Invertig™ 313/400

HTP America Inc.

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1) FOREWORD

Thank you for purchasing an HTP America® Invertig™ 313/400—our advanced, multi-process TIG welder. The Invertig 313/400 is a versatile, high-quality, and feature-rich machine that offers pulse features in every welding process. With the Invertig 313/400 you can run the following processes: SMAW (Stick), SMAW-P (pulsed Stick), GTAW (TIG), and GTAW-P (pulsed TIG). All four processes offer both AC and DC options.

In addition, the machines feature a Pipe welding mode, which, when selected, deactivates the foot pedal and the internal gas solenoid so an air-cooled torch with a valve can be used to simulate welding in the field off an engine drive in TIG or in Stick mode. The Pipe mode is DC only.

In the AC TIG mode, the following wave forms are available: square wave, soft square wave, and triangular wave. The Invertig 400 offers the ability to run on single-phase power, from 208 to 240V, or on 3-phase power, from 200 to 575V. We designed the Invertig 313 to run on single-phase or 3-phase power, from 208 to 240V only! The manual describes the Invertig 313/400 power source and its features and capabilities. For maximum performance (power output and duty-cycle) we recommend that you connect the machine to 3-phase power.

For crisp arc starts and excellent arc stability we also recommend the use of 2% ceriated (U.S. Color Code: Gray; European Color Code: Orange) tungsten electrodes as our inverter is designed to work best with them.

2) WARRANTY

It is expressly agreed that there are no warranties, expressed or implied, made by either the Salesman, Dealer, or HTP America, Inc. on products or parts furnished hereunder, except the Manufacturer's Warranty against defective materials or workmanship as follows:

HTP America, Inc. warrants each new welding machine to be free from defects in material and workmanship under normal use and service for Three (3) Years after delivery to the original purchaser. HTP America, Inc. will repair or replace, at its factory, any part or parts thereof. Products should be returned to HTP America, Inc., with transportation charges prepaid, and which its examination shall disclose to its satisfaction to have been thus defective. This warranty being in lieu of all other warranties, expressed or implied, and all other obligations or liabilities on its part and it neither assumes nor authorizes any person to assume for it any liability in connection with the sale of its machines.

This warranty shall not apply to any welding machine which has been repaired or altered by unauthorized service departments in any way so as, in the judgment of HTP America, Inc., to affect its stability and reliability, nor which has been subjected to misuse, negligence, or accident.

HTP America, Inc. shall not be liable in any event, unless HTP America, Inc. receives notice of alleged breach of warranty, actual or constructed, specifying the claimed defect within not more than Thirty (30) Days after discovery.

HTP America, Inc. has reserved the right to make changes in design or add any improvements to its products, at any time, without incurring any obligation to install the same on equipment.

This warranty is void unless the warranty card is sent to HTP America, Inc. within Fifteen (15) Business Days from the date of purchase.

EXCLUSIONS TO WARRANTY:

1) TIG welding torches are warranted for a period of Ninety (90) Days against defects in material and workmanship.
2) Tungsten electrodes, collet bodies, collets, and gas lenses are consumable items, WHICH CARRY NO WARRANTY.

Note: This warranty is to the original purchaser only. The warranty can be transferred to another owner, with HTP's approval, for a warranty transfer fee. HTP America, Inc. must be notified within Fourteen (14) Days of the sale and must be provided with the contact information of the original owner, the contact information of the new owner, and the serial number of the machine.

3) SAFETY SUGGESTIONS

It is forbidden for people with PACEMAKERS to use or come near the machine. When welding near sensitive electronics, for example in hospitals or assisted living homes or around computers or computer control modules in vehicles, we STRONGLY recommend turning off HF (high-frequency arc start). Even an AC arc on a modern inverter can be ignited in lift-arc mode! HF travels long distances, 10 to 20 feet are very common in some instances, and HF can interfere with electronics in neighboring buildings if they are on the same transformer! Unlike regular welding currents, that travel the path of least resistance, HF is unpredictable.

Electric arc welding produces ultra-violet rays, which are harmful to skin and eyes. Ultra-violet radiation can penetrate lightweight clothing, reflect from light-colored surfaces, and burn the skin and eyes.

- Wear a heavy, pocket-less, long-sleeved shirt, cuff-less trousers, and high-topped work shoes.
- Wear a full-faced welding helmet with a number ten or darker lens and a cap.

Electric arc welding produces flying sparks and hot material, which can cause fire.

- To avoid fire, do not weld on wood, plastic tile, or carpeted floors. Concrete or masonry floors are safest.
- Do not weld on pressurized containers.
- Do not weld on drums, barrels, tanks, or other containers until they have been cleared and cleaned as described in AWS Standard A6.01.
- Do not wear flammable materials.
- Wear non-oily/non-greasy, flameproof welding gloves; the oil or grease on the gloves may ignite.
- Avoid having any type of fuel, such as cigarette lighters or matches, on your person as you weld.
- Ensure that there is a fire extinguisher in the welding area.

Electric arc welding produces toxic fumes.

- Provide adequate ventilation in the welding area at all times.
- Do not weld on galvanized zinc, cadmium, or lead beryllium materials unless you are POSITIVE that sufficient ventilation is provided. These materials produce toxic fumes.
- Do no weld in areas close to degreasing or spraying operations. Chlorinated hydrocarbon vapors may react with the ultra-violet rays and form highly toxic phosphate gas.
- If you develop eye, nose, or throat irritation during welding, stop welding immediately. This is an indication that ventilation is not adequate. Do not continue to weld until ventilation is improved.

ELECTRIC SHOCK CAN KILL.

Exposed, electrically hot conductors, other bare metal in the welding circuit, or ungrounded, electrically hot equipment can fatally shock a person whose body becomes a conductor. Do not stand, sit, lie, lean on, or touch a wet surface when welding.

- Disconnect the power supply before working on the welding machine.
- Do not work with deteriorated or damaged cables.
- Frequently inspect cables for wear, cracks, and damage. Replace those with excessively worn insulation to avoid a possible lethal shock from bared cable.
- Do not touch bare electrical parts.
- Ensure that all of the panels covering the welding machine are firmly secured in place when the machine is connected to the power supply.
- Insulate yourself from the workbench and from the floor (ground); use insulating footwear and gloves.
- Keep gloves, footwear, clothes, the work area, and the welding equipment clean and dry.
- Check the machine power cable frequently; the power cable must be free from damage to the insulation. BARE CABLES ARE DANGEROUS. Do not use the machine if the power cable is damaged; a damaged power cable must be replaced immediately.
- If it is necessary to open the machine, first disconnect the power supply and then wait Five (5) Minutes to allow the capacitors to discharge. Failure to take this precaution may expose you to the dangerous risk of electric shock.

Noise can damage your hearing. Protect yourself suitably to avoid hearing damage.

The welding arc can cause burns. Keep the tip of the welding gun/torch far from your body and from other persons.

For more information, refer to the following standards and comply as applicable.

1) ANSI Standard Z49.1 SAFETY IN WELDING AND CUTTING, obtainable from the American National Standards Institute, 1430 Broadway, New York, NY 10018.
2) ANSI Standard Z87.1 SAFE PRACTICE FOR OCCUPATIONAL AND EDUCATIONAL EYE AND FACE PROTECTION, obtainable from the American National Standards Institute, 1430 Broadway, New York, NY 10018.
3) AWS Standard A6.0 WELDING AND CUTTING CONTAINERS WHICH HAVE HELD COMBUSTIBLES, obtainable from the American Welding Society, 2051 NW 7th St., Miami, FL 33125.
4) NFPA Standard 51 OXYGEN-FUEL GAS SYSTEMS FOR WELDING AND CUTTING, obtainable from the National Fire Protection Association, 470 Atlantic Ave., Boston, MA 02210.
5) NFPA Standard 51B CUTTING AND WELDING PROCESSES, obtainable from the National Fire Protection Association, 470 Atlantic Ave., Boston, MA 02210.
6) CGA Pamphlet P-1 SAFE HANDLING OF COMPRESSED GASES IN CYLINDERS, obtainable from the Compressed Gas Association, 500 Fifth Ave., New York, NY 10036.
7) OSHA Standard 29 CFR, Part 1910, Subpart Q, WELDING, CUTTING, AND BRAZING.

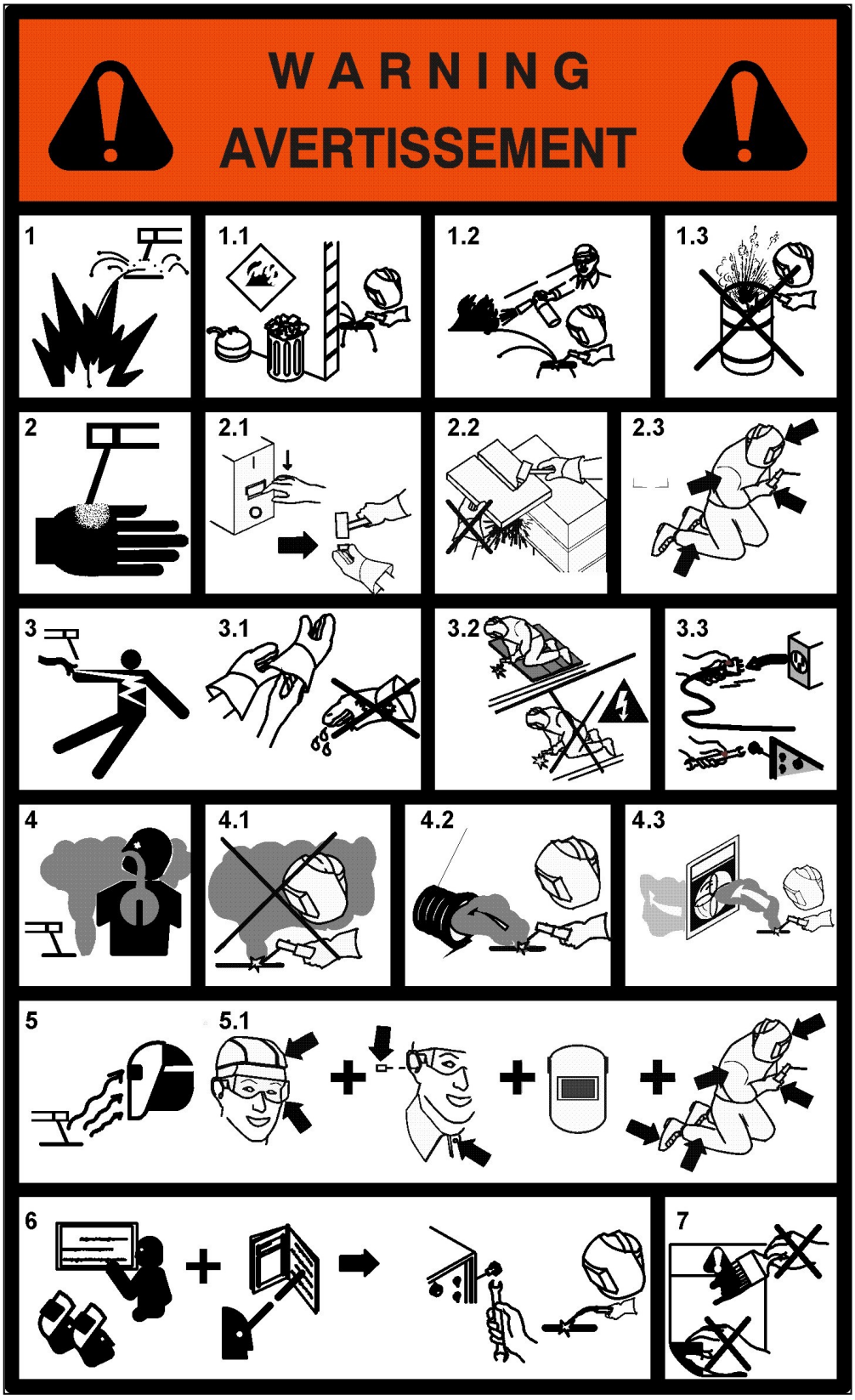
WARNING
AVERTISSEMENT
1
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Fig. 1

4) SPECIFICATIONS

	Invertig 313 AC/DC	**Invertig 400 AC/DC**
Input Voltage	230V (208 to 240V) Single or 3-Phase	Single-Phase: 230V (208 to 240V) 3-Phase: 200 to 575V
Welding Current Single-Phase	4 to 300 Amps	4 to 350 Amps
Welding Current 3-Phase	4 to 300 Amps	4 to 400 Amps
Single-Phase Rated Output	40% @ 300 Amps	35% @ 350 Amps
230V Single-Phase Input Amps @ Rated Load	44 Amps	50 Amps
3-Phase Rated Output	80% @ 300 Amps	30% @ 400 Amps
3-Phase Input Amps @ Rated Load	32 Amps	230V = 36 Amps 400V = 21 Amps 460V = 17.6 Amps 500V = 16.8 Amps
Welding Modes	STICK TIG 2T TIG 4T TIG SPOT TIG RESET	STICK TIG 2T TIG 4T TIG SPOT TIG RESET
Programmable Memories	30	30
Asymmetric AC	Yes	Yes
AC Frequency (Hz)	20 to 400 (Up to 100 Amps) 20 to 200 (Over 100 Amps)	20 to 400 (Up to 100 Amps) 20 to 200 (Over 100 Amps)
AC Balance (%)	10 to 90	10 to 90
Pre-Flow (Seconds)	0.1 to 5.0	0.1 to 5.0
Post-Flow (Seconds)	0.1 to 99.9	0.1 to 99.9
Initial Amps (%)	10 to 90	10 to 90
Final Amps (%)	10 to 90	10 to 90
Slope Up (Seconds)	0.1 to 10.0	0.1 to 10.0
Slope Down (Seconds)	0.1 to 10.0	0.1 to 10.0
Spot Time (Seconds)	0.1 to 10.0	0.1 to 10.0
Hot-Start (%)	0 to 50	0 to 50
Arc-Force (%)	0 to 500	0 to 500
Wave Forms	Square Soft Square Triangular	Square Soft Square Triangular
EN Amperage (%)	10 to 99	10 to 99
EP Amperage (%)	10 to 99	10 to 99
Duty-Cycle Single-Phase TIG	40% @ 300 Amps 60% @ 250 Amps 100% @ 200 Amps	35% @ 350 Amps 60% @ 250 Amps 100% @ 200 Amps
Duty-Cycle 3-Phase TIG	80% @ 300 Amps 100% @ 280 Amps	30% @ 400 Amps 60% @ 340 Amps 100% @ 300 Amps
Duty-Cycle Single-Phase Stick	35% @ 260 Amps 60% @ 200 Amps 100% @ 180 Amps	35% @ 260 Amps 60% @ 200 Amps 100% @ 180 Amps
Duty-Cycle 3-Phase Stick	35% @ 300 Amps 60% @ 240 Amps 100% @ 200 Amps	35% @ 300 Amps 60% @ 240 Amps 100% @ 200 Amps
Dimensions	26-1/2" L x 12-1/4" W x 17-1/2" H	26-1/2" L x 12-1/4" W x 17-1/2" H
Weight	117 Lbs.	121 Lbs.
Pulse Parameters Pulses/Second (PPS) Stick AC & DC Pulses/Second (PPS) TIG AC Pulses/Second (PPS) TIG DC Peak Time (%) Background Amps (%)	 0.4 to 5.0 0.4 to 20.0 0.4 to 999.9 10 to 90 10 to 90	 0.4 to 5.0 0.4 to 20.0 0.4 to 999.9 10 to 90 10 to 90

5) ELECTRICAL CONNECTION

Your Invertig 313/400 operates on single-phase, 230 volt power (208 to 240 volt). The Invertig 313 draws 44.4 amps out of the wall when operating at max output (300 amps), and the Invertig 400 draws 50 amps out of the wall when operating at a welding output of 350 amps (the max output of the Invertig 400 on single-phase).

We ship your machine without a plug since we don't know if you will run your machine on single or 3-phase power or what your electrical outlet looks like.

