WATERLINK®
Lanco Environmental
Products

CLARIFIER

Operation & Maintenance Manual

Serial No. C1912

Lanco Environmental Products 1766 Stehouwer NW Grand Rapids, MI 49504 USA
Tel.: (616) 791-9100 Fax: (616) 453-1832 www.lanco-online.com lanco@waterlink.com

WATERLINK®
Lanco Environmental
Products

DESCRIPTION

Lanco Environmental Products Model #200 Slant Plate Clarifier
Capacity: 200 GPM

MATERIALS OF CONSTRUCTION

HRS 1/4" Plate
Material surface blasted to near white
Settling Plates - 1/4 Grey PVC Schedule 80 grade one

COATING

Interior

(1) One application of white polyglaze epoxy primer
(1) One application of white polyglaze epoxy #40110
(1) One application of black polyglaze epoxy #40106

Exterior

(1) One application of white polyglaze epoxy primer
(2) Two applications of blue polyglaze epoxy #40106-A

DESIGN PARAMETERS

Flash mix and flocculation tank	80 gallon and 320 gallon
Volume	400 gallons
Effluent flange	6"
Solids discharge flanges (2)	4"
Design flow	200 GPM
Plate area	960 sq. ft.
Dry weight	7,500 lbs.
Liquid weight	24,490 lbs.
Liquid volume	2940 gallons
Retention time @ max. flow	14.70 minutes
Physical size	12' 11" Long x 6' 0" W x 12' 3" H
Designed solids removal	95+% @ 200 ppm influent
Underflow	1 - 2% solids
Flanged access hatch	18" x 18"

OPERATION OF LANCO CLARIFIERS

The Lanco Slant Plate Clarifier is designed to remove and thicken suspended and flocculated solids from industrial wastewaters. Using gravity in conjunction with the projected settling area allows solids to settle from the pre-treated liquid flow.

Water is first pumped into section #1 of the Lanco Clarifier. Polymer addition or pH adjustment may be made in section #1 or in line with your feed to the Clarifier. If pH adjustment is made in section #1, a mixer should be added in this section. Polymer that is added in sequence with the water is only to be added when water is going into the Clarifier. This can be accomplished by integrating your Polymer feed system with your pump to the Clarifier. When the pump turns on and off the Polymer feed will turn on and off respectively.

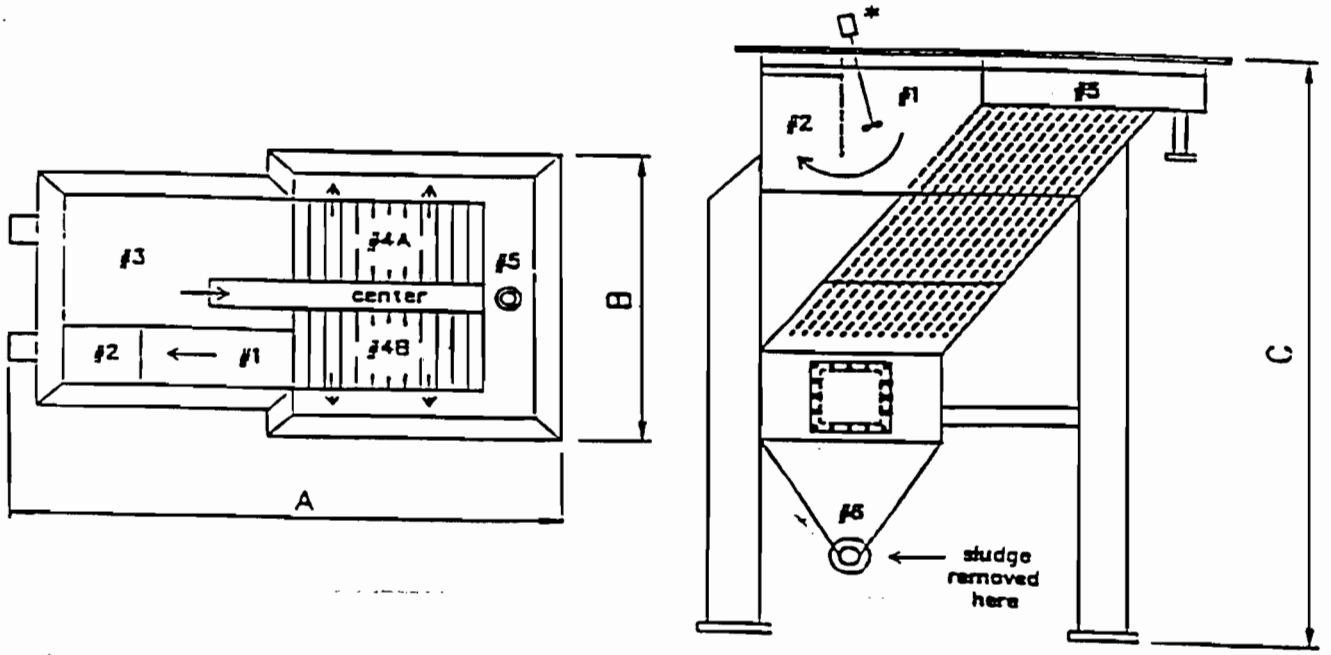
After flocculation, wastewater will flow through section #2 and into section #3. Section #3 provides more retention time and allows flocculant to grow. Water from section #3 will then flow down the center of the Clarifier into the sludge thickening cone area and back up along the inclined PVC plates, sections #4A and #4B.

In sections #4A and #4B the settling of sludge will occur. The use of a series of inclined PVC plates allows the settling area to become the total area of the plates projected on a horizontal surface.

The sludge will settle into the cone bottom of the Clarifier where it is ready for removal.

The treated effluent will rise to the top of sections #4A and #4B. Drilled ports will allow the effluent to enter section #5.

Clear liquids are discharged out of section #5.



It is important to note that not all waste streams are the same. It will require experimentation on the users part to determine the proper polymer or other chemicals(if required) and rate of usage for optimum settling. It will also be important to regulate the system at a fairly constant flow rate. Variations in the flow rate causes unwanted surges to the system. Finally, it is important to regulate the flow of sludge leaving the Clarifier so that there is a low level bed of sludge in the cone of the Clarifier. Some sludge is advantageous to the efficiency of the Clarifier, while too much will cause the sludge to enter into the plates, thus reducing the total settling area. Too much sludge build up can also lead to bridging of the sludge between the plates resulting in blockage.

The sludge should be pumped from the Clarifier by means of an air diaphragm pump to a sludge holding tank or directly to a dewatering device such as a filter press. The air diaphragm pump should be regulated to keep the sludge level to a minimum. The use of a sludge holding tank will allow the sludge to settle even further. From the holding tank, any overflow of clear liquids from the top may be returned to the waste system for retreatment.

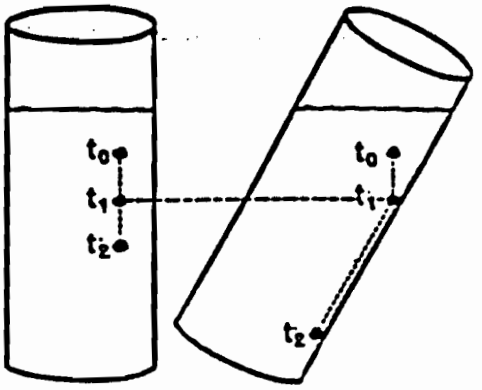
It is important not to create any siphon effects, allowing the level of water to drop below the height of the plates. This may cause hydroxides to dry on the plates, effecting the efficiency of the Clarifier.

From time to time it may become necessary to clean the Clarifier. Simply slide out the plates and clean with a soft nylon brush with a mild Hydrochloric Acid solution.

PRINCIPLE OF CLARIFICATION

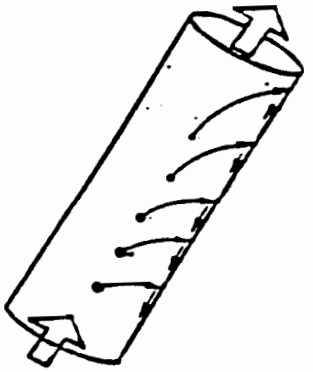
"By tilting a clarifier to an angle of 55° we have a lamella clarifier with a new relation between solids and liquids, compared to a conventional clarifier".

By a combination of a short distance of sedimentation and "frictionfree sliding" the separation speed is increased.

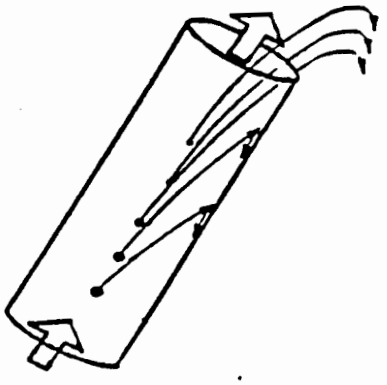


Flow Pattern for an Upstream Lamella Clarifier

Clarification is achieved when upstream velocity is low enough to allow solids to report to the "Lamella Plate".



Clarification is not achieved when upstream velocity is so high that solids cannot report to the "Lamella Plate".



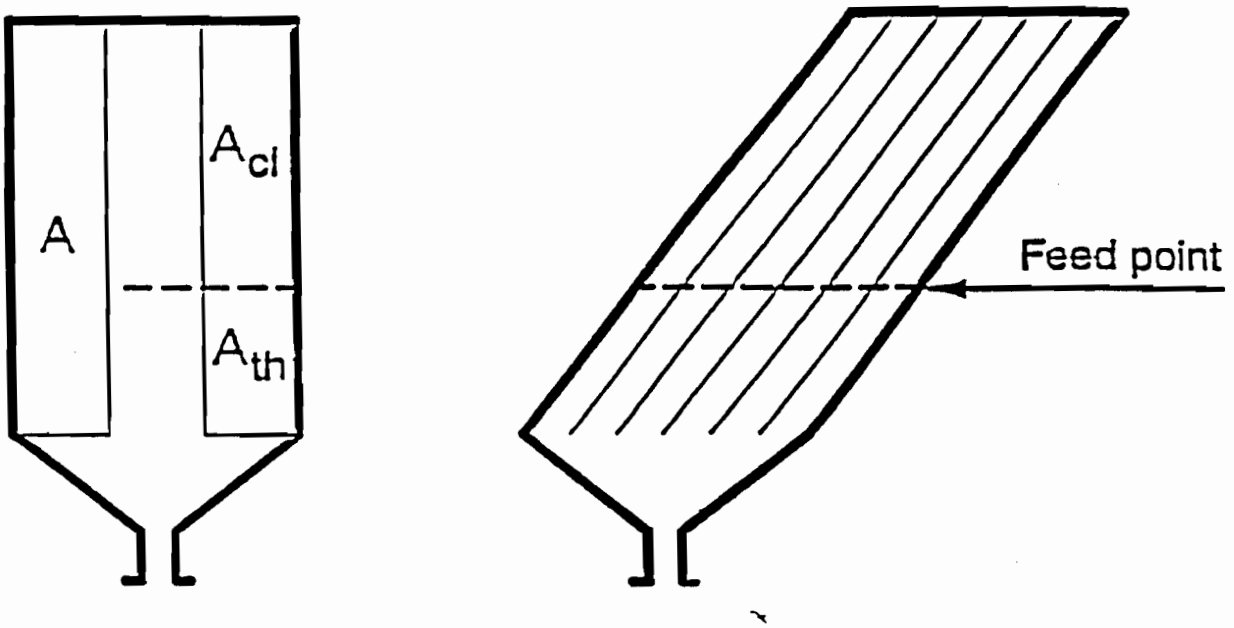
CLARIFICATION AND THICKENING

Max 80% of the lamella plate area can be used for clarification.

Only the **area above the feed point** is used as clarification.(A_{cl})

The **area below the feed point** is used for thickening.(A_{th})

Max 50% of the lamella plate area can be used for thickening.



APPLICATIONS

Typical applications of the Lanco Clarifier include the following:

Water Treatment

Potable Water
Process Water

a. Makeup water for colling towers

b. Water for manufacturing products

c. Pretreatment boiler feed water

Wastewater treatment

Designed to treat non-biological or minimally biologically active wastewaters for removal of suspended solids.

a. Metal Finishing and electro plating wastewaters for removal of metal hydroxides.

b. Power plant wastewaters for removal of fly ash, metal hydroxides, etc. These would include wastes from scrubber systems, coal pile runoff, air preheater wash waters, fireside wash waters, boiler blowdown, etc.

c. Removal of and thickening of suspended solids (refuse) from coal plant wash waters.

d. Treatment of scrubbing waters for calcium sulfate removal.

e. Treatment of paper mill effluent water for color removal with alum.

MAINTENANCE

The Lanco Clarifier is designed for ease of maintenance, and when operated properly will require nominal control and operator time. Periodic maintenance should be done to assure proper operation. the following steps can aid in the unit operation and control:

1. **Cleaning Unit**

   A) Open sludge draw-off valve for three minutes (until sludge is totally evacuated and water is predominant in discharge).

NOTE: Sludge tank should be empty!

   B) Remove 1/4" PVC plates.

   C) Using a pressure nozzle on a hose, hose down all visible surfaces, weirs, launderers and flow chamber of collected, caked solids deposits.

   D) Clean PVC plates using a soft nylon brush with a mild Hydrochloric Acid solution.

   E) Hose down tank area of all visible solids.

   F) Once thoroughly rinsed, the unit is now ready for normal operation.

TROUBLE SHOOTING

Problem: Poor Floc Formation in Flash Mix Chamber.

Possible Cause: Polymer problems due to:

- Valve closed
- Chemical Pump not operating
- Improper dosage
- Polymer aged, unreactive, and decomposed

Improper pH

Improper wastewater pretreatment due to:

- Alkaline cleaner overdose
- Phosphate overdose

Problem: Floating Solids

Possible Cause: Air entrainment due to suction leak in pump supply line.

Chemically induced gas generation.

Oil in system.

Sludge build-up into and through PVC plates due to:

- Improper blowdown sequence.
- Closed valve on sludge draw-off.

Hydraulic overloading

Problem: Solids build up on Plates.

Possible Cause: Floating Solids

Increase in flow/contaminant (TSS) loading

Blowdown timer turned off

Solids have buildup on side of cone

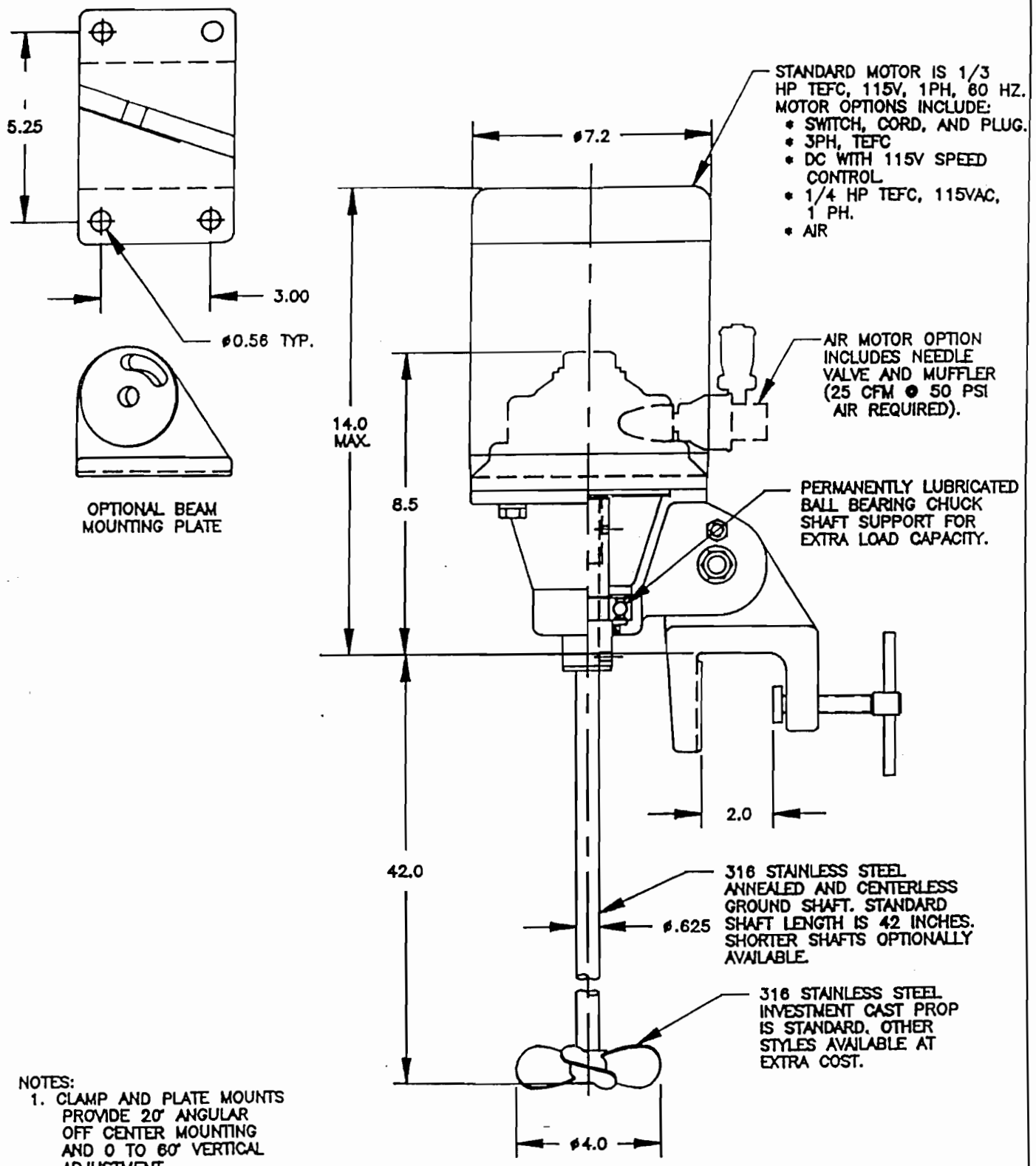
- Air agitating below plates at 1/2" sample port will clear the caked solids.
- Sometimes paint solids are inadvertently directed to the Clarifier and this results in congealing in the cone.
- In drastic cases, removal of the plates may be necessary.
  (see Maintenance)

1ST CHAMBER

BRAWN™ MIXER, INC.

OPERATION & MAINTENANCE INSTRUCTIONS

MIXING SOLUTIONS



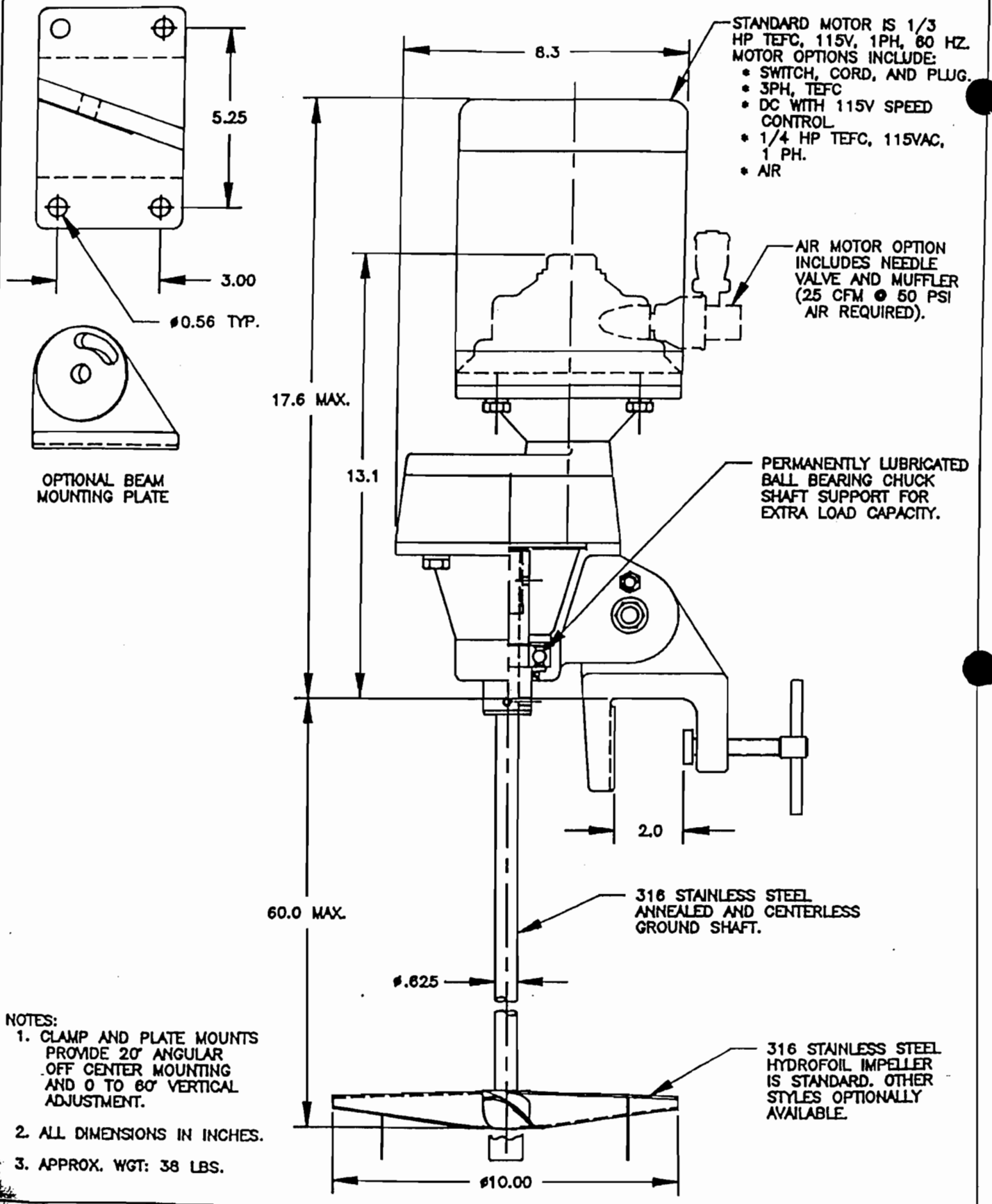
NOTES:
1. CLAMP AND PLATE MOUNTS PROVIDE 20° ANGULAR OFF CENTER MOUNTING AND 0 TO 60° VERTICAL ADJUSTMENT.
2. ALL DIMENSIONS IN INCHES.
3. APPROX. WGT: 24 LBS.

FILE NO.039301 DATE 2-16-95

BRAWN MIXER, INC.
HOLLAND, MI. 49424
PH. 616-399-5600
FAX 616-399-3084

MIXER MODEL SD25/33

DIMENSION AND ASSEMBLY DRAWING



NOTES:

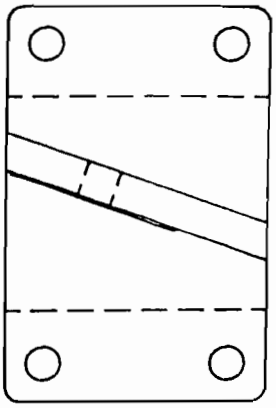
1. CLAMP AND PLATE MOUNTS PROVIDE 20° ANGULAR OFF CENTER MOUNTING AND 0 TO 60° VERTICAL ADJUSTMENT.
2. ALL DIMENSIONS IN INCHES.
3. APPROX. WGT: 38 LBS.

