1.0 INTRODUCTION TO THE ROTWEL-MAX1

The Rotwel-Max1 welding control system represents the newest and most advanced in resistance welding technology. This compact and light weight welding control, designed by Toshiba, offers the resistance welding industry the ability to reduce costs while increasing quality and overall productivity.

1.1 Micro-Processor Design:

The Rotwel-Max1 resistance weld control is designed using CMOS microprocessor which has been specially designed for the welding environment. This processor design incorporates a high clock speed; fast pipeline architecture; built-in analog to digital converter, and serial communication port.

2.2 Thyristor Design:

The Rotwel-Max1 is designed with a Thyristor unlike others used in the resistance welding industri. Special features of this Thyristor include:

Totally isolated water cooling system which provides:

* No danger of shock
* No current conduction through contaminated water

Isolated cooling system also provides:

* Very little flow restriction

Electrically the Rotwel-Max1 provides:

* High peak current ratings, for intermittent duty spot welding applications
* Very compact size

1.3 Standard Resistance Weld Control Functions:

The standard resistance weld control functions provided by the WCU are:

* Sixteen (16) step sequences that can be programmed in any configuration required by customer (free format programming)
* Sixteen (16) linear heat steppers (assignable)
* Diagnostic tracking of the stepper boost current or voltage (current and power factor windows are programmable)
* Current or voltage regulation with monitoring of the Thyristor output for true regulation, in either current or voltage mode of operation (selectable)
* Built-in weld override watchdog timer (programmable)
* Full feature diagnostic reporting
* Heat adjustments in secondary current increments of 100 Amps
* Fully network compatible
* Selectable Open Loop Voltage operation
* Selectable Constant Voltage Slope or Pre-Pulse operation
* Last Weld Data Reports (control stores information from last 100 welds)
* Touchdown initiation (selectable)
* Reweld on low current fault (selectable)

1.4 Modular System Construction:

The Rotwel-Max1´s modular system allows customers needs to be met in various configurations such as portable gun, robot or fixture configurations using the same base control. This saves the customer the expense of stocking different spare parts for the various configurations of competitive weld controls.

1.5 Serial Interface to Machine Controls:

The WCU is also the first resistance weld control to be designed to interface serially to the programmable machine controls used by most weld control users. This serial interface provides the following advantages over standard means of interfacing resistance weld controls:

* Quicker reactions from the welding control and the host since discrete I/O points have to be debounced for accuracy. All serial communications are error checked which takes less than 5 MS. A conventional control must debounce an input for at least 20 MS.
* Acknowledgement of initiation commands thereby eliminating the errors resulting from broken discrete interface wiring.
* The capability of acquiring all weld data, welding parameters, and fault status in an ASCII format that can be used for report generation and SPC.
* Reduction in the cost for a welding fixture. The elimination of the numerous I/O points required to run conventional controls results in a large reduction of costs. The use of one I/O rack slot to interface 16 weld controls minimizes the I/O rack costs associated with the welding fixture. Reduction in labour and wiring costs are realized due to the interfacing of the weld controls being done by a single twisted pair serial communication cable.

1.51 Serial Hardware Configuration:

RS 485, the selected hardware configuration for the WCU, is a "party line" version of RS 422, with the same noise and distance characteristics. Many transmitters and receivers are tied to the same pair of wires, so all devices can receive from any transmitter. To prevent one transmitter from "loading" the others down, each transmitter is turned off when not in use, controlled by the "RTS" (Ready to send) signal normally found in the RS 232 set of signals.

A method of allowing for data collision must be implemented, and many methods exists, but all are complex and slow communication down. The method used by Rotech is simple and fast. The features of multiple masters, collision detection, and error correction are not required for this system, as only one master is used, data collisions are prevented and an excellent error detection scheme is used.

1.52 Communication Protocol Configuration:

Rotech use ASCII characters for the communication to the weld control units. Although this method uses a few more bits to transmit than binary or packed binary, the minimal packaging of each transmission, and the small size of the data transmitted cause this to be of no concern.

The use of ASCII characters allows any standard communication method to handle the Rotech protocol. ASCII characters are easily handled by MSDOS computers, allowing the use of any IBM compatible, desktop, or industrial equivalent, for message handling, troubleshooting, and monitoring of communication line.

Many programmable machine controls have ASCII modules or BASIC modules that use ASCII codes on their serial port. The Rotech method is directly compatible with these devises. The instruction set uses the letters in the Alphabet to signify the meaning of the commands, i.e. "I" is used for "initiate", "H" is used for "heat", etc. This makes the instruction set easy to remember, and is very "user friendly" without compromising efficiency and speed. Monitoring of the communication line is easy, when it is in ASCII characters, and a print out of any activity for trouble-shooting purposes is easily accomplished.

1.53 Serial Character Construction:

The serial characters are constructed as follows:

1 Start Bit
7 Data Bits, 7 bit ASCII code
1 Parity bit using even parity
1 Stop Bit

2.0 STANDARD FEATURES AND FUNCTIONS

This section contains complete lists of the functions and features standardly available in the Rotwel-Max1 resistance weld control.

2.1 External Inputs:

1. E.Stop 24 VAC input externally sourced
2. Aux overtemp-requires normally closed contact or jumper
3. 110 VAC control power (85 to 140 VAC range)
4. RS 485 communications, for programming, initiation, fault read out, and sequence complete information.
5. Shunt trip output-normally closed contact

2.2 Heat Control Related Features:

Sixteen sequences, each fully programmable, any command in any order.
Command list includes:

1. Wait time (squeeze, hold)
2. Heat time and value (weld)
3. Impulse heat, pulses, heat time and cool time
4. Upslope time, starting and ending heat values
5. Downslope time, starting and ending heat values
6. Stepper assignment
7. Wait time for voltage to reach desired value (load control)
8. Transformer winding ratio, override of "master value"
9. Tip touchdown sensing and initiation
10. Reweld (once) on low current
11. Current windows for Reweld activation and diagnostics
12. Power factor windows for secondary deterioration sensing
13. Open loop voltage firing
14. Voltage slope in current mode
15. Current adjustments entered in secondary values from 100 Amps to 99,900 Amps, or 0-100%.
16. Selectable line voltage compensation, or secondary current regulation.
17. When secondary current regulation is selected, heats can be entered in actual secondary values, as the welds charts are actually formatted.
18. Fully automatic power factor compensation, no calibration required.

