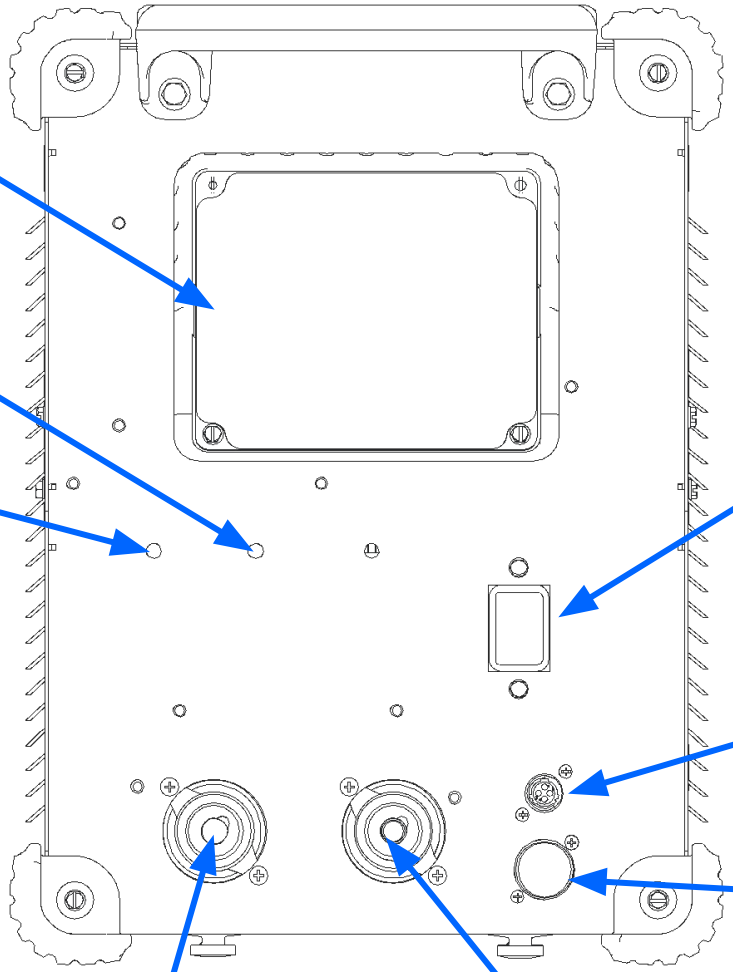
Power Wave® S350 CE & STT Module Service Training

OUTPUT CABLE GUIDELINES (Table A.1)

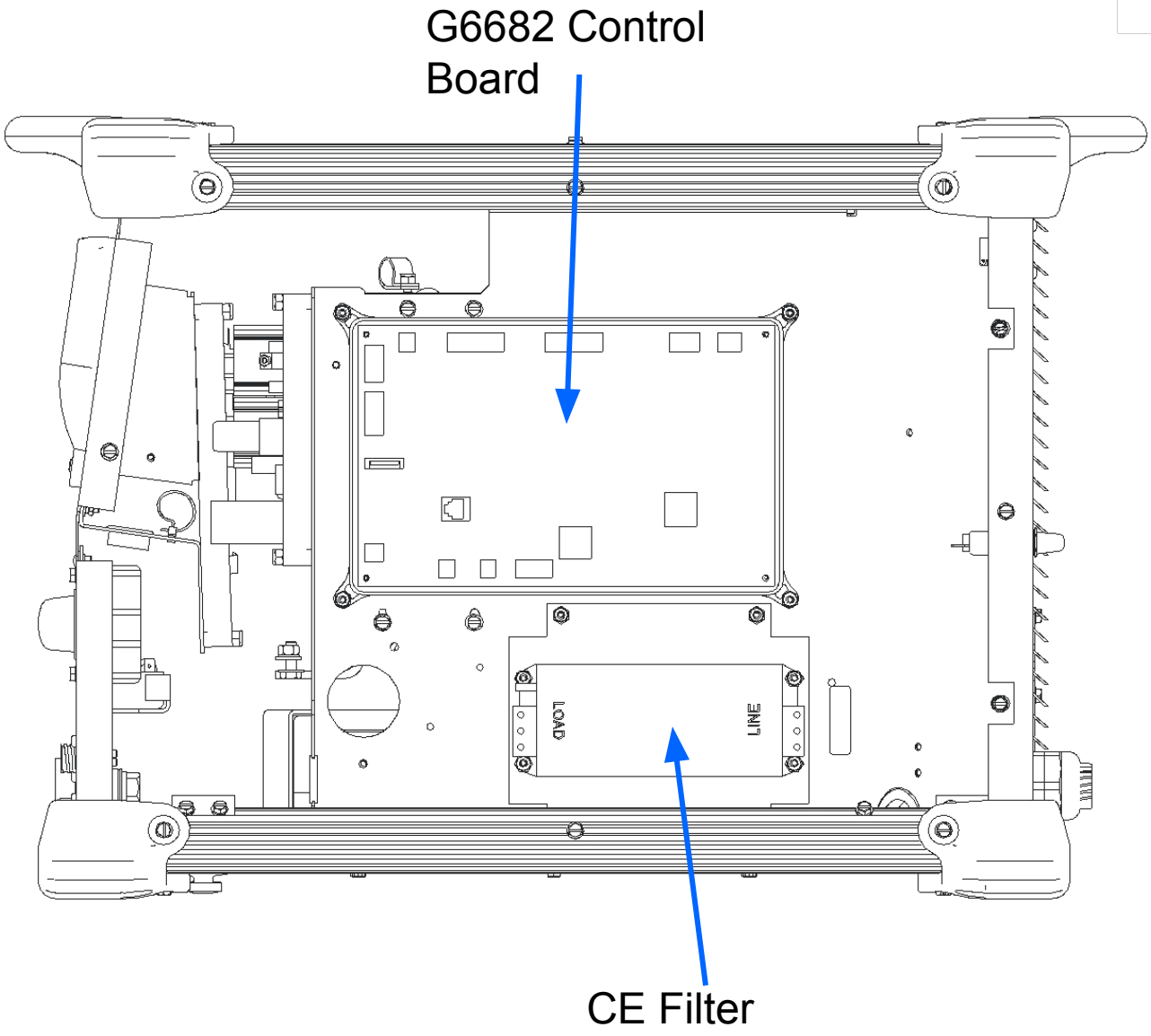
Amperes	Percent Duty Cycle	CABLE SIZES FOR COMBINED LENGTHS OF ELECTRODE AND WORK CABLES [RUBBER COVERED COPPER - RATED 167°F (75°C)]**				
		0 to 50 Ft.	50 to 100 Ft.	100 to 150 Ft.	150 to 200 Ft.	200 to 250 Ft.
200	60	2	2	2	1	1/0
200	100	2	2	2	1	1/0
250	30	3	3	2	1	1/0
250	40	2	2	1	1	1/0
250	60	1	1	1	1	1/0
250	100	1	1	1	1	1/0
300	60	1	1	1	1/0	2/0
300	100	2/0	2/0	2/0	2/0	3/0
350	40	1/0	1/0	2/0	2/0	3/0

** Tabled values are for operation at ambient temperatures of 104°F (40°C) and below. Applications above 104°F (40°C) may require cables larger than recommended, or cables rated higher than 167°F (75°C).

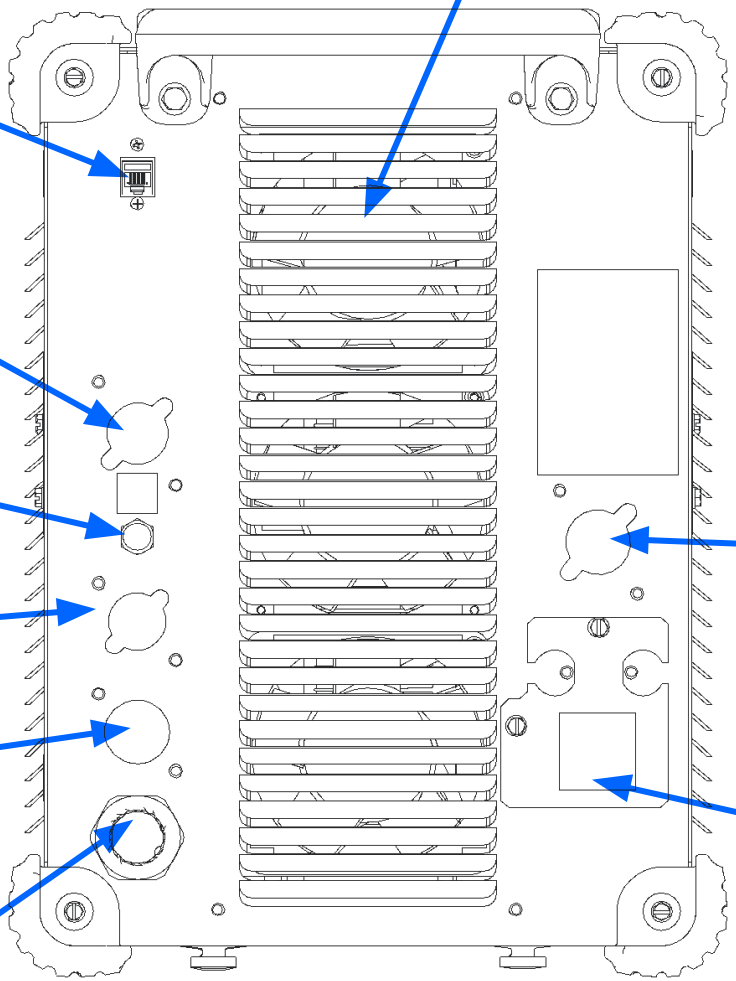
S350CE


No optional UI kit
Thermal LED
Fault LED
On/Off Switch
4 pin Work Sense
5 pin ArcLink Connector
“-” TwistMate (Dinse)
“+” TwistMate (Dinse)

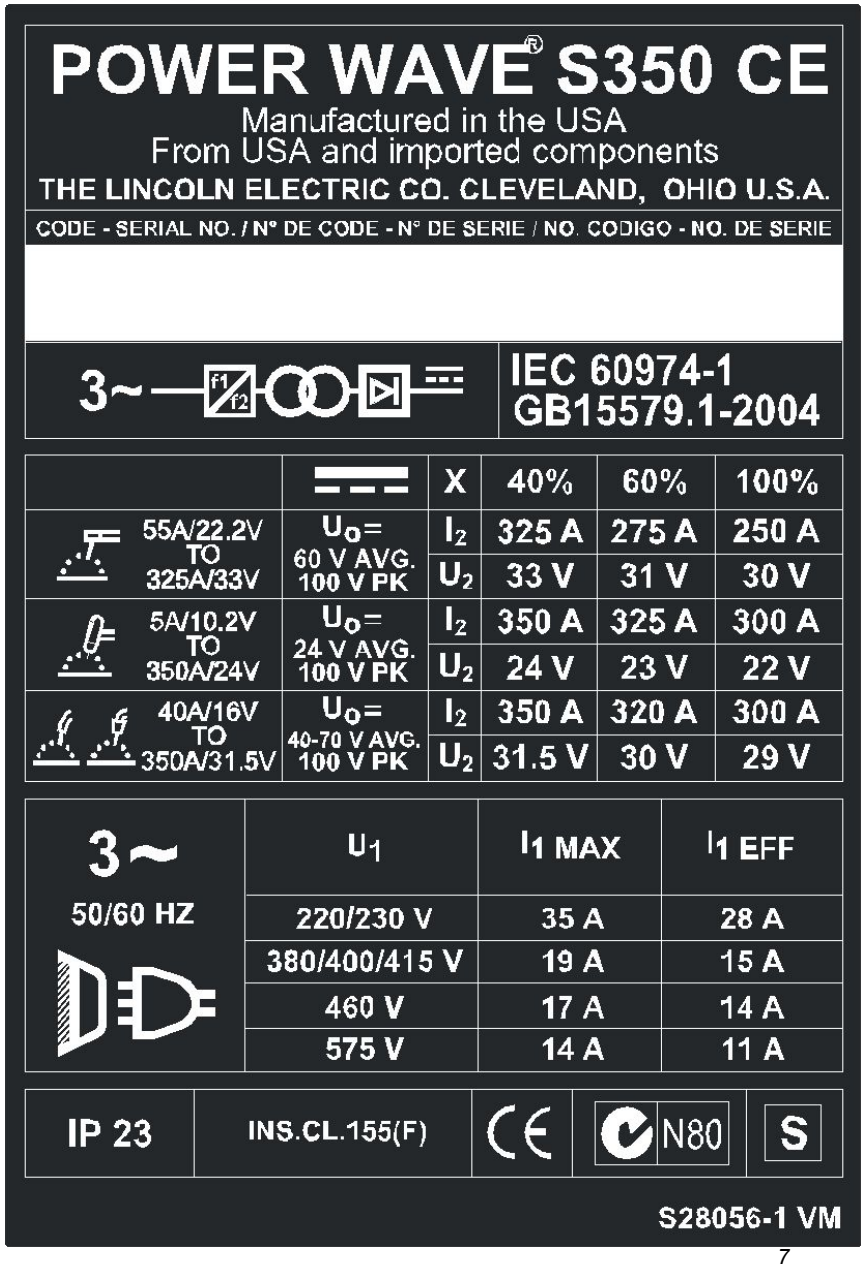
S350CE



S350CE


Easy access fans
EtherNET
Not Used
Circuit Breaker
Sync Tandem STT Connector, part of STT module
Optional DeviceNET
Line Cord
Future Development
Water cooler Connection access panel

S350CE



POWER WAVE® S350 CE

Manufactured in the USA
From USA and imported components
THE LINCOLN ELECTRIC CO. CLEVELAND, OHIO U.S.A.

CODE - SERIAL NO. / N° DE CODE - N° DE SERIE / NO. CODIGO - NO. DE SERIE

3~ — f1/f2 — IEC 60974-1 GB15579.1-2004

		X	40%	60%	100%
55A/22.2V TO 325A/33V	U_o= 60 V AVG. 100 V PK	I_2	325 A	275 A	250 A
		U_2	33 V	31 V	30 V
5A/10.2V TO 350A/24V	U_o= 24 V AVG. 100 V PK	I_2	350 A	325 A	300 A
		U_2	24 V	23 V	22 V
40A/16V TO 350A/31.5V	U_o= 40-70 V AVG. 100 V PK	I_2	350 A	320 A	300 A
		U_2	31.5 V	30 V	29 V

3~ 50/60 HZ

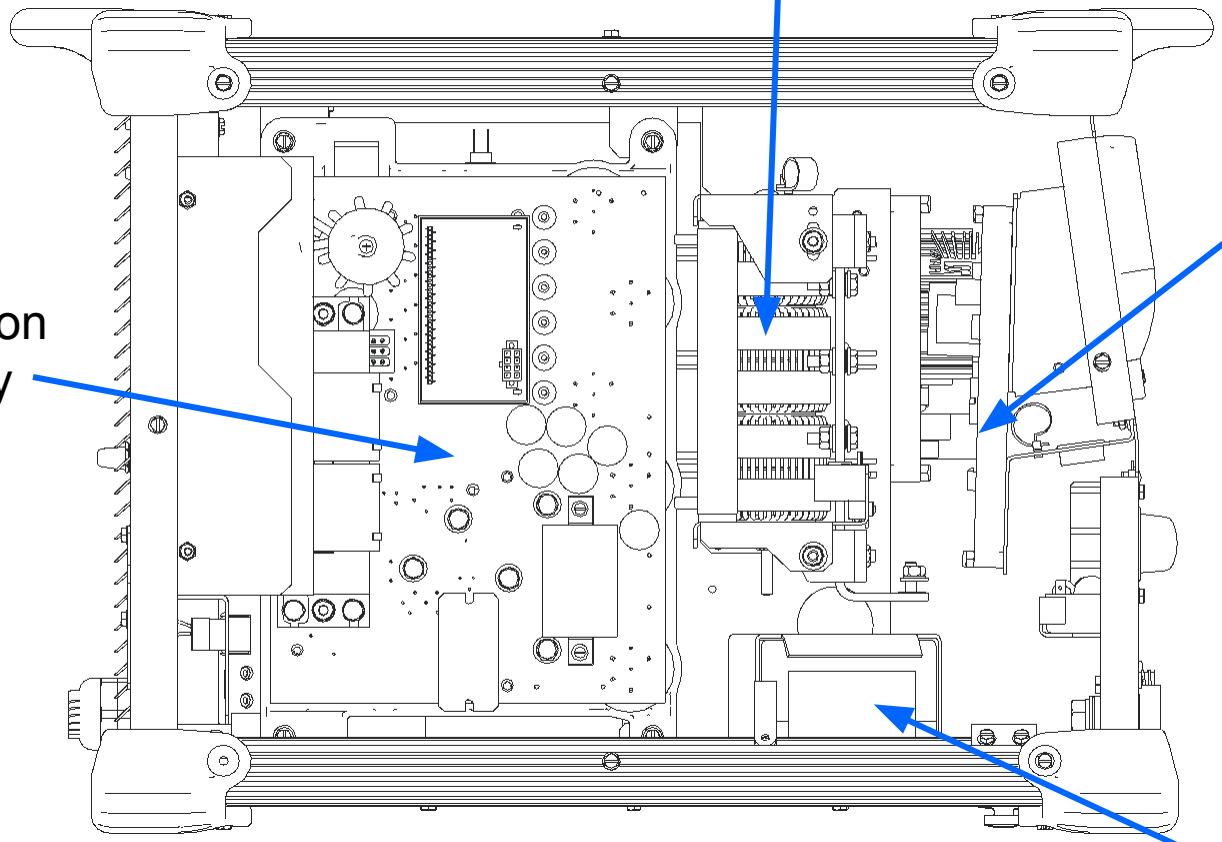
U_1	$I_{1\ MAX}$	$I_{1\ EFF}$
220/230 V	35 A	28 A
380/400/415 V	19 A	15 A
460 V	17 A	14 A
575 V	14 A	11 A

IP 23 | INS.CL.155(F) | CE | N80 | S

S28056-1 VM

- 3 phase only
- Replace line cord when operating over 450 VAC

S350CE


Output
Choke
Input
Control
Board
Power
Conversion
Assembly
Input Choke

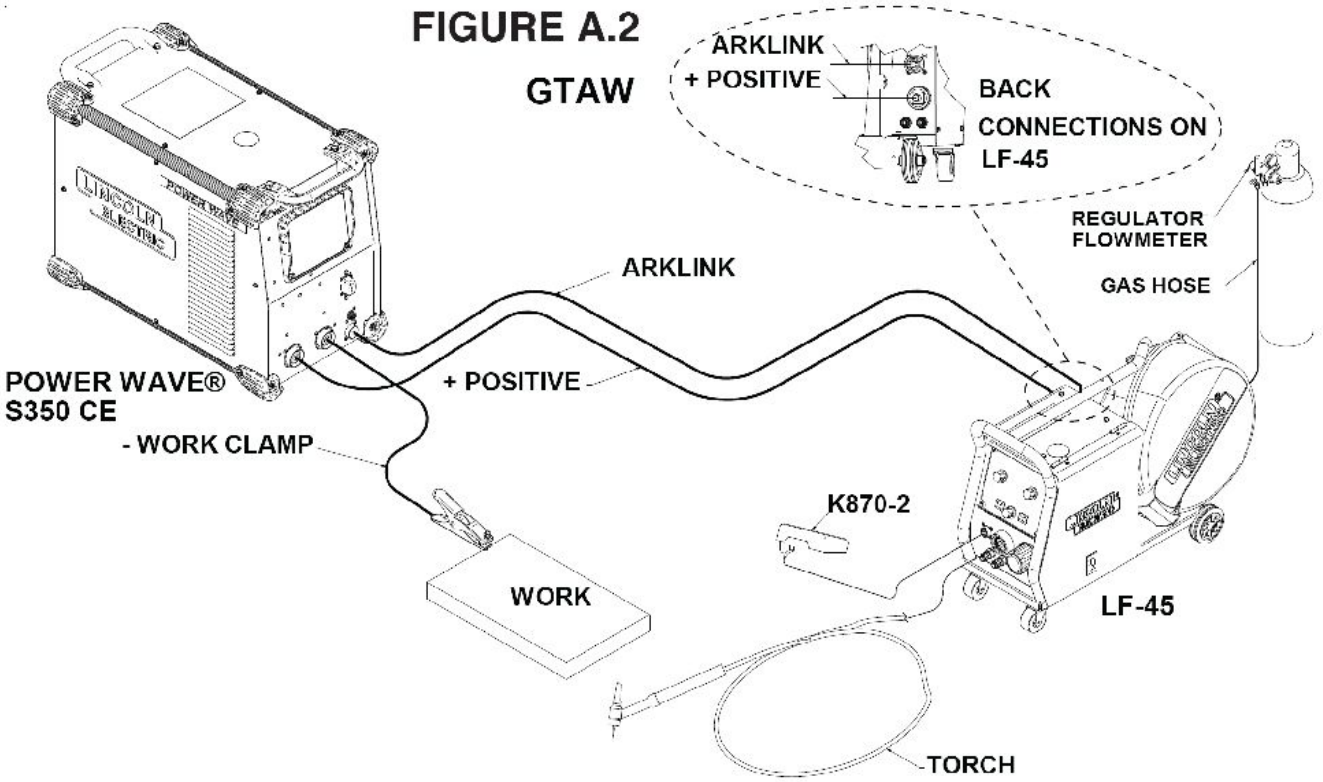
CONNECTION DIAGRAMS

GTAW (TIG) WELDING

TIG welding from a LF-45 wire feeder can be used with the power source as shown in **(Figure A.2)**,

FIGURE A.2

GTAW

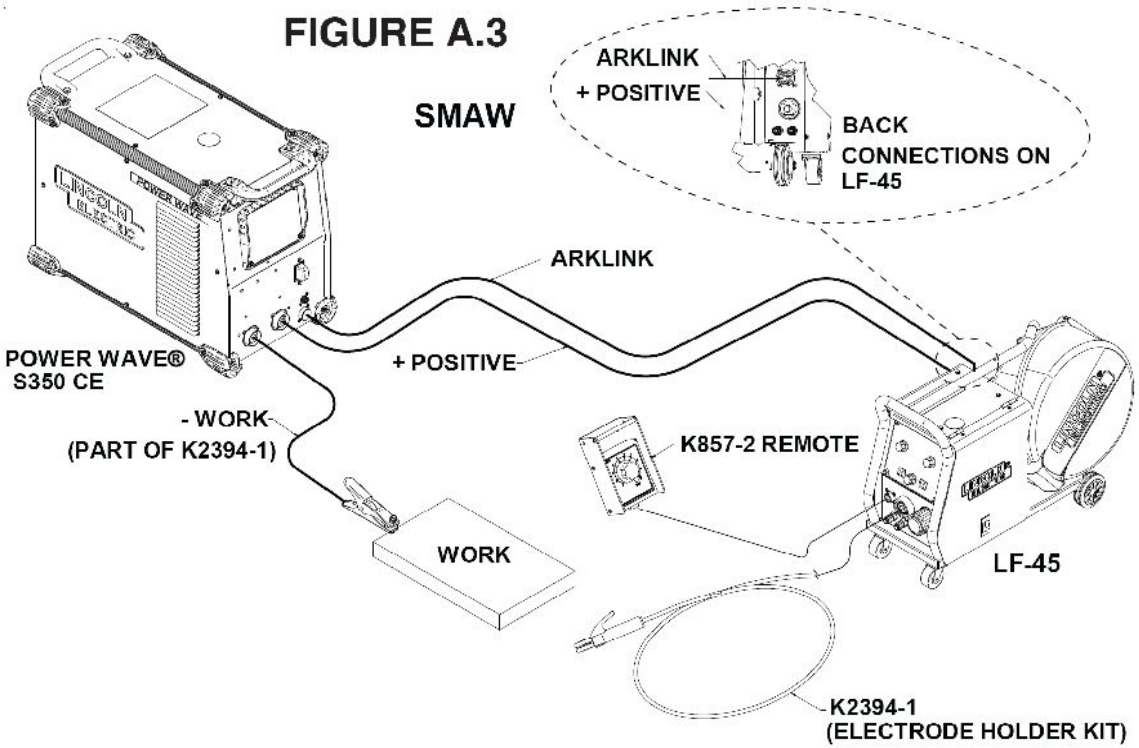


SMAW (STICK) WELDING

Stick welding from a LF-45 wire feeder can be used with the power source as shown in **(Figure A.3)**.