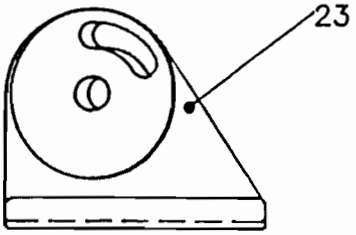
FILE NO. 039303 DATE 12-16-95 ©1995

BRAWN MIXER, INC.
HOLLAND, MI. 49424
PH. 616-399-5600
FAX 616-399-3084

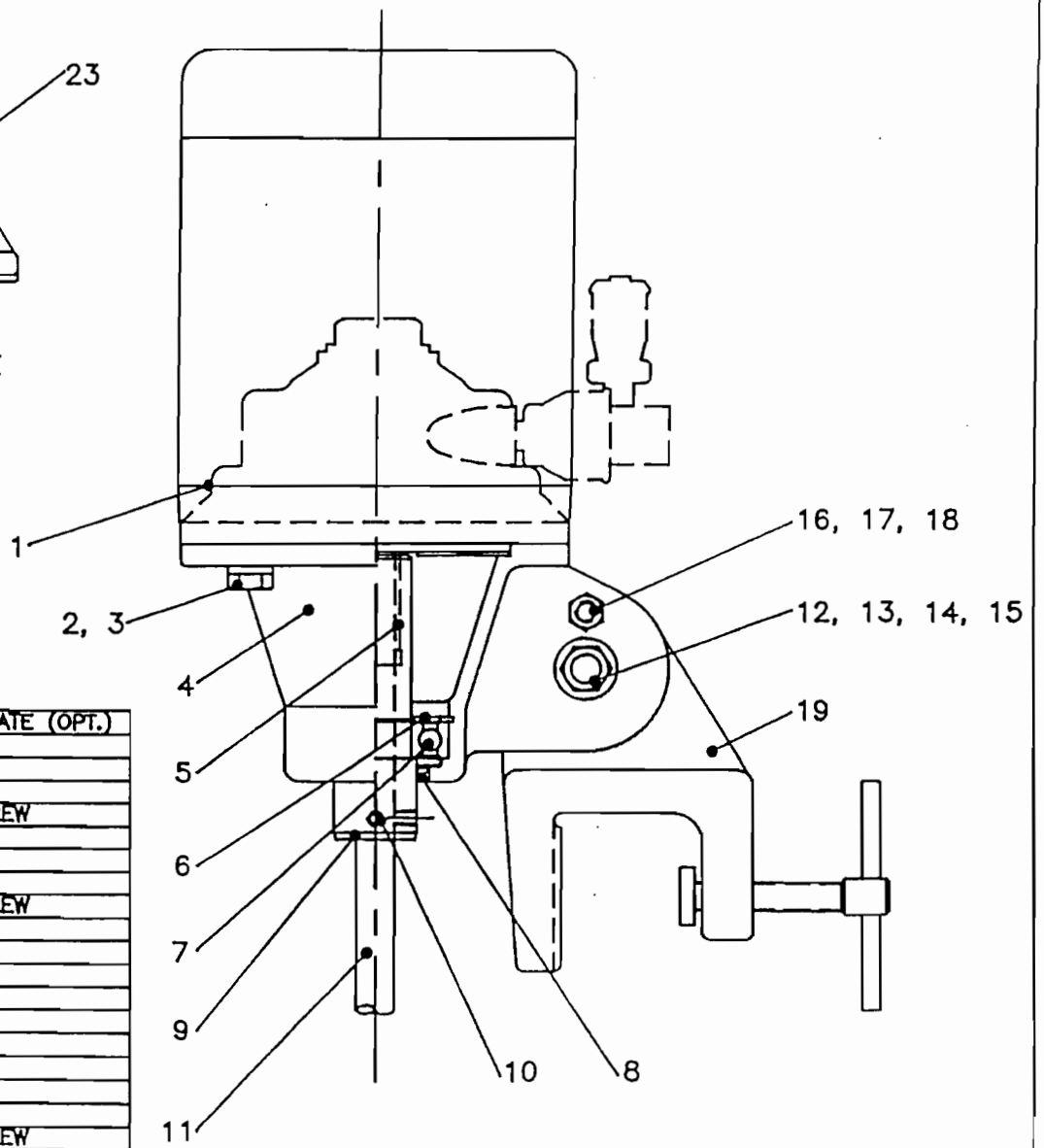
MIXER MODEL SG25/33

DIMENSION AND ASSEMBLY DRAWING





OPTIONAL BEAM
MOUNTING PLATE



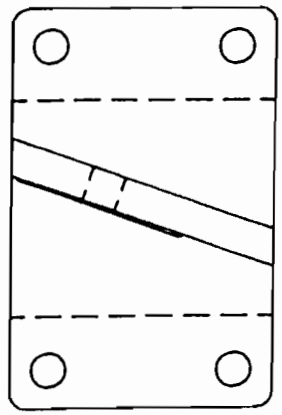
ITEM	QTY.	PART NAME
23	1	BEAM MOUNTING PLATE (OPT.)
19	1	CLAMP ASSEMBLY
18	1	LOCK WASHER
17	1	FLAT WASHER
16	1	HEX HEAD CAP SCREW
15	1	HEX NUT
14	1	LOCK WASHER
13	1	FLAT WASHER
12	1	HEX HEAD CAP SCREW
11	1	MIXER SHAFT
10	2	SET SCREW
9	1	CHUCK SHAFT
8	1	LIP SEAL
7	1	BEARING
6	1	SNAP RING
5	1	KEY
4	1	BEARING HOUSING
3	4	LOCK WASHER
2	4	HEX HEAD CAP SCREW
1	1	MOTOR

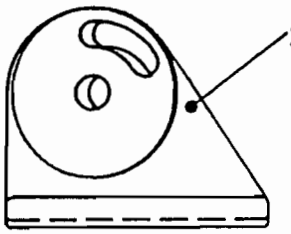
FILE NO.089404 DATE 8-1-94

BRAWN MIXER, INC.
HOLLAND, MI. 49424
PH. 616-399-5600
FAX 616-399-3084

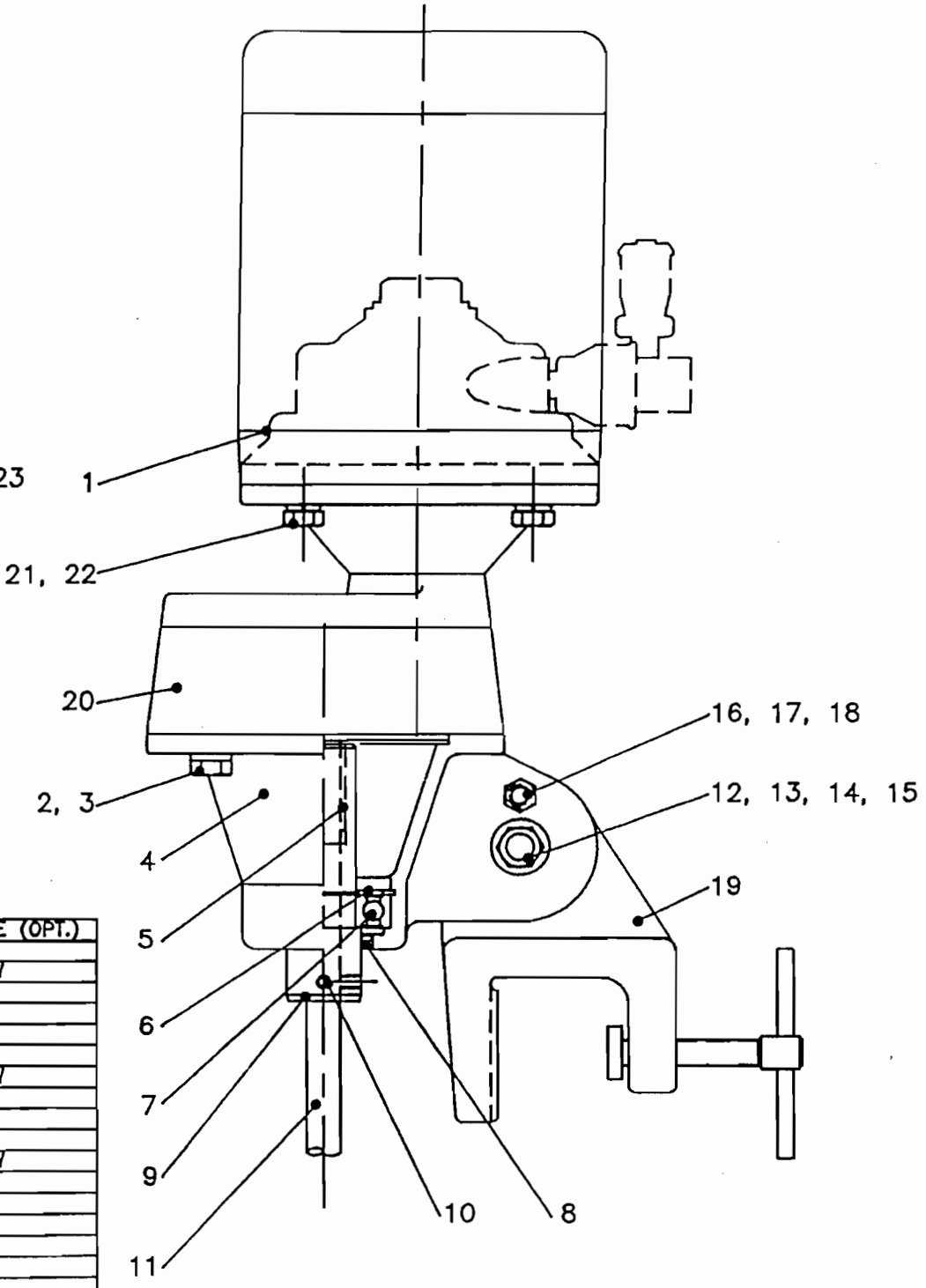
MIXER MODEL
SD25/33

DIMENSION AND ASSEMBLY DRAWING





OPTIONAL BEAM MOUNTING PLATE



ITEM NO.	QTY.	PART NAME
23	1	BEAM MOUNTING PLATE (OPT.)
22	4	LOCK WASHER
21	4	HEX HEAD CAP SCREW
20	1	GEARBOX
19	1	CLAMP ASSEMBLY
18	1	LOCK WASHER
17	1	FLAT WASHER
16	1	HEX HEAD CAP SCREW
15	1	HEX NUT
14	1	LOCK WASHER
13	1	FLAT WASHER
12	1	HEX HEAD CAP SCREW
11	1	MIXER SHAFT
10	2	SET SCREW
9	1	CHUCK SHAFT
8	1	LIP SEAL
7	1	BEARING
6	1	SNAP RING
5	1	KEY
4	1	BEARING HOUSING
3	4	LOCK WASHER
2	4	HEX HEAD CAP SCREW
1	1	MOTOR

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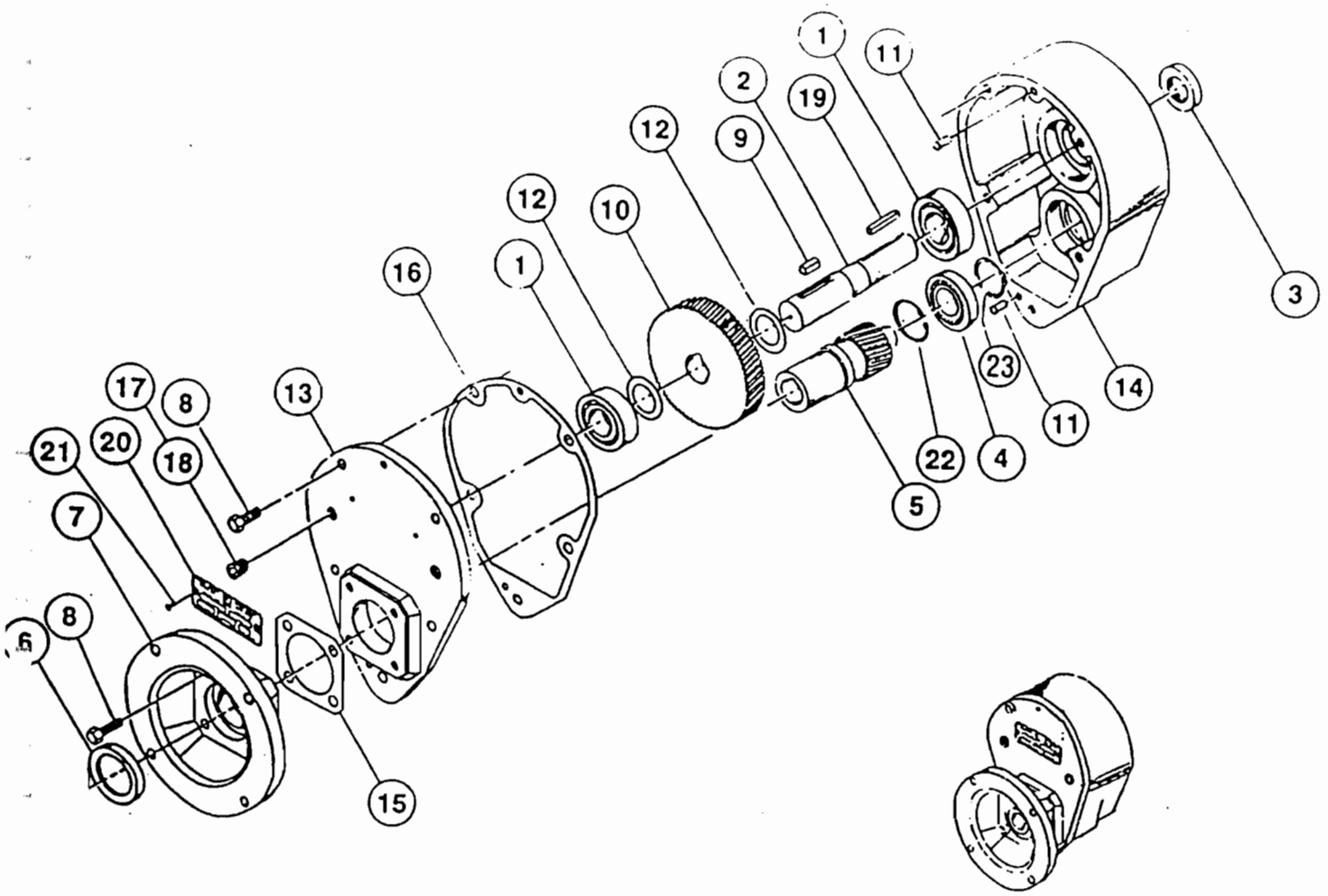


1. Bearing, Output (Ball) — 2 req.
2. Shaft, Output (state output frame size)
3. Seal, Oil (Output)
4. Bearing, Input (Ball)
5. Shaft, Input
6. Seal, Oil (Input)
7. Flange, Motor
8. Screw
9. Key, Gear
10. Gear, Output
11. Pin, Dowel — 2 req.
12. Spacer, Low Speed — 2 req.
13. Cover, Housing
14. Housing, Gear
15. Gasket, Input cover
16. Gasket, Housing
17. Plug, Pipe — 2 req.
18. Plug, Vent
19. Key, Output Shaft
20. Plate, specification
21. Screw, Drive (spec. plate) — 2 req.
22. Ring, Retaining, Internal, Input Shaft
23. Ring, Retaining, External, Input Shaft

12764 Greenly Street ▪ Holland, MI 49424 Phone: 616/399-5600 ▪ Fax: 616/399-3084

CONTENTS

CUSTOMER SERVICE

Mixer Model # ..... SD/SG-SERIES
Mixer Serial #_____
Contact:
☎ Customer Service 616/399-5600

You have received a quality engineered and manufactured BRAWN Mixer. We value your business, and we will strive to provide you with the proper service and equipment to meet your needs.

The information contained in this BRAWN Mixer Operator's Manual is designed to assist you in putting your BRAWN Mixer into operation without further delay. **Please read the entire manual before attempting to start your mixer.** If you have any further questions or if, by some chance, there are some missing components, contact your BRAWN Mixer Representative or the factory immediately.

We welcome your comments and suggestions concerning any BRAWN Mixer product. Please direct these comments in writing to the National Sales Manager at BRAWN Mixer, Inc., located in Holland, Michigan. To expedite troubleshooting service, please make your initial contact through your BRAWN Mixer Representative. If, for whatever reason, your representative cannot be reached and you have an emergency condition, please call us directly at 616/399-5600 and ask for the Customer Service Department.

Remember, you are backed by your BRAWN Mixer Technical representative and the factory support team. We are here to assist you; let us know how we can be of help.

INITIAL INSPECTION

1. Upon receipt of your BRAWN Mixer, check for possible shipping damage. Report any damage immediately to the carrier and to BRAWN Mixer, Inc.

2. All BRAWN Mixers are shipped with the shaft and impeller(s) disassembled from the drive assembly. In addition, the clamp or cup mount and any mounting hardware for portable mixers are shipped loose.

3. Storage: Mixers should not be stored near vibrating machinery to avoid damage to the bearings. Store mixers as packaged by the factory. For longer storage periods, consult factory. If electric motors have been subjected to humid conditions, check the insulation resistance between phase and mass and between the different phases. The resistance should not be less than 100 megohms. If the resistance is less, please consult the factory. If mixer is stored for more than a month, the condition of the gear and/or lubricant should be checked before the mixer is put in operation (see lubrication instructions).

[CONTINUED]

SAFETY

The precautions mentioned in this manual are not intended to cover all hazards that may exist in a plant or on this equipment. Using safety mechanisms requires the constant attention of everyone in the vicinity of this (or any) equipment.

A plant and the related equipment are only as safe as the personnel are safety-minded. Proper equipment maintenance and the use of personal safety devices will contribute as much toward safety as will any number of mechanical safety devices.

- To assure maximum safety, optimum performance, and to gain knowledge of the product, it is essential that you or any other operator of this equipment read and understand the contents of this manual before the mixer is operated.
- Do not operate this equipment unless all safety devices are working properly. Check all devices prior to starting the equipment.
- Develop a safety checklist for this equipment and perform regular maintenance to ensure continued and proper operation.
- Disconnect and lock out electrical power before servicing the mixer.
- Do not touch rotating parts.
- Do not make any field changes or modifications without reviewing the change with your BRAWN sales representative or the BRAWN Customer Service Department.

INSTALLATION

[REFER TO ASSEMBLY / DIMENSION DRAWING.]

Refer to the mixer installation / assembly drawing for important mounting structure design, assembly, mounting and dimensional data.

1. For clamp-mount units, install the mixer drive on the mounting structure and secure by tightening the clamp screw.

   - For plate-mount mixers, install the mixer drive on the mounting structure and secure with properly-sized, Grade 5 or better hardware. Torque the hardware as recommended in **TABLE 1**.

2. Install the impeller(s) on the mixer shaft by carefully sliding the impeller hub over the shaft to its proper location and tighten the set screws.

3. Install mixer shaft **[11]** by inserting one end into the chuck driveshaft until it bottoms out **[9]**. (It is recommended that the mixer shaft portion engaged in chuck driveshaft be coated with an anti-seize compound.) Tighten setscrews **[10]** to secure shaft.

TABLE 1: RECOMMENDED TORQUE VALUES

HARDWARE SIZE	TORQUE VALUES (FOOT POUNDS)	
	STANDARD GRADE 2 & 300 SERIES STAINLESS	HIGH STRENGTH GRADES 5 & 8
3/8 — 16	17	27
1/2 — 13	40	65

[CONTINUED]

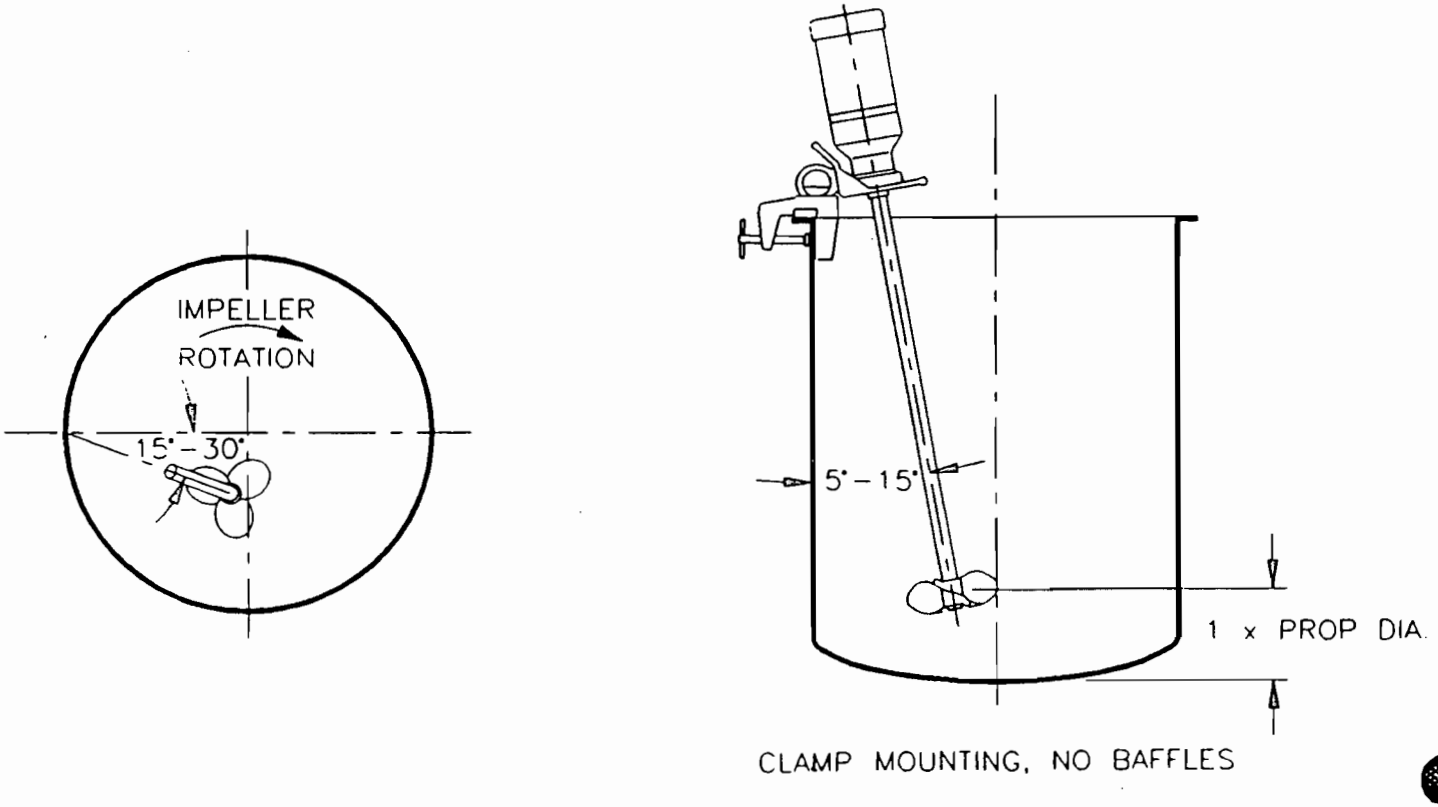
INSTALLATION CONTINUED...

BOLT-TIGHTENING RECOMMENDATIONS: Inadequately or improperly tightened hardware can loosen due to vibration during mixer operation. This can result in reduced mixer life or damage to equipment. Recommended torques for tightening all in-tank and mounting hardware are listed in **TABLE 1** [Page 2]. These average torque values should be considered only as guides and not as absolute values.

The following guidelines are based on mixing in vertical cylindrical tanks with flat, dished, or shallow cone bottoms. Mixer installations may vary with tank shape, retention times, starting conditions and other requirements.

1. For liquid levels 0.5 to 1.1 times the tank diameter, a single impeller is suitable.
2. For liquid levels 1.1 to 1.6 times the tank diameter, use dual impellers.
3. Impellers may be located from 0.5 to 2.0 impeller diameters off the tank bottom, with one diameter off bottom being optimum.
4. When dual impellers are necessary, spacing between impellers should be approximately two impeller diameters with gear drives, and four to five impeller diameters with direct drive mixers.
5. Mixer position in tank should be as shown in **FIGURE A** [below] for maximum turnover of liquid.

FIGURE A



CLAMP MOUNTING, NO BAFFLES

[CONTINUED]

STORAGE

Units shipped from BRAWN Mixer, Inc. are intended to be used within 30 days after receipt and presumed to be stored indoors in a heated building. If you intend storing units under adverse conditions or for a long period of time, special storage precautions will be necessary.

1. Store in a sheltered area away from chemical vapors or steam.
2. Cover.
3. Do not store in sunlight or near high heat.
4. Spray oil on exposed shafts and seals. Remove oil on start-up.
5. Rotate output shaft 360° every 3-4 weeks.

[CONTINUED] -

WARRANTY

WARRANTY: All equipment or parts covered by this manual are guaranteed free from defective material and workmanship for a period of eighteen (18) months from date of purchase, under normal use and service . This warranty does not cover failure of normal wear parts unless the failure of such part has resulted from defective material and workmanship. BRAWN Mixer, Inc. will repair or replace, at its option, any equipment which has been found to be defective and is within the warranty period, provided that the equipment is shipped, with previous factory authorization, freight prepaid, to BRAWN's plant in Holland, Michigan, USA. All return shipments are made FOB BRAWN's factory. BRAWN is not responsible for removal, installation, or any other incidental expenses incurred in shipping the equipment to or from BRAWN. In the case of components purchased by BRAWN Mixer, Inc. and incorporated in the equipment, the component manufacturer's guarantee shall apply. NOTE: Any modifications or corrective work done to the equipment which were not specifically authorized in writing by BRAWN Mixer, Inc. shall void this limited warranty, and BRAWN Mixer, Inc. shall accept no liability for any of the corrective work or expenditures which were conducted without their prior, written authorization. BRAWN Mixer, Inc. shall not be held liable for any further cost, expense, or labor to replace equipment or replaceable parts, or indirect or consequential damages.

With the exceptions of the limited warranty set out above, there are no other understandings, agreements, representatives, or warranties implied (including any regarding the merchant-ability or fitness for a particular purpose), not specified herein, respecting this agreement or equipment, hereunder. This contract states the entire obligation of BRAWN Mixer, Inc. in connection with this transaction.

SHOULD WE MAKE A MISTAKE...

BRAWN Mixer, Inc.'s Direct Returns Policy

To ensure proper handling of your return, please take a moment to read the following:

- **ALL** returns require a **RETURN GOODS AUTHORIZATION (RGA) NUMBER**. We are unable to process your return or issue proper credit without an approved **RGA** number.
- **ALL** returns must be **COMPLETE**, including all original warranties, manuals, documentation and packaging.
- **ALL** product must be received within 20 days of issuing an **RGA** number.

How to Return Product

You must have a **RETURN GOODS AUTHORIZATION (RGA)** number before you return any product to BRAWN Mixer, Inc. To obtain this number, call **616/399-5600** and ask for Customer Service. Be sure to have available the following information:

- your order number
- the BRAWN product serial number
- the part number and description of the product
- the reason for the return

★ IMPORTANT ★

The Return Goods Authorization number must be written clearly on all boxes being returned. C.O.D. shipments will not be accepted.

STRANCO
Water Quality Control

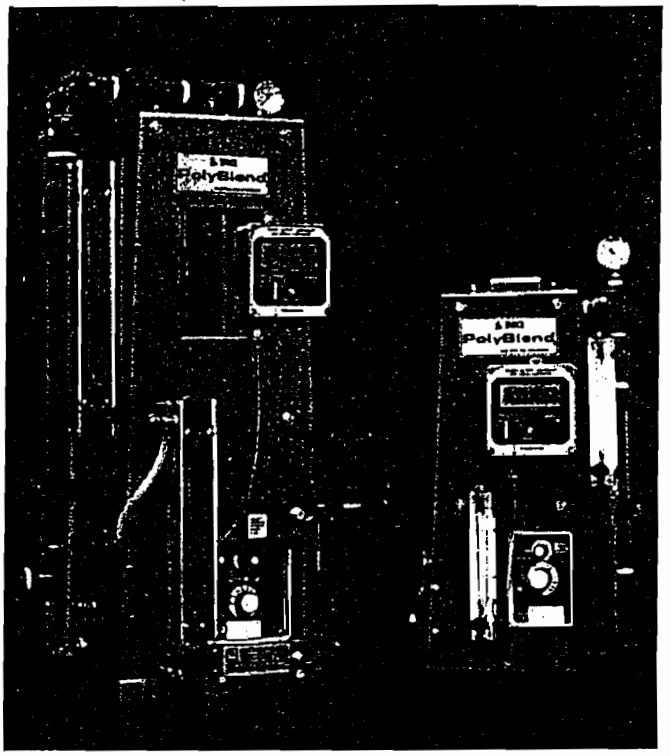
ITEM #4C-CF4

POLYBLEND SERIES

LIQUID POLYMER PREPARATION/FEED SYSTEMS

BENEFITS

- Reduces treatment costs
- Improves results
- Simple, safe and reliable
- Low maintenance
- Near zero operator attention
- Optimizes polymer performance
- Eliminates variability
- Eliminates mess
- On-site service nationwide



Since its introduction in 1972, Stranco's PolyBlend Series
s become the world's #1 automated polymer feed system.
)

Today's PolyBlend Series is a family of uniquely designed, patented systems which represent the product of continuing research and experience gained in over 16,000 operating installations.

This research and experience has shown that each polymer requires its own special combination of mixing and aging in order to achieve full activation. Consequently, the equipment used to prepare a polymer solution must have broad rangeability and programmability so that it can provide that ideal mixing environment. PolyBlend technology offers this rangeability and programmability to assure users, engineering consultants, and chemical suppliers that today's polymers, and tomorrow's, will provide maximum performance and value

The PolyBlend system offers precise control of dosing rate, dilution level, mixing time, and energy. This exclusive control of energy type, intensity and distribution optimizes polymer performance and provides maximum economy and value in the use of polymers.

system design is simple, reliable and economical when
pared with the total cost of alternate systems.

Operating results are consistently uniform and repeatable with little or no operator attention

FUNCTIONAL DESCRIPTION

The PolyBlend Series of automatic liquid polymer preparation/feed systems are capable of preparing and feeding a properly activated polymer solution with polymer dosage rates ranging from 0-475 gallons per hour and dilution water rates ranging from 1-2400 gallon per hour Whatever your dosage and dilution requirements may be, there is a PolyBlend model to satisfy your needs Special requirements outside the standard ranges can be met with a custom engineered model

The system operation is very straightforward The neat liquid polymer is metered into the patented high energy mixing chamber with a highly reliable positive displacement pump Once calibrated, these pumps deliver consistent volumes of polymer insuring consistent dosage rates. At the same time, water is added via a rotometer producing a predetermined solution strength. The water and polymer make their initial contact at the tip of a high energy mixing turbine This controlled mixing environment assures that the polymer is properly wetted

entrap undissolved polymer at the core of the agglomeration. They can range from microscopic to golf ball sized nd even bigger. It should be obvious that feed systems hich deliver fisheyes to the point of use are wasting significant amounts of polymer since geometry tells us that the amount of polymer trapped within the volume of a sphere is far greater than that making up only the surface area. If inadequate or improper energy is applied to the polymer/dilution water interface at the "moment of initial wetting" agglomerations will form. The tendency to form agglomerations is shown in Figure 1.

