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ZENA™ mobile welding system

Operator's Manual

for All Mobile Welders Utilizing
ZENA™ Series 150 & 200 Power Generators
and Using Welding Control Modules
WC.12, WC.12RO, WC.24, & WC.24RO
&
Series WSC & WSC3
Welding Cables/System Controls

Including troubleshooting for:
Hydraulic and PTO Drive Welder Models, and
Welders Factory Installed on Genie® Lifts

This document contains the latest information available at the time of preparation. Every effort has been made to ensure accuracy. However, ZENA, Incorporated takes no responsibility for errors or consequential damages caused by reliance on the information contained herein.

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I. Introduction

Congratulations, you have purchased the finest mobile DC arc welder in the world! You will find it to be one of the most versatile and useful tools that you own. Designed to meets the needs of professional welders, working farmers, and industrial maintenance personnel, it is well suited to a wide range of other uses -- underground mining maintenance, industrial maintenance and fabrication, marine maintenance and fabrication, construction, nursery work, estate maintenance, arts & crafts, residential repairs, ornamental iron work, and more.

Your new welding system has a number of unique features which, when compared to conventional welders, make it safer and easier to use and superior in welding performance. Read this manual **carefully**, and **thoroughly** familiarize yourself with all controls, design features, safety features, and specifications **before** you begin to use it. This will insure that you will be able to safely, and to properly use your new welder.

The ZENA system produces a high frequency pulsating DC current for welding which provides a number of benefits over conventional DC welders. For example:

- Improved welding "feel" -- easier to start and maintain an arc[1]
- Electrically "stirred" weld bead provides additional penetration, less impurities, and easy to remove flux deposits -- producing ultra-smooth and clean welds even when used by inexperienced operator.
- Arc length is much less critical than past technology. Maintain an arc even with electrode tip in puddle!
- Use **any** welding rod (AC or DC), including aluminum, stainless , iron, nickel.
- Weld with long cables (up to 200 ft.) without noticeable loss of power
- Deeper than normal weld penetration for a given power setting

The ZENA system also features a unique control system designed to greatly enhance user safety and to provide the operator unprecedented control of the welding process:

- Welding power is not present at the electrode tip unless a safety/control button is depressed and held down. Change rods without any danger of shock (even when standing on a wet surface) and remove excess flux from rod/electrode tips without danger of inadvertent arcing
- Welding power is infinitely variable while welding -- no performance limiting pre-set power settings
- Welding power is controlled from the welding handle and can be varied while welding to insure good weld penetration even when welding materials of varying thickness and structural stability
- Special controls assist with arc starting by allowing the operator to briefly use high power while starting an arc and then dropping back to a preset power setting when arc condition is satisfactory.

Additionally, your welder includes features which you would expect to find on any high quality welder:

- Output power is fully isolated from vehicle, engine, or earth ground.
- Weld with both standard and reverse polarity (even when installed on a vehicle).

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[1] Other arc welders require you to maintain an arc length equal to the diameter of your welding rod for optimum results. With ZENA welders, you can produce excellent welds with arc lengths ranging from .1 to 2 times rod diameter. For a 1/8" rod, you can hold your rod tip in direct contact with the puddle or as far away as 1/4" and still produce a good weld.

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II. IMPORTANT SAFETY WARNINGS & REFERENCES

A. Proper Installation

Proper installation is critical to proper welder function and safety. Follow all guidelines set forth in this manual. Failure to do so may result in personal injury and/or in damage to the vehicle in which the welder is installed and/or to the engine to which the welding system is attached.

ZENA, Inc. will not be liable, in any way, for such injury and or damage which may result from improper installation and or improper use of the product.

B. Danger of Personal Injury

Serious injury or death may result if your welding equipment is not properly installed, used, and maintained.

Welding is an inherently dangerous activity, and ALL welding equipment can be very dangerous if used improperly. Welding is often performed in dangerous environments such as high places, around water, in close quarters, etc., and it is critically important that the operator be aware of the dangers associated with these conditions. Operators must be aware of these dangers, trained in safe operating practices, and properly supervised and/or assisted.

The ZENA welding system incorporates within its design safety features and special controls that enhance operator safety. These features and controls should never be disabled.

Welding equipment, including the ZENA mobile welding system, should only be used by an experienced welder using proper eye protection devices equipped with a #12 to #14 shade filter lens and proper protective clothing. If used improperly or carelessly severe eye damage and/or severe burns can occur.

Welding equipment can damage and/or interfere with the operation of delicate electronic equipment. Use of the ZENA welding system (or other welding equipment) should not be attempted by individuals who use pace-makers and/or other life-sustaining electronic medical implants and/or devices.

C. Danger of Electrical Shock

When properly installed, the ZENA system converts your vehicle into a fully functional mobile welder capable of producing very high direct current (DC) welding energy (depending on the model, from 150 to over 800 amps). As such, it should be always be used with extreme caution. In some cases, even though the system, when operating, produces low voltage DC, life threatening electrical shock is possible.

D. Fire & Explosion

When welding out of doors, particular attention should be given to the prevention of fires. Sources of combustion are the welding arc, flame, flying sparks, hot slag, hot metal, and other heated materials.

Do not attempt to weld in remote areas without a suitable fire extinguisher and/or sufficient water and tools to extinguish any inadvertent fires which may be caused by the welding process.

Do not weld or cut containers which have held combustible materials. Arcing against compressed gas cylinders can cause explosion or damage to cylinder rendering it unsafe. Do not weld near any source of oxygen.

E. Safety / Operating References

This manual is a critical safety device. It incorporates, within its text, information that is critical to operator safety and to safe equipment operation. We recommend that it be kept with the equipment at all times. Should it become damaged and/or otherwise unusable, replacement copies will be provided at no charge. Call 877 ZENA INC or 615-897-2011 to order replacements. You can also order replacements via mail from the address noted on the cover, or via e-mail (support@zena.net).

F. Other Safety Publications/References:

US Govt. Printing Office, Washington, DC 20402 -- *Code of Federal Regulations* (OSHA) -- Section 29 Part 1910.95, 132, 133, 134, 139, 251, 252, 253, 254, and 1000.

American National Standards Institute, 1430 Broadway, NY, NY 10018 -- ANSI Z49.1 "*Safety in Welding and Cutting*"; ANSI Z87.1 "*Practice for Occupational and Educational Eye and Face Protection*"; ANSI Z88.2 "*Standard Practice for Respiratory Protection*"

American Welding Society, 550 NW Lejeune Road, POB 351040, Miami, FL 33135 -- AWS C5.3 "*Recommended Practices for Air Carbon Arc Gouging and Cutting*"; AWS F4.1 "*Recommended Safe Practices for Welding and Cutting Containers*"

National Fire Protection Association, Battery Park, Quincy, MA 02269 -- NFPA 51B "*Fire Prevention in Cutting and Welding Processes*"

Canadian Standards Association, 178 Rexdale Bl., Rexdale, Ontario, Canada M9W 1R3 -- CSA Std. W117.2. "*Safety in Welding, Cutting and Allied Processes*"

III. Checking Your Package Contents

Unless you have ordered an extra long welding cable/system control handle assembly (or a special MIG or TIG interface/adapter kit), your ZENA welding system (and any accessories which you have ordered) will typically be packaged in a single container designed to protect the product from the normal hazards of domestic and/or international shipping. It consists of an outer carton that contains the welding cables/system controls and any small accessories which you may have ordered, and an inner carton that contains the power generating unit and its electronic control module[2].

Except as otherwise noted on an enclosed packing list/invoice, a typical package should contain:

Qty.	Item Description
1 ea.	Welding System Power Generator
1 ea.	Set of Black & Red #14 AWG High Temperature Hookup Wires
1 ea.	Operators Manual & Limited Warranty
1 ea.	Electronic Control Module (mounted on Welding Power Generator[3])
1 ea.	Invoice/Packing List
1 ea.	Electrode Holder/Control Handle & Cable Assembly[4]
1 ea.	Ground Clamp & Cable Assembly

[2] In some cases, the Welding Power Control Module may be shipped in the outer carton.

[3] The Welding Power Control Module is not attached to the 200A power generator when shipped. It may, at the installer's option, be attached to the Power Generator during the installation process.

[4] And/or, whatever optional control interface accessory which you may have purchased with your welder.

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IV. ZENA Welder Specifications

Welders with 150 amp. modular welding power generators		
Power Output @ 100% Duty Cycle	150 amps.	
Typical Voltage Output @ Full Power w/Arc Established	20 to 24VDC w/High Frequency Waveform Modulation	(Typically 700 modulation transitions per second)
Direction of Rotation	Clockwise	(Viewed from pulley end)
Typical Voltage Output @ Full Power w/NO Arc Established	58 to 78VDC w/High Frequency Waveform Modulation	(Typically 700 modulation transitions per second)
Min. Power Generator Shaft Speed for Maximum Output Power	approximately 6,500 RPM	(Higher shaft speeds – up to 15,000 rpm - have no detrimental effect on welding performance, but welding at these speeds requires larger drive pulley diameters)
Typical Min. Driving Motor Speed for Max. Output Power	2,400 RPM	(Assumes typical motor drive pulley to Power Generator pulley ratio of approximately 2.5:1)
DC Power Required (When Welding)	11.5 to 14.5 volts @ 7 amps. maximum	(1 to 4 amps at average welding power settings)
DC Power Required (When NOT Welding)	11.5 to 14.5 volts @ .05 amps.	
Control Circuit Protection	Internal Fuses (2)	(2 amp. & 10 amp.)
Welding Controls	Internal, Solid State	(Built into electrode holder/welding cable assembly)
Accessory Control Outputs	Internal (2)	Control outputs for up to 3 ASC speed controls and for up to 4 WCS Slave Power Control Modules

SR150.12 welding power generator with WC12 control module

Welders with 200 amp. modular welding power generators		
Power Output @ 100% Duty Cycle	200 amps.	
Typical Voltage Output @ Full Power w/Arc Established	20 to 24VDC w/High Frequency Waveform Modulation	(Typically 700 modulation transitions per second)
Direction of Rotation	Bi-directional	
Typical Voltage Output @ Full Power w/NO Arc Established	58 to 78VDC w/High Frequency Waveform Modulation	(Typically 700 modulation transitions per second)
Power Generator Shaft Speed for Maximum Output Power	approximately 6,500 RPM	(Higher shaft speeds – up to 14,000 rpm - have no detrimental effect on welding performance, but welding at these speeds requires larger drive pulley diameters)
Typical Min. Driving Motor Speed for Max. Output Power	2,400 RPM	(Assumes typical motor drive pulley to Power Generator pulley ratio of approximately 2.5:1)
DC Power Required (When Welding)	11.5 to 14.5 volts @ 7 amps. maximum	(1 to 4 amps at average welding power settings)
DC Power Required (When NOT Welding)	11.5 to 14.5 volts @ .05 amps.	
Control Circuit Protection	Internal Fuses (2)	(2 amp. & 10 amp.)
Welding Controls	Internal, Solid State	(Built into electrode holder/welding cable assembly)
Accessory Controls	Internal (2)	Control outputs for up to 3 ASC speed controls and for up to 4 WCS Slave Power Control Modules

SR200.12 welding power generator with WC12 control module

V. Operator Controls -- Basic "Stick"/Arc Welders

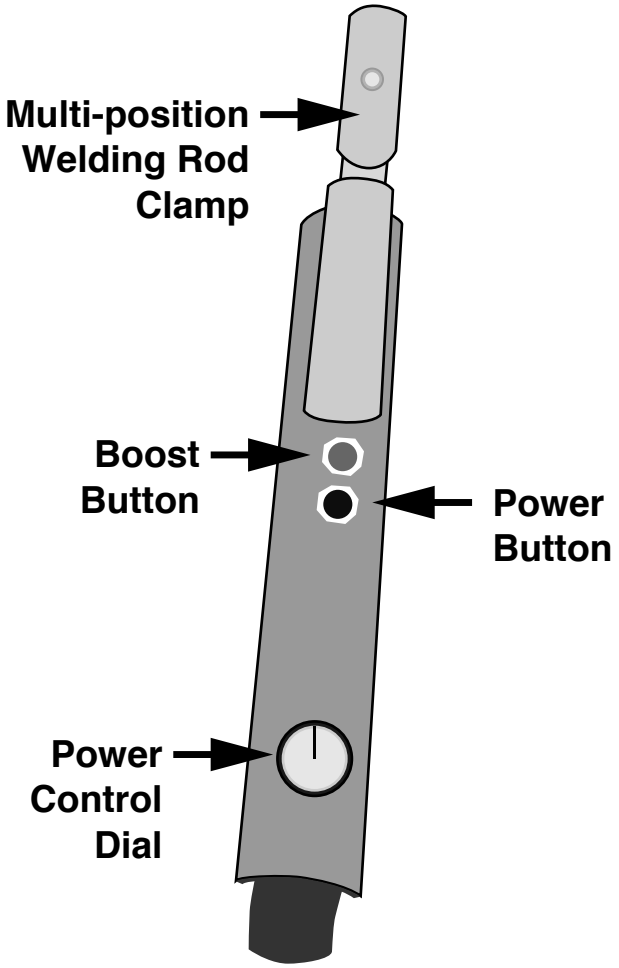
The ZENA welding system features a unique, but very simple, control system.

All welding controls, except for welding polarity selection (determined when connecting welding cables to the Power Generator), are built into the welding electrode holder[5].

Multi-position Electrode/Welding Rod Clamp

By selecting the proper groove in the clamp's contact area welding rod position can be set to a number of convenient positions relative to the control handle (i.e., 0°, 45°, 90°, 135°).

The clamp is opened by depressing the insulated arm attached to the clamp.



Power Button

Turns welding power **ON** when the Power Button is pressed and held down. Welding power is not present at the tip unless the Power Button is depressed **and held** down.

Power Control Dial

The Power Control Dial allows you to precisely control welding current/power. Welding power is infinitely variable and can be adjusted at any time – even while welding.

Turning the control fully counter clock-wise yields minimum power and turning it fully CW sets the unit to produce maximum welding power.

This control can assist an experienced welder in insuring excellent weld penetration even when welding materials of varying thickness and structural stability.

Boost Button

This control is provided to assist you with arc starting in difficult conditions (i.e., working with thin gauge, or rusty, or painted metal) by allowing you to briefly select high power to start an arc and then dropping back to your preset power setting when arc condition is satisfactory.

Press and hold the Boost Button for **full** power output, release the Boot Button to return instantly to the power setting selected by the Power Control Dial.

NOTE: The Boost Button must be held down **in addition** to the Power Button.

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[5] Welders purchased with optional controls for MIG and/or TIG welding -- or, with our PCIM (Power Control Interface Module) will differ from the description above. However, the same control features are incorporated into these alternate controls.

Welding Polarity

Welding polarity is selected/determined by the attachment of the welding cables, using the supplied wing nuts, to the terminals at the rear of the Power Generator Unit.

Red cable lug to Red terminal &
Black cable lug to Black terminal
= reverse (positive electrode) welding polarity

Red cable lug to Black terminal &
Black cable lug to Red terminal
= standard (negative electrode) welding polarity

VI. Using your ZENA™ mobile welding system

The ZENA system is exceptionally easy to use. However, the preparation of the equipment for use varies in some small degree depending on the model and control interface that you are using, the method of installation used to attach the welder to your engine or vehicle -- and, whether or not your are using one of our cable extension accessories.

A. Cabling Attachment

1. **Model 150 and 200 Series welders** (including multi-generator welders -- 300, 400, 600A, etc.) **— Power Generator Used for Welding Only**

   If you are using any series 150 or series 200 welder, and if the welder **is not** being used as an electrical power source for the vehicle in which it is installed:

   a) Attach the welding cables to wing-nut terminals at the rear of the Welding Power Generator selecting standard (negative electrode) or reverse (positive electrode) welding polarity depending on your welding needs (reverse welding polarity is the usual choice for most steel alloys and aluminum -- Red to Red / Black to Black).

   b) Attach the black control cable connector to the black mating connector attached to the short gray cable coming out of the Control Module which is affixed to the outside of Welding Power Generator.

