

Cee[®] Model 100 & 150

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Cee[®]
Cost Effective Equipment
A Division of Brewer Science, Inc.
Rolla, Missouri U.S.A. 65401

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.

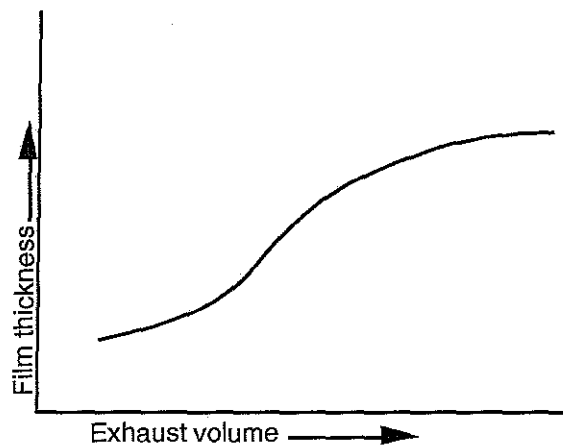
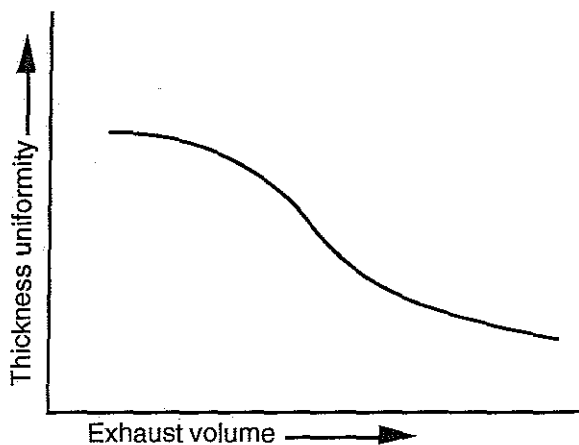
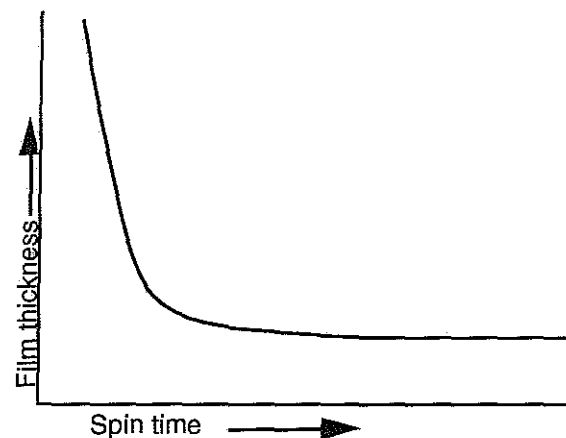
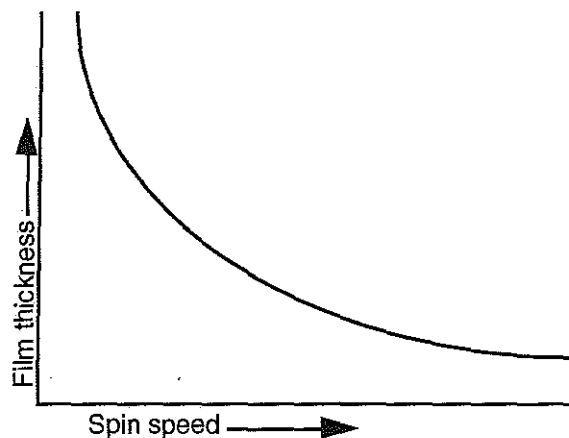
The slower rate of drying offers the advantage of increased film thickness uniformity across the substrates. The fluid dries out as it moves toward the edge of the substrate during the spin process. This can lead to radial thickness nonuniformities since the fluid viscosity changes with distance from 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
Spin time too long
Inappropriate choice of resin material

Select lower speed
Decrease time during high speed step
Contact resin manufacturer

Film too thick

Spin speed too low
Spin time too short
Exhaust volume too high
Inappropriate choice of resin material

Select higher speed
Increase time during high speed step
Adjust exhaust lid or house exhaust damper

Poor reproducibility

Variable exhaust or ambient conditions
Substrate not centered properly
Insufficient dispense volume
Inappropriate application of resin material
Unstable balance in speed / time parameters

Adjust exhaust lid to fully closed
Center substrate before operation
Increase dispense volume
Contact resin manufacturer
Increase speed / decrease time or visa versa

Poor film quality

Exhaust volume too high
Acceleration too high
Unstable balance in speed / time parameters
Insufficient dispense volume
Inappropriate application of resin material

Adjust exhaust lid or house exhaust damper
Select lower acceleration
Increase speed / decrease time or visa versa
Increase dispense volume
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.

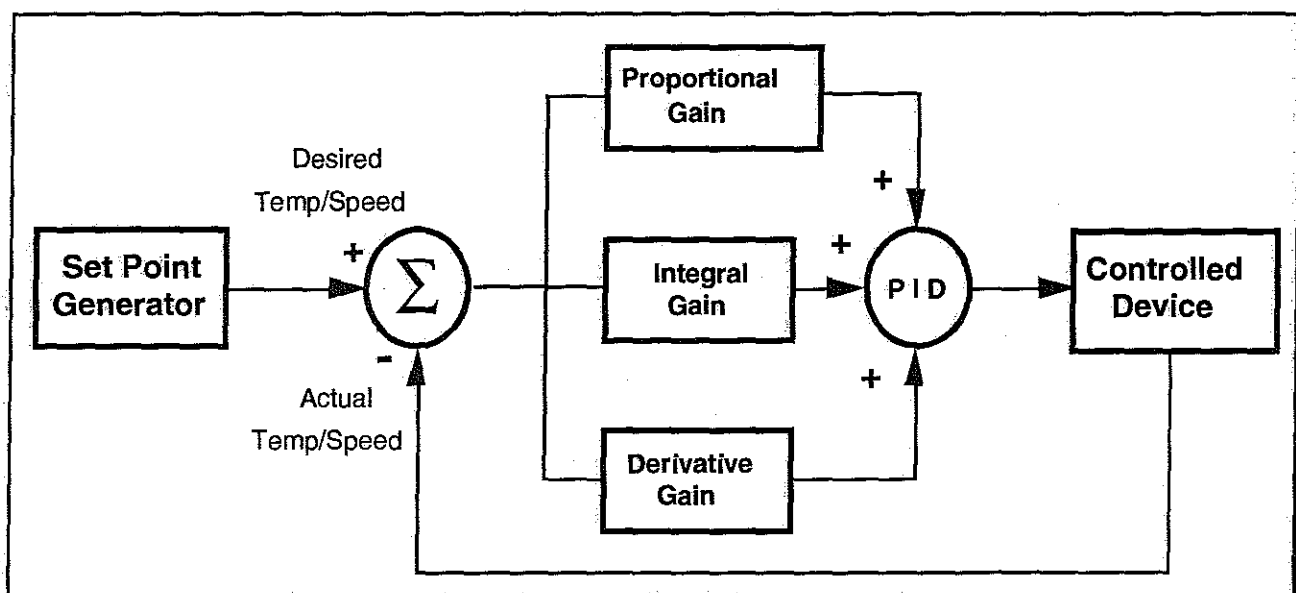


Figure 1 - PID Control Loop

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.

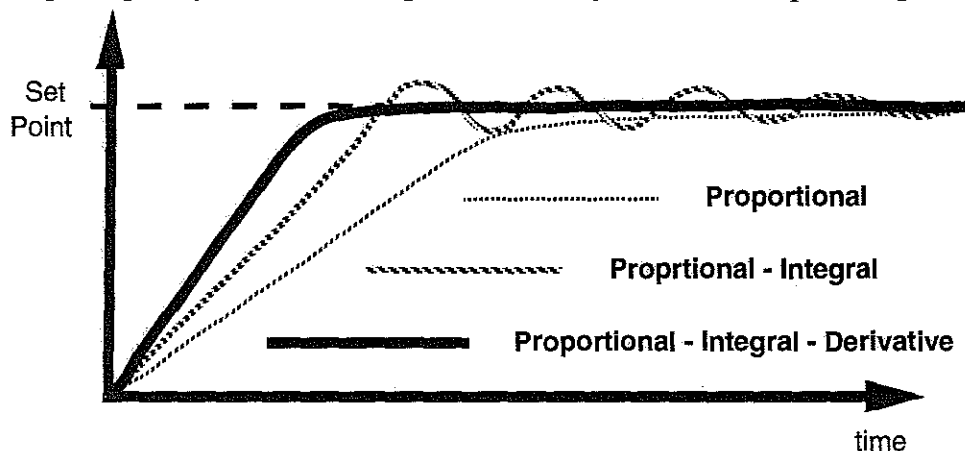


Figure 2 - Control Comparison

100 DIMENSIONS

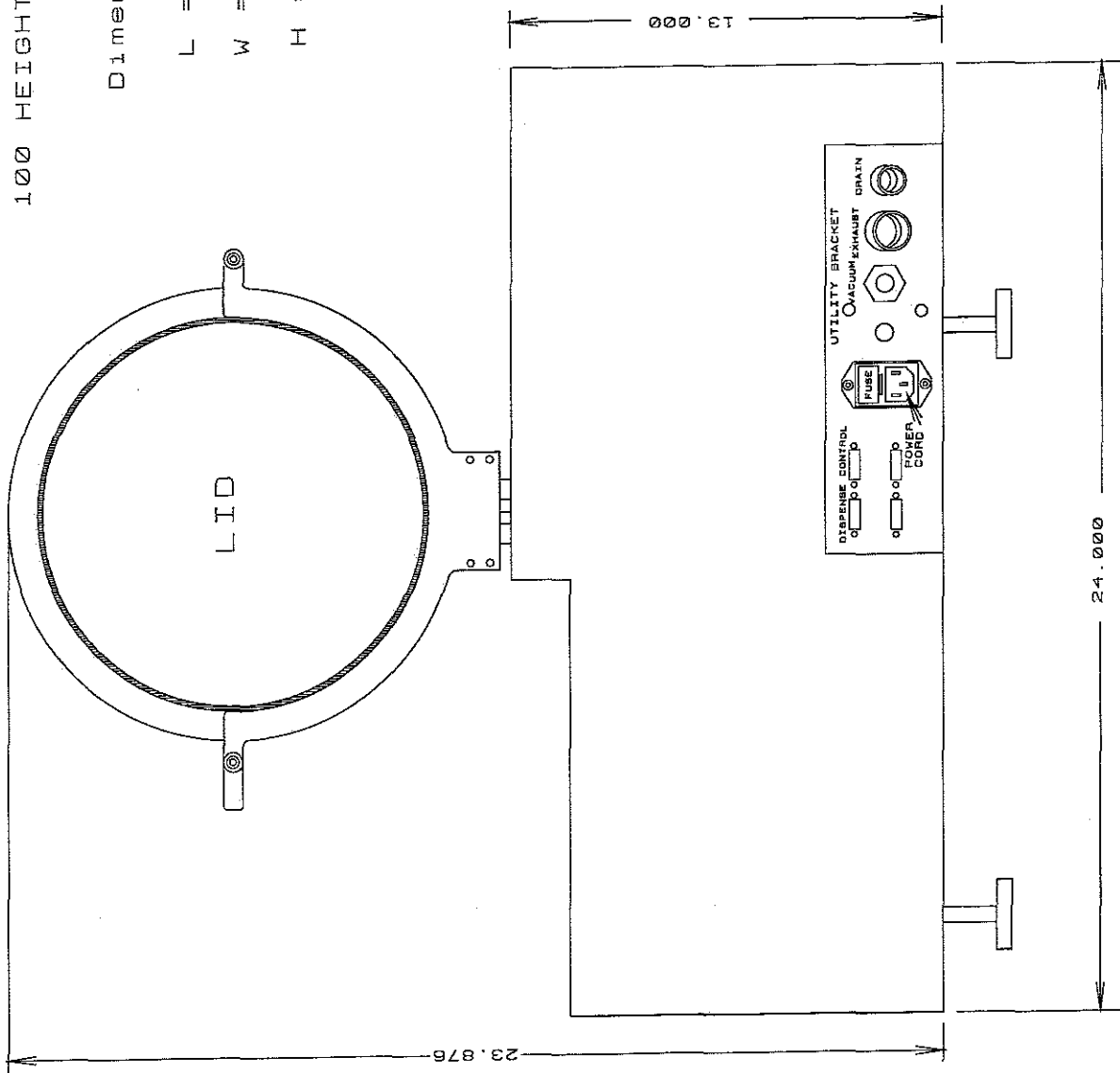
100 HEIGHT (INCHES)

Dimensions

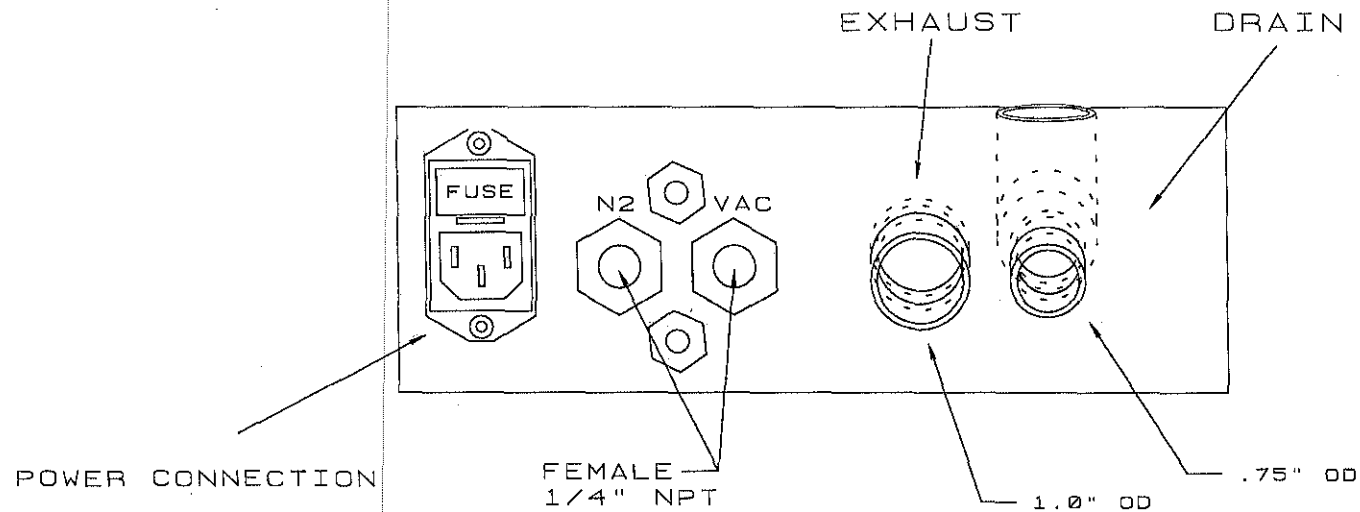
L = 24"

W = 13"

H = 13"



100 UTILITIES



VACUUM: 25" HG

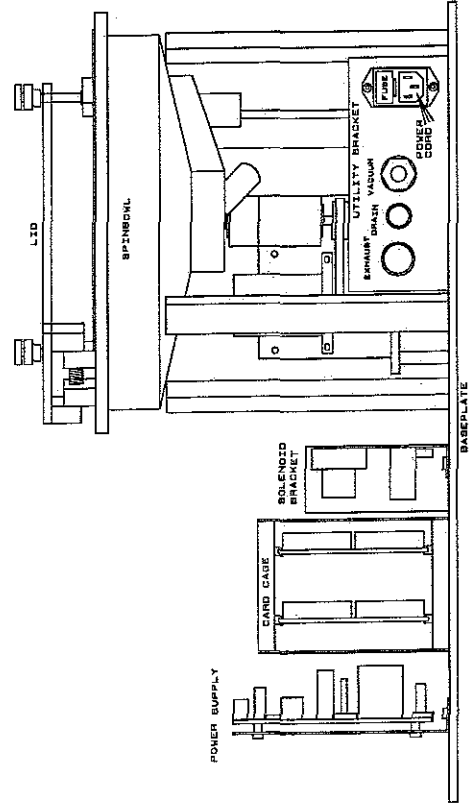
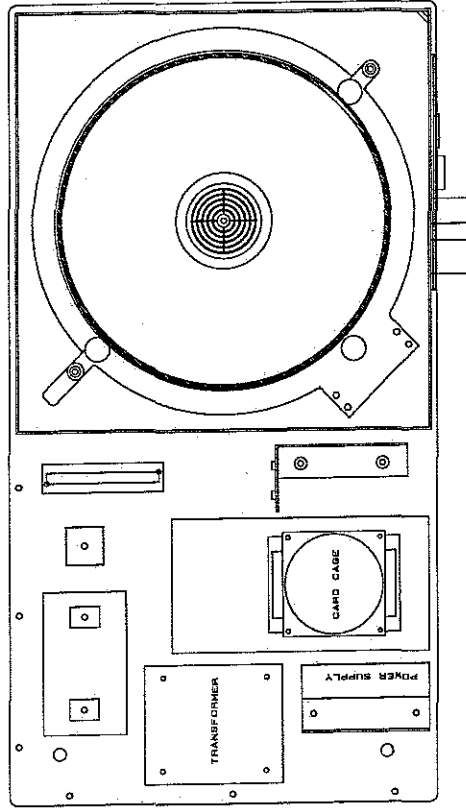
EXHAUST: 20-100 CFM

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
Page 1 of 2

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 from 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
Page 2 of 2

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
Page 1 of 1

Spin Coat Diagnostics: DIA G

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 ^{derivative} derivative 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

Page 1 of 1

Purpose:

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

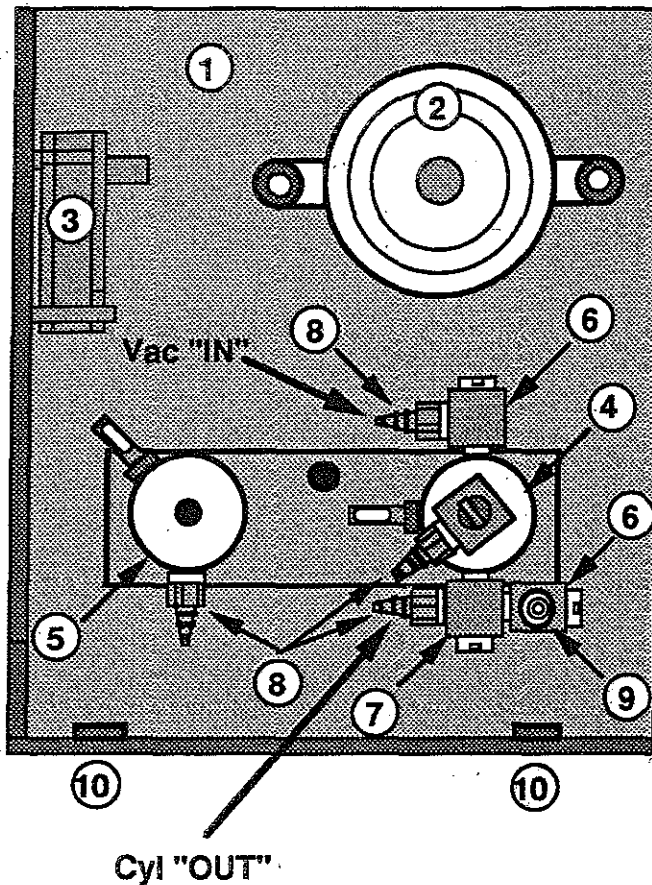
Items needed:

- 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.
2. 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.

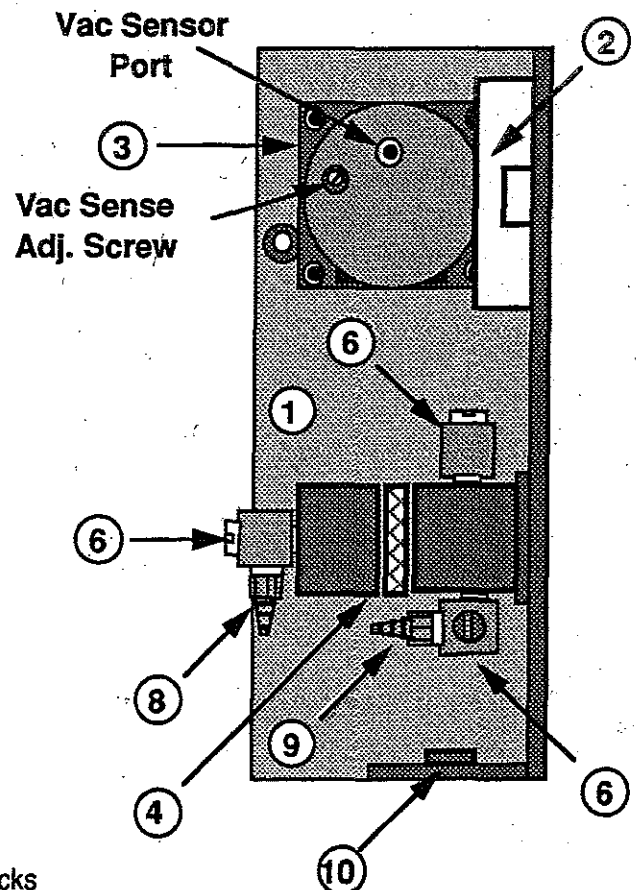
The construction and hookup of the ribbon cable wiring harness for this subassembly is covered in the BASEPLATE WIRING module.

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

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

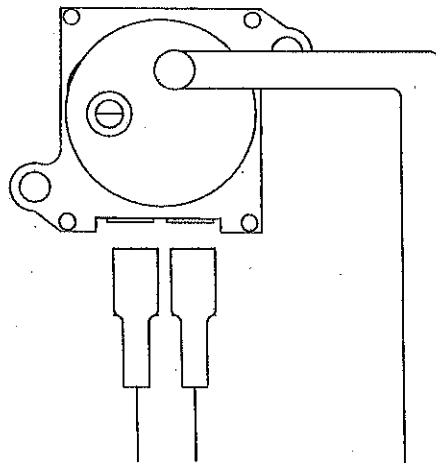
Mount Vacuum Sensor with 4-40 x 3/4" SHCS, flats & locks

