ADC System Power Scaling

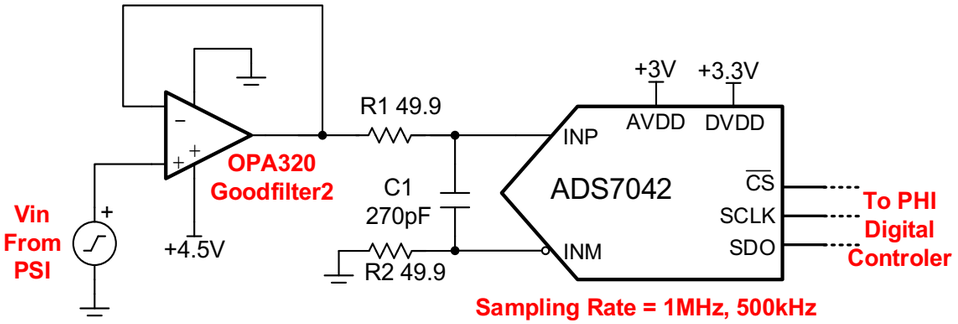
TIPL 4601-L
TI Precision Labs – ADCs

by Art Kay, Peggy Liska

Required/Recommended Equipment

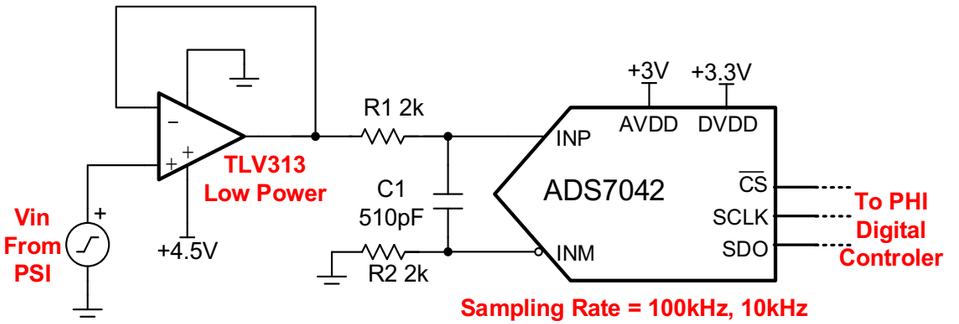
- Calculation
  - Calculate power for the amplifier, digital communications, and analog ADC supply
- Measurement
  - Short description of current shunt measurement
  - Measure power for different amplifiers and sampling rates
  - PLABS-SAR-EVM-PDK
  - http://www.ti.com/tool/plabs-sar-evm-pdk
  - Download EVM software and purchase EVM

Circuits under test



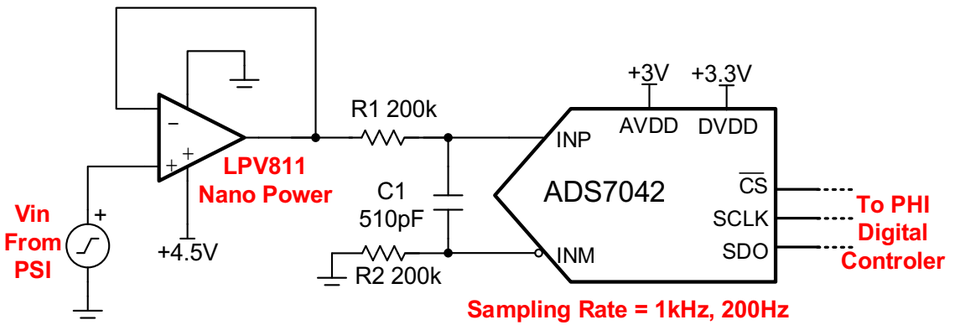
Sampling Rate = 1MHz, 500kHz

OPA320 Parameter		Test Conditions	MIN	TYP	MAX	UNIT
GBP	Gain Bandwidth Product	Unity gain		20		MHz
I_Q	Quiescent current	Vs=5.5V, Ta=25ºC		1.5	1.75	mA



Sampling Rate = 100kHz, 10kHz

TLV313 Parameter		Test Conditions	MIN	TYP	MAX	UNIT
GBP	Gain Bandwidth Product	Unity gain		1		MHz
I_Q	Quiescent current	Vs=5.0V, Ta=-40ºC to 125ºC		65	90	µA



Sampling Rate = 1kHz, 200Hz

LPV811 Parameter		Test Conditions	MIN	TYP	MAX	UNIT
GBP	Gain Bandwidth Product	Unity gain		8		kHz
I_Q	Quiescent current	Vs=3.3V, Ta=25ºC		450	540	nA

Expected results

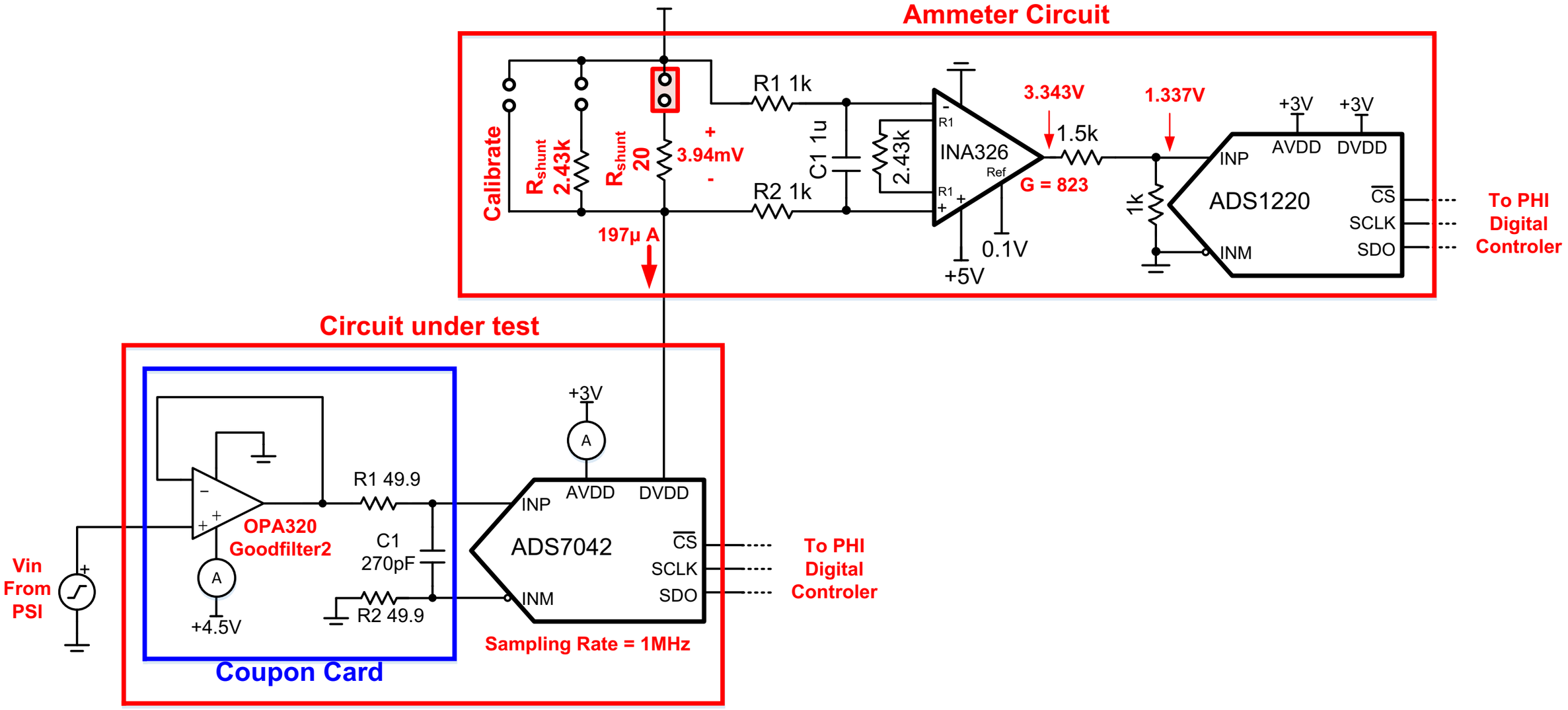
Amp	Sampling Rate	I_{Q_Amp} (µA) Max	P_{DVDD} (µW) Max	P_{AVDD} (µW) Max	P_{Q_Amp} (µW) Max	P_{TOTAL} (µW) Max
OPA320	1M	1,750	1306.80	690.00	7875.00	9871.80
OPA320	500k	1,750	653.40	345.00	7875.00	8873.40
TLV313	100k	90	130.68	69.00	405.00	604.68
TLV313	10k	90	13.07	6.90	405.00	424.97
LPV811	1k	0.54	1.31	0.69	2.43	4.43
LPV811	200	0.54	0.26	0.14	2.43	2.83