2.3 Calibration Features:

1. Linear digital calibration of current, high and low values easily entered into EEPROM, for permanent retention of values
2. Digital voltage calibration entered in EEPROM, for permanent retention
3. Selectable sensitivity of primary current measuring device with diagnostics to insure proper range has been selected
4. Transformer winding ratio resolution/range 000 to 199.9 for maximum accuracy in calibration (Reduces 1 bit "digital error" to insignificant value.)

2.4 Heat Stepper Features:

1. Sixteen independent steppers, each with its own counter, goes to 99,999 counts
2. Linear heat adjustments between "steps", resolution: applies adjustment every second weld, even if maximum count of 99,999 is used
3. Floating memory allocation allows up to 16 steps of welds made and boost per stepper
4. Each step can increase or decrease current independent of the other steps
5. Current adjustments entered in secondary values from 100 Amps to 99,900 Amps, or 0-100%
6. Selectable line voltage compensation, or secondary current regulation
7. When secondary current regulation is selected, heats can be entered in actual secondary values, as the welds charts are actually formatted
8. Fully automatic power factor compensation, no calibration required

2.5 Diagnostic Reporting Features:

0. Under current reporting for secondary
1. Over current reporting for secondary
2. Communication failure, erroneous checksum
3. Thyristor shorted
4. Reserved
5. Failed to fire detection
6. Thyristor Overtemp detection, it can include external device
7. End of stepper detection
8. Illegal sequence detection
9. Touchdown initiation failed to see tip closure (5 sec. delay)
10. Loss of 50/60 Hz reference signal
11. Memory error detection (EEPROM or RAM)
12. Weld override (watchdog timer function)
13. Power factor out of range detection
14. Primary current out of range
15. Data requested is not programmed
16. Current sensor input out of range, too low
17. Current sensor input out of range, too high
18. Directory memory error
19. Sequence program memory error
20. Stepper program memory error
21. Operating parameter memory error
22. Unmask word (for enabling/disabling fault reports) memory error
23. Parameter memory error
24. Line frequency out of range (not 48-52 Hz or 58-62Hz)
25. Failed "Use" command (Sequence aborted)
26. Current calibration error
27. E-stop

28-31 Not used (Reserved for future expansion)

2.51 Other Diagnostic Features:

1. Power factor limit window can be set in each weld sequence for deterioration of welder secondary.
2. "Last weld data" items reported:

    * Last sequence used
    * Lowest line volt of last weld
    * Highest primary current of last weld or average
    * Highest secondary current of last weld or average
    * Average power factor of last weld
    * Stepper count of last stepper used
    * Stepper number last used
3. Current limits can be set for each sequence both high and low
4. True RMS calculations used for current and voltage, high sample rate (every 4 degrees, or 0.000185 second) insures reading accuracy

2.6 Data Retention:

In conventional controls, this function is normally handled by a battery. In the Rotwel-Max1 control, It is performed by a special low leakage capacitor.
This capacitor never needs to be replaced and doesn't lose its ability to retain memory with age.

MEMORY CAPACITOR SIZE	1 FARAD
MINIMUM RETENTION TIME	2 WEEKS

2.7 Maintenance Related Features:

1. Entire control can be changed in minutes, easily hand carried
2. Control module can be carried in pocket
3. Reliability improved by extensive integration of electronics by using LSI technology.
4. Heat problems minimized by use of::

    * All CMOS technology, control power less than 150 MA at 115 VAC
    * Entire Rotwel-Max1 cooled by water applied to thyristor
5. Thyristor water isolated from voltage means no destructive ionization problems caused by current leakage (manifold to water) with water flow stopped, as is common during machine shutdown.
6. Steppers can stop control at end count, selectable feature.
7. "Weld trace" feature allows print out of 10 measured values for each cycle of weld, maximum 120 cycles per weld. Values are:

    * Cycle number
    * Power factor
    * Firing angle, lead
    * Firing angle, trail
    * Current off angle, lead
    * Current off angle, trail

* Proportional gain value for feedback
* Line voltage, true RMS
* Thyristor output voltage, true RMS
* Secondary current value

8. Current calibration procedure is aided by readout of values in Rotwel-Max1, sample in the current calibration "mode". No match required, Rotwel calculates all corrections from entry of two measurements
9. Diagnostic reports of non-fatal problems can be disabled by program control for configuration by customer
10. Each control has a jumper selectable termination resistor, used for the Rotwel at the end of the communication line
11. The control´s address is conveniently set with a 16 position selector switch.
12. Sensitivity of the current monitor device is set with "DIP switches", no resistors to add or remove. Three ranges:
    < 75 kVA
    75 to 150 kVA
    > 150 kVA
13. Software revision level reported by command, without stopping production
14. Full error checking of all values stored in nonvolatile RAM, not just monitor one or two "scrambled" values.
15. High level maintenance procedures allow override of internal parameters. These are:
    * Adjustment of feedback values
    * Memory read and write
    * Communication baud rate and set-up values (parity, bits, etc.)
    * On/Off current compensation
    * On/Off voltage compensation
    * E.Stop detection debounce timer
    * Reference loss detection timer
    * Thermal trip detection timer
    * Current proportional gain
    * Current integral compensation gain
    * Maximum trigger angle adjustment
    * Compensation start cycle
    * Current monitor start cycle
    * Indicator light timing, blink rate, etc.
    * Trace sample mode; degrees or millisec
16. Line voltage problems reduced because:
    * Control power can be separate from welding bus
    * Control power can variate +/- 25%
17. No internal hoses or water fittings to break or leak
18. All calibration values can be digitally transferred into a new replacement control module

