



**XL2000
XL3000
Instruction
Manual**

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1.0 INTRODUCTION

The purpose of this document is to describe in detail the specifications for the ABM three axis CNC machine controller. This document will describe all hardware and software features that will be supported by the Robo-Con II for the 3 axes system. Any modifications to this specification must be approved by all parties involved before the modification becomes a part of the customer requirements.

2.0 APPLICABLE DOCUMENTS

Robo-Con II Hardware Specification
Robo-Con II S200 Product Manual - Revision 5.0
ABM Instructions on Program Generation

3.0 SYSTEM OVERVIEW

The ABM machine control system consists of three axes of closed loop servo control for positioning and contouring in the (X,Y) plane with closed loop servo control of the sew head, designated as the Z axis. In addition, canned functions to enable and disable sewing and recovery from a thread brake must also be supported.

The ABM system supports the standard EIA machine tool programming language. Programs may be generated by a variety of methods: manual keyboard entry, digitization via manual jog, or download from a host computer via a serial link. Programs generated on the host computer via a compatible CAD system with G code compiler will be accepted by the controller.

In addition, the ABM system will utilize a menu driven operating system to allow the operator quick and easy access to Robo-Con commands.

The control package consists of a board level three axis S200 Robo-Con II control package. Specialized software to interface to the Christie disk drive, to support Z axis control and separate axes resolutions and canned cycles to enable and disable sewing and to recover from a thread brake will be added to the standard S200 CNC software package.

5.0 BOARD DETAILS

The CNC system delivered to ABM utilize the Robo-Con II board supporting the following hardware features. Refer to the Robo-Con II hardware manual for more details on the Robo-Con II system.

- * Four axes analog output providing signals in the range of +10 to - 10 V.
- * Four axes of complimentary encoder feedback input
- * 32K CMOS battery backed up RAM, approximately 25K is usable for program storage.
- * Standard digital I/O package consisting of 16 inputs, 8 outputs, all I/O are optically isolated.
- * Three RS-232-C ports, one for interface to the rack mount display and keyboard, one for uploading and downloading files to the Christie disk dirve and one reserved for future expansion.
- * Fault detection and watch dog circuitry which detects overvoltage and undervoltage conditions, and disables servo output when a fault occurs.

6.0 SOFTWARE DETAILS

6.1 Power Up of the Controller

The Robo-Con Board is battery backed in XL2000 series and floppy drive refreshed in XL3000 series. This means that all parameter values and the current active program will be lost whenever the controller is powered down; except in the XL2000.

This problem is solved by executing a boot up sequence on power up. This boot sequence restores the state of the Robo-Con when last powered down by reading a specific configuration file from disk. All disks must contain a bootup file ABM.BOT and should also contain a configuration file ABM.SYS. The boot file

contains additional code required by the Robo-Con; the Robo-Con will not operate if this file is not found on the disk. The configuration file contains the current values of all parameters including the general system parameters, axes parameters, gain factors and axes resolutions and also contains the name of the current active part program. The boot sequence consists of the following steps.

1. The controller attempts to establish a link with the disk drive by searching for the boot file ABM.BOT. If the disk is not operational or if the boot file is not found, the controller will hang with an error message.
2. Once the boot file is read from disk, the controller searches for the configuration file ABM.SYS. If the configuration file is not found, the boot sequence is terminated with all parameters set to the default values and no active program in controller memory.
3. The controller reads the configuration file from disk and sets the controller parameters to the values contained in the configuration file.
4. If the configuration file contains an active program name, the specified program is read from disk to controller memory and is made the active program.
(Note: Only single programs can be read and activated during the boot sequence; appended programs must be generated each time the controller is powered up.)

Once the boot sequence is completed, the controller enters the Manual Mode of operation.

6.2 Manual Mode Operations

The following information will be displayed while in the manual mode.

```
COMMAND    FAST    ON
X+ 0.0000  Y+  0.0000
Pattern    Prod    Spd
BOX                0      5
```

The first line displays the working status of the controller and will display COMMAND when in the manual mode. The Jog status (FAST/SLOW) and the Sew Enable status (ON/OFF) will follow the COMMAND descriptor. Line 2 displays the current XC and Y axes coordinates relative to the home position. The axes positions will be updated about 8 times a second when the axes are in motion. The fourth line will display the current active program name, the current Production count and the current FeedRate Override factor (5 = 100%) for the active program. If there is no active program in memory, line 4 will display NO ACTIVE PROGRAM.

The following dedicated keys will be active when in the Manual Mode.

UP	Jogs the X axis in the positive direction. Also used to scroll up during program edit, directory search and parameter configuration.
RIGHT	Jogs the Y axis in the negative direction. Also used to scroll right during program edit.
DOWN	Jogs the X axis in the negative direction. Also used to scroll down during program edit, directory search and parameter configuration.
LEFT	Jogs the Y axis in the positive direction. Also used to scroll left during program edit.
JOG SPEED	Toggles between the Fast/Slow jog mode. The axes will jog at about 8% the Fast jog speed when in the Slow jog mode.
SET HOME	Sets the Pattern Stop or Home position. The axes will display 0.0000,0,0000 at this position.
HOME	Initiates a home sequence which first lifts the needle if sewing is enabled, then sends the axes to the Home position via straight line motion at the Rapid Travel Speed.
SEWING	Toggles between the Sew Enable and Sew Disable mode. When sewing is disabled, all programmed sew enable

	and disabled commands are ignored and the program will execute at Rapid Travel Speed.
LOCK FRAME	Toggles the Frame Lock output (O5) to lock and unlock the frame.
OPERATOR	Displays the Operator Menu for selecting active programs and to change feedrates and scale factors for the active program.
TECHNICIAN	Displays the password protected Technicians menu for configuring system and program parameters, modifying and selecting the active program and for performing other miscellaneous functions.
INSERT	Used to insert a line during program edit or to append a program when selecting active programs.
DELETE	Used to delete lines during program edit.
ESC	Exits the current operation and backs up to the previous menu displayed.
START	Starts execution of the active program. The controller enters the Automatic Mode once program execution begins.

6.2.1 Operator Menu

The Operator Menu provides simplified options available to the operator. The Operator Menu is shown below:

OPERATOR MENU

1. BOBBIN
2. LOAD PATTERN
3. SET SPEED
4. SCALE

The BOBBIN option allows the operator to change the Bobbin program parameter. The current value will be displayed; the operator has the option of entering a new value or pressing ENTER without typing a new value to retain the value displayed.

The LOAD PATTERN option allows the operator to scan thru the disk directory to select a new active program. Once a program is selected, it is read from the disk, replacing the current active program. Refer to Section 6.2.2 for more details on selecting active programs from the disk directory.

The SET SPEED option allows the operator to change the FeedRate Override for the active program. The FeedRate Override can be any value from 1 to 5; 1 corresponds to 20% the programmed speed and 5 corresponds to 100% the programmed speed.

The SCALE option allows the operator to change the Scale for the active program. The Scale can be any value from 1 to 30000 (1000 = 100%); a value of 300 corresponds to 30% the programmed scale and a scale of 10000 corresponds to 10 times the programmed scale.

The changes made via the Operator Menu will not be written back to disk. This can only be done via the Technician Menu.

The controller will automatically return to the command level once a selection from the Operator Menu is completed.

6.2.2 Technician Menu

The Technician Menu provides more advanced options and is available only to the

technicians or floor managers. This menu is password protected; The user must log in by entering 4 character password consisting of alphabetical (A-Z) characters only. (All lower case a-z characters are automatically converted to upper case A-Z characters.) The characters will be echoed as * when entered. The Technician Menu will be displayed ONLY if the entered password matches either the primary password (EKIM) or the secondary password which is configurable by the technician. All selections from the Technicians Menu will exit back to the Technician Menu on completion, requiring the technician to only log in initially when performing multiple selections from the Technician Menu. The ESCAPE key must be pressed to exit the Technician Menu and return back to the command level.

The Technician Menu is shown below:

```
TECHNICIAN MENU
  1. DIAGNOSTICS
  2. FILES      3. PARAM
  4. STEP      5. TEACH
```

The DIAGNOSTICS option allows the operator to manually activate and deactivate output ports, to check the status of input ports during initial installation of the system, to manually search for the sew motor Zero Reference Marker (ZRM) and to calibrate the sew head output. When this option is selected, the following submenu will be displayed:

```
DIAGNOSTICS
  1. ON  4. ZRM
  2. OFF 5. RPM
  3. INPUT PORT STATUS
```

Selections 1 and 2 are used to turn on and off specified output ports and will first prompt for an output port number and then will activate or deactivate the specified output port. Selection 3 will display the

real time status of all input ports. Refer to the section on I/O Control of the S200 Operations Manual for a description of the input port status display. Selection 4 will initiate execution of the Sew Motor Zero Reference Marker (ZRM) Test. This test will only be executed if the Sew Enable output (O2) is ON and controls the bobbin output (O8) according to the status of the sew motor ZRM; if on, the Bobbin output will be activated for 250 milliseconds; if off, the Bobbin output will be deactivated. This test is exited by pressing any key on the HHT. Selection 5 will initiate execution of the Sew Motor RPM calibration. This test is only performed if the Sew Enable output (O2) is ON. The operator will be prompted for entry of a Sew Head speed in RPM. Once this value is entered, the controller will ramp the sew head from its current speed to the specified speed at a specified ramp and will then maintain the specified speed to the sew head motor before exiting back to the DIAGNOSTICS submenu. Once options 1-4 are selected and the command executed, the system will return back to the DIAGNOSTICS submenu. Pressing the ESC key when the DIAGNOSTICS submenu is displayed will ramp the sew motor to the specified Idle Speed and will then return the system back to the command level. There is a fifth option, the NULL ADJUST option which is not displayed in the diagnostics sub menu but which is selected via the 5 key. The null adjust selection puts the controller in an open loop mode until a hardware reset is issued. In the open loop mode, the servos are not compensated for axes position errors. The null adjust mode of operation is useful when adjusting the software gains

The FILES option is used to edit the current active program, write the active program and parameters back to disk and to activate a single pattern or an appended pattern via the disk directory display. When this option is selected, the controller will display the FILES submenu.

MANAGE FILES

1. EDIT
2. STORE ACTIVE PROGRAM
3. SHOW DIRECTORY

The operator then selects options 1-3 by pressing the appropriate number key. If the EDIT option is selected, the controller will initiate editing of the current active pattern. The EDIT option is not available if an appended pattern is currently active. Refer to the section on Text Editing of the S200 Operations Manual for more details on program editing. The STORE ACTIVE PROGRAM option allows the current active program to be rewritten to disk and is done once any changes to the part program via EDIT or the program scale and FeedRate Override have been proven. If the SHOW DIRECTORY option is selected, the disk directory read from disk will be displayed. All single or appended programs are activated via the disk directory display. The names of all part program files containing the .PAT extension will be displayed in alphabetical order. The operator may scroll through the directory one pattern at a time via the UP and DOWN keys or may press any alphabetical hot key (A-Z) to display the first pattern name beginning with the hot key. The operator may activate a single file by first scrolling to the desired file via the UP and DOWN keys or the alphabetic hot keys and then pressing ENTER to select the program for activation. Once a single program is activated, the name of the active program is written to the configuration file and the configuration file rewritten to disk as the ABM.SYS file. Multiple files may be appended by scanning to the desired files and pressing INSERT to append the selected program. (Note: All part program files stored on disk must have the .PAT extension. The disk will contain other files used for configuration; only those files with names ending with the .PAT extension will be displayed when showing the

directory.)

The PARAM option is used to configure controller parameters such as software gains, axes resolutions and system and axes parameters. All these options are displayed in the CHANGE PARAMETER submenu shown below:

CHANGE PARAMETERS
1. SYSTEM 2. AXES
3. GAINS 4. REV
5. RESOL 6. PSWD

If the SYSTEM parameter option is selected, the controller will scroll through the list of the system parameters which include default feedrates, ramps and parameters associated with the sew enable and sew disable cycles. If the AXES parameter option is selected, the controller will first prompt for an axis identifier (X or Y) and then scroll through the list of axes parameters which include jog and homing feedrates and ramps. (The rotary Z axis cannot be manually jogged and has no configurable axes parameters). Selection of the GAINS option will scroll through the axes software gains. Selection of the REV option will display the current software revision before returning to the command level. Selection of the RES option will scroll through the X, Y and Z axes resolutions. Selection of the PSWD option will allow the technician to specify the secondary password by typing 4 alphabetical characters A-Z. (The characters will not be echoed to the display when typed; the technician will be prompted to verify the entry before it is accepted.) Whenever parameters are modified, the values for all the parameters are written to the configuration file and the configuration file is then rewritten to disk as the ABM.SYS file.

The STEP option is a method of verifying programs by executing programs in the single step mode. In the single step mode, programs

are executed step by step with the controller executing cycle stops at the end of each step. Also, in this mode, the line number of the current step is displayed with the current axes position. The STEP AND EXECUTE option is useful when testing programs under no sew conditions to check the validity of programs and to identify program steps for editing. Once this option is selected, the controller prompts for the scale factor. Once this information is entered, the controller prompts the operator for the START key. Once pressed, the program is executed step by step with the START key used to step through the program. At the end of program execution, single stepping is disabled, and the controller returns to the command level. The current program step number is displayed at line 3 during program execution. This provides the operator an indication of which program step is currently being executed.

The TEACH option is used for entry of programs into controller memory and onto disk. There are three methods of program entry, Manual Data Input via the keyboard (MDI), teaching via jogging to critical points (LEARN) and digitization via the digitizer tablet (DIGITIZE). All three options are displayed on the TEACH submenu shown below:

- TEACH
- 1. MDI
- 2. LEARN

Once options 1 or 2 are selected, the controller will prompt for the pattern name of the new program before beginning the selected process. Once program generation is completed, the part program is made the current active program and is then written to disk. Refer to the S200 Operations Manual for more details on teaching via Manual Data Input and program generation via LEARN.

6.3 Automatic Mode

The automatic mode is the mode entered when program execution is initiated from the manual mode. EIA compatible part programs consist of a series of program blocks, or program steps. Program blocks consist of a series of EIA commands, terminated by an end of block character. EIA commands include commands to set programming modes, execute linear or circular motion in the XY axes, perform various I/O (process control) functions and to modify program flow via subroutine calls and program jumps. A motion block consist of one or more program blocks which contain an interpolation motion command.

Program execution may be suspended by triggering of the STOP key. Once program execution is suspended in this manner, the controller enters the cycle stop mode.

All keys with the exception of the STOP key are ignored in the automatic mode.

6.4 Cycle Stop Mode

Once program execution is suspended and the controller enters the cycle stop mode, the operator may restart the program or initiate a thread break recovery cycle. All options available eventually result in restart of program execution.

The following keys are active when in the Cycle Stop mode.

HOME	Initiates a home sequence which first lifts the needle if sewing is enabled, then sends the axes to the Home position via straight line motion at the Rapid Travel Speed.
SEWING	Toggles between the Sew Enable and Sew Disable mode. When sewing is disabled, all programmed sew enable and disabled commands are ignored and the program will execute at Rapid Travel Speed.

RESTART	Initiates a thread break recovery cycle. Refer to Section 6.10.1 for a description of the thread break recovery cycle.
START	Continues execution of the active program at the current programmed position.

6.5 Fault Mode

The fault mode is entered when irrecoverable faults are detected by the controller. There are three general sources of irrecoverable faults, servo faults, frame lock faults and part program format faults. Servo faults may occur at any time and are generated when the controller detects excess following error when closing the servo loop. Frame lock faults are generated during part program execution during the automatic frame lock cycle or when the frame lock input is deactivated. Program format faults are detected during the automatic mode when executing part programs. Program format errors include illegal G and M functions, illegal code words and illegal subroutine call and program jump commands. The most common source of program errors is when programming circular moves which must specify the start, end and center points of the arc. The controller will generate an error if the points specified do not define an arc.

The fault mode can only be exited back to the manual mode by pressing the ESC key on the keyboard.

6.6 Z Axis Control

There are two modes of operation of the sew (Z axis) motor. In the normal open loop mode, a 0V command is applied to the sew motor without any attempt to maintain positioning of the sew motor. When in the closed loop mode, a 0 to 10V closed loop command is applied to the sew motor to maintain both accurate velocity and position control of the sew motor. The mode of the sew motor is determined by the state of the Sew Motor Enable output (O2); if this output is on, the sew

motor will be in the closed loop mode; if off, the sew motor will be in the open loop mode. The Sew Enable output (O2) must be ON to enable sewing during program execution; this output will be automatically controlled via the Sew On (M20) and Sew Off (M21) program commands.

During program execution, when sewing is enabled, the speed of the sew head must be proportional to the current vector cartesian (X,Y) speed at all times. This is necessary to maintain a constant stitch length along the programmed path. The rotary sew head speed is based on the vector cartesian speed according to the following formula:

$$Frpm = Fipm * Ks$$

Frpm is the rotary sew head speed resulting in the desired number of stitches per minute, Fipm is the current cartesian speed in units of inches per minute and Ks is the desired number of stitches per inch. The number of stitches per inch is configurable as the system parameter Stitches Per Inch.

The current axes cartesian speed, Fipm is based on the programmed speed. Generally, the programmed speed is based on the Default Speed and the FeedRate Override according to the formula below:

$$Fp = (Fd * FRO) * .91$$

Fd is the Default Speed, FRO is the Feedrate Override (1 = 100%) and .91 is a 'fudge factor' to scale the actual speed by 91%. The programmed speed, Fp may be overridden by specifying a programmed speed in the part program via the F EIA command.

Once sewing is enabled under normal default programmed conditions, the sew head speed is scaled to the XY cartesian speed during steady state conditions where the XY vector speed is constant and during acceleration and deceleration of the XY axes. The sew speed is clamped to the Idle Speed during sewing and cannot fall below

this value.

An alternative Constant Velocity mode of sew speed control may be enabled via programmed Miscellaneous functions. In the Constant Velocity mode of operation, the programmed speed of the XY axes is set to the configurable system parameter Constant Speed. The sew head speed is then determined based on the Constant Speed instead of the programmed speed. The Constant Velocity mode is useful when sewing complicated patterns which cause frequent variations in the speed of the XY axes due to radius clamping and block update limitations. The Constant Speed is a configurable system parameter and is set to 50 to 75% the Default Speed used as the programmed speed during normal operations.

