POWERSMART

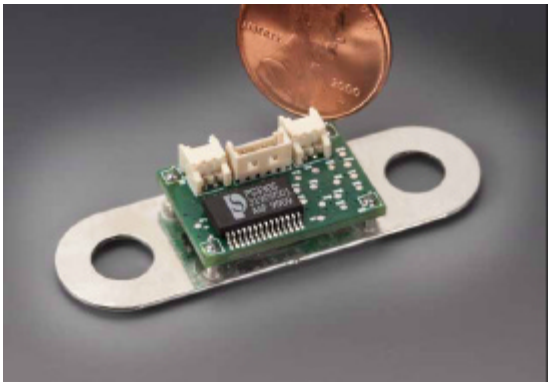
Preliminary

PS3180

SmartShunt™ Battery Monitor

FEATURES

- Performs all major battery monitoring and reporting functions including:
  - String voltage measurement,
  - Precise current measurement and integration,
  - Accurate capacity monitoring and integration with precise on-board timebase,
  - Temperature measurement in 0.1°C intervals.
- Industry's highest accuracy battery monitor based on the PS331 Smart Battery IC:
  - On-chip 14-bit integrating A/D converter,
  - On-chip 8-bit RISC microprocessor,
  - PowerSmart patented, self-learning algorithms and 3-dimensional battery cell models.
- Advanced communications interface using industry standard SMBus V1.1 with PEC/CRC-8 error correction.
- Extremely low power operation:
  - Sleep Mode: <12 µA typical
  - Sample Mode: <250 µA typical
  - Run Mode: <500 µA typical



GENERAL DESCRIPTION

The PS3180 SmartShunt™ is a completely self-contained advanced battery monitoring and reporting device. The SmartShunt™ is a high current, integrated shunt/sense resistor assembly. The module includes PowerSmart's Smart Battery IC and additional circuitry mounted on a high current shunt for simple system integration. The complete module can replace a normal bus-bar or battery cell interconnect. External connections include a communications interface (SMBus) which can be easily isolated, an optional external temperature sensor, and a string voltage input.

The PS3180 SmartShunt™ can be used as a "non-intelligent sensor" where only current, integrated current (mAhr), voltage, and temperature readings are read. At the user's option, up to 34 standard Smart Battery Data (SBData) fields can be read. These include capacity calculations which are performed by an on-board CPU and are based on PowerSmart's patented, self-learning algorithms and 3-dimensional battery cell models. The complete module operates from 5-18V to easily accommodate small and large cell strings.

BENEFITS

- Provides accurate and critical information for increasing fuel economy and lowering emissions for motive applications.
- Reduces monitoring costs for stationary battery backup applications.
- Provides accurate battery state of charge for all applications.
- Provides information for determining state of health.
- Enhances safety by reducing risk of battery overcharging.

APPLICATIONS

- Hybrid Electric Vehicle (HEV) Batteries
- Deep Cycle Marine Trolling Batteries
- SLI for 12V, 24V, and 42V Battery Systems
- Standby Telecommunications Battery Backup
- UPS Battery Backup
- Electric Vehicle Batteries

ABSOLUTE MAXIMUM RATINGS

Description	Symbol	Min	Max	Units
Supply Voltage	V_{DD}-V_{SS}	5.0	20.0	V
Voltage directly at any pin (except V_{DD})	V_{PIN}	-0.5	7.0	V
Temperature under bias	T_{BIAS}	-25	+85	°C
Storage temperature (package dependent)	$T_{STORAGE}$	-35	+150	°C

Note: These are stress ratings only. Stress greater than the listed ratings may cause permanent damage to the device. Exposure to absolute maximum ratings for an extended period may affect device reliability.

ELECTRICAL CHARACTERISTICS (T_a = -20°C to +85°C, V_{DD} = 12V ±10%)

