

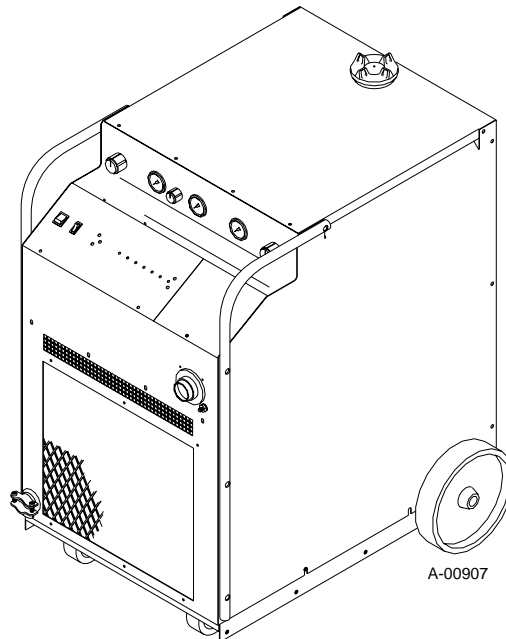
# ***THERMAL DYNAMICS***<sup>®</sup>



***A THERMADYNE<sup>®</sup> Company***

## ***MERLIN 3000***

***Plasma Cutting Power Supply***



## **Service Manual**

October 6, 1999

Manual No. 0-2533

**WARNING**

Read and understand this entire Service Manual and your employer's safety practices before installing, operating, or servicing the equipment.

**WARNING**

While the information contained in this Service Manual represents our best judgement, Thermal Dynamics Corporation assumes no liability for its use.

MERLIN 3000 Plasma Cutting Power Supply  
Service Manual Number 0-2533

Published by:  
Thermal Dynamics Corporation  
Industrial Park No. 2  
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# SECTION 1: GENERAL INFORMATION

## 1.01 Notes, Cautions and Warnings

Throughout this manual, notes, cautions, and warnings are used to highlight important information. These highlights are categorized as follows:

### NOTE

*An operation, procedure, or background information which requires additional emphasis or is helpful in efficient operation of the system.*

### CAUTION

*A procedure which, if not properly followed, may cause damage to the equipment.*



### WARNING

*A procedure which, if not properly followed, may cause injury to the operator or others in the operating area.*

## 1.02 Important Safety Precautions



### WARNINGS

**OPERATION AND MAINTENANCE OF PLASMA ARC EQUIPMENT CAN BE DANGEROUS AND HAZARDOUS TO YOUR HEALTH.**

*Plasma arc cutting produces intense electric and magnetic emissions that may interfere with the proper function of cardiac pacemakers, hearing aids, or other electronic health equipment. Persons who work near plasma arc cutting applications should consult their medical health professional and the manufacturer of the health equipment to determine whether a hazard exists.*

*To prevent possible injury, read, understand and follow all warnings, safety precautions and instructions before using the equipment. Call 1-603-298-5711 or your local distributor if you have any questions.*



### GASES AND FUMES

Gases and fumes produced during the plasma cutting process can be dangerous and hazardous to your health.

- Keep all fumes and gases from the breathing area. Keep your head out of the welding fume plume.
- Use an air-supplied respirator if ventilation is not adequate to remove all fumes and gases.
- The kinds of fumes and gases from the plasma arc depend on the kind of metal being used, coatings on the metal, and the different processes. You must be very careful when cutting or welding any metals which may contain one or more of the following:

Antimony	Chromium	Mercury
Arsenic	Cobalt	Nickel
Barium	Copper	Selenium
Beryllium	Lead	Silver
Cadmium	Manganese	Vanadium

- Always read the Material Safety Data Sheets (MSDS) that should be supplied with the material you are using. These MSDSs will give you the information regarding the kind and amount of fumes and gases that may be dangerous to your health.
- For information on how to test for fumes and gases in your workplace, refer to item 1 in Subsection 1.03, Publications in this manual.
- Use special equipment, such as water or down draft cutting tables, to capture fumes and gases.
- Do not use the plasma torch in an area where combustible or explosive gases or materials are located.
- Phosgene, a toxic gas, is generated from the vapors of chlorinated solvents and cleansers. Remove all sources of these vapors.



### ELECTRIC SHOCK

Electric Shock can injure or kill. The plasma arc process uses and produces high voltage electrical energy. This electric energy can cause severe or fatal shock to the operator or others in the workplace.

- Never touch any parts that are electrically “live” or “hot.”
- Wear dry gloves and clothing. Insulate yourself from the work piece or other parts of the welding circuit.
- Repair or replace all worn or damaged parts.
- Extra care must be taken when the workplace is moist or damp.

- Install and maintain equipment according to NEC code, refer to item 9 in Subsection 1.03, Publications.
- Disconnect power source before performing any service or repairs.
- Read and follow all the instructions in the Operating Manual.



### FIRE AND EXPLOSION

Fire and explosion can be caused by hot slag, sparks, or the plasma arc.

- Be sure there is no combustible or flammable material in the workplace. Any material that cannot be removed must be protected.
- Ventilate all flammable or explosive vapors from the workplace.
- Do not cut or weld on containers that may have held combustibles.
- Provide a fire watch when working in an area where fire hazards may exist.
- Hydrogen gas may be formed and trapped under aluminum workpieces when they are cut underwater or while using a water table. **DO NOT** cut aluminum alloys underwater or on a water table unless the hydrogen gas can be eliminated or dissipated. Trapped hydrogen gas that is ignited will cause an explosion.



### NOISE

Noise can cause permanent hearing loss. Plasma arc processes can cause noise levels to exceed safe limits. You must protect your ears from loud noise to prevent permanent loss of hearing.

- To protect your hearing from loud noise, wear protective ear plugs and/or ear muffs. Protect others in the workplace.
- Noise levels should be measured to be sure the decibels (sound) do not exceed safe levels.
- For information on how to test for noise, see item 1 in Subsection 1.03, Publications, in this manual.



### PLASMA ARC RAYS

Plasma Arc Rays can injure your eyes and burn your skin. The plasma arc process produces very bright ultra violet and infra red light. These arc rays will damage your eyes and burn your skin if you are not properly protected.

- To protect your eyes, always wear a welding helmet or shield. Also always wear safety glasses with side shields, goggles or other protective eye wear.
- Wear welding gloves and suitable clothing to protect your skin from the arc rays and sparks.
- Keep helmet and safety glasses in good condition. Replace lenses when cracked, chipped or dirty.
- Protect others in the work area from the arc rays. Use protective booths, screens or shields.
- Use the shade of lens as suggested in the following per ANSI/ASC Z49.1:

Arc Current	Minimum Protective Shade No.	Suggested Shade No.
Less Than 300*	8	9
300 - 400*	9	12
400 - 800*	10	14

\* These values apply where the actual arc is clearly seen. Experience has shown that lighter filters may be used when the arc is hidden by the work-piece.

## 1.03 Publications

Refer to the following standards or their latest revisions for more information:

1. OSHA, SAFETY AND HEALTH STANDARDS, 29CFR 1910, obtainable from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402
2. ANSI Standard Z49.1, SAFETY IN WELDING AND CUTTING, obtainable from the American Welding Society, 550 N.W. LeJeune Rd, Miami, FL 33126
3. NIOSH, SAFETY AND HEALTH IN ARC WELDING AND GAS WELDING AND CUTTING, obtainable from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402
4. ANSI Standard Z87.1, SAFE PRACTICES FOR OCCUPATION AND EDUCATIONAL EYE AND FACE PROTECTION, obtainable from American National Standards Institute, 1430 Broadway, New York, NY 10018
5. ANSI Standard Z41.1, STANDARD FOR MEN'S SAFETY-TOE FOOTWEAR, obtainable from the American National Standards Institute, 1430 Broadway, New York, NY 10018
6. ANSI Standard Z49.2, FIRE PREVENTION IN THE USE OF CUTTING AND WELDING PROCESSES, obtainable from American National Standards Institute, 1430 Broadway, New York, NY 10018
7. AWS Standard A6.0, WELDING AND CUTTING CONTAINERS WHICH HAVE HELD COMBUSTIBLES, obtainable from American Welding Society, 550 N.W. LeJeune Rd, Miami, FL 33126

8. NFPA Standard 51, OXYGEN-FUEL GAS SYSTEMS FOR WELDING, CUTTING AND ALLIED PROCESSES, obtainable from the National Fire Protection Association, Batterymarch Park, Quincy, MA 02269
9. NFPA Standard 70, NATIONAL ELECTRICAL CODE, obtainable from the National Fire Protection Association, Batterymarch Park, Quincy, MA 02269
10. NFPA Standard 51B, CUTTING AND WELDING PROCESSES, obtainable from the National Fire Protection Association, Batterymarch Park, Quincy, MA 02269
11. CGA Pamphlet P-1, SAFE HANDLING OF COMPRESSED GASES IN CYLINDERS, obtainable from the Compressed Gas Association, 1235 Jefferson Davis Highway, Suite 501, Arlington, VA 22202
12. CSA Standard W117.2, CODE FOR SAFETY IN WELDING AND CUTTING, obtainable from the Canadian Standards Association, Standards Sales, 178 Rexdale Boulevard, Rexdale, Ontario, Canada M9W 1R3
13. NWSA booklet, WELDING SAFETY BIBLIOGRAPHY obtainable from the National Welding Supply Association, 1900 Arch Street, Philadelphia, PA 19103
14. American Welding Society Standard AWSF4.1, RECOMMENDED SAFE PRACTICES FOR THE PREPARATION FOR WELDING AND CUTTING OF CONTAINERS AND PIPING THAT HAVE HELD HAZARDOUS SUBSTANCES, obtainable from the American Welding Society, 550 N.W. LeJeune Rd, Miami, FL 33126
15. ANSI Standard Z88.2, PRACTICE FOR RESPIRATORY PROTECTION, obtainable from American National Standards Institute, 1430 Broadway, New York, NY 10018

## 1.04 Note, Attention et Avertissement

Dans ce manuel, les mots “note,” “attention,” et “avertissement” sont utilisés pour mettre en relief des informations à caractère important. Ces mises en relief sont classifiées comme suit :

---

### NOTE

*Toute opération, procédure ou renseignement général sur lequel il importe d'insister davantage ou qui contribue à l'efficacité de fonctionnement du système.*

---

### ATTENTION

*Toute procédure pouvant résulter l'endommagement du matériel en cas de non-respect de la procédure en question.*



### AVERTISSEMENT

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*Toute procédure pouvant provoquer des blessures de l'opérateur ou des autres personnes se trouvant dans la zone de travail en cas de non-respect de la procédure en question.*

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## 1.05 Precautions De Securite Importantes



### AVERTISSEMENTS

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**L'OPÉRATION ET LA MAINTENANCE DU MATÉRIEL DE SOUDAGE À L'ARC AU JET DE PLASMA PEUVENT PRÉSENTER DES RISQUES ET DES DANGERS DE SANTÉ.**

*Coupant à l'arc au jet de plasma produit de l'énergie électrique haute tension et des émissions magnétique qui peuvent interférer la fonction propre d'un "pacemaker" cardiaque, les appareils auditif, ou autre matériel de santé électronique. Ceux qui travail près d'une application à l'arc au jet de plasma devrait consulter leur membre professionnel de médication et le manufacturier de matériel de santé pour déterminer s'il existe des risques de santé.*

*Il faut communiquer aux opérateurs et au personnel TOUS les dangers possibles. Afin d'éviter les blessures possibles, lisez, comprenez et suivez tous les avertissements, toutes les précautions de sécurité et toutes les consignes avant d'utiliser le matériel. Composez le + 603-298-5711 ou votre distributeur local si vous avez des questions.*

---



### FUMÉE et GAZ

La fumée et les gaz produits par le procédé de jet de plasma peuvent présenter des risques et des dangers de santé.

- Eloignez toute fumée et gaz de votre zone de respiration. Gardez votre tête hors de la plume de fumée provenant du chalumeau.
- Utilisez un appareil respiratoire à alimentation en air si l'aération fournie ne permet pas d'éliminer la fumée et les gaz.

- Les sortes de gaz et de fumée provenant de l'arc de plasma dépendent du genre de métal utilisé, des revêtements se trouvant sur le métal et des différents procédés. Vous devez prendre soin lorsque vous coupez ou soudez tout métal pouvant contenir un ou plusieurs des éléments suivants:

antimoine	cadmium	mercure
argent	chrome	nickel
arsenic	cobalt	plomb
baryum	cuivre	sélénium
béryllium	manganèse	vanadium

- Lisez toujours les fiches de données sur la sécurité des matières (sigle américain "MSDS"); celles-ci devraient être fournies avec le matériel que vous utilisez. Les MSDS contiennent des renseignements quant à la quantité et la nature de la fumée et des gaz pouvant poser des dangers de santé.
- Pour des informations sur la manière de tester la fumée et les gaz de votre lieu de travail, consultez l'article 1 et les documents cités à la page 5.
- Utilisez un équipement spécial tel que des tables de coupe à débit d'eau ou à courant descendant pour capter la fumée et les gaz.
- N'utilisez pas le chalumeau au jet de plasma dans une zone où se trouvent des matières ou des gaz combustibles ou explosifs.
- Le phosgène, un gaz toxique, est généré par la fumée provenant des solvants et des produits de nettoyage chlorés. Éliminez toute source de telle fumée.



### CHOC ELECTRIQUE

Les chocs électriques peuvent blesser ou même tuer. Le procédé au jet de plasma requiert et produit de l'énergie électrique haute tension. Cette énergie électrique peut produire des chocs graves, voire mortels, pour l'opérateur et les autres personnes sur le lieu de travail.

- Ne touchez jamais une pièce "sous tension" ou "vive"; portez des gants et des vêtements secs. Isolez-vous de la pièce de travail ou des autres parties du circuit de soudage.
- Réparez ou remplacez toute pièce usée ou endommagée.
- Prenez des soins particuliers lorsque la zone de travail est humide ou moite.
- Montez et maintenez le matériel conformément au Code électrique national des Etats-Unis. (Voir la page 5, article 9.)
- Débranchez l'alimentation électrique avant tout travail d'entretien ou de réparation.
- Lisez et respectez toutes les consignes du Manuel de consignes.



### INCENDIE ET EXPLOSION

Les incendies et les explosions peuvent résulter des scories chaudes, des étincelles ou de l'arc de plasma. Le procédé à l'arc de plasma produit du métal, des étincelles, des scories chaudes pouvant mettre le feu aux matières combustibles ou provoquer l'explosion de fumées inflammables.

- Soyez certain qu'aucune matière combustible ou inflammable ne se trouve sur le lieu de travail. Protégez toute telle matière qu'il est impossible de retirer de la zone de travail.
- Procurez une bonne aération de toutes les fumées inflammables ou explosives.
- Ne coupez pas et ne soudez pas les conteneurs ayant pu renfermer des matières combustibles.
- Prévoyez une veille d'incendie lors de tout travail dans une zone présentant des dangers d'incendie.
- Le gas hydrogène peut se former ou s'accumuler sous les pièces de travail en aluminium lorsqu'elles sont coupées sous l'eau ou sur une table d'eau. NE PAS couper les alliages en aluminium sous l'eau ou sur une table d'eau à moins que le gas hydrogène peut s'échapper ou se dissiper. Le gas hydrogène accumulé explosera si enflammé.



### RAYONS D'ARC DE PLASMA

Les rayons provenant de l'arc de plasma peuvent blesser vos yeux et brûler votre peau. Le procédé à l'arc de plasma produit une lumière infra-rouge et des rayons ultra-violet très forts. Ces rayons d'arc nuiront à vos yeux et brûleront votre peau si vous ne vous protégez pas correctement.

- Pour protéger vos yeux, portez toujours un casque ou un écran de soudeur. Portez toujours des lunettes de sécurité munies de parois latérales ou des lunettes de protection ou une autre sorte de protection oculaire.
- Portez des gants de soudeur et un vêtement protecteur approprié pour protéger votre peau contre les étincelles et les rayons de l'arc.
- Maintenez votre casque et vos lunettes de protection en bon état. Remplacez toute lentille sale ou comportant fissure ou rognure.
- Protégez les autres personnes se trouvant sur la zone de travail contre les rayons de l'arc en fournissant des cabines ou des écrans de protection.



- Utilisez la nuance de lentille qui est suggérée dans le recommandation qui suivent ANSI/ASC Z49.1:

Courant Arc	Nuance Minimum Protective Numéro	Nuance Suggestée Numéro
Moins de 300*	8	9
300 - 400*	9	12
400 - 800*	10	14

\* Ces valeurs s'appliquent ou l'arc actuel est observé clairement. L'expérience a démontré que les filtres moins foncés peuvent être utilisés quand l'arc est caché par moiceau de travail.



## BRUIT

Le bruit peut provoquer une perte permanente de l'ouïe. Les procédés de soudage à l'arc de plasma peuvent provoquer des niveaux sonores supérieurs aux limites normalement acceptables. Vous devez vous protéger les oreilles contre les bruits forts afin d'éviter une perte permanente de l'ouïe.

- Pour protéger votre ouïe contre les bruits forts, portez des tampons protecteurs et/ou des protections auriculaires. Protégez également les autres personnes se trouvant sur le lieu de travail.
- Il faut mesurer les niveaux sonores afin d'assurer que les décibels (le bruit) ne dépassent pas les niveaux sûrs.
- Pour des renseignements sur la manière de tester le bruit, consultez l'article 1, page 5.

## 1.06 Documents De Reference

Consultez les normes suivantes ou les révisions les plus récentes ayant été faites à celles-ci pour de plus amples renseignements :

1. OSHA, NORMES DE SÉCURITÉ DU TRAVAIL ET DE PROTECTION DE LA SANTÉ, 29CFR 1910, disponible auprès du Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402
2. Norme ANSI Z49.1, LA SÉCURITÉ DES OPÉRATIONS DE COUPE ET DE SOUDAGE, disponible auprès de la Société Américaine de Soudage (American Welding Society), 550 N.W. LeJeune Rd., Miami, FL 33126
3. NIOSH, LA SÉCURITÉ ET LA SANTÉ LORS DES OPÉRATIONS DE COUPE ET DE SOUDAGE À L'ARC ET AU GAZ, disponible auprès du Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402
4. Norme ANSI Z87.1, PRATIQUES SURES POUR LA PROTECTION DES YEUX ET DU VISAGE AU TRAVAIL ET DANS LES ECOLES, disponible de l'Institut Américain des Normes Nationales (American National Standards Institute), 1430 Broadway, New York, NY 10018
5. Norme ANSI Z41.1, NORMES POUR LES CHAUSSURES PROTECTRICES, disponible auprès de l'American National Standards Institute, 1430 Broadway, New York, NY 10018
6. Norme ANSI Z49.2, PRÉVENTION DES INCENDIES LORS DE L'EMPLOI DE PROCÉDÉS DE COUPE ET DE SOUDAGE, disponible auprès de l'American National Standards Institute, 1430 Broadway, New York, NY 10018
7. Norme A6.0 de l'Association Américaine du Soudage (AWS), LE SOUDAGE ET LA COUPE DE CONTENEURS AYANT RENFERMÉ DES PRODUITS COMBUSTIBLES, disponible auprès de la American Welding Society, 550 N.W. LeJeune Rd., Miami, FL 33126
8. Norme 51 de l'Association Américaine pour la Protection contre les Incendies (NFPA), LES SYSTEMES À GAZ AVEC ALIMENTATION EN OXYGENE POUR LE SOUDAGE, LA COUPE ET LES PROCÉDÉS ASSOCIÉS, disponible auprès de la National Fire Protection Association, Batterymarch Park, Quincy, MA 02269
9. Norme 70 de la NFPA, CODE ELECTRIQUE NATIONAL, disponible auprès de la National Fire Protection Association, Batterymarch Park, Quincy, MA 02269
10. Norme 51B de la NFPA, LES PROCÉDÉS DE COUPE ET DE SOUDAGE, disponible auprès de la National Fire Protection Association, Batterymarch Park, Quincy, MA 02269
11. Brochure GCA P-1, LA MANIPULATION SANS RISQUE DES GAZ COMPRIMÉS EN CYLINDRES, disponible auprès de l'Association des Gaz Comprimés (Compressed Gas Association), 1235 Jefferson Davis Highway, Suite 501, Arlington, VA 22202
12. Norme CSA W117.2, CODE DE SÉCURITÉ POUR LE SOUDAGE ET LA COUPE, disponible auprès de l'Association des Normes Canadiennes, Standards Sales, 178 Rexdale Boulevard, Rexdale, Ontario, Canada, M9W 1R3
13. ivret NWSA, BIBLIOGRAPHIE SUR LA SÉCURITÉ DU SOUDAGE, disponible auprès de l'Association Nationale de Fournitures de Soudage (National Welding Supply Association), 1900 Arch Street, Philadelphia, PA 19103

14. Norme AWSF4.1 de l'Association Américaine de Soudage, RECOMMANDATIONS DE PRATIQUES SURES POUR LA PRÉPARATION À LA COUPE ET AU SOUDAGE DE CONTENEURS ET TUYAUX AYANT RENFERMÉ DES PRODUITS DANGEREUX, disponible auprès de la American Welding Society, 550 N.W. LeJeune Rd., Miami, FL 33126
15. Norme ANSI Z88.2, PRATIQUES DE PROTECTION RESPIRATOIRE, disponible auprès de l'American National Standards Institute, 1430 Broadway, New York, NY 10018

## 1.07 Declaration of Conformity

Manufacturer: Thermal Dynamics Corporation  
Address: Industrial Park #2  
West Lebanon, New Hampshire 03784  
USA

The equipment described in this manual conforms to all applicable aspects and regulations of the 'Low Voltage Directive' (European Council Directive 73/23/EEC as amended by Council Directive 93/68/EEC) and to the National legislation for the enforcement of this Directive.

Serial numbers are unique with each individual piece of equipment and details description, parts used to manufacture a unit and date of manufacture.

### National Standard and Technical Specifications

The product is designed and manufactured to a number of standards and technical requirements among them are:

- \* CSA (Canadian Standards Association) standard C22.2 number 60 for Arc welding equipment.
- \* UL (Underwriters Laboratory) rating 94VO flammability testing for all printed-circuit boards used.
- \* ISO/IEC 60974-1 (BS 638-PT10) (EN 60 974-1) (EN50192) (EN50078) applicable to plasma cutting equipment and associated accessories.
- \* Extensive product design verification is conducted at the manufacturing facility as part of the routine design and manufacturing process. This is to ensure the product is safe, when used according to instructions in this manual and related industry standards, and performs as specified. Rigorous testing is incorporated into the manufacturing process to ensure the manufactured product meets or exceeds all design specifications.

Thermal Dynamics has been manufacturing products for more than 30 years, and will continue to achieve excellence in our area of manufacture.

Manufacturers responsible representative: Steve Ward  
Director of Operations  
Thermadyne UK  
Chorley England

## 1.08 Statement of Warranty

**LIMITED WARRANTY:** Thermal Dynamics® Corporation (hereinafter “Thermal”) warrants that its products will be free of defects in workmanship or material. Should any failure to conform to this warranty appear within the time period applicable to the Thermal products as stated below, Thermal shall, upon notification thereof and substantiation that the product has been stored, installed, operated, and maintained in accordance with Thermal’s specifications, instructions, recommendations and recognized standard industry practice, and not subject to misuse, repair, neglect, alteration, or accident, correct such defects by suitable repair or replacement, at Thermal’s sole option, of any components or parts of the product determined by Thermal to be defective.

**THIS WARRANTY IS EXCLUSIVE AND IS IN LIEU OF ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE.**

**LIMITATION OF LIABILITY:** Thermal shall not under any circumstances be liable for special or consequential damages, such as, but not limited to, damage or loss of purchased or replacement goods, or claims of customers of distributor (hereinafter “Purchaser”) for service interruption. The remedies of the Purchaser set forth herein are exclusive and the liability of Thermal with respect to any contract, or anything done in connection therewith such as the performance or breach thereof, or from the manufacture, sale, delivery, resale, or use of any goods covered by or furnished by Thermal whether arising out of contract, negligence, strict tort, or under any warranty, or otherwise, shall not, except as expressly provided herein, exceed the price of the goods upon which such liability is based.

**THIS WARRANTY BECOMES INVALID IF REPLACEMENT PARTS OR ACCESSORIES ARE USED WHICH MAY IMPAIR THE SAFETY OR PERFORMANCE OF ANY THERMAL PRODUCT.**

**THIS WARRANTY IS INVALID IF THE PRODUCT IS SOLD BY NON-AUTHORIZED PERSONS.**

The limited warranty periods for Thermal products shall be as follows (with the exception of XL Plus Series, CutMaster 80XL, Cougar and DRAG-GUN): A maximum of three (3) years from date of sale to an authorized distributor and a maximum of two (2) years from date of sale by such distributor to the Purchaser, and with the further limitations on such two (2) year period (see chart below).

The limited warranty period for XL Plus Series and CutMaster 80XL shall be as follows: A maximum of four (4) years from date of sale to an authorized distributor and a maximum of three (3) years from date of sale by such distributor to the Purchaser, and with the further limitations on such three (3) year period (see chart below).

The limited warranty period for Cougar and DRAG-GUN shall be as follows: A maximum of two (2) years from date of sale to an authorized distributor and a maximum of one (1) year from date of sale by such distributor to the Purchaser, and with the further limitations on such two (2) year period (see chart below).

	Parts			
	<u>XL Plus Series &amp; CutMaster 80XL</u>	<u>Parts Cougar/ Drag-Gun</u>	<u>Parts All Others</u>	<u>Labor</u>
<b><u>PAK Units, Power Supplies</u></b>				
Main Power Magnetics	3 Years	1 Year	2 Years	1 Year
Original Main Power Rectifier	3 Years	1 Year	2 Years	1 Year
Control PC Board	3 Years	1 Year	2 Years	1 Year
All Other Circuits And Components Including, But Not Limited To, Starting Circuit, Contactors, Relays, Solenoids, Pumps, Power Switching Semi-Conductors	1 Year	1 Year	1 Year	1 Year
<b><u>Consoles, Control Equipment, Heat Exchanges, And Accessory Equipment</u></b>	1 Year		1 Year	1 Year
<b><u>Torch And Leads</u></b>				
Maximizer 300 Torch			1 Year	1 Year
All Other Torches	180 Days	180 Days	180 Days	180 Days
<b><u>Repair/Replacement Parts</u></b>	90 Days	90 Days	90 Days	None

Warranty repairs or replacement claims under this limited warranty must be submitted by an authorized Thermal Dynamics® repair facility within thirty (30) days of the repair. No transportation costs of any kind will be paid under this warranty. Transportation charges to send products to an authorized warranty repair facility shall be the responsibility of the customer. All returned goods shall be at the customer’s risk and expense. This warranty supersedes all previous Thermal warranties.

Effective May 6, 1999

## SECTION 2: INTRODUCTION

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### 2.01 Scope Of Manual

This Manual provides Service Instructions for Thermal Dynamics Merlin 3000 Power Supply.

Refer to Operating Manual (0-2532) for individual operating procedures. Information in this edition is therefore particularly applicable to the Troubleshooting and Repair of the equipment, and is intended for use by properly-trained Service Technicians familiar with this equipment.

Read this Manual and the Operating Manual, 0-2532, thoroughly. A complete understanding of the capabilities and functions of the equipment will assure obtaining the performance for which it was designed.

### 2.02 General Service Philosophy

Several key points are essential to properly support the application and operation of this equipment.

#### A. Application

The equipment should satisfy the customer's requirements as supplied and as described in Section 3 of this manual. Be sure to confirm that the equipment is capable of the application desired.

#### B. Modifications

No physical or electrical modifications other than selection of standard options, Accessories, or Factory approved updates are to be made to this equipment.

#### C. Customer/Operator Responsibilities

It is the customer/operators' responsibility to maintain the equipment and peripheral Accessories provided by Thermal Dynamics in good operating order in accordance with the procedures outlined in the Operating Manual, and to protect the equipment from accidental or malicious damage.

#### D. Repair Restrictions

The electronics consists of Printed Circuit Board Assemblies which must be carefully handled, and must be replaced as units. No replacement of printed circuit solder-mounted components is allowed except as noted in this manual.

If to be returned, the replaced Printed Circuit Board Assemblies must be properly packaged in protective material and returned intact per normal procedures.

### 2.03 Service Responsibilities

The Service Technician should be familiar with the equipment and its capabilities. He should be prepared to recommend arrangements of components which will provide the most efficient layout, utilizing the equipment to its best possible advantage.

Maintenance work should be accomplished in a timely manner. If problems are encountered, or the equipment does not function as specified, contact Technical Services Department at West Lebanon for assistance.



# SECTION 3: INTRODUCTION & DESCRIPTION

## 3.01 Scope of Manual

The information in this Section is the same information contained in Section 2 of the Operating Manual. It is supplied here to familiarize the Service Technician with the capabilities and limitations of the equipment. This information will also provide the Service Technician with an overall understanding of the equipment which will, in turn, allow proper training of the customer's operating personnel.

## 3.02 General Description

The Power Supply contains all operator controls, electrical and gas inputs and outputs, and the torch leads receptacle. Many options and accessories can be added to further improve the versatility of the system.

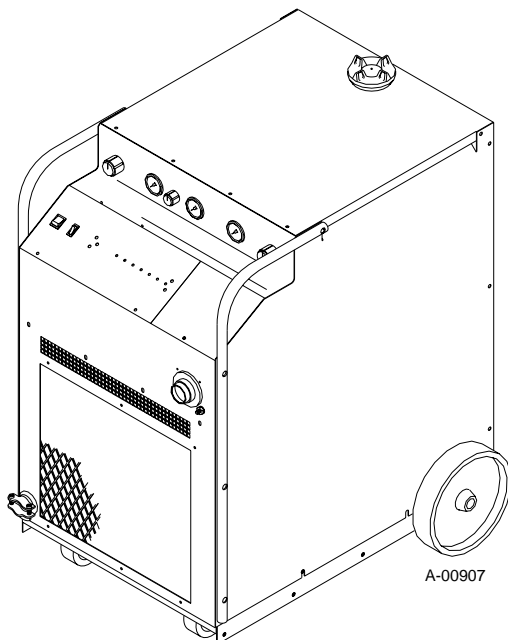


Figure 3-1 Power Supply

The Standard Coolant supplied with the Power Supply can be used in ambient temperatures down to 10° F (-12° C). If the ambient temperature will be below 10° F (-12° C) then Super Coolant should be used. This coolant can be used in areas where the ambient temperature drops to -34° F (-36° C).

A typical system configuration will contain the following:

- Power Supply with Running Gear and Handles
- Arc Starter Box
- Maximizer 300 Machine Torch with Mounting Assembly and Leads
- Torch Leads Extension
- Maximizer 300 Spare Parts Kit
- 25 ft (7.6 m) Work Cable and Clamp
- Air Line Filter Assembly (or) High Pressure Regulators

### NOTE

Refer to Section 3.05 for complete list of Power Supply Options and Accessories.

## 3.03 Specifications & Design Features

The following apply to the Power Supply only:

### 1. Controls

ON/OFF Switch, Output Current Control, RUN/SET/PURGE Switch, Secondary Gas Regulator, Plasma Gas Regulator, Secondary Mode Switch

### 2. Control Indicators

LED Indicators:

AC, TEMP, GAS, DC, PILOT, COOLANT PRES, and COOLANT COND

Gauges:

Secondary, Plasma, and Coolant Pressure Gauges

### 3. Input Power

Voltage	Frequency	Phase	Amperage
200/220/230	50 or 60 Hz	3	98/89/85
380/415/460	50 or 60 Hz	3	51/47/42
500/575	50 or 60 Hz	3	40/34

### NOTE

Refer to Appendix I for recommended input wiring size, current ratings, and circuit protection requirements.

Amps depends on input voltage (Refer to Appendix I).

### 4. Output Power

Continuously adjustable by potentiometer from 50 to 150 amps

## 5. Duty Cycle

100%

## 6. Pilot Modes

Auto-Restart, Pre-Flow Delay, Recycle

## 7. CNC Signals

Enable Start/Stop, OK-to-Move, Pilot Sensing Relay (PSR), Full CNC Available with Remote

## 8. Coolant Pressure

Internal Service-adjustable

130 psi (8.8 BAR) at zero flow

120 - 125 psi (8.2 - 8.5 BAR) at 0.6 gpm (2.6 lpm)

## 9. Coolant Flow Rate

0.5 gpm (2.2 lpm) with 150 feet (45.7m) of total torch and torch leads at 70°F (21°C)

### **NOTE**

*The flow rate varies with lead length, torch configuration, ambient temperature, amperage level, etc.*

## 10. Cooling Capacity

4,000 to 10,000 BTU

### **NOTE**

*Maximum value based on "free flow" condition.*

## 11. Coolant Reservoir Capacity

2 gallons (8.8 liters)

Capable of handling a total of 150 feet (45.7m) of torch lead length

## 12. Power Supply Dimensions

### Enclosure Only -

Width: 24.12 in (0.61 m)

Height: 38.38 in (0.98 m)

Depth: 34.25 in (0.87 m)

### Fully Assembled -

Width: 28.50 in (0.72 m)

Height: 43.38 in (1.10 m)

Depth: 43.75 in (1.11 m)

## 13. Weight of Power Supply Only

678 lbs (308 kg)

## 3.04 Theory Of Operation

### A. Plasma Arc Cutting and Gouging

Plasma is a gas which is heated to an extremely high temperature and ionized so that it becomes electrically conductive. The plasma arc cutting process uses this plasma gas to transfer an electric arc to a workpiece. The metal to be cut is melted by the intense heat of the arc and then blown away by the flow of gas. Plasma arc gouging uses the same process to remove material to a controlled depth and width.

