MAINTENANCE MANUAL
SERIES I CNC MODEL R2E4
MILLING, DRILLING AND BORING MACHINE

Code No. 11040824
(M-0824)

February 1986

Bridgeport®
Bridgeport Machines, Bridgeport, CT

IMPORTANT

SAFETY INFORMATION

To prevent serious bodily injury, you should observe the following basic safety precautions when installing, operating or servicing your Bridgeport milling machine.

1. Follow all instructions in the machine manual.
2. Wear approved industrial safety glasses and safety shoes.
3. **Do not** wear gloves, long sleeves, long hair, rings, watches, jewelry or other loose items that could become caught in moving parts.
4. Keep all parts of your body away from moving parts (belts, cutters, gears, etc.).
5. Use proper point of operation safeguarding.

These and other safety precautions are discussed in the American National Standards Institute Standard entitled *Safety Requirements for the Construction, Care, and Use of Drilling, Milling, and Boring Machines* (ANSI B11.8-1974).

This publication is available from: The American National Standards Institute
1430 Broadway
New York, New York 10018

Safeguarding for protection at the point of operation can only be designed and constructed when the parameters of the particular operation have been determined. As a result, ANSI B11.8-1974, Section 5.1, states that *"it shall be the responsibility of the employer to provide, and ensure the use of, a guard, guarding device, awareness barrier, awareness device, or shield..."*.

To assist machine users in designing point of operation safeguarding for their specific machine applications, the Occupational Safety and Health Administration has published a booklet entitled *Concepts and Techniques of Machine Safeguarding* (O.S.H.A. Publication Number 3067).

This publication is available from: The Publication Office — O.S.H.A.
U.S. Department of Labor
200 Constitution Avenue, NW
Washington, D.C. 20210

The general purpose point of operation shield provided with this machine and shown in certain illustrations throughout this manual may not be appropriate and cannot be utilized for all possible applications of the machine. Use additional or alternate safeguarding where this shield is not appropriate or cannot be utilized. Note that for purposes of display, the shield has been removed in certain other illustrations in this manual.

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FOREWORD

▪ manual is one in a series of manuals that provides the instructions for proper operation, programming, installation and maintenance of the machine system. The manuals are:

Code No.	Description
1-104-0821	Operating Manual
1-104-0822	Progamming Manual
1-104-0823	Users Manual
1-104-0825	Parts Manual

CHAPTER 1
INTRODUCTION

1.1 PURPOSE AND SCOPE

This manual contains the information needed to install, maintain, troubleshoot and repair the R2E4 Series I Milling, Drilling, and Boring machine. The information presented covers the tasks and levels of skills needed for the maintenance of a computer controlled milling machine. This manual includes theory of operation, preventive maintenance, troubleshooting, adjustments, and parts replacement. Attendance at Bridgeport Service Training Schools is recommended to acquire a thorough understanding of the R2E4.

1.2 REFERENCE MANUALS

Other manuals dealing with the R2E4 milling machine are:

Code No. 1-104-0821 — Operating Manual
Code No. 1-104-0822 — Programming Manual
Code No. 1-104-0823 — Users Manual
Code No. 1-104-0825 — Parts Manual

13 ORGANIZATION OF MANUAL

This manual has been divided into five sections for quick, easy use. Each section contains all Ihe chapters presenting information on that particular function.

Part **I: Installation** Procedures are located in the User Manual.

Part **II:** Theory Of Operation Chapters 3 through 6 provide description of the R2E4 system and theory of operation. Topics presented in these four chapters progress from general subsystems to specific components. This is done so all maintenance personnel can fully understand the information needed for their level of maintenance.

Part **III:** Maintenance Chapters 7 and 8 provide procedures for troubleshooting and testing the R2E4 controls system. Chapter 9 presents preventive maintenance for the complete R2E4 system.

Part IV: Mechanical Assembly Chapters 10 and 11 provide descriptions of the Base and Head assemblies. Included in these Chapters are adjustments and parts replacements for the milling machine.

Chapter 12 details the auxiliary systems of the R2E4. Adjustment information is also included in this chapter. Chapter 13 covers optional equipment available for the R2E4 system, Included are descriptions and installation information.

Part **V:** Appendix Appendix A provides R2E4 system specifications.

Appendix B contains information on the sale handling of static sensitive materials.

Appendix C provides communication standards and instructions for connecting peripheral equipment to the R2E4 system using Ports A and B. Specific procedures for connecting an ASR-33 teletype are also included.

1.4 LEVELS OF MAINTENANCE

Level 1 Level 1 personnel are not required to have delailed knowledge of the equipment, nor have any (electrical) tools for maintenance.

Level 1 maintenance consists of keeping the equipment clean and lubricated, ensuring power is turned on, and that proper startup and operating procedures are being followed.

Level 1 personnel are not aulhorized to make adjustments or replace components.

Level **2** Level 2 service personnel are required to have VOMs, spare fuses, printed circuit boards, etc.

Level 2 mainlenance consists of all Level 1 procedures, plus adjustment of power supply voltages and replacement of major subassemblies. Motors, cables, PC boards, and fuses, plus certain individual components (such as contactors, power switches and disconnects) may be replaced by Level 2 personnel.

Level 2 personnel are not authorized to replace individual components other than those listed above.

Level 3 Level 3 Maintenance personnel are trained at Factory Service School. They are expected to have a detailed knowledge of the equipmenl and its theory of operation.

Level 3 Maintenance personnel are equipped with all the tools available to Level 2 personnel, plus oscilloscopes and logic probes.

Level 3 Maintenance personnel are authorized to perform all Level 2 maintenance functions plus replacement of certain individual components (such as power semiconductors, filter capacitors, and certain low-level semiconductors).

CHAPTER 2
INSTALLATION

Installation procedures are described in the User Manual, Code No. 1-104-0823

CHAPTER 3

MACHINE COMPONENTS AND SYSTEMS

3.1 THE SERIES I CNC MACHINE

The R2E4 is a vertical spindle, knee-type mullifunction machine tool as shown in Figure 3-1. The equipment is built around a base assembly with a rigid ram to carry the 2HP Milling Head. The ram is mounted to the column of the machine and is secured and pinned. The milling head is provided with limited adjustment (see the Installation chapter in the User Manual).

Mounted to the machine column are the major accessories and control equipment shown in Figure 3-1:

Power Equipment Enclosure for Magnetic and Power Distribution

- Axis Drive Enclosure for the Servo System
- Operator Control Enclosure for the Operator's Control Station
- Auxiliaries Cabinet for Lubrication and Pneumatics Systems

3.1.1 The Base Assembly

The Series I CNC machine is an entirely different version of the familiar Standard Series I Vertical Milling Machine. It is specifically designed to enable its full dedication to the needs of numerical control. It has special dual knee locks lo clamp the knee (manually adjusted) to the column. The knee has additional way area at the lop to carry the extended deep saddle, and the table is designed for an automatic machine tool. The machine ways are chrome plated for long life, and an automatic one-shot lubrication system is provided. The X and Y axis drives are suspended clear of the operator's working area. This arrangement eliminates any bending moment on the table. The X-axis drive motor is mounted on the saddle where it gets better support and drives the ballnut of a stationary ballscrew. The Y-Axis motor is mounted on the knee and rotates the Y-axis ballscrew. Ballscrews are totally enclosed and mounted in the center of the guideways.

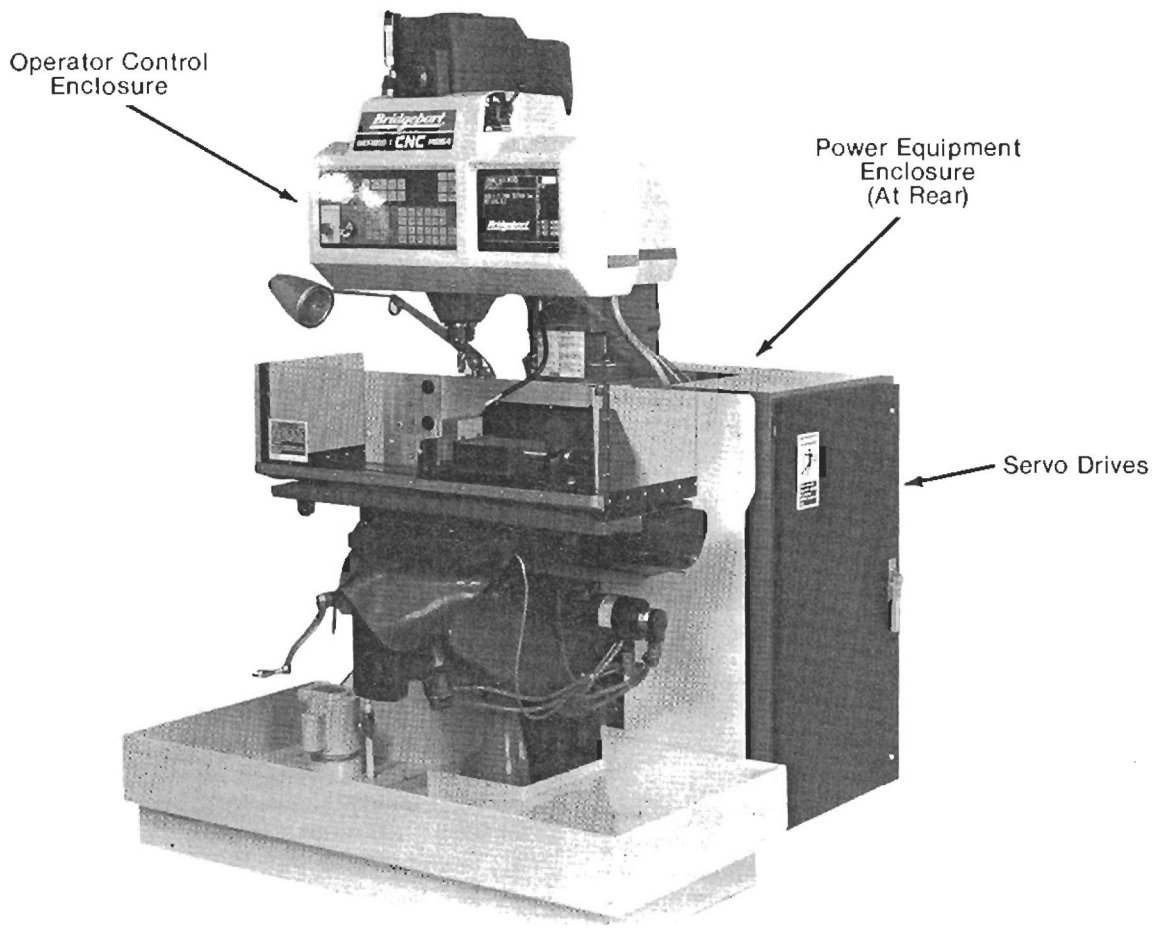

Figure 3-1. Series I R2E4

Knee Drive The knee is elevated by a 5-pitch Acme screw. A friction dial is provided, calibrated in increments of 0.001 inch (0.0254mm).

To change the knee elevation, push the knee elevating crank in until the clutch meshes; then turn the crank clockwise lo elevate the knee, or counterclockwise to lower it.

NOTE

Two knee lock wrenches (Figure 3-2) control the clamps on the knee-column ways and must be released before the knee will raise or lower.

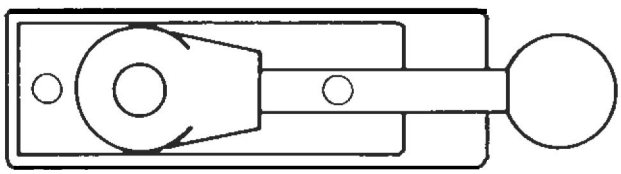

Figure 3-2. Column Knee Clamps

To clamp the knee, firmly turn the knee lock wrench handles clockwise. To release, turn them the other way. Keep the knee clamped while cutting,

The knee is supported on an Acme screw, and the nut is mounted on the pedestal, Figure 3-3.

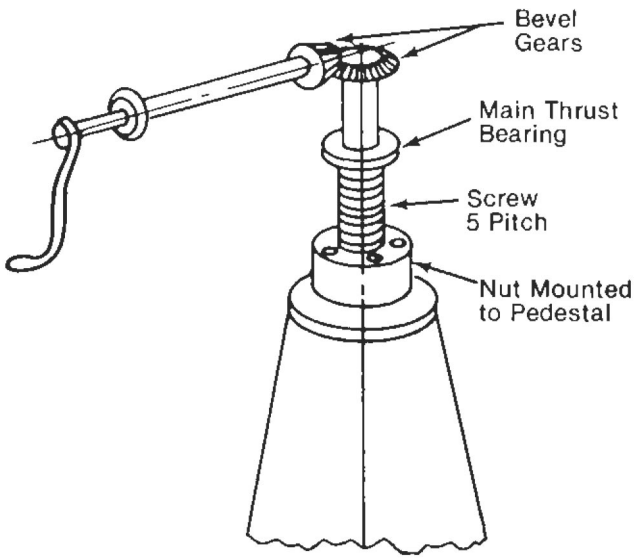

Figure 3-3. Knee Drive Transmission

3.1.2 Gib Adjustment

Preliminary Information The gibs are set properly at the factory before acceptance testing and alignment. Adjustment procedures apply only when misposition is evident or after about 6 months' use. We recommend you do not try to reset the factory set gibs unless absolutely necessary. However, if gib adjustments are required, refer to Chapter 10, Section 10.7 for the correct procedures.

3.1.3 The Milling, Drilling and Boring Head — Figure 3-5

Transmission The spindle drive motor is a 3 phase, 2 HP (1.5W) AC induction motor. The following motors are available:

200/400V	50/60 Hz
230/460V	60 Hz
575V	60 Hz

An internal cooling fan located within the motor casing draws ambient air into the front of the head, around the main drive belt and through the motor. See Figure 3-4.

Speed changing is affected by forcing the drive belt to ride at a large or small radius on the conically tapered varidisc sheaves. Each varidisc assembly is precision dynamically balanced to prevent vibration and promote long belt life.

When the high/low shifter is in high, the output of the varidisc drives the spindle directly through the clutch. A shift into back gear (low) disengages the clutch and engages the bullgear. The power now travels through a toothed belt drive to a countershaft and back to the spindle through the bullgear lor an overall reduction of 8:3:1. A pneumatically operated spindle brake and speed changer are standard. See Section 3.5 for pneumatics.

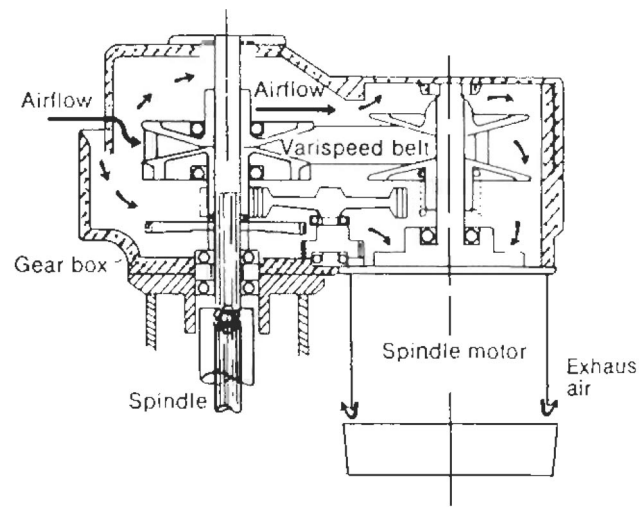

Figure 3-4. Spindle Drive Transmission

3.1.4 Z-Axis Drive

The quill is driven by the same type of servo motor as the X and Y-axes. A timing belt connects the feed drive motor and the ball quill extension. The ball quill has a 5-pitch thread carrying a recirculating ballnut with suitable internal preload. With proper adjustment *of* the timing belt, lost motion is virtually eliminated. The quill has a working travel of 5 inches. The Drive Ratio is 2:1 (.2 lead).

3.1.5 The **Quill** and **Spindle**

The quill is a 3-¾ inch diameter steel tube ground and chrome plated to a tolerance of .0002". The quill

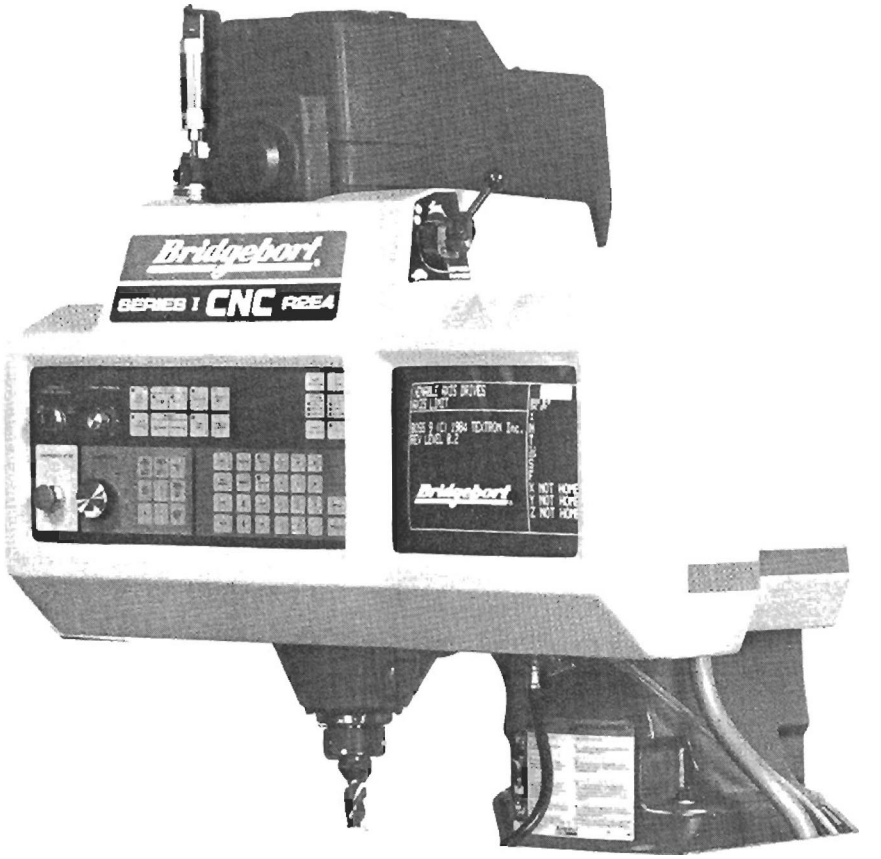

Figure 3-5. Milling, Drilling and Boring Head

secures the outer races of the angular contact special precision preloaded bearings mounted to the spindle. The spindle itself is alloy steel hardened and ground, with an involute spline at its upper end to slide internally in the power transmission train. At the lower end of the spindle, a taper is ground for Erickson #30 quick change tool holders or similar units. A Universal 200 taper is also available.

3.2 THE CNC SYSTEM

The following provides a functional description of each subsystem in the R2E4 system. Figure 3-6 is a functional block diagram of the system.

3.2.1 Operator Control Subsysfem

Most operator input is accomplished through lhis subsystem. It accepts keypad, keyboard and some switch control inputs and also provides machine status outputs through the CRT and LEDs. The CRT provides displays of programs, commands and axis positions, along with any error messages detected by the Central Processing subsystem. This subsystem contains the Front Panel membrane and one PC board, see Figure 3-7.

(Serial Front Panel) Board This board interfaces Front Panel controls with BOSS 9.0. The SFP board sends Front Panel key closures to the BSP board, and receives data and commands for the status LEDs and CRT.

NOTE

The BSP board sends signals to the EZIO board to enable translation of data for CRT display.

3.2.2 Central Processlng Subsystem

All operator and electronic input are analyzed by this subsystem. Appropriate commands and responses are sent to the Operator Control, Axis Drive or Interface subsystems, There is one board in this subsystem:

BSP (Bridgeport Standard Processor) Board This board contains a 68000, 16-bit microprocessor and controls system operations. It also contains memory space for both BOSS 9.0 and part program input.

3.2.3 Power Subsystem

This subsystem contains two line voltage transformers and two power supplies providing operating voltages to the entire R2E4 system. Incoming power enters at the main disconnect and is conditioned and distributed by this subsystem. The FPU board monitors line voltage for spikes and power downs. It contains four standard alkaline cells which maintain control memory at power down.

3.2.4 Interface Subsystem

This subsystem provides Central Processing with control and status of the Electromechanical components in the system and provides an interface between the R2E4

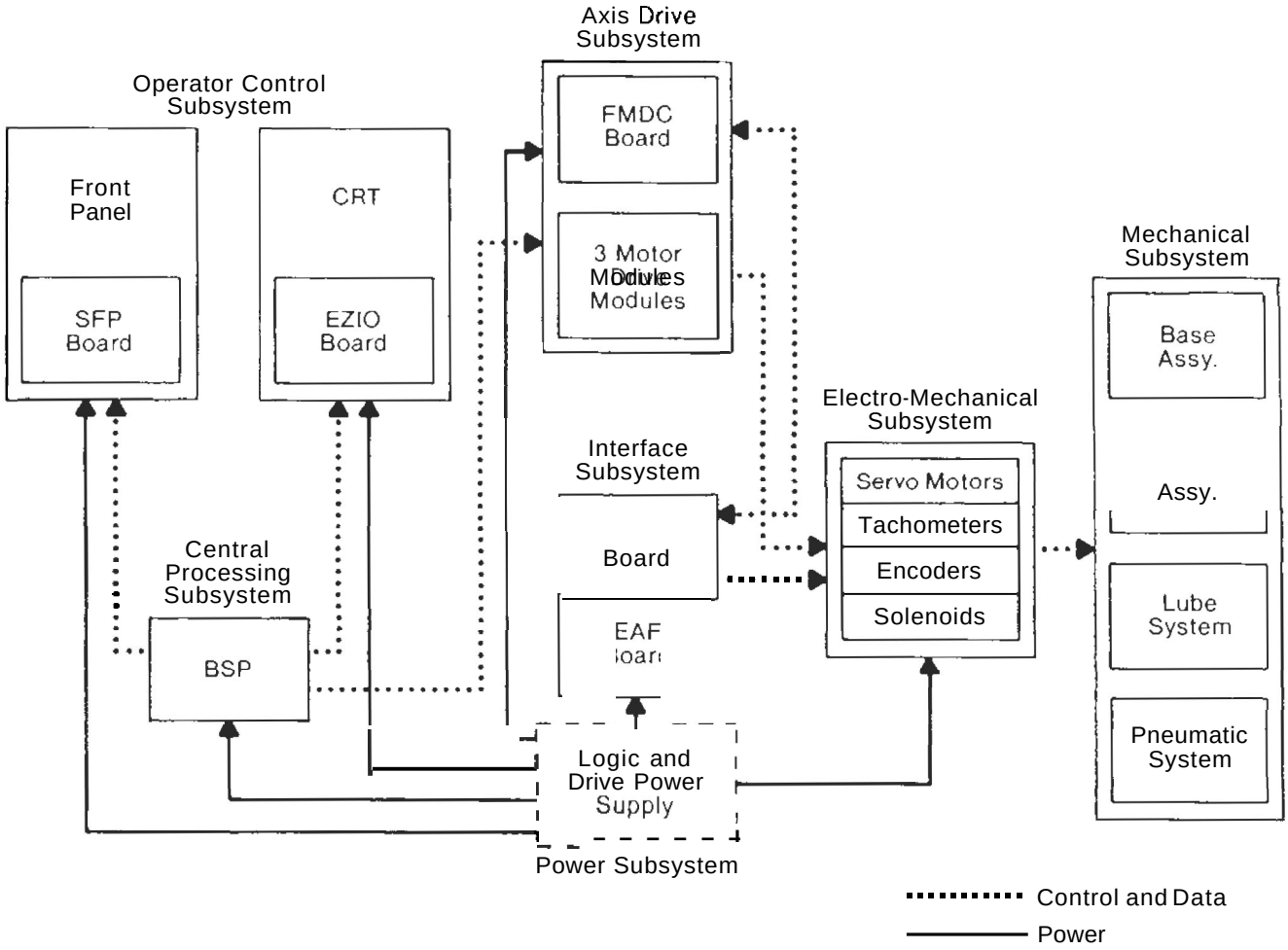

Figure 3-6. R2E4 Series I System — Functional Block Diagram

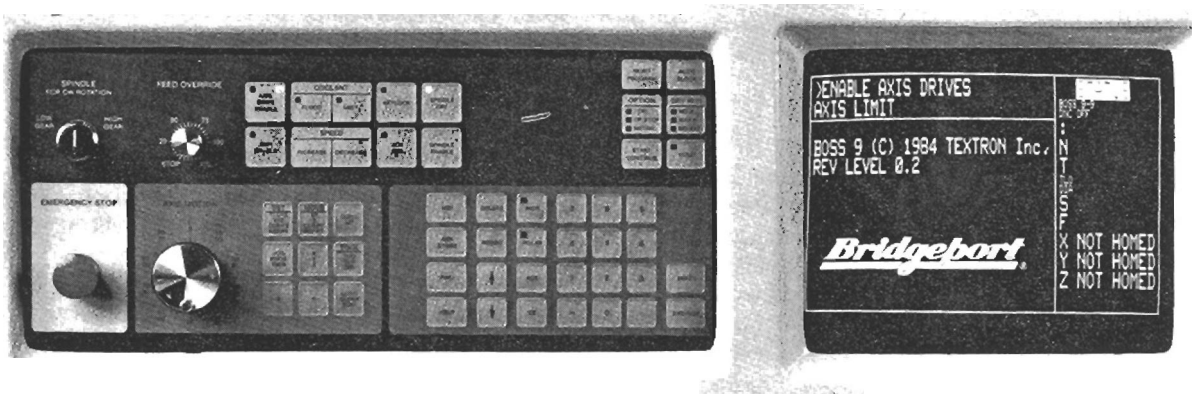

Figure 3-7. Operator's Control Panel

system and the outside world. This subsystem contains one board:

(Auxiliary Function) Board This board interfaces t. Central Processing subsystem to both the Electromechanical subsystem and the outside world. It contains the circuitry needed to establish RS-232 and RS-422 links. It also contains oplocouplers and transistors used to control and monitor various electromechanical components.

33 AXIS DRIVES

3.3.1 Axis Drive Subsystem

This subsystem receives positioning signals from the FMDC board and translates these signals into command and direction signals for the DC servo motors. It also transfers signals between the BSP board and the EAF board.

The Axis Drive subsystem consists of printed circuit boards and motor drive boards.

FMDC Board The FMDC board receives position signals from the BSP board and converts them to drive signals tor the motor drive boards. This board also monitors the home switches and communicates with the EAF board.

IFC Board The IFC board acts as an interface between the FMDC and the axis drive motors.

HBD Board The HBD board monitors drive current lor the output drive transistors.

DCS Board The DCS board processes the velocity comm. and the tachometer signals. It also generates error signals to the HBD board.

DPS Board The DPS board is a power supply board which supplies +15 VDC.

3.3.2 Electromechanical Subsystem

This subsystem receives commands and power from the Servo Drive subsystem and provides axis motion for the milling machine. Each axis of the milling machine contains the following electromechanical assemblies:

1. Motor The motor is a DC servo motor and receives current signals from the servo drive subsystem. The motor converts the signals into mechanical axis motion.
2. Encoder The encoder converls the position of the axis into a two phase pulse stream which the Axis Drive subsystem can decode.
3. Tachometer The tachometer converls the velocity of the axis into an analog voltage signal for the Axis Drive subsystem.

3.4 MECHANICAL SUBSYSTEM

This subsytem contains two assemblies:

1. Head Assembly This consists of all the mechanical components of the quill (Z-axis), the Z-axis drive motor and the spindle motor.
2. Base Assembly This contains the saddle (Y-axis), table (X-axis), knee, their support structures and the X and Y-axis drive motors.

3.5 LUBRICATION SYSTEM

3.5.1 Overview

All bearings in the spindle, the spindle drive transmission, and the ballscrew mounlings have antifriction angular contact bearings greased for life.

3.5.2 Way System Lubricant

The automatic one-shot way lubricator system is shown as installed in Figure 3-8.

All moving members are fed from a central lubricating tank, the TM-5 lubricator, which contains a filter and motorized timed plunger pump.

For more information on the lubrication system, refer lo Chapter 12.

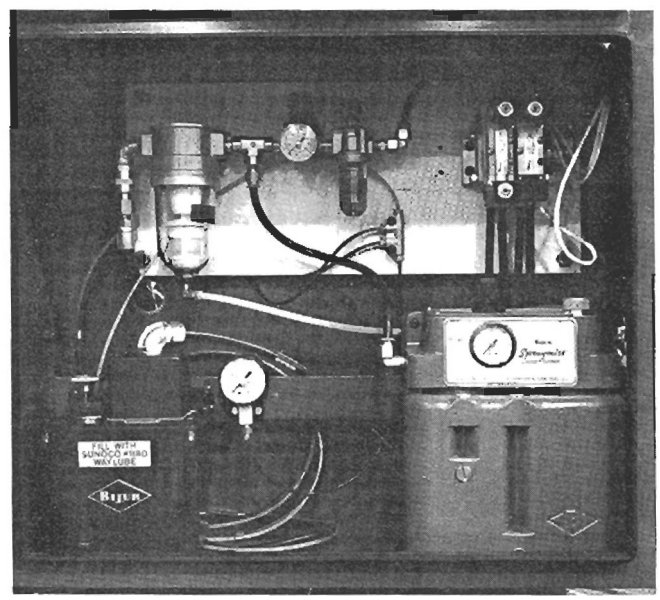

Figure 3-8. Auxiliaries Cabinet Assembly

3.6 PNEUMATIC SYSTEM

3.6.1 General Distribution

The entire pneumatic system is self-contained and requires no special startup procedures other than the need of 85-125 PSI service, along with adequately sized lines and plant equipment capacity.

The system consists of an air hose, a lubrication bowl, a manual pressure relief valve and a regulating valve set at 75 psi (482.5 kilo pascals). Average air consumption is 4 cfm. Instantaneous flow is 12 cfm, requiring lines and external equipment to be sized for 12 cfm.

Refer to Chapter 12 for more information on the Pneumatic System.

CHAPTER 4

POWER DISTRIBUTION

4.1 INTRODUCTION

This chapter discusses the power distribution throughout the control and elecIromechanical interface. Power is traced from its entry point at the Main Disconnect switch, through all of the transformers and power supplies to its end use. Figure 4-1 shows this power distribution in block diagram form. Refer to the diagram when reading the text. The System Wiring Diagram, (3-193-8313) is located at the end of this chapter, followed by duct wiring diagrams for control serial numbers marked thereon.

4.2 SYSTEM OVERVIEW

All incoming power enters at the Main Disconnect switch on the Power Equipment Enclosure. Maximum allowable line voltage is 460 volts AC. The customer has the option of selecting the following incoming line voltages from the available voltage frequency kits offered by Bridgeport.

208 VAC	60 Hz
230 VAC	60 Hz
460 VAC	60 Hz

is a 4-wire system (three phases and a ground).

After power enters Ihe Power Equipment Enclosure, it passes through a disconnect switch and fuses FU1, FU2 and FU3 before it is applied to the system for power distribution.

The incoming power is distributed into four branches as follows:

- Line voltage distribution — Line voltage is wired through a reversinglstarting contactor for the spindle motor. When the contactor is activated, voltage is switched to the spindle motor.
- **115** VAC single phase distribution — Incoming power is fed to transformer T1. T1 steps the line voltage down to 115 volts AC single phase. This voltage is used by the Logic Power Supply and provides primary power to the 24 volt DC power supply located within the Drive Power Supply.
- **90** VAC — Line voltage is fed to transformer T2. T2 is a single-phase, multiple tap step down transformer. This transformer supplies 90 VAC to the axis drive power supply and 115 VAC lo the duplex receptacles, flood and mist coolant, lube motor, three fans and three control relays. The Drive Power Supply provides 128 VDC to the motor drive modules.

The two main power supplies, the Drive Power Supply and the Logic Power supply, deliver DC voltages to the following items:

Logic Power Supply provides:

- +5 VDC to the logic boards
- ±12 VDC to FMDC and EAF boards

Drive Power Supply provides:

- +24 VDC to EAF, Limit Switches, and Pneumatics
- ±128 VDC to Axis Drives

4.3 LINE VOLTAGE DISTRIBUTION BRANCH

This branch connects line voltage directly to the spindle motor. Conlactors MF and MR switch incoming power from the line to the spindle motor.

4.3.1 Spindle Motor Protection

The spindle motor is a 3-phase 2 HP AC motor. It operates on 208, 230 or 460 VAC. Through high and low gearing and motor reversal, variable speed operation is available. Reversing contactors MF and MR changes the spindle motor's direction.

Three heaters protect the spindle motor against excessive currents. If the current caused by the load is excessive, the overload heaters will stop current to the spindle motor by opening contactor 1MOL. After cooling, the heaters must be reset before the spindle motor can be restarted; see Table 4-1.

Table 4-1. Overload Heaters

Line Voltage	Clark No.	Code No.
208V	2441	3-150-4090
230V	2438	3-150-3857
460V	2431	3-150-4240
200v	2441	3-150.4090
220v	2438	3-150-3857
380V	2434	3-150-3388
416V	2433	3-150-3324
575v	2430	3-150-3325

4.4 115 VAC DISTRIBUTION BRANCH

The 115 VAC output from T1 and T2 feed the following :

- Logic Power Supply
- Lube Motor
- Three Fans
- Duplex Receptacles
- Coolant
- EAF Board

4.5 DRIVE POWER SUPPLY

The Drive Power Supply provides +24 VDC power tor general purpose switching and control functions. The 24 VDC from the Drive Power Supply is used by the following devices:

1. Pneumatics — A pneumatic cylinder clamps a mechanical brake against the spindle whenever the

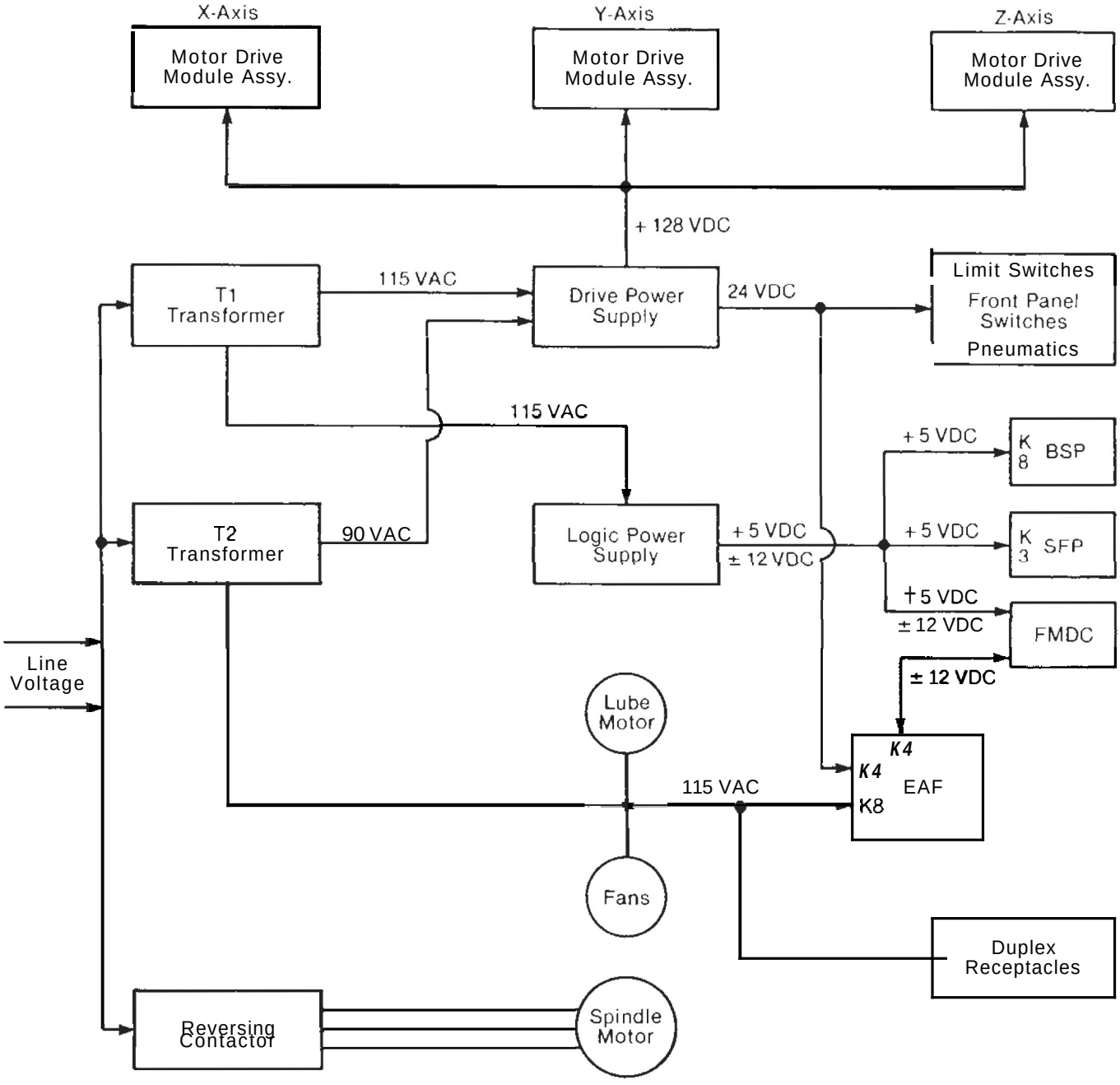

Figure 4-1. Power Distribution — Functional Block Diagram

spindle is disabled. Power to the solenoids is provided when contactors MF or MR are closed and one of the Spindle SPEED Control keys are pressed. Air passing through these solenoids rotates a pneumatic motor clockwise or counterclockwise. This motor moves levers in the head which expand or reduce effective diameters of the drive and spindle motor pulleys, changing the resultant spindle speed.

2. EAF Board — The EAF board receives 24 VDC on terminals K4B-3 and K4B-8. The 12 VDC is filtered on the EAF board for use in its logic circuitry. The EAF board also uses the 12 VDC lo supply power to the Port A data connector J2. pins 2 and 4.

3. Front Panel Switches — The Front Panel switches provide communications between the machine and the operator. Power to the EMERGENCY STOP and the SPINDLE FOR C.W. ROTATION switches is from the 24 VDC supply. The other switches are membrane type; when pressed, they complete a path in the keyboard circuitry which causes the generation of the selected code element. The selected code element is transmitted to the machine controller (BSP) board where the proper firmware is enabled to control the logic circuitry on the EAF and FMDC boards. This logic circuitry is used to control the electromechanical devices in the system.

   EMERGENCY STOP Switch — When pressed, this switch will remove power from the reversing/starting contactors, causing the spindle lo stop (wire #40 — refer to System Wiring Diagram). When pressed, the EMERGENCY STOP button will also stop the axis drive motors by disabling the logic circuitry controlling them. See Figure 4-2.

   SPINDLE FOR C.W. ROTATION — This switch is used in conjunction with the SPINDLE ENABLE button. It determines whether contactor MF or MR operates. This switch is connected to the contaclors through wires #48 and #49 (refer to System Wiring Diagram).

4. **LIMIT** and HOME Switches

   LIMIT Switches — The Drive Power Supply provides 24 VDC to all the limit switches in the system over wires #41 through #45 (refer to System Wiring Diagram). The axis limit switches have the same effect on machine operations as the EMERGENCY STOP button. If any one of the four switches open, 24 VDC is removed from the coils of the reversing contactor, turning the spindle motor off. The power is also removed from the logic circuitry controlling the axis drive.

   HOME Switches — A switch is located on each axis. When the axes are within one revolution of the Home position, these switches will close, creating a path to ground for the logic circuitry on the EAF and FMDC boards. Refer to System Wiring Diagram, wire #39.

46 LOGIC POWER SUPPLY

The Logic Power Supply receives 115 VAC from T1 on nos. 12 and 13. The power supply converts the AC ge to +5 VDC for use in the logic circuitry; and ±12 VDC for use on the EAF and FMDC boards.

EAF Board — This board uses ±12 volts DC +12 VDC enters the EAF board on pin K4-1, and the −12 VDC enters on pin K4-2. Capacilor networks are used to filter some voltages needed by the logic circuitry on the EAF board.

BSP Board — The BSP board uses the +5 VDC and the ±12 VDC from the Logic Power Supply. The voltages enter the BSP board on the following terminals:

+5 VDC	T81-6
Common	TB1-5
+12 VDC	T81-2
−12 VDC	TB1-1

These voltages are used by the logic circuitry on the BSP board.

SFP Board — The SFP board uses +5 VDC which enters the SFP board on terminals K3-5 and K3-10. This voltage is conditioned on the board for use in its logic circuitry.

4.7 128 VAC DISTRIBUTION BRANCH

This distribution branch consists of a single phase step down transformer T2, and the drive power supply. Transformer T2 can be supplied to operate on 208 VAC, 230 VAC, or 460 VAC line voltage.

Line voltage is applied to the primary of T2. T2 steps the line voltage down to 90 VAC. This 90 VAC is applied to the drive power supply. The drive power supply converts the 90 VAC to 128 VDC. This 128 VDC is used by the motor drive modules to power the axis drive system.

The +128 VDC enters the controllers on terminal TB1-4 and ground enters the controllers on terminal TB1-1.

48 115 VAC DISTRIBUTION BRANCH

The 115 VAC distribution branch originates at transformer T2. T2 steps the line voltage down to 115 VAC single phase. The following devices use 115 VAC single phase.

- Lubrication
- System fans
- EAF board
- The Duplex receptacles

4.8.1 Lubrication Motor and System Fans

A motor located in the Lube and Mist Enclosure runs the pump that pressurizes the Waylube system. This motor turns on when either MF or MR is energized.

Three fans cool Ihe R2E4 power and electronic systems. They receive their power directly from T2.

The two fans in the Drive Card Rack are protected by fuse FU5, wire numbers 5 and 2. The fan in the Logic Card Rack is protected by fuse 9, wires 15 and 2.

4.8.2 EAF Board

The EAF board uses the 115 VAC to power the Mist Coolant solenoid and the Flood Coolant outlet. 115 VAC power enters the EAF board on terminals K8-4 and K8-1. Two triacs Q1 and Q2 control the 115 VAC lo the coolant outlet and solenoid. These triacs are gated through two solid state relays, IC1 and IC2, located on the EAF board. Signals from the BSP board activate these relays. When activated, the relays supply the gating pulse for the triacs. Once the triacs are activated, they allow current to

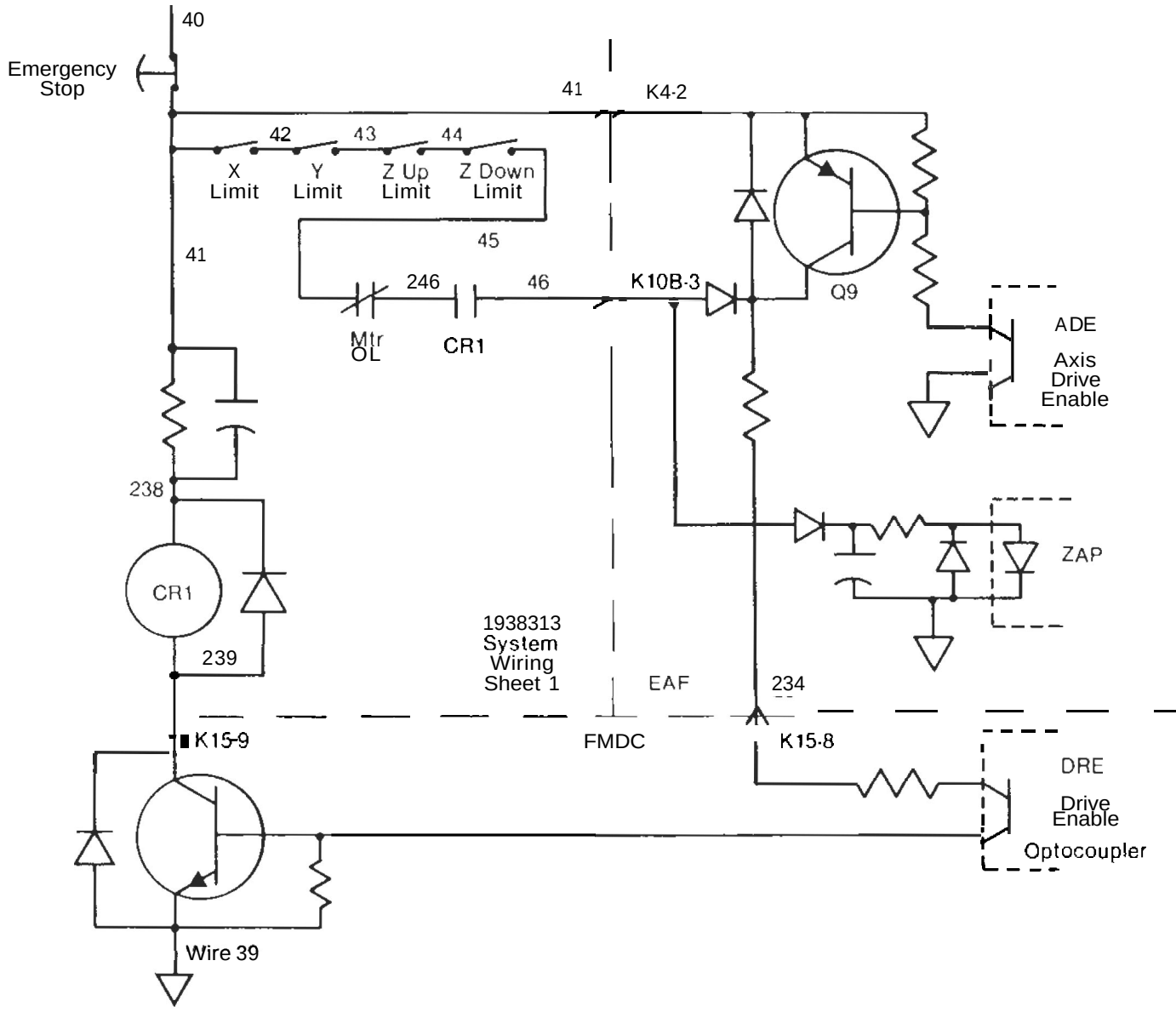

Figure 4-2. Axis Drive Enable

flow through the Mist Coolant solenoid and Flood Coolant outlet.

These devices are active when the spindle is on, and inactive when the spindle is off. The Flood Coolant outlet provides power for the Flood Coolant option. Figure 4-2 shows how this card also fits into the Axis Drive Enable circuit.

4.8.3 The Duplex Receptacle

These standard duplex outlets are located on the right side facing the Power Equipment Enclosure and are general purpose outlets capable of delivering 3A at 115VAC. These outlets are protected by Fuse 6, wire numbers 6 and 2.

Table 4-2. Fuse Chart

FUSE	DESCRIPTION	PART NUMBER	CIRCUIT IT PROTECTS
1,2,3	FRS, 20A, 600V	3-150-8736	Line Voltage — 208/230/200/220 VAC
1,2,3	FRS, 10A, 600V	3-150-8734	Line Voltage — 416/460/575 VAC
1,2,3	FRS, 15A, 600V	3-150-8735	Line Voltage — 380 VAC
4	MDA, 10A, 250V	3-150-8853	Power Transformer T2 Secondary
5	MDA, 1A, 250V	3-150-8888	Fans, Axis Drive Enclosure
6	MDA, 5A, 250V	3-150-8851	Power to the Duplex Receptacle
7	MDA, 6A, 250V	3-150-8852	Power to Flood Receptacle
8	MDA, 1A, 250V	3-150-8888	Power to Spray Mist Solenoid
9	MDL, .5A, 250V	3-150-1516	Power Transformer T1 Secondary
10	MDA, 1.5A, 250V	3-150-3869	Front Power Supply for the BSP, EFP, EAF Boards, +1– 5 VDC, +/– 12 VDC
12	MDX, 2A, 250V	3-154-0033	Auxiliary Power Supply + 24V to Limit, Operator Switches, EAF Board
13	MDA, 8A,250V	3-150-9478	+ 24 VDC Power Circuit
16	MDL, .25A, 250V	3-150-0499	Drive Power Supply
17	MDA, 1.5A, 250V	3-150-3869	DPS Board (– 22 VDC)
18	MDA, 1A, 250V	3-150-8888	CR4, CR5, and CR6 Solenoid
19	FNW, 25A, 250V	3-154-1648	Drive Power Supply
20	FNW, 25A, 250V	3-154-1648	Drive Power Supply
23	MDA, 25A, 250V	3-150-9958	Motor Drive Module
24	MDA, 25A, 250V	3-150-9958	Motor Drive Module
25	MDA, 25A, 250 V	3-150-9958	Motor Drive Module
26	MDA, 5A, 250V	3-150-8851	Logic Power Supply

D 1938313


600 V MAX. 50/60 HZ. DISC.
1 CUSTOMER INSTALLED 4 WIRE INPUT 3 PHASE + EARTH GND
CHASSIS GND
SPINDLE 2 HP
T2 ALTERNATE
REF. LINE 15
REF. LINE 32
DRIVE POWER SUPPLY
AXIS DRIVE POWER
REF. LINES 53 & 54
LOGIC POWER SUPPLY
REF LINES 114 & 115
REF LINE 9
LUBE
DRIVE CARDRACK
LOGIC CARD RACK
CASSETTE & TAPE (MISC)
DUPLEX RECEPT
WORKLIGHT
REF. LINES 58, 59, 60
SPINDLE FOR CW ROTATION
DPS
EM STOP
X LIMIT
Y LIMIT
Z UP LIMIT
Z DOWN LIMIT
MTR OL
LUBE
LOW GEAR
HIGH GEAR
CRR CONTACTS - REF. LINES 19, 21
CRF CONTACTS - REF. LINES 20, 22
MR CONTACTS - REF. LINES 6, 7, 8, 17, 27
MF CONTACTS - REF. LINES 2, 3, 5, 16, 24
CR1 CONTACTS - REF. LINES 21, 24
CRX CONTACTS - REF. LINES 24, 25, 26, 27
2 1 SEE SHEET 4 FOR TRANSFORMER CONNECTION CHART.
* SPRING RETURN TO CENTER
FMDC K15-9
COOLANT RECEPT.
FLOOD
COOLANT
SPRAY
REF. LINE 9
EAF (PWR ENCL.)
INCREASE SOL
DECREASE SOL
BRAKE SOL
X HOME
Y HOME
Z HOME
INDEX OUT
INDEX BACK
REF. LINE 99
3 ALTERNATE WIRING P.R B.C P/N 194037
FUSES: 1 THRU 10, 12 THRU 20, 22 THRU 25
WIRE NO'S 1L1, 1L2, 1L3, T1, T2, 1T1, 1T2, 1T3, 1 THRU 18, 34 THRU 63, 201, 202, 207, THRU 22, 214, 215, 238, 239, 246, 249, 250, 251, 252
CONNECTOR - J5.
A | DCN 35030 | CRE | MMA
O | INITIAL RELEASE | MMA | 6-20-84
LTR | DCN NO. | CHG'D | APPV'D | DATE
REVISION
Bridgeport®
CONTROLS MANUFACTURING PLANT
200 Precision Road, Horsham, Pa. 19044
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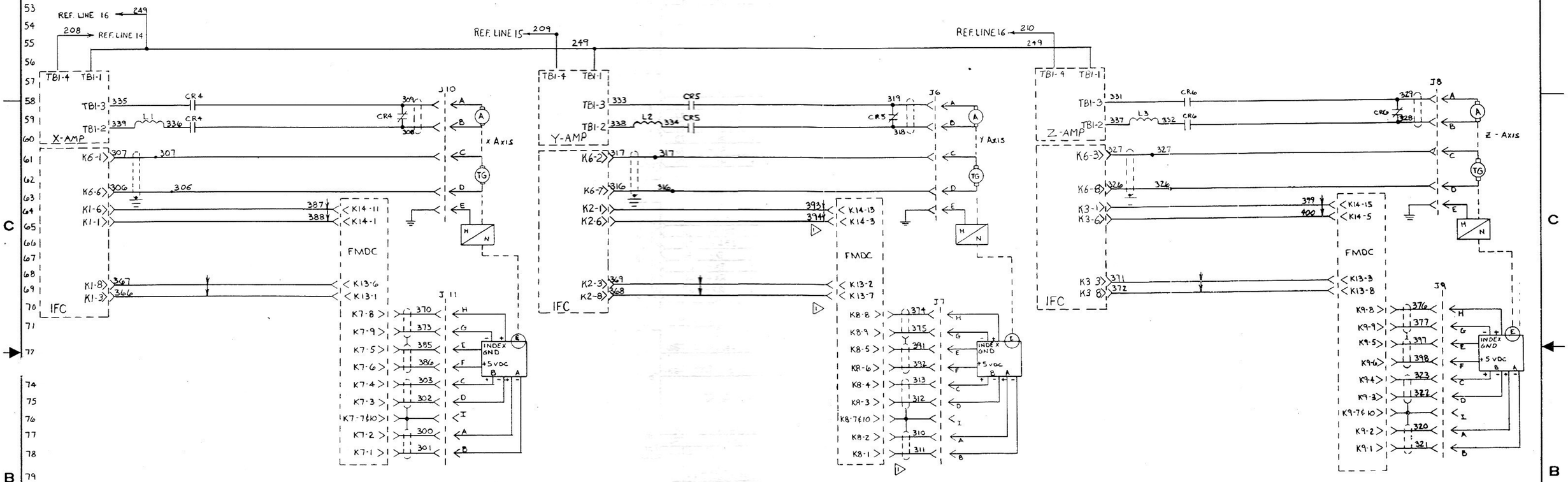
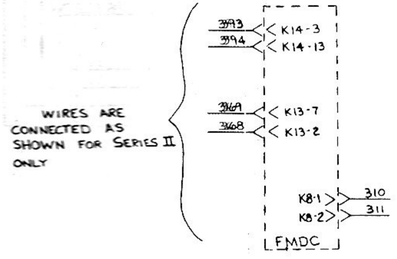
MATERIAL:
FINISH:
MARKING: PER A027099
TYPE: , CLASS: , POINT
REMOVE BURRS AND SHARP EDGES. INTERNAL CORNERS .016 MAX.
DWG NO.
PARTS LIST
NEXT ASSEMBLY
DIMENSIONING
UNLESS OTHERWISE SPECIFIED ALL DIMENSIONS ARE IN INCHES
TOLERANCES
.XX = ±
.XXX = ±
ANGLE .X = ±.5°
THIRD ANGLE PROJECTION
DESIGNED:
DRAWN: TC 5-29-84
CHECKED: B.H. 6-19-84
APPROVED: MMA 6-20-84
PROJECT NO. 100 154-01
MODEL NO.
TITLE
E-CNC CRT
SYSTEM WIRING DIAGRAM
SIZE D
DWG NO. 1938313
SCALE: DO NOT SCALE DWG
SHEET 1 OF 4





WIRE NUMBERS: 208, 209, 210, 249, 300 THRU 303, 306 THRU 313, 316 THRU 323, 326 THRU 329, 331 THRU 339, 366 THRU 377, 385 THRU 388, 391 THRU 394, 397 THRU 400

CONNECTORS J6 THRU J11.

1 WIRES ARE CONNECTED AS SHOWN FOR SERIES I ONLY.

LTR	DCN NO.	CHG'D	APPV'D	DATE
0	INITIAL RELEASE			

REVISION

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CONTROLS MANUFACTURING PLANT
200 Precision Road, Horsham, Pa. 19044

TITLE: E-CNC CRT SYSTEM WIRING DIAGRAM

DWG NO.	PARTS LIST
NEXT ASSEMBLY	

MATERIAL:
FINISH:
MARKING: PER A027099
TYPE: , CLASS: , POINT
REMOVE BURRS AND SHARP EDGES. INTERNAL CORNERS .016 MAX.

DIMENSIONING
UNLESS OTHERWISE SPECIFIED ALL DIMENSIONS ARE IN INCHES
TOLERANCES
.XX = ±
.XXX = ±
ANGLE .X = ± .5°
THIRD ANGLE PROJECTION

DESIGNED: DATE:
DRAWN: CRE DATE: 4
CHECKED: DATE:
APPROVED: DATE:
PROJECT NO. 106174-01
MODEL NO.

SIZE	CODE IDENT NO.	DWG NO.	REV.
D		1938313	0

SCALE: DO NOT SCALE DWG SHEET 2 OF 4

REF LOGIC PWR SUPPLY

WIRE NO.	VOLTAGE	REF LINE NO.
30	+12V	94
31	-12V	96
32	+5V	—
33	COM	95

LTR	DCN NO.	CHG'D	APPV'D	DATE
D	DCN 32990 & 33081 4-18-85	WAR		
C	DCN 32801	CRE		
B	DCN-31725 8-28-84	WAR	MMA	
A	DCN 31541 7-13-84	TC	MMA	7-13-84
0	INITIAL RELEASE			

REVISION

Bridgeport

CONTROLS MANUFACTURING PLANT
200 Precision Road, Horsham, Pa. 19044

TITLE: E CNC CRT SYSTEM WIRING DIAGRAM

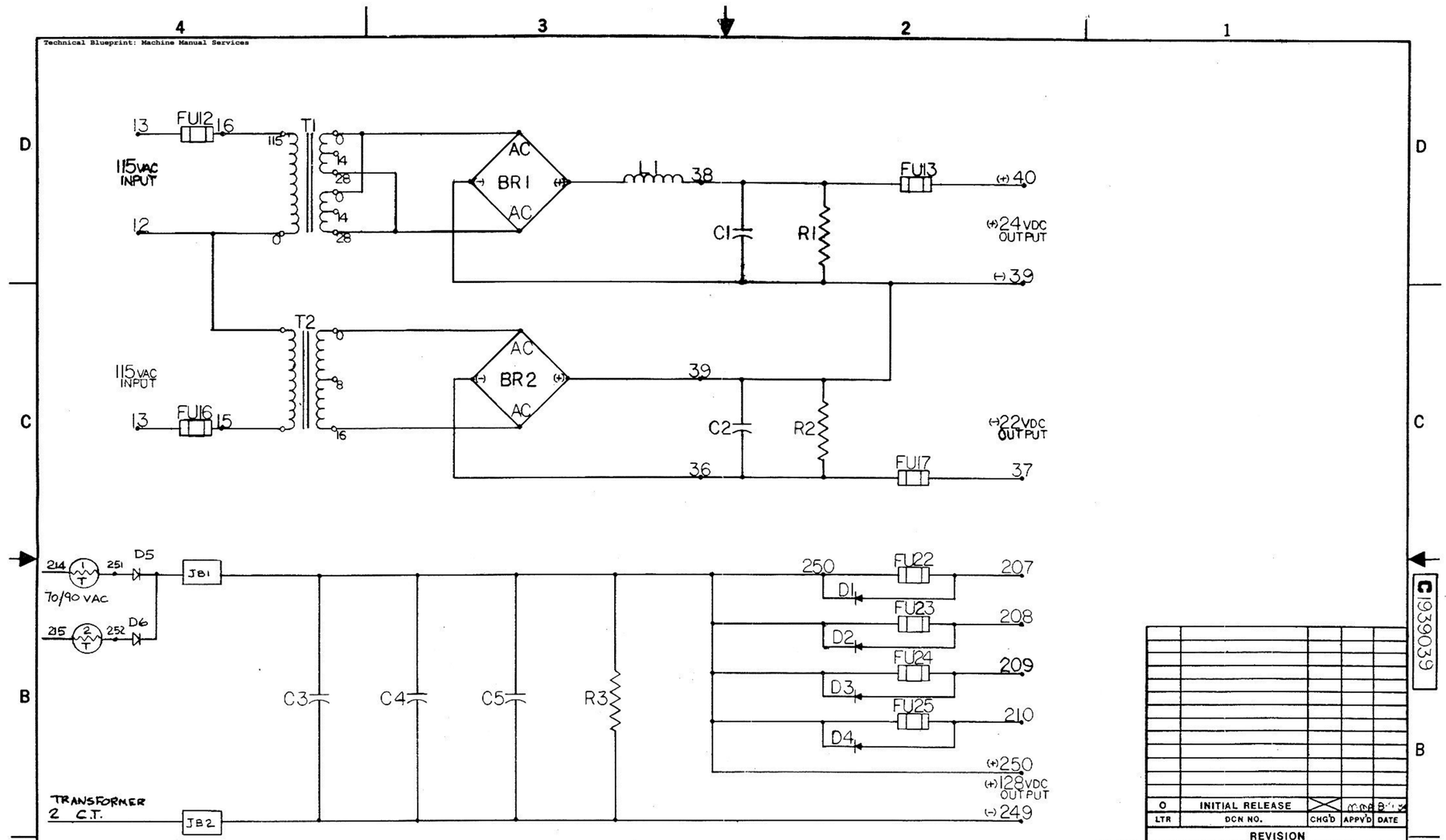
MATERIAL:
FINISH:
MARKING: PER A027099
TYPE: , CLASS: , POINT
REMOVE BURRS AND SHARP EDGES. INTERNAL CORNERS .016 MAX.

DIMENSIONING: UNLESS OTHERWISE SPECIFIED ALL DIMENSIONS ARE IN INCHES
TOLERANCES: .XX = ± .XXX = ± ANGLE .X = ±.5°
THIRD ANGLE PROJECTION

DESIGNED: | DRAWN: JEL 5-9-84 | CHECKED: B.H. 6-1-84 | APPROVED: MMA
PROJECT NO. 100154-01 | MODEL NO.

SIZE D | CODE IDENT NO. | DWG NO. 1938313 | REV. D
SCALE: | DO NOT SCALE DWG | SHEET 3 OF 4

DWG NO. | PARTS LIST | NEXT ASSEMBLY



LTR	DCN NO.	CHG'D	APPV'D	DATE
0	INITIAL RELEASE	X	MMB	8-1-84

REVISION

C1939039

REVIEWED BY MFG. BB

D1938413	A1938413
DWG NO.	PARTS LIST
NEXT ASSEMBLY	

MATERIAL :

FINISH :

MARKING: PER A027099

TYPE: , CLASS: , POINT

REMOVE BURRS AND SHARP EDGES. INTERNAL CORNERS .016 MAX.

DIMENSIONING UNLESS OTHERWISE SPECIFIED ALL DIMENSIONS ARE IN INCHES

THIRD ANGLE PROJECTION

TOLERANCES
.XX = ±
.XXX = ±
ANGLE .X = ±.5°

DESIGNED :	DATE :	
DRAWN : C.R.ENGARD	DATE : 4-19-84	
CHECKED : B.M.	DATE : 4-19-84	
APPROVED :	DATE :	
PROJECT NO. 100154-51	MODEL NO.	