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

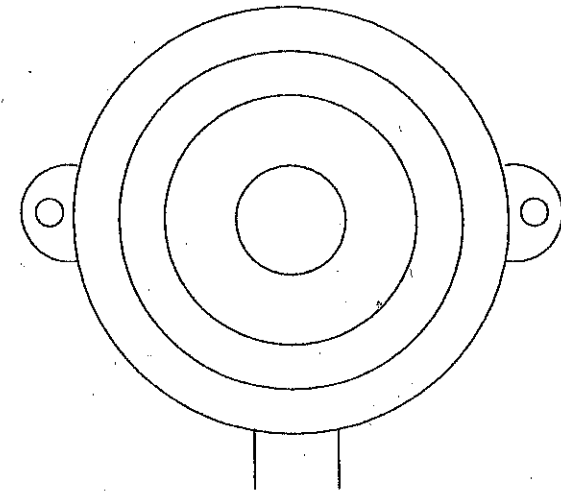


100 / 150 SOLENOID BRACKET

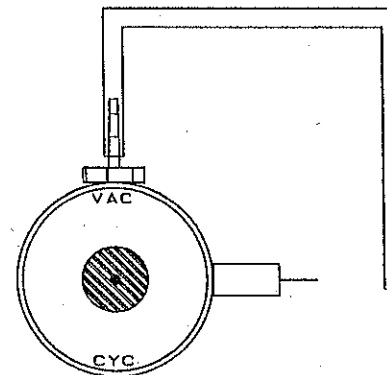
VACUUM SENSOR



PIEZO BUZZER

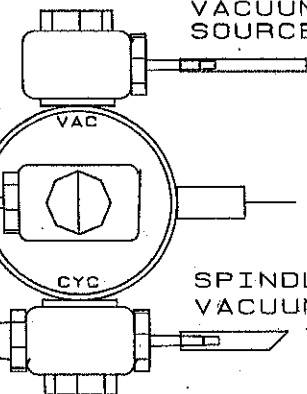


VACUUM VENT



VACUUM VENT
SOLENOID

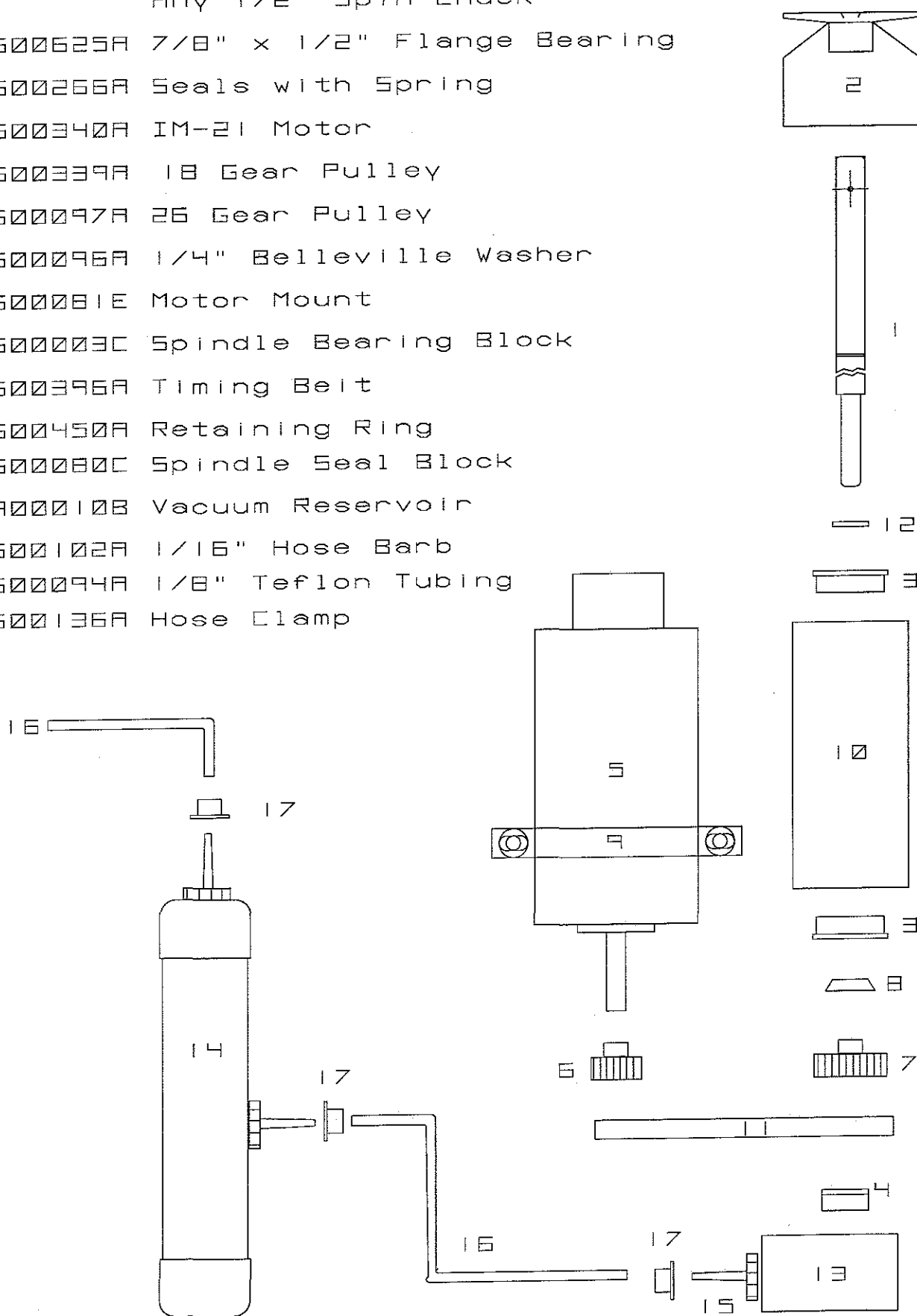
VACUUM
SOURCE

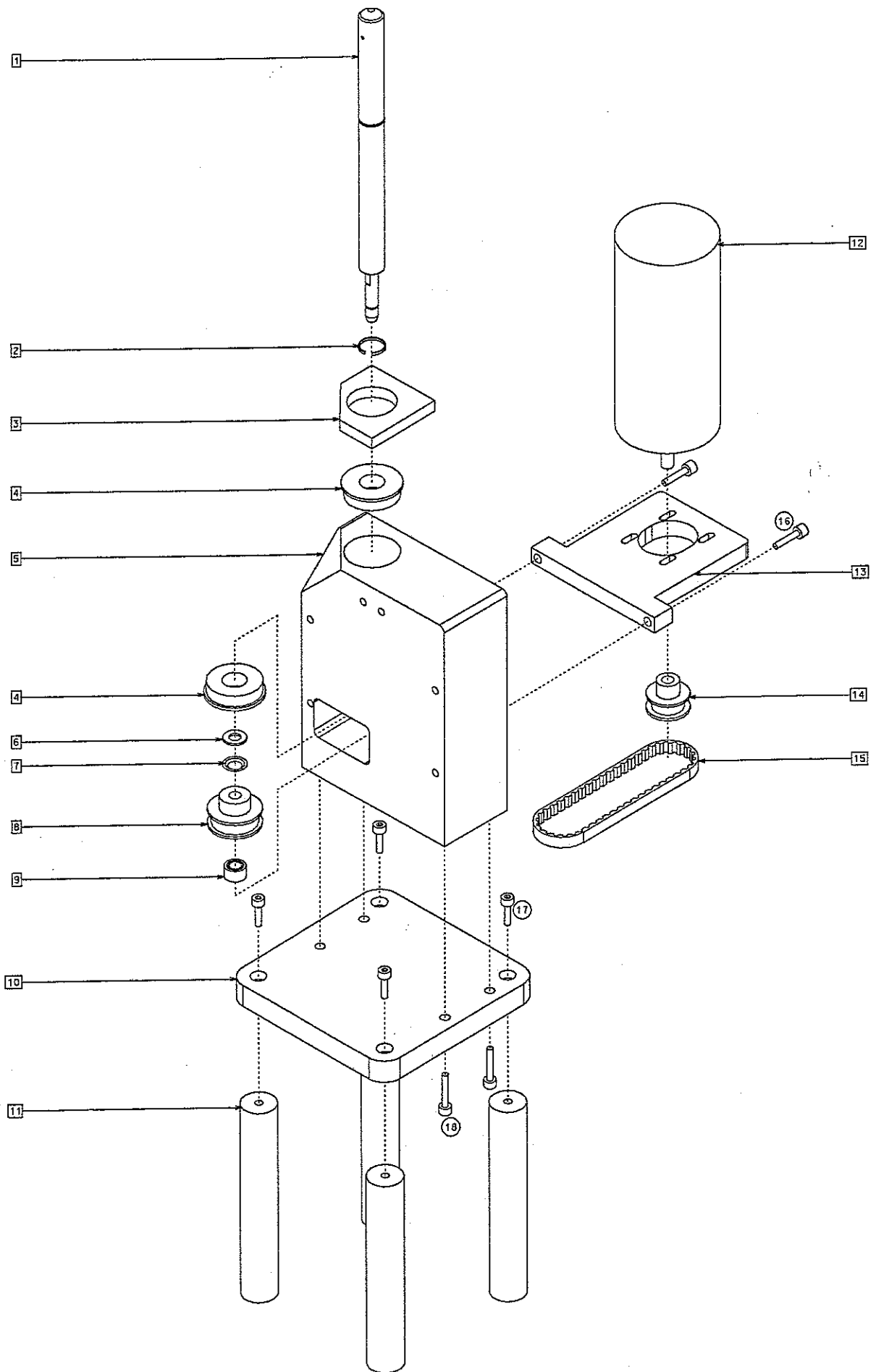


SPINDLE
VACUUM

VACUUM
SOLENOID

- 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 Belt
- 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





BOM 900648

DATE: 1/11/00

ITEM	PART NUMBER	DESCRIPTION	QUANTITY
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

Page 1 of 3

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 wrench 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.

Cee® Model 100 Series Spin Coating System
Spindle Bearing & Seal Replacement
Page 2 of 3

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

Cee® Model 100 Series Spin Coating System
Spindle Bearing & Seal Replacement
Page 3 of 3

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" Belleville 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

Vacuum Trouble Shooting

Page 1 of 3

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 Spin Coater
Vacuum Trouble Shooting
Page 2 of 3

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
Page 3 of 3

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.

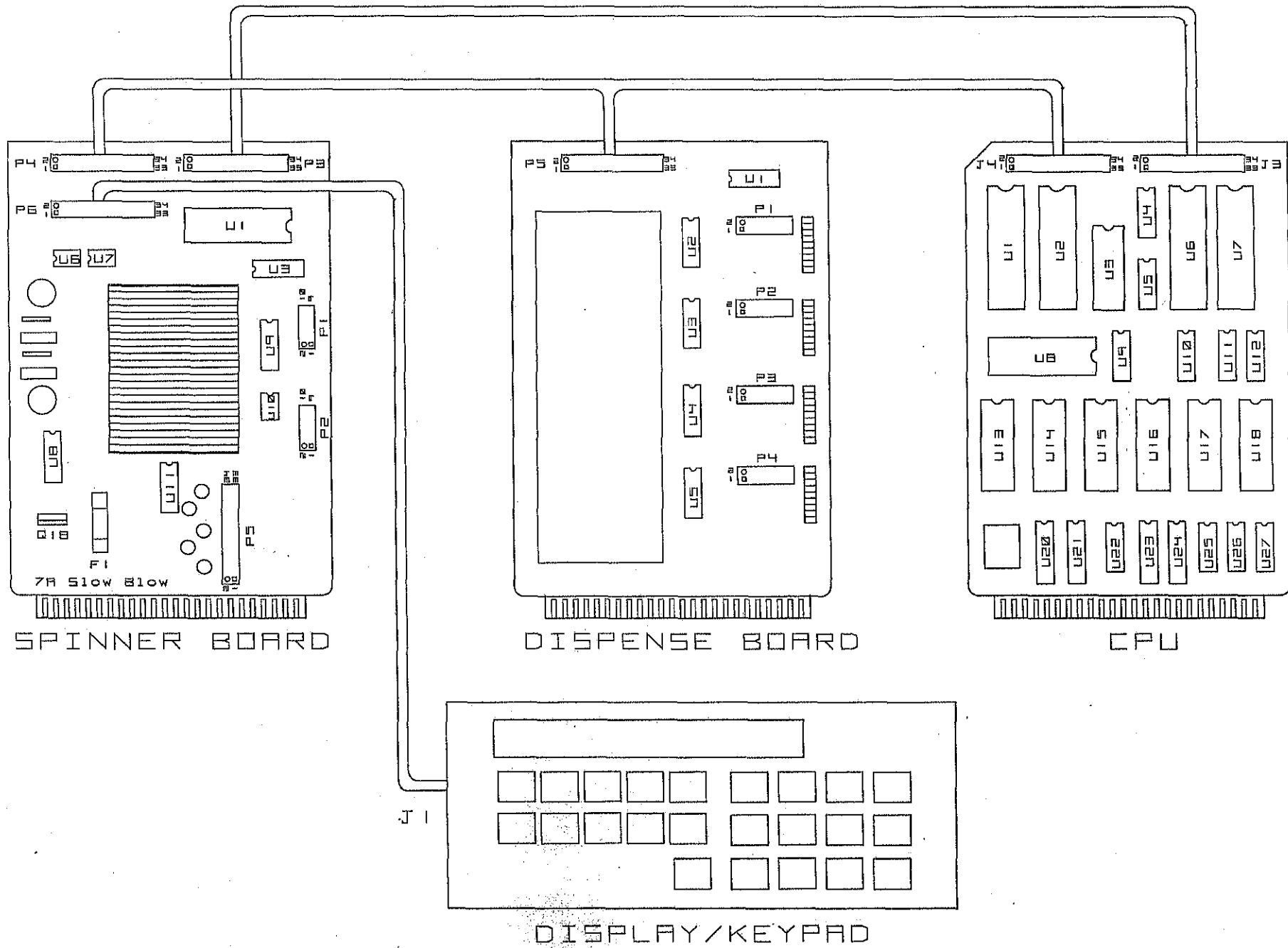
Question #8 - Is LED 9 on ?

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

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

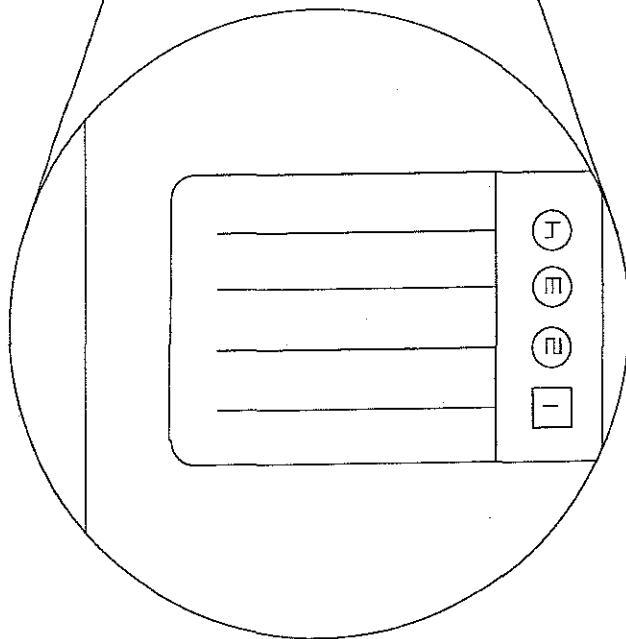
Note: If you are still experiencing vacuum problems, please contact your Cee® Customer Support Representative.

Cee Model 100 Series ELECTRONICS LAYOUT

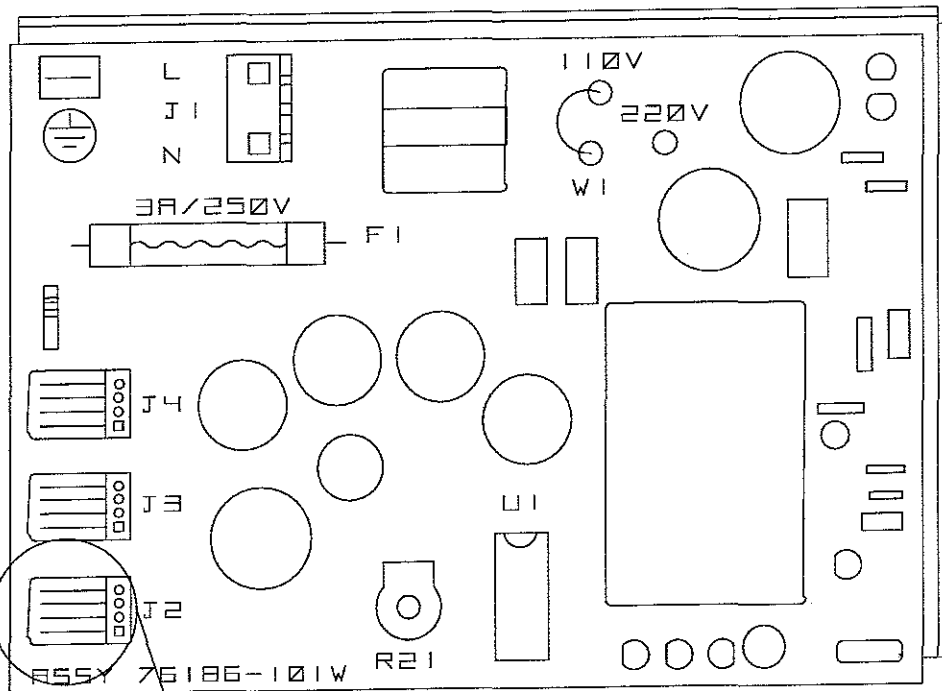


SPL-50 DC POWER SUPPLY

BSI# 100087A



- PIN 1 = -12 VDC - GREEN
- PIN 2 = +12 VDC - RED
- PIN 3 = GND - BLACK
- PIN 4 = +5 VDC - WHITE



NOTE:

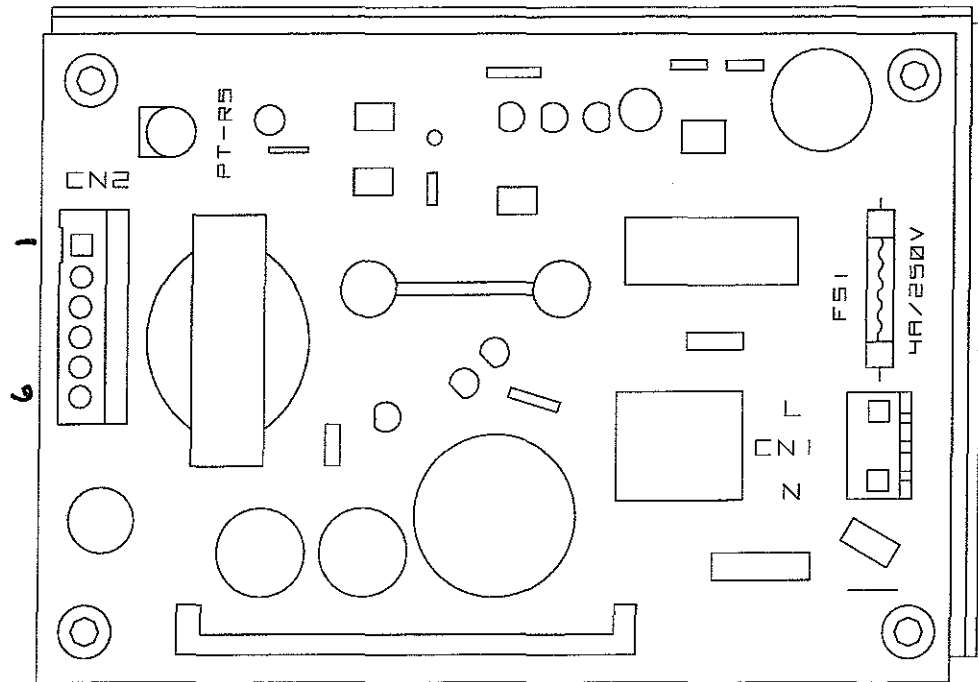
ALL 3 CONNECTORS HAVE THE SAME VOLTAGE.

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

ASTRODYNE DC POWER SUPPLY

BSI# 101047A

PIN 1 = +12 VDC - PURPLE
 PIN 3 = +5 VDC - PURPLE
 PIN 4 = GND - BROWN
 PIN 5 = -12 VDC - PURPLE



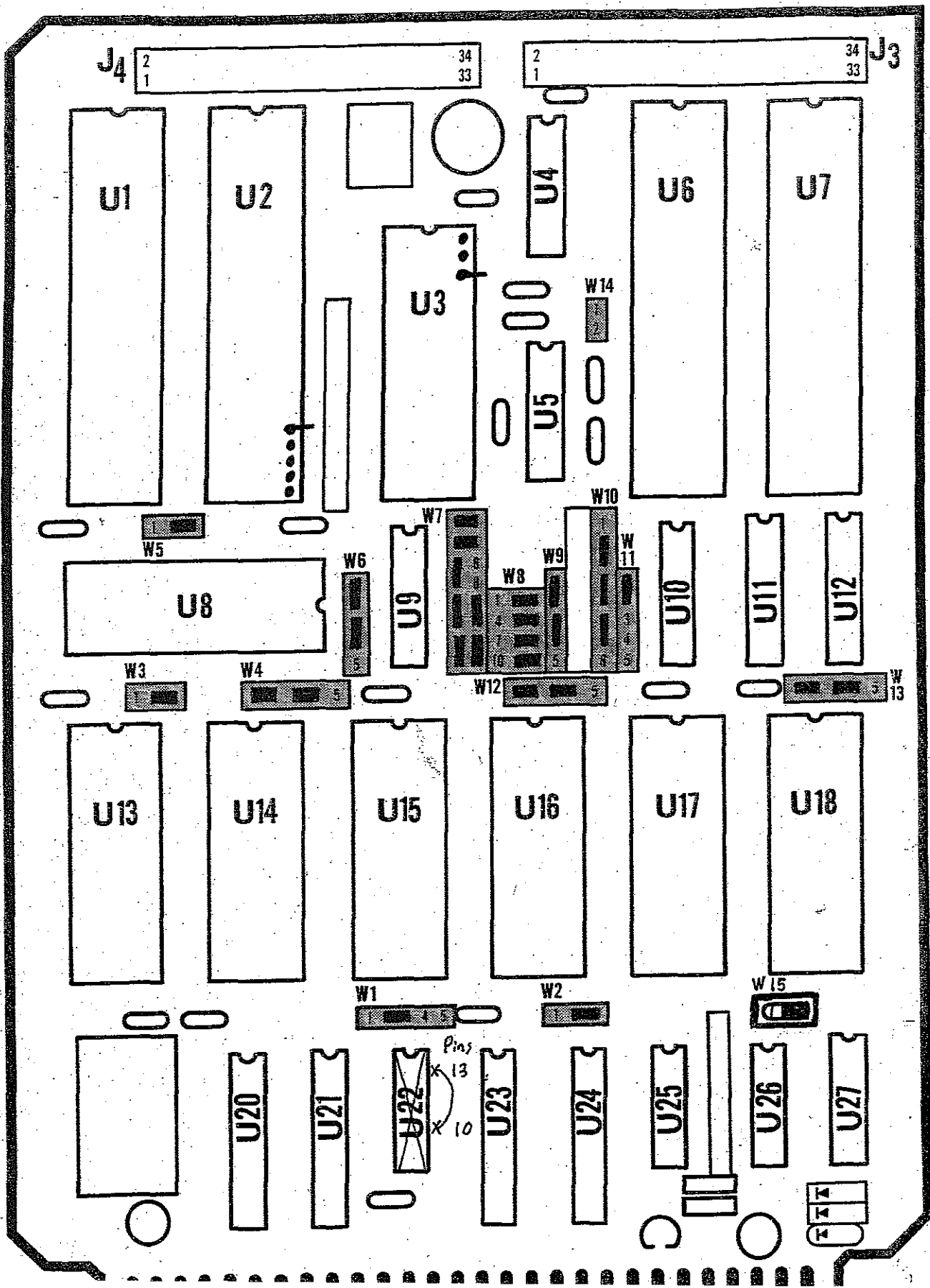
Serial CPU Boards - 8K RAM

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



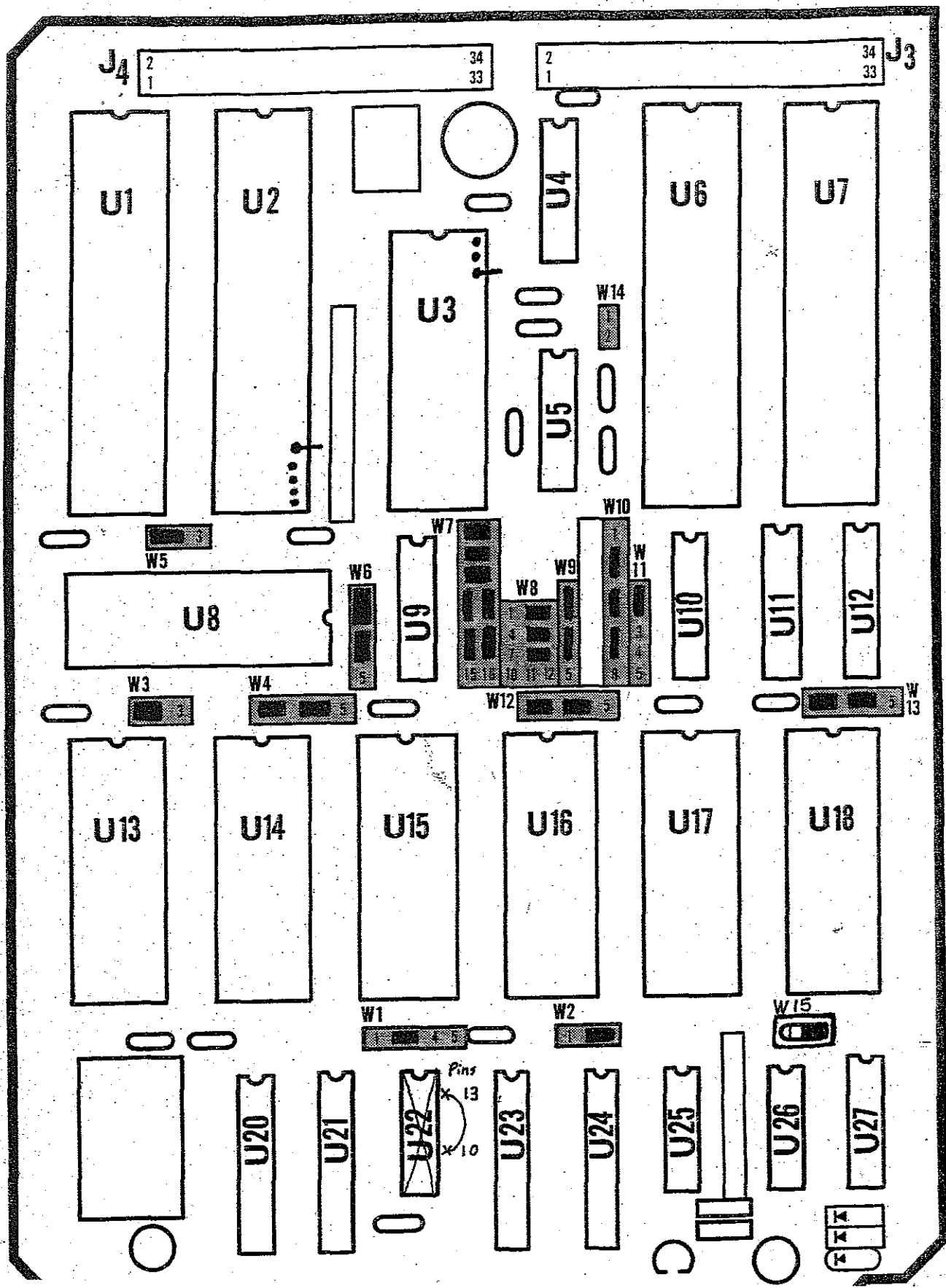
Serial CPU Boards - 2K RAM

Jumper Positions (W1 - W15) when using a 2K RAM (U8)

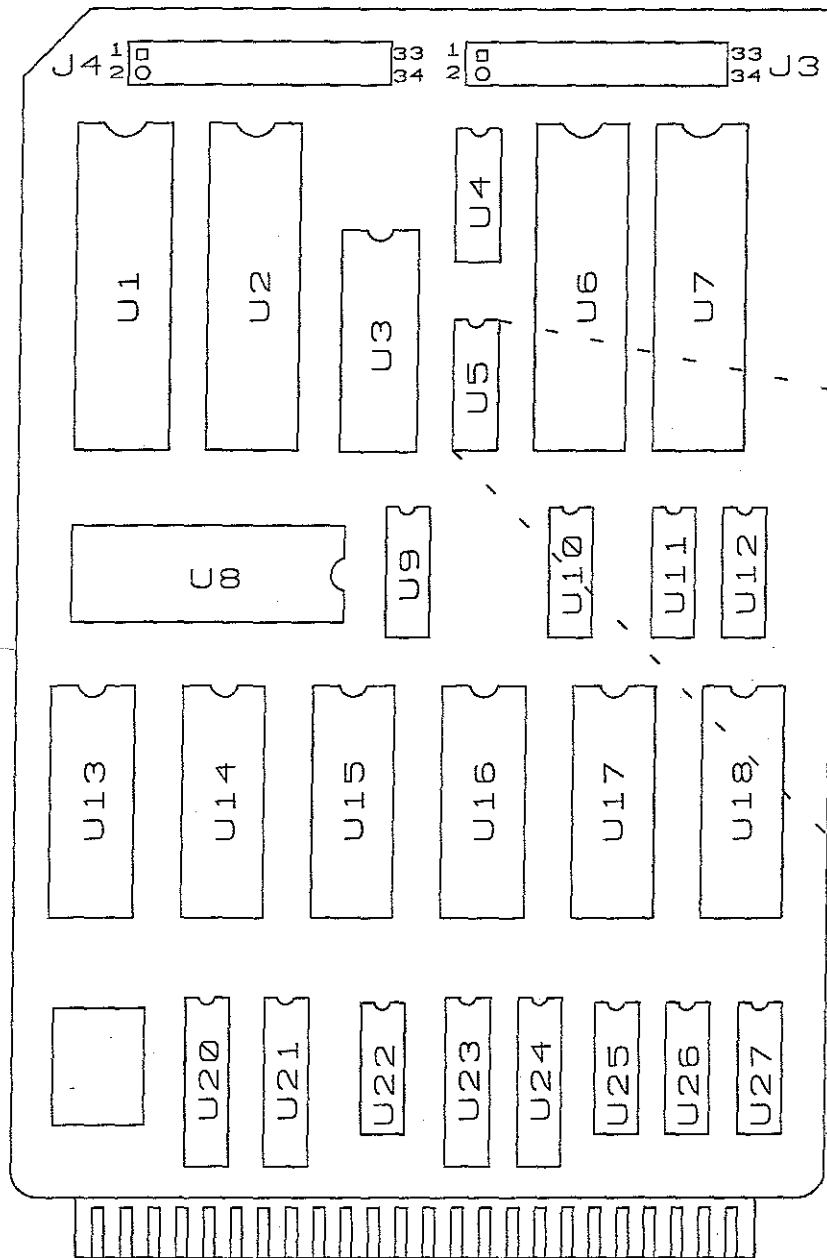
Remove IC Pin# 26 (U3) & Pin# 25 (U2)

