SVF1 Resistance Welding Controller Manual

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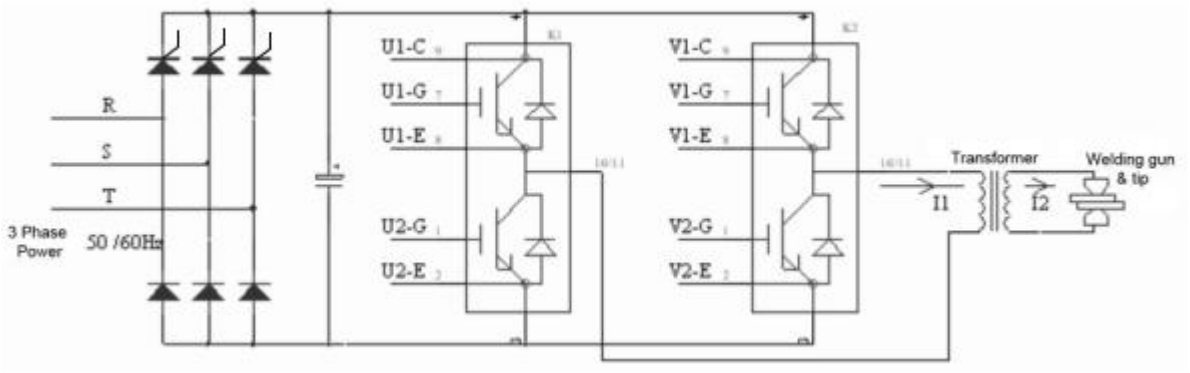
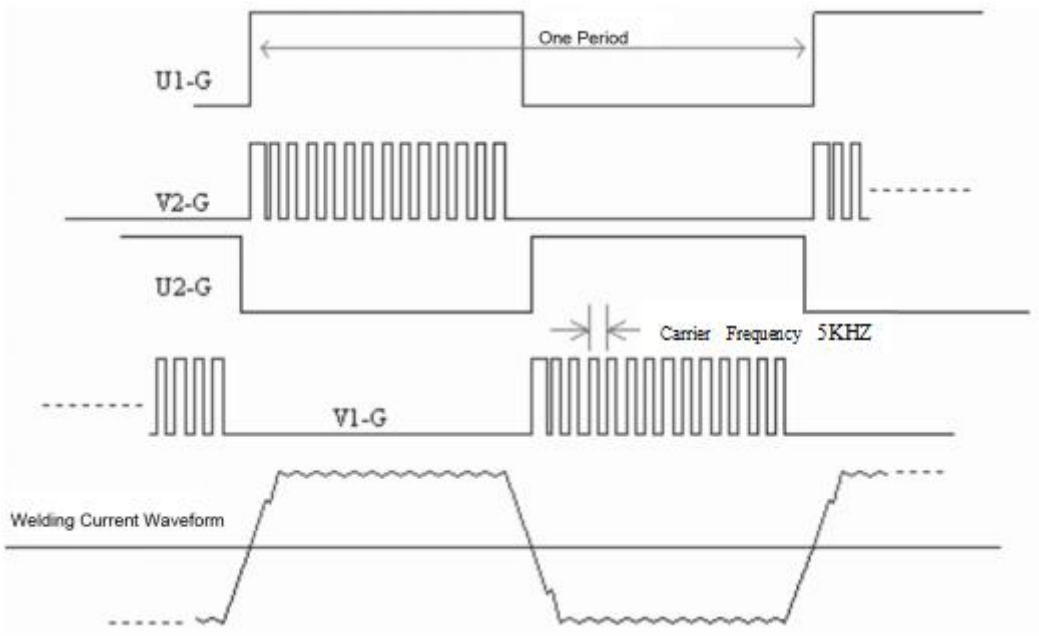
I Introduction

1. Basics of the Variable Frequency Controller

The Variable Frequency Controller takes three-phase AC 50/60Hz power input. This is rectified and smoothed into direct current. The IGBT inverter stage then switches this DC voltage across the primary side of the welding transformer. IGBT K1 provides the variable AC frequency and IGBT K2 switches the voltage at the high frequency carrier frequency of 5kHz. This provides a combination of adjustable AC frequency and precise control of the welding current.

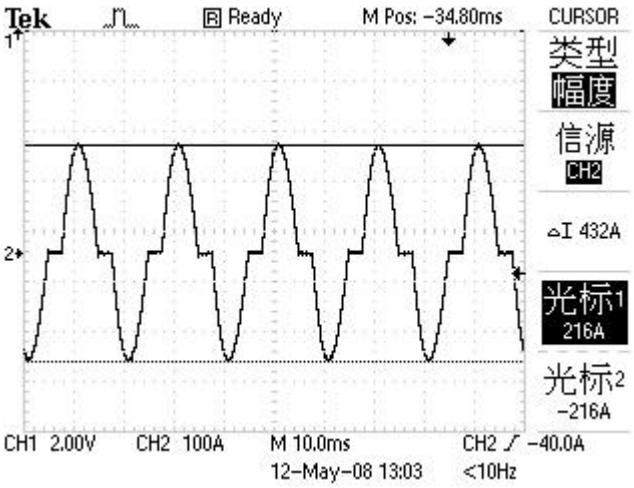


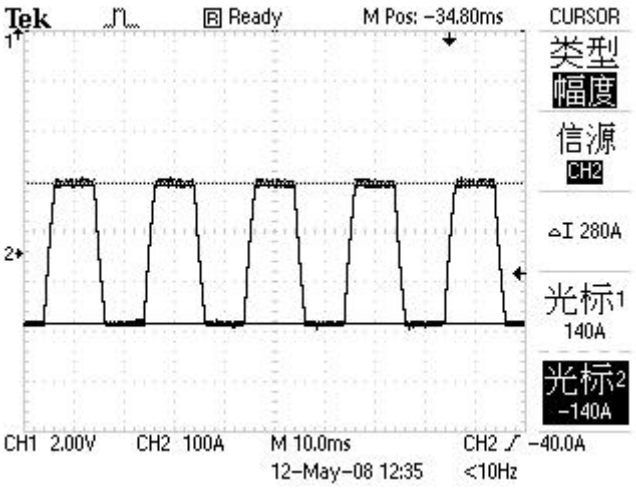


2. Variable Frequency vs. Normal Frequency Controller Comparison

Compared to Common Power Frequency welding controllers, Variable Frequency Controllers have higher heating efficiency and lower peak currents for the same welding performance.

The figure on the left below shows a Common Power Frequency welding waveform at 50Hz input power frequency and a 10kA secondary current with an 80:1 turns ratio on the transformer. On the right is a Variable Frequency Controller producing the same output current.



