PGA900EVM User's Guide

The PGA900EVM provides a platform to test the PGA900 in the QFN package.

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1 Introduction

Figure 1 shows the PGA900EVM and its main sections.

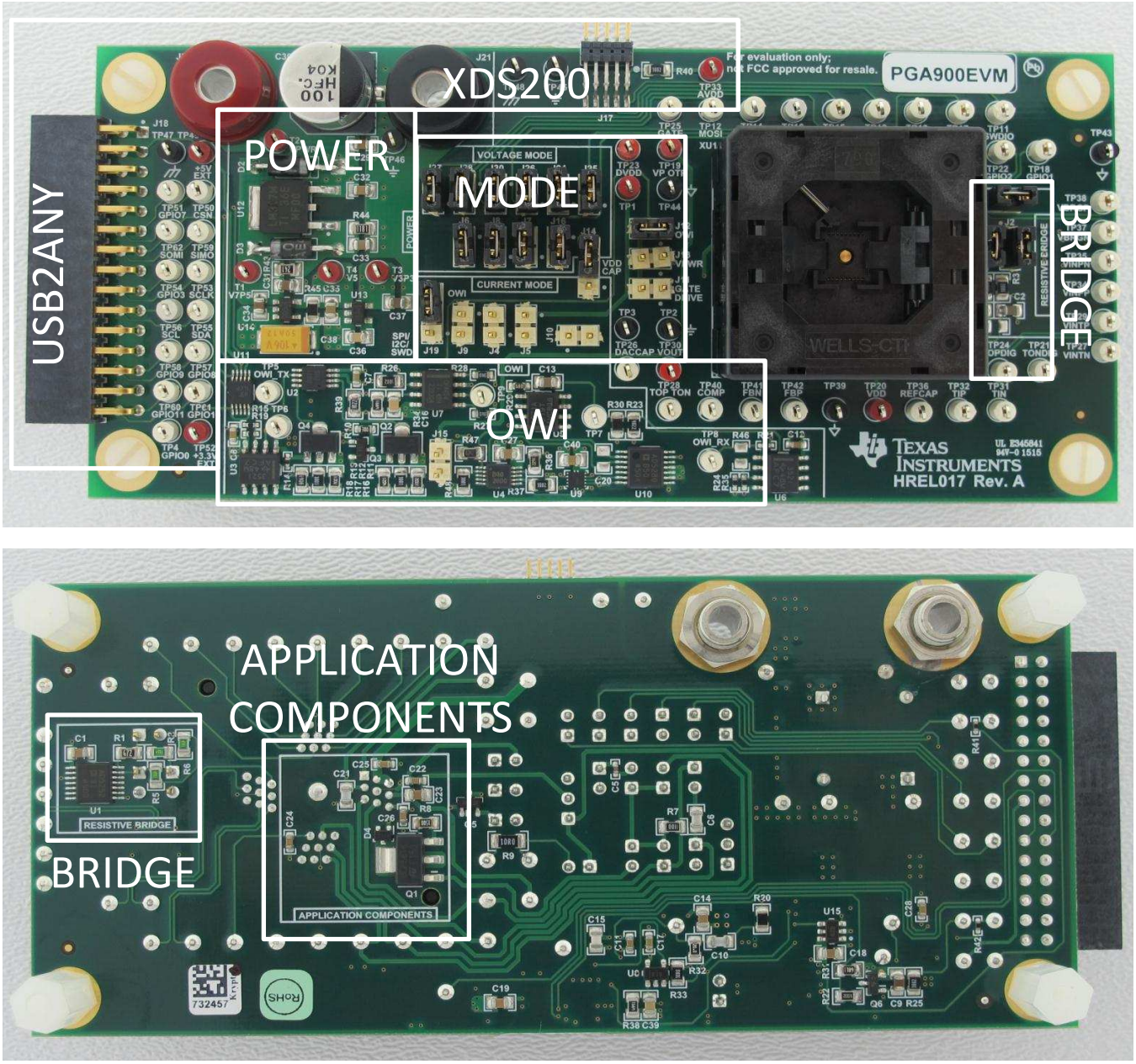


Figure 1. PGA900EVM

The PGA900EVM is divided into six sections:

1. Interface boards and external power:
   (a) USB2ANY connector
   (b) XDS200 connector (single wire debugger)
   (c) Banana connectors to power up EVM
2. Power:
   (a) 7.5-V, 5-V, and 3.3-V regulators
3. Mode selection:
   (a) 4- to 20-mA loop (current mode)
   (b) Voltage mode
4. OWI circuitry
5. Resistive bridge
6. Application components

The applications components section highlights the only required components needed in a real life application using the PGA900. In this case, the application is configured for current mode.

2 Default Configuration

The EVM requires a 10- to 30-V input applied to J20 and J21. Clamp the power supply current to 100 mA. The EVM is shipped configured for voltage mode as shown in Table 1.

Table 1. Default PGA900EVM Jumper Configuration (Voltage Mode)

	JUMPERS	PURPOSE
VDD	J12 closed	PGA900 powered up from OWI circuitry (VDD = 5 V)
Input	J1, J2, J3 closed	Connect resistive bridge to PGA900
Output	J6, J7, J8 closed	Voltage mode with a 100-nF load
Interface	J24, J25, J26, J27, J28, J30 closed	SPI/I^2C/UART enabled
Ground	J16 closed	Connect ASICGND to IRETURN
	J14 – pins 2-3 closed	Connect VDD cap to ASIC_GND
	J19 – pins 2-3 closed	Connect USBGND to IRETURN

3 Inputs and Output Configurations

3.1 Pressure Input

The PGA900EVM consists of a resistive bridge where one leg of the bridge can be changed using a digital potentiometer. The changing leg consists of two digital potentiometers connected in parallel in series with a 4.7-kΩ resistor. J1 must be closed to connect the bridge voltage from the PGA900 to the resistive bridge. In addition, J2 and J3 must be closed to connect the bridge outputs to the PGA900. An RC filter is in series with each of the input pins in the PGA900 with a cutoff frequency of about 106 Hz. Figure 2 shows the pressure stimulus circuit in the PGA900EVM.

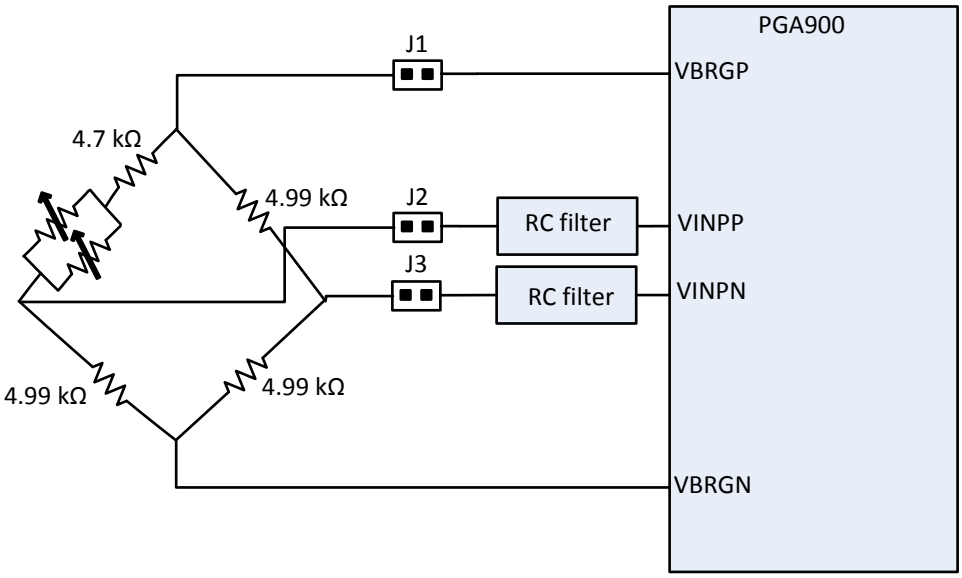


Figure 2. Pressure Stimulus in the PGA900EVM

3.2 Temperature Input

The PGA900EVM does not have on-board stimulus for the temperature inputs of the PGA900. However, TP27 and TP29 on the far right side of the board can be used to apply external signals.

3.3 Output

The PGA900EVM can be configured for voltage or current mode (4- to 20-mA loop). Each mode requires different jumper settings as described in the following sections.

3.4 Voltage Mode

The PGA900EVM is by default configured in voltage mode with a 100-nF load. A compensation capacitor and an isolation resistor are needed for stability. Figure 3 shows the PGA900 schematic for voltage mode and Table 1 shows all the jumpers needed to configure the board in this mode. If the capacitive load is different from 100 nF, then the isolation resistor and compensation capacitor values need to be changed. Refer to application note *PGA900 as a Capacitive Load Driver*, SLDA020, for more information.

