IDEAL POWER INC.

September 17, 2013

VIA EDGAR

Ms. Amanda Ravitz, Assistant Director Securities and Exchange Commission Washington, D.C. 20549

Re: Ideal Power Inc. Registration Statement on Form S-1 Filed August 6, 2013 File No. File No. 333-190414

Dear Ms. Ravitz:

This letter is in response to your letter dated August 30, 2013 to Ideal Power Inc. (the "Company") regarding the Company's Registration Statement on Form S-1 (the "Registration Statement"). For your ease of reference, we have repeated the comments included in your letter immediately above each response. In conjunction with this letter, the Company is providing amendment number 1 to the Registration Statement (the "Amendment") for your review.

Prospectus Cover

1. Please revise the cover page to disclose your relationship with MDB Capital Group.

We have revised the cover page as you requested.

2. We note your disclosure that this is a firm commitment offering. Certain of disclosure throughout suggests a different arrangement, however. For example, we note disclosure on page 4 that you will terminate the offering if you fail to raise \$10 million, which seems inconsistent with a firm commitment to take or pay for a certain number of shares. Please revise to clarify the underwriting arrangement.

We have revised the disclosure throughout to make clear that the offering is a firm commitment offering. Please see the prospectus cover page and pages 5, 6, 8, 20 and 51 of the Amendment.

3. Please define or remove technical terms and other jargon so that your document can be understood by an investor not in your industry. Examples include "topology," "utility dispatchable PV," "reference product," "PV inverter," and "distributed storage." It may also be useful to include a brief introductory explanation of where your product fits into the electric power market. For example, is it a consumer or industrial product? Which types of OEMs might be interested in using your product?

We revised the disclosure throughout the Amendment, as you requested. We deleted all references to "topology," "utility dispatchable PV" and "reference product." We revised the disclosure to explain what a "PV inverter" and "distributed storage" are. We also provided a brief introductory explanation of the industry and where our products fit into the industry. Please see the discussion titled "About Ideal Power Inc." at page 1 of the Amendment.

4. Please provide us support for the market and industry data that you cite in the sections entitled "Our Proprietary Technology" on page 2 and "Our Target Markets" on pages 3 and 4. Clearly mark the material you provide to identify the data you cite in your document, and tell us whether you commissioned any of the data disclosed in your prospectus.

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We have included with this letter documents supporting the market and industry data together with an index that includes each statement for which support is provided and the location of the supporting information. The Company did not commission any of the data disclosed in the prospectus.

5. Please provide us support for your statements regarding your leadership throughout the prospectus, such as your statements about leadership in the first and last paragraphs on page 21 of the prospectus.

We have deleted all references regarding our leadership with the exception of the first sentence in the discussion of our business on page 23 of the Amendment.

Our Proprietary Technology, page 2

6. Please provide us with support for your claims in the bullet points in this section about best-of-class safety, greater efficiency and greater reliability. In addition, where you provide statistics, please explain what they mean. For example, what does 96% efficiency mean?

As noted in our response to comment number 4, we have included with this letter documents supporting the market and industry data together with an index that includes each statement for which support is provided and the location of the supporting information. We have also revised the disclosure as you requested. Please see pages 3 and 25 of the Amendment.

7. Please expand the disclosure in the first bullet point on page 3 about "uses below 10kW to over 1MW" to briefly provide examples of the types of uses at the low and high end of the range so that the uses at either end of the range can be understood by an investor not in your industry.

We have revised the disclosure as you requested. Please see page 3 of the Amendment.

8. We note the disclosure in the last sentence of this section about a government grant. Please expand the appropriate section to disclose, if applicable, any rights that the government has to your technology and patents.

We have revised the disclosure to include information about the rights of the government to our technology and patents. Please see pages 4, 26 and 27 of the Amendment.

9. We note the disclosure in the last sentence of this section about developing and commercializing power switches and the disclosure in the second paragraph on page 3 that you are in the process of developing two more reference products. Please expand the sections entitled "Plan of Operation" and "Business" to clearly discuss each step you must take to reach commercialization of your proposed products and your estimated capital needed to achieve each product. For example, you disclose on pages 3 and 24 that the bidirectional insulated gate bipolar transistor is being funded partially by a \$2.5 million grant. However, you do not mention the total capital needed to achieve that product or the two other products mentioned on page 24.

We have revised the disclosure in the "Overview" discussion included in Management's Discussion and Analysis of Financial Condition and Results of Operations and in the "Business" discussion, as you requested. Please see pages 27, 28 and 38 of the Amendment.

Our Business Model, page 3

10. Please expand the disclosure in the fifth sentence of this section to disclose the number of companies that have purchased your products. In addition, explain to us why you chose the customer names you included here. In this respect, please note that we do not consider name recognition to be a sufficient basis for identifying a customer in your disclosure.

We have revised the disclosure as you requested. Please see page 4 of the Amendment.



Our Target Markets, page 3

11. Refer to the first bullet point under this heading. It is not clear why the rapid decline in the cost of solar cells causes growth in the PV inverter market or helps your business. Please revise to clarify.

We have revised the disclosure as you requested. Please see page 4 of the Amendment.

12. Please eliminate disclosure that appears to be marketing. For example, we note the disclosure in this section about "dozens of markets that could benefit" and the "strength of the PPSA value proposition for those markets."

We have revised the disclosure throughout the Amendment to eliminate a marketing emphasis.

13. Please expand the disclosure in the appropriate section of your filing to clarify your relationship with the U.S. Department of Defense and NRG Energy. In this regard, we note that you mention in the third bullet point of this section that the U.S. Department of Defense and NRG Energy are your "partners."

We have revised the disclosure to delete the word "partners." Our significant relationships are described at page 34 of the Amendment. We have also included additional information regarding NRG Energy at pages 5 and 33.

Status as an Emerging Growth Company, page 4

14. Please supplementally provide us with copies of all written communications, as defined in Rule 405 under the Securities Act, that you, or anyone authorized to do so on your behalf, present to potential investors in reliance on Section 5(d) of the Securities Act, whether or not they retain copies of the communications. Similarly, please supplementally provide us with any research reports about you that are published or distributed in reliance upon Section 2(a)(3) of the Securities Act of 1933 added by Section 105(a) of the Jumpstart Our Business Startups Act by any broker or dealer that is participating or will participate in your offering.

The Company has not entered into any "testing the waters" activities and has not communicated with any potential investors in reliance on Section 5(d) of the Securities Act. To our knowledge, there have been no research reports about the Company published or distributed in reliance on Section 2(a)(3) of the Securities Act.

Please clarify that despite opting out of Section 102(b)(1) of the JOBS Act, you may still take advantage of all of the other provision of that Act.

We have revised the disclosure as you requested. Please see page 6 of the Amendment.

The Offering, page 6

15. We note that you disclose that you intend to use some proceeds for "existing product development and commercialization," "protection of [y]our intellectual property" and "general corporate purposes." However, on page 57 you state that you intend to use some proceeds for the "development of existing products, including product and equipment purchases," "patent filings and the protection of intellectual property" and "working capital and general corporate purposes." Please reconcile.

We have reconciled the disclosure as you requested. Please see pages 8, 38 and 65 of the Amendment.

To date we have had a limited number of customers, page 10

16. Please expand the disclosure in this risk factor to quantify the percentage of your net revenues in the fiscal year ended December 31, 2012 from the Department of Energy and Lockheed Martin, respectively. Also, expand the disclosure to quantify the percentage of your net revenues in the fiscal year ended December 31, 2011 from Lockheed Martin and Meridian Solar, respectively.

We have revised the disclosure as you requested. Please see page 12 of the Amendment.

17. If your revenues in the last two years from Lockheed Martin were received in connection with your agreements entered into in 2009 and you do not expect any additional revenues from these agreements, expand the disclosure in this risk factor and in your section entitled "Plan of Operation" to discuss the lack of future revenues from agreements with Lockheed Martin. In this regard, we note the disclosure in the last paragraph on page 28 about your agreements with Lockheed Martin.

We have revised the disclosure as you requested. Please see pages 12 and 41 of the Amendment.

18. If your grant revenues from the Department of Energy in the fiscal year ended December 31, 2012 and in the quarter ended March 31, 2013 represent substantially all of your revenues that you expect to receive from the grants from that agency mentioned in the third paragraph on page 29, expand the disclosure in this risk factor and in your section entitled "Plan of Operation" to discuss the lack of future revenues from those two grants from that agency.

We will continue to receive funds under the ARPA-E grant. Please see pages 34 and 39 of the Amendment.

We have not devoted significant resources toward the marketing and sale, page 11

19. Please expand the disclosure in the appropriate section of your filing to discuss the material terms of your strategic marketing and distribution agreements mentioned in this risk factor.

We have not entered into any strategic marketing or material distribution agreements at this time. We have revised the risk factor to clarify this. Please see page 13 of the Amendment.

Business Strategy, page 23

20. Since you do not appear to have sold any 30kW hybrid converters, 30kW micro-grid converters and bidirectional insulated gate transistors, please revise throughout to remove claims about the characteristics of these product or their benefits, or revise to indicate that they represent management's belief. Examples include the disclosure on page 24 about "charging systems with greater energy and cost efficiency," the disclosure in Figure 5 on page 24 of the incremental benefits of BD-IGBT implementation, the disclosure on page 27 about a "lower cost, more efficient integrated solution" and the disclosure on page 28 about the product "should perform at lower cost and higher efficiency."

We have revised the disclosure throughout the discussion of the business, as you requested.

Intellectual Property, page 24

21. We note the reference in this section to a "proven ideation process." Please provide us support for your statement about a "proven" process. Also, please briefly explain the phrase "ideation process."

We have revised the disclosure in this section to delete this phrase.

22. Please disclose the duration of your material patents.

We have revised the disclosure to include this information. Please see page 29 of the Amendment.

Revenue Recognition, page 33

23. We note that you have been awarded two significant grants from the U.S. Department of Energy and have received approximately \$1.0 million in revenue to fund long-term research and next generation product development. Please revise to describe how you recognize revenue from grants. Describe how the revenue is earned and how you determine the timing for revenue recognition.

We have revised the disclosure as you requested. Please see page 39.

24. As a related matter, please clarify if the grants are for the reimbursement of costs and how you determined that grants are appropriately classified as revenue rather than netted against related expenses incurred. Please also clarify where you record expenses related to grant revenue in the statement of operations. We reference your disclosure on page F-7 that government grants are agreements that generally provide the company with cost reimbursement for certain type of research and development activities over a contractually defined period.

Our historic policy has been to recognize monies received from government research grants as a component of revenue in our statement of operations. We believe that one of our important business strategies is to build governmental awareness of our solutions that may reduce dependence on fossil fuel and improve grid resiliency. Performance of research and development activities under government grants represents a core strategy to the growth of our operations. Throughout our history, we have been able to supplement our research with U.S. government grants, including approximately \$1.2 million in grant funds that remain available at June 30, 2013.

U.S. GAAP provides limited guidance on the accounting for government grants by for-profit companies. IAS 20 recognizes that there are two broad approaches for accounting for government grants: the income approach or the capital approach. We have assessed the nature of the grants and have determined to recognize grant receipts under the income approach, classifying the proceeds as revenue, as that best represents the economics of the arrangements. In following this policy, we adhere to the guidance of Statement of Financial Concepts No. 6, *Elements of Financial Statements*, paragraphs 78 - 79 ("<u>CON 6</u>"). Performing research and development activities under government grants has historically represented a major and central aspect of the Company's ongoing operations as defined by CON 6 and therefore grant funds have been consistently recorded as revenue.

Expenses related to grant revenue are expensed under cost of revenues.

Stock-Based Compensation, page 33

25. Please revise to disclose how you determined each of the assumptions required in valuing stock options. In discussing how you determined the fair value of your common stock, disclose the following:

- The aggregate intrinsic value of all outstanding options based on the midpoint of the estimated IPO price range. Please make sure to use the pre-reverse stock split IPO price.
- Discuss the significant factors, assumptions and methodologies used in determining fair value for those options granted during the twelve months prior to the date of the most recent balance sheet.
- Discuss each significant factor contributing to the difference between the fair value as of the date of grant and the estimated IPO price for options granted during the twelve months prior to the date of the most recent balance sheet.
- · Disclose the valuation method used and the reasons why you choose that method.

We have revised the disclosure as you requested. Please note that the common stock will be sold at \$5.00 per share, so there is no mid-point. Furthermore, there were no option grants made during the 12 months prior to June 30, 2013. We used the Black Scholes pricing model, which we believe is the most commonly used valuation method, to determine the estimated fair value of our stock options. Please see page 40 of the Amendment.

26. Please also revise to include disclosure about how you value common stock issued for services and common stock warrants issued for consulting services.

We have revised the disclosure as you requested. Please see page 40 of the Amendment.

Convertible Promissory Notes and Warrants, page 34

27. Please revise to disclose the significant assumptions used to value warrants issued in connection with debt arrangements, including how you determined the estimated fair value of your common stock used in the valuation.

We have revised the disclosure as you requested. As we noted in our response to comment 25, we used the Black Scholes pricing model to determine the estimated fair value of our common stock. The assumptions used for the model were the same as the assumptions used to value the stock options. Please see page 40 of the Amendment.

Results of Operations, page 34

28. Please revise to discuss the reasons for the significant increase in grant revenue in fiscal 2012. Please also further discuss the significant decline in contract revenues from Lockheed Martin in fiscal 2012.

We have revised the disclosure as you requested. Please see pages 41 and 42 of the Amendment.

