Standard Performance Evaluation Corporation (SPEC)

Power Analyzer Acceptance Process V1.5

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1 Introduction

This document describes the processes by which SPEC members, licensees and measurement device vendors can work together to add software support for a power analyzer to the SPEC Power and Temperature Daemon (PTDaemon), and submit tests for review and possible inclusion by SPEC as an accepted device. To accomplish the tasks required for this process, prior knowledge of the usage of the SPECpower_ssj2008 benchmark, Power Analyzer setup and usage, and programming skills are required.

To check for possible updates to this document, please see http://www.spec.org/power/docs/SPEC-Power_Analyzer_Acceptance_Process.pdf.

2 Software Integration Process

2.1 Checking Device Specifications

The first step in adding device support must be to compare the new device's specifications to those of the SPECpower_ssj2008 Run Rules Section 2.13.2 Power Analyzer Specifications (http://www.spec.org/power/docs/SPECpower_ssj2008-Run_Reporting_Rules.html#2.13.2).
If it is desired that the device be included as an accepted measurement device for SPEC's PTDaemon, suitable documentation must be provided showing compliance with that section. The Power-Analyzer-Questionnaire found in Attachment 1 lists detailed questions, which may be sent to the power analyzer manufacturer to clarify in advance if the analyzer is appropriate for compliant SPECpower measurements. Devices that do not meet SPEC's requirements may still have software support added for PTDaemon; however, any benchmark testing done using such devices will be marked as non-compliant and may not be published outside of SPEC or submitted to SPEC for review.

2.2 Adding Software Support

Since PTDaemon source code is not available to SPEC non-members, when support for a new device is requested by a SPEC licensee or device vendor, a volunteer "sponsor" within SPEC will work on the software implementation. A complimentary binary license for PTDaemon may also be provided to third parties that are willing to assist with the testing of a new device.

Typically a single source code module is added, often based on another analyzer with a similar command structure and features. The module will then be updated to include commands which initialize the analyzer, set it up for the appropriate measurement mode, request power readings, and read and write ranges.

2.3 Initial Functionality Testing

Initial testing of the code is to ensure that PTDaemon can communicate successfully with the device. The initialization phases of PTDaemon, pre-benchmark, exercise this communication interface fairly well. When communication is established, a standard SPECpower_ssj2008 benchmark run should be performed using the modified PTDaemon binary. If successful, you are ready for the testing required for SPEC acceptance.

2.4 Multi-channel Analyzers

For multi-channel analyzers the software support has to be extended to manage both all individual channels and the sum channel.

If wanted, multi-channel analyzers may be used in different modes:

- Single-channel mode
  Only one channel is used for measurements. The number of this channel can be selected by the user via the input parameter "–c".

- 3-Phase mode
  Three channels are connected to three phases. In this case the analyzer can also be used similar to the single-channel mode evaluating only the sum channel.

- Multi-channel mode
  All channels can be configured independently. Only the sum of the power scores are well defined. Other summing, e.g. of the volts, is not defined.

The ZES LMG450 is an example for all three modes implemented in PTDaemon.

3 Acceptance Test Process

The following sections describe the two sets of tests required for SPEC review and possible acceptance. These tests are designed to verify that a power analyzer is in fact behaving as its specifications indicate and is compliant with the run rules requirements. All results must meet the acceptance criteria specified below before an analyzer can be accepted by SPEC.

Currently the software tools used for the acceptance test process are SPEC internal use only, so the acceptance tests must be performed by a SPEC member.

3.1 Simultaneous Measurements of a SERT Test

This pair of tests compares the results from an accepted power analyzer with the new analyzer under actual server test conditions. The SSJ and Idle worklets of the SPEC SERT suite, version 2.0.1 or later, are run. Both analyzers are run simultaneously, connected in series and measuring the same SUT. Two tests are run, with the order of the power analyzers reversed between tests, in order to eliminate any measurement differences due to voltage drops or power consumption of the analyzers themselves. The power results from the two tests, separately for each interval of the measurement phase of the worklets, are averaged for each analyzer, and then the averages compared to determine the difference.

Acceptance criteria for this set of tests: the averaged power values from the two devices must not differ by more than the sum of the tolerances of each individual device. However, a preferable result would be differences much less than the sum of tolerances. It should be expected that the analyzer connected closer to the power source should have slightly higher power readings in each test.

Tolerance formulas for some power analyzers are very complex, so some assistance from SPEC members may be required to complete the calculations for the acceptance criteria.

3.2 Power Pulse Tests

A second set of tests uses a SPEC internal tool to generate "power pulses" of specific durations which are used to examine the sampling windows of the power analyzers under test. The first test generates a series of pulses from 100ms to 900ms in width; the second series uses fixed pulse widths but shifts the start time of each pulse by 10ms.