FIGURE A.3

SMAW

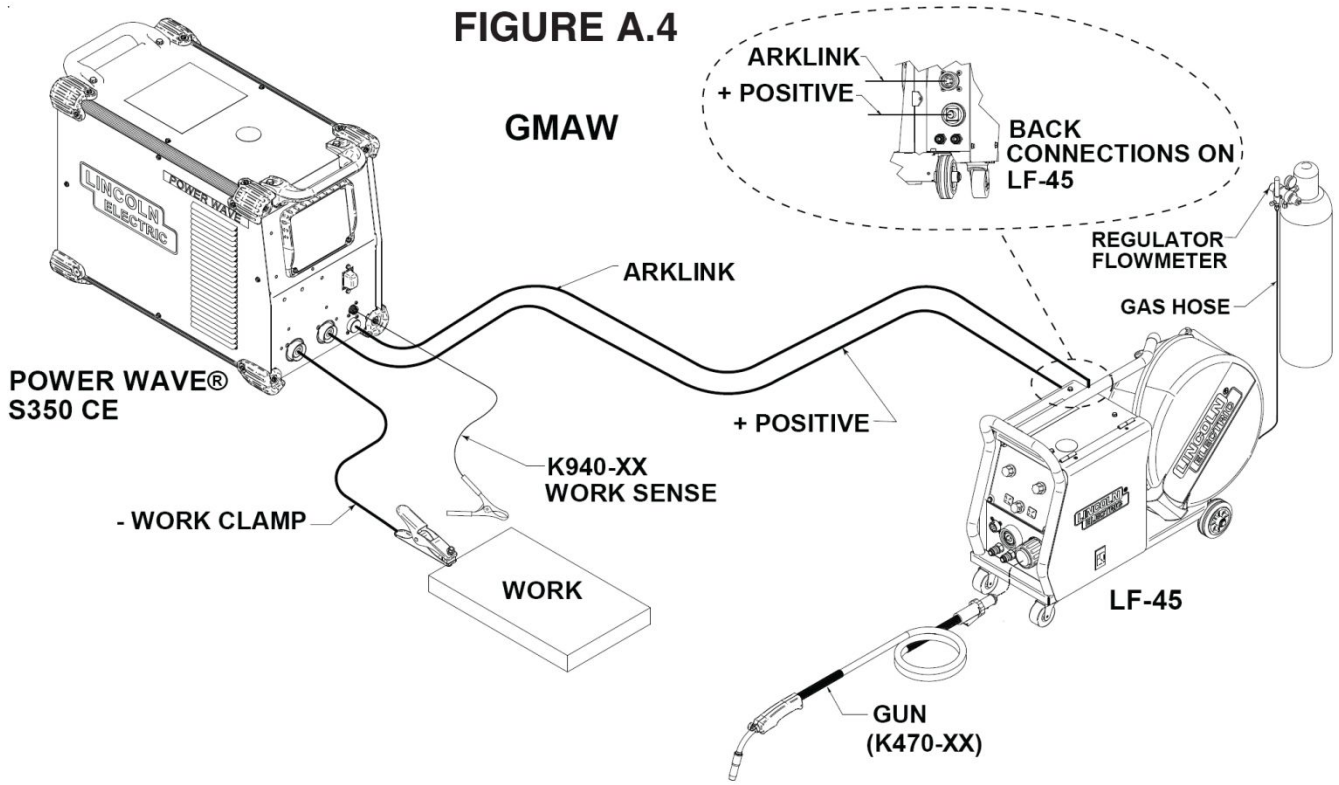


GMAW (MIG) WELDING

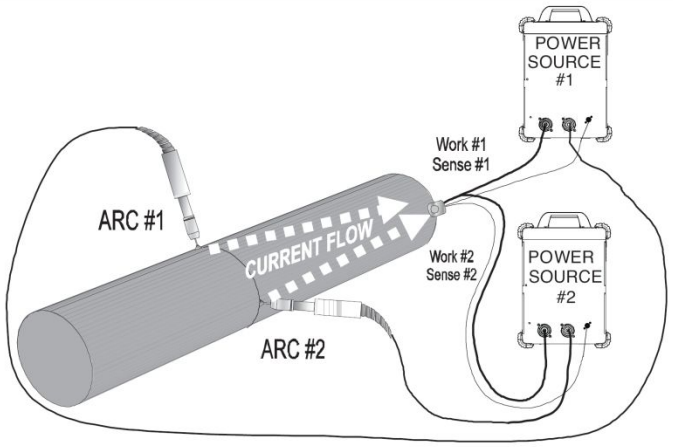
MIG welding from a LF-45 wire feeder can be used with the power source as shown in **(Figure A.4)**.

FIGURE A.4

GMAW

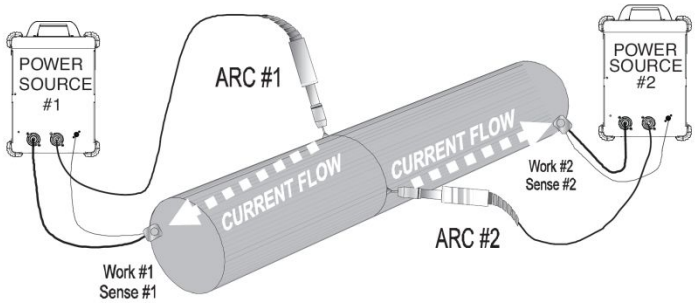


POWER WAVE® S350CE



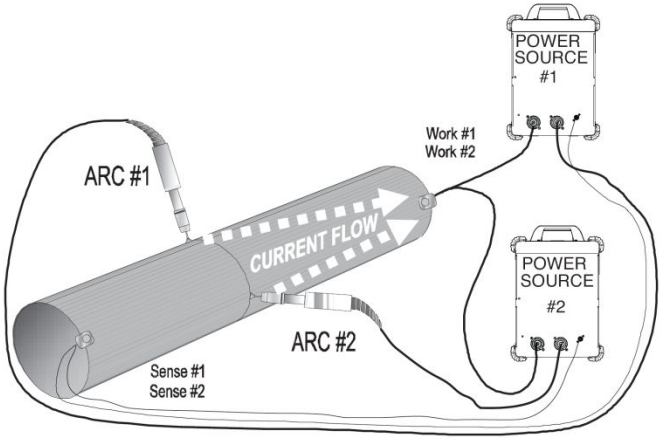
BAD

- CURRENT FLOW FROM ARC #1 AFFECTS SENSE LEAD #2
- CURRENT FLOW FROM ARC #2 AFFECTS SENSE LEAD #1
- NEITHER SENSE LEAD PICKS UP THE CORRECT WORK VOLTAGE, CAUSING STARTING AND WELDING ARC INSTABILITY



BETTER

- SENSE LEAD #1 IS ONLY AFFECTED BY CURRENT FLOW FROM ARC #1
- SENSE LEAD #2 IS ONLY AFFECTED BY CURRENT FLOW FROM ARC #2
- DUE TO VOLTAGE DROPS ACROSS THE WORKPIECE ARC VOLTAGE MAY BE LOW, CAUSING NEED FOR DEVIATION FROM STANDARD PROCEDURES



BEST

- BOTH SENSE LEADS ARE OUT OF THE CURRENT PATHS
- BOTH SENSE LEADS DETECT ARC VOLTAGE ACCURATELY
- NO VOLTAGE DROP BETWEEN ARC AND SENSE LEAD
- BEST STARTS, BEST ARCS, MOST RELIABLE RESULTS

S350CE

LINCOLN® ELECTRIC

TABLE A.2

Process	Electrode Voltage Sensing (1) 67 lead	Work Voltage Sensing (2) 21 lead
GMAW	67 lead required	21 lead optional
GMAW-P	67 lead required	21 lead optional
FCAW	67 lead required	21 lead optional
GTAW	Voltage sense at studs	Voltage sense at studs
SMAW	Voltage sense at studs	Voltage sense at studs

(1) The electrode voltage sense lead (67) is automatically enabled by the weld process, and integral to the 5 pin arclink control cable (K1543-xx).

(2) When a work voltage sense lead (21) is connected the power source will automatically switch over to using this feedback (if the auto sense feature is enable).

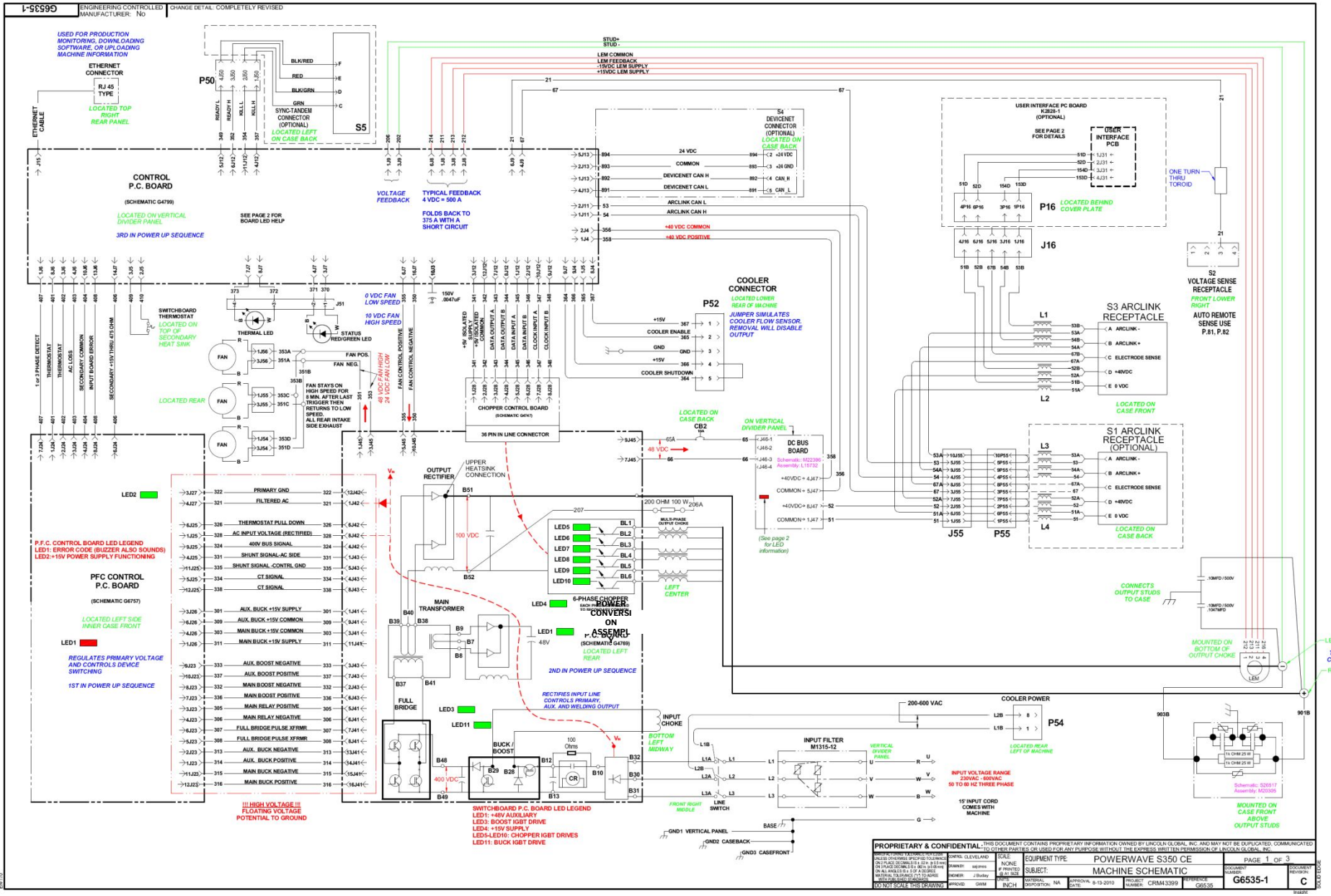
Feeder:

P.81	**Sense Leads Selection** Used in place of DIP switches for configuration of the work and electrode sense leads. This option will only appear in the list if the power source has a hardware selection option. • 67 pos polarity = An electrode sense lead is connected using positive polarity. This is used by most GMAW welding procedures. • 67 neg polarity = An electrode sense lead is connected using negative polarity. This is used by most GTAW welding procedures and some Innershield procedures. • 67 & 21 = An electrode sense lead and work sense lead are connected. Hardware Config = The hardware determines the best remote sensing configuration. This is applicable to MIG welding procedures only.

S350CE

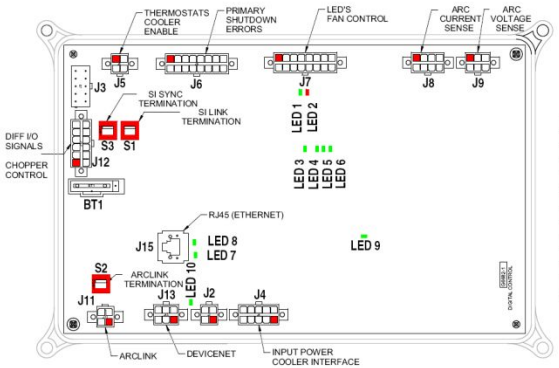
- Software Location
  - Control Board
- Hardware
  - Operates with K2921-1 STT Module
  - Use PF-25M's, PF-10M's LF-45 for feeders

G6535-1 | ENGINEERING CONTROLLED MANUFACTURER: No | CHANGE DETAIL: COMPLETELY REVISED



UNLESS OTHERWISE SPECIFIED TOLERANCES ON ON 3 PLACE DECIMALS ± 0.1 ON 2 PLACE DECIMALS ± 0.01 ON ALL ANGLES ± 1.0° A DEGREE MATERIAL FEATURES TYT TO AGREE WITH PUBLISHED STANDARDS	CONTRL: CLEVELAND	SCALE: NONE IF PRINTED @ A1 SIZE	EQUIPMENT TYPE: POWERWAVE S350 CE		PAGE 1 OF 3
	DRAWN BY: MB/PRR		SUBJECT: MACHINE SCHEMATIC		DOCUMENT NUMBER: G6535-1
	ENGINEER: J Burley	UNITS: INCH	MATERIAL DISPOSITION: NA	PROJECT NUMBER: CRM4399	REFERENCE: G6535
DO NOT SCALE THIS DRAWING	APPROVED: GWM		APPROVAL DATE: 8-13-2010		DOCUMENT REVISION: C

CONTROL P.C. BOARD



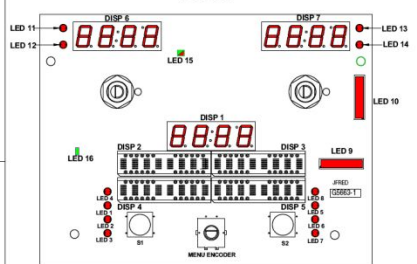
■ = MOLEX PIN 1

Description of LED functions on Power Wave S350CE *For reference only*

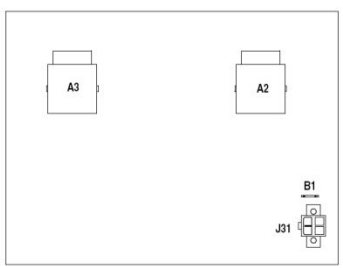
G6682 CONTROL P.C. BOARD		
LED #	COLOR	FUNCTION
1	GREEN	STATUS "OK"
2	RED	STATUS "ERROR" (CHECK CODE FOR SPECIFIC ERROR)
3	GREEN	OUTPUT ENABLE
4	GREEN	SINGLE PHASE FAULT
5	GREEN	ELECTRODE SENSE
6	GREEN	WORK SENSE
7	GREEN	ETHERNET LINK/ACTIVITY STATUS
8	GREEN	ETHERNET SPEED STATUS
9	GREEN	INPUT SUPPLY 30 VDC TO 55 VDC
10	GREEN	DEVICENET EXTERNAL 24 VDC PRESENT

F.R.E.D. P.C. BOARD (OPTIONAL)

FRONT



BACK

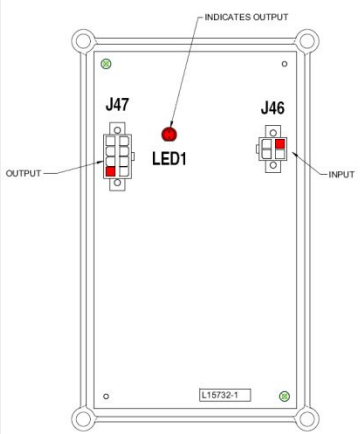


Description of LED functions on Power Wave S350

For reference only

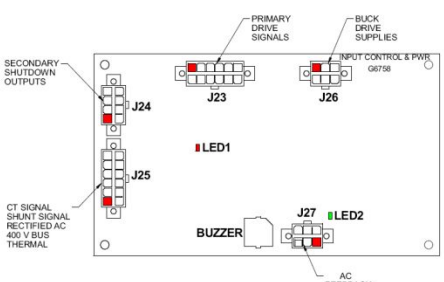
G5663 J F.R.E.D P.C. BOARD								
LED #	COLOR	FUNCTION	LED #	COLOR	FUNCTION	LED #	COLOR	FUNCTION
1	RED	MEMORY SELECT	7	RED	POST-WELD CONTROL SELECT	13	RED	VOLTS SELECT
2	RED	WAVE CONTROL SELECT	8	RED	N/A	14	RED	TRIM SELECT
3	RED		9	RED	SETUP MENU ENABLED	15	GREEN	STATUS "OK"
4	RED	N/A	10	RED	THERMAL FAULT MEASURED		RED	STATUS "ERROR" (CHECK CODE FOR SPECIFIC ERROR)
5	RED	2 STEP - 4 STEP SELECT	11	RED	WIRE FEED SPEED SELECT	16	GREEN	POWER SUPPLY FUNCTION "OK"
6	RED	PRE-WELD CONTROL SELECT	12	RED	AMPS SELECT			

+40 VDC BUS P.C. BOARD



■ = MOLEX PIN 1

PFC CONTROL P.C. BOARD



Description of LED functions on Power Wave S350

For reference only

G6758 PFC CONTROL P.C. BOARD		
LED #	COLOR	FUNCTION
2	GREEN	15 VDC POWER SUPPLY FUNCTIONING PROPERLY WHEN ON
1	RED	ERROR CODE (LED WILL FLASH ERROR AND BUZZER WILL SOUND) SEE TABLE BELOW FOR DETAILS

ERROR CODE	
ERROR	EXPLANATION
331	PEAK INPUT CURRENT LIMIT
334	START UP CURRENT CHECK FAILURE
335	START UP VOLTAGE CHECK FAILURE
336	THERMAL FAULT (NO FIRST STAGE FAN)
337	PRECHARGE TIMEOUT
346	TRANSFORMER PRIMARY OVERCURRENT

UNLESS OTHERWISE SPECIFIED TOLERANCE ON 2 PLACE DECIMALS ± .02 in. ± 0.5 mm; ON 1 PLACE DECIMALS ± .1 in. ± 2.5 mm; ON ALL ANGLES ± 1.0° X DEGREE. MATERIAL TOLERANCE (+/-) TO AGREE WITH PUBLISHED STANDARDS. DO NOT SCALE THIS DRAWING