29. Please revise to discuss why general and administrative expense increased from the three months ended March 31, 2012 to March 31, 2013. Please also further discuss the reason for the significant increase in general and administrative expenses for fiscal 2012 compared to 2011 and clarify the nature of the significant increase in business consulting and legal services.

We have revised the disclosure as you requested. Please see pages 41 and 42 of the Amendment.

Capitalization, page 57

30. Please provide us the adjustments used to determine the "as adjusted for the effect of the reverse split, debt conversion and issuance of shares to directors" in the Capitalization table on page 58. In addition, provide a reconciliation of the "as adjusted" amounts in the table to the amounts in the balance sheets on page F-1.

Column 3 of the capitalization table takes into consideration the following: (i) \$3,601,212 in convertible debt and (ii) common stock with a value of \$87,497 to be issued to our directors for services provided to us. \$1,740 is included as common stock at \$0.001 par value and the remainder is included in paid-in-capital. Included in the promissory note issued to our legal counsel is \$93,074 in third quarter legal expense that has not been accrued. This additional cost is charged to accumulated deficit in total stockholders equity.

Column 4 takes into consideration the net proceeds of our offering of 2,500,000 shares of common stock having a par value of \$0.001 per share. We estimate the net proceeds will be \$10,467,000. \$2,500 is included as common stock at \$0.001 par value and the remainder of \$10,464,500 is included in paid-in-capital. As noted above, additional legal expense of \$93,074 accrued after June 30, 2013 has been incorporated into the last two columns of the capitalization table.

Dilution, page 59

31. Please revise to disclose how the data in the table on page 59 would change assuming the exercise of all warrants and options.

We have revised the disclosure as you requested. Please see page 67 of the Amendment.

Financial Statements

32. Please update the financial statements when required by Rule 8-08 of Regulation S-X. Condensed Financial Statements for the three months ended March 30, 2013

We have included the interim financial statements for the six months ended June 30, 2013, as required by Rule 8-08 of Regulation S-

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Condensed Balance Sheets, page F-1

33. Please revise to separately identify outstanding debt that is convertible.

We have revised the balance sheet as you requested. Please see page F-1 of the Amendment.

Condensed Statement of Operations, page F-2

34. Please revise to disclose the pro forma net loss per share assuming the reverse stock split that you will effect after the effectiveness of the registration statement.

We have revised the statement of operations as you requested. Please see page F-2 of the Amendment.

Note 6. Patents, page F-10

35. We reference the disclosure that you have capitalized \$426,000 for costs related to patents that have not been awarded. Please tell us the nature of the costs capitalized as patent assets. In addition, please tell us the basis in U.S. GAAP for capitalizing costs to obtain patents. We reference FASB ASC 350-30 which states that the costs of internally developing other intangible assets, such as those that are specifically identifiable, are expensed as incurred, unless other specific guidance calls for capitalization of those costs.

The costs that are capitalized are third party legal costs and filing fees associated with obtaining patents on our new inventions. We believe the costs capitalized have future value. Because the costs we capitalize have future value, they are capitalized under the guidance of Statement of Financial Accounting Concepts, Number 5, *Recognition and Measurement in Financial Statements of Business Enterprises*. In accordance with FASB ASC 350-30, none of the internal costs of internally developing the patents have been capitalized.

Note 9. Common and Preferred Stock, page F-14

36. Please explain to us the basis in U.S. GAAP for your accounting for the 29,680 shares of common stock for services that have not been issued. If the services have been performed, explain to us why the related expense is not recorded within net loss on the statement of operations.

We have revised the disclosure in note 9 to reflect that the service was expensed as performed. The 29,680 shares valued at \$43,333 were recognized as a cost and expensed in Operating Expenses – General and Administrative, and more specifically under Stock Compensation Expense. The footnote has been changed accordingly. As of June 30, 2013 that number increased to 59,930 shares for a total expense of \$87,497. Note that the 59,930 shares are pre-split shares; the number of shares after giving effect to the one-for-2.381 reverse split is 25,170 shares.

37. As a related matter, revise to disclose how you determined the fair value of common stock to be issued in connection with services rendered of \$43,333.

We have revised note 9 to the financial statements for June 30, 2013 as you requested. Please see page F-14.

Exhibit 23.1. Consent of Independent Registered Public Accounting Firm

38. To the extent there is a delay in requesting effectiveness of your registration statement, or there is any change, other than typographical, made to the financial statements, or there have been intervening events since the prior filing that are material to the company, please provide a currently dated and signed consent from your independent accountant with your next amendment.

We have included a currently dated and signed consent from our independent accountant, as you requested.



In responding to your comments, the Company acknowledges that:

- should the Commission or the staff, acting pursuant to delegated authority, declare the filing effective, it does not foreclose the Commission from taking any action with respect to the filing;
- the action of the Commission or the staff, acting pursuant to delegated authority, in declaring the filing effective, does not relieve the company from its full responsibility for the adequacy and accuracy of the disclosure in the filing; and
- the Company may not assert staff comments and the declaration of effectiveness as a defense in any proceeding initiated by the Commission or any person under the federal securities laws of the United States.

We hope that this letter has adequately addressed your comments. If you have additional comments or questions, please contact Kevin Friedmann, Esq. via e-mail at kfriedmann@richardsonpatel.com or by telephone at (212) 561-5559.

Very truly yours,

IDEAL POWER INC.

By:<u>/s/ Paul Bundschuh</u> Paul Bundschuh Chief Executive Officer

IDEAL POWER INC. SUPPORTING DOCUMENTATION INDEX TO RESPONSE TO SECURITIES AND EXCHANGE COMMISSION ("SEC") COMMENT LETTER

Re: Ideal Power Inc. (the "Company") Registration Statement on Form S-1 Filed August 6, 2013 File No. 333-190414

This information is provided in response to certain comments contained in the SEC staff's letter to the Company, dated August 30, 2013 (the "Comment Letter"), concerning the above referenced registration statement (the "Original S-1"), which request additional support for certain statements in the Original S-1. The table below cites the name and reference number of the document(s) that provide(s) support for the applicable statement in the Company's Original S-1. For convenience of reference, (i) the comments from the Comment Letter requesting additional support are repeated below and the number beside each comment corresponds to the comment number in the Comment Letter and (ii) each reference number cited below corresponds to the document number within the attached PDF entitled "Supporting Documentation."

SEC Comment	S-1 Page #	S-1 Statement	Supporting Documentation							
	Located in Prospectus Summary									
4. Please provide us support for the market and industry data that you cite in the sections entitled "Our Proprietary Technology" on page 2 and "Our Target	2	The applicable disclosure from the Original S-1 has been revised to read as follows:	Reference #1: Power One datasheet for Trio-27.6-TL.							
Markets" on page 3 and 4. Clearly mark the material you provide to identify the data you cite in your document, and tell us whether you commissioned any of the data disclosed in your prospectus.		For example, Power One (one of the leaders in the power conversion space) currently offers a 27.6kW conventional transformer-less inverter that weighs 168 lbs., for a power-to-weight ratio of approximately 164 Watts/lbs. Conventional transformer-less inverters do not provide isolation; one of the key benefits they provide over traditional inverters is that they are smaller.								

	3	The applicable disclosure from the Original S-1 has been revised to read as follows: PV inverter market: The PV inverter market is already large and still growing; industry analysts estimate it at \$7.1 billion in 2012, with growth in the installed base from 30 GW in 2012 to over 58 GW in 2017 (a CAGR of 13.8%). Due to the oversupply of PV modules, both module costs and installed PV system costs have declined sharply in the past few years. The decline in PV installation costs has increased demand for a number of installations and for other system components such as PV inverters. The declining system costs and increasing volume of PV installations have also reduced the need for government subsidies and incentive programs, and have prompted many countries to reduce or end their incentive programs faster than originally planned. In a growing number of applications and regions, PV is cost-effective with conventional generation without subsidies. This is particularly true for distributed power generation systems whose owners will consume the electricity they generate. In this case the demand for distributed PV is not only to reduce costs, but also to secure more independence from the power grid.	 in 2012, as Asia Arises as Growth Driver [Press release]. Reference #3: ABB Global PV Inverter Market (April 2013). Source: IMS PV Inverter Report, March 2013. Reference #4: IHS (May 2013), "The Role of Energy Storage in the PV
-	4	Our 30kW PV inverter weighs 97 pounds compared to 1200 pounds for a typical transformer-based PV inverter. It also weighs about half as much as typical transformer-less PV inverters, which do not provide isolation and therefore need	inverter products.Reference #6: Advanced Energy datasheet for AE35TX.Reference #1: Power One datasheet for
	4		

The applicable disclosure from the Reference #8: DC Fast ChargingOriginal S-1 has been revised to read asEquipment for ElectricVehicles,follows:Navigant Research (2013).

Electrified vehicle DC charging market: The DC charging market is sometimes called the fast-charging market, as it can reduce charge time for a standard electric vehicle from 8 hours to 30 minutes. This market is growing quickly, spurred on by EV manufacturers such as Tesla and Nissan; industry analysts estimate that EV DC or fast charger shipments will grow from 9,000 in 2012 to 98,000 in 2020

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Comment	S-1 Page #	S-1 Statement	Supporting Documentation
5. Please provide us support for your statements regarding your leadership throughout the prospectus, such as your statements about leadership in the first	22	The applicable disclosure from the Original S-1 has been revised to read as follows:	1 8
and last paragraphs on page 21 of the prospectus.		We believe we are a leader in the development of an innovative electronic power conversion technology called Power Packet Switching Architecture (PPSA), based on our 19 issued United States patents related to this technology.	

Comment	S-1 Page #	S-1 Statement	Supporting Documentation						
	Located in Proprietary Technology								
6. Please provide us with support for your claims in the bullet points in this section about best-of-class safety, greater efficiency and greater reliability. In addition, where you provide statistics, please explain what they mean. For example, what does 96% efficiency mean?	2	The applicable disclosure from the Original S-1 has been revised to read as follows: Best-of-class safety without significant additional safeguards. The PPSA process provides electrical isolation between the input and the output without a transformer. This isolation means that PPSA systems can be grounded, so they achieve the same safety benefit as transformer-based inverters. Conventional transformer-less PV inverters generally cannot be grounded, and therefore must use other safeguards, increasing system expense. Note that it is only in the PV inverter space that we believe transformer-less inverters are even viable; in our other target markets (grid- storage battery converters and electrified vehicle DC charging), we believe that isolation will be a requirement. PPSA can provide this isolation without the size, weight, cost, and efficiency loss of using a transformer.	(October 2012), New Topology Cuts Size, Improves Performance of PV Inverters.						
2	Tl	ble disclosure from the Deference #10. C	alifamia Enames Commission (CEC)						

2 *The applicable disclosure from the* **Reference #10:** California Energy Commission (CEC) *Original S-1 has been revised to* Efficiency Test Results, Intertek Testing Services (May *read as follows:* 2012).

Greater efficiency. Efficiency is the **Reference #11:** measure of power out of the inverter CEC website of approved PV inverters including CECas a percentage of the power into weighted efficiency measurements the inverter. Thus, high efficiency http://www.gosolarcalifornia.ca.gov/equipment/inverters.php

	inverter was tested for efficiency by Intertek, a leading Nationally Recognized Testing	SMA SunnyIsland Battery Converter 94% CEC–weighted efficiency Reference #13: Nissan EV DC charger datasheet >90% efficiency
3	The applicable disclosure from the	Reference #14: U.S. Navy purchase order to fund third party reliability testing in order to prove superior robustness and reliability of PPSA.



AURORA®

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TRIO-20.0-TL TRIO-27.6-TL

GENERAL SPECIFICATIONS OUTDOOR MODELS

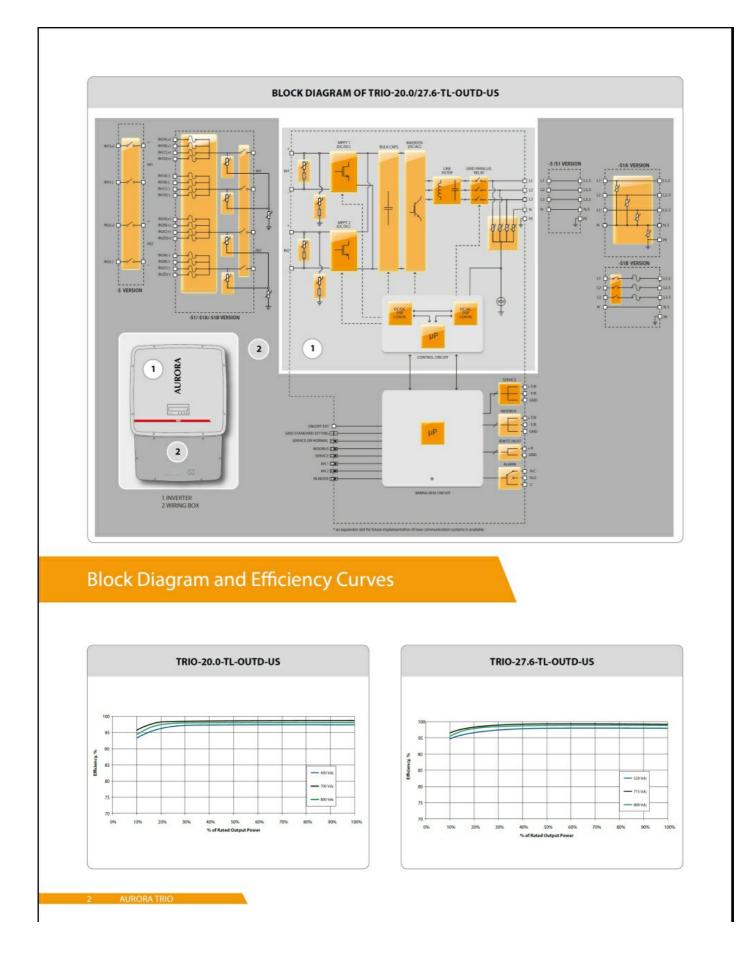
Introducing the latest innovation from the world-wide leader in three-phase string inverters, the TRIO-20.0-TL and TRIO-27.6-TL. The TRIO is a powerful, flexible and dependable three phase string inverter with innovative features to lower system LCOE and improve ROI on commercial solar installations.