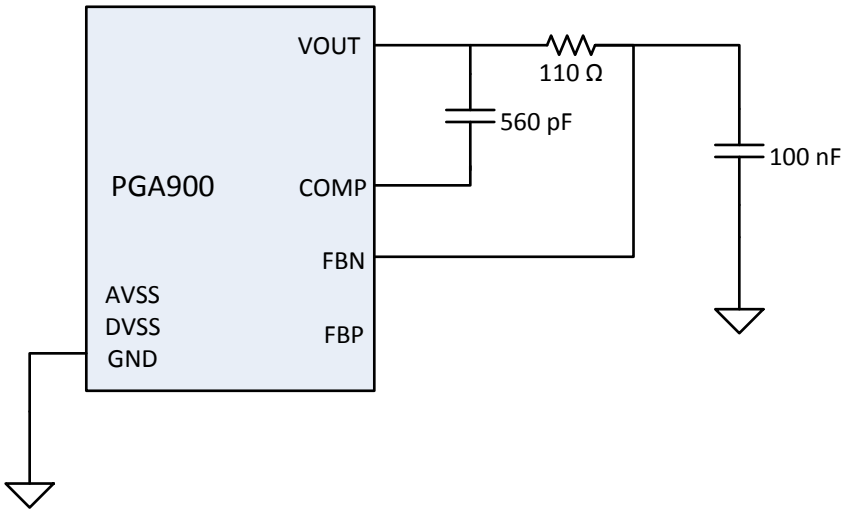


Figure 3. PGA900 in Voltage Mode Configuration

NOTE: If the designer needs VDD to be more than 5 V in voltage mode, open J12 and close J13. VDD will be equal to the power applied to the PGA900EVM.

3.5 Current Mode

When in current mode, the PGA900EVM needs to be properly configured to separate the different negative references for all the voltage levels present in the board. Figure 4 shows the main connections for current mode. The two different scenarios when in current mode are:

- Current mode using OWI
- Current mode using SPI/I^{2}C/SWD

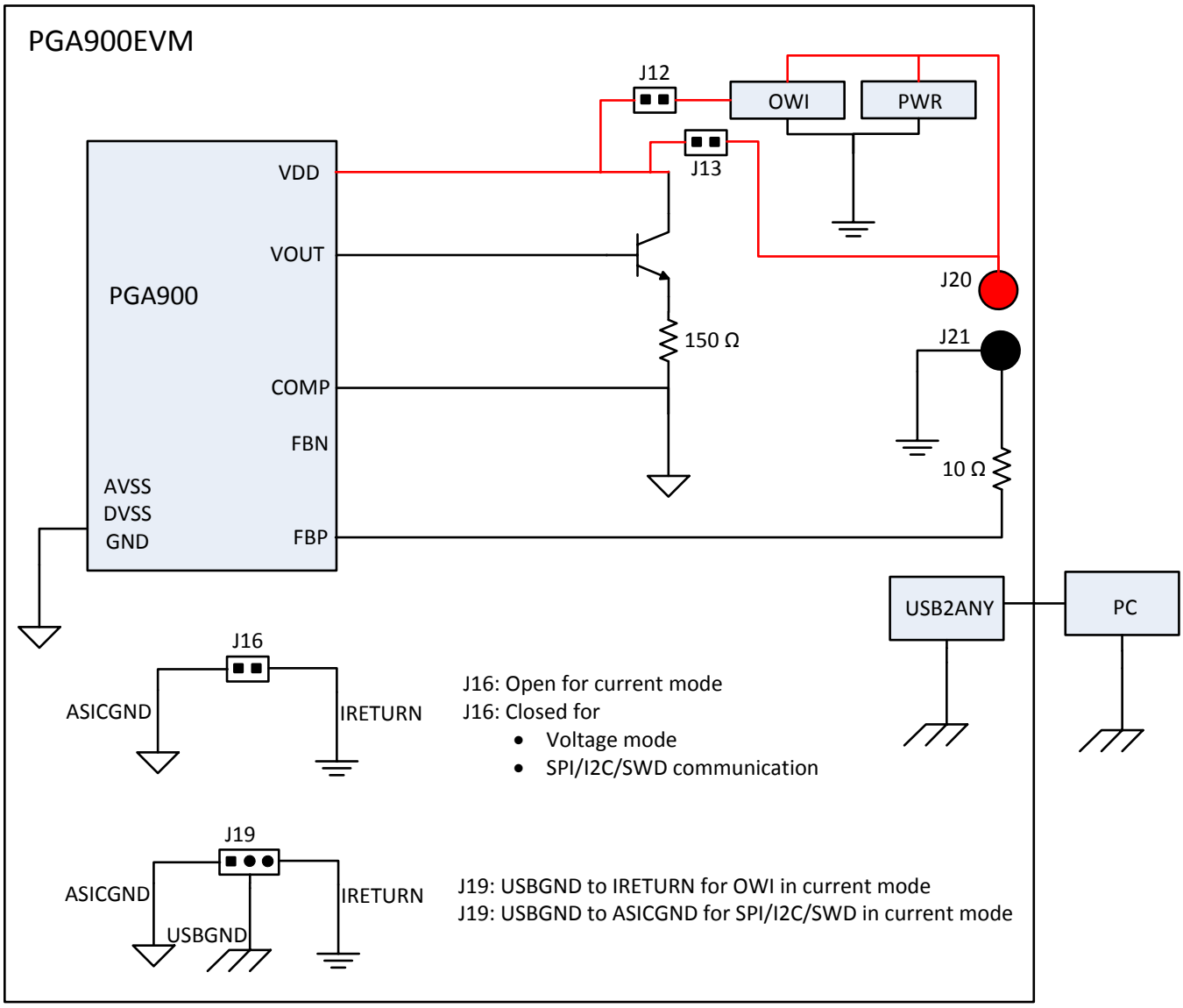


Figure 4. PGA900EVM in Current Mode

NOTE: When in current mode, the input voltage to the EVM (J20 and J21) should be at least 20 V.

3.6 OWI and SPI/I²C/SWD in 4- to 20-mA Current Loop

As mentioned previously, when in current mode, there are two different scenarios depending on whether OWI or SPI/I²C/SWD will be used as the type of communication. Table 2 shows the jumper settings needed for each of these scenarios. These jumpers are the same ones for voltage mode configuration but with different settings. Refer to Figure 4 for the locations of the jumpers.

Table 2. Jumper Settings for PGA900EVM in Current Mode

JUMPER	CURRENT MODE USING OWI		CURRENT MODE USING SPI/I²C/SWD	
	SETTING	FUNCTION	SETTING	FUNCTION
J16	Open	Disconnect ASIC_GND from IRETURN	Open	Disconnect ASIC_GND from IRETURN
J19	Pins 2 to 3	Connect USBGND to IRETURN	Pins 1 to 2	Connect USBGND to ASICGND
J13	Open	Disconnect PGA900 VDD pin from EVM input voltage	Closed	Connect PGA900 VDD pin to EVM input voltage
J6	Open	Disconnect 560 pF between COMP and VOUT	Open	Disconnect 180 pF between COMP and VOUT
J9	Closed	Connect COMP to ASIC_GND	Closed	Connect COMP to ASIC_GND
J4	Closed	Short out resistor at VOUT	Closed	Short out resistor at VOUT
J8	Open	Disconnect FBN from VOUT	Open	Disconnect FBN from VOUT
J5	Closed	Connect VOUT to BJT	Closed	Connect VOUT to BJT
J10	Closed	Connect FBP to IRETURN	Closed	Connect FBP to IRETURN
J14	Pins 1 to 2	100-nF capacitor from VDD to FBP and from DACCAP to FBP	Pins 1 to 2	100-nF capacitor from VDD to FBP and from DACCAP to FBP
J12	Closed	Connect VDD in PGA900 to OWI signal from EVM	Open	Disconnect PGA900 VDD pin from OWI signal from EVM
J25, J27	Open	Disconnect I²C pins between USB2ANY and PGA900	Closed	If I²C is desired
J24, J26, J28, J30	Open	Disconnect SPI/UART pins between USB2ANY and PGA900	Closed	If SPI/UART is desired

OWI in current mode can only be used with a device with OTP code in it. The code should:

1. Enable the OWI interrupt and service it when the activation sequence on VDD is received by the device.
2. Set the deglitch time to the 1-ms default time (OWI_DGL_CNT_SEL = 0).
3. Disconnect the DAC output from the loop by setting bit 0 of AMUX_CTRL to 0.
4. Enable the OWI transceiver and reset M0 by writing 0x03 to MICRO_INTERFACE_CONTROL register.