2.8 Safety Related Features:

1. Enclosure is mechanically interlocked; control module must be removed first, causing shunt trip of breaker when removed
2. Thyristor status monitor circuit is independent of the processor; will perform shunt trip even with control power off or processor disabled
3. Shunt trip circuit is "Fail Safe"; causes shunt trip if circuit is broken
4. Installation can have floor mounted disconnect at no cost penalty
5. Minimum of high voltage cabling between controls and transformers
6. Rotwel power can be run with communications
7. Thyristor voltage totally isolated from water supply, no shock hazard
8. Watchdog timer, shuts down control if max cycle are exceeded. Either of total sequence time or weld only; programmable function
9. Overcurrent condition shuts down control
10. Built in Thyristor overtemp switch, requires no calibration
11. Provisions for external overtemp switch, flow switch, etc.
12. Failed to fire diagnostic protects transformer from "half cycling"
13. Loss of 50/60 Hz stops control, fast recovery allows isolation contactor use
14. Current regulation limits problems on shorted transformers, wiring, etc

2.9 Accomodations of Future Requirements:

1. High speed processor, 10 MHz and pipeline architecture allows time for future processor dependent tasks such as:
    * Feedback based on a breakthrough in weld quality sensor development
    * Feedback based on expulsion detection
2. Fully networked with mutidrop RS 485 to host allows implementation of:
    * Integration with plant statistical process control systems
    * Source of weld information for report generation
    * Remote monitoring, data manipulation, over modem, etc.
3. Hardware and software has been designed to allow for multiple transformer applications:
    * Push/Pull applications
    * Cascade operation by cylinder or MC contactor control
    * Sixteen separate transformers, separate turns ratios can be entered
    * Single primary current sensor simplifies installation, calibration
    * Multiple stepper capability, allows each gun to have its own stepper
    * Multiple sequences allow each gun to have its own heat
4. Fault reporting structure allows 35% expansion of diagnostics (28 bits used out of a 32 bit word)

2.10 Available Rotwel-Max1 interfaces

Robots, PLC´s or Rotech Discrete I/O interface? Contact Rotech Tooling AB for specific details

3.0 ELECTRICAL SPECIFICATIONS:

This section details the electrical specifications of the Rotwel-Max1 control.

3.1 Thyristor Specification:

The Thyristor is custom designed for intermittent welding duty. This thyristor is designed with high peak current ratings, exceeding similary rated thyristors, previously specified in resistance welding controls.

Continious current rating	430 Amps RMS Welding Duty
30 cycles of heat at 8% duty	860 Amps RMS
10 cycles of hest at 2% duty	1220 Amps RMS
5 cycles of heat at 1 % duty	1480 Amps RMS
1 cycle non-repetitive surge	7000 Amps RMS
Repetitive Peak Reverse Voltage	2100 Volts
Peak ON-State Voltage ate 1250 Amps	1.65 Volts
Isolation to Water Supply	2500 Volts
Isolation Resistance	10 MOhm

Note all ratings are at 50 Hz

3.2 Power Supply Specifications:

Rotwel-Max1 control should be powered separately from the welding power to allow diagnostics, programming, and data transfer to occur when weld power is turned off. The power can be derived from the welding supply, if the customer specifications require this method. The WCU´s power supply is designed to provide high noise immunity and maximum tolerance to voltage variations. Specifications for the control power are:

Control voltage	85-140 VAc
Frequency	50 or 60 Hz +/-2Hz
Current requirement	150 Milliamp at 100VAc

4.0 INSTALLATION

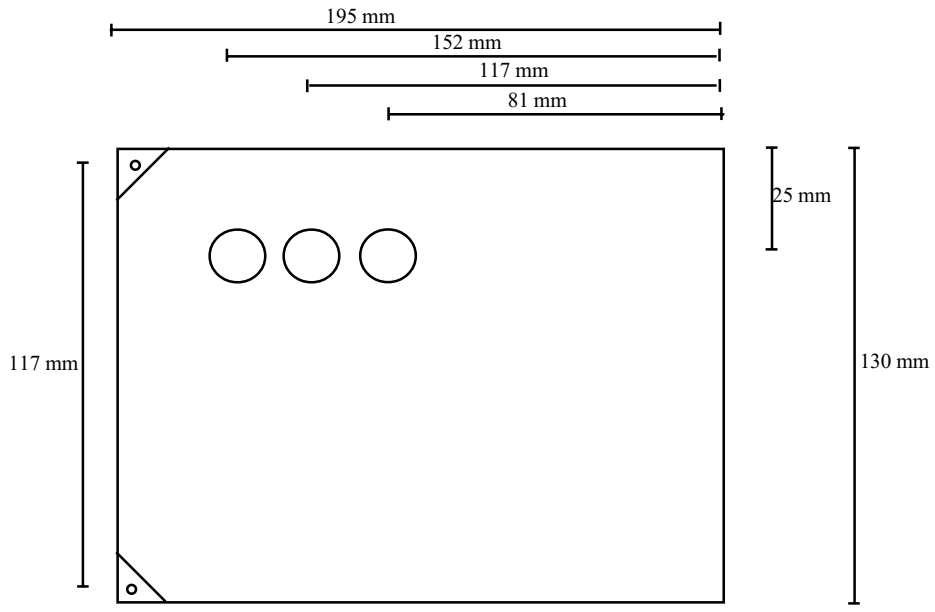
The following are general mechanical and electrical installation guide lines, contact Rotech Tooling AB for specific recommendations.

4.1 Mechanical Mounting Specifications:

The Rotel-Max1 is designed to be mounted in various methods, including mounting the unit directly on a ***Stationary Mounted*** welding transformer. This method of mounting requires an adaptor plate. Contact Rotech or your transformer manufactures representative for further information if this method of mounting is required.
The following diagram Fig.(4.1-1) shows the required mounting foot print if unit is mounted on an external cabinet surface or sub-plate inside an enclosure.

* The Rotwel-Max1 should not be subjected to acceleration in excess of one "g".

