Cee© Model 100
& Model 150

Service Manual

Cost Effective Equipment
a Division of Brewer Science, Inc.
4000 Enterprise Drive
Rolla, Missouri U.S.A. 65401

Telephone: (573) 364-0300
Facsimile: (573) 364-9513
E-Mail: ceecustserv@brewerscience.com
Web Address: http://www.brewerscience.com

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Cee© Equipment Warranty

Cee Model 100 and 150

Brewer Science, Inc. - Cost Effective Equipment Division (Cee©) warrants to the original purchaser (Buyer) that equipment is free from defects in material and workmanship under normal use and service in accordance with Cee instructions and specifications.

Buyer shall promptly notify Cee of any claim against this warranty, and any item to be returned to Cee shall be sent with transportation charges prepaid by Buyer, clearly marked with a Return Material Authorization(RMA)number obtained from Cee Customer Support.

Cee's obligation under this warranty is limited to the repair or replacement, at Cee option, of any equipment, component or part which is determined by Cee to be defective in material or workmanship. This obligation shall expire one (1) year after the initial shipment of the equipment from Cee.

This warranty shall be void if:

(a) Any failure is due to the misuse, neglect, improper installation of, or accident to the Equipment.

(b) Any major repairs or alterations are made to equipment by anyone other than a duly authorized representative of Cee. Representatives of Buyer will be authorized to make repairs to equipment without voiding warranty, on completion of the Cee training program.

(c) Replacement parts are used other than those made or recommended by Cee.

CEE MAKES NO OTHER WARRANTIES, EXPRESSED OR IMPLIED, WITH RESPECT TO EQUIPMENT. NO WARRANTY IS MADE AS TO THE MERCHANTABILITY OF THE EQUIPMENT NOR TO ITS FITNESS FOR ANY PARTICULAR PURPOSE. In no event shall Cee be liable for consequential loss or damages, however caused. No person or representative of Cee is authorized to assume for Cee any liability in connection with Equipment nor to make any change to this warranty unless such change or modification is put in writing and approved by an authorized representative of Cee in writing.

This warranty shall be governed by the laws of the state of Missouri U.S.A.

RETURNED MATERIALS

Any materials, parts, or equipment, returned to Brewer Science, Inc. - Cee Division must be clearly labeled with a Return Material Authorization (RMA) number.

To obtain an RMA number, contact:

Cee Customer Support
Telephone: (573) 364-0300
Facsimile: (573) 364-9513
E-Mail: ceecustserv@brewerscience.com
Web Address: http://www.brewerscience.com

Shipping information with RMA number:

Attn: Cee Customer Support
Cost Effective Equipment
4000 Enterprise Drive
Rolla, MO 65401

Theory of Operation

Introduction

The Cee Model 100 and 150 spinner module incorporates a stainless steel spin bowl. The spin bowl drain and exhaust connect, through Teflon (PTFE) tubing, to the main utilities bracket on the rear of the machine. The main drive spindle for the spin chuck is made of hardened, corrosion-resistant, alloy steel. The spindle is driven by a toothed belt and a servo motor. An integral optical encoder provides feedback for the closed-loop, digital, motor control system.

Spin Coating Process Theory

Spin coating has been used for several decades for the application of thin films. A typical process involves depositing a small puddle of a fluid resin onto the center of a substrate and then spinning the substrate at high speed. Centripetal acceleration will cause the resin to spread to, and eventually off, the edge of the substrate. Final film thickness and other properties will depend on the nature of the resin (viscosity, drying rate, percent solids, surface tension, etc.) and the parameters chosen for the spin process. Factors such as final rotational speed, acceleration, and fume exhaust contribute to how the properties of coated films are defined.

One of the most important factors in spin coating is repeatability. Subtle variations in the parameters that define the spin process can result in drastic variations in the coated film. The following is an explanation of some of the effects of these variations.

Spin Coating Process Description

A typical spin process consists of a dispense step in which the resin fluid is deposited onto the substrate surface, a high speed spin step to thin the fluid, and a drying step to eliminate excess solvents from the resulting film. Two common methods of dispense are Static dispense, and Dynamic dispense.

Static dispense is simply depositing a small puddle of fluid on or near the center of the substrate. This can range from 1 to 10 cc depending on the viscosity of the fluid and the size of the substrate to be coated. Higher viscosity and or larger substrates typically require a larger puddle to ensure full coverage of the substrate during the high speed spin step.

Dynamic dispense is the process of dispensing while the substrate is turning at low speed. A speed of about 200 rpm is commonly used during this step of the process. This serves to spread the fluid over the substrate and can result in less waste of resin material since it is usually not necessary to deposit as much to wet the entire surface of the substrate. This is a particularly advantageous method when the fluid or substrate itself has poor wetting abilities and can eliminate voids that may otherwise form.

After the dispense step it is common to accelerate to a relatively high speed to thin the fluid to near its final desired thickness. Typical spin speeds for this step is 1000 to 2000 rpm, again depending on the properties of the fluid as well as the substrate. This step can take from 10 seconds to several minutes. The combination of spin speed and time selected for this step will generally define the final film thickness.

In general, higher spin speeds and longer spin times create thinner films. It is not recommended that the parameters of this step be adjusted for spin times of less than 30 seconds. The spin coating process involves a large number of variables that tend to cancel and average out during the spin process and it is best to allow sufficient time for this to occur. It is common for very viscous films to require several minutes to thin out and to achieve a uniform coat thickness across the substrate.

A separate drying step is sometimes added after the high speed spin step to further dry the film without substantially thinning it. This can be advantageous for thick films since long drying times may be necessary to increase the physical stability of the film before handling. Without the drying step problems can occur during handling, such as pouring off the side of the substrate when removing it from the spin bowl. In this case a moderate spin speed of about 25% of the high speed spin will generally suffice to aid in drying the film without significantly changing the film thickness. Each program on a Cee spin coater may contain up to ten separate process steps. While most spin processes require only two or three, this allows the maximum amount of flexibility for complex spin coating requirements.

Spin Speed

Spin speed is one of the most important factors in spin coating. The speed of the substrate (rpm) affects the degree of radial (centrifugal) force applied to the liquid resin as well as the velocity and characteristic turbulence of the air immediately above it. In particular, the high speed spin step generally defines the final film thickness. Relatively minor variations of ±50 rpm at this stage can cause a resulting thickness change of 10%. Film thickness is largely a balance between the force applied to shear the fluid resin towards the edge of the substrate and the drying rate which affects the viscosity of the resin. As the resin dries, the viscosity increases until the radial force of the spin process can no longer appreciably move the resin over the surface. At this point, the film thickness will not decrease significantly with increased spin time. All Cee spin coating systems are specified to be repeatable to within ±5 rpm at all speeds. Typical performance is ±1 rpm. Also, all programming and display of spin speed is given with a resolution of 1 rpm.

Acceleration

The acceleration of the substrate towards the final spin speed can also affect the coated film properties. Since the resin begins to dry during the first part of the spin cycle, it is important to accurately control acceleration. In some processes, 50% of the solvents in the resin will be lost to evaporation in the first few seconds of the process.

Note: Acceleration can also damage your Motor Driver Board if set too high.

Acceleration also plays a large role in the coat properties of patterned substrates. In many cases the substrate will retain topographical features from previous processes; it is therefore important to uniformly coat the resin over and through these features. While the spin process in general provides a radial (outward) force to the resin, it is the acceleration that provides a twisting force to the resin. This twisting aids in the dispersal of the resin around topography that might otherwise shadow portions of the substrate from the fluid. Acceleration of Cee spinners is programmable with a resolution of 1 rpm/second. In operation the spin motor accelerates (or decelerates) in a linear ramp to the final spin speed.

Fume Exhaust

The drying rate of the resin fluid during the spin process is defined by the nature of the fluid itself (volatility of the solvent systems used) as well as by the air surrounding the substrate during the spin process. Just as a damp cloth will dry faster on a breezy dry day than during damp weather, the resin will dry depending on the ambient conditions around it. It is well known that such factors as air temperature and humidity play a large role in determining coated film properties. It is also very important that the airflow and associated turbulence above the substrate itself be minimized, or at least held constant, during the spin process.

All Cee spin coaters employ a "closed bowl" design. While not actually an air-tight environment, the exhaust lid allows only minimal exhaust during the spin process. Combined with the bottom exhaust port located beneath the spin chuck, the exhaust lid becomes part of a system to minimize unwanted random turbulence. There are two distinct advantages to this system: slowed drying of the fluid resin and minimized susceptibility to ambient humidity variations.

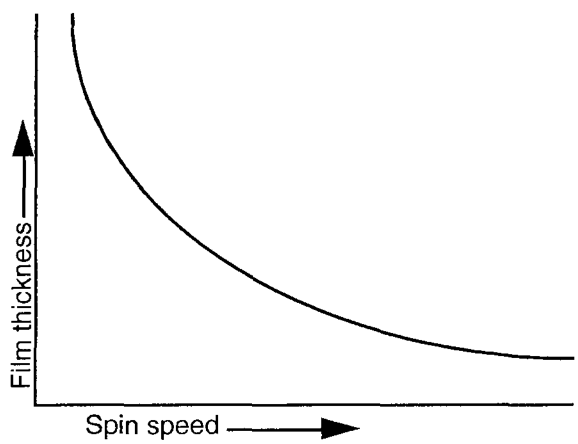
The slower rate of drying offers the advantage of increased film thickness uniformity across the substrates. The fluid dries out as it moves toward the edge of the substrate during the spin process. This can lead to radial thickness nonuniformities since the fluid viscosity changes with distance from the center of the substrate. By slowing the rate of drying, it is possible for the viscosity to remain more constant across the substrate.

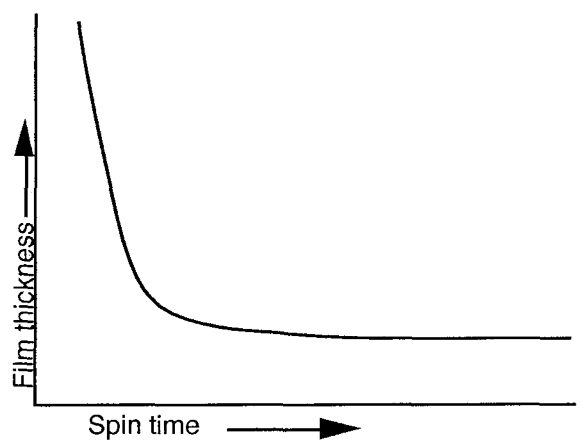
Drying rate and hence final film thickness is also affected by ambient humidity. Variations of only a few percent relative humidity can result in large changes in film thickness. By spinning in a closed bowl the vapors of the solvents in the resin itself are retained in the bowl environment and tend to overshadow the affects of minor humidity variations. At the end of the spin process, when the lid is lifted to remove the substrate, full exhaust is maintained to contain and remove solvent vapors.

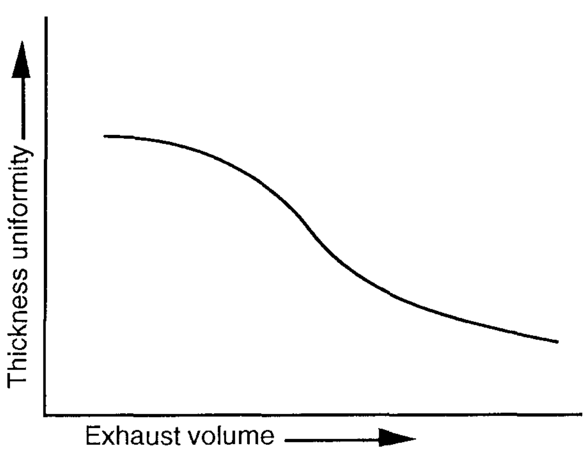
Another advantage to this "closed bowl" design is the reduced susceptibility to variations in air flow around the spinning substrate. In a typical clean room, for instance, there is a constant downward flow of air at about 100 feet per minute. Various factors affect the local properties of this air flow. Turbulence and eddy currents are common results of this high degree of air flow. Minor changes in the nature of the environment can create drastic alteration in the downward flow of air. By closing the bowl with a smooth lid surface, variations and turbulence caused by the presence of operators and other equipment are eliminated from the spin process.

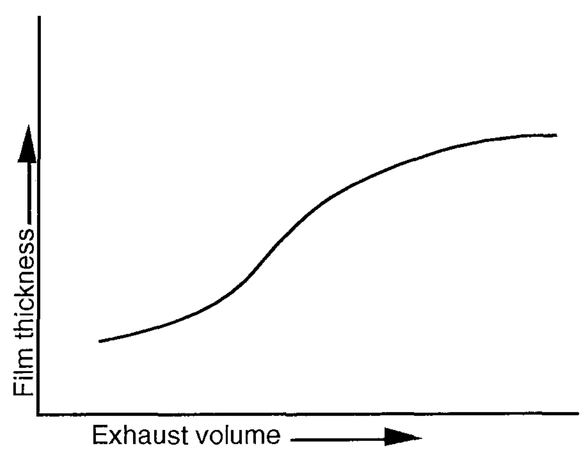
Process Trend Charts

These charts represent general trends for the various process parameters. For most resin materials the final film thickness will be inversely proportional to the spin speed and spin time. Final thickness will be also be somewhat proportional to the exhaust volume although uniformity will suffer if the exhaust flow is too high since turbulence will cause non uniform drying of the film during the spin process.









Basic Operation of the Cee Model Spinner

The Model 100 and 150 utilizes a single-board microcomputer as its main controlling element. This computer executes proprietary Cee software stored in read-only-memory (ROM) on the CPU board. Operator-originated process programs are stored in battery-backed random-access-memory (RAM). Battery-backed RAM is protected from memory loss for up to 30 years.

The CPU connects to the Spinner Board via two 34-pin ribbon cables. The Spinner Board uses commands from the CPU to control solenoid valves, the spin motor, and main keyboard display panel. Input from sensors on the machine is also fed through the Spinner Board on the way to the CPU.

Spinner Operation

The Cee spin module is programmed using the front panel. There are ten (10) user programs available, each capable of storing ten program steps. Each step consists of a discrete rotation speed value (rpm), an acceleration value (rpm/second), and a step duration time value (seconds). In addition, on a machine equipped with the auto dispense option, each step contains a pump select value to allow up to four pumps to be activated during that step. Programs are edited in program mode by pressing the "PROG" key from the main menu.

Acceleration Constraints

The Cee spin coater system is designed to process round substrates up to eight inches in diameter and square plates up to six inches square. The motor drive system incorporates a PID control loop which allows optimum performance under varying conditions. It should be noted that while the motor drive is capable of peak output power that approaches one horsepower, it is finite. The maximum available acceleration available for a given substrate will depend on the mass and shape of the substrate and any special spin chucks needed to process the substrate. In some cases, the maximum acceleration may be less than the specified maximum unloaded acceleration given for the machine.

To run a spin process program the operator must press the "RUN" key from the model number display*. The display will request that the operator specify which program is to be used (0 - 9). After selecting a program, the display will read "READY PRESS START". At this point, the operator should load a wafer and press start. The system will turn on the spin chuck vacuum, and, after about 100 ms, will check the spin chuck vacuum sensing switch. The delay is preset in the system software and is designed to allow time for the spindle and associated tubing to achieve a partial vacuum. If the vacuum cannot be sensed at this time the system will declare an error. If a vacuum is present, the system will begin the centering test for the wafer.

The centering test rotates the chuck slowly, for a preselected amount of time, to allow the operator to verify that the substrate is centered on the spin chuck before beginning the actual spin process. The time for this step is a global adjustment made in the configuration parameters through the front panel and can be set for up to nine seconds. If the centering time is set to zero, then the centering test is omitted. The test is usually omitted when the system is used with a captive spin chuck which forces the substrate to be centered.

After the centering test, the system will turn off the vacuum to allow readjustment of the substrate position on the chuck. The operator may either repeat the centering test (to verify readjustment) or begin the spin process program. While in process (running a program), the display will indicate the step number currently being executed, the current rpm of the spin chuck, the time remaining for the current step, and, if applicable, the active dispense pump. Spin chuck vacuum is tested continuously during the spin process; a failure causes the motor to immediately stop and the display to declare an error.

At the end of the program the motor will stop, the alarm will begin sounding, and the display will instruct the operator to remove the finished substrate. During this time the vacuum will pulse, allowing the system to check the vacuum and determine when the substrate has been removed. After the substrate is removed, the system will return to the point where the first substrate was loaded onto the chuck. Process programs can be terminated while in progress by pressing the "STOP" key. This causes the system to immediately abort the program and behave as if the process was completed normally.

System Interaction During Processing
During the spin process (while running a process program) the system is busy performing several tasks. The front panel display is updated continuously to show the time remaining for a given process step, the current spin speed in rpm and if appropriate, which dispense pump if any is currently active.

The keyboard panel is monitored for key presses, in particular the "STOP" key, which is used to terminate (abort) a spin process, and the "RESET" key, which will abort the process and reset the system controller. Note that the first step in the reset sequence is a check to determine whether a substrate is present and if the motor is turning. If this is the case, then, for safety reasons, the motor will be stopped before the vacuum is reset. During this situation the display will read "DECELERATING" until the motor is confirmed to be stopped.

The vacuum sensor is continuously monitored during the spin process to ensure that good vacuum is being maintained between the substrate and the spin chuck. If for any reason the vacuum is lost or insufficient, the motor will immediately stop, the process will be aborted and an error will be declared both on the display and with an audible alarm. When called for by the spin process program, dispense pumps are started and stopped, suckback and refill of the pumps are also handled automatically during the spin process.

When the program is terminated, the spin motor is turned off, all pumps are reset, and the system waits for the processed substrate to be removed. Substrate detection is performed by pulsing the spin chuck vacuum and monitoring the vacuum sensor. In some processes the resultant film is virtually invisible and it would be possible to accidentally re-coat the same substrate without realizing it had already been processed. By sounding an audible alarm and requesting that the finished substrate be removed this problem is eliminated.

Auto Dispense Option Operation
When purchased with the Cee spinner, the auto dispense option allows automatic control of up to four separate dispense pumps. In addition to the dispense times adjusted in the main process programs, there are two other parameters affecting each pump: suckback time and refill time. Suckback and refill times are individually adjusted for each pump in the configuration mode parameter list.

To prevent the formation of drips at the end of the dispense nozzle, Cee spin coaters use a suckback feature at the end of the pump cycle. Normally a pump would discharge through one pipe (the nozzle) and refill or intake through another pipe from the fluid reservoir. Suckback allows the pump to actually perform a brief part of the intake cycle through the dispense nozzle to "suck back" part of the dispensed fluid up into the nozzle. The suckback parameter refers to the amount of time that the pump will actually withdraw fluid from the dispense nozzle after the dispense is finished. Typical values are from 5 to 20 (representing 50 to 200 milliseconds). This parameter is only used with Millipore Wafergard® dispense pumps offered by Cee.

Higher viscosities will call for longer suckback times since the fluid moves more slowly. If the suckback time is set too long the fluid may actually be pulled all the way back to the pump!

Refill time is adjustable (in seconds) and also applies only to Millipore Wafergard® dispense pumps. This parameter adjusts the amount of time allowed for the pump to refill itself from the reservoir or bottle after one dispense cycle and before the next. Typical values are from three (3) to nine (9) seconds, depending on the viscosity of the dispense fluid. If this time is too short, there will be a tendency for the pump to run out of fluid in the middle of a subsequent dispense cycle.

Key Spinner Parameters - Equipment Process Variables

Programming on the Cee series spin coaters allows the adjustment of process parameters. Each of the ten battery-backed programs may contain up to ten discrete process steps. Each step contains a spin speed in rpm (one rpm resolution), an acceleration in rpm/second (one rpm resolution) a step time in seconds (one second resolution) and a dispense pump identifier (if purchased with the auto dispense option).

In addition, there are several global parameters that are very important for optimum system operation. The configuration mode parameter list contains values for the motor tuning constants as well as the pump parameters on auto dispense equipped systems. All Cee spin coaters use a PID (proportional, integral, derivative) control system for the motor drive. These parameters should be tuned for optimum performance with substrates of varying size, different spin chuck designs and other changes that affect the inertia of the spinning parts. Inertia is directly related to the mass of the chuck and substrate being spun. It is proportional to the square of the radius of the spun substrate. Thus a little bit larger substrate can make a large change in the performance of the spinner system. PID values that work fine with a 2" wafer will not give good results with an 8" wafer, and values that work well going to 2000 rpm may result in speed overshoot going to 5000 rpm. Some PID values will prevent the spinner from attaining a final stable speed, and the chuck may even oscillate forward and backward.

Spin Coating Process Troubleshooting

Spin coater:

As explained previously, there are several major factors affecting the coating process. Among these are spin speed, acceleration, spin time and exhaust.

Process parameters vary greatly for different resin materials and substrates so there are no fixed rules for spin coat processing, only general guidelines. These are explained in the "Hotplate Process Description" section. Following is a list of issues to consider for specific process problems.

Film too thin

Spin speed too high	Select lower speed
Spin time too long	Decrease time during high speed step
Inappropriate choice of resin material	Contact resin manufacturer

Film too thick

Spin speed too low	Select higher speed
Spin time too short	Increase time during high speed step
Exhaust volume too high	Adjust exhaust lid or house exhaust damper
Inappropriate choice of resin material	

Poor reproducibility

Variable exhaust or ambient conditions	Adjust exhaust lid to fully closed
Substrate not centered properly	Center substrate before operation
Insufficient dispense volume	Increase dispense volume
Inappropriate application of resin material	Contact resin manufacturer
Unstable balance in speed / time parameters	Increase speed / decrease time or visa versa

Poor film quality

Exhaust volume too high	Adjust exhaust lid or house exhaust damper
Acceleration too high	Select lower acceleration
Unstable balance in speed / time parameters	Increase speed / decrease time or visa versa
Insufficient dispense volume	Increase dispense volume
Inappropriate application of resin material	Contact resin manufacturer

PID Control Features

Cee Equipment Spin/Coat modules and Hotplate modules use advanced technology controllers. These controllers allow a higher degree of precision in substrate processing. Some control systems try to get by with just a Proportional (P) or Proportional-Integral (PI) type of feedback loop. To maintain consistency and overcome the time lag inherent in real-time control, a more sophisticated system with some ability to predict system performance is necessary. This is achieved by adding the Derivative (D) type feedback loop to the Proportional-Integral (PI) loop, forming a PID feedback control loop (figure 1). This control loop performs with the precision necessary for today's complex process requirements.

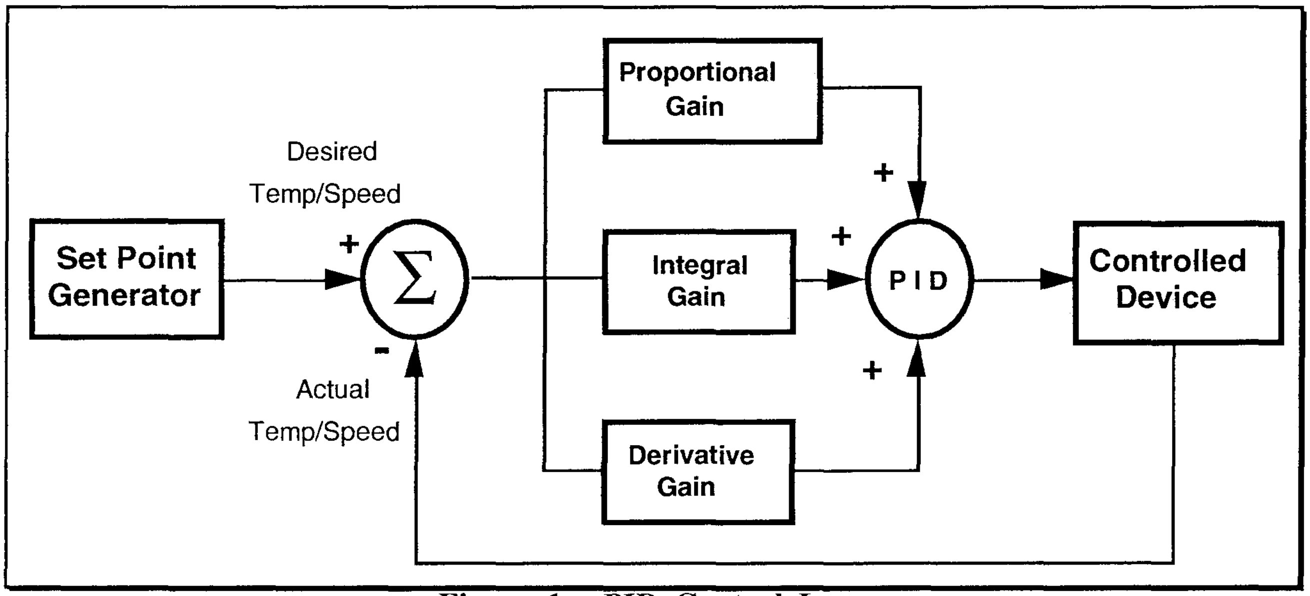


Figure 1 - PID Control Loop

Proportional Control
Inertial loading of a system will present a following (or tracking) error back to the controller. This error is the difference between the output and the target or set-point. External disturbances or loading of the system produces a displacement error. The proportional filter provides a restoring force to minimize the error. This restoring force is linearly proportional to the error. Proportional adjustment is made using the proportional gain parameter. The proportional gain of a system sets the critical damping or stiffness. If the proportional gain is too low, the restoring force will be too slow or soft in response. If the gain is too high, the system will over- and undershoot the target for a period of time; a condition referred to as ringing or oscillation. Once the median value of proportional gain is determined, the system is said to be critically damped.

Integral Control
The integral feedback loop will provide a corrective force that can eliminate tracking error. The integral force is proportional to the tracking error and increases linearly with time. Integral Adjustment is made with Integral Gain constant. Large values of integral gain provide quick compensation, but increase overshoot and ringing. Usually, integral gain should be set to a minimal value that provides a compromise between the three system characteristics of : overshoot, settling time, and the time necessary to cancel the effects of static loading. Another term usually associated with integral gain is the integral limit. This integral boundary limits the magnitude of the feedback. Due to the nature of integration, the potential of extreme error correction values is great. The integral limit value acts as a clamping force to prevent integral wind-up; a backlash effect occurring from a large tracking error.

Derivative Control
The differential feedback loop provides a damping effect to eliminate system oscillation and to minimize overshoot and ringing. The damping force adjustment, or Derivative Gain, is proportional to the rate of change of the tracking error. This parameter provides an overall stability to the system. It adds the capability of predicting system response and being able to interject corrective action well before tracking errors become visible. This prediction ability is possible because the response is determined by the systems reaction in a set time frame.

Control Comparisons Summary
The graph of figure 2 shows the types of control discussed and the relative response to be expected. The proportional control at its optimum will have a lagging response and a slower rise-time. The proportional - integral feedback has a faster rise time, but tends to oscillate about the desired set-point until the controller values settle. The proportional - integral - derivative control has the fastest rise-time and the ability to lock on to the set-point quickly; the control response necessary for bake and spin/coat processing.

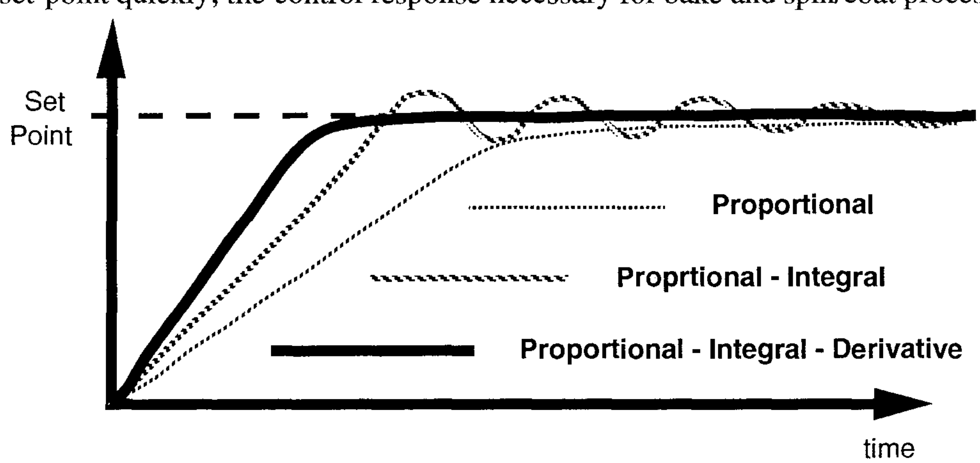
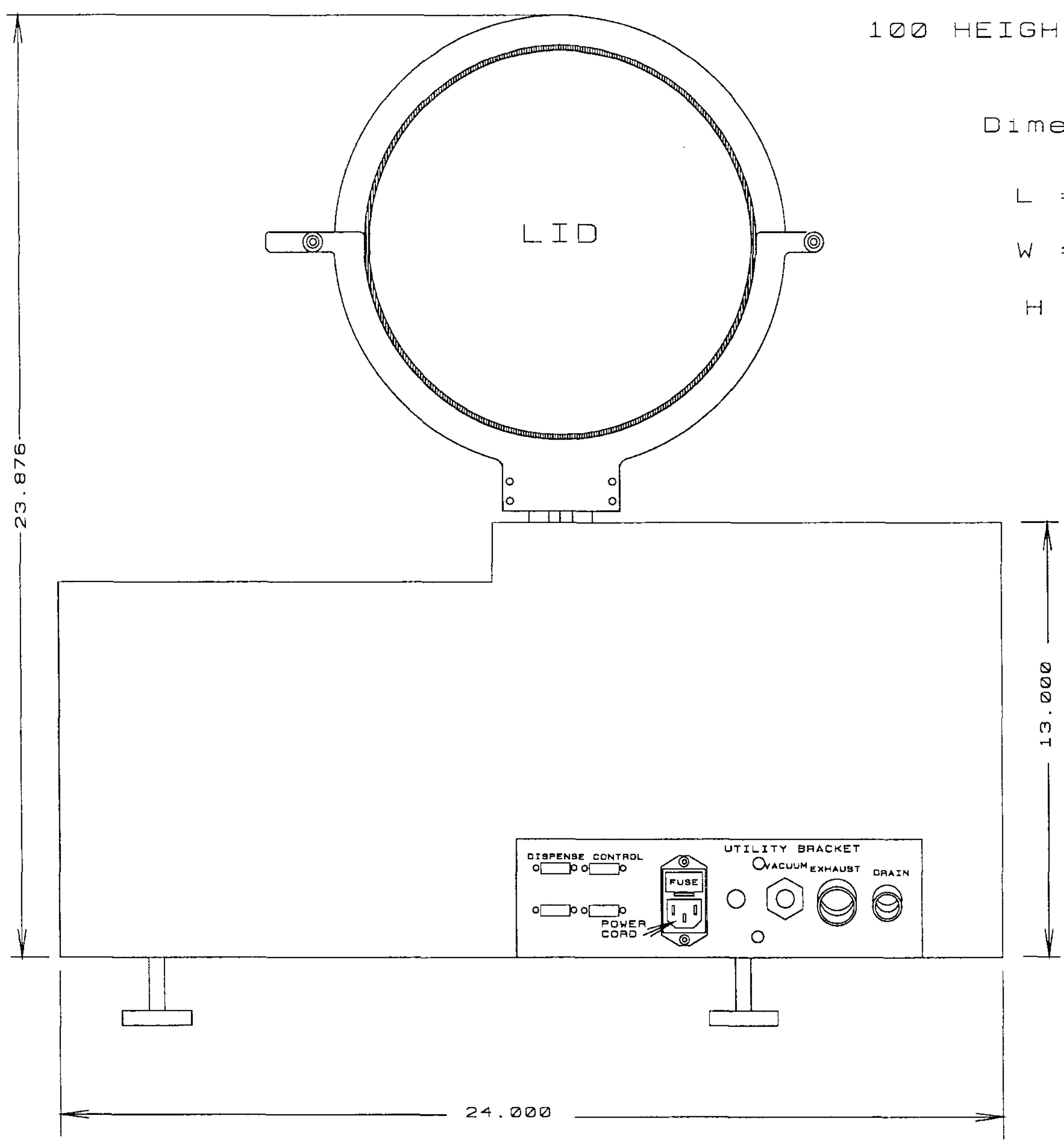


