

ARTISAN®
TECHNOLOGY GROUP

Your **definitive** source for quality pre-owned equipment.

Artisan Technology Group
(217) 352-9330 | sales@artisantg.com | artisantg.com

Full-service, independent repair center
with experienced engineers and technicians on staff.

We buy your excess, underutilized, and idle equipment
along with credit for buybacks and trade-ins.

Custom engineering
so your equipment works exactly as you specify.

- Critical and expedited services
- In stock / Ready-to-ship
- Leasing / Rentals / Demos
- ITAR-certified secure asset solutions

Expert team | Trust guarantee | 100% satisfaction

All trademarks, brand names, and brands appearing herein are the property of their respective owners.

Visit our website - *Click HERE*

TABLE of CONTENTS

SECTION 1 - THERMAL SPRAY SAFETY 1
1-1. SCOPE 1
A. General Safety Guidelines 2
B. Toxic Wastes 2
C. Flammable Solvents and Sealer Bases 2
1-2. FIRE PREVENTION AND PROTECTION 3
1-3. SAFE OPERATING CONDITIONS 3
A. Storage, Handling and Use of Compressed Gas Cylinders 3
B. Flow Meters 4
C. Compressed Air 4
1-4. FLAME SPRAY AND HVOF/HVAF EQUIPMENT 5
1-5. PLASMA AND ARC SPRAY EQUIPMENT 5
1-6. ABRASIVE BLAST MACHINES 6
1-7. HANDLING AND MANIPULATION 6
1-8. PERSONNEL PROTECTION 7
A. Eye Protection 7
B. Respiratory Protection 8
C. Noise Protection 9
D. Protective Clothing 12
E. Confined Spaces 12
1-9. VENTILATION 13
1-10.TOXIC MATERIALS 14
A. Beryllium 14
B. Cadmium 15
C. Lead, Lead Alloys, Cobalt, Chromium and Tellurium 15
D. Tin and Zinc 15
E. Solvents 15
F. Threshold Limit Values 15
1-11.SAFETY STANDARDS 16

SECTION 2 – INTRODUCTION 19
2-1. SPECIFICATIONS 19
2-2. DESCRIPTION 20

SECTION 3 – INSTALLATION 21
3-1. UNPACKING/MOUNTING 21
3-2. LOCATION 23
A. Primary Electrical Requirements 24
3-3. CONNECTIONS 24
A. Main Power Connection 24
B. Signal Cabling 25

SECTION 4 – OPERATION 27
4-1. TURNTABLE OPERATING TERMS AND CONCEPTS 27
4-2. PROGRAMMING THE TURNTABLE 28
A. Digital Input/Output 28
B. Modular Programming Techniques 29
B-1. 7354 Program Interface, MC1 Instruction Pick List (IPL) 29
C. 7354 Turntable Control Routines 30
C-1. TT_SYNC: Synchronize/Home 7354 Turntable 30
C-2. TT_Index: Index Platen to Position 31
C-3. TT_Tilt: Tilt Platen to Position 32
C-4. TT_Rotate: Rotate Platen at a Constant Velocity 33
4-3. PROGRAMMING EXAMPLES & RECOMMENDATIONS 34
A. Control Routines for use with 4X00 Computerized Process Control 34
A-1. Main Routine 34
A-2. Pass Count Routine 35
A-3. Light Position Routine 35
A-4. Safe Zone Routine 35
A-5. Routine 1 Routine 36
B. Turntable Control Programs 36
B-1. TT_SYNC: Home Turntable Routine 36
B-2. Rotate Routine 37
B-3. Index Routine 37
B-4. Tilt Routine 38
4-4. MOUNTING WORKPIECE 38

SECTION 5 – MAINTENANCE & TROUBLESHOOTING 39
5-1. MAINTENANCE 39
A. Rotate Axis Gearbox Maintenance and Lubrication 40
B. Tilt Axis Gearbox Maintenance and Lubrication 41
C. Tilt Axis Pillow Block Bearing Housings 42
5-2. TROUBLESHOOTING 42
A. Types of Error Messages 42
B. Error Message Syntax 42
C. Program Error List 43
D. System Error List 44
SCHEMATICS 45-50

SECTION 6 – PARTS LIST 51

TECHNICAL APPENDIX 65
A-1. GUN MANIPULATION 65
A-2. PARAMETERS FOR USE WITH THE 4X00 CONTROLLER 66
A-3. MODEL 7354 FULL PROGRAM LISTING 68

SECTION 1
THERMAL SPRAY SAFETY

1-1. SCOPE

IMPORTANT

Read and understand the entire contents of this manual, with special emphasis on the safety material throughout this manual, before installing, operating, or maintaining this equipment. This unit and these instructions are for use only by persons trained and experienced in the safe operation of thermal spray equipment. Do not allow untrained persons to install, operate, or maintain this unit. Contact a Factory Representative if you do not fully understand these instructions.

This chapter notes potential hazards and safety issues associated with thermal spraying, its preparation and finishing processes. Subjects in this chapter include:

- Fire Prevention and Protection
- Safe Operating Conditions
  - Storage, Handling and Use of Compressed Gas Cylinders
  - Flow Meters
  - Compressed Air
- Flame Spray and HVOF Equipment
- Plasma and Arc Equipment
- Abrasive Blast Machines
- Manipulation/Handling Equipment
- Protection of Personnel
  - Eye Protection
  - Respiratory Protection
  - Hearing Protection
  - Protective Clothing
  - Confined Spaces
- Ventilation
- Toxic Materials
  - Beryllium
  - Cadmium
  - Lead, Lead Alloys, Cobalt, Chromium, and Tellurium
  - Tin and Zinc
  - Solvents
  - Threshold Limit Values
- Applicable Safety Standards

In this chapter, the words approved or approval mean the process, action or part is acceptable to the jurisdictional authority.

A. General Safety Guidelines

Familiarize all persons concerned with thermal spraying with these safe practices and the safety regulations contained in established standards. Pertinent standards are listed in Section 1-10 at the end of this chapter.

Information presented in this manual and on various labels, tags, and plates on the unit pertains to equipment design, installation, operation, maintenance, and troubleshooting that should be read, understood, and followed for the safe and effective use of this equipment.

The installation, operation, maintenance, and troubleshooting of plasma spray equipment requires practices and procedures that ensure personal safety and the safety of others. Therefore, this equipment is to be installed, operated, and maintained by qualified persons in agreement with this manual and all applicable codes such as, but not limited to, those listed in Section 1 - Safety Rules For Operation Of Thermal Spray Equipment in this manual, and Section 1 - Rules For Operation Of Arc Welding Power Sources in the Power Source Owner's Manual. Thoroughly understand and comply with local, state and federal **(OSHA)** health standards, especially when handling toxic materials.

Safety instructions specifically pertaining to this unit appear throughout this manual highlighted by the international warning sign and identify different levels of hazard.

WARNING

WARNING statements include installation, operation, and maintenance procedures or practices that could result in serious personal injury or loss of life if not followed carefully.

CAUTION

CAUTION statements include installation, operation, and maintenance procedures or practices that could result in minor personal injury or damage to this equipment if not followed carefully.

IMPORTANT

A third signal word, IMPORTANT, highlights instructions that need special emphasis to obtain the most efficient operation of this equipment.

B. Toxic Wastes

Preparations for thermal spraying, the processes itself or subsequent finishing operations may generate toxic materials. Dispose of them according to the **EPA Resource Conservation and Recovery Act (RCRA)**.

C. Flammable Solvents and Sealer Bases

Certain de-greasing solvents and sealer bases are flammable and require special use, handling and storage precautions in and around the thermal spray area.

1-2. FIRE PREVENTION AND PROTECTION

IMPORTANT

Treat airborne metal dusts, finely divided solids, or accumulations as explosives. Minimize the danger from dust explosions by providing adequate ventilation in spray booths. Install a cartridge-type dry dust collection system to collect spray dust.

Thermal spraying requires the same basic precautions as welding and cutting. Consult **ANSI/AWS Z49.1, Safety in Welding and Cutting; NFPA 51B, Standard for Fire Prevention in Use of Cutting and Welding Processes; and NFPA 58, Standard for the Storage and Handling of Liquefied Petroleum Gases.**

Maintain a clean work area to avoid accumulation of metal dusts. Inspect rafters, tops of booths and floor cracks for dust accumulation.

Thermal spraying operations generate extremely high temperatures. **NEVER** point thermal spray equipment at any person or flammable material. **NEVER** store paper, wood, oily rags or cleaning solvents within the spray room or enclosure.

1-3. SAFE OPERATING CONDITIONS

A. Storage, Handling, and Use of Compressed Gas Cylinders

Always comply with local, state, municipal and federal regulations regarding compressed gas cylinder storage and follow recommendations in: **ANSI/AWS Z49.1, Safety in Welding and Cutting; CGA Pamphlet P-1, Safe Handling of Compressed Gases; NFPA 55 Compressed & Liquefied Gases in Portable Cylinders; NFPA 51 Oxygen-Fuel Gas Systems in Welding and Cutting; and NFPA 51B Standard for Fire Prevention in the Use of Cutting & Welding Processes**. Improper storage, handling and use of gas cylinders **CREATES A SAFETY HAZARD**.

NEVER use oil or grease on oxygen equipment. Use **ONLY** special oxidation-resistant lubricants. Consult the equipment manufacturers or a qualified dealer for more information.

If manifolding cylinders to permit longer spray times before changeover, follow **ANSI/AWS Z49.1** recommendations.

IMPORTANT

Be sure work area is adequately ventilated before opening any gas valves. Drain the regulator of gas and release the regulator adjusting screw before SLOWLY opening cylinder valves. ALWAYS stand away from the direction of force when opening cylinder valves.

Install pressure reducing regulators in accordance with **ANSI/AWS Z49.1**. Use only the appropriate regulator for each gas cylinder: **USE ONLY ACETYLENE REGULATORS ON ACETYLENE TANKS OR**

MANIFOLD SYSTEMS. Always use the correct size wrench to connect the regulator to the cylinder valve outlet; **NEVER** force or overtighten a connection. **NEVER** use oil or grease on a regulator.

B. Flow Meters

Install and use flow meters in accordance with **ANSI/AWS Z49.1**. Avoid unsafe operating conditions and ensure proper flame balance by installing backflow prevention devices in conjunction with the flow meters. Place a protective shield on flow meters with glass tubes.

Install and use hose and hose connections according to **ANSI/AWS Z49.1 and the Specification for Rubber Welding Hose** published by the Rubber Manufacturer's association and the Compressed Gas Association. Handle hoses carefully to avoid damage and use hoses only in applications for which they are designed.

NEVER OVERTIGHTEN the connecting nuts on pressure reducing regulators and flow meters, as overtightening can collapse the nipple nose. If fitting does not seal without undue force, replace the fitting.

Turn regulator adjusting screws slowly to prevent surges that could crack or burst flow meter tubes. Blow out hoses to remove any dust. Avoid any ignition sources.

Use soapy water to check all hose connections for leaks. **NEVER** use a flame to check for gas leaks. Soapy water is a safer and more sensitive test than a flame.

If any connections leak, depressurize, open the connection, clean the sealing surfaces and threads, re-assemble, pressurize and test for leaks. If leak persists, depressurize the system.

⚠ WARNING

EXPLOSION HAZARD: NEVER USE LEAKING THERMAL SPRAY EQUIPMENT. Place a "Danger - Do Not Operate" tag on the defective equipment.

Obstructed gas lines caused by defective hoses, collapsed hose stems or dirt in the gun head gas passages or nozzle jets require excessive gas pressure to obtain proper gas flow.

If required oxygen and fuel gas pressure are more than 3 psi (21 kPa) over the recommended, check for a fouled nozzle or incorrect air cap. Low pressures often indicate a serious leak. Shut down the equipment and correct the condition before restarting the system.

⚠ WARNING

EXPLOSION HAZARD: Acetylene pressures exceeding 15 psig (103 kPa) MAY CAUSE THE GAS TO DETONATE. If acetylene pressure of 15 psig (103 kPa) is insufficient, use another fuel gas.

C. Compressed Air

Always refer to gases by their proper names to avoid confusion. Never use compressed air, oxygen or fuel gas to clean clothing.

For thermal spraying or blasting operations, use compressed air only at recommended pressures. Keep air line free of oil and moisture. Consult equipment dealer for filter and after-cooler recommendations.

1-4. FLAME SPRAY AND HVOF/HVAF EQUIPMENT



Thoroughly read and understand the gun instruction manual and familiarize all operators with gun operation before lighting gun. Maintain guns according to recommendations.

WARNING

PERSONAL INJURY (BURN) HAZARD: Using a match to light a flame spraying gun can result in serious injury. Use a friction lighter, pilot light or arc ignition instead.

Properly seating and lubricating the gun's oxygen, fuel gas and compressed air valves helps the gun operate freely and shut off completely.

IMPORTANT

Extinguish gun backfires as quickly as possible. Determine the cause of gun backfires or blowouts BEFORE relighting.

When spray operations are complete or equipment is shut down, left unattended, or taken down, release all gas pressure from the regulators and hoses: close gun valves, close cylinder valve, open gun valves, turn regulator screw out until free, close gun valves, close tank valve or manifold valve ahead of regulator.

WARNING

Explosion or Fire Hazard: NEVER hang a flame spraying gun or its hoses on regulators or cylinder valves.

When cleaning flame spraying guns, **NEVER** get oil in the gas mixing chambers. Do not lubricate valves or other parts of the gun which contact oxygen or fuel gases. Use **ONLY** special oxidation-resistant lubricants.

1-5. PLASMA AND ARC SPRAY EQUIPMENT



Plasma and arc spray equipment differs from flame and HVOF equipment. High voltages and amperages represent an electrical hazard. Prior to using equipment, thoroughly train operators in the safe operations and familiarize them with all operating and safety recommendations in the instructions manuals. Always observe standard safety precautions for electrical equipment and operate in accordance with **ANSI/ AWS Z49.1**.

Be sure the plasma or arc equipment is safe to operate. All push buttons, pilot lights, plugs and cables should be intact and meet **ANSI/ NFPA 70-1979, National Electrical Code** standards. Ground or insulate all exposed plasma gun electrodes and cable connections.

Periodically inspect cables, insulation, hoses and gas lines. Repair or replace faulty equipment immediately. Never adjust, clean or repair any part of the power supply, console or gun without first disengaging the entire system, including the power supply.

Clean arc guns and power supplies frequently to prevent metal dust accumulation, which could cause electrical short circuits. Properly insulate or ground wire feed units used in conjunction with arc equipment. If the gun is suspended, insulate or ground the suspension hook. Interconnect all ground cables.

IMPORTANT

Avoid contact between any ungrounded portion of the plasma or arc gun and the spray booth or chamber. Electrically isolate plasma guns and nozzles from support brackets to prevent stray high-frequency current from damaging other electrical equipment and controls.

1-6. ABRASIVE BLAST MACHINES

Maintain and inspect abrasive blast machines according to manufacturer's instructions. Remove and repair or replace worn parts as needed. Do not exceed recommended air pressure in the blast tank.

Keep blast hoses as straight as possible between the blast machine and blasting area. Sharp hose bends cause excessive friction and wear which can lead to a blowout at those points. If hoses must be curved around an object, use long radius curves. Store blast hoses in cool, dry areas.

Be sure blast hose controls function properly, requiring continuous pressure on the activating lever for operation. Releasing the lever should cause the system to shut off (dead man control).

WARNING

PERSONAL INJURY HAZARD: NEVER point a blast nozzle at a person.

Most blasting operations require respiratory protection for the operator. Select, operate, and maintain the protective device according to **ANSI Z88.2: Standard Practices for Respiratory Protection** and as described in a subsequent section.

1-7. HANDLING AND MANIPULATION



Most thermal spray and blasting applications require rotation or other manipulation of the part being worked on. Some handling equipment can impart high rotational speeds to coating parts. Affix and balance parts when necessary. Provide protection for the operator for the event a rotating part becomes airborne. Never leave the equipment unattended while in operation.

1-8. PERSONNEL PROTECTION

The general requirements for the protection of thermal spraying operators and welders are the same as set forth in **ANSI/AWS Z49.1, Safety in Welding and Cutting; ANSI Z87.1, Standard Practices for Occupational and Educational Eye and Face Protection; ANSI Z88.2, Standard Practices for Respiratory Protection; and ANSI Z89.1, Standard Practices for Industrial Head Protection with Low Voltage Hazards**.

A. Eye Protection



Spraying and blasting operations require eye protection in the form of helmets, hand shields, face shields or goggles. See **ANSI Z87.1 and Z89.2** for recommendations. Operators **MUST** use protection against infrared and ultraviolet radiation and flying particles. Provide all helpers and adjacent operators with suitable eye protection as well. Equip the eye protection with a suitable filter plate to protect against ultraviolet, infrared and intense visible light radiation. (Table 1-1).

Table 1-1. Recommended Eye Protection Shade Numbers

Operation	Eye Protection Type Required
Wire Flame Spraying (except Molybdenum)	Shades 2-4
Molybdenum Wire Spraying	Shades 3-6
Flame Spraying of Metal Powder	Shades 3-6
Flame Spraying of Exothermic Ceramic Powder or Rod	Shades 4-8
Plasma and Arc Spraying	Shades 9-12
Arc Bonding	Shades 5-6
Fusing Operations	Shades 4-6

In thermal spray operations where additional respiratory protection is not required, operators may wear eye protecting goggles alone. The goggles should have indirect ventilating fins to reduce fogging and eliminate danger from flying particles. In plasma spray operations, replace the goggles with helmets or hand shields that provide face, chin and neck protection from infrared and ultraviolet radiation.

When blasting, use face shields or helmets equipped with dust hoods to protect eyes, face, chin and neck. Provide respiratory protection as well as discussed in the following paragraphs.

B. Respiratory Protection



Respiratory protection is necessary for most spray and blast operations. Selection of device is determined, in accordance with **ANSI Z88.2**, by the nature, type and magnitude of the fume and gas involved. **Select only devices approved by the U.S. Bureau of Mines, National Institute of Occupational Safety and Health (NIOSH), or other approved authority.** Suggested devices for typical thermal spraying and blasting operations include:

- **Blasting in the Open:** use a **mechanical filter respirator** with face shield and dust hood OR a self-contained breathing apparatus.

- **Abrasive Blasting in Confined or Enclosed Spaces:** use a **continuous flow air line respirator** consisting of a continuous flow air line respirator, a full face piece or helmet and dust hood sufficient to protect the head and neck from rebounding abrasive. Minimum air flow to the respirator is 4 cfm (11.2 L/min.) at the face piece and 6 cfm (19.6 L/min.) entering the helmet or hood. Fresh air blowers are preferred to compressed air as a source of respirator air. If no adequate ventilation is provided, use an in-line vortex cooler when possible for operator comfort. Filter the air supply line to remove objectionable odors, oil or water mist (or both) and rust particles from the air. Place air intake to ensure the respirator receives clean, dry air. If gaseous air contaminants such as carbon monoxide are possible, use a separate air purifier. Grade D or better compressed air is considered breathable.

- **Thermal Spraying in the Open or Well-Ventilated Work Area:** additional respiratory protection may not be necessary. In borderline cases of light work of short duration with nontoxic materials, but with dust exposure use approved **mechanical filter respirators** for protection against dust and metal fumes.

- **Thermal Spraying in Confined or Semi-Confined Spaces:** use an **air line respirator**. Use a device similar to the one described for abrasive blasting.