The Constant Velocity mode of operation is enabled via the programmed Miscellaneous Function M22 and disabled via the sew disable Miscellaneous function M21. The M22 function may occur in the same program line as a linear or circular motion command, however it cannot occur in the same line with another M function (either M20 or M21).

During manual operations or program execution when The Sew Enable status is ON, the sew head speed is set to the configurable system parameter, Idle Speed. The Idle Speed will always be set to zero for three axis systems. If the Sew Enable status is OFF, the Robo-Con will output an open loop 0V command to the drives regardless of the Idle Speed; therefore a nonzero Idle Speed will still result in no movement of the sew motor.

The Robo-Con supplies the 0-10V tachometer signal to the sew axis servo motor via the fourth channel of analog output. This signal is proportional to the current sew axis speed based on the encoder feedback and is scaled so that a speed of 5000 RPM will produce a tach signal of 10V.

6.7 Sew Enable and Disable

Sewing is enabled and disabled under program control via specialized EIA commands. When these commands are encountered during program execution, the controller will perform a preprogrammed series of events, refereed as canned cycles necessary to enable and disable the sewing process before continuing with program execution. The sew enable and disable processes are described below:

6.7.1 Sew Enable Cycle

The following is the sequence of events that take place when sewing is enabled under program control.

1. All programmed motion in the XY axes is disabled.
2. The sew motor enable output is energized.
3. The controller delays for a specified duration (Sew On Delay) to allow the sew head motor to engage.
4. If backtacking is enabled, a backtack operation is performed while maintaining control of the sew head speed.
5. Program execution is resumed at the next program block.

Sewing is enabled from the part program via the M20 Miscellaneous function.

6.7.2 Sew Disable Cycle

The following is the sequence of events that take place when sewing is disabled under program control.

1. All motion in the XY axes is disabled.
2. If backtacking is enabled, a backtack operation is performed while maintaining the control of the sew head speed.
3. The speed of the sew head is reduced to a specified Needle Position Speed.
4. The controller delays for a specified

duration (Sew Off Delay). During this delay, the sew head is ramped from its current speed to the Needle Position Speed.

5. If thread trimming is disabled, the cycle immediately jumps to step 13. Otherwise, the controller waits for activation of the sew motor Zero Reference Marker (ZRM).
6. The sew enable output is turned off.
7. The thread trim solenoid is activated.
8. The controller delays for a specified duration (Thread Trim Delay).
9. The thread trim solenoid is deactivated.
10. The thread lock solenoid is activated.
11. The controller delays for 250 milliseconds to allow the thread lock output to settle.
12. The sew enable output is reactivated. The cycle then jumps to step 14.
13. The controller waits for activation of the sew motor ZRM.
14. The sew motor is allowed to rotate from the zero position to the specified Needle Up Position.
15. The thread lock solenoid is deactivated.
16. The Sew Enable solenoid is deactivated.
17. The speed of the sew head is immediately set to the specified Idle Speed.
18. Program execution is resumed at the next program step.

The sew head is ramped from the Idle Speed to the Needle Position Speed during the Sew Off Delay. The sew head ramp is calculated so that ramping is completed during the first 1/4 of the delay which will allow the sew head to stabilize during the remaining 3/4 of the delay. The Idle Speed is immediately reapplied without ramping to complete the cycle. A 100 millisecond delay is executed before the cycle is completed to insure that the sew head speed has settled to the Idle Speed.

Sewing is disabled from the part program via the M21 Miscellaneous function. In addition,

M21 also disables the Constant Velocity mode of sew speed control.

Output port 2 is used as a sew motor enable. When in the off state, the sew motor enable to the drive is disengaged, preventing any motion in the sew head regardless of the voltage supplied by the Robo-Con. This output will be activated only after execution of the M20 Sew Enable command and will remain active until execution of the M21 Sew Disable command. Once activated, the sew motor enable output is automatically deactivated under the following conditions.

1. The controller enters an irrecoverable fault condition via a servo overload, program format error or frame lock fault.
2. A cycle stop is generated during program execution via the STOP key or the thread break sensor.
3. Part program execution is completed. The sew motor enable is deactivated a quarter second after execution of the part program is completed to allow the sew head speed to settle to the Idle Speed.

6.7.3 Backtack Operations

Backtacking is an operation involving repetitive back and forth movement of the XY axes a specified Backtrack Distance while matching the sew head speed to the cartesian speed and is performed when initiating or terminating a stitch. Backtacking occurs during sew enable and disable cycles.

Backtacking is always performed in the XY axes along the programmed path a distance specified by the Backtack Distance parameter. When backtacking occurs during a sew enable operation, the backtack operation involves movement along the programmed path at the start of the next move after the sew enable operation, followed by reverse movement back

to the starting point, followed by another forward movement along the programmed path of the next move, terminated by a second reverse movement back to the starting point. If backtacking occurs during a sew disable operation, the initial motion will be movement in the reverse direction along the programmed path at the end of the last motion block before sewing is disabled, followed by movement back to the start point along the programmed path. This is illustrated below:

Sew Enable

Sew Disable

Backtacking will be performed at the programmed feedrate. However, due to the short backtack distances and the repetitive back and forth motion, it is unlikely that the programmed speeds will be attained.

After a backtack operation during sew enable and disable cycles, the axes will be positioned at the start point of the next move at the end of the backtack, therefore there is no need to compensate the next programmed move after a sew enable or disable

cycle.

The speed of the sew head will be synchronized to the current XY vector speed during execution of all backtack moves during sew enable and disable operations. Once backtacking is completed during a sew enable cycle, the sew head speed will remain synchronized to the current XY vector speed until the sew disable cycle is completed.

The backtack operation may be disabled via the system parameter Backtack Enable.

6.8 Frame Locking

The ABM system is equipped with a solenoid which releases the frame and activates the autotable to unload a pattern on completion of program execution. This solenoid, interfaced to output port 5 must be activated whenever the axes are currently at the pattern stop position and must be deactivated whenever the axes move from the pattern stop position under program control. On power up, this output port is activated and will be activated when any one of the following operations are performed.

1. The pattern stop position is set via the SET HOME key.
2. Execution of the current active part program has successfully completed. This assumes that all programs position the axes to the pattern stop position as the last program command.

The autotable output is deactivated at the start of program execution in order to lock the frame prior to axes movement. The frame must be in the proper position in order to lock the frame. A frame lock proximity switch interfaced to input port 10 is used to sense whether the frame is in the proper position to be locked. This input is also used to generate a fault condition if the frame becomes unlocked during program execution.

The following cycle is performed to lock the frame

when the START command is issued to begin program execution or to continue program execution after a thread break recovery cycle.

1. The controller checks if the axes are currently at the pattern stop position by examining the status of the autotable output. If this output is off indicating that the axes are not at the pattern stop position, the cycle is completed and program execution begins. Otherwise, the cycle proceeds to step 2.
2. The controller then check the frame lock input. If this input is off, the cycle proceeds to step 3. Otherwise, the autotable output is deactivated to lock the frame, followed by a 500 millisecond delay to allow the process to complete. Program execution begins once the delay is complete.
3. If the frame lock input is off, the Y axis is moved the specified FrameLock Distance at one quarter the current Rapid Travel speed while scanning the frame lock input. The autotable output is deactivated to lock the frame without stopping the XY axes as soon as the frame lock input is seen. If the specified distance is covered without the frame lock input being activated. A FRAME LOCK FAULT message is generated and program execution is aborted.
4. The controller delays for one second once the move is completed with the frame lock input being sensed.
5. The Y axis is returned to the pattern stop position at Rapid Travel Speed. Program execution begins once the Y axis has reached the pattern stop position.

If the autotable output is currently active, indicating that the axes are at the pattern stop position, it will not be deactivated if the axes are jogged from the pattern stop position. If this occurs, the autotable output must be manually deactivated via the FRAME LOCK key. Otherwise, if this output is on and the axes are not at the

pattern stop position when the START command is issued to begin program execution, the controller will attempt to execute the frame lock cycle even though the axes are not in the proper position to lock the frame.

The moves in the Y axis during the frame lock cycle may be suspended by pressing the HOME pushbutton.

The frame lock input is continually scanned during program execution and will generate a FRAME LOCK FAULT condition if the frame lock input is deactivated. Once a FRAME LOCK FAULT is generated, all axes motion immediately stops and the controller waits for the ESC key or a hardware reset to exit the fault.

6.9 Oil Injection

The ABM system is equipped with an oil injection pump used to lubricate the sew head. The pump operates by sending a square wave signal to the oil injector solenoid at a frequency proportional to the current rotary speed of the sew head. The controller generates the square wave signal to the oil injection system by pulsing the oil injection solenoid (Output Port 7). The frequency of the square wave generated is proportional to the current sew head speed as shown below:

$$Pf = Vs / K$$

Vs is the current sew head speed in RPM
 K is a configurable constant specifying the number of revolutions of the sew head per pulse of the oil injector
 Pf is the resulting frequency of the pulse output in pulses per minute

The constant K is accessible as the configurable system parameter Injection Rate. The default value of 100 revolutions per pulse will result in an output frequency of 36 pulses per minute or 0.6 Hz at 3600 RPM sew speed.

As the speed of the sew head increases, the

frequency of the pulses to the injection system will also increase. A new pulse rate will be determined based on the current sew speed each time output port 7 is toggled to produce the square wave signal. For example, if the current motor speed is fluctuating at 1000 RPM producing a square wave with a frequency of 10 pulses per minute, a new pulse frequency will be determined every 6 seconds.

When sewing is enabled in the automatic mode, the pulse frequency will be clamped to a minimum value of 0.2 Hz (one pulse per 5 seconds). This is necessary to properly update the pulse frequency as the axes accelerate from a stop.

The oil injector solenoid is pulsed continuously based on the current sew speed only if the sew motor enable output (Output Port 2) is enabled. (Output 2 is automatically enabled while in the automatic mode via execution of the M20 Sew Enable function.) During automatic operations, the pulse frequency will be based on the current sew speed which in turn is based on the current axes speed if sewing is enabled. The square wave signal will be generated when in the DIAGNOSTICS menu during execution of the Sew Voltage and RPM tests only if Output Port 2 is manually activated from the DIAGNOSTICS menu.

6.10 Suspension of Program Execution

During program execution, motion may be suspended via a cycle stop command. When a stop is issued during program execution, the controller immediately decelerates the XY axes to a stop, disables the sew motor enable, thread lock and thread trim output ports and enters the cycle stop mode of operation.

There are two physical devices that will generate a cycle stop during program execution, the STOP key and the thread brake sensor. If either of these devices are activated, the controller will execute the following sequence of events.

1. The XY axes decelerate to a stop. Program execution is suspended at this point.
2. The sew motor enable, thread lock and thread trim outputs are deactivated.

The STOP key is recognized at all times during program execution and will generate a cycle stop when activated. The thread break input will generate a cycle stop when activated only if all of the following criteria are met.

1. Sewing is currently enabled.
2. A backtack operation is not being performed.
3. A sew enable or sew disable cycle is not being performed.

The thread break input will continuously change states as long as the thread is being properly fed to the sew head. The frequency at which the threadbreak input changes state is determined by the speed of the sew head which in turn is determined by the current XY vector speed. A thread break is sensed if the thread break input is in the same state for a period exceeding a delay which is determined by the current XY vector speed and the specified Thread Break Delay. The Thread Break Delay is a configurable system parameter and specifies the delay corresponding to the current Rapid Travel Speed. The actual delay is determined by continuously adding the Thread

Break Delay and multiplying the specified XY vector speed by 2 until the specified Rapid Travel Speed is exceeded. For example, the Rapid Travel Speed is 1000 IPM and the Thread Break Delay is 2.5 seconds. The adjusted delay will be 5 seconds for all vector speeds from 500 to 999 IPM; 7.5 seconds for all vector speeds between 250 and 500 IPM; 10 seconds for all vector speeds from 125 and 249 IPM and so forth. The thread break input is ignored if the Thread Break Delay is set to zero or if any of the three conditions listed above are not met.

On completion of the cycle stop sequence, the operator has the option of restarting program execution at the point of suspension via the START key or initiating a thread break recovery cycle via activation of the HOME key. If the START key is pressed to continue program execution, a Sew Enable cycle is performed to enable the sew head motor, provided that sewing was active when the STOP was issued and the SEW DISABLE OVERRIDE switch is off when the restart is issued.

6.10.1 Thread Break Recovery

Thread break recovery is initiated during a cycle stop via the HOME key. Once the HOME command is issued, a sew disable cycle without backtacking is performed provided that sewing is enabled at the time the cycle stop is issued prior to any motion. Once the sew disable cycle is completed, the XY axes are sent to the grid zero or pattern stopper position (X0Y0) via linear interpolation at the Rapid Travel Speed and the autotable solenoid is activated. Once this position is reached, the controller waits for activation of the START or RESTART keys. If the START key is pressed, the automatic frame lock cycle is executed and program execution will be restarted at the first line of the program at the specified feedrate. (If sewing is enabled at this point of the program and the Sew Enable status is ON, the speed of the sew head is ramped to correspond to the top XY vector speed of the initial move during

execution of the Sew On Delay. The sew motor enable is then activated once the delay is complete.) If the RESTART key is pressed, frame lock cycle is executed and the XY axes will immediately position to the start point of the motion block in which the cycle stop was generated. The operator has the option of then pressing the START key to restart program execution at the block start point, or to backup one motion block in the program by pressing the RESTART key a second time. (The program is backed up via the RESTART key until the start point of the move that contained the thread break is reached.) If the START key was pressed, a sew enable cycle is performed to enable the sew head motor (provided that sewing is enabled at this point in the program and the Sew Enable status is ON) and program execution will resume at the programmed feedrate. If the Sew Enable status is OFF when the START command is issued, program execution will resume at the reduced Threadbreak Speed with the sew head motor disengaged and running at the Idle Speed. The threadbreak sensor will be ignored once the START command is issued until the operator issues a cycle stop at the position at which the thread broke. The operator will then set the Sew Enable status to ON via the SEW key to reenabling sewing before the START command is issued to resume program execution. When the Sew Enable status is OFF to disable sewing, all programmed moves will be executed at the specified Threadbreak Speed with the threadbreak sensor disabled until a cycle stop is issued so that the system may be stopped accurately at the point of thread break. Once a cycle stop is issued and the Sew Enable status is set to ON via the SEW key, the feedrate is reset to the programmed feedrate and the threadbreak sensor is reenabled. If the RESTART key is pressed again, the XY axes will position to the start point of the previous motion block. The operator may back up as many motion blocks as desired via the RESTART key all the way to

the start of the program. Pressing the START key will re-enable sewing by ramping the sew head speed and engaging the sew motor enable (if sewing is enabled at that point in the program and the Sew Enable status is ON) and will start program execution at the current position.

The RESTART key is active only during the thread brake recovery cycle.

6.11 Bobbin Control

Bobbin control is a process where an indicator light is illuminated when a specified amount of thread has been used to warn the operator that the sew head is almost out of thread. The Robo-Con estimates the linear amount of thread used by counting the number of parts produced or the number of sew disable cycles since the bobbin was last changed. The Bobbin control defaults to counting the number of parts produced but the software may be changed to count the number of sew disable cycles. This is NOT a configurable parameter and can only be changed by ABM.

The configurable system parameter Bobbin specifies the number of parts produced or sew disable cycles executed before activation of the Bobbin indicator light. Whenever execution of the active part program has successfully completed, the number of parts produced or number of sew disable cycles executed since the last bobbin change is incremented and compared to the specified Bobbin. If equal, the Bobbin output port is activated, warning the operator that the bobbin is almost out of thread. This output will remain energized until program execution is initiated via the START key at which time the number of parts produced is cleared to zero and the Bobbin output is deactivated. The Bobbin output port is also deactivated and the number of parts produced since the last bobbin change is cleared to zero when the RESTART key is pressed during a Cycle Stop to initiate a thread break recovery cycle. If the software is configured to count sew disable cycles, a cycle stop will be generated and the

Bobbin output is activated when the specified Bobbin target is reached. The Bobbin output will remain active until program execution is restarted.

The Bobbin may be changed from both the Operator Menu and the Technician Menu.

The Bobbin output is interfaced to output port 8.

6.12 Parameter Modification

The ABM system contains several parameters which may be configured via the Technician Menu. These configurable parameters include the General or System parameters which are accessed via the SYSTEM (1) selection of the PARAM sub menu, the Axes parameters accessible via the AXES (2) selection of the PARAM sub menu, the software gains accessible via the GAINS (3) selection of the PARAMS sub menu, the axes resolutions accessible via the RES (4) selection of the PARAMS sub menu and the FeedRate Override accessible via the Operator Menu.

The ABM operating system supports both global and local parameters. Global parameters are parameters which retain their values regardless of the operational mode of the controller until modified by the operator via the ABM operating system. The global parameters are always active when executing command level operations when the main menu is being displayed. Local parameters are parameters local to the current part program being executed. Local parameters are active only during execution of the current active part programs. Local parameters are stored in part program memory along with the EIA part program code; when a part program is executed, the local parameters contained in part program memory are made the current active parameters during execution of the part program. Once part program execution is completed, the values of these parameters are set to the current global values.

The general system parameters and FeedRate Override are defined as local parameters. The

axes parameters, software gains and axes resolutions are defined as global parameters. The global parameters may only be modified via the PARAMS menu selection. All global parameters are stored on disk in the configuration file ABM.SYS. This file will be rewritten to disk each time any of the global parameters are modified.