2. **Model 150 and 200 Series welders** (including multi-generator welders -- 300, 400, 600A, etc.) **— Power Generator Used to Supply Vehicle Electrical System (controlled by an External Voltage Regulator)**

   If you are using any series 150 welder and if the welder **is** being used as an electrical power source for the vehicle in which it is installed:

   a) Disconnect the voltage regulator from the Welding Power Generator.

   b) Disconnect the cable going from the positive (Red) terminal of the Welding Power Generator to the vehicle's battery.

   c) Disconnect the cable going from the negative (Black) terminal of the Welding Power Generator to the vehicle's chassis ground.

   d) Attach the welding cables to wing-nut terminals at the rear of the Power Generator selecting straight or reverse welding polarity -- depending on your welding needs (reverse welding polarity is the usual choice -- Red cable lug to Red terminal/ Black cable lug to Black terminal).

   e) Attach the black control cable connector to the black mating connector attached to the short gray cable coming out of the Control Module (often affixed to the case of the Welding Power Generator).

B. System Operation — All Models

1) Start the vehicle/drive engine.

2) Set the vehicle/drive engine speed to welding RPM (determined during installation).

   NOTE: If you have a ZENA automatic speed control installed, vehicle/engine speed will automatically rise to welding speed when you start the welder -- returning to idle when you stop welding[6].

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[6] If your welder is equipped with the WC12.RO welding power control module engine speed will return to idle approximately 30 seconds after you release the power control button.

3) Starting from the welder's minimum power setting (Power Control Dial fully counterclockwise) set the Power Control Dial to an approximate power setting for the size of welding rod used. See the charts below:

Series 150		
30-40% CW	60-75% CW	90-100% CW
3/32 inch	1/8 inch	5/32 inch

Series 200			
25% CW	40-50% CW	6--75% CW	90-100% CW
3/32 inch	1/8 inch	5/32 inch	3/16–1/4 inch

As soon as you start welding, the Power Control Dial setting should be adjusted to yield the desired arc and proper weld penetration for the type of welding rod which is being used, the environmental conditions, and the type of material being welded. Remember, you can **adjust the power at any time while you are welding**.

4) Depress the Power Button, strike an arc, and begin welding. Remember, if you are having trouble striking an arc, for any reason, you can simultaneously depress the Power Button and the Boost Button to produce an extra strong arc. Then, as soon as an acceptable arc is established, release the Boost Button by sliding your finger off the Boost Button and moving it fully onto the Power Button to return to the welding power determined by the Power Control Dial's setting. Remember, you can adjust the power while you are welding, and you can also use the Boost Button at any time while welding in situations where extra power for a short time is desired.

CAUTION

When properly installed, ZENA system converts your vehicle into a fully functional mobile welding workstation. As such, it should be used with extreme caution and only by an experienced and knowledgeable operator.

Please read the section of manual on operator safety.

VII. Installation Notes

The ZENA system can be attached to any suitable engine or installed into virtually any vehicle (tractors, trucks, emergency vehicles, forklifts, construction equipment, water craft, lawn tractors, etc.) capable of producing at sufficient power to drive the system's Welding Power Generator[7] -- transforming the vehicle into a self-contained mobile welding station with performance and operating features that equal or exceed heavy, bulky, and expensive transportable engine-driven industrial welders. When properly installed, the ZENA power generator is **completely isolated** from the vehicle's electrical system, virtually eliminating any chance of damage to the vehicle's electrical system when welding with reverse (positive electrode) or straight polarity (negative electrode) – even if welding on the vehicle to which it's installed.

The information contained in this section is, of necessity, general in nature and is composed for individuals with the technical competency necessary for the installation and/or retrofit of electro-mechanical equipment to an engine, or into a motorized vehicle. Particularly in the case of post 1985 automotive installations, where sensitive microcomputer devices are in use, we recommend that installation be performed by mechanics who are completely familiar with a given vehicle's electrical systems. Some of these vehicles have electrical systems which are so fragile that they can be seriously damaged by maintenance activities as simple as routine battery replacement.

CAUTION:

Extensive damage to a vehicle's electrical system can occur when installing or maintaining electrical equipment if one is using improper safety and/or maintenance techniques.

NO ATTEMPT HAS BEEN MADE TO SIMPLIFY THIS INFORMATION FOR USE BY INDIVIDUALS WHO ARE NOT TECHNICALLY COMPETENT TO INSTALL THIS EQUIPMENT.

If you are unsure of your ability to successfully install the welding system, contact us. We will advise you on arranging for professional installation services.

If you are sure of your ability, and choose to "do-it-yourself", remember to check with us to see if installation notes or photos have been published for your vehicle, or a similar model. These installation notes, which are shared with us by our dealers and customers, are made available to all of our customers free of charge (just check our web site, or call us). Additionally, we have available a number of universal/generic bracketing components (some of which are described in later sections of this manual), which you can purchase from our parts department, to make your installation easier.

If you have access to the Internet, check our web site where you may find additional information that may help you with the installation of our product into a specific vehicle.

Actual installation of the ZENA system is usually quite simple and straightforward in its concept, but there is a high degree of variation from one vehicle to another. Further, in any particular vehicle,

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[7] Engine size necessary to drive a 150A Generator --> 11+ hp, if engine is gas fueled; 6+ hp for diesel engine; 7.5+ hp required for electric motor power.
To drive a 200A Generator --> 18+ hp, if engine is gas fueled; 8+ hp for diesel engine; 10+ hp required for electric motor power.

there can be many "correct" installations. Therefore, frequently this manual may simply advise what not to do, rather than trying to provide specific instructions which would, in all likelihood, only apply to a single situation.

A. Safety Notes

Safety is of key importance. Go slowly and carefully read all instructions prior to attempting any task.

In addition to any other cautions that may appear elsewhere in this document:

- Always work in a well ventilated area. Never start or operate a vehicle engine in an enclosed area without providing proper exhaust ventilation.
- Never smoke or allow open flame to come within 25 feet of the vehicle in which the system is being installed.
- Make sure that everyone within close proximity of your work site is correctly wearing approved safety glasses before operating the vehicle engine or using any power tools.
- Make sure that the vehicle's engine is off when connecting or disconnecting any welding system component, tools, or test equipment.
- Always exercise extreme caution to insure that hands, arms, clothing, etc. are kept well away from any moving parts.
- Make sure that anyone within line of sight of any welding operation is wearing and using properly approved protective eye wear for the type of work being performed.

B. Mechanical Installation

Mechanical installation is simple and straightforward. The ZENA power generating unit (or units in multi generator systems) should be installed by a competent mechanic who is familiar with the type of vehicle in which the system is being installed and who is capable of the minor fabrication work which may be required.

NOTE:

This installation information is, of necessity, general in nature.

Often, specific information that will assist in the installation of a ZENA system into a particular vehicle is available. We try to maintain and publish such information on our Internet web site (www.zena.net). If you do not have access to the Internet, we will be happy to check our files and provide such information to you, if available, at no charge. Just write, fax, or give us a call, and ask for customer support.

Key points to have in mind when planning your installation follow:
(we recommend that you read all sections before proceeding with your installation)

1. Power Generator Welding Speed

a) Welding performance is affected by engine speed. Ideal welding performance occurs when the **power generator** (not the engine) is turning between 6,000 to 7,500 rpm. Speeds as low as 5,500 rpm may provide acceptable results for low power welding applications. Generator speeds exceeding 7,500 rpm are also OK (but will provide little performance benefit).

The minimum **engine speed** for welding **is not** the same for all installations. For a given set of Power Generator and engine drive pulleys, there is a proper welding

speed range. Be sure to refer to the **charts** and/or **formulas** provided in **Section VII, Part C** to determine the proper engine speed for your installation.

b) In most cases (about 50% of the time), the stock Power Generator and engine drive pulleys will perform adequately. However, sometimes, the use of non-stock pulleys (larger or smaller in diameter), or the ZENA Add-A-Pulley™ universal alternator power take off kit, can improve performance characteristics for certain installations.

For example, engine welding speed for a powerful tractor (40-100 HP) might be determined to be approximately 2,500 rpm. However, by selecting and installing an inexpensive larger diameter secondary crank pulley in front of the engine's stock crank pulley, engine welding speed could be reduced to approximately 1,600 rpm.

Alternately, with this same tractor, the use of the Add-A-Pulley **and** a smaller than stock drive pulley on the tractor's alternator can reduce engine speed even more -- in this example, welding at as little as 1,250 rpm.

c) When making your calculations, remember that if you are driving your Power Generator from an existing alternator using a ZENA Add-A-Pulley™ alternator power take off pulley, in most cases, there will be a built-in 10-40% reduction of needed engine speed for welding (determined by ratio of existing alternator pulley diameter to Add-A-Pulley pulley diameter). For example, if 2,500 rpm would be the proper engine speed, you would only need a speed of 2,000 to 1,500 RPM, for welding, when using the Add-A-Pulley accessory.

d) Since the method of drive chosen, may effect the positioning of components and the design of bracketing for a particular installation, it is important to make these decisions BEFORE beginning the installation. Our technical support personnel, will be happy to assist you in developing an installation plan for your application.

CAUTION / NOTE:

DO NOT make the mistake of modifying drive pulley ratios to the point that an engine welding speed which is LESS than approximately 40-50% of maximum engine rpm is achieved. Doing this can cause the welding power generator to over-speed when engine speed is increased to maximum during normal vehicle use -- possibly causing damage to the generator, its bracketing, its drive belt(s), or the vehicle/engine.

2. Power Generator Positioning / Rotation

a) ZENA's proprietary power generating technology, coupled with a very efficient forced air cooling system (which draws cool air in from the **rear** and exhausts heated air from the front), results in such an efficient power generating system that, in free air conditions, even when welding continuously at full power, ZENA's Power Generator stays remarkably cool – usually cool enough so that it can be touched without undue discomfort (though it will likely be too warm to hold comfortably for any length of time). However, real-world conditions are never perfect, so the ZENA system has been designed to operate reliably in very high ambient air temperatures -- such as those existing under the hood in motor vehicles.

For maximum performance, trouble-free operation, and a long service life, plan to **mount the Power Generator so that ample cool air is available to supply its forced air cooling system**. For example, avoid mounting positions where air is hot and not "moving" and/or where the superheated air from an engine's exhaust system

will be drawn into the rear of the Power Generator. Such a heat source can, by itself, heat the Generator to temperatures which will damage internal components.

b) In automotive installations, a supply of relatively cool air for the welding system's Power Generator can be obtained by installing a **well positioned**, **high efficiency**, electric radiator cooling fan **and/or** large diameter non-collapsible duct hose[8] so cool air from outside the engine compartment will be directed to the rear of the Power Generator, or (in some cases) by simply insuring that the vehicle's engine compartment hood is "open" position when welding.

c) If possible, insure that the chosen mounting point is one which allows the operator to easily attach welding and control cables to the Power Generator. Where this is not possible, or where extra convenience is desired, consider the installation of one of ZENA's external welding cable quick disconnect kits (model BJ150 or BJ200).

d) **Drive pulley/belt alignment is critical for vibration free operation, and long belt life**. Every effort should be made to insure precise alignment between components.

e) **Consider a "piggyback" installation**. This most popular type of installation uses the existing engine alternator (which is fitted with a double pulley) as the drive point for the Power Generator (which is, typically, mounted close to the alternator) — often using the existing alternator mounting bolts and/or bracketing as part of the new Power Generator bracketing. The double pulley on the alternator allows a short (typically 20"-30") drive belt to be attached between it and the Power Generator.

   To make this sort of installation possible for engines which use a serpentine drive belt system, and to make installations onto V-belt equipped engines even easier, we have developed the Add-a-Pulley™ retrofittable secondary alternator pulley[9]. The Add-a-Pulley fits almost all existing automotive alternator designs, and come with all necessary parts to retrofit an existing alternator or with a secondary drive pulley that can be used to drive the Power Generator. See **Appendix E** for more information.

f) **The 150 amp welding power generator should be installed so that its rotation is clockwise** (as viewed from the pulley end). **However**, **the direction of rotation AND the physical (front to rear) positioning of the 200 amp Power Generator, relative to the engine, are not critical**. The 200 amp unit will operate properly rotating in its normal clockwise direction, or turning counter-clockwise, and/or when mounted with its pulley end pointing towards the rear **or** the front of the engine.

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8 Use ducting designed for automotive use. Appropriate ducting material is available from most auto parts supply outlets — typically sold as a replacement for existing grill to air filter intake fresh air ducting.

9 Add-a-Pulley™ is a trademark owned by ZENA, Incorporated for its retrofittable secondary alternator pulleys.

CAUTION / NOTE:

The shaft end nut which secures the cooling fan and the drive pulley to the front of the Power Generator is self tightening/locking in normal CLOCKWISE rotation. If the 200 amp Power Generator is rotated COUNTER-CLOCKWISE, the shaft end nut MUST be secured to the drive shaft with an appropriate high strength, high temperature chemical threadlocker. (LOCTITE® type 272, or equivalent.) Also, the points of contact between the fan and the drive pulley and the drive pulley and the nut should be strengthened/reinforced with an appropriate stud locking compound. (LOCTITE® type 648 retaining compound, or equivalent.)

These chemicals are designed for semi-permanent assembly. Disassembly can be difficult -- often requiring heat to soften the locking material for removal. Do not apply threadlockers until after you are completely satisfied with your fully completed welder installation (including any clocking operation - see item #6 below).

3. Bracketing

There are a number of vehicles in which a bolt-in installation, using existing brackets, can be accomplished. For example, your engine may have had an air-conditioner or smog pump which has been removed -- providing you with a ready made location for your new welder.

Sometimes, bracket attachments points may be available. For example, most Ford diesel engines come factory equipped with bracketing points for the installation of a second alternator

More typically, however, new brackets will be required for mounting the belt-driven Power Generator -- positioning the Power Generator as noted previously, and so that a clear path is available for the attachment of the existing drive belt (or a new drive belt) from the Power Generator to

- the engine's crankshaft pulley, or
- to the engine's existing alternator (using a secondary pulley),
- to a pulley installed on the engine's flywheel or drive shaft, or
- to some other appropriate drive/power take-off point.

Remember that your welding Power Generator is **air cooled**, and that it should be mounted in a position which is as far as possible from the engine exhaust system, or other areas, in which high ambient air temperatures may be found. Where this is not possible, electric cooling fans, metal heat shields, ducting, and/or other methods should be used to protect the unit from excessive heat and/or to route cool air to the **air intake vents** at the **rear** of the Power Generator.

As noted previously, initial consideration should be given to using an existing (factory installed), but unused, mounting bracket and/or bracket mounting fittings. For example, many vehicle engines are designed to accommodate a second alternator, a belt-driven air compressor, or a high capacity hydraulic pump. If these devices are not installed, the ZENA welding Power Generator can often be mounted to these existing fittings using either simple custom-fabricated brackets and/or parts of accessory installation kits which are often available from the vehicle's manufacturer. For example, many tractors are designed to have optional air conditioning systems installed. It is often possible to use the brackets and idlers which come with these kits for a Power Generator installation that will require little or no additional modification.

If you are not able to use existing mounting brackets, custom brackets must be fabricated. To assist you, prefabricated universal mounting brackets such as the model A300A, model A400A, and other bracket fabrication components, which can be used to construct your custom brackets, are available from ZENA, or through other commercial sources[10]. Often, an installation may require **both** prefabricated mounting brackets and some other simple parts and/or brackets which must site fabricated by the installer. **See Appendix A and Appendix B for examples**.

Make your bracket(s) VERY strong — when installed, your Power Generator must be mounted in a way which leaves it **just as firmly placed as the existing alternator, air conditioning compressor, or power steering pump in a motor vehicle**.

