

Hypertherm®

powermax65®

powermax85®

Plasma arc cutting systems



Service Manual – 807120
Revision 1

Register your new Hypertherm system

Register your product on-line at **www.hypertherm.com/registration** for easier technical and warranty support. You can also receive updates on new Hypertherm products and a free gift as a token of our appreciation.

For your records

Serial number: _____

Purchase date: _____

Distributor: _____

Maintenance notes:

powermax65

powermax85

Service Manual

English / English

Revision 1 – December 2012

Hypertherm, Inc.
Hanover, NH USA
www.hypertherm.com
email: info@hypertherm.com

© 2012 Hypertherm, Inc.
All Rights Reserved

Hypertherm and Powermax are trademarks of Hypertherm, Inc.
and may be registered in the United States and/or other countries.

Hypertherm, Inc.

Etna Road, P.O. Box 5010

Hanover, NH 03755 USA

603-643-3441 Tel (Main Office)

603-643-5352 Fax (All Departments)

info@hypertherm.com (Main Office Email)

800-643-9878 Tel (Technical Service)

technical.service@hypertherm.com (Technical Service Email)

800-737-2978 Tel (Customer Service)

customer.service@hypertherm.com (Customer Service Email)

866-643-7711 Tel (Return Materials Authorization)**877-371-2876 Fax (Return Materials Authorization)**

return.materials@hypertherm.com (RMA email)

Hypertherm Plasmatechnik GmbH

Technologiepark Hanau

Rodenbacher Chaussee 6

D-63457 Hanau-Wolfgang, Deutschland

49 6181 58 2100 Tel

49 6181 58 2134 Fax

49 6181 58 2123 (Technical Service)**Hypertherm (S) Pte Ltd.**

82 Genting Lane

Media Centre

Annexe Block #A01-01

Singapore 349567, Republic of Singapore

65 6841 2489 Tel

65 6841 2490 Fax

65 6841 2489 (Technical Service)**Hypertherm (Shanghai) Trading Co., Ltd.**

Unit 301, South Building

495 ShangZhong Road

Shanghai, 200231

PR China

86-21-60740003 Tel

86-21-60740393 Fax

Hypertherm Europe B.V.

Vaartveld 9

4704 SE

Roosendaal, Nederland

31 165 596907 Tel

31 165 596901 Fax

31 165 596908 Tel (Marketing)

31 165 596900 Tel (Technical Service)**00 800 4973 7843 Tel (Technical Service)****Hypertherm Japan Ltd.**

Level 9, Edobori Center Building

2-1-1 Edobori, Nishi-ku

Osaka 550-0002 Japan

81 6 6225 1183 Tel

81 6 6225 1184 Fax

Hypertherm Brasil Ltda.

Rua Bras Cubas, 231 – Jardim Maia

Guarulhos, SP - Brasil

CEP 07115-030

55 11 2409 2636 Tel

55 11 2408 0462 Fax

Hypertherm México, S.A. de C.V.

Avenida Toluca No. 444, Anexo 1,

Colonia Olivar de los Padres

Delegación Álvaro Obregón

México, D.F. C.P. 01780

52 55 5681 8109 Tel

52 55 5683 2127 Fax

Hypertherm Korea Branch

#3904 Centum Leaders Mark B/D,

1514 Woo-dong, Haeundae-gu, Busan

Korea, 612-889

82 51 747 0358 Tel

82 51 701 0358 Fax

ELECTROMAGNETIC COMPATIBILITY (EMC)

Introduction

Hypertherm's CE-marked equipment is built in compliance with standard EN60974-10. The equipment should be installed and used in accordance with the information below to achieve electromagnetic compatibility.

The limits required by EN60974-10 may not be adequate to completely eliminate interference when the affected equipment is in close proximity or has a high degree of sensitivity. In such cases it may be necessary to use other measures to further reduce interference.

This cutting equipment is designed for use only in an industrial environment.

Installation and use

The user is responsible for installing and using the plasma equipment according to the manufacturer's instructions.

If electromagnetic disturbances are detected then it shall be the responsibility of the user to resolve the situation with the technical assistance of the manufacturer. In some cases this remedial action may be as simple as earthing the cutting circuit, see *Earthing of the work piece*. In other cases, it could involve constructing an electromagnetic screen enclosing the power source and the work complete with associated input filters. In all cases, electromagnetic disturbances must be reduced to the point where they are no longer troublesome.

Assessment of area

Before installing the equipment, the user shall make an assessment of potential electromagnetic problems in the surrounding area. The following shall be taken into account:

- a. Other supply cables, control cables, signaling and telephone cables; above, below and adjacent to the cutting equipment.
- b. Radio and television transmitters and receivers.
- c. Computer and other control equipment.
- d. Safety critical equipment, for example guarding of industrial equipment.
- e. Health of the people around, for example the use of pacemakers and hearing aids.
- f. Equipment used for calibration or measurement.
- g. Immunity of other equipment in the environment. User shall ensure that other equipment being used in the environment is compatible. This may require additional protection measures.
- h. Time of day that cutting or other activities are to be carried out.

The size of the surrounding area to be considered will depend on the structure of the building and other activities that are taking place. The surrounding area may extend beyond the boundaries of the premises.

Methods of reducing emissions

Mains supply

Cutting equipment must be connected to the mains supply according to the manufacturer's recommendations. If interference occurs, it may be necessary to take additional precautions such as filtering of the mains supply.

Consideration should be given to shielding the supply cable of permanently installed cutting equipment, in metallic conduit or equivalent. Shielding should be electrically continuous throughout its length. The shielding should be connected to the cutting mains supply so that good electrical contact is maintained between the conduit and the cutting power source enclosure.

Maintenance of cutting equipment

The cutting equipment must be routinely maintained according to the manufacturer's recommendations. All access and service doors and covers should be closed and properly fastened when the cutting equipment is in operation. The cutting equipment should not be modified in any way, except as set forth in and in accordance with the manufacturer's written instructions. For example, the spark gaps of arc striking and stabilizing devices should be adjusted and maintained according to the manufacturer's recommendations.

Cutting cables

The cutting cables should be kept as short as possible and should be positioned close together, running at or close to the floor level.

Equipotential bonding

Bonding of all metallic components in the cutting installation and adjacent to it should be considered.

However, metallic components bonded to the workpiece will increase the risk that the operator could receive a shock by touching these metallic components and the electrode (nozzle for laser heads) at the same time.

The operator should be insulated from all such bonded metallic components.

Earthing of the workpiece

Where the workpiece is not bonded to earth for electrical safety, nor connected to earth because of its size and position, for example, ship's hull or building steel work, a connection bonding the workpiece to earth may reduce emissions in some, but not all instances. Care should be taken to prevent the earthing of the workpiece increasing the risk of injury to users, or damage to other electrical equipment. Where necessary, the connection of the workpiece to earth should be made by a direct connection to the workpiece, but in some countries where direct connection is not permitted, the bonding should be achieved by suitable capacitances selected according to national regulations.

Note: The cutting circuit may or may not be earthed for safety reasons. Changing the earthing arrangements should only be authorized by a person who is competent to assess whether the changes will increase the risk of injury, for example, by allowing parallel cutting current return paths which may damage the earth circuits of other equipment. Further guidance is provided in IEC 60974-9, Arc Welding Equipment, Part 9: Installation and Use.

Screening and shielding

Selective screening and shielding of other cables and equipment in the surrounding area may alleviate problems of interference. Screening of the entire plasma cutting installation may be considered for special applications.

Attention

Genuine Hypertherm parts are the factory-recommended replacement parts for your Hypertherm system. Any damage or injury caused by the use of other than genuine Hypertherm parts may not be covered by the Hypertherm warranty, and will constitute misuse of the Hypertherm Product.

You are solely responsible for the safe use of the Product. Hypertherm does not and cannot make any guarantee or warranty regarding the safe use of the product in your environment.

General

Hypertherm, Inc. warrants that its Products shall be free from defects in materials and workmanship for the specific periods of time set forth herein and as follows: if Hypertherm is notified of a defect (i) with respect to the power supply within a period of two (2) years from the date of its delivery to you, with the exception of Powermax brand power supplies, which shall be within a period of three (3) years from the date of delivery to you, and (ii) with respect to the torch and leads within a period of one (1) year from its date of delivery to you, and with respect to torch lifter assemblies within a period of one (1) year from its date of delivery to you, and with respect to laser heads within a period of one (1) year from its date of delivery to you, and with respect to Automation products one (1) year from its date of delivery to you, with the exception of the EDGE Pro and MicroEDGE Pro CNCs and ArcGlide THC, which shall be within a period of two (2) years from the date of delivery to you.

This warranty shall not apply to any Powermax brand power supplies that have been used with phase converters. In addition, Hypertherm does not warranty systems that have been damaged as a result of poor power quality, whether from phase converters or incoming line power. This warranty shall not apply to any Product which has been incorrectly installed, modified, or otherwise damaged.

Hypertherm provides repair, replacement or adjustment of the Product as the sole and exclusive remedy, if and only if the warranty set forth herein properly is invoked and applies. Hypertherm, at its sole option, shall repair, replace, or adjust, free of charge, any defective Products covered by this warranty which shall be returned with Hypertherm's prior authorization (which shall not be unreasonably withheld), properly packed, to Hypertherm's place of business in Hanover, New Hampshire, or to an authorized Hypertherm repair facility, all costs, insurance and freight pre paid by the customer. Hypertherm shall not be liable for any repairs, replacement, or adjustments of Products covered by this warranty, except those made pursuant to this paragraph and with Hypertherm's prior written consent.

The warranty set forth above is exclusive and is in lieu of all other warranties, express, implied, statutory, or otherwise with respect to the Products or as to the results which may be obtained therefrom, and all implied warranties or conditions of quality or of merchantability or fitness for a particular purpose or against infringement. The foregoing shall constitute the sole and exclusive remedy for any breach by Hypertherm of its warranty.

Distributors/OEMs may offer different or additional warranties, but Distributors/OEMs are not authorized to give any additional warranty protection to you or make any representation to you purporting to be binding upon Hypertherm.

Patent indemnity

Except only in cases of products not manufactured by Hypertherm or manufactured by a person other than Hypertherm not in strict conformity with Hypertherm's specifications and in cases of designs, processes, formulae, or combinations not developed or purported to be developed by Hypertherm, Hypertherm will have the right to defend or settle, at its own expense, any suit or proceeding brought against you alleging that the use of the Hypertherm product, alone and not in combination with any other product not supplied by Hypertherm, infringes any patent of any third party. You shall notify Hypertherm promptly upon learning of any action or threatened action in connection with any such alleged infringement (and in any event no longer than fourteen (14) days after learning of any action or threat of action), and Hypertherm's obligation to defend shall be conditioned upon Hypertherm's sole control of, and the indemnified party's cooperation and assistance in, the defense of the claim.

Limitation of liability

In no event shall Hypertherm be liable to any person or entity for any incidental, consequential direct, indirect, punitive or exemplary damages (including but not limited to lost profits) regardless of whether such liability is based on breach of contract, tort, strict liability, breach of warranty, failure of essential purpose, or otherwise, and even if advised of the possibility of such damages.

National and local codes

National and local codes governing plumbing and electrical installation shall take precedence over any instructions contained in this manual. In no event shall Hypertherm be liable for injury to persons or property damage by reason of any code violation or poor work practices.

Liability cap

In no event shall Hypertherm's liability, if any, whether such liability is based on breach of contract, tort, strict liability, breach of warranties, failure of essential purpose or otherwise, for any claim, action, suit or proceeding (whether in court, arbitration, regulatory proceeding or otherwise) arising out of or relating to the use of the Products exceed in the aggregate the amount paid for the Products that gave rise to such claim.

Insurance

At all times you will have and maintain insurance in such quantities and types, and with coverage sufficient and appropriate to defend and to hold Hypertherm harmless in the event of any cause of action arising from the use of the products.

Transfer of rights

You may transfer any remaining rights you may have hereunder only in connection with the sale of all or substantially all of your assets or capital stock to a successor in interest who agrees to be bound by all of the terms and conditions of this Warranty. Within thirty (30) days before any such transfer occurs, you agree to notify in writing Hypertherm, which reserves the right of approval. Should you fail timely to notify Hypertherm and seek its approval as set forth herein, the Warranty set forth herein shall be null and void and you will have no further recourse against Hypertherm under the Warranty or otherwise.

Safety information

Before operating any Hypertherm equipment, read the separate *Safety and Compliance Manual* (80669C) included with your product for important safety information.

Section 1
Specifications

Safety information	1-2
System description.....	1-2
Where to find information	1-3
Power supply dimensions	1-4
Component weights.....	1-5
Powermax65 power supply ratings	1-6
Powermax85 power supply ratings	1-8
Duramax 75° hand torch dimensions	1-10
Duramax 15° hand torch dimensions	1-10
Duramax 180° full-length machine torch dimensions.....	1-11
Duramax 180° mini machine torch dimensions.....	1-11
Powermax65 cutting specifications.....	1-12
Powermax85 cutting specifications.....	1-13
Symbols and markings.....	1-14
IEC symbols	1-15

Section 2
Power Supply Setup

Unpack the Powermax65 or Powermax85 system	2-2
Claims	2-2
Contents.....	2-3
Position the power supply.....	2-4
Prepare the electrical power	2-4
Install a line-disconnect switch	2-5
Requirements for grounding	2-5
Power connection for the Powermax65	2-6
Single-phase power cord (not for CE model).....	2-7
Three-phase power cord – plug installation.....	2-7
Power connection for the Powermax85	2-8
Single-phase power cord (not for CE model)	2-9
Single-phase power cord installation	2-10
Three-phase power cord – plug installation.....	2-11
Extension cord recommendations.....	2-11
Extension cord specifications.....	2-12
Engine-driven generator recommendations	2-13
Prepare the gas supply.....	2-14
Additional gas filtration.....	2-14
Connect the gas supply.....	2-15

Section 3**Torch Setup**

Introduction	3-2
Consumable life.....	3-2
CopperPlus™ electrode for Duramax torches.....	3-2
Hand torch setup.....	3-3
Choose the hand torch consumables	3-4
Hand torch consumables	3-5
Install the hand torch consumables.....	3-6
Machine torch setup.....	3-7
Converting a full-length machine torch to a mini machine torch	3-8
Mount the torch.....	3-10
Choose the machine torch consumables	3-12
Machine torch consumables.....	3-12
Install the machine torch consumables	3-15
Aligning the torch	3-15
Connecting an optional remote-start pendant	3-16
Connecting an optional machine interface cable.....	3-17
Connecting the torch lead.....	3-22
Using the cut charts	3-23
Estimated kerf-width compensation.....	3-24
85 A shielded consumables	3-26
65 A shielded consumables	3-30
45 A shielded consumables	3-34
FineCut® consumables.....	3-38
85 A unshielded consumables.....	3-43
65 A unshielded consumables.....	3-47
45 A unshielded consumables.....	3-51

Section 4**Operation**

Controls and indicators.....	4-2
Rear controls	4-2
Front controls and LEDs.....	4-2
Status screen	4-4
Operating the Powermax65 or Powermax85	4-6
Connect the electrical power, gas supply, and torch lead	4-6
Attach the work lead to the power supply.....	4-7
Attach the work clamp to the workpiece	4-8
Turn ON the system.....	4-9
Set the operating mode switch.....	4-9
Check the indicators.....	4-10
Manually adjusting the gas pressure.....	4-10
Adjusting the current (amperage).....	4-11
Understanding duty-cycle limitations.....	4-12

Using the hand torch.....	4-13
Operate the safety trigger	4-13
Hand torch cutting hints	4-14
Start a cut from the edge of the workpiece.....	4-15
Pierce a workpiece.....	4-16
Gouge a workpiece	4-17
Common hand-cutting faults	4-20
Using the machine torch	4-21
Ensure the torch and table are set up correctly	4-21
Understand and optimize cut quality.....	4-21
To pierce a workpiece using the machine torch	4-23
Common machine-cutting faults.....	4-24

Section 5

Troubleshooting and System Tests

Controls and indicators	5-3
Theory of operation.....	5-4
General	5-4
200 – 600 V CSA 1- or 3-phase power supply functional description.....	5-4
380/400 V CE 3-phase power supply functional description.....	5-5
Sequence of operation.....	5-6
Troubleshooting preparation	5-7
Test equipment	5-7
Troubleshooting procedures and sequence	5-7
External inspection	5-9
Internal inspection	5-9
Initial resistance check.....	5-9
Check the power switch.....	5-9
Hypertherm IGBT tester	5-12
Indicator LEDs and device tests	5-12
IGBT test preparation.....	5-13
IGBT device test using the Hypertherm tester.....	5-14
Troubleshoot the Hypertherm IGBT tester.....	5-14
Schematic for building an IGBT tester.....	5-15
IGBT device test using a non-Hypertherm tester	5-16
200 – 600 V CSA power supply overview.....	5-17
380/400 V CE power supply overview	5-18
200 – 600 V CSA power supply overview (power board removed).....	5-19
380/400 V CE power supply overview (power board removed).....	5-20

TABLE OF CONTENTS

Fault codes.....	5-21
Displaying the service screen.....	5-21
Important fault icons	5-22
Performing a cold restart	5-22
Fault codes and solutions.....	5-23
Troubleshooting guide.....	5-32
System tests.....	5-38
Test 1 – Voltage input.....	5-39
Test 2 – DC Power Buss	5-40
Test 3 – Output diodes.....	5-42
Test 4 – Inverter and PFC temperature sensor.....	5-43
Test 5 – Flyback circuit (DC minor voltages)	5-46
Test 6 – Torch stuck open (TSO)	5-48
Test 7 – Start signal	5-50
Test 8 – Torch cap switch	5-51
Test 9 – Electronic regulator	5-52
Test 10 – Pressure sensor.....	5-53
Test 11 – Fan.....	5-54
Test 12 – AUX switch.....	5-55

Section 6

Component Replacement

Remove and replace the power supply cover and Mylar® barrier.....	6-2
Remove the power supply cover and Mylar barrier	6-2
Replace the Mylar barrier.....	6-3
Replace the power supply cover	6-4
Replace the power cord.....	6-5
Replace the power cord (200 – 600 V 3-phase CSA, 400 V 3-phase CE).....	6-5
Replace the power cord (200 – 480 V 1-phase CSA)	6-10
Replace the work lead	6-11
Replace the fan	6-12
Replace the air filter element.....	6-14
Replace the air filter subassembly	6-15
Replace the power board	6-17
Remove the DSP board	6-17
Replace the power board (380/400V CE)	6-19
Replace the power board (200 – 600V CSA).....	6-22
Install the DSP board	6-25
Replace the Mylar barrier and power supply cover.....	6-26
Replace the control board.....	6-27
Replace the heat sink components	6-29
65A CSA.....	6-30
65A CE.....	6-31
85A CSA.....	6-32
85A CE.....	6-33

Section 7
Parts

Power supply parts.....	7-2
Exterior front	7-2
Exterior rear.....	7-3
Interior, power board side (200 – 600V CSA)	7-4
Interior, power board side (380/400V CE).....	7-5
Interior, fan side	7-6
Heat sink assembly.....	7-8
65A CSA.....	7-8
65A CE	7-9
85A CSA.....	7-10
85A CE	7-11
Duramax 75° hand torch replacement parts.....	7-12
Duramax 15° hand torch replacement parts.....	7-13
Hand torch consumables	7-14
Duramax 180° full-length machine torch replacement parts	7-15
Duramax 180° mini machine torch replacement parts	7-17
Machine torch consumables	7-19
Accessory parts.....	7-20
Powermax65 and Powermax85 labels.....	7-21
Safety-critical parts.....	7-22
Recommended spare parts	7-24

Section 8
Wiring Diagrams

Cutting timing diagram page 1 of 2.....	8-3
Cutting timing diagram page 2 of 2.....	8-4
Electrical schematic diagram (CSA)	8-5
Electrical schematic diagram (CE)	8-6

Section 1

SPECIFICATIONS

In this section:

Safety information	1-2
System description.....	1-2
Where to find information	1-3
Power supply dimensions	1-4
Component weights.....	1-5
Powermax65 power supply ratings	1-6
Powermax85 power supply ratings	1-8
Duramax 75° hand torch dimensions	1-10
Duramax 15° hand torch dimensions	1-10
Duramax 180° full-length machine torch dimensions.....	1-11
Duramax 180° mini machine torch dimensions.....	1-11
Powermax65 cutting specifications.....	1-12
Powermax85 cutting specifications.....	1-13
Symbols and markings.....	1-14
IEC symbols	1-15

Safety information

Before you set up and operate your Hypertherm system, read the separate *Safety and Compliance Manual* included with your system for important safety information.

System description

The Powermax65 and Powermax85 are highly portable, 65-amp and 85-amp, handheld and mechanized plasma cutting systems appropriate for a wide range of applications. The Powermax systems use air or nitrogen to cut electrically conductive metals, such as mild steel, stainless steel, or aluminum. Smart Sense™ technology automatically adjusts the gas pressure according to cutting mode and torch lead length for optimum cutting.

The Powermax65 can cut thicknesses up to 1 inch (25 mm) with a handheld torch and pierce thicknesses up to 5/8 inch (16 mm). The Powermax85 can cut thicknesses up to 1-1/4 inches (32 mm) and pierce thicknesses up to 3/4 inch (19 mm). FastConnect™ provides a simple push-button torch connection to the power supply for quick torch changes.

The typical handheld Powermax system includes a Duramax™ series 75° hand torch with a consumables box and work lead cable. Reference materials include: operator manual, quick setup card, registration card, setup DVD, and safety manual.

The typical mechanized Powermax system includes a Duramax series 180° full-length machine torch with a consumables box, work lead cable, and remote-start pendant. Reference materials include: operator manual, quick setup card, registration card, setup DVD, and safety manual.

You can order additional styles of torches, consumables, and accessories – such as the plasma cutting guide – from any Hypertherm distributor. See the *Parts* section for a list of spare and optional parts.

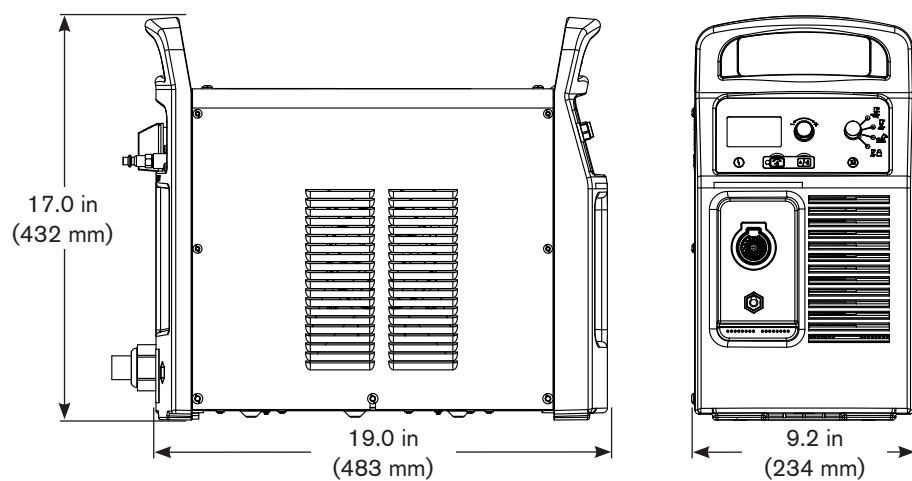
Powermax65 and Powermax85 power supplies are shipped without a plug on the power cord. See Section 2 *Power Supply Setup* for more information.

Where to find information

System specifications such as size, weight, detailed electrical specifications, and cut speeds can be found in this section. For information on:

- Setup requirements, including power requirements, grounding, power cord configurations, extension cord requirements, and generator recommendations – see Section 2, *Power Supply Setup*.
- Handheld and machine torch consumables, cut charts, and torch setup information – see Section 3, *Torch Setup*.
- Information about the controls and LEDs, steps for system operation, and hints for improving cut quality – see Section 4, *Operation*.
- Maintenance and repair – see the troubleshooting section.
- Replacing components – see the *Component replacement* section (Service Manual).
- Part numbers and ordering information for accessories, consumables, and replacement parts – see the *Parts* section.
- Timing and schematic diagrams – see the *Wiring diagrams* section (Service Manual).

Power supply dimensions



Component weights

	65 A CSA	65 A CE	85 A CSA	85 A CE
	lbs (kg)	lbs (kg)	lbs (kg)	lbs (kg)
Power supply	54.1 (24.5)	47.0 (21.3)	59.9 (27.2)	50.4 (22.8)

	65/85 A
	lbs (kg)
Hand torch 7.6 m (25 ft)	6.8 (3.1)
Hand torch 15 m (50 ft)	12.2 (5.5)
Hand torch 23 m (75 ft)	17.6 (8.0)

Machine torch 7.6 m (25 ft)	7.6 (3.4)
Machine torch 15 m (50 ft)	13.2 (6.0)
Machine torch 23 m (75 ft)	18.8 (8.5)

	65 A	85 A
	lbs (kg)	lbs (kg)
Work lead 7.6 m (25 ft)	2.8 (1.3)	6.8 (3.1)
Work lead 15 m (50 ft)	5.0 (2.3)	7.5 (3.4)
Work lead 23 m (75 ft)	6.9 (3.1)	10.6 (4.8)

SPECIFICATIONS

Powermax65 power supply ratings

Rated open-circuit voltage (U ₀) CSA, 1-phase, 3-phase CE, 3-phase	CSA 296 VDC CE 270 VDC		
Output characteristic ¹	Drooping		
Rated output current (I ₂)	20 – 65 A		
Rated output voltage (U ₂)	139 VDC		
Duty cycle at 40° C (104° F) (See data plate on power supply for more information on duty cycle.)	CSA	50% @ 65 A, 230 – 600 V, 1/3 PH 40% @ 65 A, 200 – 208 V, 1/3 PH 100% @ 46 A, 230 – 600 V, 1/3 PH	
	CE	50% @ 65 A, 380/400 V, 3 PH 100% @ 46 A, 380/400 V, 3 PH	
Operating temperature	14° to 104° F (-10° to 40° C)		
Storage temperature	-13° to 131° F (-25° to 55° C)		
Power factor 200 – 480 V CSA, 1-phase 200 – 600 V CSA, 3-phase 380/400 V CE, 3-phase	0.99 – 0.97 0.94 – 0.73 0.94		
R _{sce} – Short Circuit Ratio (CE models only)		U ₁ – Volts AC rms, 3PH	R _{sce}
		400 VAC	225.7
EMC classification CISPR 11 (CE models only) ⁴		Class A	
Input voltage (U ₁)/ Input current (I ₁) at rated output (U ₂ MAX, I ₂ MAX) (See Section 2 Power Supply Setup for more information.)	CSA	200/208/240/480 V, 1 PH, 50/60 Hz 52/50/44/22 A 200/208/240/480/600 V, 3 PH, 50/60 Hz 32/31/27/13/13 A	
	CE ^{2,3}	380/400 V, 3 PH, 50/60 Hz 15.5/15 A	
Gas type	Air		Nitrogen
Gas quality	Clean, dry, oil-free per ISO 8573-1 Class 1.2.2		99.95% pure
Recommended gas inlet flow rate/pressure	Cutting: 400 scfh, 6.7 scfm (190 slpm) @ 85 psi (5.9 bar) Gouging: 450 scfh, 7.5 scfm (210 slpm) @ 70 psi (4.8 bar)		

¹ Defined as a plot of output voltage versus output current.

² Equipment complies with IEC 61000-3-12 provided that the short-circuit power S_{sc} is greater than or equal to 2035 KVA at the interface point between the user's supply and the public system. It is the responsibility of the installer or user of the equipment to ensure, by consultation with the distribution network operator if necessary, that the equipment is connected only to a supply with a short-circuit power S_{sc} greater than or equal to 2035 KVA.

³ Equipment complies with IEC 61000-3-11 provided that the supply impedance, Z_{max} , is 0.201 or less. It is the responsibility of the installer or user of the equipment to ensure, by consultation with the distribution network operator if necessary, that the equipment is connected only to a supply with a impedance of 0.201 or less.

⁴ WARNING: This Class A equipment is not intended for use in residential locations where the electrical power is provided by the public low-voltage supply system. There may be potential difficulties in ensuring electromagnetic compatibility in those locations, due to conducted as well as radiated disturbances.

SPECIFICATIONS

Powermax85 power supply ratings

Rated open-circuit voltage (U_0) CSA, single-phase, 3-phase CE, 3-phase	CSA CE	305 VDC 270 VDC
Output characteristic ¹	Drooping	
Rated output current (I_2)	25 – 85 A	
Rated output voltage (U_2)	143 VDC	
Duty cycle at 40° C (104° F) (See data plate on power supply for more information on duty cycle.)	CSA CE	60% @ 85 A, 230 – 600 V, 3 PH 60% @ 85 A, 480 V, 1 PH 50% @ 85 A, 240 V, 1 PH 50% @ 85 A 200 – 208 V, 3 PH 40% @ 85 A 200 – 208 V, 1 PH 100% @ 66 A, 230 – 600 V, 1/3 PH 60% @ 85 A, 380/400 V, 3 PH 100% @ 66 A, 380/400 V, 3 PH
Operating temperature	14° to 104° F (-10° to 40° C)	
Storage temperature	-13° to 131° F (-25° to 55° C)	
Power factor 200 – 480 V CSA, 1-phase 200 – 600 V CSA, 3-phase 380/400 V CE, 3-phase	0.99 – 0.96 0.94 – 0.76 0.94	
R_{sce} – Short Circuit Ratio (CE models only)	U_1 – Volts AC rms, 3PH	R_{sce}
	400 VAC	225.7
EMC classification CISPR 11 (CE models only) ⁴	Class A	
Input voltage (U_1)/ Input current (I_1) at rated output ($U_{2\text{ MAX}}$, $I_{2\text{ MAX}}$) (See Section 2 <i>Power Supply Setup</i> for more information.)	CSA CE ^{2,3}	200/208/240/480 V, 1 PH, 50/60 Hz 70/68/58/29 A 200/208/240/480/600 V, 3 PH, 50/60 Hz 42/40/35/18/17 A 380/400 V, 3 PH, 50/60 Hz 20.5/19.5 A
Gas type	Air	Nitrogen
Gas quality	Clean, dry, oil-free per ISO 8573-1 Class 1.2.2	99.95% pure
Recommended gas inlet flow rate/pressure	Cutting: 400 scfh, 6.7 scfm (190 slpm) @ 85 psi (5.9 bar) Gouging: 450 scfh, 7.5 scfm (210 slpm) @ 70 psi (4.8 bar)	

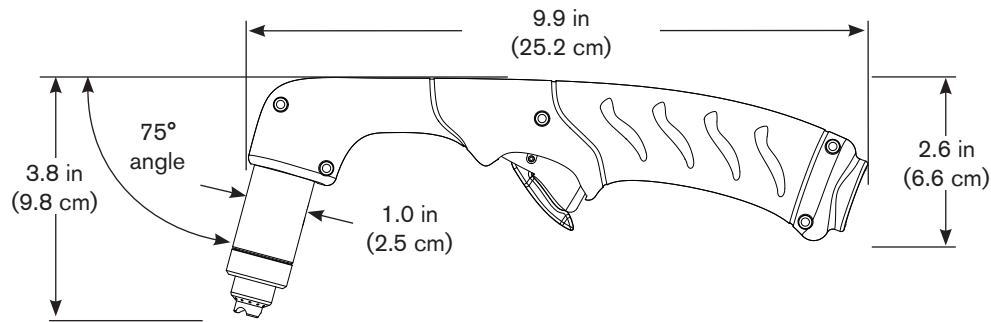
¹ Defined as a plot of output voltage versus output current.

² Equipment complies with IEC 61000-3-12 provided that the short-circuit power S_{sc} is greater than or equal to 2035 KVA at the interface point between the user's supply and the public system. It is the responsibility of the installer or user of the equipment to ensure, by consultation with the distribution network operator if necessary, that the equipment is connected only to a supply with a short-circuit power S_{sc} greater than or equal to 2035 KVA.

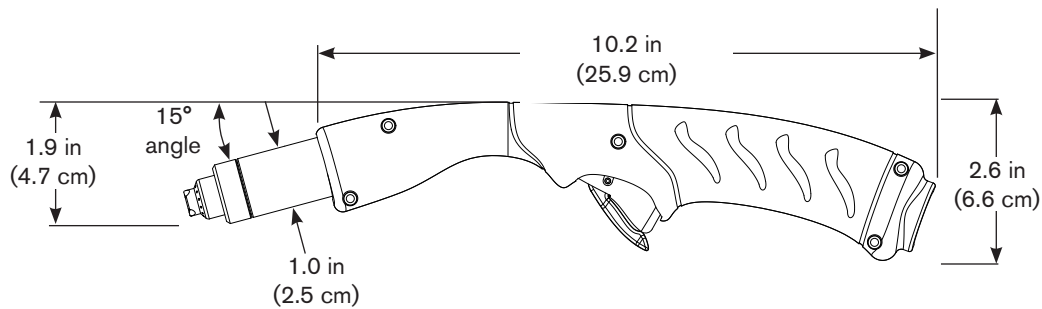
³ Equipment complies with IEC 61000-3-11 provided that the supply impedance, Z_{max} , is 0.201 or less. It is the responsibility of the installer or user of the equipment to ensure, by consultation with the distribution network operator if necessary, that the equipment is connected only to a supply with a impedance of 0.201 or less.

⁴ WARNING: This Class A equipment is not intended for use in residential locations where the electrical power is provided by the public low-voltage supply system. There may be potential difficulties in ensuring electromagnetic compatibility in those locations, due to conducted as well as radiated disturbances.

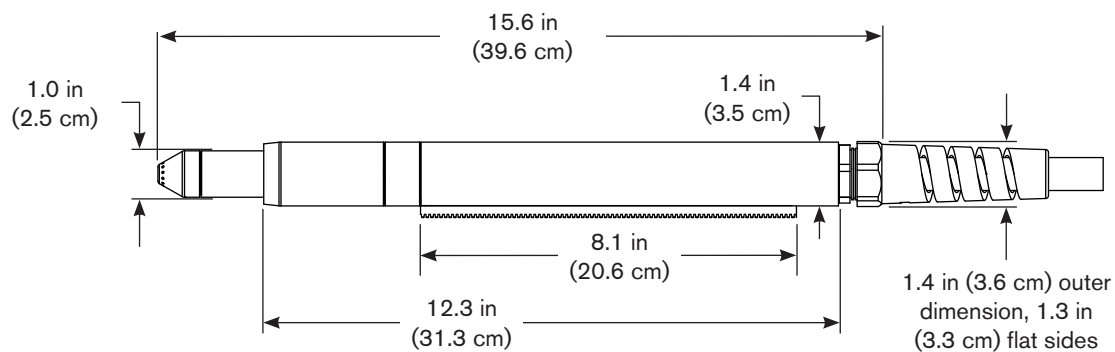
Duramax 75° hand torch dimensions



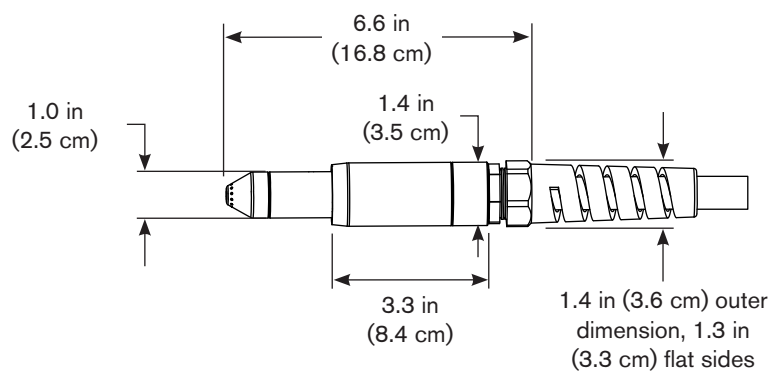
Duramax 15° hand torch dimensions



Duramax 180° full-length machine torch dimensions



Duramax 180° mini machine torch dimensions



Powermax65 cutting specifications

Handheld cut capacity (material thickness)	
Recommended cut capacity at 20 ipm (500 mm/min)*	3/4 in (19 mm)
Recommended cut capacity at 10 ipm (250 mm/min)*	1 in (25 mm)
Severance capacity at 5 ipm (125 mm/min)*	1-1/4 in (32 mm)
Pierce capacity (material thickness)	
Pierce capacity for handheld cutting, or mechanized cutting with torch height control	5/8 in (16 mm)
Pierce capacity for mechanized cutting without torch height control	1/2 in (12 mm)
Maximum cut speed** (mild steel)	
1/4 in (6 mm)	145 ipm (4000 mm/min)
1/2 in (12 mm)	50 ipm (1400 mm/min)
3/4 in (19 mm)	24 ipm (600 mm/min)
1 in (25 mm)	12 ipm (320 mm/min)
Gouging capacity	
Metal removal rate on mild steel	10.7 lbs/hr (4.8 kg/hr)
Duramax series torch weights (refer to 1-5 <i>Component weights</i>)	
Duty cycle and voltage information (refer to 1-6 <i>Powermax65 power supply ratings</i>)	

* Cut capacity speeds are not necessarily maximum speeds. They are the speeds that must be achieved to be rated at that thickness.

** Maximum cut speeds are the results of Hypertherm's laboratory testing. Actual cutting speeds may vary based on different cutting applications.

Powermax85 cutting specifications

Handheld cut capacity (material thickness)	
Recommended cut capacity at 20 ipm (500 mm/min)*	1 in (25 mm)
Recommended cut capacity at 10 ipm (250 mm/min)*	1-1/4 in (32 mm)
Severance capacity at 5 ipm (125 mm/min)*	1-1/2 in (38 mm)
Pierce capacity (material thickness)	
Pierce capacity for handheld cutting, or mechanized cutting with torch height control	3/4 in (19 mm)
Pierce capacity for mechanized cutting without torch height control	5/8 in (16 mm)
Maximum cut speed** (mild steel)	
1/4 in (6 mm)	200 ipm (5500 mm/min)
1/2 in (12 mm)	70 ipm (2000 mm/min)
3/4 in (19 mm)	36 ipm (900 mm/min)
1 in (25 mm)	21 ipm (550 mm/min)
1-1/4 in (32 mm)	13 ipm (330 mm/min)
Gouging capacity	
Metal removal rate on mild steel	19.5 lbs/hr (8.8 kg/hr)
Duramax series torch weights (refer to 1-5 <i>Component weights</i>)	
Duty cycle and voltage information (refer to 1-8 <i>Powermax85 power supply ratings</i>)	

* Cut capacity speeds are not necessarily maximum speeds. They are the speeds that must be achieved to be rated at that thickness.

** Maximum cut speeds are the results of Hypertherm's laboratory testing. Actual cutting speeds may vary based on different cutting applications.

Symbols and markings

Your Hypertherm product may have one or more of the following markings on or near the data plate. Due to differences and conflicts in national regulations, not all marks are applied to every version of a product.



S mark symbol

The S mark symbol indicates that the power supply and torch are suitable for operations carried out in environments with increased hazard of electrical shock per IEC 60974-1.



CSA mark

Hypertherm products with a CSA mark meet the United States and Canadian regulations for product safety. The products were evaluated, tested, and certified by CSA-International. Alternatively the product may have a mark by one of the other Nationally Recognized Testing Laboratories (NRTL) accredited in both the United States and Canada, such as Underwriters Laboratories, Incorporated (UL) or TÜV.



CE marking

The CE marking signifies the manufacturer's declaration of conformity to applicable European directives and standards. Only those versions of Hypertherm products with a CE marking located on or near the data plate have been tested for compliance with the European Low Voltage Directive and the European Electromagnetic Compatibility (EMC) Directive. EMC filters needed to comply with the European EMC Directive are incorporated within versions of the product with a CE marking.



GOST-R mark

CE versions of Hypertherm products that include a GOST-R mark of conformity meet the product safety and EMC requirements for export to the Russian Federation.



c-Tick mark

CE versions of Hypertherm products with a c-Tick mark comply with the EMC regulations required for sale in Australia and New Zealand.






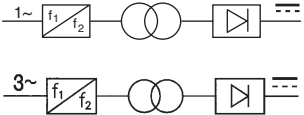













CCC mark

The China Compulsory Certification (CCC) mark indicates that the product has been tested and found compliant with product safety regulations required for sale in China.

IEC symbols

The following symbols may appear on the power supply data plate, control labels, switches, LEDs, and LCD screen.

	Direct current (DC)		Power is ON
	Alternating current (AC)		Power is OFF
	Plasma torch cutting		An inverter-based power source, either 1-phase or 3-phase
	Plate metal cutting		Volt/amp curve, "drooping" characteristic
	Expanded metal cutting		Power is ON (LED)
	Gouging		System fault (LED)
	AC input power connection		Inlet gas pressure fault (LCD)
	The terminal for the external protective (earth) conductor		Missing or loose consumables (LCD)
			Power supply is out of temperature range (LCD)

Section 2

POWER SUPPLY SETUP

In this section:

Unpack the Powermax65 or Powermax85 system	2-2
Claims	2-2
Contents.....	2-3
Position the power supply.....	2-4
Prepare the electrical power	2-4
Install a line-disconnect switch	2-5
Requirements for grounding	2-5
Power connection for the Powermax65	2-6
Single-phase power cord (not for CE model).....	2-7
Three-phase power cord – plug installation.....	2-7
Power connection for the Powermax85	2-8
Single-phase power cord (not for CE model)	2-9
Single-phase power cord installation	2-10
Three-phase power cord – plug installation.....	2-11
Extension cord recommendations.....	2-11
Extension cord specifications.....	2-12
Engine-driven generator recommendations	2-13
Prepare the gas supply.....	2-14
Additional gas filtration.....	2-14
Connect the gas supply.....	2-15

Unpack the Powermax65 or Powermax85 system

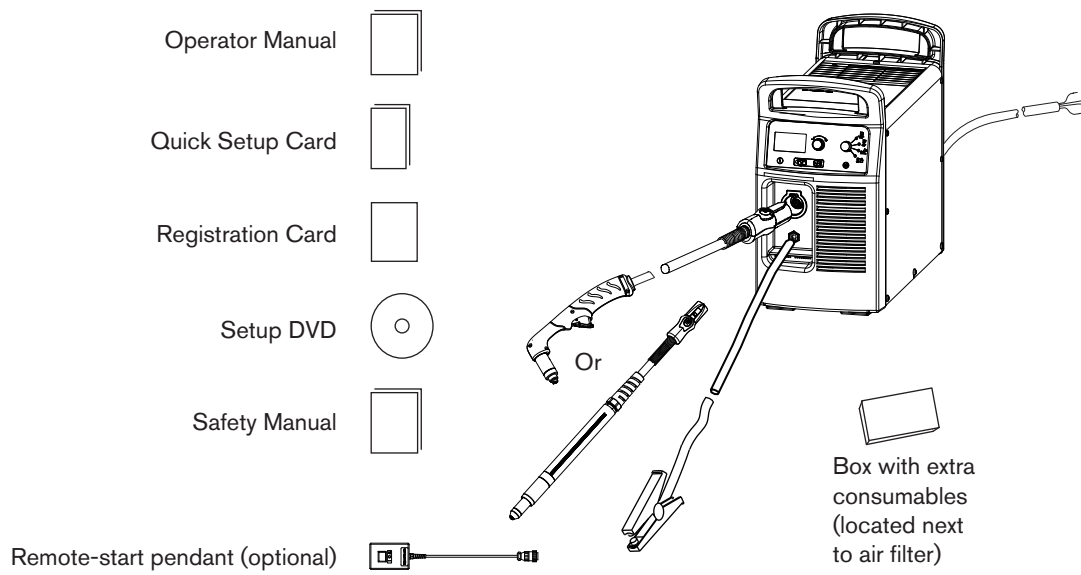
1. Verify that all items on your order have been received in good condition. Contact your distributor if any parts are damaged or missing.
2. Inspect the power supply for damage that may have occurred during shipping. If there is evidence of damage, refer to "Claims" below. All communications regarding this equipment must include the model number and the serial number located on the back of the power supply.
3. Before you set up and operate this Hypertherm system, read the separate *Safety and Compliance Manual* included with your system for important safety information.

Claims

- **Claims for damage during shipment** – If your unit was damaged during shipment, you must file a claim with the carrier. Hypertherm will furnish you with a copy of the bill of lading upon request. If you need additional assistance, call the nearest Hypertherm office listed in the front of this manual.
- **Claims for defective or missing merchandise** – If any component is missing or defective, contact your Hypertherm distributor. If you need additional assistance, call the nearest Hypertherm office listed in the front of this manual.

Contents

Verify the items in the box against the illustration.



Position the power supply

Locate the power supply near an appropriate power receptacle for your installation: 200 – 480 volts (CSA 1-phase), 200 – 600 volts (CSA 3-phase), or 380/400 volts (3-phase CE). The power supply has a 10-foot (3 m) power cord. Allow at least 10 inches (0.25 m) of space around the power supply for proper ventilation.

The power supply is not suitable for use in rain or snow.

To avoid toppling, do not set the power supply on an incline greater than 10 degrees.

Prepare the electrical power

Hypertherm (designated HYP on the data plate) input current ratings are used to determine conductor sizes for power connection and installation instructions. The HYP rating is determined under maximum normal operating conditions and the higher HYP input current value should be used for installation purposes.

The maximum output voltage will vary based on your input voltage and the circuit's amperage. Because the current draw varies during startup, slow-blow fuses are recommended as shown in the charts below. Slow-blow fuses can withstand currents up to 10 times the rated value for short periods of time.



Caution: Protect the circuit with appropriately sized time-delay (slow-blow) fuses and a line-disconnect switch.

Install a line-disconnect switch

Use a line-disconnect switch for each power supply so that the operator can turn off the incoming power quickly in an emergency. Locate the switch so that it is easily accessible to the operator. Installation must be performed by a licensed electrician according to national and local codes. The interrupt level of the switch must equal or exceed the continuous rating of the fuses. In addition, the switch should:

- Isolate the electrical equipment and disconnect all live conductors from the incoming supply voltage when in the OFF position.
- Have one OFF and one ON position that are clearly marked with O (OFF) and I (ON).
- Have an external operating handle that can be locked in the OFF position.
- Contain a power-operated mechanism that serves as an emergency stop.
- Have appropriate slow-blow fuses installed. See 2-6 *Power connection for the Powermax65* or 2-8 *Power connection for the Powermax85* for recommended fuse sizes.

Requirements for grounding

To ensure personal safety, proper operation, and to reduce electromagnetic interference (EMI), the power supply must be properly grounded.

- The power supply must be grounded through the power cord according to national and local electrical codes.
- Single-phase service must be of the 3-wire type with a green or green/yellow wire for the protective earth ground and must comply with national and local requirements. **Do not use a 2-wire service.**
- Three-phase service must be of the 4-wire type with a green or green/yellow wire for protective earth ground and must comply with national and local requirements.
- Refer to the separate *Safety and Compliance Manual* included with your system for more information on grounding.

Power connection for the Powermax65

The Powermax65 CSA model is a universal power supply that can configure itself to operate with AC voltages from 200 to 600, 1- or 3-phase. The CE model is 380/400 V, 3-phase only. The rated output is 25 – 65 A, 139 VDC.

CSA model	Single-phase			Three-phase				
Input voltage	200 – 208	230 – 240	480	200 – 208	230 – 240	400	480	600
Input current at 9.0 kw output	52	44	22	32	27	15	13	13
Input current during arc stretch	74	74	38	45	45	27	23	23
Fuse (slow-blow)	80	80	40	50	50	30	25	25

CE model	Three-phase
Input voltage	380/400
Input current at 9.0 kw output	15.5/15
Input current during arc stretch	27
Fuse (slow-blow)	30

Single-phase power cord (not for CE model)

To operate your Powermax65 on 1-phase power, you will need to install an appropriate power cord. Refer to 2-10 *Single-phase power cord installation* for instructions.

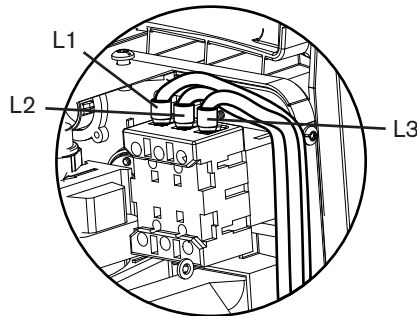


Caution: When using the Powermax65 CSA model power supply (CE model is 3-phase only) with a 1-phase power source, replace the supplied power cord with an 8 AWG (10 mm²) 3-wire power cord. The power cord must be connected by a licensed electrician.

Three-phase power cord – plug installation

The Powermax65 power supplies are shipped with an 8 AWG 4-wire power cord on CSA models. A 2.5 mm², 4-wire HAR power cord is provided on CE models. To operate the Powermax65, use a plug that meets national and local electrical codes. The plug must be connected to the power cord by a licensed electrician.

The procedure is similar to installing a single-phase power cord as shown in the section 2-10 *Single-phase power cord installation*. The figure below shows the additional wire connected to L3.



Power connection for the Powermax85

The Powermax85 CSA model is a universal power supply that can configure itself to operate with AC voltages from 200 to 600, 1- or 3-phase. The CE model is 380/400 V, 3-phase only. The rated output is 25 – 85 A, 143 VDC.

CSA model	Single-phase			Three-phase				
Input voltage	200 – 208	230 – 240	480	200 – 208	230 – 240	400	480	600
Input current at 12.2 kw output	70	60	29	42	36	21	18	17
Input current during arc stretch	98	98	50	60	60	38	31	30
Fuse (slow-blow)	100	100	50	60	60	40	30	30

CE model	Three-phase
Input voltage	380/400
Input current at 12.2 kw output	20.5/20
Input current during arc stretch	38
Fuse (slow-blow)	40

Single-phase power cord (not for CE model)

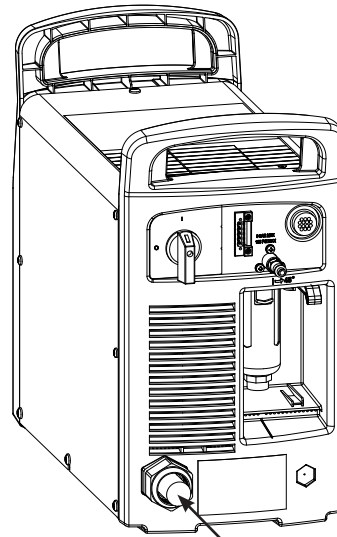
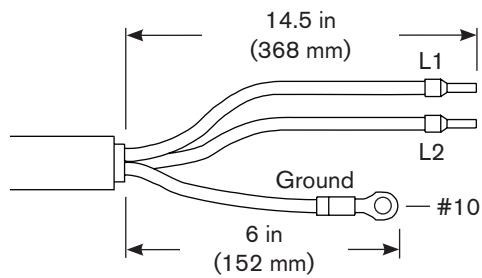
To operate your Powermax85 on 1-phase power, you will need to install an appropriate power cord. Refer to 2-10 *Single-phase power cord installation* for instructions.



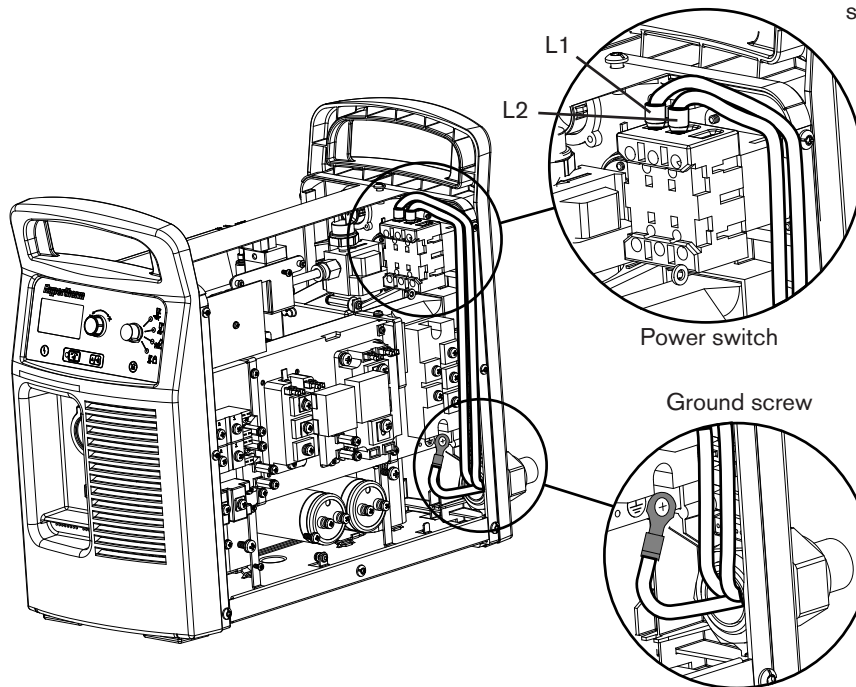
Caution: When using the Powermax85 CSA model power supply (CE model is 3-phase only) with a 1-phase power source, replace the supplied power cord with a 6AWG (16 mm²) 3-wire power cord. The power cord must be connected by a licensed electrician.

Single-phase power cord installation

Strip and prepare the power cord wires as shown below.



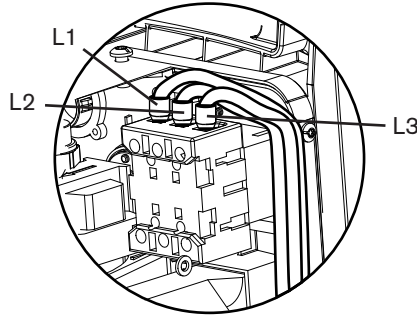
Route lead through strain relief and tighten



Three-phase power cord – plug installation

The Powermax85 power supplies are shipped with an 8 AWG 4-wire power cord on CSA models. A 4 mm², 4-wire HAR power cord is provided on CE models. To operate the Powermax85, use a plug that meets national and local electrical codes. The plug must be connected to the power cord by a licensed electrician.

The procedure is similar to installing a single-phase power cord as shown in the section 2-10 *Single-phase power cord installation*. The figure below shows the additional wire connected to L3.



Extension cord recommendations

Any extension cord must have an appropriate wire size for the cord length and system voltage. Use a cord that meets national and local codes.

The table on the next page provides the recommended gauge sizes for various lengths and input voltages. The lengths in the tables are the length of the extension cord only; they do not include the power supply's power cord.

Extension cord specifications

Extension cord length		< 10 ft (< 3 m)	10 – 25 ft (3 – 7.6 m)	25 – 50 ft (7.5 – 15 m)	50 – 100 ft (15 – 30 m)	100 – 150 ft (30 – 45 m)
65 A CSA						
Input voltage (VAC)	Phase	AWG (mm ²)	AWG (mm ²)	AWG (mm ²)	AWG (mm ²)	AWG (mm ²)
200 – 240	1	8 (10)	8 (10)	8 (10)	6 (16)	4 (25)
480	1	12 (4)	12 (4)	12 (4)	10 (6)	10 (6)
200 – 240	3	10 (6)	10 (6)	10 (6)	8 (10)	6 (16)
400/480	3	12 (4)	12 (4)	12 (4)	12 (4)	12 (4)
600	3	12 (4)	12 (4)	12 (4)	12 (4)	12 (4)
65 A CE						
Input voltage (VAC)	Phase	mm ²	mm ²	mm ²	mm ²	mm ²
380	3	4	4	4	4	4
400	3	4	4	4	4	4
85 A CSA						
Input voltage (VAC)	Phase	AWG (mm ²)	AWG (mm ²)	AWG (mm ²)	AWG (mm ²)	AWG (mm ²)
200 – 240	1	6 (16)	6 (16)	6 (16)	4 (25)	2 (35)
480	1	10 (6)	10 (6)	10 (6)	8 (10)	8 (10)
200 – 240	3	8 (10)	8 (10)	8 (10)	6 (16)	4 (25)
400/480	3	10 (6)	10 (6)	10 (6)	10 (6)	10 (6)
600	3	10 (6)	10 (6)	10 (6)	10 (6)	10 (6)
85 A CE						
Input voltage (VAC)	Phase	mm ²	mm ²	mm ²	mm ²	mm ²
380	3	6	6	6	6	6
400	3	6	6	6	6	6

Engine-driven generator recommendations

Generators used with the Powermax65 or Powermax85 should satisfy the following requirements:

CSA

- 1-phase, 50/60 Hz, 230/240 VAC
- 3-phase, 50/60 Hz, 200-600 VAC (480 VAC recommended for best performance)

CE

- 3-phase, 50/60 Hz, 380/400 VAC (400 VAC recommended for best performance)

Engine drive rating	System output current	Performance (arc stretch)
20 kw	85 A	Full
15 kw	70 A	Limited
15 kw	65 A	Full
12 kw	65 A	Limited
12 kw	40 A	Full
8 kw	40 A	Limited
8 kw	30 A	Full

Note: Based on the generator rating, age, and condition, adjust the cutting current as needed.

If a fault occurs while using a generator, turning the power switch quickly to OFF and then to ON again (sometimes called a “quick reset”) may not clear the fault. Instead, turn OFF the power supply and wait 30 to 45 seconds before turning ON again.