Description	Symbol	Min	Typ	Max	Units
DC Characteristics					
Supply Voltage	V_{DD}	5.4		17.0	V
Current consumption	I_{DD}	8	270	600	µA
Run Mode		375	500	600	µA
Sample Mode		190	250	375	µA
Low-voltage Sleep		8	12	15	µA
Shelf Sleep		10	12	18	µA
Sense resistor voltage input	V_{SENSE}	-152		152	mV
NTC Reference voltage output at TEMP pin	V_{REFT}		150		mV
DC Characteristics - SMBus					
Output voltage for 350µA output current	SCL, SDA			35	mV
Pull down current at SCL, SDA	$I_{PULLDOWN}$		0.5	1.0	µA
Current at SCL, SDA	I_{LO}, I_{HI}			10.0	µA
Input voltage for LOW at SCL, SDA	$V_{LO,IN}$	-0.5	0.4	0.6	V
Input voltage for HIGH at SCL, SDA	$V_{HI,IN}$	1.4	2	5.5	V
Output voltage for LOW at SCL, SDA	$V_{LO,OUT}$		0.2	0.4	V
Device sink current	I_{SINK}	100		350	µA
AC Characteristics - SMBus					
Clock operating frequency	f_{SMB}	<1.0		100	kHz
Broadcast bit frequency	$F_{SMB-MASTR}$	50	F_{RC}/8	68	kHz
Message buffering time	$T_{LOW:SEXT}$			24	mS
Timeout period	$T_{TIMEOUT}$	25		35	mS
Measurement Resolution and Timing					
Voltage granularity, @Max = 17000mV	$V_{granularity}$		16.5		mV/bit
Temperature granularity, look up tables	$T_{granularity}$		0.1		°C/bit
Current granularity, 25A version, Rsense = 1 mΩ	$I_{granularity}$		18.3		mA/bit
Current granularity, 100A version, Rsense = 0.25 mΩ	$I_{granularity}$		73.2		mA/bit
Voltage measurement time, 10 bit	V_{time}		45		mS
Temperature measurement time, 10 bit	T_{time}		45		mS
Current measurement time, 13 bit + sign	I_{time}		360		mS

MODULE VERSIONS

PowerSmart offers the PS3180 as a complete battery monitoring and control module in a variety of standard and semi-custom versions. The PS3180 can be easily customized for a particular application's battery cell chemistries using the on-board module EEPROM. Typical cell chemistries are Lead-Acid (both standby and cycling), NiMH, NiCd, LiIon, and LiPolymer. Upgrades to previously assembled battery units are simple via the standard SMBus serial communications interface.

The underlying metal shunt resistance can be sized to a particular current range and/or mechanical cell spacing requirement. Please contact PowerSmart for ordering information.

ELECTRICAL SCHEMATIC

Figure 1 shows the electrical schematic of the PS3180. It is divided into two sections: the printed circuit board (PCB) that sits on top of four legs and the baseplate of the unit. Electrically, the baseplate operates as a sense resistor that is connected to the PCB through the four legs. U2 is an EEPROM.