To connect the machine to single-phase power, use power cord's (**Fig. 3, T**) black wire and white wire as your two hot wires. Then, use the green wire (or green/yellow wire) as your ground. The red wire is **NOT** used in single-phase operation and should be trimmed and wrapped in electrical tape. During operation of the machine, the red wire may become electrically hot.

NOTE: The Invertig 313/400 does not include or require a common or neutral wire—even though one of the wires is white, it is meant to be connected to a hot leg (do NOT connect it to the common).

Alternatively, and to obtain maximum duty-cycle and power output, you can run your Invertig 313 on 230 volt, 3-phase power, or you can run your Invertig 400 on 200 to 575 volt, 3-phase power. With the Invertig 313, the power draw on 230 volt, 3-phase power is 31.8 amps. With the Invertig 400, the power draw on 480 volt, 3-phase power is 17.2 amps.

Once you decide to run on single-phase or 3-phase input power and install the correct plug (or wire the machine to a disconnect), turn the main switch (**Fig. 3, S**) on (Position 1). As a normal part of the boot up process, "PF0" appears in the Voltage display (red numeric; above LCD). PF0 indicates that the PFC (Power Factor Correction; for an explanation of PFC, please see the glossary at the end of the manual) sees 0, which means the PFC has not yet figured out the input voltage nor configured itself accordingly. As the machine boots up, please be patient. The boot up process only takes about 10 seconds. Please do not tap the foot pedal or attempt to adjust the front panel LCD until your machine boots up completely. Failure to allow the machine to fully boot up could render the machine temporarily unusable. Wait times from ten minutes to one hour may be needed to reset the welding machine.

If you would like to operate your Invertig on a generator, the generator can be single-phase or 3-phase. The advanced design of the Invertig lets the machine operate on most generators. However, the Invertig is not compatible with all generators. To ensure proper operation of your Invertig 313/400 on a generator, the generator must provide a stable 50 to 60Hz AC frequency with low noise levels. If your generator does NOT meet the requirements, the Invertig will likely not work with the generator. However, due to sophisticated electronics in the Invertig, it is highly unlikely to damage the machine by plugging it into a non-suitable generator.

In order to operate the Invertig 313 or 400 on a single-phase generator, the generator needs a minimum of 12000 watts (12000 watts must be the continuous rating or running watts rating of the generator, NOT the peak rating or starting watts rating of the generator). In order to get the full 400 amps on 3-phase with the Invertig 400, you need a 15000 watt or better generator.

6) FRONT PANEL CONNECTIONS

Fig. 2

Z—Negative Output Receptacle
When TIG welding, connect the TIG torch to the negative output receptacle to weld Electrode Negative (EN; with the torch negative and the work positive). When using your Invertig to TIG weld, all work will be done in EN. When Stick welding in Direct Current Electrode Negative (DCEN), plug the optional electrode holder into the negative output receptacle. When Stick welding in Direct Current Electrode Positive (DCEP), plug the ground cable into the negative output receptacle.

To install a cable into the negative output receptacle, insert the male end of the cable into the negative output receptacle and twist clockwise until snug. It is important that the cable is snug; a loose connection generates heat, damages the machine, and causes weld quality issues.

U—Gas Output Connection
Connect the gas fitting from the TIG torch to the gas output connection. The gas output is controlled by the solenoid valve, which is mounted inside the machine. The gas fitting is 1/4" BSP. **NOTE: 1/4" BSP is a 19 TPI thread and is NOT interchangeable with 1/4" NPT (regular pipe thread), which is an 18 TPI thread!**

N—Trigger Connector
Typically not used as the **Y** connector also contains trigger wires.

Y—14-Pin Remote Control Connection
Used to connect your remote amperage control or momentary switch to your Invertig. Insert the connector into the machine and twist the lock ring until snug. We find it easier to install the remote control connection prior to installing the ground cable.

W—Positive Output Receptacle
When TIG welding, connect the ground cable to the positive output receptacle to weld in straight polarity (with the torch negative and the work positive). When Stick welding in Direct Current Electrode Negative (DCEN), plug the ground cable into the positive output receptacle, and when Stick welding in Direct Current Electrode Positive (DCEP), plug the electrode holder into the positive output receptacle.

To install a cable into the positive output receptacle, insert the male end of the cable into the positive output receptacle and twist clockwise until snug. It is important that the cable is snug; a loose connection generates heat, damages the machine, and causes weld quality issues.

7) REAR PANEL CONNECTIONS

Fig. 3

P—Smart Water-Cooler Connection
Used to connect the 7-pin cable for the smart water-cooler. The connection extinguishes the arc if you lose coolant flow and starts the pump when you initiate an arc.

M—Serial Number Tag
Contains the serial number of your Invertig 313/400. The serial number consists of two letters and six numbers.

S—On/Off Switch
The switch turns your Invertig 313/400 on and off. Set the switch to position 0 for off, and set the switch to position 1 for on.

O—Smart Water-Cooler Power Connection
If you purchased an HTP America smart water-cooler, this is where the cooler picks up the voltage to operate (only available on HTP machines and with HTP smart water-coolers).

T—Input Power Cord

Q—Shield Gas Inlet Connection
Attach the gas hose from your flowmeter to the gas inlet connection. The gas fitting is 1/4" BSP. **NOTE: 1/4" BSP is a 19 TPI thread and is NOT interchangeable with 1/4" NPT (regular pipe thread), which is an 18 TPI thread!**

8) EXPLANATIONS

a) Invertig 313 vs. Invertig 400

The Invertig 313 is a 300 amp AC/DC TIG welder with single or 3-phase capability. The Invertig 300 runs on 208 to 240 volt input power, and features the same functions as the Invertig 400 but with less maximum output and a slightly lower duty-cycle. Typically, we pair the Invertig 313 with an Arctic Chill water-cooler and a CK230 TIG welding torch. For the Invertig 313, we offer hard-wired foot pedals, hand controls (rotary or slider), and momentary switches, as well as a wireless foot pedal. The Invertig 313 is also compatible with the TigControl.com TigButton™.

The Invertig 400 is a 400 amp AC/DC TIG welder with single or 3-phase capability. The Invertig 400 runs on 208 to 240 volt input power on single-phase, with a max power output of 350 amps, and runs on 200 to 575 volt input power on 3-phase, with a max output of 400 amps. To take full advantage of the Invertig 400's max power output and duty-cycle, we recommend 3-phase input power as single-phase input power limits max output and duty-cycle. Typically, we pair the Invertig 400 with a smart, multi-voltage water-cooler that is integrated into the cart, and a CK Trim Line 18 TIG welding torch (other torches available by request). For the Invertig 400, we offer hard-wired foot pedals, hand controls (rotary or slider), and momentary switches, as well as a wireless foot pedal. The Invertig 313 is also compatible with the TigControl.com TigButton™.

b) Torches

A variety of air- and water-cooled torches can be used with our Invertig machines. However, all air– and water-cooled torches have their limits! Running past the limit results in torch damage, which is not covered under warranty. We offer the following torches (the amp ratings provided represent the max amp rating, based on 100% duty-cycle, for each torch):

CK9 Air-Cooled Torch (Rated at 125 amps)
CK17 Air-Cooled Torch (Rated at 150 amps)
CK26 Air-Cooled Torch (Rated at 200 amps; uses the same consumables as the CK17 torch)
CK20 Water-Cooled Torch (Rated at 250 amps; uses the same consumables as the CK9 torch)
CK230 Water-Cooled Torch (Rated at 300 amps; uses the same consumables as the CK9 and CK20 torch)
CK TL18 Water-Cooled Torch (Rated at 350 amps; uses the same consumables as the CK17 and CK26 torch)

All torches are available in 12' and 25' lengths.

NOTE: The Invertig 400 offers the option to limit the max output of the machine to 300 amps so you can safely use a CK230 torch.

c) Wave Forms

All wave forms are available in AC TIG and Stick welding mode. Pulse can only be used with square wave.

Square Wave: The standard wave form for all modern inverter TIG welding machines. The square wave offers excellent power, arc control, and bead appearance. A good choice, all around, for aluminum welding. When in use, some operators may perceive the square wave sound as loud and unpleasant. However, many operators prefer to use a square wave due to its superior performance and features, such as the ability to run pulse.

When Soft AC and Triangular AC are turned off (**Fig. 4**), the machine is in square wave.

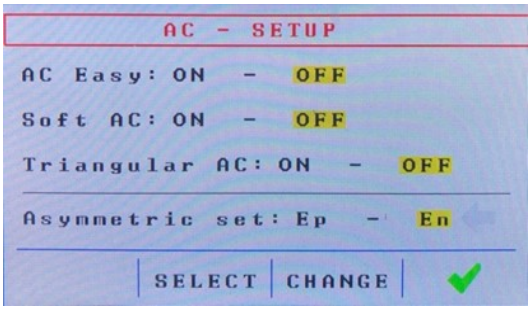


Fig. 4

Soft Square Wave: The soft square wave provides a more sinus like wave form, which allows for a softer arc and a more fluid weld puddle, and it does so while creating significantly less noise. The SOFT symbol on the right-hand side of the LCD above the 3-phase symbol (**Fig. 5**) indicates that Soft AC is selected and active. Also referred to as a modified square wave. Pulse functions are unavailable in Soft AC.

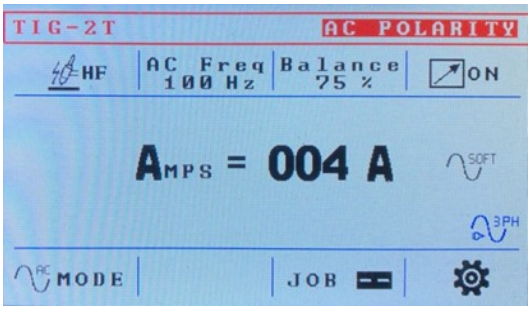


Fig. 5

Triangular Wave: The triangular wave form allows you to reach maximum peak current while dramatically reducing the overall heat input. When using a triangular wave form, the machine can be configured to show either the maximum (peak) amperage or the overall (actual) amperage welding output on the LCD. The Amperage display (red numeric; above LCD) always shows the max (nominal/peak) amperage. Rapid formation of melting points reduces the overall welding time, which, in turn, alleviates distortion—especially when welding thin material. The triangular wave creates a fast freezing puddle, which results in superior control and heat input management. When in use, the triangular wave function symbol appears on the main screen of the LCD. The TRI symbol on the right-hand side of the LCD above the 3-phase symbol (**Fig. 6**) indicates that Triangular AC is selected and active. Pulse functions are unavailable in Triangular AC.

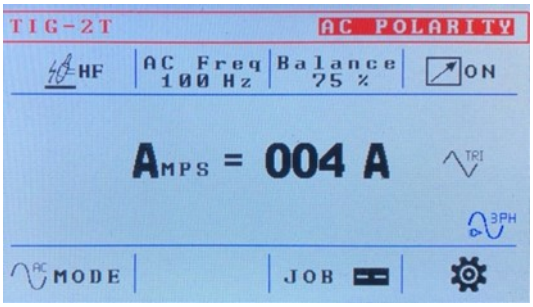


Fig. 6

d) Nominal vs. Average Amps

AC welding contains a lot of variables compared to DC welding. Those variables influence, in some cases massively, the welding arc and power output. Very high frequencies result in lower amperage outputs. Since the arc does not spend as much time on one side of the zero line, and changes directions very fast, the overall heat input is naturally reduced. This means the max amperage does not match the average amperage. For example, you can set the max amperage to 200 amps, but the average amperage you hit while welding may only be 180 amps. While not welding, the machine shows, in the Amperage display (red numeric; above LCD), the max amperage that you can achieve with the foot pedal completely depressed, and, in the LCD, the machine displays the starting amps. While welding, the Amperage display shows the nominal amperage (what the foot pedal is currently depressed to), and the LCD shows the same or the average (actual) amperage (your choice). The difference is more significant when using a soft square wave form and most significant when using a triangular wave form. When using a triangular wave form, a max setting of 400 amps could result in an average of roughly 260 amps due to the wave form and shape.

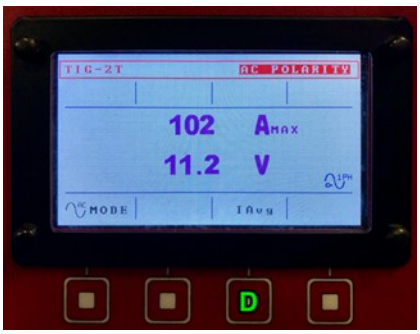


Fig. 7; By pressing button D (Fig. 11) while welding, you can toggle between displaying the average amperage and the max amperage.

e) AC Balance

Balance refers to the time the arc spends above or, in the case of HTP machines, below the zero line. What does that mean? Imagine you weld AC and you set your frequency not to 100Hz but to 1Hz (1Hz used for the purpose of easy demonstration; the frequency of the Invertig 313/400 cannot be set any lower than 20Hz). Set at 50% balance, your current would come out of the material and go into the torch (your electrode positive (EP) part) for 0.5 seconds. For the next 0.5 seconds, your current would come out of the torch and go into the material. Let's say you weld at 100 amps. For 0.5 seconds, you will see 100 amps come out of the material and go into the torch, and for the following 0.5 seconds, you will see 100 amps come out of the torch and go into the material. Do you need 0.5 seconds of electrode positive (EP)/ cleaning/breaking open of the oxide layer? No, most likely not—that is why you typically don't weld with a 50% balance. Do you want more electrode negative (EN)/penetration and to put heat into the material you are welding (rather than the torch)? Yes, absolutely. Most people consider an EN balance between 60 and 80% the sweet spot. With balance set too low, the tungsten balls, and with the balance set too high, the weld bead turns gray, flat, and dull. You may even see some peppering in the weld along with insufficient cleaning of the oxide layer. On the Invertig 313 and the Invertig 400, you can adjust the balance from 10 to 90%.

f) AC Frequency

AC frequency does two things, mainly. First, AC frequency focuses the arc. Higher frequencies feature a more focused arc and a narrower frost line, which works really well on thin material. On thick material, higher frequencies tend to make it hard to join two pieces of material, as the focused arc wants to cling to only one piece and not join it to the other piece. Second, AC frequency affects heat input. As previously discussed in 7d, higher frequencies result in a lower overall heat input. Lower frequencies result in a higher overall heat input. In other words, thin material prefers higher frequencies (this is why the Invertig offers an adjustment range from 20 to 400Hz when operating at an output under 100 amps), and thicker material prefers lower frequencies. Although the adjustment above 100 amps lets you choose AC frequencies from 20 to 200Hz, at a material thickness of 1/4", 1/2", or even higher, it is not uncommon to see frequencies of 50Hz or less be used on a regular basis for best results.

g) Asymmetric Arc

Asymmetric arc determines the intensity of the current rather than the time (the balance function determines the time). Going back to our previously described example weld with 1Hz AC and a 50% balance at 100 amps, this time limiting the EP to 50%, you now weld for 0.5 seconds at 50 amps (50% of 100 amps) of EP/cleaning/breaking open the oxide layer, and then you weld for 0.5 seconds with 100 amps of EN/penetration and heating of the material (rather than the torch).

Does asymmetric arc do the same thing as balance? Sort of, but not really. If you turn asymmetric arc off, set your frequency to 1Hz, and set your balance to 75% (EN), you weld for 0.25 seconds with 100 amps. (Is that the same as welding 0.5 seconds with 50 amps? No, but it starts to get into a similar ballpark). But NOW you have 0.75 seconds of EN, which gives you much better penetration than 0.5 seconds

So, is balance better than asymmetric arc? No, and although it is very similar, it is still different. Asymmetric arc allows you to control the size of the cleaning action line, or the frost line, much better (the cleaning action line is typically related more so to frequency but small adjustments to the asymmetric arc can make a big difference in certain situations) and also the shininess of the finished weld bead. Often, high balance settings, while providing a lot of penetration, create a rather gray, flat, and dull weld bead, even with 4000 series filler rod, where some asymmetric arc really helps with making the weld bead shinier.