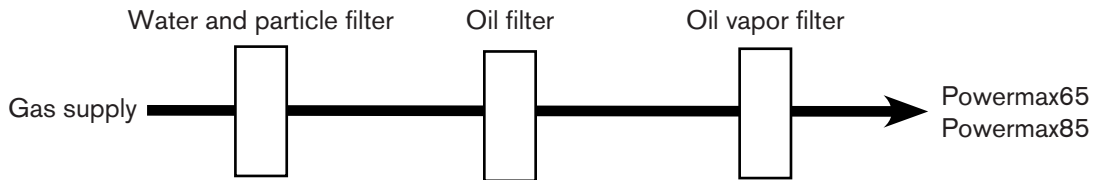
Prepare the gas supply

The gas supply can be shop-compressed or cylinder-compressed. A high-pressure regulator must be used on either type of supply and must be capable of delivering gas to the air inlet on the power supply.

If the supply quality is poor, cut speeds decrease, cut quality deteriorates, cutting thickness capability decreases, and the life of the consumables shortens. For optimal performance, the gas should be compliant with ISO8573-1:2010, Class 1.2.2 (that is, it should have a maximum number of solid particulate per m³ of <20,000 for particle sizes in the range of 0.1-0.5 microns, <400 for particle sizes in the range of 0.5-1 microns, and <10 for particle sizes in the range of 1-5 microns). The maximum water vapor dew point should be <-40° C (-40° F). The maximum oil (aerosol, liquid, and vapor) content should be less than 0.1 mg/m³.

Additional gas filtration

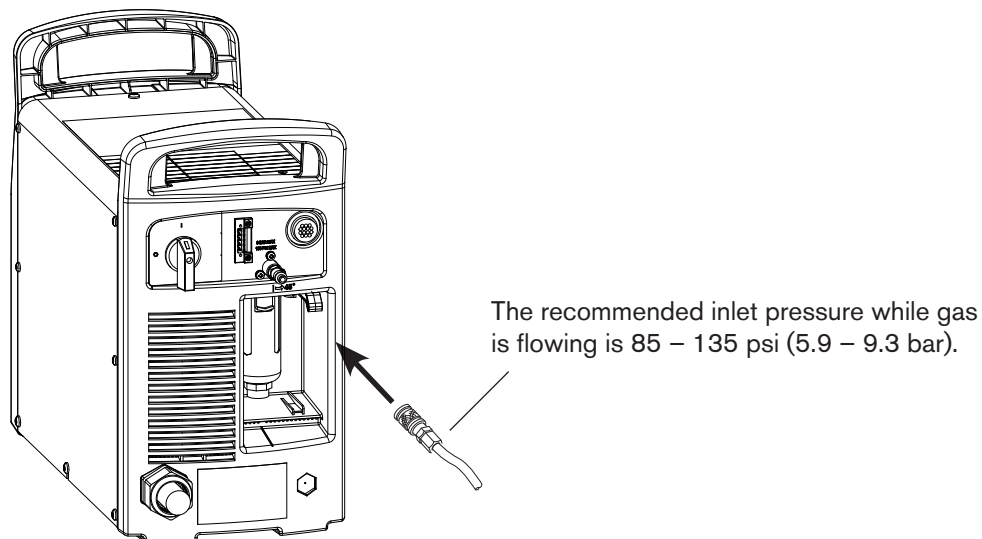
When site conditions introduce moisture, oil, or other contaminants into the gas line, use a 3-stage coalescing filtration system, such as the Eliminator filter kit (part number 128647) available from Hypertherm distributors. A 3-stage filtering system works as shown below to clean contaminants from the gas supply.



The filtering system should be installed between the gas supply and the power supply. Additional gas filtration may increase the required minimum inlet pressure.

Connect the gas supply

Connect the gas supply to the power supply using an inert-gas hose with a 3/8 inch (9.5 mm) internal diameter and a 1/4 NPT quick-disconnect coupler, or a 1/4 NPT x G-1/4 BSPP (CE units) quick-disconnect coupler.



WARNING

Do not allow the gas supply pressure to exceed 135 psi (9.3 bar). The filter bowl may explode if this pressure is exceeded.

POWER SUPPLY SETUP

Minimum inlet pressure (while gas is flowing)

This table shows the minimum required inlet pressure when the recommended inlet pressure is not available.

	Torch lead length		
	7.6 m (25 ft)	15 m (50 ft)	23 m (75 ft)
Cutting	75 psi (5.2 bar)	80 psi (5.5 bar)	85 psi (5.9 bar)
Gouging	60 psi (4.1 bar)	65 psi (4.5 bar)	70 psi (4.8 bar)

Gas flow rates

Cutting	400 scfh, 6.7 scfm (190 slpm) at a minimum 85 psi (5.9 bar)
Gouging	450 scfh, 7.5 scfm (210 slpm) at a minimum 70 psi (4.8 bar)

Section 3

TORCH SETUP

In this section:

Introduction	3-2
Consumable life.....	3-2
CopperPlus™ electrode for Duramax torches.....	3-2
Hand torch setup	3-3
Choose the hand torch consumables	3-4
Hand torch consumables	3-5
Install the hand torch consumables.....	3-6
Machine torch setup.....	3-7
Converting a full-length machine torch to a mini machine torch.....	3-8
Mount the torch.....	3-10
Choose the machine torch consumables.....	3-12
Machine torch consumables.....	3-12
Install the machine torch consumables	3-15
Aligning the torch	3-15
Connecting an optional remote-start pendant	3-16
Connecting an optional machine interface cable.....	3-17
Connecting the torch lead.....	3-22
Using the cut charts	3-23
Estimated kerf-width compensation.....	3-24
85 A shielded consumables	3-26
65 A shielded consumables	3-30
45 A shielded consumables	3-34
FineCut® consumables.....	3-38
85 A unshielded consumables.....	3-43
65 A unshielded consumables.....	3-47
45 A unshielded consumables.....	3-51

Introduction

Duramax™ series handheld and machine torches are available for the Powermax65 and Powermax85 systems. The FastConnect™ quick-disconnect system makes it easy to remove the torch for transport or to switch from one torch to the other if your applications require the use of different torches. The torches are cooled by ambient air and do not require special cooling procedures.

This section explains how to set up your torch and choose the appropriate consumables for the job.

Consumable life

How often you need to change the consumables on your Powermax65 or Powermax85 will depend on a number of factors:

- The thickness of the metal being cut.
- The average length of the cut.
- Whether you are doing machine or hand cutting.
- The air quality (presence of oil, moisture, or other contaminants).
- Whether you are piercing the metal or starting cuts from the edge.
- Proper torch-to-work distance when gouging or cutting with unshielded consumables.
- Proper pierce height.
- Whether you are cutting in “continuous pilot arc” mode or normal mode. Cutting with a continuous pilot arc causes more consumable wear.

Under normal conditions, the electrode will wear out first during machine cutting and the nozzle will wear out first when hand cutting.

A general rule is that a set of consumables lasts approximately 2 to 3 hours of actual “arc on” time for hand cutting, depending on these factors. For mechanized cutting, consumables should last about 3 to 5 hours.

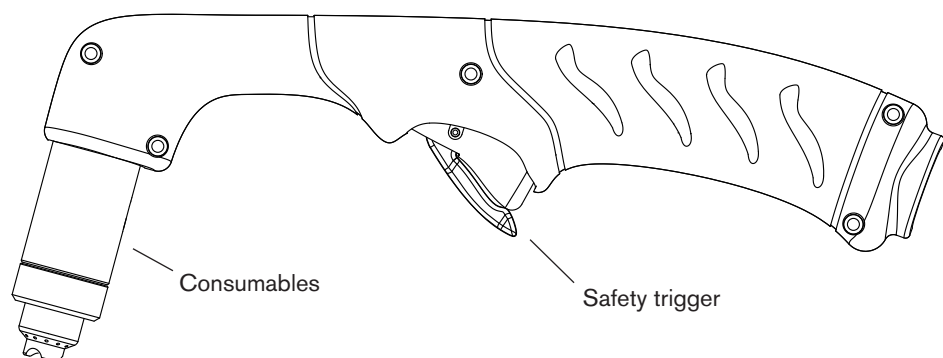
You will find more information about proper cutting techniques in Section 4, *Operation*.

CopperPlus™ electrode for Duramax torches

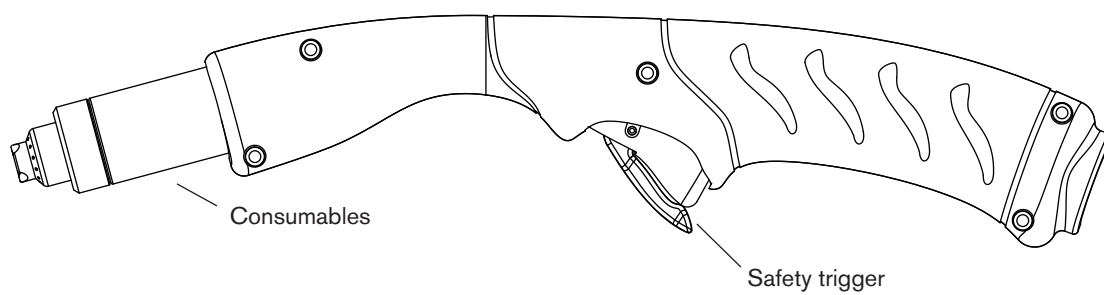
The CopperPlus electrode (part number 220777) delivers at least two times longer consumable life over standard consumables (Hypertherm consumables designed for the system). This electrode is designed exclusively for use with Duramax torches when cutting metal 12 mm (1/2 inch) and under, and is compatible with 40 A to 105 A settings.

Hand torch setup

Duramax 75° hand torch



Duramax 15° hand torch



Choose the hand torch consumables

Hypertherm includes a box of consumables with your system. Both styles of hand torches shown on the previous page use the same consumables.

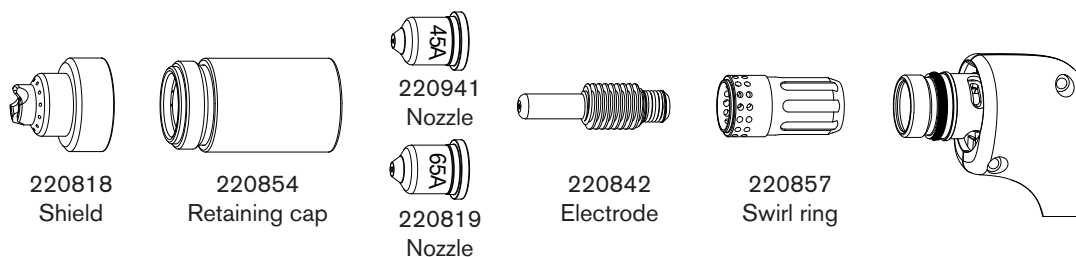
Hand torches use shielded consumables. Therefore, you can drag the torch tip along the metal.

Consumables for hand cutting are shown on the next page. Notice that the retaining cap and electrode are the same for cutting, gouging, and FineCut® applications. Only the shield, nozzle, and swirl ring are different.

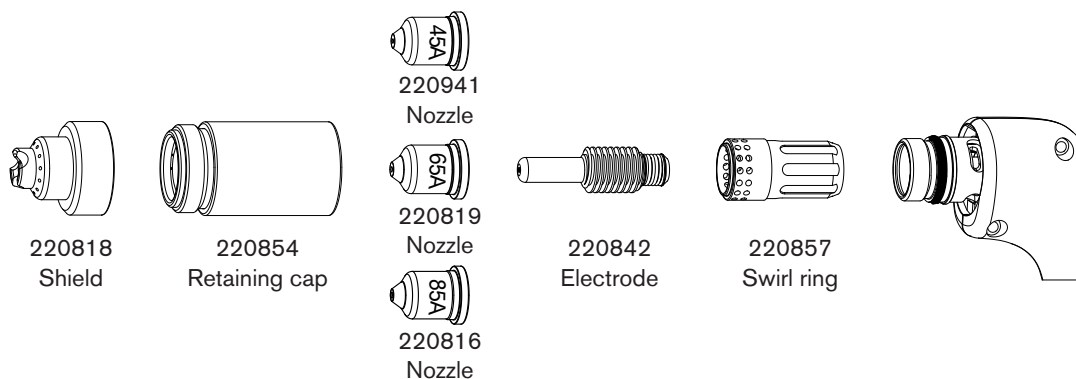
For the best cut quality on thin materials, you may prefer to use FineCut consumables, or use a 45 A nozzle and reduce the amperage to that setting.

Hand torch consumables

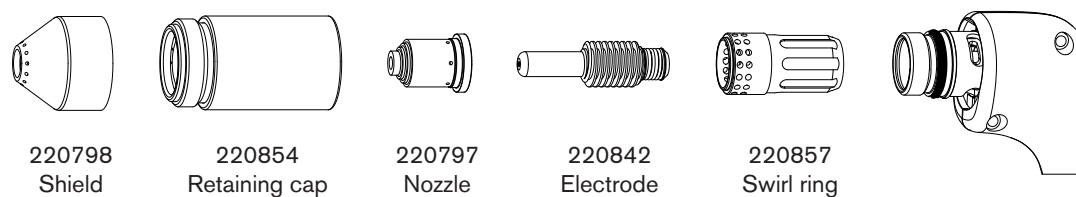
Drag-cutting consumables: Powermax65



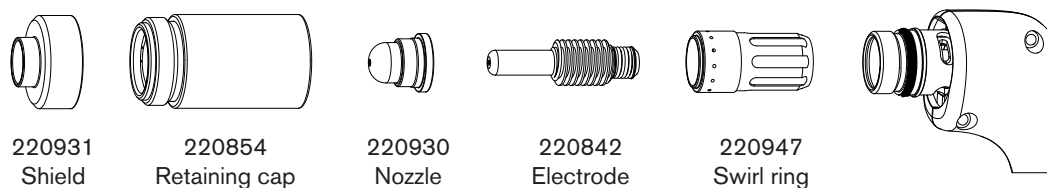
Drag-cutting consumables: Powermax85



Gouging consumables



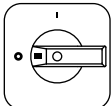


FineCut® consumables



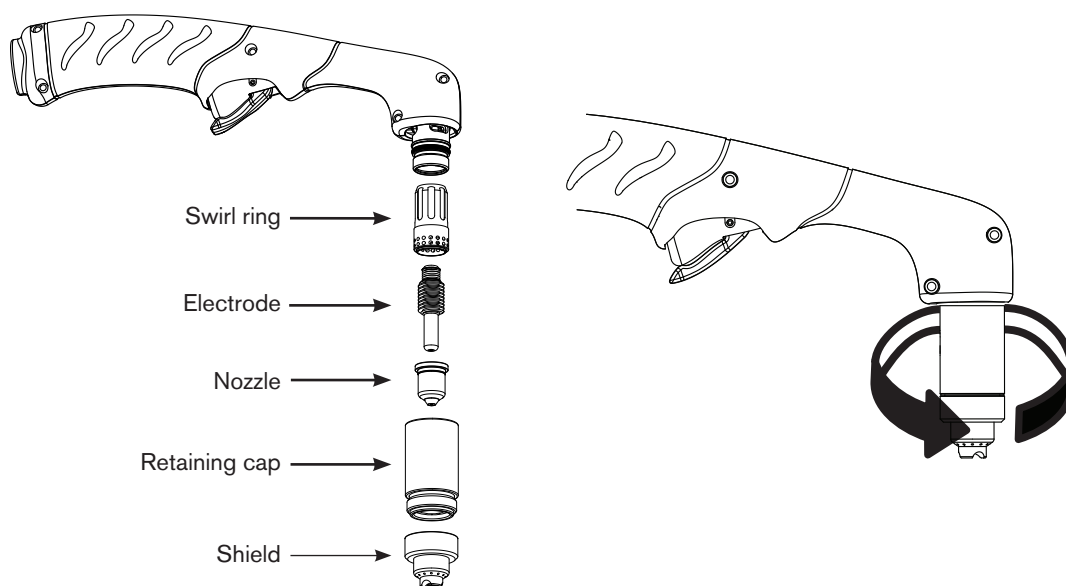
TORCH SETUP

Install the hand torch consumables

		WARNING INSTANT-ON TORCHES PLASMA ARC CAN CAUSE INJURY AND BURNS
	The plasma arc comes on immediately when the torch trigger is activated. Make sure the power is OFF before changing consumables.	

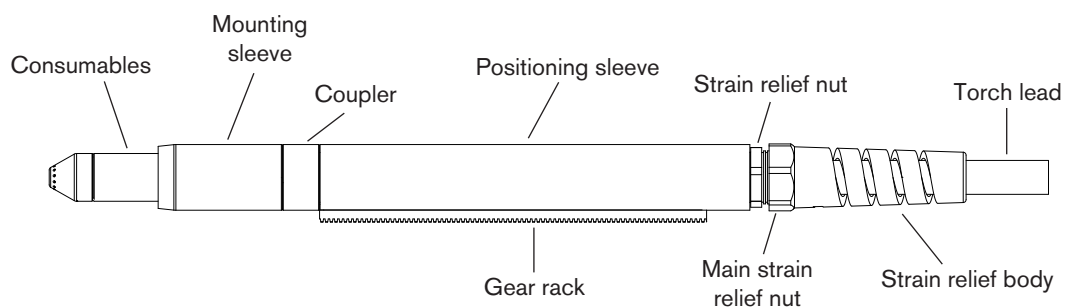
To operate the hand torch, a complete set of consumable parts must be installed: shield, retaining cap, nozzle, electrode, and swirl ring.

With the power switch in the OFF (O) position, install the torch consumables as shown below.

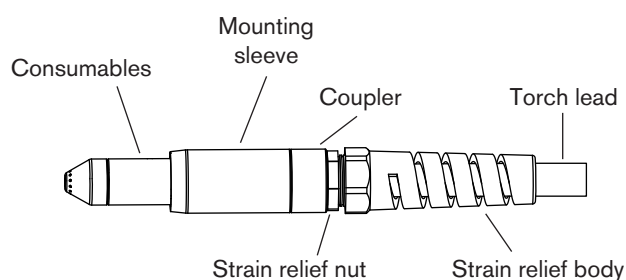


Machine torch setup

Duramax 180° full-length machine torch



Duramax 180° mini machine torch



Before using either style of machine torch, you must:

- Mount the torch on your cutting table or other equipment.
- Choose and install the consumables.
- Align the torch.
- Attach the torch lead to the power supply.
- Set up the power supply for remote starting with either the remote-start pendant or a machine interface cable.

Converting a full-length machine torch to a mini machine torch

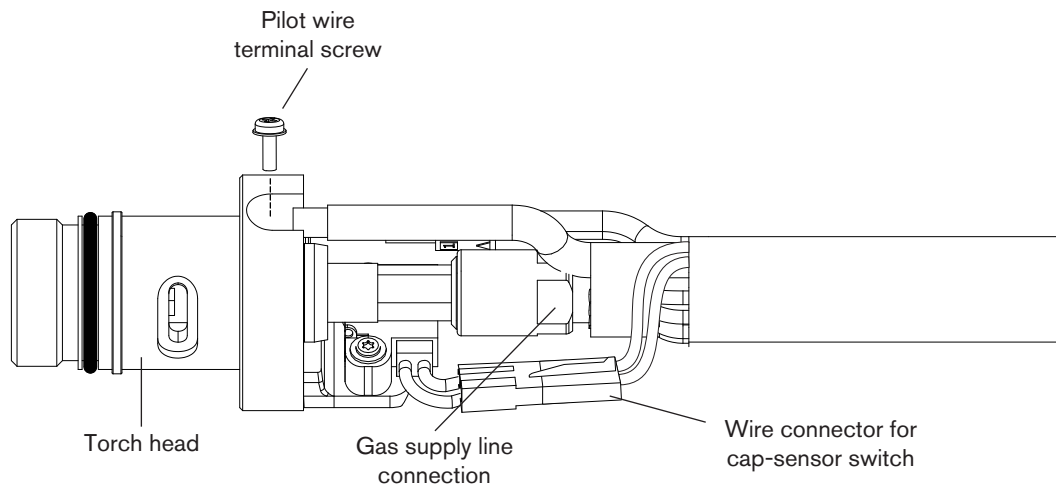
You can convert a full-length machine torch to a mini machine torch by removing the positioning sleeve.

Note: If you are converting a full-length machine torch to a mini machine torch *and* mounting the torch at the same time, skip this section and follow the instructions in 3-10 *Mount the torch*.

Refer to the figures in the section 3-7 *Machine torch setup* and follow these instructions.

Note: While disconnecting and reconnecting the torch parts, maintain the same orientation between the torch head and torch lead. Twisting the torch head in relation to the torch lead can cause damage.

1. Disconnect the torch lead from the power supply and remove the consumables from the torch.
2. Unscrew the strain relief body from the strain relief nut and slide the strain relief body back along the torch lead.
3. Unscrew the strain relief nut from the positioning sleeve and slide the nut back along the torch lead.
4. Unscrew the positioning sleeve from the coupler.
5. Unscrew the coupler from the mounting sleeve.
6. Remove the three screws from the consumables end of the mounting sleeve and slide the mounting sleeve off the front of the torch body.



7. Disconnect the wire connector for the cap-sensor switch.
8. Use a #2 Phillips screwdriver to remove the screw that secures the torch's pilot wire to the torch body.
9. Use 1/4-inch and 3/8-inch wrenches, or adjustable wrenches, to loosen the nut that secures the gas supply line to the torch lead. Set the torch body aside.
10. Slide the coupler and positioning sleeve off the front of the torch lead.
11. Slide the coupler over the torch lead.
12. Reconnect the gas line to the torch lead.
13. Reattach the torch's pilot wire to the torch body using the screw.
14. Reconnect the cap-sensor switch's wire connector.
15. Slide the mounting sleeve over the front of the torch body. Align the slot on the front of the mounting sleeve (next to one of the three screw holes) with the cap-sensor plunger on the torch body.
16. Attach the mounting sleeve to the torch body using the three screws.
17. Screw the coupler into the mounting sleeve.
18. Screw the strain relief nut into the coupler.
19. Screw the strain relief body into the strain relief nut.

Mount the torch

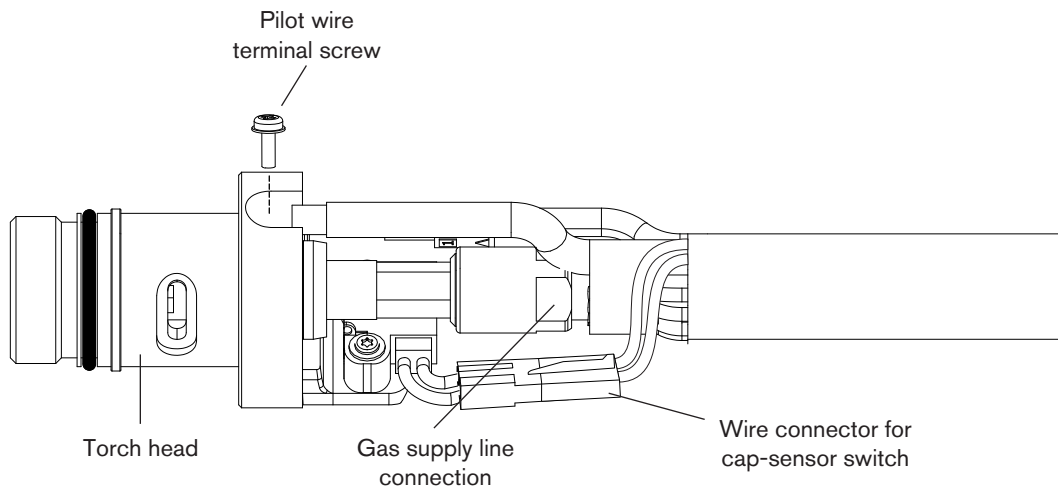
Depending on the type of cutting table you have, you may or may not need to disassemble the torch to route it through the track and mount it. If your cutting table's track is large enough for you to thread the torch through it without removing the torch body from the lead, do so and then attach the torch to the lifter per the manufacturer's instructions.

Note: The Duramax machine torches can be mounted on a wide variety of X-Y tables, track burners, pipe bevelers, and other equipment. Install the torch per the manufacturer's instructions and follow the instructions below for disassembly if necessary.

If you need to disassemble and reassemble the torch, refer to the figures in the section 3-7 *Machine torch setup* and follow these instructions.

Note: While disconnecting and reconnecting the torch parts, maintain the same orientation between the torch head and torch lead. Twisting the torch head in relation to the torch lead can cause damage.

1. Disconnect the torch lead from the power supply and remove the consumables from the torch.
2. Unscrew the strain relief body from the strain relief nut and slide the strain relief body back along the torch lead.
3. Unscrew the strain relief nut from the positioning sleeve (full-length machine torch) and slide the nut back along the torch lead.
4. Unscrew the positioning sleeve from the coupler.
5. Unscrew the coupler from the mounting sleeve.
6. Remove the three screws from the consumables end of the mounting sleeve and slide the mounting sleeve off the front of the torch body.



7. Disconnect the wire connector for the cap-sensor switch.
8. Use a #2 Phillips screwdriver to remove the screw that secures the torch's pilot wire to the torch body.
9. Use 1/4-inch and 3/8-inch wrenches, or adjustable wrenches, to loosen the nut that secures the gas supply line to the torch lead. Set the torch body aside.

Note: Cover the end of the gas line on the torch lead with tape to keep dirt and other contaminants from getting in the gas line when you route the lead through the track.

10. Slide the coupler, positioning sleeve (full-length machine torch), strain relief nut, and strain relief body off the front of the torch lead.
11. If you do not need the gear rack on a full-length machine torch, slide the gear rack from the positioning sleeve toward the consumables end of the sleeve.
12. Route the torch lead through the cutting table's track.
13. Slide the strain relief body and strain relief nut over the torch lead.
14. If you are mounting a full-length machine torch, slide the positioning sleeve over the torch head.
15. Slide the coupler over the torch lead.
16. Reconnect the gas line to the torch lead.
17. Reattach the torch's pilot wire to the torch body using the screw.
18. Reconnect the cap-sensor switch's wire connector.
19. Slide the mounting sleeve over the front of the torch body. Align the slot on the front of the mounting sleeve (next to one of the three screw holes) with the cap-sensor plunger on the torch body.
20. Attach the mounting sleeve to the torch body using the three screws.
21. Screw the coupler into the mounting sleeve.
22. If you are mounting a full-length machine torch, screw the positioning sleeve into the coupler.
23. Reconnect the strain relief nut and strain relief body.
24. Attach the torch to the lifter per the manufacturer's instructions.

Choose the machine torch consumables

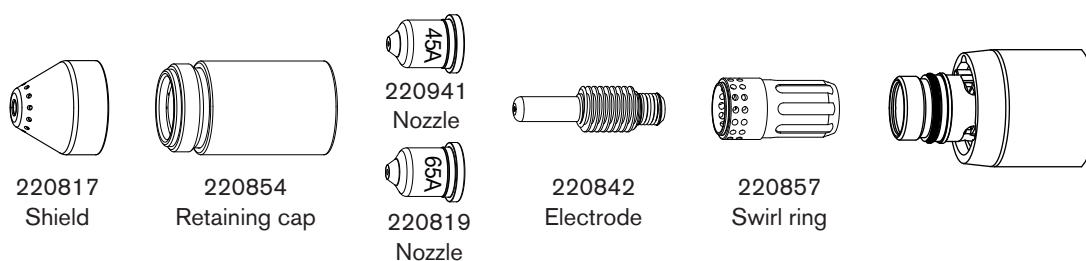
Powermax systems with the Duramax 180° full-length machine torch or Duramax 180° mini machine torch are shipped with a box of consumables. In addition, an ohmic-sensing retaining cap is available for use with shielded consumables.

With shielded consumables, the torch tip may touch the metal when cutting. With unshielded consumables, you must keep the torch a small distance, about 2 – 3 mm (.08 – .12 inch), away from the metal. Unshielded consumables generally have a shorter life than shielded consumables. Depending upon which system you order, you may receive a starter consumable kit with a standard retaining cap or ohmic retaining cap.

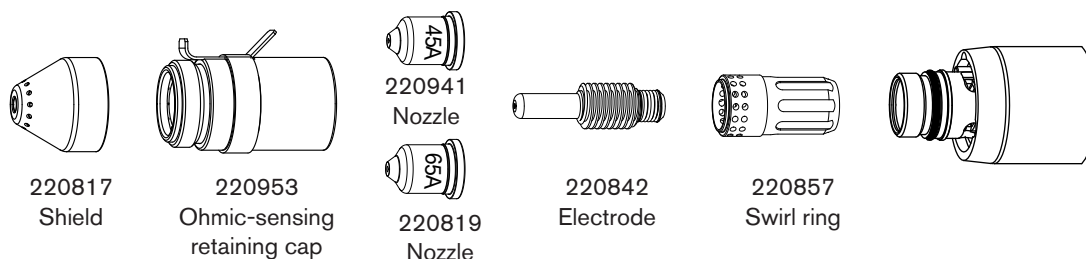
Both styles of machine torches use the same consumables.

Machine torch consumables

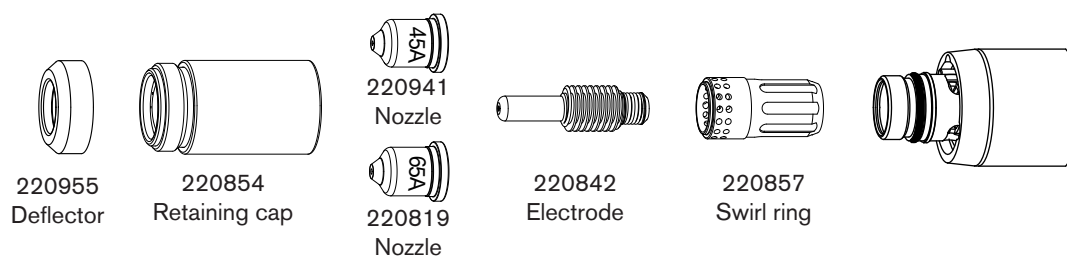
Mechanized shielded consumables: Powermax65



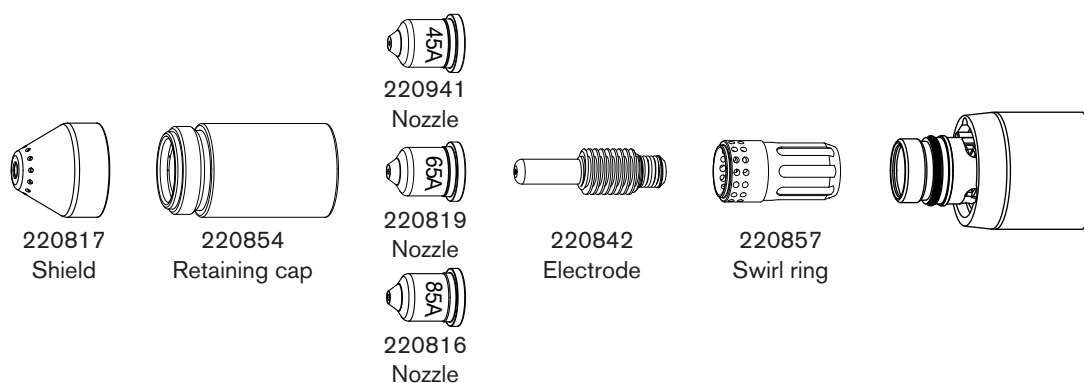
Mechanized shielded with ohmic consumables: Powermax65



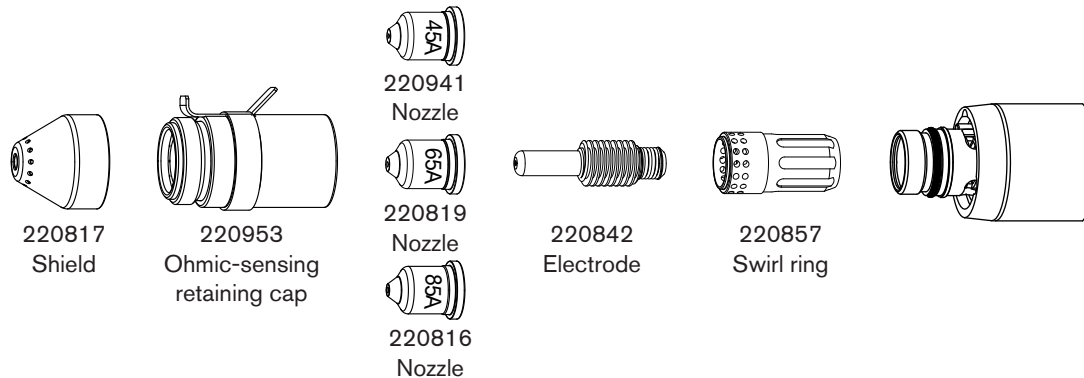
Mechanized unshielded consumables: Powermax65



Mechanized shielded consumables: Powermax85

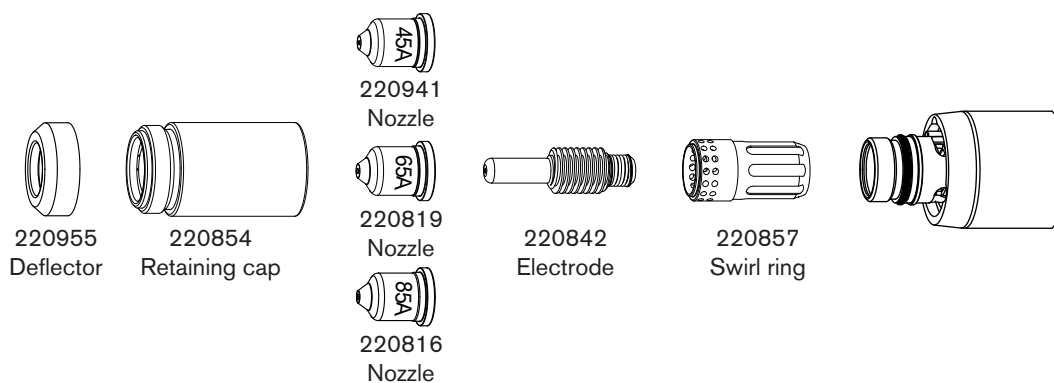


Mechanized shielded with ohmic consumables: Powermax85

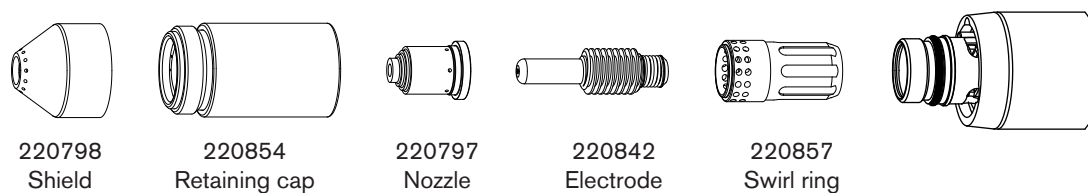


TORCH SETUP

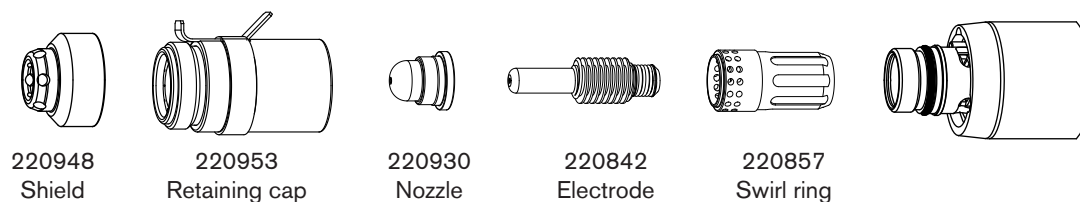
Mechanized unshielded consumables: Powermax85



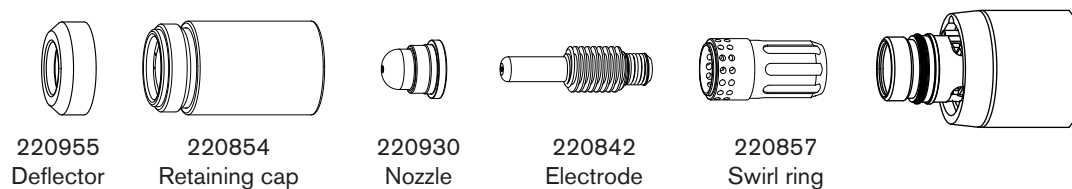
Gouging consumables





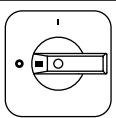
FineCut® shielded consumables



FineCut® unshielded consumables



Install the machine torch consumables

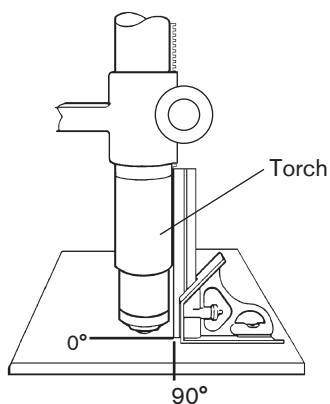
		WARNING INSTANT-ON TORCHES PLASMA ARC CAN CAUSE INJURY AND BURNS
	The plasma arc comes on immediately when the torch is activated. Make sure the power is OFF before changing the consumables.	

To operate the machine torch, a complete set of consumable parts must be installed: shield, retaining cap, nozzle, electrode, and swirl ring.

With the power switch in the OFF (O) position, install the machine torch consumables in a manner similar to the hand torch consumables. Refer to 3-6 *Install the hand torch consumables*.

Aligning the torch

Mount the machine torch perpendicular to the workpiece in order to get a vertical cut. Use a square to align the torch at 0° and 90°.



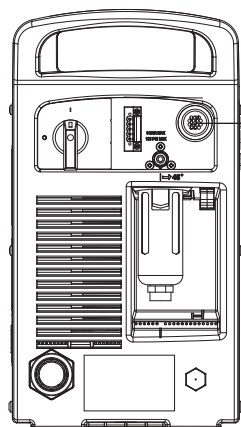
Connecting an optional remote-start pendant

Powermax65 and Powermax85 configurations with a Duramax machine torch can include an optional remote-start pendant.

- Part number 128650: 25 foot (7.6 m)
- Part number 128651: 50 foot (15 m)
- Part number 128652: 75 foot (23 m)

Remove the receptacle cover and plug the Hypertherm remote-start pendant into the receptacle on the rear of the power supply.

Note: The remote-start pendant is for use only with a machine torch. It will not operate if a handheld torch is installed.



Receptacle for the remote-start pendant or a machine interface cable.

Connecting an optional machine interface cable

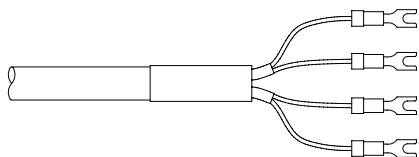
The Powermax65 and Powermax85 power supplies are equipped with an optional, factory-installed, five-position voltage divider that is designed to be safely connected without tools. The built-in voltage divider provides a scaled down arc voltage of 20:1, 21.1:1, 30:1, 40:1, and 50:1 (maximum output of 18 V). An optional receptacle on the rear of the power supply provides access to the scaled down arc voltage and signals for arc transfer and plasma start.

Note: The factory presets the voltage divider to 50:1. To change the voltage divider to a different setting, refer to 3-20 *Setting the five-position voltage divider*.

Caution: The factory-installed internal voltage divider provides a maximum of 18 V under open circuit conditions. This is an impedance-protected functional extra low voltage (ELV) output to prevent shock, energy, and fire under normal conditions at the machine interface receptacle and under single fault conditions with the machine interface wiring. The voltage divider is not fault tolerant and ELV outputs do not comply with safety extra low voltage (SELV) requirements for direct connection to computer products.

Hypertherm offers several choices of machine interface cables for the Powermax65 and Powermax85:

- To use the built-in voltage divider that provides a scaled down arc voltage in addition to signals for arc transfer and plasma start:
 - Use part number 228350 (7.6 m, 25 ft) or 228351 (15 m, 50 ft) for wires terminated with spade connectors.
 - Use part number 123896 (15 m, 50 ft) for a cable terminated with a D-sub connector. (Compatible with Hypertherm's Edge Ti and Sensor PHC products.)
- To use signals for arc transfer and plasma start only, use either part number 023206 (7.6 m, 25 ft) or part number 023279 (15 m, 50 ft). These cables have spade connectors as shown below.



TORCH SETUP

Note: The cover on the machine interface receptacle prevents dust and moisture from damaging the receptacle when not in use. This cover should be replaced if damaged or lost (part number 127204).

See the *Parts* section for more information.

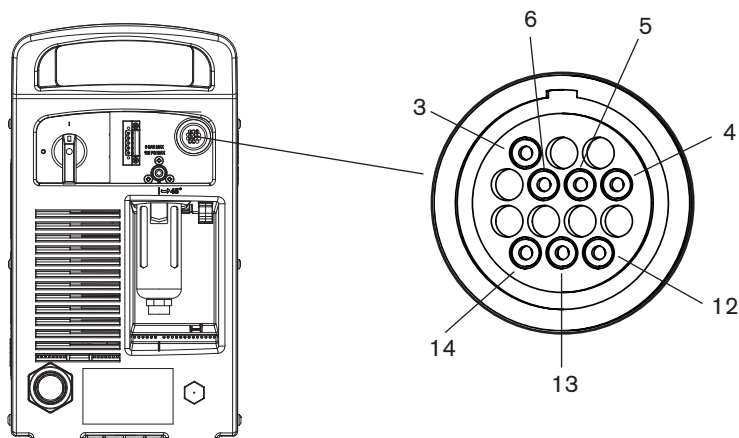
Installation of the machine interface cable must be performed by a qualified service technician. To install a machine interface cable:

1. Turn OFF the power and disconnect the power cord.
2. Remove the machine interface receptacle's cover from the rear of the power supply.
3. Connect the Hypertherm machine interface cable to the power supply.
4. If you are using a cable with a D-sub connector on the other end, plug it into the appropriate pin connector on the torch height controller or CNC. Secure it with the screws on the D-sub connector.

If you are using a cable with wires and spade connectors on the other end, terminate the machine interface cable inside the electrical enclosure of listed and certified torch height controllers or CNC controllers to prevent unauthorized access to the connections after installation. Verify that the connections are correct and that all live parts are enclosed and protected before operating the equipment.

Note: The integration of Hypertherm equipment and customer-supplied equipment including interconnecting cords and cables, if not listed and certified as a system, is subject to inspection by local authorities at the final installation site.

The connector sockets for each type of signal available through the machine interface cable are shown in the figure below. The table provides details about each signal type.



Refer to the following table when connecting the Powermax65 or Powermax85 to a torch height controller or CNC controller with a machine interface cable.

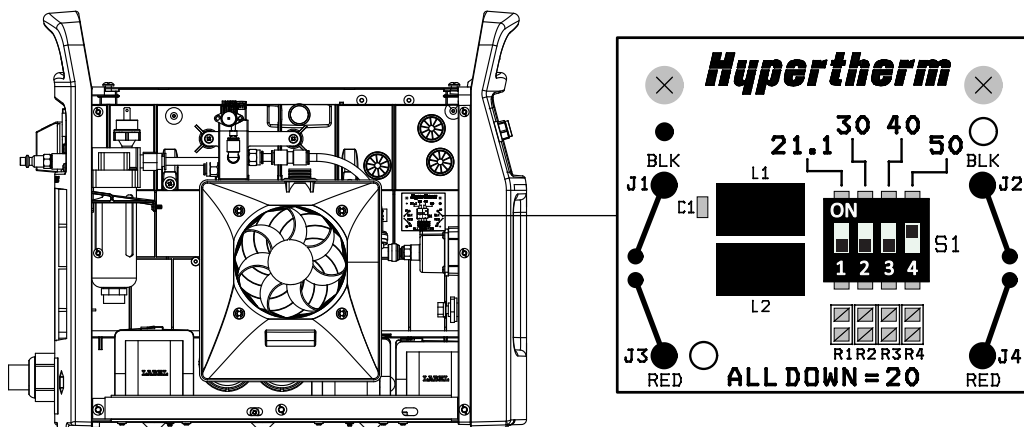
Signal	Type	Notes	Connector sockets	External cable wires
Start (start plasma)	Input	Normally open. 18 VDC open circuit voltage at START terminals. Requires dry contact closure to activate.	3, 4	Green, black
Transfer (start machine motion)	Output	Normally open. Dry contact closure when the arc transfers. 120 VAC/1 A maximum at the machine interface relay or switching device (supplied by the customer).	12, 14	Red, black
Ground	Ground		13	
Voltage divider	Output	Divided arc signal of 20:1, 21.1:1, 30:1, 40:1, 50:1 (provides a maximum of 18 V).	5 (-), 6 (+)	Black (-), white (+)

Setting the five-position voltage divider

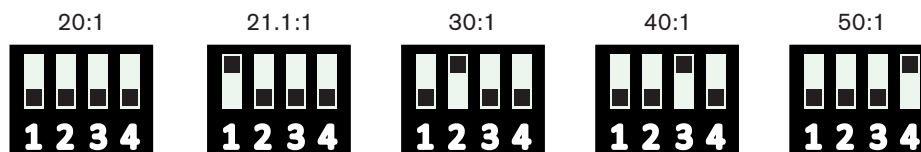
To change the factory preset voltage divider from 50:1 to a different setting:

1. Turn OFF the power supply and disconnect the power cord.
2. Remove the power supply cover.
3. Locate the voltage divider DIP switches on the left side of the power supply.

Note: The figure below shows the default setting (50:1) with the number 4 switch up.





4. Set the DIP switches to one of the following settings and replace the power supply cover.



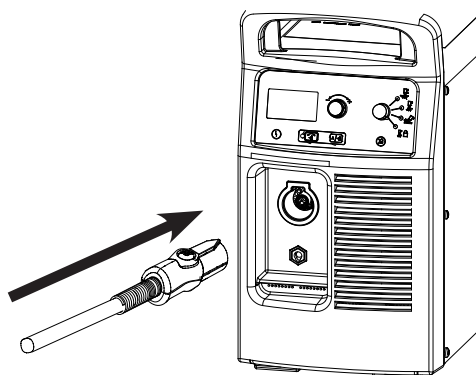
Accessing raw arc voltage

To access divided raw arc voltage, refer to Field Service Bulletin 807060.

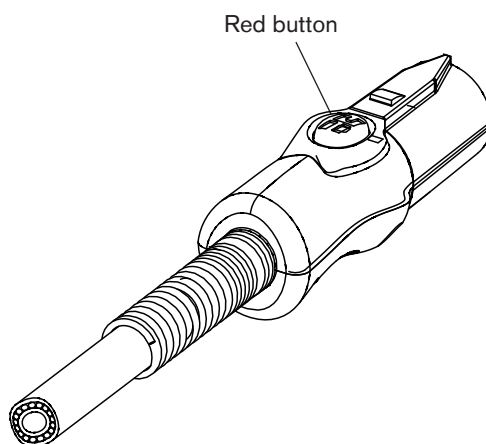
		WARNING HIGH VOLTAGE AND CURRENT
<p>Connecting directly to the plasma circuit for access to raw arc voltage increases the risk of shock hazard, energy hazard, and fire hazard in the event of a single fault. The output voltage and the output current of the circuit are specified on the data plate.</p>		

Connecting the torch lead

The Powermax65 and Powermax85 are equipped with FastConnect™, a quick-disconnect system for connecting and disconnecting handheld and machine torch leads. When connecting or disconnecting a torch, first turn OFF the system. To connect either torch, push the connector into the receptacle on the front of the power supply.



To remove the torch, press the red button on the connector and pull the connector out of the receptacle.



Using the cut charts

The following sections provide cut charts for each set of mechanized consumables. A consumable diagram with part numbers precedes each set of charts. For each consumable type, there are Metric and English charts for mild steel, stainless steel, and aluminum.

Each chart contains the following information:

- Material Thickness – Thickness of the workpiece (metal plate being cut).
- Torch-to-Work Distance – For shielded consumables, the distance between the shield and the workpiece during cutting. For unshielded consumables, the distance between the nozzle and the workpiece during cutting.
- Initial Pierce Height – Distance between the shield (shielded) or the nozzle (unshielded) and the workpiece when the torch is triggered, prior to descending to the cut height.
- Pierce Delay Time – Length of time the triggered torch remains stationary at the pierce height before the torch starts the cutting motion.
- Best Quality Settings (cut speed and voltage) – Settings that provide the starting point for finding the best cut quality (best angle, least dross, best cut-surface finish). Adjust the speed for your application and table to obtain the desired result.
- Production Settings (cut speed and voltage) – 80% of the maximum speed ratings. These speeds result in the greatest number of cut parts, but not necessarily the best possible cut quality.

Note: The arc voltage increases as the consumables wear and the voltage setting should be increased to maintain the correct Torch-to-Work Distance.

Each cut chart lists hot and cold air flow rates.

- Hot air flow rate – Plasma is on, the system is operating at running current, and the system is in a steady state at the default system pressure (automatic mode).
- Cold air flow rate – Plasma is off and the system is in a steady state with air flowing through the torch at the default system pressure.

Note: Hypertherm collected the data under laboratory test conditions using new consumables.

Estimated kerf-width compensation

The widths in the tables below are for reference. The data are obtained with the “Best Quality” settings. Differences between installations and material composition may cause actual results to vary from those shown in the tables.

