F-15-657
Jun, 2005

Installation, Operation, and Maintenance for the

ESP-400C
Plasma Power Source

ESAB CUTTING SYSTEMS

The equipment described in this manual is potentially hazardous. Use caution when installing, operating and maintaining this equipment.

Purchaser is solely responsible for the safe operation and use of all products purchased, including compliance with OSHA and other government standards. ESAB Cutting Systems has no liability for personal injury or other damage arising out of the use of any product manufactured or sold by ESAB. See standard ESAB terms and conditions of sale for a specific statement of ESAB's responsibilities and limitations on its liability.

ESAB Cutting Systems first priority is total customer satisfaction. We constantly look for ways to improve our products, service and documentation. As a result, we make enhancements and/or design changes as required. ESAB makes every possible effort to ensure our documentation is current. We cannot guarantee that each piece of documentation received by our customers reflects the latest design enhancements. Therefore, the information contained in this document is subject to change without notice.

This manual is ESAB Part Number F15657

This manual is for the convenience and use of the cutting machine purchaser. It is not a contract or other obligation on the part of ESAB Cutting Systems.

Printed in U.S.A.

This page intentionally left blank.

1.1 Introduction

The process of cutting metals with plasma equipment provides industry with a valuable and versatile tool. ESAB cutting machines are designed to provide both operation safety and efficiency. However, as with any machine tool, sensible attention to operating procedures, precautions, and safe practices is necessary to achieve a full measure of usefulness. Whether an individual is involved with operation, servicing, or as an observer, compliance with established precautions and safe practices must be accomplished. Failure to observe certain precautions could result in serious personnel injury or severe equipment damage. The following precautions are general guidelines applicable when working with cutting machines. More explicit precautions pertaining to the basic machine and accessories are found in the instruction literature. For a wide scope of safety information on the field of cutting and welding apparatus, obtain and read the publications listed in the Recommended References.

1.2 Safety Notations And Symbols

The following words and symbols are used throughout this manual. They indicate different levels of required safety involvement.

	**ALERT or ATTENTION. Your safety is involved or potential equipment failure exists. Used with other symbols and information.**
DANGER	**Used to call attention to immediate hazards which, if not avoided, will result in serious personal injury or loss of life.**
WARNING	**Used to call attention to potential hazards that could result in personal injury or loss of life.**
CAUTION	**Used to call attention to hazards that could result in minor personal injury or equipment damage.**
CAUTION	**Used to call attention to minor hazards to equipment.**
NOTICE	**Used to call attention to important installation, operation or maintenance information not directly related to safety hazards.**

1.3 General Safety Information

⚠ WARNING

Machinery often starts automatically.

This equipment moves in various directions and speeds.

Moving machinery can crush.

Only qualified personnel should operate or service this power source.

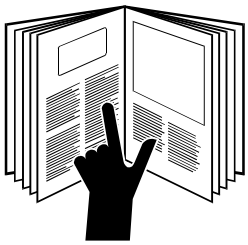
Keep all personnel, materials, and equipment not involved in production process clear of entire system area.

Fence off entire work cell to prevent personnel from passing through area or standing in the working envelope of the equipment.

Post appropriate WARNING signs at every work cell entrance.

Follow lockout procedure before servicing any equipment.

⚠ WARNING



Failure to follow operating instructions could result in death or serious injury.

Read and understand this operator's manual before using machine.

Read entire procedure before operating or performing any system maintenance.

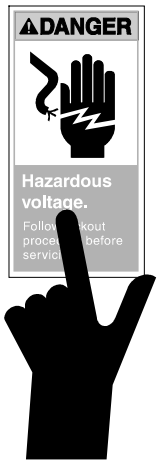
Special attention must be given to all hazard warnings that provide essential information regarding personnel safety and/or possible equipment damage.

All safety precautions relevant to electrical equipment and process operations must be strictly observed by all having system responsibility or access.

Read all safety publications made available by your company.

⚠ WARNING

Failure to follow safety warning label instructions could result in death or serious injury.



Read and understand all safety warning labels on machine.

Refer to operator's manual for additional safety information.

1.4 Installation Precautions

⚠ WARNING

Improperly Installed Equipment Can Cause Injury Or Death.

Follow these guidelines while installing machine:

Contact your ESAB representative before installation. He can suggest certain precautions regarding piping installation and machine lifting, etc. to ensure maximum security.

Never attempt any machine modifications or apparatus additions without first consulting a qualified ESAB representative.

Observe machine clearance requirements for proper operation and personnel safety.

Always have qualified personnel perform installation, troubleshooting and maintenance of this equipment.

Provide a wall mounted disconnect switch with proper fuse sizes close to the power supply.

1.5 Electrical Grounding

Electrical grounding is imperative for proper machine operation and SAFETY. Refer to this manual's Installation section for detailed grounding instructions.

⚠ WARNING

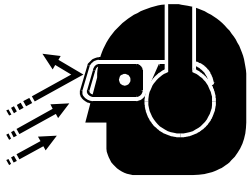
Electric shock hazard.

Improper grounding can cause severe injury or death.

Machine must be properly grounded before put into service.

1.6 Operating A Plasma Cutting Machine

⚠ WARNING



Flying debris and loud noise hazards.

Hot spatter can burn and injure eyes. Wear goggles to protect eyes from burns and flying debris generated during operation.

Chipped slag may be hot and fly far. Bystanders should also wear goggles and safety glasses.

Noise from plasma arc can damage hearing. Wear correct ear protection when cutting above water.

⚠ WARNING

Burn hazard.

Hot metal can burn.

Do not touch metal plate or parts immediately after cutting. Allow metal time to cool, or douse with water.

Do not touch plasma torch immediately after cutting. Allow torch time to cool.

⚠ WARNING

Hazardous voltages. Electric shock can kill.

Do NOT touch plasma torch, cutting table or cable connections during plasma cutting process.

Always turn power off to plasma power supplies before touching or servicing plasma torch.

Always turn power off to plasma power supplies before servicing any system component.

Do not touch live electrical parts.

Keep all panels and covers in place when machine is connected to power source.

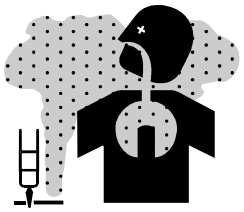
Wear insulating gloves, shoes and clothing to insulate yourself from workpiece and electrical ground.

Keep gloves, shoes, clothing, work area, and equipment dry.

Replace worn or damaged cables.

⚠ WARNING

Fume hazard.



Fumes and gases generated by the plasma cutting process can be hazardous to your health.

Do NOT breathe fumes.

Do not operate plasma torch without fume removal system operating properly.

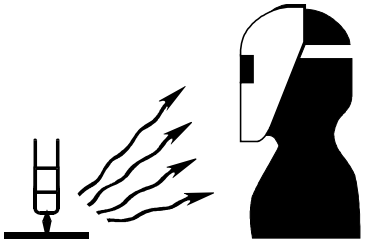
Use additional ventilation to remove fumes if necessary.

Use approved respirator if ventilation is not adequate.

Provide positive mechanical ventilation when cutting galvanized steel, stainless steel, copper, zinc, beryllium, or cadmium. Do not breathe these fumes.

Do not operate near degreasing and spraying operations. Heat or arc rays can react with chlorinated hydrocarbon vapors to form phosgene, a highly toxic gas and other irritant gases.

⚠ WARNING



Radiation hazard.

Arc rays can injure eyes and burn skin.

Wear correct eye and body protection.

Wear dark safety glasses or goggles with side shields. Refer to following chart for recommended lens shades for plasma cutting:

Arc Current	Lens Shade
Up to 100 Amps	Shade No. 8
100-200 Amps	Shade No. 10
200-400 Amps	Shade No. 12
Over 400 Amps	Shade No. 14

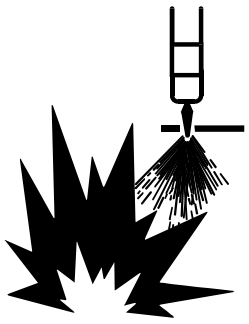
Replace glasses/goggles when lenses are pitted or broken

Warn others in area not to look directly at the arc unless wearing appropriate safety glasses.

Prepare cutting area to reduce reflection and transmission of ultraviolet light.

- Use special paint on walls to absorb UV light.
- Install protective screens or curtains to reduce ultraviolet transmission.

⚠ WARNING



Burn Hazard.

Heat, spatter, and sparks cause fire and burns.

Do not cut near combustible material.

Do not have on your person any combustibles (e.g. butane lighter).

Pilot arc can cause burns. Keep torch nozzle away from yourself and others when activating plasma process.

Wear correct eye and body protection.

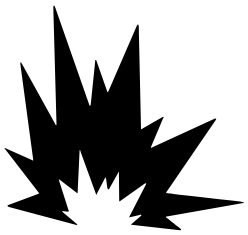
Wear gauntlet gloves, safety shoes and hat.

Wear flame-retardant clothing covering all exposed areas.

Wear cuffless trousers to prevent entry of sparks and slag.

Have fire extinguishing equipment available for use.

⚠ WARNING



Explosion hazard.

Certain molten aluminum-lithium (Al-Li) alloys can cause explosions when plasma cut OVER water.

- These alloys should only be dry cut on a dry table.
- DO NOT dry cut over water.
- Contact your aluminum supplier for additional safety information regarding hazards associated with these alloys.

Do not cut in atmospheres containing explosive dust or vapors.

Do not carry any combustibles on your person (e.g. butane lighter)

Do not cut containers that have held combustibles.

1.7 Service Precautions

⚠ WARNING

Hazardous voltages. Electric shock can kill.

Do NOT touch plasma torch, cutting table or cable connections during plasma cutting process.

Always turn power off to plasma power supplies before touching or servicing plasma torch.

Always turn power off to plasma power supplies before removing covers or panels to service any system component.

Do not touch live electrical parts.

Keep all panels and covers in place when machine is connected to power source.

Keep gloves, shoes, clothing, work area, and equipment dry.

Inspect power and ground leads cables for wear or cracking. Replace worn or damaged cables. Do not use if damaged.

Never bypass safety interlocks.

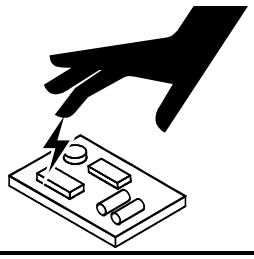
Follow lock-out procedures.

CAUTION

Establish and adhere to preventive maintenance. A composite program can be established from recommended schedules.

Avoid leaving test equipment or hand tools on machine. Severe electrical or mechanical damage could occur to equipment or machine.

⚠ CAUTION



Extreme caution should be used when probing circuitry with an oscilloscope or voltmeter. Integrated circuits are susceptible to over voltage damage. Power off before using test probes to prevent accidental shorting of components.

All circuit boards securely seated in sockets, all cables properly connected, all cabinets closed and locked, all guards and covers replaced before power is turned on.

1.8 Safety References

The following nationally recognized publications on safety in welding and cutting operations are recommended. These publications have been prepared to protect persons from injury or illness and to protect property from damage, which could result from unsafe practices. Although some of these publications are not related specifically to this type of industrial cutting apparatus, the principles of safety apply equally.

"Precautions and Safe Practices in Welding and Cutting with Oxygen-Fuel Gas Equipment," Form 2035. ESAB Cutting Systems.

"Precautions and Safe Practices for Electric Welding and Cutting," Form 52-529. ESAB Cutting Systems.

"Safety in Welding and Cutting" - ANSI Z 49.1, American Welding Society, 2501 NW 7th Street, Miami, Florida, 33125.

"Recommended Safe Practices for Shielded Gases for Welding and Plasma Arc Cutting" - AWS C5.10-94, American Welding Society.

"Recommended Practices for Plasma Arc Welding" - AWS C5.1, American Welding Society.

"Recommended Practices for Arc Cutting" - AWS C5.2, American Welding Society.

"Safe Practices" - AWS SP, American Welding Society.

"Standard for Fire Protection in Use of Cutting and Welding Procedures" - NFPA 51B, National Fire Protection Association, 60 Batterymarch Street, Boston, Massachusetts, 02110.

"Standard for Installation and Operation of Oxygen - Fuel Gas Systems for Welding and Cutting" - NFPA 51, National Fire Protection Association.

"Safety Precautions for Oxygen, Nitrogen, Argon, Helium, Carbon Dioxide, Hydrogen, and Acetylene," Form 3499. ESAB Cutting Systems. Obtainable through your ESAB representative or local distributor.

"Design and Installation of Oxygen Piping Systems," Form 5110. ESAB Cutting Systems.

"*Precautions for Safe Handling of Compressed Gases in Cylinders*", CGA Standard P-1, Compressed Gas Association.

Literature applicable to safe practices in welding and cutting with gaseous materials is also available from the Compressed Gas Association, Inc., 500 Fifth Ave., New York, NY 10036.

This page intentionally left blank.

2.1 Introduction

The ESP power Source is designed for high speed plasma mechanized cutting applications. It can be used with other ESAB products such as the PT-15 and PT-600 torches along with the Smart Flow II, a computerized gas regulation and switching system.

50 to 400 Amperes cutting current range

Forced air cooled

Solid state DC power

Input voltage protection

Local or remote front panel control

Thermal switch protection for main transformer and power semiconductor components

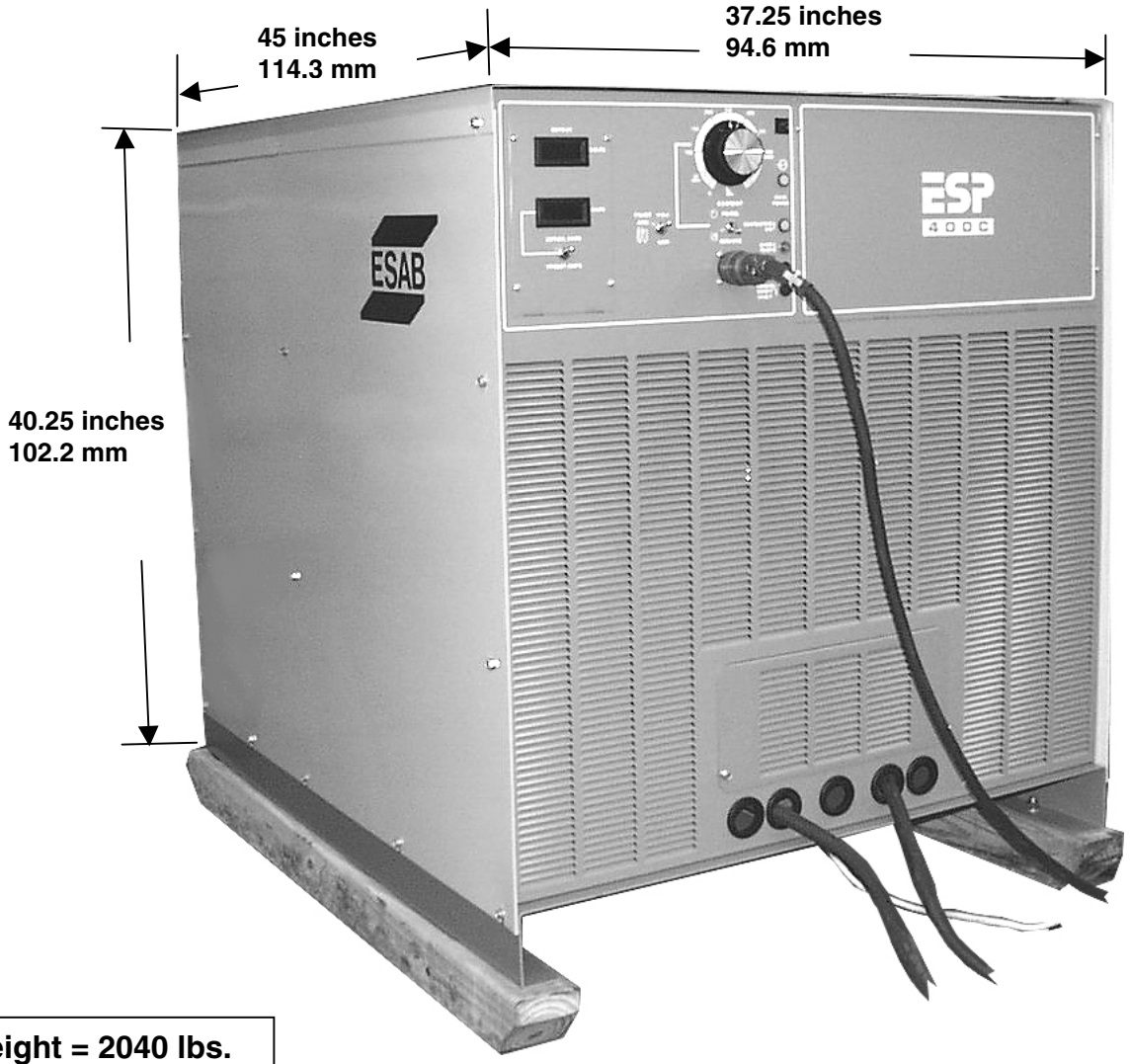
Top lifting rings or base forklift clearance for transport

Parallel secondary power source capabilities to extend current output range.

2.2 General Specifications

		ESP-400C 400V, 50Hz CE	ESP-400C 460V, 60Hz	ESP-400C 575V, 60Hz
Part Number		0558001730	0558001729	0558001731
OUTPUT (100 % duty cycle)	Voltage	200 V dc		
	Current range DC	50A to 400A		
	Power	80 KW		
	Open Circuit Voltage (OCV)	410 V dc	427 V dc	427 V dc
INPUT	Voltage (3-phase)	400 V	460 V	575 V
	Current (3- phase)	138 A RMS	120 A RMS	96 A RMS
	Frequency	50/60 HZ	60 Hz	60 Hz
	KVA	95.6 KVA	95.6 KVA	95.6 KVA
	Power	87 KW	87 KW	87 KW
	Power Factor	91.0 %		
	Input Fuse Rec.	200A	150A	125A

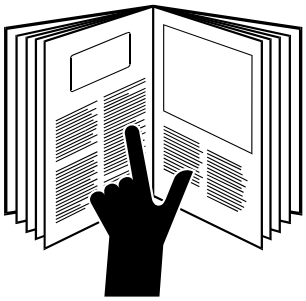
2.3 Dimensions and Weight



Weight = 2040 lbs.
(925.34 kg.)

3.1 General

⚠ WARNING



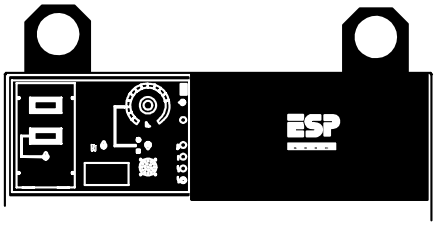
Failure To Follow Instructions Could Lead To Death, Injury Or Damaged Property

Follow these instructions to prevent injury or property damage.

You must comply with local, state and national electrical and safety codes.

3.2 Unpacking

CAUTION



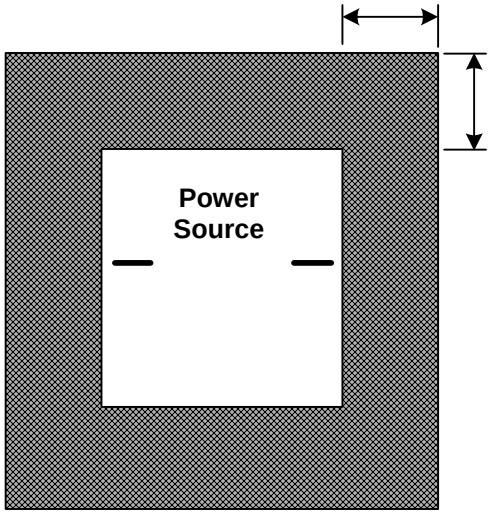
Using One Lifting Eye Will Damage Sheet Metal And Frame

Use both lifting eyes when transporting with overhead method.

Unit weighs over 2000 lbs. Use approved straps or cables in good condition.

- Inspect for transit damage immediately upon receipt.
- Remove all components from shipping container and check for loose parts in container.
- Inspect louvers for air obstructions.

3.3 Placement



Note: Use both lifting eyes when transporting from overhead.

- A minimum of 2 ft. clearance on front and back for cooling air flow.
- Plan for top panel and side panels having to be removed for maintenance, cleaning and inspection.
- Locate the ESP-400C relatively close to a properly fused electrical power supply.
- Keep area beneath power source clear for cooling air flow.
- Environment should be relatively free of dust, fumes and excessive heat. These factors will affect cooling efficiency.

CAUTION

Conductive Dust And Dirt Inside Power Source May Cause Arc Flash-Over

Equipment damage may occur. Electrical shorting may occur if dust is allowed to build-up inside power source. See maintenance section.

3.4 Input Power Connection

⚠ WARNING

Electric Shock Can Kill!

Provide maximum protection against electrical shock.

Before any connections are made inside the machine, open the line wall disconnect switch to turn power off.

3.4.1 Primary Power

ESP-400C is a 3-phase unit. Input power must be provided from a line (wall) disconnect switch that contains fuses or circuit breakers in accordance to local or state regulations.

Recommended input conductor and line fuse sizes:

Rated Load		Input and Ground conductor* CU/AWG	Time delay Fuse size (amperes)
Volts	Amperes		
400	138	4/0	200
460	120	3/0	150
575	96	1/0	125

*Sizes per National Electrical Code for a 90 °C rated copper conductors @ 40 °C ambient. Not more than three conductors in raceway or cable. Local codes should be followed if they specify sizes other than those listed above.

Input current = $\frac{\text{(V arc) x (I arc) x 0.688}}{\text{(V line)}}$

NOTICE

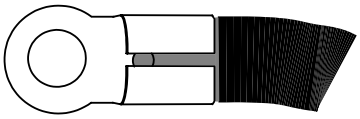
Dedicated power line may be necessary.

ESP-400C is equipped with line voltage compensation but to avoid impaired performance due to an overloaded circuit, a dedicated power line may be required.

3.4.2 Input Conductors

- Customer supplied
- May consist either of heavy rubber covered copper conductors (three power and one ground) or run in solid or flexible conduit.
- Sized according to the chart.

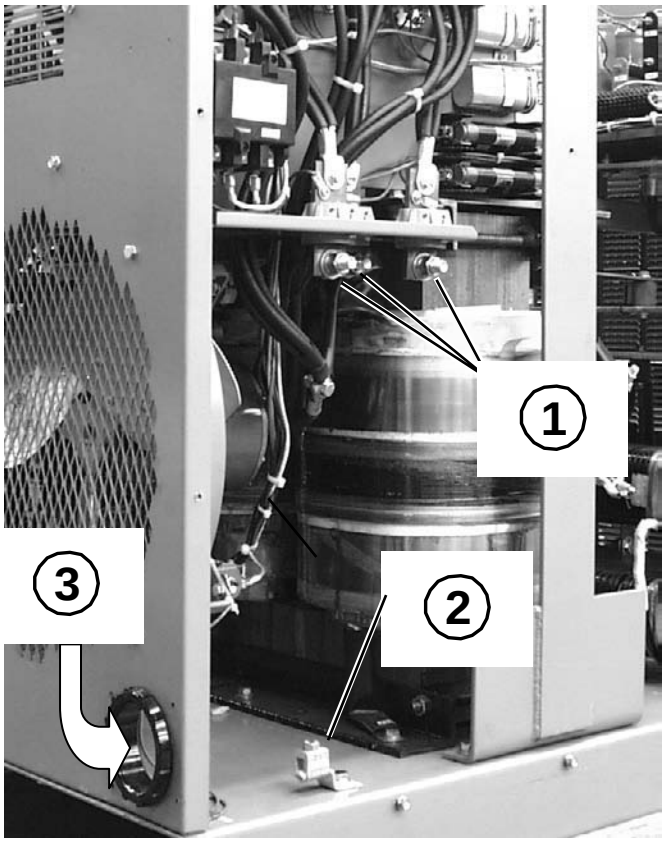
NOTICE



Input conductors must be terminated with ring terminals.

Input conductors must be terminated with ring terminals sized for ½" hardware before being attached to the ESP-400C.

3.4.3 Input Connection Procedure



1. Remove left side panel of the ESP-400C
2. Thread cables through the access opening in the rear panel.
3. Secure cables with a strain relief or conduit coupling (not supplied) at the access opening.
4. Connect the ground lead to the stud on the chassis base.
5. Connect the power lead ring terminals to the primary terminals with supplied bolts, washers and nuts.
6. Connect the input conductors to the line (wall) disconnect.

1	**Primary Terminals**
2	**Chassis Ground**
3	**Power Input Cable Access Opening (Rear Panel)**

⚠ WARNING

Electric Shock Can Kill!

Ring terminals must have clearance between side panel and main transformer. Clearance must be sufficient to prevent possible arcing

Make sure cables do not interfere with cooling fan rotation.

⚠ WARNING

Improper Grounding Can Result In Death or Injury.

Chassis must be connected to an approved electrical ground.

Be sure ground lead is NOT connected to any primary terminal.

3.5 Output Connections

⚠ WARNING

Electric Shock Can Kill! Dangerous Voltage And Current!

Any time working around a plasma power source with covers removed:

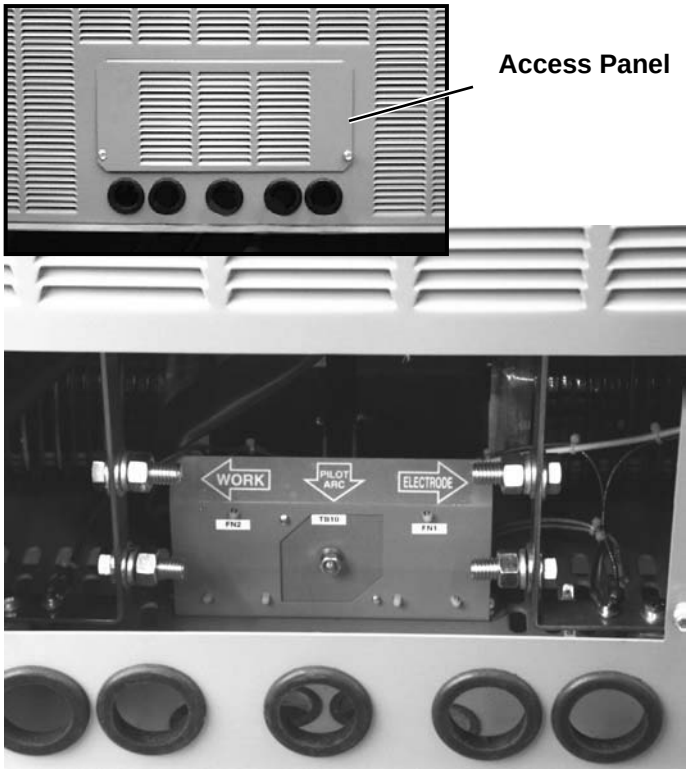
- Disconnect power source at the line(wall) disconnect.
- Have a qualified person check the output bus bars (positive and negative) with a voltmeter.

3.5.1 Output Cables (customer supplied)

Choose plasma cutting output cables (customer supplied) on the basis of one 4/0 AWG, 600 volt insulated copper cable for each 400 amps of output current.

Note: Do not use 100 volt insulated welding cable.

3.5.2 Output Connection Procedure



1. Remove access panel on the lower front of the power source.
2. Thread output cables through the openings at the bottom of the front panel or at the bottom of the power source immediately behind the front panel.
3. Connect cables to designated terminals mounted inside the power source using UL listed pressure wire connectors.
4. Replace panel removed during the first step.

3.6 Parallel Installation

Two 400A power sources may be connected together to extend the output current range.

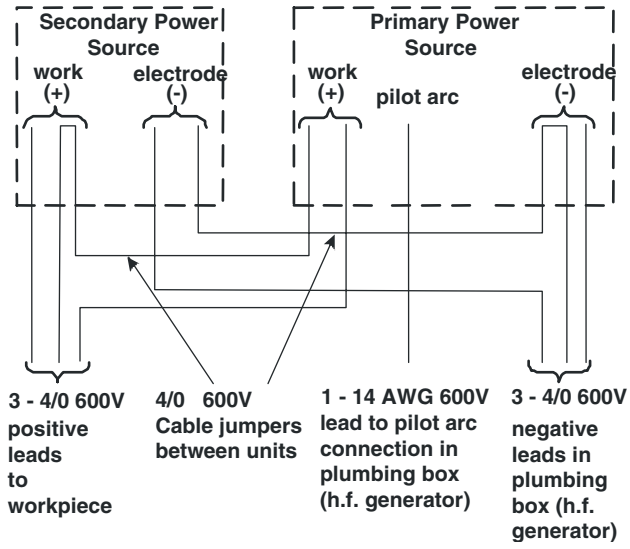
CAUTION

Parallel power source start currents exceed recommended amounts when cutting below 100A.

Use Only One Power Source For Currents Below 100A.

We recommend disconnecting the negative lead from the secondary power source when changing to currents below 100 amperes. This lead should be safely terminated to protect against electric shock.

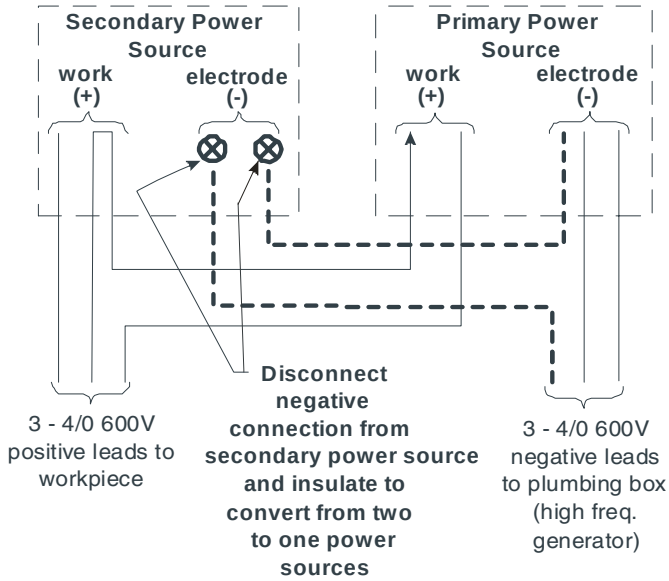
Connections for Parallel Installation of 2 Power sources



Note: Primary power source has the electrode (-) conductor jumpered. The secondary power source has the work (+) jumpered.

1. Connect the negative (-) output cables to the plumbing box (high frequency generator).
2. Connect the positive (+) output cables to the workpiece.
3. Connect the positive (+) and negative (-) conductors between the power sources.
4. Connect the pilot arc cable to the pilot arc terminal in the primary power source. The pilot arc connection in the secondary power source is not used. The pilot arc circuit is not run in parallel.
5. Set the Pilot Arc HIGH/LOW switch on the secondary power source to "LOW".
6. Set the Pilot Arc HIGH/LOW switch on the primary power source to "HIGH".

⚠ WARNING



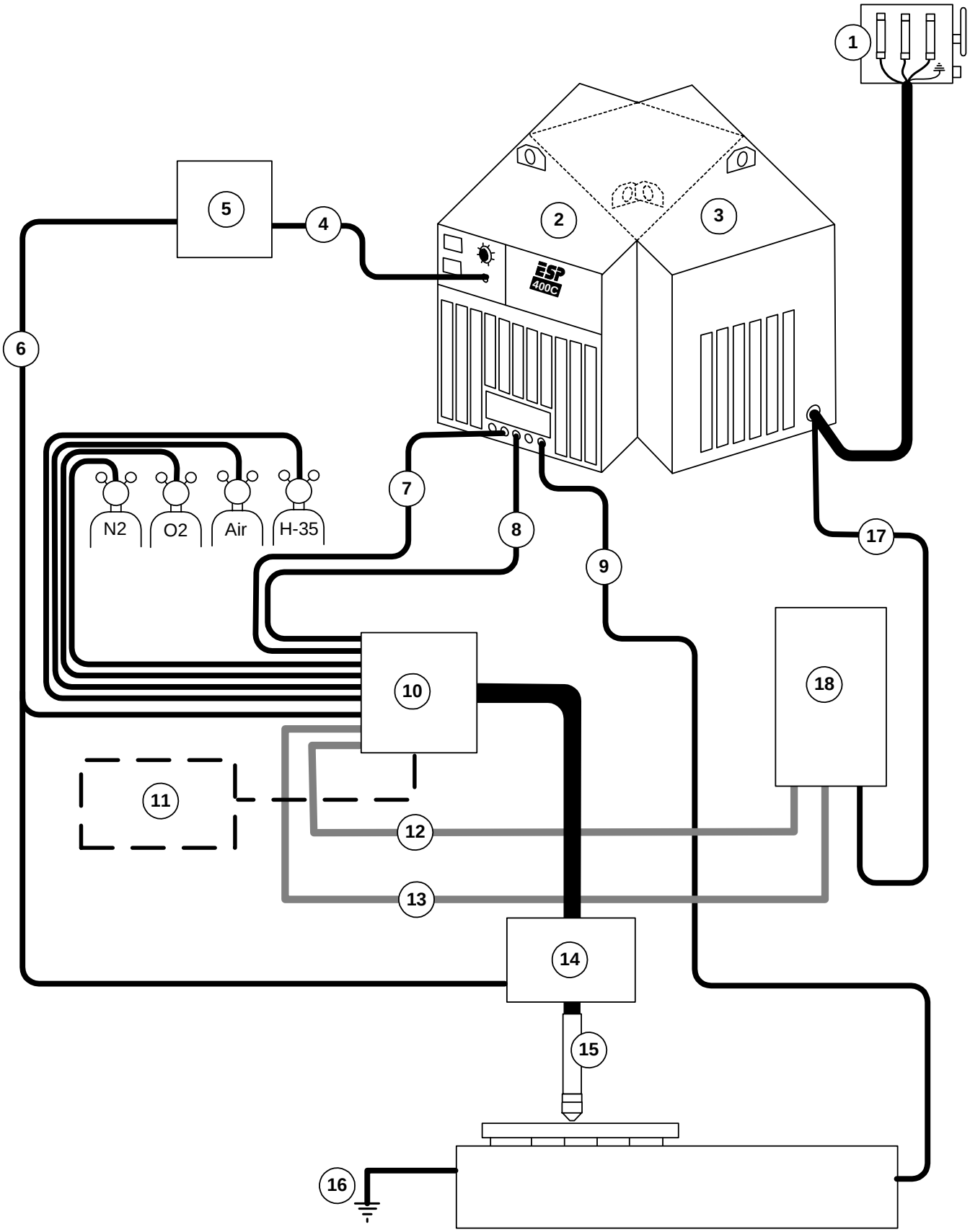
Electric Shock Can Kill!

Exposed Electrical Conductors Can Be Hazardous!

Do not leave electrically "hot " conductors exposed. When disconnecting the secondary power source from the primary, verify the correct cables were disconnected. Insulate the disconnected ends.

When using only one power source in a parallel configuration, the negative electrode conductor must be disconnected from the secondary power source and the plumbing box. Failure to do this will leave the secondary electrically "hot".

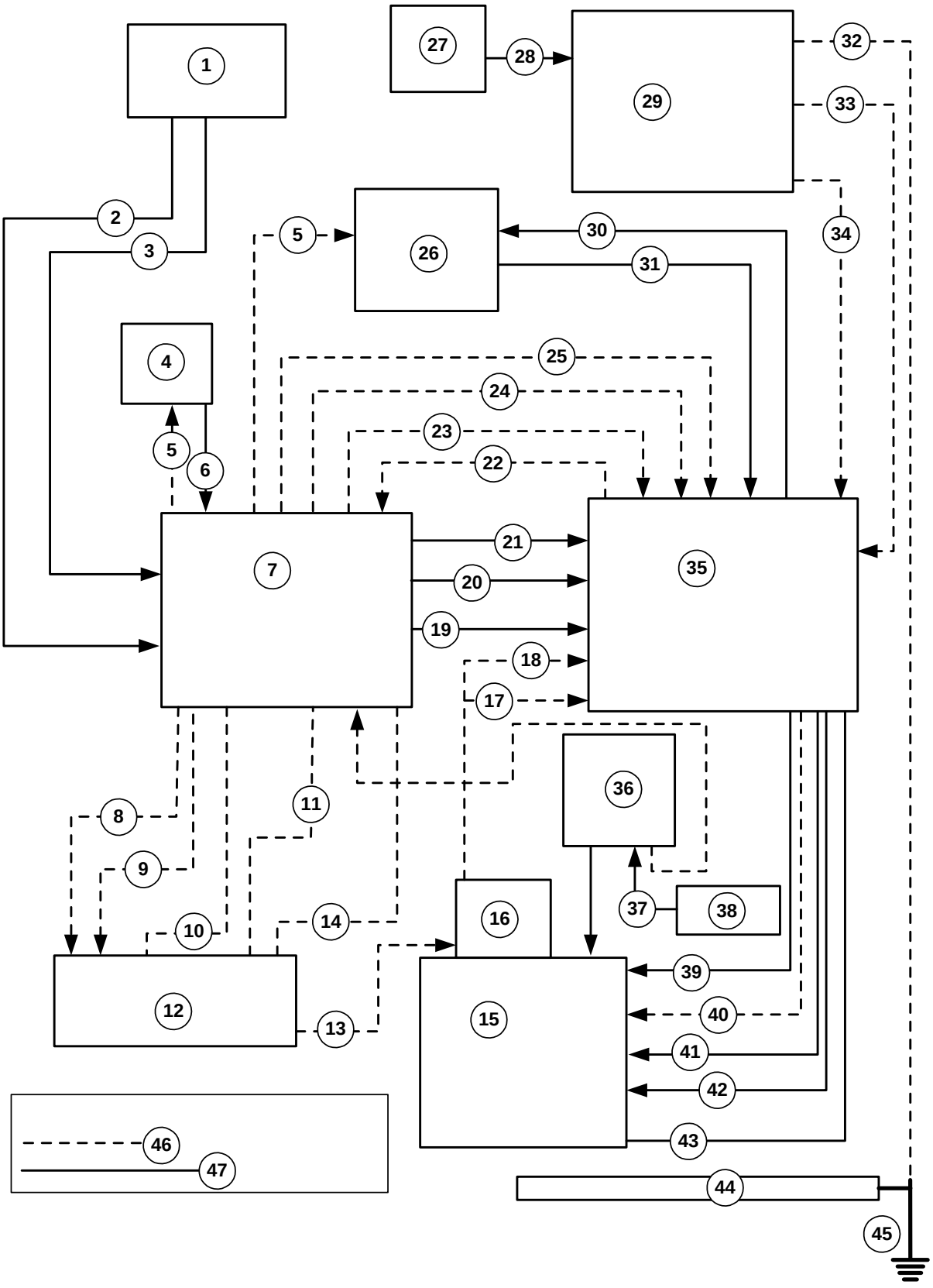
3.7 System Interconnecting Block Diagram with Smart Flow II



System Interconnecting Block Diagram with Smart Flow II

①	3 phase with ground (wall disconnect)
②	Front view
③	Rear view
④	Remote to CNC
⑤	CNC
⑥	CNC Input/Output to Smart Flow II
⑦	Torch Lead (-)
⑧	Pilot Arc Lead
⑨	Work Lead (+)
⑩	SmartFlow II
⑪	Cut Water Pump (required for PT-15)
⑫	Cooling Water to Torch
⑬	Cooling Water from Torch
⑭	Voltage Height Control
⑮	Plasma Torch Lead Bundle and Torch
⑯	Earth Ground
⑰	On/Off Control
⑱	WC-7C Water Cooling

3.8 System Interconnecting Block Diagram with Manual Flow Control



4.1 Introduction

The ESP-400C does not have an ON/OFF switch. The main power is controlled through the line(wall) disconnect switch.

