External Power Supply Definitions, Test Procedures & Testing Results – The Technical Context

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Key Technical Topics

- Historic context
- Test procedure development
- Original measurements
- New data
- External power supply definitions

History

- Power supply samples obtained and measured by Ecos Consulting – 2001 to 2004.
- First technical workshop on power supplies co-sponsored by NRDC, EPA, LBNL, and PG&E in January 2002 – savings potential and market strategies discussed.
- NRDC/Ecos power supplies paper published in May 2002 – highlights key research and workshop findings, especially regarding importance of active mode efficiency.
- Savings opportunity highlighted in 2002-2003 meetings with federal & state government agencies, EU, and utilities; and presentations at PSMA board meeting, battery conferences, and Consumer Electronics Show. Need for standard test procedure and efficiency label is identified.

Recent History

- CEC's Public Interest Energy Research (PIER) program begins funding test procedure development, design competition, and information-sharing website – May 2003.
- Initial and revised test procedure drafts posted for comment on www.efficientpowersupplies.org - June to October 2003.
- First technical workshop and U.S./China meetings – November 2003.
- Joint U.S./China/Australia data set analyzed for trends and possible specification levels (late 2003/early 2004).
- Final draft test procedure posted with broad international support, draft ENERGY STAR specification announced, and design competition unveiled at APEC – February 2004.

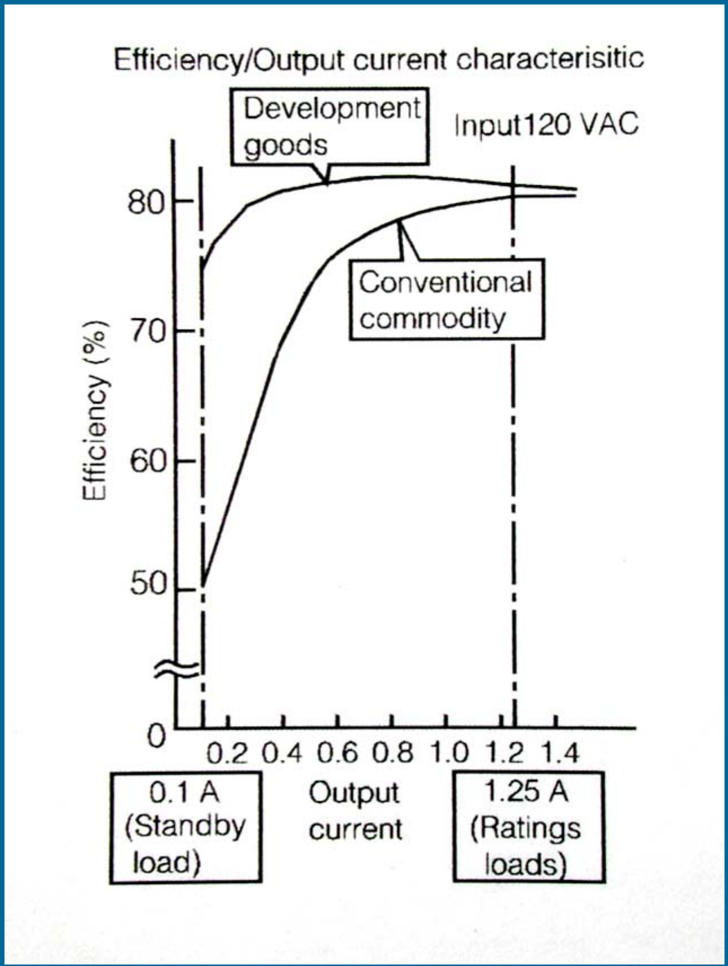
Guiding Principles

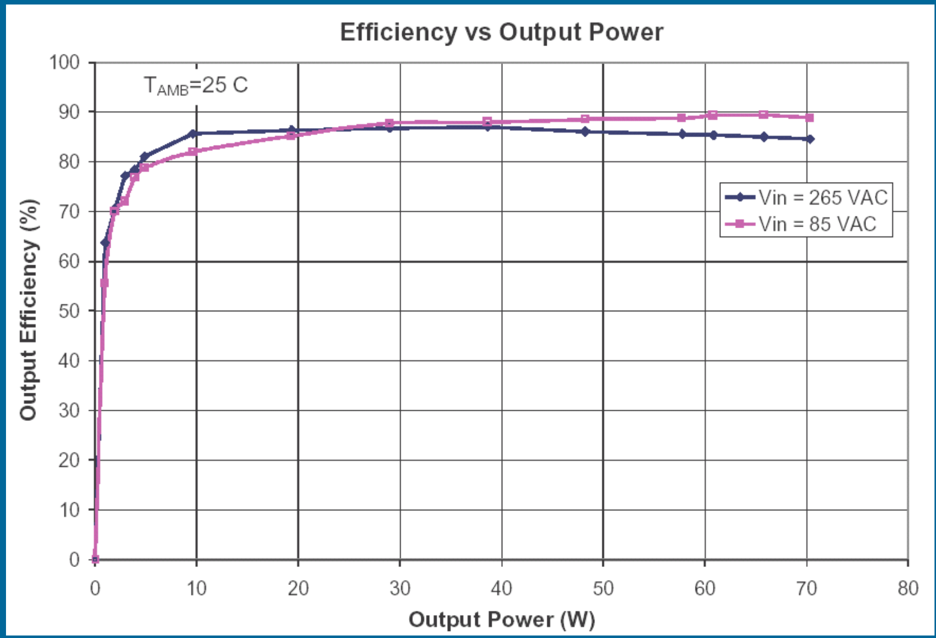
- Keep our eye on the ball – the main goals are to improve the energy efficiency of the ac-dc power conversion process and encourage customers to buy more efficient power supplies.
- What the dc power is used for is relevant but not paramount.
- New product categories can be considered in the future as needed. Power supplies represent a first step to capture a big chunk of readily available energy savings.
- Testing can be too simple to predict real world performance or too complex to justify its cost. Aiming for a balance between usefulness and cost effectiveness.

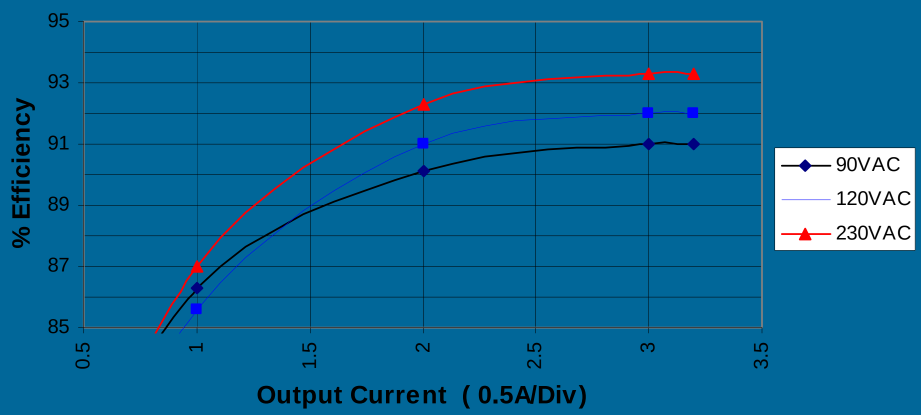
Scope of External Ac-Dc Power Supply Test Procedure

- Dc to dc converters
- Ac to ac power supplies
- Ac to dc power supplies
  - Internal
    - Multi voltage
    - Single voltage
  - External
    - Multi voltage
    - **Single voltage – focus of this test procedure**

Why do we need a standard test method?