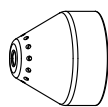
Estimated kerf-width compensation – Metric (mm)

Process	Thickness (mm)									
	0.5	1	2	3	6	8	10	12	16	20
	Mild Steel									
85A Shielded				1.7	1.8	1.9	2.0	2.2	2.4	2.6
65A Shielded			1.6	1.6	1.8	1.9	2.0	2.2	2.3	
45A Shielded	1.1	1.1	1.4	1.5	1.7					
FineCut	0.7	0.7	1.3	1.3						
85A Unshielded			1.7	1.8	1.9	2.0	2.1	2.1	2.3	
65A Unshielded			1.6	1.6	1.7	1.8	1.9	2.0		
45A Unshielded	0.5	0.9	1.3	1.3						
Stainless Steel										
85A Shielded				1.6	1.8	1.9	2.1	2.3	2.4	2.5
65A Shielded			1.4	1.5	1.8	1.9	2.0	2.2	2.4	
45A Shielded	0.9	1.1	1.5	1.6	1.8					
FineCut	0.6	0.6	1.4	1.5						
85A Unshielded			1.7	1.7	1.8	1.9	2.1	2.2	2.4	
65A Unshielded			1.6	1.6	1.8	1.8	1.9	2.0		
45A Unshielded	0.5	1.0	1.3	1.5	1.5					
Aluminum										
85A Shielded				2.0	1.9	2.0	2.1	2.2	2.4	2.6
65A Shielded			1.9	1.9	1.9	2.0	2.1	2.3	2.5	
45A Shielded		1.5	1.5	1.6	1.5					
85A Unshielded			1.9	1.9	1.9	2.0	2.0	2.1	2.2	
65A Unshielded			1.8	1.8	1.8	1.8	1.9	2.0		
45A Unshielded		1.6	1.5	1.4	1.5					

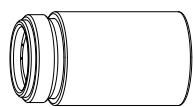
Estimated kerf-width compensation – English (inches)

Process	Thickness (inches)									
	22GA	18GA	14GA	10GA	3/16	1/4	3/8	1/2	5/8	3/4
	Mild Steel									
85A Shielded				0.068	0.071	0.073	0.078	0.090	0.095	0.100
65A Shielded			0.062	0.065	0.068	0.070	0.076	0.088	0.090	0.091
45A Shielded	0.035	0.054	0.055	0.061	0.065	0.066				
FineCut	0.024	0.043	0.049	0.051						
85A Unshielded				0.070	0.073	0.075	0.080	0.085	0.090	
65A Unshielded			0.062	0.064	0.066	0.068	0.075	0.081		
45A Unshielded	0.020	0.050	0.051	0.054	0.057	0.059				
Stainless Steel										
85A Shielded				0.068	0.071	0.073	0.078	0.090	0.095	0.100
65A Shielded			0.062	0.065	0.068	0.070	0.076	0.088	0.090	0.091
45A Shielded	0.035	0.054	0.055	0.061	0.065	0.066				
FineCut	0.024	0.043	0.049	0.051						
85A Unshielded				0.070	0.073	0.075	0.080	0.085	0.090	
65A Unshielded			0.062	0.064	0.066	0.068	0.075	0.081		
45A Unshielded	0.020	0.050	0.051	0.054	0.057	0.059				
Aluminum										
		1/32	1/16	1/8	3/16	1/4	3/8	1/2	5/8	3/4
85A Shielded				0.080	0.078	0.075	0.080	0.090	0.095	0.100
65A Shielded			0.073	0.074	0.075	0.076	0.083	0.091	0.100	
45A Shielded		0.059	0.061	0.065		0.060				
85A Unshielded				0.075	0.075	0.075	0.080	0.082	0.088	
65A Unshielded			0.070	0.070	0.070	0.070	0.072	0.079		
45A Unshielded		0.062	0.058	0.057		0.061				

85 A shielded consumables



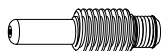
220817
Shield



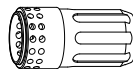
220854
Retaining cap



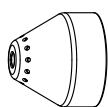
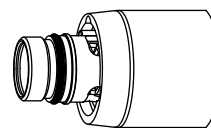
220816
Nozzle



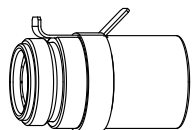
220842
Electrode



220857
Swirl ring



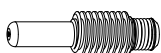
220817
Shield



220953
Ohmic-sensing
retaining cap



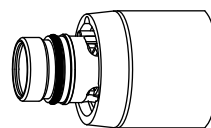
220816
Nozzle



220842
Electrode



220857
Swirl ring



85A Shielded
Mild Steel
Air flow rate - slpm/scfh

Hot 190 / 400

Cold 235 / 500

Metric

Material Thickness	Torch-to-Work Distance	Initial Pierce Height		Pierce Delay Time	Best Quality Settings		Production Settings	
					Cut Speed	Voltage	Cut Speed	Voltage
mm	mm	mm	%	seconds	(mm/min)	Volts	(mm/min)	Volts
3	1.5	3.8	250	0.1	6800	122	9200	120
4				0.2	5650	122	7300	122
6				0.5	3600	123	4400	125
8					2500	125	3100	127
10					1680	127	2070	128
12		4.5	300	0.7	1280	130	1600	130
16				1.0	870	134	930	133
20		6.0	400	1.5	570	137	680	136
25		Edge Start			350	142	450	141
30					200	146	300	144

English

Material Thickness	Torch-to-Work Distance	Initial Pierce Height		Pierce Delay Time	Best Quality Settings		Production Settings	
					Cut Speed	Voltage	Cut Speed	Voltage
	in	in	%	seconds	ipm	Volts	ipm	Volts
10GA	0.06	0.15	250	0.0	250	122	336	121
3/16 in				0.2	185	123	220	123
1/4 in				0.5	130	123	160	126
3/8 in					70	126	86	127
1/2 in					45	131	56	131
5/8 in		0.18	300	1.0	35	134	37	133
3/4 in		0.24	400	1.5	24	136	29	135
7/8 in		Edge Start			19	139	22	138
1 in					13	142	17	141
1-1/8 in					9	145	13	143
1-1/4 in					7	148	10	146

TORCH SETUP

**85A Shielded
Stainless Steel**

Air flow rate - slpm/scfh	
Hot	190 / 400
Cold	235 / 500

Metric

Material Thickness	Torch-to-Work Distance	Initial Pierce Height		Pierce Delay Time	Best Quality Settings		Production Settings		
					Cut Speed	Voltage	Cut Speed	Voltage	
mm	mm	mm	%	seconds	(mm/min)	Volts	(mm/min)	Volts	
3	1.5	3.8	250	0.1	7500	122	9200	120	
4				0.2	6100	122	7500	120	
6				0.5	3700	122	4600	122	
8					2450	124	3050	124	
10		4.5	300	0.7	1550	127	1900	126	
12					1100	131	1400	130	
16				1.0	700	135	760	134	
20		Edge Start				480	138	570	137
25						300	143	370	141

English

Material Thickness	Torch-to-Work Distance	Initial Pierce Height		Pierce Delay Time	Best Quality Settings		Production Settings	
					Cut Speed	Voltage	Cut Speed	Voltage
	in	in	%	seconds	ipm	Volts	ipm	Volts
10GA	0.06	0.15	250	0.2	275	122	336	120
3/16 in					200	122	240	121
1/4 in				0.5	130	122	164	122
3/8 in					65	126	80	125
1/2 in		0.18	300	36	132	48	131	
5/8 in				28	135	30	134	
3/4 in		Edge Start			20	137	24	136
7/8 in					16	140	19	139
1 in					11	143	14	141

**85A Shielded
Aluminum**

Air flow rate - slpm/scfh	
Hot	190 / 400
Cold	235 / 500

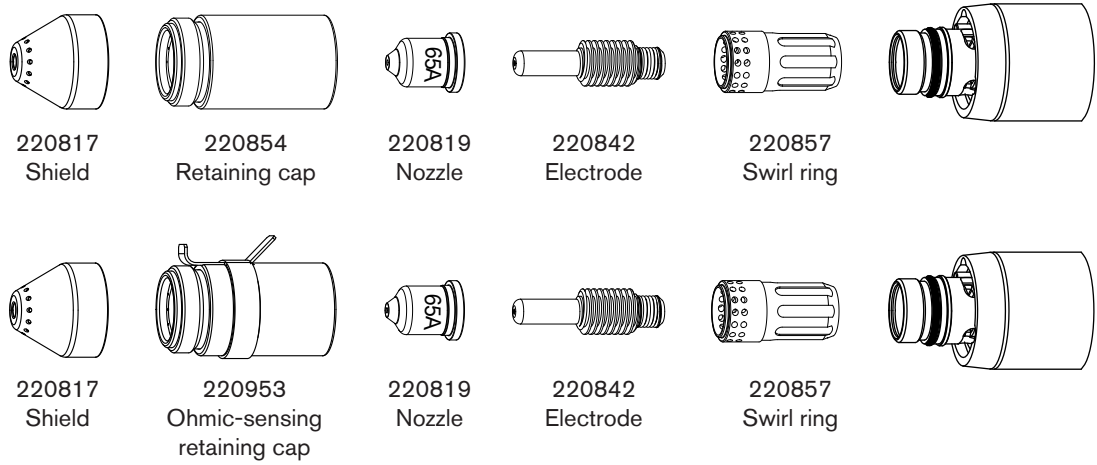
Metric

Material Thickness	Torch-to-Work Distance	Initial Pierce Height		Pierce Delay Time	Best Quality Settings		Production Settings	
					Cut Speed	Voltage	Cut Speed	Voltage
mm	mm	mm	%	seconds	(mm/min)	Volts	(mm/min)	Volts
3	1.5	3.8	250	0.1	8000	122	9400	121
4				0.2	6500	123	8000	123
6				0.5	3800	126	4900	126
8					2650	130	3470	129
10		4.5	300	1920	132	2500	131	
12				1450	134	1930	133	
16				950	139	1200	137	
20		Edge Start			600	143	880	141
25					380	146	540	144

English

Material Thickness	Torch-to-Work Distance	Initial Pierce Height		Pierce Delay Time	Best Quality Settings		Production Settings	
					Cut Speed	Voltage	Cut Speed	Voltage
	in	in	%	seconds	ipm	Volts	ipm	Volts
1/8 in	0.06	0.15	250	0.2	300	122	360	121
1/4 in				0.5	130	127	172	127
3/8 in					80	132	104	131
1/2 in		0.18	300	50	135	68	133	
5/8 in				1.0	38	139	48	137
3/4 in				Edge Start			25	142
7/8 in		20	144				29	142
1 in		14	146				20	144

65 A shielded consumables



65A Shielded
Mild Steel
Air flow rate - slpm/scfh

Hot	160 / 340
Cold	220 / 470

Metric

Material Thickness	Torch-to-Work Distance	Initial Pierce Height		Pierce Delay Time	Best Quality Settings		Production Settings	
					Cut Speed	Voltage	Cut Speed	Voltage
mm	mm	mm	%	seconds	(mm/min)	Volts	(mm/min)	Volts
2	1.5	3.8	250	0.1	6050	124	7000	121
3				0.2	5200	125	6100	123
4				0.5	4250	125	5100	124
6					2550	127	3240	127
8					1700	129	2230	128
10		4.5	300	0.7	1100	131	1500	129
12				1.2	850	134	1140	131
16		6.0	400	2.0	560	138	650	136
20		Edge Start			350	142	450	142
25					210	145	270	145

English

Material Thickness	Torch-to-Work Distance	Initial Pierce Height		Pierce Delay Time	Best Quality Settings		Production Settings	
					Cut Speed	Voltage	Cut Speed	Voltage
	in	in	%	seconds	ipm	Volts	ipm	Volts
16GA	0.06	0.15	250	0.1	260	123	294	121
10GA					190	125	224	123
3/16 in				0.2	140	126	168	125
1/4 in				0.5	90	127	116	127
3/8 in				0.7	45	130	62	129
1/2 in		0.18	300	1.2	30	135	40	132
5/8 in		0.24	400	2.0	23	138	26	136
3/4 in		Edge Start			15	141	19	141
7/8 in					12	143	14	143
1 in					8	145	10	145

TORCH SETUP

**65A Shielded
Stainless Steel**

Air flow rate - slpm/scfh	
Hot	160 / 340
Cold	220 / 470

Metric

Material Thickness	Torch-to-Work Distance	Initial Pierce Height		Pierce Delay Time	Best Quality Settings		Production Settings		
					Cut Speed	Voltage	Cut Speed	Voltage	
mm	mm	mm	%	seconds	(mm/min)	Volts	(mm/min)	Volts	
2	1.5	3.8	250	0.1	8100	125	10000	121	
3				0.2	6700	125	8260	123	
4				0.5	5200	125	6150	124	
6					2450	126	2850	126	
8				0.7	1500	129	1860	129	
10		4.5	300		960	132	1250	132	
12				1.2	750	135	920	134	
16		Edge Start				500	139	500	139
20						300	143	370	143

English

Material Thickness	Torch-to-Work Distance	Initial Pierce Height		Pierce Delay Time	Best Quality Settings		Production Settings	
					Cut Speed	Voltage	Cut Speed	Voltage
	in	in	%	seconds	ipm	Volts	ipm	Volts
16GA	0.06	0.15	250	0.1	345	124	426	121
10GA					240	125	296	123
3/16 in				0.2	155	126	168	125
1/4 in				0.5	80	126	96	126
3/8 in				0.7	40	131	52	131
1/2 in		0.18	300	1.2	26	136	32	135
5/8 in		Edge Start			20	139	20	139
3/4 in					14	142	15	142

**65A Shielded
Aluminum**

Air flow rate - slpm/scfh	
Hot	160 / 340
Cold	220 / 470

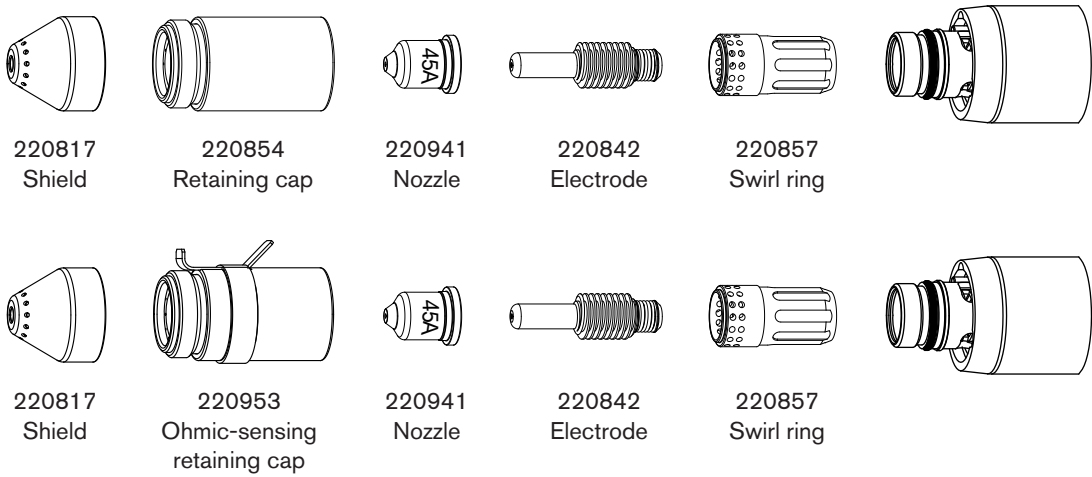
Metric

Material Thickness	Torch-to-Work Distance	Initial Pierce Height		Pierce Delay Time	Best Quality Settings		Production Settings		
					Cut Speed	Voltage	Cut Speed	Voltage	
mm	mm	mm	%	seconds	(mm/min)	Volts	(mm/min)	Volts	
2	1.5	3.8	250	0.1	8800	121	10300	122	
3				0.2	7400	124	8800	124	
4				0.5	6000	126	7350	125	
6					3200	130	4400	128	
8				0.7	1950	133	2750	130	
10		1200	136		1650	132			
12		4.5	300	1.2	1000	138	1330	136	
16		Edge Start				650	143	800	141
20						380	147	560	145

English

Material Thickness	Torch-to-Work Distance	Initial Pierce Height		Pierce Delay Time	Best Quality Settings		Production Settings	
					Cut Speed	Voltage	Cut Speed	Voltage
	in	in	%	seconds	ipm	Volts	ipm	Volts
1/16 in	0.06	0.15	250	0.1	365	121	428	121
1/8 in					280	124	336	124
1/4 in				0.5	105	131	152	128
3/8 in				0.7	50	135	68	131
1/2 in		0.18	300	1.2	35	139	48	138
5/8 in		Edge Start			26	143	32	141
3/4 in					16	146	24	144

45 A shielded consumables



45A Shielded
Mild Steel

Air flow rate - slpm/scfh	
Hot	150 / 310
Cold	210/ 450

Metric

Material Thickness	Torch-to-Work Distance	Initial Pierce Height		Pierce Delay Time	Best Quality Settings		Production Settings	
					Cut Speed	Voltage	Cut Speed	Voltage
mm	mm	mm	%	seconds	(mm/min)	Volts	(mm/min)	Volts
0.5	1.5	3.8	250	0.0	9000	128	12500	126
1					9000	128	10800	128
1.5				0.1	9000	130	10200	129
2				0.3	6600	130	7800	129
3				0.4	3850	133	4900	131
4					2200	134	3560	131
6				0.5	1350	137	2050	132

English

Material Thickness	Torch-to-Work Distance	Initial Pierce Height		Pierce Delay Time	Best Quality Settings		Production Settings	
					Cut Speed	Voltage	Cut Speed	Voltage
	in	in	%	seconds	ipm	Volts	ipm	Volts
26GA	0.06	0.15	250	0.0	350	128	500	128
22GA					350	128	450	128
18GA				0.1	350	129	400	128
16GA					350	130	400	129
14GA				0.2	270	130	320	129
12GA				0.4	190	133	216	131
10GA					100	134	164	131
3/16 in				0.5	70	135	108	132
1/4 in				0.6	48	137	73	132

TORCH SETUP

**45A Shielded
Stainless Steel**

Air flow rate - slpm/scfh	
Hot	150 / 310
Cold	210/ 450

Metric

Material Thickness	Torch-to-Work Distance	Initial Pierce Height		Pierce Delay Time	Best Quality Settings		Production Settings	
					Cut Speed	Voltage	Cut Speed	Voltage
mm	mm	mm	%	seconds	(mm/min)	Volts	(mm/min)	Volts
0.5	1.5	3.8	250	0.0	9000	130	12500	129
1					9000	130	10800	130
1.5				0.1	9000	130	10200	130
2				0.3	6000	132	8660	131
3				0.4	3100	132	4400	132
4					2000	134	2600	134
6				0.5	900	140	1020	139

English

Material Thickness	Torch-to-Work Distance	Initial Pierce Height		Pierce Delay Time	Best Quality Settings		Production Settings	
					Cut Speed	Voltage	Cut Speed	Voltage
	in	in	%	seconds	ipm	Volts	ipm	Volts
26GA	0.06	0.15	250	0.0	350	130	500	129
22GA					350	130	450	129
18GA				0.1	350	130	400	130
16GA					350	130	400	130
14GA				0.2	250	132	360	131
12GA				0.4	140	132	206	131
10GA					100	133	134	134
3/16 in				0.5	52	135	58	135
1/4 in				0.6	30	141	35	140

45A Shielded
Aluminum

Air flow rate - slpm/scfh	
Hot	150 / 310
Cold	210/ 450

Metric

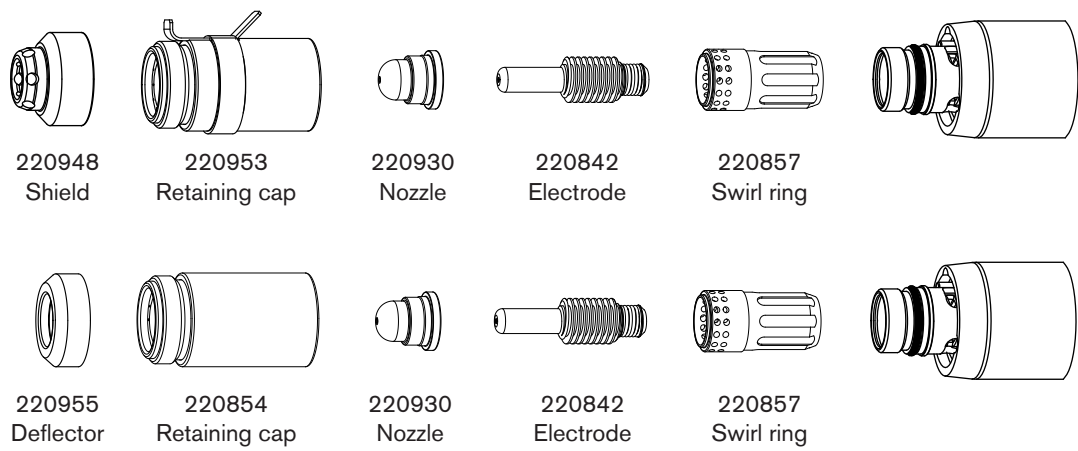
Material Thickness	Torch-to-Work Distance	Initial Pierce Height		Pierce Delay Time	Best Quality Settings		Production Settings	
					Cut Speed	Voltage	Cut Speed	Voltage
mm	mm	mm	%	seconds	(mm/min)	Volts	(mm/min)	Volts
1	1.5	3.8	250	0.0	8250	136	11000	136
2				0.1	6600	136	9200	135
3				0.2	3100	139	6250	134
4				0.4	2200	141	4850	135
6				0.5	1500	142	2800	137

English

Material Thickness	Torch-to-Work Distance	Initial Pierce Height		Pierce Delay Time	Best Quality Settings		Production Settings	
					Cut Speed	Voltage	Cut Speed	Voltage
	in	in	%	seconds	ipm	Volts	ipm	Volts
1/32 in	0.06	0.15	250	0.0	325	136	450	136
1/16 in				0.1	325	136	400	136
3/32 in				0.2	200	136	328	134
1/8 in				0.4	100	140	224	134
1/4 in				0.5	54	142	96	137

FineCut® consumables

Note: The cut charts in this section apply to both shielded and unshielded consumables.



FineCut
Mild Steel

Air flow rate - slpm/scfh	
Hot	155 / 330
Cold	215 / 460

Metric

Material Thickness	Amps	Torch-to-Work Distance	Initial Pierce Height		Pierce Delay Time	Best Quality Settings	
						Cut Speed	Voltage
mm	A	mm	mm	%	seconds	(mm/min)	Volts
0.5	40	1.5	2.25	150	0.0	8250	78
0.6						8250	78
0.8						8250	78
1	45				0.2	8250	78
1.5					0.4	6400	78
2						4800	78
3					0.5	2750	78
4					0.6	1900	78

English

Material Thickness	Amps	Torch-to-Work Distance	Initial Pierce Height		Pierce Delay Time	Best Quality Settings	
						Cut Speed	Voltage
	A	in	in	%	seconds	ipm	Volts
26GA	40	0.06	0.09	150	0.0	325	78
24GA						325	78
22GA					0.1	325	78
20GA						325	78
18GA	45				0.2	325	78
16GA					0.4	250	78
14GA						200	78
12GA					0.5	120	78
10GA						95	78

TORCH SETUP

FineCut
Stainless Steel

Air flow rate - slpm/scfh	
Hot	155 / 330
Cold	215 / 460

Metric

Material Thickness	Amps	Torch-to-Work Distance	Initial Pierce Height		Pierce Delay Time	Best Quality Settings	
						Cut Speed	Voltage
mm	A	mm	mm	%	seconds	(mm/min)	Volts
0.5	40	0.5	2.0	400	0.0	8250	68
0.6						8250	68
0.8					0.1	8250	68
1	45				0.15	8250	68
1.5					0.4	6150	70
2						4800	71
3					0.5	2550	80
4					0.6	1050	80

English

Material Thickness	Amps	Torch-to-Work Distance	Initial Pierce Height		Pierce Delay Time	Best Quality Settings	
						Cut Speed	Voltage
	A	in	in	%	seconds	ipm	Volts
26GA	40	0.02	0.08	400	0.0	325	68
24GA						325	68
22GA					0.1	325	68
20GA						325	68
18GA	45				0.2	325	68
16GA					0.4	240	70
14GA						200	70
12GA					0.5	120	80
10GA					0.6	75	80

**Low Speed FineCut
Mild Steel**

Air flow rate – slpm/scfh	
Hot	155 / 330
Cold	215 / 460

Metric

Material Thickness	Current	Torch-to-Work Distance	Initial Pierce Height		Pierce Delay Time	Recommended	
						Cut Speed	Voltage
mm	A	mm	mm	%	seconds	(mm/min)	Volts
0.5	30	1.5	2.25	150	0.0	3800	69
0.6						3800	68
0.8						3800	70
1 *	40				0.2	3800	72
1.5 *					3800	75	
2	45				0.4	3700	76
3						2750	78
4					0.5	1900	78

English

Material Thickness	Current	Torch-to-Work Distance	Initial Pierce Height		Pierce Delay Time	Recommended				
						Cut Speed	Voltage			
	A	inches	inches	%	seconds	ipm	Volts			
26GA	30	0.06	0.09	150	0.0	150	70			
24GA						150	68			
22GA					0.1	150	70			
20GA						150	71			
18GA	40				0.2	150	73			
16GA *					0.4	150	75			
14GA *	45					150	76			
12GA	45				0.5	120	78			
10GA						95	78			

*Not a dross-free cut.

TORCH SETUP

Low Speed FineCut
Stainless Steel

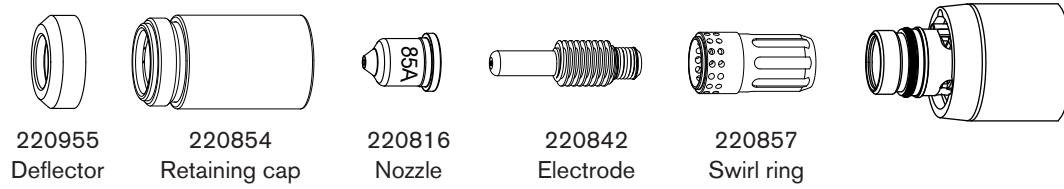
Air flow rate – slpm/scfh	
Hot	155 / 330
Cold	215 / 460

Metric

Material Thickness	Current	Torch-to-Work Distance	Initial Pierce Height		Pierce Delay Time	Recommended	
						Cut Speed	Voltage
mm	A	mm	mm	%	seconds	(mm/min)	Volts
0.5	30	0.5	2.0	400	0.0	3800	69
0.6						3800	69
0.8					0.1	3800	69
1	40				0.15	3800	69
1.5					0.4	2900	69
2						2750	69
3	45				0.5	2550	80
4					0.6	1050	80

English

Material Thickness	Current	Torch-to-Work Distance	Initial Pierce Height		Pierce Delay Time	Recommended	
						Cut Speed	Voltage
	A	in	in	%	seconds	ipm	Volts
26GA	30	0.02	0.08	400	0.0	150	69
24GA						150	69
22GA					0.1	150	69
20GA						150	69
18GA	40				0.2	145	69
16GA					0.4	115	69
14GA						110	69
12GA	45				0.5	120	80
10GA					0.6	75	80

85 A unshielded consumables

TORCH SETUP

85A Unshielded

Mild Steel

Air flow rate - slpm/scfh

Hot 190 / 400

Cold 235 / 500

Metric

Material Thickness	Torch-to-Work Distance	Initial Pierce Height		Pierce Delay Time	Best Quality Settings		Production Settings	
					Cut Speed	Voltage	Cut Speed	Voltage
mm	mm	mm	%	seconds	(mm/min)	Volts	(mm/min)	Volts
2	2.0	5.0	250	0.0	7150	117	10400	116
3				0.1	6240	118	9000	117
4				0.2	5250	118	7200	117
6				0.5	3450	120	4400	119
8					2400	121	3100	121
10					1560	123	2070	122
12		6.0	300	0.7	1200	126	1600	124
16		Edge Start			820	132	930	128
20					540	137	640	132
25					320	143	400	137

English

Material Thickness	Torch-to-Work Distance	Initial Pierce Height		Pierce Delay Time	Best Quality Settings		Production Settings	
					Cut Speed	Voltage	Cut Speed	Voltage
	in	in	%	seconds	ipm	Volts	ipm	Volts
14GA	0.08	0.20	250	0.1	280	117	416	116
10GA				0.2	230	118	328	117
3/16 in					175	119	220	118
1/4 in					0.5	125	120	160
3/8 in				65		122	86	122
1/2 in		0.24	300	0.6	42	127	56	125
5/8 in		Edge Start			33	131	37	128
3/4 in					23	136	27	131
7/8 in					18	140	21	134
1 in					12	144	15	138

**85A Unshielded
Stainless Steel**

Air flow rate - slpm/scfh	
Hot	190 / 400
Cold	235 / 500

Metric

Material Thickness	Torch-to-Work Distance	Initial Pierce Height		Pierce Delay Time	Best Quality Settings		Production Settings		
					Cut Speed	Voltage	Cut Speed	Voltage	
mm	mm	mm	%	seconds	(mm/min)	Volts	(mm/min)	Volts	
2	2.0	5.0	250	0.1	8550	117	11300	116	
3					7000	118	9660	117	
4				0.2	5600	118	7800	118	
6					0.5	3400	120	4570	121
8				2250		121	2970	122	
10		6.0	300	0.5	1430	123	1840	124	
12				0.7	1000	129	1340	128	
16		Edge Start				650	134	730	133
20						360	138	570	137

English

Material Thickness	Torch-to-Work Distance	Initial Pierce Height		Pierce Delay Time	Best Quality Settings		Production Settings	
					Cut Speed	Voltage	Cut Speed	Voltage
	in	in	%	seconds	ipm	Volts	ipm	Volts
14GA	0.08	0.20	250	0.1	340	117	452	116
10GA				0.2	250	118	352	118
3/16 in					180	119	249	119
1/4 in				0.5	120	120	160	121
3/8 in					60	122	77	123
1/2 in		0.24	300	0.6	35	131	46	129
5/8 in		Edge Start			26	134	29	133
3/4 in					17	137	24	136

TORCH SETUP

85A Unshielded

Aluminum

Air flow rate - slpm/scfh

Hot 190 / 400

Cold 235 / 500

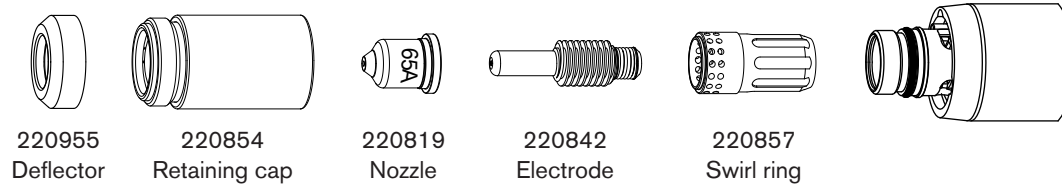
Metric

Material Thickness	Torch-to-Work Distance	Initial Pierce Height		Pierce Delay Time	Best Quality Settings		Production Settings		
					Cut Speed	Voltage	Cut Speed	Voltage	
mm	mm	mm	%	seconds	(mm/min)	Volts	(mm/min)	Volts	
2	2.0	5.0	250	0.1	8700	118	11200	118	
3					7350	120	9600	119	
4				0.2	6000	122	8100	120	
6					0.5	3300	125	4930	122
8		6.0	300	0.5		2350	127	3250	124
10					0.7	1800	128	2140	127
12				Edge Start			1300	133	1720
16					840		139	1130	134
20		470	144		700		138		

English

Material Thickness	Torch-to-Work Distance	Initial Pierce Height		Pierce Delay Time	Best Quality Settings		Production Settings	
					Cut Speed	Voltage	Cut Speed	Voltage
	in	in	%	seconds	ipm	Volts	ipm	Volts
1/8 in	0.08	0.20	250	0.2	280	120	368	119
3/16 in					200	123	271	120
1/4 in				0.5	110	126	172	122
3/8 in					75	127	88	126
1/2 in		0.24	300	0.6	45	135	62	131
5/8 in		Edge Start			34	139	45	134
3/4 in					22	143	32	137

65 A unshielded consumables



TORCH SETUP

65A Unshielded

Mild Steel

Air flow rate - slpm/scfh

Hot 160 / 340

Cold 220 / 470

Metric

Material Thickness	Torch-to-Work Distance	Initial Pierce Height		Pierce Delay Time	Best Quality Settings		Production Settings	
					Cut Speed	Voltage	Cut Speed	Voltage
mm	mm	mm	%	seconds	(mm/min)	Volts	(mm/min)	Volts
2	2.0	5.0	250	0.1	6050	117	7340	117
3				0.2	5200	118	6330	118
4				0.5	4250	118	5250	118
6					2550	120	3560	120
8					1620	123	2230	121
10		6.0	300	0.7	970	127	1500	122
12		Edge Start			760	129	1140	124
16					500	134	650	129
20					280	138	400	133

English

Material Thickness	Torch-to-Work Distance	Initial Pierce Height		Pierce Delay Time	Best Quality Settings		Production Settings	
					Cut Speed	Voltage	Cut Speed	Voltage
	in	in	%	seconds	ipm	Volts	ipm	Volts
16GA	0.08	0.20	250	0.1	255	116	308	117
10GA					190	118	232	118
3/16 in				0.2	135	119	172	119
1/4 in				0.5	90	120	116	120
3/8 in		0.24	300	0.7	40	126	62	122
1/2 in		Edge Start			27	130	40	125
5/8 in					20	134	26	129
3/4 in					13	137	18	132

**65A Unshielded
Stainless Steel**

Air flow rate - slpm/scfh	
Hot	160 / 340
Cold	220 / 470

Metric

Material Thickness	Torch-to-Work Distance	Initial Pierce Height		Pierce Delay Time	Best Quality Settings		Production Settings	
					Cut Speed	Voltage	Cut Speed	Voltage
mm	mm	mm	%	seconds	(mm/min)	Volts	(mm/min)	Volts
2	2.0	5.0	250	0.1	7950	117	10300	116
3				0.2	6600	118	8500	117
4				0.5	5050	119	6500	119
6					2300	121	3070	121
8				0.7	1400	123	1900	122
10		6.0	300	0.7	920	126	1250	123
12		Edge Start			710	130	925	127
16					430	135	500	133

English

Material Thickness	Torch-to-Work Distance	Initial Pierce Height		Pierce Delay Time	Best Quality Settings		Production Settings	
					Cut Speed	Voltage	Cut Speed	Voltage
	in	in	%	seconds	ipm	Volts	ipm	Volts
16GA	0.08	0.20	250	0.1	340	116	437	115
10GA					235	118	304	118
3/16 in				0.2	150	120	194	120
1/4 in				0.5	75	121	100	121
3/8 in		0.24	300	0.7	38	125	52	122
1/2 in		Edge Start			25	132	32	129
5/8 in					17	135	20	133

TORCH SETUP

65A Unshielded

Aluminum

Air flow rate - slpm/scfh

Hot 160 / 340

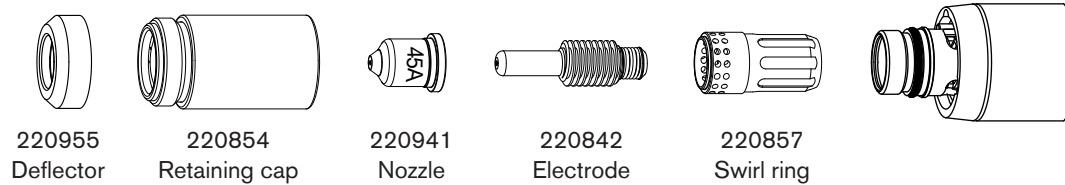
Cold 220 / 470

Metric

Material Thickness	Torch-to-Work Distance	Initial Pierce Height		Pierce Delay Time	Best Quality Settings		Production Settings	
					Cut Speed	Voltage	Cut Speed	Voltage
mm	mm	mm	%	seconds	(mm/min)	Volts	(mm/min)	Volts
2	2.0	5.0	250	0.1	7750	123	11300	122
3				0.2	6550	124	9500	123
4				0.5	5400	125	7640	124
6					3000	127	3900	126
8				0.7	1800	130	2460	127
10		6.0	300	0.7	1100	133	1640	129
12		Edge Start			900	135	1250	133
16					600	139	700	136

English

Material Thickness	Torch-to-Work Distance	Initial Pierce Height		Pierce Delay Time	Best Quality Settings		Production Settings	
					Cut Speed	Voltage	Cut Speed	Voltage
	in	in	%	seconds	ipm	Volts	ipm	Volts
1/16 in	0.08	0.20	250	0.1	325	122	476	122
1/8 in					250	124	360	123
3/16 in					175	125	245	124
1/4 in				0.5	100	127	128	126
3/8 in		0.24	300	0.7	45	132	68	128
1/2 in		Edge Start			32	136	44	134
5/8 in					24	138	28	136

45 A unshielded consumables

TORCH SETUP

45A Unshielded

Mild Steel

Air flow rate - slpm/scfh	
Hot	147 / 310
Cold	210 / 450

Metric

Material Thickness	Torch-to-Work Distance	Initial Pierce Height		Pierce Delay Time	Best Quality Settings		Production Settings	
					Cut Speed	Voltage	Cut Speed	Voltage
mm	mm	mm	%	seconds	(mm/min)	Volts	(mm/min)	Volts
0.5	1.5	3.8	250	0.0	9000	120	12500	120
1					9000	120	10800	121
1.5				0.1	7700	120	10200	121
2				0.3	6150	119	7800	122
3				0.4	3950	121	4900	123
4					2350	123	3560	124
6				0.5	1400	126	2050	124

English

Material Thickness	Torch-to-Work Distance	Initial Pierce Height		Pierce Delay Time	Best Quality Settings		Production Settings	
					Cut Speed	Voltage	Cut Speed	Voltage
	in	in	%	seconds	ipm	Volts	ipm	Volts
26GA	0.06	0.15	250	0.0	350	120	500	120
22GA					350	120	450	120
18GA				0.1	350	119	400	121
16GA					300	121	400	121
14GA				0.2	250	119	320	122
12GA				0.4	200	120	216	123
10GA					100	123	164	124
3/16 in				0.5	85	122	108	124
1/4 in				0.6	48	127	73	124

**45A Unshielded
Stainless Steel**

Air flow rate - slpm/scfh	
Hot	147 / 310
Cold	210 / 450

Metric

Material Thickness	Torch-to-Work Distance	Initial Pierce Height		Pierce Delay Time	Best Quality Settings		Production Settings	
					Cut Speed	Voltage	Cut Speed	Voltage
mm	mm	mm	%	seconds	(mm/min)	Volts	(mm/min)	Volts
0.5	1.5	3.8	250	0.0	9000	121	12500	119
1					9000	121	10800	119
1.5				0.1	9000	121	10200	120
2				0.3	6000	122	9600	120
3				0.4	3250	123	4750	120
4					1900	128	3000	122
6				0.5	700	130	1450	124

English

Material Thickness	Torch-to-Work Distance	Initial Pierce Height		Pierce Delay Time	Best Quality Settings		Production Settings	
					Cut Speed	Voltage	Cut Speed	Voltage
	in	in	%	seconds	ipm	Volts	ipm	Volts
26GA	0.06	0.15	250	0.0	350	120	500	119
22GA					350	120	450	119
18GA				0.1	350	118	400	119
16GA					350	121	400	120
14GA				0.2	300	122	400	120
12GA				0.4	150	121	224	120
10GA					100	125	140	121
3/16 in				0.5	42	131	88	123
1/4 in				0.6	25	130	48	124

TORCH SETUP

45A Unshielded

Aluminum

Air flow rate - slpm/scfh

Hot 147 / 310

Cold 210 / 450

Metric

Material Thickness	Torch-to-Work Distance	Initial Pierce Height		Pierce Delay Time	Best Quality Settings		Production Settings	
					Cut Speed	Voltage	Cut Speed	Voltage
mm	mm	mm	%	seconds	(mm/min)	Volts	(mm/min)	Volts
1	1.5	3.8	250	0.0	7400	126	11000	121
2				0.1	4400	127	9200	123
3				0.2	2800	129	6250	125
4				0.4	2100	132	4700	126
6				0.5	1050	135	2250	127

English

Material Thickness	Torch-to-Work Distance	Initial Pierce Height		Pierce Delay Time	Best Quality Settings		Production Settings	
					Cut Speed	Voltage	Cut Speed	Voltage
	in	in	%	seconds	ipm	Volts	ipm	Volts
1/32 in	0.06	0.15	250	0.0	325	126	450	121
1/16 in				0.1	200	126	400	122
3/32 in				0.2	150	127	328	124
1/8 in				0.4	100	130	224	125
1/4 in				0.5	36	136	72	127

Section 4

OPERATION

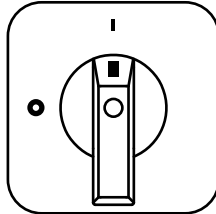
In this section:

Controls and indicators	4-2
Rear controls	4-2
Front controls and LEDs	4-2
Status screen	4-4
Operating the Powermax65 or Powermax85	4-6
Connect the electrical power, gas supply, and torch lead	4-6
Attach the work lead to the power supply	4-7
Attach the work clamp to the workpiece	4-8
Turn ON the system	4-9
Set the operating mode switch	4-9
Check the indicators	4-10
Manually adjusting the gas pressure	4-10
Adjusting the current (amperage)	4-11
Understanding duty-cycle limitations	4-12
Using the hand torch	4-13
Operate the safety trigger	4-13
Hand torch cutting hints	4-14
Start a cut from the edge of the workpiece	4-15
Pierce a workpiece	4-16
Gouge a workpiece	4-17
Common hand-cutting faults	4-20
Using the machine torch	4-21
Ensure the torch and table are set up correctly	4-21
Understand and optimize cut quality	4-21
To pierce a workpiece using the machine torch	4-23
Common machine-cutting faults	4-24

Controls and indicators

The Powermax65 and Powermax85 power supplies have the following: ON/OFF switch, adjustment knob, automatic/manual pressure setting mode selector, current/gas selector, operating mode switch, indicator LEDs, and a status screen.

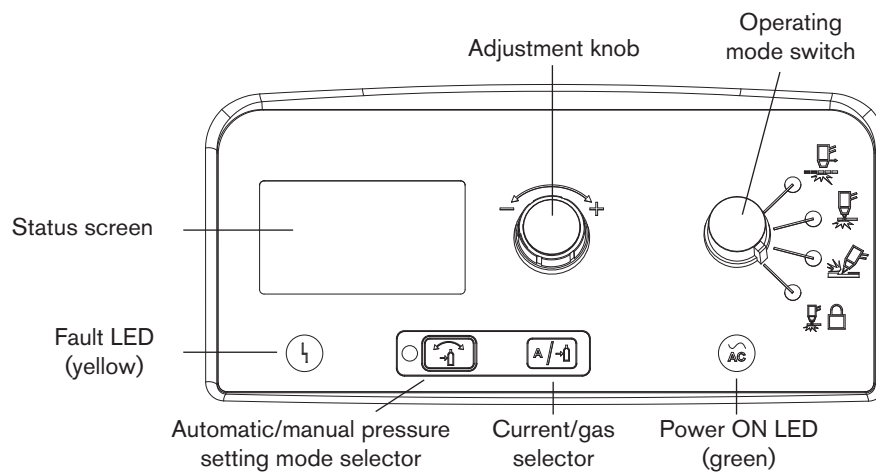
Rear controls



ON (I)/OFF (O) power switch

Activates the power supply and its control circuits.

Front controls and LEDs



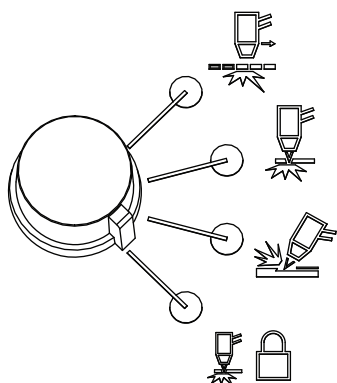
Fault LED (yellow)

When illuminated, this LED indicates that there is a fault with the power supply. For information about these fault conditions and how to correct them, refer to section 5.



Power ON LED (green)

When illuminated, this LED indicates that the power switch has been set to I (ON) and that the safety interlocks are satisfied. When blinking, the power supply has a fault.



Operating mode switch

The operating mode switch can be set in one of four positions:

- Continuous pilot arc. Cuts expanded metal or grate.
- Non-continuous pilot arc. Cuts or pierces metal plate. This is the standard setting for normal drag-cutting.
- Gouge. Gouges metal plate.
- Torch lock. Same as the non-continuous pilot arc mode except the torch is locked in the ON position when you release the trigger during a cut.



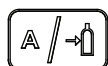
Automatic/manual pressure setting mode selector

The selector switches between automatic and manual mode. In automatic mode, the power supply automatically sets the gas pressure based upon the torch type and lead length and the adjustment knob sets only the amperage. In manual mode, the adjustment knob sets either the gas pressure or the amperage. This LED is illuminated in manual mode.

Note: Manual mode should be used by experienced users who need to optimize the gas setting (override the automatic gas setting) for a specific cutting application.

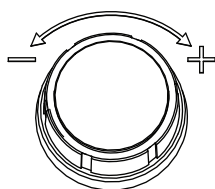
When you switch from manual mode to automatic mode, the power supply automatically sets the gas pressure and the amperage setting is unchanged. When you switch from automatic mode to manual mode, the power supply remembers the previous manual gas pressure setting and the amperage setting is unchanged.

When you reset the power, the power supply remembers the previous mode, gas pressure, and amperage settings.



Current/gas selector

When in manual mode, this selector toggles between amperage and gas pressure for manual adjustments using the adjustment knob.

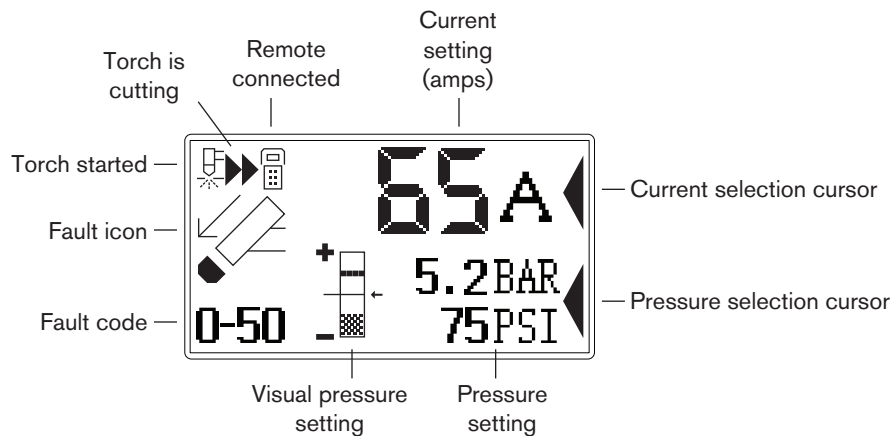


Adjustment knob

This knob adjusts the amperage. When operating in manual mode, this knob can also adjust the gas pressure, overriding the automatic setting for optimized applications.

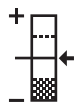
Status screen

The status screen shows system status and fault information.



Gas pressure indicators

In manual mode, the gas pressure is displayed in bar and psi. The gas pressure bar is also a visual indicator of the gas pressure.



Gas pressure bar

When the arrow is centered in the vertical bar (the reference pressure of the automatic pressure setting), the gas pressure is set to the preset (factory-defined) value. If the pressure is higher than the preset value, the arrow appears above the mid-point of the bar. If the pressure is lower than the preset value, the arrow appears below the mid-point of the bar.

Note: In automatic mode, the power supply adjusts the pressure to the preset value. You can use manual mode to adjust the pressure to satisfy the needs of a particular cutting job. Refer to 4-10 *Manually adjusting the gas pressure*.

System status icons

The screen displays icons to indicate the system's status.



Torch started

Indicates that the torch has received a start signal and has initiated a pilot arc.



Torch is cutting

Indicates that the cutting arc has transferred to the metal and the torch is cutting.



Remote control

Indicates that a remote control is controlling the power supply. All local controls are disabled.

Fault codes

When a power supply or torch fault occurs, the system displays a fault code in the lower-left corner of the status screen and displays a corresponding fault icon above the code. The first digit is always zero. The other two digits identify the problem. Refer to section 5 for troubleshooting information.

Note: Only one fault code is displayed. If more than one fault occurs at the same time, only the fault code with the highest priority is displayed.

Fault icons

The fault icons that appear on the left side of the status screen are described below. A fault code also appears to identify the fault. Refer to section 5 for troubleshooting information.



Warning

The system continues to run.



Fault

The system stops cutting. If you can not correct the problem and restart the system, contact your distributor or Hypertherm Technical Service.



Error

The system requires service. Contact your distributor or Hypertherm Technical Service.



Torch cap sensor

Indicates that the consumables are loose, improperly installed, or missing. Turn OFF the power, properly install the consumables, and turn ON the system again to reset the power supply.



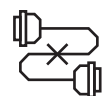
Temperature

Indicates that the temperature of the power supply power module is outside the acceptable operating range.



Gas

Indicates that the gas is disconnected from the rear of the power supply or there is a problem with the gas supply.



Internal Serial Communications Interface

Indicates a problem with the SCl communications between the control board and the DSP board.

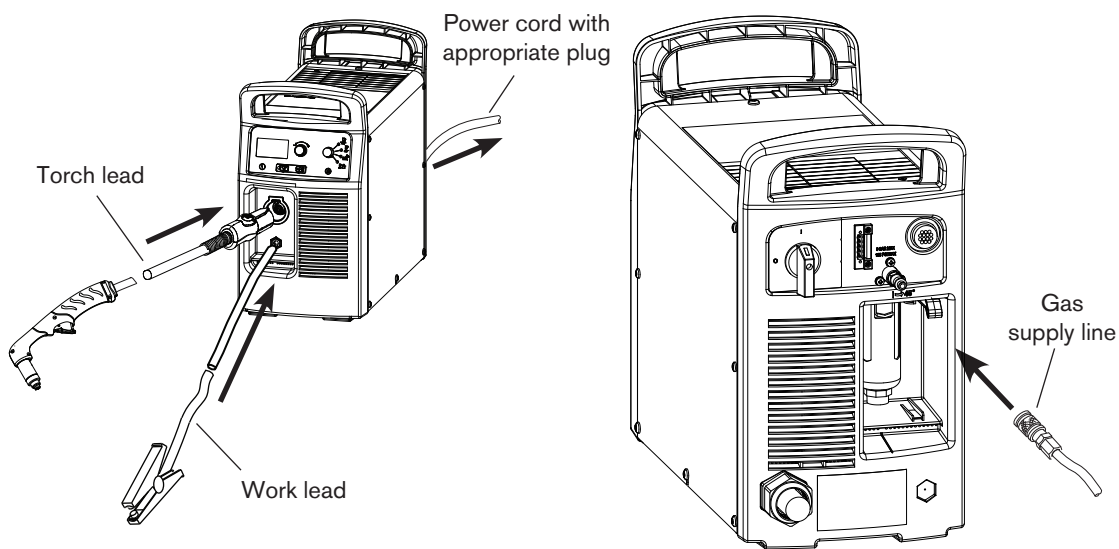
Operating the Powermax65 or Powermax85

Follow the steps below to begin cutting or gouging with the Powermax65 or Powermax85.

Connect the electrical power, gas supply, and torch lead

For information on connecting the proper power cord with plug to the power supply, refer to Section 2, *Power Supply Setup*.

Plug in the power cord and connect the gas supply line. For more information about the electrical requirements and the gas supply requirements of the Powermax65 and Powermax85, see Section 2, *Power Supply Setup*. To connect the torch, push the FastConnect™ connector into the receptacle on the front of the power supply. You will attach the work lead in the next section.



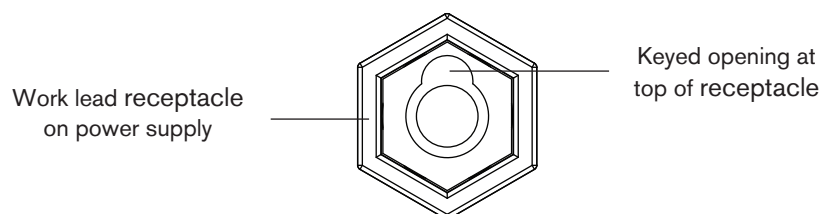
Attach the work lead to the power supply



Caution: Make sure you use a work lead that is appropriate for your power supply. Use a 65 A work lead with the Powermax65. Use an 85 A work lead with the Powermax85. The amperage is marked near the rubber boot of the work lead connector.

1. Insert the work lead connector into the receptacle on the front of the power supply.

Note: The receptacle is keyed. Align the key on the work lead connector with the opening at the top of the receptacle on the power supply.



2. Push the work lead connector all the way into the receptacle on the power supply and turn clockwise, approximately 1/4 turn, until the connector is fully seated against the stop in order to achieve an optimal electrical connection.



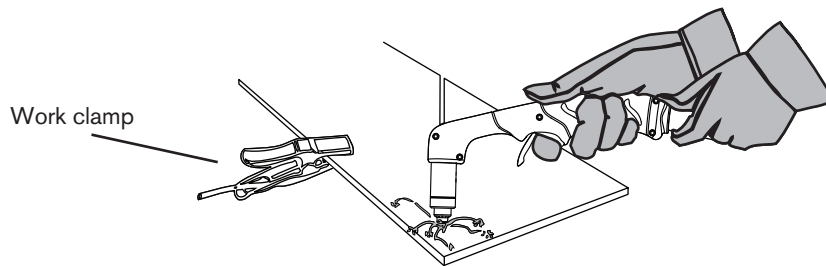
Caution: Ensure the work lead is fully seated in the receptacle to prevent overheating.

Attach the work clamp to the workpiece

The work clamp must be connected to the workpiece while you are cutting. If you are using the Powermax65 or Powermax85 with a cutting table, you can connect the work lead directly to the table instead of attaching the work clamp to the workpiece. See your table manufacturer's instructions.

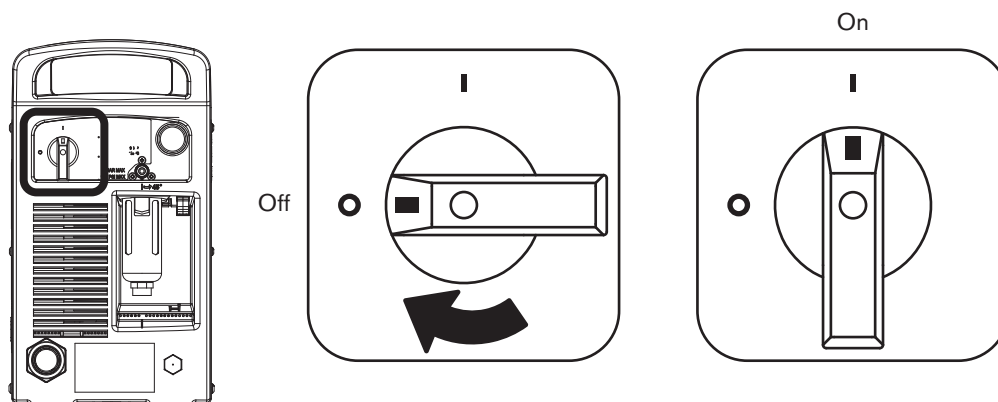
Note the following:

- Ensure that the work clamp and the workpiece make good metal-to-metal contact. Remove rust, dirt, paint, coatings, and other debris to ensure the power supply makes proper contact with the workpiece.
- For the best cut quality, attach the work clamp as close as possible to the area being cut.
- **Do not attach the work clamp to the portion of the workpiece to be cut away.**



Turn ON the system

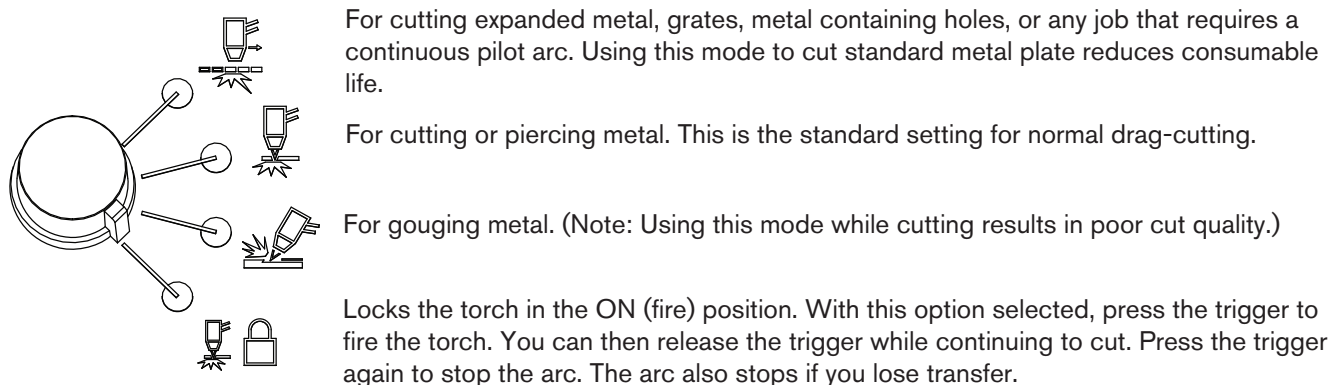
Set the ON/OFF switch to the ON (I) position.



Set the operating mode switch

Use the operating mode switch to select the type of work you want to perform.

In automatic gas mode, Smart Sense™ technology automatically adjusts the gas pressure according to the selected cutting mode and torch lead length for optimum cutting.



Check the indicators

Verify the following:

- The green power ON LED on the front of the power supply is illuminated.
- The Fault LED is *not* illuminated.
- No error icons appear in the status screen.

If a fault icon appears in the status screen, or the Fault LED is illuminated, or the power ON LED is blinking, correct the fault condition before continuing. Refer to Section 5 for troubleshooting information.

Manually adjusting the gas pressure

For normal operations, the power supply automatically adjusts the gas pressure. If you need to adjust the gas pressure for a specific application, you can use manual mode to do so.

Note: Manual mode should be used by experienced users who need to optimize the gas setting (override the automatic gas setting) for a specific cutting application.

When you switch from manual mode to automatic mode, the power supply automatically sets the gas pressure and the amperage setting is unchanged. When you switch from automatic mode to manual mode, the power supply remembers the previous manual gas pressure setting and the amperage setting is unchanged.

When you reset the power, the power supply remembers the previous mode, gas pressure, and amperage settings.

To adjust the pressure:

1. Press the automatic/manual pressure setting mode selector so that the LED next to the selector illuminates. Refer to the diagram in 4-2 *Front controls and LEDs*.
2. Press the current/gas selector until the selection cursor is opposite the gas pressure setting in the status screen.
3. Turn the adjustment knob to adjust the gas pressure to the desired level. Watch the arrow in the pressure bar as you adjust the pressure.

Adjusting the current (amperage)

Turn the adjustment knob to adjust the current for your particular cutting application.

If the system is in manual mode, do the following to adjust the amperage.

1. Press the current/gas selector until the selection cursor is opposite the amperage setting in the status screen.
2. Turn the adjustment knob to change the amperage.
3. If you wish to exit manual mode, press the automatic/manual pressure setting mode selector. The LED goes off.

Note: When you exit manual mode, the gas pressure resets to the factory-optimized value.

When you switch between manual mode and automatic mode, the power supply retains the amperage setting. When you reset the power, the power supply returns to the previous mode (automatic mode or manual mode) and remembers the previous amperage setting.

Understanding duty-cycle limitations

The duty cycle is the amount of time, in minutes, that a plasma arc can remain on within a 10-minute period when operating at an ambient temperature of 104° F (40° C).

With a Powermax65:

- At 65 A, the arc can remain on for 5 minutes out of 10 minutes without causing the unit to overheat (50% duty cycle).
- At 59 A, the arc can remain on for 6 minutes out of 10 (60%)
- At 46 A, the arc can remain on for 10 minutes out of 10 (100%).

With a Powermax85:

- At 85 A, the arc can remain on for 6 minutes out of 10 minutes without causing the unit to overheat (60% duty cycle).
- At 74 A, the arc can remain on for 8 minutes out of 10 (80%)
- At 66 A, the arc can remain on for 10 minutes out of 10 (100%).

If the duty cycle is exceeded, the power supply overheats, the temperature fault icon appears in the status screen, the arc shuts off, and the cooling fan continues to run. You can not resume cutting until the temperature fault icon disappears and the fault LED goes off.

Using the hand torch



WARNING
INSTANT-ON TORCHES
PLASMA ARC CAN CAUSE INJURY AND BURNS

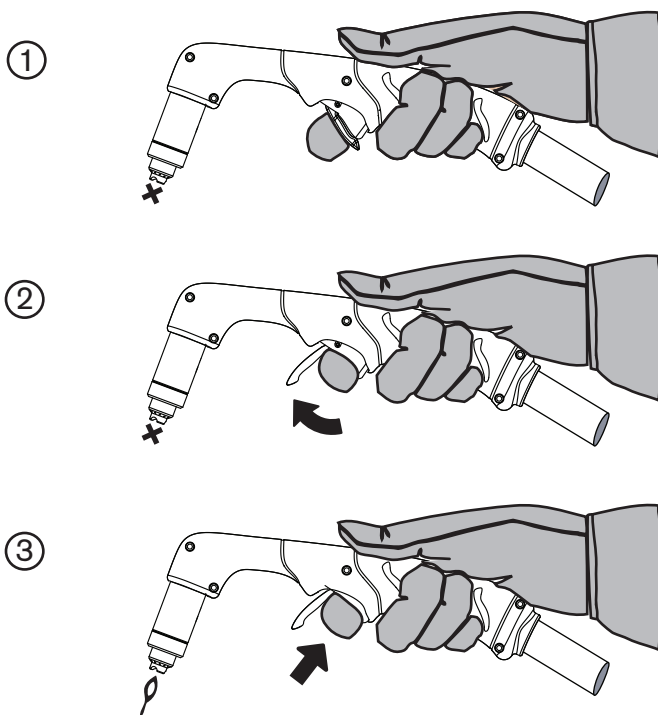
Plasma arc comes on immediately when the torch trigger is activated.

The plasma arc will cut quickly through gloves and skin.

- Wear correct and appropriate protective equipment.
- Keep away from the torch tip.
- Do not hold the workpiece and keep your hands clear of the cutting path.
- Never point the torch toward yourself or others.

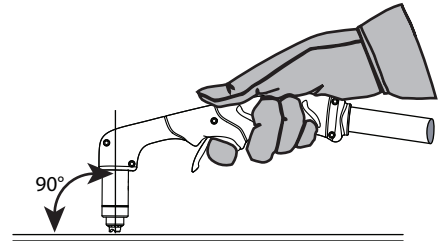
Operate the safety trigger

The hand torches are equipped with a safety trigger to prevent accidental firings. When you are ready to use the torch, flip the trigger's safety cover forward (toward the torch head) and press the red torch trigger as show below.

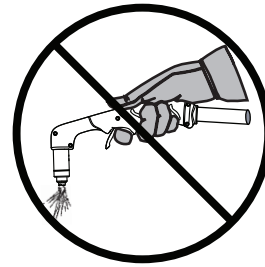


Hand torch cutting hints

- Drag the torch tip lightly along the workpiece to maintain a steady cut.
- While cutting, make sure that sparks exit from the bottom of the workpiece. The sparks should lag slightly behind the torch as you cut (15° — 30° angle from vertical).
- If sparks spray up from the workpiece, move the torch more slowly, or set the output current higher.
- With either the 75-degree or 15-degree hand torch, hold the torch nozzle perpendicular to the workpiece so that the nozzle is at a 90° angle to the cutting surface. Observe the cutting arc as the torch cuts.

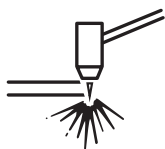


- If you fire the torch unnecessarily, you will shorten the life of the nozzle and electrode.



- Pulling, or dragging, the torch along the cut is easier than pushing it.
- For straight-line cuts, use a straight edge as a guide. To cut circles, use a template or a radius cutter attachment (a circle cutting guide). See the *Parts* section for part numbers for the Hypertherm plasma cutting guides for cutting circles and making bevel cuts.

Start a cut from the edge of the workpiece



1. With the work clamp attached to the workpiece, hold the torch nozzle perpendicular (90°) to the edge of the workpiece.



2. Press the torch's trigger to start the arc. Pause at the edge until the arc has cut completely through the workpiece.

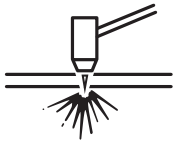


3. Drag the torch tip lightly across the workpiece to proceed with the cut. Maintain a steady, even pace.



OPERATION

Pierce a workpiece



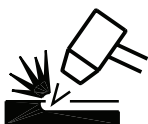
WARNING

SPARKS AND HOT METAL CAN INJURE EYES AND BURN SKIN. When firing the torch at an angle, sparks and hot metal will spray out from the nozzle. Point the torch away from yourself and others.

1. With the work clamp attached to the workpiece, hold the torch at an approximate 30° angle to the workpiece with the torch tip within $1/16$ inch (1.5 mm) of the workpiece before firing the torch.
2. Fire the torch while still at an angle to the workpiece. Slowly rotate the torch to a perpendicular (90°) position.
3. Hold the torch in place while continuing to press the trigger. When sparks exit below the workpiece, the arc has pierced the material.
4. When the pierce is complete, drag the nozzle lightly along the workpiece to proceed with the cut.



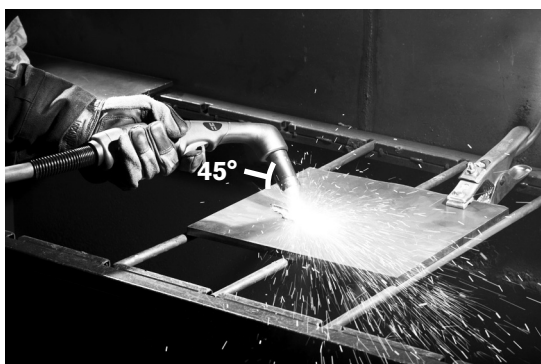
Gouge a workpiece



WARNING

SPARKS AND HOT METAL CAN INJURE EYES AND BURN SKIN. When firing the torch at an angle, sparks and hot metal will spray out from the nozzle. Point the torch away from yourself and others.