Continuous flow air line respirators are adequate for thermal spray operations involving most commonly used materials. If the respirator air supply fails and the contaminant in the space is not immediately harmful to health, the operator may stop operations, remove the supply line and return to breathable air. When applying highly toxic materials, the contaminated air is considered immediately harmful and the operator **MUST NOT** remove the respirator. In these applications, the respirator must be equipped with an emergency auxiliary source of breathable air which the operator can breathe while escaping the confined space.

C. Noise Protection



Thermal spray processes generate high noise levels. Provide everyone near thermal spray operations with ear protection if noise exceeds the limits established by **OSHA in paragraph 1910.95, entitled "Occupational Noise Exposure" of the Occupational Safety and Health Standards**. Limit personnel noise exposure according to federal standards prescribed under the **Occupational Safety and Health Act**.

Background and Measurement

The **Occupational Safety and Health Administration (OSHA)** requires employers to provide safe working conditions and requires employees to comply with all rules, regulations and orders which apply to their actions and conduct.

OSHA does not provide thermal spray-specific rules, but establishes general rules for the control of unsafe and unhealthy elements.

Noise is unneeded and objectionable sound. Excess noise reduces productivity, causes tension, hearing impairment, nervousness and slows reaction times. Noise level is a measurement of sound wave energy (pressure). The standard unit of sound measurement is decibels (dB). Humans can sense approximately 130 dB.

Table 1-2 shows typical noise levels of various environments. If a possible problem exists, verify by measurement.

Noise of sufficient intensity and duration can create physiological effects. The louder the noise, the shorter the permissible exposure. Table 1-3 shows tolerable noise limits for various exposure times.

Protect operators, nearby workers and transient passers-by from thermal spray noise in any of three ways: at the source; during its transmission; or at the receiver. Managing any one of these can solve the noise problem. Each situation contains many variables, so each case must be treated individually. This manual can provide only overall suggestions for noise control.

Use engineering or administrative controls to reduce noise or noise exposure. Engineering controls include: redesign equipment; relocate equipment; change operating conditions; isolate equipment acoustically; insulate work area; and provide operator hearing protection. Administrative controls include planning and scheduling to reduce exposure.

How to Protect Workers' Hearing

Mufflers on thermal spray equipment are impractical and ineffective. Simple baffles between the gun and nearby personnel are not effective because noise scatters around the baffle. Specially designed sound absorbing materials provide a 5 dB reduction to adjacent areas. Sound absorbing materials on walls and hanging baffles can reduce nearby levels but do not solve the problem for the operator.

Table 1-2.
Typical Thermal Spray Noise Levels

Equipment	Set-Up	dBA
Arc Guns	Steel – 24 volts/200 amps	111
	32 volts/500 amps	116
Powder Guns (Normal)	Acetylene – w/o spray booth	89
	w/spray booth	90
	w/spray booth & air jet cooling	110
	Hydrogen – w/o spray booth	100
	w/ spray booth	101
Powder Guns (High Capacity)	Acetylene – w/spray booth	94
	w/spray booth & air jet cooling	111
Wire Combustion Guns 1/8 & 3/16 in. (3.2 & 4.8 mm)	Acetylene	114
	Propane	118
	Propane & nonload hardware	125
	Methylacetylene-propadiene gas	118
Plasma Gun	Nitrogen – 600 amps	134
	Nitrogen/Hydrogen – 600 amps	133
	Argon – 1000 amps	128
	Argon/Hydrogen – 600 amps	133
	Argon/Helium – 600 amps	127
	Argon/Nitrogen – 1000 amps	131
Gritblasting Equipment		80-85
Exhaust Equipment		< 90

Table 1-3.
Allowed Noise Level Duration

	Exposure Duration (Per Day)	Sound Level (dBA)
Hours	24	80
	16	82
	8	85
	4	88
	2	91
	1	94
Minutes	30	97
	15	100
	7.5	103
	3.75	106
	1.88	109
	0.94	112
Seconds	28.12	115
	14.06	118
	7.03	121
	3.52	124
	1.76	127
	0.88	130
	0.44	133
	0.22	136
	0.11	139

Relocate Equipment

Increasing the distance between the noise source and the receiver lowers the sound pressure level. Table 1-4 indicates typical decibel reduction with distance in a free field.

Table 1-4. Decibel Reduction by Distance

Distance from Source	Theoretical dBA Reduction
3 ft. (1 m)	0
10 ft. (3 m)	10
30 ft. (9 m)	20
90 ft. (27 m)	28

Isolate Equipment

Isolate noise by moving it away from affected personnel, or placing the equipment in an acoustically insulated enclosure. Praxair offers spray rooms (the Model 9700 Acoustical Room) which house spray operations and confine noise. These rooms are designed to limit the noise level outside the room to specified limits. Consult Praxair for additional information.

Insulate Work Area

Blocking the path of sound transmission by lining the work area with sound absorbing materials provides significant noise reduction. Consult noise control experts for material recommendations.

Provide Hearing Protection

If engineering and administrative controls do not achieve acceptable noise control, **OSHA** regulations allow use of suitable personal protective equipment. This also applies while engineering and administrative controls are being established.

Plan and Schedule to Reduce Exposure Time

Engineering controls focus on eliminating, reducing or containing the noise hazard. Administrative controls attempt to reduce exposure time.

Planning and scheduling are best used where spraying is intermittent. Usually, spraying time is a small percentage of the total job, compared with setup, surface preparation and finishing.

If spraying time exceeds the permissible levels for noise exposure, schedule jobs over more than one shift or day to keep exposure within maximum limits. Jobs can be sprayed by more than one operator to keep the exposure of any one person within limits. Off-hour spraying, outside of regular plant hours can control exposure of persons near the operation. Also, rotate personnel assignments in the vicinity of the thermal spraying operation to control exposure.

D. Protective Clothing

When working in confined spaces, wear flame resistant clothing and leather or rubber gauntlet gloves. Clothing should fit snugly around the wrists and ankles to keep sprayed materials and dust away from the skin.

For work in the open, ordinary clothing may be sufficient. However, open shirt collars and unbuttoned pocket flaps are potential hazards. Wear high-top shoes and cuffless trousers which cover the tops of the shoes in all cases.

If spraying toxic materials, consult material supplier for information on protective clothing.

Plasma spraying generates intense ultraviolet radiation which can cause a "sunburn" through normal clothing. When plasma spraying, wear clothing such as thick, tightly woven wool clothing which provides protection against radiation. For more intense exposure, leather capes or aluminized clothing is necessary. Take care to attach aluminized clothing to the outside of the face shield so radiation is not reflected into the face shield. Wear aluminized gloves and dark, fire retardant clothing.

Arc spraying radiation protection is similar to that for electric arc welding and is outlined in **ANSI/AWS A49.1**. Some arc spraying guns are equipped with an arc shield which protects the operator from direct exposure to the arc. This allows reduction of eye protection shade, but a helmet should still be used if any parts of the body are exposed to direct arc radiation or if exceptionally reflective substrates are sprayed.

E. Confined Spaces

Spaces such as a closed tank, boiler, pressure vessel or ship compartment are considered confined spaces. Review **AWS F3.1, Recommended Safe Practices for the Preparation for Welding and Cutting of Containers and Piping that have Held Hazardous Substances**, if the confined space previously held combustible materials.

Work in confined spaces requires ventilation. See section 1-8 of this manual for ventilation requirements.

When thermal spraying in any confined space, keep the gas cylinders out of the work space. If operators must enter a confined space through a small opening, provide means for rapid emergency exit. If using safety belts and life lines for this purpose, attach them to the operator's body so they will not jam in a small exit. Station at least one attendant trained in rescue work outside the confined space at all times and verify this person's ability to remove the operator from the confined space if an emergency should occur.

To eliminate the chance of gas escaping through leaks or improperly closed valves, close the gun valve and shut off the gas supply at a point outside the confined area. If possible, remove the gun and hose from the confined space. Evaluate oxygen level inside the confined space with oxygen monitoring equipment.

1-9. VENTILATION



The amount of contamination to which an operator is exposed during spray operations depends on a number of factors, including:

- Volume of space in which the operation is performed
- Number of spray/abrasive blast units operating in that space
- The evolution of hazardous fumes, gases or dusts (varies, de pending on material sprayed)
- Heat generated by the spraying process
- Presence of volatile solvents

Consider all factors when selecting ventilation systems for operator safety.

Where thermal spraying operations are incidental to general operations, apply local exhaust ventilation to the spray areas to prevent contamination of the general work area.

Carefully maintain individual respiratory protective devices. Clean and disinfect devices before transferring between employees (see **ANSI Z88.2**). Use grade D or better air in forced air respiratory devices.

Provide mechanical ventilation for operations not performed in the open or in a properly designed and ventilated room. Ventilation equipment usually consists of motor driven portable exhausters with flexible piping or ducts which removes dust rapidly and allows operators suitable visibility. A ventilation system does not preclude the need for respiratory protection devices. See section 1-7.B for recommendations on protective devices and filtration systems.

When thermal spraying on a machine tool such as a lathe, mount an exhaust hood at the end of the carriage so that it travels with the gun, exhausting dust and fumes into the dust collector. Aim the gun so the sprayed material enters the face of the hood. An average lathe hood is about 2 sq. ft. (0.2 m^2) and the velocity of air entering the opening should be at least 200 ft./min. (1 m/s). The hood opening design should eliminate turbulence along the sides that could force spray dust into the operator's breathing zone. In some permanent installations, the entire tool is enclosed except the front and air enters the enclosure at approximately 300 ft./min. (1.5 m/s). The hood top can be hinged to facilitate loading and unloading with a crane. In automatic and production spraying, the entire mechanism is often totally enclosed. Consult "**Industrial Ventilation**" published by the American Conference of Governmental Industrial Hygienists.

Provide exhaust equipment for dry grinding or lapping operations performed on sprayed coatings. Consult **ANSI Z43.1, Ventilation Control of Grinding, Polishing and Buffing Metals**.

Equip spray cabinets used for spraying small and medium size parts with exhaust ventilation with an air velocity of 200 to 400 ft/min. (1 to 2 m/s) entering the hood. Operate the spray equipment within the face area of the hood and direct the spray into it. Design the cabinet to eliminate turbulent currents. Consult "**Industrial Ventilation**" published by the American Conference of Governmental Industrial Hygienists.

Design blasting rooms with adequate lighting and ventilation. Ventilation down draft and longitudinal air flow at a velocity of 80 to 100 ft./min. (0.2 to 0.5 m/s). Equip the blasting room with a dust collection system as is usually required by local ordinances. Fully investigate local, state, and federal regulations before exhausting directly into the atmosphere. Avoid using the blasting room for thermal spraying as the dust collectors can quickly become clogged with spray dust and may create a fire or explosion due to accumulation of metallic dust (see table 1-2). Provide operators with respiratory protection as detailed in 1-7.B.

Replace ventilation-removed air with clean, breathable air. Size fans to provide at least 10 air changes per minute. If using portable gasoline or diesel engines to drive ventilators, be sure they are located so engine exhaust cannot be drawn into the ventilating system or the intake of the respirator air compressor.

Use closed type dust collectors suitable for use in thermal spray environments.

Ground all fans, pipes, dust arrestors and motors. **DO NOT** ground to piping that carries fuel gas or oxygen. Run ventilation fans when cleaning out booths, pipes, etc. to prevent accumulation of dust or fumes in the system. **NEVER** weld or cut while repairing any ventilation or dust collecting equipment unless the equipment has been thoroughly cleaned.

Wear fresh air helmets and protective clothing when spraying on unusually large objects or in large confined spaces such as boilers or tanks.

1-10. TOXIC MATERIALS

Most any material, in finely divided form, can be damaging to the respiratory system. Precautions for protecting the health of spray equipment operators varies according to the type of material sprayed. Careful attention to this hazard is important, because the damage is often not sensed immediately. Take care to keep floors, work benches and booths free of dusty residues. Carefully clean protective clothing to remove dust, or discard after use.

A. Beryllium

Beryllium and its compounds are highly toxic and potentially hazardous. Spray beryllium-containing alloys only with adequate local exhaust ventilation and air line respirators. Handle the ventilation system exhaust safely while directing it to a restricted area. Protect workers in the immediate vicinity of the thermal spray operations as necessary by local exhaust ventilation or air line respirators (see 1-7.B and 1-8).

Always seek expert advice from certified industrial hygienists, the Nuclear Regulatory Commission, insurance companies, state agencies and OSHA when working with beryllium.

B. Cadmium

Cadmium is highly toxic and hazardous. Use respiratory protective equipment such as fume respirators approved by the U.S. Bureau of Mines, National Institute of Occupational Safety and Health (NIOSH) or other approving authority (see 1-7.B and 1-8).

C. Lead, Lead Alloys, Cobalt, Chromium, and Tellurium

The principal hazard when spraying or blasting these materials comes from ingestion, inhalation and the subsequent absorption of fumes, dust or vapors.

The fumes and dust from lead, lead alloys (such as solder and lead base babbitts), chromium alloys (such as stainless steels, nickel chromium and chromium oxide) and tellurium are toxic and potentially hazardous. Provide respiratory protection and adequate ventilation wherever the fume and dust concentration is above the threshold limit. (see 1-7.B, 1-8 and 1-9.E).

D. Tin and Zinc

Usually encountered in the forms of their oxides and not considered toxic, tin and zinc may cause violent illness, including coughing, headache and, particularly in the case of zinc oxide fumes, nausea, vomiting, chills, fever, muscle and joint pain, and marked thirst. (In the case of zinc oxide, the effect has been known as "brass founder's ague", "brass chills", "zinc fever", or "metal fume fever".) Temporary short term immunity can be developed.

Prevention consists of adequate ventilation and proper respirators (see 1-7.B and 1-8). Preclude from the work any operators with pulmonary disease or those who continue to suffer discomfort, even with proper ventilation and respirator measures.

E. Solvents

The radiation generated by plasma or arc spraying causes rapid decomposition of some solvent vapors into noxious and toxic gases, even at considerable distance from the arc. Slow extraction of the part from the solvent cleaning tank can reduce this problem. When spraying vapor-degreased parts, take extra care to see that all solvent (vapors or liquid films or drops of solvent caught by pockets and crevices) is removed prior to thermal spraying.

The ultraviolet radiation from plasma and arc spraying generates airborne ozone. The amount of ozone produced may exceed the maximum allowable concentration in confined spaces.

F. Threshold Limit Values

Threshold Limit Values (TLV) are air concentration levels of hazardous materials for exposures not exceeding a total of eight hours daily. TLVs are published annually by the **American Conference of Gov-**

ernmental Industrial Hygienists (ACGIH). Consult a current TLV list concerning the maximum allowable concentration of toxic material allowed.

Conduct air sampling to determine the ventilation requirements for operations involving the previously listed materials. When less toxic metals are sprayed, the concentration of dust or fumes in the work area must not exceed the TLV for eight hour exposure. Provide respiratory protection devices and exhaust ventilation when the dust or fume concentration is sufficiently high to cause operator discomfort, even when the appropriate TLV is not exceeded.

1-11. SAFETY STANDARDS

OSHA establishes mandatory federal safety regulations. For information on these regulations, refer to **OSHA Standards, Code of Federal Regulations, Title 29, Part 1910.**

Among the safety hazards associated with thermal spraying is compressed gas handling. Safe handling of compressed gases is addressed in **ANSI/AWS Z49.1, Safety in Welding and Cutting** and in the **Williams-Steiger Occupational Safety and Health Act of 1970 (84 Stat. 1943)**. More recently the **Resource Conservation and Recovery Act (RCRA)**, dealing with the disposal of toxic wastes, potentially impacts the thermal spray industry.

Where standards and other documents are referenced in this publication, they refer to the latest edition.

Occupational Safety and Health Act Standards (29CFR 1910), available from the Superintendent of Documents, U.S. Government Printing Office.

Ventilation Control of Grinding, Polishing and Buffing of Metals, ANSI Z43.1, available from the American National Standards Institute.

Safety in Welding and Cutting, AWS/ANSI Z49.1, available from the American Welding Society.

Standard Practices for Occupational and Educational Eye and Face Protection, ANSI Z87.1, available from the American National Standards Institute.

Standard Practices for Respiratory Protection, ANSI Z88.2, available from the American National Standards Institute.

Safety Requirements for Industrial Hand Protection, ANSI Z89.1, available from the American National Standards Institute.

National Electrical Code, ANSI/NFPA 70-1979, available from the National Fire Protection Association, updated annually.

Safe Handling of Compressed Gases, CGA Pamphlet P-1, available from the Compressed Gas Association.

Oxygen, CGA Pamphlet G-4, available from the Compressed Gas Association.

NFPA 51 Oxygen-Fuel Gas Systems in Welding and Cutting; NFPA 51B Standard for Fire Prevention in the Use of Cutting & Welding Processes; NFPA 55 Compressed & Liquefied Gases in Portable Cylinders, available from the National Fire Protection Association

Recommended Safe Practices for the Preparation for Welding and Cutting of Containers that have Held Hazardous Substances, ANSI/AWS F4.1, available from the American Welding Society.

Safety Release Device Standards - Cylinders for Compressed Gases, CGA Pamphlet S1.1, available from the Compressed Gas Association.

Standard for Gaseous Hydrogen at Consumer Sites, CGA Pamphlet G5.1, available from the Compressed Gas Association.

Power Piping, ANSI B31.1, available from the American National Standards Institute.

Acetylene, CGA Pamphlet G-1, available from the Compressed Gas Association.

Oxygen-Fuel Gas Systems for Welding and Cutting, ANSI/NFPA 51, available from the National Fire Protection Association.

Standard for Fire Prevention in Use of Cutting and Welding Processes, ANSI/NFPA 51B, available from the National Fire Protection Association.

Standard for the Storage and Handling of Liquefied Petroleum Gases, ANSI/NFPA 58, available from the National Fire Protection Association.

