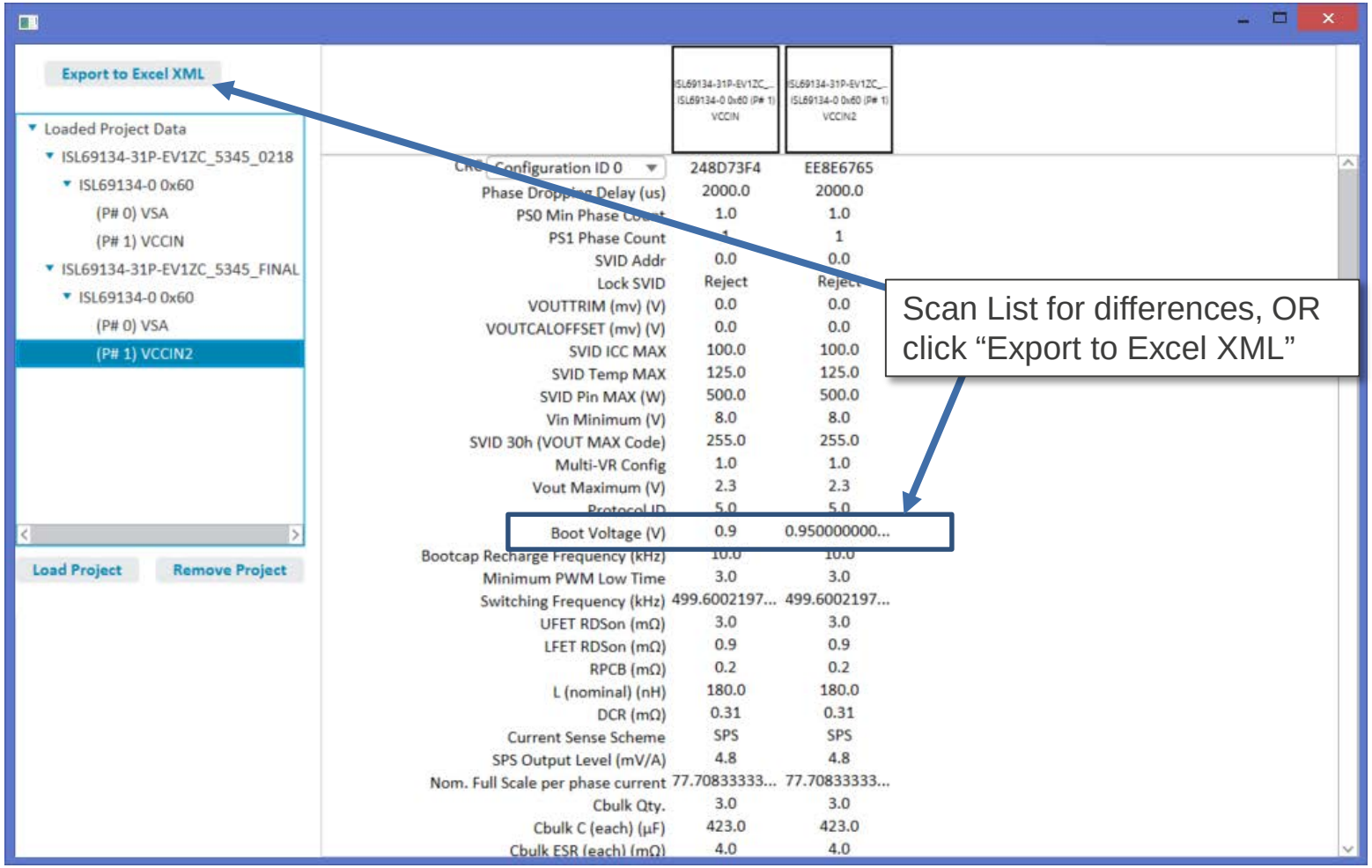


Digital Multiphase – Connecting to Hardware