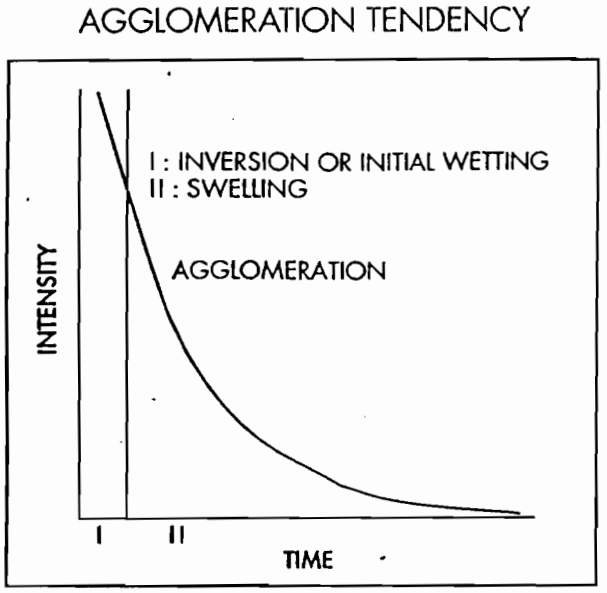


Figure 1

The owners and operators of batch tank systems are all too familiar with agglomerations since batch systems do not apply the proper type or amount of energy required to completely disperse the polymer particles into the dilution water.

So, over the years, operators have attempted to compensate for this drawback by extending the mixing time. This is the foundation for the sanctity of the aging process. Unfortunately this compensation actually diminishes the cost-effectiveness of any polymer program. This is due to the exposure and re-exposure of semi-hydrated and fully hydrated polymer molecules to inappropriate levels of high shear energy during this extended time mixing. To fully appreciate the impact of this process we must now examine the issue of fragility.

RAGILITY

..assical studies which measured the agitation intensity distribution in the universally accepted stirred tank reactor (a 6-sided turbine impeller occupying 50% of the diameter of the mixing vessel) show that under ideal laboratory design conditions the highest point of energy (directly at the impeller tip) is at least 60 times greater than the point of lowest energy (farthest away from the impeller tip). See Figure 2. In spite of the relative lack of uniformity of energy, this model has been identified as the ideal batch tank design by fluid dynamics experts for years.

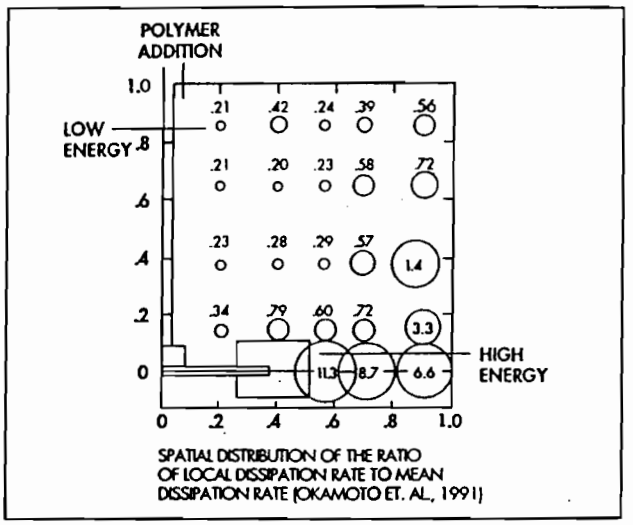


Figure 2

When we leave the laboratory and evaluate a typical batch system in use today, we see the turbine impeller replaced by a propeller blade. This modification alone changes the high to low energy ratio from 60:1 to some value greater than 500:1. When the propeller occupies anything less than 50% of the diameter of the mixing vessel, this high to low energy ratio dramatically increases. In many operating batch tank systems it is common to see the propeller occupying less than 10% of the mixing vessel's diameter. In this case, the high to low energy ratio increases to a value well beyond 2000:1. Finally, when we remove the mixer to the corner of the tank (because it's easier to mount in this manner) we create an environment which has a point of high energy which is no less than 3000 times greater than the point of low energy. This lack of uniformity of energy results in the destruction of a significant percentage of polymer molecules.

Maintaining a uniform shear field of energy is vitally important to the polymer activation process. Polymers are easily ruptured by excessive force when, after they have extended, they are re-exposed to this type of high shear environment.

The hydrodynamic force required to break a carbon-carbon bond (the bonds that hold together the monomers to create the polymer chain) is very slight. Studies by Van de ven, 1981, reveal that a million polymer molecules can be

Herein lies the explanation of how PolyBlend owners consistently report reductions in polymer usage. The PolyBlend Series design prevents agglomerations, promotes rapid full hydration and minimizes the destruction of polymer molecules.

The reductions in polymer feed rate and overall consumption relates directly to a reduction in polymer destruction.

CHARGE SITE EXPOSURE

The polymer performance improvement reported by PolyBlend owners relates to the ability to fulfill the objective of maximum charge site exposure.

The activation of a polymer molecule results in the exposure of charge sites on the polymer chain and an increase in viscosity of the polymer solution. Therefore, as the degree of activation increases so does the overall charge viscosity of the solution. The amount of polymer activation can be quantified by surface charge or rheological type measurements.

Independent studies have shown that activation with PolyBlend technology results in a charge site exposure rate which cannot be equalled by a conventional preparation system. See Figure 5.

CHARGE SITE EXPOSURE

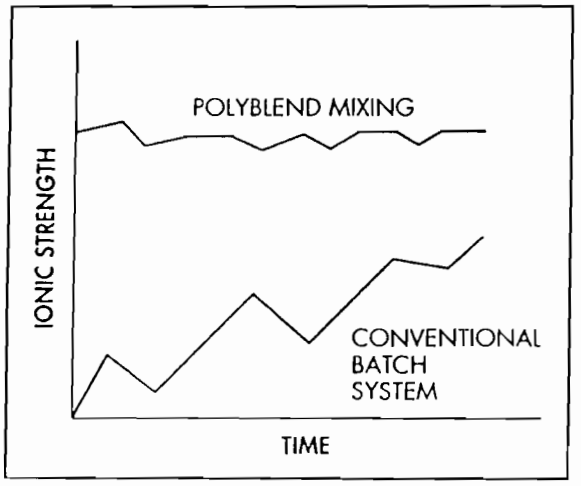


Figure 5

A review of the graph above illustrates the fact that conventional systems cannot achieve the level of charge site exposure that is achieved with the PolyBlend design even if the aging process is hyperextended. This is due to the fact that micro agglomerations are allowed to form during the initial stages of dilution. Once again, this relates to the magnitude and type of energies employed at the moment of initial wetting. In spite of the extended aging and mixing time, a percentage of polymer remains unactivated.

Conversely, the superior dispersion capabilities of the PolyBlend Series prevent even micro agglomerations. This promotes maximum charge site exposure and greatly reduces the mixing time required for full hydration.

This capability translates to improved polymer performance in virtually any polymer application.

SUMMARY

Cost effective performance of a polymer program is tremendously influenced by the activation mechanics described above.

Stranco has designed the PolyBlend Series with a full understanding of these principles. The combination of research, application expertise and quality engineering have come together in this design.

We have seen that proper amounts of uniform, controlled dispersion energy at the moment of initial wetting prevents agglomerations. This in turn eliminates the need to expose the polymer to extended time aging and the polymer destruction associated with that process. Thus, waste is minimuzed and overall polymer consumption is reduced.

Further, the prevention of agglomeration promotes the full hydration of all the polymer. This in turn maximizes charge site exposure which in turn improves polymer performance.

We can now understand the basis of the "more for less" phenomena reported by the owners of PolyBlend systems.

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PolyBlend
Model #PB16-0.4
INSTALLATION, OPERATION, AND MAINTENANCE INFORMATION

CONTENTS

READ THIS MANUAL BEFORE YOU INSTALL, OPERATE, OR SERVICE THIS UNIT.

OVERVIEW

FETY PRECAUTIONS

- ☐ Ensure that the control panel is grounded to avoid possible electrical shock or damage to equipment.
- ☐ Before servicing, turn off all power and assure power "lockout" to avoid possible electric shock.
- ☐ Disconnect external power to the control panel before removing or replacing fuses.

SPECIFICATIONS

Pump	Diaphragm
Inlet	1/2" FPT, Water Supply
	5/8" Hose Barb, Polymer Supply
Outlet	1/2" FPT, Solution Discharge
Water Capacity	16 GPH Primary
Polymer Capacity	0.4 GPH
Pressure Rating	100 PSI
Electrical Supply	120/1/60, 6 Amps
Dimensions	23" H x 10" W x 16" D
Weight	51 lbs.
Motor(s)	(1) 1/6 HP, 120VAC, 3.6 AMPS

INSTALLATION

LOCATION

Select a location that provides:

- Electrical Supply
- Potable Water (Clean)
- Proximity to the Point of Use
- Easy Handling and Storage of Polymer
- Access to Unit
- Protection Against Severe Weather

UNPACKING

Examine package contents for damage. Report any to freight forwarder. Check plastic bag(s) for contents against individual packing list(s).

NOTE: Disregard any moisture; this unit was wet tested.

CONNECTIONS

- Use Teflon tape on threads. Use joint compound (pipe dope) in small amounts, if necessary.
- Do not over-tighten fittings.
- Insure that supply water pressure is less than 100 psi.
- Install water isolation valve with unions.
- Insure that neat polymer feed line has a flooded suction.

NOTE: To enhance performance, reduce the number of piping turns and elevation changes.

OPERATION

GENERAL

This PolyBlend unit will perform the following functions: meter polymer dosage, regulate mixing water, provide uniform dilution and activation, operate on-line continuously, and feed solution to the point of use.

Neat polymer from the metering pump and dilution water controlled by the solenoid valve enter the mixing chamber. Dilution and activation occur, yielding prepared solution ready for use.

Neat polymer dosage rate is adjusted at pump face or at electronic controller (REM-1D, SCR, etc.). Primary dilution (and post dilution) water are controlled by individual flow control valves.

START-UP

Step 1: Switch pump to external mode at pump face.
Step 2: Prime polymer pump, using priming kit provided with unit.
Step 3: Place unit power switch in Off position.
Step 4: Energize power circuit that feeds unit. Solenoid opens. Allow mixing chamber to fill with water by opening primary dilution water control valve.

NOTE: Do not turn mixer motor on until chamber is filled with water, running dry will damage mechanical seal.

Step 5: Place unit power switch in On position. Mixing chamber motor starts.
Step 6: Access REM-1D controller to turn pump On/Off and for polymer output adjustment. Output can also be adjusted at pump face by varying the stroke length.

NOTE: For optimum pump performance, keep stroke frequency as high as possible. This is done by decreasing the stroke length setting. More stroke repetition with a shorter ngth is better than fewer strokes with a long oke length. If stroke length is too short, pump prime may be affected.

Step 7: Adjust water flow at mixing chamber by turning control valve. (The other control valve should be turned for post-dilution adjustment, if applicable.)

NOTE: Do not run polymer pump unless water flow is established. Polymer alone can plug discharge plumbing.

WATER PRESSURE

This unit is equipped with a flow regulator. The inlet water flow rate is maintained as pressure fluctuates. With the low dilution water rate of this unit, the regulator prevents pressure surges that could cause flow increases and affect solution concentrations. This device is factory set and not field-adjustable.

SOLUTION OUTPUT

Unit output is determined by setting pump stroke length and stroke frequency together with setting dilution water flow. Establish desired solution volume and solution concentration, then proceed.

EXAMPLE: 100 GPH (380 LPH) of .5% polymer solution desired. A 2 GPH (7.6 LPH) diaphragm pump is used.

— Determine neat polymer requirement.

(100 GPH) x (.005) = 0.5 GPH neat polymer
(380 LPH)) x (.005) = 1.9 LPH neat polymer

— Determine pump usage.

(0.5 GPH) ÷ (2 GPH) = 25% pump capacity
(1.9 LPH) ÷ (7.6 LPH) = 25% pump capacity

— Set Controls

A 2 GPH (7.6 LPH) pump @ 100% stroke length and 25 strokes per minute will deliver 0.5 GPH (1.9 LPH). However, 2 GPH (7.6 LPH) pump @ 50% stroke length and 50 strokes per minute will also deliver 0.5 GPH (1.9 LPH) with a more homogeneous mix.

NOTE: Do not exceed polymer concentrations of 1% in the PolyBlend.

MAINTENANCE

SHUTDOWNS

If out of service more than one week, flush mixing chamber.

- Turn pump off.
- Place unit power switch in On position to establish water flow for five minutes.

If out of service for more than two weeks, flush pump and mixing chamber.

- Connect pump suction to a container of mineral oil (not water).
- Place unit power switch in On position to establish water flow.
- Turn pump on and run for three minutes.
- Turn pump off.
- Continue water flow for five additional minutes.

Drain water from chamber and piping to prevent freezing.

SPARE PARTS

QTY.	PART #	DESCRIPTION
1	K2341002	Kit includes parts below:
1	SP-156PB	Pump Liquid End
1	7802910	Chamber Mechanical Seal
1	1450318	Belt, Chamber
1	1414001	Bearing, Chamber Base
1	1410002	Bearing, Chamber Top
1	28391-1	Pump Head

PUMP REPLACEMENT

QTY.	PART #	DESCRIPTION
1	AP71-156PB	Pump

MAINTENANCE

1. Clean ancillary water and/or polymer strainers weekly.
2. Flush system monthly following one week procedure.
3. Refer to the appendix for specific information on drawings, part identification, and components.

WARRANTY

Stranco warrants equipment of its manufacture and bearing its trademark to be free of defects in workmanship and materials. Stranco will at its option repair or replace at no charge any part or product of its manufacture which is returned to factory freight prepaid and found to be defective under warranty. In addition, each Stranco product is covered by a 30 day 100% buy back guarantee of customer satisfaction. If customer is dissatisfied with the Stranco product performance for any reason, he can return it to Stranco for a full refund of the sale price of the product from Stranco. The equipment must have received normal use and care and Stranco must be notified before the 30 days are up.

Warranty Term and Duration - The warranty begins with the date of shipment. However, if the product has received start-up by an authorized Stranco technician and Stranco's start-up report form has been filed with Stranco within 30 days of start-up, the warranty begins with the date of start-up. Start-up must take place within 12 months of delivery.

For products labeled PolyBlend, the warranty period is 12 months. Further, all damage to a PolyBlend system from particulates in the makeup water is excluded from warranty and is the sole responsibility of the customer.

Stranco disclaims all liability for damage during transportation, for consequential damage of whatever nature, for damage due to handling, installation, or improper operation, or damage from other causes beyond Stranco's control. Standard units not in outdoor configurations are not warranted in outdoor applications. Stranco makes no warranties either expressed or implied other than these stated. No representative has authority to change or modify this warranty in any respect. However, representatives are free to offer service contracts and preventive maintenance agreements on their own, acting independently of Stranco.

PolyBlend Owner's Manual

PB100-1

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Updated Sept. 1996

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PB100-1-09/96

PolyBlend
Model #PB100-1
INSTALLATION, OPERATION, AND MAINTENANCE INFORMATION

CONTENTS

READ THIS MANUAL BEFORE YOU INSTALL, OPERATE, OR SERVICE THIS UNIT.

OVERVIEW

SAFETY PRECAUTIONS

- ☐ Ensure that the control panel is grounded to avoid possible electrical shock or damage to equipment.
- ☐ Before servicing, turn off all power and assure power "lockout" to avoid possible electric shock.
- ☐ Disconnect external power to the control panel before removing or replacing fuses.

SPECIFICATIONS

Pump	Diaphragm
Inlet	1/2" FPT, Water Supply 5/8" Hose Barb, Polymer Supply
Outlet	1/2" FPT, Solution Discharge
Water Capacity	100 GPH Primary
Polymer Capacity	1.0 GPH
Pressure Rating	100 PSI
Electrical Supply	120/1/60, 6 Amps
Dimensions	23" H x 10" W x 16" D
Weight	51 lbs.
Motor(s)	(1) 1/6 HP, 120VAC, 3.6 AMPS

INSTALLATION

LOCATION

Select a location that provides:

- Electrical Supply
- Potable Water (Clean)
- Proximity to the Point of Use
- Easy Handling and Storage of Polymer
- Access to Unit
- Protection Against Severe Weather

UNPACKING

Examine package contents for damage. Report any to freight forwarder. Check plastic bag(s) for contents against individual packing list(s).

NOTE: Disregard any moisture; this unit was wet tested.

CONNECTIONS

- Use Teflon tape on threads. Use joint compound (pipe dope) in small amounts, if necessary.
- Do not over-tighten fittings.
- Insure that supply water pressure is **less than 100 psi.**
- Install water isolation valve with unions.
- Insure that neat polymer feed line has a **flooded suction.**

NOTE: To enhance performance, reduce the number of piping turns and elevation changes.

OPERATION

GENERAL

This PolyBlend unit will perform the following functions: meter polymer dosage, regulate mixing water, provide uniform dilution and activation, operate on-line continuously, and feed solution to the point of use.

Neat polymer from the metering pump and dilution water controlled by the solenoid valve enter the mixing chamber. Dilution and activation occur, yielding prepared solution ready for use.

Neat polymer dosage rate is adjusted at pump face or at electronic controller (REM-1D, SCR, etc.). Primary dilution (and post dilution) water are controlled by individual flow control valves.

START-UP

Step 1: Switch pump to external mode at pump face.
Step 2: Prime polymer pump, using priming kit provided with unit.
Step 3: Place unit power switch in Off position.
Step 4: Energize power circuit that feeds unit. Solenoid opens. Allow mixing chamber to fill with water by opening primary dilution water control valve.

NOTE: Do not turn mixer motor on until chamber is filled with water, running dry will damage mechanical seal.

Step 5: Place unit power switch in On position. Mixing chamber motor starts.
Step 6: Access REM-1D controller to turn pump On/Off and for polymer output adjustment. Output can also be adjusted at pump face by varying the stroke length.

NOTE: For optimum pump performance, keep stroke frequency as high as possible. This is done by decreasing the stroke length setting. More stroke repetition with a shorter length is better than fewer strokes with a long stroke length. If stroke length is too short, pump prime may be affected.

Step 7: Adjust water flow at mixing chamber by turning control valve. (The other control valve should be turned for post-dilution adjustment, if applicable.)

NOTE: Do not run polymer pump unless water flow is established. Polymer alone can plug discharge plumbing.

WATER PRESSURE

This unit is equipped with a differential pressure switch. It has been factory set. See Appendix for details.

SOLUTION OUTPUT

Unit output is determined by setting pump stroke length and stroke frequency together with setting dilution water flow. Establish desired solution volume and solution concentration, then proceed.

EXAMPLE: 100 GPH (380 LPH) of .5% polymer solution desired. A 2 GPH (7.6 LPH) diaphragm pump is used.

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- Place unit power switch in On position to establish water flow for five minutes.

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- Connect pump suction to a container of mineral oil (not water).
- Place unit power switch in On position to establish water flow.
- Turn pump on and run for three minutes.
- Turn pump off.
- Continue water flow for five additional minutes.
- Drain water from chamber and piping to prevent freezing.

SPARE PARTS

QTY.	PART #	DESCRIPTION
1	K2341001	Kit includes parts below:
1	SP-86PB	Pump Liquid End
1	7802910	Chamber Mechanical Seal
1	1450318	Belt, Chamber
1	1414001	Bearing, Chamber Base
1	1410002	Bearing, Chamber Top
1	26050-1	Pump Head

PUMP REPLACEMENT

QTY.	PART #	DESCRIPTION
1	AP51-86PB	Pump

MAINTENANCE

1. Clean ancillary water and/or polymer strainers weekly.
2. Flush system monthly following one week procedure.
3. Refer to the appendix for specific information on drawings, part identification, and components.

WARRANTY

Stranco warrants equipment of its manufacture and bearing its trademark to be free of defects in workmanship and materials. Stranco will at its option repair or replace at no charge any part or product of its manufacture which is returned to factory freight prepaid and found to be defective under warranty. In addition, each Stranco product is covered by a 30 day 100% buy back guarantee of customer satisfaction. If customer is dissatisfied with the Stranco product performance for any reason, he can return it to Stranco for a full refund of the sale price of the product from Stranco. The equipment must have received normal use and care and Stranco must be notified before the 30 days are up.

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Stranco disclaims all liability for damage during transportation, for consequential damage of whatever nature, for damage due to handling, installation, or improper operation, or damage from other causes beyond Stranco's control. Standard units not in outdoor configurations are not warranted in outdoor applications. Stranco makes no warranties either expressed or implied other than these stated. No representative has authority to change or modify this warranty in any respect. However, representatives are free to offer service contracts and preventive maintenance agreements on their own, acting independently of Stranco.

Location of Differential Pressure Switch

The high pressure port connects to the inlet manifold between the solenoid valve and the rotameter/rate-adjusting valve. The low pressure port connects to the discharge side of the rotameter.

Function of Differential Pressure Switch

The differential pressure switch ensures sufficient water flow is present before the polymer pump is energized. This integral, automatic safety feature eliminates the problem of overfeeding neat polymer to an application without proper dilution.

In operation, the rate valve is adjusted to produce the desired flow through the system. This causes a pressure drop to occur across the valve which is applied to the differential pressure switch.

If supply pressure decreases enough to affect flow rate or if back pressure between the PolyBlend and the point of solution application increases enough to affect flow rate, the differential pressure across the rotameter and valve decreases. This causes power to be interrupted to the polymer pump and prevents damage to the mixing system caused by extremely high viscosity developing in the mixing chamber.

NOTICE: **If system pressure or flow are <u>not adequate</u>, investigate the *cause* of lack of flow. (For example, inadequately sized piping can produce inadequate flow.) To avoid undesirable water dilution conditions and damage to equipment, do not bypass or adjust the differential pressure switch for a lower pressure/flow setting.**

Question: *Why doesn't the polymer pump turn off when I turn the water off using the rotameter?*

The differential pressure switch senses flow on either side of a pressure drop. Because the rotameter is the sensing point, the rotameter closing is the only cause of loss of flow that the differential pressure switch cannot see.

Test the differential switch by turning off the source water or the discharge flow. (See step 5 on the next page.)

Adjusting the Differential Pressure Switch

Adjust the PolyBlend differential pressure switch only if pressure and flow to the system **are adequate**.

The adjustment logic is the **opposite** of what you might expect. The PolyBlend differential pressure switches have a red light (on the left side) that lights up whenever source water flow is too low and the polymer pump is disabled. The pump stops pumping when the flow is too low. Low flow may be from lack of incoming water or from too much back pressure on the outgoing side.

	Adjustment		**System Reaction**
1.	Turn the PolyBlend rotameter until water flow is at **maximum** on the flow gauge.		
2.	Screw in the *differential pressure knob* until the red alarm light goes on.		Polymer pump is disabled.
3.	Back off the differential pressure knob until the red alarm light goes off.		The pump starts again.
4.	4a. If you want very close control of flow, leave the knob at this setting. *At this setting, any loss of flow (as observed by the rotameter) results in the pump being disabled.*	4b. If you want to make the system "more forgiving" prior to shutdown, continue to turn the knob another 1-2 turns. *The further you turn the knob, the more flow can be lost before the pump is disabled.*	Step 4 determines how "forgiving" the system is before it shuts down due to inadequate flow.
5.	To test sensitivity and operation, turn off the water at the source *or* the solution at the discharge. The float in the flow meter will fall more for the control knob setting described in step 4b than for 4a (above).		As the source or discharge is turned off, the float in the flow meter falls and the pump is disabled.
6.	Set the rotameter for the desired flow.		Retest (as in step 5).

DIAPHRAGM PUMP INFORMATION

WARNING: ALWAYS wear protective clothing, face shield, safety glasses and gloves when working near or performing any maintenance or replacement on your pump. See MSDS Sheet from polymer supplier for additional precautions.

OUTPUT ADJUSTMENT CONTROLS

In most external controlled pumps the uppermost knob serves as speed control. Graduations for the Speed Knob appear directly on the face of the control panel. The largest knob below is Stroke Control.

1. Speed Adjustment: Speed control provides adjustment of the percent of maximum strokes per minute. Turning this clockwise increases stroke frequency. **Note A7 Series Only:** When operating pump in external mode, the speed control knob should be fully turned counter clockwise. A click indicates pump is in external mode.

2. Stroke Adjustment; Stroke control provides adjustment of percent of maximum Liquifram® (diaphragm) travel. Turning this knob clockwise increases percent output per stroke. Only adjust while pump is running.

PRIMING THE PUMP

Hold tip of syringe firmly in fitting with one hand while using the other hand to pull back on plunger. Repeat until a small amount of polymer is drawn into the syringe. The pump is now primed.

PUMP CALIBRATION

Perform calibration if your system application requires it. Normally, calibration is NOT required.

You will need:
-A watch
-A calculator
-Calibrated cylinder (with at least 1000 ml capacity.
- Length of hose or tubing (same I.D. as pump ports).

1. Maintain all usual connections to the PolyBlend unit except disconnect the polymer suction line at pump input. The flow meter and pump settings should be those used for normal service.

2. Connect hose or tubing to the pump input. Place the free end of the tubing in the graduated cylinder.

3. Fill the cylinder with polymer to its measured capacity (for example, 1000 ml etc.).

4. Turn on the metering pump. Allow the pump to run until all air has been exhausted from the tubing and pump and polymer is injected into the mixing chamber.

5. Stop the pump.

6. Refill the cylinder to the measured capacity.

7. Start the pump again, and start timing as the pump runs. For best results, let the pump run long enough to pump at least half of the polymer out of the graduated cylinder. (In general, the longer the calibration period, the greater the accuracy of the measurement).

8. Stop the pump. Record the time and the level of the polymer remaining in the cylinder. Fill in the following equation to find the volume of polymer pumped per one unit of time (a minute, an hour, or a day).

$$\frac{\text{Starting ml - Remaining ml}}{\text{Calibration Period}} = \text{ml/TIME}$$

9. Compare the actual volume pumped to the desired volume, and adjust pump controls.

10. Check volume again to confirm the new settings.

PRESSURE CONTROL

(B and C series only)

A capped potentiometer is located on the face plate of the diaphragm pump. This potentiometer is for pressure control or power to the pump solenoid. Since the PolyBlend unit is equipped with a 20 PSI backpressure/check valve, the potentiometer should be set for full power or full clockwise.

NOTE: This is preset at the factory. In a case where obvious over-pumping is present, this potentiometer may be adjusted counter-clockwise.

Liquifram® (Diaphragm) Replacement

When replacing the Liquifram® , valve balls, seal rings and the injection check valve spring should also be replaced.

1. Carefully depressurize, drain and disconnect the pump discharge and suction lines. Place the suction tubing into a container of mineral oil. Turn the pump on to flush the head assembly. Once the pump head has been flushed, lift the suction tubing out of the mineral oil and continue to pump air into the pump head until the pump head is purged.