4 OWI

The OWI circuitry in the PGA900EVM allows communicating with the PGA900 by using voltage level translation and current sensing circuitry. The OWI circuitry is mainly based on a summing amplifier using the OPA454. This is mostly due to the current mode application where GND reference for the PGA900 (ASIC_GND) is at higher potential than the reference for the OWI circuitry (IRETURN). This is due to the internal 40-Ω resistor and the 10-Ω (R9) EVM resistor connected to FBP. However, this resistor could be a higher value, and as expected, the potential difference will be larger and is current dependent. The summing amplifier principle compensates for these voltage differences so that the OWI logic levels (with respect to ASIC_GND) remain always the same regardless of current. The OWI circuitry, shown in Figure 5, consists of four main blocks:

1. OWI write: UART data and activation pulses level translated to OWI voltage logic levels.
2. Offset voltage: Constant offset voltage selected by the user to compensate for constant drops from components such as diodes. This is only needed when operating the device in current mode. In voltage mode, the offset voltage should be set to 0 V.
3. Current compensating voltage: This additional voltage is only needed when operating the device in current mode to compensate for the voltage difference between the PGA900 ground and the OWI circuitry ground due to the loop current. In voltage mode, the gain of the OPA734 should be set to unity gain.
4. OWI read: Current to voltage and voltage level translation to UART voltage logic levels.

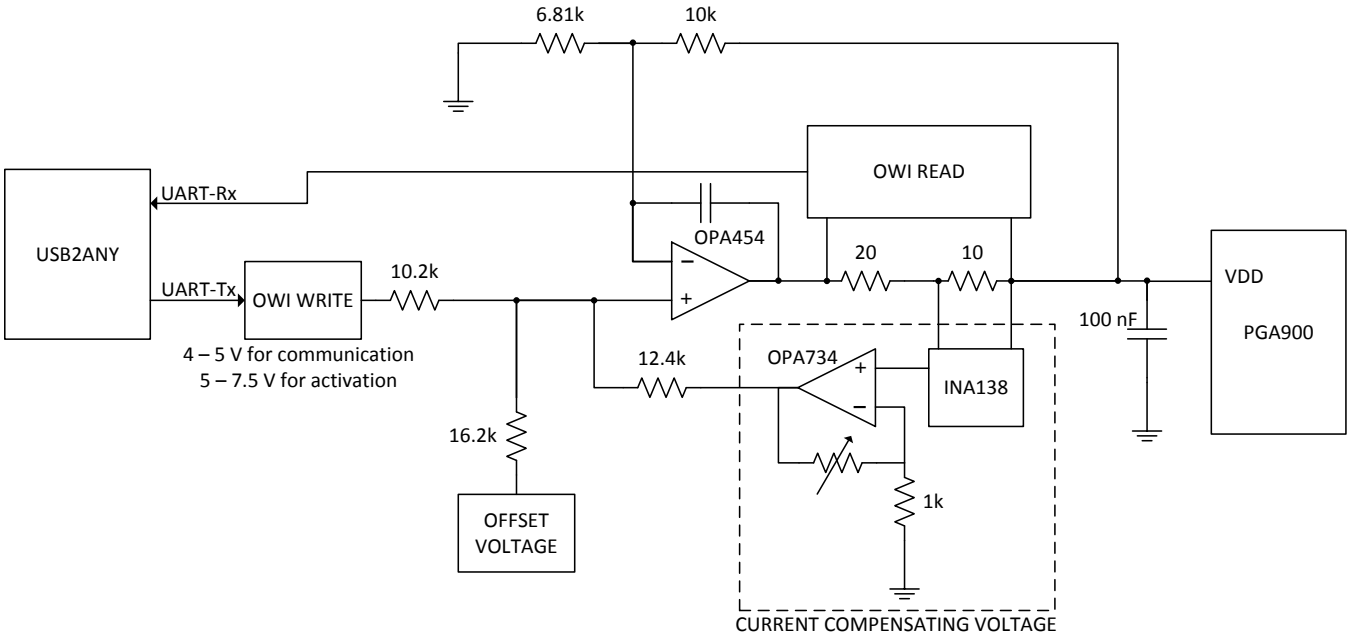


Figure 5. OWI Block Diagram

4.1 Activation Pulse

The activation pulse generated by the PGA900EVM generates the OWI interrupt needed to activate the OWI (with the proper firmware developed by the user). Figure 6 shows the activation pulse from the PGA900EVM. To use this activation pulse, select the “Through Pulse” option from the “OWI Activation Mode” menu and then click “OWI”. The duration of the activation pulse varies due to software delays, but the minimum requirement of 1 or 10 ms is always met.

If the pulse is not needed, OWI can also be enabled through I^2C. To select this option, select “Through I2C” from the “OWI Activation Mode” menu, and then click “OWI”.

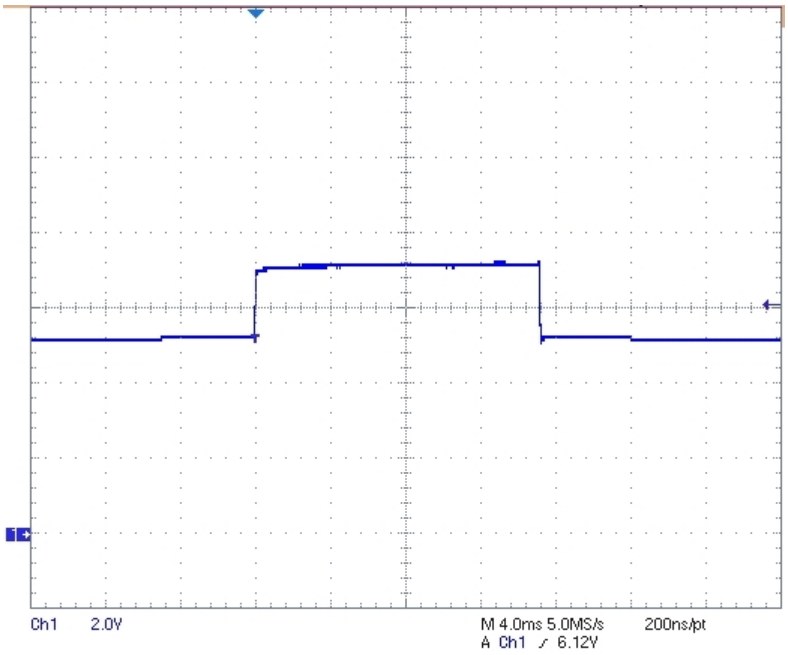


Figure 6. OWI Activation Pulse Generated by the PGA900EVM in Voltage Mode

4.2 Data Sent Through OWI

Data through OWI can be sent to the PGA900 at rates between 320 to 9600 bps. Figure 7 shows data sent at 320 bps.

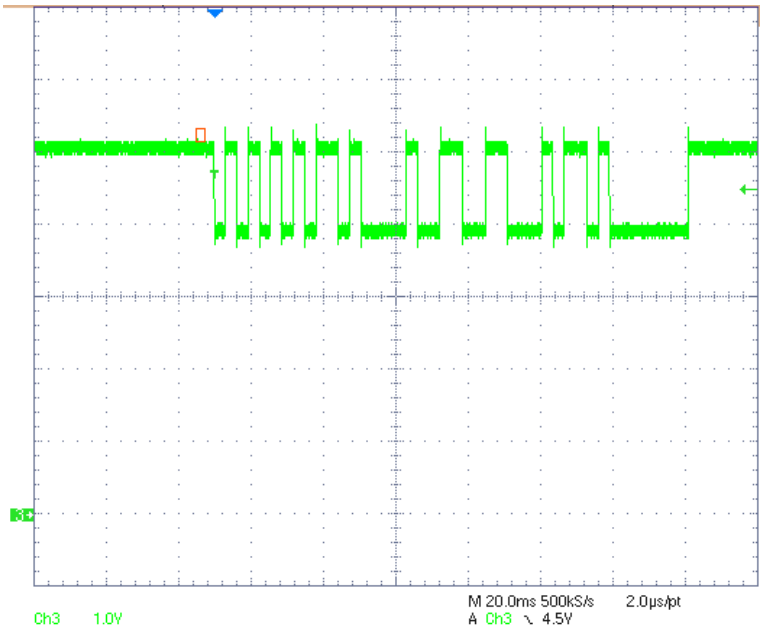


Figure 7. OWI Data at 320 bps; Oscilloscope Probe is Connected at TP20 in the PGA900EVM

5 XDS200 and USB2ANY Connectors

The XDS200 is used for the single-wire debugging (SWD) feature of the PGA900. The designer must use a small breakout board (part of the XDS200 kit) to connect to J17 in the PGA900EVM. No external connections are needed. Figure 8 shows the proper connection for the XDS200 emulator.