$$P_{DVDD} = V_{DVDD} \cdot (C \cdot V \cdot N_{bits} \cdot f_s) = 3.3V \cdot (10pF \cdot 3.3V \cdot 12 \cdot 500kHz) = 653.4\mu W$$

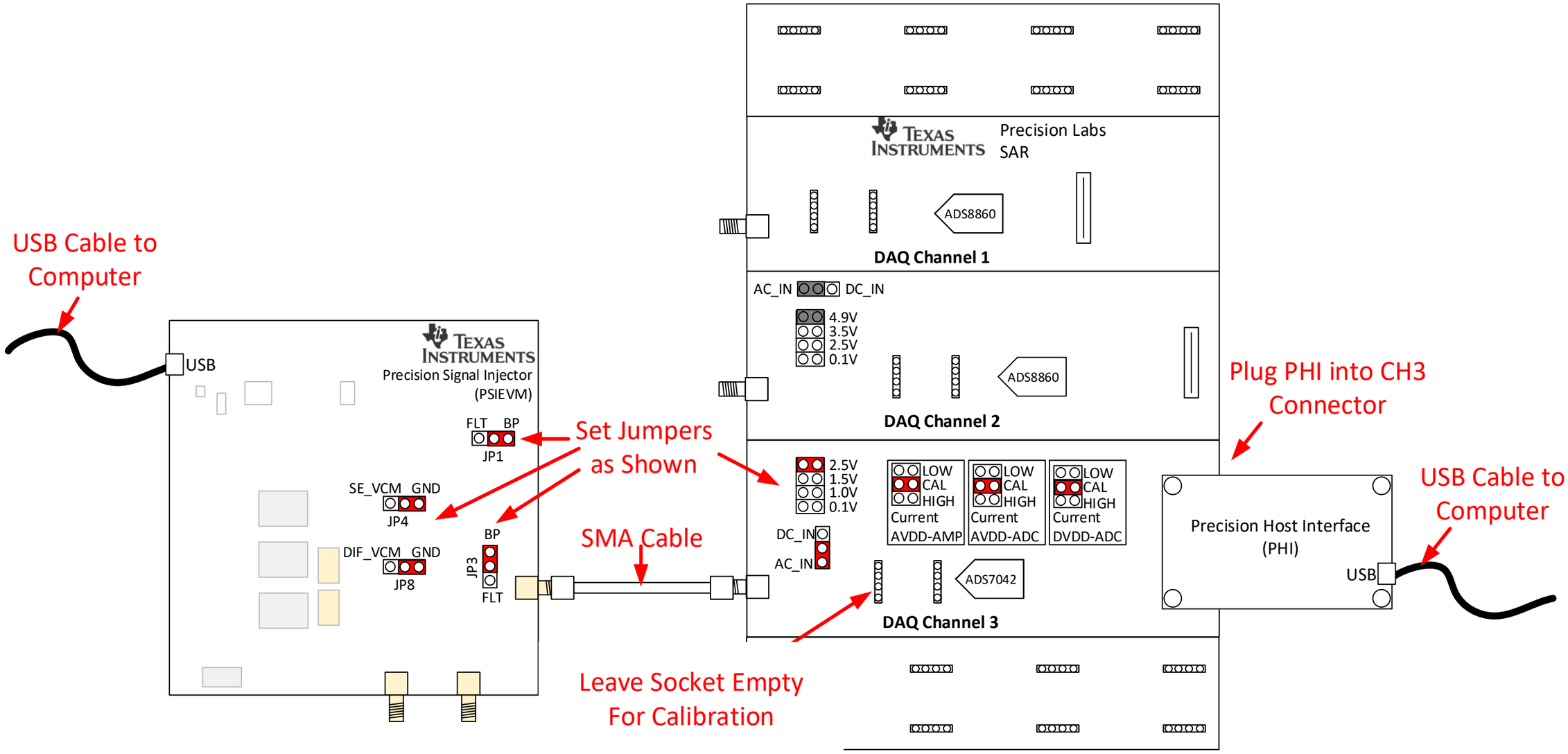
$$P_{AVDD} = V_{AVDD} \cdot \frac{I_{AVDD@1Msps} \cdot f_s}{1MHz} = 3.0V \cdot \frac{230\mu A \cdot 500kHz}{1MHz} = 345.0\mu W$$

$$P_{Q\_Amp} = V_{AMP} \cdot I_{Q_{Amp}} = 4.5V \cdot 1.75mA = 7.875mW,\ I_{Q_{AMP}}\ from\ OPA320\ data\ sheet.$$

