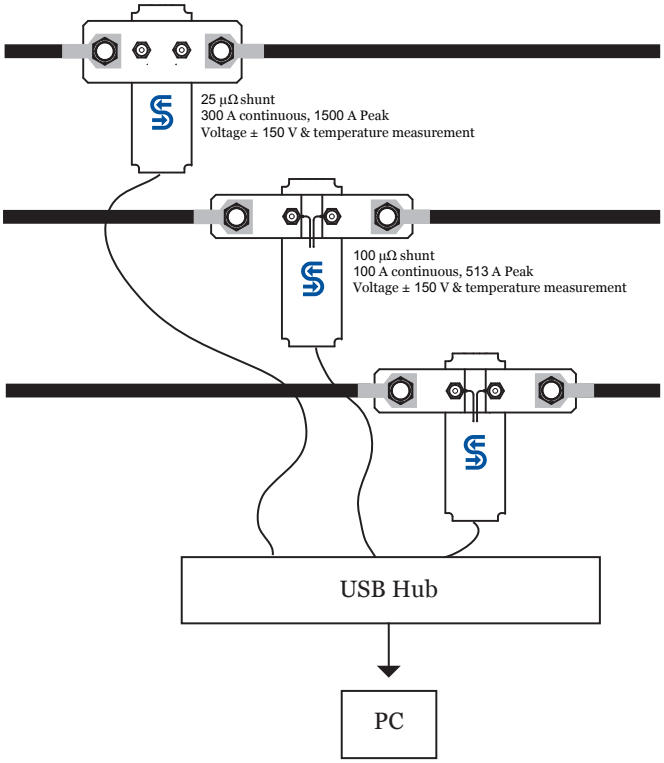
Sendyne® Sensing Products Family

Sendyne SFP101EVB-LAB Signature Series



Description

The Sendyne Signature Series SFP101EVB-LAB is a precision current, voltage and temperature measurement module. This individually-calibrated module can resolve currents up to 100 A continuous and 513 A peak. Alternate shunts are available for those who wish to measure smaller or higher currents. The module achieves an offset error of less than 3 mA and gain error of less than 0.05% which is maintained from -40 °C to +125 °C due to Sendyne's proprietary temperature compensation feature. In addition, the SFP101EVB-LAB measures voltage (0.1% of standard nominal full scale voltage of ±150 V), temperature (at one external point, ±0.5 °C) and provides separate charge, discharge and total Coulomb counters. The time between measurements is fast: 0.005 s, making the unit practical for real time experiments.

Multiple SFP101EVB-LAB modules can run concurrently to measure more than one current and voltage at a time—particularly useful in testing and lab applications. A library for import into National Instrument's LabView is available at www.github.com/sendyne allowing the use of real-time data from one or more SFP101EVB-LAB modules. Communication is achieved via a LIN-like serial interface.

The complete evaluation kit for the SFP101EVB-LAB also includes a Serial-to-USB cable, as well as Sendyne's PC-based testing software (available as a free download from www.sendyne.com).