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

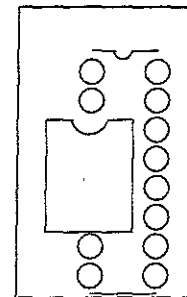
U15 = C000 ROM

U16 = A000 ROM

U17 = 8000 ROM

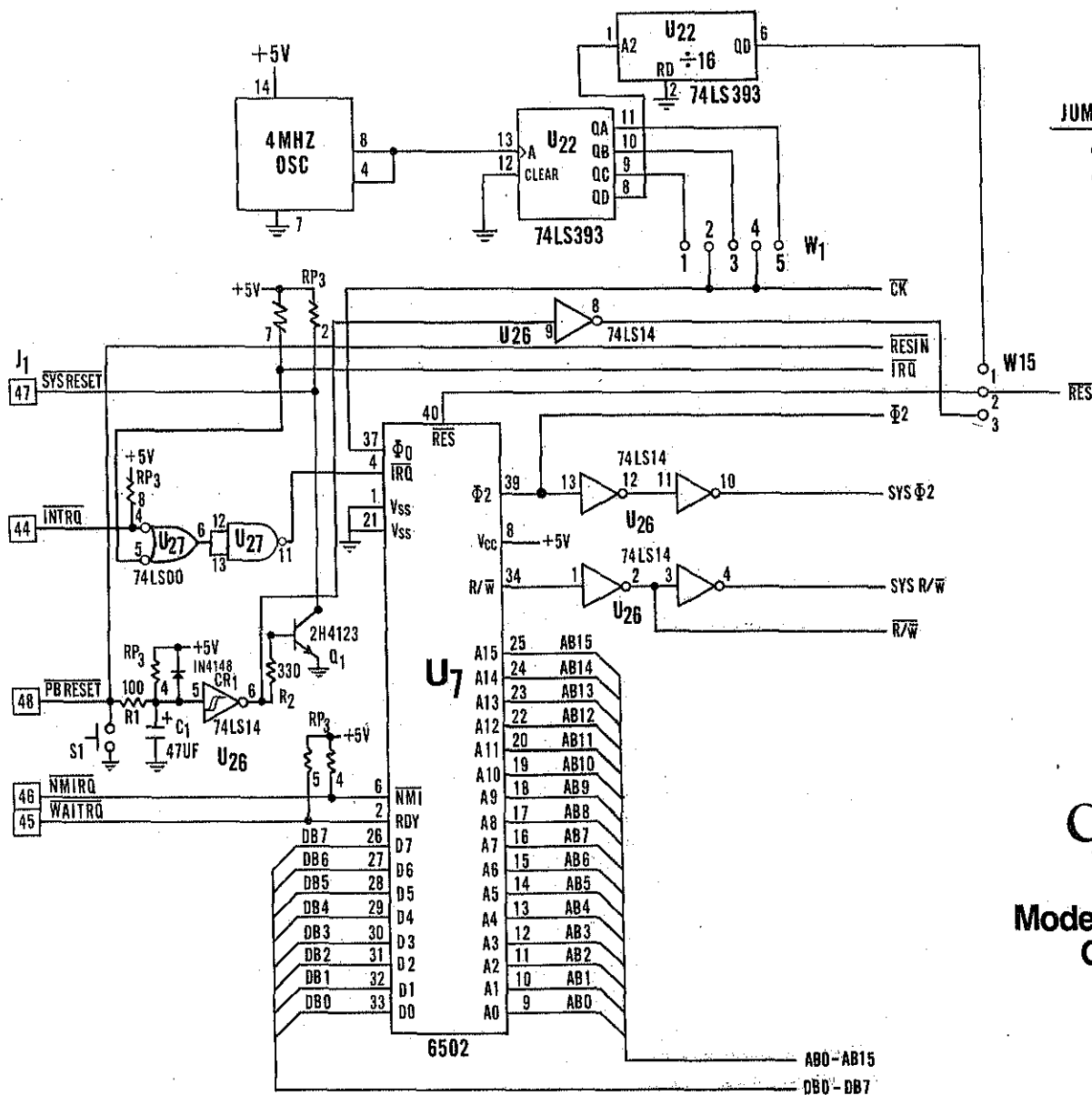
U18 = 6000 ROM

RS485 Adapter
If needed



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

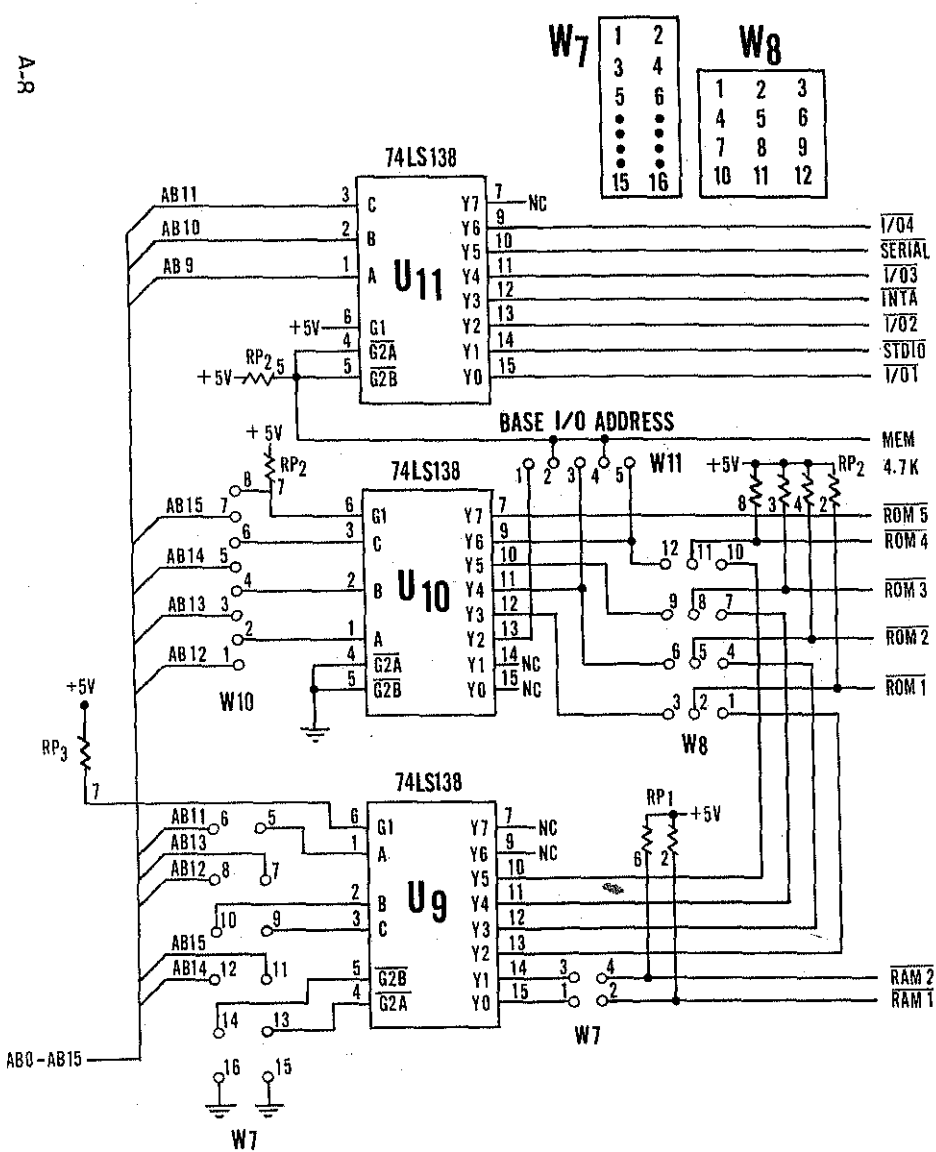
135... Component Side.



W1	
JUMPER	FREQUENCY
4-5	2 MHZ
4-3	1 MHZ

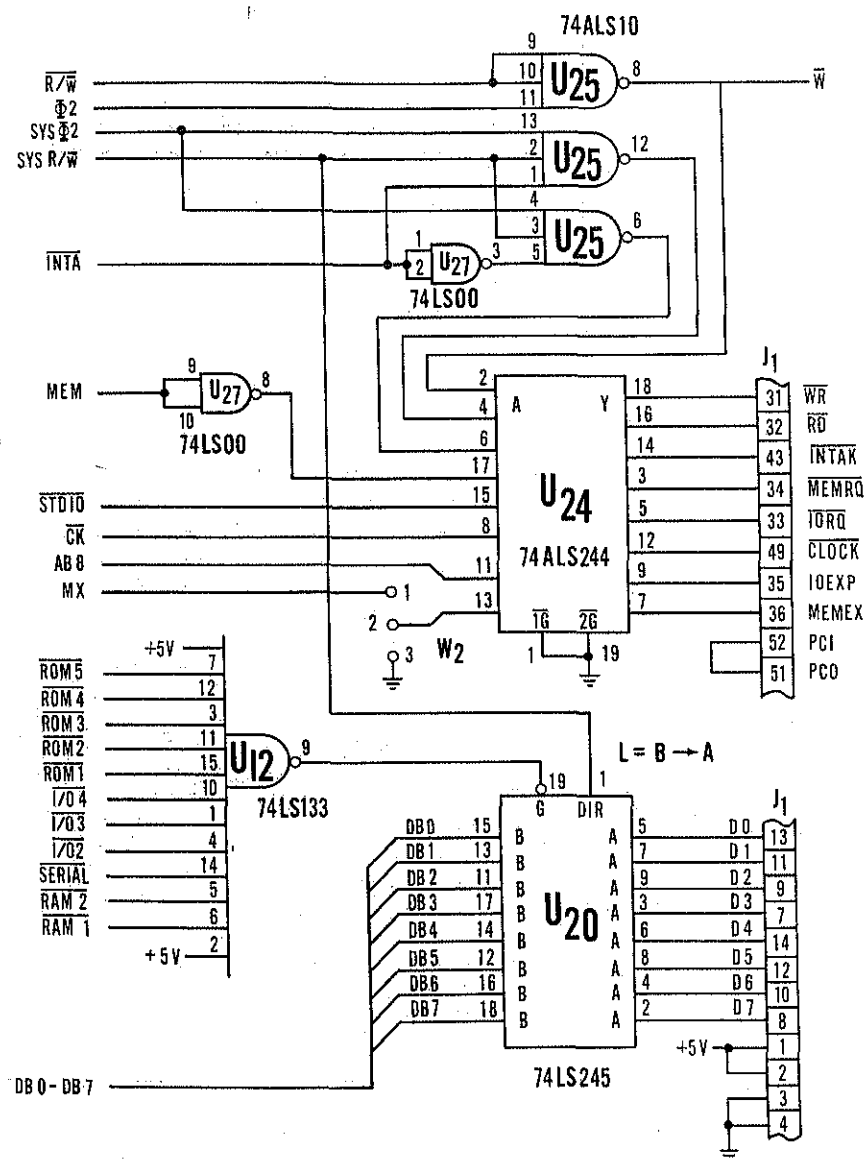
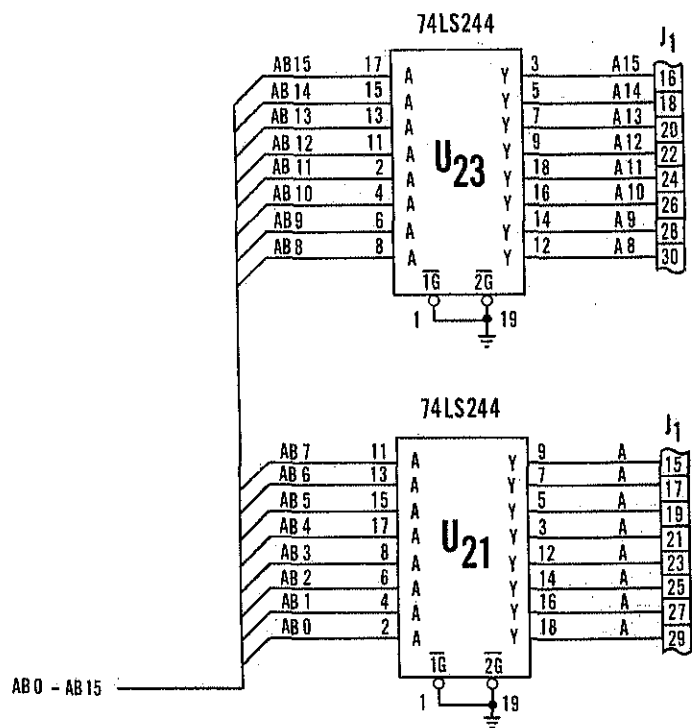
CuBIT DIVISION
OF PROTEUS INDUSTRIES

**Model 7530 and 7540
CPU Boards**



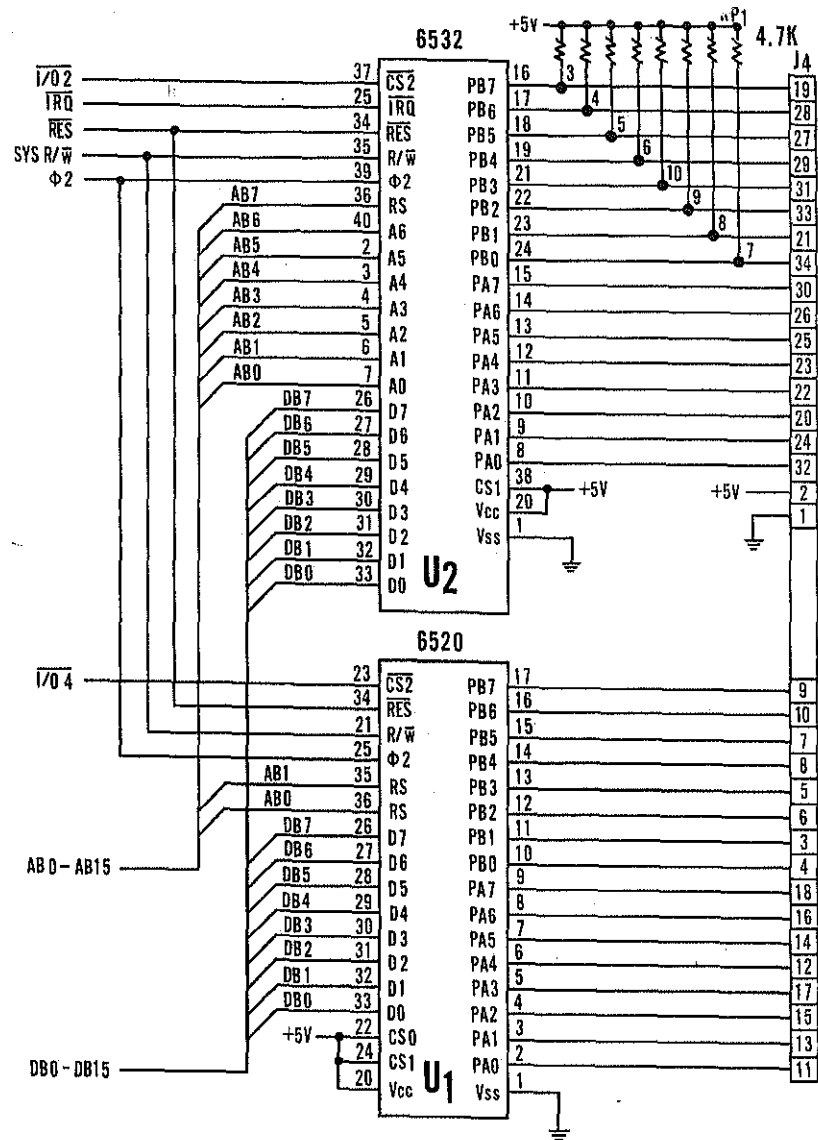
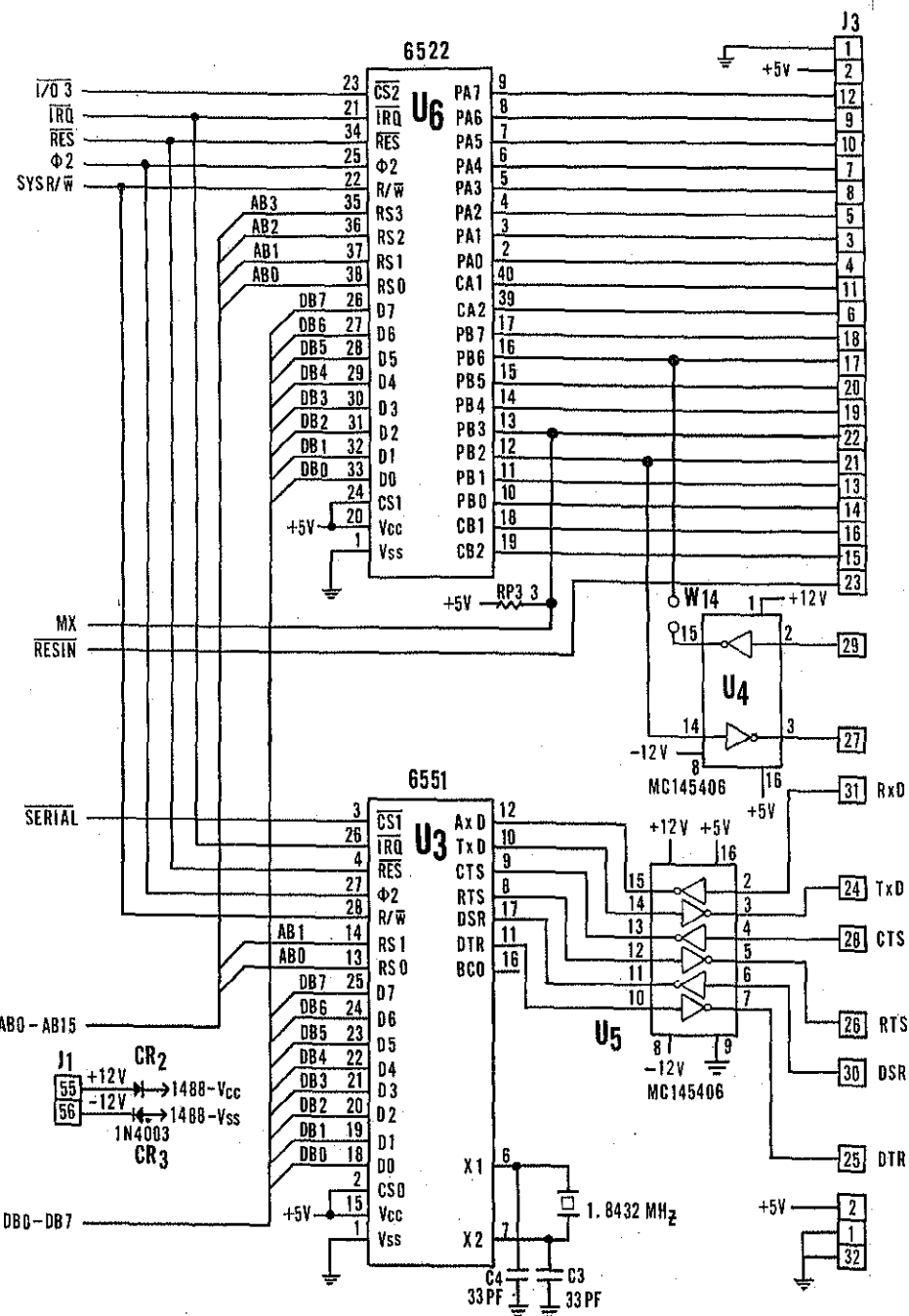
MEMORY AND MEMORY CONTROL

REV B
Sheet 2 of 4



I/O BUS SIGNALS

Model 7530 and 7540 CPU Boards

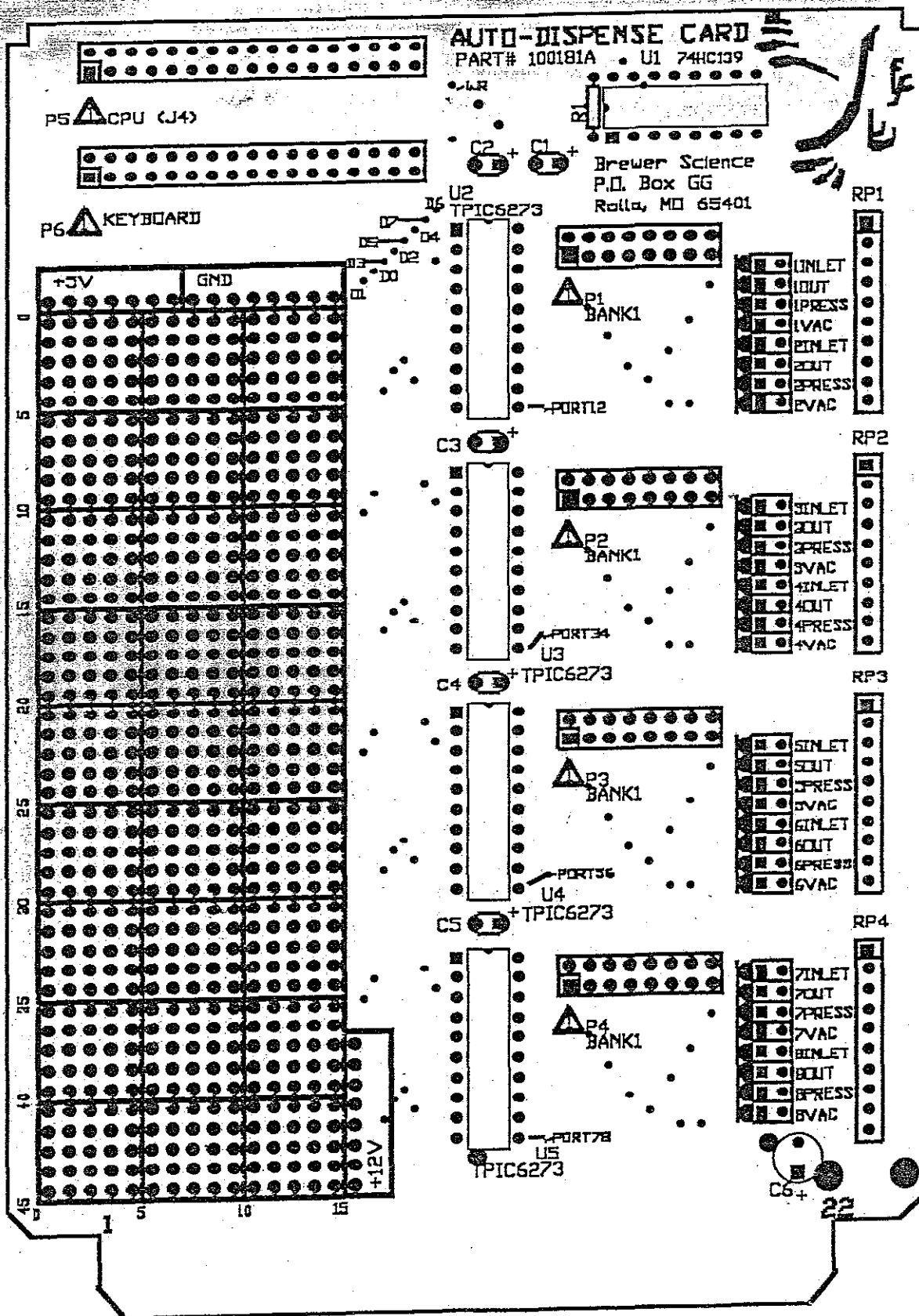


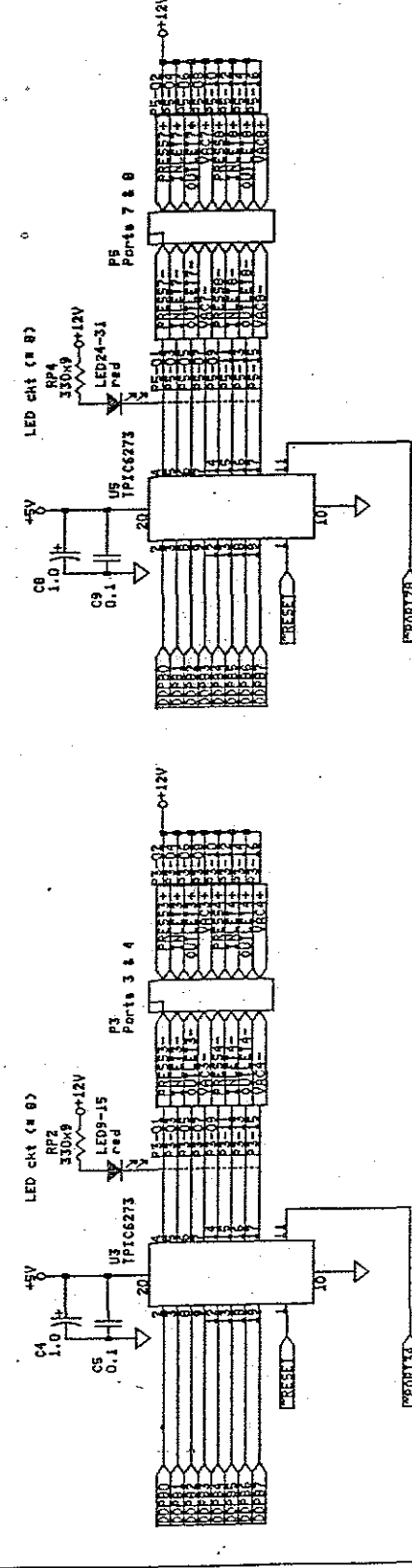
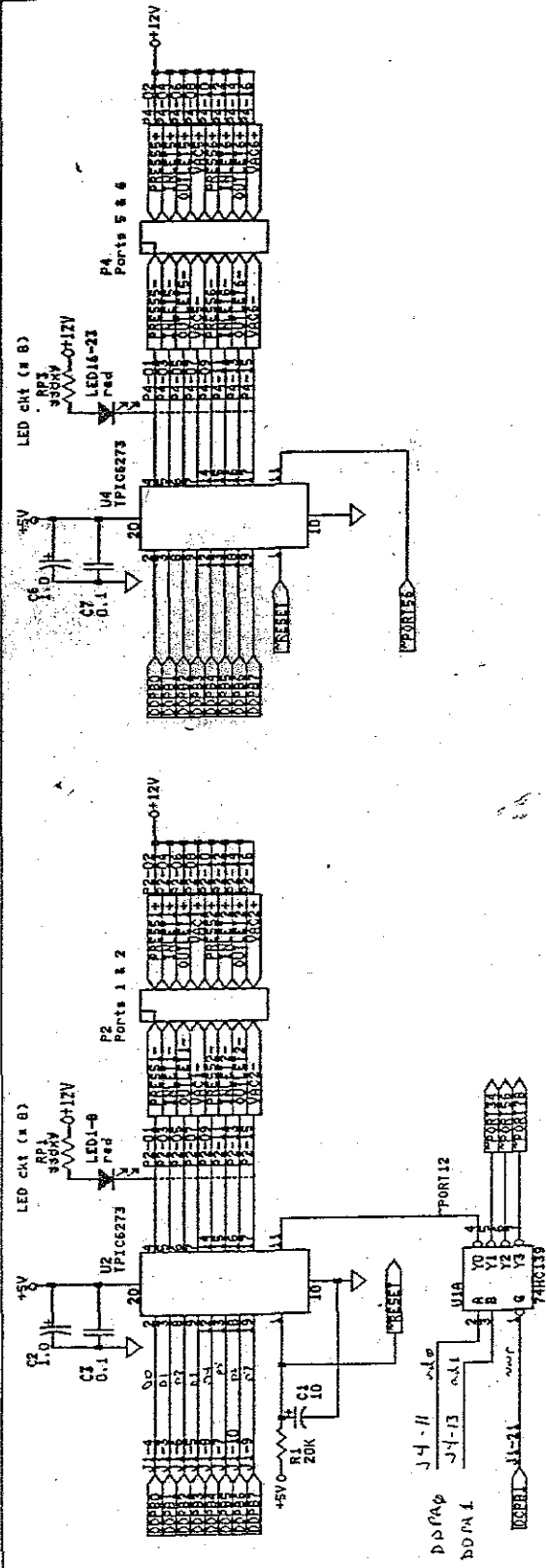
SERIAL AND PARALLEL I/O