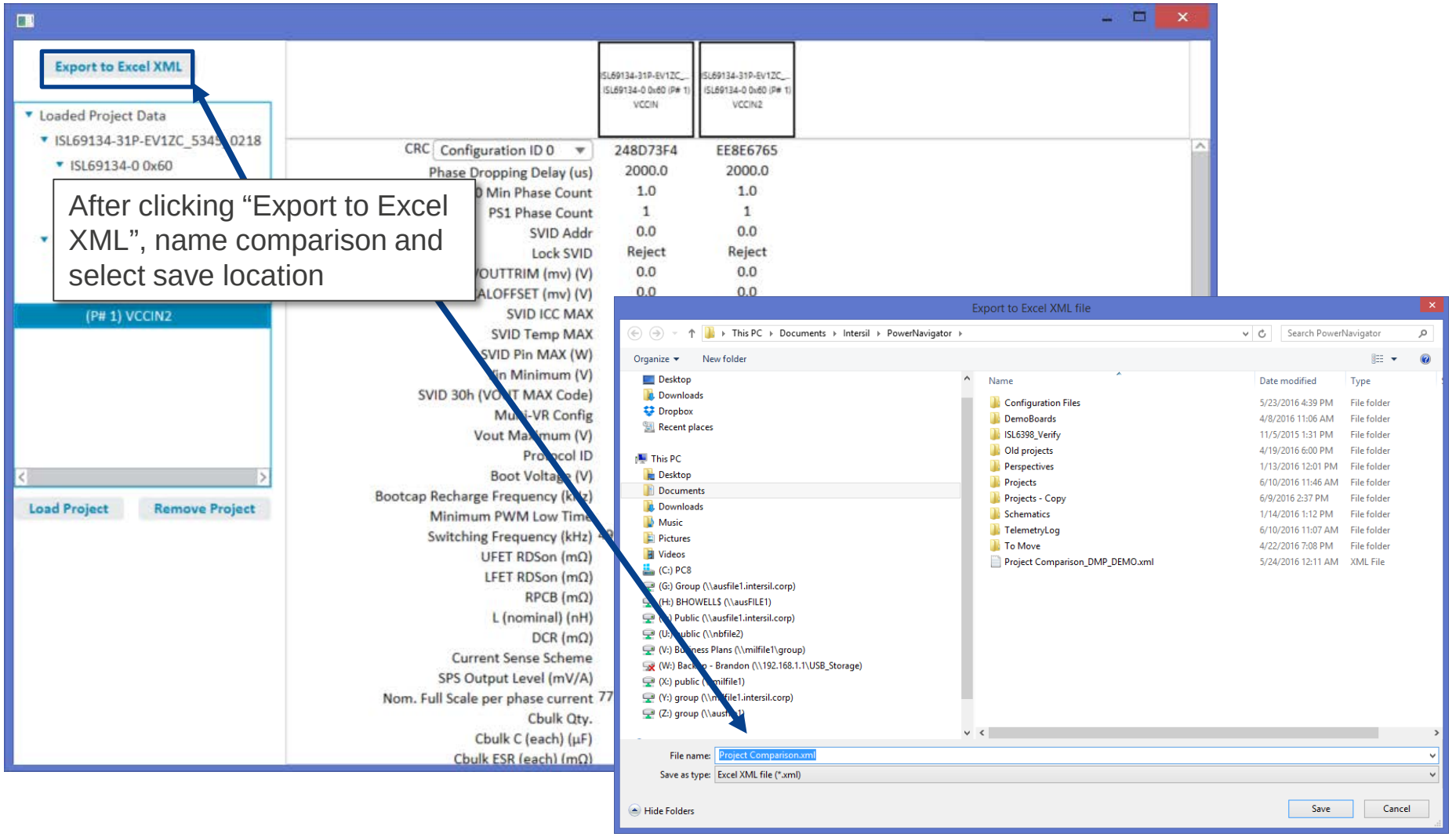
After projects have been loaded, expand to show individual rails