Typically, you cannot find literature, videos, or any other online advice on setting asymmetric arc. Your asymmetric arc setting depends a lot on your base metal; for example, 6061 welds differently than 5052, and 5052 welds differently than 3003. Your asymmetric arc setting also depends on your specific application and variables such as size, temperature, cleanliness, filler rod, etc.

You can only limit either EN or EP, not both at the same time, and the limit range spans from 10 to 99% (100% would be turning asymmetric arc off). Whichever value you do not limit is set at 100% (but this is not shown in the LCD).

h) Pulse in DC TIG

You typically use the DC pulse function to reduce the heat input when welding to prevent distortion or excessive discoloring of the base metal. The Amperage display (red numeric; above LCD) shows the maximum amperage, and

you set the background amperage and the peak time (pulse-on time or duty) based on that maximum amperage. You set both the background amperage and the peak time as a percentage of the maximum amperage. Peak time refers to the peak pulse current number. The actual duration of the peak time, in seconds or in fractions of a second, depends on the third variable—the pulse frequency. The pulse frequency determines the speed, for lack of a better word, of the time it takes to switch between the higher and the lower amperage. There are two schools of thought:

- Use low-speed pulse frequencies between 0.5 and 2.0 PPS (pulses per second or Hz) to create a ripple effect in the weld bead. The pulsing can easily be seen by the human eye. When using low-speed pulse frequencies, you typically will not experience any interference or other technical difficulties with either fixed shade or auto-darkening welding helmets.

- Use high-speed pulse frequencies between 25 and 100 PPS to create a smooth weld bead, much like DC TIG without pulse. The pulsing usually cannot be seen by the human eye. You typically use high-speed pulse frequencies when welding stainless or mild steel out of position, when heat affected zones need to be kept to a minimum, or when warpage or distortion of parts are a concern. When using auto-darkening welding helmets, depending on the frequency of the cartridge in the welding helmet and the frequency you set the machine to, there may be a very narrow band of specific frequencies where interferences are possible. Whether interferences happen at all, or at what frequency the interferences occur at, depends on the welding helmet you use (make, model, etc.); we cannot predict who will experience interferences. If, when welding, you notice flickering, change your frequency by +/- 20 PPS and try again.

For most applications, we recommend setting the background amperage to 25% and the peak time (pulse-on time or duty) to 25%. Example: You set your max amperage to 100 amps, your background amperage to 25%, and your peak time to 25%. For 25% of the time, you weld at 100 amps, and for 75% of the time, you weld at 25 amps.

Using these settings during a low-speed pulse application (with the right torch movement and either no filler or while using a lay wire technique) allows you to produce nice ripples. Using these settings during a high-speed pulse application allows you to achieve penetration close to what 100 amps of straight DC gives, but with significantly lower heat input and a much more controllable puddle. Even though you only reach 100 amps 25% of the time, and 25 amps 75% of the time, in a high-speed pulse scenario it is NOT safe to assume that the first quarter at 100 amps and the second through fourth quarters at 25 amps equal 43.75 amps of overall heat input (100 + 25 + 25+ 25 = 175/4 = 43.75). While the math does not hold true in high-speed pulse applications, the math comes a lot closer in low-speed pulse applications. In a high-speed pulse application, at a 25 PPS pulse frequency setting, you introduce 100 amps into the base material 25 times per second, and at a 50 PPS pulse frequency setting, you introduce 100 amps into the base material 50 times per second. Even though this occurs for a short or a very short period of time, the time between the 100 amp bursts is not long enough to let the material really cool down to an average of 44 amps of heat input. Nevertheless, a high-speed pulse application is significantly cooler than just DC TIG.

The strongest effects and the best results occur when you set the difference between the peak amperage and the background amperage rather high. With the Invertig 313/400, you can adjust the pulse frequency from 0.4 to 999.9 PPS, the background amps from 10 to 90%, and the peak time (pulse-on time or duty) from 10 to 90%.

i) Pulse in AC TIG (Square Wave Only)

In AC TIG, the pulse function is only available in the square wave form (the standard wave form). Also, the AC pulse frequency adjustment range is much narrower than the DC pulse frequency range and is typically used only for low-speed pulse applications. Due to the wide range of AC frequencies, and to avoid interferences, the pulse frequency cannot be set higher than the AC frequency. AC low-speed pulse applications enable you to obtain the stack of dimes look and also enable you to fix less attractive welds simply by running the torch over them at a steady, slow speed that allows the low-speed pulse to put the ripples in. You can also join material with low-speed pulse using a lay wire technique. In place of high-speed pulse, we recommend the use of the triangular wave form instead, which achieves similar results. With the Invertig 313/400, you can adjust the pulse frequency from 0.4 to 20.0 PPS, the background amps from 10 to 90%, and the peak time (pulse-on time or duty) from 10 to 90%.

j) Pulse in Stick (Square Wave Only)

Advantages of Pulse Welding

Pulse welding includes ALL of the following advantages, but **not all at the same time**. At a later point in the manual, we cover, in more detail, suggested settings regarding how, when, and where certain situations apply.

- Visually spatter free (MIG & TIG only, though still reduced spatter when stick welding)
- Higher travel speeds
- Deeper penetration
- Less heat input, which equals less material distortion
- Ability to weld thinner material than you could without pulse
- Superior control of the weld puddle, especially when welding out of position
- Easily join materials of differing thicknesses
- Better gap bridging when welding materials with poor fit up
- Ability to make leak-tight welds
- Improved bead appearance
- Ability to use one size bigger welding rod than normal
- Weld on thinner material without burning through
- Easier for beginner welders

Disadvantages of Pulse Welding

- Pulse welding can interfere with sensitive electronics like pacemakers and auto-darkening welding helmets
- Low pulse frequencies (less than 1.5Hz) can be perceived as unpleasant, sound-wise, by the operator (TIG and Stick only)

Common Stick Welding Electrode Types and Descriptions

6010—Rod with a cellulosic coating, fast freeze puddle, deep penetration, slag can be hard to remove, less elongation of welds, not the most attractive welds, may present some hydrogen cracking. However, rod runs in all positions, including vertical up and down. Also forgiving for some contamination of the parent metal. An excellent choice for root passes.

6013—Rod with a titania potassium coating that runs on old and simple AC (alternating current) stick welders. Typically referred to as the farmer's rod.

7014—Rod with properties similar to 7018, but also designed to run on older, simpler stick welders.

7018—Rod with a low hydrogen coating that flows nicely. Probably the most popular rod in today's market. Builds a thick, easy to remove slag layer on top of the weld, medium penetration, excellent bead appearance, puddle stays wet and fluid much longer than 6010, higher tensile strength than 6010. A good choice for the maintenance welder and even to do x-ray quality structural welds.

The rods listed above represent the most common types of rods available today. However, an almost endless selection of various rods exist. We simply cannot cover all rod types in the manual. Since 7018 is probably the most popular welding rod available today, please find a few pointers below. **How do you find the right amperage when you lose the box?** The general rule of thumb with 7018: For every 0.001" of welding rod diameter, you need about 1 amp. **What does this mean? Will these numbers be a perfect fit for every rod manufacturer and every position you weld 7018 rod in?** No, but the numbers get you really close.

Rod Diameter Fraction	Rod Diameter Decimal	Required Amperage
3/32"	0.09375" rounded to 0.094	94 amps
1/8"	0.125"	125 amps
5/32"	0.15625" rounded to 0.156"	156 amps
3/16"	0.1875" rounded to 0.188"	188 amps

Fig. 8

Now Let's Talk Pulse

How does pulse work? How do I set up the Invertig 313/400 to pulse weld in Stick mode?

For manufacturing or critical code repairs, welding procedures are typically specified. These welding procedures spell out everything including, but not limited to, pre-heat of the part, alloy of the filler rod, amperage setting, travel speed, bead size, multi-pass weld number of passes (if applicable), inter-pass temperature, post-heat, and so on. No variable stays undefined, and there is no room for creative freedom.

In the repair field, however, things look a little bit different. In Europe, procedures that spec pulse welding exist. But the pulse welding process is relatively new in the U.S., so no written procedures that spec pulse welding currently exist. For example, a 1/8" 7018 rod typically has an operating range between 90-160 amps. But many people like to run them between 120 and 130 amps.

To pulse weld, the operator first sets the welding current and then chooses a pulse frequency. The machine automatically sets the background current and a pulse-on time of 50%. **So what does that mean when you weld?** Let's say, for example, you dialed the machine in to 130 amps. 50% of the time the arc is lit, the welding current is 130 amps. The other 50% of the time the arc is lit, the welding current is 65 amps. You may notice that 65 amps is outside of the manufacturer's recommended amperage range. While the background current is on, the amperage is high enough to maintain an arc but low enough to where there is no metal transfer happening.

The benefit of this is especially apparent at very low frequencies (1 to 1.5Hz). The out-of-range background current allows the puddle to cool down and also allows the weld to partially solidify around the edges. This makes out-of-position gap bridging on poor fit up much easier than it is with a classic stick welder. You will not sacrifice any penetration because, during the 50% on time at 130 amps, the rod burns as hot and deep as it normally would on a classic stick welder at 130 amps.

This may prompt you to ask: **If the amperage range of the rod is 80 or 90 to 160, why not set the welding current at 160 amps so the Invertig sets the background current to 80 amps?** The amperage ratings, essentially, would be well within the specs then. This is absolutely possible and a good setting. However, this setting is very hot and metal transfer occurs the entire time. This, paired with a 3 to 4Hz pulse frequency, makes for a very high travel speed in the horizontal or flat position. Plus, the heat input into the work piece is enormous.

Knowing what we know now, let's go back to the beginning and look more closely at the advantages of pulse welding.

Pulse welding includes ALL of the following advantages, but **not all at the same time**.

- Visually spatter free (MIG & TIG only, though still reduced spatter when stick welding)
- Higher travel speeds—*As just covered, with the right settings, the travel speed can be greatly increased.*
- Deeper penetration—*If you choose the same or similar settings to the ones for a higher travel speed, the overall heat input and penetration increases also.*
- Less heat input, which equals less material distortion—*More like the first example about setting the welding current to 130 amps.*
- Ability to weld thinner material than you could without pulse—*To achieve this, you would reduce the max amperage even more. For example, 110 amps or 120 amps with a 55 amp background current, which makes for an average heat input of roughly (110 + 55)/2 = 82.5 amps. (The actual heat input may be somewhat higher, especially with higher pulse frequency settings). With this setting, you can weld materials with a 1/8" rod when you would normally need to weld with a 3/32" rod.*
- Superior control of the weld puddle, especially when welding out of position—*You have better control on lower pulse frequencies because the puddle has time to partially solidify.*
- Easily join materials of differing thicknesses—*More like the first example about setting the welding current to 130 amps.*
- Better gap bridging when welding materials with poor fit up—*More like the first example about setting the welding current to 130 amps.*
- Ability to make leak-tight welds—*Spray arc or stick welding arc, in general, works better at making leak tight welds than short arc MIG, for example.*
- Improved bead appearance—*Pulse welds, especially lower frequency pulse welds (2Hz or less) make really nice and defined ripples on the top of the weld bead; welds like this are generally thought to be aesthetically appealing.*

- Ability to use one size bigger welding rod than normal—*To achieve this, you would reduce the max amperage even more. For example, 110 amps or 120 amps with a 55 amp background current, which makes for an average heat input of roughly (110 + 55)/2 = 82.5 amps. (The actual heat input may be somewhat higher, especially with higher pulse frequency settings). With this setting, you can weld materials with a 1/8" rod when you would normally need to weld with a 3/32" rod.*
- Weld on thinner material without burning through—*More like the first example about setting the welding current to 130 amps.*
- Easier for beginner welders—*The pulsed stick process is extremely forgiving.*

With the Invertig 313/400, you can adjust the Stick pulse frequency from 0.4 to 5 PPS, the background amps from 10 to 90%, and the peak time (pulse-on time or duty) from 10 to 90%.

k) Hot-Start for Stick

Hot-start when stick welding gives a short burst of current to light hard to strike electrodes.

l) Hot-Start for TIG

The hot-start for TIG function is available in AC and in DC. Hot-start provides a short (in the range of milliseconds) burst of current to ignite the arc. Many other welding manufacturers offer hot-start, but they typically don't give the operator the option to adjust hot-start. Hot-start ensures arc starts with tungsten electrodes that are not fresh and pristinely ground, as well as material that is not perfectly prepared. If your material and torch are in mint condition, and you weld on very thin material, you can turn hot-start off. This is very uncommon in the industry because most machines have arc starting difficulties at low or very low amperages. Some machines even include a hidden, non-adjustable hot-start feature. The ability to turn hot-start off allows you to have a true 4 amp arc start, which can be extremely important when welding thin and critical material.

m) Hot-Start vs. Starting Amps in TIG

Starting amperage refers to the minimum that the foot pedal can go to without extinguishing the arc. When using a torch switch in 4T or RESET mode, the starting amperage can also play a role as a limiting factor in regard to the Initial Amps and Final Amps percentages. You can adjust the Initial Amps value and the Final Amps value from 10 to 90%. If, for example, you set the welding current to 100 amps, and you set the Initial Amps and Final Amps to 10%, the Initial Amps and Final Amps would be 10 amps; if you set the welding current to 150 amps, and you set the Initial Amps and Final Amps to 10%, the Initial Amps and Final Amps would be 15 amps.

n) HF-, LIFT-, & Scratch-Start

When welding near sensitive electronics, for example in hospitals or assisted living homes or around computers or computer control modules in vehicles, we STRONGLY recommend turning off HF (high frequency arc start). Even an AC arc on a modern inverter can be ignited in lift-arc mode! HF travels long distances; 10 to 20' traveling distances are very common. In some instances, HF interferes with electronics in neighboring buildings if they are on the same transformer! Unlike regular welding currents that travel the path of least resistance, HF is unpredictable.

Lift start, not to be mistaken for scratch-start, can be used to ignite a DC or an AC welding arc with the Invertig 313/400. If you use a foot pedal, turn HF off in the menu, and then touch the clean and cold tungsten electrode to the clean material you plan to weld on. Depress the foot pedal a little bit, at minimum, which activates the contact switch (the more you depress the foot pedal, the easier the arc will ignite). At this point, NO welding current flows through the tungsten, you are not shortening anything out, and only a very small control current flows through the torch, just sensing the short circuit. The moment you lift the torch and break the short circuit, the machine applies the welding current and ignites the arc. Typically, the tungsten electrode does not get contaminated this way, the arc starts smooth (not violent), and everything is very controllable using the foot pedal. To choose between HF start and Lift start is more a matter of personal preference and what a person is used to. When welding longer beads, the difference might appear negligible to some people, but when making a bunch of spot or tack welds, HF is definitely more comfortable.

Scratch-start is typically done on older engine drives or stick welders. The difference is the arc is lit at full power by either striking the electrically hot tungsten electrode on the base metal or flicking the filler rod between the tungsten and the parent metal. In either case, unless you have trained for this procedure well, contamination of the tungsten is very likely, and things are rather uncomfortable. The Invertig 313/400 can do scratch-start only when using a foot pedal

without HF and by depressing the foot pedal before the tungsten touches the base metal. At this point, whatever you set the machine to (however much the foot pedal is depressed) the arc will strike at that amperage. This is, by far, the least preferable arc starting method with the Invertig.

o) Pipe Mode

We specifically designed the Pipe mode for pipe welding and pipe training in an educational facility. When you activate Pipe mode, you can only choose between Stick and TIG 2T (both DC only modes). If you plug in a foot pedal or other remote control, the remote control symbol blinks since all remote control functions are deactivated. In TIG 2T, the welding output is now hot and the gas solenoid valve in the machine is deactivated. At this point, you typically install a 26 Series air-cooled torch with a gas valve on the torch head, and then hook the torch up directly to an Argon tank via a flowmeter or regulator. Torches like the Heavy Hitter 350, with full size gas lenses, are popular torches for that. In order to adapt the Dinse outlet of the Invertig to an LC-40 or Tweco #2 adapter, part number DA-5095 is required.