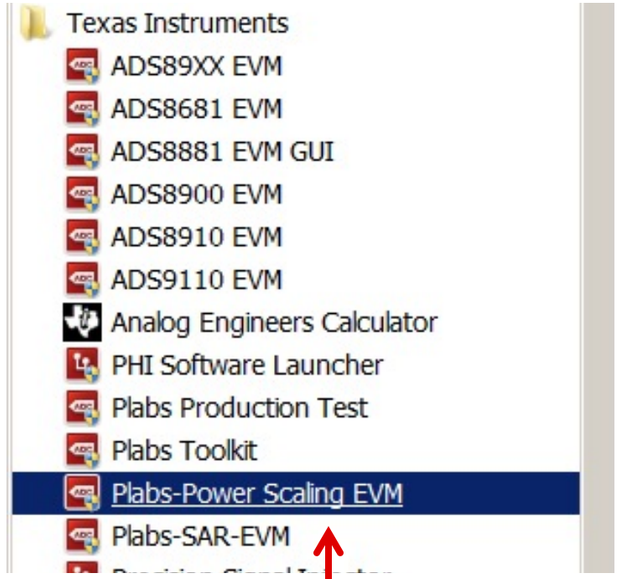
Supply Current Measurement Circuit



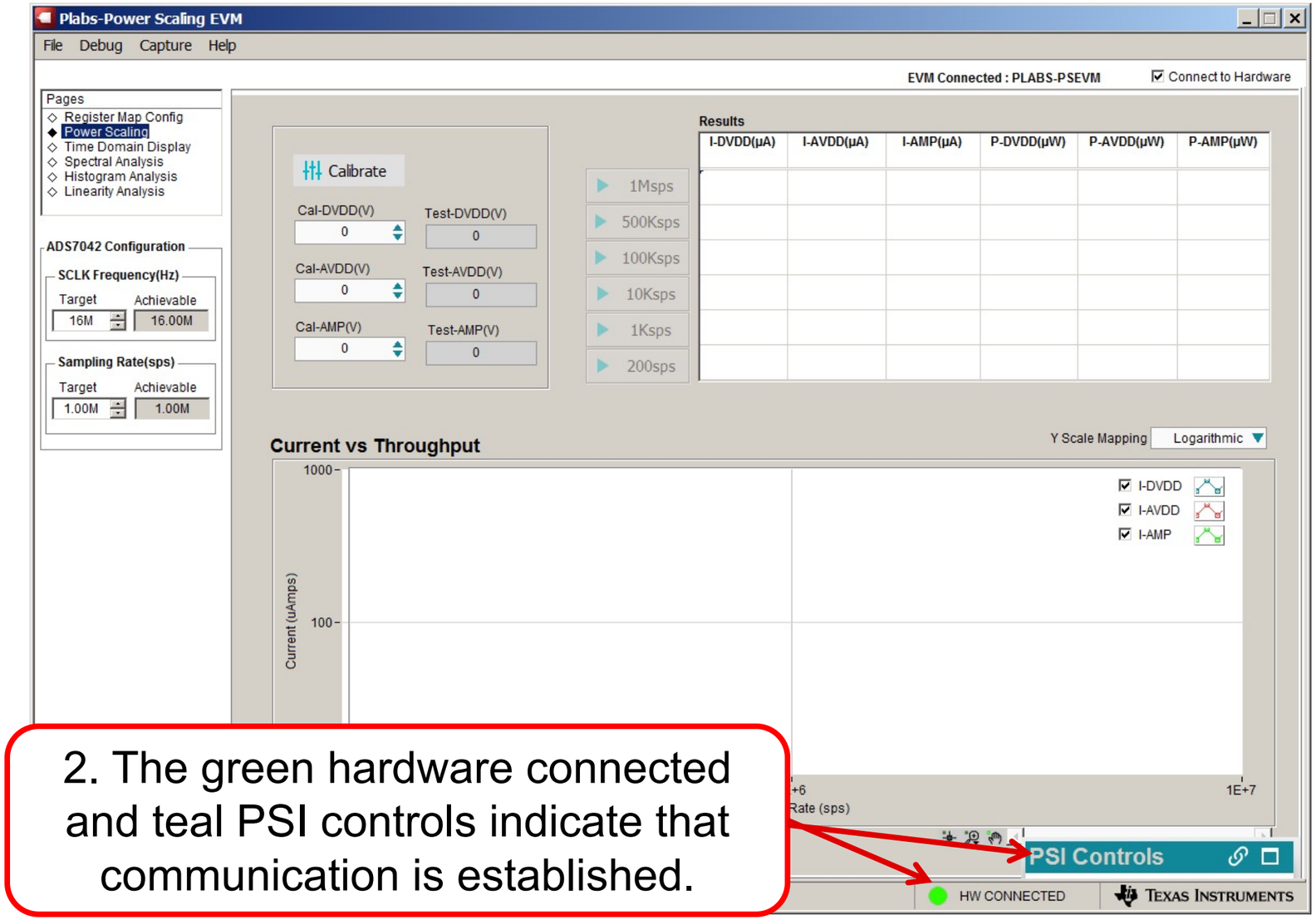
Connect the hardware



Start & Setup the Plabs-Power Scaling EVM Software

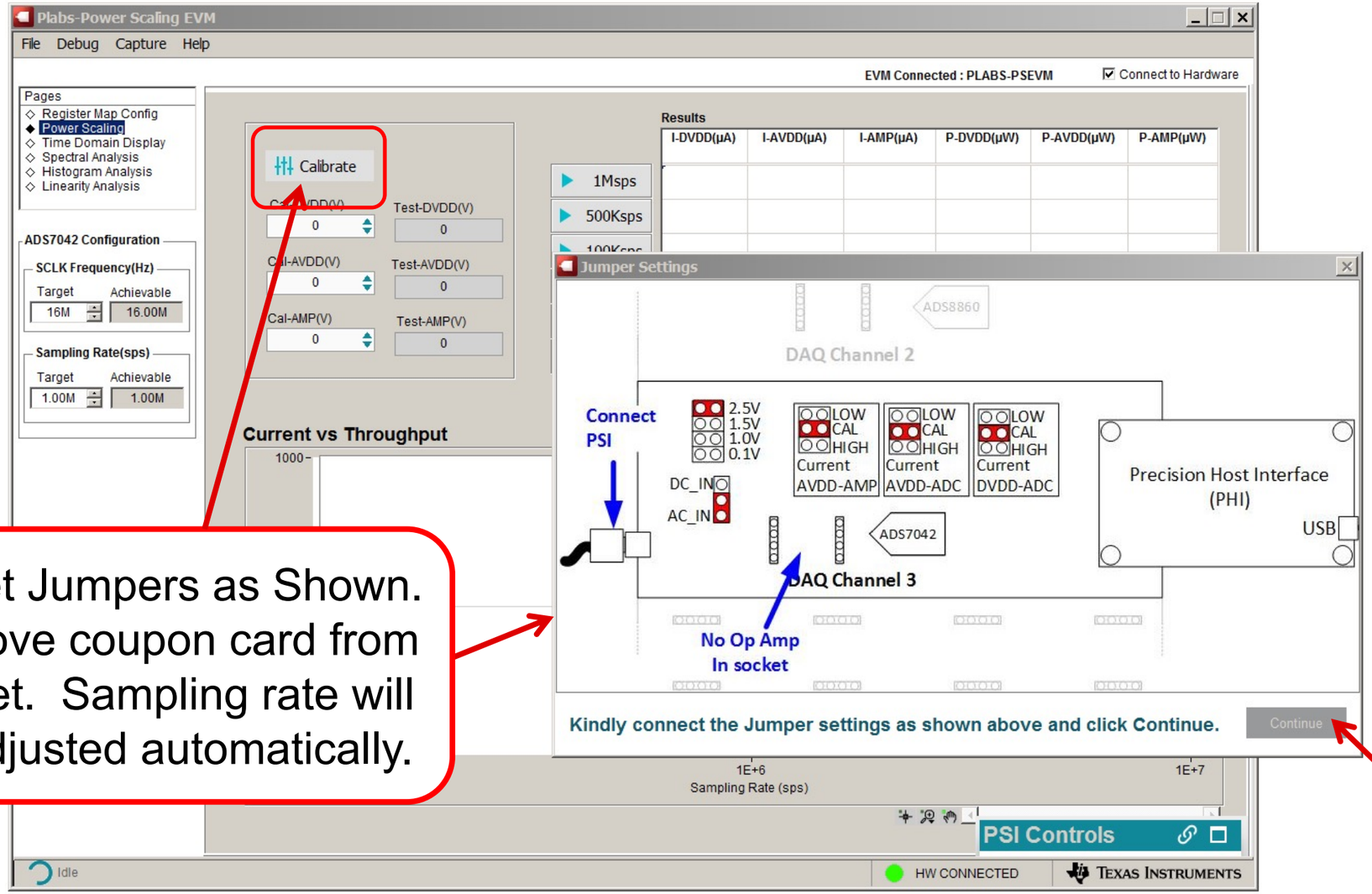


1. Select “Plabs-Power Scaling” from “start>All Programs”



2. The green hardware connected and teal PSI controls indicate that communication is established.