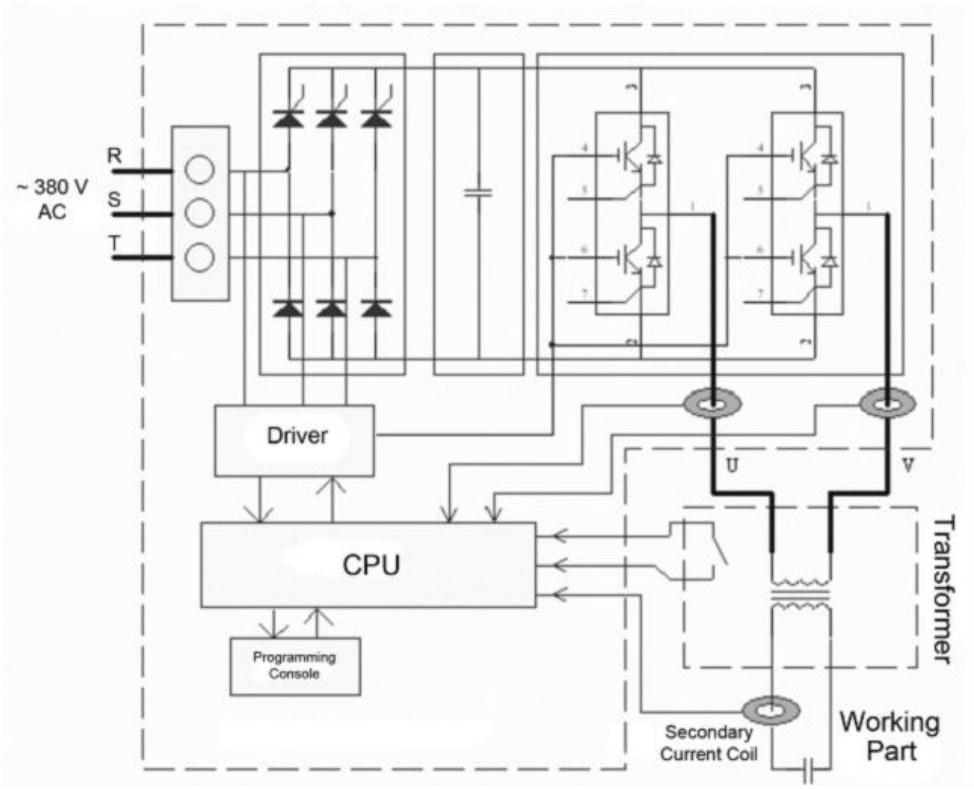


Compared to Common Power Frequency controllers, the Variable Frequency Controller has the following advantages:

1. The three-phase AC mains input exhibits more balanced power usage and a higher power factor
2. For the same weld, the weld time is shorter, saving electricity
3. The welding stability region enlarges, providing better process control
4. The electrode life is longer
5. A wider range of materials can be welded with good results, including aluminum, galvanized sheet, high-tensile steel, stainless steel, magnesium alloy, carbon steel, titanium, etc.
6. Also produces good results when welding three-layer materials and thin materials
7. Fewer expulsion events are generated, resulting in higher weld strength and better cosmetic results
8. Higher weld spot quality due to faster electric current control response due to the high-frequency switch driver

II Components of the Control System

The entire control system consists of the welding controller, the welding transformer, and the welding gun. The welding controller consists of the power supply, the rectifier, the capacitor, IGBT, and the CPU.



1. Main features:

1. Welding frequency: programmable between 15.0Hz and 400.0Hz.
2. Can program up to 64 welding schedules.
3. Three section of thermal processes: Preheating, welding, tempering. Each process has its own current stepper.
4. Programmable output: 3-stage outputs can interface with PLCs, robots, etc.
5. Spot weld count monitoring function.

2. Technical parameters:

1. Input voltage: 3-phase 380V/400V/480V, 50Hz/60Hz, power variation +10%, - 20%.
2. Output voltage: PWM 500V/550V/600V.
3. Output current: When the duty cycle is no more than 10%, depending on the control model, the maximum electric current output is 400A, 800A, 1000A,1200A,1600A, 2400A.
4. Cooling water: minimum flow rate 6L/MIN(SVF1-400),8L/MIN(SVF1-800D),12L/MIN(SVF1-800),12L/MIN(SVF1-1000D), 14L/MIN(SVF1-1200),14L/MIN(SVF1-1600D),18L/MIN(SVF1-1600),24L/MIN(SVF1-2400), temperature ≤30℃, cooling water temperature and ambient temperature must not differ more than 10℃.
5. Ambient temperature: 0-50℃.
6. Air valve voltage: DC 24V.

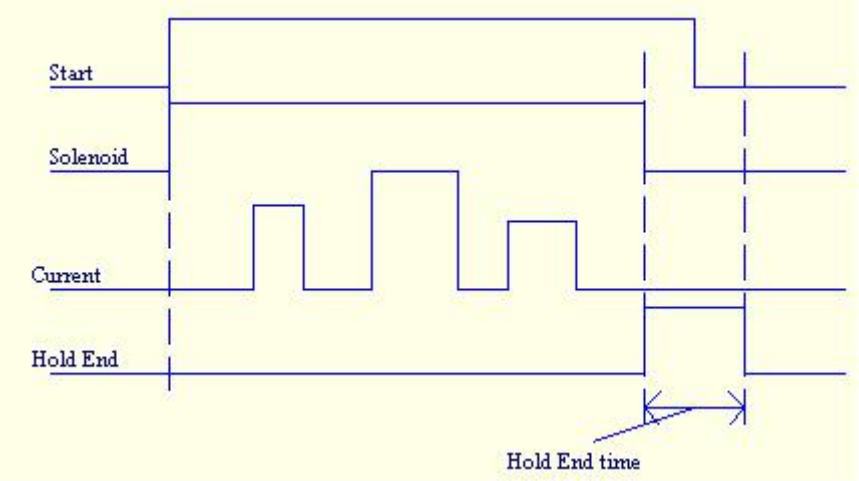
III Weld Control Functions

The weld control system has two modes: spot welding and seam welding.

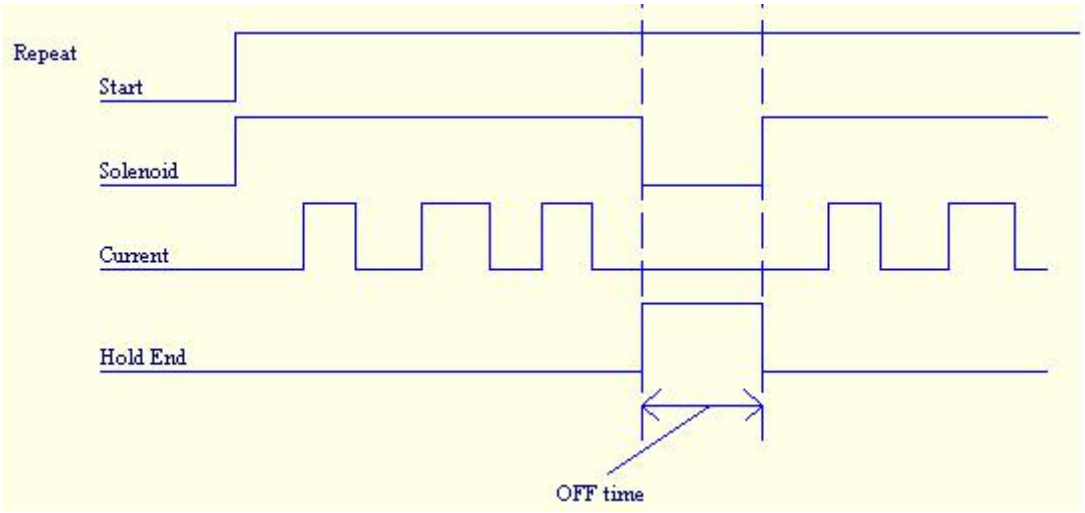
Spot Welding

There are two spot welding modes: single spot welding & repeated spot welding

1. **Single Spot Welding**: When the start signal is asserted, the welding process begins immediately. When the welding process is complete it will generate a signal to indicate completion. In all our control systems there is a standard parameter that can be set to "prohibit initiation". This permits or prohibits the initiation of the welding process. When this parameter is ON it will not allow the use of the welding operation; when this parameter is OFF the user is able to use the welding control system. The figure below shows the time sequence for the single spot welding process:



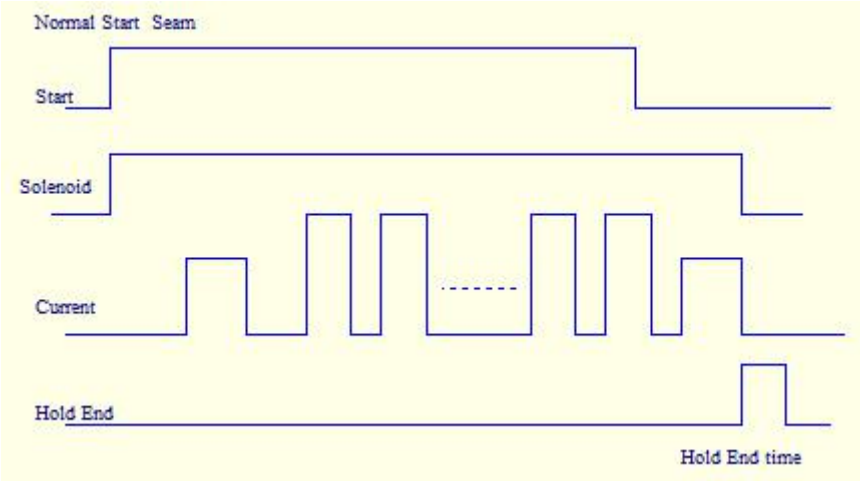
2. **Repeated Spot Welding**: during the process of repeated spot welding, the welding proceeds according to programmed parameters as long as the Start signal is asserted. In each weld cycle, the solenoid actuates, the weld is performed and the solenoid valve is released. At this time a delay equal to the OFF time begins. After the OFF time has elapsed, the solenoid valve will close, and resume the next welding process. The following figure shows the process for Repeated Spot Welding:



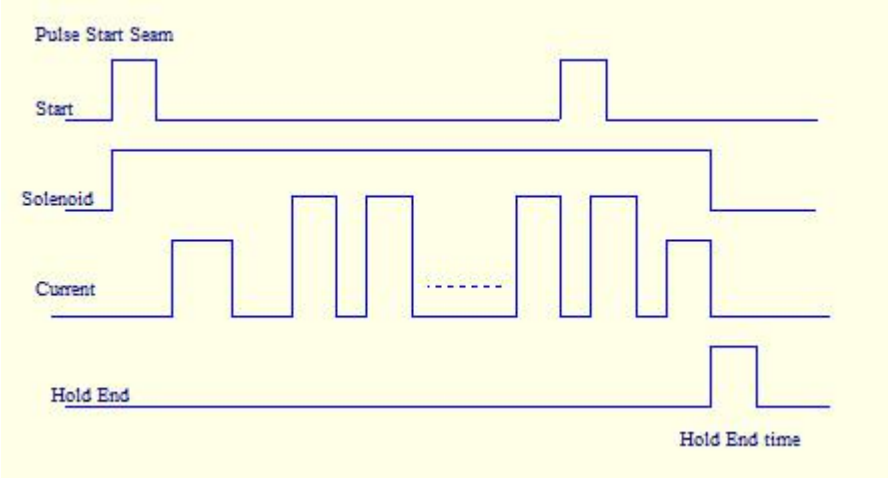
Seam Welding

There are two seam welding modes: Normal Start Seam & Pulse Start Seam

1. **Normal Start Seam** (Pulse Start OFF): In this mode, the second pulse output circulates to form the seam weld process, based on the seam welding wheel, the electric current outputs continuously until the start signal is disabled, at which time the welding process ends. The following picture shows the process for Normal Start Seam welding.



2. **Pulse Start Seam** (Pulse Start ON): According to this mode, after Start signal is asserted once, the electric current outputs continuously until the start signal is asserted for a second time, at which point the welding process ends



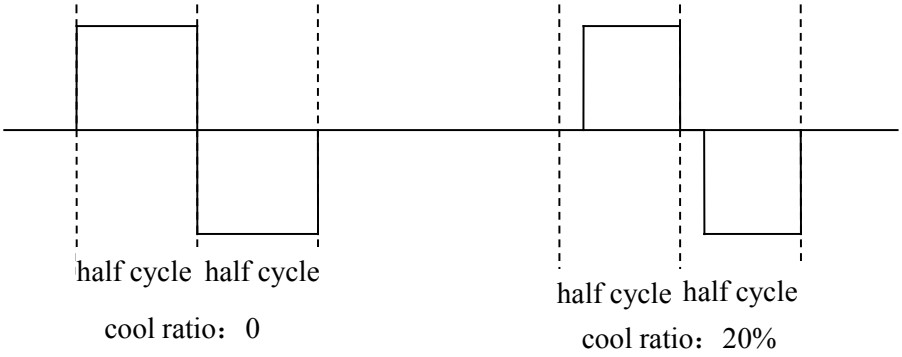
When the welding controller is in seam welding mode, the welding current switches between up to 4 “segments”, which represent 4 different currents and timing pairs. When the “SEAM TIMING” parameter is ON, the Cycle Current switch is valid, and is used to cycle between the segments in the order SEAM 1, 2, 3, 4.

Not all segments have both a time and current setting, and some of the segments can be disabled by setting the values to 0.