Local parameters may be modified only via the EDIT menu selection of the FILES sub menu (or the Operator Menu menu selection in the case of the FeedRate Override). When a new part program is created via the TEACH sub menu, the current global values for the system parameters and FeedRate Override are written into part program memory preceding the actual part program code. Once a new part program is generated, the local parameters may be modified without affecting the values for the global parameters via the EDIT menu selection of the FILES sub menu. Once the active program is selected for editing via the EDIT option, the operator will be given the option of editing the local system parameters contained in the part program being edited. The method of modifying the local system parameters is identical to the method used to modify the global parameters via the PARAMS sub menu. The initial system parameter and its value will be displayed. The operator has the option of modifying the parameter value, scrolling to the next parameter or terminating local parameter modification via the ESC key. Once local parameter modification is terminated via the ESC key, the actual part program code will be available for editing. This process modifies only the system parameters local to the part program being edited and has no affect on the global system parameters accessible via the PARAMS sub menu.

The local FeedRate Override is accessible via the Operator Menu. The Operator Menu selection sets the active FeedRate Override to the local FeedRate Override and prompts for a new FeedRate Override. Modification of the FeedRate Override will change both the global FeedRate Overrrde and the local FeedRate Override for the active program. The local FeedRate Override for all other part

programs are unaffected.

6.12.1 Local Parameter Header

When a part program is uploaded from controller memory to disk after program generation or after a program is edited, both the local parameters are uploaded as the local parameter header along with the part program code. This will allow storage of the local parameters on disk so they may be downloaded along with the part program code once the program is activated from the disk directory display.

For all software revisions preceeding 2.612I, the local parameter header was downloaded in a binary format. The first byte of a parameter header is the header ID and is always 0 for binary headers; the second byte of a binary header always specifies the length of the parameter header in bytes (minus the ID and length bytes). These bytes represent the parameter values directly in binary. Each parameter is represented as a 2 byte (lsb then msb) binary value.

For all software revisions proceeding and including 2.612I, the parameter header is downloaded in ASCII format. The parameter header ID byte is always 1 for ASCII headers. The remaining parameter header is represented in Hex-ASCII format. Four Hex-ASCII characters are required to represent a two byte value; since all local parameters are two bytes in length, each parameter including the header length must be represented as a four character Hex-ASCII string. Each 4 character Hex-ASCII string is terminated by a Carraige Retrun. The Hex-ASCII string represents the parameter value in Hexidecimal; for example 64 represents the decimal value 100, 2F represents the value 47. The first string of the ASCII header proceeding the header ID represent the number of parameters contained in the header (as

opposed to the actual length of the header). All strings proceeding this string represent the Hexidecimal value of the next local parameter.

The exact number of parameters contained in the parameter header depends on how many local parameters were supported when the part program was generated and uploaded to the host. There are a total of 28 local parameters for the current three axis software revision (27 general parameters plus FeedRate Override). The parameter header is valid only as long as the number of local parameters does not change; if future software revisions add or delete local parameters, the parameter header must be ignored when downloading the part program back to the controller.

The local parameter header need not be present when a program is downloaded from host to the controller. In fact, a program generated at the host CAD system will not contain a parameter header when initially downloaded to the controller. The presence of a parameter header is determined by the first byte of the program file. If this byte is an ASCII value, the file contains no parameter header and the local parameters will be set to the global parameter values. If the initial byte of the file is zero, the file contains a binary header. The next byte of a binary parameter header contains the header length. If this value is different than the header length supported by the current software revision or if the current software revision supports ASCII parameter headers (All revisions proceeding and including 2.612I support ASCII headers), the binary header will be ignored and the local parameters will be set to the global parameter values.

If the initial byte of the program file is one, the file contains an ASCII header. The next string represents the number of local

parameters contained in the parameter header. If this value is different than the number of local parameters supported in the current software revision, the ASCII header will be ignored and the local parameters will be set to the global parameter values. (Note: Software revisions preceding revision 2.612I cannot be used when downloading a file containing an ASCII header.)

If the initial character downloaded as the header id is not zero or one, all characters downloaded are treated as part program code. In this case, the local parameters for the part program downloaded are set to the current global parameter values. Therefore all programs generated at the host and initially downloaded to the controller will contain local parameter values set to the current values contained in controller memory.

6.12.2 System Parameter Configuration

The following system parameters will be supported by the ABM system. These parameters set default speeds and accelerations, control the speed of the sew head cycle and control the sew enable and disable cycles.

Rapid Travel Speed

The Rapid Travel Speed is the maximum allowed feedrate during program execution and axes jogging and is also the speed at which all rapid travel (G00) moved will be executed. The Rapid Travel Speed is not affected by feedrate override. The units of the Rapid Travel Speed is inches per minute (IPM). The Default value is 1000 IPM.

Default Speed

The Default Speed is the speed at which

all programmed linear (G01) and circular (G02,G03) moves will be executed in the normal mode of sewing, assuming a FeedRate Override of 100% and provided that a feedrate has not been specified from the part program via the F code word. The units of the Default Speed is inches per minute (IPM). The default value is 720 IPM. (The actual programmed speed will be the Default Speed times the Feedrate Override times .91.)

Constant Speed

The Constant Speed is the speed at which all programmed linear and circular moves will be executed when the Constant Velocity mode of sewing is enabled. The units of the Constant Speed is inches per minute (IPM). The default value is 480 IPM.

Scale

The Scale is used to scale all programmed moves by a specified amount, either expanding or shrinking the pattern. The units of the Scale is .1% (1000 = 100% scale). The default value is 1000.

Threadbreak Speed

The Threadbreak Speed is the speed at which all programmed moves are executed when the sew Disable Override toggle switch is in the on position. This speed will remain in affect until suspended by a cycle stop. The move will be executed at the programmed speed once the restart command is issued only if the Sew Disable Override switch is turned off. The units of Threadbreak Speed is inches per minute. The default value is 200 IPM.

Corner Accel

The Corner Accel is the acceleration ramp used when accelerating the XY axes during program execution with Constant Velocity mode disabled between moves that are not radius clamped. The units of Corner Accel is inches per second per second (IPSS). The default value is 10 IPSS.

Corner Decel

The Corner Decel is the deceleration ramp used when decelerating the XY axes during program execution with Constant Velocity mode disabled between moves that are not radius clamped. The units of Corner Decel is inches per second per second (IPSS). The default value is 20 IPSS.

Contour Accel

The Contour Accel is the acceleration ramp used when accelerating the XY axes during program execution with Constant Velocity mode disabled between moves that are radius clamped. The units of Contour Accel is inches per second per second (IPSS). The default value is 10 IPSS.

Contour Decel

The Contour Decel is the deceleration ramp used when decelerating the XY axes during program execution with Constant Velocity mode disabled between moves that are radius clamped. The units of Contour Decel is inches per second per second (IPSS). The default value is 15 IPSS.

Sew Ramp

The Sew Ramp is the acceleration and deceleration ramp used during the DIAGNOSTICS Sew RPM Test to ramp the sew motor from the current speed to the specified sew speed and to ramp back to the idle speed once the DIAGNOSTICS mode is exited. The default value is 15 RPSS.

Curve Angle Approach

The Curve Angle Approach determines when the axes decelerate to execute a sharp corner during program execution with Constant Velocity mode disabled and specifies the maximum discontinuity between motion blocks allowed before the axes will decelerate to the specified Corner Speed to execute a sharp corner. Refer to the S200 Product Manual on the discussion of the parameter Threshold Angle for more details. The units of the Curve Angle Approach is degrees and the default value is 25 degrees.

Quality

The Quality parameter determines whether a circular move is radius clamped and specifies the maximum allowed rotation speed of the arc which in turn depends on the radius of the arc and the programmed feedrate. The Maximum Radial Speed is only active during program execution when the Constant Velocity mode of sew speed control is disabled. The units of the Maximum Radial Speed is in radians per minute and the default value is 200 radians per minute.

Stitches per Inch

The Stitches per Inch is used when determining the sew head speed during sew enable conditions and specifies the desired number of stitches per inch of XY travel. This parameter is used to

determine the sew head speed, in RPM from the current XY vector speed in IPM. This parameter is also used to determine the minimum distance of a program block. If the distance of a program block is less than the distance of one stitch, the program block will be ignored and will be added to the next program block. The default value is 6 stitches per inch.

Needle Up Position

The Needle Up Position is used during the sew disable cycle after the thread trim cycle for locating the sew motor position prior to disabling the sew enable output at the end of the cycle. Once the thread trim cycle is complete and the sew enable output reactivated, the ZRM of the sew motor is searched. Once found, the sew motor is allowed to rotate the specified Needle Up Position before deactivating the sew enable output. The default value is 60 degrees.

Idle Speed

The Idle Speed is the speed of the sew head in RPM during manual operations or during automatic operations when sewing is disabled and is also the minimum sew head speed allowed during automatic operations with sewing enabled. The default value 500 RPM.

Needle Position Speed

The Needle Position Speed is the speed of the sew head in RPM applied to the sew head motor during a sew disable cycle. The default value is 60 RPM.

Sew On Delay

The Sew On Delay is the delay in units of milliseconds that is preformed from

the time the Sew Enable output (O2) is activated to the end of the dew enable cycle. This delay is necessary to allow the sew head motor to come to the proper speed before XY motion is allowed. The default value is 1000 (1 second).

Sew Off Delay

The Sew Off Delay is the delay in units of milliseconds that is performed from the time the Nominal Sew Head Speed is applied and the time the thread lock solenoid is activated during a sew disable cycle. The default value is 1000 (1 second).

Thread Trim Delay

The Thread Trim Delay is the delay in units of milliseconds that is performed between the time the thread trim solenoid is enabled and disabled during a sew disable cycle. The default value is 1000 (1 second).

Voltage Spike Suppressor

The Voltage Spike Suppressor is the adjustable software filter used to filter noise when reading all input ports (with the exception of the thread break sensor) and is the length, in milliseconds that the input must be continuously activated before the controller will recognize the active input. The default value is 100 (.100 seconds).

Thread Break Delay

The Thread Break Delay is the length, in milliseconds that the thread break input must be continuously activated or deactivated before the controller will recognize a thread break when the axes are running at the specified Rapid

Travel Speed. The default value is 1000 (1 second).

Backtack Distance

The Backtack Distance is the distance in units of .001 inches that the XY axes move along the programmed path when executing a backtack operation during sew enable and sew disable cycles. The default value is 250 (0.25 inch).

FrameLock Distance

The FrameLock Distance is the distance in units of .001 inches that the Y axis moves when executing a frame lock cycle during initiation of program execution. The default value is 3000 (3 inches).

Injector Rate

The Injector Rate is used in conjunction with the current sew head speed to determine the pulse frequency of the oil injector solenoid and specifies the number of revolutions of the sew head per pulse of the oil injector solenoid. The default value is 1000 revolutions per pulse.

Bobbin

The Bobbin is the number of parts that must be produced before the Bobbin output port (O8) is activated. The default value is 3 parts.

Backtack Enable

The Backtack Enable is used to enable or disable the backtack cycle during sew enable and disable cycles. If set to 0, backtacking is disabled during these cycles; if set to a nonzero value, backtacking is enabled. The default

value is 0 (Backtack disabled).

Thread Trim Enable

The Thread Trim Enable is used to enable or disable the thread trim cycle during sew disable cycles. If set to 0, thread trimming is disabled during the sew disable cycle; if set to a nonzero value, thread trimming is enabled. The default value is 0 (Backtack disabled).

All of the above system parameters are configurable from the manual mode via the PARAMS sub menu selection of the Operator Menu. The Scale and Bobbin are also configurable from the Operator Menu, although changes made from the Operator Menu will not be saved to disk..

The axes parameters are also configurable via the PARAMS sub menu selection. Axes parameters affect the speeds and ramp during jogging operations. Refer to the S200 Product Manual for a description of the axes parameters.

6.12.2 Separate Axes Resolutions

The ABM system supports separate axes resolutions for the X, Y and Z axes. The axes resolutions are configured via the PARAMS sub menu selection, Upon selection of the RES entry of the sub menu, the operator will be prompted to enter the resolution of the X, Y and Z axes respectively. The X and Y axes resolution are entered in units of encoder pulses per inch; the SEW (Z) axis resolution is entered in units of encoder pulses per revolution. The default axes resolutions is 18200 pulses per inch for the X axis, 7630 pulses per inch for the Y axis and 10000 pulses per revolution for the Z axis.

6.13 Program Execution

Program execution is initiated from the manual mode via the following sequence:

1. The axes are sent to the pattern stop position via the HOME key.
2. The desired part program is activated or an appended file created via the LOAD DESIGN option and the proper FeedRate Override set via the SPEED option of the Operator Menu.
3. The START key is pressed to begin program execution.
4. The local parameters contained in the part program parameter header are transferred as the active parameters.

6.13.1 Selection of Part Program for Execution

Prior to executing a part program, the desired program or programs must be selected as the active file for program execution. The ABM system has the capability of executing two types of files.

1. A file which consists of a single part program residing on disk.
2. An appended file which consists of a series of part programs residing on disk.

Single programs must be activated for program execution via the directory display command by scrolling to the desired program name and activating the program by pressing the ENTER key. The ABM.SYS configuration file residing on disk also contains the current active program name; whenever a single program is activated, the configuration file will be updated and rewritten to disk.

An append file consisting of a series of part programs also must be created via the directory display command. The operator selects the programs to append by scrolling through the directory display and selecting the programs to append by pressing the INSERT key. Once multiple programs are appended by this method, the programs will be executed in the order in which they were selected when program execution is initiated. Once a program append file is created via the

directory display command, execution of the RUN command will display the appended file name as the file name APPENDED.

A maximum of ten part programs may be appended. If the operator attempts to append additional programs, the controller will exit the directory display command with the first ten programs selected contained in the append file.

The append file consists of a list of part program names which are executed in order once the START key is pressed. The append file is not available for program editing, however the individual part programs specified by the append file may be edited via the EDIT option.

Once a program is activated or an appended file is created, it remains active until a new program is activated even if power to the controller is removed.

6.13.2 Execution of the Active Program File

The active program file consisting of a single part program or an appended series of part programs may be executed at any time by pressing the START key. The operator may wish to disable the sew on and off cycles via the SEW key prior to issuing the START command. This is desirable when executing a program for the first time to check the validity of the program.

All programs will be executed starting at the pattern stop position as determined by manually jogging the axes and setting the pattern stop position via the SET HOME key. The ABM system is not equipped with home switches and does not support commands to home the axes to a machine home position.

All programs should be generated in the absolute programming mode to reduce errors caused by backlash of the gear box.

On execution of a program, the controller automatically activates the autotable solenoid and

defaults to a no sew condition until sewing is enabled from the program.

Programs will be executed at the specified feedrate under all conditions with the exception of the four following conditions.

1. A sharp corner is detected by the controller via its lookahead scheme. The X and Y axes will decelerate to a stop at the corner and accelerate back to the specified programmed speed. The criteria for sharp corner detection is an adjustable system parameter. During acceleration of the XY axes, the sew head will also decelerate to maintain the linear relationship between head speed and XY speed.
2. The Constant Velocity mode of sew speed control is enabled via the Miscellaneous function M22. In this mode, the programmed speed of the XY axes is set to the parametric Constant Speed regardless of the current feedrate specified via the F code or the current default speed specified by the parametric Default Speed. The specified Curve Angle Approach is overridden to a value of 45 degrees while in the Constant Velocity mode.
3. The speed of a circular move is limited by the Quality parameter while in the normal mode of sew speed control. This is necessary for cases such as a 90 degree corner replaced by a 90 degree arc of small radius. Since there are no sharp corners detected by the controller, the controller will try to execute the 90 degree arc at the specified feed. as the radius of the 90 degree arc becomes smaller, it becomes more difficult to maintain the pattern at high speed. The Quality allows the operator to clamp the speed of all arcs based on the rotary and not the cartesian speed of the arc. Since this is a configurable system parameter, it

can if affect be disabled by entering an extremely large value. The controller utilizes the Contour Accel and Contour Decel ramps if the speed of a circular move is limited by the Quality. The feedrate of circular moves is limited by the Quality only when the normal mode of sew speed control is enabled. If the Constant Velocity mode of sew speed control is enabled via M22, the speed of circular moves are no longer limited by the Quality.

4. The speed of all moves is limited by the block update rate of the controller. This generally affects small moves at high speeds. The block update rate for the controller is approximately 800 milliseconds, which means that all moves will be executed in a minimum of 800 milliseconds. This corresponds to 1 inch of travel at 12 inches/second. All motion blocks less than 1 inch is vector distance will be executed at reduced speed. This should not be a problem with the ABM system, since the patterns do not show the complexity requiring motion blocks every 1 inch. This is especially true if the programs are developed on a scaled down pattern and then scaled up on program execution.

The controller will not execute motion blocks which specify a linear distance of less than one stitch in length but will tag these small moves to the beginning of the next move. This is necessary in order to prevent slowdowns due to execution of very small moves which are inserted by the host CAD system between motion blocks to guarantee that the motion blocks are continuous. In general, these moves inserted by CAD systems are less than .01 inch so the visual affect of ignoring these small moves will be very minimal. These small blocks are ignored by maintaining the programmed endpoints of the last record executed; if a block is ignored, the endpoint coordinates are not updated. This does not present a problem if blocks are ignored before linear moves; however if

a block is ignored before a circular move, the programmed end and center points and the start point of the arc may no longer define an arc. The controller will compensate by slightly adjusting the center point coordinates so that the three points define an arc. Since the start and end points of the arc are not adjusted and the adjustment to the arc center point is small, the visual affects will again be minimal. The minimum distance of a motion record is determined by the length of a single stitch which in turn is determined by the Stitches per Inch parameter.

6.13.3 Maintaining the Current Production Count

The controller maintains a current production count which is incremented each time a part program is successfully completed. This production count is displayed when in the Manual Mode and specifies the total number of parts completed since the current part program was activated for program execution. The current production count is cleared to zero when a single part program is activated or when an appended program file is generated from either the Operator or Technician Menus.

If an appended part program file is currently active for program execution, the production count is not incremented until the last part program in the program append list has been executed

6.14 Program Generation

All new part programs are generated via the TEACH menu as either Manual Data Input (MDI) or digitized programs. The operator will be initially prompted for entry of the part program name; program names are limited to 15 characters and cannot contain any DOS extensions or wildcard characters. All part program files stored on disk will have file names ending in the .PAT extension; the controller will automatically extend the file names to include the .PAT extension when storing to disk. Because of limitations in the Christie disk drive interface, it is highly recommended that all file names have the same number of characters. For example, if two files with names TWIN.PAT and

TW.PAT are on disk, it is probable that the disk will find the TWIN.PAT file when it was asked to find the TW.PAT file. This is a limitation in the disk operating system and cannot be remedied by Robo-Con software.