Need consistency regarding data point spacing & standby vs. active mode distinctions

Key features of IEEE 1515-2000:

- Helpful for the core issues of efficiency
- Calls for curve consisting of 10 data points between no-load and max rated load
- Calls for three plots at minimum, nominal, and maximum input voltages
- Lacks detail regarding spacing of data points and rating of output load by wattage or current

4.3.1.2 Test method

For a dc-to-dc converter, connect the test setup as shown in Figure 9. It is noted that the ratio defined in Equation (6) is zero at no-load and at short circuit. Therefore, it is desirable to define the UUT's efficiency curves as shown in Figure 10. The recommended curves would be plotted for the specified min., nom., and max. input voltages, with each curve consisting of 10 data points between no-load and max rated load.

To ensure valid measurements, input, and output power (and power factor where applicable) must be measured concurrently.

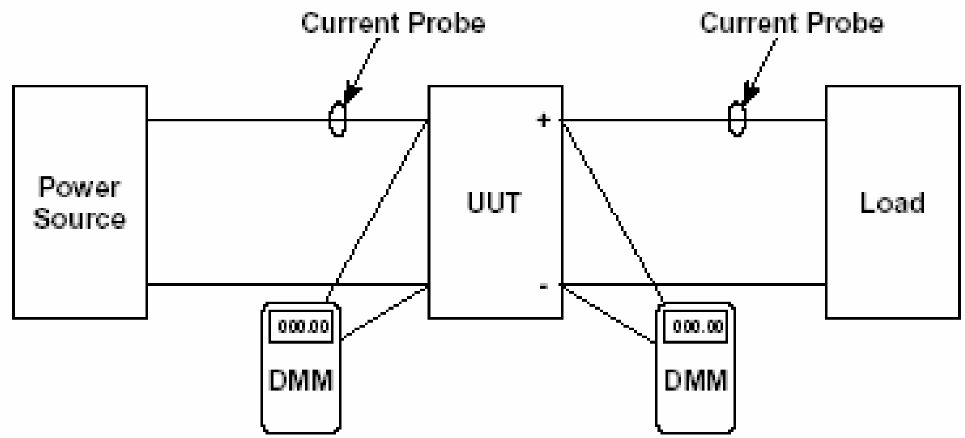


Figure 9—DC to DC converter efficiency and power dissipation measurement

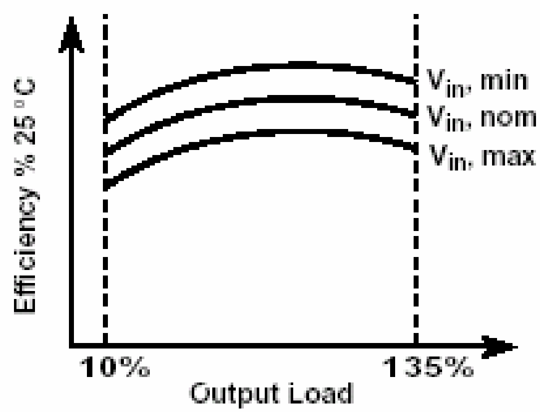


Figure 10—Efficiency vs. power curves

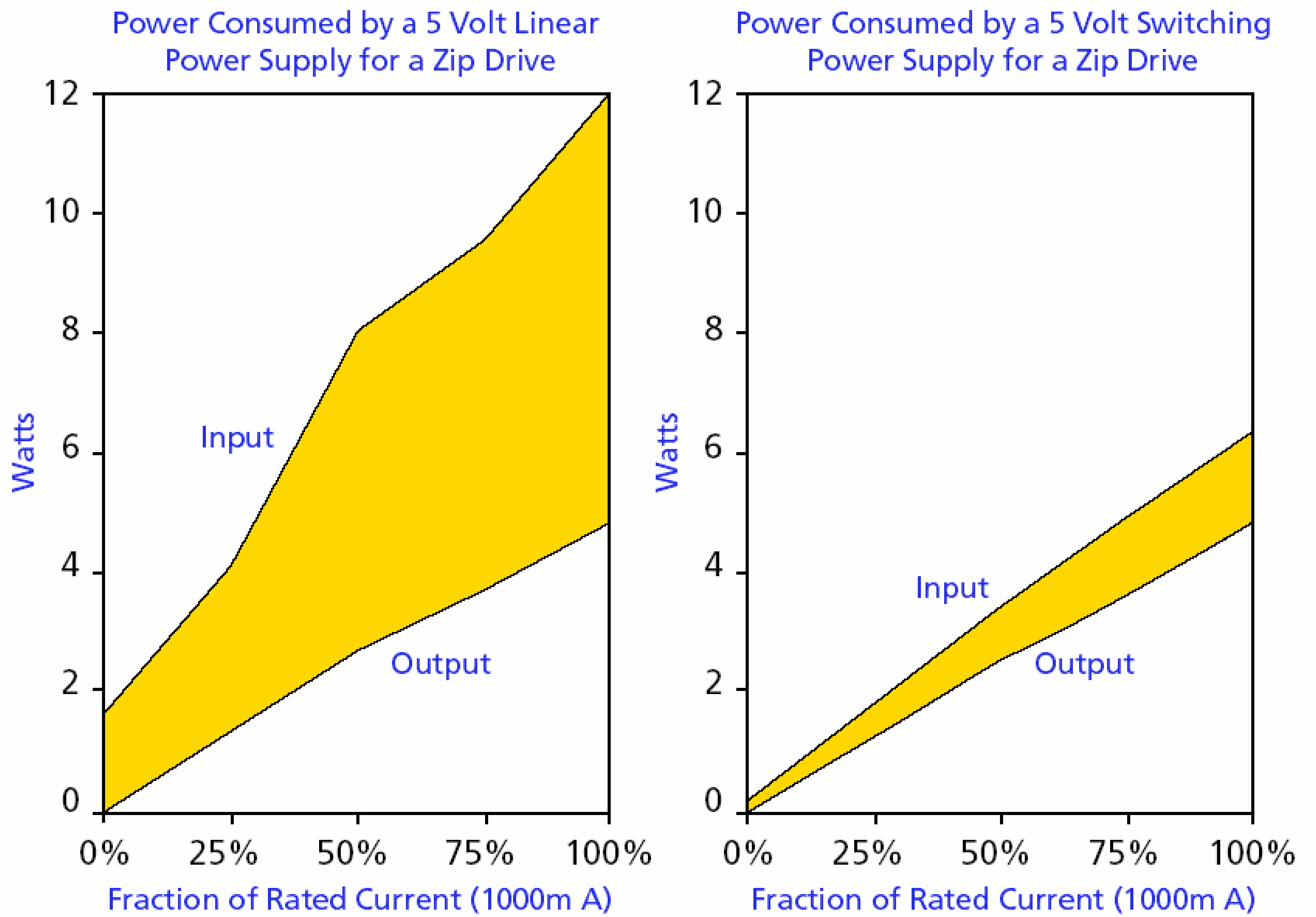
Power Supply Test Procedure- Summary

- IEC 62301 (standby), UL 60950-1 (safety), IEEE 1515-2000 (operating conditions, safety)
- Test at no load and at four different active mode conditions (25%, 50%, 75%, and 100% of nameplate output *current*).
- Test at 2 input voltages and frequencies – 115 V @ 60 Hz and 230 V @ 50 Hz
- Resistive or electronic load banks can be used to load power supply