1. Hold the torch so that the torch tip is within 1/16 inch (1.5 mm) from the workpiece before firing the torch.



2. Hold the torch at a 45° angle to the workpiece with a small gap between the torch tip and the workpiece. Press the trigger to obtain a pilot arc. Transfer the arc to the work piece.



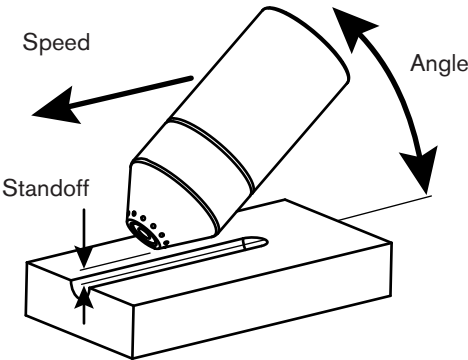
3. Maintain an approximate 45° angle to the workpiece as you feed into the gouge. Push the plasma arc in the direction of the gouge you want to create. Keep a small distance between the torch tip and the molten metal to avoid reducing consumable life or damaging the torch.

Changing the torch's angle changes the dimensions of the gouge.

OPERATION

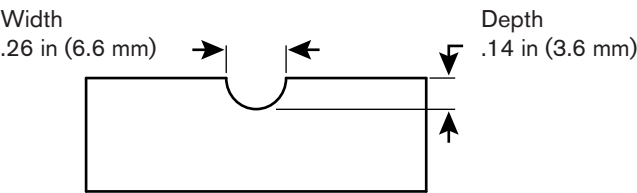
Gouge profile

You can vary the gouge profile by varying the speed of the torch over the workpiece, varying the torch-to-work standoff distance, varying the angle of the torch to the workpiece, and varying the current output of the power supply.

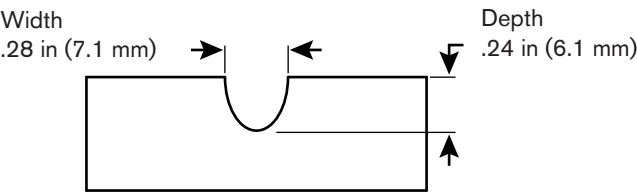


Operating parameters	
Speed	20 – 25 ipm (50.8 – 63.5 cm/min)
Standoff	1/4 – 3/8 in (6.4 – 9.5 mm)
Angle	35 – 40°

Typical Gouge Profile for 65 A



Typical Gouge Profile for 85 A



Varying the gouge profile

The following actions have the stated effects on the gouge profile:

- **Increasing the speed** of the torch will **decrease width** and **decrease depth**.
- **Decreasing the speed** of the torch will **increase width** and **increase depth**.
- **Increasing the standoff** of the torch will **increase width** and **decrease depth**.
- **Decreasing the standoff** of the torch will **decrease width** and **increase depth**.
- **Increasing the angle** of the torch (more vertical) will **decrease width** and **increase depth**.
- **Decreasing the angle** of the torch (less vertical) will **increase width** and **decrease depth**.
- **Increasing the current** of the power supply will **increase width** and **increase depth**.
- **Decreasing the current** of the power supply will **decrease width** and **decrease depth**.

Common hand-cutting faults

The torch does not cut completely through the workpiece. The causes can be:

- The cut speed is too fast.
- The consumables are worn.
- The metal being cut is too thick for the selected amperage.
- Gouging consumables are installed instead of drag-cutting consumables.
- The work clamp is not attached properly to the workpiece.
- The gas pressure or gas flow rate is too low.

Cut quality is poor. The causes can be:

- The metal being cut is too thick for the amperage.
- The wrong consumables are being used (gouging consumables are installed instead of drag-cutting consumables, for example).
- You are moving the torch too quickly or too slowly.

The arc sputters and consumables life is shorter than expected. The cause can be:

- Moisture in the gas supply.
- Incorrect gas pressure.
- Consumables incorrectly installed.

Using the machine torch

Since the Powermax with a machine torch can be used with a wide variety of cutting tables, track burners, pipe bevelers, and so on, you will need to refer to the manufacturer's instructions for specifics on operating the machine torch in your configuration. However, the information in the following sections will help you optimize cut quality and maximize consumable life.

Ensure the torch and table are set up correctly

- Use a square to align the torch at right angles to the workpiece in two dimensions.
- The torch may travel more smoothly if you clean, check and “tune” the cutting table's rails and drive system. Unsteady machine motion can cause a regular, wavy pattern on the cut surface.
- Ensure that the torch does not touch the workpiece during cutting. Contact with the workpiece can damage the shield and nozzle and affect the cut surface.

Understand and optimize cut quality

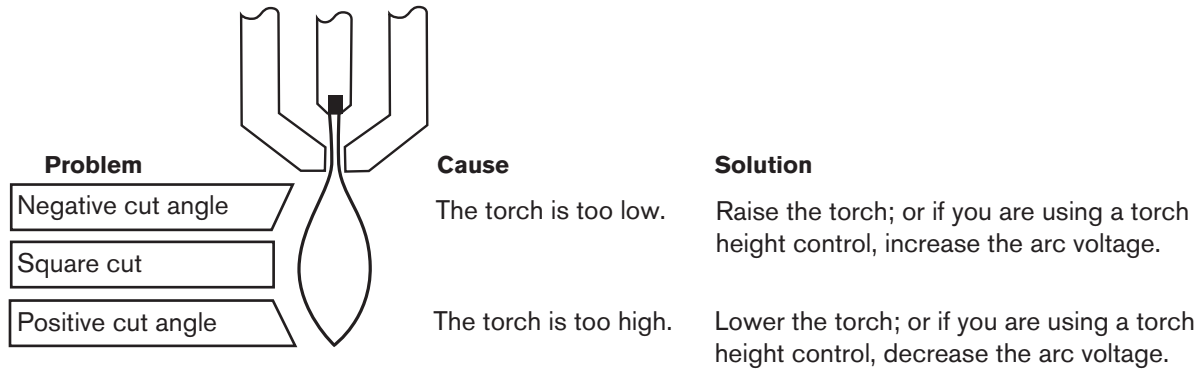
There are several factors to consider in cut quality:

- Cut angle — The degree of angularity of the cut edge.
- Dross — The molten material that solidifies on the top or bottom of the workpiece.
- Straightness of the cut surface — The cut surface can be concave or convex.

The following sections explain how these factors can affect cut quality.

Cut or bevel angle

- A positive cut angle, or bevel, results when more material is removed from the top of the cut than from the bottom.
- A negative cut angle results when more material is removed from the bottom of the cut.



Note: The squarest cut angle will be on the *right* side with respect to the forward motion of the torch. The left side will always have some degree of bevel.

To determine whether a cut-angle problem is being caused by the plasma system or the drive system, make a test cut and measure the angle of each side. Next, rotate the torch 90° in its holder and repeat the process. If the angles are the same in both tests, the problem is in the drive system.

If a cut-angle problem persists after “mechanical causes” have been eliminated (see 4-21 *Ensure the torch and table are set up correctly*), check the torch-to-work distance, especially if the cut angles are all positive or all negative. Also consider the material being cut: if the metal is magnetized or hardened, you are more likely to experience cut angle problems.

Dross

Some amount of dross will always be present when cutting with air plasma. However, you can minimize the amount and type of dross by adjusting your system correctly for your application.

Excess dross appears on the top edge of both pieces of the plate when the torch is too low (or voltage is too low when using a torch height control). Adjust the torch or adjust the voltage in small increments (5 volts or less) until the dross is reduced.

Low-speed dross forms when the torch’s cutting speed is too slow and the arc angles ahead. It forms as a heavy, bubbly deposit at the bottom of the cut and can be removed easily. Increase the speed to reduce this type of dross.

High-speed dross forms when the cutting speed is too fast and the arc angles behind. It forms as a thin, linear bead of solid metal attached very close to the cut. It is more firmly attached to the bottom of the cut than at low speed and is difficult to remove. To reduce high-speed dross:

- Decrease the cutting speed.
- Decrease the torch-to-work distance.

To pierce a workpiece using the machine torch

As with the hand torch, you can start a cut with the machine torch at the edge of the workpiece or by piercing the workpiece. Piercing will result in a shorter consumable life than with edge starts.

The cut charts include a column for the recommended torch height when starting a pierce. For the Powermax65 and Powermax85, the pierce height is generally 2.5 times the cutting height. Refer to the cut charts for specifics.

The pierce delay must be sufficiently long that the arc can pierce the material before the torch moves, but not so long that the arc “wanders” while trying to find the edge of a large hole. As consumables wear, this delay time may need to be increased. Pierce delay times given in the cut charts are based on average delay times throughout the life of the consumables.

When piercing materials close to the maximum thickness for a specific process, consider the following important factors:

- Allow a lead-in distance approximately equal to the thickness of the material being pierced. For example, 20 mm (3/4 in) material requires a 20 mm lead-in.
- To avoid damage to the shield from the buildup of molten material created by the pierce, do not allow the torch to descend to cut height until it has cleared the puddle of molten material.
- Different material chemistries can have an adverse effect on the pierce capability of the system. In particular, high-strength steel with a high manganese or silicon content can reduce the maximum pierce capability. Hypertherm calculates mild steel parameters with certified A-36 plate.
- Using a “flying pierce” (that is, starting torch motion immediately after transfer and during the pierce process) can extend the piercing capability of the system in some cases. Because this can be a complex process that can damage the torch or other components, a stationary or edge start is recommended.

Common machine-cutting faults

The torch's pilot arc will initiate, but will not transfer. Causes can be:

- The work cable is not making good contact with the cutting table or the cutting table is not making good contact with the workpiece.
- The torch-to-work distance is too large.

The workpiece is not totally penetrated, and there is excessive sparking on the top of the workpiece. Causes can be:

- The consumables are worn and need to be replaced. For optimized performance in a mechanized application, replace the nozzle and the electrode together.
- The work cable is not making good contact with the cutting table or the cutting table is not making good contact with the workpiece.
- The current (amperage) is set too low. See Section 3, *Torch Setup* for more information.
- The cut speed is too high. See the cut charts in Section 3, *Torch Setup*, for more information.
- The metal being cut exceeds the maximum capacity for the selected amperage. See Section 1, *Specifications*.

Dross forms on the bottom of the cut. Causes can be:

- The consumables are worn and need to be replaced. For optimized performance in a mechanized application, replace the nozzle and the electrode together.
- The cutting speed is not correct. Refer to the cut charts in Section 3, *Torch Setup*, for more information.
- The current (amperage) is set too low. Refer to the cut charts in Section 3, *Torch Setup*, for more information.

The cut angle is not square. Causes can be:

- The consumables are worn and need to be replaced. For optimized performance in a mechanized application, replace the nozzle and the electrode together.
- The direction of the torch travel is incorrect. The high-quality cut is always on the right with respect to the forward motion of the torch.
- The distance between the torch and the workpiece is not correct.
- The cutting speed is not correct. Refer to the cut charts in Section 3, *Torch Setup*, for more information.

The consumables' life is shortened. Causes can be:

- The arc current, arc voltage, travel speed, and other variables are not set as recommended in the cut charts.
- Firing the arc in the air (beginning or ending the cut off of the plate surface). Starting at the edge is acceptable as long as the arc makes contact with the workpiece when started.
- Starting a pierce with an incorrect torch height. Refer to the cut charts for the specific initial pierce height.

TROUBLESHOOTING AND SYSTEM TESTS

In this section:

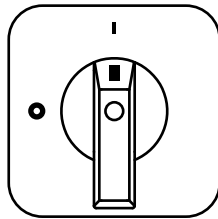
Controls and indicators	5-3
Theory of operation.....	5-4
General	5-4
200 – 600 V CSA 1- or 3-phase power supply functional description.....	5-4
380/400 V CE 3-phase power supply functional description.....	5-5
Sequence of operation.....	5-6
Troubleshooting preparation	5-7
Test equipment	5-7
Troubleshooting procedures and sequence	5-7
External inspection	5-9
Internal inspection	5-9
Initial resistance check.....	5-9
Check the power switch.....	5-9
Hypertherm IGBT tester	5-12
Indicator LEDs and device tests	5-12
IGBT test preparation.....	5-13
IGBT device test using the Hypertherm tester.....	5-14
Troubleshoot the Hypertherm IGBT tester.....	5-14
Schematic for building an IGBT tester.....	5-15
IGBT device test using a non-Hypertherm tester	5-16
200 – 600 V CSA power supply overview.....	5-17
380/400 V CE power supply overview	5-18
200 – 600 V CSA power supply overview (power board removed).....	5-19
380/400 V CE power supply overview (power board removed).....	5-20

TROUBLESHOOTING AND SYSTEM TESTS

Fault codes.....	5-21
Displaying the service screen.....	5-21
Important fault icons	5-22
Performing a cold restart	5-22
Fault codes and solutions.....	5-23
Troubleshooting guide.....	5-32
System tests.....	5-38
Test 1 – Voltage input.....	5-39
Test 2 – DC Power Buss	5-40
Test 3 – Output diodes.....	5-42
Test 4 – Inverter and PFC temperature sensor.....	5-43
Test 5 – Flyback circuit (DC minor voltages)	5-46
Test 6 – Torch stuck open (TSO)	5-48
Test 7 – Start signal	5-50
Test 8 – Torch cap switch	5-51
Test 9 – Electronic regulator	5-52
Test 10 – Pressure sensor.....	5-53
Test 11 – Fan.....	5-54
Test 12 – AUX switch.....	5-55

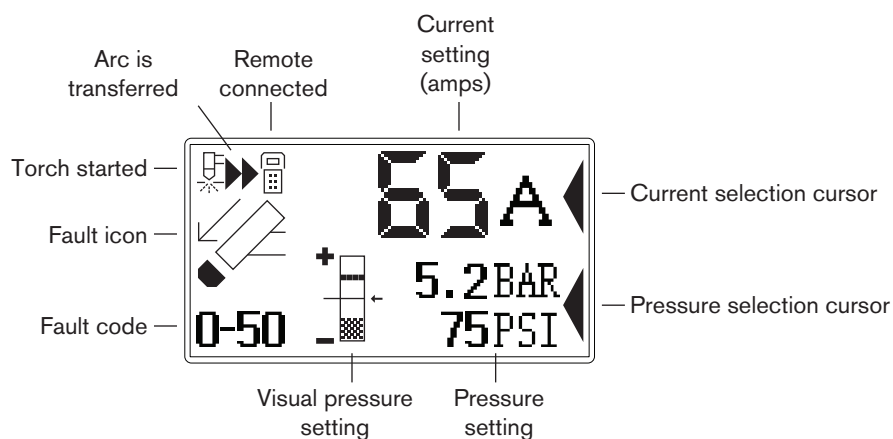
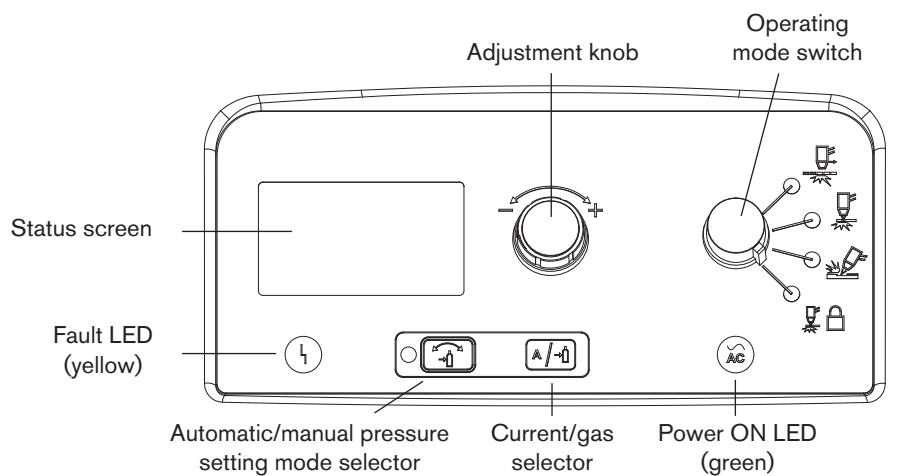
Controls and indicators

The Powermax65 and Powermax85 controls and indicators are described in Section 4, *Operation*. These figures are included for reference.



ON (I)/OFF (O) power switch

Activates the power supply and its control circuits.



Theory of operation

General

Refer to “Sequence of operation” below and Section 8, *Wiring diagrams*.

200 – 600 V CSA 1- or 3-phase power supply functional description

AC power enters the system through the power switch (S1) to the input diode bridge (D50). The voltage from the bridge supplies the power factor correction (PFC) boost converter, which provides a nominal 760 VDC bus voltage. The bus supplies voltage and current to the inverter and the flyback circuit (DC to DC converter) on the power board (PCB3). The power board provides noise suppression and spike protection. A “soft start” is implemented via the power board resistors (RT4, RT5) and relays (K2, K3).

The PFC boost converter consists of an insulated gate bipolar transistor (IGBT Q11), PFC choke, and control circuit. It provides a 760 VDC bus voltage when the input AC voltage is between 200 and 540 VAC. At 600 VAC, the nominal bus voltage is 840 VDC.

The inverter consists of a dual IGBT package (Q12), the power transformer, an output current sensor, and the control circuit. The inverter operates as a pulse-width modulated half-bridge circuit driving an isolation transformer. The output of the isolation transformer is rectified by the output bridge (D48 and D51).

The output circuitry consists of 2 current sensors located on the power board, the pilot arc IGBT (Q13), and the output choke.

The digital signal processor (PCB2) monitors and regulates the system's operation and safety circuits. The amperage adjustment knob on the control board (PCB1) is used to set the output current to the desired value: 20 – 65 amps for the Powermax65 or 25 – 85 amps for the Powermax85. The system compares the set-point to the output current by monitoring the current sensors and adjusting the output of the inverter IGBTs (Q12).

380/400 V CE 3-phase power supply functional description

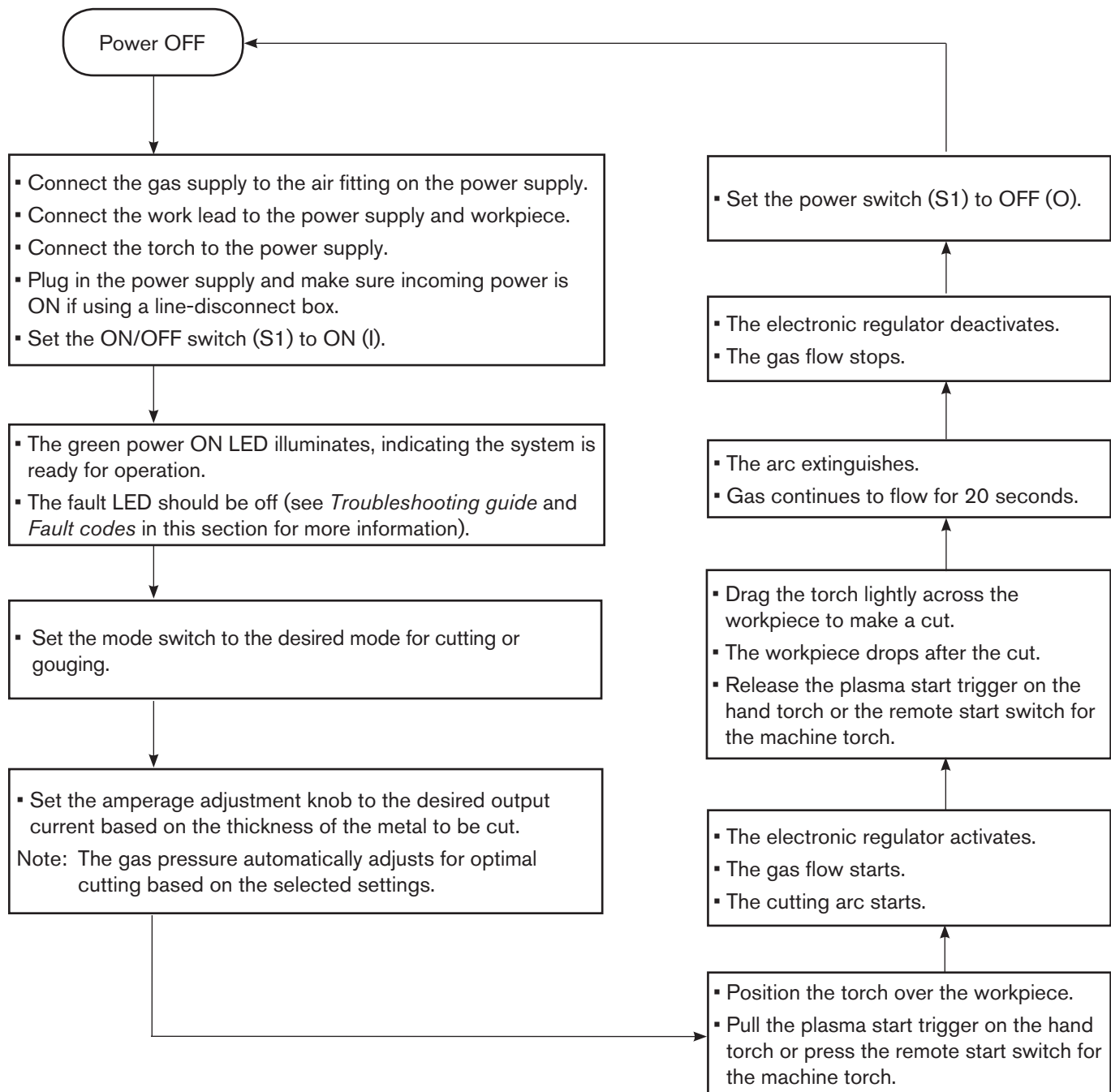
AC power enters the system through the power switch (S1) to the input diode bridge (D45). The voltage from the bridge provides a nominal 530 to 560 VDC bus voltage. The bus supplies voltage and current to the inverter and the flyback circuit (DC to DC converter) on the power board (PCB3). The power board provides noise suppression and spike protection. A “soft start” is implemented via the power board resistors (RT4, RT5) and relay (K2).

The inverter consists of a dual IGBT package (Q9), the power transformer, a current sensor, and the control circuit. The inverter operates as a pulse-width modulated half-bridge circuit driving an isolation transformer. The output of the isolation transformer is rectified by the output bridge (D44 and D46).

The output circuitry consists of 2 current sensors located on the power board, the pilot arc IGBT (Q10), and the output choke.

The digital signal processor (PCB2) monitors and regulates the system’s operation and safety circuits. The amperage adjustment knob on the control board (PCB1) is used to set the output current to the desired value: 20 – 65 amps for the Powermax65 or 25 – 85 amps for the Powermax85. The system compares the set-point to the output current by monitoring the current sensors and adjusting the output of the inverter IGBTs. (Q9).

Sequence of operation



Troubleshooting preparation

The complexity of the circuits requires that service technicians have a working knowledge of inverter power supply theory. In addition to being technically qualified, technicians must perform all testing with safety in mind.

If questions or problems arise during servicing, call the Hypertherm Technical Services team listed in the front of this manual.

Test equipment

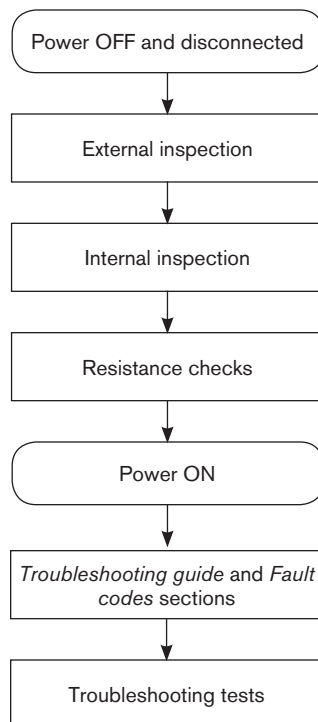
- Multimeter
- IGBT (insulated gate bipolar transistor) tester (part number 128883)







Troubleshooting procedures and sequence

When performing the troubleshooting procedures:

- Read the *Safety and Compliance Manual* (80669C) for detailed safety information.
- Refer to Section 6, *Component Replacement*.
- Refer to Section 7, *Parts*.
- Refer to Section 8, *Wiring Diagrams*.

After the problem has been located and repaired, refer to the “Sequence of operation” flow diagram in this section to test the power supply for proper operation.



	DANGER
 	<p>ELECTRIC SHOCK CAN KILL</p> <ul style="list-style-type: none"> ▪ Turn off the power and remove the input power plug from its receptacle before removing the cover from the power supply. If the power supply is connected directly to a line disconnect box, switch the line disconnect to OFF (O). In the U.S., use a “lock-out / tag-out” procedure until the service or maintenance work is complete. In other countries, follow appropriate national or local safety procedures. ▪ Do not touch live electrical parts! If power is required for servicing, use extreme caution when working near live electrical circuits. Dangerous voltages exist inside the power supply that can cause serious injury or death. ▪ Do not attempt to repair the power board or control board. Do not cut away or remove any protective conformal coating from either board. To do so will risk a short circuit between the AC input circuit and the output circuit and may result in serious injury or death.
	<p>HOT PARTS CAN CAUSE SEVERE BURNS</p> <ul style="list-style-type: none"> ▪ Allow the power supply to cool before servicing.
	<p>MOVING BLADES CAN CAUSE INJURY</p> <ul style="list-style-type: none"> ▪ Keep hands away from moving parts.
	<p>STATIC ELECTRICITY CAN DAMAGE CIRCUIT BOARDS</p> <ul style="list-style-type: none"> ▪ Put on a grounded wrist strap before handling PC boards.

External inspection

1. Inspect the exterior of the power supply for damage to the cover and external components, such as the power cord and plug.
2. Inspect the torch and the torch lead for damage.
3. Inspect the consumables for damage or wear.

Internal inspection

1. Turn OFF the power, disconnect the power cord, and disconnect the gas supply.
2. Using a T15 TORX or blade screwdriver, remove the 8 small screws from the power supply cover.
3. Using a T20 TORX or blade screwdriver, remove the 8 large screws from the power supply cover.
4. Lift the cover off the power supply.
5. Remove the Mylar barrier from the power board side of the power supply. The Mylar barrier is flexible and can be bent slightly for removal. Be certain to replace the barrier when you are finished working on the power supply.
6. Inspect the inside of the power supply, especially on the side with the power board. Look for broken or loose wiring connections, burn and char marks, damaged components, and so on. Repair or replace as necessary.

Initial resistance check

All resistance values must be taken with the power cord disconnected and all internal power supply wires attached. Perform the steps in Internal inspection before continuing in this section.

- If resistance values are not close ($\pm 25\%$) to the values given in this section, isolate the problem by removing wires attached to the resistance check points or component until the problem is found.
- After the problem has been located and repaired, refer to the Sequence of operation flow diagram in this section to test the power supply for proper operation.

Check the power switch

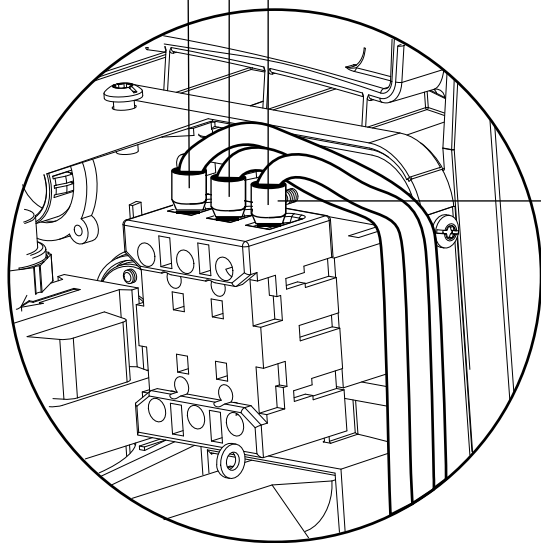
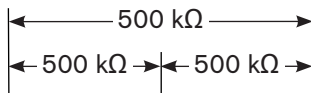
Refer to the figures and table on the following pages.

1. With the power disconnected and the torch removed from the power supply, set the ON/OFF switch (S1) to ON (I).
2. Check the resistance across the input leads (the leads are labeled L1, L2, and L3 on the power switch).
 - 200-600 V CSA: resistance across the input leads = 500 k Ω .
 - 400 V CE: resistance across the input leads = 350 k Ω .
3. Check the resistance from the input leads to ground to verify that it reads as open. For all power supplies, the resistance from input to ground should read as > 20 M Ω .

Note: With the power disconnected and the ON/OFF switch (S1) set to OFF (O), all circuits should read as open.
The electrical values shown are $\pm 25\%$.

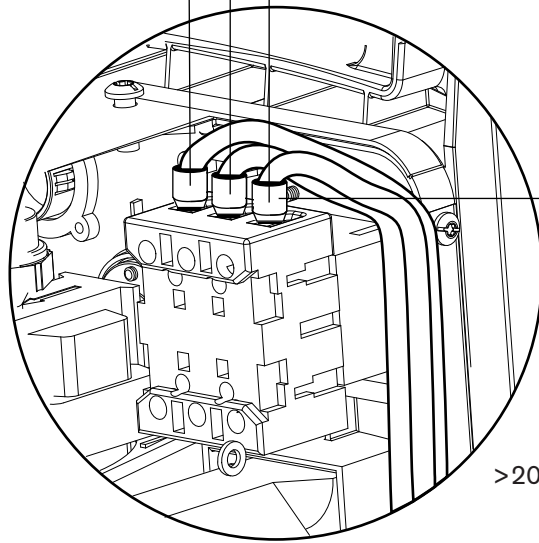
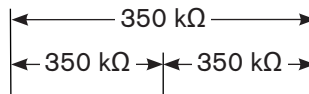
4. Check the output resistance for the values shown in the table.

200 – 600 V CSA

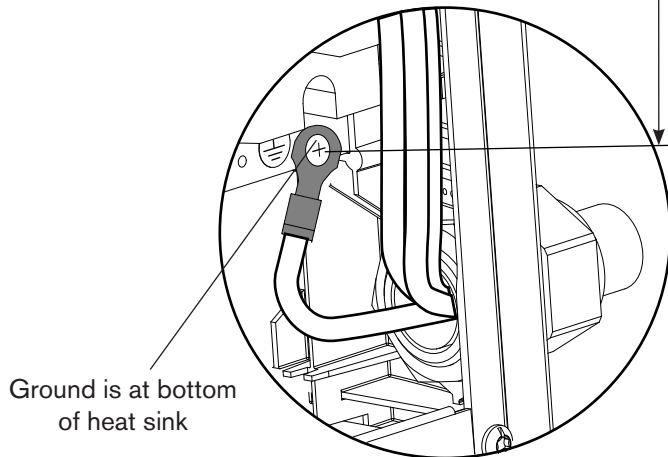


>20 M Ω

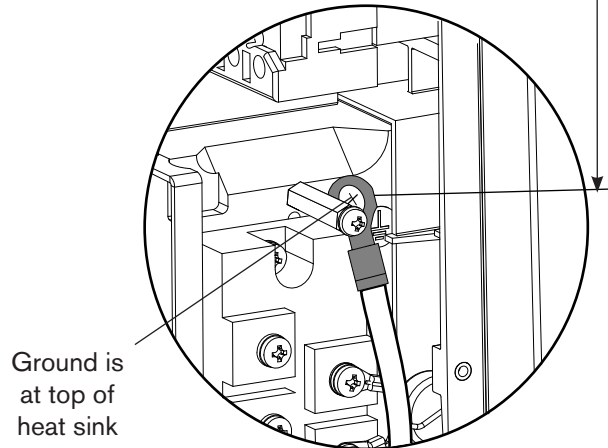
400 V CE



>20 M Ω

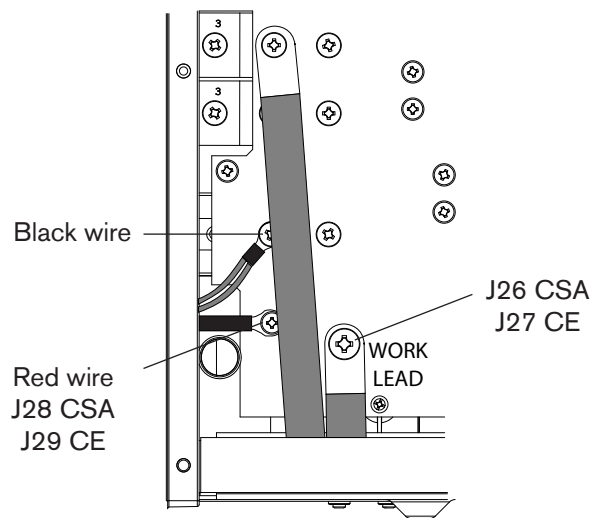


Ground is at bottom
of heat sink



Ground is
at top of
heat sink

Measure resistance from	200 – 600 V CSA power board location	400 V CE power board location	Approximate values
Work lead to nozzle	J26 to black wire	J27 to black wire	230 k Ω
Work lead to electrode	J26 to red wire	J27 to red wire	15 k Ω
Electrode to nozzle	red wire to black wire	red wire to black wire	230 k Ω
Output to ground			> 20 M Ω

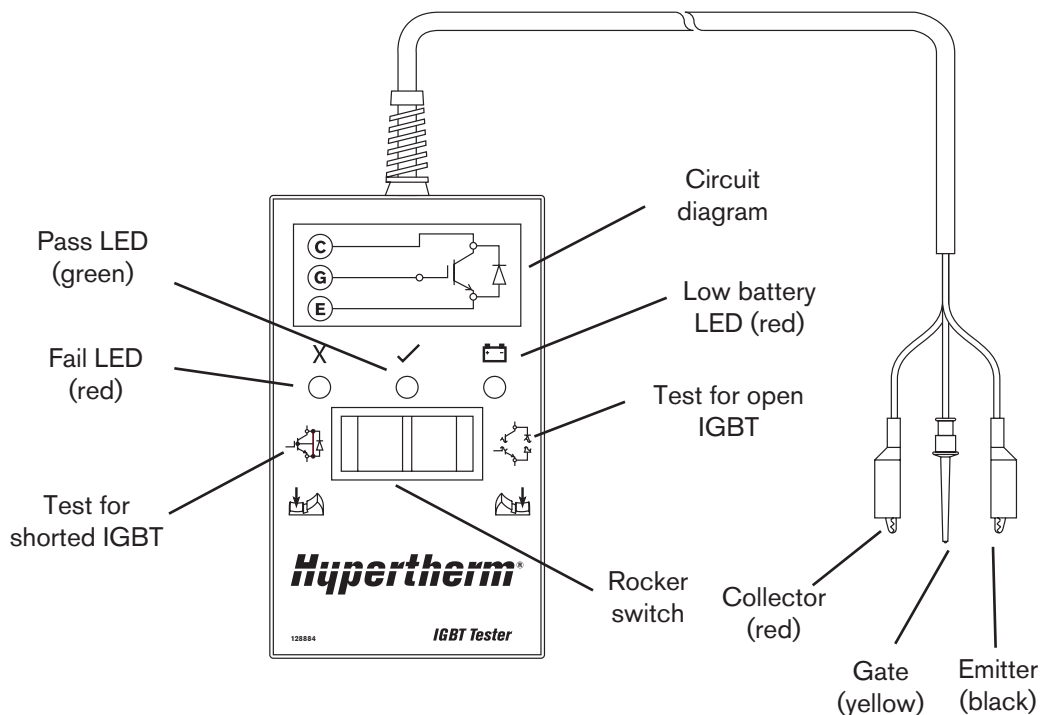


If no problems were found during the visual inspection or the initial resistance check, and the power supply still does not operate correctly, see the Troubleshooting guide.




Note: The Troubleshooting guide provides most probable causes and solutions. Study the system wiring diagram and understand the theory of operation before troubleshooting. Before purchasing any major replacement component, verify the problem with Hypertherm Technical Service or the nearest Hypertherm repair facility.

Hypertherm IGBT tester

Use the Hypertherm IGBT (insulated gate bipolar transistor) tester (part number 128883) as described in the following sections or assemble your own IGBT tester from the schematic diagram shown on page 5-15 *Schematic for building an IGBT tester* and use it to test the IGBTs.



Indicator LEDs and device tests

-  **Green “pass” LED**
When illuminated, this LED indicates that the IGBT passed the test for an open IGBT when switch is pressed to the right or for a short-circuited IGBT when switch is pressed to the left.
-  **Red “fail” LED**
When illuminated, this LED indicates that the IGBT failed the test for an open IGBT when switch is pressed to the right or for a short-circuited IGBT when switch is pressed to the left.
-  **Red “low battery” LED**
When illuminated, this LED indicates that the remaining voltage in the battery is insufficient to power the test circuitry. Replace the battery.

Note: The Hypertherm IGBT tester requires a minimum of 8 V to power its circuitry properly.

IGBT test preparation

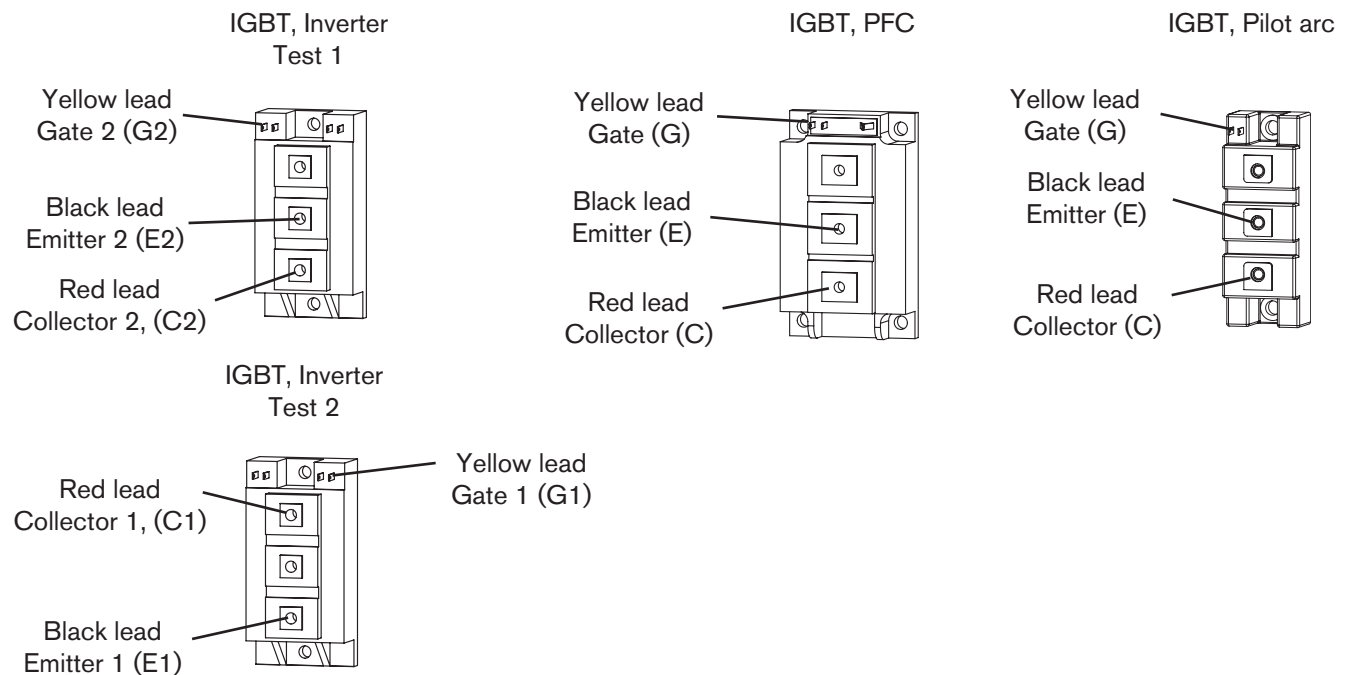
Before testing with the Hypertherm IGBT tester, connect the colored leads to the IGBT as shown on the next page.

Note: Before an IGBT can be tested, it must be electrically isolated from all circuits. If the IGBT is installed in a power supply, remove the power board and any lead connections before testing.



Caution: Failure to isolate the IGBT may result in false readings and/or damage to the IGBT tester.

The illustrations below depict three common configurations of an IGBT. Each connection on the IGBT will be labeled with an abbreviation. They may be labeled as C, E, G or 1, 2, 3 with a schematic that shows numbers and pin functions.



IGBT device test using the Hypertherm tester

Using the Hypertherm IGBT tester, press and hold the switch in the desired position to perform each test described in the following table.

Switch Position	LED			This may mean	Corrective action
	Fail	Pass	Battery		
Left	X	-	-	IGBT is short-circuited	Replace IGBT
Left	-	X	-	IGBT passed the short-circuit test	None
Left	-	-	X	Battery below 8 V	Replace battery
Left	-	-	-	Dead battery	Replace battery
Right	X	-	-	IGBT is open	Replace IGBT
Right	-	X	-	IGBT passed the open test	None
Right	-	-	X	Battery below 8 V	Replace battery
Right	-	-	-	Dead battery	Replace battery

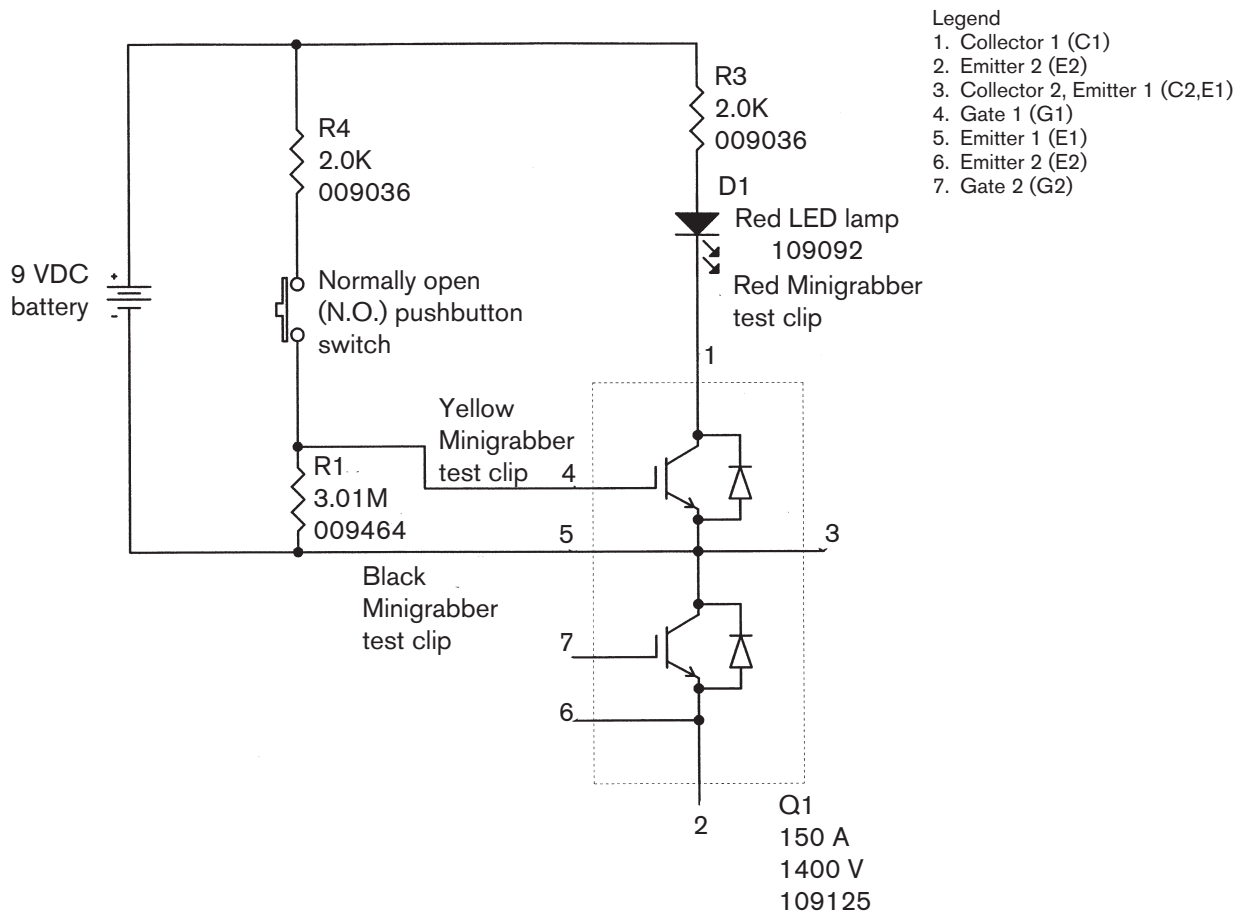
Troubleshoot the Hypertherm IGBT tester

1. Inspect the leads and the IGBT tester for damage.
2. Verify that the battery voltage is greater than 8 V.
3. Test the IGBT Tester, itself, as shown below. If the results do not match the table, replace the lead connections.



Connect leads	Short test	Open test
None	Pass	Fail
Red to Black	Fail	Pass

Schematic for building an IGBT tester

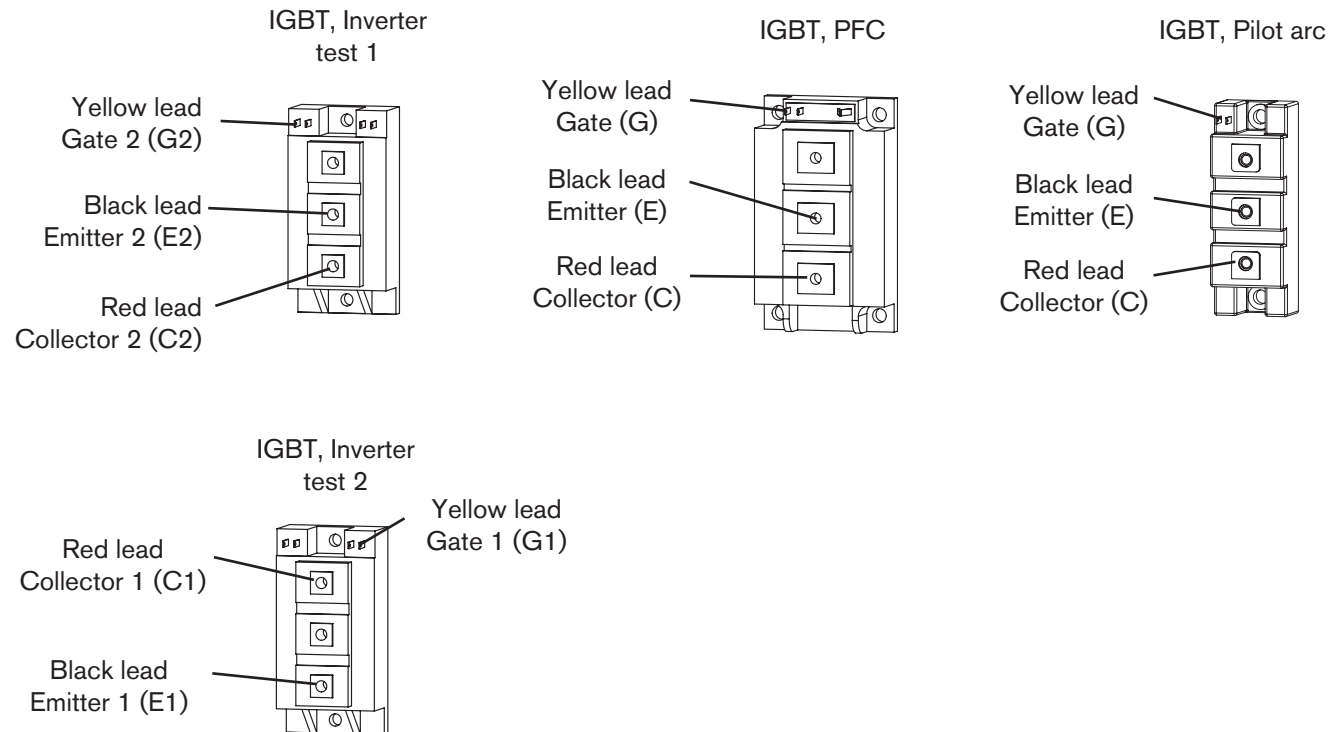


IGBT device test using a non-Hypertherm tester

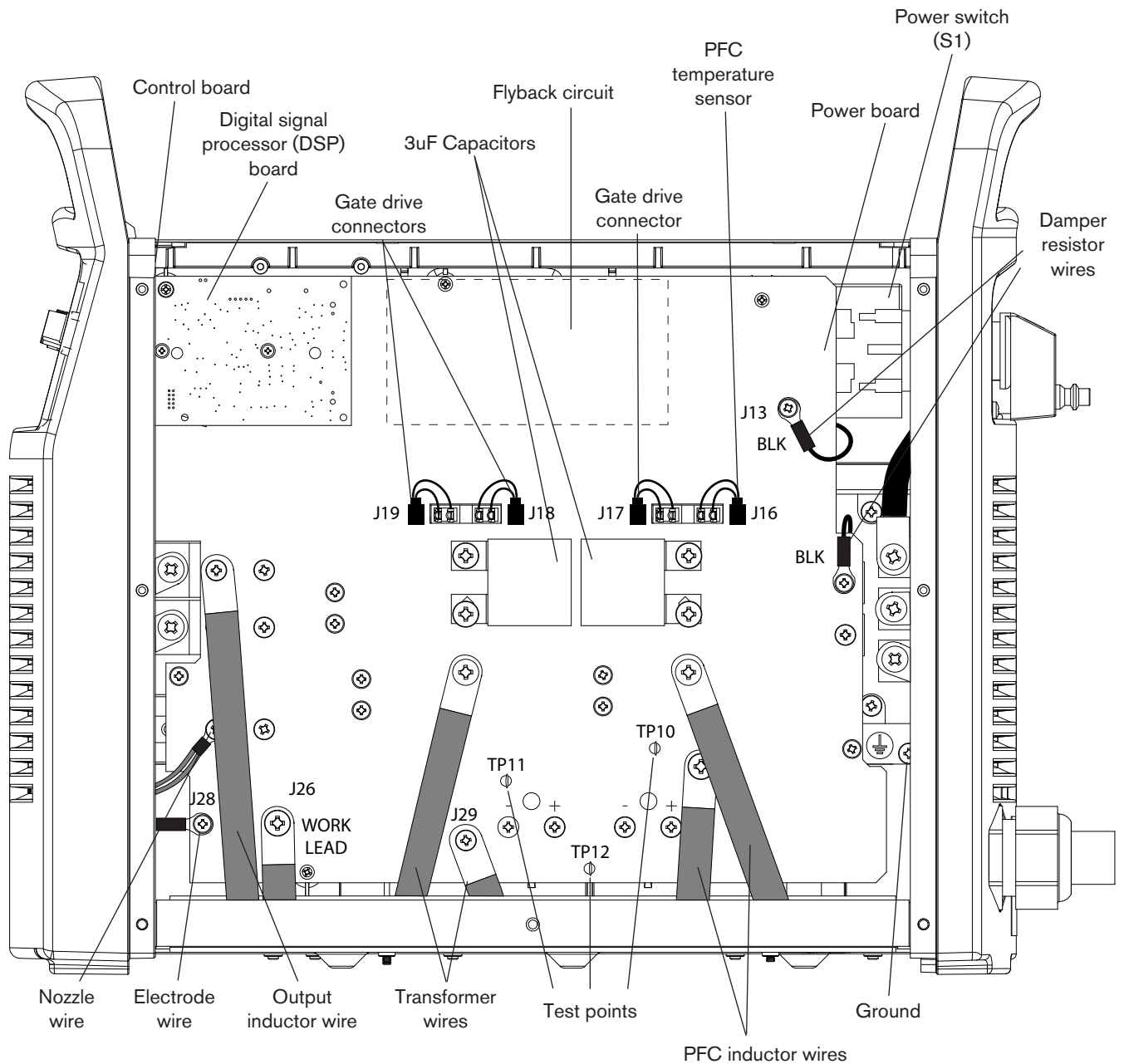
The device tester shown on page 5-15 *Schematic for building an IGBT tester* has one LED and one pushbutton switch that are used in combination to perform two tests.

Note: Before an IGBT can be tested, it must be electrically isolated from all circuits. If the IGBT is installed in a power supply, remove the power board and any lead connections before testing.

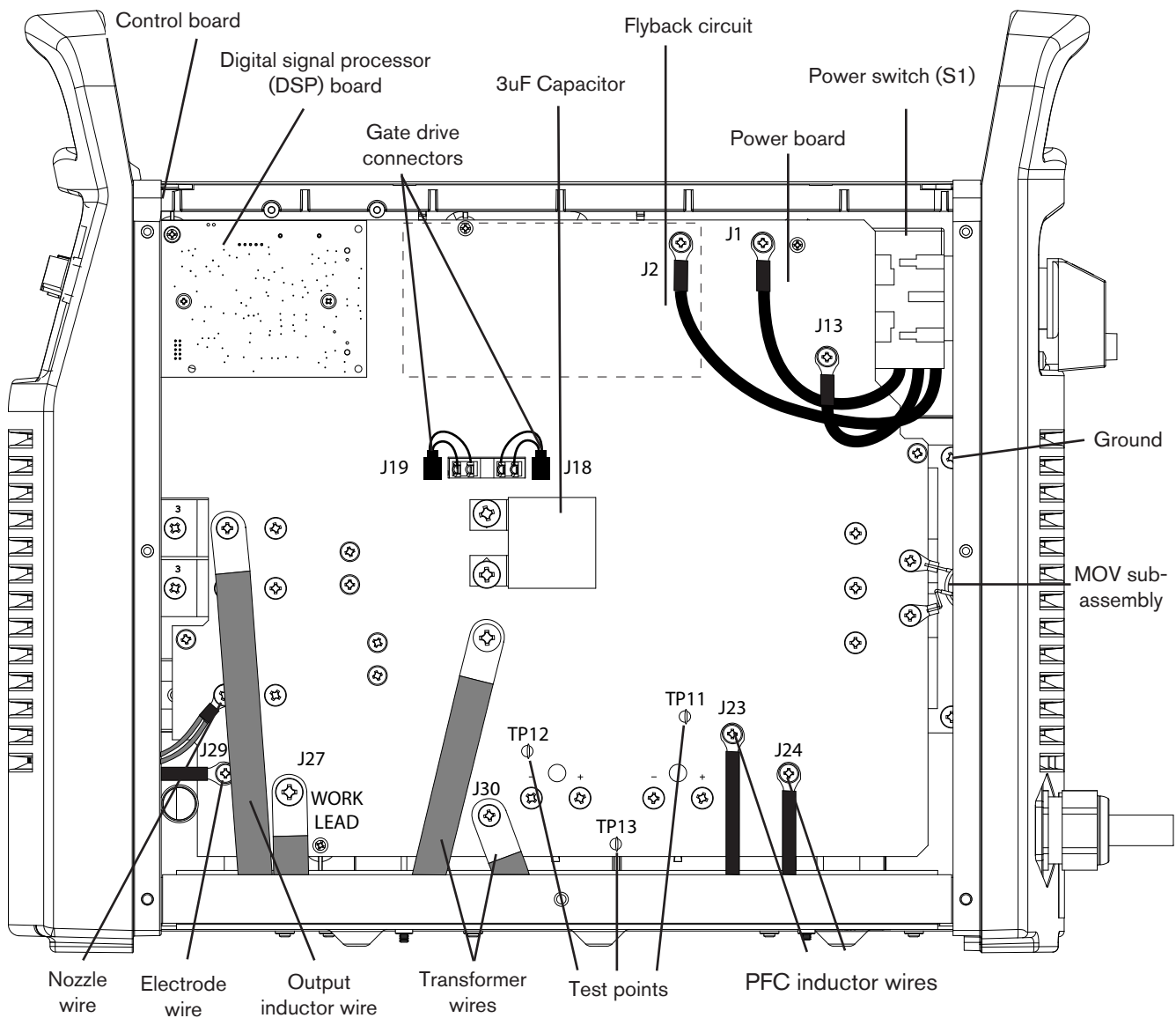
1. Inspect the IGBT for cracks or black marks. If damaged, replace the IGBT.
2. Verify that the 9 V battery reads greater than (>) 8.0 V.
3. Connect the test leads as shown below.
4. With the test leads connected and without pressing the pushbutton switch, the LED should not illuminate. If the LED is illuminated, then the IGBT is shorted. Replace the IGBT.
5. With the test leads connected, press the pushbutton switch. This time, the LED should illuminate. If the LED does not illuminate, then the IGBT is open. Replace the IGBT.