Applications

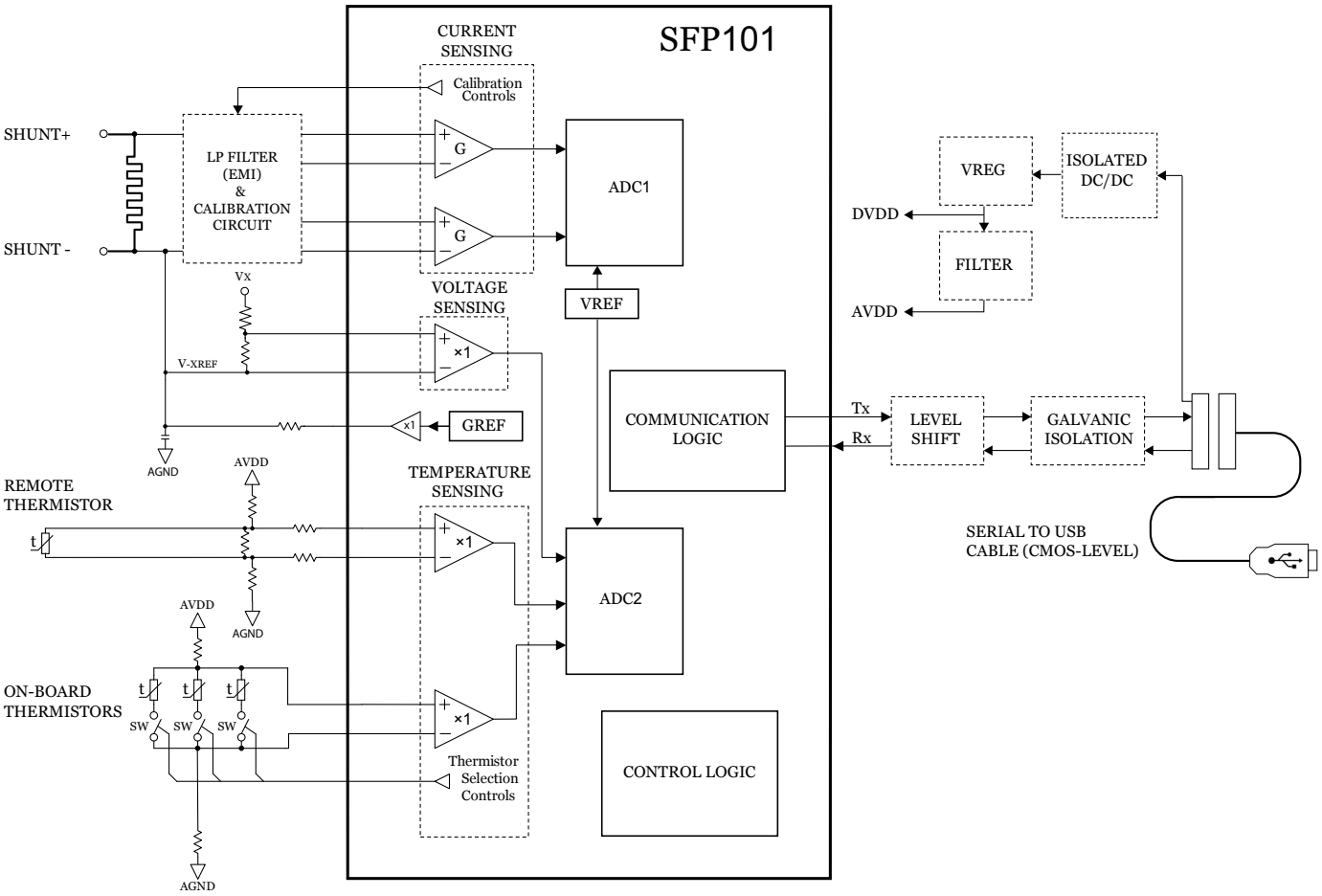
- *Test benches*
- *High accuracy lab environments*
- *Battery monitoring for industrial, automotive, railroad and utility scale storage*
- *Current flow precision metering*

Operating Specifications

Parameter	Value
Shunt value	100 µOhm
Power supply	+5.0 V ±10% (isolating DC/DC is built-in)
Interface	SCI (UART)
Current measurement range	±100 A continuous/ ±513 A peak
Voltage measurement range	±150 V
Rating	Industrial
Mating Connector	100-mil header
Module operating temperature range	-40 °C to +125 °C

Functional Block Diagram

Figure 1: Functional Block Diagram



The circuit and its operation are patented and patent pending

Technical Specifications

All specifications apply over the full ambient operating temperature range, T_A = -40 °C to +125 °C, unless otherwise noted. Supply voltage V_{CC} is 5.0 V ±10 %.

