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APPLICATION NOTE

UNDERSTANDING ACUDC-262 DUAL-CHANNEL ARCHITECTURE WITH A COMMON VOLTAGE REFERENCE FOR DC POWER SYSTEMS

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1. PURPOSE

Modern DC power systems, including EV charging infrastructures, energy storage, and DC distribution networks, often include multiple independent current branches connected to a common DC bus. Conventional monitoring methods require separate meters for each branch, increasing wiring complexity, limiting installation space leading to a higher system integration cost.

This application note presents a dual-channel current measurement architecture with a common voltage reference, enabling efficient monitoring of multiple DC current paths and reducing system complexity.

This document demonstrates the benefits of the architecture to improve system design efficiency and monitor performance in multi-branch DC power applications, including

Solar PV strings, DC microgrids in EV charging systems and Telecom Power systems, and DC Power Distribution Units (PDUs).

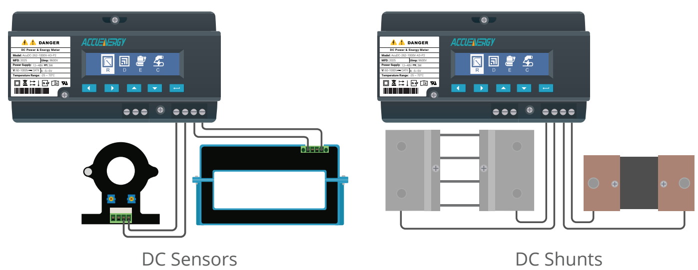

Figure 1 AcuDC-262 DC Power Applications

2. PRODUCT OVERVIEW

The dual-channel architecture (1V/2I) features independent monitoring paths for one voltage channel, 1V and two current channels, I1 and I2. The voltage input range spans from 0 to 1000V, supporting 380V DC systems and high-voltage distribution networks. To accommodate diverse installation requirements, the current input subsystem supports three options, which includes ±100mV Shunt for option A1, 4-20mA Hall Effect Sensor for option A2, and ±5V Hall Effect Sensor for option A3. This measurement subsystem delivers a current accuracy of 0.2%, enabling precise monitoring of utilization and branch load balancing. Furthermore, energy measurement accuracy complies with IEC 62053-41 Class 0.5. AcuDC-262 tracks additional parameters including current demand, power demand, and ripple factor to ensure comprehensive system oversight.

3. KEY INDUSTRIAL APPLICATIONS

The dual-channel (1V/2I) architecture offers significant technical advantages as compared to conventional single-circuit meters. Key applications are described in the following section.

3.1 Solar Photovoltaic String Monitoring

In parallel-connected Solar Photovoltaic (PV) systems, identifying performance imbalances between strings is critical for maximizing energy harvest. Traditionally, monitoring multiple strings requires complex wiring or multiple meters, increasing installation costs and potential failure points.
The AcuDC-262 addresses this by utilizing a single voltage input to monitor the common DC bus voltage, while its dual independent current channels (I1 and I2) measure the output from two separate strings simultaneously, as shown in Figure 2.

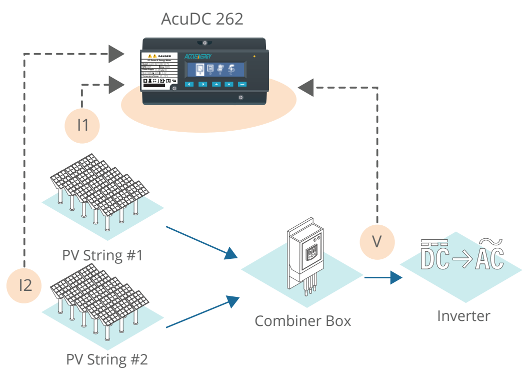

Figure 2 AcuDC-262 String Monitoring for Performance Monitoring and Imbalance Detection

As depicted in Figure 2, the 1V/2I architecture is highly effective for several functions.
In real-time performance comparison, the architecture detects string imbalance or degradation by comparing the current output of String #1 against String #2 under the same voltage reference.
By analyzing generation efficiency at the combiner box level, the design ensures the inverter operates at peak performance which helps to optimize the system performance. The configuration reduces complexity by minimizing the hardware footprint within string monitoring units or DC combiner boxes, leading to faster deployment and lower integration costs.

3.2 DC Microgrid-Based Charging

In a DC microgrid-based EV charging system, energy sources such as PV arrays, wind turbines, and Energy Storage Systems (ESS) are interconnected through a common DC bus. EV charging is managed by a DC/DC converter that delivers controlled DC power to the vehicle battery. AcuDC-262, with its dual-channel architecture provides, supports both vehicle-side billing metering and real-time condition diagnostics of the DC/DC converter, as illustrated in Figure 3.