Typically we recommend that bracket parts be constructed from steel stock which is **at least** 5/16 inch thick for 150A generators (3/8 inch is even better). For 200A generators use 3/8 inch or 1/2" stock. All bar stock used should be at least 1" in width (1-1/4" is better). When using angle stock, we recommend 2" x 5/16" angle for most applications. When in doubt, always choose materials which will result in a stiffer/stronger support system, rather than materials which will yield a less stiff/weaker support.

Brackets may be welded together to insure maximum strength (or may be assembled quite successfully with nuts and bolts). However, we **strongly** recommend that the Power Generator's mounting bracket(s) be first mounted with removable fasteners and that bolt holes be oversize or slotted. Use at least two Grade 8 5/16" bolts to attach the 150A Power Generator bracket to other bracketing components -- 3/8" bolts for the 200A Generator. Using bolts for Power Generator attachment allows you to make adjustments, before any welding), necessary to insure perfect alignment of the Power Generator to the pulley/power take off point on the engine.

Most automotive engines are mounted to the vehicle frame using some sort of flexible shock mount. When driving a Power Generator from a shock mounted engine, the Power Generator's mounting bracketing **MUST** be attached **exclusively** to the engine and/or to other components which are attached directly to the engine. Failure to do this can result in severe, and potentially damaging, vibration and very short drive belt life.

When mounting a Power Generator to tractors and other vehicles which directly, and firmly, mount the engine to the frame of the vehicle, the bracketing for the Power Generator may be attached directly to any part of the vehicle which is sturdy enough to provide proper support. DO NOT, however, attach any portion of the Power Generator bracketing to any mounting point or frame member which is also used to attach a front end loader or other similar equipment to the vehicle. This sort of equipment is subject to slight, but continuous, movement on the vehicle. This slight movement can easily cause belt alignment to vary to an unacceptable degree when mounting points are shared.

4. Bracket Fabrication Tips

Save money, save time, and minimize wear and tear to your tools:

a) Use heavy CARDBOARD to work out bracket designs. And, by taking cardboard forms with you to buy steel, you may get your vendor to do the rough cutting.

(Cardboard pieces can also insure proper welder to hood clearance. Place a couple of thickness of cardboard where clearance are tight, and close the hood, a bit at a time, observing the cardboard for indentations which indicate too little clearance.)

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[10] See links to these resources on our web site -- www.zena.net

b) Installers report the most used sizes of steel used in fabricating brackets for 150A welders are: 2"x5/16" angle, 3"x5/16" angle, 1-1/4"x5/16" bar, 1"x5/16" bar, 1-1/4"x3/8" bar, and 1"x3/8" bar. (Use thicker material for 200A Generators.)

c) If you don't have a supply of steel on hand, consider purchasing what you need from a local machine shop, welding shop, trailer fabricator, or other business involved in steel fabrication work. Their prices will be much less than hardware stores and (since you'll be buying small pieces of their scrap stock) you won't have to buy more metal than you need (as is be the case with bulk steel suppliers).

Check to insure that the pulleys are in parallel alignment with a straight-edge, making sure that the straight-edge contacts both the Power Generator pulley and the pulley to which it is being aligned at two points on the surface of each. Using the same straight-edge, make sure that the "V's" of both pulleys are in perfect alignment as well. A piece of 1/4" x 1" angle stock (steel or aluminum) is good as a straight-edge for this purpose.

Make sure that V-belts run perfectly straight and true. Belts which are mis-aligned will cause excessive frictional heating of the V-belt and excessive mechanical wear which will result in premature belt failure, possible pulley damage, and possible damage to your Welding Power Generator. **It is very important that the path of the drive belt be straight.** Brackets should always be made (and installed) so that initial adjustment is possible. Often, this may mean using slightly oversize mounting holes, or simple slots. (After initial adjustment, tack welding is sometimes done to prevent unwanted motion.)

Finally, insure that all pulleys in the drive path will have appropriate drive belt "wrap"/surface area contract. At least 40% of pulley circumference for larger pulleys -- 50-70% for smaller (under 3" dia.) pulleys. If belt wrap is not correct, use properly positioned[11] flat idler pulleys to insure proper wrap around drive and driven pulleys. If used, flat idler pulleys must be sized to be, **at least**, 30% larger than the smallest pulley in the group (typically, the smallest pulley will be the pulley on the Power Generator).

5. Drive Belts

After the brackets are installed and the Power Generating unit has been properly and securely mounted, a correctly sized drive belt (3/8 inch for the Series 150, 1/2 inch for Series 200 welders) is attached to the chosen drive source[12], and properly tensioned.

NOTE:

In some cases, it may be desirable to fit dual drive pulleys and use dual drive belts -- less belt tension is required, adjustment intervals may be longer, and belt life may be extended. A wide range of special double V pulleys are available from our parts department -- call to discuss your specific needs.

DO NOT USE lawn mower/agricultural implement type V-belts (fabric covered) to drive the ZENA welding Power Generator. They slip during operation and produce a large amount heat when used with small pulleys operating at high speeds.

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11 When placing an idler pulley in a belt drive system with clockwise rotating pulleys (as viewed looking at the pulley end), the idler should be placed on the in-going side of the smaller (driven) pulley. This will be the lower half of the belt, if the Generator is mounted on the left side of the engine (as viewed looking at the pulley end of the engine). (On the upper half of the belt, if the generator is mounted on the right side of the engine.)

12 i.e.: engine crank shaft pulley, drive from a vehicle's existing alternator (via ZENA Add-A-Pulley power take of kit or a double V-pulley installed on the vehicle's alternator)(allows "piggyback" installation -- a method which often greatly simplifies welder installation in existing vehicles), etc.

Use ONLY high-quality, **soft rubber**, automotive type V-belts. **We have found the "bottom-cog" type to be, BY FAR, the most effective for our application.**

Don't over OR under tighten drive belts. This will cause excessive frictional heating of the V-belt and drive pulleys, extra strain on bearings and internal electrical components, and will result in premature belt failure. A slipping belt is sometimes hard to detect. **However, a "hot" pulley is a sure sign of slipping (or poor alignment)**. Tighten belts just enough to prevent any slipping, or squealing, when operating your welder at full power -- yet not so tight that there is not a slight amount of give in the belt.

Consider the use of a spring loaded belt tensioning device. These devices provide, BY FAR, the best means for assuring maximum belt efficiency and maximum belt life. High quality spring loaded tensioners are available from our parts department.

Regardless the method of belt tensioning chosen, ALWAYS static test belt tension. This is key to insuring long term trouble free welder operation.

Static test belt tension by using a properly sized socket wrench on the power generator's pulley bolt to try to rotate the power generator in a CW direction. The pulley should be quite difficult to turn using moderate hand pressure. Often an engine will "turn over" before any belt slip will be noted. At the same time, you should notice a very slight slackening of the belt tension on the in-going side of the pulley[13]. If any slippage is noted, the point of failure should be easy to determine.

ALWAYS re-check belt tightness after the first few of hours of welding.

We **DO NOT** recommend the use of belt dressings for most applications -- particularly those where the system is operated in dirty or dusty conditions.

NOTE -- V-belt "wrap" around pulleys is more important than belt tension:

For example, some trucks, and other vehicles with serpentine belt accessory drive systems may have alternators which have BOTH a very small (2.5" diameter) alternator drive pulley fitted AND provide only very minimal belt "wrap" around this drive pulley (for example, 30% of pulley diameter or less).

In this case, if using an Add-A-Pulley power take off accessory, serpentine belt slipping at the alternator pulley may occur when welding at higher power settings. This sort of slipping CANNOT be prevented by simply tightening or replacing worn OEM serpentine belts.

To obtain proper "drive" for your welder, it may be necessary to install an "idler" pulley to redirect the V and/or the serpentine belt path to insure a good "wrap" around ALL small pulleys (at least 55-70%). (If this is necessary, it may also be necessary to obtain different length serpentine or V belts).

6. "Clocking" Power Generator and/or Repositioning Control Module

In some cases, installation of the Power Generator will leave it oriented so that the operator cannot easily attach the welding cables, or you may find that the Control Module will physically interfere with some existing component unless it is relocated. (You may also want to have the control module is easily visible for troubleshooting.)

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[13] This will be the lower half of the belt, if the Generator is mounted on the left side of the engine (as viewed looking at the pulley end of the engine). (On the upper half of the belt, if the generator is mounted on the right side of the engine.)

Other than to **avoid heat**, Control Module mounting is not critical. It may be moved to any of the four bolts which hold the front and rear case parts of the Power Generator together **or** to **any other** convenient point on the vehicle near the Power Generator. (The Control Module does not need to be attached to the Power Generator.)

Changing the orientation of the welding cable terminals to the Power Generator's mounting points is called "clocking". This procedure allows the installer to reposition the external welding lead terminals by rotating the front portion[14] of the Power Generator 90°, 180°, or 270° from its "stock" position relative to the rear case portion**.**

"Clocking" the Power Generator is a simple process:

a) Using an impact wrench, remove the large nut which holds the V-belt pulley and cooling fan to the front of the Power Generator.

b) Taking care NOT to separate the front and rear case parts, remove the four bolts which hold the front and rear case parts together.

c) Place the Power Generator on a workbench with the shaft pointing "up", and with the welding lead terminals "down" (taking care to protect the terminals from damage).

d) While maintaining pressure on the shaft to keep it from moving away from the rear case, lift the front case up slightly and rotate it so that proper orientation is achieved.

e) Reinstall and tighten the bolts which hold the case parts together, attaching the Control Module to the Power Generator case with one of the screws (if so desired).

f) Complete by reinstalling fan and pulley. **Tighten the nut with an impact wrench.**

7. Final Check / Other Considerations

a) Check that **bracketing is strong**, that **all bolts** (including drive pulley nut -- use impact wrench) **are tight**, and that **cooling air is available at rear of generator**. Check all electrical connections. Insure that wires are secure and routed properly.

b) In some cases, simple sheet metal covers may be used to further dress-up the installation, to shield hands and arms from moving components, etc.

c) Also, we recommend that some means of carrying welding rods and welding cables, helmet, and other tools be provided. (A medium sized plastic utility chest is ideal.)

8. Multi-Generator Welding Systems --- 300A and larger

a) Generators which have outputs combined for higher amperages **must** be driven at the same speed.

b) Electrical connections are standard with each generator. The only special wiring requirement is to interconnect all generators using the yellow control lead, built into master and slave control modules, with the **yellow** hookup wire, and connectors, supplied with your multi-unit welding system components.

c) Power output leads (**which should NOT be larger than 1 Ga.**) should be run to a central connection point to which heavier gauge welding cables are then attached.

d) Multi generator systems designed for use by multiple operators, which **do not** feature combined outputs can have generators turning at different speeds -- though, the "slowest" unit in the group must be turning at a proper welding speed.

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[14] Which includes the Power Generator's mounting lugs.

No special electrical interconnection is required for this type of welding system.

C. Determining Proper Operating Speed (AAPK not used -- Tachometer Available)

The Welding Power Generator has been designed to provide optimum performance when rotating at approximately 6,500 RPM. Operating faster than this[15] has no ill effect on the Power Generator. However, pulley sizes may have to be increased to prevent premature belt failure and/or belt slipping.

Operating slower will still allow you to weld, but will produce less welding power than may be needed for larger size rods/electrodes. (Typically, faster is better than slower.)

If your Welding Power Generator is equipped with the standard pulley for the model that you are installing (2.6" OD for 150A models, 2.75" for 200A models) you can use the charts that follow to determine the proper engine operating speed range for welding for your vehicle/engine. Otherwise, you can use a simple formula to determine your target speed.

The formula for determining minimum engine speed for welding (direct drive from engine mounted pulley -- NO Add-A-Pulley used) is:

6,500 / (Engine Drive Pulley Diameter / Pwr. Gen. Drive Pulley Diameter) = Minimum Engine Speed for Welding

Divide the outside diameter of the engine drive pulley by the outside diameter of the drive pulley fitted to the Welding Power Generator. This number is then divided into 6500 (the target welding speed). The result is the engine speed necessary to drive the welder to its target operating speed.

For example, if you have a engine pulley with an outside diameter of 5.75" and a 2.8" pulley fitted to your Welding Power Generator, the minimum engine speed for welding would be about 3,170 rpm (a good pulley set for a small gas engine).

NOTE -- If you are using an Add-A-Pulley in your installation you will also have to determine the effect of the Add-A-Pulley on you welding speed. To do this:

GO TO paragraph 3 (just after charts) for information on calculating the effect of the Add-A-Pulley on welding speed

To use the speed charts (for Welding Power Generators fitted with standard pulleys):

1) Measure the outside diameter of your motor's crank pulley[16] and find that diameter on one of the following four charts (Read chart and column headings carefully to insure that you are using the correct chart for your intended installation.)
2) Your desired operating speed range is found to the right of your crank pulley diameter.

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15 Up to 14,000 RPM

16 A crank pulley, driven directly by the engine, is assumed in these examples, since this is the most common drive method chosen for welder installations. If you are using another drive method, such as combination of a gear drive and pulley, or multiple pulleys you will have to determine your desired speed differently. Call our customer service department should you need assistance with this.

Series 150 Welder Speed Range Determination Chart 1

Crank Pulley Diameter	Desired Engine Operating Speed Range
4.5 in.	3,500 to 4,100 RPM
5 in.	3,100 to 3,700 RPM
5.5 in.	2,900 to 3,300 RPM
6 in.	2,600 to 3,100 RPM
6.5 in.	2,400 to 2,800 RPM
7 in.	2,200 to 2,600 RPM
7.5 in.	2,100 to 2,400 RPM
8 in.	2,000 to 2,300 RPM
8.5 in.	1,800 to 2,200 RPM
9 in.	1,700 to 2,000 RPM
9.5 in.	1,700 to 1,900 RPM

(Welding Power Generator equipped with stock 2.6" single-V pulley)

Series 150 Welder Speed Range Determination Chart 2

Crank Pulley Diameter	Desired Engine Operating Speed Range
120 mm	3,300 to 3,900 RPM
130 mm	3,100 to 3,600 RPM
150 mm	2,700 to 3,100 RPM
160 mm	2,500 to 2,900 RPM
170 mm	2,300 to 2,700 RPM
180 mm	2,200 to 2,600 RPM
200 mm	2,000 to 2,300 RPM
210 mm	1,900 to 2,200 RPM
220 mm	1,800 to 2,100 RPM
230 mm	1,700 to 2,000 RPM

Series 200 Welder Speed Range Determination Chart 1

Crank Pulley Diameter	Desired Engine Operating Speed Range
4.5 in.	3,700 to 4,300 RPM
5 in.	3,300 to 3,900 RPM
5.5 in.	3,000 to 3,500 RPM
6 in.	2,800 to 3,200 RPM
6.5 in.	2,500 to 3,000 RPM
7 in.	2,400 to 2,800 RPM
7.5 in.	2,200 to 2,600 RPM
8 in.	2,100 to 2,400 RPM
8.5 in.	1,900 to 2,300 RPM
9 in.	1,800 to 2,100 RPM
9.5 in.	1,700 to 2,000 RPM

(Welding Power Generator equipped with stock 2.75" Dia. Double-V Pulley)

Series 200 Welder Speed Range Determination Chart 2

Diameter of Engine Flywheel	Desired Engine Operating Speed Range
120 mm	3,000 to 3,500 RPM
130 mm	2,800 to 3,200 RPM
150 mm	2,400 to 2,800 RPM
160 mm	2,300 to 2,600 RPM
170 mm	2,100 to 2,500 RPM
180 mm	2,000 to 2,300 RPM
200 mm	1,800 to 2,100 RPM
210 mm	1,700 to 2,000 RPM
220 mm	1,600 to 1,900 RPM
230 mm	1,600 to 1,800 RPM
250 mm	1,400 to 1,700 RPM

3. If using one of our Add-A-Pulley universal alternator power take off units, the following formula can be used to determine the effect of the AAPK on welding speed:

$$1 - \left(\frac{\text{Alt. Drive Pulley Diameter}}{\text{Add-A-Pulley Effective Diameter}^{17}} \right) = \text{\% Reduction in Welding Speed}$$

For example, if you have an existing alternator with a 2.675” pulley, and you are using an Add-A-Pulley in your installation with an effective diameter of 3.5”, the formula

$$1 - (2.675 / 3.5) = .24$$

shows that you can expect a 24% reduction in welding speed when using the Add-A-Pulley in this application.