Electrical Specifications

Parameter	Min	Typ	Max	Units	Conditions/Comments
Power and General					
T_A Ambient Operating and Storage Temperature	-40		+125	°C	SFP101EVB-LAB assembly only NOTE1 (USB Interface Cable excluded)
T_{IOCBL} Operating and Storage Temperature of the Serial-to-USB interface cable	-40		+85	°C	Serial-to-USB Interface cable is normally plugged into a Host PC typically located in a human-habitable environment that is much narrower than T_{IOCBL} NOTE2
V_{CC} Supply Voltage	4.5	5.0	5.5	V	Supplied by Serial-to-USB Interface cable from Host PC
I_{VCC} Supply Current		16.4		mA	16.4 mA × 5.0 V = 82 mW Typical
T_{PON} Start-up time		0.5	0.75	s	After initial application of power and power supply stabilization; internal start-up delay before communications with SFP101EVB-LAB are first allowed
Current Measurement	Through negative and positive terminals of the shunt				
R_{SH} Total Shunt Resistance	95	100	105	μΩ	As measured between Negative and Positive terminals (i.e. 100 μΩ ± 5 %)
$R_{SH\text{-}SENSE}$ Shunt Current-sensing Resistance		73		μΩ	Effective current-sensing resistance between voltage-drop sensing leads
$I_{SH\text{-}NOM}$ Nominal Full-scale current		±100		A	Continuous rating at room temperature (23 °C) in an open environment without forced air movement. Current is supplied by 1/0 AWG copper cables terminated with appropriate crimp connectors and attached to the shunt's Negative and Positive terminals with threaded fasteners (i.e. bolt + nut) incorporating lockwasher or Belleville spring to maintain pressure during temperature changes

Electrical Specifications

Parameter	Min	Typ	Max	Units	Conditions/Comments
$I_{SH\text{-}TEMP}$ Temporary Full-scale current		±200		A	Less than 30 minutes duration, the same conditions as above for $I_{SH\text{-}NOM}$, initial shunt temperature is 23 °C
$I_{SH\text{-}PK}$ Peak Full-scale current		±513		A	Less than 10 s duration, the same conditions as above for $I_{SH\text{-}TEMP}$. Maximum current value measured and reported without clipping or distortion[NOTE8]
$I_{SH\text{-}TRANS}$ Transient over-current		±3		kA	Physical survival rating, less than 5 s duration, the same conditions as above for $I_{SH\text{-}TEMP}$ [NOTE3]
$I_{SH\text{-}OFST}$ Current offset error	-3	±1	+3	mA	I_{SH} = 0 A, uncalibrated performance, applies over the full ambient operating temperature range, T_A = -40 °C to +125 °C
$I_{SH\text{-}ERR}$ Current value error	-0.1	0.05	+0.1	%	I_{SH} = 20 A, individually calibrated with a module-specific temperature compensation table, T_A = -40 °C to +125 °C [NOTE4]
$I_{SH\text{-}NOISE}$ Current measurement noise		1.125	1.5	mA_{RMS}	1 Hz current report rate. IC is uncalibrated. Measured over full temperature range of T_A = -40 °C to +125 °C over 18 hours
$I_{SH\text{-}COUNT}$ Current measurement resolution		61.19		µA	Minimum discernible current change; corresponds to one count of Analog to Digital Converter (ADC), any current report rate[NOTE8]
$C_{SH\text{-}COUNT}$ Charge measurement resolution		76.49		nC	Minimum discernible amount of charge change; corresponds to one count change of the accumulated charge value in the CUR_ACC registers[NOTE8]