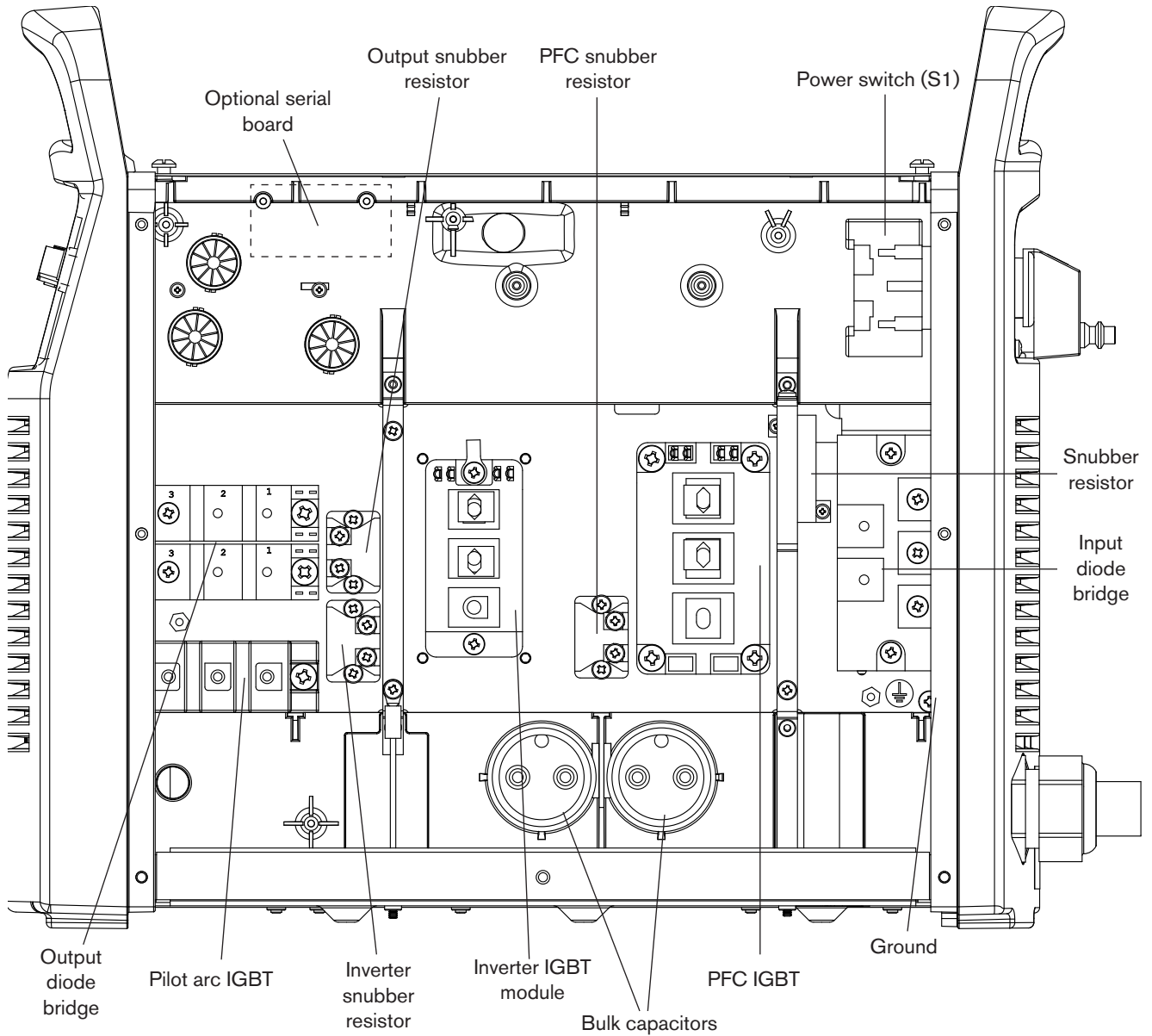
200 – 600 V CSA power supply overview



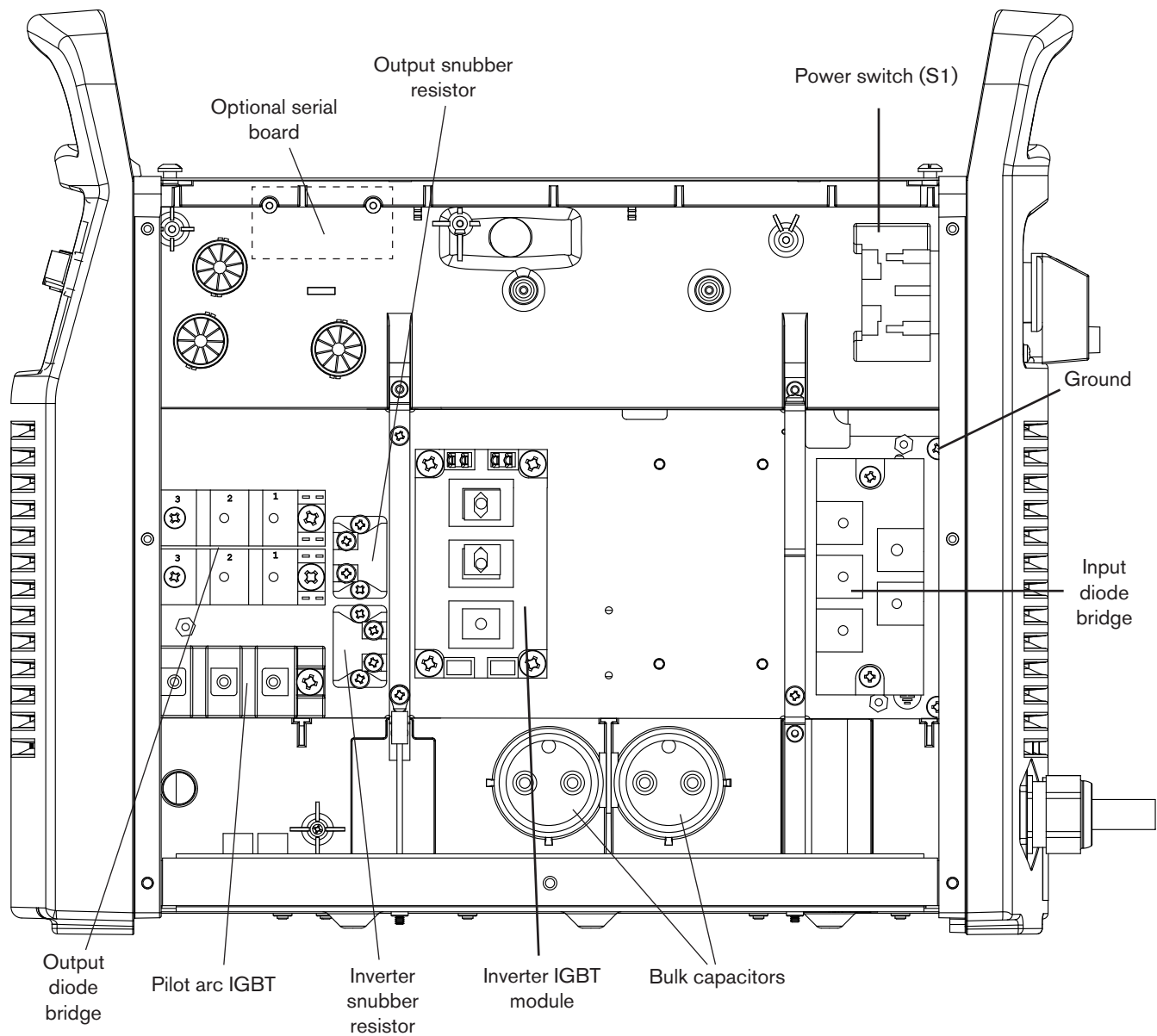
380/400 V CE power supply overview



200 – 600 V CSA power supply overview (power board removed)



380/400 V CE power supply overview (power board removed)



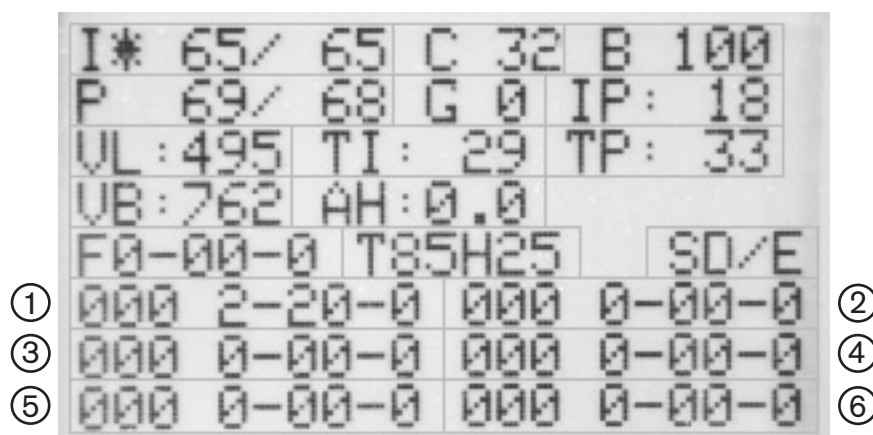
Fault codes

Fault codes displayed on the LCD screen in “service mode” are in the format N-nn-n. Fault codes displayed on the LCD screen in “operator mode” have one fewer digit and appear in the format N-nn. The tables in this section show all digits.

The fault priority is assigned based on the fault code value: the higher the number, the higher the fault priority. Only one fault code is set at one time. If more than one fault occurs at the same time, only the fault with the highest priority is set.

Displaying the service screen

For troubleshooting faults, display the service screen by simultaneously pressing the automatic/manual and current/gas mode selectors for approximately two (2) seconds. The service screen displays.



Designator	Description
I	Current set/read
C	LCD contrast
B	LCD brightness (percent)
P	Pressure set/read
G	Gas test enable (1)/disable (0)
IP	Boost circuit current (not present in CE machines)
VL	Incoming AC line voltage
TI	Inverter module temperature (°C)
TP	Boost module temperature (°C), not present in CE machines
VB	DC buss voltage
AH	Arc hours
F	Live fault code
T	Torch identifier (amps/H hand or M machine/lead length in feet)
S	DSP/Control board software versions
1 – 6	1 is the most recent fault code; 6 is the oldest fault code

Note: Fault codes beginning with zero (0-nn-n) are not recorded in the fault log.

To move the field selector (*) between fields, press the current/gas mode selector. The asterisk indicates the selected field. You can alter the I, C, B, P, and G fields by turning the adjustment knob.

To toggle between (I) Current set/read and (P) Pressure set/read, press the automatic/manual mode selector. The LED is illuminated when the Pressure set/read field is selected.

To exit the service screen, simultaneously press the automatic/manual and current/gas mode selectors. The operator screen displays.

Important fault icons

One of the following fault icons may appear on the LCD display in operator mode:



Warning

The system continues to operate.



Fault

The system stops cutting and is able to recover when the fault is cleared.



Error

The system needs service.

Performing a cold restart

Sometimes a “cold restart” clears the fault. When a cold restart is recommended in one of the Solutions below, do the following:

1. Power OFF the machine.
2. Wait 20 seconds or until the red LED near the top of the DSP board blinks.
3. Power ON the machine.

Fault codes and solutions

Each table below describes a fault category and suggests solutions for each fault code. Several of the fault descriptions show a test number. If the listed solutions do not resolve the problem, refer to page 5-38 *System tests* and perform the indicated numbered test.





0-00-n

These fault codes indicate non-hardware faults.





Fault code	Description (<i>System test number</i>)	Power LED	Fault LED	Fault icon	Solutions
0-00-0	None	On	Off	–	No errors



0-nn-n

These fault codes identify operational faults. On the operator screen, the last digit is omitted. Display the service screen for more information on faults 11, 19, 30, 40, 60, and 99.






Fault code	Description (<i>System test number</i>)	Power LED	Fault LED	Fault icon	Solutions
0-11-0	Remote controller cut mode invalid	On	Off		<p>There is a problem with the remote controller or the software interface to the system. The system cannot interpret the cut mode, cut current, or pressure information coming from the controller.</p> <ul style="list-style-type: none"> Fix the controller. Check the interface cable.
0-11-1	Remote controller current invalid				
0-11-2	Remote controller pressure invalid				
0-12-0	Low input gas pressure: Warning (Test 10) (DSP firmware revision E or before)	On	Off		<ul style="list-style-type: none"> Adjust the gas inlet pressure as needed.
0-12-1	Output gas pressure low (DSP firmware revision J or later; Refer to 5-21 <i>Displaying the service screen</i>)	On	Off		<ul style="list-style-type: none"> Adjust the gas inlet pressure as needed. Check for kinked or blocked air lines. Perform Test 10.
0-12-2	Output gas pressure high (DSP firmware revision J or later; Refer to 5-21 <i>Displaying the service screen</i>)				<ul style="list-style-type: none"> The gas subsystem is not working properly. Check the valve. Perform Test 10.
0-12-3	Output gas pressure unstable (DSP firmware revision J or later; Refer to 5-21 <i>Displaying the service screen</i>)				
0-13-0	AC input unstable (line resonance): Warning	Blinks (3 Hz)	Off		<ul style="list-style-type: none"> Perform a cold restart. If the fault does not clear, correct the power source. Change the character, generally the impedance, of the line.



TROUBLESHOOTING AND SYSTEM TESTS

Fault code	Description (System test number)	Power LED	Fault LED	Fault icon	Solutions
0-19-9	Power board hardware protection. One or more major power board hardware faults (or electrical noise) detected: Warning. Fault 0-19-9 can occur three (3) times before becoming a 0-99 fault.	On	On		The inverter shuts down and does not fire again for several seconds. If the fault is caused by electrical noise, the fault clears in a few seconds and the machine operates normally. If a true fault continues to occur, the 0-99 fault code appears on the operator screen. Access the fault log in the service screen to identify the major fault.
0-20-0	Low gas pressure (Test 10) The gas pressure has fallen below the minimum pressure for that process, mode, and lead length.	On	On		Ensure the gas line is properly installed. Replace the air filter element if dirty. Replace the gas supply line if restricted. Ensure the inlet pressure is 85 to 135 PSI (5.9 to 9.3 bar).
0-21-0	Gas flow lost while cutting (Test 9)	On	On		The DSP monitors the nozzle to electrode voltage and if it detects a rapid change in that voltage, the inverter shuts down. Usually this indicates a rapid loss of gas pressure from a kinked or blocked air supply line. <ul style="list-style-type: none">▪ Correct any gas supply restrictions and restart the power supply.▪ Check the torch lead for leaks or kinking.
0-22-0	No gas input	On	On		<ul style="list-style-type: none">▪ Restore the gas supply.▪ Restart the power supply.

Fault code	Description (System test number)	Power LED	Fault LED	Fault icon	Solutions
0-30-0	Torch stuck open (Test 6) The nozzle and electrode are not touching after a start is received.	On	On		<ul style="list-style-type: none"> If incorrect consumables are installed or the consumables became loose or were removed while the power supply is ON, turn OFF the power supply, correct the problem and then turn ON the power supply to clear this fault. Inspect the torch for signs of wet or oily air. Inspect the torch for any signs of damage or pitting on the electrode contact surface. If the consumables appear to be installed correctly, the torch may be damaged. Test with a known working torch. For a 0-30-1 fault code, place the unit in gas test mode (refer to page 5-21 <i>Displaying the service screen</i>). Enter "manual mode", move to "G" (gas), and use the adjustment knob to toggle to "1" (gas test mode). Ensure that only the dump valve light is on during the gas test. Toggle back to "0" and exit "manual mode." Replace the regulator if necessary. If the problem persists, contact your Hypertherm distributor or authorized repair facility.
0-30-1	Torch stuck closed (Test 6) <ul style="list-style-type: none"> The nozzle and electrode will not separate after a start is received. The regulator may not be functioning properly. 				
0-40-0	PFC/Boost IGBT module under temperature (Test 4)	On	On		<p>For an over-temperature fault, leave the machine powered ON and confirm that the fan is operating (Test 11). Ensure adequate air flow around the unit.</p> <p>Ensure the cover is placed with the air fins on the fan side of the power supply.</p> <p>If the duty cycle has been exceeded, let the unit cool and work within the duty cycle limits listed in the <i>Operation</i> section.</p> <p>For an under-temperature (<-22°F or -30°C) fault, move the unit to a warmer location.</p> <p>The inverter temperature sensor is a thermistor mounted on the heat sink beside the inverter IGBT module. Its room temperature resistance is about 10 kΩ.</p>
0-40-1	PFC/Boost IGBT module over temperature (Test 4)				
0-40-2	Inverter IGBT module under temperature (Test 4)				
0-40-3	Inverter IGBT module over temperature (Test 4)				


TROUBLESHOOTING AND SYSTEM TESTS

Fault code	Description (System test number)	Power LED	Fault LED	Fault icon	Solutions
0-50-0	Retaining cap off (Test 8)	On	On		<ul style="list-style-type: none"> Verify that proper consumables and retaining cap are installed. Replace damaged parts. Refer to section <i>Torch Setup</i>. With the retaining cap installed, check for continuity between pins 5 and 7 at the torch connector. If the consumables appear to be installed correctly, the torch may be damaged. Test with a known working torch. After correcting the problem, perform a cold restart.
0-51-0	Start/trigger signal on at power up (Test 7) This situation indicates that the power supply is receiving a start signal at power-up. It is sometimes referred to as a "stuck start."	On	On		<p>If the power supply is turned on while the torch trigger is pressed, the system is disabled.</p> <ul style="list-style-type: none"> Release the trigger and cycle the power to the machine. Check for continuity between Pin 6 and Pin 7 of the torch connector. There should be very low resistance when the torch trigger is pulled. Test with a known working torch.
0-52-0	Torch not connected	On	On		<ul style="list-style-type: none"> Plug a torch lead into the FastConnect receptacle on the front of the power supply and recycle the power switch.
0-60-0	Phase loss (Test 1)	On	On		<p>Wear proper personal protection equipment when checking the voltage.</p> <ul style="list-style-type: none"> Check for proper voltage (phase to phase and phase to ground) at the power source and at the machine.
0-60-1	Under voltage (Test 1)				<ul style="list-style-type: none"> Increase the supply voltage.
0-60-2	Over Voltage (Test 1)				<ul style="list-style-type: none"> Decrease the supply voltage.
0-61-0	AC input unstable: Shutdown	On	On		<ul style="list-style-type: none"> Test the machine from another AC power source. Power down and correct the line resonance problem before continuing.

Fault code	Description (<i>System test number</i>)	Power LED	Fault LED	Fault icon	Solutions
0-98-0	Internal communication failure The control board and the DSP are not communicating.	On	On		<ul style="list-style-type: none"> Perform a cold restart. Confirm that the connecting ribbon cable is installed properly between the control board and the DSP board.
0-99-0	System hardware fault (service required) Indicates a major fault with the system.	On	On		<ul style="list-style-type: none"> Display the service screen. A qualified service technician must service the system. Contact your distributor or authorized repair facility.

1-nn-n


These fault codes usually relate to the DSP board and can only be seen on the service screen.

Fault code	Description (<i>System test number</i>)	Power LED	Fault LED	Fault icon	Solutions
1-00-0	Digital signal processor fault	On	On		<p>These are internal processor checks and are not likely to be caused by a hardware failure.</p> <ul style="list-style-type: none"> Perform a cold restart. <p>If that doesn't fix the problem, it is possible that the DSP or Power board have failed.</p>
1-10-0	A/D converter fault				
1-20-0	I/O fault				

TROUBLESHOOTING AND SYSTEM TESTS


2-nn-n

These fault codes usually relate to either the DSP or the power board and can only be seen on the service screen.


Fault code	Description (<i>System test number</i>)	Power LED	Fault LED	Fault icon	Solutions
2-00-0	Analog to Digital (A/D) converter value out of range	On	On		<ul style="list-style-type: none">Perform a cold restart. <p>If that doesn't fix the problem, it is possible that the DSP or Power board have failed.</p>
2-01-0	Auxiliary switch disconnected				<ul style="list-style-type: none">Check the auxiliary switch cable.Perform Test 12.
2-10-0	Inverter module temp sensor open (Test 4)				<ul style="list-style-type: none">Check the associated wiring.Check the resistance across the thermistor. It should be about 10 kΩ at room temperature. <p>If no problems are found, it is possible that the inverter heat sink temperature sensor assembly (228805) has failed.</p>
2-10-1	Inverter module temp sensor shorted (Test 4)				
2-11-0	Pressure sensor open (Test 10)				<ul style="list-style-type: none">Check the associated wiring.If necessary, replace the pressure sensor (kit 228689)
2-11-1	Pressure sensor shorted (Test 10)				
2-20-0	Torch ID The DSP does not recognize the torch.				<ul style="list-style-type: none">Confirm that the torch is seated properly in the connector.Inspect the connector for the proper pin-out.


3-nn-n

These fault codes relate to the power board and can only be seen on the service screen.

Fault code	Description (System test number)	Power LED	Fault LED	Fault icon	Solutions
3-00-0	DC bus voltage (Test 5) DC bus voltage is out of range.	On	On		<ul style="list-style-type: none"> Inspect the PFC Boost circuitry (CSA) Test the PFC Boost IGBT (CSA)
3-10-0	Fan speed (Test 11) The fan speed is below the minimum speed.				<ul style="list-style-type: none"> Clean the fan assembly.
3-10-1	Fan (Test 11)				<ul style="list-style-type: none"> Check the associated wiring. If necessary, replace the fan assembly.
3-11-0	PFC module temp sensor open (Test 4)				<ul style="list-style-type: none"> Check the associated wiring. If necessary, replace the PFC/Boost IGBT module.
3-11-1	PFC module temp sensor shorted (Test 4)				<ul style="list-style-type: none"> Check the associated wiring. If necessary, replace the PFC/Boost IGBT module.
3-11-2	PFC module temp sensor circuit error				<ul style="list-style-type: none"> Check the temperature circuit on the power board. If Test 4 is good, replace the power board.
3-20-0	Fill valve (Test 9) Indicates that the Fill Valve is not connected.				<ul style="list-style-type: none"> Check the associated wiring. If necessary, replace the electronic regulator. (Kit 228687)
3-20-1	Dump valve (Test 9) Indicates that the Dump Valve is not connected.				<ul style="list-style-type: none"> Check the associated wiring. If necessary, replace the electronic regulator. (Kit 228687)
3-20-2	Valve ID (Test 9)				The DSP does not recognize the electronic regulator.
3-20-3	Electronic regulator is disconnected (Test 9) The electronic regulator is not drawing current.				<ul style="list-style-type: none"> Inspect the associated wiring, particularly the 7-pin connector. If necessary, replace the electronic regulator. (Kit 228687)

TROUBLESHOOTING AND SYSTEM TESTS

Fault code	Description (System test number)	Power LED	Fault LED	Fault icon	Solutions
3-41-0	Drive fault	On	On		If an activation signal is sent to a device and the device does not activate (machine motion relay or in-rush relay for example) this fault will occur.
3-42-0	5 or 24 VDC fault (Test 5)				The 5 or 24 VDC supply from the flyback circuit is out of range.
3-42-1	18 VDC fault				The 18 VDC supply from the flyback circuit is out of range. ▪ Replace the power board.
3-43-0	Inverter capacitors unbalanced (Test 2)				Voltage across one or both inverter caps is more than 25% different than nominal. ▪ CSA units have a 760 VDC bus voltage. ▪ Nominal is 380 VDC for each cap. ▪ Fault condition: < 275 or > 485 VDC across either capacitor. ▪ CE units at 400 VAC have a 560 VDC bus voltage. ▪ Nominal is 280 VDC for each cap. ▪ Fault condition: <200 or> 360 VDC across either capacitor. ▪ Test the IGBT module. ▪ Test the inverter capacitors. (2200µF)
3-44-1	PFC over current				High current in the PFC/Boost circuit. ▪ Test the PFC IGBT. ▪ Replace it if faulty. ▪ If necessary, replace the power board.

Fault code	Description (<i>System test number</i>)	Power LED	Fault LED	Fault icon	Solutions
3-51-1	Inverter saturation fault (the inverter is over current)	On	On		Upper and lower inverter IGBTs are gating (being activated) in phase rather than 180° out of phase. <ul style="list-style-type: none">▪ Test the two inverter IGBTs in the module.▪ Replace the module if either is faulty.▪ If necessary, replace the power board.
3-52-0	Shoot through				
3-60-0	Power board				The DSP does not recognize the power board. The code is for future machines where the current DSP board will not work with future power boards.
3-70-0	Internal serial communications fault				There is a fault with the communication between the DSP and Power board. <ul style="list-style-type: none">▪ Check the board connector.▪ If necessary, replace either the DSP or Power board.

Troubleshooting guide

Note: Fault icons and corresponding fault codes appear in the user display for many errors. If a fault code appears, refer to page 5-21 *Fault codes* before using this troubleshooting guide.

The following table provides an overview of the most common problems that can arise when using the Powermax65 or Powermax85 and explains how to solve them. See page 5-38 *System tests* for detailed test procedures.

Problem	Meaning	Causes	Solution
The ON/OFF power switch is set to ON (I), but the power ON LED is not illuminated.	There is insufficient voltage to the control circuits or a short-circuited power component.	No voltage, improper voltage applied to the unit, a faulty power switch (S1), or a faulty input diode.	<ul style="list-style-type: none"> ▪ Check to see that the system is plugged into an appropriately-sized circuit and that the circuit breaker has not been tripped. ▪ Verify that the power is ON at the main power panel or at the line-disconnect switch box. ▪ Verify that the line voltage is not too low (more than 15% below the rated voltage). ▪ Perform Test 1 to check the incoming voltage and the power switch. ▪ Perform Test 12 on CSA units.
		Faulty power board (PCB3), fan, or solenoid valve.	<ul style="list-style-type: none"> ▪ Perform Test 5 to check the flyback circuit.
		Faulty power board (PCB3) or IGBT.	<ul style="list-style-type: none"> ▪ Perform Tests 1, 2, and 3 and replace any faulty components.
		Faulty control board (PCB1).	<ul style="list-style-type: none"> ▪ Replace the control board (PCB1).
		Faulty DSP board.	<ul style="list-style-type: none"> ▪ Replace the DSP board.

Problem	Meaning	Causes	Solution
The power ON LED is illuminated and no fault codes are displayed, but no gas flows when the torch trigger is pulled.	The start signal is not reaching the control board.	<ul style="list-style-type: none"> ▪ The torch or torch lead may be damaged. ▪ The power board may be faulty. ▪ The control board may be faulty. 	<ul style="list-style-type: none"> ▪ Inspect the torch and torch lead for damage. ▪ Verify that the start icon appears on the LCD screen when the trigger is pulled. If it does not, perform Test 7 to check the start signal from the power board.
Power ON LED blinks or goes out while cutting.	A power component is shorted.	▪ Faulty fan.	▪ Perform Test 11.
		▪ Faulty power board (PCB3) or IGBT.	▪ Perform Tests 1, 2, or 3.
		▪ Faulty control board (PCB1).	
The arc does not transfer to the workpiece.	Poor continuity exists between the work lead and the workpiece.	<ul style="list-style-type: none"> ▪ The workpiece is dirty. ▪ The work clamp is damaged. ▪ The pierce height distance is too large. ▪ The transfer current sensor is bad. 	<ul style="list-style-type: none"> ▪ Clean the area where the work clamp contacts the workpiece to ensure a good metal-to-metal connection. ▪ Inspect the work clamp for damage and repair as necessary. ▪ If the pierce height distance is too large, move the torch closer to the workpiece and fire the torch again. ▪ If the transfer current sensor is bad, replace the power board.
Gas flows from the torch at power-up when neither the torch trigger nor a remote start is activated.	The electronic regulator, power board (PCB3), or control board (PCB1) is faulty.	<ul style="list-style-type: none"> ▪ Faulty electronic regulator. ▪ Faulty power board (PCB3). ▪ Faulty control board (PCB1). 	▪ Perform Test 9.
	The incoming gas pressure is too high.	▪ The gas pressure from the compressor or cylinder may be too high.	▪ Check the gas supply to make sure that it does not exceed 135 psi (9.3 bar). If necessary, reduce the pressure.

TROUBLESHOOTING AND SYSTEM TESTS

Problem	Meaning	Causes	Solution
When pressing the torch trigger or start switch, gas flows from the torch, but the torch does not fire or fires for only a short duration.	Worn or damaged consumables.	<ul style="list-style-type: none"> Overused or improperly installed consumables. 	<ul style="list-style-type: none"> Replace consumables.
	Damaged torch or lead assembly.	<ul style="list-style-type: none"> Electrode is not moving properly in the torch or the torch lead is damaged. 	<ul style="list-style-type: none"> Perform Test 6.
	Insufficient or excessive gas flow.	<ul style="list-style-type: none"> Gas pressure is too high or too low, or the gas supply is leaking or restricted. 	<ul style="list-style-type: none"> Ensure the inlet pressure is 85 to 135 PSI (5.9 to 9.3 bar). Repair air leaks or restrictions. Manually adjust the gas pressure on the power supply.
	Poor air quality.	<ul style="list-style-type: none"> Air filter element is dirty. Moisture or contaminants in the gas supply line. 	<ul style="list-style-type: none"> Replace the air filter element. Add appropriate filtration and purge the lines with nitrogen to flush out oil and moisture.
	Insufficient input power.	Undersized electrical supply installation: <ul style="list-style-type: none"> Breaker or fuse. Supply wire. Extension cord. 	<ul style="list-style-type: none"> Verify that the external electrical power is installed according to Section 2, <i>Specifications</i>.
	Faulty inverter IGBT	<ul style="list-style-type: none"> Faulty inverter IGBT. 	<ul style="list-style-type: none"> Use an IGBT tester to check the inverter IGBT.
	Capacitor voltage imbalance on the power board.	<ul style="list-style-type: none"> Faulty resistors on the power board (PCB3) or faulty bulk capacitor(s). 	<ul style="list-style-type: none"> Perform Tests 1, 2, or 3. If the voltage across the capacitors is not balanced, replace the power board (PCB3).

Problem	Meaning	Causes	Solution
Arc goes out while cutting or intermittently will not fire.	The arc lost contact with the workpiece.	<ul style="list-style-type: none"> The work lead or work lead connection may be faulty. The material being cut may require the use of continuous pilot arc mode. 	<ul style="list-style-type: none"> If you are cutting expanded metal, grate, or any metal with holes, set the mode switch to continuous pilot arc mode. Check for loose connections at the work clamp and at the power supply. Reposition the work lead on the workpiece. Clean the cutting surface to ensure a better connection with the work lead.
	Faulty fan.	<ul style="list-style-type: none"> The fan could be overloading the flyback circuit. 	<ul style="list-style-type: none"> Perform Tests 5 and 11.
The cut quality is poor or the cut does not sever the metal.	The consumables are worn, there is a poor work lead connection, the output from the power supply is too low, the power board is producing low current, or the selected cutting mode is incorrect..	<ul style="list-style-type: none"> The consumables need to be replaced 	<ul style="list-style-type: none"> Inspect the consumables and replace if necessary.
		<ul style="list-style-type: none"> The work lead may be damaged or not properly connected to the work piece 	<ul style="list-style-type: none"> Inspect the work lead for damage. Reposition it and clean the work surface to ensure good contact.
		<ul style="list-style-type: none"> The amperage adjustment knob may be set too low. 	<ul style="list-style-type: none"> Increase the amperage as needed.
		<ul style="list-style-type: none"> The power board (PCB3) may be faulty. 	<ul style="list-style-type: none"> Perform Tests 1, 2, and 3 and replace any faulty components.
		The cutting mode switch is in the wrong position for the cutting operation.	<ul style="list-style-type: none"> Ensure the cutting mode switch is in the correct position.
		<ul style="list-style-type: none"> Faulty pilot arc IGBT. 	<ul style="list-style-type: none"> Turn the power OFF, remove the consumables, and check the resistance between the cathode and the work clamp. If the resistance is less than 5 kΩ, check the resistance across the pilot arc IGBT (two screws on 08). If the resistance is less than 5 kΩ, replace the pilot arc IGBT.

TROUBLESHOOTING AND SYSTEM TESTS

Problem	Meaning	Causes	Solution
While in continuous pilot arc mode, the pilot arc extinguishes when you move the plasma arc off the work piece while still pulling the torch's trigger.	The continuous pilot arc feature is not working.	<ul style="list-style-type: none"> The mode switch may be set incorrectly 	<ul style="list-style-type: none"> Verify that the mode switch is set to continuous pilot arc.
		<ul style="list-style-type: none"> The power board (PCB3) or the control board (PCB1) may be faulty. 	<ul style="list-style-type: none"> Perform Tests 1, 2, and 3 and replace the power board (PCB3) or control board PCB1) if necessary.
The arc extinguishes, but re-ignites when the torch trigger is pressed again.	The consumables are worn or damaged, the gas filter element is contaminated, or the input gas pressure is not at the proper level.	<ul style="list-style-type: none"> The consumables need to be replaced. 	<ul style="list-style-type: none"> Replace the consumables as needed.
		<ul style="list-style-type: none"> The gas filter element needs to be replaced. 	<ul style="list-style-type: none"> Replace the gas filter's element if it is contaminated.
		<ul style="list-style-type: none"> The gas pressure is too high or too low. 	<ul style="list-style-type: none"> Manually adjust the gas pressure as needed.
The arc sputters and hisses.	The gas filter element is contaminated, or the input gas line contains moisture.	<ul style="list-style-type: none"> The gas filter element needs to be replaced. 	<ul style="list-style-type: none"> Replace the gas filter's element if it is contaminated.
		<ul style="list-style-type: none"> The input gas supply needs to be cleaned. 	<ul style="list-style-type: none"> Inspect the gas line for moisture. If necessary, install or repair the gas filtration to the power supply. See Section 2, <i>Power Supply Setup</i>, for more information.

Problem	Meaning	Causes	Solution
Machine does not cut well (does not appear to be cutting at full cutting power) and the arc does not time out after 5 seconds.	Inadequate ground.	<ul style="list-style-type: none"> Poor work lead connection. 	<ul style="list-style-type: none"> Verify that the work lead is attached to the workpiece and the workpiece is free of rust, paint, or other coatings.
		<ul style="list-style-type: none"> Damaged work lead. 	<ul style="list-style-type: none"> Check the resistance across the work lead. If the resistance is greater than 3 Ω, repair or replace the work lead.
		<ul style="list-style-type: none"> Faulty pilot arc IGBT. 	<ul style="list-style-type: none"> Turn the power OFF, remove the consumables, and check the resistance between the cathode and the work piece. If the resistance is less than 5 kΩ, check the resistance across the pilot arc IGBT (two screws on 08). If the resistance is less than 5 kΩ, replace the pilot arc IGBT.
		<ul style="list-style-type: none"> Faulty control board. 	<ul style="list-style-type: none"> Replace the control board.
	Low output from the power supply.	<ul style="list-style-type: none"> Current is set too low. 	<ul style="list-style-type: none"> Increase the current as needed.

System tests

Test #	Description	Associated fault codes
1	Voltage input	0-60-ALL
2	DC power buss	3-43-0
3	Output diode bridge	General
4	Temperature out of range	0-40-ALL, 2-10-ALL, 3-11-ALL
5	Flyback (DC to DC) circuit	3-00-0, 3-42-ALL, 3-43-ALL
6	Torch stuck open	0-30-ALL
7	Start signal	General, 0-51-0
8	Torch cap-sensor switch	0-50-0
9	Electronic regulator	0-21-0, 3-20-ALL
10	Pressure sensor	0-12-0, 0-20-0, 2-11-ALL
11	Fan	3-10-ALL
12	Power switch auxiliary	Unreported interlock at START

Before performing any tests do the Internal inspection and the Resistance check in Test 2 below. These tests should only be performed by a qualified service technician. Wear the proper personal protective equipment and use approved tools and measurement equipment.

Before purchasing a major replacement component, verify the problem with Hypertherm Technical Service (1-800-643-9878) or the nearest Hypertherm repair facility.

Several connectors require you to remove a white cap to access the test points. The figure below shows examples of connectors located at the top of the power board. You can pry off most covers with your thumbnail. However, you may need to use a small blade screwdriver to carefully pry off some of the covers. Be careful not to bend or break the connectors.

Pressure sensor
J5 (CSA), J7 (CE)

Electronic regulator
J4 (CSA), J6 (CE)

Fan
J3 (CSA), J5 (CE)

Inverter temperature sensor
J2 (CSA), J4 (CE)



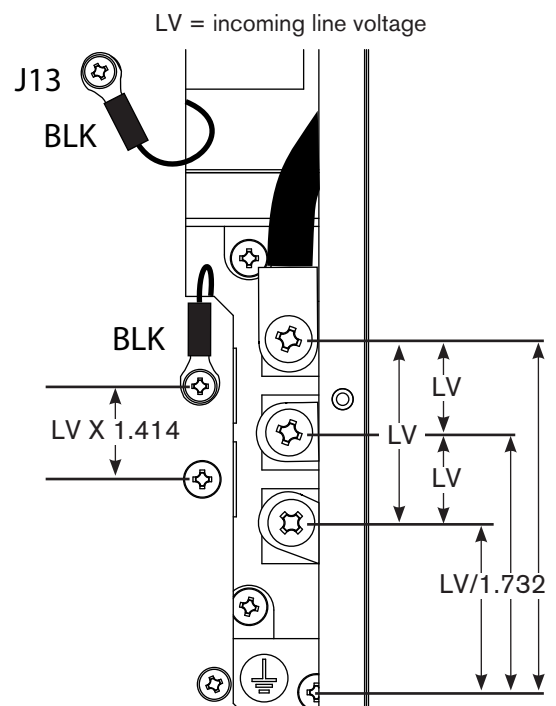
Test 1 – Voltage input

Symptom: Voltage fault (0-60-0, -1 or -2)

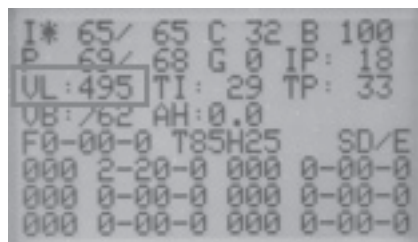
- Check the line voltage at the power switch (S1).
- Check the input voltage to the input diode bridge.
 - The AC voltage between any 2 input wires should equal the line voltage.
- If there is proper voltage to the power switch, and low voltage to the input diode, replace the power switch.
- Check the output voltage of the input diode bridge.
 - Output VDC = Line Voltage x 1.414 VDC.

Note: All values are $\pm 15\%$.

Single phase		Three phase	
L	Black (CSA)	L1	Black (CSA) Brown (CE)
N	White (CSA)	L2	White (CSA) Black (CE)
PE	Green (CSA)	L3	Red (CSA) Gray (CE)
		PE	Green (CSA) Green/Yellow (CE)



- If there is a fault and the diode bridge output value is correct:
 - Display the service screen and confirm that the value "VL" is $\pm 15\%$ of AC line voltage.



- If there is a fault and the "VL" value is correct:
 - Verify the DSP board by replacing it with a known good board.
 - If DSP board is not the problem, replace the power board and the PFC IGBT (CSA units only).

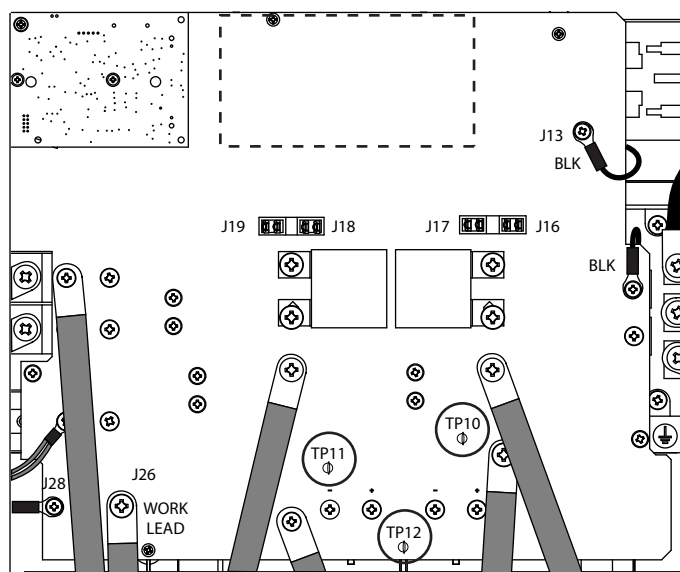
Test 2 – DC Power Buss

Resistance check

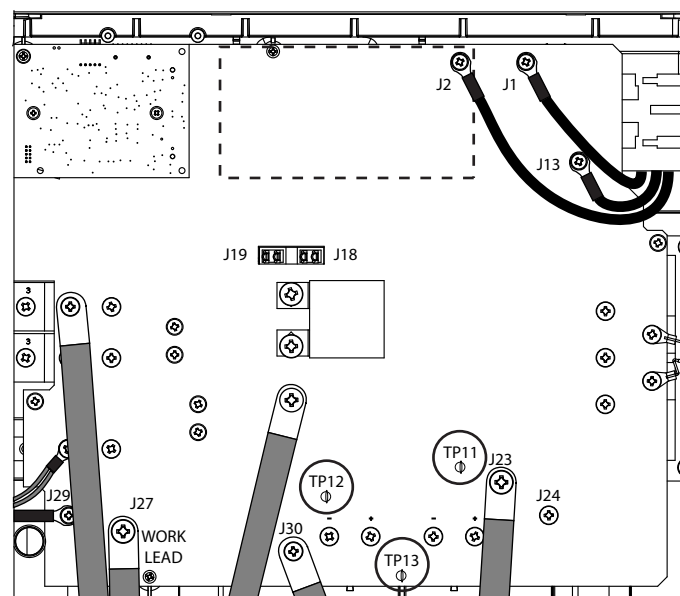
Note: All resistance values must be taken with the power cord disconnected and all internal power supply wires attached.

- Remove the mounting screws from the bulk capacitors and pull the caps away from the power board.
- Measure resistances described in the following tables.

CSA	
Test points	Value
TP 10 and 12	25 kΩ
TP 11 and 12	25 kΩ



CE	
Test points	Value
TP 11 and 13	18 kΩ
TP 12 and 13	18 kΩ



- Replace the bulk capacitor mounting screws before power-up.

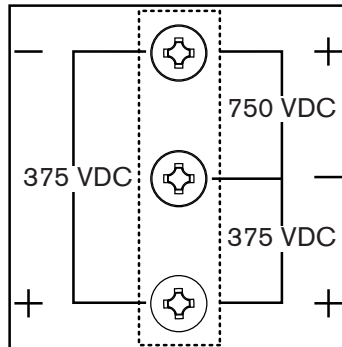
Voltage check

All voltages must be measured with the input power connected and the machine on.

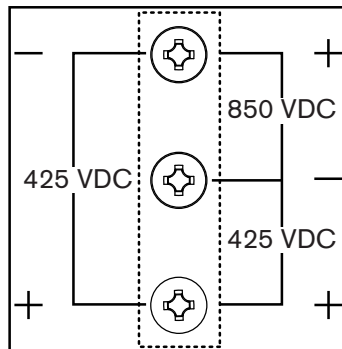
Note: Wear proper personal protective equipment (PPE) before testing powered equipment. All values are $\pm 15\%$.

- Check the inverter IGBT voltages as described below.
- The voltage measured across the bulk capacitors (half the buss voltage or the smaller values above) should be the same before and during torch operation.

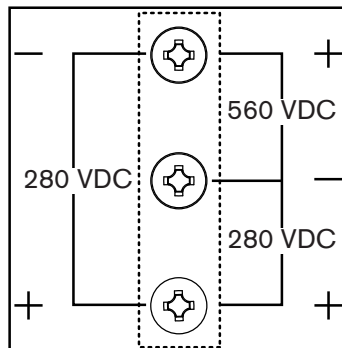
CSA 200-480 VAC input



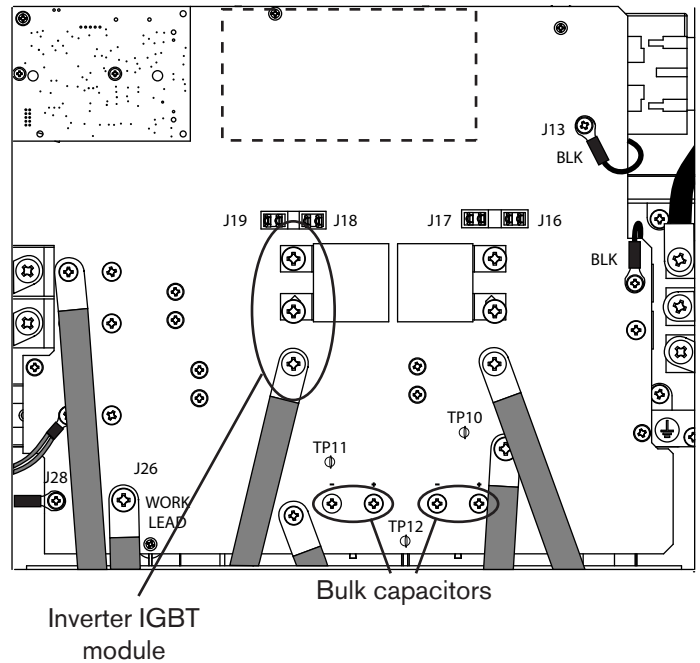
CSA 600 VAC input



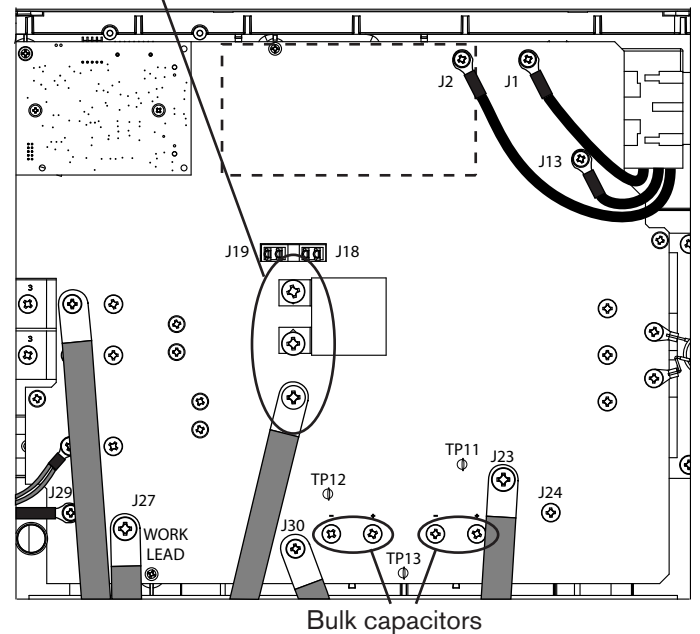
CE 400 VAC input



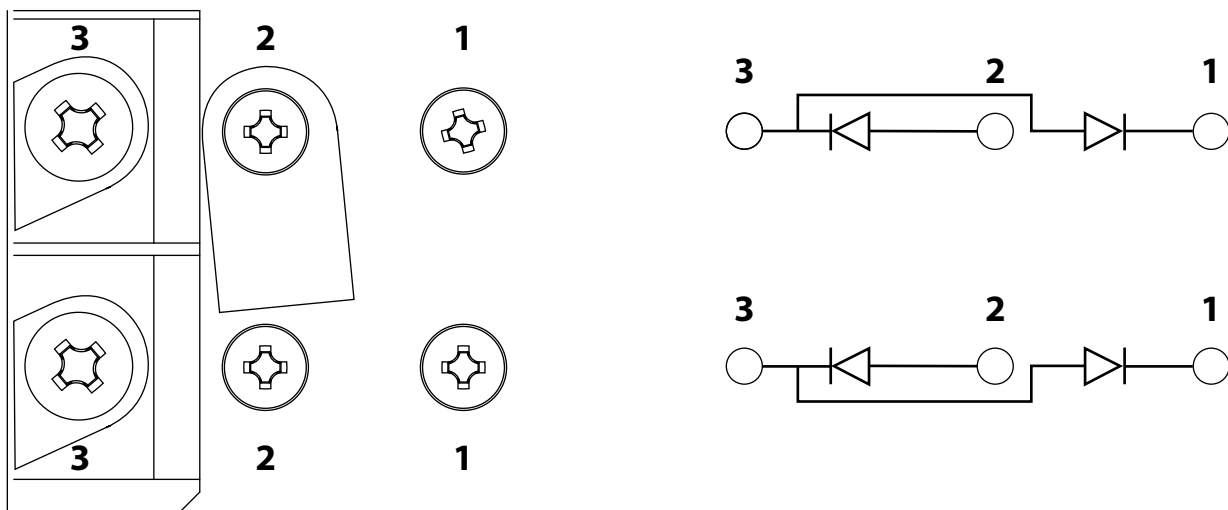
CSA



CE



Test 3 – Output diodes



- Check the four diodes in the bridge with an ohmmeter in diode test mode.
- For each diode, the value should be “open” (very high resistance) with the meter leads in one direction and 0.1 V to 1.0 V with the meter leads reversed.
 - A diode is shorted if the value is less than 0.1 V. Replace the bridge.
 - A diode is open if the value is greater than 1.0 V in both directions. Replace the bridge.

Note: In each case, common (black) should be on 3.

Test 4 – Inverter and PFC temperature sensor

Symptom: Fault code 0-40 appears in the operator screen.

Remove power and allow the system to reach room temperature (at least 60 minutes after use).

If the system has a temperature interlock, either fault code 0-40 or fault code 0-99 appears on the operator screen. Display the service screen and check the “F” field for the live (most recent) fault code. Fault code 0-40 appears on the operator screen, but you need to identify the specific 0-40 fault code variation:

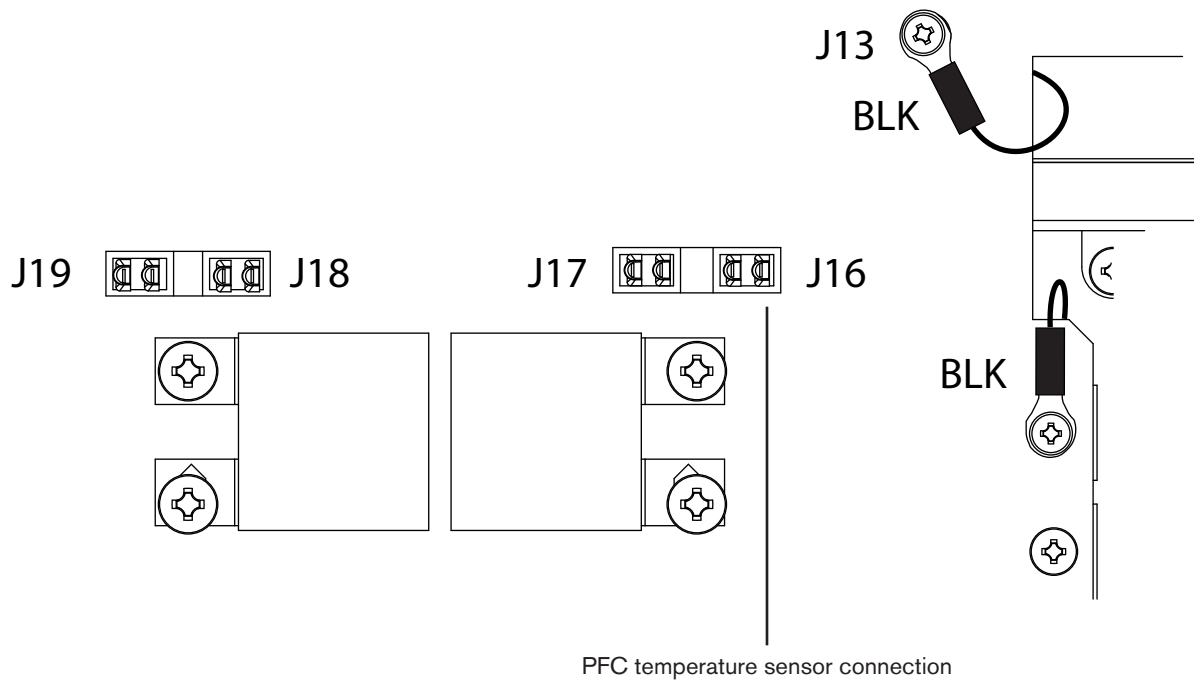
- 0-40-0 PFC module under temperature.
- 0-40-1 PFC module over temperature.
- 0-40-2 Inverter module under temperature.
- 0-40-3 Inverter module over temperature.

If fault code 0-99 appears on the operator screen, display the service screen and check the “F” field for:

- 2-10-0 Inverter module temperature sensor open.
- 2-10-1 Inverter module temperature sensor shorted.
- 3-11-0 PFC module temperature sensor open.
- 3-11-1 PFC module temperature sensor shorted.

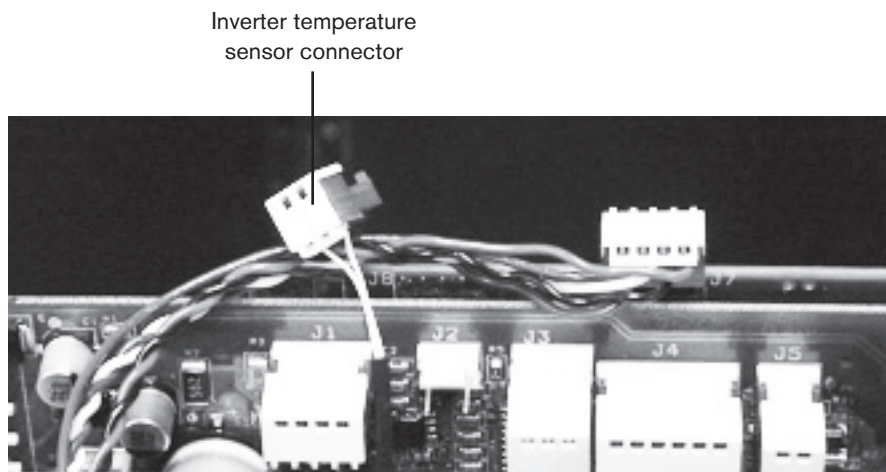
For operational fault codes 0-40-0 and 0-40-1 or power board faults 3-11-0 and 3-11-1 (CSA only)

1. Remove PFC temperature sensor connector (J16) from power board.
2. Check the resistance between pins 1 and 2 on the plug. Resistance should be about 5.5 k Ω .
3. If the resistance is incorrect, replace the PFC IGBT, gate drive wires, and PFC temperature sensor wire.
4. If the value is correct, measure resistance between pins 1 and 2 on the power board with the temperature sensor disconnected. The resistance should be about 4.7 k Ω .
5. If the value is correct, replace DSP board.
6. If the value is incorrect, replace power board.



For operational fault codes 0-40-2 and 0-40-3 or power board faults 2-10-0 and 2-10-1

1. Remove the inverter temperature sensor connector from the top-rear of the power board (J2 on CSA units or J4 on CE units).
2. Measure the resistance between pins 1 and 3 on the plug.
3. If the resistance is not within $\pm 15\%$ of 10 k Ω replace the temperature sensor.
4. If the value is correct, remove the DSP board and measure the resistance between pins 1 and 3 on the power board with the temperature sensor disconnected. The resistance should be approximately 57.6 k Ω .
5. If the value is correct, replace the DSP board.
6. If the value is incorrect, replace the power board.



Test 5 – Flyback circuit (DC minor voltages)

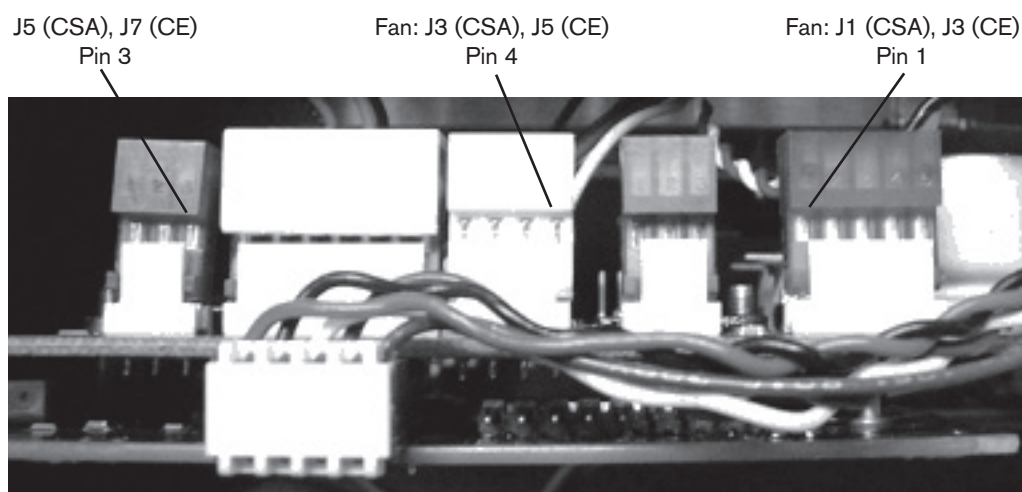
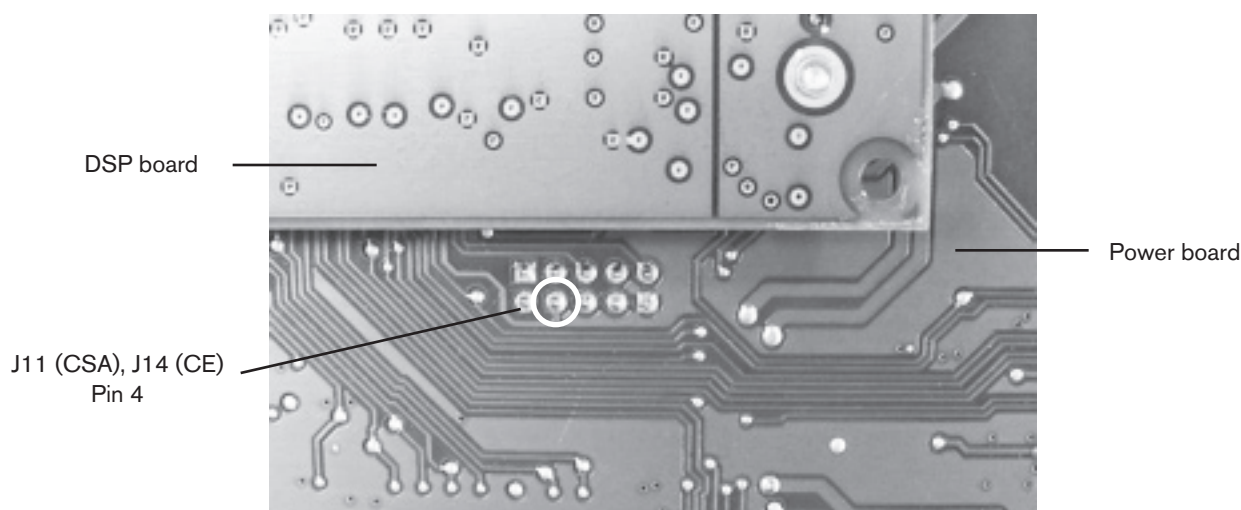
Symptom: Minor voltages are not present.

