KEITHLEY

Application Note Series

Number 3015

Thermal Guidelines for Rack-Mounting Series 2600/2600A Instruments

This document defines the environment needed to ensure proper instrument cooling when placing multiple Series 2600/2600A System SourceMeter® instruments in a racked configuration. Power requirements for running multiple instruments are also included to ensure an adequate power supply is available.

Cabinet Specifications

The cabinet used must meet IEC 19-inch rack specifications. Refer to ***Figure 1*** for the preferred cabinet dimensions.

The cabinet must be capable of exhausting 600CFM of air from its bottom. This air flow can be achieved by using multiple fans or blower(s) as long as the combined total air flow is 600CFM.

Instrument Placement in Cabinet

To avoid overheating or damage to instruments, all Series 2600/2600A System SourceMeter products must be rack-mounted in accordance with the following restrictions. Refer to ***Figures 2*** and ***3*** for instrument placement options.

- Units may be rack-mounted side by side.
- All rows of instruments are to be placed with 1U space above the units.
- Spaces between units are to be filled with vented panels having a minimum open air ratio of 33%.
- The top row of instruments must also have 1U space above it to allow for proper air flow across the unit.
- All rack spaces not occupied by an instrument or vent panel must be filled with solid blank panels.
- All cable entry or exit ports are to be sealed to close off the flow of air.
- The rear door of the cabinet (if applicable) is to be closed. The cabinet shall not have a front door.

The perimeter of all instruments is to be sealed to restrict air flow, as shown in ***Figures 2*** and ***3***.

