# Power Sources for Energy-Efficient High Input Voltage Telecommunications Equipment Development

Application Note

## Overview

Telecommunications equipment developers are faced with several challenges when selecting power sources for developing new telecommunications equipment for network installations employing high voltage power distribution.

Low voltage DC power distributions buses of +24, -48, and, to a lesser extent, -60 volts DC are well established in telecommunications networks. In contrast datacom equipment is mostly AC powered. With networks rapidly evolving into 3 and 4G broadband service systems, there is growing demand for data services on the existing internet infrastructure, as well as more datacom equipment being incorporated into the telecommunications networks. Data centers and equipment consume phenomenal amounts of power. A typical data center may require on the order of a megawatt of power. As a result there is an alarming level of power consumption these networks burden (and projected to further burden) the electrical utilities with.

One major response to this power consumption issue has been to establish a standard for powering equipment with high voltage AC or DC (universal) input power, defined by the European Telecommunications Standards Institute's ETSI 300-132-3. High voltage DC is a more efficient means for powering future telecommunications and datacom systems. This standard calls out a number of AC and DC input power requirements for new developing telecommunications equipment for high voltage universal input power.

## Problem

This standard calls for developing and testing equipment capable of being powered off either high voltage AC, rectified AC, or DC, as well as assuring the equipment can withstand the steady state and transient voltage extremes that can exist on such distribution buses. This in turn calls for having a controllable, well protected power source capable of emulating these extremes and make applicable measurements to assure the equipment being developed meets these requirements.

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# Solution

Agilent 6800 Series AC Power Source Analyzers have a universal high voltage single phase AC, DC, and arbitrary waveform output , dynamic line disturbance generation, and advanced measurement capabilities, making them well suited for powering and testing equipment being developed having high voltage universal input power.

When only high voltage DC is needed for powering equipment being developed, the Agilent N5700 and N8700 series are a family of DC sources offering a wide choice of power, high density for rack space savings, and up to 600 VDC output.

## Emerging high voltage power distribution for telecommunications

ETSI 300-123-3 calls out for equipment designed to this standard to be powered by any of high voltage AC, single or three phase rectified AC, or DC current. As the levels of each are comparably equivalent, most equipment incorporating a switched mode power supply should be able to accommodate any of these power inputs without a major amount of additional engineering. The larger challenge may actually be settling on fuses, circuit breakers, connectors, and other safety-related items suitable for high voltage DC.

Universal input power provides the equipment with flexibility to be incorporated into existing facilities running on AC power as well as in new facilities and installations incorporating high voltage DC distribution for energy savings (see sidebar *High Voltage DC for Greener Broadband Telecommunications and Datacom Networks*). This universal power requirement creates a range of voltage conditions summarized in Table 1. While universal, it is often referred to as the 400 V DC bus.

There are also a number of transient stimuli and measurements called out, including:

- Equipment shall ride through voltage drop outs of up to 20 milliseconds duration
- Other voltage transient requirements are per applicable EMC standards
- Maximum current drain in excess of 1 second duration should never exceed 1.5 times nominal current drain
- AC peak inrush current must not exceed specified limits per the standard

## Sources for powering and developing telecommunications and datacom equipment for high voltage universal input power

Proper powering and testing of telecommunications and datacom equipment during its development dictates having power sources capable of providing AC, rectified AC, and DC power under steady state conditions, and generating drop outs and other disturbances under transient conditions. In addition to these sourcing characteristics there is also the need to make a number of current drain measurements, including nominal and maximum steady state, and peak inrush currents.