Model 7530 and 7540 CPU Boards

REV B
Sheet 4 of 4

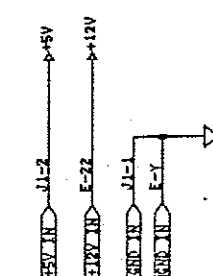
Auto-Dispense Board



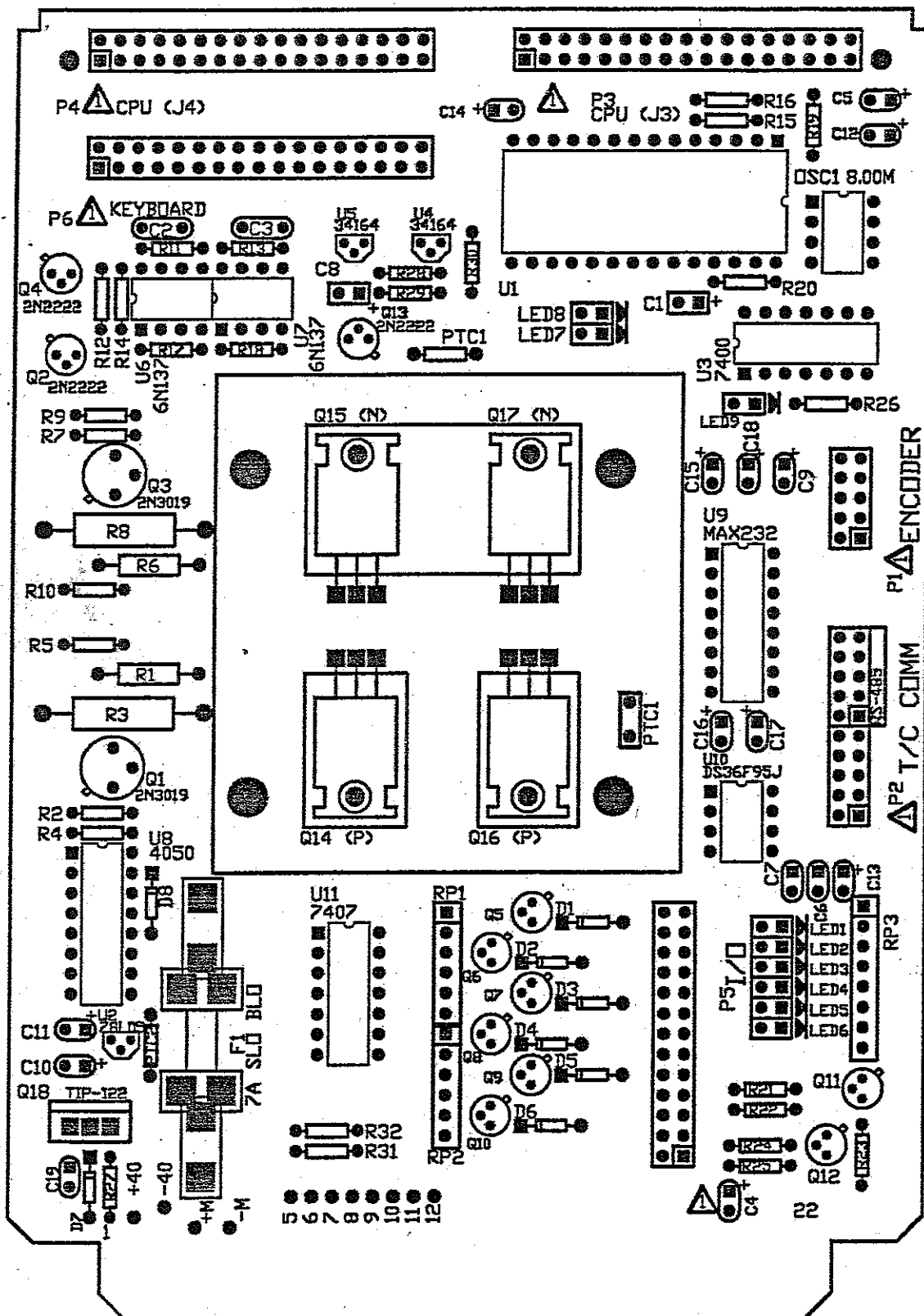


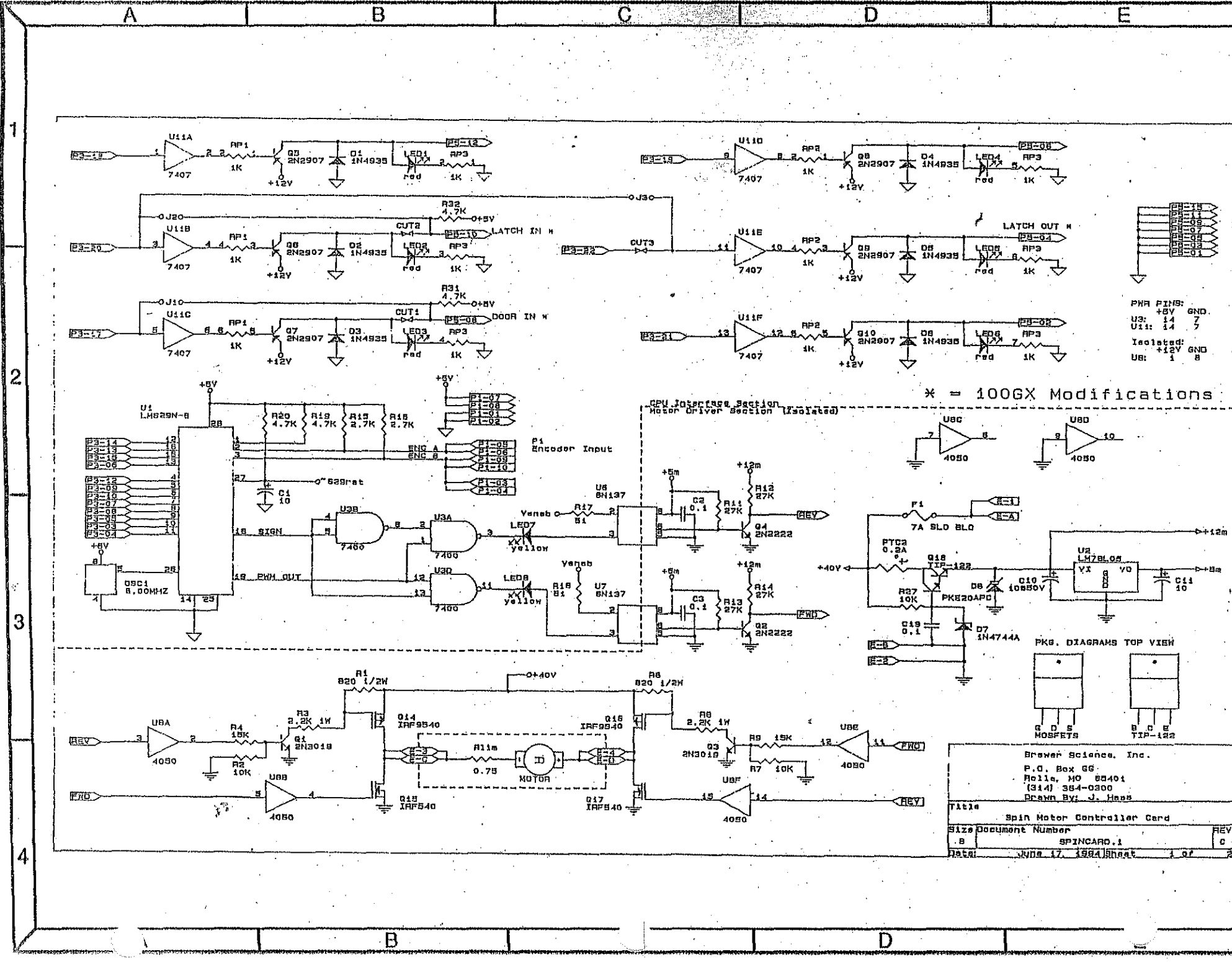
Rev 45 7/94
UI 7/94/7/94

NOTES:
For machines that require only one driver chip, the 74HC139
TPIC6273 and DCPH1 can be connected to pin 11 of the
E-1 connector. The edge connector pins, J1 goes to
the 74HC139 decoder.
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 = BLU/GRN
VNC = GRN/YLO



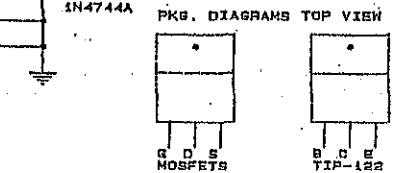
Breuer Science, Inc.	
P.O. Box 66	
Rolla, MO 65401	
(314) 364-0300	
drawn by J. J. Hazz	
Title	
Model 100CB Auto-Dispense Drivers	
Size/Document Number	
B	1000UT.PUT
REV	A
Date:	May 20, 1994 Sheet 1 of 1





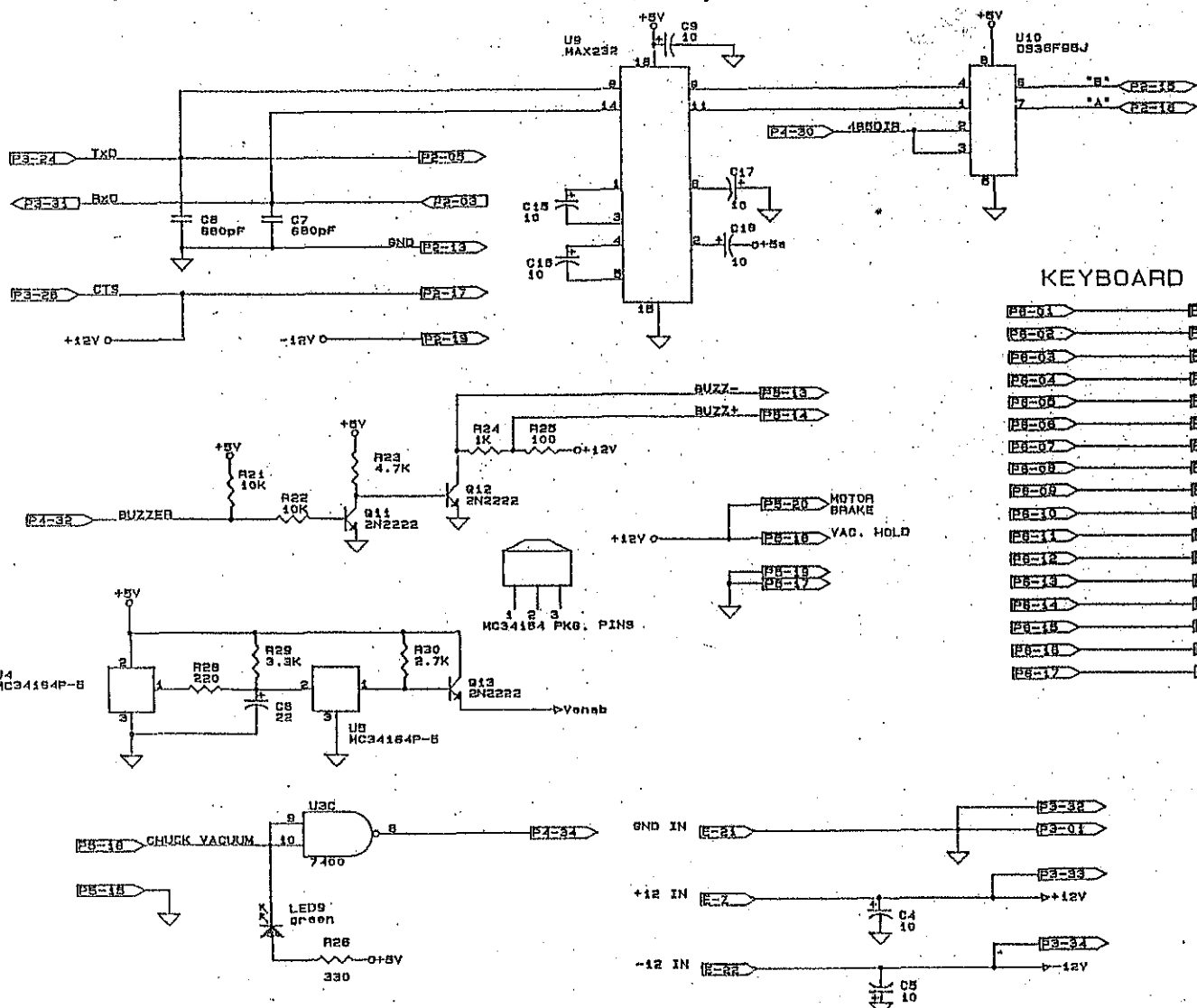
PHR PINS:
+5V: 14 7
U3: 14 7
U11: 14 7
Isolated:
+12V: 1 8
GND: 8

* = 100GX Modifications

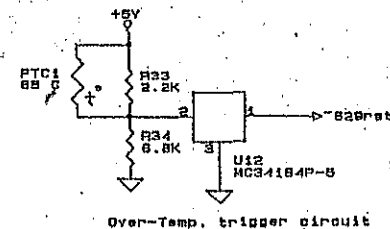


Brewer Science, Inc.
P.O. Box 66
Holla, MO 65401
(314) 364-0300
Drawn By: J. Haas

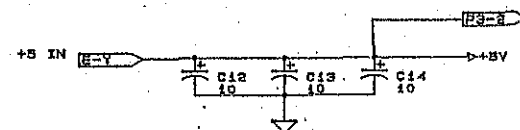
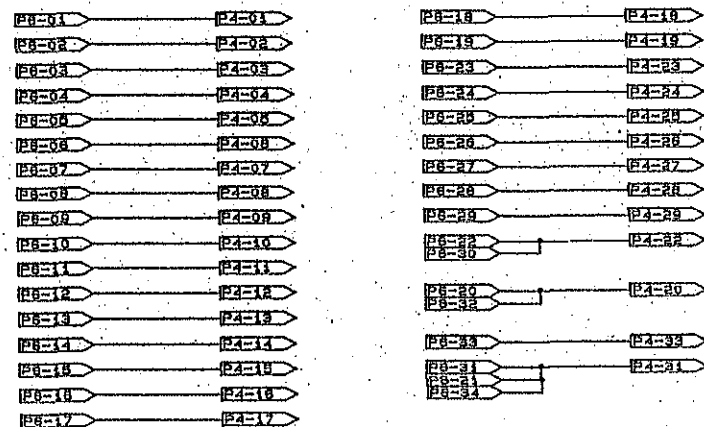
Title: Spin Motor Controller Card
Size: Document Number: SPINCARD.1
Date: JUNE 17, 1994 Sheet 1 of 2



NOTE:
PTC1 SHALL BE THERMALLY BONDED TO HEAT SINK
OF MOSFET DRIVER TRANSISTOR Q16.



KEYBOARD CONNECTOR (P4 to P6)



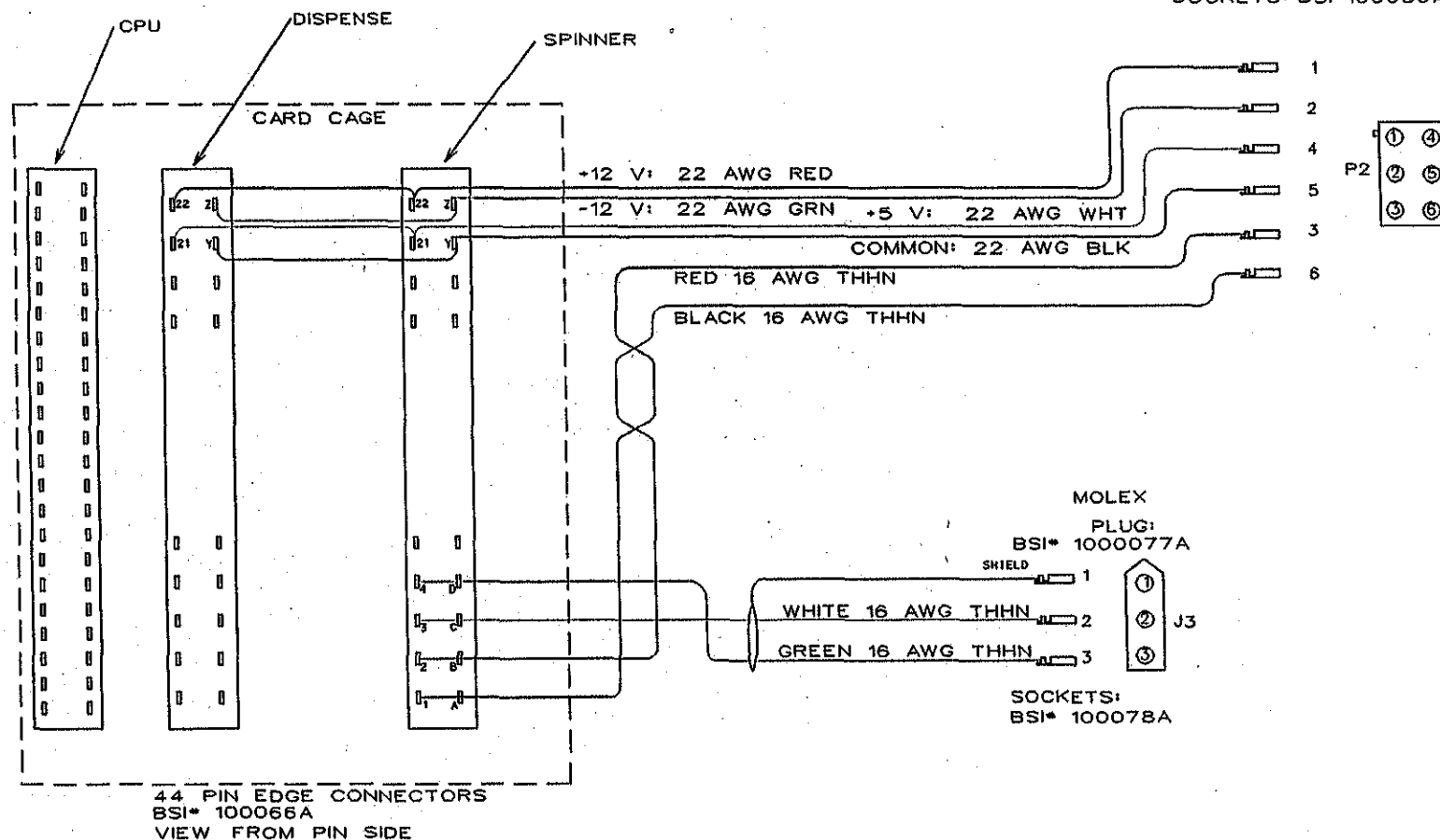
Brewer Science, Inc.
P.O. Box 69
Rolla, MO 65401
(314) 364-0300
Drawn By: J. Haas

Title: Spin Motor Controller Card
Size: Document Number: SPINCARD.2
Date: June 17, 1984 Sheet 3 of 3

REVISION INFORMATION:

SYMBOL	DATE	ENGR	DESCRIPTION
△			

AMP
PLUG: BSI* 100079A
View from Wire Side
SOCKETS: BSI*100080A



UNLESS OTHERWISE SPECIFIED LIMITS ON DIMENSIONS ARE FRACTIONS = $\pm \frac{1}{64}$
 .XX = $\pm .015$
 .XXX = $\pm .005$
 .XXXX = $\pm .0005$
 REMOVE ALL BURRS AND SHARP EDGES

MATERIAL	DESIGN ENGINEER	Jeff Leith
TYPE FINISH REQD.	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

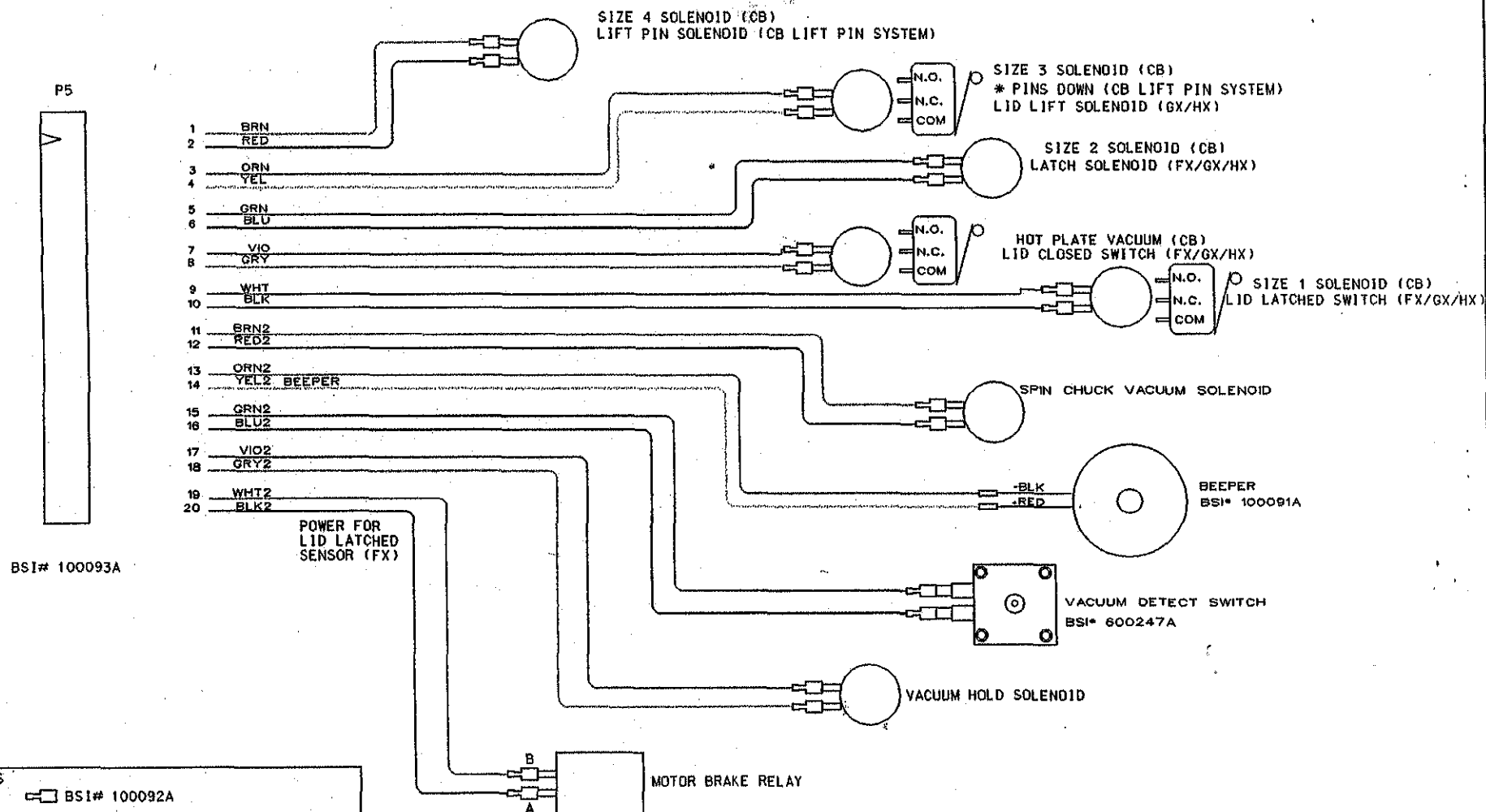
TITLE 100 Series
Card Cage
Wiring Diagram

Controller	PAPER SIZE	SHEET OF
Date:	A	1
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 = 2/64

.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

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

Cost Effective Equipment
a division of Brewer Science, Inc.

TITLE

100 Series
Solenoid Bracket
Wiring Diagram

CONTROLLER

DATE

PAPER SIZE

A

SHEET

OF

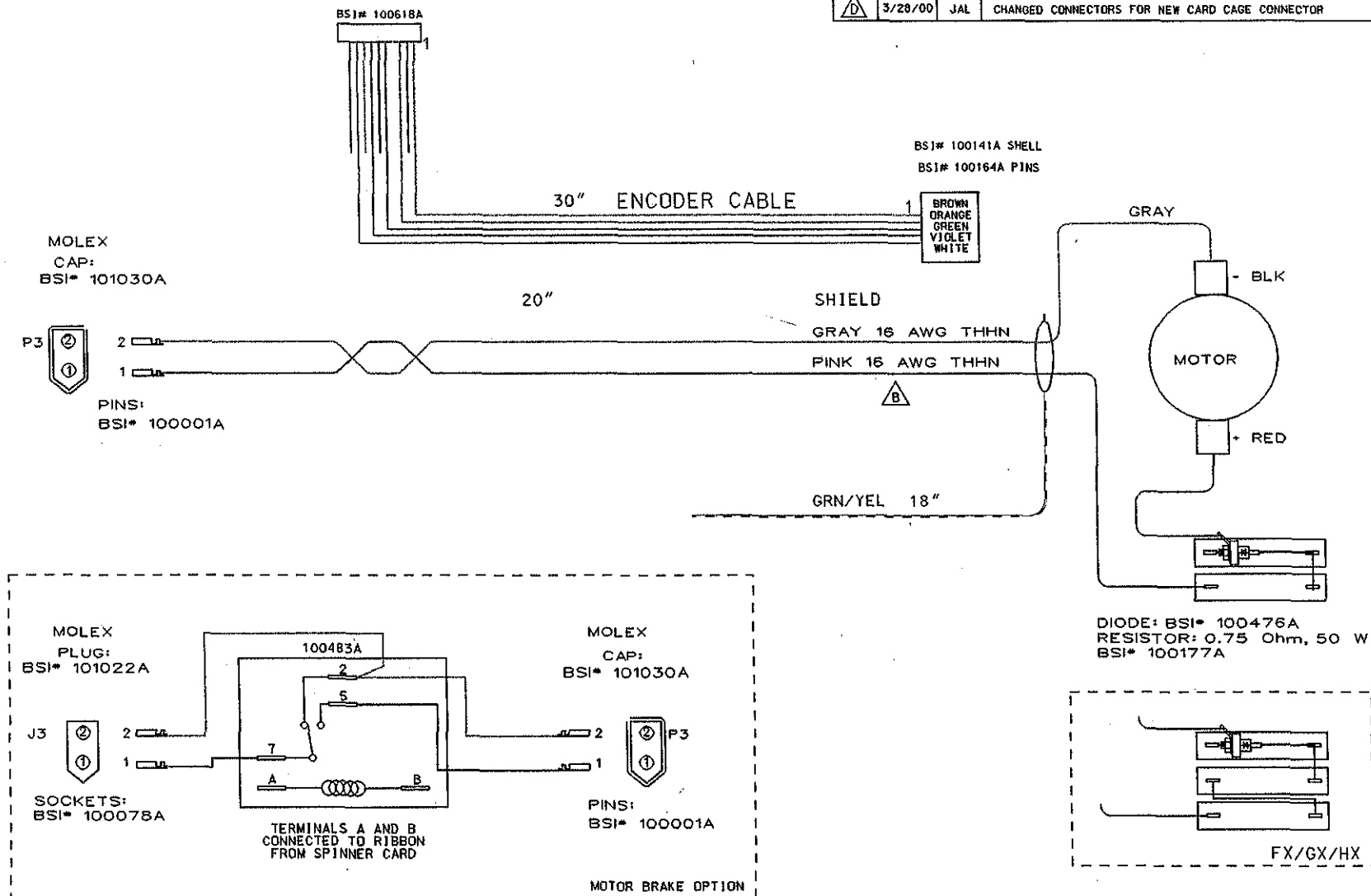
PART NO.