Electrical Specifications

Parameter	Min	Typ	Max	Units	Conditions/Comments
Voltage Measurement	Pins J3-1 & J3-2 (J3-2 is at same potential as the Negative Terminal of the Shunt)				
$V_{X\text{-}NOM}$ Nominal Full-scale voltage range		±150		V	Input voltage divider of 1 MΩ / 4.99 kΩ
$V_{X\text{-}MAX}$ Maximum input voltage		±241		V	Maximum voltage value measured and reported without clipping or distortion
$V_{X\text{-}MAX\text{-}OVLD}$ Short time maximum input voltage overload	-300		+300	V	Short duration of overload, 5 s maximum
$V_{X\text{-}OFST}$ Voltage offset error	-20		+10	mV	V_X = 0 V, applies over the full ambient operating temperature range, T_A = -40 °C to +125 °C NOTE5
$V_{X\text{-}TLIM\text{-}OFST}$ Voltage offset error for limited temperature range	-5	±2.5	+5	mV	V_X = 0 V, applies over T_A = +10 °C to +50 °C
$V_{X\text{-}ERR}$ Voltage value error	-0.1		+0.6	%	V_X = 25 V, applies over the full ambient operating temperature range, T_A = -40 °C to +125 °C NOTE6
$V_{X\text{-}CAL\text{-}ERR}$ Voltage value error with single-temperature calibration for limited temperature range	-0.1	±0.05	+0.1	%	V_X = 25 V, applies over T_A = +10 °C to +50 °C. The voltage value is calibrated at +25 °C NOTE7
$V_{X\text{-}NOISE}$ Voltage measurement noise		225	600	μV_{RMS}	1 Hz voltage report rate. IC is uncalibrated. Measured over full temperature range of T_A = -40 °C to +125 °C over 18 hours.

Electrical Specifications

Parameter	Min	Typ	Max	Units	Conditions/Comments
$V_{X\text{-}COUNT}$ Voltage measurement resolution		28.8		µV	Minimum discernible voltage change; corresponds to one count of Analog to Digital Converter (ADC), voltage report rate of 10 Hz or lower
Temp. Measurements	External Thermistor connected to J3-3 & J3-4, and three on-board Thermistors				
T_{ERROR} Absolute temperature measurement error	-1	±0.5	+1	°C	Remote and onboard thermistors, inclusive of measurement noise
$T_{DIF\text{-}ERR}$ Differential temperature measurement error		±10		m°C	Remote and onboard thermistors, for small changes in temperature
$T_{MATCH\text{-}OB}$ Temperature measurement matching, onboard thermistors	-0.5	±0.25	+0.5	°C	Between three onboard thermistors thermally coupled to current shunt
T_{RES} Temperature measurement resolution		0.5		m°C	Practical temperature measurement granularity for remote thermistor
R_{TH} Thermistors' nominal resistance		10.0		kΩ	±1 % at 25 °C, all thermistors
R_{REF} Reference resistance	9.99	10.00	10.01	kΩ	For onboard thermistors: R19, for remote thermistor R8 and 2x R7

Notes for Electrical Specifications

NOTE1 The plastic body (pin strip spacing/positioning) of connector J2 (6-pin single-row 100-mil spacing header) is only rated for operations within -25 °C to +105 °C; however, mechanical integrity is assured by connector pins soldered to plated-through holes in the PCB; extensive thermal cycling and testing of the SFP101EVB-LAB assemblies have not revealed any instances of connector malfunction. The same considerations apply to connector J3 (4-position miniature screw-terminal block with 100-mil spacing).

NOTE2 If operations of the SFP101EVB-LAB outside of the USB I/O cable temperature range are required, an appropriately-rated extension cable should be utilized between the end of the I/O cable and connector J2 on the SFP101EVB-LAB assembly; the entire USB I/O cable must be located in the environment that complies with T_{IOCBL} specification.

NOTE3 Applications of transient over-currents of maximum amplitude are decisively discouraged as the shunt's resistance may shift as much as ±0.5 %.

NOTE4 Effectively, parameters $I_{SH\text{-}ERR}$ and $I_{SH\text{-}TLM\text{-}ERR}$ characterize performance of the resistive shunt only; error contributions of the SFP101 IC and of the whole measurement circuit are minimal. Please see Fig. 7 for the chart of typical current value error dependency on the temperature.

NOTE5 Please see Fig. 8 for the chart of typical voltage offset error dependency on the temperature.

NOTE6 In fact, parameter $V_{X\text{-}ERR}$ characterizes only the performance of the voltage divider that scales the external voltage to the nominal ±1 V input on the SFP101 IC, and formed by two precision resistors (R10 and R9); error contribution of the SFP101 IC is minimal. Please see Fig. 9 for the chart of typical voltage value errors dependency on the temperature.