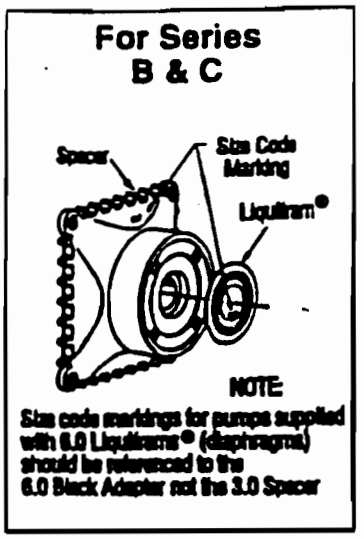
2. Start the pump. While running, set the stroke knob to zero and turn the pump off.

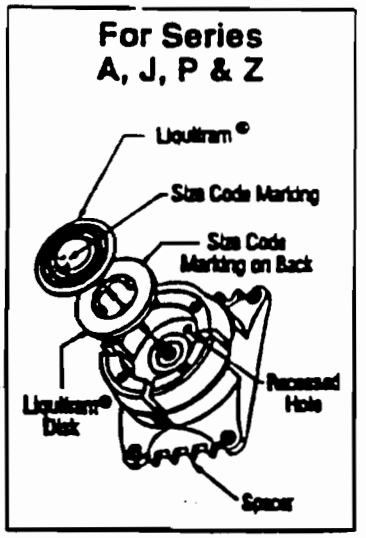
NOTE: See Section on proper zeroing.

3. With the unit off, unscrew the Liquifram® by carefully grasping the outer edge of the Liquifram® and turning it counter clockwise. Discard old Liquifram® . Remove the Liquifram® disk if so equipped (located behind the Liquifram®) and check that the size code matches the size code on the replacement Liquifram® (see illustration).

4. Reinstall the disk so the alignment pin on the disk (if present) seats in the recessed hole in the EPU.

WARNING: Take care not to scratch the Teflon face of the new Liquifram® .



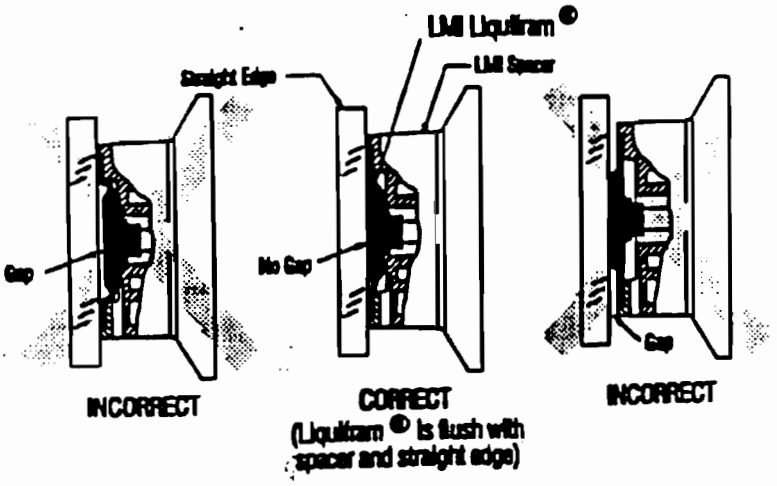


5. Start the pump and turn the stroke knob to the setting indicated on the Stroke Setting Chart which matches the pump model number located on the pump dataplate. With the pump stroking (running), screw on the new Liquifram® clockwise until the center begins to buckle inward. Stop the pump.

Liquifram® Stroke Setting Chart

Pump Series	Stroke Knob Setting
All A, B72, C72	90%
C77	70%

6. Grasp the outer edge of the Liquifram® and adjust by screwing it in or out so that the center of the Liquifram® is flush with the outside of the spacer edge (see illustration).



7. Once the Liquiframe® is properly positioned, remount the pump head to the spacer using the four (4) screws. Tighten in a crisscross pattern. After one week of operation, recheck the screws and tighten if necessary.

Seal Ring, Ball and Injection Check Valve Spring Replacement

1. Carefully depressurize, drain and disconnect the discharge and suction lines. Place the suction tubing into a container of mineral oil. Turn the pump on to flush the head assembly. After flushing, lift the suction tubing out of the mineral oil and continue to pump air into the pump head until the pump head is purged. If the liquid cannot be pumped due to Liquiframe® rupture, with protective gloves, carefully disconnect the tubing and four screws to remove the head. Immerse the head in mineral oil or other neutralizing solution.

IMPORTANT: Before disassembling valves, note the orientation of seal ring and ball. (See illustration).

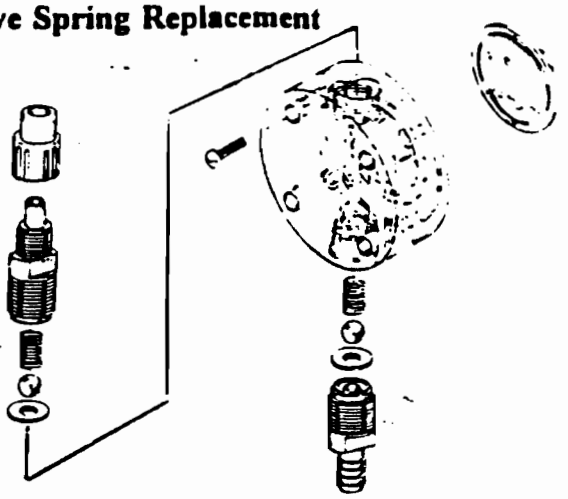
2.Carefully disconnect one tubing connection and fitting at a time and remove the worn seal ring and ball. Carefully loosen sealing by prying side to side using a small screw driver through the center hole of the seal ring.

3. Install new seal ring and ball in each location.

IMPORTANT: Note correct orientation.

4.Install the new spring in the Injection Check Valve.

Seal Ring, Ball and Injection Check Valve Spring Replacement



Order of Installation

Checking Pump for Proper Zeroing (Stroke Knob)

1. With pump running, turn stroke knob counter clockwise toward zero or end of black or red band.

2. LISTEN to the clicking as the pump is running. The pump should operate quietly at the zero position (no clicking).

3. If the pump continues to click at zero or stops clicking before zero is reached, the pump zero must be reset.

Type I - Push on Knob Rezeroing and Stroke Knob Disassembly and Assembly

1. Remove stroke knob from the pump by grasping the knob firmly and pulling it toward you.

2. Pry off the yellow cap.

3. Place the knob on a flat surface.

4. Using needlenose pliers, squeeze the inner section together while lifting the outer section up.

5. Push the inner section back onto the "D" shaped stroke shaft.

6. With the pump running, zero the pump by turning the inner section of the knob counter clockwise until the pump stops clicking.

7. Position the outer section of the knob so that the pointer aligns with zero on the nameplate or end of the black or red band.

8. Push down on the outer section (a snap sound indicates parts are locked together).

9. Replace the yellow cap over the outer section of the knob, aligning the tabs on the cap with the slots inside the knob.

Type II Collet Knob
Rezeroing and Stroke Knob Disassembly and Assembly

1. Remove Yellow Cap.

2. Hold knob with soft jaw pliers.

3. Disconnect knob by loosening 5/16" (8mm) collet nut. There is no need to remove nut.

4. Remove knob by pulling towards you.

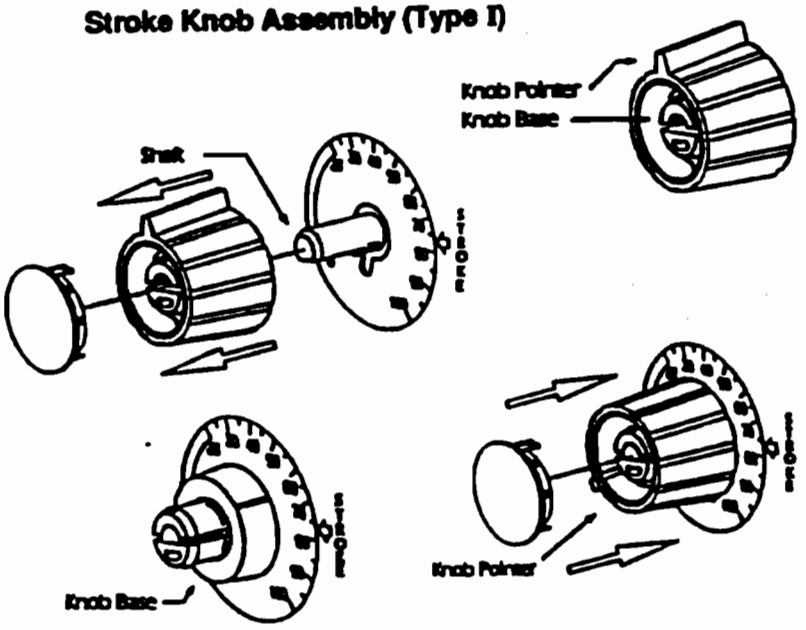
5. With pump running, zero the pump using a screw driver to turn the stroke shaft counter-clockwise until the pump just stops clicking.

6. Pump is now zeroed.

7. Position knob at zero, or the end of the low range band, and tighten 5/16" (8mm) collet nut.

8. Replace yellow cap.

Stroke Knob Assembly (Type I)



stranco®

STRANCO®
Water Quality Control

ACCESSORIES

Digital Display Pump Controller

The Stranco REM-1D digital display pump controller serves as either a pump remote control station or proportional pump controller (4-20 mA input) or both.

REM-1D can be used to vary the output of any Liquid Metronics Incorporated (LMI) series A7, B7 or C7 metering pumps (pump must be in external mode.) Simply connect either end of the four conductor cable (four conductor cable and connectors are standard) to the external input jack of the LMI pump and the other end of the four conductor cable to the bottom of the controller.

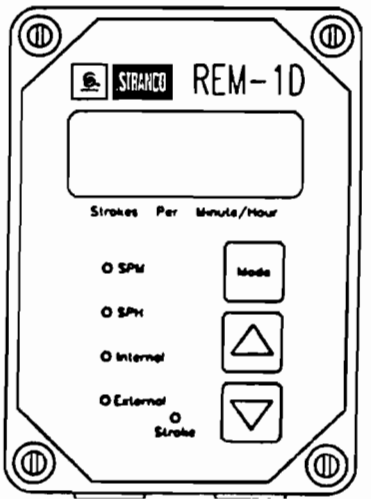
Power is supplied by the 15 VDC source from the LMI pump through the four conductor cable.

Controller output in the form of contact closures of 80 ms duration triggers the LMI pump. In the internal mode, output is 0-100 strokes per hour (SPH) or 0-100 strokes per minute (SPM). Up and down, pressure sensitive, membrane keys vary the output shown on an LCD digital display.

In the external mode, output is from 0-100 SPH or 0-100 SPM directly proportional to the 4-20 mA analog input signal. Ten feet, three conductor cable and connectors are supplied standard, for 4-20mA connection. Controller impedance is 220 ohms. Zero and span adjustments may be done through outside keys.

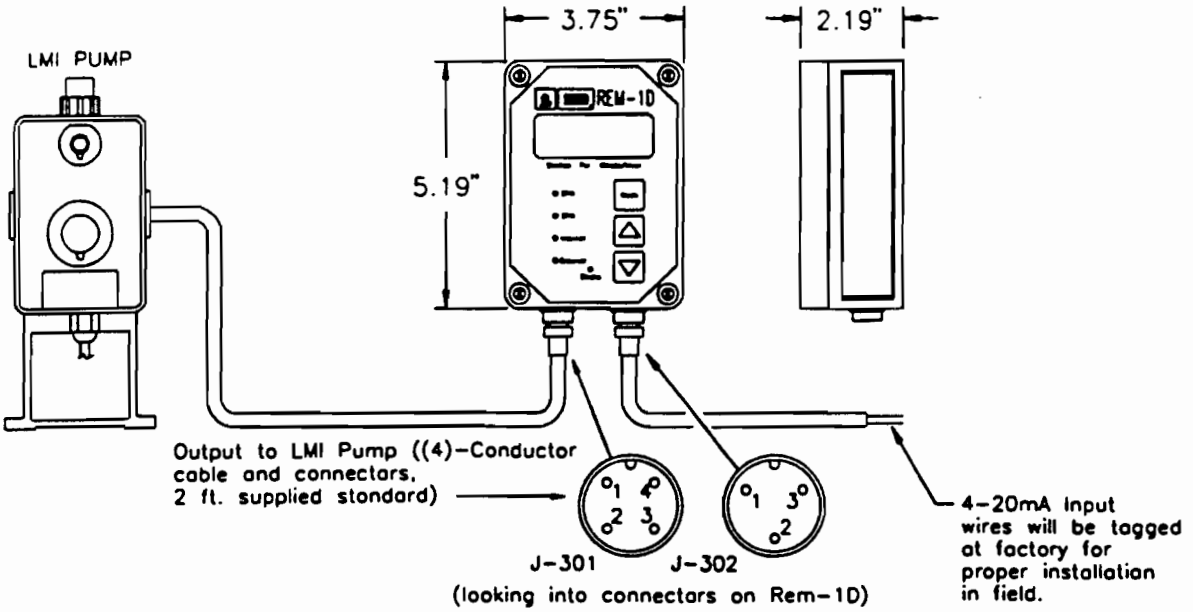
In the "OFF" position, the 15 VDC power source will be present but the controller output will be zero. The display will read "OFF."

The polycarbonate plastic Nema 4X enclosure may be easily wall-mounted near to or remote to the associated pump using standard cable/connector sets available from Stranco.



REM-1D

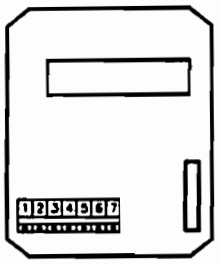
Revised 6-96



NOTE : J-301 PIN NUMBERS CORRESPOND TO IDENTICAL PIN NUMBERS ON LMI PUMP REMOTE SIGNAL INPUT CONNECTORS.

STRANCO PART NOS.

RM1974183	CABLE
2723001	3 PIN CONNECTOR
25643	4 PIN CONNECTOR



CONNECTIONS INSIDE REM-1	J-301, J-302 CONNECTORS	CABLE CONNECTIONS		
T #2 WHITE	J-301, Pin #1	RED	Future Use	4-Pin Connector J-301
T #4 BLACK	J-301, Pin #3	WHITE	Power - (Common)	
T #3 GREEN	J-301, Pin #2	GREEN	Pump Trigger (+15VDC)	
T #1 RED	J-301, Pin #4	BLACK	Power + (+15VDC)	
T #6 BLACK	J-302, Pin #2	BLACK	Signal Common	3-Pin Connector J-302 "External" Control 4-20mADC 220Ω Input Impedance
T #7 GREEN	J-302, Pin #1	WHITE	Shield •• (Mech. Ground)	
T #5 RED	J-302, Pin #3	RED	4-20 mA Signal	

ZERO AND SPAN ADJUSTMENTS

Press Mode Key to enter Externol Mode.

1. To Calibrate 4mA Point
   - A. Input 4mA into REM-1D
   - B. Press and Hold Down Arrow Key
   - C. Press Mode Key (still pressing Down Arrow Key).
2. To Calibrate 20mA Point
   - A. Input 20mA into REM-1D
   - B. Press and Hold Up Arrow Key
   - C. Press Mode Key (still pressing Up Arrow Key).
3. To Set Display Ranges
   - A. Press all 3 keys Simutoneously and Release. "SPM" and "SPH" LED'S will light up.
   - B. Use UP/DOWN Arrow keys to set Max. Display Range.
   - C. Press Mode Key to accept and then "INTERNAL" and "EXTERNAL" LED'S will light up.
   - D. Use UP/DOWN Arrow keys to set Min. Display Range.
   - E. Press Mode Key to accept and Return to NORMAL OPERATION.

STRANCO
Water Quality Control

STRANCO, INC.
P. O. Box 389
595 Industrial Drive
Bradley, IL 60915
U.S.A.
Tel. 800-882-6466
Tel. 815-932-8154
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FAX: +.44.(0)1323.646035

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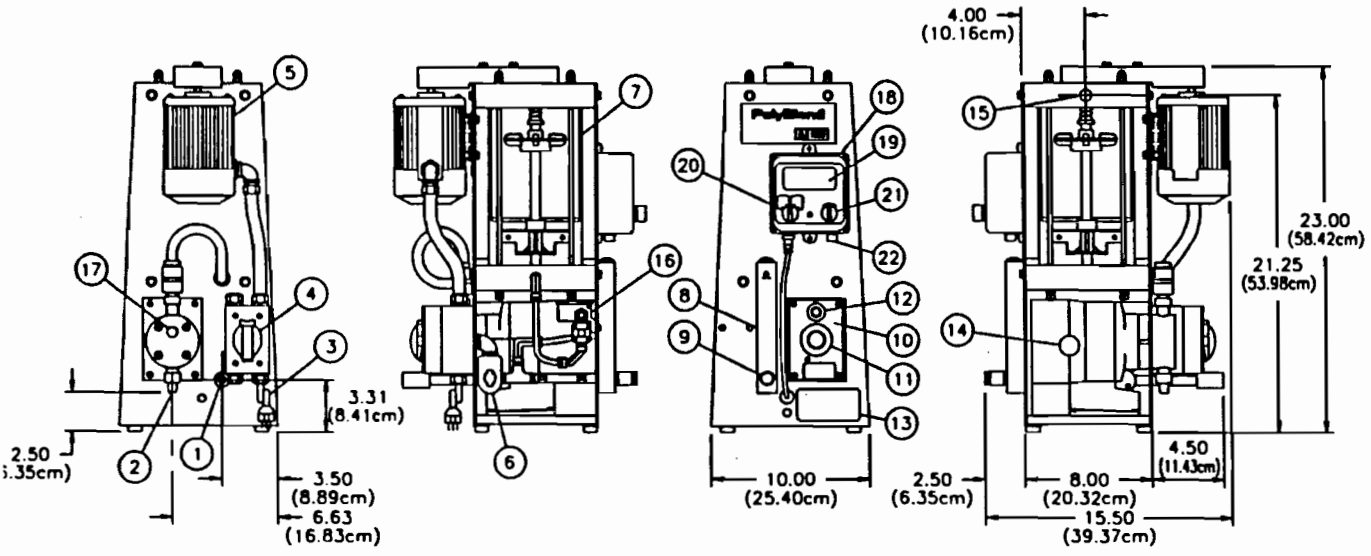
24/9 Powells Road
Brookvale NSW 2100
Australia
Tel. +.61.2.9905.7611
FAX: +.61.2.9905.3712

Visit our Internet site at http://www.stranco.com

DRAWING NUMBER:
PB100

PB UNIT	PUMP OUTPUT	ROTAMETER RANGE
PB16-0.4DP	0-0.42GPH	1-16GPH
PB16-1DP	0-1GPH	1-16GPH
PB16-2DP	0-2GPH	1-16GPH
PB50-0.4DP	0-0.42GPH	4-50GPH
PB50-1DP	0-1GPH	4-50GPH
PB50-2DP	0-2GPH	4-50GPH
PB100-0.4	0-0.42GPH	10-100GPH
PB100-0.6	0-0.6GPH	10-100GPH
PB100-1	0-1GPH	10-100GPH
PB100-2	0-2GPH	10-100GPH
PB100-1A	0-3.8LPH	38-375LPH
PB100-0.4K	0-1.6LPH	38-375LPH
PB100-1K	0-3.8LPH	38-375LPH
PB100-2K	0-7.6LPH	38-375LPH



KEY	DESCRIPTION
1	WATER INLET, 1/2" (F)NPT
2	POLYMER INLET, 5/8" O.D. BARB
3	POWER CORD
4	MIXER MOTOR SWITCH w/THERMAL OVERLOAD
5	MIXER MOTOR
6	SOLENOID VALVE, (WATER)
7	MIXING CHAMBER
8	ROTAMETER
9	RATE VALVE
10	DIAPHRAGM PUMP
11	STROKE LENGTH KNOB

12	STROKE RATE/EXTERNAL SELECTOR SWITCH
13	SERIAL PLATE
14	EXTERNAL INPUT SIGNAL CONNECTOR
15	SOLUTION OUTLET, 1/2" (F)NPT
16	DIFFERENTIAL PRESSURE SWITCH
17	PRIMING PORT, (POLYMER)
18	DIGITAL DISPLAY PUMP CONTROLLER, (REM-1)
19	STROKE RATE LCD DISPLAY
20	INTERNAL/OFF/EXTERNAL SELECTOR SWITCH
21	STROKE RATE POTENTIOMETER
22	4-20mADC INPUT

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON DECIMALS/FRACTIONS
X/X ±1/16
.XX ±0.03
.XXX ±0.010
ANGLES ±1.0°-0°
SURFACES 250

DRAWN BY: BRIAN DISMANG — DATE: 01-03-94
CHECKED BY: JRC (ON FILE) — 06-15-95
APPROVED BY: WMO (ON FILE) — 06-28-95

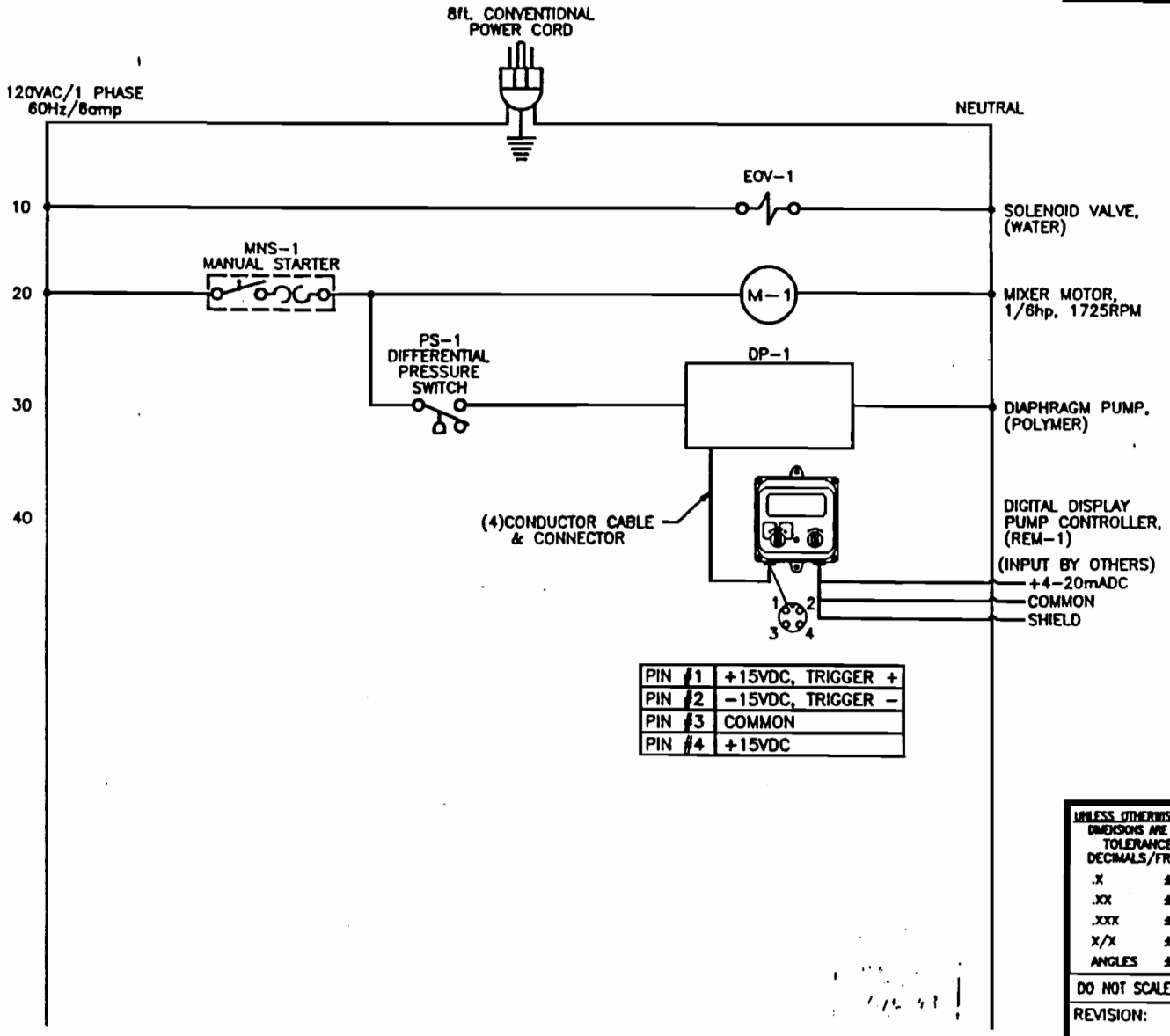
DO NOT SCALE DRAWING
WEIGHT: 56 lbs.
REVISION: 3
REVISED BY: GEORGE GIDDINGS — DATE: 06-11-96

STRANCO WATER QUALITY CONTROL
P.O. BOX 389, BRADLEY, IL 60915
PH: (815)932-8154 FAX: (815)932-0674

DRAWING TITLE:
GENERAL ARRANGEMENT
PB100
(STANDARD UNIT)

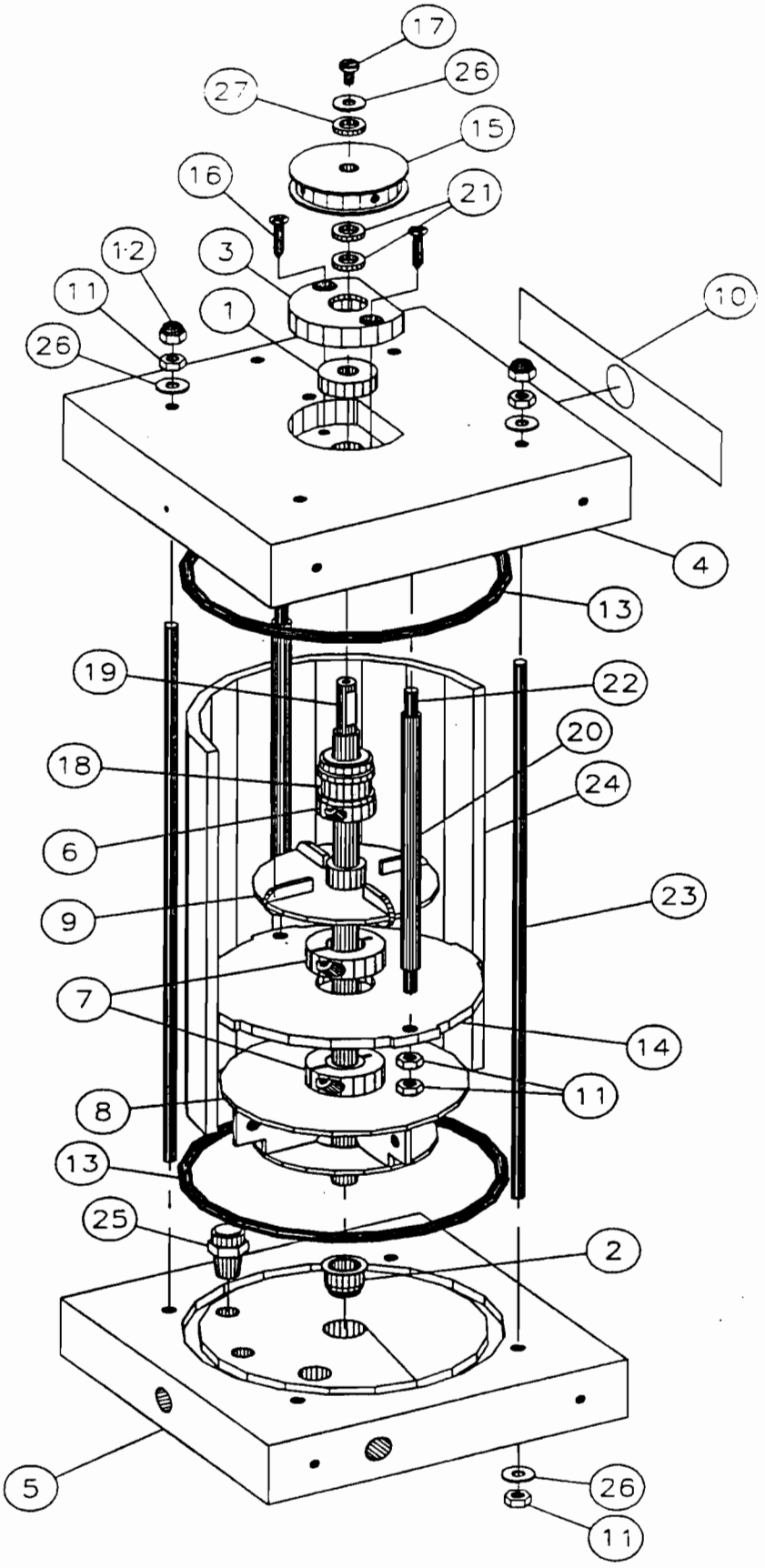
SCALE: 1/8 = 1
SHEET 1 OF 1
PART NUMBER: N/A
DRAWING NUMBER: PB100