CONTR: CLEVELAND | DRAWN BY: sajones | ENGINEER: J Bodey | APPROVED: GWM

SCALE: NONE IF PRINTED @ A1 SIZE | UNITS: INCH | MATERIAL DISPOSITION: NA | APPROVAL DATE: 8-13-2010 | PROJECT NUMBER: CRM43399 | REFERENCE: G6535

EQUIPMENT TYPE: POWERWAVE S350 CE

SUBJECT: MACHINE SCHEMATIC

DOCUMENT NUMBER: G6535-1 | DOCUMENT REVISION: C

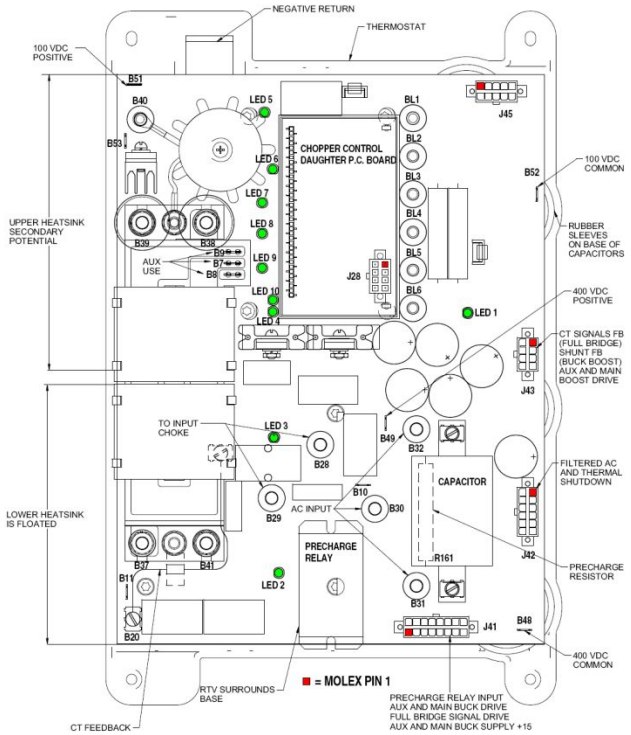
3 STAGE INVERTER

POWER CONVERSION ASSEMBLY

Description of LED functions on Power Wave S350

For reference only

G4770 SWITCHBOARD P.C. BOARD		
LED #	COLOR	FUNCTION
1	GREEN	48 VDC AUXILIARY POWER FUNCTIONING WHEN ON
3	GREEN	BOOST IGBT DRIVE FUNCTIONING WHEN ON
4	GREEN	15 VDC POWER FUNCTIONING PROPERLY WHEN ON
5	GREEN	CHOPPER IGBT 1 DRIVE FUNCTIONING WHEN ON
6	GREEN	CHOPPER IGBT 2 DRIVE FUNCTIONING WHEN ON
7	GREEN	CHOPPER IGBT 3 DRIVE FUNCTIONING WHEN ON
8	GREEN	CHOPPER IGBT 4 DRIVE FUNCTIONING WHEN ON
9	GREEN	CHOPPER IGBT 5 DRIVE FUNCTIONING WHEN ON
10	GREEN	CHOPPER IGBT 6 DRIVE FUNCTIONING WHEN ON
11	GREEN	BUCK IGBT DRIVE FUNCTIONING WHEN ON



UNLESS OTHERWISE SPECIFIED TOLERANCE ON 1 PLACE DECIMALS ± .01 in ± 0.1 mm; ON 2 PLACE DECIMALS ± .002 in ± 0.05 mm; ON ALL ANGLES ± 1 OF A DEGREE. MATERIAL TOLERANCE (T) TO AGREE WITH PUBLISHED STANDARDS. DO NOT SCALE THIS DRAWING

CONTROL: CLEVELAND	
DRAWN BY: sajones	
ENGINEER: J Burday	
APPROVED: GWM	
SCALE: NONE IF PRINTED @ A1 SIZE	
UNITS: INCH	
EQUIPMENT TYPE:	POWERWAVE S350 CE
SUBJECT:	MACHINE SCHEMATIC
MATERIAL DISPOSITION: NA	APPROVAL DATE: 8-13-2010
PROJECT NUMBER:	CRM43399
REFERENCE:	G6535

DOCUMENT NUMBER: G6535-1 | DOCUMENT REVISION: C

Power Wave S350

Power-Up Sequence

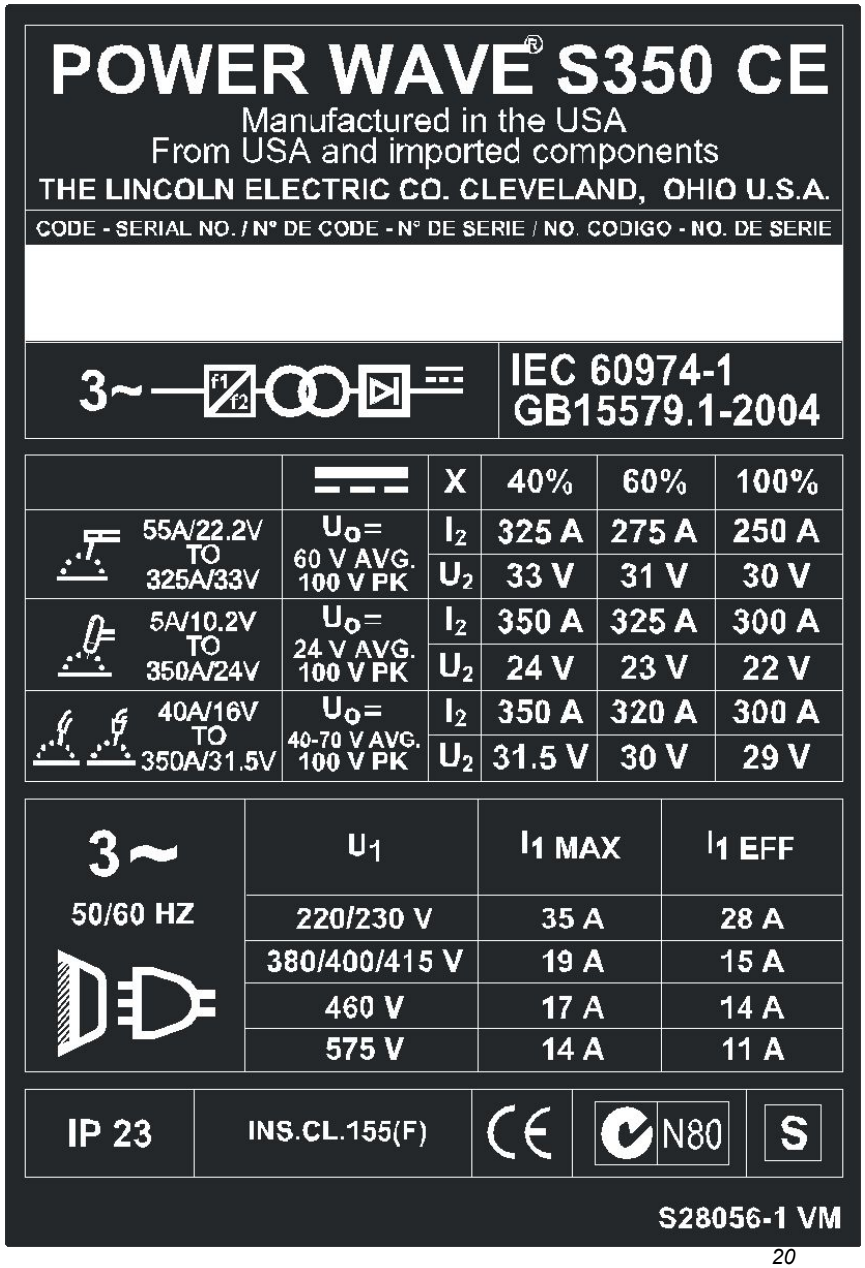
- **Once voltage is applied to the machine via the input switch, the auxiliary power supply located on the PFC Control board will turn on.**
  - **This power supply is responsible for regulating the +/- 15 volts for the control circuits, as well as the +15 volts for the buck & boost IGBTs.**
  - **LED 2 on PFC Control Board indicates a proper functioning power supply.**
- **Once the auxiliary power supply is functioning, the PFC control and full bridge circuits will turn on, close a relay, and provide a soft-start function for the buck-boost power section and simultaneously for the full bridge inverter located on the Power Conversion Assembly.**
  - **The PFC Control Board soft-start function begins with a low duty cycle and gradually increases the duty cycle until the buck-boost has met its pre-charge requirements. Completion time is dependant on the input voltage to the machine.**

Power Wave S350

Power-Up Sequence

- **After the soft-start sequence is complete, the primary side of the inverter will be regulated at 400 Volts and the secondary of the inverter will be 100 Volts.**
- **The Planar transformer has two auxiliary windings, the first one is used to provide a 48 Volt power supply for the fans & the DC Bus Board. The DC Bus Board then provides 40VDC to the Control Board & Arclink Receptacle (S3 5Pin).**
  - The 48 Volt secondary follows the same pre-charge sequence as the 100 Volt secondary.
  - Fan defaults to low speed unless a weld is made.
- **The machine is now idle and ready to make a weld**

S350CE



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CODE - SERIAL NO. / N° DE CODE - N° DE SERIE / NO. CODIGO - NO. DE SERIE

3~ — f1/f2 — IEC 60974-1 GB15579.1-2004

		X	40%	60%	100%
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		U_2	33 V	31 V	30 V
5A/10.2V TO 350A/24V	U_o= 24 V AVG. 100 V PK	I_2	350 A	325 A	300 A
		U_2	24 V	23 V	22 V
40A/16V TO 350A/31.5V	U_o= 40-70 V AVG. 100 V PK	I_2	350 A	320 A	300 A
		U_2	31.5 V	30 V	29 V

3~ 50/60 HZ	U_1	$I_{1\ MAX}$	$I_{1\ EFF}$
	220/230 V	35 A	28 A
	380/400/415 V	19 A	15 A
	460 V	17 A	14 A
	575 V	14 A	11 A

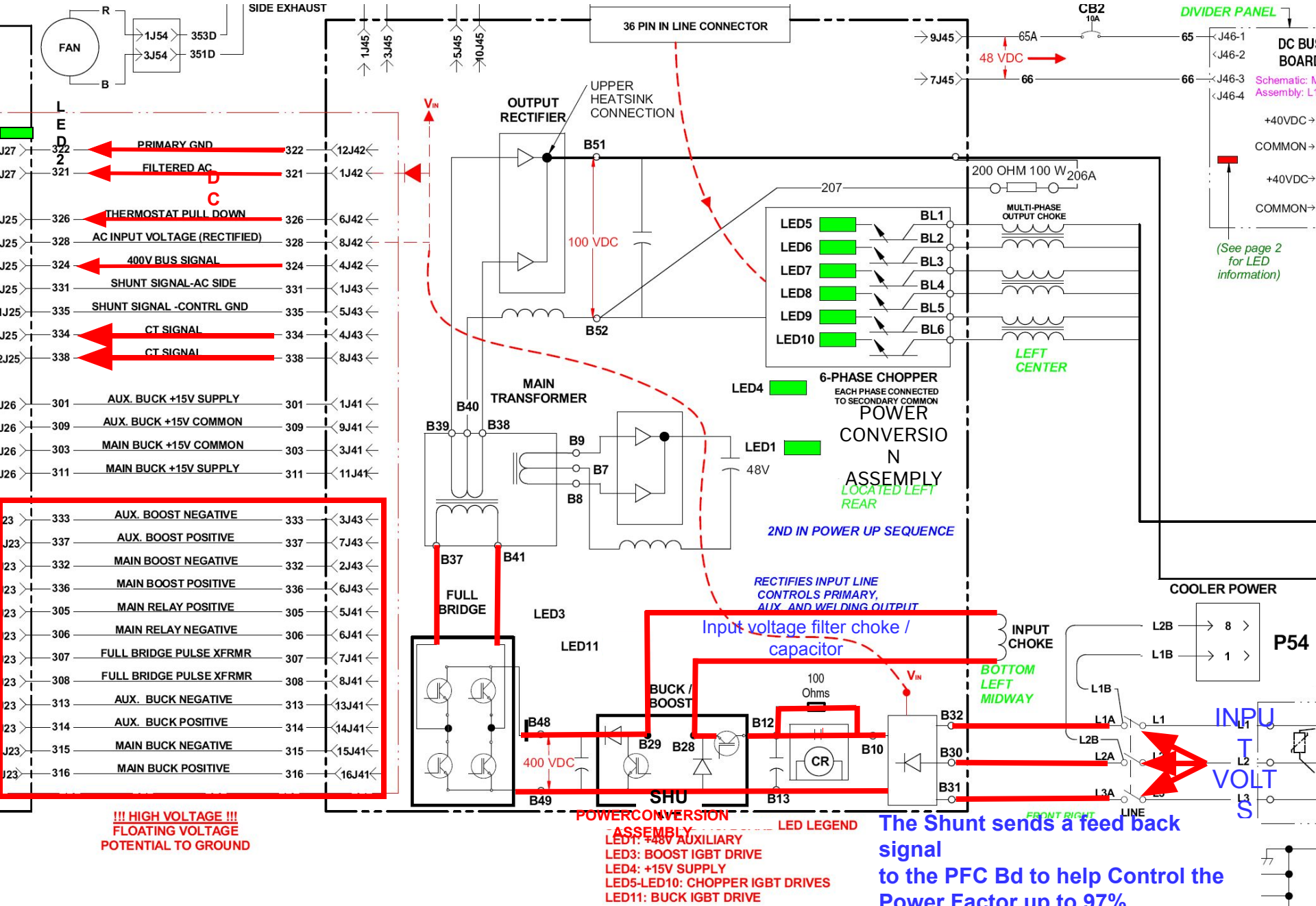
IP 23 | INS.CL.155(F) | CE | N80 | S

S28056-1 VM

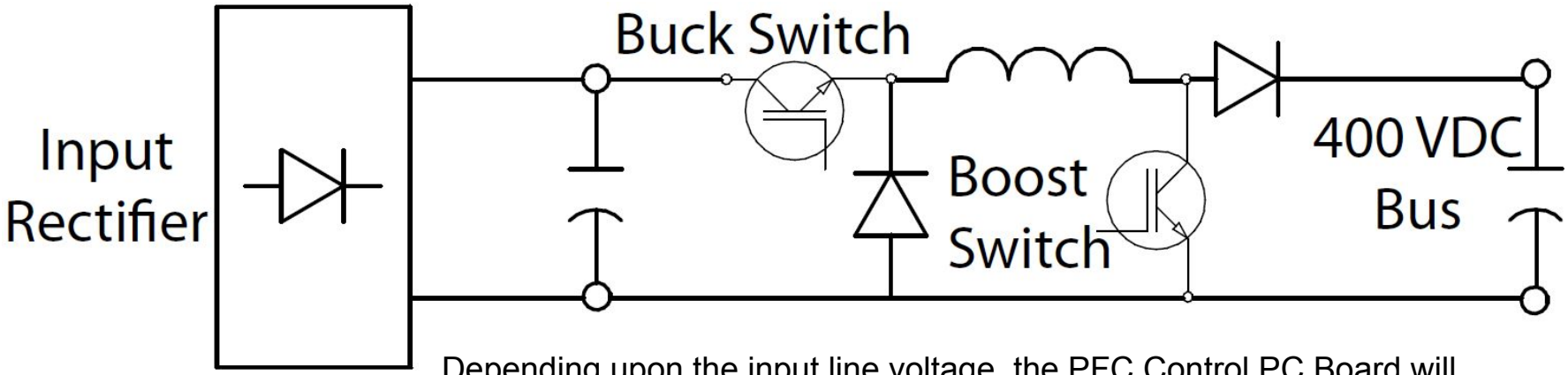
- 3 phase only
- Replace line cord when operating over 450 VAC
- If S350CE detects single phase Error 54 will Flash

First Stage Function On the Power Conversion Assembly & PFC PCB

- **Relay Provides Softstart function for DC Link Capacitor**
  - Limits inrush current during DC Link capacitor charging
  - Activated via open-collector signal from PFC PCB
- **PFC Control Board**
  - Powered from the AC line via a diode on the Power Conversion Assembly and an auxiliary power supply on the PFC Control Board
  - Auxiliary power supply requires 180 – 900 Vdc, LED 2 must be on during proper operation
  - Analog and Digital circuits control the current shaping, regulated bus voltage, and gate drive signals for the main and auxiliary buck and boost switches
- **Relay Operation**
  - Under normal operating conditions, the relay should close 50 ms after power is applied to the machine
  - Shorts 100 Ohm resistor after pre-charge
  - Under Fault Conditions the relay will generally close 50 ms after power is applied to the machine and immediately reopen.
- **Power Conversion Assembly Converts rectified 60Hz input to a regulated 400 Volts dc**
  - Topology consists of a buck converter followed by a boost converter
  - Boost switch operates at 230 Vac or less, buck switch is held on (LED 3 is On and LED 11 is On)
  - Buck switch operates at 325 Vac or more, boost switch is held off for the most part (LED 3 may be off at idle, LED 11 is ON)


FAN
R
B
1J54
3J54
353D
351D
SIDE EXHAUST
1J45
3J45
5J45
10J45
36 PIN IN LINE CONNECTOR
9J45
7J45
65A
66
CB2
10A
48 VDC
DIVIDER PANEL
J46-1
J46-2
J46-3
J46-4
65
66
+40VDC
COMMON
+40VDC
COMMON
(See page 2 for LED information)
LED2
PRIMARY GND
FILTERED AC
THERMOSTAT PULL DOWN
AC INPUT VOLTAGE (RECTIFIED)
400V BUS SIGNAL
SHUNT SIGNAL-AC SIDE
SHUNT SIGNAL -CONTRL GND
CT SIGNAL
CT SIGNAL
12J42
1J42
6J42
8J42
4J42
1J43
5J43
4J43
8J43
AUX. BUCK +15V SUPPLY
AUX. BUCK +15V COMMON
MAIN BUCK +15V COMMON
MAIN BUCK +15V SUPPLY
1J41
9J41
3J41
11J41
AUX. BOOST NEGATIVE
AUX. BOOST POSITIVE
MAIN BOOST NEGATIVE
MAIN BOOST POSITIVE
MAIN RELAY POSITIVE
MAIN RELAY NEGATIVE
FULL BRIDGE PULSE XFRMR
FULL BRIDGE PULSE XFRMR
AUX. BUCK NEGATIVE
AUX. BUCK POSITIVE
MAIN BUCK NEGATIVE
MAIN BUCK POSITIVE
3J43
7J43
2J43
6J43
5J41
6J41
7J41
8J41
13J41
14J41
15J41
16J41
!!! HIGH VOLTAGE !!!
FLOATING VOLTAGE
POTENTIAL TO GROUND
OUTPUT RECTIFIER
UPPER HEATSINK CONNECTION
B51
B52
100 VDC
207
200 OHM 100 W
206A
MULTI-PHASE OUTPUT CHOKE
LED5
LED6
LED7
LED8
LED9
LED10
BL1
BL2
BL3
BL4
BL5
BL6
LEFT CENTER
6-PHASE CHOPPER
EACH PHASE CONNECTED TO SECONDARY COMMON
LED4
POWER CONVERSION ASSEMBLY
LOCATED LEFT REAR
MAIN TRANSFORMER
B40
B39
B38
B9
B7
B8
LED1
48V
2ND IN POWER UP SEQUENCE
B37
B41
FULL BRIDGE
LED3
LED11
RECTIFIES INPUT LINE
CONTROLS PRIMARY,
AUX. AND WELDING OUTPUT
Input voltage filter choke / capacitor
INPUT CHOKE
BOTTOM LEFT MIDWAY
COOLER POWER
P54
L2B
L1B
8
1
L1B
L1A
L2B
L2A
L3A
L1
L2
L3
LINE
INPUT VOLTS
FRONT RIGHT
BUCK / BOOST
100 Ohms
B48
B49
400 VDC
B29
B28
B12
B13
CR
B10
B32
B30
B31
SHU
POWERCONVERSION ASSEMBLY
LED LEGEND
LED1: +48V AUXILIARY
LED3: BOOST IGBT DRIVE
LED4: +15V SUPPLY
LED5-LED10: CHOPPER IGBT DRIVES
LED11: BUCK IGBT DRIVE
The Shunt sends a feed back signal
to the PFC Bd to help Control the Power Factor up to 97%

Buck/Boost Theory of Operation

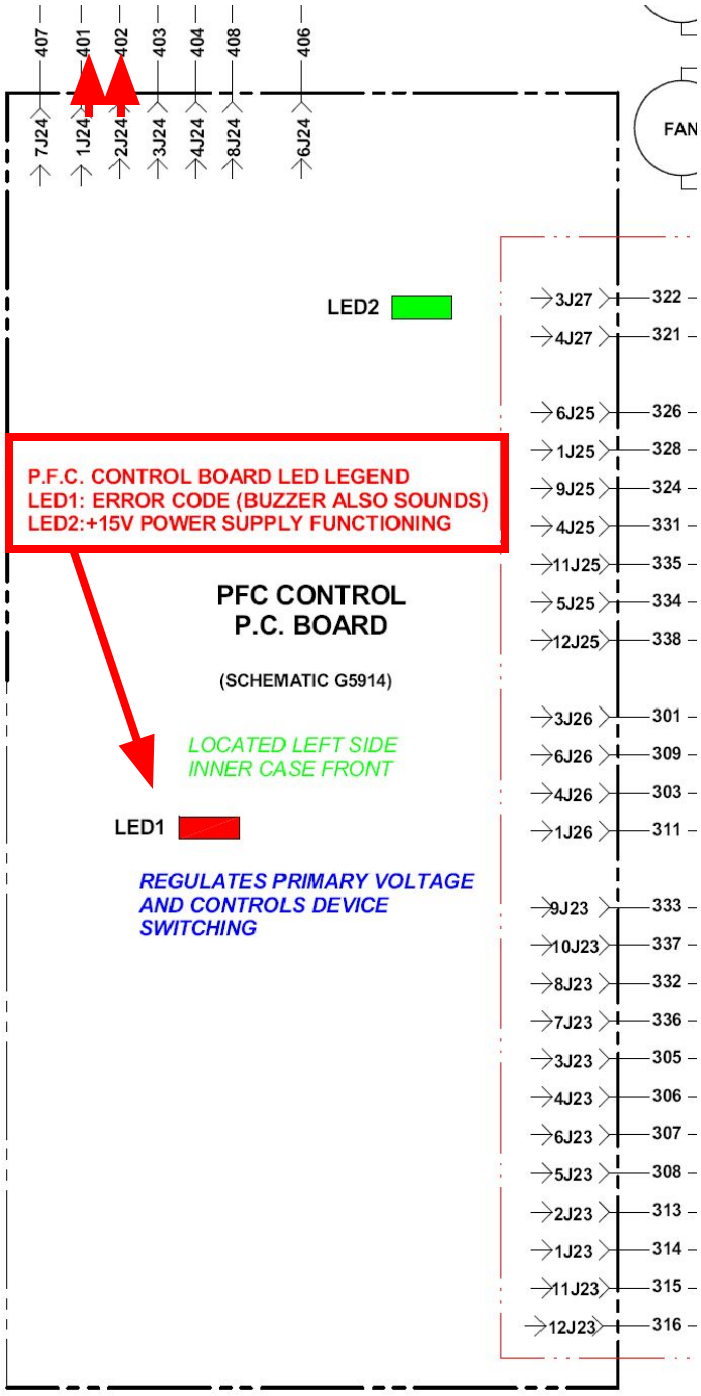


Depending upon the input line voltage, the PFC Control PC Board will very the ON time of the Buck and/or the Boost switches in order to obtain a constant 400 VDC supply.