Calibrate system offsets



1. Set Jumpers as Shown. Remove coupon card from socket. Sampling rate will be adjusted automatically.

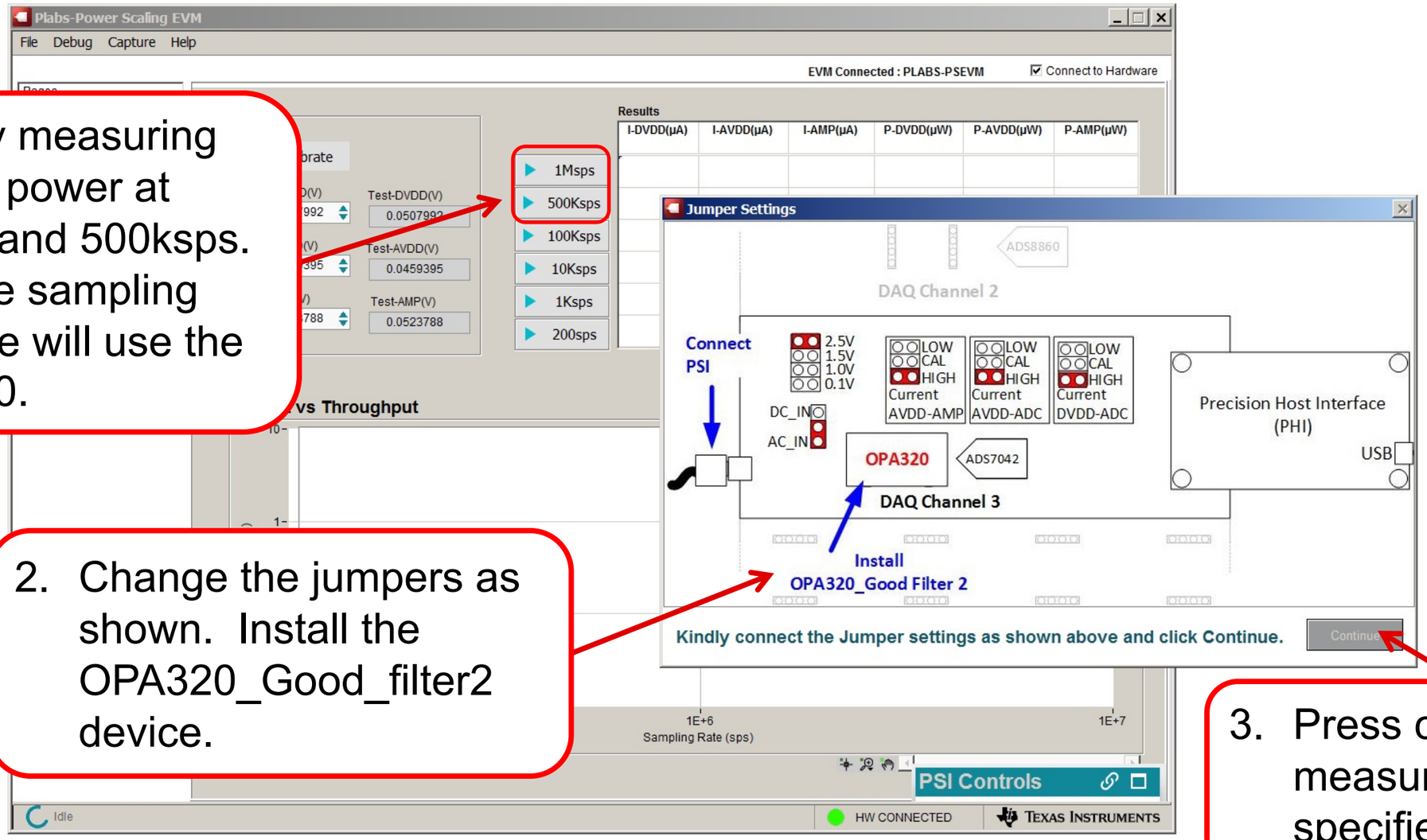
2. Press “continue” after the hardware is configured.

Measure OPA320 at different sampling rates

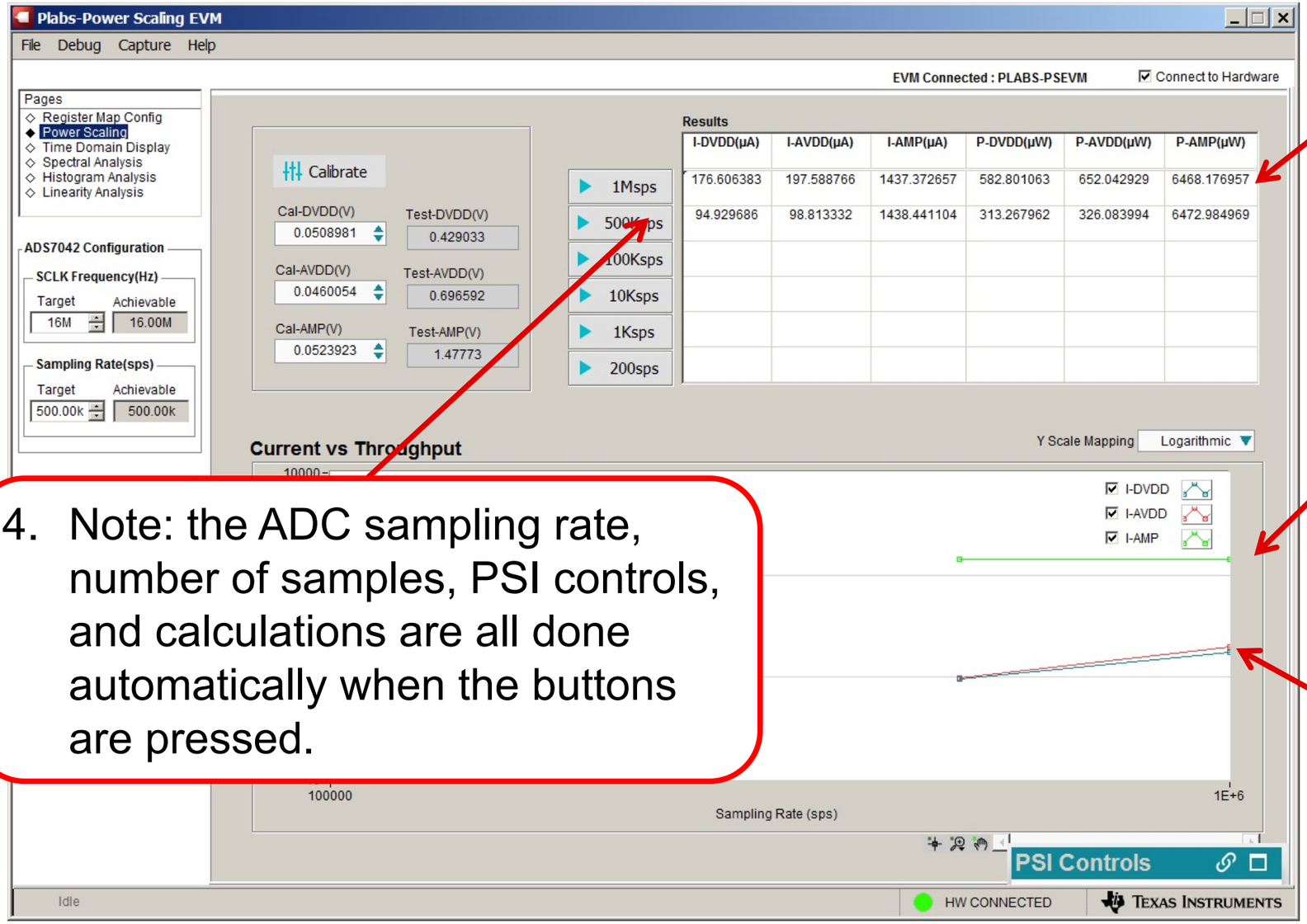
1. Start by measuring system power at 1Msps and 500ksps. At these sampling rates we will use the OPA320.