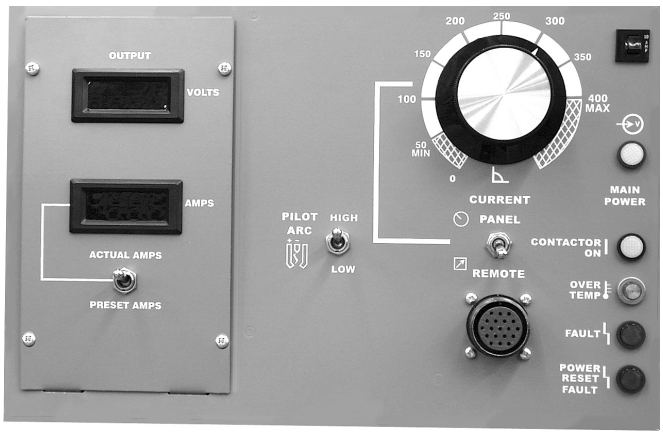
⚠ WARNING

Do not operate the ESP-400C with Covers Removed.

High voltage components are exposed increasing shock hazard.

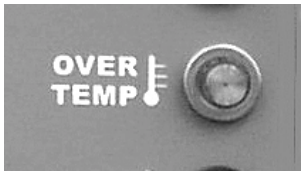
Internal component may be damaged because cooling fans will lose efficiency.

4.2 Control Panel



Main Power

Indicator illuminates when input power is applied to the power source.

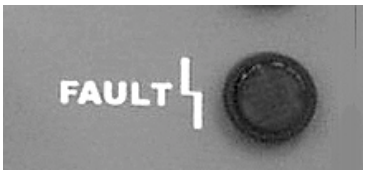


Over Temp

Indicator illuminates when power source has overheated.

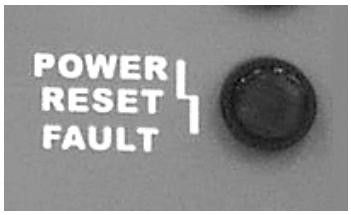
Contactor On

Indicator illuminates when the main contactor is energized.



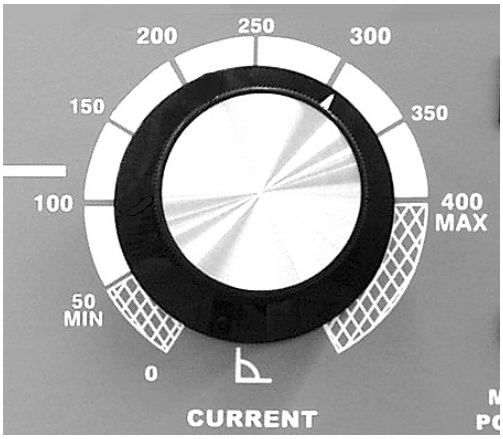
Fault

Indicator illuminates when there are abnormalities in the cutting process or when the input line voltage falls outside of the required nominal value by ±10%.



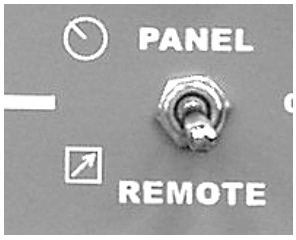
Power Reset Fault

Indicator illuminates when a serious fault is detected. Input power must be disconnected for at least 5 seconds and then reapplied.



Current Dial (Potentiometer)

ESP-400C dial shown. ESP-400C has a range of 50 to 600 A. Used only in panel mode.

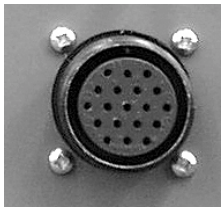


Panel Remote Switch

Controls the location of current control.

Place in the PANEL position for control using the current potentiometer.

Place in REMOTE position for control from an external signal (CNC).

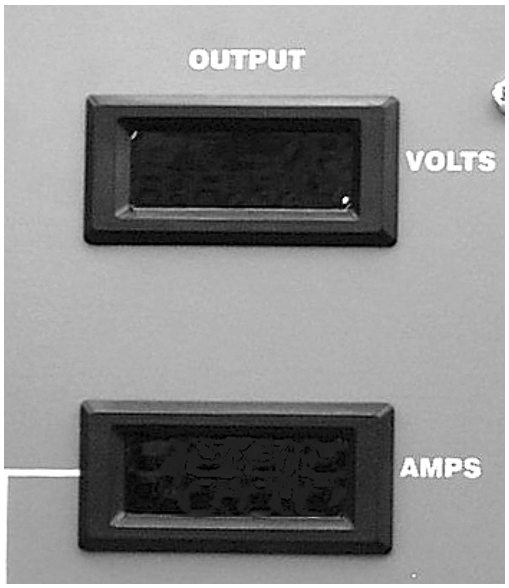


Remote Connection

Amphenol 19 pin plug for connecting power source to CNC.

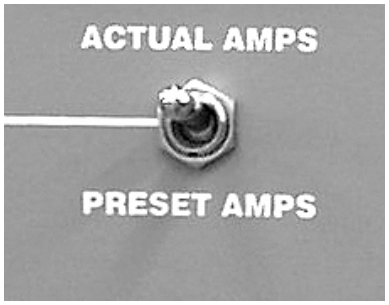
Pilot Arc HIGH/LOW Switch

Used to select amount of pilot arc current desired. As a general rule, for 100 amperes and below, a setting of LOW is used. This can vary depending on gas, material and torch used. High/Low settings are specified in cutting data included in the torch manual.



Meters

Displays voltage and amperage when cutting. The ammeter can be activated when not cutting to view an estimation of the cutting current before cutting begins.



Actual/Preset Switch

Spring return toggle switch defaults to ACTUAL position. When pressed down, the AMMETER displays an estimate of the actual current. This permits the operator to preset the cutting current close to the desired current using the current potentiometer.

Final adjustment is made after the torch has started cutting to achieve a more precise current.

⚠ WARNING

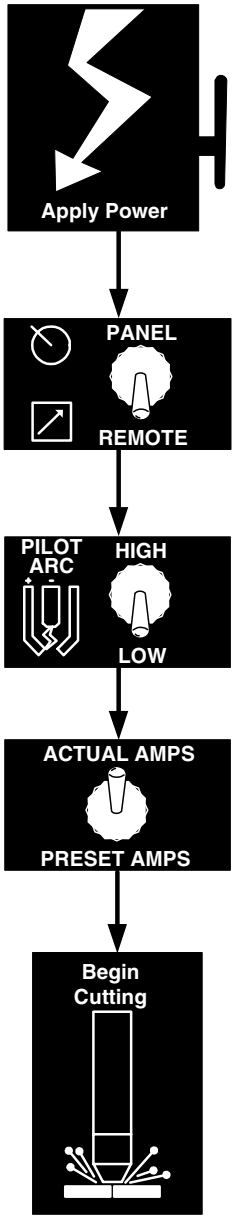
Dangerous Voltages and Current!

Electric Shock Can Kill!

Before operation, ensure installation and grounding procedures have been followed.

Do not operate this equipment with covers removed.

4.3 Sequence of Operation



1. Apply power by closing the line (wall) switch. (The ESP-400C does not have an on/off switch). The main power light will illuminate and the fault light will flash and then go out.
2. Select the Panel/Remote setting.
3. Set pilot arc High/Low switch. (Refer to cutting data in the torch manual.)
4. If using panel mode, view preset amps with the ACTUAL/PRESET AMPS switch. Adjust current until the approximate desired value is shown on the ammeter.
5. Begin plasma cutting operation. This may include manually setting up other options, depending on the total plasma package.
6. If using panel mode, after cutting has begun, adjust current to desired amount.
7. Check for fault light. If a fault light illuminates, refer to troubleshooting section.

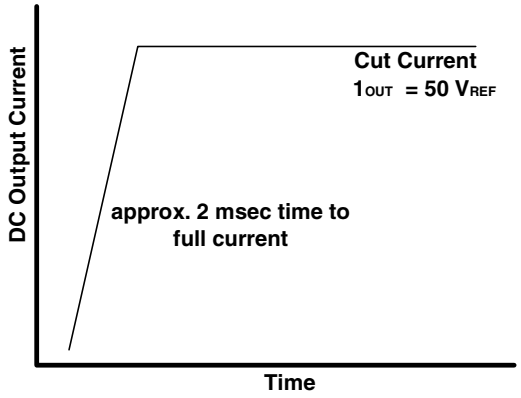
Note: The fault light flashes when the contactor is first turned on signifying the DC Bus powered up normally.

4.4 Arc Initiation Settings

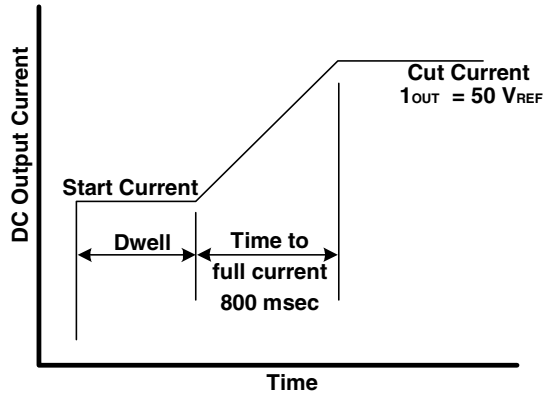
The time to achieve full current can be adjusted to suit your particular system. This feature uses 50% of the cutting current to start, dwell and then gradually (less than a second) achieve full current. The ESP-400C is factory shipped with this feature enabled. The default settings are:

Minimum Start Current	40A
Start Current	50% of cut current
Timing to achieve full current	800 msec
Dwell Time	50 msec

Start Current Waveform With Arc Initiation Timer OFF



Start Current Waveform With Arc Initiation Timer ON



These timing functions can be disabled or adjusted to suit individual system requirements.

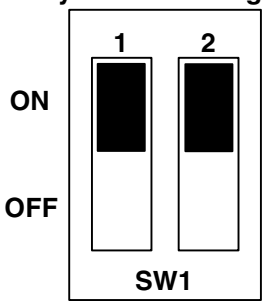
⚠ WARNING

Electric Shock Can Kill!

Shut off power at the line (wall) disconnect before removing any covers or making any adjustments to the power source.

4.4.1 Enable/Disable Arc Initiation Timer

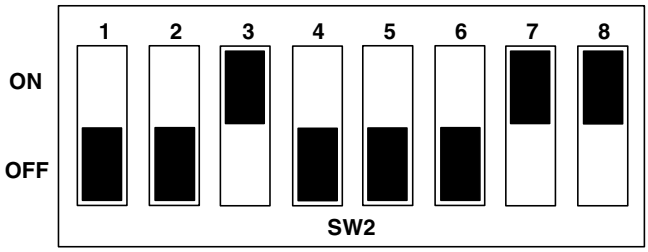
Factory default setting shown.



1. Remove access panel on the upper-right corner of the front panel. Be sure to replace this panel after adjustments have been made.
2. Locate SW1 and PCB1 and push both rocker switches down to disable. To enable push both switches up. (If one switch is up and the other is down, arc initiation time is considered on.)

4.4.2 Adjusting Arc Initiation Timer

Factory default settings shown



Minimum Start Current

Controlled by selection of positions 5 through 8 of SW2. When a switch is pushed on, its value is added to the factory set minimum value of 25A.

Switch #5 = 50A min. start current
Switch #6 = 25A min. start current
Switch #7 = 12A min. start current
Switch #8 = 6A min. start current

Default setting is with 7 and 8 on. 12A + 6A + 25A = 43A

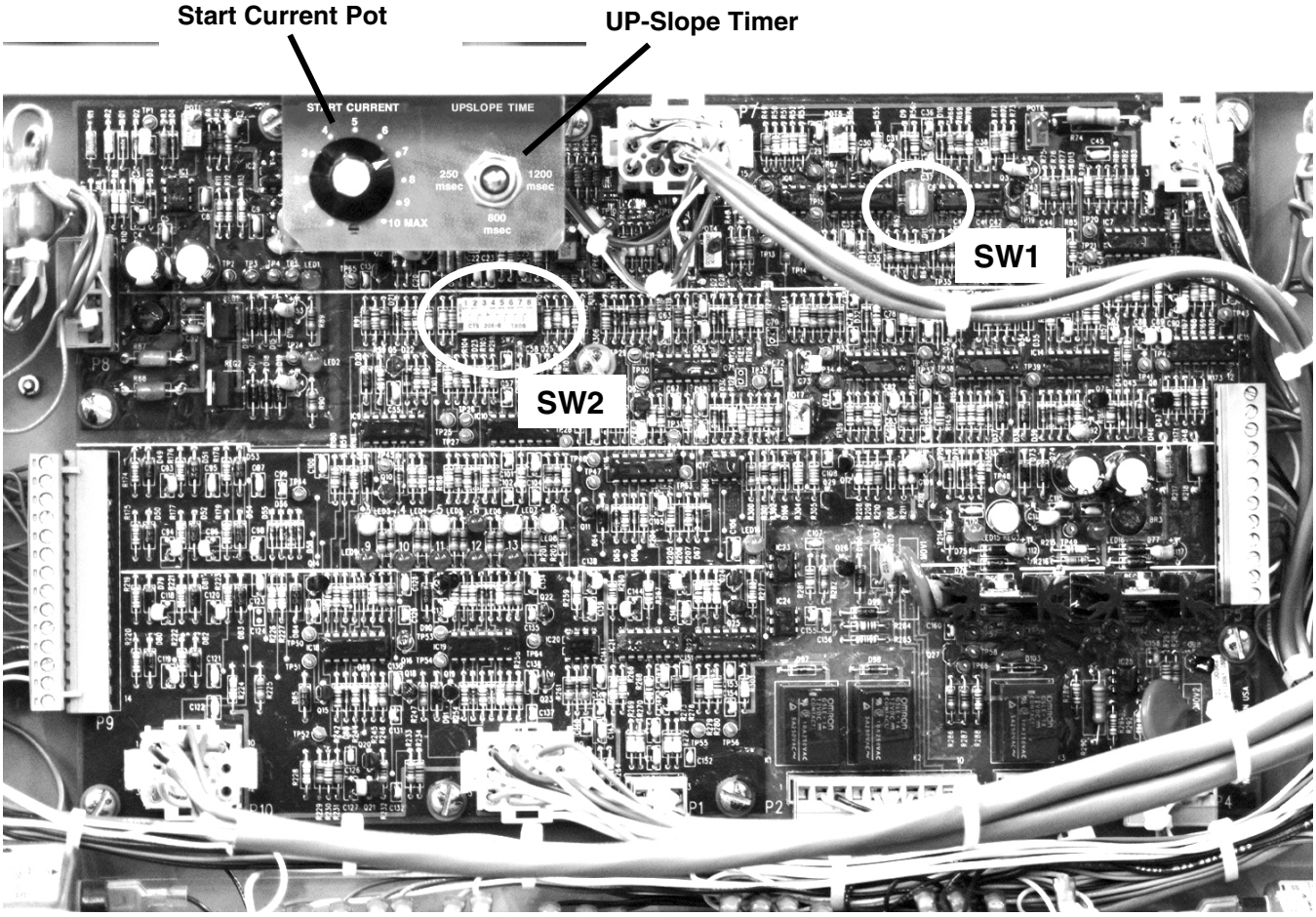
Dwell Time

Controlled by selections of positions 1 through 4 of SW2 on PCB1. When a switch is pushed on, its value is added to the minimum dwell time of 10 msec.

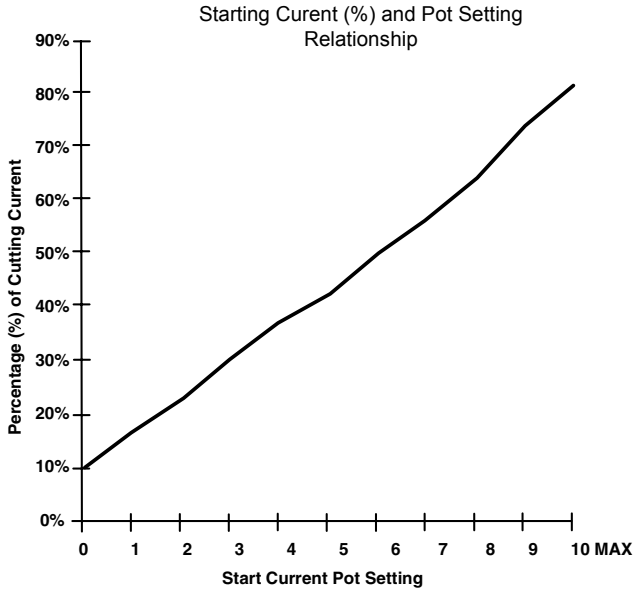
Switch #1 = 10 msec dwell time
Switch #2 = 20 msec dwell time
Switch #3 = 40 msec dwell time
Switch #4 = 80 msec dwell time

The default setting is with switch #3 on. 40 msec + 10 msec (minimum) = 50 msec

4.4.3 Arc Initiation Controls



4.4.4 Start Current and Up-Slope Timer

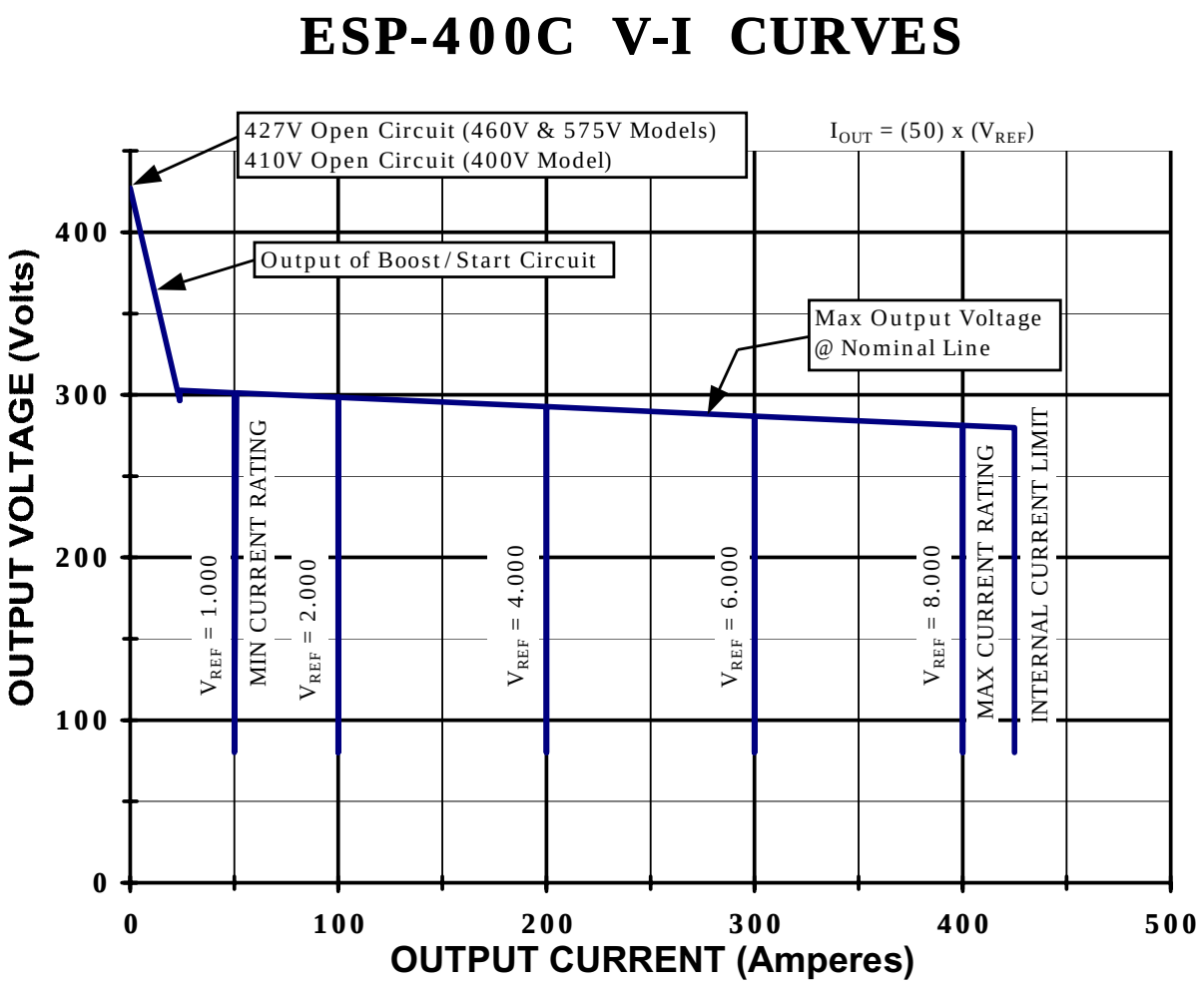


Start Current
Set using potentiometer located above and to the left of center of PCB1. Factory default setting is 7.

Up-Slope Timer
Three position switch located next to the start current potentiometer. Time is from start current (after dwell ends) to full current. Factory default = 800 msec.

Left position = 250 msec
Center position = 800 msec
Right Position = 1200 msec

4.5 ESP-400C V-I Curves



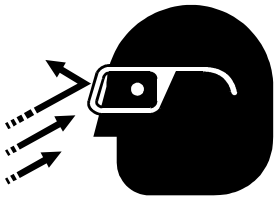
5.1 General

⚠ WARNING

Electric Shock Can Kill!

Shut off power at the line (wall) disconnect before attempting any maintenance.

⚠ WARNING



Eye Hazard When Using Compressed Air To Clean.

Wear approved eye protection with side shields when cleaning the power source.

Use only low pressure air.

⚠ CAUTION

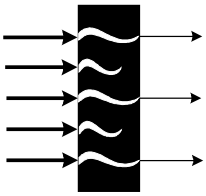
Maintenance On This Equipment Should Only Be Performed By Trained Personnel.

5.2 Cleaning

Regularly scheduled cleaning of the power source is required to help keep the unit running trouble free. The frequency of cleaning depends on environment and use.

1. Turn power off at wall disconnect.
2. Remove side panels.
3. Use low pressure compressed dry air, remove dust from all air passages and components. Pay particular attention to heat sinks in the front of the unit. Dust insulates, reducing heat dissipation. Be sure to wear eye protection.

CAUTION



Air Restrictions May Cause ESP-400C To Over Heat.

Thermal Switches may be activated causing interruption of function.

Do not use air filters on this unit.

Keep air passages clear of dust and other obstructions.

5.3 Lubrication

Some units are equipped with oil tubes on the fans. These fans should be oiled after 1 year of service.

All other ESP-400Cs have fan motors that are permanently lubricated and require no regular maintenance.

⚠ WARNING

Electric Shock Hazard!

Be sure to replace any covers removed during cleaning before turning power back on.

6.1 General

⚠ WARNING

Electric Shock Can Kill!

Do not permit untrained persons to inspect or repair this equipment.

Electrical work must be performed by an experienced electrician.

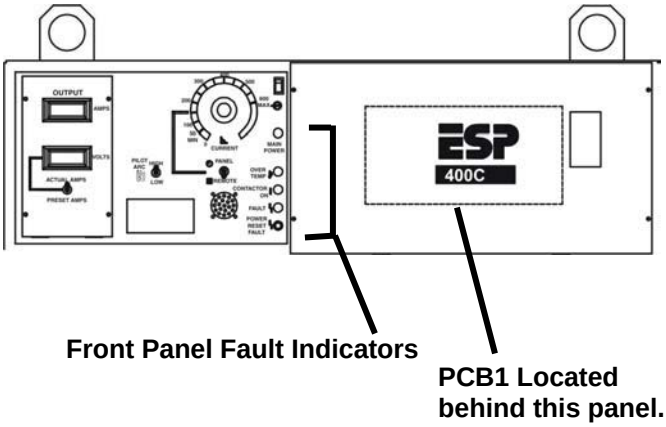
⚠ CAUTION

Stop Work Immediately If Power Source Does Not Work Properly.

Have only trained personnel investigate the cause.

Use only recommended replacement parts.

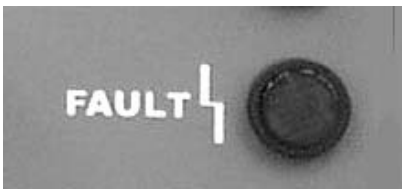
6.2 Fault Indicators



Fault indicators are found on the front panel Used with the LEDs on PCB1 (located behind the cover with the ESP label) problems can be diagnosed.
NOTE: Momentary lighting (flashing) is normal and does not indicated a fault.

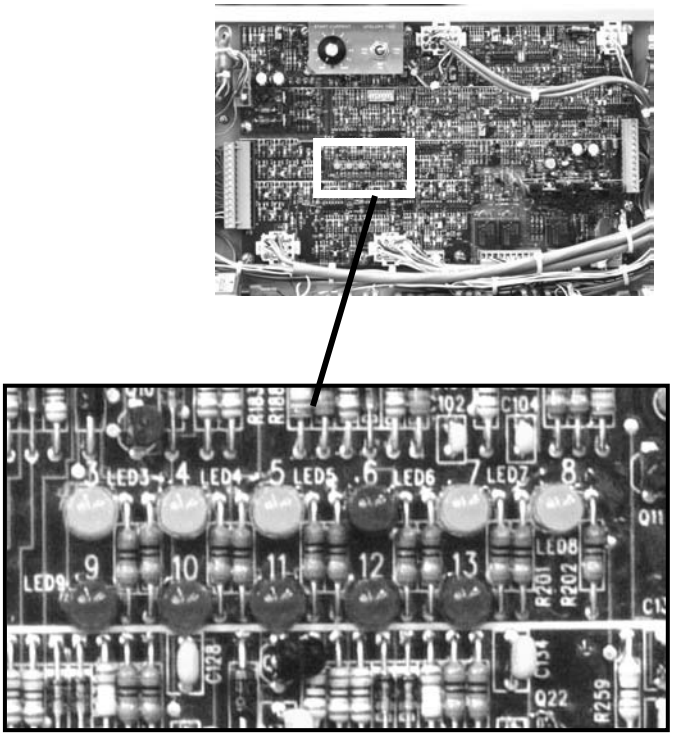
Fault Indicator used with:
- **LED 3**
- **LED 4**
- **LED 5**
- **LED 7**
- **LED 8**

Power Reset Fault Indicator used with:
- **LED 6**
- **LED 9**
- **LED 10**
- **LED 11**
- **LED 12**
- **LED 13**



Fault Indicator (Front Panel)

Illuminates when there are abnormalities in the cutting process or when the input voltage falls ±10% outside the normal value. Momentary illumination is normal. If continuously lit, check LEDs 3, 4, 5, 7, and 8 on PCB1 for further diagnosis.



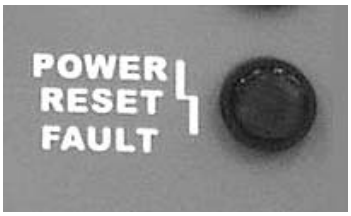
LED 3 – (amber) Bus Ripple Fault - Momentarily illuminates at the beginning of each cut. Continuously lit during single-phasing or imbalanced line-to-line voltages of the three phase input line.(Excessive Ripple) Power Source is shut down.

LED 4 – (amber) High Bus Fault – Illuminates when input line voltage is too high for proper operation (approx. 20% above nominal line voltage rating). Power source is shut down.

LED 5 – (amber) Low Bus Fault – Illuminates when input line voltage is approx. 20% below nominal line voltage rating. PS is shut down.

LED 7 – (amber) Arc Voltage Saturation Fault – Illuminates when the cutting arc voltage is too high and cutting current drops below preset level. LED will extinguish after voltage decreases and current rises.

LED 8 – (amber) Arc Voltage Cutoff Fault – Illuminates when arc voltage increases over the preset value. PS is shut down.

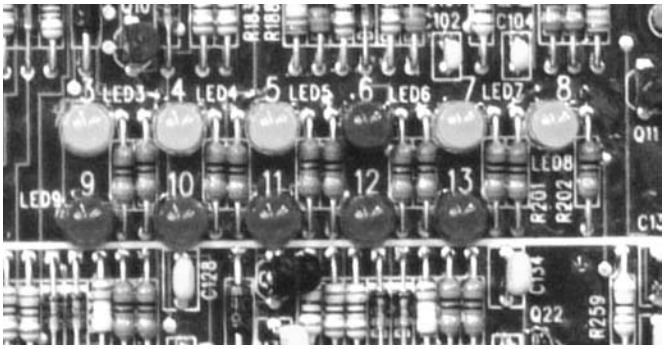


Power Reset Fault Indicator (on front panel)

Illuminates when a serious fault is detected. Input power must be disconnected for a least 5 seconds to clear this fault. Check PCB1 Red LEDs 6, 9, 10, 11, 12, and 13 if this fault is illuminated for further diagnosis.

LED 6 – (red) Right Overcurrent Fault – Illuminates when the current out of the right side chopper is too high (300 amps). This current is measured by the right-side hall sensor. The power source is shut down.

LED 9 – (red) Left Overcurrent Fault – Illuminates when the current from the left side chopper is too high (300 amps). Measured by the left hall sensor. Power source is shut down.



LED 10 _ (red) Left IGBT Unsaturated Fault – Illuminates when left IGBT is not fully conducting. PS (PS) is shut down.

LED 11 – (red) Right IGBT Unsaturated Fault – Illuminates when right IGBT is not fully conducting. Power Source (PS) is shut down.

LED 12 – (red) Left -(neg) 12V Bias Supply Fault – Illuminates when negative 12 V bias supply to the left side IGBT gate drive circuit (located on PWM-drive board PCB2) is missing. PS is shut down.

LED 13 – (red) Right –(neg) 12V Bias Supply Fault - Illuminates when negative 12 V bias supply to the right side IGBT gate drive circuit (located on PWM-drive board PCB3) is missing. PS is shut down.

6.3 Fault Isolation

Many of the most common problems are listed by symptom.

6.3.1 Fans Not Working

Problem	Possible Cause	Action
All Three fans do not run	This is normal when not cutting. Fans run only when "Contactor On" signal is received.	None
One or two fans do not run.	Broken or disconnected wire in fan motor circuit. Faulty fan(s)	Repair wire. Replace fans

6.3.2 Power Not On or LOW Voltage

Problem	Possible Cause	Action
Power source inoperable: Main Power lamp is off.	Missing 3-phase input voltage Missing 1 of 3-phase input voltage	Restore all 3 phases of input voltage to within ±10% of nominal line. Restore all 3 phases of input voltage to within ±10% of nominal line.
Low Open Circuit Voltage	Fuse F3 blown Pilot arc Contactor (K4) faulty Faulty Control PCB1	Replace F3 Replace K4 Replace Control PCB1 (P/N 38032)

6.3.3 Fault Light Illumination

Problem	Possible Cause	Action
Fault light illuminates at the end of cut but goes off at the start of the next.	Normal condition caused by terminating the arc by running the torch off the work or the arc being attached to a part that falls away.	Reprogram cutting process to ensure arc is terminated only by removing the “Contactor On” signal.
LED 3 – (amber) Bus Ripple	Imbalance of 3-phase input power Momentary loss of one phase of input power Faulty control PCB1	Maintain phase voltage imbalance of less than 5%. Restore and maintain input power within ±10% nominal Replace PCB1 P/N 38032
LED 4 – (amber) High Bus	One or more phases of input voltage exceed nominal line voltage by more than 20%. Faulty control PCB1 One or more shorted diode rectifiers (D25-D28) on the “Electrode Plate”	Restore and maintain line voltage within ±10% Replace PCB1 P/N 38032 Replace shorted diode rectifiers
LED 5 – (amber) Low Bus	One or more phases of input voltage are lower than nominal by more than 15%. Blown F1 and F2 fuses Over temp Light comes on. Imbalanced 3-phase input power Momentary loss of one phase of input power Faulty Main Contactor (K1) FAULTY Control PCB1	Restore and maintain with in ±10% of nominal See F1 and F2 in Blown Fuses Section See over temp in Fault Light Section Maintain phase voltage imbalance of less than 5% Restore and maintain within ±10% of nominal Replace K1 Replace PCB1 P/N 30832

Problem	Possible Cause	Action
LED 6 – (red) Right Over Current Note: If operation at 250A or less is possible, then the LEFT side is not working.	Output current of the right side exceeds 200A because of operating the power source over 400A.	Turn the output current down to 400A
	Cutting at over 250A with a faulty left side (left side output = 0)	See faulty left or right side
	Right current transducer connector loose or unplugged. PCB loose.	Secure connections
	Loose or unplugged connector at right PWM/Drive Printed circuit board.	Secure connection
	P2 at left of PWM/Drive PCB loose or unplugged.	Secure connection
	Check voltage between P7-6 and P7-7. A voltage in either polarity of greater than 0.01 V indicates a faulty right current transducer (TD2).	Replace right current transducer (TD2)
	Faulty PCB1	Replace PCB1 P/N 30832
	Faulty right PWM/Drive PCB	Replace right PWM/Drive PCB P/N 38030
LED 6 – (red) Left Over Current Note: If operation at 250A or less is possible, then the Right side is not working.	Output current of the left side exceeds 250A because of operating the power source over 400.	Turn the output current down to 400A
	Cutting at over 250A with a faulty right side (right side output = 0)	See faulty right side
	Left current transducer connector loose or unplugged. PCB loose.	Secure connections
	Loose or unplugged connector at left PWM/Drive Printed circuit board.	Secure connection
	P2 at right of PWM/Drive PCB loose or unplugged.	Secure connection
	Check voltage between P7-2 and P7-3. A voltage in either polarity of greater than 0.01 V indicates a faulty left current transducer (TD1).	Replace left current transducer (TD1)
	Faulty PCB1	Replace PCB1 P/N 38032
	Faulty left PWM/Drive PCB	Replace left PWM/Drive PCB P/N 38030

Problem	Possible Cause	Action
Very high Output current accompanied by either a left or right over current (LED 6)	Shorted IGBT	Replace the pair of IGBTs containing the shorted IGBT
	Current pot set too high	Lower the current setting
	Faulty left PWM/Drive PCB	Replace left PWM/Drive PCB
	High remote current signal	Decrease remote current signal
	Faulty PCB1	Replace PCB1 P/N 38032
LED 10 - (red) Left IGBT Unsaturated	Black wire connecting IGBT (Q4) collector to P3 of the left PWM/Drive PCB (PCB2) is disconnected.	Secure connector
	Shorted Freewheeling Diode(s)	Replace freewheeling diode(s)
	Loose or unplugged P1 connector at the left PWM/Drive PCB	Secure P1
	Loose or unplugged P10 connector at PCB1	Secure P10
	Faulty PCB1	Replace PCB1 P/N 38032
	Faulty left PWM/Drive PCB	Replace PCB2 P/N 38030
LED 11 - (red) Right IGBT Unsaturated	Black wire connecting IGBT (Q4) collector to P3 of the right PWM/Drive PCB (PCB3) is disconnected.	Secure connector
	Shorted Freewheeling Diode(s)	Replace freewheeling diode(s)
	Loose or unplugged P1 connector at the left PWM/Drive PCB	Secure P1
	Loose or unplugged P10 connector at PCB1	Secure P11
	Faulty PCB1	Replace PCB1 P/N 38032
	Faulty right PWM/Drive PCB	Replace PCB3 P/N 38030

Problem	Possible Cause	Action
LED 12 – (red) Left –12V Missing	Loose or unplugged P1 connector at the left PWM/Drive PCB	Secure P1 connector
	Loose or unplugged P10 connector at PCB1	Secure P10 connector
	Faulty left PWM/Drive PCB	Replace left PWM/Drive PCB P/N 38030
LED 12 – (red) Right –12V Missing	Loose or unplugged P1 connector at the right PWM/Drive PCB	Secure P1 connector
	Loose or unplugged P11 connector at PCB1	Secure P11 connector
	Faulty right PWM/Drive PCB	Replace right PWM/Drive PCB P/N 38030
Very high Output current accompanied by either a left or right over current (LED 6)	Shorted IGBT	Replace the pair of IGBTs containing the shorted IGBT
	Current pot set too high	Lower the current setting
	Faulty left PWM/Drive PCB	Replace left PWM/Drive PCB
	High remote current signal	Decrease remote current signal
	Faulty PCB1	Replace PCB1 P/N 38032
Over Temp Lamp illuminates	One or more fans inoperable	Repair or replace fan(s)
	Broken wire or unplugged connector at thermal switch.	Repair broken wires and unplugged connector
	Obstruction to air flow closer than 2 feet to rear of power source.	Allow 2 ft. minimum between the rear of the power source and any object that may restrict air flow.
	Excessive dirt restricting cooling air flow	Clean out excessive dirt, especially in the extrusions for the IGBTs and freewheeling diodes, the POS, NEG and Electrode Plates, the main transformer (T1) and the filter inductors (L1 and L2).
	Obstructed air intake	Check and clear any obstructions from the bottom, front, and top rear of the Power Source.

6.3.4 Torch Will Not Fire

Problem	Possible Cause	Action
Main Arc Transfers to the work with a short “pop”, placing only a small dimple in the work.	Panel/Remote switch in “Remote” with no remote control of the current	Place Panel/Remote switch in “Panel” position
	Remote current control present but signal missing.	Check for current reference signal at TB1-4(+) and TB1-5(-). See Signal vs. Output Current Curve this section.
	Current pot set too low.	Increase current pot setting.
	Start current pot, located behind the cover for the control PCB is set too low.	Increase the start current post setting to “7”.
Arc does not start. There is no arc at the torch. Open circuit voltage is OK at 400 –460V	Open connection between the power source positive output and the work.	Repair connection
	Fuse F6 in the Pilot arc circuit is blown.	Replace F6
	Fuse F7 in the pilot arc circuit is blown.	Replace F7
	Pilot arc High/Low switch is in the ”LOW” position when using consumables for 100A or higher (Refer to process data included in torch manuals)	Change Pilot arc to “High” position. (Refer to process data included in torch manuals)
	Pilot arc contactor (K4) faulty.	Replace K4
	Faulty PCB1	Replace PCB1 P/N 38032

6.3.5 Fuses F1 and F2 Blown

Problem	Possible Cause	Action
Fuses F1 and F2 blown.	Process controller ignites pilot arc too soon after providing the "Contactor On" signal	Process controller must allow at least 300MS to lapse between the application of the "Contactor On" signal and the ignition of the pilot arc. Fix process controller logic and replace diodes.
	Faulty negative (Electrode) output cable shorting to earth ground.	Repair cable
	Shorted freewheeling diode.	Replace shorted freewheeling diode and F1-F2
	One or more shorted diode rectifiers (D13-D18) on "POS Plate".	Replace all diode rectifiers on the "POS Plate".
	One or more shorted diode rectifiers (D7-D12) on "NEG Plate".	Replace all diode rectifiers on the "NEG Plate".

