Installation, Operation
and Maintenance Manual

DC Motors

- Frames C210ATZ - C440ATZ
- Specifically designed for operation from rectified power

General Description

The products described in this publication are designed specifically for use on rectified power. The basic design includes Class F Insulation, 1.0 Service Factor, 40 degree C (104 degree F) ambient, continuous duty, with enclosure, horsepower and speed ratings, overload and voltage in accordance with NEMA Standards. A wide variety of modifications, enclosures and accessories is available.

ATTENTION: Only qualified electrical personnel familiar with the construction and operation of this equipment and the hazards involved should install, adjust, operate, and/or service this motor. Read and understand this manual in its entirety before proceeding. Failure to observe this precaution could result in personal injury or loss of life.

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Receiving and Handling

Acceptance

Thoroughly inspect this equipment before accepting shipment from the transportation company. If any of the goods called for in the bill of lading or express receipt are damaged or the quantity is short, do not accept them until the freight or express agent makes an appropriate notation on your freight bill or express receipt. If any concealed loss or damage is discovered later, notify your freight or express agent at once and request him to make an inspection. We are willing to assist you in collecting claims for loss or damage in shipment; however, this willingness on our part does not remove the transportation company's responsibility in reimbursing you for collection of claims or replacement of material. Claims for loss or damage in shipment must not be deducted from the invoice, nor should payment of the invoice be withheld awaiting adjustment of such claims, as the carrier guarantees safe delivery.

If considerable damage has been incurred and the situation is urgent, contact the nearest Allen-Bradley Sales Office for assistance. Please keep a written record of all such communications.

Handling

ATTENTION: Eyebolt(s) or lifting lug(s) are intended for lifting the motor only with the standard accessories such as tachometer, brakes, etc., mounted by Allen-Bradley. The lifting means on the motor must not be used to lift the unit plus additional equipment. The lifting means on the motor cannot be used to lift assemblies or equipment mounted on a common base. Failure to observe this precaution could result in personal injury.

In all cases, care should be taken to assure lifting in the direction intended in the design of the lifting means. Lift using all lugs provided. Likewise, precautions should be taken to prevent hazardous overloads due to deceleration, acceleration or shock forces.

Angle of lift with rope or chain must be greater than 45 degrees from horizontal.

For unusual conditions, such as side-wall and ceiling mounting of horizontal motors or installation of vertical motors shipped in a horizontal position, special precautions must be taken. It is recommended that an experienced rigger be employed.

Storage

Motors must be stored in a clean, dry area protected from extremes of temperature, moisture, shock and vibration. Storage temperatures of 10 to 49 degrees C (50 to 120 degrees F) with a maximum relative humidity of 60% must be observed. In addition, motors subjected to extended storage must be handled and treated per the requirements specified in publication "**Motors-5.0**." This publication is available from your Allen-Bradley Sales Office or online at: **http://www.ab.com/drives/motors**.

Installation

DC motors have characteristics which can cause serious or fatal injury unless they are selected, installed, maintained and operated by qualified personnel familiar with special requirements of DC machines. Allen-Bradley DC motors are designed and built in accordance with *Safety Standard for Construction and Guide for Selection, Installation and Use Of Electric Motors And Generators* published by the National Electrical Manufacturers Association (NEMA), publication MG-2-1983 (ANSI C51.5). It is recommended that this publication be referred to whenever you select or install any motor.

The application of motors and other electrical equipment in hazardous locations is restricted by the National Electric Code. Users must observe these regulations and consult with local code inspection and enforcement agencies to insure compliance.

Location

Locate the machine where the ambient temperature is not over 40 degrees C (104 degrees F) and where clean air has free access to ventilating intake and outlet openings. Except for machines with a suitable protective enclosure, the location should be clean and dry.

Important: Sufficient clearance must be provided on all inlet and outlet openings to provide for unrestricted flow of air. Separately ventilated motors with exhaust to ambient (pipe-in only) must have at least 152.4 mm (6 in.) of clearance between the opening and adjacent walls or floor.

Air Supply

Cooling air through a self-ventilated or forced-ventilated motor must be clean and have relative humidity between 30 and 100% with no free water in the air. Use of damp, cool outside air with high humidity and free water may cause the motor to flash over. Use of excessively dry air may cause excessive brush and commutator wear. Cooling air temperature must not exceed the maximum ambient temperature indicated on the motor nameplate (standard 40 degrees C/104 degrees F). Cooling air temperature must not be lower than 0 degrees C (to provide base speed and regulation within NEMA limits. Use of outside air below 0 degrees C may cause excessive brush and commutator wear due to the low humidity. Cooling air absolute humidity must be at least 2 grains per cu. ft.

Important: Motors located in damp, moist environment must have space heater or fields energized at 50% voltage to protect against condensation when motor is not operating.

Separately ventilated motors must have the following volume of air to adequately cool the motor unless the motor nameplate specifies a different value.

Table A
Air Volume Chart

Frame	Base Speed *RPM*	Air Volume *CFM*	Static Pressure *Inches of Water*
C2113ATZ	ALL	300	2.25
C2115ATZ	ALL	290	4.1
C2512ATZ	ALL	425	2.0
C2514ATZ	ALL	385	3.4
C2515ATZ	ALL	385	3.4
C2812ATZ	ALL	550	3.25
C2813ATZ	ALL	530	3.75
C2815ATZ	ALL	530	3.75
C3210ATZ	ALL	800	3.5
C3212ATZ	ALL	800	3.5
C3214ATZ	ALL	700	4.0
C3612ATZ	ALL	1000	4.0
C3613ATZ	ALL	950	5.1
C400ATZ	ALL	1200	4.0
C440ATZ	ALL	1650	7.0

ATTENTION: To guard against premature brush wear due to silicone vapors, Do Not use silicone sealing compounds in the vicinity of the motor or its air supply.

Power Supply

Check the motor nameplate to be sure the voltage and type of power rating is the same as that of the power source.

A code stamped on the nameplate identifies the type of power supply that must be used to supply armature power to the motor in order to obtain the rated nameplate output. Since the code letter has been selected in alphabetic order of increasing magnitude of ripple current, a motor may be operated on a power supply having a letter designation prior in the alphabet to the letter stamped on the nameplate, with no loss in nameplate rating.