Line Voltage	Rectified Value	Buck Switch	Boost Switch
200 - 208 VAC	282 - 293 VDC	On	On
230 VAC	324 VDC	On	On
380 - 415 VAC	536 - 585 VDC	On	Off
460 VAC	649 VDC	On	Off
575 VAC	811 VDC	On	Off

LINCOLN® ELECTRIC

Thermostat Signal to Control Board



PFC Control Board (G5915 series)

Buzzer Error Codes

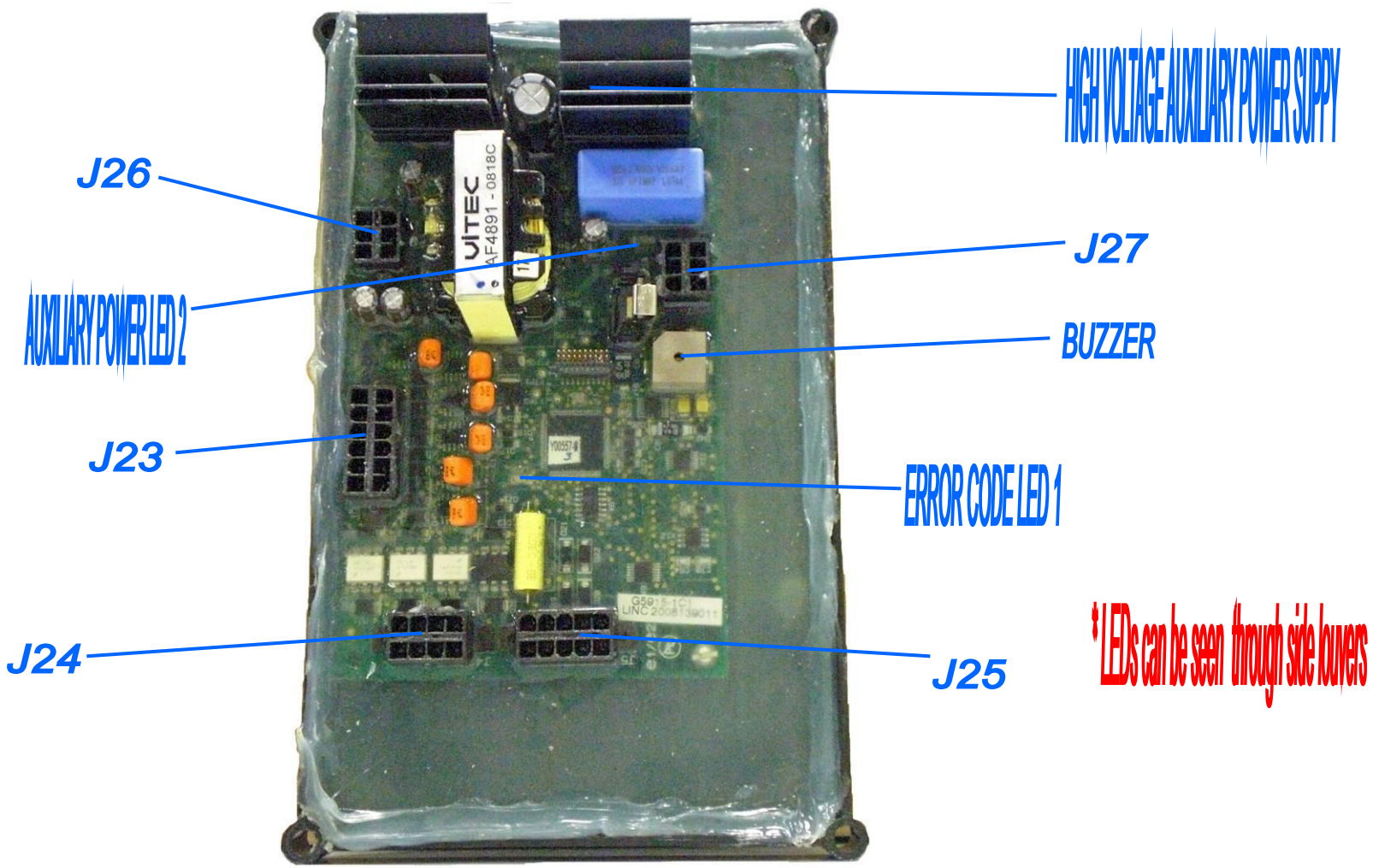
- ***First and Second Stage Error Codes are sounded on buzzer and LED 1 on Input Control Board***
  - ***RED LED 1 can be seen through the side louvers of the machine***

Error Code #	Indication
331 Peak input current limit	Input current limit has been exceeded. Typically indicates short term power overload. If problem persists contact Service Department.
333 Under-voltage lockout	+15 VDC supply on Input control board too low. Verify input voltage is within the acceptable range. If problem persists contact service department.
336 Thermal Fault	Thermostat on primary module tripped. Typically caused by bottom fan not working.
337 Pre-charge timeout	Problem with start-up sequence. If problem persists contact Service Department.
346 Transformer primary over current	Transformer current too high. Typically indicates short term power overload. If problem persists contact service department.
Other	Contact the Service Department.

- Pause before repeating the code: 3.5 seconds
- Pause between digits of the code: 1.5 seconds
- Pause between sounds/flashes indicating a specific digit: 0.5 seconds

PFC Control Board (G5915 series)

Auxiliary Power Supply and PFC Circuits



PFC CONTROL BOARD

- **Auxiliary Power Supply Failure**
  - Machine will not power up
    - LED 2 will be off or blinking if there is a problem with the PFC Control Board
      - Can be seen through side louvers of the machine
    - Failure of this circuit will fail the auxiliary input diode
  - **POWER CONVERSION ASSEMBLY Auxiliary Input Diode Failure**
    - Use DVM Diode check function from 8J42 to 1J42
      - Forward Voltage should be greater than 0.3 Volts
    - Failure of this component is a result of a auxiliary power supply failure

First Stage Function

- *Detects thermal trips that may occur on the first stage heatsink (single thermostat located on the primary module)*

Input and Output Signals

- *Signals from PFC Control Board to Power Conversion Assembly*
- *Connector J23 & J26 on PFC Control Board*
  - *Main & Auxiliary Boost Gate Drives*
  - *Main & Auxiliary Buck Gate Drives*
  - *+15 Volt dc Power Supplies for the Main and Auxiliary Buck Drives*
  - *Main Relay Drive*
  - *Full Bridge Gate Drives*
- *Connector J27 on PFC Control Board*
  - *Filter AC Input Power Supply for the Input Control Board*
- *Signals from Power Conversion Assembly to PFC Control Board*
- *Connector J25 on PFC*
  - *Buck-Boost Current Feedback*
  - *Rectified AC Input Voltage*
  - *Regulated 400 Volt Bus Feedback*
  - *Thermostat Pull-Down Signal*
  - *Full Bridge CT Feedback*

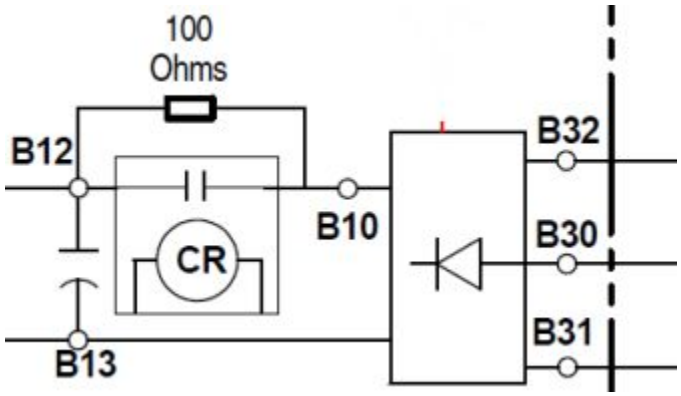
Primary Thermal Protection

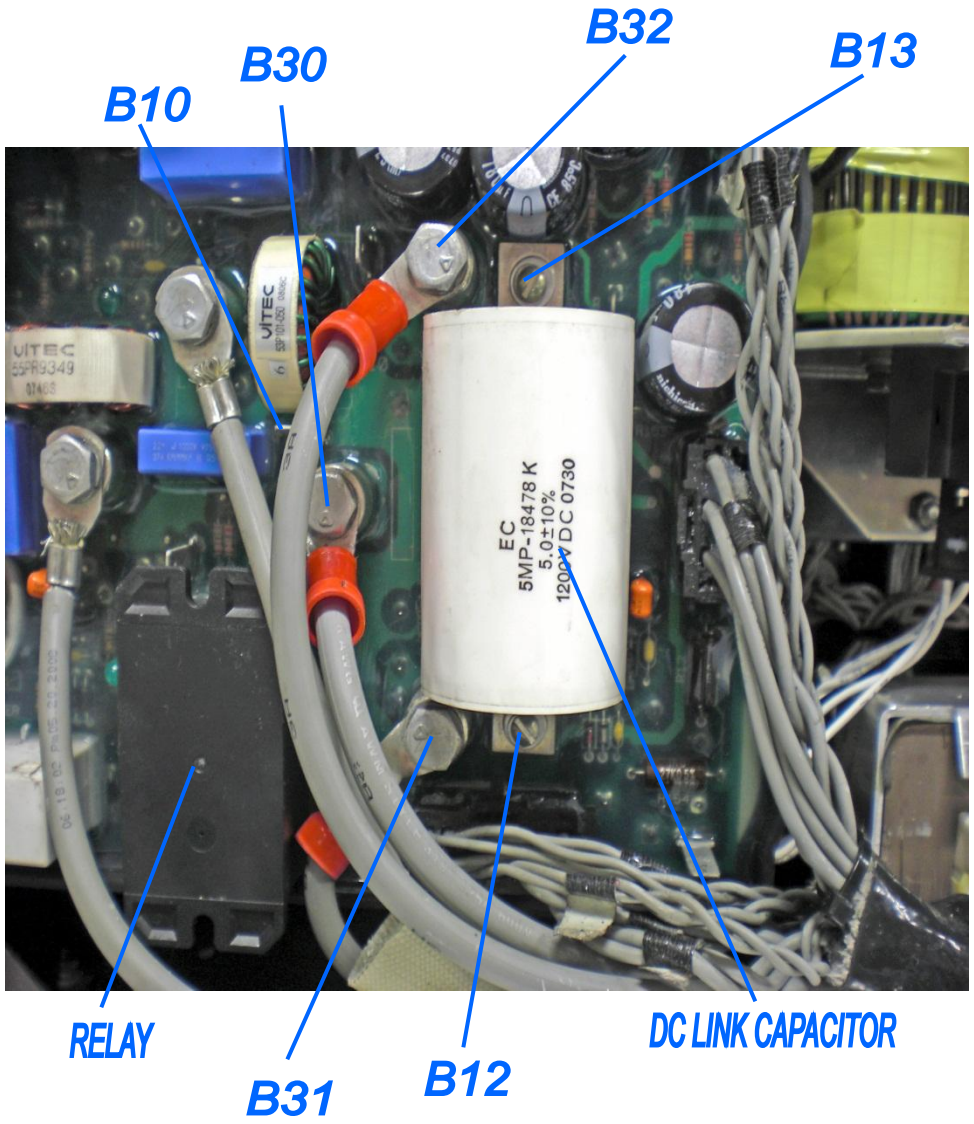
Function

- ***Primary Thermal Circuit***
  - ***Protects machine against reduced airflow or overload.***
    - ***Fan OFF / Output disabled***
    - ***All stages cease operation and machine appears to be off – Buzzer will continue to sound***
  - ***Location:***
    - ***SMT Part, First and Second Stage Module (M21214-10)***
- ***All Thermostats are normally closed***
  - ***Mechanical thermostats DO NOT immediately reset!***
    - ***First stage module thermostat opens at 90°C, resets at 60°C***
- ***Thermostat Test***
  - ***Primary Circuit***
    - ***G4770 board (6J42 to B49) – should measure short***

Relay and DC Link Capacitor

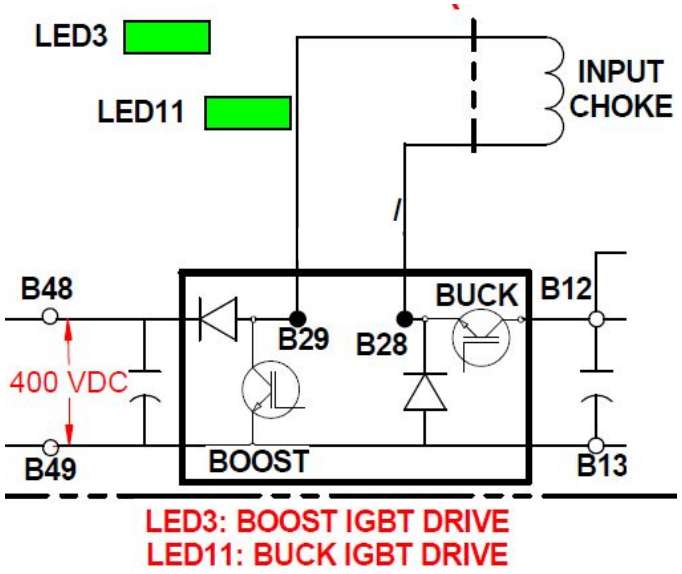
- *3-phase input rectifier converts AC line voltage to DC*
  - *Perform diode tests between line input (B30, B31, B32) and rectifier outputs (B10, B13)*
- *100 ohm resistor provides precharge path for DC Link Capacitor. Relay closes after precharge is complete.*
  - *Measure resistance from B12 to B10 with machine turned off.*
  - *100 ohms expected*
  - *OPEN indicates resistor failure*
  - *SHORT indicates fused relay contacts*

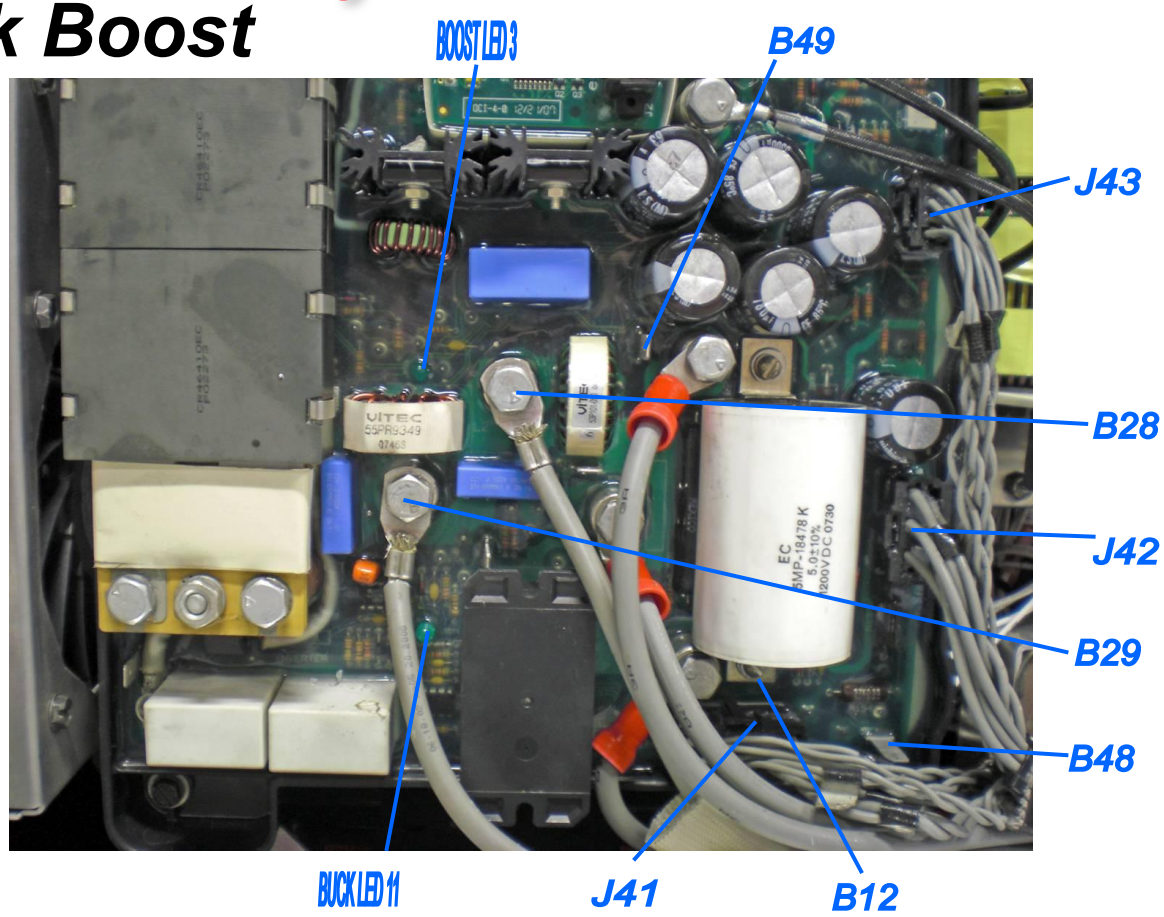




Power Conversion Assembly

First Stage – Buck Boost





Line Voltage	Rectified Value	Buck Switch	Boost Switch
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460 VAC	649 VDC	On	Off
575 VAC	811 VDC	On	Off

Depending upon the input line voltage, the PFC Control PC Board will very the ON time of the Buck and/or the Boost switches in order to obtain a constant 400 VDC supply.