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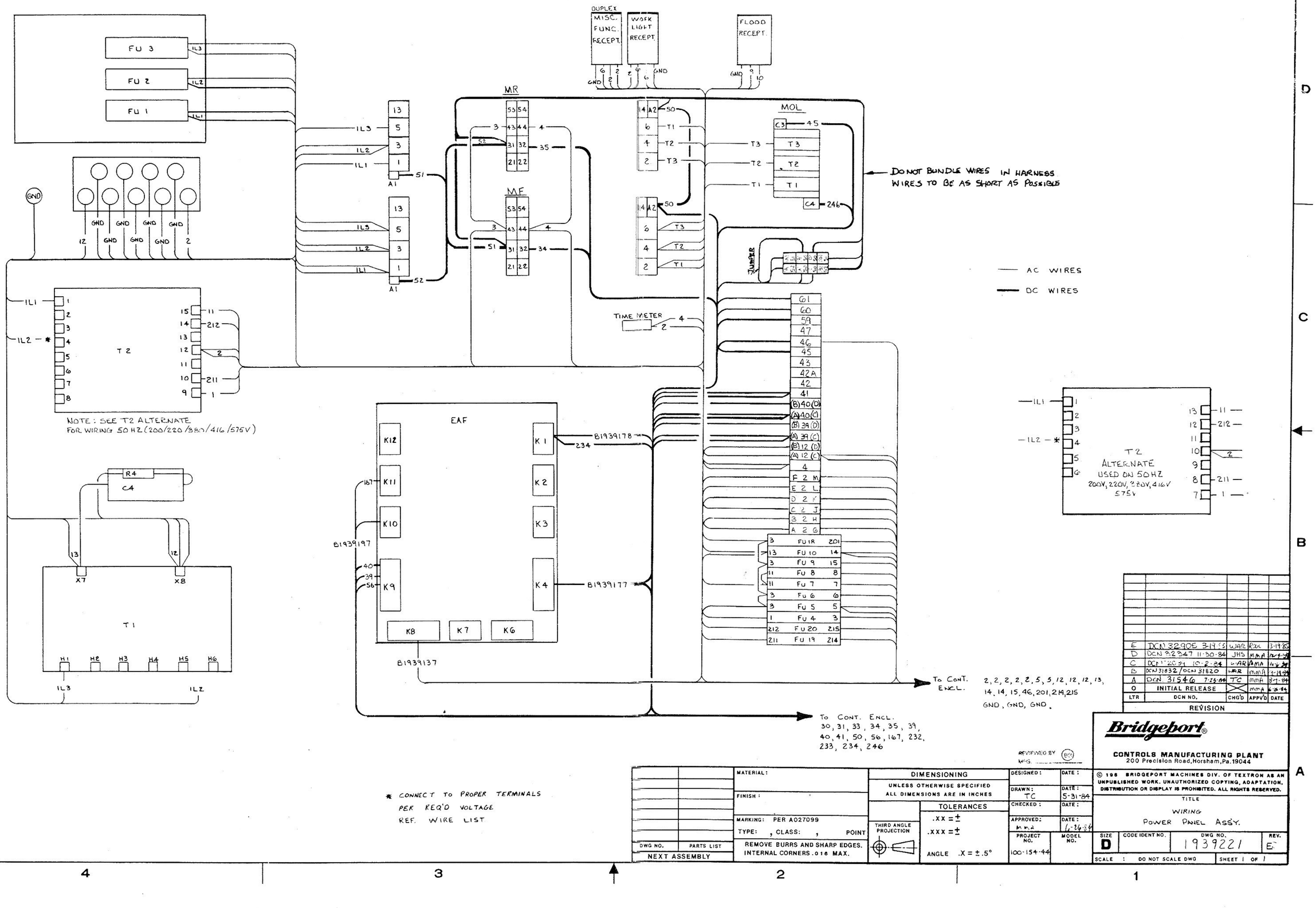
200 Precision Road, Horsham, Pa. 19044

TITLE
DRIVE PWR SUPPLY, SCHEMATIC

SIZE	CODE IDENT NO.	DWG NO.	REV.
C		1939039	0

SCALE : DO NOT SCALE DWG SHEET OF



* CONNECT TO PROPER TERMINALS PER REQ'D VOLTAGE REF. WIRE LIST

LTR	DCN NO.	CHG'D	APPV'D	DATE
E	DCN 32905 3-19-85	WAR	Rm	3-19-85
D	DCN 32347 11-30-84	JHS	MMA	12-4-84
C	DCN 32031 10-2-84	WAR	MMA	10-4-84
B	DCN 31832/DCN 31820	WAR	MMA	7-19-84
A	DCN 31546 7-13-84	TC	MMA	8-1-84
0	INITIAL RELEASE		MMA	6-28-84

REVISION

REVIEWED BY MFG.

MATERIAL:
FINISH:
MARKING: PER A027099
TYPE: , CLASS: , POINT
DWG NO. | PARTS LIST
NEXT ASSEMBLY

DIMENSIONING
UNLESS OTHERWISE SPECIFIED ALL DIMENSIONS ARE IN INCHES
TOLERANCES
.XX = ±
.XXX = ±
ANGLE .X = ± .5°
THIRD ANGLE PROJECTION

DESIGNED: DATE:
DRAWN: TC DATE: 5-31-84
CHECKED: DATE:
APPROVED: MMA DATE: 6-26-84
PROJECT NO. 100-154-44
MODEL NO.

REMOVE BURRS AND SHARP EDGES. INTERNAL CORNERS .016 MAX.

Bridgeport®
CONTROLS MANUFACTURING PLANT
200 Precision Road, Horsham, Pa. 19044

TITLE
WIRING
POWER PANEL ASSY.

SIZE D | CODE IDENT NO. | DWG NO. 1939221 | REV. E
SCALE : DO NOT SCALE DWG | SHEET 1 OF 1

CHAPTER 5

LOGIC BOARDS

5.1 INTRODUCTION

This chapter describes the logic boards in the R2E4 control system. Theories of operation and board relationships to the system are explained. Refer to Figure 5-1, System Block Diagram. Functional block diagrams and schematic drawings (located at the end of this chapter) are provided for each of the boards. Chapter 3 describes an overview of the R2E4 electrics system. Refer to the Parts Manual for part numbers.

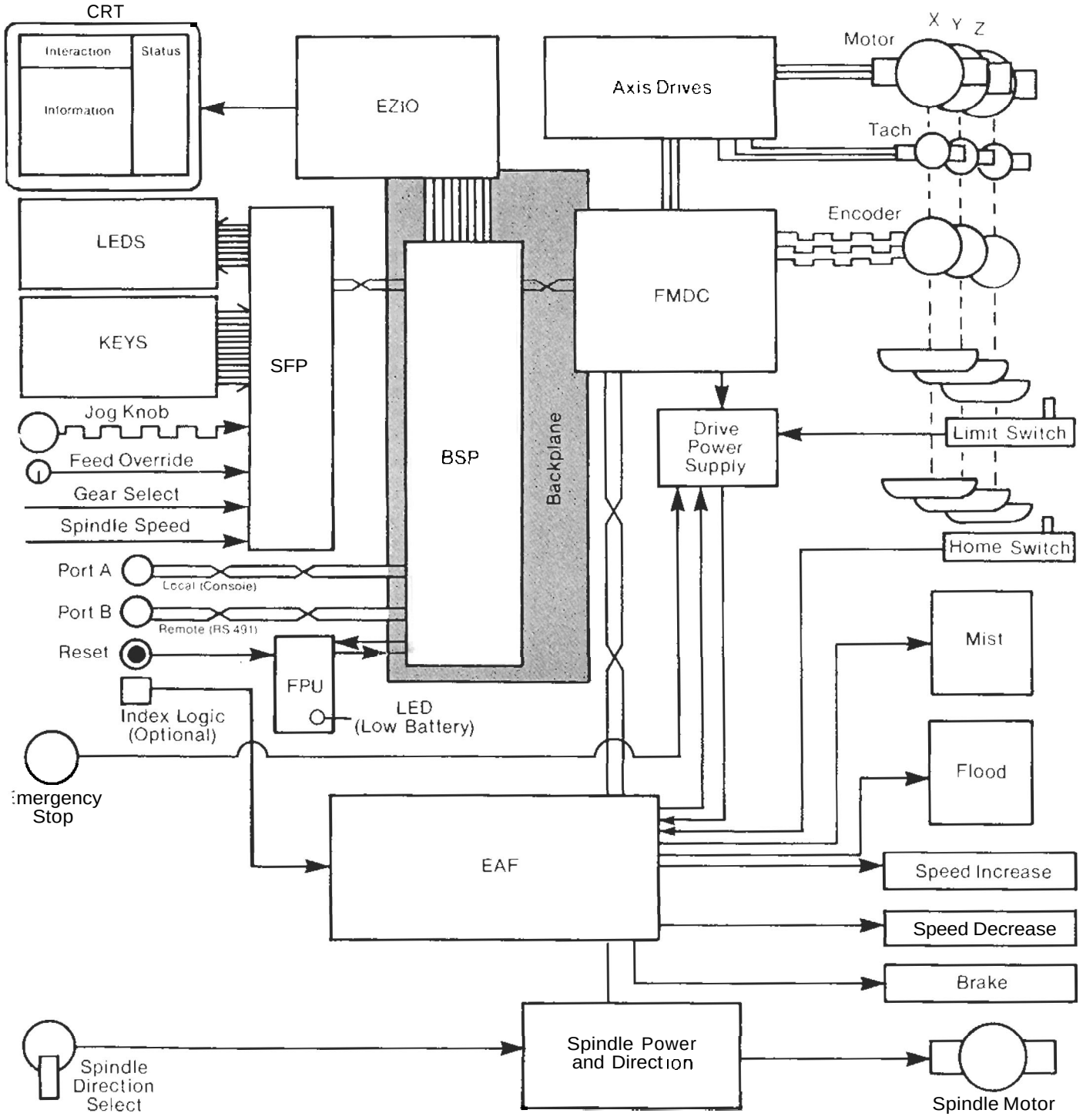


Figure 5-1. System Block Diagram

CAUTION

STATIC SENSITIVITY OF THE BOARDS

All of the logic boards in the *R2E4* syslem contain *static* sensitive elements. *Static* electricity can be generated by walking across a floor. Unless grounding precautions are taken, touching a logic board will discharge elecIricity into the board; this will cause current to flow. possibly raising *the* temperature *of* infernal junctions to their melting points. The damage can range from complete destruction of the board to hidden damage resulting in limited life and premature field failure.

For instructions on handling static sensitive devices and grounding equipment, refer to *Service* Bulletin *#82,* included as Appendix *B.*

5.2 FRONT PANEL CONTROLS — Figure **5-2**

There are four controls on the Front Panel which are not a part of Ihe Front Panel membrane. These controls are:

Feed **Override** — This potentiometer provides a signal to the SFP board by way of terminals K4-11, 12, 13. It enables changes in feedrate from 10 percent to 125 percent. Below 10 percent, the system goes into a feed hold posit ion.

Axis Motion — This encoder transducer provides a two phase signal which is sent to the SFP board via terminals K4-17, 18, 19. The AXIS MOTION handwheel allows one of the axes Io be moved manually with precision.

Spindle — This momentary action switch supplies the reversinglstarting contaclor with +24 VDC and turns on the spindle in one direction. When the contaclor is energized, it closes one of its contacts to +24 VDC.

Emergency Slop — This is a normally closed switch and supplies +24 VDC to the reversing contactor and the EAF board. When the button is pressed, it is latched in the open position and breaks the +24 VDC line. This disables the X, Y and Z axes. The EAF board also sends the emergency stop status to the BSP board. The +24 VDC line is broken to the reversingtstarting contactor, which de-energizes the contactor and turns off the spindle.

5.3 SFP CARD — **SERIAL** FRONT PANEL CARD

5.3.1 Description

The SFP card is a microcomputer-controlled board which interfaces the Operator Control panel with the BOSS (Bridgeport Operating System Software) system. It monitors the operator panel keyboard, the jog knob encoder, and the feedrate override potentiometer. The card also controls the LEDs on the Operator Control panel. When requested by the BSP card, the SFP card periodically sends the status of thesedevices to the BSP. The BSP card periodically sends information to the SFP card detailing which LEDs are to be on or off. The SFP card communicates with the BSP card through a 9600 baud, RS-422 serial link. The SFP card is a self-contained subsystem with its own power up reset logic; therefore, a system reset will not reset the SFP card. The only method for resetting the SFP card is to power down the entire system and then power up again.

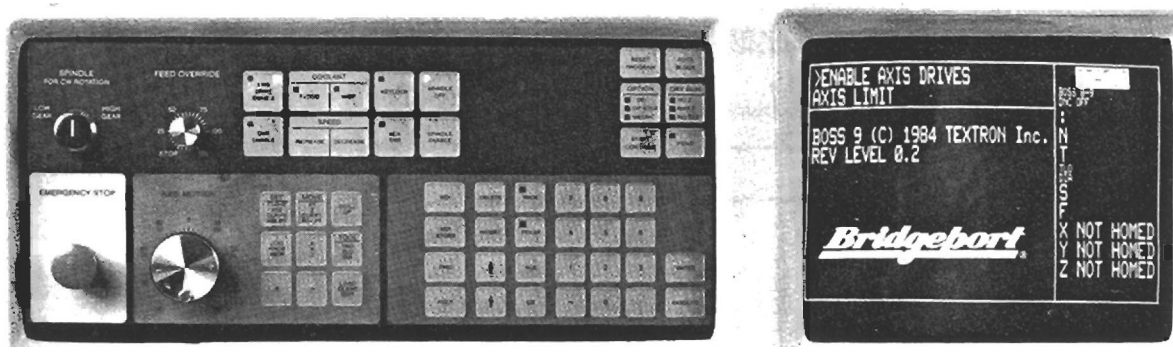


Figure **5-2.** Front Panel

5.3.2 Relationship to System

The SFP board is directly behind the Front Panel. It monitors the Front Panel Keyboard, controls the LEDs, and acts as an interface between the BSP board and the front panel.

5.3.3 Theory of Operation

The circuitry on the SFP board can be divided into three functional blocks.

Figure 5-3 is a functional block diagram of the SFP board and should be referred to when reading the following description.

Keyboard Interface — Lines XO-X4 on the keyboard encoder (IC1) continuously strobe the keyboard rows. If a key is pressed, the strobe signal is returned through the appropriate column line to the encoder. After a key is pressed and released, a delay of 30ms occurs before the strobe is resumed. This gives the BSP board time to decode the key's address. The encoder places a unique 8-bit code on the data bus for any key pressed. The BSP board obtains the key's address from the data transceiver.

5.3.4 Input and Output Signals

Signals entering and leaving the board are on three connectors (K2, K3 and K4). Connector K2 transmits the keyboard strobe signals and receives return 'strobe signals.

Connector K3 interfaces the SFP board to the BSP board. At this connector address (A01-A08), data (D08-D15) and control (/KEY, /DIS, /HIOW) signals are sent to the SFP board. These inputs are also used by the LEDs and the CRT. Control (Key Int) and data lines (D8-D15) send signals to the BSP board. These signals indicate a key has been pushed and identify the key.

Power enters the SFP board on:

K3-5	+5V
K3-8	GND
K3-9	GND
K3-10	+5V

5.4 EAF BOARD — SERIAL AUXILIARY FUNCTION CARD

5.4.1 Description

The EAF card is a microcomputer-based I/O card interfacing limit switches, home switches, relays, and coolant pumps with the control. The EAF card communicates with the BSP (through the FMDC) through serial RS-422 line. The EAF card serves to isolate the high voltage and/or noisy portions of the control from the logic section. The EAF card is periodically read by the BSP (through the FMDC) to obtain the status of the machine switches. The EAF is also commanded to activate or deactivate the various coolant pumps or solenoids, as needed. The EAF is reset by the FPU card.

5.4.2 Relationship to System

The EAF board functions as both an interface and a status board in the R2E4 system. As an interface, the EAF board transfers signals from the BSP board to the

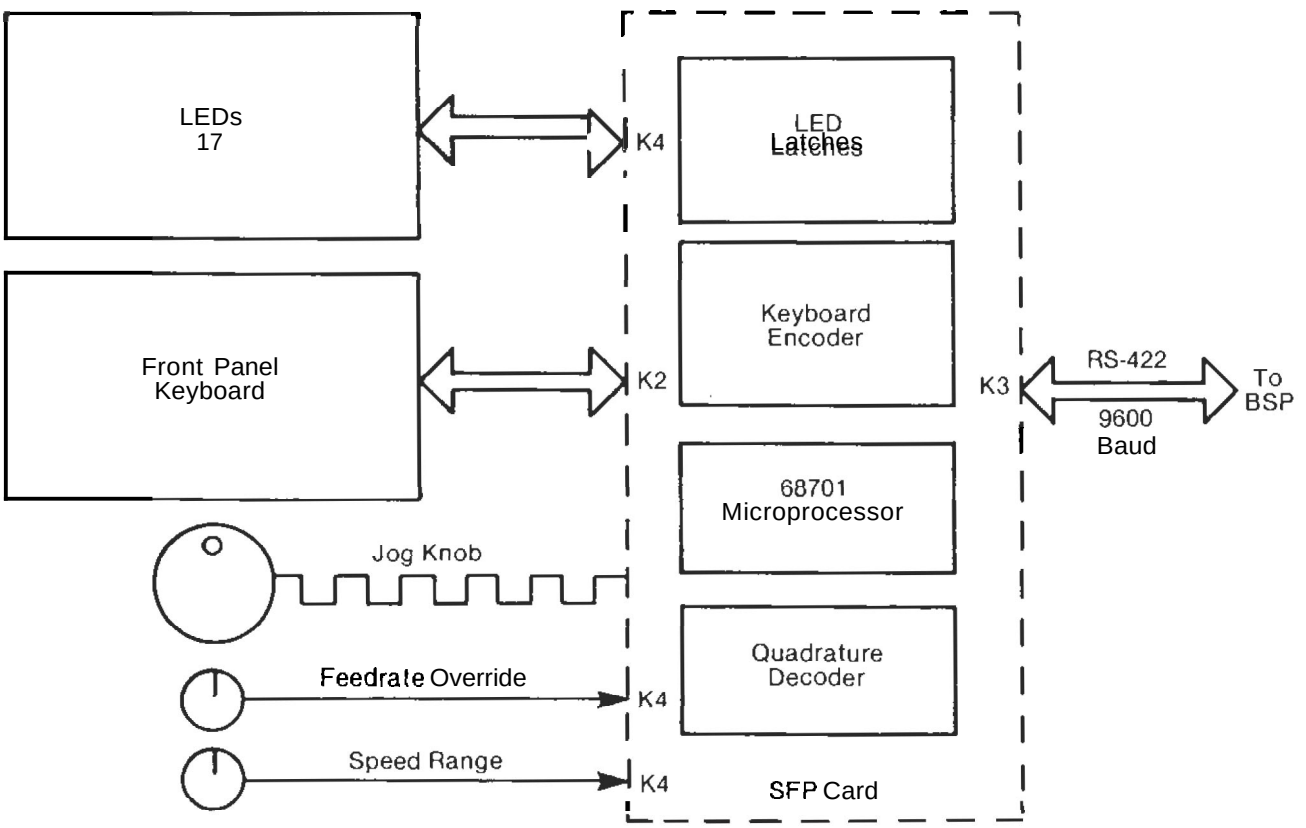


Figure 5-3. SFP Board Functional Block Inputs & Outputs

One bit activates and deactivates the status LED on the EAF board, and one bit is sent to Ihe FMDC board. TRIAC relays controlling the mist solenoid and the flood receptacle are activated by two bits.

The remaining four bits enable the spindle contactors and turn on and off the index, spindle speed increase, and spindle speed decrease solenoids. The contactors and solenoids have +24 VDC applied to one side. The other side is not grounded until the proper command bit goes low, see Figure 5-5. When one of the bits goes low, the following occurs:

1. The low bit turns on the optocoupler and pulls the output to ground.
2. Step 1 pulls the base of the transistor chip to ground.
3. The collector is disconnected from the base and ground. and the +24 VDC is applied to the base of the power transistor.
4. Step 3 pulls the collector of the power transistor to ground.

This last step either enables the startinglreversing contactor for the spindle or energizes one of the solenoids.

Monitoring — The 8748 receives machine status from an 8-bit latch. The status word is read by the 8748 and then sent to the BSP board.

Five of the bits are set by the X, Y, Z Home switches. the Index In and the Index Out swilches. Whenever one of these switches close, it turns on an optocoupler and sets one of the status bits low.

One bit is set by the fault lines from the IFC board. When a fault occurs. the bil is set low.

One bit is set by the reversinglstarting conlactors for the spindle. Whenever one of these is energized (causing the spindle to start), this bit is set low.

The last bit is set by a system crash line (ZAP). If a fault occurs and pulls this line low, the bit is set low. The result is the same as that for an emergency stop.

5.4.4 Input and Output Signals

The EAF board has nine connectors providing communication with the rest of the system. The EAF and BSP boards communicate through K6.

The EAF and FMDC boards communicate through K1 and K7. These connections are presented with the FMDC board in Section 6.6.

The tables on page 5-6 will provide the pin connections for the remaining four connectors.

5.5 BSP CARD — BRIDGEPORT PROCESSOR CARD

5.5.1 Description

The BSP card is a general purpose, high performance processor card. It contains 512K bytes of readlwrite memory, 128K bytes of EPROM memory (containing BOSS), four serial UO ports, a parallel UO port, a 9513 system timing controller and an interface to a standard logic backplane. The BSP card supports RS-422 and RS-232 interfaces for the serial I/O. The software on the BSP card contains a comprehensive power up diagnostic test package, which tests most of the logic on the BSP and EZIO cards. The BSP BOSS software interprets the G code programs, interprets Ihe operator commands received from the operator panel, and sends messages to the operator through the CRT screen (through the EZIO card). The BSP (BOSS) subsytem sends commands to Ihe FMDC card. These commands guide the machine path. The BSP card is interfaced to the EZIO card through the logic backplane.

5.5.2 Relationship to System

The BSP board is the Main Controller board in the R2E4 System. This board contains the 68000 microprocessor. user RAM, system EPROM and all of the system clock and interrupt circuitry. This board controls the operation of and communicates with every other board in the system.

The BSP board communicates with the Front Panel through the SFP board and is interfaced to the real world

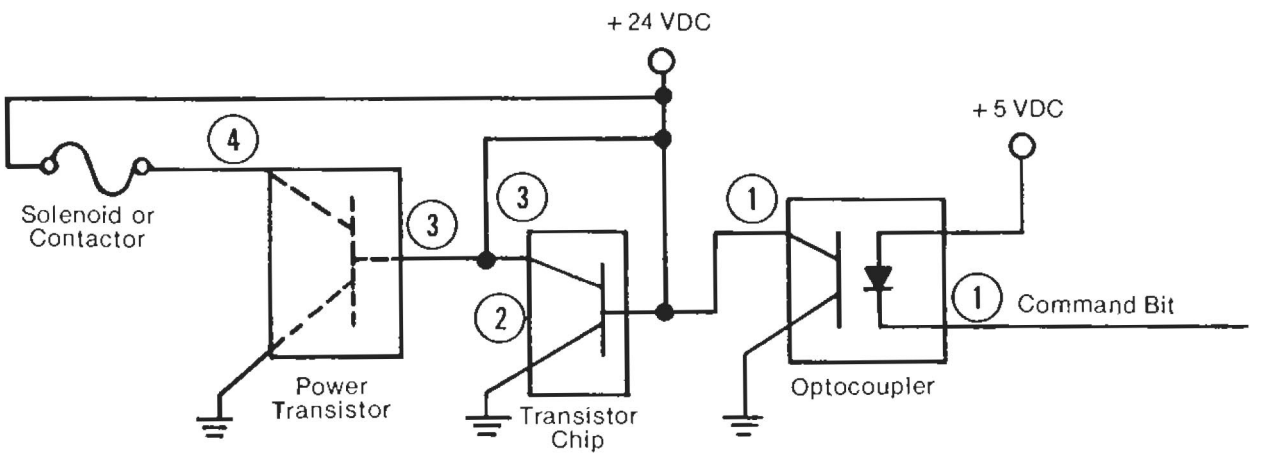


Figure 5-5. Command **Word**

Table 5-1. Input/Output Signals:
BSP — Outside World

DATA PORT B

K11-16	J1-1	RS-422 Input +
K11-15	J1-2	RS-422 Input –
K11-2	J1-3	RS-422 Output –
K11-1	J1-4	RS-422 Output +
K11-9	J1-6	RS-232 Input
K11-4	J1-7	GND
K11-6	J1-8	Output

DATA PORT A

K11-17	J2-1	Curreni Loop Output –
K11-19	J2-2	Current Loop Output +
K11-11	J2-3	Current Loop Input –
K11-20	J2-4	Current Loop Input +
K11-8	J2-6	US-232 Input
K11-14	J2-7	GND
K11-7	J2-8	RS-232 Output

RESET SWITCH

KI I-3	RETURN (GND)
K11-5	RESET TO FMDC BOARD
K11-12	RETURN (GND)
Kll-18	GND

TAPE READER

K12-19	J4-1	DO
K12-18	J4-2	D1
K12-17	J4-3	D2
K12-16	J4-4	D3
K12-6	J4-5	D4
K12-7	J4-6	D5
K12-8	J4-7	D6
K12-9	J4-8	D7
K12-13	J4-9	DATA READY
K12-10	J4-11	GND
K12-20	J4-12	GND
K12-14	J4-16	FORWARD
K12-15	J4-17	REVERSE

Table 5-2. Input/Output Signals:
EAF — Electromechanical Components

K8A-1	+ 115 VAC to Mist Solenoid
K8A-2	GND
K8A-3	Return GND from Flood Receptacle
K8A-4	Return GND from Mist Solenoid
K8B-1	+ 115 VAC to EAF Board
K8B-3	+ 115 VAC to Flood Receptacle
K8B-4	+ 115 VAC to EAF Board
K9A-1	GND
K9A-2	+24 VDC
K9A-3	Speed Decrease Solenoid
K9A-4	Speed Increase Solenoid
K9B-1	Index Air Solenoid
K9B-2	Index Out Switch
K9B-3	Index Back Switch
K9B-4	Brake Solenoid
K10A-1	Spindle Enable
K10A-2	Z Home Switch
K10A-3	X Home Switch
K10A-4	Y Home Switch
K10B-1	Spindle Forward
K10B-2	Spindle Reverse
K10B-3	ZAP
K10B-4	GND

Table 5-3. Power to the EAF Board

K4A-3	GND (24V)
K4A-4	GND (24V)
K4B-1	+ 12v
K4B-2	– 12v
K4B-3	+ 24V
K4B-4	– 24V
K4C-3	GND (LOGIC)
K4C-4	GND (LOGIC)
K4-12	+ 5V

through the EAF board. The BSP board controls the servo motors through the FMDC board.

The BSP board also receives intput from the AXIS MOTION handwheel and the FEED OVERRIDE pot on the Front Panel.

5.5.3 Theory of Operation

The electronics on the BSP board can be grouped into four modules:

1. Control
2. SFP Interface
3. EAF Interface
4. Memory

Figure 5-6 is a functional block diagram of the BPS board and should be referred to when reading the following description.

Control Module — This module contains Ihe 68000 microprocessor and the support chips used with it.

The 68000 microprocessor controls all information flow on the BSP board. Its 16 data and address lines are used to select chips, access memory, write to the UARTS and communicate with the other boards in the system.

The Control module also receives a ± AC fault signal. Whenever AC power is lost, these two signals go low; and the ACFAIL signal is set low. The 68000 sees this as a nonvectored interrupt. This gives the 68000 enough advance warning to prepare for the loss of power.

SFP Interface Module — This module allows the BSP board to communicate with the SFP board.

This moduie transfers eight address and data bits from the onboard bus to Ihe SFP board. It also receives eight bits of data from the SFP board and places it on the data bus.

Three commands are sent to the SFP board, and a front panel interrupt (FPNT) is received.

EAF Interlace Module — This module allows the BSP board to communicate with the EAF and FMDC boards. This communication can be divided into three functions: communication with the FMDC board. communication with the outside world (Ports A and B), and communication with the EAF board.

Local and Remote Ports A and B contain two UARTs. Both are used to convert parallel data from the data bus to serial data. Port A can be used lor a TTY, EZ-LINK, a CRT display, or printer; and Port B can be used for an EZ-CAM.

The lwo UARTs also receive serial data from these two ports, converl it to eight bit parallel data, and place it on the data bus.

Memory Module The memory on the BSP board can be grouped into three sections.

The first section is the EPROM. Sixleen 4K x 8 EPROM chips on the board provide 64K bytes of firmware memory. This memory is nonvolatile and is not affected by loss of power.

The second section of memory is RAM. Thirty-six RAM chips provide 1,000 feet of part program storage. This memory is volatile and is lost whenever a power loss or failure occurs.

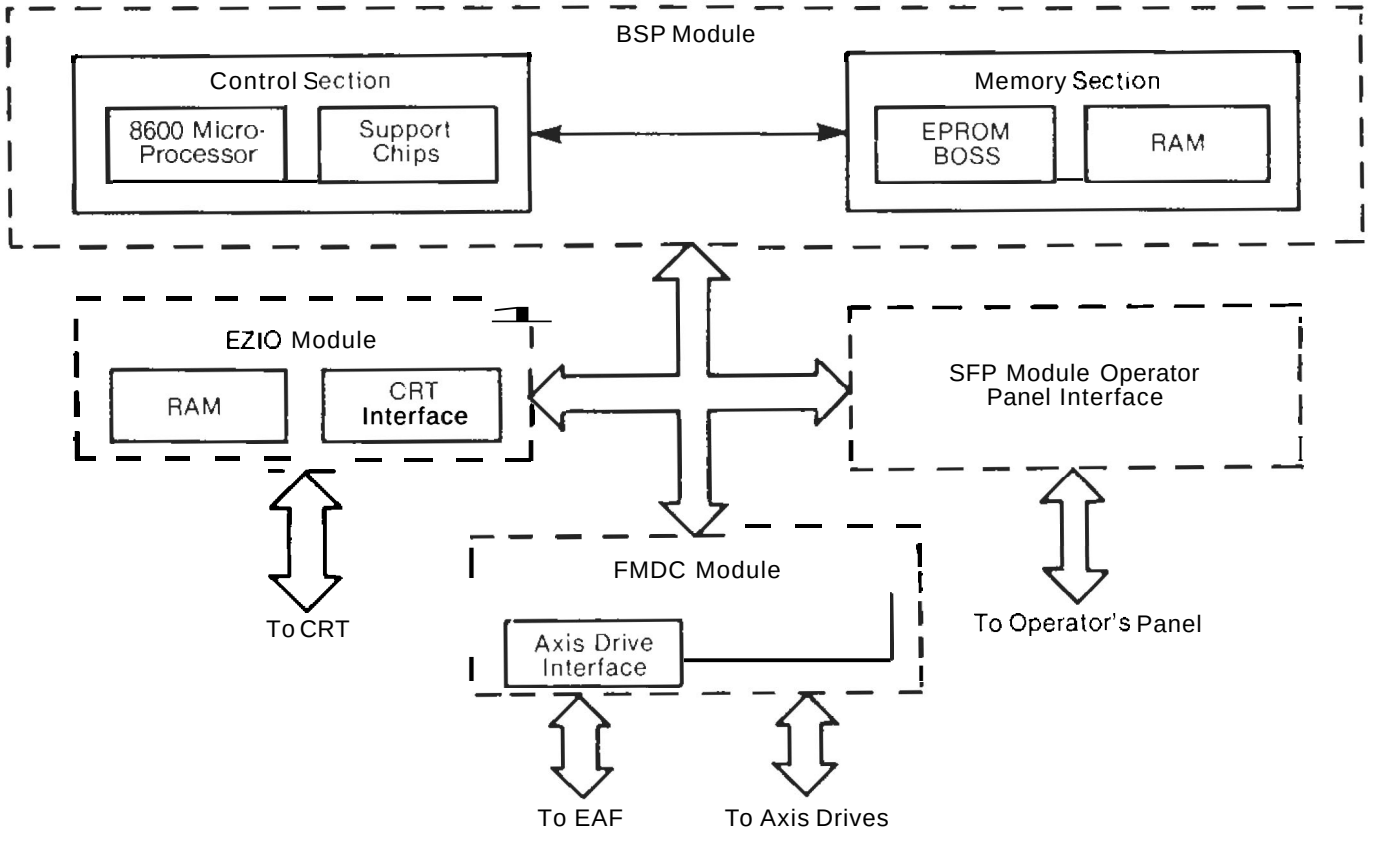


Figure 5-6. BSP Board — Functional Blocks

The last section of memory is battery-backed CMOS RAM, located on the EZIO card. This memory provides 100 feet of part program storage. The programs entered in the first 100 feet of storage are saved.

Refer to Section 5.6.4 for a complete description of the battery backup system.

5.6 EZIO CARD — THE VIDEO OUTPUT CARD

5.6.1 Description

The EZIO card (Input/Output card) is used by the BSP card to provide a high resolution video image on the CRT. It provides both alphanumeric and graphic screens. 16K bytes of battery backed up readlwrite memory are used to store the event log, the first 100 feet of part program storage/tool tables and option flags.

5.6.2 Relationship to System

The EZIO card is the interface between the BSP and the CRT. The BSP sends signals to the EZIO, and the EZIO produces these signals into alphanumeric and graphic information for display on the CRT.

5.6.3 Theory of Operation

The EZIO is situated in the backplane. It has no processor and is controlled by the BSP. The EZIO CRT section produces 60 Hz negative pulses for vertical sync; 19.4 Hz positive pulses for horizontal sync; and 18.95 MHz positive is on the pixel for the video screen (IC 43 for timing and IC 45 for character paths). The screen is continuously refreshed from dynamic RAM.

5.6.4 Battery Backup System

The EZIO board has a battery backup system, which supplies the CMOS RAM chips (IC 89 and IC 90) with a 2.9 VDC whenever the +5 VDC supply is turned off or when the card is removed from the back plane. Two diodes provide the switching from + 5 VDC (VCC) to the battery backup +2.9 VDC (VBATT).

The alkaline batteries have a rating of +2.9 VDC for .9 amp hours. The battery voltage (VBATT) is used to keep the RAM chips and SPST switches powered, and it holds the chip select lines high (disabled) when VCC is not present. The RAM chips and SPST switches draw .67 microamps typically. This low power consumption results in a battery operating life of more than a year, at which time it must be replaced. The batteries are located on the FPU card. See also Section 5.8.1.

5.7 FMDC CARD — MOTOR DRIVE CONTROLLER CARD

5.7.1 Description

The FMDC is an intelligent 68000 based controller card that monitors the drive motor tachometers and the drive motor optical encoders. This card provides analog velocity commands to the drive amplifiers. The FMDC isolates the BSP subsystem from the axis drive subsystem, and it relays commands and status from the BSP (BOSS) to the EAF board.

The FMDC has four battery-backed RAM chips to store information used in the FIST monitor.

5.7.2 Relationship to System

The FMDC card is the interface card between the BSP, the axis drive system, and the EAF card. The FMDC monitors the movement of the axis drive and acts as an interface to the EAF. This interfacing enables the BSP lo monitor the status of the machine Input/Output.

5.7.3 Theory of Operation

The FMDC circuitry uses the feedrate clock and the control module commands to create the direction and command signals for the board. The circuitry can adjust these signals when input from the FEED OVERRIDE pol on the Front Panel is received. It also adjusts these signals to maintain the feedrate during multi-axis moves.

The AXIS MOTION handwheel on the Front Panel indirectly affects this section. When the AXIS MOTION handwheel is used, an interrupt is sent to the 68000. The count pulses from the handwheel count decoder are then used to determine the command signal sent to Ihe FMDC board.

The FMDC also receives encoder feedback and uses it to ensure actual position of the axis is equal to the command signal going out to the drive.

With SIN 164 up, having metric lead screws, the FMDC card converts the metric pulse increments to inch increments. This causes the correct error signal to be generated when comparing feedback pulses with the command pulses from the BSP card. The latter always outputs inch pulses regardless of the programming dimensions. Thus the FMDC card is different for inch and metric ballscrew machines. See the Parts Manual.

5.8 FPU CARD — ADVANCED POWER UP CARD

5.8.1 Description

The FPU card monitors the 120 VAC line voltage and the 5 volt DC logic power supply. If the 120 VAC should fail, the FPU will notify the BSP card to begin the power down sequence. When the 5-volt logic supply is no longer within tolerance. the BSP, EZIO, FMDC and EAF cards are shut down. On power up, the FPU keeps these cards in a reset state until the 5-volt power is stable and within tolerance. The FPU card provides 5-volt standby for the nonvolatile memory on the EZIO and the FMDC cards. The FPU uses four standard Alkaline AA cells that should last for a year with normal use. When the batteries are weak, the LED on the FPU card will illuminate (when the control is on); and the CRT will display a message to the operator indicating the problem. The control will maintain the battery backed up memory for a while, even if a weak battery is indicated. This will allow a reasonable time to gel new batteries (approximately 30 days).

5.8.2 Relationship to System

The FPU board acts as an interface between the Logic Power supply and the rest of the system. The FPU board holds the system in a RESET state until the logic power supply has settled and the +5 VDC supply is present. This eliminates stray power supply transients and erratic CRT characters.

The FPU board also monitors the 115 VAC supply line. If the main power should fail for any reason, the FPU board will RESET the system before power is completely lost. This allows the BSP board to shut down in an orderly fashion, insuring the integrity of the data in RAM. An FPU board schematic drawing is located at the end of this chapter for reference.

5.8.3 Theory of Operation

The FPU board is a small PC board located under the logic card rack. It contains two integrated circuits and an AC to logic optocoupler. The FPU board can be explained most easily through two separate functions: power up and power down.

Power Up When the Main Disconnect switch is turned on, the system is in a RESET state. When DC voltages have risen to operating levels, the +5 VDC signal from the logic power supply enters the board on TB3-1. This voltage provides VCC for the optocoupler, setting the output low. This low signal is buffered and sent through a differential line driver to the EAF board. This low signal to the EAF board takes the system out of reset and allows all internal diagnostics and self checks to begin.

Power Down AC voltage (117 VAC) enters the FPU board on TB1-1,5. If this voltage source fails for any reason, the output of the optocoupler is set high. This high signal is buffered and sent through a line driver to the EAF board, placing the system in a RESET state.

JOG KNOB INTERFACE

K-4

R19 100 K Ω

R20 100 K Ω

IC 12 74HC14

IC 11 16 R8

C9 .01 UF

C10 .01 UF

QCLK

HOST INTERFACE

K3

BATFAIL

IN2

R18 240 Ω

IC 14 26LS33

IC 13 26LS31

R21 240 Ω

R15 1.5 K

R17 2.7 K

R16 4.3 K

C7 100 UF

4915 MHz OSC IC15

IC 10 74LS393

NCLK

HCLK

QCLK

ACLK

IC 1 68701-1

IRQ

VCC

VCC ST

VSS

TX

RX

XTAL 1

XTAL 2

RES

PC2

PC1

PC0

R14 1K Ω

R13 1K Ω

R6 1 K Ω

C11 300 UF

C8 300 UF

C12 .01 UF

C13 .01 UF

C14 .01 UF

C15 .01 UF

C2 .01 UF

C3 .01 UF

C1 .01 UF

C4 .01 UF

IC 8 25LS2539

ADOE

ADLE

ADST

LE2

LE1

KE2

KE1

E

R/W

RS

P44

P43

P42

P37 D7

P36 D6

P35 D5

P34 D4

P33 D3

P32 D2

P31 D1

P30 D0

P41 P40 P17 P16 P15 P14 P13 P12 P11 P10

TP1 TP2

4.7 K Ω SIP RZ 5

K2

R7 1K Ω

R8 1K Ω

C6 .01 UF

IC 2 ADC0808

ADDC ADDB ADDA

D7 D6 D5 D4 D3 D2 D1 D0

IC 9 MCT6

R12 1K Ω

D2

D1 R11 1K

R9 10 K

R10 10K

R41 1K Ω

R5 1K Ω

IN2

IC 3 74LS373 (KE1)

IC 4 74LS373 (KE2)

IC 5 74LS373 (LE2)

IC 6 74LS373 (LE1)

Y8 Y9

K1

LCD INTERFACE

FOVR POT

R22 1 MEG Ω

S.S. POT

Y INCR

150 Ω SIP RZ 6

150 Ω SIP RZ 2

150 Ω SIP RZ 1

150 Ω SIP RZ 4

150 Ω SIP RZ 3

R2 100 Ω

R1 10 K

R3 10K

LED 5 Y MIST

LED 8 G SPINDLE OFF

LED 12 Y MAX F

LED 10 Y NO Z

LED 3 Y FLOOD

LED 2 R AXIS OR ENABLE

LED 1 G AXIS OR ENABLE

LED 4 Y OVR ENABLE

LED 11 Y OPT OR/STOP

LED 9 Y OPT. / DEL.

LED 15 R HOLD

LED 14 Y NO XYZ

LED 17 Y POLAR

LED 13 Y OPT. / METRIC

LED 7 Y ACK ERROR

LED 6 Y KEYLOCK

LED COLORS:
Y - YELLOW
G - GREEN
R - RED

IC 12 SPARES

K4

NOTE:
THE KEYBOARD MATRIX IS NOT ON THE PC CARD. IT IS SHOWN FOR CLARITY.

LTR	DCN NO.	DWN
D	DCN 32875 3-18-85	TC
C	DCN 31623 8-13-84	TC
B	DCN 30763 3-30-84	CMH
A	INITIAL RELEASE	CMH

REVISION

REVIEWED BY TEST ENG.

Bridgeport®
CONTROLS MANUFACTURING PLANT
200 Precision Road, Horsham, Pa. 19044

TITLE: SFP BOARD SCHEMATIC

SIZE	CODE IDENT NO.	DWG NO.	REV.
D		1938371	D

SCALE — DO NOT SCALE DWG — SHEET 1 OF 1

D1938374	
D1938373	A1938373
DWG NO.	PARTS LIST

NEXT ASSEMBLY

MATERIAL:

FINISH:

MARKING: PER A027099

TYPE: , CLASS: , POINT

REMOVE BURRS AND SHARP EDGES. INTERNAL CORNERS .016 MAX.

DIMENSIONING UNLESS OTHERWISE SPECIFIED ALL DIMENSIONS ARE IN INCHES

TOLERANCES .XX = ± .XXX = ± ANGLE .X = ± .5°

THIRD ANGLE PROJECTION

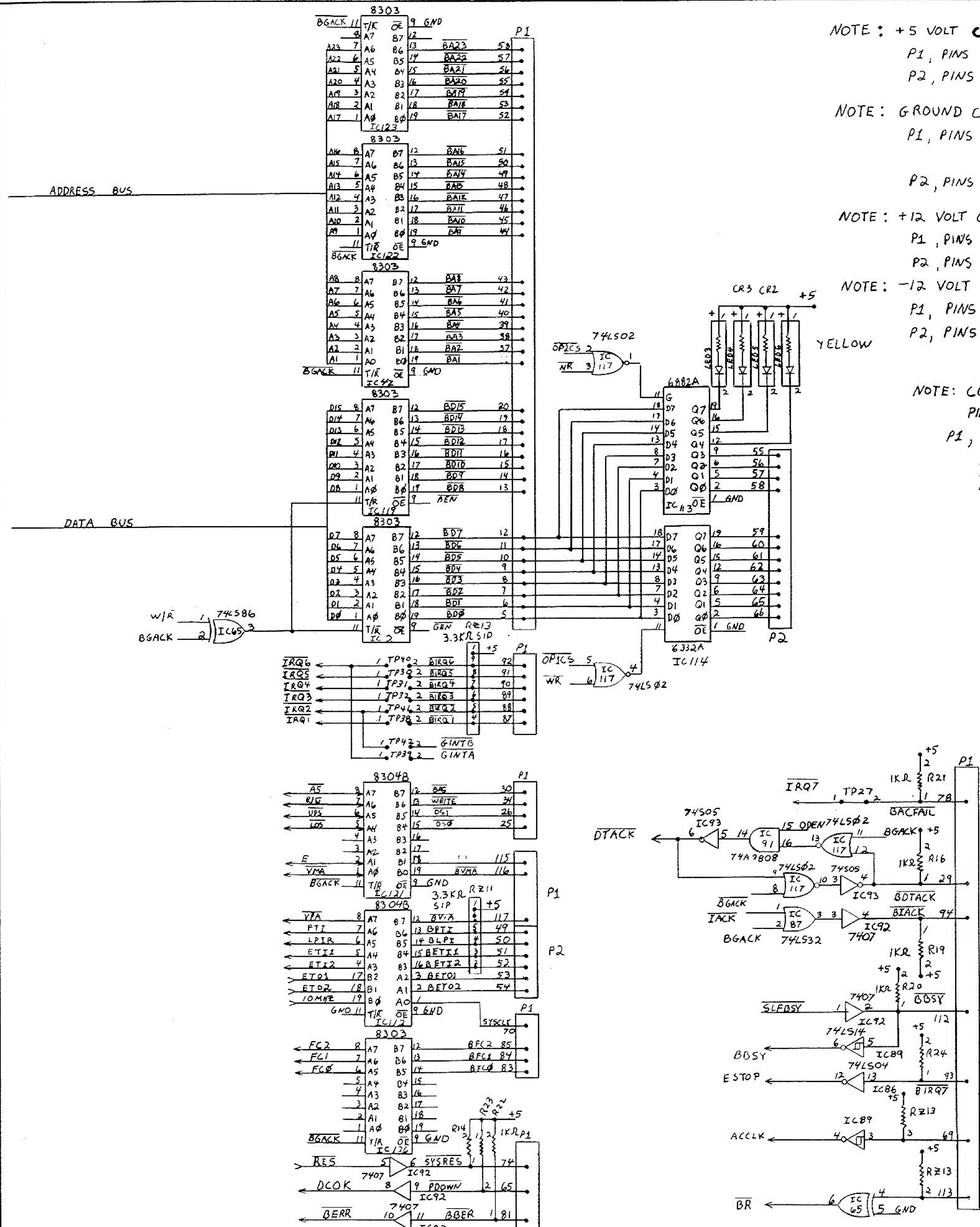
DESIGNED: B KRIS	DATE: 9-27-83	
DRAWN: T.C.	DATE: 12-6-83	
CHECKED: PAR	DATE: 12-9-83	
APPROVED: B King	DATE:	
PROJECT NO. 100-154 40	MODEL NO. R2E3+	


D1934627
Bridgeport
CONTROLS MANUFACTURING PLANT
200 Precision Road, Horsham, Pa. 19044
SCHEMATIC
EAF BOARD
DWG NO. 1934627
REV. N
SIZE D
SHEET 1 OF 1
DO NOT SCALE DWG
CONTACTER CIRCUIT (NOT ON EAF)
POWER SUPPLY FILTERS
HEAT SINK
SPINDLE ENABLE
SPINDLE SPEED INCREASE
SPINDLE SPEED DECREASE
INDEX AIR
RS422 SERIAL DATA
REMOVE BURRS AND SHARP EDGES.
NEXT ASSEMBLY
INITIAL RELEASE
REVISION


D1936738
68000
IC45 DIP PACKAGE
ADDRESS BUS
DATA BUS
2764 *
2661-2
74LS299
74LS148
74LS138
74LS137
74LS156
74LS74
IC67
* Note: THESE SOCKETS ARE WIRED TO ACCEPT 27128, 27256 EPROMS
Note: All IC's HAVE +5 AND GROUND CONNECTED TO STANDARD CORNER PINS UNLESS OTHERWISE MARKED
LED 1: L (RED) PROCESSOR HALT
(GREEN) POWER ON
REVISION
D DCN 33237
C DCN 31846
B DCN 31541
0 INITIAL RELEASE
LTR DCN NO. CHG'D. APPV'D. DATE
Bridgeport
CONTROLS MANUFACTURING PLANT
200 Precision Road, Horsham, Pa. 19044
TITLE
SCHEMATIC BSP-2
SIZE D
DWG NO. 1936738
REV. D
DO NOT SCALE DWG
SHEET 1 OF 4
MATERIAL:
FINISH:
MARKING: PER A027099
TYPE: , CLASS: , POINT
REMOVE BURRS AND SHARP EDGES. INTERNAL CORNERS .4mm (.016) MAX.
DIMENSIONING
UNLESS OTHERWISE SPECIFIED ALL DIMENSIONS ARE IN MILLIMETERS
MM (INCH)
THIRD ANGLE PROJECTION
TOLERANCES
ANGLE .X = ± .5°
DESIGNED: DRAWN: CHECKED: APPROVED:
PROJECT NO. MODEL NO.
DWG NO. PARTS LIST
NEXT ASSEMBLY

D1936738

D1936738



NOTE: +5 VOLT CONNECTS TO:
P1, PINS 1,2,129-132
P2, PINS 7-10

NOTE: GROUND CONNECTS TO:
P1, PINS 3,4,23,24,27,28,31,32,61,62
67,68,71,72,119,120,123,124,135-140
P2, PINS 1-6,13,14,97,98,101,102

NOTE: +12 VOLT CONNECTS TO:
P1, PINS 125-128
P2, PINS 11,12

NOTE: -12 VOLT CONNECTS TO:
P1, PINS 121,122
P2, PINS 15,16

NOTE: CONNECT THE FOLLOWING PINS TOGETHER:
P1, 97 to 98
99 to 100
101 to 102
103 to 104
105 to 106

NOTE: .1uF Caps ARE USED TO BYPASS THE MSM3764's and the 2764's
: .01uF Caps ARE USED TO BYPASS ALL OTHER IC's

NOTE: THE +12 and -12 VOLTAGES ARE BYPASSED BY C134, C136 (22uF)
: THE +5 IS BYPASSED BY C133, C137 (300 UF)

BSP-2 JUMPER BLOCK LIST

TEST POINT	SERIES I CRT R2E4 100-154 37	SERIES I CRT R2E4+4A 104008	TEST POINT	SERIES I CRT R2E4 100-154-37	SERIES I CRT R2E4+4A 104008
1	—	—	23	—	INSTALLED
2	INSTALLED	INSTALLED	24	INSTALLED	INSTALLED
3	—	—	25	INSTALLED	INSTALLED
4	INSTALLED	INSTALLED	26	INSTALLED	INSTALLED
5	INSTALLED	—	27	INSTALLED	INSTALLED
6	—	—	28	INSTALLED	—
7	INSTALLED	—	29	—	INSTALLED
8	INSTALLED	—	30	INSTALLED	INSTALLED
9	INSTALLED	—	31	INSTALLED	INSTALLED
10	INSTALLED	INSTALLED	32	INSTALLED	INSTALLED
11	INSTALLED	INSTALLED	33	—	—
12	INSTALLED	INSTALLED	34	—	—
13	INSTALLED	INSTALLED	35	—	—
14	—	—	36	INSTALLED	INSTALLED
15	—	—	37	—	—
16	INSTALLED	—	38	INSTALLED	INSTALLED
17	INSTALLED	—	39	INSTALLED	INSTALLED
18	—	—	40	—	—
19	INSTALLED	INSTALLED	41	—	—
20	INSTALLED	INSTALLED	42	INSTALLED	INSTALLED
21	INSTALLED	INSTALLED	43	INSTALLED	INSTALLED
22	—	—	44	—	—

BSP 2 WIRE WRAP LIST

SERIES I CRT R2E4 100-154-37		SERIES I CRT R2E4+4A 104008	
FROM	TO	FROM	TO
TP37-1	TP37-2	TP37-1	TP37-2
TP37 1	TP33-1	TP37-1	TP33-1
		TP16-1	TP16-2
		TP16-2	TP17-1
		TP22-2	TP28-2
		TP5-2	TP14-1
		TP7-2	TP8-1

LTR	DCN NO.	CHG'D	APPV'D	DATE
D	DCN 33237 6-14-85	WAR	RWL	6 14 85
C	SEE SHEET 1 OF 4	TC	RWL	3 18 85
B	SEE SHEET 1 OF 4	[illegible]	mma	8 8-84
A	[illegible]	[illegible]	DK	[illegible]
O	INITIAL RELEASE	X	[illegible]	2 11 82

REVISION

Bridgeport®

CONTROLS MANUFACTURING PLANT
200 Precision Road, Horsham, Pa. 19044

TITLE: SCHEMATIC BSP-2

MATERIAL:
FINISH:
MARKING: PER A027099
TYPE: , CLASS: , POINT
REMOVE BURRS AND SHARP EDGES. INTERNAL CORNERS 4mm (.016) MAX.

DIMENSIONING: UNLESS OTHERWISE SPECIFIED ALL DIMENSIONS ARE IN MILLIMETERS
MM (INCH)
THIRD ANGLE PROJECTION
TOLERANCES: MM .X = ± ( ) ANGLE .X = ± .5°

DESIGNED: [illegible] DATE: 1/19/82
DRAWN: [illegible] DATE: 2/3/82
CHECKED: DATE:
APPROVED: DATE:
PROJECT NO. MODEL NO.

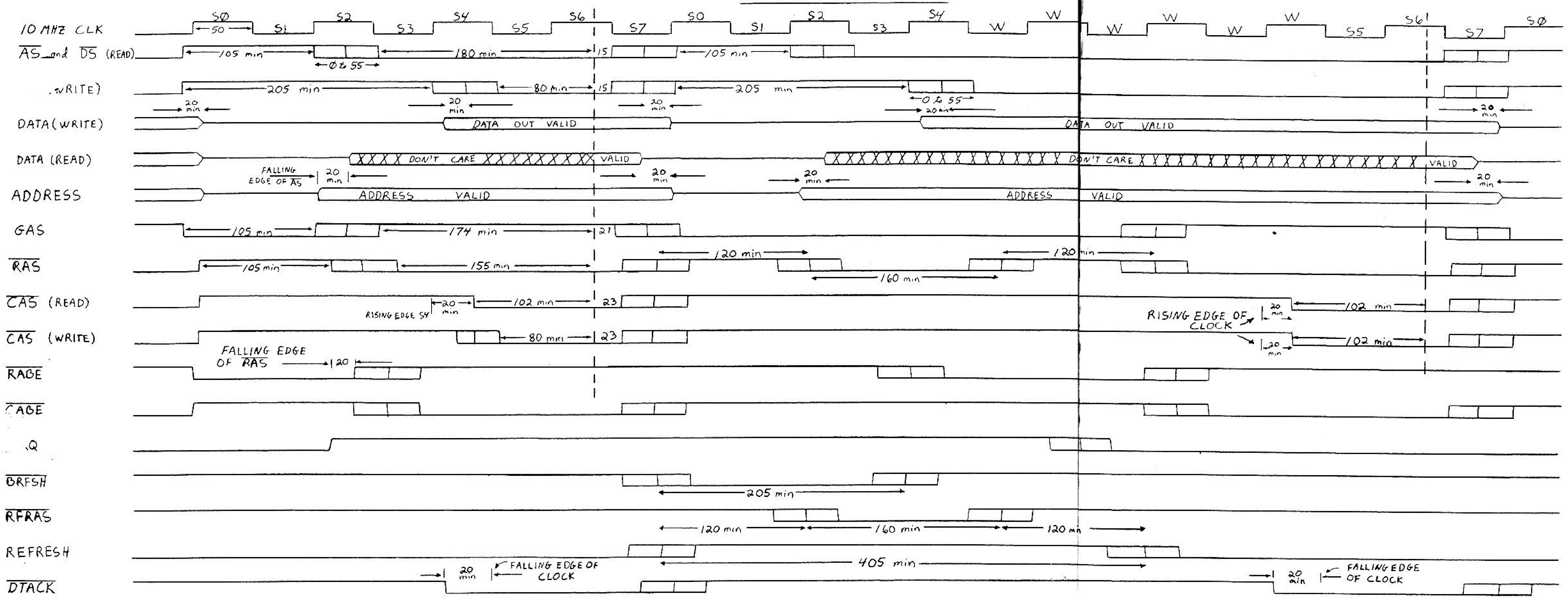
DWG NO. PARTS LIST
NEXT ASSEMBLY

SIZE D | CODE IDENT NO. | DWG NO. 1936738 | REV. D
SCALE: DO NOT SCALE DWG | SHEET 3 OF 4

D1936738

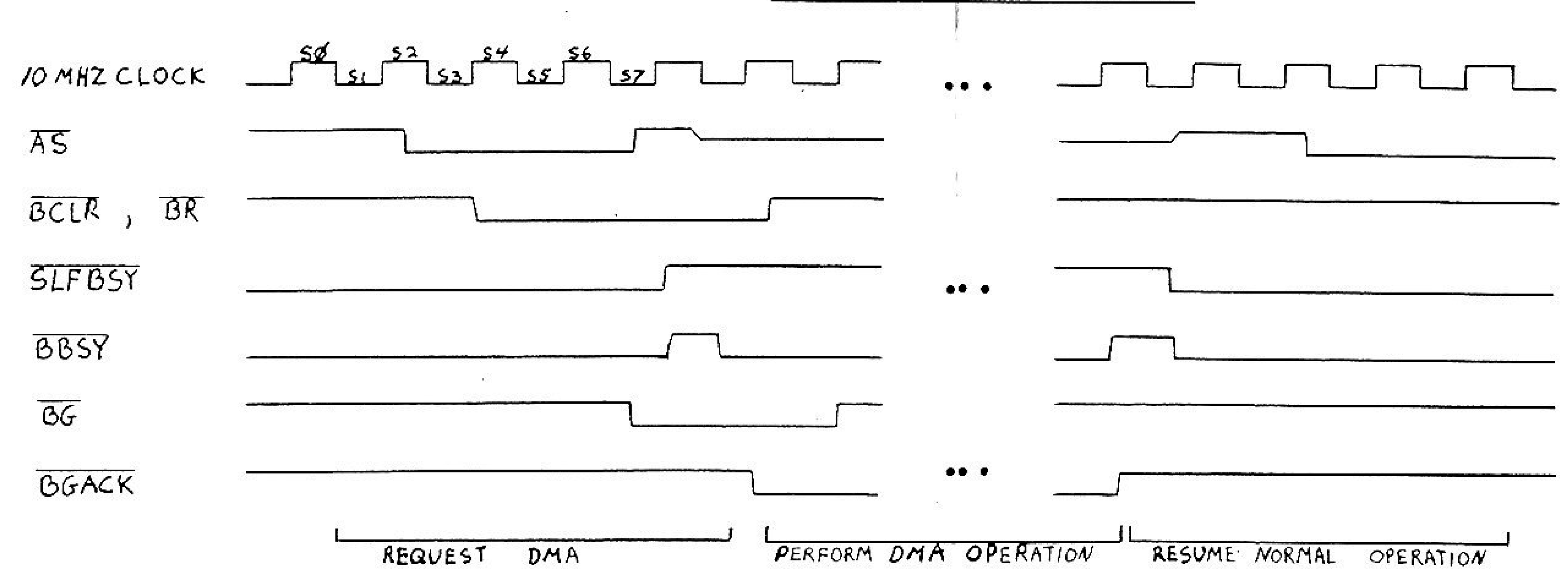
NOTE: ALL TIMES ARE SPECIFIED IN NANOSECONDS

DYNAMIC RAM TIMING



BSP HEXIDECIMAL ADDRESS MAP		
EPROM —	ØØØØØØ to ØØØØØ7	
RAM —	ØØØØØ8 to Ø3FFFF	with 64K RAMS
EPROM —	FØØØØØ to F1FFFF	with 2764's
SIO#1 — DATA REG. STATUS REG. MODE REG. COMMAND REG.	F8ØØØØ F8ØØØ2 F8ØØØ4 F8ØØØ6	# # # #
SIO#2 — DATA REG. STATUS REG. MODE REG. COMMAND REG	F8ØØØ8 F8ØØØA F8ØØØC F8ØØØE	# # # #
SIO#3 — DATA REG. STATUS REG. MODE REG. COMMAND REG.	F8ØØ1Ø F8ØØ12 F8ØØ14 F8ØØ16	# # # #
SIO#4 — DATA REG. STATUS REG MODE REG COMMAND REG.	F8ØØ18 F8ØØ1A F8ØØ1C F8ØØ1E	# # # #
CLEAR PARITY ERROR F.F.s	F8Ø1ØØ	*
9519A #1 — DATA PORT COMMAND PORT	F8Ø14Ø F8Ø142	* *
9519A #2 — DATA PORT COMMAND PORT	F8Ø18Ø F8Ø182	* *
9513 — DATA PORT COMMAND PORT	F8Ø1CØ F8Ø1C2	* *
OUTPUT REGISTER	F8ØØ2Ø	#
OUTPUT REGISTER (LED's)	F8ØØ28	#
INPUT REGISTER	F8ØØ3Ø	#
DIP SWITCH INPUT PORT	F8ØØ38	#

DMA BUS REQUEST TIMING



TIMES

BR LOW to BG LOW — 150 to 350 nsec

BR HIGH to BG HIGH — 150 to 300 nsec

BGACK LOW to BG HIGH — 150 to 300 nsec

* NOTE: ADDRESS BITS A5-A2 ARE DON'T CARES

\# NOTE: ADDRESS BITS A7-A6 ARE DON'T CARES

NOTE: WHEN USING BYTE OPERATIONS TO ACCESS THE I/O DEVICES, ADD ONE TO THE ADDRESSES TO CREATE THE PROPER BYTE ADDRESS. REMEMBER THAT ALL DEVICES ARE CONNECTED TO THE LOW BYTE OF THE DATA BUS.

LTR	DCN NO.	CHG'D	APPV'D	DATE
D	SEE SHT 1,2,3	WAR		
C				
B				
A				
O	INITIAL RELEASE			

REVISION

Bridgeport

CONTROLS MANUFACTURING PLANT
200 Precision Road, Horsham, Pa. 19044

TITLE: SCHEMATIC BSP-2

A1936740 PARTS LIST — NEX ASSEMBLY

MATERIAL: — FINISH: — MARKING: PER A027099 — TYPE: , CLASS: , POINT

REMOVE BURRS AND SHARP EDGES. INTERNAL CORNERS (.016) MAX.

DIMENSIONING: UNLESS OTHERWISE SPECIFIED ALL DIMENSIONS ARE IN MILLIMETERS — MM (INCH) — THIRD ANGLE PROJECTION — TOLERANCES: MM .X = ± ; ANGLE .X = ± .5°

DESIGNED: B. Luo DATE: 2/12/82 — DRAWN: B. Luo DATE: 2/12/82 — CHECKED: — APPROVED:

SIZE D — DWG NO. 1936738 — REV. D

SCALE — DO NOT SCALE DWG — SHEET 4 OF 4


D 1937305
4
3
2
1
D
C
B
A
PROCESSOR ADDRESS BUS
SPARES
ALL CHIPS HAVE STANDARD VCC + GND UNLESS NOTED
REVISION
LTR
DCN NO.
CHG'D
APPV'D
DATE
INITIAL RELEASE
Bridgeport
CONTROLS MANUFACTURING PLANT
200 Precision Road, Horsham, Pa. 19044
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TITLE
E ZIO BOARD SCHEMATIC
SIZE
D
CODE IDENT NO.
DWG NO.
1937305
REV.
F
SCALE
DO NOT SCALE DWG
SHEET 1 OF 3
MATERIAL:
FINISH:
MARKING: PER A027099
TYPE: , CLASS: , POINT
REMOVE BURRS AND SHARP EDGES. INTERNAL CORNERS .016 MAX.
DIMENSIONING
UNLESS OTHERWISE SPECIFIED ALL DIMENSIONS ARE IN INCHES
TOLERANCES
.XX = ±
.XXX = ±
ANGLE .X = ± .5°
THIRD ANGLE PROJECTION
DESIGNED: S.F.
DRAWN: S.F.
CHECKED:
APPROVED: SGF
DATE: 8-1-83
PROJECT NO. ICC-154-31
MODEL NO.
D1937306
A1937308
D1937307
A1937307
DWG NO.
PARTS LIST
NEXT ASSEMBLY

NOTE : MEMORY ARRAY - EACH CHIP IN ROW WIRED IDENTICALLY TO FIRST EXCEPT D1,DO

ONLY DIFF BETWEEN ROWS IS /UWE OR /LWE

VCC & GND SAME, ALL 16 CHIPS

RAM CONTROL BUS

PROCESSOR DATA BUS

REVISION				
LTR	DCN NO.	CHG'D	APPV'D	DATE
F	DCN 32501	8-85	WAR	9/14/85
E	DCN 31618 (SEE SHT 3)	TC	MMA	3-1-84
D	DCN 31346	6-12-84	MMA	6-12-84
C	DCN 31233	CRE	MMA	4-15-84
B	DCN 30841	2-16-84	TC	3-1-84
A	DCN 30237	KL	JP	8-21-83
0	INITIAL RELEASE		SGF	8-1-83

Bridgeport®

CONTROLS MANUFACTURING PLANT
200 Precision Road, Horsham, Pa. 19044

MATERIAL :	
FINISH :	
MARKING: PER A027099	
TYPE: , CLASS: ,	POINT
DWG NO. / PARTS LIST	
NEXT ASSEMBLY	

DIMENSIONING
UNLESS OTHERWISE SPECIFIED
ALL DIMENSIONS ARE IN INCHES

TOLERANCES
.XX = ±
.XXX = ±
ANGLE .X = ±.5°

THIRD ANGLE PROJECTION

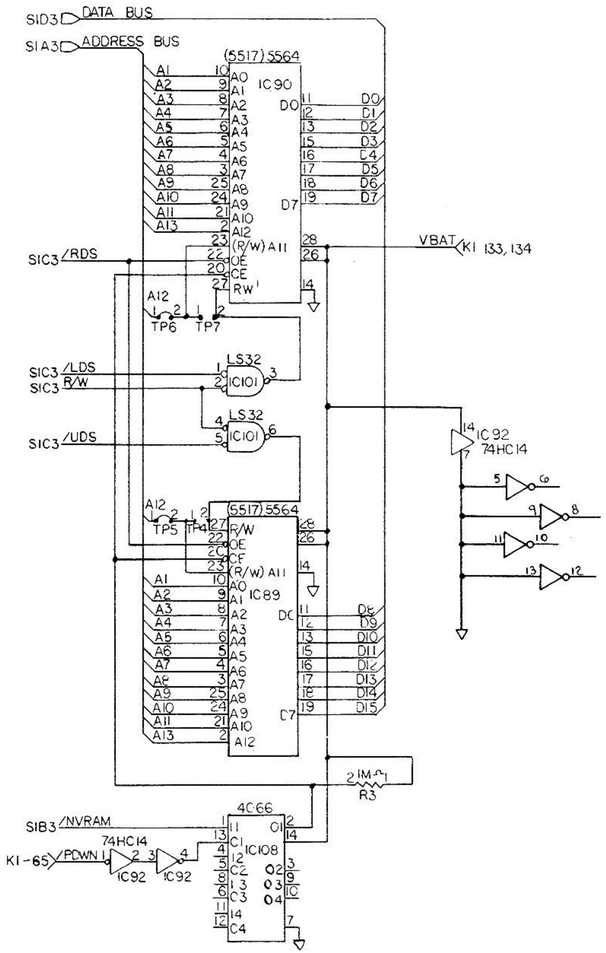
REMOVE BURRS AND SHARP EDGES.
INTERNAL CORNERS .016 MAX.