For example, a motor designed for a D type of power supply may be used on a C power supply having the same voltage rating. The types of power supplies are defined as follows.

Description	Code[1]
DC generator, battery or twelve pulse/cycle, 6 phase, full control	A
Six pulse cycle, 3 phase, full control 230 or 460 volt, 60 Hz input to rectifier	C
Three pulse/cycle, 3 phase, semi-bridge, half control 230 or 460 volt, 60 Hz input to rectifier	D
Three pulse/cycle, 3 phase, half-wave (single way) 460 volt, 60 Hz input to rectifier	E
Two pulse/cycle, 1 phase full wave (bridge circuit with 2 controlled rectifiers and 2-uncontrolled rectifiers with free wheeling rectifier) 230 volt, 60 Hz input	K

1 When the armature power supply cannot be designated by a single letter code (A. K etc.) the power supply shall be identified by the following code stamped on the motor nameplate: “M/N F-V-H-L.”

where M = Total pulses per cycle

N = Total controlled pulses per cycle

F = Free wheeling (if used)

V = Nominal line-to-line a-c voltage to rectifier

H = Line frequency-Hz

L = Value of series inductance (in millihenries) to be added externally to the motor armature circuit.

Examples:

A. "6/3 F-380-50-12" defines a power supply having 6 total pulses per cycle, 3 controlled pulses per cycle (S-3), with free wheeling, 380 volts. 50 Hz AC input to bridge, and a 12 millihenry choke to be added externally to the motor armature circuit.

B. "3/3 480" defines a power supply having three total pulses per cycle, three control pulses per cycle. 480 volts line-to-line input to the rectifier. 60 Hz power supply and no external inductance required in the armature circuit. Note that since the power source is 60 Hz and no series inductance is required. both quantities may be omitted from the code. If one of the quantities is indicated, both must be included to avoid confusion.

Conduit Box

Conduit boxes can be rotated in 90 degree increments for lead outlet at top, sides or bottom.

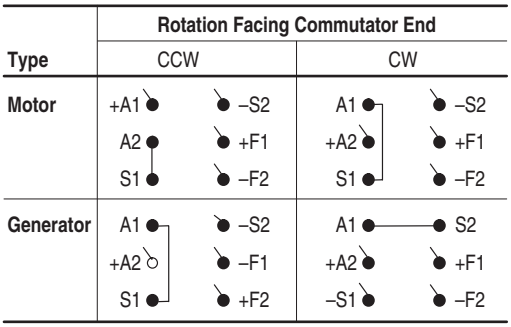
Conduit box locations can be changed from F1 to F2 or F2 to F1 by rotating the frame 180° around the shaft axis and reconnecting the brush stud leads. (contact factory for reconnecting brush stud leads.)

To obtain proper planity between the integral mounting feet on the front and back end brackets, a smooth level surface should be used to align the brackets when they are assembled to the frame.

Connections

Important: If motor has parallel leads, all lugs with the same marking: For example, A1, A1, must be connected together.

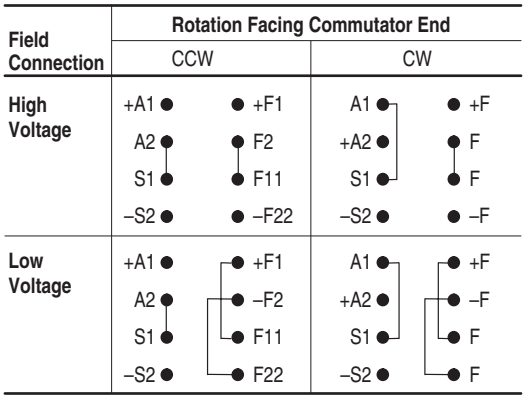
Figure 1
Basic DC Motor and Generator Connections



If machine has no series field, disregard S1 and S2 above. For machines with special windings, refer to motor or generator and controller diagrams.

Important: If motor is supplied with dual voltage shunt fields, connections must be made for appropriate voltage.

Figure 2
DC Motor with Dual Voltage Field



Thermostat (Thermal Protector)

Important: When motors are provided with thermal protection (typically thermostats), it is important to properly connect and apply the devices. This will ensure that the motor is properly protected from being operated if thermal limits are reached and/or exceeded. The control system must be configured to reduce the motor load and/or shut down the motor control system to allow the motor to cool to a level within acceptable operating ranges. If the motor is operated with the thermal protective devices tripped (indicating an over temperature condition), the motor insulation could be damaged and complete failure of the motor insulation is possible. In the event of motor failure due to an over temperature condition, Rockwell Automation requires that motor thermal protective devices (when supplied) be adequately monitored and incorporated into the motor control system to maintain warranty. Failure on the part of the individual installing this equipment to take these steps will result in the factory warranty being voided.

Important: Motors may have one or more thermostats (leads marked P1, P2, etc.) to indicate motor overheating. Thermostat contacts must be connected in the motor control or indicating circuit. Failure to connect the thermostat leads will void the motor warranty. Thermostat contact ratings are listed below. Motors having thermistors or resistance temperature detectors to indicate motor over temperature must have these devices connected in the proper control circuit to protect the motor.

Maximum Voltage	250V, 60 Hz
Rated Current	6.3 amps
Maximum Breaking Current	20 amps

Important: Motors with an overspeed switch must have the overspeed switch terminals properly connected in the control circuit to remove armature power when the switch reaches the set speed.

Grounding

The user is responsible for assuring that the grounding method is in accordance with the National Electric Code and the applicable local codes. The ground connection should be a solid and permanent metallic connection between the ground point, the motor terminal housing and the motor frame. A ground lead is provided inside the terminal box.

Mounting

Motors must be mounted on a rigid, solid base or foundation. Poor base construction may cause resonances in the motor/base assembly which can result in bearing failure and other motor damage. All hold down bolts must be the correct grade for the type of mounting and must be torqued to their recommended value.