Note: Wear proper personal protective equipment (PPE) before testing powered equipment.

The flyback circuit is the source of the minor DC voltages in the power supply. It provides +3.3 VDC, +5 VDC, +24 VDC, and +48 VDC.

Check the voltages as described in the table. If a value is not within $\pm 15\%$, perform the appropriate test later in this section.

Volts DC	Test points (use chassis for negative)	
	CSA units	CE units
+48	J3 – Pin 1	J5 – Pin 1
+24	J1 – Pin 1	J3 – Pin 3
+5.0	J5 – Pin 3	J7 – Pin 3
+3.3	J11 – Pin 4	J14 – Pin 4



Remove the connector covers to access the pins on the top-rear of the power board.

If the +48 VDC value is incorrect:

- Remove the fan connector (J3 for standard units or J5 for CE units) and repeat the test.
- If the value is now correct, replace the fan.
- If the value is still incorrect, replace the power board.

If the +3.3 VDC value is incorrect:

- Remove the fan connector (J3 CSA or J5 for CE units) and repeat the test.
- If the value is now correct, replace the fan.
- If value is still incorrect, remove the DSP board and repeat the test.
- If the value is now correct, replace the DSP board.
- If the value is still incorrect, replace the power board.

If the +5 VDC value is incorrect:

- Remove the pressure sensor connector (J5 CSA or J7 for CE units) and repeat the test.
- If the value is now correct, replace the pressure sensor.
- If the value is still incorrect, remove the DSP board and repeat the test.
- If the value is now correct, replace the DSP board.
- If the value is still incorrect, replace the power board.

If the +24 VDC value is incorrect:

- Remove the pressure switch connector (J1 CSA or J3 for CE units) and repeat the test.
- If the value is now correct, replace the pressure switch.
- If the value is still incorrect, replace the pressure switch connector, remove the solenoid valve connector (J4 CSA and J6 for CE units) and repeat the test. If the value is now correct, replace the solenoid valve. If the value is still incorrect, replace the power board.

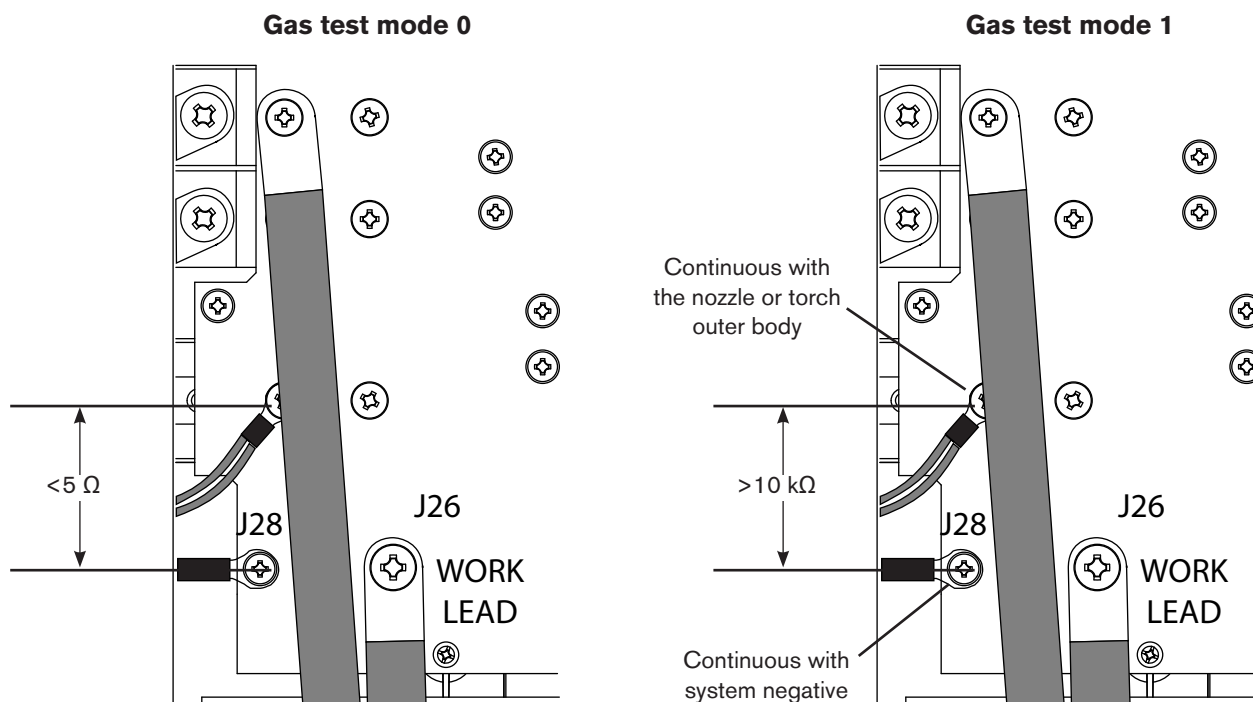
Test 6 – Torch stuck open (TSO)

Symptom: No fault occurs at power-up but an 0-30 fault displays on the operator screen when attempting to fire the torch.

Confirm that all of the proper consumables are installed in the torch.

In an idle (no start signal) working system with the torch and consumables installed, there should be continuity between the dual black wires connected to the center post of the pilot arc IGBT and the red wire connecting to J28. With gas flowing through the torch (gas test mode 1) there should be very high resistance between those two points.

Note: To set the system to gas test mode, display the service screen (refer to page 5-21 *Displaying the service screen*), move the cursor to “G” (gas), and use the adjustment knob to toggle to “1” (gas test mode).



Before continuing, turn OFF the power.

If the resistance value is always less than 100 Ω , remove the torch and recheck the resistance. If the value is still less than 100 Ω :

- Use an IGBT tester to check for a shorted pilot arc IGBT.
- Replace the pilot arc IGBT if it is shorted.

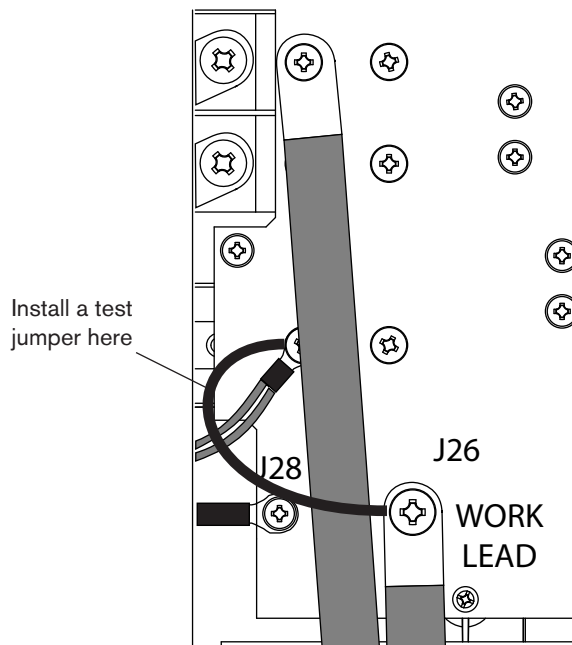
If the resistance is always greater than 100 Ω :

- Replace all consumables and recheck.
- If the resistance is correct ($<100\ \Omega$) the old consumables are bad.
- If the resistance is still greater than 100 Ω , measure the resistance in the torch between the pilot arc wires (Pin 1 or 2) and negative arc power (the center connection).
- If the resistance is still too high, replace the torch and lead.

Note: The retaining cap should be snug but not over-tightened.
All values are $\pm 15\%$

Check the function of the pilot arc IGBT:

- Turn the machine off and disconnect power.
- Install a jumper wire from the work lead (J26 for CSA, J27 for CE) to the pilot arc IGBT (dual black wires).
- Reconnect power and turn on the machine.
- Attempt to fire the torch.
- If the torch fires, replace the pilot arc IGBT.



Test 7 – Start signal

Symptom: There is no arc when the torch trigger is closed.

If the start icon is displayed and there is a fault code 0-51 at power up:

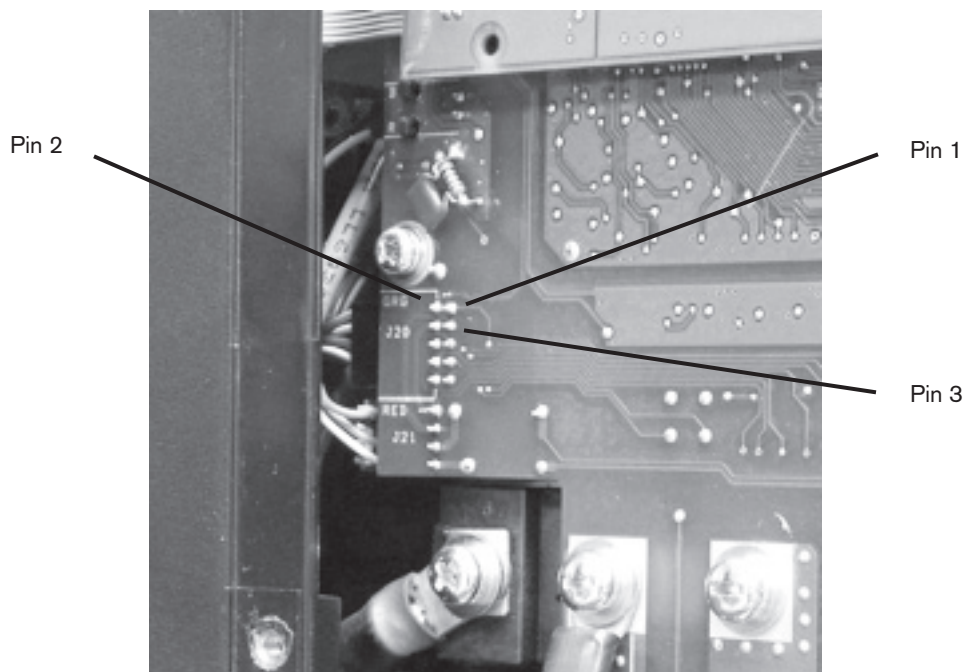
- Remove the torch from the system.
- Check the resistance between Pin 6 and Pin 7 In the lead plug, with the torch trigger open (not pulled).
- If there is very low resistance, inspect the lead set and trigger switch for shorts and replace or repair as necessary.

If the icon is not displayed at power up and does not appear when the torch trigger is closed:

- Remove the torch from the system.
- Close the trigger switch and check the resistance between Pin 6 and Pin 7.
- If there is very high resistance, inspect the lead and trigger switch for opens and replace or repair as necessary.

If there is no problem found with the torch wiring or trigger switch and there is still no arc or start icon:

- Turn the machine off and disconnect power.
- Remove the nozzle and electrode from the torch and re-install the retaining cap.
- Reconnect power and turn the machine on.
- Temporarily connect J20 Pin 2 to Pin 3. (CAUTION: Gas will flow to the torch)



- If gas does not flow and there is no start icon on the display:
 - Verify the DSP board is working by replacing it with a known good DSP board.
 - If the DSP board is not the problem, replace the power board.

Test 8 – Torch cap switch

Symptom: Fault code 0-50 and the cap-sensor switch icon appear on the operator screen.

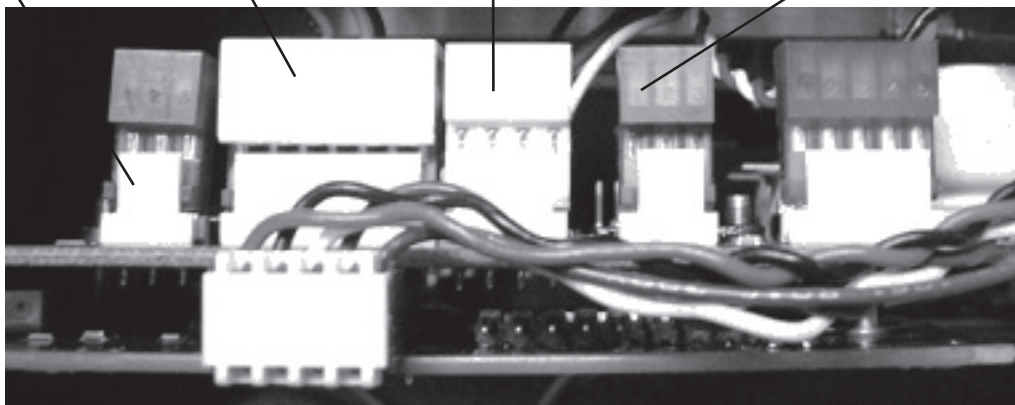
1. Confirm that the retaining cap is in place.
2. Remove the torch from the power supply and check the resistance between Pin 5 and Pin 7 in the torch lead plug.
 - a. If the resistance is very high, check for opens in the torch leads and cap sensor switch.
 - b. If there is no problem with the leads or switch, test the circuit boards.
 - Turn off the machine and disconnect power.
 - Put a jumper wire between J20 pins 1 and 2.
 - Reconnect power and turn on the machine.
 - If the cap-sensor switch icon is not displayed, verify the DSP board by replacing it with a known working board. If the DSP is not the problem replace the power board.

Test 9 – Electronic regulator

Symptom: Air flows continuously through the torch.

1. Turn off the machine and disconnect power.
2. Disconnect the electronic regulator control cable (J4 for CSA, J6 for CE) from the power board.
 - If air continues to flow, replace the electronic regulator.
 - If the air stops flowing, verify the DSP board by replacing it with a known good one. If the DSP board is not the problem, replace the power board.

Pressure sensor J5 (CSA), J7 (CE) Electronic regulator J4 (CSA), J6 (CE) Fan J3 (CSA), J5 (CE) Inverter temperature sensor J2 (CSA), J4 (CE)



Test 10 – Pressure sensor

Symptom: The pressure sensor reading doesn't agree with known pressures.

Note: Wear proper personal protective equipment (PPE) before testing powered equipment.

1. Remove the white cover on the plug at J5 for CSA units or J7 for CE units.
2. Turn the machine on.
3. Measure power to the sensor between Pin 2 and Pin 3.

If not 5.0 ($\pm 5\%$) perform the Flyback Circuit test above.

4. Display the service screen (refer to page 5-21 *Displaying the service screen*). Enable the gas test by moving the cursor to the "G" field and turning the adjustment knob to display "1" in the field. To turn off the gas test, turn the adjustment knob to display "0" in the field.

Note the flowing gas pressure in the "P" field to the right of the slash.

5. Measure VDC between Pin 2 (-) and Pin 1 (+)

The value should be 0.0463 times the pressure, for example (68 PSI * .0463 VDC/PSI = 3.148 VDC).

If the voltage measurement is within $\pm 10\%$ of the correct value and you have a pressure warning or fault:

- a. Test with a known working DSP board.
- b. If the measured voltage is correct, replace the DSP board.
- c. If the measured voltage is not correct, replace the pressure sensor.

Test 11 – Fan

Symptom: The fan does not operate properly.

Note: Wear proper PPE protection before testing powered equipment.

1. Remove the inverter temperature sensor plug from J2 in CSA units or J4 in CE units.
2. Place a jumper between Pin 1 and Pin 3 of the connector (J2/J4) on the power board.
3. Remove the white cover from the fan control cable at J3 for CSA units or J5 for CE units.
4. Turn the machine on.
5. With the fan control cable connected to J3 for CSA units and J5 for CE, measure the DC voltage between Pin 1 and Pin 4 in the plug.
 - a. If the voltage is 48 VDC ($\pm 5\%$), replace the fan.
 - b. If the voltage is not correct:
 - Remove the fan control cable and re-measure the DC voltage on the power board connector between Pin 1 and Pin 4 of J3/J5.
 - If the voltage is 48 VDC, replace the fan. Otherwise, perform Test 6 – Flyback circuit above.
 - c. If the system passes the flyback circuit test:
 - If the voltage between Pin 1 and Pin 3 (J3 / J5) is 0 VDC, replace the DSP board.
 - If the voltage is greater than 0, replace the power board.

Test 12 – AUX switch

Symptom: The display goes blank after "Hypertherm" appears. (CSA units only).

1. Turn the machine off and disconnect the power.
2. Disconnect the auxiliary switch cable from J1 on the power board.
3. Measure the resistance on the cable plug between Pin 4 and Pin 5.
4. If the power switch is closed (ON) there should be very low resistance.
5. If the power switch is open (OFF) there should be very high resistance.
6. If the resistance measurement doesn't agree, check the cable, plug, and switch for opens or shorts.

Section 6

COMPONENT REPLACEMENT

In this section:

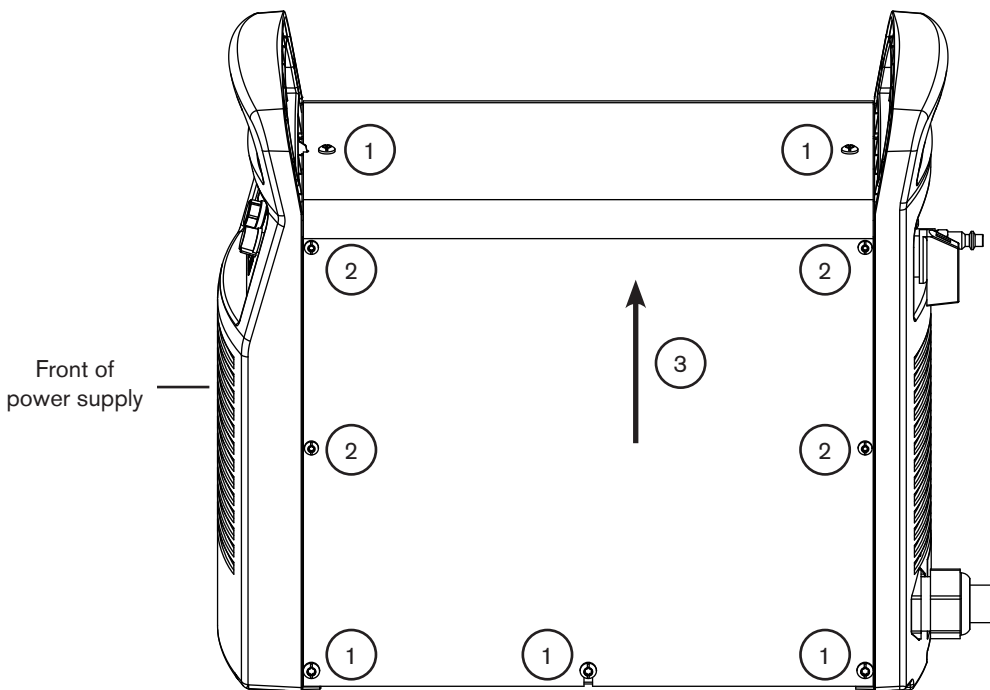
Remove and replace the power supply cover and Mylar® barrier	6-2
Remove the power supply cover and Mylar barrier	6-2
Replace the Mylar barrier.....	6-3
Replace the power supply cover	6-4
Replace the power cord.....	6-5
Replace the power cord (200 – 600 V 3-phase CSA, 400 V 3-phase CE)	6-5
Replace the power cord (200 – 480 V 1-phase CSA)	6-10
Replace the work lead	6-11
Replace the fan	6-12
Replace the air filter element.....	6-14
Replace the air filter subassembly	6-15
Replace the power board	6-17
Remove the DSP board	6-17
Replace the power board (380/400V CE)	6-19
Replace the power board (200 – 600V CSA).....	6-22
Install the DSP board	6-25
Replace the Mylar barrier and power supply cover.....	6-26
Replace the control board	6-27
Replace the heat sink components	6-29
65A CSA.....	6-30
65A CE.....	6-31
85A CSA.....	6-32
85A CE.....	6-33

Remove and replace the power supply cover and Mylar® barrier

Replacing interior components requires that you remove and replace the power supply cover and Mylar barrier. This section describes these procedures.

Remove the power supply cover and Mylar barrier

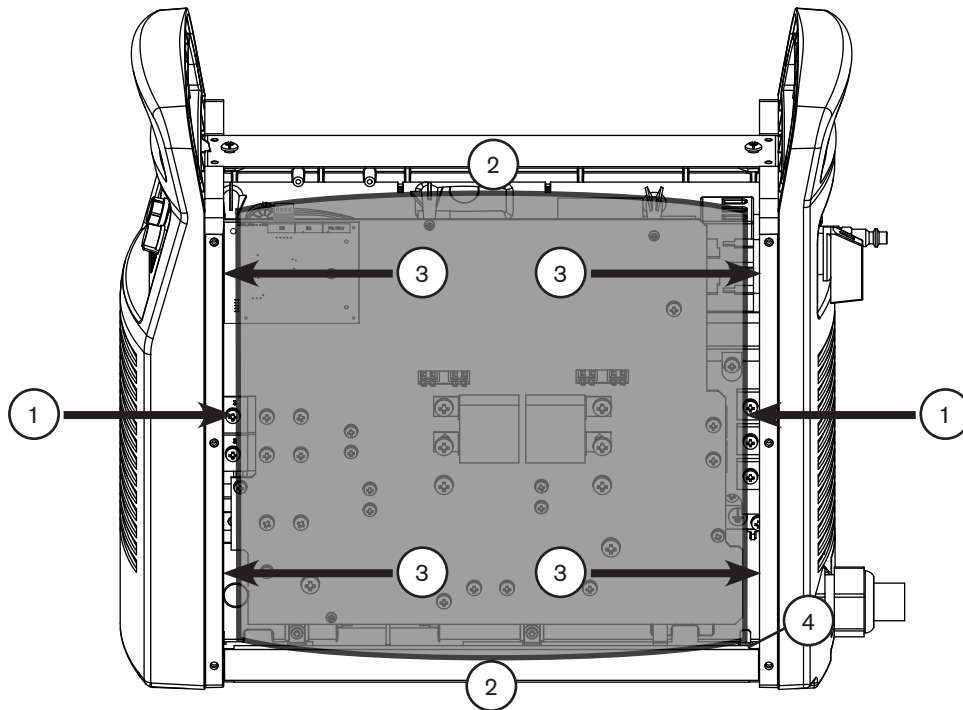
1. Turn OFF the power, disconnect the power cord, and disconnect the gas supply.
2. Using a T15 TORX or blade screwdriver, remove the 8 small screws (2) from the power supply cover.
3. Using a T20 TORX or blade screwdriver, remove the 8 large screws (1) from the power supply cover.
4. Lift the cover (3) off the power supply.



5. Remove the Mylar barrier from the power-board side of the power supply. The Mylar barrier is flexible and can be bent slightly for removal.

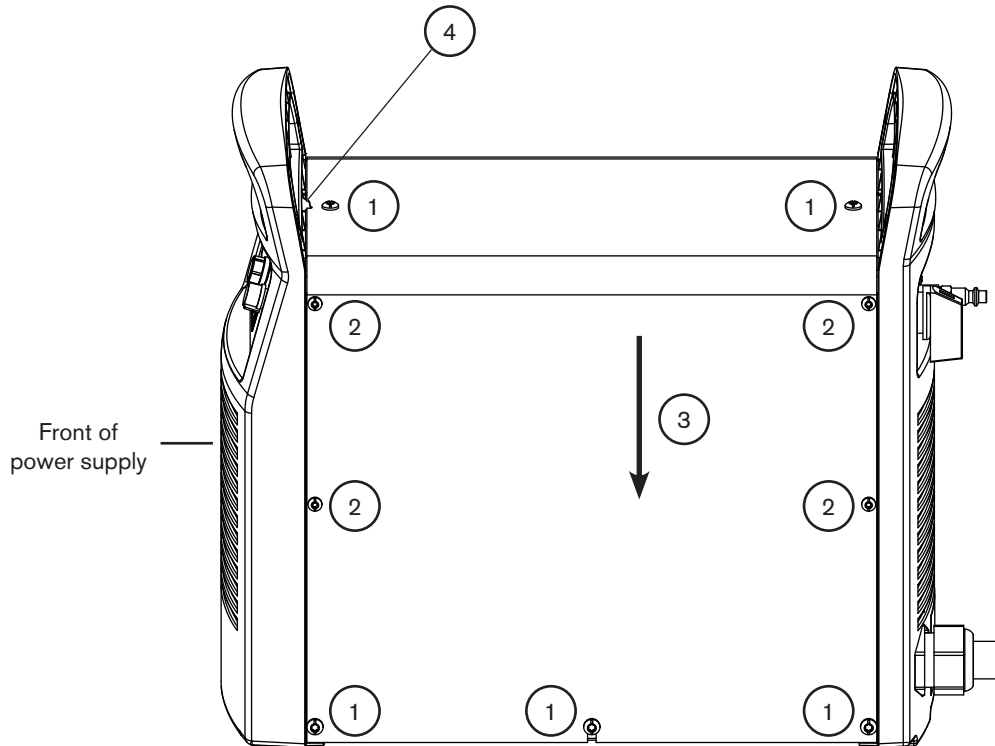
Replace the Mylar barrier

1. Remove the metal strap at the top of the power supply and pull the front panel out slightly to make it easier to install the Mylar barrier.
2. Carefully push in the sides (1) of the Mylar barrier so that the barrier bends out slightly at the top and bottom (2).
3. Slide the sides of the Mylar barrier behind the power supply frame (3). Be careful not to damage wires or accidentally disconnect wires from the connectors.
4. Gently bend the top of the barrier at the perforation so that the top bends over the top of the power supply.
5. Slide the barrier down so that the bottom edge fits inside the power supply frame (4).
6. Reattach the metal strap at the top of the power supply to secure the front and rear panels. Be careful not to pinch any wires. Align the slot in the strap with the plastic tab in the front panel and push the strap straight down. The four pins in the strap snap into the front and rear panels



Replace the power supply cover

1. Place the cover (3) over the power supply with the slot in the cover (4) over the plastic tab in the front panel. The slot and tab ensure that the vent in the side of the cover is over the fan. Be careful not to pinch any wires.
2. Using a T15 TORX or blade screwdriver, install the 8 small screws (2) into the power supply cover. Tighten the screws to 15 in-lbs (17.3 kg cm).
3. Using a T20 TORX or blade screwdriver, install the 8 large screws (1) into the power supply cover. Tighten the screws to 15 in-lbs (17.3 kg cm).



Replace the power cord

For wire sizes, see *Extension cord specifications* in Section 2, *Power Supply Setup*.

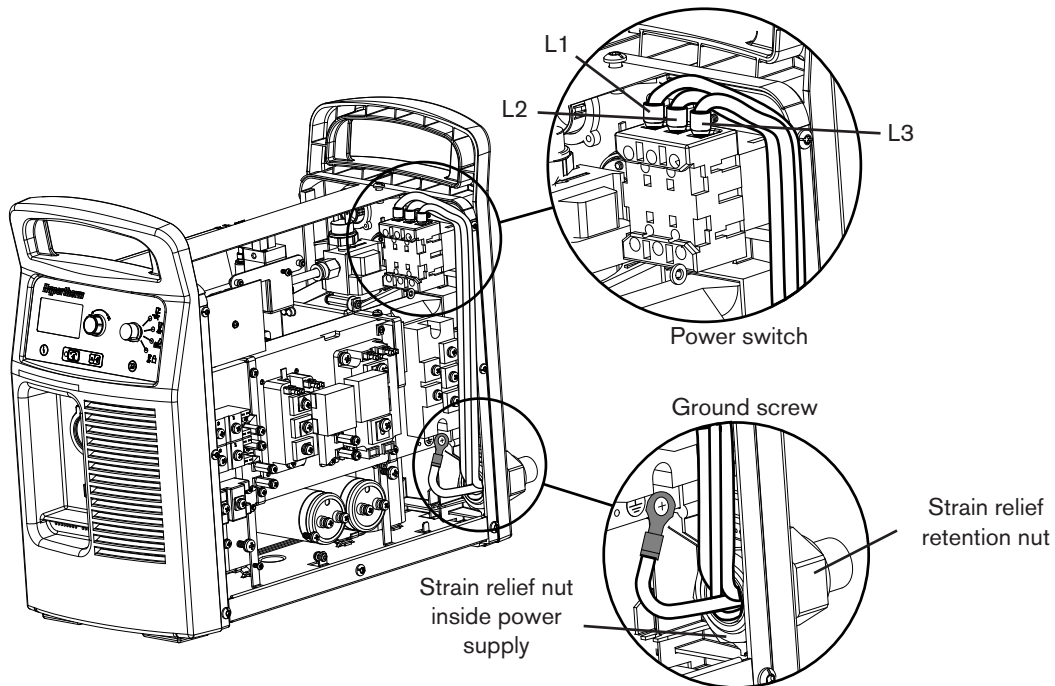
Replace the power cord (200 – 600 V 3-phase CSA, 400 V 3-phase CE)

This section describes the procedures for replacing the power cord on 3-phase power supplies.

Remove the existing 3-phase power cord

1. Turn OFF the power, disconnect the power cord, and disconnect the gas supply.
2. Remove the power supply cover and Mylar barrier. Refer to page 6-2 *Remove and replace the power supply cover and Mylar® barrier*.
3. Loosen the set screws that secure the three power wires to the top of the power switch.

Note: For CSA models, use a #2 Phillips screwdriver. For CE models, use a #1 Phillips screwdriver.

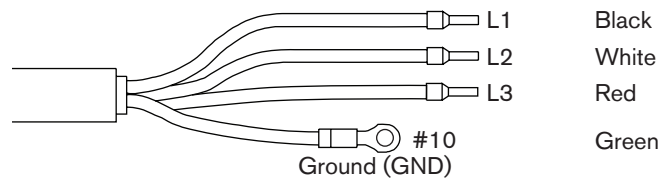


COMPONENT REPLACEMENT

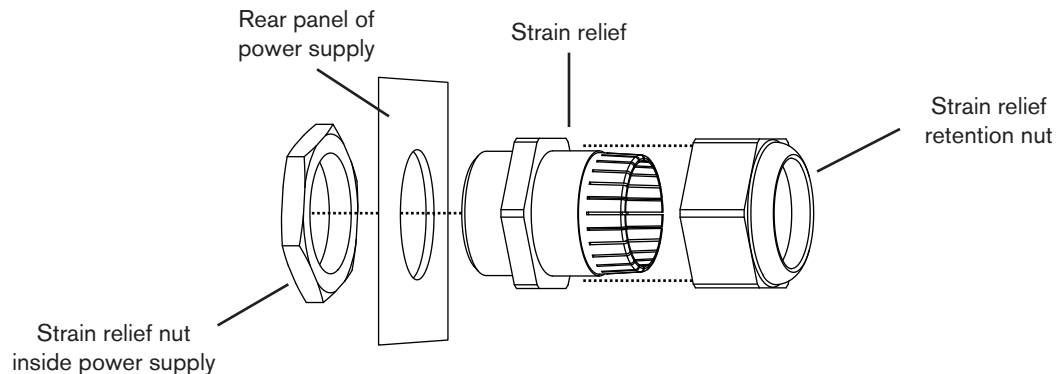
4. Pull the wires straight up to remove them from the power switch.
5. Remove the ground screw that secures the green ground wire to the heatsink.

Note: For CE models, the ground screw is located at the top of the heat sink.

6. On the outside of the power supply, unscrew the power cord's strain relief retention nut so that the wires move freely. Slide the nut back along the old power cord.
7. Pull the wires through the strain relief in the rear panel to remove the old power cord. Note: A CE power cord must be pulled forward through the strain relief.
8. If you are replacing the old strain relief:
 - a. Use an adjustable wrench to unscrew the strain relief nut on the inside of the power supply.
 - b. Remove the old strain relief.

Install the new 3-phase power cord (CSA model)

1. Slide the strain relief retention nut over the wires of the new power cord and slide it back along the cord.
2. If you are replacing the old strain relief:
 - a. Slide the new strain relief into the hole in the rear panel of the power supply.
 - b. Secure the strain relief on the inside of the power supply using the new strain relief nut. Hand tighten the nut and then over-tighten slightly more.

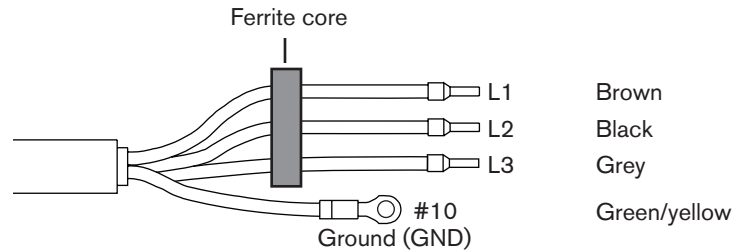


3. Route the new power cord wires through the strain relief in the rear panel.
4. Route the black, white, and red wires to the top of the power switch.
5. Insert the wire connectors into the top of the power switch and use a #2 Phillips screwdriver to tighten the set screws to 10 in-lbs (11.5 kg cm). Refer to the figure above for the correct color assignments. "L1", "L2", and "L3" are marked on the power switch above each set screw.
6. Secure the green ground wire to the heatsink using the Phillips screw and tighten to 20 in-lbs (23.0 kg cm) with the star washer between the ring terminal and the heat sink.
7. Position the wires in the wire chase up the side of the end panel and out of the way of the power board. Once the wires are in place, tighten the strain relief retention nut onto the strain relief to secure the new power cord.

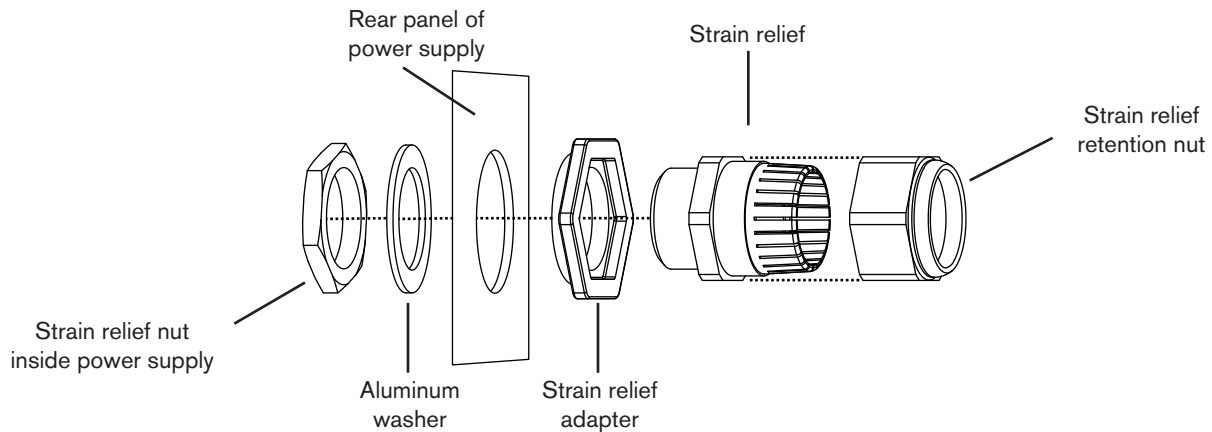
COMPONENT REPLACEMENT

Install the new 3-phase power cord (CE model)

In CE systems, the standard strain relief hole in the rear panel of the power supply is too big to accommodate the smaller CE power cord. Therefore, CE power cord kits contain an adapter that reduces the hole size. The kit also contains an aluminum washer to assist the strain relief nut in properly securing the strain relief inside the power supply. Refer to the figures below.



1. If you are replacing the old strain relief:
 - a. Slide the new strain relief through the strain relief adapter and into the hole in the rear panel of the power supply.
 - b. Place the aluminum washer over the strain relief inside the power supply.
 - c. Secure the strain relief on the inside of the power supply using the new strain relief nut. Hand tighten the nut and then over-tighten slightly more.



2. Route the new power cord wires through the strain relief in the rear panel from inside the power supply. (The CE power cord includes a ferrite core. Therefore, you can not route the power cord through the strain relief from the outside of the power supply.)
3. Slide the strain relief retention nut over the wires of the new power cord and slide the nut forward toward the power supply.
4. Route the brown, black, and grey wires to the top of the power switch.
5. Insert the wire connectors into the top of the power switch and use a #1 Phillips screwdriver to tighten the set screws to 10 in-lbs (11.5 kg cm). Refer to the figure on the previous page for the correct color assignments. "L1", "L2", and "L3" are marked on the power switch above each set screw.
6. Secure the green/yellow ground wire to the heatsink using the Phillips screw and tighten to 20 in-lbs (23.0 kg cm) with the star washer between the ring terminal and the heat sink.
7. Position the wires in the wire chase up the side of the end panel and out of the way of the power board. Once the wires are in place, tighten the strain relief retention nut onto the strain relief to secure the new power cord.

Install a plug on the power cord (CSA and CE)

Use a plug that meets national and local electrical codes. The plug must be connected to the power cord by a licensed electrician.

COMPONENT REPLACEMENT

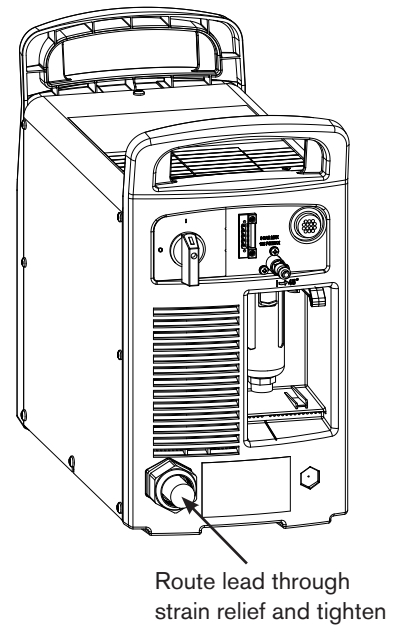
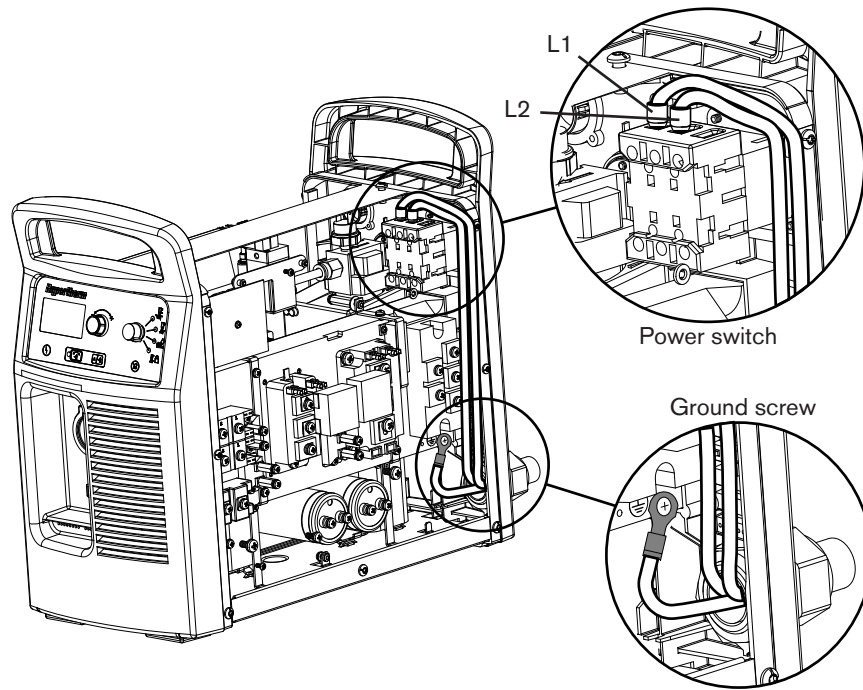
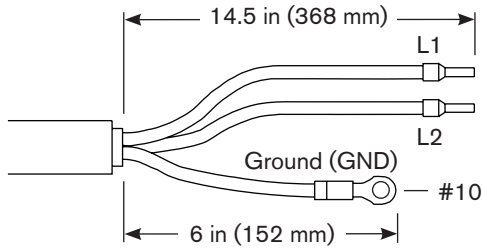
Replace the power cord (200 – 480 V 1-phase CSA)

To operate your Powermax on 1-phase power, you will need to install an appropriate power cord.



Caution: When using the Powermax85 CSA model power supply (CE model is 3-phase only) with a 1-phase power source, replace the supplied power cord with a 6 AWG (16 mm²) 3-wire power cord. The power cord must be connected by a licensed electrician.

Strip and prepare the power cord wires as shown below.



Install a plug on the power cord (CSA)

Use a plug that meets national and local electrical codes. The plug must be connected to the power cord by a licensed electrician.

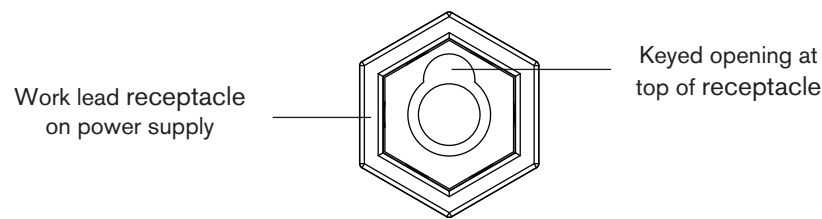
Replace the work lead



Caution: Make sure you use a work lead that is appropriate for your power supply. Use a 65 A work lead with the Powermax65. Use an 85 A work lead with the Powermax85. The amperage is marked near the rubber boot of the work lead connector.

1. Turn OFF the power.
2. Remove the old work lead from the front of the power supply. Turn the work lead connector counterclockwise approximately 1/4 turn.
3. Pull the work lead connector out of the receptacle.
4. Insert the new work lead connector into the receptacle.

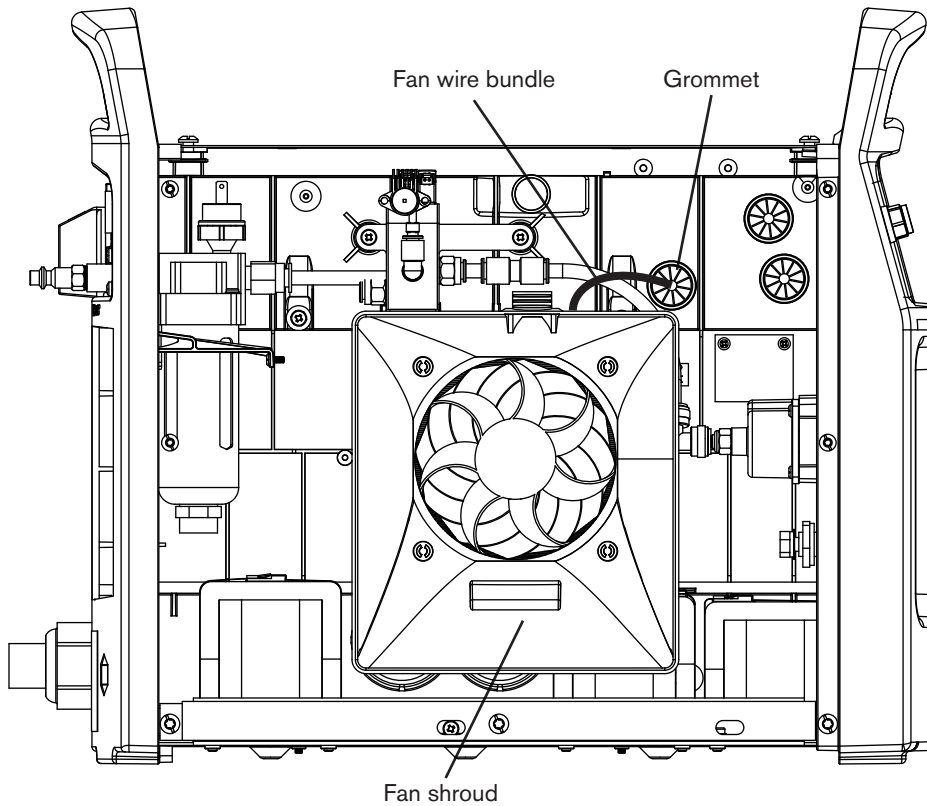
Note: The receptacle is keyed. Align the key on the work lead connector with the opening at the top of the receptacle on the power supply.



Caution: Ensure the work lead is fully seated in the receptacle to prevent overheating.

5. Push the work lead connector all the way into the receptacle on the power supply and turn clockwise, approximately 1/4 turn, until the connector is fully seated against the stop in order to achieve an optimal electrical connection.

Replace the fan



1. Turn OFF the power, disconnect the power cord, and disconnect the gas supply.
2. Remove the power supply cover.
3. Remove the fan shroud by pulling it straight off the fan housing.
4. Detach the fan wire connector from J3 (CSA) or J5 (CE) on the top-rear of the power board.

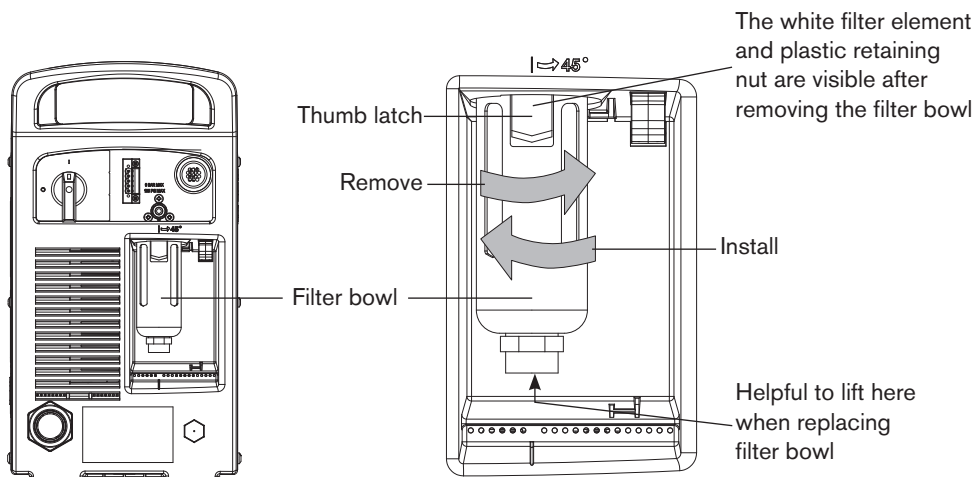
Fan connector
J3 (CSA), J5 (CE)



5. Pull the fan wire through the grommet to the fan side of the power supply.
6. Insert a #1 Phillips screwdriver through the holes in the fan casing to remove the retaining screw from each corner of the fan.
7. Slide the old fan out from the power supply.
8. Slide the new fan into place.
9. Replace the 4 retaining screws.
10. Route the fan wire through the grommet.
11. Attach the fan wire connector to J3 (CSA) or J5 (CE) on the top-rear of the power board.
12. Position the fan shroud onto the fan housing with the wider end at the bottom and snap it into place.
13. Replace the power supply cover.
14. Reconnect the electrical power and the gas supply.

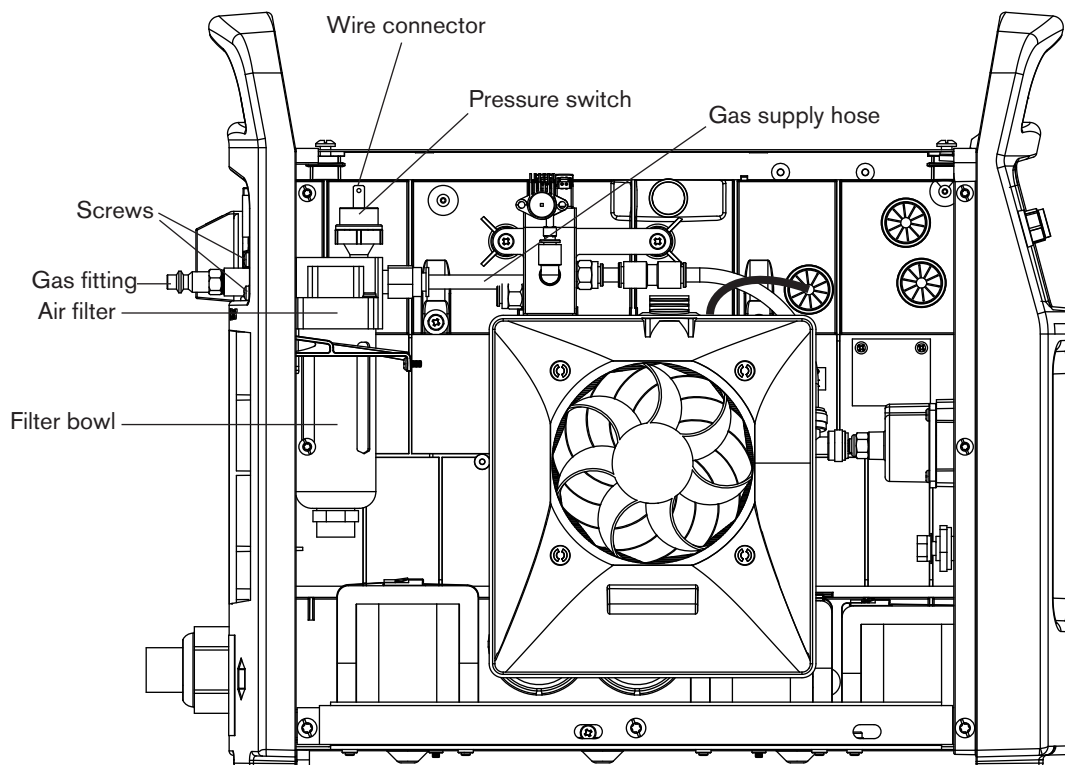
Replace the air filter element

1. Turn OFF the power, disconnect the power cord, and disconnect the gas supply.
2. Position the rear of the power supply so the removable air filter bowl is easily accessible.
3. Remove the consumables kit that ships beside the filter bowl on the rear panel.
4. Grasp the filter bowl with your right hand.
5. Push down the thumb latch and rotate the filter bowl approximately 45 degrees to the right.
6. Pull the filter bowl straight down to remove. You can see the white filter element and retaining nut.
7. Unscrew (counterclockwise) the plastic retaining nut that secures the filter element.
8. Replace the dirty element with a new element. Reinstall (clockwise) the plastic retaining nut to finger-tight only.
9. Clean the filter bowl.
10. Insert the filter bowl with the thumb latch positioned approximately 45 degrees to the right of center. This is the same orientation in which the filter bowl was pulled down and removed.
11. Vertically align the filter bowl (with metal guard) and firmly push the filter bowl up to the top of the receptacle to seat the bowl. It is helpful to lift the bowl with your left index finger under the nut on the bottom of the bowl.
12. Once the bowl is seated properly, rotate the bowl 45 degrees to the left until you hear the thumb latch click into place.
13. Reconnect the gas supply hose to the power supply and check for leaks.
14. Reconnect the electrical power.



Replace the air filter subassembly

1. Turn OFF the power, disconnect the power cord, and disconnect the gas supply.
2. Remove the power supply cover.
3. Remove the filter bowl from the air filter at the rear of the power supply. Refer to the instructions and figure on page 6-14 *Replace the air filter element*.
4. Disconnect the two wires from the top of the pressure switch.
5. Disconnect the ground wire from the air filter body.
6. Disconnect the gas supply hose from the air filter. Pull back the orange ring on the push-to-connect tube connector and pull the tube out of the connector.
7. Remove the three screws that hold the gas fitting to the rear panel.
8. Remove the old air filter subassembly.



COMPONENT REPLACEMENT

9. Temporarily remove the filter guide from the new air filter subassembly.
10. Place the subassembly into the rear panel hole.
11. Replace the three screws that hold the gas fitting to the rear panel. Torque down the screws to 15 in-lbs (17.7 kg cm).
12. Install the new filter guide onto the air filter subassembly.
13. Connect the gas supply hose to the air filter.
14. Connect the ground wire to the air filter body.
15. Connect the two wires to the top of the pressure switch.
16. Install the filter bowl onto the filter subassembly at the rear of the power supply. Refer to the instructions and figure on page 6-14 *Replace the air filter element*.
17. Replace the power supply cover.
18. Reconnect the electrical power and the gas supply.

Replace the power board

1. Turn OFF the power, disconnect the power cord, and disconnect the gas supply.
2. Remove the power supply cover and Mylar barrier. Refer to page 6-2 *Remove the power supply cover and Mylar barrier*.
3. Remove the metal strap at the top of the power supply and pull the front panel out slightly to make it easier to access the power board.

Remove the DSP board

1. Disconnect the DSP connector (1) from the top of the DSP board (3).

Note: This step is only required on systems that have an RS485 communication board installed. Systems without an RS485 communication board installed will not have a connector plugged into the top of the DSP board.

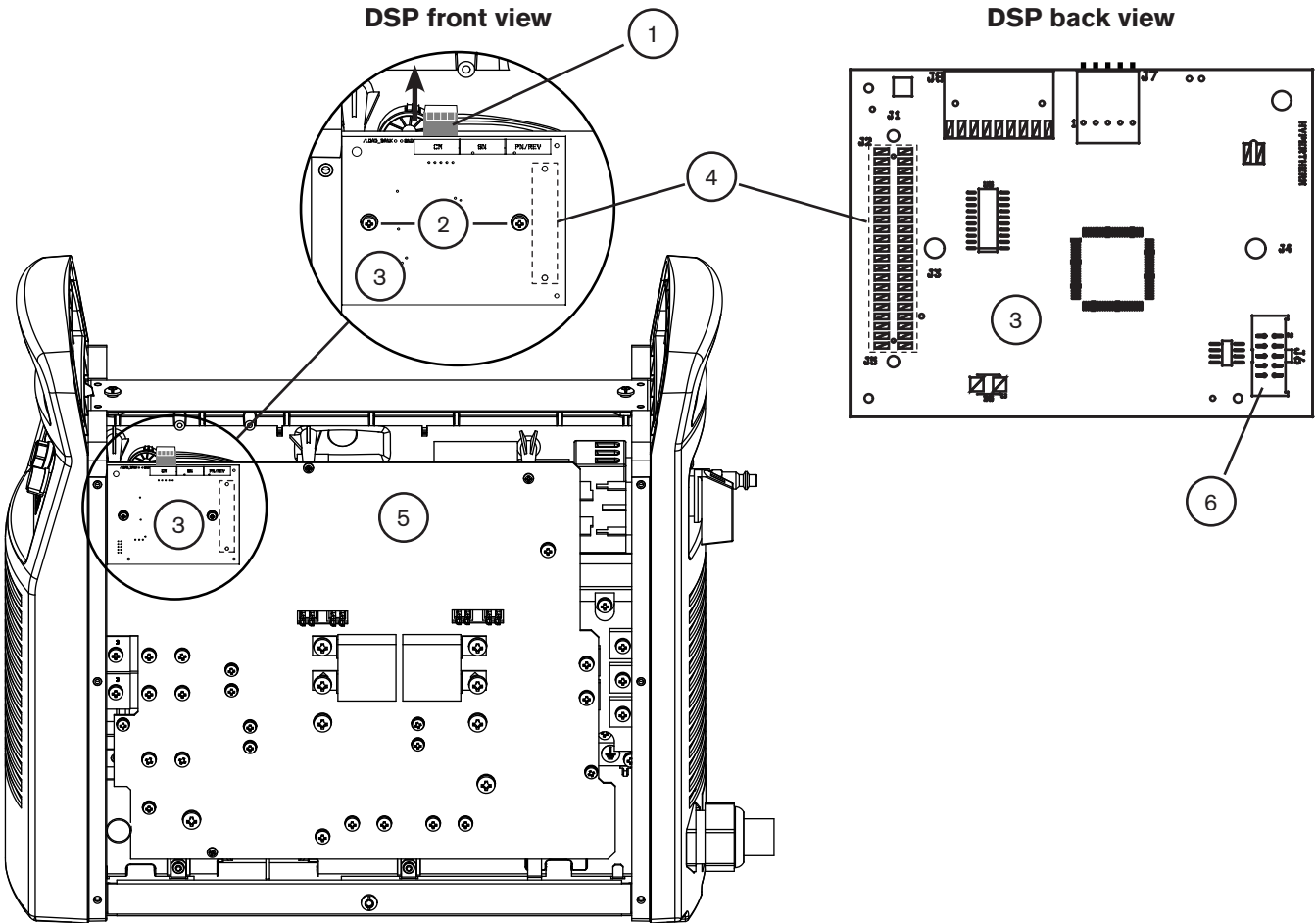
2. Use a #2 Phillips screwdriver to remove the 2 screws (2) from the DSP board.
Two rows of connector pins (4) are located on the back of the DSP board (3) as shown in the figures below. The dashed rectangle identifies the location of the pins on the back of the board.
3. Carefully pull the DSP board (3) straight out from the power board (5). Do not bend the pins.

Note: Instructions for removing the DSP board are the same for both CE and CSA models. The power board (5) shown below is a CSA model.

4. Disconnect the ribbon cable from the ribbon cable connector (6) on the back of the DSP board. Set the DSP board aside.

For CE systems, proceed to page 6-19 *Replace the power board (380/400V CE)*.

For CSA systems, proceed to page 6-22 *Replace the power board (200 – 600V CSA)*.



Replace the power board (380/400V CE)

Refer to the figure on the next page when performing the following procedure.