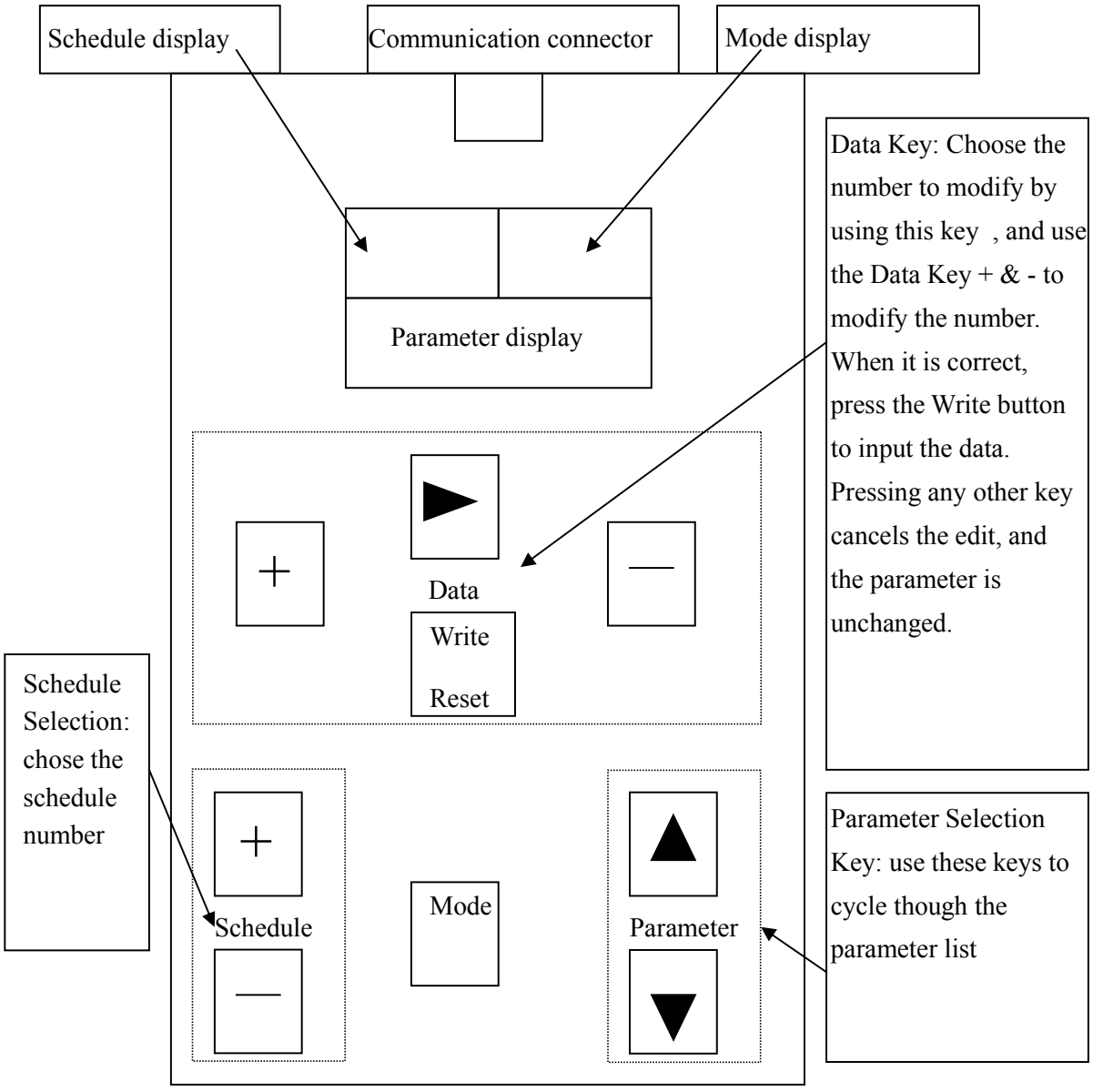
- SEAM 1 TIME (1-9999ms) and 2. HEAT give the current and and time for the first segment. Neither parameters can be set to 0 – this segment is always enabled.
- SEAM 2 TIME (0-9999ms) and SEAM 2 HEAT give the time and current for the second segment, if used (set to 0 otherwise).
- SEAM 3 TIME (0-9999ms) and SEAM 3 HEAT give the time and current for the third segment, if used (set to 0 otherwise).
- SEAM 4 HEAT gives the current in the final weld segment. Time in this segment is controlled by the start switch. After completion of this segment, welding ends. When the weld time is complete, but the start switch remains ON, the welding current will be as set by SEAM 4 HEAT until the Start switch turns off, whereupon welding is over. When weld time is complete and the start switch is already off, welding is immediately complete.

3. **Cool ratio** (0-99.99%): (half cycle-welding time)/half cycle *100.0%

This is the ratio of weld current active time to current off time. The figures below show cool ratios of 0% and 20%:



IV Programming Console



Welding Modes

The welding controller can operate in several modes, which can be selected by the “Mode” button on the user interface. The modes are as follows:

1. Welding mode (WELD): In this mode the welding control operates normally, and performs actual welds.
2. Test mode (TEST): In this mode, the welding control only allows outward movement and there is no actual welding current output.
3. Programming mode (PROG): In this mode, the parameters of the welding controller can be programmed.
4. Monitor mode (MONI): Under this mode, the user can manually advance each step in order to check for accuracy and investigate possible problems in the welds.
5. Press mode (PRES): the start switch controls the value output.

Schedule Selection Method

Two method: terminal selection and programming console selection

S8（DIP Switch）in the Main-board set to ON ,”SYSTEM KEYWORD”set to 2010.

Terminal selection: the parameter “Schedule Selection ”set to 0000;

Programming console selection: the parameter “Schedule Selection” set to 1111;

1)Terminal selection: program by changing the parameter “0 AS 1”, adjust the terminal with schedule correlation. “SYSTEM KEYWORD” set to 2010.

“ 0 AS 1” set to 0000 or 1111, the relations between the schedule selection terminal and the starting schedule ,please see Appendix.3.

NOTE: Must be that the parameter “START INHIBIT” set to OFF.

2)programming console selection: Must be that the parameter “START INHIBIT” set to OFF, or the starting schedule is the last schedule that the parameter “START INHIBIT” set to OFF.

NOTE: When setting complete, please close S8.

V. Functions Set Up

1、The meanings behind the parameters S1, S4 S5, S6, S7, S8 are as follows:

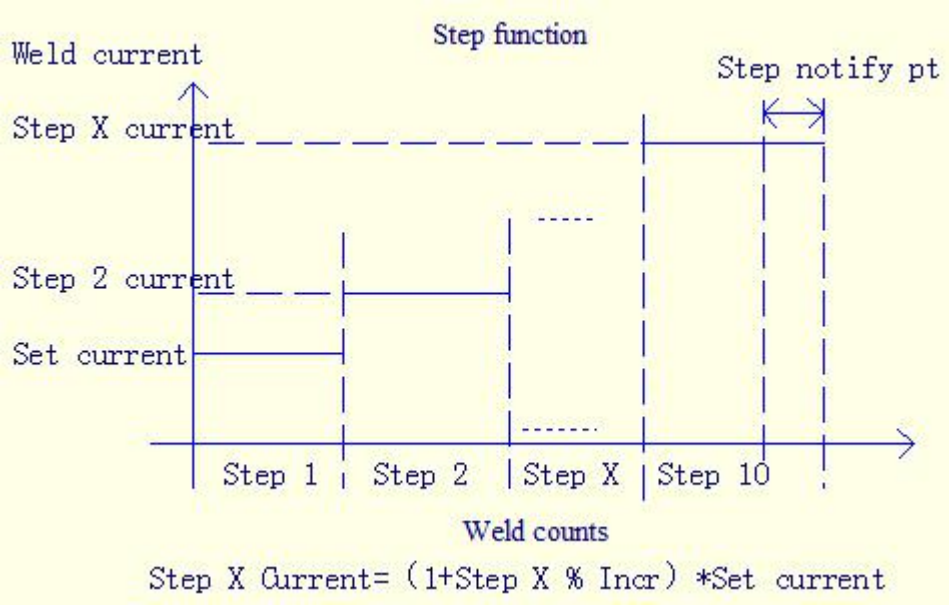
	ON	OFF
S1	The secondary-sensors are installed	The secondary-sensors are not installed.
S4	Allow for expanding of surveillance parameters.	The surveillance parameters are set to conventional
S5	Seam welding	General spot welding
S6	Warning alarm stops welding process	Warning alarm does not stop welding process
S7	The primary current feedback is effective	If the secondary sensor is installed, then secondary current feedback is effective; if the secondary sensor is not installed, the primary current feedback is effective.
S8	System parameters allows for input, restricted only by the equipment manufacturer.	

2、The signals of S2, S3 can be selected to adapt to the pressure required for various modes.