NOTE7 For all practical purposes, single-temperature calibration of the voltage value (at room temperature) removes dependency of the measured voltage value from the initial errors in the resistances of the two precision resistors (R10 and R9) utilized in the external voltage divider; the resulting specification $V_{X\text{-}CAL\text{-}ERR}$ basically describes the errors in temperature tracking between the resistances of R10 and R9, together with error contribution from thermal drift for the built-in precision voltage reference of the SFP101 IC.

NOTE8 The SFP101 IC has a programmable value for the parameter $I_{SH\text{-}COUNT}$ (and $C_{SH\text{-}COUNT}$), via the setting of register CUR_GAIN (address 0x43) that controls the Full-scale voltage of the Programmable Gain Amplifier (PGA) for the current measurements. However, with the particular shunt (and its resistance), utilized on the module, the $I_{SH\text{-}COUNT}$ (and $C_{SH\text{-}COUNT}$) are initialized to the single specific values shown in the Electrical Specifications Table, and corresponding to the Full-scale voltage of ±37.5 mV for the PGA. Likewise, the specific setting of the PGA and thermal behavior of the shunt defines the information presented for the parameter $I_{SH\text{-}PK}$.

Measured Performance Data

Figure 2: Temperature Dependency of the Absolute Offset Error for Current Measurement

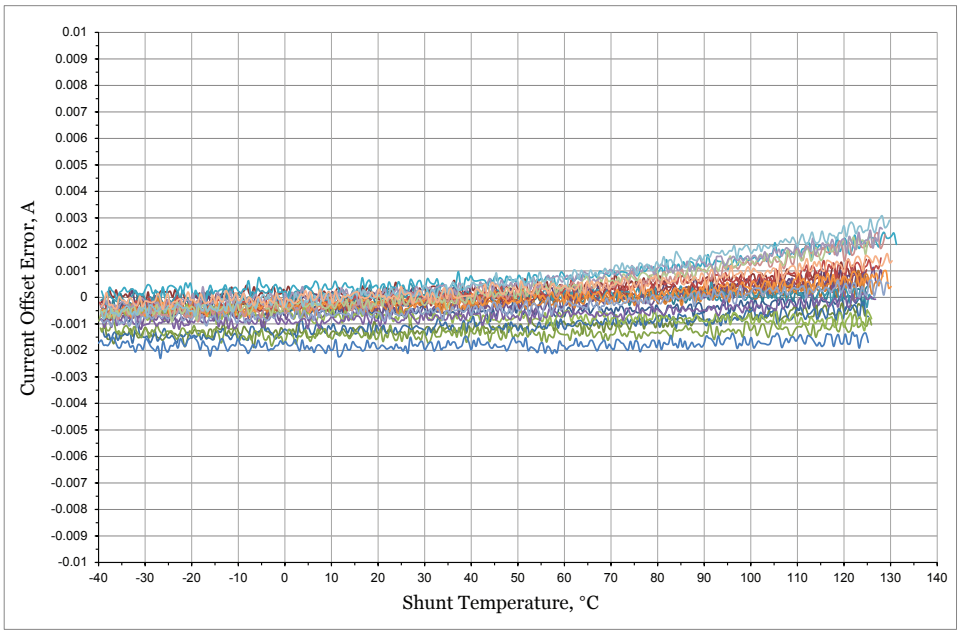


Figure 4: Temperature Dependency of Magnitude Error for Current Measurements, No Compensation