Remove the old power board (380/400V CE)

1. Unplug the five wire connectors located at the J3, J4, J5, J6, and J7 headers on the heat sink side of the power board.
2. Disconnect the two gate drive wire connectors (J18, J19) from the power board.
3. Remove the 3uF capacitor and the two transformer wires below it using a #3 Phillips screwdriver to remove the three inverter IGBT screws and the screw at J30.
4. Disconnect the work lead wire using a #3 Phillips screwdriver to remove the screw at J27.
5. Disconnect the AC input wires and PFC inductor wires using a #2 Phillips screwdriver to remove the screws at J1, J2, J13, J23, and J24.
6. Remove the four snubber resistor screws and four capacitor screws using a #2 Phillips screwdriver.
7. Disconnect the MOV subassembly from the board using a #2 Phillips screwdriver to remove the two input bridge screws on the right.
8. Remove the remaining three input bridge screws.
9. Disconnect the output inductor wire by removing the upper left diode screw with a #2 Phillips screwdriver.
10. Remove the three remaining diode screws.
11. Disconnect the nozzle wire (black) using a #2 Phillips screwdriver to remove the pilot arc IGBT screw on the left.
12. Remove the remaining pilot arc IGBT screw.
13. Disconnect the electrode wire (red) using a #2 Phillips screwdriver to remove the screw at J29.
14. Remove the three heat sink mounting screws using a #2 Phillips screwdriver.

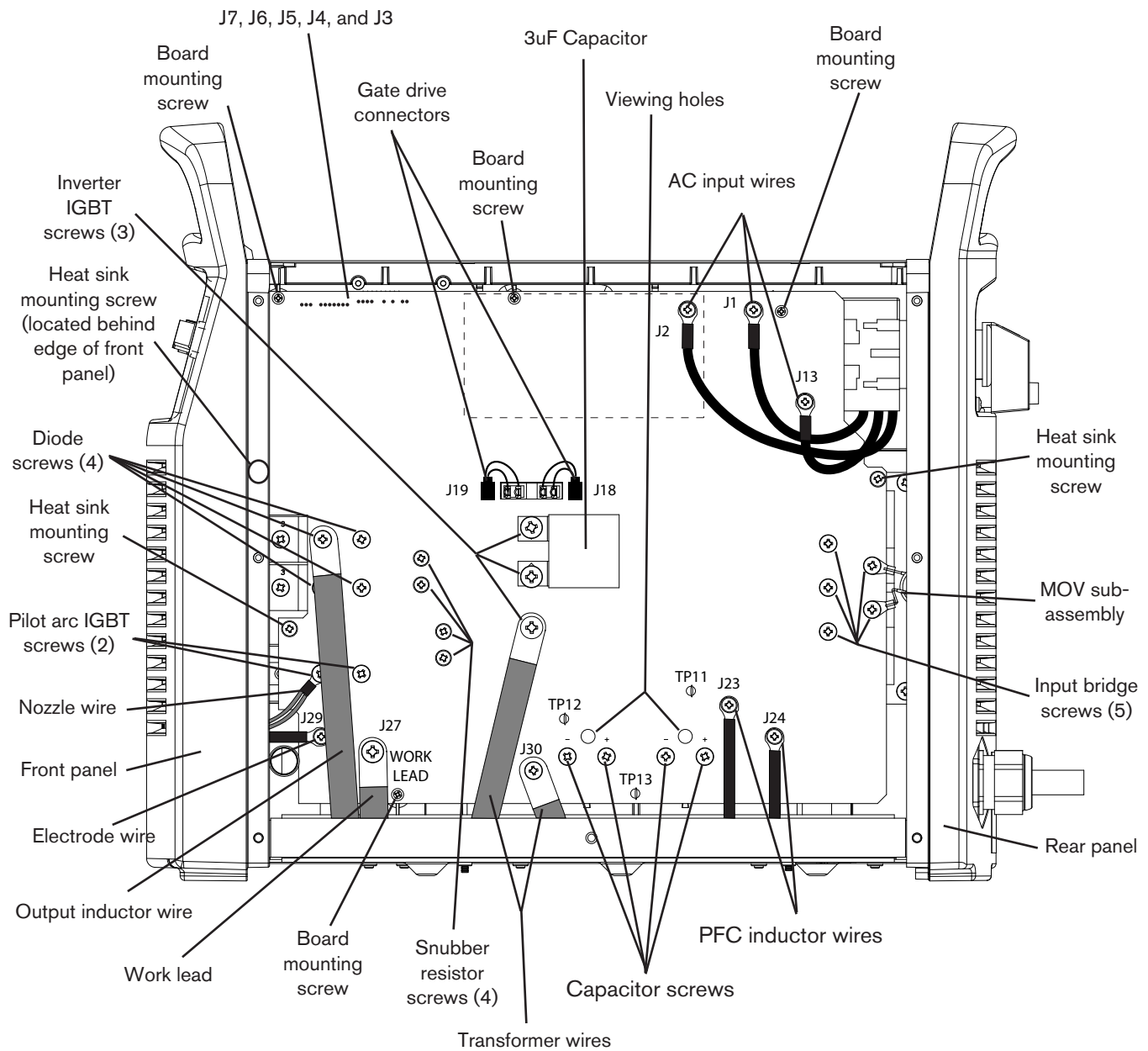
Note: It may be necessary to pull the top of the front panel slightly forward to remove the upper left heat sink mounting screw from the board.

15. Remove the four board mounting screws using a #2 Phillips screwdriver.
16. Pull the right-hand edge of the power board forward, while pushing the gate drive wires through the opening in the board, until the components on the back side of the board clear the rear panel.

Note: Silkscreen printing above the opening in the board denotes the color and order of the gate drive wires. The printing is "BLK" (black), "RED" (red), "BLK" (black), "RED" (red) from left to right.

17. Slide the board to the right until the wire connectors on the left edge of the board are accessible, approximately 2 inches (5.1 cm).
18. Unplug the wire connectors from the J15 and J20 power board connectors.
19. If a CNC interface is installed on the power supply, unplug the wire connectors from the J21 and J33 power board connectors.
20. Remove the power board from the power supply and set aside.

380/400V CE Power Board



Install the new power board (380/400V CE)

1. Position the left edge of the power board on a slight angle toward the front end panel, so the previously removed wire connectors will reach their intended locations.
2. If a CNC interface is installed on the power supply, plug the respective wire connectors into the J21 and J33 power board connectors.
3. Plug the respective wire connectors into the J3, J4, J5, J6, J7, J15, and J20 power board connectors.
4. Slide the power board into the mounting position while routing the gate drive wires through the opening in the board.

Note: Make certain all power board connection wires (11 wires with metal ring terminals) are positioned in front of the power board.

5. Install the four board mounting screws using a #2 Phillips screwdriver to tighten to 10 in-lbs (11.5 kg cm).
6. Install the three heat sink mounting screws using a #2 Phillips screwdriver to tighten to 15 in-lbs (17.3 kg cm).

Note: It may be necessary to pull the top of the front panel slightly forward to install the upper left heat sink mounting screw.

7. Connect the electrode wire (black) to J29 using a #2 Phillips screwdriver to tighten the screw to 20 in-lbs (23.0 kg cm).
8. Install the two pilot arc IGBT screws, securing the nozzle wire (red) to the board with the left screw. Use a #2 Phillips screwdriver to tighten both screws to 20 in-lbs (23.0 kg cm).

Note: All screw mounting holes which secure a wire to the power board, except for J29, have a yellow silkscreen outline on the board depicting the placement of the ring terminal.

9. Install the four diode screws, securing the output inductor wire to the board with the upper left screw. Use a #2 Phillips screwdriver to tighten all four screws to 20 in-lbs (23.0 kg cm).
10. Install the five input bridge screws, securing the MOV sub assembly with the two screws on the right. Use a #2 Phillips screwdriver to tighten all five screws to 20 in-lbs (23.0 kg cm).
11. Install the four snubber resistor screws using a #2 Phillips screwdriver to tighten to 15 in-lbs (17.3 kg cm).
12. Verify that the gray dot on each capacitor is visible through the two viewing holes. Start the four capacitor screws by hand, then use a #2 Phillips screwdriver to tighten to 20 in-lbs (23.0 kg cm).
13. Connect the AC input wires and PFC inductor wires at J1, J2, J13, J23, and J24 using a #2 Phillips screwdriver. Tighten all five screws to 20 in-lbs (23.0 kg cm).
14. Connect the work lead at J27 and the shorter transformer wire at J30 using a #3 Phillips screwdriver to tighten the screws to 30 in-lbs (34.6 kg cm).
15. Secure the 3uF capacitor and the remaining transformer wire to the board using the three inverter IGBT screws. Use a #3 Phillips screwdriver to tighten the screws to 30 in-lbs (34.6 kg cm).
16. Plug the gate drive wires into their respective power board connectors (J18, J19). Gently pull on each wire to ensure that they are fully seated.

Proceed to page 6-25 *Install the DSP board.*

Replace the power board (200 – 600V CSA)

Refer to the figure on the next page when performing the following procedure.

Remove the old power board (200 – 600V CSA)

1. Unplug the five wire connectors located at the J1, J2, J3, J4, and J5 headers on the heatsink side of the power board.
2. Disconnect the three gate drive wire connectors (J17, J18, and J19) from the power board.
3. Disconnect the PFC temperature sensor connector (J16) from the power board.
4. Remove the 3uF capacitor on the left and the longer transformer wire using a #3 Phillips screwdriver (Powermax85) to remove the three inverter IGBT screws. Use a #2 Phillips screwdriver to remove the screws on the Powermax65.
5. Disconnect the remaining transformer wire using a #2 Phillips screwdriver to remove the screw at J29.
6. Disconnect the work lead wire using a #3 Phillips screwdriver to remove the screw at J26.
7. Remove the 3uF capacitor on the right and the two PFC inductor wires below it using a #3 Phillips screwdriver to remove the three PFC IGBT screws and the screw securing the shorter PFC inductor wire.
8. Disconnect the snubber resistor wires using a #2 Phillips screwdriver to remove the screw at J13 and the two input bridge screws.
9. Remove the six snubber resistor screws and four capacitor screws using a #2 Phillips screwdriver.
10. Disconnect the output inductor wire by removing the upper left diode screw with a #2 Phillips screwdriver.
11. Remove the three remaining diode screws.
12. Disconnect the nozzle wire (black) using a #2 Phillips screwdriver to remove the pilot arc IGBT screw on the left.
13. Remove the remaining pilot arc IGBT screw.
14. Disconnect the electrode wire (red) using a #2 Phillips screwdriver to remove the screw at J28.
15. Remove the three heat sink mounting screws using a #2 Phillips screwdriver.

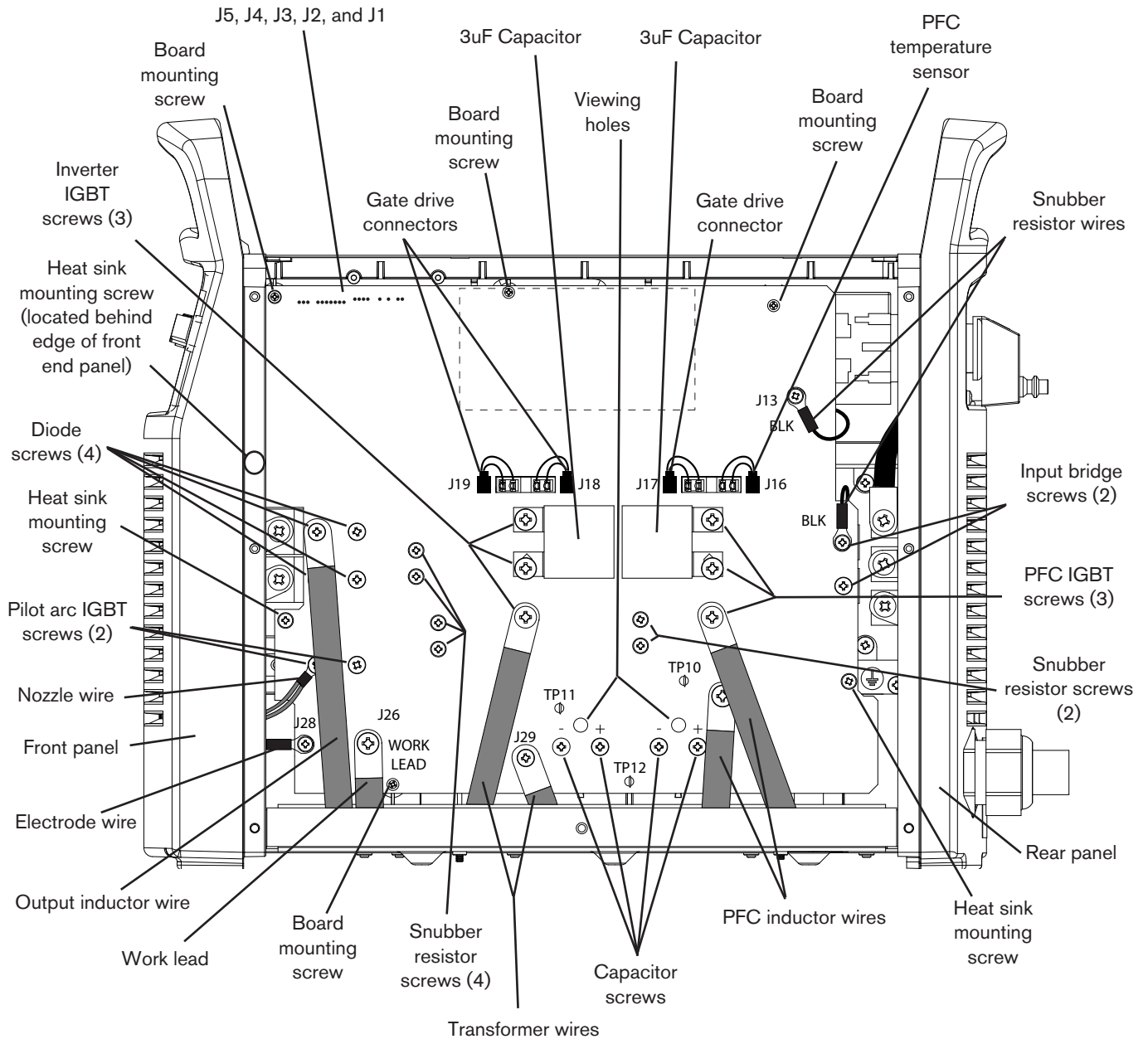
Note: It may be necessary to pull the top of the front panel slightly forward to remove the upper left heat sink mounting screw from the power board.

16. Remove the four board mounting screws using a #2 Phillips screwdriver.
17. Pull the right-hand edge of the power board forward, while pushing the gate drive wires through the two openings in the board, until the components on the back side of the board clear the rear panel.

Note: Silkscreen printing above the opening in the board denotes the color and order of the gate drive wires. The printing is "BLK" (black), "RED" (red), "BLK" (black), "RED" (red) from left to right.

18. Slide the board to the right until the wire connectors on the left edge of the board are accessible, approximately 2 inches (5.1 cm).
19. Unplug the wire connectors from the J12 and J20 power board connectors.
20. If a CNC interface is installed on the power supply, unplug the wire connectors from the J21 and J32 power board connectors.
21. Remove the power board from the power supply and set aside.

200 – 600V CSA Power Board



Install the new power board (200 – 600V CSA)

1. Position the left edge of the power board on a slight angle toward the front end panel, so the previously removed wire connectors will reach their intended locations.
2. If a CNC interface is installed on the power supply, plug the respective wire connectors into the J21 and J32 power board connectors.
3. Plug the respective wire connectors into the J1, J2, J3, J4, J5, J12, and J20 power board connectors.
4. Slide the power board into the mounting position while routing the gate drive wires through the two openings in the board.

Note: Make certain all power board connection wires (10 wires with metal ring terminals) are positioned in front of the power board.

5. Install the four board mounting screws using a #2 Phillips screwdriver to tighten to 10 in-lbs (11.5 kg cm).
6. Install the three heat sink mounting screws using a #2 Phillips screwdriver to tighten to 15 in-lbs (17.3 kg cm).

Note: It may be necessary to pull the top of the front panel slightly forward to install the upper left heat sink mounting screw.

7. Connect the electrode wire (red) to J28 using a #2 Phillips screwdriver to tighten the screw to 20 in-lbs (23.0 kg cm).
8. Install the two pilot arc IGBT screws, securing the nozzle wire (black) to the board with the left screw. Use a #2 Phillips screwdriver to tighten both screws to 20 in-lbs (23.0 kg cm).

Note: All screw mounting holes which secure a wire to the power board, except for J28, have a yellow silkscreen outline on the board depicting the placement of the ring terminal.

9. Install the four diode screws, securing the output inductor wire to the board with the upper left screw. Use a #2 Phillips screwdriver to tighten all four screws to 20 in-lbs (23.0 kg cm).
10. Install the six snubber resistor screws using a #2 Phillips screwdriver to tighten to 15 in-lbs (17.3 kg cm).
11. Verify that the gray dot on each capacitor is visible through the two viewing holes. Start the four capacitor screws by hand, then use a #2 Phillips screwdriver to tighten to 20 in-lbs (23.0 kg cm).
12. Connect the top snubber resistor wire to J13 using a #2 Phillips screwdriver to tighten the screw to 20 in-lbs (23.0 kg cm).
13. Install the two input bridge screws, securing the remaining snubber resistor wire with the upper input bridge screw. Tighten both screws to 20 in-lbs (23.0 kg cm).
14. Connect the work lead at J26 using a #3 Phillips screwdriver to tighten the screws to 30 in-lbs (34.6 kg cm).

15. Secure the 3uF capacitor on the left and the longer transformer wire to the board using the three inverter IGBT screws. On a Powermax85, use a #3 Phillips screwdriver to tighten the screws to 30 in-lbs (34.6 kg cm). On a Powermax65, use a #2 Phillips screwdriver to tighten the screws to 20 in-lbs (23.0 kg cm).
16. Connect the remaining transformer wire at J29 using a #2 Phillips screwdriver to tighten the screw to 20 in-lbs (23.0 kg cm).
17. Secure the 3uF capacitor on the right and the longer PFC inductor wire with the three PFC IGBT screws. Use a #3 Phillips screwdriver to tighten the screws to 30 in-lbs (34.6 kg cm).
18. Connect the remaining PFC inductor wire using a #3 Phillips screwdriver to tighten the screw to 30 in-lbs (34.6 kg-cm).
19. Plug the three gate drive wires into their respective power board connectors (J17, J18, and J19). Plug the PFC temperature sensor wire into the J16 power board connector. Gently pull on each wire to ensure that they are fully seated.

Install the DSP board

Refer to the figure on the next page.

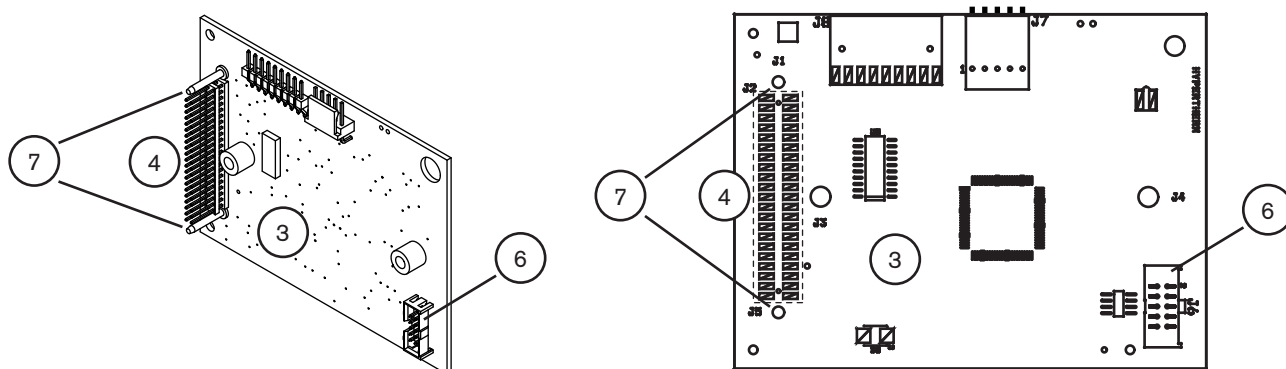
1. Connect the ribbon cable to the ribbon cable connector (6) on the back of the DSP board (3).
2. Align the two alignment pins (7) with the corresponding holes on the power board.
3. Carefully push the DSP board straight onto the power board. Do not bend the pins (4).
4. Secure the DSP board to the power board using a #2 Phillips screwdriver to tighten the two screws (2) to 10 in-lbs (11.5 kg cm).
5. If an RS485 communication board is installed on the power supply, connect the DSP connector (1) to the top of the DSP board.

Caution: Aligning the pins on the back of the DSP board with the corresponding holes on the power board is critical.

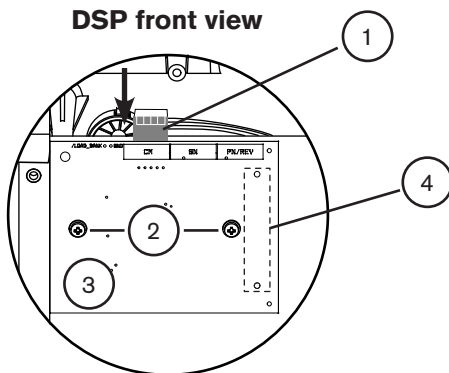


Verify all pins are properly seated after carefully pushing the DSP board straight onto the power board.

DSP back view



DSP front view



Replace the Mylar barrier and power supply cover.

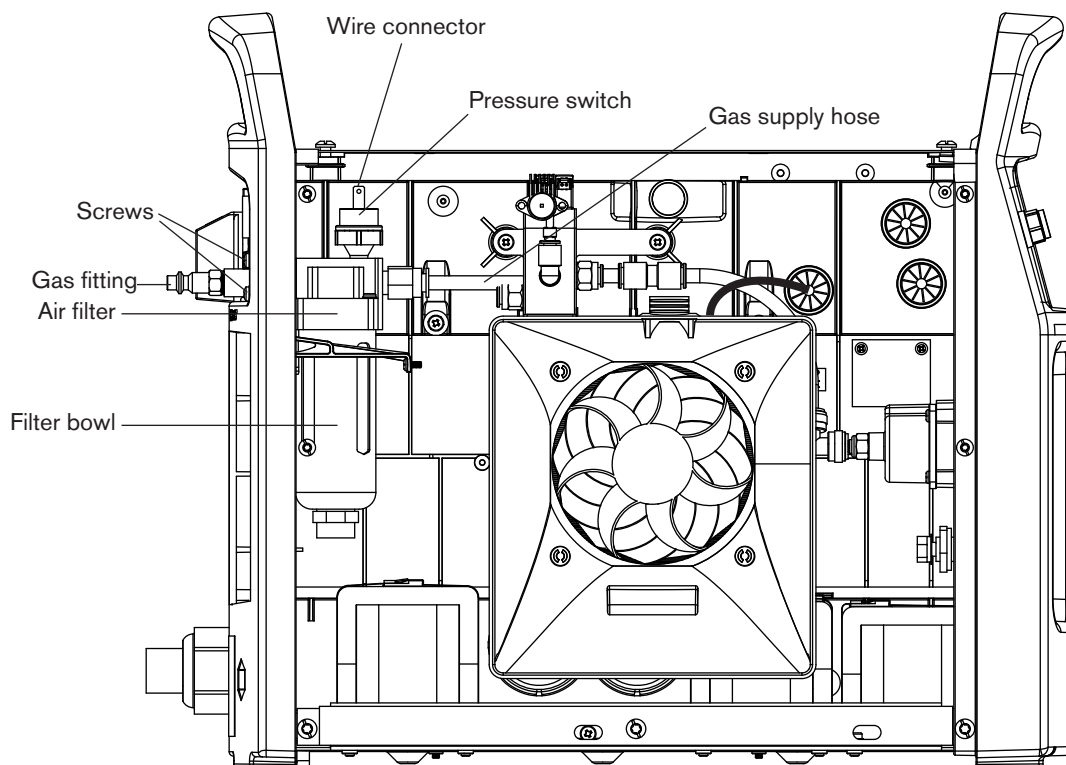
1. Replace the Mylar barrier. Refer to page 6-3 *Replace the Mylar barrier*.
2. Replace the power supply cover. Refer to page 6-4 *Replace the power supply cover*.
3. Reconnect the electrical power and the gas supply.

Replace the control board

1. Turn OFF the power, disconnect the power cord, and disconnect the gas supply.
2. Remove the power supply cover and Mylar barrier. Refer to page 6-2 *Remove and replace the power supply cover and Mylar® barrier*.
3. Remove the metal strap from the top of the power supply by lifting the strap straight up. The strap holds the two end panels together.
4. Remove the adjustment knob and operating mode switch knob from the front panel by pulling them straight off.
5. Carefully pull the top of the front panel away from the body of the power supply. The front panel is still attached to the bottom of the power supply and can only move a short distance.

Note: The figure below shows the front panel separated from the base for clarity. You can remove the two screws in the base and separate the front panel from the base if it is easier to access the components.

6. Remove the three screws that secure the control board to the front panel using a #1 Phillips screwdriver. Two screws are installed at the top of the control board, one at each end. The third screw is installed in the middle of the control board along the bottom edge.
7. Carefully slide the control board from behind the front panel toward the power board side of the power supply.
8. Disconnect the ribbon cable from the control board and set aside the old control board.



COMPONENT REPLACEMENT

9. Connect the ribbon cable to the new control board.
10. Carefully slide the control board behind the front panel.
11. Tilt the bottom of the control board toward the front panel until the control board rests on the plastic tabs. Push the knob posts through the holes in the front panel.
12. Position the control board so that the mounting holes in the control board align with the mounting holes in the front panel.
13. Secure the control board to the front panel. Use a #1 Phillips screwdriver to tighten the three screws to 7 in-lbs (8 kg cm).
14. Push the operating mode switch knob (with the white line) onto the mode switch post. Align the flat edge inside the knob with the flat side of the post.
15. Push the adjustment knob onto the remaining post.
16. Carefully push the top of the front panel against the power supply. Be sure not to pinch any wires between the front panel and the heat sink on the power supply.
17. Replace the metal strap on top of the power supply. Align the slot in the metal strap with the plastic tab in the front panel and push the strap straight down. The four pins in the strap snap into the front and rear panels.
18. Replace the power supply cover. Refer to page 6-2 *Remove and replace the power supply cover and Mylar® barrier*.
19. Reconnect the electrical power and the gas supply.

Replace the heat sink components

This section describes the procedures for replacing heat sink components for the 65A CSA, 65A CE, 85A CSA, and 85A CE models. Refer to the figures following the instructions for your particular model.

1. Turn OFF the power, disconnect the power cord, and disconnect the gas supply.
2. Remove the power supply cover and Mylar barrier. Refer to page 6-2 *Remove and replace the power supply cover and Mylar® barrier*.
3. Remove the power board to expose the heat sink. Refer to the instructions in the section beginning on page 6-17 *Replace the power board*.
4. Remove the old components from the heat sink.
5. Use isopropyl alcohol to remove the old thermal grease.
6. Install the new components to the heat sink as shown in the appropriate figure below.
7. Use thermal grease on all components. Apply a thin coat (3 mils or paper equivalent) to the component.
8. Gently tighten all screws and then tighten all screws to the required torque. Refer to the appropriate figure below for torque specifications.
9. Clean the excess grease from the heat sink.
10. Replace the power board.
11. Replace the Mylar barrier and power supply cover. Refer to page 6-2 *Remove and replace the power supply cover and Mylar® barrier*.
12. Reconnect the electrical power and the gas supply.

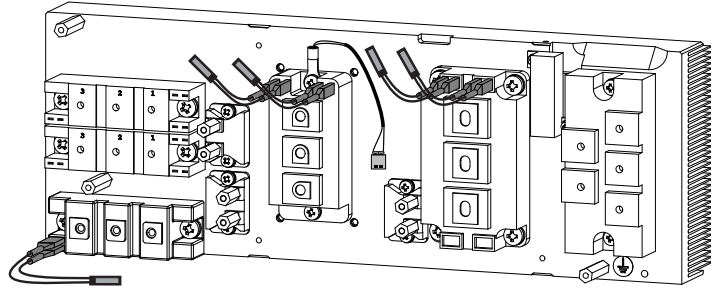
COMPONENT REPLACEMENT

65A CSA

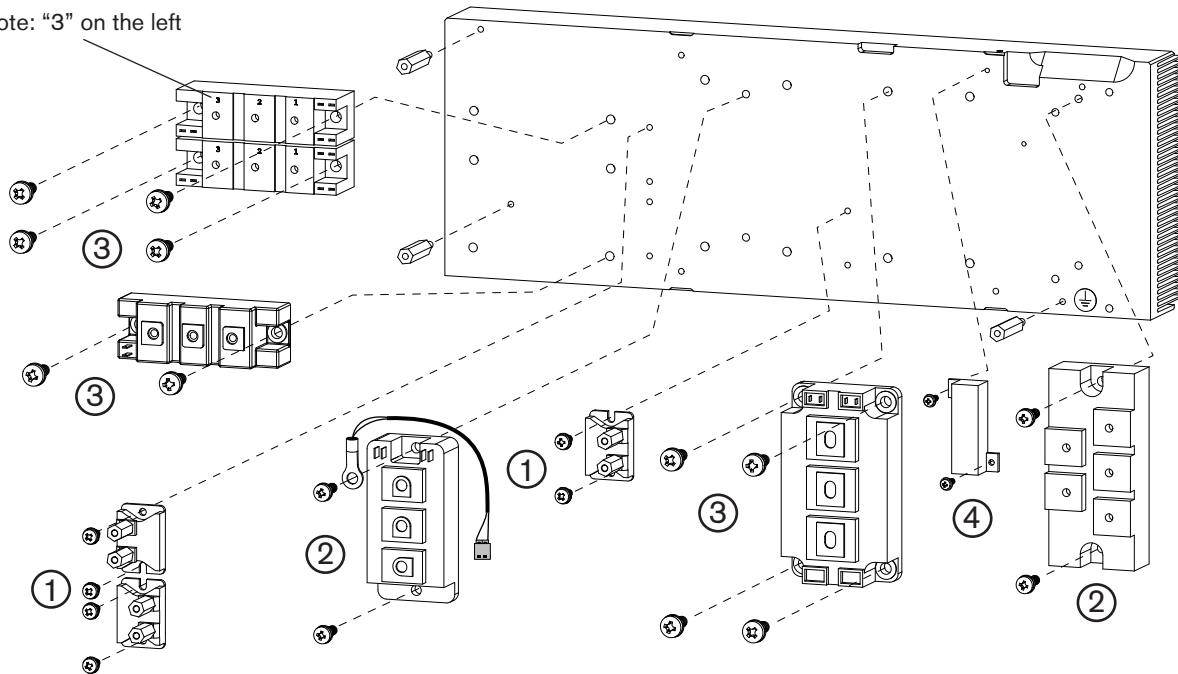
When securing a component to the heat sink, gently tighten all screws and then tighten all screws to the required torque.

Note: All screws listed are Phillips head, pan head, machine screws.

- ① Torque to 15 in-lbs (17.3 kg cm).
M4 X 10 2SEM
- ② Torque to 20 in-lbs (23 kg cm).
M5 X 16 2SEM
- ③ Torque to 35 in-lbs (40 kg cm).
M6 X 16-12.5 2SEM TRI CHRM
- ④ Torque to 10 in-lbs (11.5 kg cm).
M3 X 10 1SEM



Note: "3" on the left

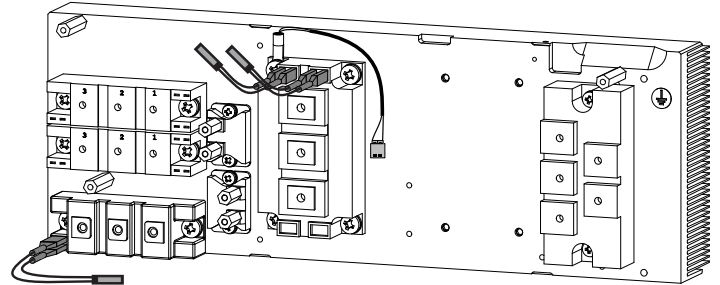


65A CE

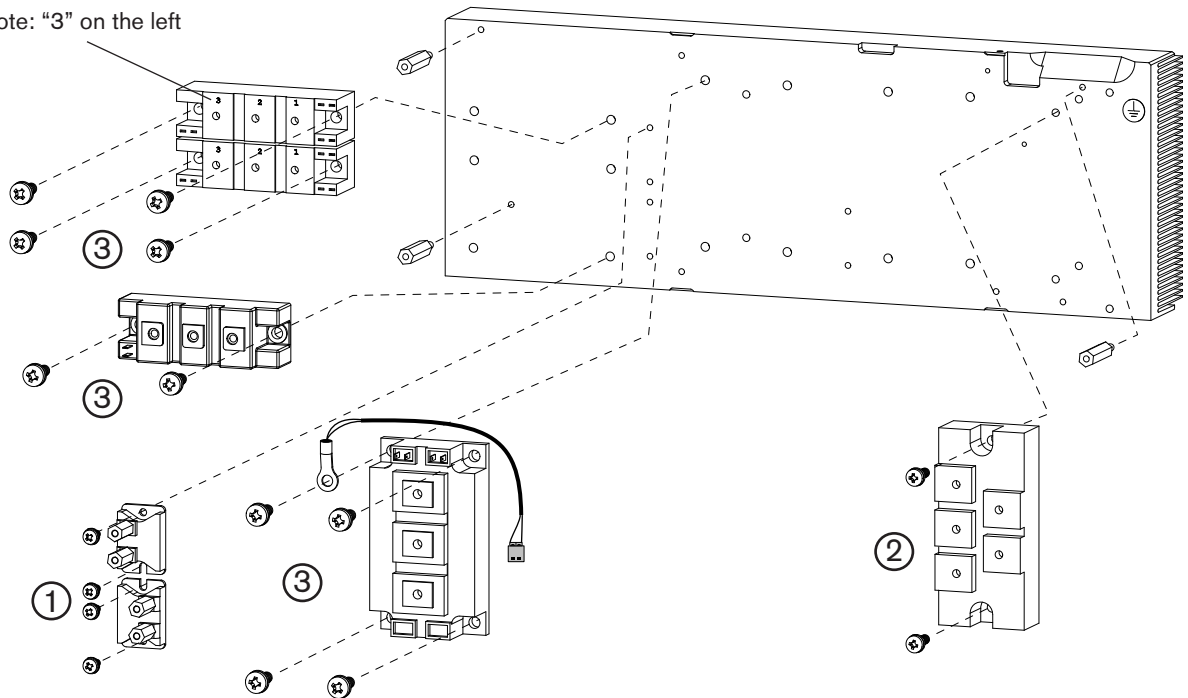
When securing a component to the heat sink, gently tighten all screws and then tighten all screws to the required torque.

Note: All screws listed are Phillips head, pan head, machine screws.

- ① Torque to 15 in-lbs (17.3 kg cm).
M4 X 10 2SEM
- ② Torque to 20 in-lbs (23 kg cm).
M5 X 16 2SEM
- ③ Torque to 35 in-lbs (40 kg cm).
M6 X 16-12.5 2SEM TRI CHRM



Note: "3" on the left



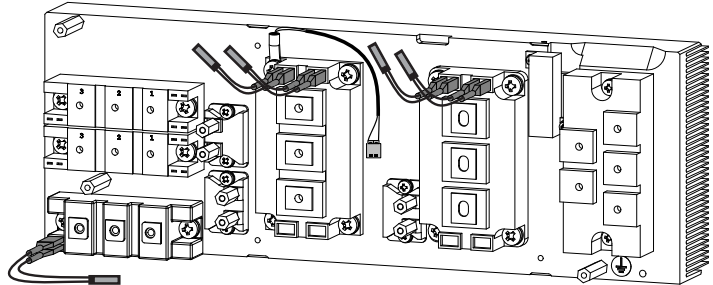
COMPONENT REPLACEMENT

85A CSA

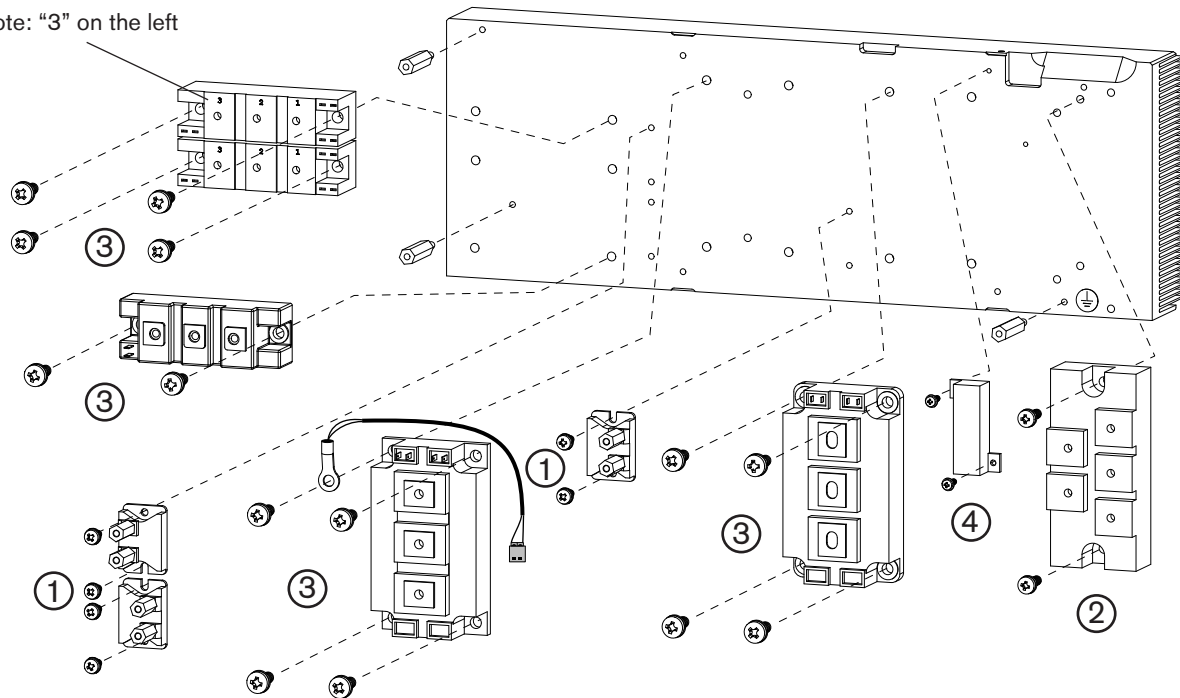
When securing a component to the heat sink, gently tighten all screws and then tighten all screws to the required torque.

Note: All screws listed are Phillips head, pan head, machine screws.

- ① Torque to 15 in-lbs (17.3 kg cm).
M4 X 10 2SEM
- ② Torque to 20 in-lbs (23 kg cm).
M5 X 16 2SEM
- ③ Torque to 35 in-lbs (40 kg cm).
M6 X 16-12.5 2SEM TRI CHRM
- ④ Torque to 10 in-lbs (11.5 kg cm).
M3 X 10 1SEM



Note: "3" on the left

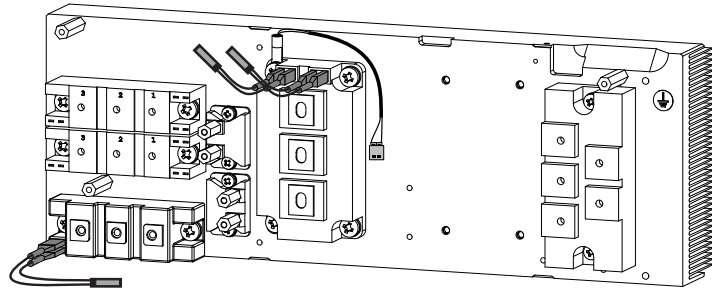


85A CE

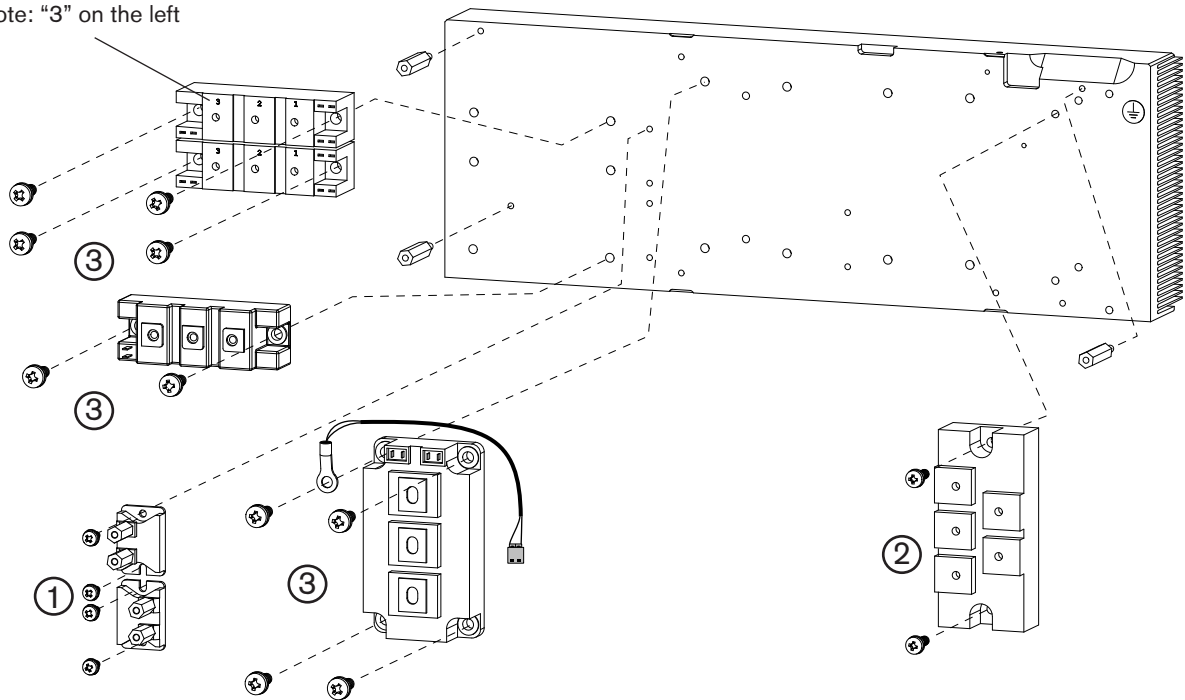
When securing a component to the heat sink, gently tighten all screws and then tighten all screws to the required torque.

Note: All screws listed are Phillips head, pan head, machine screws.

- ① Torque to 15 in-lbs (17.3 kg cm).
M4 X 10 2SEM
- ② Torque to 20 in-lbs (23 kg cm).
M5 X 16 2SEM
- ③ Torque to 35 in-lbs (40 kg cm).
M6 X 16-12.5 2SEM TRI CHRM



Note: "3" on the left



Section 7

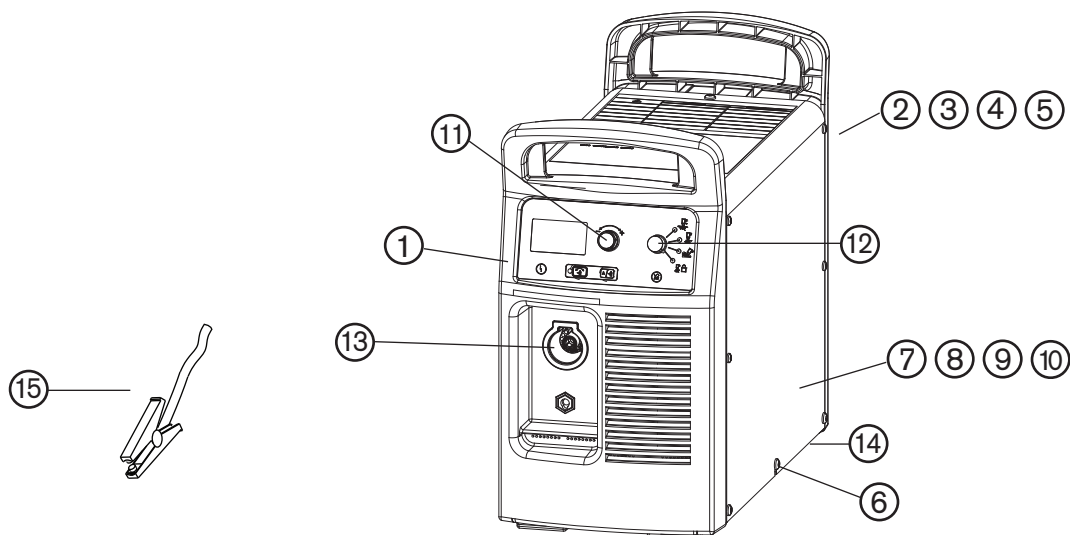
PARTS

In this section:

Power supply parts.....	7-2
Exterior front	7-2
Exterior rear.....	7-3
Interior, power board side (200 – 600V CSA)	7-4
Interior, power board side (380/400V CE).....	7-5
Interior, fan side	7-6
Heat sink assembly.....	7-8
65A CSA.....	7-8
65A CE.....	7-9
85A CSA.....	7-10
85A CE.....	7-11
Duramax 75° hand torch replacement parts.....	7-12
Duramax 15° hand torch replacement parts.....	7-13
Hand torch consumables	7-14
Duramax 180° full-length machine torch replacement parts	7-15
Duramax 180° mini machine torch replacement parts	7-17
Machine torch consumables	7-19
Accessory parts.....	7-20
Powermax65 and Powermax85 labels.....	7-21
Safety-critical parts.....	7-22
Recommended spare parts	7-24

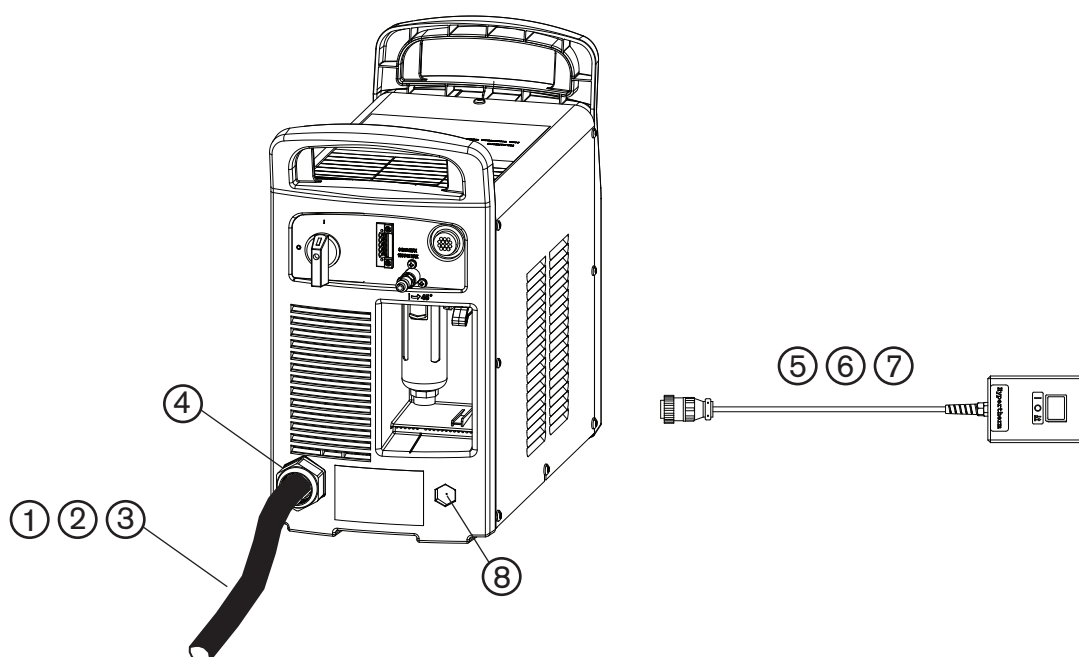
Power supply parts

Exterior front



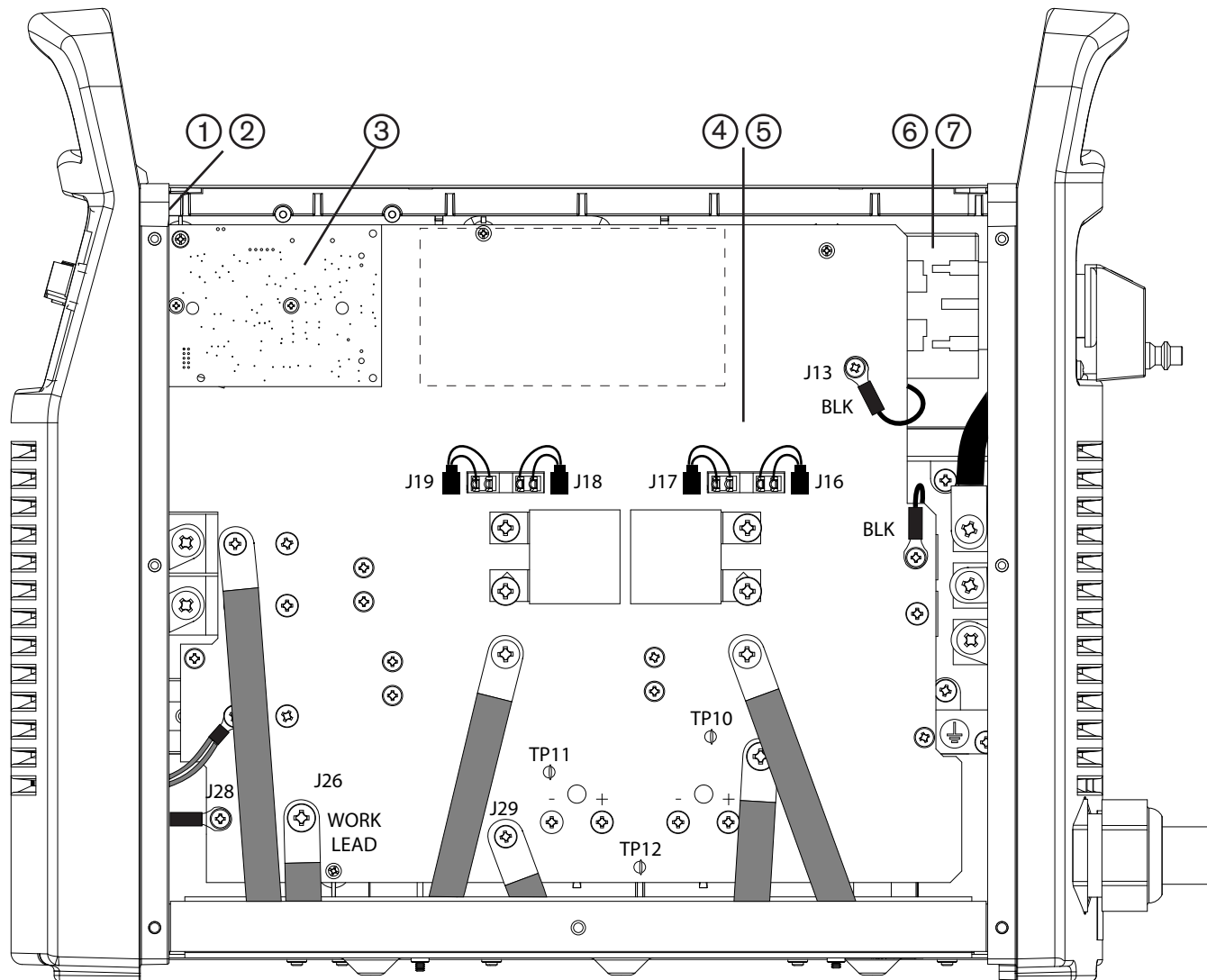
Item	Part number	Description
	228649	Kit: Powermax65 labels, CSA
	228650	Kit: Powermax65 labels, CE
	228651	Kit: Powermax85 labels, CE
	228652	Kit: Powermax85 labels, CSA
1	228643	Kit: Powermax65 and Powermax85 front panel
2	228645	Kit: Powermax65 CSA rear panel
3	228646	Kit: Powermax65 CE rear panel
4	228647	Kit: Powermax85 CSA rear panel
5	228653	Kit: Powermax85 CE rear panel
6	228642	Kit: Powermax65 and Powermax85 cover screws
7	228666	Kit: Powermax65 CSA power supply cover with labels
8	228674	Kit: Powermax65 CE power supply cover with labels
9	228676	Kit: Powermax85 CSA power supply cover with labels
10	228675	Kit: Powermax85 CE power supply cover with labels
11	108797	Adjustment knob
12	108732	Operating mode knob
13	228710	Kit: Powermax65 and Powermax85 FastConnect replacement (power supply half)
14	228640	Kit: Powermax65 and Powermax85 base
15		Work lead (see page 7-20 <i>Accessory parts</i> for a complete list of work leads with kit numbers)

Exterior rear



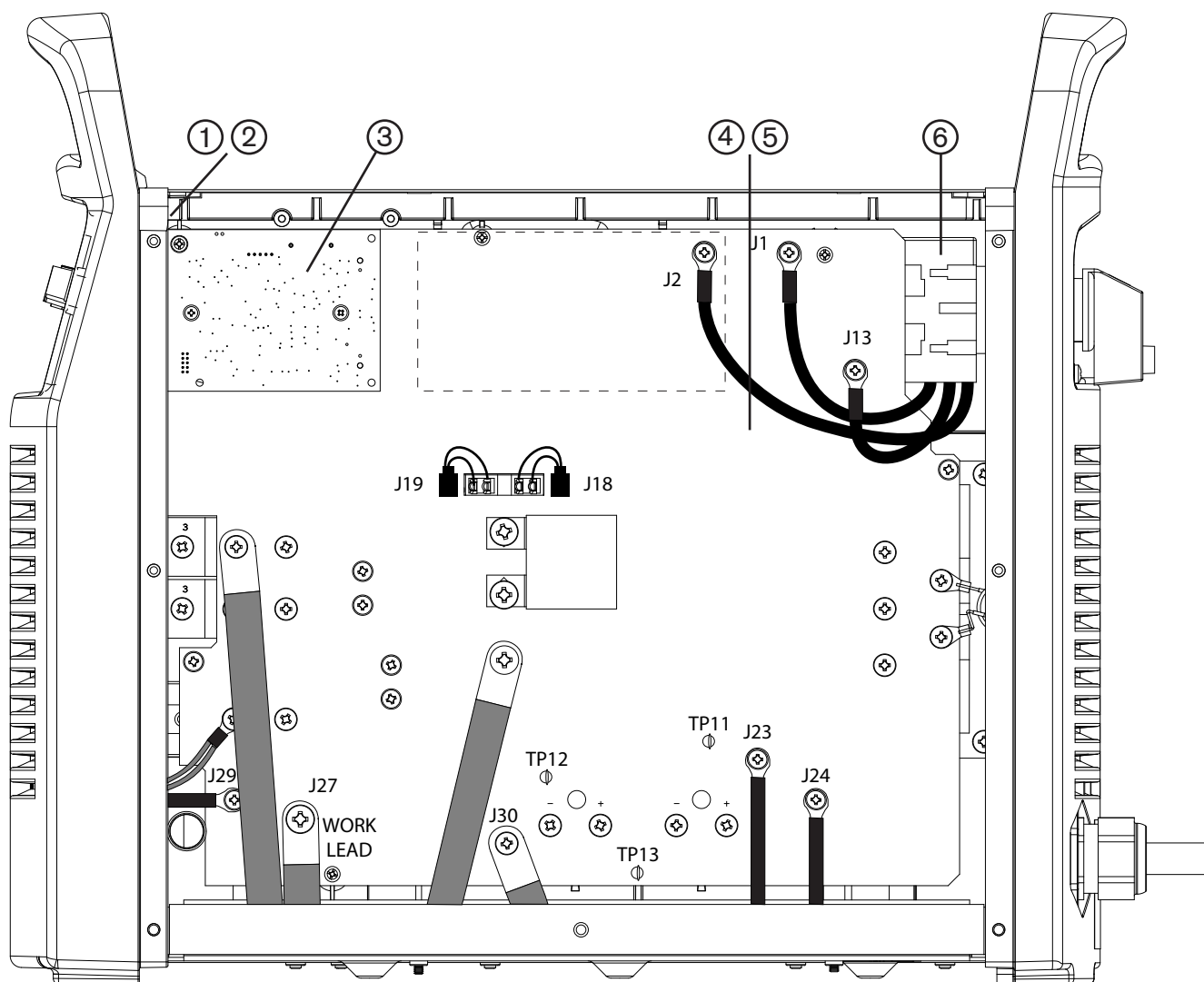
Item	Part number	Description
1	228691	Kit: Powermax65 and Powermax85 CSA power cord
2	228679	Kit: Powermax65 CE power cord
3	228678	Kit: Powermax85 CE power cord
4	228680	Kit: Powermax65 and Powermax85 power cord strain relief
5	128650	Remote start pendant for machine torch, 7.6 m (25 ft)
6	128651	Remote start pendant for machine torch, 15 m (50 ft)
7	128652	Remote start pendant for machine torch, 23 m (75 ft)
8	228711	Kit: Powermax65 and Powermax85 Mach interface strain relief kit, raw arc voltage
	023206	Machine interface cable (start, stop, arc transfer signals), 7.6 m (25 ft), spade connectors
	023279	Machine interface cable (start, stop, arc transfer signals), 15 m (50 ft), spade connectors
	228350	Machine interface cable (start, stop, arc transfer signals) for divided arc voltage, 7.6 m (25 ft), spade connectors
	228351	Machine interface cable (start, stop, arc transfer signals) for divided arc voltage, 50 ft (15 m), spade connectors
	223048	Machine interface cable (start, stop, arc transfer signals) for divided arc voltage, 7.6 m (25 ft), D-sub connector with screws
	123896	Machine interface cable (start, stop, arc transfer signals) for divided arc voltage, 15 m (50 ft), D-sub connector with screws
	127204	Powermax45, Powermax65, and Powermax85 Machine interface (CPC) receptacle cover
	228697	Kit: Powermax65 and Powermax85 Machine Interface Cable, internal cable with voltage divider board (CPC port upgrade)
	228539	Kit: RS485 board with internal cables (65/85)