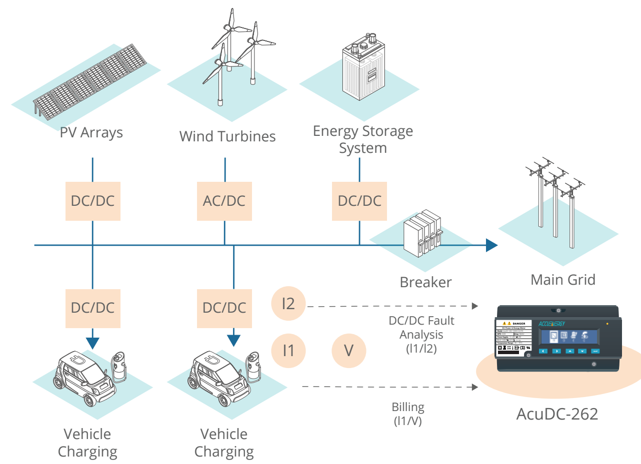

Figure 3 DC/DC Fault Analysis and Billing using AcuDC-262

As illustrated in Figure 3, the dual-channel system can be used for fault analysis and operational diagnostics. By correlating the input current (I2) and output current (I1), the AcuDC-262 enables independent diagnostic monitoring and high-precision billing within a single device. This integrated approach reduces hardware complexity and costs while ensuring the long-term reliability of the DC microgrid infrastructure.
The following logic demonstrates the method by which dual-channel correlation detects abnormal operating conditions without additional sensing hardware. Internal leakage or control fault is indicated if input current is present while no output current is measured, signifying a potential internal leakage or a control circuit failure. Efficiency degradation is identified when input current is significantly higher than output current, implying an efficiency loss that may be caused by thermal deration, aging, or component wear. A back-feed or protection failure can be triggered if output current is present while no input current is measured, suggesting a back-feed occurrence or a failure in the protection circuitry of the system.
Implementing the AcuDC-262 in this configuration allows system integrators to achieve independent diagnostic monitoring and high-precision billing within a single device. This reduces hardware complexity and integration costs while ensuring the long-term reliability of the DC microgrid infrastructure.

3.3 DC Microgrids and Telecom Power

In telecom towers and similar facilities, DC distribution networks such as 380 V DC are increasingly adopted over traditional AC systems to minimize energy conversion losses.
The primary challenge in high-density environment is efficiently monitoring multiple independent branch loads within limited panel space. AcuDC-262 provides a solution by leveraging its 1V/2I architecture, allowing simultaneous measurement of two separate load paths sharing a common DC bus voltage with a single device. As illustrated in Figure 4, this delivers significant system-level advantages.

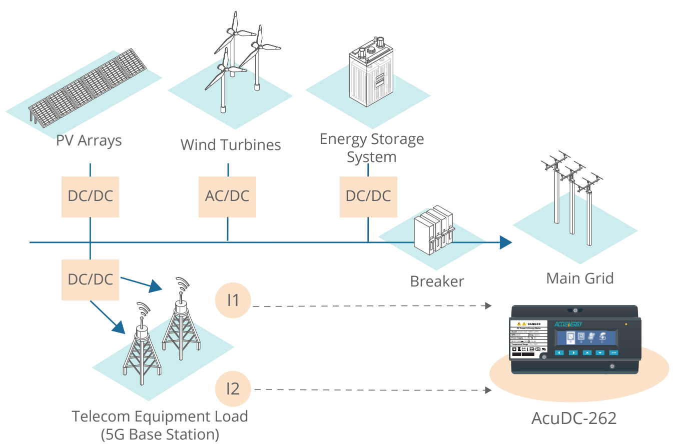

Figure 4 Multipoint Monitoring using AcuDC-262

As depicted in Figure 4, this streamlined multi-branch management structure allows a single AcuDC-262 to optimize data collection and hardware efficiency across multiple circuits. In terms of independent load tracking, a single AcuDC-262 can independently track the real-time current consumption of two separate telecom equipment branches, such as primary 5G base station equipment and auxiliary backup systems. For high-density installation optimization, eliminating the need for separate meters for each branch reduces the physical installation footprint by 50%, which maximizes critical DIN rail space within compact telecom enclosures.

Regarding integrated data management, since both channels utilize a common voltage reference, the power and energy data for both loads are perfectly synchronized. This alignment enables precise comparative analysis of energy consumption patterns across different branches within the system.

3.4 Power Distribution Unit (PDU)

In data centers and high-density IT infrastructures, DC PDUs require precise real-time monitoring to ensure maximum up-time and efficient allocation of limited power resources. Where multiple server racks share a common DC bus, accurately tracking the load status of each branch is critical for operational success. AcuDC-262, with its 1V/2I architecture, simultaneously measures two independent branch circuits, provides an advanced power management capabilities.

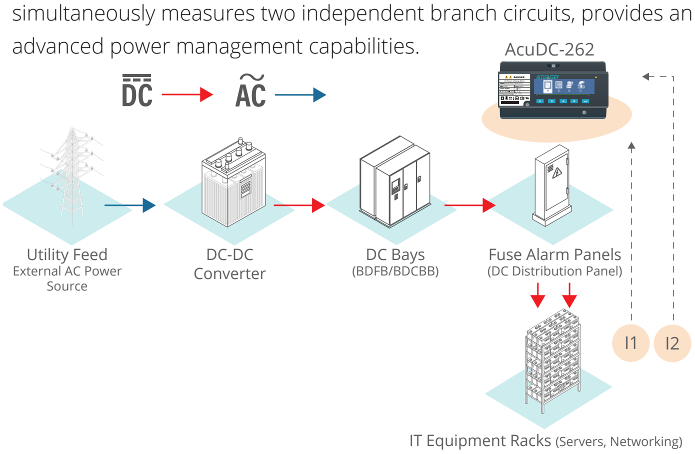

Figure 5 Independent Current Measurement using AcuDC-262

The approach to optimize utilization and load balancing ensures that electrical infrastructure operates at peak efficiency while mitigating operational risks as depicted in Figure 5. For real-time utilization monitoring, measuring the current of each branch circuit with 0.2% accuracy allows operators to monitor actual usage against designed power capacity. This capability allows for proactive measures before a specific branch reaches its limit, preventing unexpected breaker trips and ensuring system stability.

To achieve branch-to-branch load balancing, the device monitors two independent branches as I1and I2 concurrently to provide the essential data needed to distribute loads evenly across the system. This balanced distribution prevents excessive heat buildup in a single line and extends the overall lifespan of the DC infrastructure. Based on accumulated consumption data, operators can identify if branches have available capacity for additional server installations, maximizing data center scalability and resource efficiency for intelligent capacity planning.

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Datasheet

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