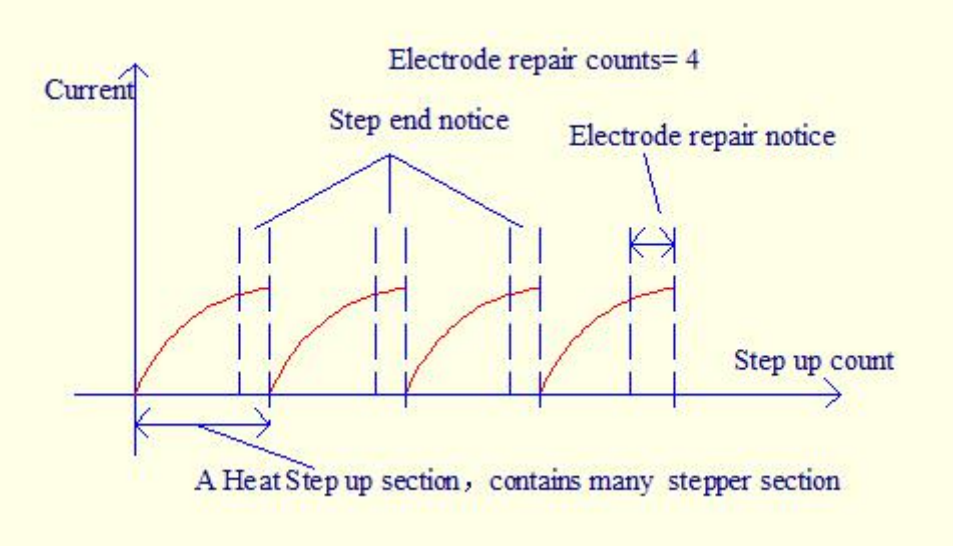
	S3	S2
0~10V	OFF	OFF
0~10V	OFF	ON
4~20 m A	ON	OFF
0~20 m A	ON	ON

VI. Electric Current Stepper and Tip Dressing

In order to compensate for the current reduction caused by electrode wear and tear, the welding controller offers a current stepper function. The user can set up to 10 steps, each with its own current setting. This function involves the following parameters: current stepper increment, step welding count, step end notice.



- **Step X% Incr** (X from 1-10): The current increment in each step refers to the reference current value. The range is from 0 to 999.9%
- **Step X Weld Count**: The weld count within each step, range from 0/1 to 9999.
- **Step End Notice**: Number of points prior to the total weld count being reached (and therefore end of the stepper program) to send a notification.
- **Continue/Stop**: set to 0000: when step is over, alarm and continue welding. Set to 1111, when step is over, alarm and stop welding.



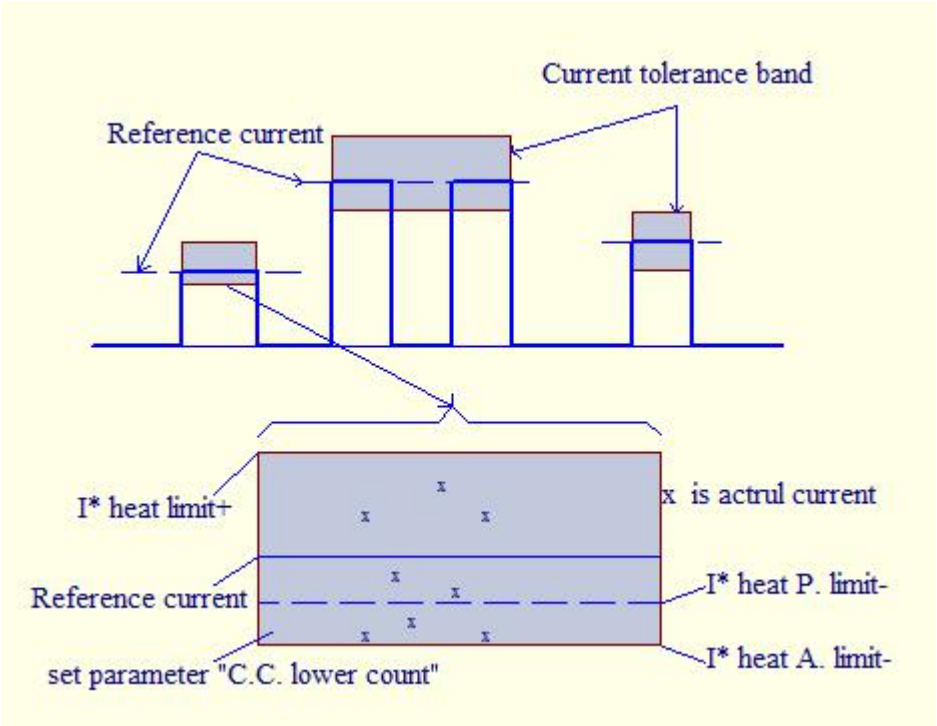
- **EL. REPAIR NOTICE**: After the last dress allowed for a tip has been performed, the weld controller issues the warning in advance of the end of the final tip dressing period, after which the tip should be replaced. The number of welds notice to give is set according to this parameter. Value is from 0 to 99.
- **EL.REPAIR COUNT**: Maximum number of dresses allowed per set of weld tips.

VII. Current Monitoring

The electric current monitoring function is used to inspect the actual current flow during the welding process. The actual welding current is compared against a reference current. If the actual current differs more than a certain amount from the reference current, indicating out-of-specification welds, welding can be stopped.

When the measured current value exceeds the allowed tolerance, the welding control will generate a report or set off a warning. If the measured current value is below the allowed tolerance, it will increment a counter and compare. If it is permitted to repair, then the controller will attempt a weld repair at the same spot.

Then regarding each weld pulse, they can be individually set to monitor the electric current. When the measured value exceeds the set current tolerance, a report can be produced or a warning signal can be produced. For each of the three welding process steps, preheating, welding, reheating, the user must set up the following, a reference current, a maximum current value (I* heat limit+), an under-current limit value (I* heat P. limit-), and an under-current alarm limit value(I* heat A limit-). The relationship between these values is shown below:



1. **I *HEAT REFERENCE** (* =1, 2 or 3, corresponding to preheating, welding and reheating respectively) For each of the three weld steps, this is the reference current that is the baseline for comparing actual currents in order to determine if the weld current is satisfactory.

2. **I * HEAT LIMIT+** (* =1, 2 or 3, corresponding to preheating, welding and reheating respectively): This determines that maximum current deemed acceptable for a weld. If this current is exceeded, the welding

control system can set off an alarm. It is possible for this welding control system to only raise an alarm and not discontinue the welding process, but is also possible to terminate welding process immediately. This function makes it possible to bypass the motherboard S6 code switch settings.

3**. I * HEAT P.LIMIT-**: if the actual weld current is less that this limit, the weld is classified as failed. In this case, a report can be posted, and welding can be terminated, not terminated or the weld can be repeated.

4. **I * HEAT A.LIMIT-:** if the actual welding current falls between this value and the Under-Current Alarm Limit, the weld is considers to be failed, but re-welding can be attempted. How this re-welding is performed depends on the Continuous Under-Limit Weld Count setting.