RAWING NUMBER:
SES-0003



PIN #1	+15VDC, TRIGGER +
PIN #2	-15VDC, TRIGGER -
PIN #3	COMMON
PIN #4	+15VDC

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON DECIMALS/FRACTIONS .X ±0.06" .XX ±0.03" .XXX ±0.010" X/X ±1/32" ANGLES ±0.0-30'	DRAWN BY: BRIAN DISMANG	DATE: 02-23-09	STRANCO WATER QUALITY CONTROL P.O. BOX 389, BRADLEY, IL 60915 PH: (815)932-8154 FAX: (815)932-0674
	CHECKED BY:	7/11/11	DRAWING TITLE: ELECTRICAL SCHEMATIC SERIES PB100 & PB200 DIAPHRAGM
	APPROVED BY: RLM	7/11/11	
DO NOT SCALE DRAWING	WEIGHT: N/A		SCALE: N/A / SHEET 1 OF 1
REVISION: 4	REVISED BY: GEORGE GIDDINGS	DATE: 06-09-93	PART NUMBER: N/A / DRAWING NUMBER: SES-0003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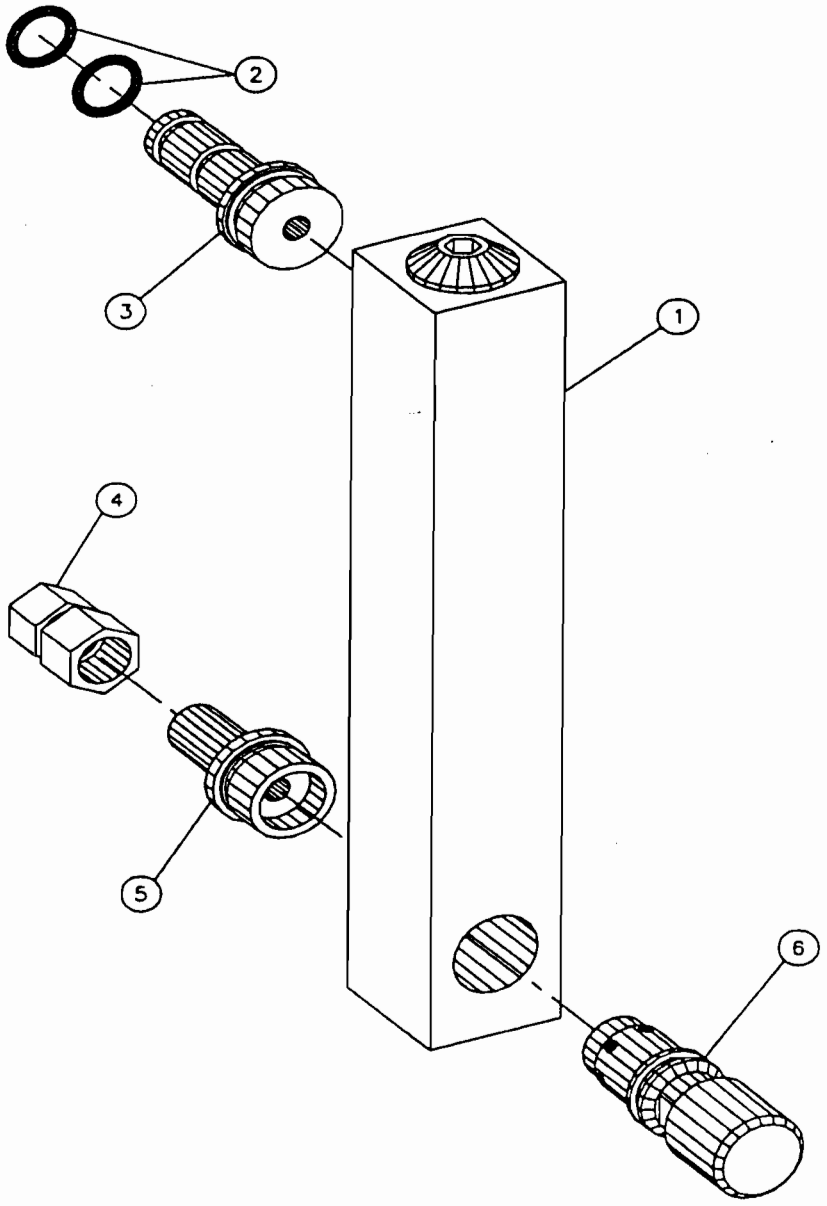
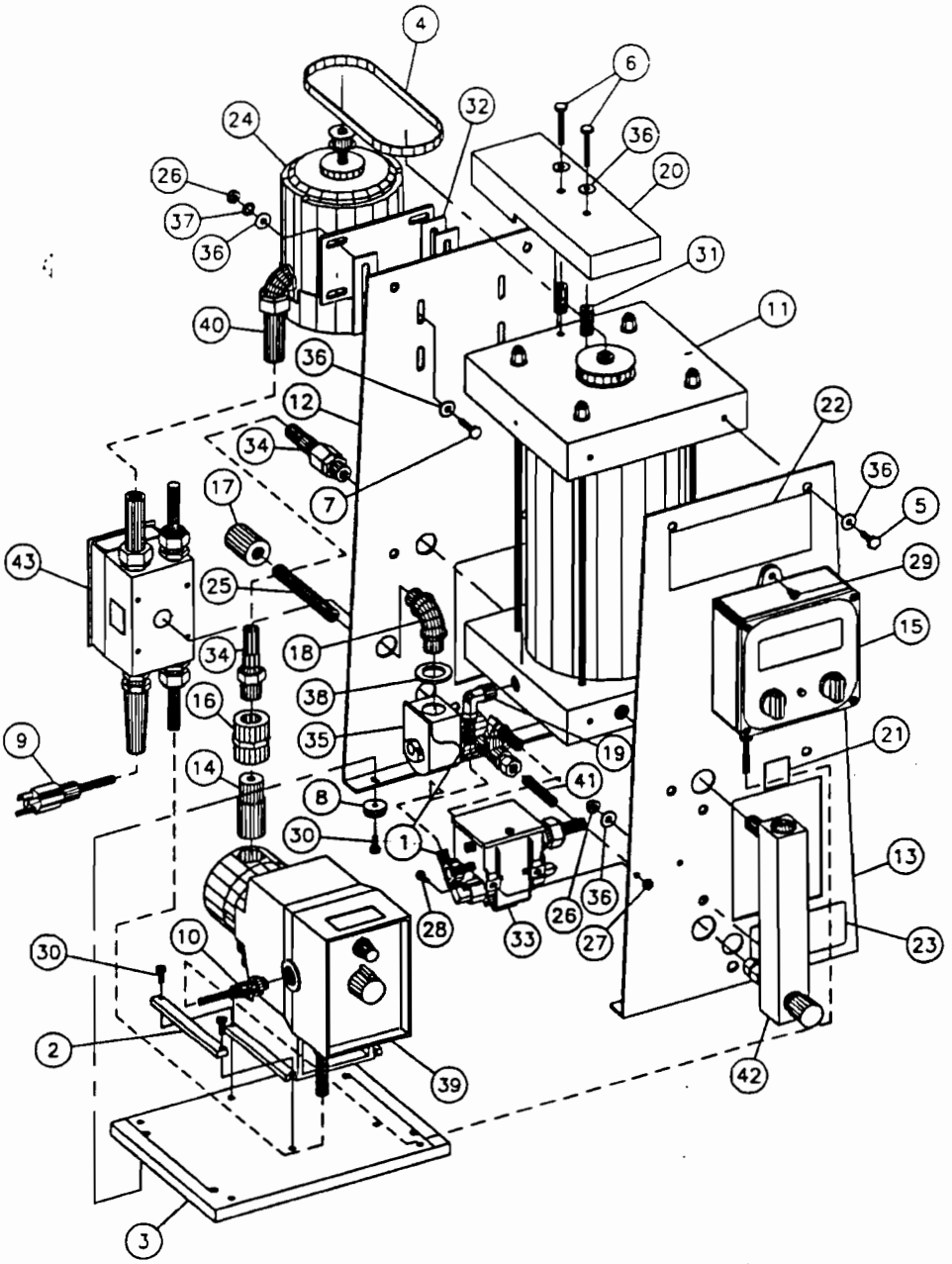
FLOWMETER

ITEM	PART NO.	DESCRIPTION	QTY.	UM
1	4291102	FLOWMETER, KING, 100GPH	1	EA
2	6091301	O-RING, BUNA N	2	EA
3	1040093	ADAPTER, SPUD	1	EA
4	2735634	CONNECTOR, TUBE, 1/4" FPT X 3/8" OD COMP.	1	EA
5	1048401	ADAPTER, FLOWMETER	1	EA
6	9579301	VALVE, KING	1	EA

Flowmeter Assembly - P/N 4301102

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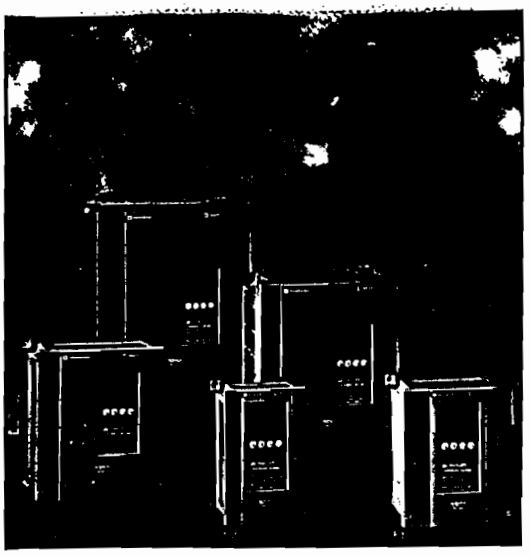
OVERALL

ITEM	P/N	DESCRIPTION	QTY	UM
1	10342	TUBING, 3/8" OD X 1/4" ID, POLYETHYLENE	1.00	FT
2	10746	BRACKET, PUMP	2.00	EA
3	1364001	BASE SUB-ASSY. PB100-0	1.00	EA
4	1450318	BELT	1.00	EA
5	1600312	BOLT, HH, 1/4-20 X 3/4 SS	8.00	EA
6	1600324	BOLT, HH, 1/4-20 X 1-1/2 SS (CAP SCREW)	2.00	EA
7	1600366	BOLT, HH, 1/4-20 X 1 SS	4.00	EA
8	1890001	BUMPER, RUBBER	4.00	EA
9	1983001	CABLE, ASSY, 110V, 8FT, GROUNDED, MALE PLG,16/3	1.00	EA
10	1984005	CABLE ASSY.	1.00	EA
11	*******	CHAMBER ASSY, MIXING SML FRM (SEE SECTION)	1.00	EA
12	2383001	CHASSIS, BACK	1.00	EA
13	2383002	CHASSIS, FRONT	1.00	EA
14	26033	VALVE	1.00	EA
15	2846006	CONTROLLER, REM-1D	1.00	EA
16	2930004	CPLG, PVC, SCH 80 1/2 FPT	1.00	EA
17	2930420	CPLG, RED, SS 1/2 X 1/4 FT X T	1.00	EA
18	3579864	ELBOW, CONDUIT	1.00	EA
19	3581604	ELBOW, 90, BRASS 3/8 OD X 3/8 MPT	1.00	EA
20	4681310	BELT GUARD	1.00	EA
21	5551209	LABEL, WATER FLOW	2.00	EA
22	5551210	LABEL, POLYBLEND	1.00	EA
23	5554000	LABEL, SERIAL PLATE	1.00	EA
24	5902001	MOTOR	1.00	EA
25	5963028	NIPPLE, SS 1/4 X 4"	1.00	EA
26	6020031	NUT, 1/4-20, HEX SS	6.00	EA
27	6020962	NUT, 8-32, HEX	2.00	EA
28	7771558	SCREW, MACH, SS PAN HD, PHIL, 8-32 X 1/2	2.00	EA
29	7772506	SCREW, MACH, 304SS PAN HD, SLTD, 10-32 X 3/8	2.00	EA
30	7772508	SCREW, MACH, 10-32 X 1/2, SLTD PS, SS	8.00	EA
31	8140001	SPACER	2.00	EA
32	8141001	SPACER, MOTOR SHIM	3.00	EA
33	8724903	SWITCH, DIFF. PRESSURE	1.00	EA
34	9414002	TUBE BRAIDED SS, 1/2" MPT X 3/8" MPT X 14" LG*	1.00	EA
35	9571301	VALVE SOLENOID	1.00	EA
36	9740300	WASHER, SS, FLAT 1/4"	9.00	EA
37	9740330	WASHER, SS, INT TOOTH, 1/4"	4.00	EA
38	9748300	WASHER, SS, FLAT 1/8"	1.00	EA
39	*******	PUMP (SEE SECTION)	1.00	EA
40	RM2702060	CONDUIT, SEALTITE 3/8"	1.00	FT
41	RM9414061	TUBE, RIGID 304 SS 3/8"OD X 1/4"ID	1.00	FT
42	*******	FLOWMETER (SEE SECTION)	1.00	EA
43	1672002	BOX JUNCTION SUB-ASSY.	1.00	EA



Instruction Bulletin
52012-008-01
March 1997
Price $10.00

ALTIVAR® 18

Adjustable Speed Drive Controllers for Asynchronous Motors

User's Manual

Telemecanique

SQUARE D

⚠ DANGER

HAZARDOUS VOLTAGE.

- Read and understand this bulletin in its entirety before installing or operating ALTIVAR 18 drive controllers. Installation, adjustment, repair, and maintenance of these drive controllers must be performed by qualified personnel.
- Disconnect all power before servicing drive controller. WAIT ONE MINUTE until DC bus capacitors discharge, then measure DC bus capacitor voltage (see pages 39 and 40) to verify DC voltage is less than 45 V. The DC bus LED is not an accurate indication of the absence of DC bus voltage.
- DO NOT short across DC bus capacitors or touch unshielded components or terminal strip screw connections with voltage present.
- Install all covers before applying power or starting and stopping the drive controller.
- User is responsible for conforming to all applicable code requirements with respect to grounding all equipment. For drive controller grounding points, refer to Figure 5 on page 11.
- Many parts in this drive controller, including printed wiring boards, operate at line voltage. DO NOT TOUCH. Use only electrically insulated tools.

Before servicing drive controller:

- Disconnect all power.
- Place a "DO NOT TURN ON" label on drive controller disconnect.
- Lock disconnect in open position.

Failure to follow these instructions will result in death or serious injury.

TABLE OF CONTENTS

RECEIVING AND PRELIMINARY INSPECTION

Before installing the ALTIVAR® 18 (ATV18) drive controller, read this manual and follow all precautions:

- Before removing the drive controller from its packing material, verify it is not damaged from shipping. Any damage to the packing carton usually indicates improper handling. If any damage is found, notify the carrier and your Square D representative.
- After removing the drive controller from its packaging, visually inspect the exterior for shipping damage. If any shipping damage is found, notify the carrier and your sales representative.
- Verify that the drive controller nameplate and label conform to the packing slip and corresponding purchase order.

⚠ CAUTION

EQUIPMENT DAMAGE HAZARD

Do not operate or install any drive controller that appears damaged.

Failure to follow this instruction can result in injury or equipment damage.

STORING AND SHIPPING

If the drive controller is not being immediately installed, store it in a clean, dry area where the ambient temperature is between -25 and +65 °C (-13 to +149 °F). If the drive controller must be shipped to another location, use the original shipping material and carton to protect the drive controller.

TECHNICAL CHARACTERISTICS

Table 1: Technical Characteristics: 200 V -15% to 240 V +10%, 50/60Hz ± 5%, Single-Phase Input, Three-Phase Output

Drive Controller Catalog Number	Input Line Current [1] Single Phase 200 V	240 V	Motor Power		Rated Output Current (In)	Transient Output Current [2]	Total Dissipated Power @ Rated Load	Short Circuit Rating
	A	A	kW	hp	A	A	W	A rms sym.
ATV18U09M2	4.4	3.9	0.37	0.5	2.1	3.2	23	1,000
ATV18U18M2	7.6	6.8	0.75	1	3.6	5.4	39	1,000
ATV18U29M2	13.9	12.4	1.5	2	6.8	10.2	60	1,000
ATV18U41M2	19.4	17.4	2.2	3	9.6	14.4	78	1,000

[1] Values correspond to the amount absorbed by drive controllers supplied by mains with fault capacity equal to short-circuit rating indicated in table and under nominal conditions of load and speed of the associated motor, without additional inductance.
[2] For 60 seconds.

Table 2: Technical Characteristics: 200 -15% to 230 V +10%, 50/60 Hz ± 5%, Three-Phase Input, Three-Phase Output

Drive Controller Catalog Number	Input Line Current [1] Three Phase 200 V	230 V	Motor Power		Rated Output Current (In)	Transient Output Current [2]	Total Dissipated Power @ Rated Load	Short Circuit Rating
	A	A	kW	hp	A	A	W	A rms sym.
ATV18U54M2	16.2	14.9	3	-	12.3	18.5	104	5,000
ATV18U72M2	20.4	18.8	4	5	16.4 [3]	24.6	141	5,000
ATV18U90M2	28.7	26.5	5.5	7.5	22 [3]	33	200	22,000
ATV18D12M2	38.4	35.3	7.5	10	28 [3]	42	264	22,000

[1] Values correspond to the amount absorbed by drive controllers supplied by mains with fault capacity equal to short-circuit rating indicated in table and under nominal conditions of load and speed of the associated motor, without additional inductance.
[2] For 60 seconds.
[3] Rated output currents shown are for switching frequencies of 2.2 to 4 kHz. If switching frequency is > 4 kHz and ≤ 8 kHz, derate output current by 5%. If switching frequency is > 8 kHz, derate output current by 10%. See page 37 for adjustment of switching frequency.

Table 3: Technical Characteristics: 380/220 V [1] -15% to 460/270 V [1] +10%, 50/60 Hz ± 5%, Three-Phase Input, Three-Phase Output

Drive Controller Catalog Number	Input Line Current [2] Three Phase 380 V	460 V	Motor Power		Rated Output Current (In) [4]	Transient Output Current [3]	Total Dissipated Power @ Rated Load	Short Circuit Rating
	A	A	kW	hp	A	A	W	A rms sym.
ATV18U18N4	2.9	2.7	0.75	1	2.1	3.2	24	5,000
ATV18U29N4	5.1	4.8	1.5	2	3.7	5.6	34	5,000
ATV18U41N4	6.8	6.3	2.2	3	5.3	8	49	5,000
ATV18U54N4	9.8	8.4	3	-	7.1	10.7	69	5,000
ATV18U72N4	12.5	10.9	4	5	9.2	13.8	94	5,000
ATV18U90N4	16.9	15.3	5.5	7.5	11.8	17.7	135	22,000
ATV18D12N4	21.5	19.4	7.5	10	16	24	175	22,000
ATV18D16N4	31.8	28.7	11	15	22	33	261	22,000
ATV18D23N4	42.9	38.6	15	20	29.3	44	342	22,000

[1] Suitable for use on neutral grounded systems only.
[2] Values correspond to the amount absorbed by drive controllers supplied by mains with fault capacity equal to short-circuit rating indicated in table and under nominal conditions of load and speed of the associated motor, without additional inductance.
[3] For 60 seconds.
[4] Rated output currents shown are for switching frequencies of 2.2 to 4 kHz. If switching frequency is > 4 kHz and ≤ 8 kHz, derate output current by 5%. If switching frequency is > 8 kHz, derate output current by 10%. See page 37 for adjustment of switching frequency.

SPECIFICATIONS

Table 4: Specifications

Environment	
Degree of Protection	NEMA Open [1] IP31 without removal of grey tape from the top of the drive controller IP20 with removal of grey tape from the top of the drive controller
Resistance to vibrations	0.6 g from 10 to 50 Hz 2 g from 50 to 150 Hz
Pollution degree	Pollution degree 2 according to NEMA ICS-1 and IEC 664. Protect the drive controller against dust, corrosive gas, and falling liquid.
Maximum relative humidity	93% maximum, non-condensing and without dripping (provide heating system if there is condensation)
Maximum ambient temperature	Storage: -13 to +149 °F (-25 to +65 °C) Operation: +14 to +104 °F (-10 to +40 °C) without grey tape removed +14 to +122 °F (-10 to +50 °C) with grey tape removed
Altitude	Up to 3,300 ft (1,000 m) without derating; derate by 3% for each additional 3,300 ft (1,000 m)
Electrical Characteristics	
Input voltage	ATV18•••M2, 1-phase: 200 V -15% to 240 V +10% ATV18•••M2, 3-phase: 200 V -15% to 230 V +10% ATV18•••N4: 380 V -15% to 460 V +10%
Input frequency	50/60 Hz ±5%
Input phases	ATV18U09M2 to U41M2: 1 ATV18U54M2 to D12M2: 3 ATV18•••N4: 3
Output voltage	Maximum voltage equal to input voltage
Output frequency	0.5 to 320 Hz
Output phases	3
Max. transient current	150% of nominal drive controller current for 60 seconds
Braking torque	30% of nominal motor torque without dynamic braking (typical value). Up to 150% with optional dynamic braking resistor
Frequency resolution	Display: 0.1 Hz Analog inputs: 0.1 Hz for 100 Hz maximum
Switching frequency	Adjustable from 2.2 to 12 kHz
Drive controller protection	Galvanic isolation between power and control (power supplies, inputs, outputs) Protection against short circuits: • in available internal sources • between output phases • between output phases and ground for 7.5 to 20 hp drive controllers Thermal protection against overheating and overcurrents Undervoltage and overvoltage faults Overbraking fault
Motor protection	Protection integrated in the drive controller by I^2t calculation

[1] Drive controller electrical creepages are designed for use in a pollution Degree 2 environment per NEMA ICS-1 and IEC 664.

DIMENSIONS

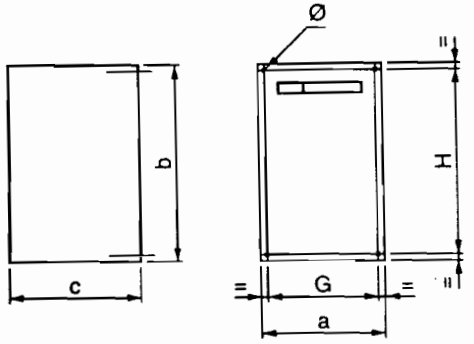


Figure 1: Altivar 18 Dimensions

Table 5: Dimensions

Catalog No.	a	b	c	Mounting G	Mounting H	Ø	Weight
ATV18U09M2 ATV18U18M2	4.41 (112)	7.17 (182)	4.76 (121)	3.94 (100)	6.7 (170)	0.20 (5)	3.3 (1.5) 3.3 (1.5)
ATV18U29M2 ATV18U18N4 ATV18U29N4	5.87 (149)	7.24 (184)	6.18 (157)	5.39 (137)	6.77 (172)	0.20 (5)	4.6 (2.1) 4.4 (2.0) 4.6 (2.1)
ATV18U41M2 ATV18U54M2 ATV18U72M2 ATV18U41N4 ATV18U54N4 ATV18U72N4	7.28 (185)	8.46 (215)	6.22 (158)	6.73 (171)	7.95 (202)	0.24 (6)	6.2 (2.8) 7.3 (3.3) 7.3 (3.3) 6.8 (3.1) 7.3 (3.3) 7.3 (3.3)
ATV18U90M2 ATV18D12M2 ATV18U90N4 ATV18D12N4	8.27 (210)	11.81 (300)	6.69 (170)	7.48 (190)	11.02 (280)	0.28 (7)	17.2 (7.8) 17.2 (7.8) 17.6 (8.0) 17.6 (8.0)
ATV18D16N4 ATV18D23N4	9.65 (245)	15.35 (390)	7.48 (190)	8.86 (225)	14.57 (370)	0.40 (10)	26.4 (12.0) 26.4 (12.0)

Dimensions are in inches (millimeters). Weights are in pounds (kilograms).

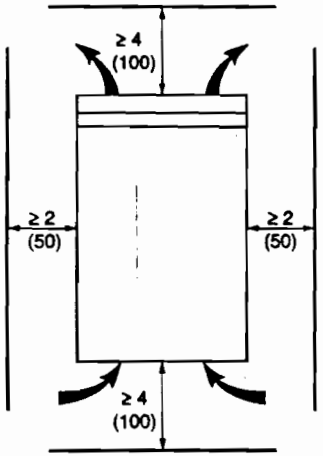
ATV18 FAN FLOW RATES

Table 6: ATV18 Fan Flow Rates

Drive Controller	Fan Flow Rate	
ATV18 U09M2, U18M2, U18N4	Non-ventilated	
ATV18 U29M2, U29N4	8.8 CFM	0.25 m^3/minute
ATV18 U41M2, U54M2, U72M2, U41N4, U54N4, U72N4	26.5 CFM	0.75 m^3/minute
ATV18 U90M2, D12M2, U90N4, D12N4, D16N4, D23N4	45.9 CFM	1.3 m^3/minute

INSTALLATION PRECAUTIONS

- The ATV18 drive controller is a NEMA Open device and must be installed in a suitable environment. The environment around the drive controller must not exceed pollution degree 2 requirements as defined in NEMA ICS-1 or IEC 664.
- When shipped the ATV18 has a protection rating of IP31 and can be operated in an ambient of up to 40 °C. When installing the drive controller in an enclosure with an ambient of up to 50 °C, remove the grey tape from the top of the drive controller. With the grey tape removed, the drive controller has a protection rating of IP20.
- Figure 2 shows the minimum clearances required around the drive controller for unobstructed airflow; above and below: ≥ 4 in (100 mm), sides: ≥ 2 in (50 mm). These clearances should not be used as minimum enclosure size for proper thermal dissipation.
- Mount the drive controller vertically. Avoid placing near any heat sources.
- Verify that the voltage and frequency characteristics of the input line match the drive controller nameplate rating.
- Installation of a disconnect switch between the input line and drive controller is recommended. Follow national and local codes.
- Overcurrent protection is required. Install line power fuses recommended in Table 10 on page 23 and Table 11 on page 23.
- Turn off all power before installing the drive controller. Place a "DO NOT TURN ON" label on the drive controller disconnect. Before proceeding with installation, lock the disconnect in the open position.