2. Change the jumpers as shown. Install the OPA320_Good_filter2 device.

3. Press continue to measure power at the specified sampling rate.



Expected results for OPA320



1. Your power measurements should be in the same range as these. When running at full speed power is in the hundreds of µW to mW.

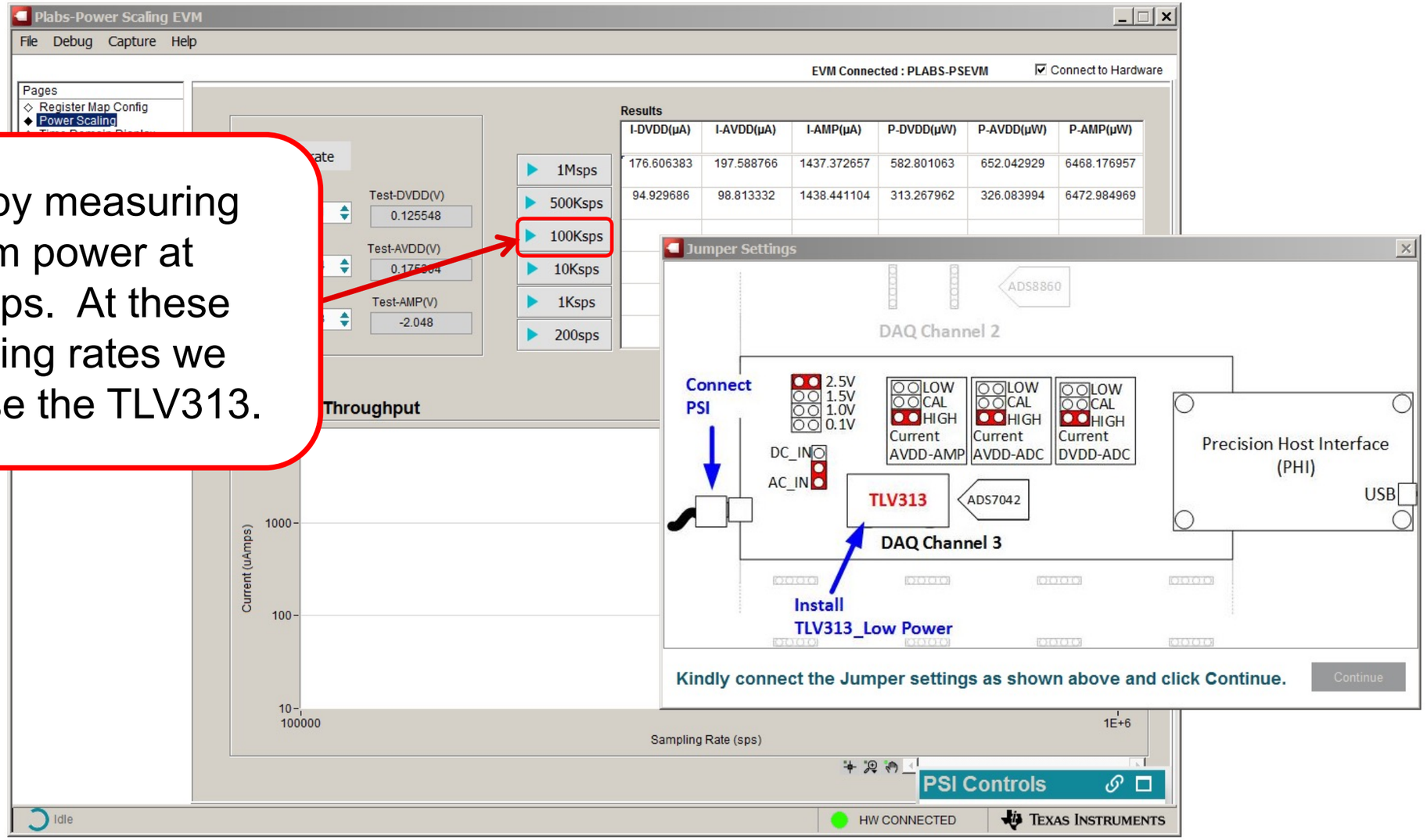
2. Notice that the amplifier current is constant and not dependent on sampling rate.

3. ADC current scales with sampling rate.

4. Note: the ADC sampling rate, number of samples, PSI controls, and calculations are all done automatically when the buttons are pressed.

Measure TLV313 at 100ksps

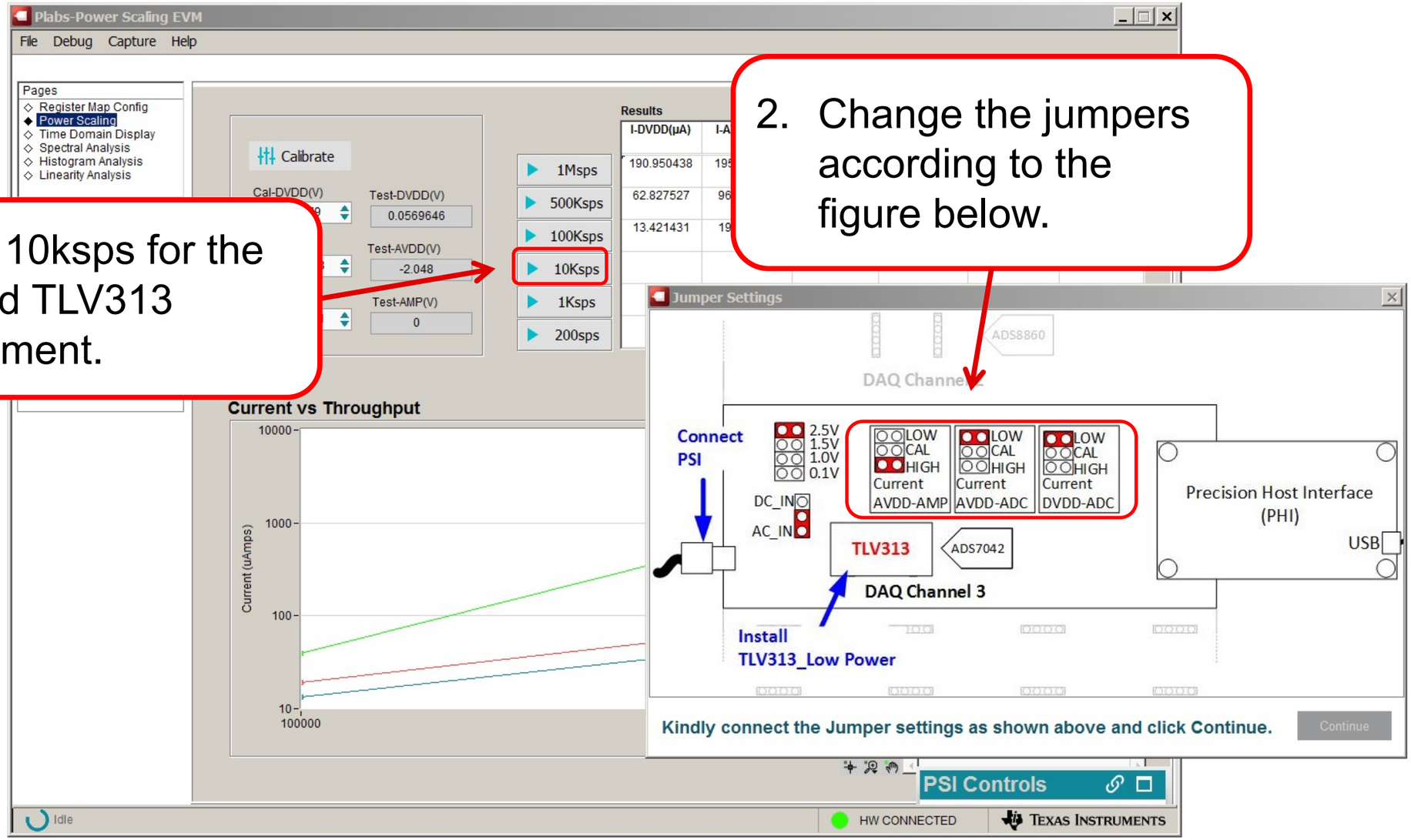
1. Start by measuring system power at 100ksps. At these sampling rates we will use the TLV313.