NOTES

SECTION 2
INTRODUCTION

2-1. SPECIFICATIONS

WEIGHT	
Turntable Weight	730 lbs. (329 kg)
Controller Weight	60 lbs. (27 kg)
TOTAL WEIGHT	790 lbs. (356 kg)

DIMENSION	
Height (platen horizontal)	39.35 in. (1000 mm)
(platen vertical)	42.46 in. (1078 mm)
Width	40 in. (1016 mm)
Length	42 in. (1067 mm)
Platen Diameter	24 in. (610 mm)
Platen Thickness	3/4 in. (19 mm)
Platen Mounting Facility	Four slots: 6 in. (152 mm) long x 9/16 in. (14 mm) wide
Load Capacity*	500 lb. (225 kg) (evenly distributed)

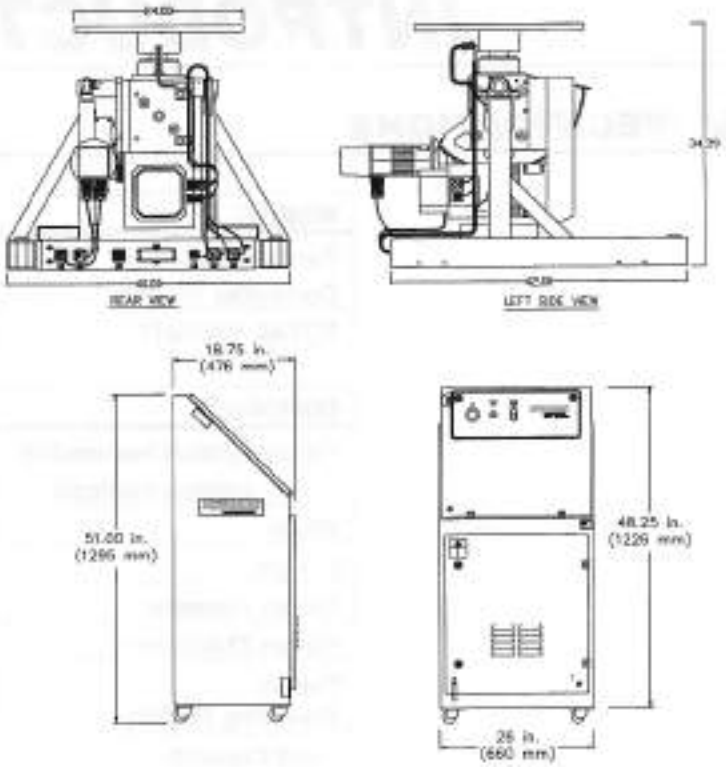
ELECTRICAL	
Supply Voltage	220 VAC, 3-phase, 50/60 Hz

ROTATION AXIS	
Speed Range	1-400 RPM (in 1 RPM increments), clockwise & counterclockwise
Index Resolution	0.1°
Brake	24VDC Fail-safe Positive Release

TILT AXIS	
Tilting Range	0-90° (0° = horizontal)
Tilt Speed	10° per second
Positioning Resolution	1° Platen
Brake	24VDC Fail-safe Positive Release

*** The capacity of the manipulator is defined as the ability to control a cylinder 24 inches long, 12 inches in diameter, weighing 500 lbs mounted vertically to the center of the platen.**

Figure 2-1.
Model 7354 Dimensions



2-2. DESCRIPTION

The Praxair Model 7354 Computerized Turntable is a rugged industrial motion control device providing precision tilting, indexing, and rotation of a workpiece.

The 7354 operates with any ABB Robot with an S4 controller (the turntable is not configured for stand-alone operation) and functions as two independent axes under robot program control. The 7354 is fully programmable via the robot teach pendant.

Although acting as an external axis, the 7354 is NOT connected to the robot as an actual axis. Constant rotational movements are not taught points, so no unwinding is necessary at the end of the constant rotate function. Rotation direction is specified in the robot program as a positive (clockwise) or negative (counterclockwise) value. The turntable tilt, index, and rotate movements can be coordinated with the robot arm movement, creating an ideal system for coating complex components.

The 7354 system includes the turntable, controller, and 20 ft. (6 m) cable connections to the robot controller.

Supported by a rugged steel frame, the Model 7354 provides maximum rigidity for high-speed workpiece manipulation required in thermal spraying operations. The unit comes with a hard-anodized aluminum platen containing four slots ideally suited for fixture and chuck attachments.

SECTION 3
INSTALLATION

3-1. UNPACKING/ MOVING

The 7354 Turntable and its controller are shipped in separate crates. Open the controller crate first:

1. Remove the panels marked "TOP" and "FRONT" from the small shipping crate to reveal controller.

2. Remove packing material and parts containers from around controller.

CAUTION

Before moving, inspect for any shipping damage. Purchaser must file any claims for loss or damage incurred in transit with the carrier. If the need to file a claim arises, request a copy of the bill of lading from the manufacturer. Be sure to supply Model Description and Serial Number information for the equipment whenever requesting information about this equipment.

3. Approach controller front with a lift truck rated for 500 lb. (227 kg) or more. Adjust lift truck forks to fit between the controller casters. Move the lift truck forks under the controller.

4. Slowly raise lift forks high enough to remove the controller (weight: 222 lbs. [101 kg]) from the crate, and back the lift truck and controller away from the crate.

5. Lower the controller to the floor, remove the lift truck and have two workers push the controller to its intended location.

6. Remove top and side panels of large shipping crate to reveal turntable.

7. Remove packing material and any parts containers from around turntable.

8. Approach turntable front (the side opposite from turntable motor) with a lift truck rated for 1,000 pounds (454 kg) or more. Adjust lift truck forks to the frame-mounted lifting lugs (Fig. 3-1) and move lift truck forward, placing the lift forks in the lifting lugs. Move the lift truck as far forward as possible without contacting the upper portion of the turntable with the truck.

9. Raise the turntable just high enough to clear the crate, and back the lift truck and turntable away from the crate.

10. Keep the turntable raised just high enough to transport it safely, use the lift truck to move the turntable to its operating location.

Figure 3-1.
Controller Lifting Points

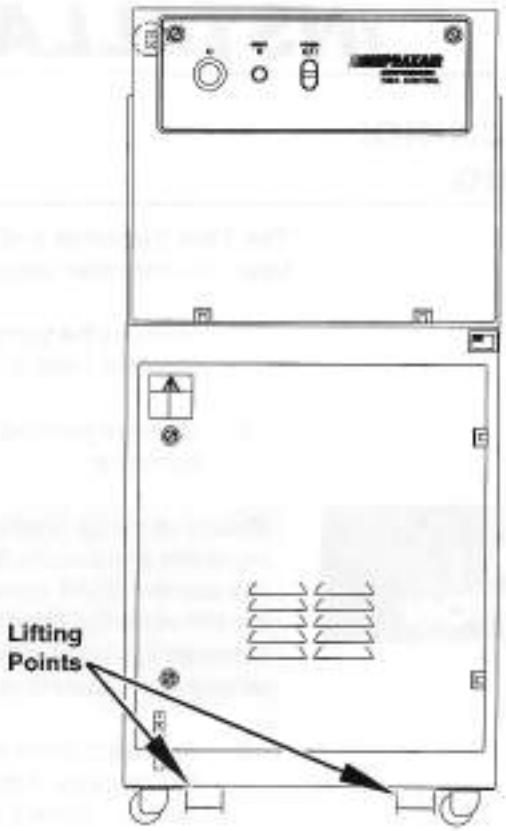


Figure 3-2.
Turntable Lifting Points

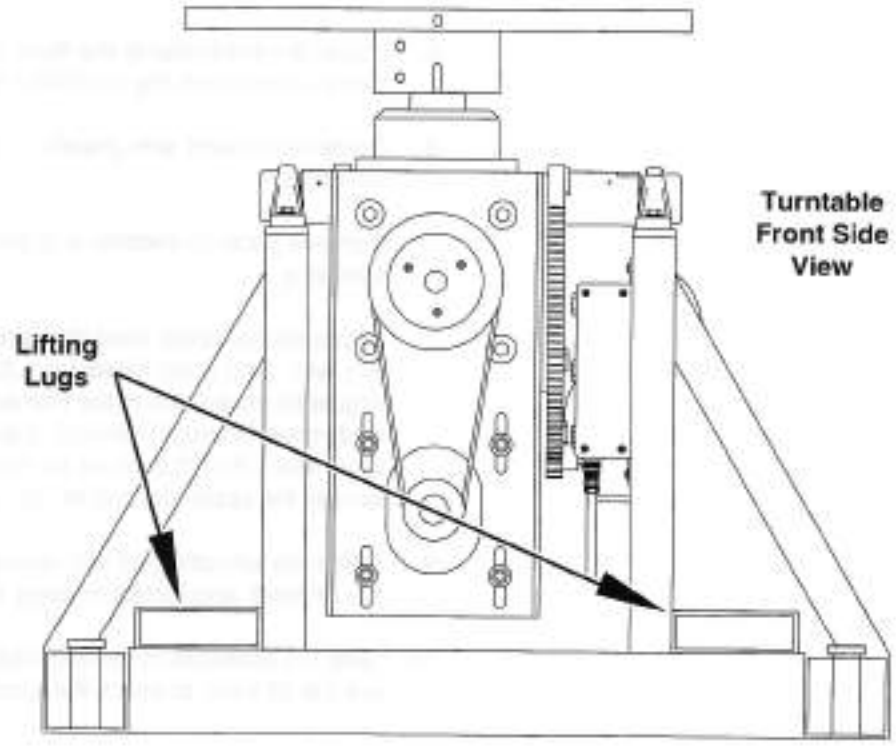
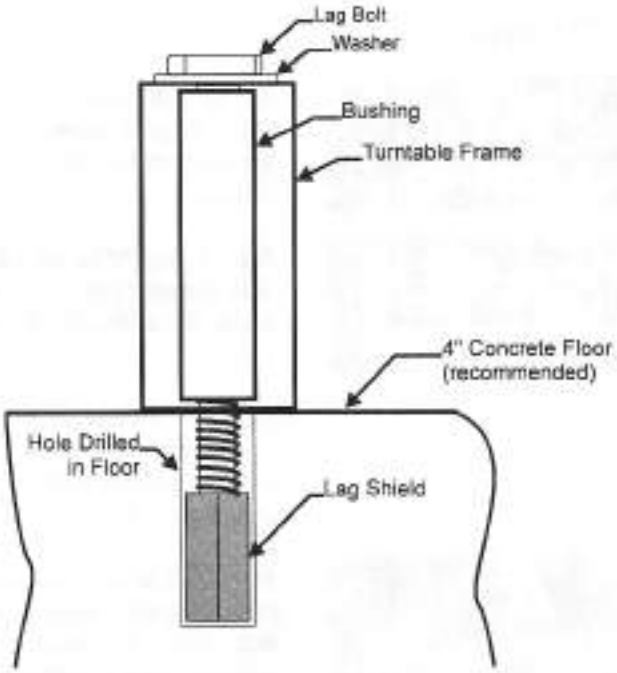


Figure 3-3.
Securing Turntable to Floor



3-2. LOCATION

The Model 7354 Turntable requires few special location considerations, other than sufficient space to accommodate its range of tilting, a floor sufficient to support the weight of the turntable and workpieces and a 220VAC electrical power supply. The controller is to be located outside of the actual spray booth, preferably in a control room providing visual contact with the turntable. In addition, a remote emergency stop control box must be located in the work area and connected to the E-stop circuit via the controller.

Place components so all interconnecting cables terminate without strain. Verify that a 220VAC electrical outlet is within 24 ft. (7.3 m) of the controller.

Most often, the turntable/manipulator is moved into position in a spray booth, leveled and connected to the controller. If the turntable will be handling heavier loads (over 200 pounds) and especially if those loads will be tilted, recommended installation includes securing the turntable to the floor. To accomplish this, install a securing bushing:

1. Use the holes in the bottom frame rails as guides and drill at least 3 in. (76 mm) into the floor at each location (see Fig. 3-3).
2. Place a lag shield into each drilled hole.
3. Insert bushings (P/N **5006833**) into frame holes.
4. Insert lag bolts (with washers) through the frame holes and bushings, into the drilled hole and lag shield (see Fig. 3-3). Tighten securely.

A. Primary Electrical Requirements

The 7354 system requires a 3-phase, 220 VAC, 50-60 Hz power source.

3-3. CONNECTIONS

WARNING

ELECTRIC SHOCK HAZARD: Do not touch live electrical parts. Shut down the power supply and disconnect input power employing lockout/tagging procedures before making cable connections.

IMPORTANT

Install the 7354 using a floor plan compliant with local rules and regulations and in accordance with general safety instructions described in Section 1.

After positioning system components, connect the turntable to the controller. See appropriate operator's manuals for more information on connecting other system components. Cable numbers refer to the callout numbers in Fig. 3-3.

IMPORTANT

Most cable part numbers end with dash and a number telling cable length in feet (example: 5005224-25 is a 25 ft. cable). Since cable lengths are custom, we do not reference actual lengths, unless it is not variable. Standard cable and hose lengths are listed in Section 6.

A. Main Power Connection

Main power is brought into the controller via a connector supplied by the manufacturer.

1. Connect one end of a cable of required length (purchaser supplied) to the factory-supplied 3-pole, 4 wire connector (P/N **5007818**).
2. To the other end of the operator-supplied cable, attach the connector(s) required to access a 220 VAC, 3 phase @ 30A power source.
3. Connect the factory-supplied connector end of the cable to connector J4 on the rear bulkhead of the Controller, then connect the other end to a locked/tagged out 220 VAC, 3 phase @ 30A power source.

CAUTION

Only licensed electricians are to make electrical connections to plant wiring. All wiring must be in compliance with all applicable local and national laws, codes and regulations.

Inside the Controller, power is routed to 3 type LP-CC-30 fuses (Ref. designations F101, F102, F103). These fuses provide interrupt isolation of 200,000 symmetrical AC rms amperes and 20,000 DC amperes. Line currents exceeding these levels require additional fusing.

B. Signal Cabling

Optimize system performance by routing signal cabling away from components and cabling which generate high levels of electronic noise (radio frequency interference), such as a high frequency unit or components carrying high levels of current, such as water cooled gun cables.

In some installations, adding line reactors or filters can prevent noise from infiltrating the system. Reactors or filters can also prevent emitted electrical noise from interfering with surrounding equipment.

Part #	Cable Function	Controller Connection	Manipulator Connection
500000	Motor Drive	J1 (8 Socket Amphenol)	J2 (8 Pin Amphenol)
	Motor Feedback	J2 (16x4 Phoenix Heavycon)	J1 (16x4 Phoenix Heavycon)
	Robot/TT Interface	J3 (16x4 Phoenix Heavycon)	JP1(16x4Phoenix Heavycon)
	E-Stop Chain Input	Jx	
	E-Stop Chain Output	Jy	

See Figure 3-4 for general system connection diagram. The connections are numbered and referenced in the following detailed instruction following the part number (in parentheses).

Remove power from turntable controller and S4 controller. Connect system as follows:

1. Attach cable 46 (P/N **5007836**) to the turntable's J2 connector, then to the turntable controller's J1 connector.

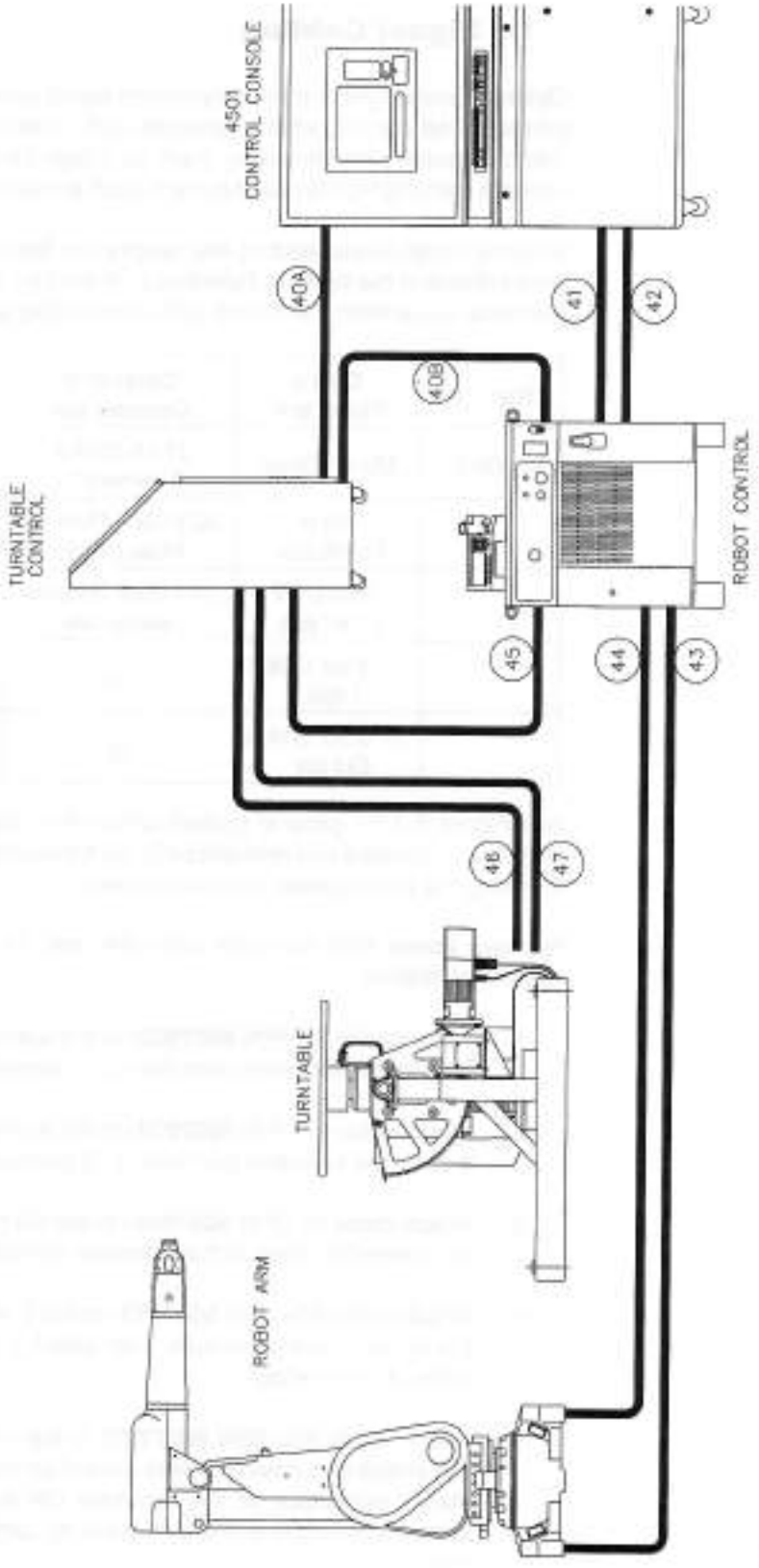
2. Attach cable 47 (P/N **5007834**) to the turntable's J1 connector, then to the turntable controller's J2 connector.

3. Attach cable 45 (P/N **5007835**) to the S4 robot controller's 24-pin connector, then to the turntable controller's J3 connector.

4. Attach cable 40a (P/N **5007777**) to the E-stop control box or to the system control console, then attach it to the turntable controller JX connector.

5. Attach cable 40b (P/N **5007777**) to the next control device in line (robot controller, process control console, etc.) and then to the JY connector on the controller OR install the E-stop end jumper connector in the JY socket to complete the E-stop circuit.

Figure 3-4.
Model 7354
Cable Connections



945000b, rev. *

SECTION 4
OPERATION

4-1. TURNTABLE OPERATING TERMS AND CONCEPTS

1. **Rotate Mode** - The 7354 is in ROTATE MODE any time the platen is commanded and turning at a constant velocity. Rotate mode is indicated to the robot program via digital input INDEX_RDY=0, and if the platen is rotating within 0.5 RPM of commanded velocity, digital input RPM_SP = 1 (high).

2. **Index Mode** - The 7354 is in INDEX MODE any time the platen is at the commanded RPM setpoint of 0 (zero) RPM. While in INDEX mode, the rotate platen may be "INDEXED" to any point within a single platen rotation from 0 to 359 degrees. (The tilt axis may be moved regardless of rotate axis mode.) Any command outside of these parameters generates an error message from the robot system. An indexed rotate axis movement (ROT/INDEX) may not be commanded while in rotate mode. Index mode is indicated by digital input INDEX_RDY=1.

3. **Angular Displacement** - For a disk rotating about a fixed axis through its center, the distance ΔS traveled by a point P on the disk is dependent on radius r, but the angular displacement is the same for all points on the disk. When the disk makes one complete revolution, the ARC LENGTH ΔS is $2\pi r$, and the angular displacement $\Delta\theta$ is $2\pi r/r = 2\pi = 360$ degrees.