With a simple change of torch parts, the system can also be used for plasma arc gouging. Plasma arc gouging is used to remove material to a controlled depth and width.

### B. Input and Output Power

The Power Supply accepts input voltages from 200 to 575V, 50 or 60 Hz, three-phase. Input voltages are set by an internal changeover in the unit. The unit converts AC input power to DC power for the main cutting arc. The negative output is connected to the torch electrode through the negative torch lead, and the positive output connects to the workpiece through the work cable.

### C. Pilot Arc

When the torch is activated there is a selectable (2, 4, 7, or 10 second) gas pre-flow, followed by a uninterrupted DC pilot arc established between the electrode and tip. The pilot arc is initiated by a momentary high frequency pulse from the Arc Starter Box. The pilot creates a path for the main arc to transfer to the work. When the main arc is established, the pilot arc shuts off. The pilot can automatically restart (factory set for No Auto-Restart) when the main arc stops, as long as the torch remains activated.

### **NOTE**

*For the arc to restart automatically, AUTO RE-START must be enabled at switch settings inside the Power Supply.*

### D. Main Cutting Arc

The Power Supply accepts 50 or 60 Hz three-phase line input. An internal changeover switches input line voltages in three ranges, for 200/220/230V, 380/415/460V, or 500/575V operation. The power supply converts AC input power to DC power for the main cutting arc. The negative output is connected to the torch electrode through the negative torch lead. The positive output is connected to the workpiece via the work cable and clamp connection.



## E. RF Shielding

All machine torch systems are shielded to minimize radio frequency (RF) interference which results from the high frequency arc initiation. These shielded systems are designed with features such as a wire for establishing an earth ground and shielded torch and control leads.

## F. Interlocks

The system has several built-in interlocks to provide safe and efficient operation. When an interlock shuts down the system, the torch switch (or control device) must be used to restart the system.

### 1. Parts-In-Place (PIP) Interlock

The Power Supply has a built-in parts-in-place interlock that prevents accidental torch starting when torch parts are not properly installed. A flow switch on the coolant return lead detects reduced coolant flow caused by improper torch assembly. If not satisfied, the switch interrupts power to the tip and electrode.

### 2. Gas Pressure Interlock

Pressure switches act as an interlock for the gas supplies. If supply pressure falls below minimum requirements the pressure switches will open, shutting off the power to the contactors, and the GAS indicator will go out. When adequate supply pressure is available the pressure switches close, allowing power to be resumed for cutting.

### 3. Thermal Interlock

Thermal overload sensors are located in the Main Transformer, Main Heatsink Assembly, and Pilot Resistor in the power supply. If one of these components is overheated the appropriate switch will open up, causing the temperature light to turn from green to red and shutting off power to the main contactor. When the overheated component cools down the switch will close again and allow operation of the system.

## G. Plasma Torches

Plasma torches are similar in design to the common automotive spark plug. They consist of negative and positive sections which are separated by a center insulator. Inside the torch, the pilot arc is initiated in the gap between the negatively charged electrode and the positively charged tip. Once the pilot arc has ionized the plasma gas, the superheated column of gas flows through the small orifice in the torch tip, which is focused on the metal to be cut.

The Maximizer 300 Torch uses an internal closed-loop cooling system. Deionized coolant is distributed from a reservoir in the Power Supply through the coolant sup-

ply lead. At the torch, the coolant is circulated around the torch tip and electrode, where the extra cooling helps to prolong parts life. Coolant then circles back to the power supply through the return lead. The Maximizer 300 also can use secondary gases such as compressed air, nitrogen (N<sub>2</sub>), water, and carbon dioxide (CO<sub>2</sub>).

## 3.05 Options And Accessories

These items can be used to customize a standard system for a particular application or to further enhance performance. Torch accessories are listed in the separate Torch Instruction Manual.

### **NOTE**

*Refer to Section 6, Parts Lists, for ordering information.*

### A. RC6010 Remote Control

For mechanized systems, this low profile unit provides full CNC capability and allows the operator to control most system functions from a remote location.

### B. Computer Control Cable Kits

For interfacing the power supply with a computer or auxiliary control device. Available in various cable lengths.

### C. SC-10 or SC11 Standoff Control

### **NOTE**

*Standoff Control SC10 requires installation of Remote Control RC6010.*

For machine torch systems, the SC-10 automatically finds height and maintains torch standoff with a high speed torch lifter motor.

### D. High Pressure Regulators

Available for air, oxygen, argon/hydrogen, nitrogen, CO<sub>2</sub> and water.

### E. High Flow Water Shield (HFWS) Assembly

Reduces arc glare, noise, and fumes during the cutting process.

### F. Two Stage Air Line Filter

Removes damaging contaminants as small as 5 microns from the plasma stream when using compressed air.

### **G. Hour/Counter Meters**

Meter assembly containing two meters. One meter indicates the total number of hours that the main cutting arc has been on. The second meter counts the number of times that the cutting arc has been started. Both meters display a maximum of 999999 hours or starts and cannot be reset.

### **H. Plasma/Secondary Gas Control**

A remote control to select one of various plasma and secondary gases, including secondary water, that can be connected to the Power Supply.

# SECTION 4: SERVICE TROUBLESHOOTING DIAGNOSTICS

## 4.01 Introduction

This Section provides service diagnostics for the Merlin 3000 Power Supply, allowing the Technician to isolate any faulty Subassemblies. Refer to Section 5, Repairs & Replacement Procedures, for parts replacement instructions.

Under no circumstances are field repairs to be attempted on Printed Circuit Boards or other Subassemblies of this unit. Evidence of unauthorized repairs will void the factory warranty.

### NOTE

*The troubleshooting contained in this manual is for the Merlin 3000 Power Supply only. Troubleshooting other parts of the system is covered in the separate manuals for that product.*

## 4.02 Periodic Inspection & Procedures

### NOTE

*Refer to Appendix XV for a recommended maintenance schedule for water cooled plasma cutting systems.*

This subsection describes inspection procedures which should be performed at periodic intervals as required.

### A. Fan Motor and Pump Lubrication

The fan motor and pump in the power supply should be oiled twice per year or once for each 100 hours of operation. To oil the motor, remove one side panel and add two or three drops of 20 SAE oil to the front and rear oil holes on the motor.

### NOTE

*Some units may utilize a sealed motor design which does not require lubrication.*

### B. Routine Maintenance

The only other routine maintenance required for the power supply is a thorough cleaning and inspection, with the frequency depending on the usage and the operating environment.

To clean the unit, first make sure that the power is disconnected. Remove the side panels and blow out any accumulated dirt and dust with compressed air especially from the radiator. The unit should also be wiped clean. If necessary, solvents that are recommended for cleaning electrical apparatus may be used.

While the side panels are off, inspect the wiring in the unit. Look for any frayed wires or loose connections that should be corrected.

### C. Coolant Filter Assembly (Rear Panel)

The rear panel filter screen should be cleaned periodically. Remove the filter screen by unscrewing the filter holder from the Coolant Filter Assembly. Clean the filter screen by rinsing with hot soapy water. Remove soap residue by rinsing with clean hot water. Be sure that all the soap has been removed and the screen is dry of water before re-installing in the Coolant Filter Assembly.

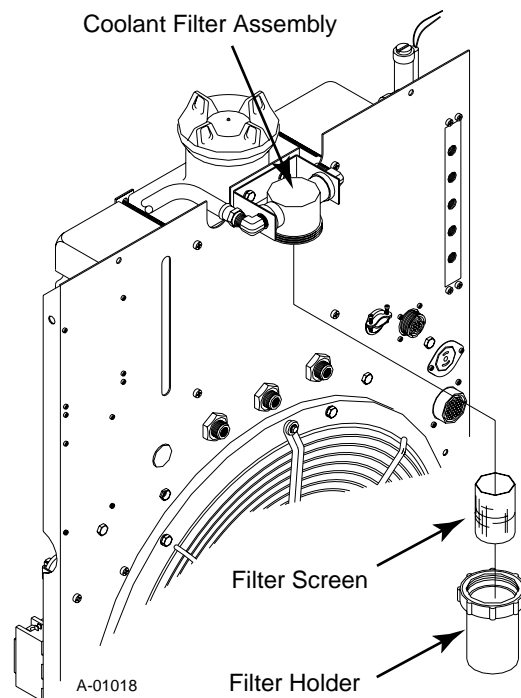


Figure 4-1 Coolant Filter Assembly (Rear Panel)

### D. Internal Filter Assembly

The internal filter screen should be cleaned periodically. To gain access to the Internal Filter Assembly remove the Left Side Panel (viewed from the front of unit) of the Power Supply. Remove the filter screen by unscrewing the filter holder from the Internal Filter Assembly. Clean the filter screen by rinsing with

hot soapy water. Remove soap residue by rinsing with clean hot water. Be sure that all the soap has been removed and the screen is dry of water before re-installing in the Internal Filter Assembly.

## E. Coolant Level and Conductivity

### 1. Coolant Level

The coolant level should be checked every day at the rear panel coolant gauge. If the coolant in the reservoir is more than 2 inches (50mm) from the top of the reservoir then add Torch Coolant.

### 2. Coolant Conductivity

The coolant conductivity LED on the front panel must be ON for normal operation. If the LED is OFF then drain the old coolant from the Power Supply and torch leads and replace with new coolant. Check the condition of the deionizer bag in the reservoir basket, if the bag is yellowish brown (straw color) replace the bag.

## F. Draining Coolant

Remove the old coolant from the Power Supply reservoir per the following procedure:

1. Remove the right side and top panels from the Power Supply.
2. Disconnect the coolant hose input to the rear panel filter assembly.
3. Carefully lower the hose out the right side of the Power Supply and drain the coolant into an acceptable container.

### CAUTION

Handle and dispose of the used coolant per recommended procedures.

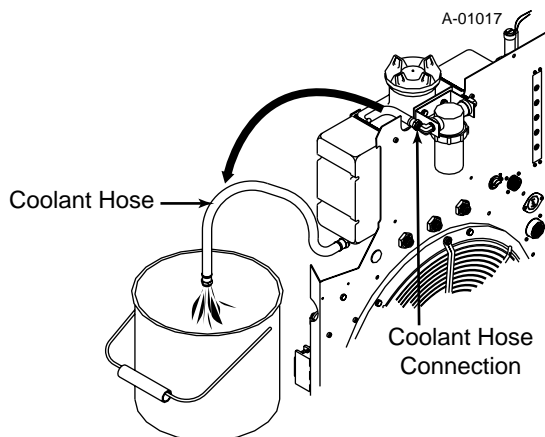


Figure 4-2 Draining Coolant From Reservoir

4. Reconnect the hose to the filter assembly.
5. Install new coolant and deionizer bag.
6. Reinstall the top and right side panels.

## 4.03 System Theory

### A. Circuit Description

The Merlin 3000 system is designed for mechanized cutting only and consists of the Merlin 3000 plasma power supply, the Maximizer 300 Torch, Torch Leads Extension, and Arc Starter Box. An Optional Remote Control (RC6010), Standoff Control (SC10 or SC11, see notes) and Gas Control (GC3000) may be used in various combinations. Different interconnect and input/output (I/O) cables may be used depending on which options are installed. An Optional Dual Meter, Arc Hours and Arc Starts Counter, may be included on the Power Supply front panel.

### NOTES

*The Standoff Control SC10 must be used with the Remote Control RC6010.*

*The Remote Control RC6010 is not used if the Standoff Control SC11 is used.*

### B. Input Voltage Selection

The main transformer (T1) has busbar connections to select one of three input voltage ranges. Each main transformer secondary has two taps. One secondary tap is automatically selected by the Voltage Selection PC board when primary power is applied. If input voltage is within the lower half of the selected voltage range (for example, 380V or 415V in the 380/415/460V range), the higher voltage taps are selected. If input voltage is within the upper half of the selected voltage range (460V in the 380/415/460V range), the lower voltage taps are selected. This arrangement provides secondary voltages close to the optimum levels. When the lower voltage taps are selected a red indicator, D18, on the Voltage Selection PC Board will be ON.

The auxiliary voltage taps, 115 VAC and 28 VAC circuits, are selected directly by relays on the Voltage Selection PC Board. The fan and pump motors are supplied by the Motor Control Contactors (MC1 and MC2). MC1 is for the high voltage tap and MC2 is for the low voltage tap. Three-phase primary power is controlled by one of the Main Contactors (W1 for the high voltage tap or W2 for the low voltage tap).

## C. Switch-Mode Power Supply Operation

Primary three-phase power is rectified by the three-phase bridge diodes D1-D6. The resulting negative DC voltage (approximately -320 VDC) is applied to the switching transistor (Q1). The switching transistor controls the output current by pulse width modulation (PWM). PWM varies the duty cycle (or on-time versus off-time) of the switch. The greater the on-time, the higher the output current will be. Components D7-10, R2-3, C13-14, L1, and the Suppression PC Board are snubbers to limit voltage and current surges caused by switching Q1 on and off. D11-14 are free wheeling diodes. When Q1 is on, current flows through Q1 into the output network. When Q1 is off, D11-14 provide a path for current to continue flowing supported by energy that was stored in the output network during the time Q1 was on. The switching transistor output is a series of pulses which are filtered back into pure DC voltage by the output network. The output network consists primarily of the main inductor (L2A and L2B), resistor R13, and capacitor C23.

## D. Switching Control PC Board

The Switching Control PC Board compares the shunt amp output with the current control pot setting and generates logic level PWM signals. The shunt and Shunt Amp PC Board are located between the input bridge positive and work lead to measure the output cutting current. The signals are sent to the driver PC board, where they are converted into the current and voltage levels needed to drive the switching transistor.

The Switching Control PC Board senses if the Remote Control (RC6010) is installed to route the current control signal from the remote instead of the Merlin front panel control. The Switching Control PC Board routes the Shunt Amp signal to the remote's current display, sends a torch voltage signal to the standoff control and supplies POT HI and POT LOW signals to set min and max output to both remote and front panel current controls. CSR (output greater than 25A) and over current shutdown (current greater than 175A) are sent to the Logic PC Board.

A relay on the Switching Control PC Board, controlled by the Remote Control (RC6010) ENABLE switch or the ENABLE input on TB2, removes power from one side of the motor (MC) and main (W) contactors coils when the enable switch is off shutting off the coolant flow and DC power to allow changing torch parts.

## E. Logic PC Board Functions

The Logic PC Board controls the timing and sequencing of the system. It monitors the pressure, temperature, and flow interlocks and controls the gas flow in

run, set, and purge modes by turning on the plasma and secondary solenoids. The Logic PC Board also controls pre-flow and post-flow durations, which are selectable by DIP switches on the board. The Logic PC Board drives the sequence status LED indicators and contains the circuit for measuring coolant conductivity.

After receiving the CNC (cutting machine controller) START signal from either the remote control, the standoff control, direct from the controller via the remote connector or TB2 the "simple" interface terminal strip, the Logic PC Board initiates gas preflow then energizes the main contactor, W1 or W2 (as determined by the Voltage Selection PC Board).

The Logic PC Board closes the pilot contactor and sends enable signals to the Switching Control PC Board to start the PWM and turn on the main switching circuits producing open circuit output voltage (OCV). When the Arc Starter Box senses OCV greater than 220 V between the Torch plus (+) and minus (-) it starts the CD (capacitor discharge) arc starting circuit to fire the spark gap producing the high voltage spark which starts the DC pilot arc. Once a constant DC pilot is established the torch voltage drops below 220 V and shuts off the CD circuit. When the Torch is close to the work the cutting arc "transfers" to the work.

The resulting current in the work lead is sensed by the Shunt Amp and the Switching Control PC Board sends the CSR signal to the Logic PC Board which opens the pilot contactor shutting off the pilot and generating an "OK-To-Move" signal. OK-To-Move can be either contact closure or 24VAC through contacts selected by switch SW5 on the Logic PCB. OK-To-Move is sent to the remote control, the standoff control or directly to the cutting machine controller. It controls the optional High Flow Water Shield and the Arc Hour/Starts Counter.

## F. LED/Current Control PC Board

The LED and current control PC board contains the sequence status LED indicators and the front panel current control pot.

## G. Remote Control

The Remote Control allows remotely controlling the cutting current, setting reduced current for corner slowdown, and enabling gas purge and set functions. An ENABLE switch shuts down the power supply and coolant pump for changing torch consumables. The Digital Amperage display allows accurate setting and monitoring of the cutting current. Connections to the cutting machine controller (CNC) are electrically isolated to minimize interference. Both a rear panel con-

necter and an internal terminal strip are provided for CNC connections. The remote includes internal connections to interface to the SC10 standoff control so the single remote cable works for both.

A Merlin 3000 system may include the following:

- No Remote Control (RC6010)
- Remote Control Only (RC6010)
- Remote Control Only (RC6010) With Standoff Control (SC10)

When an RC6010 is included the CNC signals are connected to the RC6010 through the rear panel CNC connector, J29, or may be wired directly to J6, a terminal strip inside the RC6010. All CNC inputs are optically isolated to reduce noise interference. The RC6010 allows remotely controlling the cutting current, setting reduced current for corner slowdown and selecting gas PURGE and SET functions. A digital AMPS display allows accurate setting and monitoring of the output current. An ENABLE switch shuts down the power supply and coolant pump for changing torch consumables.

## H. Standoff Control

### 1. Model SC10 Standoff Control

The Standoff Control (SC10) includes an ARC VOLTS display, a control to set the desired arc voltage as well as PIERCE HEIGHT, PIERCE DELAY and END OF CUT RETRACT (%). There are also manual UP and DOWN switches. The Standoff Control operates a lifter motor assembly moving the torch vertically to control torch tip to work distance.

When used with the Remote Control (RC6010) all inputs and outputs to the Standoff Control (except lifter motor drive) is via an internal ribbon cable between Remote Control (RC6010) J5 and Standoff Control (SC10) J7. No additional connections are required between Standoff Control and Power Supply.

### 2. Model SC11 Standoff Control

Standoff Control (SC11) is used without a Remote Control (RC6010). The Standoff Control has additional connectors on the rear panel, J40 for CNC, J41 for EXT PWR and J42 for plasma (labeled PL). A remote cable connects from the Power Supply J15 to both J41 and J42 carrying power and signals to the Standoff Control. Connector J40 accepts the same CNC cable as the Remote Control (RC6010) and like the Remote Control it has an internal terminal strip, J11. Connections J40 and J11 have only START/STOP, CSD, and OK-To-

Move signals which are optically isolated. A remote cable connects from the Power Supply to connector J41 supplying the Standoff Control power. The cable connected to J42 supplies control signals between Power Supply and the Standoff Control. Refer to the individual Instruction Manuals supplied with the equipment for more detailed information.

The Power Supply must have an enable switch connected to the terminal strip, TB2, inside the Power Supply when the Standoff Control (SC11) is used.

#### NOTE

*Refer to Appendix VIII for a Signal Flow Block Diagram of the main functions.*

## I. Gas Control

The Gas Control (GC3000) consists of additional gas solenoids mounted on the Power Supply rear panel. A remote switch box is used to select the desired Plasma and Secondary gases. Up to four plasma and three secondary gases can be connected to the manifolds and selected by the Gas Control. The secondary water input to the Power Supply may also be selected from the Gas Control.

## 4.04 Troubleshooting Guide

### A. Troubleshooting and Repair

Troubleshooting and repairing the this unit is a process which should be undertaken only by those familiar with high voltage high power electronic equipment.



*There are extremely dangerous voltage and power levels present inside this unit. Do not attempt to diagnose or repair unless you have had training in power electronics measurement and troubleshooting techniques.*

### B. Advanced Troubleshooting



*For basic troubleshooting and parts replacement procedures refer to Merlin 3000 Power Supply Operating Manual 0-2532.*

The advanced troubleshooting covered in this Service Manual requires Power Supply disassembly and live measurements. It is helpful for solving many of the common problems that can arise with the Merlin 3000 Plasma Cutting System.

If major complex subassemblies are faulty, the unit must be returned to an authorized service center for repair.

**Follow all instructions as listed and complete each in the order presented.**

Specific test procedures and LED status identification tables have been grouped together, and are referenced by the troubleshooting guide.

### C. How to use this Guide

The following information is a guide to help the Service Technician determine the most likely causes for various symptoms. This guide is set up in the following manner:

1. Perform operational check(s) on the equipment to isolate problem to possible circuit(s).
2. Determine symptom and isolate to defective assembly using the following format:

#### X. Symptom (Bold Type)

Any Special Instructions (Text Type)

##### 1. Cause (Italic Type)

- a. Check/Remedy (Text Type)

3. Locate your **symptom** in the appropriate Sub-Section.
4. Check the *causes* (easiest listed first) for the **symptom**.
5. Check the remedies listed for each cause.
6. Repair as needed being sure to verify that unit is fully operational after any repairs.

#### **NOTE**

*Many signals are transferred between Printed Circuit Board Assemblies on Ribbon Cables. If these cables become faulty they can then cause various problems. Do not forget about these cables when troubleshooting.*

#### A. No front panel LED indicators ON; Fan and pump not operating

1. *No primary power. Refer to symptoms C and D also.*
  - a. Check for proper three-phase power at input terminal board
2. *Faulty ON/OFF switch (SW1)*
  - a. Disconnect primary power. Check each section for continuity. Replace switch if necessary

#### 3. *Faulty voltage selection board*

- a. Refer to Section 4.05-A, Voltage Selection PC Board Check. Replace Voltage Selection PC Board if necessary

#### B. AC indicator ON; Fan and pump not operating

##### 1. *ENABLE signal not ON*

- a. Remote ENABLE or ENABLE at TB2 must be on. Refer to Section 4.05-B, Enable Circuit Test.

##### 2. *Blown fuse (F1 or F2)*

- a. Check and replace fuse if necessary. Refer to Section 4.05-C, Blown Fuse (F1 or F2).

##### 3. *Faulty ON/OFF switch (SW1)*

- a. Disconnect primary power. Check each section for continuity. Replace switch if necessary

##### 4. *Faulty Voltage Selection PC Board*

- a. Refer to 4.05-A, Voltage Selection PC Board Check. Replace Voltage Selection PC Board if necessary

##### 5. *Faulty motor contactor (MC1 or MC2)*

- a. Refer to Section 4.05-D, Motor Control Contactor Check (MC1 or MC2). Replace contactor if necessary

##### 6. *Faulty ENABLE circuit*

- a. Refer to Section 4.05-B, Enable Circuit Test.

#### C. No indicators are on for the RC6010 or SC10 remotes.

##### 1. *No +48 VDC power to the remotes.*

- a. 3 amp fuse blown on the Bias PCB, replace.
- b. Defective Bias PCB, Refer to Section 4.05-P, 48 Volt Bias Test.

#### D. AMPS or VOLTS displays not on for RC6010 or SC10.

##### 1. *Normal if ENABLE not on.*

- a. Turn on ENABLE at RC6010 or TB2 (if RC6010 not used)
- b. Defective ENABLE circuit, Refer to Section 4.05-B, Enable Circuit Test.

##### 2. *Faulty Remote Device*

- a. Replace as needed

**E. Fuse blown at disconnect when primary power is connected**

1. *Voltage selection busbars connected incorrectly*
  - a. Check and correct if necessary.
2. *One leg of three-phase primary connected to chassis ground*
  - a. Rewire input cable per Operating Manual.
3. *Main transformer shorted*
  - a. Replace main transformer

**F. Fuse blown at disconnect when main contactor (W1 or W2) closes**

1. *Shorted input diode (D1-D6)*
  - a. Refer to Section 4.05-E, Diode Check. Replace diode(s) as required.
2. *Switching transistor (Q1) shorted to heatsink*
  - a. Replace Q1, check heat-sink for possible damage. Refer to Section 4.05-M, Switching Control Check (Q1).
3. *Shorted input capacitor (C7-C12)*
  - a. Replace capacitor if necessary
4. *Shorted diode (D11-D14)*
  - a. Check for proper 3-phase power at input terminal board, check diodes. Refer to Section 4.05-E, Diode Check.
5. *Faulty Voltage Selection PC Board*
  - a. If W1 and W2 come on simultaneously replace Voltage Selection PC Board.
6. *Faulty main contactor (W1 or W2)*
  - a. Check both contactors for welded contacts and replace contactor(s) if necessary

**G. TEMP indicator on (red)**

1. *Unit overheated*
  - a. Clean radiator and check for obstruction.
  - b. Excessive piloting; allow unit to cool
2. *Faulty thermal sensor (TS1, TS2, or TS3)*
  - a. Refer to Section 4.05-F, Thermal Sensing Circuit Check. Replace sensor(s) if necessary
3. *Faulty Logic PC Board*
  - a. Refer to Section 4.05-F, Thermal Sensing Circuit Check. Replace Logic PC Board if necessary

4. *Faulty LED/Current Control PC Board*

- a. Refer to Section 4.05-F, Thermal Sensing Circuit Check. Replace LED/Current Control PC Board if necessary.

**H. No GAS indicator; Motor and Pump operating; Other LED indicators normal; Both gases flow**

1. *Front panel RUN/SET/PURGE switch set to PURGE, or PURGE selected at Remote Control*
  - a. Normal operation (purges plasma line only, secondary pressure switch is not satisfied)
2. *Gas pressure set too low*
  - a. Adjust pressure
3. *Faulty pressure switch (PS1 or PS2)*
  - a. Jump switches one at a time and check for indicator to determine which has failed. Replace switch if necessary.
4. *Faulty Logic PC Board*
  - a. Refer to Section 4.05-G, Pressure Sensing Circuit. Replace Logic PC Board if necessary
5. *Faulty LED/Current Control PC Board*
  - a. Refer to Section 4.05-G, Pressure Sensing Circuit. Replace LED/Current Control PC Board if necessary.
6. *Faulty SW3-B (secondary mode set to O2 or H2O )*
  - a. With secondary mode set to O2 or H2O, check for continuity from wire #52 to #55 on SW3-B. If open, replace SW3-B.
7. *If using Gas Control Option (GC3000) set for Water Secondary, faulty SW2-C in Gas Control.*
  - a. With Merlin front panel secondary mode set to GAS and the Gas Control (GC3000) set to WATER, there should be continuity from wires #52 to #55. If not, SW2-C or connections to it are faulty.

**I. GAS indicator off, plasma and/or secondary gas does not flow**

1. *Front panel RUN/SET/PURGE switch set to PURGE, or PURGE selected at Remote Control.*
  - a. Normal operation (purges plasma line only, secondary does not flow)
2. *Secondary mode set to O2*
  - a. No secondary flow is normal operation in O2 mode (but GAS indicator should be ON). Refer to **symptom 'H'** above.



3. *Gas Control (GC3000) on wrong setting*
  - a. Select input that has gas connected.
4. *Gas supply turned off (or tank empty)*
  - a. Check gas supply
5. *Faulty solenoid valve:*
  - SOL1 - plasma gas,
  - SOL2 - secondary gas,
  - SOL3 - secondary water,
  - SOL4 through SOL9 - Optional Gas Select
  - a. Check solenoid for sticking or clogging. Check coil resistance per the following:
    - SOL1 and SOL3 should be approximately 400 ohms)
    - SOL2 should be approximately 100 ohms)
    - SOL4 through SOL9 should be approximately 300 ohms)
6. *Faulty switch (SW3-A) or Gas Control (GC3000) Secondary Select Switch*
  - a. Check SW3-A for continuity (wire #75 to #88 for secondary gas, #75 to #89 for secondary water)
7. *Faulty Logic PC Board*
  - a. Refer to Section 4.05-H, Gas Solenoid Circuits. Replace Logic PC Board if necessary
8. *Input gas pressure set too high, preventing solenoids from operating*
  - a. Remove input gas line and retry
  - b. Regulate input gas pressure between 90 to 110 psi (6.2 to 7.6 bar)

#### **J. COOLANT indicator off**

1. *Little or no pressure shown on gauge*
  - a. Check coolant level
  - b. Check motor rotation and rpm.
  - c. Check and replace pump if necessary
2. *Clogged internal or external coolant filters*
  - a. Check internal and external coolant filters. Clean or replace if necessary. Flush the old coolant from the system (see note below).

#### **NOTE**

*With a clogged internal coolant filter or Torch and leads the Coolant Pressure Gauge will be normal, but the Pressure LED, indicates flow, will be OFF.*

3. *Clogged torch or leads*
  - a. Check torch and leads and replace if necessary. Flush the old coolant from the system (see note above).
4. *Faulty flow switch (FS1)*
  - a. Check and replace flow switch if necessary
5. *Faulty Logic PC Board*
  - a. Refer to Section 4.05-I, Coolant Flow Sensor Circuit Check. Replace Logic PC Board if necessary.
6. *Faulty LED/current control board*
  - a. Refer to Section 4.05-I, Coolant Flow Sensor Circuit Check. Replace Logic PC Board if necessary.

#### **K. Coolant conductivity indicator off**

1. *Ionized or contaminated coolant*
  - a. Check coolant conductivity and deionizer cartridge. Replace both if necessary
2. *Faulty (or contaminated) conductivity probe*
  - a. Clean conductivity probe and replace if necessary
3. *Faulty Logic PC Board*
  - a. Refer to Section 4.05-J, Coolant Conductivity Circuit. Replace Logic PC Board if necessary.
4. *Faulty LED/Current Control PC Board*
  - a. Refer to Section 4.05-J, Coolant Conductivity Circuit. Replace LED/Current Control PC Board if necessary

#### **L. Press cutting machine START and nothing happens or standoff finds height then nothing happens (no gas flow or pilot)**

1. *Start signal not getting to the Power Supply or Power Supply is defective.*
  - a. Determine if Remote Control or Power Supply is at fault. Remove Remote Control or CNC cable from J15 (or TB2). Jumper TB2-1 & 2 to enable unit, then jumper TB2-3 & 4 for START. If the pilot starts, after preflow, Remote Control or CNC is faulty. Refer to Section 4.05-L, Remote Control Start Circuit. If no pilot, refer to Section 4.05-K for Power Supply Start Circuit.

**M. DC indicator off (after pre-flow); Main contactor comes on momentarily; No pilot arc; No main arc transfer**

1. *Switching transistor (Q1) not turning on*

- a. Refer to Section 4.05-M, Switching Control Check (Q1).

**N. No pilot arc; DC indicator on; Pilot indicator OFF; PCR not energized**

1. *Faulty Logic PC Board, Switching Control PC Board, or Shunt Amp PC Board.*

- a. Refer to Section 4.05-N, Pilot Circuit Check.

**O. No pilot arc; PILOT indicator on; PCR energized**

1. *Faulty Arc Start Box*

- a. Refer to Section 4.05-N, Pilot Circuit Check.

2. *Shorted torch*

- a. Refer to Section 4.05-N, Pilot Circuit Check.

**P. Weak or sputtering pilot**

1. *Faulty torch consumable parts*

- a. Replace consumables as needed

2. *Plasma gas pressure too high*

- a. Adjust pressure

3. *Low OCV (normal 290-350) caused by improper connection of voltage selection bus bars*

- a. Check input voltage connections

4. *Low OCV caused by faulty Voltage Selection PC Board*

- a. If three-phase input voltage is within the lower half of range (refer to Operating Manual Section 3.07, Input Voltage Selection), D18 on Voltage Selection PC Board should be off. If D18 is on, replace the Voltage Selection PC Board.

5. *Input voltage low*

- a. Adjust pilot resistor for less resistance. Refer to Section 4.05-R, Pilot Resistor Adjustment.

**Q. No pilot; PILOT indicator on; Strong spark visible at spark gap points inside the Arc Starter Box**

1. *Electrode shorted against tip*

- a. Thread electrode securely into torch head or replace tip and electrode

2. *Shorted torch head*

- a. Check and replace if necessary

3. *Broken conductor in torch lead*

- a. Check and replace if necessary

4. *Shorted torch lead*

- a. Check and replace if necessary

5. *Dirty or wet torch lead*

- a. Clean and dry torch lead

**R. Pilot arc on; No main arc transfer (torch brought within range of work)**

1. *Work cable not connected*

- a. Connect work cable securely

2. *Defective current control pot (on front panel or remote)*

- a. If Remote Control is used, disconnect J15 and set current at power supply front panel. If transfer is correct or Remote Control is not used, refer to Section 4.05-O, Current Control, Display, and CSD Checks.

**S. Main arc starts but goes out immediately; Main contactor (W1 or W2) goes off**

1. *Fault condition causes output greater than 175 amps*

- a. Shorted Q1 or faulty Switching Control PC Board. Refer to Section 4.05-M, Switching Control Check (Q1).

**T. Main arc transfers but doesn't pierce through the plate or pierce is too slow**

1. *Corner slowdown (CSD) setting too low on Remote Control.*

- a. Most cutting machines activate CSD during piercing, if so CSD must be set at or near maximum.

2. *Cutting current too low*

- a. Set for higher current
- b. Current control circuit defective. Refer to Section 4.05-O, Current Control, Display and CSD Checks.

3. *Trying to pierce greater than 3/4 inch (19 mm) plate*

- a. Unit rated only for piercing upto 3/4 inch (19 mm)

4. *Travel speed too high*

- a. Try a stationary pierce, if piercing is correct, then adjust travel speed

#### U. Main arc transfers and pierces through the plate, but cutting machine doesn't move

##### 1. Incorrect or missing OK-To-Move signal.

- a. Many cutting machines require an AC voltage to activate the motion input. Refer to Operating Manuals for setting OK-To-Move signal.
- b. Check for missing OK-To-Move signal. Refer to Section 4.05-Q, OK-To-Move Tests.