Fig (4.1-1) Rotwel-Max1 Mounting Footprint



4.2 Welding Transformer Hookup (H1-H2):

The Rotwel-Max1 control can be configured in various manners for attachement of the welding transformer primary leads. The Fig.(4.2-1) shows attachement of the welding transformer directly to the rear of the Rotwel-Max1 control. Fig (4.2-2) shows Rotech´s standard configuration when mounting the WCU inside an enclosure.

Power to the transformer comes from terminals marked "H1" and "H2". Just a reminder that "H2" is the same terminal as "L2". The H1 and H2 connections can be routed either out of the bottom or the top of the WCU, using the cable clamp built into the access cover.

Fig (4.2-1) H1-H2 Rear Attachement to Rotwel-Max1

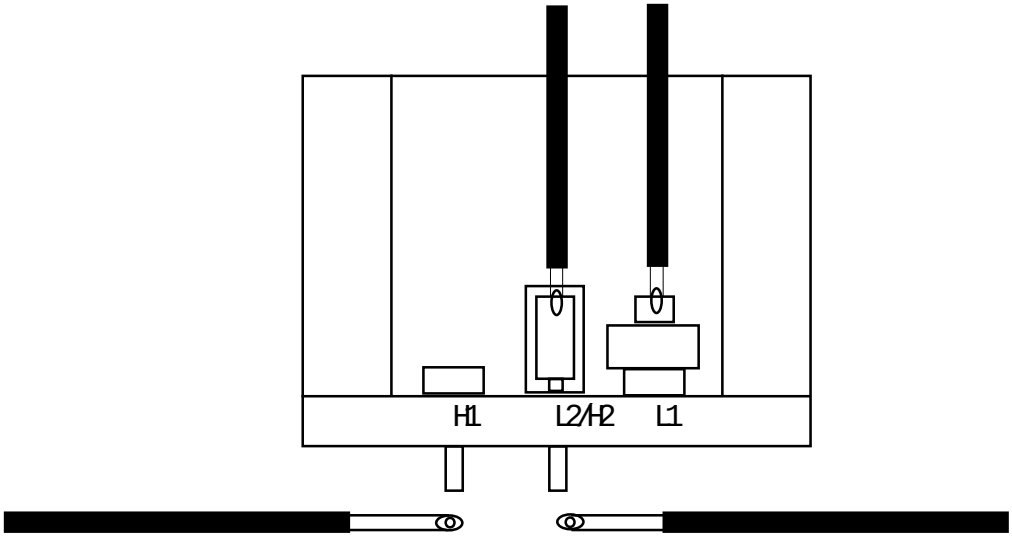
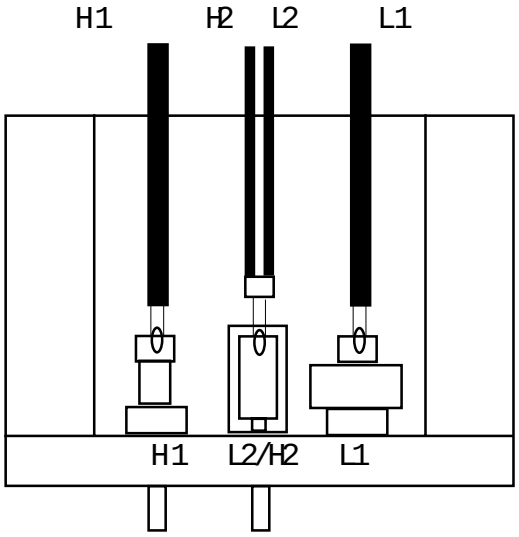


Fig (4.2-2) H1-H2 front attachment to Rotwel-Max1



4.3 Weld Power Attachment (L1-L2):

The Rotwel-Max1 control is designed to provide easy attachment of the weld power leads to the WCU´s Thyristor assembly. Fig.(4.3-3) shows attachment of line voltage leads to the front of the WCU. Fig.(4.3-4) shows attachmnet of weld power leads to rear of the WCU.

The incoming power cables are connected to the terminals labelled "L1" and "L2", and can be held by the clamping action of the access cover. Consult the system documentation for specified connection methods. Cables of smaller size can be "shimmed" with rubber tubing and any unused holes must be plugged. The bolts, used for electrical connection, can be installed in various ways to accommodate varied wiring methods. Contact Rotech Tooling AB for recommendations.

Fig (4.3-3) L1-L2 Attachment via Front of Rotwel-Max1

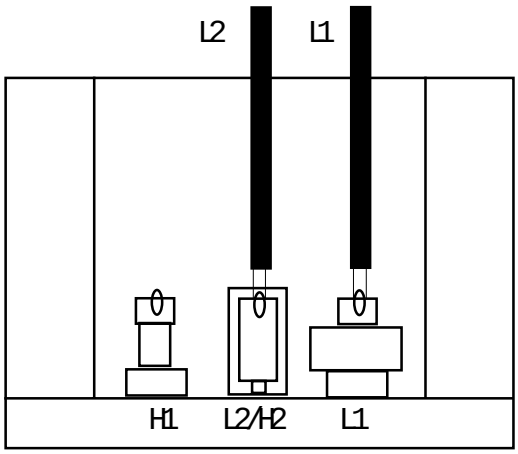
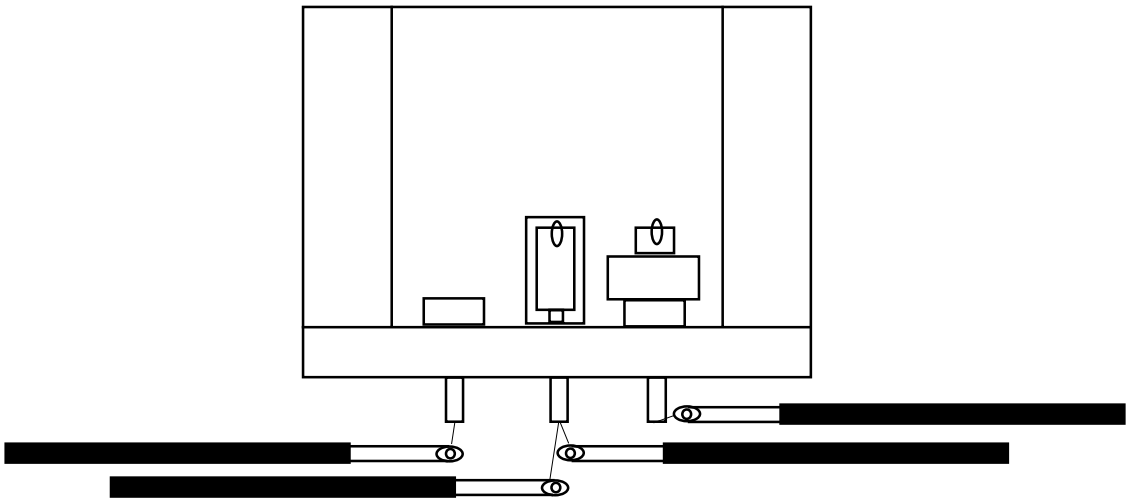