<u>Acceptance Criteria:</u>

- Pulse width test: the measured power values must correspond to the pulse widths generated by the AC load, within a tolerance of +/- 25%. All pulses must be captured by the device.

- Sliding window test: A maximum of 2 duplicate samples ("duplicate" defined as 2 consecutive identical samples) and 2 missing samples of the 200 short power pulses generated by the AC load are allowable in the analyzer output. It is possible that a pulse may be missed or duplicated as the time window shifts versus the analyzer's internal clock.

3.3 Multi-channel Analyzers

For multi-channel analyzers, first the Power Analyzer Acceptance Process should be successfully performed for one individual channel or for the sum channel, if all channels have the same specifications according to the manufacturer's manual. Otherwise all individual channels have to be considered separately.

Additionally the first power pulse test must be run with all individual channels connected in series.

Acceptance Criteria:

- The measured power values of channel 1 have to correspond to the pulse widths generated by the AC load, within a tolerance of +/- 25%. All pulses must be captured by this channel, similar to the single-channel test above.
- For the whole test the differences between all power values of channel 1 and the corresponding power values of all other individual channels of the device measured at the same point of time should be smaller than 2%. It is expected that the analyzer connected closer to the AC power will have slightly higher power readings.

3.4 DC Testing

Beginning with PTDaemon 1.7.0, DC power sources are supported. The full set of acceptance tests must be rerun using a DC power source; it is strongly recommended that acceptance testing using AC power be done first.

There are several differences to take into account when doing the acceptance tests with DC power sources. First, the uncertainty requirements for DC are loosened slightly (1.5%) as compared to AC (1.0%), so there will be some additional leeway in the calculations of the back-to-back SPECpower_ssj2008 tests. DC testing, just as AC testing, should be done with a standard voltage such as -48VDC or 400VDC. Special care must be taken with the test harness design to ensure that the wire lengths of the current-carrying segments are as short as possible, and the wire gauges are as large as possible, to reduce voltage drop between the analyzers.

3.5 Submission to SPEC

In order for SPEC to review a device's compliance to the Run Rules requirements, the following must be submitted to SPEC:

- Documentation to prove compliance with Run Rules section 2.13.2-Power Analyzer Specifications
- Source code changes and new files necessary to add the new device. All source code submitted to SPEC must include a signed SPEC Permission to Use Form (http://www.spec.org/spec/docs/permission_to_use.pdf) and must be freely available for use by other members and licensees of the benchmark.

- Spreadsheet along with the PTDaemon log files and SPECpower_ssj2008 results files from the tests in section 3.1
- Spreadsheets along with PTDaemon and test log files from the tests in section 3.2

- In the case of a multi-channel device additionally spreadsheets along with PTDaemon and test log file from the test in section 3.3

SPEC will review the information for compliance with run rules and acceptance criteria above. Further information and/or testing may be requested of the submitter. If all criteria are met, SPEC will accept the device for compliant benchmark testing and add the support to a later release of the benchmark kit.

Questions regarding this process should be sent to the standard SPECpower_ssj2008 support alias. See your benchmark documentation for further information.

4 Attachment 1 – Power Analyzer Features Questionnaire

Power Analyzer Feature List

Requirements documented in the SPECpower-Methodology (http://www.spec.org/power/docs/SPEC-Power_and_Performance_Methodology.pdf):

- **Measurements**: Active power (True RMS), volts (True RMS), amps (True RMS), and power factor must be reported by the analyzer.
- **Logging**: The meter must store measurements to an external device, with a reading/reporting – rate of >= 1/sec and an averaging rate that is 1-2 times the reading interval.
- **Control**: Either the start and stop recording/logging functions of the meter must be able to be controlled from an outside program (see Clause 5.5 of this methodology document) or the logging function must include sufficient time-stamp information that data points which are outside of a measurement interval can be ignored.
- **Accuracy**: Measurements must be reported by the analyzer with an overall accuracy of 1% or better for the data measured during the benchmark run. Overall accuracy means the sum of all specified analyzer uncertainties. Note that analyzer accuracy is dependent on range settings and on measured load.
- **Calibration**: Must be able to calibrate the meter by a standard traceable to NIST (U.S.A) (http://nist.gov) or counterpart national metrology institute in other countries. The meter must have been calibrated within the time period in which its accuracy is guaranteed. Usually this time period is 1 year, but may be smaller depending on the analyzer.
- **Crest Factor**: The meter must be capable of measuring an amperage spike of at least 3 times the maximum True RMS amperage measured during any 1-second-average sample of the benchmark test.

General question to the power analyzer manufacturers:

Are the above requirements met by the power analyzer model?

