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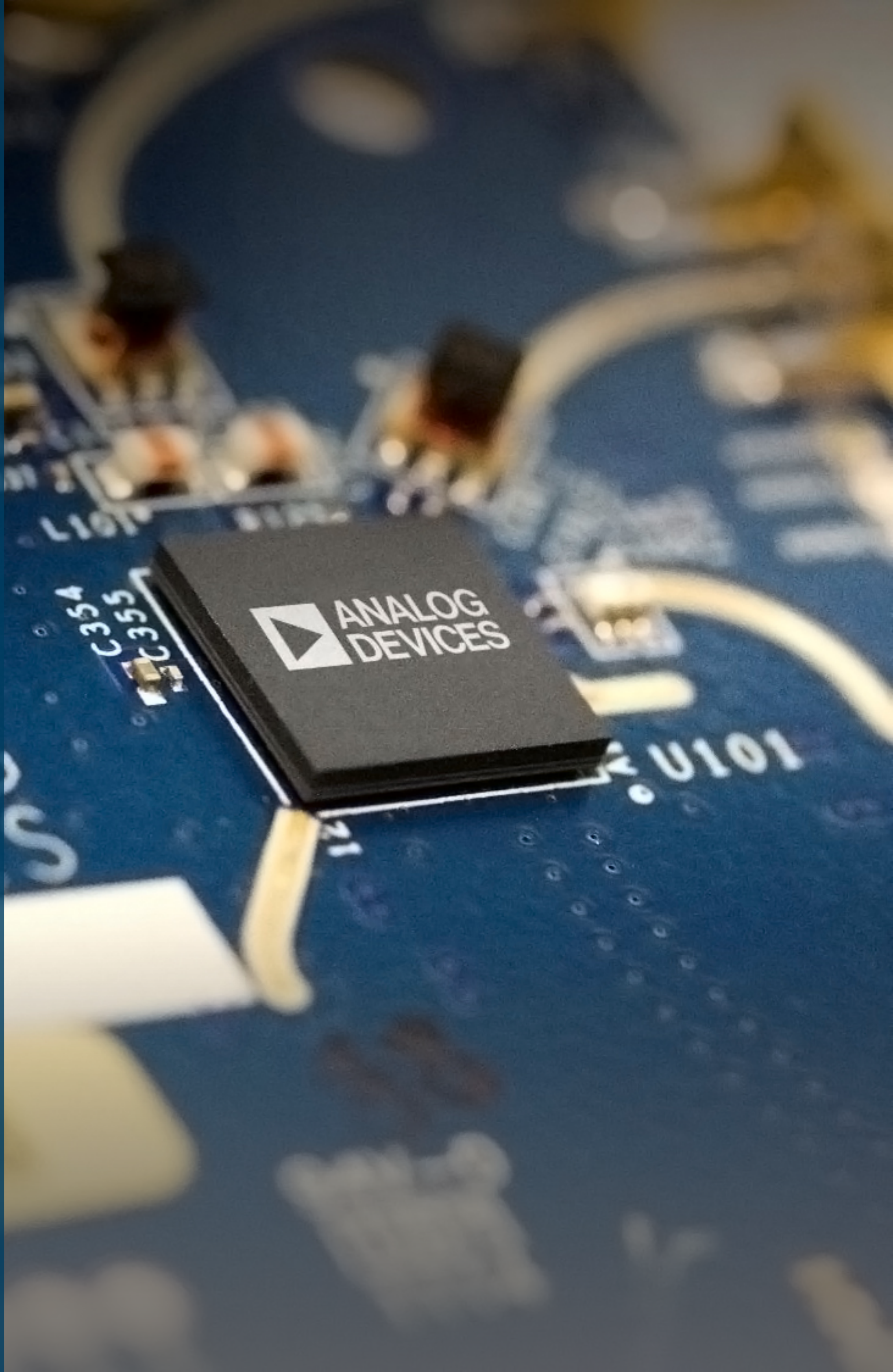
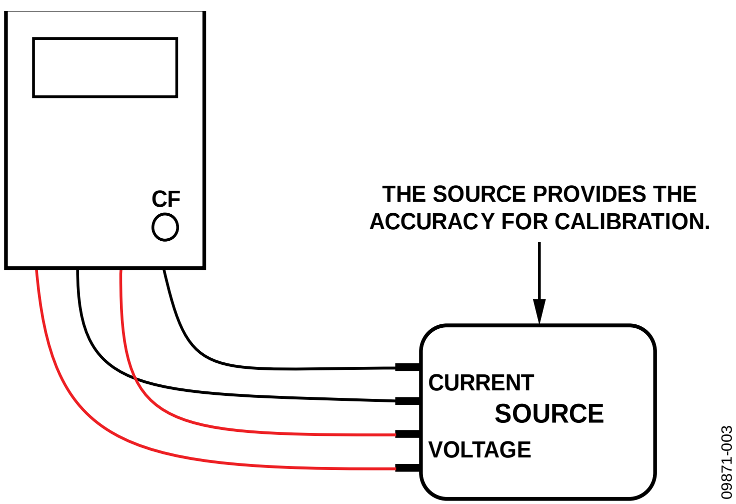
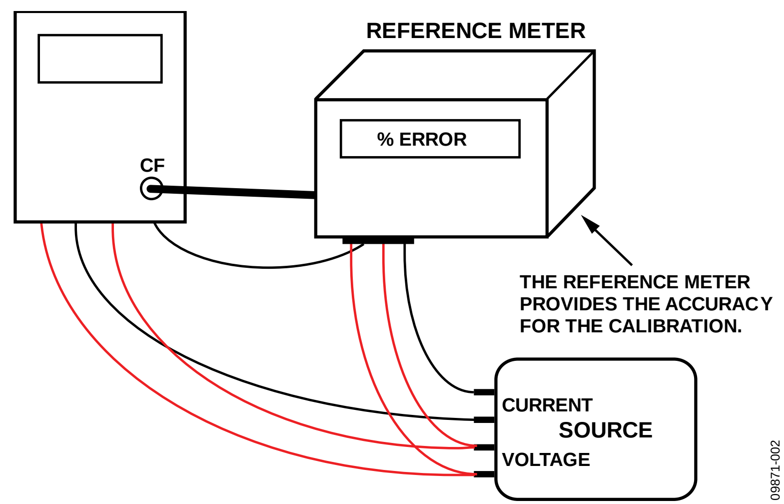
ADE9000 QUICK START & GUIDE for CALIBRATION TOOL