Dimensions are in inches (millimeters).

Figure 2: Minimum Clearances and Ventilation Flow

MOUNTING IN TYPE 12 (IP54) METAL ENCLOSURE

Calculating Enclosure Size

Below is the equation for calculating Rth (°C/W), the maximum allowable thermal resistance of the enclosure:

$$Rth = \frac{T_i - T_o}{P}$$

T_i = Max. internal ambient temp. (°C) around drive controller
T_o = Max. external ambient temp. (°C) around enclosure
P = Total power dissipated in enclosure (W)

For the power dissipated by the drive controllers at rated load, see Tables 1 and 2 on page 2 and Table 3 on page 3.

Useful heat exchange surface area, S (in^2), of a wall-mounted enclosure generally consists of the sides, top, and front. The minimum surface area required for a drive controller enclosure is calculated as follows:

$$S = \frac{K}{Rth}$$

Rth = Thermal resistance of the enclosure (calculated previously)
K = Thermal resistance per square inch of the enclosure
K = 186 with enclosure fan
K = 233 without enclosure fan

Consider the following points when sizing the enclosure:

- Use only metallic enclosures, since they have good thermal conduction.
- This procedure does not consider radiant or convected heat load from external sources. Do not install enclosures where external heat sources (such as direct sunlight) can add to enclosure heat load.
- If additional devices are present inside the enclosure, consider the heat load of the devices in the calculation.
- The actual useful area for convection cooling of the enclosure will vary depending upon the method of mounting. The method of mounting must allow for free air movement over all surfaces considered for convection cooling.

The following sample illustrates calculation of the enclosure size for an ATV18U72N4 (5 hp) drive controller mounted in a Type 12 enclosure.

- Maximum external temperature: To = 25 °C
- Power dissipated inside enclosure: P = 94 W
- Maximum internal temperature: Ti = 40 °C
- Thermal resistance per square inch of enclosure: K = 186

- Calculate maximum allowable thermal resistance, Rth:

$$Rth = \frac{40\ °C - 25\ °C}{94\ W} = 0.16\ °C/W$$

- Calculate minimum useful heat exchange surface area, S:

$$S = \frac{186}{0.16} = 1162.5\ in^2$$

Useful heat exchange surface area (S) of the proposed wall-mounted enclosure:

- Height: 24 in (610 mm)
- Width: 20 in (508 mm)
- Depth: 12 in (305 mm)

$$S = \underset{\text{front area}}{(24 \times 20)} + \underset{\text{top area}}{(20 \times 12)} + \underset{\text{side area}}{2(24 \times 12)} = 1296\ in^2$$

If the selected enclosure does not provide the required surface area or does not meet application needs, consider the following:

- Use a larger enclosure.
- Add a passive heat exchanger to the enclosure.
- Add an air conditioning unit to the enclosure.

Ventilation

When mounting the drive controller inside a Type 12 or IP54 enclosure, follow these ventilation precautions:

- Observe minimum clearance distances shown in Figure 2 on page 6.
- Follow the installation precautions on page 6.
- A stirring fan with filter may be necessary to circulate the air inside the enclosure and prevent hot spots in the drive controller and to distribute the heat uniformly to surfaces used for convection cooling.
- If there is a possibility of condensation, keep the control supply switched on during periods when the motor is not running or install thermostatically controlled strip heaters.

ELECTROMAGNETIC COMPATIBILITY (EMC)

NOTE: This section focuses on applications requiring compliance to the European Community EMC directive. The Altivar 18 is considered to be a component. It is neither a machine nor a piece of equipment ready for use in accordance with the European Community directives (machinery directive or electromagnetic compatibility directive). It is the user's responsibility to ensure that the machine meets these standards.

Installation precautions for meeting EN55011 Class A

General rules

Ensure that the grounds of the drive controller, the motor, and the cable shields are at equal potential.

Use shielded cables with the shields tied to ground at both ends of the motor cable and the control cables. The ground connection to the shield must make contact with the complete circumference of the shield. As long as there is no discontinuity, this shielding can be achieved by using metallic conduit. Bonding at conduit fittings is required.

Installation Plan

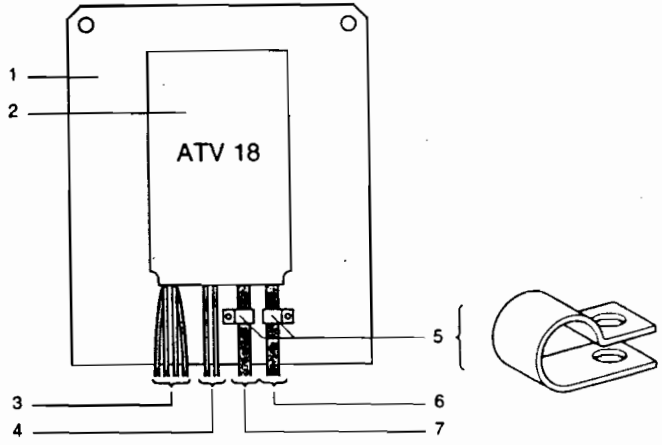


Figure 3: Installation Diagram

Description of parts in Figure 3:

1. A sheet metal plate, which is not painted, and has an anti-corrosion conductive treatment (ground plane). Painted sheet metal can be used on the condition that a good electrical contact is made between the support and fixation surfaces and 2 and 5.

Description of parts in Figure 3 (continued):

2. The ATV18 is mounted directly to the metal plate. Ensure that all four corner mounting points have good electrical contact with the metal plate.
3. Non-shielded input wire or cable, connected to the input inductors, if used. Maintain separation between input wiring and motor wiring as described in "General Wiring Practices" on page 12.
4. Non-shielded wire for the output of the fault relay contacts. Maintain separation between fault relay wiring and motor wiring as described in "General Wiring Practices" on page 12.
5. Fastening and grounding of the shields of cables 6 and 7 must be made as close to the drive controller as possible.
   - — Strip the shields
   - — Use straps with appropriate dimensions on the stripped portions of the shield for fastening to the sheet metal.
   - — Clamps should be stainless steel.

   The shields must be well clamped to the sheet metal in order to have good contact.
6. Shielded cable for connection to motor, with shield tied to ground at both ends. At the drive controller, the shield is connected to the E or G/E terminal on the far right of the power terminal strip. This shield must not be interrupted. If intermediate terminal blocks are used, they must be in EMC-shielded metallic boxes. The cable shield must have an ampacity greater than or equal to that of the ground conductor.
7. Shielded cable for connection to control/command. For applications requiring several conductors, a small wire size must be used (20 AWG or 0.5 mm^2). The shield must be tied to ground at both ends. At the drive controller, the shield is connected to the E or G/E terminal on the far right of the power terminal strip. This shield must not be interrupted. If intermediate terminal blocks are used, they must be in EMC-shielded metallic boxes. Maintain separation between control/command wiring and motor wiring.

NOTE: Connection at equal potential of the grounds between the drive controller, motor, and cable shields does not preclude the connection of equipment ground conductors as required by national and local codes.

WIRING

To access the terminal blocks remove the two screws and remove the cover. When accessing the terminals, first perform the Bus Voltage Measurement Procedure on page 39. Figure 4 shows the location of the cover screws.

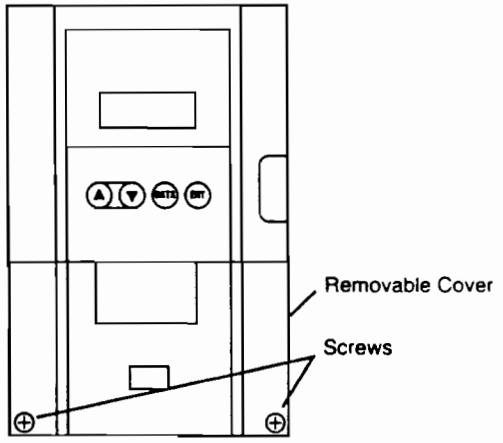


Figure 4: Accessing Terminal Strips

Figure 5 shows the location of the drive controller wiring terminals.

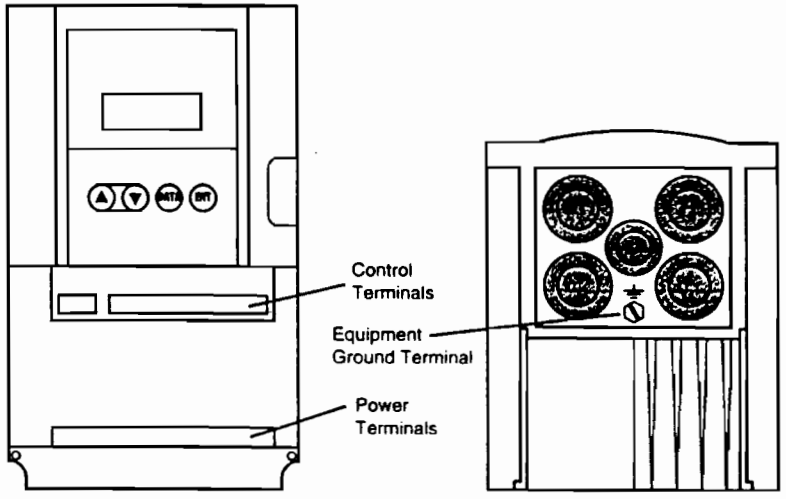


Figure 5: Wiring Terminals

General Wiring Practices

Good wiring practice requires the separation of control circuit wiring from all power (line) wiring. Power wiring to the motor must have the maximum possible separation from all other power wiring, whether from the same drive controller or other drive controllers; **do not run in the same conduit.** This separation reduces the possibility of coupling electrical transients from power circuits into control circuits or from motor power wiring into other power circuits.

⚠ CAUTION

EQUIPMENT DAMAGE HAZARD

Follow wiring practices described in this document in addition to those already required by the National Electrical Code and local electrical codes.

Failure to follow these instructions can result in injury or equipment damage.

Follow the practices below when wiring ALTIVAR 18 drive controllers:

- Use metallic conduit for all drive controller wiring. Do not run control and power wiring in the same conduit.
- Separate metallic conduits carrying power wiring or low-level control wiring by at least 3 in (7.62 cm).
- Separate non-metallic conduits or cable trays used to carry power wiring from metallic conduit carrying low-level control wiring by at least 12 in (30.5 cm).
- Whenever power and control wiring cross, the metallic conduits and non-metallic conduits or trays must cross at right angles.

Branch Circuit Connections

All branch circuit components and equipment (such as transformers, feeder cables, disconnect devices, and protective devices) must be rated for the maximum input current of the ALTIVAR 18 drive controller, not the motor full load current. The drive controller input current is stamped on the nameplate.

⚠ WARNING

OVERCURRENT PROTECTIVE DEVICES MUST BE PROPERLY COORDINATED

- **To achieve published fault withstand current ratings, install the specified fuses listed on drive controller nameplate and in Table 10 and Table 11 on page 23.**
- **Do not connect drive controller to power feeder whose short circuit capacity exceeds drive controller withstand fault rating listed on drive controller nameplate.**

Failure to follow these instructions can result in death, serious injury, or equipment damage.

Output Wiring Precautions

⚠ WARNING

DRIVE CONTROLLER DAMAGE

Drive controller will be damaged if input line voltage is applied to output terminals (U, V, W). Check power connections before energizing drive controller.

Failure to follow these instructions can result in death, serious injury, or equipment damage.

The drive controller is sensitive to the amount of capacitance (either phase-to-phase or phase-to-ground) present on the output power conductors. If excessive capacitance is present, the drive controller may trip on overcurrent.

Follow the guidelines below when selecting output cable:

- Cable type: the cable selected must have a low capacitance phase-to-phase and to ground. Do not use mineral-impregnated cable because it has a very high capacitance. Immersion of cables in water increases capacitance.
- Cable length: the longer the cable, the greater the capacitance. Cable lengths greater than 100 ft (30.5 m) may cause problems.
- Proximity to other output cables: because of the high frequency switching and increased capacitance, the drive controller may fault under some conditions.
- Do not use lightning arrestors on output of drive controller.

Wiring needs minimum inductance to protect the drive controller output from short circuits. Provide at least 19.7 in (50 cm) of cable at drive controller output (U, V, W).

⚠ CAUTION

DRIVE CONTROLLER SWITCH FAILURE

For proper drive controller electronic short circuit protection, certain values of inductance may be required in the output power wiring. Inductance can be supplied by the power wiring or auxiliary inductors.

Failure to follow these instructions can result in equipment damage.

Grounding

For safe, dependable operation, ground the drive controller according to National Electrical Code and all local codes. To ground the drive controller:

- Connect a copper wire from the equipment ground terminal to the power system ground conductor. Wire size is determined by the drive controller size and by national and local codes.
- Verify that resistance to ground is one ohm or less. Improper grounding causes intermittent and unreliable operation.

⚠ DANGER

HAZARDOUS VOLTAGE

- Ground equipment using connection provided as shown in Table 7 on page 15. Drive controller panel must be properly grounded before applying power.
- Do not use metallic conduits as a ground conductor.

Failure to follow these instructions will result in death or serious injury.

Ground multiple drive controllers as shown in Figure 6. Do not loop or series the ground cables.

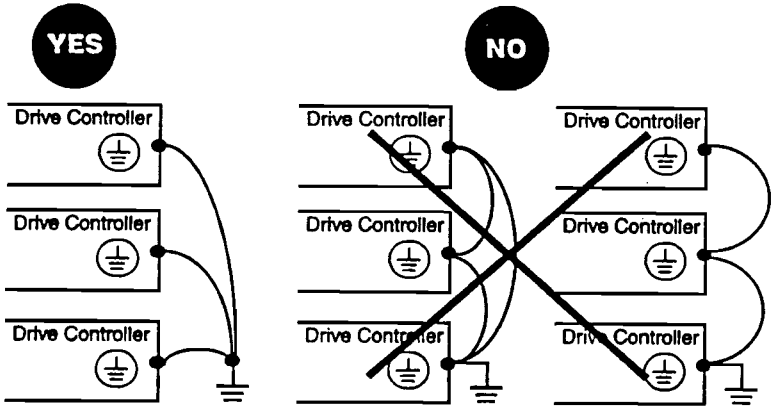


Figure 6: Grounding Multiple Drive Controllers

Power Terminals

Table 7: Power Terminal Strip Characteristics

Terminal	Function	ATV18
L1 L2	Input power	All models
L3		Three-phase units only
⏚ E or G/E	Equipment ground connection	All models
PO	Not used. Do not disconnect link between PO and PA.	All models
PA PB	Connection for dynamic braking resistance	All models
PC	Not used	D16N4U and D23N4 only
U V W	Output connections to motor	All models
⏚ E or G/E	Shield or equipment ground connection	All models
⏚	Equipment ground connection	Located on heatsink on ATV18U09M2 and U18M2. Located on metal cable entry plate on other models.

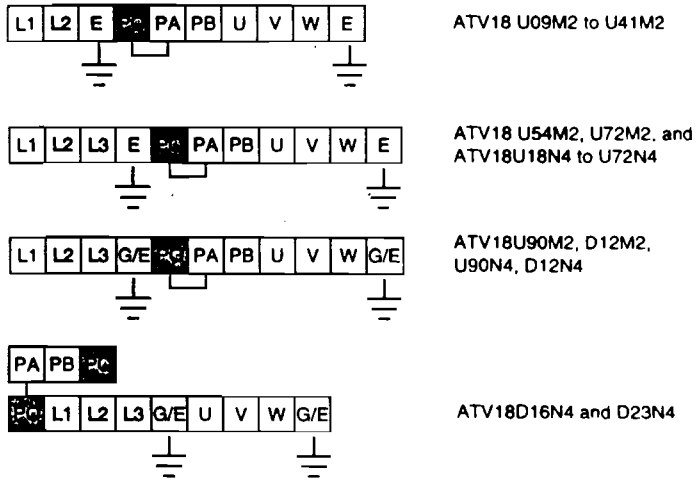


Figure 7: Location of Power Terminals

Table 8: Power Terminal Wire Size and Torque

ATV18	Maximum Wire Size [1] AWG (mm^2)	Torque lb-in (N•m)
U09M2, U18M2	14 (2.5)	9 (1.0)
U29M2, U41M2, U54M2, U72M2, U18N4, U29N4, U41N4, U54N4, U72N4	10 (4)	11 (1.2)
U90M2, D12M2, U90N4, D12N4	8 (10)	21 (2.4)
D16N4, D23N4	6 (10)	35 (4)

[1] 75 °C copper.

Equipment Ground Terminal

Equipment ground terminals are located on the power terminal strip as shown in Table 7 on page 15. In addition, an M5 equipment ground screw terminal is located on the heatsink of the ATV18U09M2 and U18M2 and on the metal cable entry plate on all other units. Maximum wire size for this screw terminal is 8 AWG (10 mm^2). Tightening torque is 21 lb-in (2.4 N•m) for drive controllers ATV18U09M2 and U18M2. Tightening torque is 31 lb-in (3.45 N•m) for all other units.

Control Terminals

Maximum wire size for all control terminals is 16 AWG (1.5 mm^2). Tightening torque is 4.4 lb-in (0.5 N•m). The control terminals are galvanically isolated from the power section.

Table 9: Control Terminal Strip Characteristics

Terminal Reference ATV18•••••	Function	Characteristics
SA SB SC	Fault relay N.O./N.C. contact Closed when drive controller energized, with no fault	Minimum: 10 mA, 24 VDC Maximum: inductive load of 0.3 A, 250 VAC 1.5 A, 30 VDC
+10	Internal supply for reference potentiometer	10 VDC, +15%, -0% 10 mA maximum Manual speed potentiometer value: 1 kΩ to 10 kΩ
AI1	Analog input 1: Speed reference voltage input	0 to +10 VDC, Impedance = 30 kΩ
AI2 or AIC [1]	Analog input 2: Voltage reference or Current analog input: current reference	0 to +10 VDC, Impedance = 30.55 kΩ or 0-20 mA, 4-20 mA, Impedance = 400 Ω
COM	Common for logic inputs, analog input and logic output	0 V
LI1 LI2 LI3 LI4	Logic input 1 Logic input 2 Logic input 3 Logic input 4	24 VDC; State 0: V<5 V; State 1: V>11 V; Vmax = 30 V
+24	Internal supply for logic inputs and outputs	24 VDC, 100 mA maximum
LO+	Supply for logic output, to be connected to +24 or to external 24 V supply	Maximum 30 VDC
LO	Open collector PLC-compatible logic output	+24 VDC, maximum 20 mA with internal supply or 200 mA with external supply

[1] AI2 or AIC can be summed with AI1. Both inputs are reassignable. Do not use them at the same time.

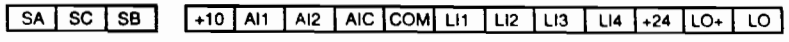
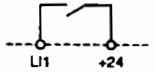


Figure 8: Location of Control Terminals

USING THE LOGIC INPUTS

The logic inputs may be operated from either the internal supply or an external supply. The possible assignments of LI1 to LI4 are shown below.

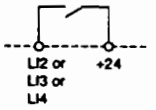
LI1: Forward. Cannot be reassigned.



When the contact is closed, the reference frequency will be applied to the motor in the forward direction.

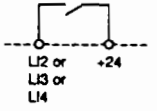
LI2, LI3, LI4 can be assigned to the following functions:

- Reverse: rSt



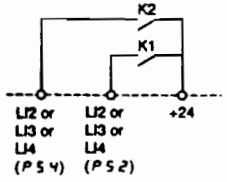
When the contact is closed, the reference frequency will be applied to the motor in the reverse direction. If LI1 and LI2 are closed at the same time, forward direction has priority. Otherwise, the direction selected first has priority.

- 2 Preset Speeds: PS2



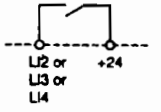
When the contact is open, the reference = LSP + analog reference. When the contact is closed, the reference = HSP.

- 4 Preset Speeds: PS4



If K1 and K2 are open, reference is LSP + analog reference.
If K1 is closed and K2 is open, reference is SP3 (Speed 3).
If K1 is open and K2 is closed, reference is SP4 (Speed 4).
If K1 and K2 are closed, reference is HSP.

- Jog: JOG



If the contact is closed, and then the direction contact is closed, the ramp time is 0.1 s regardless of the settings of ACC and dEC. If the drive is already running and the contact assigned to JOG is closed, the ramp times will be equal to ACC and dEC. The minimum time between two jog operations is 0.5 s.

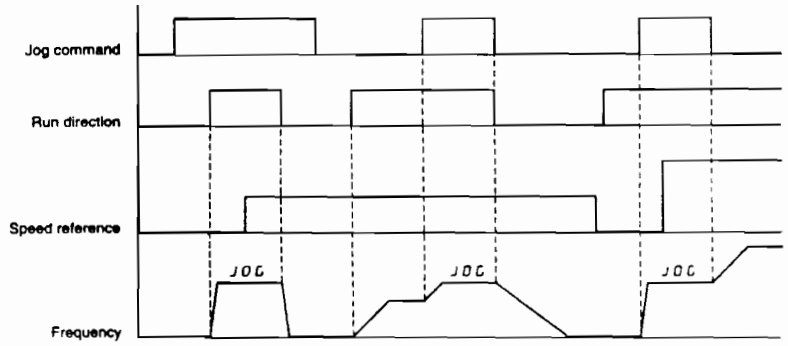
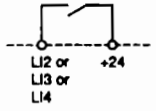


Figure 9: Jog Timing Diagram

NOTE: Whenever the drive controller is running in Jog, automatic dc injection braking upon stop is inhibited. However, DC injection braking by logic input has priority over Jog run.

- Fast Stop: FSt

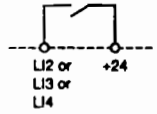


Fast stop is commanded when the contact between the logic input assigned to this function and +24 is opened.

The ramp time is the dEC time divided by 4, but limited to the minimum acceptable time for braking without causing an overbraking fault. The ramp is automatically adapted if the braking capacity is exceeded.

NOTE: When in fast stop, automatic dc injection braking and dc injection by logic input are inhibited.

- DC Injection Braking: dCI



DC injection braking is commanded when the contact between the logic input assigned to this function and +24 is closed.

The current injected is equal to the drive controller nominal current for 5 seconds. After 5 seconds, the current is limited to a maximum value of 0.5 times the motor thermal current (ItH).

NOTE: Automatic dc injection braking remains active even if a logic input is assigned to dCI. Fast stop has priority over dc injection braking.

USING THE ANALOG INPUTS

AI1 is a 0 to +10 V analog input which is used for speed reference. In addition, one of two other analog inputs may be used, either:

- AI2: 0 to +10 V or +2 to +10 V voltage input

or

- AIC: 0 to 20 mA (factory setting) or 4 to 20 mA current input.

Analog input can be assigned to reference summing with AI1 or PI feedback.

- Reference summing with AI1: S A I

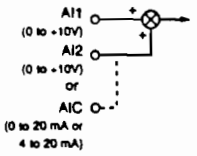


Figure 10: Reference Summing

- PI Feedback: P I F

This assignment automatically configures AI1 as PI setpoint input. AI2 or AIC is the PI feedback input.

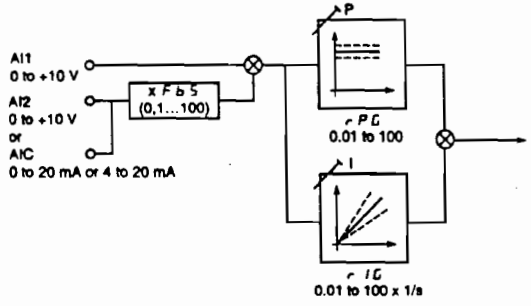


Figure 11: PI Feedback

To set up the PI regulator, with system in open loop configuration (sensor not connected), adjust High Speed setting (HSP) so that maximum flow or pressure is obtained. Then connect sensor.

The values of proportional gain (r P G) and integral gain (r I G) are factory set to give adequate performance for most applications. Factory setting for both parameters is 1.00, meaning that the output is modified by 1.00 times the input error for the proportional component and 1.00 times the input error for one second for the integral component. If improved dynamic performance is required, these parameters can be adjusted over the range of 1.00 to 100, or if the system is unstable, from 0.01 to 0.99.

Page 32 further explains the adjustment parameters r P G (Proportional Gain), r I G (Integral Gain) and F b S (Feedback Scaling).

NOTE: The PI Feedback function is not compatible with Preset Speeds or Jog.

FUNCTION COMPATIBILITY

The number of inputs/outputs required by a function, the number of inputs/outputs on the drive controller available for reassignment, and the compatibility of the selected functions (see Figure 12) limit the number of functions which can be assigned. There are 3 assignable logic inputs on the drive controller. The following functions require one input: reverse, DC injection braking, fast stop, jog, and 2 preset speeds. The use of 4 preset speeds requires two inputs.

	Automatic DC injection braking	Summing input	PI feedback	Forward direction	Reverse direction	DC injection braking by logic input	Fast stop	Jog	Preset speeds
Automatic DC injection braking	■						▒	▒	
Summing input		■	●						
PI feedback		●	■					●	●
Forward direction				■	▒		▒		
Reverse direction				▒	■		▒		
DC injection braking by logic input						■	▒	▒	▒
Fast stop	▒			▒	▒	▒	■	▒	▒
Jog	▒		●			▒	▒	■	
Preset speeds			●			▒	▒		■

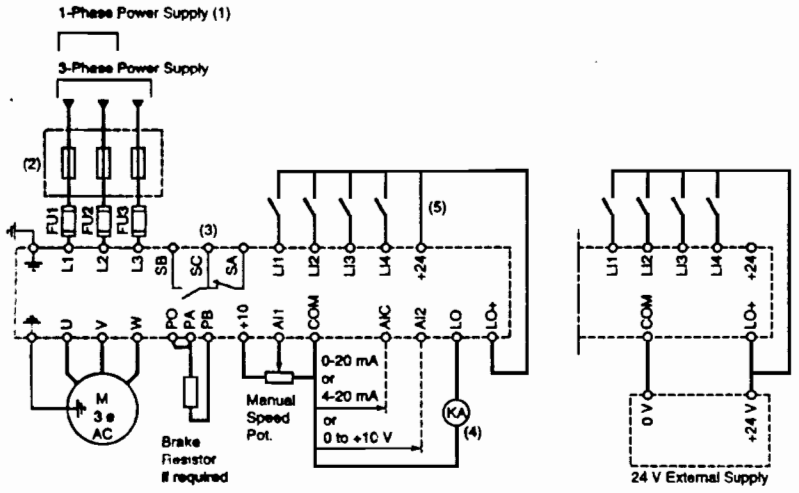
Function priority

■ Non-compatible functions
Compatible functions
▒ No significance

← The function indicated by the arrow has priority over the other one.
↑ The first operated has priority.

Figure 12: Function Compatibility Chart

WIRING DIAGRAM



(1) ATV18U09M2 to U41M2 only.

(2) Line inductor if required (1-phase or 3-phase).