Fig (4.3-4) L1-L2 Attachment via Rear of Rotwel-Max1

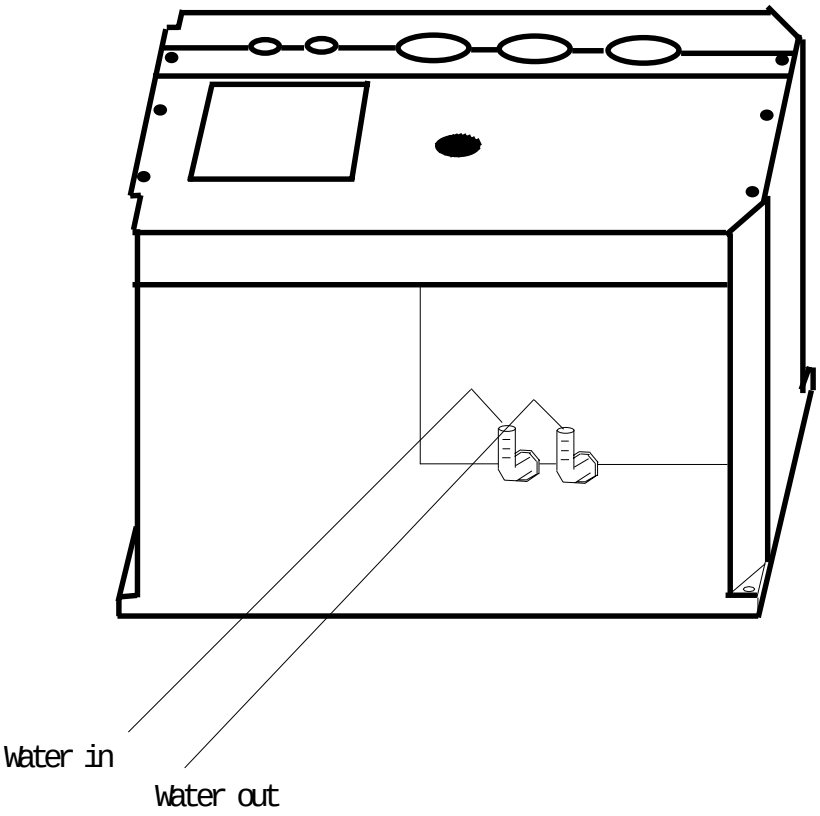


4.4 Cooling Water Specifications and Hook-up:

The Rotwel-Max1 is equipped with two water fittings that accept 1/4" to 3/8" hose and require hose clamps. The following table defines maximum and minimum water flows, pressure and temperature. Avoid using cooling water that causes condensation of the humidity in the air.

Minimum water flow	4.9 l/min / 1.3 Gallons/Min
Maximum water temperature	40°C / 104°F
Pressure drop at rated flow	17.2 kPa / 2.5 PSI
Max. Conductivity of cooland	Does not affect operation

Fig (4.4-5) Basic Water Hook-up Recommendations



5.0 HARDWARE SWITCH SETUP

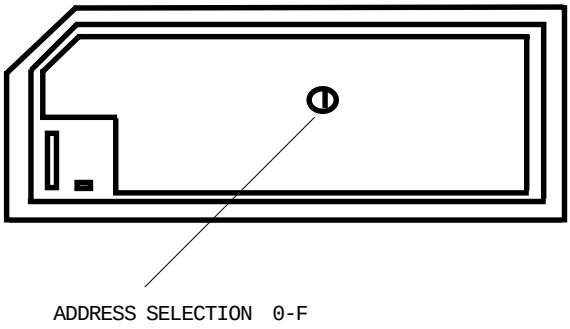
This section covers the switches which are required to be configured upon the installation or the Rotwel-Max1.

5.1 Serial Network Address Selection:

The address switch is capable of being set for the sixteen different addresses. 0-9, A-F in Hex.

Figure (5.1-6) designed to facilitate location of the Rotwel-Max1´s communication address switch settings on the processor logic assembly (702-0039).

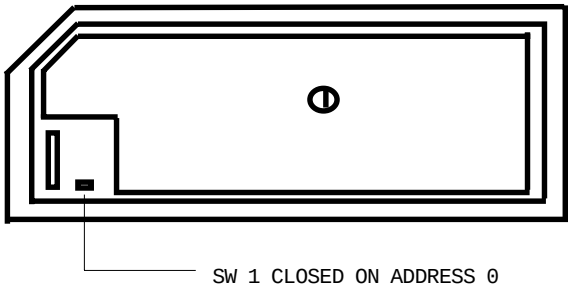
Figure (5.1-6) Network address Switch location WCU processor assembly



5.2 RS 485 Termination Switch:

Each WCU that is at end of a "string" should have termination resistor "in circuit". To do this, turn the termination switch section 1 (#2 is unused) "on". This 2-section DIP switch is on the control module near the connector. Section 1 is toward the center of the board and section 2 is toward the edge. To leave the termination resitor open, turn this switch "off". "On" is toward the surface of the board, "Off" is away from the surface of the board. Figure (5.2-7) designed to facilitate location of the WCU´s RS 485 termination switch on the processor logic assembly (702-0028).

