Attracting Tomorrow

AC Sources

for Test and Measurement, specialty power and unique applications

TDK-Lambda
A TDK Group Company
Neptune, NJ
November 6th, 2025]

Agenda for today

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- Introduction
- Overview
- Capturing Test and Use Requirements
- Operating Ranges of AC Sources
- Current Ranges and Considerations
- Output THD
- Phase Configurations
- Analog Inputs
- Unique characteristics of AC or AC+DC Sources
- Ease of Use considerations

Introduction

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Paul Moore
Product Manager, AC Sources
TDK-Lambda Corp.

EE with 35 years of hands-on, application engineering and sales experience in HV Switchgear, Industrial Robotics, Automation, Electrical Insulation, Power Electronics and T&M Equipment.

When I can I am out snowboarding with my sons.

TDK-Lambda - a global supplier and recognized leader of power conversion products suited to many applications including; medical, industrial, broadcast, defense, factory automation and LED/LCD signage. With global sales in excess of $500 million, we have design, manufacturing, and sales locations in all five (5) key geographic locations: Japan, China, EMEA, ASEAN, and the Americas.

TDK-Lambda's programmable group is known as the benchmark of DC Sources for test, development and precision processes where adaptable and reliable DC power are necessary.

Test and Use Requirements

Capture all of your needs

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Capturing Test and Use Requirements may be, or seem, quite simple, to the point of being unnecessary. It is generally well worth the time to look at secondary uses to help in the purchase justification. For some the needs may be very specific and understood, where for others, the entire use case is not known, and a “multitool” type instrument may ensure that all of the future needs can be met.

- Users requiring a general purpose AC or AC+DC source for a specific test should try to avoid tunnel vision of thinking “we ONLY need X”.
- Will the source be used to qualify to specific test standards, part of an automated end of (production) line, or for ongoing manual or automated testing for equipment such as avionics?
- Is this a replacement or upgrade use case where physical parameters are vital? (Will it fit, can it be controlled the same way)

The more you write down and capture the easier it is for your sales representative to quickly and confidently provide a solution.

Test and Use Requirements

Capture all of your needs

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Example – initial email request

“ Please Quote : Two rack mount 480VAC at 10A, 3 phase”

After 6 emails over three days, becomes :

- 2 separate sources
  - ¬ 3 Phase 480VAC
  - ¬ 3 phase 10A (nominal voltage)
- One in VC and one in CC
- V and I sources synchronized with adjustable phase angle
- Controlled by LAN/SCPI

This is a 6-phase case – with independent V and I controls - not a common use case

So Many Parameters!

AC Sources, by their nature have more parameters, but you will also find that they are inter-related and many call for tradeoffs.

- General Operation
  - V range
  - I range
  - Peak Current / Crest Factor
  - Power
  - Expandability / Reconfigurability
  - Input Power Options
  - Frequency Range
  - AC vs AC+DC
  - DC Considerations
  - Analog Control
  - Phase Configurations
  - Phase angle control
  - THD of the output
  - Harmonics Analysis
  - Waveform Control
  - Measurement Capabilities

- Physical / Mechanical
  - Audible Noise
  - Size & Weight
  - Ease of Use
  - Reliability / Warranty
  - Manufacturers Support
  - Safety : UL/CE listing – 61010-1 – 3rd party cert required?
  - Will it be rack mounted?
  - How much rack space is available
  - Will the unit be connected disconnected from multiple test set-ups
- Programmability - How will it be controlled?
  - Manually
  - A remote Graphical User Interface preferred? (Also a programming tool)
  - LabVIEW™ or some other environment?
  - Programmed in some other way, such as Python
  - or a combination of these?
- Preprogrammed Test Standards
  - Many are offered
  - What flexibility or export capabilities are supported

Voltage and operating Ratings of AC Sources

Is there really a difference between Single or Dual range?

Historically higher power AC Sources utilized dual ranges, trading off voltage and current to cover a wider operational range.

Often ranges looked like : **6KVA Source, 0-300V, 0-48A**

What this may mean is : 0-150VAC with 48 A rms
or 0-300VAC with 24A (1/2 of the current of the lower range)

The Actual Spec will read : 0-150V/48A and 0-300V/24A

Improvements in the power electronics, generally higher voltage or wide-bandgap SiC MOSFET, DSPs used in control and the measurement allow for wider, single range instruments. Higher performing devices allow for smaller passive components (filters) bringing along the added benefits of reduced size and weight.