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17 Note the effective diameter of the Add-A-Pulley will differ depending on the size of V belt used. For a 3/8”/10mm belt the effective diameter is 3-1/2”. When using a 7/16”/12mm belt, the effective diameter is 3-3/4”. With a 1/2”/13mm belt, the effective diameter is 4”.

Therefore, if the Speed Chart, for your particular welder model, shows a target speed of 2,500 rpm, using the Add-A-Pulley would further reduce this target welding speed by approximately 600 rpm [2,500 * .24 = 600] -- from 2,500 rpm to 1,900 rpm.

CAUTION

When using an Add-A-Pulley be careful not to use pulley combinations which may over speed the generator or excessively load the drive engine.

If your application is a vehicle installation, and your target engine speed for welding IS NOT at least 2-1/2 times your engine's idle speed, serious and potentially damaging welder over speed may occur when engine rpm is increased for passing or for driving at highway speeds. And/or, sufficient power for welding may not be available.

If this is the case, in your application, a LARGER diameter pulley MUST be fitted to either the Welding Power Generator OR to the existing alternator.

Typically increasing the Welding Power Generator's drive pulley diameter to match the diameter of the Add-A-Pulley is the best solution.

We stock large size pulley for both 150A and 200A generators.

Call our parts department for more information.

D. Determining Proper Operating Speed (Tachometer NOT Available)

If a tachometer is not available an appropriate welding speed can be easily determined by performing one, or more, test welds under controlled conditions:

1. Set the Power Control dial on the electrode holder to a position approximately 2/3 to 3/4 of maximum (CW).
2. Set the engine (by ear) to a fast idle (typically 2,000-2,500 rpm for a truck).
3. Make a test weld on a clean (not rusty or painted) piece of mild steel 1/4" bar, plate, or angle stock using a 1/8" welding rod (i.e., type 7018, 6011, or 6014).
4. Speed is correct when arc starts easily, and weld penetration of 99-100% can be accomplished. (Set the speed a little on the high side to compensate for engine loading.)

E. Engine Speed Control

ALL ZENA welders come with built-in electronic circuits designed for engine speed control. All that is required to use this control signal is a small headlight relay -- which will be switched on or off by the ZENA speed control output. This relay can then be used to provide on/off control for a wide range of pre-existing or home built speed control mechanisms.

ZENA™ Automatic Engine Speed Control
(for engines w/vacuum supply)

In many cases, an appropriate engine speed control mechanism is already in place. For example, most tractors and mowers come with built in speed governors connected to hand operated throttle controls. For engines equipped with governors for speed control, small constant duty solenoids can be used to directly act on the governor mechanism to control engine speed.

ATV's and many commercial vehicles may also come with built in speed controls that can be used to easily set the speed of the vehicle's engine for welding.

For gasoline fueled trucks and other motor vehicles without such built-in speed controls, there are both low-tech and high-tech solutions. An example of a low tech means of speed control is to simply use a simple wedge to block the vehicles throttle open sufficiently to achieve the desired speed (by using a wedge instead of a fixed thickness shim for this purpose, infinite variability is achieved). A sample of a higher-technology speed control mechanism, is a mechanical, electro-pneumatic, automatic throttle control device, such as the ZENA ASC1 automatic engine speed control, which was developed specifically for use with the ZENA welding system. Complex, fully electronic automatic speed controls which work directly with a vehicle's onboard computer/engine controls are also available from both OEM and after market suppliers.

For diesel engine powered vehicles with vacuum systems and mechanical throttle controls, the same speed controls that are used with a gasoline engine will usually work. For diesels with electronically controlled engine speed (and other vehicles with electronic throttle controls), we recommend using the ZENA automatic engine speed control's vacuum actuator to directly control/move the accelerator pedal. (If your accelerator pedal has a very strong spring, a second vacuum actuator (part of the ZENA ASC2 speed control kit), or a helper spring, may be used to overcome excessive spring pressure.)

The appropriate ZENA automatic engine speed control for your installation may be ordered from our parts department via our web site (www.zena.net) or by calling toll-free 877-ZENA INC. We can also help you to determine exactly which method is best for your application.

F. Electrical Installation/Hook-Up – Welder Operated IN ADDITION to an Existing Vehicle's Electrical Generating Equipment -- Standard/Recommended Method

1. General Instructions

Standard electrical installation is easy! If you are **not** replacing the vehicle's existing alternator with the ZENA power generating unit, **NO modification** to the vehicle's electrical system is required. Only connection (using supplied wires) of the Power Generator to a switched and fused[18] power source capable of providing the voltage and current that the control system requires[19] and to chassis ground is required. Typical current required from the vehicle when welding is approximately 4 amps. When not welding, the system does not draw significant power from the vehicle. A switched electrical supply can often be accomplished by connection to an appropriate point of the vehicle's ignition circuit. Typically, a 7.5A or a 8A fuse should be installed in line with the input power connection to the Welding Power Control Module.

When you want to weld, just attach the ZENA mobile welding system's cables to the Welding Power Generator (selecting positive or negative welding polarity) and plug in the system control cable to the Control Module .

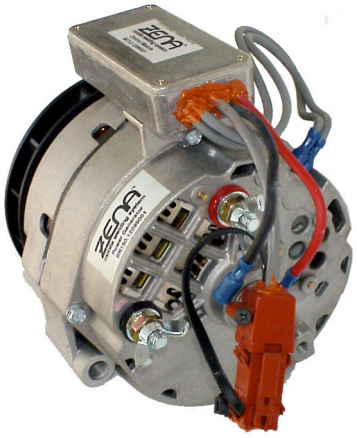
NOTE:

The ZENA welding system's output is electrically isolated from the vehicle -- allowing positive or negative polarity welding -- even to parts of the vehicle in which it is installed.

2. Wiring

a. Connect the 2 gray wires which extend out of the Control Module to the Power Generator as shown in the photo to the right.

b. Using the supplied Red wire and female bullet connector, connect the Red wire from the Control Module to a point in the vehicle's electrical system which can supply 12V @ 8A. (or 24V @ 4 A[20]) which is switched on with the vehicle's ignition.



NOTE: The welder is internally fused, and can be operated without an external fuse. However, installation of an external fuse (of the type used in your vehicle) is recommended. When using an external fuse, use a "slow blow" type – either 7.5 amp. or 8 amp. value/size.

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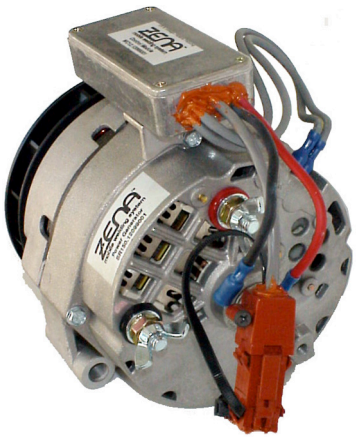
18 Fuse should be a slow acting type in either 7.5A or 8A size.

19 11-14.5 volts @ .05 amps. to a maximum of 8 amps.

20 For welders used in 24VDC electrical systems.



c. Using the supplied Black wire and male bullet connector, connect the Black wire extending out of the Control Module to the point at which the negative post of the vehicle's battery system is connected to the vehicle's chassis (or to another suitable ground point).

d. Some Control Modules have a green and/or a yellow wire extending from the Control Module. These wires are used to connect the Control Module to optional accessories. The green wire is typically used to control to the ZENA automatic speed control (or to provide a signal for controlling other speed control mechanisms), the yellow wire is used to send control signals to one or more ZENA Slave Welding Control Modules -- typically used in high power welding systems which use multiple Power Generators, connected together, to generate large welding currents.

   If you are not using these features or accessories, be careful to **NOT connect either wire to any other device**. It is permissible to fold, or to coil, either or both wires, using a wire tie or electrical tape to secure their position, to insulate them from other system components, and to make a neater looking installation -- but take care to insure that neither wire is accidentally shorted to chassis ground in the process.

e. Some Power Generators which have been ordered for custom applications may also have multiple external terminals or from one to three gray wires extending from the generator's rear case, terminating in a connector, which are used to connect special accessories and/or test equipment.

CAUTION:

To prevent blowing internal fuses, or causing damage to your welder, make sure that electrical power IS NOT applied to the Power Generator, OR to the Control Module, while connecting or disconnecting wires or while otherwise working with system wiring.

G. Electrical Installation/Hook-Up – Replacing Vehicle's Electrical Generator

If you've chosen to replace an existing alternator or generator with any Series 150 or Series 200 welding system, the electrical installation is still quite simple but it will vary from case to case depending on your vehicle's electrical system.

In all cases, a suitable external voltage regulator is required. This component can be purchased directly from our parts department (two options are available), or you can contact us for the specifications that you will need to identify and purchase a suitable unit locally.

The simplest installation of this sort (particularly for commercial installations) is one in which the ZENA WC.VR external voltage regulator is used. Since the WC.VR works with the ZENA Welding Power Control Module -- connecting to the module to the same point that the Electrode Holder Controls connect to, it provides a simple and "fool-proof" mechanism for insuring proper hook up when switching from "charging" to "welding".

If an automotive style regulator is used, the voltage regulator is connected to the battery ground, the battery positive, and then directly to the Power Generator (replacing the two gray wires which come from the Welding Power Control Module with the voltage regulator's rotor control wires). When the voltage regulator is so connected, the gray wires from the welding system's Control Module will be disconnected. Typically, a double pole double throw(DPDT) switch (or relay), capable of switching 10A is used to switch the wire connections electrically -- eliminating the need to manually remove and reinstall these control wires.

Generator charging output hook-up can also be simple. By using a ZENA BJ150.5B charging cable connection kit (or a similar cable set built on site), the simple task of plugging in your welding cables forces, and insures, proper disconnection of the Power Generator from the vehicle's electrical system. (The Welding Power Generator must be **completely** disconnected from the vehicle whenever you are welding.)

Otherwise, the connections from the Power Generator's positive and negative output terminals to the vehicles battery/electrical system can be made using appropriately sized wire and 5/16 inch lugs. (Incorporating some fool-proof mechanism to insure that the lugs, when disconnected from the Power Generator, cannot come into contact with any part of the vehicle thereby causing a short circuit.)

Remember that BOTH of these charging wires MUST be DISCONNECTED before using the Power Generator for welding (and prior to the connection of the ZENA system's supplied welding and control cables).

CAUTION:

Failure to disconnect these charging wires prior to welding can result in battery explosion or severe damage to the vehicle's battery and/or its electrical system.

In some cases you may be able to connect your vehicle's existing alternator wiring to the ZENA mobile welding system power unit and to the external voltage regulator following instructions specific to your vehicle type.

CAUTION / NOTE:

It is possible to connect an external regulator to the ZENA system in such a way as to make all interconnections (and disconnections) of the external voltage regulator and the Power Control Module noted above a semiautomatic procedure using relays to effect the required actions. A schematic diagram illustrating this sort of installation is provided in Appendix B of this manual.

This information is provided purely as a service to our customers. ZENA, Inc. makes NO REPRESENTATIONS or GUARANTEES WHATSOEVER as to the suitability of such information for any specific vehicle or installation.

H. Automatic Engine Speed Control Accessory

For gasoline fueled trucks and other motor vehicles without such built-in speed controls, a simple and reliable Automatic Engine Speed Control has been developed for use with the ZENA welding system. It may be ordered from our parts department via our web site (www.zena.net)-- or you can call in your order toll-free to 877-ZENA INC.

1. Automatic Engine Speed Control Components

The ZENA ASC1 Automatic Engine Speed Control is supplied with the following components:

a. Combination Vacuum Actuator and Adjustable Throttle Chain Assembly (w/integrated fine speed control adjustment) (Vacuum Actuator)
b. Vacuum Hose
c. Universal Vacuum Hose Supply Tap ("T" fitting)
d. Constant Duty Electrical Vacuum Control Switch (Vacuum Control Switch)
e. Installation Instructions
f. 6 foot length of red hookup wire
g. 6 foot length of green hookup wire
h. Insulated female spade connector (2 ea.)
i. Insulated male bullet connector (1 ea.)

Automatic Engine Speed Control
(for engines w/vacuum supply)

2. Installation of the Automatic Engine Speed Control

Installation is simple and straightforward.

a. Using an existing bolt, or by drilling a 1/4 inch hole and attaching a 1/4 inch bolt to a convenient point on the vehicle, position the Vacuum Actuator so that the ring on the end of its throttle chain can be affixed to the vehicle's throttle at the same point that the foot controlled throttle linkage is attached, and so the chain will "pull" in approximately the same direction as the existing throttle linkage (the chain should parallel the linkage) without binding or fouling the existing linkage mechanism. A slight (up to 20°) angle is acceptable.

NOTE: Make sure that it is possible to reach and adjust the screw in the rear of the Actuator — this is the **fine speed adjustment**.

NOTE2: When you receive your speed control kit this screw will already be at its **minimum speed point** (fully clockwise). **DO NOT turn this screw "out"(CCW) too far** or the fine adjustment screw will come free of the Actuator's Vacuum Chamber, and the o-ring which seals the Actuator Vacuum Chamber will be exposed -- resulting in a vacuum leak which will prevent your Actuator from functioning.

If this does occur, before reinserting the fine adjustment screw, lubricate the o-ring with some mineral oil. Failure to properly lubricate the o-ring before reassembly may result in permanent damage to the o-ring.

NOTE3: **If your vehicle has fully electronic speed control**, and **does not** have a throttle linkage, the Vacuum Actuator should be connected **directly** to the accelerator pedal mechanism in the passenger compartment. This can be accomplished in a number of ways. For example, see **APPENDIX B, Item J** for an illustration of one method of accomplishing this.

NOTE4: **If very strong springs are attached to your throttle/accelerator pedal mechanism**, it may be necessary to **attach a second Vacuum Actuator** to the mechanism, or to **modify the spring tension**.

If a second Vacuum Actuator is required, it can be controlled by the same Vacuum Switch that controls a single actuator (one ZENA vacuum switch can control up to 4 separate actuators).

Contact the ZENA parts department to order additional actuators.

b. Attach the Throttle Chain to the engine's throttle linkage – adjusting length of the chain so that it has just a little slack (it should not pull when at rest). The chain should be just slightly "loose" when the attachment is complete. The chain can be shortened as necessary by using the chain adjustment link located in the center of the chain. Fine tuning of chain length is accomplished by means of the 2 nuts attaching the chain to the actuator rod.

c. Find a convenient point to attach the Vacuum Switch.

NOTE: The Vacuum Switch will be connected to your welder's Power Control Module, to a switched 12 volt source, and to a suitable vacuum source.