6.3.6 Intermittent, Interrupted or Partial Operation

Problem	Possible Cause	Action
Works OK at 250A or less- Over current – Faulty Left Side	Loose or unplugged connector at left PWM/Drive PCB (PCB2)	Secure connector
	Faulty left PWM/Drive PCB	Replace right PWM/Drive PCB P/N 38030
	Check voltage between P5-1 and P5-2 at the left PWM/Drive PCB (PCB2). Should be 20V AC. Between P5-1 and P5-3 should be 40V AC. If not the control transformer (T5) is faulty.	Replace control transformer T5

Problem	Possible Cause	Action
Works OK at 250A or less- Over current – Faulty Right Side	Loose or unplugged connector at Right PWM/Drive PCB (PCB3)	Secure connector
	Faulty Right PWM/Drive PCB	Replace right PWM/Drive PCB P/N 38030
	Check voltage between P5-1 and P5-2 at the right PWM/Drive PCB (PCB3). Should be 20V AC. Between P5-1 and P5-3 should be 40V AC. If not the control transformer (T7) is faulty.	Replace control transformer T7
Power Supply turns off prematurely in the middle of the cut.	"Contactor On" signal is removed from unit.	Power source is OK. Trouble shoot process controller.
	Momentary loss of primary input power.	Restore and maintain input voltage within ±10% of nominal.
	Faulty condition, indicated by illumination of the fault lamp.	Remove control PCB (PCB1) access panel to determine the fault causing the shutdown. Refer to fault light illumination section.
	Faulty condition, indicated by the illumination of the power reset fault lamp.	Remove control PCB (PCB1) access panel to determine the fault causing the shutdown. Refer to fault light illumination section.
	Current setting too low.	Increase current setting
	Remote current signal removed during cut.	Fix remote current signal

Problem	Possible Cause	Action
Output current is unstable and drifts above or below the setting.	Place the PANEL/REMOTE switch in the “PANEL” position. Adjust current control pot. If current no longer drifts, the remote current control signal is faulty.	Fix the remote current control signal to operate the PANEL/REMOTE switch in the “PANEL” position.
	Select “PANEL” on the PANEL/REMOTE switch and adjust the current control pot. The current still drifts, measure the current reference signal at TB1-4 (+) and TB1-5 (-). If the signal drifts, the current control pot is faulty. If the signal does not drift, the Control PCB (PCB1) is faulty.	Replace the current control pot. Replace the control PCB (PCB1) P/N 38032

6.4 Testing and Replacing Components

NOTICE

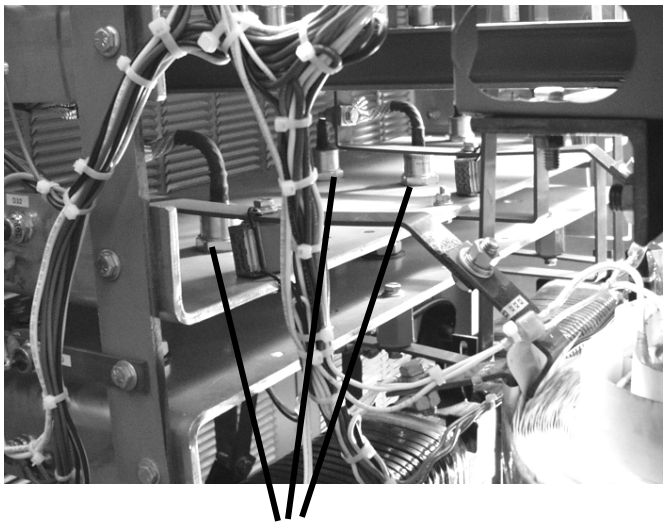
- Replace a PC board only until a problem was isolated to that board.
- Always disconnect power before removing or installing a PC board.
- Do not grasp or pull on board components.
- Always place a removed board on a static free surface.
- If a PC board is found to be a problem, check with your ESAB distributor for a replacement. Provide the distributor with the part number of the board as well as the serial number of the power source.
- Do not attempt to repair the board yourself. Warranty will be voided if repaired by the customer or an unauthorized repair shop.

Power Semiconductor Components

Three categories of power semiconductors include;

- Power Rectifiers
- Freewheeling Diodes
- IGBTs

6.4.1 Power Rectifiers

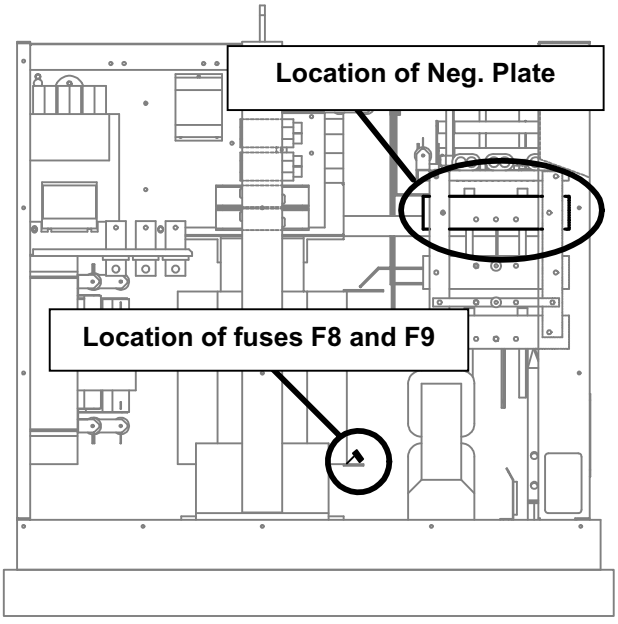


Power Rectifiers located behind the front panel.

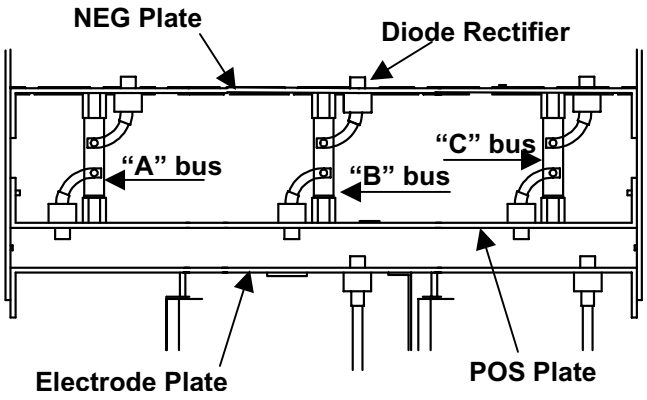
Power Rectifiers – Procedure to access behind the front panel

1. Remove top cover and side panels
2. Locate and disconnect plug in rear of ammeter (white plug with one red and one black wire)
3. Remove pilot arc switch
4. Disconnect voltmeter
5. Disconnect orange and yellow wires from relay K4.
6. Remove two bolts holding the left side of the front panel to the base.
7. Remove three bolts holding across the center base of the front panel. These are accessed from underneath.
8. Remove one of the bolts holding the right side of the front panel to the base. Loosen the second bolt. Of these two bolts, remove the bolt on the left and loosen the bolt on the right.
9. Swing the front panel out to gain access to power rectifier components.

Troubleshooting Procedures –Negative Plate



1. Visually inspect fuses F8 and F9. Replace if they show signs of being blown or melted. Inspect diodes. If ruptured or burned, replace all diodes on the NEG Plate. If diodes appear to be OK, proceed to next step.



1. Check ohms between NEG Plate and BR "A" Bus. A reading of 2 ohms or less indicates one or more shorted diodes. Replace all Diodes on NEG Plate.

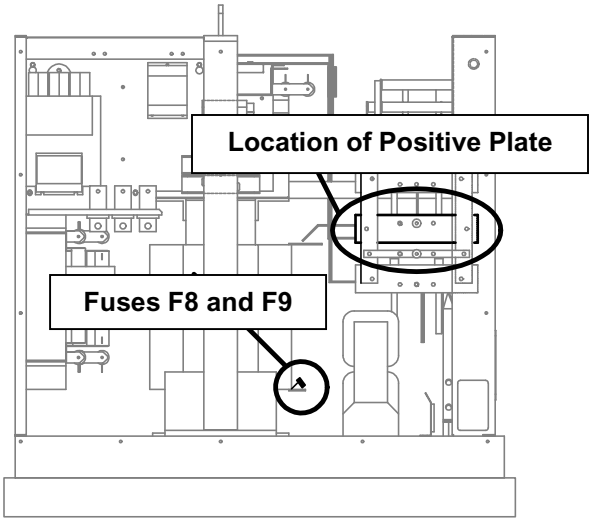
2. If fuses F8 and/or F9 were open in the first step, make two more ohmmeter readings.

A. Measure resistance between the NEG Plate and BR "B" bus.

B. Measure between NEG Plate and BR "C" bus.

If resistance is 2 ohms or less in either case, replace all the diodes on the NEG Plate.

Troubleshooting POS Plate



1. Check ohms between POS Plate and BR "A" Bus. A reading of 2 ohms or less indicates one or more shorted diodes. Replace all Diodes on POS Plate.

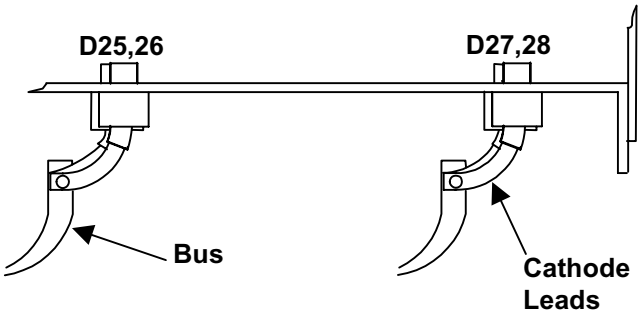
2. If fuses F8 and/or F9 were open in the first step, make two more ohmmeter readings.

A. Measure resistance between the POS Plate and BR "B" bus.

B. Measure between POS Plate and BR "C" bus.

If resistance is 2 ohms or less in either case, replace all the diodes on the POS Plate.

Troubleshooting Electrode Plate



1. Visually inspect for ruptured or burned diodes. Replace only those damaged.
2. Check resistance between Electrode Plate and the parallel pig tails (cathode leads) of D25 and D26. If reading is 2 ohms or less, disconnect leads from bus and check each diode. Replace only shorted diodes.

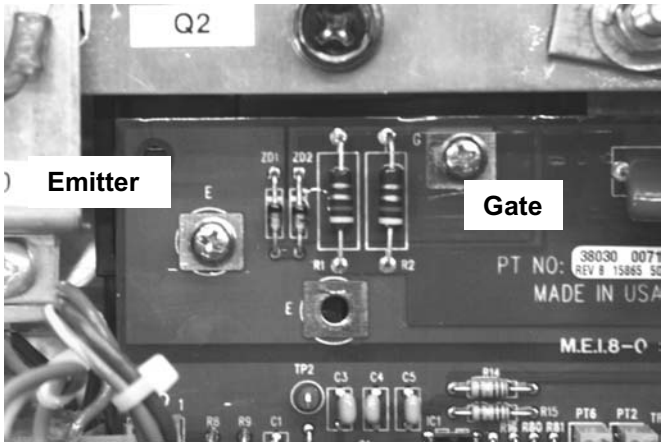
Repeat procedure for D27 and D28. Replace only shorted diodes.

6.4.2 Troubleshooting Freewheeling Diode and IGBTs

Freewheeling Diodes and IGBTs

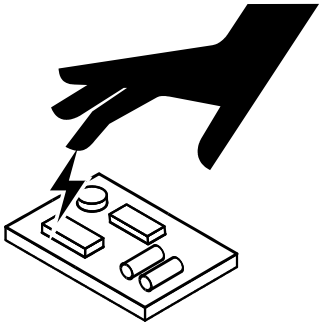
1. Remove top cover.
2. Remove “incoming” bus bars.
3. Remove PCB2 and PCB3 from IGBTs. (PC boards are held in place by four screws each.)

CAUTION



After PCB2 and/or PCB3 have been removed, protect against electrostatic damage. The emitter and the gate of each affected IGBT must be jumpered together to prevent electrostatic damage.

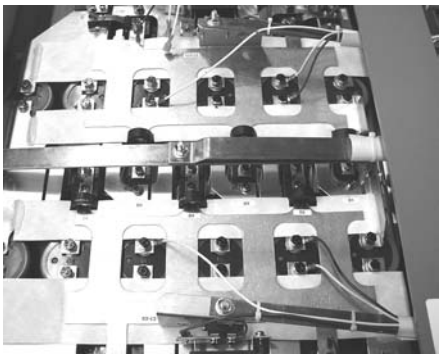
CAUTION



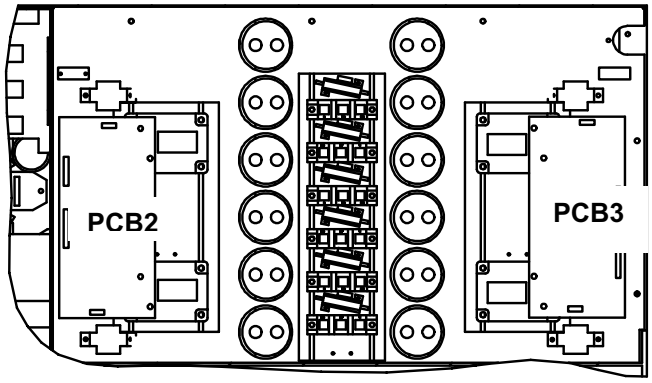
Electrostatic Discharge Hazard

Electrostatic discharge may damage these components.

- **Damage is accumulative and may only appear as shortened component life and not as a catastrophic failure.**
- **Wear a protective ground strap when handling to prevent damage to PCB components.**
- **Always place a pc board in a static-free bag when not installed.**



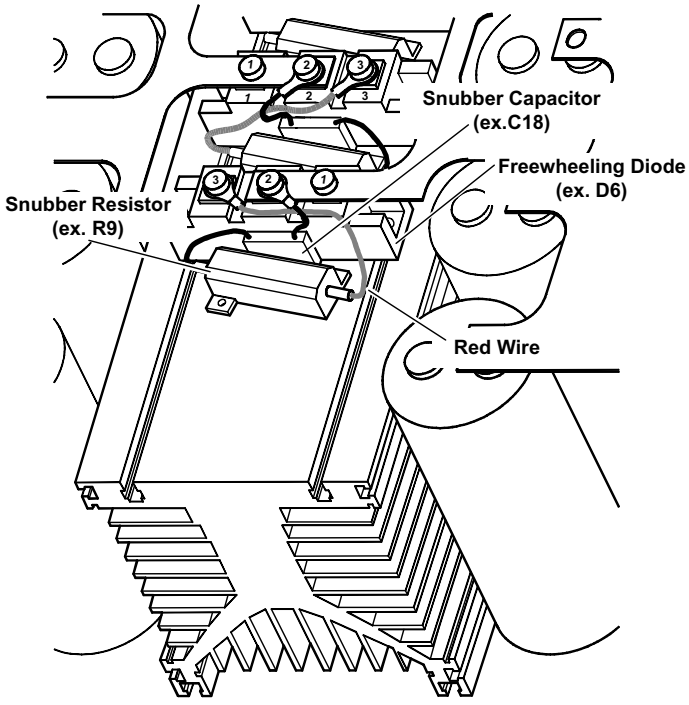
4. Remove bus bars between capacitor banks, IGBTs and freewheeling diodes.



View of freewheeling diodes and capacitor banks with bus bars removed. (PCB2 and PCB3 are shown still in place)

CAUTION

Failure To Route Leads Properly Can Lead To Failure Of Freewheeling Diodes.



Dressing Of Freewheeling Diode Snubber Leads.

Red wire of snubber resistor must be routed under capacitor self lead. Red wire terminal must have a minimum 1/8" clearance from the bus bar on diode terminal #2.

Note: Bus bar connecting terminal no. 3 is not shown for terminal clarity.

The red snubber leads are numbered as viewed from the rear of the power source:

D1 - Left	D4 - Right
D2 - Right	D5 - Left
D3 - Left	D6 - Right

Cover snubber capacitor self leads with sleeving P/N 95193486

NOTICE

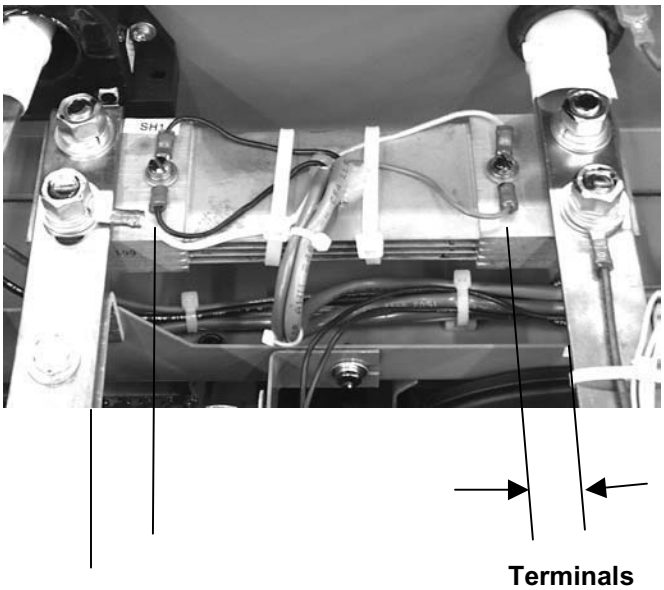
Some power sources may contain snubber resistors and capacitors in a molded module similar in size and mounting to the free wheeling diode modules. These snubber modules utilize two conductive straps. One strap attaches to the free wheeling diode terminal #1 and the other to terminal #3. Strap to #3 is sandwitched between the free wheeling diode and the stamped copper bus. The strap to #1 is mounted on top of the copper bus under the mounting hardware and in direct contact with the copper bus.

6.4.3 Power Shunt Installation

CAUTION

Instability Or Oscillation In Cutting Current Can Be Caused By Improper Dressing Of Shunt Pick-Up Leads.

Poor torch consumable life will be the result.

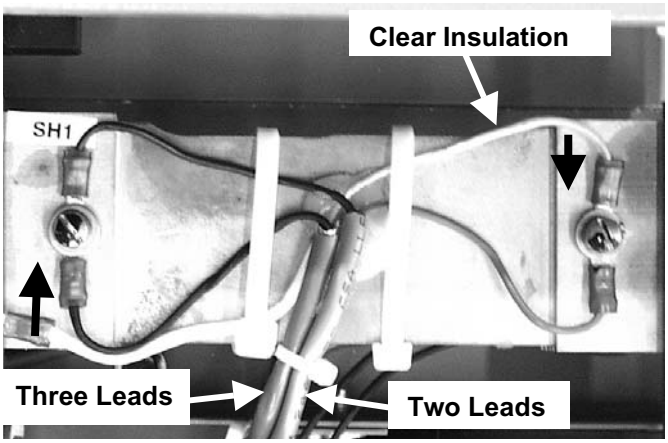


There are two cables that attach to the shunt pick-up points:
a two conductor cable drives the ammeter
a three conductor which provides the current feedback signal to PCB1 (control PCB).

Dressing of the 2 conductor cable is not critical.

The following is the dressing procedure for the 3 conductor cable.

- The breakout point should be physically at the middle of the shunt. The breakout point is the place where the conductors exit from the outer insulation jacket.
- The black and clear insulated wires must be kept next to the shunt and under the cable ties.
- The wire terminals for the black and clear insulated wires should be oriented in parallel with bus bars as shown.



- It is important to have the barrels of the black and clear insulated wires, from the three lead cable, be pointing in opposite directions.

- The third wire attaches to the bus bar on the left with the shunt mounting hardware. Orientation of this wire is not critical.

6.4.4 Procedure For Verifying Calibration Of Digital Meters.

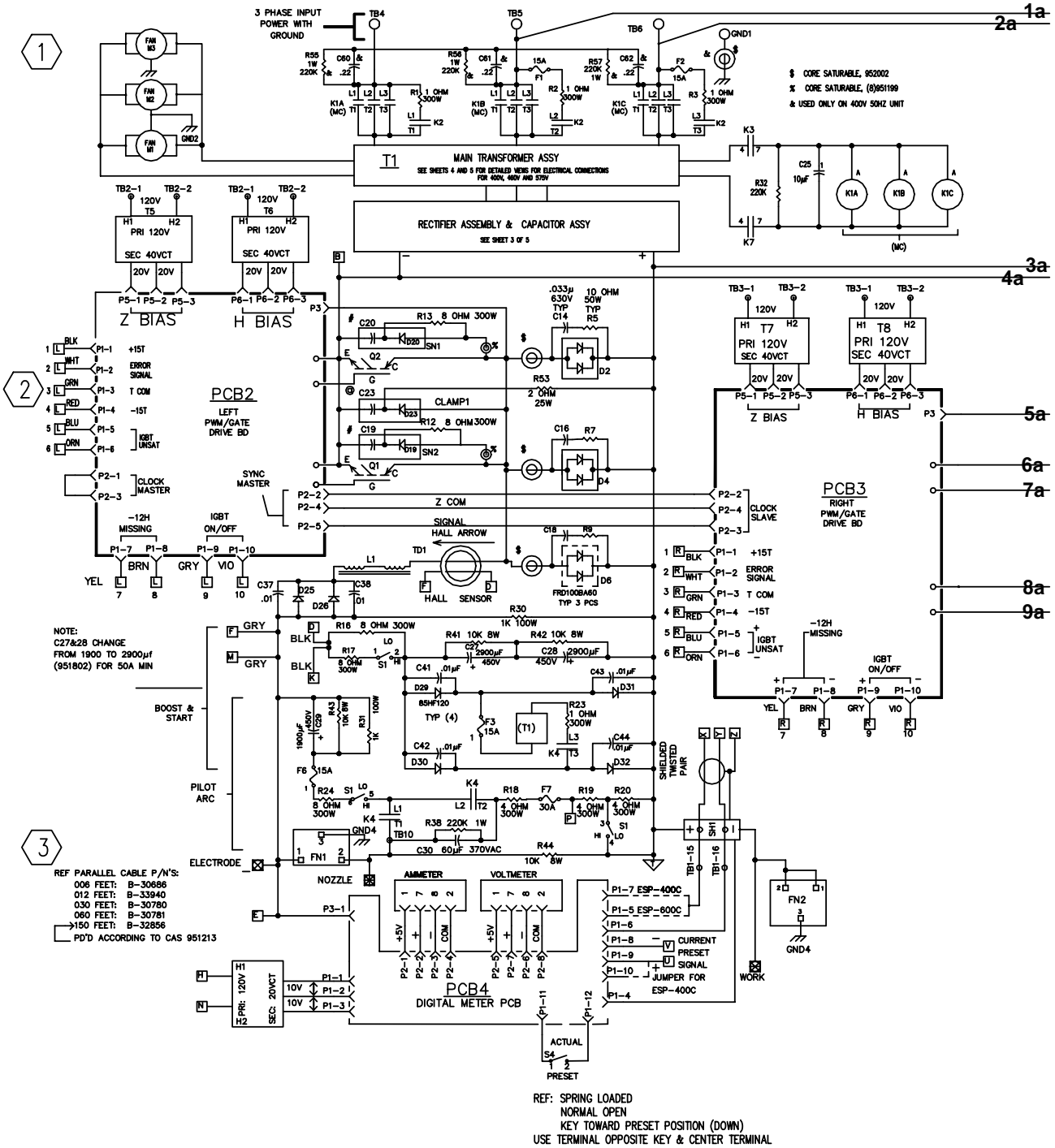
Voltmeter

1. Connect a digital meter known to be calibrated to the positive and negative output bus bars.
2. Compare the power source voltmeter reading to the calibrated meter reading. Readings should match within ± 0.75%

Ammeter

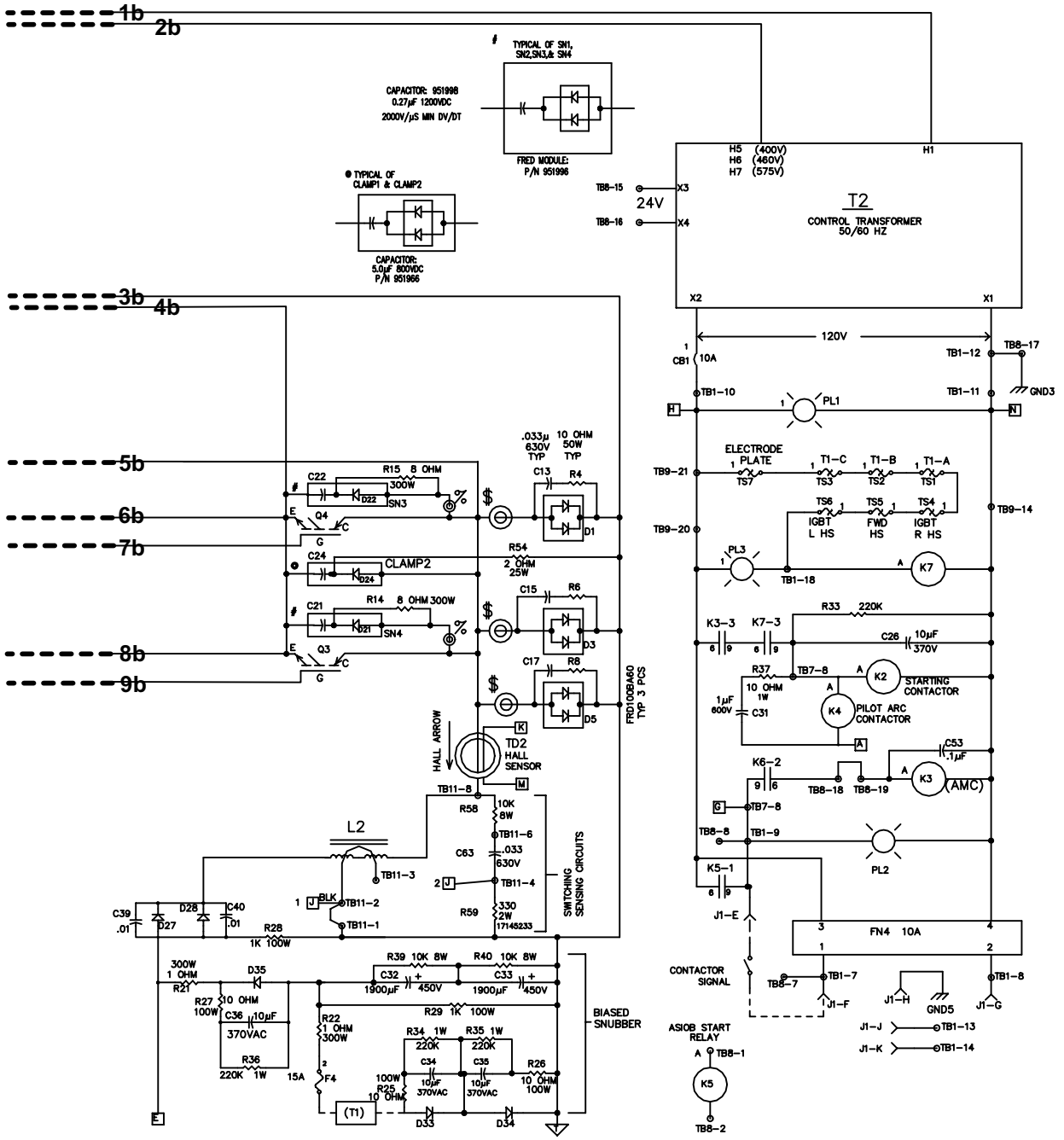
1. External to the power source, connect a precision shunt in series with the work lead(s). The best shunt is one with a value of 100 μΩ (50mV/500A or 100mV/1000A) and a calibrated tolerance of ± 0.25%.
2. Use a calibrated 4 ½ digit meter to measure the output of the shunt. The amperage indicated with the external shunt and meter should match power source ammeter to within ± 0.75%.

6.5 ESP-400C Schematic Diagrams - Drawing 1 - Part1



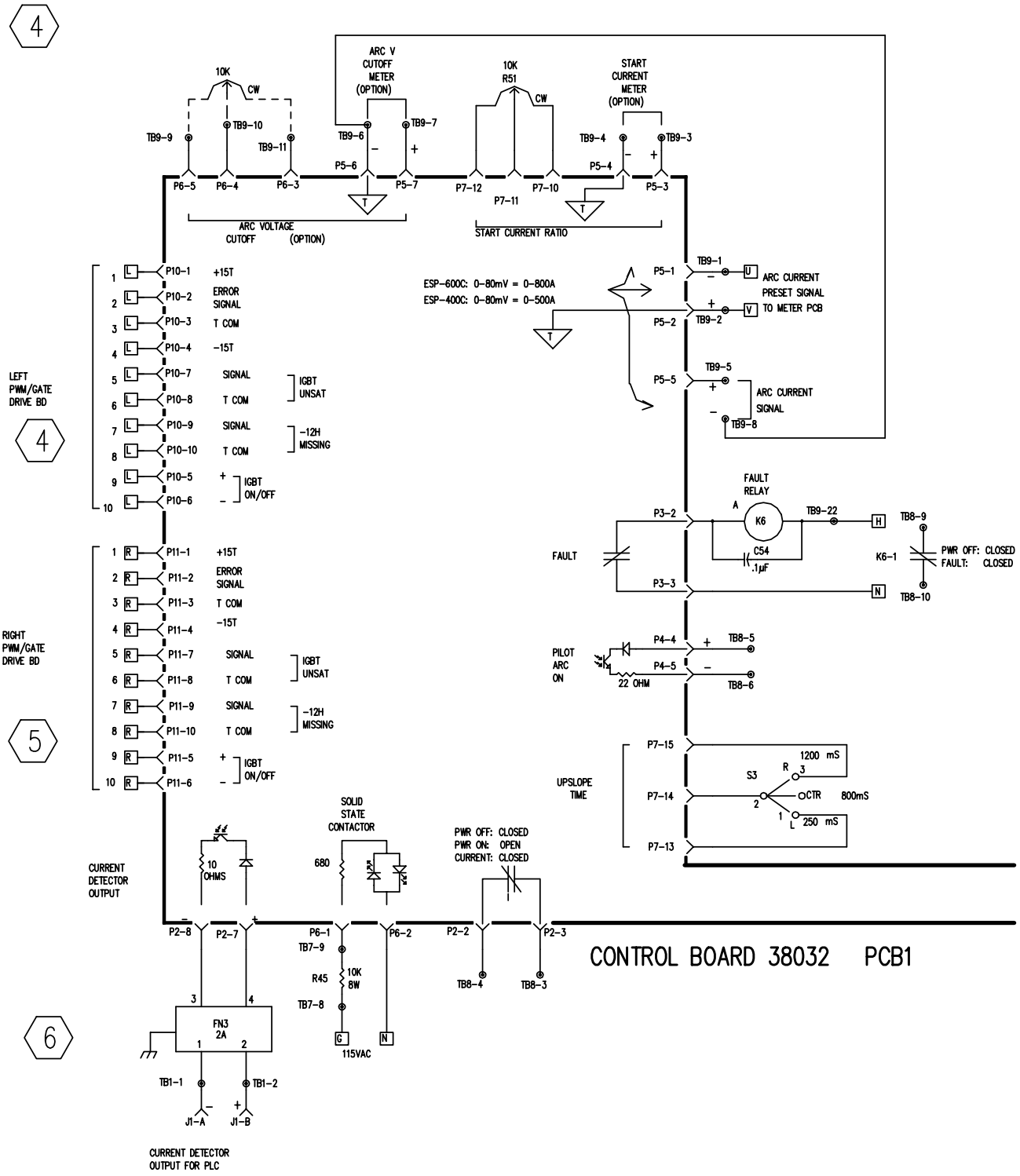
LOC	SYM	Descrip	LOC	SYM	Descrip	LOC	SYM	Descrip
1	M1,2	Motor ,fan 1/3 hp	1	C14-16	Capacitor .033uf 630v	2	C24	Capacitor 5uf 600vdc
1	M3	Motor, fan 230v 50/60hz	1	D19,20,23	Module diode rectifier 630v	2	C13,15,17	Capacitor .033uf 630v
1	T1	Transformer main	1	R12,13	Resistor 8ohm 300w	2	K2	Contactor 3 pole 90A
1	T2	Transformer control	1	D2,4	Module diode Red	2	K4	Contactor 3 pole 40A
1	T5-8	Transformer 117/12/12/24ct	1	R5,7	Resistor 10ohm 50w	2	PL1	Lamp neon wht
1	K1A,B,C	Contactor 3pole 90A	1	R53,54	Resistor 2ohm 25w	2	PL2	Lamp neon wht
1	PCB2	PC board circuit IGBT Driver	2	TD1,2	Transducer Current	2	PL3	Lamp indicator Amber
1	Q1-2	Module IGBT 600A 600V	2	PCB3	PC board IGBT driver	2	TS4,5,6	Switch thermal 176 deg.F
1	C19,20	Capacitor 27uf 1200vdc	2	Q3,4	Module IGBT 600A 600v	2	TS7	Switch thermal 194 deg.F
1	C23	Capacitor 5uf 800vdc	2	C21,22	Capacitor 27uf 1200vdc	2	TS1,2,3	Switch thermal 176 deg.F

Schematic Diagram - Drawing 1 – Part2



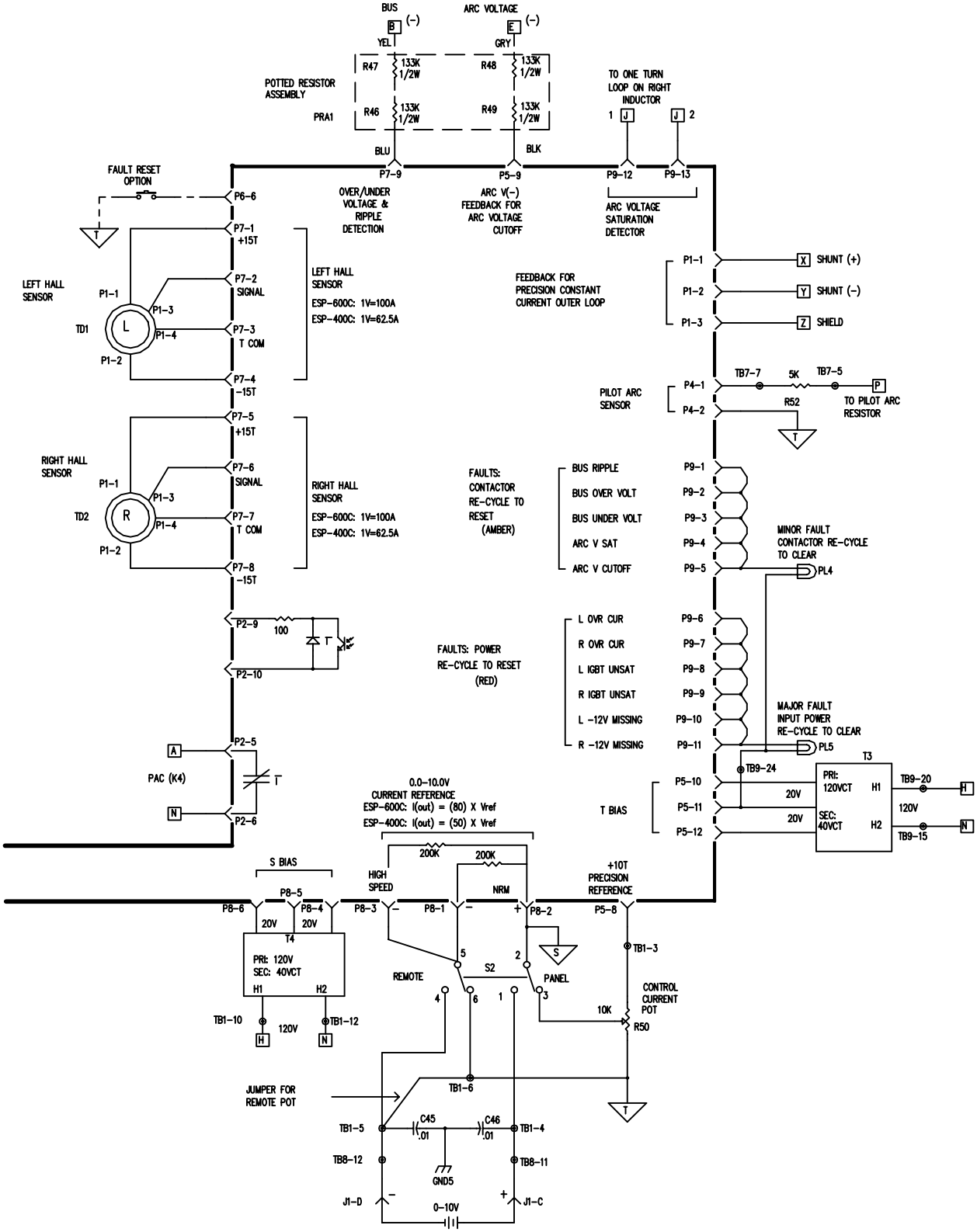
2	C18	Capacitor .033uf 630v	2	C41-43,44	Capacitor .01uf 125vdc	3	R44	Resistor 10k 8w
2	R4,6,8,9	Resistor 10ohm 50w	2	D29,30	Rectifier silicone reverse 85A	3	C30	Capacitor 60uf 370v
2	D1,3,5,6	Module diode dual 100A 600V	2	D31,32	Rectifier silicone forward 85A	3	C39,40	Capacitor .01uf 125vdc
2	D21,22,24	Module dual diode rectifier 630V	2	F3	Fuse slo-blo 15A 600v	3	D27,28	Diode rect reverse 800v 300A
2	R14,15	Resistor 8ohm 300w	2	F6	Fuse n-t delay 15A	3	D33,35	Rectifier silicone reverse 85A
2	L1,2	Inductor Assy	2	R23	Resistor 1 ohm 300w	3	D34	Rectifier silicone forward 85A
2	D25,26	Resistor 10ohm 300w	2	R24	Resistor 8 ohm 300w	3	R25,26	Resistor 10 ohm
2	C37,38	Capacitor .01uf 125vdc	2	FN1,FN2	Filter PC board	3	R39,40	Resistor 10k 8w
2	R30	Resistor 1k 100w	3	PCB4	PC board digital meter	3	R34,35,36	Resistor 220k 1w
2	R16,17	Resistor 8ohm 300w	3	SH1	Shunt 100mV 800A	3	R29	Resistor 1k 100w
2	S1	Switch toggle 3pst 2 pos	3	R31	Resistor 1k 100w	3	R21,22	Resistor 10ohm 300w
2	R41-43	Resistor 10k 8w	3	R18,19,20	Resistor 4 ohm 300w	3	R27	Resistor 10ohm 300w
2	C27,28,29	Capacitor 2900uf 450w	3	R38	Resistor 220k 1w			