Voltage and operating Ranges of AC Sources

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Here a popular, Dual Range AC Source is compared to a more recent Single Range model.

The LOW range of the Dual Range

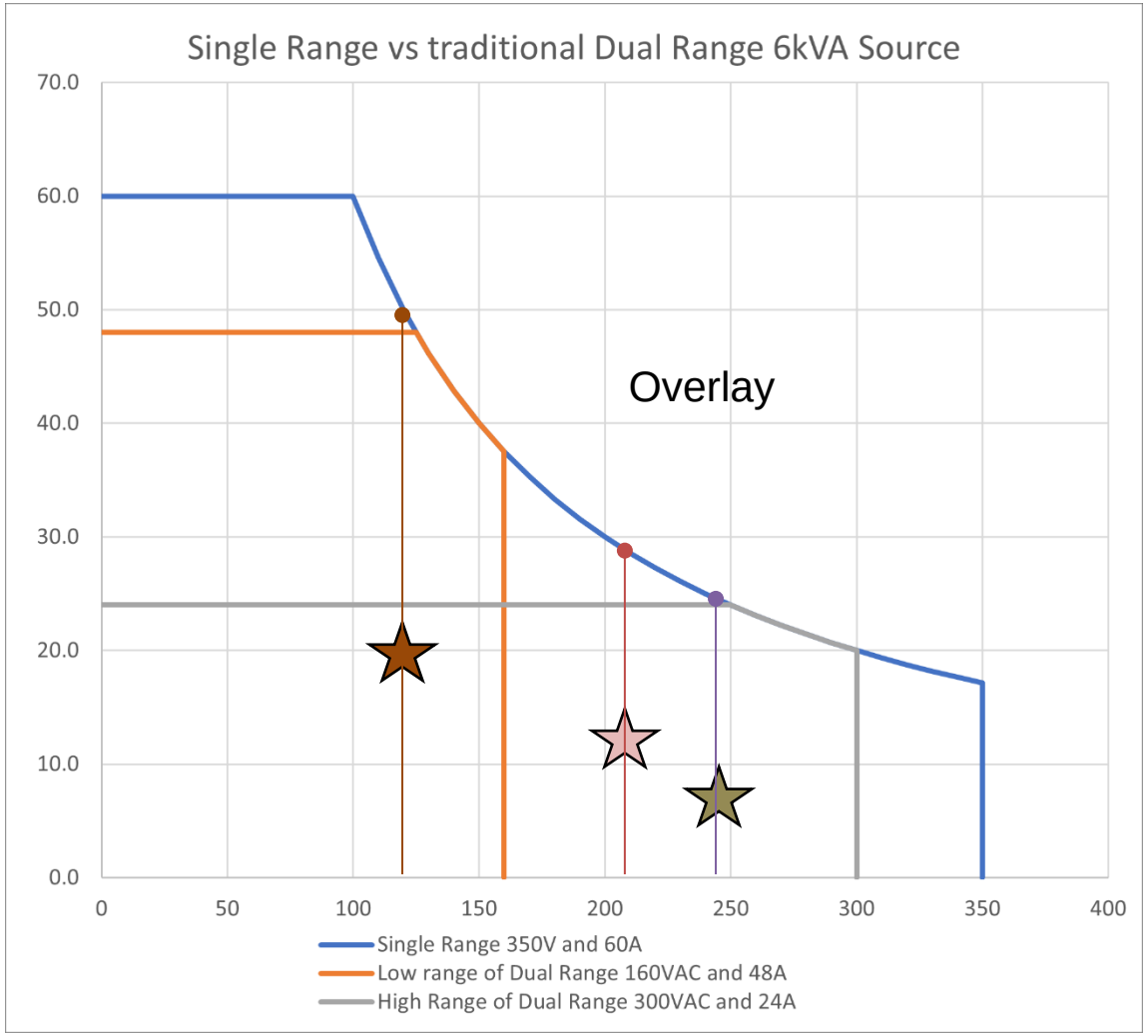
The High range of the Dual Range

A Single Range instrument

★ 120V Operating Point

★ 208V Operating Point

★ 240V Operating point



Voltage and operating Ranges of AC Sources

The Low End

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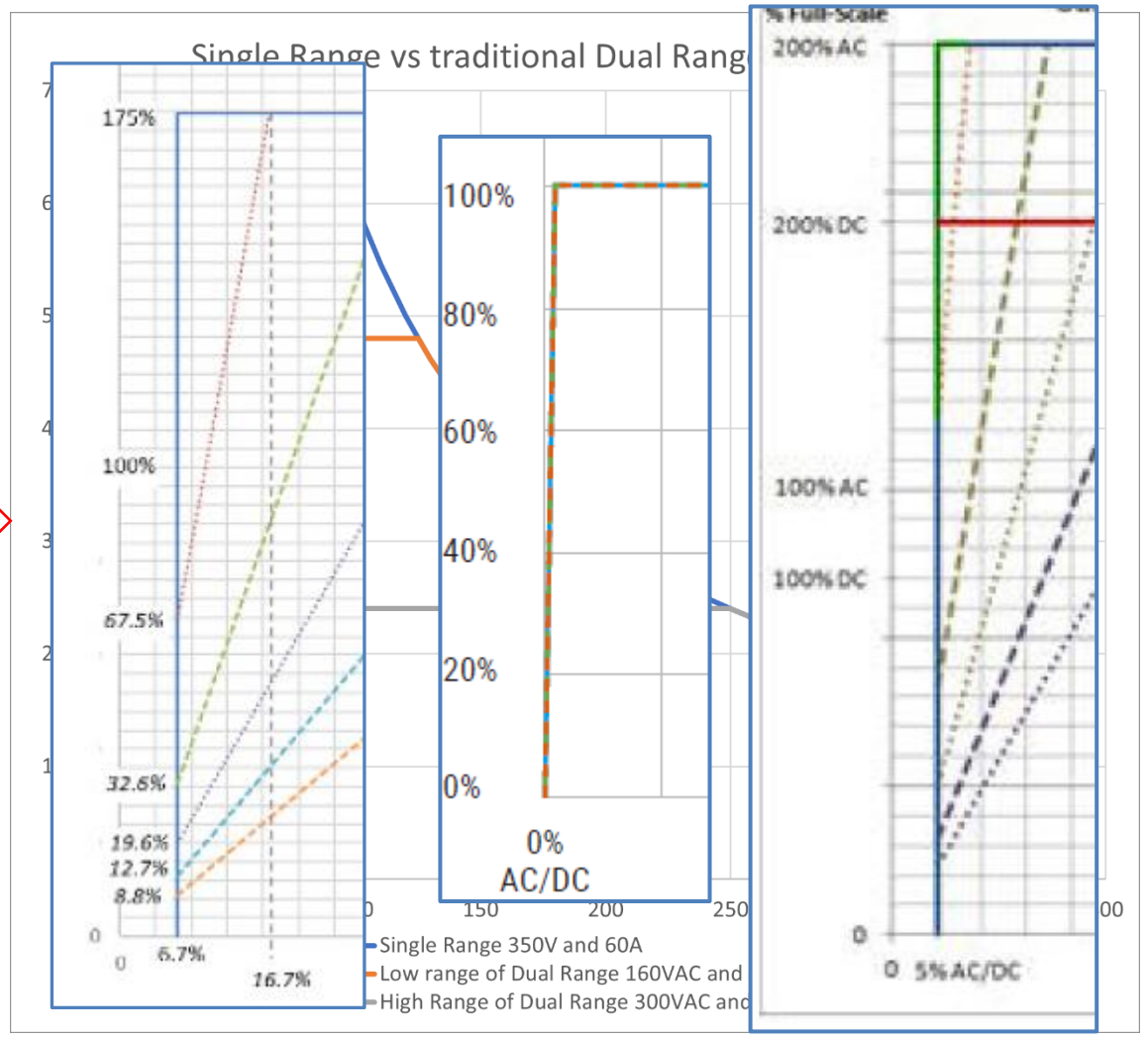
Also – inspect the entire operating range that will be needed.

If you need very low voltage – Some AC Sources can have trouble below 2-5% of the rated values.

AC Control in this Region

This is a difference between the AC and DC sources, where control from Zero is the industry standard.



Current Ranges

More than one Current Rating to consider

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Largely because the current ratings are in RMS, they are not absolute (as they typically are with DC Sources). Practically every AC source will be called on to supply much higher peak currents for inrush, harmonics, or to properly simulate dynamic or transient disturbances.