#### V. Standoff Control Not Working Correctly

Refer to Troubleshooting in the Standoff Control Instruction Manual.

#### W. Remote Control Not Working Correctly

Refer to Troubleshooting in the Remote Control Instruction Manual.

### 4.05 Test Procedures

The following tests are suggested for specific problems listed in the troubleshooting guide.



#### WARNING

*Several of these tests involve voltage measurements that must be made with power on. Use extreme care when making these tests. Tests requiring voltage measurements are marked with the warning symbol. Disconnect primary power to the system for all other tests.*

#### A. Voltage Selection PC Board Check

When wall power is first turned on, the Voltage Selection PC senses the low voltage AC present at J6-20, J6-22, and J6-24 (center tap). The Voltage Selection PC Board determines whether the voltage is in the lower or higher part of the selected input voltage range. If the input voltage is within the upper part of the range, the board energizes K1, K4, and K5 relays (labeled 'HV' on the system schematic). If the input voltage is within the lower part of the range the board energizes the K2 and K3 relays (labeled 'LV' on the schematic). If HV is selected, the red LED indicator (D18) on the voltage selection board will be lit. The relays do not energize until SW1-B (one pole of the ON/OFF switch) is closed because the DC voltage to the coils passes through it.

##### 28 VAC Test

1. Check the AC input from J6-24 to both J6-20 and J6-22 for 12 - 18 VAC.

2. Check the AC voltage from J6-24 to both J6-17 and J6-18 for 16 - 22 VAC.
3. If input voltages are correct, check output from J6-24 to both J6-19 and J6-21 for 14 - 18 VAC.
4. If output is not present at J6-19 and J6-21, check between J6-24 (-) and both J6-16 and J6-23 (+) for 12 - 16 VDC. If voltage is present at both points or neither, replace the Voltage Selection PC Board. If voltage is found at J6-23 but not at J6-16, check SW1-B and all wiring and connections.

#### 120 VAC Test

##### NOTE

*Refer to Appendix VI for 120 VAC Circuit Diagram.*

1. Check the voltage input from F2 (wire #10) to J6-9 for 100 - 120 VAC. Check the input from F2 to J6-10 for 120 - 140 VAC.
2. If the voltage input is present, check the red LED indicator (D18) on the voltage selection board. If the indicator is lit, measure voltage output between F2 (wire #10) and J6-7. If the indicator is not lit, measure between F2 and J6-12. The voltage output at either point should measure 110 - 130 VAC.
3. If both or neither J6-7 or J6-12 have high voltage present, replace the voltage selection board. Check voltage between J6-21 and wire #10 on fuse F2 for 110 - 130 VAC. This supplies 120 VAC to the rest of the unit.

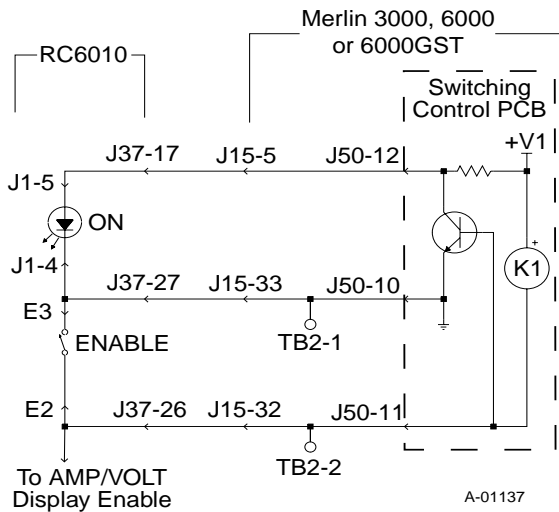
#### B. Enable Circuit Tests

Relay K1 on the Switching Control PC Board, along with SW1-A and F2, completes the 120VAC return path. K1 is energized by the ENABLE switch on the RC6010 remote or if the remote is not used by a switch connected to TB1-1 & 2.

Check for K1 being energized by measuring AC volts from F2 wire #10 to J7-22 and J7-24. It should be 0 v. If so, refer to Section 4.05-D, Motor Control Contactor Check (MC1 or MC2), to check motor contactors. If there is voltage, about 120v, at J7-24 circuit is open between J7-24 and F2 (F2 or SW1-A open). If there is no voltage at J7-24 but it is at J7-22 then K1 is not closed.

If K1 is not closing and the remote is being used temporarily jumper TB2 1 to 2. If the fan and pump come on the problem is in the remote's enable circuit. Check continuity from TB2 back to the remote ENABLE switch to find the problem. If jumping TB2 did not

work check continuity from TB2, wires 102 & 103, to J50-10 & 11. If correct, replace the Switching Control PC Board.



Enable Circuit Diagram

### C. Blown Fuse (F1 or F2)

1. A shorted or frozen motor will cause F1 to fail. To check the motors, disconnect J20 (pump motor) and J39 (fan motor). Reconnect one at a time to determine which component is faulty. A shorted or open fan motor starting capacitor (C32) may also cause F1 to fail.
2. F2 fuses the 110 VAC circuit. MC1 or MC2, T2, T3 and the gas solenoids are energized when power is first applied. If shorted, any one of these components would cause F2 to fail. W1 or W2, and PCR energize after the torch switch or remote start switch is activated. Disconnect all components and reconnect one at a time to establish which component is faulty.

### D. Motor Control Contactor Check (MC1 or MC2)

**NOTE**

*Refer to Appendix VI for 120 VAC Circuit Diagram.*

120 VAC is supplied to the Motor Control Contactors (MC1 and MC2) from the Voltage Selection PC Board, which selects the proper tap on the Main Transformer (T1). The return path travels from wire #110 through the remote connector (J15) on the rear panel to the E-Stop switch (or if no remote is used, through K1 on

the Switching Control PC Board) to wire #8, through the ON/OFF switch (SW1A) to wire #9, through fuse F2 to wire #10 and T1.

Only one of the MC contactors should have voltage applied. If the red LED indicator (D18) on the voltage selection board is lit, MC2 should be energized. If D18 is not lit, MC1 should be energized.

1. Check the voltage across the coil on the contactor for approximately 120 VAC. If voltage is present, replace the contactor. If it is not, perform the 120 VAC test (refer to test paragraph 'A' above) to check for a proper voltage supply from the voltage selection board. If correct, continue to step 2 to isolate the problem in the return path.
2. With one meter lead on the supply side of the contactor coil (wire #3 for MC1 or wire #4 for MC2) measure to wires #8, 9, and 10 to determine where the return circuit is broken. On the return path, F2, SW1-A, and E-Stop can be measured for continuity. K1 on the switching control board will normally be open when power is off.
3. When the remote control cable is installed, a jumper between J15-26 and J15-27 pulls J7-20 on the switching control board to 0 V (board connector J7-19). When the jumper is not in place (remote cable is not plugged in) J7-20 measures +15 VDC and K1 should energize, bypassing the E-stop function. If not, replace the switching control board.

### E. Diode Check

There are fourteen diodes in the main heatsink area, including six large 150 amp input rectifier diodes (D1-6) and eight small 70 amp diodes (snubbing diodes D7-10 and freewheeling diodes D11-14). To measure the resistance of each diode use one of the following:

- An ohmmeter set on the Rx1 or Rx10 scale
- Digital meter set to the diode function

Measure the resistance of each diode in both directions. The readings should differ by at least a factor of ten. If the readings do not differ (both high or both low), disconnect one end of the diode and recheck. If the diode reading is not correct with one end disconnected, then replace the diode. Check all diodes before turning on power to the system.

If a diode fails, check the potential causes of diode failure to make sure the replacement diode will not also fail when it is installed:

1. Isolate and check each diode separately to determine which individual diode has failed.

2. High frequency protection for the input rectifier diodes (D1-6) is provided by capacitors C1 - C6 and MOV 1-3, which are located between each side of the diode heatsink on the input filter PC board. Except for the shorts, these components can not be checked with a volt/ohm meter. To be safe, the complete input filter board should be replaced any time an input diode fails.
3. Diodes can overheat if air flow over the heatsink is not adequate or if the diode is not properly fastened to the heatsink. Check that all small diodes (D7-14) are torqued to 20-25 in-lbs (2.3-2.8 Nm) and all large diodes (D1-6) are torqued to 34 in-lbs (3.8 Nm). Apply a light film of electrically conductive heatsink compound between the diode and heatsink. Make sure air passages in and out of the unit are not obstructed.
4. Diodes that are faulty at the time of manufacture are difficult to diagnose. These diodes generally fail within the first few hours of operation. Before deciding that this was the case, be sure to check out other possibilities.

#### F. Thermal Sensing Circuit Check

1. Thermal sensors TS1, TS2, TS3, TS4, and TS5 are connected in series to J1-9 on the Logic PC Board. TS2 is a PTC resistor whose resistance varies with temperature from about 100 ohms at room temperature (68°F/20°C) to 3.3K at 140°F (60°C) switch point. TS1, TS3, TS4 and TS5 are switches normally closed, 0 ohms, that open at over temperature. TS1, TS4 and TS5 are part of the Main Transformer Assembly. TS2 is on the Heatsink and TS3 is on the Pilot Resistor.

Check the voltage from J1-9 to test point TP1 (or J1-8) on the Logic PC Board for less than 7.5 VDC.

If the voltage is greater than 7.5 VDC, the unit is overheated or a temperature sensor is faulty.

2. If the unit still operates but the TEMP indicator is red, the problem may be on the LED PC board. If the voltage is less than 7.5 VDC, check the voltage from J3-4 to test point TP1 (ground). If the voltage is greater than +4 VDC (and the TEMP indicator is lit red), replace the LED PC board. If the voltage at J3-4 is less than 4V, replace the Logic PC Board.

#### G. Pressure Sensing Circuit

Pressure switches PS1 and PS2 are connected in series to J1-7 on the Logic PC Board. PS2 is jumpered out by SW3-B when the unit is set to the O2 (no secondary gas) or water secondary mode or by SW2-B in the GC3000 Gas Control if that option is installed.

1. Check the voltage at J1-7 for less than 1 VDC with gases flowing and operating pressure greater than 35 psi (2.4 BAR).
2. If the voltage at J1-7 is less than 1 VDC, check the voltage at J3-3. If the voltage at J3-3 is greater than 12 VDC, replace the Logic PC Board. If the voltage at J3-3 is less than 12 VDC, replace the LED PC Board.

#### H. Gas Solenoid Circuits

1. Set the RUN/SET/PURGE switch to SET position. Measure continuity between the center terminal of the switch (wire #62) and each outer terminal (wires #61 and 63). If the resistance is less than 1000 ohms, replace the RUN/SET/PURGE switch.
2. If the resistance is greater than 1000 ohms, apply power and check for 120 VAC between wire #110 and J2-3 for plasma and J2-7 for secondary. If 120 VAC is present at one point and not the other, replace the Logic PC Board.
3. If no voltage is present at J2-3 or at J2-7, check for 120 VAC at J2-5 (the Logic PC Board input). If 120 VAC is present at J2-5, replace the Logic PC Board. If not, check the 120 VAC voltage supply (refer to Section 4.05-A, Voltage Selection PC Board Check).

#### I. Coolant Flow Sensor Circuit Check

The flow sensor (FS1) for the coolant is calibrated for 0.25 gpm (1.1 lpm). When adequate coolant flow satisfies FS1 it closes, connecting J1-5 on the Logic PC Board to J1-4 (common).

Measure voltage between J1-5 and J1-4 or TP1. If J1-5 is greater than 1 volt, FS1 or connections to FS1 are faulty. If J1-5 measures close to 0 VDC, check J3-2. If J3-2 measures less than +12 VDC, and the coolant flow indicator is not lit, replace the LED PC board. If J3-2 measures greater than +12 VDC, replace the Logic PC Board.

#### J. Coolant Conductivity Circuit

The conductivity probe consists of two insulated pins that extend into the coolant reservoir. The Logic PC Board sends out an AC voltage level on J2-24 that varies with the conductivity of the coolant.

1. Disconnect one of the wires to the conductivity probe (wire #57 or 58). The Logic PC Board will see infinite resistance and the coolant conductivity LED indicator should be lit. If the coolant conductivity indicator is lit, replace the coolant. If the problem remains after coolant is changed, replace the conductivity probe.

2. If the coolant conductivity indicator is not lit with the probe disconnected, measure between the Logic PC Board common (TP1) and J3-1. If the voltage measures below +12 VDC, replace the LED PC board. If the voltage measures above +12 VDC, replace the Logic PC Board.

## K. Power Supply Start Circuit

### **NOTE**

*Refer to Appendix IX for Start Circuit Diagram.*

The start signal enters the Merlin at J15-24(sig) and J15-25 (return) or if no remote is used it could be wired to TB2-3 & 4. From there it goes directly to the Logic PC Board. For troubleshooting remove any remote connections from either J15 or TB2. Connect a jumper from TB2-1 to TB2-2 to enable the Merlin.

The RUN (D1) and READY (D2) leds on the Logic PC Board should be on. If The front panel TEMP led is green and the COOLANT PRESSURE led is on but READY is not on, the Logic PC Board is defective. If READY is on and RUN isn't, check that RUN/SET/PURGE is set to run. Measure for less than 1 VDC on the Logic PC Board J1-13 to J1-12. If correct the Logic PC Board is defective. If greater than 1 VDC, the RUN/SET/PURGE switch or wire connections to it are defective.

If RUN and READY are on, connect a jumper from TB2-3 to TB2-4. Logic PC Board START led, D3, should come on and gases start flowing. If not, check for less than 1 VDC at J1-19 to J1-18. If correct, Logic PC Board is defective. If greater than 1 V, wiring from TB2 to J1 is defective.

After the gases flow for the selected preflow time the W ON led should light and both the main contactor (W1 or W2) and PCR contactor should come on. If W ON does not light, even momentarily, the Logic PC Board is defective.

If W ON is on for a moment then off but neither W1 or W2 comes on even momentarily do the following:

The Logic PC Board has a circuit to monitor the power supply output voltage. If the circuit doesn't sense voltage in 75 ms, if the contactor doesn't come on, it shuts off the power to the contactor which makes it hard to troubleshoot. Connecting a jumper between TP4 and TP1 on the Logic PC Board disables the voltage sensing circuit so W ON led stays on.

On the Logic PC Board, K2, sends 120 VAC to the Voltage Selection PC Board (refer to Appendix VI). Relay K5 directs that voltage to either W1 or W2 depending on the level of incoming line voltage. If high, LED D38 on the Voltage Selection PC Board will be ON

and the 120 VAC should go to W2 otherwise it goes to W1. The first step is to measure for 120 VAC from Logic PC Board J2-9 to wire #110 (PCR coil, MC1 or MC2 coils). If no voltage, the Logic PC Board is faulty. If about 120 VAC is present, measure the voltage at the W contactor coil (W2 if LED on Voltage Selection PC Board is ON, or else W1). If about 120 VAC is present the contactor is faulty. If no voltage, check from wire #110 to J6-1 and J6-3 on the Voltage selection PC Board. One of the two should have about 120VAC, if not check J6-5. If it measures 120VAC replace the voltage selection PC Board. If there is no voltage at J6-5 but was on J2-9, there is a faulty connection (wire #23).

## L. Remote Control Start Circuit

### **NOTE**

*Refer to Appendix IX for Start Circuit Diagram.*

The start signal from the cutting machine controller enters the RC6010 at J29 or J6 and may be either a momentary closure (J29-1) or sustained closure (J29-3). It passes through optical isolation circuits and, if the ENABLE is on and the station select input is active, lights internal led D103. If the Standoff Control (SC10) is not used, start goes to the remote cable at J37-9.

If the Standoff Control (SC10) is connected, then the start signal goes to it, active low at J5-13, lights internal indicator D79 and starts the find height sequence. Once height is found the front panel PLASMA ON indicator comes ON. If FIND HT is not ON, the find height function is by passed and PLASMA ON comes on immediately. The start signal then is returned to the Remote Control (RC6010), active low on J7-17, and to the remote cable on J37-9 to the Power Supply remote connector J15-24 and TB2-3 and on to the Power Supply Logic PC Board.

If the Standoff Control (SC10) is installed and the system won't find height the problem is in the Standoff Control (SC10), Remote Control (RC6010) or the interconnections to the cutting machine. Set FIND HT off, if the torch starts now the problem is in the Standoff Control (SC10).

### **NOTE**

*Refer to Section 5, Customer/Operator Service, in the Standoff Control Instruction Manual.*

If it doesn't start open the cover of either the Standoff Control (SC10) or Remote Control (RC6010), whichever one is on top, and disconnect the ribbon cable at J5 or J7. Then if the Power Supply will start the prob-

lem is in the Standoff Control (SC10) or the ribbon cable. Refer to Section 5, Customer/Operator Service, in the Standoff Control Instruction Manual.

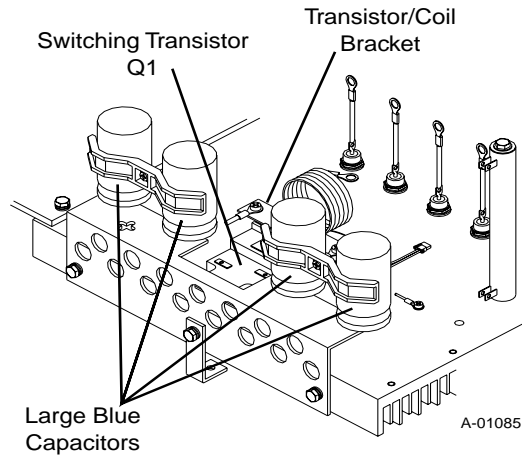
If the Standoff Control (SC10) isn't used or the Power Supply didn't start with the ribbon cable disconnected, there are two approaches you can take. Either disconnect the remote and see if the Power Supply will start without it or check if the start signal is getting to the Remote Control (RC6010). To check the Power Supply, remove the remote connector at J15 and connect a jumper TB2-1 to TB2-2 for ENABLE, then jump TB2-3 to TB2-4 for start. If it starts the problem is in the remote or CNC connections. If not refer to Section 4.05-K, Power Supply Start Circuit.

To check for start to the Remote Control (RC6010), open the Remote Control cover and see if indicator D103 comes ON. If so, problem is in Remote control (RC6010) or the remote cable. If indicator D103 is OFF, remove J29 (or the CNC start connections to J6) and jumper J29-3 to 4 or J6-3 to 4. Don't jumper to the screw heads on J6 as they don't always make electrical contact. If it starts (indicator D103 ON) with the jumper, the problem is in the CNC connections. If not, replace the Remote Control (RC6010).

### M. Switching Control Check (Q1)

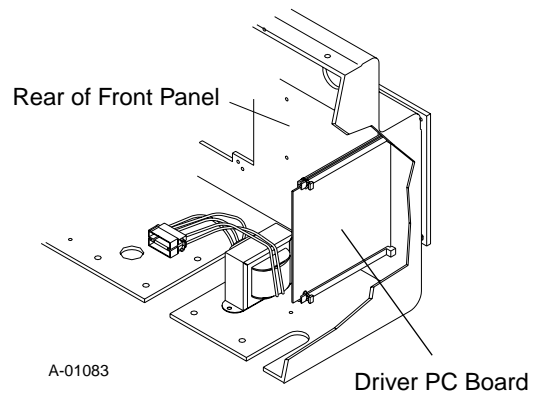
To produce DC output, the main switch (Q1) must be turned on and off rapidly. Power Supply output is controlled by the on-time. At the same time the Main Contactor (W1 or W2) closes, the Logic PC Board grounds pins 9 and 23 of the 34-pin ribbon cable (J3-9 on the Logic PC Board, J10-9 on the Switching Control PC Board). This enables the pulse width modulator (PWM) on the Switching Control PC Board.

If no DC voltage is detected within 75 ms at J1-24 on the Logic PC Board, the enable signal on J10-9 is removed and the Main Contactor opens. Connecting TP4 to TP1 (ground) on the Logic PC Board disables this function for troubleshooting if no DC output is found.



Q1 Location

To check for a defective Q1, first disconnect J27 from the Driver PC Board.



Driver PC Board Location

On a X1 or X10 scale or with a digital meter set for diode, measure between "C" (collector) terminal, wire #83, and "E" (emitter) terminal, wire #84. Reverse the meter leads and measure again. It is normal to measure an open (high reading) one way and a lower reading the other. A low or zero measurement both ways means the Q1 is shorted and must be replaced.

If correct, measure from the "B" (base) terminal, wire #82, to "E" (emitter) terminal, wire #84. Normal reading is from about 50 to 150 ohms (digital meter on ohms not diode scale) a short (zero ohms) or an open indicates a defective Q1.

**NOTE**

*If the Switching Control Q1 has failed, the Driver PC Board must also be replaced. Refer to Section 6.08, Item #2, for replacement parts.*

The PWM compares shunt amp output on J9-5 with the current control signal (3.3 - 10 VDC) from the remote (J7-18) or the panel control (J10-15). A faulty shunt amp could cause the output, normally 0 VDC with no cutting arc, to go higher, shutting off the PWM and thus producing no DC. If the shunt amp ribbon connector is disconnected or pin 1 is open, approximately 12 VDC is applied to J9-5, shutting down the PWM in the same manner as a shunt amp failure.

The Switching Control PC Board sends pulses (+15 V) to the Driver PC Board on J8-1 and J8-3. The width of these pulses controls the on-time of Q1. The pulses are best observed with an oscilloscope, but an AC voltmeter should read about 6 to 7 VAC from J8-2 to both J8-1 and J8-3. If 0 VAC is measured at both J8-1 and J8-3, with the enables (J10-9 and J10-23) and shunt amp (J9-5) input low, replace the Switching Control PC Board.



#### **WARNING**

---

*Both base and emitter are at -320 VDC potential. Use extreme caution when testing Driver PC Board output.*

---

If switching pulses are present at J8-1 and J8-3, check the Driver PC Board output between J27-3, Q1 base, and J27-2, Q1 emitter.

The Driver PC Board output, J27-3 (Q1 base) to J27-2 (Q1 emitter), should measure about 1 VAC. If voltage measures 0 to -4 VDC (+ lead on J27-3) replace Driver PC Board. If switching pulses are not present (start signal OFF), -4 VDC is normal, Driver PC Board should be replaced.

## **N. Pilot Circuit Check**

The pilot is ignited by a high frequency spark generated in the Arc Starter Box. The Arc Starter Box requires a 24 VAC supply which should always be present and a torch tip to electrode voltage greater than 220 vdc. When the PCR contactor closes, power supply open circuit voltage (280-350 volts) is connected across the torch plus (tip) and minus (electrode). Once the pilot starts the voltage drops to under 220v shutting off the arc starter.

If the front panel PILOT led is on indicating drive to the PCR contactor but there are no sparks at the spark gap in the arc starter box, first confirm that there is open circuit voltage (OCV) of 280-350 vdc between torch "NEG-" and the work lead then measure the voltage at the torch bulkhead (marked "NEG-" and "POS+"). If it is low, zero to 50v, the torch is probably

shorted (pilot resistors will get very hot). If it is between 100 and 200v PCR contactor is probably not closing. If it measures the same as the OCV the arc starter box may be defective.

For a shorted torch remove the consumable parts and check for damage, remove the head from the mounting tube and check for arcing. The short may also be internal to the head and it may or may not be measurable with an ohmmeter. Sometimes the only way to be sure is replace the head.

If the front panel PILOT indicator is OFF check the CSR indicator, D5, on the Logic PC Board. It should be OFF. If it is ON the Switching Control PC Board may be falsely indicating main arc transfer. Check for zero volts on the Switching Control PC Board at J9-5. If it does not measure zero the Shunt Amp which should have no output is defective. Otherwise the Switching Control PC Board is faulty. If the Logic PC Board CSR indicator is OFF and PILOT indicator is OFF, the Logic PC Board is faulty.

If PILOT indicator is ON and PCR is not closing, check for 120 VAC between wire #110 and J2-1 on the Logic PC Board.

#### **NOTE**

---

*Refer to Appendix VI for 120 VAC Circuit Diagram.*

If not present, replace the Logic PC Board. If 120 VAC is present, check to see if it is at the PCR coil. If voltage is present, the contactor is faulty.



#### **WARNING**

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*High Voltage is present.*

---

For the Arc Starter Box confirm that the OCV measured at the torch bulkhead is also preset at E1 and E2 on the Arc Starter PC Board, if not the torch leads extension may be open. Check for 24 VAC from J1-1 to J1-3 on the Arc Starter PC Board (see note).

#### **NOTE**

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*Later versions of the Arc Starter Box have a 24 VAC indicator on the Arc Starter PC Board. The indicator will be ON when the 24 VAC is present.*

If both OCV and 24 VAC are present, and no sparks are being generated, the Arc Starter PC Board is defective.



If 24 VAC is not present, remove J14 control connector at the torch bulkhead and measure for 24 VAC between pins 5 and 8 of the receptacle. The 24 VAC comes from T3, is fused by F3, 1A 250v, and passes through the filter FL1 to J14. If voltage is not present at J14 the most likely fault is the fuse. T3 and the FL1 are other possibilities. If F3 is blown replace it and leave J14 disconnected. If it doesn't blow, then reconnect J14. If fuse blows again then the Arc Starter PC Board is defective or there is a short in the torch leads between J14 and the Arc Starter PC Board.

## O. Current Control, Display and CSD checks

### 1. Tip Drag Circuit

The Merlin 3000 has a circuit that monitors the torch tip voltage to reduce cutting current to 40-50 amps reducing consumable parts wear if the tip voltage is less than -20 volts indicating double arcing or the tip contacting the work. Wire #7 from the torch bulkhead (+) connection connects to the Logic PC Board at terminal W7. If the voltage there is less than -20 VDC the Logic PC Board puts a low on J3-25 (can measure at TP5 on the Logic PC Board) causing the Switching Control PC Board (J10-25) to reduce the current. When piloting or cutting the tip voltage at W7 should be greater than -20 volts, if so and Logic TP5 is low the Logic PC Board is defective.

### 2. Front Panel Current Control

If the Remote Control (RC6010) is being used the front panel control is inactive, go to next step.

The front panel current control receives its high level (10 VDC) on J10-17 and its low level (3.3 VDC) on J10-13. Verify those voltages (with respect to TP1 on the Switching Control PC Board) then measure the pot's wiper between J10-15 and TP1. It should vary from 3.3 to 10 VDC as the control is moved from minimum to maximum. If it does not vary or is less than 3.3 VDC, then the control pot in the LED PC Board is faulty or the ribbon cable is faulty. If the high and low (3.3 VDC and 10 VDC) are incorrect, the Switching Control PC Board is faulty or the ribbon cable is shorted.

### 3. Remote Current Control

#### **NOTE**

*Refer to Appendix X for Current Control Display Circuit Diagram.*

The Remote Control (RC 6010) has front panel controls for OUTPUT AMPS and CSD. The upper and lower limits of the current control range are set by the POT HI (+10 VDC) and POT LOW

(+3.3 VDC) signals from J50-8 and J50-6 on the Switching Control PC Board sent to the remote via the remote cable.

The CSD control upper limit is set by the wiper of the OUTPUT AMPS control thus the CSD range is a percentage (%) of the main output. The wiper of the main pot is sent through the normally closed CSD relay contact out the remote cable to J7-18 on the Switching Control PC Board. If CSD is enabled, indicated by illuminating the 3 decimals in the display, then the CSD wiper provides the current control signal to J7-18.

#### **NOTE**

*Refer to Appendix XI for Corner Slowdown (CSD) Circuit Diagram.*

If the OUTPUT AMPS control or the CSD control have no effect on current level see if the panel control does, if so, there may be a poor connection in the REMOTE INSTALLED circuit between the remote and Switching Control PC Board. Check TP1 to J7-20, if it does not measure less than 2v there is a faulty connection, otherwise the Switching Control PC Board is faulty.

If the front panel control had no effect (which it shouldn't) measure from TP1 to J7-18 while moving the OUTPUT AMPS control from min to maximum.

The voltage at J7-18 should vary from 3.3v to 10 v. If it does the Switching Control PC Board is faulty.

If voltage is incorrect at J7-18, check J50-8 for 10 v and J50-6 for 3.3 v. If OK then the remote is defective or the connections (remote cable or Merlin) harness are open.

### 4. Remote AMPS Display

The AMPS display shows control pot setting (preview) and actual cutting amps. The decimal points indicate when CSD (standoff inhibit) is on by lighting all 3 decimals and when OK-To-Move is not on by lighting the left hand decimal.

The AMPS display is driven by a signal from the Merlin Switching Control PC Board J7-2.

#### **NOTE**

*Refer to Appendix X for Display Circuit Diagram.*

Positive 3.3 to 10 volts at J37-1 gives a display from 50 to 150 AMPS. Prior to cutting arc transfer the display signal is in the "preview" mode as indicated by the left hand decimal being on. The display is indicating the current control pot setting.

The display signal at J7-2 should be equal to the control pot wiper voltage at J7-18 measured in Step 3 above.

If this is not correct, the Switching Control PC Board is defective.

After arc transfer the display signal switches to represent actual cutting current as monitored by the Shunt Amp and Switching Control PC Boards. At the same time OK-To-Move is sent to the remote shutting off the left hand decimal, refer to Section 4.05-Q, OK-To-Move Tests. The output of the Shunt Amp at J9-5 of the Switching Control PC Board is 5.45 volts for 150 Amps. The display signal at J7-2 should be 10 volts. If the shunt voltage is correct and the display signal is not then the Switching PC Board is defective.

If the remote display and the shunt amp voltage at J9-5 is correct but the cutting current is low (measured with separate ampmeter) then the Shunt Amp may be faulty but first check step 1 of this section.

## 5. Corner Slowdown (CSD)

Corner Slowdown (CSD), a CNC signal, is also referred to as standoff inhibit or corner current reduction. The CNC signal comes from the cutting machine controller to inhibit the standoff control when cutting speed reduction is desired. Sped reduction may be needed for cutting around corners where high speeds would adversely affect the standoff regulation. It also can be used to reduce cutting current when the cut speed is lowered.

A contact closure between J29-7 and 8 or J6-7 and 8 of the Remote Control (RC 6010) sends an active low signal to the Standoff Control (SC10) via J5-21 which turns OFF the Standoff Control THC ACTIVE indicator, turns ON the three decimals in the VOLTS display and prevents the Standoff Control (SC10) from changing torch height.

### **NOTE**

*Refer to Appendix XI for Corner Slowdown (CSD) Circuit Diagram.*

At the same time, the CSD relay in the Remote Control (RC6010) closes switching current control from the OUTPUT AMPS control to the CSD control and turning on the three decimals in the AMPS display. Turning ON switch SW1-1, a dip switch on the Remote Control PC Board inside the Remote Control (RC6010), will reverse the logic so a closure is required at the CSD input for normal operation and an open for CSD.

For the Standoff Control (SC11) used without the Remote Control (RC6010), the CNC input for CSD is through J40-10 and J40-11 or J11-1 and J11-2 of the Standoff Control (SC11). For the Power Supply, corner current reduction is only available when using the Remote Control (RC6010). The CSD relay output at J42 is not used with the Power Supply.

If the problem is the CSD on all the time or none of the time disconnect the CSD input from the cutting machine, set Remote Control (RC6010) internal switch SW1-1 OFF and jumper the CSD input pins at either J6 or J29 (J42 or J11 for Standoff Control (SC11)). If CSD is on (display indicates three decimals) when the jumper is connected and off when the jumper is not connected, the problem is with the cutting machine or the CNC cable. If jumping the CSD does not work, the Remote Control (RC6010) or Standoff Control (SC11) is faulty. If while using the Remote Control (RC6010) and Standoff Control (SC10) together, CSD works in the Remote Control (RC6010) but not the Standoff Control (SC10) check for a low, less than 3 VDC., on the ribbon cable at J5-21. If not low, with CSD on, the Remote Control (RC6010) is faulty. If J5-21 is low, either the Standoff Control (SC10) is faulty or the ribbon cable is open.

## P. 48 Volt Bias Test

1. Remove the remote cable from the Remote Control (RC6010), or the Standoff Control (SC11). Temporarily jumper TB2-1 to TB2-2 for enable.

For the Remote Control (RC 6010), measure for +48 +/-5 VDC from J37-16, 35 and 37 (+) to J37-15,34 and 36 (-). If correct, Remote Control RC6010 is faulty.

For the Standoff Control (SC11), measure J41-3 and 4 (+) to J41-1 and 2 (-). If correct, Standoff Control (SC11) is faulty.

2. If the 48 VDC is not correct, go the Power Supply and measure for +48 +/- 5 VDC at J31-1 to 2 of the Bias PC Board. If correct, check for open in the Power Supply harness to J15 or the remote cable.

If 48 VDC is not correct, remove J31 from the Bias PC Board as and measure again (on the Bias PC Board). If correct, check for a short in the wiring harness of remote cable.

3. If 48 VDC is still incorrect check for 115 VAC at J30-1 to J30-3 at the Bias PC Board. If correct, replace Bias PC Board. Also, check Fuse (F1), 3A 250v, on the Bias PC Board.

## Q. OK-To-Move Tests

1. The Shunt Amp sends a voltage level to the Switching Control PC Board that corresponds to the work lead or cutting current. When that current is greater than 25 amps, a circuit on the Switching Control PC Board sends an active low signal called CSR to the Logic PC Board, J3-11, that turns on K1, the OK-To-Move relay. SW5 on the Logic PC Board selects whether the OK-To-Move output at J2-14 and 16 is a contact closure (SW5 up) or 24 vac (SW5 down). OK-To-Move from J2-14 and 16 connects to TB2-9 and 10 then on to J15-10 and 11.