Schematic Diagram - Drawing 2 – Part1



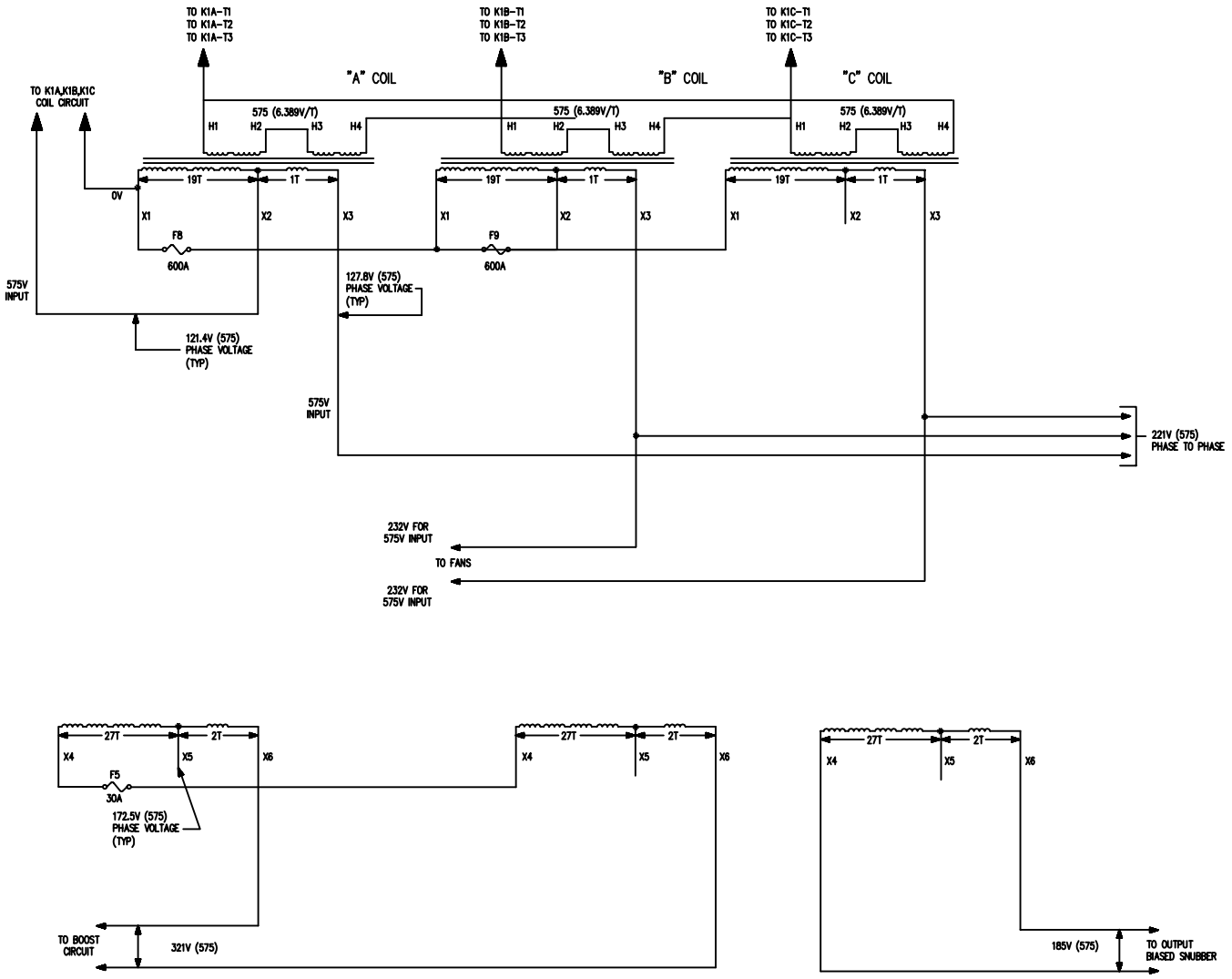
LOC	SYM	Descrip	LOC	SYM	Descrip	LOC	SYM	Descrip
	C32,33	Capacitor 1900uf 450v	4	C25	Capacitor 10uf 370v	4	K6	Relay 3pdt
	C34,35,36	Capacitor 10uf 370vac	4	R32	Resistor 220k	4	TD1	Transducer Current
	R1,2,3	Resistor 1 ohm 300w	4	FN4	Filter RFI	4	TD2	Transducer Current
	F1,2	Fuse 15A	4	R37	Resistor 10ohm 1w	4	R46-48	Resistor 133k 1/2w
	TB4,5,6	Terminal Assy	4	C31	Capacitor 1uf 600v	4	R52	Resistor 4.7k ohms 2w 10%
4	K3,5-7	Relay 3pdt brkt mt	4	R51	Pot 10k 2w	4	PL4,5	Lamp LED red 12v

Schematic Diagram - Drawing 2 – Part2



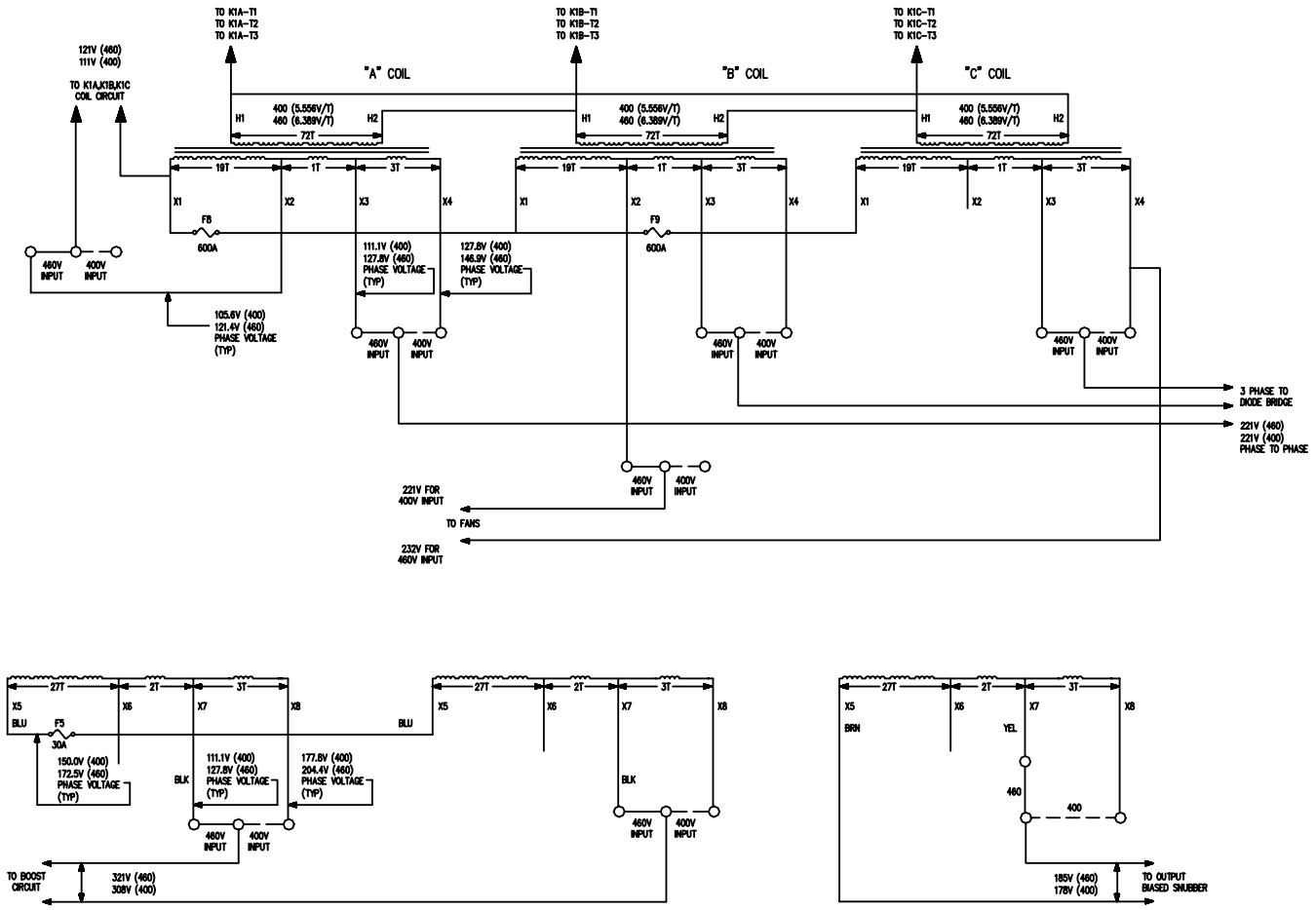
LOC	SYM	DESCRIPTION	LOC	SYM	DESCRIPTION	LOC	SYM	DESCRIPTION
4	T3,4	XMFR 117/12/12/24ct	5	C45,46	Capacitor .01uf 125vdc	5	S3	Switch toggle DPDT 3 pos
5	R50	Pot 15k 2w	5	R45	Resistor 10k 8w 5%			
5	S2	Switch toggle DPDT 2 pos	5	FN3	Filter EMI			

Schematic Diagram - Drawing 3



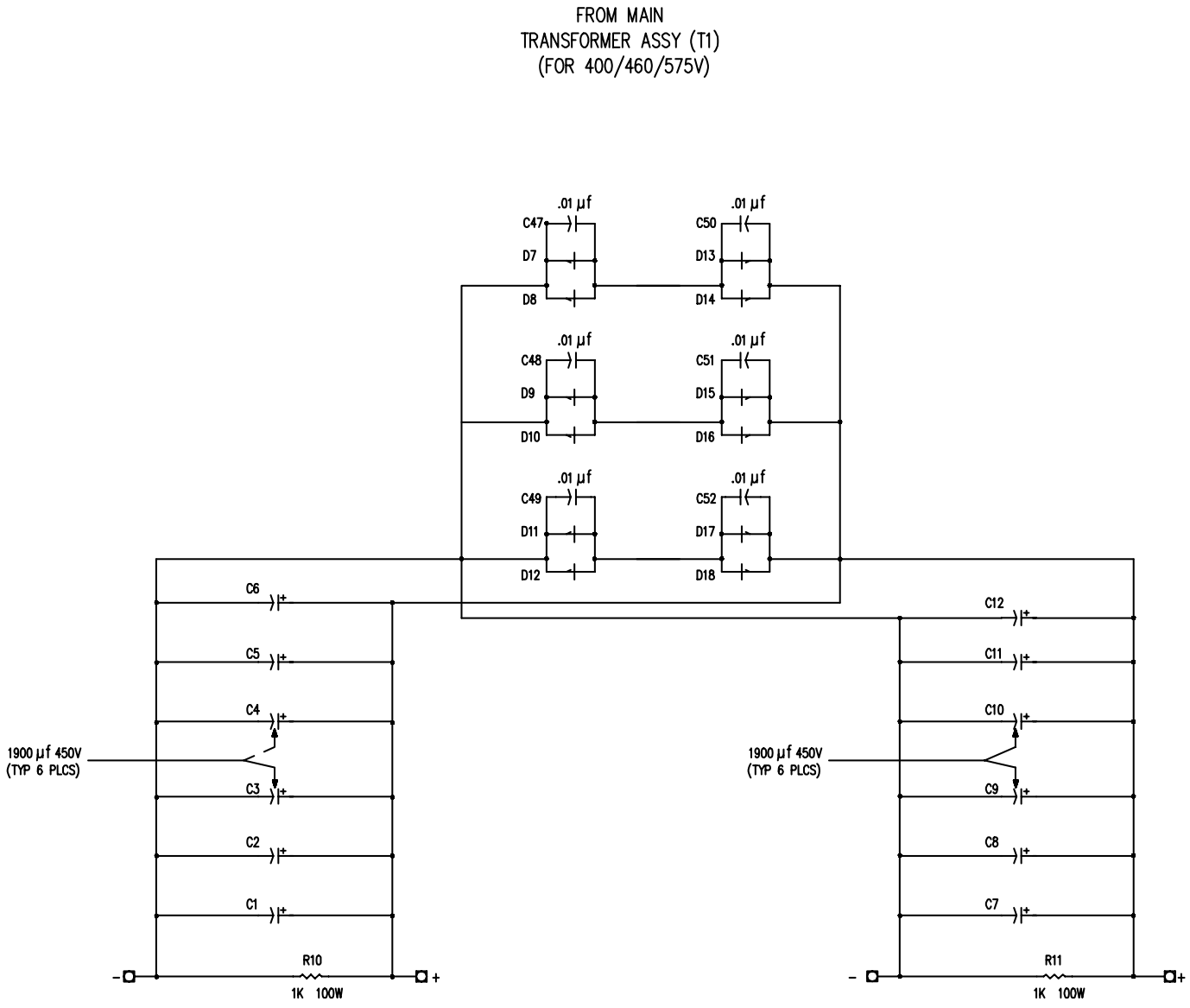
MAIN TRANSFORMER ASSY (T1)
ESP-600C/400C (575V)

Schematic Diagram - Drawing 4

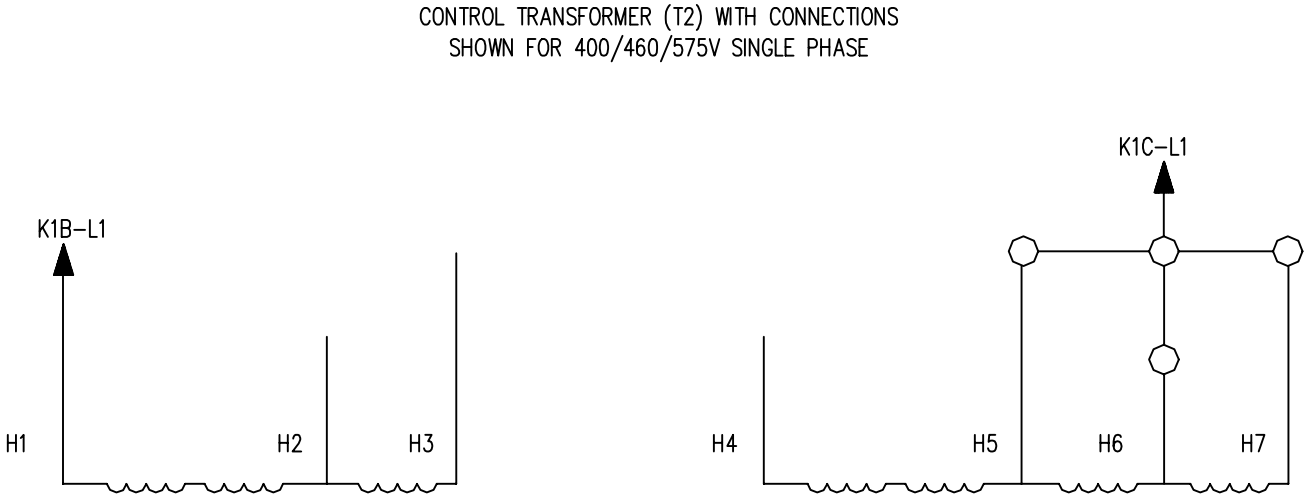


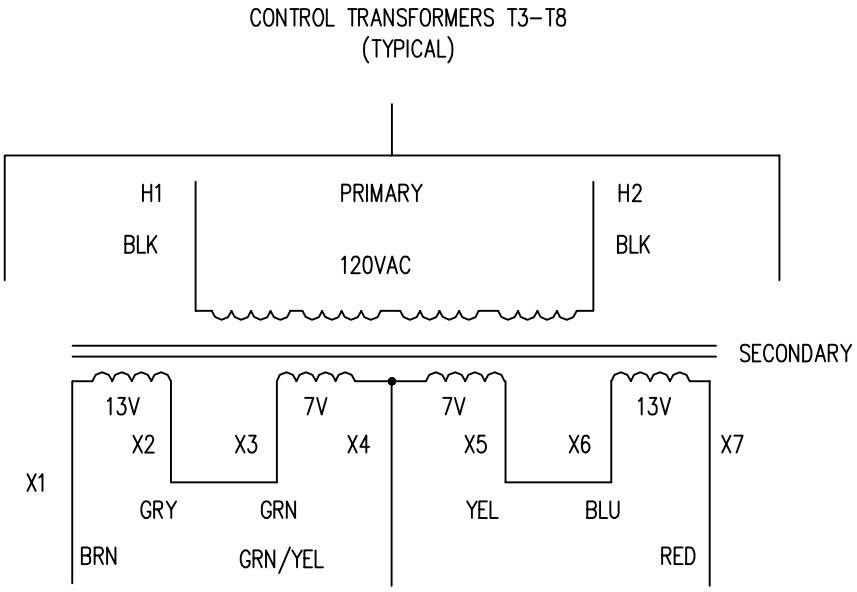
MAIN TRANSFORMER ASSY (T1)
ESP-600C/400C (400/460V)

Schematic Diagram - Drawing 5 – Part1

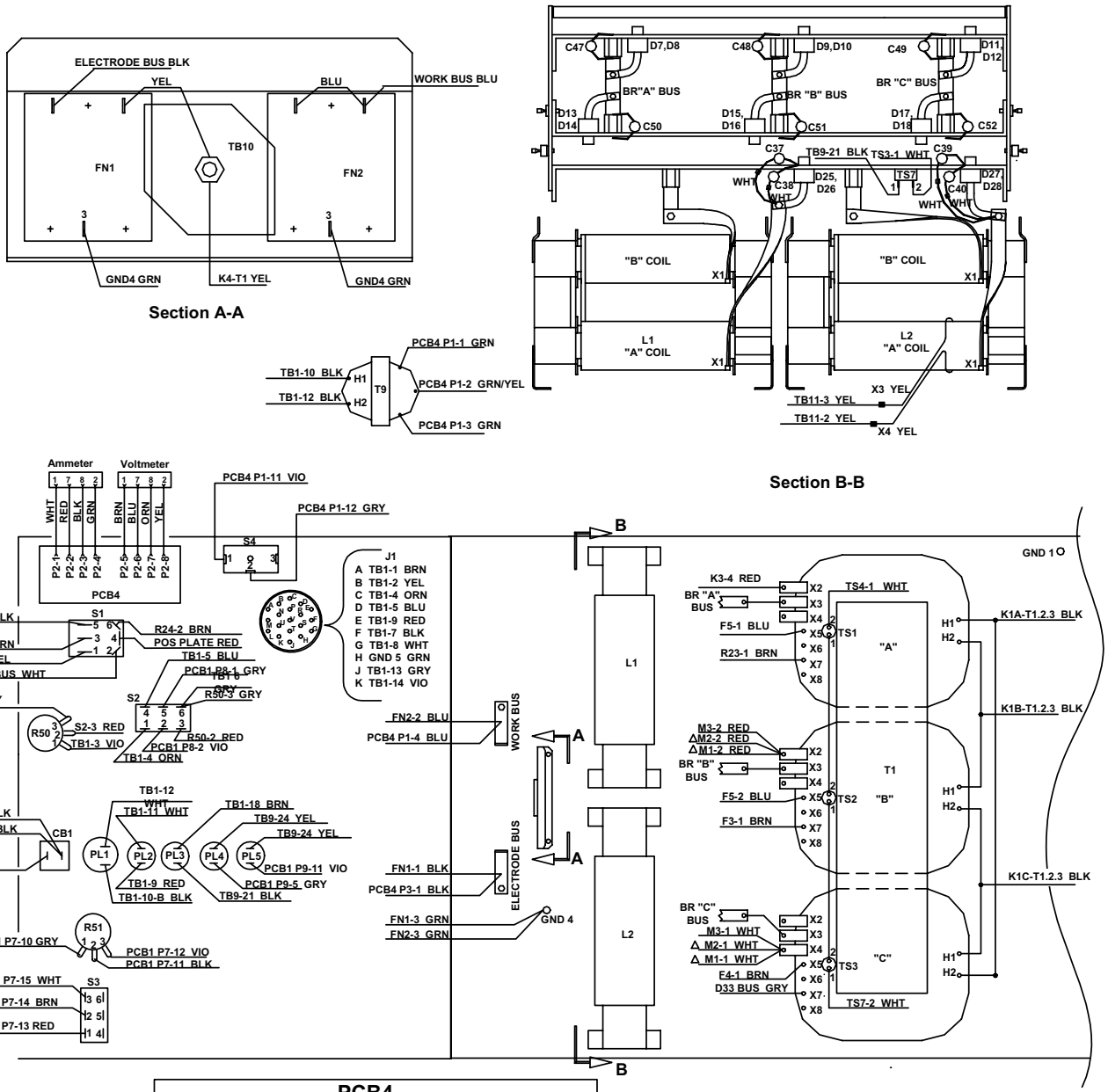


Schematic Diagram - Drawing 5 – Part2





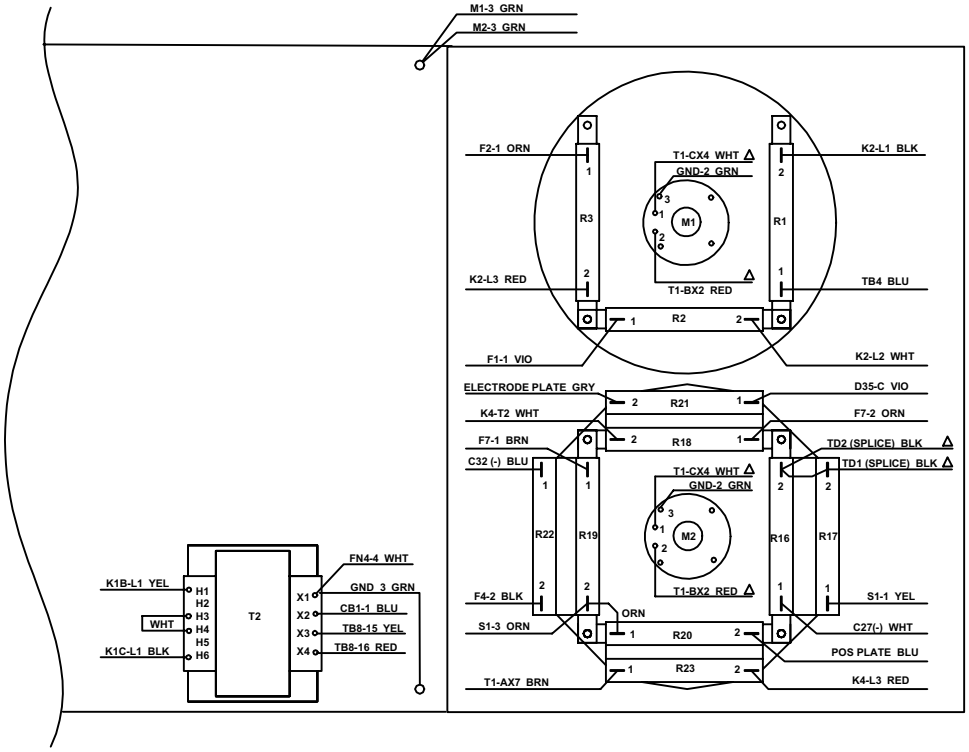
6.6 Wiring Diagrams – 460V 60H$_z$ Drawing 1 – Part1 (P/N 35878)



PCB4	
P1	**P3**
1 T9-GRN	1 ELECTRODE BUS-BLK
2 T9-GRN/YEL	
3 T9-GRN	
4 WORK BUS-BLU	
5 TB1-15 RED	
6 TB1-16 BLK	
7 SH1 +	
8 TB9-2 WHT	
9 TB9-1 ORN	
PCB4 P1-10 BLK (ESP-400C)	
10 PCB4 P1-9 BLK (ESP-400C)	
11 S4-1 VIO	
12 S4-2 GRY	

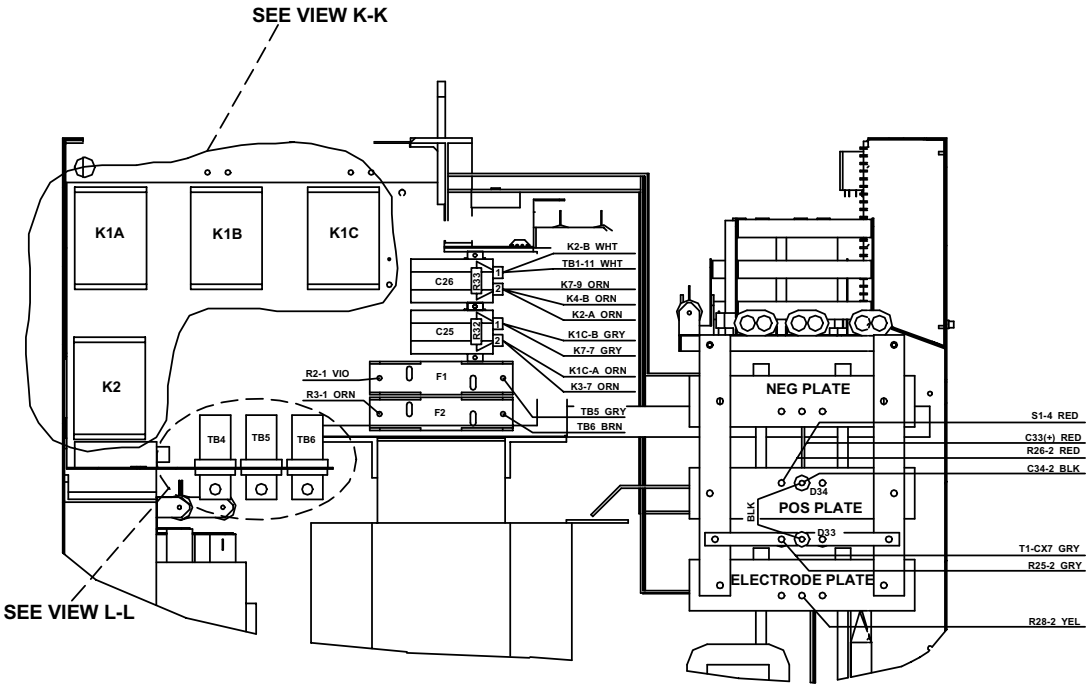
Note: From ESP-400C/600C//460V Drawing No. 35719, sheet 1 of 5 Rev E

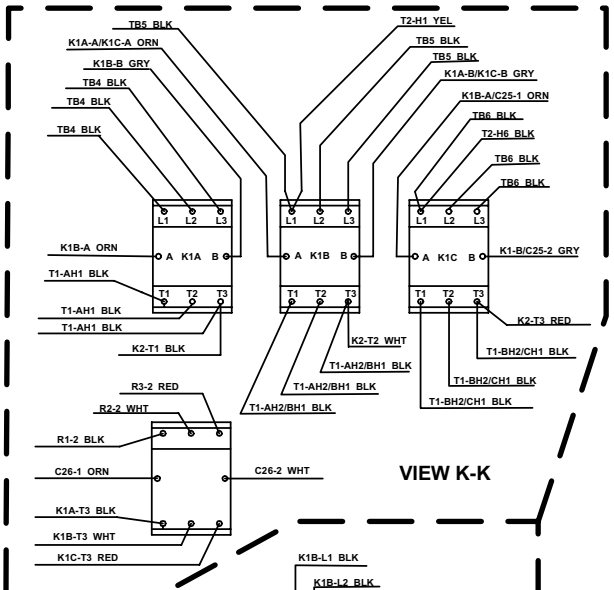
6.6 Wiring Diagrams – 460V 60H$_z$ Drawing 1 – Part2 (P/N 35878)

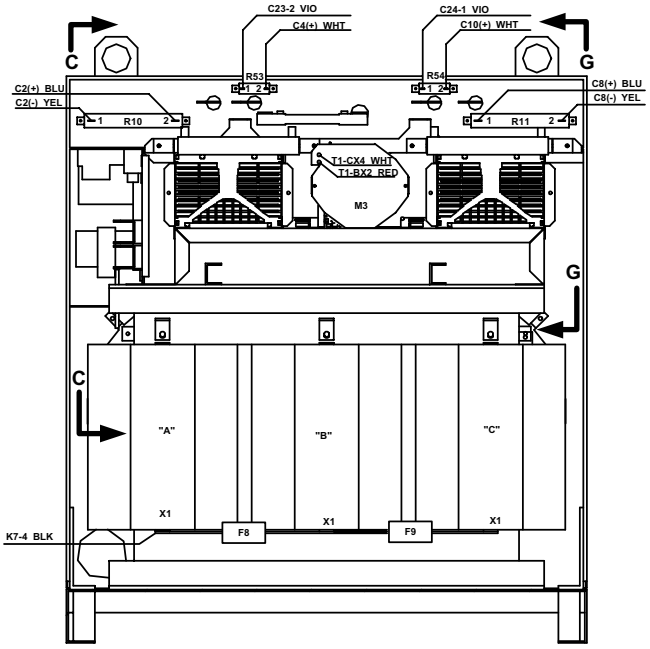


Note: From ESP-400C/600C//460V Drawing No. 35719, sheet 1 of 5 Rev E

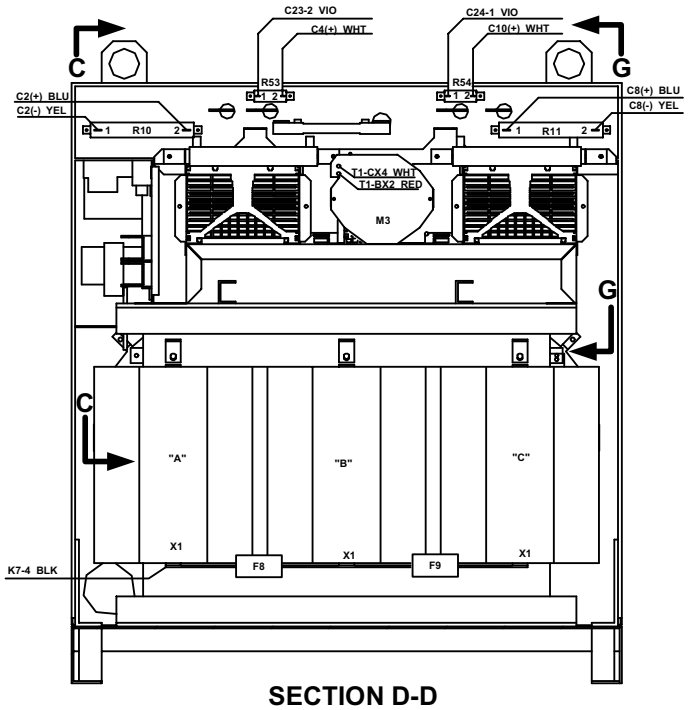
6.6 Wiring Diagrams – 460V 60H$_z$ Drawing 2 – Part 1 (P/N 35878)



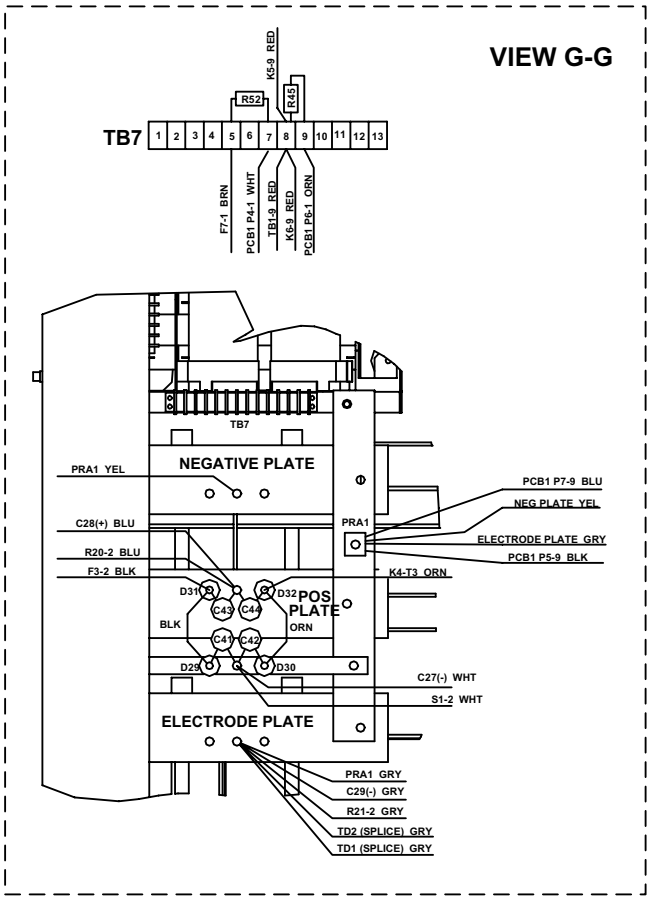




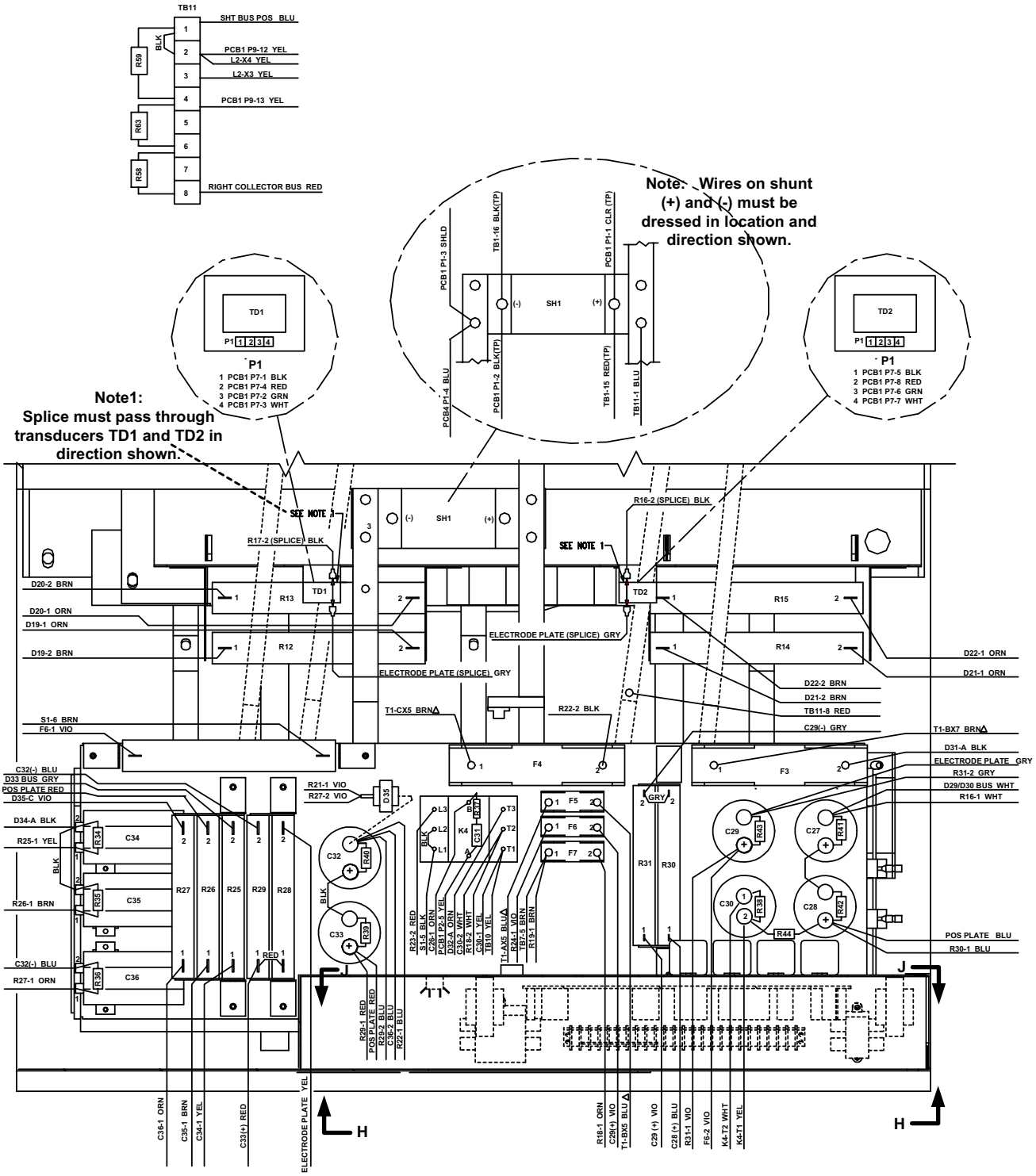
6.6 Wiring Diagrams – 460V 60H$_z$ Drawing 2 – Part 2 (P/N 35878)



SECTION D-D



6.6 Wiring Diagrams – 460V 60H$_z$ Drawing 3 (P/N 35878)



VIEW E-E

Note: From ESP-400C/600C//460V 35719, sheet 3 of 5 Rev E

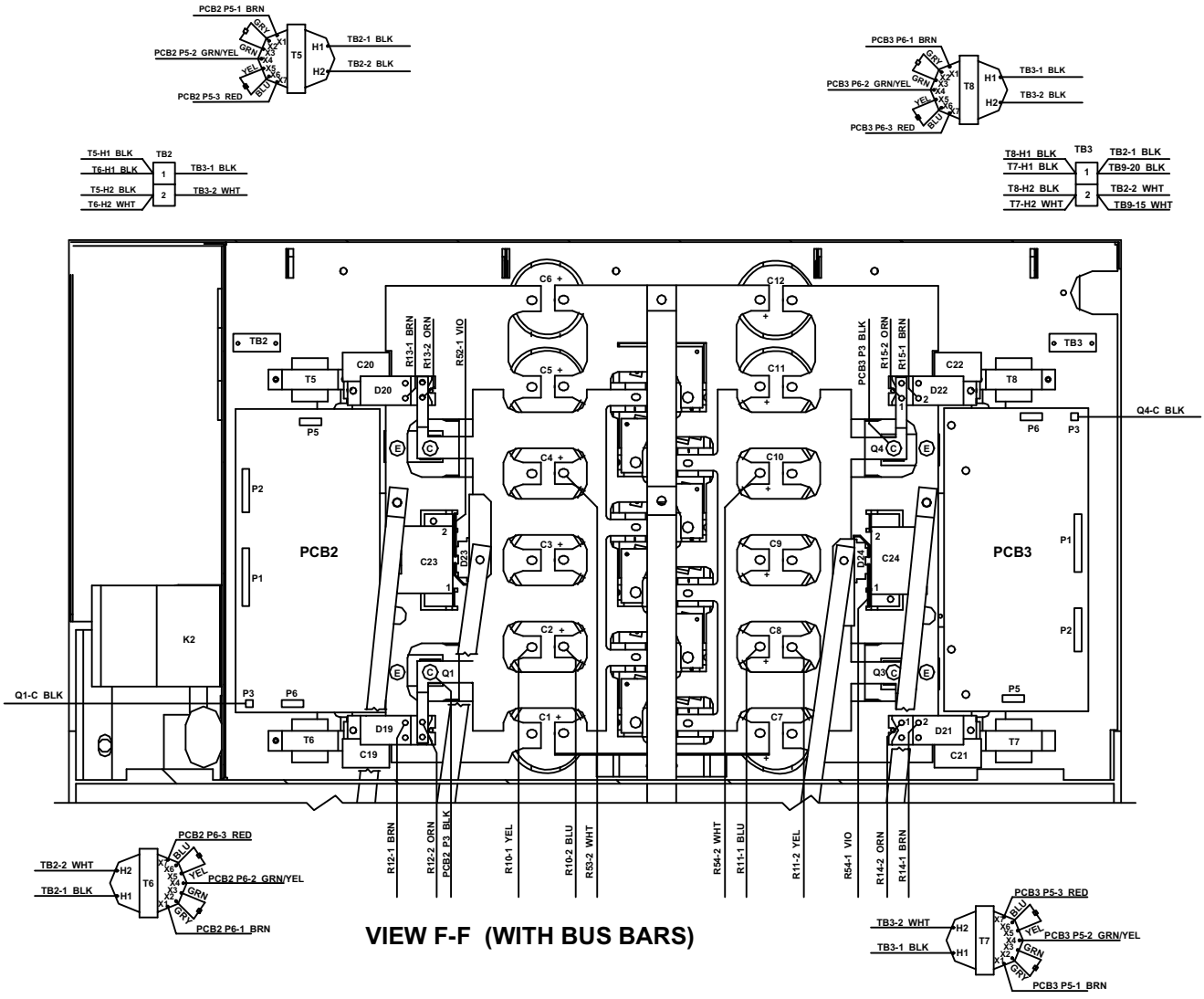
6.6 Wiring Diagrams – 460V 60H$_z$ Drawing 4 (P/N 35878)