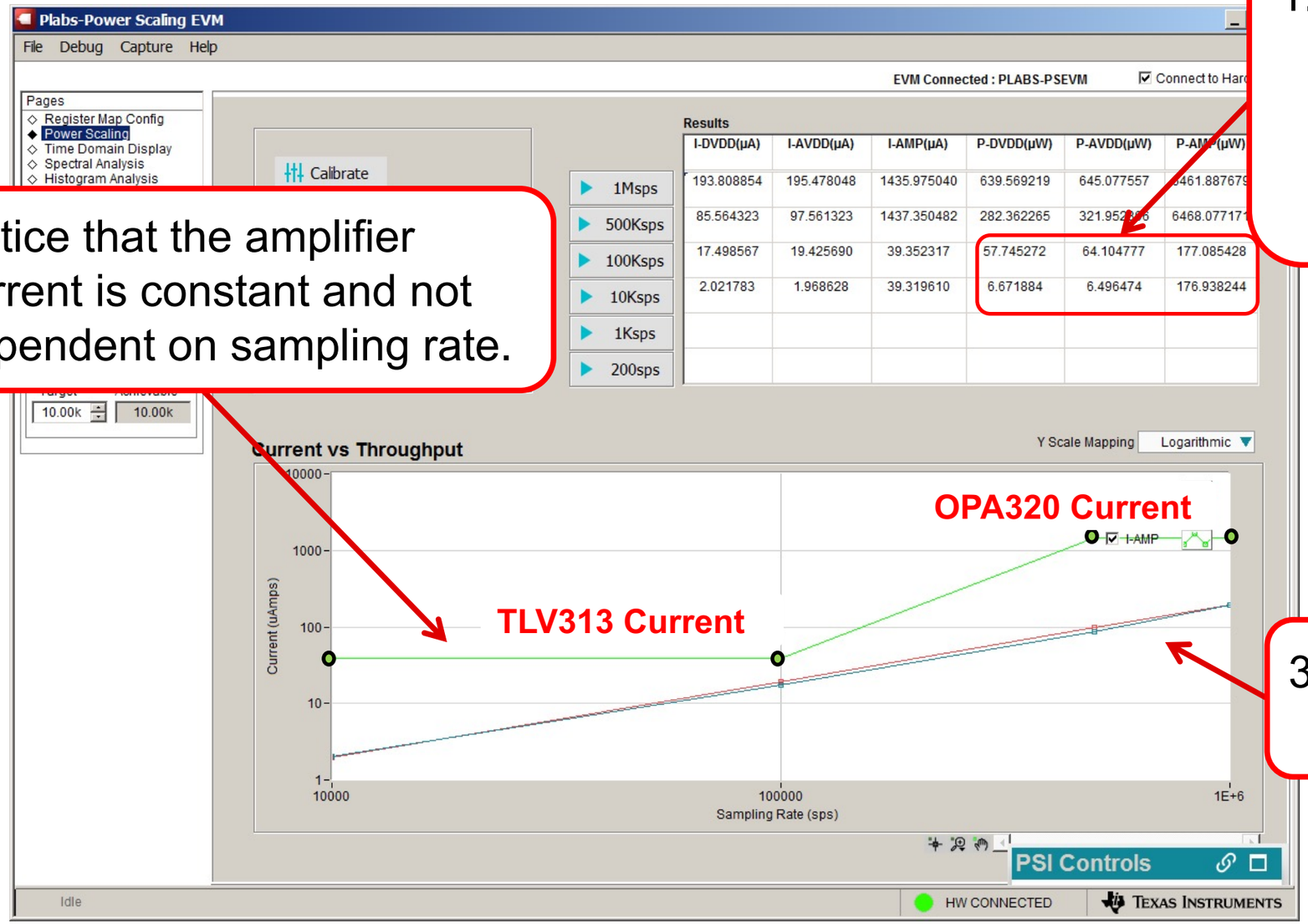
Measure TLV313 at 10ksps

1. Press 10ksps for the second TLV313 experiment.

2. Change the jumpers according to the figure below.



Expected results for TLV313



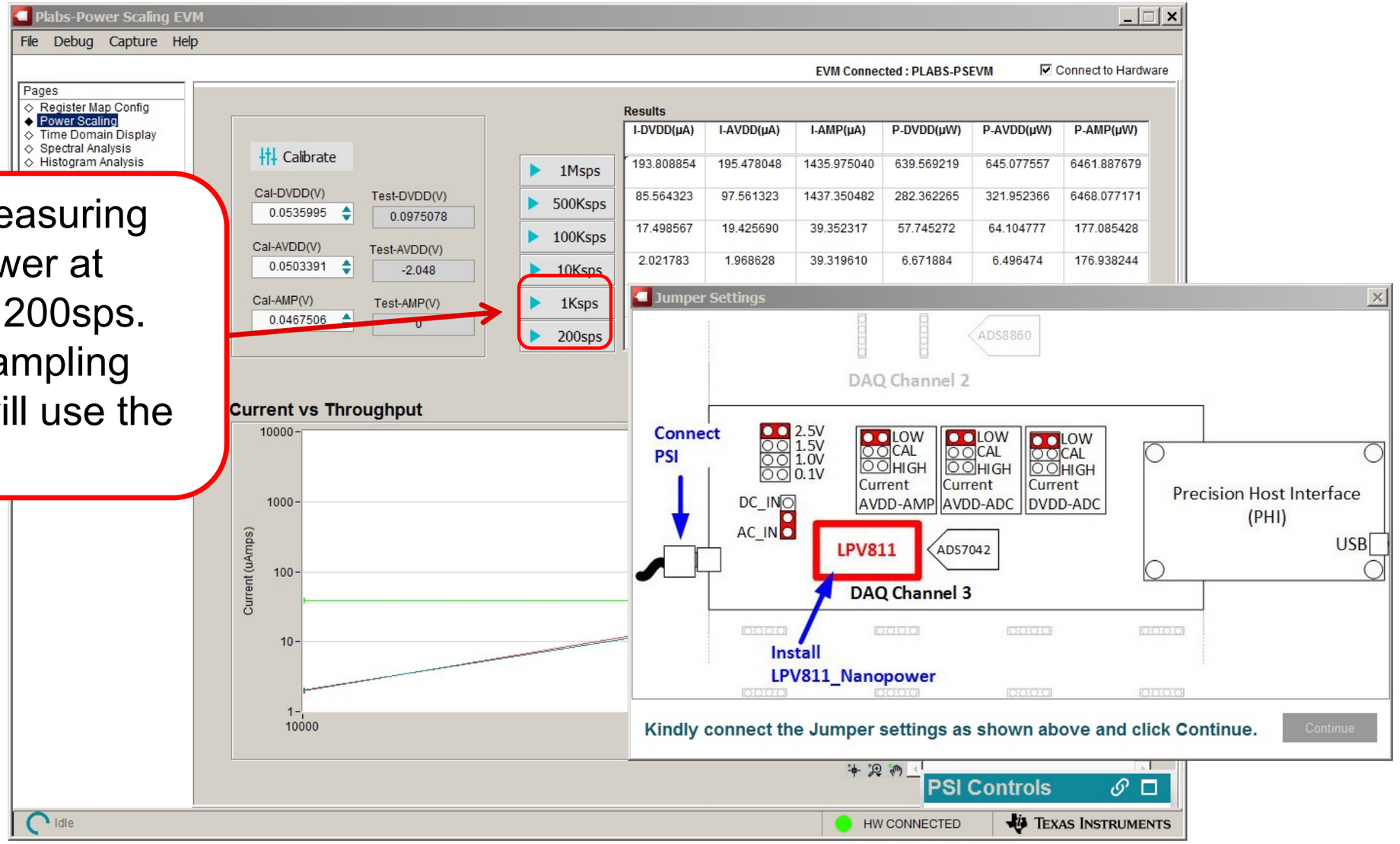
1. Your power measurements should be in the same range as these. When running at medium speed the power is in the tens to hundreds of µW.