Second Stage Functions

- **The Planar transformer has two auxiliary windings.**
  - **The first one is used to provide a 48 Volt power supply for the fans & the DC Bus Board. Green LED1 on if 48VDC power supply if present on Power Board.**
  - **The DC Bus Board then provides 40VDC to the Control Board & Arclink Receptacle (S3 5Pin).**

- **Converts rectified 400 Volts dc input to an unregulated 100 Volts dc output**
  - **Topology consists of a full bridge inverter followed by a center tap rectifier**
    - **Full bridge switches at 60 Khz with a 150 ns dead time**
    - **Open-loop control is used and the 100 Volts dc output is unregulated**
    - **Interacts directly with Input Control Board**
    - **Power Board provides primary side current feedback for inverter protection**

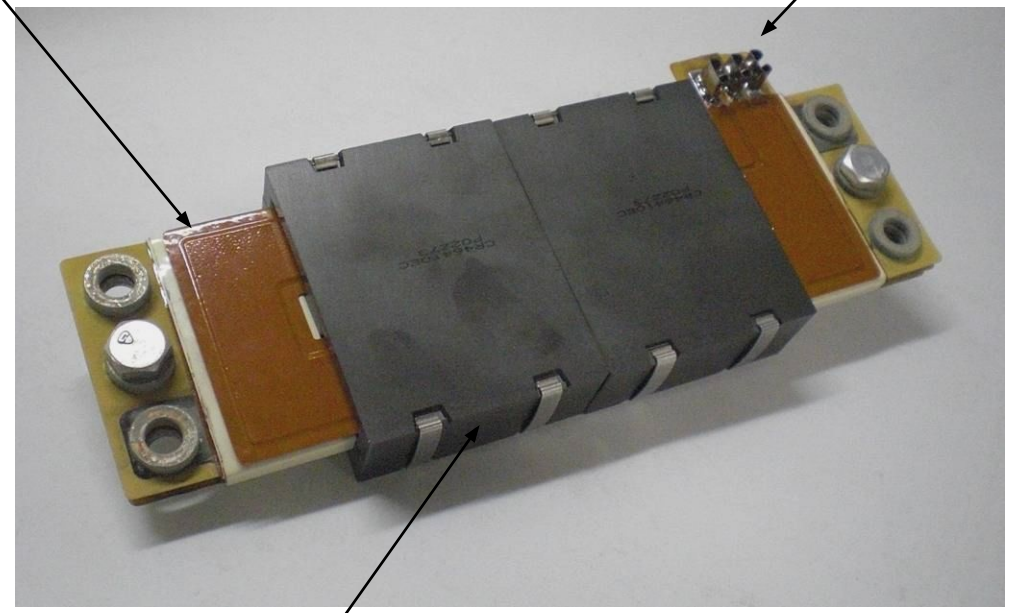
- ***The machine is now idle and ready to make a weld***

Planar Transformer

Design Features

Printed circuit board
Individually sealed

Incorporated auxiliary winding

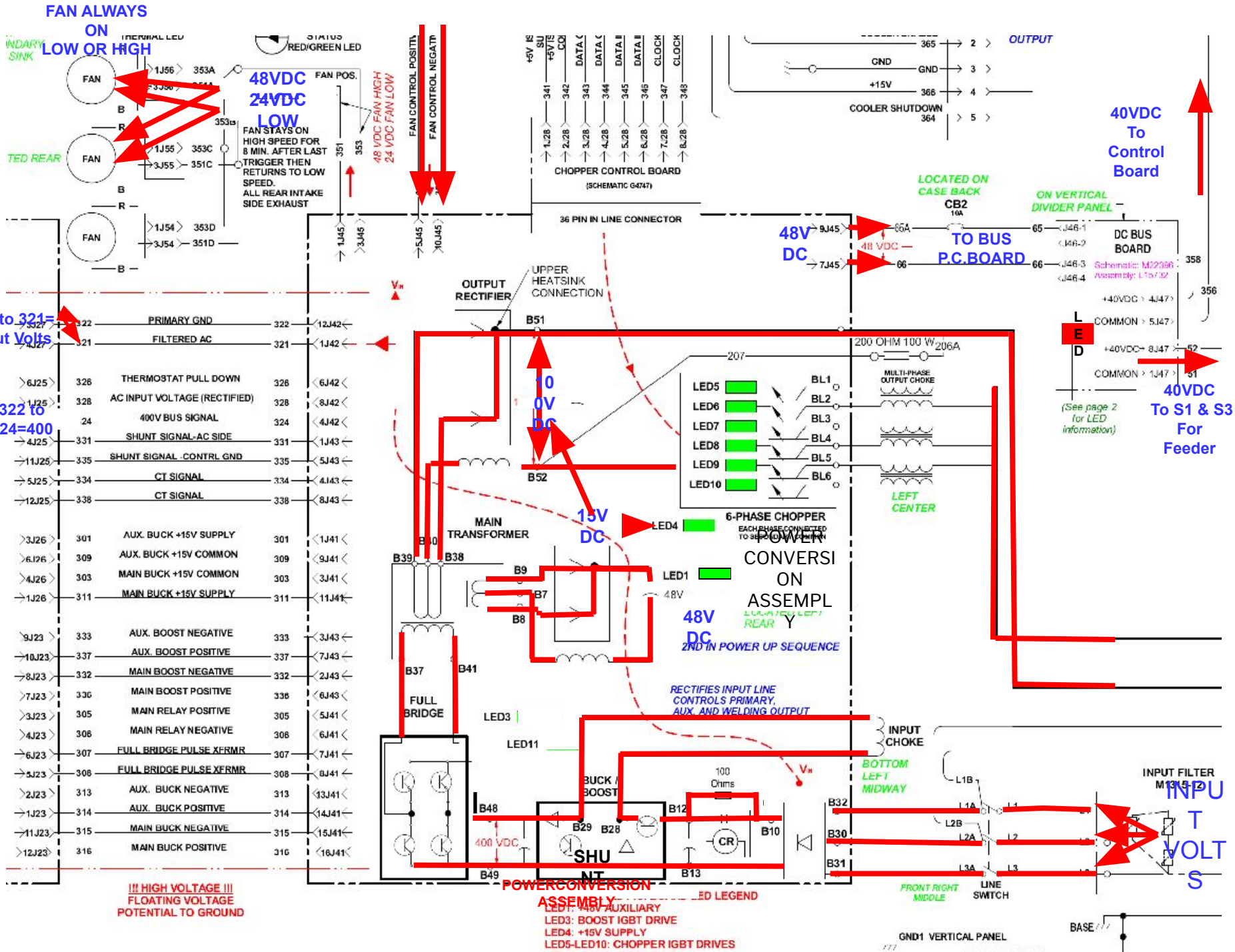


Small footprint allows
for mounting directly onto switchboard

Multi-Phase Chopper

Functions

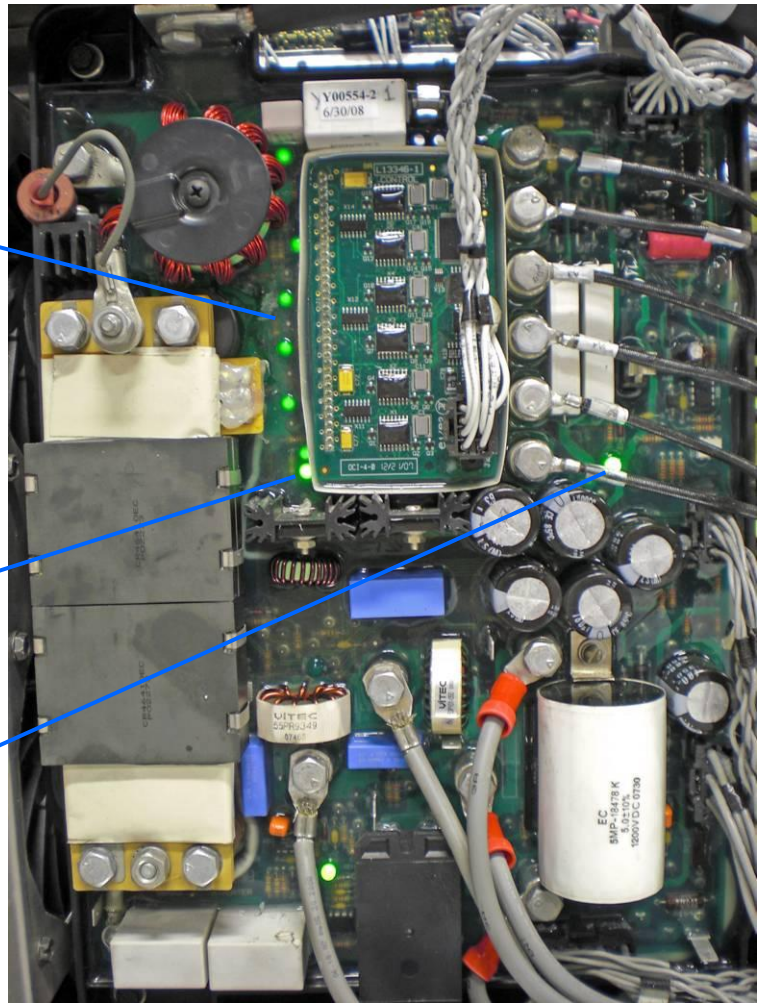
- **Used to control welding Voltage and Current**
  - **100 Volt DC input with regulated output**
  - **Six chopper phases in parallel that turn on 60 degrees out of phase**
  - **Two phases each conduct 180 degrees out of phase through the same output choke**
  - **Power Board receives commands from the Control board. Power Board uses this command and determines the on-time of the six chopper IGBTs.**


FAN ALWAYS ON
LOW OR HIGH
48VDC
24VDC
LOW
FAN STAYS ON HIGH SPEED FOR 8 MIN. AFTER LAST TRIGGER THEN RETURNS TO LOW SPEED.
ALL REAR INTAKE SIDE EXHAUST
FAN POS.
48 VDC FAN HIGH
24 VDC FAN LOW
FAN CONTROL POSITIVE
FAN CONTROL NEGATIVE
CHOPPER CONTROL BOARD
(SCHEMATIC G4747)
36 PIN IN LINE CONNECTOR
OUTPUT
GND
+15V
COOLER SHUTDOWN
LOCATED ON CASE BACK
CB2
10A
ON VERTICAL DIVIDER PANEL
DC BUS BOARD
40VDC To Control Board
48V DC
TO BUS P.C.BOARD
40VDC To S1 & S3 For Feeder
322 to 321= Input Volts
322 to 324=400
PRIMARY GND
FILTERED AC
THERMOSTAT PULL DOWN
AC INPUT VOLTAGE (RECTIFIED)
400V BUS SIGNAL
SHUNT SIGNAL-AC SIDE
SHUNT SIGNAL -CONTRL GND
CT SIGNAL
CT SIGNAL
AUX. BUCK +15V SUPPLY
AUX. BUCK +15V COMMON
MAIN BUCK +15V COMMON
MAIN BUCK +15V SUPPLY
AUX. BOOST NEGATIVE
AUX. BOOST POSITIVE
MAIN BOOST NEGATIVE
MAIN BOOST POSITIVE
MAIN RELAY POSITIVE
MAIN RELAY NEGATIVE
FULL BRIDGE PULSE XFRMR
FULL BRIDGE PULSE XFRMR
AUX. BUCK NEGATIVE
AUX. BUCK POSITIVE
MAIN BUCK NEGATIVE
MAIN BUCK POSITIVE
OUTPUT RECTIFIER
UPPER HEATSINK CONNECTION
MAIN TRANSFORMER
FULL BRIDGE
100 VDC
10 0V DC
15V DC
48V DC
2ND IN POWER UP SEQUENCE
6-PHASE CHOPPER
EACH PHASE CONNECTED TO SEPARATE WINDING
MULTI-PHASE OUTPUT CHOKE
LEFT CENTER
200 OHM 100 W
LED1
LED3
LED4
LED5
LED6
LED7
LED8
LED9
LED10
BL1
BL2
BL3
BL4
BL5
BL6
POWER CONVERSION ASSEMBLY
RECTIFIES INPUT LINE CONTROLS PRIMARY, AUX. AND WELDING OUTPUT
INPUT CHOKE
BOTTOM LEFT MIDWAY
100 Ohms
BUCK / BOOST
SHUNT
CR
INPUT FILTER
LINE SWITCH
FRONT RIGHT MIDDLE
INPUT VOLTS
!!! HIGH VOLTAGE !!!
FLOATING VOLTAGE POTENTIAL TO GROUND
LED LEGEND
LED1: +48V AUXILIARY
LED3: BOOST IGBT DRIVE
LED4: +15V SUPPLY
LED5-LED10: CHOPPER IGBT DRIVES
GND1 VERTICAL PANEL
BASE

Multi-Phase Chopper

Implementation

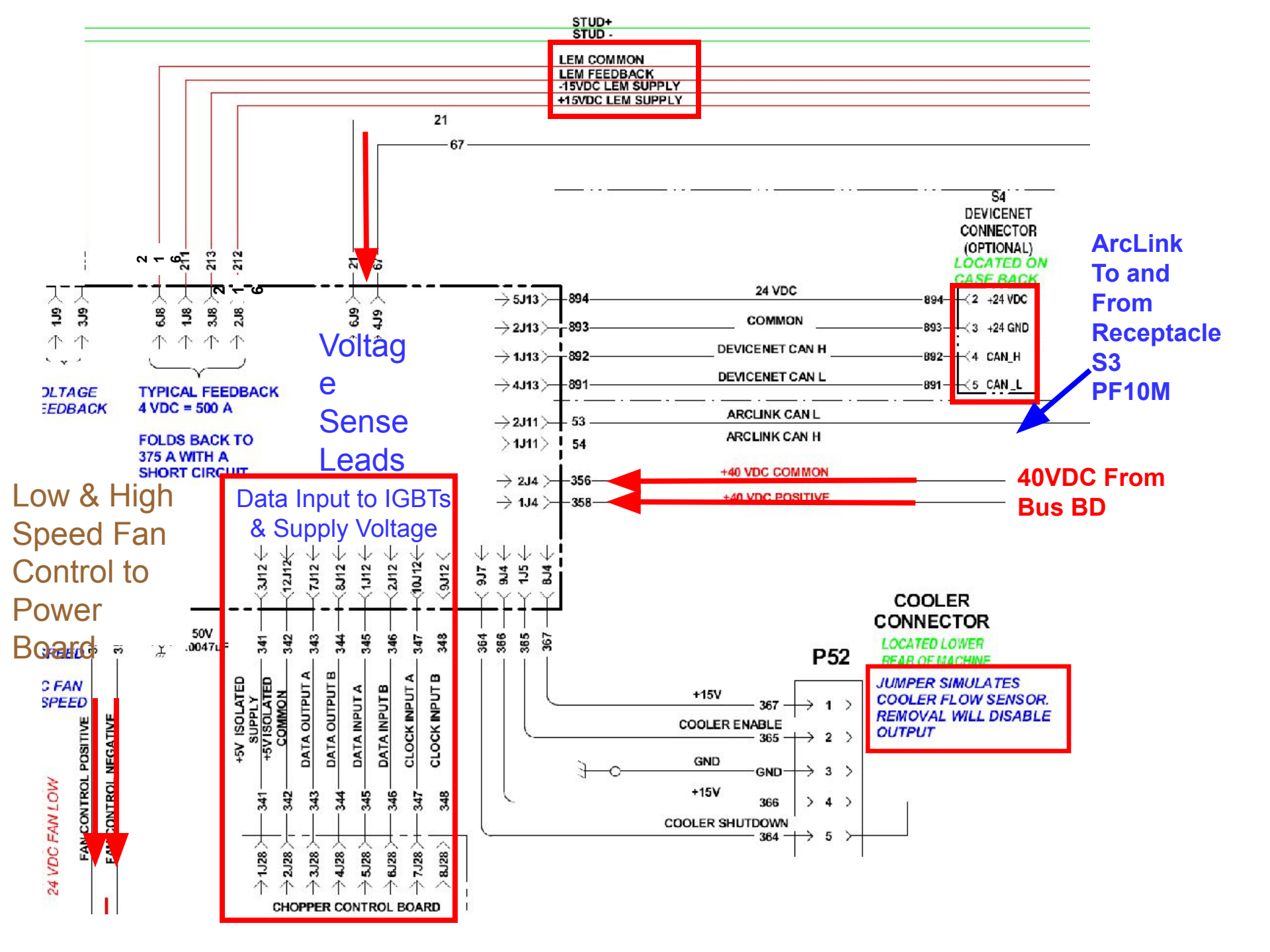
- ***Six LEDs are used to indicate a turn-on of a chopper phase***
  - ***Intensity of each LEDS 5-10 is related to the on-time of each of the IGBTs***
- ***+15 Volt dc power supply for secondary control circuits LED4***
- ***+ 48 Volt dc auxiliary power supply indicator LED1***

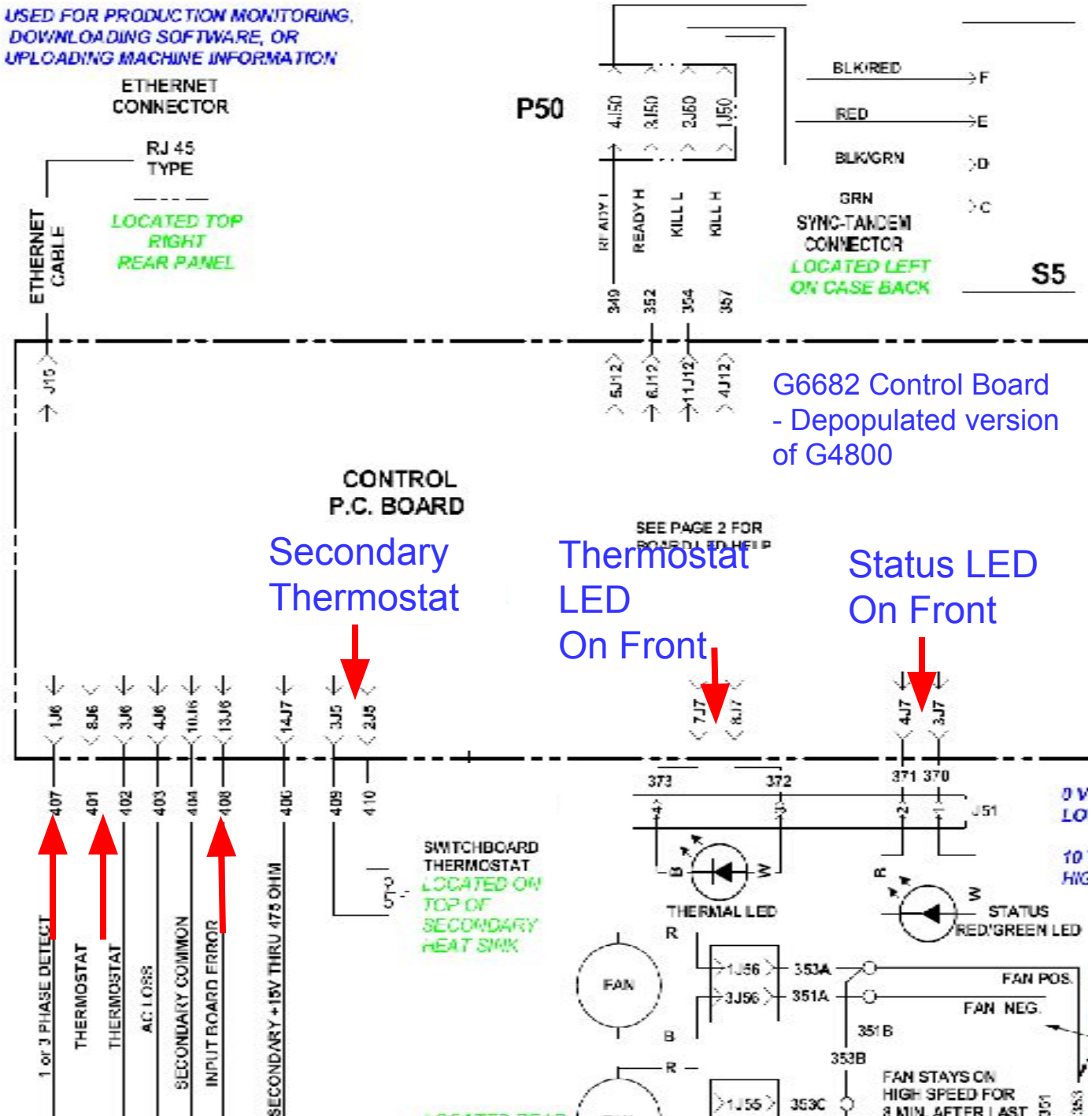


Control PC Board

Functions

- **Controls the Chopper power plant**
  - **Transmits welding commands via differential signaling**
- ***Controls welding output based on ...***
  - ***User settings***
  - ***Voltage and Current feedback***
  - ***Welding software***
- ***Serves as the main communication interface***
  - ***ArcLink master***
  - ***Ethernet***


STUD+
STUD -
LEM COMMON
LEM FEEDBACK
-15VDC LEM SUPPLY
+15VDC LEM SUPPLY
21
67
S4
DEVICENET
CONNECTOR
(OPTIONAL)
LOCATED ON
CASE BACK
ArcLink
To and
From
Receptacle
S3
PF10M
Voltag
e
Sense
Leads
TYPICAL FEEDBACK
4 VDC = 500 A
FOLDS BACK TO
375 A WITH A
SHORT CIRCUIT
24 VDC
COMMON
DEVICENET CAN H
DEVICENET CAN L
ARCLINK CAN L
ARCLINK CAN H
+40 VDC COMMON
+40 VDC POSITIVE
40VDC From
Bus BD
Low & High
Speed Fan
Control to
Power
Board
Data Input to IGBTs
& Supply Voltage
COOLER
CONNECTOR
LOCATED LOWER
REAR OF MACHINE
P52
JUMPER SIMULATES
COOLER FLOW SENSOR.
REMOVAL WILL DISABLE
OUTPUT
+15V
COOLER ENABLE
GND
+15V
COOLER SHUTDOWN
+5V ISOLATED SUPPLY
+5VISOLATED COMMON
DATA OUTPUT A
DATA OUTPUT B
DATA INPUT A
DATA INPUT B
CLOCK INPUT A
CLOCK INPUT B
FAN CONTROL POSITIVE
24 VDC FAN LOW
CHOPPER CONTROL BOARD



This is where The STT Differential I/O Connects to S350

Thermal Protection

Function

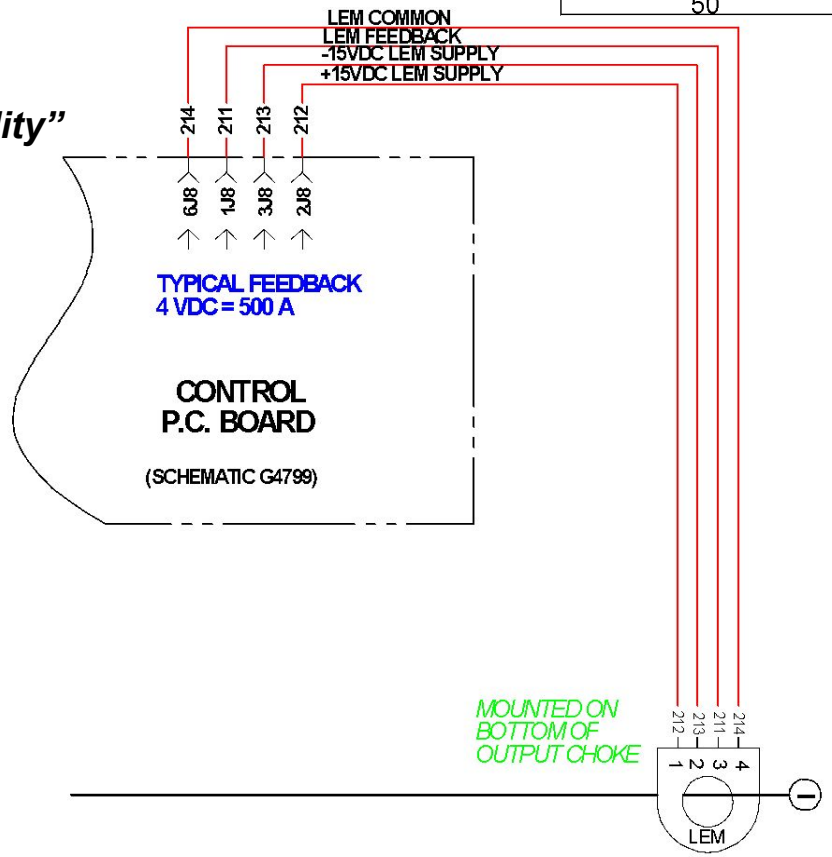
- ***Secondary Thermal Circuit***
  - ***Protects machine against reduced airflow or overload.***
    - ***Fan ON / Output disabled***
    - ***Thermal fault logged and indicated by Thermal Error and Thermal LED on User Interface board (Error 36)***
  - ***Locations:***
    - ***Secondary Heatsink***
- ***All Thermostats are normally closed***
  - ***Mechanical thermostats DO NOT immediately reset!***
    - ***Secondary heatsink thermostat opens at 68°C, resets at 48°C***
  - ***Secondary Circuit***
    - ***Digital Control board (2J5 to 3J5) – should measure short***