4. **Angular Velocity** - The rate of change of the angle in respect to time, $\Delta\theta/\tau$, is the same for all points on the disk. Angular Velocity = $\omega = \Delta\theta/\tau$. Angular Velocity, ω is positive or negative, depending on whether the angle q is increasing or decreasing in respect to 0 degrees reference. Unit of measurement = radians per second.

5. **Circumference** - The number of radians in the circle multiplied by the diameter of the circle. There are 2π radians in a circle, therefore: Circumference = πd or $2\pi r$

6. **Moment of Inertia** - A measure of the resistance of a body to changes in its rotational motion. The magnitude is dependent on the mass distribution relative to the body's axis of rotation.

7. **Angular Momentum** - The angular momentum "L" of a body is defined as the product of the moment of inertia and the angular velocity. Angular momentum = $L = I\omega$.

4-2. PROGRAMMING THE TURNTABLE

The Model 7354 system is designed to operate with the ABB S4 controller, and is not configured for stand-alone operation. Accordingly, the operator must first be familiar with robot functions and programming before attempting to program and operate the Model 7354. See robot owners manual for more information on robot operation and programming through the S4 robot controller's pendant.

IMPORTANT

Read and understand all instructions in this manual and remove ALL loose objects (tools, parts, chucks, etc.) from the turntable platen before powering up the turntable system.

A. Digital Input/Output (I/O)

The S4 Robot Controller comes standard with 16 digital inputs and 16 digital outputs. Some of those I/O are reserved for use with the Model 7354 and 4X00 Computerized Process Control. The names of those reserved I/O reflect their usage to make programming more intuitive for the user.

Digital Inputs

Name	Description
tilt_rdy	High input indicates that turntable is available to accept tilt command.
tilt_err	High input indicates turntable synchronized, no errors present. Signal low on tilt axis error, sets trap to tt_error routine.
index_rdy	High input indicates index mode, TT available for rotate axis command from robot.
rpm_sp	High input indicates rotate mode, platen RPM is within +/_ 1% of setpoint.
tt_pwr_ok	High input indicates +24VDC from TT present. Signal low on loss of TT Controller power, sets trap to tt_error routine.
rot_drv_status	Signal high on rotate servo amplifier enabled.
tilt_drv_status	Signal high on tilt axis servo amplifier enabled.

Digital Outputs

Name	Description
tstat_req	Used for communication sychronization for tilt axis status request. Used in manual or auto mode.
tilt_up	Jogs turntable up towards horizontal position. Available only in manual mode with motors on and TT synchronized. Output set by pressing button P5 on robot pendant.
tilt_dn	Jogs tilt axis down toward the vertical position. Available only in manual mode with motors on and TT synchronized. Output set by pressing button P4 on robot pendant.

Chart continued at top of page 29

Digital Output chart continued from page 28

Name	Description
tilt_hm	Synchronizes tilt axis. Cross-connected to rot_hm output. Available only in manual mode with motors on. Activated by pressing button P1 on robot pendant.
rstat_req	Used for communication sychronization for rotate axis status request. Used in manual or auto mode.
rot_hm	Synchronizes rotate axis. Cross-Connected to tilt_hm output. Available only in manual mode with motors on. Activated by pressing button P1 on robot pendant.
pgm_en	Sets TT to auto mode. Indicates auto mode and program is running. System output tied to robot "CycleOn".
mtr_state	Sets TT amplifiers to enabled state. System output tied to "MotorState".
tt_reset	Resets TT. Performs warm boot on 7354 internal program.
cmd_strobe	Used within robot system module to indicate command ready to send to TT. Signal high sets trap to cmd_write routine. No hard wired connection to TT.

B. Modular Programming Techniques

The robot and turntable use modular programming, the process of creating a program by breaking it down into smaller parts, writing subroutines to solve those smaller problems, and combining the subroutines into one functioning unit.

B-1. 7354 Program Interface, MC1 Instruction Pick List (IPL)

Programming instructions for the 7354 are selected from the IPL2 menu, sub-heading MC1.

IMPORTANT

Although this pick list (shown on next page) is not fixed and may be changed, it is programmed for operation with the Model 7354 and/or 4X00 Plasma Control System. Praxair recommends leaving the pick list unchanged. See robot owners manual for instruction on MC2 and MC3 preferences to customize an instruction pick list for specific individual preferences.

IPL2 (MC1) Pick List

Name	Description
TT_Sync	Synchronize/Home 7354
TT_Rotate	Place 7354 into Rotate Mode at X RPM
TT_Tilt	Place 7354 into Index Mode and Tilt to X degrees
TT_Index	Place 7354 into Index Mode and Index Platen
WaitDi	Wait for Digital Input
WaitUntil	Wait for a condition
RETURN	Return from a called procedure

C. 7354 Turntable Control Routines

The S4 Controller is delivered with a number of subroutines loaded as a SYSTEM MODULE. Use these subroutines to control the Model 7354 from within a robot program module. Access these routines just as any robot instruction, by selecting them from the Instruction Pick List (IPL), Most Common 1 (MC1) sub-heading:

1. Using the robot controller pendant, select the IPL2 menu.
2. Select the MC1 sub-heading.
3. The IPL2 (MC1) list displays.
4. Scroll down the list until the desired instruction is highlighted and press ENTER to select.

The following sections describe the turntable control routines.

C-1. TT_SYNC: Synchronize/Home 7354 Turntable

Use the TT_SYNC command to synchronize the turntable after system power-up, an error, or a reset. The motion control computer needs to determine where the platen is in respect to a "HOME" position. When the turntable completes synchronization, digital inputs tilt_rdy, index_rdy, tilt_err, and rot_err will be set to 1 (high). The TT_Sync routine should be executed based upon the status of tilt_err and rot_err.

Example of TT_Sync usage:

```
IF tilt_err=0 OR rot_err=0 Then
    clr_int
    TT_Sync;
    WaitUntil tilt_err=1 AND rot_err=1;
    WaitDI index_rdy,1;
    WaitDI tilt_rdy,1;
    sys_init
RETURN
```

IMPORTANT

Executing TT_Sync resets and re-initiates the turntable prior to system synchronization as though power was cycled. This sets signals tilt_err and rot_err low. Transitioning the signals from high to low can generate a false system error. Avoid this error by calling procedure clr_int before executing tt_sync. After turntable completes initialization, execute procedure sys_init to enable system interrupts.

To help reduce cycle time, check the tilt err and rot_err status before executing TT_Sync. If both signals are already 1 (high), execute TT_Tilt and TT_Rotate commands with arguments of 0 (see examples below).

C-2. TT_Index: Index Platen to Position

TT_Index positions turntable platen to a specific point within a 360° circle.

Platen position is always within one revolution of home position. For example, if current position = 0°, commanding an indexed move to 270° indexes the platen clockwise to 270°. If current position is 270°, commanding an indexed move to 10° indexes the platen counter-clockwise to 10°. The user can thus predict table direction when programming an indexed move.

Selecting TT_Index displays a prompt asking for an "Index Position." Input position with the keypad, or pass data with a register.

PASSING STRAIGHT NUMERIC DATA	PASSING DATA USING A REGISTER

PROC main()
IF reg1=0 THEN
WaitDI Index_Rdy,1;
TT_Index 90.0;
WaitDI Index_Rdy,1;
rHome Light;
rPASS_CNT;
WaitTime 2;
WaitDI loop_enable,1;
ELSE
rSafe_Zone;
ENDI
RETURN;
ENDPROC
	PROC main()
	IF reg1=0 THEN
	WaitDI Index_Rdy,1;
	reg2=90
	TT_Index reg2;
	WaitDI Index_Rdy,1;
	rHome_Light;
	rPass_Cnt;
	WaitTime 2;
	WaitDI loop_enable,1;
	ELSE
	rSafe_Zone;
	ENDI
	RETURN;
	ENDPROC

Example of TT_Index:

Program Execution

The turntable can only execute this instruction from index mode. Verify that system is in index mode by executing a TT_Rotate command with an argument of 0 RPM. When the digital input index_rdy becomes 1 (high), the system is in index mode. Valid index values range from 0.0° to 359.0°. Values outside those limits generate a programming error.

C-3. TT_Tilt: Tilt Platen to Position

TT_Tilt command tilts the turntable platen to a specific position between 0.0° (platen parallel to the floor) and 90.0° (platen perpendicular to the floor). Selecting TT_Tilt from IPL2 MC1 displays a prompt asking for a "Tilt Position". Input a number from the numeric keypad, or use a register to pass the data to the routine.

PASSING STRAIGHT NUMERIC DATA	PASSING DATA USING A REGISTER

PROC main()
IF reg1=0 THEN
WaitDI Index_Rdy,1;
TT_Tilt 45;
WaitDI Index_Rdy,1;
rHome_Light;
rPass_Cnt;
WaitTime 2;
WaitDI loop_enable,1;
ELSE
rSafe_Zone;
ENDIF
RETURN;
ENDPROC
	PROC main()
	IF reg1=0 THEN
	WaitDI Index_Rdy,1;
	TT_Index reg2;
	WaitDI Index_Rdy,1;
	rHome_Light;
	rPass_Cnt;
	WaitTime 2;
	WaitDI loop_enable,1;
	ELSE
	rSafe_Zone;
	ENDIF
	RETURN;
	ENDPROC

· **Example of TT_Tilt**

Program Execution

TT_Tilt can execute with the turntable rotating, but cannot execute if the tilt axis is busy executing another motion command. Monitoring the Tilt_rdy input as part of the program sequence ensures the tilt axis is available to accept a command.

While TT_Tilt is executing, the tilt_rdy input resets to 0 (low). After completion of the command, tilt_rdy resets to 1 (high), signaling the robot program that the tilt axis is ready for another command.

C-4. TT_Rotate: Rotate Platen at a Constant Velocity

TT_Rotate command rotates the turntable platen at a constant velocity (– 400.0 to 400.0 RPM). Selecting this command from IPL2 MC1 displays a prompt asking for "RPM". Input a number from the numeric keypad, or use a register to pass the data to the routine.

Example of TT_Rotate

PASSING STRAIGHT NUMERIC DATA	PASSING DATA USING A REGISTER

PROC main()
IF reg1=0 THEN
WaitDi tilt_rdy, 1;
TT_Tilt 45;
WaitDi tilt_rdy,1;
TT_Rotate 60.5;
WaitDI rpm_sp,1;
rHome_Light;
rPass_Cnt;
WaitDI rpm_sp,1;
ELSE
rSafe_Zone;
ENDIF
RETURN
ENDPROC
	PROC main()
	IF reg1=0 THEN
	WaitUntil rpm_sp=1 Or index_rdy-1;
	WaitDI tilt_rdy,1;
	reg3=60.5;
	TT_Rotate reg3;
	WaitDi loop_enable,1;
	rHome_Light;
	rPass_Cnt;
	WaitDI loop_enable,1;
	ELSE
	rSafe_Zone;
	ENDIF
	RETURN;
	ENDPROC

Program Execution

Execute TT_Rotate with an argument other than 0 to place turntable into rotate mode. TT_Rotate may NOT be executed with turntable in motion in index mode, OR while executing an indexing instruction (TT_Index). To ensure that the system is ready for a TT_Rotate command, the program must wait for digital input index_rdy to become 1 (high) while in index mode, OR until rpm_sp=1 while in rotate mode.

Execution of TT_Rotate resets digital input index_rdy to 0 (low) or digital input rpm_sp to 0 (low), depending on the operating mode. Once the rotate axis reaches setpoint velocity, digital input rpm_sp sets to 1 (high), signaling the program that the turntable is rotating at setpoint (+/- 0.5 rpm) and the tilt axis can execute a tilt movement.

Commanding TT_Rotate with an argument of 0 RPM ramps the turntable to a stop and then indexes it to home position. When this action is complete, the rpm_sp sets to 0 (low), and the index_rdy input sets to 1 (high), signalling to the robot controller that the rotate axis is ready for another command. Use these inputs to synchronize program execution.

The controller ignores any commands executed with the turntable in improper mode.

4.3 PROGRAMMING EXAMPLES & RECOMMENDATIONS

This section looks at the routines individually. The comments in bold are to aid user understanding and are not part of the program. The complete program is listed in the Technical Appendix section.

A. Control Routines for use with 4X00 Computerized Process Control

If using a Model 4X00 Computerized Process Control System, the robot program MUST allow process control coordination. Use the following routines for such an application.

A-1. Main Routine

Each robot program module contains a routine named "main". The main routine executes at program runtime, as the focal point of the entire robot program. The 4X00 Computerized Process Control stores the robot program on its hard disk. At process start, the 4X01 downloads the program to the robot and executes the main routine.

The main routine outlined here provides program flow and control with the 4X00 Computerized Process Control. The digital I/O allows the program to work with the process control and gives the user control of the number of passes made on the workpiece.

PROC main()	
rLight_Pos;	**Position Robot/Gun to a Gu Light Position**
rPass_Count;	**Flag 4X00 that gun is ready to light**
WaitDI loop_enable,1;	**Wait for 4X00 to enable Spray operations**
reg1:=1;	**Use REG1 as an enabling flag**
WHILE reg1=1 DO Routine1;	**Execute spray routine**
rPass_Count;	**Notify 4X00 that a pass has been completed**
WaitUntil loop_enable=1 OR loop_disable=1;	**Wait for 4X00 to command another pass or stop**
IF loop_disable=1 reg1:=0;	**Exit loop if loop_disable commanded**
ENDWHILE	
RETURN;	**Return to program beginning**
ENDPROC	

A-2. Pass Count Routine

This routine coordinates and controls passes with the 4X00 Computerized Process Control. At the beginning of the program, the routine sends a pass count to the 4X00 signaling that the gun is ready to light. A pass count sent after completion of a spray pass increments the 4X00 internal count, and the 4X00 either commands another pass or ends the program, depending on the process recipe parameters. Refer to the 4X00 Users' Manual for information on the interface with robot program.

A-3. Light Position Routine

This routine moves the robot manipulator away from the turntable and workpiece, positioning the gun to point into the dust collector. Program at least three separate moves to ensure the robot arm does not move across the part or collide with any surrounding objects. This routine may also use the Safe Zone as the position for lighting the gun.

```
PROC rLight_Pos()
  MoveJ [[100,200,300],[1,0,0,0],[1,2,-3,0],[230,-10.8862,0.34,
  -120,0,0.23]],v1000,z50,tool0
  MoveJ [[100,200,300],[1,0,0,0],[1,2,-3,0],[230,
  -10.8862,0.34,-120,0,0.23]],v1000,z50,tool0;
  MoveJ [[100,200,300],[1,0,0,0],[1,2,-3,0],[230,
  -10.8862,0.34,-120,0,0.23]],v1000,z50,tool0;
 RETURN;
ENDPROC
```

A-4. Safe Zone Routine

This routine moves robot manipulator away from the turntable and the workpiece. Program three or more separate moves to ensure the robot arm does not move across the part or collide with surrounding objects.

```
PROC rSafe_Zone()
  MoveJ [[100,200,300],[1,0,0,0],[1,2,-3,0],[230,-10.8862,0.34,
  -120,0,0.23]],v1000,z50,tool0;
  MoveJ [[100,200,300],[1,0,0,0],[1,2,-3,0],[230,-10.8862,0.34,
  -120,0,0.23]],v1000,z50,tool0;
  MoveJ [[100,200,300],[1,0,0,0],[1,2,-3,0],[230,-10.8862,0.34,
  -120,0,0.23]],v1000,z50,tool0;
 RETURN;
ENDPROC
```

A-5. Routine1 Routine

Within this template program, this routine allows the main control routine to call a procedure for executing a pass or operation. The user either inserts his own expressions into this routine, or creates a new one from scratch. Routine1 allows loading of the template module into robot memory without errors.

```
PROC routine1()
  TPErase;
  TPReadFK chk,"This is routine1","","","","","OK";
 RETURN;
ENDPROC
```

B. Turntable Control Programs

B-1. TT_Sync: Home Turntable Routine

The turntable must be synchronized to establish a HOME position (from which all Indexed movements are measured) before accepting and executing a movement command. A program error occurs if the robot program orders movement (Rotate, Index, Tilt) before system initialization.

The TT_Sync command synchronizes the turntable. The following routine moves the robot arm to a safe position and checks digital input status to verify turntable synchronization status. If turntable is synchronized, the routine stops turntable rotation (if in rotate mode), places system into INDEX mode, tilts platen to horizontal and indexes platen to home position at standard Index Mode speeds and acceleration.

PROC rHome()	**Send TT to Home pos.**
rSafe_Zone;	**Verify Robot is clear**
IF tilt_err=0 OR rot_err=0 THEN	**If TT not Sync'd, sync**
clr_int	**Disable syst. interrupts**
TT_Sync;	**Execute Sync routine**
WaitUntil tiltt_rdy=1 AND index_rdy=1;	**Wait for syst. ready flag**
Sys_init	**Enable syst. interrupts**
ELSE	**If TT Sync'd, Home**
WaitUntil index_rdy=1 OR rpm_sp=1;	**Wait for syst. ready flag**
IF rpm_sp=1 TT_Rotate 0;	**Stop Rotation. Place TT into INDEX Mode**
WaitDI index_rdy,1;	**Wait for syst. ready flag**
ELSE	
WaitDI index_rdy,1;	**Wait for syst. ready flag**
tt_index 0;	**Index Platen to 0°**
WaitDI index_rdy,1;	**Wait for syst. ready flag**
ENDIF	
Tt_tilt 0;	**Tilt Table to horiz.**
WaitDI tilt_rdy,1;	
RETURN;	**Ret. to calling routine**
ENDPROC	

B-2. Rotate Routine

This routine checks the digital I/O to verify that the system is ready to accept a command from the robot program before executing the TT_Rotate command. The routine then commands a constant turntable rotation. The variable REG2 passes the desired "RPM" parameter to the TT_Rotate system routine, and must be defined prior to calling this routine.

PROC rROT_reg2()	**Rotate Platen at constant RPM,**
WaitUntil index_rdy=1 OR rpm_sp=1;	**Wait for syst. ready flag**
TT_Rotate reg2;	**Command TT Rotation at REG2 RPM**
IF reg2=0 WaitDI index_rdy,1;	**If REG2 was 0, then wait for index mode**
IF reg2<>0 WaitDI rpm_sp,1;	**Wait for RPM to reach Setpoint if REG2 not 0**
RETURN;	
ENDPROC	

B-3. Index Routine

This routine indexes the turntable to a position from 0.0-359.0° and checks the condition of the digital I/O to verify the system is ready for a command from the robot program before executing the command. If the turntable is in rotate mode, the routine stops rotation, placing the system into index mode before executing the TT_Index routine. The variable "reg2" passes the Index Position parameter to the TT_Index system routine, and must be defined prior to calling this routine.

PROC rIndex_reg2()	**Index TT Platen to a point**
WaitUntil index_rdy=1 OR rpm_sp=1;	**Wait for syst. ready flag**
IF rpm_sp=1 TT_Rotate 0;	**Put TT in INDEX Mode**
WaitDi index_rdy,1;	**Wait for syst. ready flag**
TT_Index reg2;	**Execute Indexed mvmnt.**
WaitDI index_rdy,1;	**Wait for TT to complete movement**
RETURN;	
ENDPROC	

B-4. Tilt Routine

This routine tilts the platen to a position from 0.0°-90.0° and checks the digital input tilt_rdy to verify the turntable is ready for a TT_Tilt command from the robot program before executing the command. The variable "reg2" passes the TILT POSITION parameter to the TT_Tilt system routine, and must be defined prior to calling this routine.