Figure (5.2-7) RS-485 Termination Switch Location



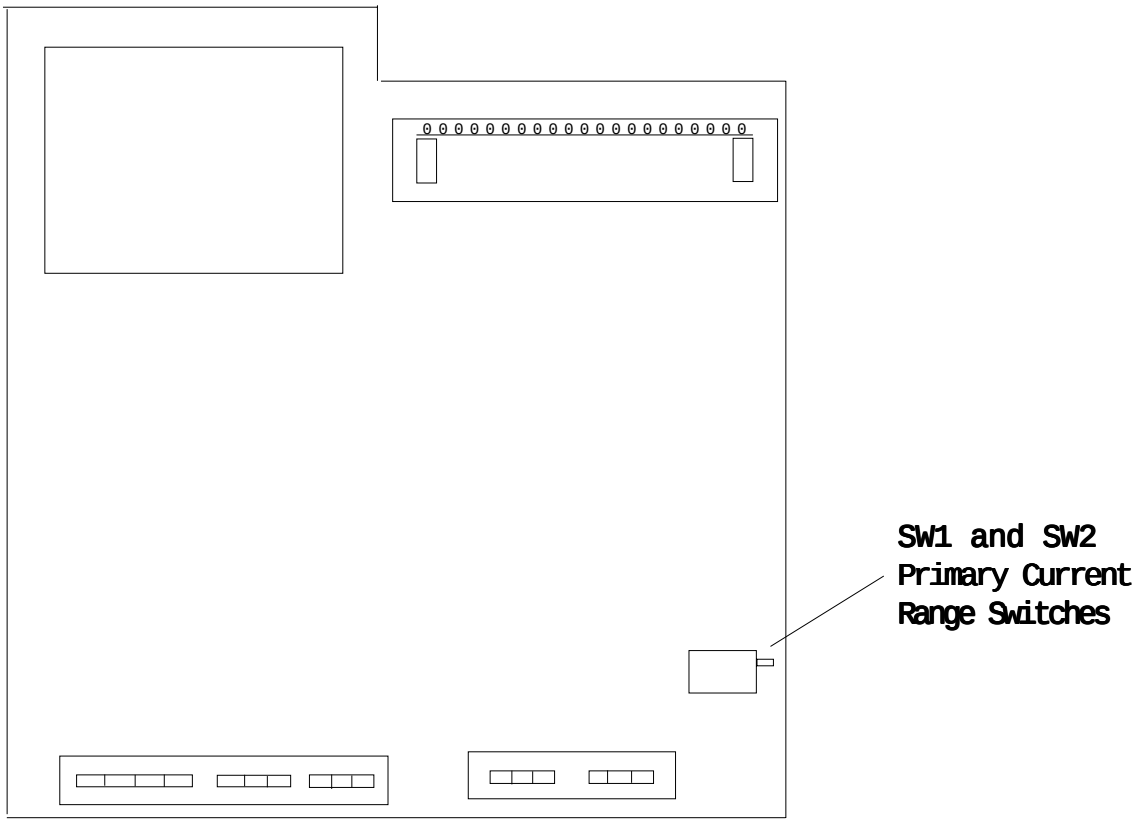
5.3 Primary Current Range Selection Switches:

The SW1 and SW2 must be set-up to match the primary current. Switches SW1 and SW2 are used to attenuate the signal for larger primary currents. This is designed so that the A/D converter input is not saturated (max output from A/D-converter is 1000). For small primary currents, less than 200 A_{RMS}, leave both SW1 and SW2 open. For 200 - 400 A_{RMS}, close SW1 only. For 400 A_{RMS} up, close SW2.

This two (2) section switch is located on the power module, below the terminal strip/connector and near the bottom of the board. "On" is close to the board, "off" is away from the board. Set this switch according to the chart below. Figure (5.3-8) should be used to locate SW1 and SW2 on Power
board assembly (702-0029)

PRIMARY CURRENT	SWITCH 1	SWITCH 2
Less than 200 A_{RMS}	Off	Off
200 - 400 A_{RMS}	On	Off
Above 400 A_{RMS}	Off	On

Figure (5.3-8) Location Primary Current Range Switches



6.0 CONTROL AND COMMUNICATION WIRING

This section deals with the wiring of the Rotwel-Max1 control in regards to control power, serial communications and I/O. This section includes circuit descriptions and specifications.

6.1 Serial Communication Circuit Description:

The network bus consists of twisted-pair shielded cable. The cable connects in a sequential multidrop path directly between successive WCU´s. The two data lines in the cable are sensitive to polarity. Serial communication baud rates are software selectable at 9600 Baud or 19.2 kBaud. Note: Selection requires that program installed in Rotwel-Max1 be EO-1a not EO-1.

The cable is attached to each network device site, and is terminated into each WCU´s connector (Terminals X1-Y1). All WCU´s have the capability to provide termination resistor for the physical end of the network. The last Rotwel-Max1 at each end of the cable should have it´s terminating resitor selected On. Closure of this switch provides termination to prevent signal reflections on the network bus.

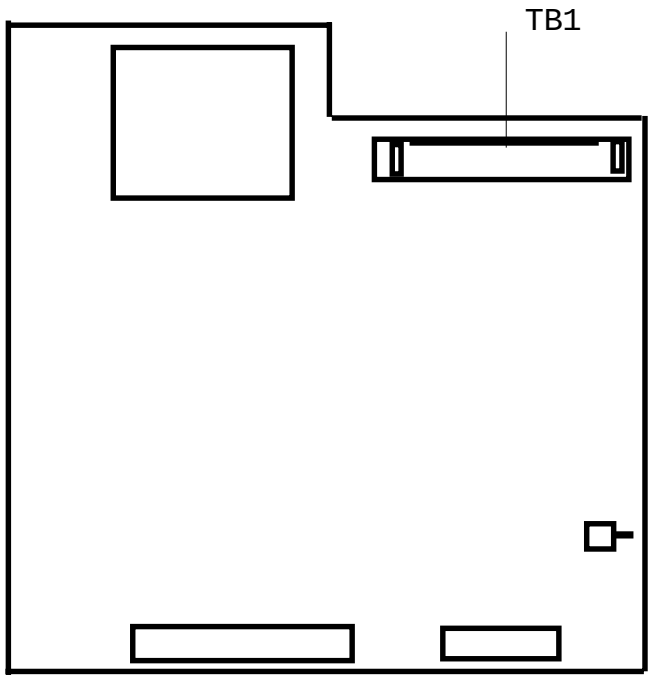
Each Rotwel´s address is set into a rotary switch located in the WCU´s logic module. Network addresses are sensed by the program logic at each station during its power-up sequence.

