

# TECHNOLOGY

**LINCOLN**  
**ELECTRIC**  
THE WELDING EXPERTS

POWER ELECTRONICS TECHNOLOGY

## Inverters and Choppers

Technology creates change. The ability to evolve along with change is what distinguishes a successful product from the rest.

Power source design is almost entirely devoted to reliability. Fast power conversion is important to obtaining a smooth welding output, but we also know that speed is inconsequential without reliability. No matter how fast your machine operates, if it is not durable, then it is not usable for welding. And if it is not welding, you are not meeting your production goals and making a living.



*The Chopper Technology<sup>®</sup> in the Ranger<sup>®</sup> 305D offers the same control over the welding arc as an inverter machine*

*The inverter technology in the Invertec<sup>®</sup> V350-PRO gives it equivalent power capabilities as a conventional transformer/rectifier such as the Lincoln CV-305, but in a much smaller and portable machine.*



### a d v a n t a g e s

#### **QUICKER RESPONSE**

High-speed power conversion allows for quick response to changing arc conditions.

#### **SMALLER FOOTPRINT**

Power electronic components are compact, making equipment size smaller and therefore more portable.

#### **UNIVERSAL INPUT VOLTAGE**

Capable of operating from 208 to 575 volts on virtually any power supply for versatile, consistent performance.

#### **HIGHLY EFFICIENT**

Smaller transformer coils, higher thermal conductivity, and higher operating frequencies means more efficient output power, and more economical use of power. This translates to decreased utility costs and increased power source efficiency.

#### **WAVEFORM CONTROL TECHNOLOGY<sup>®</sup> COMPATIBLE**

Waveform Control Technology<sup>®</sup> gives the operator improved control over the characteristics of the welding arc.



The future of welding is here.®

# Inverter Technology

## What is

### Inverter Technology?

Inverter-based welding power sources operate at frequencies above 20 kHz, whereas traditional power sources operate at a line frequency of 50 or 60 Hz. Some of the advantages an inverter has are smaller magnetic components (chokes and transformers), higher efficiency, and a fast response to the welding arc.

Inverter power sources were first introduced into the welding industry in the early 1980s. The initial attraction of the inverter was its small size and easy portability. For example, a rectifier-based machine, like the Lincoln CV305, weighs four times more than the Invertec V350-PRO. Less space is needed and the inverter unit is easily moved around the job site. As the popularity and reliability of

## Inverter Technology



The Invertec® V350-PRO



The Power Wave® 355M



The Power Wave® 455M/STT



The Power Wave® AC/DC 1000™

Inverter Technology is showcased in Lincoln's Invertec® V350-PRO, and Power Wave® welding systems

the inverter increased, the capabilities were expanded. Inverters are now designed for many different processes: SMAW, GTAW, FCAW, SAW, and are capable of operating in

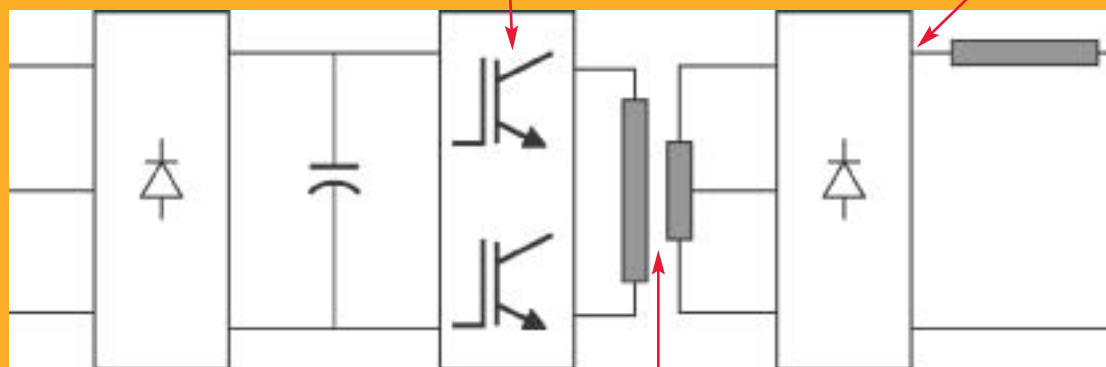
extreme environments. Over the last decade, Lincoln Electric has invested heavily in developing inverter technology, producing highly reliable inverter machines.