Table B
Recommended Torque

Frame	Hole Diameter *mm (in.)*	Bolt Size and Thread	Recommended Torque SAE 5 *N-m (lb.-ft.)*	Recommended Torque SAE 8 *N-m (lb.-ft.)*
C210ATZ	11.2 (0.44)	3/8-16	45-50 (33-37)	64-72 (47-53)
C250ATZ	14.2 (0.56)	1/2-13	113-126 (83-93)	159-179 (117-132)
C280ATZ	14.2 (0.56)	1/2-13	113-126 (83-93)	159-179 (117-132)
C320ATZ	17.5 (0.69)	5/8-11	210-239 (155-176)	271-338 (200-249)
C360ATZ	20.6 (0.81)	3/4-10	372-420 (274-310)	527-597 (389-440)
C400ATZ	26.9 (1.06)	7/8-9	588-659 (434-486)	835-934 (616-689)
C440ATZ	26.9 (1.06)	7/8-9	588-659 (434-486)	835-934 (616-689)

Belted Drive

Motor slide bases or rails, when used, must be securely anchored to the foundation with the proper bolts.

Important: The motor shaft and load shaft must be parallel and the sheaves aligned. Refer to "Motor Application Data" on page 10.

Coupled Drive

Important: Flexible couplings must be used between the motor shaft and the load shaft. Motor shaft and load shaft must be aligned to values recommended for the specific coupling before coupling is connected.

Motors will operate successfully mounted on the floor, wall or ceiling, and with the shaft at any angle from horizontal to vertical. Special mountings, duty or thrust demands may, however, require a different bearing system. Hand hole covers can be interchanged as necessary.

Important: Vertical mount hand hole covers are required to provide protection to vertically mounted Drip-Proof motors. Stock motors and other motors designed for horizontal mounting can be adapted for vertical mounting by ordering vertical mount hand hole covers from Allen-Bradley.

Motor C-Face is intended for mounting auxiliary equipment such as pumps, gears, etc. When mounted horizontally, these motors should be supported by the feet and not by the C-Face. Installations requiring a horizontally mounted motor without feet should use a D-Flange. In addition, frame sizes C2515AT and C2815AT require additional support.

ATTENTION: Surface temperature of the motor enclosure may reach temperatures which can cause discomfort or injury to personnel coming into contact with hot surfaces. The user must apply appropriate guards and/or shields to protect against accidental contact with motor surface. Failure to observe this precaution may result in personal injury.

Direction of Rotation

Unless otherwise ordered, brush rigging is assembled for NEMA standard direction of rotation, counterclockwise for motors and clockwise for generators facing the commutator end. These motors will operate in either direction of rotation, without changing the angle of the brush holders for normal field weakened speed ranges. Extended field weakened speed range motors should have the direction of rotation specified.

Drive

C210ATZ-C320ATZ frame motors are supplied with a shaft suitable for a belt or coupled drive.

C400ATZ and C440ATZ frame sizes will be supplied with a short shaft for coupled drives unless specified for belt duty.

Proper alignment is a key step for long life of bearings, shafts and belts, and minimum downtime. Misalignment can cause excessive vibration and damaging forces on shaft and bearings. For direct coupled drives, flexible couplings facilitate alignment. For belt drives, the sheave must be placed as close as possible to the motor bracket.

ATTENTION: To guard against personal injury and/or machine damage caused by incorrect motor rotation, verify direction of motor rotation before coupling motor to load.

ATTENTION: Ensure that all guards are properly installed, to guard against personal injury caused by contact with rotating parts,

Shipping Blocks

Motors supplied with roller bearings at the drive end are shipped with wooden blocking to prevent axial movement of the shaft during shipment. Remove the blocking and bolts securing it and discard. Make sure motor shafts turn freely. If motor is to be reshipped, blocking of bearing is required.

Motor Application Data

Maximum Safe Speed

ATTENTION: The machinery builder and/or user are responsible for assuring that all drive train mechanisms, the driven machine, and process material are capable of safe operation at the maximum speed at which the machine will operate. Failure to observe these precautions could result in personal injury.

The speeds given in Table C are the maximum mechanically safe operating speeds for frames with standard construction. These speeds must not be exceeded under any condition. Motor control must hold the maximum speed under any load condition including no-load within the maximum safe speed. Drive systems whose design characteristics inherently prevent the AC motor from exceeding the motor maximum safe operating speed must prevent the motor from exceeding the maximum safe speed if a single component failure should occur.

Table C
Maximum Safe Speed

Frame Diameter	Maximum Safe Speed
C210ATZ	4500 RPM
C2512ATZ	4500 RPM
C2514ATZ	4500 RPM
C2515ATZ	3400 RPM
C2812ATZ	4500 RPM
C2813ATZ	4000 RPM
C2815ATZ	3400 RPM
C3210ATZ	3600 RPM
C3212ATZ	3600 RPM
C3214ATZ	3600 RPM
C3612ATZ	3400 RPM
C3613ATZ	3200 RPM
C400ATZ	2800 RPM
C440ATZ	2450 RPM

With special construction maximum safe speed may differ from the above values. In all cases, the maximum safe speed is indicated on the motor nameplate.

Important: Normal operating speeds must be limited to those listed in order to meet nameplate rating and assure validity of warranty.

Minimum V-Belt Sheave Diameters

Application of Pulleys, Sheaves, Sprockets and Gears on Motor Shafts

To avoid excessive bearing loads and shaft stresses, belts should not be tightened more than necessary to transmit the rated torque. The pre-tensioning of the V-belt drive should be based on the total tightening force required to transmit the horsepower divided by the number of belts. This procedure avoids the excessive load caused by tightening individual belts to a prescribed level recommended by belt manufacturers.

Mounting

In general, the closer pulleys, sheaves, sprockets or gears are mounted to the bearing on the motor shaft, the less will be the load on the bearing. This will give greater assurance of trouble-free service.

The center point of the belt, or system of V-belts, must not be beyond the end of the motor shaft.

The inner edge of the sheave or pulley rim should not be closer to the bearing than the shoulder on the shaft but should be as close to this point as possible.

The outer edge of a chain sprocket or gear must not extend beyond the end of the standard motor shaft.