Each Rotwel-Max1 has an LED indicator that flashes green, during communication, even if the polarity of communications is incorrect.

6.2 I/O Terminal Strip Location:

Below is the digram that shows the location of the Rotwel´s I/O termination connector TB1 and firing board. The TB1 connector is removable for installation or replacement of the firing board assembly (702-0029).

Figure (6.2-9) TB1 Location



6.3 Communication Cable Signal Connections:

6.31 Cable Specification:

Always use approved RS 485 or RS 422 low capacity shielded cable for these connections. Polarity must be observed on the RS 485 signal.

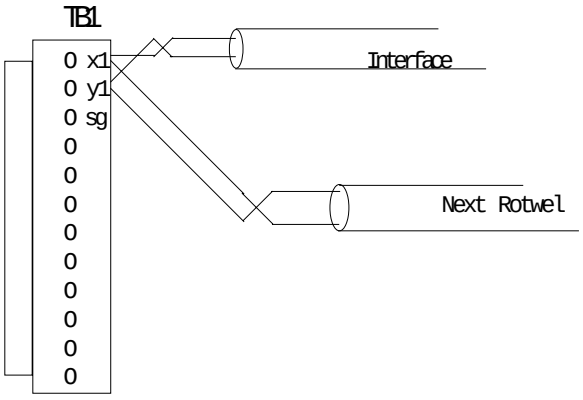
6.32 Cable Termination:

The communication signals to and from the WCU are terminated on the TB1 terminal connector on the power supply board. These connections consist of the following:

Terminal	Signal	Terminate to
"X1"	RS 485+	Machine control interface
"Y1"	RS 485-	Machine control interface
*"SG"	RS 485 ground	Machine control interface if required by system

*** Note: "SG" usually is not terminated. Some system designs could require termination, refer to system manual and documentation for proper termination.**

Figure (6.32-10) Communication Cable Terminal Location:



6.34 Serial Communication Wiring test Procedure:

To determine if communications wiring is good, shut off all power and measure with an ohmmeter, between terminals "X1" and "Y1". The proper reading should be between 110 and 220 Ohms, which indicates a termination resistor at each end of the line.

Also a reading of greater than 2 MOhms should exist between ground and either communication conductor. A reading of greater than 3000 Ohms could indicate that Rotwel-Max1s are on the line, but no termination resistor are connected.

6.4 Control Cable Wiring:

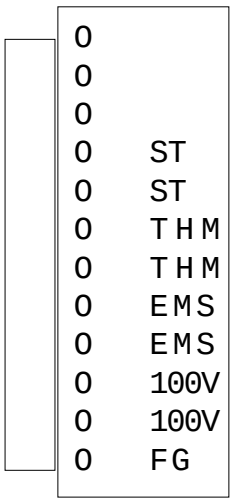
The control signals to/from the WCU are terminated on the TB1 terminal connector on the power supply board and consists of the following:

Terminal	Signal	Termination
"ST"	Shunt trip loop, 1 side	Breaker S.T.circuit
"ST"	Shunt trip loop, other side	Breaker S.T.circuit
"THM"	Thermal switch loop, external, 1 side	Norm closed device
"THM"	Thermal switch, other side	Norm closed device
"EMS"	E.Stop input signal	Source of 24 VAc
"EMS"	E:Stop input, other side	Source of 24 VAc
"100V"	Control power for WCU	Source of 80-140 VAc
"100V"	Control power, other side	Source of 80-140 VAc
"FG"	Frame Ground	Shields on cables

NOTE: The "FG" is provided as a safety ground, and not as a signal ground. It therefore does not demand a "noise-free" earth ground, as computer equipment customarily requires. It should be connected to equipment ground ("earth") through the shield on the control cable.

Figure (6.4-11) Control Cable Terminal Location:

The following diagram is designed to facilitates location of control cable terminals internal to the Rotwel-Max1 control.



6.5 External Input Circuit Descriptions:

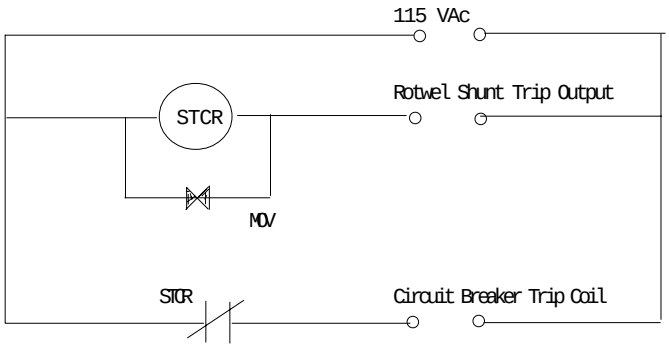
6.51 Shunt Trip Circuit:

The Rotwel-Max1 has a unique shunt trip circuit which is described in the following paragraphs, and Fig (6.51-12) details a typical design.

The shunt trip circuit employs a unique approach that maximizes the safety aspect of the circuit. All external wiring is protected by the simple function that it must have continuity or the breaker will trip. A provision exists that monitors removal of the processor module and causes shunt trip.