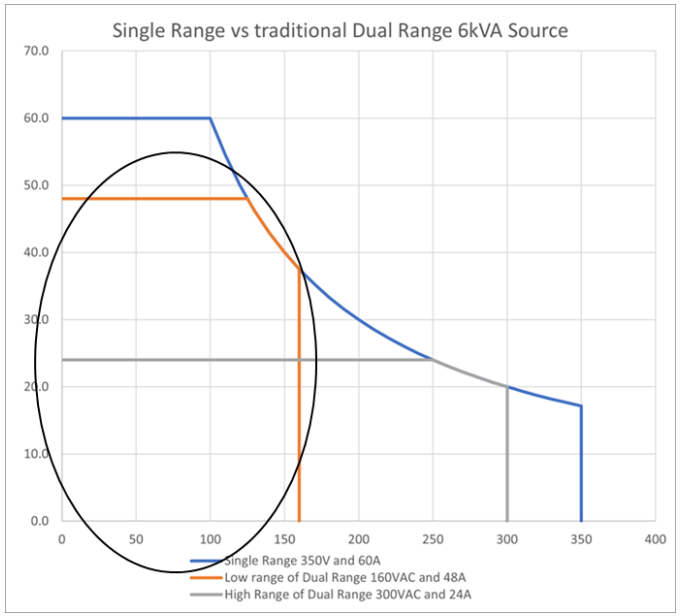
The most common metric used, Crest Factor, is a standard published spec value, but as the buyer or user, the important value is actual peak current at the test conditions.

The Single vs Dual Range issue applies here as well.

A source's crest factor may be published at 4:1 – however, this is in reference to the current rating IN THAT RANGE.

Considering the example from the operating envelope:

A low range of 48A and 4:1 – or 192A, but this is only when in the 150V Range.



Crest Factor – What is it?

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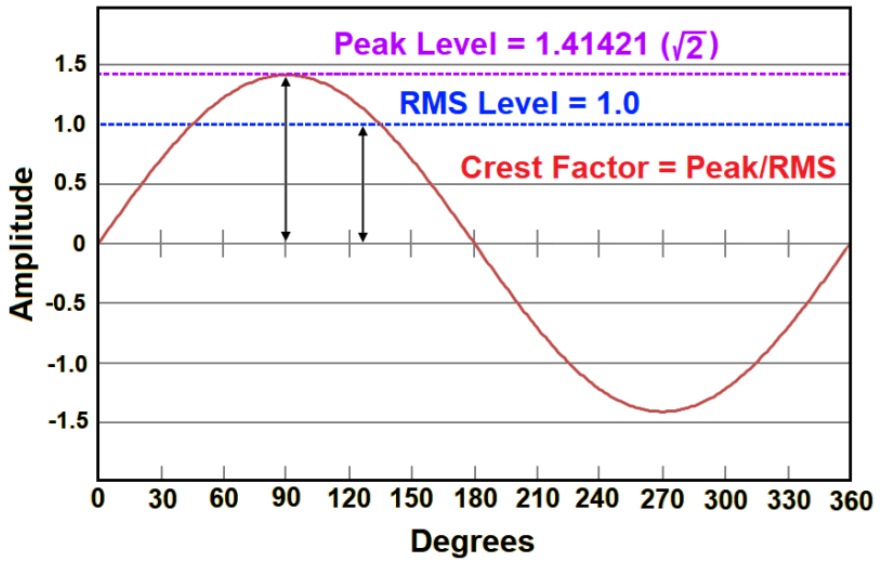
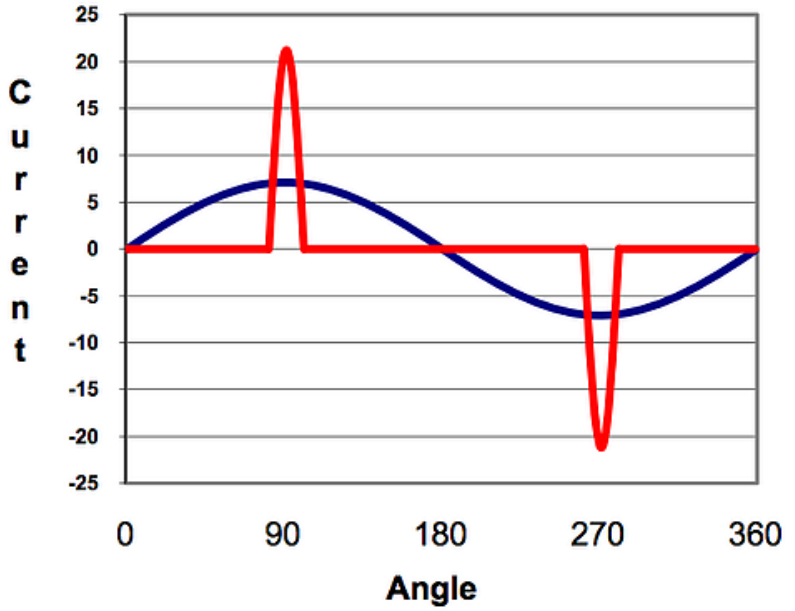
Definition – The ratio of peak values to the effective values of RMA and PEAK