Power Supply Test Procedure- Summary Continued

- Power supply warm up time is 30 minutes
- Load conditions must be tested in sequence from 100% to 25% of nameplate current, then no load
- Load condition tolerances and measurement tolerances have been specified
- Next steps-
  - Australia to bring external power supply test procedure to IEC for formal adoption
  - Continued need for internal power supply test procedure comments at efficientpowersupplies.org

Load Curves Are Unpredictable



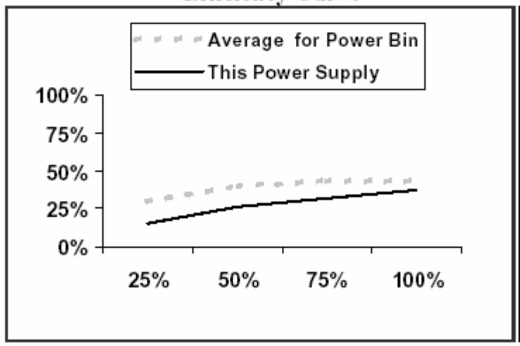
Sample Test Report

External Power Supply Efficiency Test Report

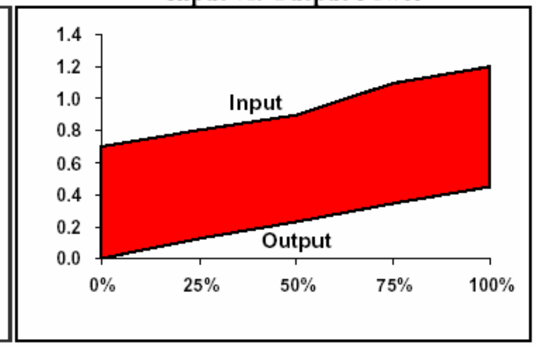
Brand Name	*ICOM*		
Model	*BC-25U*	**Type**	*Linear*
Product Powered (if known)			
Date Measured	*6/10/2003*	**Test ID**	PS12-9

Rated Product Specifications	Input	Output	Units
Voltage	120	12	Volts
Current		50	mA
Power (Watts)		0.6	Watts
Current and Voltage Type	AC	DC	NA
Frequency	60	NA	Hz

Efficiency Curve



Input vs. Output Power



	No Load	Active Power Measurements				
Percent of Rated Load	**0%**	**25%**	**50%**	**75%**	**100%**	**Average**
mA Output		13	25	38	50	
Volts Output		9.5	9.3	9.1	8.9	
Watts Output		0.1	0.2	0.3	0.4	
Watts Input	0.70	0.8	0.9	1.1	1.2	
Volts Input	121 to 126	121 to 126	121 to 126	121 to 126	121 to 126	
Watts Consumed by Power Supply	0.70	0.7	0.7	0.8	0.8	
Efficiency		15.5%	25.9%	31.4%	37.1%	27.5%
No Load Power (Watts)	0.7					
Total Harmonic Distortion (THD)						
True Power Factor (Watts/VA)		0.25	0.28	0.34	0.36	0.50
Average Efficiency for Power Bin (<2.5 watts rated output power)		30.0%	39.3%	42.5%	42.7%	38.6%
Average No Load for Power Bin	0.77					