To troubleshoot, while cutting, measure at TB2-9 to TB2-10 for 0 volts both AC and DC indicating contact closure or if Logic PC Board switch SW5 is set for AC volts measure for 24 VAC.

### **NOTE**

Refer to Appendix XII for OK-To-Move Circuit Diagram.

If correct go to step 2. If not correct, repeat the measurement at J2-14 to J2-16. If still incorrect measure Logic PC Board J3-11 to TP1. If less than 5 vdc replace the Logic PC Board otherwise the Switching Control PC Board is faulty (or the ribbon cable open).

2. If using the Remote Control (RC6010), Logic PC Board switch SW5 must be up for contact closure, indicator D104, OK PS, on the Remote Control (RC 6010) internal PC Board should come ON with OK-To-Move. If not check continuity between TB2-9 and J37-30, also TB2-10 and J37-31. The Remote Control (RC6010) OK relay is initially energized. The relay turns OFF to send the OK-To-Move signal through the relay normally closed contact. As soon as indicator D104 turns ON, or after the PIERCE DELAY if the Standoff Control (SC10) is also used, indicator D102 should go OFF indicating the OK relay is off. If no Standoff Control (SC10) is used and indicator D102 does not go OFF, the Remote Control PC Board is defective. If the Standoff Control (SC10) is used, set the torch to proper cutting height manually and disconnect the Standoff Control (SC10) by removing the ribbon cable from J5 or J7, and try again. If indicator D102 goes OFF now the Standoff Control PC Board is faulty (or the ribbon cable is open, pin 11 or 15). If indicator D102 does not go OFF with the Standoff Control (SC10) disconnected, the Remote Control (RC6010) is defective.
3. If indicator D102 goes OFF as it should and the E1 jumper is connected to J6-14 (contacts) measure for contact closure at J6-13 to 16 or if E1 jumper is

in J6-15 (24 VAC) measure for 24 VAC at J6-13 to J6-16. If OK, the problem is in the CNC cable connections to the cutting machine or the controller.

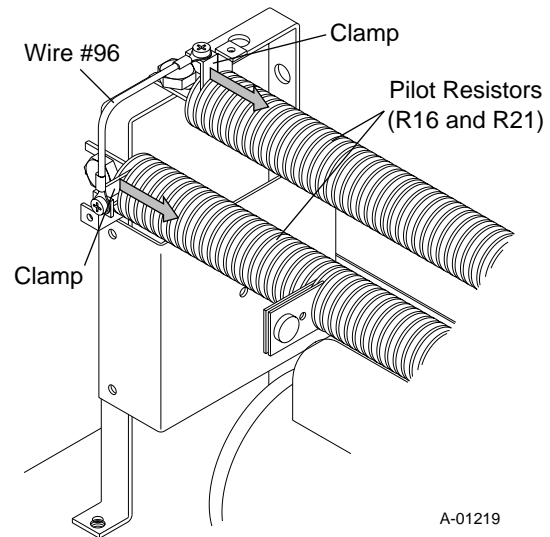
4. For the Standoff Control (SC11) refer to Section 5, Customer/Operator Service, in the Standoff Control Instruction Manual.

## R. Pilot Resistor Adjustment

The amount of pilot current is controlled by the value of the pilot resistors, R16 and R21. Too much current causes excessive tip wear and too little causes a sputtering pilot that wears the electrode. The factory setting is correct for most cases but with low input line voltage and with some combinations of gas and tips the current may be too low to maintain a steady (no sputtering) pilot.

To adjust the resistors use the following procedure:

1. Remove the left side panel, as viewed from the front of the unit.
2. Locate and identify the pilot resistors which are on a bracket in front of the fan.



Location Of Pilot Resistors

3. Locate wire #96 which is connected between the two resistors. The wire is attached to each pilot resistor with a clamp.
4. Using a screwdriver loosen both clamps.
5. Move each clamp down the pilot resistors, toward the inside of the unit, approximately 1/2 inch (12.7 mm).
6. Test the pilot, if it still sputters move the clamps another 1/2 inch (12.7 mm).

**CAUTION**

---

*Move the clamps only what is necessary for a steady pilot. Too much adjustment can cause increased parts wear. DO NOT move each clamp more than a total of 2 inches (50.8 mm).*

If a steady pilot cannot be achieved with the adjustment, then something else is wrong.

# SECTION 5: REPAIRS & REPLACEMENT PROCEDURES

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## 5.01 Introduction

This Section describes parts replacement procedures and all repairs which may be performed on the Merlin 3000 Power Supply.

Under no circumstances are field repairs to be attempted on Printed Circuit Boards or other Subassemblies of this unit. Evidence of unauthorized repairs may void the factory warranty.

## 5.02 Anti-Static Handling Procedures

### A. General

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**CAUTION**

*PC boards can be irreparably damaged by improper handling due to electrostatic discharge (ESD).*

Replacement PC boards are shipped in a protective enclosure to prevent damage from electrostatic discharge (ESD) during shipping. Included with each replacement board is a ground strap to prevent static damage during installation.



### WARNINGS

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*Read and understand these instructions and the instructions on the grounding wrist strap package before opening the equipment enclosure or removing the replacement PC board from its protective enclosure.*

*Disconnect primary power to the system before disassembling the torch, torch leads, or power supply enclosure.*

*Do not operate the equipment or test equipment under power while wearing the grounding wrist strap.*

---

### B. Procedure

1. Open the wrist strap and unwrap the first two folds of the band. Wrap the adhesive side firmly around your wrist.

2. Unroll the rest of the band and peel the liner from the copper foil at the opposite end.
3. Attach the copper foil to a convenient and exposed electrical ground.
4. Connect the equipment primary cable ground to the same electrical ground as the wrist strap.
5. Open the equipment enclosure (see instruction manual for the appropriate equipment) and remove the failed PC board.
6. Carefully open the ESD protective bag and remove the replacement PC board.
7. Install the replacement PC board in the equipment and make all necessary connections.
8. Place the failed PC board in the ESD protective bag and seal for return shipping.
9. Reassemble the equipment enclosure (see instruction manual for the appropriate equipment).
10. Remove the grounding wrist strap from your wrist and from the electrical ground connection before reconnecting primary power to the equipment.

## 5.03 Parts Replacement - General Information

The parts replacement procedures described in this manual, except for Rear Panel Coolant Filter and external Fuse(s) replacement, require that the Power Supply be disassembled. Depending on the part to be replaced will determine to what extent the Power Supply must be disassembled.

---

### NOTES

*Before removing any electrical connection mark each wire with the connection designation. When reassembling this makes sure the wires go to the proper terminals.*

*Note the routing of wires and make sure the wires are put back in the same place when reassembling the unit.*

*Turn OFF all gas inputs to the Power Supply at the source before disconnecting any gas Hose Assemblies.*

Each Subsection is referenced to Section 6 for parts lists and overall detailed drawing.



## WARNING

*Disconnect primary power from the source before opening or disassembling the power supply. Make sure AC indicator on the Power Supply front panel is OFF.*

Before disassembling any part of the Power Supply first read the procedure for the part to be replaced, then proceed with the disassembly.

## 5.04 External Parts Replacement

### NOTE

*Refer to Section 6.03, External Power Supply Replacement Parts, for parts list and overall detail drawing.*

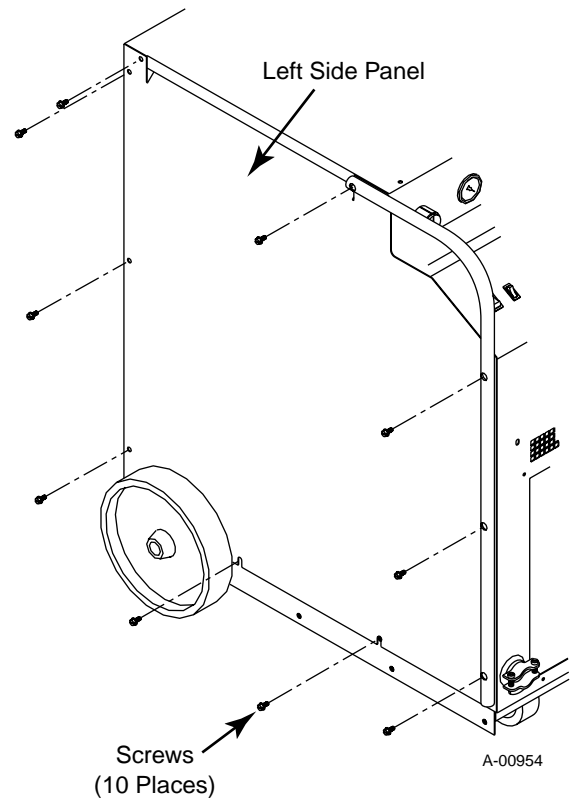
### A. Handle Replacement

The Power Supply has two Handles on each side of the unit. The Handles are the same and are replaced in the same manner.

1. Remove the four screws securing the Handle to the side of the unit.
2. Remove the Handle from the unit.
3. Place the replacement Handle onto the unit.
4. Secure the Handle to the side of the unit with the four screws removed in Step 1.

### B. Left/Right Side Panel Replacement

The Left and Right Side Panels are replaced in the same manner. The Left Side Panel of the Supply is the panel on the left side of the unit as viewed from the front of the unit.



1. Remove the Handle per paragraph 'A' above.
2. Remove the four screws that secure the rear of the Side Panel to the Power Supply.
3. Loosen the two screws securing the bottom of the Side Panel to the base of the Power Supply. These two screws are in slotted holes in the Side Panel.
4. To remove the Side Panel from the Power Supply pull up and out on the Side Panel.
5. Reinstall the replacement Side Panel by reversing the above procedure.

### D. Top Panel Replacement

1. Remove the Handles per paragraph 'A' above.
2. Remove the Left and Right Side Panels per paragraph 'B' above.
3. On the top of the unit remove the Coolant Tank Cap from the Coolant Tank.
4. Remove the four screws securing the Top Panel to the front of the unit.
5. Remove the two screws securing the Top Panel to the rear of the unit.
6. Install the replacement Top Panel by reversing the above procedure.

### E. Work Cable Replacement

1. Remove the Left Side Panel per Section 5.04-B.

2. Loosen the two screws of the Work Cable strain relief securing the Work Cable at the Front Panel.
3. Remove the nut (under the Horizontal Chassis Panel) securing the Work Cable connection to the Shunt Assembly.
4. Pull the Work Cable from the unit.
5. Install the replacement Work Cable by reversing the above procedure.

## 5.05 Access Panel Parts Replacement

### **NOTE**

*Refer to Section 6.04, Access Panel Replacement Parts, for parts list and overall detail drawing.*

### A. CURRENT Knob Replacement

1. Turn the CURRENT adjustment fully counter clockwise and note the location of the pointer on the knob.
2. Loosen the screw securing the Current Knob to the potentiometer shaft.
3. Remove the old knob.
4. Place the replacement Current Knob on to the potentiometer shaft with the location of the pointer the same as noted in step 1.
5. Tighten the screw to secure the knob to the potentiometer shaft.

### B. ON/OFF Switch Replacement

1. Unlatch the Access Panel to gain access to the rear of the ON/OFF Switch.
2. Disconnect all the wiring to the ON/OFF Switch.
3. Squeeze the top and bottom of the switch while pulling it out of the Access Panel
4. Install the replacement ON/OFF Switch by reversing the above procedure.

### C. RUN/SET/PURGE Switch Replacement

1. Unlatch the Access Panel to gain access to the rear of the RUN/SET/PURGE Switch.
2. Disconnect all the wiring to the RUN/SET/PURGE Switch.
3. Squeeze the top and bottom of the switch while pulling it out of the Access Panel
4. Install the replacement RUN/SET/PURGE Switch by reversing the above procedure.

## D. LED/Current Control PC Board Assembly Replacement

1. Remove the Current Knob per paragraph 'A' above.
2. Unlatch the Access Panel to gain access to the LED/Current Control PC Board.
3. Remove the four screws and washers securing the LED/Current Control PC Board to the Access Panel.
4. Disconnect the connector at J5 of the LED/Current Control PC Board.
5. Install the replacement LED/Current Control PC Board by reversing the above procedure.

## E. Access Panel Replacement

1. Remove the Right Side Panel per Section 5.04-B.
2. Remove the following components from the Access Panel:
  - Current Knob per paragraph 'A' above.
  - ON/OFF Switch per paragraph 'B' above.
  - RUN/SET/PURGE Switch per paragraph 'C' above.
  - LED/Current Control PC Board per paragraph 'D' above.
3. Remove the four screws securing the Access Panel to the LED/Current Control PC Board standoffs.
4. Install the replacement Access Panel by reversing the above procedure.

## 5.06 Front Panel/Chassis Parts Replacement

### **NOTE**

*Refer to Section 6.05, Front Panel/Chassis Replacement Parts, for parts list and overall detail drawing.*

### A. Internal Coolant Filter Replacement

The Internal Coolant Filter Assembly is located inside behind the Left Side Panel (viewed from the front of the unit). The filter is attached to the Radiator inside of the Lower Front Panel.

1. Remove the Left Side Panel from the Power Supply per Section 5.04-B.
2. Locate the Internal Coolant Filter near the front of the unit.

3. Remove the Coolant Hose from the Internal Coolant Filter Assembly.
4. Remove the Internal Coolant Filter from the fitting on the Radiator.
5. Install the replacement Internal Coolant Filter Assembly by reversing the above procedure and noting the following:
  - Clean the old thread sealer from the threads of the hose and the fitting.
  - Apply a thin coating of liquid teflon thread sealer to the threads of the fitting.

### B. Radiator Replacement

1. Remove the Left and Right Side Panels per Section 5.04-B.
2. On the right side of the radiator locate the Hose Assembly connected to the input of the Radiator at the top.
3. Remove the Hose Assembly from the Radiator input connection.
4. Remove the Internal Coolant Filter per paragraph 'A' above.
5. On the top and bottom of the Radiator remove the six screws and star washers that secure the Radiator to the Front Panel.
6. Carefully slide the Radiator out of the unit.
7. Install the replacement Radiator by reversing the above procedure.

### C. Bias PC Board Replacement

1. Remove the Right Side Panel per Section 5.04-B.
2. Disconnect all the wiring connections to the Bias PC Board Assembly.
3. Remove the Bias PC Board Assembly from four PC Board Standoffs.
4. Install the replacement Bias PC Board Assembly by reversing the above procedure.

### D. Transformer (T2) Assembly Replacement

The Transformer (T2) Assembly is mounted to the rear of the Horizontal Chassis Panel and has 25.2 VCT (Center Tap) output.

1. Remove the Left Side Panel per Section 5.04-B.
2. Disconnect all the wiring connections to the Transformer Assembly.
3. Remove the four screws which secure the Transformer Assembly to the Horizontal Chassis Panel.

4. Carefully remove the Transformer Assembly from the unit.
5. Install the replacement Transformer Assembly by reversing the above procedure.

### E. Internal Fuse (F3) Replacement

The Fuse (F3) is located inside the Power Supply behind the Right Side Panel. The Fuse is mounted next to the Bias PC Board on the rear of the Horizontal Chassis Panel.

1. Remove the Right Side Panel per Section 5.04-B.
2. Locate the Fuse mounted next to the Bias PC Board on the Horizontal Chassis Panel.
3. Remove the damaged Fuse from the snap type fuse holder.
4. Reinstall the replacement Fuse (1A, 250V) by reversing the above procedure.

### F. Fuse Holder (Internal) Replacement

1. Remove the Left Side Panel per Section 5.04-B.
2. Remove the Fuse from the holder.
3. Disconnect the two wires connected to the Fuse Holder.
3. Remove the two small screws securing the Fuse Holder to the chassis.
4. Install the replacement Fuse Holder by reversing the above procedure.

## 5.07 Rear Panel Parts Replacement

### **NOTE**

*Refer to Section 6.06, Rear Panel Parts Replacement, for parts list and overall detail drawing.*

### A. Fan Replacement

1. Remove the Left Side Panel per Section 5.04-B.
2. Locate the Fan Assembly wiring connector inside the Rear Panel.
3. Carefully disconnect the wiring connector from the wiring harness.
4. Note the pin location of each wire to the connector.
5. Using a pin extraction tool remove the wiring from the connector.
6. On the Rear Panel remove the strain relief securing the Fan Assembly wiring to the Rear Panel.



7. Locate and remove the four bolts and lock nuts securing the Fan Assembly to the Rear Panel Assembly.
8. Carefully pull the Fan Assembly from the Rear Panel Assembly feeding the wiring through the hole.
9. Install the replacement Fan Assembly by reversing the above procedure.

#### **B. Three-Phase Contactor Replacement**

1. Remove the Right Side Panel per Section 5.04-B.
2. Note the orientation of all the wires and then disconnect the input and output wiring from the Three-Phase Contactor Assembly.
3. Remove the two locking nuts securing the Three-Phase Contactor to the Rear Panel of the unit.
4. Install the replacement Three-Phase Contactor Assembly by reversing the above procedure.

#### **C. Voltage Selection PC Board Replacement**

1. Remove the Right Side Panel per Section 5.04-B.
2. Disconnect all the wiring connections to the Voltage Selection PC Board Assembly.
3. Remove the Voltage Selection PC Board from the four PC Board Standoffs.
4. Install the replacement Voltage Selection PC Board Assembly by reversing the above procedure.

#### **D. Gas Solenoid Assembly Replacement**

***NOTE***

*The Plasma and Secondary Gas Solenoid Valve Assemblies are replaced in the same manner.*

1. Remove the Top Panel per Section 5.04-B.
2. Disconnect the Gas Supply at the Rear Panel connection
3. Disconnect the internal Gas Hose Assembly connected to the elbow fitting on the Gas Solenoid Valve Assembly.
4. Disconnect the two wires connected to the Solenoid Valve Assembly.
5. Remove the Panel Nut securing the assembly to the Rear Panel Assembly.
6. Pull the old Gas Solenoid Valve Assembly from the Rear Panel Assembly.

7. Install the replacement Solenoid Valve Assembly by reversing the above procedure and noting the following:

- Remove the fittings from the old assembly and install on the replacement assembly.

#### **E. Secondary Water Solenoid Valve Assembly Replacement**

1. Remove the water supply from the Secondary Water connection at the Rear Panel Assembly.
2. Remove the Top Panel per Section 5.04-B.
3. Disconnect the internal Hose Assembly connected to the elbow fitting on the Secondary Water Solenoid Valve Assembly inside the unit.
4. Carefully disconnect the two wire connector to the Secondary Water Solenoid Valve Assembly.
5. Remove the Panel Nut securing the assembly to the Rear Panel Assembly.
6. Pull the old Secondary Water Solenoid Valve Assembly from the Rear Panel Assembly.
7. Install the replacement Secondary Water Solenoid Assembly by reversing the above procedure and noting the following:
  - Remove the fittings and Check Valve from the old assembly and install on the replacement assembly.

#### **F. Rear Panel Coolant Filter Assembly Replacement**

The Coolant Filter Assembly is located on a bracket on the Rear Panel Assembly of the unit.

1. Remove the two Coolant Hose connections to the Coolant Filter Assembly.
2. Remove the two elbow fitting on each side of the Coolant Filter Assembly and remove the damaged assembly from the bracket.
3. Clean the old thread sealer from the threads of the elbow fittings.
4. Apply a thin coating of liquid teflon thread sealer to the threads of the elbow fittings.
5. Place the replacement Coolant Filter Assembly in the bracket with the arrow pointing to the left and reinstall the two elbow fittings.
6. Reconnect the two Coolant Hoses to the Coolant Filter Assembly making sure that the hose to the Pump Assembly is on the output of the Coolant Filter Assembly (left side as viewed from the back).

## G. Coolant Tank Replacement

1. Remove the Left, Right, and Top Side Panels per Section 5.04-B.
2. Drain the coolant from the Coolant Tank per Section 4.02-F.

---

**CAUTION**

*Handle and dispose of the used coolant per recommended procedures.*

3. Remove the two wires from the Conductivity Sensor located on the end of the Coolant Tank near the center.
4. Unplug the wiring connection at the Flow Switch Assembly located on the end of the Coolant Tank near the top (return hole).
5. Remove the hose connected to the bottom of the Flow Switch Assembly.
6. Remove the hose connected to the 90° Adapter Fitting near the bottom side (outlet hole) of the Coolant Tank.
7. Remove the four nuts, flat washers and long screws that secure the Coolant Tank to the Rear Panel.
8. The parts on the Coolant Tank must be removed and installed on the replacement per the following:
  - a. Note the orientation of the Flow Switch Assembly to the Coolant Tank.
  - b. Remove the Flow Switch Assembly from the Coolant Tank and install it on the replacement Coolant Tank the same as noted in Step "a".
  - c. Remove the Conductivity Sensor Assembly from the Coolant Tank and install it on the replacement Coolant Tank.
  - d. Note the orientation of the 90° Adapter Fitting in the outlet hole on the bottom of the Coolant Tank.
  - e. Remove the 90° Adapter Fitting from the Coolant Tank and install it on the replacement Coolant Tank the same as noted in Step "d".
9. Reinstall the replacement Coolant Tank by reversing the above procedure.
10. Remove the Coolant Tank Cap and Deionizer Basket from the faulty Coolant Tank.
11. Fill the replacement Coolant Tank with the coolant removed or fresh Thermal Arc Torch Coolant.

12. Place the Deionizer Basket and Bag into the Coolant Tank filler hole and install the Coolant Tank Cap.

## H. Flow Switch Assembly Replacement

1. Remove the Top Panel per Section 5.04-B.
2. Drain enough of the coolant from the Coolant Tank, per Section 4.02-F, to lower the coolant level below the Flow Switch Assembly hole.

---

**CAUTION**

*Handle and dispose of the used coolant per recommended procedures.*

3. Disconnect the wiring connector of the Flow Switch Assembly from the wiring harness at J25.
4. Disconnect the hose connected to the bottom of the Flow Switch Assembly in the unit.
5. Secure the end of the hose to prevent coolant from draining out of the Coolant Tank.
6. Remove the four nuts, washers and long screws that secure the Coolant Tank to the rear panel.
7. Note the orientation of the old Flow Switch Assembly on the Coolant Tank.
8. Move the Coolant Tank forward enough to allow removal of the old Flow Switch Assembly (see note).

---

**NOTE**

*When removing the Flow Switch Assembly leave the brass fitting in the Coolant Tank.*

9. Remove the brass hose fitting in the end of the old Flow Switch Assembly and install into the replacement Flow Switch Assembly.
10. Install the replacement Flow Switch Assembly, as noted in Step 7, by reversing the above procedure.
11. Refill the Coolant Tank with the coolant removed or add fresh Thermal Arc Torch Coolant.

## I. Conductivity Sensor Assembly Replacement

1. Remove the Top Panel per Section 5.04-B.
2. Drain enough of the coolant from the Coolant Tank, per Section 4.02-F, to lower the coolant level below the Conductivity Sensor Assembly hole, located on the end of the Coolant Tank.

**CAUTION**

Handle and dispose of the used coolant per recommended procedures.

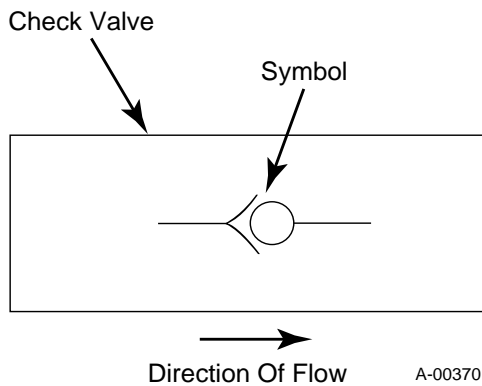
3. Remove the two wires from the Conductivity Sensor Assembly.
4. Remove the Conductivity Sensor Assembly from the Coolant Tank.
5. Install the replacement Conductivity Sensor Assembly by reversing the above procedure.
6. Refill the Coolant Tank with the coolant removed or add fresh Thermal Arc Torch Coolant.

**J. Secondary Water Check Valve Replacement**

1. Remove the Top Panel per Section 5.04-B.
2. Disconnect the Secondary Gas/Water Hose Assembly from the Elbow Fitting connection at the Check Valve.
3. Carefully remove the Check Valve and Elbow Fitting from the Secondary Water Solenoid Assembly.

**NOTE**

The output of the replacement Check Valve should be pointing towards the rear of the unit when installed. The output is designated by a symbol on the side of the part as shown in the following Figure.



4. Install the replacement Check Valve by reversing the above procedure and noting the following:
  - Coat the threads of the Elbow Fitting with a teflon sealer before installing the replacement Check Valve.

**5.08 Base Assembly Parts Replacement**

**NOTE**

Refer to Section 6.07, Base Assembly Replacement Parts, for parts list and overall detail drawing.

**A. DC Inductor (L2) Assembly Replacement**



**WARNING**

The removal of this Assembly requires the use of a mechanical lift.

1. Remove the Left and Right Side Panels per Section 5.04-B.
2. Disconnect all the wiring at the DC Inductor Assembly.
3. Remove the six mounting bolts securing the DC Inductor Assembly to the Base.
4. Place a mechanical lift next to the left side of the Power Supply.
5. Carefully slide the DC Inductor Assembly out the left side of the unit and onto the mechanical lift.
6. Install the replacement DC Inductor Assembly by reversing the above procedure

**B. 29KVA Transformer (T1) Assembly Replacement**



**WARNING**

The removal of this Assembly requires the use of a mechanical lift.

1. Remove the Left and Right Panels per Section 5.04-B.
2. Disconnect all the wiring at the Transformer Assembly.
3. Remove the six bolts, star washers and flat washers securing the Transformer Assembly to the Base.
4. Place a mechanical lift next to the left side of the Power Supply.
5. Carefully slide the Transformer Assembly out the left side of the unit and onto the mechanical lift.

6. Install the replacement Transformer Assembly by reversing the above procedure.

### C. Main Contactor (W1 or W2) Replacement

**NOTE**

---

*The Main Contactors, W1 and W2, are replaced in the same manner.*

1. Depending on which Main Contactor Assembly is to be replaced, remove the Left or Right Side Panel per Section 5.04-B.
2. Label all the wiring connected to the Main Contactor Assembly.
3. Disconnect the wires from the Main Contactor Assembly terminals.
4. Remove the two screws and star washers securing the Main Contactor Assembly to the Base.
5. Install the replacement Main Contactor Assembly by reversing the above procedure.

### D. Motor (M1) Assembly Replacement

1. Remove the Left and Right Side Panels per Section 5.04-B.
2. Loosen the allen set screw securing the Coupling to the shaft of the Motor Assembly.
3. Remove the two bolts and nuts securing the Pilot Resistors, air cooled 4.5 ohms, to the left Pilot Resistor Mounting Support.
4. Remove the two bolts securing the Pilot Resistor Mounting Support to the Base.
5. Carefully suspend the free end of the Pilot Resistors with string to prevent damage to the resistors.
6. Disconnect the Motor Assembly wiring.
7. Remove the four bolts securing the Motor Assembly to the Base.
8. Remove the complete Motor Assembly out the left side of the unit.
9. Install the replacement Motor Assembly by reversing the above procedure.

### E. Pump Assembly Replacement

1. Remove the Right Side Panel per Section 5.04-B.
2. Disconnect the two Hose Assemblies at the fittings on the Pump Assembly.
3. Loosen the allen set screw securing the Coupling to the Pump Assembly shaft.

4. Note the orientation of the Pump Assembly to the Pump Mounting Plate.
5. Remove the three nuts securing the Pump Assembly to the Pump Mounting Plate.
6. Remove the Pump Assembly from the unit.
7. Install the replacement Pump Assembly by reversing the above procedure and noting the following:
  - Remove the Fittings from the old Pump Assembly and install on the replacement Pump Assembly.
  - Be sure to align the Pump Assembly to the Pump Mounting Plate as noted in Step 4 above.

## 5.09 Upper Chassis Parts Replacement

**NOTE**

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*Refer to Section 6.08, Upper Chassis Replacement Parts, for parts list and overall detail drawing.*

### A. Power Driver PC Board Kit Replacement

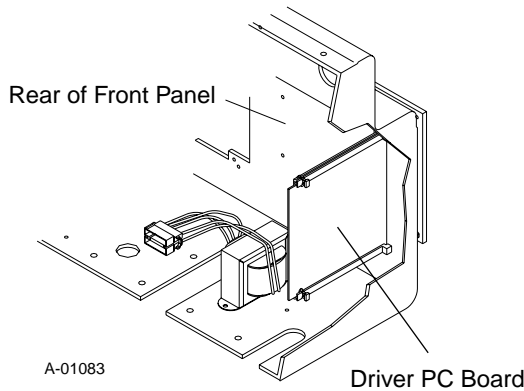
The Power Driver PC Board Replacement Kit is a direct parts replacement for the failed Driver PC Board and Switching Transistor (Q1) Assemblies in the Power Supply.



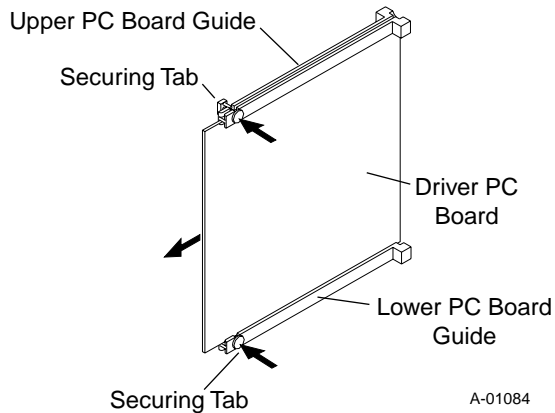
*Disconnect primary power at the source before assembling or disassembling power supply, torch parts, or torch and leads assemblies.*

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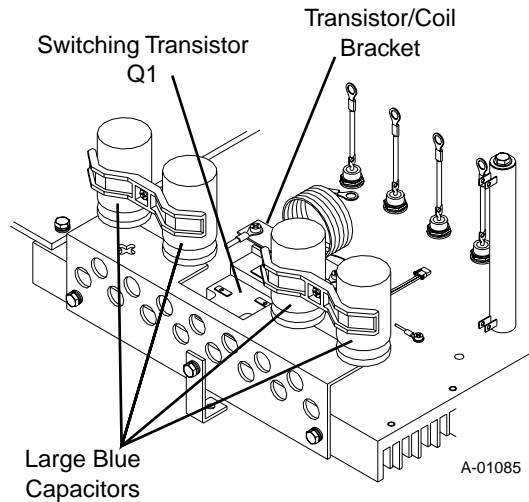
1. Turn OFF main input power to the Power Supply both at the Power Supply ON/OFF switch and at the main power disconnect.
2. Wait at least two minutes to allow the input capacitors to discharge.
3. Remove the top panel of the Power Supply. To remove the top panel of the Power Supply requires the removal of several phillips head screws. Carefully remove all the screws before attempting to remove the top panel.
4. Locate the old Driver PC Board Assembly on the inside left side, behind the front panel, as viewed from the front of the unit.



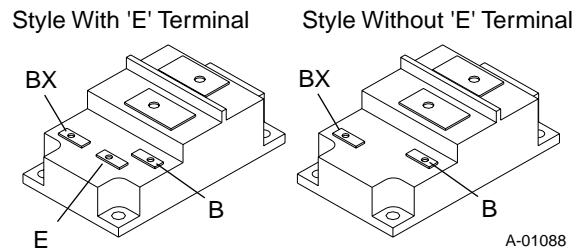
5. Note and label the two wiring connectors that connect to the Driver PC Board.
6. Disconnect the two wiring connectors from the Driver PC Board.
7. Press in the securing tab knob on the PC Board Guide to release the PC Board from the PC Board Guides. There is a securing tab on both the upper and lower PC Board Guides.



8. Carefully pull the PC Board from the guides and remove from the unit.
9. Install the replacement Driver PC Board Assembly reversing the above procedure.
10. Locate the old Switching Transistor (Q1) Assembly on the inside center-left, between the four large blue capacitors, as viewed from the front of the unit.



11. There are two different styles of the Switching Transistor (Q1). The style can be identified by looking at the top of the transistor casing.

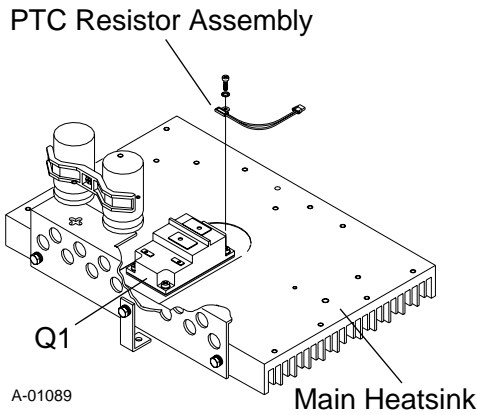


12. Note and label the wires connected to the Switching Transistor Assembly.

**NOTE**

*The older style transistor will have two wire connections to the transistor module and the newer style will have only one wire connections.*

13. Remove the two screws securing the wires to the Switching Transistor Assembly terminals 'E' and 'B'.
14. Remove the screw that secures the Capacitor Mounting Bracket to the Switching Transistor Assembly.
15. Remove the screw that secures the Transistor/Coil Bracket to the Switching Transistor Assembly.
16. Remove the screw and washer securing the PTC Resistor Assembly to the Main Heatsink. Move the PTC Resistor Assembly out of the way to prevent it from becoming damaged.