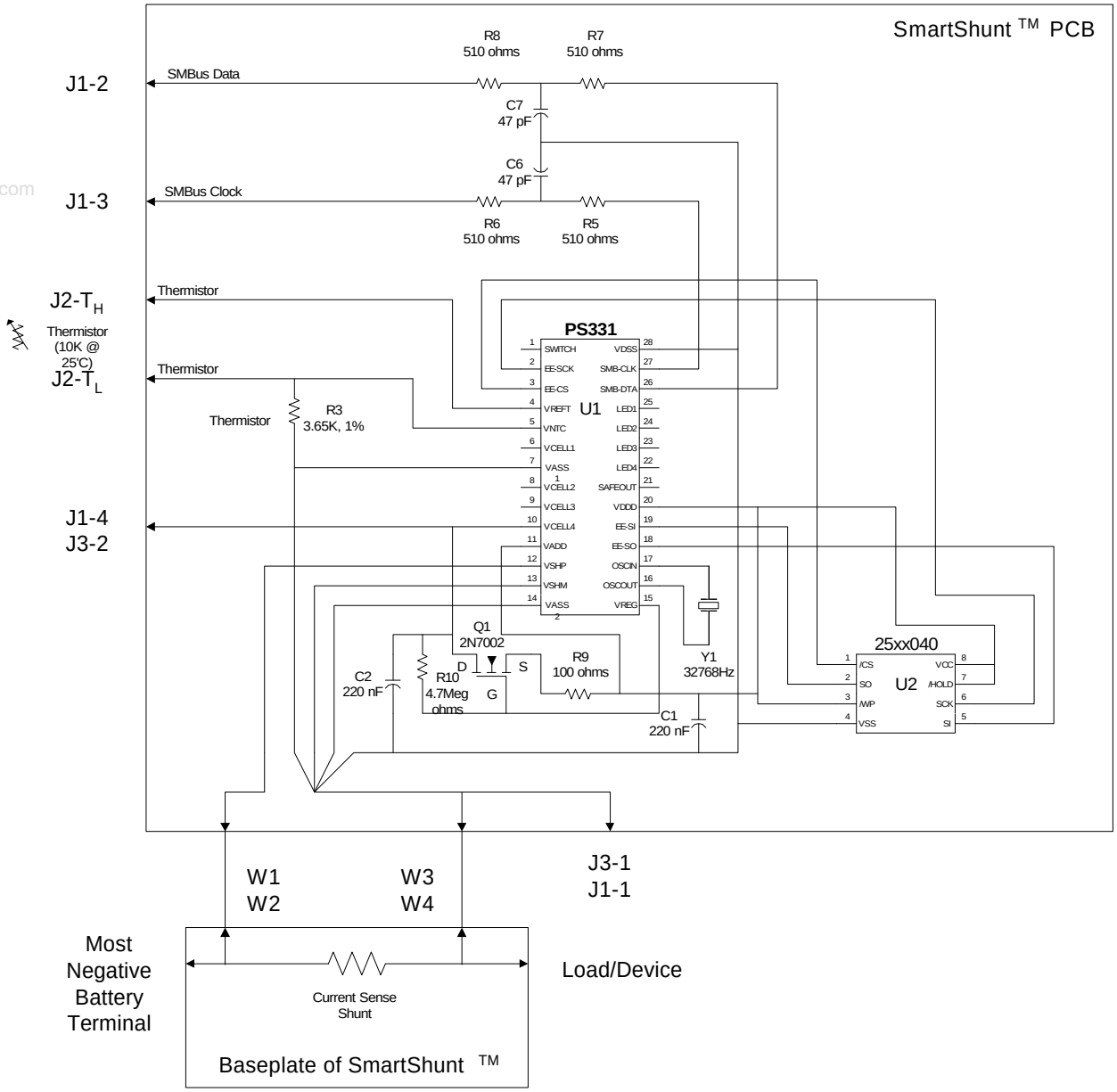


Figure 1. Electrical schematic of PS3180.

PS3180 CONNECTIONS

Figure 2 shows the external circuit connections for the PS3180. The communications connector, J1, provides an SMBus data and clock connection as well as power. The power port, connector J3, provides power to the SmartShunt™. An optional thermistor can be used to

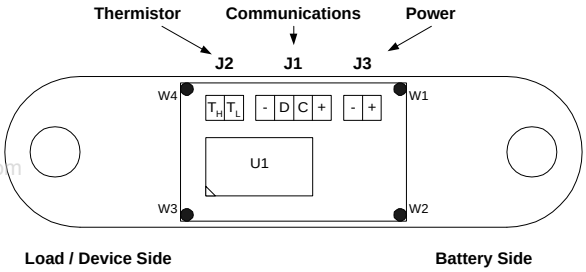


Figure 2. External circuit connections

provide a temperature input for the SmartShunt™. As shown in Figure 2, the right side of the SmartShunt™ baseplate is connected to the most negative terminal of the battery. The left side of the SmartShunt™ is attached to the load or device side, or the next cell string.

CURRENT RATINGS AND MEASUREMENTS

The two initial PS3180 SmartShunt™ models have been designed to measure the following ranges of current:

25A version: Maximum current of 150 Amps with a minimum resolution of 18.2mA (available in 36 and 52mm).
100A version: Maximum current of 600 Amps with a minimum resolution of 73.2mA.

The following paragraphs explain how these values were determined.

The maximum input voltage at either VSHP or VSHM is ±150mV (ref. Fig. 1). The sense resistor (baseplate of SmartShunt™) is sized to provide as wide a range of current measurement as required with as small a resolution as possible. Since the 14-bit A/D is operated with a resolution of 13-bit plus sign during current measurements, there are 8192 steps in the full measurement range. Based on this information, the following equations can be used to select a sense resistor value for a particular maximum current range or minimum resolution.

Current LSB = $18.3\mu V/R_{sense}$ (mΩ)

Maximum current = Current LSB x 8192

For the PS3180, a value of 1mΩ has been selected for the sense resistor (baseplate) for the 25A version and a value of 0.25mΩ has been selected for the sense resistor (baseplate) for the 100A version. The current is measured for 360 milliseconds every 500 millisecond period.

VOLTAGE MEASUREMENTS

The A/D input channel operates in a 10-bit resolution mode for voltage measurements. Therefore, there are only 1024 steps in the full voltage measurement range. Based on a maximum input range of 17V, the minimum resolution for voltage measurement is 16.5mV per LSB. The voltage is measured for 45 milliseconds every 500 millisecond period.

TEMPERATURE MEASUREMENTS

The A/D input channel operates in a 10-bit resolution mode for temperature measurements. The external thermistor should be a standard 10KΩ at 25°C negative temperature coefficient (NTC) device of the 103ETB type for proper operation. A linearization look-up table is used to convert the voltage measurement seen at the VNTC pin (ref. Fig. 1) to a temperature value. Absolute temperature accuracy is ±3°C but relative accuracy is better than 1°C. The temperature is measured for 45 milliseconds every 500 millisecond period.