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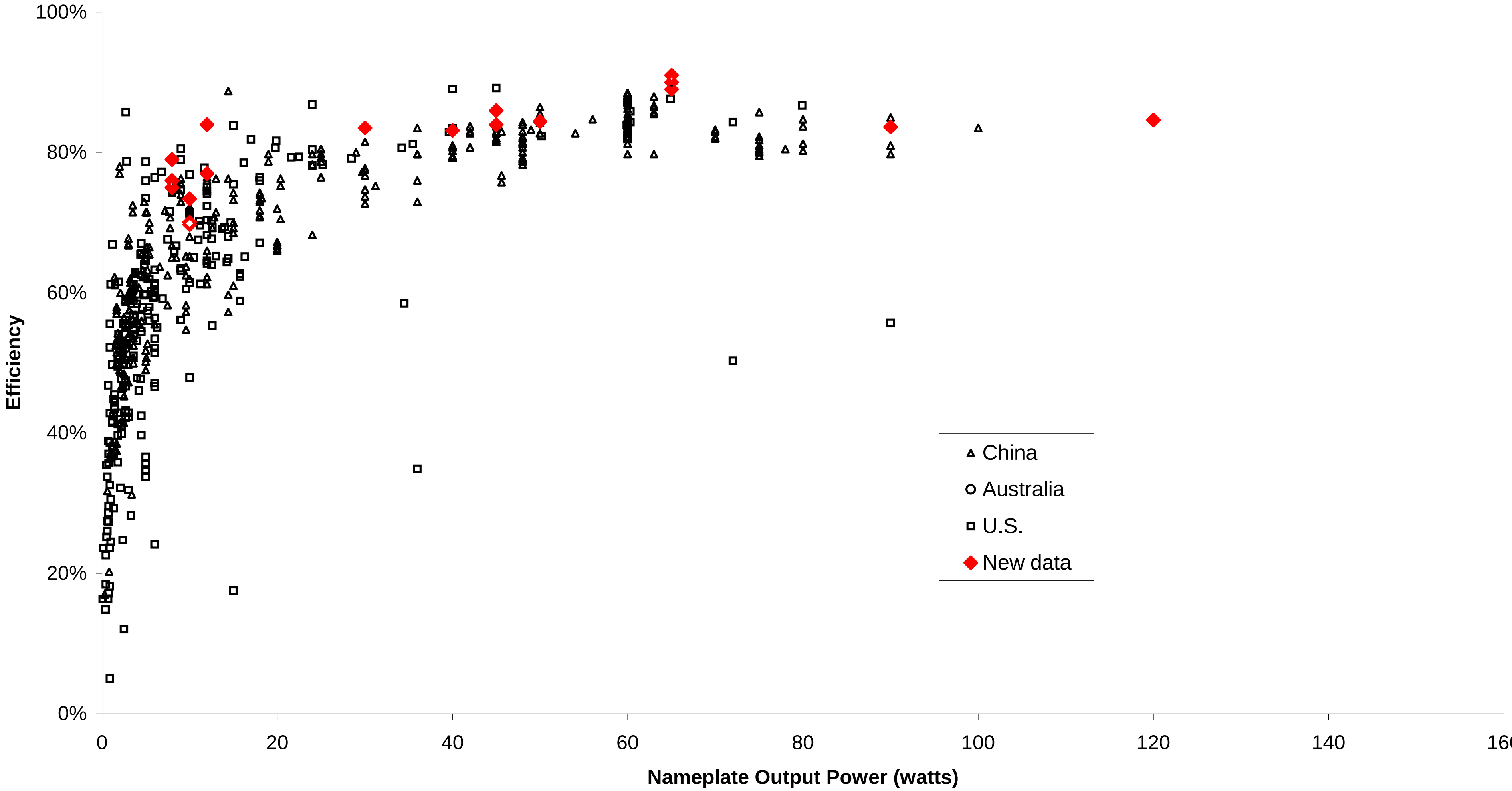
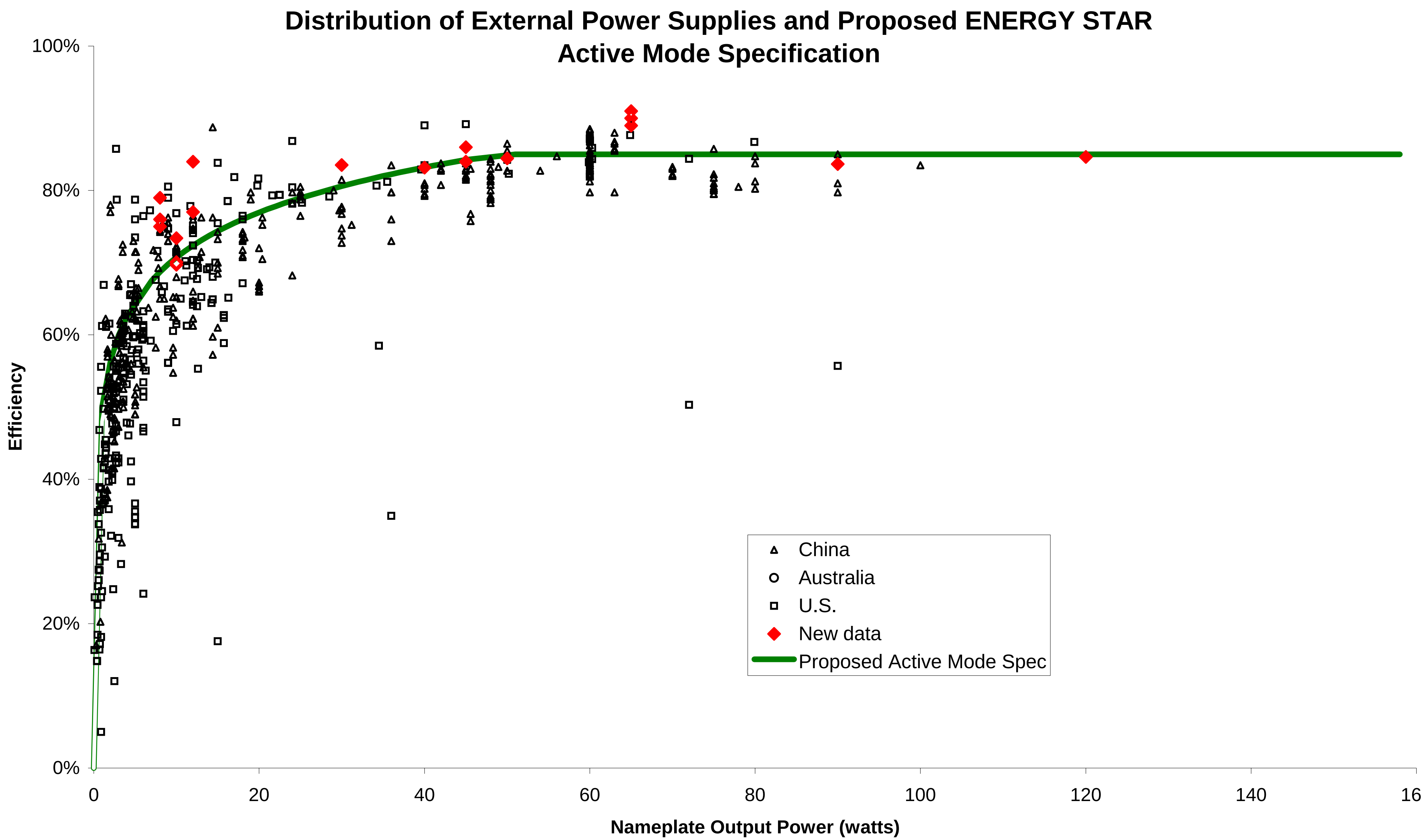