Figure 2 - Control Comparison

100 DIM JSIONS



100 HEIGHT (INCHES)

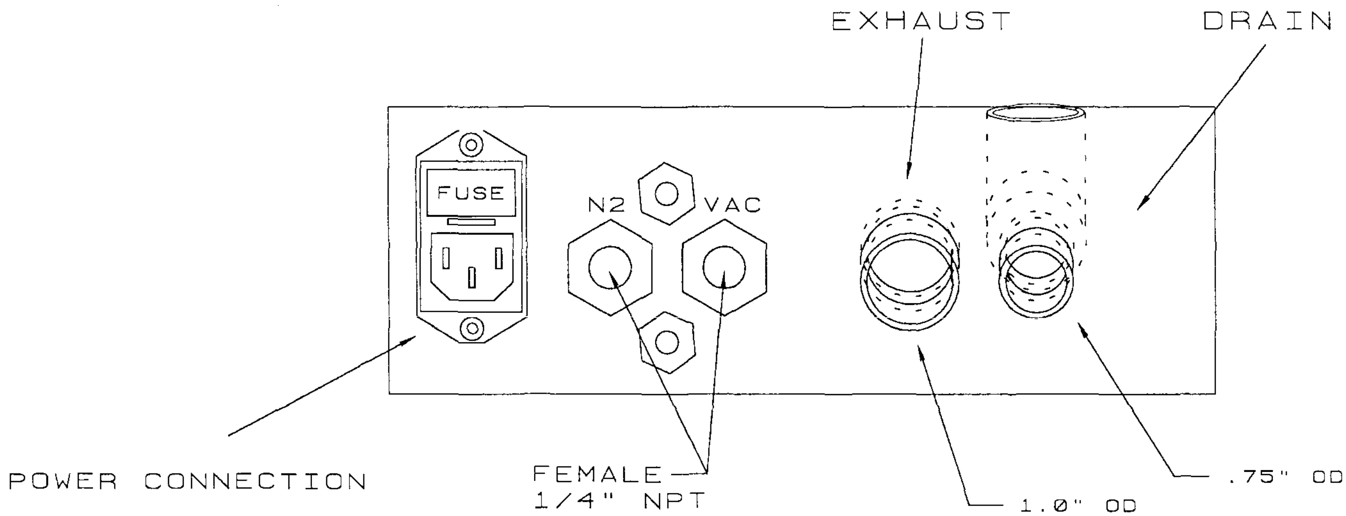
Dimensions

L = 24"

W = 13"

H = 13"

100 UTILITIES



VACUUM: 25" HG

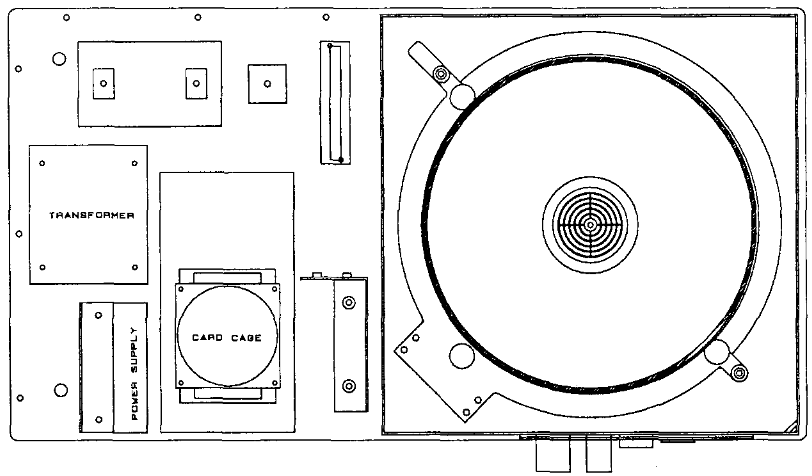
EXHAUST: 20-100 CFM

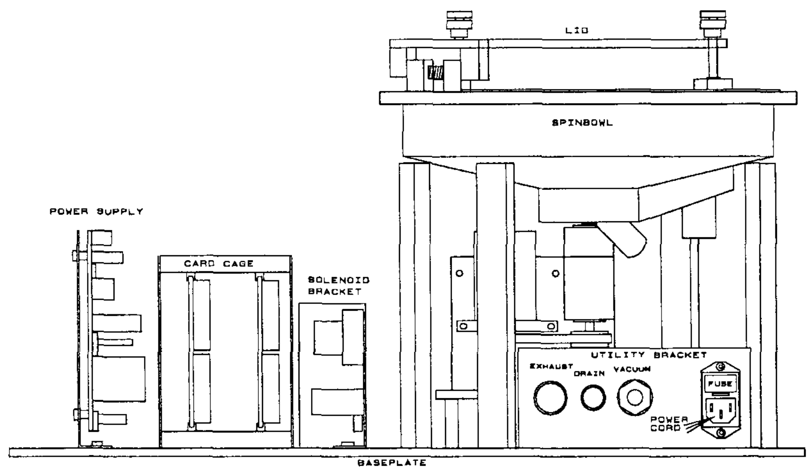
N2: 70 PSI MINIMUM FOR DISPENSE VALVE

DRAIN: CONNECT TO HOUSE DRAIN FACILITY

POWER CONNECTION: 120/240V, 800 WATTS

100 BASEPLATE TOP / BACK VIEW





Cee® Model 100 Series Spin Coating System

Preventative Maintenance

Safety Checks:

1. Check spin bowl lid for proper operation, making sure the lid opens and closes completely.

Mechanical Checklist:

1. Spin chuck flatness:
   Causes vacuum errors. Use glass slide over surface of spin chuck.
   Hold at 45° and move across surface using light pressure.

2. Spin chuck cleanliness:
   Causes vacuum errors.
   Clean using IPA or Acetone.

3. Belt wear:
   Effects speed and acceleration of spindle.
   Check for fraying of belt and misalignment of pulleys.

4. Bearing wear: 600625A - BEARING (1/2" SHAFT)
   Erratic spin speed and acceleration.
   Check for excessive bearing play by holding spindle shaft and moving it form side to side.
   Normal play is <0.001".

5. Seal wear: 600266A - SEAL
   Causes vacuum errors, symptoms are vacuum errors and vacuum leaks at seal and shaft mating surfaces.

6. Motor wear:
   Erratic spin speed and acceleration, inability to maintain speed.

7. Inspect panels to make sure they are properly positioned.

Cee® Model 100 Series Spin Coating System
Preventative Maintenance

Utility Checks:

1. Inspect all connections for proper installation.
2. Check all N2 and Vacuum for ranges specified.
3. Verify that there is a proper drain facility.
4. Check that the exhaust is functioning.
5. Verify that the AC power is at the proper voltage, 110/120 volts.

Spindle Assembly:

1. Belt tension should be adjusted so that there is 1/8" deflection between the pulleys.
2. Adjust spindle pulley so there is no axial play in the shaft. Check by gently pulling up and down on the spindle.

Pneumatics:

1. Adjust vacuum switch point to 10 inches of Hg. measured at the spin chuck.

Power Supply Assembly:

1. Verify the +60 volt spinner motor supply measured on the interface board connector.
2. Verify logic supply voltages -12, +12 and +5 volts.
   These voltages are measured on the power supply at J1.
   Pin 1 is -12 volt, pin 2 is +12 volts, pin 3 is common and pin 4 is +5 volts.

Cee® Model 100 Series Spin Coaters

Diagnostics Keymap

Spin Coat Diagnostics:

Key	Function
1	Spin chuck vacuum toggle on / off
2	NA
3	Dispense nozzle selection
4	Cycle dispense nozzle selected
5	Start spin motor (RPM set in Prog# 5)
6	Set proportional coefficient
7	Set integral coefficient
8	Set dirivative coefficient
9	Set integral limit
0	Stop spin motor
DIAG	Firmware Version Number - Odometer
ENT	Shows status bits

Cee® Model 100 Series Spin Coating System

Spindle Vacuum Switch Adjustment

Purpose:

To adjust the switch point for the spin chuck vacuum. Use this procedure during scheduled preventive maintenance to ensure reliability.

Items needed:

- Solenoid bracket drawing for your Cee® system.
- Allen wrench to remove the left most back panel.
- Small flat screw driver with a 4" long shaft and 1/8" wide tip.

Adjustment:

1. From the back, remove the left most panel.

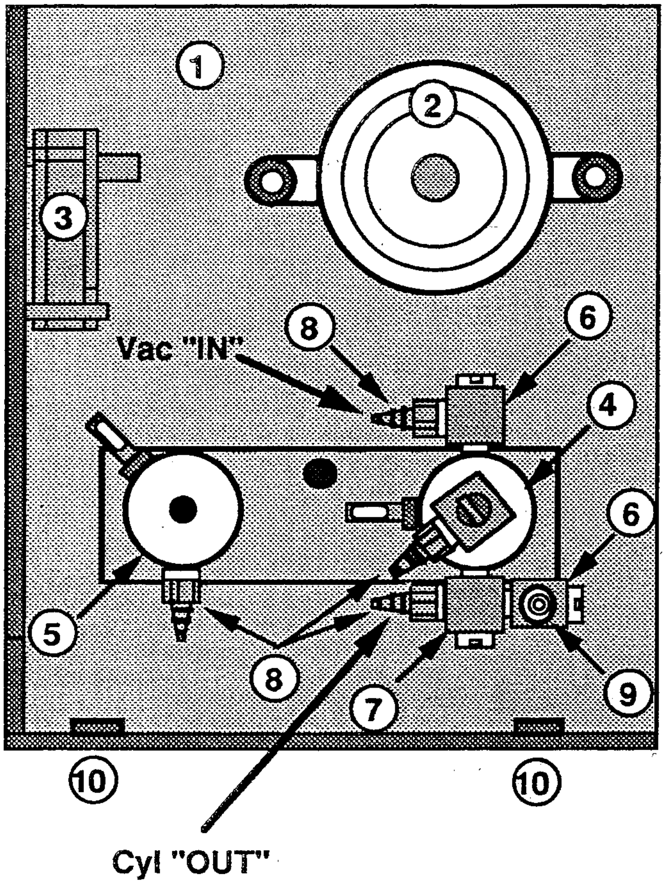
   Enter diagnostic mode. The display will read the following;
   VAC 0 PUMP #1 VEL 0
   VAC 0 indicates vacuum is not present at the spin chuck and therefore the system will not allow the spin motor to run.

3. Start without a substrate on the spin chuck. Press #1 on the keyboard to turn on spin chuck vacuum.

4. Locate the vacuum switch and turn clock wise until the display reads vacuum on (VAC 1). With the substrate still off and the display shows that the vacuum switch has vacuum, you have just found the most sensitive position or switch point (closed sensor switch).

5. Next, turn the vacuum adjustment screw counter clock wise until the display reads vacuum off (VAC 0), this should only take 1/16 of a turn.
   Once at VAC 0, turn another 1/16 or 1/4.

"100 SERIES " SOLENOID BRACKET



1 - Metal Bracket

2 - Piezo Buzzer

3 - Vac. Switch

4 - ET3 Solenoid

5 - ET2 Solenoid

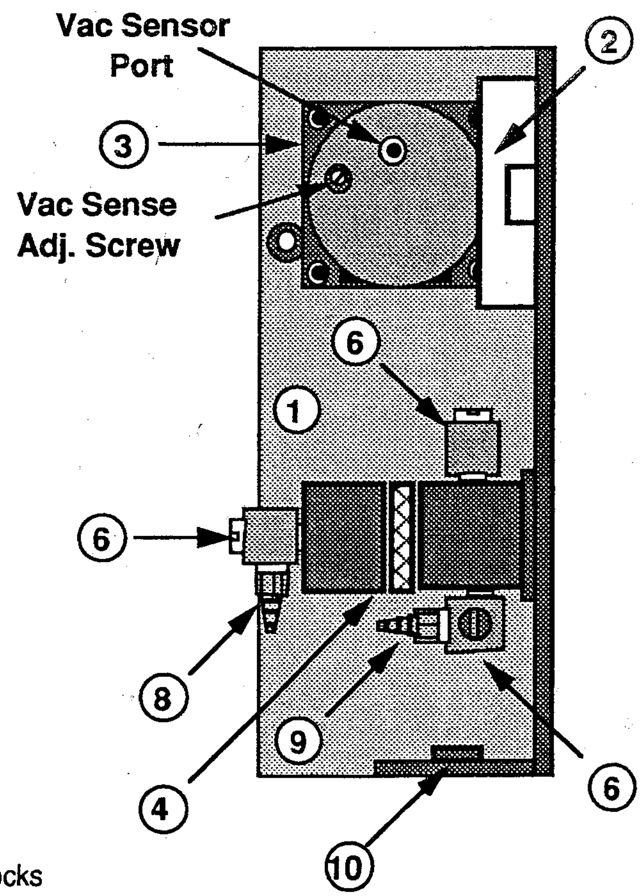
6 - Adjustable L

7 - Adjustable T

8 - Small Hose Barb

9 - Large Hose Barb

10 - PEM Mtg. Nuts



1/8" Teflon tubing attaches to the two "IN" hose barbs. The length of these are determined by the type of machine which you are building and the routing path between the Solenoid Bracket, Spinner & Utility Bracket. Cut to fit and allow some extra length for serviceing or changes.

Use approximately 4" of 1/4" clear tubing to connect the vacuum sensor port to the large hose barb on the ET3 solenoid.

The construction and hookup of the ribbon cable wiring harnes for this subassembly is covered in the BASEPLATE WIRING module.

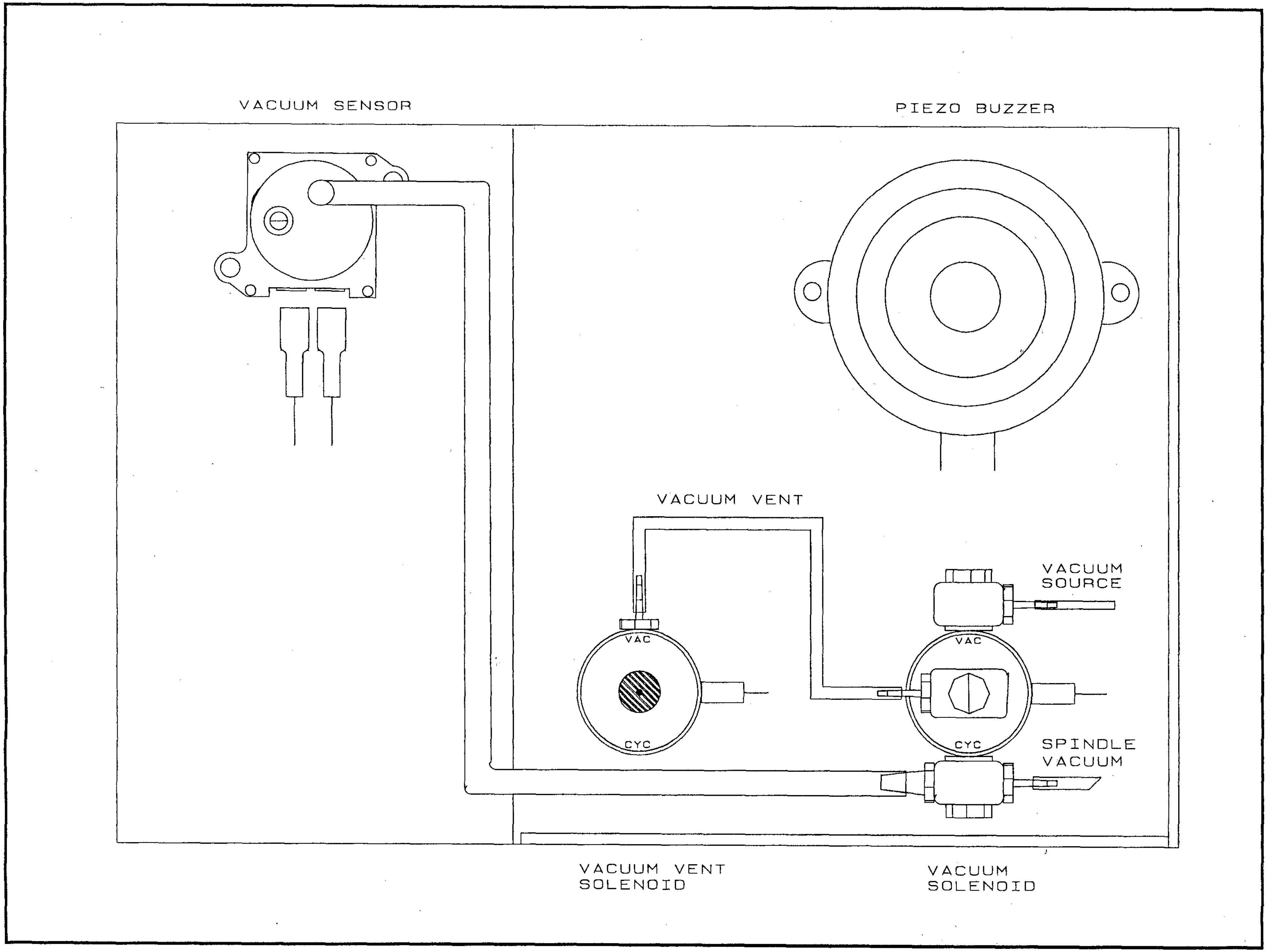
Mount Solenoids with 6-32 x 5/16" BHCS, flats & locks

Mount Piezo Buzzer with 4-40 x 3/8" SHCS, flats & locks

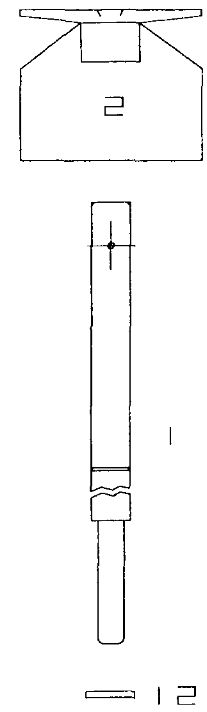
Mount Vacuum Sensor with 4-40 x 3/4" SHCS, flats & locks

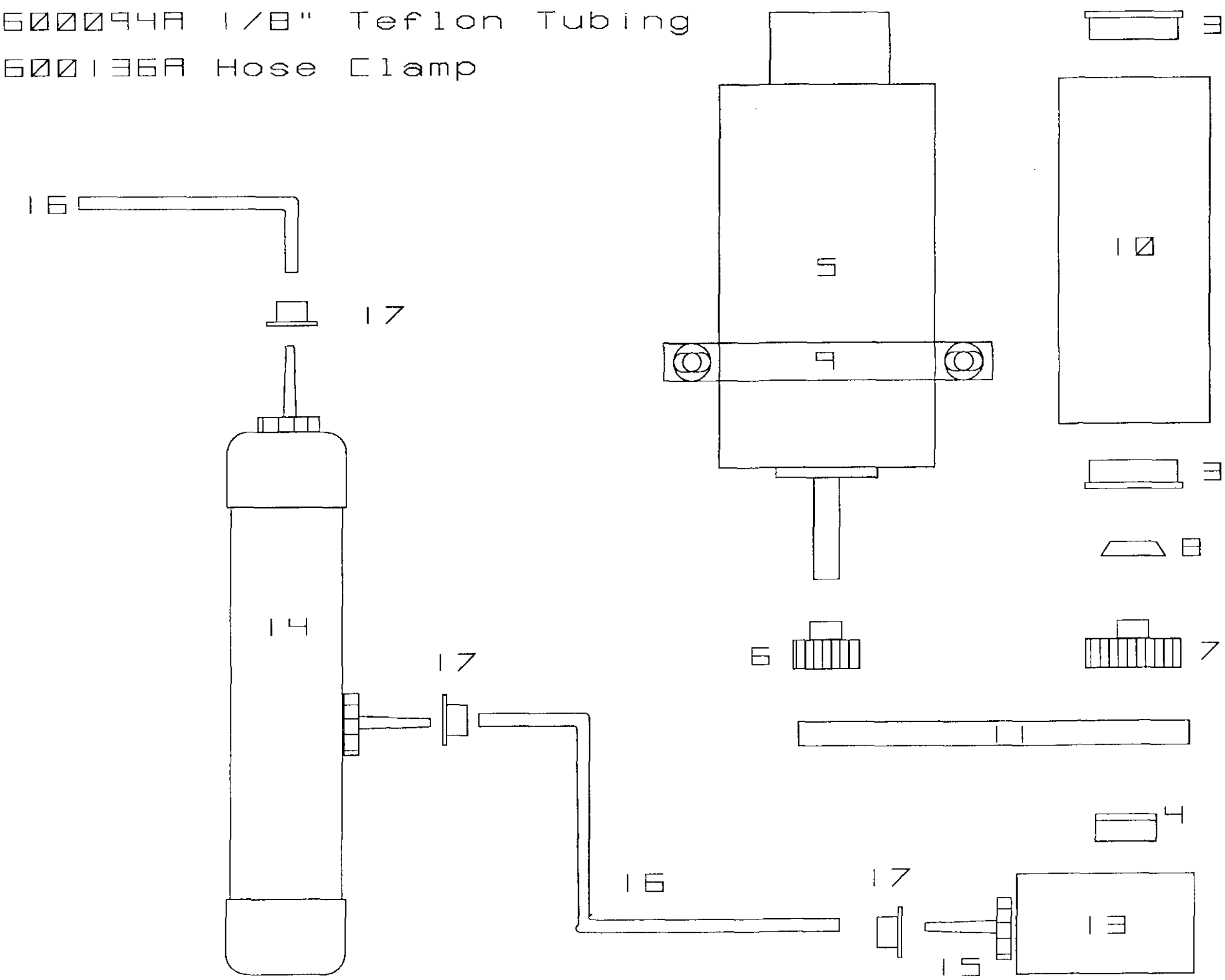
Mount Bracket to Baseplate with 8-32 x 1/2" SHCS, flats & locks

100 / 150 SOLENOID BRACKET

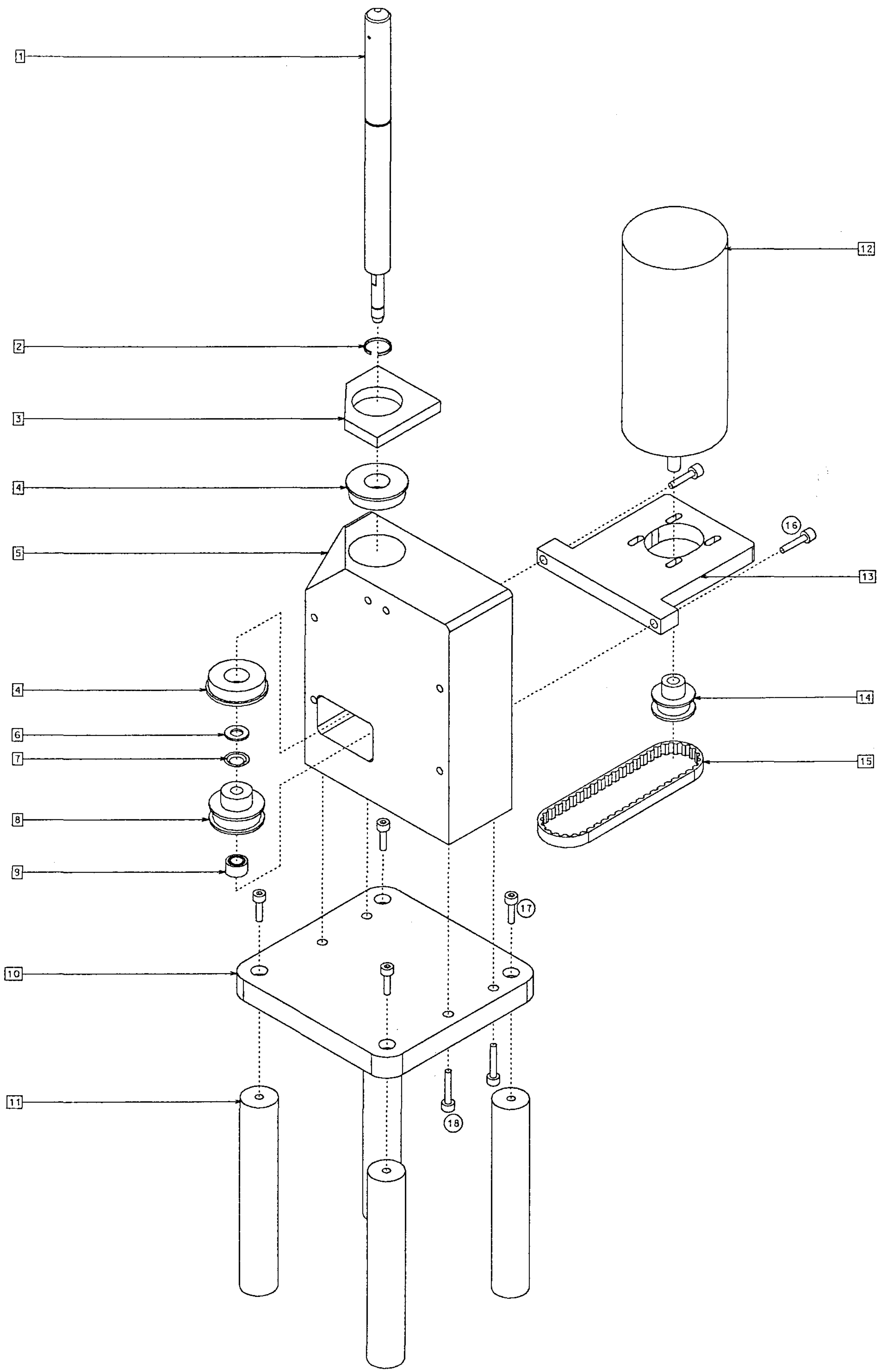


1	600270D	1/2" Spindle Shaft
2		Any 1/2" Spin Chuck
3	600625A	7/8" x 1/2" Flange Bearing
4	600266A	Seals with Spring
5	600340A	IM-21 Motor
6	600339A	18 Gear Pulley
7	600097A	26 Gear Pulley
8	600096A	1/4" Belleville Washer
9	600081E	Motor Mount
10	600003C	Spindle Bearing Block
11	600396A	Timing Beit
12	600450A	Retaining Ring
13	600080C	Spindle Seal Block
14	900010B	Vacuum Reservoir
15	600102A	1/16" Hose Barb
16	600094A	1/8" Teflon Tubing
17	600136A	Hose Clamp





1/2" SPINDLE ASSM.



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ASSEMBLY #: 900648A
DESCRIPTION: 150 Spinner Assembly
DATE: 1/11/00

ITEM	PART NUMBER	DESCRIPTION	QUANITY
1	603886C	100/100CB Spindle	1
2	600627A	1/2" Retaining Ring	1
3	Bulk	Bowl Seal	1
4	600625A	1/2" X 1 1/8" Flanged Bearing	2
5	603869B	100/4000 Spindle Block	1
6	600078A	1/4" Flat Washer	1
7	600096A	1/4" Belleville Washer	1
8	600097A	HTD Timing Pulley (26 Grooves)	1
9	600266A	0.25" X 0.438" Seal w/med Spring	1
10	604142A	150 Spindle Assembly Base	1
11	604141A	150 Spindle Assembly Standoff	1
12	600340A	IM-21 Motor	1
13	603877A	4000/4500 Spin Motor Mount	1
14	600339A	HTD Timing Pulley (18 Grooves)	1
15	600396A	Timing Belt (75 Grooves)	1
16	600118A	#8-32 SHCS, 5/8" long	2
17	600196A	#10-32 SHCS, 1" long	4
18	600196A	#10-32 SHCS, 1" long	4

Cee® Model 100 Series Spin Coating System

Spindle Bearing & Seal Replacement

Purpose:

Worn or damaged bearings and seals can cause problems with the spin coating process. The system will not be able to control the speed or you may experience intermittent vacuum problems.

Items needed:

- Spindle assembly drawing.
- Assortment of tools such as Allen wrenche set and small standard screw driver.

Tear down procedure:

1. Turn off and unplug the power cord from the unit.

2. Facing the back, remove the spinner panel.

3. Unplug the motor drive electrical connector.

4. Unplug the encoder ribbon cable from the black encoder at the top of the motor (be sure to note the original orientation of the cable - brown is pin 1).

5. Note the tension of the motor belt. Typically this belt can be deflected about 1/8" with finger pressure at the middle of the belt. At the end of this procedure you will need to reset the tension on this belt.

6. Remove the motor mount bracket screws with a 9/64" Allen key. With the screws out, take the belt off the motor pulley and remove the motor.

7. Remove the Teflon tubing from the spindle seal block.

8. Note the orientation and position of the pulley on the spindle shaft, loosen the two set screws in the side of the pulley.

9. From the spin bowl, pull the spindle straight up and out. You may need to place the spin chuck on the spindle to get leverage to pull the spindle out. Take care not to damage the spindle or the spin chuck. Do not use any tools or pry bars to remove the spindle.

10. From the bottom of the base plate, remove the screws that attach the spinner assembly to the baseplate of the machine.

11. Remove the right spin bowl support and then the spinner assembly.

12. Remove the bearings from the spindle block. This can be done by tapping on them from the inside out.

13. Remove the seal from the seal block.

14. Use solvent to clean any parts that have processing material on them.

Replacement procedure:

1. Insert the two spindle bearings into the bearing block. It is very important that the bearings are pressed in straight.

2. Insert the new seal with the spring side facing up. The top of the seal should be flush with the surface of the seal block. Apply a small amount of Teflon grease to the inside of the seal.

3. Place the spindle assembly back in to the machine and attach to the baseplate, do not tighten the bolts until after the spindle has been installed.

4. Before installing the spindle place the spindle pulley and the belleville washer (washer position is cupped up) on top of the seal block and centered over the seal. Be sure the belt is installed around the spindle pulley. Next, install the spindle shaft through the bearings, washer, pulley and into the seal

5. Align one of the set screws of the pulley with the flat on the spindle. Before you tighten the set screw, push the pulley up and the spindle down at the same time. This will pre-load the bearings so the spindle will not move vertically. Tighten both set screws.

6. Install the motor and belt. Belt tension should have an 1/8" deflection on both sides.

7. Tighten all bolts and reconnect the Teflon tubing

8. Connect the encoder cable to the motor and motor power.

Testing the spinner:

1. Program 5, set the first RPM value to 100 RPMs.

2. Enter diagnostic mode by pressing "DIAG".

3. Rotate the spin chuck counter clockwise. Did it display RPM's ?

4. If yes, place a substrate on the spin chuck and press 1.

5. If no, connect the encoder cable to the motor encoder.

6. Close the lid and press 5 to start the motor and 0 to stop.

7. When finished, press reset and remove the substrate.

Assem # 900000B 100/100CB Spinner Subassembly

PARTS

Item #	Part Number	Description	Quantity
1	600004B	Motor Bearing Plate Support	1
2	600082C	Spindle Bearing Bracket	1
3	600340A	IM-21 Motor	1
4	600081E	Motor Mount	1
5	600083B	Spindle Foot Plate	1
6	600122A	8-32 x 1" Standoffs	3
7	600002D	Spinner Spindle	1
8	600450A	Retaining Ring	1
9	600095A	7/8 x 3/8 Flange Bearing	2
10	600003C	Spindle Bearing Block	1
11	600096A	1/4" Bellevile Washer	1
12	600396A	Timing Belt (75 Grooves)	1
13	600097A	Timing Belt Pulley (26 grooves)	1
14	600266A	.25x.438 Seal w/ Med Spring	1
15	600080C	Spindle Seal Block	1
16	600102A	1/16" Tube Hose Barb	1
17	600339A	Timing Belt Pulley (18 grooves)	1

SCREWS

A		10-32x.625", Locks	4
B	600091A	4-40x.5", Locks	2
C		8-32x.75", Flats & Locks	2
D		6-32x.75", Locks	4
E	600125A	8-32x.75", Locks	3
F		10-32x.625", Locks	2
G	600463A	6-32x.625", Locks	2

Cee® Model 100 Series Spin Coater

11. Turn off and unplug the power cord.
12. Remove the Spin Motor Board.
13. Locate and replace the following two components.
    7407 IC at location U11 and the 2N2907 transistor at location Q5.
14. After replacing the components, reinstall the Spin Motor Board in the card cage.
15. Plug in the power cord and turn the power switch on.
16. Go to step number 6.