Typically the Vacuum Control Switch is mounted close to the Vacuum Actuator using an existing bolt or by drilling a 1/4 inch hole and attaching a 1/4 inch bolt to a convenient point.

d. Attach one end of the Vacuum Hose to the vacuum fitting on the Vacuum Actuator. Be careful not to break the fitting during attachment. (Wetting the end of the Vacuum Hose with a small amount of soapy water will make attachment easier.)

e. Route the Vacuum Hose connected to the fitting on the Vacuum Actuator to the "inside" vacuum fitting, which is angled 90° from the length of the Vacuum Control Switch, and cut it to an appropriate length so that it can be connected to this vacuum fitting without being tightly stretched or bent too sharply. Connect the hose to the fitting. (Wetting the end of the Vacuum Hose with a small amount of soapy water will make attachment easier.) Save the remaining length of Vacuum Hose.

f. Locate an appropriate point of vacuum supply as near a possible to the Vacuum Control Switch. Do this by either locating a convenient point on the large vacuum hose going from the vehicle's manifold (or from a vacuum reservoir if so equipped) to the vacuum assist actuator attached to the vehicle's brake cylinder or by locating a convenient unused source of **continuous** engine vacuum at the engine's intake manifold or by locating a convenient point on the large hose connecting the vehicle's vacuum reservoir (if so equipped) to the engine's intake manifold. (Connection to an unused manifold fitting is the preferred method.)

g. If the selected vacuum supply attachment point is a large vacuum hose, cut the hose and attach the straight-through sections of the "T" fitting so as to reconnect the hose which has been cut. NOTE: after you have determined which portions of the universal "T" fitting will fit tightly in the vacuum hose, cut the smaller segments off to insure a large air passage through the fitting. If you are using an existing fitting on the manifold, the "T" fitting will not be required and no existing vacuum hose will need to be cut.

h. Attach one end of the remaining length of Vacuum Hose to the 90° segment of the "T" fitting or the attachment point selected on the engine's intake manifold.

i. Route the Vacuum Hose to the Vacuum Control Switch and cut it to an appropriate length so that it can be connected to the remaining vacuum fitting on the Vacuum Control Switch without being tightly stretched or bent too sharply.

j. Using the supplied Red wire and one of the insulated spade connectors, attach the Vacuum Switch to a suitable switched 12 volt power source.

k. Using the supplied Green wire, one insulated spade connector, and the insulated bullet connector, connect the Green Wire which extends from your welder's Power Control Module to the Vacuum Switch.

l. Installation is complete.

3. Test and Adjustment of Automatic Speed Control

To test the operation of your Automatic Engine Speed Control, connect the welding and control cables to the Power Generator, start the vehicle engine, and press the Power Button. The Vacuum Actuator should cause the engine's throttle linkage to move and the engine to speed up. The engine should return to idle when the Power Button is released.

To adjust the welding speed, have an assistant press the Power Button while the vehicle engine is operating. This will cause the engine speed to increase. Check the engine speed using the vehicle's built-in tachometer, or an external tachometer and compare it to your desired welding speed range (or do a test weld as described in the previous section on determining engine speed for welding and in the paragraph below).

At this point the engine speed should be close to (say, within 500-600 rpm of) the speed which is necessary for welding. If it is **much too slow** (or if it is **much too fast**), adjust chain length (as described previously), change your chain attachment point, etc. to make a gross adjustment to correct the situation.

You can now fine tune the speed setting. A small screwdriver may be used to adjust the screw at the rear of the Vacuum Actuator until the engine speed is equal to the maximum rpm indicated for the vehicle in the welding speed determination chart.

If a tachometer is not available an appropriate welding speed can be determined by performing a test weld under controlled conditions:

a. Set the Power Control dial on the electrode holder to a position approximately 2/3 to 3/4 of maximum (CW).

b. Set the engine (by ear) to a fast idle (typically 2,000-2,500 rpm).

c. Make a test weld on a clean (not rusty or painted) piece of mild steel 1/4" bar, plate, or angle stock using a 1/8" type 7018, 6011, or 6014 welding rod.

d. Speed is correct when arc starts easily, and weld penetration of 90-100% can be accomplished.

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VIII. Care & Maintenance

The ZENA mobile welding system is very robust. Other than keeping components clean, NO regular preventive maintenance is required.

A. Lubrication

Not required. All moving parts are permanently lubricated.

B. Wet Conditions

All critical electrical parts are sealed from moisture and all mechanical components are designed to operate in wet conditions (but not when immersed in water).

C. Cleaning

Proper cooling is necessary for optimum welding performance and for maximum service life. Keeping your welding system's components clean is most important.

1) Dust/Dirt Removal

Compressed air is best for removing accumulations of dust and/or dirt from the interior and exterior surfaces of your Welding Power Generator. If compressed air is not available, clean by rinsing with a stream of soapy water followed by a fresh water rinse (DO NOT use water or strong detergent cleaning solutions from a pressure washer). After rinsing, excess water should be removed by using compressed air (if available), or by operating the engine briefly to allow the cooling fan to remove most excess moisture from inside the case.

2) Removing Corrosive Chemicals/Salts

If your welder is operated around salt water, or used in conditions where its components may be exposed to corrosive chemicals, solvents, degreasers, antifreeze, and/or liquids with a high mineral content, it should be rinsed off with fresh water as soon as possible after exposure. Remove excess rinse water from the Welding Power Generator by using compressed air (if available), or by operating the engine briefly to allow the cooling fan to remove most excess moisture from inside the case.

3) Cleaning/Drying Control Handle Assembly

Your Control Handle can be cleaned with fresh water. Excess water can be removed by simply hanging it so that the electrode holder points "down". Any moisture trapped in the handle or its components will then drain out or evaporate.

4) Removing Grease and Oils

If grease, hydraulic fluids, oils or other petroleum based lubricants cause dirt to accumulate on the **OUTSIDE** of system components, the component may be cleaned with any aerosol cleaner/ degreaser designed for **electronic components**, OR the outside surfaces can be cleaned with a clean cloth moistened with mineral spirits or kerosene and then rinsed with fresh water.

5) After Operating in Wet Conditions

Excess water should be removed from the Welding Power Generator by operating the vehicle's engine briefly to allow the cooling fan to remove most excess moisture from inside the case. Excess water can be removed from the Control Handle's internal components by simply hanging the Control Handle so that its electrode holder points "down". Moisture trapped in the handle or its components will drain out or evaporate.

D. DO NOT…

- use spray lubricants of any sort on any component; or
- operate the unit in very dusty and or dirty conditions without insuring that cooling air reaching the unit is as dust and/or contaminant free as possible; or
- allow antifreeze compounds to contact system components without cleaning the affected component with fresh water; or
- allow accumulations of grease and/or dirt to form on system components; or
- apply any sort of paint to any system component; or
- clean system components with aerosol brake cleaners, carburetor cleaners, spray degreasers, or other chemicals except as noted above in “Cleaning” above.

IX. Trouble/Fault Diagnosis

The ZENA mobile welding system has been designed to be very simple to use. In addition, no expense has been spared to insure that it is also an extremely reliable and long lasting product.

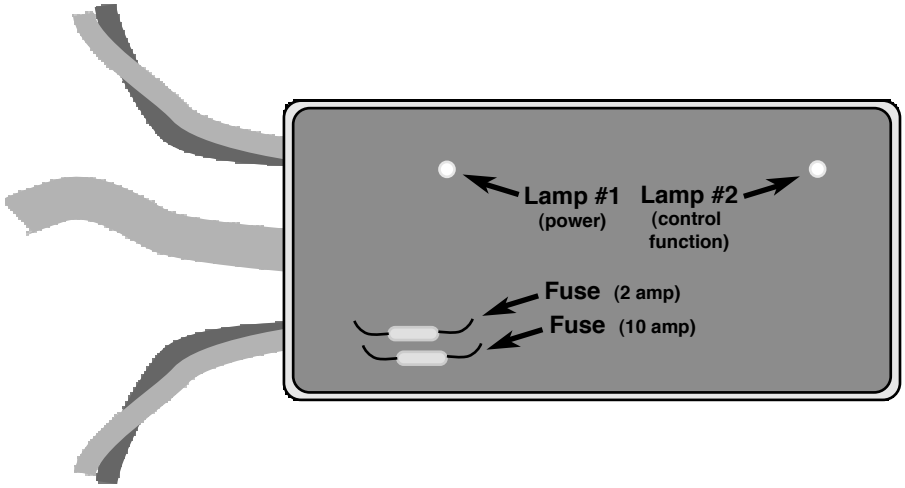
However, should you have any problems with your system, the information below will help you to use built-in fault diagnosis tools to isolate and (often) to solve the problem that you are having.

Please note that the following procedures assume that a successful installation of the welder has occurred and that everything was working properly after the installation was completed. If this is not the case, this section can still help you to find and correct problems that may show up during the installation process -- but you should also refer to the installation section of this manual to augment the procedures defined here.

A. Welding Control Module

1. Control Models WC.12 & WC.24 -- Location of Internal Indicators and Fuses

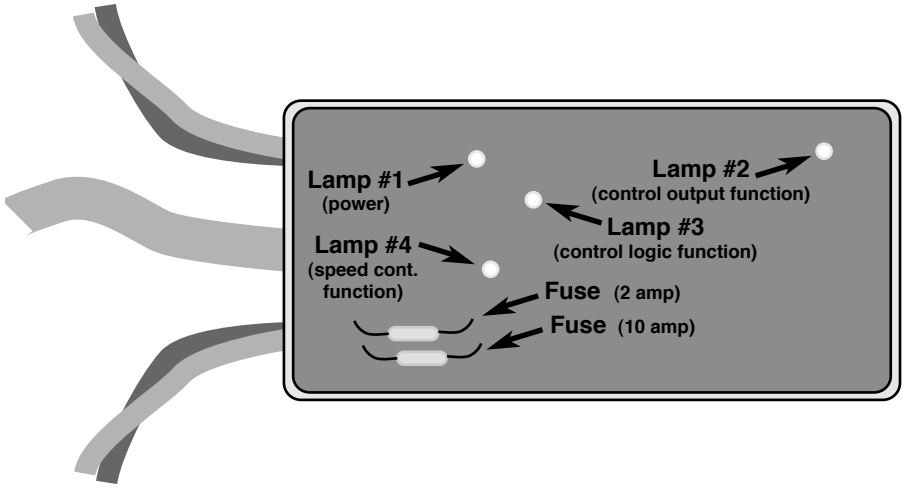
By removing 4 screws, the cover of the Control Module that is mounted on the Welding Power Generator can be removed.



Once the cover has been removed, you will see the objects shown in the drawing to the right. The two. indicators which are labeled Lamp #1 and Lamp #2 will be used in the system fault diagnosis steps that follow

2. Control Models WC.12B, WC.24B, WC.12RO, WC.12ROPS, & WC.24RO -- Location of Internal Indicators and Fuses

By removing 4 screws, the cover of the Control Module that is mounted on the Welding Power Generator can be removed.



With the cover removed, you will see the objects shown in the drawing to the right. The four indicators which are labeled Lamp #1 through Lamp #4 will be used in the fault diagnosis steps that follow.

B. Welding Power Problems

1. Welding Power is ADJUSTABLE but power output is LOW[21] OR power output drops off immediately after striking an arc.

1.1 Insure that your drive V-belt is the right size, undamaged, properly tightened, properly routed, and is not slipping. A slipping belt is sometimes hard to detect, but it will **always** cause the belt **and** the pulleys to become very hot -- and it will always prevent the welder from operating properly. Belt slipping will often occur just after an arc is struck, **or** when welding power is increased.

Test for belt slip by either using a wrench on the power generator's pulley bolt or by grasping the generator's fan, spanning it with the thumb and forefinger of both hands, to try to rotate the power generator in a CW direction[22]. It should be quite difficult to turn using moderate to strong hand pressure on the wrench and impossible to turn by hand. If any slippage is noted, the point of failure will be easy to determine.

NOTE: Often a small engine will "turn over" before any belt slip will be noted. In many cases, the engine may turn over so easily that the drive pulley will have to be "blocked"/immobilized to do this test.

If a problem is found, correct the problem[23] and re-test the system. If no problem is found, go on to the next step.

1.2 Make sure that you are using the correct engine speed for welding. During welder installation and set-up, the proper engine speed for welding should have been determined and the welder tested for proper power output at this speed.

If the speed is too slow you will have low (or possibly no) power. If the speed is much too high, belt slipping may occur -- resulting, also, in a low (or no) output just after an arc begins.

Check and re-adjust engine speed if necessary -- see "Determining Proper Operating Speed" in Section VII. (Installation Notes).

If a problem is found, correct the problem, and re-test the system. If no problem is found, go on to Part 2, "Welding Power is NOT Available", below.

2. Welding Power is NOT Available

2.1 Insure that drive belt is correctly installed and that it is properly tightened (see Step 1.1 for belt tension check procedure). If a problem is found, correct the problem and re-test the system. If no problem is found, go on to the next step in this section.

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21 Proper power output can be checked by making a test weld on a 1/4" thick piece of clean scrap material, using a type 7018, 6011, or 6013 1/8" welding rod. The arc should start easily as the electrode is "scratched" along the surface, and an acceptable welding bead with good penetration should be made with a Power Control setting of 2/3 to 3/4 of maximum.

22 An alternate method for field checking belt tightness when a wrench is not available is to grip the fan securely with two hands (the index finger and thumb of each hand spanning approximately 1/2 the fan circumference). Then, try to rotate the generator. The belt should not slip and the generator should not turn.

23 If belt is undamaged, tighten. If belt has become glazed, or if belt is delaminating, or if belt shows physical damage, the belt should be replaced. In extreme cases, the surface of the power generator's drive pulley may become glazed, or other wise damaged. In this case, drive pulley should also be replace.

2.2 With the engine OFF, open the Control Module and Observe Lamp #1 (shade from direct sunlight). If Lamp #1 is **NOT** illuminated, go on to the next step (2.3). If Lamp #1 **IS** illuminated, go to step 2.6

2.3 Check the connection of the red and black wires that provide power to the Module. The red wire should be connected to a source of +12 volt (or +24 volt) power. Check that power is present, and than no external fuse is "blown" using a multi meter or test light. The Module's black wire should be connected to the vehicle's chassis ground or to the negative battery terminal.

NOTE: If these power input leads are accidentally reversed (negative/black accidentally connected to the battery's +terminal and positive/red accidentally connected to the battery's - terminal. Internal fuses in the Control Module will be "blown".

Use your meter to insure that a proper electrical connection to chassis ground exists. If power and ground connections are OK, but Lamp #1 is still not illuminated, go on to the next step (2.4). If you found and corrected an improper connection, and if Lamp #1 is now illuminated, go to step 2.8

2.4 The Module's internal solder-in fuses are covered with a silicone sealant. Carefully remove just enough of the silicone to expose the fuse leads on either side of the fuses. Then, using a test lamp or a volt meter **with a sharp test probe end**, check for the presence of power at the end of the 2 amp. fuse which is closest to the point where wires enter/exit the Control Module. The 2 amp. fuse (one of two fuses in the Control Module) is the "top" or upper fuse when viewing the Control Module from above, with the wires going to and from the Control Module on the viewer's left. (SEE CONTROL MODULE DIAGRAM ON PREVIOUS PAGE) If you do not have a test lamp or meter, go to step 2.9.

If power is **not** present at this end of the 2 amp. fuse, power is <u>not</u> getting to the Control Module. In this case, it is likely that a problem exists at the point of connection between the red wire extending from the Control Module and the red wire which is connected to the vehicle's electrical system. Check your wiring.

If the wiring is OK, the internal wiring of the Control Module may be at fault. Check for continuity between the red wire extending from the Module and the end of the 2 amp. fuse closest to the point where wires enter/exit the Module, with your meter (the input end of the fuse). If the circuit is "open", the Module will need to be returned for repair or replacement. Go to step 2.9. If the circuit is "closed" ("0" ohms), a fault in the supply wiring exists -- carefully recheck wiring (red/supply wire) and all connections.

If you found and corrected an improper connection, and if Lamp #1 is now illuminated, or if you measure +12V (or +24) at the fuse input end, continue.

If power **is** present at the input end of the 2 amp. fuse (the end **closest** to the point at which the connection wires leave the Control Module), check for power at the **other** end of the 2 amp. fuse (the end **furthest** from the point at which the connection wires enter/leave the Control Module -- the output end). If power is NOT present here, go on to the next step (2.5). If power IS present, go to step 2.6.

2.5 You have a "blown" 2 amp. fuse.

This usually indicates one of three things: a failure in the Control Module itself, OR that an improper input voltage (too high) has been present[24], OR that the red and black leads may have been accidentally misconnected (reversed) (reversed power leads is the most common reason that this fuse is blown).

If you are able to solder, and if you have access to soldering equipment, you may choose to replace the fuse yourself, OR you can return the Control Module to us for repair. (Replacement fuses are available free of charge through our technical support department.) Go to step 2.9.