Manufacturer comments:

Detailed questions to the power analyzer manufacturers:

1) Supported interface(s) for remote commands and external storage of results:
   a. RS232, GPIB, USB?
   b. Are the interfaces optional components or included in the default configuration?
   c. Which additional equipment is needed for the different interfaces?
   d. Does the meter communication interface for remote control use a standard language, e.g. SCPI?
2) Load connection:
   a. Is the electrical load connected directly to the device or via special adapters?
   b. If adapters are required, are they optional items or included in the default configuration?
   c. Are transducers available for measuring high currents? Are they able to measure both True RMS amperage and True RMS active power correctly?
   d. If a transducer is used, can the power analyzer be configured to report the corrected value or has this to be done externally?
3) Input signals:
   a. Are possibly occurring DC signal components included in the readings?
      A DC component is often associated with the distorted current to be measured; such a DC component may produce large errors in input current transformers. Is the maximum allowed DC component indicated in the instrumentation specifications, so that the additional influence error does not exceed the stated accuracy?
   b. Is this configurable, e.g. AC only or AC+DC?
   c. Does the analyzer provide filters, e.g. frequency filters, and how do they influence the measurement results?
4) Is the data averaging interval as defined in the SPECPower_ssj2008 run rules (see http://www.spec.org/power/docs/SPECpower_ssj2008-Run_Reporting_Rules.html#2.13.2 – Logging) configurable?
   a. Which intervals can be configured?
   b. Which method is chosen to compute the average values for power, voltage, amperage and power factor?
5) Is it guaranteed that all necessary measurement values like watts, volts and amps of one interval can be collected simultaneously?
6) What is the accuracy of the data averaging interval duration?
7) Is there a measurement break between or during the measurement intervals, which are needed for internal computation, measuring of erroneous DC etc. ?

8) Requirements to pass the PAT acceptance test as documented in http://www.spec.org/power/docs/SPEC-Power_Power_Analyzer_Acceptance_Process.pdf:

    a. Is the analyzer able to measure small peak loads of 50ms as described in the acceptance process document?

9) Computation of measurement accuracy:

    a. Can you provide formulas to calculate the accuracy in the controlling software?

    b. Are there formulas to compute the accuracy for every measurement interval in the controlling software based on the readings and the range settings?

    c. How do these formulas change if transducers are used?

10) Current and voltage measuring ranges:

    a. Can the measuring ranges be read by the controlling software?

    b. Can the measuring ranges be configured by the controlling software?

11) What happens in the case of over- or under-ranging?

    a. Are such measurement values marked as invalid and if so how are they flagged?

    b. How great is the error in this case (min / max)?

12) Auto-ranging:

    a. Is auto-ranging available for voltage?

    b. Is auto-ranging available for current?

    c. Are the formulas for calculating the accuracy of each measurement different for auto-ranging mode compared to fixed range mode?

    d. What are the thresholds to switch to the next higher or lower range?

    e. How much time or how many cycles does it take to switch ranges and how many internal samples are missed?

13) CREST factor:
The SPECpower methodology requires that for all possible range settings (current only) a CREST factor of at least 3 is supported by the power analyzer, i.e. the device must provide valid measurement values for peak readings up to 3 times the configured current range.

    a. Is this requirement met for all available ranges?

    b. How much does the accuracy change for readings above the specified range?

    c. Is a reading above the specified range multiplied with the allowed CREST factor recognized and marked as invalid?
    (see question 10 a.)

14) Supported reading modes:

    a. Synchronous?
    Each reading is individually triggered by a command from the controlling software.

    b. Asynchronous?
    The power analyzer continuously sends the requested measurement values to the controlling software by itself.

    c. For both methods: Is it guaranteed that there are no breaks during the continuous measurement and that the values read by the software every 1 second are measured over the whole measurement interval?
    The only miss of data is allowed by synchronization problems during the communication with the data collecting computer system.

15) If asynchronous mode is available:

    a. How many values (watts, volts, amps, PF) can be read simultaneously in each measurement interval?

    b. Can the range settings be reported (on request) for every measurement interval?

    c. Can accuracy be computed for every measurement interval?

    d. Can the measurement be stopped and restarted for range configuration?

16) Multi-Channel analyzer:

    a. Are individual measurement readings available for each channel?

    b. Are summary readings of all channels available?

    c. Can the channels be grouped (wired) together individually for summary readings, e.g. for a 4 channel analyzer possible groups may be 3+1 or 4+0 or 2+2?

    d. Which standard is used to compute the sums of several channels?

17) Documentation:

    a. Where is this information documented?
    Manuals, Internet?

SPEC comment:

The questions above are meant for collecting important information from power analyzer manufacturers regarding operational details of their devices relevant for their usage in benchmarks as described in the SPEC-Power-Methodology. This information is required to ensure that all power analyzers evaluated in the SPEC-Power acceptance process generate the measurement results according to equivalent standards and so can be used for fair comparison in competitive benchmarks.

For acceptance of a specific power analyzer it is not required that all features mentioned above are supported by this device.

