

# A Closer Look at Inverter Generators

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In June 2008 *QST*, we looked at modern portable power generators from a typical ham's viewpoint: something safe, compact and reliable to power radio, multimedia and computer gear at Field Day, on camping trips or while tailgating at the ball park.

The article covered a lot of ground — topics chosen to help you learn the basics about the various types of portable power generators, which types are likely to be right for you, and how to safely use generators in the field. Consequently, there wasn't enough room to discuss the details and benefits of inverter-based portable power generators which, over the past few years, have revolutionized the industry and have made portable power better in every way for anyone who needs to operate sensitive electronics in the field.

Conventional generators, as detailed in the article, are heavy, loud, bulky and tend to lack voltage and frequency stability. They're fine for powering light bulbs and power saws, but when it comes to powering TVs, radios, computers and other sensitive loads, fluctuating or out-of-spec voltage and frequency values can spell doom and disaster for your expensive gear.

Inverter-based generators have changed all that, so let's take a closer look. Before we get too far, though, I need to mention that specific details about the inner workings of these modern marvels are in short supply. In addition to the fact that all of the units shown in the main article are designed and built in Asia (DX distances and language barriers). Manufacturers are typically tight-lipped about releasing details that might involve pending patents or give a leg up to the competition. That said, the units are *substantially similar* in overall scope and implementation.

## Inverter Generator Basics

Unlike conventional generators, which typically use a two-winding core that *must* turn at 3600 RPM to produce 120 V ac power at 60 Hz, inverter generators produce multiple-phase ac power at high frequencies, which is electronically “converted” to dc, then “inverted” back to rock-solid, low-distortion, 120 V, 60 Hz ac.

Because an inverter generator can draw more power per revolution from the generator core (thanks to several hundred overlap-

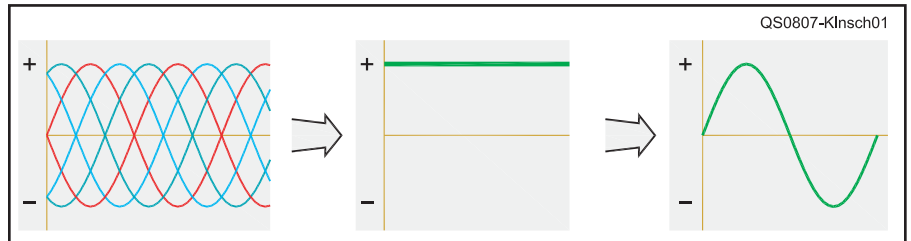


Figure 1 — The three phases of the inverter generator process: high frequency ac; converted to dc; inverted to stable, clean 120 V, 60 Hz ac.

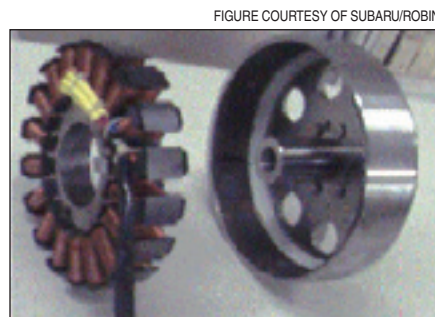


Figure 2 — Core parts from a modern inverter generator. Note the multiple windings.

ping sine waves per revolution), the core doesn't need to operate at a fixed speed to maintain regulation. Inverter generators are lighter, quieter, and more fuel efficient because generator speed is automatically adjusted to match load conditions.

## Inner Workings

A conventional generator rotates two large coils inside its core, and each full

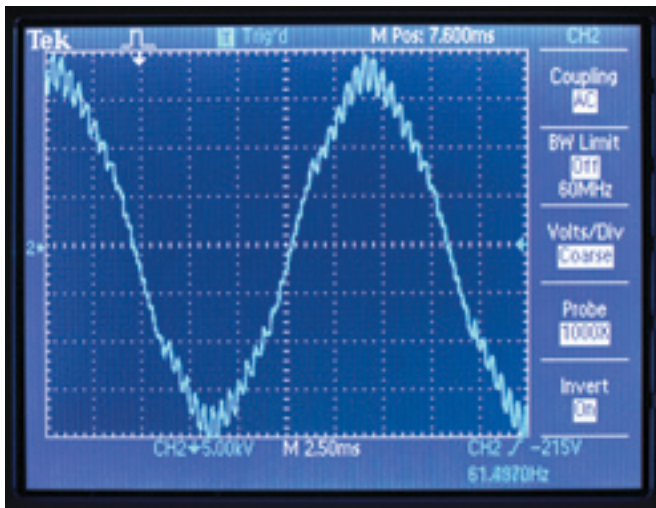
engine rotation produces one complete ac sine wave. By design, the engine must spin the generator at 3600 RPM to produce the desired ac output. If, because of varying loads, the generator spins faster or slower, the voltage and frequency of the output vary in step.