2.6 While observing Lamp #2 in the Control Module (and Lamp #3 -- if present), depress the Power Button on the Control Handle. Lamp #2 (**and** Lamp #3, if present) should light and remain lit for as long as the Power Button is held down. You should also hear a very faint "clicking" sound coming from the Control Module. If Lamp #2 (and Lamp #3) is(are) working properly, and/or if you **are** hearing the faint clicking sound, go on to the next step (2.7).

If Lamp #2 **is not** working properly, AND if you **are** hearing the faint clicking sound, the Control Module is malfunctioning. Go to step 2.9.

If you have a Module in which Lamp #3 is present, and if Lamp #2 **is not** working properly BUT Lamp #3 **is** working properly, AND if you **are** hearing the faint clicking sound you have either a "blown" 10A fuse -- and/or a defective Control Module. Go to Step 2.10 to continue.

If Lamp #2 **is not** working properly, AND if you **are not** hearing the clicking sound, go to step 2.10.

If you have a Module in which Lamp #3 is present, and if Lamp #2 **is not** working properly BUT Lamp #3 **is** working properly, AND if you **are not** hearing the faint clicking sound, go to Step 2.11.

2.7 Check to insure that the Gray wires which connect the Power Control Module to the Welding Power Generator are properly connected to the Power Generator, that the connectors at the ends of the Gray wires are secure, and that the gray wires have not been damaged. Also insure that the Yellow data bus wire (not used in most basic welder installations) is not short circuiting to chassis ground or to any other component. Also check and insure that the Yellow wire is not connected to anything other than to another Yellow wire from either a ZENA Power Control Module or a ZENA WC.VR or WC.VR2 Universal Voltage/ Current Regulator or a ZEN WC.CVR Constant Voltage Welding Power Controller. If any wires are not properly connected, correct the problem and go to step 2.8. If the wires were properly connected, it is likely that you have a problem within your Power Generator, go to step 2.12.

2.8 Congratulations, it is likely that you have successfully corrected your problem. Fully re-test your welding system to make sure.

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[24] This problem can occur when ever the engine's alternator is not connected to the battery an any time that the engine is turning **and** when the Control Module has been connected to the alternator circuit instead of the battery. On small engines, this can be caused by connecting the Control Module's red/power lead to an improperly wired ignition switch -- one where, for example, the engine's alternator is connected to the ignition switch's "accessory" terminal, instead of being directly connected to the engine starting battery. In these cases, the Control Module's red power lead should be connected directly to the battery (typically be means of an ON/OFF switch).

2.9 You have a problem which requires either further troubleshooting assistance from our tech support department (877-ZENA INC or 615-897-2011) or a return authorization for one, or more, possibly malfunctioning component(s) for test/repair.

If, for any reason, you cannot reach us by phone, it is permissible to return the suspect component for repair without a formal authorization. Just make sure that you include a written description of the problem that you have found as well as a legible return address (and a telephone #,, if available, that we can uses if it is necessary to contact you). If you are returning either an Electrode Holder Control or a suspect Welding Power Generator, it's advisable to also return the Welding Power Control Module (only a few extra ounces) so that both items can be tested together.

IF YOU DO HAVE TO RETURN AN ITEM, insure it and make sure that it is packed carefully and properly (use our packaging materials if at all possible).

- DO NOT USE foam "peanuts" for padding (dust from these can get into your welding equipment and cause future problems) or any other type of Styrofoam packaging materials that can crumble when broken/torn/stressed.
- MAKE SURE that at least 2" of firm padding material (paper/cardboard, bubble-wrap, or non crumbling foam (like the foam pads that we use in our packaging) is placed on all sides of any item so that the item is FIRMLY held safely in the center of the package -- DO NOT SCRIMP ON PADDING.
- USE A GOOD quality box with STRONG side walls.

Careful attention to packaging will avoid extra charges for shipping damages.

2.10 It is possible that an internal fuse has been "blown".

The Control Module's internal solder-in fuses are covered with a silicone adhesive/sealant. Carefully remove the silicone to expose the fuse leads.

Using a test lamp or a volt meter with a sharp test probe, check for the presence of power (12 volts or 24 volts) at the end of the 10 amp. fuse which is **farthest** from the point where wires enter/exit the Control Module. The 10 amp. fuse (one of two internal fuses in the Control Module) is the "bottom" or lower fuse when viewing the Control Module from above, with the wires from the Control Module on the viewer's left. (SEE CONTROL MODULE DIAGRAM ON PREVIOUS PAGE) If you do not have a test lamp or meter, go to step 2.9.

If power **is** present at the end of the fuse, it is possible that either the Power Control Module is defective, or that a problem with the wiring between the Module and the Power Generator exists, or that the Power Generator's rotor circuit (which includes the brush assembly) has suffered an internal failure. Go on to the next step to check the Power Generator.

If power **is not** present at the end of the 10 amp. fuse, you have a "blown" fuse.

A 10A fuse failure may indicate a possible failure in the Control Module itself, but more likely it is pointing to a component failure in the Power Generator, OR that the gray wires connecting the Control Module to the Power Generator may have been accidentally shorted to ground while connecting or disconnecting these leads with power "on" to the Control Module, OR that a voltage higher than 14.5VDC (or 29VDC in 24V systems) has been accidentally applied to the Control Module, OR that the red and black power wires may have been accidentally misconnected (reversed) to your battery. Go on to the next step.

2.11 You can easily check for a component failure in the Power Generator by disconnecting the two Gray wires which are used to connect the Control Module to the Power Generator's control terminals, and check in the electrical resistance between these control terminals with an ohm meter. A normal reading is between 1.4 and 2.4 ohms. If your meter shows a resistance of **less than 1.4 ohms**, your Power Generator has a component failure, and must be returned for repair. Go to Step 2.9.

If the electrical resistance measured between the control terminals is **higher than the "normal" range of 1.4 to 2.4 ohms** (for example, 10 ohms or 20 ohms or more) it is an indication that grease or some similar material may have caused "fouling" of the brushes and or internal slip-rings. Cleaning can be accomplished in the field, if necessary, but is best done under factory (dust free) conditions. Factory cleaning, will be performed free of any labor charge, with charges only for return freight cost. If you want to clean the unit yourself, we will provide instructions. Go to Step 2.9.

If your electrical resistance between the control terminals is correct, you should also measure the electrical resistance between either of the terminals and the case of the Power Generator. A normal reading here is an "open" circuit (an infinite resistance). If your meter shows **any** measurable resistance, your Power Generator has either an internal component failure, internal components shorted by a foreign object, or brush assembly damage (most often caused by improper "clocking"), and must be returned for repair. Go to Step 2.9.

If the readings are correct **and** the 10A fuse **was not** found to be "blown" the Control Module has malfunctioned and should be returned for repair and/or replacement. Go to Step 2.9 if this is the case.

If all resistance readings at the control terminals are correct **and** the 10A fuse **was** found to be "blown" in the previous step, simply replacing the blown 10A fuse in the Control Module will likely solve the problem.

If you are able to solder, and if you have access to soldering equipment, you may choose to replace the 10 amp. Control Module fuse yourself (replacement fuses are available free of charge through our technical support department), OR you may (providing you insure that 7.5 to 8A external fuse is installed and functioning in the supply circuit to protect the Control Module) solder a suitably sized wire across the 10A fuse leads (shorting the 10A fuse so that power may be transmitted across it), OR you can return the Control Module to us for fuse replacement. (In this case, it may also be advisable to return the Power Generator along with the suspect Control Module for inspection and/or repair.) If you choose to return the Module, or if you need a fuse, go to step 2.9.

After fuse replacement the system should be retested and, if found to be working normally, returned to service.

If the fuse is replaced, AND the fuse subsequently "blows" again -- AND if you are sure that the gray wires connecting the Control Module to the Power Generator have not been accidentally shorted to ground while connecting or disconnecting these leads (with power "on" to the Control Module), AND/OR that a voltage higher than 14.5VDC (or 29VDC in 24V systems) has not been accidentally applied to the Control Module, there may be an intermittent problem with your Power Generator. If this is the case, the Power Generator

should be returned for repair, ALONG WITH A NOTE indicating that an intermittent problem is suspected. Go to step 2.9 if this is the case.

2.12 You can easily check for a component failure in the Power Generator by disconnecting the two Gray wires which are used to connect the Control Module to the Power Generator's control terminals, and check in the electrical resistance between these control terminals with an ohm meter. A normal reading is between 1.4 and 2.4 ohms. If your meter shows a resistance of **less than 1.4 ohms**, your Power Generator has a component failure, and must be returned for repair. Go to Step 2.9.

If the electrical resistance measured between the control terminals is **higher than the "normal" range of 1.4 to 2.4 ohms** (for example, 10 ohms or 20 ohms or more) it is an indication that grease or some similar material may have caused "fouling" of the brushes and or internal slip-rings. Cleaning can be accomplished in the field, if necessary, but is best done under factory (dust free) conditions. Factory cleaning, will be performed free of any labor charge, with charges only for return freight cost. If you want to clean the unit yourself, we will provide instructions. Go to Step 2.9.

If your electrical resistance between the control terminals is correct, you should also measure the electrical resistance between either of the terminal and the case of the Power Generator. A normal reading is an "open" circuit (an infinite resistance). If your meter shows any measurable resistance, your Power Generator has a component failure, and must be returned for repair. Go to Step 2.9.

If all resistance readings at the control terminals were found to be "normal", reconnect all wires, and go on to the next step.

2.13 Attach a DC voltmeter between the electrode holder clamp and the ground clamp. Set the power control dial to its full CW position (max. power setting). Then, with the engine running, and with power "on" to the welding system, depress the power button on the electrode holder and note the voltage reading.

If the voltage is significantly lower than 60VDC, or above 80VDC, it is likely that you have a component failure in the high current section of the welding power generator and it should be returned for repair. (NOTE: If, for some reason, this is not possible, field replacement of defective components can be accomplished by a skilled technician following instructions from our service department.) Go to Step 2.9.

If the voltage is between 60 and 80VDC, your system is likely developing full welding power and (assuming no belt/drive component slipping or failure) you should be able strike an arc an begin welding. However, go to step 2.14 for one final check.

2.14 With your DC voltmeter still connected between the electrode holder clamp and the ground clamp. Depress the power button on the electrode holder and note the voltage reading while you rotate the power control dial to its full CCW position. You should note that the voltage **decreases** somewhat as the control dial is rotated. If this voltage does not decrease, it is likely that you have a component failure in the high current section of the welding power generator, and it should be returned for repair. (NOTE: If, for some reason, this is not possible, field replacement of defective components can be accomplished by a

skilled technician following instructions from our service department.)
Go to Step 2.9.

3. Welding Power is Available BUT is Not Adjustable -- Control Module Series WC.12 & WC.24

3.1 With the engine OFF, open the Control Module cover and observe Lamp #2 while holding the Control Handle Power Button "down" and rotating the Power Control Dial on the Control Handle.

If Lamp #2 changes in intensity, your problem is either in the Power Generator or the Control Module. Go to step 3.2.

3.2 You can easily check for a component failure in the Power Generator by disconnecting the two Gray wires which are used to connect the Control Module to the Power Generator's control terminals, and check in the electrical resistance between these control terminals with an ohm meter. A normal reading is between 1.4 and 2.4 ohms. If your meter shows a resistance of **less than 1.4 ohms**, your Power Generator has a component failure, and must be returned for repair. Go to Step 3.4.

If the electrical resistance measured between the control terminals is **higher than the "normal" range of 1.4 to 2.4 ohms** (for example, 10 ohms or 20 ohms or more) it is an indication that grease or some similar material may have caused "fouling" of the brushes and or internal slip-rings. Cleaning can be accomplished in the field, if necessary, but is best done under factory (dust free) conditions. Factory cleaning, will be performed free of any labor charge, with charges only for return freight cost. If you want to clean the unit yourself, we will provide instructions. Go to Step 3.4.

If your electrical resistance between the control terminals is correct, you should also measure the electrical resistance between either of the terminals and the case of the Power Generator. A normal reading is an "open" circuit (an infinite resistance). If your meter shows any measurable resistance, your Power Generator has a component failure, and must be returned for repair.
Go to Step 3.4.

If all resistance readings at the control terminals were found to be "normal" you have a Malfunctioning Control Module, reconnect all wires, and go to step 3.4.

3.3 If Lamp #2 maintain a constant light intensity, either the Control Handle Assembly, or the Control Module, or the Control Cable connection between the two assemblies is malfunctioning.

NOTE: If you are using a cable extension, or a quick disconnect system, of any sort, with your welder, remove it temporarily and repeat the tests to insure that the problem noted is not caused by a fault in the cable extension.

To determine if the Control Cable connection is at fault, temporarily hold down the Power Button (you may need an assistant to do this) and observe the behavior of Lamp #2 while you partially unplug and re-plug the two black Control Cable connectors which connect the Control Handle to the Control Module. If Lamp #2 "flickers", goes off, or changes in intensity as you do this, the connection is faulty -- either due to a broken wire, a defective connector terminal, or due to some surface corrosion that may have formed on the connector surfaces.

If the problem is corrosion (which may be noticeable as a slight sandy roughness/drag which can be felt as the connectors are connected and

disconnected), the male terminals can be cleaned by lightly dragging a sharp pen knife or box cutter blade across the both sides of each "spade". The female connector's surface can be then "cleaned" by inserting and reinserting the male connector a number of times (until reliable operation is noted). Corrosion can then be prevented by applying a good quality dielectric grease (not a conductive grease) to the contact surfaces.

If the problem is not due to surface corrosion, or if the corrosion is so bad as to cause continuing erratic operation, go to step 3.4.

3.4 You have a problem which requires either further troubleshooting assistance from our tech support department (877-ZENA INC or 615-897-2011) or a return authorization for one, or more, possibly malfunctioning component(s) for test/repair.

If, for any reason, you cannot reach us by phone, it is permissible to return the suspect component for repair without a formal authorization. Just make sure that you include a written description of the problem that you have found as well as a legible return address (and a telephone #,, if available, that we can uses if it is necessary to contact you). If you are returning either an Electrode Holder Control or a suspect Welding Power Generator, it's advisable to also return the Welding Power Control Module (only a few extra ounces) so that both items can be tested together.

IF YOU DO HAVE TO RETURN AN ITEM, insure it and make sure that it is packed carefully and properly (use our packaging materials if at all possible).

- DO NOT USE foam "peanuts" for padding (dust from these can get into your welding equipment and cause future problems) or any other type of Styrofoam packaging materials that can crumble when broken/torn/stressed.
- MAKE SURE that at least 2" of firm padding material (paper/cardboard, bubble-wrap, or non crumbling foam (like the foam pads that we use in our packaging) is placed on all sides of any item so that the item is FIRMLY held safely in the center of the package -- DO NOT SCRIMP ON PADDING.
- USE A GOOD quality box with STRONG side walls.

Careful attention to packaging will avoid extra charges for shipping damages.

3a. Welding Power is Available BUT is Not Adjustable -- Control Module Series WC.12RO & WC.24RO

3a.1 With the engine OFF, open the Control Module and observe Lamp #2 and Lamp #3 while holding the Control Handle Power Button "down" and rotating the Control Dial on the Control Handle.

If Lamp #3 changes in intensity while Lamp #2 does not OR if Lamp #2 changes in intensity while Lamp #3 does not, your Control Module is malfunctioning. Go to Step 3a.4.

If both Lamp #2 and Lamp #3 change in intensity, your problem is either in the Power Generator or the Control Module. Go to step 3a.2.

If both Lamp #2 and Lamp #3 maintain a constant light intensity, either the Control Handle Assembly or the Control Module the is malfunctioning. Go to step 3a.3.