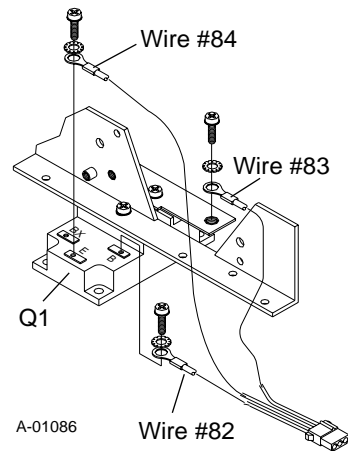


17. Remove the four screws securing the Switching Transistor module to the Main Heatsink.
18. Pry between the Main Heatsink and the faulty Switching Transistor Assembly until it slides easily.
19. Remove the faulty Switching Transistor Assembly from the unit by sliding it towards the center of the Main Heatsink.

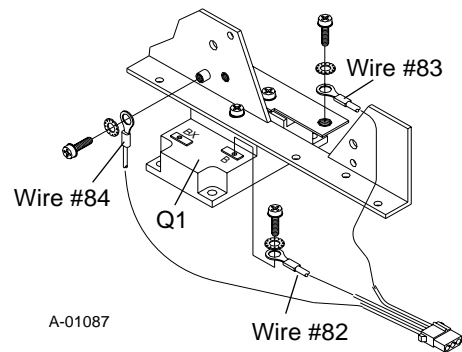
**CAUTION**

*DO NOT damage Heatsink.*

20. If the transistor thermstrate was not removed with the transistor, it must be removed.
21. Clean the old transistor thermstrate from the transistor mounting area. Verify that the Heatsink surface under the transistor is smooth and free of defects.
22. Install the replacement Transistor Thermstrate and the Switching Transistor Assembly by reversing the above procedure and noting the following:
  - Place the replacement Transistor Thermstrate onto the Main Heatsink at the Switching Transistor mounting location.
  - Depending on the style of the replacement Switching Transistor connect the wires per one of the following Figures:



Wire Connections (Q1 With E Terminal)



Wire Connections (Q1 Without E Terminal)

- The metric screws supplied with the Switching Transistor are to be used for the transistor wire connections. Small metric screws are to be torqued to 12 in-lbs (1.4 Nm). Larger metric screws are to be torqued to 26 in-lbs (2.9 Nm).

## B. Auxiliary Transformer (T3) Assembly Replacement

1. Remove the Left Side Panel per Section 5.04-B.
2. Disconnect the wiring connector from the wiring harness at the Auxiliary Transformer Assembly.
3. Remove the two mounting screws securing the Auxiliary Transformer Assembly to the Upper Chassis/Gauge Assembly.
4. Remove the Auxiliary Transformer Assembly from the unit.
5. Install the replacement Auxiliary Transformer Assembly by reversing the above procedure.

### C. Pressure Gauge Replacement

---

#### NOTE

*Both the Plasma and Secondary gauges are replaced in the same manner*

1. Remove the Top Panel per Section 5.04-B.
2. Disconnect the wiring to the desired Pressure Switch.
3. Remove the Pressure Switch from the desired Pressure Gauge Assembly.
4. Disconnect the input gas Hose Assembly from the fitting at the Pressure Gauge.
5. Remove the fitting(s) from the Pressure Gauge.
6. Remove the nut and clamp Securing the Pressure Gauge Assembly to the Upper Chassis/Gauge Assembly.
7. Slide the Pressure Gauge out of the Upper Chassis/Gauge Assembly.
8. Reinstall the replacement Pressure Gauge Assembly by reversing the above procedure.

---

#### NOTE

*Be sure that the Pressure Gauge orientation is correct when installed. The 80 PSI mark should be at the twelve o'clock position.*

### D. Coolant Pressure Gauge Replacement

1. Remove the Top Panel per Section 5.04-B.
2. Disconnect the Coolant Hose Assembly from the fitting at the Pressure Gauge.
3. Remove the fitting(s) from the Pressure Gauge.
4. Remove the nut and clamp Securing the Pressure Gauge Assembly to the Upper Chassis/Gauge Assembly.
5. Slide the Pressure Gauge out of the Upper Chassis/Gauge Assembly.
6. Reinstall the replacement Pressure Gauge Assembly by reversing the above procedure.

---

#### NOTE

*Be sure that the Pressure Gauge orientation is correct when installed. The 80 PSI mark should be at the twelve o'clock position.*

### E. Pressure Switch Replacement

---

#### NOTE

*Both the Plasma and Secondary Pressure Switches are replaced in the same manner*

1. Remove the Top Panel per Section 5.04-B.
2. Disconnect the two wires connected to the Pressure Switch Assembly.
3. Remove the assembly from the T-fitting.
4. Install the replacement Pressure Switch Assembly by reversing the above procedure and noting the following:
  - Apply pipe thread sealant to the fitting before reassembling.

### F. Coolant Supply and Return Bulkhead Adapter Fitting Replacement

---

#### NOTE

*Both the Coolant Supply and Return Bulkhead Fittings are replaced in the same manner.*

1. Remove the Top Panel per Section 5.04-B.
2. Remove the Torch connection to the Bulkhead Adapter Fitting.
3. Disconnect the gas Hose Assembly from the fitting at the end of the Bulkhead Adapter Fitting.
4. Remove the fittings from the end of the Bulkhead Adapter Fitting.
5. Remove the first nut from the Bulkhead Adapter Fitting.
6. Remove the second nut securing the Bulkhead Adapter to the Upper Chassis/Gauge Assembly.
7. Pull the Bulkhead Adapter Fitting from the Upper Chassis/Gauge Assembly.
8. Install the replacement Bulkhead Adapter by reversing the above procedure.

### G. Plasma or Secondary Gas Input Fitting Replacement

---

#### NOTE

*Both the Plasma and Secondary Gas fittings are replaced in the same manner*

1. Remove the Top Panel per Section 5.04-B.
2. Disconnect the Torch connection to the fitting being replaced at the Upper Chassis/Gauge Assembly.

3. Disconnect the gas Hose Assembly from the fitting at the end of the Gas Input Fitting.
4. Remove the fitting screwed into the end of the Gas Input Fitting.
5. Remove the first nut from the Gas Input Fitting.
6. Remove the second nut securing the Gas Input Fitting to the Upper Chassis/Gauge Assembly.
7. Pull the fitting from the Upper Chassis/Gauge Assembly.
7. Reinstall the replacement Plasma or Secondary Gas Input Fitting Assembly by reversing the above procedure.

#### H. Fuse (F1 and F2) Replacement

1. Open the hinged cover at the Front Panel torch leads connection area.
2. Locate and remove the cap from the fuse holder.
3. Pull the faulty Fuse from the fuse holder.
4. Install the replacement Fuse by reversing the above procedure.

#### I. Plasma or Secondary Regulator Assembly Replacement

**NOTE**

---

*Both the Plasma and Secondary Regulator Assemblies are replaced in the same manner*

1. Remove the Top Panel per Section 5.04-B.
2. Carefully remove the input and output gas Hose Assemblies to the Regulator Assembly.
3. On the Upper Chassis/Gauge Assembly remove the securing nut for the Regulator Assembly.
4. Slide the Regulator Assembly out of rear of the Upper Chassis/Gauge Assembly.
5. Remove the fittings from the old Regulator Assembly.
6. Reinstall the replacement Regulator Assembly by reversing the above procedure.

#### J. Control Logic PC Board Assembly Replacement

1. Open the front panel access panel cover at the front of the Power Supply.
2. Fasten the access cover open with string or rubber band.
3. Note where each connector is located on the old Control Logic PC Board.

4. Disconnect the three connectors from the old Control Logic PC Board.
5. Note the orientation of the old Control Logic PC Board.
6. Remove the old Control Logic PC Board.
7. On the new Control Logic PC Board set the switches, SW1 through SW5, the same as the old Control Logic PC Board.
8. Install the replacement Control Logic PC Board by reversing the above procedure.

#### K. Switching Control PC Board Assembly Replacement

1. Remove the Top and Right Side Panels per Section 5.04-B.
2. Note the orientation of the old Switching Control PC Board.
3. Remove the Switching Control PC Board from the rear of the Upper Chassis/Gauge Panel far enough to disconnect the wiring connections.
4. Note where each connector is located on the Switching Control PC Board.
5. Disconnect the connectors from the Switching Control PC Board.
6. Reconnect the original wiring connectors to the replacement Switching Control PC Board before installing the replacement Switching Control PC Board.
7. Install the replacement Switching Control PC Board by reversing the above procedure.

#### L. Coolant Check Valve Replacement

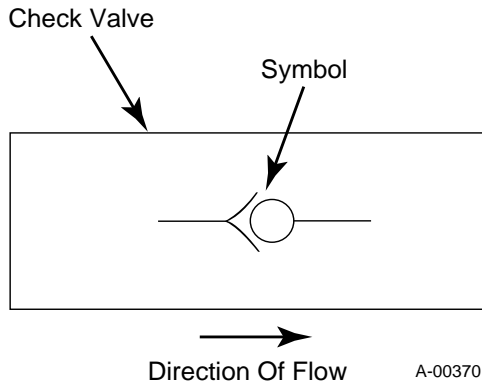
1. Remove the Top Panel per Section 5.04-B.
2. Disconnect the Hose Assemblies from the fitting connection at the input end of the Check Valve.
3. Carefully remove the Check Valve and fittings from the TORCH COOLANT SUPPLY fitting.
4. Remove the Fittings from the old Check Valve.

**NOTE**

---

*The input of the replacement Check Valve should be pointing towards the rear of the unit when installed. The output is designated by a symbol on the side of the part as shown in the following Figure.*





5. Install the replacement Check Valve by reversing the above procedure and noting the following:
  - Coat the threads of the Fittings with a teflon sealer before installing on the replacement Check Valve.

### M. Secondary Gas Check Valve Replacement

1. Remove the Top Panel per Section 5.04-B.
2. Disconnect the two Secondary Gas/Water Hose Assemblies from the T-Fitting connection at the Check Valve.
3. Carefully remove the Check Valve and Fittings from the Secondary Gas Regulator Assembly.
4. Remove the Fittings from the input of the old Check Valve.

#### **NOTE**

*The output of the replacement Check Valve should be pointing away from the Pressure Regulator Assembly when installed. The output is designated by an arrow on the side of the part.*

5. Install the replacement Check Valve by reversing the above procedure and noting the following:
  - Coat the threads of the Fittings with a teflon sealer before installing on the replacement Check Valve.

## 5.10 Main Heatsink Assembly Parts Replacement

#### **NOTE**

*Refer to Section 6.09, Main Heatsink Assembly Replacement Parts, for parts list and overall detail drawing.*

## A. 70 Amp STR. Diode Replacement

The Diode Replacement Kit (Cat # 8-1168) is a direct parts replacement for the failed Diode Assembly in the Power Supply.

The following parts are supplied with each replacement assembly:

- 70 Amp, 600V Str Diode Assembly (1 each)
  - 0.75 inch diameter Thermal Interface Pad (1 each)
  - Tube of RTV (1 each)
1. Turn OFF main input power to the Power Supply both at the Power Supply ON/OFF switch and at the main power disconnect.
  2. Wait at least two minutes to allow the input capacitors to discharge.
  3. Open the Power Supply to gain access to the faulty Diode Assembly.
  4. Locate the old Diode Assembly inside the Power Supply.
  5. Unsolder the wire lead from the old Diode Assembly.
  6. Remove the old Diode Assembly from the unit. Make sure the replacement diode is a direct replacement for the old one.

#### **NOTE**

*To avoid damage to a replacement diode from overheating during installation, a proper heatsink (example: alligator clip) must be used to disperse heat when soldering the wire lead to the diode.*

7. Install the replacement diode by reversing the above procedure and noting the following:
  - a. Wipe the surface clean where the replacement diode is to be installed.

#### **NOTE**

*The thermal interface pads must be properly aligned when replacing the diode.*

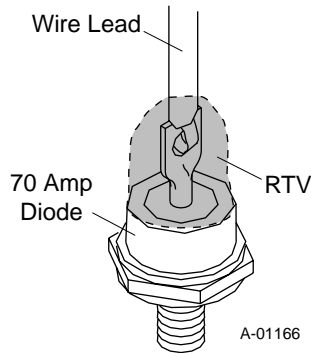
- b. Position the thermal interface pad between the diode and contact surface where the diode will be installed.

#### **CAUTION**

*Diodes can overheat if not properly installed.*

- c. Install the replacement diode and torque the diode to 20 - 25 in-lbs (2.3 - 2.8 Nm).

- d. Re-solder the wire lead to the replacement diode.
- e. Apply a layer of RTV over the top of the Diode Assembly to encapsulate the lead and top of the diode.



- f. Close up the Power Supply.

## B. Relay Replacement

1. Remove the Right Side Panel per Section 5.04-B.
2. Move the Relay Hold-Down Spring to the side of the Relay Assembly.
3. Pull the Relay Assembly from the Relay Socket.
4. Install the replacement Relay Assembly by reversing the above procedure.

## C. 150 Amp REV Diode Replacement

The Diode Replacement Kit (Cat # 8-6152) is a direct parts replacement for the failed Diode Assembly in the Power Supply.

The following parts are supplied with each replacement assembly:

- 150 Amp, 800V Rev Diode Assembly (1 each)
  - 1.06 inch diameter Thermal Interface Pad (1 each)
1. Turn OFF main input power to the Power Supply both at the Power Supply ON/OFF switch and at the main power disconnect.
  2. Wait at least two minutes to allow the input capacitors to discharge.
  3. Open the Power Supply to gain access to the faulty Diode Assembly.
  4. Locate the old Diode Assembly inside the Power Supply.
  5. Remove the nut and washer securing the old diode assembly to the mounting surface.

6. Remove the nut securing the diode wire lead to the PC Board.
7. Make sure the replacement diode is a direct replacement for the old one.
8. Install the replacement diode by reversing the above procedure and noting the following:
  - a. Wipe the surface clean where the replacement diode is to be installed.

### NOTE

*The thermal interface pads must be properly aligned when replacing the diode.*

- b. Position the thermal interface pad between the diode and contact surface where the diode will be installed.

### CAUTION

*Diodes can overheat if not properly installed.*

- c. Install the diode. Torque the nut securing the diode to 34 in-lbs (3.8 Nm).
- d. Reinstall the nut and washer securing the replacement diode wire lead to the PC Board.

## D. 150 Amp STR Diode Replacement

The Diode Replacement Kit (Cat # 8-6153) is a direct parts replacement for the failed Diode Assembly in the Power Supply.

The following parts are supplied with each replacement assembly:

- 150 Amp, 800V Str. Diode Assembly (1 each)
  - 1.06 inch diameter Thermal Interface Pad (1 each)
1. Turn OFF main input power to the Power Supply both at the Power Supply ON/OFF switch and at the main power disconnect.
  2. Wait at least two minutes to allow the input capacitors to discharge.
  3. Open the Power Supply to gain access to the faulty Diode Assembly.
  4. Locate the old Diode Assembly inside the Power Supply.
  5. Remove the nut and washer securing the old diode assembly to the mounting surface.
  6. Remove the nut securing the diode wire lead to the PC Board.

7. Make sure the replacement diode is a direct replacement for the old one.
8. Install the replacement diode by reversing the above procedure and noting the following:
  - a. Wipe the surface clean where the replacement diode is to be installed.

**NOTE**

*The thermal interface pads must be properly aligned when replacing the diode.*

- b. Position the thermal interface pad between the diode and contact surface where the diode will be installed.

**CAUTION**

*Diodes can overheat if not properly installed.*

- c. Install the diode. Torque the nut securing the diode to 34 in-lbs (3.8 Nm).
- d. Reinstall the nut and washer securing the replacement diode wire lead to the PC Board.

## 5.11 Hose Assembly Replacements

This subsection describes the replacement of the various Hose Assemblies used in the Power Supply. The replacement part numbers and detail drawings are in Section 6 as noted in each Hose Assembly replacement instructions. For a block diagram of the Power Supply Hose Assemblies refer to Appendix XV.

### A. Secondary Water Hose (Check Valve to T-Fitting) Assembly Replacement

The Secondary Water Hose Assembly goes from the Check Valve on the Secondary Water Solenoid Assembly to the T-Fitting on the Secondary Gas Pressure Gauge at the front panel. Replace the Hose Assembly using the following procedure:

**NOTE**

*Refer to Subsection 6.08, Upper Chassis Replacement Parts for part numbers and detail drawing.*

1. Remove the Right Side Panel per Section 5.04-B.
2. Disconnect the Hose Assembly from the Check Valve on the Secondary Water Solenoid Assembly.
3. Disconnect the other end of the Hose Assembly from the T-Fitting on the Check Valve from the Secondary Gas Pressure Gauge at the front panel.
4. Remove the Hose Assembly from the unit.

5. Install the replacement Hose Assembly by reversing the above procedure.

### B. Coolant Return Hose (RETURN Connector to Radiator) Assembly Replacement

The Coolant Return Hose Assembly goes from the RETURN Connector to the inlet side of the Radiator. Replace the Hose Assembly using the following procedure:

**NOTE**

*Refer to Subsection 6.05, Front Panel/Cahassis Replacement Parts for part numbers and detail drawing.*

1. Remove the Right Side Panel per Section 5.04-B.
2. Disconnect the Hose Assembly from the rear of the front panel RETURN connector.
3. Locate the other end of the Hose Assembly at the inlet of the Radiator.
4. Disconnect the Hose Assembly from the Radiator.
5. Remove the Hose Assembly from the unit.
6. Install the replacement Hose Assembly by reversing the above procedure.

### C. Coolant Supply Hose (Pump to Pressure Gauge) Assembly Replacement

The Coolant Supply Hose Assembly goes from the Pump to a T-Fitting at the Pressure Gauge. Replace the Hose Assembly using the following procedure:

**NOTE**

*Refer to Subsection 6.08, Upper Chassis Replacement Parts for part numbers and detail drawing.*

1. Remove the Right Side Panel per Section 5.04-B.
2. Disconnect the Hose Assembly from the T-Fitting at the rear of the front panel Pressure Gauge Assembly.
3. Disconnect the other end of the Hose Assembly from the Pump Assembly.
4. Remove the Hose Assembly from the unit.
5. Install the replacement Hose Assembly by reversing the above procedure.

### D. Coolant Supply Hose (Pump to Pressure Gauge Connection) Assembly Replacement

The Coolant Supply Hose Assembly goes from the Pressure Gauge T-Fitting to the front panel Coolant Pressure Gauge connection. Replace the Hose Assembly using the following procedure:

**NOTE**

---

*Refer to Subsection 6.08, Upper Chassis Replacement Parts for part numbers and detail drawing.*

1. Remove the Right Side Panel per Section 5.04-B.
2. Disconnect the Hose Assembly from the T-Fitting at the front panel Coolant Pressure Gauge connector.
3. Disconnect the other end of the Hose Assembly from the Coolant Pressure Gauge.
4. Remove the Hose Assembly from the unit.
5. Install the replacement Hose Assembly by reversing the above procedure.

**E. Secondary Gas Hose (T-Fitting to SECONDARY GAS Connector) Assembly Replacement**

The Secondary Gas Hose Assembly goes from the T-Fitting to front panel SECONDARY GAS connector. Replace the Hose Assembly using the following procedure:

**NOTE**

---

*Refer to Subsection 6.08, Upper Chassis Replacement Parts for part numbers and detail drawing.*

1. Remove the Right Side Panel per Section 5.04-B.
2. Disconnect the Hose Assembly from the T-Fitting on the Check Valve from the Secondary Gas Regulator Assembly.
3. Disconnect the other end of the Hose Assembly from the front panel SECONDARY GAS Connector.
4. Remove the Hose Assembly from the unit.
5. Install the replacement Hose Assembly by reversing the above procedure.

**F. Plasma Gas Hose (PLASMA GAS to T-Fitting) Assembly Replacement**

The Plasma Gas Hose Assembly goes from the front panel PLASMA GAS connector to the T-Fitting on the Plasma Pressure Gauge Assembly. Replace the Hose Assembly using the following procedure:

**NOTE**

---

*Refer to Subsection 6.08, Upper Chassis Replacement Parts for part numbers and detail drawing.*

1. Remove the Right Side Panel per Section 5.04-B.
2. Disconnect the Hose Assembly from the front panel PLASMA GAS connector.

3. Disconnect the Other end of the Hose Assembly from the T-Fitting at the Plasma Pressure Gauge Assembly.
4. Remove the Hose Assembly from the unit.
5. Install the replacement Hose Assembly by reversing the above procedure.

**G. Coolant Supply Hose (Coolant Filter to Pump) Assembly Replacement**

The Coolant Supply Hose Assembly goes from the rear panel Coolant Filter Assembly to the Pump Assembly. Replace the Hose Assembly using the following procedure:

**NOTE**

---

*Refer to Subsection 6.07, Base Assembly Replacement Parts for part numbers and detail drawing.*

1. Remove the Right Side Panel per Section 5.04-B.
2. Disconnect the Hose Assembly from the Coolant Filter Assembly on the rear panel.
3. Disconnect the other end of the Hose Assembly from the Pump Assembly.
4. Remove the Hose Assembly from the unit.
5. Install the replacement Hose Assembly by reversing the above procedure.

**H. Coolant Supply Hose (Tank to Coolant Filter) Assembly Replacement**

The Coolant Supply Hose Assembly goes from the Coolant Tank to the Coolant Filter Assembly mounted on the rear panel. Replace the Hose Assembly using the following procedure:

**NOTE**

---

*Refer to Subsection 6.06, Rear Panel Replacement Parts for part numbers and detail drawing.*

1. Drain the coolant from the Coolant Tank per Section 4.02-F.

**CAUTIONS**

---

*The coolant must be drained from the unit as the coolant will drain out the hose connection on the side of the Coolant Tank .*

*Handle and dispose of the used coolant per recommended procedures.*

2. Disconnect the other end of the Hose Assembly from the Coolant Tank.

3. Remove the Hose Assembly from the unit.
4. Install the replacement Hose Assembly by reversing the above procedure.
5. Refill the Coolant Tank with Thermal Arc Torch Coolant before applying power.

#### **I. Coolant Return Hose (Internal Filter to Flow Switch) Assembly Replacement**

The Coolant Return Hose Assembly goes from the top outlet of the Internal Filter Assembly to the Flow Switch Assembly located on the side of the Coolant Tank. Replace the Hose Assembly using the following procedure:

**NOTE**

---

*Refer to Subsection 6.05, Front Panel/Chassis Replacement Parts for part numbers and detail drawing.*

1. Remove the Left Side Panel per Section 5.04-B.
2. Disconnect the Hose Assembly from the outlet side of the Internal Filter Assembly.
3. Locate the other end of the Hose Assembly at the lower part of the Flow Switch Assembly.
4. Disconnect the Hose Assembly from the Flow Switch Assembly.
5. Pull the Hose Assembly from the unit.
6. Install the replacement Hose Assembly by reversing the above procedure.

#### **J. Secondary Water/Gas Hose (T-Fitting to T-Fitting) Assembly Replacement**

The Secondary Water/Gas Hose Assembly goes from the T-Fitting at the Secondary Gas Check Valve to the T-Fitting on the Secondary Gas Pressure Gauge Assembly. Replace the Hose Assembly using the following procedure:

**NOTE**

---

*Refer to Subsection 6.08, Upper Chassis Replacement Parts for part numbers and detail drawing.*

1. Remove the Right Side Panel per Section 5.04-B.
2. Disconnect the Hose Assembly from the T-Fitting on the Check Valve from the Secondary Gas Regulator Assembly.
3. Disconnect the other end of the Hose Assembly from the T-Fitting on the Secondary Gas Pressure Gauge Assembly.
4. Remove the Hose Assembly from the unit.

5. Install the replacement Hose Assembly by reversing the above procedure.

#### **K. Plasma Gas Hose (Plasma Gas Solenoid to Plasma Gas Regulator) Assembly Replacement**

The Plasma Gas Hose Assembly goes from the Plasma Gas Solenoid Assembly at the rear panel to the Plasma Gas Regulator at the front panel. Replace the Hose Assembly using the following procedure:

**NOTE**

---

*Refer to Subsection 6.08, Upper Chassis Replacement Parts for part numbers and detail drawing.*

1. Remove the Right Side Panel per Section 5.04-B.
2. Disconnect the Hose Assembly from the Plasma Gas Solenoid Assembly at the rear panel.
3. Disconnect the other end of the Hose Assembly from the Plasma Gas Regulator Assembly at the front panel.
4. Remove the Hose Assembly from the unit.
5. Install the replacement Hose Assembly by reversing the above procedure.



# SECTION 6: PARTS LISTS

---

## 6.01 Introduction

### A. Parts List Breakdown

The parts list provides a breakdown of all basic replaceable parts. The parts lists are arranged as follows:

**Section 6.03:** External Power Supply Replacement Parts List

**Section 6.04:** Access Panel Replacement Parts

**Section 6.05:** Front Panel/Chassis Replacement Parts

**Section 6.06:** Rear Panel Replacement Parts

**Section 6.07:** Base Assembly Replacement Parts

**Section 6.08:** Upper Chassis Replacement Parts

**Section 6.09:** Main Heatsink Assembly Replacement Parts

**Section 6.10:** Power Supply Options And Accessories

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### **NOTE**

*Parts listed without item numbers are not illustrated, but may be ordered by the catalog numbers shown.*

### B. Returns

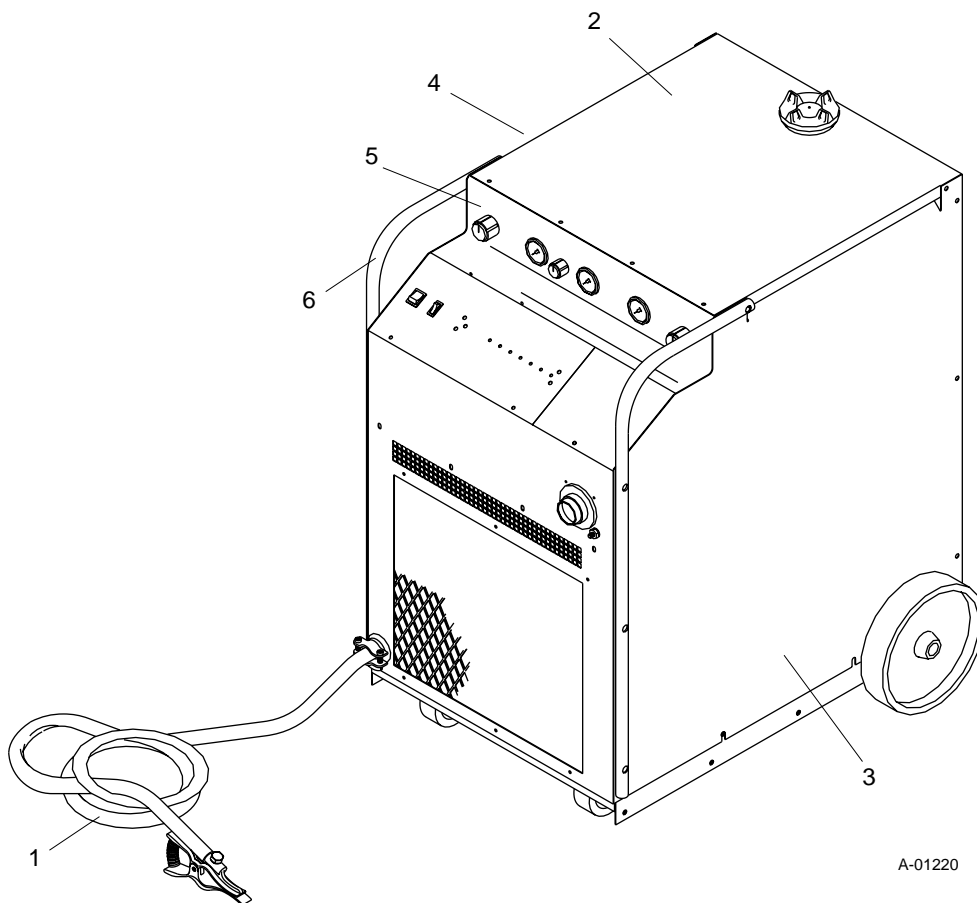
If a Thermal Dynamics product must be returned for service, contact your Thermal Dynamics distributor. Materials returned to Thermal Dynamics without proper authorization will not be accepted.

## 6.02 Ordering Information

Order replacement parts by catalog number and complete description of the part or assembly, as listed in the description column of the Parts List. Also include the model and serial number of the machine as shown on the plate attached to the front panel of the unit. Address all inquiries to your authorized Thermal Dynamics distributor.