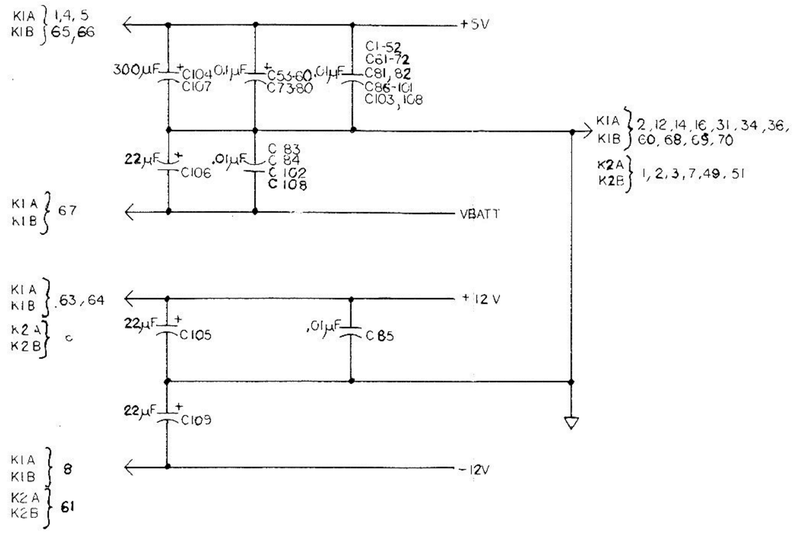
DESIGNED: SF	DATE: 4-6-83	
DRAWN: SF	DATE: 4-23-83	
CHECKED:	DATE:	
APPROVED: SGF	DATE: 8-1-83	
PROJECT NO. 100-154 31	MODEL NO.	

TITLE
EZIO BOARD SCHEMATIC

SIZE	CODE IDENT NO.	DWG NO.	REV.
D		1937305	F

SCALE : DO NOT SCALE DWG — SHEET 2 OF 3





BACKPLANE VOLTAGE CONNECTIONS

GND	K1 -	3,4,23,24,27,28,31,32,61,62, 67,68,71,72,119,120,123,124, 135-140
	K2 -	1-6,13,14,97,98,101,102
+5	K1 -	1,2,129-132
	K2 -	7-10
+12	K1 -	125-128
	K2 -	11,12
-12	K1 -	121,122
	K2 -	15,16

LTR	DCN NO.	CHG'D	APPV'D	DATE
F	DCN 32501 (SEE SHT 1#2)	WAR	[illegible]	[illegible]
E	DCN 31618 8-8-84	TC	[illegible]	9-11-84
D	DCN 31346	[illegible]	[illegible]	6-13-84
C	DCN 31233	CME	[illegible]	5-15-84
B	DCN 30841 2-16-84	TC		[illegible]
0	INITIAL RELEASE	X	SGF	8-19-83

REVISION

Bridgeport®

CONTROLS MANUFACTURING PLANT
200 Precision Road, Horsham, Pa. 19044

TITLE: EZIO BOARD SCHEMATIC

MATERIAL:	
FINISH:	
MARKING: PER A027099	
TYPE: , CLASS: , POINT	
REMOVE BURRS AND SHARP EDGES. INTERNAL CORNERS .016 MAX.	
DWG NO. / PARTS LIST	
NEXT ASSEMBLY	

DIMENSIONING: UNLESS OTHERWISE SPECIFIED ALL DIMENSIONS ARE IN INCHES

TOLERANCES: .XX = ± .XXX = ± ANGLE .X = ± .5°

THIRD ANGLE PROJECTION

DESIGNED: SF	DATE: 4-20-83	
DRAWN: SF	DATE: 4-24-83	
CHECKED:	DATE:	
APPROVED: EGF	DATE: 8-1-83	
PROJECT NO. 100-154-31	MODEL NO.	

SIZE	CODE IDENT NO.	DWG NO.	REV.
D		1937305	F

SCALE : DO NOT SCALE DWG — SHEET 3 OF 3


NOTE: UNLESS OTHERWISE MARKED, THE VCC AND GND CONNECTIONS ARE MADE TO THE CORNER PINS
DATA BUS
ENABLE
CRIOFF
DRVFF
/DRVEN1
/DRVEN2
/RES
/DISABL
Bridgeport
CONTROLS MANUFACTURING PLANT
200 Precision Road, Horsham, Pa. 19044
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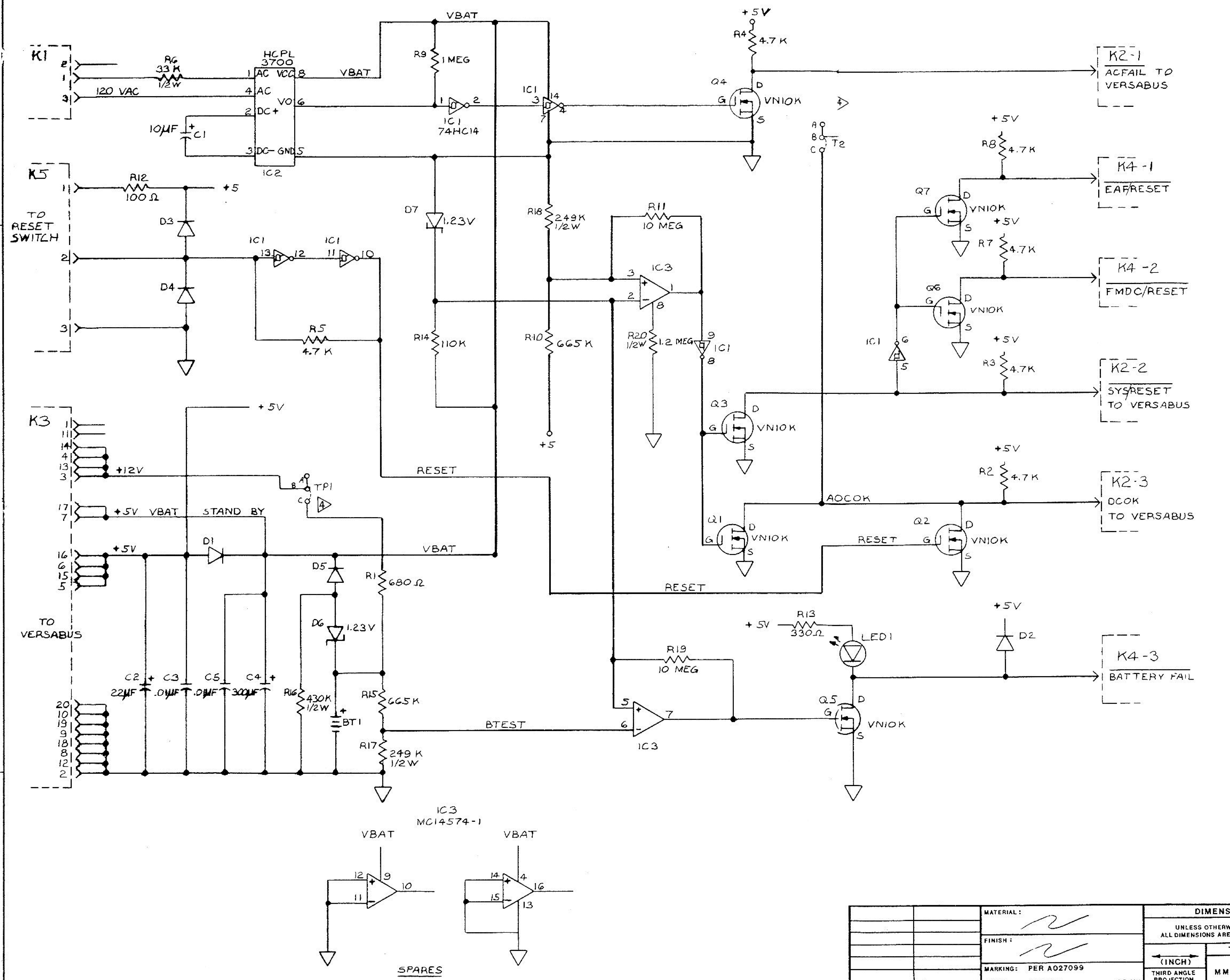
TITLE
FMDC BOARD METRIC SCHEMATIC
SIZE D
DWG NO. 1939538
REV. 0
SCALE
DO NOT SCALE DWG
SHEET 1 OF 2
INITIAL RELEASE
REVISION
MATERIAL:
FINISH:
MARKING: PER A027099
TYPE: , CLASS , POINT
REMOVE BURRS AND SHARP EDGES. INTERNAL CORNERS .4mm (.016) MAX.
DIMENSIONING
UNLESS OTHERWISE SPECIFIED ALL DIMENSIONS ARE IN
MM (INCH)
TOLERANCES
THIRD ANGLE PROJECTION
ANGLE .X = ± .5°
DWG NO.
PARTS LIST
NEXT ASSEMBLY
DESIGNED:
DRAWN:
CHECKED:
APPROVED:
DATE:
4/4/83
PROJECT NO.
MODEL NO.


D1939538
K14
XTAC
YTAC
ZTAC
ATAC
XCUR
YCUR
Z CUR
ACUR
OPTO2
OPTO3
OPTO4
OPTO5
OPTO6
OPTO1
DRVEN
K15-8
K15-9
CRIOFF
DACREF
24RET
BRCLK
BFAIL
FAILS
+5V ← K1-1, 2, 129-132, AND K2-7 THRU 10
K1A-1, K1B-1, K1A-65, K1B-65, K1A 66, K1B-66, K2A-4, K2B-4, K2A-5, K2B-5
GND ← K1-3, 4, 23, 24, 27, 28, 31, 32 61, 62, 67, 68, 71, 72, 119, 120, 123, 124, 135 THRU 140
K1A-2, K1B-2 K1A-12, K1B-12, K1A-14, K1B-14, K1A-16, K1B-16, K1A-31, K1B-31,
K1A-34, K1B-34, K1A-36, K1B-36, K1A 60, K1B 60, K1A-62, K1B-62, K1A-68, K1B-68,
K1A-69, K1B-69, K1A-70, K1B-70
K2-1 THRU 6 13 14, 97, 98, 101, 102
K2A-1, K2B-1, K2A-2, K2B 2, K2A-3, K2B 3, K2A 7, K2B-7, K2A-49, K2B-49, K2A-51, K2B-51
+12V ← K1-125 THRU 128 AND K2-11 12
K1A-63, K1B-63, K1A-64, K1B-64, K2A-6, K2B-6
-12V ← K1-121, 122 AND K2-15, 16
K1A-61, K1B-61, K2A-8, K2B-8
INNER CONNECTIONS
K3-1 TO K2-19 (K2A-10) 392
K3-2 TO K2-20 (K2B-10) 393
K3-3 TO K2-34 (K2B-17) 390
K3-4 TO K2-33 (K2A-17) 391
K4-1 TO K2-23 (K2A-12) 311
K4-2 TO K2-24 (K2B-12) 200
K4-3 TO K2-30 (K2B-15) 309
K4-4 TO K2-29 (K2A-15) 310
K5-1 TO K2-21 (K2A-11) 311
K5-2 TO K2-22 (K2B-11) 202
K5-3 TO K2-32 (K2B-16) 312
K5-4 TO K2-31 (K2A-16) 272
K6-1 TO K2-17 (K1A 9) 382
K6-2 TO K2-18 (K2B-9) 383
K6-3 TO K2-36 (K2B-18) 380
K6-4 TO K2-35 (K2A-18) 381
UNUSED GATES
5 VOLT PULLUPS
NAME VALUE COMPONENT CONNECTIONS
VX1 4.7KΩ RZ15-2 IC17-1.4 IC44-1.11
VX4 1KΩ RZ4-13 IC1.2 4.5 8, 9-4
VX2 1KΩ R24 IC37, 38, 39, 40, 41-23
IC42-11
VX3 1KΩ R28 IC58-12, 13, 21
IC36-1.4
IC56-16 IC57-16
IC67-12
REVISION
INITIAL RELEASE
Bridgeport
CONTROLS MANUFACTURING PLANT
200 Precision Road, Horsham, Pa. 19044
DESIGNED: B. KRIS DATE: 4-4-84
DRAWN: TC DATE: 9-12-84
CHECKED: mma
APPROVED: DATE: 9-14-84
TITLE FMDC (B) BOARD METRIC Schematic
MODEL NO. ECRT SERIES I
SIZE D DWG NO. 1939538 REV. B
SCALE: DO NOT SCALE DWG SHEET 2 OF 2
D11939523 A1939523
D11939548 A1939548
DWG NO. PARTS LIST
NEXT ASSEMBLY
MARKING: PER A027099
REMOVE BURRS AND SHARP EDGES.
DIMENSIONING
UNLESS OTHERWISE SPECIFIED ALL DIMENSIONS ARE IN INCH
TOLERANCES
ANGLE .X = ±.5°



NOTES:

1. VBAT VOLTAGE VARIES WITH TYPE OF BATTERY AND BATTERY AGE.

BATTERY TYPE	YIELD VOLTS
NICAD	@ 3.1
ALKALINE	@ 4.1
NORMAL AC	4.3

2. UNLESS NOTED ALL RESISTORS ARE 1/4W.
3. INSTALL TP1, TP2 ACROSS A-B.

4 JUMPERS POSITIONS A/B FOR ALKALINE BATTERY
JUMPERS POSITIONS B/C FOR NICAD BATTERY

LTR	DCN NO.	CHG'D	APPV'D	DATE
C	DCN 32647 2-4-85	WAR	mmP	2-12-85
B	DCN 30322 9/19/83	PAR	JP	9-21-83
A	DCN 30204 8/24/83	KTL	JP	8-25-83
O	INITIAL RELEASE		BL	7/7/83

REVISION

Bridgeport®

CONTROLS MANUFACTURING PLANT
200 Precision Road, Horsham, Pa. 19044

TITLE: FPU - BOARD SCHEMATIC

SIZE: D | DWG NO.: 1937429 | REV.: C
SCALE ~ DO NOT SCALE DWG | SHEET 1 OF 1

DESIGNED: B. KRIS, DATE: 5/5/83
DRAWN: PAR, DATE: 6/10/83
CHECKED:
APPROVED: BL, DATE: 7/7/83
PROJECT NO.: 100-154-30
MODEL NO.:

MATERIAL: ~
FINISH: ~
MARKING: PER A027099
TYPE: , CLASS: , POINT
REMOVE BURRS AND SHARP EDGES. INTERNAL CORNERS (.4mm/.016) MAX.

DIMENSIONING: UNLESS OTHERWISE SPECIFIED ALL DIMENSIONS ARE IN INCH
(INCH) THIRD ANGLE PROJECTION
TOLERANCES: MM .X = ± ; ANGLE .X = ± .5°

C1937431	A1937431
DWG NO.	PARTS LIST

NEXT ASSEMBLY

CHAPTER 6

AXIS DRIVE SYSTEM

(Reference Document A1939223)

6.1 INTRODUCTION

This chapter discusses the axis drive system and its relationship to the R2E4 machine. Included are descriptions of the motors, the power supply assembly, the DPS board, the motor drive module assemblies and the inductor and relay panel. At the end of the chapter is a section on drive module setup procedure.

6.2 OVERVIEW — **Figure 6-1**

The R2E4 milling machine has three axes under computer control. Each axis has a DC servo motor and a motor drive module. The IFC board is an interface between the motor drive modules and the FMDC board. The FMDC board uses positioning commands from the BSP2 board to create the drive signal for the motor drive module.

6.3 MOTORS

The machine control system uses totally enclosed, nonvented, permanent magnet, DC motors, Figure 6-2. Each servo motor contains a tachometer and an encoder. The output of the tachometer is combined with the input pulses to create the velocity command. The velocity command is used to develop the current command. The current command, along with the control and motor-encoder feedback positioning signals, is used to control the motor operation.

6.4 TRANSMISSION AND RESOLUTION

The transmission system translates motor rotation into table (X, Y-axes) motion or vertical spindle motion (Z-axis). The motor drives a precision ballscrew assembly through a 2:1 belt-driven reduction, and the resultant

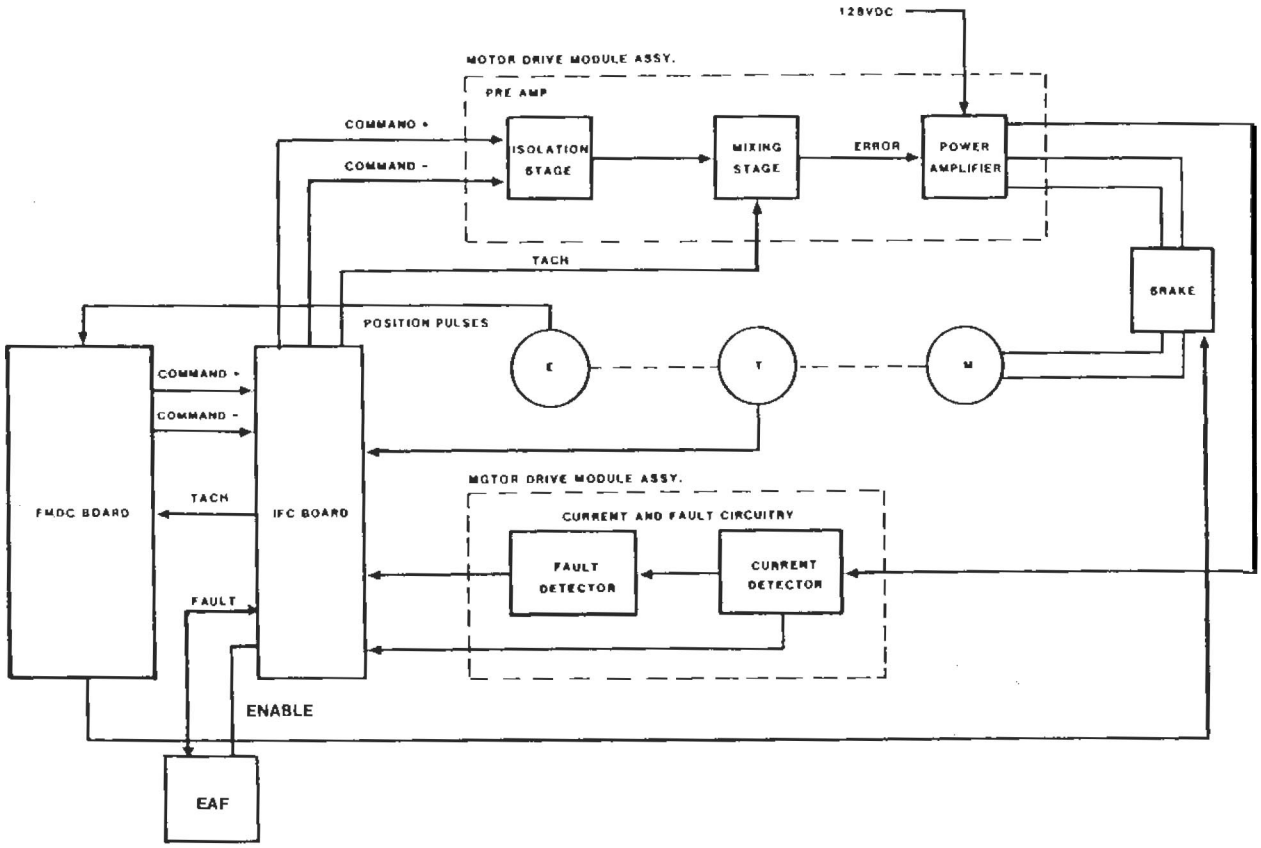
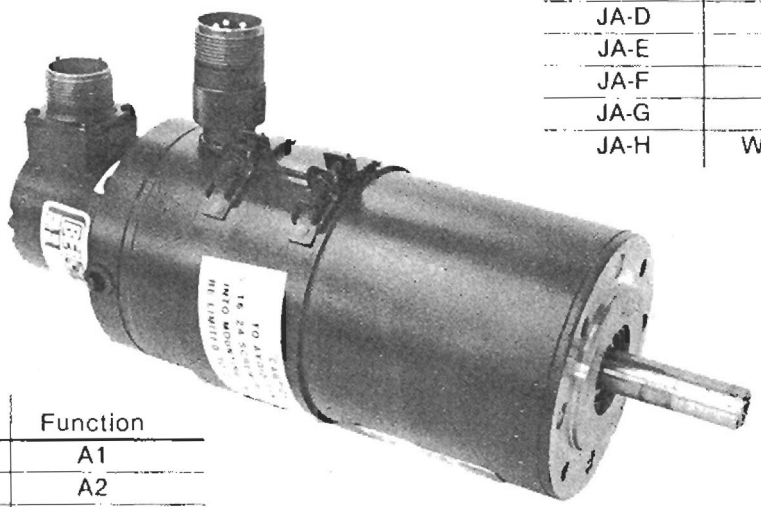


Figure 6-1. Axis Drive — Functional Blocks

From	To Wire	Function
JA-A	Blu	A+
JA-B	Wh/Blu	A–
JA-C	Wh/Yel	B+
JA-D	Yel	B–
JA-E	Blk	Gnd
JA-F	Red	+5 VDC
JA-G	Org	– Index
JA-H	Wh/Org	+ Index



From	Wire	Function
JB-A	Blk	A1
JB-B	Wht	A2
JB-C	Blk	T2
JB-D	Red	T1
JB-E	Grn	Gnd

Figure **6-2.** DC Servo Motor

linear motion of the ballnut relative to the screw causes linear motion of the corresponding axis.

Calibration The combination of 250 encoder lines per revolution of the motor-tachogenerator-encoder shaft, the 2:1 reduction, and a 5-pitch (.2000 inch per revolution) screw yields an axis molion of 0.0004 per encoder line. The CNC System accepting this signal in quadrature results in a servo resolution of 0.0001 inch (0.0025mm).

For SIN 164 up, having screws of 5mm pitch, a conversion to inch increments takes place within the FMDC card. See Section 5.7.3.

X and Y-Axis Drive Transmission The X and Y-axis movements of the table are made by belt-drive conversion of servo-motor rotation to move ballscrews, mounted on precision bearings, through each ballnut fixed to the saddle, Figure 6-3.

The Y-axis servo drive motor is mounted under the knee to protect the operator. The X and Y-axis servo motors transfer motion to the table through timing belts and pulleys at a 2:1 reduction ratio.

X and Y-Axis **Limit** Switches Lateral table movement beyond software limits is controlled by X-axis electromechanical limit switches. Software control failure or drive malfunction in the saddle is controlled by the Y-axis limit switch. (For X and Y axis limit switch locations, refer to Figures 6-4 and 6-5.) For the proper setting of these switches, see Section 10.3.

Z-Axis Drive The quill is powered by a permanent magnet DC servo motor. A timing belt drives the ball quill extension. The ball quill extension has a .2000 inch pitch thread that carries a recirculating ball type nut with

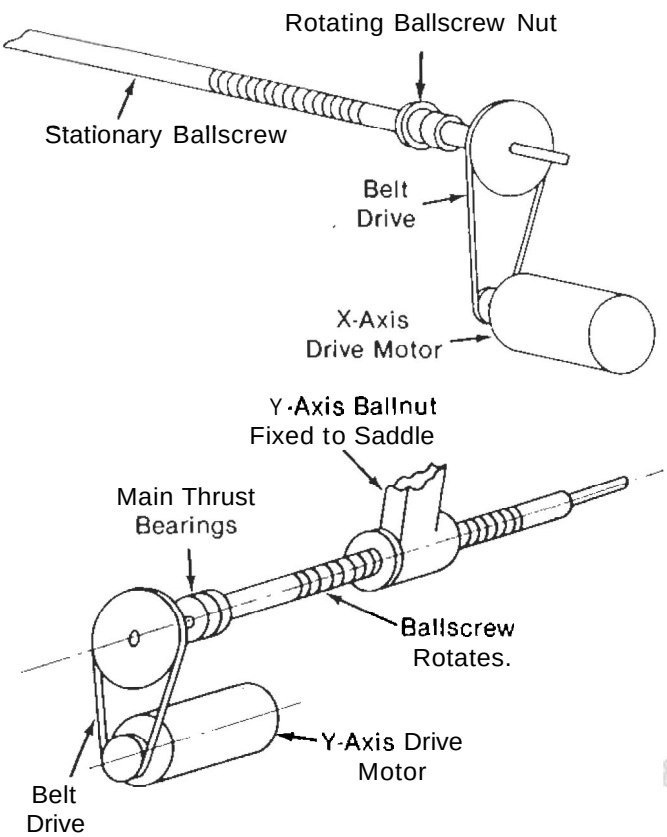


Figure **6-3.** X and **Y-Axis** Drive Transmission

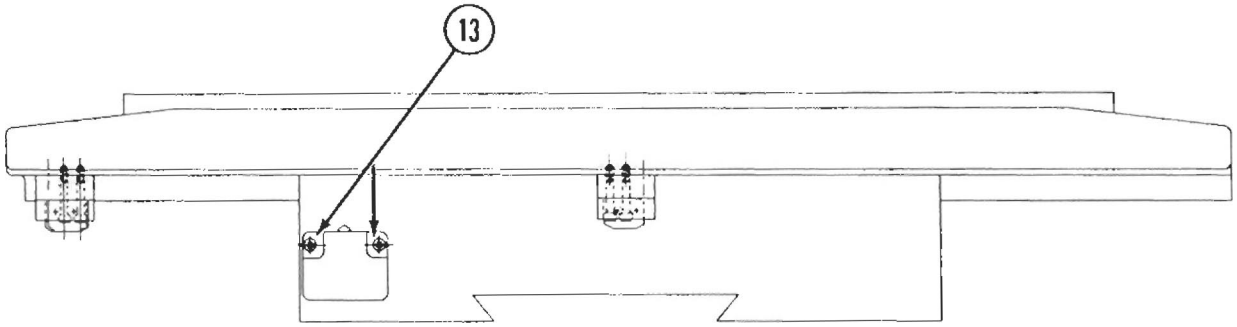


Figure 6-4. X-Axis Limit Switch Locations

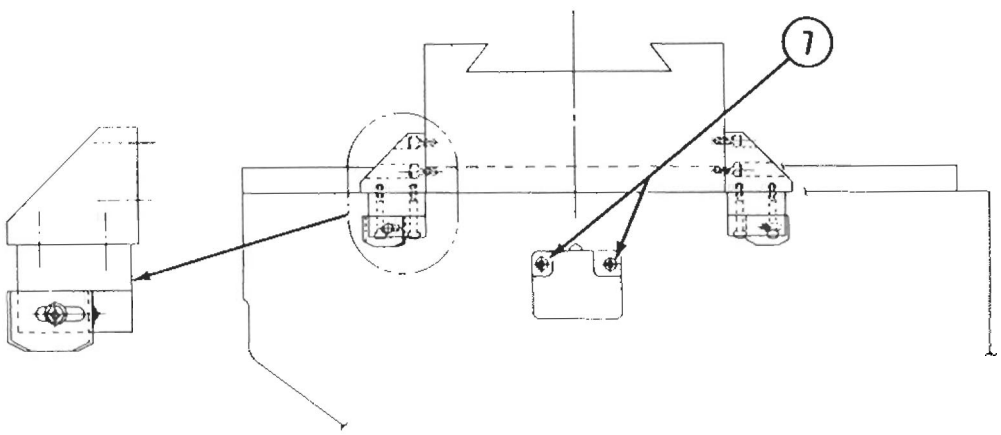


Figure 6-5. Y-Axis **Limit** Switch Location

suitable internal preload. With proper adjustment of the liming belt, lost motion is virtually eliminated. The ball quill extension drives the quill through a working travel of 125mm (4-59/64"). See Figure **6-6.**

Z-Axis Limit Switches Vertical quill travel is determined by the software limits programmed into the CNC unit. The upper (positive) limits are determined by setting the top limit switch just below the top posilion switch, Figure 6-7. The lower (negative) timits are determined by measuring full downward travel from the top limit switch and setting the bottom limit switch to actuateat that point. Software limits for operation are then established to fall just short of the limit switch settings. Any software failureor drive malfunction will cause the quill to overrun its normal software limits, tripping the limit switch and shutting down power to the Z-axis drive motor. See Section **11.4** for the proper setting of these switches.

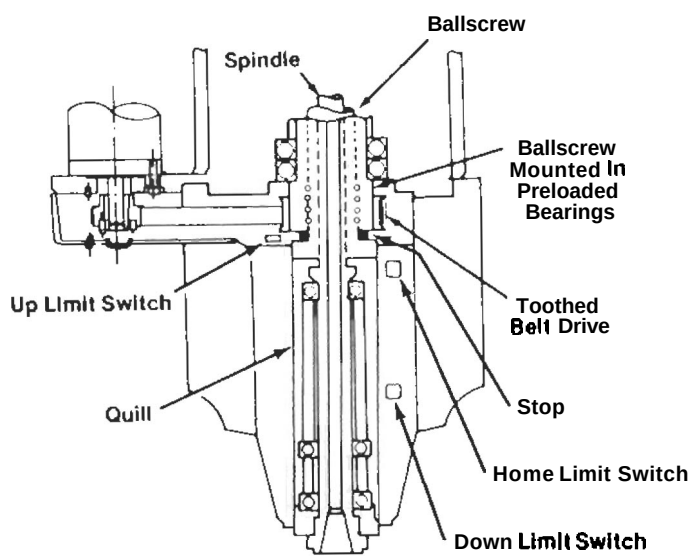


Figure 6-6. Z-Axis Drive

6.5 POWER SUPPLY ASSEMBLY

This assembly consists of both the high voltage to power the DC motors and the low voltage power supply for the logic board power. The electrical power supplied by this assembly is unregulated.

6.5.1 Theory of Operation (Single Phase 3-193-9039)

Single phase voltage from an external transformer is brought into terminals 214 and 215. The input voltage limits are **70 to** 100 VAC with a nominal voltage of 90 VAC.

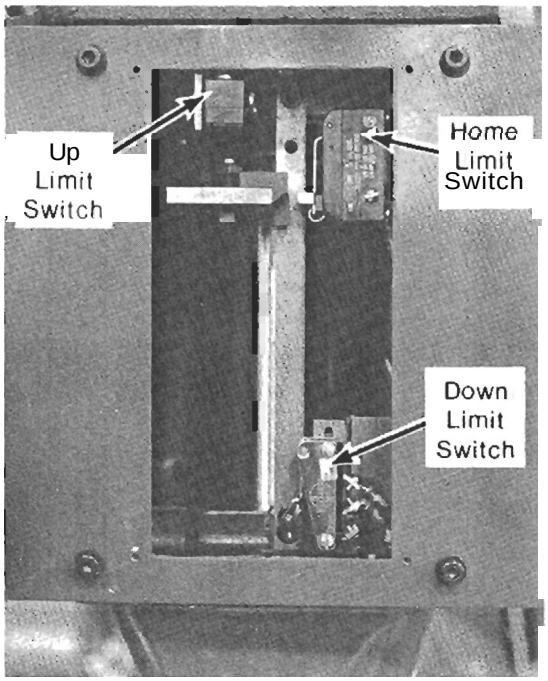


Figure **6-7.** Z-Axis Limit Switches

Diodes D5 and D6 are wired to provide lull wave rectification. Thermistors 1T and 2T prevent voltage inrush as filter capacitors C3, C4 and C5 are very low impedance devices. R3 is a bleeder resistor. +128 VDC at 15 amps is provided for three motor drive module assemblies via fuses FU23, FU24 and FU25. Diodes D1, D2 and D3 provide a path for the back EMF, produced by the generating effect of a coasting DC motor. This bleeds into the power supply in the event of a failure by their respective fuses. It also serves to protect the drive transistors in the motor drive module assemblies. Unfused +128 VDC output is available on line 250.

115 VAC is supplied to terminals 12 and 13 and passes lhrough fuses FU12 and FU16 into the primaries of transformers T1 and T2 in parallel. The output of T1 is rectified by BR1. The rectified voltage on lines 38 and 39 is filtered of 120 Hz by L1 and C1, and is fed through fuse FU13 to provide +24 VDC at 5 amps to line 40.

Theoutput of T2 is rectified by BR2, filtered by C2 and fed through fuse FU 17 to provide – 22 VDC at 3 amps to line 37. R1 and R2 are bleeder resistors.

6.6 DPS ASSEMBLY (3-193-7783)

The +24 volts at the input to this board is filtered by C8, C12 and C18. The voltage is then impressed across the input terminals of IC4 pins 1 and 2. The case of the IC is held at ground potential. IC4 is a power-switching regulator set to switch at 40 K-hertz and up to 5 amps, The purpose of the capacitor at pin 3 is to determine the frequency at which the chip will operate. The pin 5 input is the input for the voltage reference in the error amplifier. If no external voltage is applied, as in this application, capacitor C10 keeps noise transients from upsetting this voltage. The input to the error amplifier from the voltagedivider network R2, R10 and R11 is at pin 6. The resistor-capacitor network R12 and C11 at pin 7 is selected to filter out 40 K-hertz noise from the error amplifier. The input to output current at pin 8 is used to charge the inductot T2 and the capacitor C19. When the current stops flowing from IC4, the stored energy in T2 continues to flow into C19 back through D2 to T2, and to the load at K4 pins 4 and 5. (Note that the control feedback path is through R2, R10 and R11.) R2 should adjust the +15 VDC level within the range of 13 to 17.5 VDC. R13 is a bleeder resistor and C20 is a high frequency capacitor to eliminate any 40 K-hertz voltage spikes. The output voltage at K4 pins 4 and 5 is +15 VDC at 4 amps.

A similar circuit supplies +5 VDC. IC1 is configured identically to IC4 with the following exceptions:

1. The voltage divider network comprised of resistors R3 and R4 are optimized to supply an error voltage to LC1 which will cause it to operate at +5 VDC.
2. The capacitor C19 is optimized to operate at +5 VDC.
3. The bleeder resistor R6 is also optimized to operate at +5 VDC.

R1 should provide adjustments of the +5 VDC outpul within the range of 4.4 to 5.7 VDC. The current output of this supply is 5 amps.

A linear DC regulator is used to produce +12 VDC. The +22 volt supply is led to IC2 pin 1 through resistor R9, and filtered by the capacitor C6. The output of IC2 pin 2 is regulated by the internal circuitry of this device. The capacitor C16 filters any noise that passes through IC2. Resistor R7 is a bleeder resistor. The +15 VDC exits this board through K4 pin C, K2 pin 3 and K3 pins 5 and 6.

The – 12 VDC regulation is also accomplished by a linear DC control chip IC3. This circuit consists of capacitors C7 and C17, IC3 and R8. Its operation is the same as the +12 VOC circuit previously described. The – 12 VDC exits the board through K4 pin 8, K2 pin 4 and K3 pins 3and 4.

Also contained on this board is a synchronization circuit whose purpose is aligning the PWM frequency to insure that each axis drive will start its time frame separately.

To accomplish this, IC5 is designed as a free-running oscillator. The resistor R14 and the capacilor C25 set the frequency at which it will oscillate. C24 is utilized as a noise filter. The output of IC5 at pin 3 is the input trigger for IC6 at pin 3. IC6 is preset into a divide by four counter. The outputs of IC6 are logically coupled to IC7 to decode Table 6-1.

Table 6-1. IC6 Output Decode Table

	CKO	CK1	CK2	CK3
IC6-1	1	0	1	0
IC6-2	0	1	0	1
IC6-13	1	1	0	0
IC6-12	0	0	1	1
IC7-3	0	1	1	1
IC7-4	1	0	1	1
IC7-10	1	1	0	1
IC7-11	1	1	1	0

When IC7 outputs go to zero, current will flow from the +15 VDC line through the 1 K-ohm and the 10 K-ohm resistors through IC7 to ground. The current through any respective 10 K-ohm resistor also supplies base current to its associated output transistor.

IC7 pin 3 is used to supply the base current to Q3. Q3 will turn on and transfers K4 pin A to signal high. This signal will start the PWM cycle for the X-axis.

IC7 pin 4 turns on Q4 which transfers K4 pin 1 signal to a high level and controls the PWM cycle for the Y-axis.

IC7 pin 10 turns on Q1 which transfers K4 pin 2 to a high signal and controls the PWM cycle for the Z-axis.

Capacitors C26, C28 and C29 are noise filter capacitors for Q1, Q3 and Q4 respectively.

IFC Board (3-193-7860)

The interface to the X, Y and Z axis motors, the IFC board receives the axis motion command from the FMDC board. It then supplies to the FMDC board the necessary signals to control motor motion and for testing the quality of motor performance.

At the top of the board, K1, K2 and K3 interface to the FMDC for the X, Y and Z axes, respectively. K5 is implemented as a test connector. K6 is the interface connector to all axis motor tachometers. K7 is the power in. put connection from the DPS board. KO is the output connector to the motherboard in the card rack assembly.

The velocity command signals for all axes are generated on the FMDC board. They enter the board on K1 for the X-axis, K2 for the Y-axis, and K3 for the Z-axis. All three circuits are identical. Therefore. only one will be explained.

The input signal at K1 pin 3 is at zero potential in relation to K1 pin 8 when the velocity desired is zero. If the desired velocity is positive, K1 pin 3 is positive while pin 8 is negative. This voltage is developed across R38 and R39. IC1 pin 1 is designed as an emitter follower circuit with R21, R24, R33 and R40 selting the gain at unity. The output across K8 pins 12 and 14 is routed through the motherboard to the DCS board on the axis drive module.

The DCS board generates an analog signal that has a ratio of 10 volts equal to 30 amps. This signal is inputted to the interfaceat K8 pin 16 for the X-axis, K8 pin H lor the Y-axis, and K8 pin 7 for the Z-axis. The interface board divides this voltage in half, where it is presented at pin 2 on the appropriate connector for use as a signal input to the FMDC. It is alsoavailable on the test connector K5 at pin 1 for the X-axis, K5 pin 2 for the Y-axis, and K5 pin 3 for the Z-axis.

The tachometer outputs returning from each motor are brought onto the interface board through K6, the X-axis on pin 1 and pin 6, the Y-axis on pin 2 and pin 7, and the Z-axis on pin 3 and pin 8. The positive input of each tachometer voltage is fed through a resistor and is output on K8 at the bottom of the board, where it is distributed to the DCS board on the appropriate axis drive module. The series resistors are used to scale the tachometer voltage as required when motors with different tachometer voltage gain are used.

Each positive tachometer voltage is also divided in half and distributed to the FMDC board. K1 supplies the voltage for the X-axis, K2 for the Y-axis, and K3 for the Z-axis. These signals are brought out on connector K5 for use by the system test technician. The reset and fault circuit is also resident on this board. This circuit is used at system startup or when a fault is detected by any axis board. If a fault is detected by an axis, it is brought into this board at KO pin H for the X-axis, K8 pin B for the Y-axis, and K8 pin 2 for the Z-axis; CR2, CR3 or CR4 through R53 into fC5 at pin 5. When this input goes low, the output of IC5 at pin 6 goes high and charges the R64-C12 delay circuit. When the voltage at pin 9 on IC5 is greater than the level of a logic one, the output of IC5 pin 8 goes lo zero. This change of state at pin 4 of 1C7 causes the output of IC7 pin 1 to go to zero and become inactive. The output of IC5 pin 8 also puts a zero voltage into IC5 pin 11. The output of IC5 pin 10 is fed through R56 and R61. The voltage dropped across R61 causes Q1 to turn on. Q1 then pulls K4 pin 5 to a zero where it is recognized as a fault elsewhere in the system. R11 through pin 10 on K4 supplies power for external use. IC5 pin 10 also presents a logic high to IC5 pin 13, which causes IC5 pin 12 to switch low. The signal is available at K8 pin W for future use.

After a fault has been detected. a system reset must be generated. The reset signal is brought into this board at K4 pin 4. The reset input at K8 pin 19 is for future expansion. When reset goes high, Q2 draws current and causes a zero to appear at IC6 pins 8 and 9 and also at R58. R57 and R58 are selected so that the output at IC6 pin 10 causes C10 to discharge to a logic low on pin 1 of IC5. Theoutput of IC5 at pin 2 goes toa high which clocks IC7 into a set state. When 1C7 pin 1 goes high to enable IC6 pin 6, the input circuit to pin 5 of IC6 is a free running oscillator. When the output of IC6 pin 5 goes low, the output of LC6 pin 4 goes high. The two highs on the input of IC6 pins 1 and 2 cause IC6 pin 3 to go low. When IC6 pin 4 goes high, the output of IC6 pin 3 goes high. These pulses from IC6 are then taken off the board at K8 pin 15 lor X-axis reset, K8 pin F for Y-axis reset, and K8 pin 6 for Z-axis reset.

6.7 MOTOR DRIVE MODULE ASSEMBLY (3-193-7997)

The motor drive module consists of three major assemblies: the DCS board, the HBD board, and the output drive assembly.

6.7.1 DCS Board (3-193-6626) — Figure 6-8

The purpose of this board is to process the velocity command and the tachometer signal. It also generates an error signal thal changes the current request to the motor. The current through the motor is then checked to determine if the new request is permissible. If this test indicates that it is allowable, the requested currenl is passed on to the HBD board where the control for the output power stage is generated.

The differential velocity command is brought into the board at K1 pins Band 4. The input circuit of IC7, R6, R7, R8, R20, R21, R23, R24, R26, C14 and C18 performs two tasks. First, the resistor network filters incoming transients above 2 K-hertz to ground. Secondly, 1C7 must transfer the differential command to a unipolar command. 1C7 pins 1, 2, and 3 have a gain of unity.

IC1 is a flip-flop that divides the input frequency to 3.3 K-hertz and also supplies current into C2 and R70. The current through this network is fed into pin 2 of IC12. The output of IC12 pin 1 is integrated in time by the action of C35 and R72, in conjunction with R73 and C37.

When the outpul of IC1 at pin 2 goes to a high level, the output of IC12 pin 1 integrates voltage in the negative direction. When the output of IC1 is zero, IC12 integrates in a positive direction. The output of IC12 at pin 1 should be a triangular wave form operating at +5.5 to 6 volts around a zero voltage level.

The triangular wave form is fed into R95 where it is summed with the velocity signal through R96. This current is inputted into pin 6 of IC12. The output of IC12 at pin 7 will be a triangular wave form that is riding on a voltage level equal to the velocity amplitude of the velocity command.

The amplifier of IC12 pins 12, 13 and 14 has a special function. Pin 12 is constantly referenced to ground. Therefore, Ihe amplifier will always keep pin 13 at ground potential. Now the current generated through R42 and R77 into pin 13 will cause pin 14 to go negative to a voltage that forces the current from pin 14 through R74 lo equal the current through R77. By this method, positive voltage at the junction of R42 and R77 will have an equal negative voltage at pin 14 of IC12. This voltage should be 0.462 VDC +2%. C40 is a filter capacitor to keep noise off these signals.

IC9 is a dual operational amplifier designed as a window detector. The positive voltage through R44 sets a 'evel at pin 2 of IC9 lor the positive detector. The negative voltage at pin 14 of IC12 through R43 sets a level for the negative detector. The triangular wave form a! pin 7 of IC12 is then fed into both the positive and negative detectors through R46 and R48. When the triangular wave form is greater than the positive set-point, the output of IC9 at pin 1 is +10 VDC, while the output of IC9 at pin 7 is −10 VDC.

When the triangular wave form is between the two set. points, both outputs of IC9 are −10 VDC. When the triangular wave form is more negative than the negative set-point, the output of IC9 pin 1 is −10 VDC and IC9 pin 7 is +10 VDC. The period of time that the triangular wave form integrates between the two limits is a controlled recovery time and should be 15 to 20 microseconds. The resistor-capaci tor networks of R47 and C23, in conjunction with R45 and C22 from the output lo the positive inputs of the amplifiers of IC9, are speed-up circuits.

The output of each amplifier goes through a resistor divider network to +12 VDC. These networks comprised of R35, R36, R40 and R41 are level shifters. When the outpul IC9 is −10 VDC, the input to the next gate of IC8 is held at zero volts. When IC9 is at +10 VDC, the inputs to the next gate are at +11 VDC.

The logic circuit generated by two inverters on IC8, one two-input gate on IC11, and two three-input gates on 1C4 'orms the galing required to control the switching for ie power output stage. When the input at pin 1 of IC8 is at +11 VDC, the output at pin 2 is zero volts. Meanwhile, IC8 pin 3 is zero, and the output is high voltage. IC4 is arranged so that any zero voltage on the input will cause the portion of output power stage that is controlled by the gate to turn off. Therefore, IC4 pin 9 is high; and the circuit associated with K2 pin 9 on the HBD board is inactive

The operation of iC4 pins 3.4, and 5 is more complex. To turn on the power circuits, all of the inputs to this gate must be high. Therefore, all inputs must be inspected for a high voltage simultaneously. The input at pin 4 is high due to the status of tC8 pin 3 as previously explained. Pin 3 is high because IC11 pin 12 is zero, which forces IC11 output pin 11 high. Pin 5 is high because it is sampling the output of the fault detector circuit, which at this time is in a normal status. With the above condition satisfied. IC4 pin 6 is driven to zero voltage, permitting the output power circuit to turn on.

The fault status circuit checks the status of the positive and negative 12 volts, the reset line from the external control, and the status of the current detection circuit on the HBD board. The voltages are checked by the resistor-diode circuit comprised of R13, D4, and R12. D4 is a 20-volt zener diode. When the sum of the two voltages is greater than 20 volts, current will flow through the diode and into the base of Q2. Q2 will turn on, which causes the current through R11 and R37 to divide the voltage to zero at pin 5 of IC8. Pin 6 of IC8 is forced high, which enables IC4 pin 11. If the −12 VDC goes to zero, a high voltage is forced into IC8 pin 5. This causes IC4 pin 11 to go to a zero, which forces a zero into the pins 1 and 5 of IC4; and all output transistors are disabled.

If +12 VDC goes to zero, all logic chips turn off, which causes a high impedance to appear at K2 pins 9 and 10. This in turn disables all output transistors.

If either voltage falls part way to zero so that the sum of vollages is less than 20 volts, IC4 pins 6 and 9 turn to high impedance, which disables the output transistors.

If overcurrenl is detected on the HBD board, K2 pin 2 goes to a high voltage. This forces IC11 pin 3 to zero volts. This voltage places a bias on the base of Q3, causing Q3 to turn on. R30, in the emitter of Q3, generates a constant current flow through Q3 to charge C8 at a constant rate. When the voltage across C8 exceeds the threshold of IC8 at pin 9, a set level is forced into IC1 at pin 8. This signal forces IC1 pin 12 to go to a zero and disables the output transistors. Also, pin 13 goes to a high voltage, causing Q1 to turn on. The output of Q1 lights LED 1 and signals the control that a fault state exists through K1 pin C,

The reset signal is brought into this board at K1 pin D. When this signal goes to zero voltage through R39, C21 is discharged; and pins 8 and 9 of IC11 go to zero. The output of IC11 at pin 10 goes high and triggers pin 11 of IC1. The trigger causes IC1 pin 12 to go high, which enables the power output stage when no faults are present.

The current control for the drive section consists of a series of operational circuits (IC6, IC12, IC13 and IC15) that condition the current signal and modify the velocity amplifier output emerging from IC10 pin 6. The current signal, which represents the amount of current flowing through the motor, is brought into this board at K2 pin 4. This signal is scaled to 166 millivolts per amp'of current

flow. It also will be positive for one part of a cycle and negative for the remaining portion of a cycle.

The circuit consisting of R15, R16, R17, R18, R81, R82, IC13 and IC6 is a demodulator. IC6 pins 2 and 13 are selectively switched by pins 9 and 6 so lhat the input resistance from pins 2 to 4 and pins 11 to 13 are very high impedance or zero. The signal that turns on the output power stage also turns on an IC6 input. When this signal is high, current flows through that section of this chip to ground. Therefore, the alternate grounding of the signal going to the positive input of IC13 and then the signal to the negative input of IC13 causes the output of IC13 to be positive tor one direction of motor rotation and negative for the other.

The output of IC13 at pin 7 is then divided through R75 and R76. The resultant voltage at lhe junction of these resistors is fed into the buffer amplifier IC12.

The voltage at the output of the IC12 pin 8 energizes the active filter R49, R53, C26 and C28, which feeds back the output of IC13 at pin 8. This filter smoothes the switching transients that are picked up in the current signal. The output of this filter is the input of IC13 at pin 10.

The output of IC13 pin 8 is then summed with the velocity signal from IC10. The current signal is always the opposite polarity of the velocity signal so that if the current rises too high, it will reduce the time of the current generating pulse until it stabilizes at the current limit of 30 amps.

The current signal is also fed into the diode circuit, D8 and D15, which are steering diodes on the input of IC15. When the current signal is positive, D15 becomes con. ductive; and the signal is impressed on the noninverting input of IC15. This causes the output to be positive. When the current signal is negative, D8 conducts. This will energize the inverting input of IC15, which causes the output to be positive. Therefore, the output of IC15 at pin 1 is always positive.

This positive signal is fed through the gain-changing circuit consisiting of R86, R93, R94, D5 and D13 into pin 6 of IC15. The gain of this circuit is .41 if the input voltage is within the range of 0 to + 2.2. VDC. When the input voltage exceeds + 2.2. VDC, diodes D5 and D13 conduct and change the circuit gain to 4.5.

The voltage output of IC15 pin 7 is then integrated through the action of R65, R92, C32 and IC15. The rate of integration for the output voltage = 22 seconds times the input voltage. The input of IC15 pin 13 is biased high negative, which causes IC15 pin 14 to be a large positive voltage. If IC15 pin 8 is driven to a large positive voltage, the current flowing into R91 will cause pin 13 of IC15 to see a positive potential. IC15 pin 14 goes negative. This negative voltage causes D9 to conduct, which then reduces the positive current limit voltage. The overall response of the four IC15 circuits are such that if a motor is drawing 30 amps for about 15 minutes, this circuit will reduce the usable current to 15 amps and stay at 15 amps until three minutes after the demand is removed from the motor.

The current output of IC13 pin 8 also energizes pin 2 of IC14 through R56. The output of IC14 pin 6 is fed back through R84 and to K1 pin E through R99. Thirty amps through the motor is equal to 8 volts at the connector.

IC2 is a positive, 12-volt, 3-terminal regulator. It receives positive 15 volts from the HBD board on K2 pin 8. It regulates the voltage to 12 volts for power used on this board and also on the HBD board. C4 and C5 are filter capacitors.

IC3 is a negative, 12-volt, 3-terminal regulator. It receives negative 15 volts from the HBD board through K2 pin 6. It regulates this voltage to 12 volts for use of this board and also on the HBD board. C6 and C7 are filter capacitors.

The timing sequence is shown in Figure 6-9.

6.7.2 HBD Board (3-193-6447) — Figure 6-10

The purpose of this board is to generate and control the base drive current for the output drive transistors and to safely turn off the oulput transistors if the current through them becomes abnormal.

The + 15 VDC for this board is brought in at K1 pins 1, 2, A and B. It goes oft the board at K2 pin 8.

Ground is referenced on this board at K1 pins 5, 6, E and F. It is taken off at K2 pins 5 and 7. C22 is a filter capacitor.

The – 15 VDC is brought into this board at K1 pins 3, 4, C and D. It is taken off at K2 pin 6.

The pulse width modulated signals are brought into this board at K2 pins 9 and 10. (Refer to the DCS board 3-193-6626 for timing explanation.) These signals control one half of the power output bridge with identical control circuits. Therefore, except for safety interlocks, only one base drive circuit will be explained.

The circuit selected for explanation is K2 pin 10. IC1 is designed to operate as a free-running oscillator with the input at D35 having the ability to shut down the oscillator. R39 is a safety resistor that will shut down the oscillator in the event the circuit at K2 pin 10 is opened. R38 and R45 set the charge time constant for C17 while R45 determines the discharge time. The frequency of this circuit is 100 K-hertz. C14 and C20 are noise filters. IC1 pin 3 is the output which drives the base of Q15 when the output is high. It also drives the gate of Q13 through D34 when the output goes to zero. Q15 is a low impedance driver for the gate of Q13.

Q13 and T1 form a high frequency, transformer coupled, low voltage to high voltage, base current supply circuit. When IC1 pulls the gate of Q13 high, current will flow from the center tap of the primary of T1 and through Q13 to ground. When Q13 is turned off, the drain of Q13 goes to a voltage that is large enough to cause current to flow through D33 to ground, and through D36 and the other half of T1 primary. R46 and C16 form a snubber circuit to control voltage transients.

The current flow in the primary of T1 causes voltage to be induced in the secondary of T1. This voltage is rectified by two full-wave, center-tapped circuits. One circuit consists of D17 and D19 which, through R7 and C1, supplies the base drive to the upper rail transistor. The other circuit is D18 and D20 through the parallel circuit of R19, R21 and C9. At the same time, the other half of T1 secondary is generating a similar voltage through D21, D22 and D23.

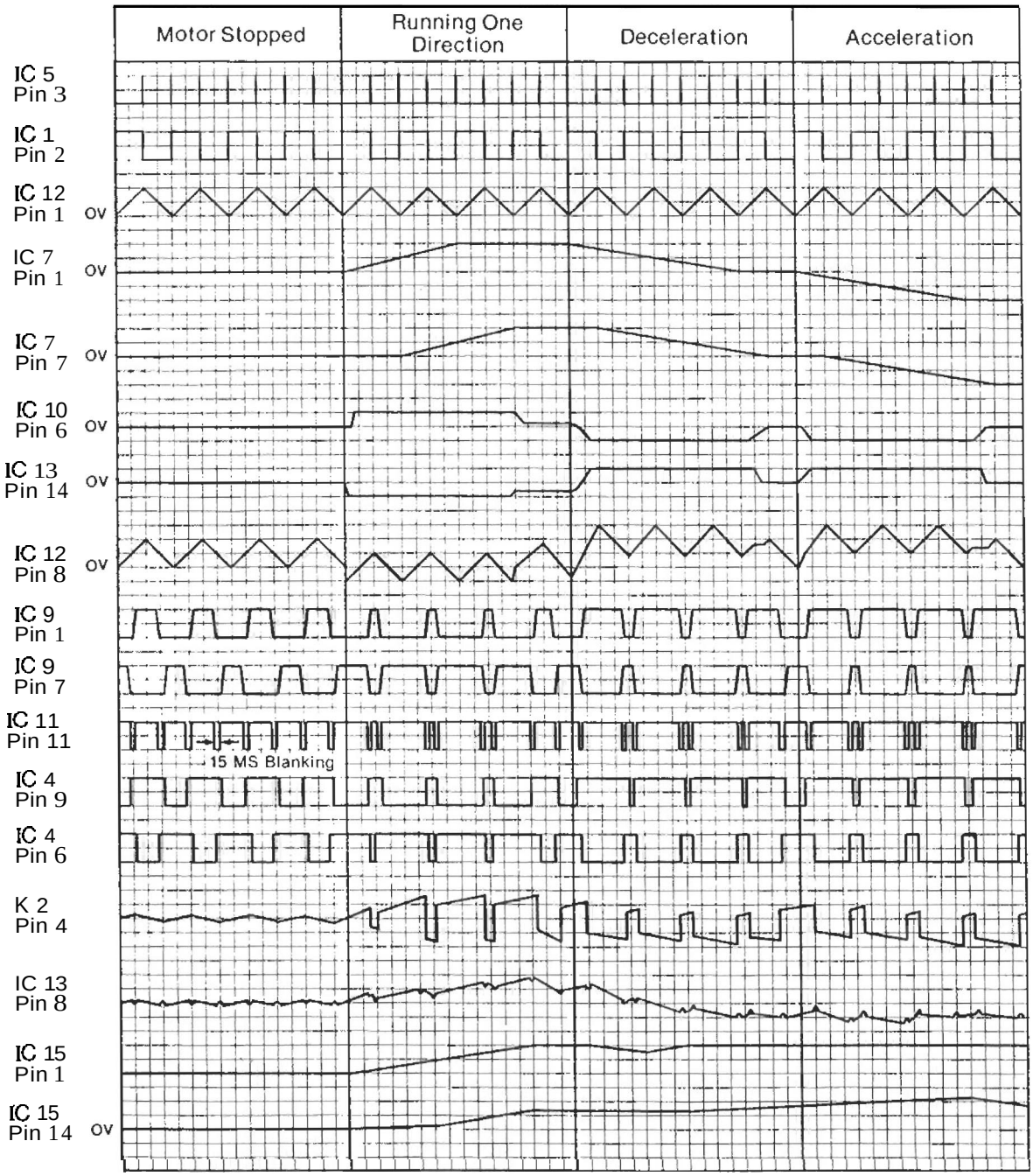


Figure 6-9. Timing Sequence for DCS Board

To understand the function of these voltages, we must describe the status of the output transistors. To show the interplay of all components, we will examine a situation where the previous pair of transistors have just turned off, all currents in the motor are normal, and the transistors and components under discussion are told to turn on. After turning on, the current will build up to an abnormally high level, and the base drive circuit must shut down the output transistor to protect it.

The instant that the previous pair of transistors turn off, the motor will attempt to be discharged. The pins of K3 wilt take on the following potentials:

Pin 1 is a high impedance.

Pin 2 is one diode-drop above supply voltage.

Pin 3 is equal to supply voltage.

Pin 4 is negative by the voltage drop across R5 and R6.

Pin 5 is the same voltage as pin 4.

Pin 6 is two diode-drops above pin 7.

Pin 7 is one diode-drop below the voltage across R5 and R6.

Pin 8 will be negative 2 volts in relation to pin 5.

As the voltage control signal turns on IC1 and the transformer secondary develops voltage, the voltage rectified at the junction of D17 and D19 rises to 12 volts in relation to the center tap of T1 secondary. This voltage causes current flow through R7, D1 and D2 to supply base current for the upper rail transistor. C1 bypasses D1 and D2 and permits the first surge of current to the transistor to bypass D1 and D2. Also, C1 will charge up to two diode-drops. This section reduces the base current to one half ampere. The charge on C1 supplies the negative bias to turn off Q1 as will be explained later,

The voltage at the junction of D18 and D20 also reaches 12 volts and is used to turn off the output transistor. As the voltage builds up, it charges C5 through D4. The voltage on C5 is fed through R1 to the drain of Q5 and the gate of Q1.

Also, the voltage at the junction of D18 and D20 is dropped across R19 and through R21 to C9 and also D3. The basic assumption was that the output transistors were operating in a normal mode and pin 2 of K3 was one diode-drop above the supply voltage. Therefore, as the anode of D3 goes positive, D3 conducts and clamps R21 and C9 to a voltage level that does not permit Q9 to turn on. Consequently, the gate of Q5 is high; and Q5 is turned on. Q5 keeps the gate of Q1 to zero, and Q1 is off. This sequence permits the base current to flow into the high power output transistor which turns it on and supplies current through the motor.

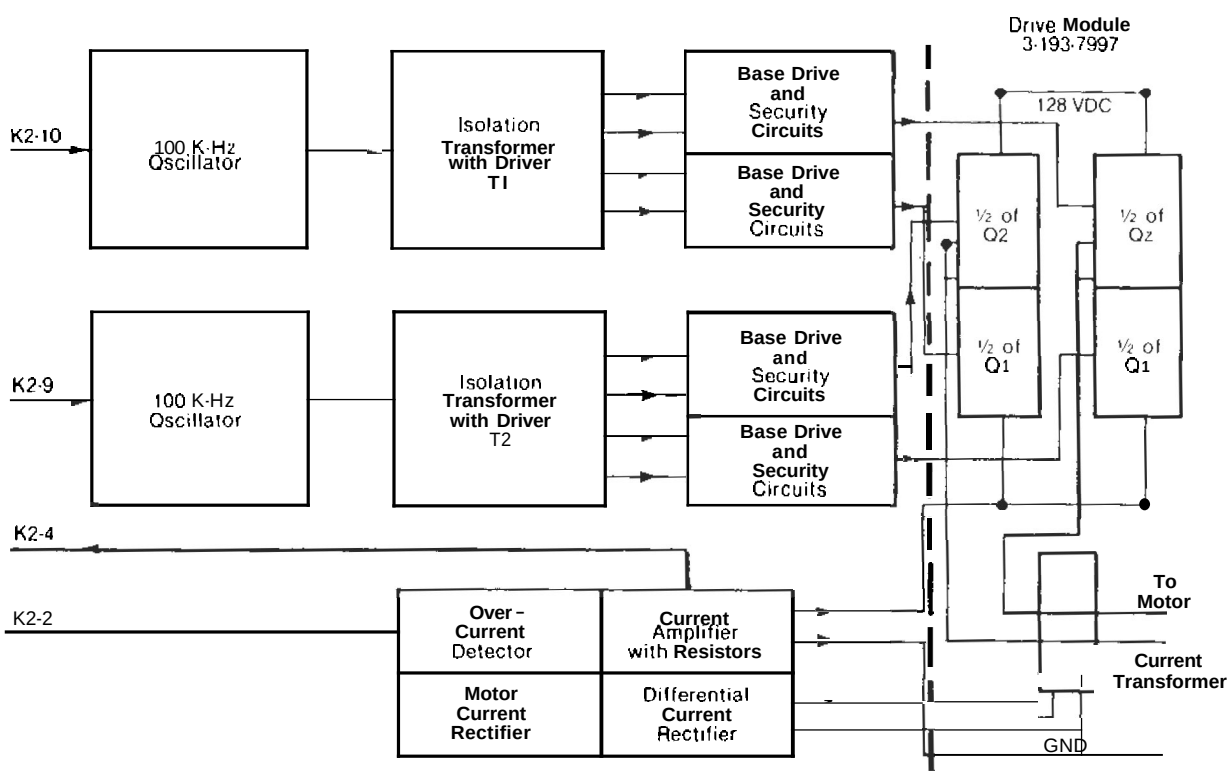


Figure 6-10. HBD Board — Functional Block

NOTE

If the opposite set of power transistors are still on when TI attempts lo turn on its output transistors, the voltage at K3 pin 2 is very high, which would back-bias D3 to a nonconducting state. Therefore, Q9 would go into conduction, and Q5 would be turned off. This would permit the gate of Q1 to charge to +12 VDC and turn Q1 on. Under these conditions, Q1 would shut the output base current to ground and maintain the output power stage in a nonconducting stage. Also, if in this hold-off state and the fower rail output transistor turned off, D3 woufd become forward biased and revert to normal operation.