CALIBRATION

The PS3180 SmartShunt™ voltage and current readings are calibrated at the factory before shipment. These calibration tests compensate for the offset and gain of the A/D as well as for any minor differences in the actual shunt resistance versus its specified value. It should be noted that the PS331 Smart Battery IC has an integral auto-offset calibration feature which operates when enabled. This feature corrects for drift in the offset error over temperature during operation.

REFERENCES

The PS331 Smart Battery IC is an integral part of the PS3180 SmartShunt™. The PS331 data sheet, available on PowerSmart's website at www.powersmart.com, provides significant detail on the IC's architecture, operational modes, communications interface, and smart battery data functions.

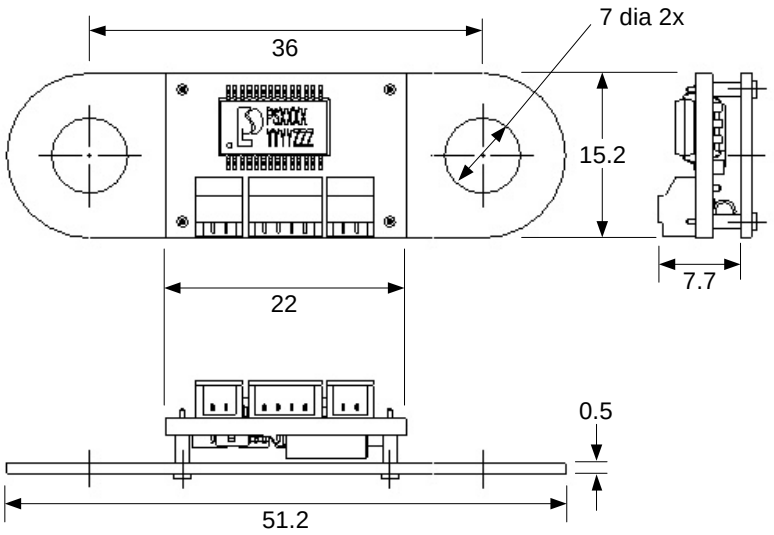
ORDERING INFORMATION

The table below describes the initially available SmartShunt™ models. Please contact PowerSmart for alternate current ranges and mechanical mounting dimensions.

Part Number	Description
PS3180-2536	25A current rating in 36mm length
PS3180-2552	25A current rating in 52mm length
PS3180-10044	100A current rating in 44mm length

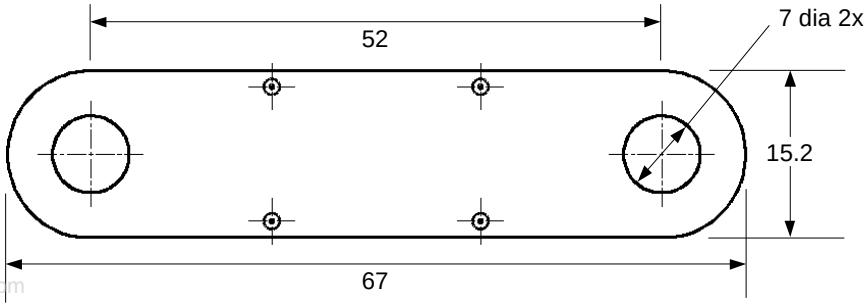
MECHANICAL PACKAGING INFORMATION

PS3180-2536: 36mm package, complete assembly



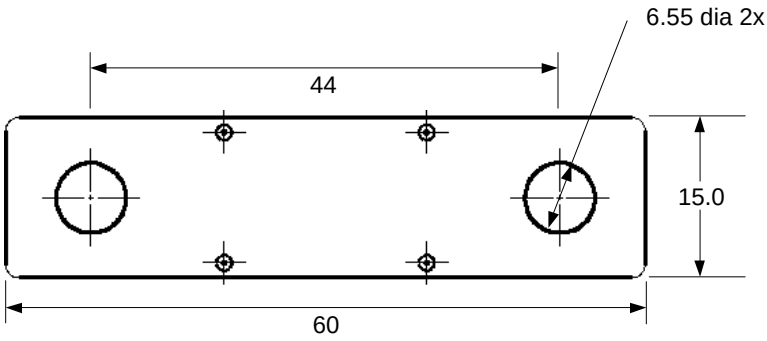
Dimensions in mm

PS3180-2552: 52 mm package, baseplate only



Dimensions in mm
Thickness of plate is 0.5

PS3180-10044: 44mm package, baseplate only



Dimensions in mm
Thickness of plate is 2