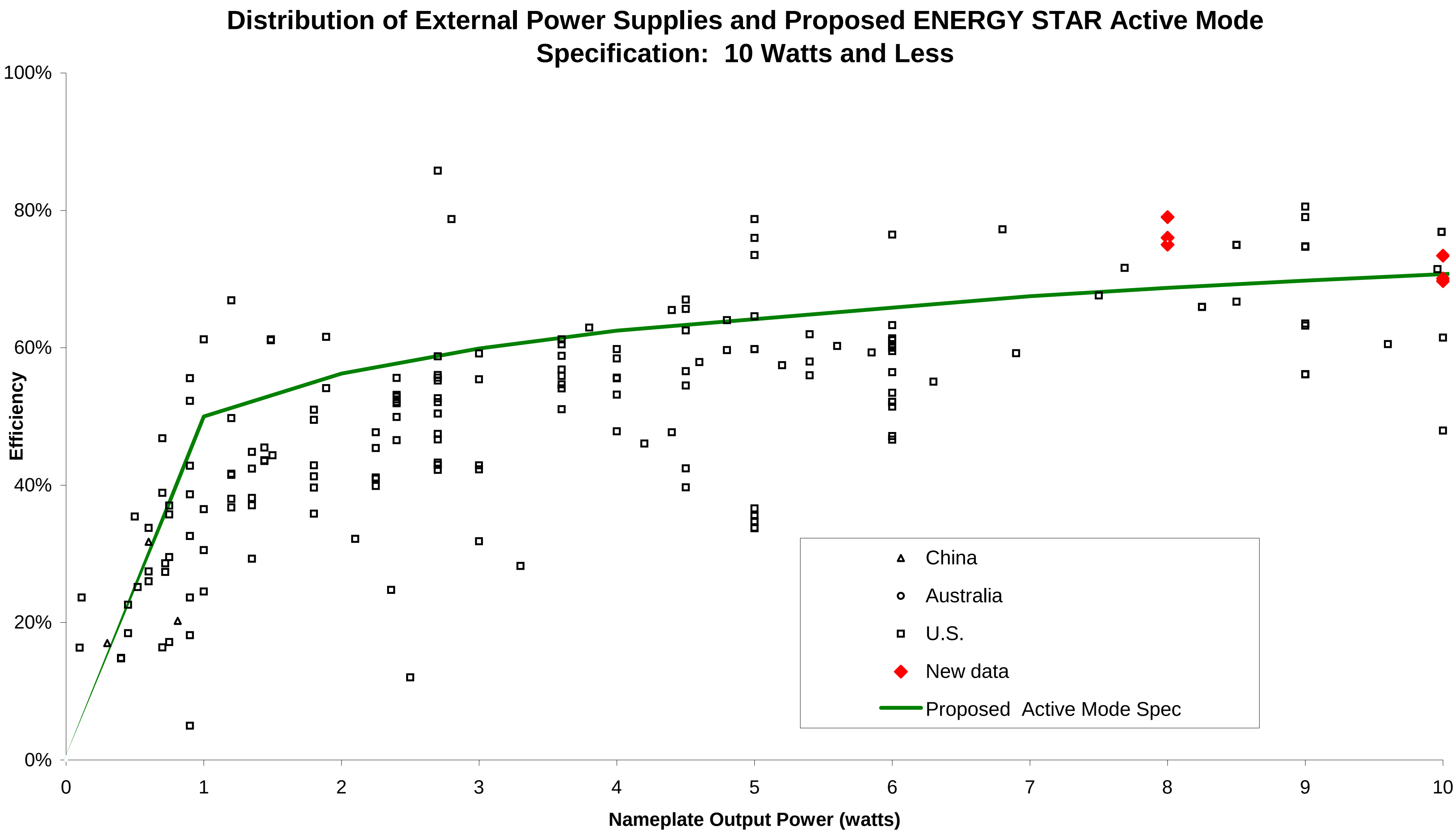
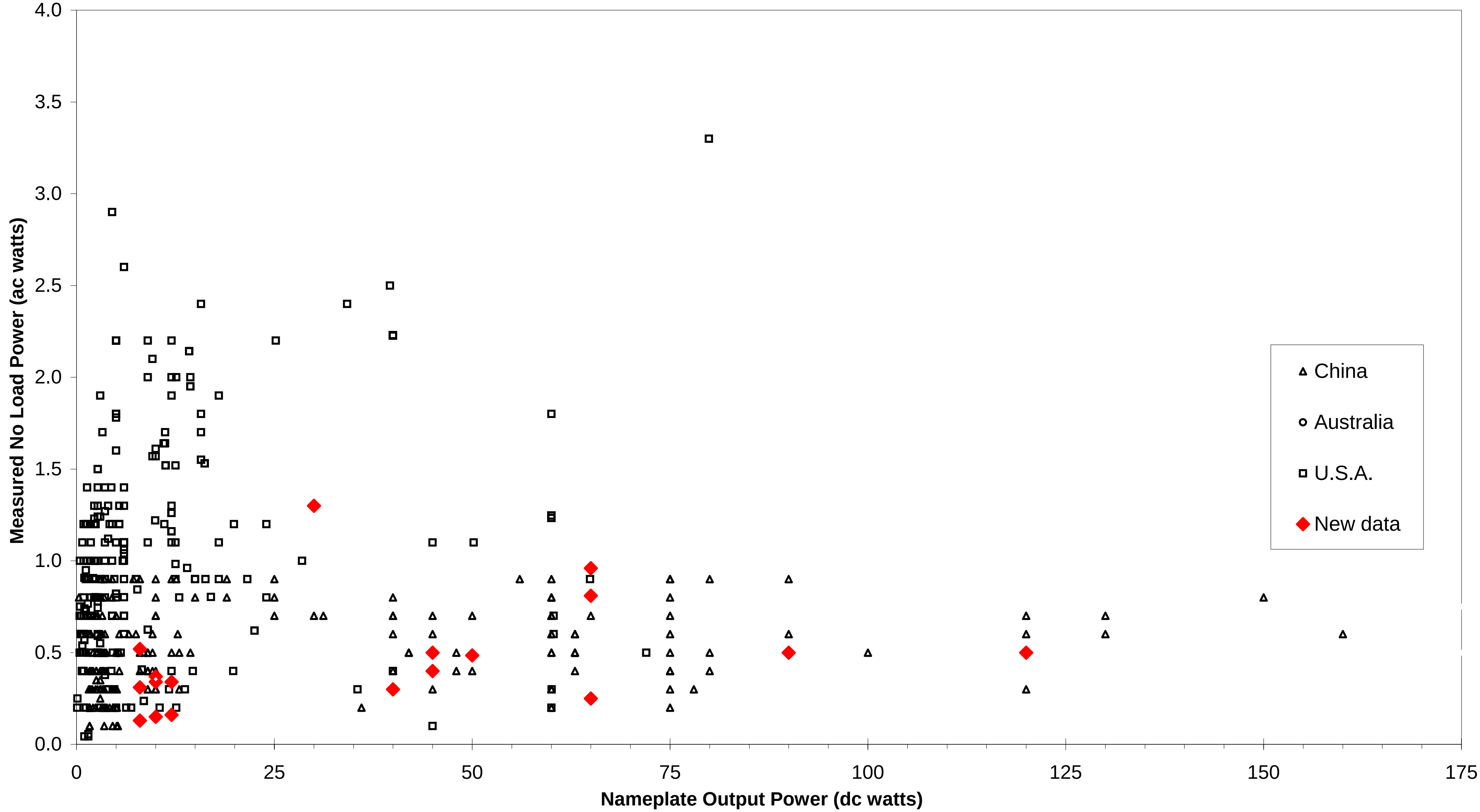
Tested by: Travis Reeder and Riley Neugebauer