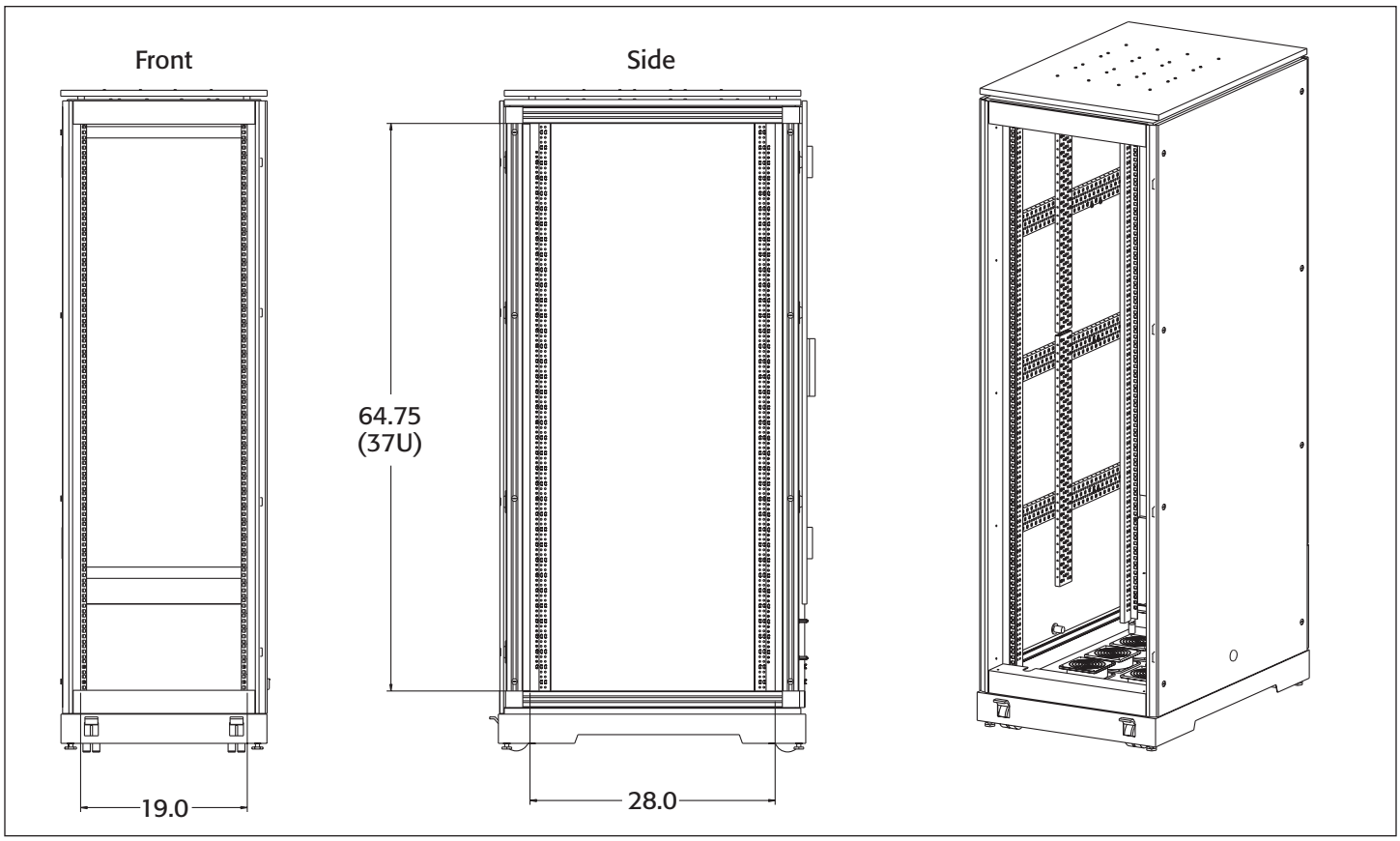

Figure 1. Cabinet dimensions

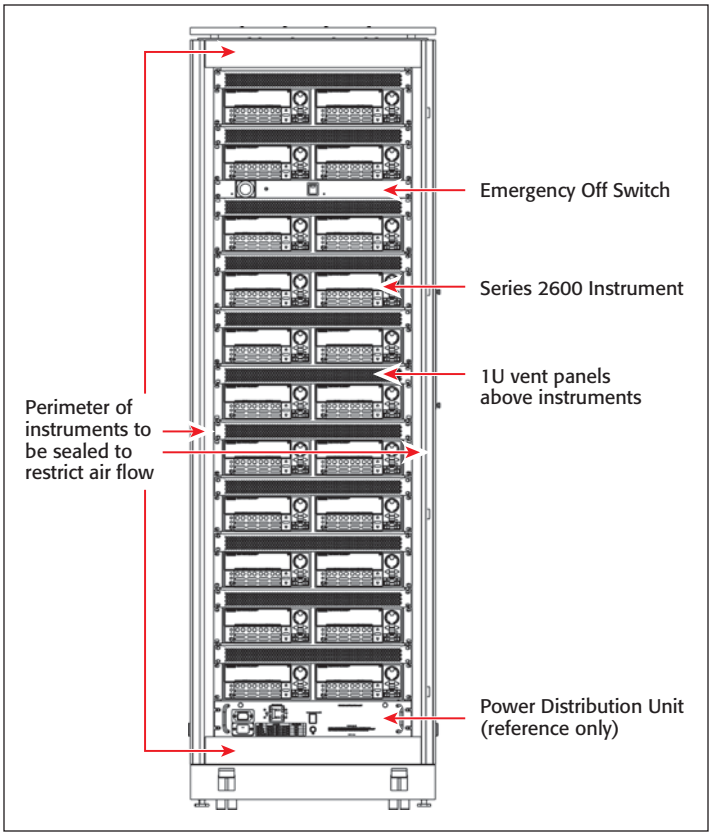

Figure 2

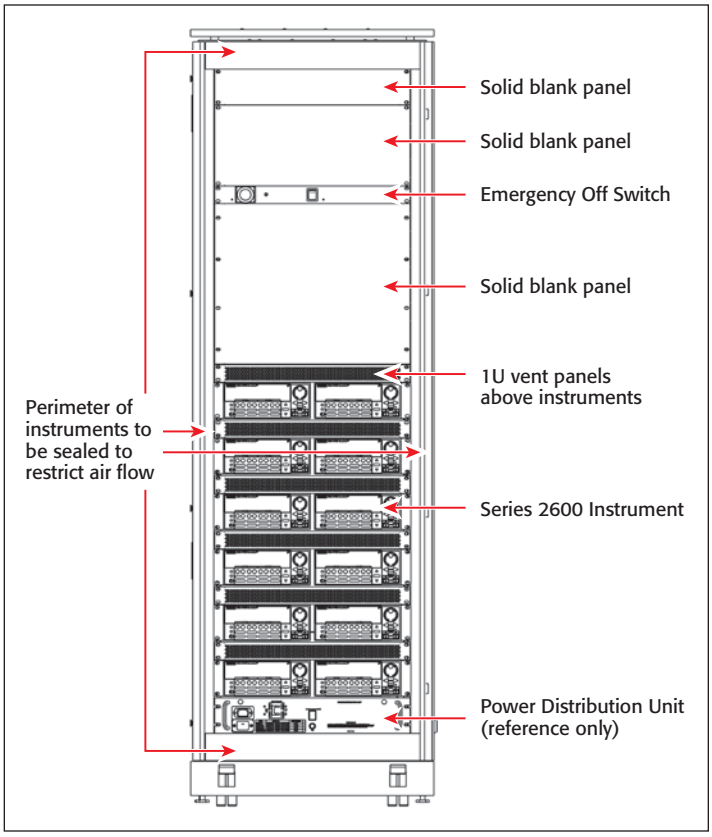

Figure 3

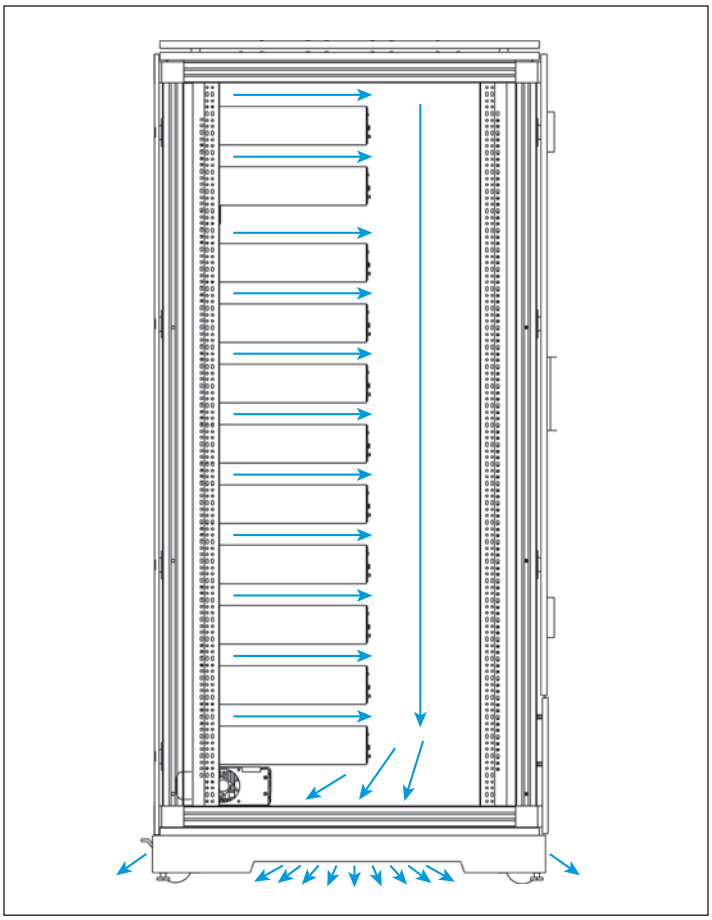

Figure 4

Thermal Characteristics

The placement of vented panels and sealed openings is critical to the performance of Series 2600/2600A System SourceMeter instruments. ***Figure 4*** depicts the flow of air into the top of each instrument and out of the rear. The air flow created by the fan(s) or blower(s) in the bottom of the cabinet draws cool air into the instruments and forces the hot air out the bottom of the cabinet.

If the ambient temperature exceeds the internal threshold of the unit, the unit may overheat. Overheating occurs when the internal temperature of the Series 2600/2600A System SourceMeter instrument is exceeded, causing the instrument's channel output to turn off and go into standby mode until the instrument's temperature drops below this limit.