$$CF = \frac{Peak}{RMS}$$

- A “perfect” sine wave crest factor is $\sqrt{2} \approx 1.414$ (which is the peak amplitude divided by the RMS value), usually written as 1.414:1 (or $\sqrt{2}: 1$)
- A distorted load current may have a dramatically different CF for the same RMS





$$CF = \frac{Peak}{RMS}$$

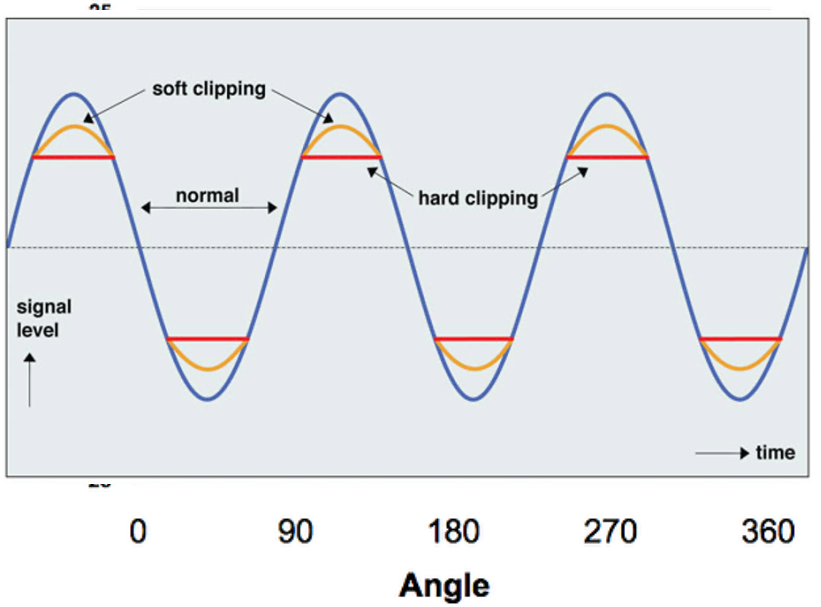
$$CF = \frac{21.21}{5}$$

$$CF = 4.24$$

(or $4.24: 1$)

Crest Factor – Why is it important?

- Assume a product requires an AC input of 230VAC to operate.
  - Let's compare the two waveforms as an example.
    Both current waveforms (red and blue) represent current of 5Arms, which means, both draw 1150VA



  - A power source of 1500VA may not, however, be able to provide the required peak currents (i.e., minimum 21.21A) that the non-sinusoidal load demands.
  - Therefore, when selecting an AC source, you must verify that it can supply the required peak current by verifying its Peak Current as well as its "Crest Factor" specification
  - If the specification of peak current is not met, the sources output waveform could be "hard clipped" or "soft clipped" distorting the test.

Current Ranges

Other Aspects of Current Ratings - Inrush

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When peak currents are needed it can often drive the entire power rating of the selection. Without fully investigating this may lead to purchasing an undersized or oversized based on the higher power source than needed.