PROC rTILT_reg2()	**Tilt TT Platen to a point from 0-90°**
WaitDi tilt_rdy,1;	**Wait for system ready flag**
TT_Tilt reg2;	**Execute Indexed movement**
WaitDi tilt_rdy,1;	**Wait for TT to complete its movement**
RETURN;	
ENDPROC	

4-4. MOUNTING WORKPIECE

The shape of the workpiece to be sprayed defines how it will be mounted to the turntable. The turntable platen has four equally-spaced tooling slots to receive tooling or hold-down clamps. The platen is tilted to the desired angle of horizontal or vertical plane by turning the hand wheel on the tilt gear box. An optional 6-inch, three-jaw chuck is available for installation in place of the platen and is held in position by six bolts.

Generally, cylindrical pieces are better held by the three-jaw chuck. Other shapes are sometimes better mounted directly to the turntable face.

CAUTION

Do not place an unbalanced load on turntable.

WARNING

ENTANGLEMENT HAZARD: Stay well away from rotating load on turntable.

CAUTION

If turntable is to be operated with platen off horizontal, the load's center of gravity MUST be within 10 inches (254 mm) of the platen.

SECTION 5
MAINTENANCE
& TROUBLESHOOTING

5-1. MAINTENANCE

Regular maintenance is critical to assure safe and accurate operation of the 3702 console. Praxair recommends developing a maintenance schedule to assure the correct tasks are performed at the proper times. A suggested schedule follows:

Table 5-1. Suggested Maintenance Schedule

Procedure	When Due	Performed By
Check motor case oil level	Each Start-up	Operator
Check rotate axis gearbox oil level	Each Start-up	Operator
Check tilt axis gearbox oil level	Each Start-up	Operator
Inspect cables for Cuts, Cracks or Abrasion (Replace as Required)	Weekly	Operator
Check turntable leveling	Monthly	Maintenance
Test safety circuits	Monthly	Electrical Technician
First rotate axi gearbox oil change	After 500 operating hours	Maintenance
Regular rotate axi gearbox oil changes	Every 2000 operating hours or annually	Maintenance
Tilt axis gearbox oil change	Semi-annual or every 2500 operating hours	Maintenance
Check bearing housing for adequate grease	Semi-Annually	Maintenance
Inspect tilt gear sector for adequate grease, alignment and wear	Semi-Annually	Maintenance
Wipe Off Excessive Dirt/Dust	As Needed	Operator/ Maintenance

WARNING

ELECTRIC SHOCK HAZARD: Do not touch live electrical parts. Before inspecting, maintaining, or servicing, shut down the control unit and disconnect input power employing lockout/tagging procedures (padlocking line disconnect switch in open position, removing fuses from fuse box, or other disconnecting device).

MOVING PARTS HAZARD: Before starting inspection, service or maintenance, verify that all parts have stopped motion. Keep away from any moving parts until completely stopped.

BURN HAZARD: Turntable platen can become hot from thermal spray operations and motors can generate heat during extended operation. Allow cooling period before servicing.

IMPORTANT

Troubleshooting to be performed by qualified persons only.

Use the information and schematics in this section while performing troubleshooting procedures. If the problem is not corrected after performing these procedures, contact a Praxair Surface Technologies Service Representative. In case of equipment malfunction, the manufacturer's recommendations must be strictly followed.

A. Rotate Axis Gearbox Maintenance and Lubrication

The rotate axis gearbox's safety, accuracy and longevity depend largely on proper lubrication. Gearbox oil provides lubrication AND cooling of the assembly. In high-speed or high-temperature applications, monitor gearbox temperature to ensure it remains within the acceptable range of 176°F to 212°F (89°C to 100°C). If the gearbox regularly exceeds these temperatures, additional cooling is required. Contact your Praxair Surface Technologies Service Representative for additional information.

Always check the oil level with the oil sight on the front of the gearbox before operating the turntable. Gearbox oil capacity is 2.4 quarts (2.25 liters). For proper operation and performance, frequently check and maintain the oil level. Low oil levels provide insufficient cooling. Overfilled oil can result in thermal breakdown and viscosity breakdown of the oil.

Change the rotate axis gearbox oil after the first 500 hours of operation. Perform subsequent oil changes every 2000 hours of NORMAL operation. If the unit consistently operates at high speeds or with heavy loads, shorten the interval between oil changes.

C. Tilt Axis Pillow Block Bearing Housings

Two bell-shaped bearing housings are separated reservoirs of Mobilplex 44 or equivalent liquid grease. The housings must be removed to access the bearings for repacking if the grease needs to be replaced. Check the oil level once every 2,000 to 3,000 hours for oil breakdown or grease leakage. If there is grease in the oil reservoir, the grease should not need replacing.

5-2. TROUBLE-SHOOTING

A. Types of Error Messages

The robot system generates one of two types of error messages in response to a turntable error:

Programming error	Error in program caused by incorrect data, or improper sequence of operations.
System error	Error Generated by the 7354, generally hardware related

B. Error Message Syntax

Header	Type of error message, Program/System
Reason Code	Numerical Code identifying the exact error
Description	Textual description of error
Correct Data Range	Correct Range of data for instruction if applicable

EXAMPLE: Program Error, 7354-001 Rotate Data Out of Range, TT_Rot -400 - +400

The manufacturer fills the gearbox with *Degol BG46* oil, ISO Viscosity class *BG46*, per European standard DIN 51519. Other approved suppliers and their products include:

Producer	Oil
Aral	Degol BG 46
BP	GR-XP 46)ISO)
Castrol	HYSPIN AWS 46
ESSO	Nutoh 46
Kluber	Lamora 46
Mobil	D.T.E. 25
Shell	Tellus Oil 46
Texaco	Rando Oil HD B-46

CAUTION

Do not use heavy weight gear oil, as this will cause excessive heat and gear wear. Only use the products recommended above or their equivalents.

B. Tilt Axis Gearbox Maintenance and Lubrication

The tilt axis gearbox oil level is indicated by an oil plug on the side of the gearbox. Fill gearbox oil to the bottom edge of the oil level plug.

IMPORTANT

Overfilling the gearbox could cause failure and possible equipment damage or personal injury.

Change the tilt axis gearbox oil every 6 months or 2500 operating hours. Using the unit in dusty or humid environments requires more frequent changes. Frequently check the oil level and add lubrication through filler plug as needed. Recommended Lubricants:

Manufacturer	Ambient Temperature	
	15°- 60° F (-10°- 16° C)	50°- 125° F (10°- 52° C)
Amoco Oil Co.	Worm Gear Oil	Cylinder Oil #680
Chevron USA	Cylinder Oil #460X	Cylinder Oil #680X
Exxon Co. USA	Cylestic TK-460	Cylestic TK-680
Gulf Oil Co	Senate 46	Senate 680D
Mobil Oil Corp	600W Super	Extra Hecla Super
Shell Oil Co.	Valvata Oil J460	Valvata Oil J680
Sun Oil Co.	Gear Oil 7C	Gear Oil 8C
Texaco	Honor Cylinder Oil	650T Cylinder Oil
Union Oil Co.	Steaval A	Worm Gear Lube 140

C. Program Error List

Program errors may be corrected by making the appropriate modifications to the robot program.

PROGRAM ERROR MSG.	EXPLANATION/CORRECTION
7354-001 Rotate Data Out of Range	The RPM parameter passed to the System routine TT_ROTATE is outside the allowable range. Allowable RPM for the turntable is −400 to +400 RPM.
7354-002 Index Data Out of Range	The INDEX POSITION paramete passed to the system routine TT_INDEX is outside the allowable range. Allowable indexing range for the turntable platen is from 0-359°.
7354-003 Tilt Data Out of Range	The TILT POSITION parameter passed to the system routine TT_TILT is outside the allowable range. Allowable tilt range for the turntable platen is from 0-90°.
7354-004 Turntable Not Synchronize	The robot program has attempted to execute a turntable movement before the turntable has been synchronized after power up, o reset after a system error.
7453-005 Program Time Ou	The execution of a turntable command has taken longer than expected. Check for system errors.

D. System Errors

System errors result from an error within the turntable itself, and can be cleared only by resetting the turntable controller:

1. Verify that turntable movement has ceased.
2. Disconnect power to the control cabinet.
3. After ten seconds, reconnect power.
4. Re-synchronize turntable.

SYSTEM ERROR MSG.	EXPLANATION/CORRECTION
7354-100: 7354 Internal Error	RPM_SP = 0, INDEX_RDY = 0, TT_RDY = 0: Internal software error caused Turntable to cease internal software operations.
7354-101: 7354 Servo Following Error	RPM_SP = 1, INDEX_RDY = 0, TT_RDY = 0: The difference between Turntable's actual and expected position exceeds allowable limits. Ma be caused by a collision or system failure. Check that turntable or workpiece is not jammed against th robot arm, dust collector, etc.
7354-102: Tilt Axis Outside Working Area	RPM_SP = 1, INDEX_RDY = 0, TT_RDY = 0: Tilt axis is outside proper working area (0-90°) and has been stopped by the hardware limit switches. Loss of synchronization data is common cause. Reset and re-synchronize the system.
7354-003: Servo Amplifier Alarm Latch	RPM_SP = 1, INDEX_RDY = 0, TT_RDY = 0: A servo amplifier triggers alarm. Improper motor tuning, or over-temperature motor or amplifier heat sinks can be the cause. Disconnect power and cool system, then restart system.