Range of Average Efficiency in Active Mode

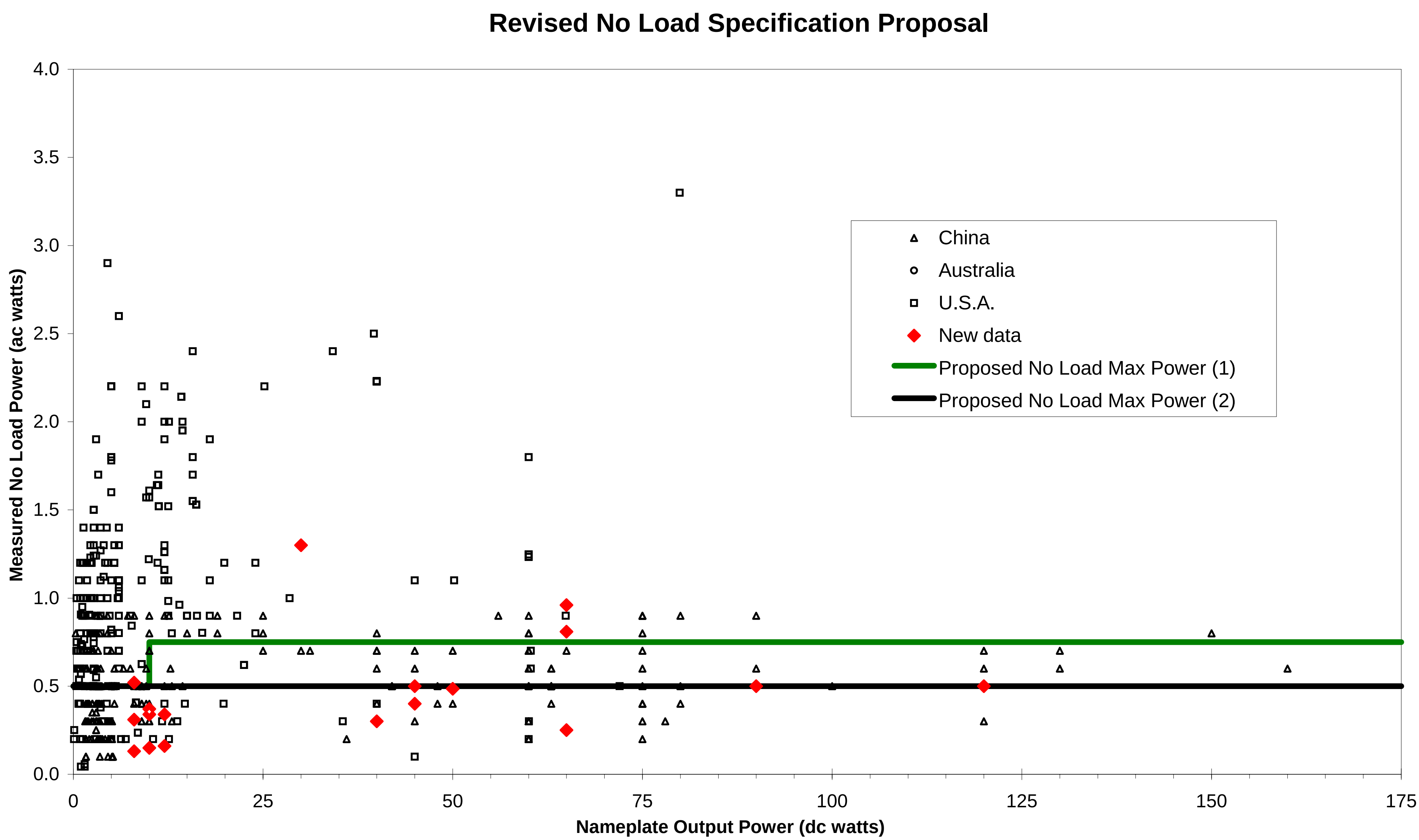



Distribution of External Power Supplies and Proposed ENERGY STAR
Active Mode Specification
100%
80%
60%
40%
20%
0%
Efficiency
0
20
40
60
80
100
120
140
16
Nameplate Output Power (watts)
China
Australia
U.S.
New data
Proposed Active Mode Spec


Distribution of External Power Supplies and Proposed ENERGY STAR Active Mode Specification: 10 Watts and Less
100%
80%
60%
40%
20%
0%
Efficiency
0
1
2
3
4
5
6
7
8
9
10
Nameplate Output Power (watts)
China
Australia
U.S.
New data
Proposed Active Mode Spec



4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Measured No Load Power (ac watts)
0
25
50
75
100
125
150
175
Nameplate Output Power (dc watts)
China
Australia
U.S.A.
New data

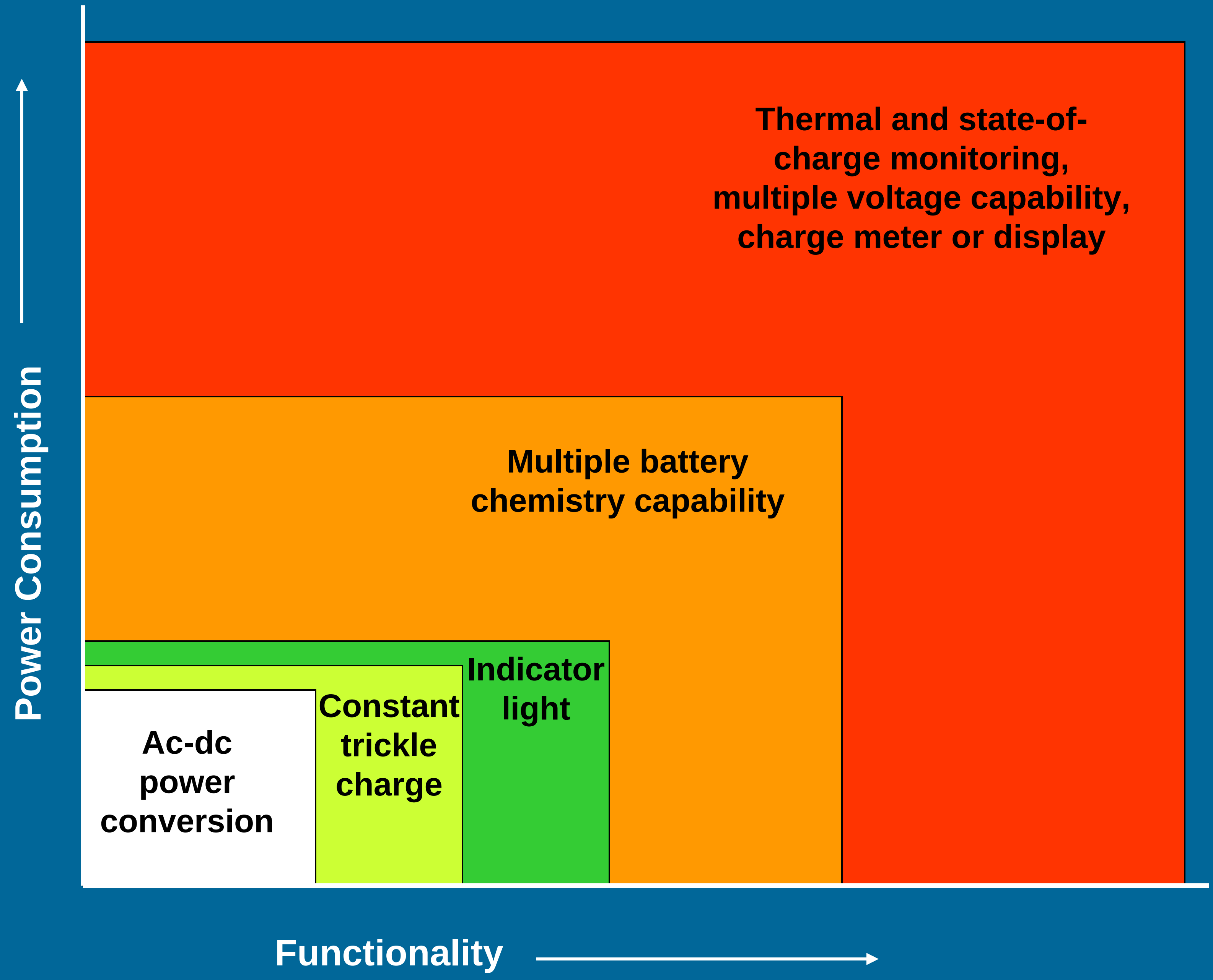

Revised No Load Specification Proposal
Measured No Load Power (ac watts)
Nameplate Output Power (dc watts)
China
Australia
U.S.A.
New data
Proposed No Load Max Power (1)
Proposed No Load Max Power (2)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
0
25
50
75
100
125
150
175