Classic Examples

	Inrush Current
Incandescent Bulb	10 - 12X
Transformer In-rush	10 - 15X
Toroidal Transformer	Up to 60x
Consumer Goods (washing Machine, etc.)	2-3X
Common Power Supplies (General Purpose/Medical/Avionic)	2-15X

Current Ranges

More on Inrush

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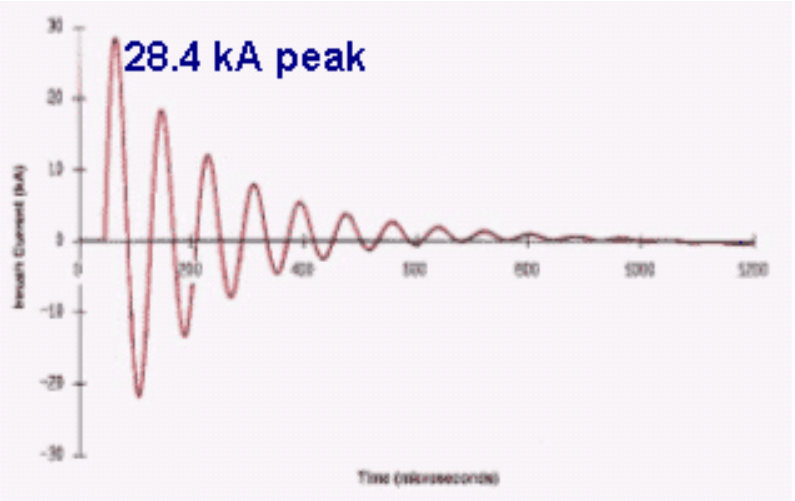
If part of your testing, or you UUT start-up procedure, Inrush is also a key item to be considered.

This is much harder to quantify from the test instrument side, since the peak current AND the settling time, or number of cycles can cause this to require significant power.

In general, a unit with higher Peak Current will perform better, but ideally you would want to consult the manufacturer and/or have it demonstrated in your approximate case, esp. if it is leading to purchasing higher power than expected.

Undersized can result in voltage distortion, or extended duration of the inrush, or tripping of the source.



Output THD

Not so simple….

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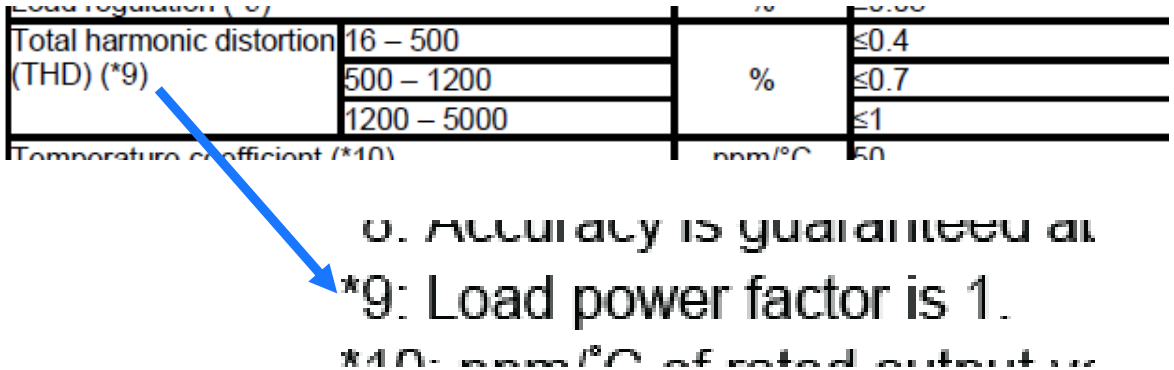
Clearly we want a clean source with perfect AC sine to allow measurement of the device under test's current harmonics.

But it is important to note the Voltage and Current distortion is always interrelated. The impedance of the source, similar to the term "stiffness" of a real power source, will determine how much Voltage distortion is created by the load's current.

Published THD Figures will always have a note specifying some test condition for the rating – and it will be pure resistive.

If your testing will be involving THD measurements, I would advise having the source demo'd under similar test conditions.

Good dynamic current range is a general indicator of one source being better than another.



Total harmonic distortion (THD) (*9)	16 – 500	%	≤0.4
	500 – 1200		≤0.7
	1200 – 5000		≤1

*9: Load power factor is 1.

Phase Configurations

Single-Phase, Split-Phase, Three-Phase

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What are all of the possible phase configurations needed ?

Can you economize by getting a reconfigurable or reduced Source-Channel Solution?