Minimum Pitch Diameter for Drives Other Than V-Belt

To obtain the minimum pitch diameters for flat belt, timing-belt, chain and gear drives, apply the multiplier given in Table D to the minimum sheave diameter calculated for V-belt drives.

Shaft Extension and Method of Drive

Frames C210ATZ-C250ATZ are supplied with a shaft and bearing system suitable for either coupled or belted drives. Frames C280ATZ-C440ATZ are supplied with larger shafts and roller bearings when belted drives are specified.

Table D
Multipliers for Drives other than V-belt

Drive	Multiplier
Flat Belt (See Note 1)	1.33
Timing Belt (See Note 2)	0.9
Chain Sprocket	0.7
Spur Gear	0.75
Helical Gear	0.85

1 The above multiplier is intended for use with conventional single-ply flat, belts. When other than single-ply flat belts are used, the use of a larger multiplier is recommended.

2 It is often necessary to install belts with a snug fit. However, tension should be no more than necessary to avoid belt slap or tooth jumping.

Table E
Axial Thrust Capacity

Frame	Units	Horizontal Mounting				Vertical Mounting			
		2500 RPM	1750	1150	850	2500	1750	1150	850 RPM
C210AT	lbs.	510	565	640	700	535+/-137	590+/-137	665+/-137	725+/-137
	kg	232	257	291	318	243+/-62	268+/-62	302+/-62	330+/-62
C250ATZ	lbs.	535	595	675	725	580+/-255	640+/-255	720+/-255	770+/-255
	kg	243	270	307	330	264+/-116	291+/-116	327+/-116	350+/-116
C280ATZ	lbs.	650	725	825	890	715+/-360	795+/-360	890+/-360	955+/-360
	kg	295	330	375	405	325+/-164	325+/-164	405+/-164	434+/-164
C320ATZ	lbs.	845	940	1065	1150	920+/-448	1020+/-448	1155+/-448	1235+/-44
	kg	384	427	484	523	418+/-204	464+/-204	525+/-204	561+/-204
C360ATZ	lbs.	1045	1160	1315	1420	1160+/-661	1280+/-661	1445+/-661	1555+/-66
	kg	475	527	598	645	527+/-300	582+/-300	657+/-300	707+/-300
C4011ATZ	lbs.	1350	1630	2000	2250	1470+/-655	1820+/-655	2210+/-655	2475+/-65
	kg	614	741	909	1023	668+/-298	827+/-298	1005+/-298	1125+/-29
MC4013ATZ	lbs.	1310	1580	1975	2200	1460+/-825	1810+/-825	2200+/-825	2460+/-82
	kg	595	718	898	1000	662+/-374	823+/-374	1000+/-374	1118+/-37
C440ATZ	lbs.	1350	1650	2000	2250	1470+/-825	1820+/-825	2210+/-825	2475+/-825
	kg	612	748	908	1021	714+/-374	828+/-374	986+/-374	1123+/-374

1 Thrust capacity for vertical mounting includes a constant whose value is plus or minus depending on the direction of the thrust load. The constant is plus for thrust loads acting upward against the force of gravity and minus for loads acting downward with gravity.

Table F
Radial Load Capacity

Frame	Capacity at End of Shaft in kg (lbs.)			
	2500 RPM	1750 RPM	1150 RPM	850 RPM
C210AT	488 (1075)	510 (1125)	510 (1125)	510 (1125)
C250ATZ	726 (1600)	794 (1750)	896 (1975)	941 (2075)
UC280ATZ	1225 (2700)	1225 (2700)	1225 (2700)	1225 (2700)
UC320ATZ	1452 (3200)	1452 (3200)	1452 (3200)	1452 (3200)
UC360ATZ	1814 (4000)	1814 (4000)	1814 (4000)	1814 (4000)
UC400ATZ	2722 (6000)	2722 (6000)	2722 (6000)	2722 (6000)
UC440ATZ	Contact Allen-Bradley for radial load applications			

1 Data for motors with roller bearings at the drive end (back end). Motors with ball bearings at the drive end are for coupled duty only.

ATTENTION: The use of these radial load capacities requires the accurate calculation of the radial load for the application. Radial loads for gears, sprockets, and flywheel are usually accurately determined but the radial loads due to V-belt drives are subject to miscalculations because they do not include all of the pre-tension load (belt tightening). The calculations of the radial load for a V-belt drive must include the pre-tension for transmitting the horsepower, pre-tension for centrifugal force on the belts, pre-tension for high start torques, rapid acceleration or deceleration, pre-tension for drives with short arc-of-contact between the V-belt and sheave, and low coefficient of friction between belt and sheave caused by moisture, oil or dust. Failure to observe these precautions could result in damage to or destruction of the equipment.

Operation

Balance

Motors are dynamically balanced to commercial limits unless ordered differently. Balance is done with a full length 1/2 height shaft key. A full shaft key is shipped with the motor. Sheave or coupling should be balanced with a 1/2 height shaft key.

Standard Dynamic Balance Limits

Highest Rated Speed *(RPM)*	**Maximum Amplitude** *(Inches)*
3,000 - 4,000	0.0010
1,500 - 2,999	0.0015
1,000 - 1,499	0.0020
Up to 999	0.0025

Series Wound Motors

Important: Series wound motors must be solidly connected to the driven machine and never operated without load to avoid possible destructive high speeds.

Motor Start-Up

ATTENTION: To guard against personal injury and/or machine damage, observe the following precautions before initial start-up:

- Remove all unused shaft keys and loose rotating parts to prevent them from flying off. Replace covers and protective devices.
- Verify that all separately excited fields are excited at their rated voltage and that relative polarities of all fields are correct. See "Checking Relative Polarity of DC Motor Fields" on page 15.
- When the motor is supplied as part of drive system, refer to the Drive User Manual for operating instructions. Tachometer feedback must be properly connected for closed loop operation. Reverse polarities or broken connections can cause dangerous overspeeds.

Maximum safe mechanical operating speeds are shown in Table C, on page 10. Motor control circuitry must prevent motor speeds from exceeding the stated values.