Current Transducer (S18504-6)

Simplified Test Procedure

- ***Verify 30 VDC present at supply leads***
- ***Check the feedback with a Constant Current Output into a load (Mode 200).***
  - ***Calibration tab in the "Lincoln Diagnostic Utility"***
  - ***Verify Transducer Vfb verses <u>actual</u> Output Current per chart***

OUTPUT CURRENT	TRANSDUCER V_{fb} (8mV/Amp)
500	4.0
450	3.6
400	3.2
350	2.8
300	2.4
250	2.0
200	1.6
150	1.2
100	0.8
50	0.4



Control PC Board

Status LED's

- *"Must Have" LED's*

  9 *Power Supply*

  1 *Board Status*

- *Ethernet Connectivity*

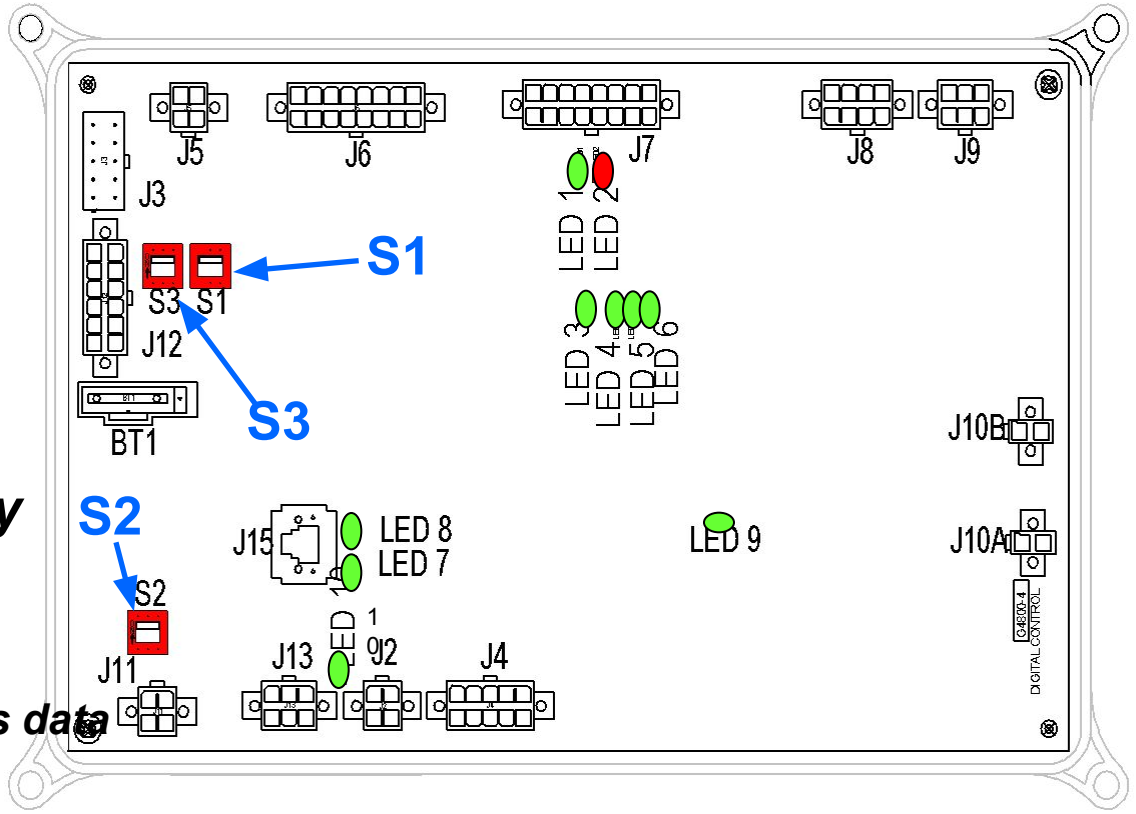
  7 *Ethernet Status*
  - *Flashing indicates data*

- *DeviceNet Connectivity*

  10 *DeviceNet Power*

DIP Switches – Factory Default Shown

All ON



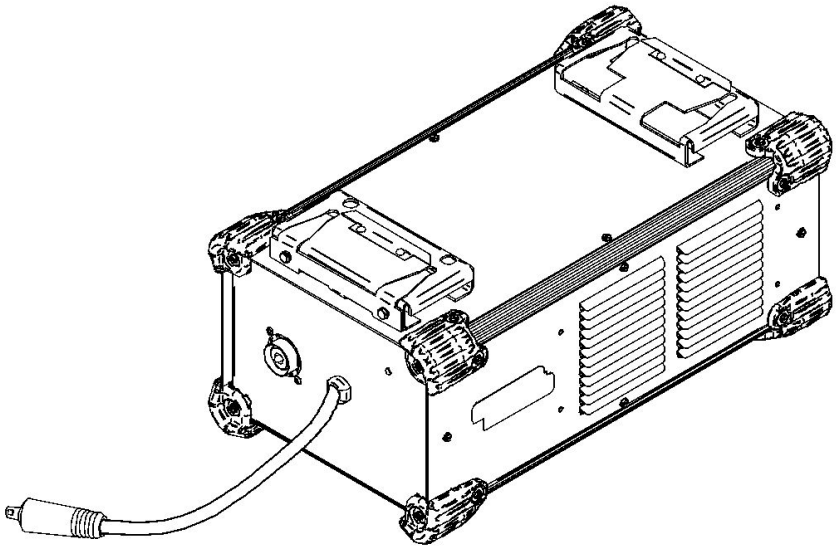
LINCOLN ELECTRIC

ERROE CODES POWER WAVE S350

Code	Fault	1st Stage	2nd Stage	Relay	Recovery	Signaling
331	Peak input current limit (4ms)	OFF	ON	OPEN	Cycle Power	G4800 & A / V signal
none	Peak input current limit	ON	ON	CLOSED	Self-recovering	G4800 to turn off output
333	Under-voltage lock-out	OFF	OFF	OPEN	Cycle Power	G4800 & A / V signal
336	Thermal fault	OFF	ON	OPEN	Self-recovering	G4800 & A / V signal
337	Precharge timeout	OFF	ON	OPEN	Cycle Power	G4800 & A / V signal
346	Transformer primary overcurrent	OFF	OFF	OPEN	Cycle Power	G4800 & A / V signal
342	No/low AC input voltage (4s)	OFF	ON	OPEN	Cycle Power	G4800 & A / V signal
none	No/low AC input voltage	OFF	ON	OPEN	Self-recovering	G4800 to turn off output
none	Cap under-voltage	ON	ON	CLOSED	Self-recovering	G4800 to turn off output
341	Start Up Current Fault (50 Amps)	OFF	OFF	OPEN	Cycle Power	A / V signal

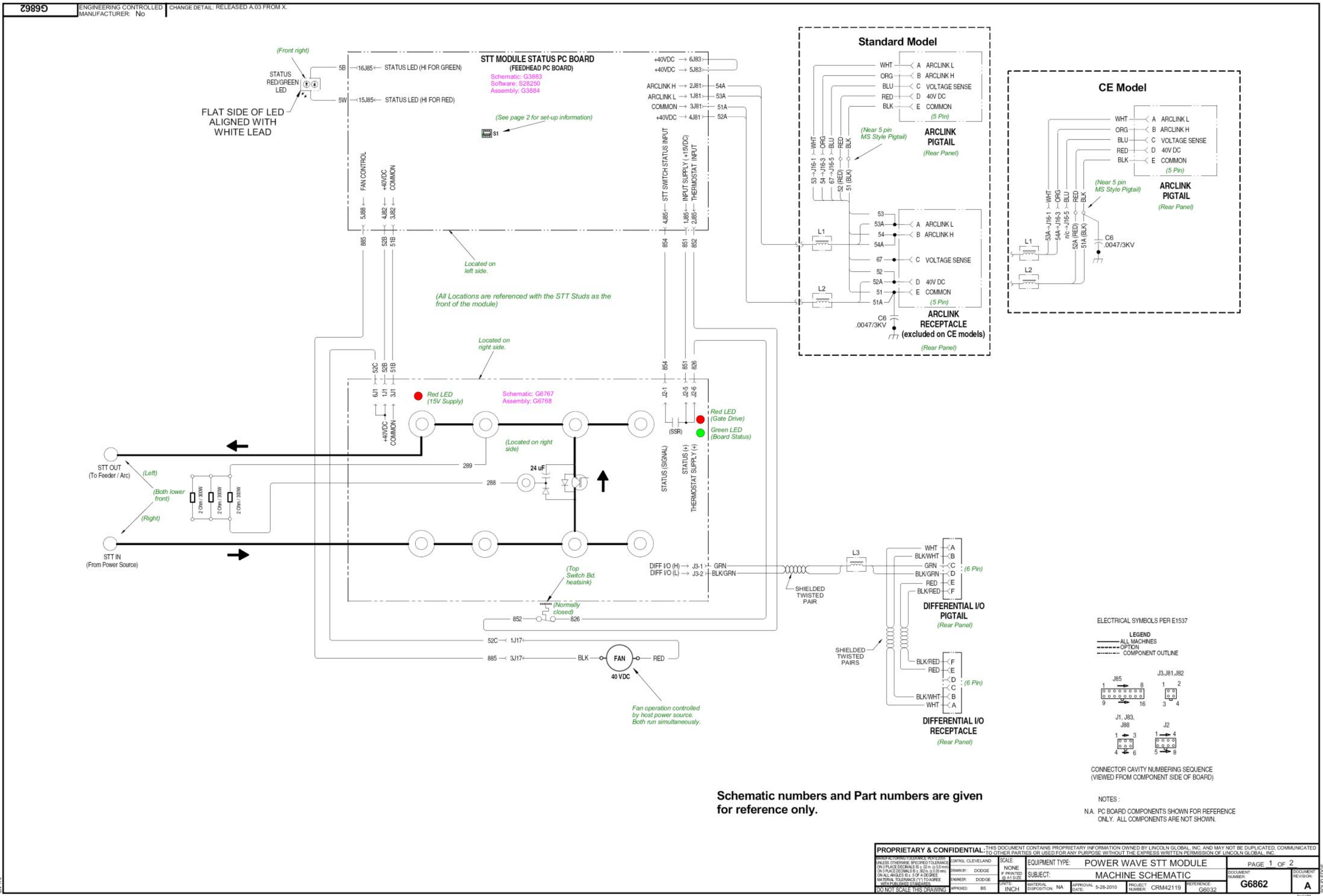
STT Module

Service Training



K2921-1

LINCOLN® ELECTRIC



G6862
ENGINEERING CONTROLLED MANUFACTURER: No
CHANGE DETAIL: RELEASED A.03 FROM X.
STT MODULE STATUS PC BOARD
(FEEDHEAD PC BOARD)
Schematic: G3883
Software: S28250
Assembly: G3884
(See page 2 for set-up information)
S1
STATUS RED/GREEN LED
(Front right)
FLAT SIDE OF LED ALIGNED WITH WHITE LEAD
STATUS LED (HI FOR GREEN)
STATUS LED (HI FOR RED)
+40VDC
ARCLINK H
ARCLINK L
COMMON
FAN CONTROL
+40VDC
COMMON
STT SWITCH STATUS INPUT
INPUT SUPPLY (+15VDC)
THERMOSTAT INPUT
Located on left side.
(All Locations are referenced with the STT Studs as the front of the module)
Located on right side.
Red LED (15V Supply)
Schematic: G6767
Assembly: G6768
Red LED (Gate Drive)
Green LED (Board Status)
(SSR)
(Located on right side)
24 uF
STATUS (SIGNAL)
STATUS (+)
THERMOSTAT SUPPLY (+)
STT OUT (To Feeder / Arc)
(Left)
(Both lower front)
(Right)
2 Ohm / 300W
STT IN (From Power Source)
DIFF I/O (H)
DIFF I/O (L)
(Top Switch Bd. heatsink)
(Normally closed)
FAN
40 VDC
Fan operation controlled by host power source. Both run simultaneously.
SHIELDED TWISTED PAIR
Standard Model
ARCLINK L
ARCLINK H
VOLTAGE SENSE
40V DC
COMMON
(5 Pin)
(Near 5 pin MS Style Pigtail)
ARCLINK PIGTAIL
(Rear Panel)
ARCLINK RECEPTACLE
(excluded on CE models)
(Rear Panel)
C6 .0047/3KV
CE Model
ARCLINK PIGTAIL
(Rear Panel)
(6 Pin)
DIFFERENTIAL I/O PIGTAIL
(Rear Panel)
SHIELDED TWISTED PAIRS
DIFFERENTIAL I/O RECEPTACLE
(Rear Panel)
ELECTRICAL SYMBOLS PER E1537
LEGEND
ALL MACHINES
OPTION
COMPONENT OUTLINE
CONNECTOR CAVITY NUMBERING SEQUENCE (VIEWED FROM COMPONENT SIDE OF BOARD)
NOTES :
N.A. PC BOARD COMPONENTS SHOWN FOR REFERENCE ONLY. ALL COMPONENTS ARE NOT SHOWN.
Schematic numbers and Part numbers are given for reference only.
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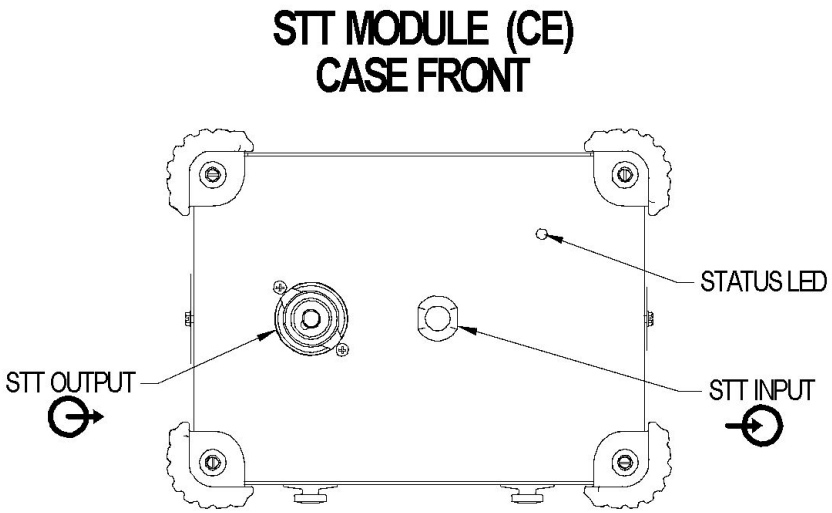
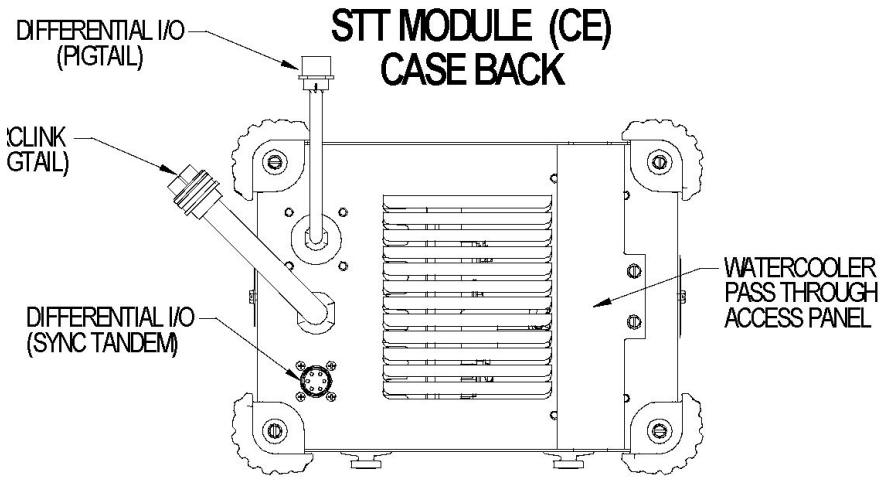
EQUIPMENT TYPE: POWER WAVE STT MODULE
SUBJECT: MACHINE SCHEMATIC
PAGE 1 OF 2
SCALE: NONE
UNITS: INCH
DRAWN BY: DODGE
ENGINEER: DODGE
APPROVED: BS
APPROVAL DATE: 5-28-2010
PROJECT NUMBER: CRM42119
REFERENCE: G6032
DOCUMENT NUMBER: G6862
DOCUMENT REVISION: A
DO NOT SCALE THIS DRAWING