## 6.03 External Power Supply Replacement Parts List

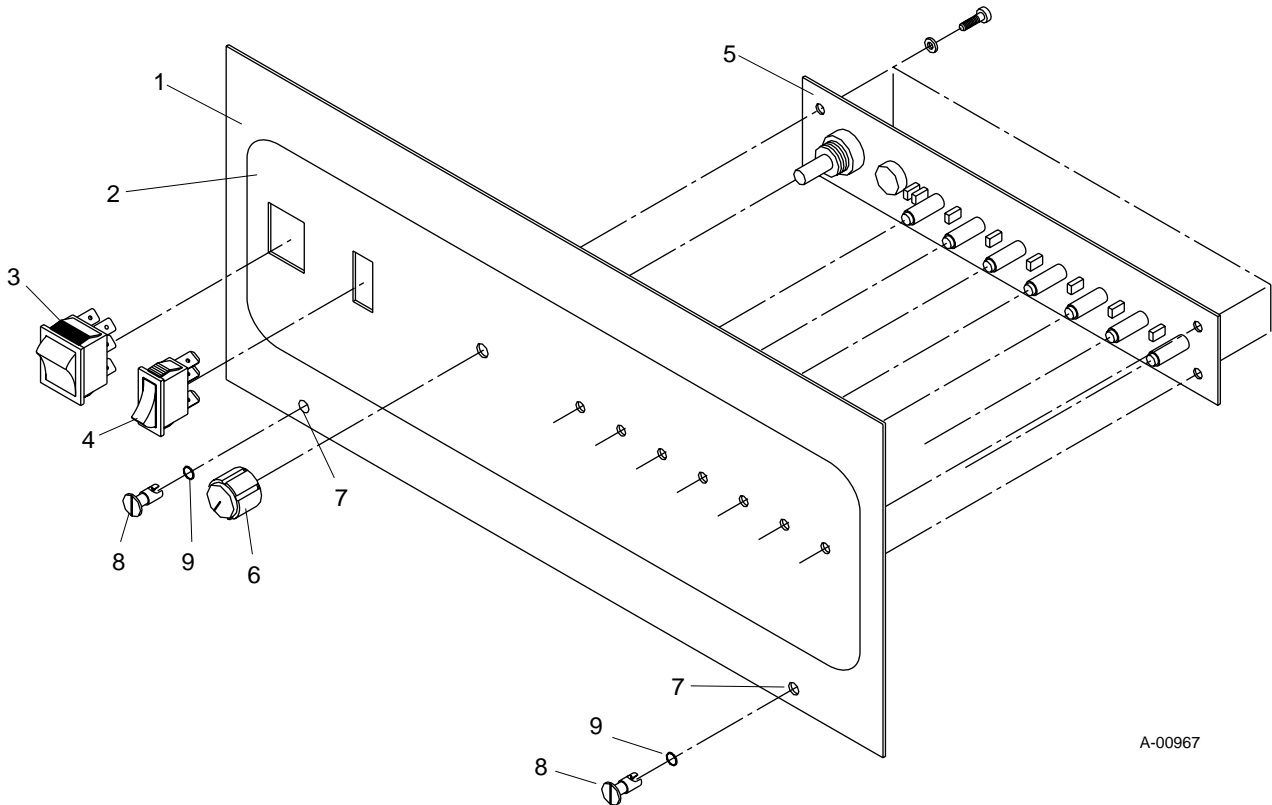
Item #	Qty.	Description	Catalog #
		Complete Merlin 3000 Power Supply With Running Gear and Work Cable	
	1	Without Gas Control GC3000	3-5100
	1	With Gas Control GC3000	3-5101
1	1	Work Cable with Clamp - 25 ft (7.6 m)	9-4380
2	1	Panel, Top	8-3300
3	1	Panel, R.H. Side With Overlay	8-6301
4	1	Panel, L.H. Side With Overlay	8-6303
5	1	Upper Gauge Panel Overlay	8-3304
6	2	Handle, Merlin	8-2172





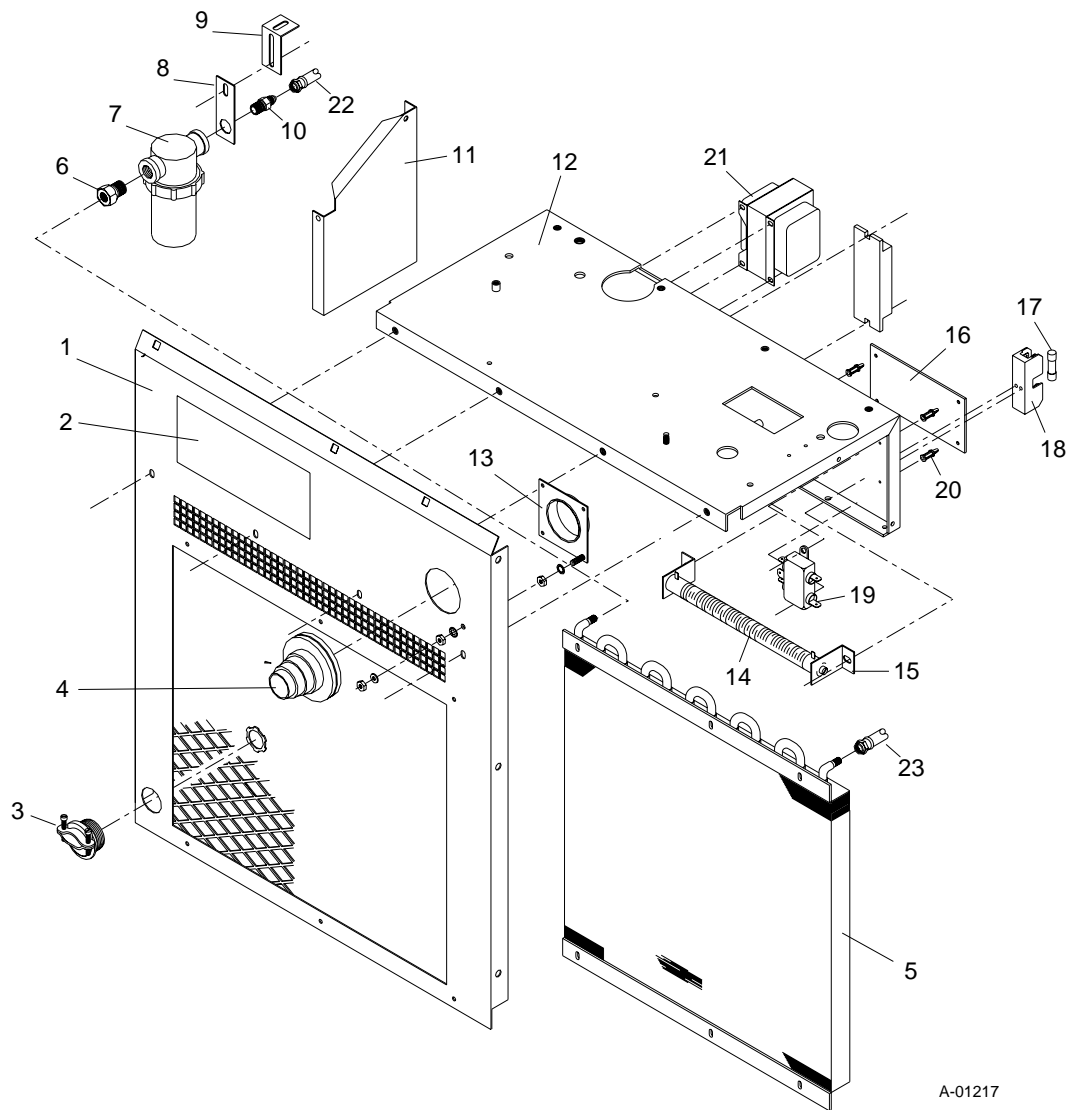
## 6.04 Access Panel Replacement Parts

Item #	Qty.	Description	Catalog #
	1	Access Panel Assembly Includes:	8-3257
1	1	Access Panel With Overlay	8-6302
2	1	Access Panel Overlay	8-3306
3	1	ON/OFF Rocker Switch, DPST	8-3258
4	1	Switch, Rocker, SPDT, Center Off	8-3259
5	1	LED/Current Control PC Board Assembly	9-5759
6	1	Knob, Inner Concentric	9-4146
7	2	Fastener Receptacle	9-3995
8	2	"DZUS" Stud	9-4346
9	2	"DZUS" Retaining Ring	9-4347



## 6.05 Front Panel/Chassis Replacement Parts

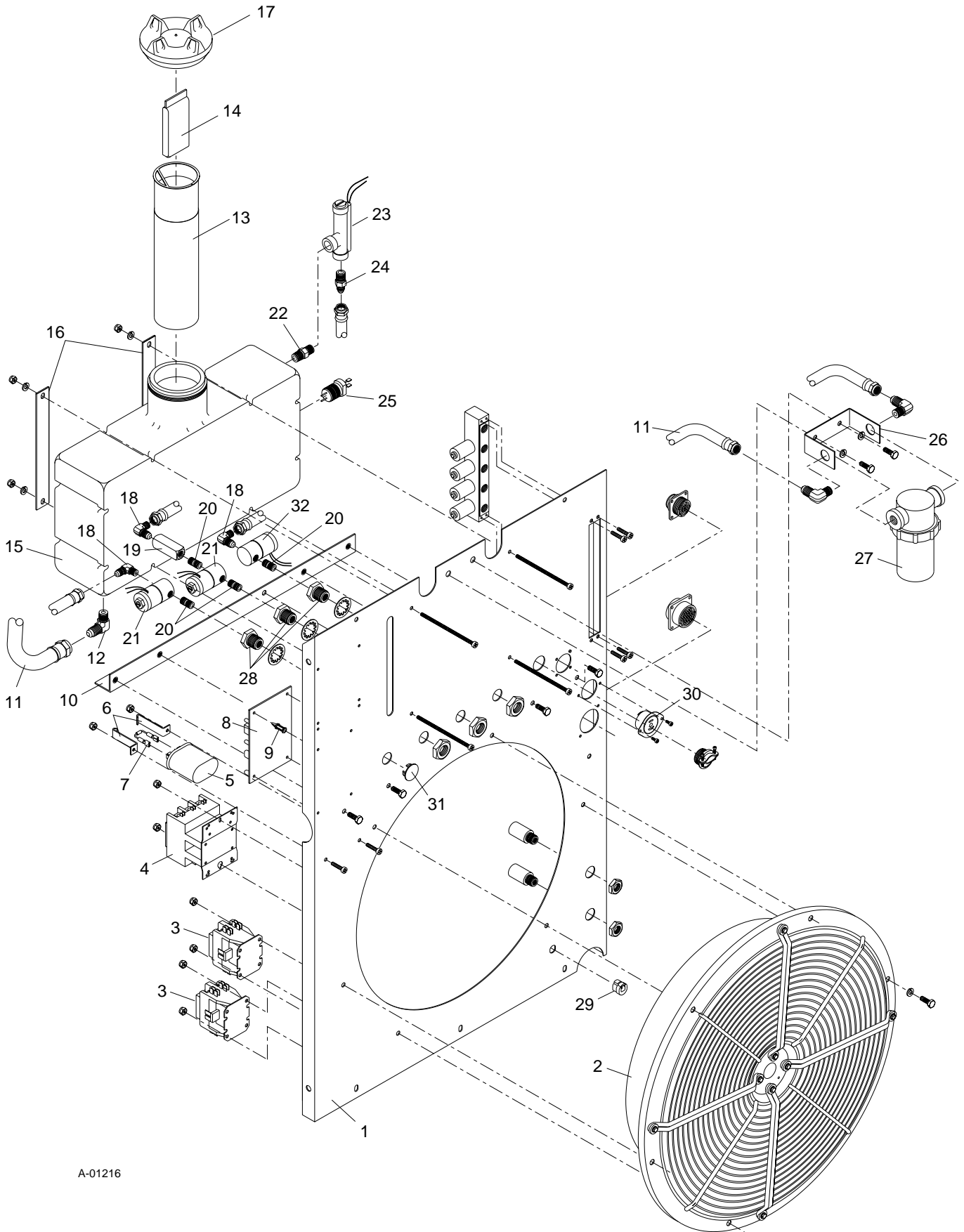
Item #	Qty.	Description	Catalog #
1	1	Front Panel With Overlay	8-6304
2	1	Front Panel Overlay	-----
3	1	Cord Grip	8-6307
4	1	Torch Leads Panel Boot	9-4210
5	1	Radiator	8-1347
6	1	#6 JIC x 3/8 NPT Male Union	8-6141
7	1	Coolant Filter	8-4276
8	1	Support, Inner Coolant Filter	8-3313
9	1	Support, Lower Coolant Filter	8-5577
10	1	#8 JIC to 3/8 NPT Straight Adapter	8-1251
11	1	Panel, Access Divider	8-6310
12	1	Horizontal Chassis Panel	8-4500
13	1	Assembly, Torch Leads Shield, 2 1/4"	8-3314
14	1	Resistor, 8 ohm	9-3431
15	1	Resistor Mounting Bracket Kit	8-4234
16	1	Assembly, Bias Supply PC Board	8-4501
17	1	Fuse, 1A, 250V	9-5530
18	1	Fuse Block (1/4 x 1 1/4 Fuse)	9-5529
19	1	EMI Filter	9-1023
20	4	P.C. Board Support	9-5333
21	1	Transformer Assembly	8-4502
22	1	Hose Assembly, Internal Filter to Tank	8-4503
23	1	Hose Assembly, Bulkhead to Radiator	8-4504



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## 6.06 Rear Panel Replacement Parts

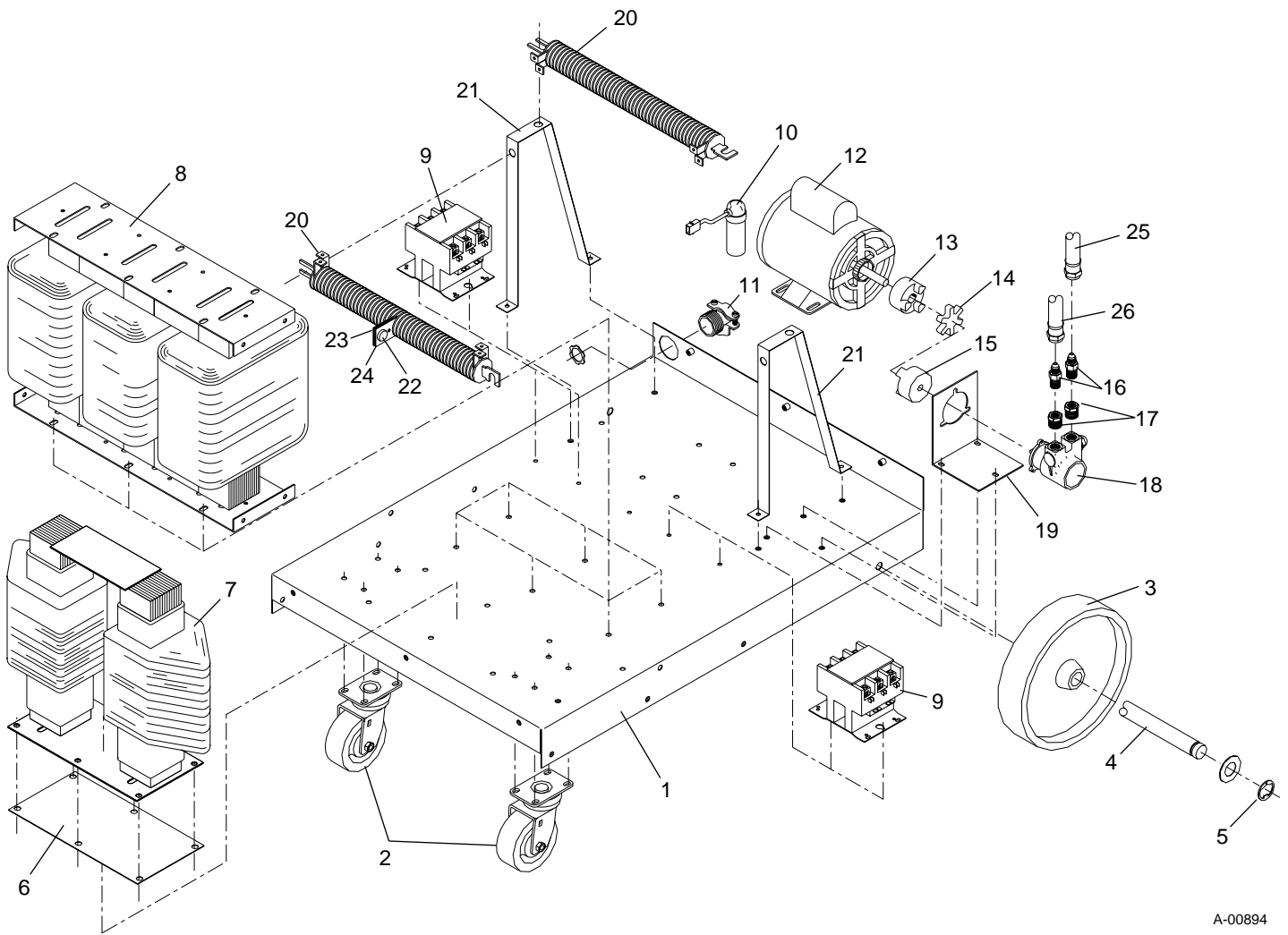
Item #	Qty.	Description	Catalog #
1	1	Rear Panel	8-4505
2	1	Fan, 16" Axial	8-6312
3	2	Contactor, 25 amp, 2-pole, 120V Coil	8-5143
4	1	3 PH Contactor	8-1373
5	1	4 mfd, Capacitor	9-3210
6	2	Capacitor Mounting Bracket	8-6308
7	1	330k Ohms Resistor Assembly	9-5545
8	1	Voltage Selection PC Board	8-5144
9	4	P.C. Board Support	9-5333
10	1	Bracket, Heatsink Support	8-5576
11	1	Hose Assembly - Tank to Coolant Filter	8-4274
12	3	#8 JIC - 3/8 NPT x 90° Adapter	8-0346
13	1	Basket, Coolant Tank	8-4273
14	1	Deionizer Bag	8-3312
15	1	Coolant Tank	8-4275
16	2	Bracket, Tank Support	8-4506
17	1	Cap, Coolant Tank	8-5142
18	3	#4 JIC - 1/8 NPT x 90° Adapter	8-0262
19	1	Check Valve 1/8 NPT Female	8-1787
20	4	1/8 NPT Close Nipple	8-0354
21	2	Assembly, Solenoid Valve Connection	8-1196
22	1	Fitting, Adapter 3/8 NPT (9/16-18, O-Ring)	9-1412
23	1	Assembly, Flow Switch	9-5969
24	1	Spec O Ring Hose Adapter	8-0319
25	1	Assembly, Conductivity Sensor	8-6203
26	1	Support, Filter	8-6202
27	1	Coolant Filter	8-4276
28	3	1/4-1/8 NPT Reducing Bulkhead	9-4078
29	1	Strain Relief, For #10 Stranded Wire	8-4249
30	1	Twist-Loc Base	9-3290
31	1	3/4 Inch Snap Button Hole	8-0232
32	1	Valve, Solenoid 5/32 Orifice 1/4 NPT	8-4323



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## 6.07 Base Assembly Replacement Parts

Item #	Qty.	Description	Catalog #
1	1	Base	8-5145
2	2	Caster, 5" Diameter	8-5578
3	2	Wheel, 8" Diameter	8-5579
4	1	Axle	9-1243
5	2	Retaining E-Ring, 1/2 Diameter Shaft	9-5539
6	1	Mat, Inductor Base	8-6143
7	1	DC Inductor Assembly	8-6145
8	1	29 KVA Transformer	8-6670
9	2	Main Contactor	9-1244
10	1	Assembly, Capacitor Connection	8-3263
11	1	1 1/4 Squeeze Connect	9-2391
12	1	Westinghouse 1/2 HP Motor, 1PH/50HZ/110/220V	9-3496
13	1	5/8" Coupling Body	9-4018
14	1	Coupling Spider	9-4019
15	1	Body, Coupling 7/16" Diameter Bore	8-6146
16	2	#8 JIC x 3/8 NPT Straight Adapter	8-1251
17	2	1/2 x 3/8 NPT Reducer	8-0353
18	1	Pump-Procon Type 2507XH	8-1328
19	1	Plate, Pump Mounting	8-3264
20	2	Resistor-Air Cooled 4.5 Ohm-Power Rib	9-3959
21	2	Support, Pilot Resistor Mounting	8-3265
22	1	Thermostat, Open 212°F, Close 192°F	8-3315
23	1	Temp. Switch Top Clamp	8-3316
24	1	Temp. Switch Bottom Clamp	8-3317
25	1	Hose Assembly, Pump Inlet to Filter	8-4507
26	1	Hose Assembly, Pump Outlet To Bulkhead	8-4508



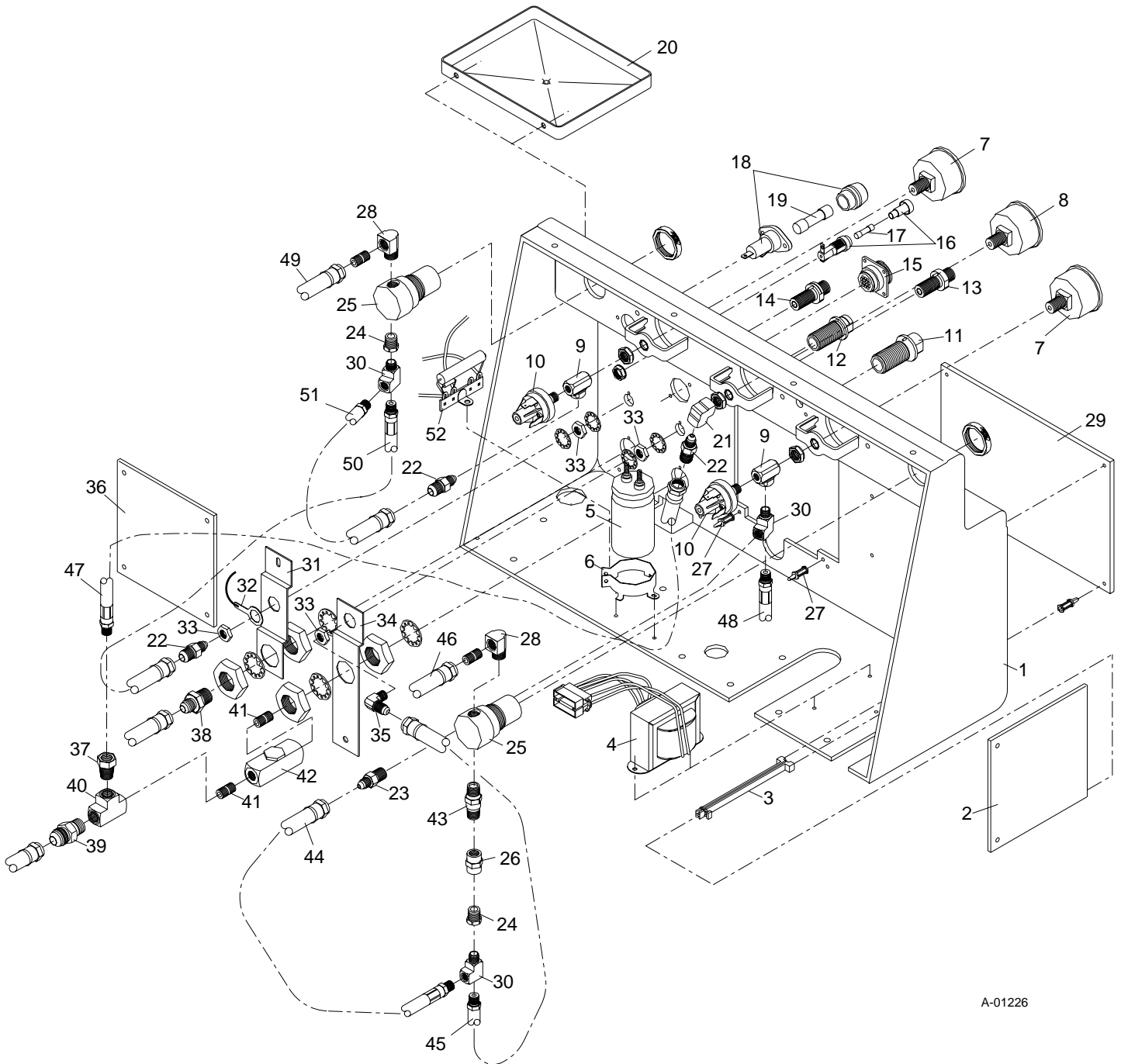
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## 6.08 Upper Chassis Replacement Parts

Item #	Qty.	Description	Catalog #
1	1	Panel, Upper Chassis/Gauge	9-1302
2	1	Power Driver PC Board Assembly Includes:	7-3360
	1	Thermstrate, Transistor (Refer to Section 6.09 Item # 7)	9-1406
	1	Transistor, 300A, 550V Darlington (Refer to Section 6.09 Item # 8)	8-6154
	1	Current Driver PC Board Assembly	9-4381
3	2	PC Board Guide With 16mm Screw	9-1054
4	1	Auxiliary Transformer Assembly	9-4383
5	1	Capacitor, 300mfd, 400VDC	9-1300
6	1	Capacitor Mounting Clamp - 1 3/4" Diameter	8-3260
7	2	Gauge, 0-100 psi/BAR 2" Diameter	8-4313
8	1	Gauge, 0-160 psi/BAR 2" Diameter	8-4330
9	2	1/8 NPT Female Tee	8-0312
10	2	Pressure Switch - 35 psi	9-1044
11	1	Adapter, Bulkhead, 3/8 NPT/Inert B	8-6147
12	1	Adapter, Bulkhead, 3/8 NPT/Inert B L.H.	8-6148
13	1	Body, Bulkhead, 1/8 NPT	8-4509
14	1	Body, Bulkhead, 1/8 NPT (LH)	8-4510
15	1	Receptacle, Square Flanged, 14 Circuit, CPC, Rev Sex	9-3293
16	1	Fuse Holder For 1/4 x 1" Fuse	9-2936
17	1	5 Amp Fuse, MTH5(250V)	8-1025
18	1	Fuse Holder, Buss.HPS	9-2937
19	1	10 Amp Fuse	9-3641
20	1	Spill Tray	8-6149
21	1	1/8 NPT Female Elbow	9-4175
22	3	#4 JIC - 1/8 NPT STR Adapter	8-0257
23	1	Orifice, Water Flow Metering	8-2177
24	2	1/4 x 1/8 NPT Reducer	9-2023
25	2	Air Regulator	8-3223
26	1	1/4 NPT Coupling	9-3885
27	10	PC Board Support	9-5333
28	2	1/4 NPT Street Elbow	9-2184
29	1	Assembly, Logic PC Board	9-5968
30	3	1/8 NPT STR Tee	8-0352
31	1	Connector, Bulkhead Lead	8-6150
32	1	Torch Lead	8-4511
33	4	9/16 x 1/8 Jam Nut	8-2149
34	1	Connector, Inductor Lead	9-1400
35	1	#4 JIC-1/8 NPT x 90° Adapter	8-0262
36	1	Assembly, Switching Control PC Board	9-5970
37	1	3/8 x 1/4 NPT Reducer	8-1422
38	1	#6 JIC x 3/8 NPT STR Adapter	8-0348
39	1	#8 JIC x 3/8 NPT STR Adapter	8-1251
40	1	3/8 NPT Female Tee	9-2385
41	2	3/8 NPT Close Nipple	9-2384
42	1	Valve, Check 3/8 NPT Female, Brass	9-1402



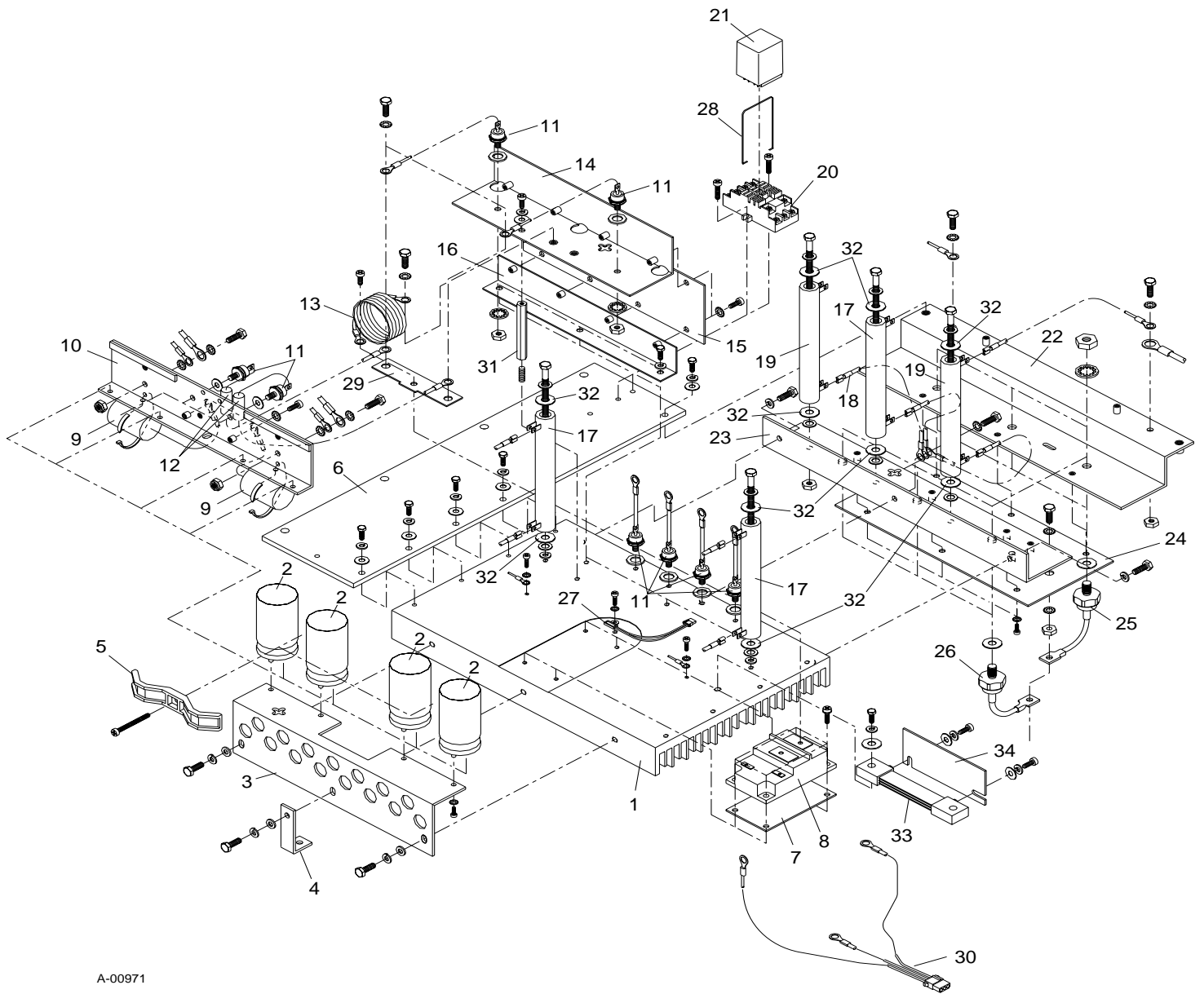
Item #	Qty.	Description	Catalog #
43	1	Check Valve, Male, 1/4 NPT, 5 PSI	8-4512
44	1	Hose Assembly, Secondary Water, Gauge To T-Fitting	8-4513
45	1	Hose Assembly, Secondary Gas/Water to Bulkhead	8-4514
46	1	Hose Assembly, Secondary Gas Inlet to Regulator	8-4515
47	1	Hose Assembly, Bulkhead to Coolant Pressure Gauge	8-4516
48	1	Hose Assembly, Secondary Water Inlet to Gauge	8-4517
49	1	Hose Assembly, Plasma Gas Inlet to Regulator	8-4515
50	1	Hose Assembly, Plasma Gas Regulator To Bulkhead	8-4513
51	1	Hose Assembly, Plasma Gas Regulator To Gauge	8-4513
52	1	Voltage Divider Replacement Kit	9-1416



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## 6.09 Main Heatsink Assembly Replacement Parts

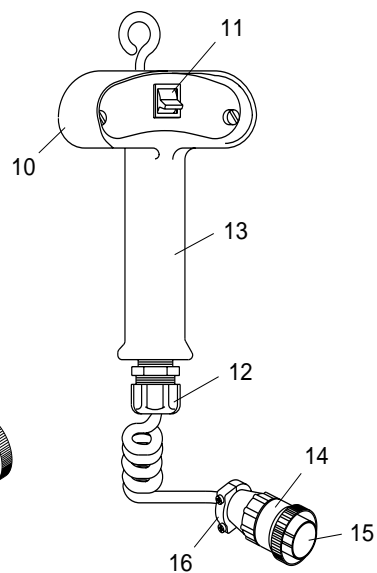
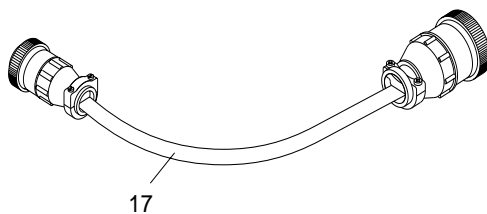
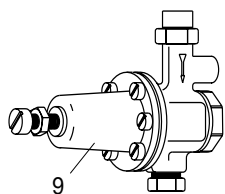
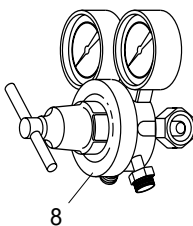
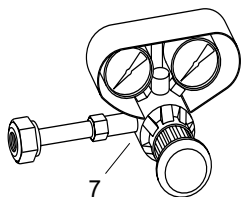
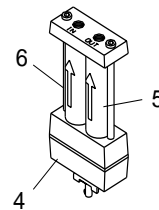
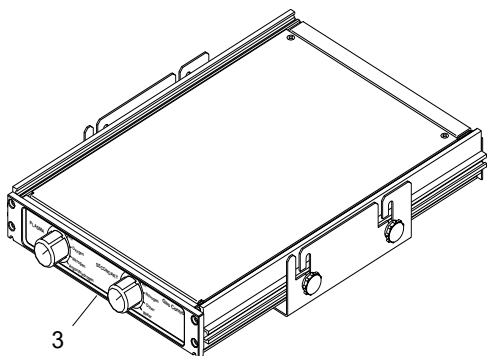
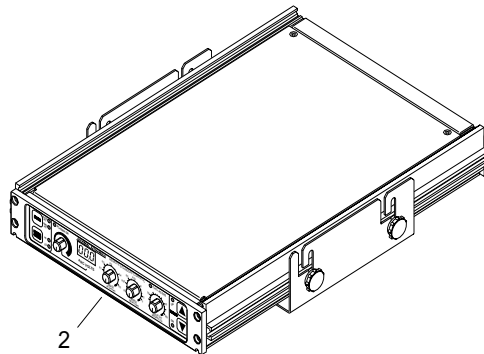
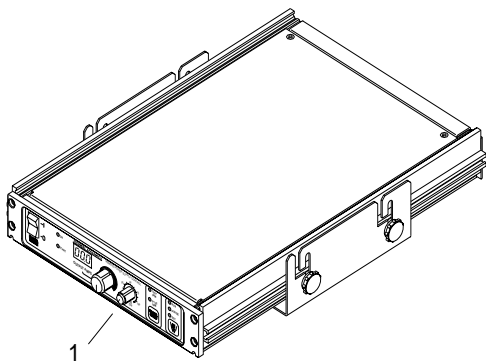
Item #	Qty.	Description	Catalog #
1	1	Main Heatsink	9-1404
2	4	Capacitor, 550 mfd, 400VDC	9-1303
3	1	Bracket, Capacitor/Heatsink	8-4521
4	1	Support, Air Foil	8-2176
5	2	Capacitor Clamp	9-4212
6	1	Support, Heatsink Assembly	9-1304
7	1	Thermstrate, Transistor	9-1406
8	1	Transistor, 300A, 550V Darlington (Refer to Section 6.08 Item #2)	8-6154
9	2	Capacitor, 10 mfd, 400V Poly., Hi-Current	9-1305
10	1	Bracket, Capacitor Mounting	8-6314
11	1	70 Amp STR. Diode Replacement Kit Includes:	8-1168
	8	Diode, 70A, 600V STR Fast	
	8	Thermal Interface Pad .75 Dia	
12	2	Capacitor, 15 $\mu$ f, 630V Poly., Hi-Current	9-1408
13	1	Suppression Coil Assembly	9-1409
14	1	Bracket, Diode Lead	8-6316
15	1	Assembly, Heatsink Suppression PC Board	9-1410
16	1	Support, Capacitor Bracket/PC Board	8-6315
17	3	Resistor, 100 Ohm, 100W Style J	9-1405
18	1	Internal Wire Assembly Package	8-4522
19	2	Resistor, 3k Ohm, 100W Style J	8-6677
20	1	Relay Socket	9-2731
21	1	Relay - DPDT, 110 VDC	9-5256
22	1	Plate, Negative Diode	8-6675
23	1	Plate, Positive Diode	8-6674
24	1	Diode Suppression PC Board Assembly	8-6155
25	1	150 Amp REV Diode Replacement Kit Includes:	8-6153
	3	Diode, 150 Amp, 800V, REV.	
	6	Thermal, Interface Pad 1.06 Dia.	
26	1	150 Amp STR Diode Replacement Kit Includes:	8-6152
	3	Diode, 150 Amp, 800V, STR.	
	6	Thermal, Interface Pad 1.06 Dia.	
27	1	Assembly, PTC Resistor	8-4523
28	1	Relay Hold-Down Spring	9-4297
29	1	Bracket, Transistor/Coil	8-6676
30	1	Harness Assembly, Transistor	8-6313
31	1	Standoff, 3/8 Hex Nylon	8-5147
32	10	Washer, Fiber Shoulder	8-6678
33	1	Shunt, 250A, 100 mV	9-4392
34	1	Shunt Amp PC Board Assembly	9-4391



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## 6.10 Power Supply Options And Accessories