In addition to observing the above precaution, all precautions (Attentions) mentioned in this document should be observed.

- The armature should rotate freely and be clear of any obstructions.
- The brushes should move easily in their holders and should make proper contact on the commutator.
- The interior of the motor should be clean and dry.
- Connections must be tight.
- The driven machine should be unloaded, if possible.

When starting, small sparks may appear on the commutator due to particles of dirt. Other than this. there should be little, if any, sparking at the brushes.

Important: Machines designed for cooling by a separate source of forced ventilation must not be operated without the air supply. Be sure blower is running in proper direction.

While operating the motor, observe the performance. It should run smoothly with little noise. The bearings should not overheat and should reach a leveling off temperature. Any undue noise, overheating, sparking or erratic performance should be investigated and necessary corrective action taken immediately to prevent serious damage. Before attempting any repairs, please contact your Allen-Bradley Sales Office.

All motors are lubricated before shipment and will operate for a long period before regreasing is required. The period will vary depending on environmental and service conditions. Refer to "Maintenance" on page 16.

ATTENTION: Surface temperature of the motor enclosure may reach temperatures which can cause discomfort or injury to personnel coming into contact with hot surfaces. The user must apply appropriate guards and/or shields to protect against accidental contact. Failure to observe this precaution may result in personal injury.

DC Motor Field Heating

ATTENTION: To guard against motor damage caused by inadequate ventilation, assure that motors designed for forced ventilation as standard have cooling air when fields are excited at rated voltage. Installations having the air supply interrupted when the motor is not operating must have field disconnected or field voltage reduced to 67%, rated by means of field economizing resistor and relay. The motor insulation life can be significantly reduced if the above precaution is not followed.

Standard continuous duty DPG, TEFC and TENV stabilized shunt wound DC motors have continuous duty fields capable of continuous excitation at standstill (armature circuit not energized) under normal industrial conditions.

Standard continuous duty self-ventilated motors are suitable for rated load at rated speed operation at field voltages up to 110% of rated value. However, motor temperature will exceed the normal class F rise with resulting reduction in insulation life if operated below approximately 90% of base speed at rated voltage for prolonged periods. Contact Allen-Bradley for torque derating curves for motors operated continuously below base speeds.

Checking Relative Polarity of DC Motor Fields

Motor speed is unstable if speed increases due to an increase in load current. As a result of instability, motor speed may hunt or overspeed. These are unsatisfactory, possibly dangerous, drive conditions.

One of the possible causes of unstable performance of shunt wound DC motors is incorrect series field polarity relative to the shunt field due to improper connection. Relative polarity of the shunt and series fields can be checked as follows:

1. Connect a low scale (3 volt) DC voltmeter across the shunt field terminals (F1, F2) with F1 connected to the positive (+) terminal of the meter. At least one of the shunt field leads must be disconnected from the controller.
2. Use two flashlight batteries as a source of low voltage (3 volts). Hold or connect the negative, to contact the S-2 series field terminal. Hold one end of a wire conductor to the positive (+) center terminal so that the other end of the wire can be used to make and break contact with the S-I series field terminal.
3. Watch the deflection of the voltmeter needle when contact is made with S-I and when contact is broken.
4. When contact is made, the needle will first deflect in either the up scale or down scale direction and then return to zero. Deflection will be in the opposite direction when contact is broken.
5. Relative polarities of the shunt and series fields are correct (ampere-turns are cumulative) if the voltmeter needle deflects up scale when contact is made and down scale when contact is broken.
6. Relative polarities of the shunt and series fields are incorrect (ampere-turns are differential) if the voltmeter needle deflects down scale when contact is made and up scale when contact is broken. The motor connections must be changed so that relative polarity is correct.

If only one series field terminal is available at the controller, use it and the available armature terminal for the test. For example, use S-2 and A-l, if S-1 and A-2 arc connected together at the motor and not brought to the controller.

Maintenance

ATTENTION: Internal parts of this motor may be at line potential even when it is not rotating. Before performing any maintenance which could result in contacting any internal part, be sure to disconnect all power from the motor. Failure to observe this precaution could result in severe personal injury or death.

Inspections

Regular inspection at intervals dependent upon service conditions is the best insurance against costly maintenance and breakdown. Experience is the best guide. Record inspection results and maintenance action required or performed.

Cleanliness

Keep the interior parts of machines clean and dry. Remove dust, dirt, corrosion, grease, oil and moisture. If used, ventilating air filters must be kept clean or replaced to assure full volume of cooling air.

Lubrication

Amount of grease to be added to motors is shown in Table G. See Table I for relubrication interval.

For motors operating in ambient temperatures shown below, use the following lubricants or their equivalent:

Ball Bearing Motors

Operating Temperature: –25 to 50 degrees C (–15 to 120 degrees F)	Chevron Oil – SRI No. 2 Exxon – Unirex N2 Shell Oil Co. – Dolium R Texaco, Inc. – Premium RB
Minimum Starting Temperature –60 degrees C (–76 degrees F)	Shell Oil Co. – Aeroshell 7

Roller Bearing Motors

Operating Temperature: –25 to 50 degrees C (–15 to 120 degrees F)	Chevron Oil – Black Pearl EP No. 2 Texaco, Inc. – Premium RB

Table G
Coupled/Belted or Tandem Duty Grease Amounts

	Volume		Weight	
Frame	*Cubic Inches*	*Cubic Centimeters*	*Ounces*	*Grams*
C210ATZ - C280ATZ	1.0	16	0.5	14
C320ATZ - C400ATZ	2.0	32	1.0	28
C440ATZ	3.0	48	1.5	42

Using the table below, determine service condition on the basis of the most severe operating parameter (i.e. temperature, bearing load, atmosphere, or operating hours per day).