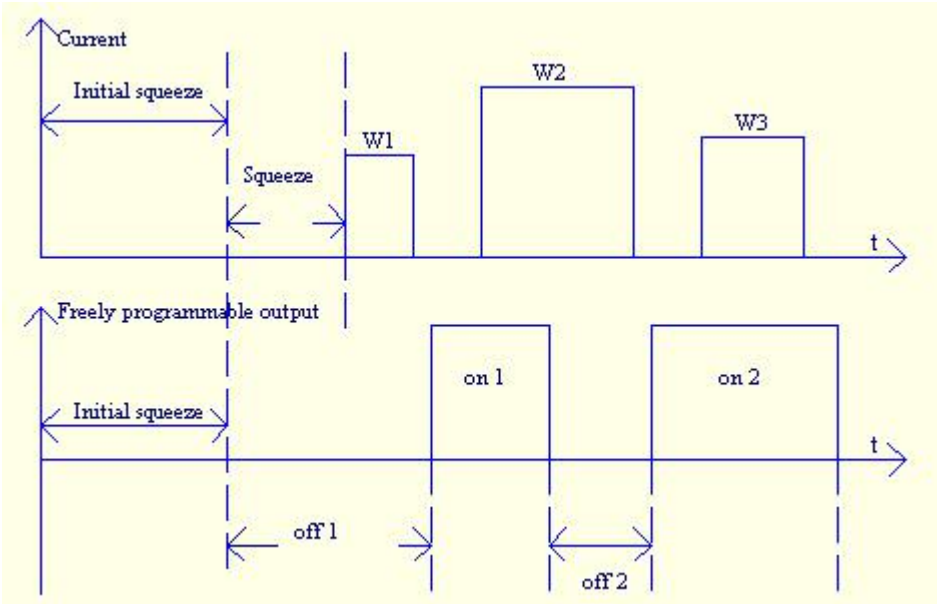
5. **C.C.LOWER COUNT:** when the actual electric current falls between the "Under-Current Alarm Limit" and the "Under-Current Limit", then it will attempt the weld one more time. If the next weld still falls within in this range the "Continuous Under Limit Weld Count" hasn't been exceeded, then another weld is attempted. This process repeats until it reaches the Continuous Under Limit Weld Count or until the weld succeeds. If the Continuous Under Limit Weld Count is reached and the weld has not be made correctly, then the weld controller will report this.

VIII. Programmable Outputs

All our welding packages include freely programmable output signals, driving output relays. This output signal can have up to three pulses, and can drive an external air valve solenoid or an additional external installation.

On/Off time: can program output during the period in which operating welding work time, beginning from the squeeze time (but after pre-squeeze) and up to the hold completion time. The user can configure up to three time periods, each consisting of an “off” and “on” period.

When the entire programming time sum total surpasses the time between the squeeze and the hold completion time, then the programmable output will be disconnected, and there will be no output.

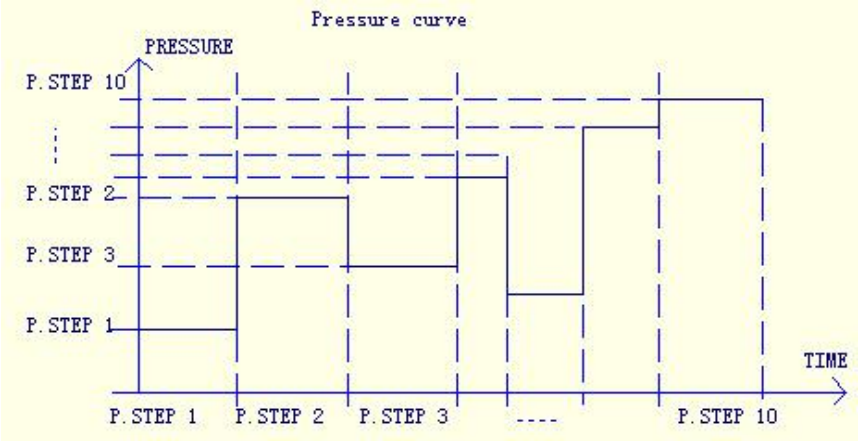


IX. Welding Pressure

A pressure curve can set up at most 10 sections; each section corresponds to a pressure and a time. The user can set the proportions of the valve's output according to the actual application circumstances.

1. Pressure-based values (Base Pressure): to set up pressure valve of the welding control machine when the machine is in standby mode, it is in proportion to the percent of maximum output pressure

   Actual output pressure = pressure based value * maximum output pressure proportional value



2. Pressure of Pressure Section 1: Pressure section 1 is relative to the maximum pressure percentage, in the same logic, every pressure section corresponds to one pressure value. It uses the "pressure-based value" as the standard scale for the maximum output pressure value.

3. Time of Pressure Section 1(P. Step 1 Time): the continuance pressure time of the pressure step increase section 1. Similarly, every pressure step increase corresponds to a time interval.

X. Weld Count Monitoring Function

The welding controller can monitor both the total number of welds, and the number of weld batches completed.

	Parameters name	**Range**	**Setting**	
145	COUNT MONI	0/1	0: Weld counting disabled; 1: Weld counting enabled	No system keyword
146	MAX COUNT	1-9999	Number of welds before signalling COUNTER COMPLETE	
147	PRODUCT CNT MONI	0/1	0: Product batch count monitoring is disabled 1: Product batch count monitoring is enabled	
148	MAX PRODUCT	1-9999	Number of batches (each batch is MAX COUNT welds) before signalling PRODUCTION COMPLETE	
149	COUNT NOT ALARM	0/1	0: When weld count limit is reached, set an alarm 1: When weld count limit reached, no alarm set	

When the COUNT MONI is on, WELD MONI COUNT increases for each welding spot. When the monitoring parameter WELD MONI COUNT reaches MAX COUNT, the COUNTER COMPLETE output turns high and welding is inhibited.

Welding can be resumed only after resetting the alarm: you can turn the Counter/Production Reset input bit HIGH or reset the monitoring parameter WELD MONI COUNT.

When COUNT MONI and PRODUCT CNT MONI are both on, when WELD MONI COUNT reaches MAX COUNT, the PRODUCT BTH COUNT increases by 1. When PRODUCT BTH COUNT reaches the MAX PRODUCT limit, the PRODUCTION COMPLETE output turns high, and welding is inhibited.

Welding can be resumed only after resetting the alarm: you can turn the Counter/Production Reset input bit HIGH for more than 3 seconds, or reset the monitoring parameter PRODUCT BTH COUNT.

XI. Control System Troubleshooting

- VALVE POWER LOWER!: Inspect whether the working air valve power source (X1 terminal 24V2) is normal.
- INVERTER DRIVER MALFUNCTION: In the inverter drive process check if the IGBT component current flow or the corresponding drive circuit is working properly.
- HEAT SINK OVER HEAT! : First, check if the temperature of the water flow through the heat sink is too high. Second, check if the temperature relay on the heat sink is damaged. In normal conditions the switch is closed.
- PRIMARY CURRENT ABNORMAL! : Can be caused by three conditions: inverter output current is too large, the mid-frequency transformer is short-circuited, the main board current detection is abnormal.
- CAPACTIOR VOL. ABNORMAL! : indicates the voltage access the DC-link capacitor is outside the normal range. Check that the charge of the capacitor is normal; check whether the electrical supply is stable and within specified parameters.
- +5V POWER HIGHER! , +15V POWER LOWER! , -15V POWER LOWER! : inspect the main board, check that the power supply is normal.
- TRANSFORMER OVERHEAT ! : check if the water temperature of the transformer is too high; check if the temperature relay in the transformer is damaged.
- 24V MAIN POWER LOWER! : check that the power supply input to the main board 24V (X2 terminal 24V1) is normal.
- CURRENT SENSOR SHORT! / CURRENT SENSOR OPEN! : inspect whether the secondary current sensor is damaged; check the current sensor connections are in working order.
- CURRENT HIGHER! : Indicates the actual current of the welding process exceeded the set limits of the current monitor. Ensure the weld controller settings are correct for the weld, and if the welding process and fit-up is appropriate.
- CURRENT LOWER! : Indicates the actual current of the welding process fell short of the set limits of the current monitor. Ensure the weld controller settings are correct for the weld, and if the welding process and fit-up is appropriate. Also ensure that the secondary circuit does not have faulty connections.
- CONTINUOUS LOW CURRENT: Indicates the actual current of the welding process overstepped the set limits of the monitor current, examine whether the parameter settings are correct, and if the welding process fits appropriately, and whether the secondary circuit has a problem.