The first 1000Vdc string inverter certified to UL1741, a commercial PV system using a TRIO based modular architecture can reduce BOS costs by as much as 40%. With two independent MPP trackers and peak efficiency ratings of 98.3%, these inverters offer superior energy harvest. Employing fan-less convection cooling and no electrolytic capacitors, TRIO is designed for long service life. Equipped with integrated Modbus and utility interactive controls including adjustable power factor and curtailment, these inverters provide the monitoring and controls features required in today's commercial solar installations.

Features

- Maximize energy production with 97.5% CEC efficiency and industry leading MPPT algorithm
- Fully utilize available roof space and maximize harvest with dual independent MPP trackers
- Wall mountable design and 1000Vdc input voltage lower installation costs
- Wide DC input voltage and operating temperature range enable greater PV array design flexibility
- Improve system uptime and eliminate single point of failure with a modular design using TRIO
- Utility interactive control features and Modbus protocol integrates with monitoring and control systems
- Design uses natural convection cooling and no electrolytic capacitors for segment leading reliability
- Standard 10 year warranty

AURORA TRIO



TECHNICAL DATA	VALUES	TRIO-20.0-TL-OUTD-US	TRIO-27.6-TL-OUTD-US
ominal Output Power	W	20000	27600
aximum Output Power	W	22000*	30000*
ated Grid AC Voltage	V	480	480
put Side (DC)			
umber of Independent MPPT Channels		2	2
aximum Usable Power for Each MPPT Channel	W	12000	16000
bsolute Maximum Voltage (Vmax)	V	1000	1000
tart- Up Voltage (Vstart)	V	360 (adj. 250-500)	360 (adj. 250-500)
ull Power MPPT Voltage Range	V	450-800	520-800
perating MPPT Voltage Range	V	200-950	200-950
aximum Usable Current per MPPT Channel	A	25.0	30.9
aximum Short Circuit Current Limit per MPPT Channel	A	30.0	36.0
umber of Wire Landing Terminals per MPPT Channel rray Wiring Termination Type		-S version: 2; -S1, -S1A, -S1B version: 8 -S version: Terminal Block, Screw Terminal, Cop-	-S version: 2; -S1, -S1A, -S1B version: 4 -S version: Terminal Block, Screw Terminal, Cop-
		per Only 12AWG-2AWG	per Only 12AWG-2AWG
utput Side (AC)		2012111 4111 - Comment	2010Wise AW, County
rid Connection Type efault Voltage Range	V	3Ø/3W or 4W+Ground 422-528	3Ø/3W or 4W+Ground 422-528
ominal Grid Frequency	Hz	422-528	422-526
djustable Grid Frequency Range	Hz	57-63	57-63
aximum Current (lac max)/phase	Anns	27.0	36.0
ower Factor		> 0.995 (adj. ± 0.8, or ± 0.9 for active power >20kW)	> 0.995 (adj. ± 0.8, or ± 0.9 for active power >27.6kW)
otal Harmonic Distortion At Rated Power	96	<3	<3
rid Wiring Termination Type		Pass-through Terminal. Tension clamp. Copper 8AWG-4AWG	Pass-through Terminal. Tension clamp. Copper 6AWG-4AWG
rotection Devices		consistenting copper on the 4Artic	rension clamp, copper ontro anno
everse Polarity Protection		Vec Paccive inverte	r protection only. **
upplementary Over-Voltage Protection Type For ach MPPT			Class II Modular Surge Arrestor
V Array Ground Fault Detection		Moote III 1741/NEC	600 5 requirements
V Array Ground Fault Detection		meets 0L1/41/NEC	690.5 requirements
nti-Islanding Protection		Meets UL1741/IEEE1547 requirements	Meets UL1741/IEEE1547 requirements
Increasing Protection upplementary Over-Voltage Protection Type fficiency			s II Modular Surge Arrestor
Naximum Efficiency	%	98.2	98.2
EC Efficiency	%	97.5	97.5
perating Parameters	70	27.5	5115
eed-In Power Threshold	WRMS	65	70
ommunication	TT NWS		
ser-Interface (Display)		5.5" x 1.25" G	raphic Display
tandard Integrated Monitoring Cards		RS485 Connection, Can be configured	red for Aurora Protocol or Modbus RTU. nitoring expansion cards.
Optional Remote Monitoring Logger nvironmental			ommercial (optional)
mbient Air Operating Temperature Range	F(°C)	$-22 \text{ to } \pm 140 (-30 \text{ to } \pm 60)$	Derating above +113 (45)
Imbient Air Operating Temperature Range	F(°C)	-40 to +185 (-40 to +85)	-40 to +185 (-40 to +85)
elative Humidity	%RH	0-100 condensing	0-100 condensing
coustic Noise Emission Level	db (A) @1m	<50	<50
Aaximum Operating Altitude without Derating	ft(m)	6560 (2000)	6560 (2000)
Achanical Specifications	,,	(2000)	
nclosure rating		NEMA 4X	NEMA 4X
ooling		Natural Convection	Natural Convection
imensions (H x W x D)	in/mm	41.7 x 27.6 x 11.5/ 1061 x 702 x 292	41.7 x 27.6 x 11.5/ 1061 x 702 x 292
nit Weight	lbs(kg)	157 (71)	168 (76)
onduit Connections			D, (2) ½" plugged openings, (1) 1" plugged opening
lounting System		Wall Bracket	Wall Bracket
ptional AC Fused Disconnect Current Rating (Per Contact) afety	A	35	45
olation Level		Transformerless Floating Array	Transformerless Floating Array
afety and EMC Standard			1-01-2001, FCC Part 15 Sub-part B Class B Limits
afety Approval		cCSAus	cCSAus
arranty			
tandard Warranty	Years	10	10
ktended Warranty	Years	15 & 20	15 & 20
vailable Models		TRIO DO ATL OUTO CUIC IOS	
tandard with DC Switch		TRIO-20.0-TL-OUTD-S-US-480	TRIO-27.6-TL-OUTD-S-US-480
/ith DC Switch, DC Fuses and DC Surge Protection		TRIO-20.0-TL-OUTD-S1-US-480	TRIO-27.6-TL-OUTD-S1-US-480
/ith DC Switch, DC Fuses, DC Surge Protection and AC urge Protection		TRIO-20.0-TL-OUTD-S1A-US-480	TRIO-27.6-TL-OUTD-S1A-US-480
Vith DC Switch, DC Fuses, DC Surge Protection and AC used Disconnect		TRIO-20.0-TL-OUTD-S1B-US-480	TRIO-27.6-TL-OUTD-S1B-US-480

** In -51, -51A and -51B models, the string polarity must be verified before connection. Please refer to installation manual for the correct installation procedure.

AURORA TRIO

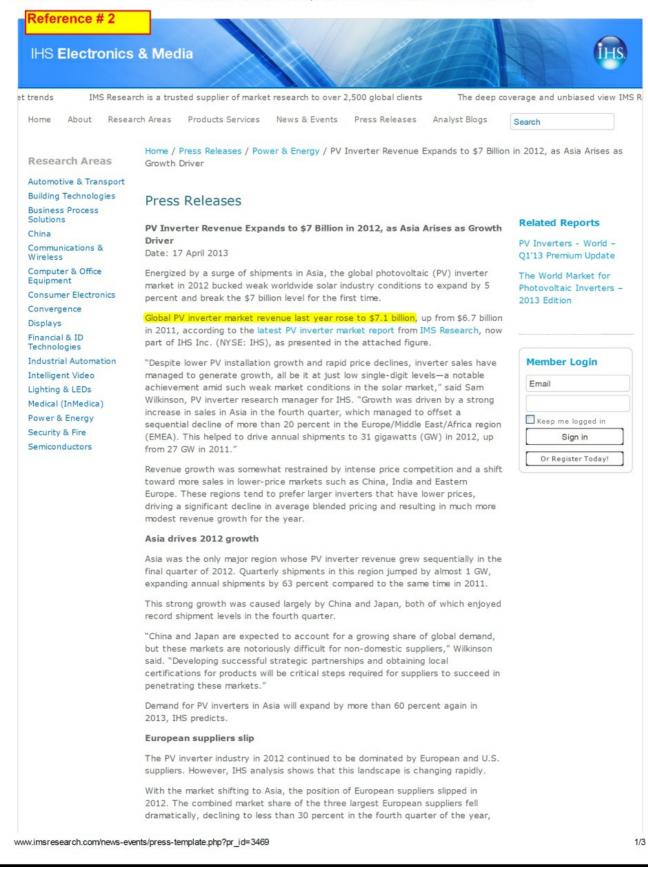


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		sales.usacentral@power-one.com
North America	+1 877 261-1374	sales.usawest@power-one.com
	Name/Region Asia Pacific Asia Pacific Asia Pacific Asia Pacific Asia Pacific Europe Europe Europe Europe Europe Europe Middle East North America North America	Asia Pacific +61 2 9735 3111 Asia Pacific +86 755 2988 5888 Asia Pacific +86 755 2986 5363 Asia Pacific +65 6896 3363 Asia Pacific +65 6896 3363 Europe +32 2 206 0338 Europe +33 (0) 141 796 140 Europe +33 (0) 141 795 2020 Europe +0 800 00287672 Opt. n°5 Europe +34 91 879 88 54 Europe +44 1903 823 323 Middle East +971 50 100 4142 North America +1 877 261-1374 North America +1 877 261-1374

IMS Research - PV Inverter Revenue Expands to \$7 Billion in 2012, as Asia Arises as Growth Driver



7/26/13

IMS Research - PV Inverter Revenue Expands to \$7 Billion in 2012, as Asia Arises as Growth Driver

down from almost 50 percent in the first quarter.

Top 3 suppliers unchanged, but leaders' market share dips in 2012

For the second year running, SMA of Germany; California-based Power-One; and Kaco, also of Germany, were the world's three largest PV inverter suppliers. However, these suppliers' absence from the fastest-growing major markets of Japan and China put their market share under considerable pressure near the end of the year.

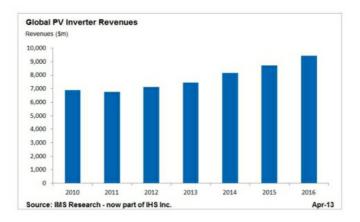
"SMA, which once was the undisputed market leader, saw its market share fall below 20 percent in the fourth quarter of 2012," Wilkinson said. "That's the lowest level that we have on record in over six years of analyzing the market. SMA has taken action by acquiring a stake in a Chinese supplier and aggressively targeting the Japanese market, and these are important steps in protecting its leading position in the PV inverter market. However, it remains to be seen if these actions will be aggressive enough as the PV market continues to fragment."

Smaller suppliers surge

The ranking of suppliers below the three leaders changed significantly.

Four of 2012's largest suppliers made big increases in their rankings: Coloradobased Advanced Energy, Enphase Energy of California, Danfoss Solar Inverters from Denmark and Omron from Japan. These companies all gained at least four places in the rankings.

Just one European supplier in the Top 10—Danfoss—was able to increase its global ranking in 2012, reflecting the changing supplier landscape as markets outside of Europe begin to account for a growing share. An Asian supplier and a microinverter supplier also appeared in the Top 10 for the first time in 2012.

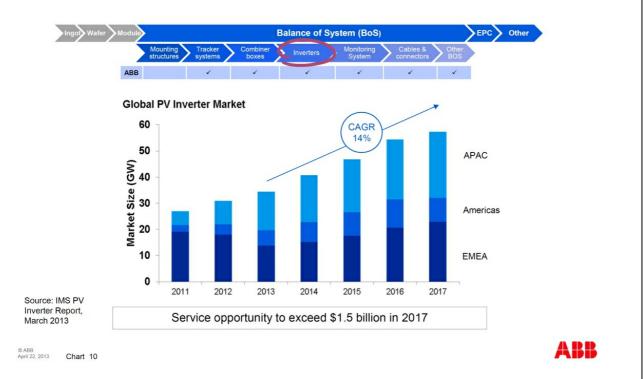








Inverters: most attractive in solar PV value chain Innovation, reliability and service are key



Reference # 4



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Published in May 2013

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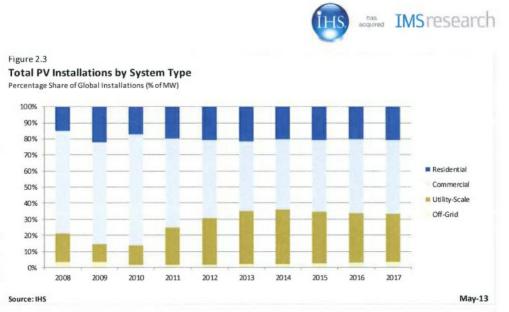


Table 2.4

System Type Percentage Share of Global PV Installations Percentage (% of MW)

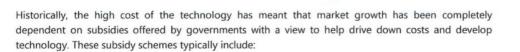
	Historical				Forecast						
	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	DIFF 12-17
Off-Grid	3%	3%	2%	1%	2%	2%	2%	2%	3%	4%	2.0%
Residential	15%	22%	17%	20%	21%	22%	20%	21%	20%	21%	-0.4%
Commercial	64%	64%	69%	56%	48%	43%	44%	45%	46%	46%	-2.1%
Utility-Scale	18%	11%	12%	23%	29%	33%	34%	32%	31%	30%	0.5%
Source: IHS										P	May-13

2.1.3 Current Status of PV Market

Given that PV is a source of electricity, its potential market size and ability to meaningfully contribute to global electricity production is highly dependent on competing with other electricity sources on cost.