The Agilent 6800 series AC Power Source Analyzers have a number of features making them ideal for developing equipment based on high voltage universal input power:

- Three models for providing 375, 750, or 1,750 VA of output power
- Outputs up to 300 volts AC RMS single phase, and up to ± 425 volts DC make them well suited for powering equipment for high voltage universal input power
- Arbitrary waveform and programming capabilities can reproduce rectified AC signals, create transient drop outs and other disturbances as required

| Input power | Low-abnorma[1] | Low-normal | Nominal | High-normal[1] | Fund frequency |
|---|---|---|---|---|---|
| 1-ph AC | 0-188 $V_{RMS}$ | 188 $V_{RMS}$ | 230 $V_{RMS}$ | 375 $V_{PK}$ | 50 Hz |
| 1-ph AC, rectified | 0-188 $V_{RMS}$ | 188 $V_{RMS}$ | 230 $V_{RMS}$ | 375 $V_{PK}$ | 100 Hz |
| 3-ph AC | 0-188 $V_{RMS}$ | 188 $V_{RMS}$ | 230 $V_{RMS}$ | 375 $V_{PK}$ | 50 Hz |
| 3-ph AC, rectified | 0-253 $V_{RMS}$ | 253 $V_{RMS}$ | 310 $V_{RMS}$ | 375 $V_{PK}$ | 300 Hz |
| DC (battery) | 0-188 $V_{DC}$ | 188 $V_{DC}$ | — | 375 $V_{DC}$ | — |

*1. For North America the high-normal value is 392 $V_{PK/DC}$*

*Table 1. Steady state service voltage characteristics*

- Programmable turn-on phase angle, dynamic digitizing waveform measurement, and high peak output current provide complete capabilities for making repeatable worst-case inrush current measurements
- Measurement capabilities include total RMS and peak currents, VA, power, and power factor, for determining equipment loading and efficiency.
- Measurement capabilities also include line and neutral current harmonics, current and voltage THD, to quantify the equipment's undesirable line loading effects
- Programmable output impedance (resistance and inductance) emulates power bus or mains impedances as is often called for in many test standards, including ETSI 300-123-3
- A full set of protection features protect equipment being powered from damage due to faults and overloads

When high voltage DC alone is sufficient, the Agilent N5700 and N8700 series are a family of DC sources well suited for developing equipment for high voltage DC input power. Applicable models are summarized in Table 2. Key features of these DC sources making them useful for this application include:

- A wide range of power levels available that are well matched for telecommunications equipment powering needs
- Like models can be connected together for even greater power
- Low profile, high power density, and being directly stackable saves valuable test equipment rack space

*Figure 1. Agilent 6800 Series AC Power Source Analyzer*

- High efficiency and power factor correction (PFC) ease the task of powering the test equipment rack
- A full set of protection features protect the equipment being powered from damage due to faults and overloads
- Measurement capabilities determine power consumption and efficiency
- LXI compliant with LAN, USB, and GP-IB interfaces and Web based user interface for flexibility

| Model | Voltage (Volts) | Current (Amps) | Power (Watts) |
|---|---|---|---|
| N5752A | 600 | 1.2 | 780 |
| N5772A | 600 | 2.6 | 1.560 |
| N5772A | 600 | 5.5 | 3,300 |
| N8762A | 600 | 8.5 | 5,100 |

*Table 2. Agilent N5700 and N8700 series DC sources; high voltage models*

*Figure 2. Agilent N5700 series DC sources*

*Figure 3. Agilent N8700 series DC sources*

# High Voltage DC for Greener Broadband Telecommunications and Datacom Networks

With the rapid growth of telecommunications networks offering 3 and 4G broadband services, such as mobile internet applications and Voice-Over-Internet Protocol (VOIP), datacom equipment is increasingly being integrated into these networks. In contrast to telecommunications, the datacom equipment is typically AC powered. In order to maintain battery back-up additional power conversion steps are needed, as depicted in Figure 4. About half of the power is lost as heat in the many stages of power conversion compared to the useful power finally delivered to the end loads. About the same amount of power lost as heat is again needed for cooling. With about 33% overall efficiency and the high demand of the datacom equipment for costly power, this is proving to be undesirable. A typical data center may consume on the order of a megawatt of power.

One major response to the power consumption issue has been to establish a standard for universal high voltage input power for telecommunications and datacom equipment, defined by ETSI standard 300-132-3. High voltage DC is more efficient for powering these future telecommunications and datacom systems by reducing the number of power conversion stages. Pilot studies have demonstrated a reduction on the order of 5 to 20% in power consumption, which is significant considering the overall amount of power consumption in such facilities. A representative configuration is depicted in Figure 5.