The controller must accept programs generated by one of the following methods:

1. Manual program entry from the keyboard.
2. Program digitization, where the axes are manually moved around the pattern by jogging and critical points of the pattern are entered. This mode of program generation is also called Teach and Learn
3. Programs developed on a PC via a compatible CAD system and stored on disk.

Manual program entry is useful only for very short programs. Teach and Learn will create EIA compatible programs directly in controller memory. Refer to the section on program digitization in the S200 Product Manual for more details on program digitization.

Teach and Learn will generate programs in the absolute programming format to reduce errors due to backlash of the gear box. This is easily accomplished by referencing all axes coordinates to the pattern stop (grid zero) position during the teaching process. There must be some means of generating sew enable and disable program commands during Teach and Learn. This is easily accomplished by dedicating alphabetical keys to generate the appropriate sew enable and disable commands. The S key is dedicated to generating the sew enable command (M20); the N key is dedicated to generating the sew disable command (M21). The M functions to enable and disable the Constant Velocity mode do not have dedicated keys and must be entered manually.

When Teach and Learn is initiated, the controller defaults to the sew disable condition. When sewing is disabled, all motion commands digitized will be written as linear rapid travel (G00) commands. This means that commands to specify the mid point of an arc will be ignored in the sew disable condition. Once sewing is enabled via the S key command, all digitized moves will

be written as linear (G01) commands if an endpoint command is issued or as circular (G02, G03) commands if a mid point command, followed by another mid point or endpoint command is issued.

Whenever a G00 rapid travel command is taught, the endpoint of the rapid travel command is saved as a close point. This close point may be selected as an end point of a linear or circular move via dedicated commands. This allows the operator to 'close' a pattern back to its initial starting point exactly without having to retrace the initial start point. It is virtually impossible to retrace this start point at the exact coordinates at which it was first taught.

During Teach and Learn, all points are entered via single dedicated alphabetical keys of the HHT. The E key is used to enter end points for linear and circular blocks; the I key is used to enter mid points of circular blocks and the C key is used to define the end point of linear and circular block as the current close point coordinate.

Teach and Learn is terminated by pressing the ESC (End of Job) key at the terminal. The controller will automatically insert a M21 (Sew Disable) command followed by a G00X0Y0 command to return to the pattern stop position before generating the M02 end of program command. All taught programs must terminate in a sew enable condition.

During Teach and Learn, the current step number will be displayed at line 3 and the step number of the previous program block will be displayed at line 4.

For more details on program digitization, refer to the ABM Instructions on Program Generation.

Once program generation is completed, the part program is stored to disk under the specified file name (with the .PAT extension added) and is also made the current active program. If the program already exists, the operator will be prompted with the following message:

```
FILE EXISTS  
REWRITE? (Y/N)
```

If the operator responds with Y, the new file will replace the existing file; if the response is N, the operator will be reprompted for entry of the file name before the part program is stored on disk.

Programs generated on a host PC and stored on disk must be generated in the EIA format. The Quick Cam system with G code compiler is an acceptable CAD package. Any CAD package can be used as long as it generates EIA compatible programs.

The following are the specifications of the controller when setting up the CAD system:

End of Block Character:	Carriage return
End of Text Character:	ASCII 03H
End of Program Function:	M2
End Point Coordinates:	absolute
Center Point Coordinates:	absolute

In addition, there may be other parameters that need to be properly set up. This will become clearer as more information on the CAD systems becomes available.

All programs generated by a host PC must include step numbers (N) for all program steps. The controller will ignore all characters in a part program file until the program step command (N) is received.

All programs generated on a host PC and stored on disk must have file names ending with the .PAT extension. The Robo-Con recognized only those files containing the .PAT extension as EIA part program files.

6.15 Download of Part Programs from Disk

When programs are downloaded to the controller from disk during the initial boot up or after program activation, the controller will automatically insert the M20 and M21 sew enable and disable commands based on the presence of G0 rapid travel moves which are always executed with sewing disabled, provided that the M20 and M21 commands are not present in the part program. The following are the rules that the controller follows when inserting an M20 or an M21 command to insure that all rapid travel moves are executed with sewing disabled.

1. If the current line being downloaded contains a G00 rapid travel command, an M21 sew disable command is inserted as a separate line before the line containing the G00 move, provided that an M21 command does not already precede the G00 command. The exception is the first G00 move of the part program.
2. If the previous line downloaded contains a G00 rapid travel move, an M20 sew enable command is inserted as a separate line between the line containing the G00 command and the current line being downloaded provided that an M20 command does not already precede the G00 command.
3. The controller will insert an M21 command followed by a G0X0Y0 command to return to the pattern stop position whenever an M02 end of program command is encountered provided that these commands do not already directly precede the M02 command. All programs generated at the host PC should always terminate in a sew enable condition.

Since the M20 and M21 commands are inserted as separate lines, the step number used for these commands is the step number of the line preceding the inserted command minus 1. This requires that the CAD system generates step numbers with an autoincrement of more than one so that the decremented step number of the inserted line still represents a unique step number.

The Robo-Con automatically inserts the ETX (End Of Text) character after the M02 (End Of Program) function. All part programs downloaded to the Robo-Con must be terminated by the M02 command.

7.0 COMMUNICATIONS DETAILS

The ABM systems will be provided with three RS-232 ports, one for communication with the rack mount display and keyboard, one for communication with an optional Hitachi or compatible digitizer tablet, and one port, referred as the DNC port interfaced to the Christie disk drive.

7.1 RS-232-C Specification

The rack mount display/keyboard serial port

configuration is shown below:

Baud Rate	9600
Stop Bits	two
Start Bits	one
Data Bits	seven
Parity	none

The rack mount display/keyboard must be interfaced to J9 of the Robo-Con board.

The disk serial port configuration is shown below:

Baud Rate	2400
Stop Bits	one
Start Bits	one
Data Bits	eight
Parity	none

Tx, Rx and ground lines will be supported. XON and XOFF will be supported only by the DNC serial port. No communications protocol other than a straight ASCII dump to the DNC port will be supported.

The disk port must be interfaced to J12 of the Robo-Con board.

8.0 INPUT/OUTPUT PORT DETAILS

The standard 16 input/8 output I/O daughter board will be used in the ABM system. The 16 input ports are numbered 1-16 and the 8 output ports are numbered 1-8.

The following is a list of the input ports and their functions.

Input Port	Function
1	Thread break sensor
2	Spare
3	Spare
4	Spare
5	Spare
6	Spare
7	Spare

8	Spare
9	Spare
10	Frame Lock proximity sensor
11	Spare
12	Spare
13	Spare
14	Spare
15	Spare
16	Spare

All inputs must be at a low (on) state normally and in the high (off) state when activated. All inputs are optically isolated. The needle up and thread trim sensor are passed through an adjustable software filter to differentiate between bounce and actual switch closure.

The following is a list of the output ports and their function.

Output Port	Function
1	Spare
2	Sew Motor Enable
3	Thread Trim solenoid
4	Fault Indicator
5	Autotable solenoid
6	Thread Lock solenoid
7	Oil Injection solenoid
8	Bobbin indicator

The solenoid outputs will be normally high (off) and will be low (on) to activate the solenoids. All outputs are optically isolated.

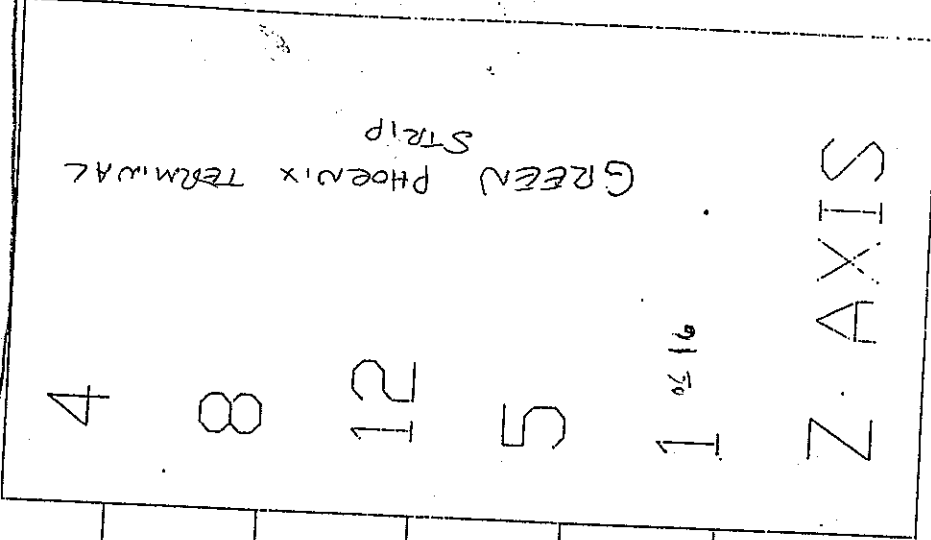
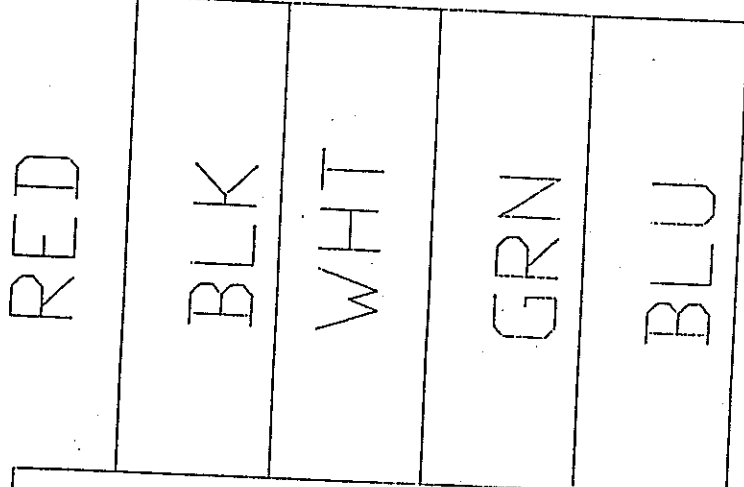
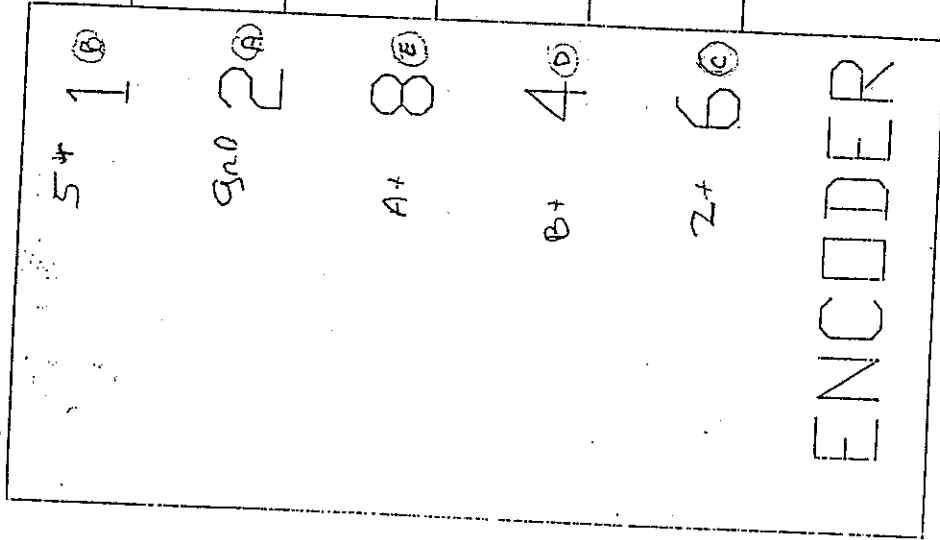
.

LED Indication (7-segment) for Troubleshooting

LED Indication for Troubleshooting

LED	Detection	Lighting Condition	Probable Cause	Corrective Action
1.	Over-current	Goes on when power is supplied to the control circuit.	• Defective control circuit board (1 PWB).	• Replace the Servopack.
		Goes on when power is supplied to the main circuit and servo power is turned on. • MCCB does not trip.	• Defective current feedback circuit • Defective main circuit transistor module.	• Insert the 3CN connector firmly. • Replace the Servopack.
		Goes on when power is supplied to the main circuit and servo power is turned on. • MCCB trips.	• Defective motor grounding • Defective main circuit transistor module.	• Replace the motor. • Replace the Servopack.
		Goes on when power is supplied to the main circuit.	• Defective main circuit transistor module.	• Replace the Servopack.
		Goes on when the motor is running.	• Faulty internal elements. • Defective internal elements.	• Replace the Servopack.
2.	Circuit protector tripped	Goes on when power is supplied to the control circuit.	• Defective control circuit board (1 PWB).	• Replace the Servopack.
		Goes on when power is supplied to the main circuit.	• Defective main circuit thyristor-diode module. • MCCB trips.	• Replace the Servopack. • Check if there is disconnection in the wiring leads in Servopack. • Check the conduction state on connecting parts.
3.	Regenerative trouble	Goes on when power is supplied to the control circuit.	• Defective control circuit board (1 PWB).	• Replace the Servopack.
		Goes on approximate 0.5 to 1 second after power is supplied to the main circuit.	• Defective regenerative transistor. • Regenerative resistor disconnection.	• Replace the Servopack. • Check and replace the regenerative resistor. (Replace the Servopack.)
4.	Over-voltage	Goes on when the motor starts or slows down.	• Load inertia (GD ²) too large. • Defective regenerative circuit.	• Check the inertia of the machine with the value converted to the motor shaft. • Replace the Servopack.
5.	Over-speed	When the reference is input, the motor runs fast and 5. goes on.	• Motor connection error. • Optical encoder connection error. • The reference input voltage too large.	• Correct the motor connection. • Check and correct pulses in phase A, B, C, U, V and W with 2CN. • Decrease the reference input voltage.
6.	Voltage drop	Goes on when power is supplied to the main circuit.	• Defective main circuit thyristor-diode module.	• Replace the Servopack.
7.	Overload	Goes on when power is supplied to the control circuit.	• Defective control circuit board (1 PWB).	• Replace the Servopack.
		Goes on during operation. • When power to the control circuit is turned off and then turned on again, the operation starts.	• Operation with 105% to 130% or more of the rated load.	• Check and correct the load (may be overload).
		The motor rotates, but the torque is unavailable. When power to the control circuit is turned off and then turned on again, the operation starts, but the torque is still unavailable.	• Motor circuit error connection, such as U→V, V→W, W→U or single-phase connection.	• Correct the connection.
b.	A/D error	Goes on when power is supplied to the control circuit.	• Defective control circuit board (1PWB).	• Replace the Servopack.
-	CPU error	Goes on during operation.	• Faulty internal elements. • Defective internal elements.	• Resume after reset operation. • Replace the Servopack.
c.	Overrun prevention	Goes on when power is supplied to the control circuit.	• Defective control circuit board (1 PWB).	• Replace the Servopack.
		The motor starts momentarily, then c. goes on.	• Motor connection error. • Optical encoder connection error.	• Correct the motor connection. • Check and correct pulses in phases A, B, C, U, V and W with 2CN.

LETTERS INDICATE
 NEW ENCODERS
 BUT DIFFERENT
 BANDS MAY BE
 DIFFERENT CHECK
 DOUBLE



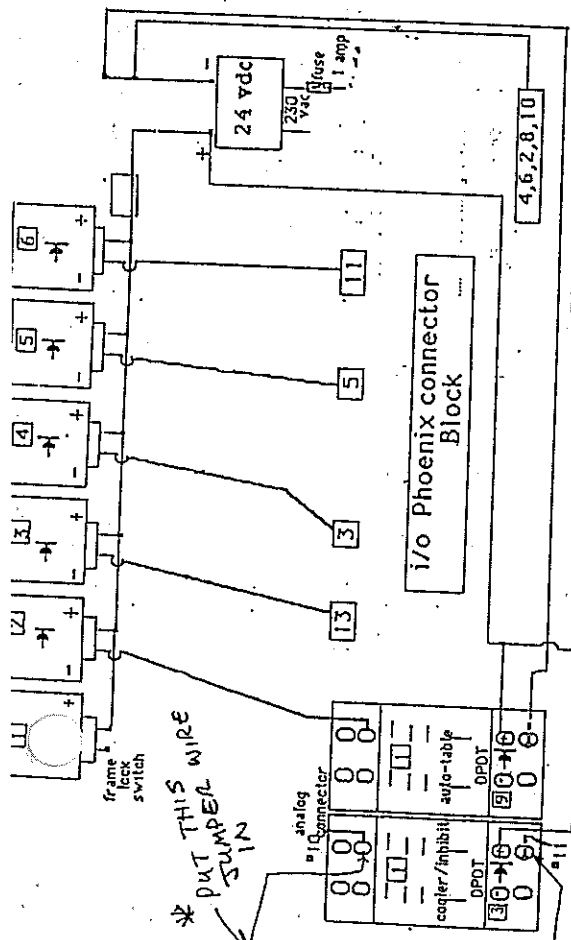
NOTE:
 SHORT TO
 RED + TO
 1 - OR 16 TO
 SIMULATE MARKER PULSE

CORRECT WIRING DIAGRAM FOR ENCODER

RELAY #1 IS USED TO INHIBIT THE ADVANCED MOTION SERVO.