The cost of PV systems has declined substantially in recent years, and in particular costs have decreased rapidly over the past 2 years. A huge oversupply of PV modules (and other associated products) has led to fierce price competition since early 2011. Although, the dramatic reduction in the price of PV components has helped to drive PV deployment, module suppliers have struggled to reduce their costs sufficiently putting huge pressure on their margins and balance sheets. 2012 saw a number of suppliers declaring bankruptcy or exiting the market.

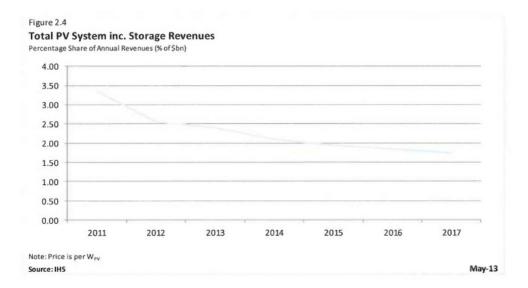
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has IMS research

- Feed-in Tariffs (FiT) FiTs are one of most common forms of incentives for renewable energy, particularly in Europe. These offer system owners fixed payments per kWh of electricity generated and/or exported to the grid.
- Grants/Tax Incentives Some countries offer grants and tax related incentives based on the upfront
 cost of a PV system to help pay for the installation.
- In some countries, such as the US, it is mandated that utilities secure a given percentage of its energy supply from renewables, otherwise financial fines are introduced. This is known as a Renewable Portfolio Standards (RPS) and in some cases; utilities have introduced incentives to ensure that RPS are met.

For many years these subsidies were the main driver for market growth. Even today, the PV market is highly reliant on subsidies and incentive schemes. However, following system prices declining much faster than expected over the last two years, many countries' incentive schemes have been prematurely ended or reduced as the high level of returns that they offered to investors resulted in markets growing faster than budgeted for. In some applications and regions, PV is now able to compete without subsidies and plans for large unsubsidized plants are emerging.



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The shift from being a subsidized to a self-sustained market has already begun and will continue over the coming years. This will cause some important changes to the dynamics of the PV industry. Whilst incentives and subsidies attract potential system owners by offering a favourable investment, small system owners that consume their own electricity in a self-sustained market will be driven by a desire to secure their own independent source and reduce the amount of electricity that they purchase from utilities in the long-term.

2.2 Overview of Energy Storage in PV

2.2.1 Introduction to Energy Storage in PV

Following several years of large-scale deployment, PV is now a significant contributor to the energy mix in a growing number of countries. However, many of the characteristics of the generation profile of a PV system present issues, particularly when there is high level of PV penetration or when relying on these systems to meet power demands. The use of energy storage solutions can help to address issues caused by the following characteristics:

A PV System Only Produces Electricity in the Day Time

A PV system relies on sunlight to generate electricity and therefore only generates electricity during daytime hours, with a peak generation around mid-day when solar irradiation is at its highest. However, as the output of systems doesn't align well with on-site demand in many cases, a significant portion of this energy is exported to the electricity-grid, increasing pressure on the limited grid-capacity. This results in the contribution of grid-connected PV in a given region varying significantly throughout a 24 hour cycle. In the most extreme case, at mid-day on Saturday 26th May 2012, PV energy accounted for 40% of total energy demand in Germany – the largest PV market.

Clearly, a PV system cannot be used to generate electricity in the evening or at night. In many countries, demand for energy in the evening is typically high, and therefore a grid-connected system owner will need to import energy from the grid when the system is not generating.

The Output of a PV System is Intermittent and Unpredictable

The output of a PV system is highly dependent on local weather a condition, meaning it is subject to rapid variations. The electricity generated by a PV system is typically fed into the electricity grid when it is not being used to power a load on-site, and rapid changes in the output of the system can cause considerable grid instability.

Similarly, because the output of a PV system is dependent on local weather conditions, it is hard to predict the output of the PV system. It therefore makes it difficult to rely on a PV system to power a specific load and for the electric grid to plan extensions and upgrades to account for the increasing integration of PV.

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Reference # 5

Comparison of PV inverter products

	Ideal Power	Advanced Energy	Power One
Product	IPV-30kW-480	35TX	Trio-27.6-TL
Isolation	Yes – PPSA	Yes – transfomer	No - transformerless
Power (Watts)	30,000 Watts	35,000 Watts	27,600 Watts
Weight (lbs)	97 lbs	1,200 lbs	168 lbs
Power-to-Weight (Watts/lbs)	309 Watts/Ibs	29 Watts/lbs	164 Watts/lbs
Efficiency (% CEC-weighted)	96.5%	96.0%	97.5%

The comparison of PV inverter products illustrates the difference of three different technology approaches. We believe the Advanced Energy product is representative of transformer based PV inverters and the Power One product is representative of transformerless PV inverters. The traditional PV inverter has used an internal transformer to provide electrical isolation, and in the last few years transformerless PV inverter products have become available.

The PPSA approach offers about a 10x weight advantage over transformer based PV inverter while providing similar electrical isolation, and about 2x weight advantage over transformerless PV inverters that lack electrical isolation.

Comparison of battery converter products

	Ideal Power	Princeton Power	SMA
Product	IBC-30kW-480	GTIB 480-100	Sunnylsland 6024-US
Isolation	Yes – PPSA	Requires external	Yes – internal
		isolation transformer	transformer
Power (Watts)	30,000 Watts	100,000 Watts	6,000 Watts
Weight (Ibs)	97 lbs	1,500 lbs* + 500 lbs transformer*	139 lbs
Power to Weight (Watts/lbs)	309 Watts/lbs	50 Watts/lbs	43 Watts/lbs
Efficiency (% CEC-weighted)	96.5%	95.0%	94.0%

* estimated

The comparison of battery converter products illustrates the difference of conventional transformer technology compared with PPSA. We believe that isolation is more important in battery converter applications. The PPSA battery converter offers improved weight and efficiency over conventional battery converters.





AE 35TX and AE 50TX

(Formerly known as PVP35kW and PVP50kW) Three-Phase inverter solutions for small commercial projects

The AE 35TX and AE 50TX commercial inverters feature the same industry leading reliability, efficiency, ease of installation, and lifetime maintainability of Advanced Energy's larger commercial inverters. These two models are sized to serve smaller PV system designs, or to provide the perfect fit to complete a larger PV project. In addition, the AE 35TX and AE 50TX deliver the highest efficiency in their class and rival the efficiency of much larger inverters.

High reliability is enabled by a ground-up design for a 20+ year operating life that features busbar power connections, card cage circuit board design, and the widest temperature rating of any inverter in its class. The highly integrated system saves installers time and money by including load break rated AC & DC service disconnects, neutral-free installation, oversized busbar landings and generous cable bending area. The AE 35TX and AE 50TX have a 295 VDC minimum MPPT voltage that enables stringing flexibility that is critical for smaller rooftop projects.

The AE 35TX and the AE 50TX are backed with an industryleading 10-year nationwide warranty and an optional 20-year warranty; plus the most responsive service and support team in the business.



Superior Reliability

- Designed for 20+ year operating life
- Smart Air Management[™]
- Increased availability with >99% monitored fleet availability
- Low parts count reduces potential failure pointsCard cage circuit board system minimizes electronic
- interconnections

Exceptional Installability

- Bottom and side cable entry with generous bending area and oversized busbar landings
- Customizable subcombiner fusing options
- Full power output at 295 VDC enables more PV array design options
- Exterior mounting flanges for fast and easy anchoring with no pre-drilling

Easy to Maintain

- All maintenance and service via front access
- · Fast change circuit board system shortens service time
- Load break rated AC and DC service disconnects
 Dedicated monitoring section separate from AC and DC modules

AE Solar Energy is a US based company.





Subject to change without notice. Refer to user manual for detailed specification.

*Note: Not all performance window specifications can be achieved simultaneously. Performance varies per site. Consult your AE sales or service representatives for specific PV system design questions at sales.support@aei.com



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costs with integrated performance monitoring hardware that enables connectivity to a variety of software solutions from industry leading integration between Advanced Energy and our monitoring partners creates a superior service and support experience while seamlessly delivering meaningful data. Factory integration and testing of our UL listed monitoring solution ensures high reliability and significantly

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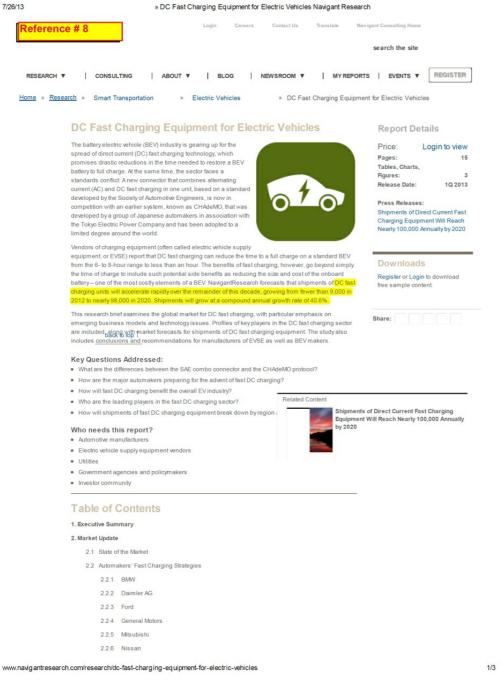


Key Points

- The Americas is predicted to remain the largest market for energy storage in grid-connected commercial PV systems over the next five years, increasing from an estimated 1.4 MW_{PV} of PV systems installed with storage in 2012, to 0.9 GW_{PV} in 2017. This relates to an annual installed effective storage capacity of 0.8 GWh_{EF} in 2017.
- IHS estimates that North America accounted for 64% of total installations of energy storage in gridconnected commercial PV systems in 2012. It forecasts that North America will account for the most installations each year over the forecast period, and will account for 44% of total installations in 2017. The financial return by reducing peak demand charges in many states of the US already make installing an energy storage system in a commercial PV application economically attractive.
- Installations of batteries in commercial PV applications in Japan will be driven by the need for backup energy following recent natural disasters and regular electrical black-outs. It is estimated that 0.2 MWh_{EF} of effective storage capacity was installed in 2012, and this is calculated to increase to 279.2 MWh_{EF} in 2017 This will account for 16% of the total annual global installed effective storage capacity.
- In much of EMEA, electrical black-outs are rare, and electricity rates typically do not include peakdemand charges. Therefore, installations of energy storage in commercial applications with a PV system will predominately be driven by the need to increase self-consumption. In 2017, IHS predicts that EMEA will be the smallest market for installed effective storage capacity, accounting for 26% of total installations.
- Installations of storage in commercial PV systems in Central and South America, India, China and the Rest of Asia are predicted to begin in 2014, as a result of reduced energy storage system prices. These will predominately be installed for back-up energy in regions with weak-grids.

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DEAL POWER CONVERTERS has developed and patented a revolutionary new current-modulation power topology for electronic power converters that will improve both energy and cost efficiency for solar inverters, grid storage, electric vehicle charging infrastructure, ac motor drives, and hybrid-electric vehicles. Its patented topology, or control methodology, depends more heavily on semiconductor switches and advanced software controls than the conventional voltage-source topology, thereby dramatically reducing the amount or weight of magnetic-metal materials.

IPC's flagship product is a 30kW PV inverter that delivers 480 Vac 3-phase power and supports grounded PV arrays without an internal or external transformer. It weighs only 94lbs, compared to the 1,200lbs for conventional 30 kW 480 Vac PV inverters which work with grounded arrays. This inverter conforms to UL1741 and achieved a CEC-weighted efficiency of 96.5 percent. This efficiency rating is superior to any other CEC-listed PV inverter under 100kW for grounded arrays, the de facto standard in the United States.

This inverter is used for large commercial rooftop arrays and solar carports, where physical space restrictions can add significantly to installation costs. Use of a lightweight inverter can save installers 0.15-0.20/W in

Texas and over \$0.30/W in Hawaii, nearly as much as the inverter cost.

Today, IPC has installations at the University of Texas at San Antonio and Austin, using twelve of its 30 kW inverters. These systems convert +/-450 V from solar arrays into three-phase ac at 480 V that feeds into the power grid. The PV inverter is based on its Universal Power Converter PlatformTM, which allows the same hardware design with new application firmware to address other markets, including battery converters for grid storage and bi-directional EV fast chargers. Each 30 kW solar inverter weighs just 94 lbs., compared with conventional

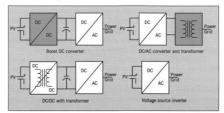


Fig. 1. Existing solar inverter topologies.