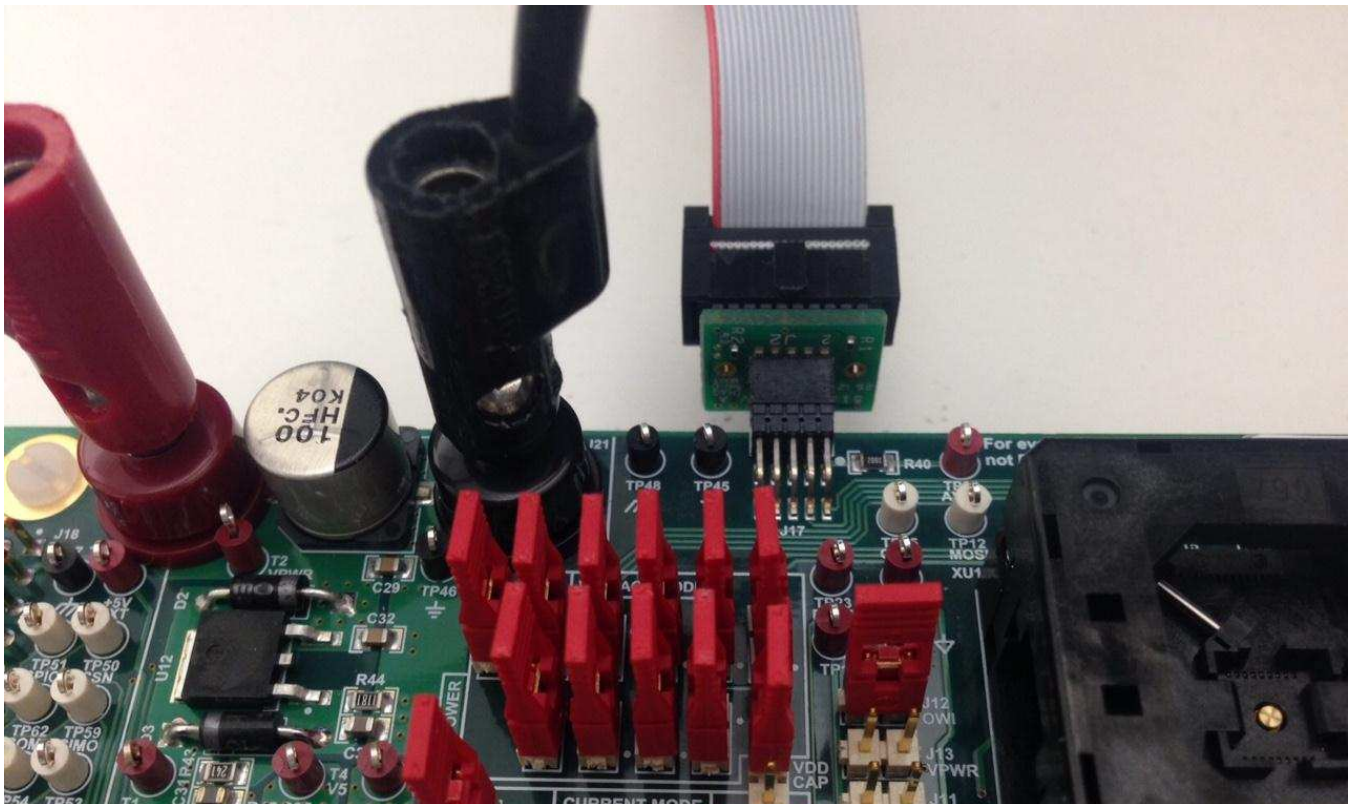


Figure 8. XDS200 Emulator Connection to the PGA900EVM

The USB2ANY is used for the different communication protocols offered by the PGA900. The USB2ANY connects to J18 in the PGA900EVM as shown in Figure 9. The USB2ANY hardware is based on the TI MSP430F5529, 16-bit microcontroller with integrated USB 2.0. The PCB is a two-layer, single-sided board with minimal component count. There are two versions of the USB2ANY, shown in Figure 10, one enclosed and one open. The functionality is exactly the same for both.

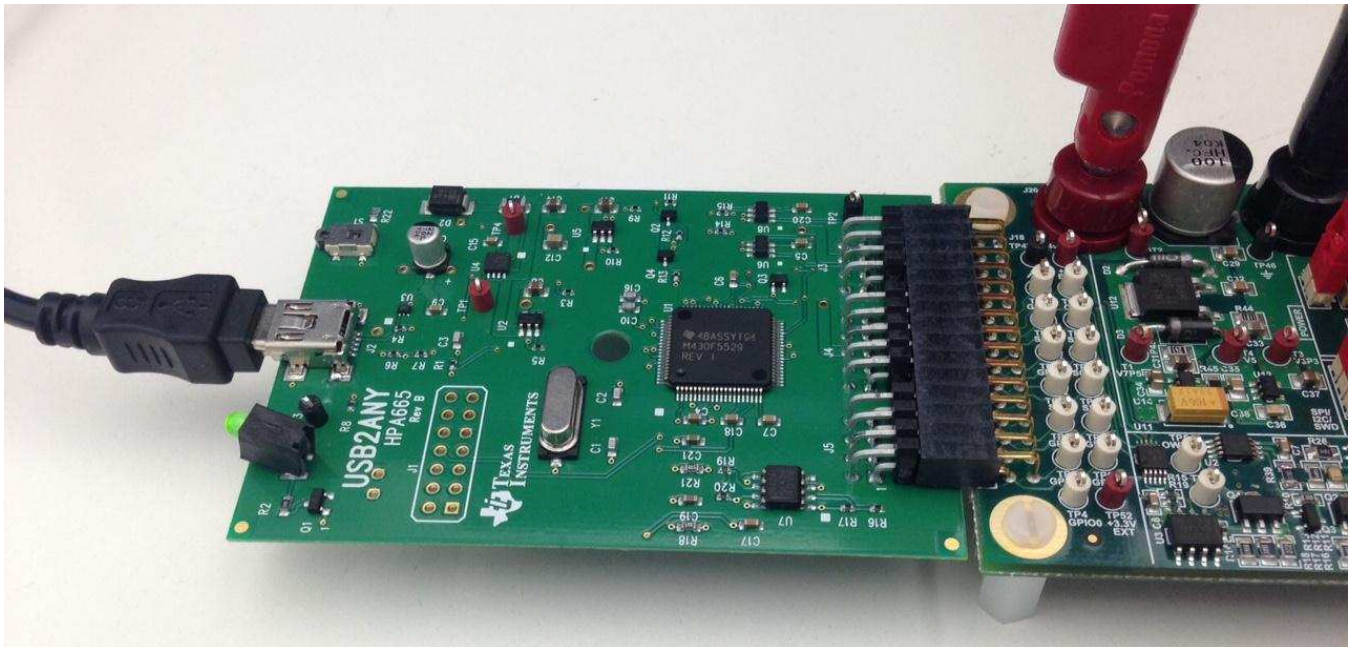


Figure 9. USB2ANY Connection to the PGA900EVM

Figure 10. USB2ANY

Figure 11 shows the pinout of the USB2ANY. The ribbon cable can only be connected one way to the USB2ANY due to a latch present in the cable. A USB cable is included to connect the device to the PC. No external supply is needed.