WHEN THE RELAY IS ON THE RED LITE ON THE SERVO SHOULD BE ON THE JUMPER WILL TIE THE #11 PIN ON THE ADVANCED MOTION SERVO TO THE SIGNAL GROUND WHICH MUST LOCK THE RED LITE ON

IF IT DOES - THE RELAY IS BAD IF IT DOESN'T, THEN CHECK THE WIRE GOING TO #10 ON THE 26 PIN ANALOG - GREEN - TERMINAL STRIP OR CHECK THE WIRE #11 GOING TO THE ADVANCED MOTION SERVO



Diagnostics

OUTPUT PORT #	FUNCTION
1	Pattern active LED
2	Needle cooler valve
3	Tread trim actuator
4	System fault LED
5	Automatic table relay
6	Thread lock cylinder
7	Oiler pump
8	Bobbin Low Warning Lite

input port #	FUNCTION
1	Thread break sensor
2	not used
3	Needle up sensor
4	Thread trim position sensor
5	Home push button
6	Restart push button
7	Start push button
8	Stop push button
9	Sewing disable toggle switch
10	Frame lock position sensors

Replaceable chips I/O board

- U1: home, restart, start, stop
- U2: thread breaker, needle up, thread trim
- U4: not used as of 2/1/92.
- U6: sew disable override, frame lock switch
- outputs
- U7 ports #5-8
- U8 ports #1-4

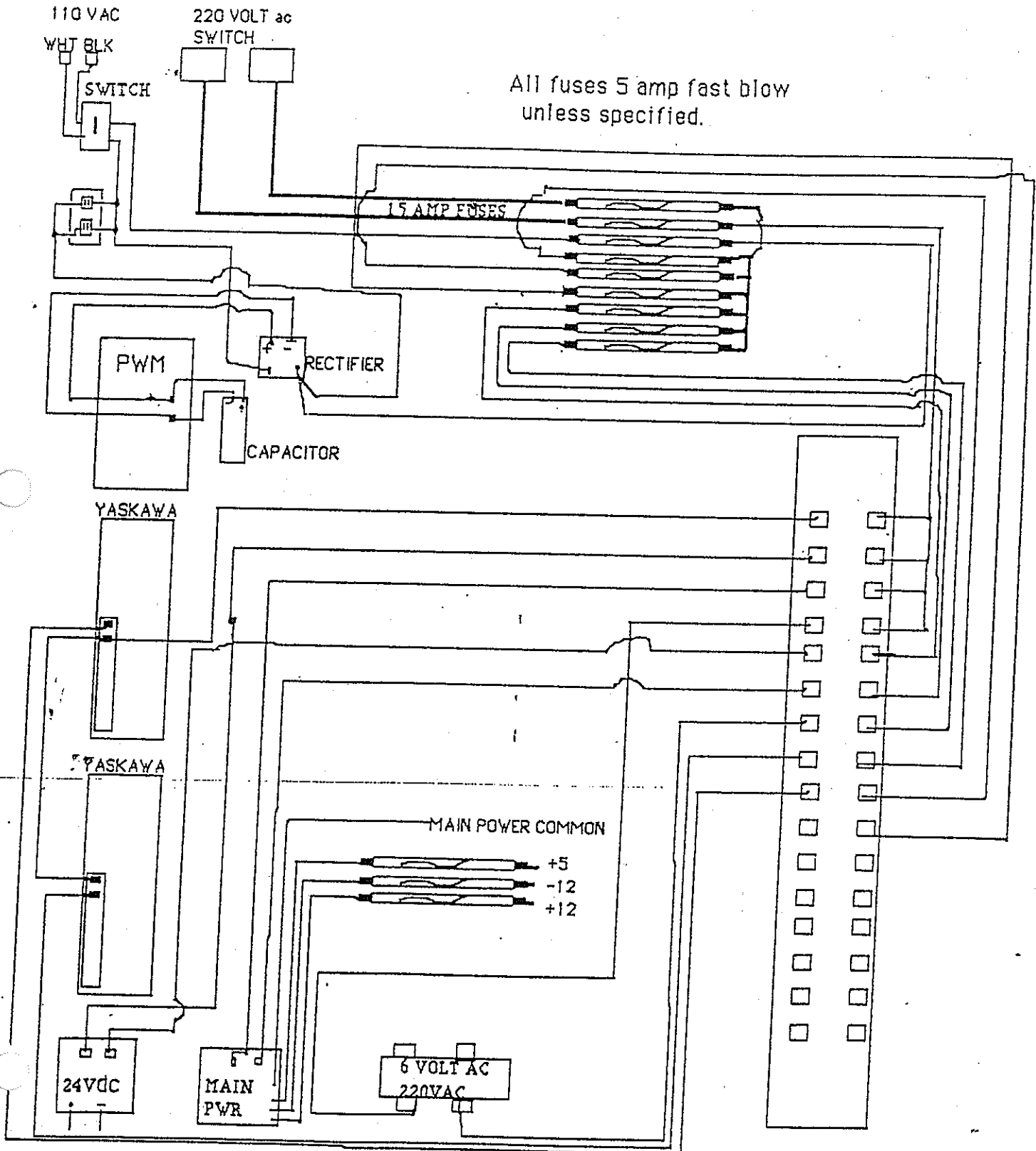
WITH JUMPER WIRE IN LIGHT SHOULD STAY RED IT DOES CHANGE RELAY MIKE

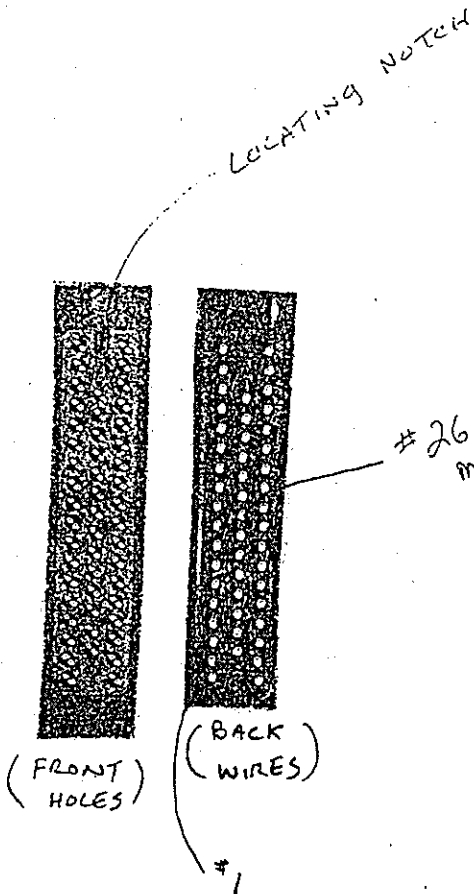
Relay Connections for CARRIERLESS CNC QUILTER

RLYCNC

TEST INFORMATION

220 volt wiring - XL-2000 Quilter





LARGE 1 CH
PLUG

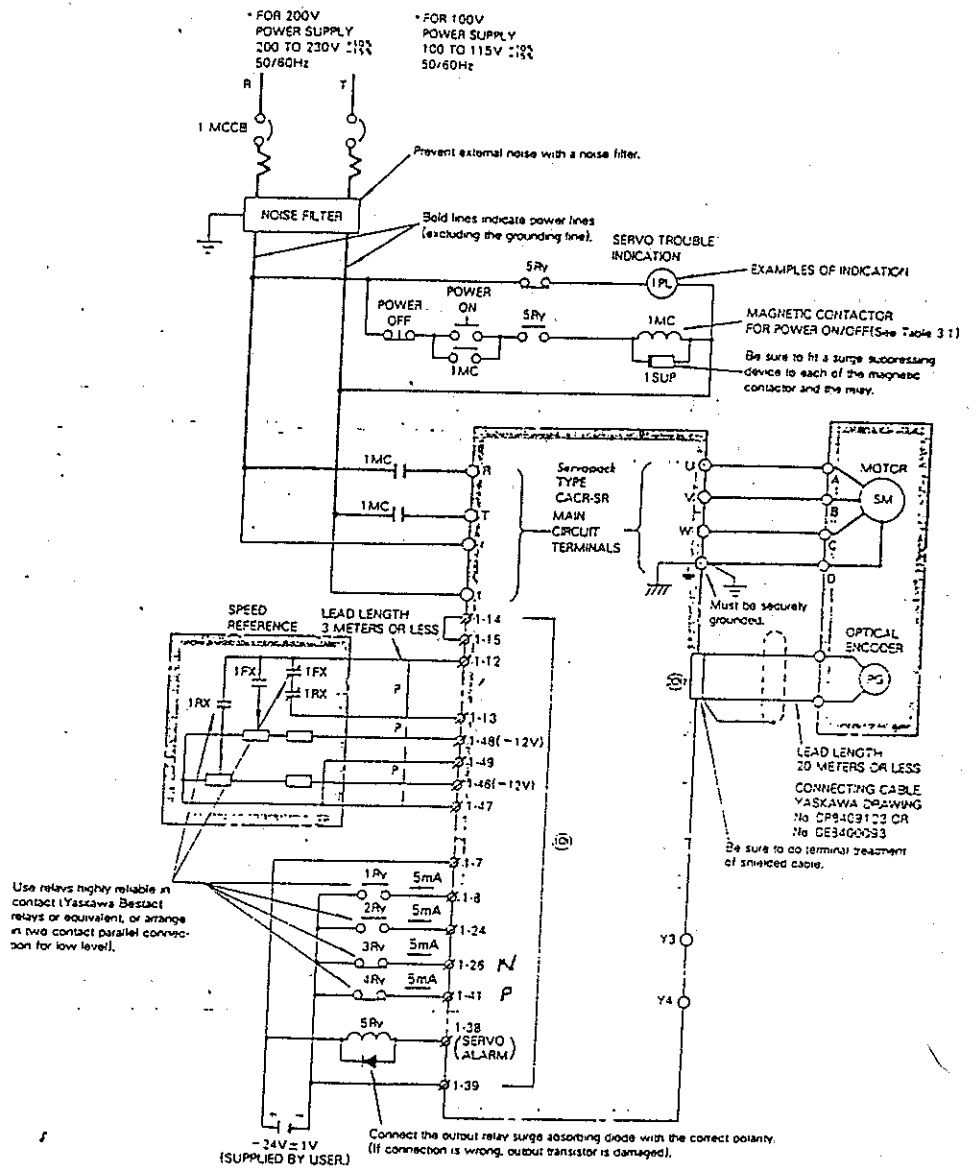
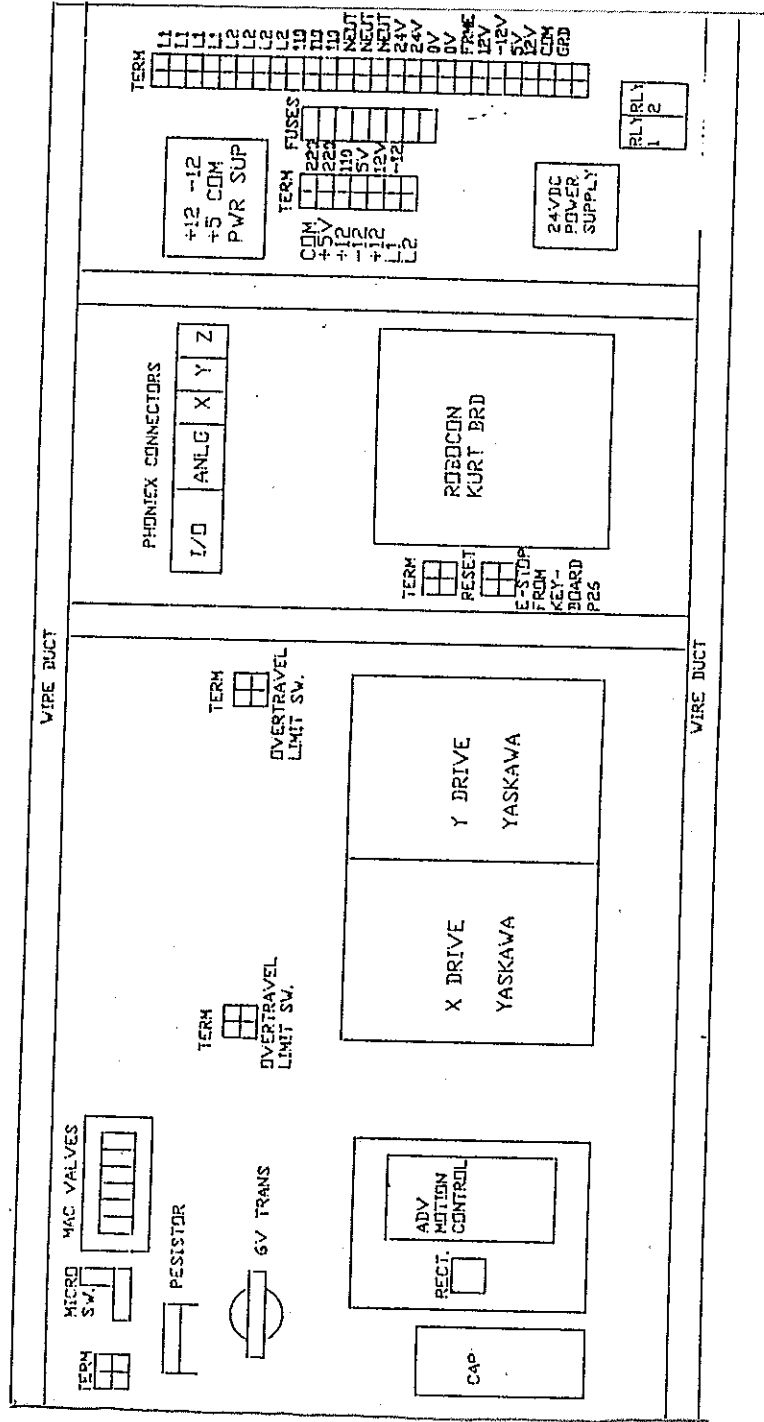
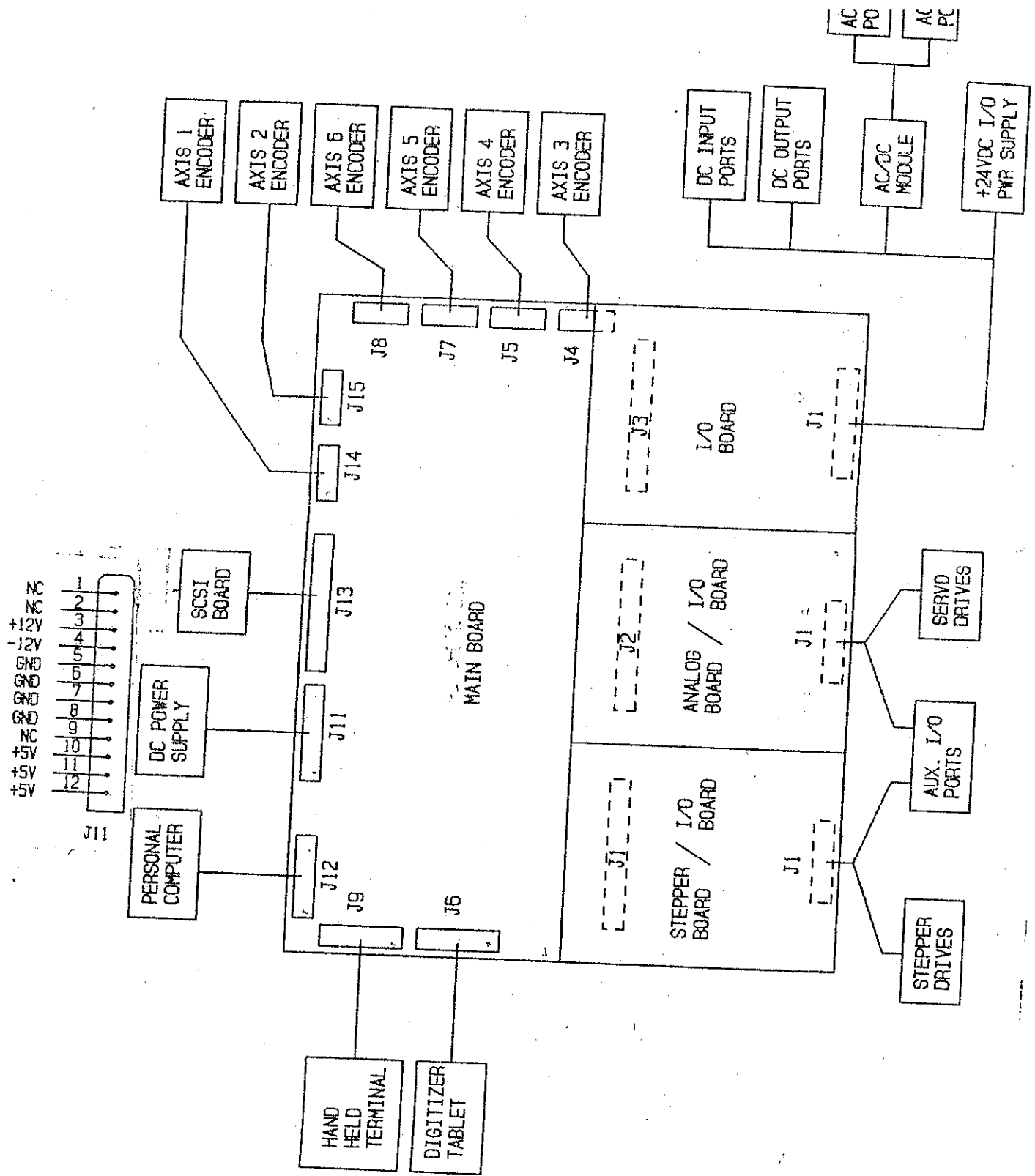