The Invertig can only be used in lift-arc mode only for pipe welding. To terminate the weld, you cold snap out or set a slope down timer to initiate the weld termination procedure. The PIPE mode reflects a very common setup and method that is taught at countless colleges and welding schools across the United States and used daily in the field to weld pipe in the oil and the food processing industries.

Procedure for TIG Welding with LIFT Start in PIPE Mode

Start Welding:
1) Bring the TIG electrode (tungsten) into contact with the work piece.
2) Lift the torch from the side, move slightly away from the work piece, and start the welding process.

End Welding:
1) With the slope down function turned on, you can end your weld by regulating the distance between the arc and the work piece as shown in **Fig. 9**.
2) With the slope down function turned off, you must pull the arc away from the work piece to end the welding process.

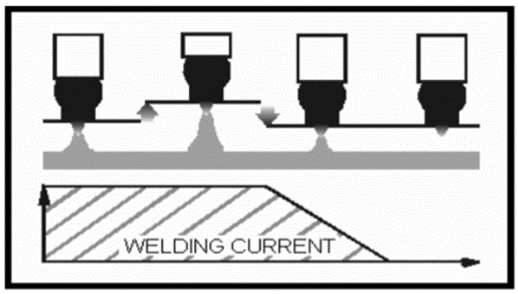


Fig. 9 Shows how you can lift the torch from the work piece to start the slope down process and end welding.

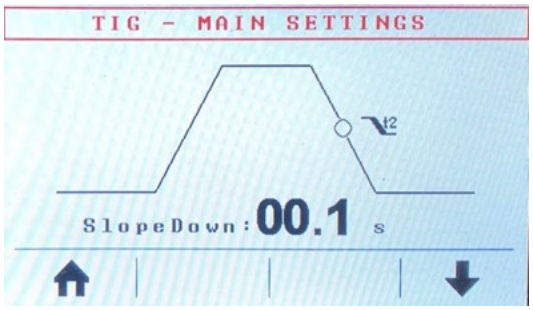


Fig. 10 The slope down function is turned off at 0.1 seconds as shown. If you increase the slope down value, then Fig. 10 is applicable to terminate the arc.

PRO TIP: When you turn on Pipe Mode, the machine automatically turns off HF-start (as this is a key feature of the Pipe Mode program). When you turn off Pipe Mode, HF does not turn back on automatically—you have to turn HF back on yourself. You can do so by pressing button E (Fig. 11) followed by button D (Fig. 11).

p) Amperage Limitation in Single-Phase (Invertig 400 AC/DC Only)

In single-phase, you can limit the output of the Invertig 400 to 300 amps. This can be an advantage when a torch is used that is not rated for 350 amps, but only for 300 amps, like the CK230. This way, accidental torch failure can be prevented. Also, when welding on single-phase the duty-cycle is limited compared to 3-phase operation. The duty-cycle at 300 amps is higher than at 350 amps so if the machine is frequently used on thicker material it helps with higher duty-cycles as well.

q) Smart Water-Cooler Operation and Control

The smart water-cooler is controlled by the welder, but the smart water-cooler also controls the welder. The pump and the fan in the cooler are on-demand, meaning they only run if and when necessary. The fan is also variable speed. If the fluid level in the cooler is low, the cooler communicates with the welding machine, turns the welding output off, and displays an error message. No matter what phase and what voltage you run the machine at, the machine and the cooler will automatically adapt without switches or jumpers.

9) FRONT PANEL CONTROLS

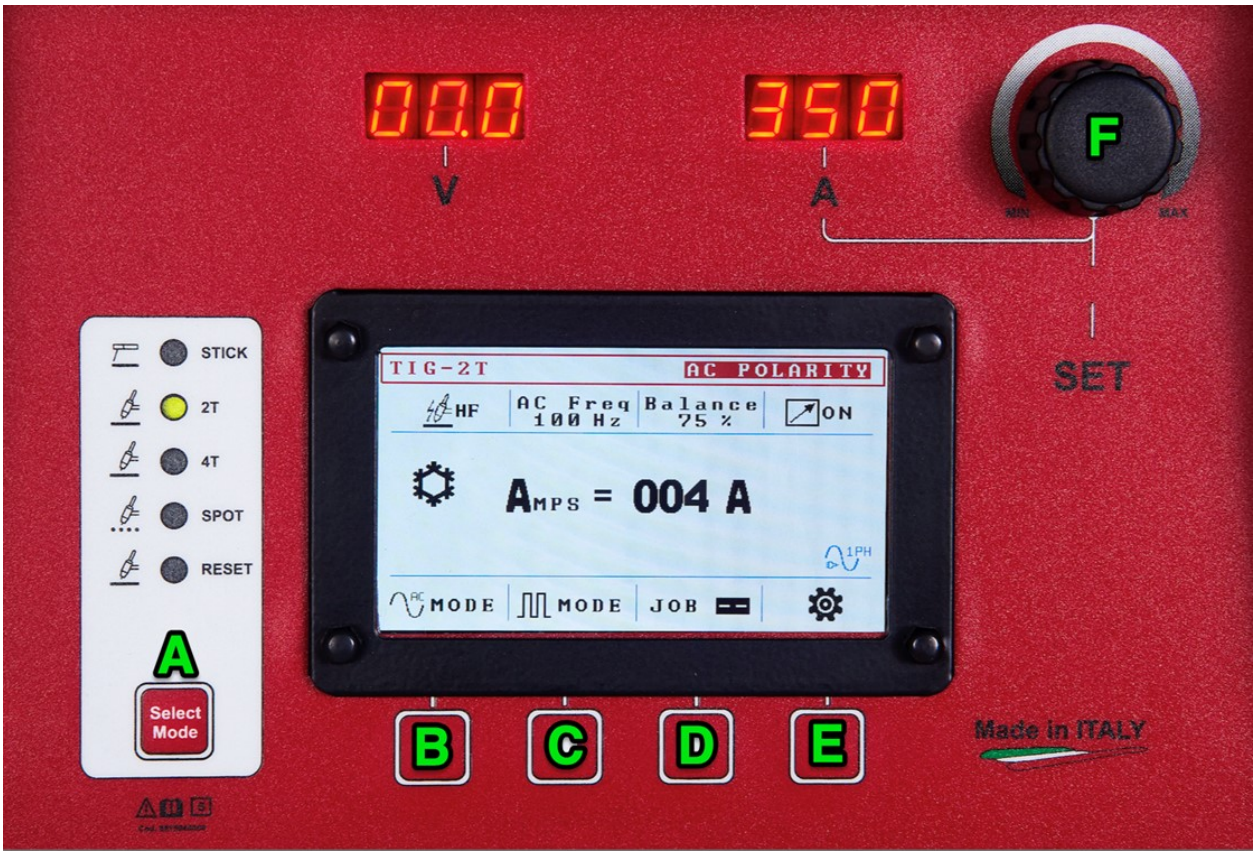


Fig. 11

A (Select Mode Button)—Allows you to access different welding modes (STICK, 2T, 4T, SPOT, & RESET) by repeatedly pressing.

B, C, D, E (Setup and Selection Buttons)—The functions of these buttons differ depending on which mode the machine is in and what setup screen the machine is on. The function of the individual button is shown in the LCD above each button.

F (Encoder)—Turning the encoder adjusts the amperage. (This can also be done while welding). The encoder also makes all adjustments (pulse settings, AC settings, etc.).

10) HOW TO WELD—STEP BY STEP

a) STICK

Use the Select Mode button (**Fig. 11, A**) to toggle through the menu until the LED next to STICK illuminates. You are now in the stick welding mode.

Plug the electrode holder (stinger) into the desired outlet (most stick electrodes use DCEP, which requires the electrode holder to be plugged into the positive output receptacle (**Fig. 2, W**)) and the ground clamp into the negative output receptacle (**Fig. 2, Z**). Use the encoder **F** (**Fig. 11**) to set your welding amperage, which is shown in the LCD.

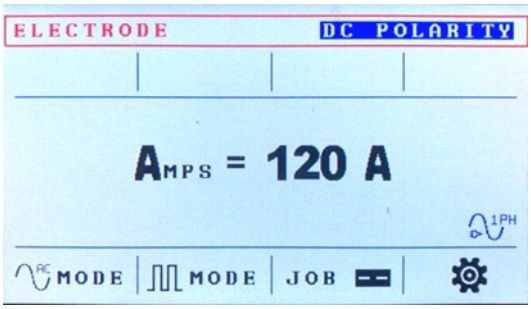


Fig. 12

Fig. 12 shows a selected welding amperage of 120 amps. When you strike an arc, the LCD changes and shows the actual welding amperage and the arc voltage. Pressing button **B** (**Fig. 11**) gives you the option to activate AC mode.

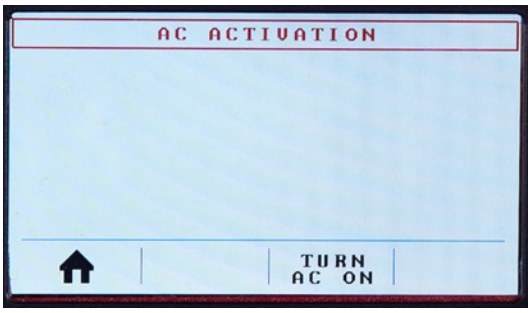


Fig. 13

In order to activate AC mode, simply press button **D** (**Fig. 11**).

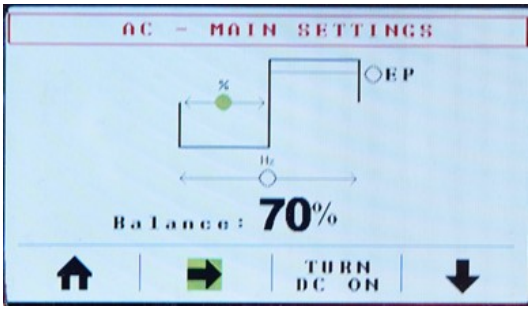


Fig. 14

The first adjustment you can make after activating AC mode is balance. **Fig. 1**4 shows 70% EN (Electrode Negative). Using encoder **F** (**Fig. 11**), you can change the balance value from 10 to 90%. Once you select the desired balance for your application, press button **C** (**Fig. 11**; the green arrow in this instance) to enter the next screen.

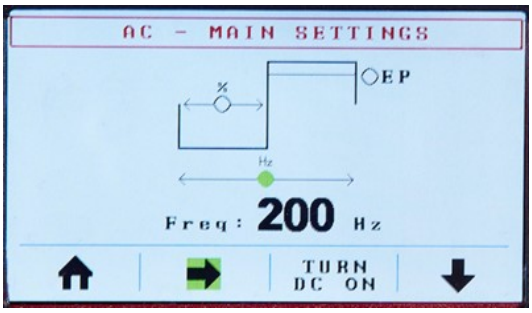


Fig. 15

You can now adjust your AC frequency. From 4 to 99 amps of welding current, you can adjust the frequency from 20 to 400Hz, and from 100 to 400 amps of welding current, you can adjust the frequency from 20 to 200Hz. Pressing button **C** (**Fig. 11**; the green arrow in this instance) takes you to the last screen in this menu.

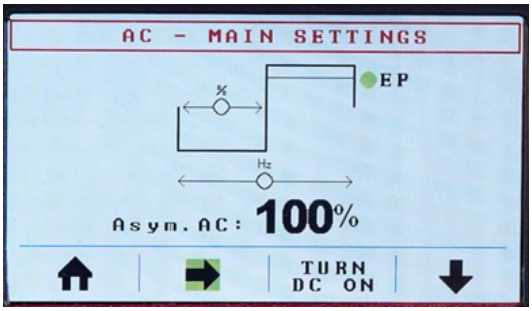


Fig. 16

You can now adjust your asymmetric arc. You can limit the EP (Electrode Positive) amperage here. In **Fig. 16**, the asymmetric arc value is set to 100%, so EP is not limited in this instance; however, you can limit EP to increase penetration. If you do not want to limit EP, but would like to limit EN instead, press button **E** (**Fig. 11**) to enter the submenu in **Fig. 17**.

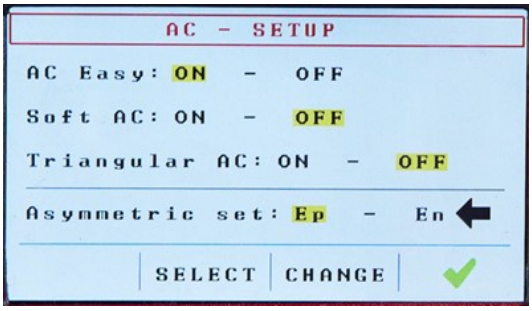


Fig. 17

When in the menu shown in **Fig. 17**, press button **C** (**Fig. 11**; SELECT in this instance) a few times to move the black arrow next to Asymmetric set: Ep - En. To change from Ep to En, or vice versa, press button **D** (**Fig. 11**; CHANGE in this instance) until the value you want to limit is highlighted. Then, press button **E** (**Fig. 6**; the green checkmark in this instance) to confirm. You should end up on the screen as shown in **Fig. 18**.

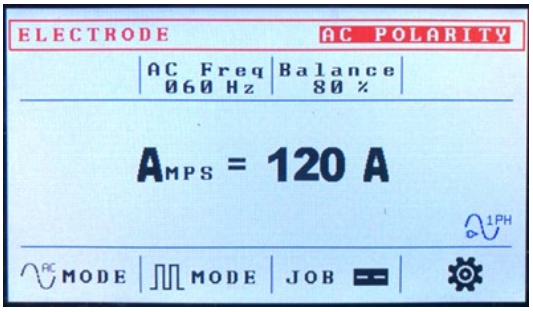


Fig. 18

If you want to get out of AC mode and go back to DC mode, press button **B** (**Fig. 11**) and then button **D** (**Fig. 11**) to turn AC mode off, which effectively puts the machine back into DC mode, as the LCD indicates in blue in the top right corner (**Fig. 19**).

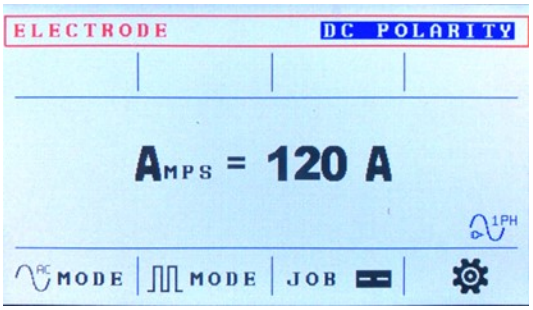


Fig. 19

In order to access the settings submenu, press button **E** (**Fig. 11**), and the following screen appears (**Fig. 20**).

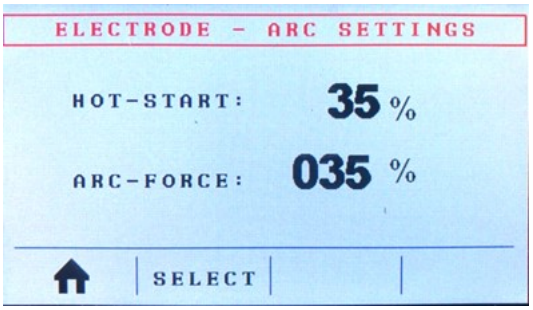


Fig. 20

Here, you can select a hot-start setting for the stick electrodes. By turning encoder **F** (**Fig. 11**), you can change the hot-start value to the desired setting. In **Fig. 20**, we set hot-start to 35%. With the amperage set to 120 amps, hot-start adds 35% more amperage (42 amps in this case) for a burst of 162 amps, that lasts less than a second, to ignite the arc.

In order to adjust the arc-force setting, press button **C** (**Fig. 11**) to move the arrow from the first line in the LCD to the second line in the LCD. Now, turning encoder **F** (**Fig. 11**) changes the arc-force value. (For explanations of what Hot-Start and Arc-Force are and what they do, please visit the glossary at the end of the manual).

To start welding, either press button **B** (**Fig. 11**; the home button in this instance) once, or wait five (5) seconds for the machine to revert back to the welding screen. Now, strike an arc.