17. If you feel vacuum pulling down on the substrate and the display shows "VAC 1" you should read the document, "Spindle Vacuum Switch Adjustment".

Question #7 - After the adjustment, does the display show VAC 0 or 1 respectively ?

Yes: Your done.

No: Go to step number 18.

18. Facing the back, remove the left most panel.
19. Using the "Card Cage Layout" and "Solenoid Bracket" drawings to locate the Spin Motor Board components LED 1 (spindle vacuum solenoid on) and LED 9 (vacuum sensor on).
20. Press DIAG.

Question #8 - Is LED 9 on ?

Yes: Replace the Vacuum Switch and or IC located at U3 (7400).

No: Possiable causes - CPU board, Spinner board, and ribbon cable connections.

Note: If you are still experiencing vacuum problems, please contact your Cee® Customer Support Representative.

Question #3 - Did "VAC 0" turn to "VAC 1" with a substrate on the spin chuck ?

Yes: If you answered yes to both question #2 and #3, you should not have an error.

No: If you feel vacuum pulling down on the substrate but "VAC 0" did not change, you should read the document, "Spindle Vacuum Switch Adjustment".

4. Facing the back, remove the left most panel.
5. Using the "Card Cage Layout" and "Solenoid Bracket" drawings to locate the Spin Motor Board components LED 1 (spindle vacuum solenoid on) and LED 9 (vacuum sensor on).
6. Press DIAG, and you will see - "VAC 0 PUMP#1 VEL 0".
7. Next press 1 and then look at LED 1 to see if it turned on.

Question #4 - Did LED 1 turn on ?

Yes: If you do not feel vacuum but LED1 is on, you need to check the solenoid voltage and / or check 1/8" O.D. Teflon vacuum tubing starting at the utility bracket (source). Then continue to step number 8.

No: Go to step number 8.

8. Locate and check the P5 connection on the Spin Motor Board.
9. Check the terminal connectors and +12 VDC on the solenoid.

Question #5 - Is there +12 VDC at the solenoid when turned on ?

Yes: Need to replace the solenoid and / or check 1/8" O.D. Teflon vacuum tubing starting at the utility bracket (source).

No: Go to step number 15.

10. Use the DC Power Supply drawing (SPL-50 or Astrodyne) to test voltages.

Question #6 - Did you get -12 VDC, +12 VDC, and +5 VDC respectively ?

Yes: Go to step number 16.

No: Need to check 120 VAC connection and fuse on the DC Power Supply.

Cee® Model 100 Series Spin Coater

Vacuum Trouble Shooting

Purpose:

To identify each component in the vacuum system for trouble shooting vacuum related errors. Cee® uses vacuum to pull down a substrate on the spin chuck, pull down a substrate on the hot plate, and controls suck back with syringe or Millipore pump dispense systems.

Items needed:

- Solenoid Bracket drawing for your Cee® system.
- Card Cage Layout drawing for your Cee® system.
- Spin Motor Board drawing.
- SPL-50 Power Supply - test point drawing.
- Allen wrench to remove the back panel.
- Multi-meter.

Trouble Shooting:

1. Press DIAG.

Question #1 - Does the display show "VAC 0 PUMP#1 VEL 0".

Yes: Go to step number 2.

No: Go to step number 17 if the display shows "VAC 1 PUMP#1 VEL 0".

2. With no wafer on the spin chuck press 1.

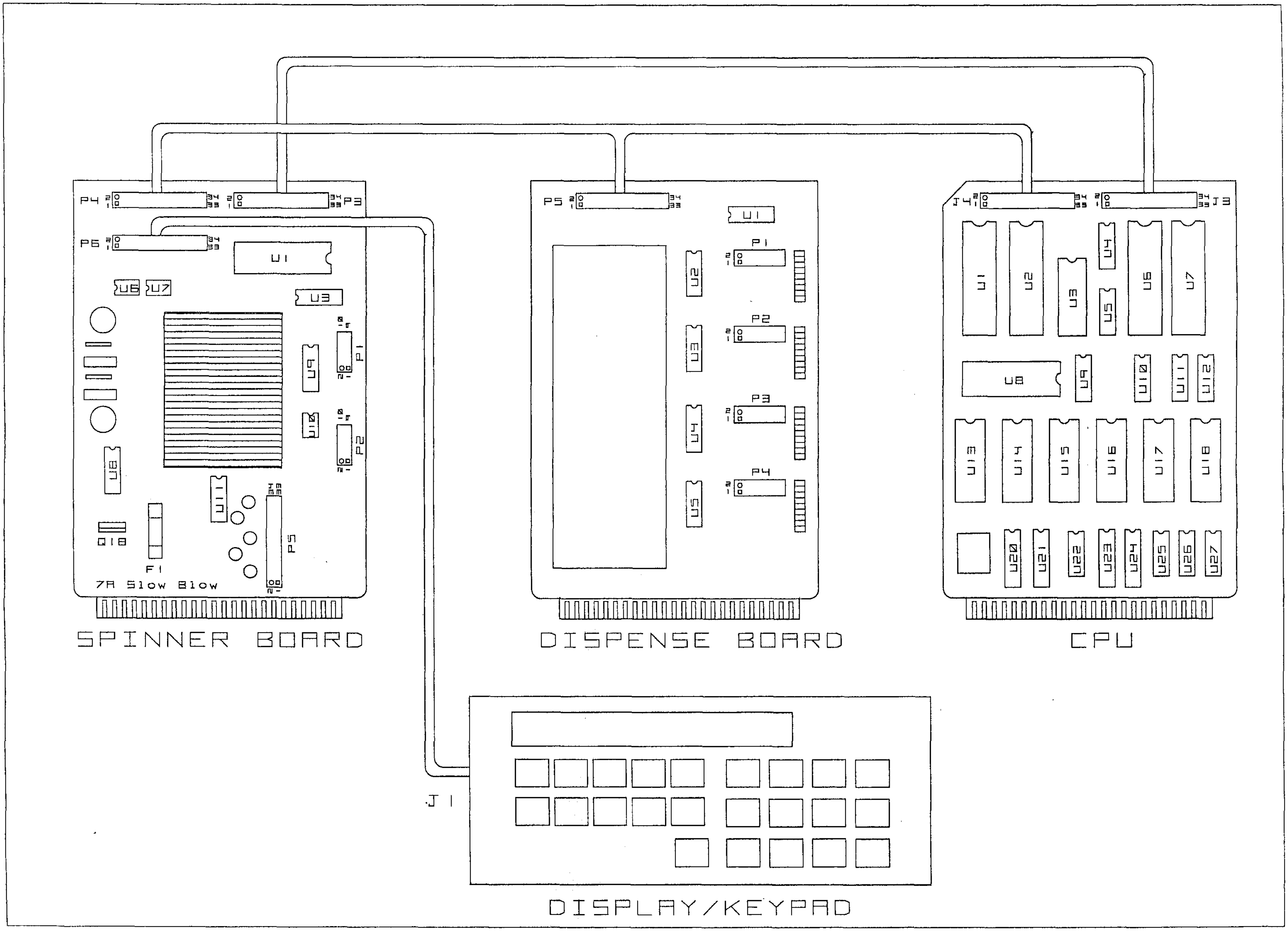
Question #2 - Do you hear or feel vacuum at the center of the spin chuck ?

Yes: Go to question number 3.

No: Go to step number 4.

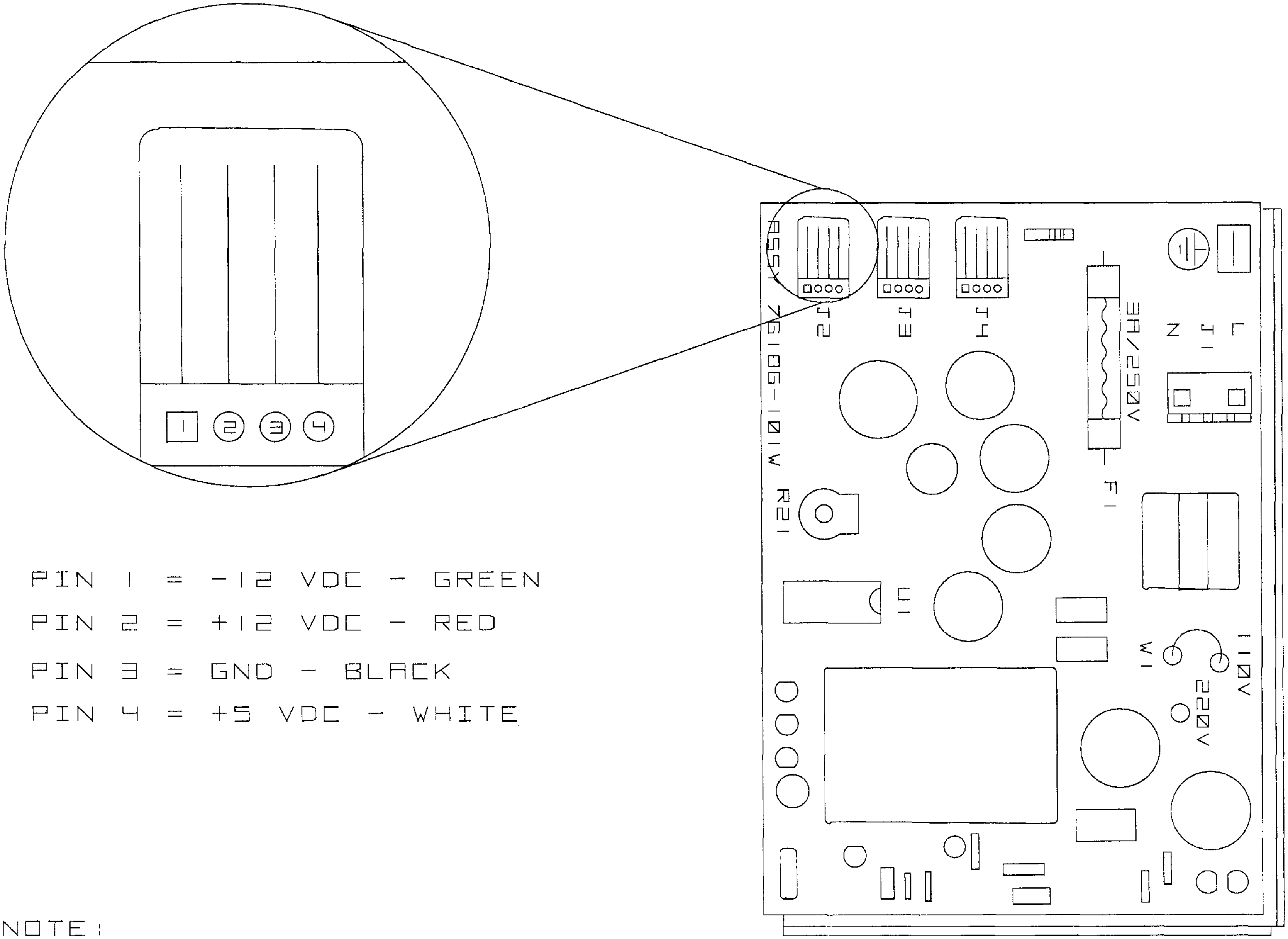
3. Place a substrate on the spin chuck.

Cee Model 100 Series
ELECTRONICS LAYOUT



SPL-50 DC JWER SUPPLY

BSI# 100087A



PIN 1 = -12 VDC - GREEN

PIN 2 = +12 VDC - RED

PIN 3 = GND - BLACK

PIN 4 = +5 VDC - WHITE

NOTE:

ALL 3 CONNECTORS HAVE THE SAME VOLTAGE.

IF THE 3 AMP FUSE OPENS, THE POWER SUPPLY NEEDS TO BE REPLACED.

ASTRODYNE [' POWER SUPPLY

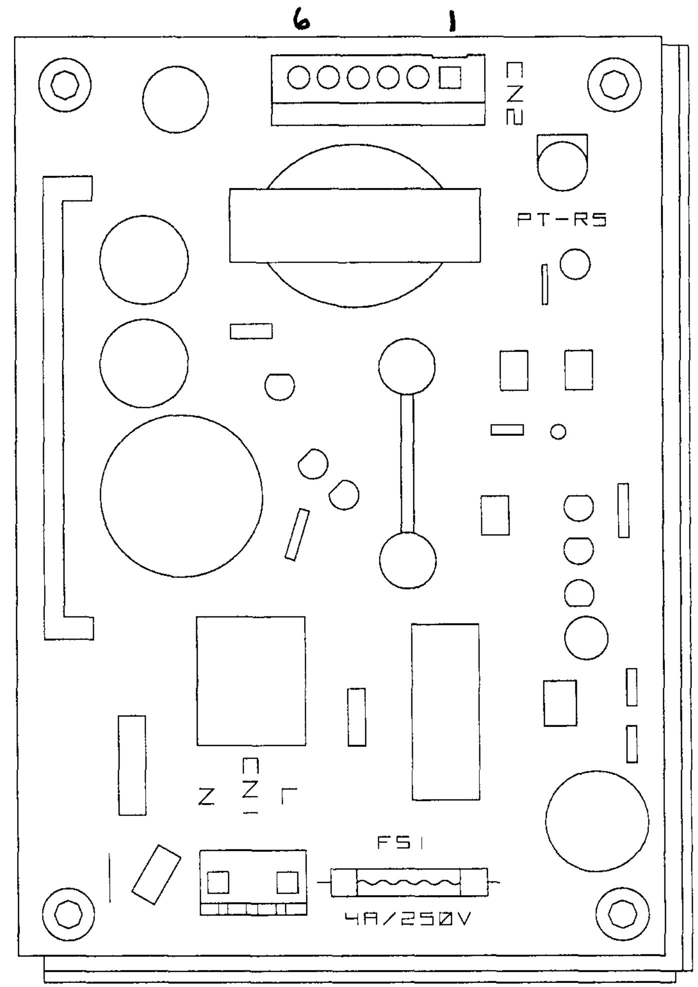
BSI# 101047A

PIN 1 = +12 VDC - PURPLE

PIN 3 = +5 VDC - PURPLE

PIN 4 = GND - BROWN

PIN 6 = -12 VDC - PURPLE



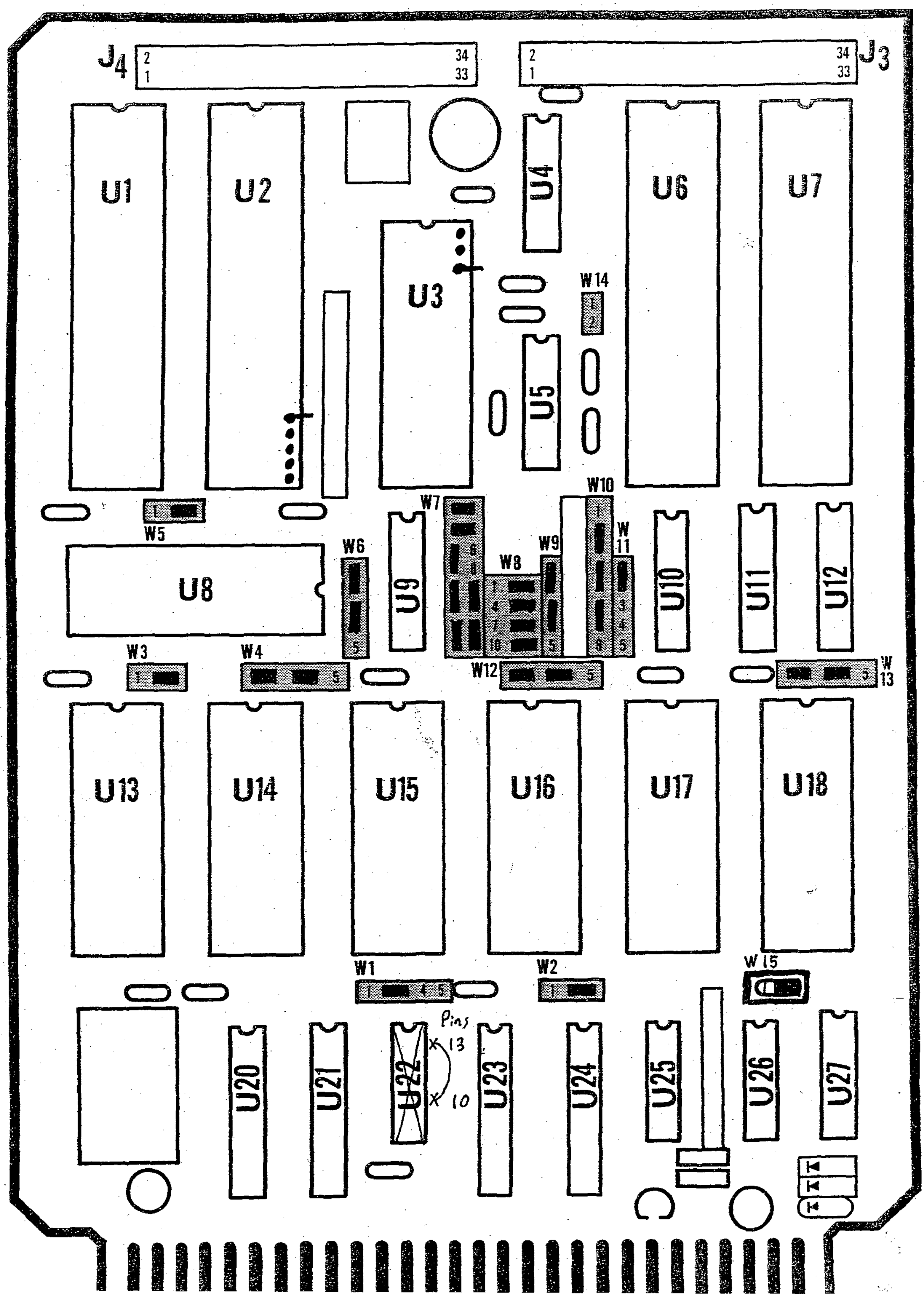
Serial CPU Boards - 8K RAM

Jumper Positions (W1 - W15) when using a 8K RAM (U8)

Remove IC Pin# 26 (U3) & Pin# 25 (U2)

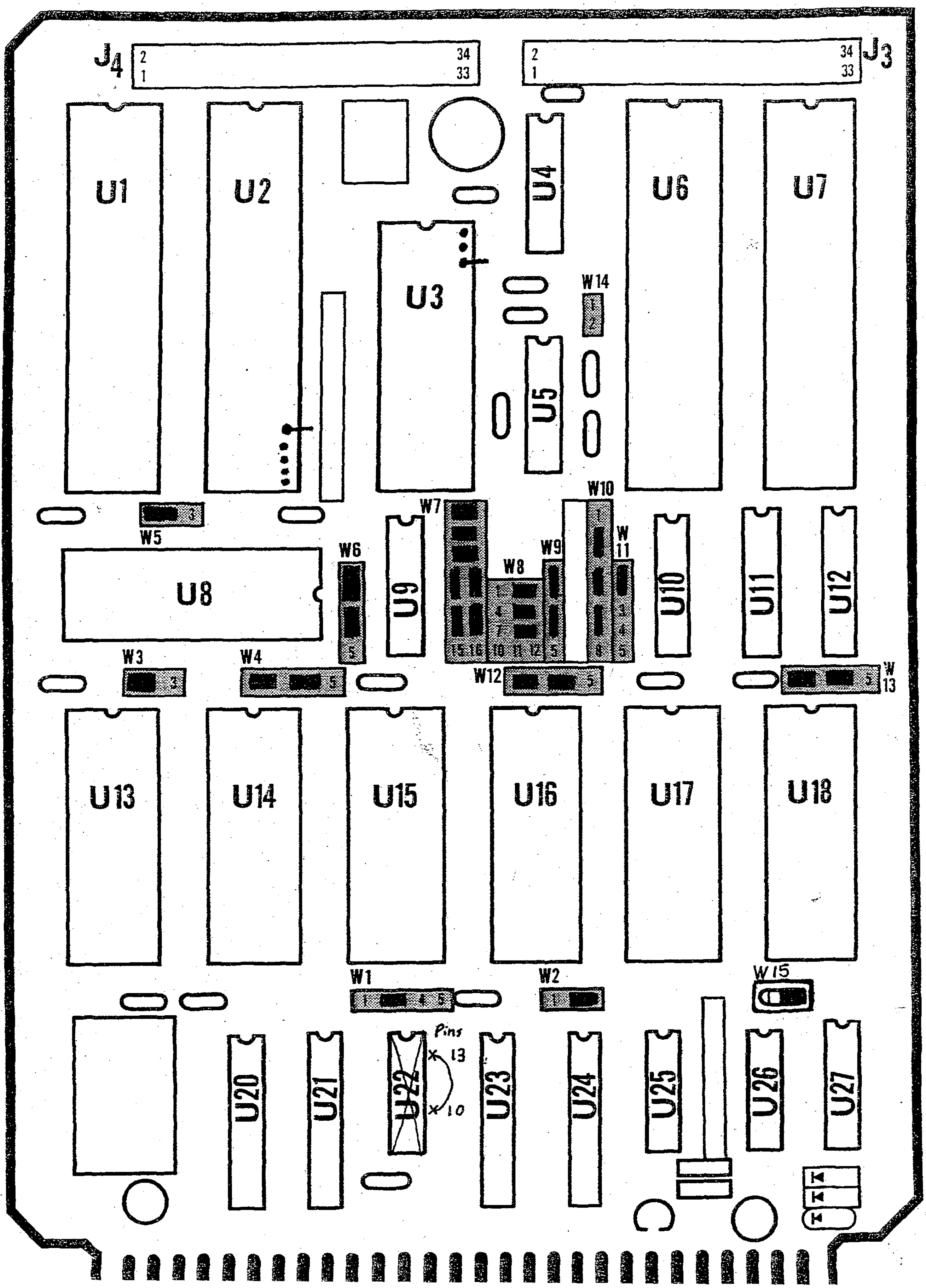
Solder Pin# 10 to 13 at IC Location U22

CuBIT Model 7530 & 7540

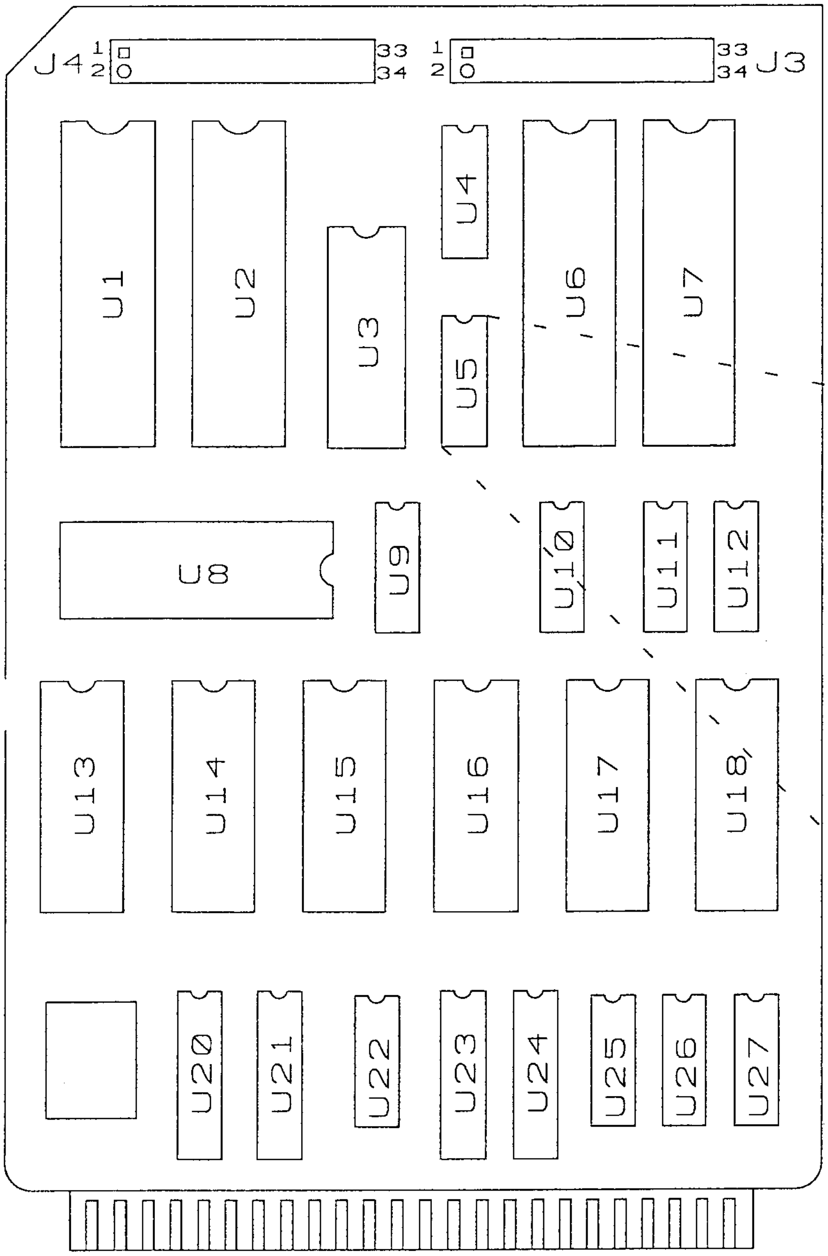


Serial CPU Boards - 2K RAM

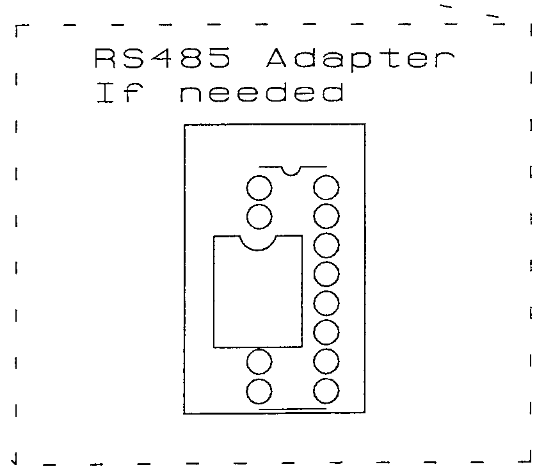
Jumper Positions (W1 - W15) when using a 2K RAM (U8)
Remove IC Pin# 26 (U3) & Pin# 25 (U2)
Solder Pin# 10 to 13 at IC Location U22
CuBIT Model 7530 & 7540



Serial CPU Board
Model 7530 & 7540

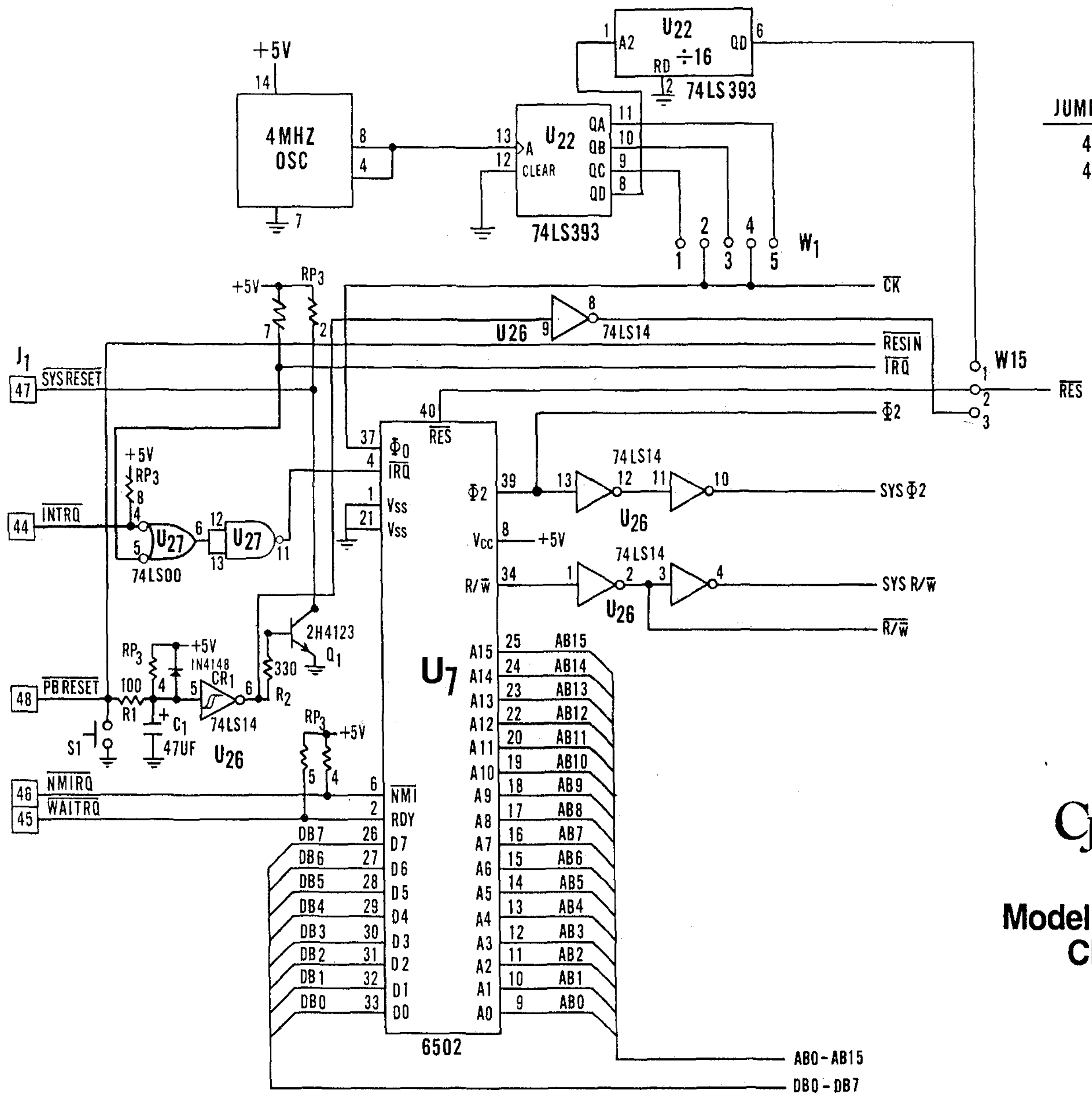


U5 = RS485 Adapter
U8 = RAM #1
U13 = RAM #2
U14 = E000 ROM
U15 = C000 ROM
U16 = A000 ROM
U17 = 8000 ROM
U18 = 6000 ROM



Power on the STD Bus
+5 VDC = pin's 1&2
GND = pin's 3&4

135... Component Side.