Figure 5-4.
7354 Controller
Electrical Schematic

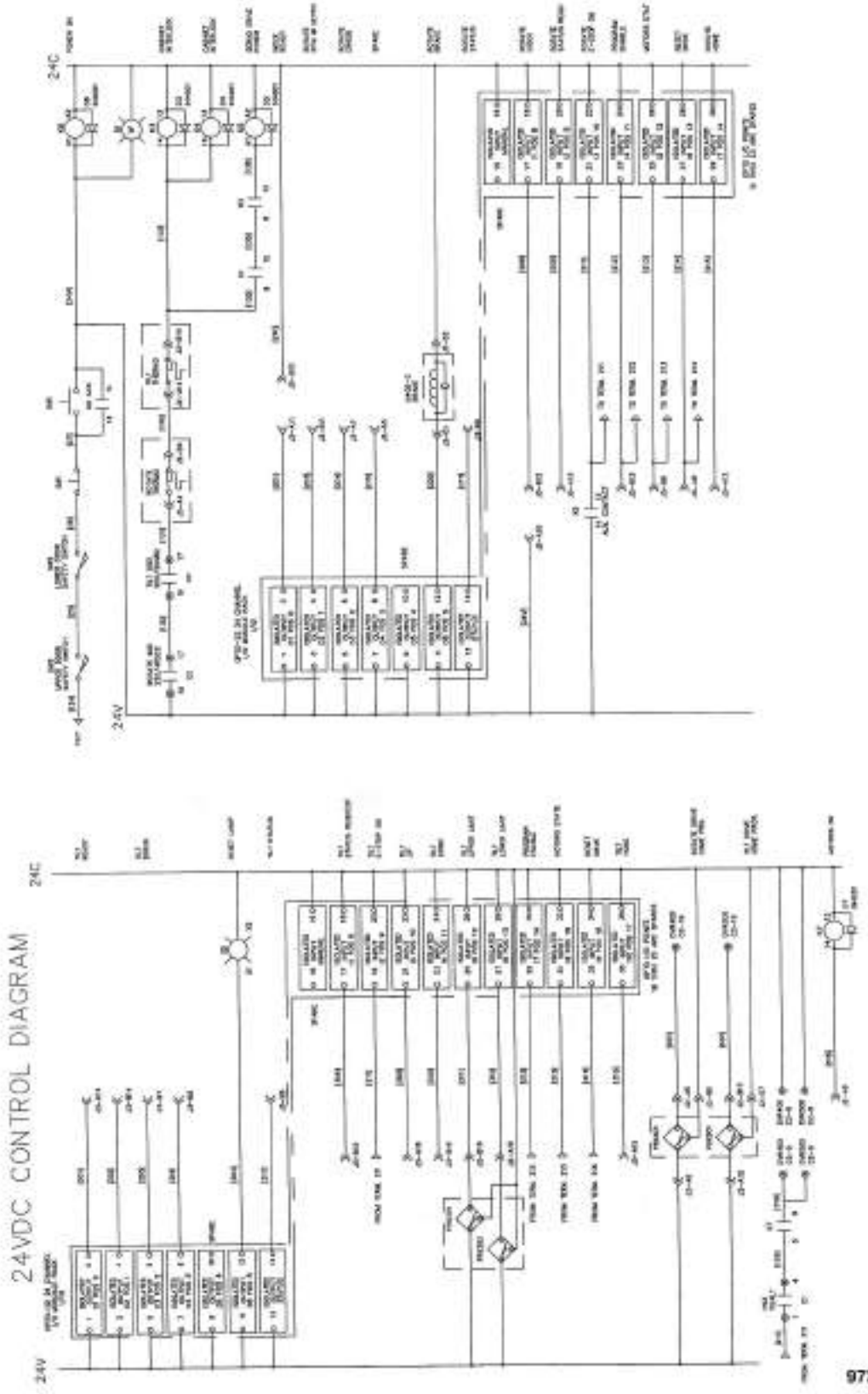


Figure 5-5.
7354 Schematic, Motors, Junction Box and Cabling

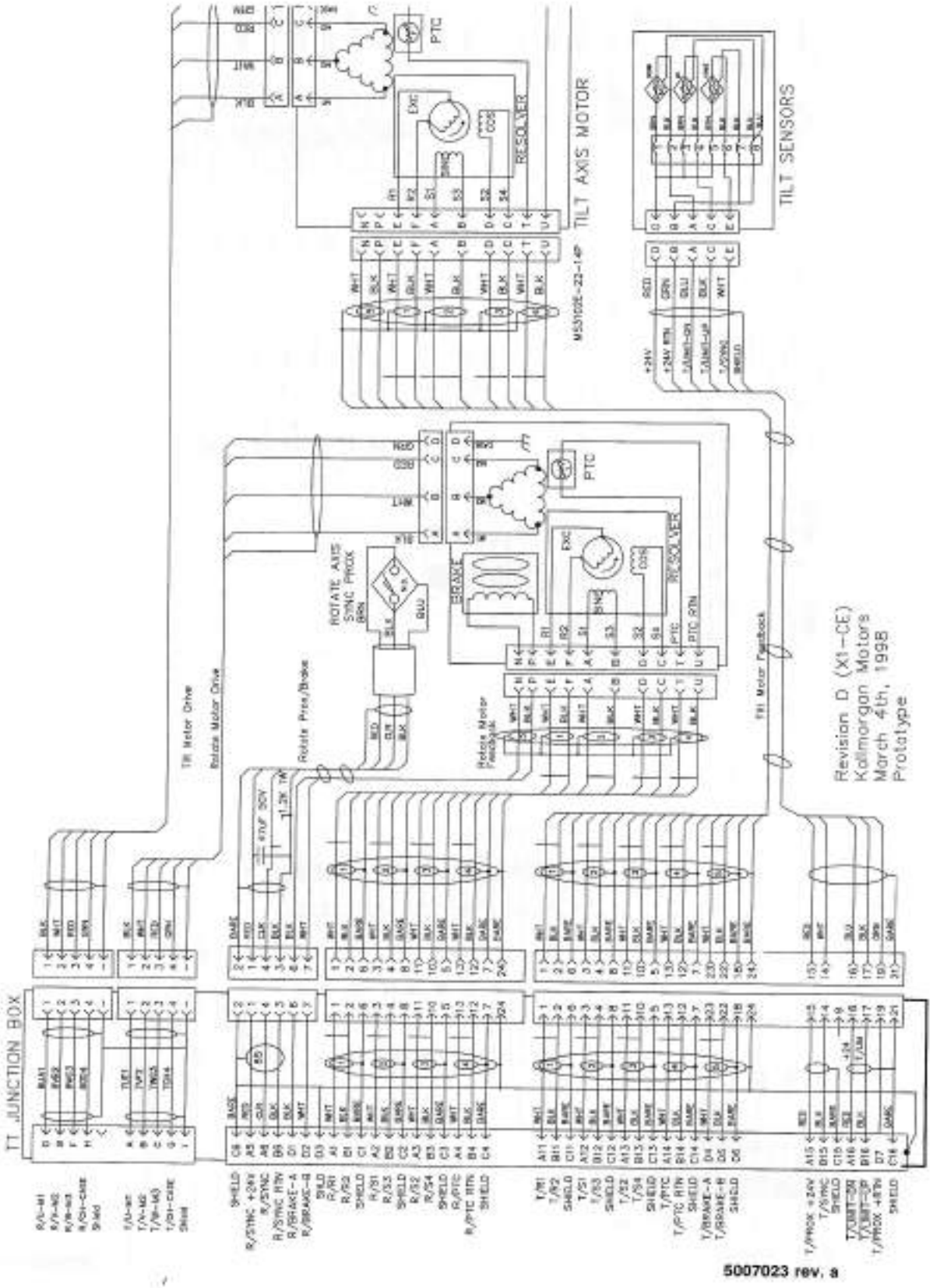


Figure 5-6.
7354 Schematic, Main Power and Servo Amplifiers

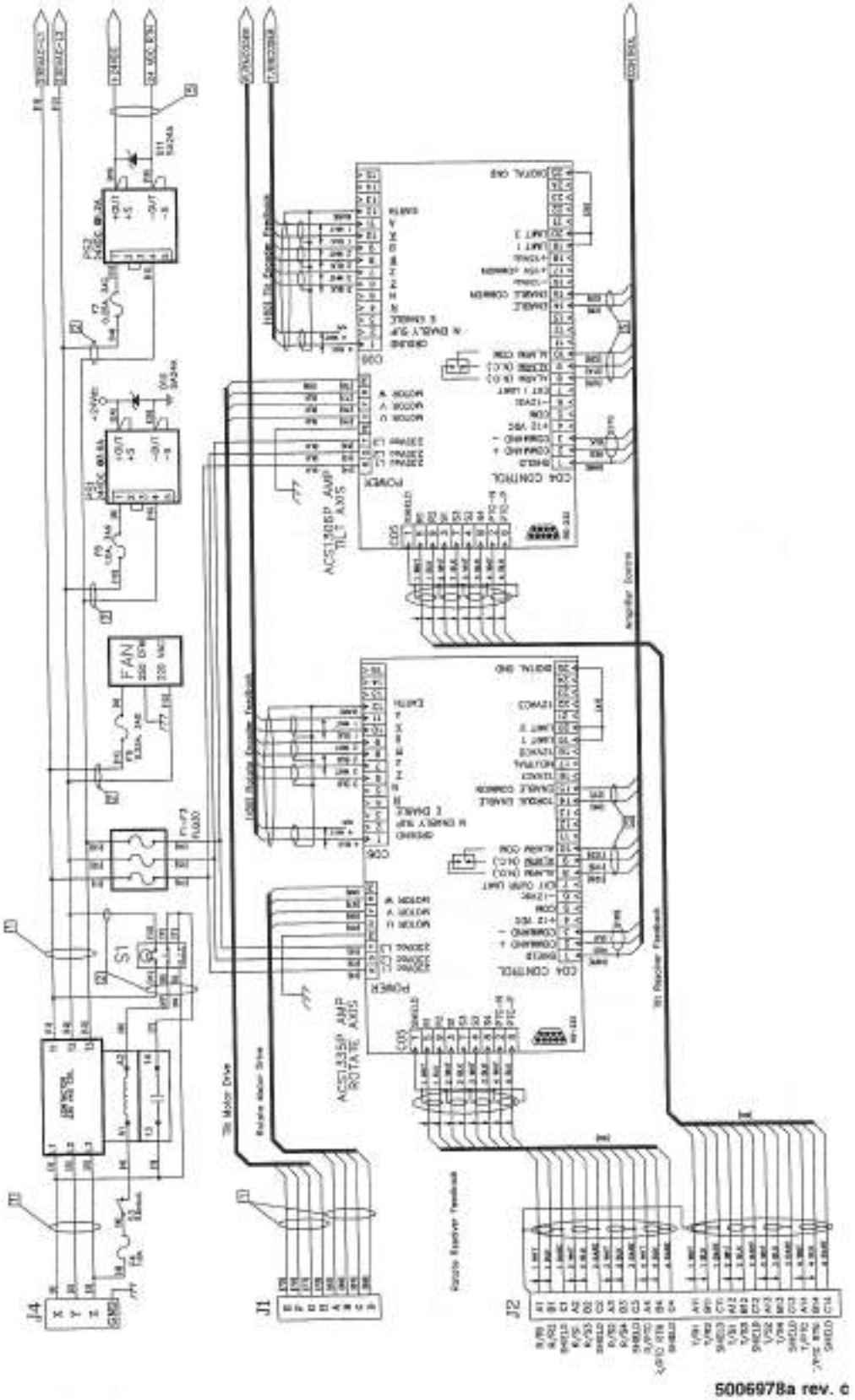
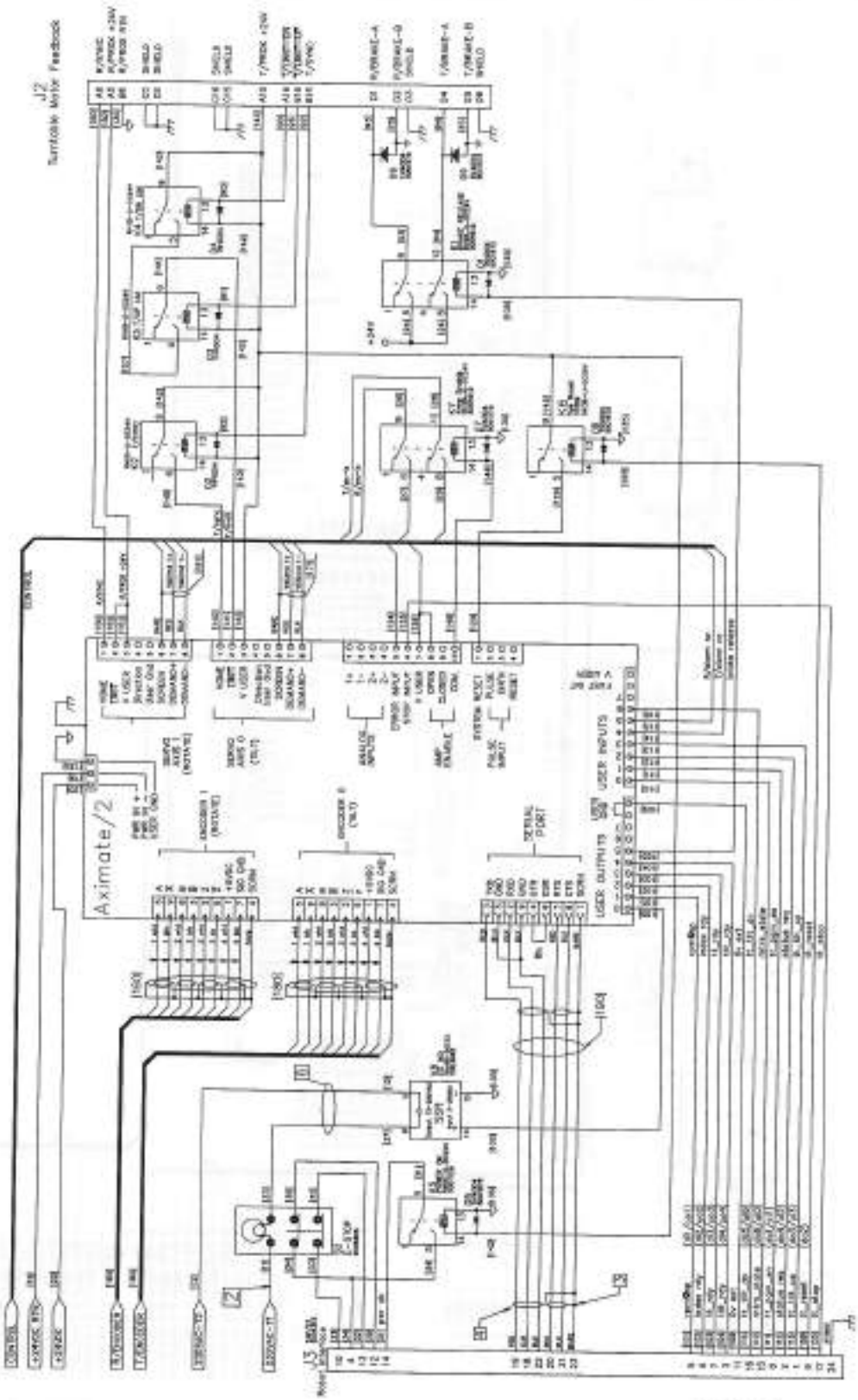
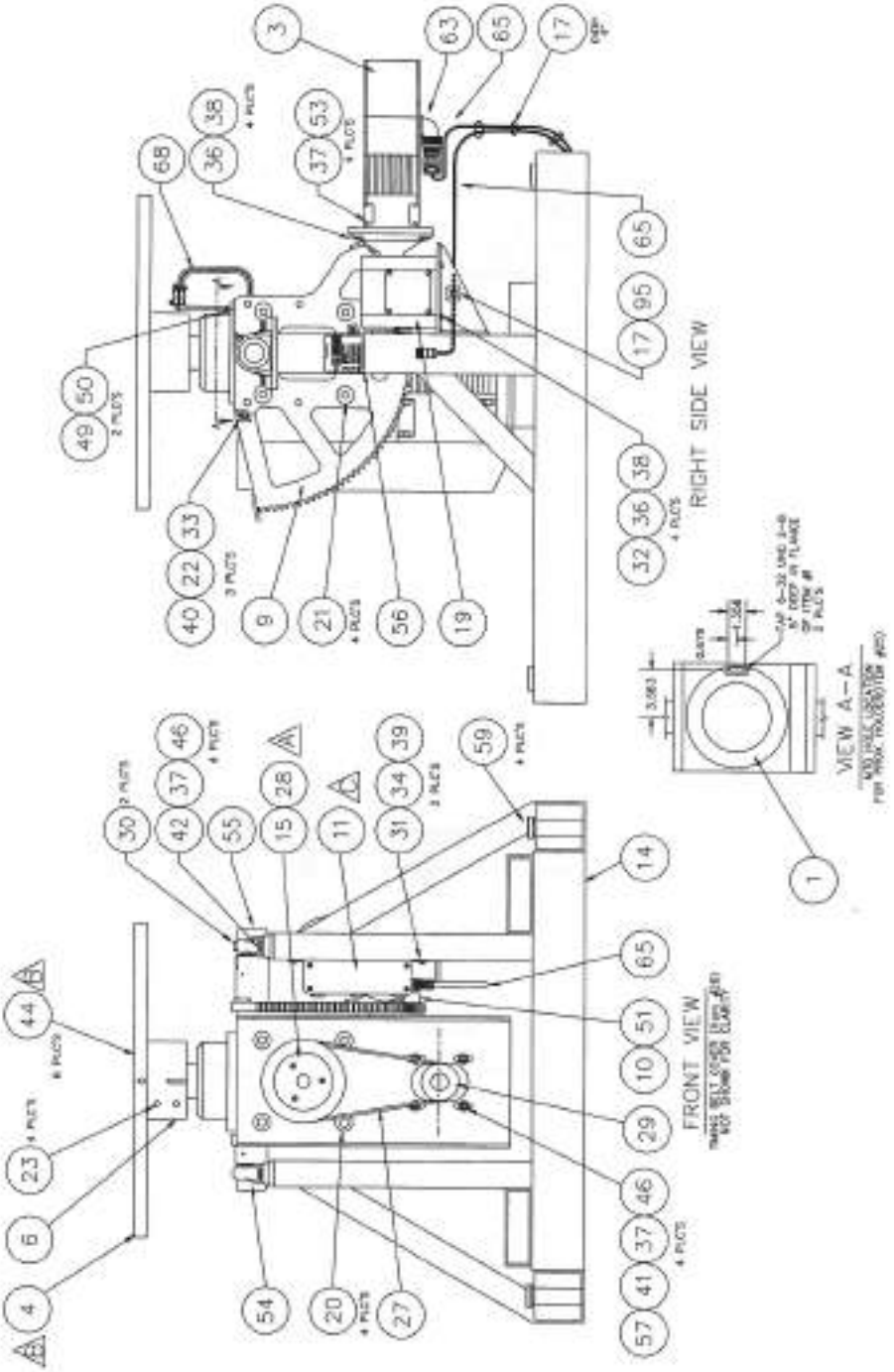