To access pulse mode and the pulse mode settings, press button **C** (**Fig. 11**) to enter the PULSE - MAIN SETTINGS menu (**Fig. 21**).

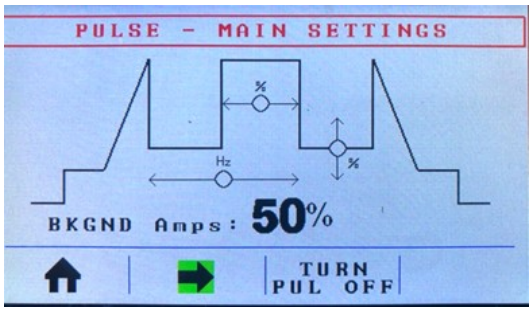


Fig. 21

Here, you can adjust the background amps from 10 to 90% by turning encoder **F** (**Fig. 11**). After selecting your background amps value, press button **C** (**Fig. 11**; the green arrow in this instance) to access the next screen where you can select your peak time (**Fig. 22**).

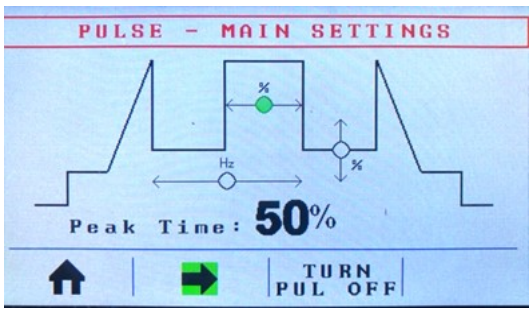


Fig. 22

Like the background amps adjustment, you can adjust the peak time (or pulse-on time; the pulse-on time refers to the time spent on the higher current) from 10 to 90% by turning encoder **F** (**Fig. 11**). After selecting your desired peak time, press button **C** (**Fig. 11**; the green arrow in this instance) to access the next screen where you can select your pulse speed/frequency (**Fig. 23**).

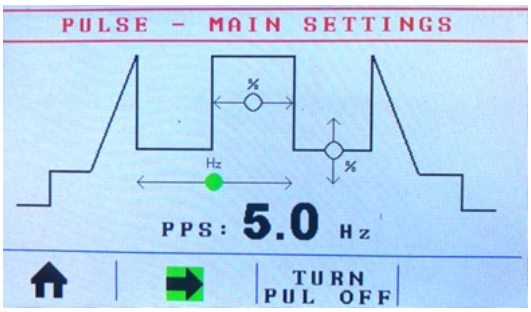


Fig. 23

Here, you can adjust your pulse speed/frequency from 0.4 to 5.0 PPS by turning encoder **F** (**Fig. 11**). After selecting your desired pulse speed/frequency, press button **C** (**Fig. 11**; the green arrow in this instance) to revert back to the main Stick welding screen (**Fig. 24**).

All other HTP stick welding machines (the Inverarc™ 200 TLP and the Invertig™ 221 AC/DC) have the background amps and the peak time factory fixed at 50% each. After months of research and years of experience, we found that this setting proves to be an all -around good setting for most rods and most situations. For you, a good starting point is to keep your background amps and peak time values at 50% and adjust from there.

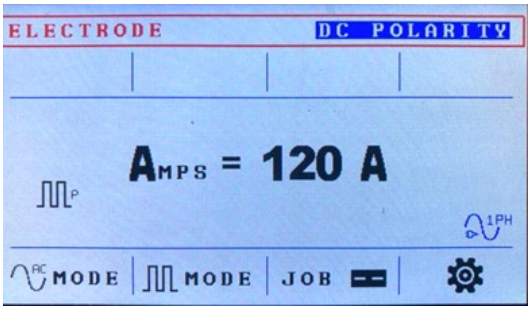


Fig. 24

The pulse symbol on the left side of the screen indicates that the machine is now in SMAW-P (Pulsed Stick) mode. To turn the pulse feature off, press button **C** (**Fig. 11**) followed by button **D** (**Fig. 11**).

b) TIG 2T

Use the Select Mode button (**Fig. 11**) to toggle through the menu until the LED next to 2T illuminates. You are now in the TIG 2T welding mode.

You typically weld in 2T with a foot pedal or most other forms of remote control (like slider controls, rotary controls, pistol grip controls, or a TigButton™). You can also use a momentary switch; however, 2T is not the best mode for momentary switch use.

If a remote control is active (for example, you plugged a foot pedal into the 14-pin remote control receptacle (**Fig. 2, Y**)), the LCD shows the starting amperage in the Amperage display (red numeric; above LCD) that always shows the max (pedal) amperage.

Plug the TIG torch into the negative output receptacle (**Fig. 2, Z**). All TIG welding uses DCEN, which requires the ground clamp to be plugged into the positive output receptacle (**Fig. 2, W**) and the TIG torch into the negative output receptacle (**Fig. 2, Z**). Use the encoder (**Fig. 11, F**) to set your maximum (pedal) amperage, which enables you to use the pedal to control your welding amperage in real time (while welding).

Fig. 25

Fig. 25 shows a maximum welding amperage of 120 amps and a starting amperage of 4 amps. When you establish an arc, the LCD changes and shows the actual welding amperage and the arc voltage.

In the top right corner, the LCD also shows DC POLARITY in blue, which indicates that the machine is in DC mode. Just below DC POLARITY, you should see the remote control status symbol. Here, the remote control status symbol (**Fig. 26**) indicates that a remote control is plugged in and active. When remote control functions are disabled, such as in Pipe Mode, the remote control status symbol blinks, indicating that remote control functions are off.

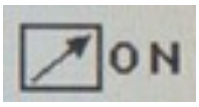


Fig. 26

On the left-hand side of the LCD, under the TIG 2T symbol, you see the HF symbol, which indicates that high frequency arc initiation is turned on. (In **Fig. 25**, you may also notice the pulse symbol, which indicates that pulse functions are turned on).

Pressing button **B** (**Fig. 11**, MODE in **Fig. 25**) gives you the option to activate AC mode.

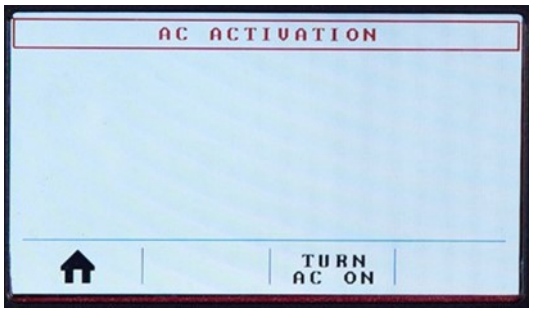


Fig. 27

When in the AC ACTIVATION screen (**Fig. 27**), simply press button **D** (**Fig. 11**) to activate AC mode.

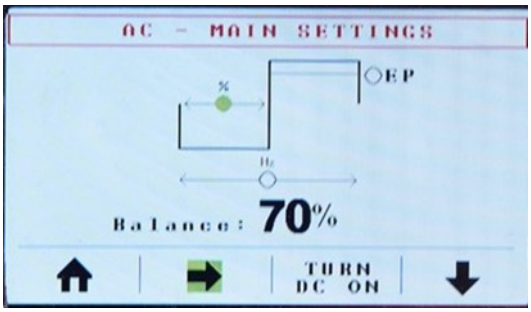


Fig. 28

The first adjustment you can make after activating AC mode is balance. **Fig. 28** shows 70% EN (Electrode Negative). Using encoder **F** (**Fig. 11**), you can change the balance value from 10 to 90%. Once you select the desired balance for your application, press button **C** (**Fig. 11**; the green arrow in this instance) to enter the next screen.

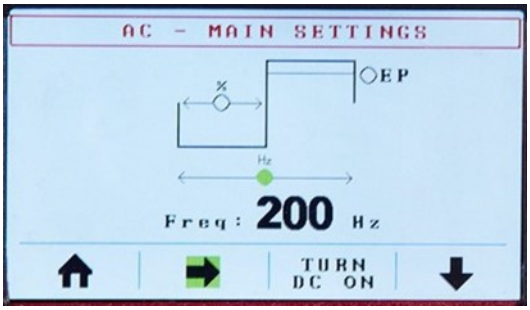


Fig. 29

You can now adjust your AC frequency. From 4 to 99 amps of welding current, you can adjust the frequency from 20 to 400Hz, and from 100 to 400 amps of welding current, you can adjust the frequency from 20 to 200Hz. Pressing button **C** (**Fig. 11**; the green arrow in this instance) takes you to the final screen in this menu.

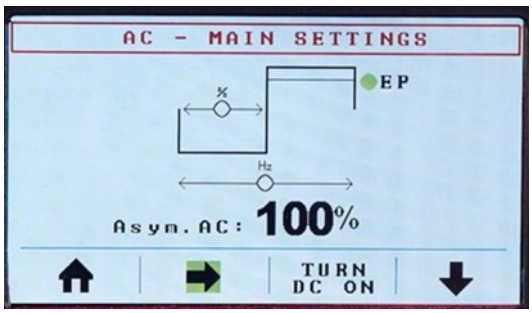


Fig. 30

You can now adjust your asymmetric arc. You can limit the EP (Electrode Positive) amperage here. In **Fig. 30**, the asymmetric arc value is set to 100%, so EP is not limited in this instance; however, you can limit EP to increase penetration. If you do not want to limit EP, but would like to limit EN instead, press button **E** (**Fig. 11**) to enter the submenu in **Fig. 31**.

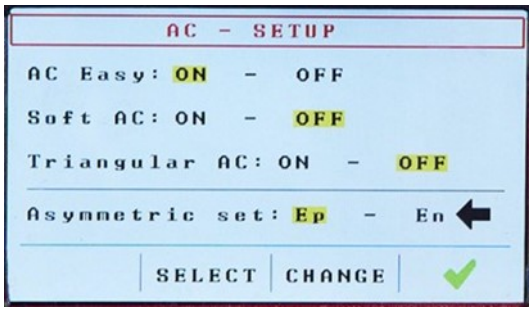


Fig. 31

When in the menu shown in **Fig. 31**, press button **C** (**Fig. 11**; SELECT in this instance) a few times to move the black arrow next to Asymmetric set: Ep - En. To change from Ep to En, or vice versa, press button **D** (**Fig. 11**; CHANGE in this instance) until the value you want to limit is highlighted. Then, press button **E** (**Fig. 11**; the green checkmark in this instance) to confirm. You should end up on the screen shown in **Fig. 32**.

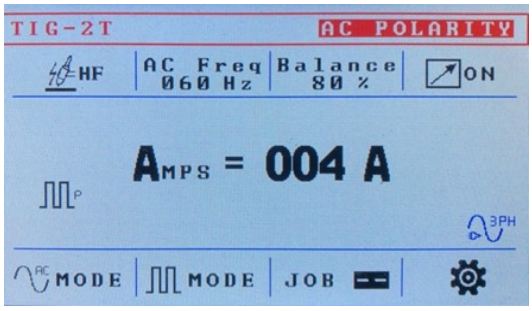


Fig. 32

The top right corner of the LCD now shows AC POLARITY in red and also shows the frequency and the balance values in black (**Fig. 32**). The frequency and the balance values shown in black indicate that the Asymmetric arc function is not active.

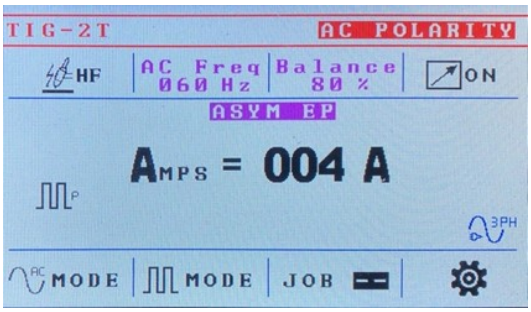


Fig. 33

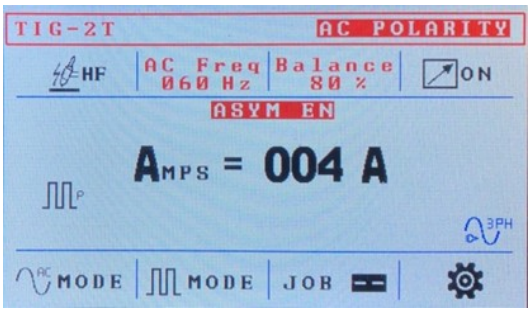


Fig. 34

When the Asymmetric arc function is active, you can see the Asymmetric arc limitation in the LCD. If you limit EP, ASYM EP displays in purple, as do the frequency and balance values (**Fig. 33**). If you limit EN, ASYM EN displays in red (**Fig. 34**), as do the frequency and balance values. The limitation value itself, however, is NOT shown on the main screen; you can only see the limitation value in the AC adjustment screen.

If you want to get out of AC mode and go back to DC mode, press button **B** (**Fig. 11**) and then press button **D** (**Fig. 11**) to turn AC mode off, which effectively puts the machine back into DC mode, as indicated in blue at the top right-hand corner of the LCD (**Fig. 35**).

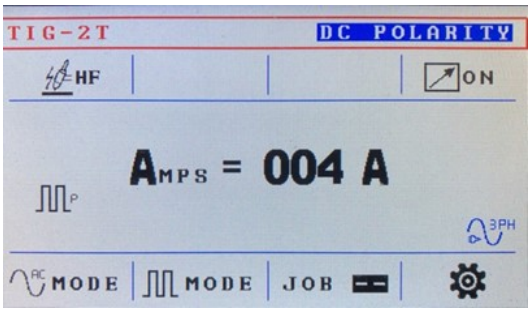


Fig. 35

In order to access the TIG - MAIN SETTINGS submenu, press button **E** (**Fig. 11**), and the following screen appears (**Fig. 35**).

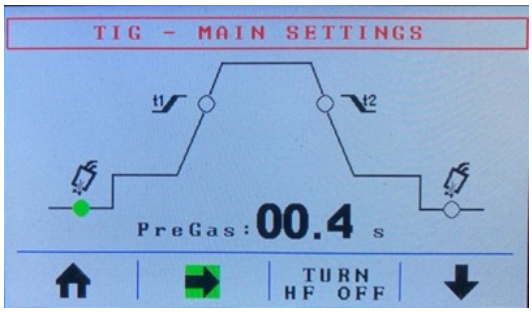


Fig. 36

Here, you can select your pre-gas flow in seconds. by turning encoder **F** (**Fig. 11**) until you reach your desired pre-gas flow duration. In **Fig. 36**, we set a pre-gas flow duration of 0.4 seconds.

In order to adjust the next value of the sequencer, in this case t1 (slope up), press button **C** (**Fig. 11**; the green arrow in this instance).

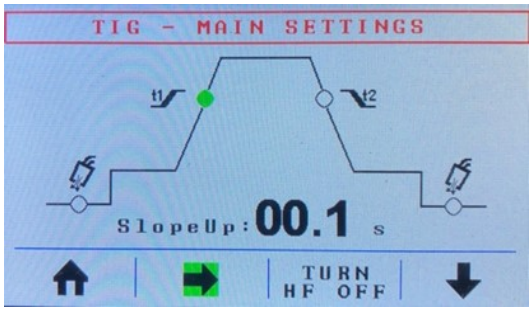


Fig. 37

When using a remote control, the t1 value is fixed (not adjustable) as you typically use the remote control to determine how fast the slope up should be. With a momentary (arc on/off) switch, the t1 adjustment feature is available. Use button **C** (**Fig. 11**; the green arrow in this instance), to move to t2 (slope down).