PHOTOVOLTAICconverters

solar inverters with traditional magnetics that weigh 1,200 lbs. or more. *Table 1* lists the inverter's specifications. To appreciate the improvements of the new inverter

topology, we must first review the older generation PV topologies shown in Fig. 1:

- · Boost DC-DC converter that provides a DC link for the inverter.
- DC-DC converter that incorporates an isolation transformer.
- DC-DC converter that transforms the power from the PV array to a low voltage ac that is stepped up using a ower transformer.
- Voltage source inverter where the input DC voltage is always higher than the peak-to-peak grid voltage, difficult to realize in PV arrays.

NEW TOPOLOGY

NEW TOPOLOGY IPC's PV topology (Fig. 2) uses 10 bi-directional switches to conduct or block in either direction. Conventional power semiconductor IGBT components cannot provide this capability, so IPC constructs bi-directional switches from four discrete components: two silicon IGBTs and two silicon diodes. IPC products will migrate to new bi-directional silicon IGBTs (BD-IGBTs) that are being developed with the support of a DOE ARPA-E grant. developed with the support of a DOE ARPA-E grant. developed with the support of a DUE AKFA-E grant. When these BD-IGBTs are available, it will more than double the power density, while also cutting the cost per watt manufacturing costs and efficiency losses in half. IPC's topology uses 100% indirect power transfer, compared with direct power transfer from conventional Toward convectors.

power converters. All the energy runs through, and is temporarily stored in, a high frequency ac link consisting of an inductor and capacitor. The inverter input and output are never directly connected, so the link provides circuit isolation without the size, weight, and cost of a transformer. Plus, the IPC PV inverter supports standard, grounded

Plus, the IPC PV inverter supports standard, grounded PV arrays, compared with European style transformer-less inverters that require the array to be ungrounded. Fig. 3 compares the circuits for the new BD-IGBTs versus bi-directional switches using commodity IGBTs and diodes. The number of silicon devices and packages are similicantly reduced and the efficiency is similicantly are significantly reduced, and the efficiency is significantly improved. Two bidirectional switches are in each leg of the converter output. There is an ac link between the input and output formed by a low-reactive-rating inductor/capacitor pair. In a completely indirect energy transfer operation, the dc input from the PV panels charges the link inductor. This

inductive energy then discharges to the output phases. This patented current-modulation topology offers siginficant improvements over conventional power electronics topologies in terms of weight, cost, and efficiency while providing the benefits of isolation. The initial 30 kW 480 V PV inverter addresses the needs of the U.S. commercial-

scale PV market and will lower PV generation costs. The 30 kW solar inverter (*Fig.* 2) is unlike older generation conventional inverters that use an inverter that generation conventional inverters are used as the solar inverter of the solar solar inverter that generation conventional inverters are used as the solar ates a chopped ac waveform, which is filtered and then transformer coupled to the ac grid, with the transformer preventing ground currents between the grounded array and the grounded neutral of the grid. In contrast, the new design works with grounded arrays but does not use a

transformer. It uses a pure ac link formed by an inductorcapacitor pair between the inverter input and output. The link charges from the input(s) and discharges into the output phases via a modulation scheme, resulting in high efficiency, near-unity power factor, and low harmonics. Although transformer-less, the IPC inverter should not be confused with other transformer-less inverters that do not work with grounded arrays.

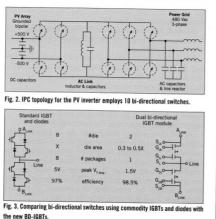
Most existing commercial PV inverters include a transformer and several sections of power conversion. In non-IPC inverters without transformer isolation ("Transformer-less Inverters"), there is a galvanic connec-(Transformer-ress inverters), there is a gaivance connec-tion of grid and PV-generator that results in a large, 120 Hz voltage fluctuation on the array, which may cause a significant leakage current to flow through the capaci-tance between PV-generator and ground. The magnitude of this capacitance depends on environmental influences. For example, it will be large when the PV-generator is covered with salty fog forming a conductive path to the grounded metallic frame of the PV modules.

LEAKAGE CURRENT

Non-capacitive leakage currents may also be significant, and are also variable with respect to environmental condi-tions. These non-capacitive leakage currents are checked before the transformer-less inverter starts up, and if the

TABLE: IP	C INVERTER SPECIFICATIONS
PV Array DC Input	Bipolar DC Input with Center Referenced to Ground
Absolute Maximum Voltage (Voc)	±600 Vdc (1200 Vdc differential)
Operating Voltage	±100 Vdc to ±450 Vdc (200 Vdc to 900 Vdc) Supports Unbalanced Voltages to 0VDC on Either Subarray
MPPT Voltage (full power range)	±300 Vdc to ±450 Vdc (600 Vdc to 900 Vdc)
Maximum Input Current	50 A (Continuous)
Minimum Start-Up Current	0.5 A
Maximum GFDI Current	1A Fuse, Programmable Trip Point at 200 to 500mA
Transient Overvoltage Protection	Yes, MOV Voltage Clamps
	AC GRID OUTPUT
Maximum Output Power	30 kW (Continuous)
AC Voltage	480 Vac, 3-Phase, Line-to-Line, +5% to -10%
AC Grid Frequency	60 Hz (59.3 to 60.5 Hz)
Power Factor	>0.97 at Rated output Power
Efficiency - CEC -Weighted	96.5%
Tare Losses	10W
Total Harmonic Distortion	<3%
Transient Protection	IEEE C62.41 Class B
	PROTECTION
	Transformer-Less with Circuit Isolation
	AC Over/Under Voltage
	AC/DC Over Current
	AC Over/Under Frequency
and shares have sold	DC Ground Fault (GFDI) on All Conductors
	ENVIRONMENTAL
Ambient Operating Temperature	-25 to 45°C (Full Power)
Ambient Storage Temperature	-40 to 85°C (Non-Operating)
Humidity	0 to 100% Relative Humidity
Cooling	Forced Convection Using Redundant Variable Speed Fans
Enclosure Rating	NEMA 3R
Certifications	UL1741 & IEEE1547 listed by ETL
	GENERAL
Weight	94 lbs./42 kg
Enclosure Size	36.5 x 15 x 0.75 inches / 97.2 x 38.1 x 27.3 cm
Communications	RS-485 with Third Party Compatible Monitoring
system Requirements	External ac and dc Disconnects Required



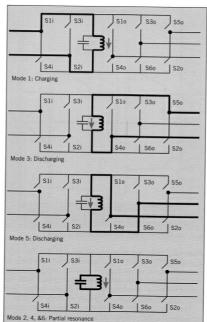


leakage resistance is less than about 200 k Ω , the TL inverter will not start. This may be a very difficult level of array isolation to achieve under all conditions. The IPC inverter also checks for ground leakage resistance on both hot and neutral lines before startup, but in contrast to TL Inverters merely issues a warning over the data interface, and continues operation, thereby avoiding numerous nuisance outages. The IPC inverter is able to do this due to its ability to operate with grounded arrays, numerous nuisance outages. The IPC inverter is able to do this due to its ability to operate with grounded arrays, but it floats the array during this ground leakage test. The warning issued by the IPC inverter on detecting neutral line faults allows the system operator to fix such faults before they lead to double ground faults which have been known to result in PV array free. Operation of the new inverter revolves around its operating modes shown in *Fig. 4*. In modes two, four, and six, all switches are off and the ac link resonates partially. Then, output switches corresponding to the selected phase pair turn on at zero voltage as they become forward-biased by the rising link voltage. The link then discharges to the output until specific system-generated references are met.

output until specific system-generated references are met. Fig. 5 shows the link voltage and current, output current. and dc current show operation in modes seven through ten is identical to that in modes one to five except that the link current is in the reverse direction. It is possible to realize a link frequency of at least 5

kHz with the semiconductor power switches available today. In the 30 kW inverters installed at the University of Texas, the link frequency is 7 kHz at full power. It goes up to 20 kHz as power drops to zero. The power cycle frequency is twice this, or 14 kHz at full power, because there are two power transfers per link cycle.

All switches in this inverter turn on at zero voltage. Turn-off losses are low because there is a capacitive buffer across each switch. The converter is essentially a PWM current source, although all link current flows are ac with no dc offset.



4. IPC inverter circuit conditions for different modes.

In operation, input switches are turned on to charge up the link. The link is then allowed to resonate partially, which lets its wing to the voltage of the output phase to which lets it swing to the voltage of the output phase to which it will discharge. The link nominally discharges to two output phase pairs. The sequence and the pairs are calculated so as to minimize the partial resonance times while meeting the desired harmonic levels. Converter operation involves six operating modes.

Mode 1: Depending on the polarity of the link current, Sli and S2i or S3i and S4i turn on charge the link. In Fig. 4, switches S1i and S2i are turned on. The link current

4, switches 311 and 521 are turned on. The link current rises to the amount needed to extract maximum power from the PV panel. Mode 2: At the end of Mode 1, all the switches are turned off and the converter enters its second mode. Here, the link resonates partially until its voltage swings to the first current parts are in The list the suit to be form. the first output phase pair. The link then discharges into the grid in two different modes to proportionately power the three output phases. The instantaneous sum of the three phases is zero.

Assume that the output filter results in zero phase shift between voltage and current and that link frequency is much greater than the line frequency. Suppose instantaneous phase voltages are $V_{an} = 100 \text{ V}$, $V_{bn} = -70 \text{ V}$, $V_{cn} = -30 \text{ V}$ and the link charges to 10 A during Mode 1 (for

PHOTOVOLTAICconverters

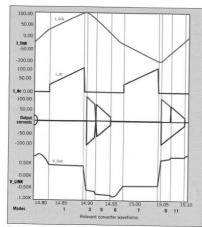


Fig. 5. Link voltage and current, output current, and dc current.

illustration only, not meant to reflect 480 Vac line voltages or 30 kW inverter). The link would then discharge to ages or 30 kW inverter). The link would then discharge to lines AB and AC to equivalently supply 7 and 3 A, respec-tively. This makes the output currents in phase with the output voltages, resulting in unity power factor, thus extracting the maximum real power from the PV cells. The output discharge happens in order of decreasing instantaneous line voltage to minimize the partial reso-nant periods. In real life, the actual algorithm removes the assumptions made to handle real senarizer

assumptions made to handle real scenarios. Mode 3: Previously enabled output switches, cor-

responding to the selected phase pair, turn on at zero voltage as they become forward-biased by the rising link Voltage as they become rorward-nased by the rising link voltage. The link then discharges to the output until specific system-generated references are met. Again, the references are generated so as to give unity power factor at the output while maintaining strict harmonic levels. In

nearby example, switches S10 and S60 turn on to let the link discharge to phase BC. Mode 4: Switches turn off to let the link resonate until

its voltage equals that of the second output phase pair into

which it will discharge. Mode 5: Switches become forward-biased to let the link discharge to the second phase pair. In our example, switches S40 and S50 are enabled and then turn on to let the link discharge to phase ac. Mode 6: The link is allowed to partially resonate back

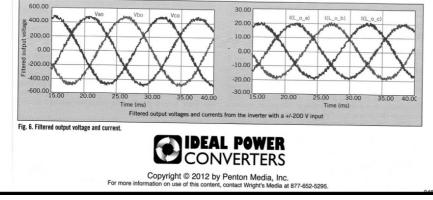
to the input voltage to start the next charging cycle. Then, Modes 7 through 10 are identical to modes 1 through 5,

Modes 7 through 10 are identical to modes 1 through 5, except the link current is in the reverse direction. At full array voltage and power, the dc input voltage is nominally equal to the ac average output voltages. At reduced PV array voltage and power, as when clouds pass overhead, the converter boosts the array voltage to the required ac output voltage. The inverter can raise or lower the current from the array for MPPT (maximum power robint tracking) by controlling the amount of current

the current from the array for MPPT (maximum power point tracking) by controlling the amount of current charge that the link receives from the input. Simulation results for a 25-kW, 575-V utility grid converter show that the waveforms in various parts of the circuit are shown in Fig. 6. These simulation results looked at the case where the PV array is 400 V and 200 V either side of ground. Simulations also assumed a grounded earted bindea mere and a new data case. a grounded neutral bipolar array and a grounded neutral three-phase output. Link voltage and currents show the buck capability of the converter. After charging from the input capacitors, the voltage swings to a lower output phase pair to discharge.

Similarly, the converter's boost capability is also evi-dent. After charging from an input of ±200 V, the link swings to a much higher output voltage to discharge. The converter's inherent buck-boost capability removes the need for a separate dc-dc stage that directly impacts efficiency. And, the input never directly connects to the output, so there is no need for a transformer.