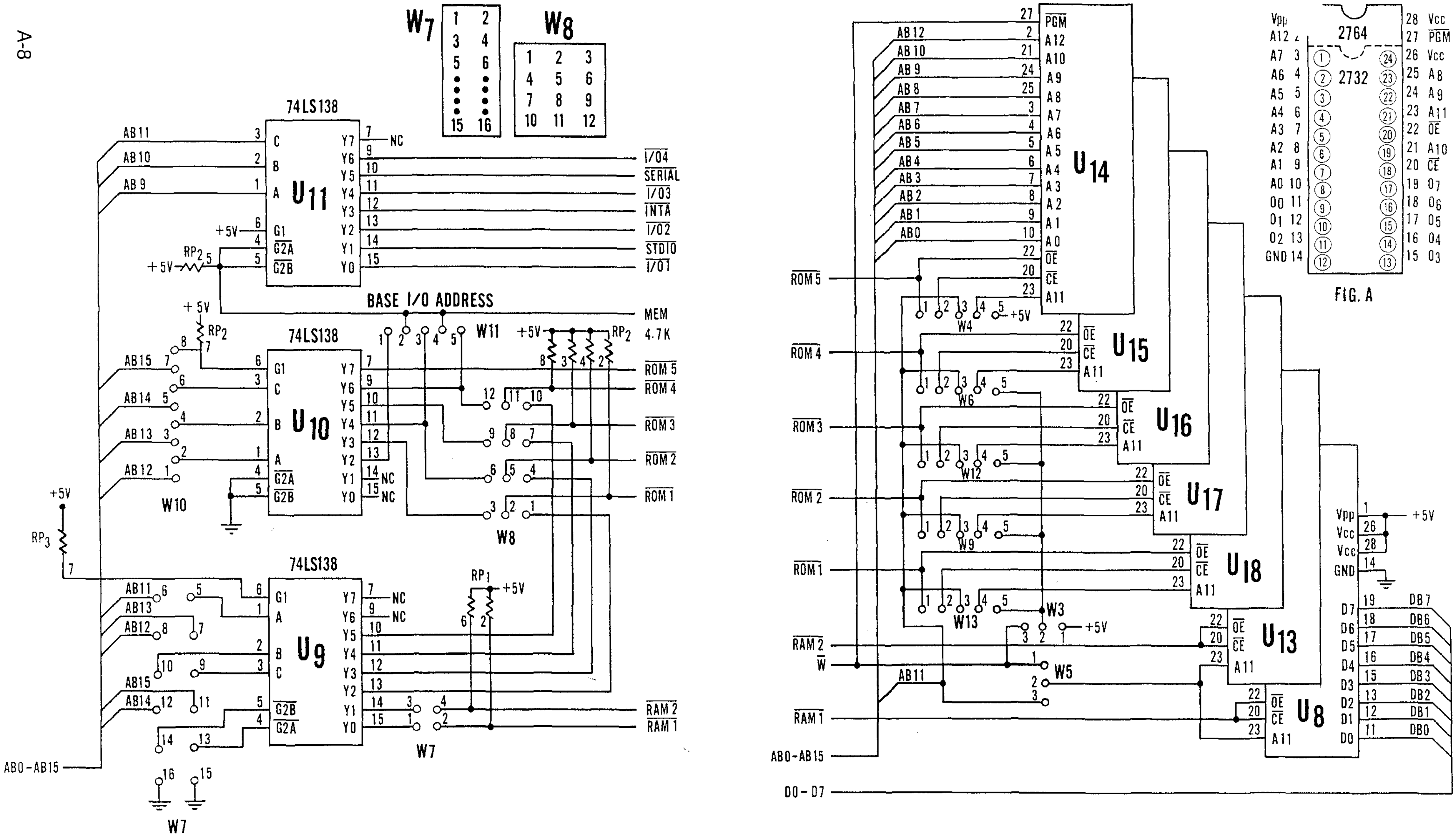
W1

JUMPER	FREQUENCY
4 - 5	2 MHZ
4 - 3	1 MHZ

CuBIT DIVISION OF PROTEUS INDUSTRIES

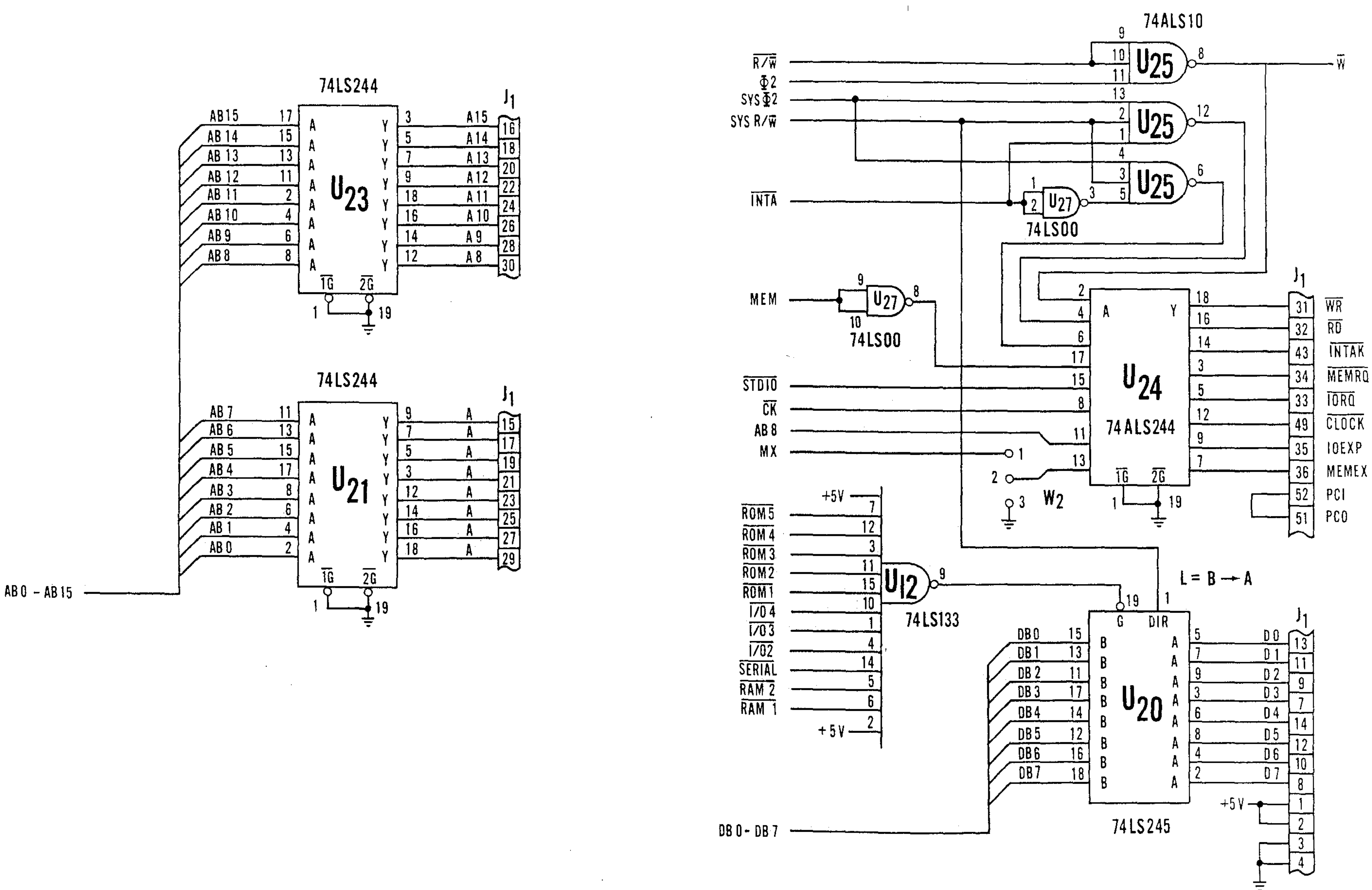
Model 7530 and 7540 CPU Boards

REV B
Sheet 1 of 4



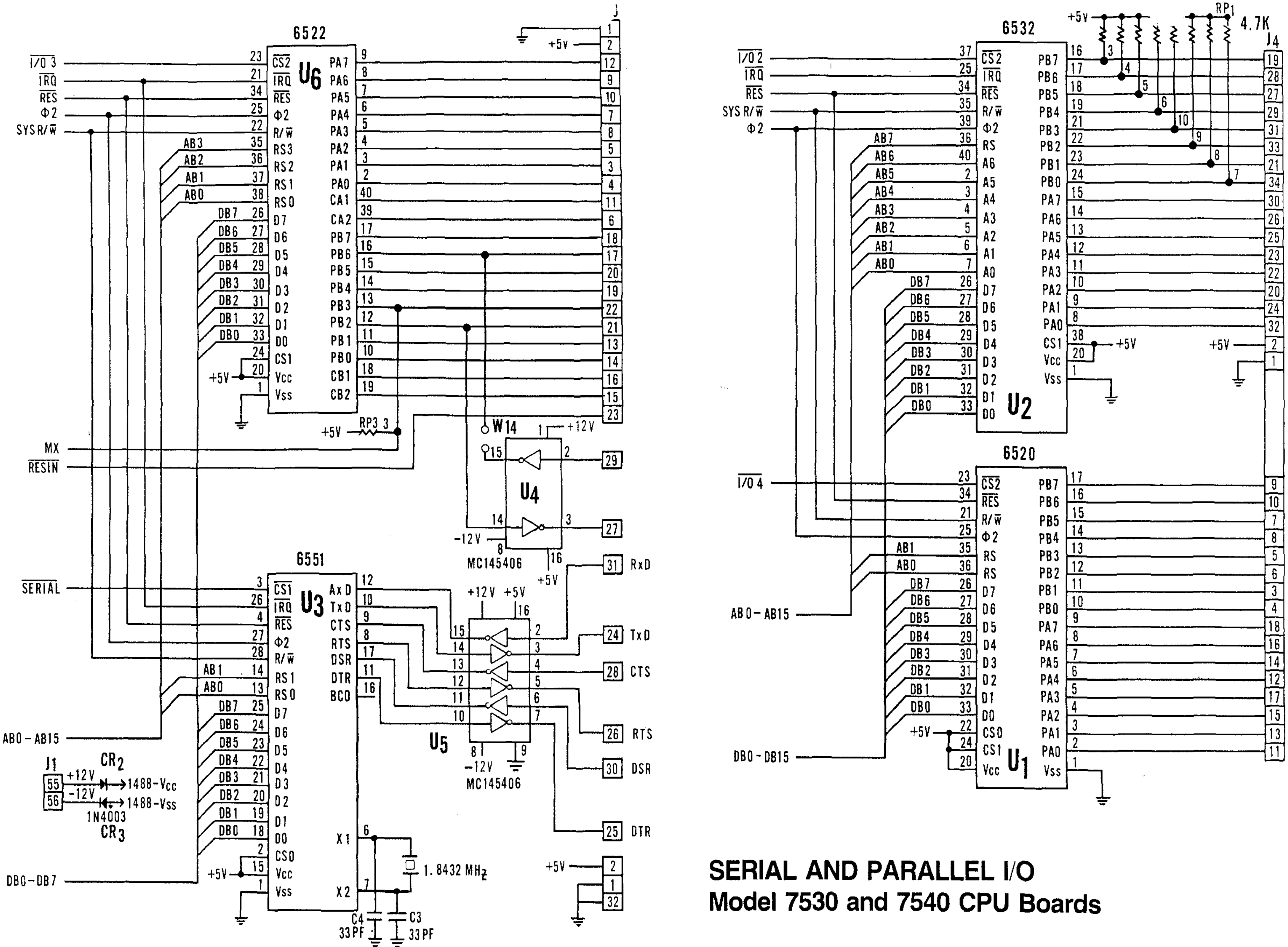
MEMORY AND MEMORY CONTROL
Model 7530 and 7540 CPU Boards

REV B
Sheet 2 of 4



I/O BUS SIGNALS
Model 7530 and 7540 CPU Boards

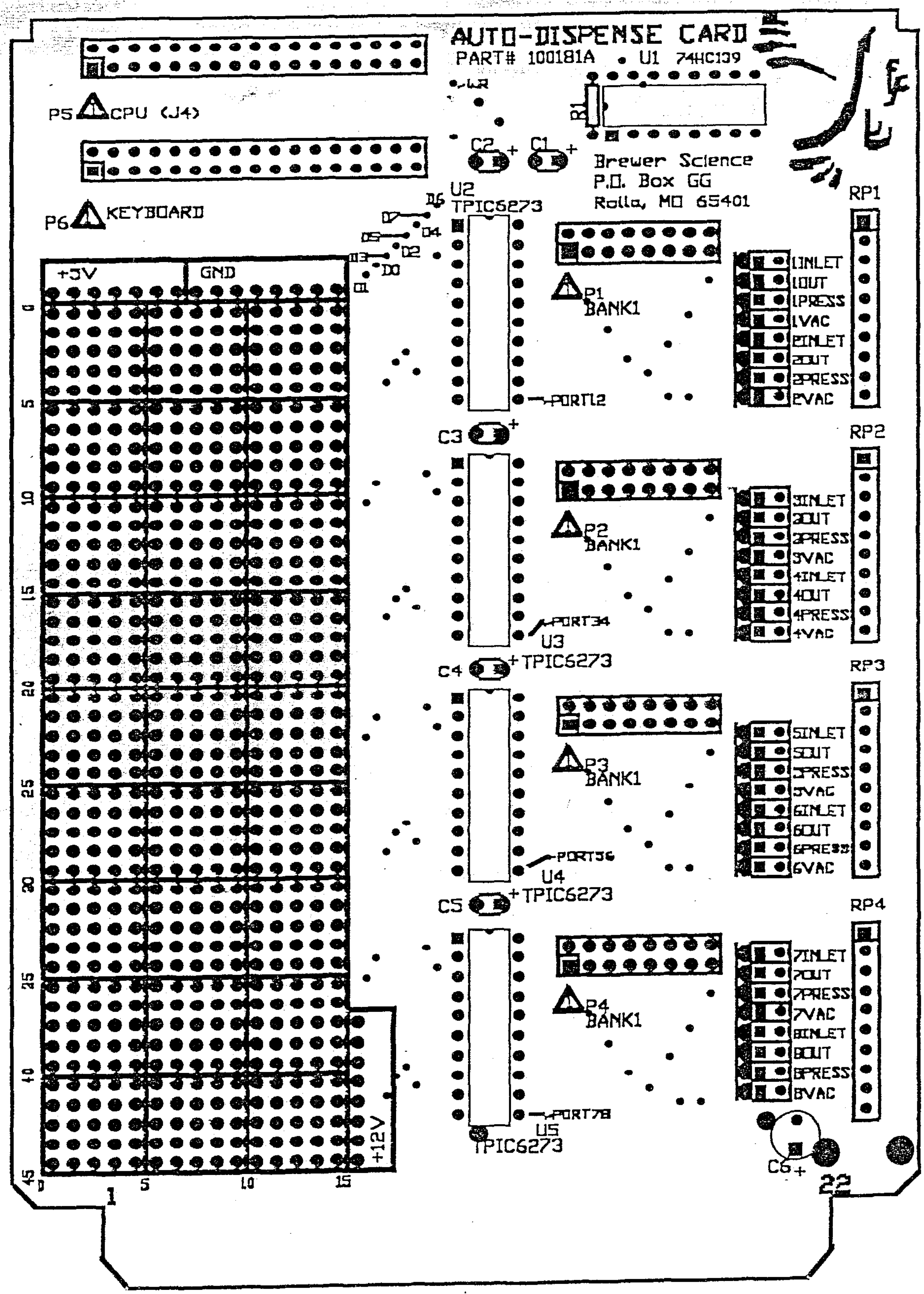
REV B
Sheet 3 of 4

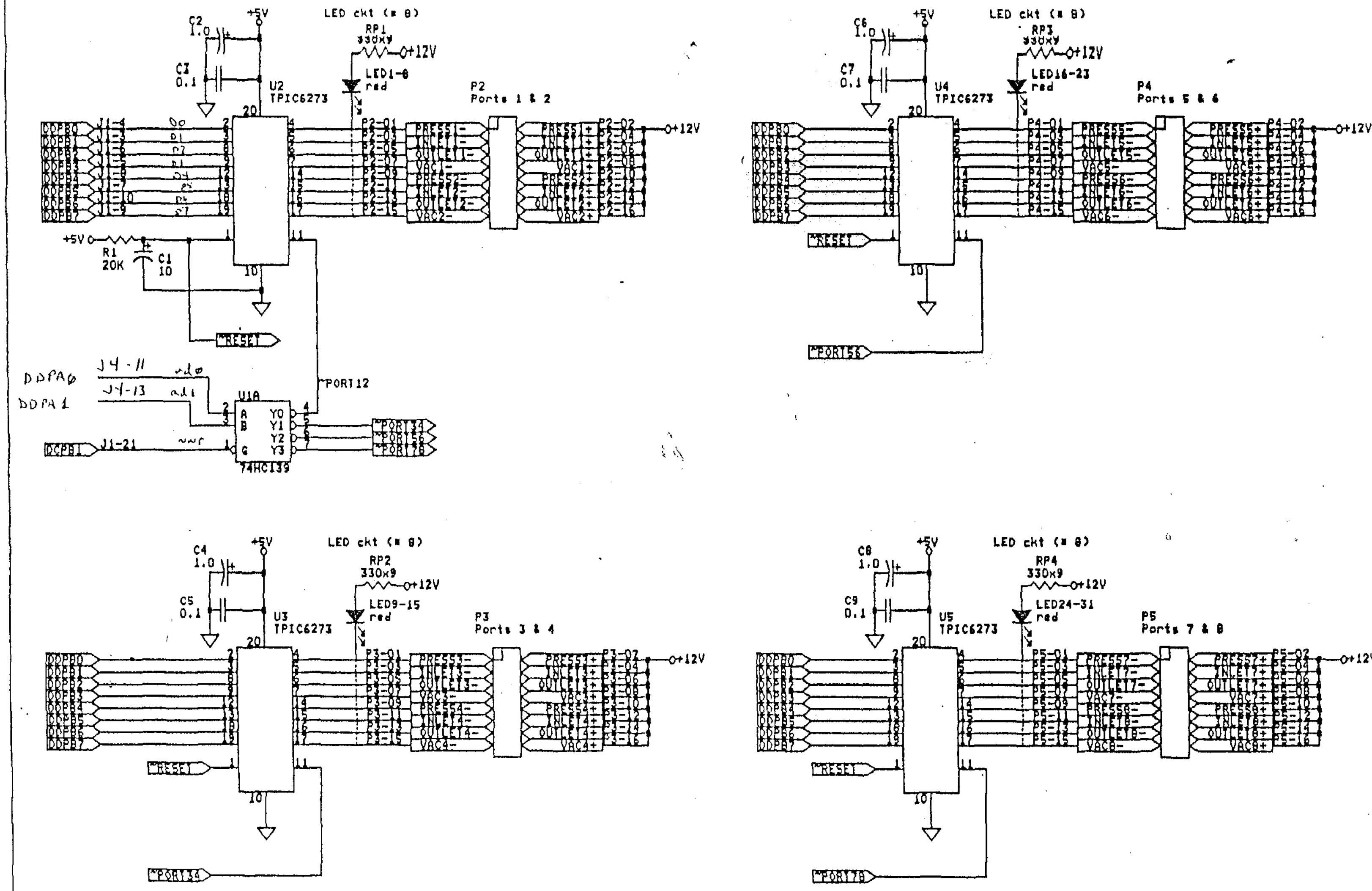


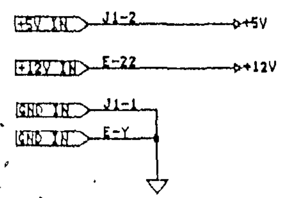
SERIAL AND PARALLEL I/O
Model 7530 and 7540 CPU Boards

REV B
Sheet 4 of 4

Auto-Dispense Board



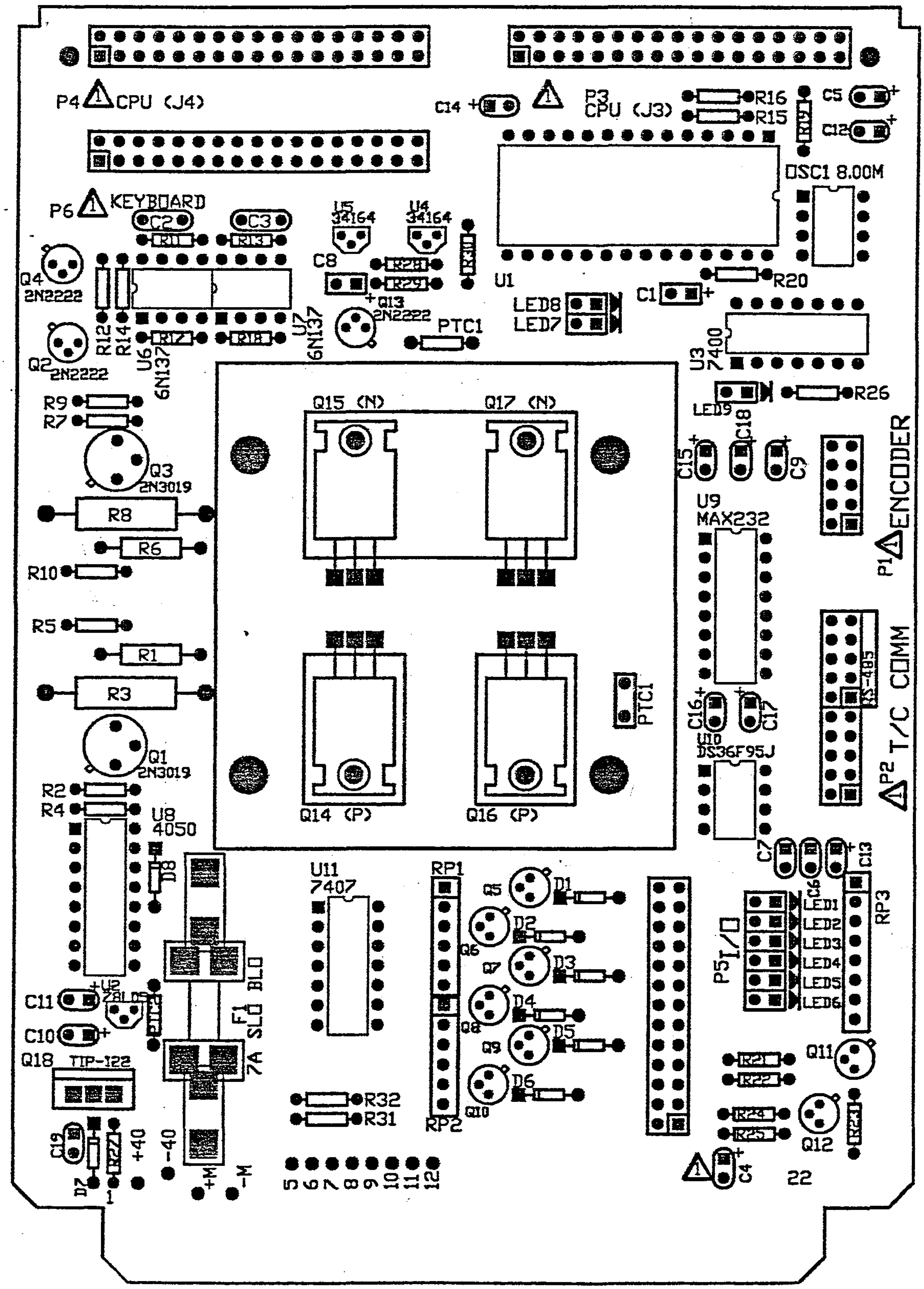




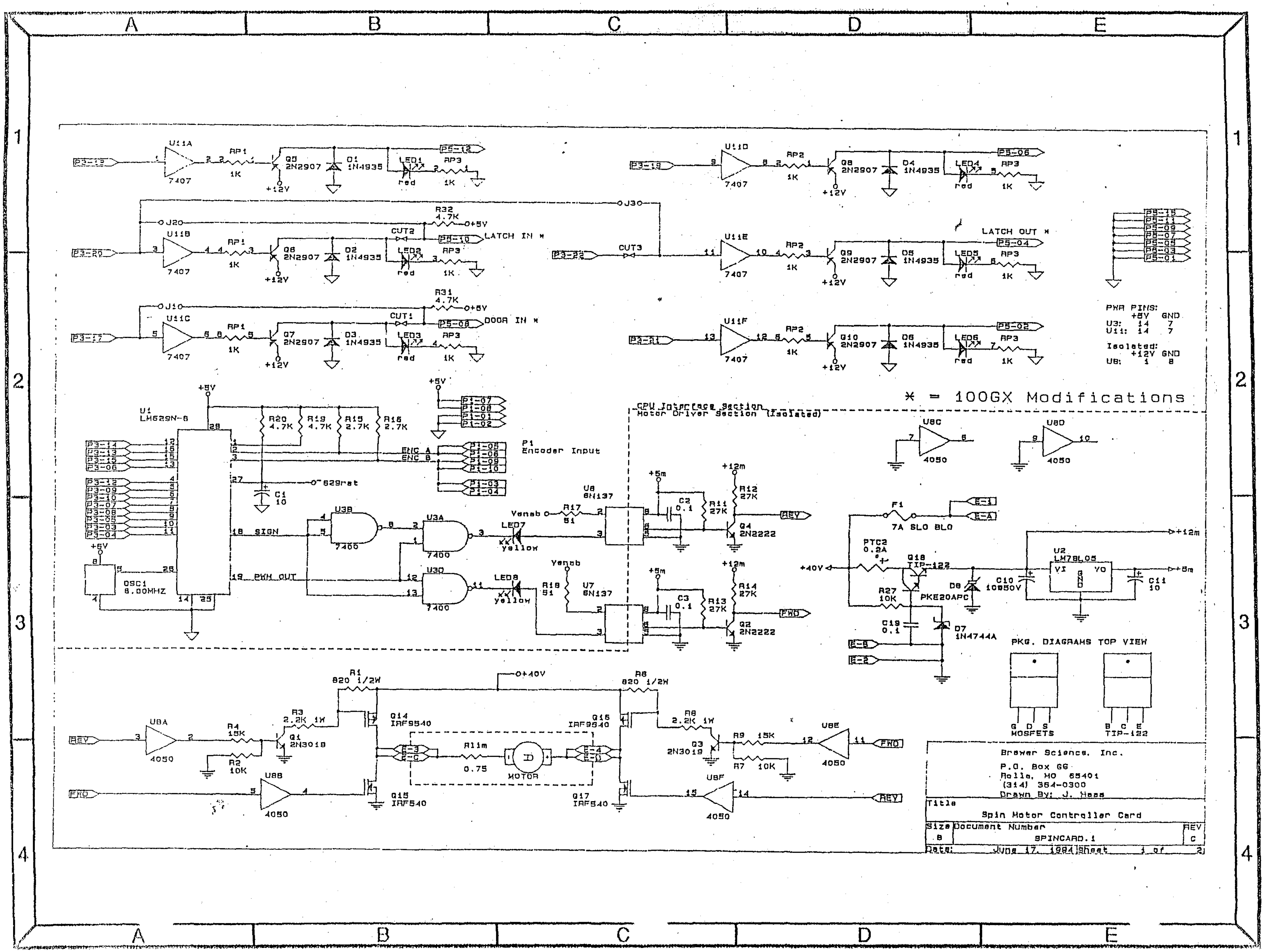
NOTES:
For machines that require only one driver chip, the 74HC139 may be omitted and DCPB1 can be connected to pin 11 of the TPIC6273.
E-x designations are edge connector pins. J1 goes to the CuBit J4 connector.
The connector for J1 can be crimped mid-cable to allow it to daisy-chain with the display connector.
Dispense wiring color code:
INLET = BRN/RED
OUTLET = YEL/ORG
PRESS = BLU/GRN
VAC = GRAY/VIO

Brewer Science, Inc.
P.O. Box GG
Rolla, MO 65401
(314) 364-0300
drawn by: J. Haas

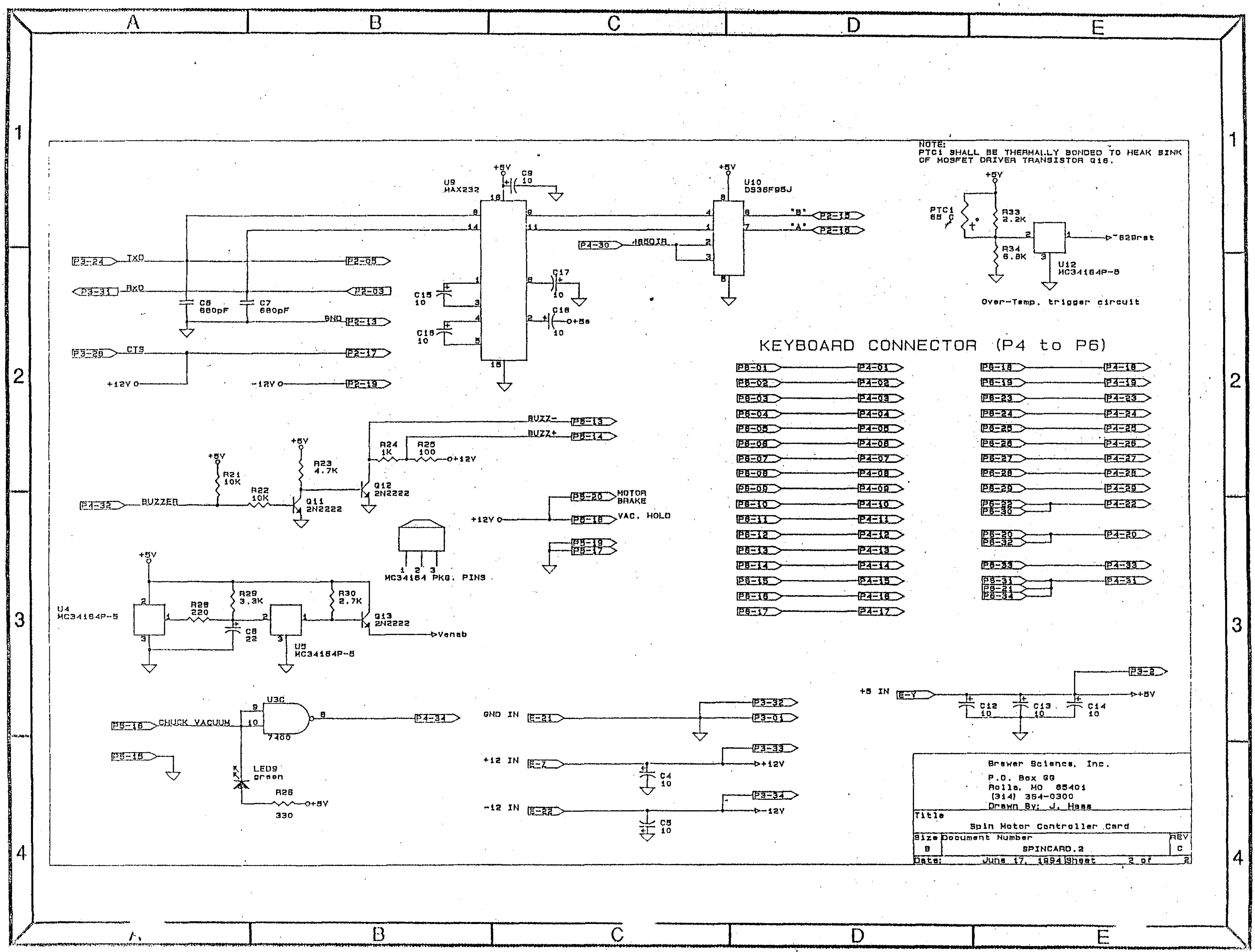
Title			
Model 100CB Auto-Dispense Drivers			
Size	Document Number		REV
B	100OUT.PUT		A
Date:	May 20, 1994	Sheet 1 of 1	



P4 CPU (J4)
P3 CPU (J3)
P6 KEYBOARD
C14
R16
R15
C5
C12
R19
OSC1 8.00M
U1
C2
C3
R11
R13
U5 34164
U4 34164
R30
C8
R28
R29
Q13 2N2222
Q4 2N2222
Q2 2N2222
R12
R14
U6 6N137
U7 6N137
R17
R18
PTC1
LED8
LED7
C1
R20
U3 7400
R26
LED9
C18
C15
C9
R9
R7
Q3 2N3019
R8
R6
R10
R5
R1
R3
Q1 2N3019
R2
R4
U8 4050
D8
Q15 (N)
Q17 (N)
Q14 (P)
Q16 (P)
P1 ENCODER
U9 MAX232
C16
C17
U10 DS36F95J
RS-485
P2 T/C COMM
C7
C6
C13
RP3
LED1
LED2
LED3
LED4
LED5
LED6
P5 I/O
U11 7407
RP1
RP2
Q5
Q6
Q7
Q8
Q9
Q10
D1
D2
D3
D4
D5
D6
F1 SLO BLO 7A
C11
U2 78L05
C10
Q18 TIP-122
C19
D7
R27
1
+40
-40
+M
-M
5 6 7 8 9 10 11 12
R32
R31
R21
R22
R24
R25
R23
Q11
Q12
C4
22