- ELECTRODE REPLACE REQUEST: when the electrode life span has expired, replace electrode. Once the electrode has been replaced, reset the alarm signal or, in the X10 terminal, input the electrode replacement signal.
- ELECTRODE REPAIR REQUEST: request to dress the electrode tip. After the electrode is dressed, reset the alarm or, in the X10 terminal, input the electrode replacement signal.
- ILLEGAL DATA: examine whether the weld controller parameter settings have exceeded allowed boundaries.
- CALIBATE COEFFICIENT!!: There is a problem with the main board.
- WATER PRESSURE ABNORMAL! / GAS PRESSURE ABNORMAL!: inspect whether water pressure and air pressure are normal; inspect whether the electrical power supply for the air valve 24V2 supplies is normal
- START INHIBIT!: Current weld settings are such that weld initiation is inhibited.
- EMERGENCY STOP: alarm when the input terminal is off,when the input terminal is on, the alarm is clear.
- COMPLETE WELDING COUNTS: when the Monitoring Parameter WELD MONI COUNT is greater than or equal to MAX COUNT, an alarm is asserted on the output terminals. To clear, reset the output terminals or reset the monitoring parameter WELD MONI COUNT .
- COMPLETE BATCH COUNTS: when the Monitoring Parameter PRODUCT BTH COUNT is greater than or equal to MAX PRODUCT, an alarm is asserted on the output terminals. To clear, reset the output terminals or reset the monitoring parameter PRODUCT BTH COUNT.

XII. Cautions

1. The case must be well grounded at all times when the power supply is connected.
2. The controller can only be used after connecting to cooling water supply. Adequate cooling water flow and pressure is required, as well as a sufficiently low water temperature. The water cooling system must be checked at least once per month.
3. Do not open the controller or touch the internal components while the power is connected. This can lead to fatal electric shock: voltages in the controller and on the secondary outputs exceed 600V during normal operation.
4. After disconnecting power, the voltage on the DC storage capacitors reduces slowly. When the lights on the controller go out, there is still up to 30V present across these capacitors. Exercise extreme caution near these capacitors and take care that capacitors are fully discharged before touching any part of the controller internal circuitry.
5. Check their internal wiring and control board wiring. Make sure to cut off power supply and discharge capacitors completely before modifying the wiring.
6. Never touch control board components by hand. The controller contains components that may be damaged by electrostatic discharge.
7. Never touch IGBTs by hand, otherwise the components may be damaged by electrostatic discharge.

Appendix 1: Welding Control Program Parameter Table

	Parameter Name	**Value Scope**	
0	START INHIBIT	ON: Inhibit to start OFF: Allow to Start	
1	PULSE START	ON: Pulse Start Mode OFF: General Start Mode	
2	INITIAL SQUEEZE	0–9999ms	
3	SQUEEZE	0–9999ms	
4	1.HEAT MODE	PHA: Constant phase angle mode KSR: Constant current control mode KUR: Constant voltage mode	
5	1.WELD TIME	0–9999ms	
6	1.HEAT	0–99.99KA [%] Current mode unit is KA Voltage & Constant Angle Mode unit is %	
7	1.COOL TIME	0–9999ms	
8	2.HEAT MODE	PHA: Constant phase angle mode KSR: Constant current control mode KUR: Constant voltage mode	
9	UP/DOWN CONTROL	ON: UP/DOWN function enabled OFF/ UP/DOWN function disabled	
10	UPSLOPE TIME	0–9999ms	Effective only if UP/DOWN CONTROL is active
11	UPSLOPE HEAT	0–99.99KA [%]	

12	2.WELD TIME	1–9999ms	
13	2.HEAT	0–99.99KA [%]	
14	DOWN SLOPE TIME	0–9999ms	Effective only if UP/DOWN CONTROL is active
15	DOWNSLOPE HEAT	0-99.99KA [%]	
16	2.COOL TIME	0-9999ms	
17	HEAT2 PULSE	1-99	
18	3.COOL TIME	0-9999ms	
19	3.HEAT MODE	PHA: Constant phase angle mode KSR: Constant current control mode KUR: Constant voltage mode	
20	3.WELD TIME	0-9999ms	
21	3.HEAT	0-99.99KA [%]	
22	HOLD TIME	1-9999ms	
23	OFF TIME	0-9999ms	
24	TRF TURNS RATIO	1.0-199.9	
25	REPEAT/SINGLE	ON/OFF	
26	HOLD END TIME	40-1000ms, Hold end time until weld complete signal in Single Spot Welding mode	

27	UNDEFINED		
28	MEASURE DELAY	0-99ms	Invalid parameter (Only effective on Sub-Current Feedback)
29	TRAIL CURRENT	ON/OFF ON: Trailing Current Detection enabled OFF: Trailing Current Detection disabled	
30	REWELD ON/OFF	ON/OFF ON: When weld current is below reference current, re-welding is allowed OFF: When Current is below reference, , assert alarm directly. Re-Welding is not allowed	
31	REWELD NUMBER	1-99. The allowed number of re-weld attempts on a single spot	Effective when REWELD ON/OFF is ON
32	UNDEFINED		
33	UNDEFINED		
34	UNDEFINED		
35	1.HEAT MONITOR	ON/OFF ON: Monitoring enabled OFF: Monitoring disabled	
36	1.HEAT REFERENCE	0-99.99KA; Monitoring current reference value	
37	1.HEAT LIMIT+	0-100.0%: allowable excess current as a proportion of the reference current.	

38	1.HEAT P.LIMIT-	0-100.0%: continuous low current limit as a proportion of the reference current. Too many sequential welds below this limit lead to an alarm condition.	
39	1.HEAT A.LIMIT-	0-100.0%: low current alarm limit as a proportion of the reference current. Current below this value cause an alarm condition.	
40	2.HEAT MONITOR	ON/OFF	
41	2.HEAT REFERENCE	0-99.99KA	
42	2.HEAT LIMIT+	0-100.0%	
43	2.HEAT P.LIMIT-	0-100.0%	
44	2.HEAT A.LIMIT-	0-100.0%	
45	3.HEAT MONITOR	ON/OFF	
46	3.HEAT REFERENCE	0-99.99KA	
47	3.HEAT LIMIT+	0-100.0%	
48	3.HEAT P.LIMIT-	0-100.0%	
49	3.HEAT A.LIMIT-	0-100.0%	
50	C.C.LOWER COUNT	1-99. Continuous Current Low count limit. More than this number of sequential welds falling between P.LIMIT- &A.LIMIT- produce an alarm	

51	BASE PRESSURE	0-100.0%: As a percentage of the maximum pressure	Pressure control not available
52	PRESSURE PROFILE	ON/OFF ON: Pressure Profile can be set according to requirements OFF: Pressure Profile cannot be set	
53	P.STEP1 TIME	0-9999ms: Pressure step 1 duration	Pressure Profile is effective as ON
54	P.STEP1 PRESSURE	0-100.0%: Pressure step 1 pressure, relative to maximum pressure	
55	P.STEP2 TIME	0-9999ms	
56	P.STEP2 PRESSURE	0-100.0%	
57	P.STEP3 TIME	0-9999ms	
58	P.STEP3 PRESSURE	0-100.0%	
59	P.STEP4 TIME	0-9999ms	
60	P.STEP4 PRESSURE	0-100.0%	
61	P.STEP5 TIME	0-9999ms	
62	P.STEP4 PRESSURE	0-100.0%	
63	P.STEP6 TIME	0-9999ms	
64	P.STEP6 PRESSURE	0-100.0%	