There are a variety of common causes of overheating:

- Allowing openings in the cabinet such as cable ports, rear door, auxiliary vents, removed side panels, etc.
- Failing to seal off the perimeter around the instruments.
- Failing to remove the front door of the cabinet.
- Exceeding the power output on each channel (see power equation and table in ***Figure 3***). Refer to the Series 2600/2600A System SourceMeter Reference Manual for output derating due to ambient temperature.

Equations apply to both channels, sinking or sourcing power simultaneously. If a duty cycle less than 100% is required to avoid overheating, the maximum on time must be less than 10 seconds.

General SourceMeter Power Equation

$$\left|(V_{OA}-V_P)(I_P)\right|\sqrt{DC_{MAX}}+\left|(V_{OA}-V_B)(I_B)\right|\leq(P_{CS}-P_{DER})$$

P_{CS} = The maximum power generated in a SourceMeter channel that can be properly dissipated by the SourceMeter cooling system.

T_{AMB} = The ambient temperature of the SourceMeter operating environment.

$P_{DER} = T_{AMB} - 30$

- This factor represents the number of watts the SourceMeter instrument is de-rated when operating in environments above 30°C. This is represented as a temperature because the maximum output power of each SourceMeter channel is reduced by 1W per degree C above 30°C.
- P_{DER} is 0 when the ambient temperature is below 30°C.

V_{OA} = The SourceMeter output amplifier voltage. This constant can be found in the tables below.

V_P = The voltage level the SourceMeter instrument is attempting to force while at the pulse level.

- When operating in quadrants 1 or 3 (sourcing power), the sign of this voltage must be **positive** when used in the power equations.
- When operating in quadrants 2 or 4 (sinking power), the sign of this voltage must be **negative** when used in the power equations.

V_B = The voltage level the SourceMeter instrument is attempting to force while at the bias level.

- When operating In quadrants 1 or 3 (sourcing power), the sign of this voltage must be **positive** when used in the power equations.
- When operating in quadrants 2 or 4 (sinking power), the sign of this voltage must be **negative** when used in the power equations

I_P = The current ftowing through the SourceMeter channel while at the pulse level.

I_B = The current ftowing through the SourceMeter channel while at the bias level.

Maximum duty cycle equation [1]

$$DC_{MAX}\leq\left[\frac{(P_{CS}-P_{DER})-\left|(V_{OA}-V_B)(V_B)\right|}{\left|(V_{OA}-V_P)(I_P)\right|}\right]^2\times 100$$

NOTE When attempting to determine the maximum duty cycle where the off state will be 0V or 0A:

- I_B is 0
- I_P and V_P are the voltage and current levels when the SourceMeter instrument is on.

CAUTION This maximum duty cycle equation is an approximation. In general, if the duty cycle calculation yields a number > 90%, then DC under those conditions should not cause the SourceMeter instrument to overheat. However, if the calculation yields a number < 10%, the calculated duty cycle should not be exceeded by more than 0.5% to avoid potential overheating.

Model 2601A/2602A Maximum Duty Cycle equation constants

Constant	100mV range	1V range	6V range	40V range
P_{CS}	56	56	56	56
V_{OA}	18	18	18	55

Model 2611A/2612A/2635A/2636A Maximum Duty Cycle equation constants

Constant	200mV range	2V range	20V range	200V range
P_{CS}	56	56	56	56
V_{OA}	40	40	40	220

The general SourceMeter power equation and the maximum duty cycle equation are taken from Keithley Instruments' 2600A Reference Manual.

Examples

Refer to Section 8 of the 2600/2600A System SourceMeter® Reference Manual for further examples.

Instrument	Max Source Value (into a short: continuous)	Example
2601A	6.0V 1.5A	40.4W (6.06V@3.0A or 3.03A@6.0V)
2602A	6.0V 1.5A	
2611A	20.0V 1.0A	30.3W (20.2V@1.5A or 1.51A@20.0V)
2612A	20.0V 1.0A	
2635A	20.0V 1.0A	
2636A	20.0V 1.0A	

Power Consumption

Refer to 2600/2600A System SourceMeter instrument VA ratings for the total power draw in your system. Adequate power distribution can then be specified to meet your specific needs.

Instrument	Power Draw (VA)
2601A	240
2602A	240
2611A	240
2612A	240
2635A	250
2636A	250

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