PCB2

P1	P2
1 PCB1 P10-1 BLK	1 PCB2 P2-3 YEL
2 PCB1 P10-2 WHT	2 PCB3 P2-2 CLR(TP)
3 PCB1 P10-3 GRN	3 PCB2 P2-1 YEL
4 PCB1 P10-4 RED	4 PCB3 P2-4 SHLD
5 PCB1 P10-7 BLU	5 PCB3 P2-3 BLK(TP)
6 PCB1 P10-8 ORN	6
7 PCB1 P10-9 YEL	**P5**
8 PCB1 P10-10 BRN	1 T5-X1 BRN
9 PCB1 P10-5 GRY	2 T5-X4 GRN/YEL
10 PCB1 P10-6 VIO	3 T5-X7 RED
	P6
	1 T6-X1 BRN
	2 T6-X4 GRN/YEL
	3 T6-X7 RED

PCB3

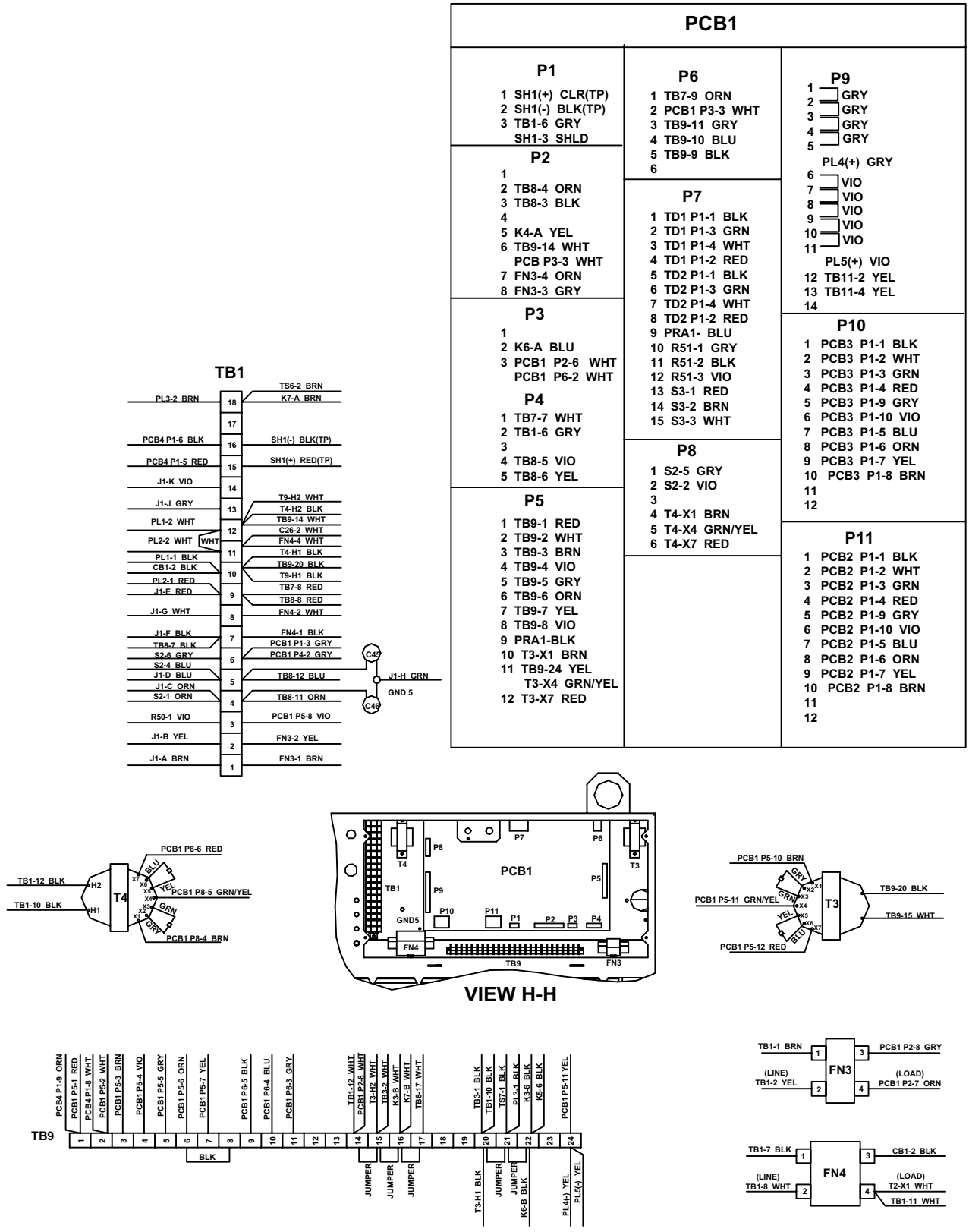
P1	P2
1 PCB1 P11-1 BLK	1
2 PCB1 P11-2 WHT	2 PCB2 P2-2 CLR(TP)
3 PCB1 P11-3 GRN	3 PCB2 P2-5 BLK(TP)
4 PCB1 P11-4 RED	4 PCB2 P2-4 SHLD(TP)
5 PCB1 P11-7 BLU	5
6 PCB1 P11-8 ORN	6
7 PCB1 P11-9 YEL	**P5**
8 PCB1 P11-10 BRN	1 T7-X1 BRN
9 PCB1 P11-5 GRY	2 T7-X4 GRN/YEL
10 PCB1 P11-6 VIO	3 T7-X7 RED
	P6
	1 T8-X1 BRN
	2 T8-X4 GRN/YEL
	3 T8-X7 RED



VIEW F-F (WITH BUS BARS)

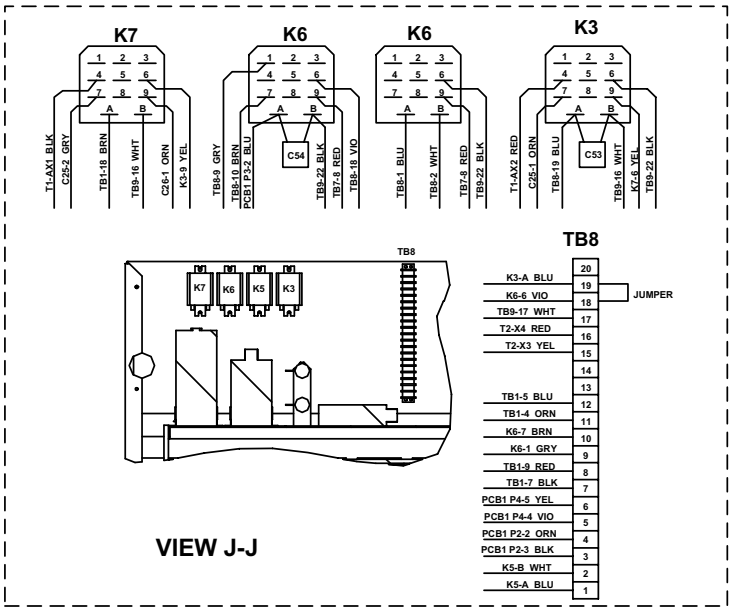
Note: From ESP-400C/600C//460V
35719, sheet 4 of 5
Rev E

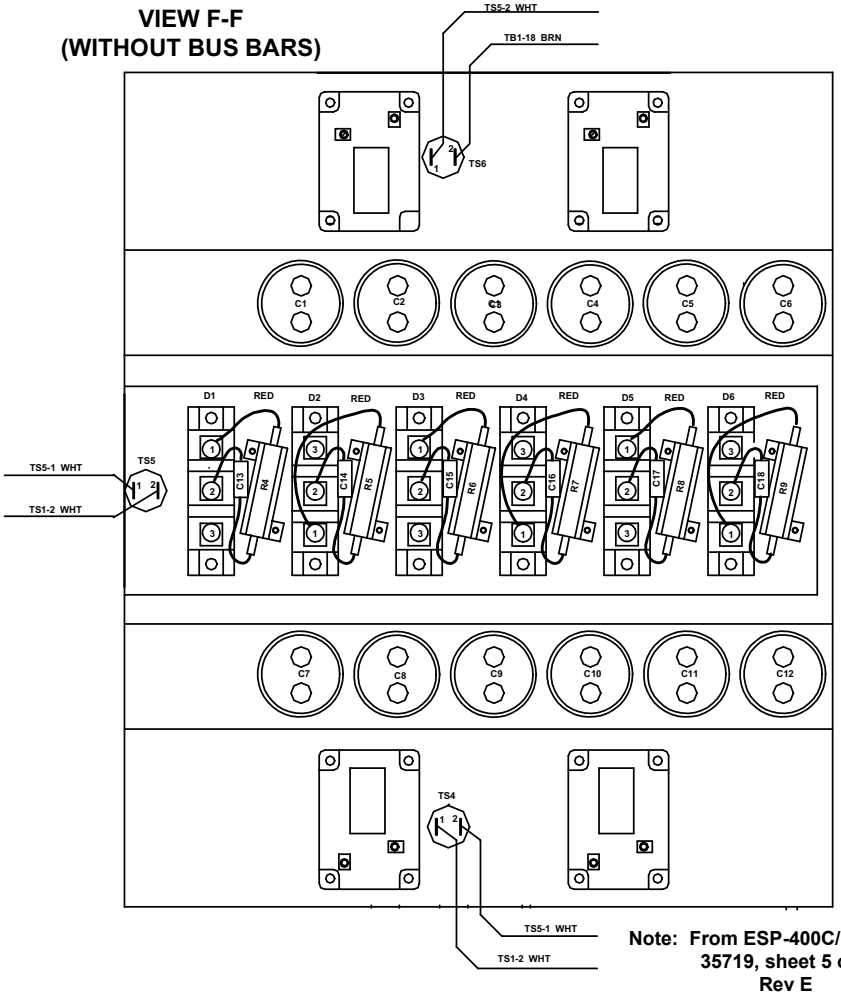
6.6 Wiring Diagrams – 460V 60H$_z$ Drawing 5 – Part 1 (P/N 35878)



Note: From ESP-400C/600C//460V 35719, sheet 5 of 5 Rev E

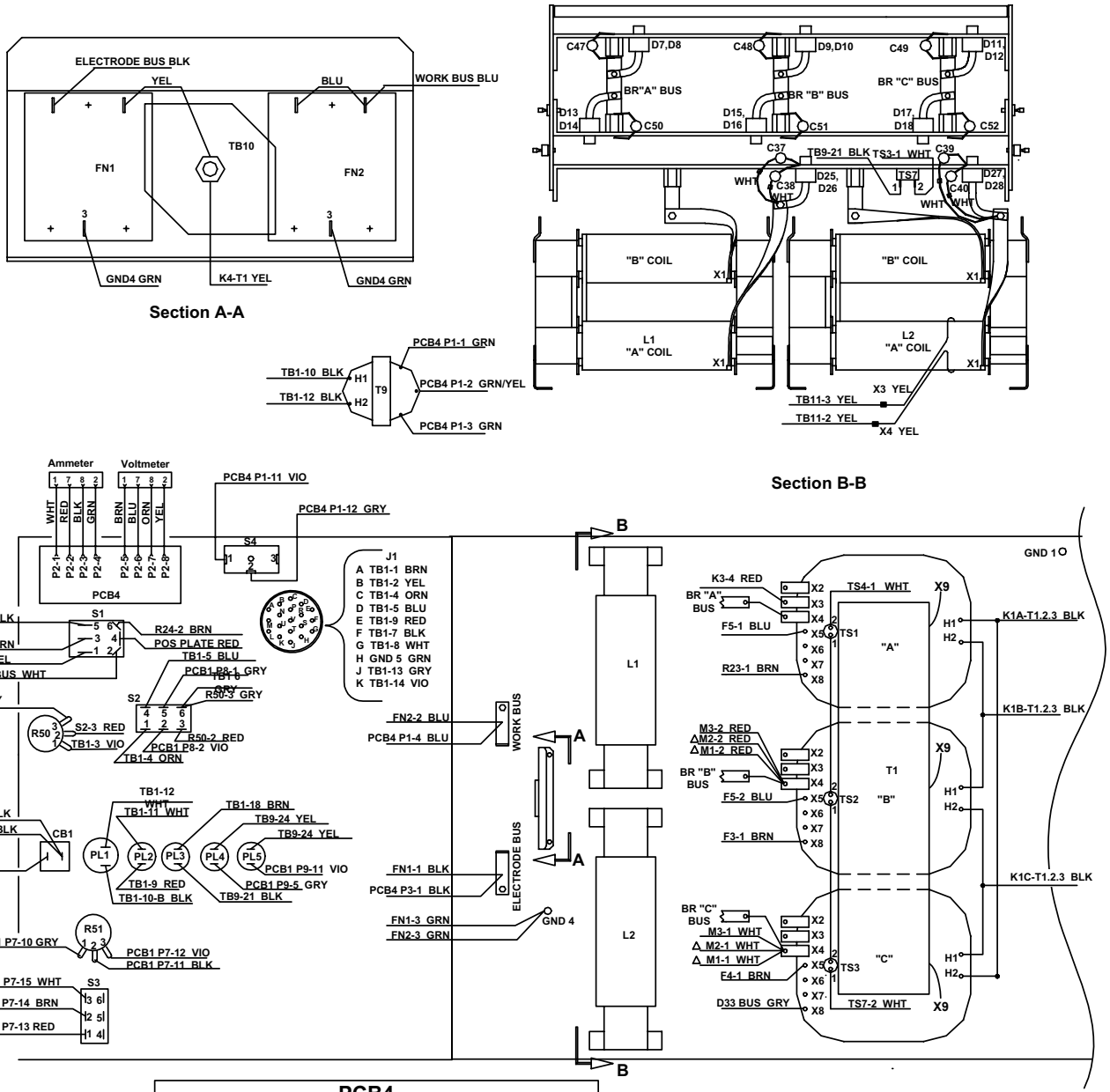
6.6 Wiring Diagrams – 460V 60H$_z$ Drawing 5 – Part 2 (P/N 35878)





Note: From ESP-400C/600C//460V 35719, sheet 5 of 5 Rev E

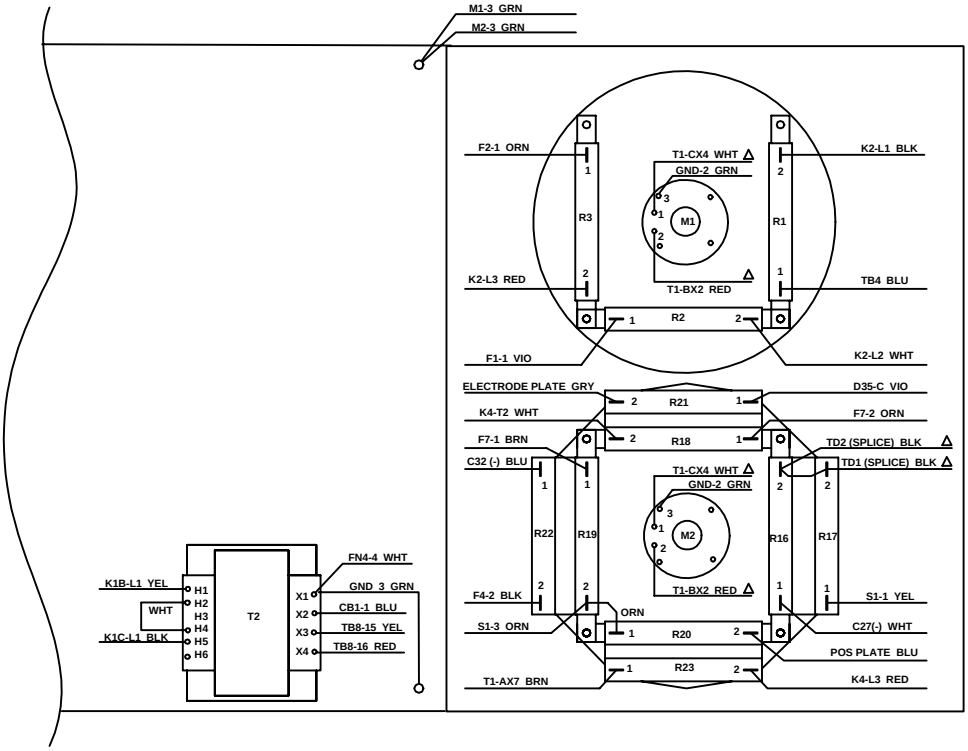
6.7 Wiring Diagrams – 400V 50H$_z$ Drawing 1 – Part 1 (P/N 35879)



PCB4	
P1	**P3**
1 T9-GRN 2 T9-GRN/YEL 3 T9-GRN 4 WORK BUS-BLU 5 TB1-15 RED 6 TB1-16 BLK 7 SH1 + 8 TB9-2 WHT 9 TB9-1 ORN PCB4 P1-10 BLK (ESP-400C) 10 PCB4 P1-9 BLK (ESP-400C) 11 S4-1 VIO 12 S4-2 GRY	1 ELECTRODE BUS-BLK

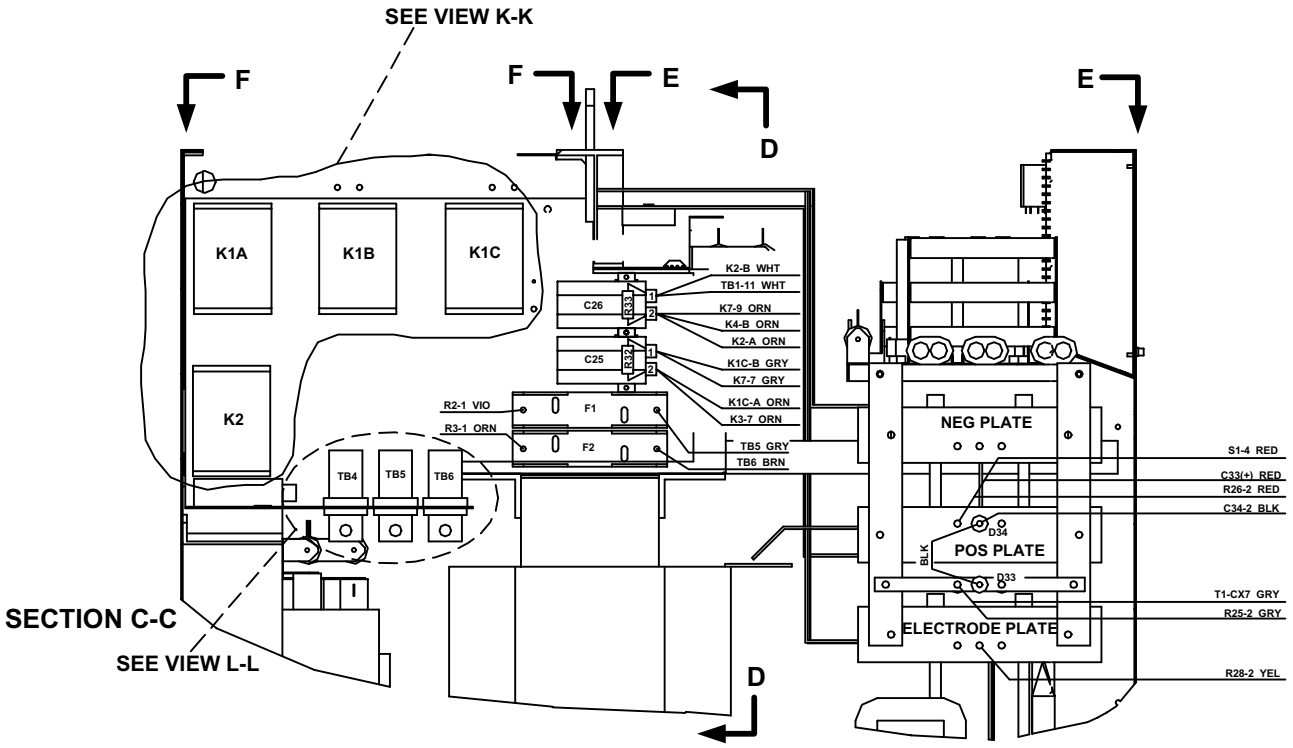
Note: From ESP-400C/600C//400V 0558002859, sheet 1 of 5

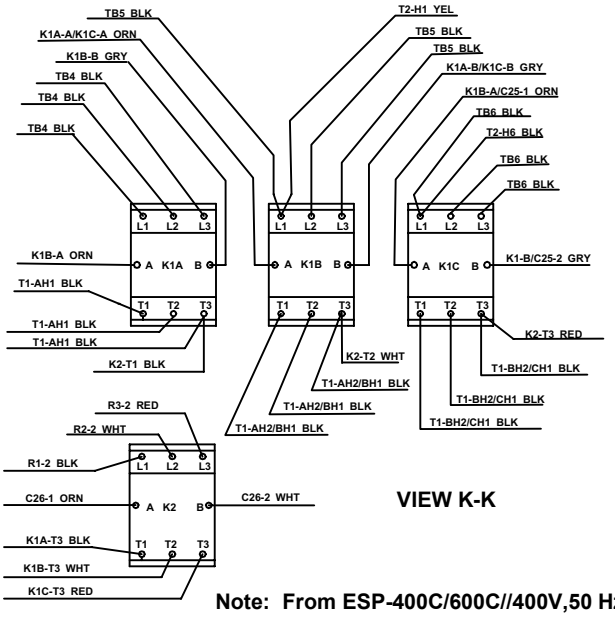
6.7 Wiring Diagrams – Drawing 1 – Part 1 400V 50H_z (P/N 35879)

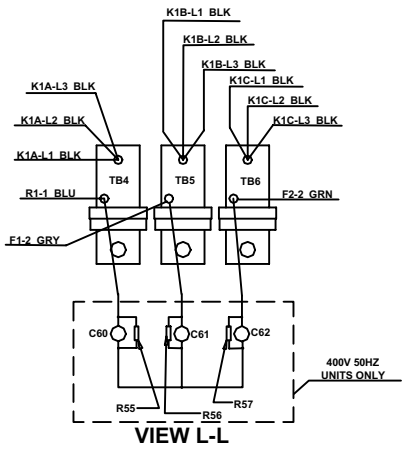


Note: From ESP-400C/600C//400V,50 Hz Drawing No. 0558002859, sheet 1 of 5 OR

6.7 Wiring Diagrams – Drawing 2 – Part 1 400V 50H$_z$ (P/N 35879)

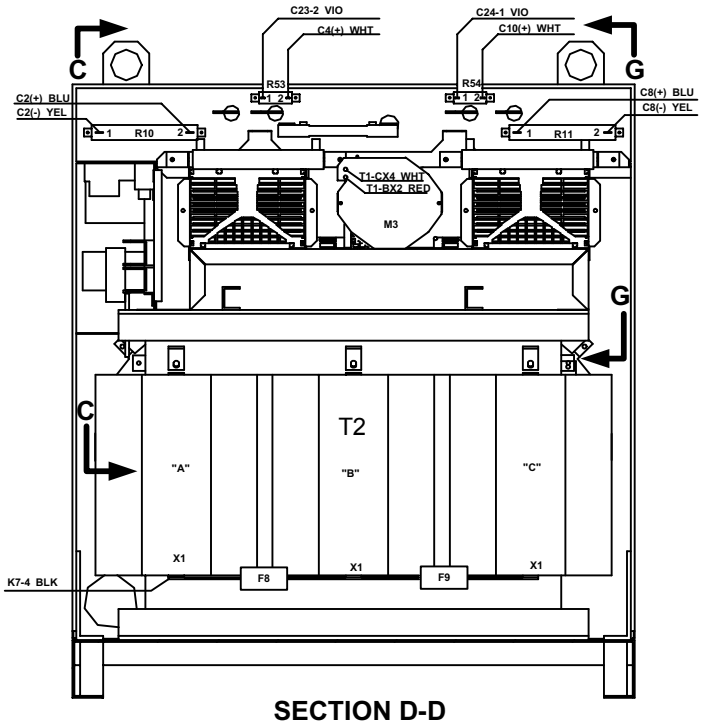




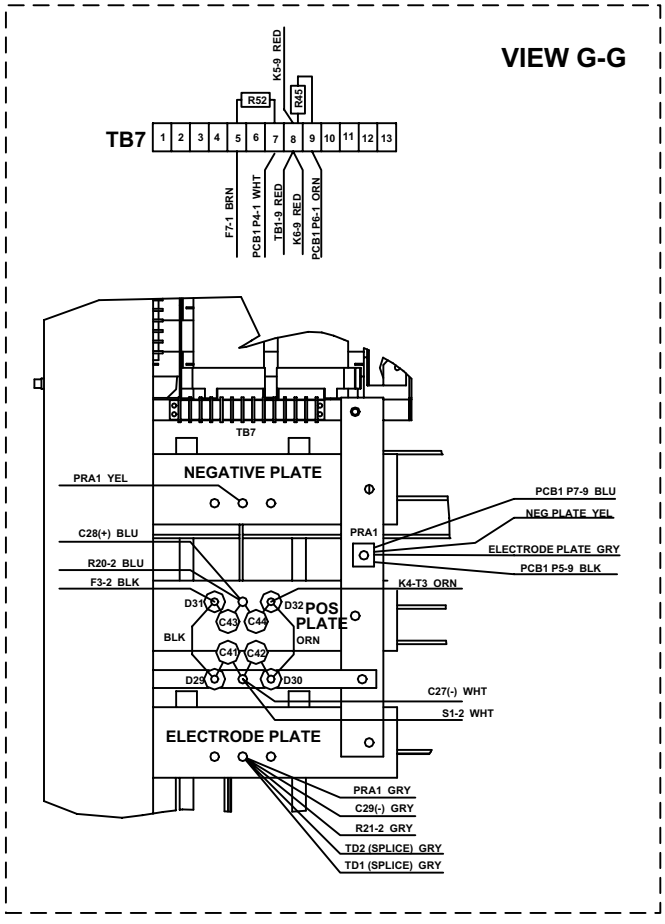


Note: From ESP-400C/600C//400V,50 Hz Drawing No. 0558002859, sheet 2 of 5 OR

6.7 Wiring Diagrams – Drawing 2 – Part 2 400V 50H$_z$ (P/N 35879)

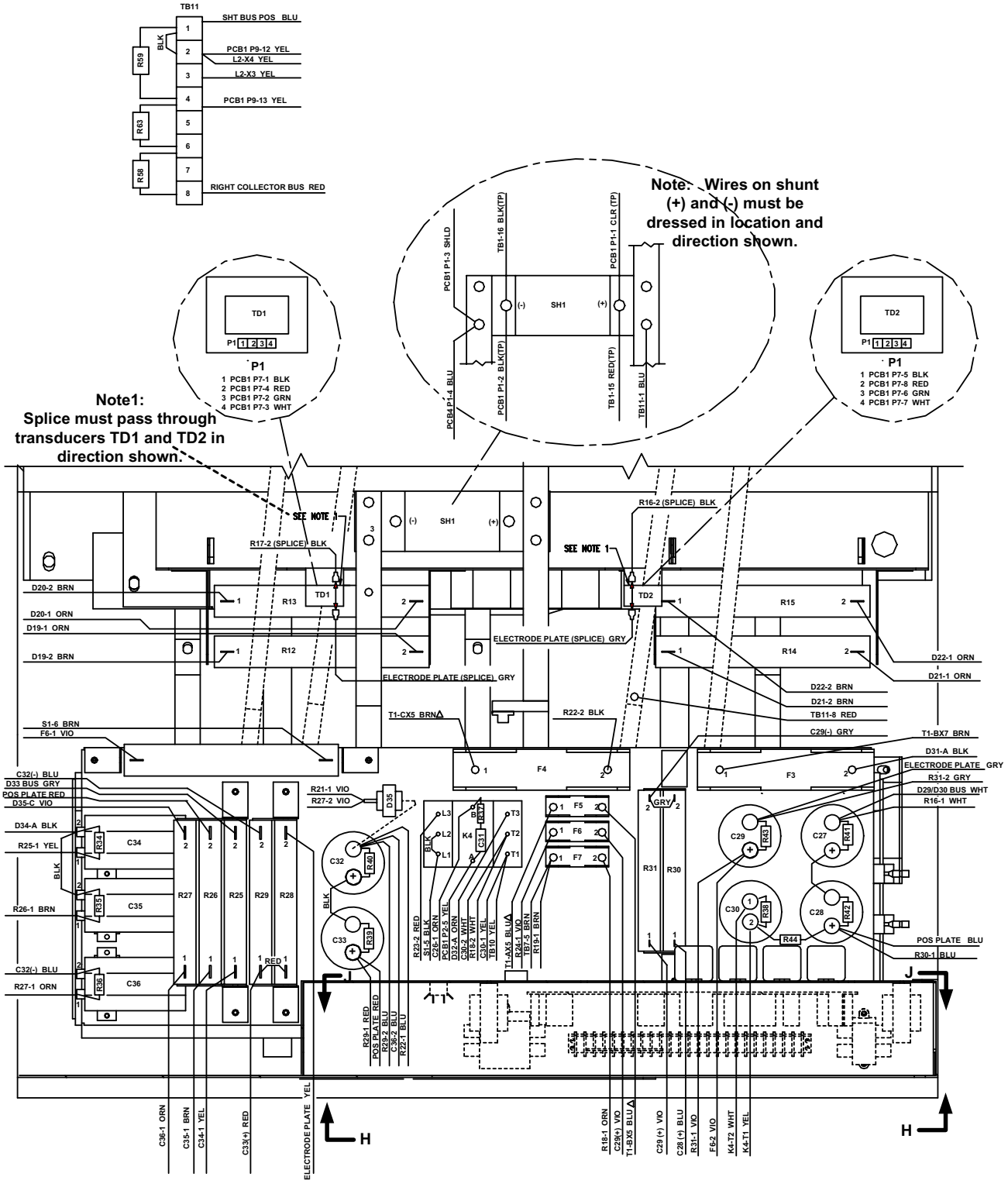


SECTION D-D



Note: From ESP-400C/600C//400V,50 Hz Drawing No. 0558002859, sheet 2 of 5 OR

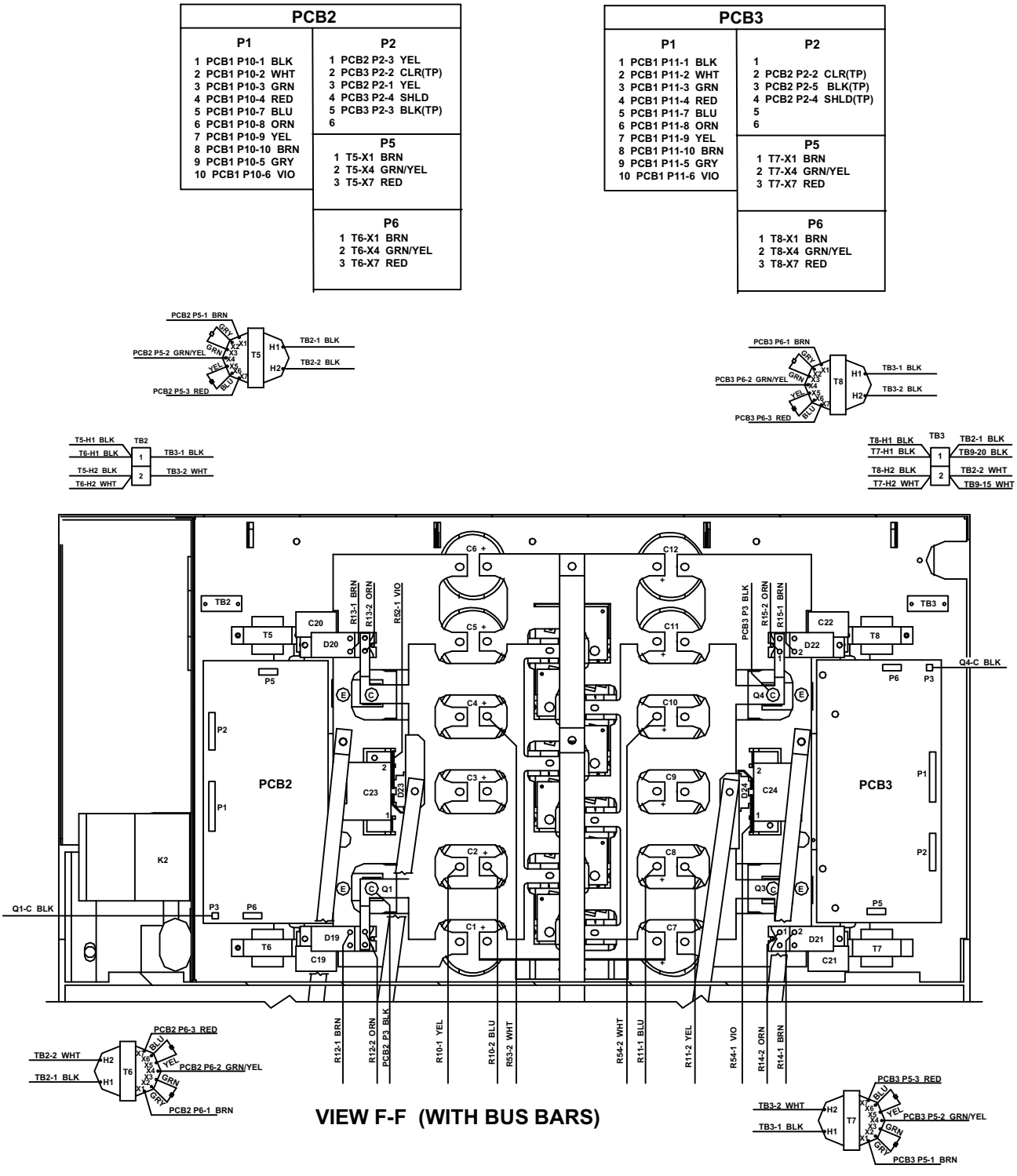
6.7 Wiring Diagrams – Drawing 3 400V 50H$_z$ (P/N 35879)



VIEW E-E

Note: From ESP-400C/600C//400V,50 Hz Drawing No. 0558002859, sheet 3 of 5 OR

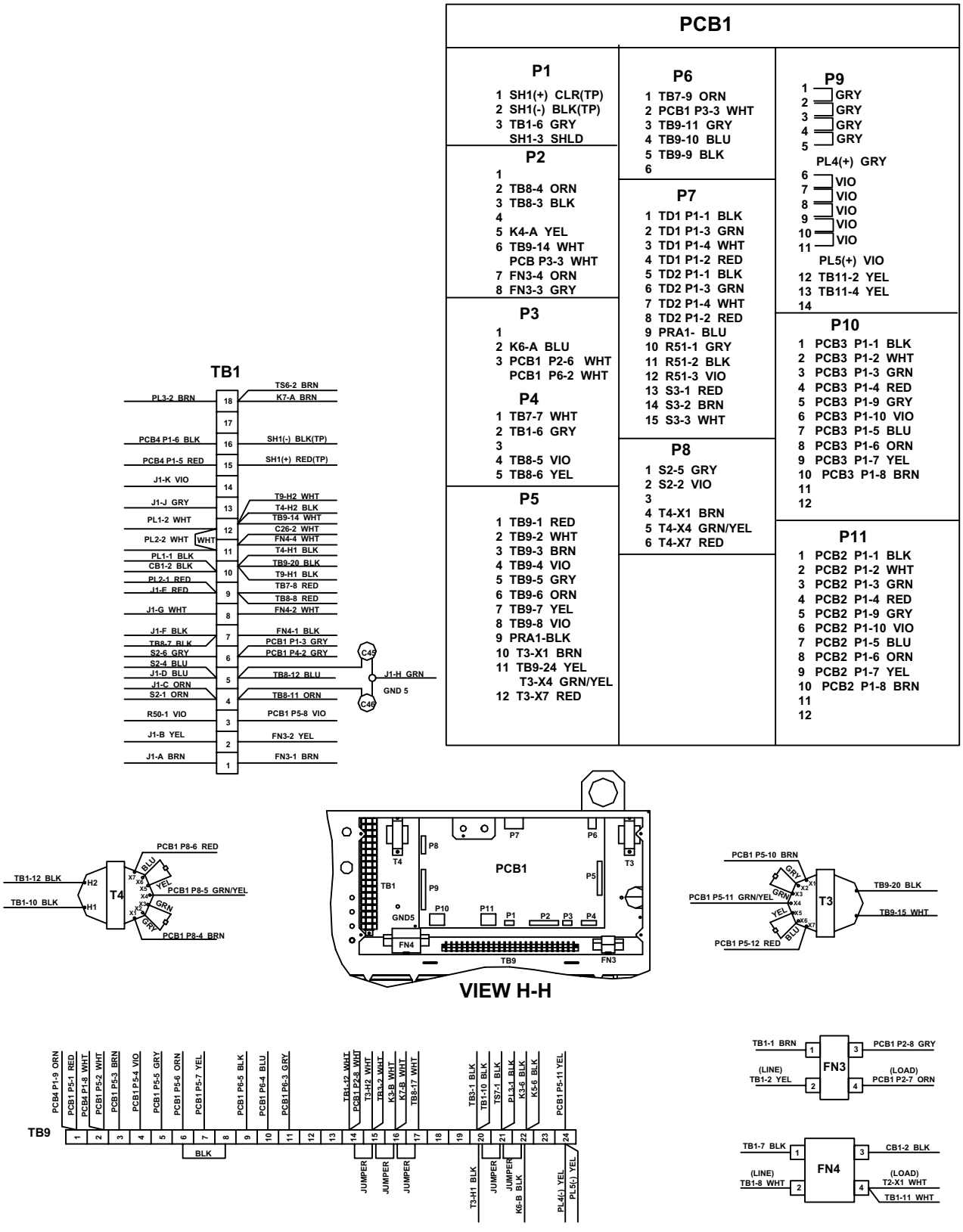
6.7 Wiring Diagrams – Drawing 4 400V 50H$_z$ (P/N 35879)



VIEW F-F (WITH BUS BARS)

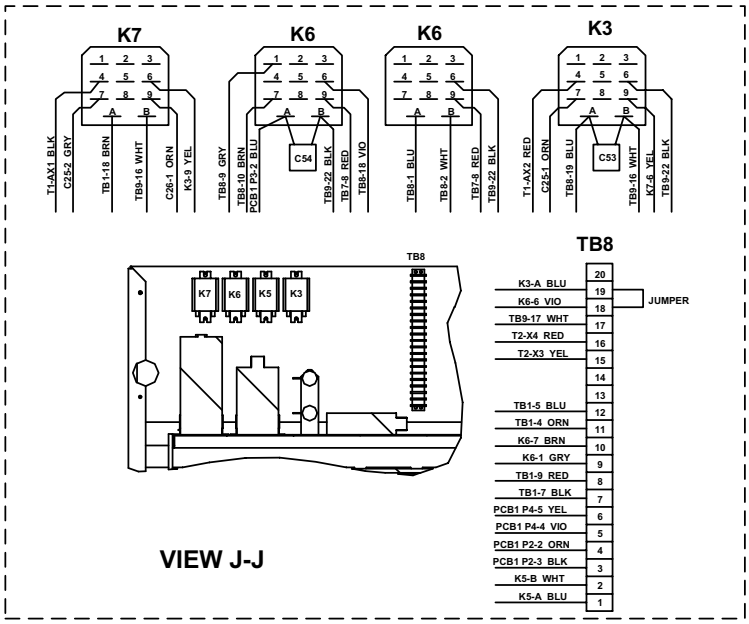
Note: From ESP-400C/600C//400V,50 Hz
Drawing No. 0558002859, sheet 4 of 5
OR