STT Module

Front View

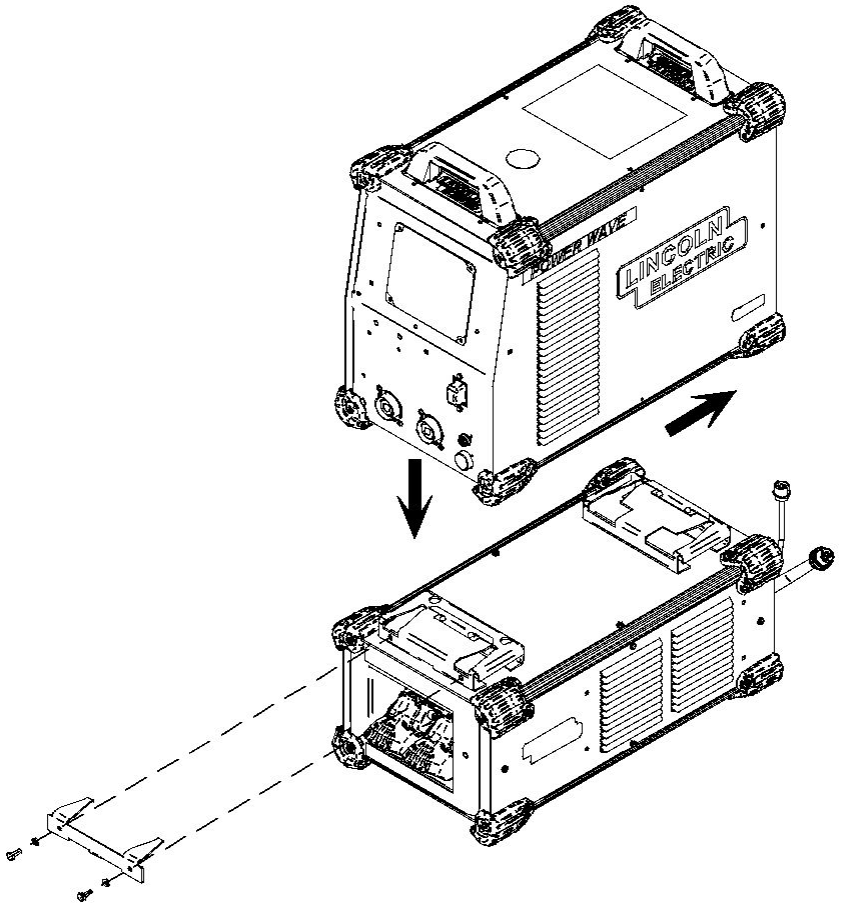


Rear View



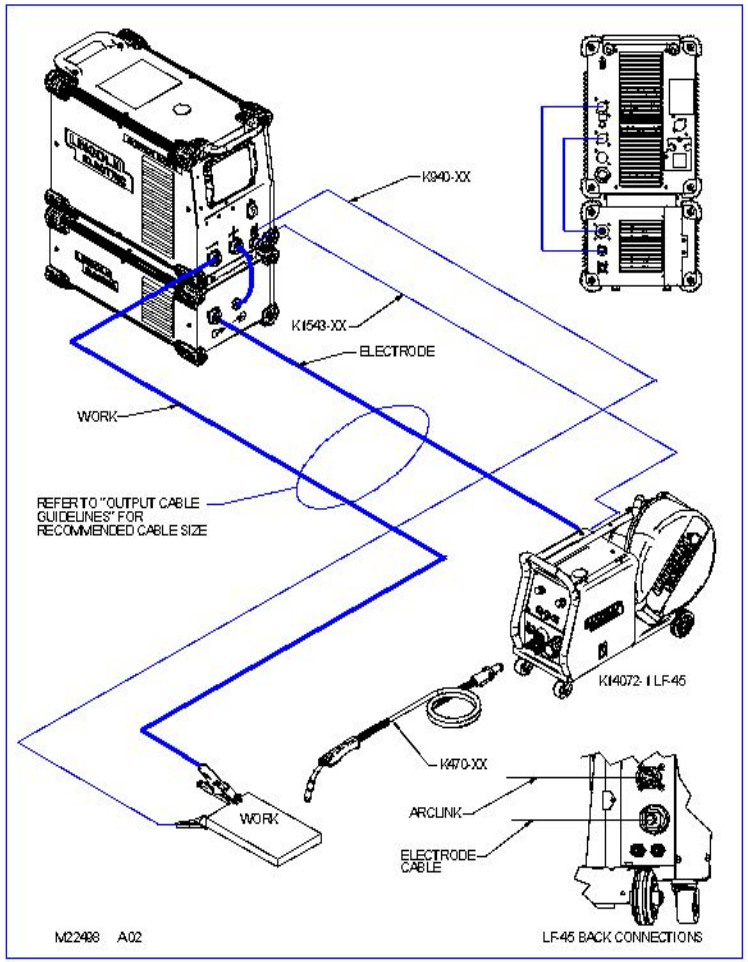
STT Module

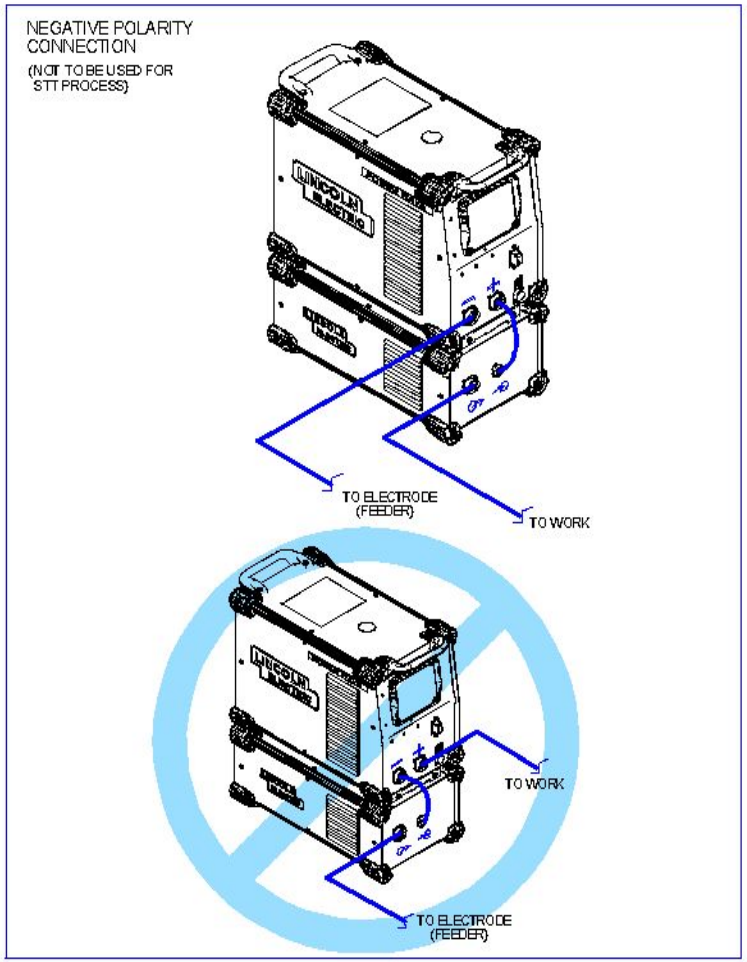
Typical Mounting



STT Module

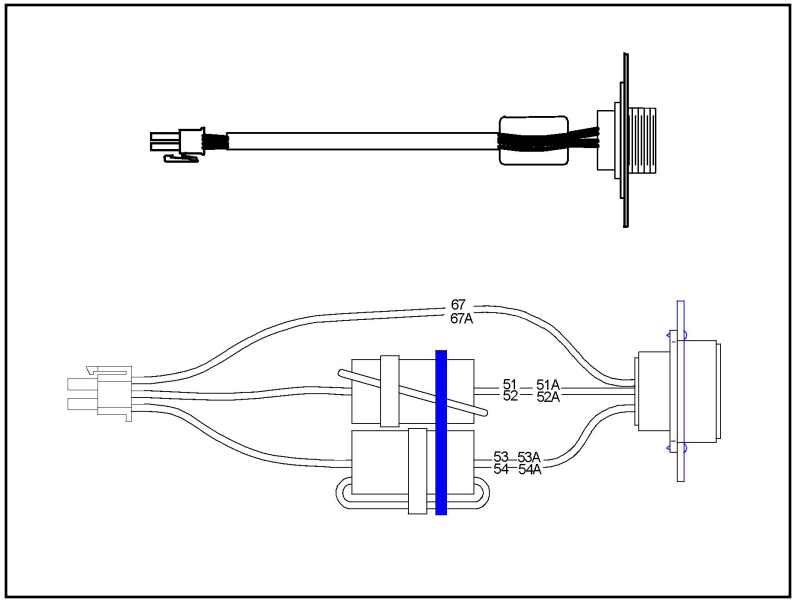
Connection Diagram (CE) (Reference M22498)

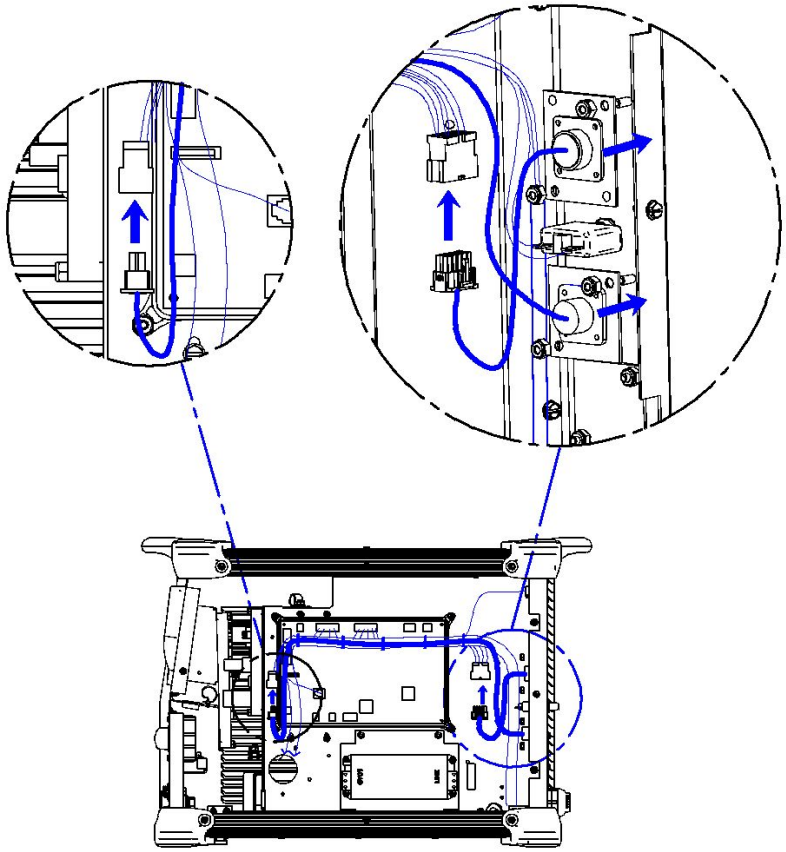




STT Module

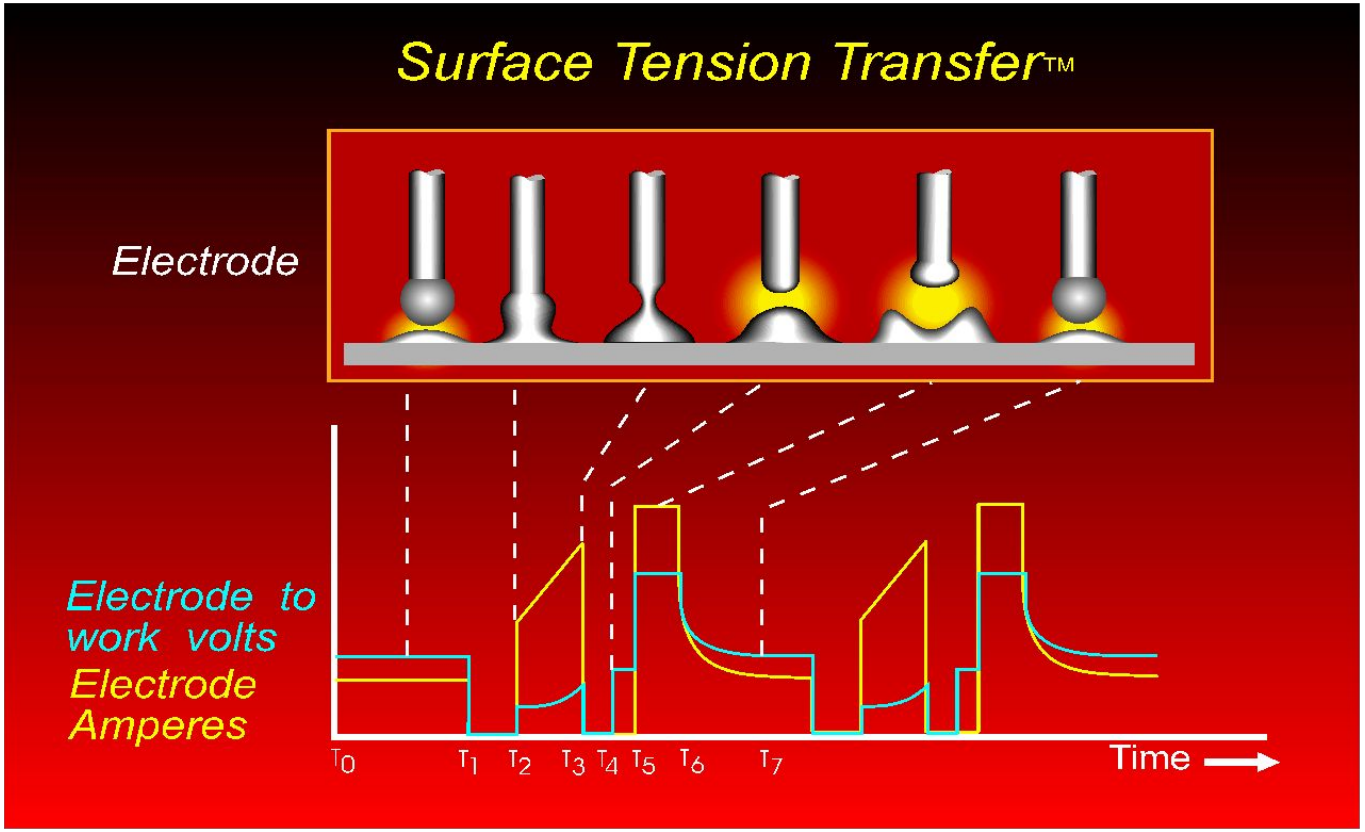
STT Update Kit (CE) Included with K2921-1 for S350 CE





STT Module

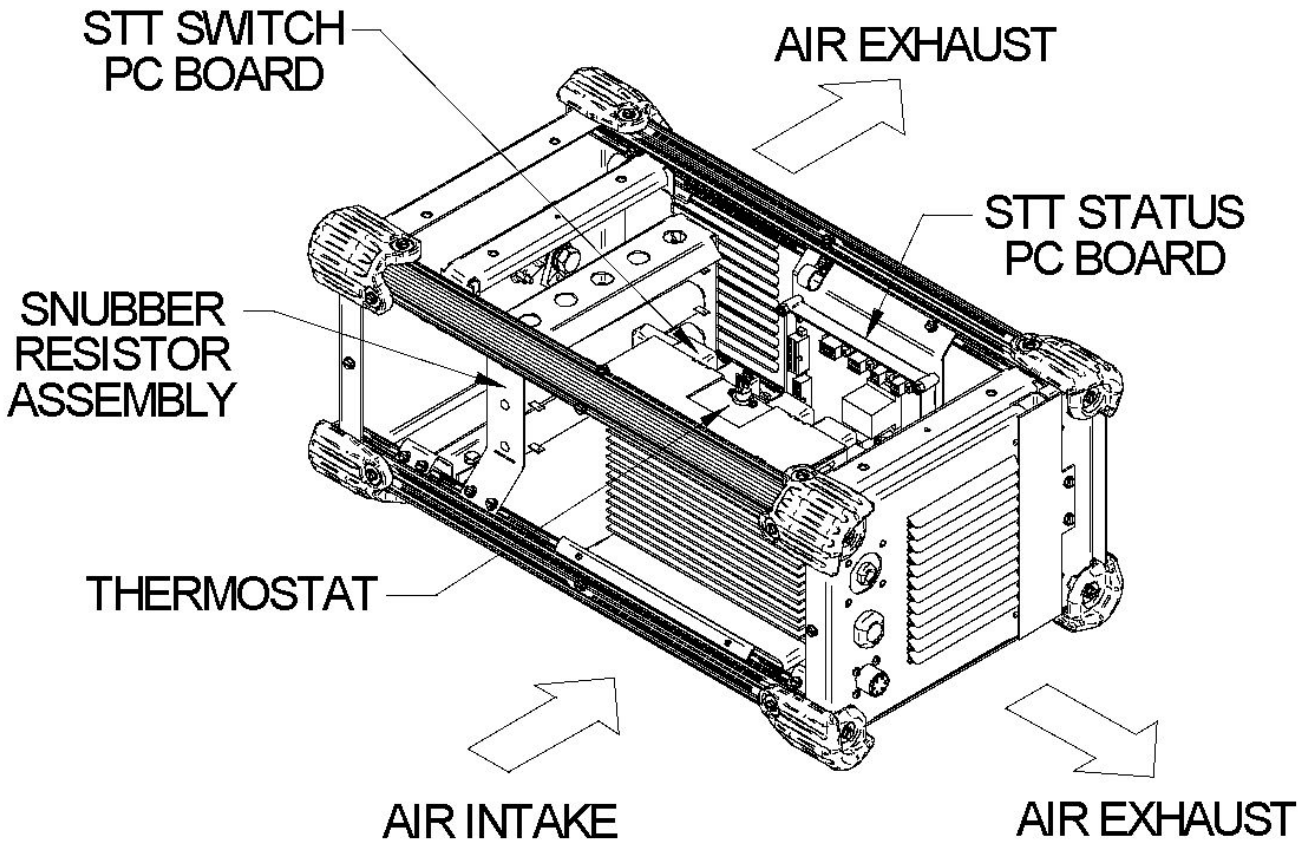
STT - The Basics



- ***Typical shorting frequency ≅ 100 - 120Hz***

STT Module

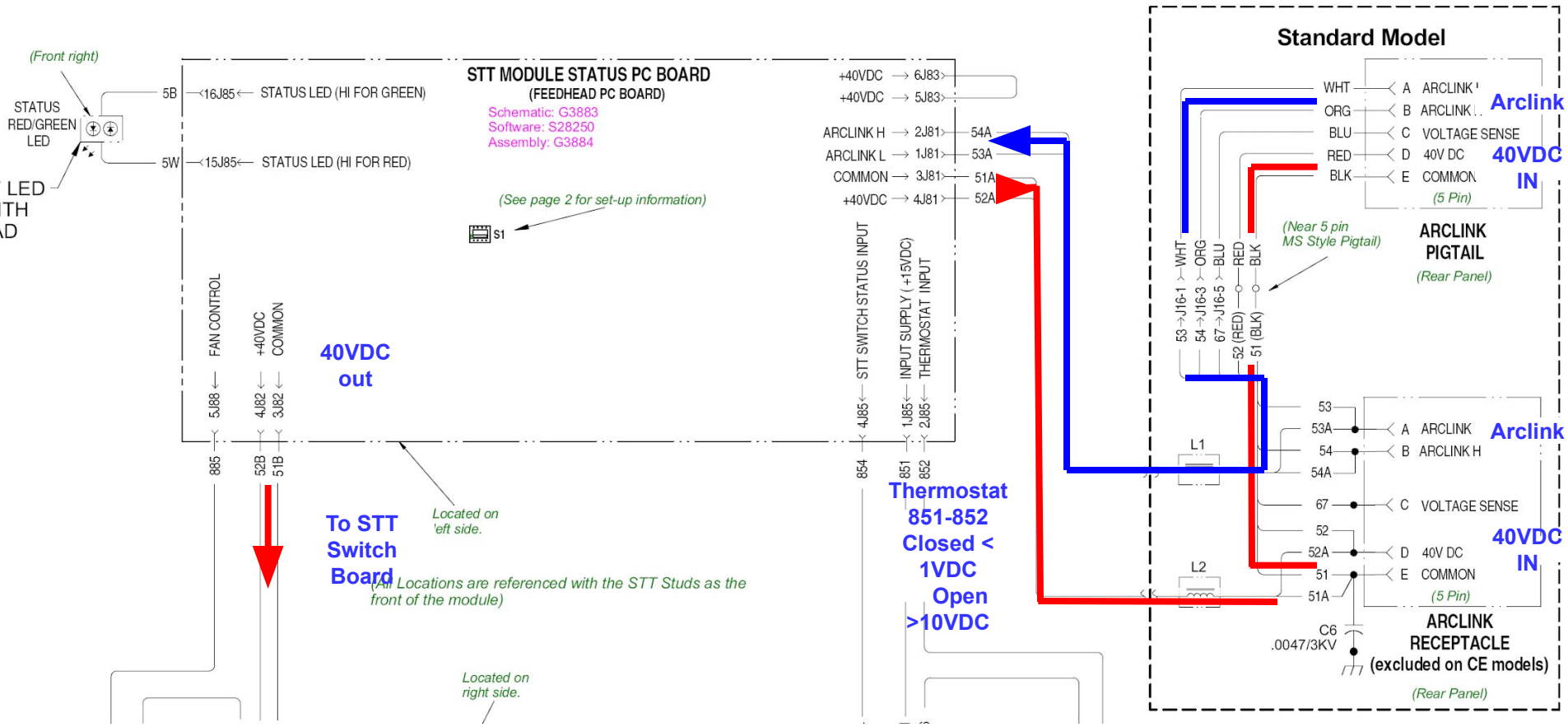
Component Location



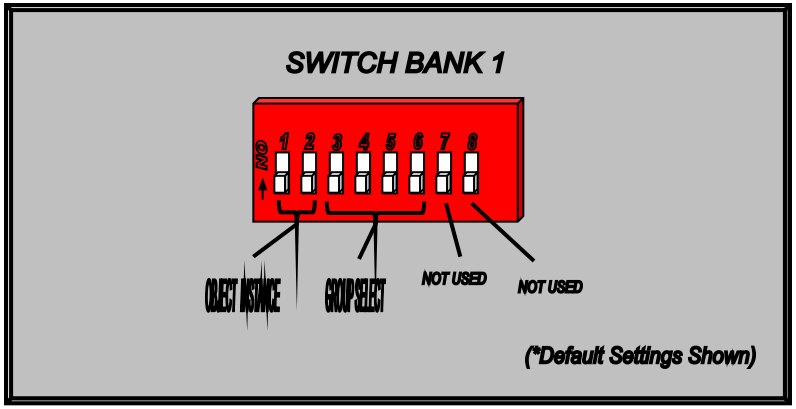
STT Status PC Board (S28250/G3884 series)

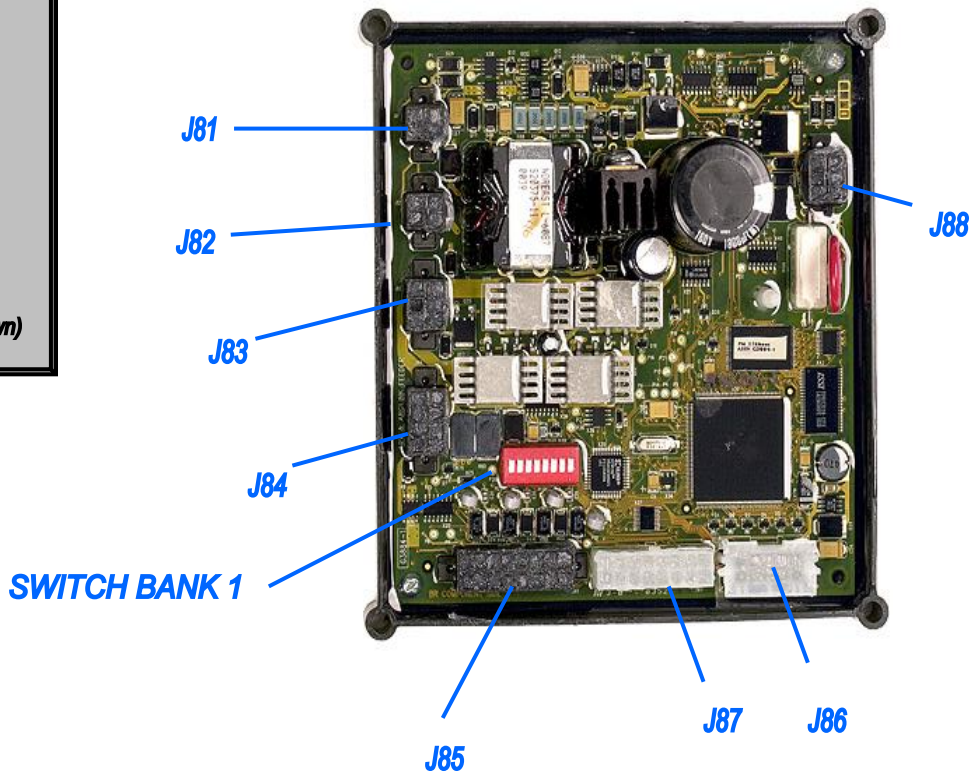
Functions

- ***Identifies STT Module to ArcLink Network***
  - ***Receives Switch PCB Status and Thermal information***
  - ***Communicates Errors to Power Source via ArcLink***
- ***Drives Fan***
  - ***Fan driven via Power Source Control Board command***
- ***Controls external Status LED***


(Front right)
STATUS RED/GREEN LED
5B
16J85
STATUS LED (HI FOR GREEN)
5W
15J85
STATUS LED (HI FOR RED)
STT MODULE STATUS PC BOARD
(FEEDHEAD PC BOARD)
Schematic: G3883
Software: S28250
Assembly: G3884
(See page 2 for set-up information)
S1
+40VDC → 6J83
+40VDC → 5J83
ARCLINK H → 2J81 → 54A
ARCLINK L → 1J81 → 53A
COMMON → 3J81 → 51A
+40VDC → 4J81 → 52A
FAN CONTROL
+40VDC
COMMON
5J88
4J82
3J82
885
52B
51B
40VDC out
To STT Switch Board
Located on left side.
(All Locations are referenced with the STT Studs as the front of the module)
STT SWITCH STATUS INPUT
INPUT SUPPLY (+15VDC)
THERMOSTAT INPUT
4J85
1J85
2J85
854
851
852
Thermostat 851-852 Closed < 1VDC Open >10VDC
Located on right side.
Standard Model
WHT
ORG
BLU
RED
BLK
A ARCLINK
B ARCLINK
C VOLTAGE SENSE
D 40V DC
E COMMON
(5 Pin)
Arclink
40VDC IN
(Near 5 pin MS Style Pigtail)
ARCLINK PIGTAIL
(Rear Panel)
53 → J16-1 → WHT
54 → J16-3 → ORG
67 → J16-5 → BLU
52 (RED)
51 (BLK)
L1
L2
53
53A
54
54A
67
52
52A
51
51A
C6
.0047/3KV
ARCLINK RECEPTACLE
(excluded on CE models)
(Rear Panel)

STT Status PC Board (S28250/G3884 series)





STT Status PC Board (S28250/G3884 series)

Troubleshooting with External LED

- ***No LED***
  - *Check LED placement and connections*
  - *Verify 40 Vdc input (J81-4 to J81-3)*
- ***Fast blinking Green LED – Mapping Error***
  - *Verify continuity of ArcLink cable (pins "A" and "B")*
  - *Verify ArcLink Pigtail to Status PCB*
    - *Pin "A" to J81-1*
    - *Pin "B" to J81-2*
- ***Red and Green Blinking LED***
  - *Read and interpret Error Code*
    - *Power Wave Manager Diagnostic Tab*

STT Status PC Board (S28250/G3884 series)

Troubleshooting with External LED

Error codes for the Power Wave STT Module

(Indicated on the externally mounted Status LED)

STT Module	
Error Code #	**Indication**
36 Thermal error	Indicates over temperature. Usually accompanied by Thermal LED on the host power source. Check fan operation. Be sure process does not exceed duty cycle limit of the machine.
39 Misc. hardware fault	Unknown glitch has occurred on the fault interrupt circuitry. Sometimes caused by intermittent connections in the thermostat circuit.
99 STT Status error	Error reported by the STT Switch PC Board. Generally caused by misconnection of welding leads (reverse polarity). May also be caused by loss of input voltage or board failure. Observe diagnostic LED's on the STT Switch PC Board to determine the exact cause.
Other	A complete list of error codes is available in the ***Power Wave Manager Utility*** *(available at* ***www.powerwavesoftware.com****).* Error codes that contain three or four digits are defined as fatal errors. These codes generally indicate internal errors on the Power Source Control Board. If cycling the input power on the machine does not clear the error, contact the Service Department.