Typical Calibration Setups

- **Accurate Source**
  - Suitable for calibration using internal registers
- **Reference meter**
  - Suitable for calibration using CF outputs





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Calibration Techniques

1) **Reading internal energy registers**
2) **CF outputs**
   - Error output from reference meter using CF readings
   - Impulse/kWHr output from reference meter using CF readings

- **Download ADE9000 calibration tool: http://www.analog.com/media/en/engineering-tools/design-tools/ADE9000-Calibration-Tool.zip**

Calibration Flow using Internal Registers

- **Setup initialization registers.**
  - Set PGA Gain, HPF_CRN,INTEN(&DICOEFF=0xFFFFE000),VLEVEL as described in ADE90078 datasheet. Setup and enable energy accumulation (EP_CFG). Set RUN=1.
- **Apply Nominal Voltage and Current.**
- **If accurate RMS readings are required, calibrate RMS.**
  - Perform voltage and current gain (xVGAIN and xIGAIN) calibration.
  - Perform RMS offset calibration if high accuracy is desired at lower end of dynamic range.
  - After calibration, convert register values to electrical parameters using the following equations:
    - *Voltage(V)= xVRMS *Voltage Conversion Constant*10^-6*
    - *Current(I)= xIRMS * Current Conversion Constant*10^-6*
- **Calibrate the Energy.**
  - Perform Phase calibration(xPHCAL) at PF=0.5 lagging by recording active and reactive energy register values.
  - Perform Power Gain (xPGAIN) calibration at PF=1. After calibration,
    - *Power(Watt/VAR/VA) = Power register reading * Power Conversion Constant*10^-3*
    - Energy(kWHr) over accumulation time = *Energy register reading* *Energy *Conversion Constant*10^-6*
  - Perform Power offset calibration if high accuracy is desired at lower end of dynamic range.

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Calibration flow using internal registers: Using the ADE9000_calibration_tool.xlsm

Enter Input Conditions.