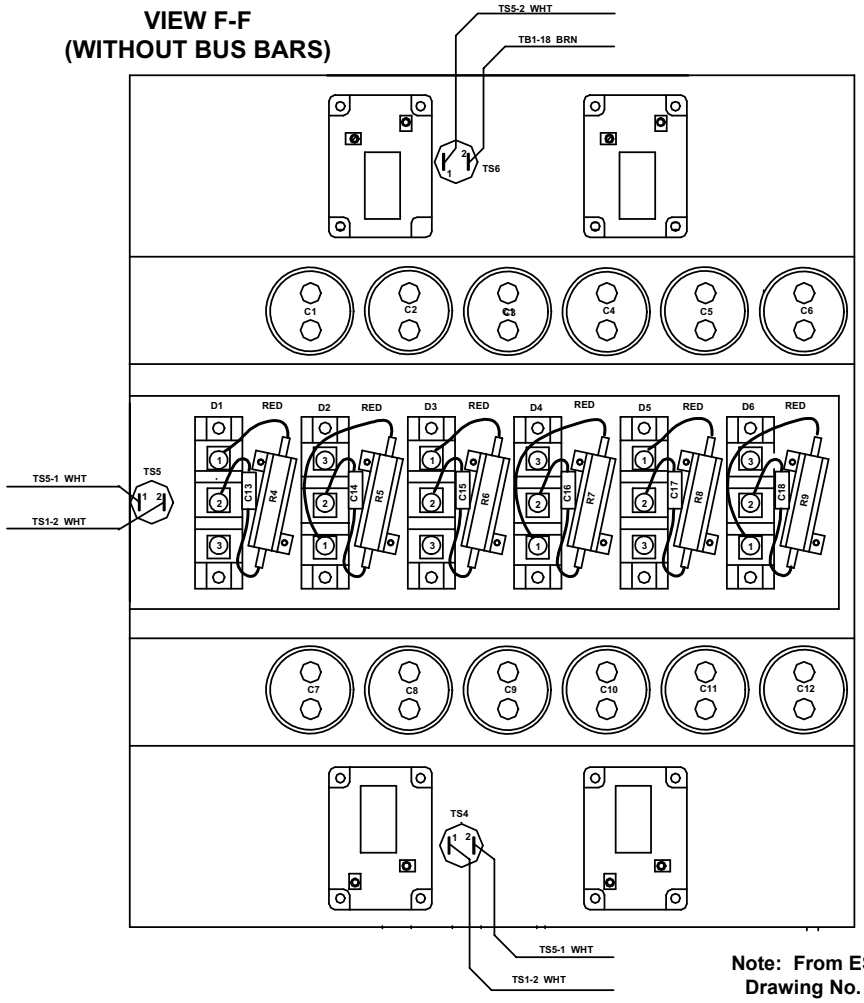
6.7 Wiring Diagrams – Drawing 5 – Part 1 400V 50H$_z$ (P/N 35879)



Note: From ESP-400C/600C//400V,50 Hz Drawing No. 0558002859, sheet 5 of 5 OR

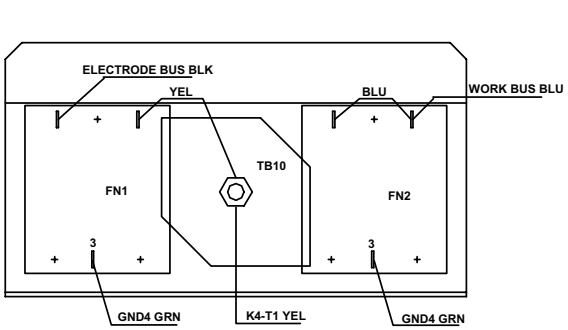
6.7 Wiring Diagrams – Drawing 5 – Part 2 400V 50H$_z$ (P/N 35879)



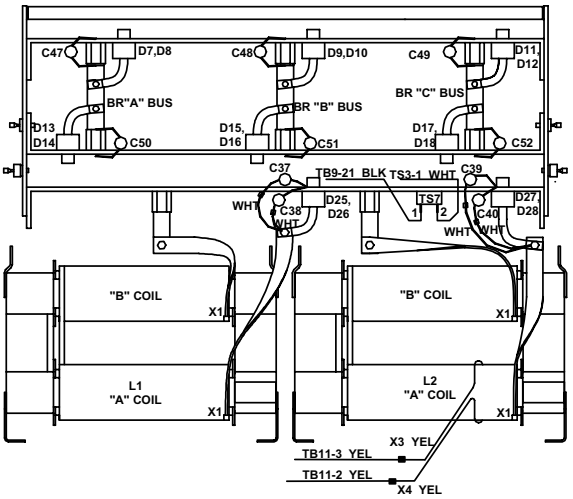


Note: From ESP-400C/600C//400V,50 Hz Drawing No. 0558002859, sheet 5 of 5 OR

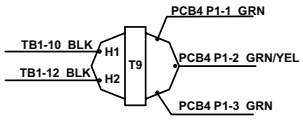
6.8 Wiring Diagrams – 575V 60H$_z$ Drawing 1 – Part 1 (P/N 35880)

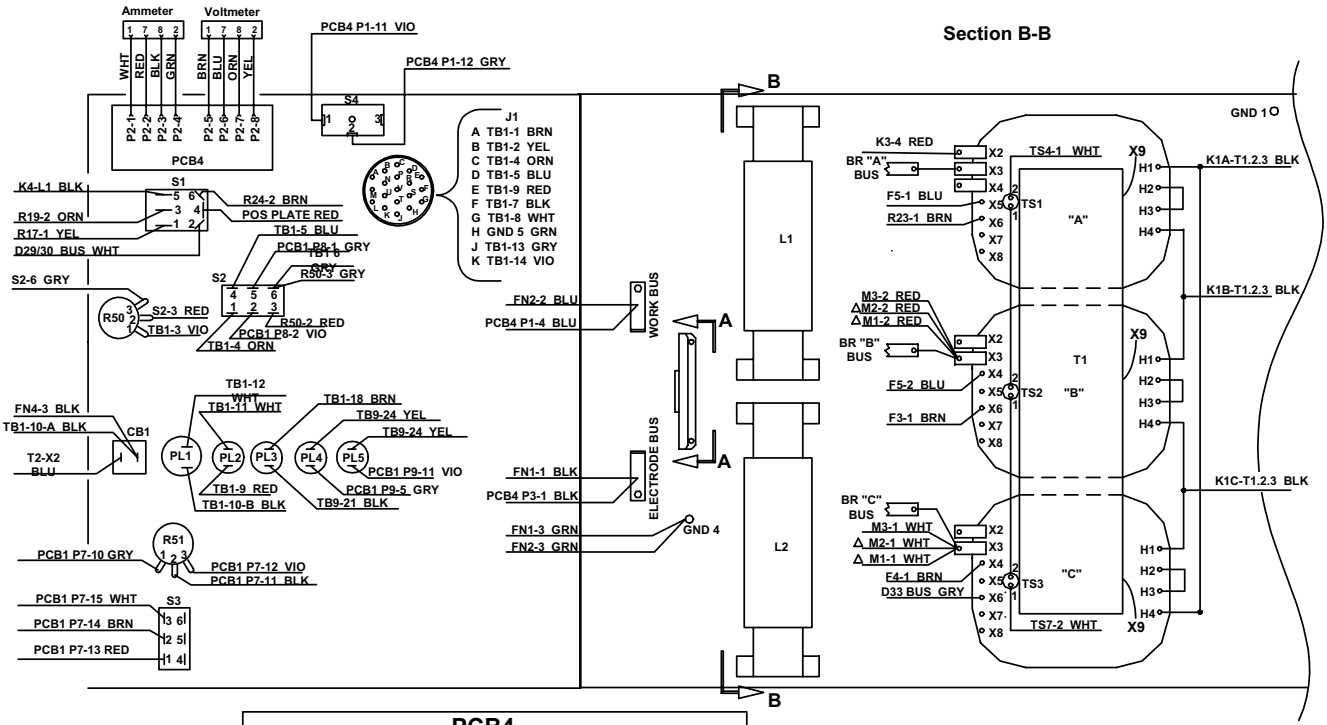


Section A-A



Section B-B

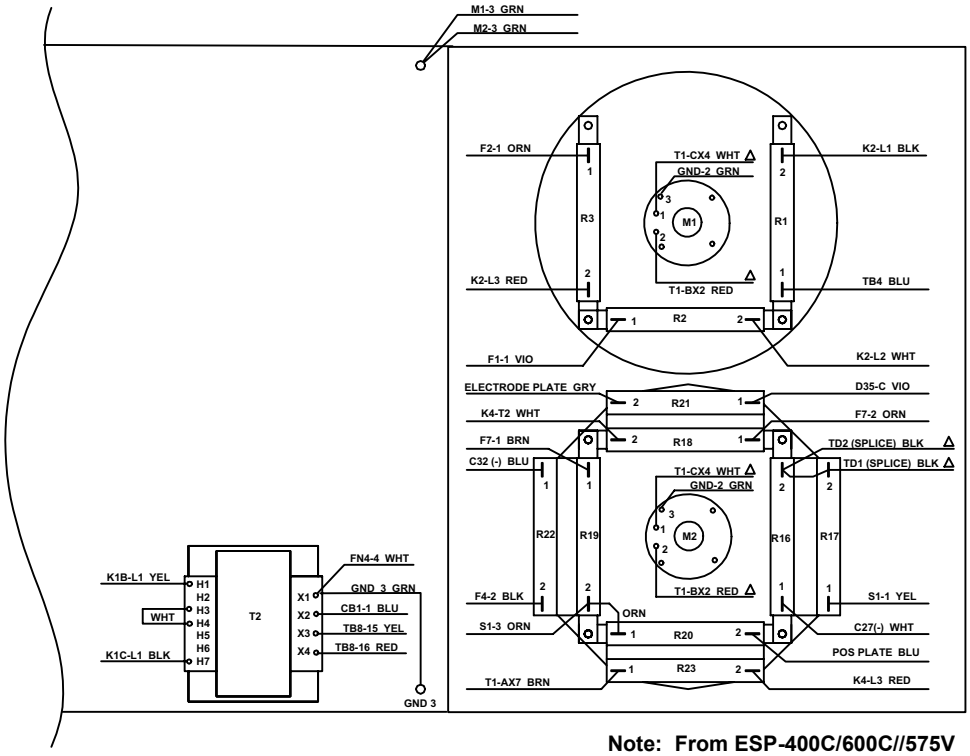




PCB4	
P1	**P3**
1 T9-GRN 2 T9-GRN/YEL 3 T9-GRN 4 SHUNT 1-3 -BLU 5 TB1-15 RED (600C Only) 6 TB1-16 BLK 7 TB1-15 (400C Only) 8 TB9-2 WHT 9 TB9-1 ORN PCB4 P1-10 ORN (ESP-400C) 10 PCB4 P1-9 ORN (ESP-400C) 11 S4-1 VIO 12 S4-2 GRY	1 ELECTRODE BUS-BLK

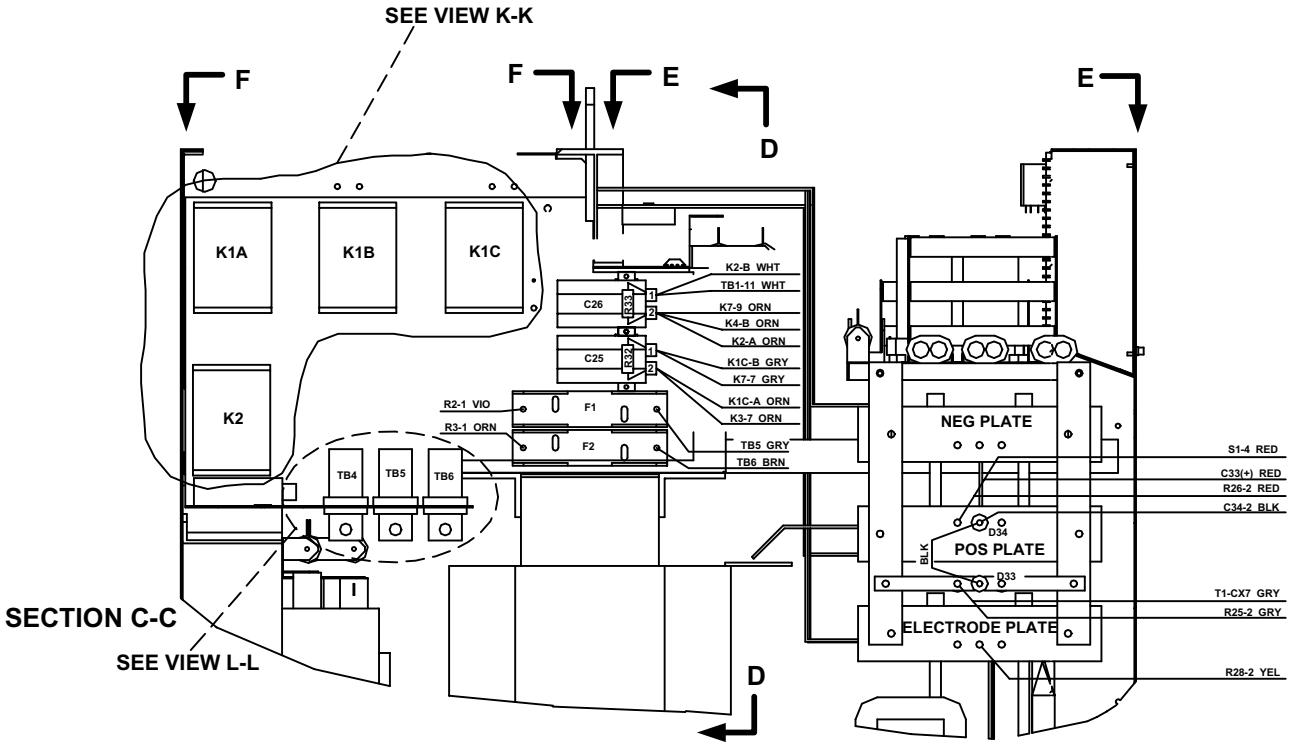
Note: From ESP-400C/600C//575V Drawing No. 0558002852, sheet 1 of 5 OR

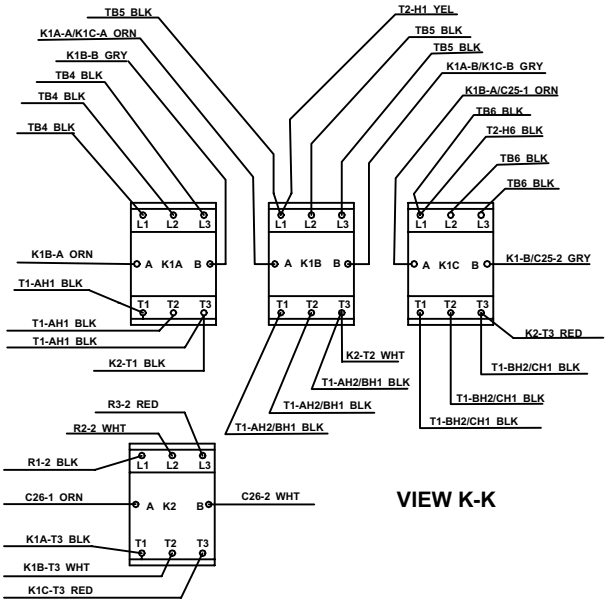
6.8 Wiring Diagrams – 575V 60H$_z$ Drawing 1 – Part 2 (P/N 35880)



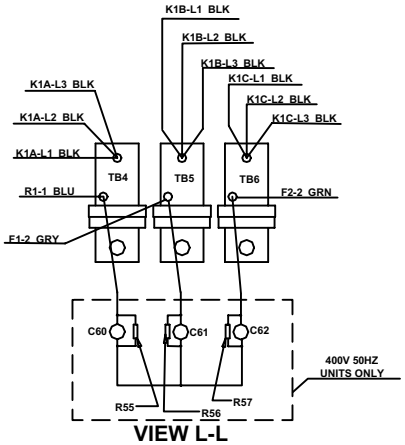
Note: From ESP-400C/600C//575V Drawing No. 0558002852, sheet 1 of 5 OR

6.8 Wiring Diagrams – 575V 60H$_z$ Drawing 2 – Part 1 (P/N 35880)





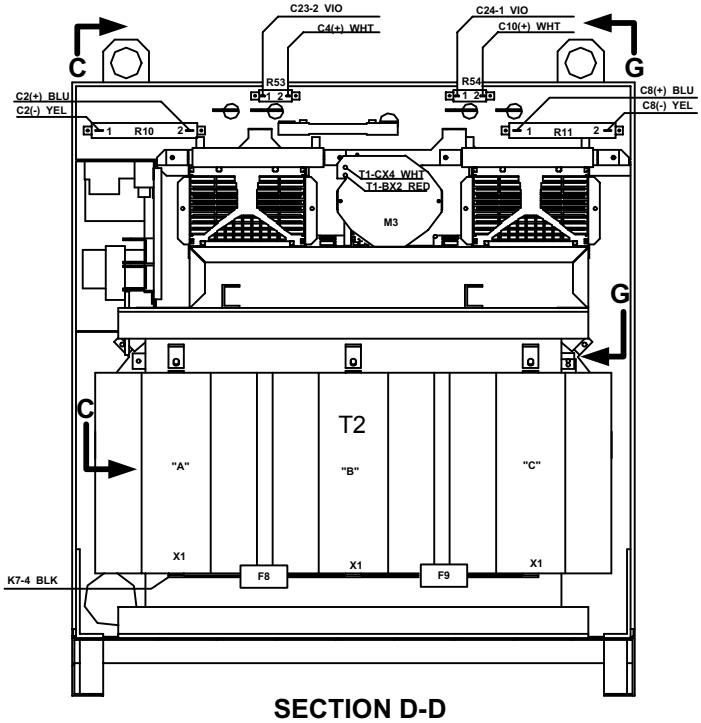
VIEW K-K



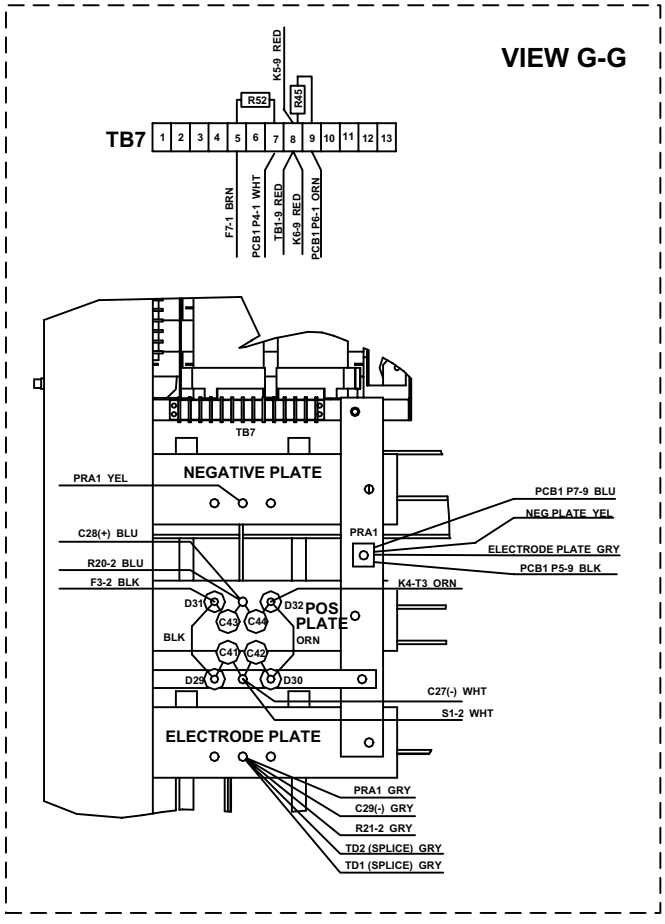
VIEW L-L

Note: From ESP-400C/600C//575V Drawing No. 0558002852, sheet 2 of 5 OR

6.8 Wiring Diagrams – 575V 60H$_z$ Drawing 2 – Part 2 (P/N 35880)

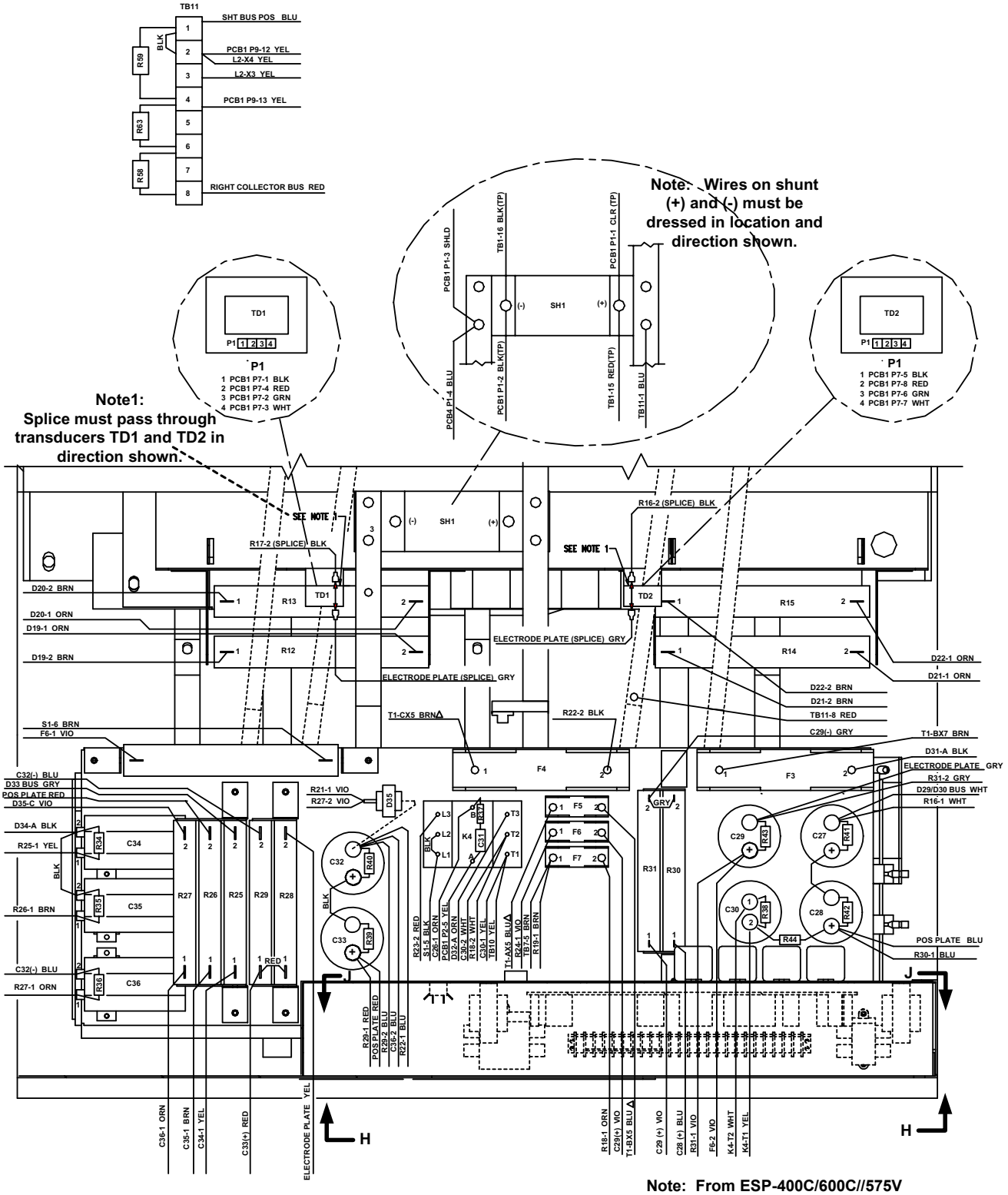


SECTION D-D



Note: From ESP-400C/600C//575V Drawing No. 0558002852, sheet 2 of 5 OR

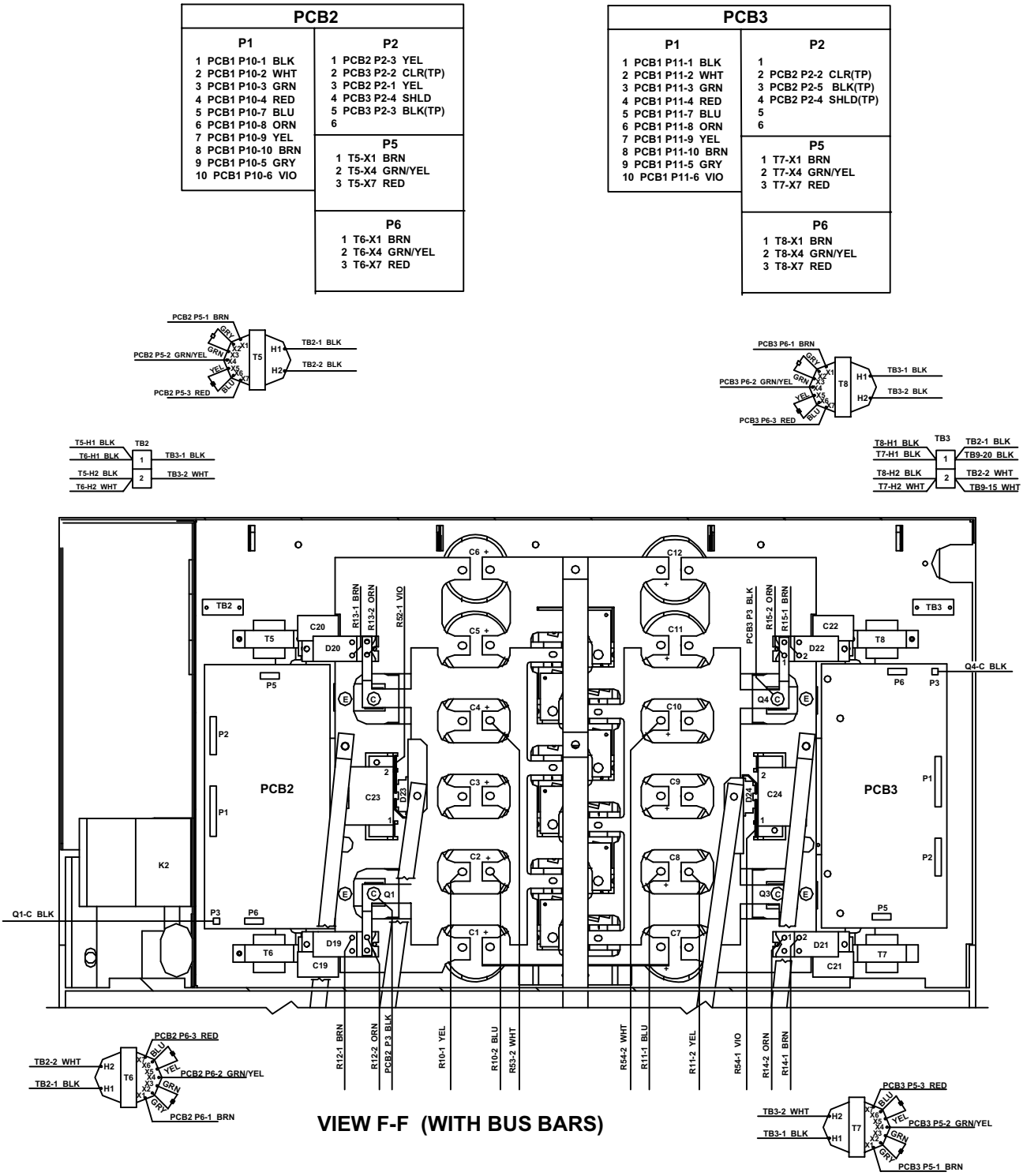
6.8 Wiring Diagrams – 575V 60H$_z$ Drawing 3 (P/N 35880)



VIEW E-E

Note: From ESP-400C/600C//575V Drawing No. 0558002852, sheet 3 of 5 OR

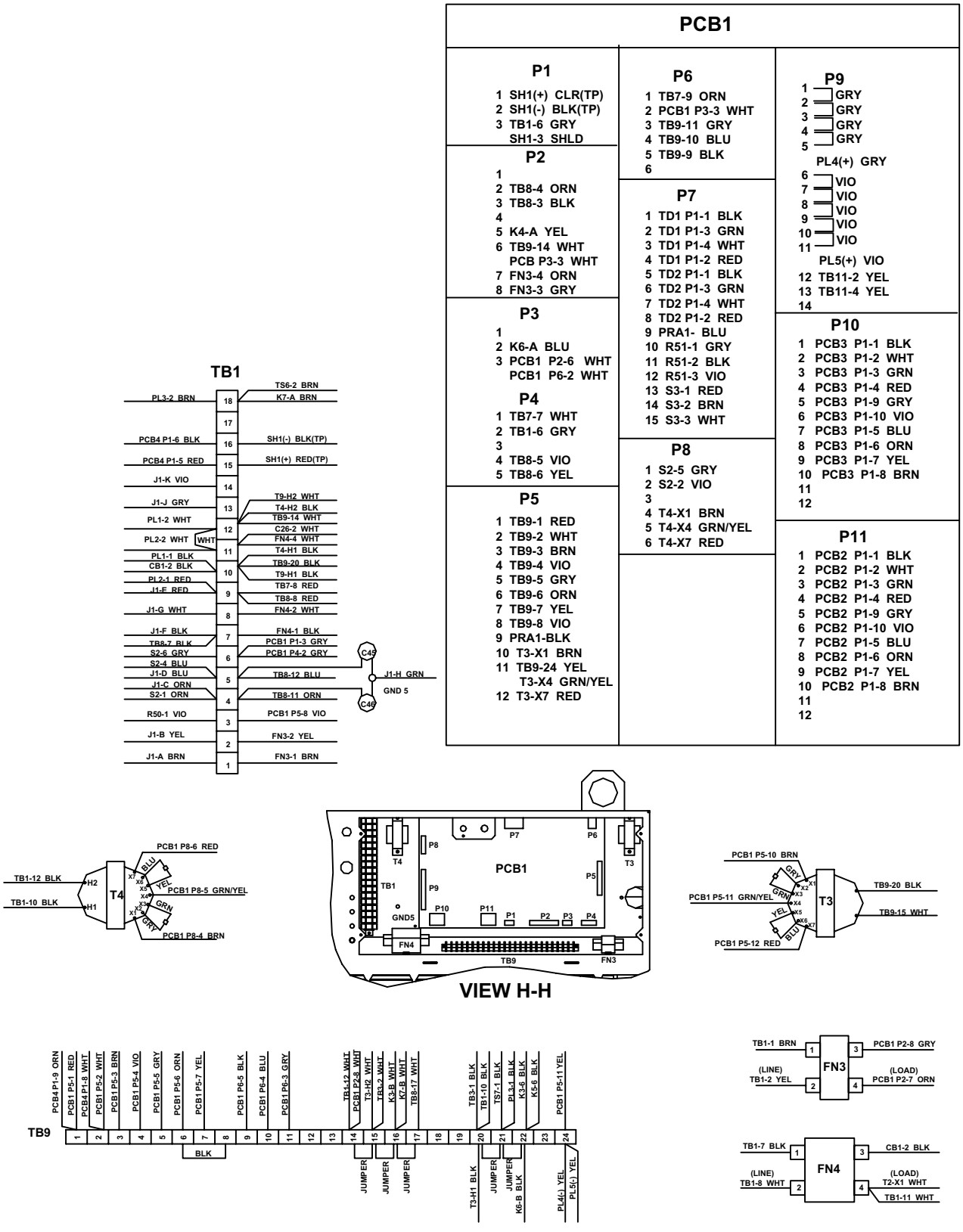
6.8 Wiring Diagrams – 575V 60H$_z$ Drawing 4 (P/N 35880)



VIEW F-F (WITH BUS BARS)

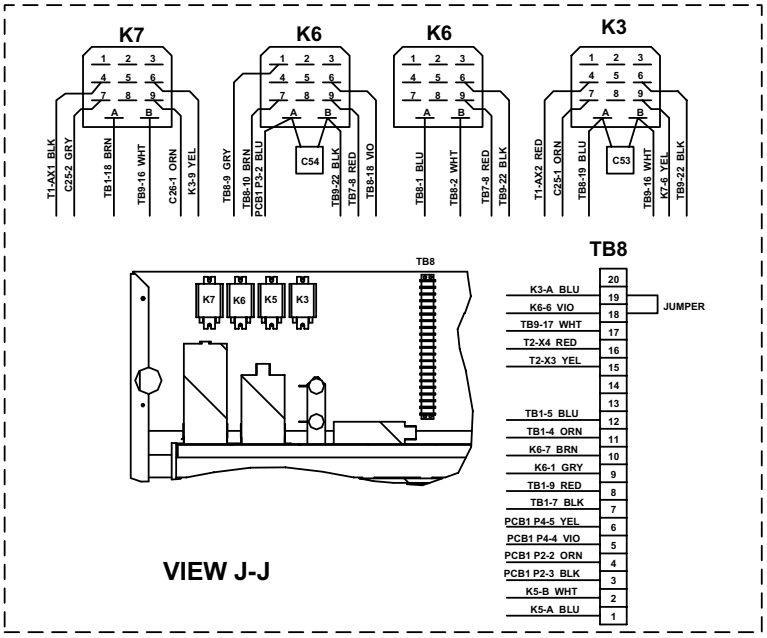
Note: From ESP-400C/600C//575V Drawing No. 0558002852, sheet 4 of 5 OR

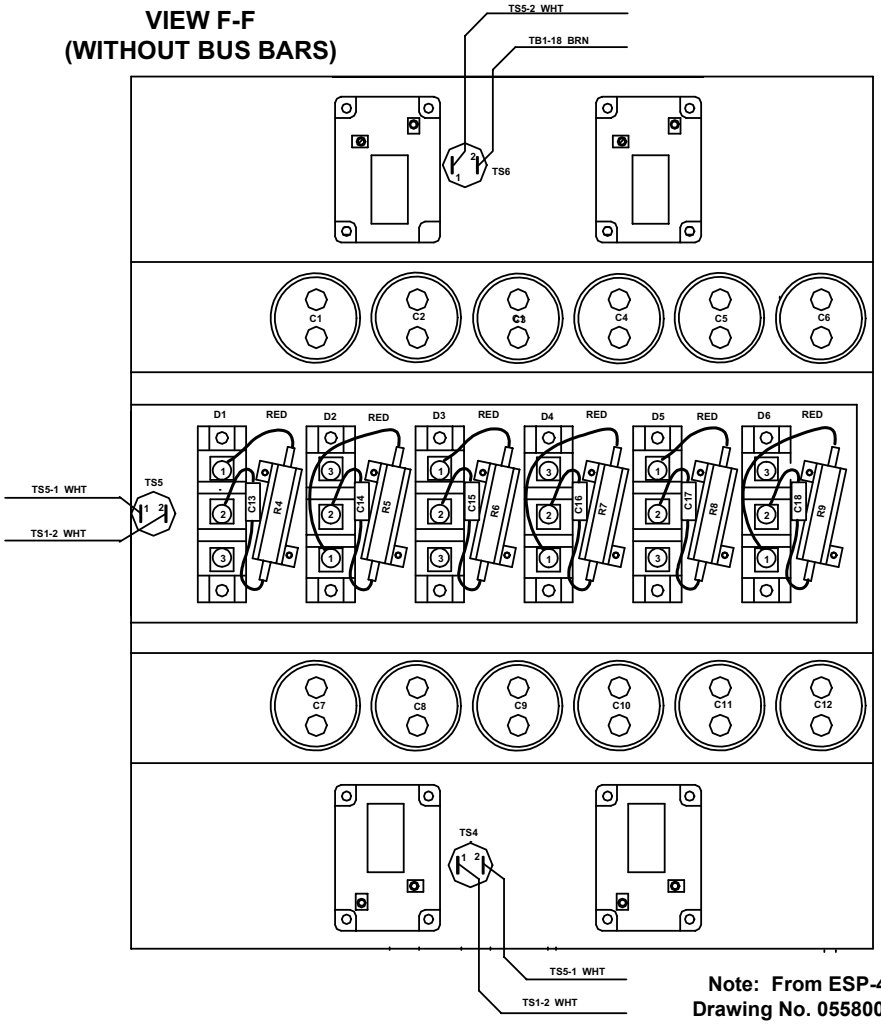
6.8 Wiring Diagrams – 575V 60H$_z$ Drawing 5 – Part 1 (P/N 35880)



Note: From ESP-400C/600C//575V Drawing No. 0558002852, sheet 5 of 5 OR

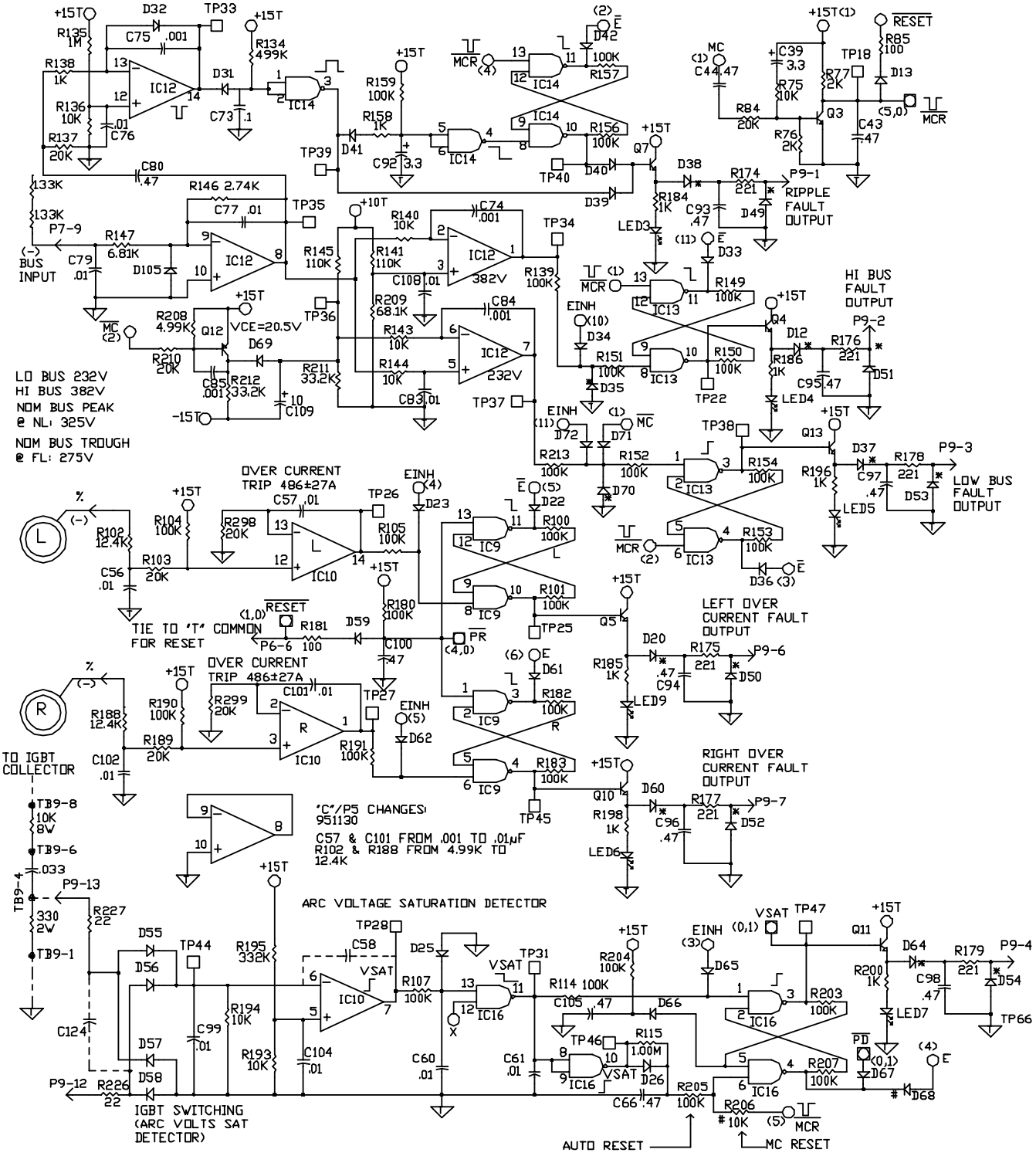
6.8 Wiring Diagrams – Drawing 5 – Part 2 575V 50H$_z$ (P/N 35880)