3a.2 You can easily check for a component failure in the Power Generator by disconnecting the two Gray wires which are used to connect the Control Module

to the Power Generator's control terminals, and check in the electrical resistance between these control terminals with an ohm meter. A normal reading is between 1.4 and 2.4 ohms. If your meter shows a resistance of **less than 1.4 ohms**, your Power Generator has a component failure, and must be returned for repair. Go to Step 3a.4.

If the electrical resistance measured between the control terminals is **higher than the "normal" range of 1.4 to 2.4 ohms** (for example, 10 ohms or 20 ohms or more) it is an indication that grease or some similar material may have caused "fouling" of the brushes and or internal slip-rings. Cleaning can be accomplished in the field, if necessary, but is best done under factory (dust free) conditions. Factory cleaning, will be performed free of any labor charge, with charges only for return freight cost. If you want to clean the unit yourself, we will provide instructions. Go to Step 3a.4.

If your electrical resistance between the control terminals is correct, you should also measure the electrical resistance between either of the terminals and the case of the Power Generator. A normal reading is an "open" circuit (an infinite resistance). If your meter shows any measurable resistance, your Power Generator has a component failure, and must be returned for repair.
Go to Step 3a.4.

If all resistance readings at the control terminals were found to be "normal" you have a Malfunctioning Control Module, reconnect all wires, and go to step 3a.4.

3a.3 If Lamp #2 and Lamp #3 maintain a constant light intensity, either the Control Handle Assembly, or the Control Module, or the Control Cable connection between the two assemblies is malfunctioning.

NOTE: If you are using a cable extension, or a quick disconnect system, of any sort, with your welder, remove it temporarily and repeat the tests to insure that the problem noted is not caused by a fault in the cable extension.

To determine if the Control Cable connection is at fault, temporarily hold down the Power Button (you may need an assistant to do this) and observe the behavior of Lamp #2 and Lamp #3 while you partially unplug and re-plug the two black Control Cable connectors which connect the Control Handle to the Control Module. If Lamp #2 and Lamp #3 "flicker", go off, or change in intensity as you do this, the connection is faulty -- either due to a broken wire, a defective connector terminal, or due to some surface corrosion that may have formed on the connector surfaces.

If the problem is corrosion (which may be noticeable as a slight sandy roughness/drag which can be felt as the connectors are connected and disconnected), the male terminals can be cleaned by lightly dragging a sharp pen knife or box cutter blade across the both sides of each "spade". The female connector's surface can be then "cleaned" by inserting and reinserting the male connector a number of times (until reliable operation is noted). Corrosion can then be prevented by applying a good quality dielectric grease (not a conductive grease) to the contact surfaces.

If the problem is not due to surface corrosion, or if the corrosion is so bad as to cause continuing erratic operation, go to step 3a.4.

NOTE: If you are using a cable extension, or a quick disconnect system, of any sort, with your welder, remove it temporarily to insure that the problem noted is not caused by a wiring fault in the cable extension.

3a.4 You have a problem which requires either further troubleshooting assistance from our tech support department (877-ZENA INC or 615-897-2011) or a return authorization for one, or more, possibly malfunctioning component(s) for test/repair.

If, for any reason, you cannot reach us by phone, it is permissible to return the suspect component for repair without a formal authorization. Just make sure that you include a written description of the problem that you have found as well as a legible return address (and a telephone #,, if available, that we can uses if it is necessary to contact you). If you are returning either an Electrode Holder Control or a suspect Welding Power Generator, it's advisable to also return the Welding Power Control Module (only a few extra ounces) so that both items can be tested together.

IF YOU DO HAVE TO RETURN AN ITEM, insure it and make sure that it is packed carefully and properly (use our packaging materials if at all possible).

- DO NOT USE foam "peanuts" for padding (dust from these can get into your welding equipment and cause future problems) or any other type of Styrofoam packaging materials that can crumble when broken/torn/stressed.
- MAKE SURE that at least 2" of firm padding material (paper/cardboard, bubble-wrap, or non crumbling foam (like the foam pads that we use in our packaging) is placed on all sides of any item so that the item is FIRMLY held safely in the center of the package -- DO NOT SCRIMP ON PADDING.
- USE A GOOD quality box with STRONG side walls.

Careful attention to packaging will avoid extra charges for shipping damages.

4. Welding Power Boost is Not Working and All Other Welding Functions are OK

4.1 It is likely that your Control Handle is defective.

You have a problem which requires either further troubleshooting assistance from our tech support department (877-ZENA INC or 615-897-2011) or a return authorization for one, or more, possibly malfunctioning component(s) for test/repair.

If, for any reason, you cannot reach us by phone, it is permissible to return the suspect component for repair without a formal authorization. Just make sure that you include a written description of the problem that you have found as well as a legible return address (and a telephone #,, if available, that we can uses if it is necessary to contact you). If you are returning either an Electrode Holder Control or a suspect Welding Power Generator, it's advisable to also return the Welding Power Control Module (only a few extra ounces) so that both items can be tested together.

IF YOU DO HAVE TO RETURN AN ITEM, insure it and make sure that it is packed carefully and properly (use our packaging materials if at all possible).

- DO NOT USE foam "peanuts" for padding (dust from these can get into your welding equipment and cause future problems) or any other type of Styrofoam packaging materials that can crumble when broken/torn/stressed.

- MAKE SURE that at least 2" of firm padding material (paper/cardboard, bubble-wrap, or non crumbling foam (like the foam pads that we use in our packaging) is placed on all sides of any item so that the item is FIRMLY held safely in the center of the package -- DO NOT SCRIMP ON PADDING.
- USE A GOOD quality box with STRONG side walls.

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5. Welding Power is "ON" CONTINUOUSLY -- Control Module Series WC.12 & WC.24

5.1 Temporarily disconnect the plug that is used to connect the Control Handle/Control Cable Assembly to the Power Control Module. If welding power is now "OFF", go on to the next step.

If welding power is still "ON" continuously, go to step 5.3.

NOTE: If you are using a cable extension, or a quick disconnect system, of any sort, with your welder, remove it temporarily to insure that the problem noted is not caused by a wiring fault in the cable extension.

5.2 Reconnect the plug used to connect the Control Handle/Control Cable Assembly to the Power Control Module.

With the engine OFF, open the Control Module cover, rotate the Power Control Dial on the Control Handle/Control Cable Assembly to its full counter clock wise position (CCW), turn on power to the Control Module and observe Lamp #2. If Lamp #2 **is** illuminated, go to step 5.6.

If Lamp #2 **is not** illuminated, go on to the next step.

5.3 It is likely that either your Power Generator or your Control Module is defective. You can easily check for a component failure in the Power Generator by disconnecting the two Gray wires which are used to connect the Control Module to the Power Generator's control terminals, and check in the electrical resistance between **either** of the terminals and the case of the Power Generator. A normal reading is an "open" circuit (an infinite resistance).

If your meter shows **any** measurable resistance, your Power Generator has a component failure, and must be returned for repair. Go to Step 5.5.

If your meter shows **no** measurable resistance, go to the next step.

5.4 Check in the electrical resistance **between** the Power Generator control terminals with an ohm meter. A normal reading is between 1.4 and 2.4 ohms. If your meter shows a resistance of **less than 1.4 ohms**, your Power Generator has a component failure, and must be returned for repair. Go to Step 5.5.

If the electrical resistance measured between the control terminals is **higher than the "normal" range of 1.4 to 2.4 ohms** (for example, 10 ohms or 20 ohms or more) it is an indication that grease or some similar material may have caused "fouling" of the brushes and or internal slip-rings. Cleaning can be accomplished in the field, if necessary, but is best done under factory (dust free) conditions. Factory cleaning, will be performed free of any labor charge, with charges only for return freight cost. If you want to clean the unit yourself, we will provide instructions. Go to Step 5.5.

If a low resistance readings at the control terminals is found, you have a Malfunctioning Power Generator. If a the resistance readings at the control terminals is not low, you have a Malfunctioning Control Module. Reconnect all wires, and go to step 5.5.

5.5 You have a problem which requires either further troubleshooting assistance from our tech support department (877-ZENA INC or 615-897-2011) or a return authorization for one, or more, possibly malfunctioning component(s) for test/repair.

If, for any reason, you cannot reach us by phone, it is permissible to return the suspect component for repair without a formal authorization. Just make sure that you include a written description of the problem that you have found as well as a legible return address (and a telephone #,, if available, that we can uses if it is necessary to contact you). If you are returning either an Electrode Holder Control or a suspect Welding Power Generator, it's advisable to also return the Welding Power Control Module (only a few extra ounces) so that both items can be tested together.

IF YOU DO HAVE TO RETURN AN ITEM, insure it and make sure that it is packed carefully and properly (use our packaging materials if at all possible).

- DO NOT USE foam "peanuts" for padding (dust from these can get into your welding equipment and cause future problems) or any other type of Styrofoam packaging materials that can crumble when broken/torn/stressed.
- MAKE SURE that at least 2" of firm padding material (paper/cardboard, bubble-wrap, or non crumbling foam (like the foam pads that we use in our packaging) is placed on all sides of any item so that the item is FIRMLY held safely in the center of the package -- DO NOT SCRIMP ON PADDING.
- USE A GOOD quality box with STRONG side walls.

Careful attention to packaging will avoid extra charges for shipping damages.

5.6 It is likely that your Control Handle/Control Cable Assembly is malfunctioning. To troubleshoot further, go to step 3.1.

5a. Welding Power is on CONTINUOUSLY -- Control Module Series WC.12RO & WC.24RO

5a.1 Temporarily disconnect the plug that is used to connect the Control Handle/Control Cable Assembly to the Power Control Module. If welding power is now "OFF", go on to the next step.

If welding power is still "ON" continuously, go to step 5a.3.

NOTE: If you are using a cable extension, or a quick disconnect system, of any sort, with your welder, remove it temporarily to insure that the problem noted is not caused by a wiring fault in the cable extension.

5a.2 Reconnect the plug used to connect the Control Handle/Control Cable Assembly to the Power Control Module.

With the engine OFF, open the Control Module cover, rotate the Power Control Dial on the Control Handle/Control Cable Assembly to its full counter clock wise position (CCW), turn on power to the Control Module and observe Lamp #2 and Lamp #3. If Lamp #2 is illuminated and Lamp #3 is not OR if Lamp #3 is illuminated and Lamp #2 is not, go to step 5a.3. If BOTH Lamp #2 AND Lamp #3 are illuminated, go to step 5a.6.

5a.3 It is likely that either your Power Generator or your Control Module is defective. You can easily check for a component failure in the Power Generator by disconnecting the two Gray wires which are used to connect the Control Module to the Power Generator's control terminals, and check in the electrical resistance between **either** of the terminals and the case of the Power Generator. A normal reading is an "open" circuit (an infinite resistance).

If your meter shows **any** measurable resistance, your Power Generator has a component failure, and must be returned for repair. Go to Step 5a.5.

If your meter shows **no** measurable resistance, go to the next step.

5a.4 Check in the electrical resistance **between** the Power Generator control terminals with an ohm meter. A normal reading is between 1.4 and 2.4 ohms. If your meter shows a resistance of **less than 1.4 ohms**, your Power Generator has a component failure, and must be returned for repair. Go to Step 5a.5.

If the electrical resistance measured between the control terminals is **higher than the "normal" range of 1.4 to 2.4 ohms** (for example, 10 ohms or 20 ohms or more) it is an indication that grease or some similar material may have caused "fouling" of the brushes and or internal slip-rings. Cleaning can be accomplished in the field, if necessary, but is best done under factory (dust free) conditions. Factory cleaning, will be performed free of any labor charge, with charges only for return freight cost. If you want to clean the unit yourself, we will provide instructions. Go to Step 5a.5.

If a low resistance readings at the control terminals is found, you have a Malfunctioning Power Generator. If a the resistance readings at the control terminals is not low, you have a Malfunctioning Control Module. Reconnect all wires, and go to step 5a.5.

5a.5 You have a problem which requires either further troubleshooting assistance from our tech support department (877-ZENA INC or 615-897-2011) or a return authorization for one, or more, possibly malfunctioning component(s) for test/repair.

If, for any reason, you cannot reach us by phone, it is permissible to return the suspect component for repair without a formal authorization. Just make sure that you include a written description of the problem that you have found as well as a legible return address (and a telephone #,, if available, that we can uses if it is necessary to contact you). If you are returning either an Electrode Holder Control or a suspect Welding Power Generator, it's advisable to also return the Welding Power Control Module (only a few extra ounces) so that both items can be tested together.

IF YOU DO HAVE TO RETURN AN ITEM, insure it and make sure that it is packed carefully and properly (use our packaging materials if at all possible).

- DO NOT USE foam "peanuts" for padding (dust from these can get into your welding equipment and cause future problems) or any other type of Styrofoam packaging materials that can crumble when broken/torn/stressed.
- MAKE SURE that at least 2" of firm padding material (paper/cardboard, bubble-wrap, or non crumbling foam (like the foam pads that we use in our packaging) is placed on all sides of any item so that the item is FIRMLY held safely in the center of the package -- DO NOT SCRIMP ON PADDING.
- USE A GOOD quality box with STRONG side walls.

Careful attention to packaging will avoid extra charges for shipping damages.

5a.6 It is likely that your Control Handle/Control Cable Assembly is malfunctioning. To troubleshoot further, go on to step 3a.1.

6. ASC1 Automatic Speed Control Stays at High Idle Constantly When Welder Power is ON -- Welder Operates Normally -- Control Module Series WC.12 & WC.24

6.1 With the engine ON, temporarily disconnect the green wire that is used to connect Power Control Module to the Speed Control Vacuum Switch, turn on power to the Control Module, and observe throttle control actuator.

If engine speed stays at high idle it is possible that the Vacuum Switch is malfunctioning, or that the vacuum actuator has become physically "jammed" in some way. If no physical or mechanical problem is noted, go to Step 6.2.

If engine speed returns to low/normal idle when the green wire is disconnected, it is likely that the Control Module is malfunctioning. Go to Step 6.4.

6.2 The connection of the vacuum lines to the two connection points on the Speed Control Vacuum Switch is important. One of the points is to be connected to the vacuum source/supply, the other is connected to the actuator. Carefully check the diagram in APPENDIX E to insure that your vacuum lines are properly connected. If the connections are correct, go to the next step.

6.3 Temporarily disconnect the vacuum line going from the Speed Control Vacuum Switch to the Control Actuator (at either end) while observing the actuator. If the Control Actuator returns to its "rest" position, your Speed Control Vacuum Switch is likely to be malfunctioning. If the Actuator remains activated, and if it is not physically "jammed" the actuator will need replacement. In either case, go on to the next step.

6.4 You have a problem which requires either further troubleshooting assistance from our tech support department (877-ZENA INC or 615-897-2011) or a return authorization for one, or more, possibly malfunctioning component(s) for test/repair.

If, for any reason, you cannot reach us by phone, it is permissible to return the suspect component for repair without a formal authorization. Just make sure that you include a written description of the problem that you have found as well as a legible return address (and a telephone #,, if available, that we can uses if it is necessary to contact you). If you are returning either an Electrode Holder Control or a suspect Welding Power Generator, it's advisable to also return the Welding Power Control Module (only a few extra ounces) so that both items can be tested together.

IF YOU DO HAVE TO RETURN AN ITEM, insure it and make sure that it is packed carefully and properly (use our packaging materials if at all possible).

- DO NOT USE foam "peanuts" for padding (dust from these can get into your welding equipment and cause future problems) or any other type of Styrofoam packaging materials that can crumble when broken/torn/stressed.
- MAKE SURE that at least 2" of firm padding material (paper/cardboard, bubble-wrap, or non crumbling foam (like the foam pads that we use in our packaging) is placed on all sides of any item so that the item is FIRMLY held safely in the center of the package -- DO NOT SCRIMP ON PADDING.
- USE A GOOD quality box with STRONG side walls.

Careful attention to packaging will avoid extra charges for shipping damages.