## How

### Inverter Works

The DC power is inverted into high-frequency AC power, using semiconductor switches above 20 kHz. High-speed switching improves welding. Switching above 20 kHz improves efficiency, reduces weight, and is above the maximum frequency people can hear. Digital controls dictate the switching rate of the transistors.

The current is "smoothed" by a rectifying and filtering circuit to make it suitable for welding.



Incoming 50 to 60 Hz alternating current (AC) is converted to direct current (DC) by a full wave rectifier.

The high-frequency AC voltage requires a step-down transformer. The transformer takes high voltage, high frequency AC and converts it to low voltage, high frequency AC.

# Inverter Technology

## Using

### Inverter Technology

#### For Multi-Process Welding

Inverters are capable of multiple process welding, providing optimum arc characteristics for each process.

#### For Reduced Electrical Power Consumption

Copper conductors, compact transformers, and smaller coils translate to energy savings.

#### For Waveform Control Technology\*

Inverter machines are software programmable, which means that they are equipped to use Waveform Control Technology® to manipulate output weld characteristics.

#### For Networking Capability\*

Multiple inverter machines can be networked together over a Local Area Network (LAN) or Wide Area Network (WAN) with an Ethernet/DeviceNet Gateway board.

## Advantages

### Of Inverter Technology

#### Reliable

Every inverter undergoes rigorous testing to ensure product reliability.

#### Compact and Portable

Smaller chokes, transformers, and rectifiers, give the inverter equivalent power to older SCR machines, without the added size and weight.

#### Fast Response to Welding Arc

Digital controls regulate the output very accurately so the welding performance is consistent from machine to machine.

#### Universal Input Voltage\*\*

The inverter can run on any power supply that supplies between 208 to 575 volts.

#### Efficient

The smaller chokes and transformers of the inverter yield an efficiency rating of 87% to 90%, which means the inverter consumes less energy to convert the same amount of energy as SCR-based machines.



*The Power Wave® 455M uses Inverter technology to produce consistent welds with a variety of weld processes.*

\* Applies only to Power Wave Welding Systems F355i, 355M, 455M, 455M/STT, 655 Robotic, and Power Wave AC/DC 1000.

\*\*Power Wave 655 Robotic and Power Wave AC/DC 1000 operate from 460 to 575 volts.

# Chopper Technology®

## What

### Is Chopper Technology?

Lincoln Electric's Chopper Technology is the simplest form of high frequency power conversion. A chopper is composed of a transistor switch and a diode. DC input power is "chopped" to a lower output voltage, and a choke is placed in the path of the output to smooth current variation.

Choppers were developed for engine driven welders to offer the same control over the welding arc as the inverter machines. This allows more consistent arc performance across product lines. Choppers are ideal for the customer searching for an inexpensive option for low cost, high quality arc performance.

## Chopper Technology®



Vantage® Series



Power MIG® 350MP



Chopper Board



Ranger® 250 & 305D

Chopper Technology is showcased in Lincoln's Vantage, Ranger, Multi-Weld and Power MIG 350MP