Table H
Service Condition

Service Condition	Ambient Temperature	Bearing Load	Atmosphere	Operating Hours/Day
Standard	–18 to 40 degrees C (0 to 104 degrees F)	Steady	Clean	8
Severe	–30 to 50 degrees C (–22 to 122 degrees F) [1]	Medium Shock, Vibration (less than 0.2 in/sec.)	Medium Dirt, Abrasives, Corrosion	8 to 24
Extreme [2]	–54 to 65 degrees C (–65 to 149 degrees F) [1]	Heavy Shock, Vibration (more than 0.44 in/sec)	Heavy Dirt, Abrasives, Corrosion	8 to 24

1 Motors must be specially designed for operation in ambient outside the range of –30 to 40 degrees C (–22 to 104 degrees F). Special grease is required.

2 "Extreme" service conditions are rare in actual practice. Corresponding lubrication cycles should therefore be applied with caution. It is also advisable to check with Allen-Bradley for related special instructions.

Table I
Relubrication Periods – Frames C210ATZ - C440ATZ

Maximum Normal Operating Speed *(RPM)* [1]	Frame	Relubrication Interval *(Months)* [2]		
		Standard Service	Severe Service	Extreme Service
3450 and higher	All	9	4	1
2400 - 3449	C210ATZ - C250ATZ	24	9	3
	C280ATZ - C400ATZ	9	3	1
1700 - 2399	C210ATZ - C320ATZ	36	12	3
	C360ATZ - C400ATZ	18	6	2
	UC360ATZ - UC400ATZ	9	3	1
800 - 1699	C210ATZ - C320ATZ	36	24	8
	C360ATZ - C400ATZ	36	12	3
	UC360ATZ - UC400ATZ	18	6	1
500 - 799	C210ATZ - C320ATZ	48	36	12
	C360ATZ - C400ATZ	36	24	8
	UC360ATZ - UC400ATZ	18	12	4
499 and lower	C210ATZ - C440ATZ	48	36	12
	UC360ATZ - UC440ATZ	24	18	6

1 Maximum speed occupying more than 30% of operating time.

2 For Tandem drives increase frequency of lubrication by multiplying values by 0.8.

Frames C210ATZ - C440ATZ

These motors are designed to route new grease directly into the bearing. The relubrication periods shown in Table I are offered as a guide for varying service conditions, speeds, bearing types and operating hours.

Important: Certain special motors may have a lubrication instruction plate permanently attached. These specific lubricating instruction must be followed.

Lubrication Procedure

1. Relubrication with the shaft stationary and a warm motor is recommended.
2. Locate the grease inlet at the top of the bearing hub, clean the area and replace the 1/8 inch pipe plug with a grease fitting (if the motor is not equipped with a grease fitting).

ATTENTION: To guard against personal injury or death from rotating parts or electrical shock, relubrication should only be performed while the motor is stationary and disconnected from the power source.

3. Remove grease drain plug located opposite the grease inlet.
4. Using a manual grease gun, pump in the recommended grease in the amount shown in Table G. This amount of grease will provide an ample supply of lubricant between lubrication periods as determined from Table I for the condition listed in Table H.

   Use Chevron SRI-2 grease or equivalent unless motor nameplate specifies special grease. Use only clean, fresh grease from clean containers and handle carefully to keep it clean.

   In general, mixing of greases is not recommended. If an incompatible grease is used, the lube system must be repacked completely with the new grease.
5. Wipe away any excess grease at the grease drain or relief and replace drain plugs.

Repacking Bearings or Greasing New Bearings

When existing bearings have been completely cleaned of old grease or when bearings are replaced, use this procedure for packing the bearing.

1. Apply one bead of grease around the inboard side of the bearing, between bearing and inner cap. Assure that grease adheres to balls or rollers.
2. Apply one bead of grease around outboard side of bearing, making sure grease adheres to balls or rollers.
3. Completely fill grease inlet and outlet passage holes with grease.
4. Fill outboard bearing cavity 60% to 90% full of grease.
5. If possible, rotate shaft of assembled machine at least three revolutions by hand to distribute grease within bearings before starting motor.

Bearings

These motors are designed to provide a mounting for anti-friction bearings to give:

- Maximum protection to windings and interior of machine by preventing grease leakage from bearing housing.
- Maximum protection to bearings against excess lubricant, insufficient lubricant, dirt and moisture.

Various types of anti-friction bearings are used in the wide range of frames as needed to meet specific load, speed and service requirements.

Most commonly used bearings are:

- Single row, open ball bearings for coupled and belted duty for frames C210ATZ - C250ATZ.
- Single row, open ball bearings for coupled duty for frames C280ATZ - C440ATZ.
- Cylindrical roller bearings at drive end for belted duty on frames UC280ATZ - UC440ATZ

Frequent bearing checks are recommended. If temperatures become excessive, investigate immediately for the cause. Total bearing temperatures should not exceed 90 degrees C (194 degrees F). Causes for high bearing temperature are:

- Contaminated grease.
- Insufficient grease or excessive amount.
- Incorrect grease.
- Excessive load or thrust due to misalignment or motor overload.
- Loose bearings.
- Bearing failure.
- Excessive ambient temperature.

Replacement bearings should be ordered from Allen-Bradley in order to obtain the same carefully selected bearing as the original. Bearings should never be exposed by disassembly of the motor unless absolutely necessary for inspection or replacement of the bearing or maintenance in other parts of the machine. Protect good bearings from dirt and contamination at all times. Most bearing failures are caused by dirt.

The open ball bearings for motor frames C210ATZ - C250ATZ are the same regardless of whether application is coupled or belted. Belted duty for frames UC280ATZ - UC440ATZ requires the use of roller bearings. Coupled duty uses ball bearings.

Brushes

Brush pressure is correctly established at the factory and maintained at the correct value throughout the life of the brush by means of a constant pressure design. Brushes and brush-holders should be clean so that the brushes are free to move in the holders. Replace brushes with new brushes of the same grade before wear permits the rivet or tamped pigtail to score the commutator. It is best to change out complete set.

Brush Changing Procedure

1. Remove hand hole covers from each side of the commutator end bracket.
2. Loosen four (4) hex head cap bolts which hold the rocker ring assembly to the bracket.
3. Brushes are removed from the holder by lifting the brush finger and removing the hex head cap bolt which secures the brush lead to the holder. New brushes are installed by following the reverse procedure.