Figure 5-7.
7354 Schematic, Servo Controller & Robot Interface



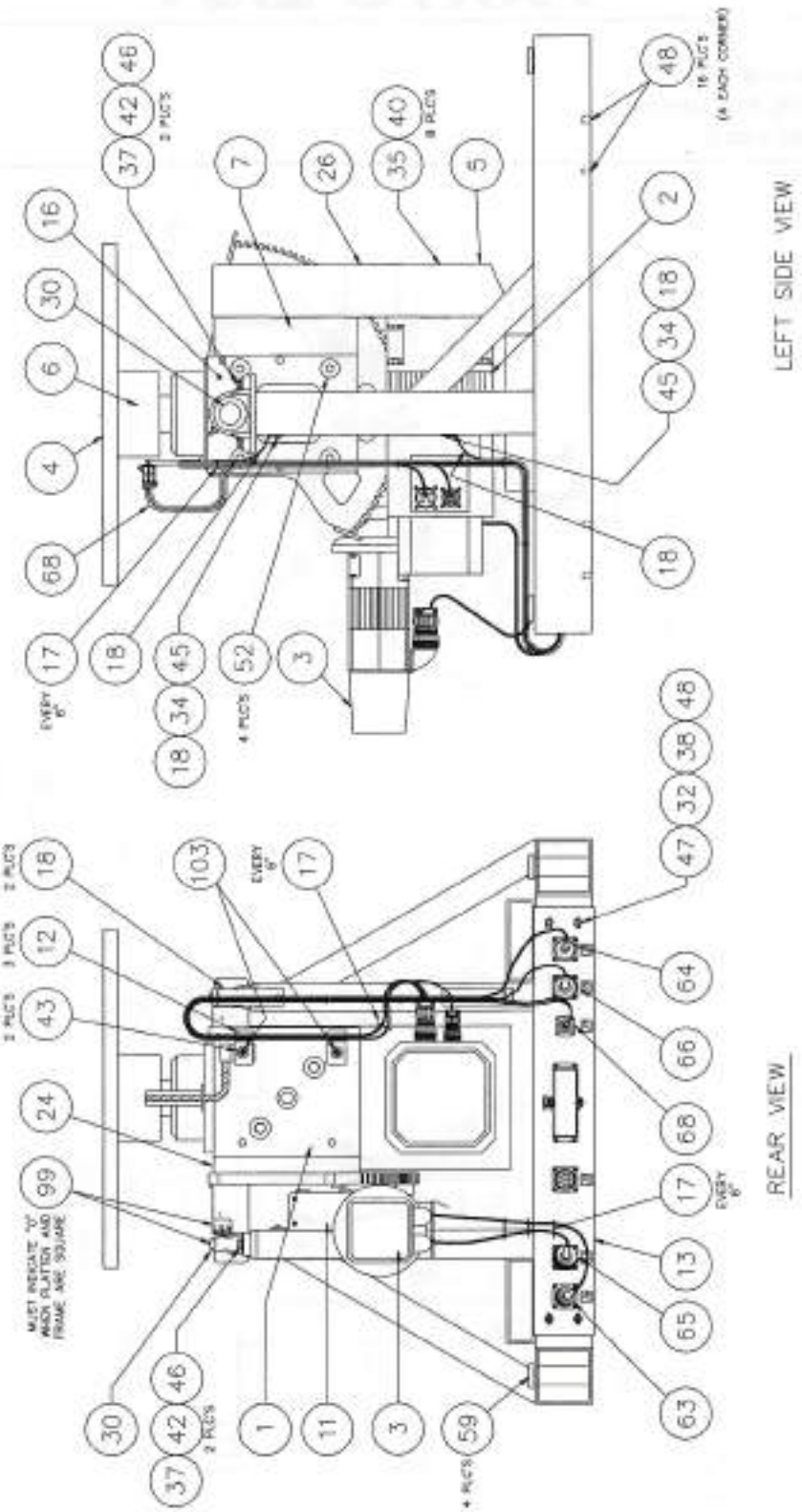
SECTION 6
PARTS LIST

**Figure 6-1.
7354 Assembly Key Drawing,
Sheet 2 of 5**



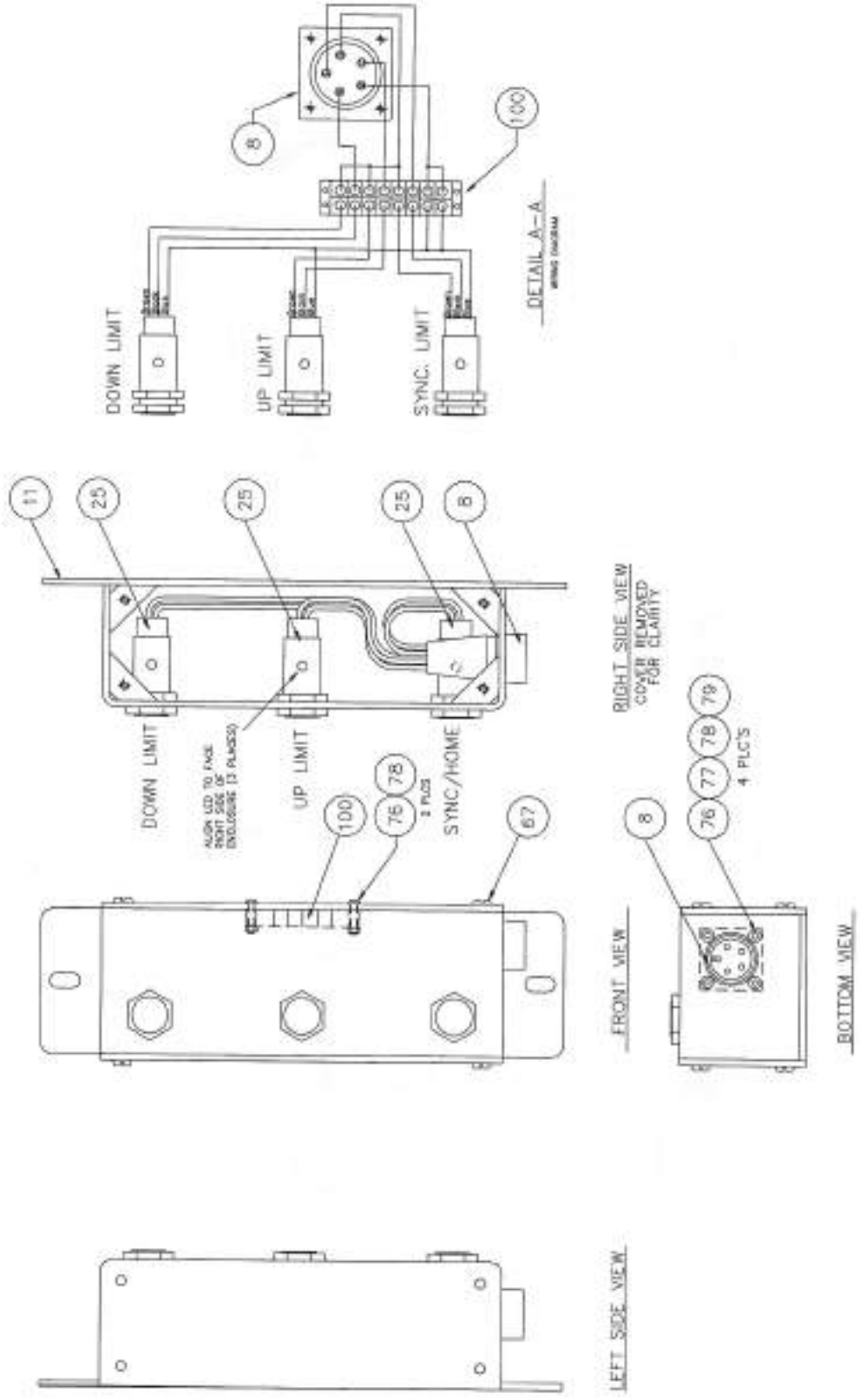
97354m0b rev. *

Figure 6-2.
7354 Assembly Key Drawing,
Sheet 3 of 5



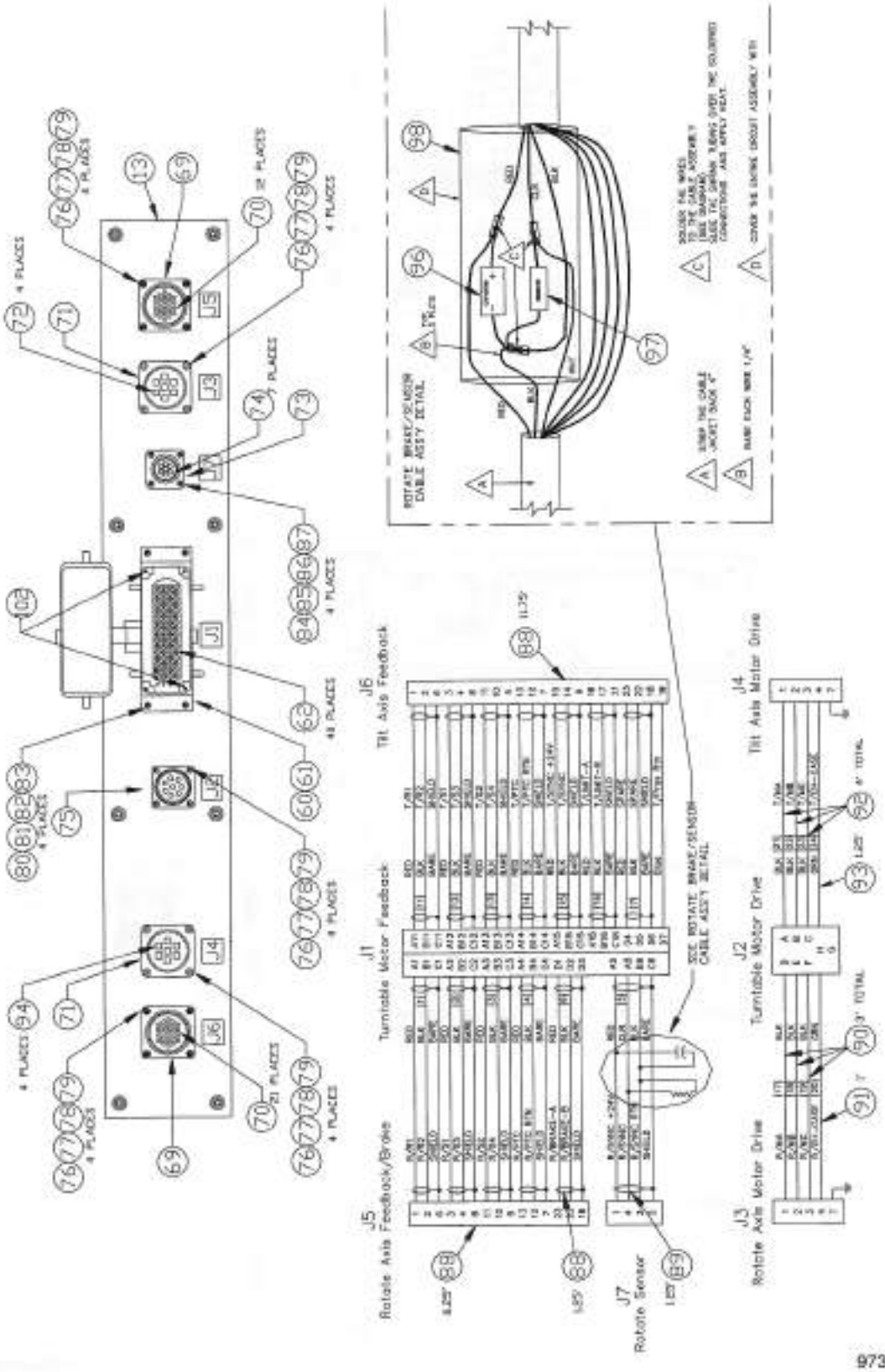
97354m0c rev. *

Figure 6-3.
7354 Assembly Key Drawing,
Sheet 4 of 5



97354m0d rev. *

Figure 6-4.
7354 Assembly Key Drawing,
Sheet 5 of 5



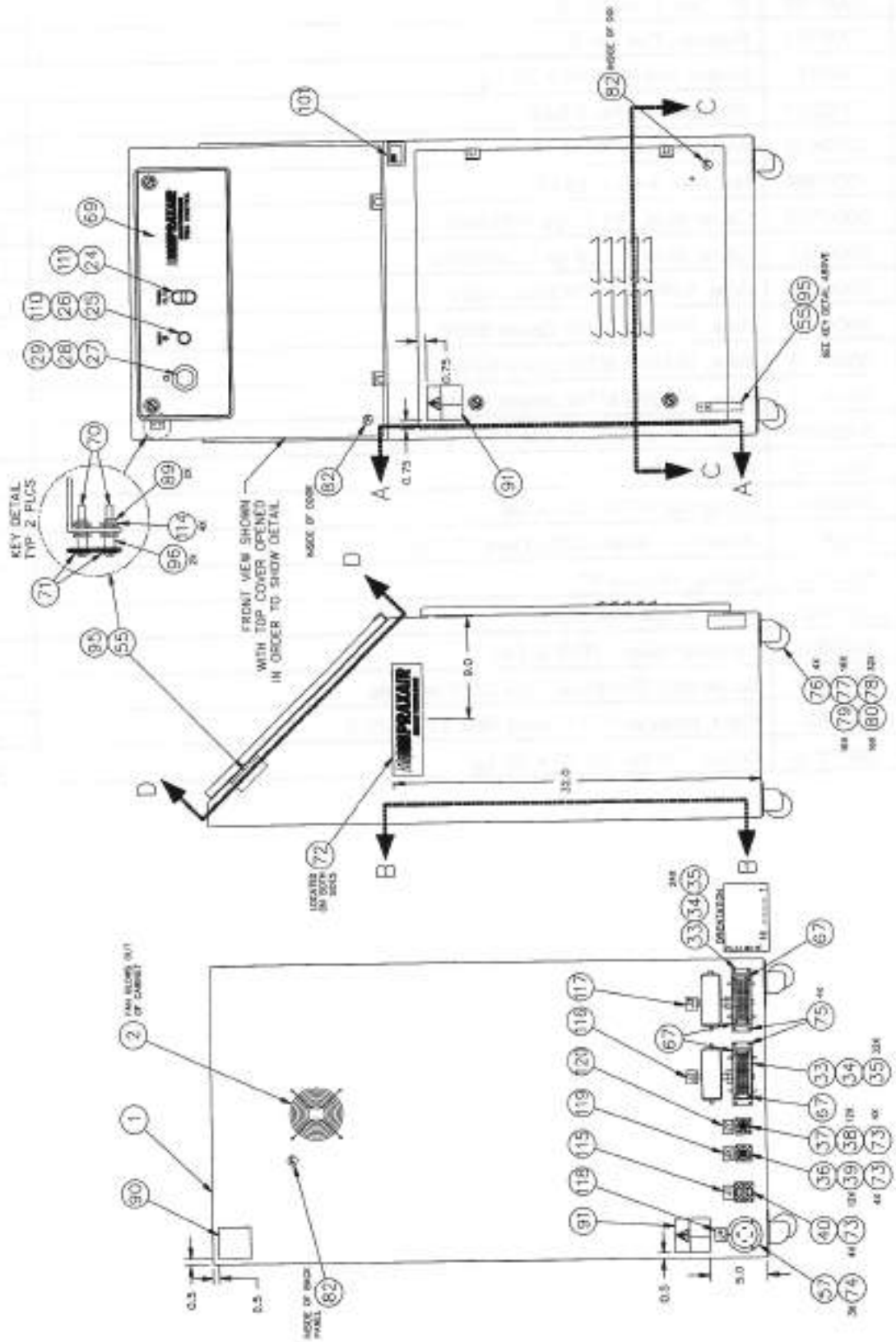
97354m0e rev. *

ITEM	PART #	DESCRIPTION	QTY
1	5001183	Gear Box, Tandler 5:1 Spiral Bevel	1
2	5007816	Motor, Brushless Servo 7.3 hp #405	1
3	5007815	Motor, Brushless Servo 2.1 hp #204	1
4	6421-021	Platen, 24" Dia. 4 Slot Alum Anodized	1
5	5007949	Channel, 73xx Rotate Motor Mount	1
6	5002337	Collar, 73xx Turntable Platen Mounting	1
7	5002336	Block, 73xx Rotate Motor/Gearbox Alignment	1
8	5002348	Amphenol, Recep Box 5 pin	1
9	5002550	Gear, 90 Degree Sector	1
10	5002343	Gear, 12 Tooth Pinion	1
11	5002346	Enclosure, 7354-001 Tilt Prox. Assy	1
12	5002604	Clamp, 0.625 Conduit	3
13	5006849	Enclosure, 7354 TT Junction Box	1
14	5006794	Frame, Turntable	1
15	5002625	Bushing	1
16	5002549	Pivot Ass'y, 73xx Turntable Right Side	1
17	5001974	Cable Tie, 14" Nylon	A/R
18	5006864	Clamp, 2.5" Unistrut	1
19	16837	Gearbox, Grove gear 30:1 Tilt	1
20	7000532	Screw, Flat Head, Sock. Drive, M16 x 90	4
21	7000529	Screw, Flat Head, Sock. Drive, M16 x 70	4
22	7000533	Screw, Sock. Hd Cap, 10-32 x .375" lg	3
23	7000531	Screw, Set, Sock. Drive, 1/2 - 20 x 1"lg	4
24	5002334	Spacer, Gear	1
25	5002350	Sensor, N.C. Proximity	3
26	5002341	Cover, Drive Belt	1
27	5002338	Belt, 8M9621 21mm Timing	1
28	5002339	Pully, 8mm 60 groove, 21mm belt	1
29	5007948	Pulley, 8M-30S-21-24mm Bore Drive Motor	1
30	5002333	Bearing, Pivot	2
31	7000019	Washer, 1/4" Lock	2
32	5000636	Washer, 5/16"	10
33	5002345	Trigger, Prox.	3
34	5002584	Insert, 1/4-20	4
35	7000384	Screw, Button Hd. Sock. Drive, 10-32 x .25"	8
36	7000468	Screw, Sock. Hd Cap, 5/16 - 18 x .75" lg	8
37	7000203	Washer, 3/8" Lock	12
38	7000202	Washer, 5/16" Lock	14
39	7000431	Screw, Butt. Hd Sock Drive, 1/4-20 x .75" lg	2
40	7000200	Washer, #10 Lock	11

ITEM	PART #	DESCRIPTION	QTY
41	7000423	Screw, Socket Hd. Cap, 3/8-16 x 1.5" lg	4
42	7000122	Bolt, Hex Hd, 3/8-16 x 1.25" lg	4
43	5003724	Screw, Hex Hd., 16mm x 12	2
44	7000519	Screw, Flat Hd. Sock. Drive, 3/8-16 x 1.5" Lg	6
45	7000466	Screw, Skt Hd Cap 1/4-20 x .75 Lg	1
46	7000429	Washer, 3/8" Flat	8
47	7000111	Screw, Hex Hd Cap 5/16-18 x .75" Lg	6
48	5002330	Insert, 5/16" Steel Nutsert	22
49	7000379	Screw, Sck Hd Cap, 6-32 x 1/2	2
50	7000209	Washer, #6 Star	2
51	7000326	Screw, Set, 1/4-20 x .187 Lg	1
52	7000530	Screw, Flat Hd, Sock Drive, M16 x 40	4
53	7000121	Screw, Hex Hd Cap 3/8-16 x 1.0	4
54	5002567	Shaft, 4' x 1" Dia 73xx Turntable Tilt Pivot	1
55	5002622	Shaft, 6" x 1" Dia 73xx Turntable Tilt Pivot	1
56	1007-52	Nameplate	1
57	7000014	Nut, Hex 3/6-16	4
58	7000464	Screw, Skt Hd Cap #4-40 x .500 Lg	2
59	5006833	Bushing, 4" Tubular Frame Mounting	4
60	5002951	Phnx, Heavycon-D Insert Male	1
61	5002590	Phnx, Heavycon-D Base Panel Mount	1
62	5002867	Phnx, Heavycon-D Crimp Pin 20-22 ga	40
63	5007841	Cable Assy, Tilt Axis Motor Drive	1
64	5007837	Cable Assy. Rotate Axis Motor Drive	1
65	5007840	Cable Assy, Tilt Axis Motor Feedback	1
66	5007839	Cable Assy, Rotate Axis Motor Feedback	1
67	7000399	Screw, 10-32 x 3/8 Pan Head	8
68	5007838	Cable Assy, Rotate Axis Sensor	1
69	5004315	Amp, Recep CPC-1 24 pin #23 Shell	2
70	5003862	Amp, Crimp Pin CPC-1 24-20 ga.	33
71	5006133	Amp, Recep, CPC-3, 7 Soc #23 Shell	2
72	5004721	Amp, Crimp CPC-3 Socket 10-08 ga.	4
73	5004404	Amp, Recep CPC-1 VDE Rev Sex 7 Soc 13 Shell	1
74	5003863	Amp, Crimp CPC-1 Soc 24-20 ga	7
75	5002594	Amphenol, Recep Box 8 Pin	1
76	7000544	Screw, Btn Hd 6-32 x 5/8 Lg	24
77	7000440	Washer, Flat No. 6	24
78	7000060	Nut, Hex 6-32	24
79	7000545	Washer, Lock No. 6 Spring Steel	24
80	7000397	Screw, Mach Pan Hd 8-32 x 5/8 Lg	4

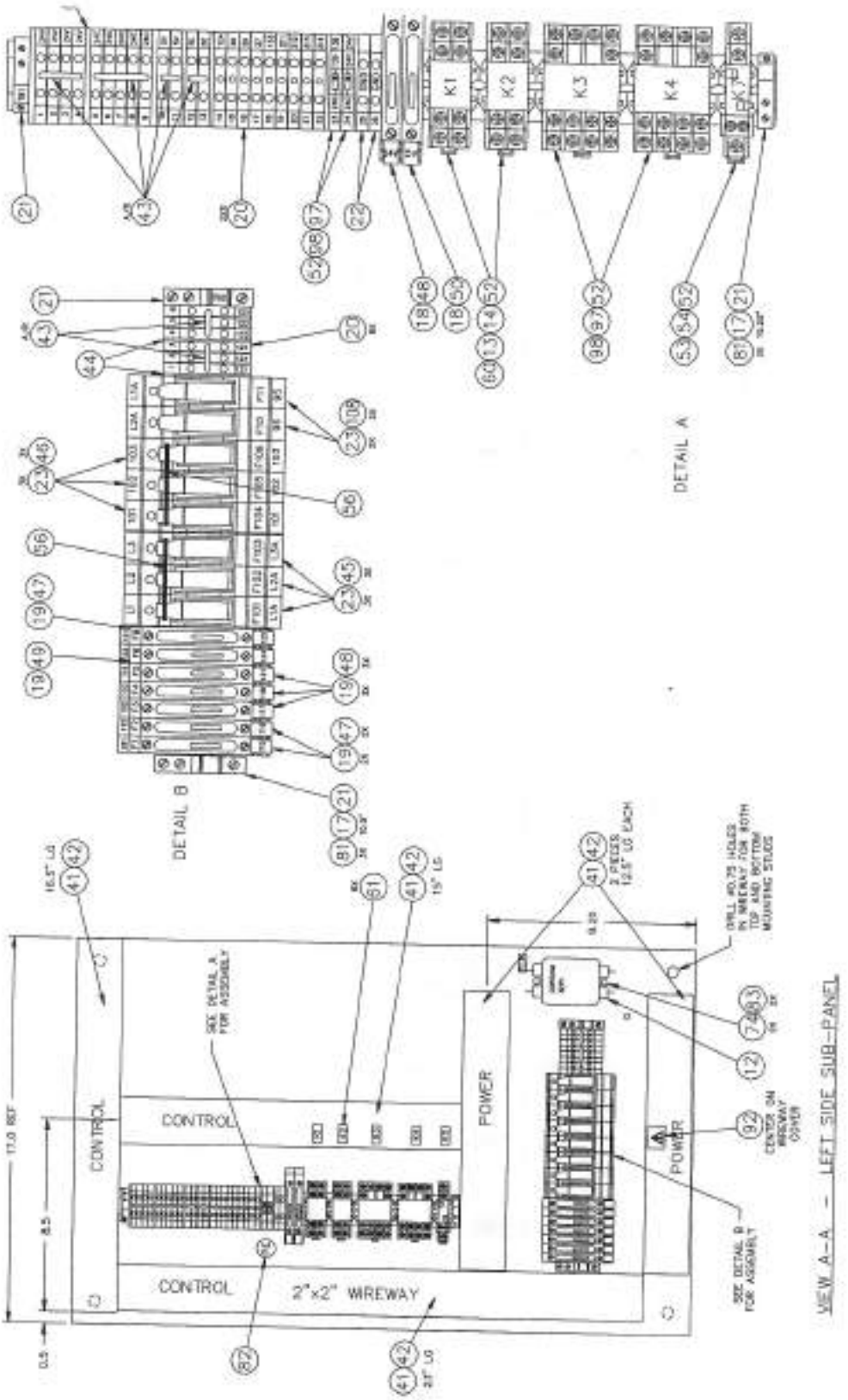
ITEM	PART #	DESCRIPTION	QTY
81	7000061	Nut, Hex 8-32	4
82	7000199	Washer, Lock No. 8	4
83	7000181	Washer, Flat No. 8	4
84	7000517	Screw, Btn Hd 4-40 x 3/8 Lg	4
85	7000541	Washer, Flat No 4 SAE	4
86	7000409	Washer, Lock No. 4	4
87	7000364	Nut, Hex 4-40 x .25 OD	4
88	5002503	Cable, Bulk TW 20 ga 1PR/Shld	19.3'
89	5000601	Cable, Bulk, Ctl 22 ga 3 Con/Shld	1.25'
90	5004369	Wire, 10AWG MTW Black 600V	3'
91	5004370	Wire, 10AWG MTW Green 600V	1'
92	5004278	Wire, 14AWG MTW Black 600V	4'
93	5004279	Wire, 14AWG MTW Green 600V	1.25'
94	5005268	Amp, Crimp, CPC-3, Skt 14-12 ga Type XII	4
95	5000172	Anchor, Wire Tie	1
96	5002642	Capacitor, 47UF 50V Axial	1
97	5002614	Resistor, 1 Watt 12000 Ohm 5% Tol	1
98	5000113	Tubing, Ht Shrk 1"	1
99	5006983	Label, Angle Indicator	1
100	5000312	Terminal Block, TRW 6-140	1
101	5007958	Schematic, Electrical 7354 CE Turntable	Ref
102	5007832	Phnx, Heavycon-D Keying Pins 17-72-72-2	2
103	5007556	Screw, Btn Hd 1/4-20 x .50 Lg	2