	Single	Split	Three (WYE)	Open Delta
Winding	L1- (240V) - L2	L1- (120V) - N- (120V)- L2	L2 - (277V)- N N- (277V)- L1 L3- (277V)- N	L1 - (208V)- L2 L2 - (208V)- L3 Virtual 208V Phase
Phasor	V line to Line, or Line to Neutral	L1 120V- - N- - L2 120V		
Source		Will a single channel do?		

Analog Control

Input or Programming

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There are a number of reasons to need analog control in AC, especially to coordinate the waveforms with specific conditions in the test. In a DC source there would be little difference between analog control of the voltage like “Vdc” and a real time input.

In AC we may only have the need to just control basic parameters, such as Vrms or Frequency.

This is a basic Analog Control set up – that is common with most sources.

Some AC sources, typically as a premium models can also provide Real Time analog signal to output effectively turning the AC Source into an Amplifier.

This is commonly used in Power Hardware in the Loop (PHIL) testing test scenarios are run in real time.

If you are needing this functionality, be sure to review the documentation and discuss with the manufacturer, because there are some different terminologies used.

Unique characteristics of AC or AC+DC Sources

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AC sources are called on to be both steady as a rock, and practically chaotic. The output quality can not really be “filtered in” – it generally need to use the speed of the power electronics and control to obtain the desired output.

- In Sources with AC+DC capabilities you have a DC source with potentially very different behavior than a traditional DC source
  - ¬ By nature, it is bipolar
  - ¬ Filtering is reduced – so expect a nosier source
  - ¬ Filtering is reduced – response speed is much faster
    - ○ Response to setpoint change may be 50 to over 100X faster than a traditional DC Source

GENESYS AC PRO (2KVA, +/- 500VDC)		Genesys+ DC (2700W / 300V)	
Response speed Trise, Tfall	1200Hz models: **≤120 µs** 5000Hz models: **≤40 µs**	Up-prog. Response time	50 mS
		Down-prog.response time:	Loaded 100mS Unloaded 3200mS
Transient response time	**≤40 µs**		

Unique characteristics of AC or AC+DC Sources

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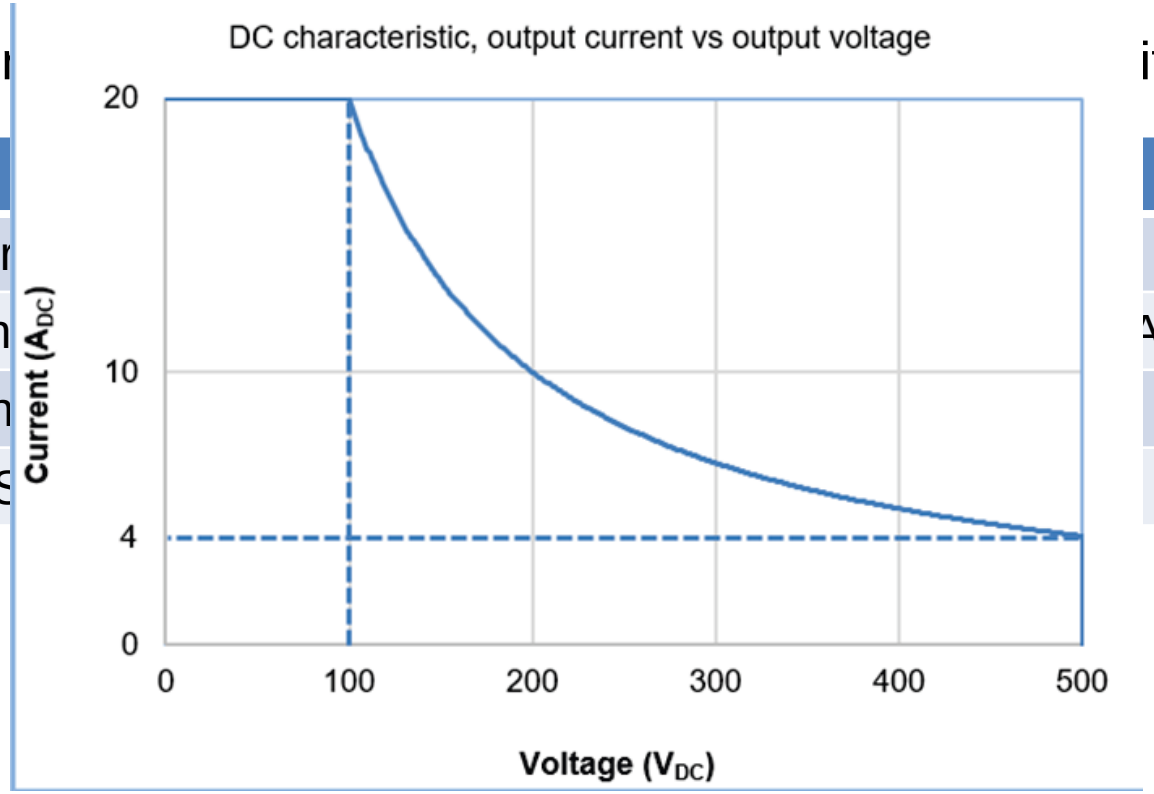
On the AC sources with DC capabilities – pay attention to the operating envelope as well.