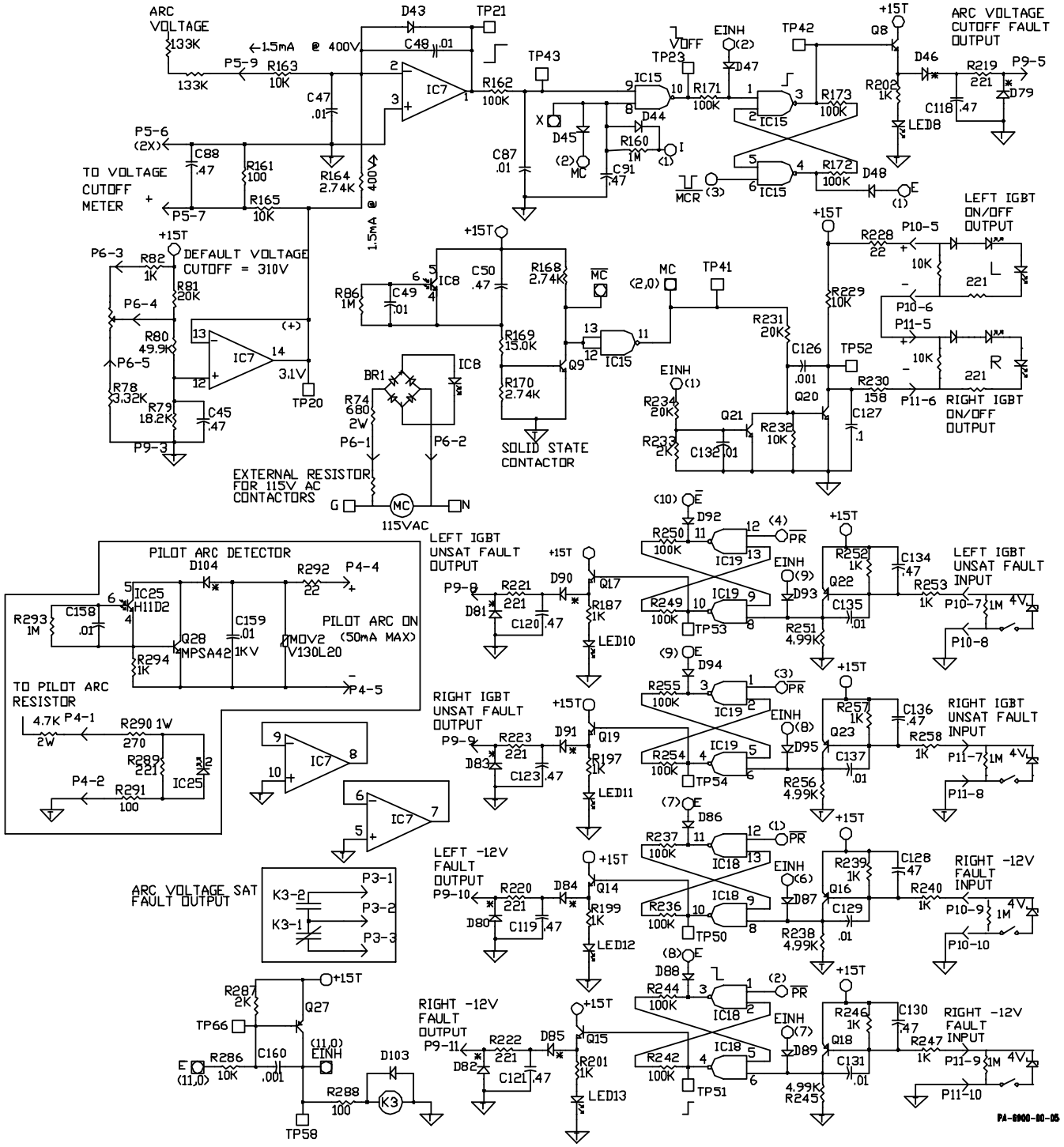


Note: From ESP-400C/600C//575V Drawing No. 0558002852, sheet 5 of 5 OR

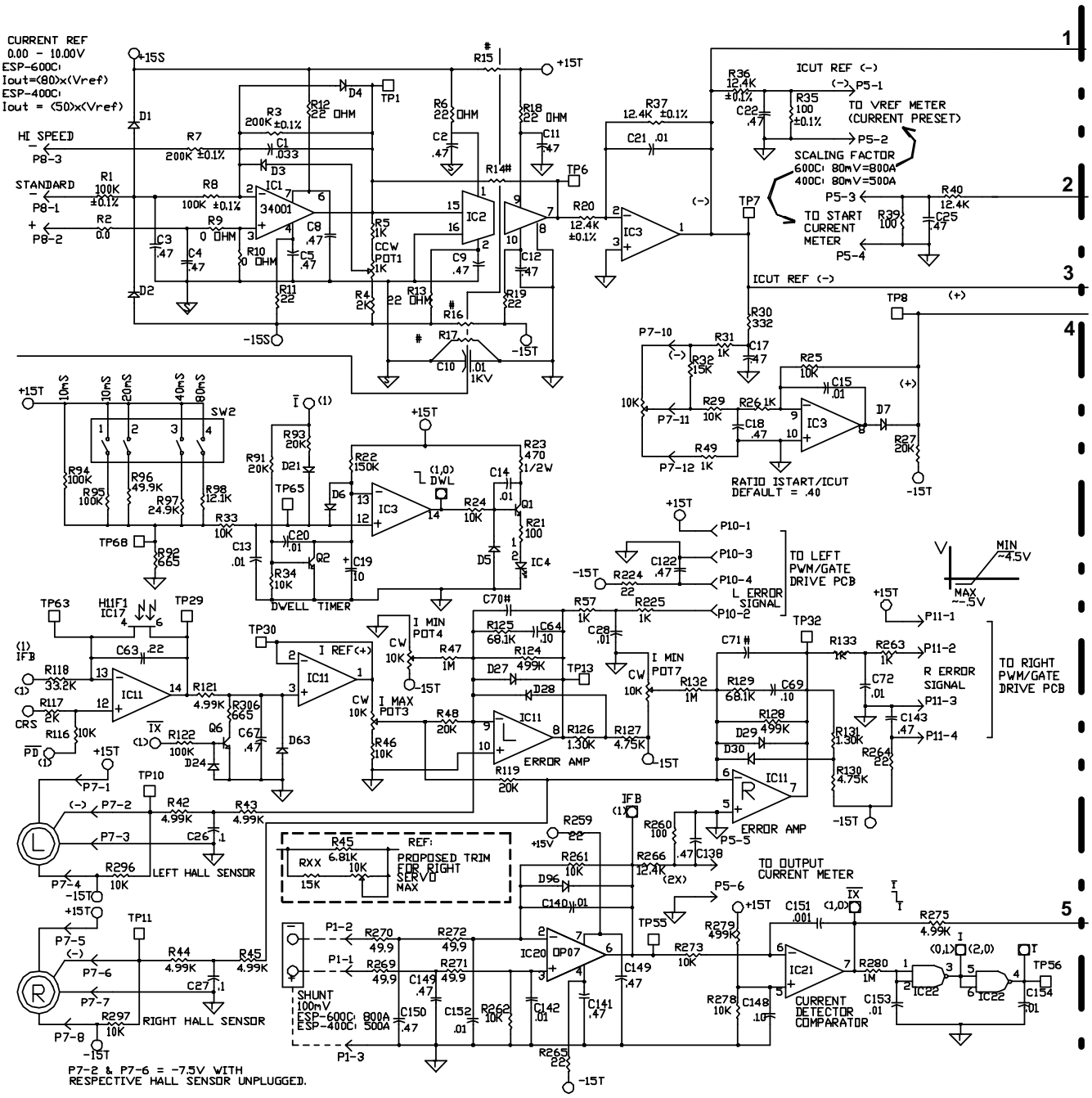
6.9 PC Controller Board (PCB1,P/N 38032, REV C) Schematics Drawing 1 Part 1



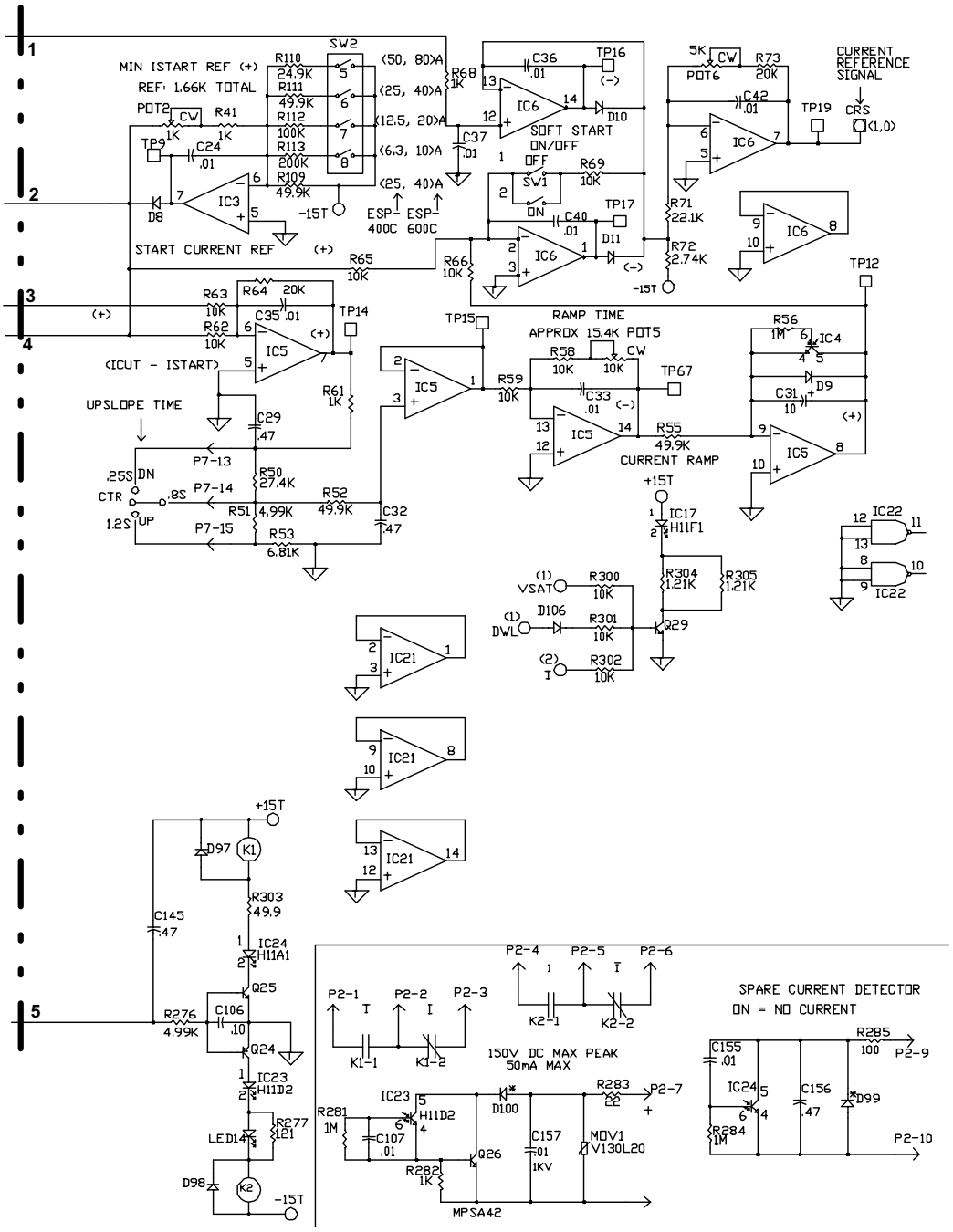
6.9 PC Controller Board (PCB1-P/N 38032) Schematics - Drawing 1 Part 2



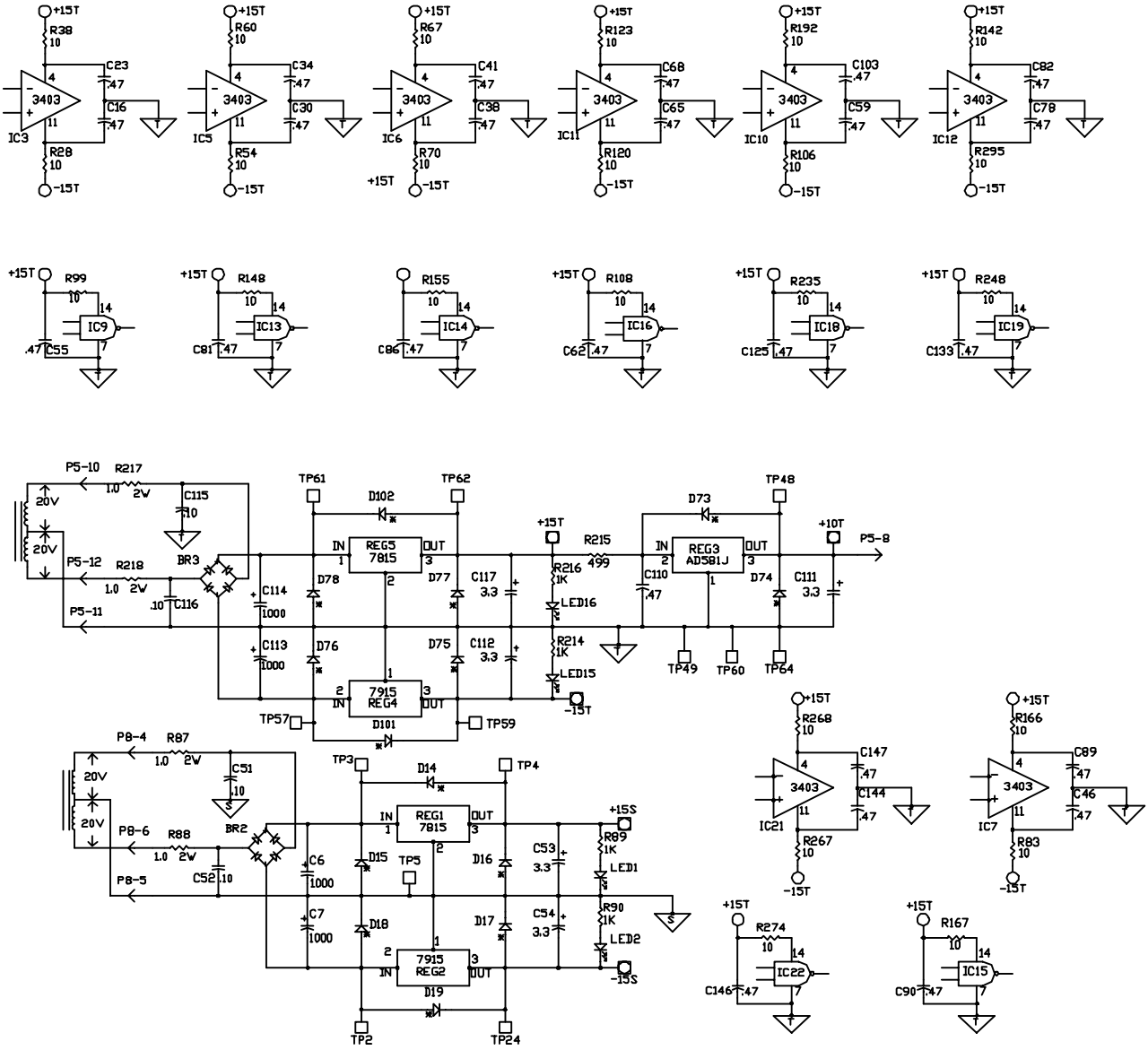
6.9 PC Controller Board (PCB1-P/N 38032) Schematics - Drawing 2 Part 2



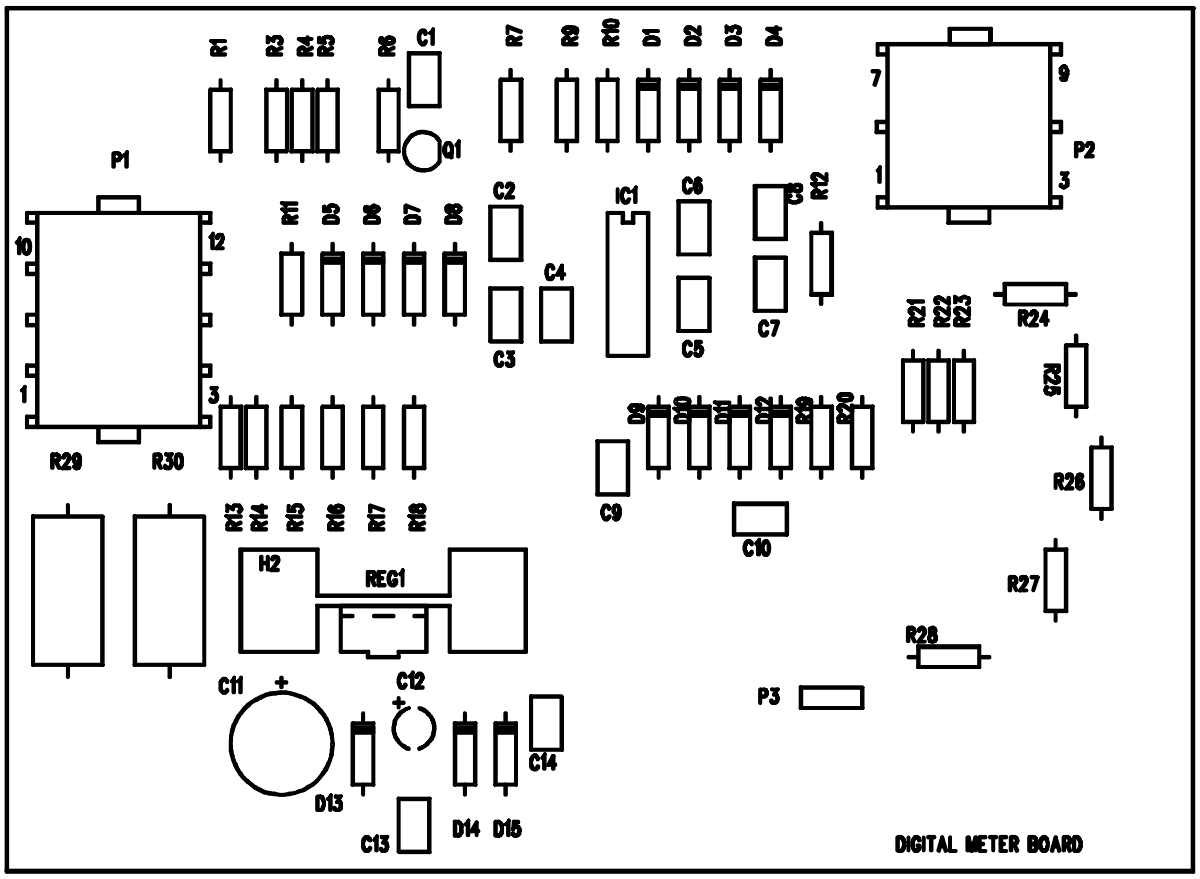
6.9 PC Controller Board (PCB1-P/N 38032) Schematics - Drawing 2 Part 2



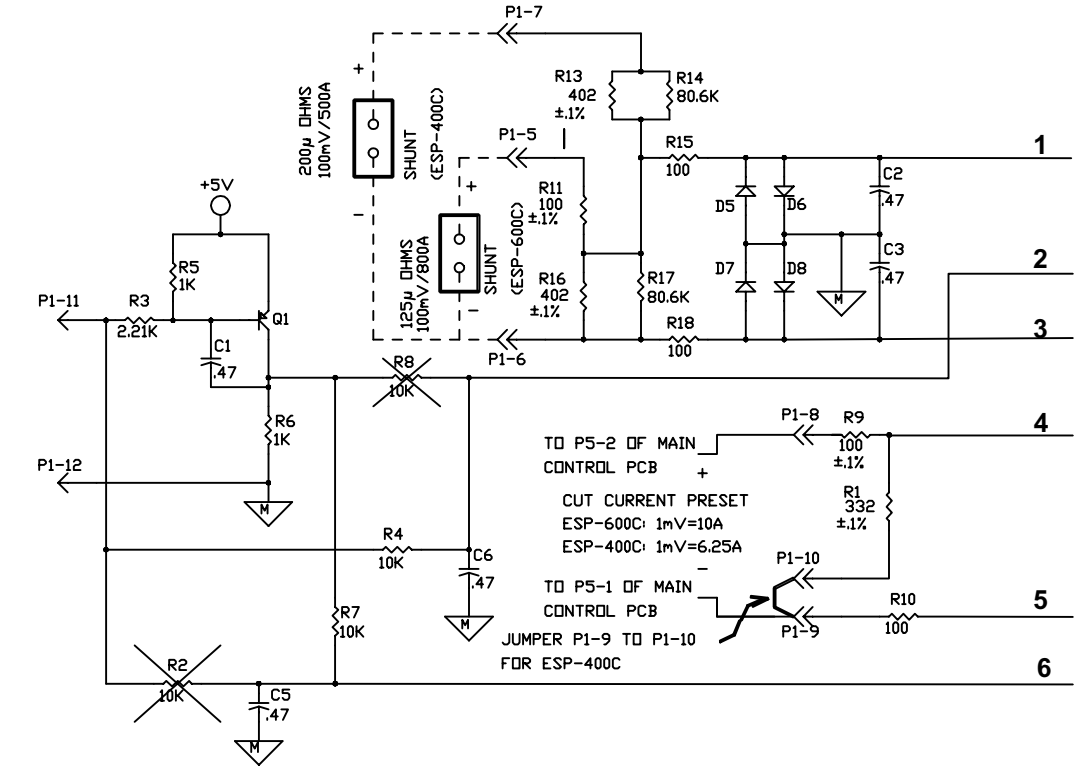
6.9 PC Controller Board (PCB1-P/N 38032) Schematics - Drawing 3

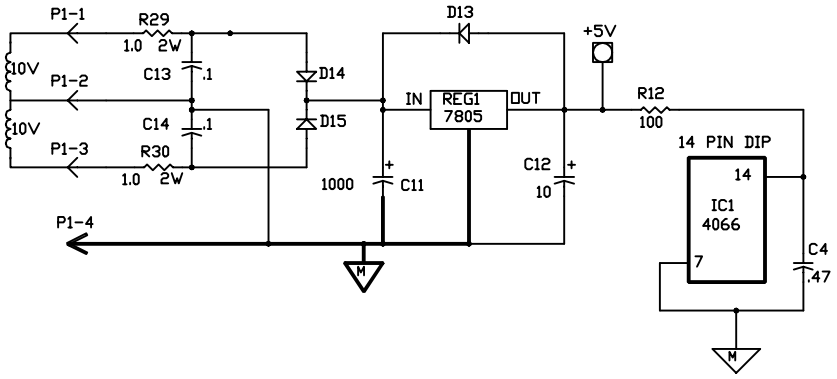


6.10 PCB Digital Meter Board (PCB4-P/N 38139) Drawing 1

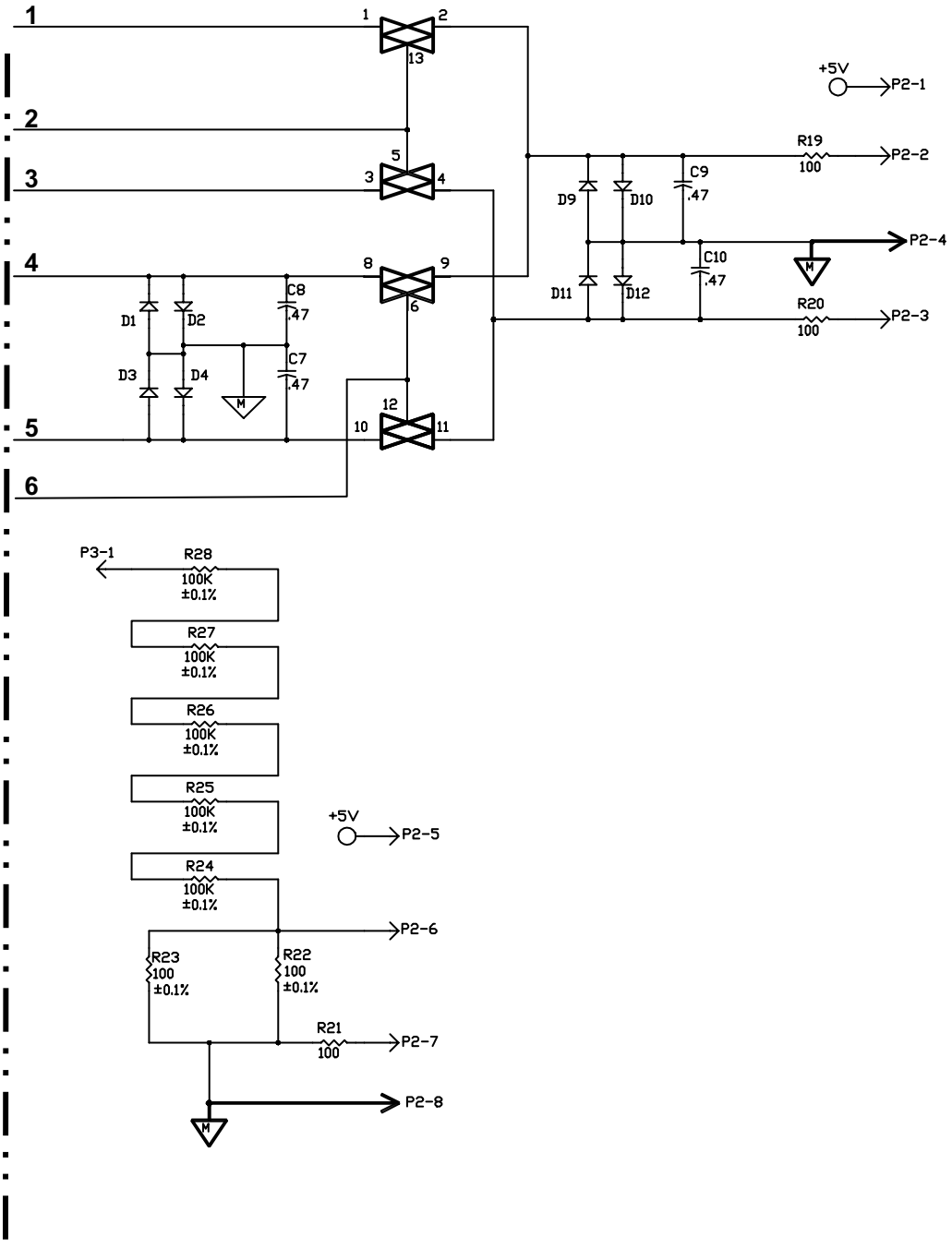


6.10 PCB Digital Meter Board (PCB4-P/N 38139) Drawing 2 Part 1

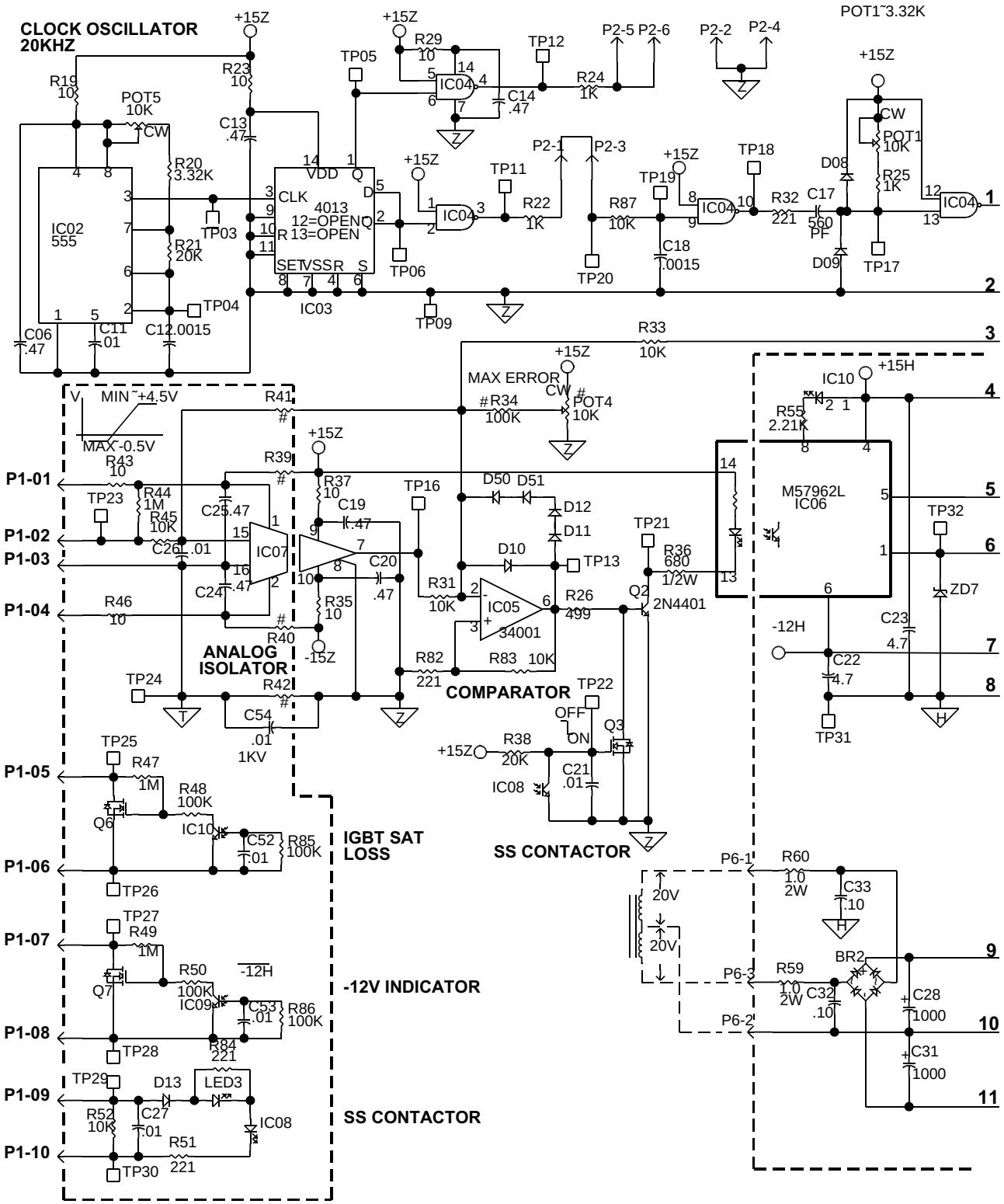




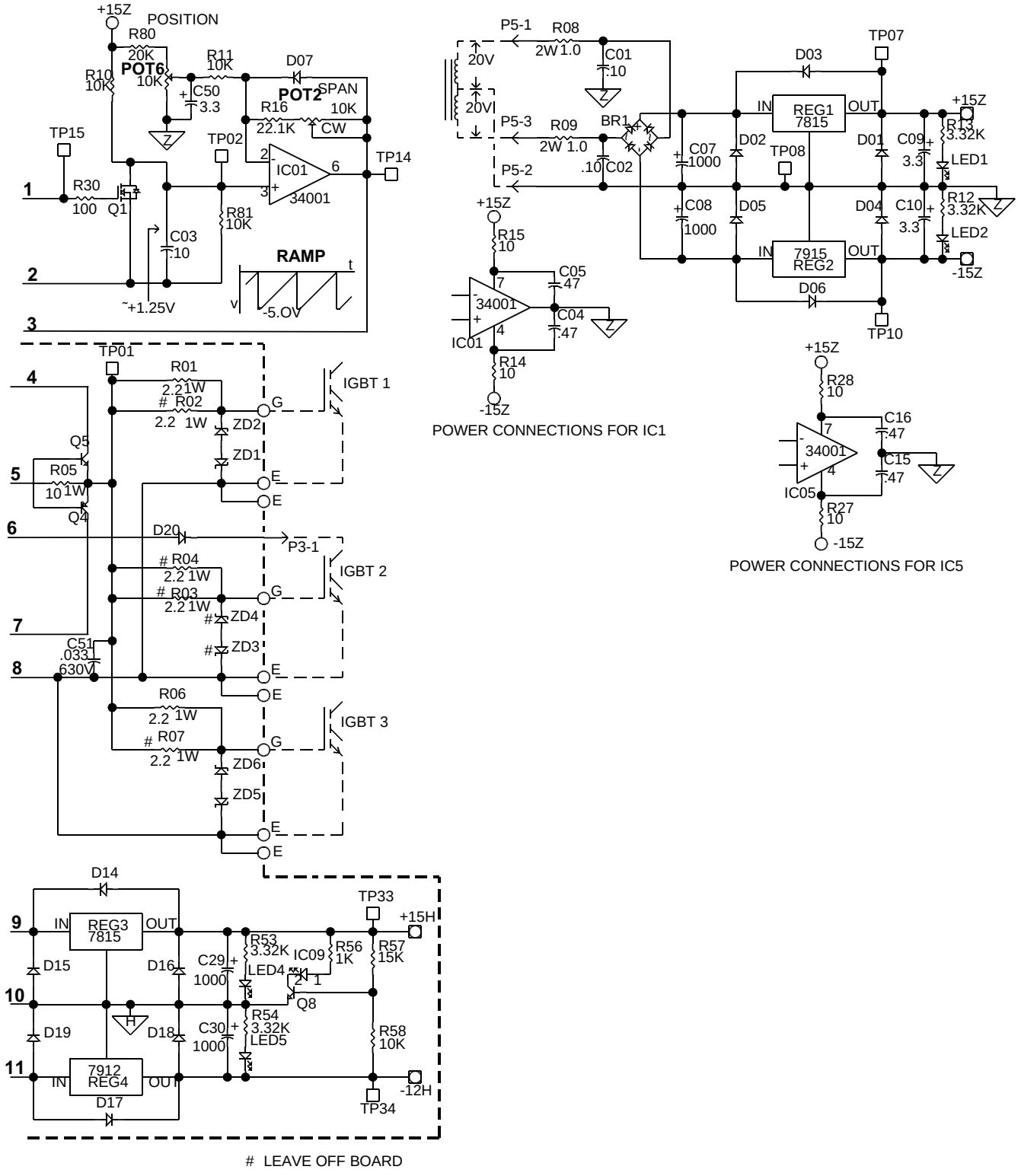
6.10 PCB Digital Meter Board (PCB4-P/N 38139) Drawing 2 Part 2



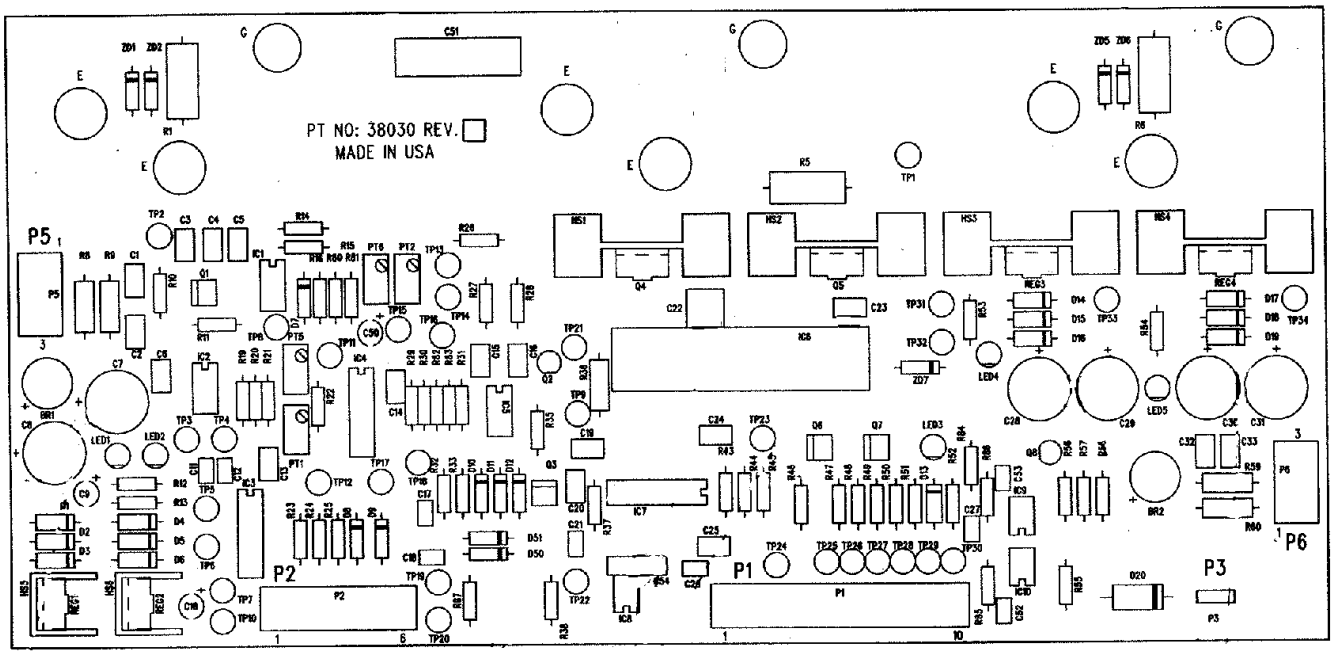
6.11 IGBT Driver Board (PCB2,3 – P/N 38030) Drawing 1 Part 1



6.11 IGBT Driver Board (PCB2,3 – P/N 38030) Drawing 1 Part 2



6.11 IGBT Driver Board (PCB2,3 – P/N 38030) Drawing 2



7.1 General

Always provide the serial number of the unit on which the parts will be used. The serial number is stamped on the unit nameplate.

7.2 Ordering

To ensure proper operation, it is recommended that only genuine ESAB parts and products be used with this equipment. The use of non-ESAB parts may void your warranty.