300014A

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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 = $\pm 1^\circ$
FRACTIONS = $\pm 1/64$
.XX = $\pm .015$
.XXX = $\pm .005$
.XXXX = $\pm .0005$
REMOVE ALL BURRS
AND SHARP EDGES

MATERIAL

TYPE FINISH REQ.

DESIGN ENGINEER

Jeff Leith

DRAWN

APPROVED

DATE

1/11/99



Model 100 Spinner
Motor Wiring Diagram

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

CONTROLLER

DATE

PAPER SIZE

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OF

PART NO.

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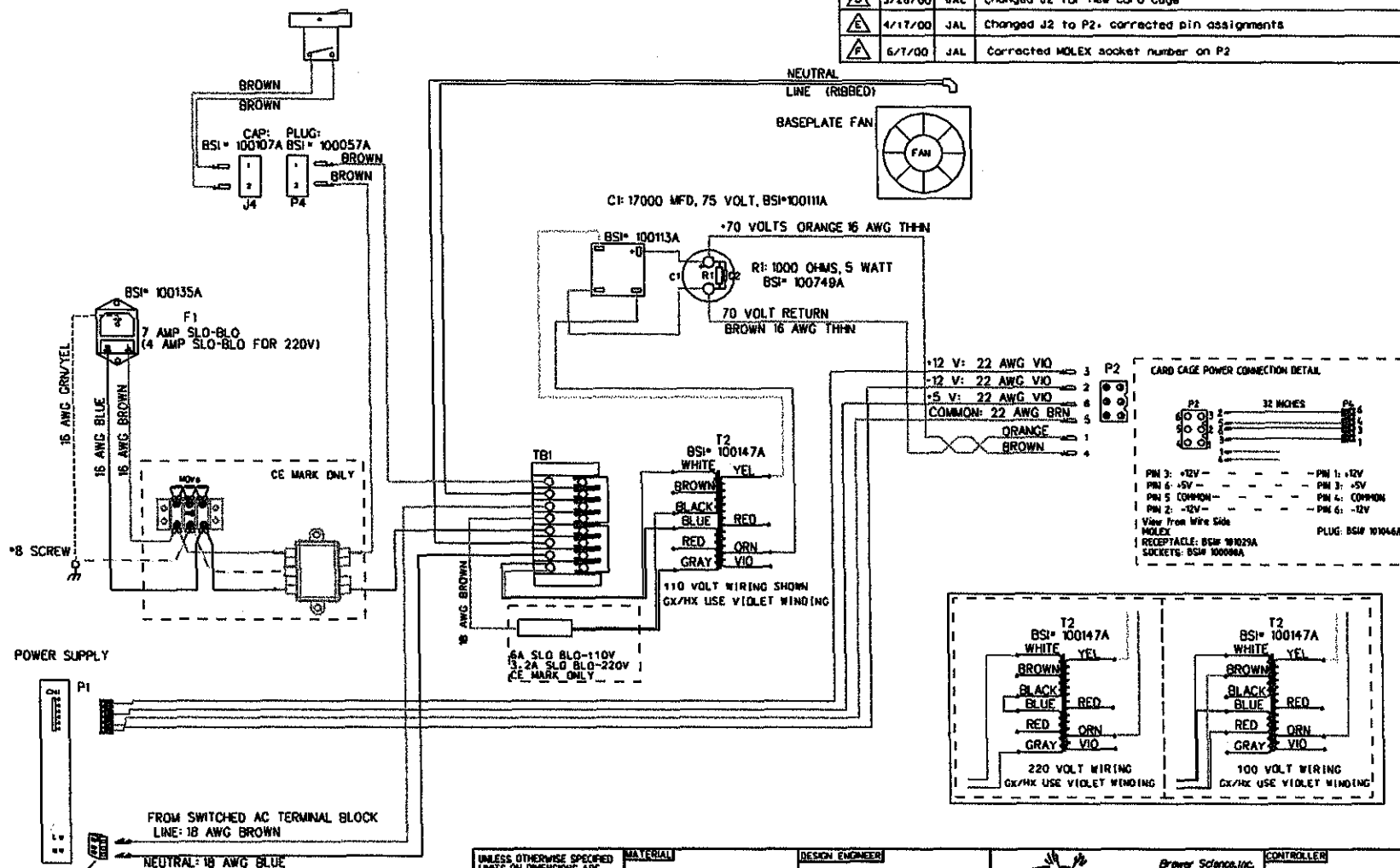
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REVISION INFORMATION:

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

REVISION INFORMATION:

SYMBOL	DATE	ENGR	DESCRIPTION
B	2/16/00	JAL	Changed wire colors for SEM
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
UNITS ON DIMENSIONS ARE
ANGULAR = ± 1°
FRACTIONS = 1/64
XX = ± .015
XXX = ± .005
XXXX = ± .0005
REMOVE ALL BURRS
AND SHARP EDGES

MATERIAL
TYPE: FRESH RECO.

DESIGN ENGINEER
Jeff Leith
DRAWN
APPROVED
DATE
2/16/00

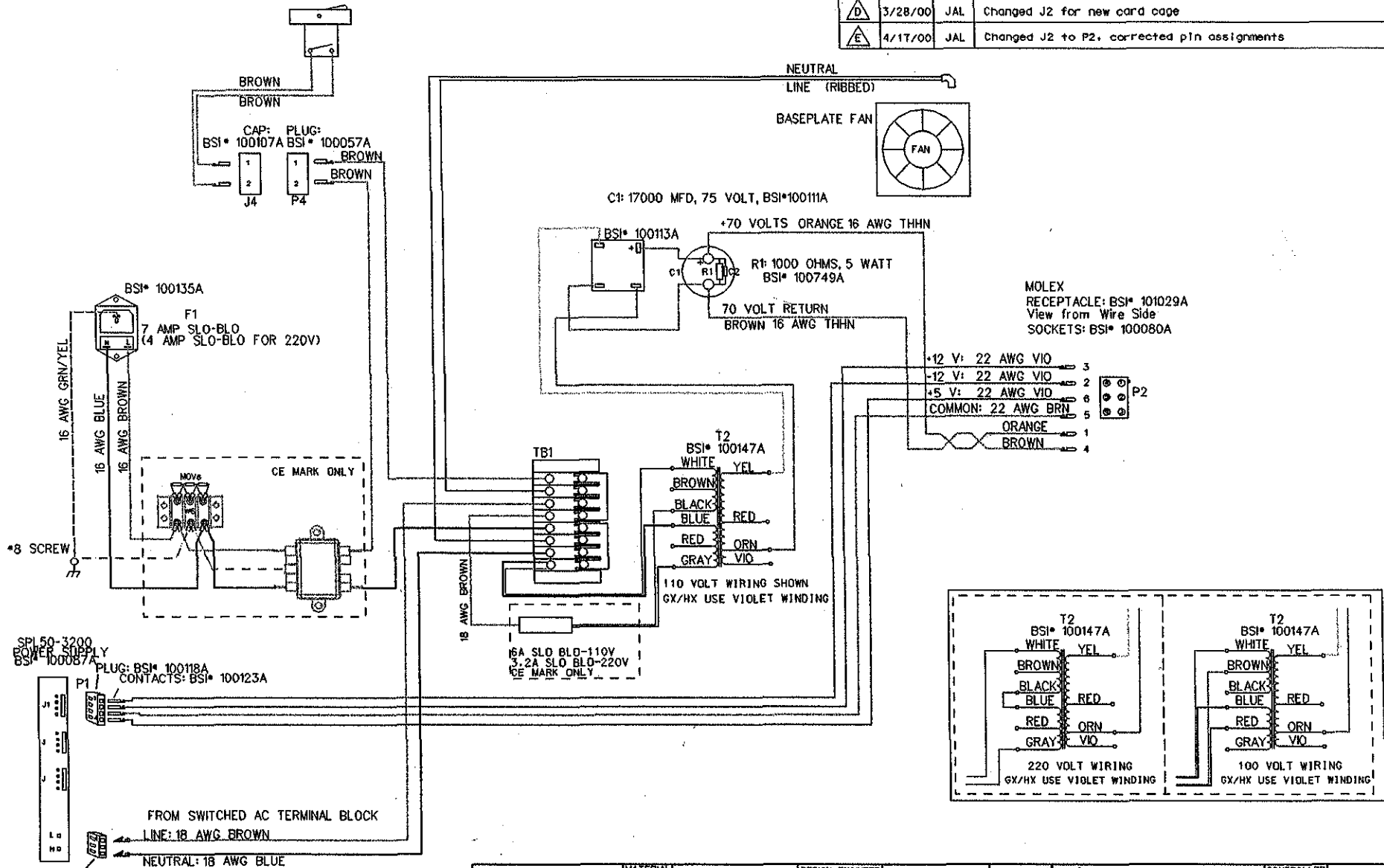
Brewer Science, Inc.
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4000 Enterprise Drive
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Phone: (573) 364-0300
Fax: (573) 364-9513
Model 100
Wiring Diagram

CONTROLLER
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UNLESS OTHERWISE SPECIFIED
LIMITS ON DIMENSIONS ARE:
ANGULAR = $\pm 1^\circ$
FRACTIONS = $\pm \frac{1}{64}$
.XX = $\pm .015$
.XXX = $\pm .005$
.XXXX = $\pm .0005$
REMOVE ALL BURRS
AND SHARP EDGES

MATERIAL

TYPE FINISH REQ.

DESIGN ENGINEER

Jeff Leith

DRAWN

APPROVED

DATE

2/16/00



Model 100
Wiring Diagram

CONTROLLER

DATE

PAPER SIZE

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PART NO.

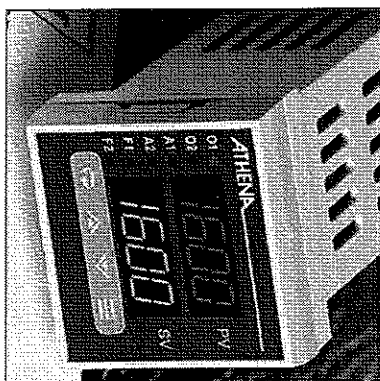
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ATHENA
The Temperature Control Company

SERIES 16 TEMPERATURE/PROCESS CONTROLLER



Instruction Manual

Introduction

Congratulations on your purchase of an Athena® Series 16 Single-Loop Controller. It is designed for ease of use and reliability wherever accurate closed-loop control is required. Your Series 16 has been configured according to your ordering specifications as either a universal process controller or a dedicated temperature controller. In addition, special functions such as a heater break alarm, digital communications, etc., do not require you to make any internal jumper or DIP switch settings.

After following the instructions for installation, simply step through and set your desired parameters using the Series 16's easy menu system. The instrument may then be automatically or manually tuned to your process for optimum setpoint control. A Quick-Start Reference Card is attached to the back of the instruction manual for experienced users of PID controllers. If you still have questions or require any assistance in setting up or operating your controller, please contact your Athena representative or call 1-800-782-6776.

Precautions

After unpacking, inspect the instrument for any physical damage that may have occurred in shipping. Save all packing materials and report any damage to the carrier immediately.

Safety Warning

In addition to presenting a potential fire hazard, high voltage and high temperature can damage equipment and cause severe injury or death. When installing or using this instrument, follow all instructions carefully and use approved safety controls. Electrical connections and wiring should be performed only by suitably trained personnel.

Do not locate this instrument where it is subject to excessive shock, vibration, dirt, moisture, oil or other liquids. Safe ambient operating temperature range is 32° to 131° F (0° to 55° C).



NOTES ON CE EMC COMPLIANCE

This unit is compliant with the following standards when properly installed in a grounded metal panel:
EN55011 (CISPR 11), Class B
EN50082-1.

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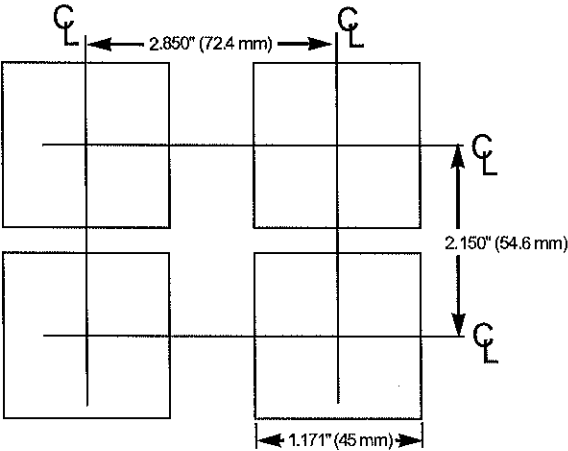
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Installation

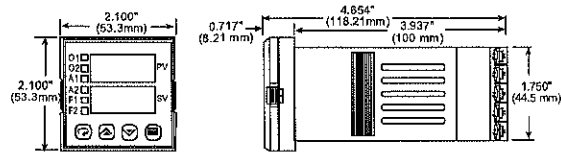
Measurements between centerlines of panel cutouts are minimum recommended.

Figure 1. Recommended Panel Layout for Multiple Controllers



Installation

Figure 2. Case Dimensions



Prior to mounting the Series 16 in your panel, make sure that the cutout opening is of the right size, 1.771" x 1.771" (45 mm x 45 mm), and deburred to enable a smooth fit. A minimum of 4" (100 mm) of depth behind the panel is required.

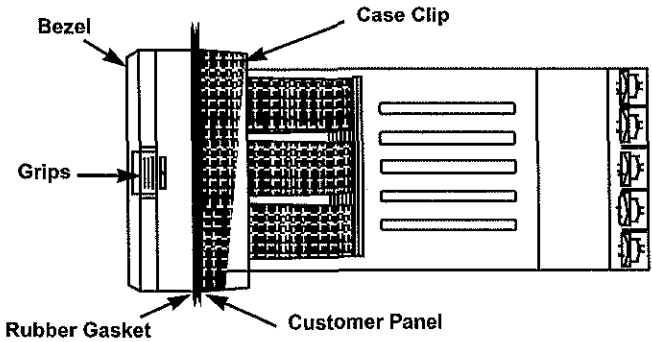


Figure 3. Series 16 Mechanical Components

Mounting

Slide the mounting collar off and remove any wrapping material from the instrument. (To ease removal of the collar, gently pry up all three tabs on each side with a thin-blade screwdriver.)

Insert the Series 16 through the front panel cutout and slide the mounting collar back onto the unit from behind the panel. Press the tabs of the mounting collar into the ridges of the case housing. The case should now be secure in the cutout. If it can still be moved, reposition the mounting collar until the unit is completely immobile within the panel.

If it is necessary to remove the Series 16 chassis from the case housing, press the grips on each side of the front panel bezel firmly until the tabs release. The chassis may then be pulled out. To re-install, press both bezel grips simultaneously and carefully push the chassis back into the case housing until the tabs snap into place.

Wiring

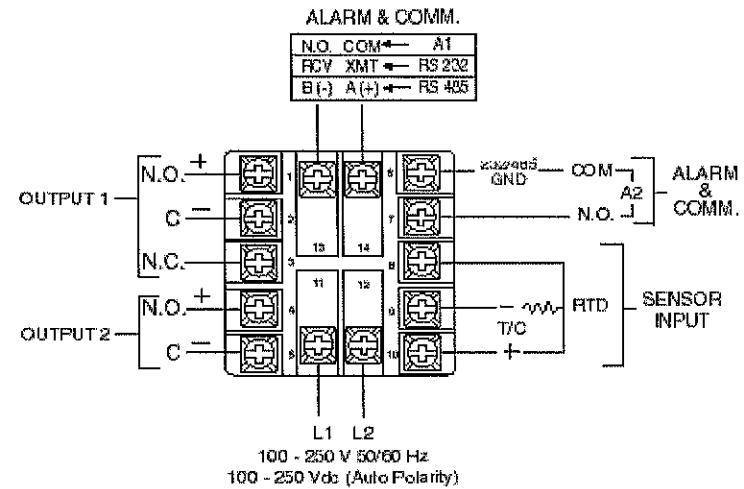
IMPORTANT: All electrical wiring connections should be made only by trained personnel, and in strict accordance with the National Electrical Code and local regulations.

Power and signal wires should always be kept separate and input leads should never be placed in the same conduit as power leads. We recommend separating connecting wires into bundles: power, signal, alarms and outputs. These bundles should then be routed through individual conduits.

Shielded sensor cables should always be terminated at panel ground.

If additional RFI attenuation is required, noise suppression devices such as an R.C. snubber at the external noise source may be used. If you wish, you may order this suppressor directly from Athena, part number 235Z005U01.

Figure 4. Contact Identification



Sensor Input Connections

Thermocouple circuit resistance should not exceed 100 ohms for rated accuracy; errors will occur at higher resistance values. If shielded thermocouple wire is used, terminate the shield only at panel ground.

Use wire with a resistance no greater than 10 ohms. An error of 0.2° F will result for each additional 10 ohms of resistance encountered. If shielded RTD wire is used, terminate the shield only at panel ground.

Figure 5. Thermocouple Input Wiring

Make sure that you are using the appropriate thermocouple and extension wire. Connect the negative lead (generally colored red in ISA-type thermocouples) to contact #9; connect the positive lead to contact #10. Extension wires must be the same polarity as the thermocouple.

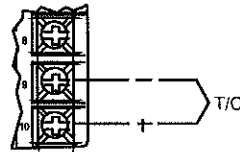
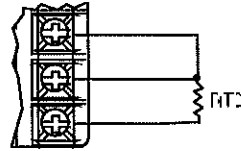


Figure 6. RTD Wiring

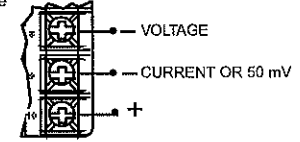
The Series 16 accepts input from 2- or 3-wire, 100 ohm platinum resistance temperature detectors (RTDs). Connect 2-wire RTDs to contacts #9 and #10, with a jumper across contacts #8 and #9. Keep leads short and use heavy gauge copper extension wire, if necessary, to minimize lead resistance. For long runs, 3-wire RTDs should be used.



Note: For 2 Wire RTD
Jumper 8 & 9

Figure 7. Process and Linear Input Wiring

Voltage Inputs: Connect the positive voltage input to contact #10; the negative input to contact #8.
mV/Current Inputs: Connect the positive current input to contact #10; the negative input to #9.



Power Wiring

The Series 16 power supply accepts 100 to 250 Vac and 100 to 330 Vdc line power without any switch settings or polarity considerations. All connections should be made in accordance with the National Electrical Code and local regulations, using only NEC Class 1 wiring for all power terminals.

It is advisable, but not necessary, to fuse one leg of the incoming power line, contact #11, with a 2AG, 0.5 amp rated fuse. *Be sure that only instrument power input is fused — not power to the load.*

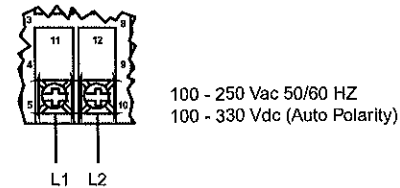


Figure 8. Power Wiring Connection

Operation

Throughout this manual, instructions that pertain solely to the Series 16 process controller are shown in blue.

Athena Series 16 Universal Controller

The Series 16 is a full-function, autotuning PID controller, calibrated and pre-configured for your application requirements, according to the ordering code specified, either as a temperature or linear process controller. (See pages 61 - 64 for specifications and ordering code).

Just a few easy steps are required before the instrument can be placed into service. After completing the mounting and wiring procedures as previously instructed, set your individual process parameter values by stepping through the Series 16's setup menus, using the simple front-panel keys as instructed. Then, initiate the autotuning sequence as shown (or tune manually).

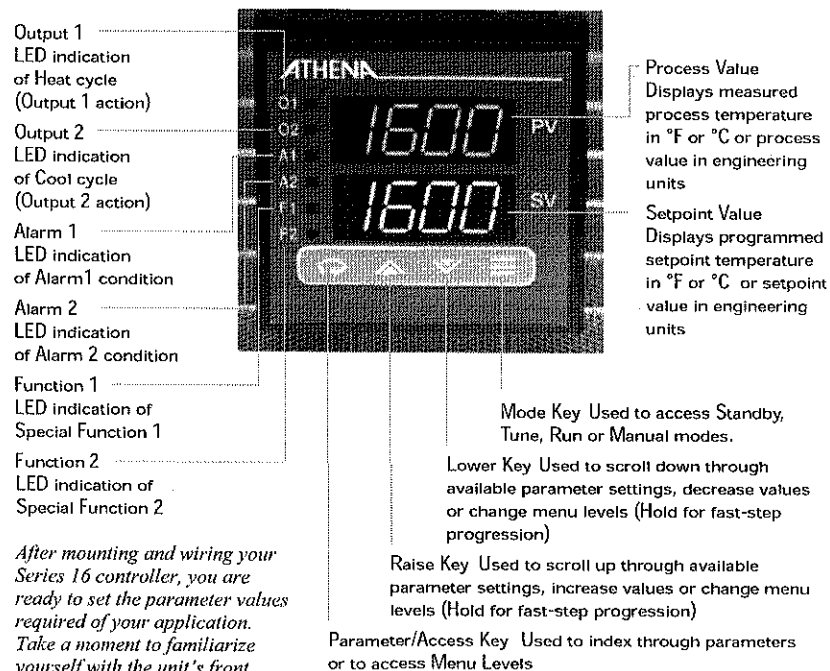
Notes on Outputs

When you ordered your Series 16 controller, a specific output type was specified, designated as either "B", "E", "F", "S", "T" or "Y". You also had the option of configuring your controller with either one or two output actions. Generally, output 1 is a heat (reverse-acting) function and output 2 is a cool (direct-acting) function. For best results, follow the recommendations for setting cycle times for the output type supplied with your controller. A brief description of output types follows:

Output Type	Description
B	5A/3A (120/240 Vac) relay, normally open, used for switching resistive loads. If relays or solenoids are to be driven, select the "T" output. If a "B" output is selected, order snubber network 235Z005U01.
E	0-20 mA
F	4-20 mA, full output to load with 500 ohm impedance max. (suppressed).
S	20 Vdc pulsed output for solid-state relays.
T	1 A @ 120/240 Vac, solid-state relay, zero voltage-switched and optically isolated from drive signal. Only resistive loads to may be controlled directly. Larger loads may be controlled using an external contactor.
Y	5A/3A (120/240 Vac) relay, but normally closed (output 2 only).

Operation

Figure 10. Front Panel Controls and Indicators



After mounting and wiring your Series 16 controller, you are ready to set the parameter values required of your application. Take a moment to familiarize yourself with the unit's front panel controls and indicators.

Operation

Power On



When power is first applied to the Series 16, both displays and all LED indicators are momentarily illuminated. The Process Value (PV) window then displays [-At-] or [-Ap-] and the Setpoint Value (SV) window displays an initialization code, e.g., [tr06]. The last two digits of this code indicate the software revision supplied with your controller. Please provide this revision number when contacting us regarding your controller. Depending upon whether Setpoint Target Time [SP.tt] is enabled, you may also see this symbol: or . This means that the controller is ramping up or down to setpoint according to its previously programmed parameters. The default setpoint on initial power up is equal to the process temperature (process value). Before proceeding further, wait until the display has stabilized and then use the Raise or Lower keys to enter or adjust your desired Setpoint Value.


Parameter Menu Organization

Your Series 16 controller has five distinct menu levels. This enables quick access to relevant parameters without the need for scrolling through long menus. Menu "05" is used for



Operation

You cannot enter Standby Mode from menu level "00". Follow the instructions for changing menu levels to select another level.

initial controller configuration and menus "02" and "03" are used for setting or changing parameters. Menus "00" and "01" are used when the controller is in regular unattended operation and are not used for setting parameters. For safety and security purposes, we recommend placing the controller in menu level "00" or "01" when in regular operation; however, it is not required.

If you wish to "escape" from parameter selection within these menus at any time, simply press the Mode  key once. A description of the menu hierarchy and a detailed listing of menus and parameters begins on page 20.



Standby Mode StbY

When the controller is placed in Standby Mode, outputs are disabled; however, access is permitted to all menu levels and, unless the controller is at Run menu levels "00" or "01", operating parameters may still be changed. Use this mode for tuning the controller. To enter Standby Mode, press and hold the Mode key  for four seconds until the lower window display flashes [StbY]. To exit Standby Mode from Menu Levels "01" to "05", press and hold the Mode  key for four seconds until the lower window display flashes [tUnE]. (If the Damping setting in menu "02" is [OFF], then [HEAt] or [Cool] will be displayed instead of [tUnE]. Press and hold the Mode key for four more seconds until the lower window returns to a steady display of Setpoint Value.





Operation

(This procedure will not affect tuning). Removing power to the controller will also take the instrument out of Standby Mode.

Accessing Menu Levels AcCd

To access menu levels from Standby Mode from menu levels "02" to "05", press the Parameter/Access  key once. From menu levels "00" and "01", press and hold the Parameter/Access  key for approximately 11 seconds until the lower window display alternates between [AcCd] and the menu level number last activated.