Under normal operation, the upper rail transistor of Q1 on the drive module and the lower rail transistor of Q2 on the drive module would turn on; and current would flow through the motor. If the rate of current rise remained normal but began to approach the current limit as set on the DCS board, the DCS board would shorten the pulse width request and turn off the current into T1 primary. That would remove the voltage on the secondary and the base drive to the output transistor. At the same time, the voltage on the collector of Q9 and the gate of Q5 would fall to zero. However, because of the charge on C5, the gate of Q1 would go to +12 VDC, which would cause Q1 to conduct and discharge C1 through the base of the output transistor in the opposite direction of the original base drive on-current. This reverse drive forces the output transistor to turn off completely.

Also, the same sequence would be followed if the current request was such that the currents were within current limits, but the pulse width time had completed its timing cycle.

In the case *of* an abnormal rate of current rise through Q1 as may occur if the motor is shorted out, the voltage from collector to emitter will begin to rise from a nominal of 2.5 VDC to a larger voltage. The increase of VEC is indicative of a transistor that is entering a complete failure mode. When the VEC approaches 5 VDC, the voltage that D3 was holding low is now permitted to build up on the base of Q9. When the base of Q9 reaches .5 VDC, Q9 will turn on. Q5 will turn off and Q1 will turn on. Q1 then takes the base drive away from the upper rail transistor and inserts the negative base current sequence. This act forces the output transistors to turn off before they go into a destruct mode. See Figure 6-11.

Although this discussion is devoted to the section of T1 that controls the upper rail transistor, the same timing and sequences are applicable to the other secondary of T1 that controls the lower rail transistor.

Also IC2 and T2 form an identical circuit for controlling a second pair of transistors on the drive module.

Pins A and B are current sense inputs. The resistors R5 and R6 are inserted in series with the motor current. R5 and R6 are scaled so that 1 amp through the motor is equal to 10 millivolts at the input of IC3. The gain of 1C3 pins 1, 2 and 3 is set at 16.75. Therefore, the signal at IC3 pin 1 is 167.5 millivolts per amp of motor current. This signal is fed to the DCS board through K2 pin 4 and into D44 and D45 for use by IC3 pins 8, 9 and 10.

If the current signal is positive, D44 conducts, which impresses the current signal on the noninverting input of IC3 at pin 10. The output of 1C3 at pin 8 is then positive. If the current signal is negative, D45 conducts, which presents the current to the inverting input of IC3 at pin 9 through RZ1. 1C3 pin 8 is forced positive for this case also.

The output of IC3 at pin 8 is then divided in half through RZ1 and inputted to the noninverting input of IC3 at pin 5. A set-point voltage is set on pin 6 of IC3 by the voltage divider consisting of R42 through K4 pin 1, through a thermal switch on the heatsink, back into K4 pin 2, through R43 and across R44 and C6. This set-point is equal to positive 20 millivolts. Pins 5, 6 and 7 of 1C3 are configured as a very high gain switch. Because of the positive set-point on the inverting input the output is normally negative and D47 is back biased. If the current signal at pin 5 on IC3 becomes greater than the positive set-point, the output of IC3 at pin 7 goes to +10 VDC, This voltage forward biases D47 and pulls K2 pin 2 to a +9 VDC. K2 pin 2 is the current fault into the DCS board, which forces the inputs to IC1 and IC2 to shut off the current into the motor.

NOTE

ff a thermaf switch is not used, K4 pin 1 is jumpered to pin 2.

Each motor drive module has a current sensing toroid, and the motor leads run through the center of it. The theory here is that the same amount of current is returning trom the motor as is flowing from it. As long as that statement is true, the current sense transformer has a zero voltage on its output. If one of the motor leads is shorted to ground, then no current is returned to the current sense circuit; but the transformer detects a large current rise in the wire going through it. The transformer output goes to a high voltage.

The output of this transformer is connected to K4 pins 3 and 4. The current signal is then presented to R32 and C13, which is a voltage smoothing filter. The voltage on C13 is fed to D41 and D42. The amplifier 1C3 pins 12, 13 and 14 works exactly the same as IC3 pins 8, 9 and 10 which were previously explained. The output of IC3 pin 14 is coupled through D43 to the input of the current detector circuit, which shuts down the drive module.

K2 pin 1 is the +12 VDC input. C25 is a noise filter,

K3 pin 3 is the −12 VDC input. C26 is a noise filter.

6.7.3 Output Drive Module (3-193-7997)

The output drive module consists of a sheet metal plate with two power transistor blocks, a toroid transformer, a voltage filter capacitor, and an output terminal block. Each power transistor block contains two darlington transistors capable of switching 50 amperes of DC current and two 50 ampere diodes connected from emitter to collector of each transistor,

6.8 INDUCTOR AND RELAY PANEL (3-193-8465)

The inductor and relay panel contains the inductor, which is wired in series with the motor. The relays are wired so that a normally closed contact is shunted around the motor, and two normally open contacts are wired in series with the motor and inductor. When the motor drive is enabled, the relay is energized; and the motor armature is connected to the output of the molor drive module. When emergency stop is invoked, the relay is de-energized, the armature is disconnected from the motor drive, and the voltage in the motor is shorted by the closed contact.

6.9 THE DRIVE MODULE SET-UP PROCEDURE

The current limit potentiometer must be adjusted during high current surges. During bench set up, connect a 3 millihenry at 30 amp inductor in place of the motor. Put a small square wave signal of 1 Hertz into the velocity command.

NOTE

R62 may have to be paralleled with a *100* K-ohm resistor.

With an oscilloscope, observe the current feedback signal. Slowly increase theamplitudeof the input signal until the current through the inductor reaches 30 amps. Adjust R33 until the current is clamped at 30 amps, even when the input signal is increased.

To check the tachometer feedback circuit, establish the above conditions and input a tachometer signal. When that tachometer signal reaches about 7 volts, the current should start decreasing. As the tachometer signal is increased, the current clamp should continue to decrease.

Remove the tachometer signal and the velocity signal. Input a voltage into the velocity command to maintain the current at 30 amps without changing position. After about 15 seconds, the current should feed back to 15 amps.

NOTE

Tachometer gain and ollset should be adjusted in actual operation.

The offset can be adjusted with the axis at rest. Go to the FIST Monitor and adjust the offset until the input to the DAC is 800. If a FIST monitor is not available, do not adjust offset.

The tachometer gain potentiometer should be adjusted clockwise. If a check of the tachometer shows overshoot at the instant of stop, adjust counterclockwise until overshoot goes to zero.

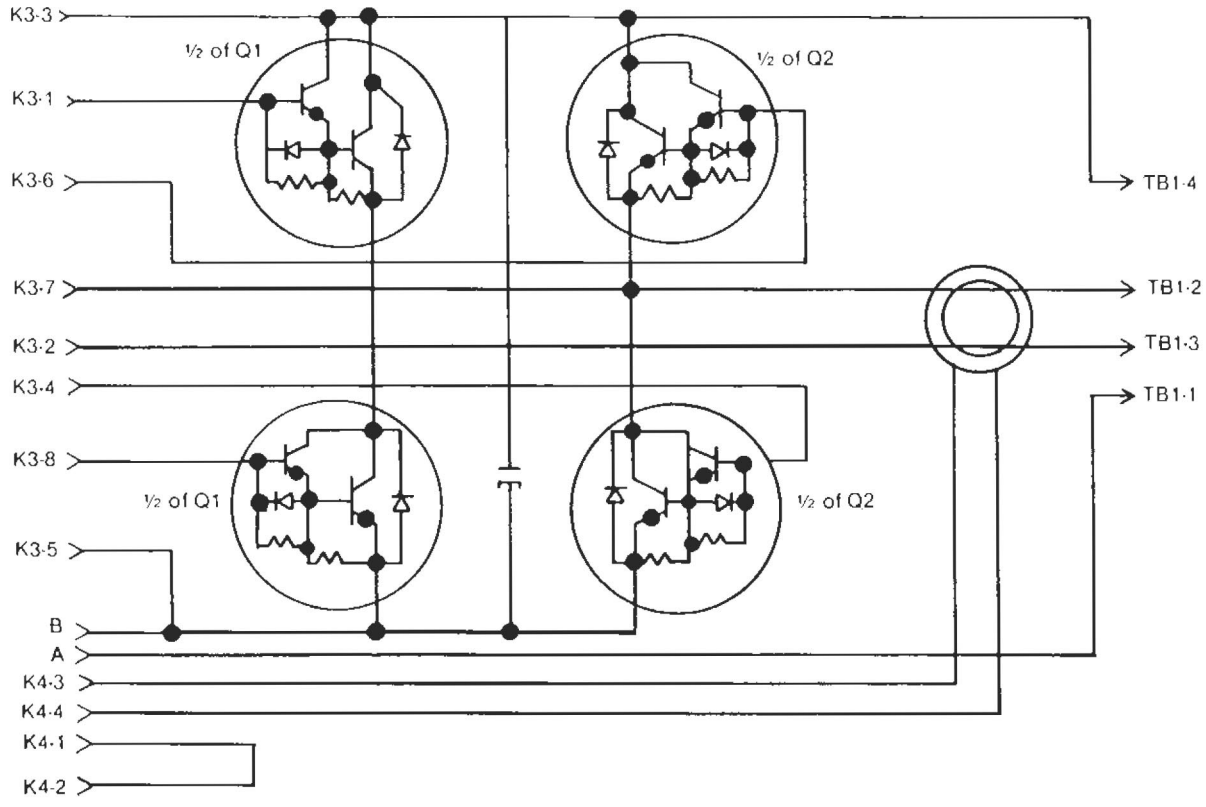
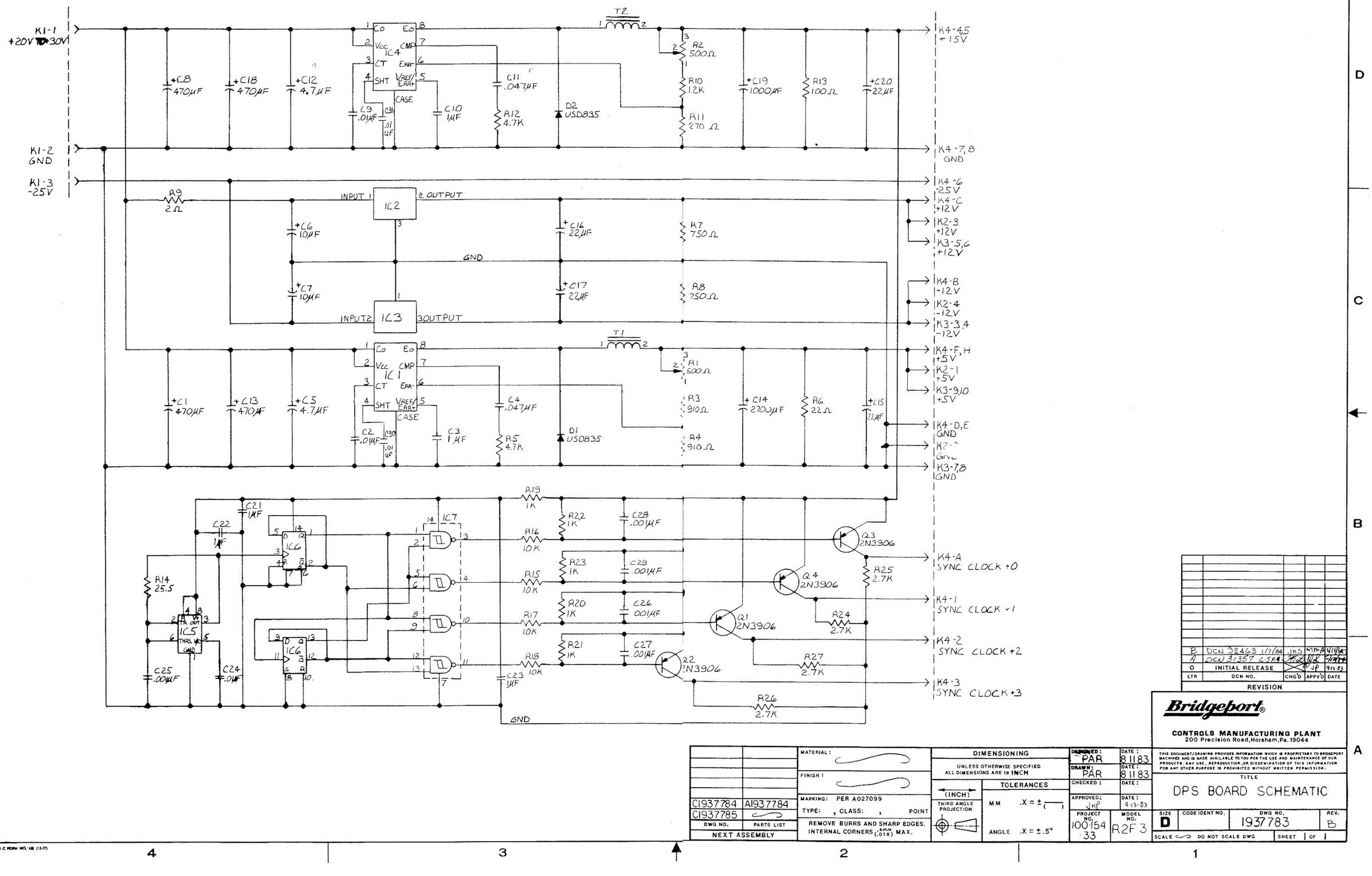


Figure 6-11. Drive Output Transistors



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A	DCN 31357	MDA	JHP	9/15/83
0	INITIAL RELEASE		JHP	9/13/83

REVISION

Bridgeport®

CONTROLS MANUFACTURING PLANT
200 Precision Road, Horsham, Pa. 19044

TITLE: DPS BOARD SCHEMATIC

C1937784	A1937784
C1937785	
DWG NO.	PARTS LIST
NEXT ASSEMBLY	

MATERIAL:
FINISH:
MARKING: PER A027099
TYPE: , CLASS: , POINT
REMOVE BURRS AND SHARP EDGES.
INTERNAL CORNERS .4mm (.016) MAX.

DIMENSIONING
UNLESS OTHERWISE SPECIFIED ALL DIMENSIONS ARE IN INCH
TOLERANCES
(INCH) THIRD ANGLE PROJECTION
MM .X = ±
ANGLE .X = ±.5°

DESIGNED: PAR	DATE: 8 11 83	
DRAWN: PAR	DATE: 8 11 83	
CHECKED:	DATE:	
APPROVED: JHP	DATE: 9-13-83	
PROJECT NO. 100154 33	MODEL NO. R2F 3	

SIZE	CODE IDENT NO.	DWG NO.	REV.
D		1937783	B

SCALE — DO NOT SCALE DWG — SHEET | OF |

B C FORM NO. 426 (13-77)

D 1937860

NOTES.
1. UNLESS OTHERWISE NOTED. ALL RESISTORS ARE 5%
2. COMPONENTS NOT INSTALLED AT LOCATIONS R3, R7, R10, R15, R56, R57

LTR	DCN NO.		CHG'D	APP'D	DATE
C	DCN 33414	9-18-85			
B	DCN 31487	7-3-84		mma	7-3-84
A	DCN 31255	5-23-84		mma	6-6-84
O	INITIAL RELEASE			JP	

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Bridgeport
CONTROLS MANUFACTURING PLANT
200 Precision Road, Horsham, Pa. 19044

TITLE: IFC SCHEMATIC

DESIGNED: J.H.R.	DATE: 9-1-83
DRAWN:	DATE: 9-1-83
CHECKED:	DATE:
APPROVED:	DATE: 11-10-83
PROJECT NO. 100154-35	MODEL NO. R2F3

SIZE D | CODE IDENT NO. | DWG NO. 1937860 | REV. C
SCALE: DO NOT SCALE DWG | SHEET 1 OF 1

MATERIAL: | FINISH: | MARKING: PER A027099 | TYPE: , CLASS: , POINT
REMOVE BURRS AND SHARP EDGES. INTERNAL CORNERS 4mm (.016) MAX.

DIMENSIONING: UNLESS OTHERWISE SPECIFIED ALL DIMENSIONS ARE IN MILLIMETERS. MM (INCH). THIRD ANGLE PROJECTION.
TOLERANCES: MM .X = ± ( ); ANGLE .X = ± .5°

DWG NO.	PARTS LIST
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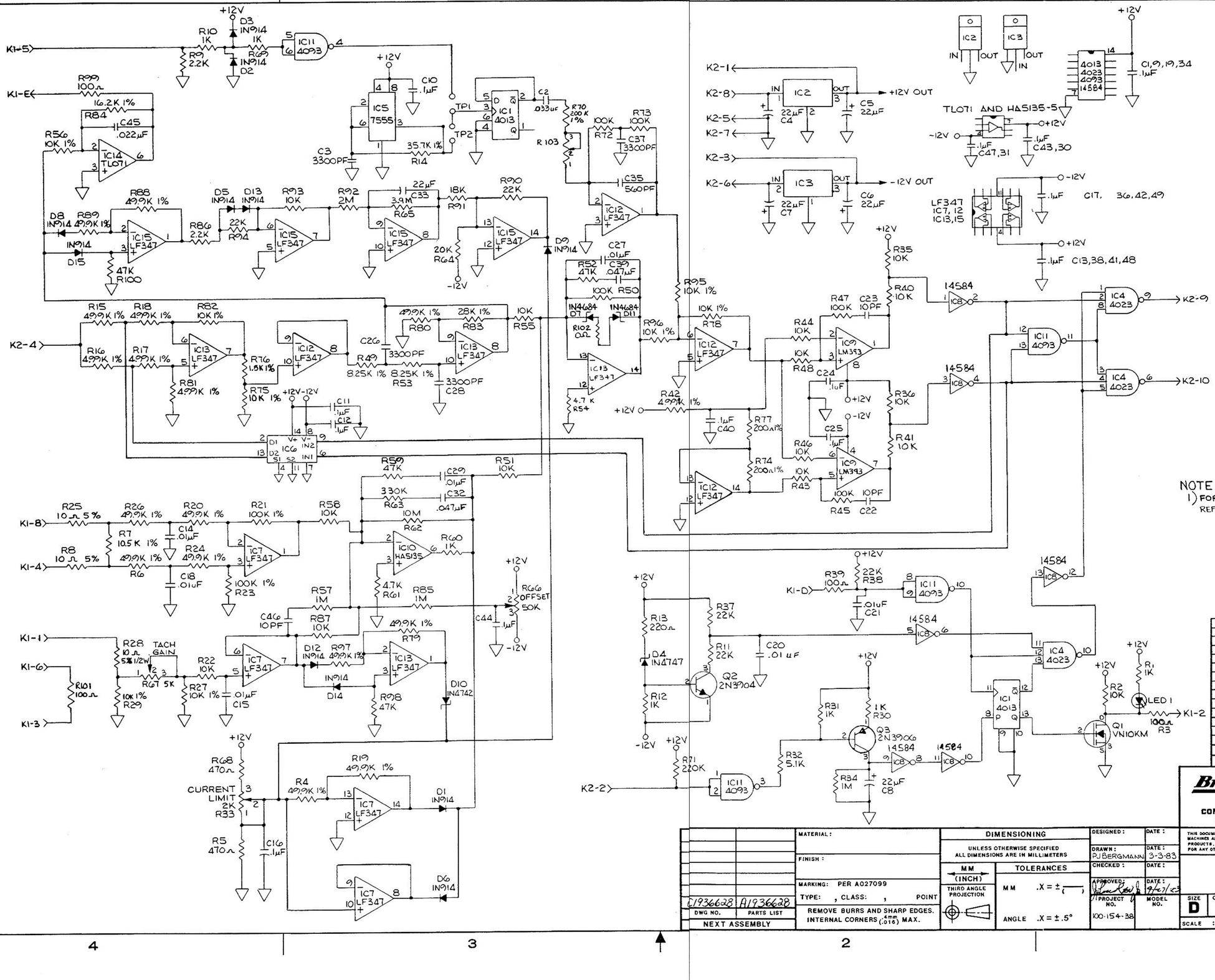
NEXT ASSEMBLY



NOTE:
1) FOR THEORY OF OPERATION REFER TO *TEXT IN CHAPTER 6.*

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E	DCN 32963 & 32980	WAR	RWL	4-2-85
D	DCN 32442 2/5/85	TC	MMA	2-12-85
C	DCN 32188 10/30/84	WAR	MMA	11-7-84
B	DCN 32143 10/22/84	T.C.	MMA	10-26-84
A	DCN 31777 9-7-84	TC	MMA	9-17-84
0	INITIAL RELEASE		WJF	9/27/83

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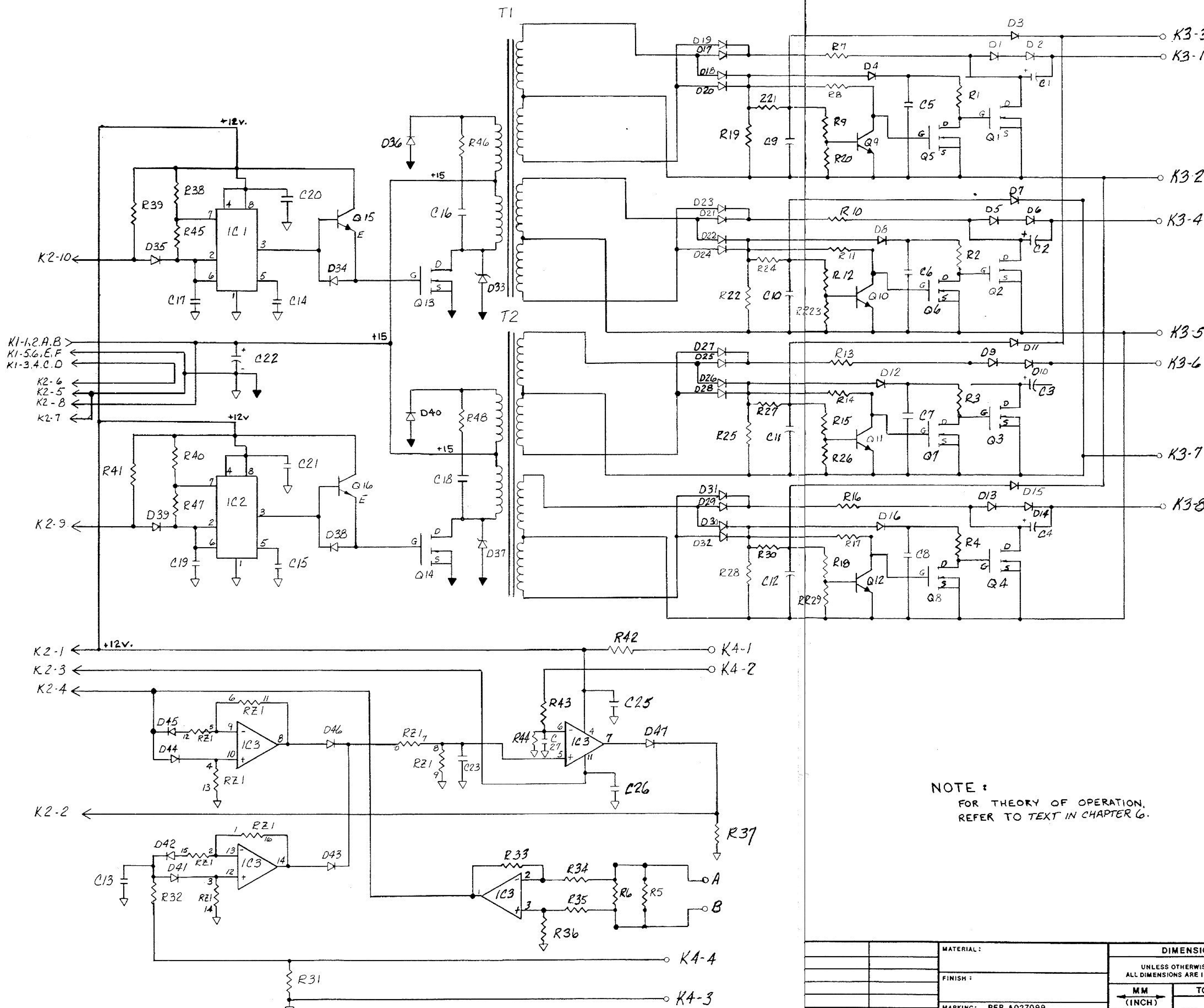
200 Precision Road, Horsham, Pa. 19044

MATERIAL:	DIMENSIONING	DESIGNED:	DATE:
FINISH:	UNLESS OTHERWISE SPECIFIED ALL DIMENSIONS ARE IN MILLIMETERS	DRAWN: PJBERGMANN	DATE: 3-3-83
MARKING: PER A027099	MM (INCH) THIRD ANGLE PROJECTION	CHECKED:	DATE:
TYPE: , CLASS: , POINT	TOLERANCES: MM .X = ± ( ) ; ANGLE .X = ± .5°	APPROVED:	DATE: 9/27/83
C1936628 / A1936628 (DWG NO. / PARTS LIST)	REMOVE BURRS AND SHARP EDGES. INTERNAL CORNERS (.4mm (.016)) MAX.	PROJECT NO. 100-154-38	MODEL NO.
NEXT ASSEMBLY			

TITLE
SCHEMATIC
D&S BOARD

SIZE	CODE IDENT NO.	DWG NO.	REV.
D		19366626	E
SCALE : DO NOT SCALE DWG		SHEET / OF /	

D 1936447



NOTE:
FOR THEORY OF OPERATION,
REFER TO TEXT IN CHAPTER 6.

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C	& 32036 3175 10-2-84	TC	mma	10-3-84
B	DCN 30720 4/11/84			
A	DCN 30498 11/8/83			
O	INITIAL RELEASE			

REVISION

Bridgeport®

CONTROLS MANUFACTURING PLANT
200 Precision Road, Horsham, Pa. 19044

TITLE: H-BRIDGE DRIVER SCHEMATIC

D1936478	A1936478
DWG NO.	PARTS LIST
NEXT ASSEMBLY	

MATERIAL:
FINISH:
MARKING: PER A027099
TYPE: , CLASS: , POINT
REMOVE BURRS AND SHARP EDGES.
INTERNAL CORNERS .4mm (.016) MAX.

DIMENSIONING
UNLESS OTHERWISE SPECIFIED ALL DIMENSIONS ARE IN MILLIMETERS
MM (INCH)
THIRD ANGLE PROJECTION
TOLERANCES
MM .X = ±
ANGLE .X = ± .5°

DESIGNED: DATE:
DRAWN: J. J. Loftus DATE: 11-4-82
CHECKED: DATE:
APPROVED: DATE:
PROJECT NO. 100-154-39
MODEL NO. R2F3

SIZE D | CODE IDENT NO. | DWG NO. 1936447 | REV. E
SCALE: DO NOT SCALE DWG | SHEET 1 OF 1

CHAPTER 7

TROUBLESHOOTING

7.1 INTRODUCTION

Troubleshooting consists of locating faults by starting with obvious causes and moving to the less obvious. Field diagnosis of machine problems can be divided into three sets of checks which are listed below. A flow chart, Figure 7-1, is provided to assist in following the steps. The flow chart indicates which subsystem is likely to be at fault and directs the technician to the proper section in this chapter.

7.1.1 Procedure

Follow the flow chart, Figure 7-1, to determine the best place to begin troubleshooting the R2E4 system. The three major sets of checks are:

1. Incoming Power (Section 7.2.1)
2. Power Supplies (Section 7.2.2)
3. Diagnostic Tests (Section 7.3)

An additional two sets of checks for axis stalling and spindle problems are presented in Sections 7.4 and 7.6.

Use the System Wiring Diagram (3-193-8313) to follow the electrical checks and to perform any additional electrical checks, if necessary.

7.2 ELECTRICAL POWER TEST — Figure 7-2

Lethal voltages are present in the Power Distribution Enclosure, even when the Main Disconnect switch is off. Use extreme *caution* whenever working in the Power Distribution Enclosure. Failure to do so may cause electric shock, resulting in serious personal injury or death.

Power enters the machine at the Main Disconnect switch on the Power Distribution Enclosure. It is distributed from there to the Axis Drive Enclosure and the Operator Control Enclosure. Check the Power Distribution Enclosure and then the Operator Control Enclosure.

7.2.1 Incoming Power

1. Be sure that AC power at the voltage stamped on the label on the outside of the Power Distribution Enclosure is properly supplied to the machine. If not, correct any problems.
2. Turn on the Main Disconnect switch at the Power Distribution Enclosure. Measure the incoming power at the main fuses between pairs of terminals 1L1, 1L2, and 1L3.

Machine	Reading
208 VAC	187-229 VAC
230 VAC	220-240 VAC
460 VAC	414-506 VAC

If any reading is zero, test the input fuses FU1-FU3 and the disconnect; replace if necessary. If any reading is not within the bounds listed, seek better line regulation,

3. Measure the input voltage to transformers T1 and T2. The voltage should match the voltage measurement in Step 2. If not, locate and correct bad connection(s) between the fuses (FU1, FU2, and FU3), T1 or T2, as necessary.

   The inputs lo T1 are:

Wire #S	Machine
1L2, 1L3	20812301460 VAC, 60Hz

   The inputs to T2 are:

Wire #S	Machine
1L1, 1L2	20812301460 VAC, 60Hz

4. Measure the output voltage from transformers T1 and T2:

   T1:

Wire #S	Reading
13, 12	110-120 VAC

   T2:

Wire #S	Reading
1, 2	110-120 VAC

   If the output voltage is not correct, repair the connection(~)r replace T1 or T2, as necessary.

5. Measure the output voltage to transformer T2 between pairs of terminals marked #211-2, #212-2.

Machine	Reading
A l l	90 VAC

   If the outpul voltage is not correct, repair the connections, replace T2 or continue troubleshooting the circuitry shown on the System Wiring Diagram (3-193-8313) to determine the problem.

7.2.2 Power Supplies — Figure 7-3

1. Turn on the power and locate the terminal strip for Drive Power Supply (3-193-9039). Measure the following voltages:

Terminals	Reading
12,15 (115 VAC Input)	110-120 VAC
12,13 (115 VAC Input)	110-120 VAC
37,39 (– 22 VDC Output)	– 20-24 VDC
40,39 (+ 24 VDC Output)	22-26 VDC

   If the 115 VAC is not present, check the output of T1 again. If it is within tolerance, check fuses 12 and 16 and the wiring between T1 and DPS.

   The + 24 VDC outpul is used in part for the reversinglstarting contactors and the EMERGENCY STOP

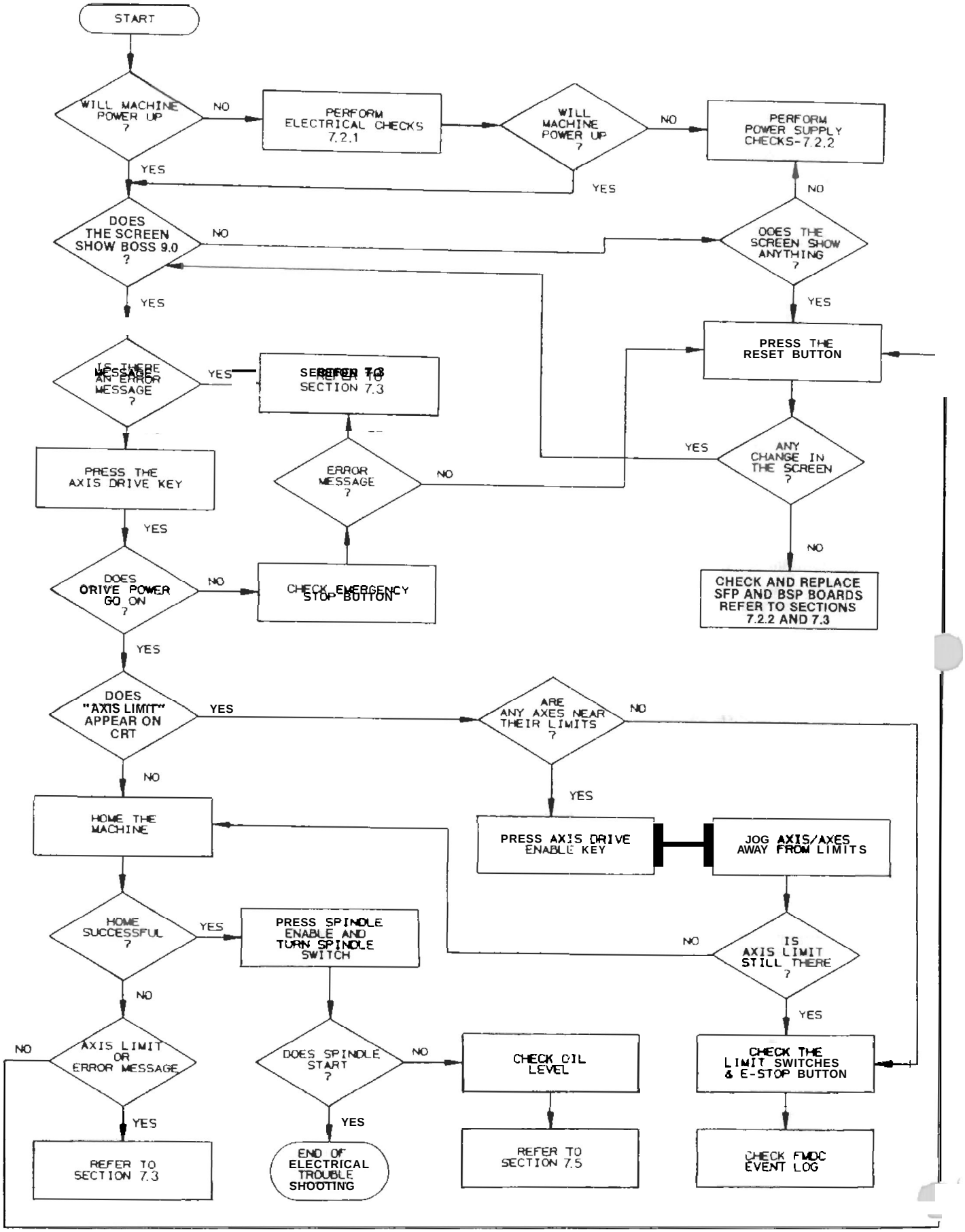


Figure 7-1. Troubleshooting Flow Chart

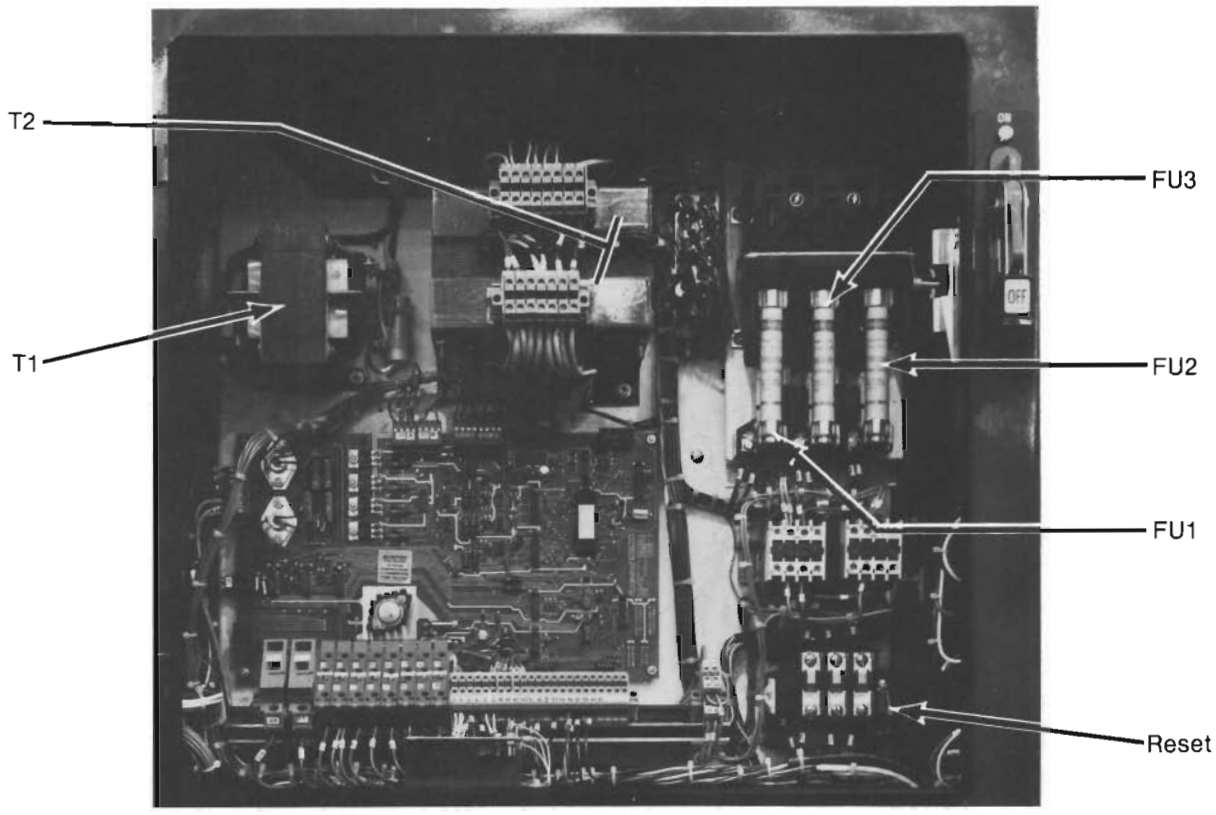


Figure 7-2. Power Distribution Enclosure

button. The control will remain in an emergency stop condition without this supply.

Also on the DPS terminal strip, measure the following voltages:

Terminal	Reading
214-2,215-2	90 VAC
249,250	128 VDC

If the 90 VAC is not present, recheck the output of T2. If the 128 VDC is not present, T2 should be replaced.

2. Locate terminal 14, at fuse 10, on the center terminal strip in the Power Distribution Enclosure. This is the input voltage for Logic Power Supply. Check the voltage between wires 14 and 12.

Terminal	Reading
14,12	110-120 VAC

If this voltage is not present, check fuse 10.

3. Locate the Logic Power Supply in the Operator Control Enclosure. Measure the voltages between the following terminals:

Terminals	Reading
TB1-2	+12 VDC ±.06V
TB1-1	−12 VDC ±.06V
TB1-6	+5 VDC ±.05V
TB1-5	Common

These are the output voltages of Logic Power Supply and are used by the SFP and BSP2 boards. If none of the voltages are present, check fuse 10 and recheck T1. If any of the output voltages are not within tolerance, the Logic Power Supply must be replaced.

4. Locate Wire 40, at fuse 13, on the center terminal block. This is the input voltage for Drive Power Supply. Check the voltage between wires 40 and 39.

Terminal	Reading
40,39	24 VAC

If this voltage is not present, check fuse 10.

5. Locate the terminal strip for DPS Power Supply 3-193-7783 in the DPS board in the Axis Drive Enclosure. Measure the voltages between the following terminals:

Terminals	Reading
K1-2,K2-3	+12 VDC ±.60V
K1-2,K2-4	−12 VDC ±.60V
K1-2,K2-1	+5 VDC ±.05V
K4-7,K4-4	+15 VDC ±.75V

These voltages are used by the FMDC and EAF boards. If none of the voltages are present, check fuse 10 and recheck T1. If any of the output voltages are not within tolerance, the DPS Power Supply must be replaced.

6. Locate the orange power terminal on the left side of the EAF board. Measure the voltages between the following wire numbers:

Wire No.	Reading
K4B-3	+24 VDC ±2.0V
K4B-1	+12 VDC ±.60V
K4B-2	−12 VDC ±.60V

If the +24 VDC is not present, check fuse 13 and recheck DPS, Step 1. If any of the other voltages are

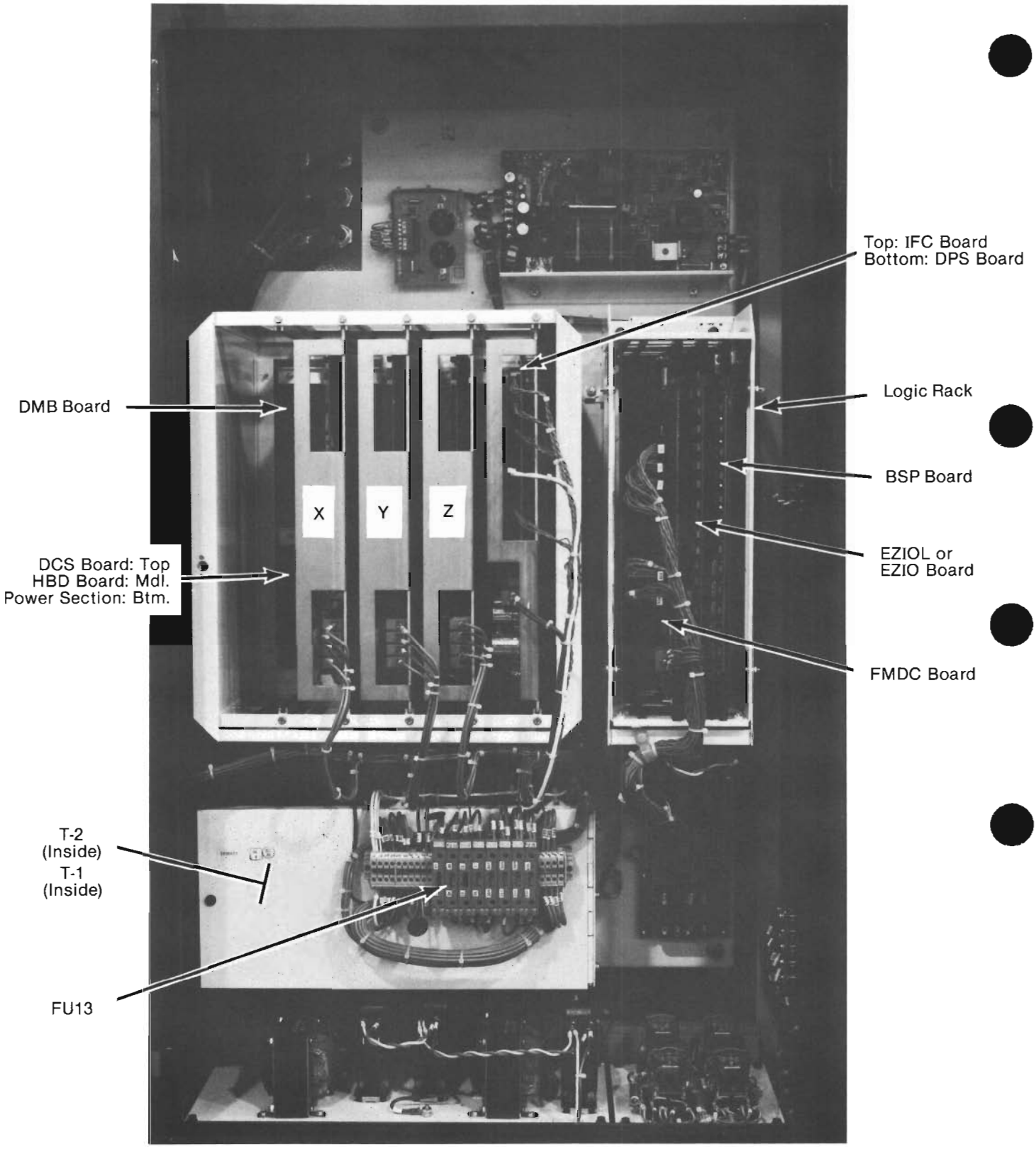


Figure 7-3. Axis Drive Enclosure

not present, check fuse 10 and the wiring from PS2 to the EAF board.

7. Locate the orange power terminal on the lefthand side of the SFP board. Measure the voltages between the following terminals:

Terminals	Reading
K3-8	GND
K3-5	+5 V
K3-10	+ 5 v
K3-9	GND

If any of these voltages are not present or are not within range, recheck Logic Power Supply, Steps 2 and 3.

8. Check for +24 VDC between both leads of the EMERGENCY STOP button, and the GND terminal (green wire) on the terminal strip.

7.3 DIAGNOSTIC TESTS (ON BOARD)

7.3.1 EAF Board

*Lethal voltages are present in the Power Distribution Enclosure. Use extreme caution whenever working in the Power Equipment Enclosure. Failure to do so **may** result in serious personal injury or death.*

If this error appears, it indicates a bad EAF board. First try resetting the machine. If that does not clear theerror, open the Power Equipment Enclosureand locate the EAF board.

EAF Board — The LED on the EAF board has two states: OFF or BLINKING. On power-up or after a RESET, the EAF board performs a series of self diagnostics. If the board fails these diagnostics, the LED will remain OFF. If the board passes the diagnostics, the LED will begin BLINKING about once every second. If at any time during operation a communication failure occurs, the LED will stop BLINKING and will remain in the state it is in (either ON or OFF).

When troubleshooting the EAF board, first locate the green LED.

If the LED is BLINKING, there are no problems with the EAF board.

If the LED is ON, the EAF board is functioning properly, but one of the other boards is not sending it valid data.

If the LED is OFF, open the Power Distribution Enclosure, press the RESET button, and watch the LED on the EAF board.

If the LED begins BLINKING and then stops (either OFF or ON) or if the LED turns ON and remains on, the EAF board is functioning properly; and the fault is in the communications link with another board.

If the LED does not turn ON, check the incoming voltages.

Locate the orange power terminal on the EAF board. Check the voltages between the following wire numbers:

Terminal	Reading
30,33	+12 VDC ±.60V
31,38	−12 VDC ±.60V
39,40	+24 VDC ±.2V

If the incoming voltages are all within range, the EAF board is bad and must be replaced.

7.3.2 **BSP** Board

The BOSS 9 scftware includes a number of tests that are executed on power up or reset which are used to verify the integrity of the system hardware. The test names are displayed on the CRT screen, and the corresponding test number is displayed by the LEDs on the BSP card. The LEDs are arranged on the BSP card in the following order:

LED6 (Yellow)	LED 3 (Yellow)
LED 5 (Yellow)	LED 2 (Green)
LED 4 (Yellow)	LED 1 (Red)

The RED LED (1) indicates that the processor has been halted. This may be due to a hardware problem or the processor is in a reset state. A reset state may be initiated by the user with the system reset button on the BSP card, the reset button on the side of the machine, or the FPU card may be detecting that the 5 volt power supply is too low.

The GREEN LED (2) indicates that the BSP card has 5 volts.

The lour YELLOW LEDs (3-6) are used to indicate which test is currently being run during the power up or reset sequence. The tests are numbered as follows:

LED 6	LED 5	LED 4	LED 3	TEST
Off	Off	Off	On	Non-Destructive Memory Test
Off	Off	On	Off	CRC-16 Test of the BOSS EPROM
Off	Off	On	On	Destructive Memory Test
Off	On	Off	Off	Port A (Local) Uart Test
Off	On	Off	On	Port B (Remote) Uart Test
Off	On	On	Off	FMDC Communications Uart Test
Off	On	On	On	SFP Comunications Uart Test
On	Off	Off	Off	Print "HI" lo the Console, if attached
On	Off	Off	On	9513 Timer Test
On	Off	On	Off	Clock Oscillator Test
On	Off	On	On	Bus Error Logic Test
On	On	Off	Off	9519 #1 Interrupt Controller Test
On	On	Off	On	9519 #2 Interrupt Controller Test
On	On	On	Off	Video Ram (On EZIO) Test

After these tests are run successfully, the YELLOW LEDs will be turned off and the processor will wait one second.

Then the processor will perform the BIG BANG test which tests the Uarts, the interrupt controllers, and the system timer as a group.

The YELLOW LEDs will sequence through the Uart test encodings from Off, On, Off to Off, On, On, On. The YELLOW LEDs will then be cleared, and the processor will wait one second. The BOSS software will then be initialized and started.

The state of the LEDs when BOSS is running is:

LED **6** (Yellow) On	LED 3 (Yellow) Blinking
LED *5* (Yellow) On	LED 2 (Green) On
LED 4 (Yellow) Blinking	LED 1 (Red) Off

7.3.3 FMDC **Board**

IMPORTANT

Before replacing the ***FMDC*** Board, write down the ***status*** and number *of* each LED on the ***FMDC*** board, Include this information on your service report.

The FIST software includes a number of tests executed on power up or reset which are used to verify the integrity of the FKDC board. The test numbers are displayed on the FMDC board as the tests are run. The LEDs are arranged on the FMDC board in the following order:

LED 1 (Green)	LED *5* (Red)
LED 2 (Green)	LED **6** (Yellow)
LED 3 (Yellow)	LED 7 (Red)
LED **4** (Yellow)	LED 8 (Green)

The RED LED (#7) indicates that the processor has been halted. This may be due to a hardware problem or the processor is in a reset state. A reset state may be initiated by the either operator using the system reset button on the side of the machine or the FPU card detecting the *5* volt power is too low.

The GREEN LED (#8) indicates that the FMDC card has 5 volts.

The LEDs #1 through #6 indicate which test is currently running during the power up or reset sequence. The tests are numbered as follows:

LED **1** (GREEN)	LED **2** (GREEN)	LED 3 (YELLOW)	LED **4** (YELLOW)	LED 5 **(RED)**	LED **6** (YELLOW)	TEST
On	On	On	On	On	On	Clear LED Register Test
On	Off	Off	Off	Off	Off	Drive Enable FF Test
Off	On	Off	Off	Otf	Off	Non-destructive Memory Test
On	On	Off	Off	Off	Off	CRC16 Eprom Test
Off	Off	On	Off	Off	Off	Destructive Memory Test
On	Off	On	Off	Off	Off	BSP Communication Uart Test
Off	On	On	Off	Off	Off	Console Uart Test
On	On	On	Off	Off	Off	EAF Communications Uart Test
Off	Off	Off	On	Off	Off	Uart #4 Test
On	Off	Off	On	Off	Off	Print "HI" to Console
Off	On	Off	On	Off	Off	– 10 Volt REF and ADC Test
On	On	Off	On	Off	Off	Input #0 of ADC #1 Test
Off	Off	On	On	Off	Off	Input #1 of ADC #1 Test
On	Off	On	On	Off	Off	Input #2 of ADC #1 Test
Off	On	On	On	Off	Off	Input #3 of ADC #1 Test
On	On	On	On	Off	Off	Input #4 of ADC #1 Test
Off	Off	Off	Off	On	Off	Input #5 of ADC #1 Test
On	Off	Off	Off	On	Off	Input #6 of ADC #1 Test
Off	On	Off	Off	On	Off	Input #7 of ADC #1 Test
On	On	Off	Off	On	Off	X-Axis 9513 Test
Off	Off	On	Off	On	Off	Y-Axis 9513 Test
On	Off	On	Off	On	Off	Z-Axis 9513 Test
Off	On	On	Off	On	Off	C-Axis 9513 Test
On	On	On	Off	On	Off	S-Axis 9513 Test
Off	Off	Off	On	On	Off	Clock Oscillator Test
On	Off	Off	On	On	Off	Drive Enable FF Test
Off	On	Off	On	On	Off	X-Axis DAC Test
On	On	Off	On	On	Off	Y-Axis DAC Test
Off	Off	On	On	On	Off	Z-Axis DAC Test
On	Off	On	On	On	Off	C-Axis DAC Test
Off	On	On	On	On	Off	S-Axis DAC Test
On	On	On	On	On	Off	Bus Error Logic Test
Off	Off	Off	Off	Off	On	#1 Interrupt Controller Test
On	Off	Off	Off	Off	On	#2 Interrupt Controller Test
Off	On	Off	Off	Off	On	Combined Interrupt Test

After the successful completion of the tests, the FIST software will be initialized and begin execution. The state of the LEDs when running the FIST is:

LED 1 (Green) Blinking	LED 5 (Red) Off
LED 2 (Green) Blinking	LED 6 (Yellow) On/Off
LED 3 (Yellow) On/Off	LED 7 (Red) Off
LED 4 (Yellow) On/Off	LED 8 (Green) On

LED 3 and LED 4 will be on or off depending on the setting of the backlash compensation pots.

LED 5 will normally be oft unless the safety tests that are run by FIST detect an error.

LED 6 will be on when the axis drives are enabled.

7.4 AXIS STALLING

The following check is made while the axes are moved.

Check to see that the motor and screw pulleys are tight and the belt is not broken.

For further information on Axis Preventative Maintenance, see Tables 7-1 and 7-2.

See Figure 7-3 for location of components.

7.5 AXES MISPOSITIONING

Gross mispositioning is alerted through the control and is the result of the axis not completing a command move.

The following are areas to check:

1. Lubrication, see Chapters 3 and 12.
2. Interference of motion may be caused by a build-up of chips. Clean ways.
3. Check gibs, see Section 10.7.
4. Review axis alignment procedures explained in Section 6.6.

7.6 SPINDLE FAILURE

1. If the spindle has stopped abruptly, check to see if the spindle overload, MOL, has tripped. If it has, give the heaters in the device a chance to cool and then reset it by pushing the red RESET button, see Figure 7-2. Make sure that all connections from the power line to the spindle motor are tight.
2. If the spindle will not start after a move has been completed, check the lubricant level. If the machine has enough lubricant, the lube level float switch may be bad.
3. Should the spindle stop turning as soon as the Spindle Control switch is released, the reversing contactor may be at fault.
4. Check all contacts to the logic boards and terminal strips.
5. If the spindle motor still will not turn, check the power coming into the motor at the motor terminals, T1, T2, and T3 (assuming that the electrical power test has been completed). The spindle motor itself may be at fault.
6. The spindle motor cannot reverse direction if the reversing contactor is defective.

7.7 OVERLOAD RELAY TRIPOUT — Figure 7-2

Power to the motors may be disabled by a break in the overload relay. This may be restored by pushing the red RESET switch located to the right of the relay in the Power Equipment Enclosure. Follow this procedure:

1. Turn OFF the power.
2. Wait 5 minutes.
3. Try the RESET by pushing in the switch. If it does not work, wait another 5 minutes and try again.
4. Make sure that all connections from the power line to the spindle motor are tight.
5. Power should be restored to the motors. If relays trip out more than twice, make sure the feedrate matches the type of material you are cutting.

7.8 POWER-UP SEQUENCE

1. Turn on disconnect switch at Power Distribution Enclosure.
2. The following message will appear on the CRT. "HARDWARE TEST IN PROGRESS 1".
   At this time, the BSP board will go through a self-diagnostic where it will check for any errors in RAM. This test is labeled CRC. All tests will be listed on the CRT as they are completed.

   The second test will check the EZIO board. All front panel LEDs will be lit during test period. If any errors appear at this point, press the reset button on the side of the Axis Drive Enclosure to restart the power-up sequence.
3. Upon completion of these self-diagnostic tests, the CRT will prompt you with this message:
   "PRESS ANY KEY WITHIN THE NEXT 5 SECONDS TO START THE FRONT PANEL TEST. PRESSING NO KEYS CAUSES BOSS TO START."

   The front panel test is independent from the rest of the system tests. With the front panel test activated, all buttons on the front panel must be pressed to exit from the test.

   NOTE

   Any axis faults or zap string problems which may occur will appear at this time on the CRT.

4. The next page displayed on the CRT will be the BANNER PAGE. Read all messages before proceeding.

Table 7-1. Axis Preventative Maintenance Procedures

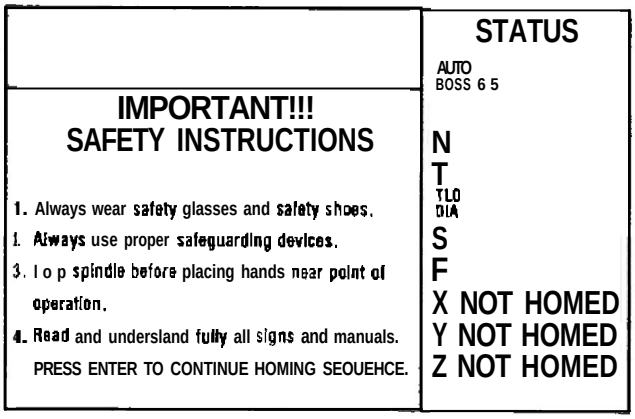
Item	Procedure	Time
Motor Brushes and Commutator	Check the brushes for wear and arcing. Replace brushes, if necessary. Check the commutator for wear and arcing. (Wear is greatly dependent upon application.)	Semiannually
Positioning Accuracy	As a normal manufacturing procedure, check the parts made. Check the electrical positioning accuracy and the mechanical machine accuracy.	As Required
Voltage Checks	Check voltages listed under 7.2.1, Paragraphs 1 through 5, and 7.2.2 Paragraph 1.	Semiannually

Table 7-2. Axis Troubleshooting Chart

Symptom	Possible Cause
Brush or Commutator Failure	Current limit is inoperative or improperly set. There is high current due to injected electrical noise at the transducer inputs to the servo. The motor is overspeeding.
Power Transistor Failure	The fault sensor is defective. Switching lcgic is defective on the printed circuit board.
Contouring Inaccuracy	Gains of all axes are not identical There is servo current limiting in contouring speed range.
Inadequate Performance	The required accelerating current is not available. There is excessive lost motion such as backlash or windup. There is low frequency mechanical resonance (check by observing open loop response).
Position Overshoot	The current limit is too low, or the tachometer gain is too low.
Poor Surface Finish	The position loop gain is too high. The tachometer is noisy. There is a defective feedback device or device excitation. A machine drive member is defective. Machine tooling is defective.
No Motion (All Axes)	The customer's protective interlocks are set. The main supply fuse is open.
Overcurrent Fault (1 Per Axis)	There is an armature circuit fault. The current limit is inoperative or set too high. The HBD board is shorted. The armature is shorted to ground.
Instability During Power Enable	The position or velocity transducer signal is reversed or the armature wires are reversed. The velocity command is not correct. The position or velocity transducer signal is lost. A printed-circuit board is defective.

Table 7-2. Axis Troubleshooting Chart (Continued)

Symptom	Possible Cause
Instability	The axis is not tuned properly. The position loop gain is too high. The lag capacitor is too small. The high frequency gain is improperly set. Multiple position loop gains are improperly adusted (if they are used in the controller).
Instability Manifested by Low Amplitude and/or Low Frequency Oscillation	There is high static to running friction ration. Backlash or deadband is present in the machine or transducer.
Positioning Inaccuracy	High friction is present. Position loop gain and/or low frequency gain of velocity loop is low. There is backlash or wind-up in the position transducerlmotion connection. The tool reaction forces are too high to be consistent with high accuracy. Pulley loose on motor shaft. Encoder output not accurate.
Positioning Cycle Time Too Long	The final position is overshot. The speed is low. Current limit is set too low.
Excessive Machine Wear	Current limit is set too high or is inoperative. The ripple current in the motor is too high due to noise injected from the transducers.
Motor Overheats	The friction level is too high. Current limit is set too high or is inoperative. There is a noise from the transducers that is being injected into the servo. The duty cycle is too severe. The inertia is high. There are high tool reaction forces requiring high motor current. Permanent magnet fields have been demagnetized causing high armature current to develop torque.
Poor Speed Regulation Top Speed	The +128 volt bus is low. Friction is too high. The motor is incapable of operating at the speed being commanded.
Axis-to-Axis Speed Interaction	Power supply capacitance is too small, allowing voltage to dip during motor acceleration Incoming AC line voltage is dipping during acceleration of the motor and allowing the +128 volt bus to drop. High friction of inertia load is pulling the +128 volt bus low. Poor ground connection. The rectitiers are bad or there is some other problem causing the rectificaiton in the power supply to be half wave rather than full wave creating a low voltage +128 volt bus under load.
Erratic Motor Operation	Noise is manifested in the motor current introduced into the servo by transducers. There is poor grounding or there are loose connections. There is a jump on startup or shutdown **due** to improper interfacing.



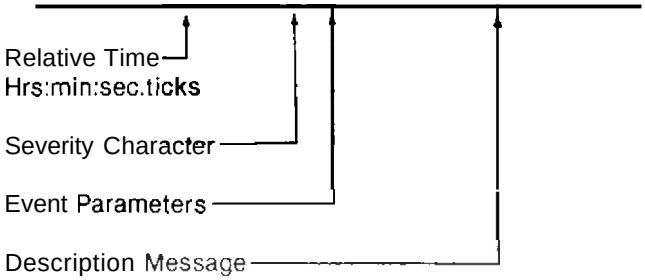
5. Pressing ENTER will enable you to start the homing sequence. Then home all axes by pressing EXECUTE. If any messages appear on the CRT at this time, acknowledge the error by pressing ACKERR button and determine the cause of the error.

7.9 BOSS EVENT LOG

The BOSS Event Log displays a log of all events that took place in the R2E4 operator control. To access the BOSS Event Log:

1. Press the HELP key. A menu will appear on the screen.
   - 0 G-Codes
   - 1 M-Codes
   - 2 Keys-Function
   - 3 BOSS Event Log
   - 4 FIST Event Log
2. Select the number 3 by pressing the front panel key.
3. A list in chronological order will appear on the CRT of all significant events to occur in the operator control. The event log is capable of handling up to 200 events. Once this capacity is reached the first lines of information are dumped out of the event log.

Example 000:27:10.23 ! 0000 0000 Program Too Large



Relative lime is measured from the instant that the command to display the Event Log is entered into the control. All the events shown in any one display are relative to the same time. A tick is one hundredth of a second.

Six levels of severity are displayed. An exclamation character (!) indicates that a failure level event has occurred. A failure event removes power from the axis drives and requires an Axis Drive Enable command. The machine must be rehomed. Some failure events require machine reset.

A (^) indicates a success
(?) is warning
(.) is an error
(*) is abort
(I) is information

Failures arid errors will cause an error message to be displayed on the CRT.

Some events display stored parameters when the event is displayed.

All events display a short message indicating which fault occurred. Following is a list of all the events which can be logged in the BOSS Event Log.

Success Events
Runtime Monitor Passwords:

- Maint Pass
- Factory Pass
- Cancel Pass

Part Program Power Up Checks:

- Part Program Copied From Nonvolatile RAM at Reset
- Good Checksum on Volatile Program Buffer at Reset

Key Sequences:

- Error Acknowledge by User
- Safety Message Acknowledged by User
- Jog Before Homing
- Ade Went to Jog Due to Zap
- Key from Front Panel

Internal Operations:

- Drive Enable & Clear Sent to FMDC
- Part Program Buffer Cleared
- SIO3FQ Called Machentry & Switch
- DNC LINK Canceled

Information Events
Internal Operations:

- Drive Fault, Kill Command Sent to FMDC.