In an inverter generator, the core uses multiple coils and multiple magnets. Each full rotation of the engine produces more than 300 three phase ac sine waves at frequencies up to 20 kHz, which produces more electrical energy per engine revolution. A microprocessor-controlled inverter module converts the high-frequency ac to dc (about 200 V in at least one unit) before “inverting” it back to clean, stable 120 V, 60-Hz ac power.

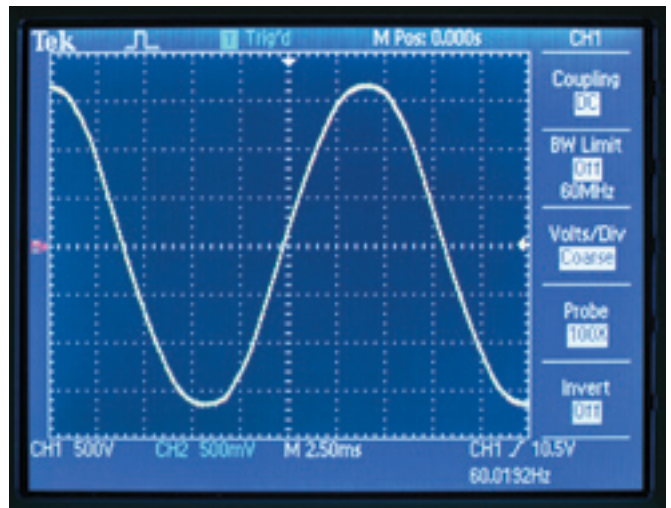
Typical inverter generator regulation specs are 3% voltage, 1% frequency and 3% sine wave distortion. That's essentially “power company” ac in a hand-carried unit! Compare that to the other types of generators in Table 1.

Table 1 — Measured Voltage and Frequency Comparisons Between Representative Gensets

Type	V and f at no load, 500 W and 1000 W	Notes
Inexpensive Worksite Genset, 2500 W	157/64; 151/64; 149/64	On the ragged edge. Should be adjusted. V and f range widely under varying loads.
Deluxe Homesite Genset with AVR 4000 W	128/63; 125/62; 125/62	Decent power. May be adjustable. May be “right on the money” at higher loads.
Honda EU2000i Genset with Inverter 2000 W	126/60; 124/60; 123/60	Quality power. Frequency does not change with varying loads.



**Figure 3 — The sine wave output produced by a conventional portable power generator. Note the frequency error and the noticeable distortion.**



**Figure 4 — The sine wave output produced by a modern inverter generator. There's almost no discernible distortion or frequency error.**

## Sound Design

A compact, tightly regulated ac power source just wouldn't be quite so handy if it sounded like a jet engine. To minimize noise and vibration, manufacturers designed extra large internal exhaust mufflers, multi-chambered inner structures that isolate intake air from output exhaust, innovative internal cooling and air transport fans and enclosures that use unconventional laminates.

The generators are compact and “friendly” looking, but the internal construction is carefully tailored to minimize sound and provide adequate cooling. If you look closely, you'll notice that, unlike typical construction site generators that use open frame designs that let everything “hang out,” the smaller inverter gens are completely enclosed. Instead of using a single layer of plastic for the outer shell, at least one manufacturer sandwiches a layer of sound and vibration-dampening foam between two thin layers of plastic. This dramatically reduces sound levels and prevents the enclosure from “resonating” with the whirring and rotating internal parts and exhaust notes.

## Size and Efficiency

If you're wondering whether portable generators have been getting smaller these days, you're right! Thanks to relentless design efforts and the fact that inverter generators are some 20% more efficient than their conventional counterparts, engines,

SUBARU/ROBIN



**Figure 5 — Inverter generators, a bit larger than the relatively small units examined in the article, often feature voltage, frequency and run-time monitors. You'll know when to change the oil — and you'll have peace of mind when powering your sensitive gear.**

generator cores and enclosures have been shrinking, in size and weight.

## Handy Extras

The brains behind the braun — the inverter modules — are typically designed to function beyond their rated loads. Most incorporate a suite of temperature, voltage and current sensors to make sure everything is operating correctly, even in demanding field conditions, and to ensure that the generators can put out extra power for short time periods to start demanding loads such as air conditioners or other motor driven equipment.

## Conclusion and Thanks

I'd like to thank Brad Murphy, a Vice President at Subaru/Robin, and his helpful staffers, for providing photos, details and insights when nobody else was forthcoming!

Small, lightweight, quiet, powerful and relatively affordable, modern inverter generators are truly a ham's best friend during Field Day or a power outage near you!