4. Rotate the rocker ring by hand 90 degrees to replace brushes located in the 12 and 6 o'clock position.
5. Return rocker to original position and change brushes in the 3 and 9 o'clock position.
6. Re-align the neutral setting mark on the rocker ring in line with the mark on the bracket boss.
7. Tighten the four hex head cap bolts which hold the rocker ring to the bracket.
8. Fit the face of new brushes to the contour of the commutator with sandpaper only, no emery abrasive. Keep brush lead (pigtail) connections tight. Replacement brushes should have sleeved pigtails.
9. Install the hand hole covers to each side of the commutator bracket.

ATTENTION: To guard against personal injury or death, ensure that all power to the motor has been removed and the motor shaft is stationary. Brushes must not be touched or replaced while motor is energized or rotating.

Commutator

A commutator in good condition is clean and smooth with a medium polish and a light brown color. Keep clean by occasionally wiping with a canvas pad. Use no lubricant or emery abrasive. If a commutator becomes rough, it needs to be resurfaced. Roughness can be easily detected with the machine running by resting a pencil-like rod of insulating material (dry wood) on one of the brushes. In mild cases, a commutator dressing stone can be used. Very rough or out of round commutators require turning in a lathe. In every case, maintain concentricity and remove the minimum material required for proper cleanup. Undercut the mica approximately l/16” and polish. Adjust brush holders for approximately 3/32” clearance to commutator.

The new diameter and the minimum diameter of the commutator for the various frames sizes are as follows:

	New Diameter		**Minimum Diameter**	
Frame	*Inches*	*Millimeters*	*Inches*	*Millimeters*
C210ATZ	5.03	127.8	4.59	116.6
C250ATZ	5.78	146.8	5.34	135.6
C280ATZ	6.53	165.9	6.09	154.7
C320ATZ	7.53	191.3	7.09	180.1
C360ATZ	8.70	221.0	8.26	209.8
C400ATZ	9.55	242.6	9.06	230.0
C440ATZ	10.78	274.0	10.31	262.0

The commutator should be replaced if the final diameter would have to be turned down to a value less than minimum limits.

Table J
Commutation Problem Quick Check Chart

Symptom	Identified By	Possible Cause
1. Excessive sparking at motor or generator commutator.	Sparking	1. Dirty or corroded commutator due to dirt, ambient contaminants, oil or oil mist, etc. 2. Brushes incorrectly seated. 3. High or feather-edged mica. 4. Faulty machine adjustment. 5. Interpoles failed or improperly adjusted. 6. Loss of brush spring tension. 7. Brushes sticking in brush holder. 8. Unit overload. 9. Defective commutator or armature. 10. Unequal spacing of holders around commutator.
2. High commutator bars produce a rough commutator.	Generally associated with sparking and noisy operation of the brushes on the commutator.	1. Loose commutator.
3. Low commutator bars produce rough commutator.	Generally associated with sparking and noisy operation of the brushes on the commutator.	1. Loose commutator. 2. High mica. 3. Open or high resistance connection at commutator.
4. Streaking or threading of commutator surface.	Rough commutator with associated sparking. Fine lines in brush track.	1. Low average current density in brushes due to light machine loading. 2. Contaminated atmosphere. 3. Oil on commutator or oil mist in air. 4. Humidity too low. 5. Lack of film forming properties in brush. 6. Brush too abrasive.
5. Bar etching or burning.	Rough commutator with associated sparking and eventual flashover.	1. High mica. 2. Operation of machine with brushes off neutral. 3. Commutator dirty. 4. Incorrect spring tension. 5. Machine overload or rapid load change such as plugging.
6. Bar marking at pole-pitching spacing.	1. Two bars marking 180 degrees C (356 degrees F) apart on 4-pole machine at start. 2. Three bars marking 120 degrees C (248 degrees F) apart on 6-pole machine at start. 3. As pitch bar marking progresses, it will eventually show at all bars on the machine. 4. Associated sparking and eventual flashover.	1. Shorted commutator bars or coils. 2. Open armature or field circuit. 3. Unequal air gap. 4. Cyclic disturbance either electrical or mechanical.
7. Bar marking at slot-pitch spacing.	Sparking and marking of one or more bars at equal spacing around commutator according to bar-per-slot ratio with eventual flashover.	1. Unequal compensation of armature coils. The energy unbalance is reflected into the last coil in the slot to undergo commutation, and will result in a spark at the brush.
8. Rapid commutator or brush wear.	Bright commutator surface.	1. Abrasive material under brush. 2. Too abrasive a brush. 3. Low average brush current density due to light machine loading. 4. Contaminated atmosphere. 5. Humidity too low. 6. Incorrect brush tension.

Commutation

Intermittent sparking due to overloads or slight visible sparking does not necessarily indicate poor commutation. Poor commutation exists when there is excessive sparking requiring abnormal maintenance. Every case of excessive sparking should be investigated to determine the cause and correct it. Table J may help in analyzing commutation problems. DC motors and generators are brushed for full load current. If unit or units are consistently operated at less than 1/2 rated load a condition known as threading will result.

Windings

For long life, keep windings clean and dry. Dirt or dust can be removed by wiping them with a clean cloth, by blowing with clean, dry, low pressure air or by vacuum cleaner. Oil or grease can be removed with a cloth moistened with mineral solvent. Be sure not to get any solvent on the commutator and observe all product warnings.

Filters - Cleaning

When supplied, filters on motors must be kept clean to assure proper air flow and cooling of the motor.

The standard filter is a six-layer woven-steel fabric. The following procedure should be used to clean these filters:

1. For light accumulations of dust, use compressed air to clean.
2. For moderate accumulations, water may be used.
3. For heavy accumulations of dirt and grease, clean the filter using water and detergent.
4. Always completely dry filter after cleaning with water.
5. After heavy cleaning, spray with a very light coat of protective oil to protect against possible loss of plating.

Important: Do Not use flammable solvents to clean filters.

Important: Standard washable filters may not be suitable for motors operating in atmospheres with heavy concentrations of oil mist. Oil mist may be drawn into the motor and cause damage to the commutator and windings. Contact Allen-Bradley for motors operating in heavy oil mist atmospheres.