It Is Easier to Spot the Difference Between an External Power Supply and a Battery Charger In Some Products than Others

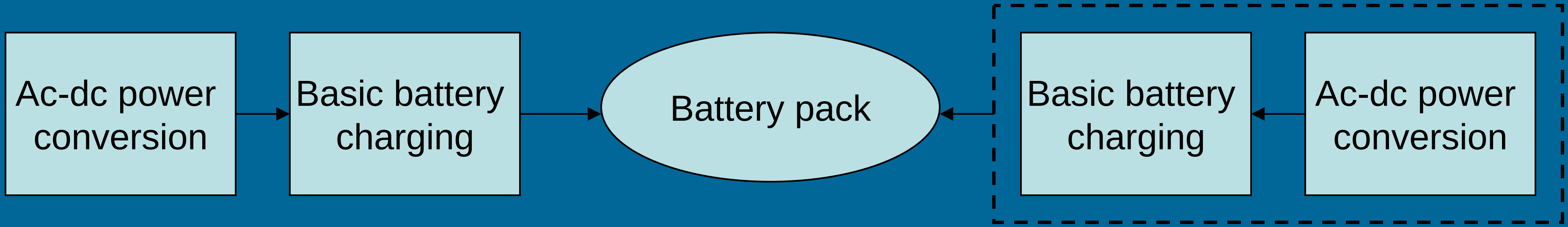
Most Products Connected to External Power Supplies Are Battery Chargers

- Approximately 60% of products connected to external power supplies are battery chargers
- Examples of EPS where dc output is used to charge batteries - cellular and cordless phones, cordless shavers, PDAs, laptops
- Examples of EPS with no battery charging - answering machines, computer speakers, faxes and modems

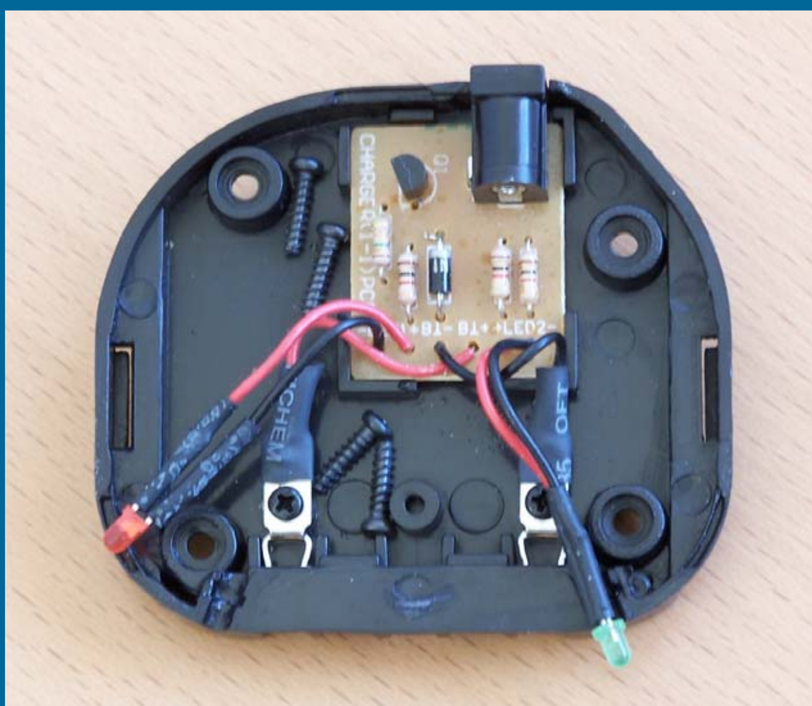
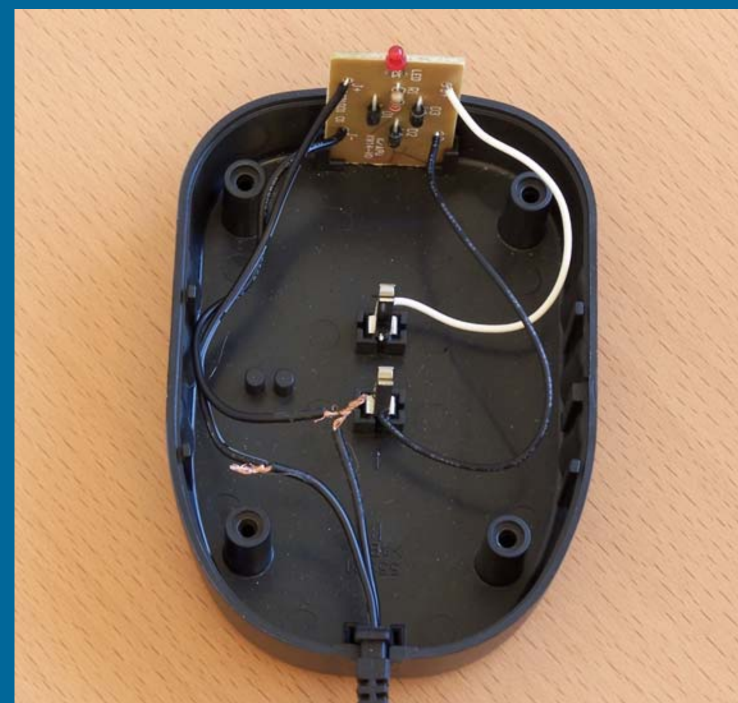
Defining Power Supply/Battery Charger Differences



Circuitry Location Is Less Important than Circuitry Function and Power Consumption