Item #	Qty.	Description	Catalog #
1	1	Remote Control (RC6010)	3-6106
2	1	Standoff Control (SC10)	3-6110
3	1	Gas Control (GC3000)	7-3411
4	1	Air Line Filter Assembly	7-3139
5	1	Replacement First Stage Filter Element	9-1021
6	1	Replacement Second Stage Filter Element	9-1022
7		Gas Regulators	
	1	Nitrogen Regulator	9-2722
	1	CO2 Regulator	9-2759
	1	Argon/Hydrogen Regulator	9-3053
8	1	Oxygen Regulator	9-4379
9	1	Water Regulator	8-6118
10	1	Remote Pendant Control Assembly	7-3114
11	1	Switch - for Remote Pendant	9-4229
12	1	Cord Grip - for Remote Pendant	9-4228
13	1	Handle Only - for Remote Pendant	8-1662
14	1	14-pin Plug - for Remote Pendant	9-3294
15	3	Pin - for Remote Pendant Plug	8-4524
16	1	Cable Clamp - for Remote Pendant	9-3295
17	1	Remote Pendant Adapter	9-4393
The following are not shown:			
	1	Plasma Gas Supply Line - 10 ft (3.0 m)	9-2146
	1	Secondary Gas Supply Line - 10 ft (3.0 m)	9-2147
	1	High Pressure Air Regulator	9-3022
	1	High-Flow Water Shield	
		220V Version	7-2984-1
		460V Version	7-2984-2
		Remote Control Cable	
	1	25 ft (7.6 m)	9-5961
	1	50 ft (15.2 m)	9-5962
	1	75 ft (22.8m)	9-5963
	1	100 ft (30.4m)	9-5964
		Remote Control (RC6010) CNC Interface Cable	
	1	5 ft (1.5 m)	9-4483
	1	10 ft (3.0 m)	9-4484
	1	15 ft (4.5 m)	9-4485
	1	20 ft (6 m)	9-4486
		Standoff Control Lifter Motor Control Cable	
	1	10 ft (3.0 m)	9-4535
	1	15 ft (4.5 m)	9-4536
	1	20 ft (6 m)	9-4537
		Power Supply CNC Interface Cable	
	1	25 ft (7.6 m)	8-3380
	1	50 ft (15.2 m)	8-3381
	1	75 ft (22.8m)	8-3382
	1	100 ft (30.4m)	8-3383
	1 gal	Torch Coolant	
		Standard 25/75 Mix for Ambient Temperatures to +10°F (-12°C)	7-2850
		Super 50/50 Mix for Ambient Temperatures to -34°F (-36°C)	7-2959



A-01218



# APPENDIX I: INPUT WIRING REQUIREMENTS

Input		Power Input	Current	Suggested Sizes (See Notes)		
Voltage (Volts)	Freq. (Hz)	3-Ph (kVA)	3-Ph (Amps)	Fuse (Amps) 3-Ph	Wire (AWG) 3-Ph	Wire (Canada) 3-Ph
200	50/60	34	98	110	AWG 2	2
208	50/60	34	95	110	AWG 2	2
220	50/60	34	89	100	AWG 2	2
230	50/60	34	85	100	AWG 4	2
380	50/60	34	51	60	AWG 6	6
415	50/60	34	47	60	AWG 8	6
460	50/60	34	42	50	AWG 8	6
506	50/60	34	40	45	AWG 8	6
575	50/60	34	34	40	AWG 8	6

Line Voltages with Suggested Circuit Protection and Wire Sizes  
Based on National Electric Code and Canadian Electrical Code

## NOTES

*Refer to Local and National Codes or local authority having jurisdiction for proper wiring requirements.*

*Cable size is de-rated based on the Duty Cycle of the equipment.*

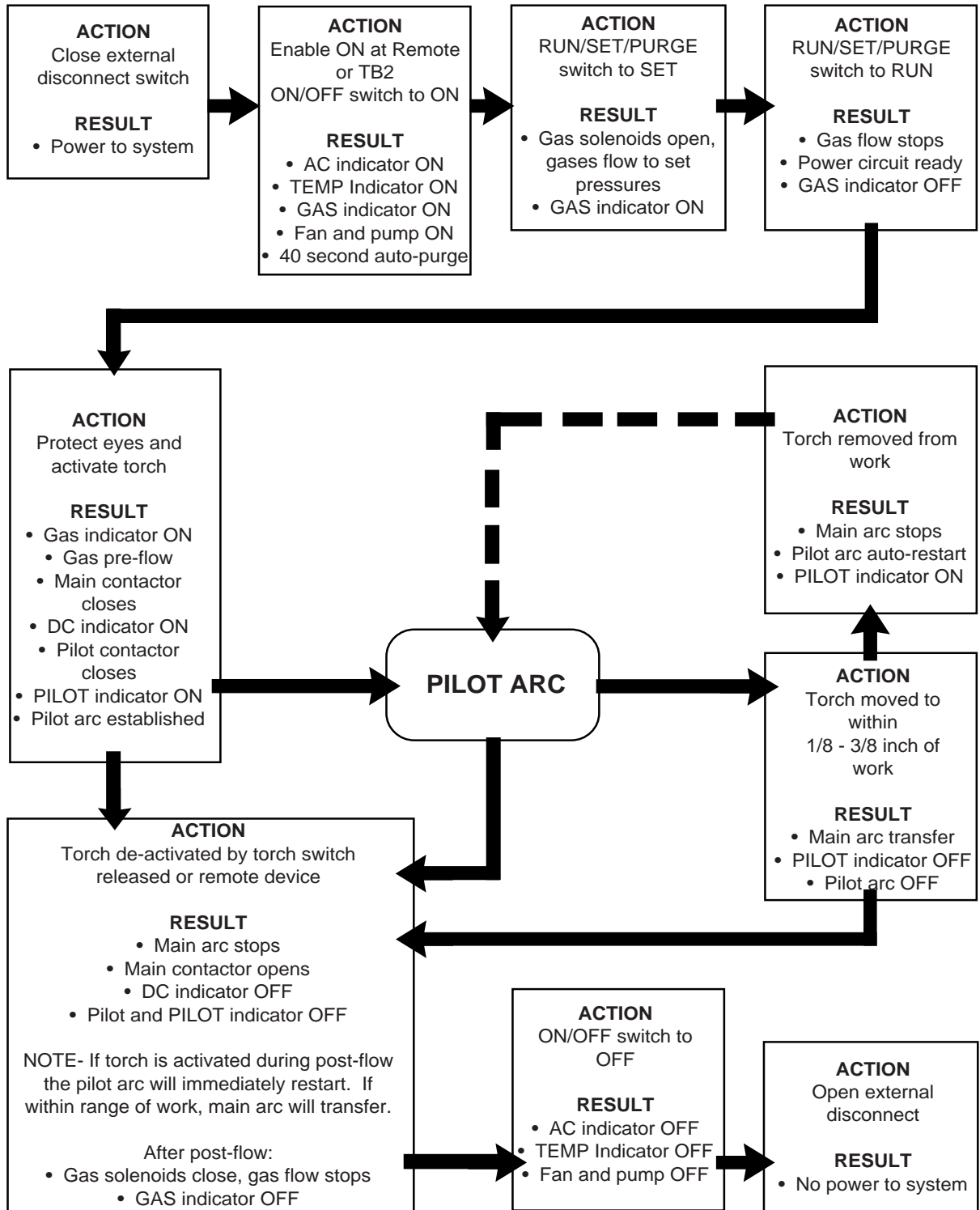
*The suggested sizes are based on flexible power cable with power plug installations. For hard-wired installations refer to local or national codes.*

*Cable conductor temperature used is 167° F (75° C).*

*An energy limiting fuse UL Class RK-1 (examples: BUSS LPS/LPN-RK or Gould-Shawmut AZK-A6K) should be used to minimize damage to Plasma Cutting, Welding or power distribution equipment.*

**NEVER** use replaceable element fuses like UL Class H, or "one-time" fuses like UL Class K5.

# APPENDIX II: SEQUENCE OF OPERATION BLOCK DIAGRAM

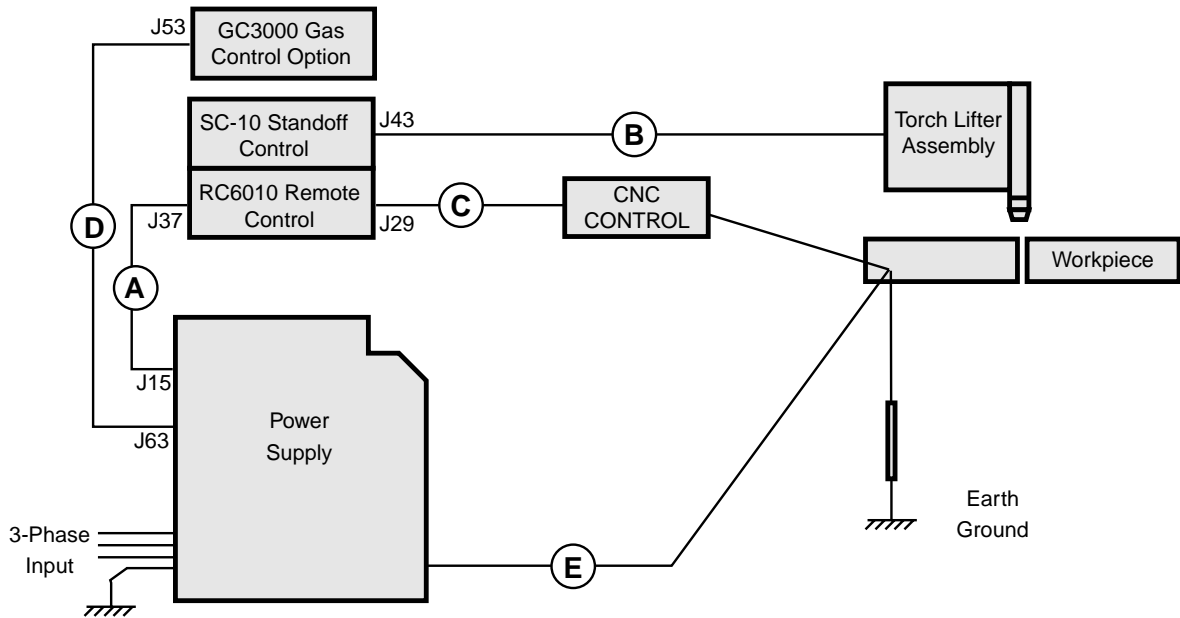


A-01016

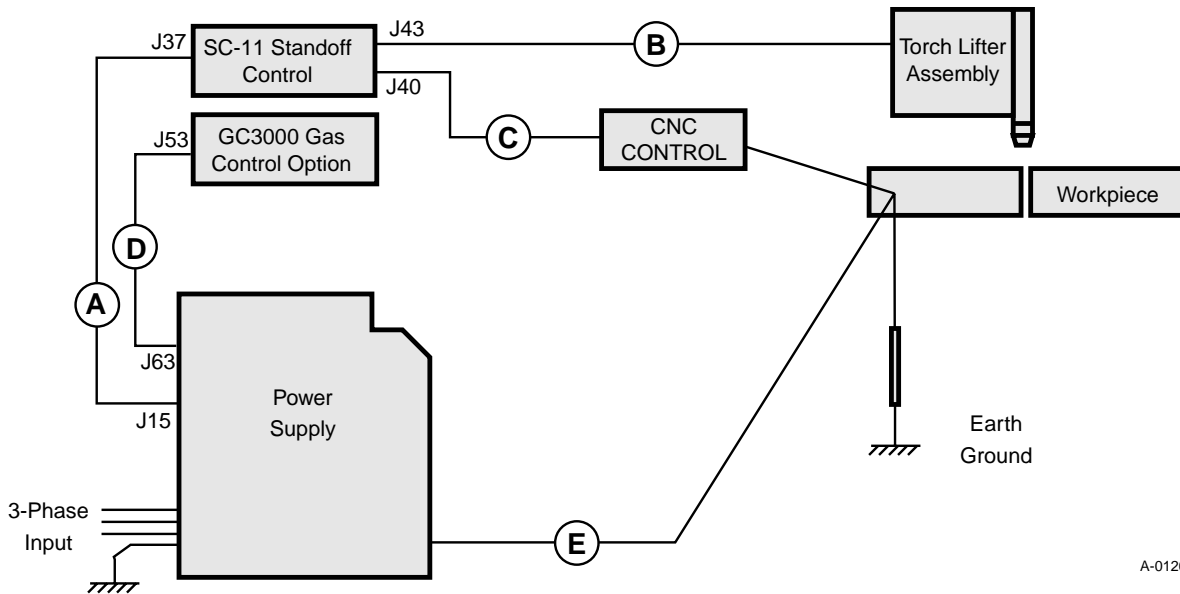


# APPENDIX III: TYPICAL MECHANIZED SYSTEM CABLE CONNECTIONS

System With Remote Control RC6010, Standoff Control SC10 And Gas Control GC3000



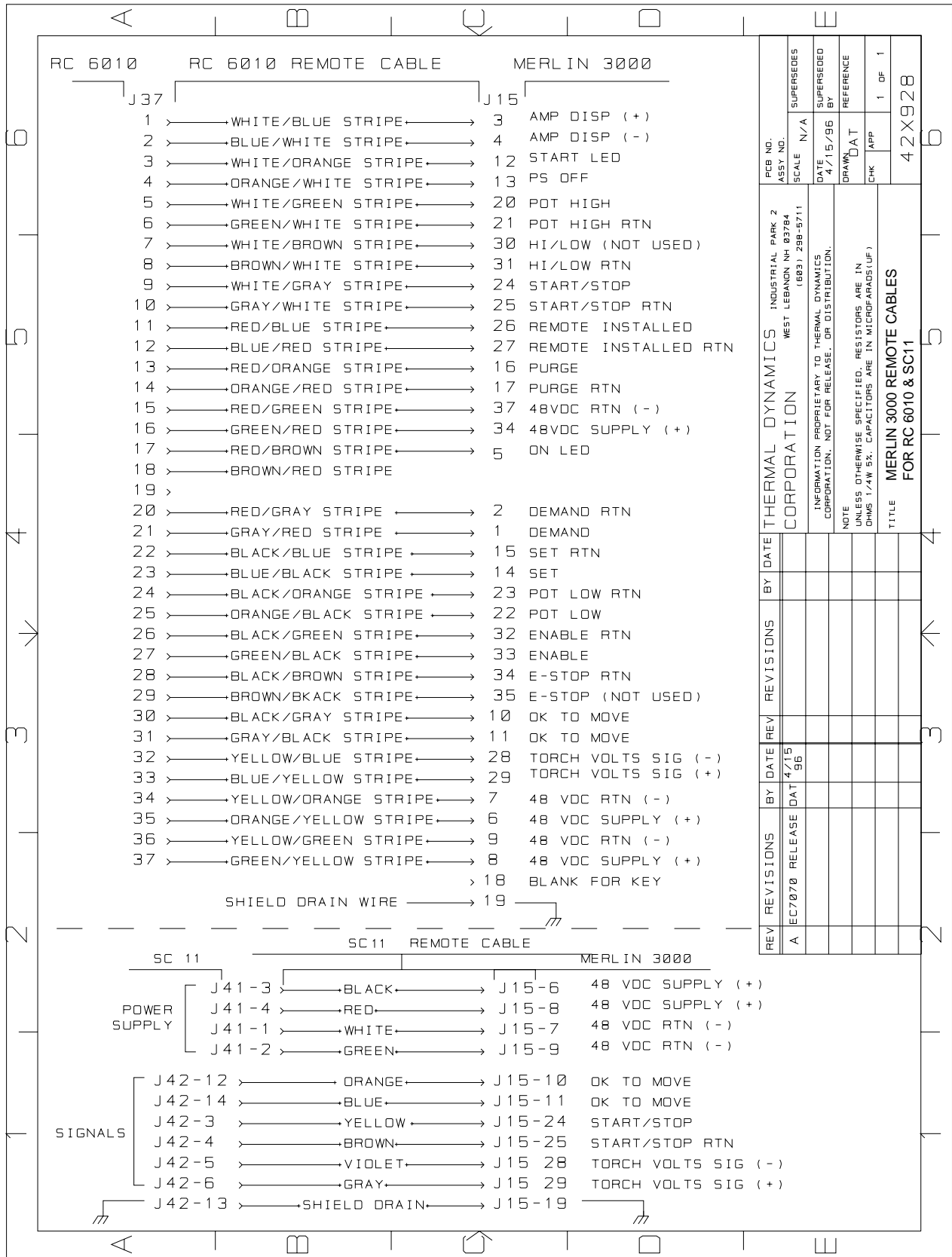
System With Standoff Control SC11 And Gas Control GC3000



A-01261

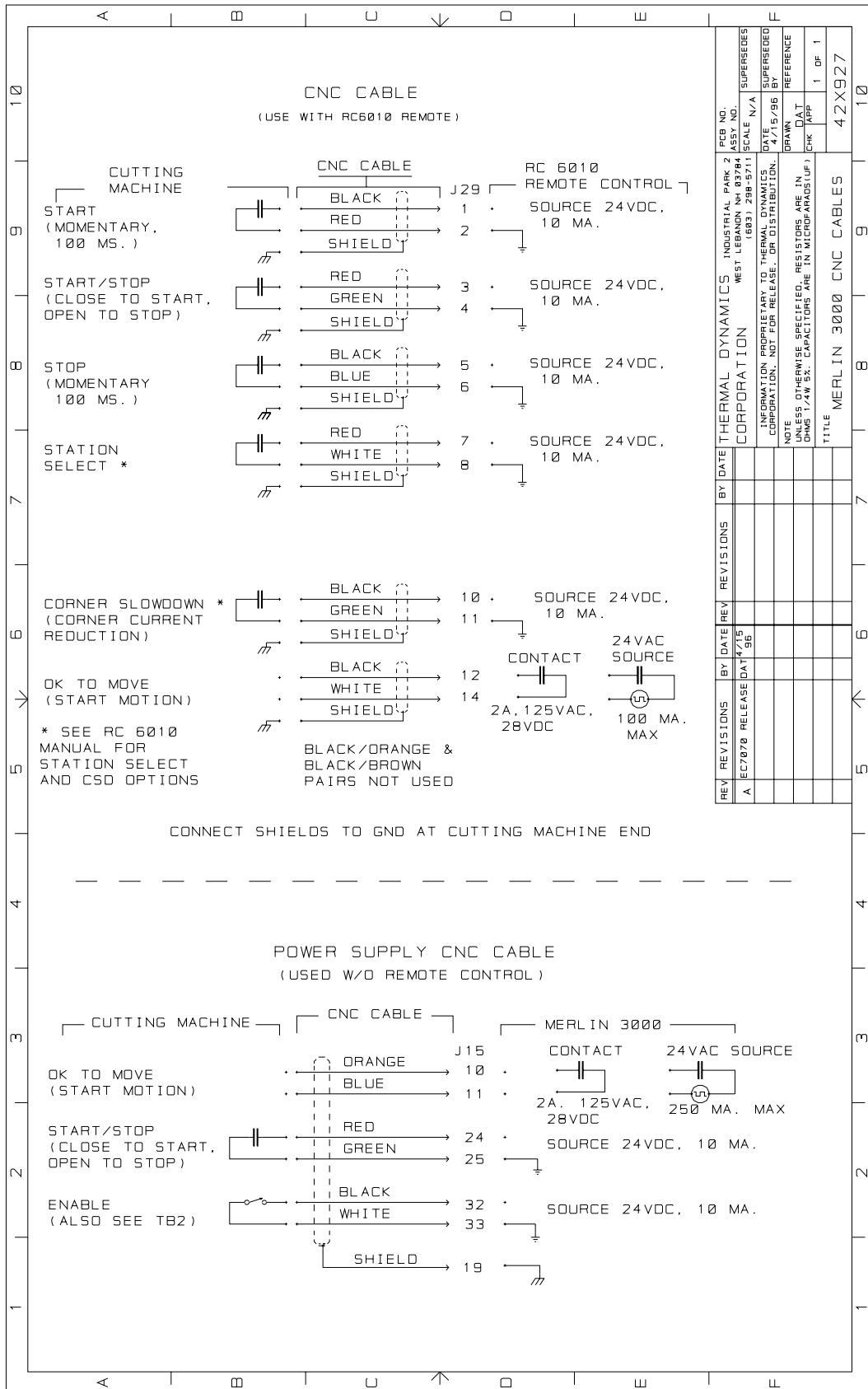
Cable Description	Letter Designation
Power Supply to Remote Control	A
Standoff Control to Torch Lifter Assembly	B
Remote Control to CNC Control	C
Power Supply to Gas Control	D
Power Supply Work Cable to Workpiece	E

# APPENDIX IV: INTERFACE CABLES FOR REMOTE CONTROL (RC6010) AND STANDOFF CONTROL (SC11)



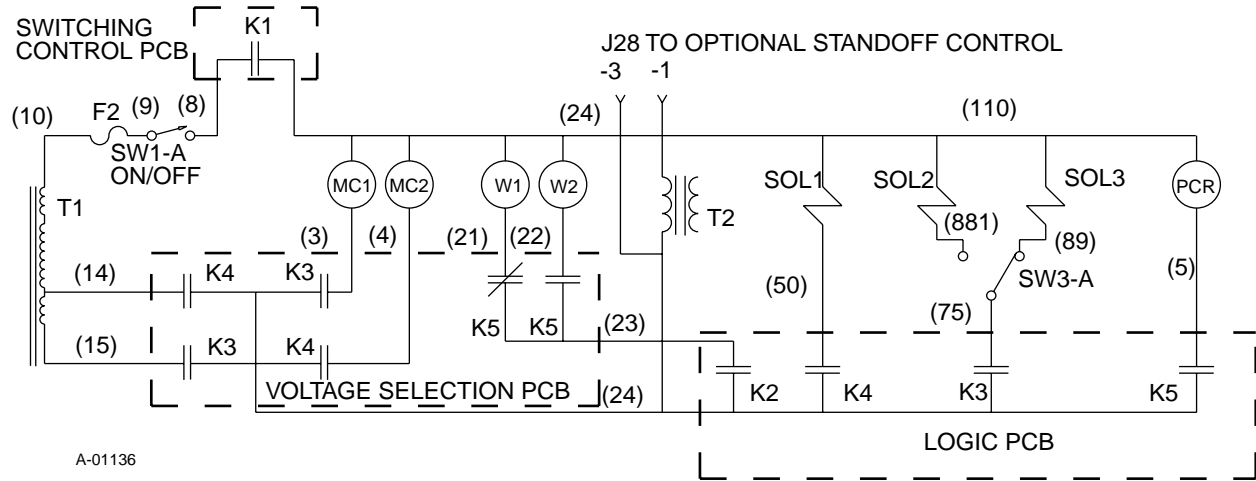
A-00983

# APPENDIX V: CNC INTERFACE

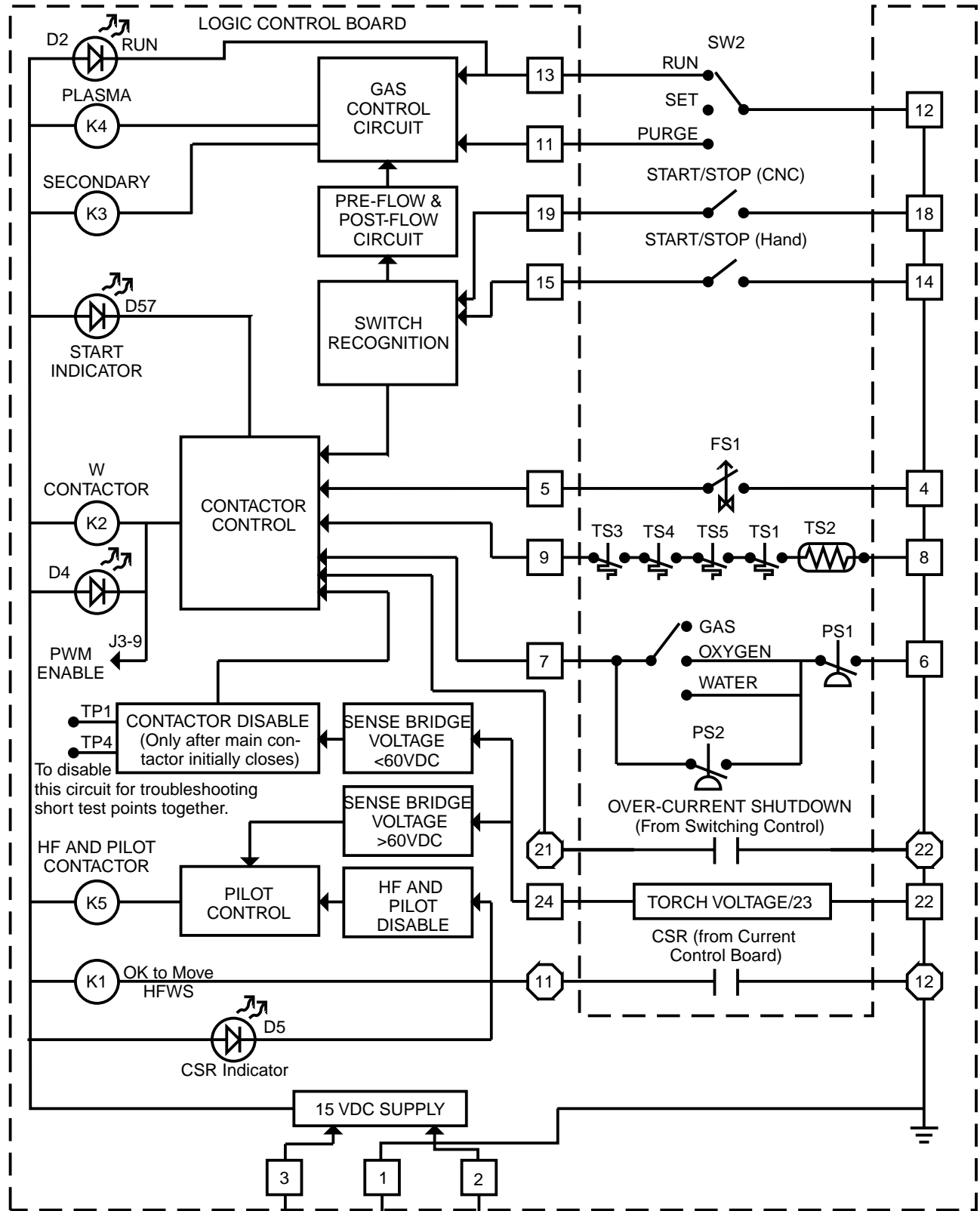


A-00982

# APPENDIX VI: 120 VAC CIRCUIT DIAGRAM



# APPENDIX VII: LADDER DIAGRAM - 15 VDC



□ REFERENCES J1 CONNECTOR

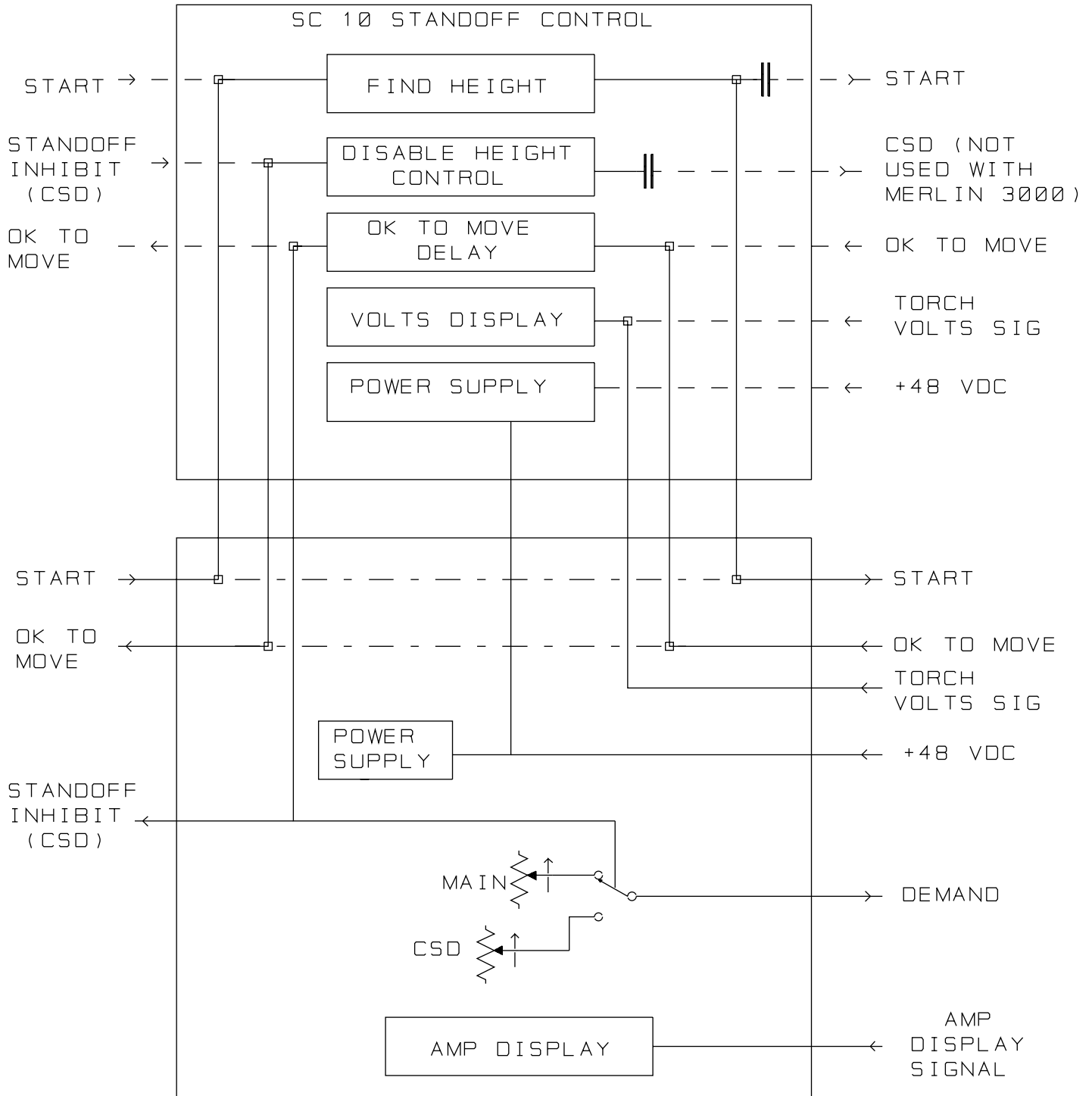
○ REFERENCES J3 CONNECTOR

A-01013

# APPENDIX VIII: SIGNAL FLOW BLOCK DIAGRAM

## SC 10 / RC 6010 SIGNAL FLOW BLOCK DIAGRAM

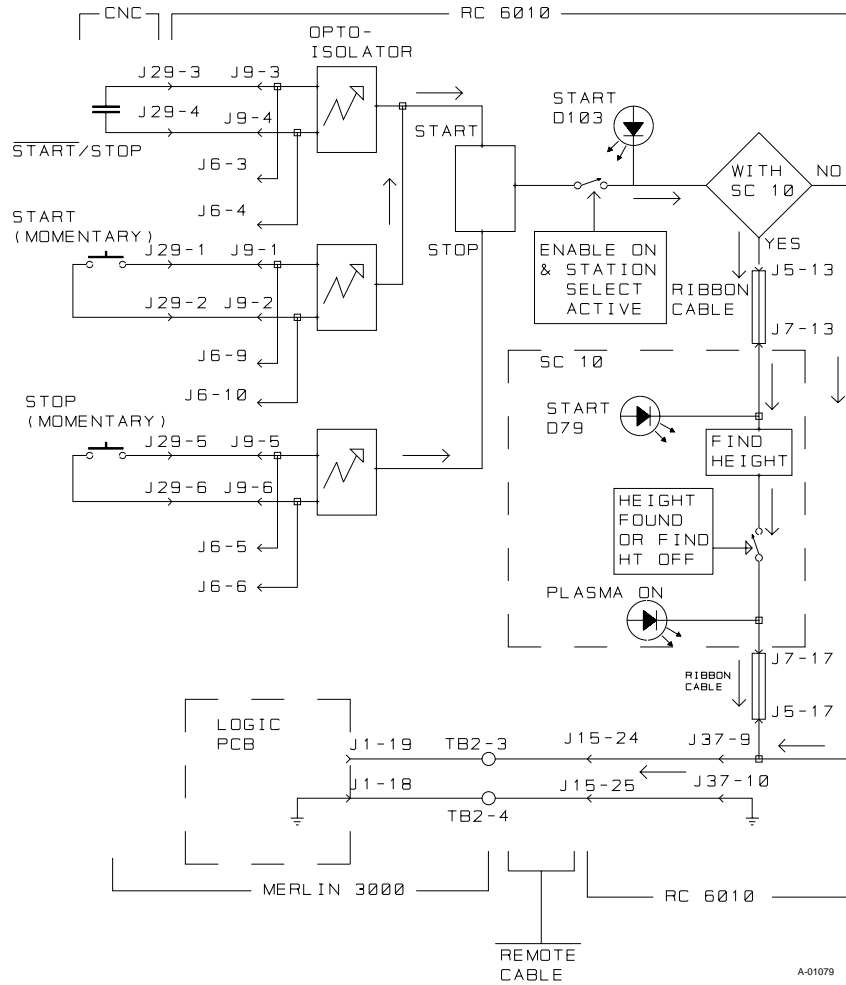
\_\_\_\_\_ SIGNALS WITH SC 10 + RC 6010  
 - - - - - SIGNALS WITH SC 10 ONLY  
 - - - - - SIGNALS WITH RC 6010 ONLY