Multi-Weld®

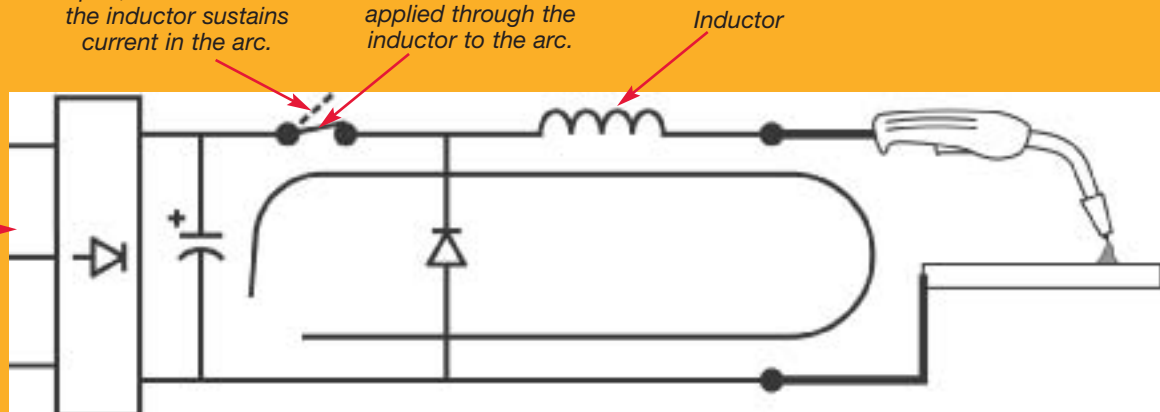
## How

### Chopper Technology Works

When the transistor switch is open, current stored in the inductor sustains current in the arc.

When the switch is closed, current is applied through the inductor to the arc.

Incoming AC power is converted to direct current (DC) by a full wave rectifier.



DC voltage is applied through a solid state switch, which controls the welding arc by opening and closing, regulating the amount of current that is applied to the arc.

The repetition of this cycle of switch closure is at least 20 kHz, which allows fast control of the arc.

# Chopper Technology®

## Using

### Chopper Technology®

#### For the "On-The-Go" Welder

Chopper Technology is the field welder's answer to superior arc performance. Engine drives allow for the flexibility of operating in conditions where "plugging in" is not an option. Lincoln engine drives provide excellent arc characteristics through Chopper Technology, while providing high-capacity AC generator power.

Chopper Technology also allows multiple welding arcs to operate from a single power supply using Multi-Weld 350 units.

## Advantages

### Of Chopper Technology®

#### Flexible

- Engine-driven Chopper Technology® power sources are not limited by the weld environment or access to a power line.
- Chopper Technology® is also available in an electric powered welder, the Power MIG 350MP.

#### Fast Control over Welding Arc

- Fast response time of the Chopper Technology® circuit allows greater operator control over the welding arc.



Lincoln engine-driven welders such as the Vantage® 500 can be used in virtually any work environment. Chopper Technology® enables fast and consistent arc control, while providing high-capacity AC generator power.



Chopper Technology® allows up to four Multi-Weld 350 machines to draw power from a single SAE® 400 power supply.

## Power Electronics Design

The reliability of a welding power source is critical. Electronics improvements are the foremost method of continually improving the reliability, efficiency, and performance of our power sources. Lincoln invested in improving the dependability, durability, and efficiency of its inverters. Lincoln engineers developed innovative solutions for power conversion. Extensive research is conducted in the electronics, EMC, and power laboratories.

### The Electronics Lab

is equipped to support the design and analysis of analog and digital control systems.

### The EMC Lab

is equipped to conduct electro-magnetic interference testing.

### The Power Lab

is equipped to build and test full-scale prototype machines rapidly to support the development of new power conversion techniques. As new power electronic components emerge they are evaluated and implemented.



## Reliability Testing

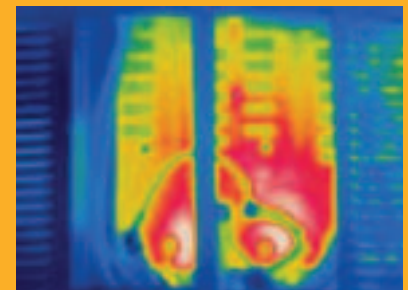
### During Product Design



*Environmental Stress Screening (ESS) subjects the machine to extreme conditions of temperature and humidity.*



*Mechanical tests such as vibration and drop testing provide evidence to the machine's durability and resistance to breaking.*



*Infrared thermal analysis is done on power electronic assemblies in the power electronics lab. This is done at both the PC board level and the machine level.*

# Reliability

7/8

From initial design to product build, we ensure that every power source we release to a customer meets our standards for reliability and efficiency.

## Power Section designed around high speed switching modules

- Lincoln manufactures its own integrated modules, which allows us to optimize each module for reliability and performance.