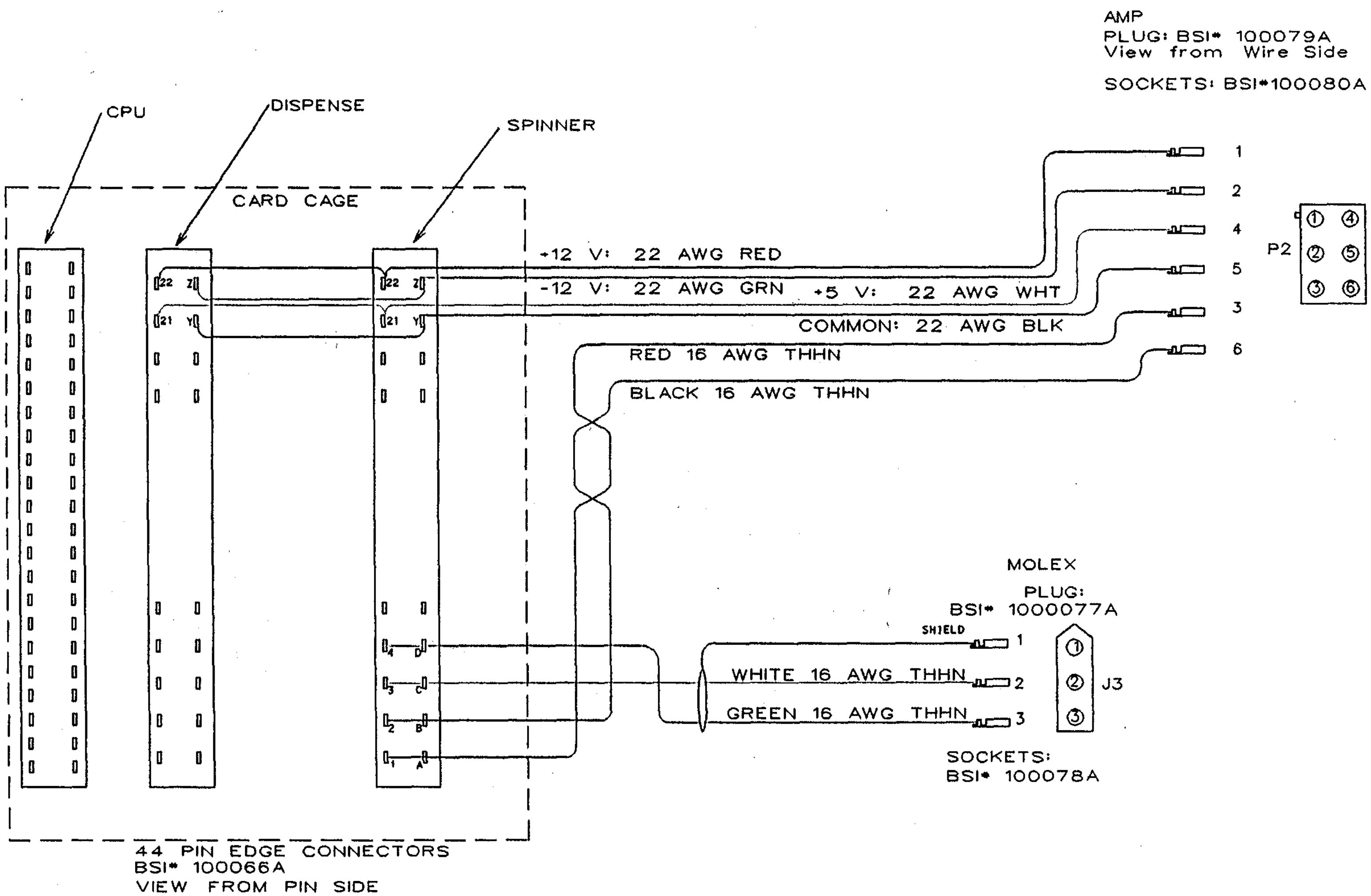


* = 100GX Modifications
CPU Interface Section
Motor Driver Section (Isolated)
LATCH IN *
LATCH OUT *
DOOR IN *
P1 Encoder Input
ENC A
ENC B
U1 LM629N-6
OSC1 8.00MHZ
SIGN
PWM OUT
629rst
PWR PINS: +5V GND
U3: 14 7
U11: 14 7
Isolated: +12V GND
U8: 1 8
U2 LM78L05
F1 7A SLO BLO
PTC2 0.2A
Q18 TIP-122
PKE20APC
D7 1N4744A
MOTOR
R1 820 1/2W
R6 820 1/2W
Q14 IRF9540
Q16 IRF9540
Q15 IRF540
Q17 IRF540
PKG. DIAGRAMS TOP VIEW
G D S MOSFETS
B C E TIP-122
Brewer Science, Inc.
P.O. Box GG
Rolla, MO 65401
(314) 364-0300
Drawn By: J. Haas
Title
Spin Motor Controller Card
Size B
Document Number SPINCARD.1
REV C
Date: June 17, 1994
Sheet 1 of 2


NOTE:
PTC1 SHALL BE THERMALLY BONDED TO HEAK SINK OF MOSFET DRIVER TRANSISTOR Q16.
U9
MAX232
U10
DS36F95J
PTC1
R33
2.2K
R34
6.8K
U12
MC34164P-5
Over-Temp. trigger circuit
TXD
RXD
CTS
GND
C6
680pF
C7
680pF
C9
C15
C16
C17
C18
+12V
-12V
+5V
KEYBOARD CONNECTOR (P4 to P6)
BUZZER
BUZZ-
BUZZ+
R21
10K
R22
10K
R23
4.7K
R24
1K
R25
100
Q11
2N2222
Q12
2N2222
MOTOR
BRAKE
VAC. HOLD
MC34164 PKG. PINS
U4
MC34164P-5
U5
MC34164P-5
R28
220
R29
3.3K
R30
2.7K
C8
22
Q13
2N2222
Venab
U3C
7400
CHUCK VACUUM
LED9
green
R26
330
GND IN
+12 IN
-12 IN
+5 IN
C4
C5
C12
C13
C14
Brewer Science, Inc.
P.O. Box GG
Rolla, MO 65401
(314) 364-0300
Drawn By: J. Haas
Title
Spin Motor Controller Card
Size
B
Document Number
SPINCARD.2
REV
C
Date: June 17, 1994
Sheet 2 of 2

REVISION INFORMATION:

SYMBOL	DATE	ENGR	DESCRIPTION
△			



UNLESS OTHERWISE SPECIFIED LIMITS ON DIMENSIONS ARE FRACTIONS = ± 1/64
.XX = ±.015
.XXX = ±.005
.XXXX = ±.0005

REMOVE ALL BURRS AND SHARP EDGES

MATERIAL

TYPE FINISH REQD.

DESIGN ENGINEER	Jeff Leith
CREATION DATE	1/8/99
APPROVED BY	Jeff Leith
EFFECTIVE DATE	1/8/99

CEE DIVISION
BREWER SCIENCE, INC.
4000 ENTERPRISE DR.
ROLLA, MO 65401
PHONE: (573) 364-0300

TITLE 100 Series Card Cage Wiring Diagram

Controller

Date:

PAPER SIZE A

SHEET OF

PART NO. 300013A

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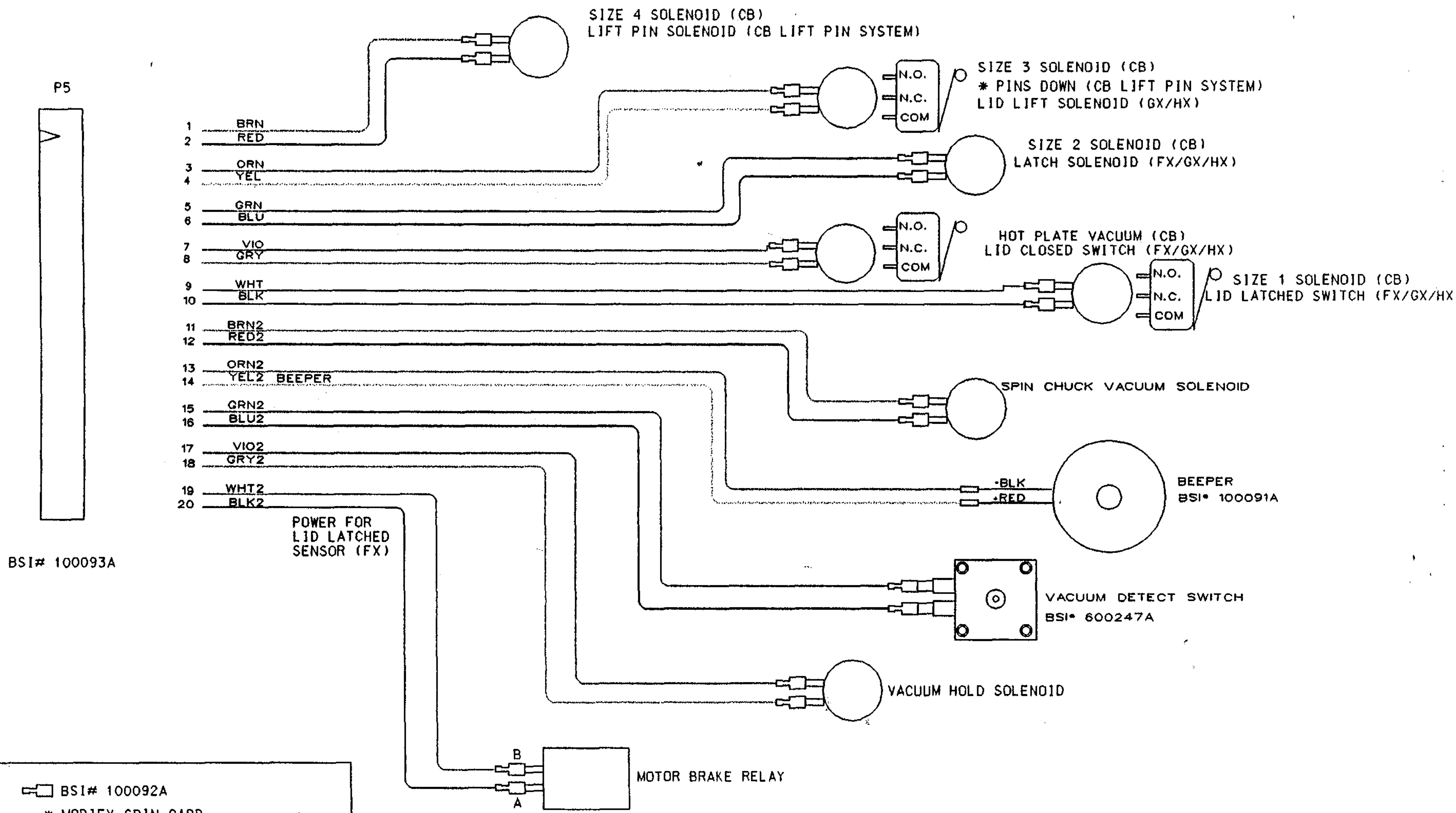
REVISION INFORMATION:			
SYMBOL	DATE	ENGR	DESCRIPTION
△			



NOTES

BSI# 100092A

* MODIFY SPIN CARD

USE NORMALLY OPEN CONTACTS ON SWITCHES

UNLESS OTHERWISE SPECIFIED LIMITS ON DIMENSIONS ARE
ANGULAR = ± 1°
FRACTIONS = ± 1/64
.XX = ± .015
.XXX = ± .005
.XXXX = ± .0005
REMOVE ALL BURRS AND SHARP EDGES

MATERIAL:

TYPE FINISH REQD.:

DESIGN ENGINEER: Jeff Leith

DRAWN:

APPROVED:

DATE: 1/8/99

Cost Effective Equipment
a division of Brewer Science, Inc.
Brewer Science, Inc.
Cee Division
4000 Enterprise Drive
Rolla, Mo. 65401
Phone: (573) 364-0300
Fax: (573) 364-9513

TITLE: 100 Series Solenoid Bracket Wiring Diagram

CONTROLLER:

DATE:

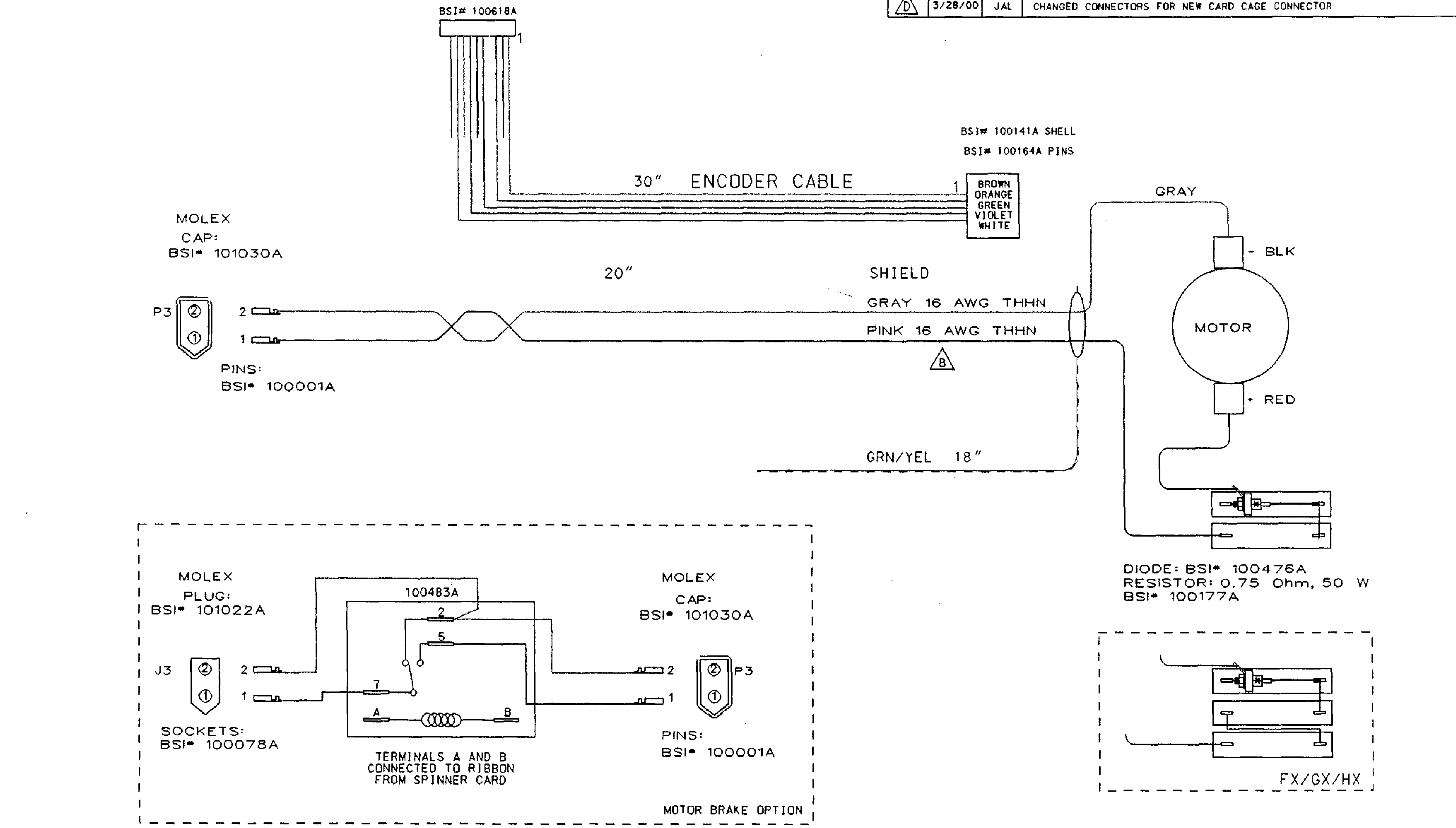
PAPER SIZE: A

SHEET: OF

PART NO.: 300014A

REVISION INFORMATION:

SYMBOL	DATE	ENGR	DESCRIPTION
B	6/21/99	JAL	CHANGED MOTOR WIRE COLORS
C	12/8/99	JAL	ADDED MOTOR BRAKE OPTION
D	3/28/00	JAL	CHANGED CONNECTORS FOR NEW CARD CAGE CONNECTOR



UNLESS OTHERWISE SPECIFIED LIMITS ON DIMENSIONS ARE
ANGULAR = ± 1°
FRACTIONS = ± 1/64
.XX = ± .015
.XXX = ± .005
.XXXX = ± .0005
REMOVE ALL BURRS AND SHARP EDGES

MATERIAL

TYPE FINISH REQD.

DESIGN ENGINEER: Jeff Leith

DRAWN

APPROVED

DATE: 1/11/99

Cost Effective Equipment, a division of Brewer Science, Inc.

Brewer Science, Inc.
Cee Division
4000 Enterprise Drive
Rolla, Mo. 65401
Phone: (573) 364-0300
Fax: (573) 364-9513

TITLE: Model 100 Spinner Motor Wiring Diagram

CONTROLLER

DATE

PAPER SIZE: A

SHEET OF

PART NO. 300015D

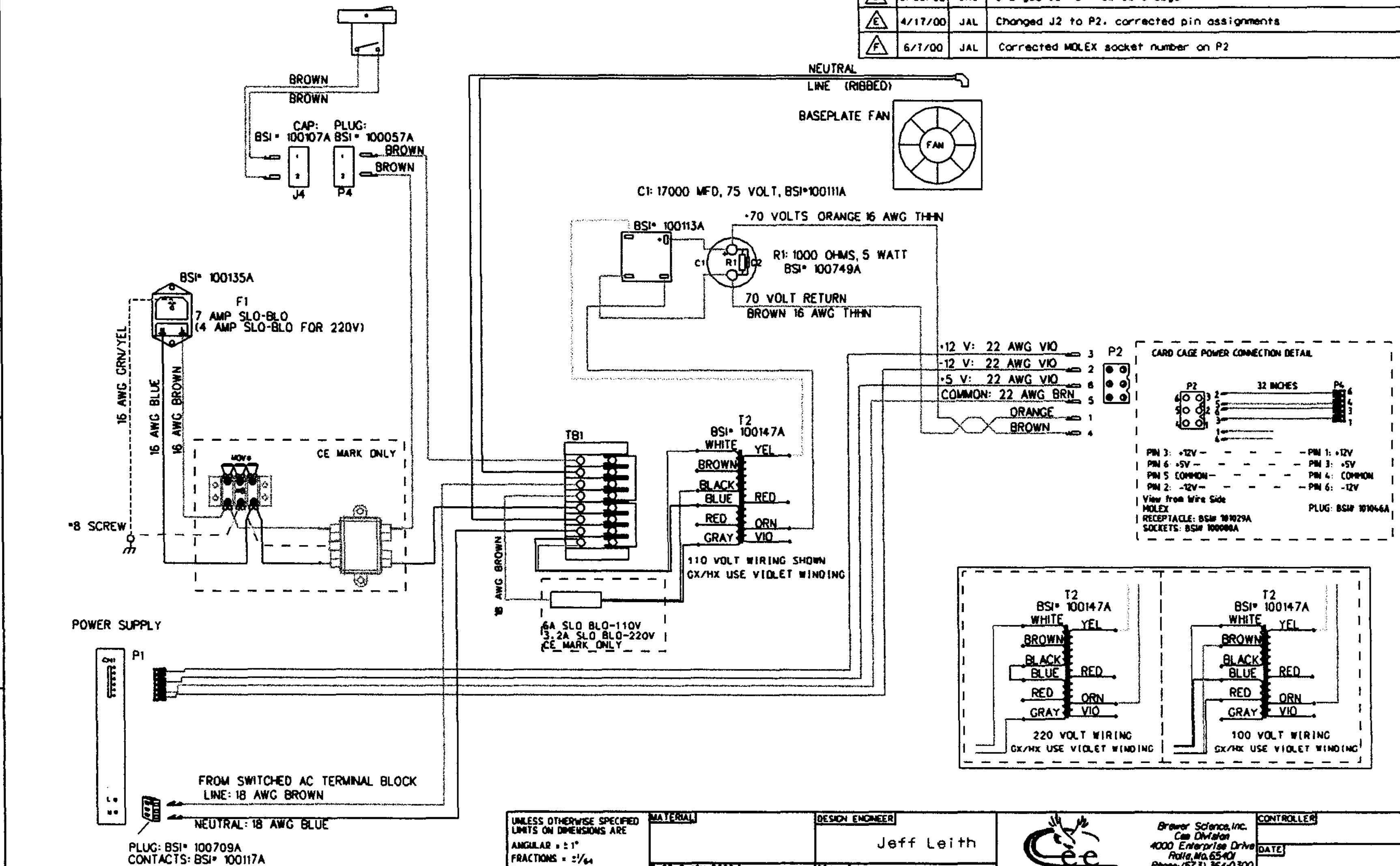
25 APR 20006 14:36:35

REVISION INFORMATION:

SYMBOL	DATE	ENGR	DESCRIPTION
C	12.4.00	JAL	Changed to astrodyne power supply

REVISION INFORMATION:

SYMBOL	DATE	ENGR	DESCRIPTION
B	2/16/00	JAL	Changed wire colors for SEMI
C	3/27/00	JAL	Changed wire colors for CE mark
D	3/28/00	JAL	Changed J2 for new card cage
E	4/17/00	JAL	Changed J2 to P2, corrected pin assignments
F	6/7/00	JAL	Corrected MOLEX socket number on P2



UNLESS OTHERWISE SPECIFIED LIMITS ON DIMENSIONS ARE
ANGULAR ± 1°
FRACTIONS ± 1/64
.XX = ±.015
.XXX = ±.005
.XXXX = ±.0005
REMOVE ALL BURRS AND SHARP EDGES

MATERIAL:

TYPE FINISH REQD.:

DESIGN ENGINEER: Jeff Leith

DRAWN:

APPROVED:

DATE: 2/16/00

Cost Effective Equipment, a division of Brewer Science, Inc.
Brewer Science, Inc.
Cee Division
4000 Enterprise Drive
Rolla, Mo. 65401
Phone: (573) 364-0300
Fax: (573) 364-9513

TITLE: Model 100 Wiring Diagram

CONTROLLER:

DATE:

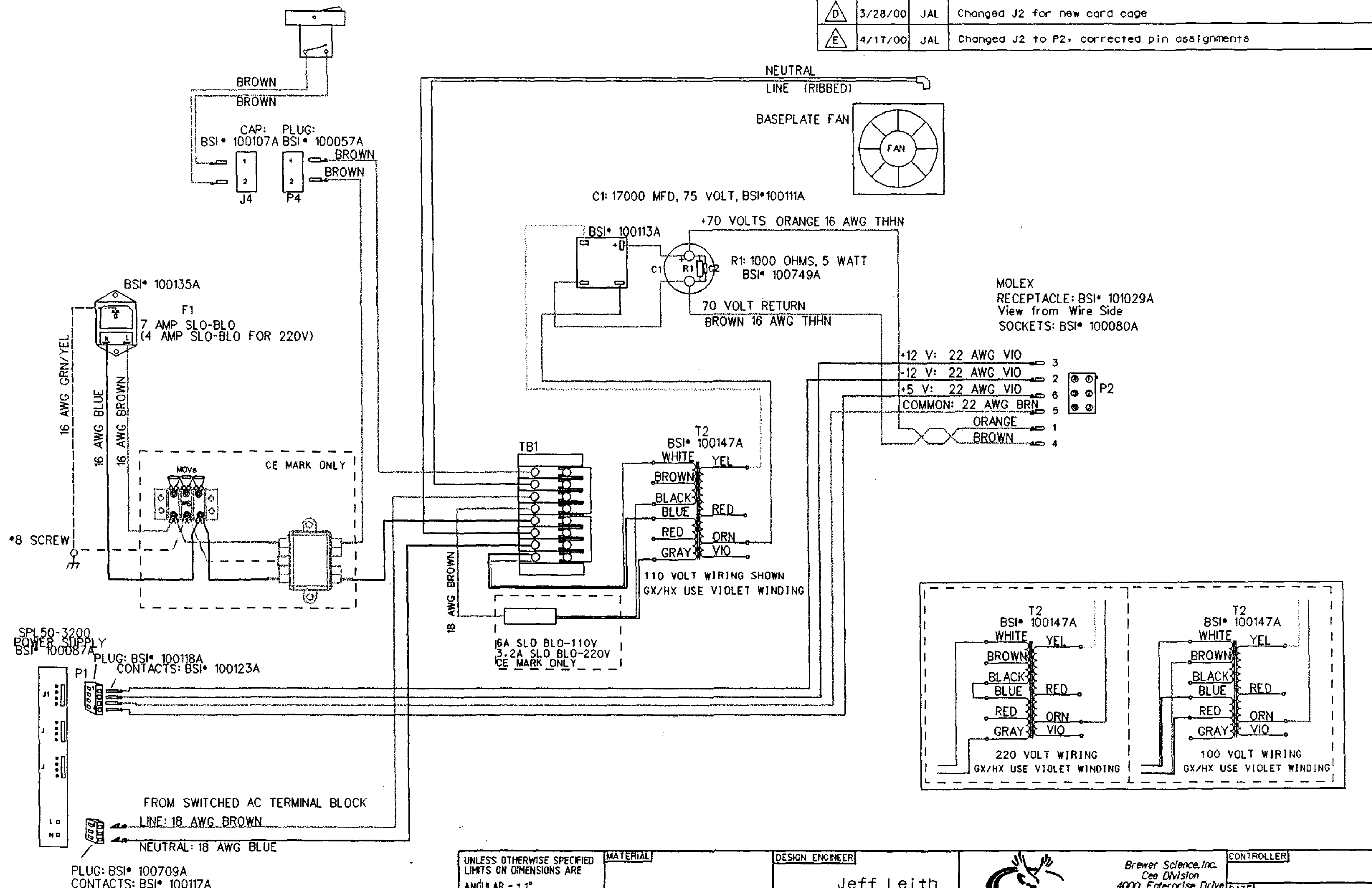
PAPER SIZE: A

SHEET: of

PART NO.: 3000160

REVISION INFORMATION:

SYMBOL	DATE	ENGR	DESCRIPTION
B	2/16/00	JAL	Changed wire colors for SEMI
C	3/27/00	JAL	Changed wire colors for CE mark
D	3/28/00	JAL	Changed J2 for new card cage
E	4/17/00	JAL	Changed J2 to P2, corrected pin assignments



UNLESS OTHERWISE SPECIFIED LIMITS ON DIMENSIONS ARE
ANGULAR = ± 1°
FRACTIONS = ± 1/64
.XX = ± .015
.XXX = ± .005
.XXXX = ± .0005
REMOVE ALL BURRS AND SHARP EDGES

MATERIAL	DESIGN ENGINEER		CONTROLLER
	Jeff Leith		DATE
TYPE FINISH REQD.	DRAWN		PAPER SIZE: A / SHEET: OF
	APPROVED	TITLE: Model 100 Wiring Diagram	PART NO.: 300016E
	DATE: 2/16/00		

Cost Effective Equipment, a division of Brewer Science, Inc.
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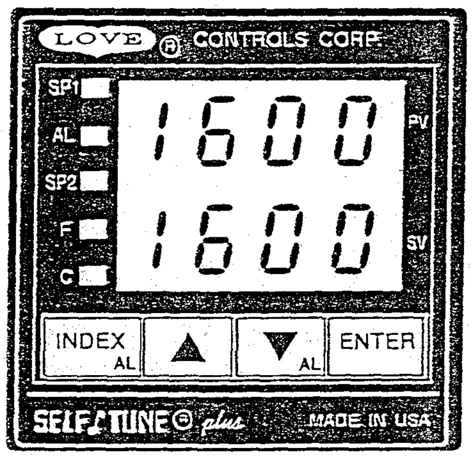
25 APR 2006 14:41:16

MARCH 1993

INSTRUCTIONS FOR THE 1600 SERIES MICROPROCESSOR BASED TEMPERATURE / PROCESS CONTROL

INCLUDES FUZZY LOGIC OPTION



If all else fails, please read these instructions

LOVE®
CONTROLS DIVISION
Dwyer® Instruments, Incorporated
1475 S. WHEELING ROAD • WHEELING ILLINOIS 60090
(708) 541-3232 • FAX (708) 541-7366

949-1239-2

TABLE OF CONTENTS

GETTING STARTED

1. Install the control as described on page 3.
2. Make sure that the Input DIP switch is set correctly for the input you wish to use. Instructions on page 3.
3. If you wish to use the Logic (5 VDC) output, make sure that the Logic jumper is in the correct position. See page 4 for details.
4. Wire your control following the drawing on page 5.
5. Make any programming changes necessary first in the Secure Menu (page 11), next in the Secondary Menu (page 8), and finally in the Primary Menu (page 7). DO NOT make changes to the Configuration Menu unless specifically instructed. If you need to back up in a menu, press the INDEX and DOWN ARROW keys together.
6. To quickly return to the HOME position, press the UP ARROW and ENTER keys together, and then the INDEX and DOWN ARROW keys.

HOW TO USE THIS BOOK

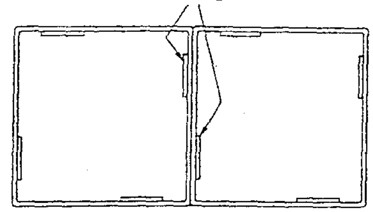
Because of the number of features available in this control, information is included that may not apply to your specific control. Options, for example, are included in this book, but may not be included in your control. To increase clarity the following conventions are used:

1. Optional features or functions are shown in this book in *Roman type*. The Option code (from the configuration menu) is listed after the menu item in parenthesis. If you do not have an option installed, you may skip any items listed in *Roman type*.

2. The "#" symbol is used in two ways. It is used inside a group of characters to indicate which set point function (SP1 or SP2) is being affected. *It is also used before a group of characters of a menu item to indicate that there may be more than one selection or value for that menu item. This is only used when the 4-stage set point option is used (948).*

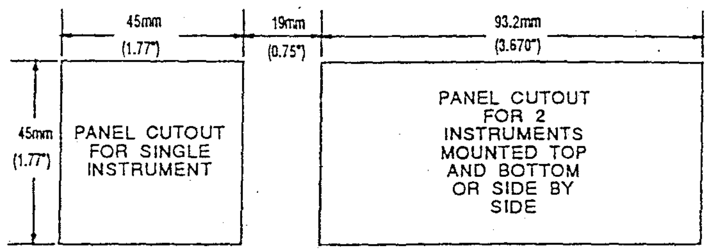
INSTALLATION

Mount the instrument in a location that will not be subject to excessive temperature, shock, or vibration. All models are designed for mounting in an enclosed panel.



Select the position desired for the instrument on the panel. If more than one instrument is required, only two units can be mounted closely together, either one above the other or side by side. When mounted together, the mounting collar will require modification by removing the inside tab from each collar.

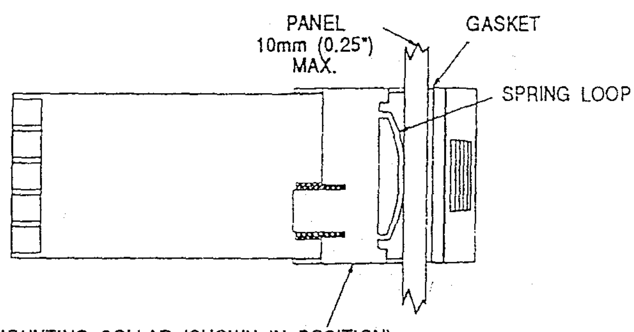
Prepare the panel by cutting and deburring the required opening.



ALL TOLERANCES ARE
-0.00 +0.25mm (-0.000 +0.010)

From the front of the panel, slide the housing through the cut out. The housing gasket should be against the housing flange before installing.