Although the output voltages and filtered output cur-rents with a ±200 V input show some distortion at points of voltage crossover, these have been eliminated in the production inverter which meets all harmonics limits required by UL 1741. O



Reference # 10

Manufacturer: Austin Manufactering

Model #: IPV-30KW-480 "Bi Polar Input"

Vmin: 600 Vdc

Rated Maximum Continuous Output Power:	<u>30.07</u> kW	Night Tare Loss:	<u>9.83</u> W

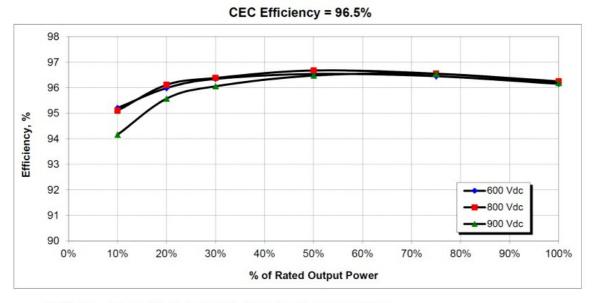
Vnom:

		10%	20%	30%	50%	75%	100%	
Input Voltage (Vdc)		3.01	6.01	9.02	15.04	22.56	30.07	Wtd
Vmin	600	95.2	96.0	96.3	96.5	96.5	96.2	96.4
Vnom	800	95.1	96.1	96.4	96.7	96.6	96.3	96.5
Vmax	900	94.2	95.6	96.1	96.5	96.5	96.2	96.3

800 Vdc

Vmax:

900 Vdc



All Efficiency data is within 3 standard deviations from the average? Pass All input power levels are within tolerances during Efficiency Test? Pass

Equipment Used:

Asset # Description		Model	Serial	Cal Date	Cal Due	
E437Z	Power Analyzer	WT3000	91F730638	27-Jan-12	27-May-12	
C189	C.T. control Box	Ultrastab Saturn	10093785	13-Sep-11	13-Sep-12	
C190	C.T. control Box	Ultrastab Saturn		13-Sep-11	13-Sep-12	
C191	C.T. control Box	Ultrastab Saturn	10093775	13-Sep-11	13-Sep-12	
C192	Current Transformer	Ultrastab Saturn	9101040047	13-Sep-11	13-Sep-12	
C196	Current Transformer	Ultrastab Saturn	9101040046	13-Sep-11	13-Sep-12	
A349	Current Transformer	Transformer	2983883	29-Feb-12	2/29/2013	

Test Engineer: Jeffrey Wilson

DATE: 30-Apr-12

Reference #11:

The "List of Eligible Inverters per SB1 Guidelines," including each manufacturer's name, inverter model number, description, power rating and weighted efficiency, is publicly available at: <u>http://www.gosolarcalifornia.ca.gov/equipment/inverters.php</u>. A hard or PDF copy will be delivered to the SEC upon request; however, please note that the full source contains 90 pages.

Reference # 12

SUNNY ISLAND 4548-US / 6048-US





Efficient

- Maximum efficiency of 96%
- CEC efficiency of 94.5% and 94%
- State of charge calculation

 Intelligent battery management for maximum battery life

Simple

- Easy commissioning with the "Quick Configuration Guide"
 Complete off-grid management
- Excellent for grid-tied battery

back up

Flexible

- For Sunny Island systems from 4.5 to 100 kW
- Single, split-phase and three-phase operation, connectable in parallel
- and modularly expandable • AC and DC coupling

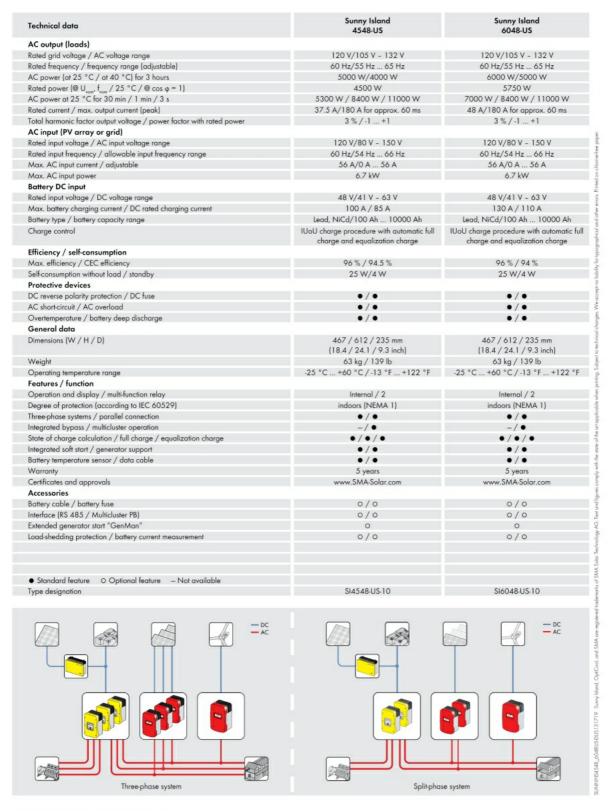
Durable

- Extreme overload capability
 OptiCoolTM active temperature
- management system • 5-year standard warranty
- e jour manadra manan

SUNNY ISLAND 4548-US / 6048-US

The efficient off-grid manager

The SMA Sunny Island 4548-US and 6048-US inverters are based on proven off-grid technology and feature industry leading power output. A maximum efficiency of 96 percent ensures peak production, which results in reduced diesel usage in rural communities. More flexible sizing allows for simplified system planning. And, with multicluster technology, up to 12 Sunny Islands can be integrated into off-grid power systems up 110 kW in size.



Toll Free +1 888 4 SMA USA www.SMA-America.com

SMA America, LLC



Charge smarter. Drive farther.

AeroVironment is the exclusive distributor of Nissan's DC fast charge station.

The Nissan DC Quick Charger allows you to charge your electric vehicle from 0% to 80% in about 30 minutes*, ideal for public or commercial/fleet applications.

STANDARD FEATURES

- > Standard CHAdeMO connector
- > Input power: 480V, 3 phase, 50/60Hz
- > Rated output power: 44kW
- > Dimensions: 72"H x 15"W x 28"D (approximate)
- > UL Listed
- > One year limited warranty
- > LCD user interface screen
- > Exposed, outdoor weather rated enclosure (NEMA 3R)

INSTALLATION AND MAINTENANCE OPTIONS

- > Site technical feasibility report
- > Full turn-key installation service available through AV
- > Construction management services
- > Final commissioning services
- > Maintenance services

- > Color LCD option
- Color Leb option
- > Cellular Network Capabilities (optional)
 - Access control**
 REID fobs
 - Remote authorization
 - User and charge session length data**
 - User and charge session length dat

Request a quote: www.nissanqc.com

*Based on 24kWh Nissan LEAF battery **Availability end of 2012

 AeroVironment[™]
 EV Solutions[™]

 181 W. Huntington Dr., Suite 202, Monrovia, CA 91016
 P. 888. 833.2148
 F. 626.359.9628
 www.evsolutions.com
 ev@avinc.com



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Public/Commercial DC Fast Charge Stations **Specifications**

Technical Specifications	Model NSQC442E
Input	
Fixed Input Voltage	480 VAC +/- 15% 3 phases
Input Power	50 kVA
Power Factor	> 95%
Input Frequency	50/60 Hz +/- 5%
Total Harmonic Distortion (THD)	less than 5% rated output
Efficiency	> 90%
Input Current	54 A @ 480 VAC
Output	
Output Voltage Range	50 - 500 V DC
Output Current Range	0 to 120 A DC
Maximum Output Power	44 kW
Cable/Connector	CHAdeMO compliant, conforms to JEVS G 105-1993
Cable Length	13.1 feet
Cable Management	Cord grip handle and stowage hook
Dimensions (housing only/as shipped 2 per crate)	
Depth	27.6" / 58.3"
Width	15.0" / 43.3"
Height	72.4" / 85.0"
Weight (Unit only/as shipped 2 per crate)	
Charge Station / As Shipped 2 per crate	441 lbs / 1,102 lbs
Mechanical	
Cooling	Forced air
De-energization on Cable Breakaway	Yes
Environmental Conditions	
Installation Placement	Outdoor
Enclosure Rating	Rain Proof (UL2202) / NEMA 3R
Operating Temperature Range	+14°F to +104°F
Operating Humidity	30% to 90% RH
Elevation	Installed at < 3,280 ft
Atmosphere	Free of corrosive or flammable gas
RoHS	All elements are RoHS compliant
Operational Noise Level	< 65 dBA (39.4" away, 39.4" in height)
Standards and Certifications	
Safety for Electric Vehicle (EV) Charging System Equipment	UL 2202
Personnel Protection Systems for EV Charging Circuits	UL 2231-1 and UL-2231-2
Plugs, Receptacles and Couplers for Electric Vehicles (EV)	UL 2251
rags, receptacies and couplers for Electric vehicles (EV)	CHAdeMO certification Rev. 0.9 Americans with Disabilities Act (ADA) FCC Compliant NFPA 70 National Electrical Code N(NEC), Article 625 EV Charging System

Specifications subject to change without notice.

©2012 AeroVironment, Inc. 0912_r3



Reference # 14

	ORDER FOR	SUPPL	IES OR SE	RVICE	S			PA	AGE 1 OF 17
1. CONTRACT/PURCH. ORDER/ AGREEMENT NO. N00244-13-P-0707	2. DELIVERY ORDER/		3. DATE OF ORDI (YYYYMMMDD) 2013 Aug 13) NE	921813RC		INO.	5. PRI	ority 9
6. ISSUED BY NAVSUP FLC SAN DIEGO REGIONAL CONTRACTS (CODE 2 800 SEAL BEACH BLVD BUILDING 239 SEAL BEACH CA 90740-5000	CODE N00244		SEE ITEM (than 6)	CODE			LIVERY FOB DESTINATION OTHER e Schedule if other)
9. CONTRACTOR IDEAL POWER CONVE NAME PAUL BUNDSCHUH AND 5004 BEE CREEK RD 1 ADDRESS SPICEWOOD TX 78669	STE 600		FACILITY		(Y) SEE S	LIVER TO FOB TTMMMDD) SCHEDULE COUNT TERMS		Date)	ARK IF BUSINESS IS SMALL SMALL DISADVANTAGED WOMEN-OWNED
						AIL INVOICE SCHEDULE	ся то тні	EADDRESS	IN BLOCK
14. SHIP TO SEE SCHEDULE	CODE	DFAS 1240	AYMENT WILI S CLEVELAND EAST 9TH STREE 'ELAND OH 44199	т	E BY	CODE N6873	2	PA PA IDE N	MARK ALL CKAGES AND APERS WITH N'IIFIC ATION UMBERS IN OCKS 1 AND 2.
16. DELIVERY/ Thi TYPE CALL Thi	s delivery order/call is issued on a	nother Gove	ernment agency or in	accordance w	ith and su	bject to terms and	d conditions	ofabove numbe	red contract.
OF PURCHASE X Re	frence your quote dated mish the following on terms specif	iad bassia - F	EE.						
NAME OF CONTRACTO	CEPTANCE. THE CONTR DER AS IT MAY PREVIOU ID CONDITIONS SET FOR	ACTOR H USLY HAV TH, AND	IEREBY ACCEP VE BEEN OR IS AGREES TO PE RE	NOW MOI	DIFIED, HE SAM	SUBJECT TO	ALL OF	THE TERMS	D PURCHASE
If this box is marked, suppl			e following num	ber of copie	ts:				
See Schedule 18. ITEM NO.	9. SCHEDULE OF SUPPLI	ES/ SERVI	CES		NTITY ERED/ EPTED*	21. UNIT	22. UNIT	PRICE	23. AMOUNT
	SEE SCHED	ULE							
* If quantity accepted by the Governme quantity ordered, indicate by X. If diff quantity accepted below quantity orde 27a. QUANTITY IN COLUMN	erent, enter actual red and encircle. 24. UNITED TEL: 562-620 EMAIL: caron BY: Caron L	STATES OF 6-7384 n.rigali@r		CONTRAC	CTING / O	ORDERING OFFI		25. TOTAL 26. DIFFERENCES	\$116,500.00
INSPECTED RECEIV	ED ACCEPTED, ANI CONTRACT EXC								
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(YYYYMMMDD)				PART FINAL	IAL			35. BILL OF	LADING NO.
37. RECEIVED AT 38. RE	SCEIVED BY 39	9. DATE I	RECEIVED 4 fMDD)	0. TOTAL CONTA	4	41. S/R ACCO	UNT NO.	42. S/R VOU	UCHER NO.
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Page 2 of 17

Section B - Supplies or Services and Prices

ITEM NO SUPPLIES/SERVICES QUANTITY UNIT UNIT PRICE AMOUNT 0001 Group \$0.00 REALIABILITY TESTING FFP Of IPC Power Electronic Converters In Accordance With Statement of Work FOB: Destination MILSTRIP: N6921813RC10080 PURCHASE REQUEST NUMBER: N6921813RC10080 NET AMT \$0.00 AMOUNT ITEM NO SUPPLIES/SERVICES QUANTITY UNIT UNIT PRICE 0001AA \$2,200.00 Group \$2,200.00 1 Field History Data Analysis FFP FOB: Destination MILSTRIP: N6921813RC10080 PURCHASE REQUEST NUMBER: N6921813RC10080 NET AMT \$2,200.00 ACRN AA \$2,200.00 CIN: N6921813RC100800001AA

					Page 3 of 17
ITEM NO 0001AB	SUPPLIES/SERVICES MTBF Calculation FFP Mean Time Between Failu	QUANTITY 1 re (MTBF) calcula	UNIT Group ations	UNIT PRICE \$3,900.00	AMOUNT \$3,900.00
	FOB: Destination MILSTRIP: N6921813RC PURCHASE REQUEST N		313RC10080		
	ACRN AA CIN: N6921813RC100800	0001AB		NET AMT	\$3,900.00 \$3,900.00
ITEM NO 0001AC	SUPPLIES/SERVICES FMEA FFP Failure modes and effects a FOB: Destination MILSTRIP: N6921813RC PURCHASE REQUEST N	10080	UNIT Group 813RC10080	UNIT PRICE \$8,500.00	AMOUNT \$8,500.00
	ACRN AA CIN: N6921813RC100800	0001AC		NET AMT	\$8,500.00 \$8,500.00