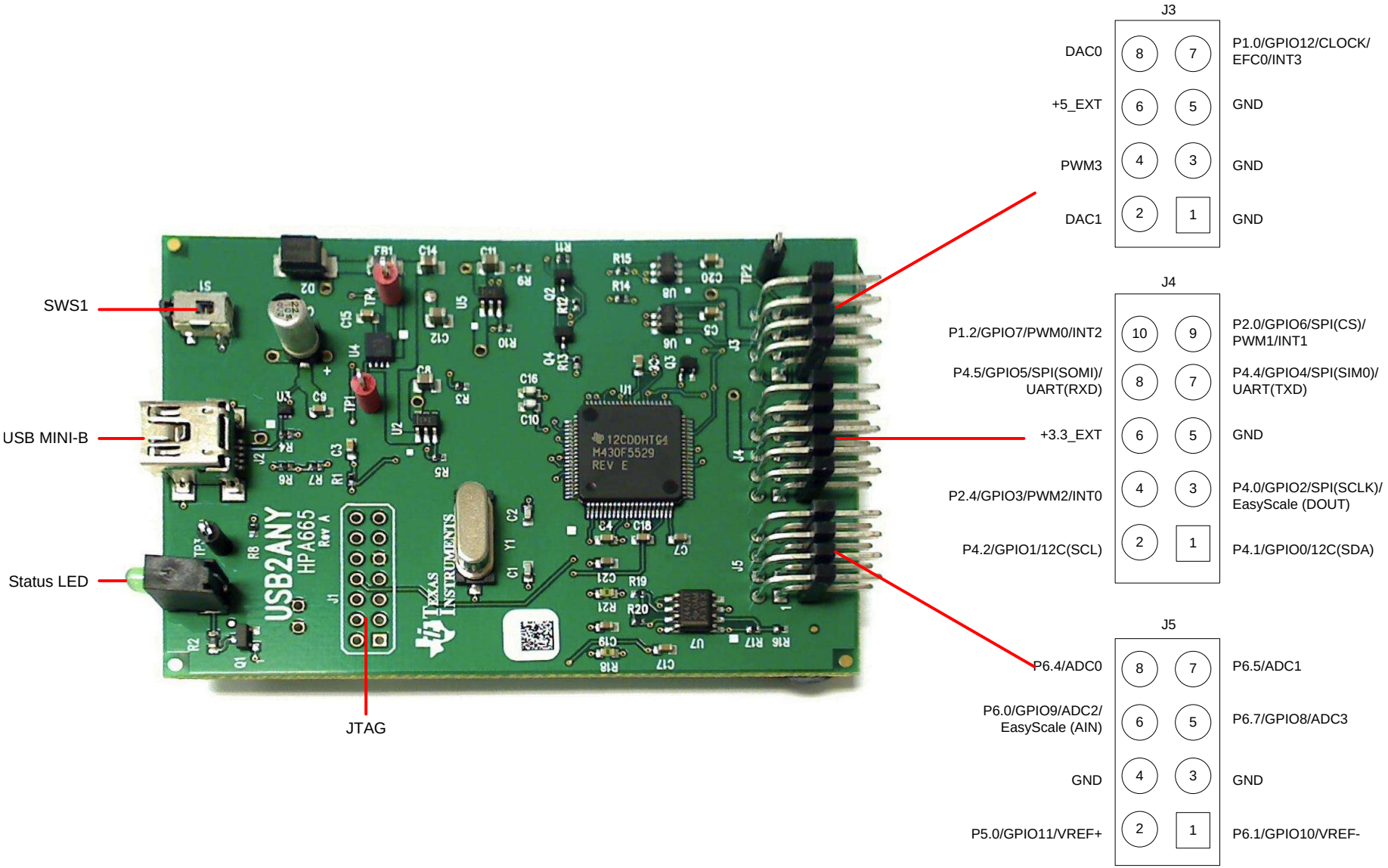


Figure 11. USB2ANY Pinout

6 Power Supplies in the PGA900EVM

The PGA900EVM requires an input voltage between 10 to 30 V to properly operate. Figure 12 shows how the EVM input voltage flows.

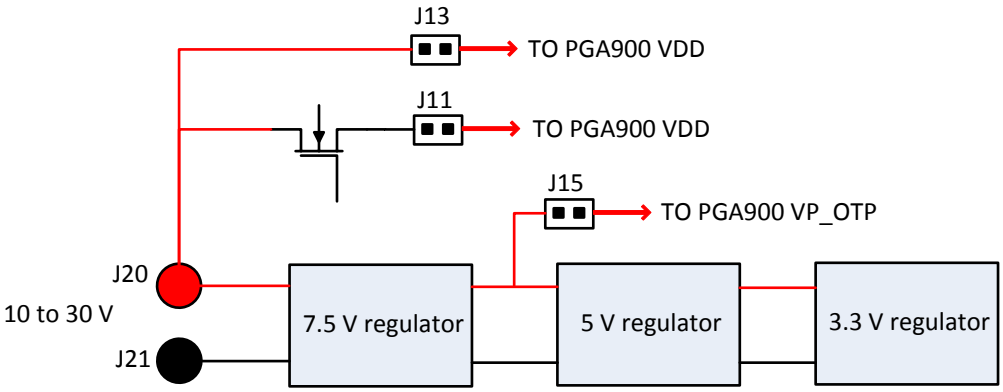


Figure 12. Power Distribution in PGA900EVM

7 Schematics

Figure 13 through Figure 18 show the PGA900EVM schematics.