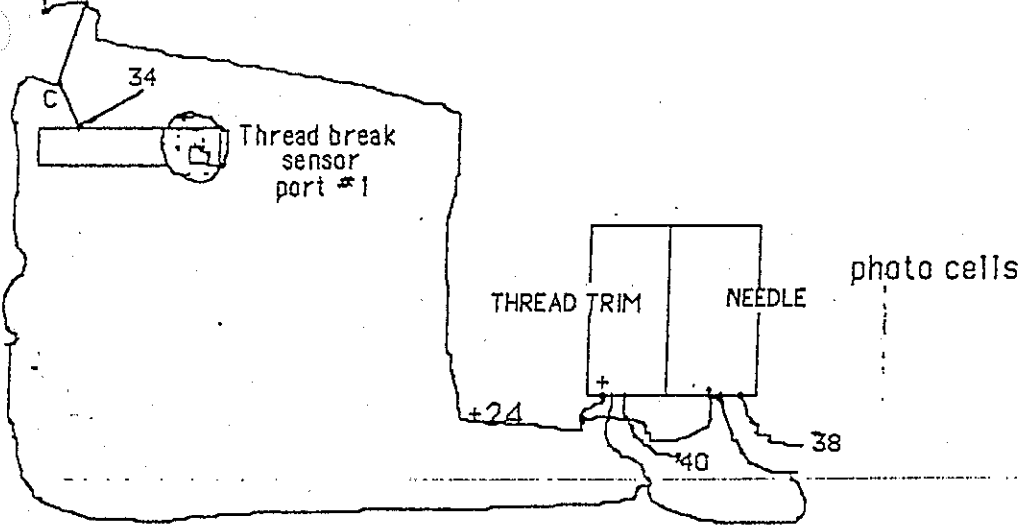
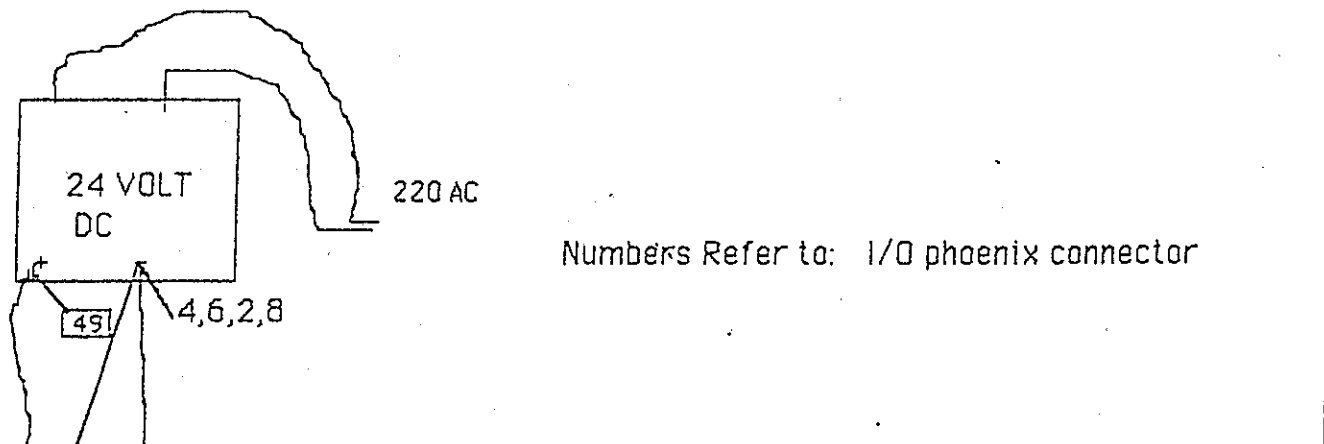
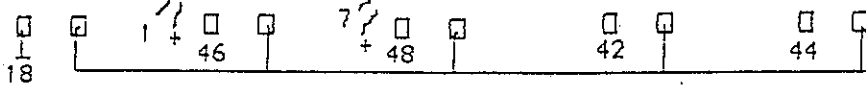
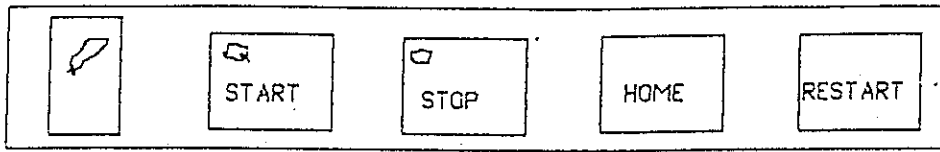
Fig. 5.1 Example of Connection Diagram of Servopack with a Servomotor and Peripherals



NOTE: ALL COMPONENTS MOUNTED WITH 10-32 MACHINE SCREWS
 ON 12GA. PANEL WITH WHITE POWDER COAT



Start-Stop Station Control



SEE INPUT/ OUTPUT
PORT DIAGRAM FOR ADDITIONAL
INFORMATION
ALSO Relay connections for
carrierless CNC quilter

INPUT / OUTPUT CONNECTIONS

50 PIN CONNECTOR ON ENCLOSURE



50 PIN CONNECTOR ON I/O CABLE

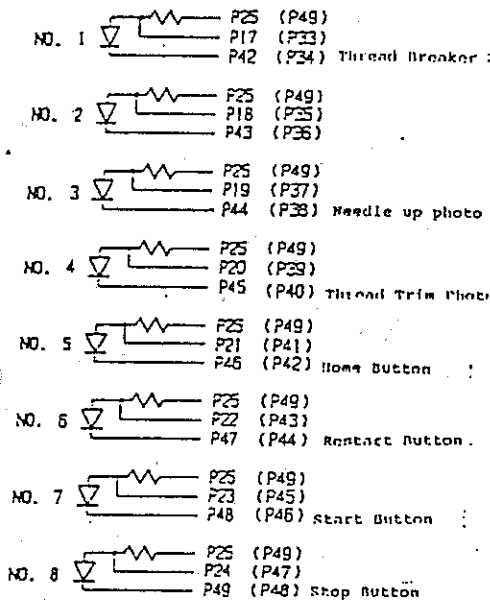


DIODE/TRANSISTOR IS A NEC PS2502-4 MULTICHANNEL PHOTO COUPLER
ABSOLUTE MAXIMUM RATINGS

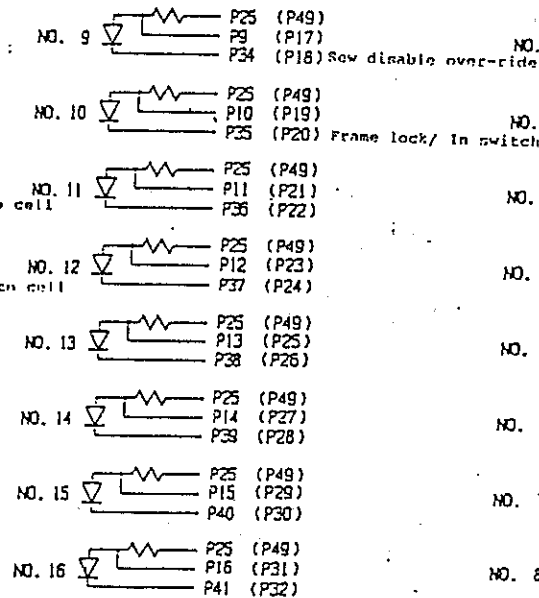
DIODE
FORWARD CURRENT 80mA

TRANSISTOR
COLLECTOR TO EMITTER VOLTAGE
COLLECTOR CURRENT 160mA

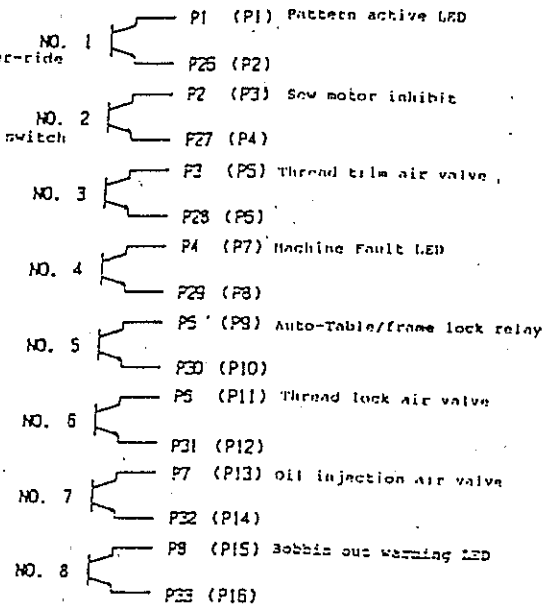
INPUT PORTS



INPUT PORTS



OUTPUT PORTS



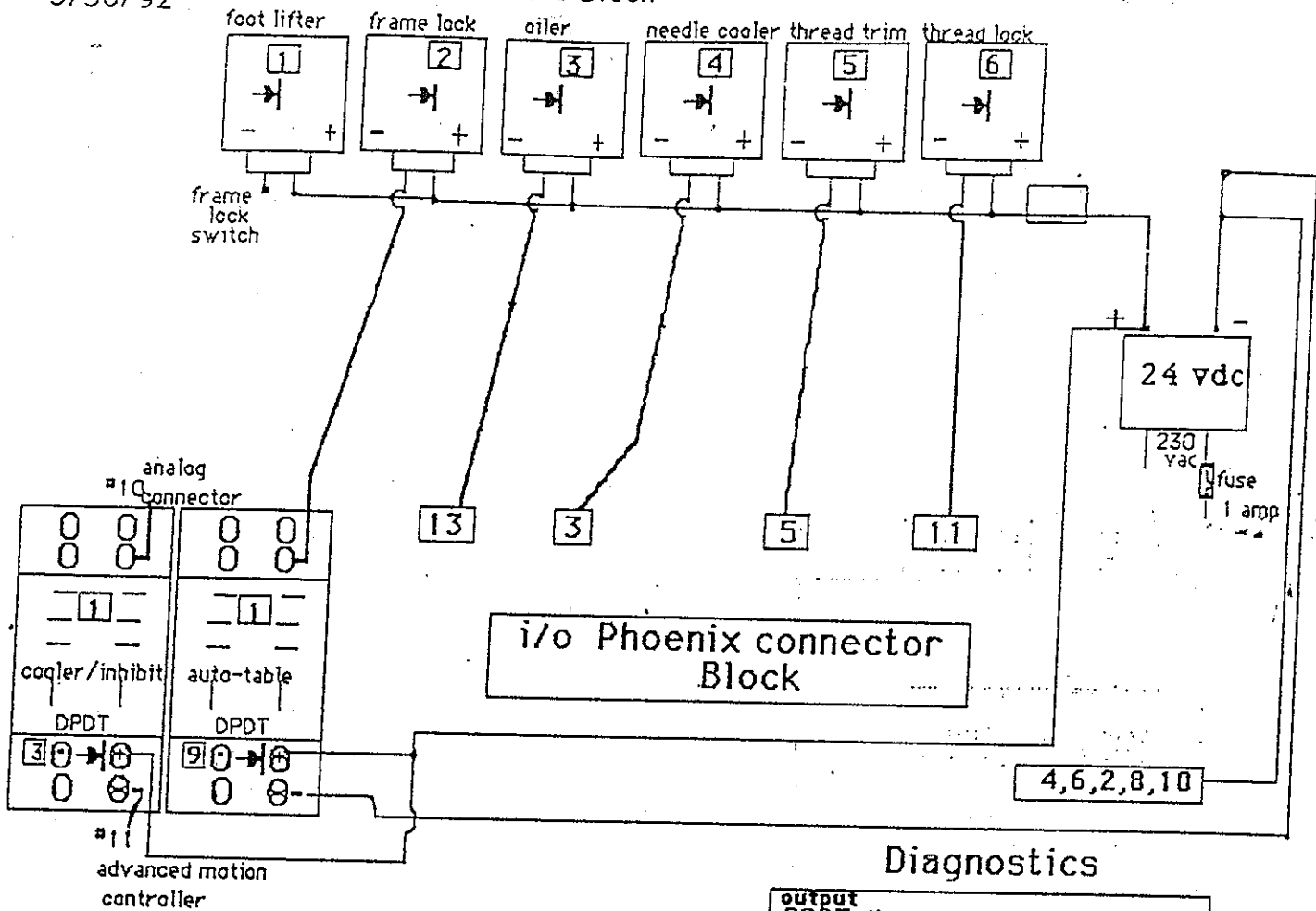
For further reference refer to START-STOP STATION CONTROL.

The number in parenthesis refers to the I/O green terminal strip connector number.

cnrlyb
3/30/92

201042-1135

Valve Block



Diagnostics

output PORT #	FUNCTION
1	Pattern active LED
2	Needle cooler valve
3	Tread trim actuator
4	System fault LED
5	Automatic table relay
6	Thread lock cylinder
7	Oiler pump
8	Bobbin Low Warning Lite

input port #	FUNCTION
1	Thread break sensor
2	not used
3	Needle up sensor
4	Thread trim position sensor
5	Home push button
6	Restart push button
7	Start push button
8	Stop push button
9	Sewing disable toggle switch
10	Frame lock position sensors

Replaceable chips I/O board

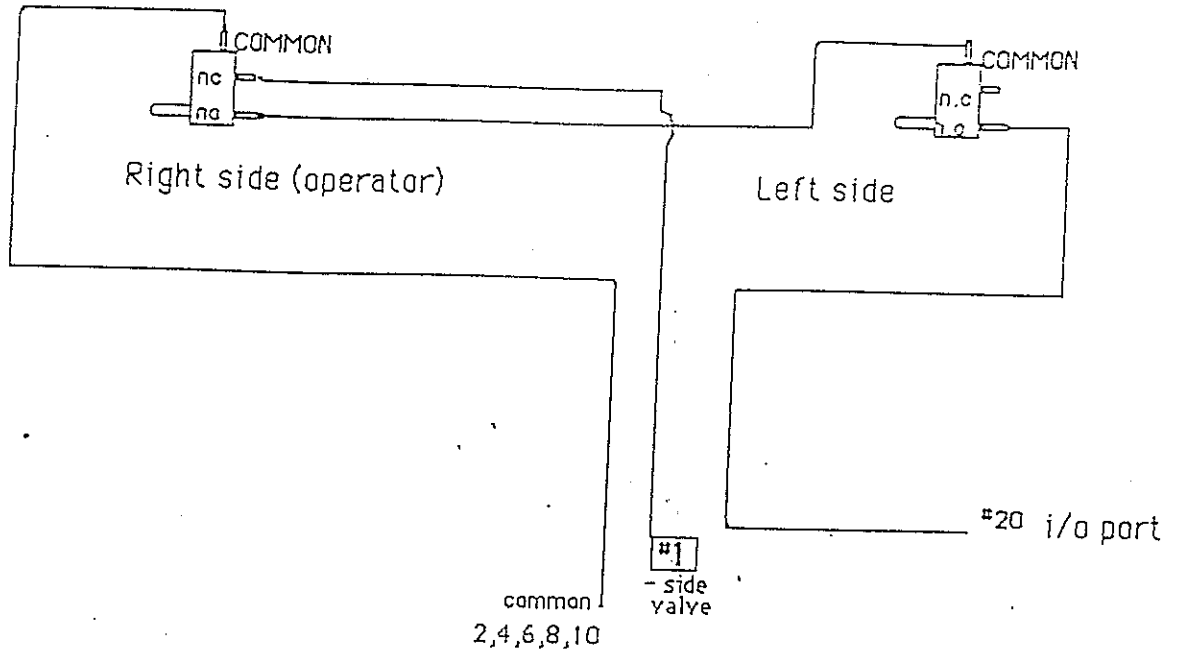
Inputs	
U1	home, restart, start, stop
U2	thread breaker, needle up, thread trim
U4	not used as of 2/1/92
U6	sew disable override, frame lock switch
outputs	
U7	ports #5-8
U8	ports # 1-4

2nd row

Relay Connections for CARRIERLESS C N C QUILTER

RLYCNC

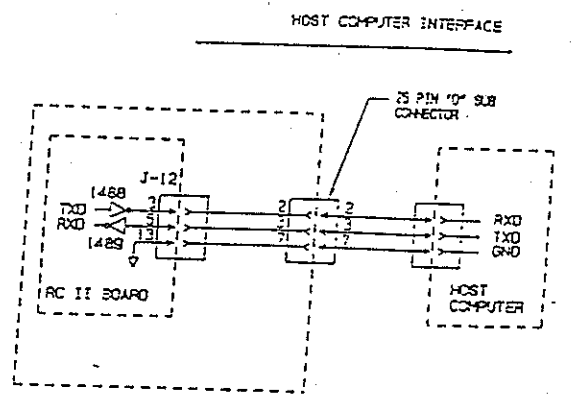
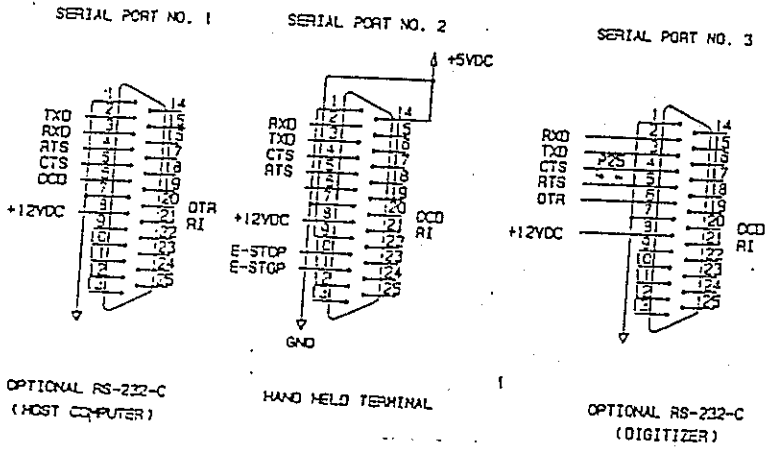
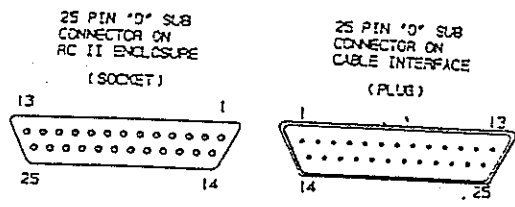
CNCframe
3/30/92