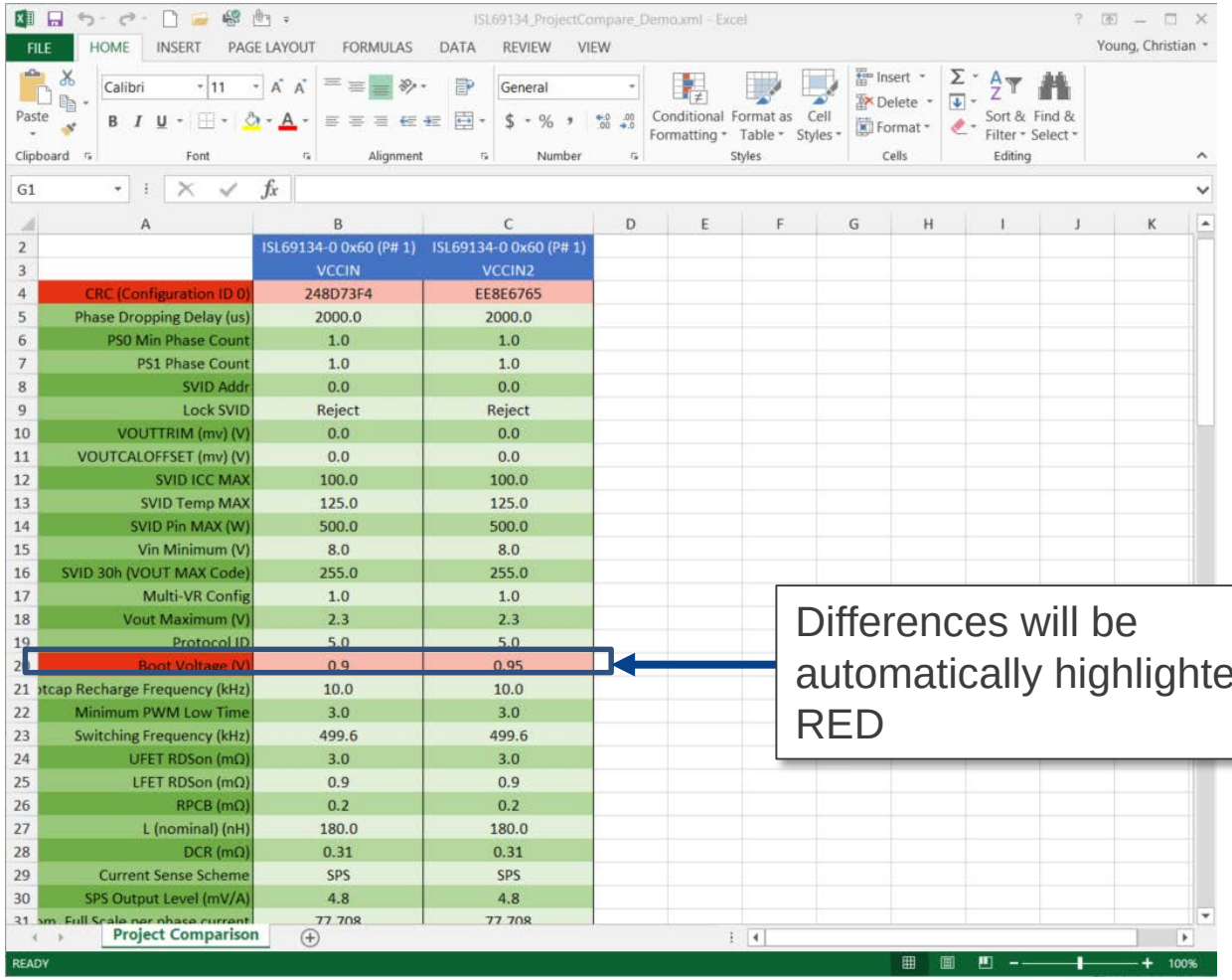
Digital Multiphase – Connecting to Hardware



Digital Multiphase – Connecting to Hardware



Digital Multiphase – Connecting to Hardware



	A	B	C
2		ISL69134-0 0x60 (P# 1)	ISL69134-0 0x60 (P# 1)
3		VCCIN	VCCIN2
4	CRC (Configuration ID 0)	248D73F4	EE8E6765
5	Phase Dropping Delay (us)	2000.0	2000.0
6	PS0 Min Phase Count	1.0	1.0
7	PS1 Phase Count	1.0	1.0
8	SVID Addr	0.0	0.0
9	Lock SVID	Reject	Reject
10	VOUTTRIM (mv) (V)	0.0	0.0
11	VOUTCALOFFSET (mv) (V)	0.0	0.0
12	SVID ICC MAX	100.0	100.0
13	SVID Temp MAX	125.0	125.0
14	SVID Pin MAX (W)	500.0	500.0
15	Vin Minimum (V)	8.0	8.0
16	SVID 30h (VOUT MAX Code)	255.0	255.0
17	Multi-VR Config	1.0	1.0
18	Vout Maximum (V)	2.3	2.3
19	Protocol ID	5.0	5.0
20	Boot Voltage (V)	0.9	0.95
21	btcap Recharge Frequency (kHz)	10.0	10.0
22	Minimum PWM Low Time	3.0	3.0
23	Switching Frequency (kHz)	499.6	499.6
24	UFET RDSon (mΩ)	3.0	3.0
25	LFET RDSon (mΩ)	0.9	0.9
26	RPCB (mΩ)	0.2	0.2
27	L (nominal) (nH)	180.0	180.0
28	DCR (mΩ)	0.31	0.31
29	Current Sense Scheme	SPS	SPS
30	SPS Output Level (mV/A)	4.8	4.8
31	m. Full Scale per phase current	77.708	77.708

Differences will be automatically highlighted in RED

BIG IDEAS FOR EVERY SPACE

Renesas.com