Brakes

Motor mounted brake, when supplied, must be adjusted and maintained in accordance with the instructions for the specific brake. Refer to separate instructions supplied with the motor.

Disassembly and Reassembly Instructions

The motor design incorporates many new techniques which are described in this section. It is recommended that these differences be understood thoroughly before any disassembly work is done to avoid possible damage or harm to either machine and/or maintenance personnel.

Air Gap And Shimming

(Frames C210ATZ - C400ATZ)

Main Pole

Steel or brass shims, when used, are placed between pole and frame. If for any reason the shims are removed they must be replaced under the same poles. Main pole bolts are steel SAE Grade 5 (120,000 psi).

Interpoles

Excluding the C440ATZ frame, interpoles are an integral part of the frame and do not require nor are they capable of shimming.

Axial Float

Motors have a wave spring washer between the drive end bracket and bearing. The commutator end bearing is positioned axially by a float restricting inner cap. Axial float (including bearing internal clearance) should be within the limits listed below.

Axial Float

Frame	Maximum	Minimum
C210ATZ - C440ATZ	1.29 mm (0.051 in.)	0.33 mm (0.013 in.)

Anti-Friction Bearing Assemblies

The bearings are positioned and secured in a machined cavity in the end brackets. Open type ball bearings are used for direct coupled and belt drive applications for frames C210ATZ - C250ATZ and are protected by inner caps at both ends.

Frames UC360ATZ - C440ATZ employ a cylindrical roller bearing on the drive end for belt drives, and a ball bearing for coupled service.

Bearing Replacement

Remove bearing by means of bearing puller. Clean bearing housing and bearing seat prior to assembly of bearing. Place new bearing in a bake oven for 1/2 hour at 121 degrees C (250 degrees F). Place bearing onto shaft and push home to bearing shoulder. Hold it in place for a minimum of 30 seconds.

After bearing has cooled down for about 1 minute, add 1/2 cu. in. of fresh grease into back of bearing. When the motor has been assembled, grease per instructions found on page 16.

Conduit Boxes

Conduit box on C210ATZ - C400ATZ is located on the frame at the commutator end.

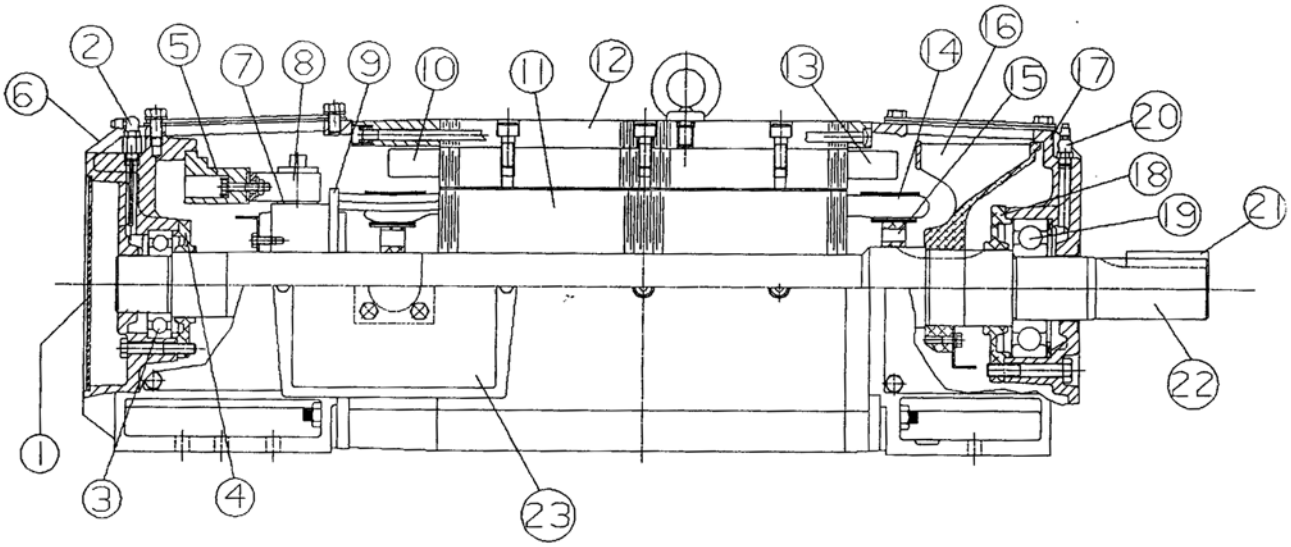
Brush Rigging and Brush Holders

The brush holders are of constant pressure design and do not require nor are capable of adjustment over the life of the brushes.

Bracket Re-assemblY

To obtain proper planity between the integral mounting feet on the front and back end brackets. a smooth level surface should be used to align the brackets when they are assembled to the frame.

Parts Identification C210ATZ - C440ATZ



Number	Description	
1	Outer Cover	FE
2	Grease Plug	FE
3	Ball Bearing	FE
4	Bearing Cap	FE
5	Rocker	
6	Bracket	FE
7	Brush	
8	Brush Holder	
9	Commutator	
10	Field Coil with Pole	
11	Armature Core	
12	Frame	

Number	Description	
13	Field Coil with Pole	
14	Armature Coil	
15	Winding Support	
16	Inner Fan	
17	Bracket	BE
18	Bearing Cap	BE
19	Ball Bearing	BE
20	Grease Plug	BE
21	Shaft Key	
22	Shaft	
23	Conduit Box	

Total Service Programs

Allen-Bradley can provide a wide range of maintenance programs to help you reduce downtime, improve productivity and increase profits. Capabilities include:

- Motor Start-up Service
- Motor Electrical and Mechanical Preventive Maintenance
- Vibration Analysis
- Mobile Van Repair Service
- Balancing and Alignment Service
- Maintenance Service
- 24-Hour Technical Support
- Modernization Service

For more information contact your local Allen-Bradley Sales Office.

Notes

Notes

Online Documentation

The latest motor information can be obtained from the Allen-Bradley Drives & Motors home page on the World Wide Web at:

http://www.ab.com/drives/motors

www.rockwellautomation.com

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