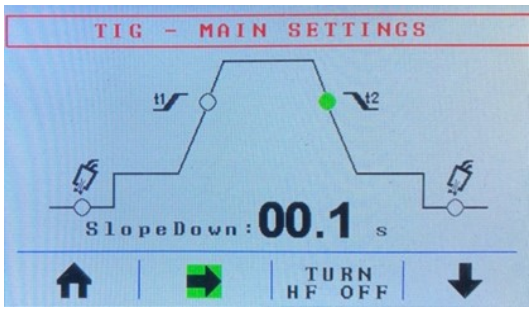


Fig. 38

Here, you can adjust the slope down duration in seconds. Like t1 (slope up), it is very uncommon to set slope down when using a foot pedal. However, setting a slope down time may be done to implement a fail safe in an attempt to avoid abrupt termination of the weld and subsequent crater formation, which leads to weld defects. Use button **C** (**Fig. 11**; the green arrow in this instance), to move to the final station of the sequencer—post-gas flow (**Fig. 39**).

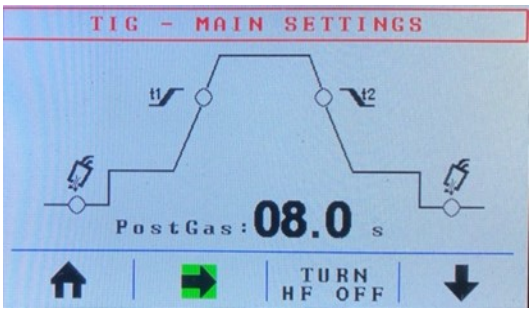


Fig. 39

When setting post-gas flow, more is better—especially when in doubt. How much post-gas flow you need depends on the material you plan to weld, the cup you plan to use, the amperage you plan to weld at, and the amount of tungsten stick-out you use. Some people advocate that you never need more than 5 seconds of post-gas flow, claiming that more post-gas flow is just a waste of Argon. Well, let's put it this way. At a bare minimum, you need to keep the tungsten electrode shielded until the tungsten is cold enough to where it does not react with the ambient air. What does that mean? If the shielding gas stops when the tungsten electrode is still too hot, you will most likely see gray or even black discoloration of the tungsten, which is very bad! After you finish welding, the tungsten should be the same shiny silver color that it is when it was brand new. If you weld stainless or even titanium, post-gas flow times of 30 or 60 seconds, and sometimes longer depending on the amperage, are not unheard of. During post-gas flow time, you also need to hold the torch in position to shield the metal from discoloring.

By pressing button **E** (**Fig. 11**; the down arrow in this instance) you get deeper into the TIG - MAIN SETTINGS submenu.

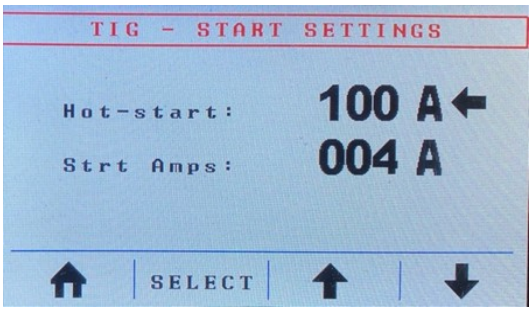


Fig. 40

The Invertig 313/400 allows you to adjust TIG hot-start in both AC and DC. Most other TIG welding machines, and all other high-end, brand name welding machines, feature a hot-start function that delivers a factory pre-set amount of hot-start, for a predetermined amount of time (typically in the range of several dozen or several hundred milliseconds). Some competitive machines allow you to preselect a tungsten diameter, which will, in some cases, change the hot-start parameters of the machine. The downside to this is that there is always hot-start, and, although all TIG machines have a minimum amperage listed in the literature, they never actually start an arc at that amperage since hot-start cannot be turned off.

Why is this so important? On very thin material the ability to adjust hot-start way down, or even turn it off, can be a huge advantage. Some find it helpful to light the arc on a piece of filler rod resting on the work piece so they don't burn through. Others use run in tabs. With the ability to adjust the hot-start parameters, those tricks become things of the past.

If a low hot-start is such a great thing, then why did we make it adjustable from Off or from 4 to 130 amps?

Sometimes, depending on the size and type of tungsten you use (the Invertig welds best with 2% Ceriated tungsten), and, depending on whether you are welding in AC or DC and potentially collected a fair amount of aluminum oxide on the tungsten, you may find re-striking an arc hard after welding for awhile. In this case, you might need a higher starting amperage all together. But, first and foremost, you need hot-start, and plenty of it, to initially ignite the arc. With that being said, most competitive machines with non-adjustable hot-start generally have too much hot-start rather than not enough, which can make welding thin materials challenging.

As a good starting point for welding in DC, we suggest around 40 amps of hot-start for small diameter electrodes and around 70 amps of hot-start for large diameter electrodes. As a good starting point for welding in AC, we suggest around 60 amps of hot-start for small diameter electrodes and around 100 amps of hot-start for large diameter electrodes.

Now, on an initial, freshly ground arc start, hot-start most likely can be turned off completely (**Fig. 41**). Also, clean tungsten electrodes require less hot-start than contaminated electrodes.

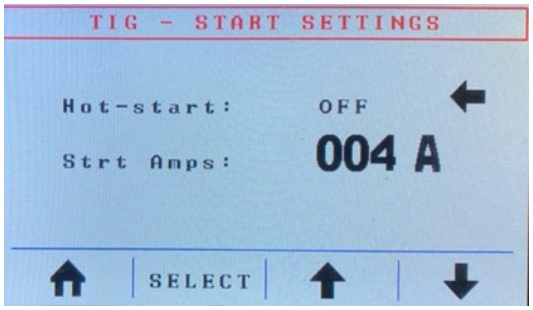


Fig. 41

The following example shows a setting that could be used for 3/8" thick material.

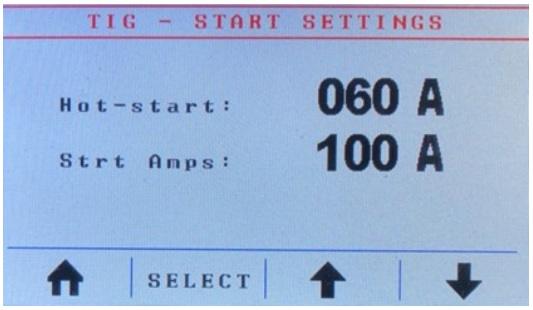


Fig. 42

Since we set the hot-start value lower than the starting current value (as seen in **Fig. 41**), there really is no hot-start. In this case, as soon as you depress the foot pedal, you have 100 amps minimum amperage.

Now, let's look at the entire front of the machine (**Fig. 42**).

Fig. 43

You can see the machine is in AC mode, with the starting amps set to 100A (as shown in the LCD display). The maximum amperage (120A) can be seen in the Amperage display (red numeric; above LCD). Now, use encoder **F** (**Fig. 11**) to adjust the amperage up to 400 amps—a suitable setting to weld 3/8" or 1/2" aluminum.

Your starting current does not always have to be 4 amps! When working with thicker, colder material (especially aluminum), a higher starting current gives you better arc ignition and arc stability.

To access pulse mode and the pulse mode settings, press button **C** (**Fig. 11**) to enter the PULSE ACTIVATION screen (**Fig. 44**).

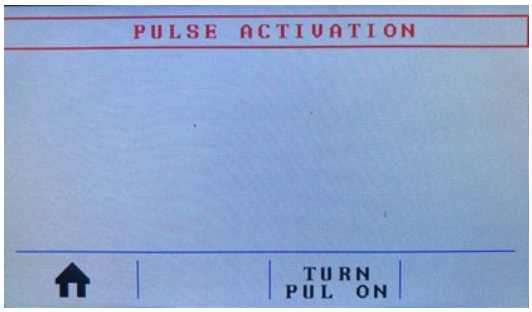


Fig. 44

Now, press button **D** (**Fig. 11**) to turn pulse-on and proceed to the PULSE - MAIN SETTINGS menu (**Fig. 45**).

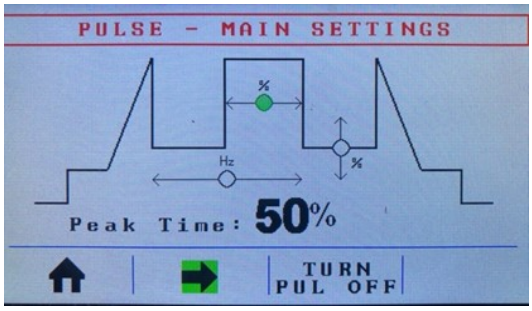


Fig. 45

Here, you can adjust the background amps from 10 to 90% by turning encoder **F** (**Fig. 11**). After selecting your background amps value, press button **C** (**Fig. 11**; the green arrow in this instance) to access the next screen where you can select your peak time (**Fig. 46**).

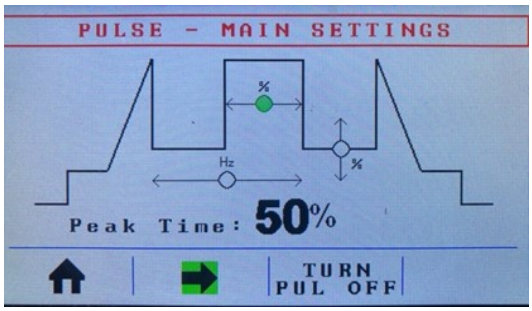


Fig. 46

Like the background amps adjustment, you can adjust the peak time (or pulse-on time; the pulse-on time refers to the time spent on the higher current) from 10 to 90% by turning encoder **F** (**Fig. 11**). After selecting your desired peak time, press button **C** (**Fig. 11**; the green arrow in this instance) to access the next screen where you can select your pulse speed/frequency (**Fig. 47**).

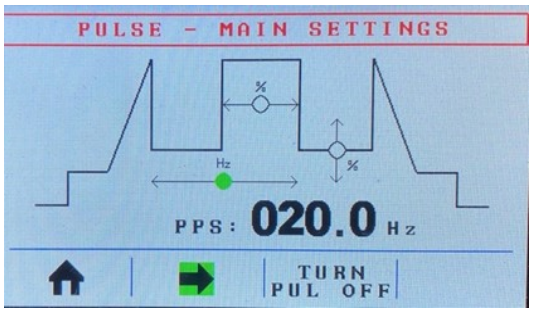


Fig. 47

Here, you can adjust your pulse speed/frequency from 0.4 to 20.0 PPS in AC and 0.4 to 999.9 PPS in DC by turning encoder **F** (**Fig. 11**). After selecting your desired pulse speed/frequency, press button **C** (**Fig. 11**; the green arrow in this instance) to revert back to the main TIG welding screen (**Fig. 48**).

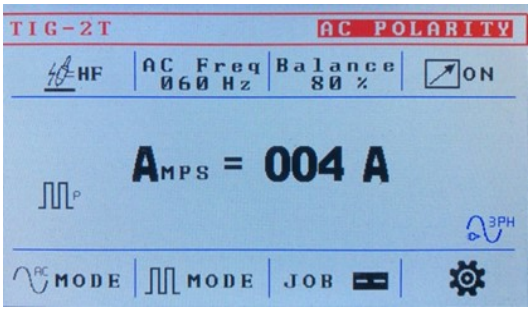


Fig. 48

The pulse symbol (**Fig. 49**) on the left-hand side of the screen indicates that the machine is now in pulse mode. To turn the pulse feature off, press button **C** (**Fig. 11**) followed by button **D** (**Fig. 11**).

Fig. 49

From the TIG 2T main screen, you can enter the setup menu by pressing button **E** (**Fig. 11**) three (3) times. Pressing button **E** one (1) time brings you to the sequencer screen, pressing button **E** two (2) times brings you to the hot-start screen, and pressing button **E** three (3) times brings you to the TIG - SETUP (system settings) screen (**Fig. 50**).

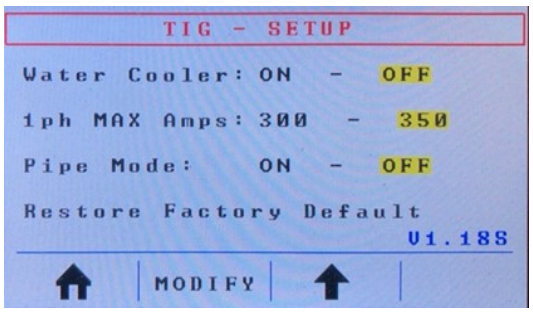


Fig. 50

Water-Cooler: ON - OFF

Use the water-cooler feature only when using a water-cooled torch with an HTP America® smart water-cooler. With the water-cooler feature turned on, the, machine controls the smart cooler and the pump and fan work on -demand. To ensure proper operation, it is essential to not only turn the cooler on, but to also activate the water -cooler function in the software. If you use an air-cooled torch, the water-cooler function MUST BE turned off to avoid false alarms and interruption of the welding arc.

If you purchased an Invertig 313 with the Arctic Chill water-cooler option, where the cooler plugs directly into a wall outlet and not into the back of the machine like the smart cooler, you need to turn the water-cooler feature off as the stand-alone Arctic Chill is not a smart cooler and is not controlled or monitored by the Invertig.

1ph MAX Amps: 300 - 350 (Invertig 400 Only)

This function allows a software limitation of the welding output when using the machine on single-phase power. Instead of having 350 amps of max power available, this feature allows you to limit the machine output to 300 amps so a CK230 torch can be safely used without the risk of accidental damage to the torch.

Pipe Mode: ON - OFF

We specifically designed the Pipe Mode for pipe welding and pipe weld training to simulate an engine drive. For full details on Pipe Mode, please refer to section **7), o)** on **page 18** of the manual.

Fig. 51

c) TIG 4T

TIG 4T is a very popular process in Europe where people typically use a momentary (arc on/off) switch instead of a foot pedal.

Use the Select Mode button (**Fig. 11, A**) to toggle through the menu until the LED next to 4T illuminates. You are now in the TIG 4T welding mode.

The main difference between TIG 2T and TIG 4T is that there is no option to control the maximum amperage while welding. If you want to weld material and know you need about 110 amps, you can dial the machine to 110 amps and weld.

In TIG 2T, when you press the momentary switch button the machine welds and when you let go, the machine stops. In TIG 4T, the process works different. Let's take a look at the sequencer.

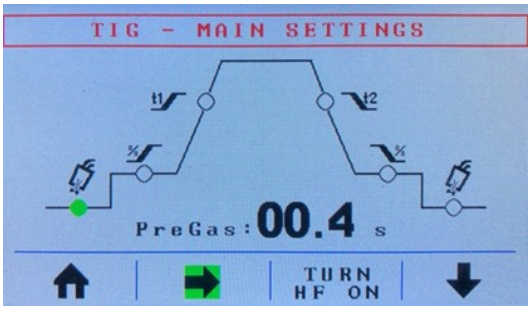


Fig. 52

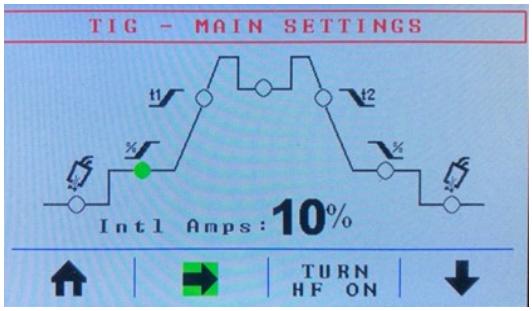


Fig. 53

If you press and hold the momentary switch button, the pre-gas flow timer runs (**Fig. 52**) followed by arc ignition at initial amps (Intl in **Fig. 53** stands for Initial). Initial amps refers to a small (typically) percentage of your amperage setting. In the **Fig. 52-54** example, we selected a welding amperage of 110 amps, a pre-gas flow value of 0.4 seconds, and an Intl Amps value of 10%, meaning that when you press and hold the momentary switch button the pre-gas flow timer runs for 0.4 seconds followed by arc ignition at 11 amps.

When you let go of the momentary switch button, the machine goes into t1 (slope up), which we set to 1.5 seconds (**Fig. 54**).