Changing or Displaying Menu Levels 05

To change menu levels, access the menu level display as instructed in the previous paragraph, then use the Raise  or Lower  key to set the desired menu level number. To display the current menu level setting in menu levels "02" to "05", from Standby or while adjusting/viewing parameters, press the Parameter/Access  key once. For menu levels "00" and "01", press and hold the Parameter/Access  key for approximately 11 seconds.






Operation

Because the Series 16's initial configuration affects other menu levels, it is important to set all required parameters in this menu first before accessing other menu levels.

Menu Level Descriptions

Menu "05" (Configuration Setup)

This is the menu level used for specifying initial configuration parameters before the controller is placed in Run mode.

After changing the access code to "05" as instructed in the previous paragraph, press the Parameter/Access  key to step through the various control parameters. Available parameters will flash in the lower window display, alternating with the current value for that parameter. To increase or decrease the value, simply press the appropriate Raise  or Lower  key, then press the  key to step to the next parameter. To exit the menu at any time, press the Mode  key.


Note: When programming in menu level "05", all outputs are disabled; however, any active alarms will remain active until the alarm condition is removed. New alarm conditions will not be recognized.

Menu "04" (Communications and Calibration Setup)

This menu is used to set up the controller for digital communications and for recalibrating the controller. If your Series 16 controller was ordered with the digital communications option, set these parameters next. To access this menu level, follow the instructions previously given.

Operation




Menu "03" (Alarm, Timing and Limit Setup)

In this menu, alarms, cycle times, setpoint target time and limits are established. After changing the access code to "03", press the Parameter/Access  key to step through the various parameters. To set or change parameter values, follow the instructions given previously.

Menu "02" (Control)

Gain, Rate and Reset parameters are automatically set during autotuning. However, they can be manually adjusted by the operator. To return the controller to the Run mode, change the menu level access code back to "00" or "01" as previously shown.

Menu "01" (Run — Limited Access Mode)

The only parameter that can be changed at this menu level is the Setpoint Value, using the appropriate Raise  or Lower  key. To set or change other parameters, the operator must access another menu level by pressing and holding the Parameter/Access  key for 11 seconds.

Menu "00" (Run — Key Lock Mode)


This menu is automatically active when power is first applied. Both display windows are illuminated; however, access is denied to all parameters. To set or change parameters, the operator must access another menu level as instructed previously.

Operation

Notes on Alarms

Either [OUT 1] or [OUT 2] in menu level "05" (but not both) may be configured as an alarm [ALr] if your Series 16 was ordered with a "B", "S" or "T" type of output module. (With "Y" modules, an alarm may be configured only on [OUT 2]) When one of the two available Outputs is configured as an alarm, the other Output may be used for control .

When the controller is provided with the Dual Alarm option, two independent alarms are automatically enabled for both outputs. DO NOT USE THE [ALr] SETTINGS FOR [OUT 1] OR [OUT 2]. Otherwise, follow the regular instructions for configuring the Dual Alarms in menu level "05".

The Series 16 offers a unique capability that provides for the activation of two software alarms (in addition to the dual alarms) to monitor a total of four possible alarm conditions. To enable these software alarms, set the [OUT 1] and [OUT 2] parameter(s) in menu level "05" to on/off mode [Ht.O], [CL.O] or [On.F]. Set the Setpoint Value to your first alarm point. Switch to menu level "02" and set Spread [C.Spr] [Spr.2] to the desired deviation value from the first alarm point. Set [H.HYS] and [C.HYS] to 1. Then switch to menu level "03" and set the desired values for the third and fourth alarm points at [ALr 1] and [ALr 2], respectively. Press the Mode  key to resume operation.

Operation

Available Alarm Types [A1.P.d.] [A2.P.d.]


Selectable at menu level "05", as either Process [Pr] or Deviation [dE] and either high or low [A1.HL] or [A2.HL].

Process Alarm: Activates at preset value independent of setpoint. "High" process alarm activates at and above alarm setting. "Low" process alarm activates at and below alarm setting.

Deviation Alarm: Activates at a preset deviation value from setpoint. "High" or "Low" deviation alarm activates above or below setpoint according to the preset deviation value.

Latching Alarms

The Series 16's alarms may also be configured as latching alarms by selecting "LAT" in the [A1.O.P.] or [A2.O.P.] parameter selection at menu level "05".

When a latching alarm has been activated and the alarm condition has been removed, the Mode  key must be pressed to unlatch the alarm.

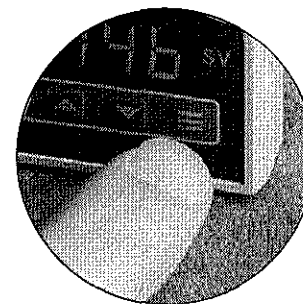
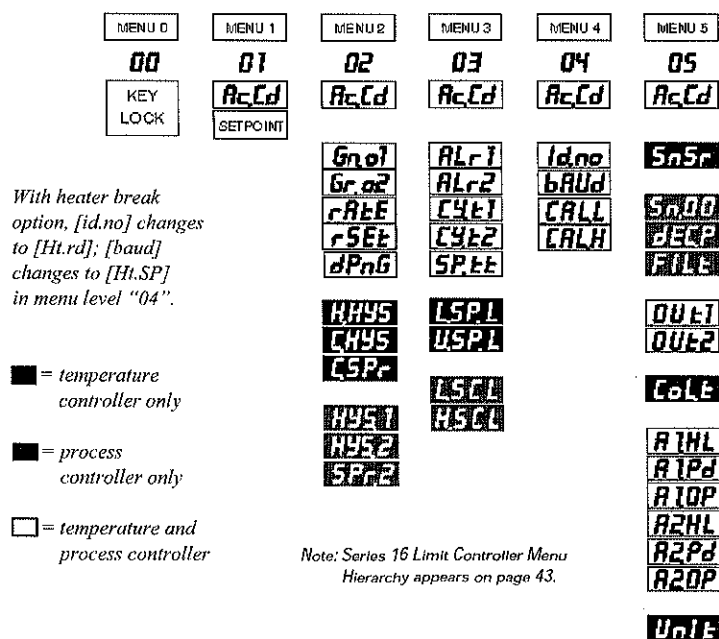


Figure 11. Series 16 Controller Menu Hierarchy



Parameter Descriptions

Series 16 Temperature/Process Controller

Menu "05"

Display	Parameter	Selection	Code
SnSr	Sensor type	Thermocouple:	
		K	c.A
		J	J
		N	n
		R	r
		T	t
		S	S
		Platinet II	PLII
		RTD	P
		RTD (decimal range)	d
OUt1	Output 1 action	Heat PID	Ht.P
		Heat On/Off	Ht.O
		Alarm	ALr
		Cool PID	CL.P
OUt2	Output 2 action	Cool On/Off	CL.O
		Alarm	ALr
		Unsuppressed	U.Su
		Suppressed	Su
SN.00	Input Zero Level		
Dec.P	Decimal Point		999, 99.9, 9.99
FILt	Digital Filtering		0.1, 1, 10
OUt1	Output 1 action	PID	Pid
		On/Off	On.F
OUt2	Output 2 action	Alarm	ALr
		PID	Pid
		On/Off	ON.F
		Alarm	ALr

The Digital Filtering setting [FILt] on the Series 16 process controller allows the operator to compensate for noise which may cause the last digits of the PV display to become unstable. Sampling rate is not affected. The settings are time constants, in seconds, with 0.1 equivalent to "no filtering."

Parameter Descriptions

CoL.t*	Cooling type	Water	H2o (non-linear output)
A1.H.L.	Alarm 1 select	Normal	nor (linear output)
A1.P.d.	Alarm 1 type	Enable	Lo/Hi
A1.O.P.	Alarm 1 output	Process/Deviation	Pr/dE
A2.H.L.	Alarm 2 select	Off/Normal/Latching	OFF/nor/LAt
A2.P.d.	Alarm 2 type	Enable	Lo/Hi
A2.O.P.	Alarm 2 output	Process/Deviation	Pr/dE
Unit	Measurement units	Off/Normal/Latching	OFF/nor/LAt
		*F or °C	F/C

* For water-cooled extruders, select H2o.

With the Heater Break Alarm option, [Id.no] changes to Heater Current Reading [Ht.rd] (indication only) and [bAUd] changes to Heater Break Alarm Setpoint [Ht.SP] (indication only, either 00-30 A or 00-60 A).

Menu "04"	Parameter	Allowable Values
Display	Device ID number	00 to 99
Id.no	(remote communications)	
bAUd	Baud, parity and data bit selection	See chart below
CAL.L	Calibration low	Preset at factory
CAL.H	Calibration high	Preset at factory

Available Communications Settings



Display	Baud Rate	Parity	Data Bits	Stop Bits
3.o.7	300	odd	7	2
6.o.7	600	odd	7	2
12.o.7	1200	odd	7	2
24.o.7	2400	odd	7	2
3.n.8	300	none	8	1
6.n.8	600	none	8	1
12.n.8	1200	none	8	1
24.n.8	2400	none	8	1



Parameter Descriptions

Setting output cycle time to "00" initiates a 200 ms timebase. A cycle time setting is required for smooth proportional action. Too long a setting will cause proportional ripple; too short will decrease relay contactor life.

When changing thermocouple types, be sure to check/adjust upper and lower setpoint limit values.

Menu "03"	Parameter	Allowable Values
Display	Alarm 1 preset	Dependent on sensor range
ALr1	Alarm 2 preset	Dependent on sensor range
ALr2	(if ordered)	
CY.t1	Cycle time output 1	00 to 120 seconds
CY.t2	Cycle time output 2	00 to 120 seconds
SP.tt	Setpoint target time (ramp-to-setpoint)	Off/1 to 100 minutes
L.SP.L	Lower setpoint limit	Dependent on sensor range
U.SP.L	Upper setpoint limit	Dependent on sensor range
L.SCL	Low scale setting	-1999 to 9999
H.SCL	High scale setting	-1999 to 9999
Output Type	Recommended Setting (seconds)	
B (5A/3A)	15 to 120	
E (0-20 mA)	00	Note: Shorter cycle times may be used when driving heater loads directly.
F (4-20 mA)	MUST be set to 00	
S (pulsed 20 Vdc)	00 to 120	
T (S.S. relay)	15 to 120	
Y (5A/3A) N.C.	15 to 120 (Output 2 only)	

Notes on Setpoint Target Time: The [SP.tt] parameter allows the operator to enter a time delay for the process to reach setpoint temperature (ramp to setpoint), from disabled [OFF] or 1 to 100 minutes. When enabled, the ramp sequence starts on power-up. The ramp-to-setpoint feature will also be initiated whenever a new setpoint target time is entered AND the Setpoint Value is 5° F or more from the current process temperature. In operation, the controller's lower window display will flash  or  to indicate that it is "ramping" up or down to setpoint. The Setpoint Value cannot be changed during this procedure. After it is finished, the operator can adjust the setpoint temperature to the desired value.

While in ramp startup, the ramp-to-setpoint mode can be aborted and the controller returned to regular operation by pressing the Parameter/Access  key until parameters are displayed and then pressing the Mode  key once.

Parameter Descriptions

Setting Rate (Derivative) or Reset (Integral) to [00] disables that aspect of PID control. The ratio for non-zero settings of rate-to-reset is limited to a minimum of 1:4, i.e., Reset value cannot be set any lower than four times Rate.

The parameters of Heat Hysteresis, Cool Hysteresis and Cool Spread are only available when Output 1 and/or Output 2 are set to on/off mode [Hi.O] or [CL.O]. They replace Gain Output 1 and Gain Ratio Output 2, respectively.

Menu "02"

Display	Parameter	Allowable Values
Gn.o1	Gain Output 1 (PID heat gain)	00 to 400 (This value may exceed 400 during autotuning.)
Gn.o2	Gain Ratio Output 2 (PID cool gain ratio)	0.0 to 2.0
H.HYS	Heat Hysteresis	01 to 100°
C.HYS	Cool Hysteresis	01 to 100°
HYS1	Output 1 Hysteresis	1 to 100 units
HYS2	Output 2 Hysteresis	1 to 100 units
SPr.2	Spread Adjustment, Output 2	0 to 100 units
C.SP	Cool Spread	0 to 100°
rAtE	PID rate	00 to 900 seconds
rSEt	PID reset	00 to 3600 seconds
dPnG	Damping (see notes)	Lo, nL, Hi, Off

Notes on Damping: The damping parameter is an autotune feature that enables more precise control of setpoint overshoot during recovery from process upsets in which thermal or transfer lag is a factor. See Figure 12. Use the correct setting prior to autotuning to compensate for power and load/sensor coupling characteristics.

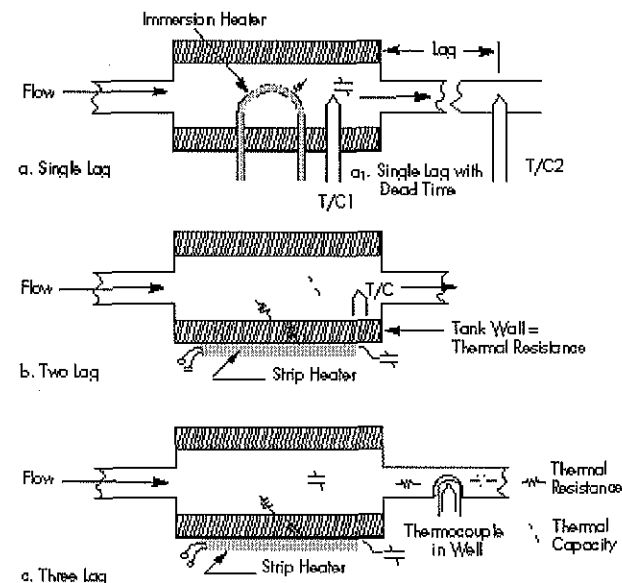
Lo = Fast recovery with slight overshoot. For single-lag processes.
Ex. Adequate power and excellent load/sensor coupling.

nL = Normal recovery with no overshoot. For two-lag processes.
Ex. Properly sized heaters or components and good load/sensor coupling.

Hi = Slow recovery with no overshoot. For three-lag processes.
Ex. Overpowered with multiple lags. Poor load/sensor coupling.

Off = Autotune disabled; manual output control.

Figure 12. Typical Lag Processes



Tuning Procedures









For best results in tuning the temperature controller, the setpoint value should be at least 100°F above or below ambient temperature.

While some processes other than heat or cool applications may respond successfully to autotuning procedures, the controller must be manually tuned for most non-temperature processes.



Introduction

The Series 16 is an "on demand" autotuning controller that automatically sets PID parameter values (Proportional Band, Reset and Rate) before the process reaches setpoint. A damping setting (menu level "02") MUST be selected for autotuning to take place. (see *Notes on Damping*, page 28). The controller may also be tuned manually (see page 33).


Autotuning the Series 16 Temperature Controller






- 1) With the power off and the process at ambient, apply power and immediately put the controller in Standby mode by holding the  key for four seconds until [StbY] flashes in the lower display window.
- 2) Enter the desired Setpoint Value using the appropriate Raise  or Lower  key. [StbY] will continue to flash.
- 3) If controller is in menu level "00" or "01", hold the Parameter/ Access  key for 11 seconds until [Ac.Cd] appears. Then change to menu level "05". Otherwise, press the  key once and use the  key to select menu level "05".
- 4) Press the Parameter/Access  key twice until [SnSr] is displayed to make sure that the proper sensor has been selected. Then set the controller's heating mode or alarm functions by pressing the Parameter/Access  key again

Tuning Procedures

until [OUt1] is displayed. (If you scroll past it, just continue scrolling until the parameter menu repeats.) Using the appropriate Raise  or Lower  key, select the one of the following settings according to the requirements of your process. *Note: For autotuning, at least one output MUST be set to PID mode.*

Mode	Output 1 (Heat) Setting	Output 2 (Cool) Setting
PID	[Ht.P]	[CL.P]
On/Off	[Ht.O]	[CL.O]
Alarm	[ALr]	[ALr]

Press the Parameter/Access  key again to step to output 2 [OUt2]. Repeat the selection process for cooling mode or alarm. (If only one output is PID, set the other output to either On/Off or Alarm.)

- 5) Press the Parameter/Access  key again to display the Cooling Type parameter [CoL.t], and select either Normal/Linear output [nor] or Water-Cooled/Non-Linear output [H2o].
- 6) Exit menu level "05" by pressing the Mode  key once. The lower window will flash [StbY]. Now press the Parameter/Access  key once. The lower window will display [Ac.Cd] and [05]. Press the Lower  key twice to select menu level "03".
- 7) Press the Parameter/Access  key and select Cycle Time for Output 1 [CY.t1] and Cycle Time for Output 2 [CY.t2]. For Control Output type B, T or Y, enter "15". For Control Output type E, F or S, enter "00".

Tuning Procedures

Before autotuning can take place, you must select a damping setting. If the damping parameter does not appear on the menu, you have not selected a PID option for outputs 1 or 2. Refer back to step (4) and select the proper setting(s).

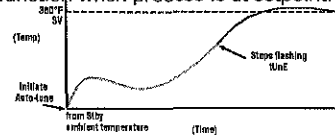
During autotuning, the process temperature will gradually cycle from ambient to setpoint. When autotuning is complete, the [tUnE] display will stop flashing and the Gain, Rate and Reset numbers "learned" will be kept in memory for subsequent startups.

- 8) Press the Parameter/Access key until Setpoint Target Time [SP.tt] is displayed. Select [OFF].
- 9) Press the Mode \equiv key once. The lower window will again flash [StbY]. Press the Parameter/Access \rightarrow key once and the lower window will display [Ac.Cd] and [03]. Press the Lower ∇ key once to select menu level "02".
- 10) Press the Parameter/Access \rightarrow key and scroll through the displayed parameters. If Gain Ratio [Gr.o2] is displayed, set it to [1.0]. Otherwise, continue scrolling until [dPnG] appears. Set Damping initially to Normal [nL]. (This setting may have to be changed later. See *Notes on Damping*, page 28).
- 11) Press and hold the Mode \equiv key until [tUnE] flashes in the lower display window. The controller is now autotuning. When it stops flashing, the autotuning procedure is completed and the controller is ready for your process. As a security measure, you may wish to place the controller in Key Lock "00" or Limited Access "01" Run mode by changing menu levels as instructed previously.

Note: Re-tune controller only from ambient temperature.

Autotuning will not function when process is at setpoint.

Figure 13. Typical "Autotune" Temperature Profile.



Tuning Procedures

If overcooling exists on heat/cool processes after autotuning, decrease Gain Ratio [Gr.o2] in steps of 0.1 until oscillation is minimal. If cooling is sluggish, increase the value in steps of 0.1 until optimum results are achieved.

Gain ratio [Gr.o2] is the cooling gain expressed as a factor of the heating gain.


*Ex. [Gn.01] = 100
Cooling Gain = 50
[Gr.o2] = .5*

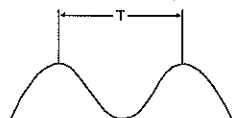
Manual Tuning Procedure - Temperature Controller (Zeigler-Nichols PID Method)

This tuning method may be used if the spread between ambient temperature and process operating temperature is small. For best results, the use of a recording device is suggested when tuning with this method.

- 1) Disable any cooling device used.
- 2) Apply power and place the controller in Standby by pressing and holding the Mode \equiv key for four seconds.
- 3) Using Raise \blacktriangle or Lower \blacktriangledown key, adjust setpoint to desired value.
- 4) Access menu level "02" following instructions given previously.
- 5) Using the Parameter/Access \rightarrow key, index to Heat Gain [Gn.o1]. Select [01].
- 6) Index to Gain Ratio [Gr.o2] and select [1.0].
- 7) Index to Rate [rAtE] and select [00].
- 8) Index to Reset [rSEt] and select [00]. Note: In order to set Reset to [00], Rate must first be set to [00].
- 9) Change to menu level "03".
- 10) Index to Cycle Time 1 [CY.t1] and select the timebase, in seconds, appropriate to the device being controlled. (See note on page 27.)

Tuning Procedures

- 11) Repeat for Cycle Time 2 [CY.t2].
- 12) Change to menu level "05".
- 13) Set Cooling Type [CoL.t] to [nor].
- 14) Press the Mode  key once. Setpoint Value will be displayed. The recording device should now be tracking process temperature.
- 15) Double the Gain [Gn.o1] until a small, sustained oscillation is visible on the recording device's trace.
- 16) Measure the period of one cycle of oscillation ("T" on the diagram below).





- 17) Divide the period of oscillation (T) by eight (8). The resulting number is the correct Rate time [rAtE] in seconds. Multiply this number by four. This is the correct Reset time [rSEt] in seconds.
- 18) Multiply the gain (from step #15) by 0.6 and enter this number as Gain [Gn.o1].
- 19) Enable the cooling device. If overcooling exists, decrease the Gain Ratio [Gr.o2] in steps of 0.1 until temperature oscillation stops. If cooling is sluggish, increase the Gain Ratio in steps of 0.1 until optimum results are achieved.

Tuning Procedures

Manual Tuning Procedure - Process Controller (Zeigler-Nichols PID Method)

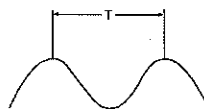
A chart recorder to monitor the process variable is required. The controller must be properly scaled and filtering set as instructed previously.

- 1) Apply power and place the controller in Standby by holding the Mode  key for four seconds.
- 2) Adjust the setpoint to the desired value.
- 3) Access menu level "05" and select one output: [OUt 1] for reverse-acting control or [OUt 2] for direct-acting control. Set the active output to PID [Pid] and the unused output to Alarm [ALr] or On/Off [On.F].
- 4) Access menu level "02" and set [Gn.O1] to 1.0; [Gr.o2] to 1.0; and [rAtE] and [rSEt] to "00".
- 5) Press the Mode  key for four seconds until display flashes [tUnE]. Press the Mode key for another four seconds and the process will run in closed loop mode.
- 6) While monitoring the chart, increase Gain [Gn.o1] by doubling the gain number until the process variable becomes unstable. Then decrease Gain until the process oscillations are sustained, neither increasing nor decreasing in amplitude as a result of momentary setpoint change.
- 7) Multiply the Gain from Step (6) by 0.6.
- 8) Measure the period of one complete cycle of oscillation, "T", in seconds.

Calculate and enter these numbers:

Rate [rAtE] = $T/8$
 Reset [rSEt] = $T/2$
 Gain [Gn.O1] = Gain from Step (6)



On noisy processes, where Rate cannot be used:
 Gain [Gn.O1] = from Step (6) $\times 0.45$
 Reset [rSEt] = $T/1.2$



Special Functions

In manual control mode, error conditions such as A/D errors and open or reversed sensors will be ignored.

Auto/Manual Operation (Standard)

To put the controller in manual mode, set the damping [dPnG] parameter in menu level "02" to [OFF]. Press and hold the Mode  key for four seconds until the lower display window flashes [StbY]. Hold down the Mode key for another four seconds to initiate manual operation. The lower display window will flash percentage of output power, from 100 to ~100, alternating with the output controlled (temperature controllers will flash [HEAt] or [Cool], process controllers will flash [OUt1] or [OUt2].) To take the controller out of manual mode, press and hold Mode  key to four seconds.

Note: The Series 16 controller can only be ordered with one of the following Special Functions installed per instrument.

Remote Setpoint Select

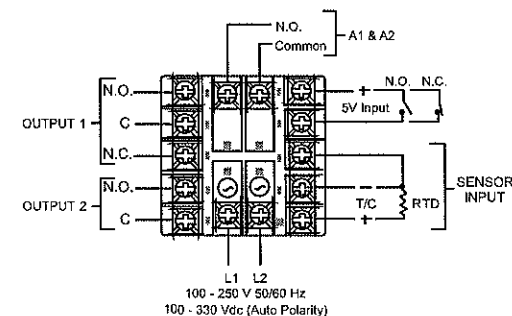
If your Series 16 controller was ordered with this option, you may select either of two setpoints for your process. The second setpoint can be enabled only by an external switch or signal, according to your ordering specifications. The "F2" LED on the front panel will illuminate when a second setpoint is selected. If you do not know how your Series 16 was configured, refer to the ordering code and description on page 64.

Special Functions

Option Part #	Description
40	External switch wired to terminals 6 and 7 Switch Open: Normal operation, first setpoint enabled Switch Closed: Second setpoint enabled Setpoint Adjustments: Made from front panel
41	External switch wired to terminals 6 and 7 Switch Closed: Normal operation, first setpoint enabled Switch Open: Second setpoint enabled Setpoint Adjustments: Made from front panel
42	0-5 Vdc signal at pins 6 and 7 0 Vdc: First setpoint enabled 5 Vdc: Second setpoint enabled Setpoint Adjustments: Made from front panel

Maximum Input Impedance: 400 ohms @ +5 Vdc, 5 mA

Figure 14. Wiring Diagram for Remote Setpoint Select Option



Special Functions

These output values are linear with and dependent upon the sensor being used, i.e., the lowest value of the sensor's output range corresponds to zero or low for the output function.

For voltage output, a jumper must be installed between terminals 13 and 14.

Figure 15. Wiring Diagram for Process Variable Retransmission

Process Variable Retransmission

If your Series 16 controller was ordered with this option, you may retransmit the signal representing the process variable for analysis or storage to an external device that accepts analog input, such as a chart recorder, datalogger, or process control computer. These outputs are:

Suppressed: 1-5 Vdc/4-20 mAdc

Unsuppressed: 0-5 Vdc/0-20 mAdc

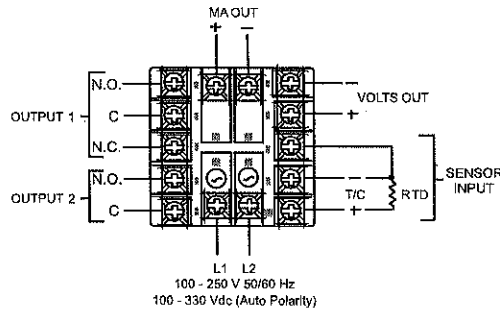
Process Variable Retransmission Specifications

I_{out} (current output) = 0-20 mA/4-20 mA

Voltage Headroom \approx 8 Vdc (standard) 18 Vdc
(for multiple recording devices)

V_{out} (voltage output) = 0-5Vdc/1-5 Vdc

I_{out} Max = 20 mA



Special Functions

The Heater Break Alarm option is not available on controllers with an "F" type output.

With the Heater Break Alarm option, cycle time is limited to greater than 2 seconds.

Heater Break Alarm (Series 16 Temperature Controller)

The heater break alarm option detects failures in the load or power handler and provides an alarm output. It uses an external current transformer to monitor the load current. If the load current falls below a set current value, the alarm output is activated.

With this option, a heater current reading [Ht.rd] from a current transformer is displayed at menu level "04", along with the preset Heater Current Alarm Setpoint Value [Ht.SP], either 00-30 A or 00-60 A.