65	P.STEP7 TIME	0-9999ms	
66	P.STEP7 PRESSURE	0-100.0%	
67	P.STEP8 TIME	0-9999ms	
68	P.STEP8 PRESSURE	0-100.0%	
69	P.STEP9 TIME	0-9999ms	
70	P.STEP9 PRESSURE	0-100.0%	
71	P.STEP10 TIME	0-9999ms	
72	P.STEP10 PRESSURE	0-100.0%	
73	UNDEFINED		
74	UNDEFINED		
75	HEAT STEP ON/OFF	ON/OFF ON: Heat step control is enabled OFF: Heat step control is disabled	
76	HEAT STEP 1. % I	0-100.0%	Effective if Stepper Control Function is ON
77	HEAT STEP 1. C	1-9999	
78	HEAT STEP 2. % I	0-100.0%	
79	HEAT STEP 2. C	0-9999	

80	HEAT STEP 3. % I	0-100.0%	
81	HEAT STEP 3. C	0-9999	
82	HEAT STEP 4. % I	0-100.0%	
83	HEAT STEP 4. C	0-9999	
84	HEAT STEP 5. % I	0-100.0%	
85	HEAT STEP 5. C	0-9999	
86	HEAT STEP 6. % I	0-100.0%	
87	HEAT STEP 6. C	0-9999	
88	HEAT STEP 7. % I	0-100.0%	
89	HEAT STEP 7. C	0-9999	
90	HEAT STEP 8. % I	0-100.0%	
91	HEAT STEP 8. C	0-9999	
92	HEAT STEP 9. % I	0-100.0%	
93	HEAT STEP 9. C	0-9999	
94	HEAT STEP 10. % I	0-100.0%	
95	HEAT STEP 10. C	1-9999	
96	HEAT STEP UP	0-999.9%: the total range of the current stepper, relative to Current Reference Value	

97	CONTINUE/STOP	0/1 0:CONTINUE 1:STOP	
98	STEP END NOTICE	0-99 : The number of points before the end of the Heat Step sequence to signal that the end of the sequence is approaching	
99	STEP UP COUNT	1-9999； Number of weld spots before tip dressing	
100	UNDEFINED		
101	UNDEFINED		
102	EL.REPAIR ON/OFF	ON/OFF	
103	EL.REPAIR COUNT	0-9999: The total times of tip dressings allowed per electrode	Electrode Repair Function is effective as ON
104	UNDEFINED		
105	UNDEFINED		
106	EL.REPAIR NOTICE	0-99; spots notice to give before the the electrode repair required signal is given	
107	HEAT1 PULSE	1-99	
108	UNDEFINED		
109	NO WELD FAULT	0/1	
110	SCHEDULE FREQUENCY	0/15.0-400.0Hz	

111	DC/AC	0/1, 0:DC; 1:AC	
112	FREELY P.OUTPUT	ON/OFF	
113	OFF1 TIME	1-9999ms	Effective only if the Programmable Function is ON
114	ON1 TIME	0-9999ms	
115	OFF2 TIME	0-9999ms	
116	ON2 TIME	0-9999ms	
117	OFF3 TIME	0-9999ms	
118	ON3 TIME	0-9999ms	
119	SEAM TIMING	ON/OFF	
120	SEAM 1 TIME	1-9999ms	
121	SEAM 2 HEAT	0-99.99KA	
122	SEAM 2 TIME	0-9999ms	
123	SEAM 3 HEAT	0-99.99KA	
124	SEAM 3 TIME	0-9999ms	
125	SEAM 4 HEAT	0-99.99KA	
126	COOL RATIO	0-99.99%	

Appendix 2: Table of Monitoring Parameters

1	WELD COUNT	The present number of completed welds	
2	STEP POINTER		
3	STEP COUNT		
4	EL.REPAIR COUNT		
5	VOLTAGE OF CAPACITOR	Present voltage of DC-link capacitor	
6	VOLTAGE OF ELECTRODE	Present voltage across electrodes	
7	HEAT1 C.VOLTAGE	Capacitor voltage of HEAT 1 stage	
8	HEAT1.S.VOLTAGE	Electrode voltage of HEAT 1 stage	
9	HEAT1 P.CURRENT	Primary current of HEAT 1 stage	
10	HEAT1 S.CURRENT	Secondary current value of HEAT 1 stage	
11	HEAT1 TIME	Time of HEAT 1 stage	
12	HEAT1 PHASE	The actual conduction ratio of HEAT 1 stage	
13	HEAT1 TRAIL TIME	Current trailing time of Heat 1 stage	
14	HEAT2 C.VOLTAGE		
15	HEAT2.S.VOLTAGE		
16	HEAT2 P.CURRENT		
17	HEAT2 S.CURRENT		
18	HEAT2 TIME		
19	HEAT2 PHASE		

20	HEAT2 TRAIL TIME		
21	HEAT3 C.VOLTAGE		
22	HEAT3.S.VOLTAGE		
23	HEAT3 P.CURRENT		
24	HEAT3 S.CURRENT		
25	HEAT3 TIME		
26	HEAT3 PHASE		
27	HEAT3 TRAIL TIME		
28	WELD MODI COUNT		
29	PRODUCT BTH COUNT		

Appendix 3: Schedule Selection

Schedule Selection Terminal input						0 AS 1	0 AS 1
X11-4	X11-5	X11-6	X11-7	X11-8	X11-9	1111	0000
32	16	8	4	2	1	Schedule	Schedule
						Invalid	1
					x	1	2
				x		2	3
				x	x	3	4
			x			4	5
			x		x	5	6
			x	x		6	7
			x	x	x	7	8
		x				8	9
		x			x	9	10
		x		x		10	11
		x		x	x	11	12
		x	x			12	13
		x	x		x	13	14
		x	x	x		14	15
		x	x	x	x	15	16
	x					16	17
	x				x	17	18
	x			x		18	19
	x			x	x	19	20
	x		x			20	21
	x		x		x	21	22
	x		x	x		22	23
	x		x	x	x	23	24
	x	x				24	25
	x	x			x	25	26
	x	x		x		26	27
	x	x		x	x	27	28
	x	x	x			28	29
	x	x	x		x	29	30
	x	x	x	x		30	31
	x	x	x	x	x	31	32
x						32	33
x					x	33	34
x				x		34	35
x				x	x	35	36
x			x			36	37
x			x		x	37	38

x			x	x		38	39
x			x	x	x	39	40
x		x				40	41
x		x			x	41	42
x		x		x		42	43
x		x		x	x	43	44
x		x	x			44	45
x		x	x		x	45	46
x		x	x	x		46	47
x		x	x	x	x	47	48
x	x					48	49
x	x				x	49	50
x	x			x		50	51
x	x			x	x	51	52
x	x		x			52	53
x	x		x		x	53	54
x	x		x	x		54	55
x	x		x	x	x	55	56
x	x	x				56	57
x	x	x			x	57	58
x	x	x		x		58	59
x	x	x		x	x	59	60
x	x	x	x			60	61
x	x	x	x		x	61	62
x	x	x	x	x		62	63
x	x	x	x	x	x	63	64

Fig.1 Main Board Terminal Wiring Diagram