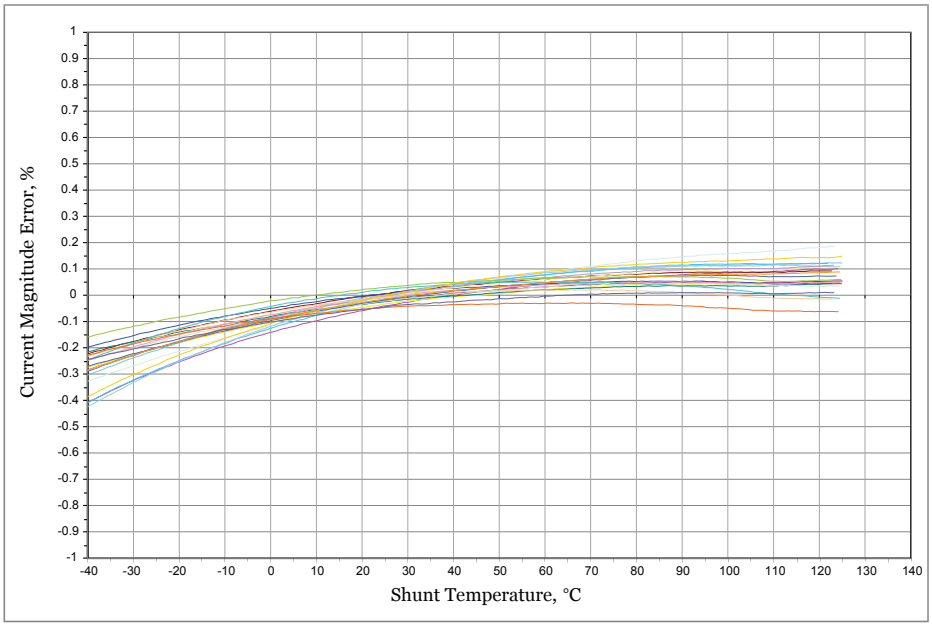


Figure 3: Temperature Dependency of Magnitude Error for Current Measurements, With Compensation

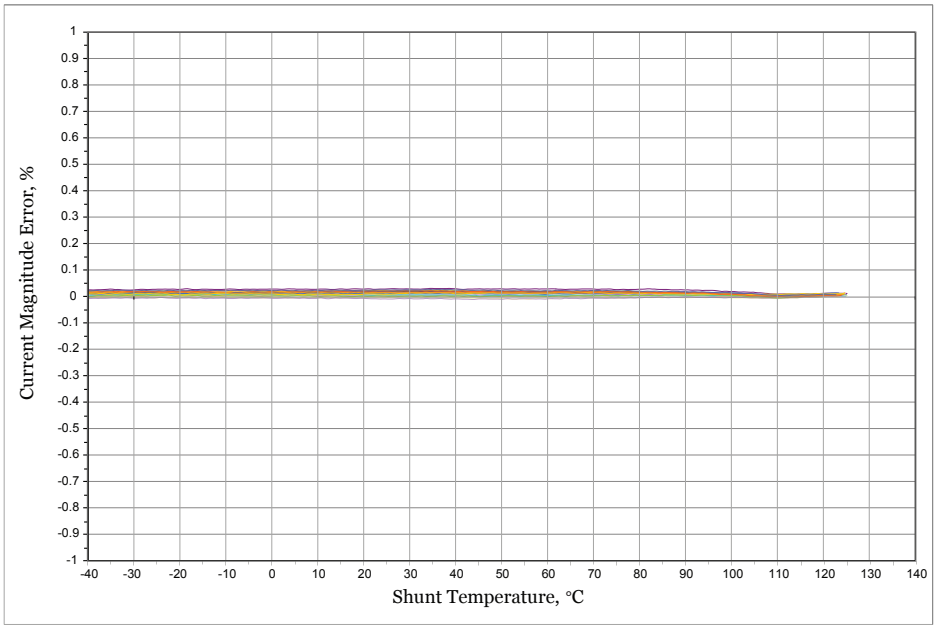


Figure 5: Temperature Dependency of the Absolute Offset Error for the Voltage Measurements