Step 1: Input Conditions	
Select Channel Being Calibrated	Channel A
Enter Line Frequency(Hz)	50
Select Current Sensor	Current Transformer
Select Voltage Sensor	Resistor divider
Enter Nominal RMS Input Voltage(Vrms)	220
Enter Nominal RMS Input Current(Arms)	10
Enter Meter Constant(impulses/kWHr)	3000
Enter Energy Accumulation Time(sec)	10
Enter Voltage PGA_GAIN	1
Enter Current PGA_GAIN	1
Step 2: Seting up CF pulses	
Enter CT Turns ratio	2500
Enter Total CT Burden Resistor(Ohm)	20
Current Transfer Function(V/A)	0.008
Enter Top Leg (R1) of Divider Resistor (KOhm)	990
Enter Bottom Leg (R2)of Divider Resistor (kOhm)	1
Voltage Transfer Function(V/V)	0.001009082
Expected CF at Nominal Conditions(Hz)	1.833333333
Program xTHR to Recommended Value(xTHR=0x00100000)	100000
Nominal Voltage percentage of full scale	31.40%
Nominal Current percentage of full scale	11.31%
CFxDEN Register(hex)	BF3
Voltage Conversion Constant(uVrms/Code)	13.29629989
Current Conversion Constant(uArms/Code)	1.677131672
Power Conversion Constant(mWatt/Code)	2.993007754
Energy Conversion Constant (uWxHr/xxTTHR_HI Code)	0.851344428

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Calibration flow using internal registers : Using the ADE9000_calibration_tool.xlsm

- **Select calibration technique for rms voltage and current calibration.**
  - If accurate RMS readings are not required, this step can be skipped. xIGAIN & xVGAIN affects power datapath, hence xIGAIN & xVGAIN is performed before xPGAIN
  - If accurate RMS readings are required, use the tool to calculate xIGAIN and xVGAIN register values.

Step 3:Voltage and Current Gain Calibration	
Select Calibration technique	Calibrate using Register values
Enter Measured xIRMS register value(hex)	
Enter Measured xVRMS register value(hex)	
Expected xIRMS register value(hex)	5AFB41
Expected xVRMS register value(hex)	FC78A5
AIGAIN Register(hex)	#DIV/0!
AVGAIN Register(hex)	#DIV/0!
Enter Measured xIRMS register value after calibration(hex)	
Enter Measured xVRMS register value after calibration(hex)	
Current Error after Compensation	-100.00%
Voltage Error after Compensation	-100.00%
Step 3.1: RMS offset calibration	
Enter Offset Calibration Current(Arms)	
Enter Offset Calibration Voltage(Vrms)	
Enter Measured xIRMS register value(hex)	
Enter Measured xVRMS register value(hex)	
Enter Measured xIFRMS register value(hex)	
Enter Measured xVFRMS register value(hex)	
AIRMSOS Register(hex)	0
AVRMSOS Register(hex)	0
AIFRMSOS Register(hex)	0
AVFRMSOS Register(hex)	0

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Calibration flow using internal registers : Using the ADE9000_calibration_tool.xlsm

- **Phase calibration**
  - Set PF=0.5 lagging such that the active and reactive powers are positive with the nominal inputs entered in step 1.
  - Enter the active and reactive energy register readings
  - Program calculated xPHCAL0 register

Step 4: Phase calibration	Done at Lagging PF=0.5 such that Active and Reactive Energies are Positive
Select Calibration technique	Calibrate using Register values
Enter Calibrating Angle between V and I(°)(positive angle for lagging PF)	60
Expected Active Energy Register(xWATTHR_HI hex) at calibrating angle	36C3E6
Expected Reactive Energy(xVARHR_HI hex) at calibrating angle	5EDB2D
Enter measured Active Energy register xWATTHR_HI (hex) at calibrating angle	
Enter measured Reactive Energy register xVARHR_HI (hex) at calibrating angle	
Desired Phase Error Compensation(°)	#DIV/0!
APHCAL0 Register(hex)	#DIV/0!

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Calibration flow using internal registers : Using the ADE9000_calibration_tool.xlsm

- **With nominal inputs entered in step 1, perform gain calibration**
  - Enter energy register reading in the input field. Program the calculated xPGAIN register
- **Perform offset calibration if high accuracy at low dynamic range is required**

Step 5: Power Gain Calibration	Done at PF=1 or lagging PF = 0.5
Select Calibration technique	Calibrate using Register values
Enter Angle between V and I(°)	0
Enter measured Active Energy register xWATTHR_HI (hex)	
Expected Active Energy register xWATTHR_HI (hex)	6D87CC
Expected Rective Energy register xVARHR_HI (hex)	0
APGAIN Register(hex)	#DIV/0!
Enter measured Active Energy register xWATTHRHI (hex) after xPGAIN Calibration	
Active Energy Error after xPGAIN Calibration	-100.00%