7. ASC1 Automatic Speed Control Will NOT Increase Engine Speed -- Welder Operates Normally -- Control Module Series WC.12 & WC.24

7.1 With the engine ON, disconnect the green wire that is used to connect Power Control Module to the Speed Control Vacuum Switch, turn on power to the Control Module, and observe throttle control actuator while temporarily grounding the green wire which goes to the Vacuum Switch.

If engine speed stays at low/normal idle it is likely that either there is no 12V power to the Vacuum Switch, or that the switch is malfunctioning, or that the vacuum actuator has become physically "jammed" in some way. To check for power to the switch use a volt meter -- touching one probe to the end of the green wire with the other grounded. You should see 12-14.5V at this point with the ignition on. If voltage is present and if no physical or mechanical problem is noted, go to Step 7.2.

If engine speed goes to high idle it is likely that the Control Module is malfunctioning. Go to Step 7.6.

7.2 The connection of the vacuum lines to the two connection points on the Speed Control Vacuum Switch is important. One of the points is connected to the vacuum source/supply, the other is connected to the actuator. Carefully check the diagram in APPENDIX E to insure that your vacuum lines are properly connected. If the connections are correct, go to the next step.

7.3 Temporarily disconnect the vacuum line going from vehicle vacuum source/supply to the Speed Control Vacuum. A strong/definite vacuum should be noted. If vacuum is not found correct, the problem and retest. If vacuum is present, reconnect the vacuum line and go on to the next step.

7.4 Temporarily disconnect the vacuum line going from the Speed Control Vacuum Switch to the Control Actuator (at the Actuator end). Place a finger tip over the end of the hose and "feel" for vacuum at the hose end while temporarily grounding the green wire which goes to the Vacuum Switch (as you did in step 7.1). As the wire is connected to ground, vacuum should appear at the hose end. If it does not, the Speed Control Vacuum Switch is likely defective. Go on to step 7.6

If vacuum appears at the hose end, the Control Actuator should be checked for a vacuum leak. Go to the next step.

7.5 Check for a vacuum leak by disconnecting the vacuum line to the actuator, manually moving the actuator to its "closed" position, placing a finger tip over the vacuum connection pipe end and then releasing the actuator. If a good vacuum seal exists within the actuator it will stay in position (moving only very slightly, if at all) -- moving fully back to rest only when the pipe end is uncovered.

A vacuum leak can occur if the diaphragm inside the actuator is damaged, or if the fine adjustment screw on the rear of the vacuum actuator if the screw is turned "out"(CCW) too far -- to the point where the fine adjustment screw comes "free" of the Actuator's Vacuum Chamber, exposing the o-ring which seals the Actuator Vacuum Chamber -- resulting in a vacuum leak which will prevent your Actuator from functioning.

If you find that an o-ring leak exists, you can often clear the problem by carefully reinserting the part. However, before reinserting the fine adjustment

screw, lubricate the o-ring with some mineral oil. Failure to properly lubricate the o-ring before reassembly may result in permanent damage to the o-ring.)

If a o-ring leak is not the problem, or if the o-ring seal cannot be reestablished, the actuator will require replacement. Go on to the next step.

7.6 You have a problem which requires either further troubleshooting assistance from our tech support department (877-ZENA INC or 615-897-2011) or a return authorization for one, or more, possibly malfunctioning component(s) for test/repair.

If, for any reason, you cannot reach us by phone, it is permissible to return the suspect component for repair without a formal authorization. Just make sure that you include a written description of the problem that you have found as well as a legible return address (and a telephone #,, if available, that we can uses if it is necessary to contact you). If you are returning either an Electrode Holder Control or a suspect Welding Power Generator, it's advisable to also return the Welding Power Control Module (only a few extra ounces) so that both items can be tested together.

IF YOU DO HAVE TO RETURN AN ITEM, insure it and make sure that it is packed carefully and properly (use our packaging materials if at all possible).

- DO NOT USE foam "peanuts" for padding (dust from these can get into your welding equipment and cause future problems) or any other type of Styrofoam packaging materials that can crumble when broken/torn/stressed.
- MAKE SURE that at least 2" of firm padding material (paper/cardboard, bubble-wrap, or non crumbling foam (like the foam pads that we use in our packaging) is placed on all sides of any item so that the item is FIRMLY held safely in the center of the package -- DO NOT SCRIMP ON PADDING.
- USE A GOOD quality box with STRONG side walls.

Careful attention to packaging will avoid extra charges for shipping damages.

8. ASC3 Automatic Speed Control Stays at High Idle Constantly When Welder Power is ON -- Welder Operates Normally -- Control Module Series WC.12 & WC.24

8.1 With the engine ON, temporarily disconnect the green wire that is used to connect Power Control Module to the Speed Control Relay, turn on power to the Control Module, and observe throttle control actuator.

If engine speed stays at high idle it is possible that the Speed Control Relay is malfunctioning, or that the electric actuator has become physically "jammed" in some way, or that the actuator is malfunctioning. If no physical or mechanical problem is noted, reconnect the green wire and go to Step 8.2.

If engine speed returns to low/normal idle when the green wire is disconnected, it is likely that the Control Module is malfunctioning. Go to Step 8.4.

8.2 The connection of the wires to the Speed Control Relay is important -- as are the connections between the relay and the electric actuator mechanism. Carefully check the diagram that came with your speed control to insure that all wires are properly connected. If the connections are correct, go to the next step.

8.3 Temporarily disconnect the white wire going from Speed Control Relay to the electric actuator. If engine speed stays at high idle it is possible that electric actuator has become physically "jammed" in some way, or that the actuator is

malfunctioning. If no physical or mechanical problem is noted, the actuator is defective. Reconnect the white wire and go to Step 8.4.

8.4 You have a problem which requires either further troubleshooting assistance from our tech support department (877-ZENA INC or 615-897-2011) or a return authorization for one, or more, possibly malfunctioning component(s) for test/repair.

If, for any reason, you cannot reach us by phone, it is permissible to return the suspect component for repair without a formal authorization. Just make sure that you include a written description of the problem that you have found as well as a legible return address (and a telephone #,, if available, that we can uses if it is necessary to contact you). If you are returning either an Electrode Holder Control or a suspect Welding Power Generator, it's advisable to also return the Welding Power Control Module (only a few extra ounces) so that both items can be tested together.

IF YOU DO HAVE TO RETURN AN ITEM, insure it and make sure that it is packed carefully and properly (use our packaging materials if at all possible).

- DO NOT USE foam "peanuts" for padding (dust from these can get into your welding equipment and cause future problems) or any other type of Styrofoam packaging materials that can crumble when broken/torn/stressed.
- MAKE SURE that at least 2" of firm padding material (paper/cardboard, bubble-wrap, or non crumbling foam (like the foam pads that we use in our packaging) is placed on all sides of any item so that the item is FIRMLY held safely in the center of the package -- DO NOT SCRIMP ON PADDING.
- USE A GOOD quality box with STRONG side walls.

Careful attention to packaging will avoid extra charges for shipping damages.

9. ASC3 Automatic Speed Control Will NOT Increase Engine Speed OR begins to increase speed and fails -- Welder Operates Normally -- Control Module Series WC.12 & WC.24

9.1 With the engine ON, disconnect the green wire that is used to connect Power Control Module to the Speed Control Relay, turn on power to the Control Module, and observe the electric throttle control actuator while temporarily grounding the green wire which goes to the Speed Control Relay.

If the actuator does not move and engine speed stays at low/normal idle it is likely that either there is no 12V power to the Speed Control Relay, or that the relay is malfunctioning. To check for power to the relay use a volt meter -- touching one probe to the end of the green wire with the other probe touching "ground". You should see 12-14.5V at this point with the ignition on. If voltage is present, and if no physical or mechanical problem is noted, go to Step 9.2.

If engine speed goes to high idle it is likely that the Control Module is malfunctioning. Go to Step 9.4.

9.2 The connection of the wires to the Speed Control Relay is important -- as are the connections between the relay and the electric actuator mechanism. Carefully check the diagram that came with your speed control to insure that all wire are properly connected. If the connections are correct, go to the next step.

9.3 Temporarily disconnect the white wire going from Speed Control Relay to the electric actuator at the relay side of the wire. Then, observe the electric throttle control actuator while temporarily connecting the end of the white wire to +12V.

If engine speed stays at low/normal idle, or if the actuator moves a bit but almost immediately returns to its "off" position, it is possible that electric actuator has become physically "jammed" in some way, or that the actuator's linkage to the throttle mechanism has been adjusted so that the actuator cannot fully engage (go to its full travel limit), or that the actuator is malfunctioning.

If no physical or mechanical problem is noted, and if you are sure that the actuator is reaching its full on position[25] (see footnote below), the actuator is defective. Reconnect the white wire and go to Step 9.4.

If the actuator activates properly when the white wire is connected to +12V--increasing and holding a steady engine speed, the Speed Control Relay is defective and should be replaced. Go to Step 9.4.

9.4 You have a problem which requires either further troubleshooting assistance from our tech support department (877-ZENA INC or 615-897-2011) or a return authorization for one, or more, possibly malfunctioning component(s) for test/repair.

If, for any reason, you cannot reach us by phone, it is permissible to return the suspect component for repair without a formal authorization. Just make sure that you include a written description of the problem that you have found as well as a legible return address (and a telephone #,, if available, that we can uses if it is necessary to contact you). If you are returning either an Electrode Holder Control or a suspect Welding Power Generator, it's advisable to also return the Welding Power Control Module (only a few extra ounces) so that both items can be tested together.

IF YOU DO HAVE TO RETURN AN ITEM, insure it and make sure that it is packed carefully and properly (use our packaging materials if at all possible).

- DO NOT USE foam "peanuts" for padding (dust from these can get into your welding equipment and cause future problems) or any other type of Styrofoam packaging materials that can crumble when broken/torn/stressed.
- MAKE SURE that at least 2" of firm padding material (paper/cardboard, bubble-wrap, or non crumbling foam (like the foam pads that we use in our packaging) is placed on all sides of any item so that the item is FIRMLY held safely in the center of the package -- DO NOT SCRIMP ON PADDING.
- USE A GOOD quality box with STRONG side walls.

Careful attention to packaging will avoid extra charges for shipping damages.

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[25] Check for proper actuator travel by disconnecting all links (beaded chain etc.) connecting the actuator to the throttle mechanism so that the actuator can be observed with nothing connected to it which could be preventing the actuator from reaching its full travel position.

C. Mechanical Problems

Symptom	Likely Problem
V-belt squealing	Belt loose OR worn out
V-belt and/or pulley attached to the Welding Power Generator gets very hot	Belt mis-aligned OR too tight OR too loose
Mechanical noise is heard continuously	Mounting bracket loose or mis-aligned
Mechanical noise is heard only when welding	Mounting bracket loose or mis-aligned or defective Welding Power Generator
When the engine is running, excessive vibration is felt at (or in) the Welding Power Generator.	Mounting bracket loose or mis-aligned
Excessive vibration is felt at Welding Power Generator ONLY when welding power is being generated	Mounting bracket loose or mis-aligned or defective Welding Power Generator

X. If You Need Help/Support

We want you to get the most from your new equipment. To this end, we are committed to providing you with whatever level of support you may need (starting with this manual) to insure that when you take delivery of your new welder, or complete your welding system installation, your new equipment will be perfectly installed and ready to provide you with the best welding experience of your life.

A number of different support mechanisms are available to you:

A. The Internet -- www.zena.net

Our web site is available 24 hours a day and contains our most up-to-date product information, photos and descriptions of typical installations, and other technical information that may be of assistance to you. If you have access to the web, log on to our site and browse before you begin your installation. A good starting point is our web site map:

http://www.zena.net/htdocs/Map.shtml

B. E-Mail -- support@zena.net

Feel free to send us e-mail at any time. We try to answer all e-mail within 24 hours.

C. Fax -- 615-897-2023

Feel free to send us a fax at any time (include pictures and/or diagrams if possible). We make every effort to answer all faxes within 24 hours.

D. Mail

ZENA, Incorporated
Technical Support
330 Club Springs Road
Elmwood, Tennessee 38560
U.S.A.

E. Telephone Support

When all else fails, we can also provide you with help via telephone support. Telephone support is available during our normal business hours: 9:00 AM to 5:00 PM CST

Toll Free in U.S.A. --> **877-ZENA INC** (877-936-2462)

Outside U.S.A. --> **615-897-2011**

NOTE: We **do not** use inexperienced people (often halfway around the world) who attempt to provide technical support by simply reading from a computer screen and/or a prepared script. O**ur web site, and this manual, already contain everything that would be included in such a script -- and more!** Instead, **all** of our support personnel are individuals with extensive welding experience who also have extensive hands-on installation and service experience with our products. Bringing you a wealth of experience and knowledge which goes beyond the scope of this document.

This means, however, that we don't have a support staff numbering many hundreds with a huge number of incoming phone lines -- so, depending on the time of day that you call, you may have to interact with our simple voice mail system, and wait a short period for a call back. Should this occur, please accept our apologies.

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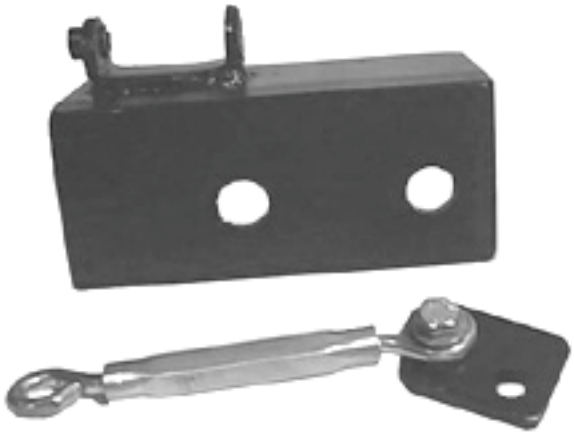
Appendix A Brackets & Accessories

A. Misc. Brackets (available accessories & custom built)

A215 Alternator Support/ Belt Tensioning Bracket



User fabricated bracket components
(from a tractor installation in which a Universal Mounting Bracket was mounted to a piece of 2" x 2" x 1/4" angle stock to support Power Generator)

A300 Universal Weldable Mounting Bracket
(often used to mount base of Power Generator directly to a user fabricated welded bracket assembly)

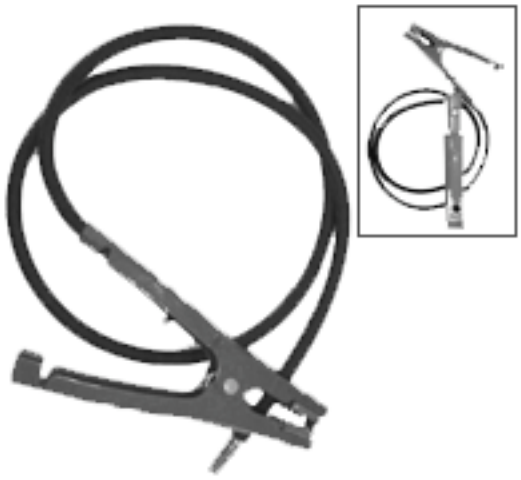
A300A Bolt-On Pivot Mounting Bracket
(our most popular bracketing accessory -- used to mount base of Power Generator directly to other bracketing components)

While not technically a bracket, this simple to build
engine speed control mechanism
made from scrap pieces of PVC pipe, a couple of furniture casters, and a caulking gun shows how a little ingenuity can make your welder easier to use.

B. Misc. Accessories

BJ150 Welding Lead Extension Mount Accessory
(used typically in automotive installations where attaching /removing control cables might be inconvenient or time consuming)

Automatic Engine Speed Control
(when used in conjunction with control circuits built into all ZENA welders this accessory increases engine speed to optimum welding speed **automatically** when Power Button is depressed and returns engine speed to an idle as soon as Power Button is released)
(**for engines w/vacuum supply**)



Battery Boost/Charger Clamp
(easy to fabricate accessory which is used to attach a jumper cable clamp to electrode holder)

Add-A-Pulley™ alternator power take off kit
(use to attach a pulley to existing alternator in vehicles with serpentine belt accessory drive system)