## Designed to withstand extreme environmental conditions

- All PC boards are trayed and potted.
- The transformers and chokes go through a double dipped varnish impregnation process.
- Harness connectors are made with locking pins and sealed with electrical grease.



## Designed with

### Fan As Needed (FAN™) Circuitry

- This reduces the amount of debris that gets drawn into the machine by turning the fan off when it is not needed.
- The fan turns on before components get too hot, thus increasing life expectancy of the electronics.
- Reduces the power used during machine idle.

## All electrical components are derated for added reliability

- All electrical components are designed to operate at voltages lower than their rated voltages and temperatures below their rated temperatures.

## Designed for stable operation

- Patented dual current transformers prevent current imbalance.
- Active balancing technology is utilized for keeping the voltages balanced under all conditions.

## Control system utilizes common PC boards and software

- Able to accommodate feature enhancements and optimizations from other products for longer life of the inverter.

## Designed for protection if a fault occurs

- Thermal protection, misconnection protection, secondary over-current protection, and primary over-current protection are all standard in inverter machines.

## Reliability Testing

During Product Build



Each Power Wave machine is weld-tested.



Dielectric tests provide evidence that electrical insulation will withstand the rigors of the welding environment.



The burn-in cycle is conducted to ensure machine performance matches Lincoln Electric requirements.

The future of welding is here.®

# Power Electronics Products

## Lincoln Welding Systems Power Electronics

### Chopper Products

Lincoln Electric power sources equipped with Chopper Technology® include the Ranger® and Vantage® engine driven welders, as well as the Power MIG® 350MP and Multi-Weld®.



### Inverter Products

Lincoln products equipped with Inverter Technology include the Power Wave® AC/DC 1000™, Invertec® V350-PRO, Power Wave® 355M, and the Power Wave® 455M.



### Customer Assistance Policy

The business of The Lincoln Electric Company is manufacturing and selling high quality welding equipment, consumables, and cutting equipment. Our challenge is to meet the needs of our customer and to exceed their expectations. On occasion, purchasers may ask Lincoln Electric for advice or information about their use of our products. We respond to our customers based on the best information in our possession at that time. Lincoln Electric is not in a position to warrant or guarantee such advice, and assumes no liability, with respect to such information or advice. We expressly disclaim any warranty of any kind, including any warranty of fitness for any customer's particular purpose, with respect to such information or advice. As a matter of practical consideration, we also cannot assume any responsibility for updating or correcting any such information or advice once it has been given, nor does the provision of information or advice create, expand or alter any warranty with respect to the sale of our products.

Lincoln Electric is a responsive manufacturer, but the selection and use of specific products sold by Lincoln Electric is solely within the control of, and remains the sole responsibility of the customer. Many variables beyond the control of Lincoln Electric affect the results obtained in applying these types of fabrication methods and service requirement.

*Subject to change* - This information is accurate to the best of our knowledge at the time of printing. Please refer to [www.lincolnelectric.com](http://www.lincolnelectric.com) for any updated information.

### WHAT IS NEXTWELD?

*The challenges facing industrial fabricators today are growing in number and complexity. Rising labor, material and energy costs, intense domestic and global competition, a dwindling pool of skilled workers, more stringent and specific quality demands all contribute to a more difficult welding environment today.*



*Through our commitment to extensive research and investments in product development, Lincoln Electric has established an industry benchmark for applying technology to improve the quality, lower the cost and enhance the performance of arc welding processes. Advancements in power electronics, digital communications and Waveform Control Technology® are the foundation for many of the improvements.*

*NEXTWELD brings you a series of Process, Technology, Application and Success Story documents like this one. NEXTWELD explains how technologies, products, processes and applications are linked together to answer the important questions that all businesses face:*

- *How can we work faster, smarter, more efficiently?*
- *How can we get equipment and people to perform in ways they've never had to before?*
- *How do we stay competitive?*

*NEXTWELD is the future of welding but its benefits are available to you today. Ask your Lincoln Electric representative how to improve the flexibility, efficiency and quality of your welding operations to reduce your cost of fabrication.*

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