12/11/91

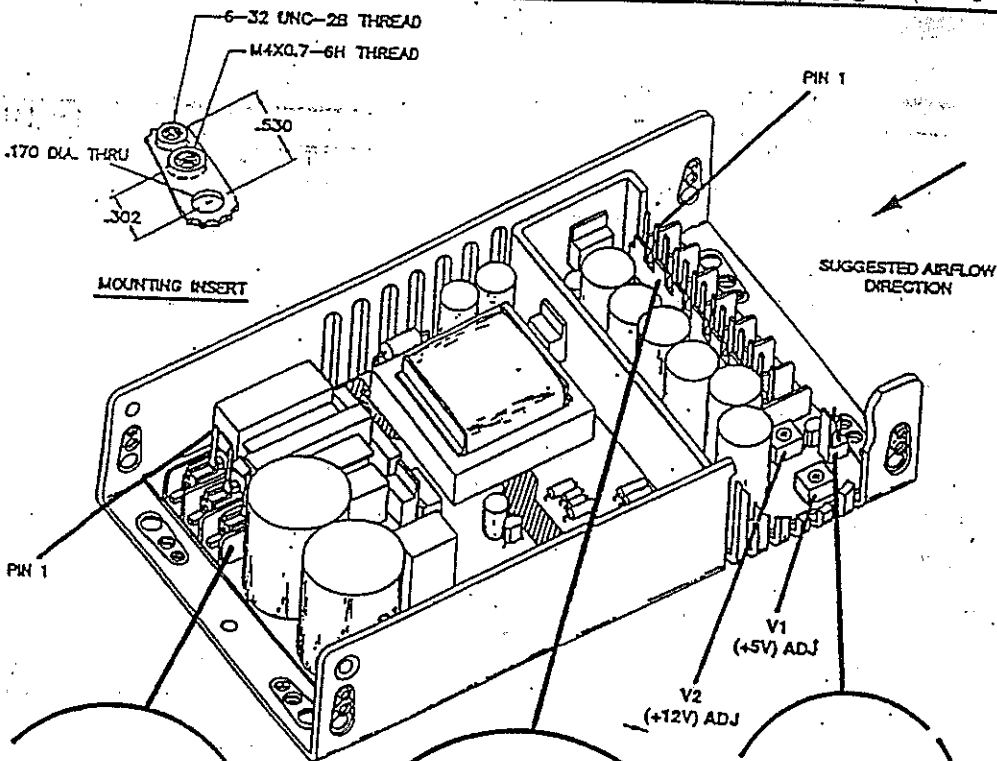
CNC Quilter FRAME LOCK CONNECTIONS

SERIAL PORT CONNECTIONS

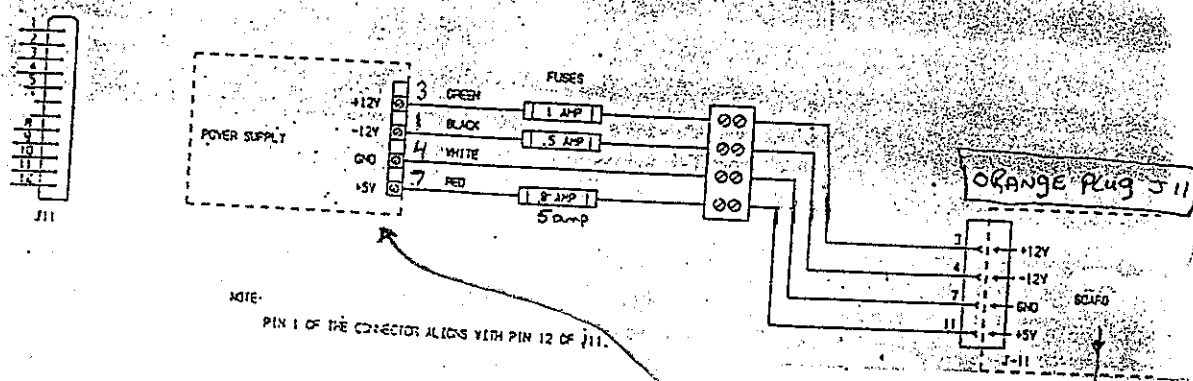
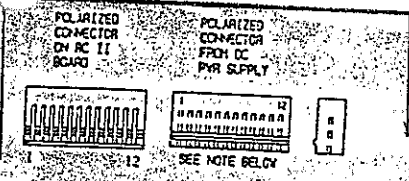
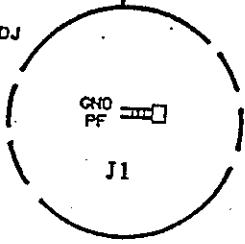
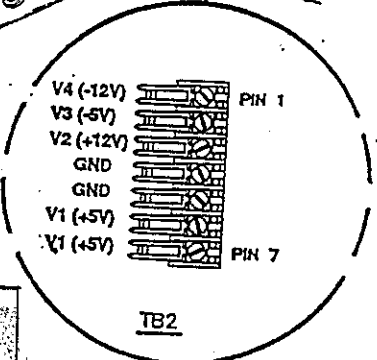
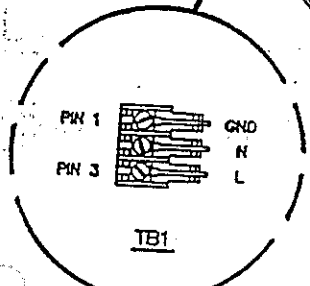


• TORQUE RANGE FOR CUSTOM MOUNTING INSERT IS 7.5-8.5 INCH LBS.

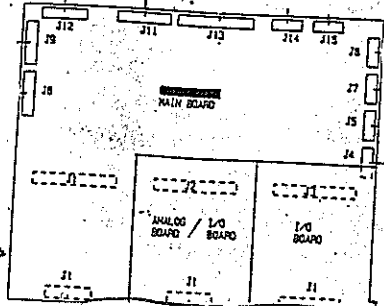
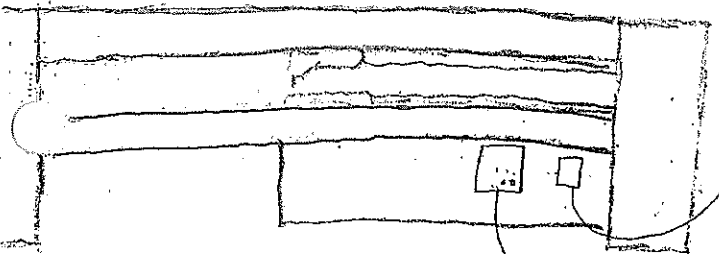
MAP 80-4000 c POWER ONE (845) 927-8741



CONNECT POWER AT TB1
CHASSIS GROUND AT PIN #1 TB1



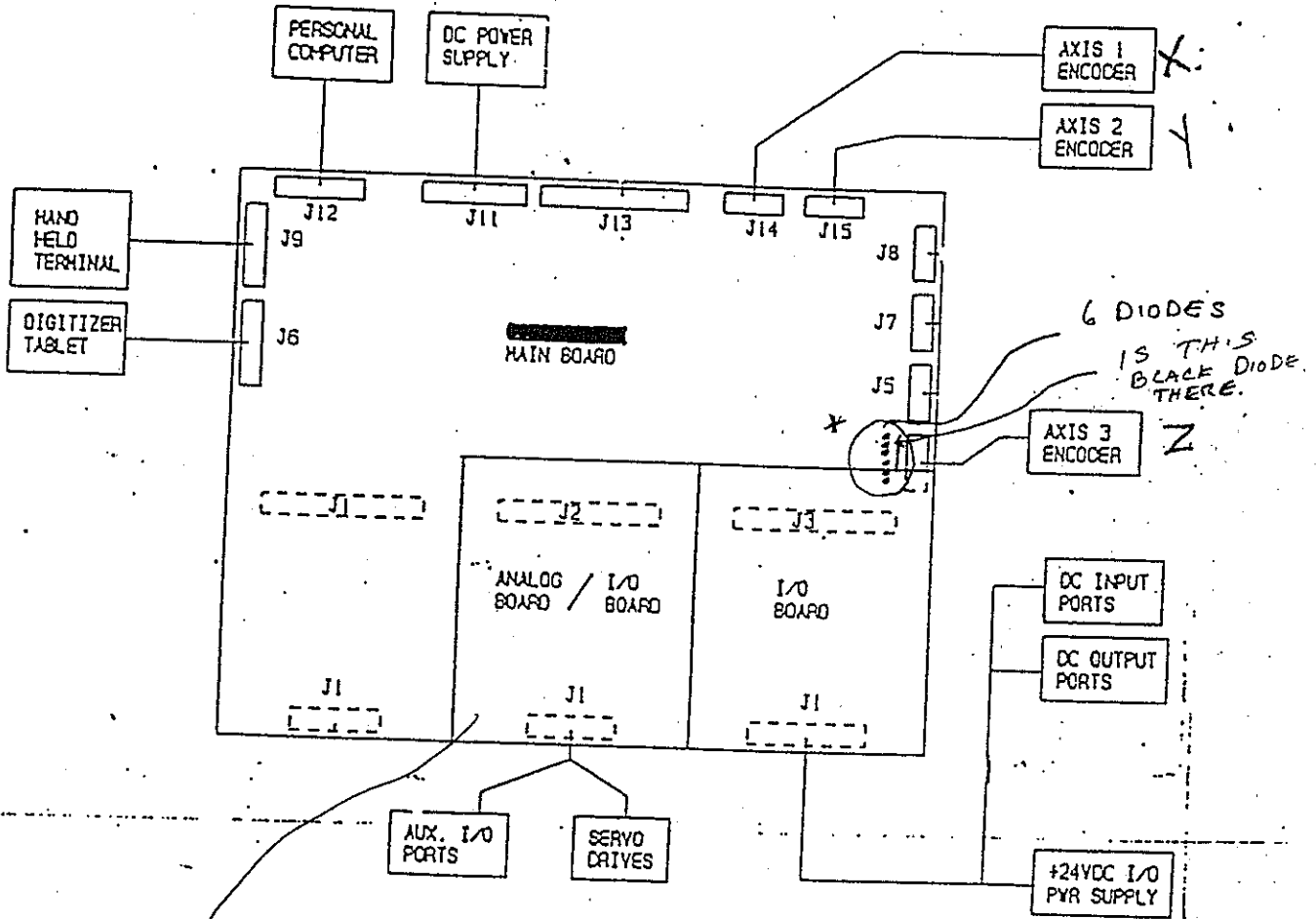
NOTE:
PIN 1 OF THE CONNECTOR ALIGNS WITH PIN 12 OF J11.



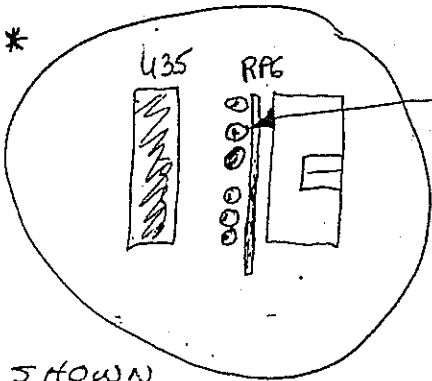
BLOCK DIAGRAM FOR CABLE HOOK-UP
TO MAIN CNC CONTROLLER BOARD

RODOLFO

BASED ON MY
LAST FAX I MAY WANT
TO KNOW ANSWER TO THIS
DIODE QUESTION
MIKE



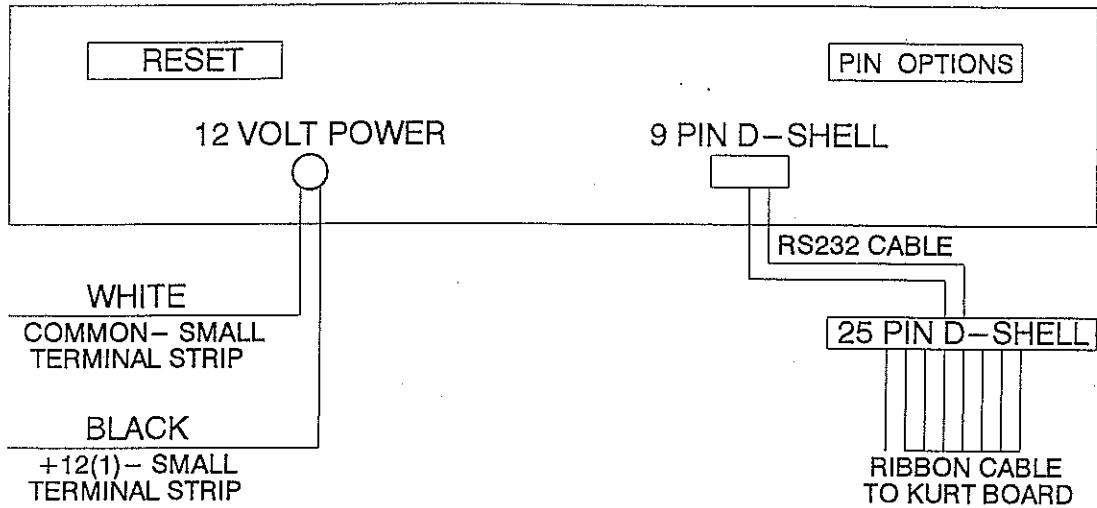
U14 SWITCH
1 & 2 ON 3 AXIS
1 OFF 2 ON 2 AXIS



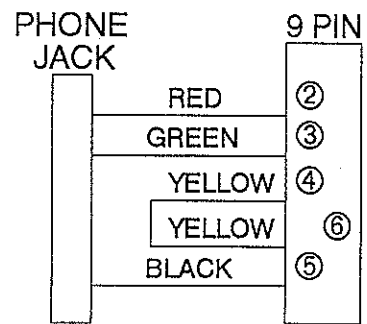
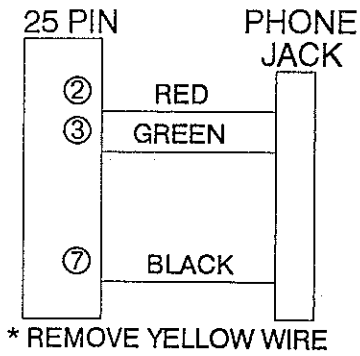
IS THIS BLACK DIODE ON CUSTOMERS BOARD.

DIODE SHOWN MAY INTERFERE WITH READING MARKER PULSE.

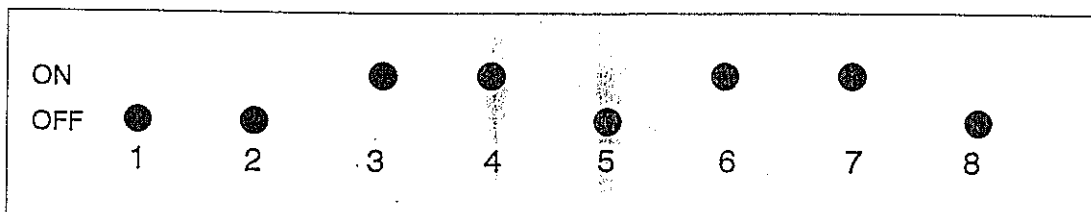
DISC DRIVE



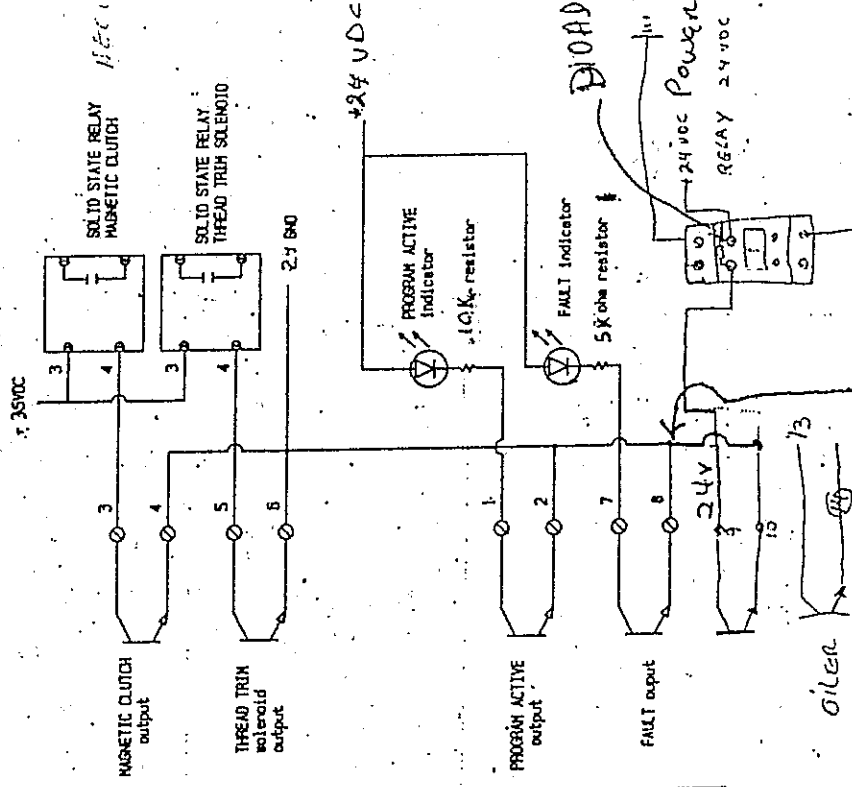
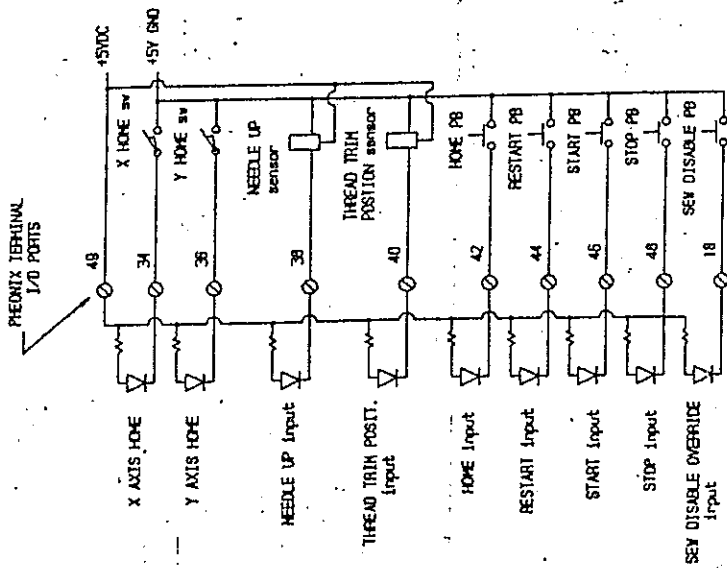
D-SHELL CONNECTIONS