(3) Fault relay contacts for remote signalling of the drive controller state. Contact state shown with drive controller deenergized or faulted.

(4) Relay must draw ≤ 20 mA to be used on internal supply. For relay up to 200 mA, use external supply.

(5) This jumper needed only if logic output is used. When using a +24 V external supply, connect the 0 V to the COM terminal, and connect LO+ to the external +24 V instead of the +24 V terminal on the drive controller.

Figure 13: ALTIVAR 18 Drive Controller Wiring Diagram

FAULT RELAY

The fault relay is energized whenever there is power to the drive controller and there is no fault. It is a Normally Open-Normally Closed contact.

Drive controller r... t after a fault is accomplished either by cycling power, allowing the red LED (see Figure 15 on page 27) to go dark; or automatically after certain faults if automatic restart is selected. For further explanation of automatic restart, refer to page 37.

RECOMMENDED FUSES

Table 10: Recommended Fuses for 230 V Drive Controllers

Motor		Drive Controller	Fuses	
kW	HP	ATV18•••••	Class CC	Class J
0.37	0.5	U09M2	600 V, 6 A	600 V, 6 A
0.75	1	U18M2	600 V, 10 A	600 V, 10 A
1.5	2	U29M2	600 V, 20 A	600 V, 20 A
2.2	3	U41M2	600 V, 25 A	600 V, 25 A
3	--	U54M2	600 V, 25 A	600 V, 25 A
4	5	U72M2	--	600 V, 30 A
5.5	7.5	U90M2	--	600 V, 40 A
7.5	10	D12M2	--	600 V, 40 A

Table 11: Recommended Fuses for 460 V Drive Controllers

Motor		Drive Controller	Fuses	
kW	HP	ATV18	Class CC	Class J
0.75	1	U18N4	600 V, 5 A	600 V, 5 A
1.5	2	U29N4	600 V, 12 A	600 V, 12 A
2.2	3	U41N4	600 V, 10 A	600 V, 10 A
3	-	U54N4	600 V, 15 A	600 V, 15 A
4	5	U72N4	600 V, 20 A	600 V, 20 A
5.5	7.5	U90N4	600 V, 25 A	600 V, 25 A
7.5	10	D12N4	--	600 V, 40 A
11	15	D16N4	--	600 V, 40 A
15	20	D23N4	--	600 V, 60 A

Equip all inductive circuits near the drive (relays, contactors, solenoid valves) with noise suppressors or connect them to a separate circuit .

When commanding the power by line contactor, avoid frequently opening and closing the line contactor which could cause premature failure of the filtering capacitors and precharge resistor. Use inputs LI1 to LI4 to command the drive. Limit operations of the line contactor to less than once per minute.

THERMAL OVERLOAD PROTECTION

- Thermal overload protection of the drive controller is accomplished by a thermal sensor on the heatsink of the drive controller and a calculation of the I^2t.
- In addition, the ALTIVAR 18 drive controller provides indirect motor thermal protection by continuously calculating the I^2t of the motor based on the setting of the ItH parameter.

These methods allow thermal protection of the motor and drive controller for normal conditions of ambient temperature.

Typical trip values are:

- motor current = 185% of nominal drive controller current for 2 seconds
- motor current = 150% of nominal drive controller current for 60 seconds

If the motor current ≤ 110% of the nominal drive controller current, the drive controller will not trip.

Derating for switching frequencies > 4 kHz are automatically taken into account and the allowable I^2t is reduced.

The thermal state of the drive controller is automatically reset when power is removed.

⚠ CAUTION

LOSS OF MOTOR OVERLOAD PROTECTION

- Setting the ItH parameter to maximum will disable internal motor overload protection function.
- In this case, external motor overload protection must be provided.

When using external overload relays connected to the drive controller output, the overload relay must be capable of operation over the expected range of drive controller output frequencies (including direct current).

When DC injection braking is used:

- The overload relay must be suitable for operation with direct current flowing in the motor.
- Do not use overload relays equipped with current transformers for sensing the motor current.

Failure to follow these instructions can result in equipment damage.

⚠ CAUTION

MOTOR OVERHEATING

This drive controller does not provide direct thermal protection for the motor. Use of a thermal sensor in the motor may be required for protection at all speeds and loading conditions. Consult motor manufacturer for thermal capability of motor when operated over desired speed range.

Failure to follow this instruction can result in injury or equipment damage.

AVAILABLE TORQUE

Continuous duty:

- For self-ventilated motors, motor cooling depends on the speed.
- Continuous duty results in derating for speeds less than 50% of the nameplate motor speed.

Operation in overspeed:

- In overspeed operation, the voltage no longer increases with the frequency, resulting in reduced induction in the motor which translates into loss of torque. Consult the motor manufacturer to ensure that the motor can operate in overspeed.
- For a special motor, the nominal frequency and the maximum frequency can be adjusted between 40 and 320 Hz.

⚠ CAUTION

MACHINERY OVERSPEED

Some motors and/or loads may not be suited for operation above nameplate motor speed and frequency. Consult motor manufacturer before operating motor above rated speed.

Failure to follow this instruction can result in injury or equipment damage.

Figure 14 on page 26 shows the typical torque characteristics of the ALTIVAR 18 drive controller.

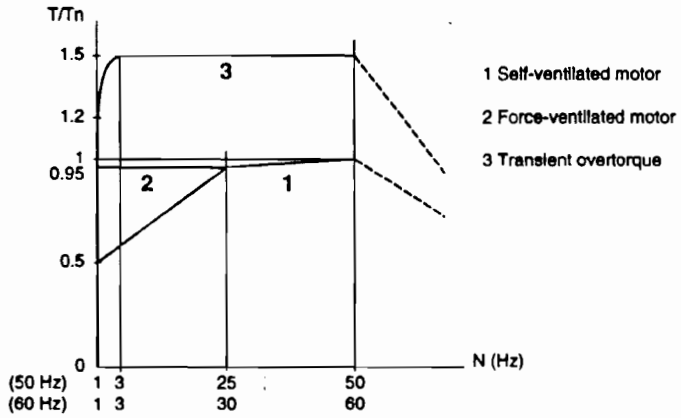


Figure 14: Typical ALTIVAR 18 Drive Controller Torque Characteristics

FACTORY SETTINGS

The ALTIVAR 18 is preset for constant torque applications. Table 12 lists factory settings.

Table 12: Factory Settings

Function	Setting
Display	Drive ready (when stopped) Reference frequency (when running)
Base frequency	50 Hz
Motor voltage	230 V or 400 V, depending on the model
Acceleration and deceleration ramps	3 s
Low speed	0 Hz
High speed	50 Hz
Frequency loop gain	Standard
Motor thermal current	Nominal drive controller current
DC braking current at stop	0.7 times nominal drive controller current for 0.5 s
Operation	Constant torque with sensorless vector control
Logic inputs	2 run directions (LI1, LI2) 4 preset speeds (LI3, LI4): 0 Hz, 5 Hz, 25 Hz, 50 Hz
Analog inputs	AI1: 0 to +10 V reference AI2 (0 to +10V) or AIC (0 to 20 mA) summed with AI1
Logic output	LO: Speed reference attained
Deceleration ramp adaptation	Automatic in the case of overvoltage when braking
Switching frequency	4 kHz

To modify these adjustments, use the keypad to change the parameter settings. The following section explains the keypad and parameters. For operation at 60 Hz, the bFr and HSP parameters must be adjusted.

USING THE DISPLAY KEYPAD

Figure 15 shows the locations and functions of the display keypad keys.

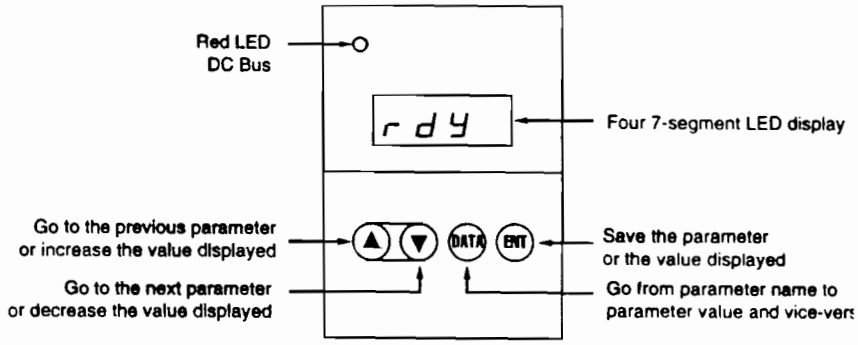


Figure 15: Functions of Keys and Display

Normal display when there is no fault:

- In it: Initialization sequence
- rdy: Drive controller ready
- 43. 0: Display of the reference frequency
- dcb: Braking by DC injection in progress
- rtr y: Automatic restart in progress

Figures 16, 17, and 18 illustrate operation of the keypad push buttons.

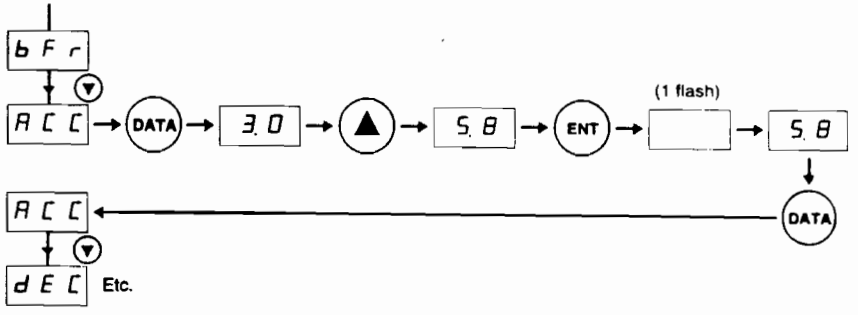


Figure 16: Example 1: Adjustment of Ramp Time

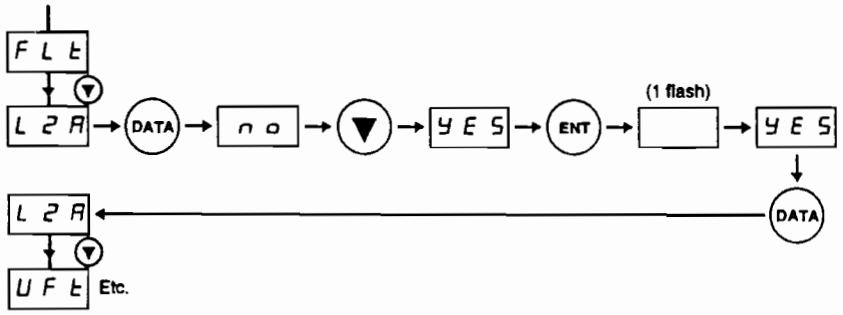


Figure 17: Example 2: Access to Level 2 Parameters

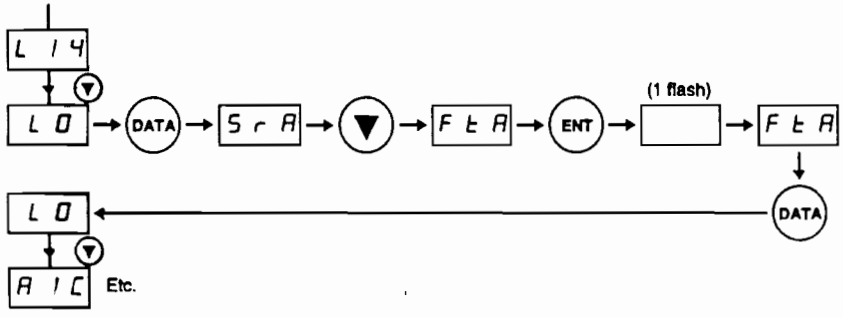


Figure 18: Example 3: Configuration of a Logic Output

PARAMETER SUMMARY

Figure 19 lists the parameters. There are two levels of access:

- Level 1: adjustments (basic configuration)
- Level 2: extensions in functionality

There are three types of parameters:

- Display: values displayed by the drive controller
- Adjustment: can be modified when the motor is running or stopped
- Configuration: only modifiable when the motor is stopped. Can be displayed when the motor is running.

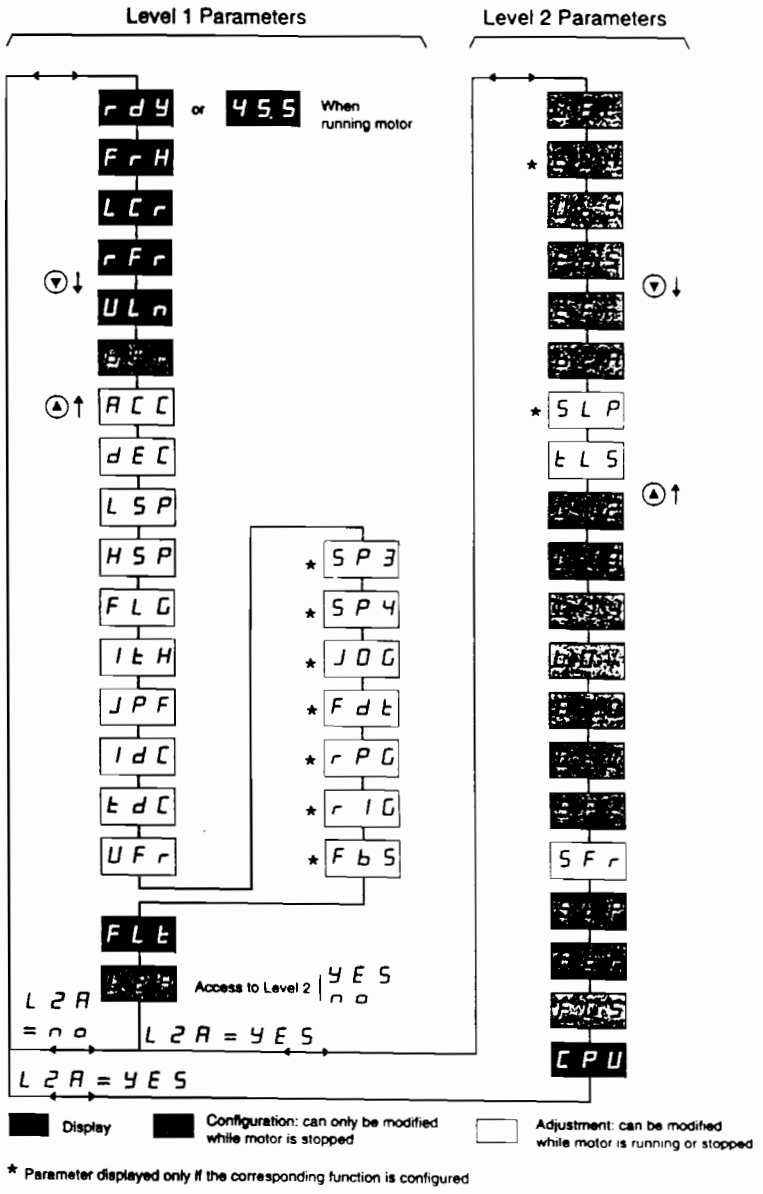


Figure 19: Parameter Summary

RIVE CONTROLLER SET UP

evel 1 Parameters

Table 13 shows the Level 1 parameters. The maximum value is always obtained by pressing and holding the ▲ key. The minimum value is always obtained by pressing and holding the ▼ key.

Table 13: Level 1 Parameters

Code	Function	Factory Setting	Max. Value	Min. Value	Units	Min. Increment	Type
rdY	Drive ready						Display
FrH	Frequency reference	Choice of parameter displayed while running [1]			Hz	0.1	Display
LCr	Motor current				A	0.1	Display
rFr	Rotation frequency				Hz	0.1	Display
ULn	Maintains voltage				V	1	Display
		FrH					
bFr	Base frequency. Select the same frequency as the mains frequency	50	50	60	Hz		Config.
	If the value of bFr is changed, the drive controller will display 1n1t as it automatically adjusts the nominal motor voltage (UnS) and nominal frequency (FrS) to the following values: ATV18...M2: bFr = 50: 230 V/50 Hz bFr = 60: 230 V/60 Hz ATV18...M4: bFr = 50: 400 V/50 Hz bFr = 60: 460 V/60 Hz The settings of UnS and FrS can be modified in the level 2 parameters.						
ACC	Linear acceleration ramp	3.0	3600	0.1	s	0.1 (from 0.1 to 999.9) or 1 (from 1000 to 3600)	Adjust.
dEC	Linear deceleration ramp	3.0	3600	0.1	s		Adjust.
	These ramps are defined for the base frequency. For example, for a 10 s ramp: If bFr = 50 Hz, 0 to 25 Hz takes 5 s If bFr = 60 Hz, 0 to 30 Hz takes 5 s						
LSP	Low speed	0.0	=HSP	0.0	Hz	0.1	Adjust.
HSP	High speed: ensure that the adjustment matches the motor and the application	50.0	=tFr [2]	=LSP	Hz	0.1	Adjust.
FLG	Frequency loop gain	33	100	0		1	Adjust.
	Dependent on the inertia and resistive torque of the driven mechanical equipment: -machines with high resistive torque or high inertia: progressively reduce FLG from 33 to 0. -machines with fast cycles, low resistive torque and low inertia: gradually increase the gain from 33 to 100. An excess of gain can cause unstable operation.						

[1] LCr, rFr and ULn cannot be saved by pressing ENT, but can be displayed momentarily, until the motor is stopped, or the next parameter is displayed.

[2] tFr is a level 2 parameter, adjustable from 40 to 320 Hz, preset at 60 Hz. For HSP > 60 Hz, first modify tFr by going to the level 2 parameters.

Table 13: Level 1 Parameters (Continued)

Code	Function	Factory Setting	Max. Value	Min. Value	Units	Min. Increment	Type
ItH	Motor thermal protection [3]	In [4]	1.15 In [4]	0.5 In [4]	A	0.1	Adjust
	Adjust ItH to the motor nameplate current. The thermal state of the motor thermal protection is automatically reset when power is removed. To suppress motor thermal protection, increase the value of Ith to the maximum and provide external thermal protection.						

⚠ CAUTION

LOSS OF MOTOR OVERLOAD PROTECTION

- Setting the ItH parameter to maximum will disable internal motor overload protection function.
- In this case, external motor overload protection must be provided.

When using external overload relays connected to the drive controller output, the overload relay must be capable of operation over the expected range of drive controller output frequencies (including direct current).

When DC injection braking is used:

- The overload relay must be suitable for operation with direct current flowing in the motor.
- Do not use overload relays equipped with current transformers for sensing the motor current.

Failure to follow these instructions can result in equipment damage.

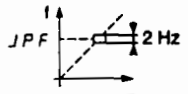
⚠ CAUTION

MOTOR OVERHEATING

This drive controller does not provide direct thermal protection for the motor. Use of a thermal sensor in the motor may be required for protection at all speeds and loading conditions. Consult motor manufacturer for thermal capability of motor when operated over desired speed range.

Failure to follow this instruction can result in injury or equipment damage.

JPF	Jump frequency with a bandwidth of 2 Hz. Suppression of a critical speed which causes mechanical resonance. Factory setting of 0 indicates that the function is not used.	0.0	HSP	0.0	Hz	0.1	Adjust.



[3] For motors in parallel fed by the same drive controller, a separate thermal relay should be added for each motor.

[4] In = drive controller rated output current. See Table 1 and Table 2 on page 2 and Table 3 on page 3.

Table 13: Level 1 Parameters (Continued)

Code	Function	Factory Setting	Max. Value	Min. Value	Units	Min. Increment	Type
Idc	Automatic DC injection current level	0.7 In [4]	In [4]	0.25 ItH	A	0.1	Adjust.
tdc	Automatic DC injection current time	0.5	25.5	0.0	s	0.1	Adjust.
	Adjustment to 0 suppresses automatic DC injection. Adjustment to 25.5 causes permanent injection of DC upon stop. [5]						
	⚠ WARNING **NO HOLDING TORQUE** • DC injection braking does not provide holding torque at zero speed. • DC injection braking does not function during loss of power or drive controller fault. • When required, use separate brake for holding torque. **Failure to follow these instructions can result in death, serious injury, or equipment damage.**						
UFr	Allows optimization of torque at low speed	20	100	0		1	Adjust.
SP3 [6]	3rd preset speed	5.0	HSP	LSP	Hz	0.1	Adjust.
SP4 [6]	4th preset speed	25.0	HSP	LSP	Hz	0.1	Adjust.
JOG [6]	Jog speed	10	10	0	Hz	0.1	Adjust.
Fdt [6]	Frequency level associated with "frequency level attained" when LO is assigned to this function. This level allows a hysteresis of 0.2 Hz.	0	HSP	LSP	Hz	0.1	Adjust.
rPG [6]	Proportional gain for the PI feedback function	1	100.0	0.01		0.01	Adjust
rIG [6]	Integral gain for the PI feedback function	1	100.0	0.01	1/s	0.01	Adjust.
FbS [6]	Feedback scaling factor for the PI feedback function, associated with the analog input AIC or AI2.	1	100.0	0.1		0.1	Adjust.
FLt	By pressing the DATA key when this parameter is displayed, the last fault can be displayed. When there has been no fault, the display is nEr.						Display
L2A	Level 2 access	no	YES	no			Config.
	no: no → next display will be rdY if down arrow pressed yes: YES → next display will be the first level 2 parameter if down arrow pressed						

[4] In = drive controller rated output current. See Table 1 and Table 2 on page 2 and Table 3 on page 3.

[5] Note that during braking, configuration parameters cannot be modified. Adjust tdc to 25.5 s if continuous DC injection is necessary.

[6] These parameters only appear if the associated functions have been selected.

Level 2 Parameters

Level 2 parameters are accessed by setting the L2A parameter to yes. Table 14 lists the Level 2 parameters and their functions. The maximum value is always obtained by pressing and holding the ▲ key. The minimum value is always obtained by pressing and holding the ▼ key.

⚠ WARNING

UNINTENDED EQUIPMENT ACTION

- Application of voltages to the logic inputs while a Level 2 parameter is being adjusted may result in power being applied to the motor.
- While changing a Level 2 parameter, ensure that no voltage is applied to the logic inputs.

Failure to follow these instructions can result in death, serious injury, or equipment damage.

Table 14: Level 2 Parameters

Code	Function	Factory Setting	Max Value	Min Value	Units	Min Increment	Type
UFt	Selection of the type of volts/ frequency ratio L: constant torque for special motors or motors connected in parallel P: variable torque n: sensorless flux vector control for constant torque applications nLd: energy savings, for variable torque applications	n	L	nLd			Config.
tUn	Auto-tune. Only active when UFt is set for n or nLd. no: no auto-tune (factory parameters for standard IEC motors) donE: auto-tune has already been performed (auto-tune parameters already in use) YES: setting to YES and pressing ENT starts auto-tune When auto-tune is completed, rdY is displayed. Returning to tUn displays donE. If tnF (tuning fault) appears, the motor is not adapted to the drive controller. Use L or P mode.	no	YES	no			Config.
UnS	Nominal motor voltage. Set to the nameplate value. Maximum, minimum and factory preset values depend on the model and the setting of the bFr parameter (level 1). ATV18...M2 ATV18...N4 with bFr = 50 ATV18...N4 with bFr = 60	 230 400 460	 240 460 460	 200 380 380	 V V V	 1 1	Config.
FrS	Nominal motor frequency Set to the nameplate value if it is different from that set by bFr.	bFr	320.0	40.0	Hz	0.1	Config.
tFr	Maximum output frequency	60.0	320.0	40.0	Hz	0.1	Config.

⚠ CAUTION

MACHINERY OVERSPEED

Some motors and/or loads may not be suited for operation above nameplate motor speed and frequency. Consult motor manufacturer before operating motor above rated speed.

Failure to follow this instruction can result in injury or equipment damage.

brA	Automatic deceleration ramp adaptation to avoid an overbraking (ObF) fault. YES: function active no: function not active This function may be incompatible with the use of dynamic braking.	YES	no	YES			Config.
SLP	Slip compensation This parameter only appears if UFt is set for n.	[1]	5.0	0.0	Hz	0.1	Adjust.
tLS	Low speed run time. Time at which the motor runs at LSP if reference goes to 0 and direction command (FW or RV) is still present. If tLS = 0, the drive controller will run at the LSP setting as long as FW or RV is present. The drive controller restarts when the reference becomes greater than 0, or if the direction input (FW or RV) is cycled.	0.0	25.5	0.0	s	0.1	Adjust.

[1] The factory setting depends on the drive controller rating.

Table 14: Level 2 Parameters (Continued)

Code	Function	Factory Setting	Max Value	Min Value	Units	Min Increment	Type
LI2	Reassignment of the LI2 logic input Note: Before assigning, make sure that there is no voltage to the logic input.						

⚠ WARNING

UNINTENDED EQUIPMENT ACTION

- Assigning a logic input when it is in state 1 (high, with voltage present) can cause the motor to start.
- Before assigning,verify that there is no voltage to the logic input.

Failure to follow these instructions can result in death, serious injury, or equipment damage.

If the function is already assigned to another input, it will appear as a choice, but will not be saved upon pressing ENT. If PS2 and PS4 are both assigned, the input assigned to PS4 must be changed before the input assigned to PS2 can be changed.

If AIC is assigned for summing with AI1 (SAI) [2], and one of the logic inputs is assigned to PS2 [2], the choices for LI2 are: OFF: not assigned rrS: reverse dCI: continuous dc injection braking drive in for 5s, then at 0.5 ItH	rrS	OFF	PS4			Config.

⚠ WARNING

NO HOLDING TORQUE

- DC injection braking does not provide holding torque at zero speed.
- DC injection braking does not function during loss of power or drive controller fault.
- When required, use separate brake for holding torque.

Failure to follow these instructions can result in death, serious injury, or equipment damage.

FSt: Fast stop. This function is active when the LI is at state 0 (off) JOG: Jog [3] PS2: 2 preset speeds [3] (however, display will not flash when ENT is pressed because another input was already assigned to PS2) PS4: 4 preset speeds [3]						
If AIC is assigned for summing with AI1 (SAI), and no other LI is assigned to PS2, the choices for LI2 are: OFF: not assigned rrS: reverse dCI: continuous dc injection braking at drive in for 5s, then at 0.5 ItH FSt: Fast stop. This function is active when the LI is at state 0 (off) JOG: Jog [3] PS2: 2 preset speeds [3]	rrS	OFF	PS2			Config.
When AIC is assigned to PI feedback, the choices for LI2 are: OFF: not assigned rrS: reverse dCI: continuous dc injection braking at drive controller in for 5s, then at 0.5 ItH FSt: Fast stop. This function is active when the LI is at state 0 (off).	rrS	OFF	FSt			Config.

[2] Factory setting.

[3] These function cause parameters to appear in Level 1 (JOG, SP2, SP4) which must be adjusted.