Current Transformer Specifications

.29 Dia. Opening

INDICATING RANGE: 2 thru 100 A

MAX. CONT. CURRENT: 100 A

MAX. TRANSIENT CURRENT: 150 A for 5 sec.

WORKING CLASS: 600 • FREQUENCY: 50-60 Hz

WEIGHT: .5 Oz (14 grams)

LEAD WIRE: #22 AWG UL Style 1213

CASE COLOR: Black • CASE MATERIAL: Thermoplastic

Special Functions

Figure 16. Current Transformer Supplied with Heater Break Alarm Option, Part # 580E023UOI

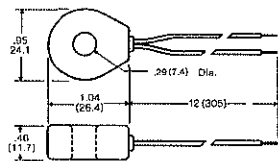
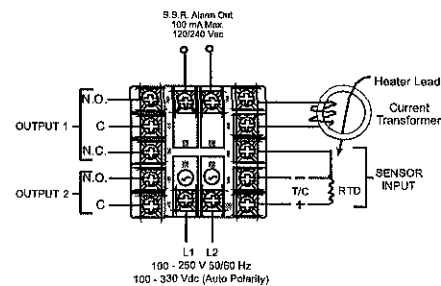


Figure 17. Wiring Diagram for Heater Break Alarm



Special Functions

Transducer Excitation

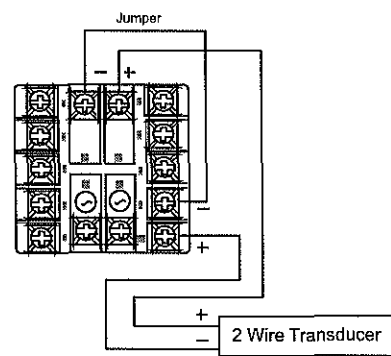
The transducer excitation voltage option is used to produce a constant dc voltage of 10, 12 or 15 Vdc out to an external device, eliminating the need for an additional external power supply. Refer to the ordering code if you do not know which voltage output was specified.

Option Ordering Code	Voltage Output
50	10 V
51	12 V
52	15 V
53	5 V

Maximum Current = 22 mA

Special Functions

Figure 18. Wire Diagram for 2-Wire Sensor Input with Transducer Excitation Option



Limit Controller
Option ED

Series 16 Limit Controller Menu Hierarchy

Menu 1				
00	01	02	03	04
	AcCd	AcCd	AcCd	AcCd
		ALSP	Idno	IntP
		SPLo	BAUD	LtP
		SPH1	CALL	ALtP
			CALH	ALSL
				ALot
				oPSL
				dECP
				FILE
				Unit

Limit Controller Option ED

Parameter Descriptions

Menu "04"			
Display	Parameter	Selection	Code
IntP	Sensor type	Thermocouple	
		Platinel II	PLII
		S	S
		T	t
		R	r
		N	n
		J	J
		K	c.A
		RTD	P
		RTD (decimal range)	d
LUp	Limit type	High Limit	HI
		Low Limit	Lo
AltP	Alarm type	Process/Deviation	Pr/dE
ALSL	Alarm select	High/Low Alarm	HI/Lo
ALot	Alarm output	Normal/Latching	nor/LAt
oPSL		(Not Functional)	00
dECP	Decimal point	(Not Functional)	02/01/00
FILt	Digital filtering		10.0/1.0/0.1
Unit	Measurement units	F-deg or C-deg	F/C

Limit Controller Option ED

Parameter Descriptions (continued)

Menu "03"		
Display	Parameter	Allowable Values
Idno	Device ID number	00 to 99
	(remote communications)	
bAUD	Baud, parity and data bit selection	See next page under the heading of "Available Communications Settings"
CALL	Calibration low	Preset at factory
CALH	Calibration high	Preset at factory

Limit Controller
Option ED

Parameter Descriptions (continued)

Menu "02"		
Display	Parameter	Allowable Values
ALSP	Alarm setpoint	0 to 8191
SPLo	Setpoint low (lower setpoint limit)	Dependent on sensor range
SPHi	Setpoint high (upper setpoint limit)	Dependent on sensor range

Available Communications Settings				
Display	Description			
	Baud Rate	Parity	Data Bits	Stop Bits
24.n.8.	2400	none	8	1
12.n.8.	1200	none	8	1
6.n.8.	600	none	8	1
3.n.8.	300	none	8	1
24.o.7.	2400	odd	7	2
12.o.7.	1200	odd	7	2
6.o.7.	600	odd	7	2
3.o.7.	300	odd	7	2

Limit Controller
Option ED

Operation

High Limit Operation — During normal operation the mechanical relay in output "1" is closed. If the process temperature exceeds the high limit setting, then the mechanical relay in output "1" will open ("01" LED is now lit) cutting off power to the load. When the process temperature drops back down to below the limit setting, output "1" will remain open until you press the mode key to reset the controller.

Low Limit Operation — During normal operation the mechanical relay in output "1" is closed. If the process temperature drops below the low limit setting, then the mechanical relay in output "1" will open ("01" LED is now lit) cutting off power to the load. When the process temperature rises back above the limit setting, output "1" will remain open until you press the mode key to reset the controller.

Mode Key (Reset Button) — Operates as a reset button.

The Parameter Access Key — Used to index through parameters or to access menu levels.

Raise Key — Used to scroll up through available parameter settings, increase values or change menu levels (Hold for fast-step progression).

Lower Key — Used to scroll down through available parameter settings, decrease values or change menu levels (Hold for fast-step progression).

Limit Controller Option ED

Warning: Do not change the values in the CALL or CALH menu parameters. If this is done, the controller may need to be recalibrated.

Tech Tip: After setting up your controller, index through the entire menu system and write down the value or setting of each menu parameter. Keep this hard copy on hand in the event that an operator accidentally changes the values or settings. Then you can refer back to this list of settings and values to correctly set up the controller.

Operation (continued)

Quick Start Procedure

- 1) Apply power to the controller.
- 2) Press parameter access key to access the menu system.
- 3) Using the up/down arrow keys, select menu level "04".
- 4) Press the parameter access key once until you reach the sensor type (IntP).
- 5) Select the sensor type that you will be using by pressing the up/down arrow keys (refer to parameter descriptions for menu "04" described earlier).
- 6) Press the parameter access key again to reach the limit type (LItP).
- 7) Using the up/down arrows keys, select High or Low limit.
- 8) Press the mode key to return to limit setting.
- 9) Set your limit to the desired value by pressing the up/down arrow keys.
- 10) To deny controller access through the front panel, press the parameter access key once, then using the up/down arrow keys, select menu level "00". Press the mode key once. The controller is now in lockout mode. To regain controller access you must hold the parameter access key in for 11 seconds.

Digital Communications

Two communication options are available for the Series 16 which allow interfacing to remote devices utilizing the most common industry standards, RS232 and RS485.

WARNING

Signal ground only. Grounding to frame may damage the controller and void warranty.

RS232

This method allows bidirectional data transfer via a three-conductor cable consisting of signal ground, receive input and transmit output. It is recommended for communication distances less than fifty feet between the computer terminal and the instrument. Note: Multiple instruments cannot be connected to the same port.

The RS232 port is optically isolated to eliminate ground loop problems. Typically, "Data Out" of the computer/terminal connects to the "RCV" terminal. "Data In" connects to the "XMT" terminal. If shielded cable is used, it should be connected to the frame ground at one end only. Signal ground is to be connected at appropriate ground terminals (refer to wiring diagram, page 50).

RS485

The RS485 multipoint capability allows up to 32 controllers to be connected together in a half-duplex network or up to 100 controllers with an appropriate communications repeater. This method allows bidirectional data transfer over a shielded twisted pair cable. The twisted pair cable is a transmission line; therefore, terminating resistors are required at the most distant ends of the line to minimize reflections (typically 60 ohms from each line to signal ground). The RS485 circuit is fully optically isolated, eliminating ground loop problems. Parallel drops from the transmission lines should be kept as

Digital Communications

Note: Call factory for a recommended RS485 converter.

short as possible; however, the line may be daisy-chained at each controller. The polarity of the line is important and each device will specify an "A" (+) and "B" (-) connection.

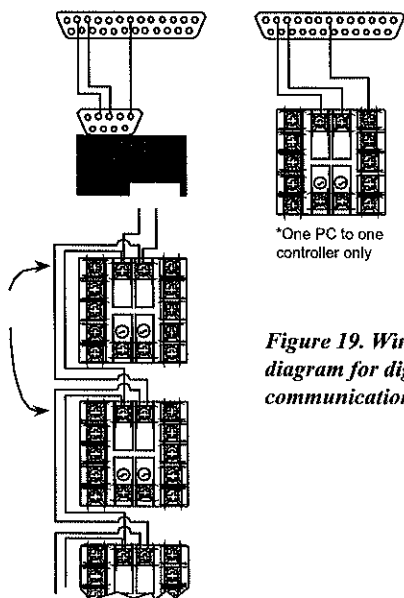


Figure 19. Wiring diagram for digital communications.

Digital Communications

Table 1. Communications Parameter List (Temperature Controller)

Parameter No.	Description	Display	Minimum	Maximum
00	Process Value	nnnn	Sensor Dependent	
01	Setpoint	nnnn	Low Limit	High Limit
02	Access Code	Ac.Cd	00	05
03	Gain Output 1	Gn.o1	00	400
04	Gain Ratio 2	Gr.o2	0.0	2.0
05	Rate	rAtE	00	900
06	Reset	rSEt	00	3600
07	Heat Hysteresis	H.HYS	01	100
08	Cool Hysteresis	C.HYS	01	100
09	Cool Spread	C.SP.r	00	100
10	Damping	dPnG	00	Low/Normal/High
11	Alarm 1	ALr1	Range Dependent	
12	Alarm 2	ALr2	Range Dependent	
13	Cycle Time 1	CY.t1	00	120
14	Cycle Time 2	CY.t2	00	120
15	Setpoint Target Time	Sp.tt	00 (OFF)	100
16	Low Setpoint Limit	L.SP.L	Sensor Dependent	
17	High Setpoint Limit	U.SP.L	Sensor Dependent	
18	Controller ID	Id.no	00	99
19	Baud Rate	bAUd	300	2400

Table 2. Communications Parameter List (Process Controller)

Parameter No.	Description	Display	Minimum	Maximum
00	Process Value	nnnn	Low Scale	High Scale
01	Setpoint	nnnn	Low Scale	High Scale
02	Access Code	Ac.Cd	00	05

Digital Communications

03	Gain Output 1	Gn.o1	00	400
04	Gain Ratio 2	Gr.o2	0.0	2.0
05	Rate	rAtE	00	900
06	Reset	rSEt	00	3600
07	Hysteresis 1	HYS.1	01	100
08	Hysteresis 2	HYS.2	01	100
09	Spread 2	SPr.2	00	100
10	Damping	dPnG	00	Low/Normal/High
11	Alarm 1	ALr1	Low Scale	High Scale
12	Alarm 2	ALr2	Low Scale	High Scale
13	Cycle Time 1	CY.t1	00	120
14	Cycle Time 2	CY.t2	00	120
15	Setpoint Target Time	Sp.tt	00 (OFF)	100
16	Low Scale	L.SCL	-1999	9999
17	High Scale	H.SCL	-1999	9999
18	Controller ID	Id.no	00	99
19	Baud Rate	bAUd	300	2400

Table 3. Serial Communications Data Format

Baud Code	Baud Rate	Parity	Data Bits	Stop Bits
0	300	Odd	7	2
1	600	Odd	7	2
2	1200	Odd	7	2
3	2400	Odd	7	2
4	300	None	8	1
5	600	None	8	1
6	1200	None	8	1
7	2400	None	8	1

Digital Communications

Interface Examples

This section describes the protocol for communication between an Series 16 controller and either a video display terminal or computer (referred to below as "the host"). Message strings may be of two types — commands to controller or responses from controller.

General Comments

One host and multiple controllers may be interconnected on a single bus. The host may send commands to any controller and may receive responses from any controller. Each controller on the bus is assigned an identification code between 00 and 99. No two controllers on a given bus may have the same identification code. Controllers are not capable of communicating with other controllers.

Every valid message begins with a pound-sign (#) character.

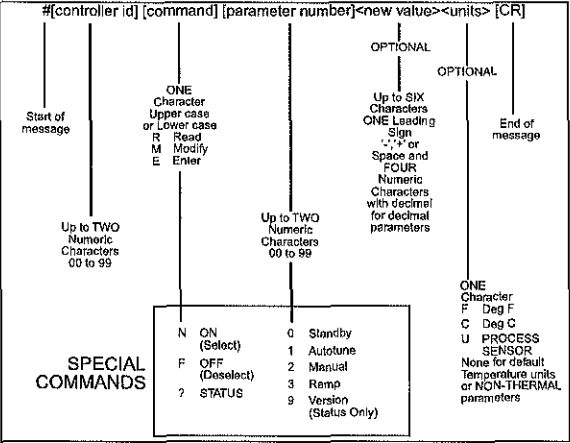
Every valid message ends with a carriage-return (<CR>) character.

A valid message is composed of: Start Message, Controller ID Code, Command, Parameter and Data.

Every response begins with a line-feed (<LF>) character and ends with a carriage-return, line-feed pair (<CRLF>).

Caution:
Modifying parameter
#19 (Baud Rate) by
host may cause loss of
data link.

Figure 20. General Communications Message Format



Example: For Standby "On", type #01N0[CR].

Figure 21. Sample Communications Commands

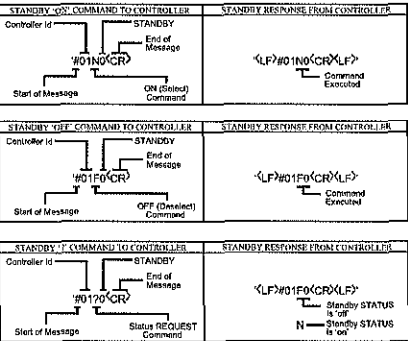
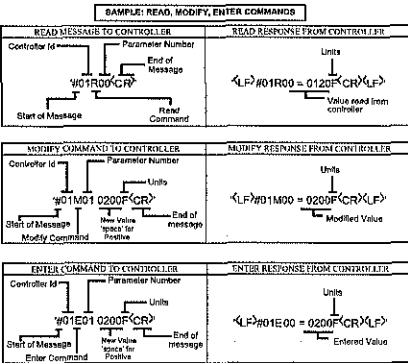


Figure 22. Requesting a Parameter from a Controller



Communications Notes

Caution:






Wherever possible, avoid using the "Enter" command and use "Modify" or "Read" instead. The "Enter" command makes permanent changes to the NOVRAM in the Series 16's microprocessor, and after accepting a maximum capacity of 100,000 "Enter" statements, it will have to be returned to the factory and replaced.

1. The controller will respond with <LF>ERROR<CR><LF> for messages containing invalid/incorrect commands, parameter number or data (with decimal, if needed).
2. Process Value is a read-only parameter; therefore, a modify or enter command for Process Value will result in a <LF>ERROR<CR><LF> response.
3. For modify or enter command: if the new value is out of the parameter's range, the controller will default to the highest or lowest allowable parameter value.
4. Parameters with decimal data must contain a decimal character in the data portion of the message.
5. Ramp "on" command (Setpoint Target Time) will not be executed if ramp time is set to zero or absolute deviation between Setpoint and Process Value is less than or greater than 5 temperature or process units.
6. Autotune, manual and ramp commands are mutually exclusive, i.e., selecting manual while autotune is enabled will abort the autotune mode.
7. If the controller is in Standby mode, selecting autotune, manual or ramp will de-select Standby.
8. Setpoint should not be modified while the controller is in autotune or ramp mode.
9. The Setpoint Value enter command should not be executed while the controller is in manual mode.

Recalibration

Only qualified individuals utilizing the appropriate calibration equipment should attempt recalibration of the controller. For assistance, contact your Athena representative or call 1-800-782-6776.

Your Series 16 has been calibrated at the factory, and need not be adjusted during the life of the controller unless sensor type is changed from thermocouple to RTD, or vice versa. In the event that recalibration is warranted, follow these procedures.

- 1) Access menu level "05" as previously instructed and select the sensor type.
- 2) Use a calibrator with a range appropriate for the unit to be calibrated and set the range, and a low or zero value.
- 3) Access menu level "04" and then the Parameter/Access key until [CAL.L] is displayed. Then, press the Raise  or Lower  key until the number in the controller's upper (PV) display window matches the indicated value of the calibration instrument.
- 4) Enter a value on the calibration instrument corresponding with the high-end value of the sensor range (span).
- 5) Again, in menu level "04", press the Parameter/Access key until [CAL.H] is displayed. Then, press the Raise  or Lower  key until the number in the controller's upper (PV) display window matches the indicated value of the calibration instrument.
- 6) Repeat steps 3 through 5 until all readings agree.
- 7) Return the controller to regular operation by pressing the Mode  key.

Error Codes

Display	Problem	Action
[Err.H]	Open sensor	Check sensor and wiring Check type of sensor Recalibrate
[Err.L]	Reversed sensor	Check sensor and wiring Check type of sensor Recalibrate
[Err.O]	A/D error	Return to factory
[Err.J]	A/D error	Return to factory
- - - -	Display out-of-range	Sensor over- or under-range

Warranty/Repair Information

Two-Year Limited Warranty

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Unit Repairs

It is recommended that units requiring service be returned to an authorized service center. Before a controller is returned for service, please consult the service center nearest you. In many cases, the problem can be cleared up over the telephone. When the unit needs to be returned, the service center will ask for a detailed explanation of problems encountered and a Purchase Order to cover any charge. This information should also be put in the box with the unit. This should expedite return of the unit to you.

This document is based on information available at the time of its publication. While efforts have been made to render accuracy to its content, the information contained herein does not cover all details or variations in hardware, nor does it provide for every possible contingency in connection with installation and maintenance. Features may be described herein which are not present in all hardware. Athena Controls assumes no obligation of notice to holders of this document with respect to changes subsequently made.

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Technical Specifications

Performance

Accuracy	$\pm 0.2\%$ of full scale, \pm one digit
Setpoint Accuracy	1 degree/0.1 degree
Temperature Stability	5 $\mu\text{V}/^\circ\text{C}$ max; 3 $\mu\text{V}/^\circ\text{C}$ typical
TC Cold End Tracking	0.05° C/°C ambient
Noise Rejection	Common mode >100 dB Series Mode >70 dB
Process Sampling Rate	10 Hz (100 ms)

Inputs

Thermocouple	K, J, N, R, T, S, Maximum lead resistance 100 ohms for rated accuracy
RTD	Platinum 2- and 3-wire, 100 ohms at 0° C, DIN curve standard (0.00385)
Linear	0-50 mV/10-50 mV, 0-5 V/1-5 V 0-20 mA/4-20 mA

Input Impedances

0-50 mV/10-50 mV:	1 K ohm $\pm 1\%$
0-5/1-5 V:	100 K ohms $\pm 1\%$
0-20 mA/4-20 mA:	2.5 ohms $\pm 1\%$
0-10 V/2-10 V:	200 K ohms

Technical Specifications

Outputs

#1	Reverse acting (heating or alarm)
#2	Direct acting (cooling or alarm)
B	Relay, 5 A @ 120 Vac resistive 3 A @ 240 Vac
E	0-20 mA _{dc}
F	4-20 mA _{dc} , 500 ohms max.
S	20 V _{dc} pulsed
T	Solid-state relay, 120/240 Vac, zero voltage-switched, 1 A continuous, 10 A surge @ 25° C
Y (Output 2 only)	N.C. Relay, 5 A @ 120 Vac resistive 3 A @ 240 Vac

Alarms

Electromechanical relay, 5 A @ 120 Vac,
3 A @ 240 Vac (Output 1 OR 2 only)

Dual-Alarm option: Two solid-state
relays, 120/240 Vac, zero voltage-
switched, 1 A continuous, 10 A surge
@ 25°C

Control Characteristics

Setpoint Limits	Limited to configured range
Alarms	Adjustable for high/low; selectable process or deviation
Rate	0 to 900 seconds
Reset	0 to 3600 seconds
Cycle Time	0.2 (zero setting) to 120 seconds

Technical Specifications

Gain	0 to 400
Gain Ratio	0 to 2.0 (in 0.1 increments)
Control Hysteresis	1 to 100 units (on/off configuration)
Cool Spread, Output 2 (Temperature Controller)	0 to 100° F/C (above setpoint)
Spread 2, Output 2 (Process Controller)	0 to 100 units (above setpoint)
Damping	Selectable (low, normal, high, off)
Setpoint Target Time (Ramp-to-Setpoint)	0 (off) to 100 minutes
Autotune	Operator-initiated from front panel
Manual	Operator-initiated from front panel

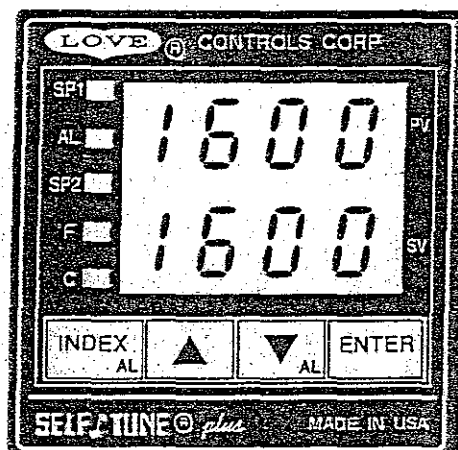
General

Line Voltage	115 to 230 V ±10%, 50-60 Hz 115 to 300 V _{dc} ±10% (Auto-Polarity)
Display	Dual, 4-digit 0.36" (9.2 mm) LED display Process Value: Orange Setpoint Value/Menu: Green
Power Consumption	Less than 6 VA (@ 120/240 Vac)
Panel Cutout	1.771" x 1.771" (45 mm x 45 mm)
Depth Behind Panel	3.937" (100 mm)
Front Panel Rating	NEMA 4X
Operating Temperature	32 to 131° F (0 to 55° C)
Humidity Conditions	90% R.H. max., non-condensing
Parameter Retention	Solid-state, non-volatile memory
Connections	Input and output via barrier strip with locking terminals
Contacts	Twin bifurcated

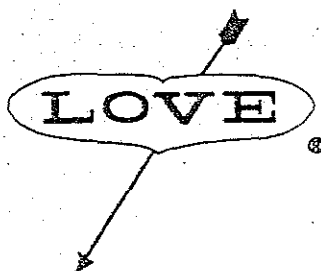
MARCH 1993

INSTRUCTIONS FOR THE 1600 SERIES MICROPROCESSOR BASED TEMPERATURE / PROCESS CONTROL

INCLUDES FUZZY LOGIC OPTION



If all else fails,
please read these
instructions



CONTROLS DIVISION

Dwyer Instruments, Incorporated

1475 S. WHEELING ROAD • WHEELING ILLINOIS 60090

(708) 541-3232 • FAX (708) 541-7366

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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:

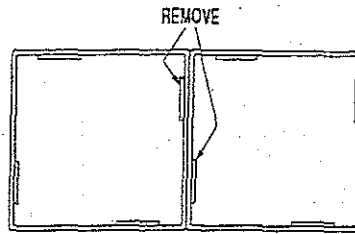
1. Optional features or functions are shown in this book in *Roman type*. The Option code (from the configuration menu) is listed after the menu item in parenthesis. If you do not have an option installed, you may skip any items listed in *Roman type*.

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

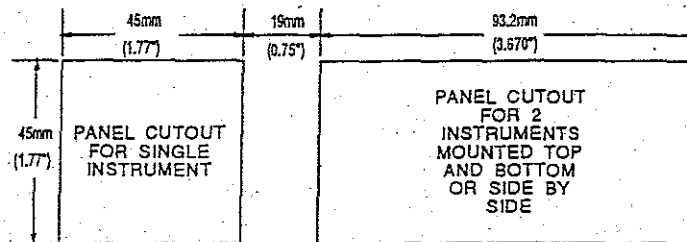
Mount the instrument in a location that will not be subject to excessive temperature, shock, or vibration. All models are designed for mounting in an enclosed panel.

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.



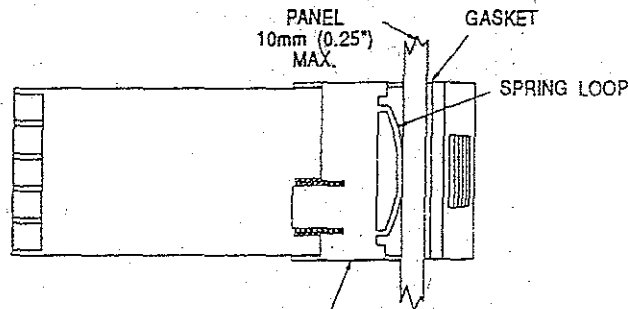
Prepare the panel by cutting and deburring the required opening.

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



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

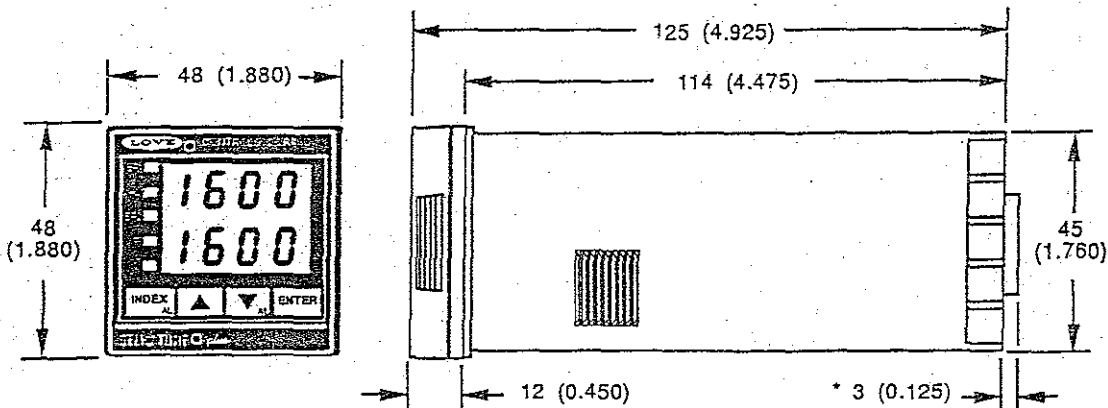
From the rear of the panel slide the mounting collar over the housing. Hold the housing with one hand and using the other hand, push the collar evenly against the panel until the spring loops are slightly compressed. The ratchets will hold the mounting collar and housing in place.



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.