Figure 6-5.
7354 Control Box, Sheet 2 of 4



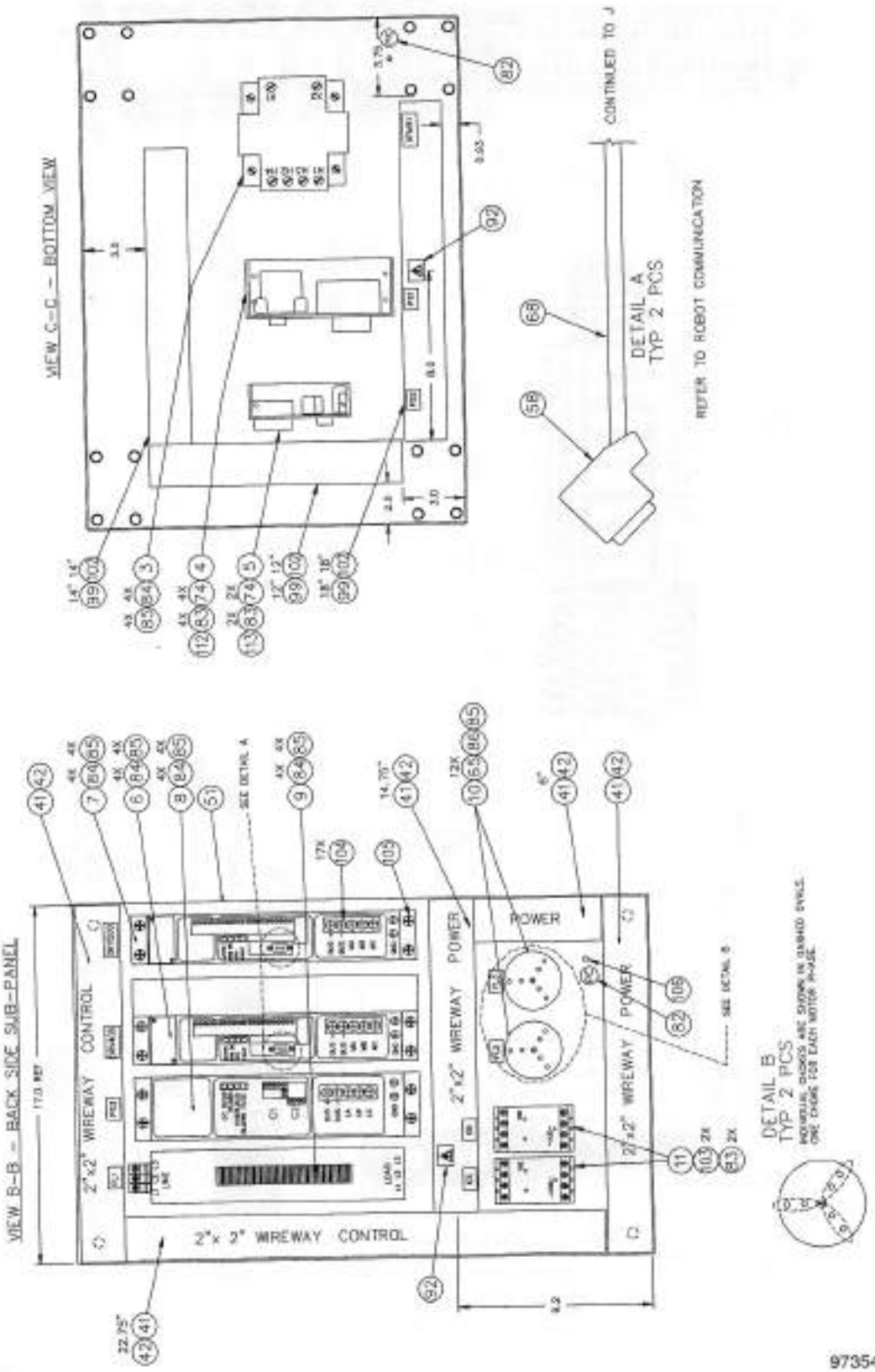
97354c0b rev. a

Figure 6-6.
7354 Control Box, Sheet 3 of 4



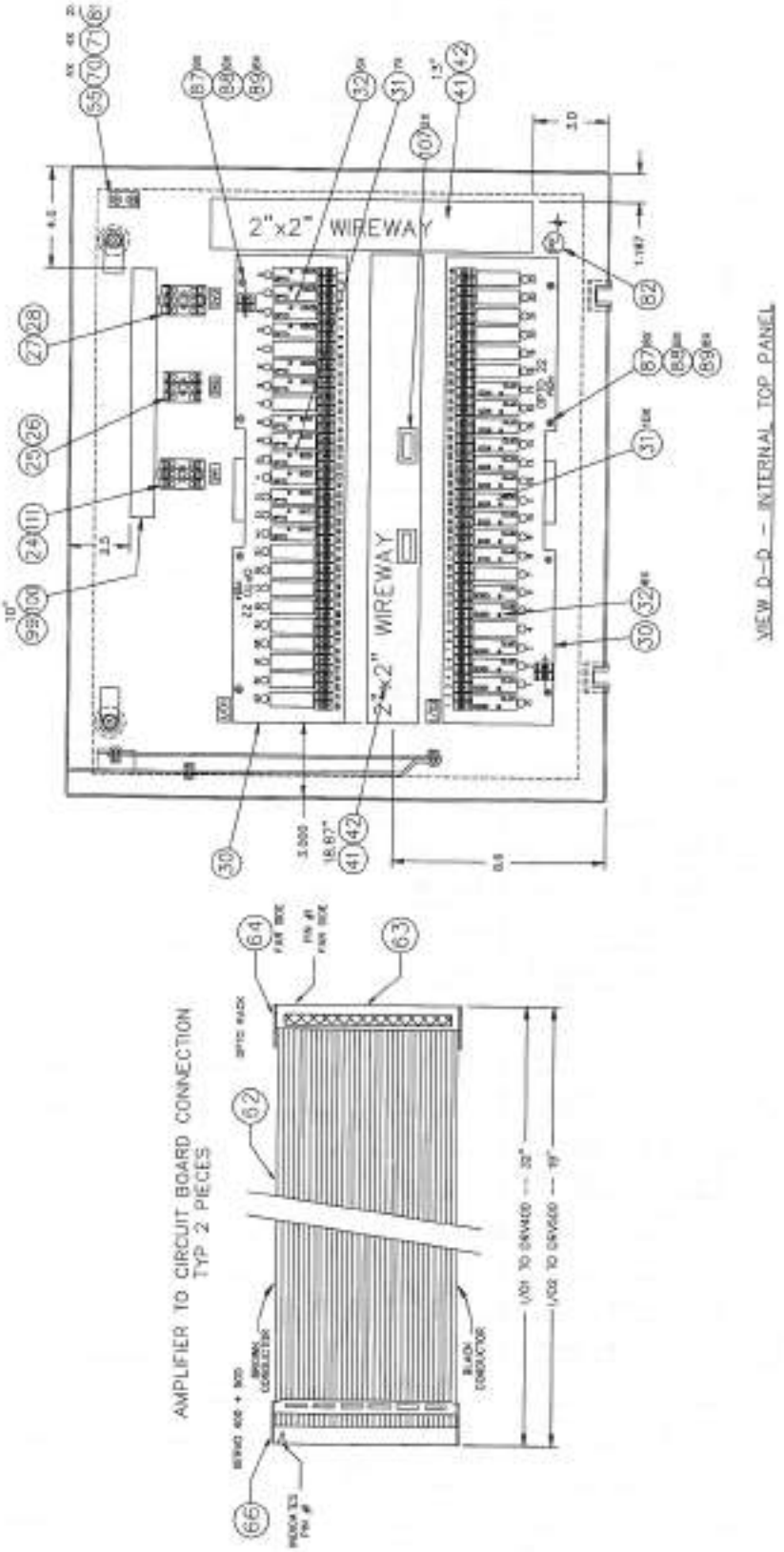
97354c0c rev. a

Figure 6-7.
7354 Control Box, Sheet 4 of 4



97354c0d rev. a

Figure 6-8.
7354 Control Box, Sheet 5 of



97354c0e rev. a

ITEM	PART #	DESCRIPTION	QTY
1	5007814	Box, 7354 Control	1
2	16828	Fan, Enclosure a-4AXFN	1
3	5007799	Transformer, 240,480/120VAC E380	1
4	5002611	Power Supply, 24VDC @ 3.6A HN24-3.6-A	1
5	5007798	Power Supply, 5VDC @ 1.5A HA5-1.5/OVP-A	1
6	5007796	Amplifier, AC Brushless Servo 220/405c	1
7	5007797	Amplifier, AC Brushless Servo 206/204B2	1
8	5007795	Power Supply, Amplifier Kollmorgan	1
9	5007794	Filter, Electrical, 240VAC @ 30A	1
10	5007793	Filter, Electrical, Choke	2
11	5007792	Contactor, 3 Pole 30A 24VDC Coil	2
12	5006749	Filter, Electrical 120/420VAC, 3A @ 120VAC	1
13	504612	Relay, 2PDT 24VDC	2
14	5002982	Socket, Relay 2PDT	2
15	5007217	Relay, 4PDT 24VDC	2
16	5002985	Socket, Reyay 4PDT	2
17	500479	DIN Rail, Typr NS 35/7.5 2M	A/R
18	5003782	Phnx, Term Block, Fuse UK6.3 Lit 15-30V	2
19	5002744	Phnx, Term Block, Fuse UK6.3 LIT 110-250V	7
20	5001053	Phnx, Term Block, UK5 34A 750V 10AWG	28
21	5001057	Phnx, Term Block, End Clamp	4
22	5001054	Phnx, Term Block, GND USLKG4 12 AWG 34A	2
23	5002743	Phnx, Term Block, Fuse UK 10.3 HESI	8
24	5007598	Switch, Operator, 2 Function 2 Pushbutton	1
25	5007128	Button, Green Lighted	1
26	5007129	Contact Assy., For Green Button	1
27	5007130	Button, Red Mushroom E-Stop	1
28	5007131	Contact Asst., For Red E-Stop	1
29	5007132	Legend, Blank Yellow	1
30	5007800	Circuit Board, Opto22, 24Pos	2
31	5003796	Module, Opto22, IDC5 Input 12-32VDC	17
32	5003799	Module, Opto22, OCD5 Output 5-60VDC	12
33	5002590	Phnx, Heavycon-D, Base Panel Mount	2
34	5002838	Phnx, Heavycon-D, Insert Female	2
35	5002837	Phnx Heavycon-D, Crimp Socket	56
36	5004703	Amp, Recp, CPC-1 14 Skt #17	1
37	5004339	Amp, Recp. CPC-1 16 Pin #17	1
38	5004274	Amp, Crimp, CPC-1 Pin 18-16AWG	12
39	5004275	Amp, Crimp, CPC-1 Skt 18-16AWG	12
40	5002635	Amphenol, Recp. 8 Soc MS-3102A-24-6S	1

ITEM	PART #	DESCRIPTION	QTY
41	5001679	Wireway, Cover, White 2"	A/R
42	5003609	Wireway Duct, White 2" x 2"	A/R
43	5001055	Phnx, Term Block, Bridge FB10-6	A/R
44	5001056	Phnx, Term Block, End Cover D-UK 4/10	9
45	5007808	Fuse, 30A, LPCC-30	3
46	5007809	Fuse, 25A, LP-CC-25	3
47	5003114	Fuse, .25A, 3AG #313.250	3
48	5002527	Fuse, 3A 3AG SLO-BLOW 313003	4
49	5007161	Fuse, 1A, 3AG SLO-BLOW 313001	1
50	5001193	Fuse, 1.5A, 31301.5	1
51	7000017	Nut, Hex 1/4-20	1
52	5001675	Diode, IN4004	7
53	5007159	Relay, 1PDT, 24VDC, RHIB-U-UDC24V	1
54	5006096	Socket, Relay, 1PDT, SH1B-05C	1
55	5007082	Switch, Interlock, Door	2
56	5007810	Phnx, Fuse Connection Pin, 30-04-53-7	2
57	5007817	Recp. 3 Pole, 4 Wire, 250V 30A 2725	1
58	5007889	Phnx, Subcon 9 91819 9/F-SH	2
59	5007088	Label, Protective Earth Symbol	6
60	5004586	Relay Hold Downs	A/R
61	5002418	Label, Brady Component Marker	A/R
62	5002739	Cable, Flat, 50 Conductor 3M 3811/50	4.3'
63	5002734	Connector, 50 Pin Socket, 3M 3425-6600	2
64	5002740	Connector, Strain Relief 50 Pin 3M 3448-3050	2
65	5003776	Butt Conn, 10-12 ga Yellow	12
66	5007830	Connector, Card Edge 50 Pos 3M 3415	2
67	5007832	Phnx, Heavycon-D, Keying Pins, 17-72-72-2	4
68	5003908	Cable, Bulk, TW20GA 4PR	22'
69	5007845	Lexan, Top Panel	1
70	7000505	Screw, Mach Rd Hd 6-32 x 1.000	4
71	7000627	Washer, Flat #6 Black Nylon	4
72	5000802	Label, Praxair Logo	2
73	7000359	Screw, Btn Hd 6-32 x 0.250	12
74	7000612	Screw, Btn Hd 8-32 x 0.250	11
75	7000385	Screw, Btn Hd 10-32 x 0.500	8
76	15911	Caster, 2" 160 lbs Svl Dual Whl Faultless	4
77	7000111	Screw, Hex Hd 5/16-18 x 0.750	16
78	5000636	Washer, Flat 5/16	32
79	7000202	Washer, Lock 5/16	16
80	7000064	Nut, Hex 5/16-18	16

ITEM	PART #	DESCRIPTION	QTY
81	7000058	Rivet, 1/8 Pop	6
82	5007294	Label "PE" Ground	7
83	7000212	Washer, Lock #8 Star Intl Pld	12
84	7000024	Screw, Skt Hd Cap 1/4-20 x 3/8	20
85	7000019	Washer, Lock 1/4	22
86	7000040	Screw, Skt Hd Cap 1/4-20 x 2.00	2
87	5001186	Standoff, 6-32 x 1/2	16
88	7000209	Washer, Lock #6 Star Intl Pld	16
89	7000060	Nut, Hex 6-32	20
90	1007-52	Label, Serial Number	1
91	5007094	Label, Warning CE	2
92	5007087	Label, Elec. Hazard Symbol	3
93	5002408	Tape, Brady Wire Marker, Size Code 105	A/R
94	5003625	Tape, Brady Size Code 111	A/R
95	5007134	Bracket, Interlock Switch	2
96	7000312	Stand Off, #8 CL x 0.25 Lg	4
97	5003919	Phnx, Term. Base	2
98	5003920	Phnx, Term, Plug	2
99	5001680	Wireway, Cover, 1"	A/R
100	5001678	Wireway, 1" x 1"	A/R
101	5007158	Label, "Made In The U.S.A.", 2 x 1.5	1
102	5001677	Wireway, 2" x 1"	A/R
103	7000622	Screw, Btn Hd 8-32 x 0.625 Lg	4
104	5000598	Term, Fork, 10ga #8	17
105	5007946	Term, Ring, 10ga #8 Stud	5
106	5007947	Term, Ring, 10ga 0.250 Stud	10
107	5002170	Tie Down, Wire Saddle on Base	2
108	5002728	Fuse, 1A FLQ-1	2
109	5007818	Plug, 30A 250V 3PL 4WR	1
110	5007504	Bulb, Light 24V	1
111	5007597	Contact Block Assy 1 N.O. - 1 N.C.	1
112	5007152	Transorb, 24V	1
113	5007953	Transorb 5V	1
114	7000440	Washer, Flat #6	8
115	5006102	Label, "J1"	1
116	5006103	Label, "J2"	1
117	5007868	Label, "J3"	1
118	5007869	Label, "J4"	1
119	5007866	Label, "JX"	1
120	5007867	Label, "JY"	1

TECHNICAL APPENDIX

A-1. GUN MANIPULATION

Surface speed, pitch, standoff, and angle of impingement are significant variables in producing a coating with desired characteristics.

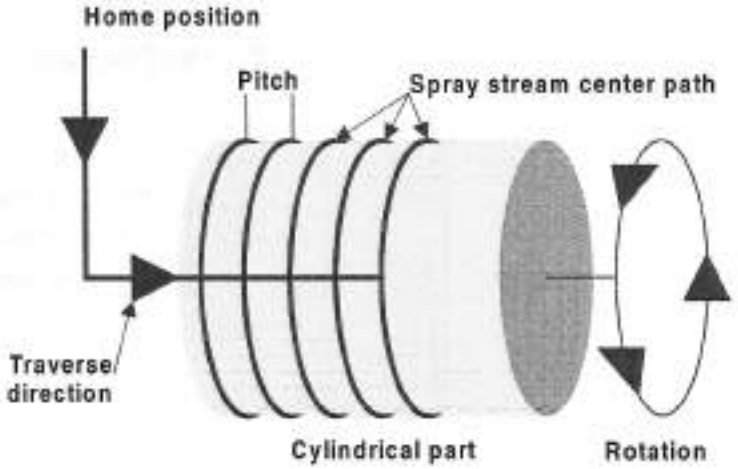
Generally, a **gun surface speed** of about 1200 in/min (.5 m/sec) is desirable for most applications. The ideal surface speed typically creates deposits of approximately .001 in/pass (25.4 microns/pass) for metallic and coarse materials and .0005 in/pass (12.7 microns/pass) for ceramic and fine materials. Targeting this thickness buildup rate decreases residual stress, increases maximum thickness buildup, and decreases porosity. Adjustments in traverse speed are usually required to obtain the desired buildup.

Pitch or increment is the step or feed of the gun motion associated with traverse. Generally a pitch or increment of 0.125-0.200 in. (3-5 mm) per revolution is desirable. Pitch may need adjustment to prevent striping or "barber poling."

Standoff is the distance from the front of the gun to the surface of the part being sprayed. It is usually that point where the particles are hot enough to form the coating while the heat transfer from the gun to the part is as low as possible. Spray stream should be perpendicular (within +/- 15 degrees) to the part surface.

Cylindrical part spraying requires the calculation of traverse speed to achieve the desired pitch. Spraying cylindrical objects is analogous to machining threads: the rotational speed of the part and the gun traverse speed are "locked" based on the desired surface speed and pitch.

Figure A-1.
Increment on rotating workpieces.



To calculate the gun traverse speed, use the following formulas. Make sure to use consistent units of measure throughout the calculations:

1. To calculate **RPM** of the part: **Desired Surface Speed / (part diameter x π*)**

*π = pi (approximately 3.14)

2. To calculate **traverse speed** in in/min: **RPM x pitch**

A-2. PARAMETERS FOR USE WITH THE 4X00 CONTROLLER

The robot parameters listed here refer only to those which are modified for operation with the 7354 Turntable and the 4500 Computerized Process Control Systems. All other parameters are to left at their default values.

TOPIC: Controller
TYPE: Event Routines

Event	Routine	Task
STOP	clr_int	0
START	sys_init	0

TOPIC: Communication
TYPE: Physical Channels

Name	Sio1:	com2
Type	Sio	Sio
Channel	1	2
baud Rate	9600	9600
Parity	none	none
No. of Bits	8	8
No. of Stop Bits	1	1
RTS/CT	Off	Off
Duplex	Full	Full

TYPE: Transmission Protocol

Name	Slip_4500
Type	Slip
Phy Channel	1
Local Address	100.100.100.101
Remote Address	100.100.100.102

TYPE: Application Protocol

Name	Rap_4500
Type	RAP
Trans Protocol	Slip_4500
Port No.	-1
SendStsrtupMsg.	No
Enable Subscw	No

TOPIC: I/O
TYPE: User I/O

Name	Name	Signal Type	Signal Number	Filter Passive	Filter Active	Inverted
tilt_rdy	Board11	DI	1	0	0	no
tilt_err	Board11	DI	2	0	0	no
rot_rdy	Board11	DI	3	0	0	no
rot_err	Board11	DI	4	0	0	no
rpm_sp	Board11	DI	5	0	0	no
tt_pwr_ok	Board11	DI	6	0	0	no
DI11_7	Board11	DI	7	0	0	no
DI11_8	Board11	DI	8	0	0	no
rot_drv_stat	Board11	DI	9	0	0	no
tilt_drv_stat	Board11	DI	10	0	0	no
DI11_11	Board11	DI	11	0	0	no
DI11_12	Board11	DI	12	0	0	no
DI11_13	Board11	DI	13	0	0	no
DI11_14	Board11	DI	14	0	0	no
loop_enable	Board11	DI	15	0	0	no
loop_disable	Board11	DI	16	0	0	no
tstat_req	Boerd11	DO	1	n/a	n/a	no
tilt_up	Board11	DO	2	n/a	n/a	no
tilt_dn	Board11	DO	3	n/a	n/a	no
tilt_hm	Board11	DO	4	n/a	n/a	no
rstat_req	Board11	DO	5	n/a	n/a	no
rot_index	Board11	DO	6	n/a	n/a	no
rot_hm	Board11	DO	7	n/a	n/a	no
pgm_en	Board11	DO	8	n/a	n/a	no
mtrs_on	Board11	DO	9	n/a	n/a	no
tt_reset	Board11	DO	10	n/a	n/a	no
cmd_strobe	Board11	DO	11	n/a	n/a	no
auto_on	Board11	DO	12	n/a	n/a	no
DO11_13	Board11	DO	13	n/a	n/a	no
DO11_14	Board11	DO	14	n/a	n/a	no
rob_stopped	Board11	DO	15	n/a	n/a	no
pass_count	Board11	DO	16	n/a	n/a	no

NOTES

Artisan Technology Group is an independent supplier of quality pre-owned equipment

Gold-standard solutions

Extend the life of your critical industrial, commercial, and military systems with our superior service and support.

We buy equipment

Planning to upgrade your current equipment? Have surplus equipment taking up shelf space? We'll give it a new home.

Learn more!

Visit us at **artisantg.com** for more info on price quotes, drivers, technical specifications, manuals, and documentation.

Artisan Scientific Corporation dba Artisan Technology Group is not an affiliate, representative, or authorized distributor for any manufacturer listed herein.

We're here to make your life easier. How can we help you today?

(217) 352-9330 | sales@artisantg.com | artisantg.com

ARTISAN® TECHNOLOGY GROUP