Remote communications:

- Upload Link Aborted by Remote
- Cancel from Port B Device
- Operator Abort Load
- Port B No Response

Warning Events
Spindle Operations:

- Desired Spindle Speed Forced to 520 RPM
- Desired Spindle Speed Forced to 450 RPM
- Spnble with No Spnon

Internal Operations:

- AC Fail During Edit
- Error Reported to User
- SIO3 Dropped Byte

SFP Communications:

- PCOM Received Out of Range Keypad Value
- S104 Uart Status, at 160 Ms
- Received Too Few Characters in PCOM Subpacket
- Received Too Many Characters in PCOM Subpacket
- Received Extra Characters in PCOM Subpacket
- PCOM Link Synch Error, No Modified STX
- SI04 Uart Status, Receive Error
- Bad Key Value from Front Panel

Key Sequences:

Hold Key During Tapping
Spindle Off Key While Tapping Ignored

Part Program Checks:

Bad Checksum on Nonvolatile Program Buffer at Reset
Invalid Bottom Pointer
Bad Checksum on Volatile Program Buffer

FMDC and BSP Internal Communications:

FMDC Receiver Hardware Error
Temp Loss of Response from FMDC
FMDC Sending Extra Chars
FMDC to BSP Receive Error

Remote Communications:

Improper Termination of DNC Program

Error Events

Spindle Operations:

Desired Spindle Speed is Too Slow
Desired Spindle Speed is Too High
Set Spindle Speed Time Out

Part Programming Errors:

Move was Aborted due to Lack of Specified Feedrate
Comp — Neg Radius
Comp — Dummy Won't Fit
Comp — Nopick Xsect
Pars Internal Err, Bad ROFSM
Variable Subscript out of Range
G-Code Invalid
Illegal Condition Code
Incomplete Syntax (PPPL)
Syntax Missing Value (PPPL)
Expected Operator (PPPL)
Synlax Error (PPPL)
Exceeded Max Digit Count (PPPL)
2 Arg Functions Require Parens
Invalid Tool Number
Too Many Digits Left of Decimal Point
Too Many Digits Right of Decimal Point

DNC Link and Remote Load Errors:

No Room in Text Buffer for DNC Link
Char Not Xon from Port B
Uart Status Err from Port B
Program Too Large
DNC Error
DNC Link Errs
DNC Buffer Overflow
Port B Uart Error

Failure Events

Internal Errors:

High Byte Parity Error
Low Byte Parity Error

FMDC and BSP Internal Communications:

FMDC Receiver Hardware Failure
FMDC Not Responding to ESP Commands
Bad Response from FMDC to BSP
BSP to FMDC Xmit Hardware Failure

SFP and BSP Internal Cornmunications:

Cannot Sync with SFP Card, Link may be Dead

Abort Events

System Self Test Failures:

BSP, System Ram Failure
BSP Maintenance Mode on Port A
BSP Dynamic Ram Failure
EZIO Graphics Ram Failure
Diagnostic Test Ram Failure
BSP Communications Device Failure
BSP System Timer Test Failed
BSP Processor or Baud Clock Failure
BSP Memory Logic Failure (Timeout)
BSP Interrupt Controller Test Fail
BSP Readonly Memory Failure (Bad CRC)
BSP Memcry Failure (Vector Space)
BSP Interrupt Circuitry Failure

NOTE

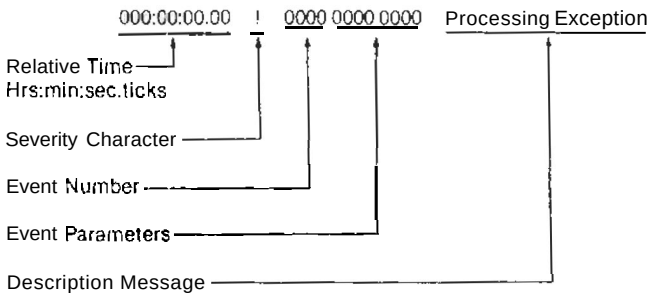
If any of *the* following messages, or any message not previously listed, appear in a BOSS *9* system with which you are working, inform Bridgeport Machines *as* soon as possible.

Sked *Re-Entered*
Nega*tive* Receive Pointer
Negative *Tpointr?*
Panint Error

7.10 FMDC EVENT LOG

The Fist Event Log displays a chronological log of all events that took place on the R2E4 FMDC card. It also powers down Ihe axis drives and disables any movement. The operator must rehome the machine to continue. To access the Fist Event Log:

1. Press the HELP key. The menu will appear on the screen.
2. Press Button Number ***4.*** The drive system will shut down and the events significant to the FMDC will be listed on the screen.



Relative time is measured from the instant that the command to display the Event Log is entered into the control. All the events shown in any one display are relative to the same time. A tick is one hundredth of a second.

There are three levels of severity displayed. An exclamation character (!) indicates that a failure level event has occurred. A failure event removes power from the axis drives and requires an Axis Drive Enable command. The machine must be rehomed. Some failure events require machine reset.

The event number is not necessary for diagnosis. It indicates the location on the event message in the prom memory.

Some events display stored parameters when the event is displayed directly from the FMDC monitor. These events do not display parameters when shown on the front panel in HELP Mode.

All events display a short message indicating which fault occurred. Following is a list of all the events which can be logged in the FIST Event Log.

Runtime Monitor Passwords:

Maintenance Password Entered
Technician Password Entered

Reset and Power-up Testing:

Reset
Non-Volatile Ram Invalid
Log Pointers Bad on Power-up
Ram Error
Uart
ADC Reference Fail
ADC Fail
9513 Timer Fail
Clock Fail
Drive Enable Fail
DAC Fail
Bad Dtack
9519 IC Fail
0000 Rom CRC Fail

Processor Circuitry and Software:

Processing Exception
Bad Break Recovery

Communications to EAF (Affected by Communications to Host):

EAF Not Active
0000 EAF Bad Echo
0000 EAF Uart Error, P I = Status
0000 EAF Uart Error, P1 = Status
0000 EAF Uart Lost Byte, Sent Again
No EAF Echo Before Transmit Attempt
EAF Stat Too Soon
0000 EAF Stat Trans Inhibited

Communications to Host:

Can't Synch to Host
Servo Lost Sync to Communications
Char from Host before 'Stx'
Chars from Host, No 'Stx'
BSP Uart Dropped Byte
Dropbyte, Host (2-13)
0000 Uart Err, Host Status

Host Commands:

E Stop
Host Sent Drives On
No Err, Host Command Drives On
Not Err, Host Command E-Stop
Log Dump to Host
Test

Axis Homing:

No Z Marker After Home Switch
No X Marker After Home Switch
No Y Marker After Home Switch

Fine Interpolation of Cutter Path from Host Command Position:

No Command from Host in 10ms
X, Y or Z Velocity Limit
0000 Motion Error, Lasting More lhan .1 Sec.
0000 X Accel Warning
0000 Y Accel Warning
0000 Z Accel Warning

Encoder Safety Checks:

0000 0000 Misposition: X=1 Y=2 Z=4, Distance
0000 Nu Mark During Encoder Checks. 1st– X=l Y=2 Z=4

Drive Response Checks:

X Vel Err Limit
X Vel Err Large
Y Vel Err Limit
Y Vel Err Large
Z Vel Err Limit
Z Vel Err Large

Hardware Timeout Circuitry:

System Deadman Timed Out, Must Reset
System Deadman Not Count, Replace FMDC
Baud Deadman Timed Out, Must Reset
Baud Dcadman Not Count, Replace FMDC

Tachometer Feedback Checks:

0000 0000 X Tach Disagrees wlcommand 1=Tach, 2=Com
0000 0000 Y Tach Disagrees wlcommand 1=Tach, 2=Com
0000 0000 Z Tach Disagrees w/command 1=Tach, 2=Com

Velocity Command (Following Error) Checks:

– X Overflow
+ X Overflow
– Y Overflow
+ Y Overflow
– Z Overflow
+ Z Overflow

7.11 EAF COMMUNICATIONS

If this error appears, it indicates a problem in the serial RS-422 communications lines between the EAF and BSP boards. Try resetting the machine. If the error is still displayed, measure the voltage between the following wire numbers on the EAF board power terminal:

Terminal	Reading
34,40	+ 24 VDC ± 2.0V
30,33	+ 12 VDC ± .60V
31,33	– 12 VDC ± .60V
32,33	+ 5 VDC ± .05V

If any of these voltages are not present, or are not in range, perform the checks in Section 7.2.2, Steps 1 and 8.

If the voltages are all within range, try replacing the EAF board. If that does not work, try replacing the BSP board.

7.11.1 Communications

If this error appears, it indicates a problem between the EAF board and the outside world.

Try resetting Ihe machine. If the error is still displayed, check all devices connected to the Power Distribution Enclosure. Remote or local devices must be connected to Port A andior 8. If all devices are correctly configured, then perform the following procedure:

1. Press the OPTION key four times to the following screen:

   The baud rates should be correct for the two ports.
2. If Port A is wrong, enter the correct baud rate and press EXECUTE.
3. If the baud rate for Port B is wrong, press EXECUTE, enter the correct baud rate and press EXECUTE again.

7.12 SYSTEM FATAL ERROR

If this error appears, it indicates a problem with the BSP board. Try resetting the machine. If the error is still displayed, locale the orange power terminal on the BSP board and measure the voltage between the following wire numbers:

Terminal	Reading
30,33	+12 VDC ±.60V
31,33	−12 VDC ±.60V
32,33	+5 VDC ±.60V

If any of these voltages are not present, or are not in range, then perform the electrical checks in Section 7.2.2, Steps 2 and 3. If the voltages are all within range, the BSP board must be replaced.

7.13 CRT TROUBLESHOOTING TIPS

Blank Screen

1. No Screen At All
   a. Cable to CRT
      1. Reseat connectors
      2. Meter cable (use System Wiring Diagram, 3-193-8313, sheet 3)
   b. +12 V to CRT
      1. Filament glow in neck.
3. No Alphanumerics (Editor mode, power-up tests)
   b. EZIO Card — IC45
3. Graphics (All modes except Editor, power-up tests)
   a. EZIO Card

Distorted, **Dim** or **Fuzzy** Screen

1. CRT Misalignment
   a. Vertical Sync - Rolling
      1. VR2 V-Hold
   b. Horizontal Position — Wraparound
      1. **VR7** H-Phase
   c. Dim Screen
      1. VR6 BRL
   d. Dim Scrsen
      1. VR6 BRL
   e. Shrunken Image
      1. VR1 V-Height
      2 VR3 V-Line
2, CRT Voltage
   a. +12V − meter
3. EZIO Card
   a. Not likely for shrunken image
4. CRT Unit

Garbage on Screen

1. EZIO Card

Bus Errors in Address Range $00E00000 — $00EFFFF

1. EZIO Card
2. Backplane Connection
   a. Clean edge connectors and reseat BSP and EZIO Cards

Non-volatile RAM Corruption

1. Battery
   a. Check FF'U battery LED
2. EZIO Card

7.14 MAINTENANCE MONITOR

7.14.1 General Operation

Operation of the Maintenance Monitor (Debugger) is done from a terminal attached to Port A of the machine. While BOSS 9.0 is running, the monitor will operate in an interrupting mode without affecting BOSS functionality. When running in this mode, the monitor uses a '}' for a prompt. When any nonrecoverable system failure occurs, execution of BOSS 9.0 is stopped; and the monitor will operate in direct mode using a '<' for a prompt character.

Entry to the Debugger is only through processor exception, i.e., bus errors, address errors. bad vectors, spurious interrupts, illegal instructions, division by zero, etc. The entire processor state is saved at this time. It is then possible to examine these values. BOSS can be restarted by a powerup cycle or by resetting the machine. Memory operations can be done in word mode or long mode. Word or long mode is selected by the W and L commands.

The Debugger can be run by switching dip switch 3 on the BSP to the ON position and applying power to the machine. Execulion will start in "BSP Maintenance Mode on Port A". From this mode, the only way to cause BOSS to run is to power the machine up with dip switch 3 in the OFF position.

See flow diagram. Figure 7-4.

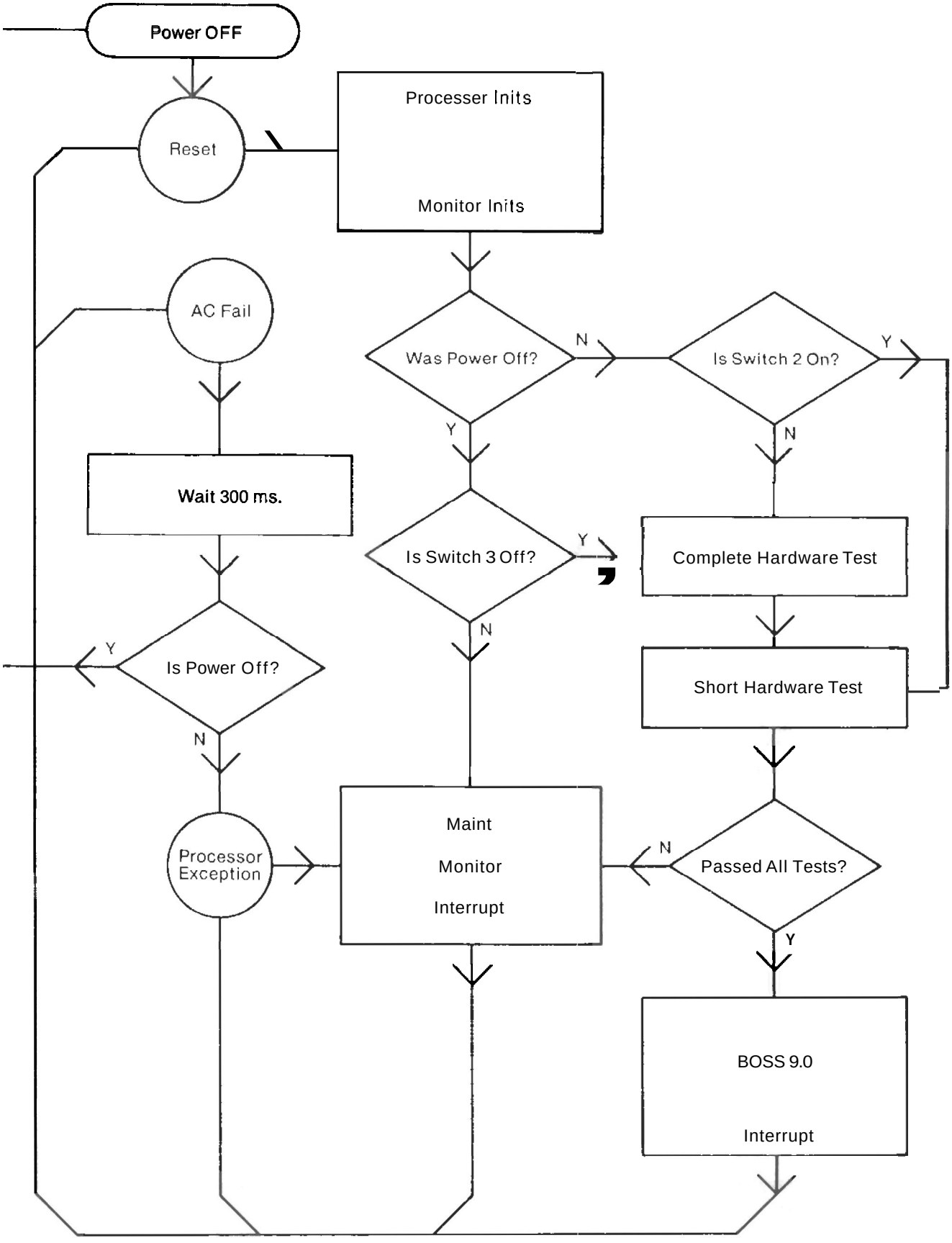


Figure 7-4. Flow Chart, Maintenance Monitor

7.14.2 Command Syntax

All commands consist of a single letter followed by zero or more parameters, separated by delimiters. Delimiters are: <space> ! " # $ % & ' ( ) * + , - . / Note, however, that spaces between the command letter and the first parameter are not delimiters and are ignored; whereas any other delimiter in this position will cause a first parameter of 0. This can be summarized as follows:

1<space>[h][,h][,h][,h]

Where 1 indicates any upper case letter from A through Z. Spaces before the first parameter are optional and ignored. The "h" indicates a hexadecimal number, of which up to four may be specified. The comma may be any of the delimiters. Parameters in excess of those needed by a command are ignored.

Additionally, a subcommand mode for several commands allows continued examination of a memory location or register and the entering of new values to be deposited in that location or register. After the locationlregister has been opened and displayed, the new value may be entered. If none is entered, no change will be made to the location/register. In either case, the line should be terminated with a <CR>, <LF>, or <BS>.

A <CR> will return to command mode unless a new value was entered, in which case the location will be redisplayed. An <LF> will open the next locationlregister. A <BS> will open the previous locationlregister. All commands using this mode are noted in the summary. Also in the subcommand mode, an L or W may be typed to switch modes and redisplay the memory location.

7.14.3 Command Summary

@ (Password)

This command takes one parameler as a password to enable privileges. Maintenance password enables all display commands, but disallows any action that will modify operation of the machine. The entered password value is not echoed to the screen of the terminal.

Syntax: @n1<CR> where n1 = password value

A (Address Register)

This command takes up to one parameter, the number of the register to examine. If no parameter is given, register A0 will be opened. After the register is displayed, subcommand mode is entered.

Syntax: A[r]<CR> where r = register number

CDEAD (Call Hardware Tests) Debug Only.

This is a special instruction for running hardware tests. Instructions for use appear on the screen.

Syntax: CDEAD<CR>

D (Data Register)

This command takes up to one parameter, the number of the register to examine. If no parameter is given, D0 is opened. After the register is displayed, subcommand mode is entered.

Syntax: D[r] <cr> where r = register number

E (Exception Dump)

Repeats the last exception dump. No parameters.

Syntax: E<CR>

H (Hex-ASCII Dump)

This command takes up to two parameters, starling and ending address. It causes memory dump from starting address to ending address in both hex and ASCII. If no ending address is supplied, the next 64 words are dumped. If no starting address is supplied, dumping is continued from the last dump address.

Syntax: H[s][,e]<CR> where s = starting address, e = ending address

I (Initialize and Clear Event Queue)

No parameters

Syntax: I<CR>.

K (Calculate)

This instruction takes two parameters. It displays the sum and difference of two hex numbers in hex and decimal.

Synlax: Knl, n2>CR> where sum = n1 + n2, dif = n1 - n2.

L (Long Mode)

No parameters. Sets long mode.

Syntax: L<CR>

M (Memory)

Memory takes up to one parameter, the address to display. If none is supplied, the last address examined is used. After the location is displayed, subcommand mode is entered.

Syntax: M[a]<CR> where a = address

P (Examine PC)

No parameters. Displays exception program counter.

Syntax: P<CR>

Q (Queue Dump)

Queue Dump takes up to one parameter, the number of entries to dump. If omitted, 20 are dumped.

Syntax: Q[n]<CR>

S (Display Status Register) Debug Only

No parameters. Displays exception status register.

Syntax: S<CR>

T (Transparent Mode) Debug Only

This command lakes up to one parameter, exit character. It enters transparent with Host on SIO 2. The parameter specifies which control character will cause an exit from transparent mode. A through F specifies Ctrl-A through Ctrl-F, respectively. If another character, string of characters or no character is specified, the exit character defaults to Ctrl-A.

Syntax: T[e]<CR> where e is exit char.

U (Display User Slack Pointer) Debug Only

No parameters. Displays user stack pointer. (Note: SSP is A7)

Syntax: U<CR>

W (Word Mode)

No parameters, Sets word mode.

Syntax: W<CR>

X **(Dump Registers)**

No parameters. Displays all 16 saved registers.

Syntax: X<CR>

CHAPTER 8

TESTS

8.1 INTRODUCTION

This chapter presents the use of the FIST (Fast Interpolator Servo Task) realtime monitor. This is an advanced diagnostics tool used to monitor activity and access failure information, internal system data, and parameters. The word "realtime" is used here to mean the monitor can operate at the same time as the machine. This data can be used by a trained technician to optimize operation of the machine tool and to diagnose hardware failures. It is recommended that customers using this feature or communicating with service personnel are familiar with the contents of this chapter.

8.1.1 Terminal Requirements and Connection Instructions

A connector is provided to attach a terminal device or terminal emulator. This connector is located on the FMDC circuit board in the R2E4 control.

Connector K3 provides connections as follows:

- K3-1 Inverted terminal to FMDC data
- K3-2 Non-inverted terminal to FMDC data
- K3-3 Inverted FMDC to terrninal data
- K3-4 Non-inverted FMDC to terminal data
- K3-5 No connection
- K3-6 No connection
- K3-7 No conneclion
- K3-8 No connection
- K3-9 Logic ground
- K3-10 +5 volt supply (100 ma. maximum)

The signals on pins 1 through 4 are RS-422 compatible. RS-232 devices can be used for distances less than 15 feet by connecting the device's transmitted data to pin 1 and the received data to pin 3. A reference level must be provided by connecting pin *2* to the device's signal common. Five (5) volt and logic ground are provided to power small device interface so that connection to 20 milliamp loop and other standards can be handled. It may also be used to power small handheld terminals.

This is a serial communications channel operating at 1200 baud. The UART device is set to send one start bit and receive one stop bit. Eight bits of data are transmitted in each character, and parity is not used on transmitted or received data.

8.2 DESCRIP"ION

When a terminal is correctly attached to the FMDC and the machine tool is reset, the following message should appear on the screen, see Figure 8-1.

The first line "HI" is a token from the powerup test routine. It indicates the terminal is connected properly and the terminal interface hardware is functioning. The next five lines are a message sent by the monitor initialization soltware. This message is not transmitted until the powerup hardware has been completed successfully or has been bypassed (technician privilege code required). The prompt "=>" is displayed whenever the monitor is ready for command input.

"!4622" is a message from the event logging software. Whenever a significant event occurs, it is logged in the event history; and a notification message is sent to the screen. In this case, the significant event was the reset we started with (see Section 8.3.8 referring to Event History). A new prompt is issued after the message.

If the hardware test encounters a problem, the system

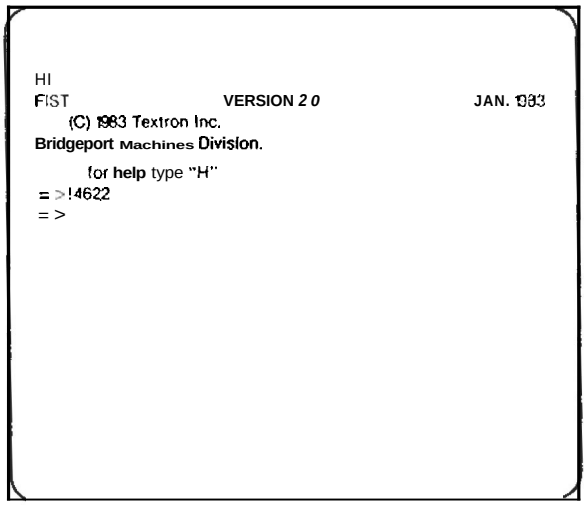


Figure 8-1. Banner Page

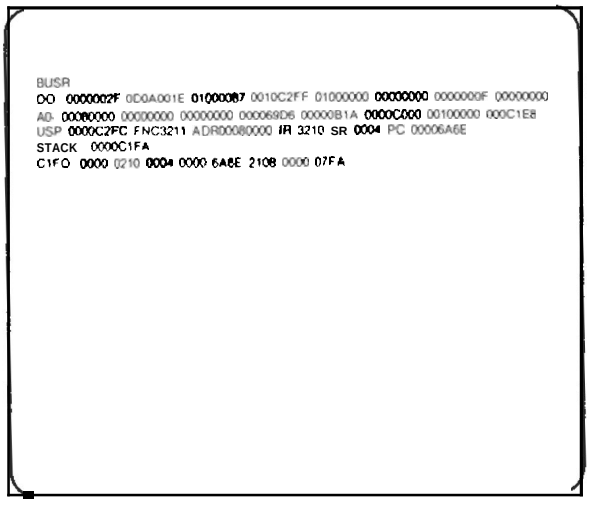


Figure 8-2. Failure **Code**

will not reset properly. An error "2000" may appear on the machine front panel, and the FMDC terminal might display a failure code such as "BUSR" or "FAIL". The token "HI" may or may not appear on the screen. Any failure code will be followed by a processor stack dump displayed in Figure 8-2.

Contact the field service department for repair of hardware problems.

8.2.1 Use of an RPN Monitor

The FIST monitor responds immediately to command keys and action keys when they are entered. This method of specifying commands is called "Reverse Polish Notation" (invented by a Polish mathematician). It differs from algebraic notation, which requires a termination character to signal the completion of the command. In the RPN context, the carriage return character "<CR>" is a specific action command.

8.2.2 Hexadecimal Numbers

The FIST monitor accepts data in the form of hexadecimal numbers. Hexadecimal is another way of saying base sixteen. Sixteen characters are needed to express numbers in hexadecimal. Zero through nine are accepted at their normal value; and the letters A through F are used to represent the values ten through fifteen, respectively. Four hex digits are needed to express sixteen bit values used as data in the 68000 processor. Eight digits are needed to express addresses. For a more complete coverage of base sixteen, consult a mathematics textbook.

8.2.3 Opening Locations

To display the contents of a specific memory location in the address space of the processor, you may enter the address (leading zeros may be omitted) and then press slash *"/"*. To open a location in the working ram area, the address is followed by a semicolon (;). To open a location in the hardware device area, the address is followed by a single quote ('). Opening the device area requires the technician privilege code.

Altering the memory *will* cause *the* machine to malfunction.

Locations to be opened may be specified to be either word or longword locations. The letters "W" and "L" are entered with no preceding data to switch the monitor from one mode to the other. The mode will remain the same until it is changed by another mode command. "Word" is the default mode on reset.

8.2.4 Control Characters

Linefeed is used to display additional location values after an initial location has been opened. The monitor will add two (four for longword mode) to the current address, display the new address, and display the contents of the new location.

Backspace is the inverse of linefeed. It displays the previous location.

Carriage return is used to close an open location. If new data has been specified, the data may be written into the location before it is closed. Modifying memory contents requires technician privilege code.

Table 8-1 is an example of a session using the location commands.

Table 8-1. Location Commands

	Entered by Operator	
=>200/61DE	200/	Open a location in word mode
=>00000202/61DC	<LF>	Open the next location
=>00000204/61DA	<LF>	Open the next location
=>00000206/61D8	<CR>	Close the location
=>		
=>		
=>200 ????	*200'*	Open device location w/o privilege
=>		
=>200 61BF	*200'*	Open device location with privilege
=>00100202/61CF	c LF>	(Start of device space = 100000)
=>00100204/61BF	<LF>	
=>00100206/61CF	<CR>	
=>		
=>200;FFFF	*200;*	Open a location in working ram
=>0000C202/8000	<LF>	(Slart of working ram = C000)
=>0000C204/FFFF	<LF>	
=>0000C206/0000	<CR>	
=>L	L	Switch to longword mode
=>0000C20A/0A00FFFF	<LF>	
=>0000C20E/00000110	<LF>	
=>0000C212/FFFF0000	<CR>	
=>W	W	Switch to word mode
=>	<CR>	
=>0000C214/0000	<LF>	
=>0000C216/FFFF	<LF>	
=>0000C218/3000	<LF>	
=>0000C21A/FFFF	<CR>	
=>	<BS>	Open the previous location
=>0000C218/3000	<BS>	
=>0000C216/FFFF	<HS>	
=>0000C214/0000	<BS>	
=>0000C212/FFFF	<BS>	
=>0000C210/0110	<CR>	
=>		
>F		

8.3 COMMANDS

The commands are functions of the monitor that are not oriented to memory locations. Pressing a specified key will start the action immediately. Two types of command are in the FIST monitor. The first group of commands is self-terminating. These commands execute the desired function and show the command has been completed by displaying a new prompt on the screen. The second group of commands are continuous com-

mands. These commands will continue to display the associated information on the screen until the command is terminated by another operator command.

There are several ways a continous command can be controlled. The following five keys are used to modify or terminate a continuous command,

< ^Z > or < ecs >	Pressing the control Z or theescape key terminates a continuous command. A prompt will be displayed to show the monitor is ready for the next command.
< xoff >	XOFF may be sent by pressing "control S" or by pressing the no scroll key on some terminals. XOFF will cause the monitor to suspend output to the screen, but will not terminate the command.
< xon >	XON cancels any previous XOFF commands. It may be sent by pressing "control Q" or by pressing the no scroll key a second time.
< ^O >	Control O will cause the continous display output to remain on the same line (it suppresses linefeeds). Each new line of data will overwrite the previous line. This mode is easier for the operator to watch when a display of consecutive values is not needed.

8.3.1 Help

Pressing "H" on the keyboard after a prompt will result in the following message on the screen.

```
=>H
  OPEN
     I          Memory
     ,          First ram
     '          Device *
    W,L         Word, long
  CLOSE
  <CR>          *
  <LF>          *, Open next
  <BS>          *, Open previous
DISPLAY COMMANDS
  X, Y, Z       Axis
     S          Status
     P          All
     R          Hardware registers
     Q          Event log
  AW, CW        Allow, cancel warnings *
  a0ddL         Load backlash *
  <CNTL 0>      Holdline
  <XON>         No scroll
  <XOFF>        No scroll
     *          Privilege code required
=>
```

This message is intended only as **a** reference to an operator who is familiar with the FMDC monitor. Anything in the help message which is not understood should be looked up in this Maintenance Manual.

8.3.2 Display Axis Information

Information about an axis will be displayed continuously when the letter for that axis is pressed preceded by no data. The following is an example of the output to the screen. Only one line of each axis is shown in Figure 8-3.

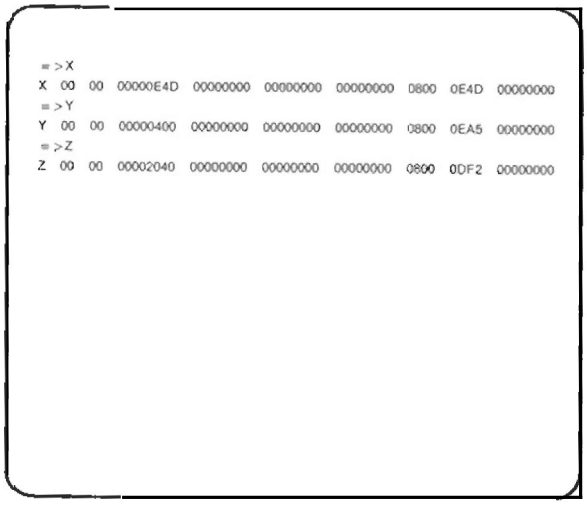


Figure **8-3. Axis** Information

Ten items are on each line of an axis display.

letter	Showing which axis the data is for,
byte	The stored value for backlash compensation for this axis. This value only changes when the operator causes a change.
byte	The actual value of backlash compensation being used in the servo loop at the current time. This will change when the axis changes direction.

The following position values are 32 bit integers in ,0001 inch.

longword	The command position last sent to the FMDC from the BSP. This will be invalid if the communications link is not established between these two units.
longword	The internal command position generated in the FMDC. This will be equal to the BSP command if the axes are powered and homed.
longword	The actual position of the drives. This will be valid anytime after the axes have been homed.

This velocity is 16.16 bit fixed point in .0001 inch per 1.25 ms.

longword	The internal command velocity generated in the FMDC.
word	The actual command for digital to analog conversion. 12 bit signed integer, sign bit inverted.
word	The distance in .0001 inch from home that the home switch closes when moving in the minus direction.

longword The total distance in .0001 inch that the axis has moved in the positive direction. Increases when moving plus; does not change when moving minus.

8.3.3 Display **Status,** Fault, **and** Communications **Information**

Information about the system state will be displayed continuously when the letter "S" is pressed preceded by no data. The following is an example of the output to the screen shown in Figure 8-4.

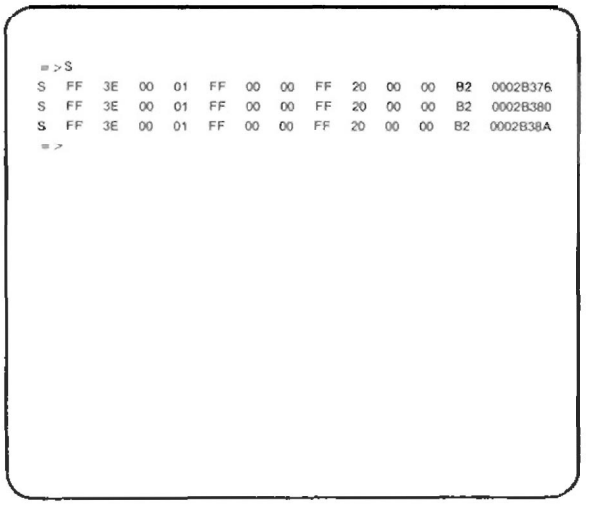


Figure 8-4. Status, Fault and Communication Information

Fourteen items on each line of a system status display.

All of the two-digit items show the contents of a flag register. Each flag register has eight bit-flags that can be either on or off, The following tables show the meaning of each of the defined flag bits. Each of the eight bits is assigned a bit number (zero through seven). When the eight bits are displayed as two hexadecimal digits, the bits are mapped as follows:

bit 0 = 01
bit 1 = 02
bit 2 = 04
bit 3 = 08
bit 4 = 10
bit 5 = 20
bit 6 = 40
bit 7 = 80

Adding up the value of each bit in the one state will result in the hexadecimal value shown on the screen.

Example: Bits 1, 4, and 6 are in the 'one' state. The other bits are in the 'zero' state. By adding 02, 10, and 40, the displayed value will be 52. Working backwards, we can see that a displayed value of 39 is the sum of 01, 08, 10, and 20; this means the bits 0, 3, 4 and 5 are in the 'one' state, and the others are 'zero'.

The last item on the system state display line is a longword which shows the count of the system running time clock. This clock is used to calculate the relative time shown when an event history display is commanded,

The 'S' command can also be entered with a preceding hex digit. The digit will select one of the items on the system state display line. This item will be displayed without the olhers in a continuous display.

```
=8S
8S FF
8S FF
8S FF
=>
```

8.3.4 Display Parameter

The 'P' command will cause one line of each axis display and one line of system tape display to be shown on the screen. This command is not continuous.

8.3.5 Display Hardware Information

The 'R' command is a noncontinuous command. 'R' shows the contents of the registers on the FMDC board that are internal to the hardware devices implementing the FMDC functions, Each line of the display shows the registers of one hardware device. Device register information is used in the factory to troubleshoot hardware malfunctions. This information will not be discussed fully in this manual.

8.3.6 **Insert** Backlash Values

Changing the backlash values stored in the control is only mean: to be done at installation time. It would also be done when an FMDC board is changed in a machine that does not have backlash adjustment potentiometers.

Any person entering the privilege password to alter the backlash compensation assumes responsibility for the values of the backlash compensation and for the accuracy of any parts cut with the tool alter the values are changed.

To enter password, type 'BEEP' after a prompt.

```
=>BEEP
=>
```

To display the current compensation, type 'P'. The stored comp value is the first value on the X and Y lines.

```
=>P
X 00 ...
Y 00 ... Compensation values are zero
```

To load a new value, type five characters as follows. See the section on adjustment of the backlash compensaiion for more details.

1. Type '1' for the X-axis value or a '2' for the Y-axis.
2. Type '0' (Zero).
3. & 4. Type the desired value. From '02' to '28' in .0001 inch.
5. Type 'L'. This letter causes the load to occur.

If the load is successful, a new prompt will appear. Question mark (?) indicates bad load. No change. Display value to verify.

```
=>1004L
```

Type 'P' again to check entered value.

```
=>P
X 04 ...
Y 00 ...
```

Notice the number entered in the command is in decimal, but the number displayed from the memory is in hexadecimal.

```
=>2022L
=>P
X 04 ...
X 16 ...
=>2010L
=>P
X 04 ...
Y OA ...
```

After the values are set, press the space bar to cancel the privilege password.

8.3.7 Warning Control

Two commands are used to control logging and display of significant events that are not failures. These warning and success messages can be enabled or disabled. Enabling warning messages requires technician privilege code.

Type "AW" to allow warnings and "CW" to cancel warnings.

See Section 8.4 on event logging for more detail.

8.3.8 Display Event History

The command 'Q' is used to display the contents of the event log. This command does not alter the contents in any way. Typing a 'Q' with no previous data will cause the monitor to display the last twenty events on the screen. A data parameter may be typed before the 'Q' to specify an exact number of events to display shown in Figure 8-5.

```
=>EVENT HISTORY
-000:11:37.91 !4662 RESET
-000:11:37.91 !4622 RESET
-000:11:37.91 !7F96 4641 494C PROCESSING EXCEPTION
-000:11:37.91 !4D06 ROM CRC FAIL
=>
```

Figure 8-5. Event History

The first item in each line is the relative time between the log listing request and when the listed event occurred. In the example display, all three events shown occurred 11 minutes, 37 seconds and 91 hundredths of a second before the display was requested. The second item on each line of the display is the event code. For more detail about the event code, refer to the Section 8.4. The third item on each line is a message briefly describing the event. This is not intended to be a complete description of the event.

8.4 EVENT LOGGING

The software of the FMDC is programmed to recognize events significant to the function of the board. Whenever a significant event occurs, the severity indicator and event code are shown on the screen immediately. If the screen is currenlly being used to show a continuous display, the event information will be held in a queue until the screen becomes available; then all accumulated information is sent to the screen. In addition, all displayed events are stored in a log. This log is stored in the nonvolatile ram area of the FMDC. There is room to retain 200 messages. When more than 200 events occur the earliest are dropped so that the most recent can be retained. The contents of the event log are lost when tho nonvolatile ram is initialized.

8.4.1 Severity Indicator

Three levels of severity are associated with the events that can be logged. The exclamation mark '!' is the indicator for failure events. The question mark '?' is the indicator for warning events. The up arrow '^' is the indicator for success events. The severity indicator appears before the four digits of the event code. Other four-digit numbers on a line not preceded by an event code are parameters for the previous event code. Warning and success events are not reported or logged if they have not been specifically allowed by operator command.

8.4.2 Event Codes

The event code following the severity indicator is a pointer used by the event logger and display routines to determine the exact type of event that has occurred. It is actually the memory address of the software which has recognized the event. The display routines use the event code to find the appropriate message to be displayed for the event history. The actual value of a particular code may change from one level of software to another.

8.4.3 Parameters

An event may have zero, one, or two parameters associated with it. These parameters will be displayed with the event code when the event occurs. The parameters are also stored in the event log to be shown during an event history display. The message associated with an event may or may not describe the meaning of tho parameters. Generally, the parameters are diagnostic aids for factory troubleshooting of hardware problems.

8.4.4 Event Description Message

Stored in the permanent read-only memory of the FMOC is a table of short messages associated with each event that might be logged. When an operator requests a display of the event history, the software searches the table for the message for each event in the log and displays it at the end of the line with the other information about that event. The messages are intended only as a reference aid so the operators and technicians can quickly determine the importance of an event.

Table 8-2. Meaning of Register Bit

			Meaning of Register or Bit
FAULT	Flag	Register	If any bits are set, the drives are disabled
FEFAULT	=bit	0	Following error overflow
EAFERR	=bit	1	EAF not communicating
PATHERR	=bit	2	Command from BSP not continuous
NOSYNC	=bit	5	Communication from BSP abnormal
SAFAULT	=bit	6	Safety limit violation
POWUP	=bit	7	Emergency stop
•			
FEFAULT	Flag	Register	Any bit set here sets FEFAULT in FAULT
XOVERFLOW	=bit	0	X following error overflow
YOVERFLOW	=bit	1	Y following error overflow
ZOVERFLOW	=bit	2	Z following error overflow
XNOMARK	=bit	4	X encoder marker bit missed
YNOMARK	=bit	5	Y encoder marker bit missed
ZNOMARK	=bit	6	Z encoder marker bit missed
OUTSYNC	=bit	7	Servo lost sync with communications
•			
PATHFAULT	Flag	Register	Any bit set here sets PATHERR in FAULT
XVELERR	=bit	0	X command velocity too large
YVELERR	=bit	1	Y command velocity too large
ZVELERR	=bit	2	Z command velocity too large
XACCERR	=bit	4	X command acceleration too large
YACCERR	=bit	5	Y command acceleration too large
ZACCERR	=bit	6	Z command acceleration too large
NOCMD	=bit	7	Command missing
▪			
EAFFAULT	Flag	Register	Any bit set here sets EAFERR in FAULT
BADECHO	=bit	0	EAF echo does not match command
NOECHO	=bit	1	EAF echo missing
•			
SAFAULT	Flag	Register	Any bit set here sets SAFEERR in FAULT
XTACERR	=bit	0	X axis tach feedback out of range
YTACERR	=bit	1	Y axis tach feedback out of range
ZTACERR	=bit	2	Z axis tach feedback out of range
*			
EAFECHO	Flag	Register	Copy of command from BSP to EAF
			Bit definitions not available
*			
EAFSTATUS	Flag	Register	Status of communications software
ECHREQ	=bit	0	FMOC waiting for EAF echo

Table 8-2. Meaning of Register Bit (Continued)

ECOYET	= bit	1	Echo received, but not sent to BSP yet
COMRDY	= bit	4	Command for EAF received from BSP
RESTART	= bit	5	Enable drives commanded by BSP
REQUEST	= bit	6	Waiting for requested status from EAF
COMSNT	= bit	7	Command echo sent to BSP
•			
EAFDATA	Flag	Register	Machine sensor status from EAF
ZAP	=bit	0	Drive enable string is open
XHOMSW	= bit	1	X axis is on the home switch
YHOMSW	=bit	2	Y axis is on the home switch
ZHOMSW	=bit	3	Z axis is on the home switch
DRVFAULT	= bit	6	Fault received from any axis
FMDCSTATUS	Flag	Register	Condition of FMDC activity
HOMING	= bit	0	FMDC homing all axes, BSP must wait
BADNVR	=bit	4	Nonvolatile ram corrupted
NOPOTS	=bit	5	Backlash pots turned down or missing
DEAD	=bit	6	Fatal error, FMDC requires reset
GOHOME	Flag	Register	Homing activity state register
XGO	=bit	0	X axis being homed
YGO	= bit	1	Y axis being homed
ZGO	=bit	2	Z axis being homed
WAIT4MARK	=bit	3	Home switch seen, waiting for marker
XOFFHOM	=bit	4	X axis off home switch, move toward home
YOFFHOM	=bit	5	Y axis off home switch, move toward home
ZOFFHOM	=bit	6	Z axis off home switch, move toward home
WAIT4HOM	=bit	7	Moving toward home, waiting tor home switch
HOMED	Flag	Register	Homing completion register
XHOMED	=bit	0	X axis finished homing
YHOMED	= bit	1	Y axis finished homing
ZHOMED	=bit	2	Z axis finished homing
XZEROD	=bit	4	X axis zeroed, command must be modified
YZEROD	=bit	5	Y axis zeroed, command must be modified
ZZEROD	=bit	6	Z axis zeroed, command must be modified
•			
OUTPUTREG	Flag	Register	LED shadow register, 'zero' = LED on
GREEN LED 0	=bit	0	Blinking once per 1 sec. = timer interrupt on
GREEN LED 1	=bit	1	Blinking once per 4 sec. = timer interrupt on
ORANGE LED 2	= bit	2	X axis backlash least significant bit
ORANGE LED 3	= bit	3	Y axis backlash least significant bit
RED LED 4	= bit	4	FMDC dead, requires reset
ORANGE LED 5	=bit	5	Drives enabled by FMDC when on
MONACTIVE	= bit	7	No LED, signal high when FMON active

CHAPTER 9

PREVENTIVE MAINTENANCE

9.1 INTRODUCTION

This chapter is written for operators or designated customer representatives. The operator inust know how to operate the machine, monitor the levels of pneumatic oil, lubricating oil and coolant reservoirs, and recognize problems that require Dealer or Bridgeport Field Service maintenance. Most operator tasks deal with the external machine; however, the operator should be able lo locate the overload heater reset in the Power Distribution Enclosure, if necessary.

The operator is not authorized to make adjustments or to replace components.

9.2 OVERVIEW

On the next pages are maintenance procedures required for proper upkeep of the machine. Charts in Section 9.5 are geared to two types of operating conditions. Follow the chart that applies to your operating conditions. Section 9.4 explains each procedure in detail.

Operating conditions are defined as follows:

1. REGULAR SHIFT: The machine is used eight hours a day, live days a week.
2. MULTIPLE SHIFT: The machine is used in a three-shift operation, five or more days per week.

A third operating condition is DRY CUTTING. In this case, the machine is used to cut materials such as cast iron, magnesium or carbon that produce unusually large amounts of dust in the air. This cutting could take place in either REGULAR or MULTIPLE SHIFT conditions. This is considered to be a HOSTILE environment which requires more than the average amount of care.

If the workpiece is cut dry, you must take extraordinary precautions both while cutting and in cleanup to prevent dust and air from entering the system. Follow the maintenance procedures recommended for your shift conditions. In addition, use the following guidelines:

1. The cooling system in the head drives air into the system from behind the speed indicator plate. This air inlet should be filtered. This filtering system is not standard equipment supplied by Bridgeport and must be constructed by the machine owner.
2. Use an industrial vacuum cleaner and clean the exterior of the machine frequently. Do not use compressed air hoses to clean the machines.
3. Use specially designed vacuum systems at the cutting tool.
4. Use electrostatic filters if clean air cannot be directed to the head or the control cabinet inlets.

9.3 EQUIPMENT AND SUPPLIES

- Dry rags or paper cleaning cloths.
- Brush to sweep chips from the tables and ways.
- Industrial vacuum cleaner.
- Mobil DTE 24 or DTE light oil (for pneumatic system filter regulator).
- Coolant fluid. Bridgeport recommends Trim Sol or comparable antibacterial emulsified cutting oil.
- Lubricant for the way lubrication system. The following way lubricants or equivalents are approved for use in this system:

  Gulfway 68
  Sunoco Way Lubricant 1180
  Mobil Vactra Oil No. 2
  Way Lubricant 68 (Texaco)
  Tonna 68 (Shell)

9.4 DESCRIPTION OF MAINTENANCE PROCEDURES

1. Check lube system oil level; fill if necessary. The most convenient procedure is to keep the level of oil to the top of the tank. Check it every day. If the reservoir is allowed to empty, a liquid level switch at its base shuts down the power to the spindle.
2. Clear dirt and chips from the ways. Do this at the end of the day. Use a brush and/or an industrial wet or dry vacuum cleaner, then wipe carefully to remove damage-causing abrasive material. Do not use compressed air to clean the ways.
3. Clean machine exterior; clear intakes and exhausts. Clear dirt and chips from machine at the end of the day. Use an industrial wet or dry vacuum cleaner, then wipe carefully to remove damage-causing abrasive material. Do not use compressed air to clean the machine.

Do not use compressed air *to* clean *the* ways or around the cabinets. Using compressed air could blow chips and other foreign material into the interlocking parts, control system, or the operator, resulting in exrensive damage or serious personal injury.

Check the air intakes and exhausts; clear of obstructions. Foreign material in these areas can cause damage to the machine by entering the Control or Power Enclosures.

4. Clean and apply a light coat of oil to the way covers once a week to keep them pliable.
5. Check coolant level; fill if necessary.

   Flood Coolant: Keep hose joint areas free of chips **and** dirt. The coolant will come out of nozzle in spurts when the level is too low. Fill with Trim Sol or comparable antibacterial emulsified cutting oil.

Mist Coolant: Wipe off excess grime from the top periodically. We recommend filling it only with the amount to be used in one operation.

Clean the air filters. Replace them if necessary. If you can no longer see light through them, it is time to replace them. Dirty shop air can cause damage to the control system if not filtered properly.

NOTE

If mist coolant is used on this or on nearby machines, it will be necessary to change the filter frequently.

Keep the air filters clean to prevent problems, Watch the air filters for the first few months of operation in order to get an idea of how often they should be replaced. The time between filter changes cannot be predicted because it depends on many things, including the hours of operation per day and the nature of materials being machined in the vicinity.

7. Check pneumatic regulator system bowls; fill lubricator bowl if necessary. When the level drops below the EMPTY line, fill to FULL with Mobil DTE 24 or its equivalent.
   a. Shut off the air pressure.
   b. Unscrew the screw from the fill hole at the left rear of the lubricator.
   c. Fill the bowl to the FULL line. Do not overfill.
   d. Replace the fill hole screw.
8. Drain and clear refill pneumatic regulator bowls. The bowl should be drained whenever you notice it filling up with sludge. The bowls should be cleaned semi-annually.
   a. Put a dry rag under the regulator to catch the drips.
   b. Drain the filter bowl by pressing up on the drain valve.

   To clean the bowls:
   a. First drain the filter bowl.
   b .Gently unscrew both bowls.
   c. Rinse them with WARM WATER only. Do not use soap.

Use only warm waler to clean the filter bowls. Using soap, solvent or chemicals may weaken the bowl and cause it to burst, resulting in serious personal injury.

   d. Replace the bowls. Fill the lubricator with Mobil DTE 24 or its equivalent. See Step 7 in this section.

   Clean Tape Reader head. The Remex Company supplies a small brush made especially to clean the least accessible areas of the paper tape head. Use this brush with Miller Stephenson MS 200™ tape cleaner or isopropyl alcohol.

10. Inspect the tape for tears or ragged edges. Replace it if it rooks damaged or worn.
11. Check the spindle motor for dirt; wipe if necessary. The spindle motor can become over-heated if excessive grease and dirt are allowed lo build up on it.
    a. Remove the spindle motor hood.
    b. Inspect the motor for dirt.
    c. Wipe the motor with a rag and remove as much of the build-up as possible.
    d. Replace the hood.
12. Check spindle drive belt for dirt and wear. Notify Dealer Service to replace it if necessary. If the housing itself is excessively dirty, it is a sign that the belt may be worn or weak.
    a. Remove the spindle drive belt cover.
    b. Inspect the belt for wear, cracks, or damage.
    c. If the belt looks worn, call Dealer Service to replace it.
    d. Replace the cover.
13. Remove and clean the automatic oil system pump filter.
14. Clean the dirt and chips from inside the Power Equipment Enclosure and around the card frame. Metal chips can come into contact with the boards and disrupt the electronic signals of the PC boards.

Check each item listed in the checklist on a regular basis. Refer to the step numbers in Section 9.3 for an explanation of each numbered item on the checklist.

9.5 OPERATOR MAINTENANCE REQUIREMENTS

Periodicity Codes:

D = Daily, performed on a daily basis or during a 24 hour period.

W = Weekly, performed on a weekly basis.

M = Monthly, performed on a monthly basis.

S = Semi-annually, performed twice a year.

AS REQUIRED = Depends on working environment.

9.6 CLEANING PC CARDS

Printed circuit boards and wire-wrap boards require different cleaning procedures. Boards with trimmers or switches require special treatment, For printed circuit boards with switches or trimmers, use Procedure 1. For wire-wrap boards, use Procedure 2. For printed circuit boards without switches or trimmers, use Procedure 3.

Use the correct method for cleaning each board. Do not use a compressed air hose on any of the boards. Failure to follow these cautions may result in damage to the boards.

Read the procedures in Appendix B on handling static-sensitive boards before attempting to clean any boards. All of the boards in the R2E4 system are static sensitive and can be damaged if the safety procedures in Appendix B are not followed.

any boards. All of the boards in the *R2E4* system are static *sensitive* and can be damaged if the safety procedures in Appendix *B* are not followed.

Assemble the following materials:

1. Mild liquid dishwashing detergent (JOY? recommended).
2. Soft brush.
3. Isopropyl alchohol (Miller-Stephenson MS 200™ Magnetic Tape Head Cleaner recommended).
4. Freon' TF degreaser (Miller-Stephenson MS 180™).
5. Hair dryer.

Procedure **1** — Boards with Trimmers and Switches

Use only the recommended cleaners and degreasers. Do not use water to clean these boards. Using water may ruin the boards.

1. Wash the boards down with MS 200™ (or isopropyl alcohol) and Freon' alternately, using a soft brush to help loosen the grime.
2. Dry with a hair dryer. Be careful not to get the board too hot. If the air is too hot for your hand, it is too hot for the board.

Procedure **2** — Wire-wrap Boards

Use only the recommended cleaners and degreasers. Do not use water on these boards. Using water may ruin the boards.

1. Wash the board down with MS 200™ (or isopropyl alcohol and Freon' alternately. Use a soft brush on the component side to help loosen the grime, but not on the wire-wrap side.
2. Dry the board using a hair dryer. Be careful not to get the board too hot. If the air is too hot for your hand, it is too hot for the board.

Procedure 3 — **Boards** without Switches and Trimmers

Wash *these* boards quickly, then rinse them off. Do not immerse these boards in water or attempt to soak them clean. Doing so may ruin the boards.

1. Wash the board with a solution of JOY' and warm water, scrubbing gently with a soft brush to remove grime. Rinse thoroughly under running water.
2. Shake off as much water as possible.
3. Support the board in a vertical position with the edge connector at the top. Wash it down with MS 200™ or isopropyl alcohol, starting at the top and working down.
4. Use a hair dryer on a low heat to finish drying the board. Be careful not to get the board too hot. If the air is toc hot for your hand, it is too hot for the board.

9.7 AUXILIARIES SYSTEMS

Though Section 9.4 itemizes the procedures to be followed, refer also to Chapter 12 for further details.

9.8 BATTERY REPLACEMENT

NOTE

This is a Level 2 maintenance procedure.

The four alkaline batteries on the FPU board have a working life of about one year. The FPU board is located in fheaxis drive enclosure, bottom right hand side. After one year,the batteries should be replaced.

To replace the battery on the FPU board, use the following procedure

1. Turn off power to the system at the Main Disconnect switch.
2. Remove old batteries and place the new batteries in position. Be sure to face the "+" in the same direction as the old batteries.
3. Restore power to the system.

OPERATOR DAILY MAINTENANCE REQUIREMENTS – MULTIPLE SHIFT

REF #	REQUIREMENT	PERIODICITY				
		D	W	M	S	AS REQ.
1	Check lube system oil level; fill if necessary	X				
2	Clean dirt, chips from ways	X				
3	Clean machine exterior; clear intakes and exhausts					48 hrs
4	Clean way covers; lightly oil					48 hrs
5	Check coolant level; fill if necessary		X			
6	Check both air filters; replace if necessary. Use electrostatic fillers if dry cutting					48 hrs
7	Check pneumatic lubricator bowl; fill if necessary			X		
8	Drain, clear, refill pneumatic filter bowl. See all warnings; Section 9.4				X	
9	Clean Tape Reader head	X				
10	Check tape for wear; replace if necessary	X				
11	Check spindle motor for dirt: wipe if necessary		X			
12	Check spindle drive belt for wear. Notify dealer service to replace if necessary		X			
13	Clean lube system pump filter			X		
14	Clean inside control cabinet					48 hrs

Check each item listed in the checklist on a regular basis. Refer to the step numbers in Section **9.4** for an explanation of each numbered item on the checklist.

OPERATOR DAILY MAINTENANCE REQUIREMENTS

REF #	REQUIREMENT	PERIODICITY				
		D	W	M	S	AS REQ.
1	Check lube system oil level; fill if necessary	X				
2	Clean dirt, chips from ways	X				
3	Clean machine exterior; clear intakes and exhausts		X			
4	Clean way covers: lightly oil		X			
5	Check coolant level; fill if necessary		X			
6	Check both air filters; replace if necessary. Use electrostatic filters if dry cutting		X			
7	Check pneumatic lubricator bowl; fill if necessary			X		
a	Drain, clear, refill pneumatic filter bowl. See all warnings, Section 9.4				X	
9	Clean Tape Reader head		X			
10	Check tape for wear; replace if necessary	X				
11	Check spindle motor for dirt; wipe if necessary			X		
12	Check spindle drive belt for wear. Notify dealer service to replace if necessary			X		
13	Clean lube system pump filter				X	
14	Clean inside control cabinet			X		

Check each item listed in the checklist on a regular basis. Refer to the step numbers in Section 9.4 for an explanation of each numbered item on the checklist.

CHAPTER 10

BASE ASSEMBLY

Refer to the Base Assembly Drawing No. 1-274-0022 located in the Parts Manual along with the noted change from Inch to Metric Ballscrews.

NOTE

Most of the following procedures alter the relationship between the axis ballscrew and the drive motors. It will be necessary to confirm the proper axis home position after each of these procedures is completed. See Section 10.3 for proper axis home setting procedure.

10.1 X AND Y-AXIS DRIVE MOTORS

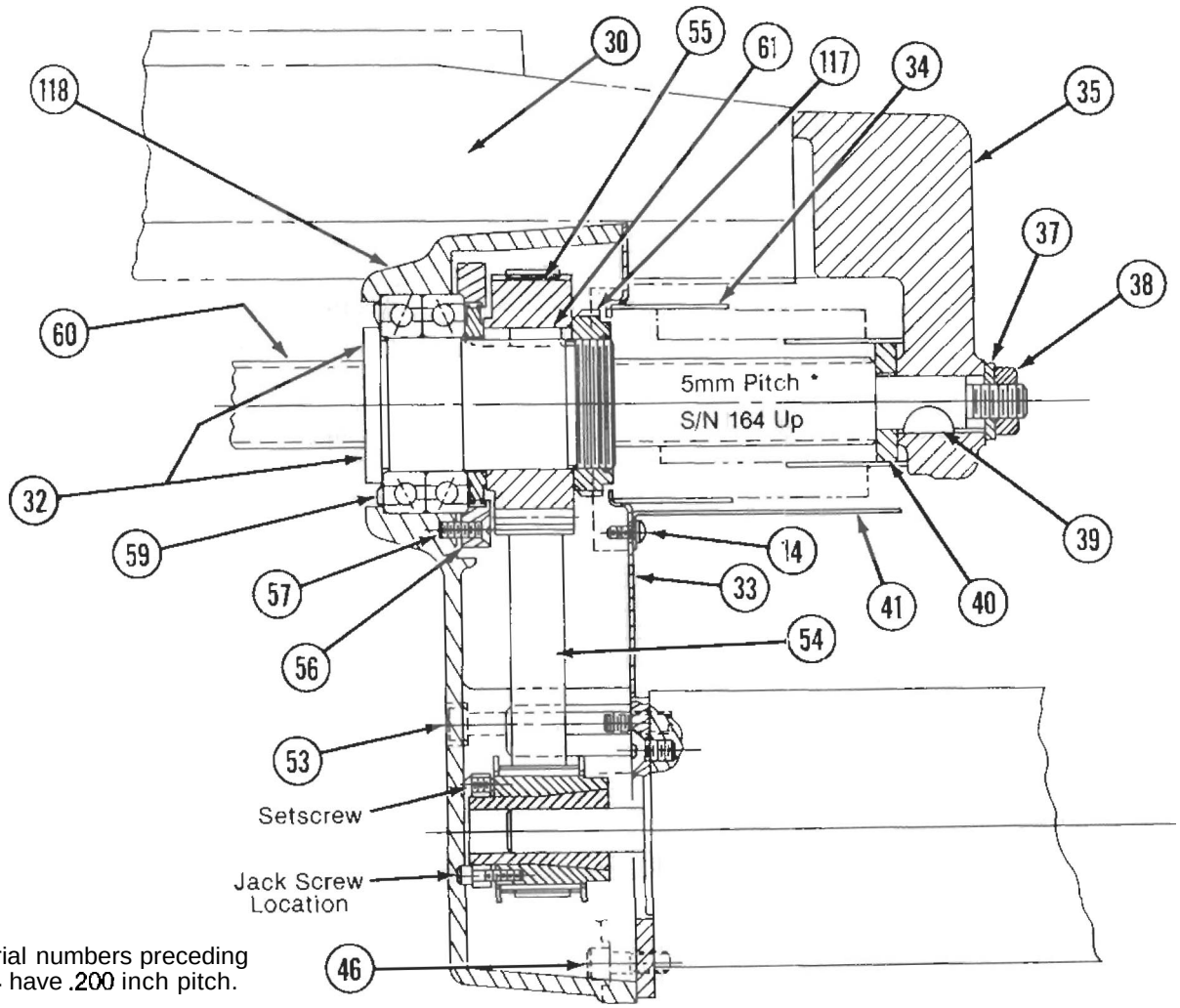
10.1.1 X-Axis Drive Belt Replacement — Figure 10-1

1. Position the table fully to the left side of the machine.
2. Disconnect power to the machine by throwing the main circuit breaker to the OFF position.
3. Compress the ballscrew cover (34) and secure it in the compressed position with a length of wire.
4. Remove the nut (38) and washer (37) from the end of the ballscrew.
5. Slide the table by hand lo the right, approximately 3½ inches or until the table end bracket clears the end of the ballscrew (60).
6. Remove the cover from the ballscrew.

WARNING

Do not release the cover from its compressed position! If the cover is released, it will spring open and will cause personal injury.

7. Remove key (39) and spacer (40) from the end of the ballscrew.



* Serial numbers preceding 164 have .200 inch pitch.

Figure 10-1. X-Axis Drive

8. Remove two screws (14) securing the covers (33) and (41) to the transmission housing (118).
9. Support the drive motor. Remove four screws, two each (53) and (46). Remove the drive motor (with the drive pulley attached) from the transmission housing (118).
10. Remove the X-axis ballscrew drive belt (54) from the ballscrew, Figure 10-2.
11. Install a new belt by reversing the disassembly procedure.
12. Set the proper belt tension; refer to Figure 10-3.

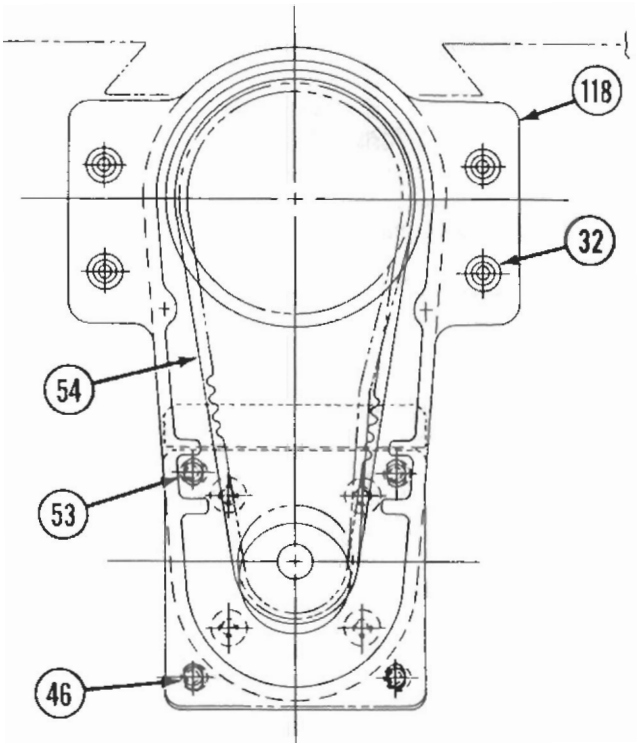
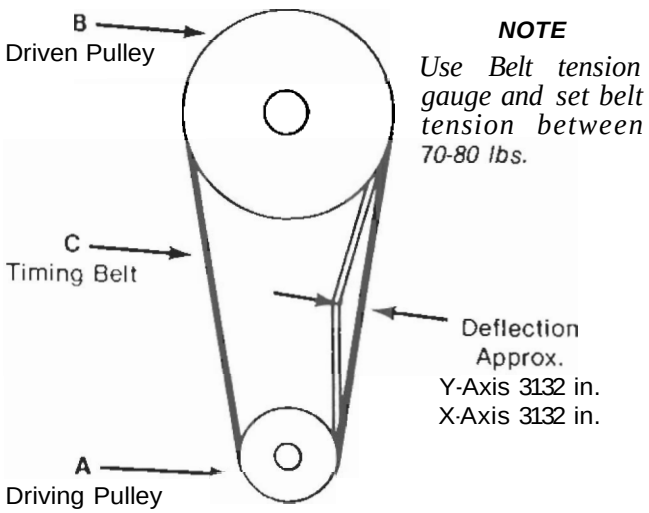


Figure 10-2. X-Axis Drive Belt



NOTE

Use Belt tension gauge and set belt tension between 70-80 lbs.

Figure 10-3. Timing **Belt** Tensioning

CAUTION

Make sure that the motor pulley does not rub on the casting or there will be damage to the motor.

13. Turn ON power.
14. Run the axis drive in both directions to check the belt alignment. Adjust it if necessary.

10.1.2 X-Axis Drive Belt Adjustment — Figure 10-1

1. Position the table fully to the right side of the machine.
2. Shut down the machine using normal procedure. Compress the ballscrew cover (34) and tie it in the compressed position with a length of wire. Move to the right side of the ballscrew.

WARNING

Do not release the cover lrom its compressed position! If the cover is released, it will spring open and may cause personal injury.

3. Remove two screws (14) securing the covers (33) and (41) to the transmission housing (118). Move the covers to the right side of the ballscrew. The belt will now be exposed.
4. Loosen, but do not remove, two (53) and two (46) screws (Figure 10-2) securing the drive motors to the transmission housing (118).
5. Set the belt tension. Pulling the motor downward will increase the tension; lifting the motor upward will decrease the tension.
6. The belt should have a tension of 93 pounds or should deflect 3/32 in the middle on one side with 7 pounds force applied.
7. Tighten the four motor mounting screws when the proper tension is obtained.