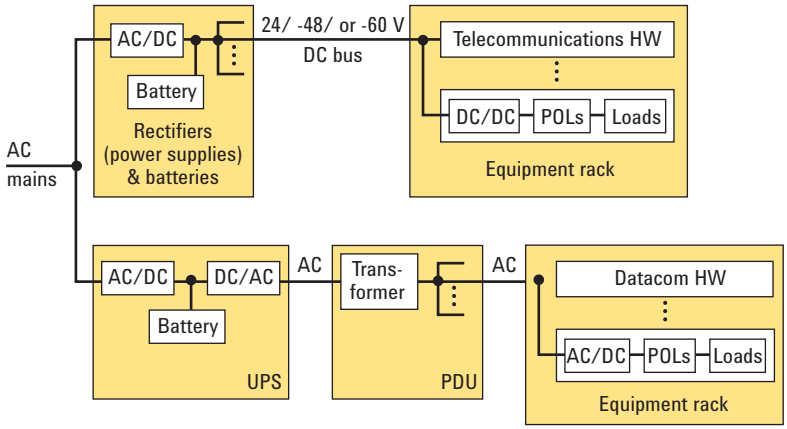


*Figure 4. Representative existing broadband telecommunications system*

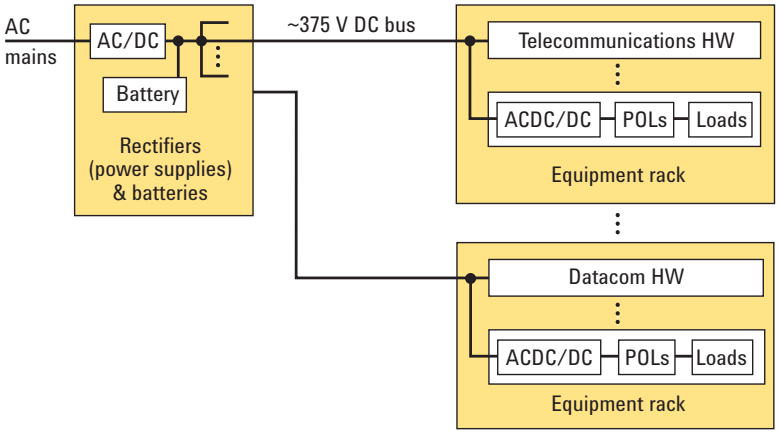


*Figure 5. Telecommunications system employing high voltage DC distribution*

## Summary

Telecommunications networks are rapidly evolving into 3 and 4G broadband service systems, placing more demand for data services on existing internet installations, as well as for incorporating a lot more datacom equipment into these telecommunications networks. As datacom equipment consumes considerable power there is an urgency to improve the efficiency of these installations. One major response has been to establish a standard for a high voltage universal input power, ETSI standard 300-123-3. High voltage DC distribution could provide an energy savings between 5 and 20% over existing AC and hybrid power distribution schemes in existing facilities.

New equipment having high voltage universal input power capability needs to be developed using controllable and well protected power sources capable of emulating the extreme conditions for such input powering and make applicable measurements. Agilent's 6800B Series AC Power Source Analyzers have a universal single phase AC/DC output with wide range of sourcing and measurement features making them ideal for this application. When high voltage DC alone is sufficient, the Agilent N5700 and N8700 series are a common family of DC sources well suited for supporting this development work.

For more information visit the following Agilent websites:

6800 Series AC Power Source Analyzers:
**www.agilent.com/find/6800**

N8700 Family of Power Supplies:
**www.agilent.com/find/N8700**

N5700 Family of Power Supplies:
**www.agilent.com/find/N5700**

## Related Literature

| Title | Pub number |
|---|---|
| Agilent 6800 Series AC Power Source Analyzer, Product note | 5963-7044E |
| Agilent N8700 Series System DC Power Supplies, Datasheet | 5990-3881EN |
| Agilent N5700 Series System DC Power Supplies, Datasheet | 5989-1330EN |
| 10 Practical Tips You Need to Know About Your Power Products, Application Note | 5965-8239E |

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