Replacement parts may be ordered from your ESAB Distributor or from:

ESAB Welding and Cutting Products
ATTN: Customer Service Department
PO Box 100545 Ebenezer Road
Florence, SC USA 29501-0545
Phone (843) 664-4405
(800) ESAB-123 (372-3123)

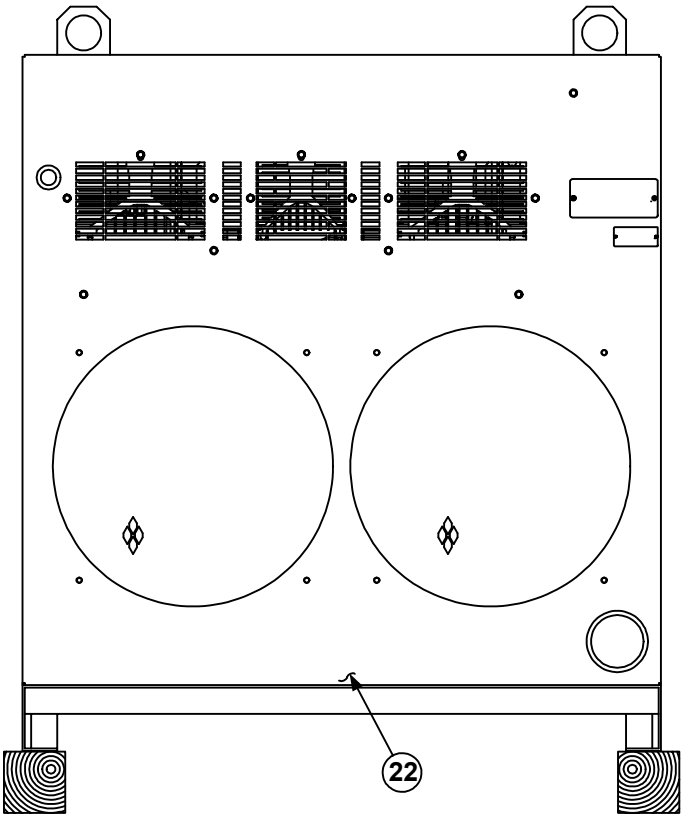
ESAB Cutting Systems - Canada
6010 Tomken Road
Mississauga, Ontario, Canada L5T 1X9
Phone (905) 670-0220
Fax (905) 670-4879

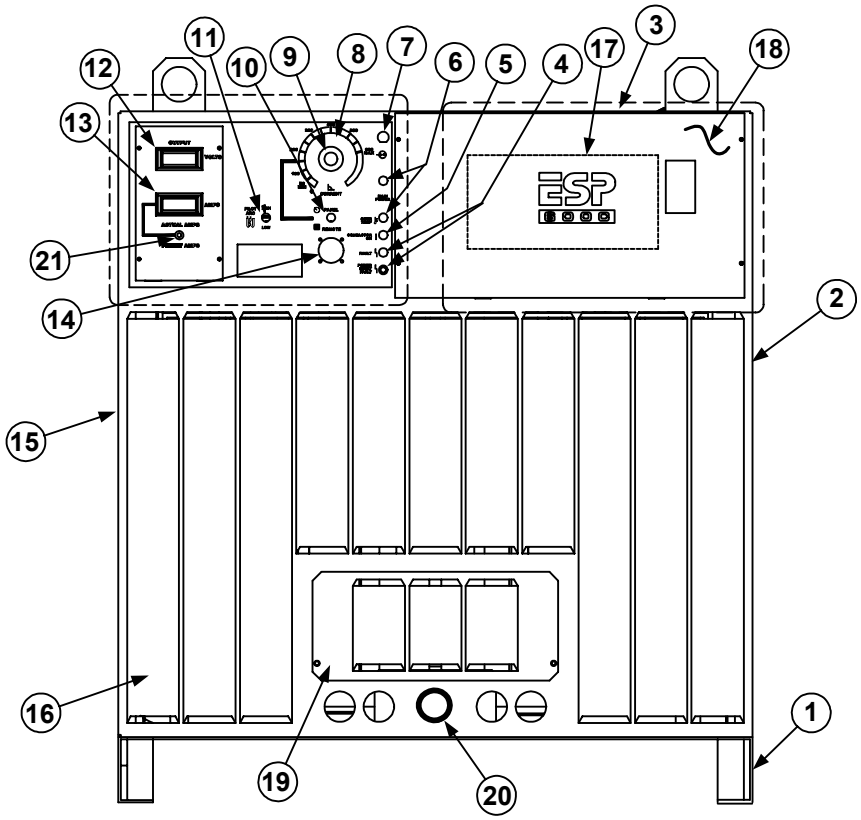
ESAB Cutting Systems GmbH
Robert-Bosch-Strasse 20
P.O. Box 1128
D-61184 Karben
Phone +011 49 60 39 400
Fax +011 49 60 39 40301 02
http://www.esab.de

Be sure to indicate any special shipping instructions when ordering replacement parts.

Refer to the Communications Guide located on the last page of this manual for a list of customer service phone numbers.

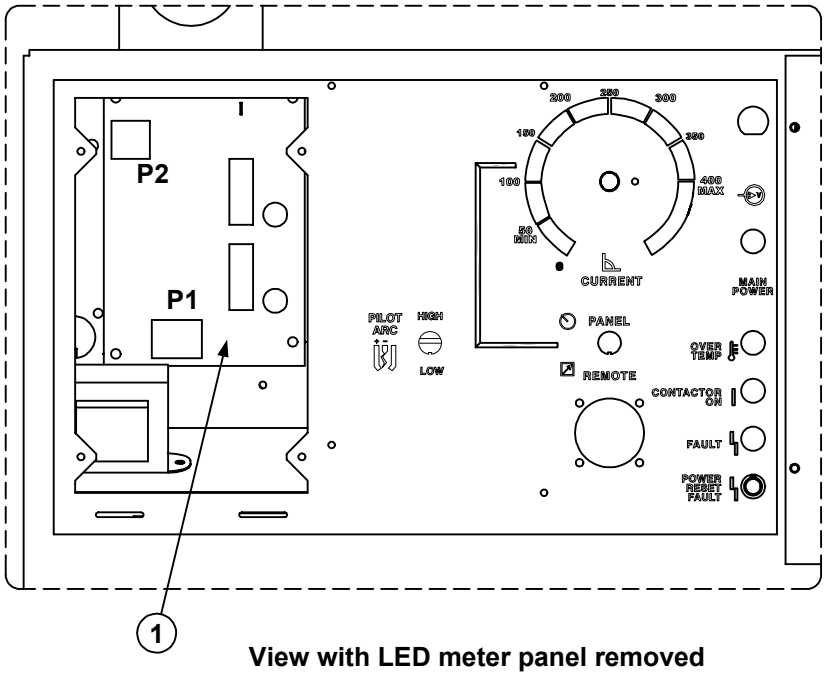
7.3 Outside View – Front And Back



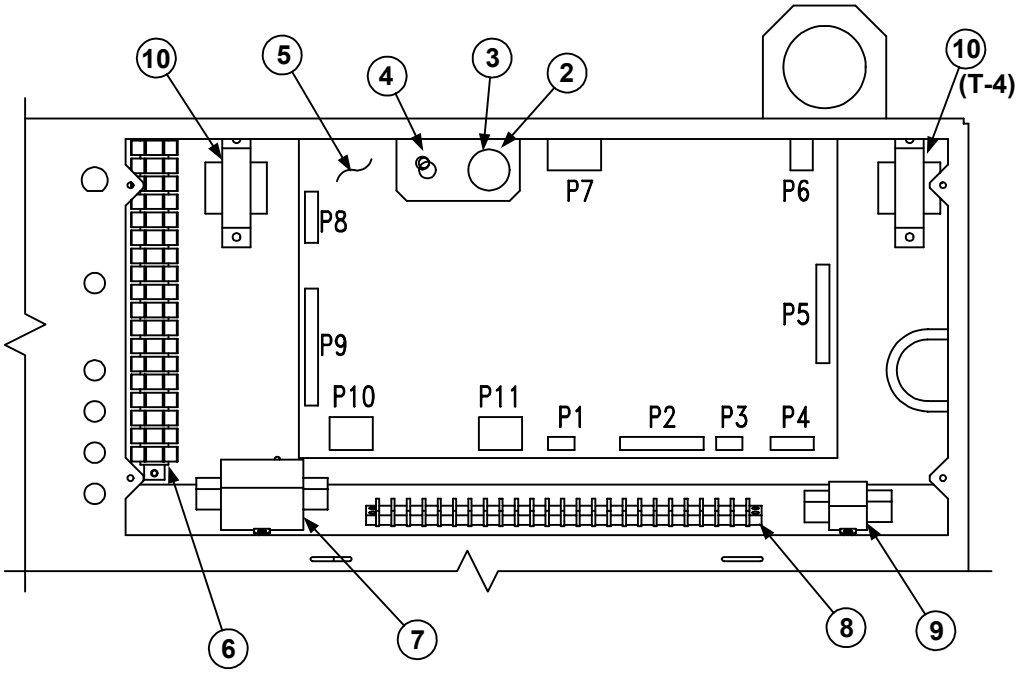


Item No	Qty	Part Number	Description	Circuit Symbol
1	1	35749	Base	
2	1	35751	Panel Right Side	
3	1	35753	Cover Top	
4	2	951032	Lamp LED Red 12V	PL4, PL5
5	1	2134926	Lamp Indicator Amber	PL3
6	2	951526	Lamp Neon White	PL1, PL2
7	1	950122	Circuit Breaker 10A	CB1
8	1	950715	Potentiometer 15K 2W	R50
9	1	2062170	Knob	
10	1	634518	Switch Toggle DPDT 2 pos	S2
11	1	672508	Switch 10GL 3pst 2 pos	S1
12	1	951061	Meter LED 5VDC 200MN #dp-350	VM
13	1	951061	Meter LED 5VDC 200MN #dp-350	AM
14	1	1006733	Conn Box Recp 19P	J1
15	1	35752	Panel Left Side	
16	1	35722	Panel Front	
17	1	954932	Label PC Box Cover –ESP-400C	
18	1	32338GY,BK,DG	Plate Cover ESP-400C	
19	1	35822GY,BK,DG	Access Door	
20	5	993426	Grommet Rubber 1.5 ID	
21	1	634516	Switch Toggle SPDT 2 pos 10A 250V Q/D	S4
22	1	35750GY,BK,DG	Rear Panel	

7.4 Front View With PCBs Exposed



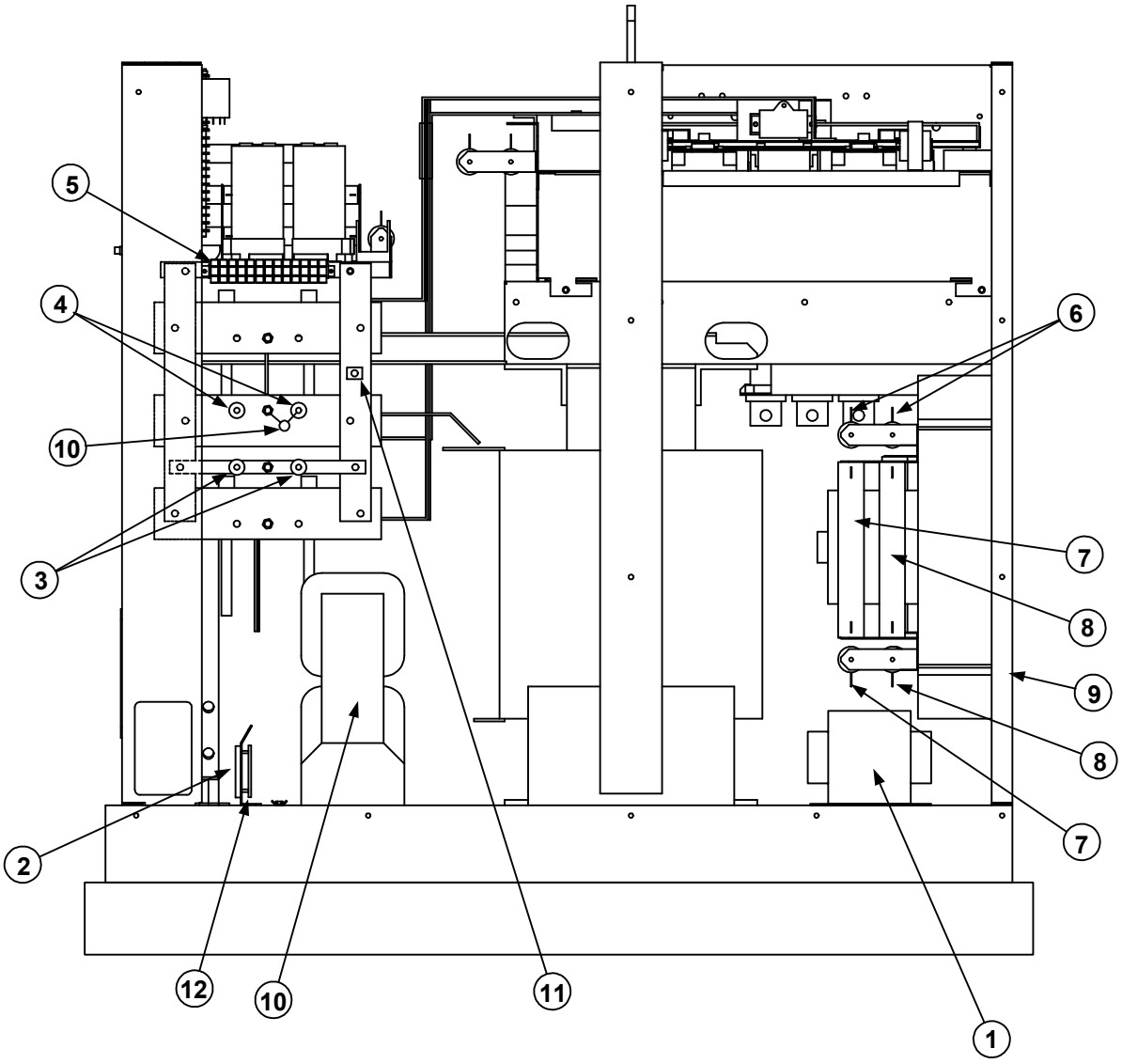
View with LED meter panel removed



View with PCB Cover Removed

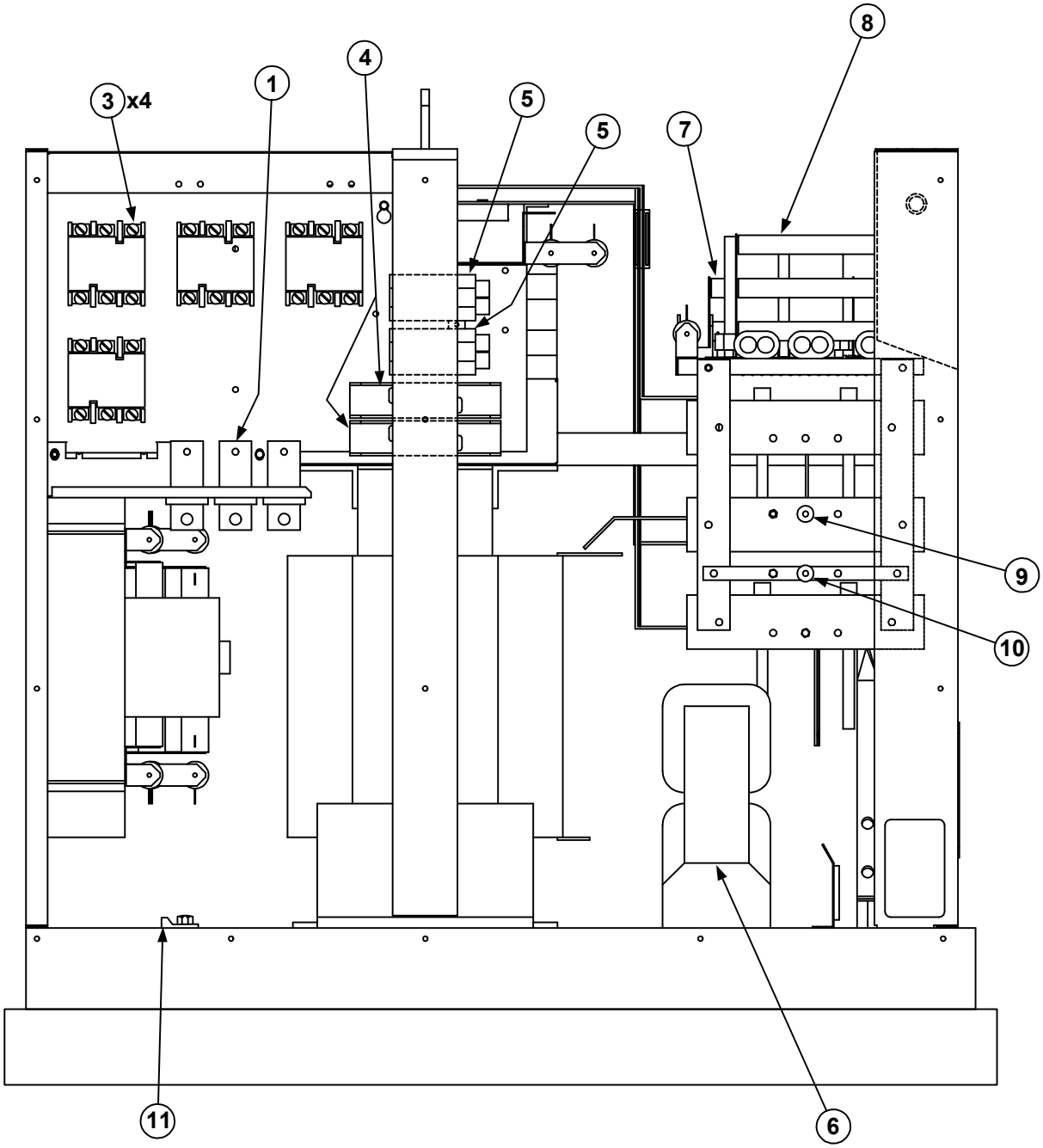
Item No	Qty	Part Number	Description	Circuit Symbol
1	1	38139	PCB Meter Digital	PCB4
2	1	2062018	Potentiometer 10 K 2W	R51
3	1	951502	Knob	
4	1	950458	Switch Toggle DPDT 3 pos	S3
5	1	38032	PC Board Control	PCB1
6	1	635568	Terminal Block 18 pos	TB1
7	1	951275	Filter RFI	FN4
8	1	995103	Terminal Strip 24 pos	TB9
9	1	950116	Filter OMI	FN3
10	1	35779	Kit Wire 600C Control 460/575V	

7.5 Right Side View



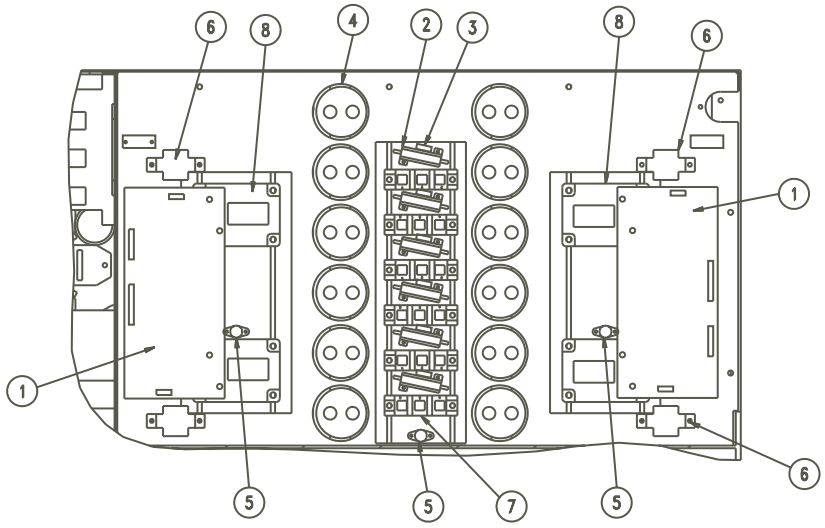
Item No	Qty	Part Number	Description	Circuit Symbol
1	1	35717	Transformer Control	T2
2	2	674969	PCB Filter	FN1,2
3	4	950704	RECT SIL Reverse 85A	D29,30,35
4	3	950703	RECT SIL Forward 85A	D31,32,34
5	1	973168	Terminal Strip 13 pos	TB7
6	7	17300008	Resistor 8 OHM 300W	R12-17,24
7	6	17300001	Resistor 1 OHM 300W	R1-3,21-23
8	3	17300004	Resistor 4 OHM 300W	18-20
9	1	35750	Panel Rear	
10	1	35710	Inductor	L2
11	1	0558002525	Potted Resistor Assembly	PRA1
12	6	950631	PC Board Support	

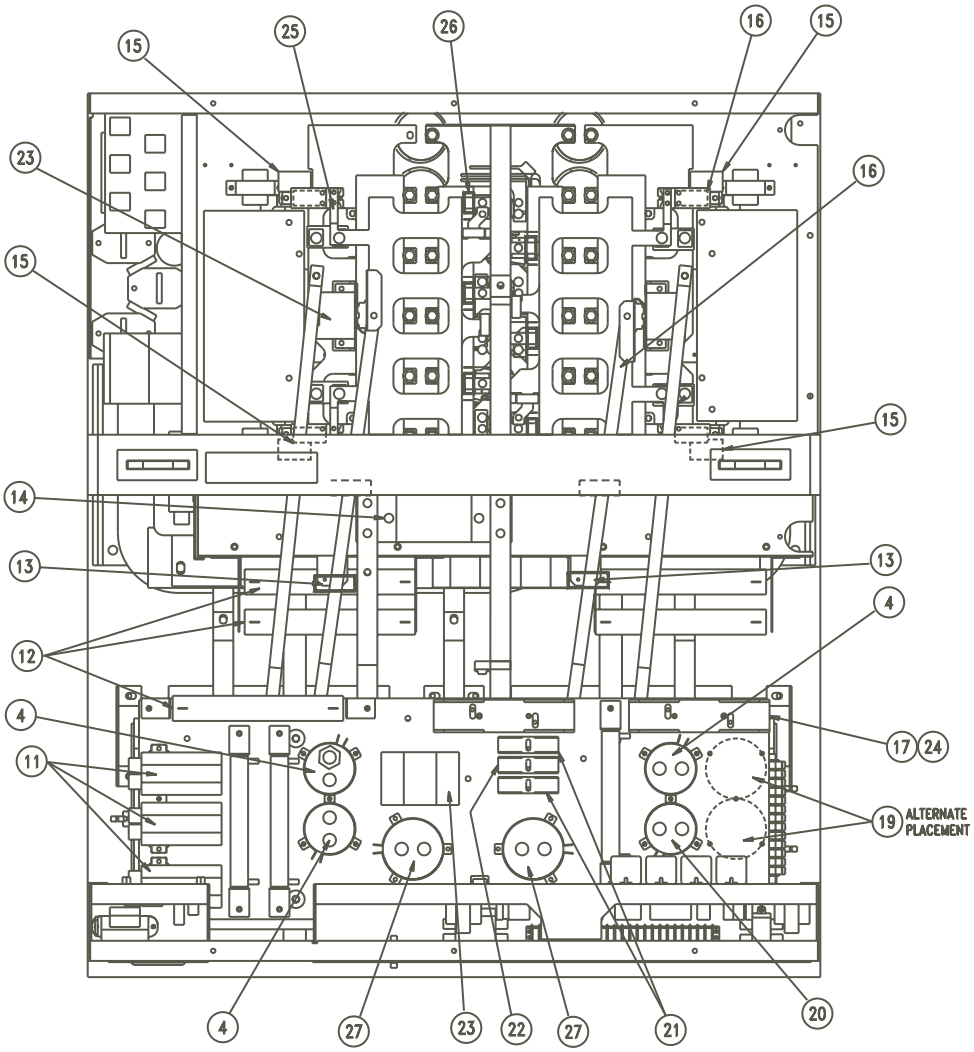
7.6 Left Side View



Item No	Qty	Part Number	Description	Circuit Symbol
1	3	35895	Kit Wire 600C 400V	C60,61,62, R55-57
3	4	951491	Contactor 3 pole 90A	K2,K1a,1b,1c
4	2	2046333	Fuse Slo-Blo 15A 600V	F1,2
5	2	672772	Capacitor 10 uf 370V	C25,26,34-36
6	2	17280210	Resistor 1K ohms 100W	R10,11,28-31
7	3	17280010	Resistor 10 ohms 100W	R25,26,27
8	1	950703	RECT SIL Forward 85A	D34
9	1	950704	RECT SIL Reverse 85A	D33
10		35710	Inductor (REF)	L1,2
11	1	952002	Core, Saturable Amorphos	

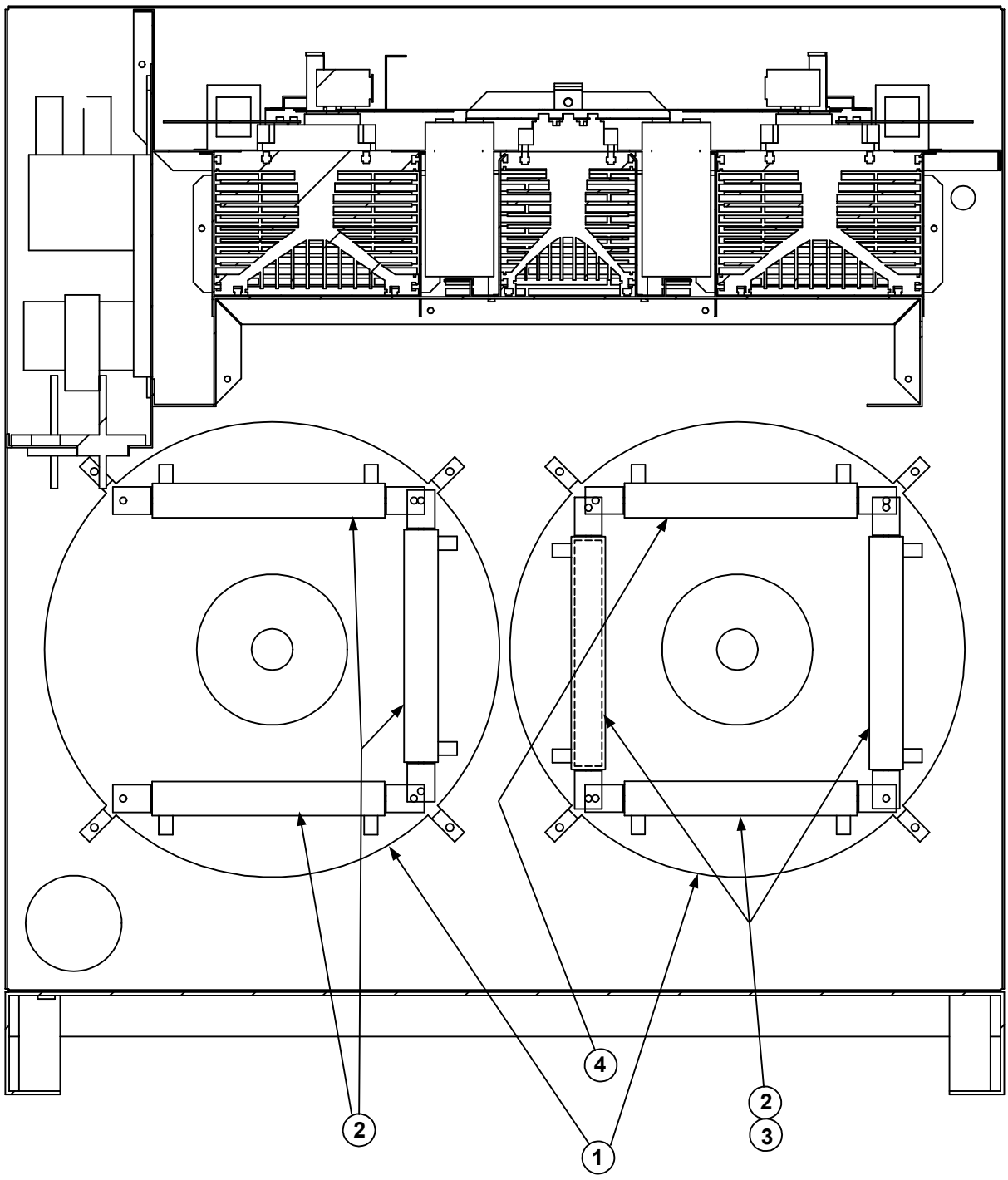
7.7 Top View


6
8
4
2
3
8
6
1
1
5
5
7
5
6


15
25
26
16
15
23
16
15
15
14
13
13
12
4
4
11
17
24
19
ALTERNATE PLACEMENT
4
27
23
22
27
21
20

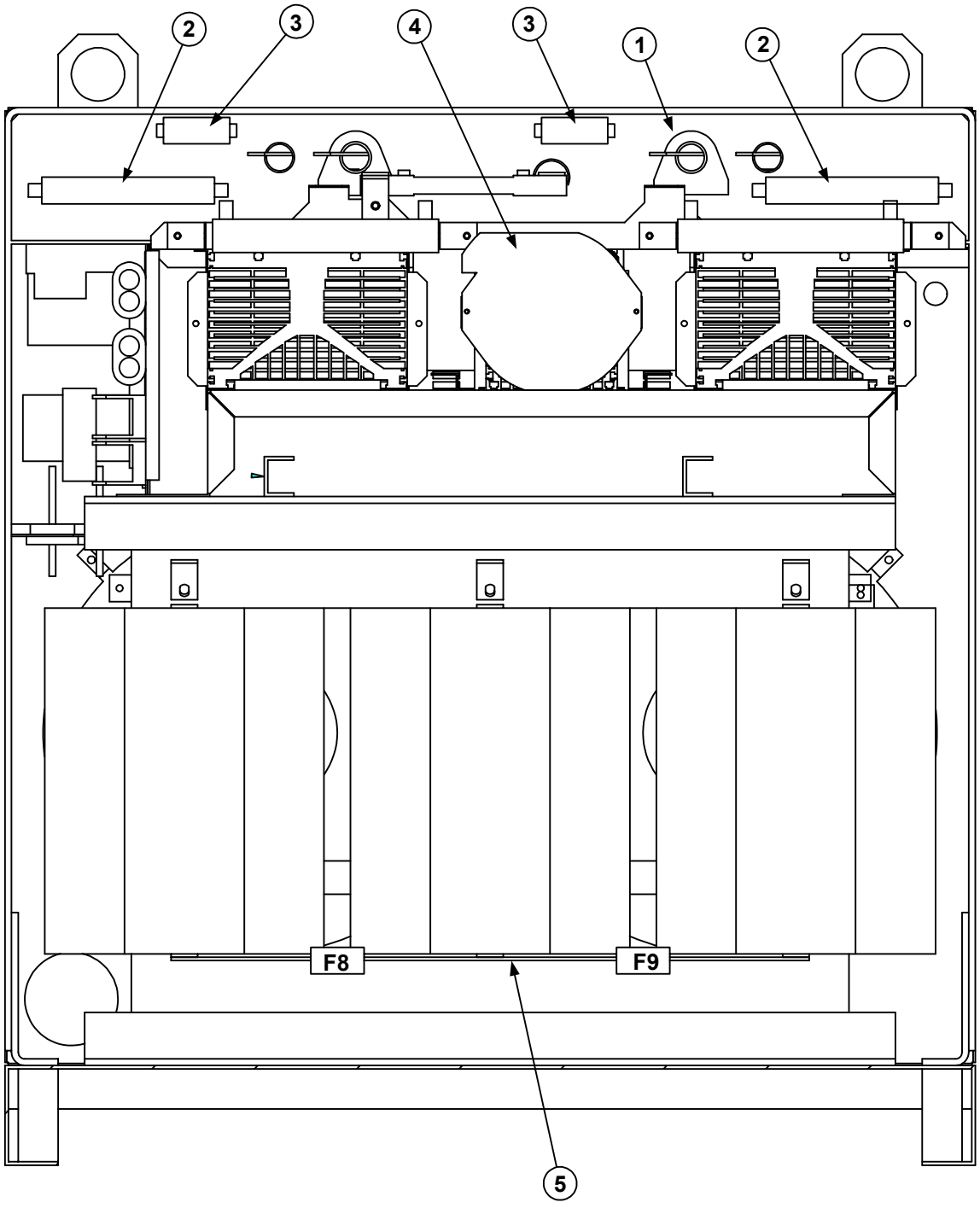
Item No	Qty	Part Number	Description	Circuit Symbol
1	2	38030	PCB IGBT Driver	PCB2,3
2	6	17750051	Resistor 10ohm 50W Noninductive	R4-9
3	6	951828	Capacitor .033 µf 630V	C13-18
4	15	951635	Capacitor 1900 µf 450V	C1-12,29,32,33
5	3	951085	Switch Thermal 176 DEG F	TS4-6
6	4	35779	Kit Wire ESP Control 460/575V	
7	6	0558001020	Module Diode Dual 100A 600V	D1-6
8	2 pr	951951	IGBT Matched Pair 600A 600V	
9				
10	4	950704	RECT SIL Reverse 85A	
11	5	672772	Capacitor 10 µf 370V	C25,26,34,35,36
12	5	17300008	Resistor 8 ohm 300W	R12-15,24
13	2	0558002348	Transducer Current	TD1,2
14	1	951223	Shunt 100mV 500A	SH1
15	4	951998	Capacitor .27 µf 1200 VDC	C19-22
16	4	951996	Module Dual Diode Rectifier 600V 30A	D19,22
17	2	2046333	Fuse Slo-Blo 15A 600V	F3,4
18				
19	2	951802	Capacitor 2900 µf 450V	C27,28
20	1	950255	Capacitor 60 µf 370V	C30
21	2	2062357	Fuse Slo-Blo 30A 250V	F5,7
22	1	951527	Fuse 15A	F6
23	1	673458	Contactor 3 pole 40A	K4
24	2	952103	Fuse holder 60A	
25	4	951199	Core Saturable	
26	6	952002	Core Saturable Amorphous	
27	2	0558002435	Capacitor 3100 µf 450V	C27,28

7.8 Back Inside View



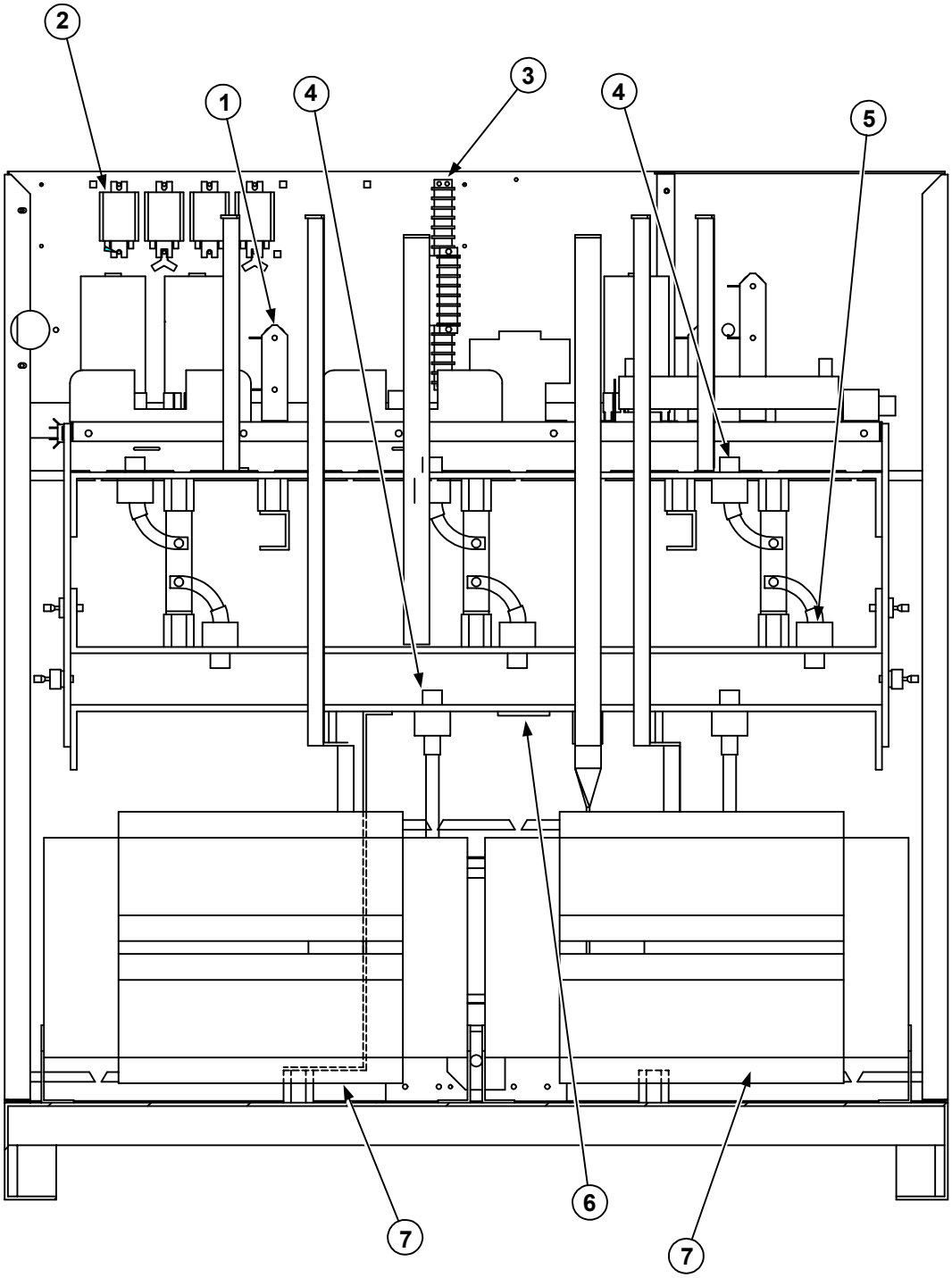
Item No	Qty	Part Number	Description	Circuit Symbol
1	2	2062334	Motor Fan 1/3 hP	M1,2
2	6	17300001	Resistor 1 ohm 300W	R1-3,21-23
3	3	17300004	Resistor 4 ohm 300W	R18-20

7.9 Middle Cross Section



Item No	Qty	Part Number	Description	Circuit Symbol
1	2	951997	Transducer Current (ref)	TD1,2
2	2	17280210	Resistor 1K ohms 100W	R10,11
3	2	23610413	Resistor 2 ohms 25W	R53,54
4	1	951816	Fan 230 V 50/60 Hz	M3
5	1	677298	Fuse Assembly	F8,9

7.10 Front Cross Section –Behind Front Panel



Item No	Qty	Part Number	Description	Circuit Symbol
1	6	17280210	Resistor 1k ohms 100W	R10,11,28-31
2	4	2080196	Relay 3 pos brkt MT	K3,5,6,7
3	1	0558004783	Terminal Block 18 pos	TB8
4	10	13730638	Diode Rectifier Reverse 800V 300A	D7-12,25-28
5	6	13730639	Diode Rectifier Forward 800V 300A	D13-18
6	1	950711	Switch Thermal 194 DegF	TS7
7	2	35710	Inductor	L1,2

This page intentionally left blank.

REVISION HISTORY

1. Revision – Oct., 2004 – Added "1 - 14 AWG 600V lead to pilot arc connection in plumbing box (h.f. generator)" note to top diagram on page 3-7. Changed note 4 to read - "Connect the pilot arc cable to the pilot arc terminal in the primary power source. The pilot arc connection in the secondary power source is not used. The pilot arc circuit is not run in parallel" on page 3-7. Modified bottom diagram and changed note to read – "Disconnect negative connection from secondary power source and insulate to convert from two to one power source" on page 3-7.
2. Revision - June, 2005 - Section 6, Replaced 6.7 wiring diagram - drawing 1 - part 1 400v 50Hz to show new white wire connection from H2 to H4 on page 6-37.

Customer // Technical Support

(843) 664-4405
(800) ESAB-123 (372-2123)

ESAB Welding and Cutting Products
PO BOX 100545 Ebenezer Road
Florence, SC 29501-0545
http://www.esab.com

ESAB Cutting Systems – Canada
6010 Tomken Road
Mississauga, Ontario Canada L5T 1X9
Phone: (905) 670-0220
Fax: (905) 670-4879

ESAB-Hancock GmbH
Cutting Technologies
P.O Box 1128
D-61174 Karben
Robert-Bosch-Strasse 20
D-61184 Karben
Phone + 49 60 39 40-0
Fax + 49 60 39 40 301_302
http://www.esab.com
esab_info@compuserve.com

ESAB® **CUTTING SYSTEMS**

Printed in U.S.A