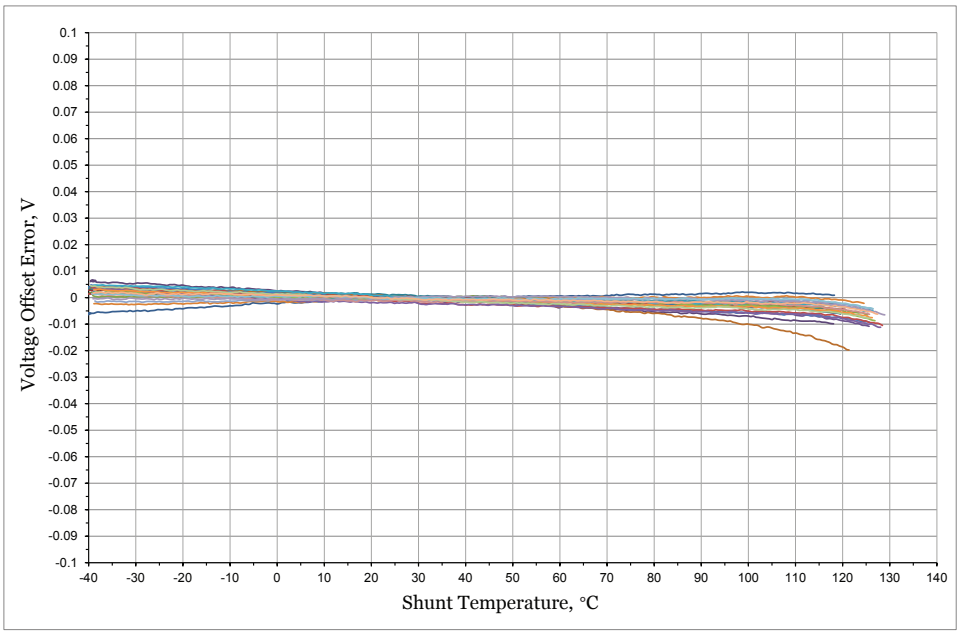
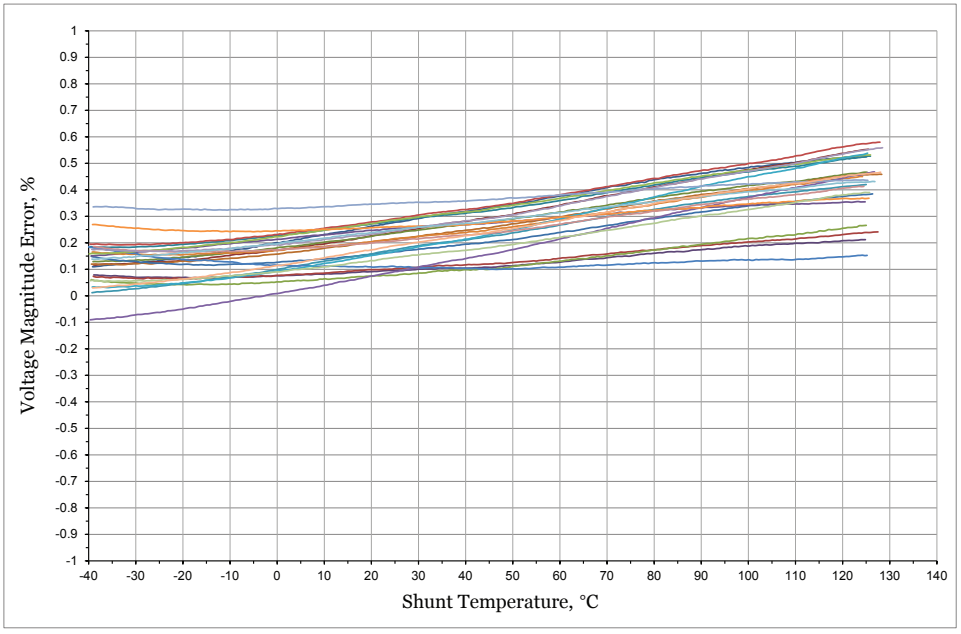


Figure 6: Temperature Dependency of the Relative Magnitude Error for the Voltage Measurements