					N00244-13-P-0707
					Page 4 of 17
ITEM NO 0001AD	SUPPLIES/SERVICES Analysis FFP Third Party Design Docum Test Record Analysis FOB: Destination MILSTRIP: N6921813RC PURCHASE REQUEST 1	210080	UNIT Group 813RC10080	UNIT PRICE \$5,500.00	AMOUNT \$5,500.00
	ACRN AA CIN: N6921813RC10080	0001AD		NET AMT	\$5,500.00 \$5,500.00
ITEM NO 0001AE	SUPPLIES/SERVICES Testing	QUANTITY 1	UNIT Group	UNIT PRICE \$35,000.00	AMOUNT \$35,000.00
	FFP HASS/HALT Design Verification Test (cycling, humidity cycling,			aging, temperature	
	FOB: Destination MILSTRIP: N6921813RC PURCHASE REQUEST 1		813RC10080		
	ACRN AA CIN: N6921813RC10080	0001AE		NET AMT	\$35,000.00 \$35,000.00

					Page 5 of 17
ITEM NO 0001AF	SUPPLIES/SERVICES Analysis FFP Third Party Stress/Deratin FOB: Destination MILSTRIP: N6921813RC PURCHASE REQUEST 1	210080	UNIT Group 813RC10080	UNIT PRICE \$9,800.00	AMOUNT \$9,800.00
	ACRN AA CIN: N6921813RC10080	0001AF		NET AMT	\$9,800.00 \$9,800.00
ITEM NO 0001AG	SUPPLIES/SERVICES Analysis FFP Lifetime Warranty failure Analysis FOB: Destination MILSTRIP: N6921813RC PURCHASE REQUEST 1		UNIT Group 813RC10080	UNIT PRICE \$5,500.00	AMOUNT \$5,500.00
	ACRN AA CIN: N6921813RC10080	0001AG		NET AMT	\$5,500.00 \$5,500.00

					Page 6 of 17
ITEM NO 0001AH	SUPPLIES/SERVICES Analysis FFP End of Life Analysis FOB: Destination MILSTRIP: N6921813RC PURCHASE REQUEST 1		UNIT Group 813RC10080	UNIT PRICE \$8,600.00	AMOUNT \$8,600.00
	ACRN AA CIN: N6921813RC10080	0001AH		NET AMT	\$8,600.00 \$8,600.00
ITEM NO 0001AJ	SUPPLIES/SERVICES Power Converters FFP for Testing FOB: Destination MILSTRIP: N6921813RC PURCHASE REQUEST D		UNIT Group 813RC10080	UNIT PRICE \$37,500.00	AMOUNT \$37,500.00
	ACRN AA CIN: N6921813RC10080	0001AJ		NET AMT	\$37,500.00 \$37,500.00

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Section C - Descriptions and Specifications

STATEMENT OF WORK

STATEMENT OF WORK

Reliability calculations and testing for IPC's 30kW Universal Power Converter PlatformTM

1.0 SCOPE

Ideal Power Converters (IPC) offers a unique transformerless power converter hardware that is lighter and more efficient than current PV inverters on the market. IPC's 30kW Universal Power Converter Platform[™] uses a patented circuit topology that has the potential to lower the cost of PV inverters. NAVFAC Engineering Expeditionary Warfare Center has purchase two IPC Converters for PV Inverter and DC battery charging applications respectively for field evaluation. EXWC would also like to evaluate the reliability of this new power electronics architecture through laboratory accelerated life testing.

A series of tests and calculations are requested to be performed to gather reliability data. Testing will be accomplished on the IPC-30kW-480 PV converter. As part of this contract, four IPC converters will be supplied by the contractor for testing. The contractor will supply support personnel time, engineer travel cost, and repair materials for the IPC converters under test as required, to complete these efforts.

The scope of this proposal is comprehensive, including the following aspects, each described in additional detail in the following pages:

1) Field history data for the product or similar earlier generation products

2) Mean Time Between Failure (MTBF) calculations

3) Failure modes and effects analysis (FMEA)

4) Review Design drawings, product specs and prior failure analysis with corrective actions taken

5) Design Verification Test (DVT) HALT, HASS, accelerated aging, temperature cycling, humidity cycling, and corrosive environment tests

6) Derating/Stress Analysis

7) Warranty Analysis

8) End of Life Design Analysis

2.0 TECHNICAL REQUIREMENTS

Testing will be divided into 8 tasks as detailed below. A report will be provided to EXWC for each task.

Task 1: Field History Data Analysis- Multiple IPV30kW-480 inverters have been operating in the field. This field data should assist in reliability modeling.

Tasks: Analyze/plot the data using Weibull software to determine an accurate reliability figure based upon field experience.

Value: Analyzes the expected product life based upon accumulated operational time, taking into account the mean time to failure for any failures.

Deliverables: Reliability analysis and reliability statement in a report format.

Task 2: MTBF Calculation - An MTBF Calculation estimates a product's reliability to satisfy customer requirements and diagnoses weak points in the design.

Basic Analysis

Tasks: This analysis estimates a product's overall reliability using industry standard failure rates for each component. The prediction is to be based upon Telcordia (Bellcore) SR-332, Issue 3 Mean (50% UCL) and 90% UCL failure

Page 8 of 17

rates using component supplier information where available. The influence of additional factors on each component (quality, temperature, electrical stress, etc.) will be included.

The latest issue of Telcordia SR-332 Issue 3supports the calculation of MTBF at various Upper Confidence Levels (UPL) using MEAN failure rate values and the respective standard deviations. By calculating these standard deviations for each failure rate number it is easier to determine the confidence of each number relative to all the other FIT numbers. The standard deviation is a reflection of the strength of the data supporting the mean failure rate estimate. A smaller standard deviation proportional to the mean indicates a more accurate estimate.

Value: This analysis produces an overall reliability estimate, typically for a product early in the life cycle. It is helpful to indicate which components dominate the MTBF calculation.

Assumptions: Temperature and electrical stress shall be factored into this calculation given the following: 1) Three ambient temperatures

Temperatures for specific components that deviate significantly from a nominal thermal rise (15C above ambient)
 Manufacturing screening parameters so that we can calculate the early life reliability.

Deliverables: Report which includes detailed spreadsheet showing failure rate of each component, standard deviations, and the source of the data and a summary spreadsheet showing failure rate of entire assembly/system. Report also includes recommendations on where you can make reliability improvements.

The report includes a "Service-Affecting" Analysis which discounts failures which do not affect system performance.

Task 3: FMEA - Complete Failure Modes and Effects Analysis (FMEA), an inductive failure analysis of failure modes within a system for classification by the severity and likelihood of the failures.

Task 4: Third party design document / test record analysis- A third party design analysis is helpful to determine expected reliability based upon factors such as design margin and fault tolerant design.

Task 5: HASS / HALT testing Stress testing to include vibration and inverter operation under conditions (typically temperature, voltage, and current) which incrementally exceed the product specifications. The combined intentionally destructive effects empirically elicit the portions of the inverter most likely to fail under these abnormal conditions. Analysis of the failure mechanism may lead to a better understanding of the environmental sensitivity of the design and improvements in the product.

Task 6: Third Party Stress/Derating Analysis - A stress/derating analysis considering the applied stresses compared to recommended stresses to calculate the effects on the failure rates.

Tasks: Evaluate and calculate the electrical stresses on each component using schematics and additional product documentation. The analysis also considers derating guidelines. The Stress Analysis addresses the key operational inverter components.

Value: Stress Analysis produces a more accurate estimate than a Parts Count Analysis with default values. With the thermal data included, this analysis is key to identifying potential issues, especially those related to thermal management.

Deliverables: Detailed spreadsheet showing the electrical analysis of each component. This will be used as input to the Phase 2 MTBF Prediction to make more accurate.

Task 7: Lifetime Warranty Failure Analysis- Performing a Warranty Analysis is essential to determine the warranty exposure for the product. It is a monetized measure of the product reliability, helpful to quantify the total cost of ownership for the inverter.

Page 9 of 17

Tasks: Identify the most likely warranty events (failures) for the product. Develop a warranty cost model and then calculate warranty costs for each identified warranty event. Deliverables: Warranty cost model including calculation

 Task 8: End of Life Analysis Performing an End-of-Life Analysis is essential to determine if any areas of the design will fail before the end of the expected product life. Sherlock Automation Design Analysis software tool provides a probability of failure based lifetime prediction given the field environment.

 Deliverables:
 Report showing how long product will last relative to each potential failure mechanism.

3.0 GOVERNMENT FURNISHED MATERIAL (GFM)

Government will provide NO material for the testing. The four IPC PV inverters will be supplied by the vendor as part of this contract.

4.0 <u>OTHER</u>

4.1 Billing

Progressive billing will be allowed at the completion of each task. Billing for the 4 IPC converters for a total of \$36K, can be accepted once the testing facility has receipt of the units for testing in task 5.

4.2 Security

Personnel performing on this task do not require a security clearance.

4.3 Place of Performance

4.3.1 Testing may be performed at the company / contractors choosing.

4.4 Deliverables

- 4.4.1 Report for each task given
- 4.4.2 The four IPC PV converters used for testing after completion.

5.0 PERIOD OF PERFORMANCE

The period of performance on or about August 13, 2013 -Completion Date: On or about November 20 2013.

DELIVERY ADDRESS:

NAVFAC Eng Expeditionary Warfare Center 1100 23rd Avenue Port Hueneme, CA 9304304370 ATTN: Ken HO Ken.Ho@navy.mil

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Section G - Contract Administration Data

ACCOUNTING AND APPROPRIATION DATA

AA: 97X4930 NH5A 000 77777 0 069218 2F 000000 COST CODE: 00013RC10080 AMOUNT: 5116,500.00 CIN N6921813RC10080001AA: \$2,200.00 CIN N6921813RC100800001AB: \$3,900.00 CIN N6921813RC100800001AD: \$5,500.00 CIN N6921813RC100800001AE: \$35,00.00 CIN N6921813RC100800001AF: \$5,500.00 CIN N6921813RC100800001AF: \$5,500.00

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Section I - Contract Clauses

CLAUSES INCORPORATED BY FULL TEXT

52.252-2 CLAUSES INCORPORATED BY REFERENCE (FEB 1998)

This contract incorporates one or more clauses by reference, with the same force and effect as if they were given in full text. Upon request, the Contracting Officer will make their full text available. Also, the full text of a clause may be accessed electronically at this/these address(es):

FAR Clauses: http://acquisition.gov/comp/far/ DFARS Clauses: http://www.acq.osd.mil/dpap/dars/dfars/

(End of clause)

CLAUSES INCORPORATED BY REFERENCE

52.212-4 Contract Terms and Conditions--Commercial Items FEB 2012

CLAUSES INCORPORATED BY FULL TEXT

ADDENDUM

The following clauses are hereby incorporated by reference or full text as appropriate.

CLAUSES INCORPORATED BY REFERENCE

52.204-10	Reporting Executive Compensation and First-Tier Subcontr Awards	actAUG 2012
		100 0010
52.219-28	Post-Award Small Business Program Rerepresentation	APR 2012
52.223-18	Encouraging Contractor Policies To Ban Text Messaging	AUG 2011
	While Driving	
52.247-34	F.O.B. Destination	NOV 1991
252.204-7004 Alt A	System for Award Management Alt A	MAY 2013

CLAUSES INCORPORATED BY FULL TEXT

52.212-5 CONTRACT TERMS AND CONDITIONS REQUIRED TO IMPLEMENT STATUTES OR EXECUTIVE ORDERS--COMMERCIAL ITEMS (NOV 2012) (DEVIATION)

(a) Comptroller General Examination of Record. The Contractor shall comply with the provisions of this paragraph (a) if this contract was awarded using other than sealed bid, is in excess of the simplified acquisition threshold, and does not contain the clause at 52.215-2, Audit and Records-Negotiation.

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(1) The Comptroller General of the United States, or an authorized representative of the Comptroller General, shall have access to and right to examine any of the Contractor's directly pertinent records involving transactions related to this contract.

(2) The Contractor shall make available at its offices at all reasonable times, the records, materials, and other evidence for examination, audit, or reproduction, until 3 years after final payment under this contract or for any shorter period specified in FAR Subpart 4.7, Contractor Records Retention, of the other clauses of this contract. If this contract is completely or partially terminated, the records relating to the work terminated shall be made available for 3 years after any resulting final termination settlement. Records relating to the work terminated shall be made available for 3 years after any resulting final termination settlement. Records relating to the settlement of claims arising under or relating to this contract shall be made available until such appeals, litigation, or claims are finally resolved.

(3) As used in this clause, records include books, documents, accounting procedures and practices, and other data, regardless of type and regardless of form. This does not require the Contractor to create or maintain any record that the Contractor does not maintain in the ordinary course of business or pursuant to a provision of law.

(b)(1) Notwithstanding the requirements of any other clause in this contract, the Contractor is not required to flow down any FAR clause, other than those in this paragraph (b)(i) in a subcontract for commercial items. Unless otherwise indicated below, the extent of the flow down shall be as required by the clause-

(i) 52.203-13, Contractor Code of Business Ethics and Conduct (APR 2010) (Pub. L. 110-252, Title VI, Chapter 1 (41 U.S.C. 251 note).

(ii) 52.219-8, Utilization of Small Business Concerns (DEC 2010) (15 U.S.C. 637(d)(2) and (3)), in all subcontracts that offer further subcontracting opportunities. If the subcontract (except subcontracts to small business concerns) exceeds \$650,000 (\$1.5 million for construction of any public facility), the subcontractor must include 52.219-8 in lower tier subcontracts that offer subcontracting opportunities.

(iii) Reserved.

(iv) 52.222-26, Equal Opportunity (MAR 2007) (E.O. 11246).