10.1.3 X-Axis **Drive** Motor Replacement — Figure 10-1

DANGER

Disconnect power lo the machine by moving the main circuit breaker to the OFF position before beginning this procedure. Failure to do so may result in serious personal injury or death.

1. Remove four screws and remove the plate on the back of the drive motor.
2. Disconnect the electrical wiring and remove the cable from the motor.
3. Support the motor. Remove four screws, two (53) and two (46), Figure 10-2. Remove the drive motor, with the drive pulley attached, from the transmission housing (118).
4. Loosen the three setscrews (turn CCW).

5. Place three 10-32x¾ inch round head screws in jack screw locations. Turn these screws CW to disengage pulley from motor shaft.
6. Install pulley on replacement motor.
7. Reverse procedure to install replacement motor, After the motor is installed, set the proper tension to the belt and correct alignment of pulleys. Refer to Section 10.1.2.

10.1.4 Y-Axis Drive Belt Replacement — Figure **10-4**

DANGER

Disconnect all power to the machine by moving the main circuit breaker to the OFF position before beginning this procedure. Failure to do so may result in serious personal injury or death.

1. Support the housing cover (74), remove three screws (75), and lilt the housing cover from the housing (68).
2. Loosen, but do not remove, the four screws (76) securing the drive motor to the housing (68).

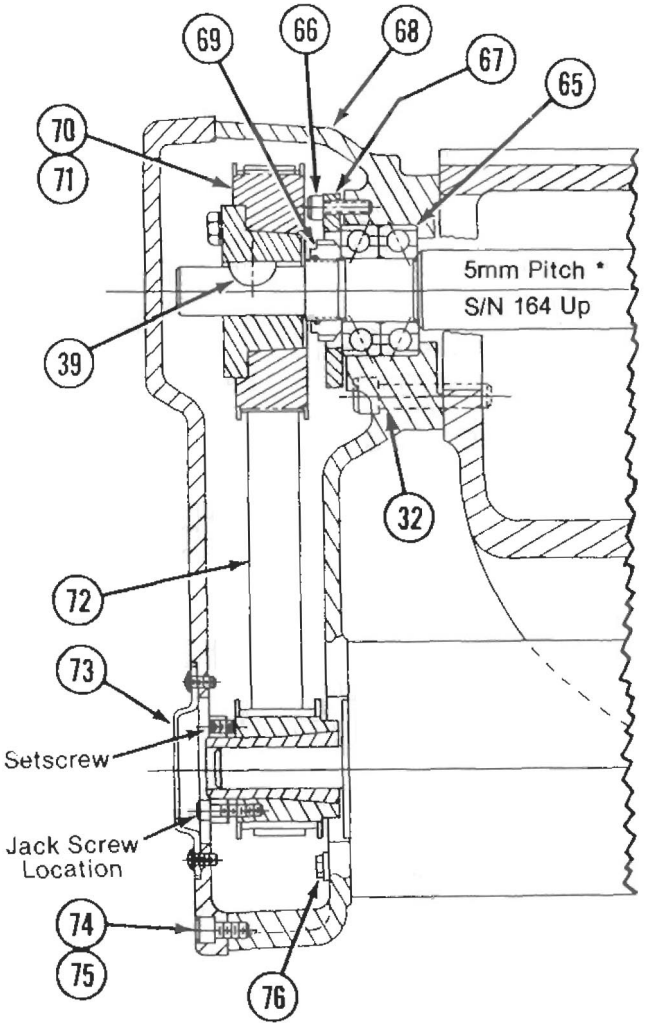


Figure 10-4. Y-Axis Drive

3. Remove the belt (72) from the drive and driven pulleys.
4. Install the new belt.
5. To set the belt tension, follow steps 3-5, Section 10.1.5.
6. Tighten the four motor mounting screws when the proper tension is obtained.

NOTE

Use belt tension gauge and set belt tension between 70-80 lbs.

10.1.5 Y-Axis Drive Belt Adjustment — Figure **10-3**

DANGER

Disconnecf all power to the machine by moving the main circuit to the OFF position before beginning this procedure. Failure to do so may result in serious personal injury or death.

1. Follow steps 1 and 2 in Section 10.1.4 to remove the housing cover.
2. Set the belt tension. Pulling the motor downward will increase the tension; lifting the motor upward will decrease the tension.
3. The belt should have a tension of 70-80 pounds or should deflect 3/8 inch in the middle on one side with 7 pounds force applied.
4. Tighten the four motor mounting screws when the proper tension is obtained.

10.1.6 Y-Axis Drive Motor Replacement — Figure **10-4**

DANGER

Disconnect all power to the machine by moving the main circuit to the OFF position before beginning this procedure. Failure to do so may result in serious personal injury or death.

1. Remove four screws and remove the plate on the back of the drive motor.
2. Disconnect the electrical wiring and remove the cable from the motor.
3. Support the housing cover (74), remove three screws (75), and lift the housing cover from the housing (68).
4. Support the motor, remove four screws (76) and remove the drive motor from housing (68).
5. Loosen the setscrew and tap the drive pulley with a mallet to remove from the motor shaft. Take notice of the pulley's position on the shaft.
6. Install replacement motor.
7. After the motor is installed, set the proper belt tension and correct alignment of pulleys. Follow Steps 2-4, Section 10.1.5.

10.2 X AND Y-AXIS BALLSCREWS

10.2.1 X-Axis Ballscrew Assembly Replacement — Figure 10-1

1. Remove the nut (38) and washer (37) from the end of baltscrew.
2. Compress the ballscrew cover (34) and secure it in the compressed position with a length of wire.
3. Remove the screws holding the end bracket (35) on the right side of table and remove the bracket.
4. Remove the ballscrew cover (34).
5. Remove two screws (14) securing the covers (33) and (41) to the mounting bracket.
6. Support the drive motor. Remove four screws, two each (53) and (46); then remove the drive motor (with the drive pulley attached) from the transmission housing (118), Figure 10-5.
7. Using a 2 in. to 4 ¾ in. adjustable Spanner wrench, loosen and remove locknut (117) on ballnut. Remove pulley (55) and key (61).

NOTE

The X-axis oil line must be disconnected before continuing. The nylon line runs from the mounting bracket to the ***4-way*** *manifold located in the saddle. Disconnect the oil line at the coupling. A new compression sleeve must be used forreassembly.*

8. Remove four screws (57) securing the bearing retainer plate (56) to the housing (118). Lift the bearing retainer plate off the ballscrew.
9. Remove the ballscrew cover from the left side of the saddle. This will expose the end of the ballscrew.
10. Tap the left end of the ballscrew with a plastic mallet until the ballscrew assembly is unseated from the transmission housing (118). The entire ballscrew assembly slides out of the housing.

NOTE

A thin bearing seal is located behind the bearings in the mounting bracket. Do not distort the seal when removing ballscrew from housing. A distorted seal must be replaced.

10.2.2 Y-Axis Ballscrew Removal — Figure 10-4

1. Support the cover (74) and remove three screws (75). Remove cover from Y-axis housing (68).
2. Support motor and remove four screws (76). Remove motor from Y-axis housing (68).
3. Remove three hex head screws from taper lock bushing (71). Use the same three hex head screws to jack taper lock bushing and pulley (70) apart. (Three threaded jack screw holes are located in the bushing.) Remove the pulley and bushing from the ballscrew.
4. Drill two 15164 in. holes on each side of the bearing hole in the Y-axis housing (68). Ream these holes ¼ in. Install two ¼ in. x 1 in. dowel pins. (These will be used for alignment when reassembling.).
5. Remove the side inspection cover (24) located on the left side of the knee, (Figure 10-10). Locate the ballnut. Find the brass oil line and carefully lift it out of the ballnut. DO NOT BEND OIL LINE. Remove four socket head cap screws (46) from the ballnut and ballnut bracket, Figure 10-6.
6. Support housing (68) and remove four socket head cap screws (32). Ballscrew and housing can be removed from the knee as an assembly, Figure 10-4.
7. Place the assembly on bench. Remove four socket head cap screws (66) and bearing retainer (67). Tap on the back end of the ballscrew with a plastic mallet until bearings (65) are clear of the housing (68).
8. Trap the end of the ballscrew on the stop collar in a vise-

CAUTION

Use vise jaw guards to protect the ballscrew from damage.

9. Remove locknut (69) with a spanner wrench. Remove bearings (65). Remove housing (68).

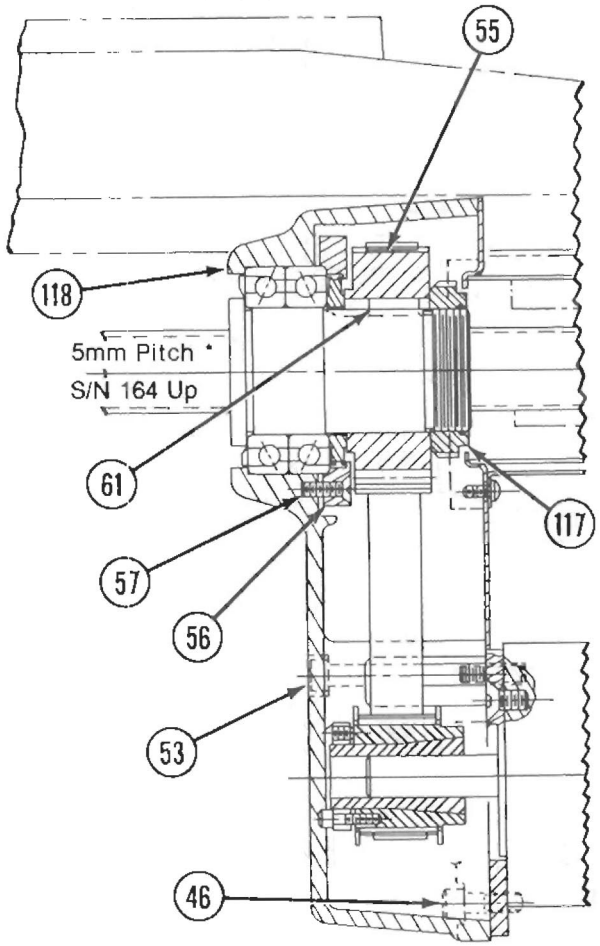


Figure **10-5.** Adjusting the **X-Axis** Ballscrew

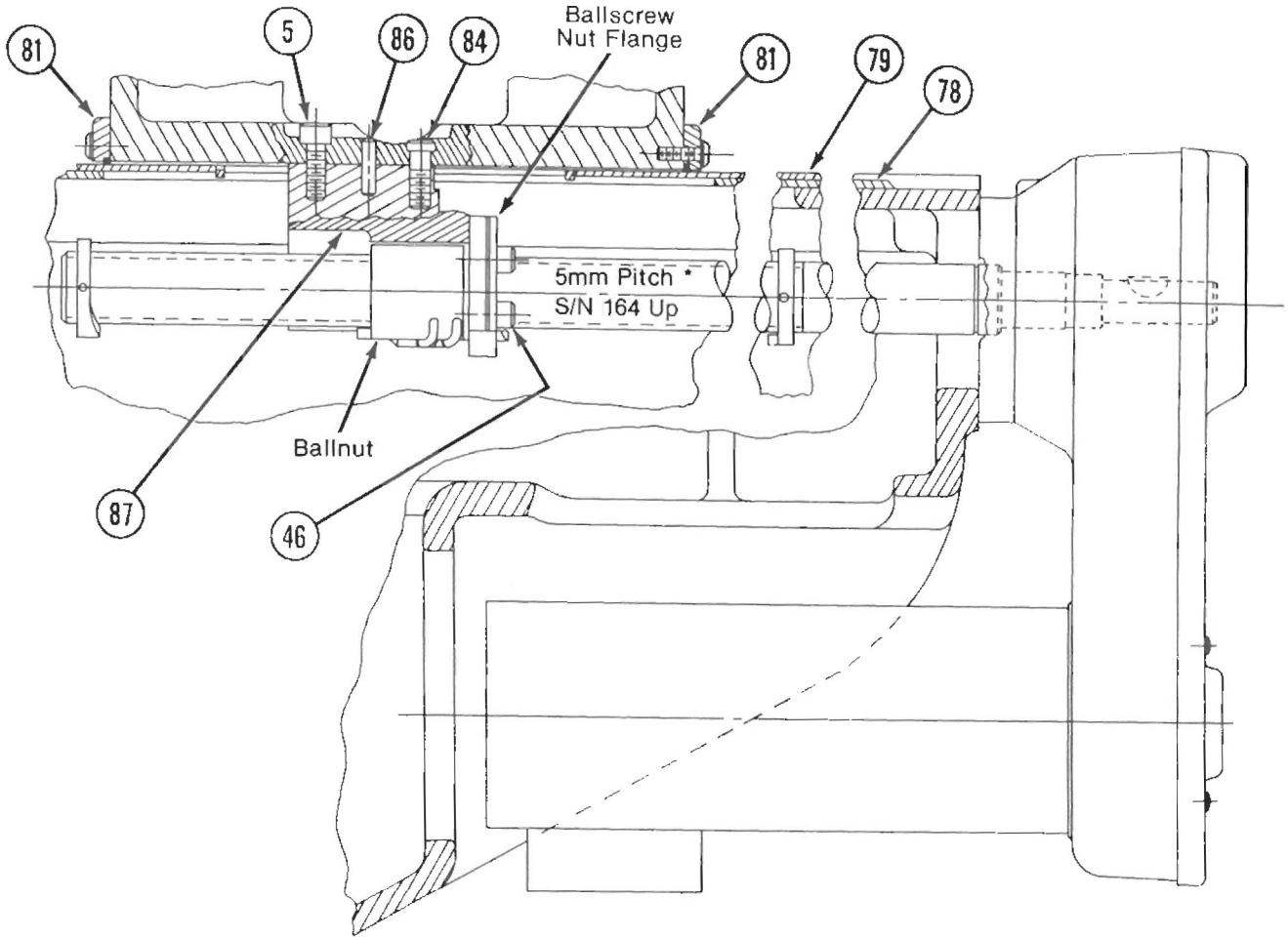


Figure 10-6. Y-Axis Ballscrew Removal/Installation

10.2.3 Y-Axis Ballscrew Assembly Replacement — Figure 10-4

1. After removal of the worn ballscrew, locate a nylon ball in the ballscrew nut flange. This ball must plug a radial hole in the flange. When viewed along the Y-axis from the front, the hole to be plugged is on the right side with the ball return tubes on the bottom.
2. Replace the #7 Woodruff Key **(39)** in the ballscrew with a new key.
3. Replace the Y-axis housing (68), bearings (65) and locknut **(69)** in the knee using a Spanner wrench. Use dowel pins to check alignment.
4. Replace the bearing retainer **(67)** with four socket head cap screws **(66).**
5. Reattach the ballnut bracket **(87)** and ballnut with four socket head cap screws (46), Figure 10-6.
6. Carefully place the brass oil line into the ballnut. DO NOT BEND OIL LINE.
7. Reconnect the taper lock bushing **(71)** and pulley **(70)** to the ballscrew. Remove the three hex head screws from the jack screw holes and replace the screws in the taper lock bushing, Figure 10-4.
8. Replace the motor in the Y-axis housing **(68).** Support the motor and secure with four screws **(76).**
9. Support the cover **(74)** and secure it to the Y-axis housing **(68)** with three screws **(75).**

10.3 LIMIT SWITCH ADJUSTMENT

10.3.1 X-Axis **Home** and Overtravel Limit Switch Settlng — Figures 10-7 and 10-8

NOTE

The spindle should be properly trammeled. Instructions are given in Chapter 2 in the Users Manual.

1. Place a ⅝-inch dia. dowel in the spindle.
2. Position the table so the dowel pin centering is aligned with the table center slot centerline.
3. Remove the X-axis servo motor from the transmission housing (118), Figure 10-5, and set it aside. (Leave all electrical connections intact.)
4. Home all axes. It will be necessary to actuate the X-axis home switch with a screwdriver to complete the homing operation.
5. Jog the X-axis until the position displayed on the CRT reads 9.000 inches.

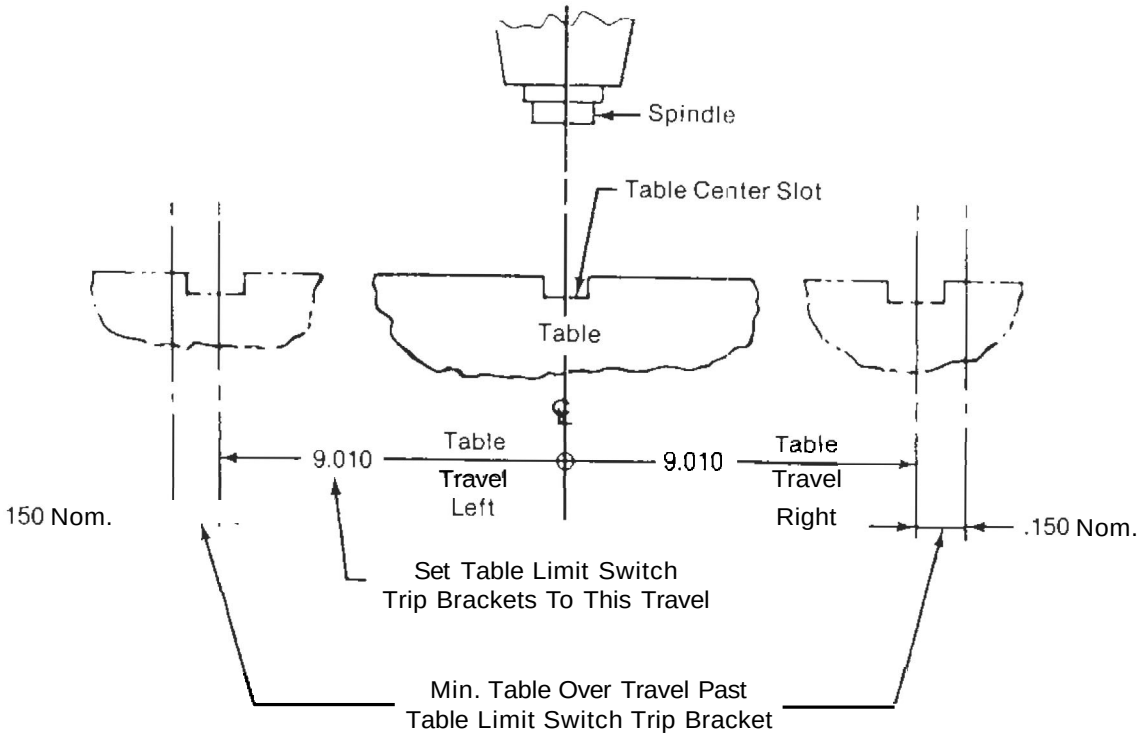


Figure **10-7.** X-Axis Trip-Dog Adjustment

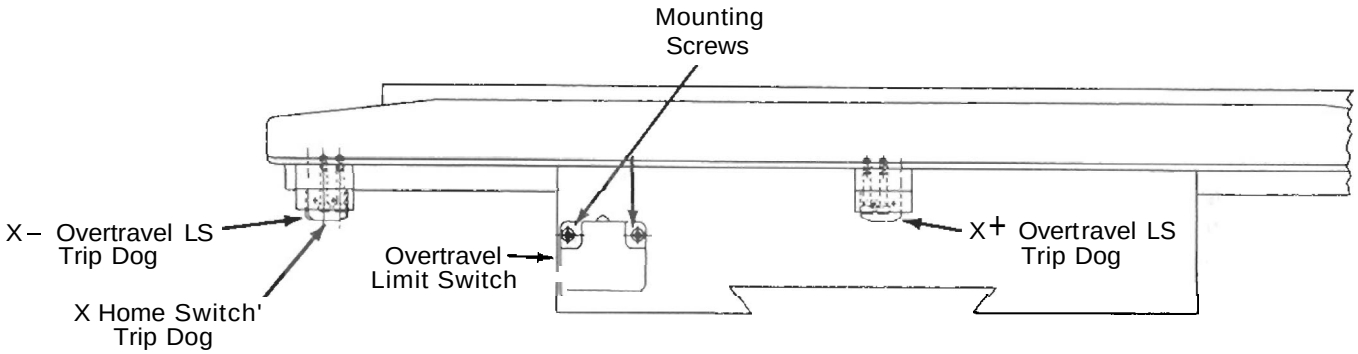


Figure **10-8.** X-Axis Limit Switch

6. Reinstall the X-axis motor in the transmission housing. Take special care not to move the X-axis ballscrew pulley when tightening the drive belt.
7. Jog the X-axis until the position displayed on the CRT reads 0.350 inch.
8. Adjust the X-axis home switch trip dog so the X home limit switch just actuates at this point.

Lethal voltages are present in the Power Distribution Enclosure, even when the main disconnect is off. Use extreme caution whenever working in the enclosure. Failure to do so may result in serious personal injury or death.

Connect a volt meter to wire no. 59 located in the Power Distribution Enclosure. The switch is actuated when the **24** volt DC signal on wire no. 59 changes to 0.0 volts.

9. Jog the X-axis to a position readout of 0.0000 in. Adjust the X– overtravel limit switch trip dog until it just begins to depress the switch plunger. Tighten the trip dog.
10. Jog the X-axis to a position readout of 18.000 in. Adjust the X+ overtravel limit switch trip dog until it just begins to depress the switch plunger. Tighten the trip dog.
11. Home all axes. Jog the X-axis to a position readout of 9.000 inches. The X-inch dia. dowel pin centerline should line up with the table center slot centerline. If it does not, repeat this procedure. (It may be necessary to readjust the home switch trip dog to obtain the proper X-axis home position.)

10.3.2 Y-Axis Home and Overtravel **Switch** Setting — Figure **10-9**

1. Place a ⅝-inch dia. dowel in the spindle.
2. Position the table so the dowel pin centerline is aligned with the center table T-slot centerline.
3. Remove the Y-axis transmission housing cover (74), Figure 10-4. Loosen four screws (51) and turn the setscrew to separate the taper-lock pulley from the motor shaft. (The motor shaft must be able to rotate freely without turning the ballscrew.)
4. Home all axes. It will be necessary to actuate the Y-axis home switch with a screwdriver to complete the homing operation.
5. Jog the Y-axis until the position displayed on the CRT reads 6.000 inches.
6. Secure the taper lock pulley to the Y-axis motor shaft by tightening the four screws (57).
7. Jog the Y-axis until the position displayed on the CRT reads 0.350 inch. Adjust the Y-axis home switch trip dog so the Y home switch just actuates at this point.

DANGER

Lethal voltages are present in the Power Distribution Enclosure, even when the main disconnect is off. Use extreme caution whenever working in the enclosure. Failure to do so may result in serious personal injury or death.

8. Connect a voltmeter to wire no. 60 in the Power Distribution Enclosure. The switch is actuated when the 24 volt DC signal on wire no. 60 changes to 0.0 volts.
9. Jog the Y-axis to a position readout of 0.00 inches. Adjust the Y– overtravel limit switch trip dog until it just begins to depress the switch plunger. Tighten the trip dog.
10. Jog the Y-axis to a position readout of 12.000 in. Adjust the Y+ overtravel limit switch trip dog until it just begins to depress the switch plunger. Tighten the trip dog.
11. Home all axes. Jog the Y-axis to a position readout of 6.000 inches. The ⅝-inchdia. dowel pin centerline should line up with the table center T-slot centerline. If it does not, repeat this procedure. (It may be necessary to readjust the Y-axis home switch trip dog to obtain the proper Y-axis home position.)

10.4 TABLE AND SADDLE REMOVAL

10.4.1 Table Removal — Figure **10-1**

1. Move the table to the left side of the machine,
2. Disconnect power to the machine by throwing the main circuit breaker to the OFF position.
3. Remove the nut (38) and washer (37) from the end of the ballscrew.
4. Compress the ballscrew cover (34) and tie the cover in the compressed position.
5. Manually slide the table to the right until the table end bracket clears the end of the ballscrew (60), or approximately 3½ inches.

WARNING

Do not release the cover from its compressed position! If the cover is released, it will spring open and may cause personal injury.

6. Remove the cover from the ballscrew.
7. Remove the table gib adjusting screw (3), Figure 10-10, and remove the gib (26) from the table.

WARNING

The table weighs 330 pounds. Use appropriate care to prevent equipment damage and possible personal injury.

8. Support the table with an overhead hoist and slide it to the right until it clears the saddle.

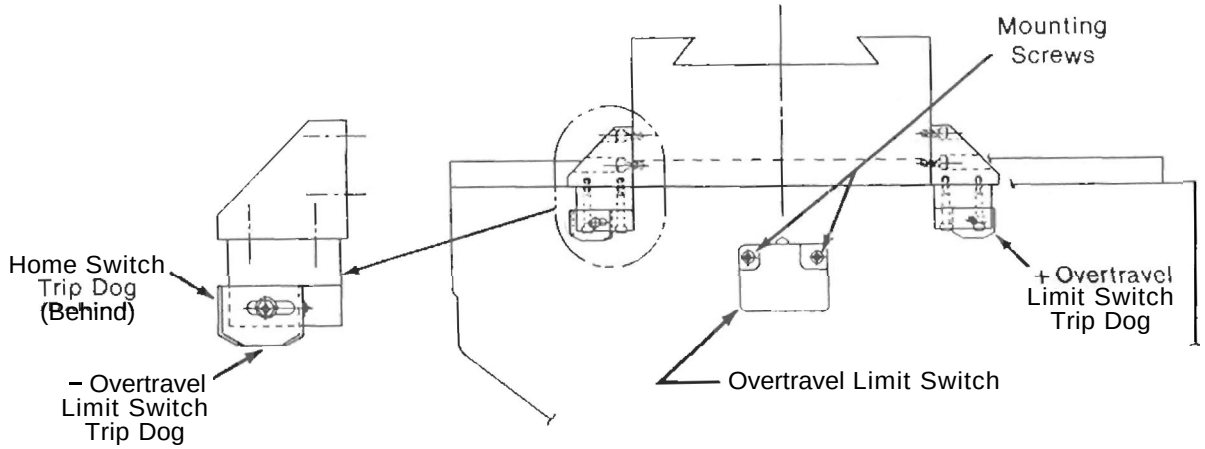


Figure 10-9. Y-Axis Limit Switch

9. After the table has been installed, reset the table saddle gib. See Section 10.7.

10.4.2 Saddle Removal

1. Move the saddle to the full out position (maximum distance from the column).
2. Remove the table from the machine. See Section 10.4.1.
3. Remove the X-axis ballscrew assembly. See Section 10.2.1.
4. Remove the Y-axis drive belt. See Section 10.1.4, Steps 1 through 4.
5. Remove the Y-axis ballscrew assembly. Refer to Figure 10-4. Support the Y-axis motor, remove four screws and remove the drive motor from housing (68). Remove drive pulley (70) and bushing (71) from the ballscrew. Remove the ballscrew bearing locknut (69) from the ballscrew. Support housing (68) and remove four screws securing the housing to the knee. Remove the side cover plate (24), Figure 10-10, located on the rear left side of the knee.

   Cut or remove the lube line to the Y-axis ballnut where it passes through the saddle. This line must be replaced tor reassembly. Use only new ferrules in the fittings.

   Loosen two (5) and two (84) screws, Figure 10-6, an equal amount; and tap on the head of each screw to lower the ballnut bracket (87). The two pins (86) will either remain with the saddle or the ballnut bracket. Continue the procedure until the pinned connection is loose. Remove four screws, two (5) and two (84).

   Lower the ballscrew. Ensure the lube line does not interface with the ballscrew. Slide chip guards (79), (78), Figure 10-6, from under the saddle. Remove the Y-axis ballscrew and ballnut bracket by lifting it out of the knee from behind the saddle. Remove the two pins (86) from the ballnut bracket and hold for reassembly.
6. Disconnect the lubrication line where it enters the saddle. Its location is on the left underside of the saddle.
7. Remove the X axis limit switch. Refer to Figure 10-8 for switch location.
8. Remove wiper (111). Remove the saddle to knee gib screw (3) and gib (26), Figure 10-10.

WARNING

Saddle weight is 735 pounds. Use appropriate care to prevent equipment damage and possible personal injury.

10. Support the saddle with an overhead hoist and slide it to the front until it clears the knee.

10.4.3 Saddle Installation — Figure 10-8

1. Slide the rear way wiper cover (83) over the knee **to** saddle ways.
2. Slide the saddle onto the knee.
3. Install and temporarily set the saddle to knee gib.
4. Slide the front way wiper cover (81) over the knee to saddle ways.
5. Install Ihe X-axis limit switch. Refer to Figure 10-8 for switch location.
6. Connect the lubrication line at the saddle.
7. Install the Y-axis ballscrew. See Section 10.2.3.

10.5 MANUALLY OPERATED KNEE DRIVE — Figure 10-11

10.5.1 Dial Replacement

1. Slide the knee crank handle (95) off its shaft (98).
2. Pry the clutch (94) out from the knurled locknut (93) and remove it from the shaft.
3. Unscrew and remove the locknut (93).
4. Slide the dial (91) off the end of the shaft.
5. Cut outer face of dial for ,005-inch gap.

10.5.2 Crank **Shaft** Removal — Figure 10-11

1. Remove the elevating dial. See Section 10.5.1.
2. Remove three screws (89) to release the bearing retainer (90), thereby allowing the knee elevating crank snaft and bearing to be withdrawn from the knee.

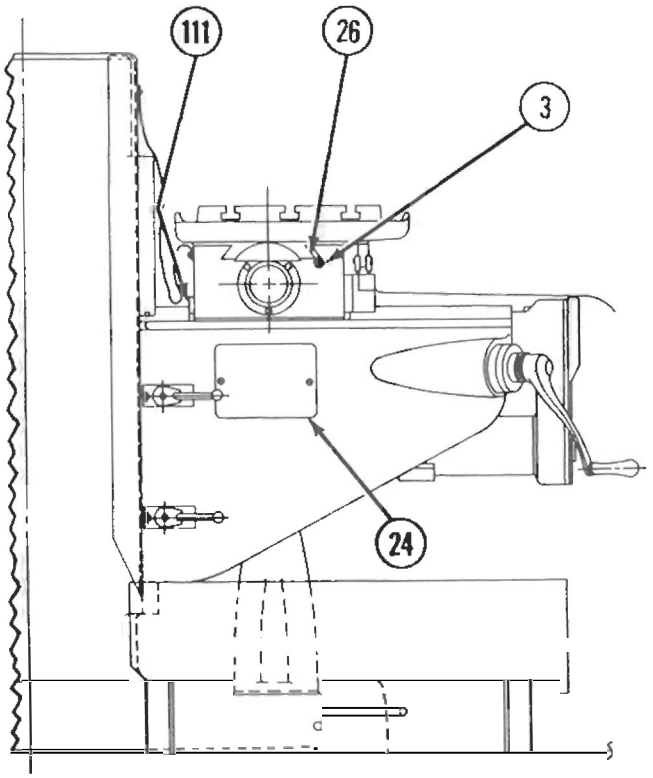


Figure 10-10. Side View of Machine

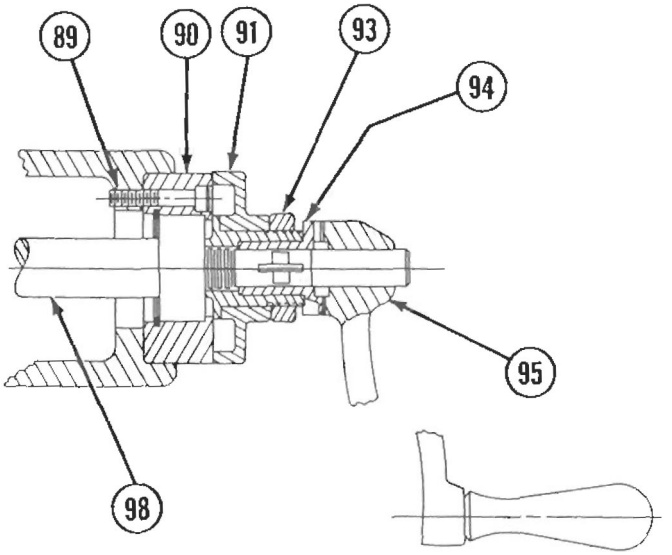


Figure 10-11. Manual Knee Drive

10.5.3 Knee Removal — Figure **10-12**

WARNING

To avoid personal injury and damage to the machine, the knee must be blocked up from underneath or supported by a hoist throughout this operation.

1. Remove the saddle. See Section 10.4.2.
2. Remove the knee elevating crank. See Section 10.5.2.
3. Remove the Y-axis limit switch. See Figure **10-9** for switch location.
4. Remove the lube pump reservoir lines from the left side of the knee.
5. Reach in through the top of the knee and remove the hex head jam nut (103), washer (104), and gear **(105)** from the top of the knee elevating screw **(107).**

NOTE

The head must be removed. The procedure is described in Section 11.2.2. When the head has been removed, support the knee with an overhead hoist. Complete the procedure starting with Step 6.

6. Loosen, but do not remove, the four screws securing the turret to the top of the column. Turn the ram and head to clear the area above the knee, and attach a suitable sling and hoist to support and raise the knee.
7. Remove the way wiper felt (111), Figure **10-14,** and wiper holders **(116)** and **(113)** to expose the knee-column gib **(114).**

CAUTION

Use care to avoid damage to the upper end of the knee elevating screw remaining on the column pad.

8. Remove the gib (114) by removing the adjusting screw (3).
9. Lift the xnee upward off the knee-column ways.

10.5.4 Knee Elevaling Screw Replacement — Figure **10-12**

1. Support the knee with a chain hoist or floor jack.
2. Remove the knee elevating crank shaft. See Section **10.5.2.**
3. Remove the cover plate located on the left side of the knee.
4. Through this side opening, remove the hex head jam nut (103), washer **(104)** and gear **(105)** from the top of tha elevating screw **(107).**

NOTE

In lifting the knee. the knee elevating screw will slide out of the bearing assembly. The bearing cover (708) and bearing (106) should remain intact in the knee.

5. Lift the knee up slowly lo its maximum travel.
6. Lock the knee in place. Also block or support with a hoist.
7. Remove two screws (9) securing the knee elevating leadscrew nut (8) to the pedestal **(4).** (Figure **10-13**)
8. Lift the elevating screw out of the pedestal, pulling it upward and forward.

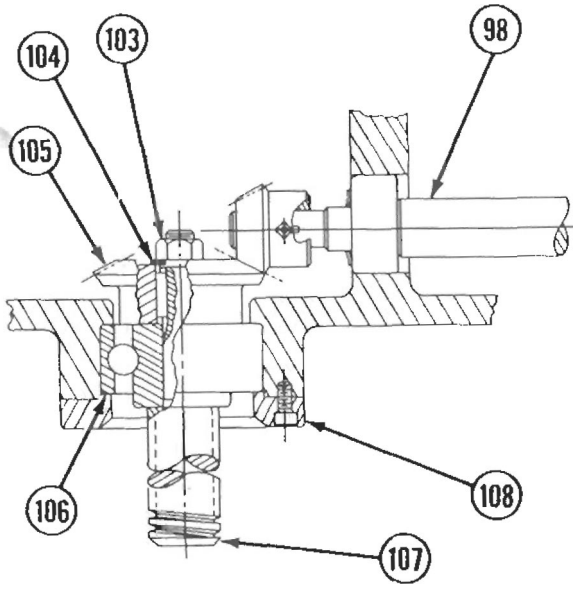


Figure 10-12. Knee Elevating **Screw**

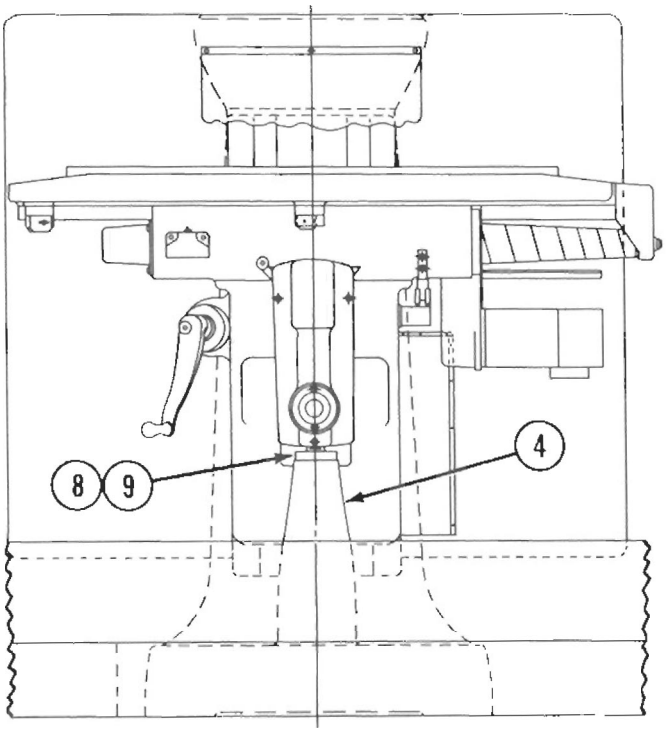


Figure 10-13. Knee Pedestal

10.6 LUBRICATION (Refer to Dwg. 1-241-0083 in the Parts Manual)

10.6.1 X, Y, And Z-Axes

The table, saddle, and head quill are lubricated by an automatic system that operates whenever the spindle motor is running.

The oil reservoir and pump are located in the pneumatic enclosure mounted on the back of the column.

A float switch in the oil reservoir prevents restart of the spindle if the oil level is too low.

NOTE

The float switch will not stop the spindle while it is running, but will protect it against restarting without sufficient lubrication.

Oil distributors for the table and saddle are located inside the saddle and can be exposed by removing the table. For instructions on table removal see Section **10.4.1.** Oil distributors for the head quill are located on the left side of the column.

NOTE

Use only Waylube 1180 or equivalent to ensure maximum effectiveness of the lubrication system.

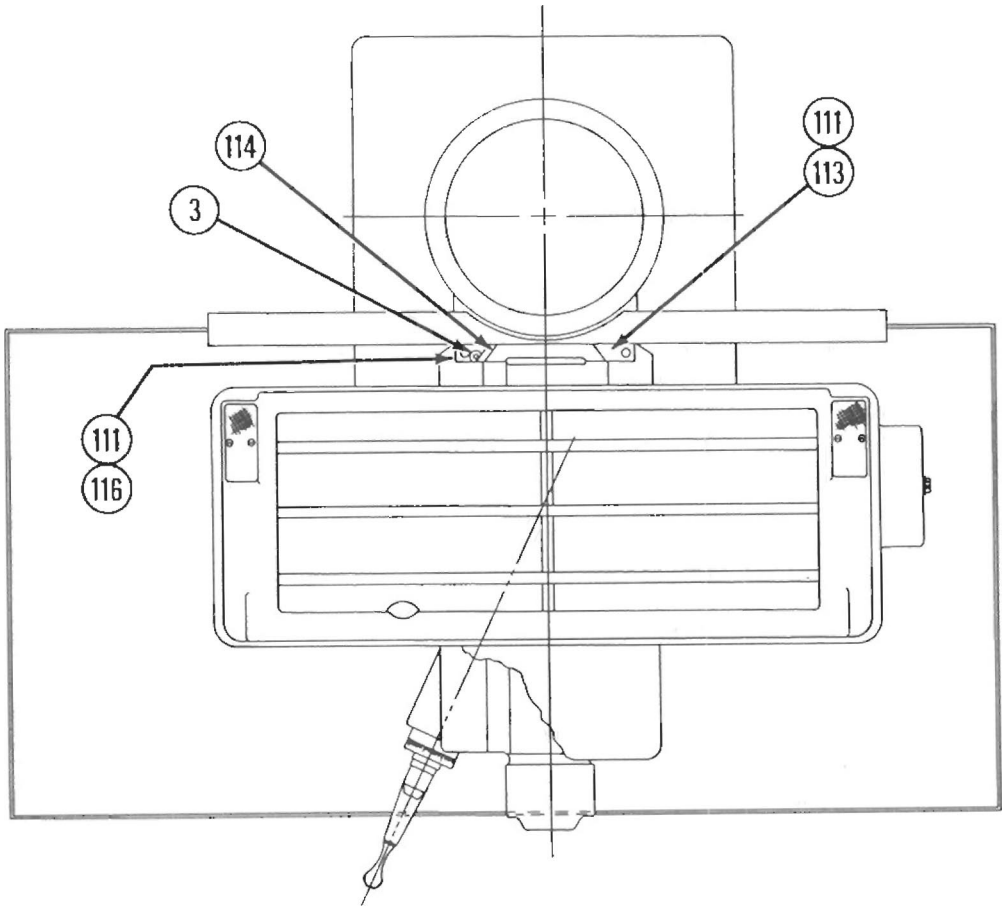


Figure 10-14. Knee Column Gibs

All other moving parts such as bearings, gears, etc., are pre-packed with lifetime grease and should not require further servicing tor their full service life.

10.6.2 Knee Lubrication

The Knee ways are lubricated by an automatic system from a distributor located inside the knee. External feeder hoses are attached to the left side of the knee. All bearings are greased for life.

10.7 GIB ADJUSTMENT — Figure **10-16**

At the factory all gibs are given an initial setting, the machine is cycled for approximately 50 hours, and the gibs are given a final setting. Therefore, they should not require readjusting if proper maintenance of the automatic lube system is provided. However, if gib adjustment is required, proceed as follows:

Saddle to Table Gib **Setting** — Figures **10-15** and **10-16**

1. Set up indicators in position No. 1.
2. Push end of table and release. Pull end of table and release. Note the total indicator reading less the springback.
3. Adjust the gib by turning the adjusting screw to obtain a maximum indicator reading (less springback) of .0005 inch.
4. After the gib is set, move the indicator to position No. 2.
5. Push and pull the end of the table and note the total indicator reading (less springback).
6. Total indicator reading in position No. 1 (after gib is set) shculd equal the total indicator reading in posilion No. 2 within ±.0002 inch. If not, remove and scrape :he gib and repeat setting.

Saddle to **Knee** Gib Setting — Figures **10-15** and **10-16**

1. Move indicator to position No. **1**
2. Push the end of the table and release. Pull the end of the table and release. Note the total indicator reading, less springback.
3. Adjust the gib by turning the adjusting screw to obtain a maximum indicator reading (less springback) of .0005 inch.
4. After the gib is set, move the indicator to position No. 2.
5. Push and pull the end of the table and not the total indicator reading (less springback).
6. The total indicator reading in position No. 1 (after the gib is set) should equal the total indicator reading in position No. 2 within ±.0002 inch. If not, remove and scrape the gib and repeat the setting.

Knee to **Column** Gib Setting — Figures **10-14** and **10-15**

1. Remove the wipe cover (116) and wiper (111) to expose the knee to column gib.
2. Using the crank handle, raise and lower the knee and turn the adjusting screw (3) until a smooth movement is attained.

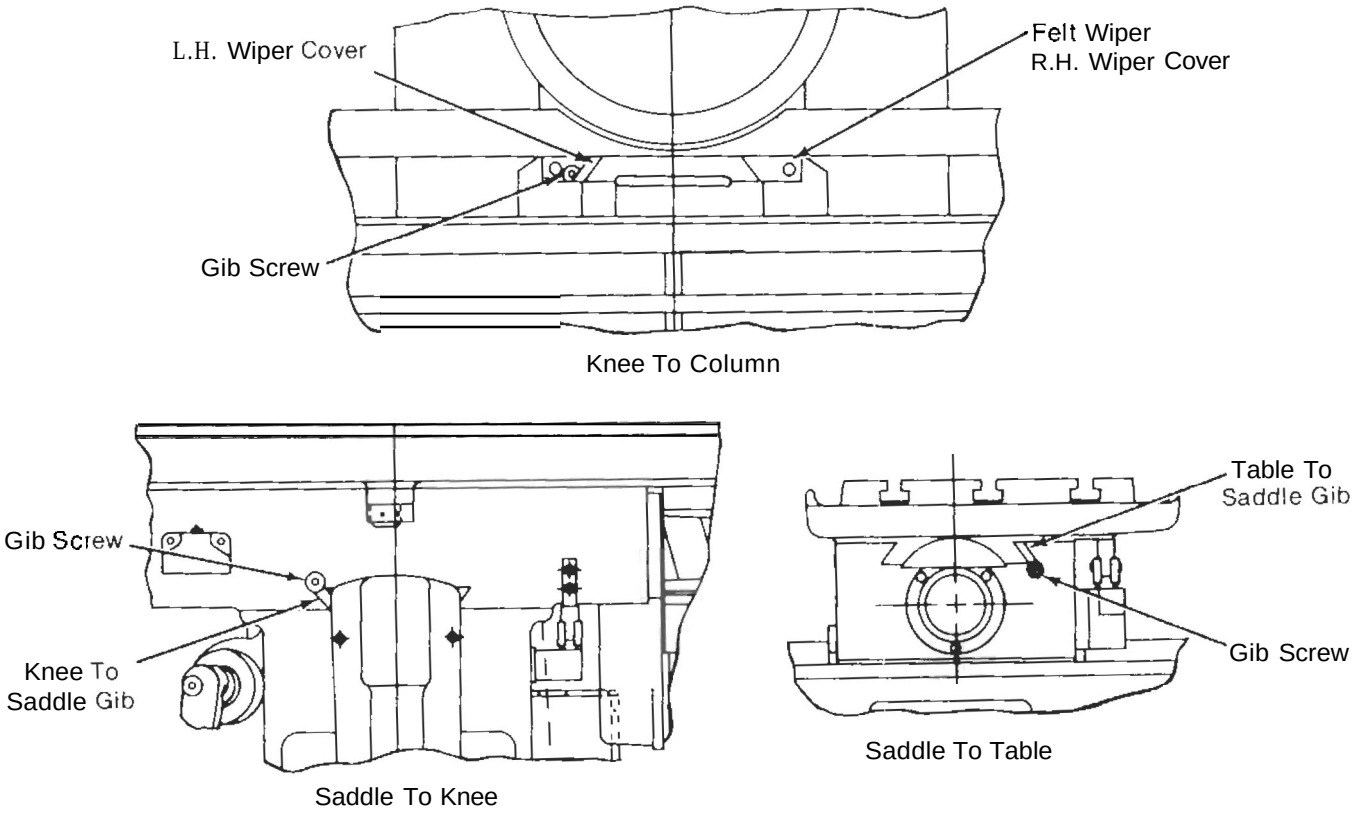


Figure 10-15. Gib Locations

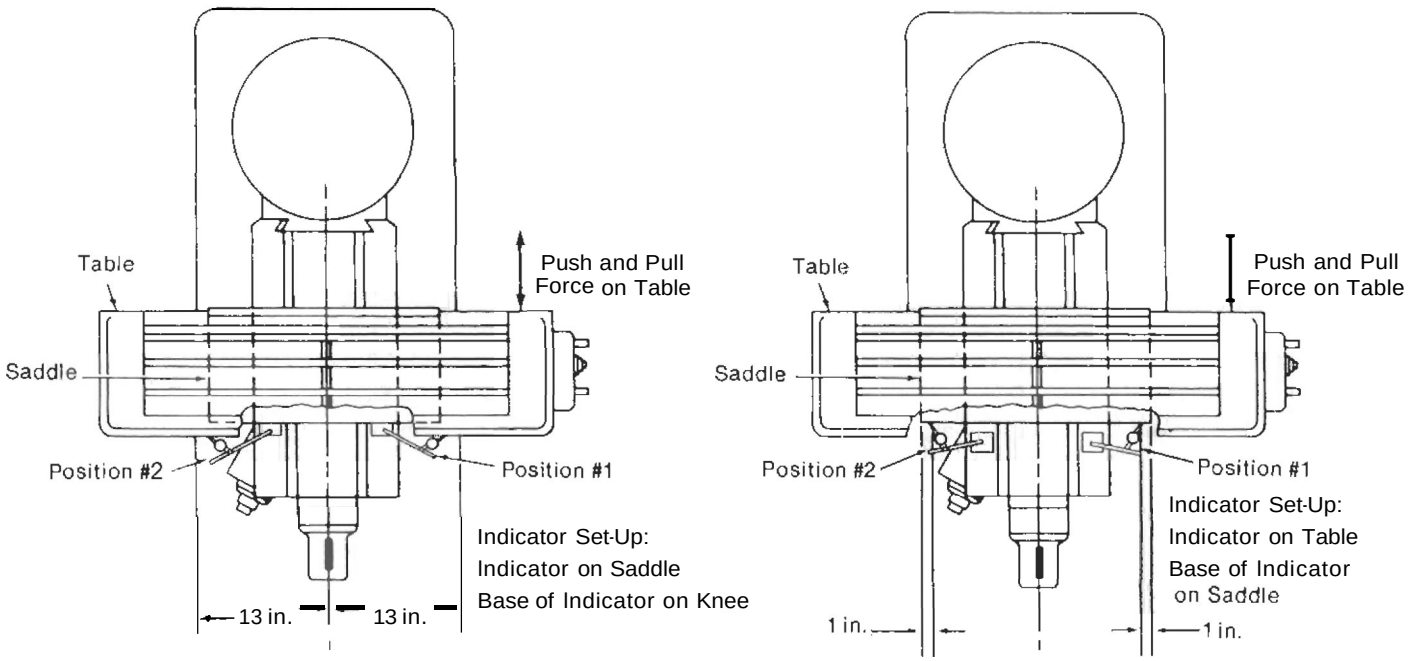


Figure 10-16. Gib Adjustments

CHAPTER 11
HEAD ASSEMBLY

Refer to the Head Assembly Drawing No. 1-274-0152 located in the R2E4 Parts Manual. Note the change from Inch to Metric Ballscrew at Serial Number 164.

11.1 LUBRICATION

All bearings and gears in the head are lubricated for life. Bearings are lubricated with BRB lifetime grease and the back gears with Sunoco No. 741 E.P. grease or Mobil Lux No. 1 E.P.

The automatic lubrication system for the table, saddle, and knee also lubricates the ball quill extension. Periodically fill the reservoir, located on the left side of the column, with Sunoco Waylube No. 1180 or equivalent.

The Rigid Ram machine's HI-LO sleeve is connected to the automatic lubrication system and needs no special attention.

11.2 POWER TRANSMISSION

11.2.1 Resetting Speed Control — Figure 11-1

NOTE

Excess wear on the vari-drive belt will cause a slight increase in actual speed as compared to that shown on the dial. The speed control can be reset by the following procedure.

1. With the spindle rotating, turn the variable speed control snugly against the high speed stop (4200 reading on dial). Loosen the jam nut and turn the pivot pin at the top of the head. Use a tachometer to set the spindle speed at 4200 R.P.M. Tighten the jam nut.
2. Place the HI/LO gear shift in low gear.
3. Adjust the gear select cable so a 1/16-inch gap exists between the cable nut and the sensor target.
4. Unscrew two 10-32x1.625 socket head cap screws to remove the speed sensor cover (located at the front top of the head). Slightly loosen two clamp screws securing the speed sensor cable.
5. Move the gear shift lever to place the machine in high gear. Turn on the spindle.
6. Press the speed increase button until the CRT displays an RPM reading exceeding 4200.
7. Slowly turn the speed sensor counterclockwise until a CRT reading of 4200 ±100 RPM is obtained. Tighten the two clamp screws on the sensor.
8. Press the speed decrease button on the panel to bring the CRT RPM reading down to 500 ±100.
9. Check the speed control adjustment by pressing the Speed Increase button until a maximum reading is obtained. If the CRT reading is 4200 ±100, the speed control is properly set.

   If the CRT reading is not 4200 ±100 RPM, repeal Steps 5 through 9 until this reading is obtained.

NOTE

When the belt is worn to the extent that accurate speed adjustment is no longer possible, the belt must be replaced. See Section 11.2.4.

11.2.2 Head Removal — Figure 11-2

Disconnect all power to the machine by moving the main circuit breaker to the OFF position before beginning this procedure. Failure to do so may result in serious personal injury or death.

1. Remove the electrical connection box cover at the motor. Disconnect the wires and remove the electrical cable from the motor.
2. Remove two screws (16) and washers (15) securing the motor mounting bracket cover (18).
3. Remove the right and left quill housing covers (3) and (70).

NOTE

The quill housing covers weigh 25 lbs.; care should be taken when removing them.

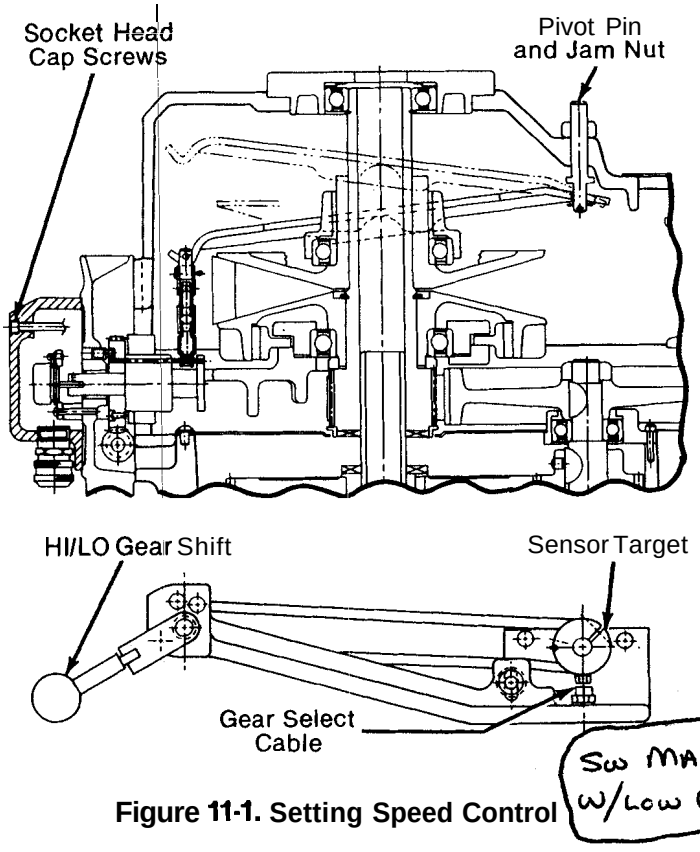


Figure 11-1. Setting Speed Control

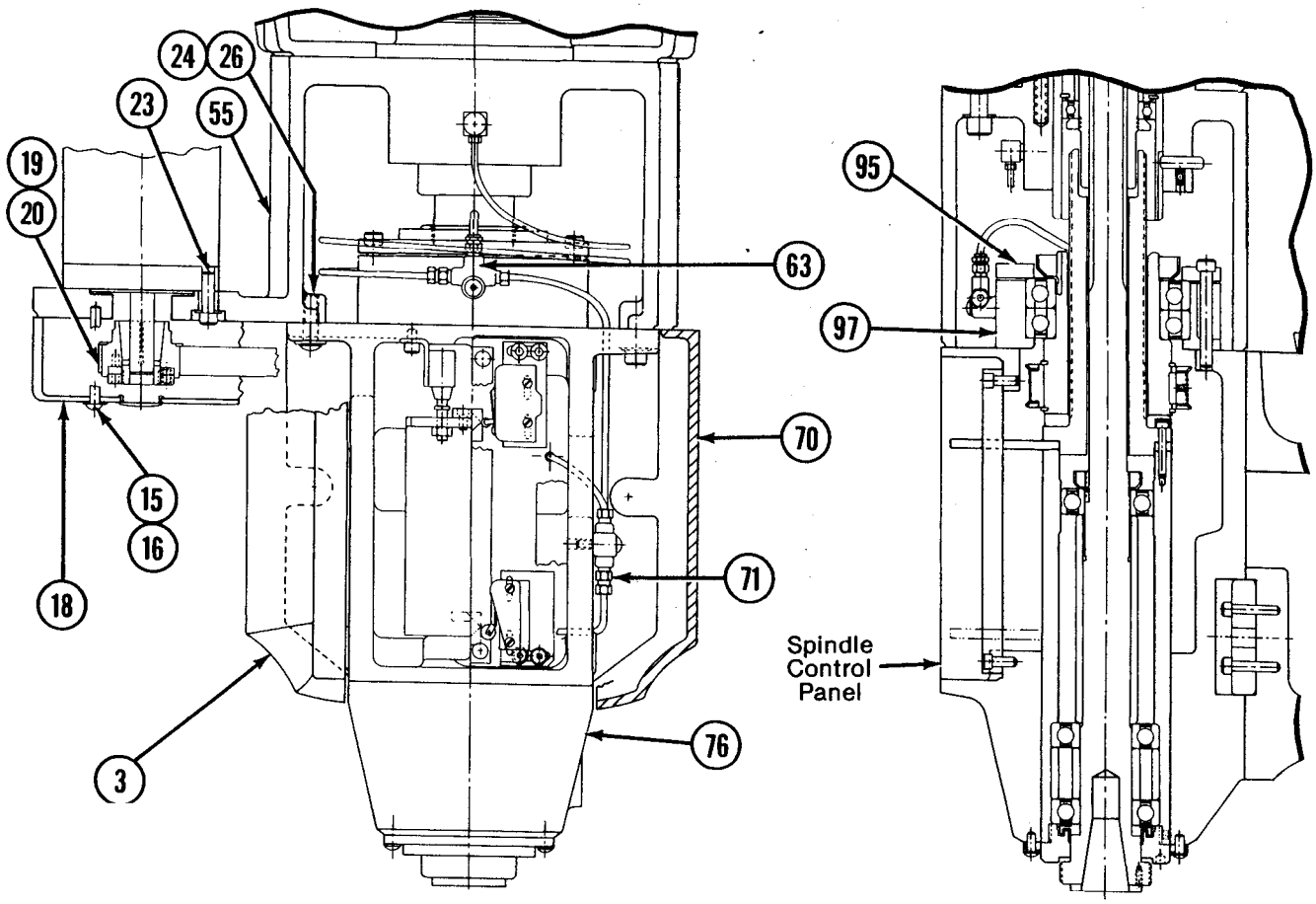
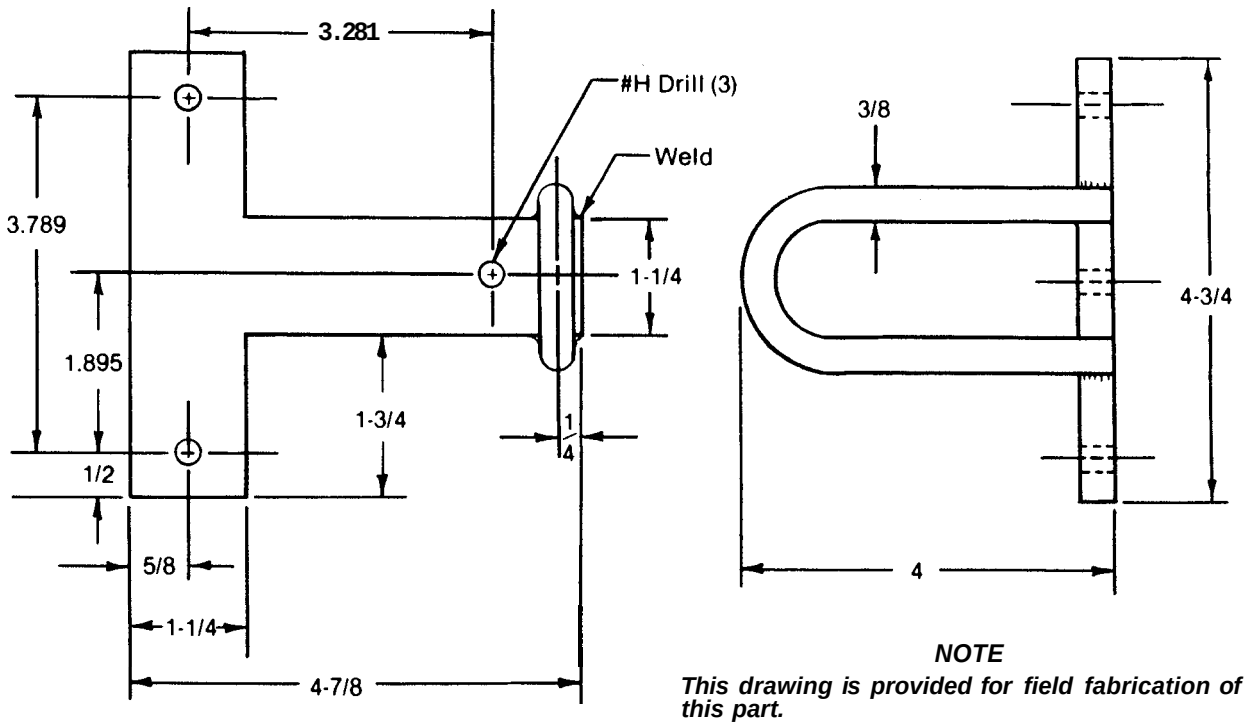


Figure 11-2. Head Removal



NOTE

This drawing is provided for field fabrication of this part.

Figure 11-3. Special Tool ST-6921 **Headlift** Bracket

4. Loosen two screws located on the right side of the spindle control box.

NOTE

Oil is likely to drop from the spindle control box cover. This oil should be discarded and need not be replaced upon reassembly.

5. The spindle control box cover is attached to a hinge. Open the cover and disconnect the wires from the microswitches.

NOTE

Refer to the wiring diagram for reassembly.

6. Locate the nylon tubing at the back of the ram and disconnect it from the Bijur lubricator and the hose clamp.

7. Pull the nylon tubing through the ram, coil, and tie.

NOTE

Remove the nameplate on each side of the ram to facilitate rethreading of the nylon tubing.

8. Remove the quill drive motor. See Section **11.3.3,** steps **1** through **9.**

NOTE

The head should now be clear of all electrical connections.

9. Attach the head lifting tool (ST-6921), Figure **11-3,** to the belt housing **(34)** (Figure **11-5)** using three screws. The loop in the lifting tool should be over the center of gravity of the head.
10. Support the head with an overhead hoist through the loop of the lifting tool.
11. Remove the remaining four bolts securing the head to the ram.
12. After reassembly set:
    a. Home switch adjustment. See Section **11.4.**
    b. Upper limit switch adjustment. See Section **11.4.**
    c. Down limit switch adjustment. See Section **11.4.**
    d. Quill drive belt adjustment. See Section **11.3.4.**

11.2.3 Motor Removal — Figure 11-4

1. With the motor running, adjust the variable speed control to the top of the speed range. Adjust the speed changer in the red zone until the mechanical stop in the speed changer is reached. This adjustment may be made in either the high or low speed range. The variable speed belt is now in the proper position for motor removal.

NOTE

It is essential to adjust the speed range before proceeding to Step 2.

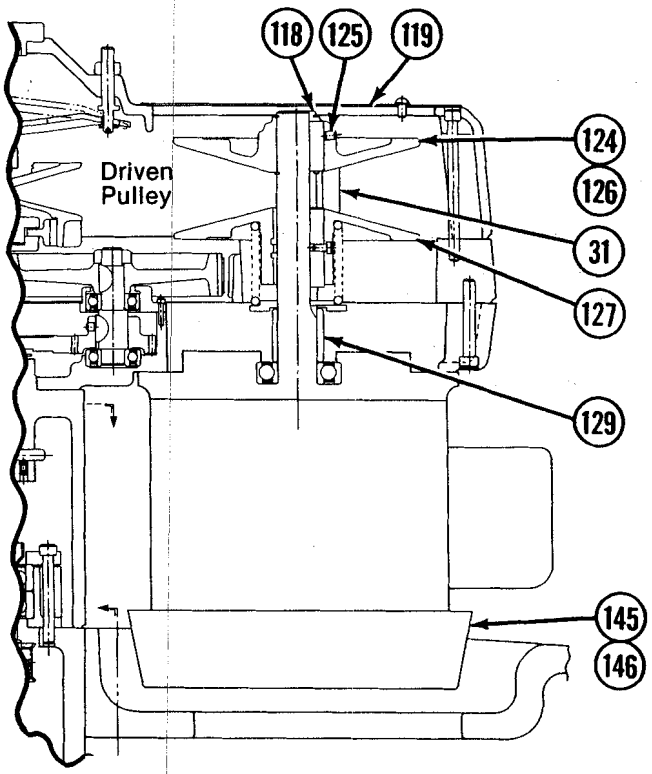


Figure 11-4. Motor **Removal**

2. Press the spindle off pushbutton to stop the motor.
3. Disconnect power to the machine. Remove the electrical cable from the motor.
4. Remove the head. See Section **11.2.2.**
5. Remove the belt housing cover **(119).**

NOTE

If Step 1 was done correctly, the drive belt *(31)* will *ride toward the outside edge of the pulleys (127) and (124). If this condition does not exist, reassemble the head and correctly perform Step 1.*

6. Remove the retaining ring **(118).**
7. Be prepared for the pulley to spring up approximately one-half inch when the socket set screw **(125)** is loosened. Loosen the socket set screw and remove the pulley **(124).**
8. Compress the lower pulley **(127)** on the motor shaft to relieve pressure from the retaining ring **(126).** Remove the ring. Lift the lower pulley **(127),** compression spring, and spacer **(129)** off the motor shaft.