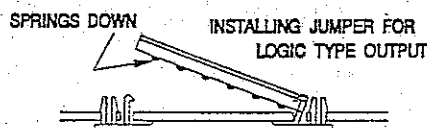
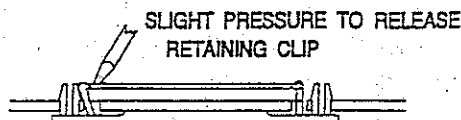
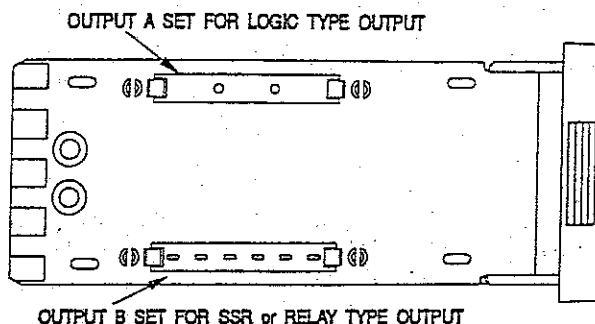
LOGIC JUMPER SELECTION

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.

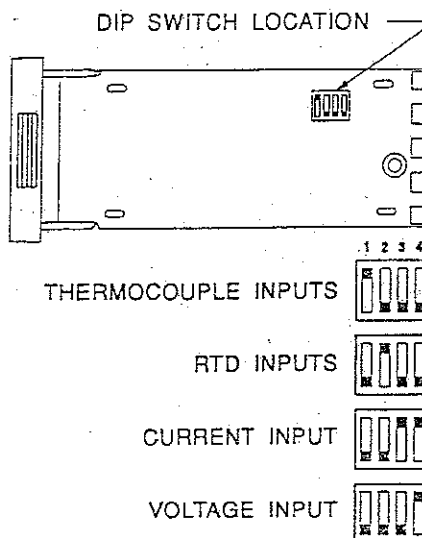
1. Remove the instrument from its housing. Grasp the front bezel sides and pull forward to release it from the housing lock.
2. Locate the desired logic jumper strip on the left printed circuit board. The **OUTPUT A** jumper strip is always located near the top edge.
3. To remove the logic jumper strip, 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

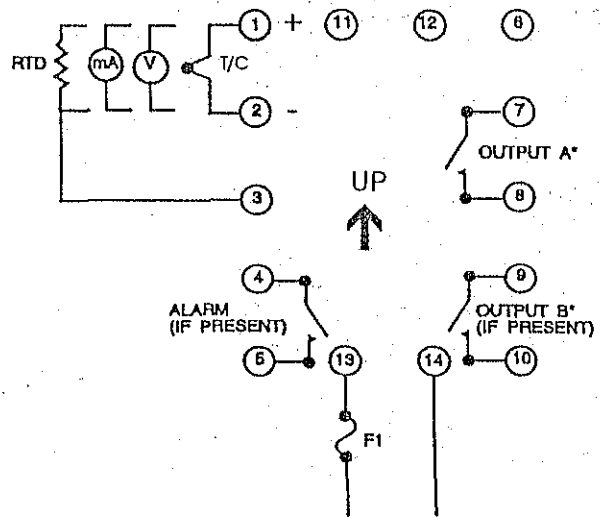
To change the input type, remove the instrument from its housing. Grasp the front bezel sides and pull forward to release it from the housing lock. Locate the dip switch on the right pcb. Determine the input type desired and change the dip switch setting as shown at the right.

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



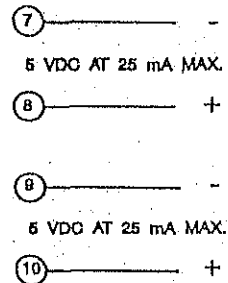
WIRING

RELAY OUTPUT **

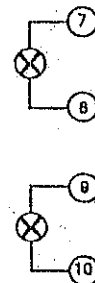


SEE LABEL ON CONTROL FOR RATINGS

LOGIC OUTPUT



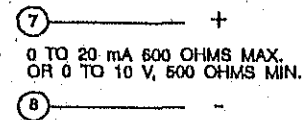
SSR OUTPUT



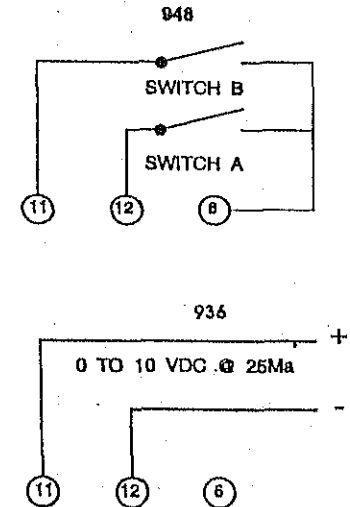
SSR DERATING CHART

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

CURRENT OR VOLTAGE OUTPUT



OPTIONS

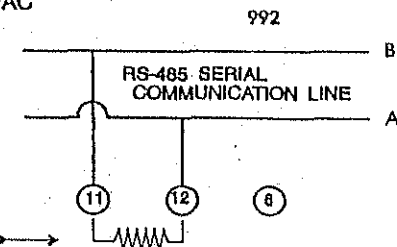


F1: FOR LINES OVER 85 V USE 1/4 AMP 3AG 250 VAC, FOR LINES LESS THAN 30 V (OPTIONAL), USE 1/2 AMP 3AG 250 VAC
 LOAD POWER: SEE SPECIFICATIONS FOR OUTPUT RATINGS
 FOR RELAY OR SSR OUTPUTS: TYPE MDA OR 3AB 3.5A MEDIUM LAG FUSE RECOMMENDED

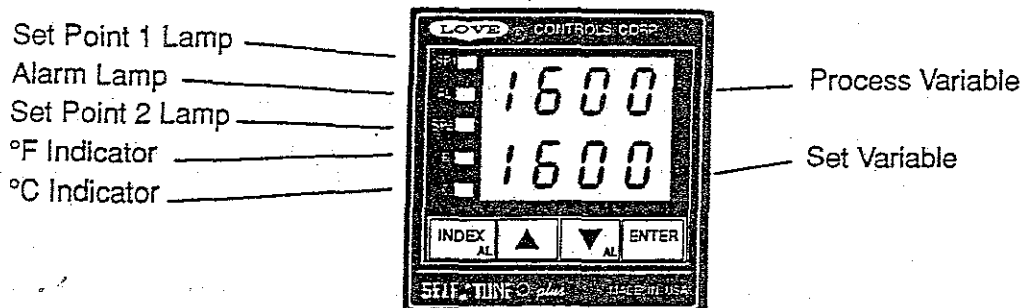
INPUT WIRING: Do not run thermocouple or other input wiring in the same conduit as power leads. Use only the type of thermocouple or RTD probe for which the control has been programmed. See the "Secure Menu" for input selection.
 For thermocouple input always use extension leads of the same type designated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

SEnC: Sensor rate of change

ALiH: Alarm inhibit

OPEn InP: Open input error message

bAd InP: Bad input error message

ArEA: Area error message

CHEC CAL: Check calibration 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 Locked Secondary Locked Secure Locked	1	1110
Primary Unlocked Secondary Locked Secure Locked	2	1101
Primary Unlocked Secondary Unlocked Secure Locked	3	1011
Primary Unlocked Secondary Unlocked Secure 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 "o" 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 set point (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 rE terms for heat/cool applications.
OFF Sp2 functions without rEs and rE.

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 rE 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.

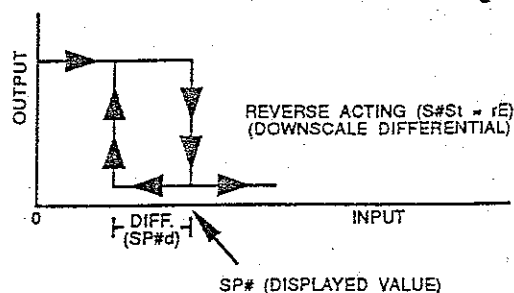
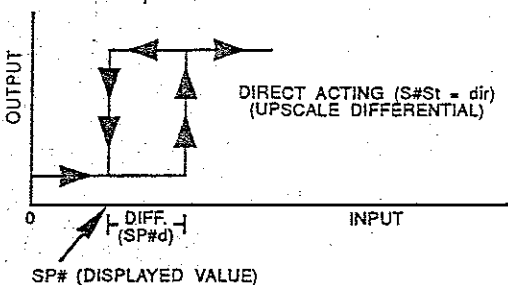
FrtE Fuzzy Logic Rate of Change(942): Select 0.00 to 99.99 °F/sec., 0.00 to 55.55 °C/sec., or 0.00 to 99.99 counts/sec. For best initial setting, find the degree/sec change of process value near set point 1 with output **ON** 100%. Multiply this value by 3. Set FrtE to this calculated value.

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 linearly 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 "5" 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:

$$K = \frac{(\text{Highest desired temperature} - \text{Lowest desired temperature})}{(\text{Maximum desired voltage} - \text{Minimum desired voltage})}$$

$POH = ((10 - \text{Maximum desired voltage}) * K) + \text{Highest desired temperature}$
 $POL = ((\text{Minimum desired voltage} - 0) * K) - \text{Lowest desired temperature}$

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 $\Omega/\Omega/^\circ\text{C}$), Love Cal. 104.
n120 120 ohm Nickel, Love Cal. 105.
P385 100 ohm Platinum (DIN 0.00385 $\Omega/\Omega/^\circ\text{C}$), Love Cal. 106.
Curr DC Current Input 0.0 to 20.0 or 4.0 to 20.0 milliamperes.
VolL 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 to 10 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 **On** or **CoFF**.
On Lamp ON when Output is ON.
CoFF 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)



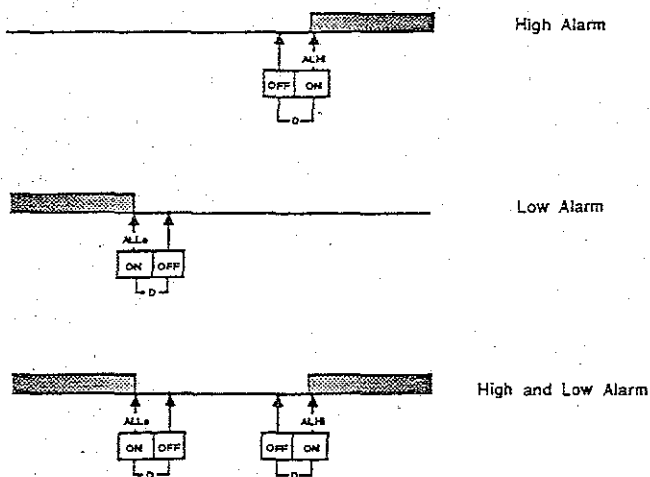
Caution: In any critical application where failure could cause expensive product loss or endanger personal safety, a redundant limit controller is recommended.

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

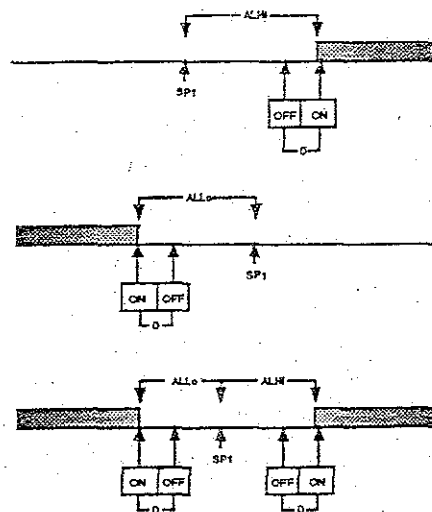
When setting the alarm value for a deviation alarm (**ALt = dE**), set the difference in value from the Set Value (**SV**) desired. For example if a low alarm is required to be 5 degrees below the **SV**, then set **ALLo** to -5. If a high alarm is required 20 degrees above the **SV**, then set **ALHi** 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.

ABSOLUTE ALARMS



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.
- hAUd** 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 LoE** 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 CFL 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 the 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 is 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	Remove the instrument for service and / or recalibration. To reset use the INDEX & ENTER keys.
	Check calibration appears as a flashing message if the instrument calibration exceeds specification.	Set point outputs inactive Alarms active	

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 procedure. 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

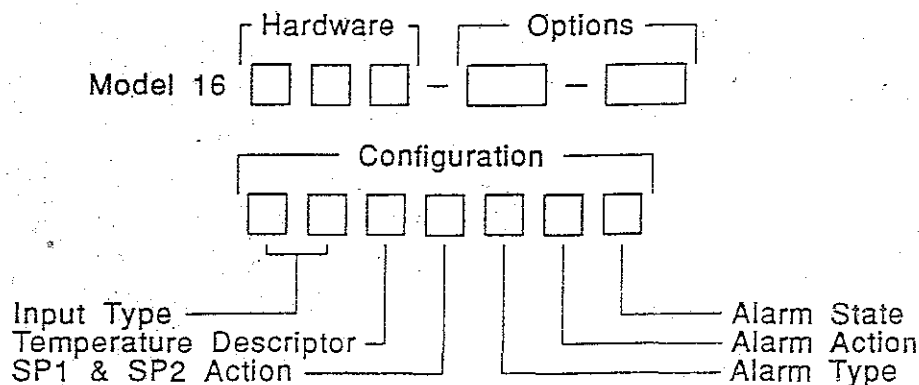


DO NOT ENTER THE CONFIGURATION MENU UNLESS YOU HAVE BEEN INSTRUCTED TO BY ANOTHER PART OF THESE INSTRUCTIONS. INCORRECT ENTRY OF DATA IN THE CONFIGURATION MENU MAY PREVENT YOUR CONTROL FROM OPERATING PROPERLY.

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		<p>Factory default. Defaults Configuration to factory codes shown in boldface type in the chart above.</p> <div style="display: flex; align-items: center;">  <p>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.</p> </div> <p>If factory default is desired, simultaneously press the ENTER & DOWN ARROW keys.</p>

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 μ A.

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: $\pm 0.25\%$ of span, ± 1 least significant digit.

Resolution: 1 degree, 0.1 degree, or 1 count.

Line Voltage Stability: $\pm 0.05\%$ over the supply voltage range.

Temperature Stability: 4 μ V/°C (2.3 μ V/°F) typical, 8 μ V/°C (4.5 μ V/°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.



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

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

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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: $\pm 2.0\%$ 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.

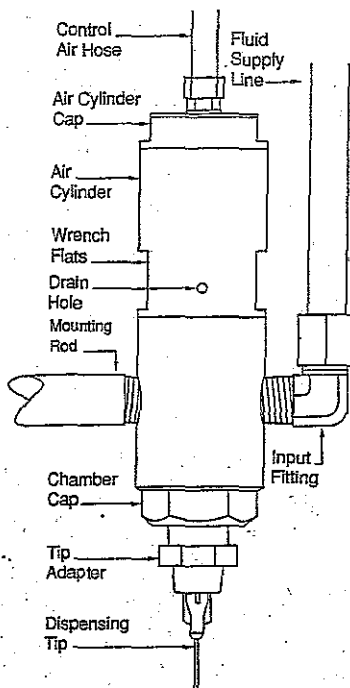
Each valve is shipped with a #2186 polypropylene tip adapter installed. The input fitting for the supply line is specified at the time of order.

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

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.

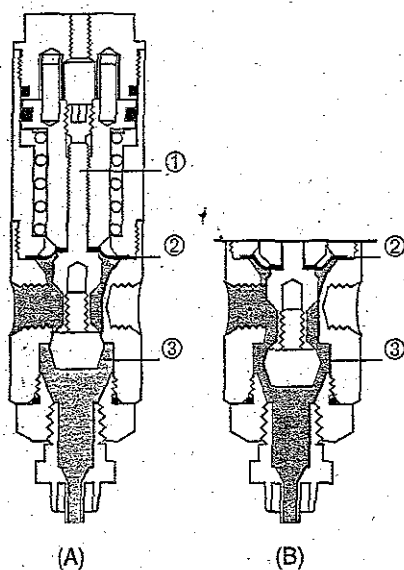


Illustration (A) shows the valve closed. Illustration (B) shows the sealing head ③ open and the diaphragm seal ② slightly deflected.

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

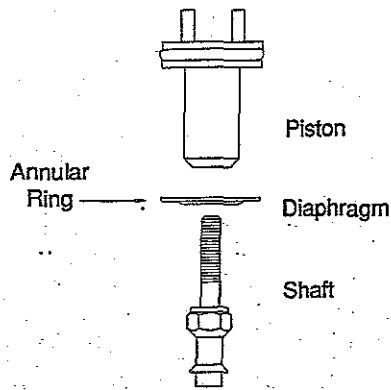
Maintenance and Cleaning

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.

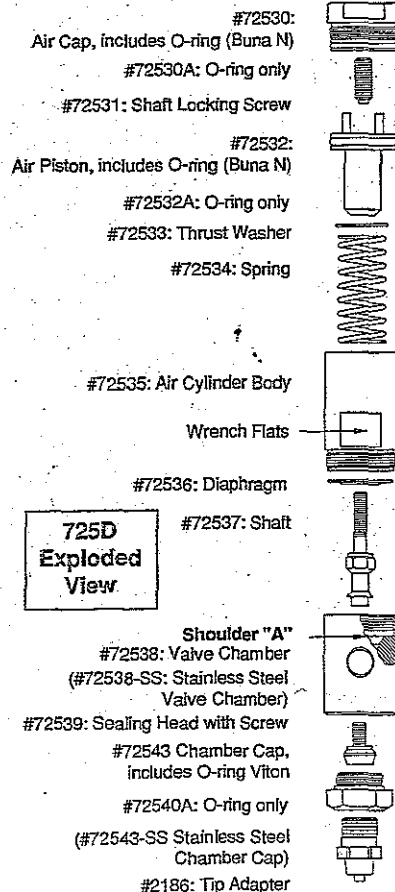
1. Always operate the valve at an air pressure between 70 psi and 90 psi (4.8-6.2 bar).

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.



725D assembly of piston, diaphragm and shaft.

**STEP 1: To Thoroughly Clean Valve Chamber**

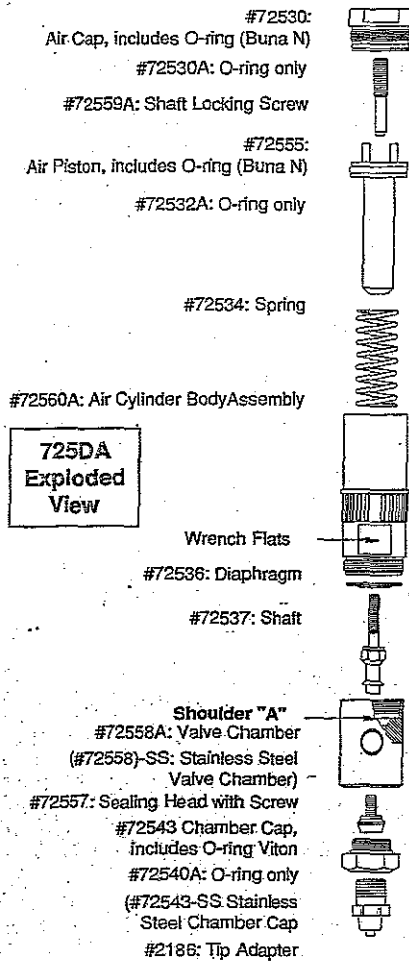
Note: For the 725DA only, set stroke adjustment to the full open position (two complete rotations). Refer to illustration on page 8. Stroke adjustment must stay open throughout reassembly.

- 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.

**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

- Remove the parts described in **STEP 1, A** through E.
- Remove input air hose fitting from air cap.
- 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.
- 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 of 15 inch pounds) to provide a tight seal of the diaphragm, but not so excessively tight as to cause the diaphragm material to extrude.

- 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.
- Install the air hose fitting.
- Complete reassembly **STEP 1, G** through I.

STEP 4: To Replace or Lubricate Piston O-ring

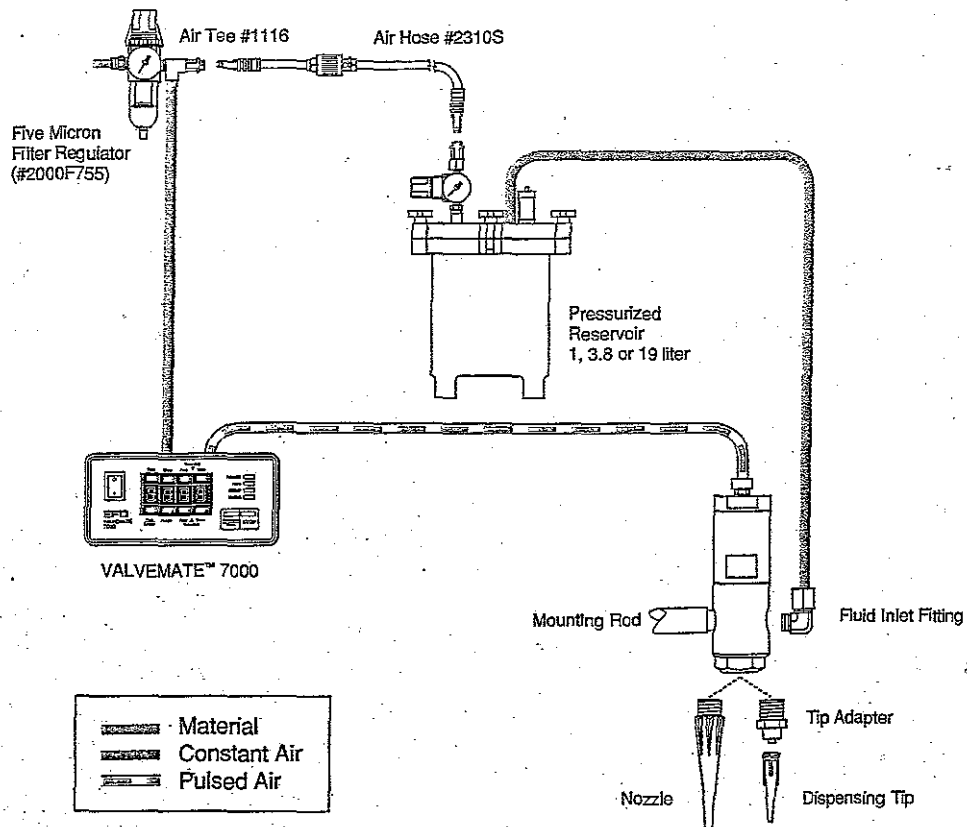
- Remove parts following **STEP 1 A** through E and **STEP 3 B** through C.
- Unscrew the air cap from the air cylinder body, using a wrench.
- Remove the piston and spring.

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.

- Clean all parts; replace O-rings as required.
- Lubricate O-rings, spring ends, air cylinder wall and two nonrotating pins on piston, preferably with an O-ring lubricant.
- 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.

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

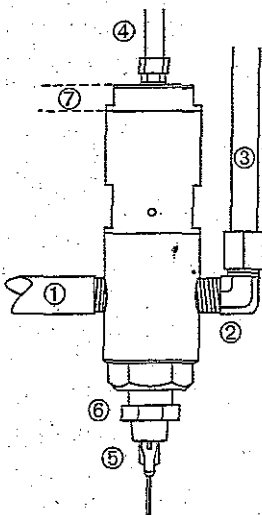
Connect the liquid reservoir hose ③ to the fluid inlet fitting ②.

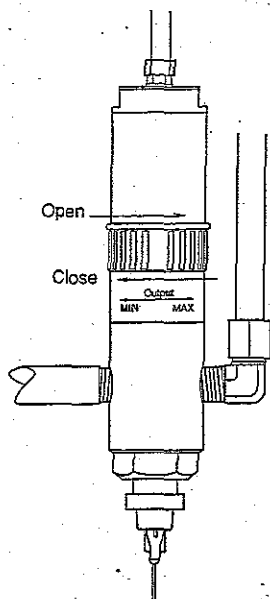
Connect the control air hose ④ to a valve controller or other pneumatic switch that is to be used to control the ON time of the valve. (Refer to the EFD VALVEMATE™ 7000 or 7020 operating manual, if appropriate.)

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.





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

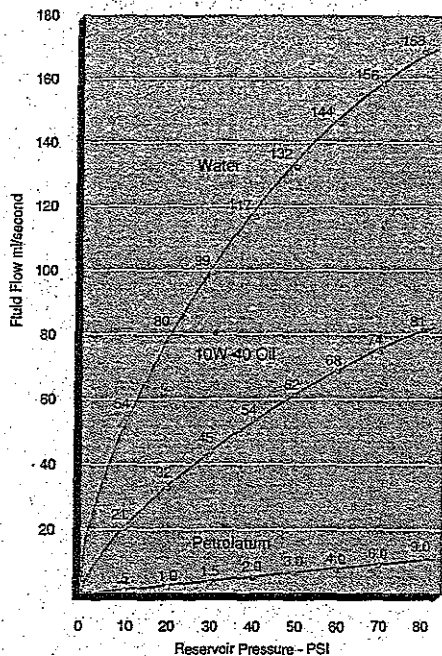
All types dispense well, including rubber-based, contact, even fast air-drying adhesives. Reduce "stringing" by using a small tip. If stringing persists, dilute the adhesive with recommended solvent. Refer to adhesive manufacturer's specifications.

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.



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.

725D and 725DA Fluid Flow

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

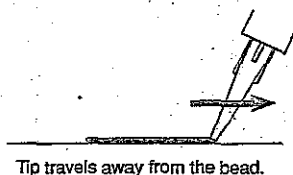
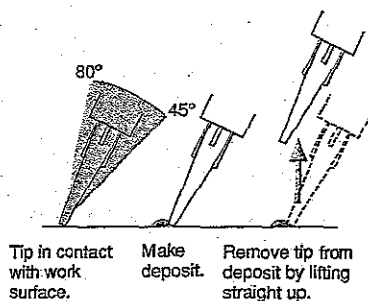
Troubleshooting Guide

Trouble	Possible cause and correction
No fluid flow.	<p>If valve operating air pressure is too low, the valve will not open. Increase air pressure to 70 psi (4.8 bar) minimum.</p> <p>The reservoir air pressure may not be high enough. Increase pressure.</p> <p>The dispensing tip may be clogged. Replace tip.</p> <p>If using the 725DA, the stroke adjustment may be closed. Open stroke adjustment.</p> <p>Fluid may have solidified in the valve chamber. Clean the valve chamber.</p> <p>Fluid feed line is installed into blind mounting hole. Remove and reinstall properly.</p>
Fluid drools after the valve closes, eventually stopping.	<p>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.</p> <p>If the fluid has entrapped air, the material must be degassed before dispensing.</p>
Fluid drips at a steady rate after the valve closes.	<p>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.</p>
Trouble	Possible cause and correction
Valve responds slowly when opening and closing.	<p>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.</p>
Fluid flows out of the drain hole.	<p>Fluid flowing out of the drain hole indicates a ruptured diaphragm. Replace in accordance with the maintenance instructions starting on page 14.</p>
Inconsistent deposits.	<p>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).</p> <p>The time the valve is open must be constant. Check to be sure the valve controller is providing a consistent output.</p>

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.



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.

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
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Dispensing Wand

7530B	18" length
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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.