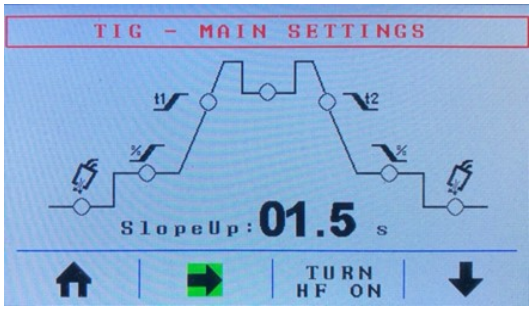


Fig. 54

With our selected t1 value, the machine ramps up from 11 amps to 110 amps in 1.5 seconds. Now, you can weld as long as you want at 110 amps. When you finish welding, press and hold the torch button again and the machine goes into t2 (slope down).

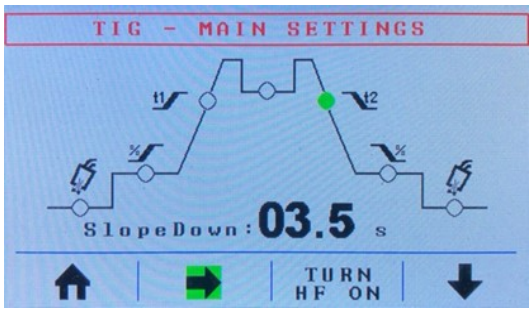


Fig. 55

As you can see in **Fig. 55**, we set t2 (slope down) to 3.5 seconds. Once the slope down timer runs out, the machine goes into final amps (Fnl Amps in **Fig. 56**). The final amps value is typically a small percentage of the amperage setting just like the initial amps value. Final amps guard against crater formation, cracks, and other weld defects.

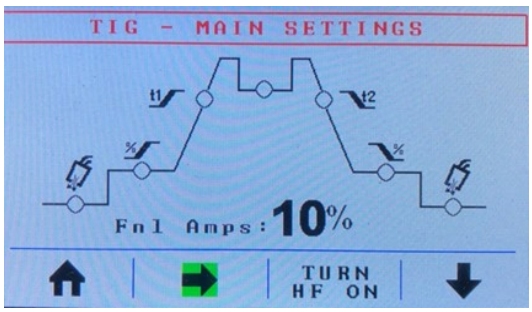


Fig. 56

Once you let go of the momentary switch button, the arc extinguishes and the post-gas flow timer engages (**Fig. 57**; 12.0 seconds in this instance).

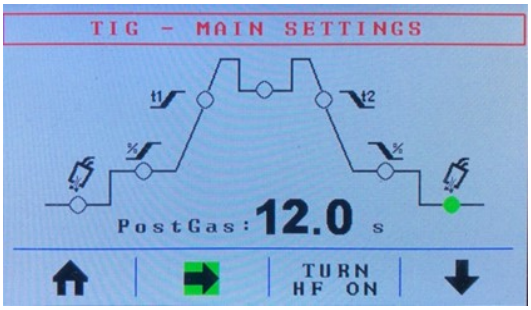


Fig. 57

PRO TIP: TIG 4T welding can be done in AC or DC, in every wave form, and with (where applicable) or without pulse. If you plug a foot pedal in with TIG 4T activated, the machine deactivates the remote control's amperage adjustment feature (the remote control symbol blinks in the LCD when the amperage adjustment feature of the remote control is deactivated). However, the on/off switch in the foot pedal can now be used instead of a torch mounted momentary switch.

d) TIG SPOT

This is a fusion spot weld function. Use the Select Mode button (**Fig. 11, A**) to toggle through the menu until the LED next to SPOT illuminates. You are now in the TIG SPOT welding mode. In the TIG Spot welding mode, all remote control functions are unavailable. Press button **E** (**Fig. 11**) to enter the TIG Spot setup menu.

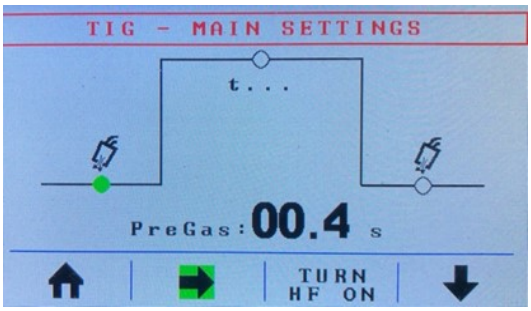


Fig. 58

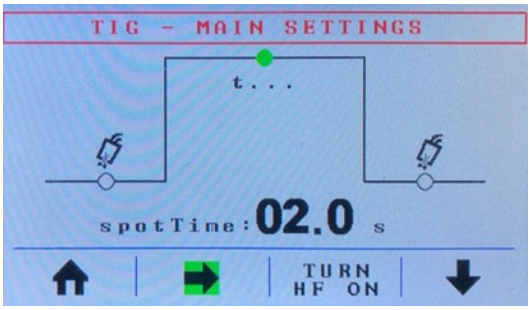


Fig. 59

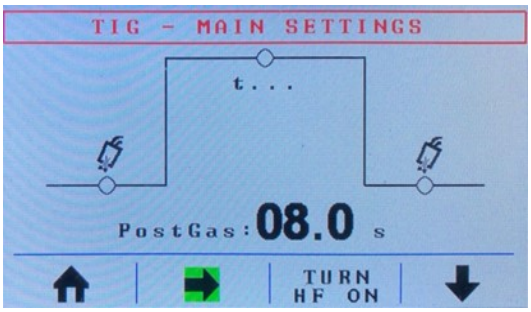


Fig. 60

Here, you can set the pre-gas flow duration in seconds (**Fig. 58**), the spot weld time in seconds (**Fig. 59**; spot weld time refers to the arc on time that will create the fusion weld), and the post-gas flow duration in seconds (**Fig. 60**).

In order to perform the fusion spot weld, press the momentary switch button or the foot pedal for at least the amount of time you selected for the spot weld (in this case 2.0 seconds). If the you depress the momentary switch button or foot pedal for more than 5 seconds, no harm is done to the machine. Your Invertig turns off automatically after the spot weld timer runs out.

PRO TIP: Spot welding can be done in AC or DC, in every wave form, and with (where applicable) or without pulse. If you plug a foot pedal in with TIG Spot activated, the machine deactivates the remote control's amperage adjustment feature (the remote control symbol blinks in the LCD when the amperage adjustment feature of the remote control is deactivated). However, the on/off switch in the foot pedal can now be used instead of a torch mounted momentary switch.

e) TIG RESET

TIG RESET is a very popular process in Europe where people typically use a momentary switch rather than a foot pedal. TIG RESET is essentially a TIG 4T welding mode with the option to toggle between two amperages as you weld.

Use the Select Mode button (**Fig. 11, A**) to toggle through the menu until the LED next to RESET illuminates. You are now in the TIG RESET welding mode.

The main difference between TIG 2T and TIG RESET is that there is no option to control the maximum amperage while welding, other than by toggling between your two preset amperages. If you want to weld material and know you need about 110 amps, you can dial the machine to 110 amps and weld. If you think that you might have to weld out-of-position, with poor fit up, or if the material heats up too much, you can set and select a second amperage. With a swift press of the momentary switch button, you can toggle between the two preset amperages as needed.

In TIG 2T, when you press the momentary switch button the machine welds and when you let go, the machine stops. In TIG RESET, the process works different. Let's take a look at the sequencer.

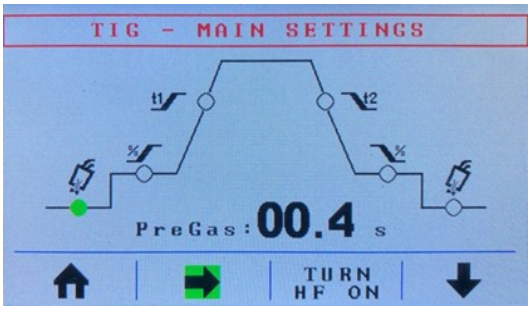


Fig. 61

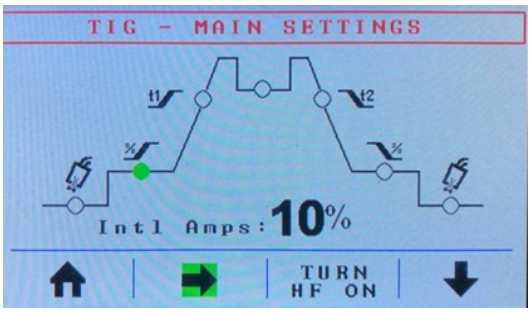


Fig. 62

If you press and hold the momentary switch button, the pre-gas flow timer runs (**Fig. 61**) followed by arc ignition at initial amps (Intl in **Fig. 62** stands for Initial). Initial amps refers to a small (typically) percentage of your amperage setting. In the **Fig. 62** example, we selected a welding amperage of 110 amps, a pre-gas flow value of 0.4 seconds, and an Intl Amps value of 10%, meaning that when you press and hold the momentary switch button the pre-gas flow timer runs for 0.4 seconds followed by arc ignition at 11 amps.

When you let go of the momentary switch button, the machine goes into t1 (slope up), which we set to 1.5 seconds (**Fig. 63**).

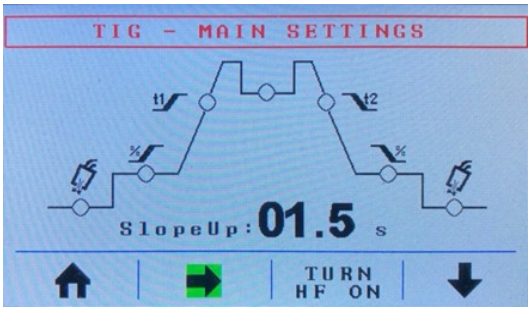


Fig. 63

With our selected t1 value, the machine ramps up from 11 amps to 110 amps in 1.5 seconds. Now, you can weld as long as you want at 110 amps.

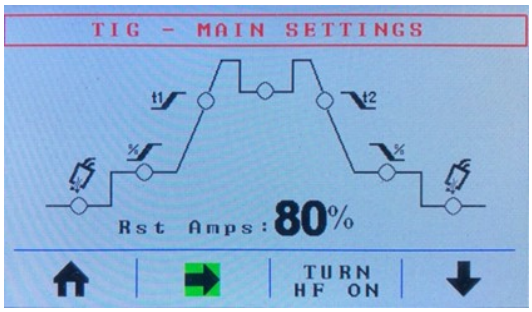


Fig. 64

If you want to weld at a lower amperage, a swift flick of the momentary switch button allows you to weld at your lower set amperage (**Fig. 64**). In our example, we set the Rst Amps (RESET Amps) to 80%. With this setting, a swift flick of the momentary switch button allows you to weld at 88 amps. From here, you can flick the switch as often as you want to toggle between 88 and 110 amps.

When you finish welding, press and hold the momentary switch button again and the machine goes into t2 (slope down). You can put the machine into slope down regardless of whether you are welding at 88 amps or 110 amps.

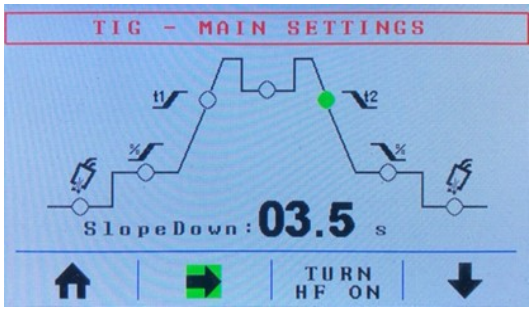


Fig. 65

As you can see in **Fig. 65**, we set t2 (slope down) to 3.5 seconds. Once the slope down timer runs out, the machine goes into final amps (Fnl Amps in **Fig. 66**). The final amps value is typically a small percentage of the amperage setting just like the initial amps value. Final amps guard against crater formation, cracks, and other weld defects.

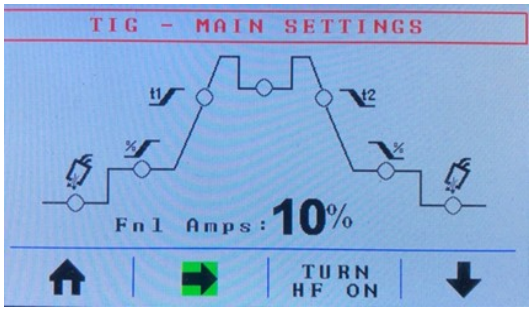


Fig. 66

Once you let go of the momentary switch button, the arc extinguishes and the post-gas flow timer engages (**Fig. 67**; 12.0 seconds in this instance).

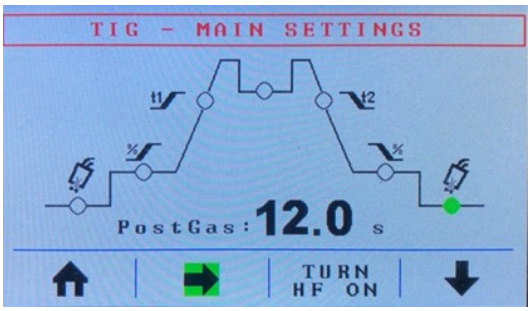


Fig. 67

PRO TIP: TIG RESET welding can be done in AC or DC, in every wave form, and with (where applicable) or without pulse. If you plug a foot pedal in with TIG RESET activated, the machine deactivates the remote control's amperage adjustment feature (the remote control symbol blinks in the LCD when the amperage adjustment feature of the remote control is deactivated). However, the on/off switch in the foot pedal can now be used instead of a torch mounted momentary switch.

10) JOB Mode

The JOB Mode function, which is active in all welding modes, allows you to store and recall up to 30 JOBs (welding parameter settings).

How to Store JOBs

1) Press the JOB button **D** to pull up the JOB LIST page.
2) Use the ↑ button **D**, the ↓ button **E**, or the encoder **F** to select the program in which you want to save the welding parameter settings.
3) Press and hold the SAVE button **C** for about three (3) seconds until you hear a double beep. If you hear a triple beep and see "THIS JOB IS PROTECTED, DO YOU WANT TO OVERWRITE IT?" in the display, either press button **E** to proceed or button **D** to cancel.
4) After saving the JOB, the LCD reverts back to the main page where you can see the JOB number above button **C**.

NOTE: An * symbol next to the JOB means the JOB is in use, and a flashing * symbol next to the JOB means the JOB is modified from the original.

To leave the current JOB and return the Invertig into the regular welding mode, quickly press and release the JOB button **D**, and then press and hold the Select Mode button **A** for approximately five (5) seconds. You should hear five (5) short beeps and one longer beep, after which the * symbol next to the JOB you were using clears. Wait an additional six (6) seconds, and the Invertig will be back in the regular welding mode.

How to Load Stored JOBs

1) Press the JOB button **D** to pull up the JOB LIST page.
2) Use the ↑ button **D**, the ↓ button **E**, or the encoder **F** to select the JOB you want to recall.
3) Press and hold the RECALL button **B** for about three (3) seconds until you hear a double beep.
4) After recalling the JOB, the LCD reverts back to the main page where you can see the JOB number above button **D**.

ATTENTION: THE PARAMETERS SAVED IN JOBS 1 THROUGH 12 ARE PROTECTED. WHEN YOU RECALL JOBS 1 THROUGH 12, THEY WILL BE BLOCKED, WHICH MEANS YOU CANNOT ACCIDENTALLY ALTER OR MODIFY THEM. IN ORDER TO INTENTIONALLY MODIFY A SAVED AND PROTECTED JOB, DO THE FOLLOWING:

- Quickly press and release the JOB button **D**, and then press and hold the Select Mode button **A** for about five (5) seconds; you will hear five (5) short beeps and one (1) long beep, and the * symbol next to the JOB you are using disappears. After an additional six (6) seconds, the machine will be back in the regular welding mode.
- Make the desired adjustments and modifications to the program.
- Follow the steps from the **How to Store JOBs** instructions to overwrite the protected parameters with the new parameters.
- Each set of parameters (JOB) saved in slots 1 through 3 needs to have a pre-gas flow time of at least 0.3 seconds or higher.

Important Things to Know about the JOB Mode

You can delete the preprogrammed JOBs, as well as Jobs you saved on the machine. To delete all save JOBs, press and release the JOB button **D**, and then press and hold the Select Mode button **A** and button **E** at the same time for approximately five (5) seconds. After hearing five (5) beeps, all JOBs, including preprogrammed demo JOBs, will be permanently erased from the machine's memory.