Step 5.1: Power offset calibration	PF=1/0 for active/reactive respectively. Nominal voltage
Select Calibration technique	Calibrate using Register values
Enter Accumulation Time for Offset calibration(sec)	
Enter Calibration Current(Arms)	
Enter measured Active Energy register xWATTHR_HI (hex)	
Enter measured Reactive Energy register xVARHR_HI (hex)	
Enter measured Fundamental Active Energy register xFWATTHR_HI (hex)	
Enter measured Fundamental Reactive Energy register xFVARHR_HI (hex)	
AWATTOS Register(hex)	#DIV/0!
AVAROS Register(hex)	#DIV/0!
AFWATTOS Register(hex)	#DIV/0!
AFVAROS Register(hex)	#DIV/0!

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Calibration flow using internal registers: Using the ADE9000_calibration_tool.xlsm

- **The tool computes the conversion constants using the ideal full scale codes given in the datasheet. After calibration, multiplying a register reading with corresponding conversion constant provides respective physical output.**
- **E.g if AIRMS register reading after calibration = 5962491**
- **The RMS current is calculated as Airms(A) = AIRMS register * conversion constant**

  = 5962491 * 1.677uA/code/10^6 ~= 10Arms

Step 2: Seting up CF pulses	
Enter CT Turns ratio	2500
Enter Total CT Burden Resistor(Ohm)	20
Current Transfer Function(V/A)	0.008
Enter Top Leg (R1) of Divider Resistor (KOhm)	990
Enter Bottom Leg (R2)of Divider Resistor (kOhm)	1
Voltage Transfer Function(V/V)	0.001009082
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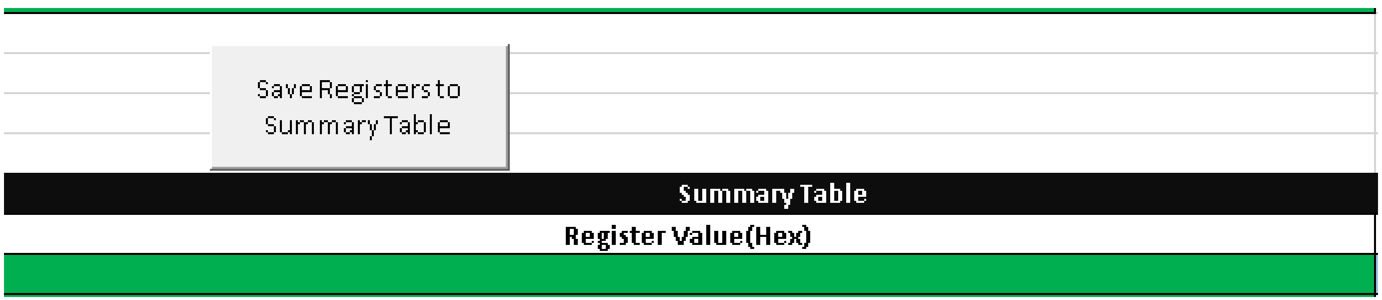
Save

Save Calibration values:

- Press the save button after calibrating each channel.
- This populates the Summary Table



Calibration Flow using CF outputs

- **Setup initialization registers.**
  - Set PGA Gain, HPF_CRN, INTEN (&DICOEFF=0xFFFFE000), VLEVEL as described in ADE9000 datasheet.(See appendix)
  - Setup and enable energy accumulation (EP_CFG). Set RUN=1.
- **Select desired Impulses/kWhr**
- **Using ADE9000 calibration_sheet compute CFxDEN. Configure CF registers.**
  - Set CFMODE and COMPMODE registers as needed in application.
  - Set WTHR = VARTHR = VATHR=0x100000.
  - Program calculated CFxDEN.
  - If desired, configure CF_LCFG register.
- **Apply Nominal Voltage and Current.**
- **If accurate RMS readings are required.**
  - Perform voltage and current gain (xVGAIN and xIGAIN) calibration using internal register read method.
  - Perform offset calibration if high accuracy is desired at lower end of dynamic range.
- **Calibrate the Energy.**
  - Perform phase(xPHCAL) calibration by recording CF/ Active Energy error/Active Energy impulses/kWHr at PF=1 and PF=0.5 lagging.
  - Perform Power Gain calibration at PF=1.
  - Perform Power Offset calibration if high accuracy is desired at lower end of dynamic range.

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