2. Notice that the amplifier current is constant and not dependent on sampling rate.

3. ADC current scales with sampling rate.

Measure LPV811 at different sampling rates

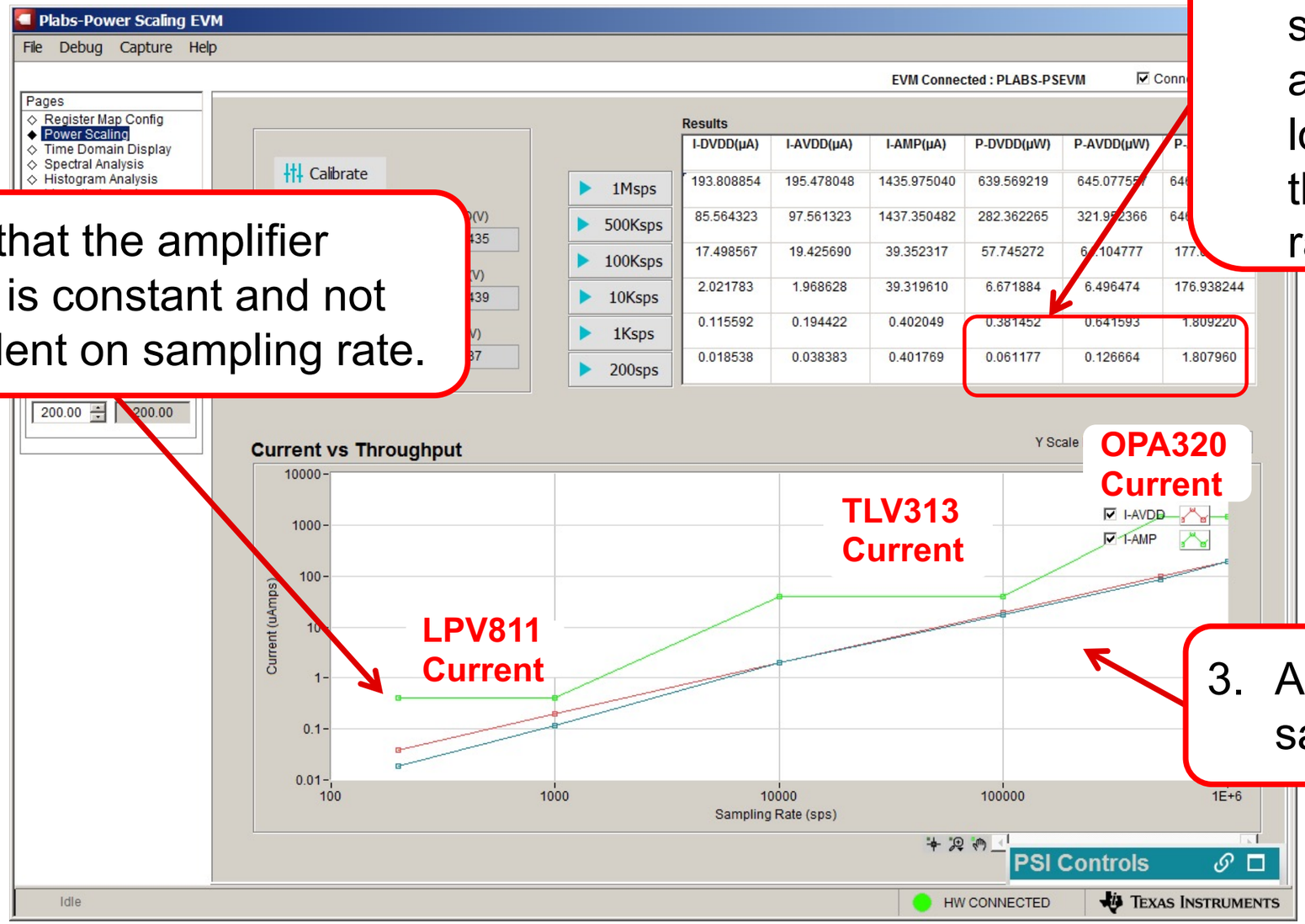
1. Start by measuring system power at 1ksps and 200sps. At these sampling rates we will use the LPV811.