(v) 52.222-35, Equal Opportunity for Special Disabled Veterans, Veterans of the Vietnam Era, and Other Eligible Veterans (SEP 2006) (38 U.S.C. 4212).

(vi) 52.222-36, Affirmative Action for Workers with Disabilities (JUN 1998) (29 U.S.C. 793).

(vii) 52.222-40, Notification of Employee Rights Under the National Labor Relations Act (DEC 2010) (E.O. 13496). Flow down required in accordance with paragraph (f) of FAR clause 52.222-40.

(viii) 52.222-41, Service Contract Act of 1965 (Nov 2007) (41 U.S.C. 351, et seq.).

(ix) 52.222-50, Combating Trafficking in Persons (FEB 2009) (22 U.S.C. 7104(g)).

_____ Alternate I (AUG 2007) of 52.222-50 (22 U.S.C. 7104(g)).

(x) 52.222-51, Exemption from Application of the Service Contract Act to Contracts for Maintenance, Calibration, or Repair of Certain Equipment--Requirements (Nov 2007) (41 U.S.C. 351, et seq.).

(xi) 52.222-53, Exemption from Application of the Service Contract Act to Contracts for Certain Services--Requirements (FEB 2009) (41 U.S.C. 351, et seq.).

(xii) 52.222-54, Employment Eligibility Verification (JUL 2012).

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(xiii) 52.226-6, Promoting Excess Food Donation to Nonprofit Organizations. (MAR 2009) (Pub. L. 110-247). Flow down required in accordance with paragraph (e) of FAR clause 52.226-6.

(xiv) 52.247-64, Preference for Privately Owned U.S.-Flag Commercial Vessels (FEB 2006) (46 U.S.C. Appx 1241(b) and 10 U.S.C. 2631). Flow down required in accordance with paragraph (d) of FAR clause 52.247-64.

(2) While not required, the contractor may include in its subcontracts for commercial items a minimal number of additional clauses necessary to satisfy its contractual obligations.

(End of clause)

252.212-7001 CONTRACT TERMS AND CONDITIONS REQUIRED TO IMPLEMENT STATUTES OR EXECUTIVE ORDERS APPLICABLE TO DEFENSE ACQUISITIONS OF COMMERCIAL ITEMS (MAR 2013)

(a) The Contractor agrees to comply with the following Federal Acquisition Regulation (FAR) clause which, if checked, is included in this contract by reference to implement a provision of law applicable to acquisitions of commercial items or components.

52.203-3, Gratuities (APR 1984) (10 U.S.C. 2207).

(b) The Contractor agrees to comply with any clause that is checked on the following list of Defense FAR Supplement clauses which, if checked, is included in this contract by reference to implement provisions of law or Executive orders applicable to acquisitions of commercial items or components.

 252.203-7000, Requirements Relating to Compensation of Former DoD Officials (SEP 2011) (Section 847 of Pub. L. 110-181).

(2) _____252.203-7003, Agency Office of the Inspector General (DEC 2012)(section 6101 of Pub. L. 110-252, 41 U.S.C. 3509).

(3) _____252.205-7000, Provision of Information to Cooperative Agreement Holders (DEC 1991) (10 U.S.C. 2416).

(4) _____ 252.219-7003, Small Business Subcontracting Plan (DoD Contracts) (AUG 2012) (15 U.S.C. 637).

(5) 252.219-7004, Small Business Subcontracting Plan (Test Program) (JAN 2011) (15 U.S.C. 637 note).

(6)(i) X 252.225-7001, Buy American and Balance of Payments Program (DEC 2012) (41 U.S.C. chapter 83, E.O. 10582).

(ii) _____ Alternate I (OCT 2011) of 252.225-7001.

(7) ____ 252.225-7008, Restriction on Acquisition of Specialty Metals (MAR 2013) (10 U.S.C. 2533b).

(8) _____252.225-7009, Restriction on Acquisition of Certain Articles Containing Specialty Metals (MAR 2013) (10 U.S.C. 2533b).

(9) ____ 252.225-7012, Preference for Certain Domestic Commodities (FEB 2013) (10 U.S.C. 2533a).

(10) ____ 252.225-7015, Restriction on Acquisition of Hand or Measuring Tools (JUN 2005) (10 U.S.C. 2533a).

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(11) 252.225-7016, Restriction on Acquisition of Ball and Roller Bearings (JUN 2011) (Section 8065 of Pub. L. 107-117 and the same restriction in subsequent DoD appropriations acts).

12) ____ 252.225-7017, Photovoltaic Devices (DEC 2012) (Section 846 of Pub. L. 111-383).

13)(i) ____ 252.225-7021, Trade Agreements (DEC 2012) (19 U.S.C. 2501-2518 and 19 U.S.C. 3301 note).

(ii) _____ Alternate I (OCT 2011) of 252.225-7021.

(iii) _____ Alternate II (OCT 2011) of 252.225-7021.

(14) _____ 252.225-7027, Restriction on Contingent Fees for Foreign Military Sales (APR 2003) (22 U.S.C. 2779).

(15) 252.225-7028, Exclusionary Policies and Practices of Foreign Governments (APR 2003) (22 U.S.C. 2755).

(16)(i) X 252.225-7036, Buy American Act—Free Trade Agreements—Balance of Payments Program (DEC 2012) (41 U.S.C. chapter 83 and 19 U.S.C. 3301 note).

(ii) Alternate I (JUN 2012) of 252.225-7036.

(iii) _____ Alternate II (NOV 2012) of 252.225-7036.

(iv) _____ Alternate III (JUN 2012) of 252.225-7036.

(v) _____ Alternate IV (NOV 2012) of 252.225-7036.

(vi) _____Alternate V (NOV 2012) of 252.225-7036.

(17) _____252.225-7038, Restriction on Acquisition of Air Circuit Breakers (JUN 2005) (10 U.S.C. 2534(a)(3)).

(18) _____ 252.225-7039, Contractors Performing Private Security Functions (JUN 2012) (Section 862 of Pub. L. 110-181, as amended by section 853 of Pub. L. 110-417 and sections 831 and 832 of Pub. L. 111-383).

(19) 252.226-7001, Utilization of Indian Organizations, Indian-Owned Economic Enterprises, and Native Hawaiian Small Business Concerns (SEP 2004) (Section 8021 of Pub. L. 107-248 and similar sections in subsequent DoD appropriations acts).

(20) 252.227-7013, Rights in Technical Data--Noncommercial Items (FEB 2012), if applicable (see 227.7103-6(a)).

(21) _____ 252.227-7015, Technical Data—Commercial Items (DEC 2011) (10 U.S.C. 2320).

(22) _____252.227-7037, Validation of Restrictive Markings on Technical Data (JUN 2012), if applicable (see 227.7102-4(c)))(10 U.S.C. 2321).

(23) X 252.232-7003, Electronic Submission of Payment Requests and Receiving Reports (MAR 2008) (10 U.S.C. 2227).

(24) _____252.237-7010, Prohibition on Interrogation of Detainees by Contractor Personnel (NOV 2010) (Section 1038 of Pub. L. 111-84)

(25) 252.237-7019, Training for Contractor Personnel Interacting with Detainees (SEP 2006) (Section 1092 of Pub. L. 108-375).

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(26) _____ 252.243-7002, Requests for Equitable Adjustment (DEC 2012) (10 U.S.C. 2410).

(27) 252.246-7004, Safety of Facilities, Infrastructure, and Equipment For Military Operations (OCT 2010) (Section 807 of Pub. L. 111-84).

(28) _____252.247-7003, Pass-Through of Motor Carrier Fuel Surcharge Adjustment to the Cost Bearer (SEP 2010) (Section 884 of Pub. L. 110-417).

(29)(i) X 252.247-7023, Transportation of Supplies by Sea (MAY 2002) (10 U.S.C. 2631).

(ii) _____ Alternate I (MAR 2000) of 252.247-7023.

(iii) _____ Alternate II (MAR 2000) of 252.247-7023.

(iv) _____ Alternate III (MAY 2002) of 252.247-7023.

(30) _____ 252.247-7024, Notification of Transportation of Supplies by Sea (MAR (2000) (10 U.S.C. 2631).

(31) ____ 252.247-7027, Riding Gang Member Requirements (OCT 2011) (Section 3504 of Pub. L. 110-417).

c) In addition to the clauses listed in paragraph (e) of the Contract Terms and Conditions Required to Implement Statutes or Executive Orders--Commercial Items clause of this contract (FAR 52.212-5), the Contractor shall include the terms of the following clauses, if applicable, in subcontracts for commercial items or commercial components, awarded at any tier under this contract:

(1) 252.225-7039, Contractors Performing Private Security Functions (JUN 2012) (Section 862 of Pub. L. 110-181, as amended by section 853 of Pub. L. 110-417 and sections 831 and 832 of Pub. L. 111-383).

2) 252.227-7013, Rights in Technical Data--Noncommercial Items (FEB 2012), if applicable (see 227.7103-6(a)).

(3) 252.227-7015, Technical Data--Commercial Items (DEC 2011), if applicable (see 227.7102-4(a)).

(4) 252.227-7037, Validation of Restrictive Markings on Technical Data (JUN 2012), if applicable (see 227.7102-4(c)).

(5) 252.237-7010, Prohibition on Interrogation of Detainees by Contractor Personnel (NOV 2010) (Section 1038 of Pub. L. 111-84).

(6) 252.237-7019, Training for Contractor Personnel Interacting with Detainees (SEP 2006) (Section 1092 of Pub. L. 108-375).

(7) 252.247-7003, Pass-Through of Motor Carrier Fuel Surcharge Adjustment to the Cost Bearer (SEP 2010) (Section 884 of Pub. L. 110-417).

(8) 252.247-7023, Transportation of Supplies by Sea (MAY 2002) (10 U.S.C. 2631).

(9) 252.247-7024, Notification of Transportation of Supplies by Sea (MAR 2000) (10 U.S.C. 2631).

(End of clause)

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252.232-7006 WIDE AREA WORKFLOW PAYMENT INSTRUCTIONS (MAY 2013)

(a) Definitions. As used in this clause-

Department of Defense Activity Address Code (DoDAAC) is a six position code that uniquely identifies a unit, activity, or organization.

Document type means the type of payment request or receiving report available for creation in Wide Area WorkFlow (WAWF).

Local processing office (LPO) is the office responsible for payment certification when payment certification is done external to the entitlement system.

(b) Electronic invoicing. The WAWF system is the method to electronically process vendor payment requests and receiving reports, as authorized by DFARS <u>252,232-7003</u>, Electronic Submission of Payment Requests and Receiving Reports.

(c) WAWF access. To access WAWF, the Contractor shall-

(1) Have a designated electronic business point of contact in the System for Award Management at https://www.acquisition.gov; and

(2) Be registered to use WAWF at https://wawf.eb.mil/ following the step-by-step procedures for self-registration available at this web site.

(d) WAWF training. The Contractor should follow the training instructions of the WAWF Web-Based Training Course and use the Practice Training Site before submitting payment requests through WAWF. Both can be accessed by selecting the "Web Based Training" link on the WAWF home page at https://wawf.eb.mil/

(e) WAWF methods of document submission. Document submissions may be via web entry, Electronic Data Interchange, or File Transfer Protocol.

(f) WAWF payment instructions. The Contractor must use the following information when submitting payment requests and receiving reports in WAWF for this contract/order:

(1) Document type. The Contractor shall use the following document type(s).

COMBO

Note: If a "Combo" document type is identified but not supportable by the Contractor's business systems, an "Invoice" (stand-alone) and "Receiving Report" (stand-alone) document type may be used instead.)

(2) Inspection/acceptance location. The Contractor shall select the following inspection/acceptance location(s) in WAWF, as specified by the contracting officer.

____Not Applicable_____

(3) Document routing. The Contractor shall use the information in the Routing Data Table below only to fill in applicable fields in WAWF when creating payment requests and receiving reports in the system.

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Routing Data Table*

Field Name in WAWF	Data to be entered in WAWF
Pay Official DoDAAC	N68732
Issue By DoDAAC	N00244
Admin DoDAAC	N00244
Inspect By DoDAAC	
Ship To Code	
Ship From Code	
Service Approver (DoDAAC)	N69218
Service Acceptor (DoDAAC)	N69218
LPO DoDAAC	N69218

(4) Payment request and supporting documentation. The Contractor shall ensure a payment request includes appropriate contract line item and subline item descriptions of the work performed or supplies delivered, unit price/cost per unit, fee (if applicable), and all relevant back-up documentation, as defined in DFARS Appendix F, (e.g. timesheets) in support of each payment request.

(5) WAWF email notifications. The Contractor shall enter the e-mail address identified below in the "Send Additional Email Notifications" field of WAWF once a document is submitted in the system.

NAVFACESCOUTGOINGACCEPTANCES@NAVY.MIL LPO: LUPE.CHAVEZ@NAVY.MIL 805-982-4981 ACCEPTOR: PATTY.CHICO@NAVY.MIL 805-982-4981

(g) WAWF point of contact.

(1) The Contractor may obtain clarification regarding invoicing in WAWF from the following contracting activity's WAWF point of contact.

LUPE.CHAVEZ@NAVY.MIL

(2) For technical WAWF help, contact the WAWF helpdesk at 866-618-5988.

(End of clause)

UNIT PRICES (OCT 2001)

Contractor unit prices, when incorporated into a Government contract, will be released under the Freedom of Information Act (FOIA) without further notice to the contractor submitter. If the Contractor takes issue with the release, it should submit its proposal data with the appropriate legends and explain in detail why such data cannot be released as a public record under the Freedom of Information Act.