WARNING

The motor (145) weighs approximately 20 lbs. Take appropriate precautions to prevent equipment damage and possible personal injury.

9. Support the motor and remove two screws **(146)** securing the motor to the variable speed housing. Remove the motor from the housing.

Reverse this procedure to replace the motor. The retaining ring (126) is easily damaged during removal and may need replacement. You may have difficulty assembling the pulley (124). First, work the belts as far toward the center of the driven pulleys as possible. Next, work the belt as far as possible toward the outside edges of the drive pulleys (124) and (127).

Apply pressure to lower the pulley until the retaining ring (118) can be assembled. (A small plastic mallet may be used to tap the pulley into place.) Trammel the spindle after reassembly; refer to the User's Manual (1-104-0823), Chapter 2.

11.2.4 Vari-Drive Belt Replacement — Figure 11-5

1. With the motor running, adjust the variable speed control to the top of the speed range. Adjust the speed changer in the red zone until the mechanical stop in the speed changer is reached. This adjustment may be made in either the high or low speed range. The variable speed belt is now in the proper position for motor removal.

NOTE

The speed range must be adiusted before proceeding to Step 2.

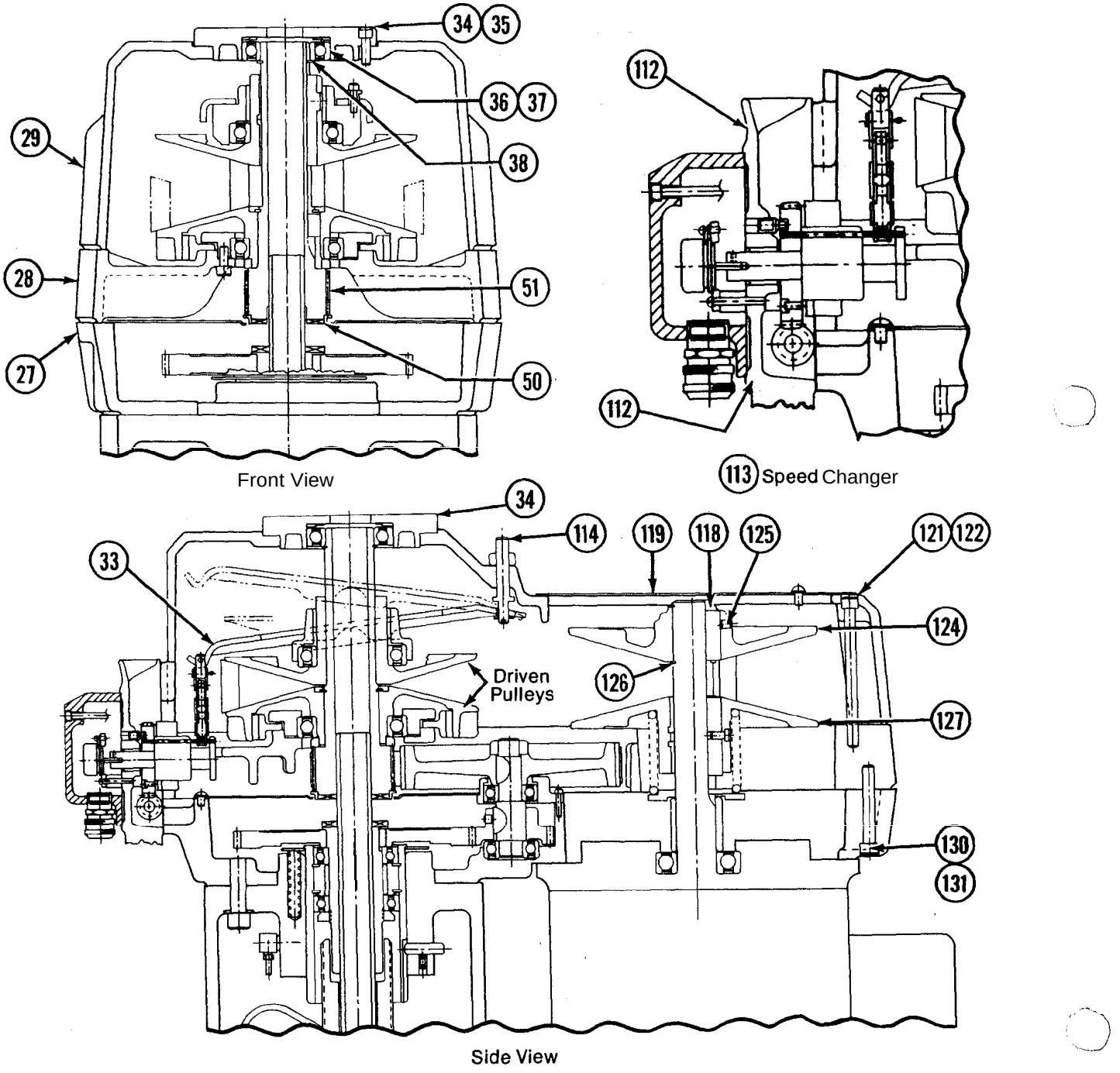


Figure 11-5. Vari-Drive and Timing Belt

2. Press the SPINDLE OFF pushbutton to stop the motor.
3. Disconnect power to the machine.
4. Remove the two lower screws (112) in the speed changer assembly (113).
5. Remove three socket head cap screws (35) from the belt housing cap (34). Detach the cap and the spring washer (37) from the head.
6. Remove four screws (121) from the belt housing cover (119) and the top screw (3), Figure 11-13, from the pneumatic brake assembly. Remove the belt housing cover.
7. Remove the retaining ring (118) from the motor shaft.

WARNING

Be prepared for the pulley to spring up approximately %-inch when the set screw is loosened.

8. Loosen the socket set screw (125) and remove the pulley.
9. Remove three (130) and two (131) socket head cap screws. Tap upward on the speed changer assembly with a plastic mallet until the upper belt housing separates from the lower housing. Remove the top belt housing.
10. Remove the worn belt and install a new belt.

CAUTION

Use replacement belts purchased from a Bridgeport representative only. The wrong belt may cause vibration and overheating.

Reverse this procedure to reassemble. To facilitate assembly of the pulley, work the belt as far toward the center of the driven pulleys as possible; then work the belt as far as possible toward the outside edges of the pulley. Apply pressure to lower the pulley until the retaining ring (118) can be assembled. (A small plastic mallet may be used to tap the pulley into place.)

11.3 QUILL AND SPINDLE

11.3.1 Spindle Locknut — Figure 116

1. Remove three screws from the locknut.
2. Tighten the nut assembly as much as possible — then back off one turn.
3. Insert a standard Quick Change adapter and tighten the locknut.
4. Screw in the longest button head screw (dog point) in the hole permitting the greatest amount of rotation for unlocking (the hole closest to a locking ear).
5. Rotate the nut back to load position (locking ears and keys are in line).
6. Insert a cadmium plate screw in the hole in line with the locking ear. This identifying screw enables the operator to load adapters.

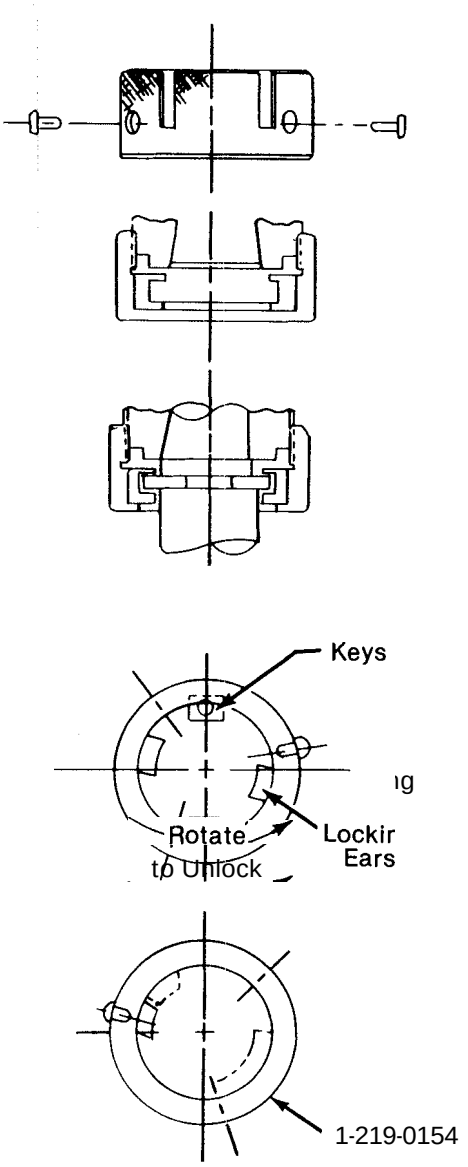


Figure 11-6. Quick Change Locknut Assembly

7. Put the remaining screw in the remaining open hole. The spindle is now ready to use.

11.3.2 Spindle Removal — Figure 11-7

1. Lower the quill one inch from the home position. See Section 11.4 for location of the home position.
2. Remove the spindle nose set screw (136) located on the quill outside diameter.
3. Move the quill to the home position. Lower the knee to the full down position.
4. Place blocks under the spindle to prevent it from dropping when loosened from the quill. Remove the spindle nose locknut from the quill by unscrewing the nose cap. The spindle is now free to be removed from the quill.
5. If the spindle does not drop out, tap on the end of the spindle with a soft mallet (through the opening on the top of the variable speed assembly). This will force the spindle bearing out from the bore of the quill.

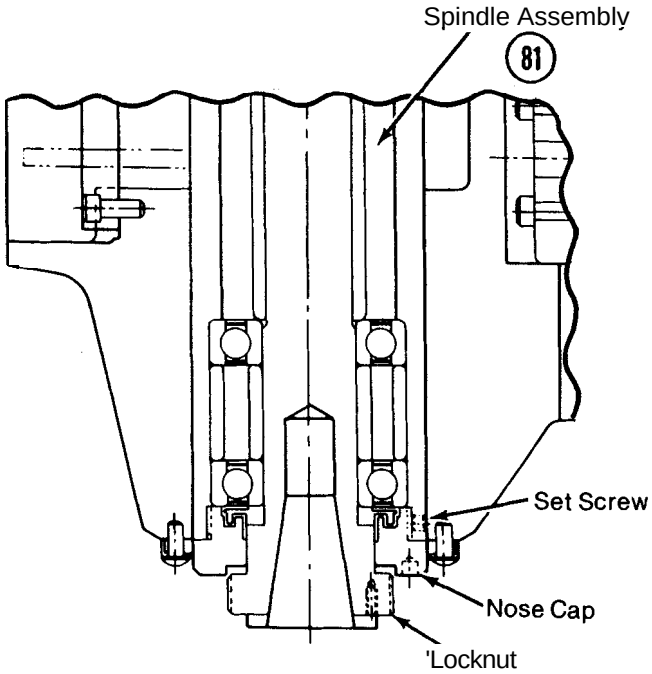


Figure **11-7.** Spindle Removal

WARNING

To prevent serious injury, keep hands away from the area between the spindle and support blocks. When the spindle bearings clear the bore in the quill, the spindle rapidly drops out of the quill.

11.3.3 Quill Drive Motor Replacement — Figure **11-8**

1. Disconnect power to the machine by throwing the main circuit breaker to the OFF position.
2. Disconnect the electrical wiring and remove the cable from the motor.
3. Remove two screws (16) and lift the motor mounting bracket cover (18) off the motor mounting bracket (55).
4. Remove four screws (23) holding the drive motor to the motor mounting bracket (55).
5. Slide the timing belt (19) off the motor pulley assembly (20).
6. Loosen the set screw and pull the motor pulley off the motor shaft.

CAUTION

The motor should, remain in one complete piece. Magnetic characteristics of the motor are destroyed if the armature is removed. Care should be taken when removing the motor; approximate weight is 10 lbs.

7. Lift the drive motor off the motor mounting bracket (55).
8. Install the replacement motor by reversing Steps 1 through 7.
9. After the drive motor is installed, set the proper belt tension; see Section 11.3.4.
10. Set the quill home position, see Section 11.4.

11.3.4 Quill **Drive** Belt Adjustment — Figure **11-8**

1. Follow Steps 4 through 6 in Section 11.3.3.
2. Loosen, but do not remove, four screws (23) securing the drive motor to the motor mounting bracket (55).
3. Adjust the belt tension. Pulling the motor away from the head will increase the belt tension. Pushing the motor toward the head will decrease the tension.

NOTE

The belt should have a tension of 66 lbs. or should deflect,' in the middle on one side, 1/8 inch with 5 lbs. force applied.

Tighten the four motor mounting screws when the proper tension is obtained.

11.3.5 Quill Drive Belt Removal — Figure **11-2**

1. Disconnect power to the machine.
2. Remove two screws (16) and lift the motor mounting bracket cover (18) off the motor mounting bracket (55).
3. Remove four screws (23) holding the drive motor in the motor mounting bracket (55).

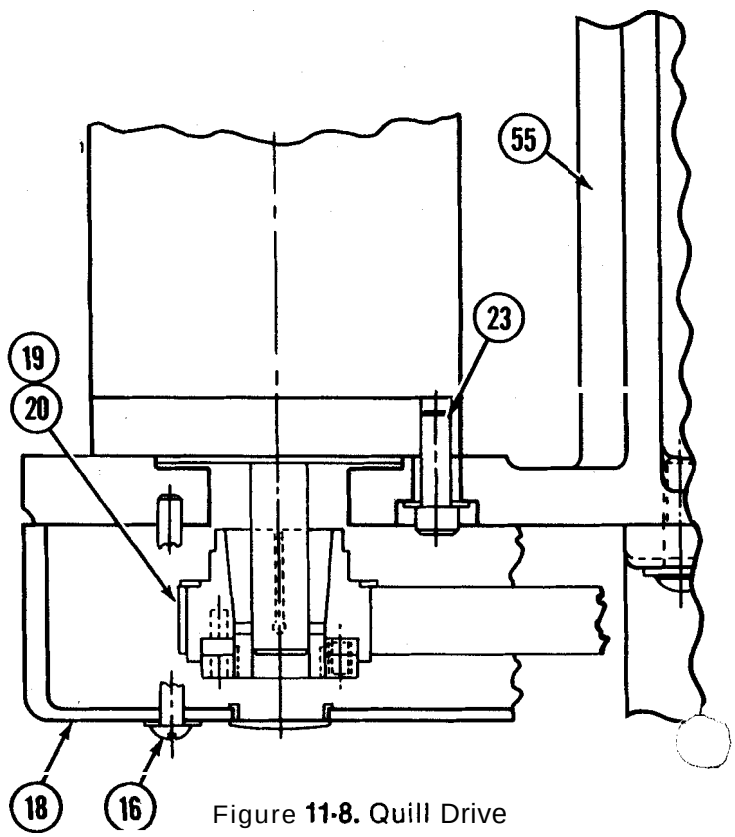


Figure **11-8.** Quill Drive

4. Slide the timing belt (19) off the motor pulley assembly (20).
5. Loosen the set screw and pull the motor pulley assembly off the motor shaft.
6. Lift the drive motor off the motor mounting bracket.
7. Remove the right and left quill housing covers (3) and (70).

NOTE

The quill housing covers weigh 25 lbs., care should be taken when removing them.

8. Remove two screws located on the right side of the spindle control panel.

NOTE

Oil is likely to drop from the quill housing cover. This oil should be discarded and need not be replaced upon reassembly.

9. The spindle control cover is attached to a hinge. Open the cover. Carefully note and record the colors and locations of all six limit switch wires.
10. Remove the six wires from the three limit switches.
11. Disconnect the top hose feeding into the meter (71).
12. Attach the head removal tool (ST-6921) Figure 113, to the belt housing cap (34), Figure 11-5, with three .250-20 x .750 screws.
13. Support the head with a hoist attached to the removal tool .
14. Remove screws (24) and (26) connecting the quill housing (76) to the motor mounting bracket (55).
15. Lower the spindle.
16. Lift the upper head assembly 2 to 2½ inches.
17. Disconnect the oil line to the left of the metering unit (63).
18. Remove the upper head assembly.
19. Support the spindle in the up position.
20. Remove four bearing retainer screws (95).
21. Remove the metering unit (63) from the lower bearing support (97).

CAUTION

If the ballnut is rotated off the ballscrew, the ballscrew assembly will be destroyed; and new ballscrew assembly will be needed.

22. Rotate the ballnut assembly on the ballscrew just enough to raise the pulley assembly (20) above the quill housing (76).
23. The timing belt (19) may be lifted up over the spindle and out of the machine.

NOTE

The area must be kept free of any contaminating elements.

24. Revers? the removal procedure to reassemble the machine. A special assembly procedure for the quill housing (76) and motor mounting bracket (55) is given in Section 11.5.
25. Set the quill home position. See Section 11.4.
26. Set the timing belt (19) tension. See Section 11.3.4.

11.3.6 Ball Quill Extension Removal — Figure 11-9

Special Tools

1. ST-6921 (Figure 113)
2. 2-inch adjustable spanner wrench
3. 3%-inch diameter adjustable hook spanner wrench

Procedure

1. Follow {he disassembly procedure for the Quill Drive Belt Removal; Section 11.3.5, Steps 1 through 20.
2. The ball quill extension has a total travel of 5 inches.

CAUTION

If a 5-inch distance is exceeded, the balls will fall out of the assembly; and a new ball quill extension will have to be purchased.

3. Rotate the ball quill extension nut up far enough to remove six socket head cap screws (88), but not to exceed 5 inches of travel.
4. Rotate the ball quill extension back down and remove from the spindle.
5. Remove the bearing support (97) and bearings (96) by removing the lock bearing washer (100) and lock nut (99). Use a 2-inch adjustable spanner wrench and a 3½-inch adjustable hook spanner wrench.

NOTE

The bearings must be re-installed in the same orientation. Use the "V" on the outside diameter as a guide for correct orientation of these bearings. Note theshields of the bearings are toward the outside.

6. Removetwo retaining rings (91) and timing pulley (93).
7. Before installation, inspect and clean the ball quill extension assembly. See Section 11.6.2.

NOTE

CLEANLINESS is of great importance. Ensure the quill and ball quill extension are free of chips or dirt.

8. After the assembly is complete, perform the following settings.
   a. Align the motor mounting bracket (55) to the quill housing (76). See Section 11.5.2.
   b. Set the timing belt (19) tension. See Section 11.3.4.
   c. Check and reset the quill limit switches (72) and (12) and home switch (66), if necessary. See Section 11.4.

11.3.7 Quill Removal

CAUTION

The quill outside diameter and the quill housing bore are a matched fit. The quill should only be removed in the case of severe damage by scoring through lack of lubrication or other causes.

1. Support the quill with blocks. Follow the procedure for the ball quill extension removal; Section 11.3.6, Steps 1 through 4.
2. The quill will fall out of the housing when the supporting blocks are removed.

11.4 SETTING Z HOME AND QUILL **LIMIT** SWITCHES
Figures 11-8 and 11-10

1. Remove two screws (16) and lift the motor mounting bracket cover (18) off the motor mounting bracket (55).
2. With machine power off, position the quill (Z-axis) in its uppermost position.
3. Manually rotate the Z-axis motor pulley one revolution. This will cause the quill to move .050 inch downward from the positive stop position.
4. Loosen four bolts (23) holding the drive motor to the motor mounting bracket (55). Slide the Z-axis belt off the motor pulley assembly (20).
5. Attach a volt meter (set to read DC voltage) to terminals 39 and 61. When actuated, the voltage will change from 24 volts to 0 (zero) volts DC. Loosen the two screws holding the home switch (66). Position the switch so it is not actuated.
6. Enable the axis drives by pressing AXIS DRIVE ENABLE. The CRT display will indicate homing of the axis is necessary.
7. Press EXECUTE. The Z-axis motor will begin to turn.
8. Using a screwdriver, actuate the Z-axis home switch. Hold the switch until the motor stops. The X and Y-axes will home out after the Z-axis homing completes.
9. Re-install the belt on the Z-axis motor; adjust for proper belt tension. Tighten the motor securely.
10. Press JOGIKNOBIINCIZ. Turn the axis motion handwheel – .350 inch. Tighten the Z-axis home switch so it just actuates at this point.
11. Jog the Z-axis to a position of 0.0 inches.
12. Place a .020-inch feeler gage between the upper limit switch (12) plunger and the stop bolt (7). Adjust the stop bolt until the upper limit switch actuates and causes an emergency stop. Lock the screw with a hex nut (8).
13. Press AXIS ENABLE. Jog the Z-axis to a position of –5.00 inches. Adjust the position of the down limit switch (72) until it just touches the trip plate. Tighten the switch.

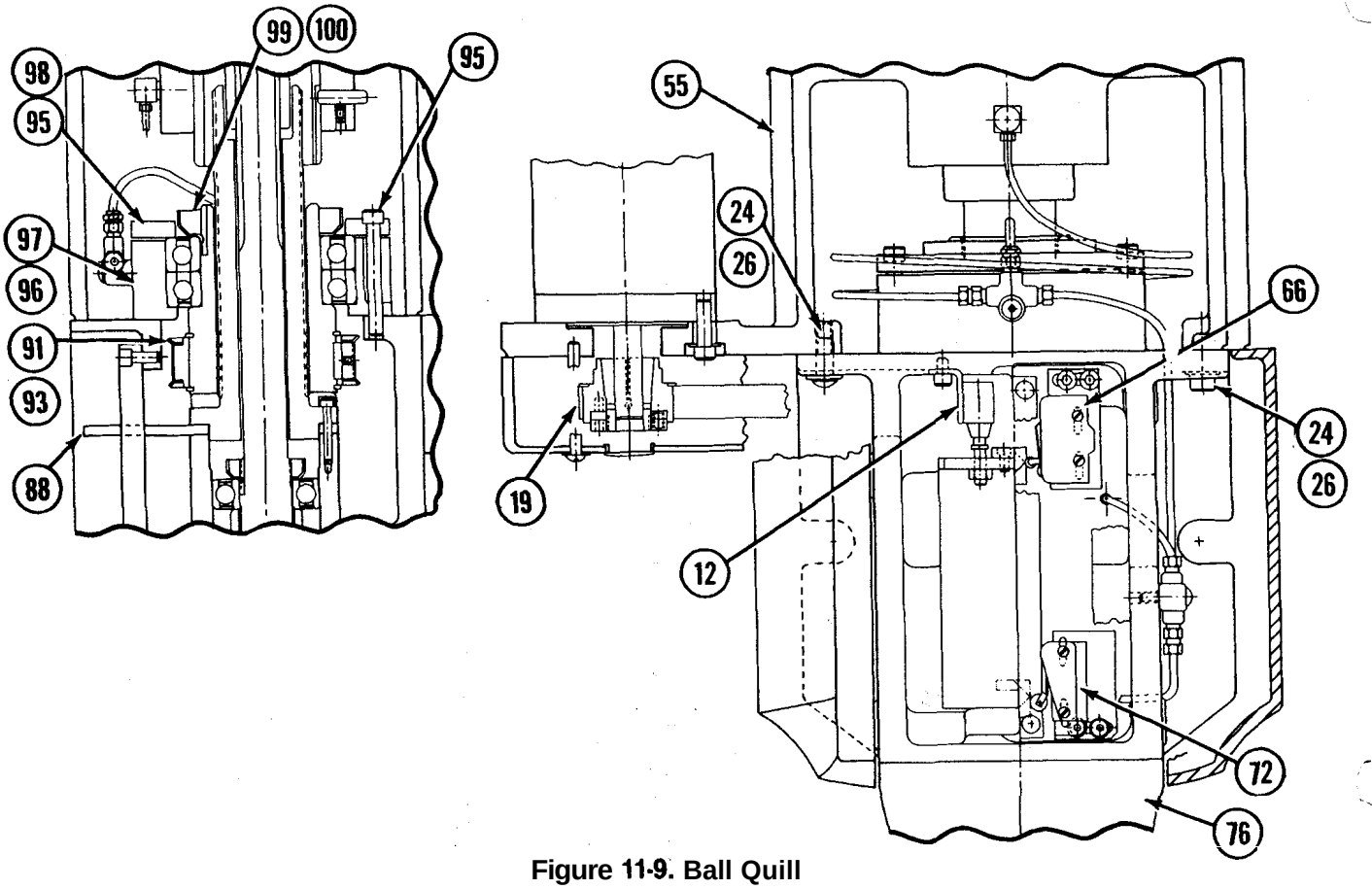


Figure 11-9. Ball Quill

11.5 ALIGNMENT OF BALL QUILL AND QUILL HOUSING TO DRIVE MOTOR HOUSING — Figure 11-9

Perform these procedures whenever the ball quill extension assembly or the motor mounting bracket (55) has been moved.

11.5.1 Ball Quill Alignment

1. Install, but leave loose, the four screws (95) securing the bearing support (97) and bearing support cover (98) to the quill housing (76).
2. Use the belt (19) to move the quill up and down along its travel. Return to home position. This should allow the bearing support to float and align itself with the quilt housing.
3. Tighten the four socket head cap screws (95) securing the bearings to the quill housing.

11.5.2 Quill Housing Alignment

1. Loosen four screws (24 and 26) securing the quill housing to the motor housing.
2. Start the spindle and adjust the speed to 3800 RPM.
3. Shift the quill housing until minimal spindle rattle is obtained. Tighten the four screws (24 and 26).

11.6 CLEANING AND FLUSHING THE BALL QUILL EXTENSION ASSEMBLY — Figure 11-11

CAUTION

CLEANLINESS is of great importance in this operation. Operators' hands and clothing must be free of dirt and oil. Test equipment, fixtures, and tables must be free of dirt, dust, chips and oil. The inspection area must be free of air-contaminating equipment, such as grinding machines, exhaust blowers, etc.

1. Set the ball quill extension assembly in a horizontal position and place over a flushing tank.
2. Pour an oil-dissolving solvent over the ball threads and ballnut. This will remove any contaminated oil, chips, or foreign material from the ball quill extension assembly. Remove from the flushing tank.
3. Set the ball quill extension assembly in an upright position in a container, with the ball threads facing upward and the mounting flange downward.
4. Pour an oil-dissolving solvent over the ball threads and into the top of the nut, while rotating the nut over its total travel. This will remove any contaminated oil on the threads and flush any chips or foreign material lodged in the ballnut tracks.
5. After cleaning, apply a film of light machine oil over the threads and into the ballnut.

11.7 REMOVAL OF SPEED CHANGER — Figures 11-5 and 11-12

1. With the spindle running, set spindle speed at minimum of 60 RPM.

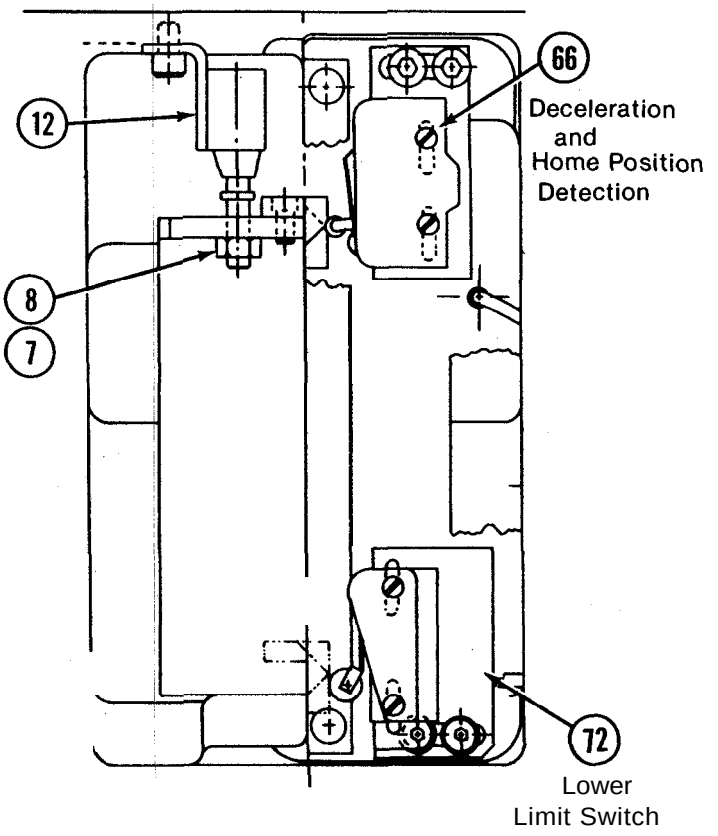
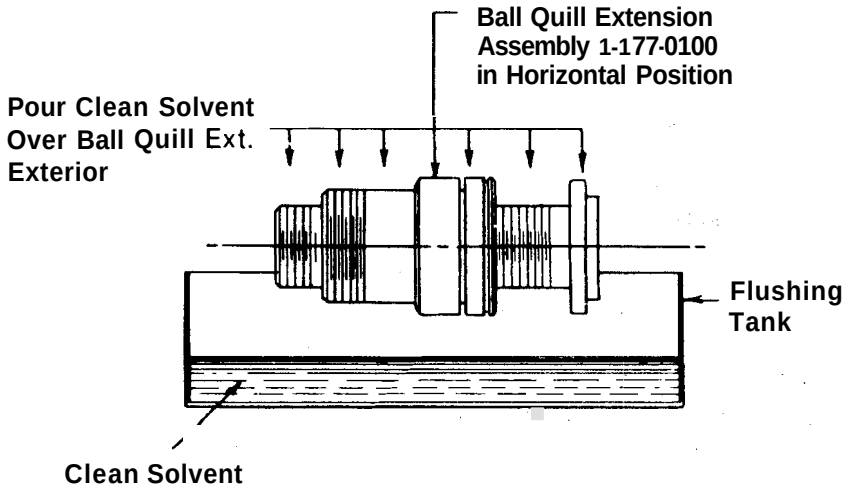


Figure 11-10. Setting Z Home and Quill Switches

2. Turn OFF the spindle motor and set the main disconnect to the OFF position.
3. Remove the two lower socket head capscrews (112) on the speed changer housing.
4. For convenient access to the speed changer adjusting screw (114) during reassembly, remove the three socket head capscrews (35) and the belt housing cap (34), complete with spring washer (37).
5. The two (122) and three (121) socket head capscrews can be removed from the top of the belt housing (29).
6. The belt housing can be removed, exposing the speed changer assembly.
7. Remove the chain stud and pin from the speed changer plate. These are items 1 and 2 in the Speed Changer Drum Assembly (Figure 11-13).
8. Remove the remaining two socket head capscrews (112) from the speed changer housing.
9. The speed changer assembly is now free to be removed from the belt housing.

Installation

To install th$ speed changer, reverse the removal procedure. Set the speed changer adjusting screw (114), accessing the $crew through the opening provided in the belt housing (29). Refer to Section 11.2.1 (Figure 11-1) to reset the speed control.



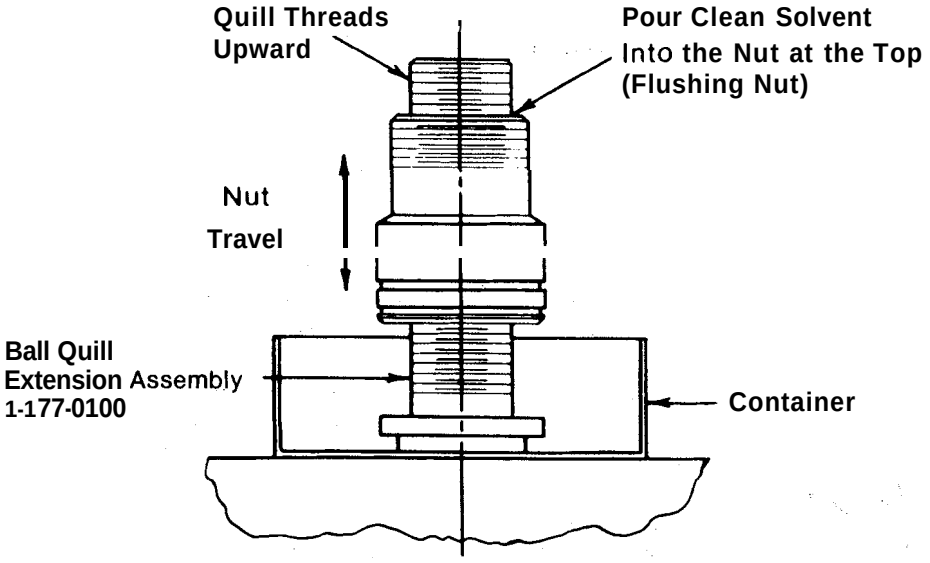


Figure 11-11. Ball Quill and Nut Flushing

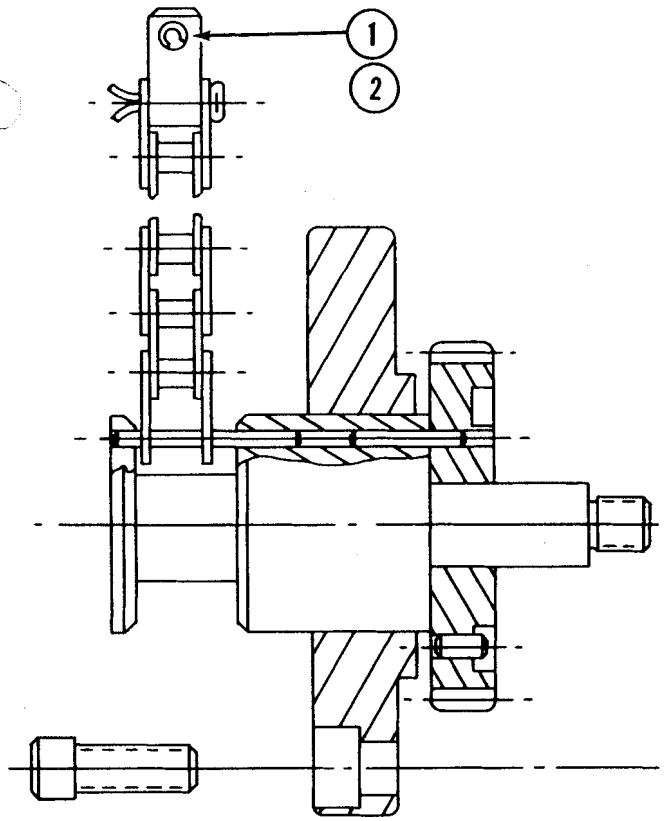


Figure 11-12. Speed Changer Drum Assembly

11.8 REMOVAL OF BRAKE LOCK — Figure 11-13

1. Turn power OFF.
2. Turn the pneumatic supply OFF at the machine.
3. Remove the hoses from the brake cylinder.
4. Remove the single socket head capscrew (3) and washer (2) securing the cylinder device (5) to the belt housing.
5. Remove the single socket head capscrew (11).
6. Slide the brake lever (13), complete with attached cylinder, from the brake adjust (10).

Installation

To install the brake lock, reverse the removal procedure. Tightening the three socket screws (3), (12), and (11) is the final installation step.

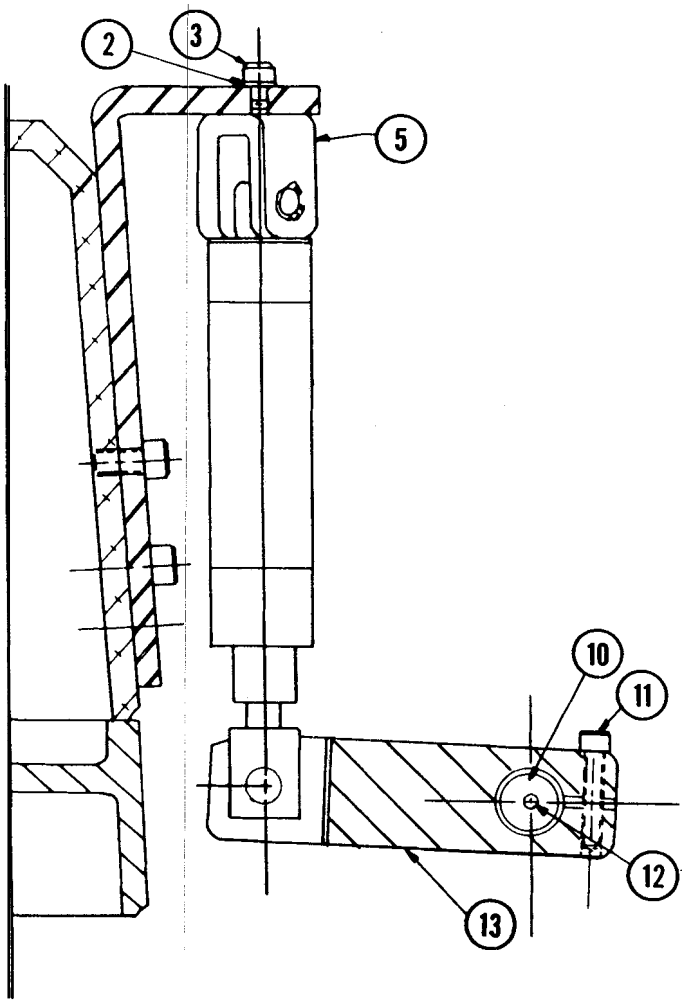


Figure 11-13. Pneumatic Brake

CHAPTER 12
AUXILIARIES

12.1 INTRODUCTION

The first section of this chapter supplies general information concerning the R2E4 auxiliaries system. The following pages provide adjustment procedures and parts replacement information for the pneumatic and lubrication systems in the R2E4 milling machine. Vendor information, specifications and replacement part numbers are also included.

12.2 PNEUMATIC SYSTEM

12.2.1 Speed Changer and Brake

Pneumatic system contains a filter/regulator with a drain and a lubricator. There is also a manifold that controls air flow to the pneumatic motor and spindle brake. Two kinds of valves are used.

Single solenoid, 4-way, 2-position, for Brake and Index (Options)

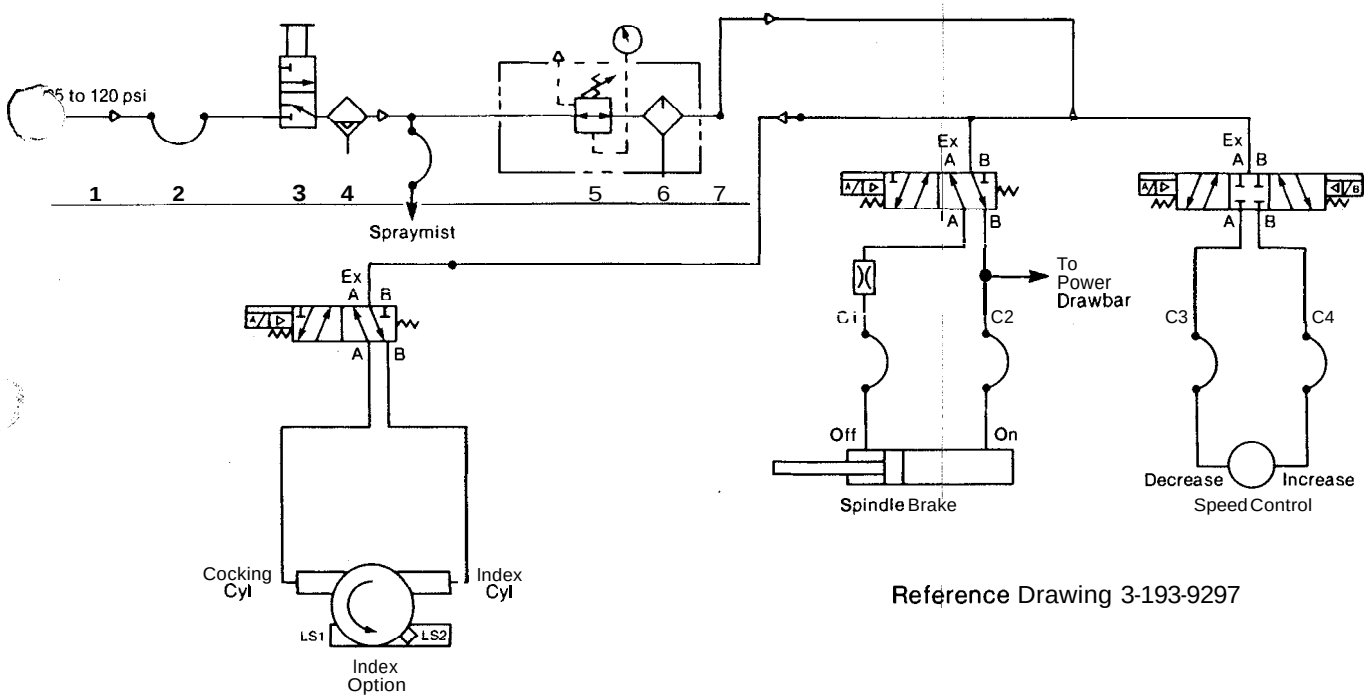
Double solenoid, 4-way, 3-position, for Speed Changer

The air is lubricated with a small amount of oil. The flow of oil is controlled by a knob on the top of the filter/lubricator. To set the air flow, turn the knob clockwise to OFF then counter clockwise to ON approximately ½ turn (¾ turn is full flow). See Parts Manual for details.

CAUTION

Do not operate the system with the air system lubricator valve OFF. This will cause the hoses to deteriorate *over* a period of time.

Only one type of lubricant is approved for use in the pneumatic system of machines so equipped: Mobil DTE24 or direct equivalent, refer to Specification Sheet 1-037-0001 at the end of this chapter. Seediagram Figure 12-1.



Reference Drawing 3-193-9297

NOTES

1. 3/8 NPT male connection to customer equipment.
2. 20 ft. 3/8 ID flexible air hose.
3. On/Off slide valve.
4. Filter with Drain.
5. Pressure regulating valve, set 75 psi.
6. *Lubrication:* Use Mobil *DTE24* or direct equivalenf. Adjust drip frequency so that the air exhaust *shows* a slight fog.
7. Location for the insertion of optional index function *control.*

See Chapter 4 System Wiring Diagram for *electrical interface.*

Figure 12-1. Pneumatic Diagram

12.3 LUBRICATION SYSTEM

12.3.1 Overview

The bearings in the spindle, the spindle drive transmission, and the ballscrew mountings have antifriction angular contact bearings greased for life.

The moving members are all fed from a central lubricating tank, the TM-5 lubricator, which contains a filter and motorized timed plunger pump.

Approved Lubricants (The viscosity range is 150 to 8000 SUS at operating temperature.) The following lubricants or equivalents are approved for use in the automatic lubrication system. See Specification Sheet 1-137-0020 at the end of this chapter.

Gulf Oil Corp. and Subsidiaries	Gulfway 52
Mobil Oil Corp.	Mobil Vactra Oil No. 2
Shell Oil Co.	Tonna 68
Sun Oil Corp.	Sunoco Way Lubricant 1180
Texaco Inc.	Way Lubricant D

Maintenance and Service

NOTE

When starting a new machine, fill the reservoir. It has a *1 litre (1000 cu* cm) refill capacity *(1* quart). Pull and release the *"Instant* Feed" button at the top of the reservoir several times until the oil shows freely on all bearing surfaces.

Maintenance

1. Check the oil level daily and refill the reservoir when required.
2. Check the system periodically for loose or broken tubing, worn hoses, and loose fittings and connections.
3. Check the bearing surfaces daily. If there is too little oil, check the following and repair as necessary:
   a. Low oil level
   b. Broken, cracked tubing
   c. Loose connections
   d. Flattened lubricator outlet tube
   e. Clogged filter

Motor Replacement

1. Remove the motor cover and the two screens holding the motor to the top of the reservoir.
2. Replace the motor Code No. 1-141-7850.
3. On reassembly, make sure the slot in the motor shaft is engaged with the pin in the drive shaft before replacing the screens.

For additional information on the lubrication system, see the Parts Manual.

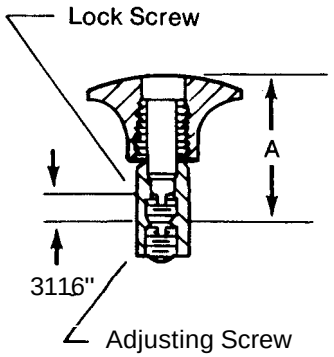
VENDOR: D-2994UR No.:	DESCRIPTION: LUBRICATOR UNIT TYPE TM-5	Bridgeport® Code No.: 1-141-3208 Page 1 of 2

When Ordering Specify Lubricator Type and Part Number such as: Lubricator Type TM-5 D-2994.

LUBRICATOR CYCLE TIME IN MINUTES		PART NUMBER WITH LIQUID LEVEL SWITCH
50 Hz	60 Hz	BIJUR
6.4	5.3	D-2994

OPERATION Lubricator is a motor driven piston pump, spring-discharge type. Pump cylce time is controlled by an integral gear reduction in the motor. Lubricator can be actuated manually by raising and releasing the Instant Feed Button. Available cycle times are shown in the above table.

DISCHARGE VOLUME PER CYCLE Adjustable from 2.5cc minimum to 5.0cc maximum. The lubricator is supplied at the maximum stroke setting. To reduce oil delivery, remove the lockscrew; measure A; and turn adjusting screw clockwise increasing dimension A in the increment (corresponding to the desired discharge), as shown on the following table.



INCH	DISCHARGE
.400	2.5cc
.320	3.0cc
.240	3.5cc
.160	4.0cc
.080	4.5cc
0	5.0cc

DISCHARGE PRESSURE 60 psi maximum. Peak system pressure will decrease when: (a) discharge volume decreases, (b) number of Meter-Units in system increases, (c) oil viscosity decreases.

OIL VISCOSITY RANGE 150 to 8,000 SSU at operating temperature.

LUBRICATOR FILTER 40-micron particle separation. It should be inspected periodically and cleaned or replaced, as required. (Bijur S-109, Code No. 1-141-0078)

DISTRIBUTION SYSTEM Use Type F Meter-Units (see Data Sheet 2400) limitations. Maximum number of meter-units permissible — 70. For system Flow Value ($\phi\tau$) limitations, refer to table below:

Number of Meter-Units	CC's Per Cycle 2.5	3	4	5	Max. Permissible System Flow Value, $\phi\tau$
5		700	800	800	
10		550	680	750	
15		440	520	650	
20		360	460	520	
25		320	400	450	
30		275	325	390	
40		210	245	290	
50		155	185	220	
60		110	135	160	
70		70	85	96	
	Max. Permissible Flow Value				

MOTOR Continuous duty, single phase, synchronous induction timing motor for 50/60 Hz, dual wound for 115/230 volts AC. Power consumption 3 watts. Code No. 1-141-7850.

For correct wiring, see instruction tag attached to lubricator.

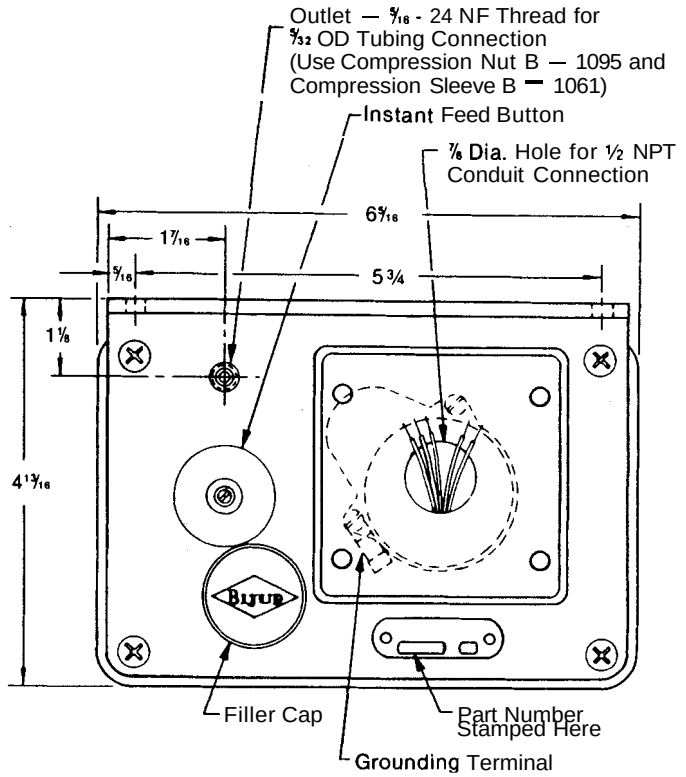
Bijur reserves the right to change motor size, mounting dimensions and/or manufacturer.

LIQUID LEVEL SWITCH The liquid level switch are listed in the table. They are supplied so that switch will close an electrical circuit whenever the oil in the reservoir is above the minimum operating level. Thus, when connected to a light or other indicating device, the liquid level can be monitored, DB 8561 (Code No. 1-141-3241).

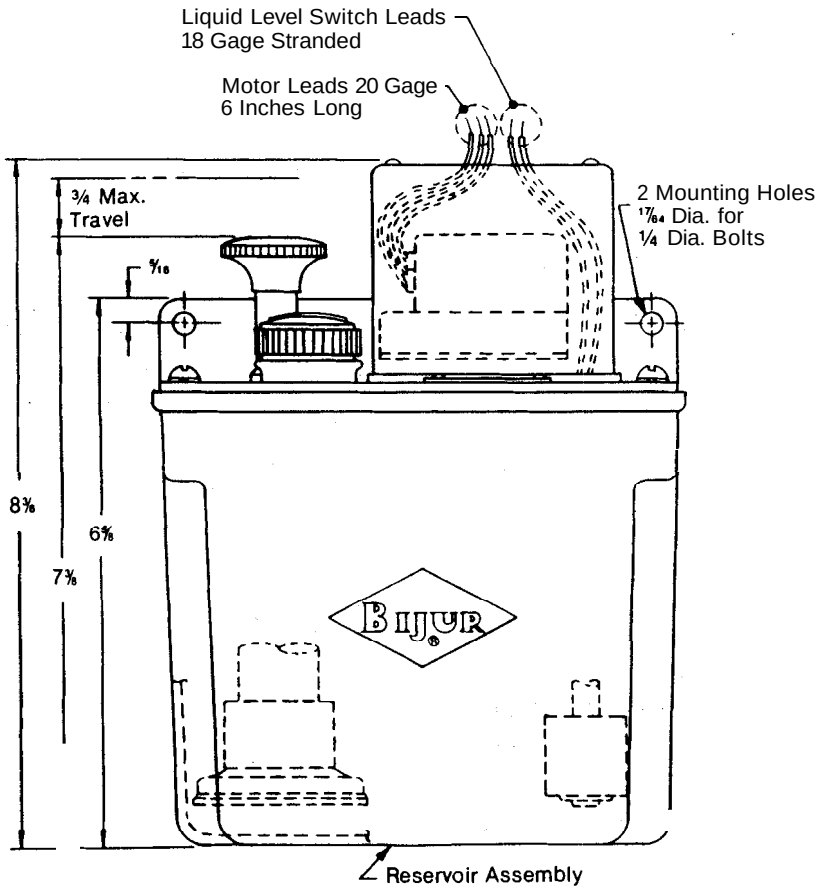
Customers may reverse the operation when desired by inverting the float. When the float is reversed, the switch will close an electrical circuit whenever the oil level is below the minimum operating level.

NOTE

Switch contact rating: 10 Watts maximum (Light or indicating device not supplied by Bijur)



All Dimensions in Inches



Lubricator Unit

LUBE SPECIFICATION NO. 1-037-0001

GENERAL DESCRIPTION: Hydraulic Oil — High quality nondetergent mineral oil with metallic phosphate antiwear additive.

USES: Hydraulic systems, spindles, turbines, gear drives, sleeve or roller bearings, and Kusters Swimming Rolls (non-driven).

Lubricant specifications listed herein are minimum standards which must be met by all lubricants recommended for use on the machine. For specific applications to the machines, see lubrication recommendation sheets for individual machines.

LUBE CODE NO. 1-037.0001				1.037-0002
ASTM or ASLE Lube No.				150
Viscosity S.U.S.		100 °F		1351165
		210 °F		—
V. I. — Min.				95
Flash Pt. — °F Min.				400
Pour Pt. — °F Max.				10
Max. Op. Temp. — °F			⑦	200
Additives or Inhibitors			⑧	R.O.W.P.
TEST REQUIREMENTS				
Timken O.K. Ld. — Min.				—
Oxidation	ASTM D-943	Min. Hrs.		1500
		Neut. No. Chg.		.25
	ASTM D-943 Modified			—
Cu. Corrosion — ASTM — D-130 STAIN				#1
ASLE Accelerated Breakdown Test				—
Foam — ASTM D-892				②
Emulsion — ASTM — D-1401				③
Bijur Differential Filtration Test				—
Evaporation Rockwell Test				⑥
Stick Slip Ratio — CMM Test — Max.				—
Rust — ASTM D-665A				PASS

LUBE SPECIFICATION NO. 1-037-0020

GENERAL DESCRIPTION: Waylube — Must contain tackiness additives; must NOT contain lead or chlorine compound additives.

USES: Machine tool ways, heavily loaded journals, and screws.

Lubricant specifications listed herein are minimum standards which must be met by all lubricants recommended for use on the machine. For specific applications to the machines, see lubrication recommendation sheets for individual machines.

LUBE CODE NO. 1-037-0020			1-037-0021
			Waylube
ASTM or ASLE Lube No.			315
Viscosity S.U.S.	100 °F		2831347
	210 °F		—
V. I. — Min.			—
Flash Pt. — °F Min.			350
Pour Pt. — °F Max.			0
Max. Op. Temp. — °F			150
Additives or Inhibitors ⑧			R.F.S.
TEST REQUIREMENTS			
Timken O.K. Ld. — Min.			
Oxidation	ASTM D-943	Min. Hrs.	—
		Neut. No. Chg.	—
	ASTM D-943 Modified		—
Cu. Corrosion — ASTM D-130 STAIN			—
ASLE Accelerated Breakdown Test			⑤
Foam — ASTM — D-892			②
Emulsion — ASTM — D-1401			—
Bijur Differential Filtration Test			PASS
Evaporation Rockwell Test			⑥
Stick Slip Ratio — CMM Test — Max.			.85
Rust — ASTM D-665A			PASS

VENDOR: C.A.NORGREN CO. No.: F12-200-A3TA	DESCRIPTION: COMPRESSED AIR FILTER	Bridgeport® Code No.: 3-150.6459 Page 1 of 1

SPECIFICATIONS

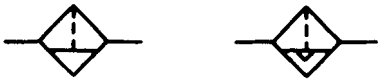
Filter Element (Sintered Bronze)
- 50-Micron (Standard)
- 5 or 25-Micron (Optional)

Bowl
- ½-pt. Transparent Polycarbonate (Standard)
- ½-pt. Aluminum (Optional)

Maximum Rated Operating Conditions
Polycarbonate Bowl
- 150 psi (10.3 bar)
- 125" F (52° C)

Metal Bowl
- 250 psi (17.2 bar)
- 175" F (80" C)

GRAPHIC SYMBOLS



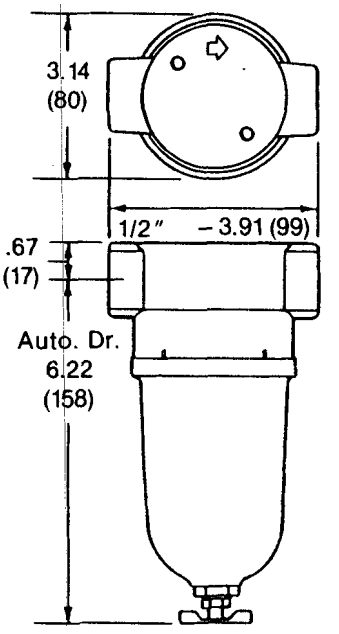
Manual Automatic

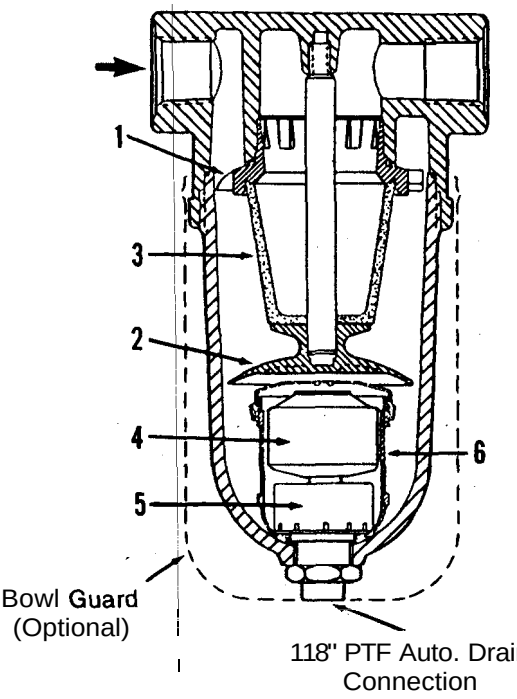
Air entering the filter is guided into a swirling pattern by the louvers (1). Liquid and coarse particles are thrown against the bowl wall by centrifugal force and run down to the bottom of the bowl. Baffle (2) creates a "quiet zone" at the bottom of the bowl to prevent air turbulence from re-entraining separated liquid into the air stream. Air leaving the bowl passes through the element (3), where finer solid particles are removed and retained.

The automatic drain (4 and 5) is a float-operated mechanism at the bottom of the bowl, which automatically expels any liquid accumulating above a certain level. An over-accumulation of liquid in the bottom of the bowl causes float (4) to rise. This admits bowl pressure into the drain mechanism (5), opening a bleed valve and allowing excess liquid to be expelled under pressure. When the liquid level drops sufficiently, the float drops and draining stops. A screen (6) around the drain mechanism traps the large particles which would not pass through the bleed valve. The automatic drain is normally open during shutdown periods so any liquid in the bowl or which may later collect drains by gravity and does not overfill the bowl. At startup, the automatic drain will close when bowl pressure reaches approximately 5 psi. Minimum operating pressure is 10 psi.

DIMENSIONS

All dimensions are in inches (millimeters).





VENDOR: C.A.NORGREN CO. No.: B07-202-HIKA	DESCRIPTION: MINIATURE FILTER/ REGULATOR FOR COMPRESSED AIR SERVICE	Bridgeport® Page 1 of 4

SPECIFICATIONS

Rated Operating Conditions

Polycarbonate Bowl — 150 psig (10.3 bar) maximum inlet pressure, 0" to 125" F (– 18° to 52° C)••

Metal Bowl — 250 psig (17.2 bar) maximum inlet pressure; 0° to 150" F (– 18° to 66° C)••

Port Size — 118" or 114" PTF

Gauge Ports — 118" PTF (Two)

Filter Elements — 5 micron or 100 micron

Filter Bowl — Transparent polycarbonate or metal

Filter Drain — Manual or Automatic

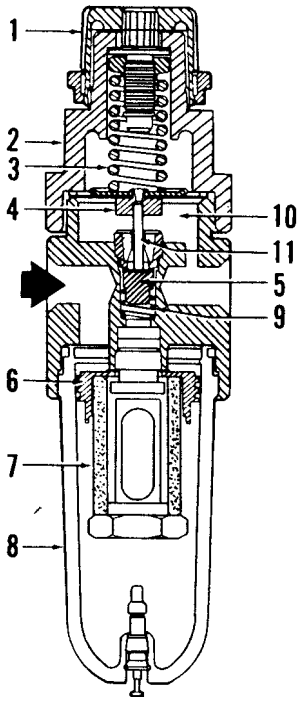
Regulator type — Diaphragm; relieving or nonrelieving

Outlet Pressure Adjustment Ranges • —
Standard — 5 to 100 psig (.3 to 6.9 bar)
Optional — 1 to 10 psig (.07 to .7 bar)
Optional — 5 to 50 psig (.3 to 3.4 bar)

Material of Construction
Body — Aluminum
Bowl —
Transparent — Polycarbonate
Metal — Aluminum (Configuration A Bowl)
Zinc — (Configuration B Bowl)
Element — Polypropylene
Elastomers — Neoprene & Buna-N
Bonnet — Acetal Plastic
Valve — Brass

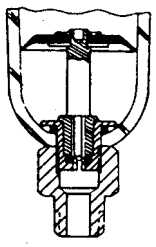
• Outlet pressure adjustment ranges are not minimum or maximum outlet pressure limits. Filterlregulators can be adjusted to zero psig outlet pressure and, generally, to pressures in excess of those specified. The use of these filterlregulators to control pressures outside of the specified ranges is not recommended.

•• With dewpoint less than air temperature below 32° F(2°C)

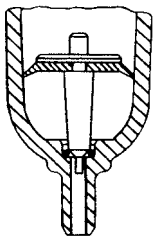


Manual Drain

Automatic Drains



Configuration A Bowl



Configuration B Bowl

OPERATION

A filter/regulator performs two functions in a compressed alr system. It removes most liquid and solid particles from the compressed air. It maintains a nearly constant outlet pressure despite changes in the inlet air pressure and changes in downstream flow requlrements.

Air entering the filterlregulator is guided into a swirling pattern by the louvers (6). Coarse solid particles and liquids are forced to the bowl wall (8) by centrifugal force and drop to the bottom. Air leaving the bowl passes through the filter element (7), where most finer solid particles are retained. Clean air flows upward from the element to the regulator valve (5).

These filters have either a manual or automatic drain. Manual drain models must be drained periodically. Automatic drain models expel liquid automatically when a rapid change in flow through the filterlregulator occurs. They may be operated manually by inserting a small rod into the drain connection and pushing the drain valve upward.

Outlet pressure is controlled by the adjusting knob (1). Clockwise rotation increases and counterclockwise rotation decreases outlet pressure setting. When the knob (1) is rotated fully counterclockwise, no force is applied to the regulating spring (3), and the valve (5) is held closed by the valve spring (9). Clockwise rotation of the knob (1) compresses the regulating spring (3), which applies a downward force on top of the diaphragm and valve pin assembly (4). The diaphragm and valve pin assembly (4) move downward, forcing valve (5) off its seat and allowing air to flow through the filterlregulator to the downstream system.

Outlet pressure increases in the downstream system and in the sensing chamber (10) and applies an upward force on the bottom of the diaphragm. The diaphragm and valve pin assembly (4) and the valve (5) move upward, compressing the regulating spring (3). Upward

movement stops when the forces below the diaphragm balance the forces above the diaphragm. When there is no downstream flow demand, the balance of forces occurs with the valve (5) closed. When there is downstream flow demand, the balance of forces occurs when the valve opens sufficiently to compensate for demand, thus maintaining the desired outlet pressure.

Relieving Type FilterlRegulators. With relieving filterlregulators, outlet pressure can be reduced even though the system is dead-ended. When the adjusting knob (1) is turned counterclockwise, the force on the regulating spring (3) is reduced, and air pressure in the sensing chamber (10) moves the diaphragm and valve pin assembly (4) upward. This upward movement opens the relief passage (11) in the valve pin and allows air to escape from the outlet side of the filterlregulator through the relief passage (11) and bonnet (2) to atmosphere. As the outlet air pressure decreases to the reduced pressure setting, the diaphragm moves downward and closes the relief passage.