Expected results for LPV811

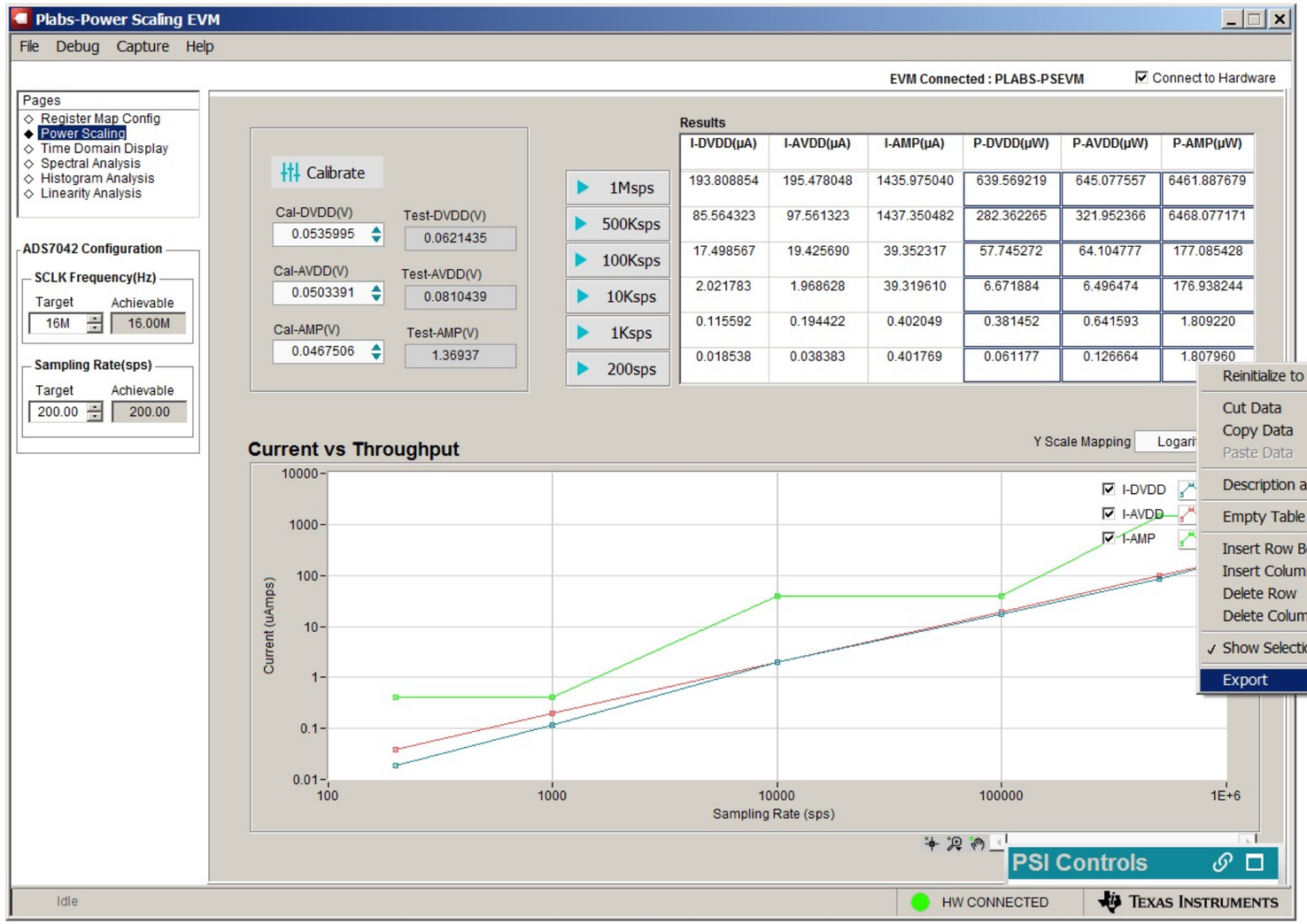
1. Your power measurements should be in the same range as these. When running at lowest speed the power is in the hundreds of nW to µW range.

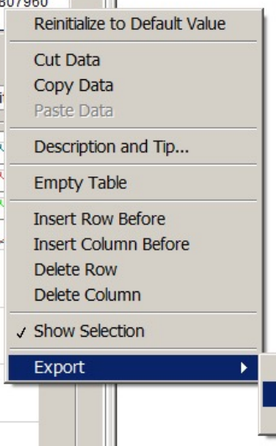
2. Notice that the amplifier current is constant and not dependent on sampling rate.

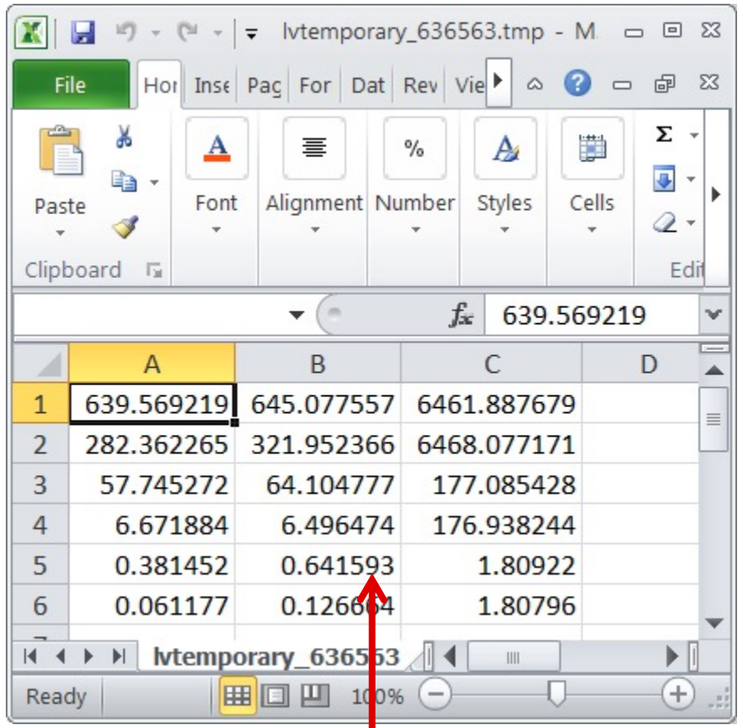


3. ADC current scales with sampling rate.

Compare final test results to calculated values







Select the “Power” cells in the measured table. Right click and “Export Data to Excel”.

Measured vs Expected Results

Your results should show the same trend as the expected result but the specific values will differ.

		Calculated				Example Measurements			
Amp	Sampling Rate	P_{DVDD} (µW) Max	P_{AVDD} (µW) Max	P_{Q_Amp} (µW) Max	P_{TOTAL} (µW) Max	P_{DVDD} (µW)	P_{AVDD} (µW)	P_{Q_Amp} (µW)	P_{TOTAL} (µW)
OPA320	1M	1306.80	690.00	7875.00	9871.80	639.57	645.08	6461.89	7746.53
OPA320	500k	653.40	345.00	7875.00	8873.40	282.36	321.95	6468.08	7072.39
TLV313	100k	130.68	69.00	405.00	604.68	57.75	64.10	177.09	298.94
TLV313	10k	13.07	6.90	405.00	424.97	6.67	6.50	176.94	190.11
LPV811	1k	1.31	0.69	2.43	4.43	0.38	0.64	1.81	2.83
LPV811	200	0.26	0.14	2.43	2.83	0.06	0.13	1.81	2.00

Measured vs Expected Results

		Calculated				Your Measurements			
Amp	Sampling Rate	P_{DVDD} (µW) Max	P_{AVDD} (µW) Max	P_{Q_Amp} (µW) Max	P_{TOTAL} (µW) Max	P_{DVDD} (µW)	P_{AVDD} (µW)	P_{Q_Amp} (µW)	P_{TOTAL} (µW)
OPA320	1M	1306.80	690.00	7875.00	9871.80				
OPA320	500k	653.40	345.00	7875.00	8873.40				
TLV313	100k	130.68	69.00	405.00	604.68				
TLV313	10k	13.07	6.90	405.00	424.97				
LPV811	1k	1.31	0.69	2.43	4.43				
LPV811	200	0.26	0.14	2.43	2.83				

Thanks for your time!