Interior, power board side (200 – 600V CSA)



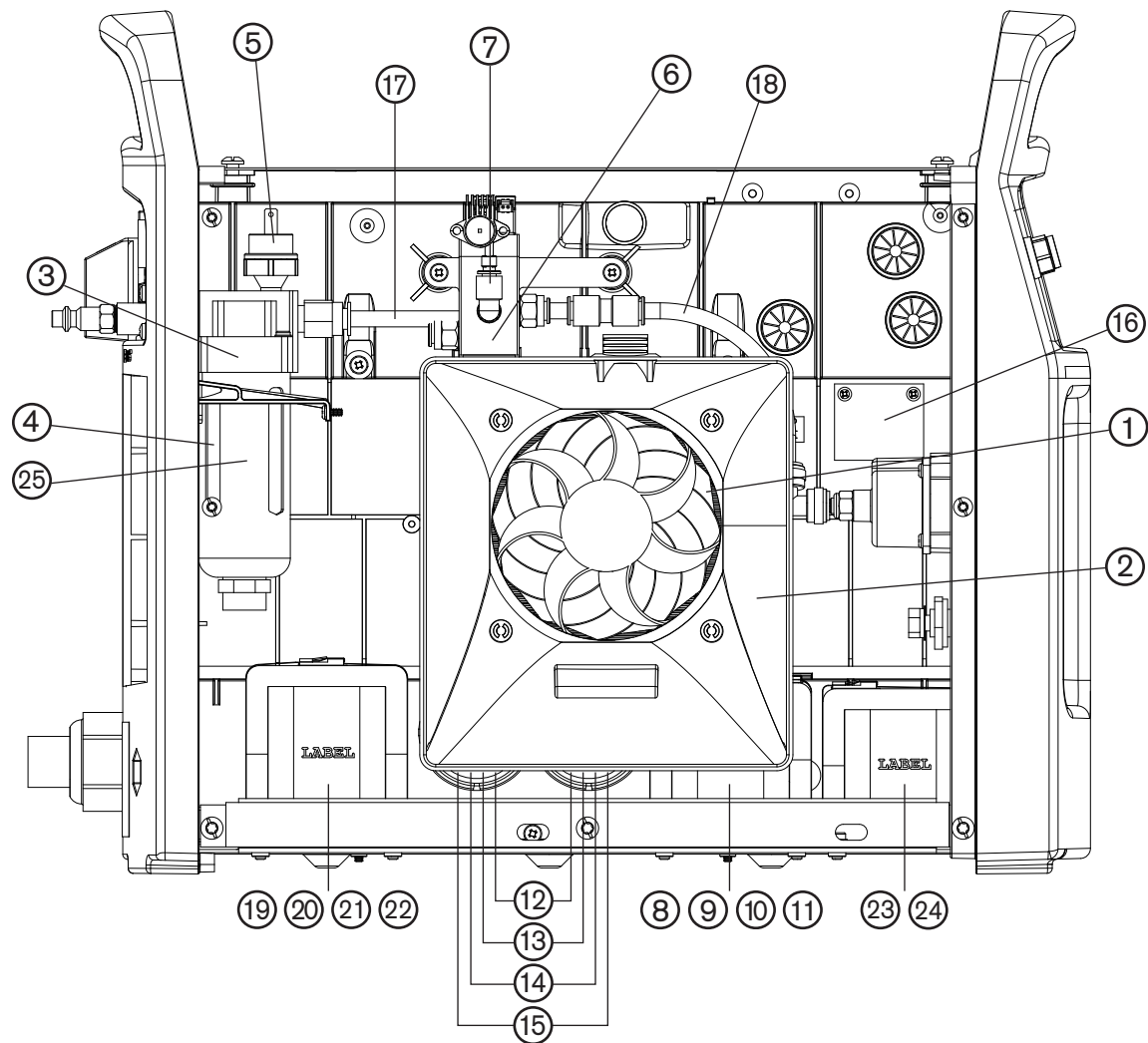
Item	Part number	Description
1	228657	Kit: Powermax65 control board
2	228658	Kit: Powermax85 control board
3	228656	Kit: Powermax65 and Powermax85 DSP board
4	228659	Kit: Powermax65 Power board CSA
5	228662	Kit: Powermax85 Power board CSA
6	228644	Kit: Powermax65 CSA Power Switch
7	228655	Kit: Powermax85 CSA Power Switch
	228690	Kit: Powermax65 CSA wire group
	228700	Kit: Powermax85 CSA wire group
	228705	Kit: Powermax65 and Powermax85 Mylar barrier

Interior, power board side (380/400V CE)



Item	Part number	Description
1	228657	Kit: Powermax65 control board
2	228658	Kit: Powermax85 control board
3	228656	Kit: Powermax65 and Powermax85 DSP board
4	228708	Kit: Powermax65 Power board CE
5	228672	Kit: Powermax85 Power board CE
6	228671	Kit: Powermax65 and Powermax85 CE Power Switch
	228698	Kit: Powermax65 CE wire group
	228677	Kit: Powermax85 CE wire group
	228705	Kit: Powermax65 and Powermax85 Mylar barrier

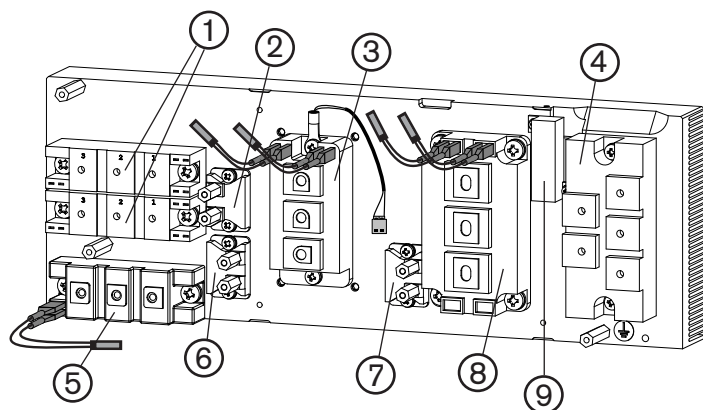
Interior, fan side



Item	Part number	Description
1	228686	Kit: Powermax65 and Powermax85 fan subassembly
2	228694	Kit: Fan shroud
3	228685	Kit: Powermax65 and Powermax85 air filter
4	228695	Kit: Powermax65 and Powermax85 air filter element (inside filter bowl)
5	228688	Kit: Powermax65 and Powermax85 pressure switch
6	228687	Kit: Powermax65 and Powermax85 regulator (solenoid valve subassembly)
7	228689	Kit: Powermax65 and Powermax85 pressure transducer
8	228663	Kit: Powermax65 transformer CSA
9	228669	Kit: Powermax65 transformer CE
10	228667	Kit: Powermax85 transformer CSA
11	228654	Kit: Powermax85 transformer CE
12	228683	Kit: Powermax65 CSA bulk capacitor (2 in kit)
13	228684	Kit: Powermax65 CE bulk capacitor (2 in kit)
14	228681	Kit: Powermax85 CSA bulk capacitor (2 in kit)
15	228682	Kit: Powermax85 CE bulk capacitor (2 in kit)
16	228697	Kit: Powermax65 and Powermax85 machine interface cable with voltage divider board
17	228641	Kit: Powermax65 and Powermax85 tubing: part number 104487 (short tube in kit)
18	228641	Kit: Powermax65 and Powermax85 tubing: part number 104488 (long tube in kit)
19	228661	Kit: Powermax65 PFC inductor CSA
20	228670	Kit: Powermax65 PFC inductor CE
21	228668	Kit: Powermax85 PFC inductor CSA
22	228664	Kit: Powermax85 PFC inductor CE
23	228648	Kit: Powermax65 output inductor
24	228665	Kit: Powermax85 output inductor
25	428015	Kit: AF30 air filter bowl/guard

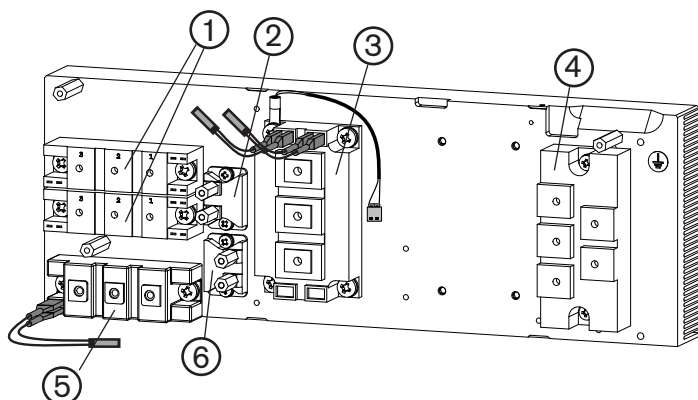
Heat sink assembly

65A CSA



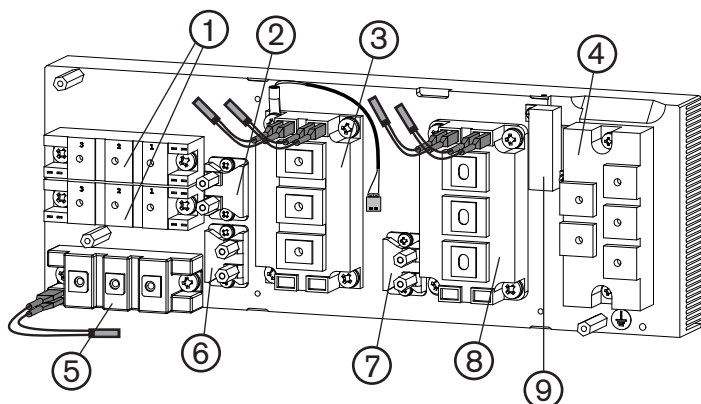
Item	Part number	Description
1	228803	Kit: Powermax65 output diode bridge
2	228693	Kit: Powermax65 and Powermax85 5 Ω snubber resistor with thermal grease
3	228704	Kit: Powermax65 inverter IGBT with thermal grease
4	228742	Kit: Powermax65 CSA/CE, Powermax85 CE input diode bridge with thermal grease
5	228692	Kit: Powermax65 pilot arc IGBT with thermal grease
6	228706	Kit: Powermax65 and Powermax85 15 Ω snubber resistor with thermal grease
7	228693	Kit: Powermax65 and Powermax85 5 Ω snubber resistor with thermal grease
8	228707	Kit: Powermax65 PFC IGBT with thermal grease
9	228740	Kit: Powermax65 and Powermax85 damper resistor with thermal grease
	127128	Thermal grease, T-grease 2500™, 10cc

65A CE



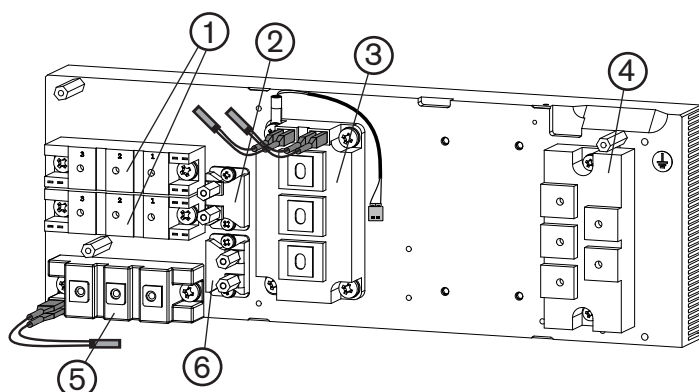
Item	Part number	Description
1	228803	Kit: Powermax65 output diode bridge
2	228693	Kit: Powermax65 and Powermax85 5 Ω snubber resistor
3	228703	Kit: Powermax85 CSA, Powermax65 CE inverter IGBT
4	228742	Kit: Powermax65 CSA/CE, Powermax85 CE input diode bridge
5	228692	Kit: Powermax65 pilot arc IGBT
6	228706	Kit: Powermax65 and Powermax85 15 Ω snubber resistor
	127128	Thermal grease, T-grease 2500, 10cc

85A CSA



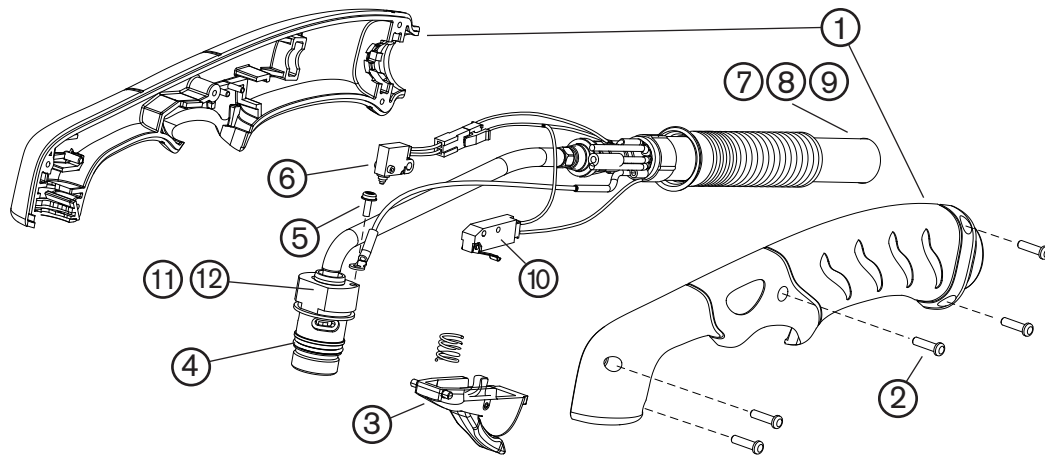
Item	Part number	Description
1	228804	Kit: Powermax85 output diode bridge
2	228693	Kit: Powermax65 and Powermax85 5 Ω snubber resistor
3	228703	Kit: Powermax85 CSA, Powermax65 CE inverter IGBT
4	228741	Kit: Powermax85 CSA input diode bridge
5	228701	Kit: Powermax85 pilot arc IGBT
6	228706	Kit: Powermax65 and Powermax85 15 Ω snubber resistor
7	228693	Kit: Powermax65 and Powermax85 5 Ω snubber resistor
8	228699	Kit: Powermax85 PFC IGBT
9	228740	Kit: Powermax65 and Powermax85 damper resistor
	127128	Thermal grease, T-grease 2500, 10cc

85A CE



Item	Part number	Description
1	228804	Kit: Powermax85 output diode bridge
2	228693	Kit: Powermax65 and Powermax85 5 Ω snubber resistor
3	228702	Kit: Powermax85 CE inverter IGBT
4	228742	Kit: Powermax85 CSA/CE, Powermax85 CE input diode bridge
5	228701	Kit: Powermax85 pilot arc IGBT
6	228706	Kit: Powermax65 and Powermax85 15 Ω snubber resistor
	127128	Thermal grease, T-grease 2500, 10cc

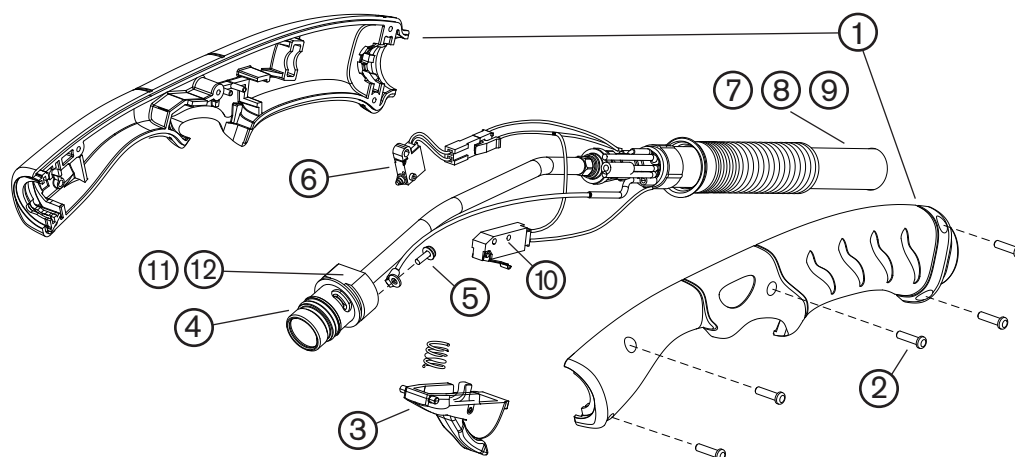
Duramax 75° hand torch replacement parts



The entire hand torch and lead assembly can be replaced, or individual component parts can be replaced. Part numbers starting with 059 indicate complete torch and lead assemblies.

Item	Part number	Description
	059473	Powermax65/85/105 75° hand torch assembly with 7.6 m (25 ft) lead
	059474	Powermax65/85/105 75° hand torch assembly with 15 m (50 ft) lead
	059475	Powermax65/85/105 75° hand torch assembly with 23 m (75 ft) lead
1	228954	Kit: Duramax 75°/HRT torch handle replacement
2	075714	Handle screws, #4 x 1/2 slotted TORX pan head, S/B
3	228721	Kit: Duramax 75°/15° hand torch safety trigger with spring replacement
4	058519	O-ring: VITON .673 X .063
5	075504	Pilot terminal screw: MSCR:4-40 X 5/16 SW CN SEM PH PAN S/Z
6	228719	Kit: Duramax 75° hand torch cap-sensor switch replacement
7	228959	Kit: Duramax hand torch lead replacement, 7.6 m (25 ft)
8	228960	Kit: Duramax hand torch lead replacement, 15 m (50 ft)
9	228961	Kit: Duramax hand torch lead replacement, 23 m (75 ft)
10	128642	Kit: Trigger start switch replacement
11	228714	Kit: Duramax 75° hand torch main body replacement (torches built before May 2012)
12	228958	Kit: Duramax 75° hand torch main body replacement (torches built after May 2012)
	228314	Kit: Powermax45/65/85/105 torch quick disconnect repair (latch & spring)

Duramax 15° hand torch replacement parts

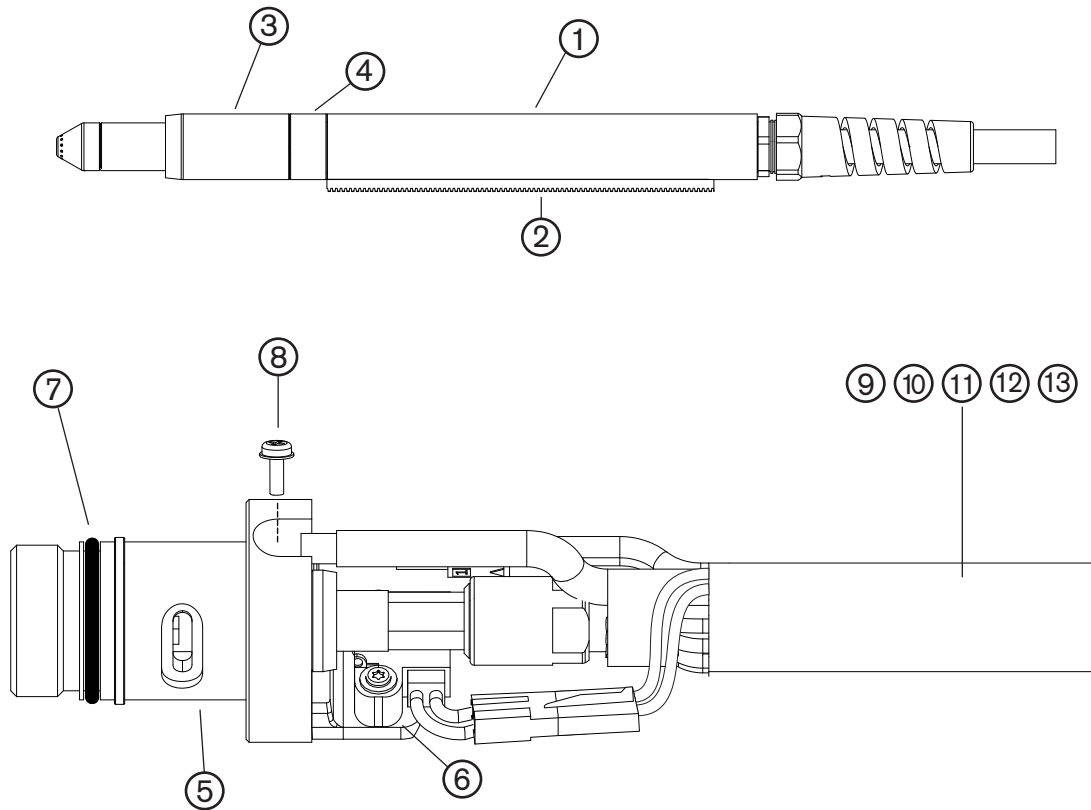


The entire hand torch and lead assembly can be replaced, or individual component parts can be replaced. Part numbers starting with 059 indicate complete torch and lead assemblies.

Item	Part number	Description
	059470	Powermax65/85/105 15° hand torch assembly with 7.6 m (25 ft) lead
	059471	Powermax65/85/105 15° hand torch assembly with 15 m (50 ft) lead
	059472	Powermax65/85/105 15° hand torch assembly with 23 m (75 ft) lead
1	228955	Kit: Duramax 15°/HRTs torch handle replacement
2	075714	Handle screws, #4 x 1/2 slotted TORX pan head, S/B
3	228721	Kit: Duramax 75°/15° hand torch safety trigger with spring replacement
4	058519	O-ring: VITON .673 X .063
5	075504	Pilot terminal screw: MSCR:4-40 X 5/16 SW CN SEM PH PAN S/Z
6	228109	Kit: Powermax30/45/65/85/105 15° hand torch/T30v/T45v/HRTs cap-sensor switch replacement
7	228959	Kit: Duramax hand torch lead replacement, 7.6 m (25 ft)
8	228960	Kit: Duramax hand torch lead replacement, 15 m (50 ft)
9	228961	Kit: Duramax hand torch lead replacement, 23 m (75 ft)
10	128642	Kit: Trigger start switch replacement
11	228715	Kit: Duramax 15° hand torch main body replacement (torches built before May 2012)
12	228957	Kit: Duramax 15° hand torch main body replacement (torches built after May 2012)
	228314	Kit: Powermax45/65/85/105 torch quick disconnect repair (latch & spring)

Hand torch consumables

Part number	Description
Drag cutting	
220818	Shield
220854	Retaining cap
220941	45 A Nozzle
220819	65 A Nozzle
220816	85 A Nozzle
220842	Electrode
220857	Swirl ring
Gouging	
220798	65 A/85 A shield
220854	Retaining cap
220797	65 A/85 A nozzle
220842	Electrode
220857	Swirl ring
FineCut	
220931	Deflector
220854	Retaining cap
220930	Nozzle
220842	Electrode
220947	Swirl ring

Duramax 180° full-length machine torch replacement parts

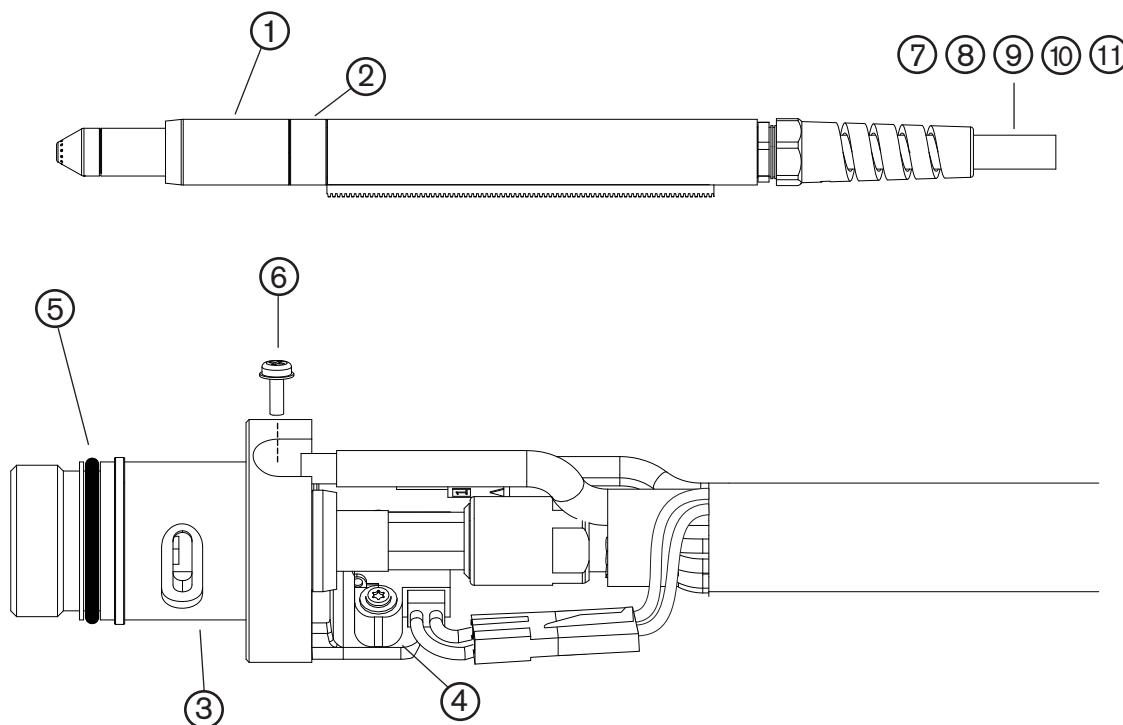
PARTS

The entire machine torch and lead assembly can be replaced, or individual component parts can be replaced. Part numbers starting with 059 indicate complete torch and lead assemblies.

Item	Part number	Description
	059476	Powermax65/85/105 180° full-length machine torch assembly with 4.6 m (15 ft) lead
	059477	Powermax65/85/105 180° full-length machine torch assembly with 7.6 m (25 ft) lead
	059478	Powermax65/85/105 180° full-length machine torch assembly with 10.7 m (35 ft) lead
	059479	Powermax65/85/105 180° full-length machine torch assembly with 15 m (50 ft) lead
	059480	Powermax65/85/105 180° full-length machine torch assembly with 23 m (75 ft) lead
1	228737	Kit: Powermax65/85/105 180° full-length machine torch/MRT positioning sleeve
2	228738	Kit: Powermax65/85/105 180° full-length machine torch/MRT removable gear rack replacement
3	228735	Kit: Powermax65/85/105 180° full-length/mini machine torch/MRT front mounting sleeve
4	228736	Kit: Powermax65/85/105 180° full-length/mini machine torch/MRT adapter ring (coupler)
5	228716	Kit: Powermax65/85/105 180° full-length/mini machine torch main body replacement
6	228720	Kit: Duramax/MRT 180° machine and robotic torch cap-sensor switch replacement
7	058519	O-ring: VITON .673 X .063
8	075504	Pilot terminal screw: MSCR:4-40 X 5/16 SW CN SEM PH PAN S/Z
9	228730	Kit: Powermax65/85/105 180° full-length/mini machine torch lead replacement, 4.6 m (15 ft)
10	228731	Kit: Powermax65/85/105 180° full-length/mini machine torch lead replacement, 7.6 m (25 ft)
11	228732	Kit: Powermax65/85/105 180° full-length/mini machine torch lead replacement, 10.7 m (35 ft)
12	228733	Kit: Powermax65/85/105 180° full-length/mini machine torch lead replacement, 15 m (50 ft)
13	228734	Kit: Powermax65/85/105 180° full-length/mini machine torch lead replacement, 23 m (75 ft)
	228314	Kit: Powermax45/65/85/105 torch quick disconnect repair (latch & spring)

Duramax 180° mini machine torch replacement parts

Note: This illustration shows the Duramax 180° machine torch. The Duramax 180° mini machine torches do not have a positioning sleeve and gear rack.



PARTS

The entire machine torch and lead assembly can be replaced, or individual component parts can be replaced. Part numbers starting with 059 indicate complete torch and lead assemblies.

Item	Part number	Description
	059481	Powermax65/85/105 180° mini machine torch assembly with 4.6 m (15 ft) lead
	059482	Powermax65/85/105 180° mini machine torch assembly with 7.6 m (25 ft) lead
	059483	Powermax65/85/105 180° mini machine torch assembly with 10.7 m (35 ft) lead
	059484	Powermax65/85/105 180° mini machine torch assembly with 15 m (50 ft) lead
1	228735	Kit: Powermax65/85/105 180° full-length/mini machine torch/MRT front mounting sleeve
2	228736	Kit: Powermax65/85/105 180° full-length/mini machine torch/MRT adapter ring (coupler)
3	228716	Kit: Powermax65/85/105 180° full-length/mini machine torch main body replacement
4	228720	Kit: Duramax/MRT 180° machine and robotic torch cap-sensor switch replacement
5	058519	O-ring: VITON .673 X .063
6	075504	Pilot terminal screw: MSCR:4-40 X 5/16 SW CN SEM PH PAN S/Z
7	228730	Kit: Powermax65/85/105 180° full-length/mini machine torch lead replacement, 4.6 m (15 ft)
8	228731	Kit: Powermax65/85/105 180° full-length/mini machine torch lead replacement, 7.6 m (25 ft)
9	228732	Kit: Powermax65/85/105 180° full-length/mini machine torch lead replacement, 10.7 m (35 ft)
10	228733	Kit: Powermax65/85/105 180° full-length/mini machine torch lead replacement, 15 m (50 ft)
11	228734	Kit: Powermax65/85/105 180° full-length/mini machine torch lead replacement, 23 m (75 ft)
	228314	Kit: Powermax45/65/85/105 torch quick disconnect repair (latch & spring)

Machine torch consumables

Part number	Description
Shielded	
220817	Shield
220854	Retaining cap
220953	Ohmic retaining cap
220941	45 A Nozzle
220819	65 A Nozzle
220816	85 A Nozzle
220842	Electrode
220857	Swirl ring
Unshielded	
220955	Deflector
220854	Retaining cap
220941	45 A Nozzle
220819	65 A Nozzle
220816	85 A Nozzle
220842	Electrode
220857	Swirl ring
Gouging	
220798	65 A/85 A shield
220854	Retaining cap
220797	65 A/85 A nozzle
220842	Electrode
220857	Swirl ring
FineCut¹	
220955	Deflector
220948	Shield
220854	Retaining cap
220953	Ohmic retaining cap
220930	Nozzle
220842	Electrode
220857	Swirl ring

¹The deflector (220955) is used only with the standard retaining cap (220854). The shield (220948) is used only with the ohmic retaining cap (220953).

Accessory parts

Part number	Description
024548	Leather torch sheathing, brown leather, 7.6 m (25 ft)
024877	Leather torch sheathing, black leather with logos, 7.6 m (25 ft)
127102	Basic plasma (circles and lines) cutting guide
027668	Deluxe plasma (circles and lines) cutting guide
127301	Powermax65 and Powermax85 dust cover
128647	Kit: Elimimizer air filter
228570	Kit: Elimimizer air filter with protective metal cover
228624	Kit: Elimimizer filter protective metal cover
223125	Kit: 65 A Work lead with hand clamp, 7.6 m (25 ft)
223126	Kit: 65 A Work lead with hand clamp, 15 m (50 ft)
223127	Kit: 65 A Work lead with hand clamp, 23 m (75 ft)
223194	Kit: 65 A Work lead with C-style clamp, 7.6 m (25 ft)
223195	Kit: 65 A Work lead with C-style clamp, 15 m (50 ft)
223196	Kit: 65 A Work lead with C-style clamp, 23 m (75 ft)
223200	Kit: 65 A Work lead with ring terminal, 7.6 m (25 ft)
223201	Kit: 65 A Work lead with ring terminal, 15 m (50 ft)
223202	Kit: 65 A Work lead with ring terminal, 23 m (75 ft)
223035	Kit: 85 A Work lead with hand clamp, 7.6 m (25 ft)
223034	Kit: 85 A Work lead with hand clamp, 15 m (50 ft)
223033	Kit: 85 A Work lead with hand clamp, 23 m (75 ft)
223203	Kit: 85 A Work lead with C-style clamp, 7.6 m (25 ft)
223204	Kit: 85 A Work lead with C-style clamp, 15 m (50 ft)
223205	Kit: 85 A Work lead with C-style clamp, 23 m (75 ft)
223209	Kit: 85 A Work lead with ring terminal, 7.6 m (25 ft)
223210	Kit: 85 A Work lead with ring terminal, 15 m (50 ft)
223211	Kit: 85 A Work lead with ring terminal, 23 m (75 ft)
229370	Kit: Powermax65 and Powermax85 Wheel kit assembly

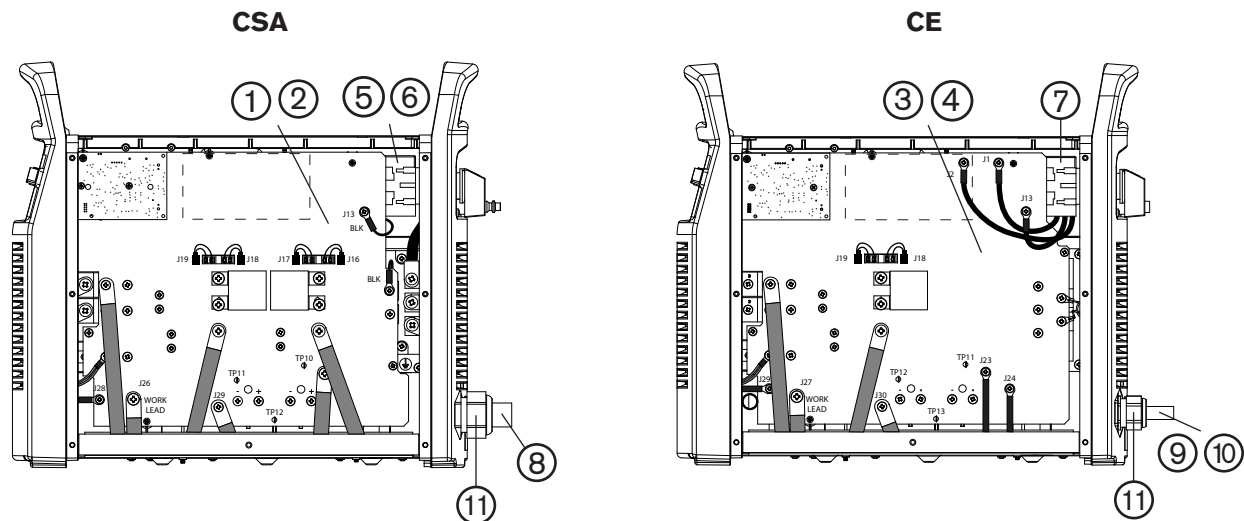
Powermax65 and Powermax85 labels

Item	Part number	Description
	228649	Kit: Powermax65 labels, CSA
	228650	Kit: Powermax65 labels, CE
	228651	Kit: Powermax85 labels, CE
	228652	Kit: Powermax85 labels, CSA

The label kits include the consumable label, appropriate safety labels, display panel label, power switch label, and side decals.

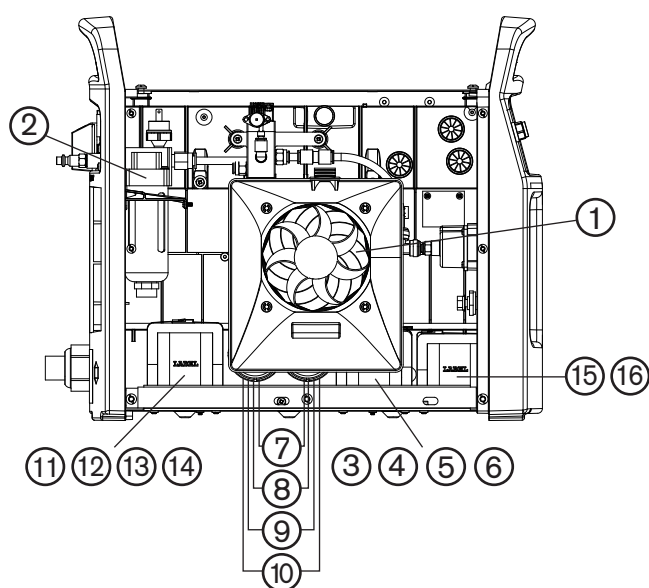
Safety-critical parts

Genuine Hypertherm parts are the factory-recommended parts for your Hypertherm system. Any damage caused by the use of other than genuine Hypertherm parts may not be covered by the Hypertherm warranty. In addition, the parts listed below are considered safety-critical parts that must be replaced only with Hypertherm parts to maintain the warranty and all system certifications, including CE, CSA, GOST, and CCC certification.



Item	Part number	Description
1	228659	Kit: Powermax65 Power board CSA and subcomponents
2	228662	Kit: Powermax85 Power board CSA and subcomponents
3	228708	Kit: Powermax65 Power board CE and subcomponents
4	228672	Kit: Powermax85 Power board CE and subcomponents
5	228644	Kit: Powermax65 CSA Power Switch
6	228655	Kit: Powermax85 CSA Power Switch
7	228671	Kit: Powermax65 and Powermax85 CE Power Switch
8	228691	Kit: Powermax65 and Powermax85 CSA power cord
9	228679	Kit: Powermax65 CE power cord
10	228678	Kit: Powermax85 CE power cord
11	228680	Kit: Powermax65 and Powermax85 power cord strain relief

CSA, CE



Item	Part number	Description
1	228686	Kit: Powermax65 and Powermax85 fan subassembly
2	228685	Kit: Powermax65 and Powermax85 air filter
3	228663	Kit: Powermax65 transformer CSA
4	228669	Kit: Powermax65 transformer CE
5	228667	Kit: Powermax85 transformer CSA
6	228654	Kit: Powermax85 transformer CE
7	228683	Kit: Powermax65 CSA bulk capacitor (2 in kit)
8	228684	Kit: Powermax65 CE bulk capacitor (2 in kit)
9	228681	Kit: Powermax85 CSA bulk capacitor (2 in kit)
10	228682	Kit: Powermax85 CE bulk capacitor (2 in kit)
11	228661	Kit: Powermax65 PFC inductor CSA
12	228670	Kit: Powermax65 PFC inductor CE
13	228668	Kit: Powermax85 PFC inductor CSA
14	228664	Kit: Powermax85 PFC inductor CE
15	228648	Kit: Powermax65 output inductor
16	228665	Kit: Powermax85 output inductor

Recommended spare parts

Part number	Description
108797	Adjustment knob
108732	Operating mode knob
223125	Kit: 65 A Work lead with hand clamp, 7.6 m (25 ft)
223035	Kit: 85 A Work lead with hand clamp, 7.6 m (25 ft)
228643	Kit: Powermax65 and Powermax85 front panel
228645	Kit: Powermax65 CSA rear panel
228646	Kit: Powermax65 CE rear panel
228647	Kit: Powermax85 CSA rear panel
228653	Kit: Powermax85 CE rear panel
228640	Kit: Powermax65 and Powermax85 base
228657	Kit: Powermax65 control board
228658	Kit: Powermax85 control board
228659	Kit: Powermax65 power board CSA
228662	Kit: Powermax85 power board CSA
228708	Kit: Powermax65 power board CE
228672	Kit: Powermax85 power board CE
228644	Kit: Powermax65 CSA Power Switch
228655	Kit: Powermax85 CSA Power Switch
228671	Kit: Powermax65 and Powermax85 CE Power Switch
228663	Kit: Powermax65 transformer CSA
228669	Kit: Powermax65 transformer CE
228667	Kit: Powermax85 transformer CSA
228654	Kit: Powermax85 transformer CE
228683	Kit: Powermax65 CSA bulk capacitor (2 in kit)
228684	Kit: Powermax65 CE bulk capacitor (2 in kit)
228681	Kit: Powermax85 CSA bulk capacitor (2 in kit)
228682	Kit: Powermax85 CE bulk capacitor (2 in kit)
228661	Kit: Powermax65 PFC inductor CSA
228670	Kit: Powermax65 PFC inductor CE
228668	Kit: Powermax85 PFC inductor CSA
228664	Kit: Powermax85 PFC inductor CE

Part number	Description
228648	Kit: Powermax65 output inductor
228665	Kit: Powermax85 output inductor
228688	Kit: Powermax65 and Powermax85 pressure switch
228687	Kit: Powermax65 and Powermax85 regulator (solenoid valve)
228686	Kit: Powermax65 and Powermax85 fan subassembly
228685	Kit: Powermax65 and Powermax85 air filter
058519	O-ring: VITON .673 X .063
228954	Kit: Duramax 75°/HRT torch handle replacement
228955	Kit: Duramax 15°/HRTs torch handle replacement
075714	Handle screws, #4 x 1/2 slotted TORX pan head, S/B
228721	Kit: Duramax 75°/15° hand torch safety trigger with spring replacement
228719	Kit: Duramax 75° hand torch cap-sensor switch replacement
228109	Kit: Powermax30/45/65/85/105 15° hand torch/T30v/T45v/HRTs cap-sensor switch replacement
059473	Powermax65/85/105 75° hand torch assembly with 7.6 m (25 ft) lead
059474	Powermax65/85/105 75° hand torch assembly with 15 m (50 ft) lead
059470	Powermax65/85/105 15° hand torch assembly with 7.6 m (25 ft) lead
059471	Powermax65/85/105 15° hand torch assembly with 15 m (50 ft) lead
228959	Kit: Duramax hand torch lead replacement, 7.6 m (25 ft)
228960	Kit: Duramax hand torch lead replacement, 15 m (50 ft)
059477	Powermax65/85/105 180° full-length machine torch assembly with 7.6 m (25 ft) lead
059478	Powermax65/85/105 180° full-length machine torch assembly with 10.7 m (35 ft) lead
059479	Powermax65/85/105 180° full-length machine torch assembly with 15 m (50 ft) lead
059482	Powermax65/85/105 180° mini machine torch assembly with 7.6 m (25 ft) lead
059483	Powermax65/85/105 180° mini machine torch assembly with 10.7 m (35 ft) lead
059484	Powermax65/85/105 180° mini machine torch assembly with 15 m (50 ft) lead

PARTS

Part number	Description
228737	Kit: Powermax65/85/105 180° full-length machine torch/MRT positioning sleeve
228738	Kit: Powermax65/85/105 180° full-length machine torch/MRT removable gear rack replacement
228735	Kit: Powermax65/85/105 180° full-length/mini machine torch/MRT front mounting sleeve
228736	Kit: Powermax65/85/105 180° full-length/mini machine torch/MRT adapter ring (coupler)
228720	Kit: Duramax/MRT 180° machine and robotic torch cap-sensor switch replacement
228731	Kit: Powermax65/85/105 180° full-length/mini machine torch lead replacement, 7.6 m (25 ft)
228732	Kit: Powermax65/85/105 180° full-length/mini machine torch lead replacement, 10.7 m (35 ft)
228733	Kit: Powermax65/85/105 180° full-length/mini machine torch lead replacement, 15 m (50 ft)

Section 8

WIRING DIAGRAMS

In this section:

Cutting timing diagram page 1 of 2.....8-3

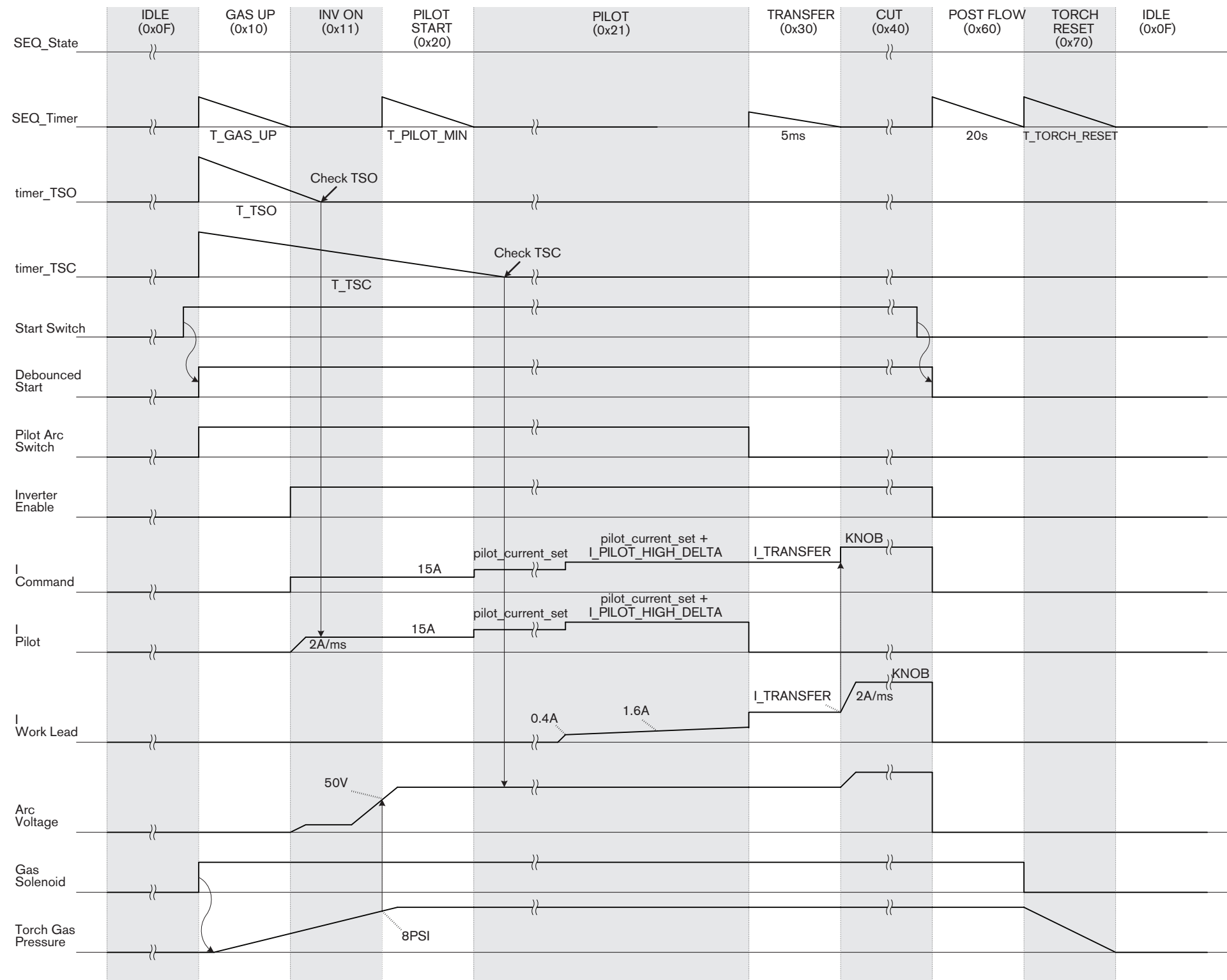
Cutting timing diagram page 2 of 2.....8-4

Electrical schematic diagram (CSA)8-5

Electrical schematic diagram (CE)8-6

Cutting timing diagram page 1 of 2


1			
REVISIONS			
REV.	DESCRIPTION	DATE	BY
A	Initial Release	2009-04-28	QLIU

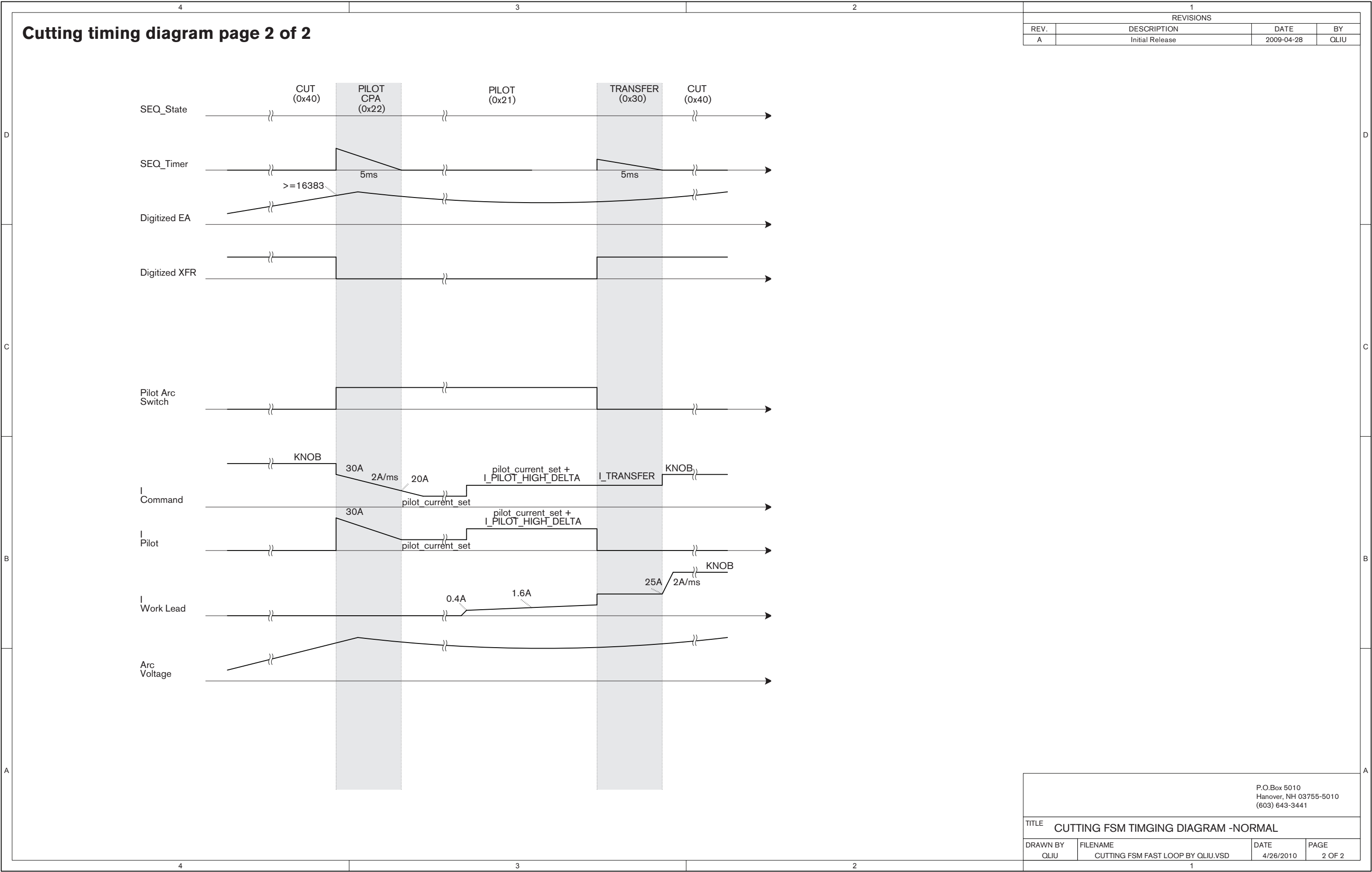


Assumptions:

- This diagram represents most but not all possible State transitions.
- No Faults Occur.
- System is not connected to a Load Bank.
- System is running at Normal Mode at normal input line voltage.

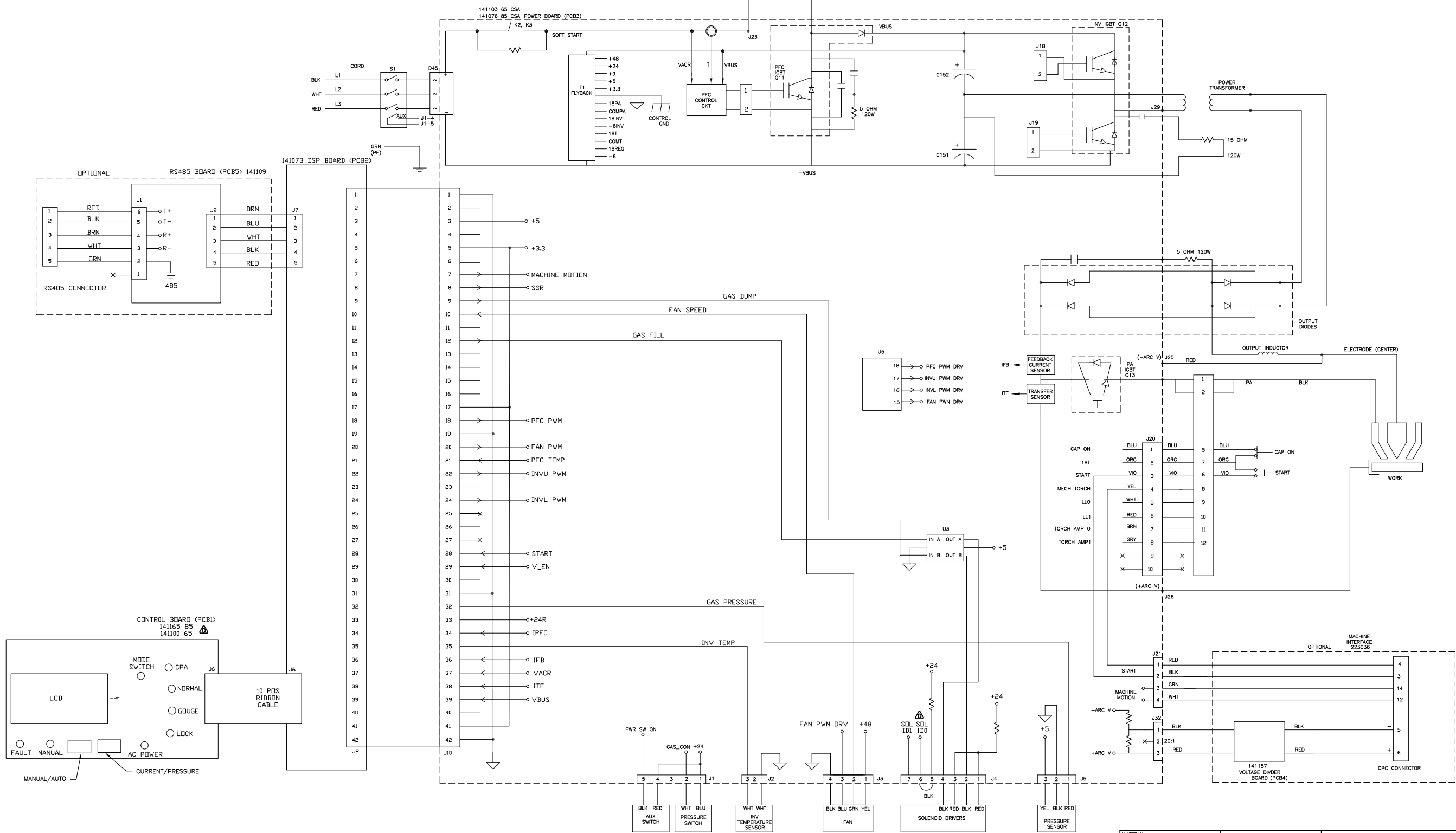
Mnemonic	Description
Timeouts and Delays	
T_GAS_UP	Torch gas ramping up delay
T_PILOT_MIN	Minimum pilot time delay
T_TSO	Delay from Gas Up to TSO test
T_TSC	Delay from Gas Up to TSC test
T_TORCH_RESET	Torch consumable Reseat Time
Current Setpoints	
pilot_current_set	Regular pilot current setting
I_PILOT_HIGH_DELTA	Pilot current boost value
I_TRANSFER	Transfer current = pilot_current_set + I_PILOT_HIGH_DELTA

		P.O.Box 5010 Hanover, NH 03755-5010 (603) 643-3441	
TITLE CUTTING FSM TIMGING DIAGRAM -NORMAL			
DRAWN BY QLIU	FILENAME CUTTING FSM FAST LOOP BY QLIU.VSD	DATE 4/26/2010	PAGE 1 OF 2



Electrical schematic diagram (CSA)

REVISIONS					
REV	ECN	DATE	APPROVED	DATE	BY
D	21645	11-29-12	CSM	11-30-12	QL



MATERIAL		Hypertherm	
THIS DRAWING AND ALL INFORMATION CONTAINED THEREON IS CONSIDERED PROPRIETARY AND MAY NOT BE USED FOR MANUFACTURING OR FABRICATION PURPOSES WITHOUT PERMISSION FROM HYPER THERMAL, INC.		Box-5010 Hanover, NH 03755-5010 603/843-3441	
TOLERANCES ARE: 2 PL. DECIMAL ±.01 3 PL. DECIMAL ±.005 FRACTIONS ±1/64 ANGULAR ±.2° PART MUST BE FREE OF BURRS AND SHARP EDGES. BREAK SHARP EDGES IF NECESSARY WITH CHAMFER OR RADIUS .015 MAX.		DESCRIPTION ELEC SCHEM:65/85A CSA SYS	
ITEM NO. 013370		FILE NAME 013370D	
DATE 05-03-10		APPROVED BY DMB	
DRAWN BY CSM		DATE 05-04-10	
SCALE NTS		SHEET 1 OF 1	

Electrical schematic diagram (CE)

REVISIONS					
REV	ECN	DATE	DRAWN	DATE	APPROVED
D	21645	11-29-12	CSM	11-30-12	QL

D

D

C

C

B

B

A

A