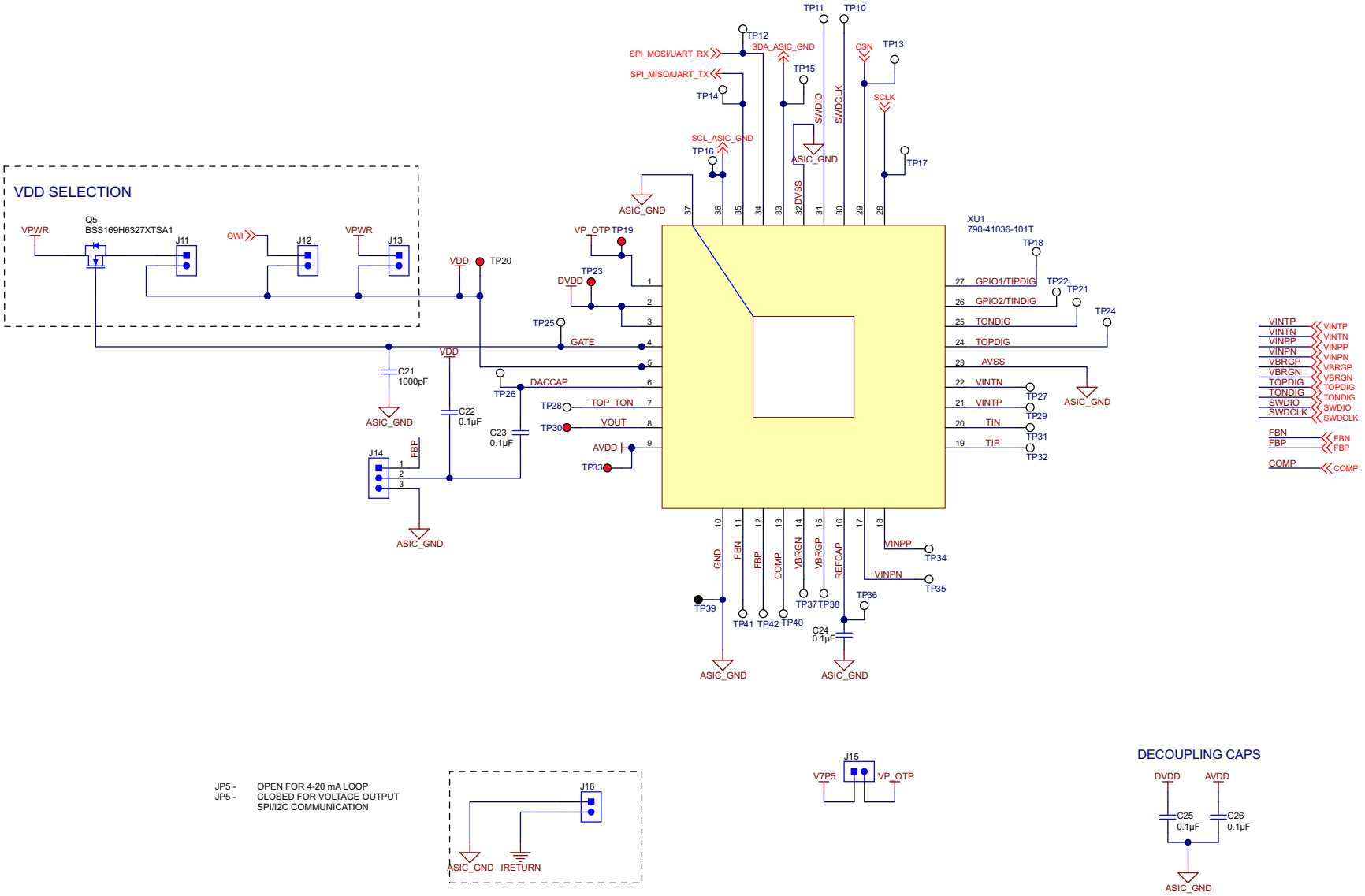


Figure 13. PGA900EVM Main Schematic

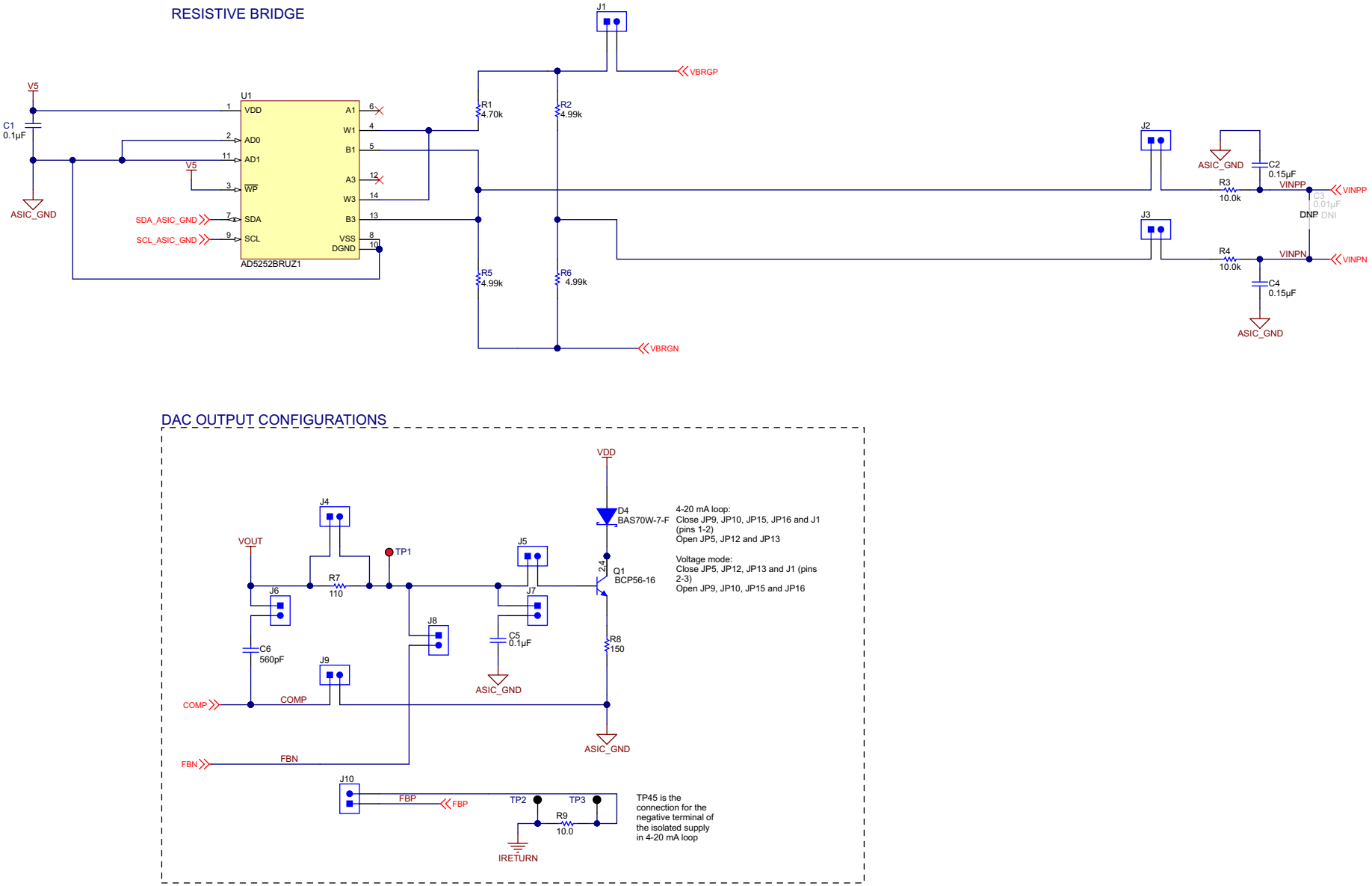


Figure 14. Input and Output Schematic

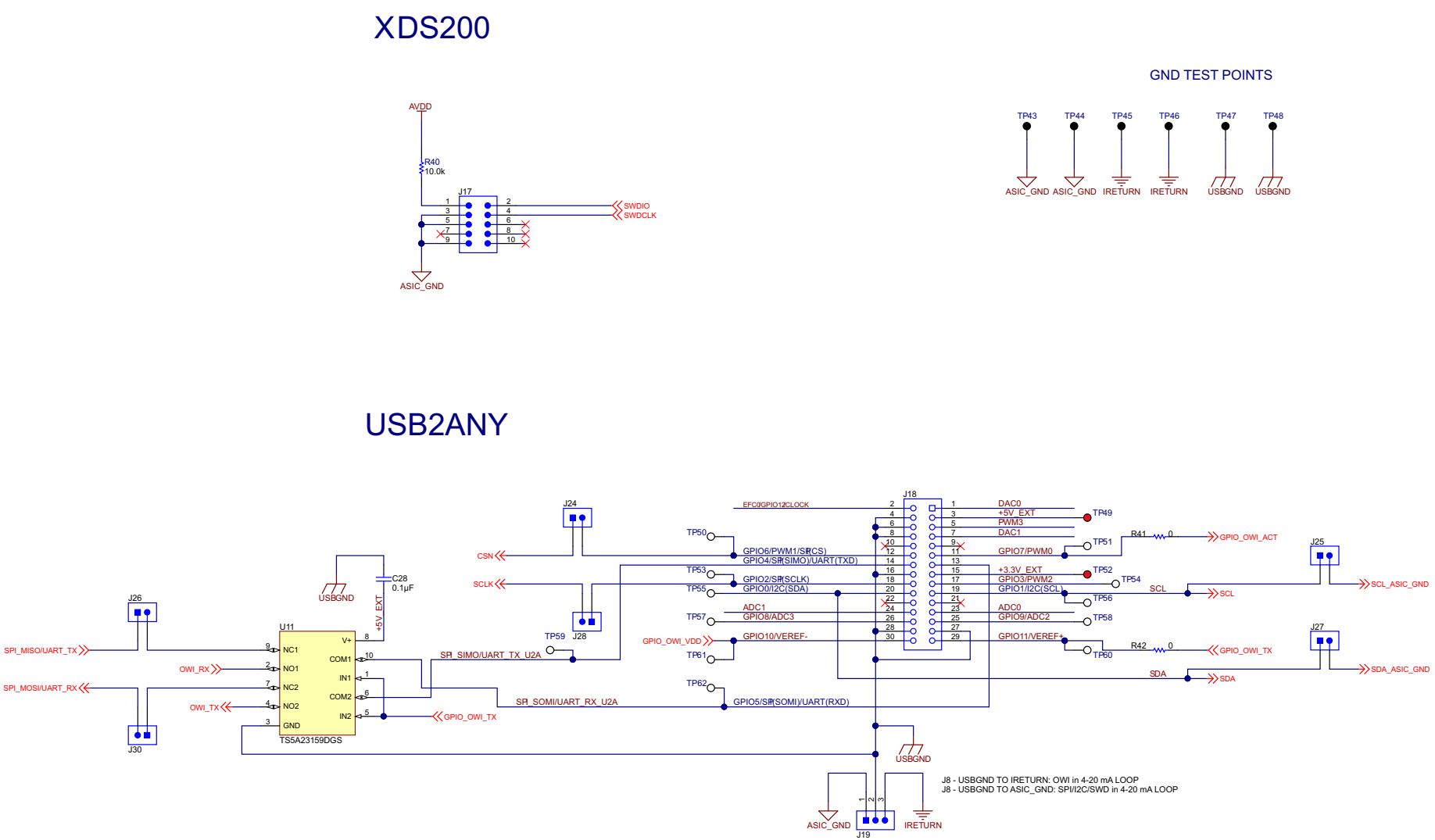


Figure 15. USB2ANY Schematic

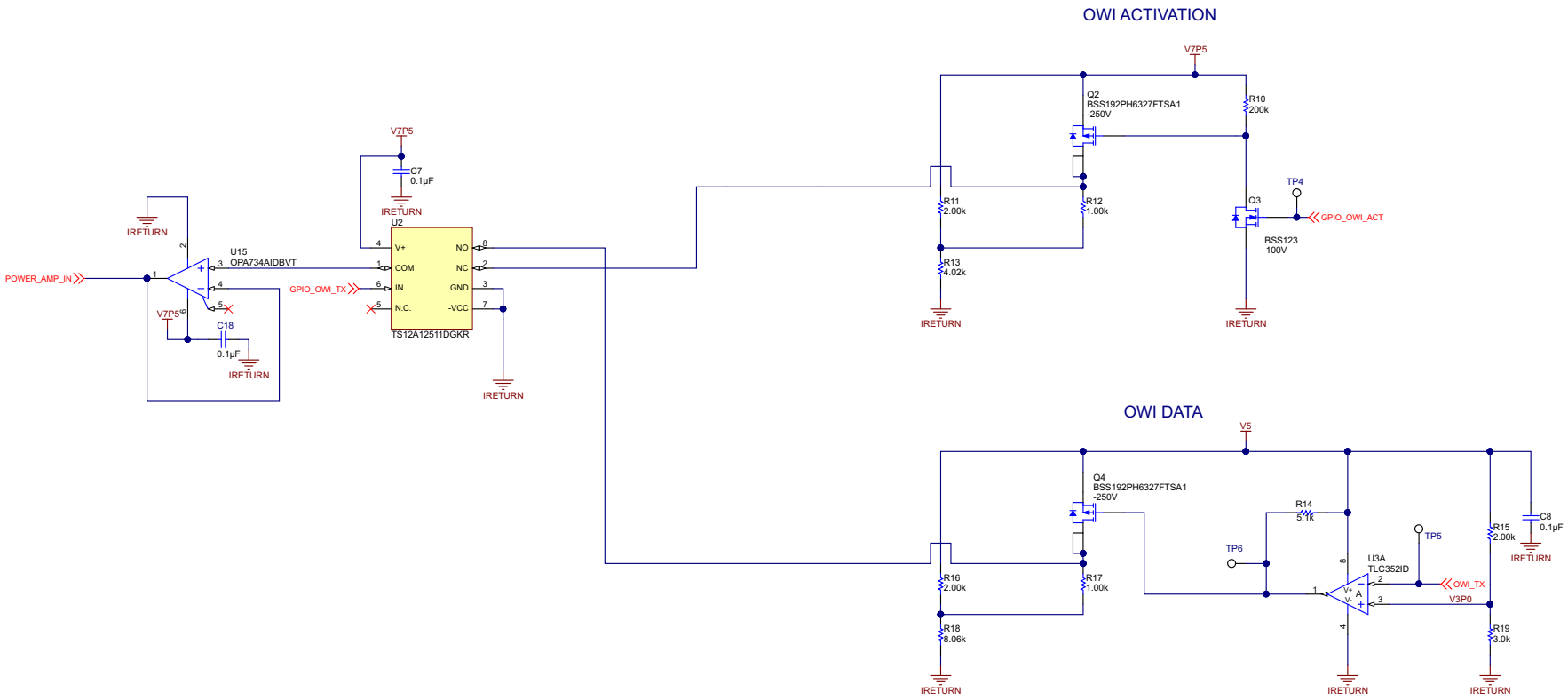


Figure 16. OWI Activation Pulse and Data Schematic

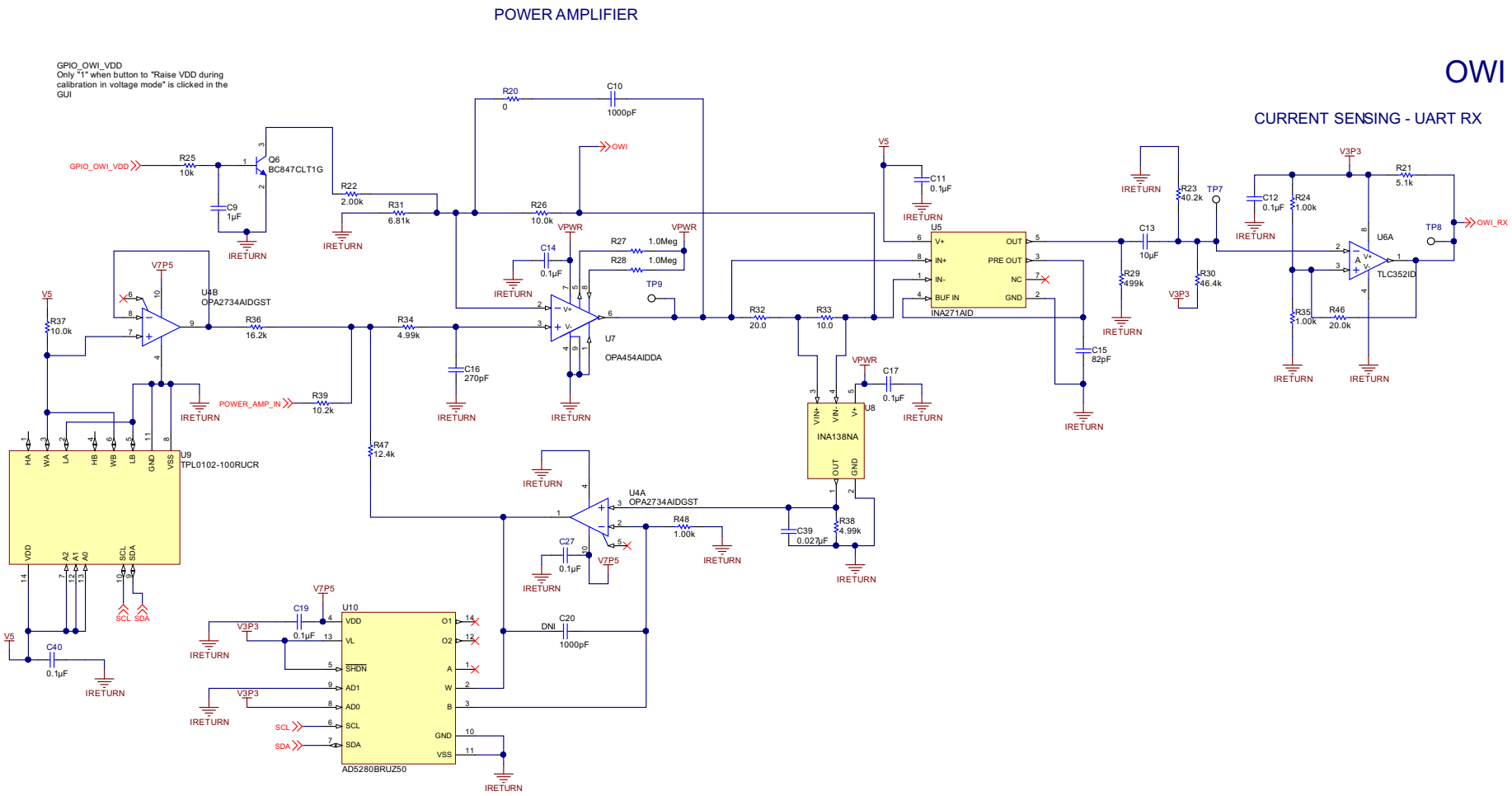
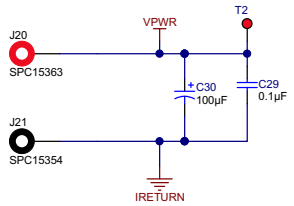


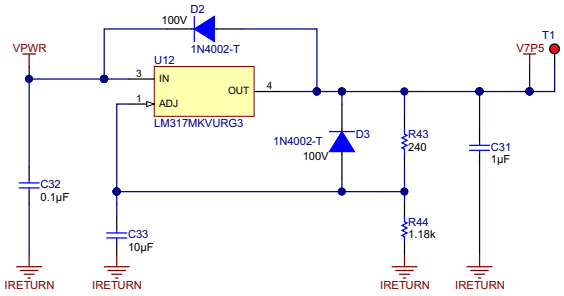
Figure 17. OWI Power Amplifier Schematic

POWER SUPPLIES

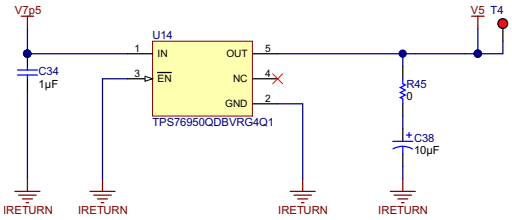
10-V to 30-V PGA900EVM Input



7.5-V Regulator



5-V Regulator



3.3-V Regulator

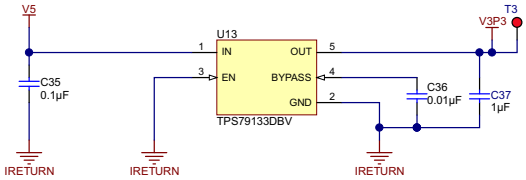


Figure 18. Power Supplies Schematic

STANDARD TERMS AND CONDITIONS FOR EVALUATION MODULES

1. *Delivery:* TI delivers TI evaluation boards, kits, or modules, including any accompanying demonstration software, components, or documentation (collectively, an “EVM” or “EVMs”) to the User (“User”) in accordance with the terms and conditions set forth herein. Acceptance of the EVM is expressly subject to the following terms and conditions.

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   1.2 EVMs are not intended for consumer or household use. EVMs may not be sold, sublicensed, leased, rented, loaned, assigned, or otherwise distributed for commercial purposes by Users, in whole or in part, or used in any finished product or production system.