STT Status PC Board (S28250/G3884 series)

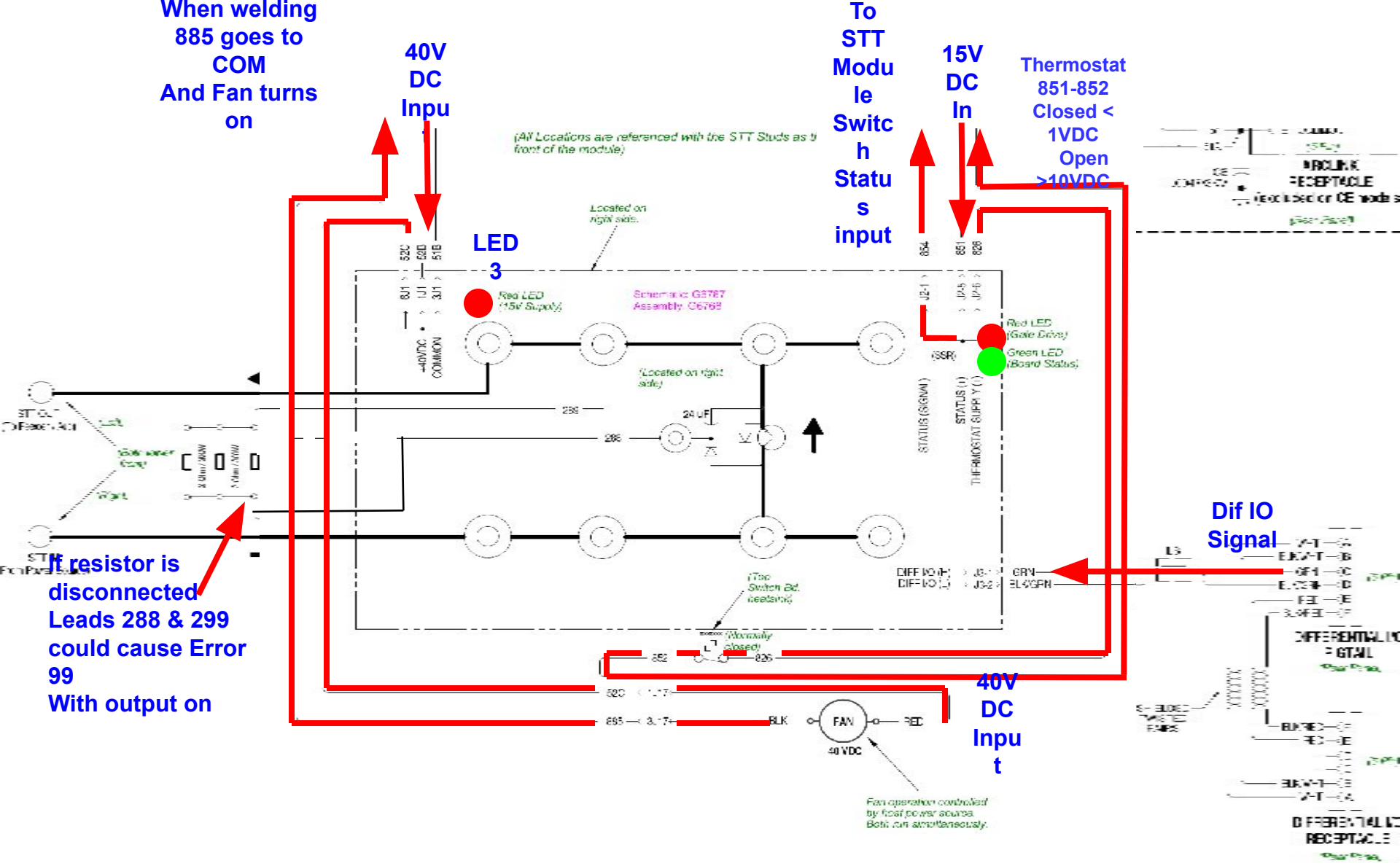
Troubleshooting Input and Output Circuits

- ***Thermostat Input***
  - ***Best Measured across the Thermostat***
    - ***Closed < 1VDC***
    - ***Open > 10VDC***
- ***Switch PCB Status Input***
  - ***Best Measured at STT Switch PC Board (J2-5 to J2-1)***
    - ***Closed < 1VDC***
    - ***Open > 10VDC***
- ***Fan Output***
  - ***Open Collector style (J88-5)***
  - ***Supplied from STT Switch PCB (J1-6)***

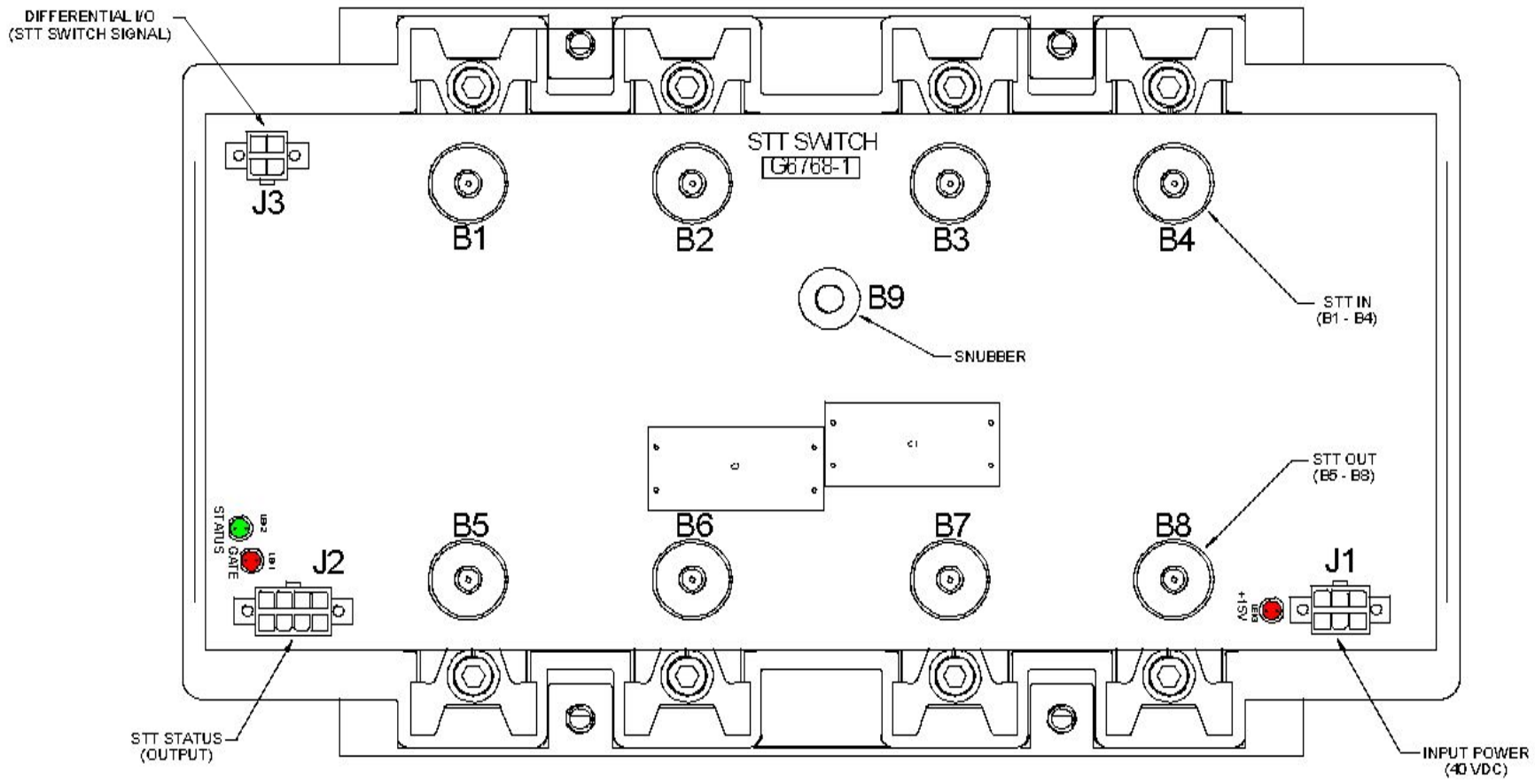
STT Switch PC Board (G6768 series)

Functions

- ***Interrupts Power Source Output Current***
  - ***Includes integral snubber diodes and capacitors***
    - ***Resistor bank located off Board***
- ***Includes on board Protection Circuitry***
  - ***Intelligent Gate Drive***
    - ***Minimum ON time = 223µsec***
    - ***Maximum OFF time 1.5 seconds***
  - ***Under Voltage Lockout (ERROR 99)***
  - ***Over Voltage Protection***
    - ***Turns Switch ON if Snubber voltage exceeds 500V***
  - ***Reverse Polarity Protection (ERROR 99)***
    - ***Only when connected through Status PCB (ArcLink)***

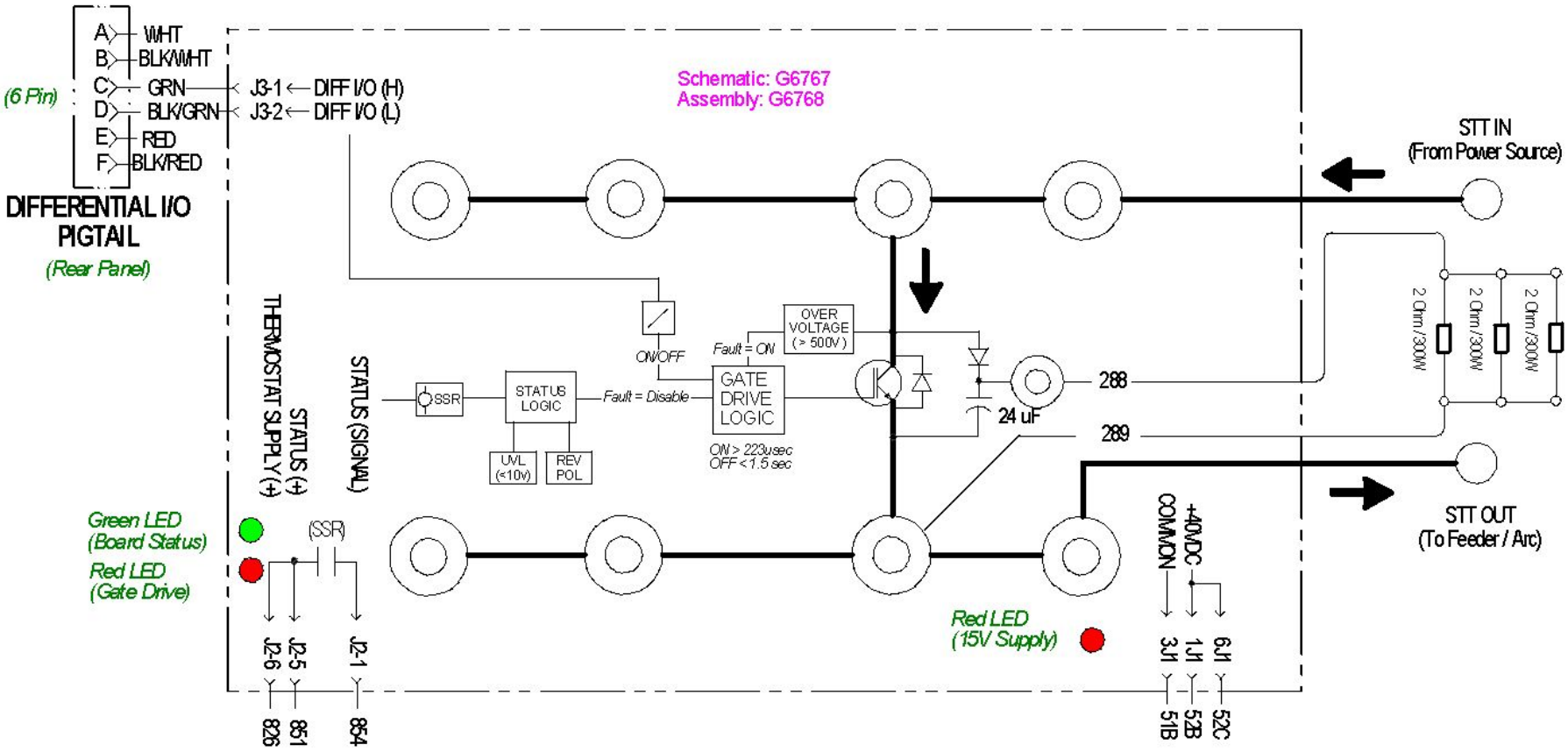

When welding 885 goes to COM And Fan turns on
40V DC Inpu
To STT Modu le Switc h Statu s input
15V DC In
Thermostat 851-852 Closed < 1VDC Open >10VDC
LED 3
Red LED (15V Supply)
Red LED (Gate Drive)
Green LED (Board Status)
24 uF
If resistor is disconnected Leads 288 & 299 could cause Error 99 With output on
Dif IO Signal
40V DC Inpu t
FAN
40 VDC
BLK
RED
Fan operation controlled by heat power source. Both run simultaneously.

STT Switch PC Board (G6768 series)



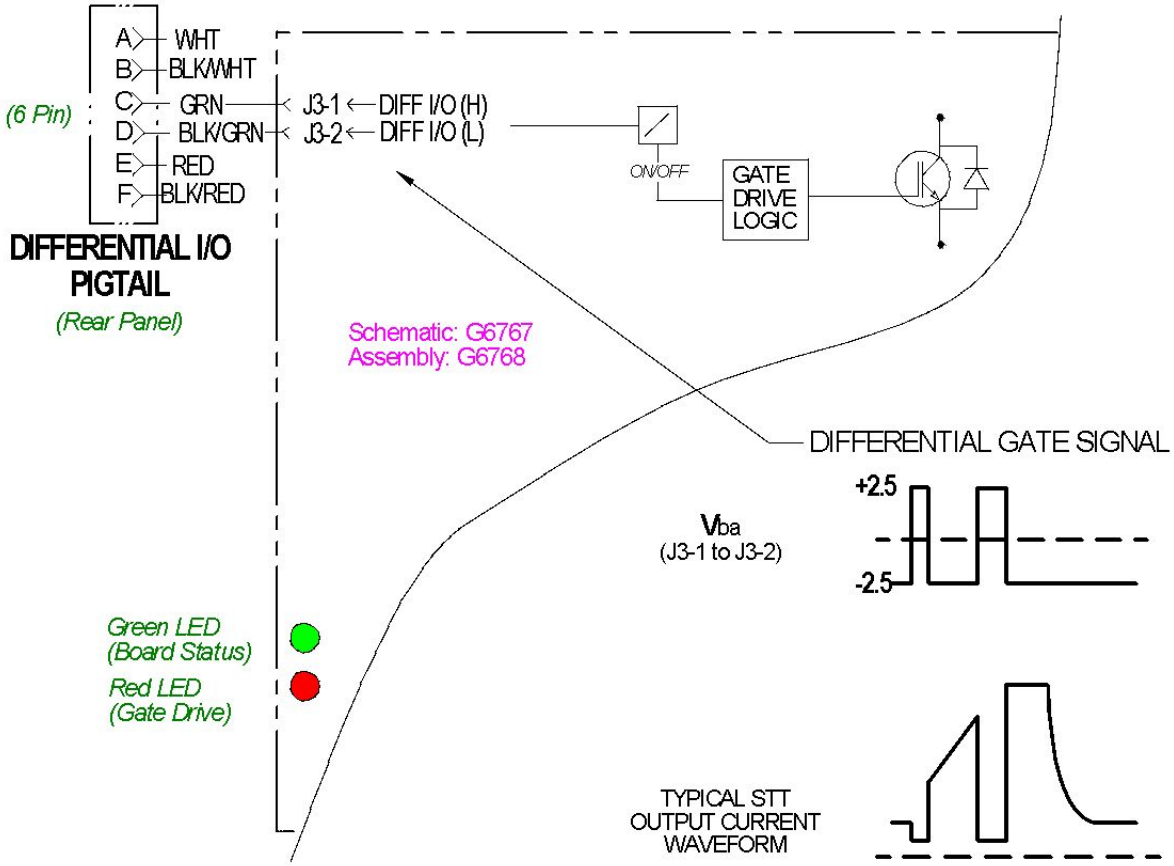
STT Switch PC Board (G6768 series)

Functional Block Diagram



STT Switch PC Board (G6768 series)

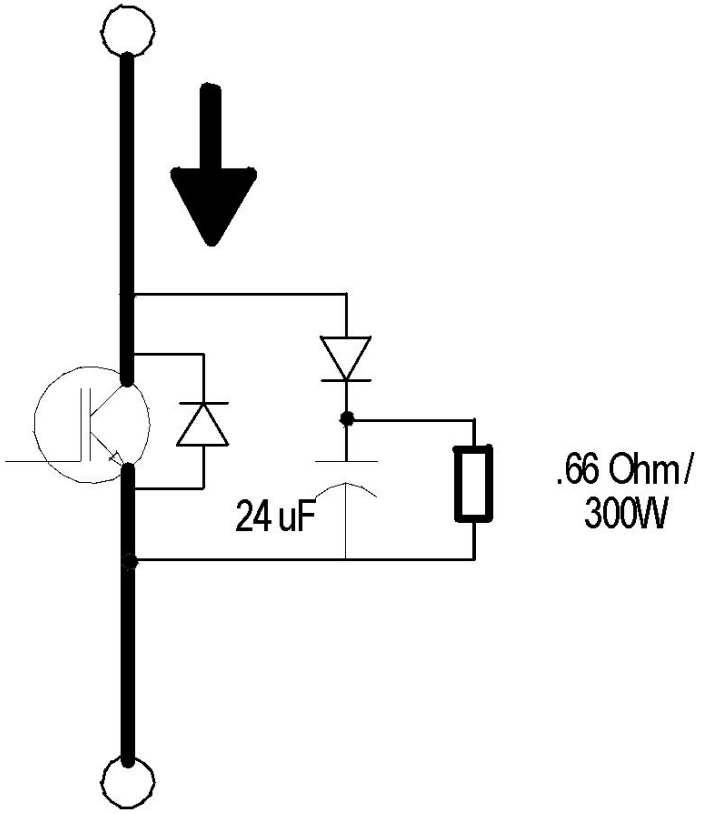
Gate Drive Signal *(RS-485 Differential signal from Power Source)*



STT Switch PC Board (G6768 series)

Snubber Configuration

- ***Capacitor***
  - ***Absorbs initial energy***
- ***Resistor***
  - ***Limits maximum voltage***
  - ***Provides path to sustain arc current***
  - ***Dissipates Energy from weld circuit inductance***



STT Switch PC Board (G6768 series)

Troubleshooting

On Board LED's for the STT Switch PC Board

(Visible through the rear and left side louvers)

STT Switch PC Board				
MACHINE OUTPUT	**LED1 (GATE)**	**LED2 (STATUS)**	**LED3 (+15V)**	**Indication**
ON/OFF	ON	ON	ON	Normal Condition – STT Switch is ON
ON	OFF	ON	ON	Normal Condition – STT Switch has been commanded OFF Note: During normal STT operation the OFF state of the LED may only be detectable as a slight dimming.
ON	OFF	OFF	ON	Status Failure (only when triggered). Should be accompanied by Error 99 on the external STT Module Status LED. Most likely caused by weld cable misconnection (reverse polarity).
ON/OFF	OFF	OFF	ON/OFF	Status Failure (constantly). Should be accompanied by Error 99 on the external STT Module Status LED. Most likely caused by the on board power supply under-voltage lockout. Verify input voltage to the STT Switch board.