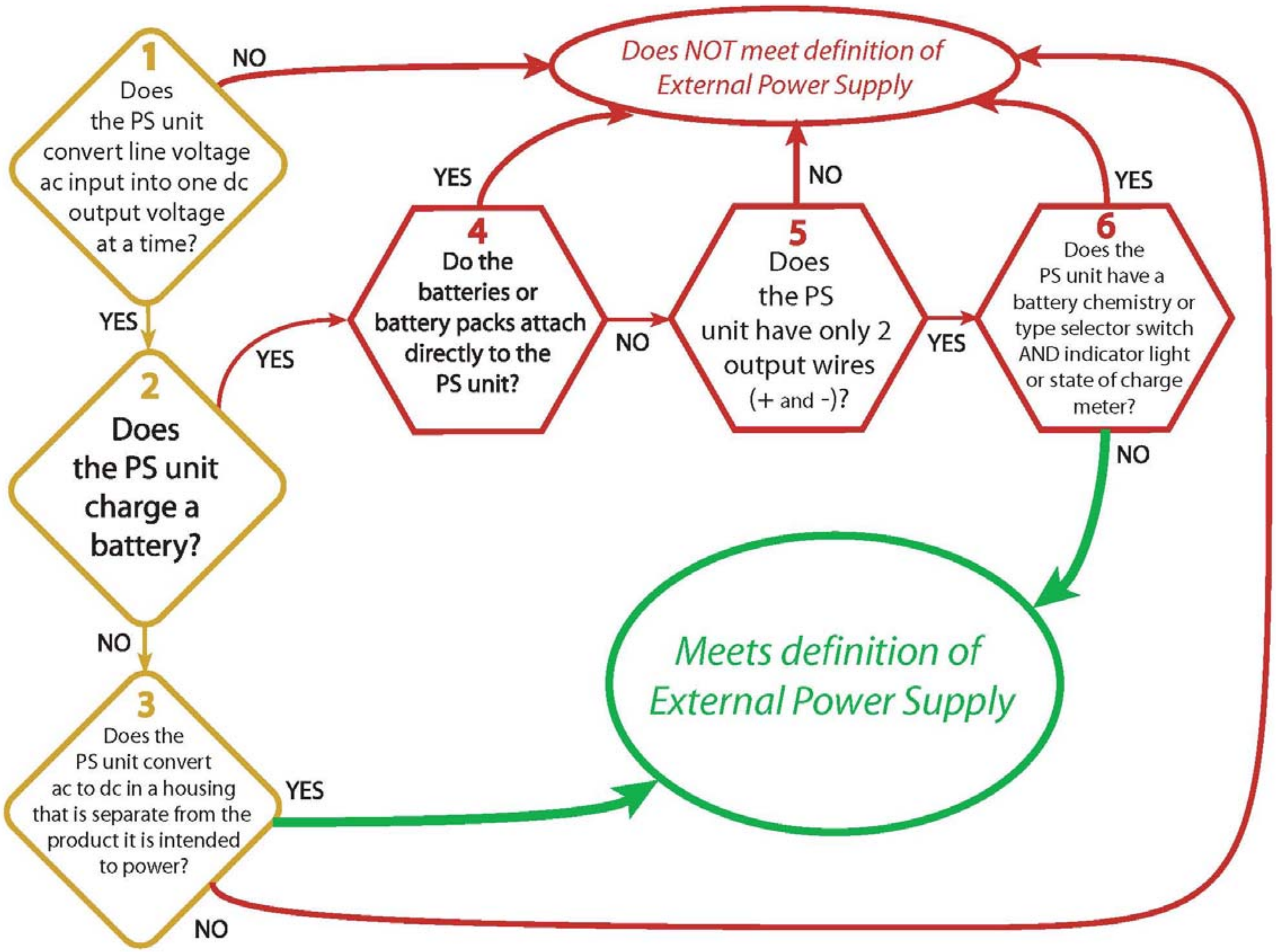



Meets definition of External Power Supply

OR

Does NOT meet definition of External Power Supply

Defining Differences Between External Power Supplies and Cosmetically Similar Battery Chargers



1

Does the PS unit convert line voltage ac input into one dc output voltage at a time?

No

Yes

2

Does the PS unit charge a battery?

→ Yes

↓ No

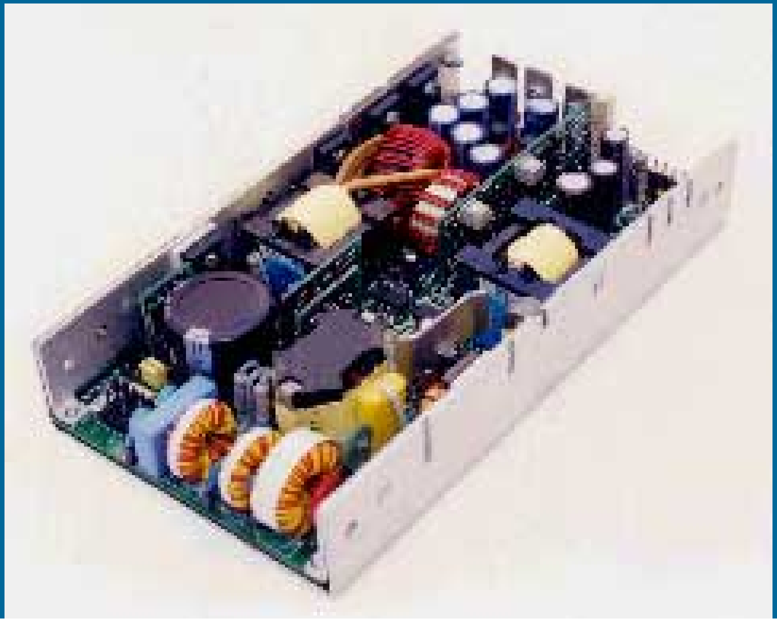
XBOX Power Supply

3

Does the PS unit convert ac to dc in a housing that is separate from the product it is intended to power?

→ Yes

↓ No



4

Do the batteries or battery packs attach directly to the PS unit?

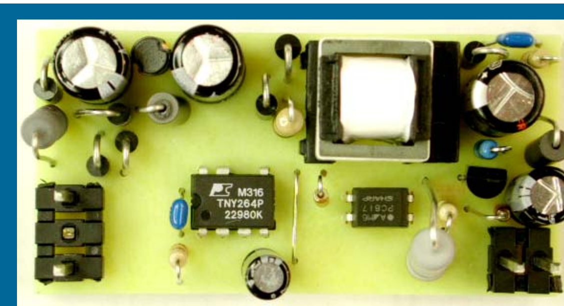
Yes

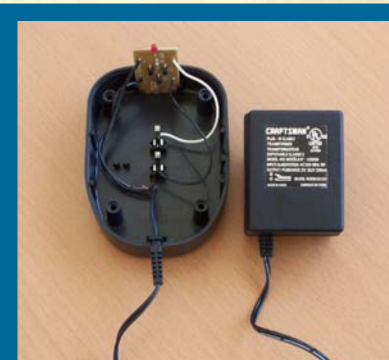
No

5

Does the PS unit have only 2 output wires (+ and -)?

→ Yes





↓ No

6

Does the PS unit have a battery chemistry or type selector switch AND indicator light or state of charge meter?

→ No

↓ Yes

Putting It All Together