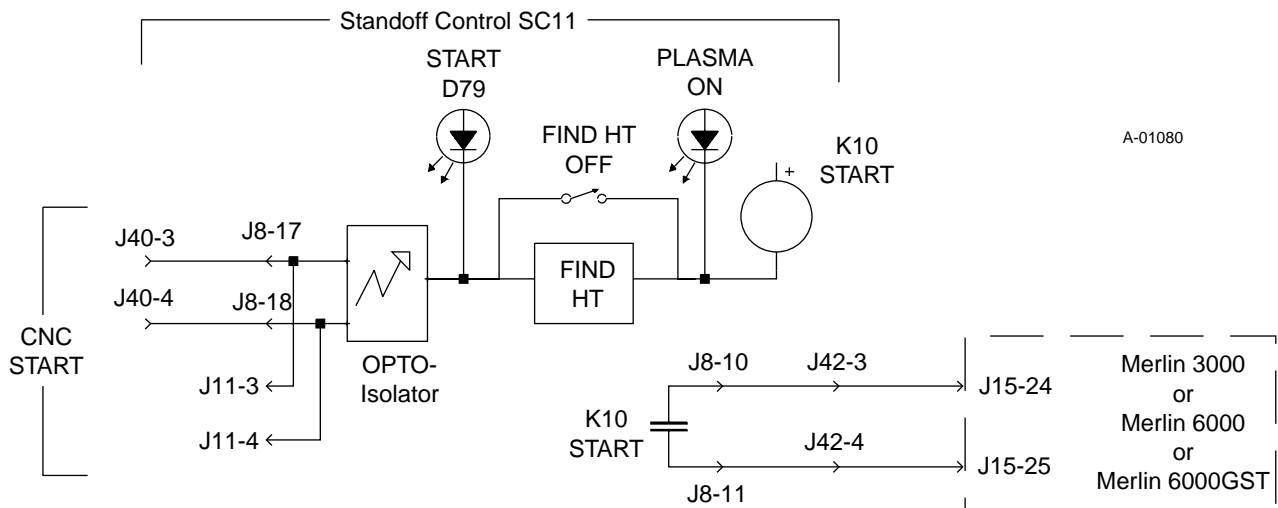
A-01139

# APPENDIX IX: START CIRCUIT DIAGRAM

RC 6010/SC 10/MERLIN 3000 START CIRCUIT



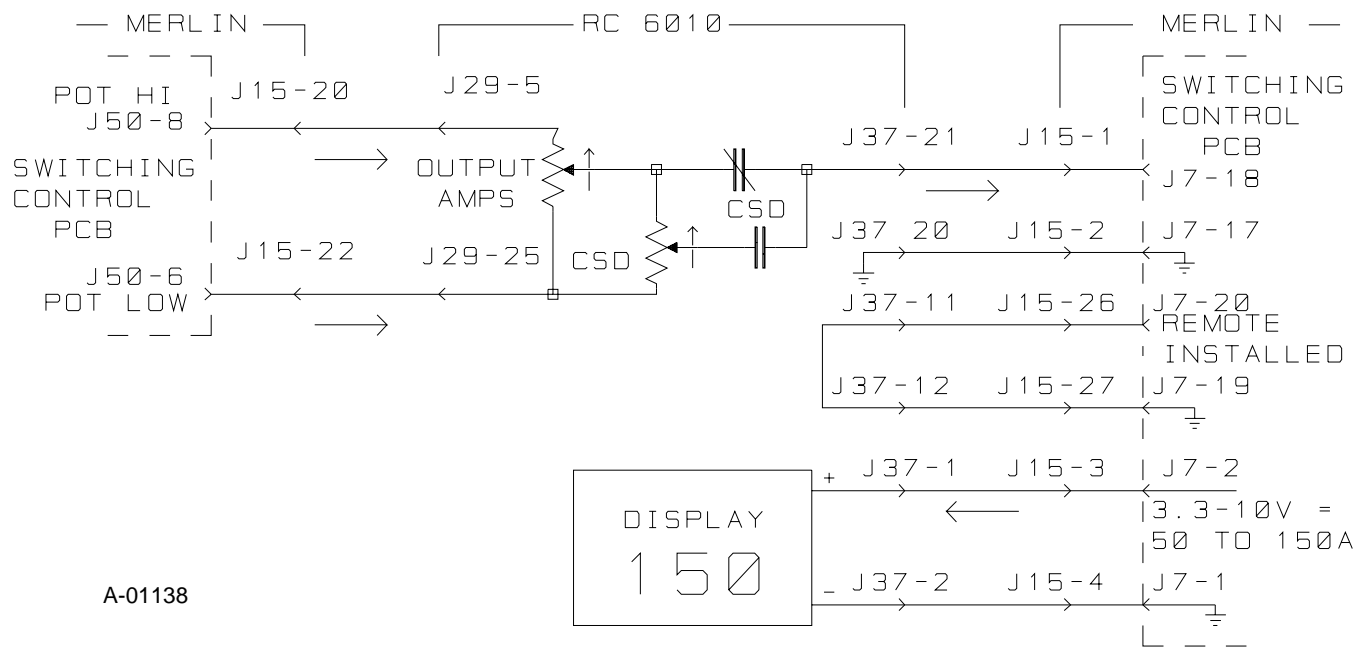
A-01079



A-01080

# APPENDIX X: CURRENT CONTROL / DISPLAY CIRCUIT DIAGRAM

## CURRENT CONTROL / DISPLAY CIRCUITS

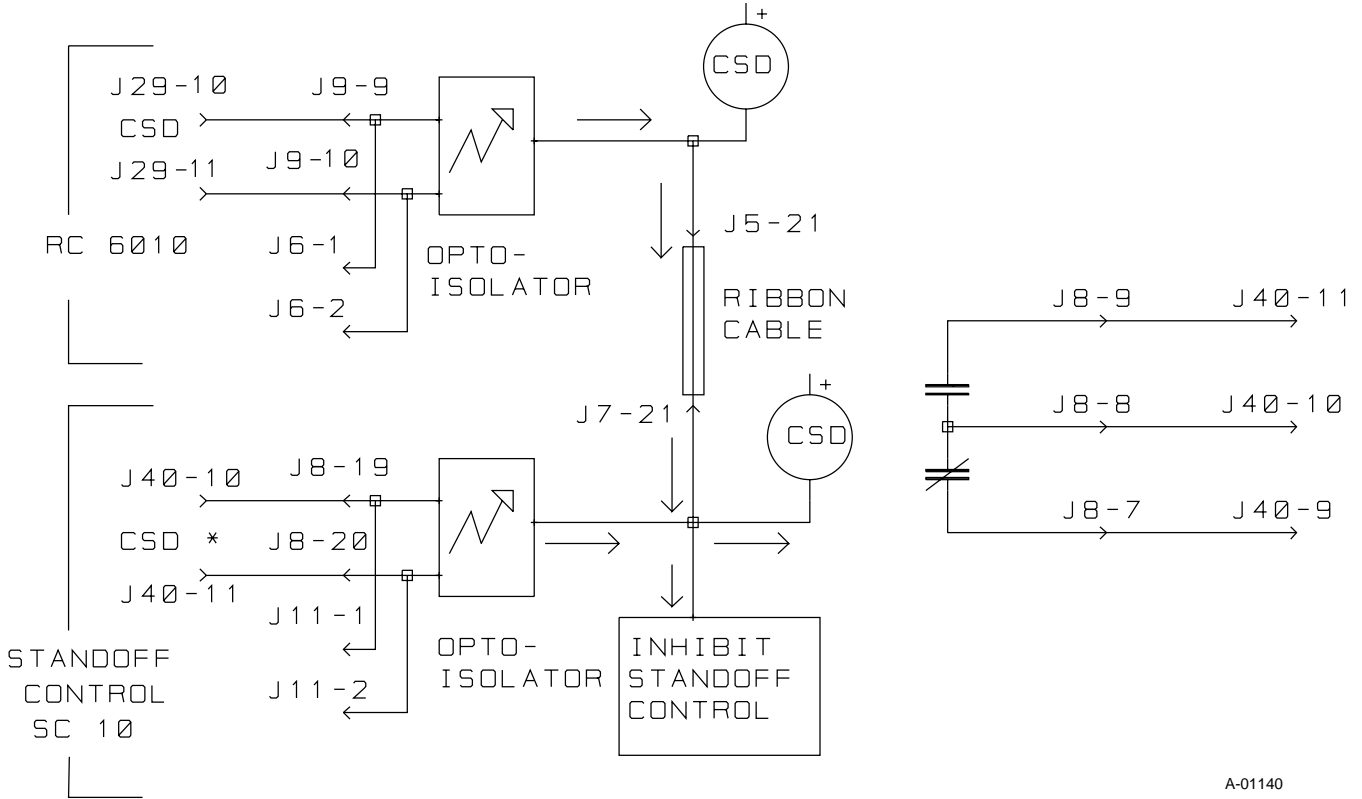


A-01138



# APPENDIX XI: CSD (CORNER SLOWDOWN) CIRCUIT DIAGRAM

## CSD CIRCUITS

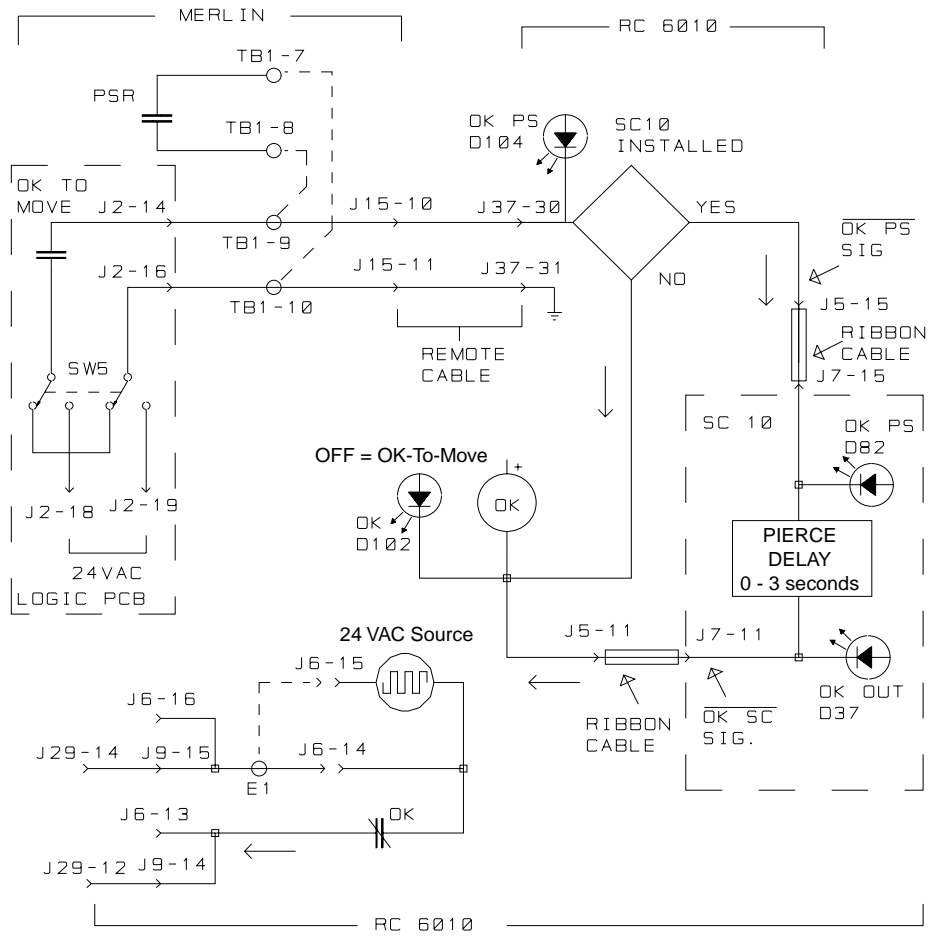


\* USED ONLY WITH STANDOFF CONTROL SC 11

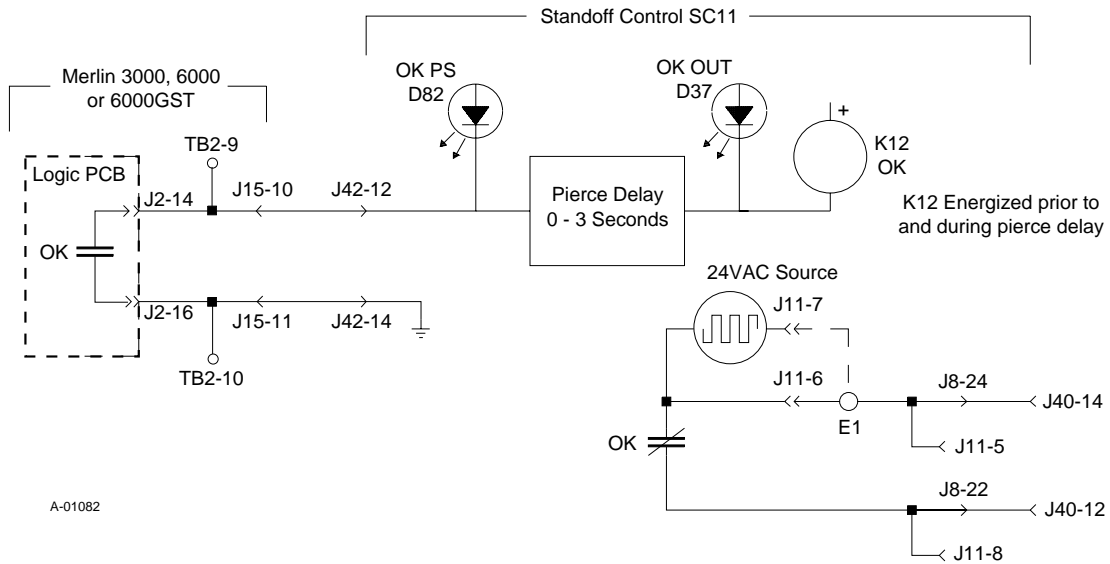
A-01140

# APPENDIX XII: OK-TO-MOVE CIRCUIT DIAGRAM

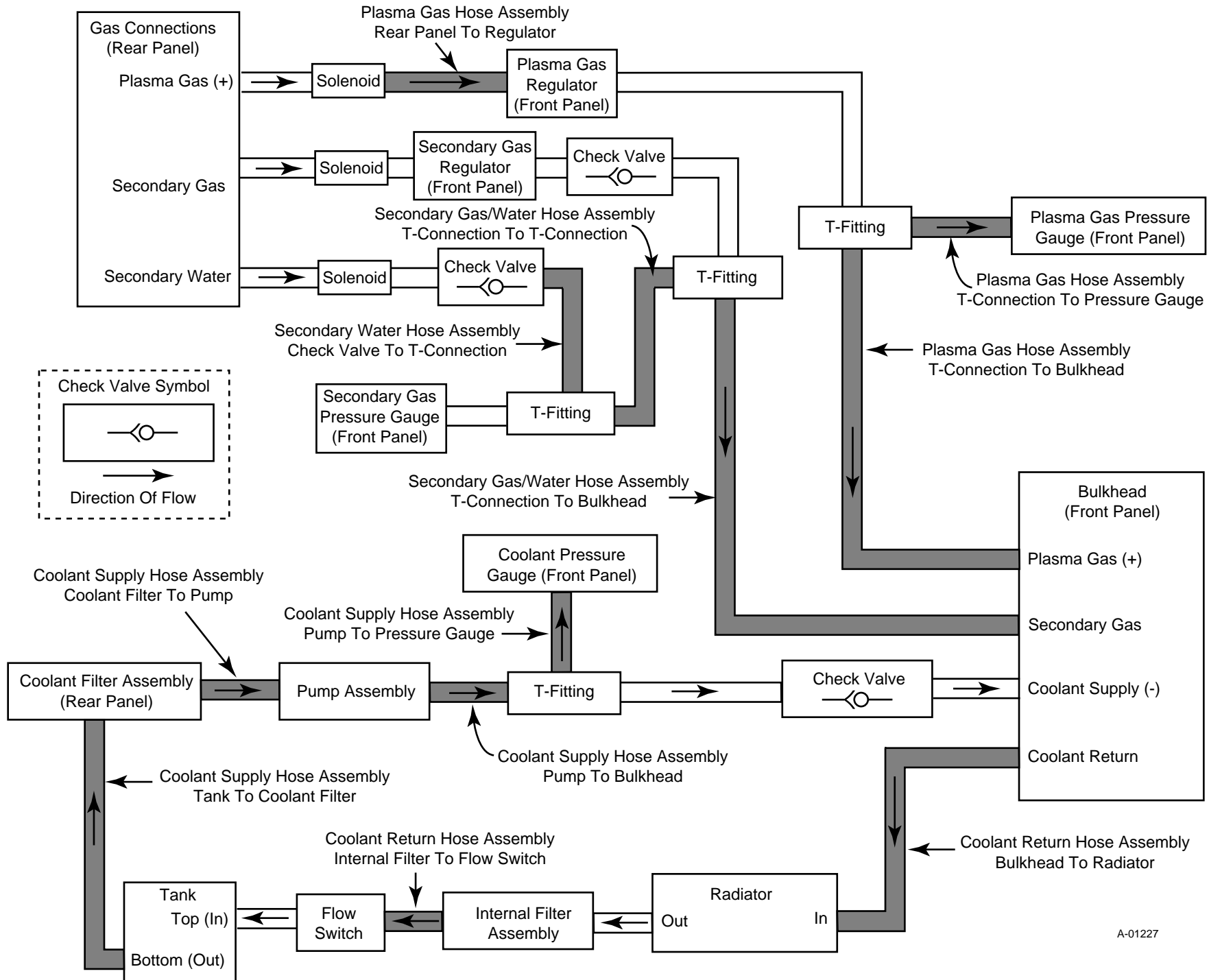
Merlin 3000 or Merlin 6000 or Merlin 6000GST with  
Remote Control RC6010 / Standoff Control SC10  
OK-To-Move Circuit



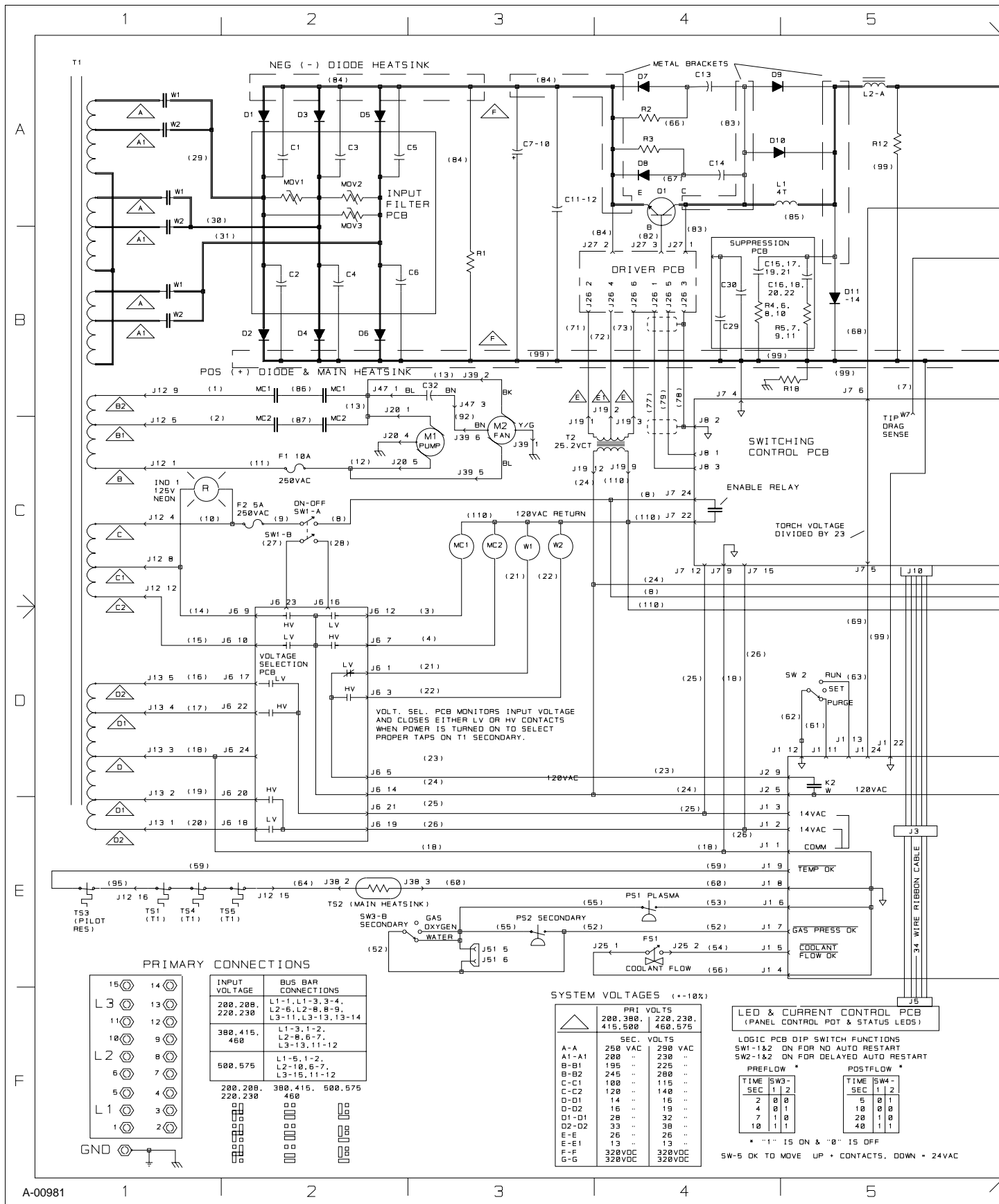
A-01081

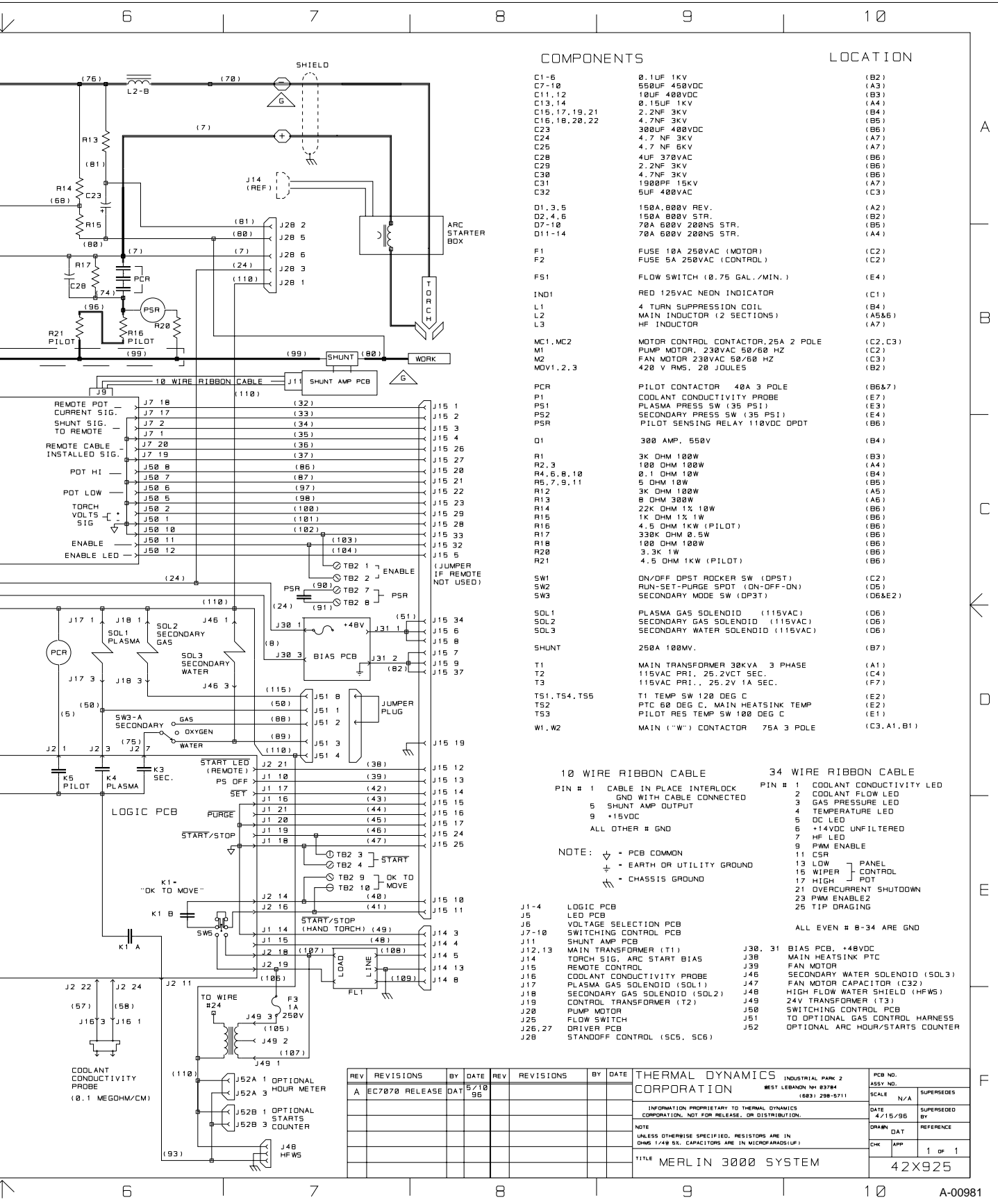


A-01082



# APPENDIX XIV: SYSTEM SCHEMATIC





COMPONENTS

LOCATION

- C1-6 0.1UF 1KV (B2)
- C7-10 550UF 450VDC (A3)
- C11,12 10UF 400VDC (B3)
- C13,14 0.15UF 1KV (A4)
- C15,17,19,21 2.2NF 3KV (B4)
- C16,18,20,22 4.7NF 3KV (B5)
- C23 300UF 400VDC (B6)
- C24 4.7 NF 3KV (A7)
- C25 4.7 NF 6KV (A7)
- C28 4UF 370VAC (B6)
- C29 2.2NF 3KV (B6)
- C30 4.7NF 3KV (B6)
- C31 1900PF 15KV (A7)
- C32 5UF 400VAC (C3)
- D1,3,5 150A 800V REV. (A2)
- D2,4,6 150A 800V STR. (B2)
- D7-10 70A 600V 200NS STR. (B5)
- D11-14 70A 600V 200NS STR. (A4)
- F1 FUSE 10A 250VAC (MOTOR) (C2)
- F2 FUSE 5A 250VAC (CONTROL) (C2)
- FS1 FLOW SWITCH (0.75 GAL./MIN.) (E4)
- IND1 RED 125VAC NEON INDICATOR (C1)
- L1 4 TURN SUPPRESSION COIL (B4)
- L2 MAIN INDUCTOR (2 SECTIONS) (A5&6)
- L3 HF INDUCTOR (A7)
- MC1,MC2 MOTOR CONTROL CONTACTOR,25A 2 POLE (C2,C3)
- M1 PUMP MOTOR, 230VAC 50/60 HZ (C2)
- M2 FAN MOTOR 230VAC 50/60 HZ (C3)
- MOV1,2,3 420 V RMS, 20 JOULES (B2)
- PCR PILOT CONTACTOR 40A 3 POLE (B6&7)
- P1 COOLANT CONDUCTIVITY PROBE (E7)
- PS1 PLASMA PRESS SW (35 PS1) (E3)
- PS2 SECONDARY PRESS SW (35 PS1) (E4)
- PSR PILOT SENSING RELAY 110VDC DPDT (B6)
- Q1 300 AMP, 550V (B4)
- R1 3K OHM 100W (B3)
- R2,3 100 OHM 100W (A4)
- R4,5,8,10 0.1 OHM 10W (B4)
- R5,7,9,11 5 OHM 10W (B5)
- R12 3K OHM 100W (A5)
- R13 8 OHM 300W (A6)
- R14 22K OHM 1/2 10W (B5)
- R15 1K OHM 1/2 1W (B6)
- R16 4.5 OHM 1KW (PILOT) (B6)
- R17 330K OHM 0.5W (B6)
- R18 100 OHM 100W (B6)
- R20 3.3K 1W (B6)
- R21 4.5 OHM 1KW (PILOT) (B6)
- SW1 ON/OFF DPST ROCKER SW (DPST) (C2)
- SW2 RUN-SET-PURGE SPDT (ON-OFF-ON) (C5)
- SW3 SECONDARY MODE SW (DP3T) (D6&E2)
- SOL1 PLASMA GAS SOLENOID (115VAC) (D6)
- SOL2 SECONDARY GAS SOLENOID (115VAC) (D6)
- SOL3 SECONDARY WATER SOLENOID (115VAC) (D6)
- SHUNT 250A 100MV. (B7)
- T1 MAIN TRANSFORMER 30KVA 3 PHASE (A1)
- T2 115VAC PRI., 25.2VCT SEC. (C4)
- T3 115VAC PRI., 25.2V 1A SEC. (F7)
- TS1, TS4, TS5 T1 TEMP SW 120 DEG C (E2)
- TS2 PTC 60 DEG C, MAIN HEATSINK TEMP (E2)
- TS3 PILOT RES TEMP SW 100 DEG C (E1)
- W1,W2 MAIN ("W") CONTACTOR 75A 3 POLE (C3,A1,B1)

10 WIRE RIBBON CABLE

- PIN # 1 CABLE IN PLACE INTERLOCK
- 2 GND WITH CABLE CONNECTED
- 3 SHUNT AMP OUTPUT
- 4 +15VDC
- 5 ALL OTHER # GND

34 WIRE RIBBON CABLE

- PIN # 1 COOLANT CONDUCTIVITY LED
- 2 COOLANT FLW LED
- 3 GAS PRESSURE LED
- 4 TEMPERATURE LED
- 5 DC LED
- 6 +14VDC UNFILTERED
- 7 HF LED
- 8 PWM ENABLE
- 9 CSR
- 10 LOW
- 11 WIPER
- 12 HIGH
- 13 POT
- 14 OVERCURRENT SHUTDOWN
- 15 PWM ENABLE 2
- 16 TIP DRAGING

NOTE: ▽ - PCB COMMON  
 ⊕ - EARTH OR UTILITY GROUND  
 ⊞ - CHASSIS GROUND

- J1-4 LOGIC PCB
- J5 LED PCB
- J6 VOLTAGE SELECTION PCB
- J7-10 SWITCHING CONTROL PCB
- J11 SHUNT AMP PCB
- J12,13 MAIN TRANSFORMER (T1)
- J14 TORCH SIG, ARC START BIAS
- J15 REMOTE CONTROL
- J16 COOLANT CONDUCTIVITY PROBE
- J17 PLASMA GAS SOLENOID (SOL1)
- J18 SECONDARY GAS SOLENOID (SOL2)
- J19 CONTROL TRANSFORMER (T2)
- J20 PUMP MOTOR
- J25 FLOW SWITCH
- J26,27 DRIVER PCB
- J28 STANDOFF CONTROL (SC5, SC6)
- J30,31 BIAS PCB, +48VDC
- J38 MAIN HEATSINK PTC
- J39 FAN MOTOR
- J45 SECONDARY WATER SOLENOID (SOL3)
- J47 FAN MOTOR CAPACITOR (C32)
- J48 HIGH FLOW WATER SHIELD (HFWS)
- J49 24V TRANSFORMER (T3)
- J50 SWITCHING CONTROL PCB
- J51 TO OPTIONAL GAS CONTROL HARNESS
- J52 OPTIONAL ARC HOUR/STARTS COUNTER

REV	REVISIONS	BY	DATE	REV	REVISIONS	BY	DATE
A	EC7070 RELEASE	DAT	5/18/96				

THERMAL DYNAMICS CORPORATION		INDUSTRIAL PARK 2 WEST LEBANON, NH 03784 (603) 298-9711	
SCALE	N/A	SUPERSEDES	
DATE	4/15/96	SUPERSEDED BY	
DRAWN	DAT	REFERENCE	
CHK	APP	1 OF 1	
TITLE MERLIN 3000 SYSTEM			

# APPENDIX XV: RECOMMENDED ROUTINE MAINTENANCE SCHEDULE FOR LIQUID COOLED PLASMA CUTTING SYSTEMS

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This schedule applies to all types of liquid cooled plasma cutting systems. Some systems will not have all the parts listed and those checks need not be performed.

## **NOTE**

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*The actual frequency of maintenance may need to be adjusted according to the operating environment.*

### **Daily Operational Checks or Every Six Arc Hours:**

1. Check torch parts, replace if damaged.
2. Check plasma and secondary supply and pressure/flow.
3. Purge plasma gas line to remove any moisture build-up.
4. Check deionizer bag/cartridge, replace if color is predominantly yellow.
5. Check coolant pressure (100 - 120 psi).

### **Weekly or Every 30 Arc Hours:**

1. Blow or vacuum dust and dirt out of the entire machine.

### **Six Months or Every 720 Arc Hours:**

1. Remove and clean in-line filter screens.
2. Check cables and hoses for leaks or cracks, replace if necessary.
3. Check all contactor points for severe arcing or pits, replace if necessary.
4. Check all pillow blocks and bearings, clean and lubricate if necessary.
5. Check fan, pump and pulley belts for wear or cracking, replace if necessary.

### **Twelve Months or Every 1500 Arc Hours:**

1. Drain coolant, fill with distilled water, turn on main power switch and let machine run for approximately 30 minutes.



**WARNING**

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*DO NOT energize the Torch.*

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Drain distilled water and replace with Thermal Arc Coolant. Use Standard Mix Coolant (Catalog # 7-2850) or Super Mix Coolant (Catalog # 7-2959) for environments below +10° F (-12° C).

2. Check radiator fins, clean and comb out if necessary.
3. Repeat six month maintenance.