The shunt trip power for the breaker is derived from a transformer on the load side of the breaker. This 110 VAc power is applied to the shunt trip coil of the breaker through a normally closed relay contact, which is held energized if power appears on the output of the Thyristor, when no Voltage should present on the output. This opens the shunt trip loop and trips the breaker. The weld control can override this relay for normal firing, but always returns to the "armed" condition to insure operation of the shunt trip after it is done.

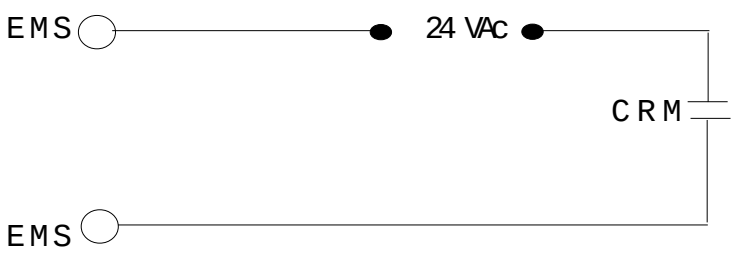
Figure (6.51-12) Thypical Shunt Trip Circuit Diagram



6.52 Emergency Stop Circuit:

The Rotwel-Max1 is designed with a externally sourced 24 VAc Emergency Stop input circuit. This circuit requires the application of 24 VAc between the "EMS" terminals on TB1. The Figure (6.52-13) details the external emergency stop circuit requirements of the WCU.

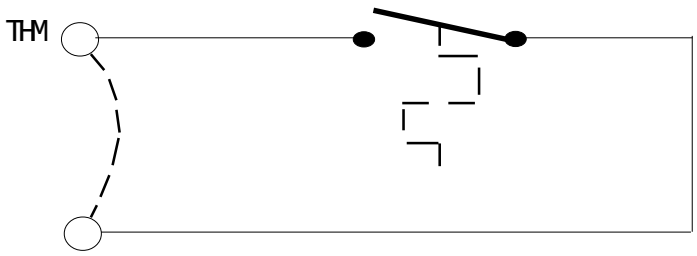
Figure (6.52-13) Typical Emergency Stop Circuit Diagram



6.53 External Temperature Switch Circuit:

Figure (6.53-14) details the external circuit requirements for the external Temperature switch input to the Rotwel-Max1 control.

Figure (6.53-14) Typical Temperature Switch Input Circuit Diagram



7.0 MINIMUM SOFTWARE SETUP REQUIREMENTS:

The Rotwel requires specific items to be setup via programming prior to initiating a welding sequence. Those items include, operational parameters, mode of compensation, welding transformer size selection, Thyristor short limits and weld schedules.

7.1 Operational Parameters:

The operating parameters include values for all sequences, even though some may be temporarily overridden within a sequence. These values can also be retrieved out of the WCU by request. To program these parameters refer to Rotwl-Max1 protocol EO-1 or to system programming manual.

Parameter	Value
Low Primary Current	0000-9999
High Primary Current	0000-9999
Primary Bus Voltage	000-600
Maximum Heat Cycle Limit	00-99
Maximum Secondary Current	

Note1: The turns ratio of a transformer is the primary voltage rating of the transformer divided by the secondary voltage (usually of tap 4). Then divide the result by the number of guns being fired "simultaneously" on the secondary of transformer. If the transformer secondary is tied in series the result is again divided by 2 (usually only 1 gun on a secondary is in series).
On a "push-pull" application, count the number of guns being fired simultaneously, disregarding the fact that there are two transformers.

7.2 Mode of Compensation and Transformer Size:

This setting determines the mode of compensation the WCU will use to correct for changes in applied line voltage, secondary loading changes, or secondary loop configurations. Please refer to Rotech Tooling Protocol EO-1, or system programming manual for information on how to program there items.

Mode **(Note1)**	0 = Current Compensation Mode 1 = Voltage Compensation Mode
Transformer Size Selection	0 = Transformers smaller then 75 kVA 1 = Transformers from 75 kVA to 150 kVA 2 = Transformers larger then 150 kVA

Note 1: Default mode operation is voltage mode. Heat setting programmed into control are interrupted as % heat values. In voltage mode transformer size selection values is ignored.

7.3 Thyristor Short Limits:

The Rotwel-Max1allows the user to set limits of voltage level and duration at which the control senses a shorted Thyristor has occured. These limits are adjustable via programming and should be programmed prior to attempting to weld with the Rotwel-Max1. Refer to Rotech Tooling protocol EO-1 or system programming manual for specific means of programming these values.

Typical values

Voltage level	200
Number of cycles (duration)	20

7.4 Minimum Weld Schedules

Minimum weld schedule programming is required prior to attempting to weld with the Rotwel-Max1 control. Refer to the system programming guide or to Rotech Tooling protocol manual EO-1, for further information on weld schedule programming.

8.0 TROUBLESHOOTING:

The following sections details troubleshooting procedures on the Rotwel-Max1, as indicated by the faul messages displayed by the sustem Man Machine Interface or the Rotwel´s status LED.

8.1 Fault Indication Methods:

The rotwel indicates fault conditions in two methods. One method is general and the other is specific.

8.2 General Fault Indication:

The general method of fault indication is via LED located on the external surface of the Rotwel´s logic module. The state and changing state of this LED indicate general fault status. The following table defines these general fault states. Refer to section 8.3 for Specific fault information report serially by Rotwel-Max1.

LED STATUS	MEANING
LED solid red blinking green	No Fault, communications occurring
LED solid red	No Fault
LED blinking red at rate of 20 per second	Emergency stop fault
LED blinking red at rate 7 per second	General faults exist

8.3 General Reset Methods for Faults:

The general reset methods for the faults are as follows:

1. Use reset method defined in system manual. This may be either by closing external machine control input, or by a fault reset method from Man Machine Interface.
2. Reset Faults by sending reset command on serial communication lines. Refer to Rotech Tooling AB protocol EO-1 for specific serial command required to reset faults.

8.4 Specific Fault Bit Decriptions and Probably Causes

Bit 0 to Bit 31: Refer to Rotech protocol EO-1 page 2-37 to 2-46.