2 *Limited Warranty and Related Remedies/Disclaimers*:

   2.1 These terms and conditions do not apply to Software. The warranty, if any, for Software is covered in the applicable Software License Agreement.

   2.2 TI warrants that the TI EVM will conform to TI's published specifications for ninety (90) days after the date TI delivers such EVM to User. Notwithstanding the foregoing, TI shall not be liable for any defects that are caused by neglect, misuse or mistreatment by an entity other than TI, including improper installation or testing, or for any EVMs that have been altered or modified in any way by an entity other than TI. Moreover, TI shall not be liable for any defects that result from User's design, specifications or instructions for such EVMs. Testing and other quality control techniques are used to the extent TI deems necessary or as mandated by government requirements. TI does not test all parameters of each EVM.

   2.3 If any EVM fails to conform to the warranty set forth above, TI's sole liability shall be at its option to repair or replace such EVM, or credit User's account for such EVM. TI's liability under this warranty shall be limited to EVMs that are returned during the warranty period to the address designated by TI and that are determined by TI not to conform to such warranty. If TI elects to repair or replace such EVM, TI shall have a reasonable time to repair such EVM or provide replacements. Repaired EVMs shall be warranted for the remainder of the original warranty period. Replaced EVMs shall be warranted for a new full ninety (90) day warranty period.

3 *Regulatory Notices:*

   3.1 *United States*

      3.1.1 *Notice applicable to EVMs not FCC-Approved:*

      This kit is designed to allow product developers to evaluate electronic components, circuitry, or software associated with the kit to determine whether to incorporate such items in a finished product and software developers to write software applications for use with the end product. This kit is not a finished product and when assembled may not be resold or otherwise marketed unless all required FCC equipment authorizations are first obtained. Operation is subject to the condition that this product not cause harmful interference to licensed radio stations and that this product accept harmful interference. Unless the assembled kit is designed to operate under part 15, part 18 or part 95 of this chapter, the operator of the kit must operate under the authority of an FCC license holder or must secure an experimental authorization under part 5 of this chapter.

      3.1.2 *For EVMs annotated as FCC – FEDERAL COMMUNICATIONS COMMISSION Part 15 Compliant:*

      CAUTION

      This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

      Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

      FCC Interference Statement for Class A EVM devices

      NOTE: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

FCC Interference Statement for Class B EVM devices

NOTE: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- *Reorient or relocate the receiving antenna.*
- *Increase the separation between the equipment and receiver.*
- *Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.*
- *Consult the dealer or an experienced radio/TV technician for help.*

3.2 *Canada*

3.2.1 *For EVMs issued with an Industry Canada Certificate of Conformance to RSS-210*

Concerning EVMs Including Radio Transmitters:

This device complies with Industry Canada license-exempt RSS standard(s). Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

Concernant les EVMs avec appareils radio:

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes: (1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

Concerning EVMs Including Detachable Antennas:

Under Industry Canada regulations, this radio transmitter may only operate using an antenna of a type and maximum (or lesser) gain approved for the transmitter by Industry Canada. To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (e.i.r.p.) is not more than that necessary for successful communication. This radio transmitter has been approved by Industry Canada to operate with the antenna types listed in the user guide with the maximum permissible gain and required antenna impedance for each antenna type indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device.

Concernant les EVMs avec antennes détachables

Conformément à la réglementation d'Industrie Canada, le présent émetteur radio peut fonctionner avec une antenne d'un type et d'un gain maximal (ou inférieur) approuvé pour l'émetteur par Industrie Canada. Dans le but de réduire les risques de brouillage radioélectrique à l'intention des autres utilisateurs, il faut choisir le type d'antenne et son gain de sorte que la puissance isotrope rayonnée équivalente (p.i.r.e.) ne dépasse pas l'intensité nécessaire à l'établissement d'une communication satisfaisante. Le présent émetteur radio a été approuvé par Industrie Canada pour fonctionner avec les types d'antenne énumérés dans le manuel d'usage et ayant un gain admissible maximal et l'impédance requise pour chaque type d'antenne. Les types d'antenne non inclus dans cette liste, ou dont le gain est supérieur au gain maximal indiqué, sont strictement interdits pour l'exploitation de l'émetteur

3.3 *Japan*

3.3.1 *Notice for EVMs delivered in Japan:* Please see http://www.tij.co.jp/lsds/ti_ja/general/eStore/notice_01.page 日本国内に輸入される評価用キット、ボードについては、次のところをご覧ください。
http://www.tij.co.jp/lsds/ti_ja/general/eStore/notice_01.page

3.3.2 *Notice for Users of EVMs Considered "Radio Frequency Products" in Japan:* EVMs entering Japan may not be certified by TI as conforming to Technical Regulations of Radio Law of Japan.

If User uses EVMs in Japan, not certified to Technical Regulations of Radio Law of Japan, User is required by Radio Law of Japan to follow the instructions below with respect to EVMs:

1. Use EVMs in a shielded room or any other test facility as defined in the notification #173 issued by Ministry of Internal Affairs and Communications on March 28, 2006, based on Sub-section 1.1 of Article 6 of the Ministry's Rule for Enforcement of Radio Law of Japan,
2. Use EVMs only after User obtains the license of Test Radio Station as provided in Radio Law of Japan with respect to EVMs, or
3. Use of EVMs only after User obtains the Technical Regulations Conformity Certification as provided in Radio Law of Japan with respect to EVMs. Also, do not transfer EVMs, unless User gives the same notice above to the transferee. Please note that if User does not follow the instructions above, User will be subject to penalties of Radio Law of Japan.

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1. 電波法施行規則第6条第1項第1号に基づく平成18年3月28日総務省告示第173号で定められた電波暗室等の試験設備でご使用いただく。
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3.3.3 *Notice for EVMs for Power Line Communication:* Please see http://www.tij.co.jp/lsds/ti_ja/general/eStore/notice_02.page

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4 *EVM Use Restrictions and Warnings:*

4.1 EVMS ARE NOT FOR USE IN FUNCTIONAL SAFETY AND/OR SAFETY CRITICAL EVALUATIONS, INCLUDING BUT NOT LIMITED TO EVALUATIONS OF LIFE SUPPORT APPLICATIONS.

4.2 User must read and apply the user guide and other available documentation provided by TI regarding the EVM prior to handling or using the EVM, including without limitation any warning or restriction notices. The notices contain important safety information related to, for example, temperatures and voltages.

4.3 *Safety-Related Warnings and Restrictions:*

4.3.1 User shall operate the EVM within TI's recommended specifications and environmental considerations stated in the user guide, other available documentation provided by TI, and any other applicable requirements and employ reasonable and customary safeguards. Exceeding the specified performance ratings and specifications (including but not limited to input and output voltage, current, power, and environmental ranges) for the EVM may cause personal injury or death, or property damage. If there are questions concerning performance ratings and specifications, User should contact a TI field representative prior to connecting interface electronics including input power and intended loads. Any loads applied outside of the specified output range may also result in unintended and/or inaccurate operation and/or possible permanent damage to the EVM and/or interface electronics. Please consult the EVM user guide prior to connecting any load to the EVM output. If there is uncertainty as to the load specification, please contact a TI field representative. During normal operation, even with the inputs and outputs kept within the specified allowable ranges, some circuit components may have elevated case temperatures. These components include but are not limited to linear regulators, switching transistors, pass transistors, current sense resistors, and heat sinks, which can be identified using the information in the associated documentation. When working with the EVM, please be aware that the EVM may become very warm.

4.3.2 EVMs are intended solely for use by technically qualified, professional electronics experts who are familiar with the dangers and application risks associated with handling electrical mechanical components, systems, and subsystems. User assumes all responsibility and liability for proper and safe handling and use of the EVM by User or its employees, affiliates, contractors or designees. User assumes all responsibility and liability to ensure that any interfaces (electronic and/or mechanical) between the EVM and any human body are designed with suitable isolation and means to safely limit accessible leakage currents to minimize the risk of electrical shock hazard. User assumes all responsibility and liability for any improper or unsafe handling or use of the EVM by User or its employees, affiliates, contractors or designees.

4.4 User assumes all responsibility and liability to determine whether the EVM is subject to any applicable international, federal, state, or local laws and regulations related to User's handling and use of the EVM and, if applicable, User assumes all responsibility and liability for compliance in all respects with such laws and regulations. User assumes all responsibility and liability for proper disposal and recycling of the EVM consistent with all applicable international, federal, state, and local requirements.

5. *Accuracy of Information:* To the extent TI provides information on the availability and function of EVMs, TI attempts to be as accurate as possible. However, TI does not warrant the accuracy of EVM descriptions, EVM availability or other information on its websites as accurate, complete, reliable, current, or error-free.

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