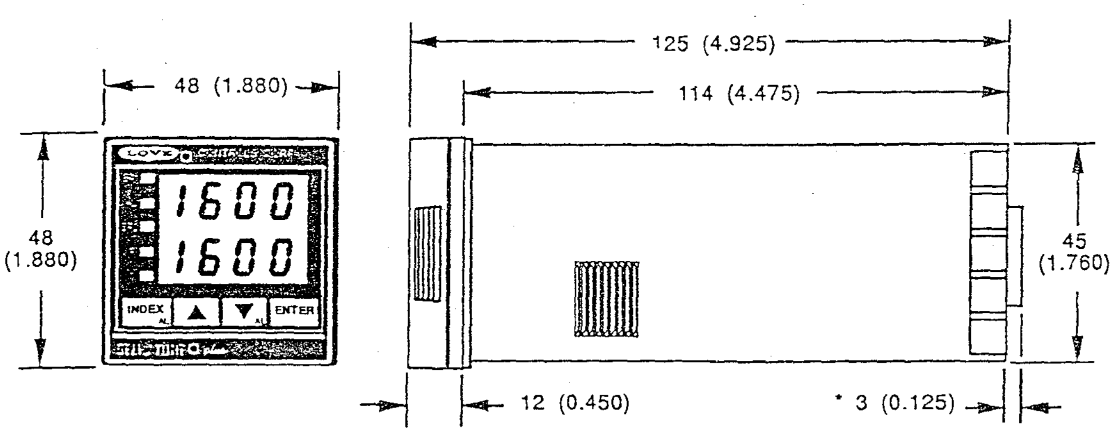
From the rear of the panel slide the mounting collar over the housing. Hold the housing with one hand and using the other hand, push the collar evenly against the panel until the spring loops are slightly compressed. The ratchets will hold the mounting collar and housing in place.



MOUNTING COLLAR (SHOWN IN POSITION)
SLIDE COLLAR ONTO THE HOUSING
BEFORE WIRING THE REAR TERMINALS

DIMENSIONS

(ALL DIMENSIONS IN MM WITH INCHES IN PARENTHESIS)

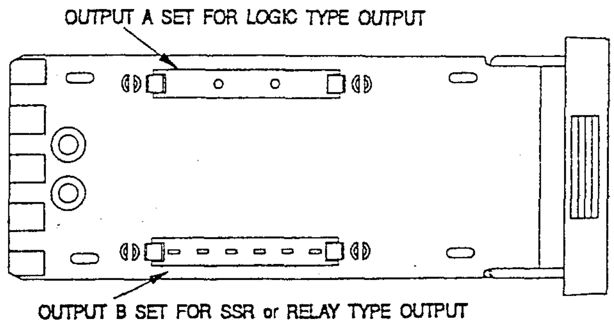


PANEL CUTOUT FOR ALL MODELS 45 MM X 45 MM (1.775" X 1.775")
ALLOW FOR 13 MM (0.5") CLEARANCE AT THE REAR OF INSTRUMENT.
* PRESENT FOR ALL OUTPUTS OTHER THAN RELAY.

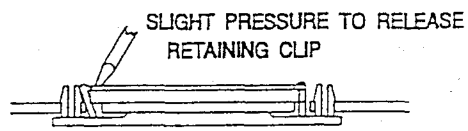
LOGIC JUMPER SELECTION

Instruments with **SSR** or **RELAY** type outputs can be changed to and from a **LOGIC** output in the field.

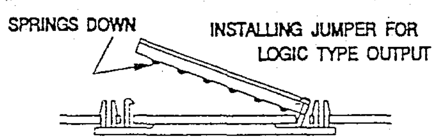
CAUTION: Damage to the instrument may result from an incorrectly installed jumper strip. Follow the instructions carefully.

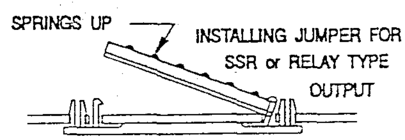


1. Remove the instrument from its housing. Grasp the front bezel sides and pull forward to release it from the housing lock.
2. Locate the desired logic jumper strip on the left printed circuit board. The **OUTPUT A** jumper strip is always located near the top edge
3. To remove the logic jumper strip, carefully insert a small flat blade screwdriver between the retaining clip and the jumper at one end of the jumper strip. Apply slight pressure to move the clip away from the jumper end until it is released, then lift it up and out of the clip.



4. To re-install the jumper strip, hold it with the spring contacts in the desired position. Face springs **up** for **SSR** or **RELAY** outputs, or face springs **down** for **LOGIC** outputs. Insert one end of the jumper strip under the retaining clip and press the other end down until the remaining clip engages the jumper.



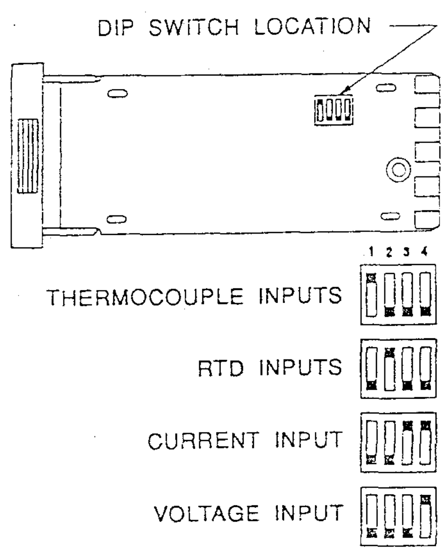


5. To avoid any damage, recheck the jumper installation and the housing rear terminal panel output wiring.
6. Replace the instrument into its housing.

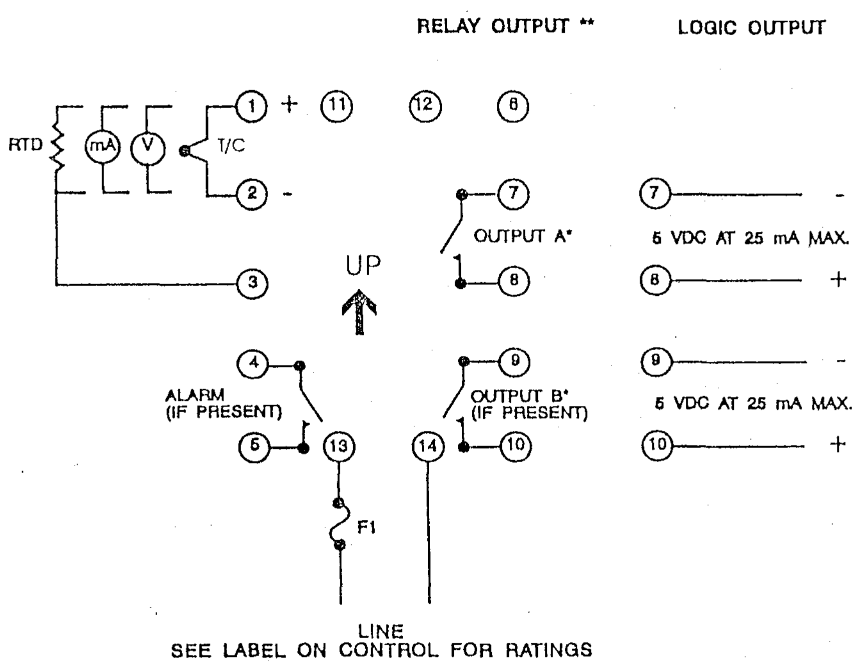
INPUT SELECTION

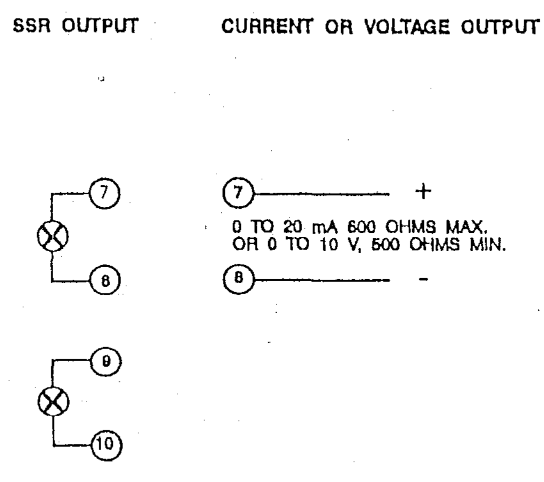
To change the input type, remove the instrument from its housing. Grasp the front bezel sides and pull forward to release it from the housing lock. Locate the dip switch on the right pcb. Determine the input type desired and change the dip switch setting as shown at the right.

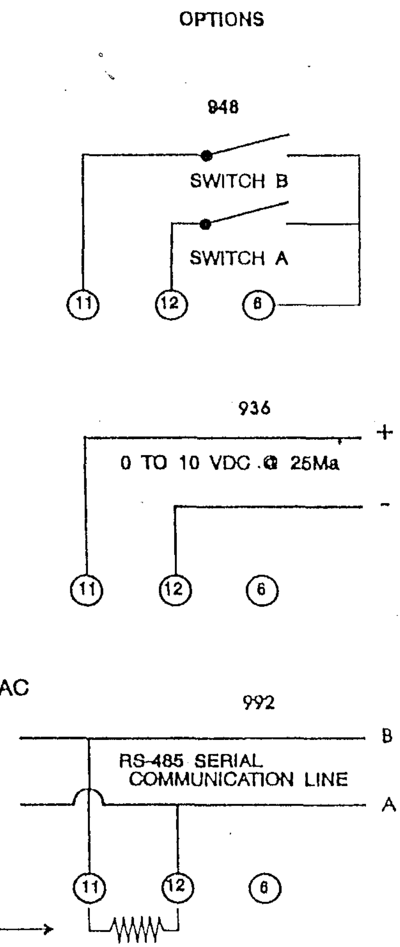
After changing input selection with the DIP switches, be sure to change the InP menu item (page 11) in the Secure Menu.



WIRING







SSR DERATING CHART

°C	°F	COMBINED OUTPUTS A AND B
25	77	3.50
35	95	2.75
45	113	2.00
55	131	1.25

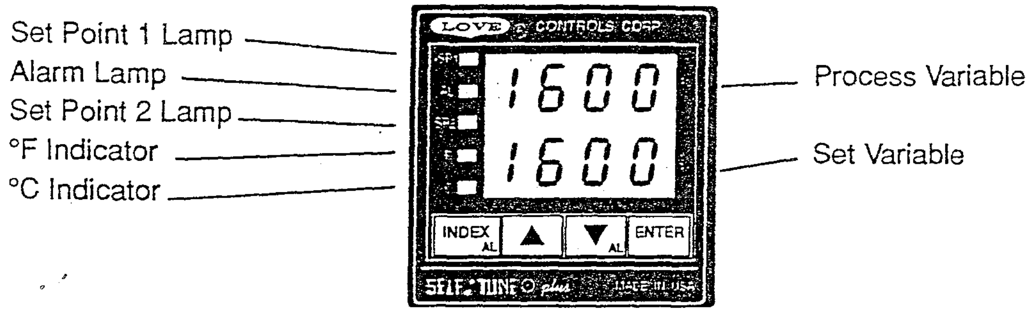
F1: FOR LINES OVER 85 V USE 1/4 AMP 3AG 250 VAC, FOR LINES LESS THAN 30 V (OPTIONAL), USE 1/2 AMP 3AG 250 VAC
LOAD POWER: SEE SPECIFICATIONS FOR OUTPUT RATINGS
FOR RELAY OR SSR OUTPUTS: TYPE MDA OR 3AB 3.5A MEDIUM LAG FUSE RECOMMENDED

INPUT WIRING: Do not run thermocouple or other input wiring in the same conduit as power leads. Use only the type of thermocouple or RTD probe for which the control has been programmed. See the "Secure Menu" for input selection.
For thermocouple input always use extension leads of the same type designated for your thermocouple.

* SOFTWARE CONFIGURABLE AS SP1 OR SP2
** R/C SNUBBER RECOMMENDED FOR DRIVING SOLENOID OR CONTACTOR LOADS

Install 121 ohm resistor on last control in chain.

FRONT PANEL KEY FUNCTIONS



1. **INDEX:** Pressing the INDEX key advances the display to the next menu item. May also be used in conjunction with other keys as noted below.
2. **UP ARROW:** Increments a value, changes a menu item, or selects the item to ON in the upper display.
3. **DOWN ARROW:** Decrements a value, changes a menu item, or selects the item to OFF in the upper display.
4. **ENTER:** Pressing ENTER stores the value or the item changed. If not pressed, the previously stored value or item will be retained.
5. **UP ARROW & ENTER:** Pressing these keys simultaneously brings up the **secondary menu** starting at the auto/manual selection. Pressing these keys for 5 seconds will bring up the **secure menu.**
6. **INDEX & DOWN ARROW:** Pressing these keys simultaneously will allow backing up one menu item, or if at the first menu item they will cause the display to return to the **primary menu.** If an alarm condition has occurred, these keys may be used to reset the alarm.
7. **INDEX & ENTER:** Pressing these keys simultaneously and holding them for 5 seconds allows recovery from the various error messages. The following menu items will be reset:

   LPbr: Loop break
   ALiH: Alarm inhibit
   bAd InP: Bad input error message
   CHEC CAL: Check calibration error message
   SEnC: Sensor rate of change
   OPEn InP: Open input error message
   ArEA: Area error message

Correct the problems associated with the above conditions first before using these reset keys. More than one error could be present. Caution is advised since several items are reset at one time.

While in the **Primary or Secondary menu,** if no key is pressed for a period of 30 seconds, the display will return to the HOME position displaying the PV and SV values. The time is increased to 1 minute when in the **Secure menu.**

NOTE: To move to the **primary menu** quickly from any other menu, press the **UP ARROW & ENTER** keys followed by pressing the **INDEX & DOWN ARROW** keys.

NOTE: Program the **Secure Menu first,** the **Secondary Menu second,** and the **Primary Menu last.**

METHOD FOR SET UP OF A HEAT / COOL CONTROL WITH SELF TUNE

Determine if the process is predominantly heating or cooling. An extruder, for example, is predominantly cooling when running product. An environmental chamber can be either heating or cooling. (For explanation of terms see pages 12 & 13.)

If the process is predominantly cooling, set S1St to dir and S2St to rE. If the process is predominantly heating, set S1St to rE and S2St to dir. Redirect SP1 to output A or B as required by the hardware (see SP1o). Set S2t to dE. Set SP2 for zero (no overlap of bands, no deadband). Set Pb2 to a desired value (default is 12° F). Set tunE to SELF, Strt to YES, and LErn to End.

Start the process and wait for it to come to stability. Occasionally check that the Self Tune has completed the learning process by INDEXing to Strt in the secondary menu. If the YES value has changed to no, then the process has been learned. Once learning is complete, you may adjust SP2 to either overlap the SP1 band (SP2 value less than zero), or add some separation between them (deadband -- SP2 greater than zero) if required to optimize control.

SECURITY LEVEL SELECTION

Four levels of security are provided. The display shows the current security level. To change security levels change the password value using the **UP** & **DOWN ARROW** keys and pressing the **ENTER** key. Refer to the password table below for the correct value to enter for the security level desired. The **SECr** menu item security level may be viewed or changed at any time regardless of the present security level. The password values shown in the table cannot be altered, so retain a copy of this page for future reference. This will be the only reference made to password values in this instruction book.

PASSWORD TABLE

SECURITY LEVEL MENU	SECURITY	DISPLAYED VALUE WHEN VIEWED	PASSWORD VALUE TO ENTER
Primary Secondary Secure	Locked Locked Locked	1	1110
Primary Secondary Secure	Unlocked Locked Locked	2	1101
Primary Secondary Secure	Unlocked Unlocked Locked	3	1011
Primary Secondary Secure	Unlocked Unlocked Unlocked	4	111

MENU SELECTIONS

PRIMARY MENU

Press **INDEX** to scan the Lower Display. Press **UP ARROW** or **DOWN ARROW** to change the value in the upper display.

In the following the symbol "#" will be used before a letter to indicate the set point value to be viewed and/or modified. (Applies to Option 948 only.)

#SP1 (948) or
SP1 Set Point 1, Main Control Point.

SP2 Set Point 2, if equipped.

SECONDARY MENU

Hold **UP ARROW** & **ENTER.** Press **INDEX** to scan the Lower Display. Press **UP ARROW** or **DOWN ARROW** to change the value in the upper display.

Auto Auto/Manual Control: Select On or OFF.

- **On** Automatic Control
- **OFF** Manual Control is enabled. The lower display in the HOME position will display the output in percent for SP1 or SP2, and is adjustable for each from 0.0 to 100 percent. SP1 appears first with a flashing "o" on the right hand corner of the lower display to represent percent. Press INDEX to display SP2 output. A flashing "ō" will appear on the right hand corner of the lower display to represent percent. When Manual is enabled, the present control outputs are held (bumpless transfer) and displayed. The output for SP1 or SP2 can then be manually adjusted while displayed by pressing the **UP** or **DOWN Arrow** key to change the value, and then the **ENTER** key. The Upper display will normally indicate the Process Value. Since Manual will override most fault messages the upper display could indicate a fault message. Refer to the Diagnostic Error Message Section for further explanation.

ALLo Alarm Low: The Low Alarm point is usually set below the Main Set Pt.

ALHi Alarm High: The High Alarm Point is usually set above the Main Set Pt.

SP *Active setpoint (948): Select **1SP1, 2SP1, 3SP1,** or **4SP1**. Allows setting of the multiple stages of SP1, and SP1 tuning constants.*

#SP1 *Set Point Value # (948): Select desired value.*

#tun *(948) or*
tunE Tuning Choice: Select **SELF, Pid, SLO, nor,** or **FASt.**

- **SELF** The Controller will evaluate the Process and select the PID values to maintain good control. Active for SP1 only.
  - **Strt** Select **YES** or **no**
    - **YES** Start Learning the Process. After the process has been learned the menu item will revert to **no**.
    - **no** Learning will stay in present mode.
  - **LErn** Select **Cont** or **End**
    - **Cont** Continuously adjust the PID values to maintain the best control. The Process is being monitored at all times by collecting and analyzing the data to adjust the PID values. (adaptive control).
    - **End** The Process data is collected once and then the PID values are saved, tuning is stopped.
  - **dFAC** Damping factor, Select **OFF**, **1** to **7**. Sets the ratio of Rate to Reset for the SELF tunE mode. 7 = most Rate. Factory set to 3. For a fast response process the value should be lowered (less Rate). For a slower process the value should be increased (more Rate).
- **Pid** Manually adjust the PID values. PID control consists of three basic parameters, Proportional Band (Gain), Reset Time (Integral), and Rate Time (Derivative).
  - *#Pb1* *(948) or*
    Pb1 Proportional Band (Bandwidth). Select **6** to **5000** °F, **3** to **2778** °C, or 6 to **9999** counts.
  - **Pb2** Proportional Band (Bandwidth). Select **6** to **5000** °F, **3** to **2778** °C, or 6 to **9999** counts. *(Appears after #rtE when Option 948 is selected.)*
  - *#rES* *(948) or*
    rES Automatic Reset Time. Select **OFF**, **0.1** to **99.9** minutes. Select **OFF** to switch to **OFS.**
  - *#OFS* *(948) or*
    OFS Manual Offset Correction Select **OFF, 0.1** to **99.9%**. Select **OFF** to switch to **rES.**
  - *#rtE* *(948) or*
    rtE Rate Time. Select **OFF, 0.01** to **99.99** minutes, Derivative.
- **SLO** PID values are preset for a slow response process.
- **nor** PID values are preset for a normal response process.
- **FASt** PID values are preset for a fast response process.

Pid2 Linkage of PID parameters between SP1 and SP2: Select **On** or **OFF**.
- **On** Links SP2 to SP1 *or #SP1* rEs and rtE terms for heat/cool applications.
- **OFF** Sp2 functions without rEs and rtE.

ArUP Anti- Reset Wind-up Feature: Select **On** or **OFF**.
- **On** When ArUP is **On** the accumulated Reset Offset value will be cleared to 0% when the process input is not within the Proportional Band.
- **OFF** When ArUP is **OFF**, the accumulated Reset Offset Value is retained in memory when the process input is not within the Proportional Band.

ArtE Approach Rate Time: Select **OFF**, **0.01** to **99.99** minutes. The function defines the amount of Rate applied when the input is outside of the Proportional Band. The ArtE time and the rtE time are independent and have no effect on each other. To increase damping effect and reduce overshoot set the approach rate time for a value greater than the natural rise time of the process (natural rise time = process value time to set point).

Fint *Fuzzy Logic Intensity(942): Select 0 to 100%. 0% is OFF (disables Fuzzy Logic). The function defines the amount of impact Fuzzy Logic will have on the output.*

Fbnd *Fuzzy Logic Error Band(942): Select 0 to 4000 °F, 0 to 2222°C, or 0 to 4000 counts. Sets the bandwidth of the Fuzzy Logic. Set Fbnd equal to PID proportional band (Pb1) for best results.*

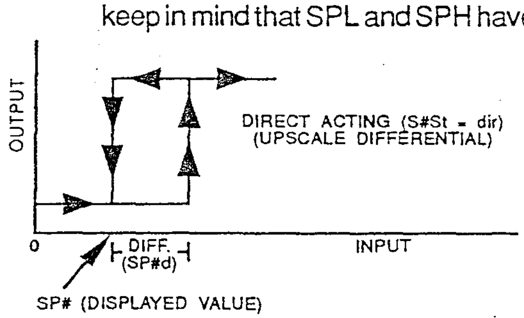
FrtE *Fuzzy Logic Rate of Change(942): Select 0.00 to 99.99°F/sec., 0.00 to 55.55°C/sec., or 0.00 to 99.99 counts/sec. For best initial setting, find the degree/sec change of process value near set point 1 with output ON 100%. Multiply this value by 3. Set FrtE to this calculated value.*

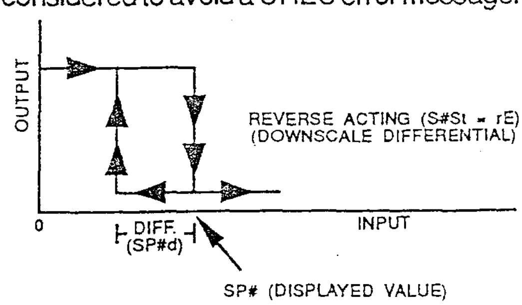
PEA Peak and Valley feature will remember the Highest (**PEA**) and lowest (**VAL**) Input the Instrument has had since the last reset or Power On. At Power On they are reset to the present input, and **VAL** therefore may have to be manually reset. To manually reset the value, PEA or VAL must be in the lower display and then press the **ENTER** key. This will cause the Item to be reset to the present input value.

In the following the symbol "#" will be used following letters to refer to either a number "1" or number "2". The "1" will relate to SP1 functions, the "2" for SP2. If your control is not equipped with a second set point, no SP2 functions will appear. The appearance of **CY#**, **SP#d**, or **PUL#** is dependent upon the output type selected in the Secure Menu item S#Ot. If time proportioning (cycle time) was selected, then CY# is adjustable. If On - Off was selected, then SP#d is adjustable. If pulsed time proportioning was selected then PUL# is adjustable. If none of the above are selected the menu indexes directly to S#Ot.

CY# Cycle Rate: Select **2** to **80** sec. Time Proportioning Control is adjustable in 2 sec. steps. For best contact life, a time should be selected as long as possible without causing the process to wander.

SP#d Set Point On-Off Differential. Select **1** to **1999** deg. or counts. When adjusting SP#d keep in mind that SPL and SPH have to be considered to avoid a CHEC error message.





PUL# Pulsed Time Proportioning Output: Select **1** to **7**. 1 = Linear and 7 = most non-linear. Changes output linearty for use in cooling applications or for an extremely fast response processes. At the center of the proportional band, a pulse value of 1 provides an output of one second on and one second off (50% output). A pulse value of 2 provides an output of one second on and two seconds off (33% output). Output at center of band equals one second on, $2^{(\text{pulse value}-1)}$ seconds off.

S#Ot Set Point Output Type. FT, Curr, or Volt.

- **Ft** refers to Fast Time Proportioning, for Solid State Relay or 5V Logic Outputs. Timing is fixed at 1 sec.
- **Curr** refers to Proportional Current Output of 0 to 20 mA.
- **Volt** refers to Proportional Voltage Output of 0 to 10 V.
  Both Curr & Volt are selected by the Hardware Configuration Code and cannot be changed.

PctO Percent Output Feature: Select **On** or **OFF**.

- **On** When selected **On**, the HOME lower display will indicate the output of the controller in percent. An "o" will appear in the right hand side of the lower display to indicate percent output for SP1. An "ō" will appear on the right hand corner of the lower display to represent percent output for SP2. The display will alternate between these values.
- **OFF** Percent Output display is disabled.

Prog Ramp/Soak Feature: Select **On** or **OFF**

StAt Status Display in the HOME Position when Prog (above) is On: Select **On** or **OFF**. When selected OFF, the HOME display will alternately indicate the normal HOME and the Ramp/Soak partial status in the Lower Display. The partial status display sequences with the set value showing the ramp (S1rA) or soak (S1So) segment being processed at that moment. It will also show the Program output status if at Hold or OoFF.
When selected On, the HOME Display will alternately indicate the normal HOME and the Ramp/Soak full status in both the upper and lower displays. The full status display sequences with the set value; Program run, Hold, or OoFF; and with the time remaining for the ramp S1rA or the soak S1So segments.

1rt Ramp Time in Hours & Minutes: Select **0.00** to **99.59** (HH.MM).

1St Soak Time in Hours & Minutes: Select **0.00** to **99.59** (HH.MM).

PEnd End of Soak action: Select **Hold** or **OoFF**.

- **Hold** Stay at the Present Set Pt.
- **OoFF** Turn Off SP1 and SP2 Outputs at the End of the Soak.

InPC Input Correction: Select **±500** °F (**±260** °C) or **±1000** counts. This feature allows the input value to be changed to agree with an external reference or to compensate for sensor error. When setting values having one or more decimal points, the lowest negative value allowed is -199.9, -19.99, or -1.999. **Note:** InPC is reset to zero when the input type is changed, or when decimal position is changed in T/C or RTD ranges. Changing decimal position in current or voltage ranges will not reset InPC.

FiLt Digital Filter: Select **OFF**, **1** to **99**. In some cases the time constant of the sensor, or noise could cause the display to jump enough to be unreadable. A setting of 2 is usually sufficient to provide enough filtering for most cases, (2 represents approximately a 1 second time constant). When the 0.1 degree resolution is selected this should be increased to 4. If this value is set too high, controllability will suffer.

LPbr Loop Break Protection: Select **OFF**, **1** to **9999** seconds. If, during operation, the output is minimum (0%) or maximum (100%), and the input moves less than 5°F (3°C) or 5 counts over the time set for LPbr, the **LOOP bAd** message will appear. This condition can also be routed to an Alarm Condition if alarms are present and turned On (see ALbr in the secure menu). The loop break error can be reset by pressing the **ENTER** key when at the LPbr menu item. The **INDEX** & **ENTER** keys may also be used.

POL *Process Output Low (936): Select -450°F, -260°C, or -1999 counts to 50 degrees or counts less than* ***POH***.

POH *Process Output High (936): Select from 50 degrees or counts greater than* ***POL*** *to +9990°F, +5530°C, or 9990 counts. A voltage output is scalable from 0 to 10 VDC that represents the Process Variable. To properly scale the output, the values for* ***POL*** *and* ***POH*** *must be calculated. The simplest example is an output of 0 to 10 VDC from 0 to 200°. In this example POL=0 and POH=200. To Calculate POL and POH for other ranges use the following:*
K *= (Highest desired temperature - Lowest desired temperature) /*
(Maximum desired voltage - Minimum desired voltage)

*POH = ((10 - Maximum desired voltage) * K) + Highest desired temperature*
*POL = ((Minimum desired voltage - 0) * K) - Lowest desired temperature*

LOrE *Local / Remote Status (992): Select LOC or rE. When LOC is selected, the host computer is advised not to send remote commands. When rE is selected, CFLt=2, and nAt is set > 0, if the control is not accessed by the host computer in the time set in nAt, the control will revert to the CFSP*

CFSP *Communications Fail Set Point (992): Set to desired value.*

Addr *Control Address (992): Set from 1 to FF. This number (hexadecimal, base 16) must match the address number used by the host computer. Viewed only in this menu.*

SECURE MENU

Hold **UP ARROW** & **ENTER** for 5 Seconds. Press **INDEX** to change the lower display. Press **UP ARROW** or **DOWN ARROW** to change the value in the upper display.

SECr Security Code: See the Security Level Selection and the Password Table in this manual, in order to enter the correct password.

InP Input Type: Select one of the following. The Inputs are based on four different groups; Thermocouples, RTD's, Current, and Voltage. If changing from one of these groups, the DIP switch on the A/D circuit board will have to be changed to match that particular group. Refer to the Input wiring section for the proper switch settings.

- **J-IC** Type "J" Thermocouple, Iron/Constantan (NIST)
- **CA** Type "K" Thermocouple Chromel/Alumel
- **E-** Type "E" Thermocouple Chromel/Constantan
- **t-** Type "T" Thermocouple Copper/Constantan
- **L-** Type "L" Thermocouple Iron/Constantan (DIN)
- **n-** Type "N" Thermocouple Nicrosil/Nisil
- **r-13** Type "R" Thermocouple Pt 13%Rh/Pt
- **S-10** Type "S" Thermocouple Pt 10%Rh/Pt
- **b-** Type "B" Thermocouple Pt 6%Rh/Pt 30%Rh
- **C-** Type "C" Thermocouple W 5%Re/W 26%Re
- **P392** 100 ohm Platinum (NIST 0.00392 Ω/Ω/°C), Love Cal. 104.
- **n120** 120 ohm Nickel, Love Cal. 105.
- **P385** 100 ohm Platinum (DIN 0.00385 Ω/Ω/°C), Love Cal. 106.
- **Curr** DC Current Input 0.0 to 20.0 or 4.0 to 20.0 milliamperes.
- **VoLt** DC Voltage Input 0.0 to 5.0 or 1.0 to 5.0 volts.
- **----** Reserved

OSUP Zero Suppression: Select **On** or **OFF**. Only with Current and Voltage input types.

- OFF The input range will start at 0 (zero) Input.
- On The input range will start at 4.00 mA or 1.00 V.

Unit F, C or None

- F °F descriptor is On and temperature inputs will be displayed in actual degrees Fahrenheit.
- C °C descriptor is On and temperature inputs will be displayed in actual degrees Celsius.
- nonE °F and °C descriptors will be Off. This is only available with Current and Voltage Inputs.

dPt Decimal Point Positioning: Select **0**, **0.0**, **0.00**, or **0.000**. On temperature type inputs this will only effect the Process Value, SP1, SP2, ALLo, ALHi, and InPC. For Current and Voltage Inputs all Menu Items related to the Input will be affected.

- **0** No decimal Point is selected. This is available for all Input Types.
- **0.0** One decimal place is available for Type J, K, E, T, L, RTD's, Current and Voltage Inputs.
- **0.00** Two decimal places is only available for Current and Voltage Inputs.
- **0.000** Three decimal places is only available for Current and Voltage inputs.

InPt Input Fault Timer: Select **OFF, 0.1** to **540.0** minutes. Whenever an Input is out of range, shorted, or open the timer will start. When the time has elapsed, the controller will revert to a safe condition (Outputs Off, Flashing Displays). If OFF is selected, the Input Fault Timer will not be recognized (time = infinite).

SEnC Sensor Rate of Change: Select **OFF, 1** to **4000** °F, °C, or counts per 1 second period. This value is usually set to be slightly greater than the fastest process response expected during a 1 second period, but measured for at least 2 seconds. If the process is faster than this setting, the SEnC bAd error message will appear. The outputs will then be turned off. This function can be used to detect a runaway condition, or speed up detection of an open thermocouple. Use the **INDEX** & **ENTER** keys to reset.

SCAL Scale Low: Select **100** to **9999** counts below **SCAH.** The total span between **SCAL** and **SCAH** must be within 11998 counts. Maximum setting range is -1999 to +9999 counts. For Current and Voltage inputs, this will set the low range end. Viewable only for Thermocouples and RTD's.

SCAH Scale High: Select **100** to **9999** counts above **SCAL.** The total span between **SCAL** and **SCAH** must be within 11998 counts. Maximum setting range is -1999 to +9999 counts. For Current and Voltage inputs, this will set the high range end. Viewable only for Thermocouples and RTD's.