When saving a JOB, please note that the machine saves everything, which means not just amperage, but also pre -gas flow, post-gas flow, t1 (slope up), t2 (slope down), pulse settings, AC settings and wave forms where applicable, etc. For different JOBs, these settings can and will be different, and, as you recall each JOB, the JOBs will load with the exact settings used when you saved them.

11) OVER-TEMP (OVER-HEAT) & DUTY-CYCLE

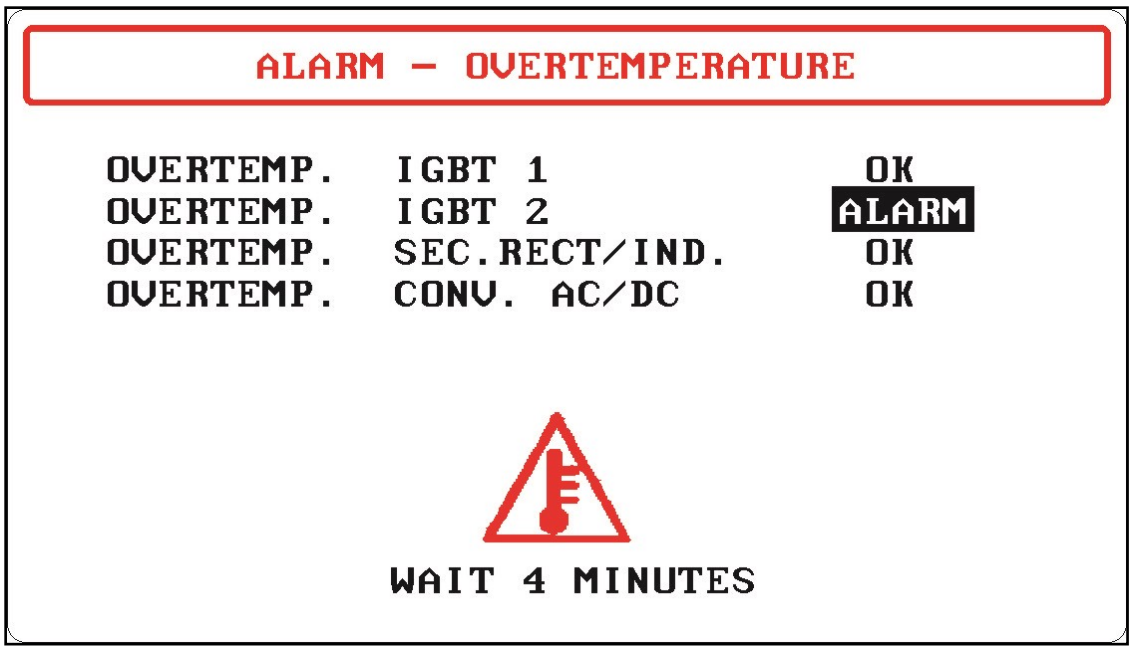
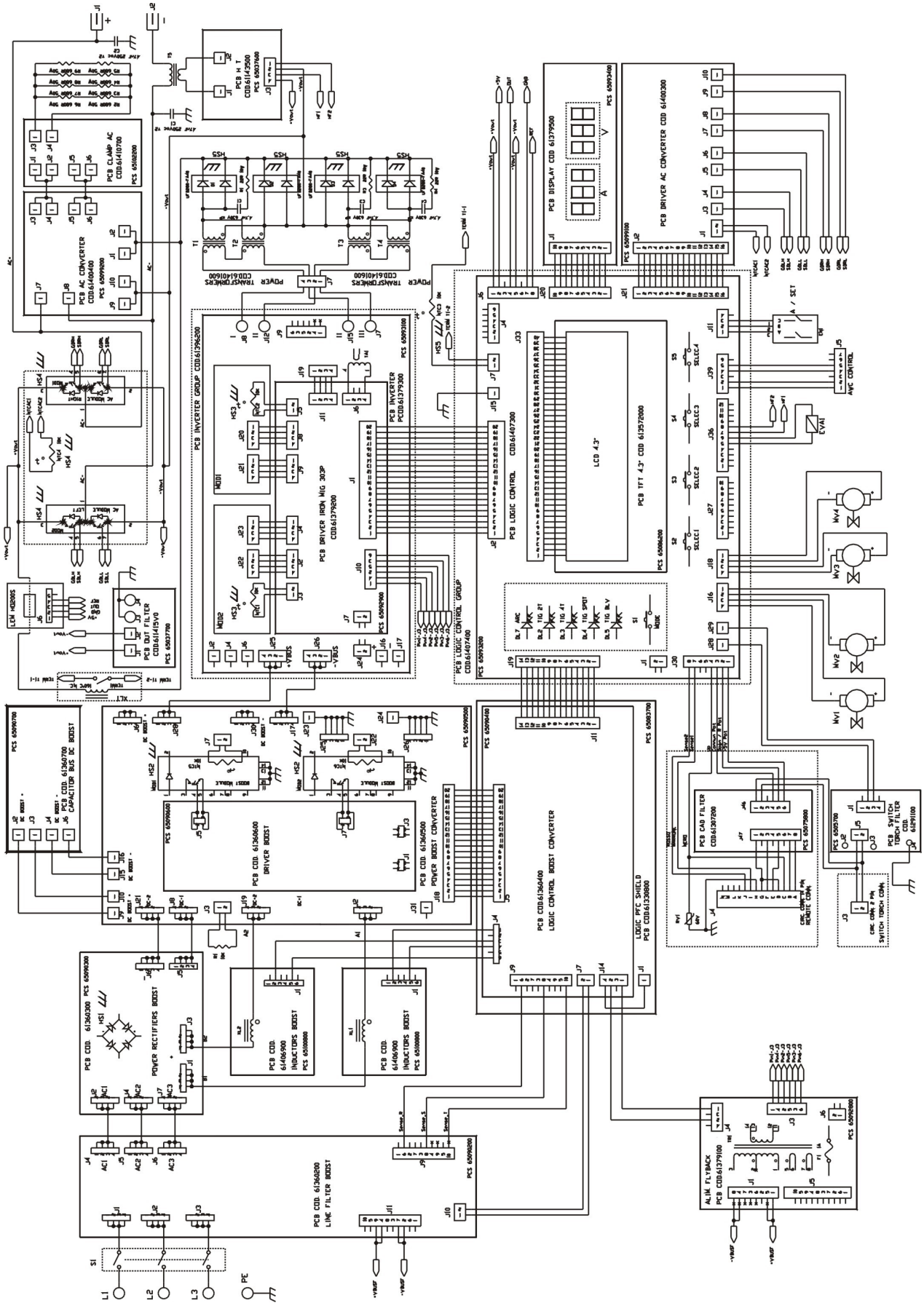


Fig. 68

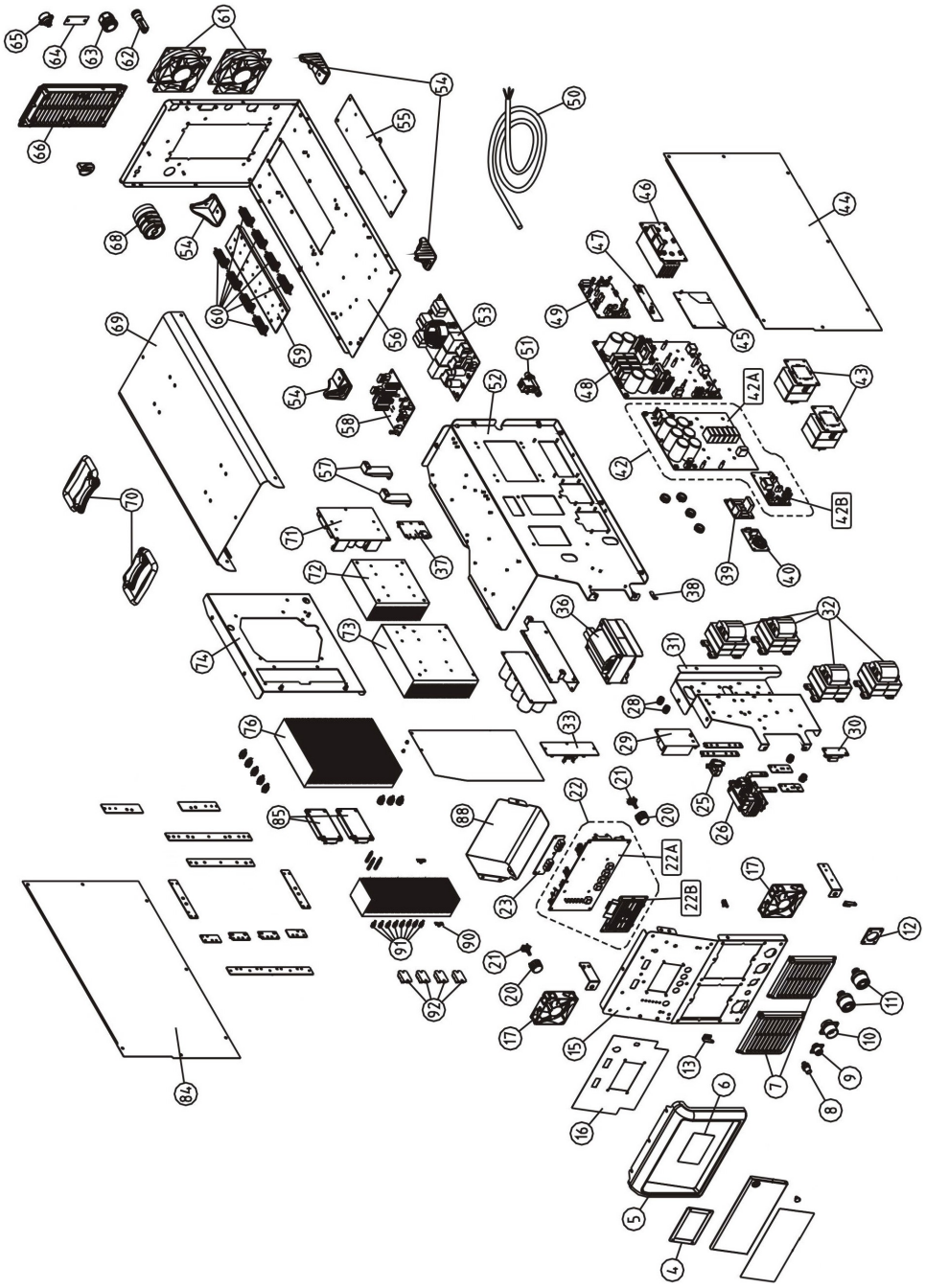
Duty-cycle ratings can be confusing, but we want to make duty-cycle less confusing. An 80% duty-cycle means that, out of a ten (**10**)-minute time span (duty-cycle is always a ten (**10**)-minute time span, per definition, and this never changes), the machine can weld for eight (**8**) minutes and then needs to idle with the cooling fan running for two (**2**) minutes. Do not turn off or unplug the machine during this time.

However, these numbers change with the selected welding amperage and the ambient temperature. In reality, very few can keep track of welding time like this, so we equipped the Invertig 313/400 AC/DC with a highly sophisticated over-heat protection. The machine monitors the temperature of several vital internal components. Just before temperatures venture outside of the safe operating range, the machine displays a message to the operator, the cooling fan continues to run, and the welding output is shut down for four (**4**) minutes. This time allows the machine and internal components to cool down to a safe operating temperature. There is no harm to the machine when the message is displayed, and it does not matter how often this happens. There is no way to override this function.

12) WIRING DIAGRAM—Invertig 400 AC/DC ONLY



13) EXPLODED VIEW—INVERTIG 400 AC/DC ONLY



PARTS LIST—INVERTIG 400 AC/DC ONLY

Pos.	Part#	Description
4	620809	LCD Protection Frame
5	661385	Front Panel Frame
6	660466	LCD Protection Panel
7	611043	Front Fan Cover
8	631970	Gas Connector
9	641030	2-Pin Connector
10	645270	14-Pin Connector
11	642740	Welding Socket
12	660793	Insulator
15	620813	Front Panel
16	661504	Front Panel Label
17	614319	Fan Motor 90 x 90 x 25
20	661062	Knob
21	611902	Encoder
22	614127	Front Panel Logic µP PCB Group
22A	614128	Logic µP PCB
22B	613572	Display PCB
23	614179	Display 7 Seg. PCB
25	650977	Lem Probe
26	614013	HF Transformer
29	611435	HF PCB
30	611415	Output Filter PCB
31	620854	Support
32	614005	Power Transformer
33	614003	AC Driver PCB
36	613997	Output Inductance
37	614107	Clamper PCB
38	633940	Spring
39	613072	Remote Filter PCB
40	612911	Torch Switch Filter PCB
42	613962	Primary Inverter PCB Group
42A	613993	Primary Inverter PCB
42B	613792	Driver PCB
43	614323	Boost Inductance
44	620839	Left Side Panel

Pos.	Part#	Description
45	613308	Shield Logic PCB
46	613603	Primary Rectifiers Boost PCB
47	613606	Driver Boost PCB
48	613605	Power Boost PCB
49	613604	Logic Control Boost
50	613032	Input Power Cable
51	617030	Solenoid Valve
52	620851	Support
53	613602	Line Filter Boost PCB
54	661418	Plastic Foot
55	620885	Closing Metal Plate
56	620814	Base
57	620856	PCB Support
58	613791	Flyback PCB
59	620853	Support
60	646070	Resistor (680R, 50W)
61	614322	Fan 120 x 120 x 38
62	647760	Fuse Holder
63	660785	Cable Relief
64	620584	Closing Plate 65 x 27
65	613931	Control AWC Connector
66	661093	Rear Fan Cover
68	647010	Switch
69	620841	Cover
70	661034	Handle
71	614004	AC/DC Converter PCB
72	636650	Heat Sink
73	636630	Heat Sink
74	620852	Support
76	636640	Heat Sink
84	620838	Right Side Panel
85	650989	IGBT Inverter Module
88	620857	PCB Cover
90	636660	Heat Sink
92	650302	Secondary Diode

14) Glossary

Arc-Force Related to amps and volts when welding. When stick welding, the Pro Pulse 300 power source produces a CC, or constant current, output; in other words, the machine holds a constant amperage level, while the voltage varies according to the arc length, or the distance between the rod and the work surface—longer arc lengths increase voltage and shorter arc lengths decrease voltage. Increased voltage (a long arc length) keeps the puddle more fluid and the arc more stable, while decreased voltage (a short arc length) allows you to achieve better metal transfer and a wetter weld quality. The decrease in arc voltage, however, does pose the risk of extinguishing the rod, which is where arc-force comes into play.

When you set arc-force and your arc voltage begins to drop while welding due to a short arc length, arc-force increases your amperage (not you voltage) to give the weld puddle more drive and to keep the rod lit, and burn in (or burn through) deeper, without snuffing out the arc. Arc-force is an adaptive-dynamic process. If, for instance, you select 50% arc-force and set your welding machine to 100 amps, a decrease in arc voltage will cause the amperage to increase automatically up to 150 amps (as needed and only when you meet certain voltage drop conditions; you will NOT run at 150 amps continually). Likewise, if you weld at 100 amps and set arc-force to 200%, the amperage can increase, under certain conditions, up to 300 amps. At a 200% setting, drops in arc voltage will cause the amperage to climb faster than if would if set at 50% arc-force. Essentially, with arc-force set, you will not see the voltage go up at all if you hold the correct arc length, and if you hold the arc length too tightly, your amperage will increase, as needed, so the rod stays lit. Of course, you cannot watch the machine's display and weld at the same time, but you will hear the difference if/when arc force kicks in—our inverter welding machines sound unique, especially when arc force kicks in.

Hot-Start A burst of amperage for a very short time—typically less than one (**1**) second to help light the rod, or start the arc. When you set hot-start, you select a percentage of the welding current. For instance, if you set the machine to weld at 100 amps and then set hot-start to 30%, for a fraction of a second the machine puts out 130 amps to help light the rod and start the arc.