The diaphragm will likewise move upward in response to an increase in outlet pressure above the filterlregulator setting, allowing air to escape to the atmosphere as described above. However, the flow capacity of the relief passage is limited, and depending upon the source of the overpressure condition, the outlet pressure might increase to a point significantly higher than the regulator setting. For this reason, the relief feature of a filterlregulator must not be relied upon as an overpressure safety device. See the following WARNING note.

Nonrelieving Type FilterlRegulators With nonrelieving filterlregulators, outlet pressure cannot be reduced through the regulator if the system is dead-ended. The nonrelieving type filterlregulator is identical to the relieving type with the exception of the valve pin, which is not equipped with relief passage (11). This type of filterlregulator will not vent the outlet air pressure as described under "Relieving Type FilterlRegulators", and some other means of venting the outlet air pressure must be provided.

WARNING

These filterlregulators are intended for use in industrial compressed air systems only. They must not be used where pressure or temperature may exceed rated operating conditions. See Specifications.

The polycarbonate plastic bowls used on these *filter/regulators* can be damaged and possibly burst if exposed to such substances as certain solvents, strong alkalies, compressor oils containing *ester*-based additives or synthetic oils. Fumes of these substances in contact with the polycarbonate bowl, *externally* or internally, can also result in damage. *Clean* with warm water only.

Use metal bowl in applications where a plastic bowl might be exposed to substances that are incompatible with polycarbonate.

If outlet pressures in excess of the filterlregulator pressure *setting* could cause downstream equipment to rupture or *malfunction,* install a pressure relief device *downstream* of the filterlregulator. The relief pressure and flow capacity of the relief device must satisfy system requirements.

The accuracy of the indication of pressure gauges can change, both during shipment (despite care in packaging) and during the service life. If a pressure gauge is to be used with these products and if inaccurate indications may be hazardous to personnel or property, the gauge should be calibrated before initial installation and at regular intervals during use. For gauge standards refer to ANSI B40 1-1974.

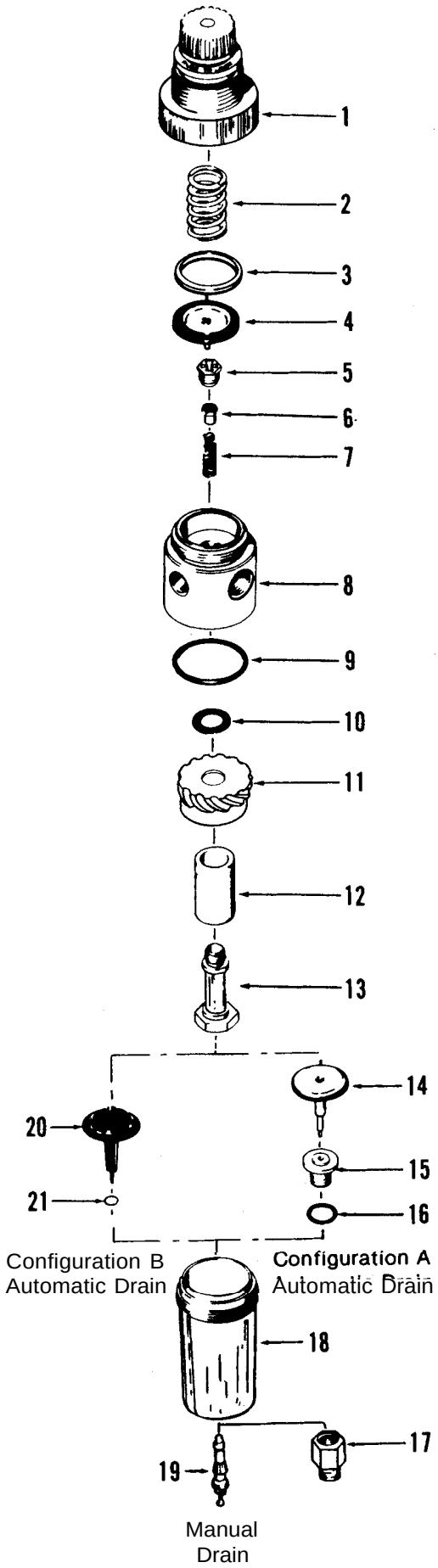
Before using with fluids other than air, for non-*industrial applications, or* for life support systems, *consult C.A. Norgren Co.*

INSTALLATION

1. Air line piping should be same size as filterlregulator ports.
2. Install filter/regulator in a vertical position with adjustment knob up and filter bowl down.
3. Connect piping to proper ports using pipe thread sealant on male threads only. Do not allow sealant to enter interior of regulator. The "IN" port is marked on the filter/regulator body.
4. In systems with a cyclic demand, install filter/regulator upstream of cycling control valves.
5. Connect outlet pressure gauge to one of the gauge ports. Gauge ports can also be used as additional low flow outlets. Plug unused ports.
6. On filters equipped with automatic drain, flexible tubing can be attached to the drain connection to pipe away expelled liquid. Use 118" minimum I.D. flexible tubing for the drain line on configuration A bowls. Do not overtighten automatic drain nut (17). See torque chart. Use 114" I.D. flexible tubing on configuration B bowls (slip tubing over protrusion on bottom of bowl — clamping is not required).

ADJUSTMENT

1. Before turning on system air pressure, turn filter/regulator adjustment fully counterclockwise until knob stops.
2. Turn on system air pressure.
3. Turn filterlregulator adjustment clockwise until the desired outlet pressure is reached.
4. To avoid minor readjustment after making a change in pressure setting, always approach the desired pressure from a lower pressure. When reducing from a higher to a lower setting, first reduce to some pressure less than that desired, then bring up to the desired point.
5. Push lockring on adjusting knob downward to lock pressure setting. To release, pull lockring upward. Pressure setting can be made tamper resistant by installing a seal wire (see Accessories) in groove above lockring.



SERVICING

Filter with manual drains must be drained as frequently as necessary to keep liquid level in bowl below the element mounting stud. If liquid level rises above the stud, liquid will be carried downstream. Replace filter element when plugged or dirty.

DISASSEMBLY

1. Shut off inlet pressure and reduce pressure in inlet and outlet lines to zero.
2. Turn adjusting knob counterclockwise until it stops. Filter/regulator can be disassembled without removal from air line.
3. Unscrew the bonnet (1), then remove regulating spring (2), slipring (3), and diaphragm (4). Unscrew the valve seat (5) using a 318" socket, then remove valve (6) and valve spring (7).
4. Unscrew bowl (18) and remove O-ring (9). Unscrew stud (13), then remove gasket (10), louver (11) and element (12). Remove manual drain or automatic drain.

CLEANING

1. Clean plastic bowl using warm water only. Clean other parts using warm water and soap. Dry parts and blow out internal passages in body (8) using clean, dry compressed air. Blow air through filter element (12) from inside to outside to dislodge surface contaminants. Replace filter element when plugged.
2. Inspect all parts carefully.
3. Replace damaged parts. If plastic bowl show signs of cracking or cloudiness, replace with metal bowl.

REASSEMBLY

1. Prior to reassembly, lubricate the following items:

Item	Lubricant
O-ring and lip (9) of auto drain (14, 20)	Wipe coat of Dow Corning 44 grease (or equivalent)
Threads on metal bowls (18)	Small, even amount of Dow Corning 44M grease (or equivalent)

2. During reassembly, make sure the valve lip (14 or 20) is turned down. Use a soft, blunt tool such as a piece of cardboard to turn lip down. DO NOT SCRATCH THE BOWL SURFACE WHEN TURNING LIP DOWN.
3. Install element (12) on stud (13).
4. Tighten the following items to the specified torque:

Item	Torque (Inch-Pounds)
Bonnet (1)	50 to 60
Valve Seat (5)	7 to 10
Element Stud (13)	5 to 10
Bowl (18)	5 to 10
Auto Drain Nut (17)	5 to 8
Manual Drain Valve (19)	3 to 4

REPAIR **KITS**

Relieving Type, 5-micron
(Items 3, 4, 5, 6, 7, 9, 10, 12) 3820-02
Nonrelieving Type, bmicron
(Items 3, 4, 5, 6, 7, 9, 10, 12) 3820-01
Automatic Drain (Configuration A)
(Items 9, 14, 15, 16) 3654-01
Automatic Drain (Configuration B)
(Items 9, 20, 21) 3654-02

REPAIR PARTS

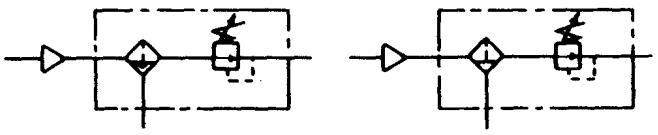
Regulating spring (Item 2)
5 to 100 psig (color yellow) 2960-04
1 to 10 psig (color yellow) 2969-02
5 to 50 psig (color green) 613-03
O-ring (Item 9) 2315-24
Filter Element (Item 12)
5-micron 5726-01
100-micron 5726-02
Bowl (Item 18)
Transparent with Automatic Drain
(Includes Item 9) 3635-66
Transparent with Manual Drain 3635-51
Metal with Automatic Drain 3809-50
Metal with Manual Drain 3809-52

ACCESSORIES

Panel Mounting Nut 2962-89
Wall Mounting Bracket and Nut 18-025-003
Tamper-Resistant Wire Seal 2117-01

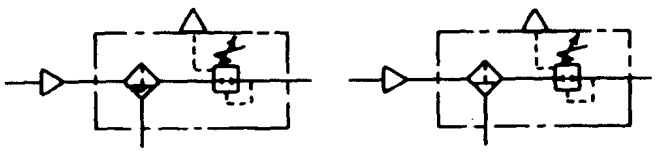
GRAPHIC SYMBOL

Nonrelieving **Filter/Regulator**



Automatic Drain Manual Drain

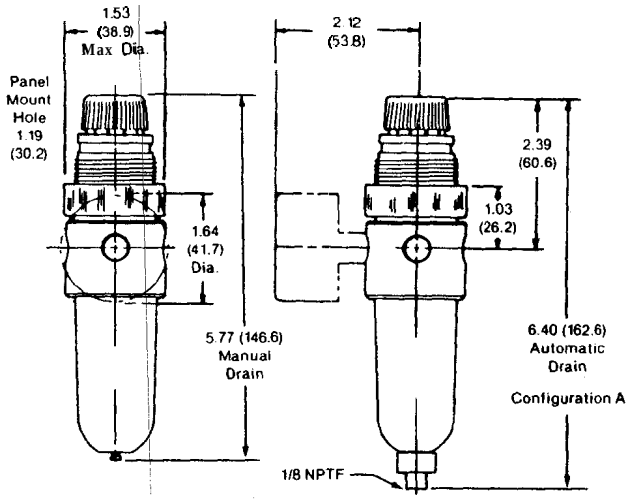
Relieving **Filter/Regulator**

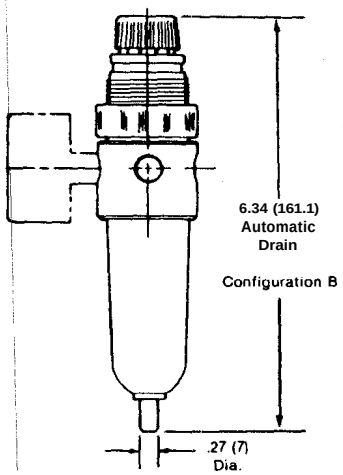


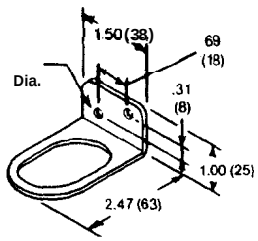
Automatic Drain Manual Drain

DIMENSIONS

All dimensions in inches (millimeters).







Wall Mounting Bracket

VENDOR: C.A.NORGREN CO.	DESCRIPTION: PRESSURE REGULATOR TYPE R07 FOR COMPRESSED AIR SERVICE	Bridgeport® Code No.: 3-154-1444 Page ▮ of 2

SPECIFICATIONS

Fluid: Compressed Air

Main Ports: 118" or 114" PTF

Gauge Ports: Two 118" PTF full flow

Rated Operating Conditions —

Inlet Pressure: 400 psi (27.6 bar) maximum

Temperature: 0° to 150" F (– 18" to 66° C) with dew point less than air temperature below 35" F (2° C)

Type: Diaphragm; relieving or nonrelieving

Outlet Pressure Adjustment Ranges • —

Standard: 3 to 100 psi (.2 to 6.9 bar)

Optional: 2 to 50 psi (.I to 3.4 bar)

Optional: 1 to 10 psi (.07 to .7 bar)

• Outlet pressure adjustment ranges are not minimum or maximum outlet pressure limits. Regulators can be adjusted to zero psi outlet pressure and, generally, to pressure in excess of those specified. The use of these regulators to control pressures outside of the specified ranges is not recommended.

MATERIALS OF CONSTRUCTION

Bonnet	Acetal Resin
Body	Die Cast Zinc
Valve	Brass
Valve Seat	Acetal Resin
Elastomers	Buna-N

OPERATION

A regulator is used in a compressed air system to maintain a nearly constant outlet pressure despite changes in the inlet air pressure and changes in downstream flow requirements.

Outlet pressure is controlled by an adjusting knob. Clockwise rotation increases and counterclockwise rotation decreases outlet pressure.

Relieving Type Regulators With relieving regulators, outlet pressure can be reduced even though the system is dead-ended.

The regulator will likewise relieve in response to an increase in outlet pressure above the regulator setting, allowing air to escape to atmosphere. However, the flow capacity of the relief passage is limited, and depending upon the source of the overpressure condition, the outlet pressure might increase to a point significantly higher than the regulator setting. For this reason, the relief feature of a regulator must not be relied upon as an overpressure safety device. See the WARNING note.

Nonrelieving-Type Regulators With nonrelieving regulators, outlet pressure cannot be reduced if the system is dead-ended. This type of regulator will not vent the outlet air pressure as described under "Relieving-Type Regulators", and some other means of venting the outlet air pressure must be provided.

WARNING

These regulators are intended for use in industrial compressed air systems only. Do not use these regulators where pressure or temperature can exceed rated operating conditions. See Specifications.

If outlet pressures in excess of the regulator pressure setting cause downstream equipment to rupture or malfunction, install a pressure relief device downstream of the regulator. The relief pressure and flow capacity of the relief device must satisfy system requirements.

Before using with fluids other than air, for nonindustrial applications, or for life support systems, consult C.A. Norgren Co. for approval.

INSTALLATION

1. Install regulator as close as possible to the device being serviced. The "IN" port is marked on the regulator body. Regulator can be installed at any angle.
2. In systems with a cyclic demand, install regulator upstream of cycling control valves.
3. Air line piping should be same size as regulator ports.
4. Connect piping to proper ports using pipe thread sealant on male threads only. Do not allow sealant to enter interior of body.
5. Connect outlet pressure gauge, if used, to one of the gauge ports on side of body. Gauge ports can also be used as additional low flow outlets. Plug unused ports.
6. To obtain maximum reliability and service life, install a filter upstream of the regulator.

ADJUSTMENT

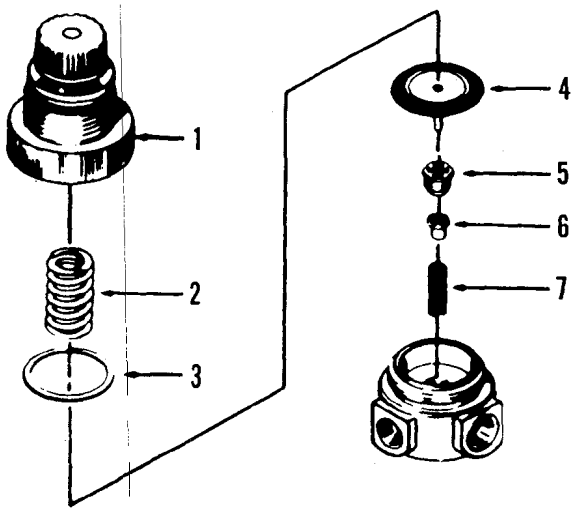
1. Before turning on system air pressure, turn regulator adjustment counterclockwise.
2. Turn on system air pressure.
3. Turn regulator adjustment clockwise until the desired outlet pressure is reached.
4. To avoid minor readjustment after making a change in pressure setting, always approach the desired pressure from a lower pressure. When reducing from a higher to a lower setting, first reduce to some pressure less than that desired, then bring up to the desired point.
5. Push lockring on adjusting knob downward to lock pressure setting. To release, pull lockring upward.

MAINTENANCE

1. Shut .off inlet pressure and reduce pressure in inlet and outlet lines to zero.
2. Turn adjusting knob fully counterclockwise. Regulator can be disassembled without removal from air line.
3. Unscrew the bonnet (1), then remove regulating spring (2), slipring (3), and diaphragm (4). Unscrew the valve seat (5) using a 3/8" socket, then remove valve (6) and valve spring (7).
4. Clean parts using warm water and soap.
5. Inspect all parts.
6. Replace damaged parts.
7. At reassembly, apply a small, even amount of Lubriplate 110 (or equivalent) to adjusting screw threads inside bonnet (1).
8. Torque valve seat (5) to 7 to 10 inch-pounds. Torque bonnet (1) to 50 to 60 inch-pounds.

REPAIR KITS

Nonrelieving Regulators
(Items 3 through 7) 3407-01
Relieving Regulators
(Items 3 through 7) 3407-02



VENDOR: C.A.NORGREN CO.	DESCRIPTION: MINIATURE MICRO-FOG LUBRICATOR FOR COMPRESSED AIR SERVICE	Bridgeport® Code No.: 3-154-1355 Page 1 of 3

SPECIFICATIONS

Port Threads: 118″ or 1/4″ PTF

Oil Reservoirs —
Standard: Transparent Polycarbonate; 112 oz. (.015) oil capacity
Optional: Metal; 112 oz. (.015) oil capacity

Maximum Rated Operating Conditions —
Polycarbonate Reservoir: 150 psig (10.3 bar); 125° F (52° C)
Metal Reservoir: 250 psig (17.2 bar); 175° F (79° C)

Recommended Operating Flow Range: .5 to 10 scfm (.25 to 4.7 $dm^3$1s) at 90 psig (6.2 bar)

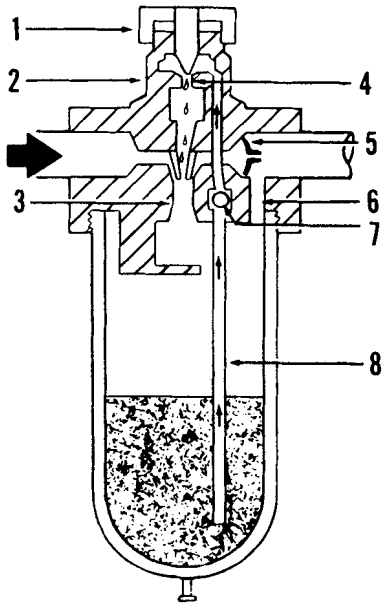
Recommended Lubricants: This lubricator will perform satisfactorily using misting-type oils rated 50 to 200 SSU at 100° F (38° C). The oils used must be compatible with materials of construction. Contact your lubricant supplier and the builder of the equipment to be lubricated to obtain specific lubricant recommendations

Materials of Construction —
Body: Zinc
Reservoir — Transparent: Polycarbonate
Metal: Aluminum
Sight Feed Dome: Trogamid-T
Elastomers: Neoprene and Buna-N

OPERATION

The Micro-Fog lubricator is a device for injecting a finely divided 'fog' of oil into a flowing stream of compressed air, automatically providing the proper internal lubrication for air-operated tools and other devices. Micro-fog denslty is controlled by the drip rate adjusting knob (1). Counterclockwise rotation increases and clockwise rotation decreases Micro-Fog density.

The lubricator utilizes a flexible flow sensor (5) to control the flow of a small amount of inlet air into the reservoir through fog generator (3) in proportion to the air flow past the sensor. The high velocity air flowing through the generator aspirates oil up the siphon tube (8) into the sight-feed dome (2), where it drips downward through needle valve (4) into the generator. The oil drops are then atomized and mixed with the air flowing through the generator into the reservoir. Most of the larger oil particles return to the reservoir. The finer particles (Micro-Fog) remain airborne and are carried through passage (6) into the downstream system. Only a small portion of the drops visible in the sight-feed dome are delivered downstream to the device being lubricated. The proportionate control afforded by the flow sensor provides a nearly constant oil-to-air density ratio over a wide range of air flows. Check ball (7) keeps the siphon tube full during periods of low flow.



WARNING

These units are intended for use in industrial compressed air systems only. They must not be used where pressure or temperature may exceed maximum rated operating conditions. See Specifications.

The polycarbonate plastic reservoirs used on these units can be damaged and possibly burst if exposed to such substances as certain solvents, strong alkalies, compressor oils containing ester-based additives, or synthetic oils. Fumes of these substances in contact with the polycarbonate reservoir, externally or internally, can also result in damage. Clean with warm water only.

Use metal reservoir in applications where a plastic reservoir might be exposed to substances that are incompatible with polycarbonate.

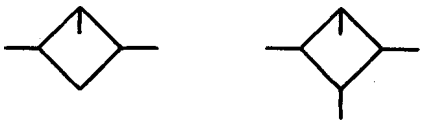
In lubrication applications, some oil mist may escape from the point of use into the surrounding atmosphere. Users are referred to OSHA Safety and Health Standards for limiting oil mist contamination and utilization of protecting equipment.

Before using with fluids other than air, for non-industrial applications, or for life support systems, consult C.A. Norgren Co.

INSTALLATION

1. Air line piping should be the same size as lubricator ports.
2. Install lubricator vertically (adjustment knob up) in air line downstream of filter and regulator as near as possible to the device being served.
3. Connect piping to proper ports using pipe thread sealant on male threads only. Do not allow sealant to enter interior of lubricator. Air flow must be in direction of arrow on top of body.
4. Fill reservoir with a good quality lubricant (see Specifications) to level indicated by maximum fill line. DO NOT OVERFILL.

GRAPHIC SYMBOLS



No Drain Manual Drain

ADJUSTMENT

1. Turn lubricator drip rate adjusting knob fully clockwise, then turn on system air pressure.
2. Adjust lubricator drip rate only when there is a constant rate of air flow through the lubricator. Monitor drip rate through sight feed dome.
3. Determine the average rate of air flow (scfm) through the lubricator, then turn the adjusting knob to obtain the recommended drip rate (Drops/Min). See Table 1. Turn adjusting knob counterclockwise to increase and clockwise to decrease the drip rate. Push lockring on adjusting knob downward to lock drip rate setting. To release, pull lockring upward.
4. Monitor the device being lubricated for a few days following initial adjustment. Readjust the drip rate if the oil delivery at the device appears either excessive or low.
5. Drip rate setting can be made tamper resistant by installing a seal wire (see Accessories) in groove above lockring.

DISASSEMBLY

1. Shut off inlet pressure and reduce pressure in the inlet and outlet lines to zero. Loosen fill plug (1). Lubricator can be disassembled without removal from air line.
2. Use a 1-inch deep socket to remove the sight feed dome (3), then remove seal (4), oil fill plug (1), O-ring (2), reservoir (7), gasket (8), and baffle (6). Do not attempt to remove siphon tube (10) from body (5), as these parts are permanently assembled.

CLEANING

1. Clean transparent reservoir (7) using warm water. Clean other parts using soap and water. Dry parts and blow out internal passages in body (5) using clean, dry compressed air.
2. Inspect all parts carefully.
3. Replace damaged parts. If plastic reservoir shows signs of cracking or cloudiness, replace with metal reservoir.

REASSEMBLY

1. Prior to reassembly, apply a generous coat of Dow Corning 44 grease (or equivalent) to seal (4) and O-rings (2, 8). Apply a small amount of Dow Corning Molykote G grease (or equivalent) to full length of threads on metal reservoirs.
2. Torque sight-feed dome (3) to 30-to-35 inch-pounds. Torque reservoir (7) to 5-to-10 inch-pounds.

REPAIR KITS

Seal Kit (Items 2, 4, 8) 3795-03

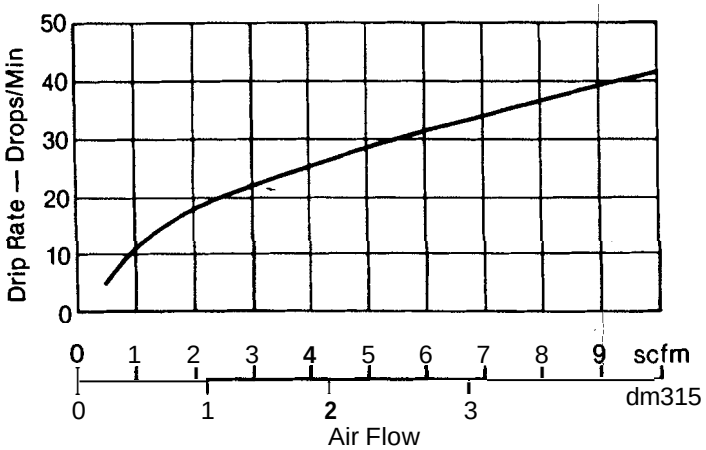
REPAIR PARTS

Metal Reservoir (with Drain, Items 7 & 9) 3809-52
Polycarbonate Reservoir (without Drain. Item 7) . . 3635-64
Polycarbonate Reservoir (with Drain, Items 7 & 9). 3635-63
Sight-Feed Dome (Item 3) 5055-54

ACCESSORIES

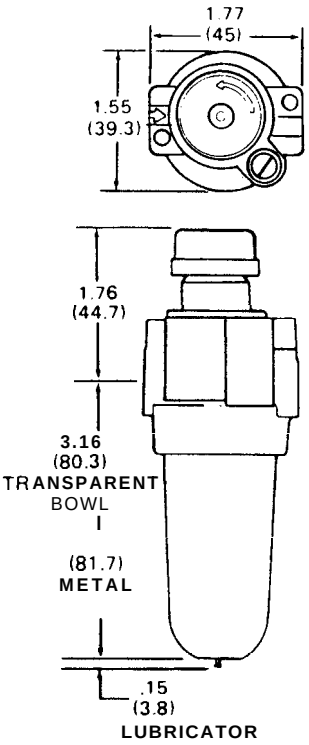
Mounting Bracket and Screws 5939-08
Tamper-Resistant Seal Wire 2117-01

Table 12-1. Recommended Drip Rate Setting for Average Lubrication

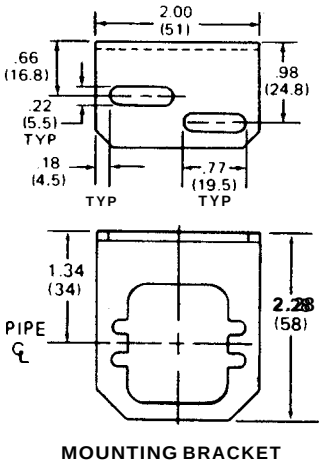


DIMENSIONS

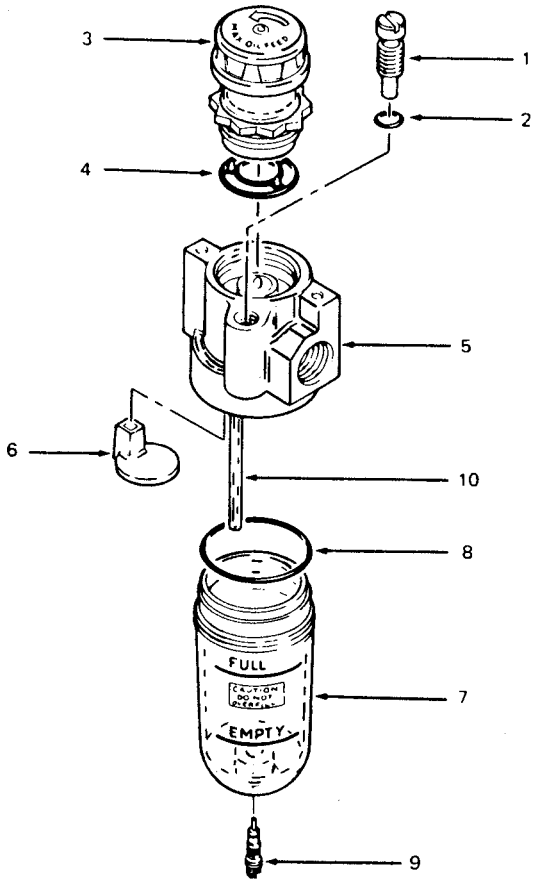
All dimensions in inches (mm).



LUBRICATOR



MOUNTING BRACKET



CHAPTER 13

OPTIONAL EQUIPMENT

13.1 INTRODUCTION

The following optional equipment is available for the Series I R2E4 system:

1. Paper Tape Reader
2. EZ-FILE
3. #30 Quick Change Tool Kit (1-157-0551)
4. I-4 Indexer (3-193-9475)
5. Coolant System — Mist and/or Flood
6. EZ-CAM®

The following sections provide detailed descriptions of each option.

13.2 PAPER TAPE READER

This option is a high speed device for fast loading of stored programs. It can be used with long tapes, since the DNC capability of the control will automatically segment the data and control the tape reader. The paper tape reader is a portable unit that can be transported from one machine to another. For this reason, the Series I R2E4 is equipped with an MS-type connector for the paper tape reader and various other input devices. In this mode, the following operations are required to use the pe reader.

1. Connect the data cable to the tape reader port.
2. Plug in the tape reader power cable.
3. Turn ON the power.
4. Press the LOAD/CLEAR/EDIT key to bring the LOAD option message to the Screen. Enter "0" then EXECUTE to enable the paper tape reader (PTR).
5. Place the LOOP/LOAD/SPOOL button in the SPOOL position and operate the tape reader normally. Refer to the Operating Manual.

13.3 EZ-FILE

The Bridgeport EZ-FILE is a floppy disk base device providing easy and fast part program storage. The storage medium is a 5-¼ inch floppy diskette with a storage capacity of 400K bytes (3200 feet of paper tape) and up to 77 part programs. These floppy diskettes are also compatible with the Bridgeport Interactive Graphics Part Programming System, EZ-CAM@.

Communications and control of the EZ-FILE are primarily through the R2E4 system. All part programs can be saved and retrieved through their individual 5-digit numeric name. A special communications link is also provided for the execution of part programs that are too long to reside in the Control's memory.

4 #30 QUICK CHANGE TOOL KIT

This option contains a Bridgeport #30 Quick Change basic tooling package composed of collets and corresponding tool holders, a locking fixture for assembly of cutters in the holder, and appropriate wrenches. The kit contains:

1. End Mill Holders
2. Shell Mill Adapters
3. Tenthset Boring Head with Adapter
4. Boring Cutter (Carbide Tipped)
5. Drill and End Mill Chucks
6. Standard Collets
7. Drill and End Mill Extension Chuck
8. 300 Series Collets

13.5 I-4 INDEXER

This option permits miscellaneous function M51 (Index Table) to be progr mmed in conjunction with the use of a suitable Indexin Table. The table must inhibit data transfer and prev nt machine movement while the indexing operation is t king place (Erickson 450 or 600 Indexer with oil tight limit switches LS-1 and LS-2).

The Pneumatic Enclosure of the R2E4 system is designed to house the solenoid and interconnecting hoses for this option. The lug receptacle for the Index Table option is next to the 15-pin paper tape plug on the right hand side of the Power Equipment Enclosure.

The field retrofit kit number is: 3-193-9475.

13.6 COOLANT SYSTEM — MIST AND/OR FLOOD

With the Auxiliary Control Group option, the coolant will be turned ON/OFF with the spindle. A separate COOLANT switch is provided.

All coolant systems must be ordered as Coolant Tank Kits and as Nozzle Assemblies, either separate or installed. The tank units are designated as 11511150 or 11511160 units, and all heads will have one flood nozzle.

13.6.1 Ratings

Flood Coolant — Gusher Model 1-P3

Electrical	Transformers 115V secondary and Triac (4ASB fuse)
Motor	1/10 HP, 115 volts, 1-phase, 50160 Hertz, 3450 RPM, Rated 2.2 amps
Flow	Zero flow 16 ft., 20gmp at 6 ft. head (water soluble oil), Impeller 6055
Tank Capacity	5 Gallons

Mist Coolant —

Solenoid	115 volts, 60 Hz AC 0.2 amps inrush, 0.1 amps holding (Triac driven 1ASB fuse)
Air	1 cipm free air @30 psi operating pressure, 120 psi max supply
Liquid	2-3 ozlhrljet (Max. 60 ozlhrljet)

13.7 EZ-CAM®

The EZ-CAM (Computer Aided Manufacturing) is a desk top computer with interactive graphics and part programming capability. This option permits the operator to accomplish the following:

1. Reproduce a part graphically on the CRT from an engineering drawing.
2. Program the part through an interactive menu format.
3. Display the shape and tool path to "prove" the program before committing it to production.
4. Load the generated programs, through the DNC or paper tape punch, directly into the CNC milling machines.

Refer to the Bridgeport EZ-CAM User's Manual, Code No. 1-104-0512 for information on Installation and Troubleshooting.

13.8 CNC POWER DRAWBAR

An inexpensive, easily installed CNC power drawbar kit that cuts downtime for tool changing from minutes to seconds is available from Bridgeport. Designed specifically for Bridgeport CNC, the power drawbar provides uniform tightening of tool holders and allows very easy tool holder removal from the spindle. The unit is designed for Bridgeport/Erickson #30 taper tooling. No special tooling or extended tool holder length is required as with other units.

The drawbar operates on standard shop air supply of 70 psi and is provided with an air line lubricator. As an added safety feature, a built-in interlock with the spindle brake allows operation only when the quill is up and when the spindle brake is applied.

The CNC power drawbar is easily installed in any machine equipped with a gun-drilled spindle and comes complete with mounting hardware, installation drawings and operating instructions.

APPENDIX A

SYSTEM SPECIFICATIONS

A.1 OVERVIEW

The R2E4 machine design is dedicated to Numerical Control. The following four sections list the system's mechanical and electrical specifications and features.

A.2 STANDARD FEATURES OF THE BRIDGEPORT SERIES I R2E4

1. Entire machine design dedicated to numerical control and sold only for that purpose.
2. Vertical heavy duty spindle with extra precision bearings in 3⅜" dia. quill.
3. #30 quick change tooling with optional power drawbar.
4. 2 HP continuous duty fan cooled AC induction motor with air operated spindle brake.
5. Spindle speeds 60-4200 RPM with air turbine power operated speed changer.
6. Head design based upon the proven (2J) model with standard rigid ram.
7. High inertia spindle assembly characteristic of good milling capabilities.
8. Heavy head support with special rigid ram.
9. Large diameter turret support from standard column.
10. Dovetail ways throughout with large contact area to promote good milling characteristics.
11. Chrome plated ways at table to saddle and saddle to knee juncture.
12. New rigid knee with increased way area and dual locking means.
13. Dual special locks on the side of the knee to bind the knee to the rigid column.
14. Extended deep saddle to promote the accuracy and repeatability of table position.
15. Table contains larger mounting surface in XY directions, than XY travel.
16. T-slot spacing standard for all Bridgeport NIC equipment.
17. Traverse keyway in the center of the working surface for fixture positioning and repeatability.
18. Coolant trough completely surrounding the working surface.
19. Ballscrews 1¼" diameter in X and Y axes totally enclosed.
20. X ballscrews stationary to enable the mounting of its drive on the saddle for stiffer support.
21. Z ballscrews 2½" diameter — a ball quill design.
22. Center guideway system for maximum accuracy and best repeatability of position.
23. Ballscrews mounted in the center of the guideway systems.
24. Ballscrews supported by steep angular contact high precision(combination radialIthrust bearings in heavy bracket.
25. Axis drive motors mounted entirely clear of the operator'$ working area.
26. Travel limit switches with lamp indicator and override.
27. Closed loop DC Servo drives with encoder feedback.
28. Sealed power cabinet mounted on the machine structure.
29. Automatic and manual control of floodlmist coolant (optional) systems.
30. Chip and coolant shield and splashback supplied as standard equipment.
31. Chip and coolant collector pan below the working area .

A.3 CONTROL FEATURES

1. Microcomputer based control capable of storing the equivalent of 1666 ft. of EIA RS-358 tape, 100 ft. Non-Volatile.
2. Multiple part program storage (6 digit identification) with display of program comments.
3. Interchangeable variable block format compatible with EIA RS-274D in ASCII input format.
4. 3-Axis simultaneous continuous path contouring; 2-axis circular interpolation in each of 3 switchable planes.
5. Point in space can be established by polar (longitude\ angle, the co-latitude angle (E-word) and radius.
6. 3-axis helical interpolation — arc in XY plane with simultaneous linear motion in Z-axis.
7. Programmed R, alternate to IJ, and in automatic corner rounding mode.
8. Absolutelncrementallpreset data input, fixture offsets; rectangular or polar coordinate input.
9. Plus or minus programming, inch or metric dimensions with full floating zero.
10. Decimal programming with- leading and trailing non-significant zero suppression.
11. Controlled feedrate directed in IPM or MM/MIN at constant vector velocity in any combination of axis motion.
12. Manual feedrate override 10-120% infinitely variable with enable control, disable at tool change; modal deceleration override.
13. 40 Macros with variable parameter calls and 4 levels of nested loops, repeat 16384 times.

14. Canned Z-axis cycles (8) including 2 deep hole drilling routines.
15. Canned drill patterns (5) including bolt circle, rows, frame.
16. Canned milling cycles (9) including facing, pocketing, slotting, bore milling, inside or outside frame milling.
17. Parametric language with algebraic and trigonometric functions, conditional block execution.
18. Transformation of data by rotation or scaling and by programmable mirror image.
19. Bi-directional search for program, sequence or tool number; definition block.
20. Feed hold and restart without losing information or position; software limit checks.
21. Full jog control of any axis in any direction at variable traverse rate: continous, jog knob, or step.
22. AUTO, SETUP, MDI, MDI STORE operation modes; dialogue format on CRT in manual data input mode.
23. Programmable spindle speeds (±5% accuracy) and full override; reverse spindle tapping (maximum 5 per minute).
24. Tool length offset for 24 values with display capability of tool number and Z value; non-volatile.
25. Tool diameter compensation for 24 values with display of tool number and diameter value; non-volatile.
26. Look-ahead cutter diameter compensation with automatic feed adjust for tool path radius.
27. Buffer storage preprocessing 1 block, 2 blocks with cutter compensation in effect.
28. XY zero storage, clear point XY coordinates, non-volatile.
29. Optional stop, block delete, and automatic tool withdrawal to quill home position.
30. Dry run modes: no Z, maximum feedrate, no XYZ.
31. Compatibility mode enables most features of BOSS 4-7.2 programs.
32. 12" CRT for status (mode, program, N, T, TLOIDIA, S, F, X, Y, Z, C); and 17 status LED.
33. 31 help pages, G-code list, M-code list, BOSS event log, axis event log.
34. Diagnostic message codes (25) for input errors and system faults.
35. Editor with 22 command characters for keyboard (Port A) use with CRT and block edit via front panel.
36. Serial port A Interface, RS-232C compatible or RS-422 compatible.
37. Serial port B Interface RS-232C compatible (for 25ft.) and RS-422 compatible (for 300ft.); in-built DNC loading (EZ-LINK).
38. Programmed controller for auxiliary functions including indexing.
39. Data input device optional: tape reader, teleprinter, magnetic tape cassette, Bridgeport EZ-FILE or EZ-CAM systems.

A.4 TOTAL SYSTEMS FEATURES

1. Single electrical power connection to fusible disconnect.
2. Electrical construction complies with the intent of NFPA 70 and 79.
3. Control cabinet is mounted on the machine structure.
4. Diagnostic routine automatically conducted every time power is turned on.
5. Interlock on feed if spindle is not operating.
6. Factory scheduled school for general training in operatinglprogramming (1 student — 1 week).
7. Factory scheduled school for maintenance (1 week & special fee).
8. Factory trained Service Engineer's startup & operator training (1 day).
9. Single source service responsibility — Bridgeport.
10. One-year warranty on materials and workmanship of Bridgeport's manufacture.

A.5 LEADING DATA

RANGE	INCH	METRIC
Table Travel (X-axis)	18.0"	(457mm)
Saddle Travel (Y-axis)	12.0"	(305mm)
Quill Travel (Z-axis)	5"	(127mm)
Knee Travel (Manual)	14½"	(368mm)
Throat Distance	14½"	(368mm)
Table to Spindle - Up at Gage Line	7⅛"	(181mm)
Maximum Vertical Load Uniform Distribution	300 lbs.	(136kg)
TABLE		
Overall Size	42"x16⅛"	(1067x410mm)
Working Surface	34"x12½"	(864x318mm)
T-Slots	3 on 4⅜" centers	(3 on 111mm centers)
T-Slot Size	5/8"	(15mm)
Positioning Speed	250 ipm	(6350 mmlmin)
Height Above Floor - Max.	47½"	(1207mm)

SPINDLE	INCH	METRIC
Motor Rating	2 HP	(1.5kw)
Power Rating at Spindle Nose	1-1.75 HP	(.75-1.4kw)
Taper	#30 for Quick Change Holders	
Speed Range	60—4200 RPM	
Programmable Speed	Display Only. Power speed changer standard	
Transmission Ratios	1:1 and 8.92:1	
Rapid Approach Rate (Z-axis)	250 ipm	(6350 mmlmin)
Controlled Downfeed Range (Z-axis)	.I-250.0 ipm	(2-6350 mmlmin)
Drilling Capacity - Mild Steel	314 diameter	(19mm dia.)
Milling Capacity - Mild Steel	1.5 cu inlmin	(25cc/min)
Boring Range	To 4 diameter	(To 102mm dia)
Tapping Range	#5-40 to 1/2-13	(M3 x 0.5 to M12 x 1.75)
Spindle Diameter	1-318"	(35mm)
Quill Diameter	3-318"	(86mm)

MILLING		
Feedrate	.I-250.0 ipm	(2-6350 mmlmin)
Feed Increments	.1 ipm	(1mmlmin)
Override - Infinitely Variable	10-120% with Feed Hold	
Vector Feedrate Control (XYZ)	Constant to 100. 0 ipm	(2540 mmlmin)

POSITIONING		
Jog Rate in Setup, Variable to	150 ipm	(3810 mmlmin)
Rapid Traverse X Y	250 ipm	(6350 mmlmin)
Rapid Traverse Z	250 ipm	(6350 mmlmin)

MACHINE AND CONTROL PERFORMANCE		
Positioning Accuracy	±.0008"	(0.02mm)
Positioning Repeatability	±.0003"	(0.01mm)
Servo Resolution	.0001"	(0.0025mm)
Input Resolution	.0001"	(0.001mm)

CONTROL SYSTEM	
System Type	AbsIIncremental CNC
Format	Interchangeable Variable Block
Format Detail	:5N4G3X+34Y+34Z+34U+34V+34W+34I+34J+34K+34C+43R34A+33B+33D+43E33P+34F31S4T2M2
Reference EIA Standards	RS-227, RS-232, RS-274D, RS-358, RS-422, RS-491
Axis Drive	3 KVA; DC Servo motors with encoder feedback
Logic System	E4 - Control By Bridgeport

CNC FEATURES	
Storage Capacity	1666 ft. (500m) of Equivalent EIA RS-358 Tape
Battery Backup-1 year	Stored coordinates, data tables and first 100 ft. of Program Text
Manual Data Input	Interactive Dialog
Subroutines	40 Macros and 4 Levels of Nested Loops
Repetitive Programming	By subroutines and by use of Parametric Part Programming Language
Transformation	Rotation or Scaling
Editing	22 Command Characters (external keyboard) display on CRT
Part Program Loading	Paper Tape, Magnetic Tape or Downline Loading
Display	12" CRT 24x80 and 12 x 40, 17 Status LED
Dry Run	No-Z, No-XYZ or Max. Feed
Tool Recovery	Quill Up with full resumption
Data Port A	Serial Line Interface @ RS-232C or RS-422
Data Port B	Serial LIne Interface @ RS-232C or RS-422, RS-491 Level 2 Protocol for DNC
Maintenance	Diagnostic Routines Embedded In the System

SPACE AND WEIGHT (Drawing 74-0064, Sheet 3)		
Floor Area (doors open)	80" x 85"	(2032 x 2159mm)
Floor Area (doors closed)	64" x 64"	(1626 x 1626mm)
Height	87"	(2210mm)
Weight (with control)	3150 lbs.	(1429kg)
Shipping Weight	3550 lbs.	(1610kg)

POWER

Electrical Supply - 60 Hz, 3 phase	230V/460V single connection, or 208V on special order
Main Power Breaker	25a/15a per phase
Electrical Rating	6kva
Pneumatic Rating	4cfm (0.06cm/min) @ 75/psi (5.6kg/c²) 11 cfm (0.18cm/min) instantaneous flow

COLOR

Standard	Two-Tone Gray for Machine Tools

APPENDIX B

STATIC SENSITIVE EQUIPMENT

B.I STATIC SENSITIVE MATERIALS

This is to notify the appropriate personnel of the potential damage static electricity can cause to delicate electronic components and to outline guidelines to be followed when handling these electronic components or assemblies.

Static damage of components by operating personnel is becoming a significant problem plaguing the electronics industry. Technological advances in IC manufacture make possible devices with greater circuit densities, higher unit performance and quite often, higher static susceptibility. Fortunately, the problems associated with static charges in the electronics environment can be controlled.

The following are some general guidelines to follow during assembly or handling of static sensitive devices or assemblies.

B.2 GENERAL GUIDELINES

1. Since August, 1981, all printed circuit boards, or assemblies containing static sensitive devices have been IDENTIFIED by this label.
2. All assembly operations involving static sensitive devices must be performed at a specially grounded work station.
3. The technician must be grounded by use of the wrist strap when working at this station.
4. All electrical assembly equipment, such as soldering iron, should be grounded.
5. Avoid handling static sensitive devices except when absolutely necessary.
6. Under no circumstances may the static sensitive devices or assemblies containing static sensitive devices be allowed to come into direct contact with plastics (polyethylene bags, styrofoam, styrene boxes, plexiglass, etc.).

It is necessary for all field personnel to follow proper static prevention procedures when servicing Bridgeport equipment containing static sensitive assemblies. The following is a recommended procedure to follow when removinglreplacing a printed circuit board containing static devices from the card rack.

B.2.1 Equipment Required

1. Portable static-free work station kit containing floor mat, grounding wire and wrist strap.
2. Protective connector shunt for printed circuit board, 3M Co. 5020.
3. Protective shipping/handling bag Part No. 3M Co. 2004.

822 Procedure

1. Place a floor mat in front of the cabinet and connect ground wire to an appropriate earth ground. Check to make sure wrist strap connection is secure.
2. Stand on the mat and place a wrist strap on your wrist.
3. Carefully rembve the printed circuit board from the unit.
4. Place the PC board in a protective shippinglhandling bag.

B.3 VENDOR INFORMATION FOR STATIC PROTECTION EQUIPMENT

1. Work station bits.
   a. 3M portable field service kit — 8005 (Recommended for light duty).
   b. 3M Velostat floor mat — 1864
      3M static control wrist strap — 2064
      (Recommended for heavy use)
2. Velostat PC doard edge protector — 5200
3. Velostat shipping/handling PC board protective bag — 2044

All equipment available from:

3M Static Control System
223-2 southwest 3M Center
St. Paul, MN 55101
(612) 733-9420

APPENDIX C

COMMUNICATION STANDARDS

C.I INTRODUCTION

Three ports are supplied with the machine for communication purposes with peripheral equipment. Each port supports a full ASCII character set. LOAD selection by menu shown on the LCD will define the port to which the chosen peripheral equipment is connected. The transmission BAUD rate for the selected port can be keyed in at the Front Panel. Also refer to the appropriate technical bulletins.

C.2 INPUT/OUTPUT PORTS

Port A will receive a transmit ASCU serial data parity or nonparity to an RS-232C compatible device communicating through the internal EDITOR. A terminal may be attached for ODT purposes.

Port B is set to receive a transmit ASCU serial data through RS-232C or RS-422 communication with parity. The major peripheral devices considered are the Bridgeport EZ-CAM™ or Casette Tape Controller (CTC). The EZ-CAM may have several programs stored, in which case the chosen one can be selected at the machine and caused to be downloaded. The CTC can store a single program only. Uploading or downloading is possible. Selection of an unlimited length of program and its snsmission under DNC ON is also possible from a mass storage device.

The Tape Reader port is a parallel RS-408 port dedicated to the use of the input of a single program of less than 100 feet from a tape reader. Tape data in ASCU code may be with or without the parity channel.

No internal adjustments are needed to change from one standard to the other. The communication cable which is selected will determine the standard used by the R2E4 system.

C.3 COMMUNICATIONS CABLES

Select the desired standard (the one corresponding to the type of equipment being used) by selecting the proper cable from the following tables. Note that a passive 20mA device may be used with a 20mA to RS232C converter, part number 3-193-9060.

Table C-1. 20 mA Cables

CODE NUMBER	PART NUMBER	LENGTH
1-177-1303	1-192-4184	Connector Only
1-177-1009	1-192-4185	10 ft.
1-177-1010	1-192-4186	25 ft.
1-177-1011	1-192-4187	50 ft.
1-177-1012	1-192-4188	75 ft.
1-177-1013	1-192-4189	100 ft.
1-177-1329	1-192-5827	300 ft.
1-177-1330	1-192-5828	500 ft.*

* Not recommended for use above 2400 baud

Table C-2. RS-232 Cables

CODE NUMBER	PART NUMBER	LENGTH
1-177-1303	1-192-4184	Connector Only
1-177-1327	1-192-6561	10 ft.
1-177-1328	1-192-6562	25 ft.

C.4 TELETYPE CONNECTION

C.4.1 Teletype Conversion

Before connecting the teletype to the Series I CNC R2E4, the TTY must be properly prepared.

1. Remove the cover of the teletype. Loosen the three thumbscrews in the back and remove the platen that holds the roll of paper, the MODE switch knob and the face plate. You should now be able to lift the cover off. Use Figure C-1 to locate the various parts described below.

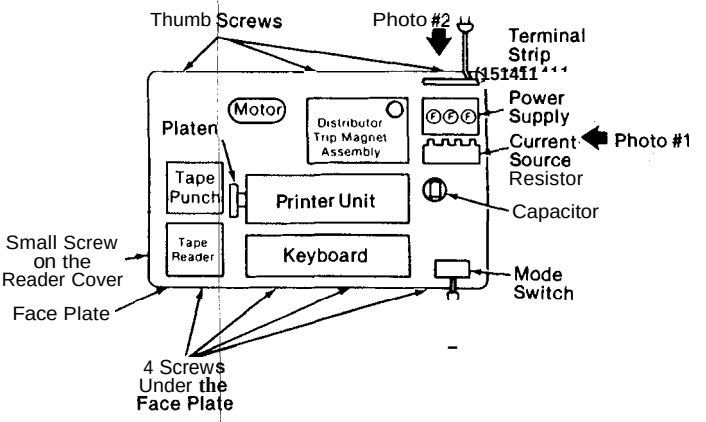


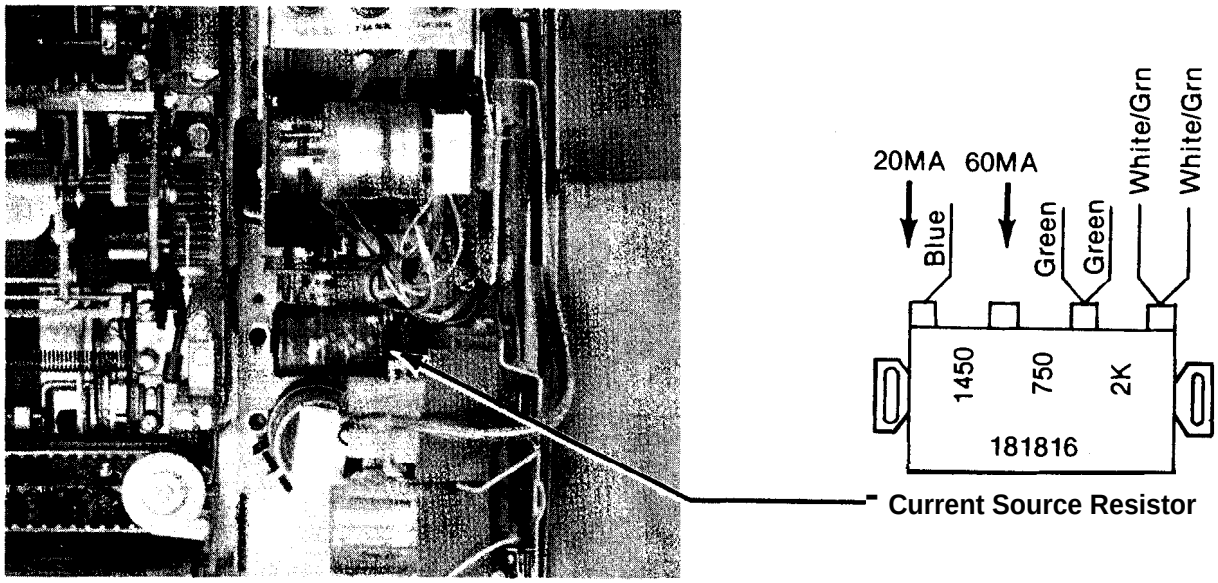
Figure C-1. ASR-33 Teletype

2. Change the loop current from 60 to 20mA. The current source resistor must be changed from 750 ohms to 1450 ohms. This is accomplished by moving the blue wire connected to the 750 ohms terminal to the 1450 ohm terminal on the resistor. The receiver current level is changed by moving the purple wire connetted to terminal #9 on the same strip.
3. Wire the teletype for full duplex. Move the brownlyellow wire from terminal #5 and move the whitelblue wire from terminal #4 to terminal #5 on the terminal strip 151411.

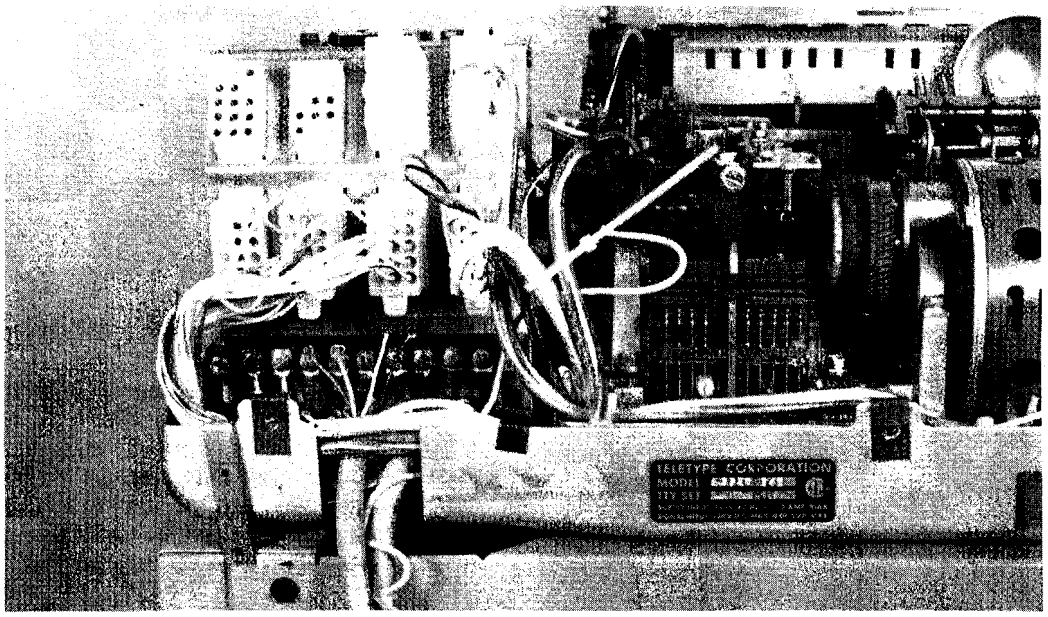
Choose a 20 mA cable from Table C-1. Connect it to the teletype as shown in Figure C-3.

NOTE

The DB-25S connector is available from Bridgeport under the part number 1-150-4815, with backshell part number 1-150-4816.



Right Side — Plan View Photo #1



Rear View Photo #2

Figure C-2. Modifications to Teletype

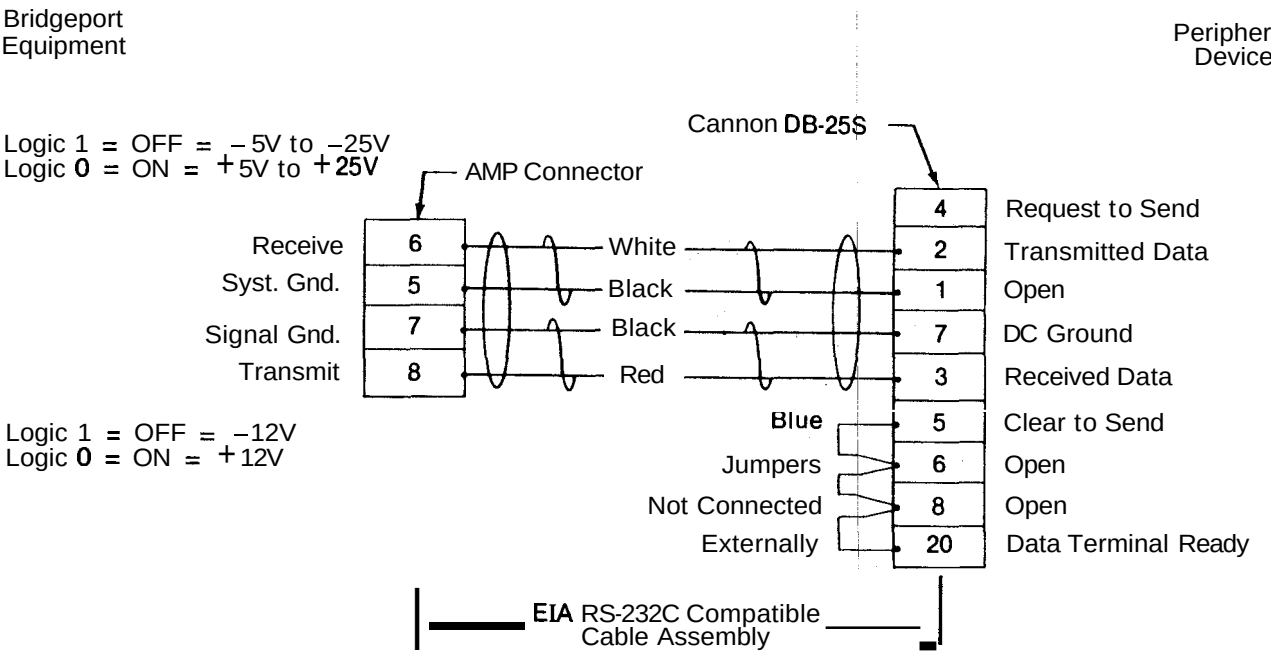


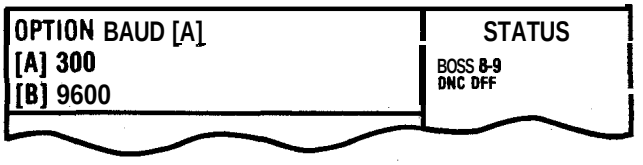
Figure C-3. Transmission Connections

C.4.2 Setting the Baud Rate

NOTE

The baud rate is 110 for ASR-33 and 300 baud ASR-43 teletypes.

To check or change the baud rate Port A, press the OPTION key on the R2E4 Front Panel until the CRT screen shows:



The initial values displayed will be the current settings. To change the baud rate for a teletype, key in 1-1-0 followed by ENTER. This will change the displayed Port A baud rate. Press EXECUTE to initiate the newly entered baud rate.

Refer to the Users Manual (Code No. 1-104-0823) for further information on changing and entering baud rates.

C5 R2E4 DOWNLOAD FROM €2-FILE

Set up EZ-FILE:

1. Set baud rate for channel "0" (43#) (4800#).
2. Select parity (even) for channel "0" (45#) (2#).
3. Select protocol (4#, EZ-LINK) (47#) (4#).
4. Select port (46#) (0#).
5. Save parameters (42#).

Connect RS-232 cable into Port B on R2E4 and selected port on EZ-FILE.

RS-232 Cable	Code Number
6 Ft.	1-168-2004
25 Ft.	3-193-4006
90 Ft.	3-193-4011

Set baud rate dn R2E4 for Port B (4800).

On R2E4 press:

1. Load
2. Remote, (2) execute
3. From, (0) execute
4. Enter file name, to 5 digits

NOTE

Not needed if file is previously selected in EZ-FILE. If files are alphanumeric or user decides to select file from EZ-FILE, the following procedures must be taken on EZ-FILE:

1. ***2# (select file)***
2. ***Number of file (1-77)***
3. ***# (activates file)***

5. Execute (on BOSS)

R2E4 Upload to EZ-FILE

Same procedure as downloading except on the R2E4 press:

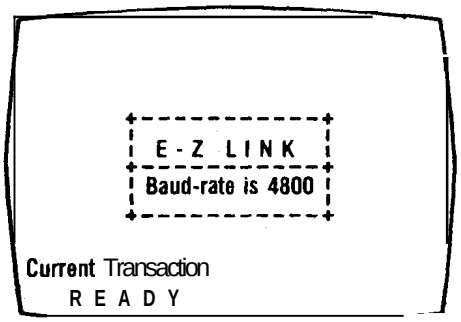
3. to, (1), execute
4. a. **1#** (define file)
   b. File name
   c. **#** (activates file)

C.6 **COMMUNICATION** PROCEDURES BETWEEN **EZ-**CAM **II** AND BOSS 9

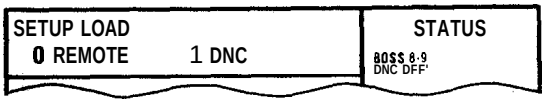
The following procedure describes how to use an **EZ-**CAM **II** connected to Port B, as a mass storage device to download or upload programs of length less than the available storage. Port **B** is also used to transfer part programs that exceed the memory capacity of the particular control to be used. This method is called DNC LINK.

Communication

1. On the EZ-CAM II:
   a. In the main menu, select "5> UTILITIES'.
   b. Select "2> PROGRAM" and enter "EZLINK", the desired utility program and press the RETURN key.
   c. Select "3> EXECUTE". The EZ-CAM **II** CRT will soon display:

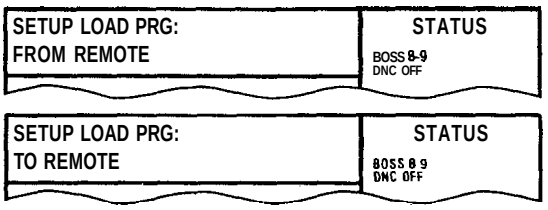


2. The BOSS 9:
   a. Press the **LOAD/CLEAR/EDIT** key until the following is displayed:



   b. Key in **0** and then press the EXECUTE key. This will prompt:

   c. Key in **0** or 1, according to whether you are downloading or uploading respectively, and then press the EXECUTE key again. The CRT **will** now prompt either:



3. At this point, enter the file name in one of the following two ways:
   a. If the file has a numeric name of five digits or less, you may key in the file name through the front panel of the control and press the EXECUTE key.
   b. If the file has an alphanumeric or numeric name, press the EXECUTE key, without keying in the file name at the control. This will cause the EZ-CAM **II** CRT to prompt you for the file name. Enter the file name through the keyboard, then enter a decimal point and the letter "D" at the end of the file name for proper execution, and press the RETURN key.

NOTE

If more than one part is to be made, the operator must follow the steps listed above. The EZ-CAM II, however, will remain in the EZLINK mode and does not need to be reset for each part.

C.7 TAPE READER INPUT

The Remex **7300** tape reader may be used to input data provided that the Parallel to RS-422 converter, part number **3-193-9775,** is used. Connect to Port B at the machine.

C.8 LONG DISTANCE TRANSMISSION

A converter, part number **3-193-9058,** will convert **RS-**232C signals to RS-422 for use with Port B at the machine.