- Are the Voltage, Current and Power ranges the same in DC vs AC?

Cor ity

	Mfr C
Rated DC Power	2000W
Rated AC Curren	A entire range
Rated DC Curren	20A DC
% DC to AC RMS	100%



Ease of Use

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AC source set up may have a lot parameters

With any instrument with many settings, it is valuable to be able to recall a specific set up, or clearly see and understand it's settings, save and recall them and re-set test configurations to replicate test.

The nature of testing is moving to more repetitive and automated - having an AC Source that reduced set up time and errors adds considerable value.

- For Manual Operation
  - ¬ Are the controls clear and intuitive
  - ¬ Is the Data presented clearly

- Remote operation
  - ¬ Does the Manufacturer offer a Graphical User Interface (is there added costs?)
  - ¬ Are there multiple hardware interface types available ($?)

- Programming and Control
  - ¬ Are LabView and SCPI drivers included (Added cost?)

Ease of Use

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When Considering replacing or upgrading

AC Sources are not new, but their capabilities and technology are advancing, arguably faster than DC. The advancing technology allows modern design sources to be smaller and lighter. In many or most cases allowing them to easily fit into existing design spaces.

Freeing up floor space
Smaller and lighter = easier to manipulate

Consider a well known 15kVA workhorse

	15kVA Legacy Source	18kVA Stacked Source
Dimensions	31”H x 24”W x 28”D	10.5”H x 17”W x 23”D
Volume	~12 Ft^3	2.4 Ft^3
Weight	600#	105#

The legacy products and designs are also becoming harder to support from components and original product knowledge in the manufacturing organizations.

Ease of Use

Some other considerations

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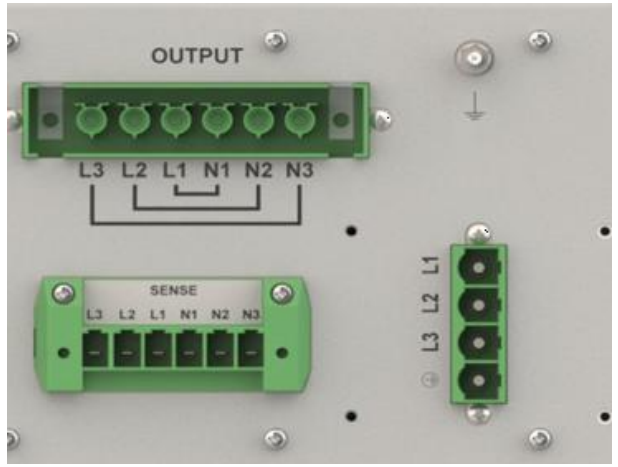
Are the sources User Configurable – can power be increased, or multiphase set ups be reconfigured for different test scenarios.

Are the connections screw terminal or connectorized, allowing fast and repeatable changing out of test rigs/cabling.



Closing -

With the wide variety of suppliers, technologies and their approaches, I would encourage any potential AC Source shopper to :

- Clearly Define their Needs – in writing
  - ¬ Not just operating specs, but all aspects of how the Source will or may be used, timing, etc
  - ¬ Make a diagram
- Consider Automating and Capturing Test Info (Setups and Data)
  - ¬ Plan to automate more, programming is becoming very easy
- Review any data sheets in detail
  - ¬ but always check the reference notes – many specs are in based on specific test conditions

Engage with your suppliers – be specific with your requirements and questions. This will help ensure the investment provides as much value as possible

Questions?

Comments?

Thank You!

Discussion?

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