SPL Set Point Low: Select from **SCAL** value to **SPH** value. This will set the minimum SP1, SP2, ALLo, ALHi, SP1d, and SP2d values that can be entered. If any of the values are less than the SPL value, a check message will appear and the value will not be accepted.

SPH Set Point High: Select from **SCAH** value to **SPL** value. This will set the maximum SP1, SP2, ALLo, ALHi, SP1d, and SP2d values that can be entered. If any of the values are greater than the SPH value, a check message will appear and the value will not be accepted.

SP1o Set Point 1 Output Terminal Assignment: Select **OutA** or **Outb.**
NOTE: Reassigning the output terminals does not change the Hardware type assigned to those terminals. For single set point models, SP1o is locked to OUT A.
- **OutA** Set Pt. 1 output will be directed to terminals 7 & 8 and Set Pt. 2 output to terminals 9 & 10.
- **Outb** Set Pt. 1 output will be directed to terminals 9 & 10 and Set Pt. 2 output to terminals 7 & 8.

S#Ot Set Point Output Type: Select **CY, OnOF, PUL**, or **Ft**. Fixed for Curr and Volt, the Hardware Configuration has selected this.
- **CY** Cycle Rate, Adjustable Time Proportioning.
  - **CY#** Cycle Rate Time: Select **2** to **80** sec.
- **OnOF** On/Off Output.
  - **SP#d** Set Point Differential in 1 degree or count steps from 2 degrees or counts to full scale, but limited by SPL and SPH.
- **PUL** Pulse Time Proportioning.
  - **PUL#** Pulse Width Value: Select **1** to **7**.
- **Ft** Fast Time Proportioning: Fixed at 1 sec. Time Base.
- **Volt** Proportional Voltage, 0 to10 V.
- **Curr** Proportional Current, 0 to 20 mA.

S#St Set Point State: Select **dir** or **rE**.
- **dir** Direct Action. As the input increases the output will increase. Most commonly used in cooling processes.
- **rE** Reverse Action. As the input increases the output will decrease. Most commonly used in heating processes.

S#OL Set Point Output Low Limit: Select **0** to **90%** but less than **S#OH**. This item limits the lowest output value. This is useful for adding a bias to the process when needed. When a current or voltage output is used, the standard output value is 0 to 20mA or 0 to 10V. If 4 to 20 mA or 2 to 10 V is required, the S#OL value should be set for 20% to raise the lowest output.

S#OH Set Point Output High Limit: Select **10** to **102%** but greater than **S#OL**. This item allows setting the maximum output limit. This is useful with processes that are over powered.

S#LP Set Point Lamp: Select **O on** or **OoFF**.
O on Lamp ON when Output is ON.
OoFF Lamp OFF when Output is ON.

S2t Set Point 2 type: Select Abs or dE.
AbS Absolute SP2. SP2 is independent of SP1, and may be set anywhere between the limits of SPL and SPH.
dE Deviation SP2. SP2 is set as a deviation from SP1, and allows SP2 to retain its relationship with SP1 when SP1 is changed (tracking SP2).

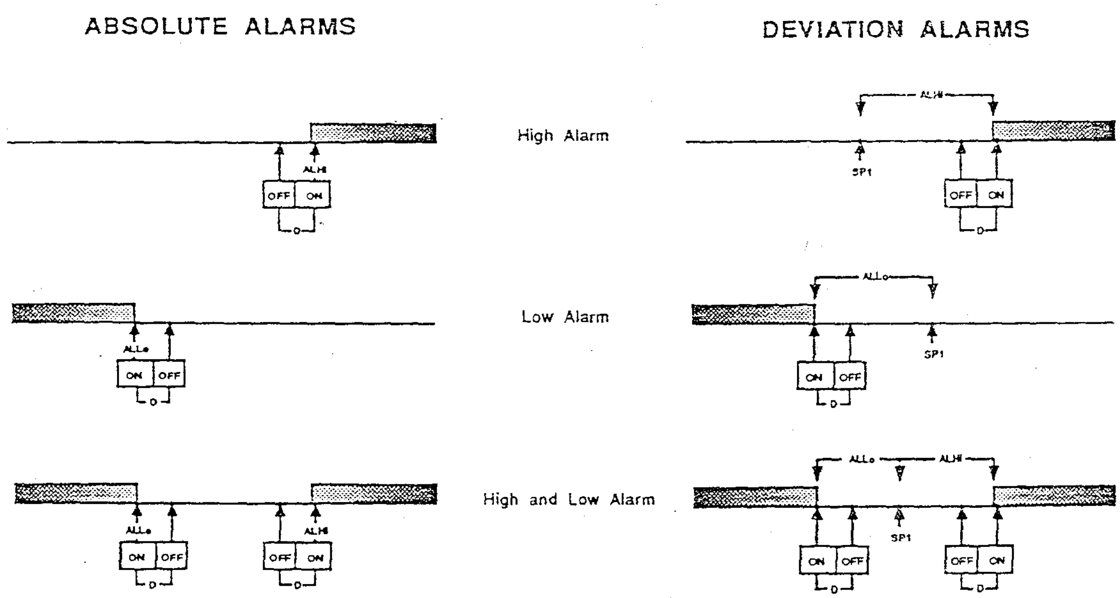
ALARM TYPE AND ACTION (if present)

Caution: In any critical application where failure could cause expensive product loss or endanger personal safety, a redundant limit controller is recommended.

When setting an alarm value for an absolute alarm (ALt = AbS), simply set the value at which the alarm is to occur.

When setting the alarm value for a deviation alarm (ALt = dE), set the difference in value from the Set Value (SV) desired. For example if a low alarm is required to be 5 degrees below the SV, then set ALLo to -5. If a high alarm is required 20 degrees above the SV, then set ALHi to +20. If SP1 is changed, the alarm will continue to hold the same relationship as originally set.

The following diagram shows the action and reset functions for both absolute and deviation alarms.



When "Alarm Power Interrupt" ALPi is programmed ON and "Alarm Reset" is programmed for Hold, the alarm will automatically reset upon a power failure and subsequent restoration if no alarm condition is present.

If "Alarm Inhibit" ALiH is selected ON, an alarm condition is suspended upon power up until the process value passes through the alarm set point once. Alarm inhibit can be restored as if a power up took place by pressing together the **INDEX** and **ENTER** keys for 5 seconds.

Warning: Resetting a high alarm inhibit will not allow an alarm to occur if the Process Value does not first drop below the high alarm setting. Do not use the Alarm Inhibit feature if a hazard is created by this action. Be sure to test all combinations of high and low alarm inhibit actions before placing control into operation.

The following Secure menu items apply only to the alarm.

AL Alarms: Select **OFF, Lo, Hi,** or **HiLo.**
- **OFF** Alarms are turned OFF. No Alarm menu items appear in the Secondary and Secure menus.
- **Lo** Low Alarm Only. ALLo appears in the Secondary Menu.
- **Hi** High Alarm Only. ALHi appears in the Secondary Menu.
- **HiLo** High and Low Alarms. Both share the same Alarm Relay output.

ALt Alarm Type: Select **AbS** or **dE**
- **AbS** Absolute Alarm that may be set anywhere within the values of SPL and SPH and is independent of SP1.
- **dE** Deviation Alarm that may be set as an offset from SP1. As SP1 is changed the Alarm Point will track with SP1.

ALrE Alarm Reset: Select **OnOF** or **Hold.**
- **OnOF** Automatic Reset.
- **Hold** Manual Reset. Acknowledge by simultaneously pressing the **INDEX** & **DOWN ARROW** keys for 5 sec.

ALPi Alarm Power Interrupt: Select **On** or **OFF.**
- **On** Alarm Power Interrupt is ON.
- **OFF** Alarm Power Interrupt is OFF.

ALiH Alarm Inhibit: Select **On** or **OFF.**
- **On** Alarm Inhibit is ON. Alarm action is suspended until the process value first enters a non-alarm condition.
- **OFF** Alarm Inhibit is OFF.

ALSt Alarm Output State: Select **CLOS** or **OPEn.**
- **CLOS** Closes Contacts at Alarm Set Point.
- **OPEn** Opens Contacts at Alarm Set Point.

ALLP Alarm Lamp: Select **O on** or **OoFF.**
- **O on** Alarm Lamp is ON when alarm contact is closed.
- **OoFF** Alarm Lamp is OFF when alarm contact is closed.

ALbr Alarm Loop Break: Select **On** or **OFF.**
- **On** Loop Break Condition will cause an Alarm Condition.
- **OFF** Loop Break will not affect the Alarm Condition.

The following Secure menu items apply only to Options. They may not appear in your control.

SPSA *Set Point Select Action (948): Select **rE** or **Int.***
- ***rE*** *Remote (external) selection of active set point value.*
- ***Int*** *Internal selective of active set point value.*

Addr *Control Address (992): Set from 1 to FF. This number (hexadecimal, base 16) must match the address number used by the host computer.*

bAUd *Communications baud rate (992): Select 300, 1200, 2400, 4800, 9600, 19.2, 28.8, or 57.6. This number must match the baud rate used by the host computer. The data format is 8 bits, 1 stop bit, No parity.*

nAt *No Activity Timer (992): Select OFF to 99. If a number is set, the control will expect access by the host computer. If no access is detected within that time, the control will indicate an error, **CHEC LorE** and go to the set point indicated by **CFLt.***

CFLt *Communication Fault Mode (992): Select 1 or 2. 1 = On Communication fault use local Set Point. 2 = On Communications fault use **CFSP**.*

DIAGNOSTIC ERROR MESSAGES

DISPLAY	MEANING	SP1, SP2, and ALARM OUTPUTS	ACTION REQUIRED
UFL or OFL	Underflow or Overflow: Process value has exceeded input range ends set by SCAL or SCAH.	Set point outputs active Alarms active	Input signals may normally go above or below range ends. If not, check input and correct.
    bAd InP OPEn InP	UFL or OFL will sequence to display one of these messages if the **InPt** is set for a time value. For RTD, CURRENT, or VOLTAGE inputs; input error has occurred. For THERMOCOUPLE inputs thermocouple is open.	Set point outputs inactive Alarms active	To reset use the **INDEX** & **ENTER** keys. When **InPt** (input fault timer) has been set for a time, the outputs will be turned off after the set time. Setting the time to OFF causes the outputs to remain active, however UFL or OFL will still be displayed. Correct or replace sensor. To reset use the **INDEX** & **ENTER** keys.
LOOP bAd	The sensor may be defective, heater fuse open, heater open or the final power output device is bad.	Set point outputs inactive Alarms active	Correct or replace sensor, or any element in the control loop that may have failed. To reset use the **INDEX** & **ENTER** keys, or press the **ENTER** key while in the **LPBr** menu item.
SEnC bAd	Sensor rate of change exceeded the programmed limits set for **SEnC**.	Set point outputs inactive Alarms active	Check the cause. The value setting may be too slow for the process, or the sensor is intermittent. To reset use the **INDEX** & **ENTER** keys.
#### ArEA	Area appears if the controller's ambient temperature nears specification ends, -5°C (+23°F) or +50°C (+122°F).	Set point outputs active Alarms active	Correct the ambient temperature conditions. Ventilate the area of the cabinet or check for clogged air filters.
(blank) ArEA	Area appears if the controller's ambient temperature exceeds specification ends, -10°C (+14°F) or +55°C (+131°F).	Set point outputs inactive Alarms active	Correct the ambient temperature conditions. Ventilate the area of the cabinet or check for clogged air filters. To reset use the **INDEX** & **ENTER** keys.
CHEC CAL	Check calibration appears as an alternating message if the instrument calibration nears tolerance edges.	Set point outputs active Alarms active	
	Check calibration appears as a flashing message if the instrument calibration exceeds specification.	Set point outputs inactive Alarms active	Remove the instrument for service and / or recalibration. To reset use the **INDEX** & **ENTER** keys.

DISPLAY	MEANING	SP1, SP2 AND ALARM OUTPUTS	ACTION REQUIRED
No displays lighted	Both displays are blank. Instrument may not be getting power, or the supply voltage is too low.	Set points inactive Alarms inactive	Check that the power supply is on, or that the external fuses are good.
FAIL tESt	Fail test appears upon power up if the internal diagnostics detect a failure. This message may occur during operation if a failure is detected. Displays flash.	Set points inactive Alarms inactive	Press the **INDEX** key to display the following messages: **FACt dFLt:** Memory may be corrupted. Press the **ENTER** key and the **DOWN ARROW** key to start the factory default proceedure. Re-check controller programming. **bAd A-d:** The A/D board is bad, return to factory. **rEt FACt:** Can not recover from error, return to factory for service.
CHEC SCAL or CHEC SCAH	The difference between scale low and scale high is programmed for more than 11,998 or less than 100 counts during programming of the voltage or current ranges.	Set points inactive Alarms inactive	Program parameter within the allowed count range.
CHEC SP1, CHEC #SP1, CHEC SP1d, CHEC SP2, CHEC SP2d, CHEC ALLo, CHEC ALHi, or CHEC CFSP	One or more of these messages will appear upon power up if any of these set points or differentials are set outside of the SPL or SPH values, or the range ends (SCAL or SCAH).	Set points inactive Alarms inactive	Check that each of the set points are within **SPL, SPH** range, or reprogram SPL and / or SPH values to be at or beyond the set points values found in error. Do not exceed the range ends (SCAL or SCAH).
CHEC SPL or CHEC SPH	This message appears at power up if SPL or SPH values are programmed above or below the range ends (SCAL or SCAH). This message also appears if one or more set points are set above or below SPL or SPH during normal programming.	Set points inactive Alarms inactive	Correct the SPL or SPH values by programming new values. **CAUTION:** The old values are retained when these messages appear during set point programming.
CHEC POL or CHEC POH	This message appears if the POL or POH values are incorrectly programmed.	Set points active Alarms active	Correct the POL or POH by programming new values.

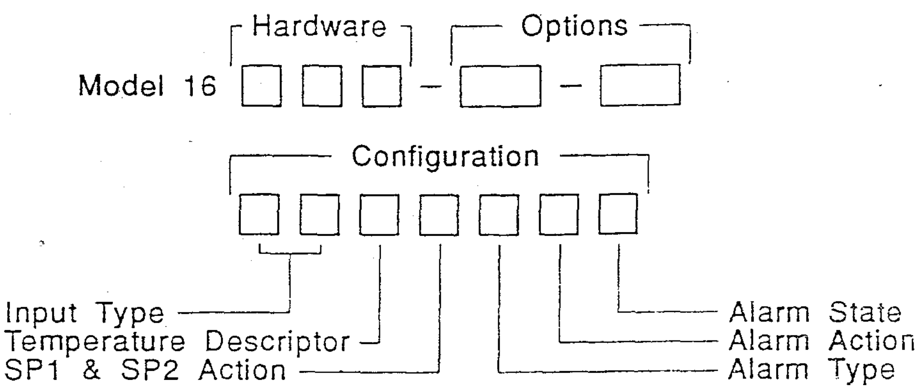
CONFIGURATION MENU

DO NOT ENTER THE CONFIGURATION MENU UNLESS YOU HAVE BEEN INSTRUCTED TO BY ANOTHER PART OF THESE INSTRUCTIONS. INCORRECT ENTRY OF DATA IN THE CONFIGURATION MENU MAY PREVENT YOUR CONTROL FROM OPERATING PROPERLY.

If re-configuration is required, follow the instructions below.

The Configuration Menu is used to quickly configure the instrument. The configuration for your particular model is shown on the Model / Serial label located on the top of the instrument housing. A label found inside on the right printed circuit board only shows the hardware configuration and options.

The numbers shown are defined as follows:



The Hardware configuration code **must not** be changed as it defines the hardware for the specific instrument. All other configuration may be altered if necessary. It is important that the codes be correctly entered in order for the instrument to function properly. If an invalid code number is entered for a particular configuration item, it will not be accepted and the old configuration code will be retained.

To re-configure:

1. At power up, simultaneously press and hold the **INDEX** & **ENTER** keys while the lamp test or self test is displayed. Hold the keys down until **Hrd1** appears. A dash appears in the upper display.
2. Press the **INDEX** key to advance through the menu items. Pressing the **INDEX** & **DOWN** keys simultaneously will back up to a menu item. Stop at the menu item you wish to change.
3. Press the **UP** or **DOWN** key to select the desired Configuration Code from the following chart.
4. Press **ENTER** to retain.
5. Press **INDEX** to advance.
6. If you do not want to retain the re-configuration, this is your last chance to return to the old configuration. Press **ENTER** at **AcPt no** to exit and retain the old configuration.

CONFIGURATION CHART

Do not change Hrd1, Hrd2 or Hrd3 to codes different from those on the controller labels. Codes in boldface type indicate factory defaults. See FACt dFLt.

DISPLAY	MENU ITEM	CONFIGURATION CODE
Hrd1	Alarm Hardware	0 = NO 1 = YES
Hrd2	Output A Hardware	1 = SSR/LOGIC 3 = RELAY/LOGIC 5 = CURRENT 2 = LOGIC/SSR 4 = LOGIC/RELAY 6 = VOLTAGE
Hrd3	Output B Hardware	0 = NONE 2 = LOGIC/SSR 4 = LOGIC/RELAY 1 = SSR/LOGIC 3 = RELAY/LOGIC
OPt1	Option Hardware	942 = Fuzzy Logic Software 936 = Process Output 937 = Isolated 0 to 20mADC (Monitor) 948 = 4-Stage Set Point 992 = Serial Communications If number flashes, option is NOT selected. Press ENTER to select (number will not flash).
CnF1	Input Type	**01 = J 1°** 10 = L 0.1° 19 = RTD 1° (NIST) 02 = J 0.1° 11 = N 1° 20 = RTD 0.1° (NIST) 03 = K 1° 12 = N 0.1° 21 = RTD 1° Ni 04 = K 0.1° 13 = R 1° 22 = RTD 0.1° Ni 05 = E 1° 14 = S 1° 23 = 0 to 20 mA 06 = E 0.1° 15 = B 1° 24 = 4 to 20 mA 07 = T 1° 16 = C 1° 25 = 0 to 5 VDC 08 = T 0.1° 17 = RTD 1° (DIN) 26 = 1 to 5 VDC 09 = L 1° 18 = RTD 0.1° (DIN)
CnF2	Temperature Descriptor	0 = No Descriptor 2 = Degree C **1 = Degree F**
CnF3	SP1 and SP2 Action	**0 = SP1 = Output A, rev. act.** (Single set point Models) 1 = SP1 = Output A, dir. act. (Single set point Models) **2 = SP1 = Output A, rev. act.; SP2 = Output B, dir. act.** 3 = SP1 = Output B, rev. act.; SP2 = Output A, dir. act. 4 = SP1 = Output A, dir. act.; SP2 = Output B, rev. act. 5 = SP1 = Output B, dir. act.; SP2 = Output A, rev. act. 6 = SP1 = Output A, rev. act.; SP2 = Output B, rev. act. 7 = SP1 = Output B, rev. act.; SP2 = Output A, rev. act. 8 = SP1 = Output A, dir. act.; SP2 = Output B, dir. act. 9 = SP1 = Output B, dir. act.; SP2 = Output A, dir. act.
CnF4	Alarm Type	0 = No Alarm 4 = Deviation Low Alarm **1 = Absolute High Alarm** 5 = Absolute High - Low Alarms 2 = Deviation High Alarm 6 = Deviation High - Low Alarms 3 = Absolute Low Alarm
CnF5	Alarm Action	0 = No Alarm 4 = On - Off with Inhibit **1 = On - Off** 5 = Manual Reset with Inhibit 2 = Manual Reset with Power Interrupt 3 = Manual Reset without Power Interrupt
CnF6	Alarm State	0 = No Alarm 3 = Close at SP, LED off **1 = Close at SP, LED flashing** 4 = Open at SP, LED off 2 = Open at SP; LED flashing

CONFIGURATION CHART, CONT'D.

DISPLAY	MENU ITEM	CONFIGURATION CODE
AcPt	Accept Configuration	no = Retain old Configuration. Press ENTER to exit. YES = Accept Configuration. Press ENTER to exit.
id ##		Factory Identification. Not for customer use.
FACt dFLt		Factory default. Defaults Configuration to factory codes shown in boldface type in the chart above. **Warning:** The Hardware Configuration will be cleared and must be re-entered using the Hardware Configuration code found on the Model / Serial label located on the top of the instrument housing. The configuration menu cannot be exited until valid Hardware codes are entered. If factory default is desired, simultaneously press the **ENTER** & **DOWN ARROW** keys.

Input Ranges

Thermocouple Types

Input Type		Type J or L Iron-Constantan	Type K Chromel-Alumel	Type E Chromel-Constantan	Type T Copper-Constantan
Temperature Range & Unit of measure	1°F	-100 to +1600	-200 to +2500	-100 to +1800	-350 to +750
	1°C	-73 to +871	-129 to +1371	-73 to +982	-212 to +398
	0.1°F	-100.0 to +990.0	-190.0 to +990.0	-100.0 to +990.0	-190.0 to +750.0
	0.1°C	-73.0 to +871.0	-129.0 to +990.0	-73.0 to +982.0	-212.0 to +398.0

		Type R PT 13% RH-PT	Type S PT 10% RH-PT	Type B PT 6% RH-PT 30% RH	Type C W 5% RE-W 26% RE	Type N Ni Cro Sil-Ni Sil
Temperature Range & Unit of measure	1°F	0 to 3200	0 to 3200	+75 to +3308	0 to 4208	-100 to +2372
	1°C	-17 to +1760	-17 to +1760	+24 to +1820	-17 to +2320	-73 to +1300
	0.1°F	-	-	-	-	-100.0 to +990.0
	0.1°C	-	-	-	-	-73.0 to +990.0

RTD Types

		100 Ohm Platinum 0.00385 DIN Curve Love Cal. 106	100 Ohm Platinum 0.00392 NIST Curve Love Cal. 104	120 Ohm Nickel Love Cal. 105
Temperature Range & Unit of measure	1°F	-328 to +1607	-328 to +1607	-112 to +608
	1°C	-200 to +875	-200 to +875	-80 to +320
	0.1°F	-190.0 to 990.0	-190.0 to 990.0	-112.0 to +608.0
	0.1°C	-190.0 to +875.0	-190.0 to +875.0	-80.0 to +320.0

Current and Voltage Types 0 to 20 mADC, 4 to 20 mADC, 0 to 5 VDC, or 1 to 5 VDC; scalable from 100 to 11,999 counts with adjustable decimal point placement.

SPECIFICATIONS

Selectable Inputs: Thermocouple, RTD, current or voltage.
Input Impedance:
Thermocouple = 3 megohms minimum. RTD current = 200 µA.
Current = 249 ohms. Voltage = 5000 ohms.
Set Point Range: Selectable.
Displays: Two 4 digit, 7 segment 0.3" high LED's. PV red, SV green.
Control Action: Reverse (usually heating), Direct (usually cooling) selectable for single or dual set point models.
Proportional Band: 6 to 5000 °F or equivalent °C for temperature inputs. 6 to 9990 counts for current or voltage inputs.
Reset Time (Integral): Off or 0.1 to 99.9 minutes.
Rate Time (Derivative): Off or 0.01 to 99.99 minutes.
Cycle Rate: 2 to 80 seconds,
Approach Rate: Off to 99.99 minutes.
On - Off Differential: Adjustable 1° F to full scale in 1° steps (equivalent °C), or 1 count to full scale in 1 count steps for current and voltage inputs.
Alarm On - Off Differential: 2° F or equivalent in °C, or 2 counts.
Accuracy: ±0.25% of span, ±1 least significant digit.
Resolution: 1 degree, 0.1 degree, or 1 count.
Line Voltage Stability: ±0.05% over the supply voltage range.
Temperature Stability: 4µV/°C (2.3 µV/°F) typical, 8 µV/°C (4.5 µV°F) maximum.
Common Mode Rejection: 140 db minimum at 60 Hz.
Normal Mode Rejection: 65 db typical, 60 db at 60 Hz.
Isolation: Relay and SSR outputs are isolated. Current, voltage, and logic outputs must not share common grounds with the input.
Supply Voltage: 100 to 240 VAC, nom., +10 -15%, 50 to 400 Hz. single phase; 132 to 240 VDC, nom., +10 -20%. This applies to the instrument power only.
Power Consumption: 5VA maximum.
Operating Temperature: -10 to +55 °C (+14 to 131 °F).
Storage Temperature: -40 to +80 °C (-40 to 176 °F).
Humidity Conditions: 0 to 90% up to 40 °C non-condensing 10 to 50% at 55 °C non-condensing.
Memory Backup: Non-volatile memory. No batteries required.
Control Output Ratings:
1. SSR, 3.5 A @ 250 VAC at 25 °C. Derates to 1.25 A @ 55 °C.
2. Relay, Form A contact (SPST), 3 A @ 250 VAC resistive; 1.5 A @ 250 VAC inductive; Pilot Duty Rating: 250 VA, 2 A @ 125 VAC or 1 A @ 250 VAC.
3. Alarm Relay, Form A contact (SPST). Same rating as control relay (2) above.
4. Current (non-isolated), 0 to 20 mA across 600 ohms maximum.
5. Voltage (non-isolated), 0 to 10 VDC across 500 ohms minimum.
6. Logic (non-isolated), 5 VDC @ 25 mA.

Panel Cutout: 45 mm x 45 mm (1.775" x 1.775").
Depth Behind Mounting Surface: 115.3 mm (4.54").
Weight: 227 g (8 oz).
Agency Approvals: UL E83725, CSA LR40125.
Front Panel Rating (for indoor, non-hazardous locations): Meets UL 2, 3R, 3S, and 12 ratings.

LIMITED WARRANTY

Love Controls Corporation warrants to the Buyer that any equipment sold will be free from defects in material or workmanship. If, at any time within sixty (60) months after shipment of 1600 Series Controls or within three (3) months after shipment of thermocouples, or other assemblies or parts, the Seller is notified of such defect and the defective item is returned to Seller by Buyer, transportation prepaid, for examination, the Seller will, at his option, either repair or replace the defective items.

This warranty shall be effective only if installation and maintenance is in accordance with Sellers instructions and the defect is not caused by shipping damage, misuse or abuse by the Buyer. There are no other warranties, written, oral, or implied. The liability of the Seller is limited to the repair or replacement of the defective item as above set forth.

Items which wear or are perishable by misuse are not warranted. These include, but are not limited to, relays, contact points, lamps, LED's, load SCR's, SSR's and triacs.

If you require any assistance, or have specific questions, please call us.

EFD® 1-800-556-3484 (US and Canada)
Between 8:30 am and 6:00 pm EST.
(in Rhode Island, 434-1680)
Fax: (401) 431-0237

United Kingdom
Ring free on: 0800 585 733
Telephone: (01582) 29444
Fax: (01582) 451184

EFD Inc., 977 Waterman Avenue, East Providence, RI 02914-1378 USA

Contents

Introduction

Each EFD dispense valve is thoroughly tested and inspected prior to shipment. To obtain the maximum performance of these fine valves, please read through these instructions.

725D

The 725D is a piston type, precision dispense valve, manufactured to the highest standards of quality. Each part is finished to extremely close tolerances. The piston action provides a slight pull-back at the end of the dispense cycle for positive material cutoff.

The 725D is simple to use and will operate many millions of cycles without maintenance, except for normal purging.

725DA

The 725DA is identical to the 725D except for the precision adjustable piston stroke. This unique adjustable stroke provides additional flow control and also allows fine-tuning of the pull-back amount when making very small deposits.

This manual will refer to the 725D in all cases, except where the parts or operation is pertinent to the 725DA exclusively.

Specifications

725 Series

Cylinder unit: Hard-coated aluminum

Fluid chamber and cap:
Hard-coated aluminum (optional: stainless steel)

Piston: Hard-coated aluminum

Spring: Stainless steel

Valve seal/diaphragm: FDA-approved UHMW polymer

Fluid inlet thread: 1/8 NPT female

Output thread: 1/4 NPT female

Mounting hole: (1) 1/8 NPT female blind hole

Operating frequency: Exceeds 400 per minute

Output variation: ± 2.0% nominal

Diaphragm life: 5×10^6 nominal

Air pressure required: 70 to 90 psi (4.8 to 6.2 bar)

Maximum fluid pressure: 100 psi (6.9 bar)

Air input: 10-32 internal thread

725D

Size: 4.220" length x 1.120" diameter
(107.2 mm x 28.4 mm)

Weight (less fittings):
725D: 6.5 oz (184 grams)
725D-SS: 9.5 oz (269 grams)

Minimum mounting center distance: 1.130" (28.7 mm)

725DA

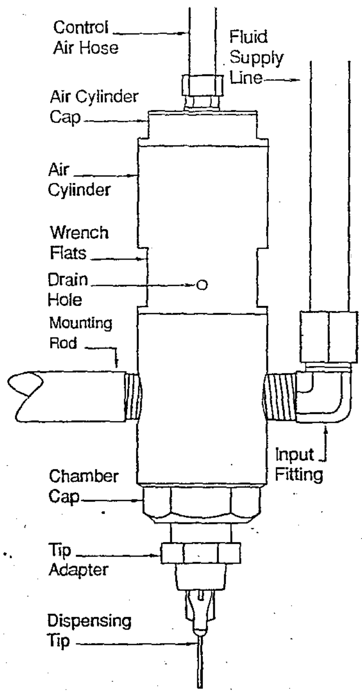
Size: 5.200" length x 1.160" diameter
(132.1 mm x 29.5 mm)

Weight (less fittings):
725DA: 8.0 oz (227 grams)
725DA-SS: 11.0 oz (312 grams)

Minimum mounting center distance: 1.165" (29.6 mm)

Note: Specifications and technical details are subject to engineering changes without prior notification.

Description



The exterior components are listed in the illustration to the left. (Refer to page 8 for the 725DA exterior view.) The exploded views for the 725D and 725DA are shown on pages 15 and 16.

Each valve is shipped with a #2186 polypropylene tip adapter installed. The input fitting for the supply line is specified at the time of order.

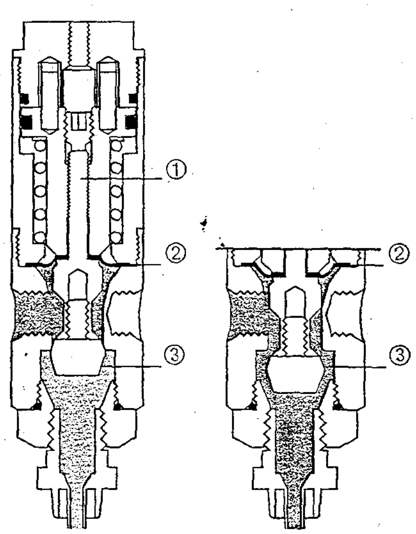
The 5-ft air hose, with male quick-connect fitting, is installed on the valve.

The output thread size is 1/4 NPT and accepts 1/4 NPT metal or plastic nozzles with the #2186 tip adapter removed.

Internally, the valve chamber is sealed from the air-actuated piston and cylinder by a UHMW polyethylene diaphragm. In the unlikely event that the diaphragm ruptures, fluid will exit through the drain hole in the cylinder body.

Using the 725D valve is easy and requires no special techniques. However, to avoid difficulties, and to maximize the effectiveness of this valve, please carefully read the operating instructions on the following pages.

How The Valve Operates



(A) (B)

Illustration (A) shows the valve closed. Illustration (B) shows the sealing head ③ open and the diaphragm seal ② slightly deflected.

The 725D is a normally closed, fail-safe valve. With no input air pressure, the internal spring holds the sealing head closed, preventing liquid flow.

Input air pressure at 70-90 psi (4.8-6.2 bar) forces the internal piston ① to move, causing the diaphragm seal ② to deflect and the sealing head ③ to open and permit liquid flow. When the input air pressure exhausts, the sealing head closes, stopping the liquid flow.

By using a UHMW polyethylene diaphragm seal ②, no shaft seals or seal adjustments are required to isolate the fluid from the piston cylinder.