Table 14: Level 2 Parameters (Continued)

Code	Function	Factory Setting	Max Value	Min Value	Units	Min Increment	Type
LI3	Reassignment of the LI3 logic input. Same as LI2. To reassign LI3 from PS2 if LI4 is set to PS4, LI4 must be reassigned first.	PS2	•	•			
LI4	Reassignment of the LI4 logic input. Same as LI2.	PS4	•	•			
LC	Assignment of logic output. There are 2 choices: SrA: Speed reference attained, with a hysteresis of ± 2.5 Hz FtA: Frequency level attained. When FtA is selected, Fdt appears in the Level 1 parameters. This parameter must be adjusted.	SrA	SrA	FtA			Config.
AIC	Assignment of the analog input AIC/AI2.						
	If the logic inputs are not assigned to PS2, PS4 or JOG, the choices are: SAI: Reference summing with AI1 PIF: PI feedback. This configuration automatically assigns AI1 as PI setpoint input and causes rPG, rIG, and FbS to appear in the Level 1 parameters. Note: PIF is only possible if the logic inputs have previously been assigned as follows in this order: 1) LI4 = OFF or FSt 2) LI3 = OFF or dCI 3) LI2 = OFF or rrS	SAI	SAI	PIF			Config.
	If a logic input is assigned to PS2, PS4 or JOG, the choice is: SAI: Reference summing with AI1	SAI	SAI	SAI			Config.
CrL	Configuration of the AIC/AI2 input current range: 0.0 = AIC:0 to 20 mA, AI2: 0 to +10 V 4.0 = AIC:4 to 20 mA, AI2: 2 to +10 V	0.0	0.0	4.0	mA		Config.
SPr	Automatic catch on the fly with speed research. After a brief input line undervoltage, the motor restarts following a ramp without starting at zero. The maximum time for speed research is 3.2 s. The speed reference and the run direction input must be maintained when power is restored. no: Function not active YES: Function active	no	no	YES			Config.

⚠ WARNING

UNINTENDED EQUIPMENT ACTION

- Automatic catch on the fly can only be used for machines or installations that present no danger in the event of automatic restarting, either for personnel or equipment.
- Equipment operation must conform with national and local safety regulations.

Failure to follow these instructions can result in death, serious injury, or equipment damage.

Table 14: Level 2 Parameters (Continued)

Code	Function	Factory Setting	Max Value	Min Value	Units	Min Increment	Type
SFr	Switching frequency, adjustable in order to reduce audible motor noise generated by the motor. Above 4 kHz, the drive controller output current must be derated as follows: ATV18U09M2U, U18M2U, U29M2U, U41M2U, U54M2U: no derating necessary All other models: ≤ 8 kHz: 5% derating > 8 kHz: 10% derating	4.0	12.0	2.2	kHz	0.1	Adjust.
StP	Controlled stop upon loss of input power. no: motor coasts to stop at loss of input power YES: deceleration follows a self-adjusting ramp which is a function of the regenerated energy	no	YES	no			Config.
Atr	Automatic restart after a fault if the cause of the fault has disappeared and the other operating conditions allow it. The drive controller will attempt to restart after 1s, then 5s, then 10s, and then 1 minute for the remaining attempts. If the fault is still present after 5 minutes, the fault relay de-energizes and the drive controller must be reset by cycling power. Automatic restart can be attempted after the following faults: OHF, OLF, USF, ObF, OSF. The drive controller fault relay remains energized if the function is active. The speed reference and the rotation direction must be maintained. no: Function not active YES: function active	no	YES	no			Config.

⚠ WARNING

UNINTENDED EQUIPMENT ACTION

- Automatic restart can only be used for machines or installations that present no danger in the event of automatic restarting, either for personnel or equipment.
- Equipment operation must conform with national and local safety regulations.

Failure to follow these instructions can result in death, serious injury, or equipment damage.

FCS	Return to factory settings no: do not return to factory settings YES: Return to factory settings, display will then be rdY	no	no	YES			Config.
CPU	Firmware version	•	•	•			Display

MAINTENANCE

Read the following safety statements before proceeding with any maintenance or troubleshooting procedures.

The following steps should be done at regular intervals:

- Check the condition and tightness of the connections.
- Make sure ventilation is effective and temperature around the drive controller remains at an acceptable level. The average lifetime of the fans is 3 to 5 years depending on the conditions of use.
- Remove dust and debris from the drive controller, if necessary.

PRECAUTIONS

Table 15 on page 42 lists the fault codes for the faults which can be automatically reset, the probable causes of the faults and associated corrective action. Table 16 on page 43 lists the fault codes for the faults which are not automatically resettable (thus requiring reset by cycling power) along with the probable causes of the faults and associated corrective action. When taking corrective action, follow the procedures outlined on pages 39-41.

⚠ DANGER

HAZARDOUS VOLTAGE

Read and understand these procedures before servicing ALTIVAR 18 drive controllers. Installation, adjustment, and maintenance of these drive controllers must be performed by qualified personnel.

Failure to follow these instructions will cause shock or burn, resulting in death or serious injury.

The following procedures are intended for use by qualified electrical maintenance personnel and should not be viewed as sufficient instruction for those who are not otherwise qualified to operate, service, or maintain the equipment discussed.

Procedure 1: Bus Voltage Measurement

⚠ DANGER

HAZARDOUS VOLTAGE

- Read and understand Bus Voltage Measurement Procedure before performing procedure. Measurement of bus capacitor voltage must be performed by qualified personnel.
- DO NOT short across capacitors or touch unshielded components or terminal strip screw connections with voltage present.
- Many parts in this drive controller, including printed wiring boards, operate at line voltage. DO NOT TOUCH. Use only electrically insulated tools.

Failure to follow these precautions will cause shock or burn, resulting in death or serious injury.

Drive Controllers ATV18•••M2 and ATV18U18N4 to D12N4

The voltage is measured between the equipment ground and each terminal on the power terminal strip. The equipment ground is located on the heatsink for drive controllers ATV18U09M2 and U18M2, and on the metal conduit entry plate for the other products. The power terminal strip is located on the power board, as shown in Figure 20 on page 40. A second measurement is made between the PA terminal, located on the power terminal strip and the other terminals on the power terminal strip. To measure the bus capacitor voltage:

1. Disconnect all power from drive controller.
2. Wait 1 minute to allow the DC bus to discharge.
3. Remove all covers.
4. Set the voltmeter to the 1000 VDC scale. Measure the voltage between the equipment ground terminal and each terminal on the power terminal strip and verify the DC voltage is less than 45 V for each measurement.
5. With the voltmeter at the 1000 VDC scale, measure between the PA terminal and all of the other terminals on the power terminal strip. Verify the DC voltage is less than 45 V for each measurement.
6. If the bus capacitors are not fully discharged, contact your local Square D representative – do not operate the drive controller.
7. Replace all covers.

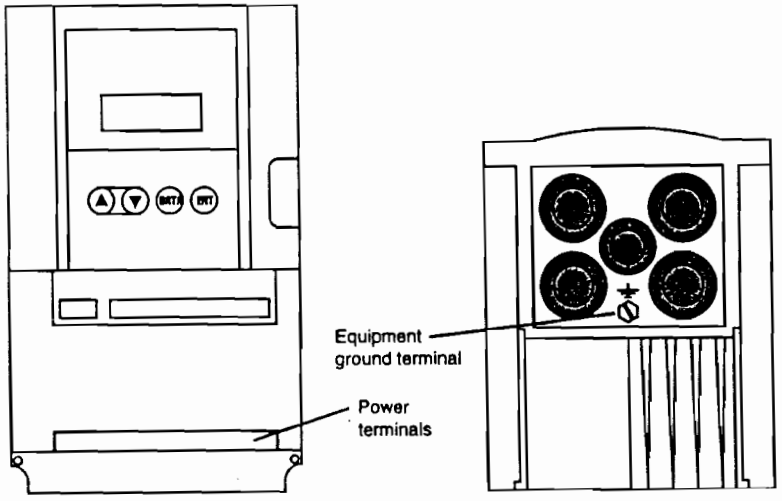


Figure 20: Measuring Bus Capacitor Voltage

Drive Controllers ATV18D16N4 and ATV18D23N4

For these drive controllers, the voltage is measured between the PA and PC terminals located on the power board, as shown in Figure 20. To measure the bus capacitor voltage:

1. Disconnect all power from drive controller.
2. Wait 1 minute to allow the DC bus to discharge.
3. Remove all covers.
4. Set the voltmeter to the 1000 VDC scale. Measure the bus capacitor voltage between the PA and PC terminals to verify that DC voltage is less than 45 V. **Do not short across capacitor terminals with voltage present!**
5. If the bus capacitors are not fully discharged, contact your local Square D representative – **do not operate the drive controller.**
6. Replace all covers.

Procedure 2: Checking Supply Voltage

To measure the input line voltage:

1. Perform Bus Voltage Measurement procedure (see page 39).
2. Attach meter leads to L1 & L2. Set voltmeter to the 600 VAC scale.
3. Reapply power and check for correct line voltage, per drive controller nameplate rating.
4. Remove power and repeat procedure for L2 & L3, and L1 & L3 if wired for three phase.
5. When all phases have been measured, remove power. Remove leads and reinstall covers.

Procedure 3: Checking the Peripheral Equipment

The following equipment may need to be checked. Follow the manufacturers' procedures when checking this equipment.

1. A protective device such as fuses or circuit breaker may have tripped.
2. A switching device such as a contactor may not be closing at the correct time.
3. Conductors may require repair or replacement.
4. Connection cables to the motor or high resistance connections to ground may need to be checked. Follow NEMA standard procedure WC-53.
5. Motor insulation may need to be checked. Follow NEMA standard procedure MG-1. Do not apply high voltage to U, V, or W. Do not connect the high potential dielectric test equipment or insulation resistance tester to the drive controller since the test voltages used may damage the drive controller. Always disconnect the drive controller from the conductors or motor while performing such tests.

⚠ CAUTION

EQUIPMENT DAMAGE HAZARD

- Do not perform high potential dielectric tests on circuits while the circuits are connected to the drive controller.
- Any circuit requiring high potential dielectric tests must be disconnected from the drive controller prior to performing the test.

Failure to follow these precautions can result in equipment damage.

Fault Storage

The first fault detected is saved and displayed on the keypad screen if power is maintained. The drive trips and the fault relay opens.

To reset the fault:

- Remove power from the drive controller.
- Before switching power back on, identify and correct the cause of the fault.
- Restore power. This will reset the fault if it has been corrected.

In certain cases, if automatic restart has been enabled, the drive can be automatically restarted after the cause of the fault has disappeared. Refer to the Level 2 parameters.

FAULT CODES

Table 15: Resettable Faults with Automatic Restart

Fault	Probable Causes	Corrective Actions
OHF Drive Overload	• Drive controller I^2t too high or • Drive controller temperature too high	• Ensure the motor load is not greater than intended for the drive controller. Check settings of motor voltage (UnS) and motor frequency (FrS). Verify drive controller ventilation is sufficient and the environment is controlled. • Wait for the drive controller to cool down before restarting.
OLF Motor Overload	• Thermal trip due to prolonged motor overload • Motor I^2t too high	• Check the motor thermal protection adjustment (ItH). • Ensure the motor load is not greater than intended for the drive controller. • Wait for the motor to cool down before restarting.
OSF Overvoltage in steady state or acceleration	• Input voltage too high or • Noisy mains	• Verify the input voltage (Procedure 2 on page 41). • Consider the installation of line inductors.
USF Undervoltage	• Input voltage too low or • Failed precharge resistance	• Verify the input voltage (Procedure 2 on page 41) and the voltage parameter (UnS). • Reset. • Replace the drive controller.
ObF Overvoltage in deceleration	Overbraking due to excessive braking or overhauling load	• Increase the deceleration time. • Activate the brA function if compatible with application. • Add dynamic braking resistor if necessary.

Table 16: Non-Automatically Resettable Faults

Fault	Probable Causes	Corrective Actions
OCF Overcurrent	• Output of the drive short-circuited or grounded or • Overcurrent in the braking resistance	• Switch drive off. Disconnect drive controller from motor at U,V,W. • Check cables connected to motor and motor insulation (Procedure 3 on page 41). • Check the dynamic braking resistance. With the drive disconnected, verify the wiring, the isolation of the resistance, and its ohmic value (Procedure 3 on page 41).
dbF Dynamic braking overload	Overload of dynamic braking circuit	• Verify the ohmic value of the resistance. • Ensure that the drive controller horsepower size meets the application.
InF Internal fault	Internal fault	• Verify that electromagnetic interference does not effect drive controller operation. • Replace the drive controller.
tnF Auto-tuning fault	• Special motor • Motor horsepower size different from drive controller	Use L or P law.
EEF	Memory failure	Replace the drive controller.

Installation and Maintenance Instructions

UNION-END BALL VALVES
Tru-Bloc — True Union (Mod. "C")
Tru-Bloc — Single Union (Mod. "C")
Multi-Port* (3-Way 3-Position)
(Mod. "B")
Diverter* (3-Way 2-Position)
(Mod. "B")

INSTALLATION

Chemtrol union-end ball valves can be fitted with socket, threaded, or flanged connections. When joining union-end valves, or when flanging End Connectors, **NEVER MAKE THE JOINT TO THE END CONNECTORS WHILE THEY ARE ATTACHED TO THE VALVE BODY.** Remove the Union Nuts and End Connectors from the valve cartridge first. In order to prevent mishaps with the Union Nut, slide it (smallest bore first) over the pipe or Nipple-and-Flange end (when flanging) before making the joint to the End Connector.

Threaded-End Valves — Refer to the plastic thread joining instructions in the Chemtrol Thermoplastic Piping Technical Manual for proper joining techniques. **Caution: Do not overtighten threads. Usually, one to two turns beyond hand tight using a suitable strap-wrench if necessary, is sufficient. (ANSI B20.1 defines hand tight as 4 to 5 threads for sizes through 2" and 5 to 6 threads for sizes over 2".)**

Socket-End Valves (PVC/CPVC and Chem-Aire) — Refer to the solvent cement joining instructions in the Chemtrol Thermoplastic Piping Technical Manual for proper joining techniques. **Caution: Do not allow Purple Primer or Solvent Cement to come in contact with the sealing face of the End Connectors. When joining the fixed end of a Single Union Valve, place the valve in the open position to allow for proper drying and to avoid Primer or Solvent Cement contacting internal components of the valve.**

For PP or PVDF valves, refer to the heat fusion joining instructions in the Chemtrol Thermoplastic Piping Technical Manual for proper joining techniques. **Caution: Chemtrol valves require special heat fusion tools to make proper connections.** These tools can be found in the Chemtrol Fitting Guide.

Flanged-End Valves — Refer to the plastic Flange joining instructions in the Chemtrol Thermoplastic Piping Technical Manual for proper joining techniques. **Caution: Do not overtighten Flanges. When flanging the fixed end of Single Union Valves, care should be taken to properly align the Flange bolt holes, unless Van Stone type Flanges are used.**

Valve Cartridge — After allowing the proper joint curing time, end connections may be joined to the valve cartridge. The Ball should be turned so that the handle is perpendicular to the Body. "O"-rings provide the seal between the Body faces and the End Connectors faces. Ensure that these "O" -rings are in place and in their proper grooves before slipping the valve cartridge between its End Connectors. Slide the Union Nuts over the End Connectors and screw onto the valve cartridge threads, no more than hand tight. **Caution: The "Adjust" end of the valve should normally be installed facing upstream.**

Adjustment — With the Handle still in the closed or perpendicular position, tighten the Union Nuts on the valve ends. Each of the Union Nuts must apply adequate force on its End Connector to prevent shell leaks at the "O"-ring face seals on each end of the body. Obviously, further tightening of the Union Nuts should stop shell leaks at these locations if the "O"-rings have been properly seated in their grooves. If unable to adjust the Nut by hand, a suitable strap-wrench may be used. **Caution: Do not overtighten. Usually, 1/4 turn or less adjustment is sufficient to restore the valve to sealing condition. Immediately after adjustment, return the handle to the open position, allowing solvent vapors to dissipate.**

Note: Misalignment of adjacent piping can result in loss of seal at end connections. Always properly adjust union ends prior to final bolt-up of flanges or hangers and supports.

MAINTENANCE

Should a valve need repair, depressurize and drain the system on both sides of the valve. Loosen the valve Union Nuts and slide them back over the End Connections. To minimize downtime, it may be advisable to have a replacement valve cartridge ready to install in place of the one to be repaired. Disassemble valve cartridge as follows:

1) Set Ball in closed position.
2) Using a suitable spanner wrench, remove the Seal Carrier by rotating counterclockwise. If the valve is not a Mod. "C" Tru-Bloc style, this step may be omitted.
3) Insert a soft blunt instrument into the valve end marked with the Flow arrow and push the Ball and Seal Carrier out of the valve end marked with the Adjust arrow.
4) Remove the Handle from the Stem by pulling upward and away from the Body.
5) Push the Stem into the body and remove through the open Body end.
6) Examine all parts and replace any damaged or worn components. If the Body is damaged, we recommend replacing the entire valve cartridge.
7) Reassemble valve in reverse order.

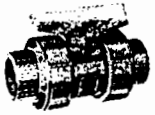
Replacement Parts Lists for Chemtrol union-end type ball valves may be found this page. The valve should be properly identified before selecting replacement parts. **Caution: Valve repair should only be performed by qualified maintenance personnel. Contact your nearest Chemtrol distributor should further information be required.**

"O"-Ring Kits - In the event o-ring replacement becomes necessary, contact factory for proper size and material information.

TFE Seat Kits — Each kit contains two seats. **Note correct seat orientation before removing old seats.**

To determine suitability of Chemtrol valves in your application, consult the Chemtrol Chemical Resistance Guide.

TRUE UNION

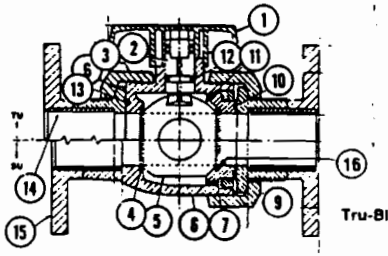


SINGLE UNION

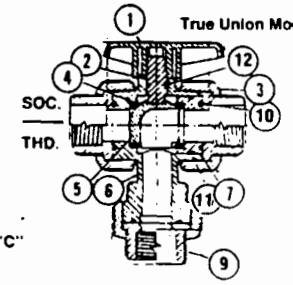
REPLACEMENT PARTS LIST

	PART
1.	Handle Lever
2.	Stem
3.	Union Nut
4.	Seat (2)
5.	Ball
6.	Body — TU or SU, Socket or SU, Thread
7.	Seal Carrier
9.	End Connector — Socket, or Thread
10.	"O"-Ring — Carrier End (TU or SU)
11.	"O"-Ring — Carrier O.D. (TU or SU)
12.	"O"-Ring — Stem (TU or SU)
13.	"O"-Ring — Body End (TU only)
14.	Plain End Pipe Nipple — SPG x SPG
15.	Flange — Socket
16.	"O"-Ring — Carrier Seat Energizer (Mod. "C" only)
17.	Stem Friction Washer (4" & 6")
18.	Handle Bolt (4" & 6")

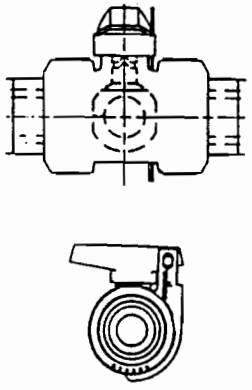
MULTIPORT/DIVERTER



Tru-Bloc Mod. "C"



Safety vent lock-out valve (shown below) is used for Chem-Aire service as optional equipment on 1/2, 3/4 and 1" sizes. Must be installed with flow arrow in correct orientation.



PRESSURE RATINGS

The maximum pressure rating for Chemtrol valves, regardless of size, is 150 psi at 73°F. As with all other thermoplastic piping components, the maximum non-shock operating pressure is related to temperature. Above 100°F refer to the chart below.
Note: For vacuum or throttling service, consult factory

Maximum Operating Pressure (psi) vs. Temperature

Operating Temperature (°F)	PVC	CPVC	PP	PVDF	CHEM-AIRE
100	150	150	150	150	150
110	135	140	140	150	124
120	110	130	130	150	98
130	75	120	118	150	71*
140	50	110	105	150	45*
150	N.R.	100	93	140	N.R.
160	N.R.	90	80	133	N.R.
170	N.R.	80	70	125	N.R.
180	N.R.	70	50	115	N.R.
190	N.R.	60	N.R.	106	N.R.
200	N.R.	50	N.R.	97	N.R.
250	N.R.	N.R.	N.R.	50	N.R.
280	N.R.	N.R.	N.R.	25	N.R.

N.R. — Not Recommended *3"-4" N.R. above 120 F

Do not use or test PVC, CPVC, PP OR PVDF Valves with compressed air or other gases. See Chemtrol Chem-Aire™ literature for more information about a shatter-resistant thermoplastic piping system specifically designed for compressed air and other gases. (See Chem-Aire PSI rating this page).

Installation and Maintenance Instructions

True-Union Ball Check and Foot Valves

INSTALLATION

Chemtrol union-end check/foot valves can be fitted with socket, threaded, or flanged end connections. When joining union-end valves, or when flanging End Connectors, **NEVER MAKE THE JOINT TO THE END CONNECTORS WHILE THEY ARE ATTACHED TO THE VALVE BODY.** Remove the Union Nuts and End Connectors from the valve cartridge first. In order to prevent mishaps with the Union Nut, slide it (smallest bore first) over the pipe or Nipple-and-Flange hub (when flanging) before making the joint to the End Connector.

Check valves should be installed at least four feet from the discharge side of a pump. Ball chatter and internal damage may result if fluid flow is too turbulent. Also, in keeping with good mechanical design practice, the upper threshold of fluid flow recommended from Chemtrol products is five feet per second.

Caution: The valves may be installed vertically or horizontally (refer to table on this page for minimum seating head requirements), but the molded-in Flow arrow on the valve cartridge must be installed in the direction of the fluid flow such that reverse flow will be checked. For vent valve applications contact customar service for PP floating ball arrrangement.

Threaded-End — Refer to the plastic thread joining instructions in the Chemtrol Thermoplastic Piping Technical Manual for proper joining techniques. **Caution: Do not overtighten threads. Usually, one to two turns beyond hand tight using a suitable strap-wrench if necessary, is sufficient. (ANSI B1.20.1 defines hand tight as 4 to 5 threads for sizes through 2" and 5 to 6¾ threads for sizes over 2".)**

Socket-End Valves (PVC/CPVC and Chem-Aire) — Refer to the solvent cement joining instructions in the Chemtrol Thermoplastic Piping Technical Manual for proper joining techniques. **Caution: Do not allow Purple Primer or Solvent Cement to come in contact with the sealing face of the End Connectors or internal components of the valve.**

For PP or PVDF valves, refer to the heat fusion joining instructions in the Chemtrol Thermoplastic Piping Technical Manual for proper joining techniques. **Caution: Chemtrol valves require special heat fusion tools to make proper connections.** These tools can be found in the Chemtrol Fitting Guide.

Flanged-End Valves — Refer to the plastic Flange joining instructions in the Chemtrol Thermoplastic Piping Technical Manual for proper joining techniques. **Caution: Do not overtighten Flanges.**

Valve Cartridge — After allowing the proper joining curing time, end connections may be joined to the valve cartridge. "O"-rings provide the seal between the valve faces and the End Connectors faces. **Ensure that these "O" -rings are clean and in their proper grooves before slipping the valve cartridge between its End Connectors.** Slide the Union Nuts over the End Connectors and screw onto the valve cartridge threads, no more than hand tight. See adjustment section this page

Foot Valve Conversion — Foot Valves may be obtained as factory assembled units or they can be field converted from Ball Check Valves. Screen Housing Assemblies may be installed in place of the regular Union Nut and End Connector on the supply side of the valve to convert it to a Foot Valve.

Adjustment — Adjustment to the seating action is not required. However, each of the Union Nuts must apply adequate force on its End Connector to prevent shell leaks at the "O"-ring face seals on each end of the Body.

Obviously, further tightening of the Union Nuts should stop shell leaks at these locations if the "O"-rings have been properly seated in their grooves. If unable to adjust the Nut by hand, a suitable strap-wrench may be used. **Caution: Do not overtighten. Usually, ¼ turn or less adjustment is sufficient to restore the valve to sealing condition.**

MAINTENANCE

Should a valve need repair, depressurize and drain the system on both sides of the valve. Loosen the valve Union Nuts and slide them back over the End Connections. To minimize downtime, it may be advisable to have a replacement valve cartridge ready to install in place of the one to be repaired. Disassemble valve cartridge as follows:

1) Insert a soft blunt instrument into the downstream end of the valve and push the Ball and Seal Carrier out of the upstream end of the valve.

2) Examine all parts and replace any damaged or worn components with new replacement parts. If the Body is damaged, we recommend replacing the entire valve cartridge.

Replacement Parts List for Chemtrol union-end type ball Check and Foot valves may be found this page. The valve should be properly identified before selecting replacement parts. **Caution: Valve repair should only be performed by qualified maintenance personnel. Contact your nearest Chemtrol distributor should further information be required.**

Valve Seat — The fluid seal between the Ball and Body seat (chamfered shoulder) is affected by a standard "O"-ring located in a groove in the Body seat. This Seat Seal is included in the "O"-ring Kit which is identified in the Replacement Parts List.

"O"-Ring Kits - In the event o-ring replacement becomes necessary, contact factory for proper size and material information.

To determine suitability of Chemtrol valves in your application, consult the Chemtrol Chemical Resistance Guide.

Valve Size	Minimum Seating Head Ft — H_2O Vert.	Horiz.
1/2	6	7
3/4	6	7
1	4	5
1 1/4	4	5
1 1/2	4	5
2	4	5
3	3	4
4	3	4

REPLACEMENT PARTS LIST

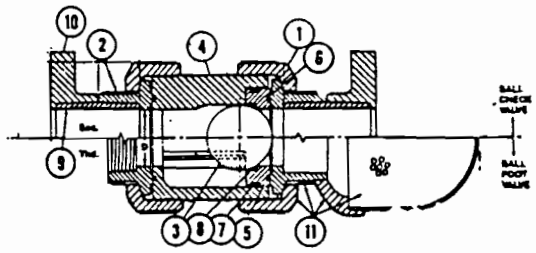
PART	
1.	Union Nut (2)*
2.	End Connector — Socket (2)* or Thread (2)*
3.	Ball
4.	Body
5.	Seal Carrier
6.	"O"-Ring — End Seal (2)
7.	"O"-Ring — Carrier Seal
8.	"O"-Ring — Seat Seal
9.	Plain End Pipe Nipple (2)*
10.	Flange — Socket (2)*
11.	Foot Valve Screen Housing Assy.

VALVE MODELS

BALL CHECK

BALL FOOT

* Ball Check Valves have two (2) of each end connection component. One Set of end connection components is replac with a Screen Housing Assembly on the receiving end of the Body to create a Foot Valve.



PRESSURE RATINGS

The maximum pressure rating for Chemtrol valves, flanges, and unions, regardless of size, is 150 psi at 73°F. As with all other thermoplastic piping components, the maximum non-shock operating pressure is related to temperature. Above 100°F refer to the chart below

Maximum Operating Pressure (psi) vs. Temperature

Operating Temperature (°F)	PVC	CPVC	PP	PVDF
100	150	150	150	150
110	135	140	140	150
120	110	130	130	150
130	75	120	118	150
140	50	110	105	150
150	N.R.	100	93	140
160	N.R.	90	80	133
170	N.R.	80	70	125
180	N.R.	70	50	115
190	N.R.	60	N.R.	106
200	N.R.	50	N.R.	97
250	N.R.	N.R.	N.R.	50
280	N.R.	N.R.	N.R.	25

N.R. — Not Recommended