OPTION SETTINGS



AUTO TABLE CONNECTION



DIOD IN 1001
 ATTACH TO BRIDGE OF
 24VDC

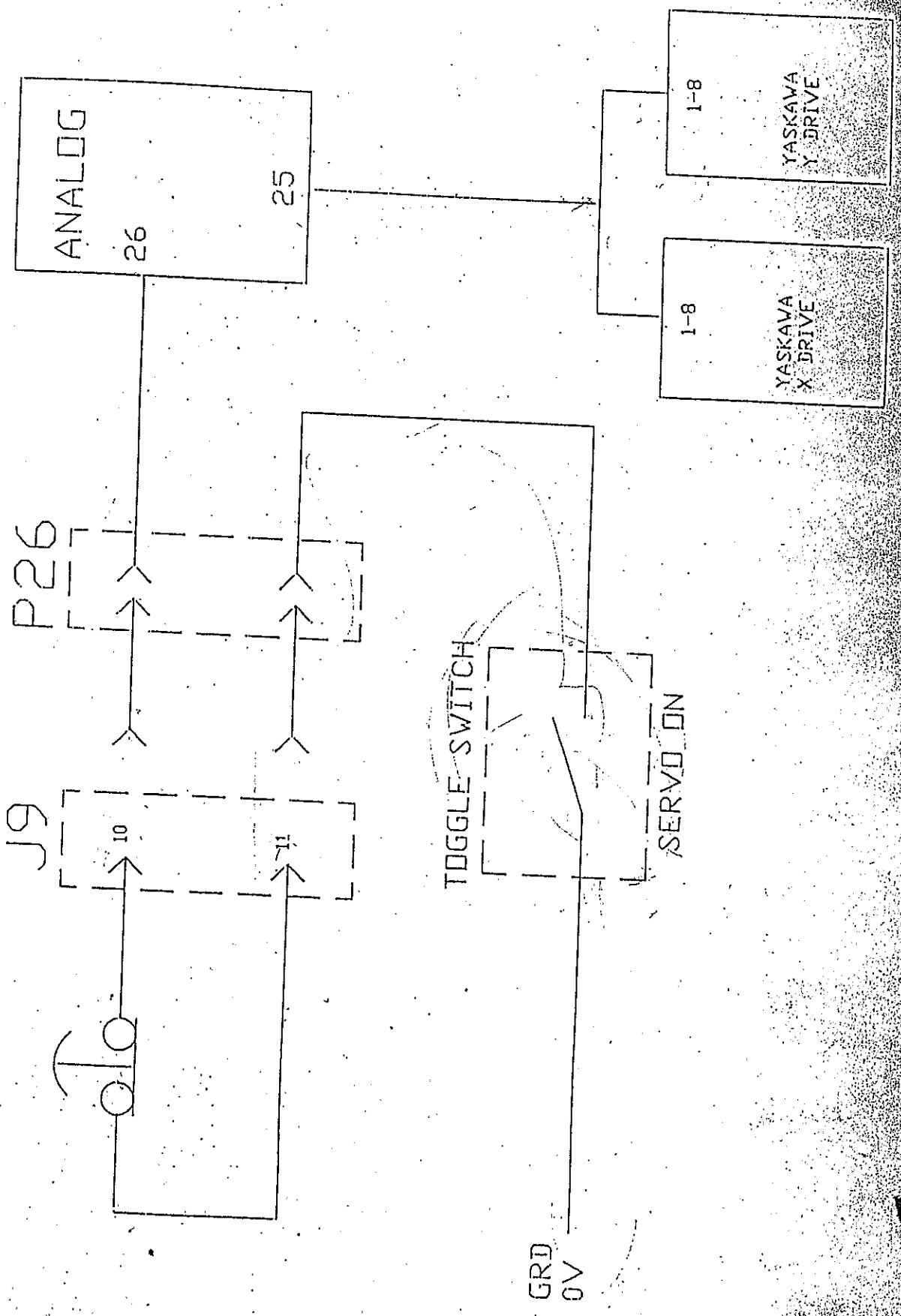
24VDC Power Supply
 RELAY 24VDC 40MA
 PART # 5

LOW VOLT COMMON #8 24VOLT
 SUMPER

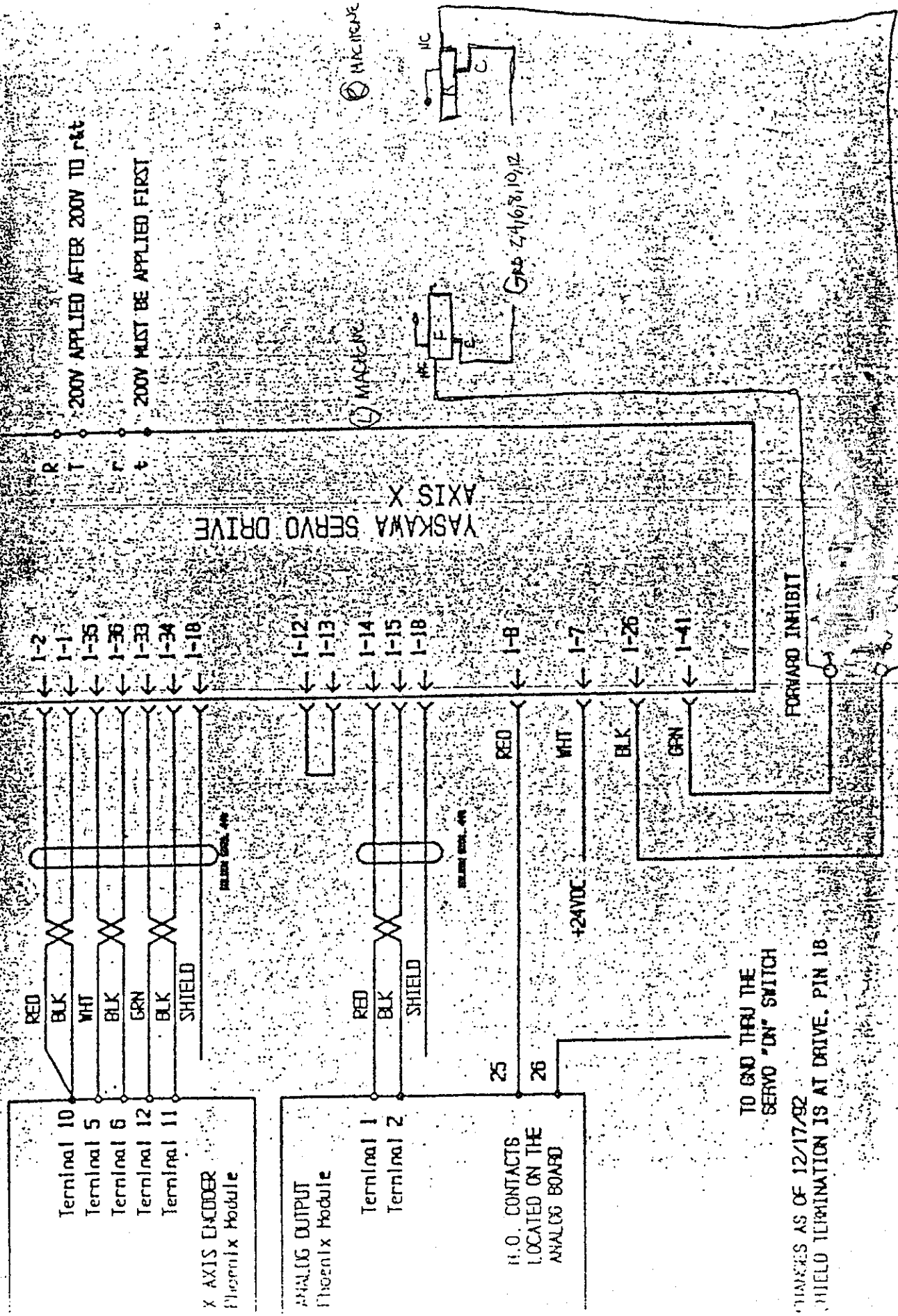
RECORD CONNECTION

TO BYPASS THIS CIRCUIT
CONNECT ANY GROUND 2,4,8,10

TO 26 IF YOU SUSPECT ROBB-COM FAILURE
#25



AXIS A CONNECTIONS



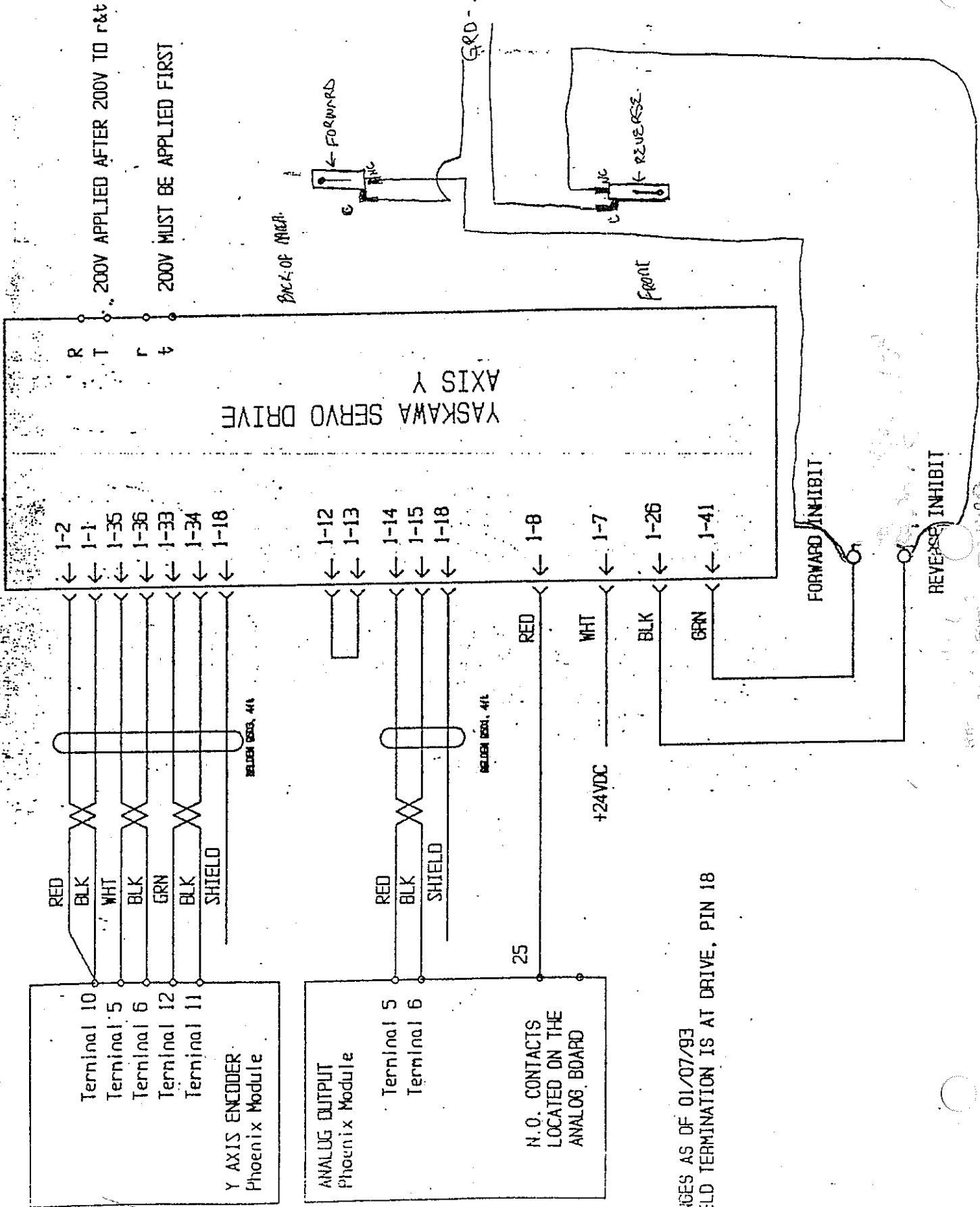
200V APPLIED AFTER 200V TO R&T
 200V MUST BE APPLIED FIRST

MACRO-ONE

MACRO-ONE

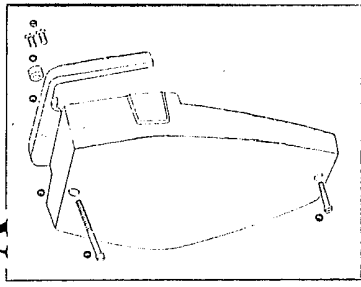
GRN 241681012

TO GND THRU THE
 SERVO "ON" SWITCH
 (CHECKS AS OF 12/17/92)
 SHIELD TERMINATION IS AT DRIVE. PIN 18



Sewing Head Upper Assembly

A, B, C, D, E, F, G



SECTION E

- (1) 5106099 Thread take-up clamping screw (hex head)
- (2) 5106306 Thread take-up fit alignment set screw (stented)
- (3) 010002 Main arm shaft (lower bearing)
- (4) 260001 Adaptor bushing for above bearing (not shown)
- (5) 080001 Flexible coupling for main arm shaft with 260001 and 010002 installed
- (6) 5106303 Main counter-weight shaft with 5106303-1 and 5106304
- (7) 5106303-1 Black counter-weight only

SECTION F

- (2) 516554 3-hole thread guide lock nut
- (3) 5163777 3-hole thread guide
- (30) 5443 Tension assembly locking set screw
- (31) 5140610 Access hole plug
- (32) 5106374 Tension assembly Rotary disc style
- (33) 5106374-1 Tension assembly Rotary disc style
- (34) 5106374-2 Rotary disc for 5106374
- (35) 5106374-3 Check spring for either tension assembly
- (36) 5106374-4 Tension assembly-Air Operated for XL quilters with thread cutter

SECTION G

- (5) 5106706 Timing pulley upper shaft 'S/S'
- (6) 5106303-3 Set screws for timing pulleys (upper or lower)
- (7) 5106305 Rubber timing belt
- (13) 5106307 Timing belt separator

SECTION A

- (1) 5140966 Upper face plate cover screw (long)
- (2) 5106399 Face plate cover complete with guard
- (3) 5106353 Face plate cover thread take-up lever guard
- (4) 5106354 Face plate cover screw spacer
- (5) 51131 Face plate cover lower screw (short)
- (6) 51227 Thread take-up lever guard attachment screws

SECTION B

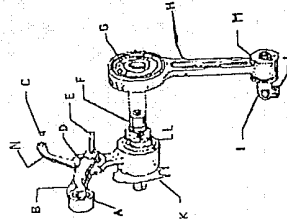
- (6) 5106202 Rear arm cover
- (5) 5127 Arm cover screws

SECTION C

- (1) 51350435 Pressure bar-pressure regulating screw with extended knob for bridge
- (11) 5106316 Pressure bar spring-long black
- (12) 5106394 Pressure bar spring-long pin
- (13) 5276023 Pressure bar friction ball
- (14) 5190 Slack thread regulator
- (15) 5106342 Slack thread regulator attachment screw
- (16) 5106335 Pressure bar position guide screw (5135)
- (17) 5138 Pressure bar position guide screw
- (18) 5276028 Pressure bar lifting lever bracket (optional only on manual quiltery)
- (19) 5139042 Pressure bar lifting lever screw (optional only on manual quiltery)
- (20) 5276117 Pressure bar lifter finger screw (optional only on manual quiltery)
- (21) 5276556 Pressure bar lifter finger (optional only on manual quiltery)
- (22) 5276541 Pressure bar with screw and ball
- (23) 5176 Pressure bar screw
- (24) 500039 Small pressure cup
- (25) 500070 Large pressure cup (option not shown)

SECTION D

- (1) 5435 Thread take-up lever link hinge stud set screw
- (5) 5106357 Thread take-up lever link hinge stud (fits on web)
- (6) 51065684 Thread take-up lever assembly complete individual parts.



- Part # 5106368A
- (A) Hinge stud bronze bushing #5106368A-1
 - (B) Side link #5106368A-2
 - (C) Thread eyelet #5106368A-3
 - (D) Take-up finger ball bearing #5106368A-4
 - (E) Side link support pin #5106368A-5
 - (F) Counter weight main stud #5106368A-6
 - (G) Main link ball bearing #5106368A-7
 - (H) Main link #5106368A-8
 - (I) Needle bar stud #5106368A-9
 - (J) Needle bar stud screw #5140705
 - (K) Main stud needle bearing #5106368A-10
 - (L) Main stud needle bearing #5106368A-11
 - (M) Needle bar stud needle bearing #5106368A-12
 - (N) Take-up Finger #5106368-12
 - (*) Kit containing plastic thrust washers, all plug, snap ring

- (7) 5106397 Upper oil felt
- (8) 5106335 Upper needle bar bushing (older quilters only) NO oil groove
- (9) 5106325-1 Upper needle bar bushing (All XL quilters and newer manual quilters) Oil groove
- (10) 200030 Lower oil felt
- (11) 510642-1 Lower needle bar bushing (all quilting machines) with retaining ring
- (12) 510642-2 Retaining ring can be used for both upper and lower bushings
- (13) 59923 Lower needle bar bushing wire thread guide
- (14) 200032 Needle bar with screw
- (15) 200032-1 Needle bar set screw
- (16) 200032-2 Needles (please check with the factory for application recommendation)
- (17) 5106316 Thread eyelet and guide
- (18) 5106316 Thread eyelet and guide
- (19) 5106316-1 Thread eyelet attachment screw

Sewing Head Lower Assembly

- (1) 200055 Bobbin case L style
- (2) 200055-1 Bobbin case - large capacity M style
- (3) 200050-1 Screw for bobbin case holder finger
- (4) 200050 Bobbin case holder finger
- (5) 200045 Hook-plain chrome L style
- (6) 200045-1 Hook-black teflon coated basket L style
- (7) 200045-2 Hook-large capacity-M style
- (8) 3272229 Hook pump-complete
- (9) 200046 Hook pump holding set screw
- (10) 200041 Ring gear - inside oil reservoir drives hook pump
- (11) 200043 Gasket for oil reservoir
- (12) 5276246 Oil reservoir cover
- (13) 5276246 Set screw to hold ring gear drive shaft bushing in oil reser.
- (14) 3276244 Reservoir oil drain plug
- (15) 200040 Ring gear drive shaft
- (16) 010001 Ring gear drive shaft rear bearing
- (17) 5114063 Lower timing pulley set screws



THE STANDARD BY WHICH OTHERS ARE JUDGED

ABM INTERNATIONAL, INC.