The amount of fluid dispensed will depend on the time the valve is open, the viscosity of the fluid, the air pressure in the liquid reservoir and the dispensing tip size.

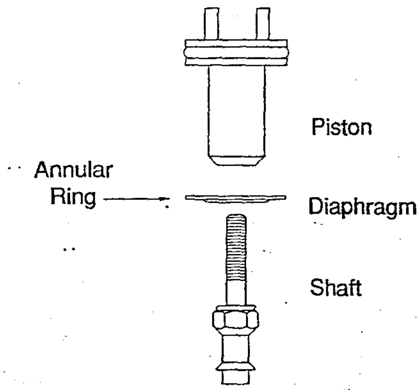
The 725D can be operated in any position without affecting the dispensing characteristics. Vibration has no effect on performance. The valve can be moved in and out of dispense positions (such as on a recycling cylinder) at high cycle speeds without affecting the dispensing performance.

Because the diaphragm seal area is larger than the sealing head area, increasing the pressure of the incoming fluid causes a tighter seal, preventing any tendency to leak under higher pressures.

The unique design of the 725D valve, with slight "suck-back" at the end of the dispense cycle, provides extremely fast cycle rates with close output tolerances.

Maintenance Tools:

- 1/8" Hex wrench
- 1/4" Flat tip screwdriver
- 3/8" Box wrench
- 7/8" Open end wrench
- 10" Adjustable wrench
- 1/8" NPT male pipe or rod



725D assembly of piston, diaphragm and shaft.

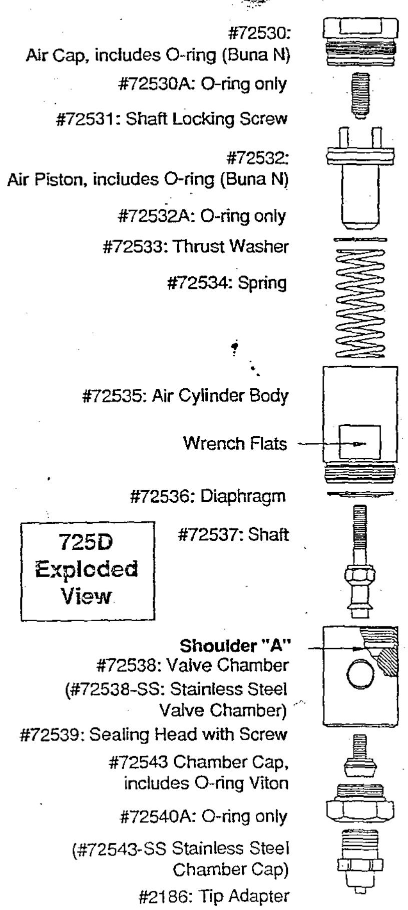
Maintenance and Cleaning

First, follow these precautions to avoid the need for any major disassembly and maintenance. For normal cleaning, purge the valve with an appropriate solvent. Please note that cleaning can be accomplished without dismounting the valve.

1. Always operate the valve at an air pressure between 70 psi and 90 psi (4.8-6.2 bar).

Note: Operation at less than 60 psi prevents full opening of the sealing head and can cause inconsistent deposits.

2. Maximum input fluid pressure is 90 psi (6.2 bar).
3. After use, immediately purge with appropriate flush material or solvent. Routine cleaning is the best method to avoid more complex maintenance.
4. Periodically, depending on the type of fluid being dispensed, the sealing head, chamber cap and valve chamber should be removed and thoroughly cleaned to prevent harmful buildup of solidified fluid.



STEP 1: To Thoroughly Clean Valve Chamber

Note: For the 725DA only, set stroke adjustment to the full open position (two complete rotations). Refer to illustration on page 8. Stroke adjustment must stay open throughout reassembly.

A. Remove tip adapter.

B. Remove chamber cap, using a wrench.

C. Remove sealing head, using a screwdriver.

D. Put rod in threaded mounting hole or fluid feed inlet hole and, with a wrench on flats of air cylinder body, turn to loosen valve chamber.

E. Remove valve chamber. (Do not loosen or remove the shaft.)

F. Clean valve chamber with appropriate solvent. It is not necessary to remove the diaphragm seal unless it is to be replaced.

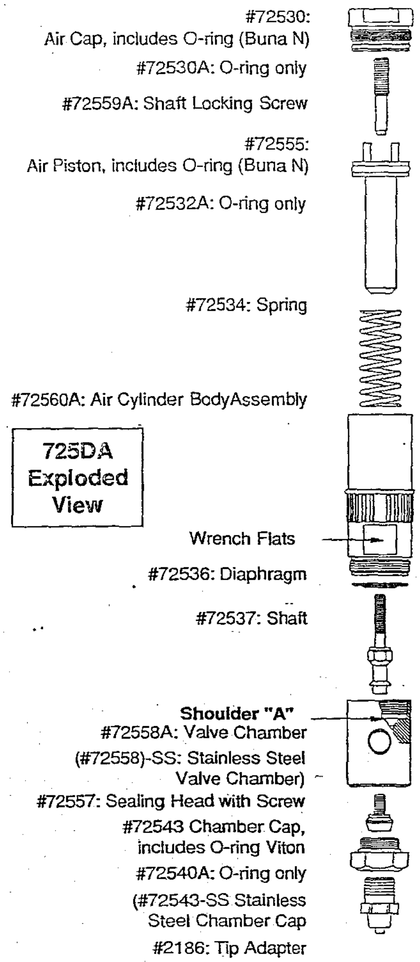
Note: The diaphragm can be carefully wiped clean. Do not use sharp instrument, as damage to diaphragm may result.

To reassemble

G. Apply thin film of lubricant on shoulder **"A"** (see illustration at left). Screw on valve chamber and tighten approximately 15-20 foot pounds.

H. Reinstall sealing head and tighten screw.

I. Reinstall chamber cap and tip adapter.



725DA Exploded View

STEP 2: To Replace Sealing Head

When the sealing head becomes worn, replace by following **STEP 1**, A through C. Reassemble in reverse order.

STEP 3: To Replace Diaphragm

A. Remove the parts described in **STEP 1**, A through E.

B. Remove input air hose fitting from air cap.

C. Insert 1/8" hex wrench through the air inlet hole in the cap and back out the shaft locking screw, two turns. Using the hex on the shaft, unthread the shaft and remove the shaft and diaphragm.

D. Place a new diaphragm against the cylinder body. The convex annular ring on the diaphragm should be away from the cylinder body. (See page 14.)

Note: Do not apply lubricant to the contact surface of the cylinder body and diaphragm.

Reinsert the shaft using a light coat of lubricant on the threads and then tighten the shaft sufficiently (approximate torque value or 15 inch pounds) to provide a tight seal of the diaphragm, but not so excessively tight as to cause the diaphragm material to extrude.

E. Insert 1/8" hex wrench through the air inlet hole and tighten the shaft locking screw as tightly as possible while holding the hex portion of the diaphragm shaft.

F. Install the air hose fitting.

G. Complete reassembly **STEP 1**, G through I.

STEP 4: To Replace or Lubricate Piston O-ring

A. Remove parts following **STEP 1** A through E and **STEP 3** B through C.

B. Unscrew the air cap from the air cylinder body, using a wrench.

C. Remove the piston and spring.

Note: The stroke adjustment ring on the 725DA air cylinder assembly is not removable. If this assembly requires repair, it must be returned to EFD.

D. Clean all parts; replace O-rings as required.

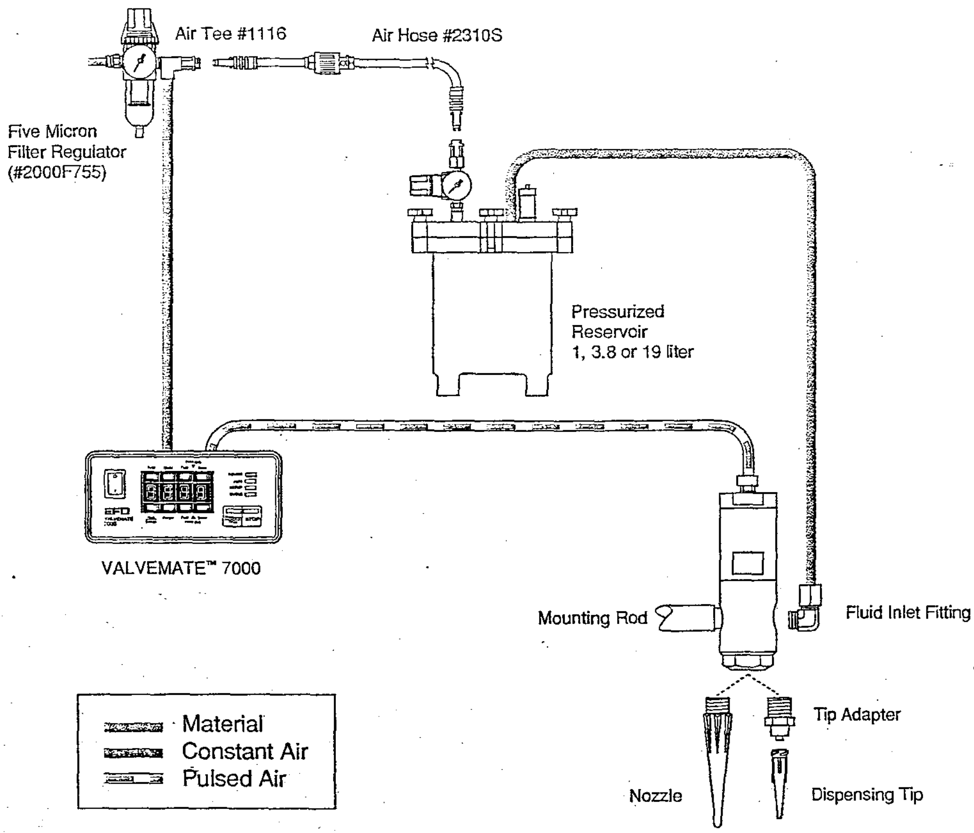
E. Lubricate O-rings, spring ends, air cylinder wall and two nonrotating pins on piston, preferably with an O-ring lubricant.

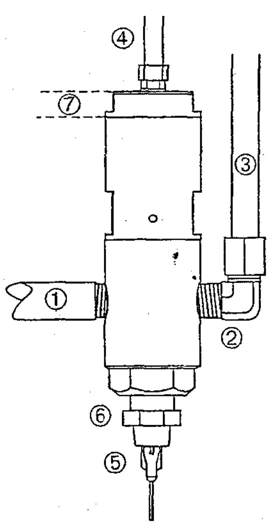
F. Reassemble the spring, piston, shaft locking screw and air cap.

Note: Two nonrotating studs on the piston must be mated with the air cap before threading the air cap into the cylinder body.

G. Tighten the air cap into body (8-10 foot pounds of torque).

H. Reinstall the diaphragm **STEP 3**, D through G.





Setup

Mount the valve on the holder rod ① using the 1/8 NPT blind hole. Any other mounting fixture should grip the valve around the air cap ⑦ only.

Install the fluid inlet fitting ② in the 1/8 NPT fluid inlet port.

Refer to the schematic on page 6 and to the EFD Dispense Valve Systems Price List for proper fittings and feed hose.

Connect the liquid reservoir hose ③ to the fluid inlet fitting ②.

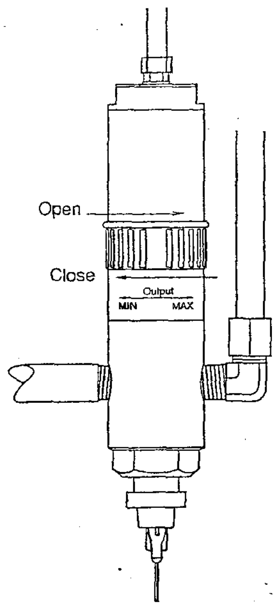
Connect the control air hose ④ to a valve controller or other pneumatic switch that is to be used to control the ON time of the valve. (Refer to the EFD VALVEMATE™ 7000 or 7020 operating manual, if appropriate.)

The liquid reservoir (cartridge, pressure tank) must be pressurized. How much pressure depends on the size of the deposit you require and the viscosity of the fluid you are dispensing.

For example, small deposits of a low viscosity fluid may require only 2 to 5 psi (0.1-0.3 bar). High viscosity fluids require higher reservoir pressures.

Connect an appropriate size dispensing tip ⑤ to the output adapter ⑥. The standard fitting accepts EFD Safety Lok™ dispensing tips. Use small diameter tips (21 to 22 gage) for low viscosity liquids. Use larger tips (15 to 20 gage), tapered tips or nozzles for more viscous fluids.

(Setup continues on page 8.)



725DA Stroke Adjustment

With the valve controller set up and connected to the valve, and the liquid reservoir connected to the valve, proceed to fill the reservoir.

CAUTION: **Always treat a pressurized reservoir with respect, and check air gauge to ensure pressure is at zero before opening.**

On all EFD tanks, there is a pressure relief valve that should be activated before opening the tank to ensure that all pressure is bled off.

After filling, check to be certain the reservoir is sealed.

Before proceeding, check the following:

1. Be sure all the connections are tight.
2. Pressurized reservoir is within normal limits. For low viscosity liquids, start with a pressure between 1 and 5 psi (0.07-0.34 bar.)
3. Be sure the air pressure to the 725D is a minimum of 70 psi and does not exceed 90 psi (4.8-6.2 bar).
4. If using the 725DA, open the stroke adjustment one complete turn.

Open the valve with an air pulse long enough to fill the valve and start liquid flow. Then, test the dispensed amount with a nominal time setting. If more or less liquid is required, increase or decrease the liquid reservoir air pressure, change the open time or substitute a different size dispensing tip.

If you have any questions at this point, please call us. In the U.S. and Canada, **1-800-556-3484**. (Between 8:30 am and 6:00 pm EST.) In the U.K., ring free 0800 585 733.

Fluid Compatibility

The 725D dispense valve is chemically compatible with most fluids used in assembly operations.

The unique diaphragm and sealing head are made of UHMW polyethylene which is highly resistant to a broad range of solvents, acids and reagents. The 725D valve chamber is made of hard-coated aluminum with optional stainless steel available.

Commonly dispensed fluids include:

Adhesives	Glues	Potting Compounds
Cements	Greases	Reagents
Conformal Coatings	Heat Sink Compounds	RTVs
Dampening Fluids	Inks	Silicone Greases
Dopants	Lacquers	Silicone Lubricants
Electrolytes	Lubricants	Solder Masks
Epoxies	Oils	Thick Film Pastes

Particle-filled fluids are considered to be **conditional** based on particle mesh size, abrasion and separation rate. The particle size and abrasion affects the valve seat performance and life. Materials that separate will clog the valve. Examples of conditional fluids are filled epoxies, braze pastes, slurries and glazing frits.

Fluids that are **not recommended** for use with the 725D valve include anaerobics, cyanoacrylates, solder pastes and UV cure adhesives. EFD provides specially designed valves and air-powered dispensers for these applications. Please call us for more information regarding your specific fluid and assembly requirements.

Dispensing Specific Fluids

Low Viscosity Fluids

For dispensing volumetric amounts, adjust reservoir pressure, pulse time, and use appropriate tip to provide required flow.

High Viscosity Fluids

For large volume deposits of viscous fluids, use high reservoir pressure (up to 90 psi, 6.2 bar) and a large flow capacity nozzle or tapered tip. Use time control to make final adjustment.

Particle Filled Materials

Particle-filled materials can reduce sealing head and valve seat life. The stainless steel fluid chamber provides extended valve seat life.

Adhesives

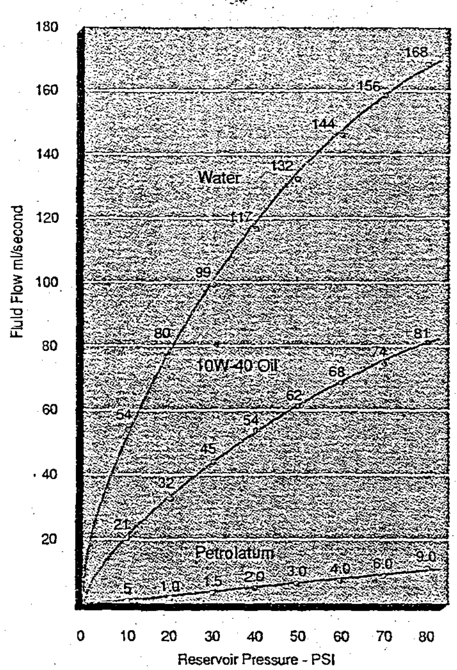
All types dispense well, including rubber-based, contact, even fast air-drying adhesives. Reduce "stringing" by using a small tip. If stringing persists, dilute the adhesive with recommended solvent. Refer to adhesive manufacturer's specifications.

Lubricants

The 725D is ideal for all types of lubricants, from machine oil to molybdenum disulfide. Provides perfect volumetric control for application of lubricants to small machine parts, ball bearings or assemblies.

Silicones

If you use a material that skims with air contact, consider using nitrogen or any inert gas to pressurize the reservoir.



725D and 725DA Fluid Flow

Free flow of water, oil and petrolatum through 725D and 725DA with tip adapter and no tip.

Epoxies

One-part epoxies can be dispensed, using any reservoir size. The higher the viscosity, the slower the dispense flow. Keep feed line as short as possible. For two-part pre-mixed systems, remember that as the epoxy cures, the viscosity will change, affecting the dispensed amount. Ideally, mix only that amount that can be dispensed prior to viscosity changes. Before the epoxy can cure, purge the valve to remove all epoxy from the tip adapter, body cap, valve chamber and diaphragm seal.

Marking Inks

The 725D is ideal for high-speed component marking with low viscosity or UV inks. It is also useful for ink handling, transfer and filling.

Summary

The 725D valve solves a wide range of applications. For additional information or data appropriate to your production, contact EFD for helpful application assistance.

Troubleshooting Guide

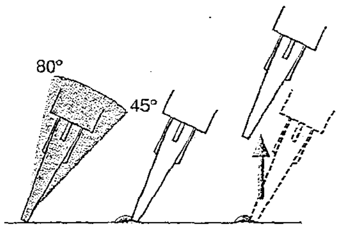
Trouble	Possible cause and correction
No fluid flow.	If valve operating air pressure is too low, the valve will not open. Increase air pressure to 70 psi (4.8 bar) minimum. The reservoir air pressure may not be high enough. Increase pressure. The dispensing tip may be clogged. Replace tip. If using the 725DA, the stroke adjustment may be closed. Open stroke adjustment. Fluid may have solidified in the valve chamber. Clean the valve chamber. Fluid feed line is installed into blind mounting hole. Remove and reinstall properly.
Fluid drools after the valve closes, eventually stopping.	This is caused by air trapped in the outlet section of the valve chamber, or the fluid has entrapped air. The air will expand after the valve closes, causing extrusion until the air reaches atmospheric pressure. Purge the valve by dispensing at a steady flow until clear. If a small tip is used, it may be necessary to remove the tip while purging to obtain sufficient flow to carry the air down through the tip adapter. If the fluid has entrapped air, the material must be degassed before dispensing.
Fluid drips at a steady rate after the valve closes.	A steady drip indicates failure of the sealing head to close fully due to particle buildup or wear. In either case, replace the sealing head in accordance with the maintenance instructions starting on page 14.

Trouble	Possible cause and correction
Valve responds slowly when opening and closing.	Valve response is related to control air line length and size. EFD valves are supplied with 5-ft of 1/8" ID tubing attached. Any additional length or size change will affect response time. Check to be sure the length and size have not been changed.
Fluid flows out of the drain hole.	Fluid flowing out of the drain hole indicates a ruptured diaphragm. Replace in accordance with the maintenance instructions starting on page 14.
Inconsistent deposits.	Inconsistent deposits can result if the air pressure controlling the valve and/or supplying the reservoir is fluctuating, or if the valve operating pressure is less than 70 psi (4.8 bar). Check to be sure air pressures are constant and the valve operating pressure is 70 psi (4.8 bar). The time the valve is open must be constant. Check to be sure the valve controller is providing a consistent output.

If trouble cannot be corrected, or if you need further assistance, please call us.
In the U.S. and Canada, **1-800-556-3484**. (Between 8:30 am and 6:00 pm EST.)
In the U.K., ring free 0800 585 733.

Applications

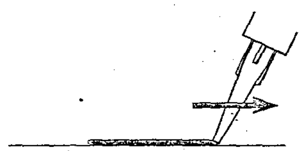
The 725D dispense valve provides productive solutions to many types of applications. The following information is a guide to provide application data that will help you to utilize the valves most effectively. For specific application assistance, please call EFD. We welcome the opportunity to share our experience with you.



Tip in contact with work surface. | Make deposit. | Remove tip from deposit by lifting straight up.

Correct Method to Dispense Dots. Bring valve to part, or part to valve tip, at the angle shown. Cycle valve. Withdraw tip as indicated. This technique ensures consistent dot deposit. Very low viscosity liquids may tend to flow up the outside of the tip. The angle shown will prevent this.

Micro-deposits. To achieve very small deposits, use a combination of settings of valve open time, reservoir air pressure, dispensing tip size and stroke adjustment if using a 725DA. The tip must contact the work surface prior to the dispense cycle to ensure transfer of liquid.



Tip travels away from the bead.

Applying beads. Bring the tip in contact with the part or close enough to ensure fluid transfer. If the bead is to be applied in one direction only, position the valve at a 45° angle as shown. If the installation requires X-Y motion, position the valve perpendicular to the work surface with the gap determined by thickness of the bead.

Multiple valves-one controller. CAUTION: Valve timing is the primary control of deposit size. When several valves are manifolded from one controller, deposit size adjustment must be made using a secondary control such as reservoir pressure or stroke control. This adds more setup time, and these settings may end up in undesirable ranges, causing inconsistent output. When consistency is critical, we recommend using one valve controller per valve.

Rack-mounted Valves. For filling, it is often expedient to mount several valves for multiple, simultaneous filling. This can result in significantly increased production speeds, while retaining precise fill control.

Reservoirs. Standard EFD reservoirs include 2.5, 6 and 12 ounce cartridges; and 1,3.8 and 19 liter pressure tanks. Standard fittings are available to connect these reservoirs to the 725D.

Fluids with Entrapped Air. After the dispense cycle, some post extrusion can be expected as the compressed air bubbles in the fluid in the output side of the valve expand to atmospheric pressure. This effect will cause additional material flow for a very short period. Within limits, this effect can be measured and the flow adjusted to compensate for this post extrusion. Ideally, be sure all entrapped air is eliminated from the fluid before attempting to dispense it.

Temperature. The 725D is designed to operate between 50°F (10°C) and 110°F (43°C).

Fluid Pull-back. After each dispense cycle, fluid flow is stopped by the pull-back of the sealing head. During this shut-off process, there is a negative displacement of the sealing head in the output side of the valve chamber. Fluid fills this displacement, causing a slight "suck back" effect at the output end of the dispensing tip. This effect is minimized to prevent air from being pulled into the tip. The result of this positive slight pull-back means a clean cutoff of dispensed fluid. The adjustable stroke of the 725DA allows fine tuning of the pull-back amount.

Accessories

Part #	Input Fittings (1/8 NPT thread)
72520N	Cartridge adapter fitting
72521	Feed hose elbow fitting for 3/8" OD tubing
7543BP	Feed hose elbow fitting for 1/4" OD tubing
7610BP	Feed hose fitting for 3/8" OD tubing
7611BP	Feed hose fitting for 1/4" OD tubing
	Output Fittings
2186	Tip adapter, 1/4" NPT-polypro
2186B	Tip adapter, 1/4" NPT-metal
	Polypropylene Nozzles
5180-B	Nozzle, 2.5" long x 1/8" opening
5181-B	Nozzle, 2.5" long x 1/16" opening
	Cartridge Reservoir Fittings
2275BP	Cartridge fitting to 3/8" OD tubing
2269BP	Cartridge fitting to 1/4" OD tubing
	Mounting Rod
7319	725D stainless holder rod
	Dispensing Wand
7530B	18" length

Repair Kits

725D-RK for 725D valve
725DA-RK for 725DA valve
Each repair kit includes the sealing head, diaphragm, required O-rings and lubricant for general maintenance.

Part Number Listings by Material

Acetal
Female quick connects: 2004B, 2004C
Male quick connect: 2004A

Aluminum (hard-coated)
725D and 725DA valve body
725D and 725DA piston

Buna
600D5, 615D and 625D tank gaskets

EPR
Special order O-rings

Nylon
615D and 625D tank fittings: 62503, 62504, 62516
Retainer cap: 5195R
Cartridge retainer: 5190R-5194R

Polyethylene
2.5, 6 & 12 oz cartridge and plunger
Tubing: 2025, 2315, 2316
Tapered tips: 5116TT-5125TT
Tank liners: 615DRL, 625DRL, 625DRL-BP

Polypropylene
Output fittings
1/4 NPT nozzles: 5180-5183
Dispensing tip hubs: 5114-5132
Flexible Tips: 5115PP-5125PP
Liquid Manifold (7600L series) and manifold fittings

Stainless Steel
19 liter tank: 600D5
Tank fittings: 600D5-DT, 2198A, 62509, 62510
Valve - piston rod and hardware

Stainless Steel: optional
725D valve chamber: 72538-SS
725D chamber cap: 72543-SS
725DA valve chamber: 72558A-SS
725DA chamber cap: 72543-SS

UHMW Polyethylene
Diaphragm: 72536
725D sealing head: 72539
725DA sealing head: 72557

Urethane
Air hose: 2310S
Valve actuation air hose: 20246

Aluminum (cast)
1 liter tank: 615 series
3.8 liter tank: 625 series

Questions & Answers

Q. Can more than one valve be operated from one controller?

A. Yes, but only when deposit volume is not critical. The valve controller is the primary control of deposit size. When we operate more than one valve from one controller, the timing functions cannot be used to fine tune only one valve output. EFD can provide assistance concerning special multiplexing of valves. Please call for more specific information.

Q. Can the 725D be operated from an air switch instead of an EFD controller?

A. Yes, however, whatever air switch you use must be 3-way, to permit air exhaustion after the dispense cycle.

Q. What is the flow rate for the 725D?

A. The 725D flows 168 milliliters per second of water at a reservoir pressure of 80 psi (5.4 bar). See page 11 for Flow Chart.

Any additional operation or application questions will be answered if you phone an EFD Product Specialist toll free within the U.S. and Canada, **1-800-556-3484**. (Between 8:30 am and 6:00 pm EST.)
In the U.K., ring free 0800 585 733.

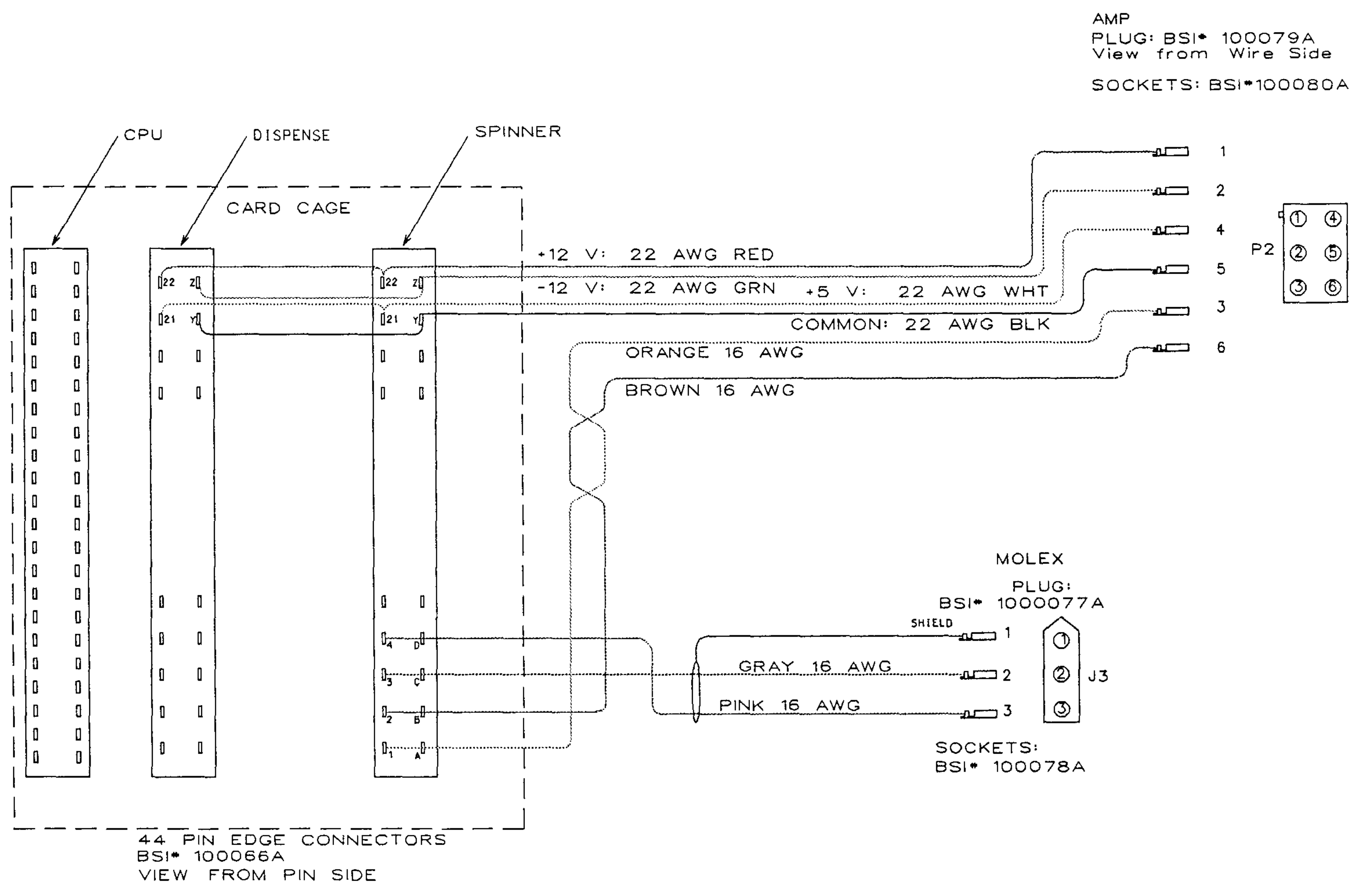
EFD ONE YEAR LIMITED WARRANTY

All components of EFD dispense valves are warranted for one year from date of purchase to be free from defects in material and workmanship (but not against damage caused by misuse, abrasion, corrosion, negligence, accident, faulty installation or by dispensing material incompatible with equipment) when the equipment is installed and operated in accordance with factory recommendations and instructions. EFD will repair or replace free of charge any part of the equipment thus found to be defective, on authorized return of the part prepaid to our factory during the warranty period. The only exceptions are those parts which normally wear out and must be replaced routinely, such as but not limited to, diaphragms and sealing heads.

In no event shall any liability or obligation of EFD arising from this warranty exceed the purchase price of the equipment. This warranty is valid only when clean, dry filtered air is used.

EFD makes no warranty of merchantability or fitness for a particular purpose. In no event shall EFD be liable for incidental or consequential damages.

REVISION INFORMATION:			
SYMBOL	DATE	ENGR	DESCRIPTION
△	7/8/99	JAL	CHANGED COLOR ON SPINNER WIRES



UNLESS OTHERWISE SPECIFIED LIMITS ON DIMENSIONS ARE FRACTIONS = ± 1/64 .XX = ±.015 .XXX = ±.005 .XXXX = ±.0005 REMOVE ALL BURRS AND SHARP EDGES	MATERIAL	DESIGN ENGINEER	Jeff Leith	CEE DIVISION BREWER SCIENCE, INC. 4000 ENTERPRISE DR. ROLLA, MO 65401 PHONE: (573) 364-0300	Controller
					Date:
	TYPE FINISH REQD.	CREATION DATE	1/8/99	TITLE 100 Series Card Cage Wiring Diagram	PAPER SIZE A / SHEET OF
		APPROVED BY	Jeff Leith		PART NO. 300013B
		EFFECTIVE DATE	7/8/99		