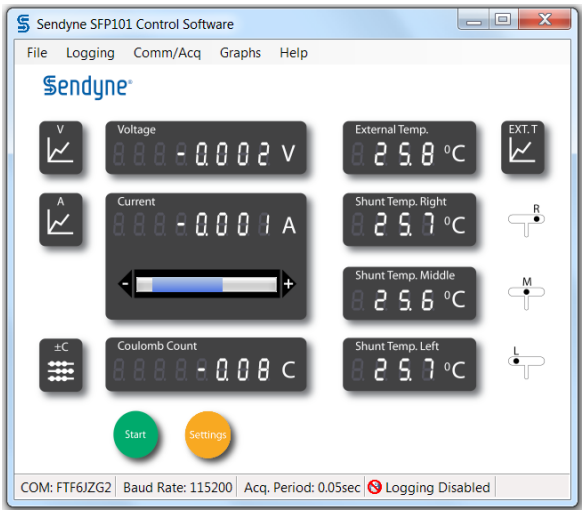


Evaluation Kit

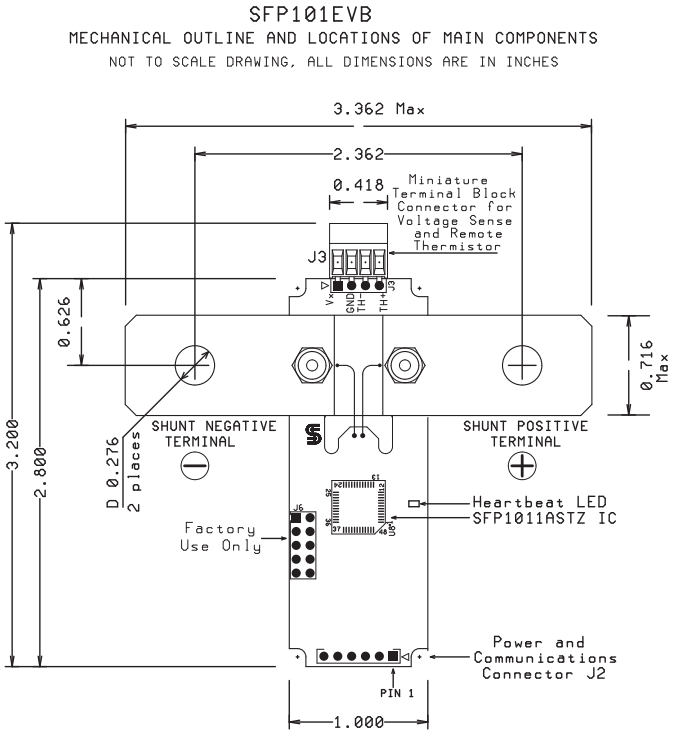
An evaluation kit is available for Sendyne SFP101EVB-LAB. The kit contains the SFP101EVB-LAB and a module interface cable. Please see the ordering section of this document for details.

Evaluation Software

Sendyne's control software for the SFP101EVB-LAB initializes the SFP101 IC for the desired communications rate (9.6 kBd, 19.2 kBd - default, or 115.2 kBd), and polls for data at the selected acquisition rate; it receives the data, checks the data for communications errors, and decodes the values for voltage, current, coulomb counts (three independent values for Total, Charge, and Discharge accumulators), and temperatures for one external and three on-board thermistors. All of these nine channels can be sampled at the acquisition rates up to 20 Hz, when the fastest communications rate of 115.2 kBd is selected. All SFP101 IC registers can be observed and Read/Write registers can be manipulated using this software.



Mechanicals



Ordering Information

Available devices

Model	Temperature Range	Description	Package	Ordering Quantity
SFP101EVB-LAB	*−40 °C to +125 °C*	Module	NA	1
SFP101EVB-LAB-25	*−40 °C to +125 °C*	Module, with 25 micro-Ohm shunt from Vishay Dale	NA	1
SFP101EVB-LAB-KIT	*−40 °C to +85 °C*	Module, Cable, Software	NA	1
SFP100CBL	*−40 °C to +85 °C*	Module cable	NA	1
SFP101SFT	*NA*	Module software	NA	1

Ordering Information

SFP101EVB-LAB

SFP101 — Sendyne base part number

EVB-LAB — Module

Revision History

Revision Table

Revision Number	Date	Comments
1.0	03/07/2016	Preliminary; initial release

Information contained in this publication regarding device applications and the like is provided only for your convenience and may be superseded by updates. It is your responsibility to ensure that your application meets with your specifications.

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Patents

US Pat. 8,264,216
US Pat. 8,289,030
US Pat. 9,052,343
Other patents pending

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